Proceedings of the First International E-Services Workshop, ICEC 03, Pittsburgh, USA

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Introduction to the First International E-Services Workshop, ICEC 03

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ABSTRACT

E-services are a relatively new phenomenon and have gained more and more attention by researchers. Services are often characterized as intangible, perishable, experience based, difficult to standardize products needing many interactions between customers and providers. E-services are about the use of information and communication technology, especially web services, for efficient and effective service provisioning.

Although e-services is clearly an interdisciplinary research area, and consequently is rather broad, this workshop covers two e-service aspects: (1) modeling and conceptualizing e-services, and (2) e-government services. These two perspectives on e-services exemplify the richness of various views on this new research area. In this way it should strengthen the body of research, widen the view and provides endless opportunities for starting new research.

Keywords

E-Services, E-government, web-services, modeling, .

1. E-SERVICES

A recent and important research topic is to understand the exploration, design and assessment of innovative e-services. Clearly, work has been done on the more technical e-service aspects (e.g. UDDI, WSDL, WSFL, SOAP) but a sound theory on the social-economic and commercial aspects of e-services is still lacking. The proposed workshop aims at sketching the inter-disciplinary research field of e-services and identifying research issues for the coming years.

This workshop is the result of a merge of two ICEC workshops on e-services, that both emphasize the business value characteristics of e-services, although connections to e-service platforms (such as various forms of web-services) are of interest also. The workshop does so from two angles. First, a central question is how to model e-services. Modeling may serve various purposes, ranging from creation of common understanding of the e-service at hand to facilitating service composition, configuration, and delivery. Second, e-services can be viewed within a particular domain: in this case e-government. It is clear that an applied domain as e-services is, only can be studied using practical case studies taken from application domains.

In particular, the workshop aims at a better understanding of value chain configuration in dynamic network organizations, which contain commercial and non-commercial entities, which create, distribute, and consume e-services. Such services can be rather elementary but can also be complex compositions, e.g. service parts offered by different actors, electronic contracting, trust or security services etc..

In this workshop e-services are explored by considering specific application domains, amongst others the government. This domain has a vast potential of offering service via the Internet. Citizens in all countries are calling for better services at lower cost and for more responsiveness in a dynamic and continuously changing political, economic, societal and technological (PEST) environment. Public administrations should stay closer to citizens' every-day life, and act more proactively rather than reactive. Governments employ a vast range of technology to support all kinds of business processes to meet the challenge to provide more customer-oriented products and services. The engineering of customer-centric services in the public sector demands systematic and methodology support and has become a major focus of academic research. Much can be learned from international e-government practices, experiences and the translation of e-commerce research to the public domain.

In the remainder of this document, we introduce the upcoming papers shortly. We start with papers that focus on modeling e-services generally, and conclude with e-government services.

2. MODELING E-SERVICES

The papers on e-services modeling can be classified into two segments: (1) two papers that focus on the more technical aspects of e-services, related to web-services, and (2) four papers biased towards e-service business issues.

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The paper "Compatibility Determination in Web Services" by Yunyao Li and H.V. Jagadish falls into the first category. One of the issues with web-services is how to support dynamic discovery and collaboration of web-services. The authors address this problem by a compatibility determination algorithm. The algorithm takes the interfaces of web-services as an input and produces a judgment of compatibility.

Related to this paper is the paper by Simona Colucci, Tommaso Di Noia, and Francesco M. Donini entitled "Logic Based Approach to Web Services Discovery and Matchmaking". They introduce a framework based on Description Logics that overcomes simple subsumption matching of service descriptions and allows for match ranking and service classification. Additionally, they implemented the framework into a prototype and present results of testing the prototype in a realistic e-commerce scenario.

Pascal van Eck and Roel Wieringa advocate the need for a requirements engineering approach for service oriented computing (paper title: "Requirements Engineering for Service-Oriented Computing"). They argue that this enforces a new approach to requirements engineering for services, and that two different kinds of requirements engineering will emerge: requirements engineering for service consumers and requirements engineering for service providers. For the latter kind, they propose service blueprinting, which originated in marketing, as a good source to develop a requirements engineering approach to serviced-oriented computing.

The paper "Business models for personalised real-time traffic information in cars: which route to take?" by Edward Faber, Timber Haaker, Harry Bouwman and Oscar Rietkerk addresses case-study wise the design of a complex ICT-enabled service. The focus of the paper is on the relations between the value elements in the value proposition and the value network activities that actors perform. As a case study result, they found that the government plays an important role in keeping traffic information services affordable. Without the support of the government both services would not be possible.

The paper "A Business Model Framework for E-Business Planning" by Chien-Chih Yu provides a framework that facilitates e-business planning and strategic making. The paper contains a well-done literature overview on existing e-business modeling work. It then proposes a framework for e-business planning and presents how such a framework could have been applied in tourist e-services sector.

Finally, the paper "The Configurable Nature of RealWorld Services: Analysis and Demonstration" by Ziv Baida, Hans Akkermans, Amaia Bernaras, Jessica Aguado, Jaap Gordijn proposes an ontologically founded approach for configuring complex real-life services out of more primitive service elements. The approach is illustrated by a case study of an enterprise that offers the service of organizing conferences and meetings.

3. E-GOVERNMENT SERVICES

The body of knowledge is growing at a fast pace. We feel that the presentations in this workshop represent a variety of topics that give an excellent overview of the state-of-the-art and complexity of the domain of e-government services.

The excellent paper "Diffusion of Innovation & Citizen Adoption of E-Government Services' written by Lemuria Carter and France Belanger is one of the first papers dealing with the citizen's perspective on e-services adoption. The success and acceptance of e-government services, such as online voting and license renewal, are contingent upon citizens' willingness to adopt these services. Numerous studies have analyzed user adoption of electronic commerce, however, non-have identified the core factors that influence citizen adoption of e-government services. The authors found that three of the four adoption factors - relative advantage, compatibility and image - to be significant in predicting citizen intention to use e-government services.

Open Source Software is getting more and more attention for providing cost-effective e-service. Rob Peters and Ruben Wendel de Joode provide the first insights of their explorative research into the motives for using open sources software. In their paper 'European Open Source Application Development" they carefully conclude that open source software is a vehicle for rapid knowledge sharing within a community of organizations with the same application domain and the developers working for several organizations.

This discussion paper 'Exploring whether E-Government can promote McDonaldization of Governments' of Abhijit Jain expresses the concern how current e-government thinking emulates the success of the services industry by focusing on efficiency calculability, predictability and control. The author discusses how McDonaldization results in various irrational and negative phenomena and discusses a research agenda on this topic.

Hans de Bruijn and Marieke Koopmans-van Berlo make an excellent contribution to the field in their paper "Strategies for E-enforcement; Lessons Learned from two Case Studies in the Netherland". They use the rational and stakeholder perspectives for analyzing two case studies and conclude that although ICT helps to increase the transparency and reduce the risk and can increase the ability to detect fraud, ICT does not help to reduce opportunistic behavior, does not automatically lead to better behavior and better compliance to rules, and calls for new legitimacy questions. The authors propose five strategies for dealing with and avoiding the negative effects.

Developing countries have taken up the challenge to use information and communication technology to improves access to and delivery of their services Janet Kaaya paper 'Towards Implementation of E-government Services in East Africa: Content Analysis of Government Websites" presents an overview of the state-of-the-art of services provision in developing countries. The study has conducted visibility and usability tests of websites of the governments' of Kenya and Tanzania and Uganda. The researcher concludes that all of the East African websites are at the first and second stages of the website development life cycle.

Services require a reliable, flexible and effective ICT-infrastructure for the orchestration, integration and management of distributed enterprise services. The paper "Towards a reference architecture for a business counter" of Marijn Janssen and René Wagenaar provides the first step to a mature architecture for government services provisioning. They provide various trade-offs at organizational, functional and applications level. The authors conclude that there is no over-arching framework and that governments still have a long way to go to fully realize the benefits of e-government.

E-Services Workshop Discussion Panel

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ABSTRACT

E-services are a relatively new phenomenon and have gained a more and more attentions by researchers. Services are often characterized as intangible, perishable, experience based, difficult to standardize products needing many interactions between customers and providers. E-services are about the use of information and communication technology, especially web services, for efficient and effective service provisioning.

This workshop includes multiple perspectives on e-services and captures the richness of various views on this area. In this way it should strengthen the body of research, widen the horizon and provide endless opportunities for starting new research. The discussion panel is focused on highlighting the various research directions and views on e-services phenomenon.

Keywords

E-Services, E-government, modeling

1. What makes e-services different from 'services' in general?

Is an e-service more or less than a service in general? Why makes research in e-services different from research in services in general.

2. What makes e-services different from web-services?

Web services have a technical bias. Are e-services web services? Or are e-services more biased towards business? What are the relations with DAML/S and OWL-S? Can web-services be seen as implementation platform for web-services? Is service composition in e-services the same as in web-services? Can they benefit from each other?

3. Is there something like a 'grand' design theory for e-services?

Researchers are continually searching for better and improved methodologies in different domains. The domain of e-services can learn from other theories, however, can an integral theory be developed?

4. How can we model e-services?

The driving forces for e-services are the technology which is increasingly offered and adopted worldwide.. A sound theory on the social-economic and commercial aspects of e-services is still lacking. How can we create a better understanding of e-services? Which are the main elements of importance when modeling e-services?

5. What distinguishes e-government from e-business or e-commerce? And what are the implications for research?

The engineering of customer-centric services in the public sector demands systematic and methodology support and has become a major focus of academic research. Much can be learned from international e-government practices, experiences and the translation of e-commerce research to the public domain.

6. Do we see a bright future for open sources? Is there really something new on the longer term?

The use of open source software seems to be motivated by vendor lock-in and by reducing costs. It is sometimes argued that the reduction of vendor lock-in is more motivated by other vendors than by Some argue that opens sources will only decrease license costs, which are only a relatively small part of the total costs of

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ownership. Do we see a bright future for open sources? Is there really something new on the longer term?

7. Can e-services help governments to become customer-centric?

The rapid adoption of Internet-based technologies enables all kind of innovative services. How can researcher and organizations benefit from each other and work effectively together?

Compatibility Determination in Web Services

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ABSTRACT
Determining the compatibility between Web services plays a critical role in supporting dynamic discovery and collaboration of Web services in the inherently heterogeneous web environment. In this paper we present a compatibility determination algorithm. The algorithm takes two graphs (each representing the external interface of a Web service) as inputs, and produces the following as outputs (1) judgment of compatibility (*true* or *false*), and (2) differences between two graphs. The outputs can be used by a Web service to enable dynamic collaboration between Web services. A visualized representation of differences found can enable a human to determine the criticality of the differences.

Categories and Subject Descriptors
H.2.1 [**Information Systems**]: Database Management - *Logical Design;* H.5.3 [**Information Systems**]: Group and Organization Interfaces - *Web-based interaction, Asynchronous interaction*

General Terms
Algorithms, Verification, Design

Keywords
Web services, compatibility, difference detection, graph matching, business process

1. INTRODUCTION
Web services are generally described as self-contained, self-describing, modular applications that can be published, located, and invoked across the web [1]. Ultimately, web services should be able to dynamically discover other Web services and interact with them automatically without human involvement, just like the open, ubiquitous connectivity the Web has enabled for person-to-person communications. To support collaboration processes between business partners, electronic commerce standards such as Electronic Business XML (ebXML) [2], the Web Service Conversation Language (WSCL) [3] and Business Process Execution Language for Web Services (BPEL4WS) [4] have been developed.

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All these standards requires a Web Service to publish its external interface, describing operations requesting services from service providers or offering services to service requestors. Such an external interface of a Web service defines how a Web service could interact with other Web services [5], and is referred as the business process interaction (BPI) model in this paper. To ensure correct interactions between Web services in a dynamic collaboration, ebXML requires that all the participating Web services share the same BPI model, while other standards currently do not even support dynamic discovery and collaboration of Web services [6]. None of these standards directly address the significant problem of how to handle the discrepancies between the BPI models of Web services.

The existences of discrepancies between the BPI models of two Web services may not necessarily prevent them from interoperate with each other [7]. For example, let Service A and Service B be services from different companies. Suppose that the buyer Service A wants to engage in a seller-buyer interaction with the seller Service B. Service A and Service B may not share the same BPI model for the sell-buyer interaction. For instance, Service A does not require the ability of canceling order, while Service B provides this facility. Similarly, Service A requires the ability to change the order, while Service B does not provide such a facility. Some of the differences, such as latter difference in the above example may affect their interoperability; other differences, such as the former one, may be immaterial to the collaboration, since Service A could always choose not to cancel an order even if service B allows it.

Moreover, the external interface published by a Web service may not necessarily be the only interaction process it supports. In the above buyer-seller example, a Web service A's internal business rules may require the ability of canceling order when the total amount of order is over $10,000, while not requiring it for other orders. Such dynamic configurable internal business process may not be able to be represented by one BPI model, while it is not feasible to require a Web service to reveal all of the interaction processes it supports. It is important for a Web service to be able to automatically detect the differences between its BPI model from that of others'. Such information is critical for the Web service to whether and how to change its own business process to enable the collaboration with Web services, for negotiation between Web services. It also provides useful reference for future Business Process Reengineering.

In this paper, we propose an efficient algorithm to support automatic compatibility determination of BPI models between Web services. Specifically, we take the BPI models defined in ebXML as the basis for developing our algorithm. EbXML is a widely recognized electronic commerce standard supporting

dynamic collaboration of Web services [6]. The BPI model defined by ebXML is generally compatible with other standards involving Web Service. It is reasonable to expect that future standards developed with the intent to support dynamic collaboration of Web services will have similar characteristics as ebXML. Thus our ideas discussed in this paper should be still applicable to such electronic business standards.

2. OVERVIEW AND PRELIMINARIES

In Section 2.1, we introduce BPI model in ebXML. Details of the graph representation of a BPI model used in our paper follow in Section 2.2. In Section 2.3, we give a brief overview the BPI model Difference Detection problem using an example.

2.1 Introduction to ebXML BPI model

We can represent the external interface of a Web service as BPI model. In ebXML, we can consider a Business Collaboration represented by Business Process Schema as a BPI model. (Hereafter, when we use the term "Business Collaboration" or "Business Process" we mean BPI model.) ebXML Business Process Schema provides the semantics, elements and properties necessary to define Business Collaborations [2]. Two or more business partners participate in a Business Collaboration through roles. The roles interact with each other through Business Transactions. The business transactions are sequenced relative to each other in a "Choreography". Each Business Transaction consists of one or two predefined Business document flows. The basic semantics of Business Collaboration are as shown in figure 1.

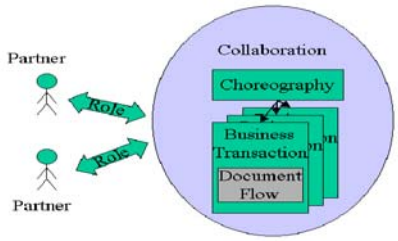


Figure 1. Basic semantics of Business Collaboration

In this paper, we consider BPI models involving two Web services. However, this analysis can be easily extended to situations involving multiple Web services.

2.2 Graph representation

A BPI model is represented by an acyclic directed graph. G (V, E).

V: Set of nodes in the graph. Each node represents a Business State associated with a Business Transaction, or a Join or a "waitforall" Join. Each node has a unique integer identifier generated by our algorithms. For conciseness, we refer to the node with identifier x as "node x". The value of a node specifies which Business Transaction it is associated with, or which type of Join it is.

E: Set of edges in the graph; each edge represents a transition from one Business State to another. Each transition has a *conditionGuard* label marking the condition under which the transition occurs.

Adjacency matrix representation is used to represent the directed graph described above. Each element of the matrix A (a_{ij}) is defined as the following:

$$a_{ij} = \begin{cases} 1, if\ (i,j) \in E, \& conditionGuard = Success \\ 2, if\ (i,j) \in E, \& conditionGuard = NoGuard \\ -1, if\ (i,j) \in E, \& conditionGuard = Failure \\ 0, otherwise \end{cases}$$

Figure2 shows the graph representation of a BPI model. The number inside each node is the node's identifier. The label beside each node represents the Business Transaction or the type of Join that the node associated with. Such labels are for readability only, and are not used in the algorithm. The number beside each edge is the value of corresponding element in the adjacency matrix.

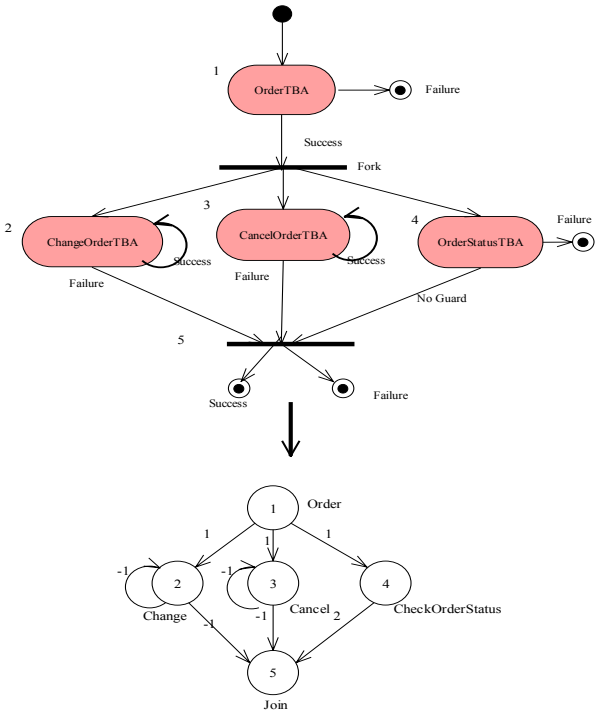


Figure 2. Example of BPI model Graph Representation

2.3 Overview of The Problem

We will take the task of determining compatibility between BPI models A and B as shown in Figure 3 as a running example to illustrate our algorithm. Model A represents an order process in which, after placing an order, a buyer may cancel, change or check order status; the buyer must confirm the order or cancellation of that order afterwards. BPI model B is an order process where a buyer may change the order during a certain period of time after placing an order; after that grace period, the buyer may only cancel or confirm the order; and the buyer may check the order status anytime before confirmation or cancellation of the order.

Suppose there are two Web services: one is a Buyer who intends to execute BPI model A; the other is a Seller who intends to

execute BPI model B. By searching an online registry, Buyer locates Seller

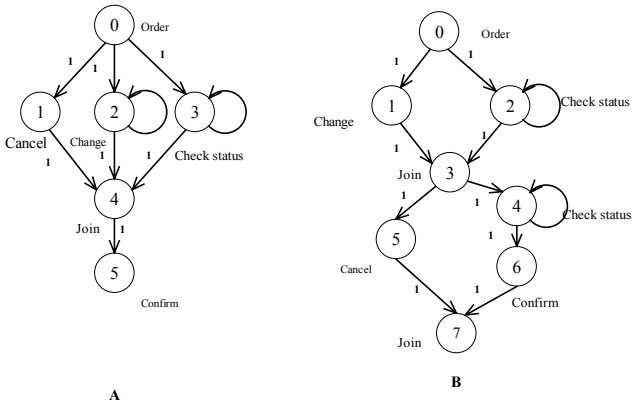


Figure 3. Example of BPI models

as a potential business collaboration candidate. However, Buyer and Seller must hold the same or compatible BPI models to be able to interoperate with each other. Our algorithm is designed to help Buyer judge the compatibility of BPI models A and B, and in the case of incompatibility, determine the discrepancies associated with minimum cost needed to transfer one model to be compatible with another.

Our first task is to convert the BPI models from their native format as XML files into directed graphs using a filter that understands the definitions of ebXML Business Process Schema. This mainly involves syntactic name checking, and is not interesting. We do not discuss details of such filter in this paper.

Our next task is to determine the nodes in A and B that correspond to each other. A node *j* in B is a *match* of a node *i* in A, if the Business States they represent are compatible, i.e., the Business Transaction or type of Join they associated with is the same, or it satisfies one of the user-predefined compatibility rules. A node in A may have multiple *matches* in B; similarly, a node in B may be a *match* to multiple nodes in A.

However, in the final mapping of A and B, only one-to-one node matches are allowed. To obtain the final mapping, we first try to eliminate the number of matching candidates for each node by introducing the notion of *anchor*. In Section 3.1, we explain the notion of *anchor* in detail.

As a fourth step, we determine the best match for each node in model A. A fixpoint algorithm is used for this purpose.

After obtaining the node mapping between BPI model A and B, we need to do edge matching. After this step, we obtain the difference graph between these two BPI models. If the difference graph, after taking non-material differences into consideration, is empty, then BPI models A and B are compatible; otherwise, they are not. We will explain non-material differences in section 3.1.

The above steps can give us a sound conclusion of the compatibility between A and B. However, we may obtain more than one mapping. As the final step, we need to determine the optimal mapping with minimal cost according to our measurement metrics introduced in Section 3.3.

3. Compatibility Determination Algorithm

In this section, we explain our algorithm in detail using the simple example described in Section 2.3.

3.1 Procedure I: Compare Nodes in the Graph

Step a. **Creating Business Transaction Mapping**

We first create a dictionary representing mappings betweens Business Transactions in the two BPI models. We assume that the same Business Transaction will only be defined once in a Business Collaboration Specification. Therefore, a Business Transaction in a BPI model would have at most one matching Business Transaction in another model.

Create array BTAA (Business Transaction Array A) as a list of Business Transactions involved in Business Process A in the same order as they appear in the Business Process Specification of Business Process A. The last two elements of BTAA represent a Join with "waitforall" and a Join without "waitforall" respectively. For conciseness, hereafter in this paper, when we talk about Business Transactions, we also mean the two kinds of Joins. Similarly, create array BTAB (Business Transaction Array B) for Business Process B. Denote the number of Business Transactions defined in the Business Process A and B as |BTAA| and |BTAB| respectively.

Create array BT-MAP-A-B (Business Transaction Map from A to B) with the same length as BTAA. The value of each element is defined as following:

(1) BT-MAP-A-B[i] = j (j $\geq$ 0), if BTAA[i] is a compatible Business Transaction of BTAB[j].

(2) BT-MAP-A-B[i] = -1, if there is no compatible Business Transaction in BTAB for BTAA[i].

Similarly, we can create array BT-MAP-B-A (Business Transaction Map from B to A) with the same length as BTAB.

If all the elements in BT-MAP-A-B are equal to -1, then there is not a single pair of compatible Business Transactions between these two Business Processes. In this case, we can terminate the calculation and safely draw the conclusion that A and B are not compatible. Otherwise, we will continue the following steps to determine A and B's compatibility as well as their differences. Due to the size limitation, we will not go into the details of this part. The result of running the above example is as show in figure 4.

Matrixes MA, MB are adjacency matrixes for directed graphs representing BPI model A and B correspondingly. Arrays BSA and BSB represent the nodes in the respective directed graphs. The value of an element in BSA is defined as following: BSA[i] = j, if BSA[i] is a Business Transaction Activity conducting Business Transaction BTAA[j]. Similar definition is used for elements in BSB.

Step b. **Initial Nodes (Business State) Mapping**

During the process of assigning values to BSA and BSB, we can naturally obtain the following two mappings of Business Transaction Activities to Business Transactions: one is from

BTAA plus join types to BSA, and the other is from BTAB plus join types to BSB. An example is as shown in Figure 5.

Business Transaction	i
Order	0
Check Status	1
Change	2
Cancel	3
Confirm	4
Join (waitforall)	5
Join (not waitforall)	6

Business Process A

Business Transaction	i
Order	0
Change	1
Check Status	2
Cancel	3
Confirm	4
Join (waitforall)	5
Join (not waitforall)	6

Business Process B

i	BT-MAP-A-B
0	0
1	2
2	1
3	3
4	4
5	5
6	6

i	BT-MAP-B-A
0	0
1	2
2	1
3	3
4	4
5	5
6	6

Figure 4. Business Transaction Mapping

Business Transaction	i	BTA-BS-MAP-A[i]	Link list
Order	0	0 // represent BTAA[0]	← 0 // 0 represent BSA0]
Check Status	1	1	← 3
Change	2	2	← 2
Cancel	3	3	← 1
Confirm	4	4	← 5
Join	5	5	← 4

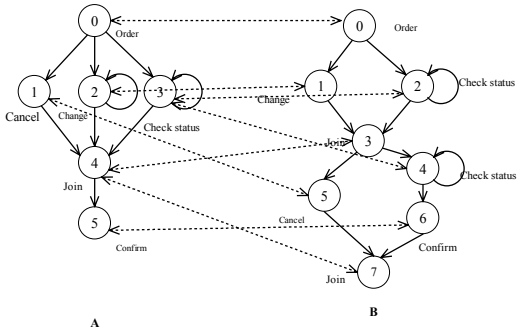
Business Transaction	i	BTA-BS-MAP-B[i]	Link list
Order	0	0	← 0 // 0 represent BSB0]
Change	1	1	← 1
Check Status	2	2	← 2, 4
Cancel	3	3	← 3
Confirm	4	4	← 6
Join	5	5	← 3, 7

Figure 5. BTA-BS-MAP

A node BSB[j] is called a mapping node of BSA[i] in BSB, if BSB[j] corresponds to a Business Transaction that is compatible with the Business Transaction corresponding to BSA[i]. By iterating through BSA and BSB, we can create an array NODE-MAP-A-B with the same length as BSA, mapping nodes in B's directed graph to those in A's directed graph. Such a map represent possible mapping of nodes in these two graphs. Each element NODE-MAP-A-B[i] in NODE-MAP-A-B contains a header to a link list. Each link list contains a list of nodes in B that match with BSA[i]. If a node in BSA has no mapping node in BSB, then the corresponding entry in NODE-MAP-A-B will be NULL. Initial compatibility score 1 is assigned to all the nodes in the link lists. An example of NODE-MAP-A-B is as shown in Figure 6.

Step c. **Calculate anchors**

In step b, one node in BSA is matched by more than one node in BSB, and that the same node in BSB may match more than one node in BSA. However, there may still exist one-to-one mappings between nodes in BSA and BSB. We will prove later that if such one-to-one mappings exist, such mappings must appear in the final mapping of BSA and BSB. We introduce the following notions to take advantage of this kind of special mapping cases.



I	NODE-MAP-A-B[i]	Link list
0	0 // represent BSA[0]	← 0 (1) // 0(1) represent BSB[0] with compatibility score 1 with BSA[0]
1	1	← 5 (1)
2	2	← 1 (1)
3	3	← 2 (1), 4(1)
4	4	← 3 (1), 7 (1)
5	5	← 6 (1)

Figure 6. Initial Mapping: NODE-MAP-A-B

Anchors: If a node BSA[i] in BSA is only compatible with a node BSB[j] in BSB, and vice versa, then such a pair of nodes BSA[i] and BSB[j] is called an *anchor* in the mapping between BSA and BSB, denoted as BSA[i] ↔ BSB[j]. BSA[i] and BSB[j] each is called an *anchor node* in the corresponding Business Process.

Conflicting Anchor Pair: For a pair of anchors BSA[i1] ↔ BSB[j1] and BSA[i2] ↔ BSB[j2], if there exists a path from BSA[i1] to BSA[j1] in BSA but there is no path from BSB[i2] to BSB[j2] while existing a path from BSB[j2] to BSB[i2], we call such a pair of anchors as a *conflicting anchor pair*. At most one of the anchors in a conflicting anchor pair may appear in the final mapping.

Anchor group: Denote S as the set containing all the anchors between BSA and BSB. For any G ⊆ S, G is called an *Anchor group* between BSA and BSB, if the following conditions hold:

(1)There is no conflicting anchor pair in G;

(2) When any anchor a ∈ S and a ∉G is added to G, at least one conflicting anchor pair is created

Non-material Difference Without user-predefined exceptions, only the following differences between BSA and BSB will not change their compatibility. We refer such differences as non-material differences.

(1) BSA[i] ↔ NULL, i.e., node BSA[i] in BSA may has no mapping in BSB, if B takes the role of initiator in the Business Transaction represented by the node

(2) NULL ↔ BSB[j], i.e., node BSB[j] can appear in BSB without mapping in BSA, when A is the initiator in the Business Transaction represented by this node.

If BSA[i] and BSB[j] represent the same Business Transaction, then BSA[i] ↔ NULL and NULL ↔ BSB[j] may not co-exist in the final mapping without changing the compatibility of the two BPI MODEL, because A and B cannot both be the initiator in the same Business Transaction. Therefore, if BSA and BSB are compatible, then all the anchors BSA[i] ↔ BSB[j] must appear in

the final mapping. Otherwise, BSA[i] ↔ NULL and NULL ↔ BSB[j] will co-exist in the final mapping.

Based on the above discussion, we can draw the following conclusions:

Rule 1: Non-material differences between two BPI models will not change their compatibility.

Rule 2: If there exists at least one conflicting anchor pair, then BSA and BSB are not compatible, because at least one anchor will not appear in the final mapping.

Rule 3: If there exists no conflicting anchor pair, all the anchors must appear in the final mapping. Otherwise, any capability judgment is not reliable.

Suppose there are two non-conflicting anchor pairs exists in the mapping from BSA to BSB, namely START-A ↔ START-B, and END-A ↔ END-B. A non-anchor node BSA[i] is on a path between two anchor nodes START-A and END-A in BSA, and is mapped to a node BSB[j]. If there is no path from START-B to BSB[j], and no path from BSB[j] to END-B in BSB, then both deleting and adding the same node BSA[i] are involved in BSB. However, as we have discussed before, any node, which represents a Business Transaction, can only be missing from or adding to BSB to allow BSA and BSB to be compatible with each other without customer-defined compatibility rule. Therefore, any non-anchor node BSA[i], if it is between two anchor nodes in BSA and the pair of corresponding anchors do not conflict with each other, then this non-anchor node will only map to a node that is also between the corresponding anchor nodes in BSB, if BSA and BSB are compatible.

Due to *Rule 2*, if there exists no conflicting anchor pair, then all anchors must appear in the mapping in order to make correct judgment on the compatibility of BSA and BSB. Based on this, the following rule could be deduced:

Rule 4: Within an anchor group, for any node *j* = BSA[i] in BSA, if *j* is not an anchor node itself, and is on a path between two non-conflicting anchor nodes *s* and *e* in BSA, then for the list of nodes in BSB that are compatible to BSA[i], the ones that are have no path from *s* and no path to *e* are not the possible final mapping candidates of the node, and therefore, can be remove from the list.

We obtain an initial nodes (Business State) mapping in Step b. Here we use the following algorithm to remove initial mapping candidates that fails to satisfy *Rule 3*. Notice that this algorithm is greedy when applying to incompatible BPI MODEL with or without conflicting anchor pairs, as the anchors in an anchor group are not necessarily included in the optimal mapping. In order to find out the optimal solution for incompatible BPI MODEL, we will run a compensating algorithm in procedure iii.

- *Construct all-pairs shortest paths matrix for BSA and BSB*

Since the computation of all pairs shortest paths matrix for BSA can be done ahead of time, and only once. This step will take $O(V^3 \lg V)$ (V = |BSB|) [8] .

- *Get a list of anchor nodes*

For our running example, the list of anchors is as following: BSA[0] ↔ BSB[0], BSA[5] ↔ BSB[6]

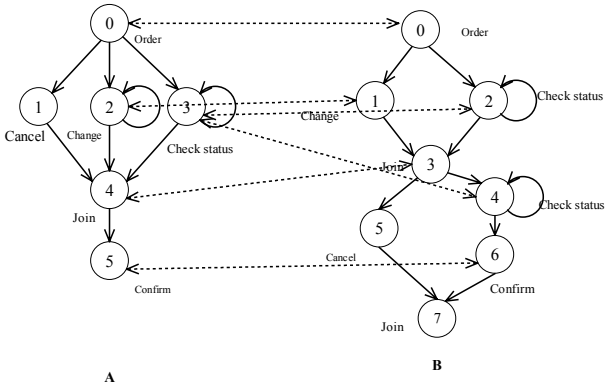
- *Create Anchor Groups*

This step generates all the anchor groups, denoted as G, satisfying the following condition: for an anchor group g ∈ G, if there exists a1∈S and a1∉g, then there exists a0 ∈ g that is conflicting with a1.

If there are multiple anchor groups, we can safely draw the conclusion that the two BPI models are incompatible without further calculation. But to obtain the differences between them, we still need to run the following steps for each anchor group.

Notice this step is of exponential time worst-case complexity. We argue that our algorithm remains an efficiency algorithm for solving practical problems. First of all, BPI models in the same industry or related industry tend to be similar, and thus have limit amount of differences. Secondly, detecting the exact differences between BPI models with significant amount of conflicting anchors does not make much sense. For example, in the worst case, the two BPI models have the same amount of nodes with all the node matches be conflicting anchors. A model needs to change every node within it in order to be compatible with the other model. Knowing the exact differences between the models is not needed, since it provides no help to reduce any reconstruction efforts at all.

Step d. **Reduce Candidate Node (Business State) Matching**



I	COPY-MAP-A-B	Link list
0	0 // represent BSA[0]	← 0 (1) // 0(1) represent BSB[0] with compatibility score 1 with BSA[0]
1	1	NULL
2	2	← 1 (1)
3	3	← 2 (1), 4(1)
4	4	← 3 (1)
5	5	← 6 (1)

Figure 7. Using Anchor to reduce mapping candidates

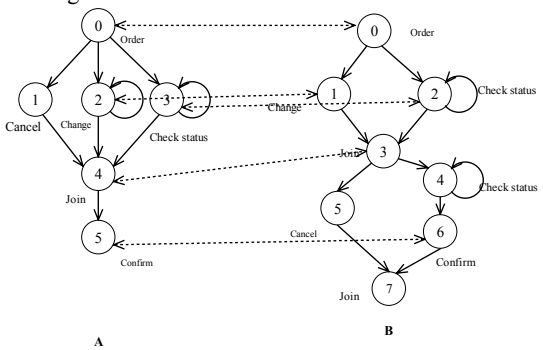
According to *Rule 4*, for any node BSA[i] that is on a path between two anchor nodes, if one node BSB[j] in its initial mapping candidate list is not on a path between the corresponding anchor nodes in BSB, we can remove such a matching candidate from the list. We can interpret *Rule 4* in terms of path weight as following: let l_{ij} be the minimum weight of any path from node i to node j. For connected two nodes a and c, if node *b* on a path from node *a* to node *c, then* $0 < l_{ab}, l_{bc,}, l_{ac.} < \infty$; else, if node *b* has no path from the start anchor node and no path to the end anchor node, then both l_{ab}, l_{bc} equal to ∞.

We iterate over all the anchors pairs within the current anchor group, and eliminate any match that does not satisfy *Rule 4*. Once the number of matching candidates of a node has been reduced to 1, we check whether this match conflicting with the remaining anchors. If not, this match is added to the *Anchors*. Continue calculation until all the anchor pairs have been checked. Figure 7 shows the result of step c. in our example.

Step e. **Final Nodes Mapping within the same Anchor Group**

Step c may help to reduce the candidate nodes in BSB mapping to a node in BSA. But we may still find one node in BSA is mapped by more than one node in BSB, and the same node BSB may map more than one node in BSA. To complete the final graph mapping within each anchor group, we use the following rule: two nodes tend to be compatible if their neighbors tend to be compatible, to determine which node in the list of BSB nodes should map with a node in BSA.

If BSB[i] is compatible with BTA[j] and BSB[i]'s adjacent states is compatible with a state which is BTA[j]'s adjacent state, then its compatibility score of BSB[k] in NODE-MAP-A-B C(k+1) = C0 + C(k) + ∑C'(k) (adjacent states of BSB[i] which are compatible with states in A; k means the number of iteration so far.) We then normalize the compatibility scores with in the same list. The value of similarity of a state decides its rank in the mapping list. Stop iteration if no rank change is made in the latest round of calculation. The ones with highest compatibility score in the candidate mapping node lists to construct the final mapping.The result of running this algorithm in our example is shown in Figure 8.



I	COPY-MAP-A-B	Link list
0	0 // represent BSA[0]	← 0 (1) // 0(1) represent BSB[0] with compatibility score 1 with BSA[0]
1	1	NULL
2	2	← 1 (1)
3	3	← 2 (3/4), 4(1/4)
4	4	← 3 (1)
5	5	← 6 (1)

Figure 8. Final mapping between nodes

3. 2 Procedure II: Compare Edge in the Graph

After obtaining the node mapping between Business Process A and B, we need to calculate the difference between these two Business Processes if any, as well as judge whether these two Business Process A and B compatible with each other.

We use adjacency matrixes MA' and MB' to represent compatible edges and nodes between Business Process A and B. Similarly, we use adjacency matrixes MA'', B'' to represent incompatible edges between A and B and all the nodes, referring to the difference between graphs. An edge (i_b, j_b) in B is a *match* of an edge (i_a, j_a) in A, if and only i_b is a *match* of i_a j_b is a *match* of j_a, and both edges hold the same *conditionGuard*. Figure 9 illustrates the differences represented by MA'' and MB'' respectively.

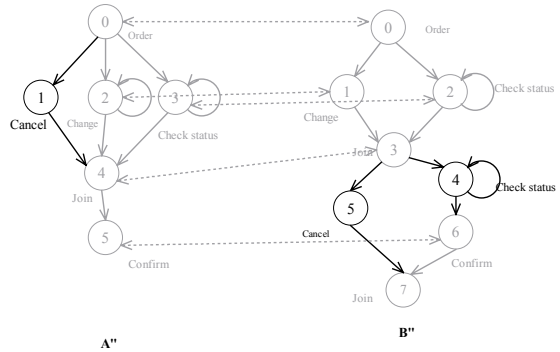


Figure 9. Differences between BPI models (highlighted)

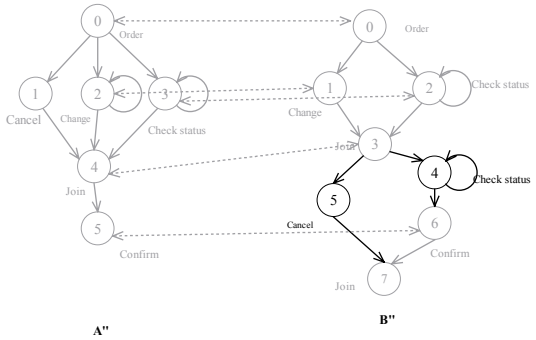


Figure 10. Material differences between BPI models

We can take non-material differences into account in the above steps. In our example, Buyer is the initiator of Business Transaction *Cancel* in Business Process A. According to *Rule 1*, missing of mapping of this Transaction's in the Seller's Business Process B is acceptable. The result after taking non-material differences into account is shown in Figure 10. Human intervention at this stage can be used to examine the discrepancies found.

After taking non-material differences into consideration, remaining differences between the two Business Processes are material, and cannot be ignored. If any material difference exists, which is true in our example, the two Business Processes are incompatible. Otherwise, they are compatible.

3.3 Procedure III: Determine optimal result

Procedure i and ii can give us a sound conclusion in regards to the compatibility between BSA and BSB. However, when BSA and BSB are incompatible, and there are conflicting anchors between them, multiple mappings will be obtained by running the two procedures. In such a case, we need to decide which mapping is the optimal mapping between BSA and BSB. By optimal, we mean the mapping is the most desired match result according to our measurement metric.

Measurement metric. To determine the optimal mapping, we must first have a measurement metric. The quality metric that we suggest below is based upon *efforts needed to reconstruct BSA into a business process compatible with BSB*. To reconstruct BSA to be compatible with BSB, what needs to do is to remove the material differences detected between BSA and BSB by adding and deleting business transaction activities made up the differences. The reconstruction effort is intuitively related to the number of additions and deletions performed. Meanwhile, anchors in each anchor group presumably make it easier to reconstruct BSA to be compatible with BSB by maintaining the global structure similarity between the two business processes. The more anchors in the final mapping, the less effort is needed for a user to understand and verify the differences detected before making changes.

Detection Accuracy. We use a simplified metric called *detection accuracy* to measure the reconstruction effort needed. For simplicity, let us assume that deletions and additions of any single business transaction activities not represented by an anchor node in BSA require the same amount of efforts. We also assume that each missing anchor from the same anchor group in the final mapping requires the same amount of efforts. Let *a* be the number of additions needed, *d* be the number of deletions needed to make BSA compatible with BSB. Let *m* be the total number of business transaction activities in BSA, and *n* be the total number of business transaction activities in BSB. Denote the number of anchors missing from the final mapping as *k*. We recognize that the efforts added for lacking global structural reference vary by person, and therefore a user-predefined discount factor α is used to represent such individual differences. If the user reconstructs BSA manually to be compatible with BSB blindly without making use of any difference information, then totally *m* deletions and *n* additions are needed. Thus the overall effort needed to reconstruct BSA after applying the automatic difference detector amounts to $(1-\alpha)\cdot\frac{a+d}{m+n}+\alpha.\frac{k}{m}, 1\geq\alpha\geq 0$ of the total effort needed of full reconstruction of BSA blindly.

We approximate the effort savings obtained by using an automatic difference detector as accuracy of detection result, defined as following:

$$Accuracy = 1-[(1-\alpha)\cdot\frac{a+d}{m+n}+\alpha.\frac{k}{m}], 1\geq\alpha\geq 0$$

Optimal mapping If BSA and BSB are compatible, then $a = d = 0$, and $k = 0$, resulting in accuracy 1; the automatic difference detector saves all the manual efforts needed. If none of the business transaction activities in BSA and BSB are compatible, accuracy equals to 0. In such a case, the automatic difference detector provides no useful information and the user has to do the same amount of work when reconstructing BSA to be compatible with BSB as what he/she has to do blindly.

If BSA and BSB are compatible, or there is no conflicting anchors between them, only one mapping will be obtained in procedure i and ii. This mapping is optimal; no further calculation needed. If BSA and BSB are not compatible, and there are conflicting anchors between them, multiple mappings will be returned. In such a case, we want to find the optimal mapping in which the value of accuracy is maximized. This is straightforward: for each mapping returned, we calculate its accuracy. The one with the highest value of accuracy is the optimal mapping we are looking for.

4. RELATED WORK

Schema Matching. There has been extensive research in the area of schema matching (mapping) [9-14]. A few works have taken machine-learning techniques to perform matching[13]. A learner is trained by a set of user-provided mappings using a variety of learning techniques. Extensive preparing and training efforts are needed in this approach. The majority of current solutions employ handcrafted rules that describe how to match elements in the source schema with semantically corresponding elements in the target schema [9, 11, 13]. Schema information such as element names, data types, structure, and number of sub-elements is exploited in the rules to help matching. Domain-specific rules are also crafted for different application domains. Human efforts are required in both rule creating and schema matching process [9, 11, 14].

The BPI model of a Web service in ebXML is specified as a XML schema file [2]. Intuitively the problem of compatibility determination between BPI models is related to schema matching. In fact, in our approach finding a match between the two BPI models is a necessary step towards compatibility determination between Web services.

When designing our algorithm, we borrowed some ideas from current schema matching solutions. The fixpoint computation and filter for ranking and choosing multiple mapping node candidates have been used in a generic schema matching approach called Similarity Flooding. Unlike Similarity Flooding, our algorithm only does compatibility propagation locally, i.e., between Anchor node pairs, and hence could achieve a better convergence rate. Our filter used to choose the best mapping out of multiple candidate mappings is also much simpler than those used in Similarity Flooding. In Similarity Flooding, filters decide the final mapping result. In our algorithm, however, the final mapping returned by our algorithm is the optimal solution based on our cost model; the impact of filter to the final result is significantly reduced. In most works, integrity constraints have been used to match representation elements locally. For example, many works match two elements if they participate in similar constraints (among other things). The main problem with this scheme is that it cannot exploit "global" constraints and heuristics that relate the matching of multiple elements. We overcome this limitation in our work by taking non-local context into consideration by making use of *Anchors*. Works such as Similarity Flooding make the assumption that manual correctness verification is free. We argue that this assumption does not hold in practice, and that maintaining global structural references helps to reduce human effort required to understand and verify the result returned.

