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Trust Requirements in E-Business: A Conceptual Framework

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Introduction

Trust in information services and technologies is an increasingly important issue. The development of trust between businesses, consumers and other stakeholders is seen as crucial to the expansion of e-business markets, and the full exploitation of technological developments in this area [3, 5, 11]. However, the way in which trust may be gained in this context is not yet well understood. Requirements relating to trust are seen from many different perspectives by different stakeholders, and often expressed in different terms. There is therefore a need for a common framework or language, which will support a shared understanding of the concept of trust, and which will allow the requirements of different stakeholders to be discussed in common terms [6].

This paper aims to provide a basis for such a framework. The preliminary framework presented here is intended to be used in structuring early phases of requirements elicitation and documentation in e-business system development projects. It includes a number of different views on the origins of trust requirements and the context in which they must be defined, each of which may be used as a thinking tool, or checklist, to help break down the complexity of the problem.

Although the focus here is on requirements for trust, it is argued later in the paper that parts of the framework may also be useful in structuring the elicitation and specification of other kinds of requirements for e-business systems.

A conceptual framework specific to the needs of e-business developments is seen as potentially useful for a number of reasons:

- The widespread introduction of e-business is provoking a radical re-conceptualisation of the way in which businesses operate: it provides the potential for new business models in existing businesses, as well as new businesses - information brokerages and trust service providers are just two examples of types of business which did not exist, in their current form, before the advent of e-business. Requirements for new e-business systems must therefore often be identified from the first principles of new business goals, and cannot simply be carried across from existing systems. Yet such new e-business systems are often very complicated, involving numerous different stakeholders with different objectives, constraints and requirements, and the negotiation and organisation of requirements for the system as a whole becomes a real challenge. A general-purpose conceptual model can help us to manage such complexity.
- There is also a shift in emphasis in the type of systems now required for e-business. It is often important to the commercial success of a business that the systems it uses for e-business are dependable (secure, reliable and available when

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needed), however, the level and type of dependability required may be different from that which security and safety-critical systems communities have traditionally dealt with. Requirements concerning security, reliability and availability must be made by trading off costs and benefits and identifying acceptable levels of risk.

- The environment in which e-business systems operate is also changing – businesses are no longer likely to have total control over the systems and networks upon which their e-business applications depend. It therefore becomes more important to understand, and regulate, perhaps by contractually binding statements of requirements, the relationships between stakeholders responsible for different parts of the system.
- There is a real and growing problem with interoperability between different e-business solutions. Work is underway to tackle this problem (see, for example, [8]), but most of this is focussing at an architectural level, and is therefore not so helpful in eliciting consistent user requirements. The challenge now is to establish a link between business interests and engineering work in this area.
- Finally, because of the changes described above, traditional views of key concepts such as trust and security must be re-examined and re-defined for use in this new context.

In the rest of the paper, we will present the general definitions of e-business, trust and dependability on which later sections are based, and then describe the views of e-business stakeholders, processes and concepts which make up the framework. An initial list of generic trust requirements is presented. Finally, the implications of the framework for future developments are discussed.

Background

The work described in this paper was carried out as part of the TRUST-EC project, which was carried out on behalf of the European Commission. The aim of the project was to characterise trust and confidence requirements in e-business. The project began with a review of the literature, from which a definition of e-business was formed, and initial views of key concepts such as trust and dependability as well as stakeholders, processes and concepts were obtained. A workshop was then organised, with the aim of further characterising and refining our view of trust requirements in e-business, and validating our initial views of stakeholders, processes and concepts. The workshop was attended by 19 invited participants from European industry, universities and public authorities, who came from different backgrounds, including IT, retail, medicine and law. It discussed trust requirements in four case studies in the area of information brokering from the domains of on-line retailing, virtual hospitals, on-line information services and virtual enterprises, and from these, drew some tentative conclusions about requirements for trust and confidence in e-business as a whole. A full account is provided in [6]¹.

¹ Note that although the workshop originally used the term e-commerce to describe the domain of interest, we have now adopted the term e-business to describe the same field, for reasons described in section 2.

