2006

Open vs.Closed standards for ambient intelligence: an exploratory study of adoption

D Kelly
University College Cork

P Finnegan
University College Cork

J Feller
University College Cork

OPEN VS. CLOSED STANDARDS FOR AMBIENT INTELLIGENCE: AN EXPLORATORY STUDY OF ADOPTION

David Kelly, Business Information Systems, University College Cork, Ireland.

Patrick Finnegan, Business Information Systems, University College Cork, Ireland.

Joseph Feller, Business Information Systems, University College Cork, Ireland.

Abstract

Emerging forms of structurally complex information systems, such as Ambient Intelligence (AmI), requires the integration of a range of technologies. To enable such systems' development there is a reliance on interoperability standards. However, due to their inherent characteristics, the adoption of open or closed standards by technology vendors can have impacts the later stages of the adoption and diffusion of systems. This paper reports on research-in-progress which explores the adoption of open and closed standards by technology vendors engaged in AmI development. Existing models of innovation adoption and diffusion fail to adequately account for adoption in more complex technological contexts. In order to address such deficiencies, current perspectives on standards are discussed, before a conceptual framework for structuring the research is proposed which integrates both existing adoption theory and standards-oriented research. The use of the European Consumer Electronics sector as a unit of analysis is discussed, before concluding with an overview of how the study will progress.

Keywords: Emerging IS/IT, Ambient Intelligence, Standards Adoption, Research-in-Progress.

1 INTRODUCTION

Ambient Intelligence (AmI) refers to a vision in which there is convergence between the related concepts of ubiquitous computing, ubiquitous communications, and intelligent user-friendly interfaces, (Ducatel *et al.*, 2001). The concept of ubiquitous computing first emerged in the early 1990's (Weiser, 1991) as a vision in which computers are removed from being objects of conscious attention. Rather than having computers operate in an environment in which people must adapt to them, they are instead integrated into the human environment. This concept of removing the physical computer has remained the cornerstone for much of research into the area of ubiquitous computing (Abowd and Mynatt, 2000, Tolmie et al., 2002). The development of such systems results in a comparatively higher level of structural system complexity than is currently evident due to the need to integrate multiple heterogeneous devices (Garlan et al., 2002, Henricksen et al., 2001) or other system components (Islam and Fayad, 2003, Davies and Gellersen, 2002, Henricksen et al., 2001). While interoperability standards play a role in facilitating or inhibiting the technical development of systems, they also possess inherent economic and social characteristics which can not only impact their adoption, but also shape the future adoption and diffusion of systems based upon them. Thus, the adoption of open or closed standards by technology vendors can not only have consequences for the

system's technical development, but also impact the later economic and social characteristics of AmI technologies.

This paper discusses research-in-progress in the area of interoperability standards adoption. This research aims to explore issues impacting the adoption of open and closed interoperability standards by technology vendors engaged in the development of AmI technologies. Following a discussion of the motivation for such a study, which draws on theories of innovation adoption and existing standards oriented research, a conceptual framework is proposed as a lens through which to examine standards adoption. The paper concludes with a discussion of the research approach used and the choice of the European Consumer Electronics (CE) industry as a unit of analysis, before identifying how future work will progress.

2 RESEARCH MOTIVATION AND OBJECTIVE

The structural complexity of AmI is evident from key features such as mobility, unobtrusiveness and context awareness which results in the need for high levels of interaction and large numbers of services. Mobility enables the user to move seamlessly through the environment with services changing depending on the users' location (Lyytinen and Yoo, 2002). Unobtrusiveness is achieved through the removal of the computer from the user's conscious attention (Ducatel et al., 2001, Abowd and Mynatt, 2000, Tolmie et al., 2002). Contextual awareness refers to applications that are capable of altering their behaviour in response to contextual information from the user (Abowd et al., 2002). Thus, interoperability standards are required to facilitate the development of such structurally complex systems.