Tree Matching. [12] and [13] address the change detection problem for ordered and unordered trees respectively. The changes between two trees are portrayed as an edit script that gives the sequence of operations needed to transform one tree into another. Operations on entire sub-tree of nodes such as *move* and *copy*, in addition to the traditional "atomic" insert, delete, update operations are used to describe changes. *LaDiff* uses a simple cost model in which *insert*, *delete* and *move* operations are unit cost operations. *LaDiff* assumes the existence of special label for each

node that describes its semantic as well as specifies partial order relationship between nodes. *LaDiff* also assumes absence of duplicates in the labels of the nodes in the input trees. *MH-DIFF* adapts a more flexible cost model in which the cost of each operation is user-defined. *MH-DIFF* does not hold the above assumptions required by *LaDiff,* but takes quadratic time.

Our algorithm aims to detecting differences between two incompatible BPI models. There are a number of differences between the difference detection problem discussed in this paper and the change detection problem in tree matching. First, a BPI model is represented by a non-cyclic graph, instead of a tree. Some of the edit operations on subtrees such as *update, copy* and *move* in [13] are not meaningful in our problem. Second, the assumption of absence of duplicates in the node labels does not necessarily hold true. In fact, the duplicates handling process plays a significant role in our algorithm. Third, while the assumption of semantic label holds for all the nodes in a BPI model, it is not reasonable to assume the existence of partial order relationship over the labels. Fourth, cost models in both *LaDiff* and *MH-DIFF* assume that understand and manual verification of the results are free. We adapted a cost model taking human efforts into consideration.

Graph Matching. Much work has been done in the area of graph matching in the context of graph isomorphism and weighted graph matching [14, 16]. The graph matching problem is NP-complete [14]. To develop efficient algorithms that can effectively match graphs, various heuristics have been proposed. The essential difference between the existing graph matching approach and our algorithm is that we are targeting the problem of compatibility determination, and thereby graph matching is just an important step in the whole solution. Other major differences include: (1) we choose domain-specific heuristics to reduce sufferings from speed and accuracy; (2) we take advantage of special node mapping called anchors to facilitate our mapping process; (3) we take domain-specific non-material differences into account; (4) we use a customizable cost model to choose the optimal solution.

5. CONCLUSIONS AND FUTURE WORK

In this paper we have proposed an algorithm to determine the compatibility between two Web services. Such an algorithm can be used to develop tools needed to support dynamic collaboration of Web services, which is of critical importance to realize the ultimate goal of Web services. Furthermore, differences detected between incompatible Web services provide valuable information for dynamic configuration of Web services, dynamic negotiation between Web services, as well as Business Process Reengineering.

Future work includes finding real world dataset to study our algorithm empirically, and extending our algorithm to support compatibility determination for Web services with complex BPI models involving more than two Business partners. In the long term, on the base of the algorithm discussed on the paper, we plan to develop efficient index and search mechanism to support dynamic discovery of Web services.

6. ACKNOWLEDGMENTS

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Logic Based Approach to Web Services Discovery and Matchmaking

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ABSTRACT

We present a logic based approach to web services discovery and matchmaking in an e-commerce scenario. In particular, we describe our framework, based on Description Logics formalization and reasoning, and its deployment in a prototype, which overcomes simple subsumption matching of services descriptions and allows match ranking and services classification. We also present results of first experiments testing the performance of our prototype in a realistic e-commerce scenario.

Categories and Subject Descriptors

H.4.2 [**Information Systems Applications**]: Decision Support; I.2.4 [**Knowledge Representation Formalisms and Methods**]: Representation languages

General Terms

Algorithms, Languages

Keywords

E-commerce, Web-Services, Matchmaking, Knowledge Representation, Description Logics.

1. INTRODUCTION

A Web service is a software system identified by a URI, whose public interfaces and bindings are defined and described using XML. Web services have been gaining an increasing popularity, however, as they become more widespread new issues arise, such as automatic discovery and interoperability. Initially Web services were mainly intended to engage in dynamic business-to-business interactions with services deployed on behalf of other enterprises or business entities. However, with the evolution of Web service technology services will not only become increasingly sophisticated, but also move into the area of business-to-consumer or even peer-to-peer interactions. Because of todays wide variety of services offered to perform a specific task, there is a need for mediation infrastructures able to support humans or agents in the eventual selection of appropriate services. It is a common opinion that such issues should be solved adopting semantically rich clear descriptions, so ontologies should be used to describe services to ease their discovery and selection. In this paper we investigate how Semantic and Web Services technologies can be used to support service advertisement and discovery in an e-commerce scenario. In particular, we describe our framework, based on Description Logics formalization and reasoning, and its implementation in a web services matchmaking prototype for an e-commerce scenario, which overcomes simple subsumption matching of services descriptions and allows match ranking and services classification.

Recently there has been a growing interest towards matchmaking engines and techniques, with emphasis placed either on e-marketplaces or generic Web services, in view of the promised transformation of the Web from human understandable to the Semantic, machine understandable, Web. Significant examples include [20] and [18] where a language, LARKS, is proposed specifically designed for agent advertisement. The matching process is carried out through five progressive stages, going from classical IR analysis of text to semantic match via Θ-subsumption. The notion, inspired by Software Engineering, of *plug-in* match is introduced to overcome in some way the limitations of a matching approach based on exact match. No ranking is presented but for what is called relaxed match, which basically reverts again to a IR free-text similarity measure. So a basic service of a semantic approach, such as inconsistency check, seems unavailable with this type of match. In [21] and [13] a matchmaking framework is proposed, which operates on service descriptions in DAML+OIL and is based on the FaCT reasoner. Unfortunately as the authors admit, though very expressive, FaCT lacks of concrete datatypes, which are obviously extremely useful for, *e.g.*, e-commerce applications, and their prototype is incomplete. In [15] a framework for matchmaking based on DAML-S and describing an implementation for service discovery using Racer is

presented, which anyway reverts to basic subsumption based matchmaking. In [10] a knowledge-based system for person-to-person e-commerce is proposed. In [9] a logic based approach to matchmaking in an e-marketplace, which allows to categorize and rank matches is presented. Semantic service discovery via matchmaking in the Bluetooth framework is investigated in [19].

In the remaining of the paper we start with Description Logics basics in order to make the paper self-contained. In section 3 we outline our framework for matching of services and algorithm for matchmaking, which overcomes subsumption matching and allows logical ranking between descriptions. Then we describe technologies we adopt in our system. We present our prototype and describe its operation mode in section 5. Initial experiments are presented in the last section, outlining the system behavior.

2. DESCRIPTION LOGICS BASICS

Description Logics are a family of logic formalisms for Knowledge Representation [2, 12]. Basic syntax elements are *concept* names, *e.g.*, `book`, `person`, `product`, `apartment`, *role* names, like `author`, `supplier`, `hasRooms` and *individuals*, such as `NewYorkCity`, `BackYardGarden`, `TVset#123`. Intuitively, concepts stand for sets of objects, and roles link objects in different concepts, as the role `author` that links books to persons (their writers). Individuals are used for special named elements belonging to concepts.

More formally, a semantic *interpretation* is a pair $\mathcal{I} = (\Delta, \cdot^{\mathcal{I}})$, which consists of the *domain* Δ and the *interpretation function* $\cdot^{\mathcal{I}}$, which maps every concept to a subset of Δ, every role to a subset of $\Delta \times \Delta$, and every individual to an element of Δ. We assume that different individuals are mapped to different elements of Δ, *i.e.*, $a^{\mathcal{I}} \neq b^{\mathcal{I}}$ for individuals $a \neq b$. This restriction is usually called *Unique Name Assumption* (UNA).
Basic elements can be combined using *constructors* to form concept and role *expressions*, and each DL has its distinguished set of constructors. Every DL allows one to form a *conjunction* of concepts, usually denoted as $\sqcap$; some DL include also disjunction $\sqcup$ and complement $\neg$ to close concept expressions under boolean operations.
Roles can be combined with concepts using *existential role quantification*, *e.g.*, `book` $\sqcap \exists$`author.italian` which describes the set of books whose authors include an Italian, and *universal role quantification*, *e.g.*, `product` $\sqcap \forall$`supplier.japanese`, which describes products sold only by Japanese suppliers. Other constructs may involve counting, as number restrictions: `apartment` $\sqcap (\leq$ 1 `hasRooms`) expresses apartments with just one room, and `book` $\sqcap (\geq$ 3 `author`) describes books written by at least three people. Many other constructs can be defined, increasing the expressive power of the DL, up to n-ary relations [5].
Expressions are given a semantics by defining the interpretation function over each construct. For example, concept conjunction is interpreted as set intersection: $(C \sqcap D)^{\mathcal{I}} = C^{\mathcal{I}} \cap D^{\mathcal{I}}$, and also the other boolean connectives $\sqcup$ and $\neg$, when present, are given the usual set-theoretic interpretation of $\cup$ and complement. The interpretation of constructs involving quantification on roles needs to make domain elements explicit: for example, $(\forall R.C)^{\mathcal{I}} = \{d_1 \in \Delta \mid \forall d_2 \in \Delta : (d_1, d_2) \in R^{\mathcal{I}} \rightarrow d_2 \in C^{\mathcal{I}}\}$

Concept expressions can be used in *inclusion assertions*, and *definitions*, which impose restrictions on possible interpretations according to the knowledge elicited for a given domain. For example, we could impose that books can be divided into paperbacks and hardcover using the two inclusions `book` $\sqsubseteq$ `paperbacks` $\sqcup$ `hardcover` and `paperbacks` $\sqsubseteq \neg$`hardcover`. Or, that books have only one title as `book` $\sqsubseteq (\leq$ 1 `title`). Definitions are useful to give a meaningful name to particular combinations, as in `doubleRoom` $\equiv$ `room` $\sqcap (=$ 2 `hasPlaces`). Historically, sets of such inclusions are called TBox (Terminological Box). In simple DLs, only a concept name can appear on the left-hand side of an inclusion.
The semantics of inclusions and definitions is based on set containment: an interpretation $\mathcal{I}$ satisfies an inclusion $C \sqsubseteq D$ if $C^{\mathcal{I}} \subseteq D^{\mathcal{I}}$, and it satisfies a definition $C = D$ when $C^{\mathcal{I}} = D^{\mathcal{I}}$. A *model* of a TBox T is an interpretation satisfying all inclusions and definitions of T.
In every DL-based system, at least two basic reasoning services are provided:

1. *Concept Satisfiability*: given a TBox T and a concept C, does there exist at least one model of T assigning a non-empty extension to C?
2. *Subsumption*: given a TBox T and two concepts C and D, is C more general than D in any model of T?

Our engine for service descriptions matching is based on an adapted version of the CLASSIC system [3, 4], which was developed at AT&T Bell Laboratories, where it was applied in several projects for configuration [22] and program repositories [6]. Its language has been designed with the goal to be as expressive as possible while still admitting polynomial-time inferences. So it provides intersection of concepts but no union, universal but not existential quantification over roles, and number restrictions over roles but no intersection of roles, since each of these combinations is known to make reasoning NP-hard [11]. Classic obviously provides subsumption and satisfiability reasoning services. Being a complete knowledge representation system (and not just a reasoner), Classic provides also data types as numbers and strings, and other services which are useful in a deployed prototype. Every Classic concept has an equivalent normal form, hence using such a normal form ensures syntax independence. In our current setting we use just a subset of CLASSIC constructors, *i.e.*, those needed in a $\mathcal{ALN}$ logic.

3. MATCHMAKING

The key question that has to be answered is how far is a request from the provided service? And which are the requirements that would eventually fulfill it? We consider descriptions of service advertisements and requests as logical descriptions, and move on to Description Logics (DLs). Hence, from now on we suppose that advertisements and requests are expressed in a DL $\mathcal{L}$, equipped with a model-theoretic semantics. We suppose also that a common ontology for service description is established, as a TBox $\mathcal{T}$ in $\mathcal{L}$. Now a match between a service description S and a request R could be evaluated according to $\mathcal{T}$. This framework ensures the first property that we would like to hold for matchmaking, namely, an open-world assumption. The

absence of a characteristic in the description of a service advertisement or a request should not be interpreted as a constraint of absence. Instead, it should be considered as a characteristic that could be either refined later, or left open if it is irrelevant for a user Obviously, also the algorithm employed for matchmaking should take this issue into account. Secondly, a matchmaking system may give different evaluations depending on whether it is trying to match a service description S with a request R, or R with S — *i.e.*, depending on *who* is going to use this evaluation. This requirement is already evident when characteristics are modeled as sets of words. in that case, underconstrained requirements of S from the point of view of R are expressed by $R - S$ (set difference) while underconstrained requirements of R from S's viewpoint are expressed as $S - R$. Let $T \models \ldots$ denote logical implication (truth in all models of T), and let $\sqsubseteq$ (subsumption) denote also implication between constraints of S and R. There are three relations between concepts expressing service descriptions and requests, that we consider meaningful in matchmaking: implication, consistency, and inconsistency.

In the first case, $\mathcal{T} \models (R \sqsubseteq S)$, *i.e.*, constraints imposed by R imply those of S, and vice versa if $\mathcal{T} \models (S \sqsubseteq R)$. This relation extends the previous set-based inclusion to general concepts. If both $\mathcal{T} \models (R \sqsubseteq S)$ and $\mathcal{T} \models (S \sqsubseteq R)$, then R and S should be considered equivalent in $\mathcal{T}$. This relation extends exact matching, making syntax differences irrelevant. In case of consistency, $R \sqcap S$ is satisfiable in $\mathcal{T}$. Then, there is a *potential* match, in the sense that the constraints of neither proposal exclude the other. This relation has been highlighted also by other researchers [21, 15]. However, they lack of a *ranking* between different potential matches. In the third case, $R \sqcap S$ is unsatisfiable in $\mathcal{T}$. Although also in this case a matching could be defined [8], we do not treat this case here for lack of space. Hence, from now on we concentrate on potential match only. We now highlight some principles that — we believe — every ranking function should have in logical matchmaking. First of all, if a logic is used to give some meaning to descriptions of services and requests, then proposals with the same meaning should have the same ranking, independently of their syntactic descriptions. We now state some properties that — we believe — every ranking function should have in logical matchmaking. First of all, if a logic is used to give some meaning to descriptions of services and requests, then proposals with the same meaning should have the same ranking, independently of their syntactic descriptions. Hence, a ranking for semantic matchmaking should be *syntax independent*. That is, for every pair of services S_1 and S_2, requests R, and ontology T, when S_1 is logically equivalent to S_2 then S_1 and S_2 should have the same ranking for R — and the same should hold also for every pair of logically equivalent requests R_1, R_2 with respect to every service S. Secondly, a ranking for semantic matchmaking should be *monotonic over subsumption*. That is, for every request R, for every pair of services S_1 and S_2, and ontology T, if S_1 and S_2 are both potential matches for R, and $T \models (S_2 \sqsubseteq S_1)$, then S_2 should be ranked either the same, or better than S_1. The same should hold also for every pair of requests R_1, R_2 with respect to a service S. Intuitively, this property could be read of as "A ranking of potential matches is monotonic over subsumption if the more specific, the better." When turning to partial matches, adding another characteristic to an unsatisfactory proposal may either worsen its ranking (when another characteristic is violated) or keep it the same (when the new characteristic is not in contrast). Note that this ranking should be kept different from the ranking for potential matches. Obviously, properties pointed out here are independent of the particular DL employed, or even the particular *logic* chosen. For instance, the same properties could be stated if propositional logic was used or also logics, such as DAML, for which reasoning systems are not yet fully available. Clearly, when the logic admits a normal form of expressions — as CNF or DNF for propositional logic, or the normal form of concepts for the DL of CLASSIC [3] — using such a normal form ensures by itself syntax independence. We remark that the properties and definitions we stated in this section are independent of the particular DL employed, or even the particular *logic* chosen. In this respect, we believe that the definition of our framework keeps its significance also if one chooses more expressive DLs such as $\mathcal{SHOQ}(\mathcal{D})$ [14] or DAML [18].

Based on our matching framework we developed an algorithm [9], which has been obtained adapting the original CLASSIC structural [4] subsumption algorithm, to classify and rank matches.

The algorithm can be proved to respect outlined properties. Complexity is obviously of paramount importance, for an algorithm to be of practical use. It is well known [16] that the expansion of the TBox in the construction of the normal form can lead to an exponential blow-up. Nevertheless the expansion is exponential in the depth of the hierarchy of the TBox $\mathcal{T}$; it can be proved that if the depth of $\mathcal{T}$ is $O(\log |\mathcal{T}|)$, then the expansion is polynomial, and so also the algorithm [7]. This result further validates the use of CLASSIC , which although having a reduced expressiveness w.r.t. new reasoners *e.g.*, FAcT and Racer, is expressive enough for our purposes while maintaining in practical cases still a polynomial inference. On the contrary, time may become prohibitive in approaches such as the one devised in [15], where Racer is adopted, also for much simpler subsumption-based matching without ranking.

4. SERVICE DISCOVERY ELEMENTS

Services search needs at least tree phases to yield consistent and effective results:

Categorization: classification of the Service in a possibly standard category.

Description: representation of the Service in a semantic conveying language.

Deployment: storage of Service descriptions in a Marketplace.

Our prototype implements these phases using and at times extending three developing technologies: UNSPSC(United Nations Standard Products and Services Code) attends to Categorization, DAML-S(DARPA Mark-up Language for Services) attends to Description, UDDI(Universal Description Discovery and Integration) attends to Deployment.

The three technologies are detailed in the following.

4.1 UNSPSC: A Standard Product Classification

UNSPSC is a wide open-standard developed and maintained by *Dun & Bradstreet*, leader for development of information and finance standards.

UNSPSC provides a product classification, for E-commercepurposes, useful to identify the category of a selling item (and then of the selling item web service). It helps in the search and localization of Services identifying suppliers of a given product or service. Search by code avoids the shortcomings of textual retrieval: results of searching process are Services providing capabilities classified under the given code and not irrelevant Services whose name contains the searched product.
UNSPSC is a hierarchical classification made up of four levels. Each level includes a two digits numeric code and a textual description, as shown in the following:
XX Segment identify the market segment of a product
XX Family identify a universally recognized product category
XX Class identify a group of products with the same functionality or usage.
XX Commodity identify a group of equivalent products
An example of UNSPSC classification is shown in Figure 1.

```
Hierarchy       Category Number and Name
Segment        44  Office Equipment, Accessories
                   and Supplies
                   10 Office Machines and their
                       supplies and accessories
                   11 Office and desk accessories
Family             12 Office supplies
                       15 Mailing supplies
                       16 Office supplies
                       17 Writing instruments
                       18 Correction media
Class                  19 Ink and lead refills
                           01 India ink
                           02 Lead refills
Commodity                  03 Pen refills

"Pen refills" = UNSPSC classification 44-12-19-03.
```

Figure 1: UNSPSC classification example

4.2 DAML-S: Semantic Mark-up for Web Services

DAML-S([1]) is an ontology describing Web localizable and accessible Services in a computer-interpretable way. Ontology basic structure is made up of three kinds of information: a *Profile* describing what Service takes from users and returns to them, a *Model* describing how Service functions and a *Grounding* describing how to use the Service.
The basic class of DAML-S ontology is *Service*, whose instances are deployed Services. *Service* is also the domain of properties *presents*, *describedBy* and *supports*, that respectively have classes *ServiceProfile*, *ServiceModel*, *ServiceGrounding* as range.
The class *Service*, then, *presents* a *ServiceProfile* describing Service capabilities; it is *describedBy* a *ServiceModel* showing Service behavior and *supports* a *ServiceGrounding* specifying Service access information.
Each **Service** may be described by at most one **ServiceModel**, linked to at least one **ServiceGrounding**.
The class **ServiceProfile** allows one to describe capabilities both provided by Services and searched by requestors. So it is the most interesting element of DAML-S ontology w.r.t. Service Discovery.
ServiceProfile structure, also extensible with the use of DAML subclasses, makes Service representable through the class **Profile**.
A DAML-S Profile describes a Service through:
Provider Information: general contact information
Functional Description: transformations produced by the Service from required inputs and pre-conditions to outputs and generated effects.
Properties: definition of Service main characteristics.
In the aims of the DAML-S authors, the Functional Description of the **Profile** class should be used to perform the service discovery. A detailed analysis of Profile Properties is out of the purpose of this paper and is available in [1]. We underline here only two Profile Properties we use in our prototype system. The first is **textDescription**, one of the human-readable properties providing a brief textual description of capabilities supplied by the Service. The latter, **ServiceCategory**, belongs to Profile additional attributes referring *i.e.*, to quality and classification of Service. The attribute describes Service category being based upon an eventually external code(UNSPSC in our prototype).

4.3 UDDI

UDDI aims to define a facilities set supporting description and discovery of Web Services providers, Web Services itself, and technical access interfaces to Services.
UDDI uses widespread standards such as HTTP, XML, XML Schema and SOAP, providing a set of functions allowing one to register companies, services and their access information, to modify or cancel registrations and to search in the registrations database.
The deployment of a Web Service is made up of three phases:
registration of the provider as company
deployment of a description of provided service
deployment of service invocation information
These information are usually grouped in categories: *white pages*(Businesses), *yellow pages*(Services), *green pages*(technical information). User may search a Service, then, by company or by capability.
UDDI Registries are available on the Web and are themselves Web Services: the user have to know access information to a given UDDI to use it.
Business UDDI Registries store in their records four types of knowlwdge:
businessEntity: non technical information about providers(white pages)
businessService:non technical information about provided capabilities(yellow pages)
bindingTemplate: technical information about services(green pages)
tModel: Service access details(depending on *bindingTemplate*)
UDDI provides also API(Application Programming Interfaces) for information and Services search(**Inquiry API**) and deployment(**Publishing API**).

UDDI Registry is used here to publish and retrieve web services semantic description. We do not consider here actual business transactions related to the web service use, which should be anyway kept into account in a practical use of the system.

5. A PROTOTYPE SYSTEM FOR SERVICE DISCOVERY

Our prototype for Web Service Discovery is able to find Services by evaluating the semantic match of provided capabilities. To perform such a match we implemented a framework which uses UNSPSC, DAML-S, DAML+OIL and UDDI. The search algorithm is made up of four steps, shown in the following:

- Classification: process of finding the UNSPSC code corresponding to the searched Service.
- Description: representation of the searched Service in an expressive and standard language.
- Extraction: selection of a list of servers providing the searched Service from a UDDI Registry.
- Matchmaking: semantic based assessment of closeness between Service request and descriptions.

The System basic Architecture is shown in Figure 2.

The user performing the discovery could be either a

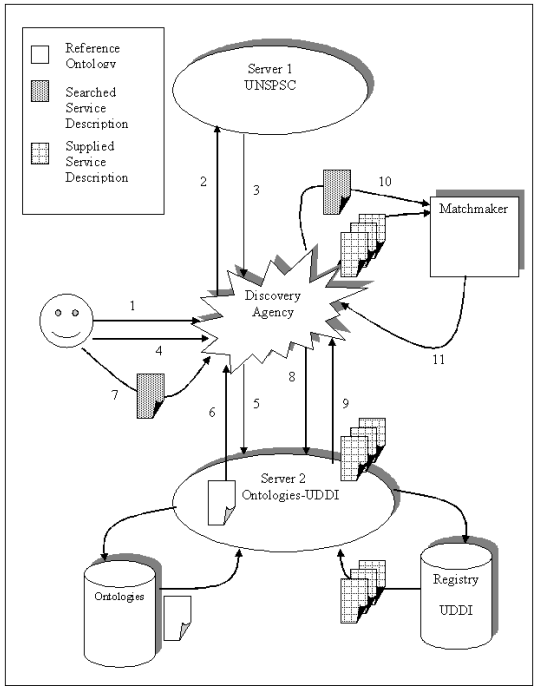

Figure 2: System Architecture

software agent or a human user. In the latter case an applet is used to guide her through the composition of the service description, as shown in Figure 3,

either to search for or to publish in UDDI. The applet dynamically loads a DL-based ontology identified by a UNSPSC code (see par. 5.1 and par. 5.2). With reference to the well-known *triangle diagram* for web services interaction, our framework represents a distributed *Discovery Agency* made up of a UDDI registry, an ontologies repository, a module for UNSPSC codes retrieving and

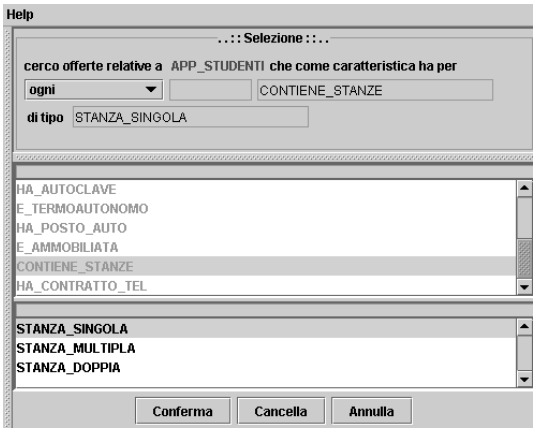

Figure 3: User Interface

a matching engine. The choice of using an ontologies repository rather than referring to their URIs is based on the remark that from time to time they are unreachable or are deprecated. As in our framework we refer to the same ontology to describe the service and to represent dynamically the request, as described below, we always need to have the ontologies availability.

We are going to explain the system behavior w.r.t. the four steps of the search algorithm.

5.1 Step 1: Classification

When finding a Web Service it is necessary to limit the search field by classifying the service in a category. Our system uses UNSPSC codes to classify searched Services. So this step takes in input words describing the request context and returns none, one or more UNSPSC codes as output. We preferably search UNSPSC codes corresponding to the demanded Service at a *commodity* level, the most detailed one. In this way there are less advertisements to analyze in the matchmaking process, but these are also the nearest to the request.

In our prototype a user searching for a Service accesses the *Discovery Agency* web page and submits a keyword expressing the searched product or service context. The Agency queries *Server1* asking for a list of UNSPSC codes, whose name contains submitted keyword. The listed codes may belong to every level of the UNSPSC tree; if a code corresponds to a high level node in the tree it is possible to browse the hierarchical structure of the taxonomy starting from the proposed node.

The list of codes is sent to the user, who chooses the item better corresponding to the searched product or service. The selected code may lay at a commodity level or, if it is on a higher level, the user can expand the item following the tree up to its bottom level.

5.2 Step 2: Description

The UNSPSC code selected by the user is the output of Step 1 and, obviously, is taken in input by Step 2. The output of Description process is a representation of the searched service in a standard and expressive language, able to convey the semantics underlying the request. Users have to express their Services requests according to the same

language by which the service description is represented. This common language is provided by standard reference ontologies which formalize the contexts represented in UNSPSC. In an ideal world we should have either an ontology for each ID in UNSPSC or a global common ontology describing the whole UNSPSC taxonomy. In the former case there would be about 10'000 ontologies related to each other, in the latter one there would be a unique ontology with a huge number of concepts and roles. Both cases are not easily manageable. To overcome these drawbacks we proposed to develop an ontology for each *Family* in UNSPSC. In our prototype the standard ontologies information are provided by the second server. *Discovery Agency* sends the UNSPSC code selected by the user in the previous step to *Server2 Ontologies-UDDI*, that returns to the Agency the reference ontology corresponding to the UNSPSC *Family* of the input code. The ontology is shown to the user, who returns to the *Discovery Agency* the output semantically endowed description of the searched Service according to the reference ontology.

5.3 Step 3: Extraction

In the previous steps we defined the request of the Web Service we are going to discover. This step, instead, aims to extract from the UDDI Registry a list of Service advertisements that can, to some extent, fulfil the request.
In our system *Server2* contains the UDDI Registry, so the *Discovery Agency* queries *Server2* asking for descriptions of Services classified with the UNSPSC code selected by the user in the first step.
UDDI allows providers to be accessed on the Web by deploying all information useful to know and get Services. But no information conveying the semantics can be deployed by means of UDDI. In [17]it is proposed to overcome this shortcoming by mapping DAML-S in UDDI.
DAML-S Profile and UDDI share, in fact, much information, even if it is differently stored by them. DAML-S handles information as literals filling ontology properties; UDDI, instead, makes use of Database records.
The correspondence between information shared by the two models is elicited in Figure 4. DAML-S information not included in UDDI can be conveyed using *Category Bag* and *T-Models* provided by UDDI. A T-Model is a data structure allowing one to specify further attributes for entities yet registered in a UDDI repository. Instances of T-Models are called *KeyedReferences* and include three fields:
KeyName: name of the attribute to elicit with T-Model;
KeyValue: value of the attribute;
TModelKey:key of used T-Model.
A *BusinessService* may be described by KeyedReferences belonging to different T-Models. A *CategoryBag* include all KeyedReferences describing the same BusinessService. So, in order to convey also in UDDI information provided only by DAML-S, we can create a T-Model endowing UDDI with semantics.
On the basis of so far explained models we can extract from the UDDI Registry advertisements semantically fitting the demand. Our extraction method creates a T-Model containing a KeyedReference, whose KeyValue is the UNSPSC code output of the first step. We can so extract only BusinessServices classified with the searched code.
UDDI Server has to return at least three data about extracted advertisements:
discoveryURL: Service socket
Service name
URI: URI of the semantic description of the Service.
The third information is crucial for the search process. It allows us to locate descriptions anywhere in the Web and retrieve them following the reference points provided by URI. This description is embedded in the DAML-S *SeviceProfile* class of the services. The aim of this modelling is to perform a two steps comparison of services capabilities (what the service does).We would like to compare: In the first step the service semantic description to the request semantic representation;
In the second step the semantic representation of service inputs and outputs to the user or agent requirements. The matchmaking approach is different between the two steps. In step one we assess closeness between service request and available service descriptions. For instance, the request "Apartment, Soho, 2 rooms, smoker, dog, garden" and service description "Apartment, center(Piccadilly), car place, fireplace, 2 rooms", could match even if the requestor is not completely satisfied. In the step two instead, the user has to be able to provide all service input constraints and vice versa for the service output constraints. This leads to a subsumption relation between the inputs provided by the user and service input constraints and vice versa for output. For instance, if the service requires credit-card number as input and outputs both a payment receipt and immediate availability, then it can be queried only by users providing at least their credit-card numbers and asking for at most a payment receipt and immediate availability.
Moreover the semantic description may be expressed without language constraints: DAML-S, DAML+OIL, or even WSDL(not endowed with semantics) may be used. The choice of description language obviously affects the degree of match with the request, but the chance of choosing the language of representation provides flexibility to the system.

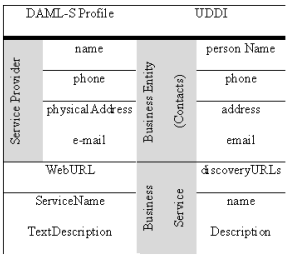

Figure 4: Information shared by DAML-S and UDDI

5.4 Step 4: Matchmaking

Discovery Agency now holds both the description of the Service requested by the user(output of the second step) and the advertisements of Services extracted in the previous step. These descriptions are the input to the Matchmaking step. The Agency is endowed with a Matchmaker module that processes input descriptions according to the algorithm previously outlined, trying to find the advertisement better cor-

```
 Request: student looking for a nice 1/2 bed flat, ch, furnished,
kitchen, washing machine. Price: 150

 Service1: large, fully furnished room, price includes cable TV
and bills. Price: 120
 Service2: double room, suit a couple or two girls, required
deposit. Price: 150
 Service3: room to rent, suit a non smoking female student with
worker, international preferred, deposit required. Price: 80
 Service4: single room in clean flat for nosmoker quiet student,
sharing with 2 others. Price: 120
 Service5: dbl room in shared house, suit single person, use of
lounge, kitchen , garden, rent includes council tax. Price: 85
 Service6: female to share a room in a residential area
flatshare, washing machine, TV, VCR. Price: 81
 Service7: large room in family houseshare with 2 adults, suit
prof / student female, viewing recommended. Price: 95
 Service8: 2 bed flat, perfect for student, double bed ADSL
computer beneath. Price: 600
```

Figure 5: User request and service descriptions in a human-readable representation

```
Request (and Bedroom (all toLetFor Student) (at-least 1 hasBed)
(at-most 2 hasBed) (at-least 1 hasFacilities) (all hasFacilities
(and WashingMachine NoAutonomousHeating FullyFurnished)) (all
hasServices Kitchen) (all price (maximum 150)))

Service1 (and Bedroom (all price (minimum 120)) (all priceIncludes
(and Bill TVPrice)) (all hasFacilities (and FullyFurnished
Spatious)))
Service2 (and (all price (minimum 150))(at-least 2
hasRoom)(at-most 2 hasRoom)(all hasRoom Room)(at-least 2
toLetFor)(at-most 2 toLetFor)(all toLetFor (and Couple
Student))(at-least 1 depositRequired)(all depositRequired Yes))
Service3 (and (at-least 1 depositRequired)(all depositRequired
Yes)(all price (minimum 80)) Bedroom (all toLetFor (and Student
NoSmoker Worker (all sex Female))))
Service4 (and SingleRoom (all toLetFor (and NoSmoker
Student))(at-least 2 occupants)(all price (minimum 120)))
Service5 (and DoubleRoom (all toLetFor Single)(all hasFacilities
(and Lounge Garden))(all hasServices Kitchen)(all price (minimum
85))(all priceIncludes CouncilTax))
Service6 (and Bedroom (at-least 1 occupants) (all price (minimum
81)) (all toLetFor Female)(all hasFacilities (and WashingMachine
TV VCR)))
Service7 (and Bedroom (all price (minimum 95)) (all occupants
Family) (at-least 2 occupants) (all toLetFor (and Student
Professional (all sex Female))))
Service8 (and Flat (at-least 2 hasBed) (at-most 2 hasBed) (all
toLetFor Student) (all hasFacilities ADSL) (all price (minimum
95))))
```

Figure 6: User request and service descriptions in a lisp-like representation

responding to the requested Service.
Our matching engine is based on Java servlets; it embeds a modified NeoClassic reasoner and communicates with it running as a background daemon. The system receives a Knowledge Representation System Specification (KRSS) or DAML+OIL string describing the request/service description.
The Reasoner checks the description for consistency; if it fails, based on the reasoner output, the system provides an error message stating the error occurred. Otherwise the proper matchmaking process takes place.
The module compares requests with service descriptions and ranks discovered advertisements on the basis of their degree of match with the searched Service.

6. EXPERIMENTS AND RESULTS

For test purposes we created eight different web services which were published in a UDDI registry using the proposed mapping of DAML-S in UDDI. For each service it was built a semantic description w.r.t. a reference ontology on *Real estate services* (the UNSPSC *Family* identified by the 80.13.00.00 id) in which it is specified what kind of service is offered, as shown in Figure 5 - 6. Of course we could have services referring to different ontologies. In this scenario we have all the elements to achieve a semantic service discovery:
UNSPSC server for a service category search.
test ontology for semantic service description identified by a UNSPSC id.
semantically described web services represented by a code which is the same or at most is strictly related to their reference ontology name (i.e. the UNSPSC *Family* code)
UDDI registry server in which is stored web services information to be searched.
The result of the service discovery is a set of ranked URI representing the services which best match the request as shown in Figure 7. Of course if the request is the same as, or sub-

Figure 7: Returned page with ranked services for the *Request* in Figure 6

sumes, a service description, we will have the corresponding item ranked with 0 (see the *Let's Let* service in Figure 8). During the discovery we can encounter basically two kinds

Figure 8: Returned page with ranked services for a Request description subsumed by the *Let's let* one

of error in two different phases of the search process: error due either to the absence in the UNSPSC taxonomy of the searched category or to the inconsistency of the request description w.r.t. the reference ontology. In the former case the error is catched by the *UNSPSC server* and a message of *No Items Found* is sent back to the client, in the latter case the error is catched by the *Matchmaker module* which sends back to the client a message containing the description

parts causing the inconsistency. In both cases the client is able to modify its search specification.

7. CONCLUSIONS

In this work we have proposed a framework for web service discovery based not only on a rigid categorization (UNSPSC) but also on the semantic model of a web service (DAML-S upper ontology) and of its domain (domain ontology). With the proposed system, which overcomes simple subsumption matching of services descriptions, we are able to classify web services matching their semantic descriptions in order to establish both how far the offered service is from the requested one and which are the differences in terms of logical constraints. Having a ranked list of candidate web services, it is possible then to assign a preference value useful for a further interaction with the "discovered" web services, that is the negotiation of logical constraints, in the request description, which are not satisfied by discovered ones. We are currently working on a new version of the system that will return *input* and *output* **DAML-S Service Profile** properties for a two steps search. In the first step the comparison is performed between requested service and offered descriptions using the algorithm in [9], implemented in the ***Matchmaker*** module of the proposed architecture; in the second step the comparison is performed between input and output descriptions using a subsumption algorithm.

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Requirements Engineering for Service-Oriented Computing: A Position Paper

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ABSTRACT

Modern XML-based technologies as well as current business trends enable a move to service-oriented computing, in which functionality previously offered by application software, is now offered by the infrastructure. We argue that this enforces a new approach to requirements engineering for services, and that two different kinds of requirements engineering will emerge: requirements engineering for service consumers and requirements engineering for service providers. For the latter kind, we propose service blueprinting, which originated in marketing, as a good source to develop a requirements engineering approach to serviced-oriented computing.

1. INTRODUCTION

A current trend in computing is to provide more and more IT functionality as services to be offered by third parties. We see this trend happening inside organisations, where more and more IT functionality is provided by central departments instead of by the same departments that use this IT. We also see this trend between organisations, for instance in the form of applications being provided by application service providers (ASPs). In this paper, we argue that this trend has implications for requirements engineering, and that we expect two different kinds of requirements engineering to emerge: requirements engineering for service consumers and requirements engineering for service providers.

Recently, the term *service-oriented computing* emerged to denote the concept of computing by consuming fine-grained computational services delivered over the Internet. Service-oriented computing entails a move of functionality from applications to infastructures. This move is not new: The company-wide database management systems that arose in the 1970s are early examples of service-oriented infrastructures. However, recent trends have accelerated the movement to service-oriented computing. First, the opening of the Web has made computing resources available world-wide to users world-wide. As has been noted by several authors, this reduces the risk of outsourcing business tasks [1]. Second, XML and associated standards such as WSDL, UDDI and DAML-S [2] provide the technical foundation for providing even small-scale functionality as a service. A service no longer needs to provide independent functionality, as provisions for service composition offered by these standards allow functionality to be combined with other functionality offered as a service. Third, mergers and acquisitions are the driving force in the business for service orientation: Functionally equivalent IT programmes in different parts of the merged organisation are taken over by shared service centers that are cheaper because of economies of scale.

The distinction between requirements engineering for service consumers and requirements engineering for service providers originates from separation of concerns. On the one hand, service consumers focus on a particular task they have to perform that is supported by an IT service. Service consumers are concerned with performing this task as effectively and efficiently as possible. In many cases, ownership and management of the hardware and software needed to support their task has no positive influence on effectiveness and efficiency. In these cases, outsourcing the IT functionality needed for the task as a service to be provided by a service provider is beneficial as it relieves service consumers of all distracting activities associated with owning and managing their own IT support.

On the other hand, the service provider, be it a central IT department in a large organisation or an independent application service providers, focusses on utilising economies of scale to provide one or more services as effectively and efficiently as possible. Economies of scale should be interpreted in a broad sense here. First, we see direct economies of scale: the additional costs for the service provider of providing a service to one more customer if there are already very many customers approaches zero. Second, we see indirect economies of scale: A large service provider, when providing a new service for the first time, is leveraged by experience gained by ongoing business and by having, on

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average, more highly skilled personel.

This separation of concerns has consequences for both service consumers and service providers. To reach economies of scale, service providers need to offer a service portfolio that is highly standardised and stable over time. This means that service providers cannot meet each individual, business-specific function demanded by service consumers, but have to find some way to offer a set of more generic services that large groups of both current and future users may find beneficial. Service consumers have to take the current offering of services as a starting point and align their tasks and processes with these services, such that these processes can be supported with a minimal need for custom services. Requirements engineering for service-oriented computing has to take these consequences into account.

The structure of this paper is as follows. Section 2 discusses the consequences of service-oriented computing for requirements engineering and presents the two kinds of requirements engineering that we expect to emerge. In Section 3, we present service blueprinting, a well-known technique from service marketing, as an example of a technique that we think may benefit requirements engineering for service providers. Section 4 concludes the paper and discusses further research.

2. THE CONSEQUENCE OF SERVICE-ORIENTED COMPUTING FOR REQUIREMENTS ENGINEERING

2.1 Service layers

In this paper, we view an organisation, or a department within an organisation, as a stack of service layers (see Figure 1). The mission of an organisation is to deliver services to its environment[1]. This mission is realised by business processes, which in turn are supported by business-specific application software. This application software is itself supported by a generic software platform (consisting, for instance, of a relational database management system, middleware, etc.). The software platform is supported by processing and network hardware that it is allocated to.

Service orientation occurs at all layers. Probably the oldest example is service orientation at the hardware layer, in the form of (national) supercomputer centres offering raw computing power as a service to universities and research institutes. We already mentioned service orientation at the platform layer in the introduction: for at least two decades, it is possible to offer storage as a service (e.g., in the form of a file server or database management system). More and more, we see that business-specific application software is offered as a service. Currently, most often this is done within one organisation, but it is also possible to outsource business-specific applications to an independent Application Service Provider (ASP). Business processes can be outsourced as well. As an example, in many financial institutions, back office processes (e.g., credit card payment processing) are outsourced to so-called shared service centres that execute these processes for more than one bank or

[1]Without loss of generality, we assume that every organisation delivers services. This means that even for e.g. a manufacturer of a commodity, we view its offering as a complex service that consists of manufacturing the commodity, logistics, and pre/after sales services.

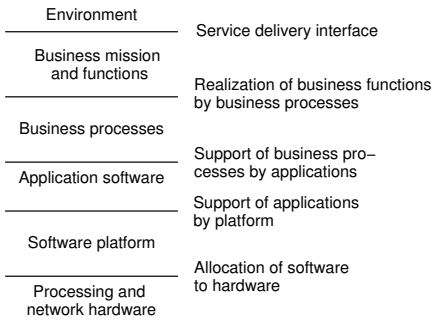

Figure 1: Service layers and interfaces.

	Centralised	Decentralised
Concentrated	No autonomy whatsoever for functional units	IT service provider owns and manages IT, but provides any service requested by departments
Deconcentrated	Decisions made at central level, but operated at many sites for reasons of performance or redundancy	Every department is completely self-sufficient

Table 1: Centralisation vs. concentration.

service brand.

2.2 Centralisation versus concentration

In IT service management, it is important to distinguish between centralisation and concentration [6]. Centralisation refers to the amount of autonomy: in a fully centralised situation, one central authority makes all decisions. In a fully decentralised situation, each functional unit of an organisation can make all IT management decisions fully autonomously. Concentration refers to ownership and management of hardware and software. In a fully concentrated situation, all hardware and software is managed by a central department in one physical location. In a deconcentrated situation, hardware and software are owned, operated and located physically within functional departments. All combinations of centralisation and concentration are possible, as illustrated in Table 1.

Centralisation/decentralisation and concentration/deconcentration can apply to any layer discussed in the previous section. In a financial institution, it is for instance possible that application software is concentrated (everyone uses a customer relationship management system that is managed by a central department), but customer relationship management processes are deconcentrated: each front-office department has its own helpdesk personel.

Service orientation occurs in concentrated situations, where there is one department that owns and operates hardware, software, or applications, and offers it as a service to other departments. In a decentralised situation, each of

these other departments can decide for itself which services it sources from which provider, and it can negotiate with providers to customize existing services or develop new ones. In a centralised situation, it is decided by a central authority which services are offered to which department.

It is often difficult to determine whether deconcentrated IT is offered as a service. For instance, in a Dutch government branch with offices in a number of regions, file storage services are centralised but deconcentrated for reasons of performance. In each regional office, file server hardware and maintenance personel can be found. Nevertheless, to the managers of functional departments, file storage is offered as a centralised service. In many other cases, however, deconcentrated maintenance personel and hardware is part of the functional departments in which it is located. Whether IT policy is centralised or not, in this case the provisioning of IT functionality cannot be considered a service.

2.3 Consequences for requirements engineering

In a large organisation where IT services at one or more layers (in the sense of Section 2.1) are concentrated, there are two groups of stakeholders that deal with services:

- User groups responsible for some business function, who need IT support for this. As IT support is concentrated, this support is delivered to them in the form of a service. Therefore, we call these users *service consumers.*
- Those responsible in IT departments (where IT functionality is concentrated) for designing, implementing and providing IT services. Let us call these, in a generalized sense, *service providers.*

Service provider and service consumer are actually roles of user groups. A service consumer consumes services that support the business process this service consumer is responsible for. It may be the case that this business process is actually itself the provisioning of a service either to external clients or another department within the organisation. Thus, the service consumer is also a service provider.