Characterisation of E-Business

There is as yet little consensus as to what exactly constitutes e-business, or e-commerce, and many different definitions of these terms are either given or implicit in the literature [7]. In this paper, we have used the term 'e-business', rather than 'e-commerce' to describe the domain of interest, as we believe this more accurately reflects the diversity of activities affected by recent developments in the use of network and communications technologies such as the Internet. According to the Chambers Concise 20th Century Dictionary, the term 'commerce' denotes trade, or the interchange of merchandise, and is, by implication concerned only with the exchange of goods of financial value. The term 'business', on the other hand, denotes more general dealings or commercial activities, or a commercial or industrial concern, and therefore includes operational activities and logistics. The availability of new technologies is revolutionising not only the way in which goods may be bought and sold, but also the way in which companies operate (for example by permitting the creation of so-called 'virtual enterprises'), and we wish to include this type of activity within our framework.

Taking an inclusive view, based on the definitions presented in the literature (see, for example, [2, 4, 5]), we therefore define e-business as follows.

E-business is the carrying out of business activities that lead to an exchange of value, where the parties interact electronically, using network or telecommunications technologies.

In this definition, we include the exchange, not only of goods and services with a definite market value, but also of information, which is of value to partners in specific commercial activities (such as the formation or maintenance of a virtual organisation), but has no market value per se. This is in line with the view of CommerceNet that: 'The new paradigm of eCommerce is built not just on transactions but on building, sustaining and improving relationships, both existing and potential.'

Although most attention is currently focussed on e-business conducted using the Internet and World Wide Web, we also include in our definition activities carried out using a broad range of other technologies such as narrowband (videotex), broadcast (teleshopping), proprietary corporate networks (such as those used in banking), digital television infomercials with Internet response mechanisms (for immediate ordering), CD-ROM catalogues with Internet connections (for content or price updates), and commercial websites with local CD-ROM extensions (for memory-intensive multimedia demonstrations).

Our definition of e-business thus includes a number of related areas identified as:

- 'Electronic trading', in which a supplier provides goods or services to a customer in return for payment
- 'Electronic retailing', in which the customer is an ordinary consumer rather than another company
- 'Internet commerce', that part of e-commerce which is conducted using the Internet, rather than other technologies (see below).

From the current literature (see, for example, [2, 4, 5]), we can construct a superset of the types of e-business currently of interest or being practised as follows:

- Business-business (eg electronic trading, Virtual Enterprises)
- Business-consumer (eg on-line retailing)
- Intra-organisational (eg managements of logistics within businesses or administrations)
- Business-administration (eg submission of trading information for tax purposes)
- Consumer-administration (eg electronic submission of tax returns)
- Consumer-consumer (eg on-line auctions)

The interactions between the different parties involved are summarised in figure 1.

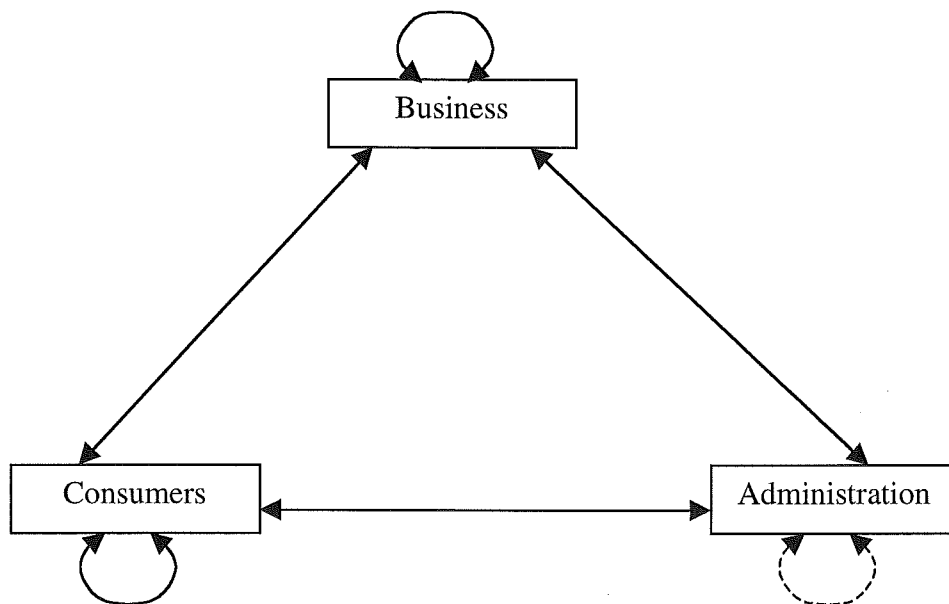


Figure 1: Different Types of E-business

Trust and Dependability

As described earlier, the new context of e-business demands a new understanding of key concepts such as trust and dependability. In recent literature relating to e-business, the term 'trust' is usually employed for characterising the reliance of business actors and private citizens or consumers on other actors or systems within the Information Society [3, 9]. According to [1], dependability is seen as a system property and consists of four attribute categories, as shown in table 1.