Research in the area of standards is fragmented, and can be broadly categorised as emerging from technical, business and economic, and socially oriented perspectives. From a technical perspective, the role of standards is viewed primarily as a means of facilitating interoperability throughout a system, (e.g. Christiaanse et al., 2004, Damsgaard and Treux, 2000, Sirkemaa, 2002, Strand et al., 1994), and enabling system scalability in the later stages of the technology's diffusion, (Helal, 2005, Strand et al., 1994). Stegwee and Rukanova, (2003) identify three levels of technical interoperability standards. Firstly, Interconnectivity standards enable systems to communicate with each other at the network level (i.e. communication standards, e.g. TCP/IP). Second, Interchangeability standards enable systems to exchange information at the presentation level (i.e. data representation standards, e.g. ASCII, HTML, XML). Finally, Interoperability standards (which are also discussed by Strand et al. (1994)) enables systems to operate together as one through interoperability at the application level, (i.e. interaction standards, e.g. SOAP, SMTP). Technical interoperability standards can also be classified according to the "level of openness" (West, 2004). As argued by Krechmer (2005) this "level of openness" refers to a view that standards are best placed along an open – closed continuum, rather than categorised as being completely open or closed.

The business and economic perspective on standards oriented research puts forward the dominant view of the roles and impacts of standards. In the development stage of new technologies, this perspective has focused on the role and impact of standards on issues such as competitive strategy decisions (Besen and Farrell, 1994, Iversen, 2001, Gabel, 1991, West and Dedrick, 2000), infrastructure investment costs (Christiaanse *et al.*, 2004), the availability of complementary assets (Damsgaard and Treux, 2000, Tassey, 2000, Rice, 2001), and their impacts on the size of production costs (Feng, 2003, Iversen, 2001). In the later stages of the technology's adoption and diffusion, research on the role of standards has focused on issues such as competitive advantage and network dominance through network externalities and lock-in (Sirkemaa, 2002, Funk and Mehte, 2001), the introduction of price competition (Besen and Farrell, 1994, Farrell and Saloner, 1985), and the availability of complementary assets (Tassey, 2000, Funk and Mehte, 2001).

Finally, from a social perspective, research in the area of standards has highlighted their role as a means to store and preserve knowledge, (Feng, 2003, Damsgaard and Treux, 2000), influence the

variety of technology available (Tassey, 2000, Farrell and Saloner, 1985), impact user uncertainty and risk (Damsgaard and Treux, 2000, Funk and Mehte, 2001), as a means of quality control (Feng, 2003, Tassey, 2000), and on the alignment of users' actions (Feng, 2003).

Much research to date in the area of AmI has called for technology development to occur based on open standards in order to facilitate interoperability (see for example, ISTAG, 2002, Kourouthanassis et al., 2002, Helal, 2005). Such a position does not take into account the broader roles of standards, as emerging from the business and economic and social perspectives identified above. The integration of these perspectives is particularly important in relation to the adoption of standards for AmI. The need for such a combined view emerges from the fact that reliance on one perspective alone can give an incomplete or inaccurate picture of how the complex issues interact (Iversen, 2001, Williams, 1999). In order to address such needs, a conceptual framework is proposed which draws on upon the varying perspectives evident in standards oriented research. These perspectives are integrated with aspects of Diffusion of Innovation theory in order to move toward the required combined approach to examining standards adoption by technology vendors. In developing such a framework, the aim is to provide a comprehensive means of structuring research which seeks to explore the issues impacting the adoption of open or closed interoperability standards by AmI technology vendors.

3 PROPOSED CONCEPTUAL FRAMEWORK

Standards as Base IT innovations are the underlying technologies used by IS service providers and are antecedents to innovation in the other IS classifications (Lyytinen & Rose, 2003). The suitability of using traditional Diffusion of Innovation (DOI) theory (Rogers, 1962) to explain issues impacting the adoption of certain complex network based technologies has been questioned (Fichman, 2000, Lyytinen and Damsgaard, 2001). The theory's value has however been well established and serves as a suitable base from which to develop a framework appropriate for structuring research within the current technological context. A literature survey was conducted of research in the areas of standards and that which has extended DOI theory in the context Base IT Innovation adoption. The purpose of the survey was to address the need, as identified by Fichman (2000) and Lyytinen and Damsgaard (2001), to focus on characteristics of the specific adoption context. Figure 1 illustrates the conceptual framework which represents the standard (innovation), organisational, and external contexts.