Service users need to determine what IT support they need, and service providers need to determine what IT support is needed by the organisation. Although both groups try to determine what IT is needed, both groups will differ in the way they determine this, as their goals and organisational context differ. This is why we expect two different kinds of requirements engineering to emerge. In this section, we will sketch these two kinds of requirements engineering.

First, requirements engineering for service consumers. Service consumers can be found in all departments of an organisation except the IT department (where IT functionality is concentrated)[2]. The goal of service consumers is derived from the business goal of the department in which they are located and usually concerns some part of the organisation's mission. Service consumers try to support this mission as effectively and efficiently as possible.

The primary task of requirements engineering for service consumers is to align business processes and user tasks with services offered. This means that a requirements engineer may ask whether there is a desire for new services to be developed. But the requirements engineer may also suggest changes to the business processes or user tasks to adapt them to services currently offered. In a centralised situation, this may be the only option, as service consumers are forced to adapt to the services offered. For example, if bookkeeping operations are offered centrally as shared web services, then then users have no choice but using these services. The requirements engineer, in this case, can help to adapt. In a decentralised situation, for reasons of costs, it is often better to adapt to services currently offered than to have new ones developed.

As an aside, private end users of a service (e.g., consumers at home) are considered service consumers as well. However, requirements engineering for end users in this context amounts to requirements engineering of a special class of commercial of-the-shelf (COTS) software packages for end users: packages that provide functionality by consuming services offered by third parties. Just as for service consumers in an organisation, in this case the primary task of the requirements engineer is to align end users wishes with the services offered.

Second, requirements engineering for service providers. Service providers can be found in the IT department of an organisation, or, in the case of outsourcing, in a different organisation altogether. Their goal concerns the availability of a service infrastructure for the current and future user base. Service providers need to develop and maintain this infrastructure as efficiently and effectively as possible. Therefore, they will try to provide one single generic infrastructure for all current and future users, rather than custom solutions for each specific user group.

Thus, the requirement engineer no longer constructs a specification of desired functionality needed for a concrete user task of a well-defined user group. Instead, the requirements engineer is designing an infrastructure. As is often the case with infrastructures, it is not known in advance who will use it and what the context of use is. This means that when a service is designed and implemented, a particular user group is targeted, but the individual members of the group are not known. Moreover, after the desired functionality is specified, designed and implemented, it is not handed over to the users, but remains with the service provider and is offered as a service. This means that the requirements engineer is not only responsible for specifing IT functionality, but also for designing a service that can be offered to users. In the next section, we present a technique that is used in general service design in marketing and that we think is beneficial for this aspect of requirements engineering for service providers.

Requirements engineering for service providers can be compared with for instance designing the public road system: When designed and constructed, the targeted user group consists of private individuals and transport companies. The members of this group are not known individually. The requirements for the road system are diverse and originate from the law, safety regulations, individual companies that may have conflicting interests, and the interests of private individuals who rarely give a thought about what the road system should look like. This is completely different from the development, in a traditional way, of an application that computes next year's budget in a government organization, developed for a particular government department. The ap-

[2]The IT department may itself outsource part of its own IT support. In this case, service consumers are also found in the IT department

plication embodies the budgeting rules of that department and has a small number of users, who, at least in theory, can all give their requirements to the application designer. The functionality offered by such an application becomes a service when it is outsourced to a system that provides this service not only to this particular department, but to a varying number of departments that are not known in advance.

Notwithstanding their differences, both kinds of requirements engineering have a number of characteristics in common. First, service level agreements (SLAs) play an equally important role in both kinds of requirements engineering. At the service consumer side, current service level agreements offered are a starting point for aligning user tasks and processes to the services offered. In a decentralised situation, a specification of a service level agreement may be one of the results of requirements engineering. This SLA is offered to a service provider as a specification of desired functionality. At the service provider side, a specification of a generic SLA is an outcome of requirements engineering that specifies a new service to be developed and offered to users. SLAs have been studied intensively (see e.g., [3, 4]).

Second, we expect that both kinds of requirements engineering will be embedded in the consumers' and provider's departments in a way that differs from traditional requirements engineering. We expect that requirements engineering will become less of a project-like kind of task (which preceedes design and implementation and is at some point in time finished). Instead, requirements engineering will evolve in the direction of a continuous task, as the alignment of business processes with services offered is never finished. Requirements engineering will become a role or function in user departments and the IT department centered around continuously monitoring service level agreements to determine whether services are delivered as agreed, whether the services delivered are (still) the right ones for the task at hand (consumer side), and whether new services should be offered (provider side).

3. SERVICE BLUEPRINTING

As explained in the previous section, one of the characteristics of requirements engineering for the service provider side is that the requirements engineer is not only involved with specifying which IT functionality is needed, but is designing a service. In this section, we present service blueprinting [7], a technique that is used in general (not necessarily IT-related) service design.

Service blueprinting is a technique that describes all activities that are carried out by a service provider and its customer to deliver a service. These activities are classified in four categories:

- Service customer activities
- "Onstage" contact employee activities
- "Backstage" contact employee activities
- Support activities

Both "onstage" and "backstage" contact employees directly deal with customers (i.e., handle individual customer service delivery instances, for instance taking an order at a counter or processing a mail-in form). The difference between "onstage" and "backstage" contact employees is that "backstage" contact employees are invisible for the customer: the customer never sees the "backstage" contact employee, or speaks with this employee. Support activities (as they are usually named in service blueprinting) are activities that are decoupled from customer contact, e.g. logistics in the case of a chain of fast-food restaurants. Despite their name, support activities in the sense of service blueprinting are often part of the core business of an organisation.

Figure 2 shows an example service blueprint. The service offered in this example is an electronic newspaper article service for which the user has to apply for a password. The top line of the figure shows the ("tangible") evidence of service delivery. The other four lines (separated by three lines) depict the four categories of activities. Arrows between activities should be interpreted loosely as cause-and-effect relations or temporal precedence or enabling of activities. An important part of every service blueprint are activities included to resolve service delivery problems. In this example, a helpdesk is included to provide assistance in case of problems. Other such activities could for instance be activities that roll back transactions.

In constructing a service blueprint, the following design choices have to be made:

- Which service delivery activities are carried out by the consumer, i.e., what amount of self-service is involved? At service design time, it must be determined whether a customer can be expected to be able and willing to perform his or her part of the service delivery process.
- Which events occur in a service delivery process? For each event, there must be someone or something that responds to this event.
- Which part of a service delivery process is specific for a particular customer, and which part is generic?
- Which part of a service delivery process is visible for a customer (i.e., where is the line of visibility)? Activities that are visible for customers may need to be supported such that a customer is always treated with the same quality of service. This may have consequences for IT support for these activities, e.g., access to a customer relationship management system must be provided.
- What activities have to be performed in case of service delivery problems? To retain customers, it is very important to have proper procedures in case of problems. In the case of services delivered via the web, there are many different technologies to support these procedures [5].

The notation of service blueprints bears some resemblance to the notation of UML activity diagrams. Activities in a service blueprint translate to activities or wait states in an activity diagram. In activity diagrams, there is a richer notation for representing temporal relations between activities (i.e., choice, concurrency and synchronisation). The 'line of interaction', 'line of visibility' and 'internal line of interaction' can be represented in an activity diagram by boundaries between swimlanes.

We think that the service blueprint notation is a valuable technique in requirements engineering at the provider side[3]. A service blueprint makes important design choices explicit

[3]Service blueprinting plays a minor role in requirements en-

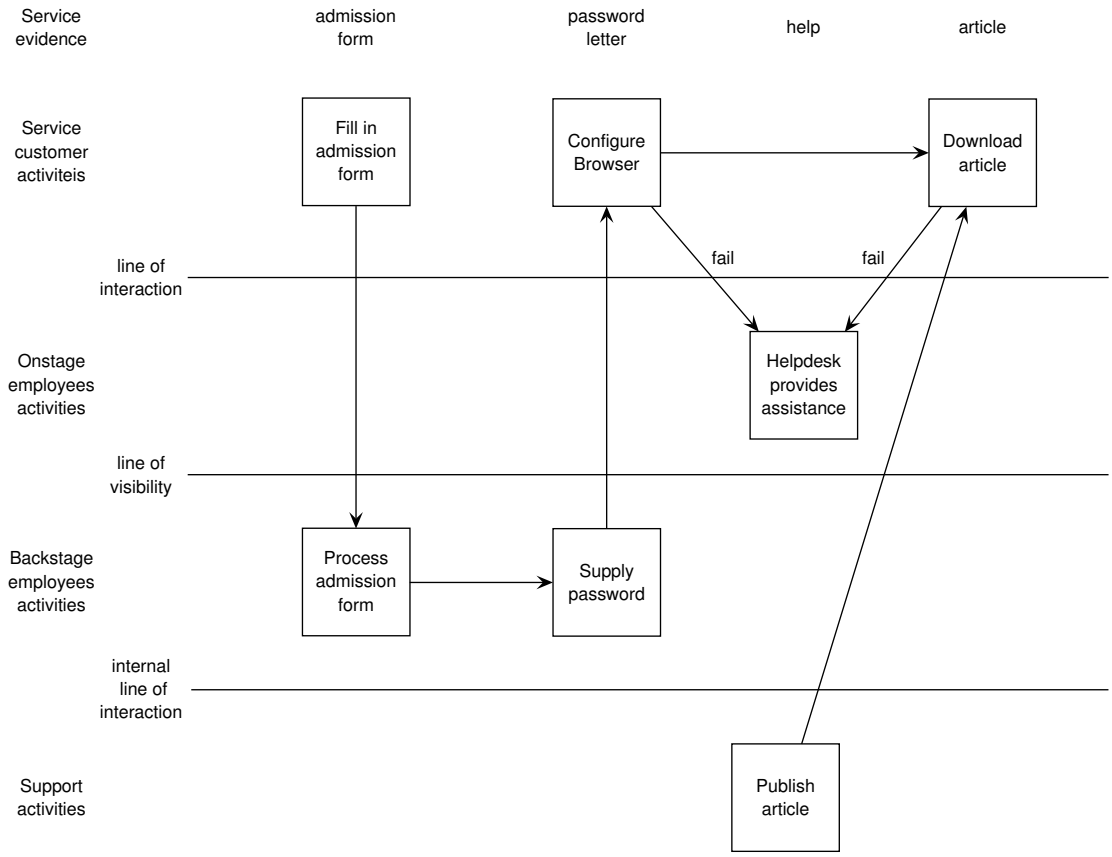

Figure 2: Example service blueprint.

without using a notation that is too formal or complex to appeal to non-IT personel or process engineers. After service blueprints have been approved by all stakeholders, specialists can translate them into activity diagrams and add all details needed to design IT support for the service modelled in a service blueprint.

4. DISCUSSION AND CONCLUSIONS

We observe a trend to move increasingly more IT functionality from applications to IT infrastructures. We have argued that this trend will influence requirements engineering and that we expect two different kinds of requirements engineering to emerge: requirements engineering for service consumers and requirements engineering for service providers. Both forms of requirements engineering cooperate to jointly define sets of services, described in service level agreements, that supports tasks of service consumers as efficiently and effectively as possible and can be offered by central departments at a sufficiently large scale to generate significant cost savings. We have identified service blueprinting, a technique from service marketing, as a useful technique for requirements engineering for service providers.

Note that the requirements engineering task for the provider side is not the same as requirements engineering for commercial off-the-shelf software (COTS), as COTS is first and foremost a tangible product, not an (intangible) service. COTS is sold to a market and after the sale, the seller does not provide the service implemented in the COTS (but the seller may provide after-sales service in maintaining the COTS). In fact, a COTS vendor may sell its software to a service provider, who then provides it to end users as a service (in which case the end users do not recognise it as a COTS product). Requirements engineering for COTS is different as it does not have to pay attention to service delivery issues (i.e., the design choices mentioned in Section 3). Instead, requirements engineering for COTS has to pay attention to software functions that enable the COTS buyer to manage and operate the software himself.

Our approach to service-oriented computation complements the work in mainstream web services [2], which mainly has a technical focus. Whereas mainstream web services research develops for instance service registries, web service query languages and associated query processors, we analyze how to determine which services to put in a service registry (service provider side) and which queries to submit to find services that support a user group (service consumer side).

In future research, we plan to gather other ideas from the general service marketing and service management literature, apply them to service-oriented computing, and evaluate our results in case studies and consultancy work. Moreover, we plan to investigate the relation between service blueprints, UML activity diagrams and the formalisms for service description provided by standards such as DAML-S, ebXML and BPEL4WS.

Acknowledgements

The authors thank Jaap Gordijn for pointing us to the service blueprinting literature and the example, and the anonymous reviewers for a number of valuable suggestions for improvement.

gineering for users in their role as service consumers, e.g. when the consumer side involved in a design process at the provider side.

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Business models for personalized real-time traffic information in cars: which route to take?

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ABSTRACT
ICT developments such as radio navigation and mobile traffic information services offer opportunities to improve traffic information services by delivering personalized real-time route guidance to motorists. However, designing a viable and sustainable business model for these services is a complex undertaking. In this paper the business models of two Dutch traffic information services, TMC4U and Traphic, are reviewed. Hereby the focus is on the relations between design choices in the service and organization domain. More specifically the focus is on the relations between the value elements in the value proposition and the value network activities that actors perform. Clear connections have been found between the resources and capabilities actors in a value network possess and their contribution to elements of the value proposition. The results indicate that the government plays an important role in keeping traffic information services affordable. Without the support of the government both services would not be possible.

Keywords: business models, mobile ICT services, traffic information services

1. INTRODUCTION
It is generally felt that the next step in 'mobility info' or 'route and traffic information' should supply personalized, easily accessible and up-to-the-minute route and traffic information that guides the driver from point a to b in the fastest or shortest way. Traditional traffic information collection and distribution systems do not meet these demanding user needs. Current information collection systems include: road detection loops and cameras, road guards and police surveillance. Current information distribution systems include radio traffic reports and dynamic road signs. These traditional systems have a limited coverage and suffer from time delays, which results in outdated information and frustration at the end-user side.

ICT developments such as radio navigation and mobile traffic information services offer opportunities to improve traffic information services by delivering personalized real-time route guidance to motorists. However, designing a viable and sustainable business model for these services is a complex undertaking because user, organizational, financial and technical requirements need to be accommodated and balanced. Design choices in one domain (e.g. the role of the government in the organizational domain) may affect those of the other domains (e.g. the traffic information collection systems in the technical domain). This interrelatedness of design choices complicates the design of viable business models for mobile services.

In [5] a conceptual framework for designing business models describing the most important design variables within the service, organisation, finance and technology domain and the relationships between these variables is presented.

In this paper we use this framework to analyse the business models of two Dutch services for personalized and real-time traffic information. We focus in particular on the service and organisational design of these services, and on the linkages between design choices in the service and organizational domain. The data for this analysis is obtained from desk research and interviews with the content and service providers.

This paper is organised as follows. First, we will review theory of business models and introduce the conceptual framework. Second, the generic value chain for traffic information services is outlined. Third, the business models for the two case studies are analysed and compared. Finally, conclusions are drawn with respect to the balancing of user and organizational requirements.

2. THE BUSINESS MODEL CONCEPT
The provisioning of traffic information services requires firms with different resources (e.g. installed base, and customer base) and capabilities (e.g. radio broadcasting, and traffic management), to co-operate to create value for merchants and customers. Given the low success rate of inter-firm co-operations (see e.g. [1], [6] and [8]) and the risks and cost involved introducing new technological innovations it is not surprisingly that there is much

attention of practitioners and academia for the concept of business models.

Despite its popularity, there is little consensus on how to define business models (see e.g. [10], [12], [14] and [15]). We see a business model as a blueprint of the way a *network of organisations* co-operates to create and capture value from the employment of technological opportunities. So we look beyond the individual firm and consider the business model for a networked *enterprise*: a collaborative effort of multiple companies to offer a joint proposition to their consumers. When comparing the different definitions of business models it is possible to distinguish some common elements, that are network oriented or can easily be extended to be so (see e.g. [5]):

- *Service domain*: a description of the value that the value network offers to a specific target group of users, in particular in terms of a service offering.
- *Organization domain*: a description of the configuration of actors that is needed to deliver a particular service, the roles that each plays, making clear how the network creates value for end-users.
- *Technology domain*: a description of the fundamental organization of a technical system, the technical architecture, which is needed by the firms in the value network to deliver the service offering exhibited in the service design.
- *Finance domain*: a description of how a value network intends to capture monetary value from a particular service offering and how risks, investments and revenues are divided over the different actors of a value network.

Still little is known about how to effectively design and balance these different blueprints. Only recently, researchers have started to address this important issue (see e.g. [2], [3], [8] and [11]).

3. THE CONCEPTUAL FRAMEWORK

As depicted in Figure 1, the conceptual framework (see [5]) consists of four interrelated domains: the service, organization, technology and finance domain. The service domain is put deliberately on top because we believe that a business model design should start with the demand side of a service offering (see e.g. [4]).

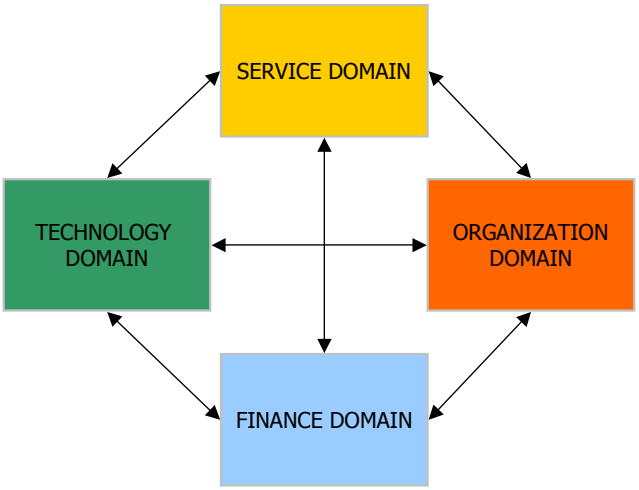

Figure 1: high level conceptual framework

Organization and technology and finance domains represent the supply side of a service offering. The finance domain is deliberately put below because we believe that revenues are the bottom line for all design choices. For each of these domains important design variables and their relationships have been identified, which have been summarized in so-called domain models. For the purpose of this paper we have given in Figure 2 the most important variables in the service domain and the organizational domain together with their relations.

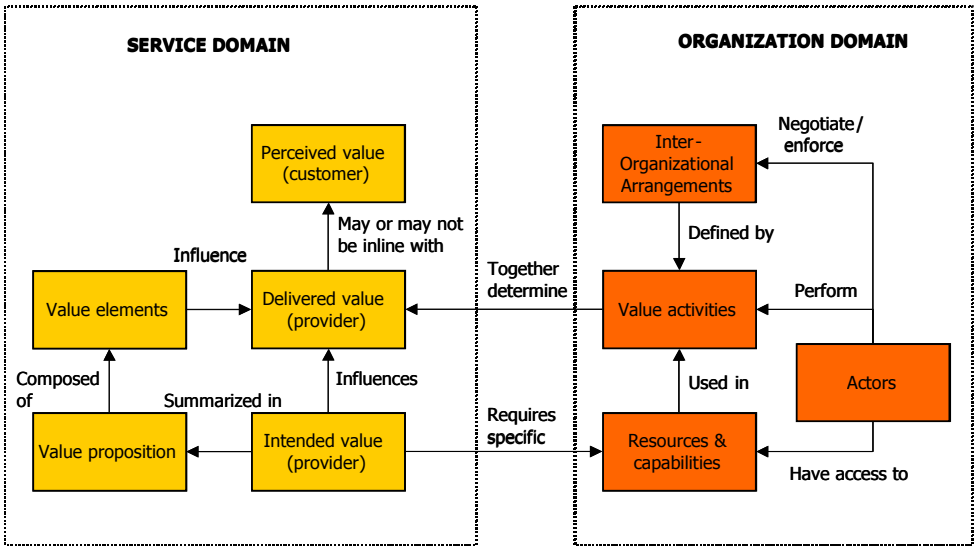

Figure 2: Important variables in the service and organization domain and their relations

The central issue in the Service domain is related to the *value* of the service: a provider intends and delivers a certain value to a specific target group. The intended value is summarized in a value proposition. This value proposition, in turn, contains value

elements. A customer perceives a certain value when consuming or using the service. The perceived value is influenced by the customer's perception of the delivered value elements. The organization domain describes the value network that is needed to realize a particular service offering. For realizing a service offering specific resources and capabilities are needed. Actors are selected based on the access they have to these resources and capabilities. Depending on the power they have actors negotiate or enforce inter-organizational arrangements defining who performs which value activities in what way. A combination of value activities defines the role an actor plays in the value network. The value activities, performed by the different actors, together determine the delivered value to the customer.

3.1 Design of the value proposition

Important value elements for the value proposition of traffic information systems are accuracy, ease of use, personalisation and costs. The interviewees explicitly mentioned these four elements to be the most important. The value elements are elaborated below.

Accuracy The added value of traffic information is dependent on the accuracy of the offered information. Accuracy is dependent on the sample frequency of traffic information. Especially accidents and other unforeseeable events may be noticed too late when traffic information is distributed in too large time intervals. Accuracy of traffic information carries the notions of being correct and useful as well as being on time. The degree of sophistication of data collection and subsequent processing is mainly responsible for the correctness and usefulness of the information. For example an estimate of expected travel time is considered as very useful information, albeit difficult to generate. The value of the traffic information is greatly reduced if the time-delay between the collection of the traffic data and the distribution of the traffic information is too large.

Ease of use is generally regarded as an important factor in consumer adoption. The usability of traffic information services is determined by different factors. First, the barriers to start using a mobile device should be as low as possible. E-commerce research shows that many consumers cancel a transaction when they find out that they have to fill in all kinds of registration forms. Second, the device (e.g. radio and mobile phone) that is being used to receive and filter traffic information should be user friendly.

Personalization is regarded as critical success factor for mobile services. Both for the users as well as for mobile service providers personalization can offer added value. For the user personalization can offer: (a) better adjustment to wishes and preferences in a particular situation, (b) a possibility to filter out the desired information from the flood of information, (c) a richer user experience, and (d) easy access to other interesting services, which fit in his or her user profile. For mobile service providers personalization is seen as an opportunity (a) to increase the perceived value of their services, (b) to bind customers to a particular service or bundle of services, (c) to obtain information on user preferences, and (d) to customize advertisement campaigns.

Costs Traffic information is typically regarded as a public service. As such people are not used to pay for this type of information. It seems therefore to be difficult to generate revenues from offering traffic information. Yet usage statistics of I-mode show that traffic and weather information are among the top five of most popular services. Users pay a monthly fee of €2 to gain access to the traffic information I-mode site. Thus there appears to be a group of users that is willing to pay for traffic information.

3.2 Value network roles

A configuration of actors is needed to realize a service offering for a customer. Hawkins [7] identifies three basic types of actors in a value network: *structural* partners, which provide essential and non-substitutable (in-) tangible assets, *contributing* partners, which provide goods and/or services to meet specific network requirements, and *supporting* partners, which provide substitutable, generic goods and services to the network. This classification scheme is helpful to analyse the balance of power or control between the partners depending on the assets they contribute to the value network in each specific case. Structural partners in principle are better positioned to exert control over the network than supporting partners.

The classification scheme as introduced in [7] requires extension with a set of explicit criteria that decide whether a partner is structural, contributing or supporting. Hawkins based the distinction on the substitutability of assets and the financial risks partners take in the enterprise. We elaborate on the substitutability of assets for this purpose, because it can be directly related to the design of the value proposition. In fact, we consider a partner as structural if it controls assets and *value activities* that are required to realise the identified core elements of the value proposition, and which are hard to substitute. If the partner controls such assets and activities, but is substitutable, then we consider the partner as 'contributing'. Other partners are regarded as supporting.

4. THE TRAFFIC INFORMATION VALUE CHAIN

The traffic information value chain can be broken down into three value activities: the collection of traffic data, the processing of traffic data, and the distribution of traffic information. These value activities are depicted in Figure 3 and discussed in more detail below. Critics of value chain analysis (e.g [13]), note that the chain metaphor masks the importance of horizontal aspects of a firm's processes, particularly their relationships with other firms. In the analysis of the two services we therefore consider value networks.

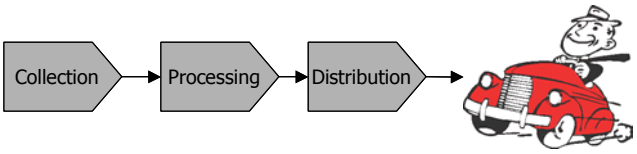

Figure 3: value chain for traffic information

4.1 Collection of traffic data

The first step in the traffic information value chain is the collection of traffic data. For the highways an extensive infrastructure for generating traffic data exists in the densely populated Netherlands. There is about 2500 kilometre of highway of which some 1000 kilometres are covered by signalling devices. These devices operate on traffic detection loops build in asphalt, personal observation by police, highway maintenance, highway patrol (ANWB wegenwacht) and voluntary road guards. For the secondary roads currently no country-covering infrastructure exists. Current initiatives focus on traffic information for cities with severe traffic jams such as Utrecht and Rotterdam. For the collection of real-time traffic and route information one can make use of the installed base of traffic management systems or the installed base of mobile communication devices. Both are elaborated below.

- Installed base of traffic management systems. Companies like Vialis and Siemens operate large numbers of traffic management systems in urban and suburban areas. Systems include road signals, detection loops, railroad crossing protection, access management systems, etc. Most of these systems are 'wired' which in principle allows for real-time data collection on traffic flows. This 'raw' data may be converted to traffic information similar to the way this is done with highway information.
- Installed base of mobile ICT devices. Another way of gathering data is directly from the moving car itself. This technique is referred to as floating car data. Satellite-based navigation techniques, like the Global Positioning System (GPS) may be used to determine the position and velocity of cars in the network. Alternatively mobile phones may be used to collect this information. The Dutch government is currently actively stimulating the market to develop systems with floating car data in the Intermezzo program. An accurate and real time picture of the traffic flow can be obtained if sufficient cars can be monitored. As traffic data is extracted from the installed base of mobile telecom operators, costly and cumbersome sources of traditional traffic information - such as ground-based sensors and surveillance equipment - are no longer needed.

4.2 Processing of traffic data

The second step in the traffic information chain is to convert the raw traffic data into traffic information. In the Netherlands there is one public authority, the Traffic Information Centre (TIC), which gathers all highway information, converts it to the so-called DATEX format, and subsequently distributes it to about sixteen different service providers.

4.3 Distribution of traffic information

The third step in the traffic information value chain is the distribution of traffic information. This is the domain of the traffic information service providers. In the Netherlands the motorist association ANWB and the service provider 'Verkeers Informatie Dienst' (VID) are the two biggest providers of traffic information. Today the 'current information' department of the ANWB appears more than 60.000 times a year on the radio on both national and commercial channels. With the appearance of the Internet and later mobile telephony new ways of distributing traffic information became possible. There are many, mostly free, services on the Internet providing traffic information in various graphical forms. On the mobile front there exist SMS services, voice response services, WAP services, GPRS services and Traffic Message Channel services.

5. THE ANALYSIS OF THE TWO CASES

In the remainder of this paper we will focus on the business models of two Dutch services for personalized and real-time traffic information: 'TMC4U' and 'Traphic SMS alerts'.

5.1 Research method

The research reported in this paper has been conducted within the Freeband[1] B4U[2] project. The findings are based on an exploration of literature and white papers on tracking & tracing services and a case study of two traffic information services. For the service exploration part industry reports, academic literature and company web sites were consulted. The service exploration allowed us to gain an overview of tracking & tracing services and to narrow down the scope of the case studies to traffic information services. For the case study part representatives from service providers and content providers were consulted. In total we conducted four semi-structured interviews. For the case study interviews a case and interview protocol ([1]) was used. Interviews were recorded and transcribed. Data from interviews were supplemented with information from company websites, industry reports and academic literature. Data were systematically analyzed and results were validated by interviewees.

[1] The Freeband Impulse programme aims at the generation of public knowledge in advanced telecommunication (technology and applications). It specifically aims at establishing, maintaining and reinforcing the Dutch knowledge position at the international forefront of scientific and technological developments. The B4U project is part of the Freeband Impulse programme.

[2] The findings reported in this paper are based on research conducted within the B4U ('Business 4 Users') project (http://www.freeband.nl/projecten/b4u).

5.2 The TMC4U case

TMC4U is a co-operation between Siemens and the Dutch motorist association ANWB, which provides traffic information on highways using the Traffic Management Channel (TMC). Siemens is responsible for the technical systems needed for the coding of traffic information into TMC codes. ANWB takes care of the editing of traffic data.

Value proposition The value proposition of TMC4U to end-users is that car drivers can obtain actual traffic information. Moreover if the car is equipped with a TMC-navigation system it can offer dynamic route guidance, which alerts the driver of a problem on the planned route and calculates an alternative route. Main advantage of TMC4U vis-à-vis traffic information periodically broadcasted on the radio is that it is more detailed, accurate and up-to-date.

Value network The value network of TMC4U is depicted in Figure 4 below. TMC4U receives on a near continuous basis traffic data from the Traffic Information Centre (TIC). TIC uses data from among other things detection loops, road signals, road guards, and police observations to construct meaningful traffic (DATEX) information. The ANWB complements this information with data from their own voluntary road guards and highway patrol (Wegenwacht), and uses it to construct traffic news. The department actual information has several mini-studios with newsreaders, which provide traffic information to several public and commercial radio stations. Besides this the department provides editorial on traffic information that cannot be directly encoded into a TMC-signal. For approximately 5% of the DATEX information editorial is needed. The ANWB has a close working relationship with the TIC. It critically reviews the information provided by the TIC and reports back errors. The TMC data is broadcasted using public (Radio 3FM) and commercial (Sky radio and Classic FM) radio stations. For the public radio stations the signal is transmitted by the NOZEMA. This party manages the distribution of all public radio and TV signals. Radio stations provide their radio programmes to NOZEMA, which subsequently broadcast it. Commercial stations broadcast the radio signals themselves. Cars equipped with a RDS tuner can receive the TMC data. Traffic information appears as text messages on the radio's displays. Cars equipped with a navigation system and a TMC module can filter this information and incorporate it in the route planning and guidance. In this way car drivers are automatically guided along an alternative route in case of a long traffic jam. The information distribution can be characterized as a push model. Traffic information is pushed to navigation systems, which in turn filter it according to pre-defined user settings.

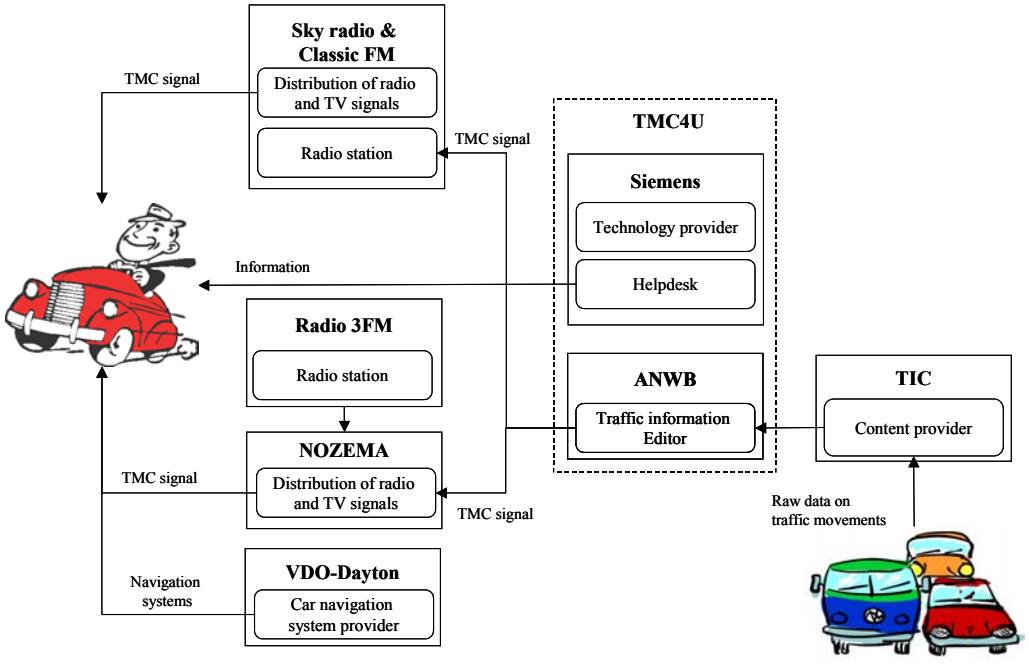

Figure 4: Value network TMC4U

Revenue model At this moment TMC4U is not a profitable initiative for both the ANWB and Siemens. The TMC signal is offered for free. The costs of TMC4U are divided on a 50-50% basis between Siemens and the ANWB (see Figure 5). Main sources of revenue are VDO-Dayton, which is a subsidiary of Siemens, and members of the ANWB. VDO-Dayton sponsors TMC4U with a small amount per sold car navigation system with TMC module. Hence, at this moment the sale of hardware sponsors the service. VDO-Dayton sponsors TMC4U because it is of added value to potential buyers of car navigation systems. The ANWB uses a part of its membership contributions to finance TMC4U. The government has committed itself to fund a public TMC service and has put out a public tender. If TMC4U succeeds in winning this tender it receives government funding. TMC4U strives to extend its services to secondary roads. Besides a public TMC service it wants to set up a commercial variant, which makes use of coded access.

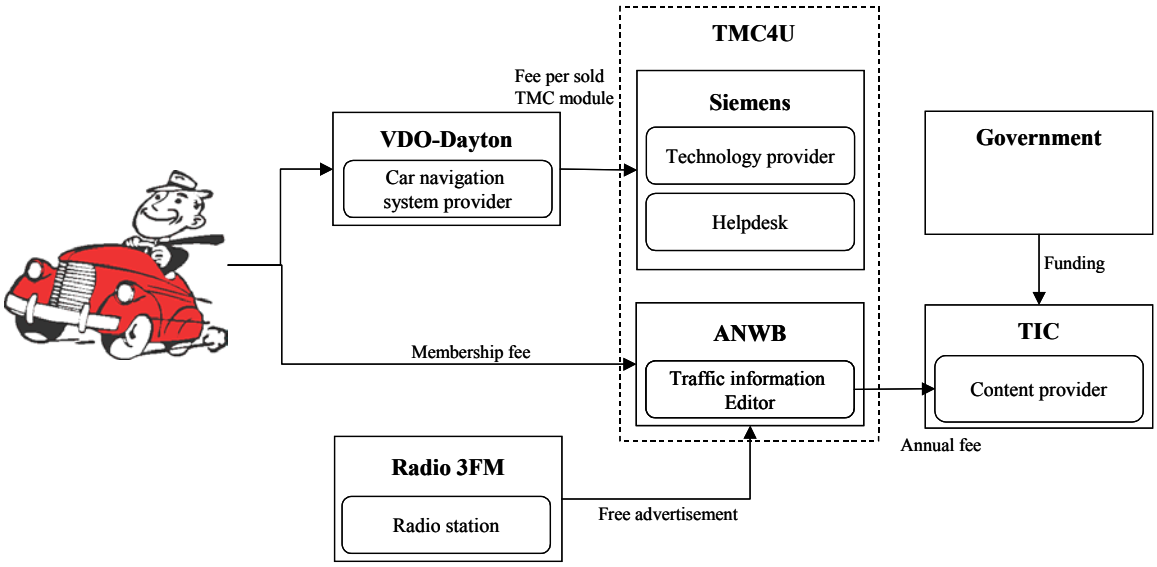

Figure 5: Revenue model TMC4U

5.3 The Traphic case

Traphic is a multi-modal (WAP, web, voice, SMS) traffic information service offered by Vialis. Vialis is a company specialised in traffic management systems. Traphic offers re-routing services to companies and positions itself as a cheaper alternative to 0900 information numbers. Traphic also offers a SMS alert service, which can be activated and deactivated on their website. Finally, Traphic also sells its content to service providers on the Internet (e.g. Vizzavi, mViva, Jamba) and mobile operators (e.g. O2). In this paper we will focus on the SMS-alert service.

Value proposition The value proposition of the Traphic SMS-alert service towards end-users is that car drivers can obtain actual specific traffic information via SMS for their favourite daily route, at a specified time. Drivers can fill in a 'personal profile' on the Traphic website containing both a route, for which they want information, and a time at which they wish to receive the SMS. The user also activates and de-activates the service at the site. The specific route and time may be changed at any moment. The main advantage of this service is that drivers get personalized information at the moment they wish to receive it.

Value network The value network of the SMS alert service of Traphic is depicted in Figure 6 below. Vialis receives on a near continuous basis traffic data from the Traffic Information Centre (TIC).

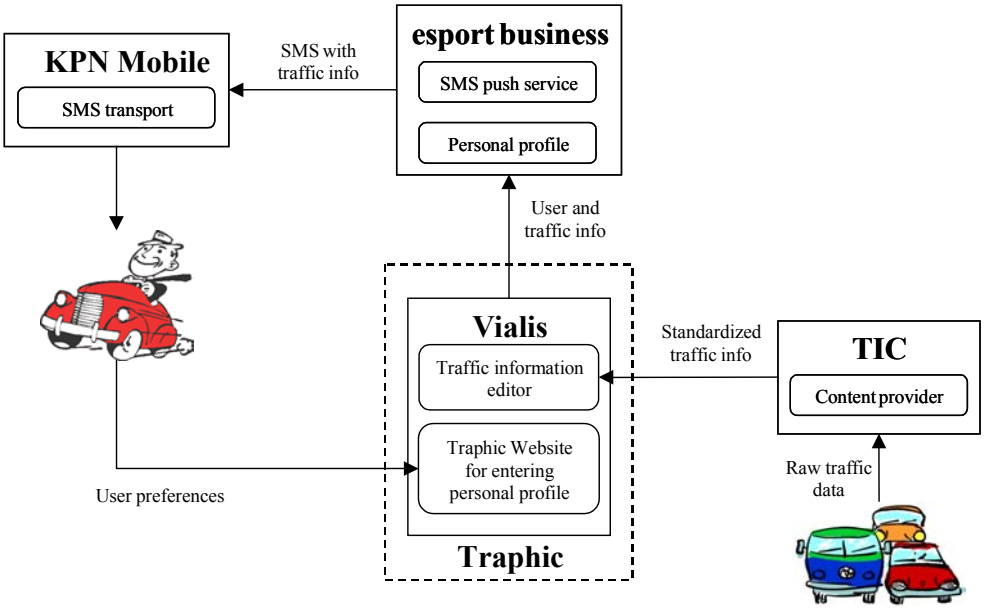

Figure 6: Value network Traphic SMS-alerts

The TIC provides actual traffic information for the Dutch Highway system. On the Traphic website the user can supply his personal profile. The profile information and the processed real-time traffic info are used by esportbusiness to push the specific traffic info via SMS at the right time to the user. Finally, the mobile operator KPN Mobile performs the actual transport of the SMS.

Revenue model At this moment Traphic is not a profitable initiative for Vialis. The main reason for offering this service is to understand and develop the market for 'mobility information'. Vialis believes that in the long run door-to-door traffic information will become available. To realise this it is necessary to collect traffic data not only from the highways but also from the secondary roads. Rather then a traffic information distributor, Vialis views itself as the future content provider for this secondary road traffic data. It intends to extract the traffic info from its current large installed base. Most of these systems are 'wired' which in principle allows for real-time data collection on traffic flows. This 'raw' data may be converted to traffic information similar to the way this is done with highway information.

Vialis pays a small annual fee to the TIC. Revenues received from the end-user are split over the operator, the SMS services provider (esport business) and Vialis (see Figure 7).

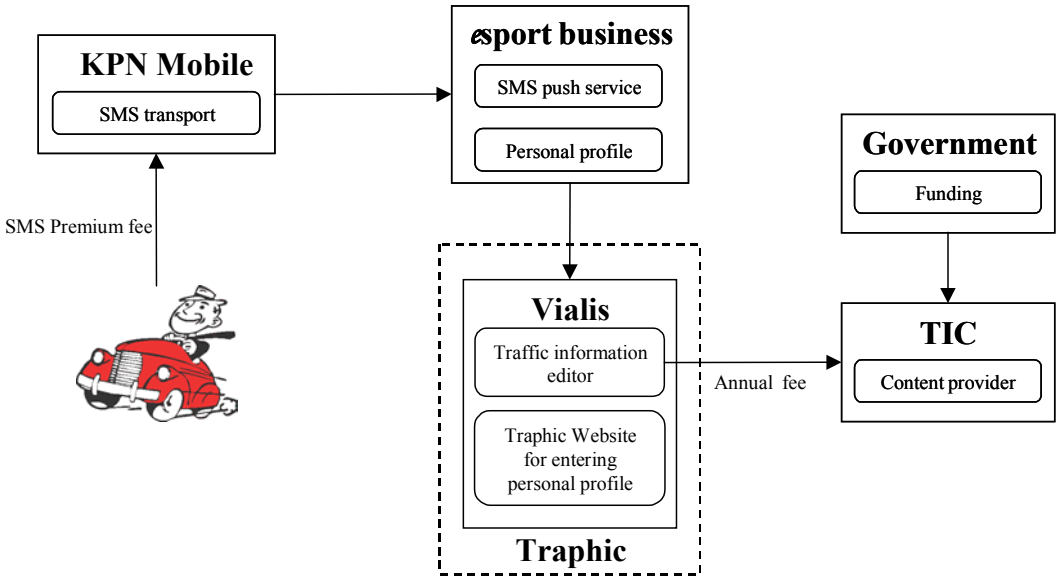

Figure 7: Revenue model Traphic SMS-alerts

5.4 Cross-case analysis

In this section the value elements of the value proposition, and the design of the value networks of TMC4U and Traphic will be compared. First, the value elements of the value propositions are compared. Subsequently the critical resources and capabilities needed to realise this value proposition are analysed. Finally, actors' contribution to the value proposition will be analysed.

With respect to accuracy, personalization and ease of use TMC4U clearly has more to offer to end users than Traphic. When comparing the costs of both services some interesting differences can be noted (see Table 1). In the Traphic case SMS costs may be too big an entry barrier, which in turn may diminish the added value (accuracy) of traffic information.

The TMC4U service, on the other hand, is free of charge, yet it requires end users to invest in a RDS tuner/ navigation system. Hence, whereas TMC4U is characterised by zero variable cost and relatively high fixed cost for end users, Traphic is characterised by relatively high variable cost and virtually no fixed costs for end users.

Both services may be augmented in the future with forecasts about the expected time of travel on the defined route.

Table 1: comparison of value elements

Value elements	TMC4U	Traphic
Accuracy	Almost continuous stream of traffic information is pushed	Traphic information is distributed on a predefined point(s) in time
Personalization	If the user has a navigation system, TMC messages can be filtered when destination is known so that only information relevant to the current journey are displayed	Users need to fill in personal profile containing their favorite daily route at a specified time
Ease of use	Automatic route guidance when navigation system is used	Specific and actual traffic information via SMS for users' favorite daily route at a specified time
Variable cost	Public service, free of charge. In future service may be charged for traffic information on secondary roads.	0,55 euro per message Cheaper than 0900 numbers
Fixed cost	Requires users to invest in RDS tuner / navigation system	Requires users to invest in mobile phone

As discussed before the traffic information value chain can be broken down into three main value activities: collection, processing and distribution of traffic data. To perform these value activities the following resources and capabilities are needed, respectively: access to data generating infrastructure, access to content and traffic movement expertise, and access to customers (distribution channels). If one compares the critical resources and capabilities needed to provide traffic information it is striking to see that both TMC4U and Traphic are very much dependent on the Government (TIC). Traphic seems more vulnerable than TMC4U in this respect since their role is limited to the distribution of traffic information. TMC4U has a role in two of the three value activities (see Table 2).

If one considers partners' contribution to the value elements the following image appears (see Table 3). Whereas TMC4U focuses on providing an accurate information service, Traphic focuses on providing a personalized and easy to use information service. This difference in focus can be explained if one considers the resources and capabilities of TMC4U and Traphic (see Table 2).