Dependability categories	
Safety	non-occurrence of catastrophic events that threaten human life, health, the environment.
Reliability	continuity of service
Availability	readiness for usage
Security	authentication, confidentiality, non-repudiation, integrity

Table 1: Components of dependability [1]

From these definitions, we can deduce that a dependable system *contributes* towards raising and assuring trust in business relationships and services. However, trust encompasses wider issues than simply the dependability of a computing or communication infrastructure. For example, business partners need to be able to trust not just their own systems, but also other partners and the systems they use, as well as the infrastructures exploited for establishing communication. There is often a need to identify and trace digital objects in order to prevent unauthorised copying or use of those objects. Management of risks may need to be done on an on-going and dynamic basis based on commercial cost-benefit decisions. Finally, although businesses and consumers may consider underlying systems to be completely dependable, in the traditional sense, they may not trust those systems with their business or personal interests unless there exists a suitable legal framework which they can fall back on, should problems arise. Thus requirements for trust in e-business are broader than dependability requirements in other domains, and a new framework is needed in order to ensure that they are fully addressed.

Four broad categories of drivers shape new perspectives on trust requirements in e-business applications, and challenge our existing understanding in this area. These drivers were identified, in workshops and studies held in connection with the European Dependability Initiative [12], as characterising the new context within which e-business systems must operate. These drivers may be briefly characterised as follows:

D1 Increasing globalisation

D2 Complexity of large-scale open information infrastructures

D3 Transition to a digital virtual environment

D4 Evolving systems and environment

For the business contexts considered in the TRUST-EC workshop, the main drivers for issues relating to trust were, in rough order of perceived significance:

- **the transition to a digital virtual environment (D3)**, which means that
 - traditional bases for trust, relating, for example, to physical characteristics of people or premises, are absent, and
 - businesses rely increasingly on digital assets, which must be protected from new threats

- **the complexity of large-scale open information infrastructures (D2)**, which implies
 - the need for co-operation between a large number of different stakeholders, and
 - an increasing vulnerability to malicious attack
- **the increased possibility for and exploitation of opportunities for global activity (D1)**, which
 - make it harder for businesses to win trust due simply to the geographical distribution of partners, and
 - impose additional challenges in relation to differences in national legal frameworks and lack of understanding as to how such differences may be accommodated.

Each of these drivers is, to a certain extent, reflected in components of the framework, which are presented in the following sections.

Stakeholders in E-business

The first of the views in our framework focuses on system stakeholders. We define a stakeholder as 'a person or organisation who is or is likely to be significantly affected by e-business'. Since we are focussing here on general concerns, rather than requirements for particular e-business systems, we consider general classes of stakeholders, such as service providers, consumers and businesses.

We have found it useful to group these different types of stakeholders into three categories as described below. However, we note that the same type of stakeholder may fall into a different category, depending on the nature of business being conducted, or on the perspective adopted. For example, when thinking about on-line retailing, from the point of view of the retailer, a financial service provider is an enabling stakeholder. But when considering the perspective of a bank generating income through the provision of online payment services, the same financial service provider may be seen as a participating stakeholder. Thus the following categorisation is not fixed.

Participating Stakeholders

Stakeholders who are doing business by means of using e-business services and technologies:

- Business partner or customer (typically an organisation or company)
- Individual customer (typically a member of the public)
- Public administration (includes, for example, tax authorities and legal authorities)
- Suppliers (includes producers, wholesalers and individual creators of digital assets)
- Delivery services (for physical goods)

Enabling Stakeholders

Stakeholders who provide services or technologies to enable e-business to take place:

- Financial service providers (typically banks)

- Trust service and technology providers (providers of digital signatures, certification authorities, key recovery and confidentiality services, electronic cash, copyright management facilities, or technology to prevent illegal content, or protect personal data)
- Information brokers (organisations which provide information about other organisations involved in e-business or their products)
- Transaction service providers (providers of negotiation and brokerage tools)
- Information and communications technology providers
- Internet and communications service providers (providers of services using communications infrastructure)