At the level of Standard (Innovation) Context, the three most consistently identified attributes of relative advantage, compatibility, and complexity within Rogers' DOI model (Tornatzky and Klein, 1982) are present. In line with Rogers' view of Relative Advantage, it is defined here as the degree to which the adopter perceives the standard as being better than that which it supersedes. In contrast to earlier approaches, the compatibility attribute has been broken down into a number of component parts. Firstly, the perceived strategic compatibility of the type of standards (i.e. open vs. closed) being adopted is included. The decision to partake in inter-technology, i.e. within a technology class, or in intra-technology, i.e. between technology classes, is reliant on the adoption or non-adoption of compatibility standards as proposed by Besen and Farrell (1994). As such, the compatibility between the candidate standards and the existing or desired approach to organisational strategy warrants investigation. Secondly, the technical compatibility of the standards being adopted in relation to backward compatibility (between new products based on the emerging standard and (i) existing product offerings and (ii) internal systems) can impact the adoption decision. Finally, the compatibility between standards being adopted for inclusion within a new product requires attention. This factor is included in order to ascertain how interdependencies between standards of different levels (i.e. at the application, data, and network levels) can impact the adoption decision.

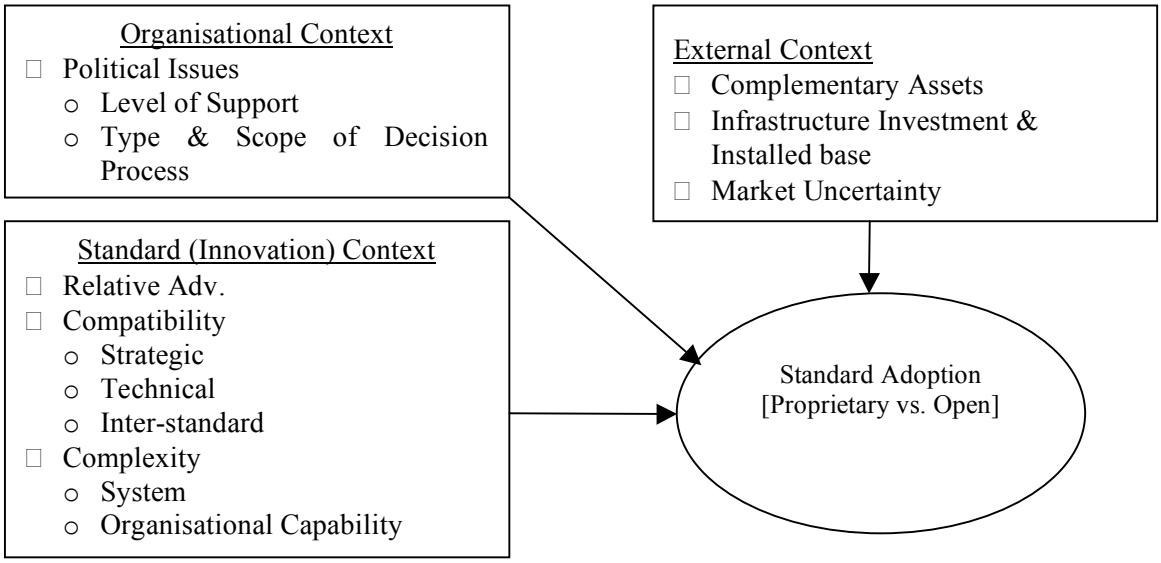

Figure 1: Standards Adoption in a Complex Network-Based System – A Research Framework

The complexity of the standard is considered in two ways. Firstly, the structural complexity of the system and its relationship to the standards being adopted is included. The structural complexity of complex network based systems requires modularity in design to facilitate interaction between system elements. The decision to adopt open or closed interoperability standards can impact on the systems' ability to function, and as such, the organisation's perception of the technical requirements of the system are an important consideration. The second aspect of complexity relates to the knowledge requirements of complex innovations and the organisation's capability to respond to them. The inclusion of such a factor is in-line with the arguments of Attewell (1992) and Gallivan (2001) who point out that with complex innovations a high level of technical knowledge may be required, with the resulting knowledge requirements being a potential barrier to adoption.

Given the complexities involved in the decision process surrounding standards adoption, and the weakness of DOI theory in adequately understanding such complexities, the Organisational Context level identifies a number of factors broadly termed political issues which require consideration. Firstly the level of support given to the standards adoption process, and the issue of mandated adoption can both have an effect on adoption. The scope of the decision process, as related to the extent of collaboration at an individual, organisational unit, inter-organisational level is an important consideration. Such issues may be linked to organisational or inter-organisational strategy or existing participation in the standards development process.