Table 2: Critical resources and capabilities

Resources and capabilities	TMC4U	Traphic
Access to data generating infrastructure	TIC TMC4U (ANWB)	TIC
Access to content & expertise	TIC TMC4U (ANWB)	TIC
Access to customers	Radio stations (Broadcast radio)	Mobile operator (Mobile phones) Traphic (Website)

TMC4U's position is primarily grounded in their capability to access the data collection infrastructure and their expertise in interpreting traffic movements. Traphic's position is grounded in their capability to access customers.

In both cases the TIC is a structural partner. The TIC plays an important role in the value proposition (accuracy) and is difficult

Table 3: Partners' contribution to the value elements

Value elements	TMC4U	Traphic
Accuracy	TIC (data collection) TMC4U (data refinement)	TIC (data collection)
Personalization	Car navigation provider providing hardware that collects travel information of end user) User providing travel information)	Traphic (collecting travel information of end user) User (providing travel information)
Ease of use	Car navigation provider	Traphic
Variable cost	Car navigation provider TIC	Mobile operators TIC
Fixed cost	Car manufacturers Car navigation providers	Mobile operators

to replace with another content provider. Moreover, due to government funding the TIC can offer traffic information for a

relatively cheap tariff to service providers. Hence the government plays an important role in keeping traffic information affordable for service providers and end users. End users are also important structural partners in both cases. Without their co-operation it is difficult to offer personalized traffic information. TMC4U itself has a limited role (accuracy) in the value proposition whereas Traphic seems to have a more structural role (personalization and ease of use) in the value proposition.

Also striking is that the car navigation providers play a dominant role in the TMC4U case. They are involved in four of the five value elements. Surprisingly enough the car navigation providers are currently paying TMC4U for the provisioning of traffic information, instead of vice versa. Hence, at this moment the sale of hardware is sponsoring the service. This can be explained if one considers the critical resources and capabilities (see Table 2). In contrast to the car navigation providers, TMC4U does have critical resources and capabilities.

6. Discussion and Conclusions

The cases provide two different routes for offering real-time traffic information in cars. Both initiatives are currently not profitable and it remains to be seen if they will be in the near future. It seems that traffic information services by themselves cannot generate enough revenues to be profitable. On the long term TMC4U seems to be dependent on government funding for its survival and it is questionable if Traphic can survive as independent service.

It should be noted that these results are dependent on the specific Dutch context, in which the government sponsors the collection and processing of traffic information data, and end-users expect traffic information to be (nearly) free.

Clear connections have been found between the resources and capabilities actors in a value network possess and their contribution to elements of the value proposition. The TMC4U case has shown that contributing to the visible part of a value proposition (the car navigation providers) does not necessarily mean that an actor can be considered a structural actor. Thus access to critical resources and capabilities is more important than contributing to the value elements of a value proposition.

The current conceptual framework is still descriptive and static in nature. It provides a structured way for analysing business models, and to study the precise way in which organizations intend to deliver value to their customers. However, it does not provide a structured process for exploring and developing business models for a new service. With this we mean a method for developing a set of design proposals or blueprints for each of the domains (see e.g. [11]). Future research is aimed at developing such a method.

In this paper we have specifically focused on the service and organization domain and the linkages between them. Of course also linkages with the other domains exist, e.g. the perceived value will influence the number of end-users and revenues. Further case studies are necessary to further improve the conceptual model, i.e. the concepts within the domains and the linkages between them.

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A Business Model Framework for E-Business Planning

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ABSTRACT
This paper aims at providing an integrated framework of business models for efficiently and effectively guiding e-business modeling and strategic planning. By adopting this framework, Internet-based companies are expected to get better ideas on how to design and implement e-business models to gain competitive advantages and financial profits, as well as to sustain continuous business operations. Structural components and their interactive relationships of the proposed e-business model framework will be identified and discussed, and then formulated as a dynamic programming model. Major components in this framework include markets, customers, competitors, supply chains, products, services, assets, costs, prices, promotion, distribution, transactions, revenues, profits, marketing strategies, competitive advantages, market shares, and economic scales. Process and considerations of strategic planning based on the structured e-business models will be addressed along with an example regarding the planning of innovative e-Tourism services.

Categories and Subject Descriptors
J.1 [**Computer Applications**]: Administrative Data Processing – *business, financial, marketing.*

General Terms
Management, Measurement, Performance, Design, Economics.

Keywords
Electronic Business, Business Model, Strategic Planning, Dynamic Programming, e-Tourism Services.

1. INTRODUCTION
Business models, since the early emerging of the electronic commerce (EC) and electronic business (EB) applications, has been a critical research and management issue in both the academia and industry sectors. How to design and implement feasible, or ultimately, optimal business models to gain competitive advantages and ensure financial profitability has become an important strategic planning problem for top management. Based on well-defined e-business models, Internet-based companies can efficiently and effectively conduct businesses on the web, make strategic plans for competitive business and transaction processes, as well as evaluate and control business performances. Although the literature on business models is continuously growing in recent years, researchers' perspectives on model classification and formulation are inconsistent, and opinions on how and to what extent business models can practically help companies in business planning and operations also diverge [2,3,4,11,16,22,23,26,30]. There is no agreement on whether it is used to describe the type and state of existing Internet businesss operations or to help assessing and creating sustainable and profitable web-based business plans. In other words, whether profitability/optimality is an issue for e-business models is still under argument. Besides, there is no commonly accepted ontology or framework exists for specifying the component structure of e-business models and for illustrating the dynamic relationships among model constructs. Moreover, no clear guidelines for e-business strategic planning and performance evaluation is available. As a result, business models and related issues are often considered as the most discussed but least understood area in the EC and EB domains that is not well covered and thus deserves more research efforts and extensive explorations [8,19,22,32]. The goal of this paper is to propose an integrated framework of e-business models for efficiently and effectively guiding e-business modeling and strategic planning. With such an e-business model framework, better understanding and suitable design of e-business models can be achieved, enhancement of companies' capabilities and competitive powers can be expected, and chances to make and sustain profits can be ensured. In the following, a brief literature review on business models is given in section 2, the e-business model framework with structural model constructs and a simplified dynamic programming (DP) model illustrating the objective, variables and constraints of business models are presented in section 3. Considerations and processes for e-business strategic planning based on the proposed framework of e-business models are addressed in section 4 followed by an example in section 5 demonstrating the planning process of innovative e--Tourism services. The final section contains a conclusion.

2. LITERATURE REVIEWS
In the literature, although there are a few previous research efforts focused on classifying business models and on discussing business model components, the views of business models and their implications to business performances diversified. Among a variety of inconsistent definitions provided, a business model is

defined in the basic sense as a method of doing business by which a company can generate revenue [22]. It is also considered as an architecture for the product, service and information flows within which the various business actors and their roles, the potential benefits for the various actors, and the sources of revenues are described [15]. For treating it as a method by which a firm builds and uses its resources to offer its customers better value than its competitors and to make money doing so, it is conceptualized as a system that is made up of components [1]. Recently, component structure or ontology based research works focused on business models have quickly emerged that aim at identifying model components and their interrelations [1,5,8,17,19,32]. However, no commonly accepted conceptual e-business model framework exists, and no clear guideline provided to illustrate how the business model framework can facilitate business strategic planning and performance evaluation. In the following, some examples of different classification approaches and types of business models, as well as different business model frameworks and components in the literature are briefly reviewed.

1. **Types of business models in general:** Depending upon the classes of trading parties and the transaction environments, business models identified include Business-to-Business (B2B), Business-to-Consumer (B2C), Consumer-to-Consumer (C2C), and Intra-Business models [9,25,27,30]. Depending upon the types of web site services and functions, generic forms of business models observed include Brokerage, Advertising, Infomediary, Merchant, Manufacturer, Affiliate, Community, Subscription, and Utility models [22]. Depending upon the types of electronic markets, eleven implemented business models pointed out include E-Shop, E-Procurement, E-Auction, E-Mall, Third Party Marketplace, Virtual Communities, Value Chain Service Provider, Value Chain Integrator, Collaboration Platforms, Information Brokers, and Trust Service Provider [26]. Depending upon economic effectiveness and revenue sources, identified business models include Content, Advertiser, Intermediaries, and Relationships [23]. Concerning the contents of the Internet sales, business models such as selling goods and services, selling information or other digital content, and the advertising supported model, advertising-subscription mixed model as well as the fee-for-transaction model are classified [25].
2. **Type of business models in specific application domains:** Focusing on the B2B applications, three marketplace business models including buyer-oriented, supplier-oriented, and intermediary-oriented models are identified depending on the control roles of the marketplace, and three service models including virtual corporation, networking between headquarter and subsidiaries, and online services to business are classified [27]. Five new business models including mega-exchange, specialist originator, e-speculator, solution provider, and sell-side asset exchange are identified for B2B commerce [31]. An E-Hubs concept has been proposed to classify B2B marketplaces as MRO hubs, Yield managers, exchanges, and catalog hubs [10]. Business models related to other specific application domains include those discussed in the cases of computer manufacturing and direct sales, virtual bookstore, network publishing, marketplace for small and medium enterprises, e-brokerage, e-finance, and electronic cash, etc [6,7,11,13,14,15,18,28].
3. **Business Model Framework and Components:** From the perspectives of business model framework and component structure, components presented include value, scope, revenue sources, price, connected activities, implementation, capabilities, and sustainability, as well as linkages and dynamics in [1]. Main components identified and described in [32] include markets, customers, competitors, products and services, assets and costs structures, promotion and distribution, pricing and billing methods, revenues and profits sources, marketing strategies and competitive advantages, market shares and economic scales. An ontology-based e^3-value approach is provided in [5] to represent e-business models that consist of actor, value object, value port, value interface, value exchange, value offering, market segment, and value activity. In the e-business model ontology presented in [19], there are four elements including production innovation, customer relationship, infrastructure management, and financials. Theses elements are further decomposed into child elements that include customer segment, value proposition, capabilities; and information strategy, feel and serve, trust & loyalty; and resources, activity configuration, partner network; and revenue model, profit/loss, cost structure. Components described in [8] include market, offering, activities and organization, resources, factor market, causality, and longitudinal process, and 66 e-business models were analyzed and classified based on these model components.

As can be seen, the concepts, frameworks and implications of e-business models vary significantly. These results neither fully encompass various facets of business models nor clearly point out guidelines for e-business modeling, strategic planning and performance evaluation. Therefore, an integrated conceptual framework to provide a well-defined component structure for illustrating entities and relationships of e-business models and for guiding efficient and effective e-business model planning, design and implementation is still lacking and desires further development.

3. A BUSINESS MODEL FRAMEWORK

An integrated framework for e-business models is to structurally represent entities and relationships of business model constructs that indicate influence and critical success factors for running electronic businesses. The more companies understand the business model framework, the better they can design and implement business models suitable for facilitating e-business conductions, gaining competitive advantages, and sustaining profits. In this section, we propose an architectural business model framework that extends the framework presented in [32] by taking into account other critical components from literrature. Main structural components include markets, customers, competitors, supply chain partners, products and services, assets and resources, costs, prices, promotion, channeles and distribution, transactions and payments, revenues, profits, marketing strategies, competitive advantages, market shares and economic scales, etc. Among these components, assets, costs, products, services, prices, channels, promotions, etc. are associated with the internal market environment, and customers, competitors, supply chain partners are related to external market environment. Other market-related factors of the external environment not considered at this point include stakeholders,

technology impacts, international policies, as well as legal, political, and economical situations. In the following subsections, a component structure of the business model framework and a simplified mathematical programming model, specifically formulated as a stochastic DP model, for demonstrating the business model constructs and their interrelationships to support e-business strategic planning are presented.

3.1 The Component Structure

The integrated framework for business models with major structured components and interactive relationships is illustrated in Figure 1 in which plane, thick and dashed lines represent the flows of activities or resources, the aggregation of components or factors, and the impacts or references respectively. Key components, elements, factors, and interactions are described below.

Markets: Markets are trading environments for buyers and sellers which can be classified in different ways including: (1) global, regional, national, or local markets by scope; (2) business-oriented or consumer-oriented markets by targeted customers; (3) catalog-based or auction-based markets by transaction functions; and (4) books, cars, or medicine by product categories; etc. Markets can also be segmented by customer characteristics such as ages, sexes, incomes, and be clustered by customer behaviors or preferences. Markets provide opportunities for e-business to gain profits but also fill with risks of failure.

Customers: Customers are buyers of the markets with various types including individuals, businesses, organizations, and communities. Major goal of the e-business is to create customer values and to gain customer shares.

Competitors: Competitors are other market players of the same markets that provide alternative buying choices to customers. Bigger competitors usually hold larger market shares.

Supply chain partners/participants: Supply chain partners/participants are other types of market players including suppliers of product materials or providers of delivery or payment services. Supply chain partners are strategic alliances that share information and values and are closely coordinated in transaction, production and distribution cycles.

Products: Products, physical or digital in forms, are one of the target objects of business transactions that are offered by sellers to potential buyers. Products can be positioned and differentiated by specific features that are perceived by customers as valuable and worthy to buy.

Services: Services are another targeted objects of business transactions that can be classified into a variety of categories including information, brokerage, recommendations, advertising, intermediary marketplaces, payments, trust, utilities, networking, community, affiliate, and personalized services.

Assets and resources: Assets, used as financial supports for conducting businesses, are major business resources that can be measured by money values. Tangible assets consist of fixed and floating capitals such as equipment, cash reserves, stocks, and money collected from venture capitals and/or initial public offering (IPO). Other intangible assets and resources include trademarks, brand awareness, technology infrastructure, patents, human resources, management capabilities, and expertise.

Costs: Costs are necessary expenditures for starting up and continuously operating businesses. Essential costs include expenses and charges on products and services development, websites and information systems implementation, marketing, purchasing, inventory, distribution, transaction processing, human resources, Internet and other intermediary services, investment and acquisition, and goodwill amortization, etc.

Prices: Prices are specified money values for customers to pay in exchange of products and services. Besides of the fixed pricing method, the frequently used dynamic pricing methods include negotiation and auction. Billing methods include charging the customers by product volume, by service time or times, by monthly fees, by project costs, by number or amount of transactions, as well as charging the advertisers.

Channels: Channels are intermediary mechanisms with interactive processes between buyers and sellers for facilitating communications, sales, and deliveries.

Promotion: Promotion is one of the marketing activities to capture customer attentions and to stimulate their buying desires. Possible types of promotion include advertisement, price discount, gift, trade show, and other related activities. Push marketing techniques can be used to reach better-matched target customers for achieving better promotion effects.

Distribution: Distribution is an activity to deliver information, products and services through online and/or physical channels. Physical products require establishing and operating physical channels or allying with some existing distribution channels.

Transactions and payments: Transactions and payments represent activity processes for customers ro get information, place orders and issue payments for acquiring products and services.

Revenues: Revenues are incoming money received from prices paid by customers who actually buy products and services. Revenue sources include products, services, and advertising sales, as well as transaction fees and trading commissions etc.

Profits: Profits, reflecting company's business performances, are net earnings that equal to the difference between total revenues and total costs. Web-based companies are trying hard to design and implement profitable business models to ensure e-business profitability.

Market shares: Market share, representing portion of the market size owned by the company, is a percentage number obtained from dividing the company's volume of sales or size of customer body by that of the entire market.

Economic scales: Economic scale is a targeted size of customer body that indicates the company's break-even point. As a company's business operation reaches the economic scale, it starts to gain profits.

Marketing strategies and plans: Marketing strategies and plans are strategic marketing decisions and action processes related to products, prices, promotions, and places factors, as well as their mix. The objective for implementing marketing strategies and plans is to increase market shares and make profits.

Competitive advantages: Competitive advantages represent strength and capabilities of the company to outperform

competitors by offering better values to customers, obtaining higher market shares, and sustaining stronger profitability.

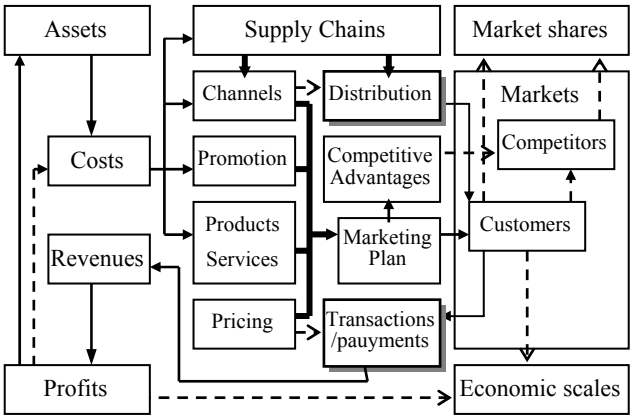

Figure 1.A component structure of business models

A company preparing to enter a new market must raise enough capitals and properly plan the usage of assets to cover all possible expenses and costs for ensuring continuous business operations. They need to identify target customers, develop products and services that match customers' needs, and set up supply chains for strengthening company capabilities and attaining better business qualities. By implementing a well-designed marketing mix plan, a company should be able to develop and offer products and services to customers of the targeted markets with better customer values in terms of better product quality, channel availability, price attractiveness, as well as brand awareness than their competitors and thus to gain competitive advantages. The company can then expect to attain high growth rates on revenues, market shares, and ultimately gain profits when the economies of scales are reached, or in other words, the total revenues exceed the total costs. When a company experiencing financial losses but expecting increasing revenues, they must make sure the current assets and future funding can support the business operations longer enough to break even and to start making profits. As for the customer site, they should be able to activate online transaction processes easily for searching and browsing desired information, placing orders, paying prices, and then receiving products and services through established sales and distribution channels. The greater customer satisfaction on company products, services, and marketing mechanisms ensures the higher customer loyalty to the company that leads to the fulfillment of company's goal of sustaining competitive advantages as well as profitability.

3.2 The Dynamic Programming Model

Business models help companies in making strategic and management decisions related to business planning, operation, and control with expectations to make profits over time. Setting the objective and scope of e-business models to encompass financial and marketing decisions based on the model framework and constructs presented in the previous subsection, we can formulate a generic business model as a dynamic programming (DP) model as follows to assist in developing feasible/optimal strategic plans. The multi-period multidimensional DP model can be characterized by a time index t, a state vector $\underline{S}_t$, a decision vector $\underline{D}_t$, an influence vector $\underline{I}_t$, a revenue function $\underline{R}_t$, and a return functional Z_t, as well as a balance equation with a transition function $\underline{T}_t$ and a recursive equation with a profit functional F_t.

The state vector:

$\underline{S}_t = (s_{1t},...,s_{nt})$, t=1,2,…..,T

s_{it} is the asset level allocated to market i at time period t,

and $s_{it} \geq 0$.

n is the total number of markets the company participated.

T is the total number of time periods under planning.

The decision vector:

$\underline{D}_t = (\underline{A}_t,\underline{C}_t, \underline{B}_t, \underline{P}_t, \underline{W}_t)$, t=1,2,…..,T

$\underline{A}_t = (a_{1t},...,a_{nt})$, a_{it} is the capital to be raised and allocated to market i at time t.

$\underline{C}_t = (c_{1t},...,c_{nt})$, c_{it} is the budgetary cost expenditure on market i at time t.

$\underline{B}_t = ((0,b_{12t},\ldots,b_{1nt}),\ldots..,(b_{n1t},...,b_{nn\text{-}1t},0))$, where $(b_{i1t},...,b_{int})$ represents the assets transferred form market i to other markets at time t.

$\underline{P}_t = ((p_{11t},\ldots,p_{14t}),\ldots..,(p_{n1t},...,p_{n4t}))$, where $(p_{i1t},...,p_{i4t})$ represents the 4P marketing mix plan to be implemented on market i at time t.

$\underline{W}_t = ((w_{11t},\ldots,w_{1mt}),\ldots..,(w_{n1t},...,w_{nmt}))$, $(w_{i1t},...,w_{imt})$ represents the weighting program of cost spending over m cost accounts on market i at time period t.

The constraints are $a_{it} \geq 0$, $c_{it} \geq 0$, $b_{i1jt} \geq 0$, $w_{i1j} \geq 0$, and $s_{it} \geq c_{it}$, $sum(w_{i1t},...,w_{imt})=1$, as well as $s_{it} \geq sum(b_{i1t},...,b_{int})$ for all i and t.

The influence vector:

$\underline{I}_t = (i_{1t},...,i_{nt})$, t=1,2,…..,T

i_{it} indicates the uncertain total market sales of market i at time period t.

The revenue function $\underline{R}_t$:

$\underline{R}_t = (r_{1t},...,r_{nt})$, t=1,2,…..,T

r_{it} indicates the revenue obtained from market i at time period t.

$\underline{R}_t$ depends on $\underline{C}_t$, $\underline{P}_t$, $\underline{W}_t$,.and $\underline{I}_t$, i.e. $\underline{R}_t = \underline{R}_t (\underline{C}_t, \underline{P}_t, \underline{W}_t,.\underline{I}_t)$.

The return functional Z_t :

Z_t indicates the return on investment and operation gained from market i at time t.

Z_t depends on $\underline{S}_t$, $\underline{A}_t$, $\underline{C}_t$,.and $\underline{R}_t$, i.e. $Z_t = Z_t (\underline{S}_t, \underline{A}_t, \underline{C}_t,.\underline{R}_t)$, t=1,2,…..,T.

For a simple case, Z_t can be expressed as follows:

$Z_t = Z_t (\underline{S}_t, \underline{A}_t, \underline{C}_t,.\underline{R}_t) = [(\underline{R}_t - \underline{C}_t)\underline{a}_t']^+ + (\underline{S}_t + \underline{A}_t)\underline{b}_t'$.

$\underline{a}_t$ and $\underline{b}_t$ are 1 by n coefficient vectors that indicate deduction or gaining ratios of the return such as tax ratio.

The balance equation with transition function $\underline{T}_t$:

$\underline{S}_{t+1} = \underline{T}_t (\underline{S}_t , \underline{A}_t , \underline{B}_t , \underline{C}_t , \underline{R}_t) = \underline{S}_t + \underline{A}_t + \underline{B}_t'\mathbf{G} - \underline{C}_t + \underline{R}_t$,

where **G** is an nn by n transfer matrix indicating asset flows among markets.

The transition function $\underline{T}_t$ shows how $\underline{S}_{t+1}$ is derived from previous state, and decisions made with revenues gained in time period t.

The recursive equation with profit functional F_t :

$F_t(\underline{S}_t) = \text{OPT}[E[Z_t(\underline{S}_t, \underline{A}_t, \underline{C}_t, \underline{R}_t) + F_{t+1}(\underline{S}_{t+1})]]$, i.e.

$F_t(\underline{S}_t) = \text{OPT}[E[Z_t(\underline{S}_t, \underline{A}_t, \underline{C}_t, \underline{R}_t(\underline{C}_t, \underline{P}_t, \underline{W}_t, \underline{I}_t)) + F_{t+1}(\underline{T}_t(\underline{S}_t, \underline{A}_t, \underline{B}_t, \underline{C}_t, \underline{R}_t(\underline{C}_t, \underline{P}_t, \underline{W}_t, \underline{I}_t)))]]$.

$F_t(\underline{S}_t)$ is the objective functional indicating the optimal profit obtained at state $\underline{S}_t$ of time period t.

The OPT indicates that the optimization of the DP model at time period t is to determine the optimal decision vectors $\underline{D}_t$, i.e. the

$(\underline{A}_t, \underline{C}_t, \underline{B}_t, \underline{P}_t, \underline{W}_t)$, to optimize the profit from the current state $\underline{S}_t$ to the end state of the time horizon $\underline{S}_T$.

E[..] indicates the expect value of $Z_t + F_{t+1}$, since both depends on an unknown influence vector $\underline{I}_t$.

The final goal of the DP model is to determine a sequence of decision vectors $\underline{D}_1, \underline{D}_2, \ldots, \underline{D}_T$, i.e. the strategic plans, to optimize the total profits over the entire planning time horizon.

Also to be constructed along with the multi-period strategic plan are the control policies that reflect the functional dependencies between $\underline{D}_t$ and $\underline{S}_t$ for all t.

The formulation of marketing mix plans and associated revenue functions is a critical but hard step, as a consequence, adopting or developing appropriate marketing sciences models and methodologies becomes necessary. As the revenue functions are specified using some marketing decision models, the major activities in the solution procedure of the above stochastic DP model include the estimation of the expected influence vector, the optimization of the decision vector, the approximation of the optimal objective functional F_t, and the construction of strategic plans and control policies. Since the major concern of the DP modeling approach is to structurally represent the interrelationships among the e-business model constructs as well as between business models and strategic plans, the detailed stochastic DP solution procedure is beyond the scope of this paper and is skipped from discussion in this stage.

4. E-BUSINESS STRATEGIC PLANNING

Strategic intent of a firm is refered to as the firm's objectives of decisions and actions to make money and/or leverage capabilities [1]. Six Internet-related principles of strategic positioning outlined in [20] include sustained profitability, value proposition, distinctive value chain, trade-off, fit together, and continuity. By using our proposed e-business model framework and DP model as guidelines, e-business related strategies can be easily identified and the strategic planning process can be conducted and accomplished in a more systematic way. Accordingly, e-business strategies to be planned include capital acquisition and asset allocation strategy, market strategy, customer strategy, product and service strategy, supply chain/value chain strategy, web site and system development strategy, business operation strategy, marketing strategy, innovation and competitive strategy, and profit strategy.

Capital acquisition and asset allocation strategy:

The capital acquisition and asset allocation strategy, as part of the corporate finance strategy, focuses mainly on identifying sources and methods of capital acquisition, as well as on specifying directions and processes for asset allocation, management and control.

Market strategy:

This is to clarify considerations, factors, and processes for market selection, segmentation, integration, and globalization, as well as to specify goals on market shares and economic scales. Also identified include market opportunities and risk, as well as trends of the market related industries.

Customer strategy:

This is to specify approaches for customer clustering and classification, to enforce efforts on personalization, customization, and community services, as well as to capture the trend of customer value management and relationship management.

Product and service strategy:

This is to identify the key characteristics and features of products and services that match the market needs while showing better customer values than competitors' products and services, as well as to specify the processes of product and service development, and life cycle management.

Supply chain/value chain strategy:

This is to indicate considerations for supply chain/value chain establishment, partner selection, as well as to outline processes for supply chain/value chain management and operation. Also considered include information sharing, value sharing, and production and infrastructure integration policies.

Web site and system development strategy:

This is to decide on the technology adoption policies, the budgeting and the implementation schedule for developing and providing functions and services on the web sites/application systems. Also to be specified is an e-business infrastructure including system organization and operating environment, content and network access services, communication facilities, commerce and customer supports, etc.

Business operation strategy:

This is to specify methods and processes for e-business operations. Major considerations include transaction and payment processes, billing and payment collecting methods, sales and distribution channels, business alliances and cooperation, costs and revenues management, as well as feedback control and conflict resolution.

Marketing strategy:

This is to clearly direct marketing decisions and policies related to brand and reputation building, products and services positioning, selling, pricing, advertising and promotion, delivering and channel integration, etc. Basically, 4P, i.e. product, price, place and promotion strategies, and a 4P mix strategy are included. Also to be specified includes an implementation plan of the marketing mix strategy.

Innovation and competitive strategy:

This is to specify distinctive organization capabilities and competence needed to outperform the competitors, and the ways to generate competitive advantages through product, process, and technology innovations. SWOT (Strength, Weakness,

Opportunity, Threat) analysis as well as Porter's competitive forces model can be used to help illustrating the planning considerations.

Profit strategy:

This is to specify cost, revenue and profit sources and structures, as well as short-term, mid-term, and long-term plans to increase market and customer shares, generate more sources and volumes of revenues, maintain competitive advantages, achieve market leadership, as well as to ensure optimal profits and sustain high profitability.

Figure 2 shows a road map for e-business strategic planning in which all the above mentioned strategies are included and arranged as a flow of considerations.

5. NNOVATIVE E-TOURISM SERVICES PLANNING

According to the reports released from World Trade Organization (WTO) (**www.world-tourism.org**), World Travel and Tourism Council (WTTC) (**www.wttc.org**), and several marketing research organizations such as Forrester Research Group (**www.forrester.com**) and Gartner Group (gartner12.gartnerweb.com), the tourism industry is among the world's largest industries. In 1999, this industry generated revenues of US$4.3 trillion that approximately accounted for 10% of the global GDP, and is expected to sustain a steady growth up to 2010. From 1999 to 2000, the global Internet travel market increased sixfold from US$5 billion to US$30 billion. The US online sales of leisure travel in 2003 and 2004 are predicted to reach US$25.2 billion and US$30.4 billion respectively. As for the case in Taiwan, according to money.chinatimes.com, the Internet travel market has doubled its revenues for five consecutive years and is about to reach an estimated NT$15 billion (approximately US$0.5 billion) by the end of this year that accounts for 5% of the total tourism market. And by 2010, the revenues of e-tourism services in Taiwan is expected to exceed NT$150 billion or 50% market share. Although it seems that there exists a great opportunity for e-tourism services providers to gain significant profits, the slow adaptation of innovative EC and web technologies in the online tourism services sector results in high product similarities and severe price competitions, as well as low total market share within the entire tourism market. Several research works in the literature have signaled a strong demand of innovative personalized travel-related planning and decision services [21,24]. These desired services may enable a e-tourism service provider to grasp the emerging business opportunities by more efficiently and effectively capturing consumer values as well as gaining competitive advantages. Adopting the business model-centered strategic planning process presented in previous section, an example process for planning innovative e-tourism services is given below.

1. Make decisions related to asset strategy such as to acquire investment capitals from international or local venture capitalists or from local stock market.
2. Concentrate on providing global tourism-related products and services to customers of the local market.
3. Aim at capturing the customer values by offering personalized and decision support services to meet customer needs and preferences, no matter as an individual or as a group.
4. Design innovative services by fully incorporating innovative characteristics, functions, and processes in the WWW, EC, and EB domains to help customers in all phases of travel-related decision-making process. These innovative e-tourism services include personalized management, navigation and search, evaluation and selection, planning and design, community and collaboration, auction and negotiation, transactions and payments, quality and feedback control, as well as communications and information distribution services.
5. Select partners in the upstream and downstream segments of the tourism value chain such as destination, accommodation, and transportation vendors, travel agencies and operators etc to form strategic alliances for offering one-stop services and ensuring service qualities, as well as for creating added values while lowering operating costs.
6. Develop a web-based consumer-oriented decision support system for customers to easily activate all types of innovative tourism services.
7. Specify all possible transaction, payment, delivery, tracking, and feedback processes.
8. Design and choose a marketing mix plan to optimize the outcomes of product, price, place, and promotion activities.
9. Select and adopt innovative EC and web technologies to facilitate innovative tourism services and thus increase competitive advantages over the competitors.
10. Make short term and long term profit plans by identifying and selecting most profitable revenue sources for concentrating efforts to ensure profitability and sustain continuous business operations.

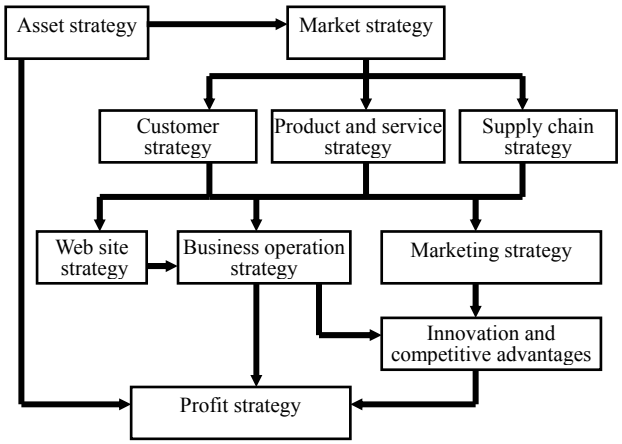

Figure 2. A road map for e-business strategic planning

Detail description of the proposed innovative e-tourism services is provided as follows.

Personalized Management Services. Services provide in this group allow customers to create and maintain their personal profiles including basic information, personalized travel preferences, evaluation criteria for selecting tourism-related products, services, agents, and vendors. Also included are editing facilities for customers to create their own travel web pages with subject directories and bookmarks to link with frequently

accessed tourism resources, as well as to add annotations and notebooks in relation to specific destinations and tours.

Navigation and Search Services. These services provide customers with navigational facilities such as subject directories and guided tours as well as search and retrieval functions to retrieve and browse detailed tourism information such as destinations and events, airline schedules and fares, accommodations and transportations, individual and group packaged tours, as well as relevant news, weathers, maps, travel agencies and other tourism service providers, etc.

Evaluation and Selection Services. This group offers decision support services to customers for evaluating and selecting tourism products and services such as destinations, hotels, package tours, and travel agents in order to match their needs and preferences while using system default or consumer-specified evaluation criteria.

Planning and Design Services. Personalization and customization are main characteristics of this group of decision services that aim at helping customers in planning and designing their own travel plans. The associated service operational process includes interactive steps to assist customers in picking attractive destinations, accommodations, and transportations, and then in designing trip plans that bundle and organize the chosen destinations in daily basis for future implementation.

Community and Collaboration Services. The basic community services allow customers to form special tourism interest groups, to set up tourism-related community forums and communication channels, to share travel experiences and resources. Advanced services allow customers to present their personal trip plans to the community, to exchange ideas and create alternative trip plans, to vote and select commonly accepted group trip plans for booking and implementation. Extended collaborative and decision support services include recommendations for individual or group trip plans based on collaborative filtering or case based reasoning techniques.

Auction and Negotiation Services. This group of services provides a dynamic and competitive pricing environment for customers to hold better bargaining positions. The auction services offer dynamic platforms for customers to launch reverse auctioning sessions that call for travel agencies, tourism product vendors and services providers in the tourism supply chain to bid on posted individual or group trip plans. The negotiation services allow customers to negotiate terms and contracts with chosen tourism operators.

Transaction and Payments Services. These types of services are responsible for allowing customers to actually book and issue payments for selecting trip plans, or to simply purchase specific tourism products and services such as tickets or souvenirs.

Trip Tracking and Quality Control Services. This service group provides mechanisms for trip members and their families, the travel agencies and operators to track in-progress situations during the trip plan execution process, as well as to make necessary changes in trip plan operations in order to control the qualities of services.

Communications and Information Distribution Services. This group of services is responsible for facilitating push and pull marketing activities that deliver tourism-related information most relevant to customers' interests. It also provides email, online chatting, FAQ, feedback and complaint handling functions, as well as situation reporting channels via wired and/or wireless communication networks.

6. CONCLUSIONS

E-business models have quickly emerged as critical research topics and management issues in the EC and EB domains for the past few years. However, in the literature, the concepts and conceptual framework of e-business models have not been well defined, and the model constructs and design methods for constructing suitable e-business models have not been clearly addressed either. There is still no common understanding on how the e-business models can help companies in strategic planning and business operation while taking into account profitability concerns. In this paper we present an integrated framework with a component structure and a mathematical programming model for illustrating key constructs and associated interactive relationships, as well as linkage to strategic decisions of e-business models. We also identify and discuss major e-business strategies and associated strategic planning process based on this e-business model framework and then provide an example to show the process and outcomes regarding innovative e-tourism services planning. As for business implications, the proposed e-business model framework provides a guideline for companies pursuing competitive advantages and profitability to efficiently and effectively plan, design and implement operable, measurable, and controllable e-business models. Future research works will include performing surveys, in depth case studies, and cross business/industry comparative analyses to validate the proposed e-business model framework as well as to demonstrate how this framework and processes can support companies in e-business model design, business process reengineering, strategic marketing decision making, and business performance evaluation.

7. ACKNOWLEDGMENTS

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The Configurable Nature of Real-World Services: Analysis and Demonstration

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ABSTRACT

A collaborative design of complex real-world services (ranging from plumbing services, transportation, network connectivity and events hosting to insurances and governmental public services) over the WWW requires services to be described as components, the building blocks of a configuration. Defining complex services then becomes a traditional configuration task, where services are seen as components. Reducing the process of defining complex services into a configuration task (as studied in knowledge engineering) implies that it can be supported by information technology, to be used either by service personnel or by customers via the Internet. Furthermore, to facilitate service configuration by customers, it is required that the customer value of services is linked to services – or *service elements* – that shall be configured. A subset of the service outcomes, very often intangible, reflects the customer value of a service, in supply-side terms. In this paper we describe the component-like nature of services, in the framework of a service ontology comprising of the customer value (demand-side terms) as well as a supply-side, component-based description of services. We demonstrate the process of configuring – or bundling – services with a case study on hosting a meeting.

Keywords

Collaborative eCommerce, Service, Configuration, Semantic Web technologies

1. INTRODUCTION

Current eCommerce is still mainly characterized by the trading of relatively straightforward commodity goods. Whereas the term *products* is often used to describe physical goods, according to the business literature it includes physical goods as well as *services*: performances of a mostly intangible nature [16]. Many industries offer complex compositions of goods based on customers' specifications. This is facilitated through a component-based description of goods, supported by a variety of product ontologies, e.g., UNSPSC and eCl@ss. These ontologies focus on physical goods – referred to as *products* – rather than on services. To enable similar eCommerce scenarios for services, a service ontology is required that supports a component-based structure of services.

Furthermore, a customer is typically not interested in a service as such (e.g., worldwide money transactions), but in the *value* of this service (e.g., the ability to pay worldwide). Consequently, service offerings (a supplier description of services) must be linked to the customer value perspective of a service. This enables a customer to configure a complex service by himself, based on what he considers to be of value.

Service is a loaded term in the IT world. It is used mostly to refer to Web Services: loosely coupled, reusable software components that semantically encapsulate discrete functionality and are distributed and programmatically accessible over standard Internet protocols [1]. Real-world services, on the other hand, are not software components, but business activities, deeds and performances of a mostly intangible nature [20, 13, 10]. Real-world services are the products of service industries; they can be compared with the physical products of traditional manufacturing industries. A car manufacturer sells cars (a physical, tangible product); similarly, a bank sells financial services, a hairdresser provides haircuts, a comedian provides entertainment and a government provides care for citizens. These are all services, or intangible products. In the business world they mostly represent how a business makes money, and why it exists as a business in a particular market. Since we refer to services in their business connotation, the business and economic sciences are the starting point of our research. Business literature is characterized by a broad consensus on what services are. We drew knowledge on services from the business literature, and combined it with work done in the field of knowledge engineering, to create a service ontology where services are described as components. The ontology acknowledges and emphasizes a component-based structure of services, and presents not only a supply-side description of services (in terms of service elements to be offered to potential customers), but also a demand-side description of the

service: its value for the customer. The service ontology can be used for (online) configuration of services, a process we call 'serviguration': service configuration. Various service elements can be configured to a more complete and value-adding service offering, possibly involving multiple service providers. In this paper we give a detailed analysis of a component-based structure of services, required to enable serviguration. We describe a service by its functionality, its required inputs, the outcomes it generates, its properties and constraints. Service elements can then be bundled, as long as their constraints permit it, and the required inputs are available. We use a case study to demonstrate how services can be configured in accordance with the service ontology, after they are described as components.

The remainder of this paper is organized as follows. We start with a short top-level description of the service ontology. In section 3 we present a component-based structure of services. Section 4 discusses a case study of hosting a meeting. Finally, in section 5 we present conclusions, and outline future research.

2. SERVICE ONTOLOGY

2.1 Top-Level Viewpoints

Using the service management and marketing literature as a starting point, we have developed a generic component-based service ontology [4]. The ontology incorporates both a customer perspective and a supplier perspective, and it includes unique characteristics of services (compared to goods), e.g., the intangible nature of services. It allows the customer to configure compound services, based on his/her specific requirements and expectations.

On a high level of abstraction, a service ontology must embody three interrelated top-level viewpoints or perspectives, as sketched in Figure 1: *service value, service offering* and *service process*. The *service value* perspective describes the service from a customer's point of view; it describes the service in terms of the customer's needs and wants, his quality descriptors and his acceptable sacrifice, in return for obtaining the service (including price, but also intangible costs such as inconvenience costs and access time). The *service offering* perspective describes a service from a supplier's perspective; it provides a hierarchy of service components (a core service and supplementary services) and outcomes, as they are actually delivered by the service provider in order to satisfy customers' needs. The *service process* perspective describes how the service offering is put into operation in terms of business processes that can be modeled using existing technologies as ebXML [2], WSFL [14] or BPEL [3].

2.2 Serviguration: Service Configuration

Three relationships between perspectives are sketched in Figure 1:

1. Service configuration, or *serviguration*: defining sets of service elements (a supply-side description of services, part of the *service offering* perspective), that satisfy the customer description of his desired service (*service value* perspective, in our terminology). Serviguration can be split into two sub-processes: (1) Transformation process between the customer description of the requested service (service value perspective), and the supplier's terms for describing the service; and (2) Defining zero or more sets of service elements (service offering perspective) that satisfy this supplier description of the requested service, and thus also the customer description of his requested service.
2. The service process describes which business processes are required to put the service offering into operation.
3. The participation of customers (who are part of the service value perspective) in the service production process.

This paper focuses on the serviguration process, and specifically on the second sub-process: a task of configuring service elements. The service value and service process perspectives are not discussed further in this paper.

3. SERVICE OFFERING CONCEPTS

Configuration tasks ontologies [11] use components as the building blocks of configurations. Similarly, we claim that service elements (possibly offered by multiple suppliers) can be configured into a complex service (*service bundle*, in our terminology). Using configuration task ontologies to configure services requires a mapping between the service ontology and configuration tasks ontologies. We claim that such a mapping is feasible, due to the configurable nature of services. In the remainder of this section we present the concepts that play a major role in configuring services. We use a running example of an event hosting service, such as conferences, board meetings, executive courses, exhibitions, and more. Every type of event has its own characteristics. Our case study considers the service of hosting a meeting. Meetings can be hosted in various locations (e.g., meeting rooms), for differing numbers of participants, providing a broad range of equipment, as well as catering. A future scenario would include providing accommodation and possibly transportation for meeting participants.

In the remainder of this section we model elements of the service offering perspective which, unlike concepts within the service process perspective, cannot be modeled using business process modeling techniques, as the essence of value-oriented models is different from that of business process models. For a thorough explanation see [7].

3.1 Service Element

The service offering perspective centers around the concept *service element*.

Service elements represent what a supplier offers to his environment. We distinguish three types of service elements: a core service (the main business), a supplementary service with a supporting role (making the core service possible) and a supplementary service with an enhancing role (improving the service's value by adding extra features).

Core service. A core service describes how the supplier's business adds value to a value chain. This is the reason for the supplier's presence on the market. A firm may have multiple core services; it may offer banking facilities as well as insurances as its core services.

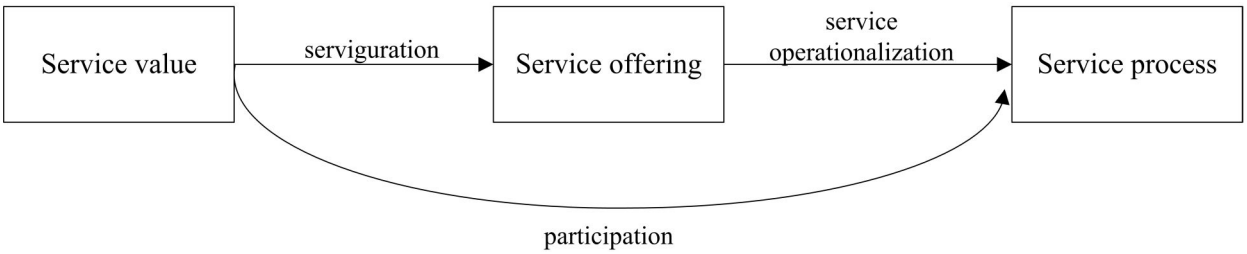

Figure 1: Three top-level ontological distinctions to be made in a generic service ontology: the customer-value perspective, the supply-side perspective, and the joint operationalization of these viewpoints in terms of the actual service production process.

Supplementary service. A service that accompanies the core service/product, ranging from finance to training. It may be of two types:

- *Supporting* supplementary services are needed in order to enable the core service consumption. In the absence of these services, the core service consumption is no longer possible.
- *Enhancing* supplementary services are often considered to be the elements of the service that define it and make it competitive. They increase the value of the service, or differentiate it from those of competitors [10]; the core service can nevertheless be consumed without them.

Supplementary services of both types are not offered to customers separately; they are always related to a core service, which stands for how a business makes money. A business can decide to offer a supplementary service independently, and then classify the service as a new core service in its service offerings.