Supervisory Stakeholders

Stakeholders who regulate or provide advice on e-business in some way:

- Regional and national advisory bodies and support centres
- International advisory bodies (eg the OECD, World Trade Organisation, G8, International Chambers of Commerce)
- Industry led advisory bodies (eg CommerceNet, the Open Group, the World Wide Web Consortium, the Trans-Atlantic Business Dialogue)
- Technical standard-makers (eg the International Standards Organisation, CEN/ISSS)
- Legislators/Regulators (eg the European Commission)

Of course, these different types of stakeholders are not all likely to be involved in any particular e-business system. The above is intended simply as a checklist of commonly occurring stakeholder types whose views may need to be taken into account in elaborating the requirements, including trust requirements, for the system.

E-Business Process Models

Another useful way of breaking down the complexity of requirements for an e-business system is to consider, in general terms, what business processes that system must support.

A number of more or less explicit process models for e-business have been presented in the literature (see, for example, [2, 4, 5]). From our understanding of the different types of e-business, presented in section 2, and the various stages, processes and activities presented in the literature, we may synthesise the following very coarse process identifiers:

- P1 Procurement
- P2 Marketing/information search
- P3 Comparison of alternatives
- P4 Exchange of information (eg orders, invoices, contracts, design data)
- P5 Payment
- P6 Delivery of goods

P7 Logistics (including stock management etc)

P8 Interface with public administration

Once again, this list of possible processes is intended to be used simply as a checklist of business processes commonly supported by e-business systems – any particular system is likely to support only a subset of these processes, and some systems may also support processes not included in the above list.

We note that, as described in [2], more detailed descriptions of the processes in above, as well as the way in which the processes are composed, will vary depending on:

- The type of e-business being practised (business-business, business-consumer or business-administration etc)
- The viewpoint of the stakeholder (whether we are looking at the process from the point of view of, for example, a seller or a buyer, an administration, a business or a consumer).

It should also be noted that the same system may need to support different processes in interactions between different combinations of stakeholders, or in different aspects of the business. For example, while the interaction between a retailer and a consumer may involve the processes of marketing (P2), exchange of documentation (P4), payment (P5) and delivery (P6), that between the retailer and its supplier may involve processes of procurement (P1), exchange of documentation (P4), payment (P5), delivery (P6) and logistics (P7). Global enterprises will predominantly involve exchange of design and production information (P4) or may involve logistics in the interaction with other businesses in the supply chain (P7).

An E-Business Concept Model

A final way in which the complexity of the problem of identifying e-business requirements may be broken down is by considering the important types of ‘things’ or objects involved in an e-business transaction, and the relationships between them.

Figure 2 provides a graphical representation of important concepts and the relationships between them. Again, this model is simply a thinking tool, aimed at helping to identify significant relationships between stakeholders, information and infrastructure in an e-business system. The relationships identified in the model do not form a complete set, and are certainly not mandatory – any particular system may embody a different subset of such relations, and will probably involve more than are shown.