To avoid confusion, note that the use of the terms supporting and enhancing services is author-dependent. The services that we refer to as supporting, respectively enhancing, are called facilitating services and supporting services respectively by [10].

Defining the type of service (core service, supporting supplementary service or enhancing supplementary service) is supplier-dependent. Catering will be the core service of a caterer, but an enhancing service of an event hosting company. A different event hosting company may consider catering to be a supporting, rather than enhancing service, since it does not offer the possibility of hosting an event without some catering service.

In our running example, hosting a meeting is the core service, the supplier's added value. We identify two supporting supplementary services: (1) planning (organizing) a meeting, and (2) room renting (a meeting cannot be held without having a location rented for it). We also identify two enhancing supplementary services: (1) coffee catering, and (2) equipment provisioning (e.g., video conference facilities, Internet facilities). Though practically every meeting requires some equipment, this is not a supporting service, since it is possible to hold a meeting without such equipment. In the remainder of this paper we concentrate on one supporting supplementary service element (room renting) and one enhancing supplementary service element (coffee catering).

A service element can be a composite concept, meaning that it is built of smaller components, each of which is a service element as well. A service element can thus be decomposed to smaller service elements, as long as the smaller service elements can be offered to customers separately or by different suppliers.

Components, as described in the knowledge engineering literature [11, 15, 5, 6], have constraints, properties and ports. As mentioned before, the component-based nature is inherent to services. As such, we can identify ports, properties and constraints for service elements.

Ports. Every service element has *ports* of two types: input ports and outcome ports. The provisioning of a service element requires core resources, and results in the availability of other resources. A port indicates a certain resource that is either a pre-requisite for carrying out this service element (input port), or the result (outcome) of carrying out this service element. A service element is characterized by its required inputs and by the outcomes it produces. The notion of ports stems from the technical system theory [6]; ports are used to abstract away from the internals of a service element. Inputs and outcomes may be tangible (e.g., coffee) or intangible (e.g., information, in a news service). Some service elements may produce outcomes that are pre-requisites for other service elements. In such a case an outcome of one service element will be the input of another. Since inputs and outcomes may refer to the same thing(s), we call them *resources*; every port stands for a resource.

As we will show later, the notion of two ports being *identical* is important for the configuration of service elements. Two ports are considered identical if and only if their associated resources are identical. The set of all input ports, respectively all outcome ports of a service element form the element's *input interface*, respectively *outcome interface*. Two interfaces are identical if and only if they include the same set of ports, and all their ports are identical. Note that based on this definition, two interfaces of different types (input and outcome) may be identical.

Properties. Service elements have certain properties, of-

ten referred to as *attributes* or *parameters*. We prefer the term properties, since *attributes* and *parameters* are loaded terms; they are often associated with primitive data types, as characters, strings or integers. A property, on the other hand, may be of a more complex nature. For example, the property "quality" may be defined by a set of criteria. We identify the following properties of service elements:

- *Type*. As explained earlier in this section, we distinguish three types of service elements: core service, supporting supplementary service and enhancing supplementary service.
- *Quality*. A customer identifies two main dimensions of quality: process quality and product quality. Although this is a generic statement, in accordance with [10] and other research, quality definition has to be verified by every business.
- *Productivity* refers to the rate of service production. Whereas it is common to measure productivity within manufacturing industries, this issue is not often dealt with in the service literature. The business literature defines productivity from a supplier point-of-view, as the rate between (1) the quantity and quality of the output, and (2) the quantity and quality of the input [18]. It measures the economic performance of a business. Our work is customer-oriented, rather than supplier-oriented. A customer is typically not interested in measuring the economic performance of a supplier; when discussing productivity, he's more likely to be interested in the rate between (1) the quantity and quality of the output, and (2) time. In some cases time may play an important role. For example building a new house according to plan A will last a year; building it according to plan B will last 16 months. In other cases the time is constant, and only the quality and quantity are relevant. For example, a movie has a fixed duration, but quality properties as the type of seats, location and bars availability, as well as quantity properties, e.g., the number of seats and the lounge size, will influence customers' choice for one cinema or another.
- *Sacrifice*. As explained in the previous section, sacrifice may be more than the price. It includes [10] the price of the service, as well as relationship costs (direct costs: investment in office space, additional equipment etc; indirect costs: related to the amount of time and resources that the customer has to devote to maintaining the relationship; and psychological costs: inconvenience, lack of trust, unpleasant sensory experience, such as noises and smells). The (financial) cost of a service is not a *constant* value, but a function, determined by the supplier. It may change as the service offering changes, as demand fluctuates or based on any criteria of the supplier.
- Domain-specific properties may be identified per service. We defined the set of generic properties *type, quality, productivity* and *sacrifice*, based on the business literature. At the same time we acknowledge the fact that these generic properties may not be enough for every real-world case.

Constraints. A constraint [11] on a service element is a description that limits the permissible values for properties or characteristics of a service element. A constraint may refer to properties, to resources (inputs or outcomes), to ports, to interfaces or to relationships between resources. We will provide examples of constraints in the following sections, after we have discussed the concept *resource*.

Two service elements are identical if and only if:

- All their associated ports (and thus resources) are identical
- They have the same set of properties (type, quality, productivity, sacrifice and possibly domain-specific properties)
- All their properties have the same values

Constraints need not be identical for two service elements to be identical, because they relate to the internals of a service element, whereas we adopt a customer-driven perspective: two service elements are identical if their external, "black-box" representation is the same. Often it is possible to achieve the same outcomes with different inputs. In such a case, the different options will stand for different service elements.

Suppliers will typically generalize their service offerings when publishing them (e.g., in service directories). For example, a supplier will publish a 'meeting hosting' service, rather than 'a meeting hosting service for 100 people, at the cost of ... Euro'. At a later stage, when an interested customer wishes to buy this service (or explore possibilities), a detailed service description is required. This is when different values of ports, resources, properties and constraints play a role, and a 'meeting hosting' service element is instantiated with multiple possible values, generating a number of 'meeting hosting' service elements.

The concept *service element* is visualized in Figure 2.

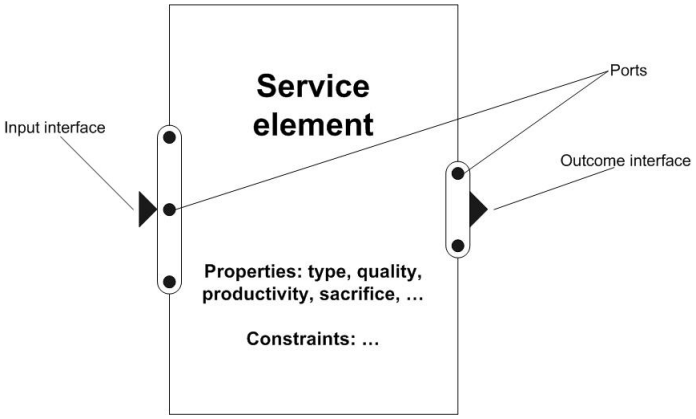

Figure 2: Service element

3.2 Resource

As explained before, *resources* can either be required for the provisioning of some service element, or can be the result of a

service element. The natural way to understand this term is in the sense of resources for carrying out a business process. This is however not the case here. We make a distinction between resources on the service offering level and resources on the service process level:

- Resources on the service offering perspective describe *what is being offered (which service).* Services involve the transfer of value [17], hence resources on the service offering level are objects of economic value. The most trivial example is money, but also information (e.g., in a news provisioning service), capabilities (e.g., the possibility to receive a replacing credit card worldwide in case of card loss) and other types of resources have economic value.

- Resources on the service process perspective relate to *how* the service is being offered. They are related to the actual service production and consumption process, and typically include the means required to produce the service, e.g., information, service personnel and machines, as well as mostly tangible outcomes of a service, e.g., a train ticket.

There may be some overlapping between resources on the two levels (e.g., coffee is a resource on both perspectives in our case study), but they are conceptually different. In the rest of this paper we refer to resources on the service offering level, rather than the service process level.

We distinguish the following types of resources:

Physical goods: sometimes defined as 'those things that can be dropped on the floor'. The business literature determines that services are of intangible nature [10, 12, 13, 16, 19]. Quite often however interactions between customer and supplier result in the customer having something of a tangible nature, like airline tickets or a credit card. In other scenarios, the physical product has a central role, and services are added to it (like plumbing services and a new house). These services may look more tangible than services that are not related to physical objects, but in fact there is no difference in the tangibility of the service itself [12]. The tangible aspect of a service may be an accompanying physical good (often wrongly referred to as *product*), having a supporting or an enhancing role in the service offering. The concept *physical good* can be used to link the service ontology with existing product classifications, e.g. UNSPSC and eCl@ss[1], by means of an ontology *import* relationship.

Human resources: human resources may refer to the supplier (i.e., employees) or to the customer (own participation in the process). On the service offering perspective we model the human resources only where they reflect value (or costs, thus a negative value) for the customer. When human resources do not reflect value *for the customer*, we refer to them as *inherent* to the service, and we do not model them. They are however still resources on the service process level. We will explain this by means of an example. If a customer orders coffee catering, it is obvious that an employee will bring the coffee to the meeting room and serve it to meeting participants. This is inherent to the service, and thus not a human resource on the service offering level. We will model the *customer* as a human resource (on the service offering level) when he serves himself, after the coffee was brought to the room (self-service reflects lowering the costs of the service); and we will model the *employee* as a human resource when he stays in the meeting room to serve coffee upon request for a longer period (in return for a higher fee). It is of course up to the service provider to define when a human resource is inherent to his service, and when it reflects value/costs for the customer.

Monetary resources: mostly money, but one could also consider stocks or similar value-papers. Monetary resources are, like the earlier presented notion of *sacrifice*, not a *constant* value, but a function, determined by the supplier.

Information resources: information may be of economic value, for example in a news provisioning service or in a weather report service. Suppliers often value information about their customers, when trying to increase customer loyalty. Since suppliers are willing to reward customers for this information, it has economic value and is a resource.

Capability resources: the ability to do something is often of value for customers or suppliers. For example, when buying an insurance we pay for the ability to receive some service in case something goes wrong, but often we eventually do not need that service, because nothing goes wrong. Another example is a customer who uses the services of a free-of-charge Internet Service Provider (ISP). Such a customer provides the ISP with the capability to generate telephone connections (by dialing the ISP's phone number every time he connects to Internet), for which the ISP is rewarded by a telecom provider. Hence, the service can be provided free of charge, because a customer who uses the service provides a capability resource that is of (financial) value.

Experience resources: every service involves a service experience. The experience becomes a resource, when it reflects costs (e.g., the earlier mentioned psychological costs) or value for the customer (e.g., an added value of going to Euro Disney is having fun; a Gold credit card is a status symbol).

State-change resource: services are "activities... of bringing about a desired change in – or on behalf of – the recipient of the service" [16]. A variety of objects can be subject to change, e.g., a customer himself (e.g., haircut, transportation from A to B, medical treatment), a physical good (e.g., car repair, shipment of goods) or information (e.g., translation services). In some services the change can be related to a property of some resource (e.g., a car's state changes in a car repair service), whereas in other services the subject of the state-change is not a resource (in the sense of economic value), e.g., a passenger taking a flight undergoes a state change, but he is not a human resource because he doesn't reflect economic value. In such cases the economic value of a service, from the customer point of view, is a change of state: the customer *was* in Amsterdam, and now he *is* in Sydney. He pays for this change of state.

[1]UNSPSC and eCl@ss address products (physical goods) as well as services, but the emphasis is on (physical) products

This set of resources is derived from our experience with analyzing and modeling value-based transactions, e.g., services. It has been and will be tested on case studies, and if necessary updated.

A resource can be of one of the earlier mentioned types. Once a resource is associated with an input- or outcome-port, it becomes a **service input** or a **service outcome**. A service input is thus a resource that is a pre-requisite for a specific service element, and a service outcome is a resource that is the result of a specific service element. Those two terms make it easier for us humans to understand that resources may be required for providing a service, or be the result of providing a service, but in fact they are the same thing: a resource. The same holds on the service process level: a resource is called service input or service outcome only when it is related to some process.

Resources, like service elements, have constraints and several properties: type (physical resources, human resources etc), quality, productivity and possibly other, domain-specific properties. Identifying and defining relevant properties and constraints is a domain-specific task. We add three more properties for resources[2]:

- *State.* The change of state is a main characteristic of services, as we have explained. For example, in a room renting service element, the resource *room* has a state *available* as input, and a state *reserved* as outcome. Note that a service element does not have this property, since it is not the state of a service that changes.

- *Sharability.* A resource can be shared if it is still available for consumption, after being consumed already. When bundling service elements A, B and C (and possibly more) into service bundle X, service element A may have a service outcome that is required as a service input for service elements B as well as C (and possibly more). If this resource (outcome/input) is *sharable*, it can be used as an input by both B and C, and not only by one of them. A second scenario is that this service outcome of service element A is required by service element B, but will also be part of the outcome interface of service bundle X (implying that it can be consumed by an external entity). These two scenarios are depicted in Figure 3. Sharability is expressed by a number between 1 and infinite, standing for the number of times that this resource may be consumed. Sharability 1 means that a resource cannot be shared.

- *Compositeness* refers to whether and how two or more resources of the same type (possibly, but not necessarily resources of different service elements) can be united into and modeled as one resource, when they appear in the same interface. Resources may either not be united into one resource (e.g., tables of type A, and tables of type B – both physical resource – cannot be united into one resource), or they may be united by some formula. The formula may be simple (e.g., add the values of both resources) or a more sophisticated function. A common example for the compositeness property is the (financial) costs of services. If service element A costs 5000 Euro, and service element B costs 3000 Euro, the bundle may cost only 7000 Euro (the new price is calculated by a formula).

[2]In order to fully understand two of these properties, it is necessary to be familiar with the term 'service bundle', presented in section 3.4. For the time being, it suffices to say that a service bundle is a set of service elements, so that one service element may produce resources that another service element consumes.

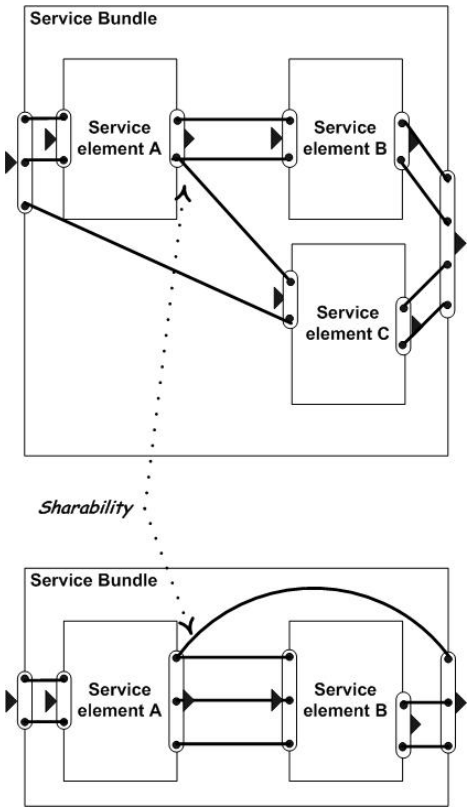

Figure 3: Resource sharability

Two resources are identical if and only if:

- They have the same set of properties (type, quality, productivity, state, sharability, compositeness and possibly domain-specific properties)

- All their properties have the same values

3.3 Service Outcome

Every service element eventually results in one or more tangible and/or intangible *service outcomes*. They are an observable, and thus an objective external representation of the supplier's service elements. By delivering service outcomes to a customer, the related service elements have been provided. Service outcomes are sometimes used to measure service quality.

3.4 Service Bundle

Service bundle is a set of core service(s) and possibly supplementary service elements, to be offered to customers. A

service bundle, being a composite service element, also has an input interface and an outcome interface, as defined for service elements. Service elements can be bundled in two ways:

1. Service elements A and B *can be bundled* if one or more outcome ports of A and one or more input ports of B are identical. Inputs of service element B, for which service element A does not provide identical outcomes, must be satisfied by the input interface of the service bundle. This type of a service bundle reflects a set of related service elements. Their relation may be of varying degrees. In the extreme case (see Figure 4a), the outcome interface of service element A is identical to the input interface of service element B; we call such two service elements *strongly connected*. In weaker cases only a subset of the outcome ports of service element A is identical to input ports of service element B; we call such two service elements *weakly connected* (see Figure 4b). Bundling services in this way requires defining the earlier presented notions of *identical ports* and *identical resources*.

2. Service elements A and B *are bundled* into a service bundle if (see Figure 4c):

   - The input interface of the service bundle is equal to the union of the input interfaces of A and B (taking the compositeness property of resources into consideration), and
   - The outcome interface of the service bundle is equal to the union of the outcome interfaces of A and B (also taking the compositeness property of resources into consideration).

   This type of a service bundle is less classic, but yet possible: a situation in which multiple services are provided together, although they are not related at all. Of course, there always exists some logic behind the bundling (e.g., lowering operational costs). We call such two service elements *independently connected*.

Note that although these examples and explanations refer to the bundling of two service elements, they can be generalized to the bundling of any number of service elements.

3.5 Service Offering

Service offering is not only the name of a perspective, but also a concept within that perspective. It should not be confused with *service bundle*. Whereas a service bundle stands for a set of one or more core service elements, plus zero or more supporting/enhancing service elements, a service offering is a set of zero or more service elements (of any type) plus zero or more service outcomes (with the constraint of having at least one service element or service outcome). Both *service bundle* and *service offering* describe what a business offers to its customers. The difference between a service offering and a service bundle is that the latter does not include a direct reference to service outcomes, associated with the service elements. The service offering, on the other hand, may include service outcomes without service elements. The need for the notion service offering, next to the notion service bundle, stems from customers' inclination to assess a service based on some observable outcomes. The service offering does not have to include all of the outcomes, associated with certain service elements, but only a subset thereof - the subset that is of interest for a customer at certain circumstances. Since a service offering includes outcomes that present what a customer is interested in (in supplier terms), we can use the service offering in the transformation process of customer input (service value perspective) into a supplier description of the service (service offering perspective).

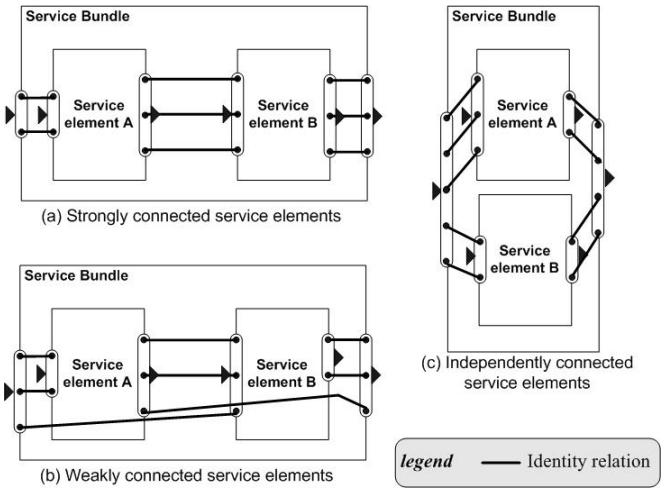

Figure 4: Service bundle

4. HOSTING A MEETING: A BUNDLE OF SERVICE ELEMENTS

Our running example includes the following five service elements; more service elements can be identified, but that is not necessary to demonstrate how our theory can be put into practice:

- core service element: hosting a meeting
- supporting supplementary service elements: planning (organizing) a meeting and room renting
- enhancing supplementary service elements: coffee catering and equipment provisioning

Hosting a meeting requires, like every service, the supporting service elements; the decision whether or not to choose enhancing service elements depends on the requested functionalities and quality requirements of the customer, and on the price he's willing to pay. In the following sections we analyze the service elements *room renting* and *coffee catering*. Each of them is actually a name for many service elements, since two service elements (e.g., two coffee catering services) with differing sets of properties (e.g., sacrifice, quality) are considered to be different service elements. Resource properties of secondary importance are omitted for simplicity. Where the valid values of properties are important, we mention it. Note that it is the supplier's task to decide which values are valid per property.

4.1 Room Renting

Like many other supporting service elements, room renting as a service happens "behind the scenes". For a customer who organizes a meeting, the existence of a space for the meeting goes without saying. A supplier, on the other hand, sees a more complex process behind it.

Room renting has the following **properties**:

Type: Supporting.

Quality: Is not considered in our running example. Examples would be regular or high quality, whereby high quality could imply mahogany tables (as a constraint).

Productivity: Refers to the maximum number of people that can participate in a meeting. Two resources determine the productivity of this service element: the room itself, and the setup (how tables and chairs are organized, e.g. in an O-shape or a U-shape). Productivity, expressed in a number (integer), is thus the maximum number of people in a room, considering the room setup.

Sacrifice: Price.

Room renting requires the following **service inputs**:

Payment. Type: monetary resource.

Room. Type: physical good. State: available. Productivity: number (as explained before, it depends on the setup).

Room renting results in the following **service outcomes**:

Room. Type: physical good. State: reserved. Productivity: number of people.

Room-setup. Type: physical good (a setup is an organization of tables and chairs). State: O or U (no other values are allowed for a meeting). Productivity: number.

Room renting has the following **constraints**[3]:

- Relation between the resources *room* and *setup* (some setups are not possible in specific rooms; the productivity of a room depends on the room setup).
- Price (sacrifice) is a function that depends on the supplier's pricing strategy, and takes quality and productivity issues into consideration.
- The value of service property *sacrifice* is equal to the value of service input *payment.*
- The value of the service property *productivity* is determined by the productivity of the resources *room* and *room-setup.*
- If we had considered the quality property, we would have had constraints on the service outcome *room* (various rooms may offer differing levels of luxury).

[3]We provide generalized, and thus not machine-readable example constraints; they can be further specified with concrete values. For example, if resource 'room' has value 'room X', then valid values for resource 'setup' are 'O' or 'U'.

4.2 Coffee Catering

A meeting can be held without coffee catering. Including this service element in a service offering will probably make the service more expensive. The customer may choose one of several predefined service quality levels.

Coffee catering has the following **properties**:

Type: Enhancing.

Quality: This is a composite property; it is composed of two properties: product quality (referring to the variety of products to be provided) and process quality (referring to the degree of required customer participation vs. employee doing the work). The possible quality values are:

Product quality: (1) Basic: coffee, milk, sugar and cutlery; (2) Regular: basic, plus water and cake; (3) Luxurious: regular, plus juice, tea and several types of cakes

Process quality: (1) Basic: catering is brought in, but not served (self-service); (2) Regular: catering is brought in and served; (3) Luxurious: catering is brought in, and served upon request (employee remains in room for a long period)

Productivity: Maximum number of people to be served.

Sacrifice: Price.

Coffee catering requires the following **service inputs**:

Room. Type: physical good. State: reserved. Productivity: number of people.

Customer/Employee. Type: Human resource. This resource depends on the chosen process quality. We model only human resources that are not inherent to the service: we do not model the employee who brings the coffee to the meeting room. Basic process quality implies that the customer has to serve himself (in return for a lower price), and is thus considered as a human resource. Regular quality is the standard service, in which an employee brings refreshments to the meeting room, serves it and leaves the room. In such a case we do not model human resources, because they are inherent to the service. Luxurious quality implies that the employee remains in the room for a longer period, to serve coffee upon request. This last part of the service is not inherent to the service (and reflects costs for customers); it is thus modeled as a human resource.

Payment. Type: monetary resource.

Coffee, milk etc. are *inputs* on the service process perspective, but not on the service offering perspective, since on this perspective they are invisible to the customer, as inputs. They are, however, modeled as *outcomes* on the service offering perspective, since they reflect – as outcomes – what the customer pays for. As input they reflect value (costs) for the supplier, and as outcomes they present value for the customer. Only the latter type of resource is modeled on the service offering level.

Coffee catering results in the following **service outcomes**:

Coffee. Type: physical good. Productivity: number of people.

Milk. Type: physical good. Productivity: number of people.

Sugar, water, cake etc: based on the chosen product quality.

Ability to freshen up. Type: capability. A coffee catering service during a meeting is not only about consuming beverages and/or snacks; it provides meeting participants with the opportunity to take a break and gain some new energy. Productivity: number of people.

Coffee catering has the following **constraints**:

- Process quality (basic, regular, luxurious) determines the service input of type human resource (valid values: customer, null, employee, respectively).
- Product quality (basic, regular, luxurious) determines the service outcomes of type physical good (coffee, milk etc).
- Price (sacrifice) is a function that depends on the supplier's pricing strategy, and takes quality and productivity issues into consideration.
- The value of service property *sacrifice* is equal to the value of service input *payment*.
- The productivity of the resource "ability to freshen up" equals the lowest productivity value of the resources *coffee, milk, sugar, cake* etc.

4.3 Bundling Service Elements

Since it is a supporting service element, *room renting* has to be part of every service bundle for meetings. Coffee catering is an enhancing service element – the decision whether or not to include it in a service bundle depends on the customer. When configuring these two service elements, we face two conceptually different levels of configuration. The first level reflects a high level decision regarding the services to be configured: (1) only room renting, or (2) room renting AND coffee catering. The second level is choosing which of the various room renting service elements and (possibly) coffee catering service elements to configure. As explained before, a coffee catering service element with product quality X, and a coffee catering service element with product quality Y are two different components – two different service elements. The same holds for room renting, or for any other service element. An important observation can be made regarding room renting and coffee catering: they can be weakly connected. A reserved room is an outcome of the service element *room renting*, as well as an input of the service element *coffee catering*. Figure 5 presents the first option for a service bundle: the bundle includes a room renting service element, but no coffee catering. It shows two different service bundles, with two different room renting service elements. The difference between them is limited to the productivity property (number of participants), but typically the price would be different as well. Figure 6 presents two examples of possible coffee catering service elements. In the first one, the process quality is set to *regular*, implying no human resource input. In the second one, the process quality is *basic*, implying that the customer is an input of type human resource. Finally, Figure 7 shows two of many possibilities to bundle a room renting service element with a coffee catering service element. This is where we see that both service elements can be weakly connected; an outcome resource of the room renting service element is also an input resource of the coffee catering service element. Both examples presented in Figure 7 combine weakly connected service elements. Whereas the coffee catering service element in Figure 7a requires two inputs, in Figure 7b it requires three inputs (next to two more inputs required by the room renting service element). The service bundle would consequently have four and five service inputs respectively. But since one input is satisfied internally, the service bundle eventually has only three and four inputs respectively.

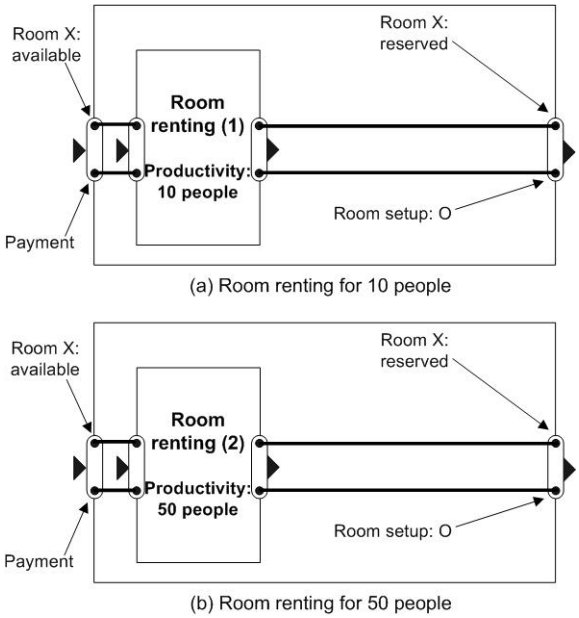

Figure 5: Service bundles, including a room renting service element only

4.4 Analysis

Even with only two simple service elements, room renting and coffee catering, a supplier can offer a broad variety of services; a room has to be suitable for a certain number of people, and can be organized in various ways (room setups). A further – very realistic – complication would be to include requirements on available equipment (e.g., network connectivity). Also a simple service as coffee catering may be offered in different setups (product and process quality); ample possibilities to configure a service bundle exist. Analyzing the meeting case with domain experts revealed that the service is much more complex than expected. The component-like analysis of the service offering is new to the business, and mapping a service offering into service elements and resources is a time-consuming task. It is required though to make implicit knowledge explicit, and to facilitate a machine-enabled scenario of offering services. Analyzing the meeting case study was a useful exploration activity to domain experts as well. It helped understand characteristics of the service, which were not explicitly acknowledged as such before. Mainly, domain experts concluded that two

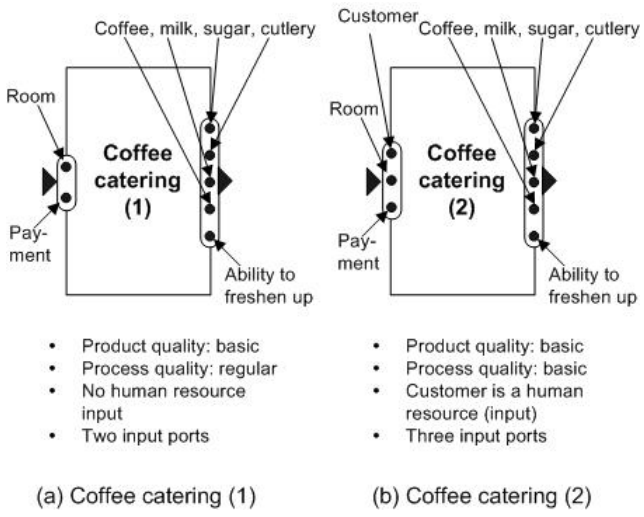

Figure 6: Two possible coffee catering service elements

quality dimensions are important for customers in organizing a meeting: product quality and process quality. This corresponds with the Nordic school for service quality [10], and not with the North American school [20], also used by [13] and by [16]. The process provided us with new insights on the service ontology. Mainly, the distinction between resources on the service offering level (stand for *which service is provided*) and resources on the service process level (relate to *how* the service is provided) was not yet clear at earlier stages.

5. CONCLUSION AND FUTURE WORK

We have created a generic ontology of real-world services, based on the scientific literature in service management and marketing. Such an ontology has to be component-based, in order to facilitate the online configuration of services. By expressing services as components with related resources, we make it possible for software to reason about bundling services: it becomes a 'traditional' configuration task. Since services are business activities that present value to customers as well as suppliers, a value element has to be dominant in a service ontology. The configuration of service elements into a service bundle is triggered by a customer's desire for some value, reflected by service outcomes. The sacrifice property of service elements represents the most common value from the supplier side. Together these concepts give us a good understanding of a service offering's value. In order to understand the business model behind such a service offering (or service bundle), one must use a business value analysis tool, e.g. by integrating the service ontology with a value ontology [8, 9].

Many product-oriented industries configure products based on a componential description of their (tangible) products. Services, being intangible products, can be handled in the same way. Whereas many ontologies exist for classifying tangible products (physical goods, in our terms), a generic service ontology for the support of service configuration is yet missing. This is the contribution of our service ontology. In this paper, we have shown how it can be put into practice.

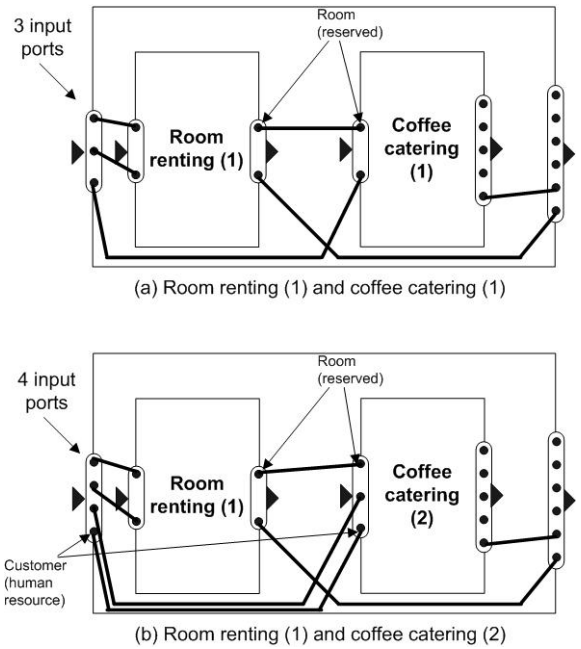

Figure 7: Service bundles, including room renting and coffee catering

The work presented in this paper is still in an ongoing stadium. Work is being performed on multiple fronts. First, the service ontology is in the process of testing for real-life suitability, based on case studies. The ontology is evolving through the learning process of our research. Second, we are working on the integration of the service ontology with a configuration ontology, developed by a project partner in accordance with [11] and [15]. Third, we plan to work also on integrating the service ontology with a value ontology, i.e. e^3*-value* ontology [8, 9].

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Diffusion of Innovation & Citizen Adoption of E-government Services

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ABSTRACT
State government agencies all over the nation are making their services available online. The success of e-government initiatives is contingent upon citizens' willingness to adopt these Web-enabled services. This study uses Rogers' Diffusion of Innovation Theory to identify factors that influence citizen adoption of e-government initiatives. To pilot test our adoption model we administered a survey to 140 undergraduate students at an accredited research university. This paper discusses the results of the study and their implications for research and practice.

Categories and Subject Descriptors
H.4.3 [**Information Systems Applications**]: Communications applications. K.6 [**Management of Computing and Information Systems]**.

General Terms
Management, Human Factors

Keywords
e-government, diffusion of innovation, adoption

1. INTRODUCTION
E-government is the use of information technology, especially telecommunications, to enable and improve the efficiency with which government services and information are provided to citizens, employees, businesses, and government agencies. Federal, state and local government agencies have implemented numerous e-government initiatives to enable the purchase of goods and services, the distribution of information and forms, and the submission of bids and proposals. There are predictions of more than $600 billion of government fees and taxes to be processed through the Web by 2006 [11]. In the U.S., federal government spending is predicted to reach $2.33 billion by the year 2005 [5].

While there seems to be substantial growth in the development of e-government initiatives, it is not clear that citizens will embrace the use of such services. The success and acceptance of e-government initiatives, such as online voting and license renewal, are contingent upon citizens' willingness to adopt these services. Numerous studies have analyzed user adoption of electronic commerce [6, 7, 14, 19]. Yet, to date, few studies have explored the core factors that influence citizen adoption of e-government services. According to a survey conducted by the International City/County Management Association (ICMA) administered to chief administrative officers (CAO) at government agencies, 74.2 % of CAOs reported that their government agency had a Web site. However, 90.5 % of these agencies have not conducted a survey to see what online services citizens and businesses actually want [10].

This study uses constructs from Rogers' [21] diffusion of innovation theory (DOI) to identify fundamental elements of e-government adoption. These constructs have been used in IT research [16, 19] and e-commerce research [24]. Based on similarities between e-commerce and e-government, DOI constructs are proposed as useful indicators of e-government adoption.

2. THEORETICAL FOUNDATIONS
2.1 E-commerce & E-government
2.1.1 Similarities
E-commerce and e-government are both based on Internet technology designed to facilitate the exchange of goods, services and information between two or more parties. E-commerce refers to the commercial use of Internet technology to sell and purchase goods or services. Laudon [13] identifies three major electronic commerce categories: business-to-consumer (B2C), business-to-business (B2B), and customer-to-customer (C2C). B2C commerce refers to the retailing of products or services to individual shoppers. B2B commerce is the sale of goods and services among businesses. In C2C commerce, consumers sell goods and services to other consumers online.

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The United States' General Accounting Office in 2001 identified comparable categories for electronic government - government-to-citizen (G2C), government-to-employee (G2E), government-to-government (G2G), and government-to-business (G2B) - each of which uses Internet technology to provide government services online [8]. G2C government allows citizens to retrieve information and complete government transactions, such as license renewal, online. G2E government takes advantage of Internet technology by allowing government agencies to interact with their employees online. G2G government supports online communication and interaction among government agencies. G2B government allows businesses to retrieve timely government information and complete transactions with government agencies, such as bid submission, online.

Other studies have resulted in similar categories of e-government. The Office of Management and Budget (OMB) categorizes e-government into four types: G2C, G2B, G2G, IEE [13]. Instead of G2E, OMB includes IEE, Internal Efficiency and Effectiveness, as its fourth category. IEE initiatives "bring commercial best practices to key government operations, particularly supply chain management, human capital management, financial management and document workflow [18]."

Hiller and Belanger [9] classify e-government into six categories: Government Delivering Services to Individuals (G2IS), Government to Individuals as a Part of the Political Process (G2IP), Government to Business as a Citizen (G2BC), Government to Business in the Marketplace (G2BMKT), Government to Employees (G2E), and Government to Government (G2G). G2IS and G2IP are comparable to G2C government. G2IS refers to the government communicating and providing services to citizens online. G2IP refers to the "relationship between government and its citizens as a part of the democratic process [9]." G2BC and G2BMKT are comparable to G2B. G2BC supports capabilities such as paying taxes and filling SEC reports online, while G2BMKT refers to e-procurement. Hiller and Belanger's G2E and G2G categories are comparable to those defined by GAO and OMB.

Not only are e-commerce and e-government categorized in similar ways, but they also provide similar services to individuals and organizations. Both e-commerce and e-government systems support the electronic mediation of transactions over potentially great distances. Both services also require consumer or citizen trust [1, 14, 19, 25] due to the absence of face-to-face interaction.

2.1.2 Differences

Jorgenson and Cable [12] identify three major differences between e-commerce and e-government: access, structure and accountability. In e-commerce, businesses are allowed to choose their customers; however, in e-government, agencies are responsible for providing access to information and services to the entire eligible population, including individuals with lower incomes and disabilities. The digital divide makes this task of providing universally accessible online government services challenging. Also, the structure of businesses in the private sector is different from the structure of agencies in the public sector. Decision-making authority is less centralized in government agencies than in other businesses. This dispersion of authority impedes the development and implementation of new government services. The third difference between e-commerce and e-government identified by Jorgensen and Cable [12] is accountability. In a democratic government, public sector agencies are constrained by the requirement to allocate resources and provide services that are "in the best interest of the public [12]."

Warkentin et al. [25] recognize the political nature of government agencies as a distinguishing feature of e-government from e-commerce. They also note another difference between e-commerce and e-government: mandatory relationships. Mandatory relationships exist in e-government. For instance, legislation, such as the Government Paperwork Elimination Act of 1998, obligates government agencies to "give persons who are required to maintain, submit, or disclose information the option of doing so electronically, when practicable, by October 21, 2003" [4].

2.1.3 Constructs

Although e-government and e-commerce differ in terms of access, structure, accountability [12] and mandatory relationships [25], constructs from e-commerce models can be used to study the adoption of electronic services in the public sector. Previous research has found that factors from DOI play a role in user acceptance of electronic commerce in the private sector [24]. In the public sector, citizen adoption of e-government is subject to similar factors [25]. Considering the similarities between electronic commerce and electronic government, the constructs used to study e-commerce adoption, are also applicable to e-government adoption.

2.2 Diffusion of Innovation

Rogers' [21] Diffusion of Innovation Theory (DOI) is used frequently in information systems research to explain user adoption of technological innovations. Rogers defines diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social society." He defines an innovation as "an idea, practice or object that is perceived as new by an individual or other unit of adoption." Based on previous research [17, 22, 24] we study the effects of relative advantage, compatibility, complexity and image on citizen intention to use a state e-government service.

According to Rogers [21] the rate of diffusion is affected by an innovation's relative advantage, compatibility, complexity, trialability and observability. Relative advantage is "the degree to which an innovation is seen as being superior to its predecessor." Compatibility refers to "the degree to which an innovation is seen to be compatible with existing values, beliefs, experiences and needs of adopters." Complexity, which is comparable to TAM's perceived ease of use construct, is "the degree to which an innovation is seen by the potential adopter as being relatively difficult to use and understand." Trialability is the "degree to which an idea can be experimented with on a limited basis." Observability is the "degree to which the results of an innovation are visible."

Tornatzky and Klein [22] posit that relative advantage, compatibility, and complexity are the most relevant constructs to adoption research, thus we include these three constructs in our study. Moore and Benbasat [17] present image, result demonstrability, visibility, and voluntariness as additional factors that influence the acceptance and use of an innovation [17]. Given the amount of coverage Web-based systems have received in the popular press, we include image in our study. Image refers to the "degree to which the use of the innovation is seen as enhancing to an individual's image or social status [24]."

We do not explore the constructs of voluntariness or trialability. Voluntariness is the degree to which individuals feel they have the option to use an innovation or not. Since citizen use of a Web-based state government service is an individual choice and is not likely to be mandated, voluntariness would be unlikely to show significant variability, and is therefore inappropriate to include in this study.

A comparable argument can be made for excluding trialability from the study. Trialability is degree to which potential adopters feel that they can use the innovation before they actually adopt it. Since it was dubious that perceived trialability would display adequate variance to offer explanatory power, this construct was not included in the study.

3. Research Model

Figure 1 presents a high-level research model that summarizes the constructs discussed above.

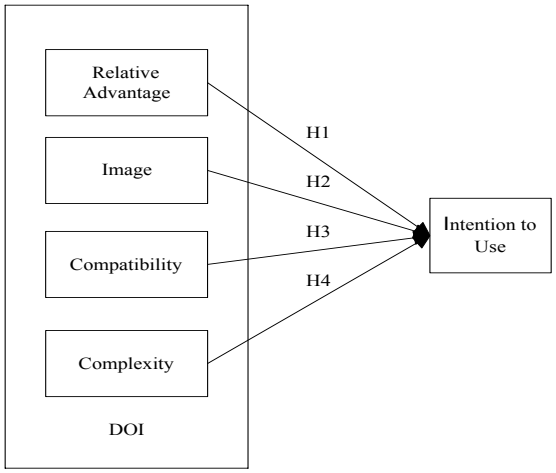

Figure 1. DOI & E-government Adoption

4. HYPOTHESES

In prior technology adoption literature [16, 23] the adoption factors illustrated in Figure 1 all demonstrate a positive relationship with use intentions except for complexity, which has a negative relationship with use intentions. We expect the nature of these relationships to remain the same in the context of electronic government. Therefore, based on prior research in e-commerce and information technology adoption, four hypotheses are posited (see Table 1).

Table 1. Hypotheses

Name	Hypothesis	Construct
H1.	Higher levels of perceived relative advantage will be positively related to higher levels of intention to use a state e-government service.	Perceived Relative Advantage (RA)
H2.	Higher levels of perceived image will be positively related to higher levels of intention to use a state e-government service.	Perceived Image (IM)
H3.	Higher levels of perceived compatibility will be positively related to higher levels of intention to use a state e-government service.	Perceived Compatibility (CT)
H4.	Lower levels of perceived complexity will be positively related to higher levels of intention to use a state e-government service.	Perceived Complexity (CP)

5. METHODOLOGY

5.1 Sample

To pilot test our model, we administered a survey instrument to 140 undergraduate students at a southeastern research university. Of the 140 surveys administered, 136 were complete and used in the analyses. The subjects had an average of 9 years of experience using a computer; the average age was19 years; and, 63% were male. 98% of the sample uses the Web everyday; however, the majority (52%) use the Web to gather information about or from the government less than once a month, and 32 % have never used the Web to gather information about or from the government. Also, 89% have never used the Web to complete a government transaction, such as a license renewal.

5.2 Instrument Development

The items used in this survey were adapted from previous studies. The measures of compatibility, relative advantage, and image were adapted from Van Slyke et al. [24]. Complexity was measured using perceived ease of use items adapted from Davis' TAM model [3]. The items used to measure use intentions were adapted from Pavlou [19] and Gefen and Straub [6]. A list of the items is provided in the appendix. Each item is rated on a scale of 1 to 7 (Strongly Disagree to Neutral to Strongly Agree).

The reliability of the items was evaluated using Cronbach's alpha [2]. Table 2 presents the results of the reliability analysis, demonstrating acceptable reliabilities (above 0.70) for all scales.

Table 2. Reliability Analysis

Construct	# of Items	Reliability
Relative Advantage (RA)	5	.7773
Image (IM)	4*	.7824
Compatibility (CT)	4	.7469
Complexity (CP)	4*	.7222
* Originally this construct was measured with 5 items. One reverse worded item was dropped to improve reliability.		

Factor analysis using principle components with Promax rotation was used to evaluate construct validity (Table 3). As shown in Table 3, most items loaded properly on their expected factors. However, relative advantage items and compatibility items loaded together.

Table 3. Factor Analysis

Item	Factor Loading				
	USE	RA	IM	CT	CP
USE1	.754				
USE2	.833				
USE3	.778				
USE5	.723				
RA1		.796			
RA2		.836			
RA4		.842			
RA5		.765			
IM1			.832		
IM2			.400		
IM3			.837		
IM5			.828		
CT1		.713			
CT2		.537			
CT3	.741				
CT4		.510			
CP1					.701
CP3					.697
CP4					.680
CP5					.697

RA and CT items have loaded together in other DOI research [17]. Moore and Benbasat conducted a rigorous study using multiple judges and sorting rounds to develop reliable measures of [21] diffusion of innovation constructs. Although the items for RA and CT were identified separately by the judges and sorters, all the items for these two constructs loaded together. Moore and Benbasat conclude, "this may mean that, while conceptually different, they are being viewed identically by respondents, or that there is a causal relationship between the two [17]. " For example, "it is unlikely that respondents would perceive the various advantages of using [state e-government services], if its use were in fact not compatible with the respondents' experience or [life] style [17]."

In summary, model and hypotheses testing was conducted with four independent variables - perceived relative advantage, perceived image, perceived compatibility and perceived complexity - and one dependent variable – use intentions. The basic characteristics of these variables are presented in Table 4.

Table 4. Final Regression Variables

Variable	# Items	Mean	Stand. Dev.
RA	4	5.0821	0.9240
IM	3	2.9333	1.1686
CT	2	4.6000	1.0217
CP	2	5.6179	1.0047
Use	3	4.8714	1.0492

6. RESULTS

The results were analyzed using multiple linear regression analysis. The purpose of a regression analysis is to relate a dependent variable to a set of independent variables [15]. Regression analysis was seen as the most appropriate analytical technique since the goal of this study was to determine the relationship between use intention (dependent variable) and citizen perceptions of state e-government initiatives (independent variables).

Assumptions of multivariate normal distribution, independence of errors, and equality of variance were then tested. There were no violations of these assumptions. Multicollinearity was not a concern with this data set as confirmed by the main effect regression models with variance inflation factors (VIF range from 1.012 to 2.310). Outlier influential observations were identified with leverage, studentized residuals, and Cook's D-statistic. This analysis indicated that there were no problems with respect to influential outliers.

The model explains 50 percent of the variance in citizen adoption of e-government; adjusted R Square is .500, F=35.714, p=.000. Three of the four adoption factors - relative advantage, image and compatibility - were found to be significant in

predicting citizen intention to use state e-government services. Table 5 presents the results of the individual hypotheses being tested.

Table 5. Hypothesis Testing

Name	Variable	Coeff.	t-value	Sig.	Supported
H1	RA	.255	2.671	.009	YES
H2	IM	.206	3.421	.001	YES
H3	CT	.439	4.811	.000	YES
H4	CP	.066	.817	.416	NO

7. DISCUSSION

The purpose of this research was to use DOI constructs to test a model of e-government adoption. Perceived relative advantage, image, and compatibility, were found to be significant in predicting citizen intention to use state e-government services. These factors are summarized in Figure 2.

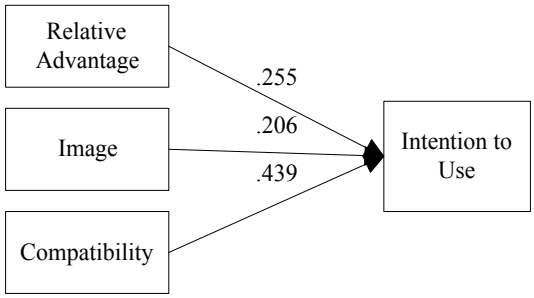

Figure 2. DOI & E-government Adoption

7.1 Relative Advantage

Higher levels of perceived relative advantage increase citizens' intentions to use state e-government services. State government agencies should identify and communicate to citizens the advantages of using online services as opposed to other means of retrieving information from and completing transactions with state government agencies. As a result of e-government services, citizens receive faster, more convenient services from a more responsive and informed government [23]. For example, state agencies could encourage the adoption of online license renewal by emphasizing its convenience and speed compared to the traditional method of license renewal. It is more convenient than the traditional method of visiting the brick-and-motor Department of Motor Vehicles (DMV). Online license renewal can be completed from the home or office 24 hours a day, seven days a week. The availability of the service isn't limited to standard business hours. The citizen can complete this transaction whenever and from wherever it is most convenient. The online service is also quicker than the traditional method since citizens don't have to travel to a physical branch of the DMV and then wait in line. The online service is immediately available to each citizen. T

Emphasizing and communicating the benefits of e-government services compared to traditional state government services will increase perceived relative advantage, which increases citizens' intention to use state government services online. The comparative benefits of online services such as, license renewal, tax filing, etc. should be shared with citizens to increase adoption of these services.

7.2 Image

Higher levels of perceived image enhancing value of e-government increase citizens' intention to use state government services online. In other words, those who regard the use of state e-government services as prestigious will have higher intention to use state e-government services than those who do not. In the United States, the priority and importance of e-government is increasing. E-government is one of the five items on the President's Management Agenda. Citizens who view the adoption of e-government services as a way to appear technically savvy and politically progressive will therefore have a higher intention to use e-government services.

7.3 Compatibility

Higher levels of perceived compatibility are associated with increased intentions to adopt state e-government initiatives. For example, citizens who've adopted e-commerce initiatives can be expected to view e-government initiatives as compatible with their lifestyle. These citizens will have higher intentions to use e-government services than those who view these services as incompatible with their lifestyle. Since many cultures now embrace Internet technology in business (e-commerce and e-business) and leisure (instant messaging and virtual communities), it can be expected that citizens who've adopted these Internet-supported initiatives are likely to adopt state e-government services as well.

7.4 Complexity

Contrary to hypothesis 4, lower levels of perceived complexity are not significantly associated with increased use intentions of e-government services. This unpredicted outcome could be the result of the use of college students as subjects. Our sample for this pilot test consisted of experienced computer users whose perceptions of complexity probably differ from the overall population of American citizens. The subjects have an average of 9 years of experience using a computer and 98 % of the sample uses the Web everyday. Since these college students are confident in their ability to use online services, apprehension provoked by potential complexity is not a significant deterrent of e-government adoption.

8. LIMITATIONS

Our sample consisted of undergraduate students at a southeastern research university. The use of student subjects may limit the generalizability of the results. Although several

studies in technology acceptance have used student subjects [3, 6, 16, 23], college student demographics, such as experience using the Internet, differ from the demographics of the overall population of American citizens. A majority of college students frequently use and have easy access to Internet services. However there are many citizens who are members of the digital divide, in the United States and other countries, who do not have easy access to or much experience with Internet technology. This study is the pilot of a larger scale study of citizen adoption of e-government initiatives. The next phase of data collection will elicit participation from a broad diversity of citizens in age, gender, ethnicity, and social groups.

9. IMPLICATIONS

9.1 Implications for Research

This study presents an introductory model that explains 50 percent of the variance in citizen adoption of state e-government initiatives. This model can serve as a starting point for other e-government adoption research. The model accounts for a significant portion of the variance in citizen adoption of e-government services, while encouraging further exploration and integration of other adoption constructs. In the future, we plan to integrate constructs from the technology acceptance model [3] and the Web trust literature [1, 7, 14] to develop a more comprehensive, yet parsimonious model of e-government adoption.

9.2 Implications for Practice

The study reveals three significant indicators of citizens' intention to use state government services online. State agencies should promote citizen acceptance and use of e-government services by manipulating these factors: perceived relative advantage, perceived image, and perceived compatibility. State government agencies should encourage adoption of online services by encouraging citizens to capitalize on the unique benefits of these services, promoting use of e-government services as a status symbol and indicating the services' congruence with a citizen's lifestyle. State agencies could communicate the unique benefits, or relative advantages, of e-government services by sending citizens a letter explaining the speed, convenience and accessibility of online government services. In this letter, government agencies could also increase citizens' perceptions of compatibility by noting the similarities between traditional government services and online government services. For instance, online license renewal may use the same form used in the manual process to allow citizens to easily incorporate the use of e-government services into their life. To enhance the perceived image of e-government adopters, agencies could pursue endorsements from local celebrities or well-respected citizens in the community to advocate the use of state e-government services. These endorsements would enhance the image of citizens who adopt this innovation.

10. CONCLUSION

This study uses constructs from Diffusion of Innovation Theory [21] to develop a parsimonious model of citizen adoption of state e-government services. Perceived relative advantage, perceived image, and perceived compatibility are significant elements of e-government adoption. The model explains 50 percent of the variance in citizen intention to use e-government services. As e-government grows in importance and priority for governments worldwide, an understanding of the factors that influence citizen adoption of these online services is invaluable.

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Appendix

State E-government Adoption Items

Use Intentions (USE)

USE 1. I would use the Web for gathering state government information.

USE 2. I would use state government services provided over the Web.

USE 3. Interacting with the state government over the Web is something that I would do.

USE 5. I would use the Web to inquire about state government services.

Relative Advantage (RA)

RA 1. Using the Web would enhance my efficiency in gathering information from state government agencies.

RA 2. Using the Web would enhance my efficiency in interacting with state government agencies.

RA 4. Using the Web would make it easier to interact with state government agencies.

RA 5. Using the Web would give me greater control over my interaction with state government agencies.

Image (IM)

IM 1. People who use the Web to gather information from state government agencies have a high profile.

IM 2. People who use state government services on the Web have a high profile.

IM 3. People who use the Web to gather information from state government agencies have more prestige than those who do not.

IM 5. Interacting with state government agencies over the Web enhances a person's social status.

Compatibility (CT)

CT 1. I think using the Web would fit well with the way that I like to gather information from state government agencies.

CT 2. I think using the Web would fit well with the way that I like to interact with state government agencies.

CT 3. Using the Web to interact with state government agencies would fit into my lifestyle.

CT 4. Using the Web to interact with state government agencies would be incompatible with how I like to do things.

Complexity (CP)

CP 1. Learning to interact with a state government Website would be easy for me.

CP 3. I believe interacting with a state government Website would be a clear and understandable process.

CP 4. I would find most state government Websites to be flexible to interact with.

CP 5. It would be easy for me to become skillful at using a state government Website.

E-Government Services and the McDonaldization of Government

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ABSTRACT
Sociologist George Ritzer has written extensively on the phenomenon of 'McDonaldization' occurring in various facets of the American life experience, and increasingly around the world. This paper posits that the current interest in E-Government may be considered a new front in the trend towards McDonaldization, in this case the McDonaldization of government. Concepts from Ritzer's theory are used to demonstrate why E-Government may be considered an effort to foster McDonaldization of government; and to explore what this may mean for the future of government. It is proposed that McDonaldization can serve as a useful paradigm and framework for E-Government research; and that by familiarizing themselves with Ritzer's McDonaldization thesis, researchers in E-Government should be able to glean useful insights that can help them during the course of their research.

Categories and Subject Descriptors
H.0 [**Information Systems**]: General.

General Terms
Management, Standardization, Theory.

Keywords
E-Government, Society, Standardization.

1. INTRODUCTION
Sociologist George Ritzer [12], [13] has written extensively on the phenomenon of 'McDonaldization' occurring in various facets of the American life experience, and increasingly around the world. According to Ritzer, McDonaldization refers to the proliferation of a consumer culture that is propagated by, and owes its success to, the following four dimensions:

- **Efficiency**: E.g., increasing speed and lowering cost of service.
- **Calculability**: E.g., using quantity as a proxy for quality (e.g., a larger hamburger is a better hamburger).
- **Predictability**: E.g., assuring customers of uniformity of products and services, and by avoiding giving surprises to customers.
- **Control**: E.g., by substitution of human by non-human technology and via limited choice offerings.

Education, medical care, tourism, journalism and even sociological theory, according to Ritzer, are some areas of human activity where the trend towards McDonaldization can be perceived.

Ritzer argues that McDonaldization may be seen as a new paradigm of rationalization that has superseded 'bureaucracy' as was discussed by Max Weber. Weber had maintained that persistent and heightened formal rationalization of processes in Western society had precipitated the emergence of bureaucratic structures in this society. Ritzer suggests that the hyper-rationality of McDonaldization may simply be a more up-to-date consequence of that same trend.

Although Ritzer laments the McDonaldization of society, this phenomenon should not be thought of as something that has been imposed on society from the outside; McDonaldization must be understood as a consequence of legitimate societal demands and valid organizational efforts to satisfy them. Nevertheless, it should be recognized that, even though it is thriving due to a demand for it and for its considerable advantages, McDonaldization bring along with it substantial negative baggage; especially in the form of what Ritzer refers to as the 'irrationality of rationality', i.e. seemingly rational processes that are not necessarily so.

This paper posits that the current interest in E-Government[1] may be considered a new front in the trend towards McDonaldization,

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[1] For the purposes of this paper, E-Government is defined as the use of internet technologies to improve government functioning and to facilitate interactions with citizens.

in this case the McDonaldization of government. Governments and citizens alike are keenly interested in the application of new information technologies to make governments more citizen-centric, accessible and responsive. Take, for example, the current interest in E-Voting. This interest in E-Voting is driven by a concern for making voting, a slightly time-consuming and inconvenient task, more convenient for citizens, by allowing them to cast their votes in the comfort of their own homes via the internet. Although it is likely to be a while before true E-Voting systems are implemented, governments around the world have already begun the process of installing a range of applications that allow citizens to fulfill, via online means, a variety of processes that may have formerly required a visit to a government office.

Thus, governments are bowing to new exigencies and demands from citizens to become increasingly citizen-friendly (customer-friendly) and citizen-centric (customer-centric) through the use of information technologies. Therefore, it may be proposed that, in a sense, E-Government is driving the McDonaldization of government. That, government is joining the large sphere of human activity that continues to inexorably become McDonaldized.

In light of this discussion, this paper posits that E-Government researchers may find the McDonaldization paradigm useful in the course of their research. By familiarizing themselves with the McDonaldization thesis, E-Government researchers may place themselves in a position to identify and focus on certain issues that are often seen to emerge out of McDonaldization. Additionally, the four dimensions of McDonaldization offer researchers a framework within which to analyze developments in E-Government.

This paper is organized in the following way. The next section offers a deeper discussion of Ritzer's McDonaldization thesis. The subsequent section explains why E-Government may be considered an effort to foster McDonaldization of government and explores what this may mean for the future of government. The next, i.e. final, section offers concluding remarks on why it may be useful for E-Government researchers to take cognizance of this paper's propositions on the McDonaldization of government.

2. RITZER'S McDONALDIZATION THESIS

Ritzer demonstrates that a diverse range of human activity systems can be seen to be getting increasingly McDonaldized. According to him, the McDonaldization paradigm is especially attractive to service industries because they seek to emulate the success of fast food restaurant chains by focusing on the four dimensions identified earlier in the introduction to this paper; namely: efficiency, calculability, predictability and control.

In the tourism industry for example, a tourist on a package tour could visit 7 countries in a week, yet stay in identical hotels, make pre-programmed, scripted site-seeing visits, hobnob only with other tour members and avoid ever meeting an actual native!

People who are conscious about wrinkles on their face can schedule a Botox face-lift during their lunch break, and be back at work minutes later, looking many years younger; a sign that the medical industry too is becoming McDonaldized. In fact, a new phenomenon has taken hold with respect to Botox face-lifts; doctors are organizing Botox parties where people can have a good time and get a face-lift at the same time… this echoes the McDonald's concept of marketing, to children, that a visit to a McDonalds is a fun thing to do.

The popularity of USA Today (the newspaper) is suggestive of McDonaldization of the journalism profession. USA Today likes to present complex news via simplified formats, such as short summaries, dumbed-down statistics and easy to understand graphics (such as color-coded pie-charts). Ritzer describes the USA Today format as consisting of news hamburgers. Similar trends can be seen in the case of news programs on TV.

Of special interest to the readers of this paper would be Ritzer's views on the McDonaldization of education and social science theory.

The McDonaldization of education can be seen in the way universities are trying to make the process of education more convenient for students. Universities are modifying their curricula to offer courses that students find more appealing. Students are assigned textbooks that offer overviews and summaries of entire fields, (somewhat like the USA Today format mentioned earlier) and it is rare for students to be required to read original works. In a rush to increase enrolment, universities are marketing degrees and credentials via television and radio spots; media that are more traditionally associated with mass consumption goods. In the ultimate expression of marrying technological possibility with customer demand, universities are offering online courses. Thus, universities can be seen to be attempting to increase their production of degrees and to make it increasingly easier for students to earn degrees.

Ritzer provides a detailed account of the McDonaldization of American sociological theory. For example, research that involves large samples is more likely to be published than that which involves small samples, because large samples are supposed to lend themselves to greater generalizability. This is an example of quantity as a proxy for quality, i.e. 'calculability'. McDonald's restaurants propagate the same concept when they offer to super-size a meal or drink for a small additional cost. Another example of the ascendance of calculability is the fact that sociologists are usually judged according to the number of papers they have published. Thus, the field demands increased efficiency from members, who are expected to produce larger numbers of measurable outputs in smaller units of time. This has resulted in a situation wherein functional, positivist research is produced in disproportionately greater numbers than interpretive, ethnographic research, because the last two kinds of research tend to be more time-consuming. Today, journal articles are highly predictable in certain respects. They usually tend to be of a uniform length, and tend to follow a predictable format (i.e. they have an introduction, followed by a literature review, followed by a methodology and results sections, followed by conclusions and limitations). Readers know what to expect and where to expect it. They can quickly predict with great accuracy how long it will take them to read the article, and what they will learn from it. The reviewing process enforces the view that new research should be built upon existing research. Thus article reviewers tend to be experts in their field whose main concern often is whether the new work builds on their own prior work and whether it extends the intellectual tradition they are a part of. Works that do not conform to such expectations are often rejected for being too

different, and for not borrowing enough from established traditions. A large number of articles have multiple authors, each of whom has probably contributed to a specialized task (e.g. surveying, statistical analysis) in the final production of the article. Non-human technologies, such as computers, are replacing human technologies. Ritzer suggests that the net result of such McDonaldization of the field of American sociology has been the efficient production of large numbers of unimaginative sociological theories that are uninteresting and explain very little; i.e. research hamburgers. According him, a large part of the reason for this is the fact that journals require fixed length articles, and that most good theories cannot be effectively presented in such short length articles. He contrasts this with the situation in Europe, where he says that it is more accepted for sociologists to introduce new theories and ideas via full-length books. According to him, this book-length format has permitted European sociologists to contribute far more interesting theories than their American counterparts. According to this view, the well regarded theories of Europeans researchers like Latour, Giddens and Habermas may not have seen development if, like their American counterparts, these sociologists had been expected to produce research hamburgers.

Ritzer criticizes such McDonaldization of society. He asserts that instead of ushering in true rationality, McDonaldization foists a large number of irrationalities in the garb of rationality; something he terms 'the irrationality of rationality'. He argues that McDonaldization allows corporations to exploit consumers more efficiently. For instance, in fast food stores, customers are expected to fill their own beverage glasses, thus becoming unpaid workers. Interestingly, they are even supposed to regard this activity as a fun thing to do. In another example of efficient exploitation of customers, Disney theme parks have essentially become malls for Disney merchandise. People may think they're visiting a theme park, but they're actually visiting a giant mall for Disney branded products. Another example of the 'irrationality of rationality' is the fact that while fast food restaurants offer advantages such as speed of service and low prices, they usually serve food that is largely unimaginative, often tasting like nothing and drawn from a very limited menu of choices. Still another example of 'irrationality of rationality' that Ritzer cites is the creation of a large number of so called 'McJobs' in the McDonaldized economy. Such 'McJobs' usually require a low level of skills to perform a limited number of routine tasks in a robot-like fashion, pay poorly, are highly controlled by non-human technologies and typically lead to high levels of resentment, dissatisfaction, absenteeism, alienation and turnover. Also, Ritzer warns that McDonadization is leading to a decline in segmented and fractionated markets which are being replaced by a mass market in which there are few choices, controlled environments and no surprises.

In light of these criticisms of McDonaldization, it would be useful to consider some of the reasons driving the McDonaldization trend. It has already mentioned earlier that it would be absurd to suggest, as some people do, that the McDonaldization phenomenon is somehow being imposed unwittingly on society due to some secret global conspiracy by greedy corporations. Instead, the McDonaldization phenomenon must be seen as a logical outcome of consumer expectations and organizational efforts to satisfy them. Ritzer offers many such propositions. Perhaps consumers value consistent quality more than the occasional surprise. Perhaps humans are simply averse to uncertainty and unpredictability. Perhaps consumers like the idea of using quantity as a proxy for quality, since quantity can be more easily perceived and judged. Perhaps people like the convenience of having a limited number of choices and the cognitive simplicity it entails. Perhaps people care more for lower prices than for higher quality. Perhaps McDonaldization evolved from bureaucracy because it was better at meeting the demand-supply gap for various products. Perhaps McDonaldization is popular because it leads to better standards of living for the most people.

Reasons underlying the McDonaldization phenomenon have not yet been definitively explicated. Nevertheless, McDonaldization of society is now well recognized as a major theme and trend of our times. Perhaps it is high time for social science researchers to pay closer attention to Ritzer's McDonaldization thesis in order to incorporate ideas from it into the broader framework of mainstream social science research.

3. E-GOVERNMENT AND THE McDONALDIZATION OF GOVERNMENT

Among the various unpleasant tasks that human beings have to perform in course of their daily lives, surely one of them must be the process of dealing with the government. This is reflected in the fact that the word 'bureaucracy', which originally was a value-free description of government administrative structure, has come to acquire a highly negative connotation. When an organization is described as being 'bureaucratic', it now usually means that the organization exhibits a bundle of negative characteristics usually associated with government departments, such as customer-unfriendliness, lack of response to a changing environment and an adherence to processes rather than outcomes. Such perceptions have probably developed over a long period of time during which citizens have experienced frustration from interacting with their governments.

In light of such a history of interactions, new information technologies have given hope to governments and citizens alike that it may be possible to create new forms of interaction and service that can reform government functioning and alleviate some of the past problems. Such new, technology-enabled, forms of interaction and service are collectively referred to as 'E-Government'.

Interestingly, in light of the earlier discussion, E-Government may be seen as an effort to McDonaldize government. Indeed, current E-Government efforts incorporate all the four dimensions of McDonaldization (namely: efficiency, calculability, predictability and control) in abundant measure.

The dimension of calculability is manifested in the methods by which current E-Government efforts are measured and judged. It is vastly more common for E-Government initiatives to be judged through quantitative, rather than qualitative, methods. Metaphorically speaking, most assessments of E-Government progress rely on measuring the number of 'widgets' being produced rather than the quality of 'widgets'. Thus, the quality E-Government websites is usually compared and evaluated on the basis of easily measurable objective attributes such as the number of features available on these websites rather than on the basis of subjective assessments of individual user experiences. E-

Government efforts are being judged on the basis of measures such as their cost [6], the return on investments from such efforts [6], the increase in worker productivity from them [8], the quantity of technological infrastructure employed [16], the quantity of technical manpower employed [16], the number of features being offered in websites [17], whether websites display a privacy policy [17], whether websites display a security policy [17], whether websites offer disability access [17], the number of days websites take to respond to e-mails [17], website download speeds [2], whether text alternatives to graphical interfaces are available [2] and whether sites display a statement of purpose [2].

The dimension of efficiency can be evidenced in E-Government strategy documents that usually pitch increased efficiency as a major expected outcome from E-Government [7], [9], [10], [11]. According to these documents, efficiencies are expected to arise out of government efforts to use information technology to increase the information processing speed and capacity of government, and efforts to outsource various tasks from the private sector. A focus on efficiency is also seen in efforts to evaluate E-Government projects on basis of cost reductions, returns on investments and productivity gains from such projects, as discussed in the previous paragraph.

The dimensions of predictability and control are evident in the increasing use of technology and automation in order to provide a uniform level of service to citizens. For instance, a large number of E-Government efforts are incorporating the technology of Customer Relationship Management (CRM) in order to automate service delivery [1], [4], [3], [14], [16]. To quote another example, citizens are being invited to participate in online rule making by giving their opinions on proposed laws; thus substituting non-human technology, i.e. the internet, for human technology, i.e. the town hall meeting. Another kind of control is manifest in the way a central technology czar may dictate E-Government policies to all the different agencies that form a government. Such cases often demonstrate an incredibly high degree of institutional imitation, with a certain security or privacy policy getting imitated along an entire chain of government agencies. Predictability is also considered to be an important determinant of citizen trust in E-Government [5].

The apparent push to McDonaldize government should be seen as a logical consequence of citizens' demands, and governmental efforts to meet these demands. Indeed, there are many advantages anticipated from such McDonaldization of government. It is expected that E-Government will lead to faster and better service fulfillment by governments. It is expected that E-Government will lead to more lean government structures that will cost taxpayers less money. And it is expected that objective measures of judging government service performance may prove more useful than subjective methods.

However there are also some potential downsides that should be kept in mind. If, at some future date, government employees find themselves working at 'McJobs', it could spell a disaster for the functioning of government, and in turn for society. The continued digitization and mechanization (i.e. substitution of non-human for human technology) of information also spells considerable privacy concerns. Digital storage of vast amounts of sensitive citizen information will always be a highly risky proposition due to its vulnerability to hacking. Also, technologies such as E-Voting can lend themselves to being abused. Further the reality of the digital divide may mean that technologically-savvy people will end up exploiting government services in a better way than their less technologically-savvy brethren. Finally, just as in the case of mass retailing, McDonaldization of government may force a consolidation of fractionated and diverse client citizen constituencies into mass-constituencies (i.e. convert fractionated markets to mass-markets); and it is not clear what outcomes may result from such an eventuality.

4. CONCLUDING REMARKS

This paper has sought to establish that the McDonaldization paradigm offered by Ritzer is a useful perspective with which to understand the current interest in E-Government. The concept of E-Government may be comprehended as an effort to McDonaldize government. By familiarizing themselves with Ritzer's McDonaldization thesis, researchers in E-Government should be able to glean useful insights that can help them with their research.

For instance, E-Government researchers may find it useful to become cognizant of the problems of so-called 'McJobs' and to explore the potential human resource development issues that may result from McDonaldization of government.

Some organizations in highly McDonaldized industries such as the fast food industry have been quite successful at offering mass-customization to their customers (e.g. Subway). Perhaps E-Government researchers may find it useful to examine such organizations to study the potential for E-Government systems to offer mass-customized services.

If, as discussed earlier, it is true that McDonaldization of government may force a consolidation of fractionated and diverse client citizen constituencies into mass-constituencies (i.e. convert fractionated markets to mass-markets), then E-Government researchers would be well advised to expend considerable energies in order to understand what outcomes may result from such an eventuality.

Finally, E-Government researchers should keep in mind that McDonaldization is a modern, contemporary form of Weberian bureaucracy; a hyper-rational form of bureaucracy or a more 'bureaucratic' form of bureaucracy. Since 'bureaucracy' has come to acquire such a bad name in contemporary society, it may imply that McDonaldized government in the form of E-Government could acquire a much worse reputation in the future. It is not difficult to conceive of a future scenario wherein citizens get frustrated because they never come in contact with a human face of government and instead are directed to only deal with 'robots' in the form of websites and web-servers.

5. ACKNOWLEDGMENTS

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7. ABOUT THE AUTHOR

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European Open Source Application Development

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ABSTRACT
The Open Source software movement is often described in terms of license terms or Battles against vendors, which is all indeed relevant enough. Recent successes of some open source communities at the application level may indicate a more profound change in the way we do business. The known models describing networked businesses and resource distribution mechanisms have failed to cover the dynamics of open source communities in general.

In this paper an explorative research is conducted by investigating four instantiations of this emerging application level type of collaboration and describe the assumed parameters influencing decision makers to participate in "open source application communities". A number of business models are identified to describe how the community evolves, pinpointing the probable area's of dispute and tension.

General Terms
Management, Performance, Design, Standardization

Keywords
E-government, architecture, business counter, modeling

INTRODUCTION
The Open Source software movement is often described in terms of license terms or Battles against vendors, which is all indeed relevant enough. Recent successes of some open source communities at the application level may indicate a more profound change in the way we do business. It seems that the lessons learned in the traditional open source communities gradually infiltrate the contracting world, thereby creating a mixture of paid and non-paid contributions. Could it be that Open Source Application development follows a different path than server level communities? The known models[1] describing networked businesses and resource distribution mechanisms have failed to cover the dynamics of open source communities in general. Is "open source" such a fremdkorper in the organizational landscape? The authors have taken a first look at four instantiations of this emerging application level type of collaboration and describe the assumed parameters influencing decision makers to participate in "open source application communities". They identify business models around which the community evolves, pinpointing the probable area's of dispute and tension. The claim of the research is the notion that the open source roadmap is a necessary, but fragile step in the organization of complex innovative E-service engineering. Open (source) application development is perceived as a vehicle for rapid knowledge sharing within a community of organizations with the same application domain and the developers working for several SME's. The Authors did an orientation survey of four instantiations to base their model on:

- The case for education; Extremadura in Spain and Regional Education Centres in the Netherlands (Dutch version of K12 related projects)
- The case for broadcasting; The 12 Dutch broadcasting companies and the National Film Archives "Beeld en Geluid"
- The case for eGov and municipalities: Province of Drenthe, Leeuwarden and Amsterdam , London;
- The case for Grass root neighborhood applications: The Hague and Emmen.

The most obvious common denominator for all four cases is the relation with the Internet and this medium as a means for the delivery of a service to the end-user. The second common denominator is the extreme rate of change in the perceived requirements; most project managers involved have experienced a rather organic requirements definition process together with the suppliers. Normal Request For Proposal procedures did not seem to work. A third attribute is the tight relationship between the back-office and the front-office where a small change in the navigation of the front-end may have a huge impact on the organization of the back-end. All communities investigated were a mixture of suppliers, closed source vendors, clients, government, users and affiliated organizations and in all of them the clients had the power to influence the group. So what's so new and exciting about it?

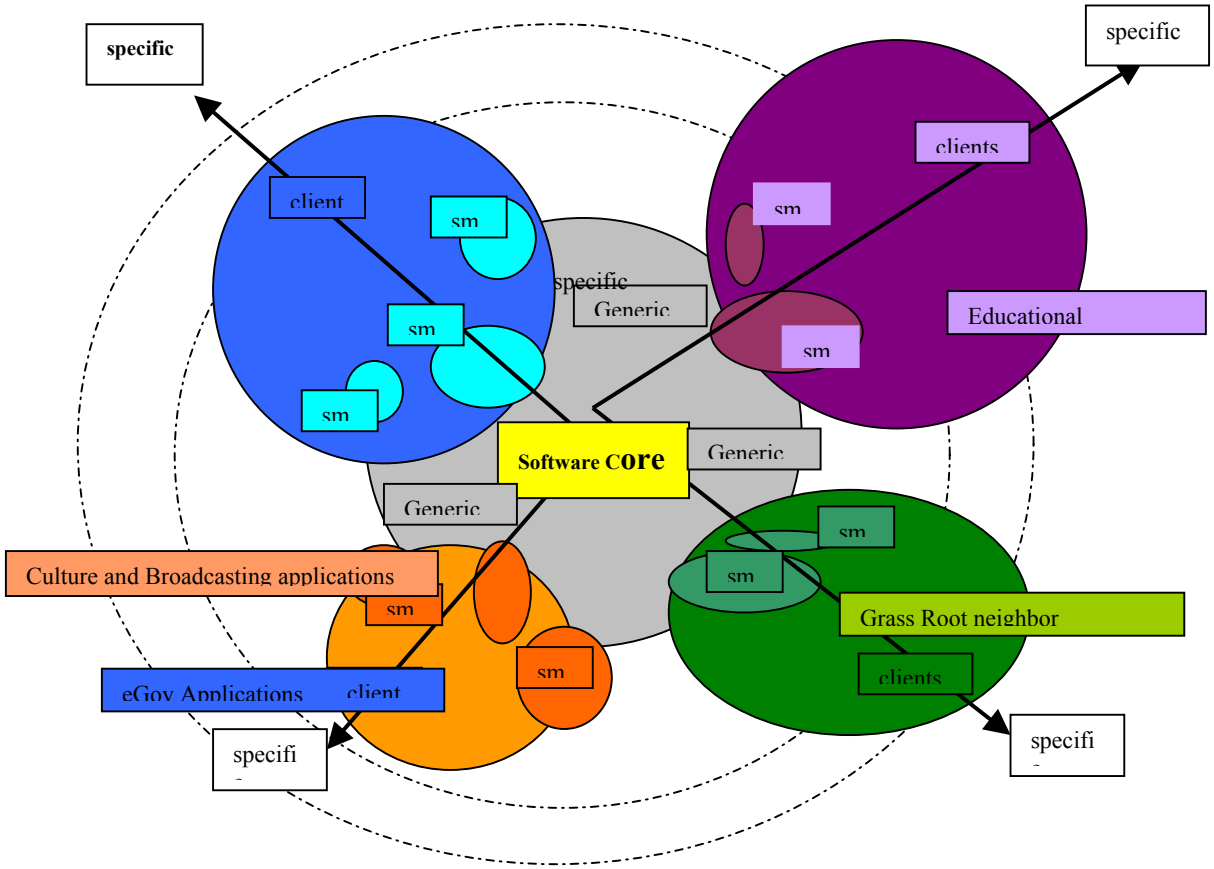
International conference on E-commerce '03, Pittsburgh, USA

[1] E. Todeva, Heterogeneity in business networks, colloquium Delft 2003

FRAMEWORK

Economies of scale, reusability and low set-up costs are attributes of any open source development since Stallman, Distribution of Trust and power are also organized in much the same way. Earlier communities were involved with the joint development of software, but they were not concentrated around implementation and even deployment of specific services for specific target groups. The user is involved now and this ultimate enemy of each software developer is now breathing in his neck. This has severe consequences for communication and relationship management.

In earlier days the risk of failure could be hidden behind the walls of the organization in the catacombs of the IT departments. Developers within the organizations and their software suppliers could keep the outside world at bay. E-Services, though, are highly visible for the outside world. Trough the Internet, they involve clients more directly than the organizations involved were ever equipped or ready for. E-services require a dialogue between cultures along the whole of the production chain those working on apache never had to perform. So what exactly drives these people into application development communities? What is the motor behind the collaborations between normally competing SME's and Governmental agencies that normally have no incentive whatsoever to look beyond their territorial boundaries? Integrators usually keep their knowledge to themselves and license applications if they can get away with it. So what is the type of trade going on here?



We think the basic trade-mechanism follows about the same rules as the way Universities have organized the sharing of knowledge for centuries. In the case of Internet software development, it is combined with high speed, a high level of integration and above all, a high user involvement or even a super-type of co-makership[2]. Universities share ideas using a distribution

[2] Peter Keen, Mark McDonald; The eProcess Edge, page 117, 2000

mechanism based on a dimension along the Generic-Specific axis and wise and respected elders (Editors) are chosen to accept or reject additions to the map. Universities share ideas based on trade without coin except for ritualized communication between peers in the hierarchy. The open (source) Community is an organizational mechanism to share knowledge about a complex, dynamic process, which changes while people are still trying to describe the specifications. While Universities are mechanisms of some similarity, they differ in the sense that the taxpayer supports them. The most interesting space to look at for Application development Communities therefore is the boundary where money comes into the equation. The authors have observed that this line is to be found alongside the polarity of Generic versus Specific; The more specific an application is defined, the more money is accepted as instrument of exchange, whereas in the Generic arena money is replaced by nuggets of knowledge and contribution of improved code. Universities were faced with some of the same mechanism when funding dried up and sponsorships made by businesses became dangerously close to payments for consultancy. Consultancy does not obey the rules of knowledge sharing and generalization and scientists are well aware of the distinction.

In the model described the software core is the kernel, which does not change without full consultation. Near the core one finds a number of general applicable tools like “news”, “streaming”, “editing”, “chat” in the case of MMBase and Ldap, authentication, multimedia middleware, API’s, etc..
Further away from the Software core more specific application functionality is being forged which does not necessarily involves value for the other application areas. It may happen though, that a module created in the broadcasting area turns out to be beneficial for the educational field. The application area mainly consists of a group of organizations (clients) working together on building, implementing and above all maintaining an increasing set of modules that cater for the E-Services at hand. It can be a group of schools building an alternative for blackboard or a group of municipalities upgrading a shared service system for neighborhoods. This group of clients is supported by a number of contributions, ranging from free modules out of the core area and contributions by free lancers and SME’s specialized in the application area. The modules build by the SME’s and Free lancers may or may not obey the rules of the community but they are not necessarily build without payments. There is a mix of paid and non-paid contributions going on, depending on the generality and the role of the player.

The Generic-Specific Business model at application level builds on top of an impressive network of global open source components, languages, middleware, standards and discussion groups at the “Server level” like Linux, Python, Apache, etc . This area is much better researched than the application level. .One of the major differences between application level and server level communities is that for server level the choice between stand alone commercial development or joined development is evidently for the latter , unless one can gather the momentum of IBM, Sun or Microsoft. For European companies this is no realistic option.

There is a price to pay for generic development. One has to realize that modular design does not happen by coincidence. It is very expensive to create modules within a general architecture or even stand alone’s with modular or component characteristics. The schools in the example do not have the resources to manage the complex dynamic development process, but as a community they can.

The generic-specific model should help to describe the behavior of the key players within the community in the way that they display the willingness to share with or without monetary exchange. In the case where no reusability value is perceived it would be logic to act as “normal” contract partner (which happens to work with open source tool boxes but without the open behavior). There where re-use is a probability the clients will enforce more modularity, better component based design and transparent documentation. The developers will now stay closer to the core code to operate within the boundaries of compatibility. It is here where most generic modules will be placed for others to re-use. Community gossip keeps track of the balance between give-and take. The meritocracy is at work here, as long as there is commonality in the required functionality and the indicated usage. Both objectweb.org Zope and MMBase consist of more then one sub-community based on the characteristics of the target audience.

EXCHANGE MECHANISMS

Within the community exchange different participants have different “exchange mechanisms”. This may lead to tensions within an organization because they have to manage both the developers’ culture of “the commons” and the target culture of the “sales”. While the developers maintain a structure based on merit and a thereby a balance based on contributions to the core modules that work, the project managers and the account managers of the integrators exchange knowledge only outside their commercial Application domain. This notion implies that between the walls of the same SME, the developer shares technical knowledge with a developer of competing SME in the same application domain, where the account manager would not even think about sharing domain expertise. At the same time all benefit from the creditability of the open source brand among the different client groups in different application area’s. Further research at the application level should focus on the exact parameters that determine the behavior of the players in the community. Measuring real behavior against predicted behavior according to the generic-specific model may actually help to elaborate on the theory of knowledge sharing communities.

For our research we identified as working parameters the following list:

Re use	innovation
Learning Curve	maintenance
License costs	security
Ideology	additional functionality upgrades
Transparancy	Implementation time
Internal knowledge	Software quality
Openess	Timeliness of patches
Speed	Standardisation
Maintenance	Security

CONCLUSIONS AND FUTURE RESEARCH

We hope to gather data in Europe in the coming year regarding the relevance of these decision criteria for application owners within organizations. Similar work can be done on the other continents where other parameters may be more important. A global inventory should help to determine where open source application development would be relevant for new cases.

Application development is not the sole owner of this special kind of collaboration. It is an emerging feature of other complex and innovative application development arena's like SAP Enterprise Resource planning tools and recent Geographical Information System applications.

While the software involved here is "closed", the first signs are there that this will not stay that way for long. It has become clear that SAP and GIS have to turn to open standards in any case: SAP opened up for external JAVA code and openGIS is rapidly growing in influence. But this may prove to be insufficient. Our assumption is that project managers will face the same dynamic problems as described above and soon will turn to even more open software to share the burden of the expensive learning curve. Grass and MAPserver are open source GIS systems with little coverage compared to ESRI. Another line of future research would be to measure inclinations to more open types of software development in area's like GIS where the market is still dominated by closed contracts. If this inclination would prove to be nonexistent the model would be difficult to uphold. For both lines of research one of the original questions remains unanswered: is an open source community a functional network or another type of organizational phase to get the job done?

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Strategies for E-enforcement; Lessons Learned from Two Case Studies in the Netherlands

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ABSTRACT
The introduction of information and communication technology in the primary process of enforcement allows many enforcement problems to be solved. For example, E-enforcement can increase the inspection capacity and provide a better insight into the characteristics of offenders and offences. However, the problem-solving capacity only concerns the "rational perspective", because enforcement problems continue to persist in a network perspective. For example, inspectees will continue to undermine enforcement by their strategic behaviour, compliance will not automatically increase and new legitimacy questions will arise. The findings are derived from three case studies, two of which are dealt with in this article: the digital tachograph and Weigh in Motion with Video. This article presents five strategies to avoid the adverse effects of e-enforcement: acting from a network perspective in addition to a rational perspective, coupling costs for inspectees to benefits, generating gain for the good guys and loss for the bad guys, thinking through the rules to be enforced, and coupling innovation of the tool to a new method.

General Terms
Management, Measurement, Performance, Design, Experimentation, Security, Human Factors, Theory, Legal Aspects.

Keywords
Enforcement, innovation, public sector, Netherlands, traffic

1. INTRODUCTION
Safety, fair competition and protecting the environment. These are the interests the government serves through proper enforcement of the laws and regulations on Transport and Water Management. Proper enforcement is therefore important.

Enforcement is subject to innovation. A recent development is e-enforcement: the use of information and communication technology (ICT) in the primary process of enforcement. Examples include the arrival of cameras and sensors to replace inspectors, and computers taking over human judgement.

The use of ICT in enforcement can offer added value for the government, for the public and for regulated industries, because e-enforcement can make enforcement more efficient, more effective and more intelligent [16]. Enforcers using fewer staff can realize a larger span of control. Moreover, more information will become available, which enforcers can use to formulate strategies. Data analysis, for example, can show that particular companies are frequent offenders, or that a particular offence occurs only at certain times. E-enforcement can therefore help the government to improve the performance of its task with fewer human resources. Social safety and a clean environment are in the public interest. Companies regard the potential fall in administrative costs and the use of the e-enforcement technologies for their own corporate process as major advantages of e-enforcement.

The added value of e-enforcement is not uncontested; e-enforcement is the subject of debate. E-enforcement may cause inspectors to disappear [5]. Here, proponents see the advantage of savings and a more objective judgement. Opponents, however, prefer to retain the human measure and feel that the visibility of inspectors and personal contact with inspectees promotes compliance. E-enforcement enables a ‘zero tolerance’ approach. Proponents here recognize the enforcement ideal; opponents feel, however, that this approach deprives inspectees of their responsibility [10]. E-enforcement allows inspection capacity to be employed for high-risk groups. Proponents say this is an effective approach, but opponents feel this is a reprehensible selectivity: of two offenders with the same offending behaviour, one is likely to be dealt with more leniently than another is [15].

The aim of this study is to find strategies to make e-enforcement a success. This paper deals with the following research questions:

1. What are the positive effects of e-enforcement?
2. What are the new risks?
3. What are strategies to control the new risks?

All questions have been asked and answered from the perspective of enforcers. The study was carried out at the Netherlands Transport and Water Management Inspectorate [17], born in 2001 from the merger of five separate inspectorates. The agency is responsible for enforcing a particular part of the laws and regulations governing transport and water. The former agencies were found to have developed in recent years –independently of each other– e-enforcement applications that were still in their

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infancy at the time of the merger. The formation of the new agency created the need for a central e-enforcement policy. This study was launched in preparation for it.

2. E-ENFORCEMENT

2.1 The enforcement process

Enforcement is the whole of activities aimed at promoting compliance with rules, based on particular powers [7].

The operational process of enforcement comprises: (1) gathering information about the question whether an act or case meets the relevant requirements, (2) forming a subsequent judgement about it and (3) intervening because of it, if necessary [11].

This involves what we call 'first-order information': information about a particular object of regulation to compare it with the norm.

Enforcement also contains a tactical component. Sparrow calls this 'intelligence': 'a collective notion for all that a regulator does to gain 'knowledge' of developments in the sector.' [15].

Enforcement on the tactical level is based on second-order information: aggregated data, giving an insight into the whole sector, to assess risks, to set priorities, to analyse patterns, to target capacity, to account for enforcement efforts and costs or to adapt sanctions. One example is the change in the level of compliance after a change in enforcement policy [15].

2.2 Types of e-enforcement

We distinguish several types of e-enforcement, based on the above description of the enforcement process. The division of types is based on a stocktaking of e-enforcement applications within Transport and Water Management Inspectorate. The examples show a substantial overlap with a joint study by a number of Dutch regulators into ICT innovations in regulation, although it uses different categories [12].