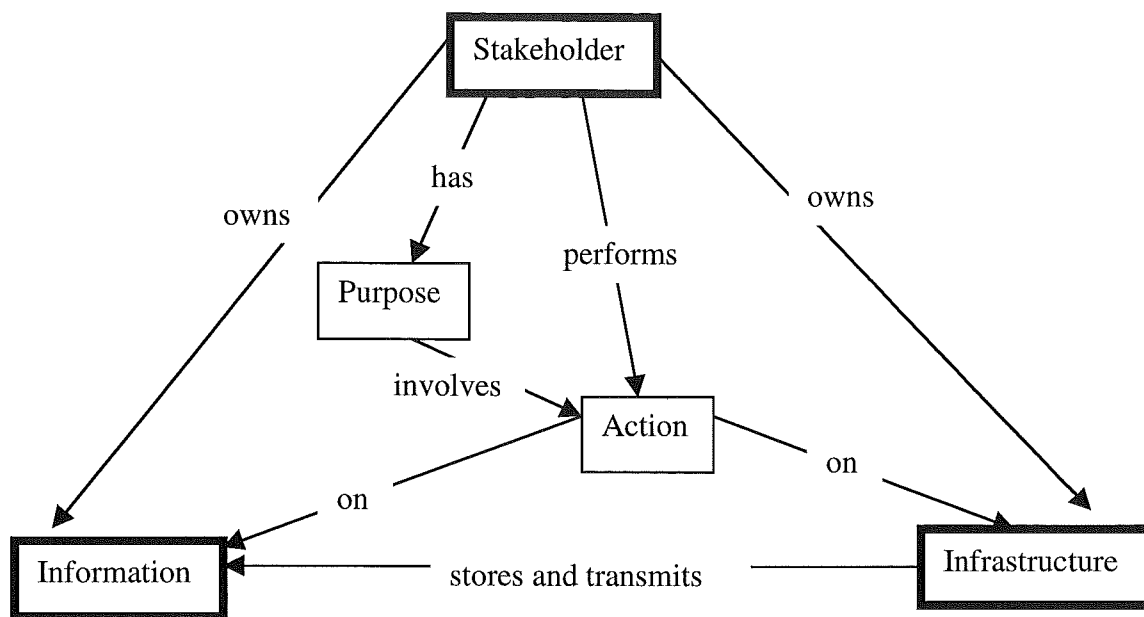


Figure 2: An E-Business Concept Model

In the model shown above, each of the objects (shown in boxes) may have certain types, roles, attributes or states. For example, several different types of stakeholders may be involved in different types of e-business and different e-business processes, as described above. Many different types of information (including, for example, payment information, consumer contact details or company strategy) may be involved in different ways, and also many components of the supporting infrastructure. For example, customer contact details may be used in on-line retailing to support the delivery process, and may be stored on a companies in-house database, but transmitted to a separate company, to whom delivery of goods is out-sourced, using the Internet. Bona fide actions may include seeing, copying, using sending and receiving information, or using parts of the infrastructure. Actions to be prevented may include corrupting or destroying information or damaging the infrastructure. Similarly, a bona fide purpose for which information (such as a consumer's contact details) may be used is to deliver goods, whereas a less desirable purpose for which the same information may be used is the sending of junk mail.

Generic Trust Requirements for E-business

In addition to general-purpose checklists and thinking tools such as those presented in sections 3 – 6, another tool, likely to be useful to the would-be specifier of a new e-business system is a list of generic requirements which could be tailored to the needs of a particular system by using lists of stakeholders and process and concept models of the kind described above. This section provides an initial characterisation of such generic, high level trust requirements for e-business. These requirements have been identified from the literature and validated in the workshop described in [6].

Requirements have been grouped into course-grained categories relating to the three main components (Stakeholders, Information and Infrastructure) of the concept model presented in the previous section:

- ensuring the identity and reliability of e-business stakeholders;
- the quality and protection of digital assets;
- the dependability of services and systems

A further category of requirements, relating to the overall context or environment within which e-business systems must operate has been added. These requirements may be characterised as relating to:

- the need for a stable and interoperable legal and business framework for e-business.

We list, as examples, requirements relating to the quality and protection of digital assets. As explained earlier, the transition to a digital virtual environment means that businesses rely increasingly on digital assets, which may include design or product information for virtual organisations, digital goods for suppliers of multimedia content, or simply order, invoice and payment information for on-line retailers. Requirements which have been identified in relation to digital assets are:

Confidentiality of sensitive information, including customer, payment and product information – stakeholders may require either that the access to certain information is restricted, or that the purposes to which that information is put should be limited (for example, while consumers may be happy to give retailers their contact details to enable the delivery of goods, they may not be happy for those same details to be used for the purposes of junk mailing).

Integrity of critical information, including payment information and information to be used for commercial purposes – companies may require that both information (such as customer payment information) intended for internal use, and public (eg advertising) information should not be damaged or defaced.

Availability of critical information – information (such as product information for consumers) should be accessible to those who need it within an acceptable timeframe.

Identification of digital objects – to facilitate prevention of unauthorised copying and traceability of objects (see below).

Prevention of unauthorised copying or use of critical information or digital assets - companies supplying digital goods (such as music, pictures or videos) are concerned that such goods should only be available to those who have paid for them.

Traceability of digital objects to enable the creation of audit logs for non-repudiation purposes

Quality of digital goods - both consumers and companies may be concerned that the digital goods they purchase should be of the quality agreed upon with the supplier.

Management of risks to critical information – businesses need to identify likely threats and to decide upon how to either guard against the threats or manage situations in which threatened events have occurred.