2.2.1 Obtaining first-order information

First-order information can be gathered remotely with the use of information technology, by means of sensors and cameras in and around the infrastructure. They observe outward characteristics and behaviour, such as the type of vehicle, weight and speed (e.g. measuring overloading by means of weighing points in the road surface), or by means of signals from the vehicle or the cargo that are received ashore (e.g. tracking and tracing of hazardous substances).

First-order information can be gathered 'conventionally' with the human eye, inspectors on the spot being supported by ICT, by means of strategic information (e.g. a knowledge web for laws and regulations, which inspectors can access on location), or by means of electronic tools (e.g. printers, laptops, software to make an official report, digital cameras).

With the help of ICT, first-order information can be gathered and/or supplied better at or by inspectees themselves, by means of an electronic registration system in the vehicle (e.g. an onboard computer in taxis, a tachograph), or by information obtained electronically (e.g. an inspectee sending data on a CD-ROM or via the Internet) .

2.2.2 Judging first-order information

ICT helps to process large quantities of information, to store and analyse them. Examples are the creation of databases about the objects of regulation, with basic data and the current state of inspections, analysing flight movements around an airport in the context of noise enforcement, with a computer program automatically calculating whether offences are being committed, and the computing of offences by the digital tachograph.

2.2.3 Obtaining and using second-order information

Second-order information is obtained by aggregating first-order information. For example, a database containing data about tachograph inspections supplies information about the level of compliance, the type of offences and the characteristics of offenders.

Software programs offer support in carrying out risk analyses [15]. Data about the overloading of trucks, for example, automatic result in the top twenty offending companies.

Second-order information is obtained by linking files, also in cooperation with other inspectorates. For example, enforcers can examine whether there is any connection between particular behaviour, [6] e.g. between drivers' compliance with the Driving and Rest Hours Act and the presence of ergonomic facilities in the cab. In merchant shipping, enforcers use a ranking of ship owners.

2.2.4 Intervention

Regulators can use ICT for preventive intervention by warning drivers on the infrastructure automatically, sending warning letters automatically, informing companies about the laws and regulations in force, digital complaints desks and publicizing offences on the Internet, for example.

ICT can also be used in repressive interventions, by sending or processing fines or other sanctions automatically, and for enforcing compliance with rules, for example by speed limiters or automatic train management.

3. METHODOLOGY

3.1 Choosing case studies

Three existing applications of e-enforcement form the empiric basic material in the form of case studies. This article deals with two of these case studies.

We have opted for case study research, first because scientific research into e-enforcement is still in its infancy. Second, because empirical research renders a matter-of-fact picture of the actual pros and cons of e-enforcement. We have confined our research to three case studies, first because the number of case studies that satisfied the selection criteria was limited. Second, to obtain a rich picture of each case study.

We inventoried existing examples of e-enforcement within the Transport and Water Management Inspectorate, which formed a long list. The short list of three case studies was based on the following criteria: the presence of empiric material, the degree of intervention in the enforcement process and societal relevance. The material for the case studies was gathered with the help of available documents and semi-structured interviews, both in and outside the Inspectorate of Transport and Water Management. For each case study, we adopted the following procedure:

- Describing the form of e-enforcement in this case study
- Describing the motives and occasion for using e-enforcement in this situation
- Concretizing the enforcement problems in the zero situation (without e-enforcement)
- Analysing the situation with e-enforcement: which enforcement problems are solved; which are not; and what new problems arise?
- What measures have been taken to overcome problems, if any?

We will draw general conclusions, based on the similarities and differences between the case studies; conclusions will therefore be derived by inductive reasoning. Although the research material is based on existing situations, the eventual recommendations are only aimed at new designs of e-enforcement.

3.2 Two perspectives on e-enforcement

The case studies were analysed with the help of De Bruijn and ten Heuvelhof's theory: the rational perspective versus the network perspective [4]. We have opted for this theory, because it has proved to have a considerable explanatory effect as to the success or failure of a particular approach to problem solving. We expected that the two perspectives would also explain the success or failure of e-enforcement.

3.2.1 The rational perspective

A rational approach deals with the substance of a problem, taking facts and causalities into account. A careful analysis maps problems and solutions step by step. From an objective perspective, a solution is the best alternative for a particular problem, even if this clashes with the interests of particular parties.

A rational approach will work in a hierarchy. In the rational perspective, the problem owner formulates the problem definition, carries out the analysis, chooses a solution and implements it. This only works if the problem owner has both the information and the power to steer effectively. The problem owner should have a complete insight into the substance of the problems. The situation should be transparent. In a hierarchy, the superior is able to implement decisions unilaterally. The problem owner's actions have the intended effect. He or she does not depend on other parties for information or steering; other parties depend on him or her. The other parties behave loyally and are involved in formulating the problem and choosing a solution. The organizations that have to be controlled are open to interventions of the controlling actor. Mutual power relations do not change and the environment is hardly dynamic.

3.2.2 The network perspective

In a network approach, each actor has their own perception of the problem, arising from their particular interests. Actors try to serve their own interests. The road from problem to analysis to policy to evaluation is not a linear route, but a cycle, each round offering new opportunities for actors to serve their interests. The result of the process is a 'package deal', in which various problems and solutions are coupled. Most actors will find part of their aims achieved. Some actors are winners, other are losers.

A network approach works… in a network. In a network, actors depend on other actors for the solution of their problem. Relations of superiority and subordination vary with time. Problem owners are unable to implement decisions unilaterally, lacking the power to do so. Moreover, they have not got all the information required. The parties they want to influence are not always open to their steering and may have a different perception of reality. The actors to be controlled differ. Due to these features, steering may have an effect different from the one intended. A network involves a negotiating position. To serve their interests, actors will have to obtain the cooperation of other parties. They can do so by trying to join their interests, by widening the problem definition and by coupling their problem and solution to the problems and solutions of those other parties.

Applying the two perspectives

Table 1 presents an overview of the characteristic differences between the rational perspective and the network perspective.

Table 1. The rational perspective versus the network perspective

Rational perspective	**Network perspective**
Substance, factors, information	Process, actors, relations
Right-wrong	Gain-loss
Rational and successive completion of steps: from problem definition to solution	Game in which actors try to serve their own interests by strategic behaviour
Solution for problem	Package deals
Works in a hierarchy: Unilateral power relation Objective and transparent information	Works in a network: Mutual dependencies No consensus about norms, information that cannot be measured objectively

The two perspectives have been worked out for enforcement. A number of general enforcement problems have been derived from each perspective by logical conclusion from the above theory, based on enforcement literature (partly Dutch) and iterating practice. Many problems are only problems retrospectively, i.e. after a better alternative became available. The enforcement problems form the basis for the analysis of the case studies (e.g. What enforcement problems exist in the zero situation? Which are solved by e-enforcement? Which are not? What new problems arise?) The following two sub-sections only describe the enforcement problems that featured in the case studies.

3.2.3 Enforcement problems in the rational perspective

In the rational perspective, we define enforcement as fixing aims and priorities, gathering the correct information about norms, facts and risks and taking the correct measures, aimed at compliance with the rules. The following general enforcement problems have been derived from the rational perspective:

Enforcement is too labour-intensive: Most enforcement is based on inspections. Inspectors stand by the roadside, check the rails, inspect an aircraft, a ship, or visit a company. Enforcement is

labour-intensive; it is done by people. Enforcers are unable to check the entire sector. There is an enforcement deficit [7].

No preselection is possible: Preselection means that enforcers, using little manpower, have a first filter, which filters out the offenders. Enforcers can then focus their full attention on the offenders. Without preselection, enforcers have to carry out 'blind' checks. An inspector may spend a lot of time on a check without finding any offence [13].

Enforcers have insufficient first-order data: Such a shortage may mean in the first place that there are insufficient data to judge one particular inspectee. Although this inspectee will be inspected, there can be no judgement. A shortage of first-order data may also mean that few first-order data is available for the sector overall. Consequently, only a small part of the sector is checked. This may be due to a labour-intensive enforcement process [7].

Enforcers have insufficient second-order data: Second-order data concerns the insight into the sector. A shortage of second-order data blinds enforcers. They do not know where the risks are and can only conduct random checks. Nor are they able to intervene intelligently, because they do not know what lies behind the offences. Finally, enforcers are unable to report sufficiently to policy makers and the public about what is going on in the sector [15].

Data is difficult to process: It would be helpful to enforcers if they could easily store inspection data, search them and analyse them. Accessibility of inspection data is a condition for intelligent forms of enforcement. Poor processability of data, for example because all information is only available on paper, or always in another format, is therefore a problem [6].

Enforcers lack sufficient powers to apply sanctions: Enforcers have a wide range of intervention options, from giving information and cautioning to imposing fines and suspending a licence [15]. Enforcers need an extensive set of tools for a flexible response to situations of non-compliance. Having insufficient sanction powers means having insufficient influence on non-compliant behaviour of inspectees.

3.2.4 Enforcement in the network perspective

In the network perspective, we define enforcement as a process of interaction between enforcers and inspectees, who are mutually dependent and optimize their own position by their strategic behaviour. Hawkins has also analysed enforcement from this perspective [9].

The following general enforcement problems have been derived from the network perspective:

Inspectees avoids checks: The main aim of a check is to catch offenders. A check works only if offenders can actually be checked. Check avoidance by offenders is therefore a problem. If checks are relatively easy to avoid, they have no deterrent effect [9].

Inspectees tamper with information: In many cases, enforcers primarily depend on inspectees for first-order information, like cases involving company records. It is important for the information on which enforcers base their judgement to be correct. Incorrect information leads to an incorrect judgement: offenders may thus escape punishment. Cases are known in which inspectees committed deliberate fraud, e.g. for economic reasons [2].

Inspectees fail to comply: The aim of enforcers is to realize compliance. Non-compliance is undesirable. There are motives for spontaneous compliance, like a favourable costs-benefit ratio for compliance, acceptance of rules and social control. In the absence of such motives, inspectees have an interest in offending. This is why enforcers depend on checks and sanctions, which is more labour-intensive and less effective than spontaneous compliance [7], [13].

Inspectees question the enforcement: The independence, professionalism and integrity of the agency should be beyond question. It would therefore be a problem if inspectees criticized enforcers, feeling the enforcement policy is unjust or irrational. This would question the legitimacy of the enforcement [11].

Enforcers are unable to uncover fraud: If enforcers depend on inspectees for obtaining first-order information and there is a risk of fraud, enforcers usually have means to check the correctness of the information. One example is a consistency test of supplied data against each other and against the other company records [8]. If enforcers are unable to uncover fraud sufficiently, the information supplied may be unreliable: offenders get off scot-free.

Enforcers cannot influence non-compliant behaviour: Prevention and the threat of sanctions should encourage inspectees to abide by the law. Enforcers should be able to touch the right chord. However, it may not be clear to enforcers what incentives influence the behaviour of inspectees. For example, inspectees may be insensitive to fines, because they can charge them on in their prices. Constant failure of enforcement efforts to affect compliance is a problem, since there is no return on the investment in enforcement [13].

4. CASE STUDIES

The case studies are based mainly on interviews and internal documents of Transport and Water Management Inspectorate. We have therefore chosen to omit the source references in this article. Those interested can request the detailed research material from the authors.

4.1 Weigh in Motion with Video

4.1.1 Introduction

Trucks can be overloaded either as a whole and/or on one axle. Both types of overloading are punishable, because they cause road damage, constitute unfair competition and may cause dangerous situations.

Overloading used to be measured by teams of inspectors, randomly pulling over trucks to weigh them on a weighing platform. Sanctions could be imposed on the spot. The original enforcement process was highly labour-intensive and scored relatively little result, because inspectors could not foresee whether a truck would be overloaded. Drivers suffered delays because of the checks, even though many of them were not in breach of the law.

Weigh in Motion with Video (WIM-VID) was introduced in cooperation between various agencies within the Ministry of Transport and Water Management and the National Police Agency. The system consists of sensors in the road surface and overhead cameras for identification. Currently, there are six weighing points in the Netherlands. The case study is mainly

based on the experiences with a pilot scheme lasting approximately one year.

The system has several applications. Applied 'repressively,' it is used for preselection purposes. A police team at the weighing point sees the images of overloaded trucks and pulls them over. The weight of the trucks is checked with a certified weighing system, sanctions imposed being based on these checks. In the future, the weighing system in the road surface may itself be certified, making weighing checks superfluous and allowing penalty notices to be sent automatically.

Applied 'preventively', the system gathers the data of all offences, turning them into company files based on registration plates. Inspectors visit frequently offending companies, and solutions are worked out in cooperation with these companies. Unwilling companies may face a check offensive by inspectors at the company gate.

4.1.2 Effects in the rational perspective

We can distinguish a number of effects of e-enforcement based on the enforcement problems formulated.

From labour-intensive enforcement to preselection: Enforcers used to perform random checks. Inspectors pulled over trucks on the grounds of a suspicion. Both enforcers and drivers lost time if a vehicle was checked that was not overloaded. Using WIM-VID, they know what vehicles are overloaded. All inspection capacity on the road can be spent dealing with offenders.

More first-order data: Inspectors used to check only at certain intervals. WIM-VID checks round the clock at all weighing points. Whereas there used to be only first-order data about the vehicles that were pulled over, WIM-VID records the data of all passing trucks.

More second-order data: The large quantity of digital first-order data makes aggregation and analysis possible. Whereas insight into the sector used to remain hidden in the 'tacit knowledge' of inspectors, accessible statistics are now available. Enforcers now have the top twenty offenders and have also gained new insights: 70% of overloading involves one axle rather than the total weight. Particular types of transport that used to be hardly checked because inspectors had reason to believe that no overloading would occur, proved to be high-risk groups. Targeted checks on these groups are now possible.

Data is easier to process: Inspectors used to fill in forms about the checks on overloading. The information was neither easily accessible nor suitable for analyses. WIM-VID stores all records in a digital form, which lends itself to analysis. WIM-VID also creates company files automatically.

No change in sanction powers: WIM-VID is not accurate enough to be certified to. This is why no sanctions based on WIM-VID information can be imposed. Checking weights with a certified system remains necessary and company visits can only be preventive. To obtain certification, enforcers depend on other authorities.

4.1.3 Effects in the network perspective

Inspectees continue to avoid checks: Under the old enforcement system, drivers could easily avoid inspection teams. Using their on-board communication equipment, drivers could inform each other of the presence of inspection teams. Those who knew or suspected that their vehicles were too heavy used to wait at a truck stop till the team had gone home, or chose a different route. The same behaviour seems to occur with WIM-VID. The proportion of overloads in the transport flow drops shortly after an inspection team has taken up a position at a weighing point for repressive weight checks. Moreover, many companies that were visited in the preventive scheme no longer occur in the statistics, it is found. At present, it is unclear whether these companies have given up overloading, or whether they tend to avoid the weighing points.

Improving compliance is uncertain as yet: Estimates are that, under the old policy, approximately twenty per cent of trucks were overloaded. The aim of WIM-VID was to reduce overloading by 75%. During the pilot, however, hardly any rise in the original level is visible. But there are many positive developments in the sector: a constructive dialogue with enforcers, information sessions about solutions for overloading problems, technological innovations and adaptations to the fleets of vehicles. Inspectors can give many examples of companies having mended their ways after a preventive visit. They expect compliance to increase over time. The sector itself also says it needs more time.

Inspectees question the enforcement: Before WIM-VID, overloading was hardly dealt with at all. Now that enforcement has been intensified, the rules are being questioned. Most of the rules on total overloading are beyond criticism; sector representatives first focus their attack on the rules on axle overloading, claiming they are too strict. WIM-VID has shown that axle overloading usually occurs while there is no total overloading. According to industry associations, this means that it should not be punished as an economic offence, because the company does not carry more cargo. Apparently, axle overloading tends to occur without drivers being aware of it: if the cargo of a truck laden in accordance with the rules is unloaded in parts at various stages of the journey, the centre of gravity shifts and axle overloading occurs. This is very difficult to remedy for several reasons and, in many cases, requires changes to the fleet of vehicles. Industry associations feel that the rules on axle overloading should not be enforced as strictly as they are now. They advocate a toleration period for minor axle overloads, allowing them time to make changes to their fleets.

The sector also criticizes the location of the weighing points, which are situated only in the western, densely populated part of the Netherlands (the 'Randstad' area). Haulage companies mainly operating there are thus subjected to checks more often than their colleagues in the eastern part of the Netherlands are. They complain, because these colleagues are thus allowed to practise unfair competition. The disadvantage of intelligent enforcement, focusing on the high-risk groups, is that identical behaviour does not involve equal risks of being caught. WIM-VID not only puts companies in the west of the country at a disadvantage, but also large companies and particular types of trucks.

The sector finally criticizes the 'big brother' level of the enforcement system. The current position is still acceptable, because company files are only used for prevention purposes. A future expansion of the system into an 'automatic fine on your doormat' would , however, not go down very well and might also provoke aggression against the systems. Another big brother

threat is the possibility of tracking trucks, if the number of weighing points is expanded.

Enforcers' response to strategic behaviour of inspectees improves, but remains limited: As in the past, avoidance of weighing points may be partly overcome with traps on the detour routes. Their effectiveness depends directly on the number of inspectors deployed on the detour routes, since the number of vehicles that can be checked on the detour routes depends on the human resources. What is new is that vehicles waiting at a truck stop will be recorded later anyway. Although they incur no fine, they are recorded in the company files. There is no chance of passing the weighing points unseen, nor of denying guilt.

The extent to which enforcers can influence non-compliant behaviour is uncertain: Both the improvements and the cooperative attitude among companies inspectors have met during the pilot scheme has raised expectations that compliance will increase in the long term because of WIM-VID. Inspectors attribute the positive developments to the new enforcement approach: the preventive approach of companies. On the other hand, the extent to which WIM-VID has increased the risk of offenders being caught in the repressive approach is not known. The chance of catching them proves to be directly proportional to the chance of offenders passing a weighing point and the number of officers manning these points. The chance of passing them is unknown and can depend on offenders' avoidance behaviour. Moreover, offenders are found to pass on any fines in their operating costs, or charge them on to their customers.

The new approach affects one aspect of the original approach: the overall check. Overloading used to be just one of the aspects in road checks. An inspector would not let drivers go until having found them and their vehicles safe as a whole. WIM-VID limits the check to overloading, making it possible in theory for a vehicle that has just been checked for overloading by the inspection team to cause an accident a short time later because for example its dangerous cargo was not properly packed.

4.2 The Digital Tachograph

4.2.1 Introduction

Tired drivers are a road hazard. This is the reason behind laws on driving and rest hours for truck drivers and coach drivers. Breaking the rules is an economic offence.

A tachograph is a device in a vehicle that records drivers' driving and rest hours. There is a statutory obligation for each truck or coach within the EU to have a tachograph on board. An inspector can read on drivers' tachograph charts whether they have taken enough breaks and rests. Inspectors can perform roadside checks, but they can also visit companies. Companies are obliged to retain their drivers' tachograph charts and an inspector can impose sanctions for offences committed earlier, based on a company visit paid later.

So far, a tachograph has always been an analogue device with paper charts. Fraud with analogue tachographs was the reason for the EU decision to introduce compulsory digital tachographs. Not only was tampering with digital tachographs believed to become more difficult; enforcement would become more efficient and companies would be able to link the data from digital tachographs to their company records.

The digital tachograph will measure the speed of a truck in the same way as the analogue tachograph and store the data digitally. The driver has a personal driver's smartcard, on which the data is also stored. A roadside inspector can read out the device. When visiting a company, inspectors can check the whole file, which can be analysed much faster than the pile of paper charts. In the future, companies may be obliged to send their data to the Transport and Water Management Inspectorate, which would make enforcement even more efficient.

4.2.2 Effects in the rational perspective

The dual system reduces the fall in labour-intensiveness: Digital tachograph data can be read faster and with less expertise than analogue tachograph data. In theory, this can boost efficiency: the labour-intensiveness of company checks might decrease. However, since digital and analogue systems will exist side by side over the next ten years, this gain in efficiency will be limited during this period.

After the dual period, enforcers might improve the method further, for example if they can make the reporting of tachograph data obligatory and impose sanctions without a further visit. There is a risk, however, that the current digital technologies will be dated in fifteen years' time and that a new generation of digital tachographs will introduce the damper of a new dual system.

Preselection was possible already, but is so on a larger scale now: At present, it is usual to request about a thousand companies a year to submit their analogue tachograph charts voluntarily. Companies that refuse, or whose charts are suspicious, can expect a company visit. The digital tachograph can increase the scale of this quick scan, because digital data is easier to process. Here, too, the dual system may reduce the effect.

Enforcers have more first-order data: In the preselection, more companies can be checked because of the digital tachograph, and a fall in the labour-intensiveness of company checks makes a larger number of company checks per year possible. The speed gained per company in the digital check therefore enables enforcers to check a larger part of the sector.

There is a slight improvement in the second-order data: The existing approach already gives an insight into the frequent offenders. The digital tachograph adds little information, apart from providing a larger sample. The digital data is easier to analyse for patterns of offences than analogue data are. The digital tachograph stores more data than the analogue one: the speed over the past twenty-four hours, smartcard insertions, attempts to commit fraud and the driver's identity. Ideas about their use for enforcement are being developed.

The data is easier to process: Digital data is easier to process than analogue data. Charts may get lost, whereas the digital data has a back-up. However, there is no back-up obligation in the new law yet.

4.2.3 Effects in the network perspective

Fraud risk remains: Anderson, a Cambridge security expert, is pessimistic about the envisaged digital system being fraud-proof [1].

First, malevolent companies can continue to use the analogue devices with their corresponding fraud methods for another ten years.

Second, drivers using the analogue tachograph can hold back intermediate charts. The digital tachograph no longer has any charts, but carries the risk of 'loss' of or sabotage to the driver's smartcard. Drivers are allowed to drive without a smartcard for a week while waiting for a new one. The fallback option in case the driver drives without a smartcard has the same disadvantages as the analogue system.

Third, the analogue tachograph is easy to manipulate: a paperclip will do. The digital tachograph was designed to make manipulation difficult. However, a substantial risk of the digital tachograph appears to be the "workshop smartcards", special smartcards with which workshops can change the settings of the device. Bribing the workshops and circulating the workshop smartcards would make large-scale fraud possible.

Fourth, analogue charts could 'get lost' in the post or the place of storage could burn down 'accidentally'. The attraction of the digital tachograph might be to manipulate downloaded data.

To prevent this, the data is tightly secured, but here, too, the question is whether fraudsters may eventually prove smarter than the technology. Should the security device be cracked, the risk of spreading is greater for digital technologies than it is for analogue technologies. It is even easier to make the computer crash. In the absence of a back-up obligation, this is an attractive way to get rid of a negative file.

Enforcers can uncover fraud more easily in particular cases only: In road checks, chart fraud and smartcard fraud in a vehicle with an analogue tachograph, a dysfunctional digital tachograph, a missing or broken chart are as difficult to uncover as they used to be. However, the expansion of company checks does give enforcers a better weapon; inconsistencies are likely to show up such fraud. The digital tachograph allows the number of company checks to be expanded.

Since, in road checks, inspectors can rely on a European network of smartcard registrations, they can check whether smartcards are authentic and whether a missing smartcard has been reported stolen or lost. This is an important weapon in the battle against forged and deliberately lost smartcards. However, a driver is allowed to be on the road without a smartcard for a week, and enforcers can do little against it.

The digital device records attempted hackings, which a check will show up. What may be far more difficult to uncover is fraud with the help of workshop smartcards. Inspectors on the road will be unable to establish it, although company checks may reveal it. Tampering with an analogue tachograph was easier to establish, because it involved physical manipulation.

In the absence of a back-up obligation, enforcers can do nothing to prevent a computer from crashing. To counter manipulation of downloaded data, enforcers have the weapon of the consistency check, because downloaded data has to match the data in the tachographs' memories and smartcards as well as the other company records.

The impact of the digital tachograph on the level of compliance is uncertain: Offences against the rules on driving and rest hours usually stemmed from economic motives or the wish to get home earlier. The arrival of the digital tachograph will leave these motives unchanged. Enforcers have fixed no explicit targets for a rise in compliance. More checks are expected to raise the chance of catching offenders. There will be no change in sanctions. A company's economic trade-off between compliance and non-compliance may still favour committing an offence. Moreover, unchanged possibilities to commit fraud and a low risk of getting caught may reduce the impact of a higher risk of being checked.

Inspectees question the enforcement: Although the tachograph offers little added value for the sector, it will have to meet the cost of it. The digital tachograph has disappointed industry associations, because it has failed to meet expectations that the new device could be used for company purposes like company records. To prevent fraud, the design offers little room for applications other than enforcement. Moreover, applying for smartcards and downloading them is expected to involve extra costs: drivers may have to make extra return journeys from abroad to collect their smartcard or to have their tachographs read out. At present, a company can purchase tachograph charts for all drivers and drivers can send charts carrying data home by post.

A second point of criticism concerns the level playing field. Road hauliers fear for legal inequality arising from different interpretations of the regulations by enforcement agencies and a different approach. Non-EU companies operating in Europe are not obliged to use a digital tachograph. In their case, enforcers can check fewer days, which gives them a competitive advantage. A final point of criticism is the 'big brother' association caused by the digital tachograph. The digital tachograph may affect the attraction of the occupation of an independent driver.

5. SUMMARIZED EFFECTS of E-ENFORCEMENT

The two cases studies suggest that e-enforcement has positive effects notably in the rational perspective, which the literature confirms [14], [16]:

- Inspection capacity is utilized better.
- E-enforcement facilitates preselection.
- Checks cover a larger part of the sector; offenders face a greater risk of being checked.
- Insight into the sector increases (or remains the same).
- Information is easier to process.

In the network perspective, most of the original problems remain. Positive effects, if any, are both insignificant and uncertain. Criticism of enforcement increases.

- Strategic behaviour of inspectees, or the risk of it, will continue to exist.
- In general, enforcers might not influence strategic behaviour any better.
- The rise in the level of compliance is unknown; e-enforcement does not automatically touch the right chord.
- E-enforcement faces substantial criticism.

Remarkably, where the positive effects are limited, the cause usually lies with policy makers: The choice not to introduce the digital tachograph with retroactive effect reduces the gain in efficiency. Non-certification of WIM-VID necessitates the use of inspection teams at the weighing points and reduces the powers of inspectors in a company visit. The location of the WIM-VID weighing points encounters criticism.

We have to make a few comments on the observed effects. The study involved three case studies, the third of which was comparable only to a limited extent to the two case studies presented here. Although the two case studies show many identical effects, it is hardly possible to draw general conclusions from two case studies. Enforcement has many forms. The two case studies concern cargo transport, and both of them concern relatively simple rules with measurable quantities. None of the effects measured have been quantified, and even some of the qualitative conclusions are mere presumptions. However, we can postulate that there is a logical relationship between the conclusion that e-enforcement particularly works in the rational perspective and the fundamental attitude of enforcers we have observed. This increases confidence in the findings.

6. STRATEGIES FOR E-ENFORCEMENT

We present five strategies in short, based on the case studies and underpinned by literature, to make e-enforcement also successful in the network perspective. The strategies have the following aim:

- to fully realize the potential gain in the rational perspective;
- to prevent or reduce strategic behaviour of inspectees;
- to raise compliance, and
- to prevent criticism of the legitimacy or professional quality of the enforcement.

6.1 Design e-enforcement to bring about changes in behaviour

Act from the network perspective: enforcement is the controlling of behaviour. A broad interpretation of the enforcement task involves the solution of social problems by changing the behaviour of inspectees [15]. In designing e-enforcement, enforcers should not only seek to improve the enforcement effort, but always continue the line of reasoning to a change in the behaviour of inspectees. Enforcers should ask themselves to what incentives inspectees are sensitive; this may not be a higher risk of being caught [13]. In designing e-enforcement, enforcers should also take existing or new strategic behaviour into account: What is the effect of a larger number of checks if offenders avoid them? What traps are available to us if the security device of the system is cracked anyway? etc.

6.2 Couple the cost for inspectees to benefits

E-enforcement may involve costs for inspectees. If so, the costs should be coupled to benefits. Benefits may be a natural and effective barrier to strategic behaviour of inspectees and prevent criticism of the enforcement.

Some e-enforcement automatically offers benefits already: checks taking less time, checks on offenders only, and a better insight into inspectees' own behaviour. Enforcers can realize additional benefits for inspectees by coupling e-enforcement to innovations in the sector. In many cases, the sector itself has good ideas for such couplings and about possibilities to cut costs. Enforcers can also realize benefits in cooperation with other authorities. For example, inspectees investing in more axles on their trucks pay less road tax.

6.3 Generate gain for the good guys and loss for the bad guys

Incentives for compliance and non-commission of fraud are the prospect of gain for good behaviour and the prospect of loss for bad behaviour [4]. This also increases the legitimacy of the enforcement.

In both case studies, enforcers primarily focus on serious offenders. However, well-meaning inspectees are not spared: administrative costs are high and one-axle overloading is dealt with severely. Enforcers can reward good behaviour better by lowering the administrative cost for compliant inspectees and those mending their ways, for example by means of fewer checks, temporarily tolerating minor offences, or by shifting the costs to the serious offenders.

6.4 Think through the rules that have to be enforced

A more intensive enforcement demands the rethinking of the rules that have to be enforced. If compliance with these rules fails to realize the objective behind them, it is unwise to intensify their enforcement. The rules may need changing [7].

Enforcers should feed back their findings and the criticism of inspectees to policy makers. Enforcers should not adopt the passive, inflexible attitude of ‘the law is the law and offenders will be punished’, but look at the objectives behind it: safety, fair competition, a clean environment, etc. [15].

6.5 Couple the innovation of a tool to a new method:

Most of the gain brought by e-enforcement comes from a new method. The case studies show that a new method may be limited by preconditions from policy makers: the obligation to submit digital data is still in the future. Owing to the dual system and the absence of certification for WIM-VID, there are still inspection teams at the weighing points. If enforcers are to fully utilize the potential gain afforded by a new method, they will have to involve policy makers in the design of e-enforcement.

Enforcers can avail themselves of the innovation of the method to create goodwill in the sector through lower costs. WIM-VID sets a good example: compliant inspectees are no longer bothered by checks. The digital tachograph seems to do the opposite.

A final warning yet about changing the method: avoid the unnoticed loss of important aspects of the original method. Enforcers should consider the importance of having inspectors on the road, of retaining overall checks and retaining room for discretion [3], which may diminish using ICT rather than people [5].

7. CONCLUSIONS AND FURTHER RESEARCH

E-enforcement generates positive effects in a rational perspective, whereas enforcement problems in a network perspective continue to exist or increase. Six strategies aim to expand the positive effects of e-enforcement into the network perspective.

The strategies convince by their intrinsic logic, but have not been tested. The generalizability of two case studies may be limited.

We recommend further research into other examples of e-enforcement, both inside and outside the domain of transport, and both with much and with little discretionary room. This is how the generalizability of the findings and serviceability of the strategies can be tested. We also recommend research into the interaction between policy makers and enforcers in the development and implementation process of e-enforcement, asking how enforcers can guarantee the key success conditions for e-enforcement in that process.

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Towards Implementation of E-government Services in East Africa: Content Analysis of Government Websites

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ABSTRACT

Recent proliferation of information and communications technologies (ICTs) has played a great role in changing various spheres of the society. These include ICTs' use in facilitating access to and provision of government services to citizens to improve performance, hence 'e-government' services. Developing countries have also taken up the challenge of improving access to and delivery of their services to users through implementation of e-government services. The first stage of this implementation is creation of government websites. This paper describes a content analysis study to identify and determine the status of government websites of three East African countries - Kenya, Tanzania and Uganda - using visibility and usability attributes. The results were compared with a four-stage model of e-government growth based on status of websites from simple to sophisticated features. The study identified 98 government websites including 33 for Kenya, 37 for Tanzania and 28 for Uganda. Nineteen Kenyan government ministries out of 20 (95%) have websites while 20 of 21 (95%) Tanzanian ministries, and 14 out of 16 (88%) Ugandan ministries have websites. Most of the websites were established between 2000 and 2003 and their creators are still undergoing learning experience. The website visibility test ranged from 27% to 40% and the average for three countries was 32%. Usability analysis revealed more interactivity features for Tanzanian and Ugandan websites than Kenyan websites because the former two have undergone a longer learning experience than the latter. Thus all of the East African websites are at the first and second stages of the website development and corresponding e-government services.

Categories and Subject Descriptors

J.1. Administrative Data Processing: Government

General Terms

Documentation, Performance, Management, Measurement

Keywords

Website visibility, website usability, website interactivity, East Africa, Kenya, Tanzania, Uganda, content analysis.

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1. INTRODUCTION

The concept of e-government was first coined in the United States in February 1997 through a joint report of the National Performance Review (NPR) and the Government Information Technology Service Board [24, 27]. The NPR was established during the Clinton Administration and was given the task of developing recommendations to 'reinvent' the Federal Government, with the aim of having a government with these qualities: "works better, costs less, and gets results Americans care about" [27, p.15]. Salem further notes: "Early in the process it became clear that the reinvention of government was tied to the proliferation of information technology. According to Vice President Gore, 'information technology (IT) was and is the great enabler of reinvention. It allows us to rethink, in fundamental ways, how people work and how we serve customers'." (p.15).

Several authors have since defined this concept in various ways but the keywords include the use of information and communication technologies (ICTs) to facilitate access to and provision of government services to people; hence to improve performance (efficiency, effectiveness, transparency and accountability) of government [2, 20, 28, 33, 34]. In that connection, recent developments in ICTs -- especially the Internet and the World Wide Web -- have created great potential for social and economic progress due to their effect in facilitating access to information for decision-making processes [5, 11, 15, 31, 35]. In utilizing that potential, many countries have decided to employ ICTs so as to enhance delivery of government services to their citizens, and are thus at various stages of e-government implementation [8, 10, 12, 20, 30, 31].

Several developing countries have also taken up the challenge of exploiting the potential of the Internet to disseminate information and be accessed for the benefit of their citizens. This is especially so in Asian countries [10, 14, 20] and to a lesser extent in African countries [17, 20, 30, 31, 34]. Likewise, many scholars have taken keen interest in e-government services implementation as a research area particularly in Western countries and to some extent in Asia and South America. These researchers have come up with findings or models that indicate the various stages of implementing e-government services using specified criteria [10, 12, 20, 30, 31]. Similar empirical studies in Africa as a whole and specifically in East Africa are almost negligible despite a couple of emerging e-government services [20, 31, 34]. This study, therefore, attempts to fill this gap and aims to examine the status of implementation of e-government services in East Africa through a content analysis of government websites of three

countries, namely, Kenya, Tanzania and Uganda. In determining the status, the study uses website visibility test and usability attributes in connection with the e-government growth model.

2. BACKGROUND

2.1 Which Services?

There are various services that different governments are using to reach their users[1] electronically depending on the level or stage of e-government development and the users' needs. However the basic service is dissemination of information about structures and functions of particular government agencies. Mutula [17] elaborates this to include local political information, unit lists, official reports and speeches, tenders and draft bills. Silcock [28] reports findings of a survey on user needs of e-government services in the UK to include: "National Health Service hospitals (non-emergencies), social services, doctor's surgeries, local councils and the Passport Agency public services". (p. 92).

Silcock further notes that one of the major potential areas of e-government services is that it can facilitate democratic activities ('e-democracy') such as online voting, campaigning and fund raising, voter registration, opinion polling, representative-voter communication and public feedback. In connection to that, Netchaeva [20] notes that Singapore developed a government portal, 'e-Citizen', to maximize use of e-government to enhance people's participation in democracy. This also led this country to be the first nation in the world to conduct population census online. In many other countries, including the United States, studies have shown that people would like e-government services to help with [20]: renewing driver's license, filing government tax, filing complaints, ordering government publications, searching reservations and parking information. Mutula [17] suggests that in Africa people might be interested in information related to health, agriculture, small businesses, job opportunities, sources of credit and education destinations, among others.

2.2 Importance of E-Government Services

Several benefits are presumed to be associated with e-government services which basically translate to provision of direct services to users instead of/or in addition to traditional flow of paper work between the government and its citizens [8, 20, 28, 33, 30, 31]. The benefits include savings in terms of money and time. A fully-fledged e-government service is expected to provide users with 'one-stop shopping' [7, 8] to access and transact the information they need via a government website that is tailored to provide information irrespective of the various functional units of that particular government agency. This saves time for both parties involved, (i.e. the government and the users). Whitson and Davis [33], enumerate costs and benefits associated with implementation of e-government services by the Department of Energy's (DOE) Office of Scientific and Technological information (OSTI):

> Costs of transitioning to an e-government were also absorbed by redirecting resources to focus on the new way of doing business. OSTI's appropriations budget to support DOE's scientific and technical information activities was $15M in 1995. In FY-2000, OSTI's budget was $8.6M, fully allocated to the development, maintenance, and administration of collaborative ventures, networks, systems and tools that support the collection, organization, and delivery of useful and useable electronic information…. Data from 1995 indicates that 808,500 customer transactions were served as the transition to electronic dissemination was underway. With an investment of $15 million, the cost per customer transaction was $18.55. In 2000, 3.4 million customer transactions were accommodated electronically at a cost of 8.6 million, for a cost per customer transaction of $2.59..." (p.87).

Whitson and Davis also argue that successful implementation of e-government services affects the way the government agencies measure their transaction with users. They do so by focusing users as key to the transaction process. The main issue here is that e-government services are affecting how the public sector provides services to the public by shifting from system-oriented to user-oriented focus.

Improvement of government accountability is another benefit that many observers have associated with e-government services [20, 28, 33, 34 etc]. This is basically related to the above-mentioned benefits of cost-saving since the government uses less taxpayer money to provide more services that give results within a shorter period of time than did traditional processes. Certainly, these benefits can apply to different government environments and this study also explores whether the emerging e-government services in East Africa bear indications of benefiting the intended users via one-stop 'shopping'.

Many observers have also noted a trend toward more partnership among governments, users and the private sector agencies as a result of implementing e-government services [2, 8, 10, 13, 31]. This partnership has led to the emergence of internal and external networks that are beneficial to all parties involved. The private sector is exerting pressure on the government agencies to improve efficiency while the governments are creating a spillover effect (acting as role models) to small businesses to improve efficiency by adopting e-commerce strategies.

2.3 Implementation Strategies and Challenges

One of key prerequisites for implementing e-government services is to have the necessary infrastructure in place, such as include computer hardware and software, together with reliable telecommunications services for connectivity. To ensure users' easy access to government information online, availability of the infrastructure should be coupled with availability of human resources with necessary skills to collect and organize information. All these require political will and adequate commitments from top government officials for successful e-government implementation[2]. That brings us to barriers and challenges of e-government implementation that need to be addressed if governments are to realize the potential of e-

[1] In this study, the terms 'users', 'citizens', 'people', 'customers' and 'public' are used interchangeably.

[2] Silcock [28] underlines the importance of these elements operating together: "Even though most of the excitement centres upon the Internet, governments must be aware that e-government affects every aspect of how organisation delivers service to the public. It is not just business processes; it is not just human resources. It is all these areas combined. At the centre of it all is the customer. How well governments grasp the integration of all the components will largely determine how much value e-government can bring to citizens and to governments themselves. Governments will need committed leadership…and a clear strategy for overcoming the barriers to change… (p.88).

government services. One of the fundamental issues associated with barriers is the question of access to e-government services, that is the whole concept of digital divide: the gap between those with full access to electronic information and those without it due to such factors as socio-economic conditions, language barriers, physical situations, age, education, and so on [see 6, 9, 16, 19, 21, 22, 26]. These are the real challenges to governments because establishment of e-government services is one issue but access to those services by the intended citizens is another issue altogether, and the former can be easier than the latter.

Such barriers tend to be more pronounced in developing countries, especially Africa [1, 5, 17, 18, 30, 31]. In reviewing the contribution of Africa to the global Internet content, Mutula [17] itemizes the following problems that face African countries in creating and accessing such content: Disparity in infrastructure development between urban and rural areas (the former being favored) and associated poor power and telephone supplies; English dominated content which is only understood by a minority elite; generally low literacy levels of the population and uncoordinated e-government activities. All these exacerbate the digital divide problem both nationally and internationally. In East Africa, for instance, out of a total population of about 91 million, only about 1 million people have access to the Internet (see Table 1). Likewise, the number of telephone lines per 100 people (teledensity) shown in Table 1 signifies the magnitude of existing digital divide. This implies that the people with telephone lines represent 0.1%, 0.05% and 0.03% of the population in Kenya, Tanzania and Uganda respectively. Moreover, these services are concentrated in urban areas; for example, Kenya has the teledensity of 0.16 in rural areas and 4 in urban area while in Tanzania 50% of telephone lines in the country are in the capital city [3] where less than 3% of the population lives.

It is thus widely accepted that implementation of e-government services should go hand in hand with strategies to narrow the digital divide. According to Silcock, "One of the fundamental differences between e-government and e-business is that whereas business can, by and large, choose their customers, government cannot. For e-government to succeed fully, the dream of Internet access for all has to become a reality" (p.94). Discussion on strategies to narrow the digital divide is beyond the scope of this study but several other authors have addressed them [e.g. 6, 9, 15, 16, 19, 26].

The issue of political will is also important here because it reflects the government's willingness to embrace e-government services, and commit financial, human and physical resources to establish and maintain the websites; all of these will reflect the quality of government's websites. In essence, the present content analysis study can also be considered as a website quality assessment. Allen et al [2] note that governments should create suitable environments for e-government services: "The rise of e-government refers to the new patterns of decision-making, power sharing and coordination – made possible, or even necessary by the advent of IT" (p.94). They caution that implementation of e-government services might face internal resistance from government leaders who would not like the organizational change from vertical to horizontal coordination characterized by new partnerships of sharing of government information delivery services.

2.4 Stages of E-government Implementation

Various authors have described four to six stages of e-government implementation [12, 20, 28, 30, 31] but all of them show the development of e-government services as an evolutionary process. For example, Silcock [28] describes six stages which she characterizes as dynamic; these include: information publishing/dissemination; official two-way transaction; multi-purpose portals; portal personalization; clustering of common services; and full integration and enterprise transformation. Netchaeva [20] describes more or less similar stages without giving them specific terms but she condenses them to five stages, whereas the UN [30] categorizes five stages as emerging; enhanced; interactive; transactional; and seamless (fully integrated). Layne and Lee [12] propose a four-stage growth model for e-government development: cataloguing; transaction; vertical integration; and horizontal integration.

The above models can be summarized into four main stages, starting from simple to sophisticated and interactive websites:

2.4.1 Website creation

This involves setting up of websites to provide information about structure, functions and services of a government agency information publishing and dissemination). At this stage there might be links to related websites.

2.4.2 Initial two-way interaction

At this stage the website also includes downloadable forms that can be submitted offline and there can be a two-way interaction between government officials and users via e-mail.

2.4.3 Online transactions

At this stage, the website supports some formal online transactions; these can be payments or creating and submitting information such as renewing driving license and filing tax returns.

2.4.4. Comprehensive government portals

This stage exhibits availability of comprehensive government portals that can provide a wide range of information to users and supports one-stop transactions without the need for dealing directly with different agencies. The sophistication of the web design includes improved gateway points coupled with security/privacy/confidentiality features.

The present study will help to ascertain which stage the three East African countries fall into in implementing e-government services.

2.5 Assessment of E-government Services

The concept and implementation of e-government services have become a recent addition to numerous challenges facing researchers in this area. Specifically, a number of scholars have conducted studies to assess implementation status, the quality of e-government services, and to some extent the impact of e-government implementation [7, 8, 10, 27, 30, 33]. For instance, the 'cost-benefit' assessment of DOE's e-government services has already been mentioned [33]. Some of the studies have involved content analysis of government websites or a combination of

[3] See http://www.africaone.com/English/about/fact_sheet_indicators.cfm & http://www.ifla.org

methods to determine the quality and stages of e-government implementation (8, 10).