Authentication of payment information – businesses need to be sure that payment information given by consumers, or even other businesses, is genuine.

Conclusions

It has been our experience that the framework presented in this article has assisted us in understanding the implications of new e-business issues for traditional concepts of trust and dependability. The framework has also been helpful in identifying a full range of high-level trust requirements for each of the four case studies discussed in the TRUST-EC workshop. It also permitted such requirements to be discussed by participants from a range of different backgrounds including IT, law and retail. A more detailed account of this is provided elsewhere [6].

We argue that such a framework will be useful in identifying requirements for new e-business systems which instantiate new business models, and for which requirements must be identified from first principles, and on the basis of high-level business objectives, without simply being able to carry over requirements from existing systems. We also argue that a significant focus on such a new understanding of trust and dependability requirements is well-justified in the situation where businesses depend for their survival on the reliability of their e-business support systems. However, we also believe that, despite its roots in work on trust and dependability, the framework can provide a useful basis for identifying and structuring other types of requirements. For example, the list of stakeholders and process models provide a first step for scenario or use-case analysis enabling the identification of functional requirements. The concept model may help to bring out non-functional requirements or constraints regarding portability (perhaps relating to the storage of a particular kind of information on systems belonging to a number of different stakeholders) or performance.

Our next step will be to investigate the feasibility of developing a requirements process for e-business, based on the framework, which will assist developers in structuring both the process of eliciting requirements (by providing a checklist of issues to be discussed with different stakeholders), and the way in which such requirements are documented. As experience of using the framework in this way is gained, we envisage that patterns of requirements, centred around the framework, will begin to emerge, and could form the basis for requirements templates for developing systems instantiating a small number of core business models including, for example, e-shop, e-mall, e-auction, virtual community and information broker models, such as those identified in [10].

References

- [1] Avizienis, A., Kopetz, H. and Laprie J. C. (eds.), *Dependability: Basic Concepts and Terminology*, Volume 5, Springer-Verlag, 1993.
- [2] EBES/EWOS Project Team on Building Blocks for Electronic Commerce (PRB), *Building Blocks for Electronic Commerce: Final Report*, version 5.1 Brussels, 1997. Available from: <http://www.cenorm.be/iss/Workshop/ec/Projects.htm>
- [3] Hoffman, D. L., Novak, T. P. and Peralta, M. Building Consumer Trust Online. *Commun. ACM* 42, 4 (April 1999), 80-85.

- [4] Information Society Project Office, Electronic Commerce - An Introduction, <http://www.ispo.cec.be/ecommerce/introduc.htm>
- [5] Information Society Project Office, Memorandum of Understanding "Open Access to Electronic Commerce for European SMEs" - Guidelines, issue EN 1.3, April 1998, <http://www.ispo.cec.be/ecommerce/mou/default.htm>
- [6] Jones, S. and Morris, P. TRUST-EC: Requirements for Trust and Confidence in E-Commerce – Report of the Workshop held in Luxembourg, April 8th – 9th, 1999. Issue 2. European Communities EUR Report, EUR 18749 EN
- [7] Riggins and Rhee, Toward a Unified View of Electronic Commerce, *Commun. ACM*, (October 1998)
- [8] Steiner, M. (ed), SEMPER Consortium: Advanced Services, Architecture and Design, Deliverable D10 of ACTS project AC026, Public Specification, March 1999, <http://www.semper.org>
- [9] Tan, Y. and Thoen, W. Towards a Generic Model of Trust for Electronic Commerce. In Deception, Fraud and Trust in Agent Societies, Castelfranchi, C., Tan, Y., Falcone, R. and Firozabadi, B. S. (eds), proceedings of Agents'99, workshop 7, May 1st, 1999, Seattle, published by the National Research Council, Institute of Psychology, Rome, Italy, pp117 – 126.
- [10] Timmers, P. Business Models for Electronic Markets, *Electronic Markets*, 8, 2, 1998, pp 3-8.
- [11] UK Department of Trade and Industry, Building Confidence in Electronic Commerce - A Consultation Document, March 1999
<http://www.dti.gov.uk/CII/elec/consfn1.pdf>
- [12] Wilikens, M., Morris, P. and Masera, M. (eds) Defining the European Dependability Initiative – A Strategy Document. European Communities EUR Report, EUR 18139 EN, May 1998.