The United Nations' Division for Public Economics and Public Administration has developed the E-government Index which is an indicator of the progress the UN member countries have made in implementing e-government services. To come up with E-government Index, several parameters and factors are taken into consideration. These include web presence measure (indicating stages of government websites), telecommunication infrastructure measures which define the capacity of a country's ICTs (indicators are internet hosts per 10,000 people, percentage of a nation's population online, and PCs-, telephone lines-, mobile phones-, and televisions per 100 people); human capital measure (using the UNDP Human Development Index, the Information Access Index, and urban/rural population ratio as indicators). According to 2001 survey results [30], Kenya, Tanzania and Uganda scored the E-government indexes of 0.90, 0.84 and 0.42 respectively. These are considered to have deficient e-government capacity but are classified as having enhanced web presence (equivalent to stage 2.4.3 above). Top e-government-environment countries globally are USA, Australia, New Zealand and Singapore with E-government indexes of 3.11, 2.60, 2.59 and 2.58 respectively. These are classified to have transactional web presence (equivalent to stage 2.4.4. above). The global average E-government index is 1.62.

La Porte and colleagues [13] have attempted to measure the concept of organizational openness as a result of implementing e-government services. In doing so, they conducted a cross-national comparison of websites using the Website Attribute Evaluation System (WAES), with such attributes as ownership, contact information, organizational or operational information, freshness and interactivity. Likewise, Holliday [10] conducted a study to evaluate e-government implementation progress of 16 states of East and Southeast Asia. He analyzed government homepages and sites by measuring their visibility and utility. Ho [8] supplemented a survey study with a content analysis of city websites in the United States to determine whether the cities were indeed reinventing their local governments.

The present study adapts and integrates some of parameters used by these researchers to assess the status of government websites of East African countries; this helps to determine the stage of e-government implementation of these countries based on the above four-stage model.

3. STUDY AREA

This study covered government websites of three East African countries, namely Kenya, Tanzania and Uganda. Geographically, these countries are located in eastern Africa and share common borders and Lake Victoria. They also border Ethiopia and Sudan to the north; Congo DP, Burundi and Rwanda to the west; Zambia, Malawi and Mozambique to the south; and Somalia and the Indian Ocean to the east. As well as their common borders, these three countries share common historical and cultural characteristics; and they have established a regional body, the East African Community, (EAC)[4] to facilitate their integration. Okello (1999) summarizes the common characteristics:

> Given East Africa's common history (the three countries were colonized and got independence about the same time); common cultural practices; the existence of widely spoken languages (English and Kiswahili); the close economic interdependence (consisting of infrastructural linkages and intense trade); the political and social foundations for integration are strongly present. (p.3).

The 2000-2005 development strategy[5] of EAC recognizes the role of information and ICTs in facilitating the process of regional integration. That implies that they recognize the importance and benefits associated with e-government implementation.

Some basic physical, social and economic characteristics of these countries are shown in Table 1.

Table 1. Basic characteristics of East African countries

		Kenya	Tanzania	Uganda
Size (sq. km[mls])		582,646 [224,961]	945,087 [364,900]	236,040 [91,136]
Population		31,138,735 (02 est)	34,569,232 (02 Cens.)	24,748,977 (02 Cens.)
Indep. year		1963	1961	1962
Languages	National	Swahili	Swahili	English
	Official	English	Sw & En	English
% GDP contrib.by sector (2000 est)	Agric	24	48	44
	Industry	13	17	18
	Service	63	35	38
GDP growth rate (2001 est.)		1%	5%	5.1%
GDP per capita (US$)		1,000	610	1200
Literacy rate (1995 est)		78.1%	67.8%	62.7%
Life expec at birth yrs)		47.02	51.7	43.8
Human dev. Index		0.513	0.440	0.444
E-govt Index		0.90	0.84	0.42
Internet users (2002 est)		500,000	300,000	60,000
Teledensity		1.03	0.46	0.26

Sources: CIA World Yearbook [3]; UN [30]; UNDP [32]; UNECA[6], The Times Atlas of the World.

4. ANALYSIS OF WEBSITES

Analysis of government websites was conducted between May 10 and May 31, 2003. The study focused on the websites of central governments only; that is the government ministries headed by cabinet ministers and their direct agencies, bodies or departments, as well foreign missions of these countries (all these hereafter referred to as government agencies); as such, local government units are not included[7]. First of all, it was necessary to establish

[4] See http://www.eachq.org/

[5] See EAC Development Strategy 2001–2005 at http://www.eachq.org/Dev_Strategy/Development_Stra.htm

[6] See http://www.uneca.org/aisi/nici/country_profiles/default.htm

[7] Although local government agencies provide such services as business licenses in their localities, major services that can be provided online

whether government websites of the three countries exist. This was done by assessing their visibility (important initial indicator of e-government implementation) and then conducting the content analysis to assess their status in terms of their level of development (stage) using usability attributes. I consider usability as a website's quality or the ease with which the users can use it.

Hence, the study assessed each of the identified websites by employing a combination of selected attributes from WAES (adapted from [13]) and utility indicators (adapted from [10]). Additionally, dates of establishment of the websites were recorded together with languages used other than English; the latter attribute was categorized as a utility indicator. All the selected attributes, together with the names of government agencies and their website addresses, were recorded and compiled in tabular forms and the results were drawn by simple descriptive statistics.

The attributes are described below as well as the results and implications:

4.1 Website Visibility

Using Holliday's [10] approach to assess the visibility of the website, the Internet was searched using three of powerful search engines - Google, MSN and Yahoo! - by typing separately 'Kenya Government', 'Tanzania Government' and 'Uganda Government'. It was expected that early appearance of a government website, that is if it appeared within first 10 hits of the results, would confirm its visibility. Moreover, subsequent hits were taken note of for further observations if need be.

Table 2 shows the results of the website visibility test which range from 27% to 40%. The average for three countries is 32%. These results fall more or less within the same range that Holliday found in East and Southeastern Asian countries and considered them as under performers in terms of visibility. However, these results led the study researcher to official national websites that provided links to most of other websites. For example, the visibility of Kenyan websites using MSN search engine was only 10% but the only hit was the national official website that provided links to most of the ministries'

Table 2. Appearance (%) of government websites of East African countries in 1-10 hits of three search engines

	Kenya	Tanzania	Uganda	EA Average
Google	30	20	30	**27**
MSN	10	70	20	**33**
Yahoo!	40	30	40	**37**
Average	**27**	**40**	**30**	**32**

websites. In information retrieval terms this particular outcome had a high precision.

There are also notable extreme results of web visibility between countries within the same search engines; for instance, the MSN gave 10% for Kenya and 70% for Tanzania. It seems the Tanzania's websites are configured to be visible although the results were not as attractive with Google. This might be a subject of further debate and study.

Further searching and analysis led to identification of 98 government websites including 33 for Kenya, 37 for Tanzania and 28 for Uganda. Each country has an official national website[8] that provides comprehensive government information to a wide audience together with links to its ministries that have websites and full addresses to those with or without websites. We can argue that these websites have indications of becoming one-stop shopping gateways for government information delivery and access (e.g. the Tanzanian national website has links to government tender documents that can be downloaded by prospective bidders).

Nineteen Kenyan ministries out of 20 (95%) have websites while 20 of 21 (95%) Tanzanian ministries, and 14 out of 16 (88%) Ugandan ministries have websites; this also implies a promising trend of e-government presence in these countries. However, this trend does not correspond to these countries' embassies abroad. Out of 39 Kenyan embassies identified only 5 (13%) have websites. Likewise, out of 28 Tanzanian embassies identified, only 7 (25%) have websites, whereas 5 (24%) out of 21 identified Ugandan embassies have websites. This is also an interesting trend which signifies that the embassies and their governments at home have either different or no policies in relation to implementation of e-government services. This will be further explored in a subsequent study. It was also necessary to conduct further searches to identify more embassy websites (of 17 embassy websites identified, only 8 were linked to relevant government websites back home). In that case, the Internet sources such as 'Governments on the www'[9] were useful tools in assisting the study researcher to trace 'invisible' websites.

4.2 Website Establishment Date

The establishment date is an important parameter of a website as it helps us derive the extent of learning experience of the website owners [8]. As the website owners gain more experience in maintaining the website, they tend to incorporate more information for the users and the websites become more and more sophisticated and interactive (higher stages of development) with corresponding e-government services. Moreover, capturing establishment dates will give us a pattern of growth in implementing e-government services over time. Most websites give this date with the copyright information. For the present study, where this information was not available or it was not clear, the information was searched from the Internet Archives' 'Wayback Machine'[10, 11].

The numbers of new websites and corresponding years of establishment are shown in Table 3. It is clear from the table that there is a general increase in the number of websites from the first year of their establishment, that is, from 3 websites in 1998 (all of them from embassies) to 31 websites in 2001 and 28 websites in 2003. However, there was also a sharp decline in the number of new government websites in East Africa, from 31 in 2001 to 7 in

such as issuance of passports and visa are provided by central government agencies in East Africa.

[8] See http://www.kenya.go.ke/ (Kenya); http://www.tanzania.go.tz/ (Tanzania); www.government.go.ug (Uganda).
[9] See http://www.gksoft.com/govt/
[10] See http://web.archive.org/
[11] I would like to thank Christine Borgman for drawing my attention to this important tool.

2002. This might be due to a consolidation period after a massive establishment of the government websites in 2002-2001 (new millennium) when a total of 50 websites were established, especially in Tanzania and Uganda (only 2 were established in Kenya during that period).

A sharp increase from 7 new websites in 2002 to 28 (24 of them from Kenya) in 2003 might be due to recent government leadership changes in Kenya. This will further be examined in a subsequent study by this author. It is also interesting to note that when the UN [30] assessed the current e-government indexes in 2001 (see also Table 1), Kenya had a total of 4 government websites while Tanzania and Uganda had 28 and 24 government websites respectively. This implies that the UN measures the potential rather than real e-government presence, owing to Kenya's relatively well-established telecommunication system, higher literacy, with corresponding human development index (see Table 1). However, a study by McConnell International[12] to assess 'e-readiness' of 53 countries worldwide places the assessed countries into four categories from low e-readiness in the first inner tier to high e-readiness in the forth-outer tier. Kenya is placed in the first tier, Tanzania in the third tier, while Uganda was not included in that assessment. Various assessment methodologies and criteria can thus produce different results. The results further show that there is still a very low rate of establishing new websites by missions representing the East African countries abroad. This will also be examined further in a subsequent survey.

4.3 Website Ownership

It is important to take note of the website's owner as it reflects the seriousness with which the government agency takes in implementing e-government services [13][13]. The ownership information was captured from the copyright information given on the homepages of the websites. These were matched with names of the government agencies under observation.

Results of the analysis show that respective government agencies own the majority of websites. However, the ownerships of 10 websites (1 Kenya, 9 Uganda) were not established from content analysis, while 7 websites (2 Tanzania and 5 Ugandan) were designed and maintained by private companies. The study researcher also noted that several embassies representing their countries in Japan, including the Kenyan and Tanzanian embassies and even some few developed countries have subverted their websites to a company called KCOM Corporation under the Embassy Avenue[14] program. Although this study did not establish the terms and conditions attached to this program, it generally shows embassies are surrendering control of their websites to this body.

Table 3. Number of government websites of East African countries established each year from 1996 to 2003

Estb Yr	KN		TZ		UG		EA		Total
	Mn	Em	Mn	Em	Mn	Em	Mn	Em	All
1998	-	1	-	1	1	-	-	3	3
1999	-	1	1	1	-	-	1	2	3
2000	-	-	9	-	9	1	18	1	19
2001	1	1	14	2	11	2	26	5	31
2002	3	-	2	1	1	-	6	1	7
2003	24	-	1	2	1	-	26	2	28
Not av.	-	2	2	-	2	1	4	3	7

(KN=Kenya; TZ=Tanzania; UG=Uganda; EA=East Africa; Mn=Govt ministry or department; Em=Embassy; Not av.=establishment date not available)

4.4 Website Update/Freshness

Like ownership, assessment of the website's freshness gives a general picture of how serious a government agency considers e-government services by committing necessary resources for costly updating of the website [13]. In this study, the date of last update of each website was captured from both the website and the Internet Archives. The websites that were updated more than 12 months ago were considered to contain outdated information and are thus slow in achieving full e-government service delivery and access.

The results show that the majority of the websites were established between 2000 and 2003; as such they seem to be pretty fresh. However, others have not been updated since their establishment. Thus, if we set aside 35 websites that were established in 2002/3 (27 Kenya, 6 Tanzania and 2 Uganda), 22 websites (2 Kenya, 15 Tanzania, 5 Uganda) have not been updated since 2001. For Tanzania, the figure represents nearly 40% of the websites and this signifies poor performance in delivering e-government services especially at this initial stage of implementation. Overall, however, the freshness of the East African government websites is an encouraging step towards full e-government implementation.

4.5 Website Usability

4.5.1. Important links

A website providing links to relevant bodies within and outside the government system is considered to be user-friendly since the user just clicks to that link to access needed information instead of conducting a new search. The more user-friendly and usable the government website the more the country it represents is heading towards full implementation of e-government services [7, 28]. Thus, in this study, after recording the appearance of the website the study researcher took note of the links to other relevant government websites and sources of information.

All of the websites have important links ranging from the official national websites to the multiplicity of links to various government and international institutions. The national official websites were particularly instrumental in providing links to government agencies that constitute the majority of the websites analyzed. They also provided links or contact information for their embassies abroad. However, as noted under Item 4.1 above,

[12] See McConnell International's summary report on e-readiness at http://www1.worldbank.org/publicsector/egov/docktor_mcconnell.pdf

[13] La Porte and colleagues [13] state: "The aim to ascertain if the agency itself is tailoring the material for the site or has shunted these content decisions to someone else…Agencies that own their own Web operations are more likely to consider it a key part of their organizations compared with those that leave the development of their Web site to others". (p.415)

[14] See http://www.embassy-avenue.jp/index-e.htm

only 8 of 17 embassies representing the East African countries had their websites linked to their home country government websites. These were only identified after further searching.

4.5.2. Contact information

Contact information is an important attribute of a website important because it enables users to contact relevant officials in relation to that website's content or any other queries. The information captured includes contact email address to the webmasters and, more importantly, names and full addresses (postal, telephone, fax, e-mail) of relevant government officials.

With the exception of 7 websites (3 Kenya, 4 Tanzania) with unclear or no contact information, the majority of the websites analyzed have some form of contact information including postal address, phone and fax numbers, e-mail addresses, as well as names of senior officials. However, during the study period, only six websites (3 Tanzania, 3 Uganda) had clickable e-mail addresses to their webmasters. This implies lack of permanent staff for day-to-day maintenance of the websites. It could also mean that they just don't want to deal with a lot of e-mail.

4.5.3 Interactivity

Website interactivity signifies the level of two-way communication between a government agency and users. Interactivity attributes captured from websites under analysis include hot-linking addresses for easy contact; provision for user searching, downloadable materials or forms; and feedback e.g. feedback forms or provision for electronic submission of downloadable material. Government websites with these attributes indicate a country is heading towards full implementation of e-government services and is evolving into advanced stages of e-government development [7, 10, 12, 13, 20, 24, 28, 30].

The results of analysis show varying levels of interactivity among the identified websites and among the three countries (Table 4). Generally, Tanzania and Ugandan websites have outperformed Kenyan websites in interactivity with their users. This is probably because most of the Kenyan websites were just established in 2003 while the Tanzanian and Ugandan ones have undergone a longer period of 'learning curve experience' [8]. Ugandan websites have especially attractive user interactivity features like clickable hotlinks "ask the president", "ask us", provision for user searching, feedback forms and FAQs. All these features are crucial means of communication between governments and their users and they imply a promising e-government presence [7, 13, 30].

Downloadable materials observed in the study that were at the users' disposal include: forms for visa, passport and license applications; tender bidding documents; various government publications; forms for student and nationals registration abroad; and so on. These are basic e-government services that these countries offer in addition to general dissemination of information about government agencies that own the websites. However, these forms are to be submitted off-line with the exception of one website (the Tanzanian Embassy in Bonn) which has a provision for online submission of student registration form. These features correspond with stage two of e-government growth model.

Table 4. Number of government websites in East Africa that exhibit user interactivity features

Interactivity feature	Kenya	Tanzania	Uganda
Hot-linking contact	7	21	17
User searching features	0	4	11
Downloadable forms/materials	4	15	14
Feedback features	6	4	10
Online submission of downloadable forms/materials	0	1	0
Total	17	45	50

4.5.4 Language(s) used

The question that especially interested the study researcher is: 'does the language used represent the languages used in the websites represent the languages understood by the population that the website intends to address?' Mutula [16] observes that the general insignificance of the contribution by African countries to online content is the use of the language that represents only the minority of the population[15]. For East African countries, English is an official language in government and commercial transactions. However, it is only spoken and read by about 3-9% of the population [4, 29]. Swahili is a national language in Kenya and Tanzania (it is also an official language along with English in Tanzania) and is also somewhat spoken and read in Uganda. Baganda is another major language in Uganda spoken by 16% of the population. The website analysis checked whether the website contents of these governments contain languages read (since the Internet is also textural) other than English. This will signify governments' intentions of reaching most users through the Internet.

From the results, almost the whole content of the East African websites is in English. Only the national website of Tanzania has a Swahili version and the users can choose between the two languages. Likewise, the non-English-speaking missions abroad have their websites in English and the languages of host countries (i.e. Chinese, French, German, Italian and Japanese). Two Ugandan websites have their contents solely in German. One Kenyan website provides a link to one website with Swahili instructional materials. Eight Tanzanian websites have links to various publications and speeches in Swahili and one in Uganda has publications in tribal languages. This seems to be a good start. However, it is generally hard to draw concrete conclusion and implications relating to the language issue before we take stock of the users and problems of digital divide. But we know that the first potential users of e-government services are current Internet users [28]. In East Africa, these represent a very small fraction of the populations of these countries (see Table 1). Thus the question is: is the language of the website content going to alter this fraction of the users?

4.6 Other Information

[15] According to Mutula, "The continent's proportion of web content was estimated in 2001 to be 0.04% of the global web content. … This situation is exacerbated by the fact that Africa's content on the web is largely in the English language, which is spoken by mostly the educated elite. The lack of local content in a widely spoken and understood language reduces the demand for Internet use in Africa" (p. 35).

A look at the contents of the websites analyzed revealed they basically focus on describing the mission, functions, structures and leaders of government agencies. They are also geared towards promoting these countries to foreign investors and tourists.

4.7 A Note on Statistical Analysis

An attempt to subject the data to tests of statistical significance could not yield satisfactorily meaningful results because most of the tables even after collapsing data - had cells of expected counts of less than five. Therefore, the preceding interpretation of results is based on raw observations (tables 2-4).

5. CONCLUSIONS & FUTURE RESEARCH

This study has sought to examine the status of e-government services in East Africa through content analysis of government websites. Specifically, the study has conducted visibility and usability tests of these websites and analyzed their establishment dates and other parameters. The attributes used to assess the websites include: visibility, ownership and freshness (up-to-datedness). Usability attributes include important links, contact information, interactivity and languages used. Interactivity attributes are extremely useful in determining the migration of a country towards e-government implementation and have a bearing on assessing the country's stage in e-government service development. These include features for hot-linking to enhance easy contacts to the government, user searching, downloadable material, general feedback and FAQs.

The study has identified a total of 98[16] government websites in East Africa and there is a general trend of increase in the number of and improvement of the websites judging from the analyzed attributes. For instance, each country has an official national website that provides comprehensive government information to a wide audience together with links to its ministries and other sources of information (this feature tended to offset their relatively low visibility of 27-40%). The national official websites bear necessary indications of becoming one-stop shopping gateways for government information delivery and access. Furthermore, almost all government ministries (95% Kenya and Tanzania, and 88% Uganda) have websites owned by government departments; this also signifies a promising trend of e-government presence in these countries (most of them were established in 2000-2003). However, this trend is not reflected in these countries' missions and embassies abroad and there is a need to improve coordination between the two sides.

Taking into account all the attributes assessed we can conclude that the three countries' websites are generally in the second stage of the e-government development model. This corresponds well with the UN's assessment of these countries as having 'enhanced' web presence for e-government services [30]. However, in considering the interactivity attributes alone in this study, the Kenyan websites gave the lowest score of 17 while Tanzania scored 45 and Uganda 52. Despite this observation, Kenya scored the highest on the e-government index by the UN due to this country's relatively well-developed telecommunications infrastructure and stronger human resource capital in comparison with Tanzania and Uganda.

On the language question, and from the results, almost the entire content of East African websites is in English. However, it is generally hard to draw concrete conclusions and implications relating to this issue before the e-government user study is conducted in these countries. But one thing is certain: the future of successful implementation of e-government services in East Africa and other countries is linked to the intended users' universal access to the Internet.

This study bears both practical and theoretical implications relating to implementation of e-government services in East Africa and other regions. The attributes used to assess the websites can easily be used by other researchers for similar studies. As such, this study contributes toward a more standardized methodology of assessing government websites and thus avoiding conflicting conclusions. Additionally, these attributes can serve as indicators for governments to strive toward advanced stages of e-government implementation.

The study has also shed light on potential topics of future studies in this and other regions: Firstly, the need to study user composition of e-government services and the types of e-government services they require. This will also address the issue of language. Secondly, there is a need to study insights of policies that govern implementation of e-government services. The issue specific to this region is why the foreign missions of these three countries were the first adopters of e-government services while they are now lagging behind home government agencies. Also, the reason why, on the overall, Tanzania and Uganda started implementation relatively earlier than Kenya while the latter has relatively better developed infrastructure and human resources than the former two. Thirdly, there is a need for conducting more visibility studies to compare various search engines and more countries. Finally, there is a need to extend this study to cover more countries and regions and to give a deeper analysis of the attributes considered in this study.

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Towards a Reference Architecture for a Virtual Business Counter

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ABSTRACT
A customer-oriented approach towards a one-stop government requires online public services, 24 hrs a day from anywhere in a east-to-use and simple way meeting customer needs. Currently in each region of the Netherlands a virtual business counter is under development focusing on providing services within a particular geographical area. These projects are a one-stop shop in only a very limited sense as cooperation is limited to the public organizations operating within a certain area and there is no such thing as national access or a national business counters

For providing a true one-stop shop a more national-oriented approach should be followed having multiple access points at distinct levels of public administrations. A more structured approach to reuse of knowledge and experience, but also components and services is necessary. A reference architecture can help decision-makers to support in this process. The goal of this research is to gain insight into the problems needing to be considered when designing a one-stop virtual counter and to develop some preliminary ideas about a reference architecture for an integrated virtual counter.

General Terms
Management, Performance, Design, Standardization

Keywords
E-government, architecture, business counter, modeling

1. INTRODUCTION
The current economic climate is already forcing government agencies to focus on efficient delivery of their core services by cooperating with other agencies. Up to now, an experimenting with various pilot projects of designing a virtual counter has occurred in the field. This has resulted in some interesting and innovative results, however, the aim of a really integrated counter is not reached. The government reality of today is the emergence of 'islands' of e-government that are frequently unable to interoperate due to fragmentation resulting from uncoordinated efforts in developing the services, at all levels of public administration [5].

By joining up administrative processes across agencies a significant increase in efficiency and enhanced services delivery can be created. The minister for Government Reform and Kingdom relations of the Netherlands aim is to reduce the citizens' and business' bureaucratic obligations and burdens by 25% [4]. That reduction will largely be brought about through reduction of unnecessary regulation and by far better use of ICT.

There are a number of challenges in designing a virtual counter such as designing electronic solutions not built along existing governmental structures, ensuring government departments cooperation, redefining current works processes and structures, acquiring adequate funding, and retaining sufficient human resources skilled in ICT [3]. To date most research have focus on the extend to which public agencies present information via the Internet and on the types of access necessary and not on architectures supporting the collaboration between independent government agencies for effective services delivery. The *goal* is to better understand what makes up an architecture for a integrated virtual counter. We do this by first comprehending factors influencing the architecture of an integrated virtual counter and thereafter deriving some preliminary ideas about designs that could make up a reference architecture.

In this paper we start with describing the concepts behind a virtual counter, thereafter we discuss design problems and pitfalls influencing the design of integrated virtual counter. We do this by investigating some pilot studies using interviews. In the following section we discuss some preliminary ideas, trade-offs and decisions needing to be made to design an integrated architecture that can be used for discussion in the e-services workshop.

2. BACKGROUND
Businesses work within a regulatory regime of a government that includes frequent and mandatory dealing with government. The creation of a business counters needs to adapt diverse preferences of access and communication modes. Some problems need to be personally deal with by a business representatives and government officials. It becomes critical how that actual access point in a virtual and physical setting are arranged within an organization.

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2.1 Pilot projects

The field of government can be characterized by independent agencies having all kinds of information systems and providing various kinds of services. In a virtual business counter municipalities, taxes and chamber of commerce have to cooperate for effective service provisioning. Those are stovepiped organizations with no history of working together. The starting situation is a highly fragmented ICT-architecture that has been vertically organized around agencies, and departments within the agencies, and with hardly share any common horizontal functionality. The existence of isolated, overlapping in function and content, highly fragmented and unrelated computerized applications within the same public organization has resulted 'isolated islands of technology' while information systems were viewed as being internal to the public organizations [16].\

2.2 Virtual Counter

A virtual counter is a major gateway through which citizens, businesses and civil servants can access information and communicate and collaborate with each other. As such a virtual counter is a gateway of information resources and other services via a single point of access. It provides an integrated and intuitive view of products and services. Based on Detlor, and Finn (2002) and expanded using interviews, Common features include

1. Classification schema of services categories that help organize information for advanced retrieval;
2. Search engine to facilitate more exact and specifies information requires;
3. Personalization mechanisms to accommodate individual information need, uses and preferences;
4. Reuse of information entered once;
5. Tracking and tracing of the status and progress of services requests;
6. Information space could providing press notes, polices, news, and third party information such as environmental data, economical data;
7. Links to internal and external websites and information sources that might be or interest;
8. Communication space to have discussions;
9. Collaboration or work space to support work action;

2.3 Architecture

ICT-Architecture is the description of the set of components and the relationships between them [1]. Architecture aims to bridge the gap between business and ICT departments and conceptual and implementation design by defining a systems composition from various viewpoints. Often it incorporates a blueprint of the existing and desired design and a overall plan regarding realizing part of its. Stakeholders can use architectures to make decisions concerning system development strategies. In this conception a architecture is not only a technical artifact but also a phenomenon having strong organizational connotations [15].

From a rational perspective the design of a architecture is usually seen as a set of trade-offs between available resources, e.g. money, personnel, time, and functional and technical requirements related to the architecture such as scalability, capacity response time, security and availability [10]. Architecture provides design tools for such as architecture description languages, common architectural patterns, trade-offs methods, service-oriented or component-based frameworks and technologies.

The work of architectures and the usage of architecture include also more diverse connotations than the technically, rational oriented architecture approach [15]. Architects have social and even a political roles in organization. Stakeholders can give different meanings to architecture to fulfill their requirements. Consequently an architecture is not completely designed through rational decisions and trade-offs. Instead an architecture emerges through non-deliberate actions taken by stakeholders and determined by the state-of-the-art of technology developments and insights.

Experienced architects can use pass experience to solve new problems. A new domain may not be able to directly learn from an existing architecture, while it can after abstraction. A *reference architecture* is the highest level of abstraction and includes experiences from various domains. A reference architecture should enable developers to focus on the understanding of the domain, the established of an analogy between the new domain and previously investigated architectures and the establishment of the link to corresponding components. A repository of experiences, components and services can support this process. A reference architecture can emphasis on the reuse of experiences and the reuse of resources like services and components. Abstraction and analogy are the key to develop a reference architecture.

A reference architecture can be used by the establishing an analogy between the new domain under study and the reference architectures. Analogy enables a new business component or service to match existing components and services even though they have some difference in appearance. In the next step the suitable components and services should be discovered and mapped to fill in the architecture. Using the reference architectures and repository a solution for the new domain under study can be found. The use of a reference architecture can have the following advantages;

1. Decrease the complexity of the systems. A complex system can be analysis by looking at the parts which has a lower complexity than the whole system;
2. Increase the reusability and the connectivity. Both experiences as well as components can be reused. When a service or component is developed by one agency other agencies can reuse this component or service.
3. Reducing errors and mistakes. Ax experience with various architectures are stored, making the same mistakes over and over again can be avoided;

Reference architectures need to have a *grey box* approach, as this is essential for reuse. Architectures can reuse component not only by checking its interface and functionality, but also by knowing it processing logic. In this we enable architects and users to understand its behavior through process scenarios to make a proper relationship to the business.

3. PROBLEMS AND PITTFALLS

Large organizations structures can have their own difficulties [1]. Armour [1] mentions a number of pitfalls for developing an

enterprise architecture including, not-taking an iterative, incremental approach, inexperience with large-scale efforts, passive or outright resistance to enterprise-wide architecture development, stove-piped organizations with no history of working together, lack of common visions, lack of leadership that can really own and drive the process, lack of agreement on roles and responsibilities.

3.1 Historical Inertia

Governments' history with independent agencies and their sometimes-overlapping functions and objectives has resulted in a slow progress. Each agency has a number of legacy system with different technical architectures and supporting different business processes. It is not possible to replace operative legacy systems with a uniform solution at once, so they have to be incorporated. Some large systems have been designed over years and they form the very basis of an agency.

There is no information management or architecture department that is responsibility for all systems under developments. The role of central level information architecture has been a minor one, where as the roles of individual information managers in agencies has guided development.

3.2 Responsibilities and Ownership

Collaboration requires rearrangement of organization roles and responsibilities and identifying new responsibilities. In the pilot projects responsibilities are assigned by trial-and-error experiments. A more fundamental approach is necessary where roles and responsibilities are identified and assigned consciously.

New cross-organizational roles and responsibility need to be established, e.g. who is responsible for monitoring service levels, who initiates action to increase service levels. Organizations need sound organizational procedures, such as requiring the consent of two individuals before changes can be made influencing more than one record.

Data is treated by the organization as a valuable asset. The collaboration faces issues about the ownership of the rights of data. The Dutch government uses the principle of *authentic registrations*. This principle states the organization who gathers the information at the sources, is responsible for keeping information up-to-date and for distributing the organizations to other organizations. The core-business of government is often based on the information in these authentic registers. The services currently provided by a municipality are only provided by that municipality because it owns, controls and maintains the citizens authentic register. When another organization, like the virtual counter, would control and maintain the citizens authentic register they might lose their right to exist. Simulation should draw the attention to this issue.

3.3 Legal Responsibilities and Liability

Many of the organizations roles are founded in laws and regulations. These organizations have a legal duty and are responsible for services provisioning. Laws and regulations often block collaboration in a virtual counter. For example, the Dutch taxes have the duty to collect sales taxes, which blocks the road for collecting sales taxes using another legal entity. It is unclear which functions might be executed by a virtual counter and who is liable.

3.4 Content Management

Content management can be characterized by the management of heterogeneous information sources and document types that need to be structured access using customized interfaces. Content and information management is not always a success as the scale of staff resources needed to maintained the content currency has become painfully clear over time. Information is outdated, incomplete or can even be wrong. As access to government information is still not centralized and customer complaints center around and not being able to find answers easily to their questions across government departments. The availability of information provided by different government agencies has even resulted in a website dedicated to opposing laws and rules (http://www.strijdigeregels.nl/). This website is established by the Ministry of Economic affair and provide businesses the opportunity to enter real-life examples with opposing rules.

3.5 Services Innovation

The services brought online are some of the services currently provided by the individual organizations and do hardly include services requiring the collaboration between government organizations. As such the virtual counter is only seen as new channel for making a selection of existing services online by government organizations, instead of making all services online and providing new, innovative and/or integrated services.

Molenaar [13] makes a classification into four types of orientations, based on the level of the use of ICT and the focus of the approach, product, market, customer and customer-participation and interaction. *Product orientation* means that existing products and services are made available online. Existing brochures and forms are made available online in a one-to-one manner. Current products, a copy of the physical brochures and order forms, are placed on the Internet. It establishes a departmental 'presence' and product access points to the customer. In a market orientated approach customers are targeted as segments, group of customers, additional services are provided, and services are made available using life-events.

Customer orientation is a natural progression to re-organize information by services, by different actions or by different events. References to services provided by private parties are becoming part of the web site. A life-event marrying will not only contain information about possible wedding locations and procedures to get married but also links to wedding photographers and dressing companies. Customers can customize the web site according to their personal preferences using profiles. A customer profile details each customer's product interests, demographics, roles and other information used to approach customers. Customers can use their profile to subscribe to events, such as getting an email just before the expiration of her or him drivers license or get information concerning building permits in their neighborhood.

In a customer-participation and interaction approach customers are part of the policy-making processes or service provisioning. Customers are asked to fill in online surveys used for the continuous evaluation and improvement of products and services. Expert systems can be used to guide customers to the right service or to draw customers attention to possible information sources, such as that they meet certain requirements to get a subsidy, they would not know otherwise. Customer analysis might be

performed to provide additional services, e.g. somebody complaining regularly about the noise in his or her neighborhood gets informed about a new subsidy for isolating houses.

A simple new service that solves the customer problem of entering similar data multiple times was not solved by pilot projects. Data can be re-used by using a virtual counter and collecting data centrally. Another example of a new service could be the simultaneous registration by entrepreneur in the trade registry of the chamber of commerce and in the tax register of Dutch taxes. Providing progress and status information about the status of a services is more complicated, as the status is determined by individual organizations. In the example, information about the status of the registering procedures of both organizations should be collected and appropriate measures should be taken when registering takes too long or the resubmitting of the registering request when information is loss.

3.6 Commitment and decision-making

The historically independent government organizations need observable benefits or some kinds of incentive to stay committed to the effort. As such quick and visible results can be crucial. In contrary the drive for quick results led to quick-and-dirty and architecturally unsound solutions that may fail to meet the expectations of customer-driven service provision and results in non-expandable, non-scalable structures.

Due to the history of independent and a lack of central authority that is able to make architectural decision on behalf of all participants in the virtual counter. Our interviewees indicated that this resulted in a kind of conflict and problem avoidance and a tendency to compromise, instead of making decisions based on customer-centric criteria.

3.7 Unclear Requirements and Lack of Common Understanding

Since the government agencies have their owns histories and developed their own legacy systems and ICT-architectures, the interpretation on the situation and objectives were not agreed on an some interviewees indicated that the objectives diverged instead of converged during the projects. This, combined with stove piped organization, missing common working practices or any other reference, created difficulties in understanding and transferring of architectural knowledge between the participants.

3.8 Level of Integration

On the one hand, the projects were mainly concentrated on building a front-office without looking at integrating the system with existing back-office organizations and legacy systems. On the other hand the organizations were concerned with keeping the responsibility and operation of the services they currently provide. The organizations have various levels of automation, were the organization with the lowest level of automation determines the maximum level of integration.

In addition, actual implementation of integration may be problematic. Since, the legacy systems cannot be replaced easily they have to be interfaced. This means that many interface need to be developed, controlled and maintained, and security and transaction issues need to be resolved.

The business processes of the government agencies might be integrated. Workflows involving multiple companies are still in their infancy Sources for issues in this context include heterogeneity of workflow management systems and languages and applications used by the various organizations.

4. Towards a Reference Architecture

Problems and pitfalls need to be dealt with when designing a architecture for an integrated business counters. In this section we discuss various approaches to and decisions needed to be taken when designing an integrated virtual counter. The main goal of the one-stop virtual counter is to enhance the relationships with the customers by enabling cooperation between government organizations.

4.1 General Requirements

Fluctuating objectives, meanings, and requirements might be a source of conflicts and problems. When reasoning from a citizen perspective, some requirements might be agreed on by all involved agencies within a virtual counter. Although business can have various requirements on a one-stop shop, some users might be e powers users, which want to have their services as quickly as possible and do not mind some complexity for finding a services when they are able to find it fast. Some users might be non-experienced Internet users, which should be guided to the service they need and do not mind if this is more slow process. A requirement that can be agreed on by agencies is for example, government want to empower citizens by providing self-service options, to access server any time, any place, and to increase their own cost. Our preliminary ideas resulted in a number of general requirements. Integrated service counters should address unique concerns and challenges

1. Choices – make electronic delivery of services and information using the business counter the preferred option of businesses;
2. Privacy - such as the need to protect citizen privacy, ensure confidentiality;
3. Fraud prevention- and the requirement to prevent (government) misuse of information, prevent fraud or computer hacking, provide access and availability to all its constituents;
4. Accessibility of services in a format the customer requires;
5. Efficiency; reduction of administrative costs of both business and government;
6. Rationalization – share resources for services, functions, and processes which are common to more than one department or agency;
7. Content availability and quality; Up-to-date content should be available and content quality should, including credibility, usability and utility, should be ensured;
8. Open information – make information readily available in convenient, useable and findable forms;
9. Responsiveness – confirm request and react on request within limits set by law and provide insight in progress;

4.2 Organizational Coordination

Lapré and Venrooy [8] identify two opposing models, the integration and fragmentation model as shown in table 1. In the integration model the aim is to provide one integrated virtual counter where the various services from the different back-offices are provide to the customer in an integrated manner. The integrated counter is an aggregate of an individual government counters and the integration mainly applies to services provided by different government organisations.

In contrast, the fragmentation model does not aim to offer services integrated with other government services. Here governments try to find existing channels, which can belong to other government organisations, but can also belong to market parties. In this case, market parties that are in regular contact with the target group are seen as front-offices for government service provision. Governments want to provide a one-stop shop to their customers. As each customer segment may have a different integral view, future business models will support more than one integral view by cooperating with other organizations using a flexible and open information architecture.

Table 1. Comparison of Integration and Fragmentation approaches

Aspect	Integration model	Fragmentation model
Role of government	All-in-one service provider	Government provides back-office, market provides front-office.
Visibility of government	Government visibly in the foreground.	Government withdraws.
Perception of counter and service	Public makes use of the service via interaction with the online government counter.	Public gets the service as an extra with a online market product it already uses.
Co-ordination focus	Intergovernmental co-operation	Private/Public sector co-operation.
Typical problems	Linking back-office records Departments within the organization become invisible Finding suppliers Co-ordination problems during use	Difficult start of service development Getting market parties interested. Persuading market parties to operate to the quality standards of the government. New role for intermediaries. Channel harmonization

4.3 Process Integration

Business process perspectives relates to the division of tasks and the coordination of the interdependencies between tasks [12]. The responsibilities of tasks can be divided among actors. In e-government, business processes have to deal with the following constraints [9].

1. Rule constraint: including laws and government agencies strategies;
2. Organization constraints: the responsibilities, authorities and duties of the organization and members within the organizations;
3. Resource constraints including human and information resources available for executing business processes.

In figure 1 various approaches to process integration are shown. On the left side of this figure the processes are not integrated and data is shared by providing access to each other databases. In the middle of this figure the databases are really shared by each other and on the right side of the figure processes of various organizations are integrated.

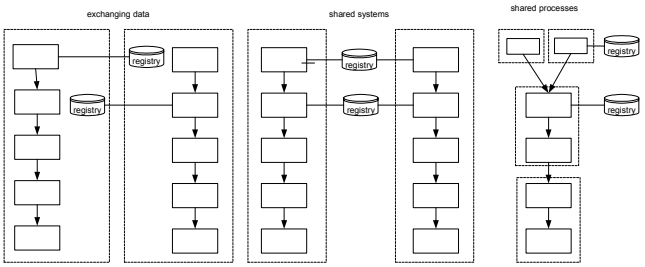

Figure 1. Process integration

4.4 Content Management

It is often argued that the real challenge of government portals is the content, and thus the range of electronic services delivery [17]. Content of a virtual counter need to be maintained and regularly updated. Content Management Systems (CMS) are a response to organizing and managing large-scale website. Apart from being a product, Goodwin and Vidgen [7] define a CMS is an organizational process, aided by software tools, for the management of heterogeneous content on the web, encompassing a life-cycle that runs from creation to destruction. Six major roles can be identified for maintaining content [6]

1. Subject expert: the subject expert creates content, typically in paper form for a brochure, report, regulation, scientific paper or other paper output. The expert is having specialized knowledge and both the content and citizens using the content
2. Editor: The editor corrects the content and shapes it into an appropriate format.
3. Converter: The converter takes care about convert the medium into a publishable format. Typically this is done automatically or by a person using a web-authoring tool;
4. Approver: The approver reviews and approves content for publication. Review criteria vary by approver by may include factual correctness, political sensitivity, match with agency goals, grammar etc.
5. Publisher: This role has permission to make content online and visible;

Content managements review and approval processes should help to balance conflicting agency goals of publishing content and achieving absolute oversight over published content. Web content creation can be an entirely electronic activity., however, to enforce policy there should be some kind of workflow for routing content, approval request and notifications etc. Apart from these roles there is thus also a need for a policy creator role, which makes the policy and procedures for publication and control of

data. Content management need to support this flexibility in arrangements. Workflow might deal with review an approach of short and simple content, and review and approval of content in which a part of the content changes on a regular basis or incidentally such as changes in law. Review and approval work might be much more improvisational or dynamic as content need to be published in time. Moreover the approval process might be constantly changing in reaction to changes such a misuse of information in the current past. Carefully balancing between publication and oversight of content is necessary to ensure availability, accuracy and utility of content.

4.5 Integration and Sharing of eServices

There are two main approaches to information systems developed. Building an integrated business counter using a new system. or integrating existing systems. Developing new systems from scratch requires much time and money and is prone to failure and does not leverage investments in legacy systems. Often existing systems are integrated using all kinds of middleware technology.

Three approaches to information systems integration can be taken [11]. Data level integration is the process of moving data between databases. Application level refers to integrating application using methods or interfaces. In this way the application logic of programs in shared and integrated. User-interface is a primitive way, but nonetheless the usable way to start integrating of a virtual business counter. Access to application is bundled by providing user interfaces as a common point of integration.

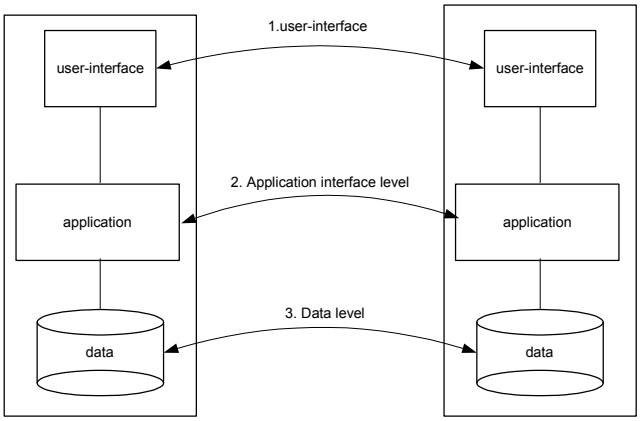

Figure 2. Approaches to integration

Instead of trying to integrate existing system, functionally of systems can be shared and provide by one party to all the other agencies involved. *Shared e-services* have large potential for a variety of other public and commercial applications [14]. Shared use can make IT infrastructure management and application exploitation and use more efficient. Sharing of services introduces new opportunities for, especially small government organizations, to (1) outsource non-core activities, (2) dimension the capacity of their ICT infrastructures efficiently and (3) to access and use ICT resources currently out-of-reach.

On-line reuse of generic application services can considerably ease networked application creation and deployment. Applications will more and more evolve into sets of interoperable services. These sets can be assembled and configured, on the fly, over the Internet to perform functions or execute business processes. Ideally, this allows organizations to easily compose, adapt and orchestrate lower level generic services into specific, customized higher-level applications.

5. CONCLUSIONS AND FURTHER RESEARCH

Governments still have a long way to go to fully realize the benefits of e-government. There is no over-arching framework, or reference architecture available guiding e-government initiatives in The Netherlands. Each geographical region is designing a virtual counter without learning or only partly profiting from the experiences from other projects. This focus results in two major problems, 1) the inability to provide a true one-stop shop as this needs a national focus and the use of additional channels which might even be provided by private parties and 2) the need for a reference architecture to capture the experiences and knowledge obtained in the various projects. A reference architecture is the highest level of abstraction and includes experiences from various domains by describing a set of components and the relationships between them.

The transition to e-governments offers many opportunities but also major challenges. Well-designed and smoothly functioning virtual counters can be strong platform for delivering a wide range of services. Current initiatives encounter a large number of problems and pitfalls that need to be resolved. By looking at various trade-offs and decisions to be made we developed our first ideas of a reference architecture for a virtual counters. We investigated the concept of integration and fragmentation models, coordination of processes of autonomous government agencies, roles for content management and technical possibilities for integration and sharing of services.

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