At the External Context level three issues are examined for their impact on adoption. Firstly, that of complementary assets, i.e. products that can be used with the technology, e.g. software is a complementary asset to an operating system, in that only certain software can be used with certain operating systems. The decision on the choice of interoperability standards made by vendors will also impact the type and number of complementary assets available for adopters of the technology. Dedrick and West (2003) have argued that a key barrier to the adoption of a new standard is the availability of complementary assets relating to the existing standard. The development of technology based on proprietary standards can limit the availability of complementary assets produced by other companies. In certain circumstances such a situation is desirable to a vendor, particularly where they intend on developing a full range of proprietary complementary assets and wish to limit competition or imitation of their products. In the area of network technologies however, it is often the case that limiting the availability of complementary assets is not a desirable strategy. In many circumstances one vendor does not have the capability to produce the necessary quantity and quality of complementary components required to successfully complete the construction of a network based system (Rice,

2001). The lack of such a capability could, as Tassey (2000) argues, be a consequence of unwillingness to diversify operations into fields in which they have no comparative advantage, or from having limited access to resources (e.g. finance or knowledge).

The second issue relates to the issue of infrastructure investment and the existing installed base. The underlying technical infrastructure, e.g. the communications systems, for a large scale system requires substantial investment to implement and maintain. In existing complex network-based IS the costs vary depending on the type of network involved. The implementation of network-based systems based of a proprietary nature requires upfront investment in assets (Christiaanse *et al.*, 2004). Such a situation means that the addition of new network members is costly, leading to a limiting effect on the number of users (Afuah, 2003). In order to utilise an existing infrastructure, the reliance on standards is an important issue. In the case of the internet, the result of using a low-cost, open standard means that "anyone, anywhere" can connect to it once the required communications protocols are implemented (Afuah, 2003). In relation to the installed base, given the characteristic of network effects in network based technologies, the existence of a system based on standards of a certain type (i.e. open or closed) can be influential in the adoption process, and as such, its consideration is warranted in the context of new standards adoption.

The final factor in the External Context area relates to market uncertainty, and draws upon Chau and Tam's (1997) Open Systems adoption model. Markus (1987) has shown that the characteristics of network markets show that once a critical mass of users adopt the technology, its growth will become self-sustaining. Karlsbjerg (2002) has argued that should the technology be based on proprietary standards the standard owner can increase switching costs leading to user lock-in, meaning that they will be less likely to move to a competing technology due to uncertainty or risk associated with leaving an established network (Damsgaard and Treux, 2000), or problems with a lack of interoperability between competing standards (Karlsbjerg, 2002). It is with this in mind that the consideration of market conditions such as the existing stage of market evolution and the presence of existing standards is included in the analysis of the adoption decision.

4 RESEARCH APPROACH

It has been argued that the use of case-based research is appropriate where the phenomenon is dynamic and not yet mature or settled (Darke et al., 1998), and where research in an area is in its early stages (Benbasat et al., 1987). In the case of the current research, while much of the theory on standards is well developed from an economic perspective, a more unified approach involving the incorporation of an innovation oriented view is required. When viewed from the emerging technological context in which the study will occur and the complexities involved in the adoption process, case-based research is a suitable research approach.

The investigation will focus on the European Consumer Electronics (CE) sector, following an approach to unit of analysis identification similar to that of Reimers et al. (2004). The choice of the European CE sector was made based on the prominence of CE devices in the many application scenarios proposed for AmI, for example by Aarts and Marzano (2003) and Ducatel et al. (2001). As the AmI concept requires the integration of a large number of technologies, the use of an organisational unit of analysis focusing on individual vendors engaged in the production of only one of these technologies has the potential to give misleading results. By viewing what is occurring within a sector the adoption decisions of both primary and secondary software users, i.e. vendors whose primary business is not the production of software, rather it is used in the production of their primary product offering, gives the opportunity to conduct a more comprehensive study of open vs. closed standards adoption. Such an approach also avoids the problems associated with using a specific standard as the unit of analysis. To do so would limit the scope of the study by omitting organisations that have not adopted standards of a pre-selected type. A similar situation could arise were the study to focus on one or more pre-selected enabling technologies for AmI, for example, Radio Frequency Identification (RFID). For the purpose of this study, it was felt that by limiting the scope by pre-

selecting technologies, organisations developing AmI based systems, but not using the pre-selected technology, could be omitted.

In total 28 vendors have been identified as being engaged in AmI technology development within this sector. These vendors were identified based on their participation in EU funded AmI projects, membership of a Standards Development Organisation, through discussion with a member of the Telecommunications and Systems Software Group (www.tssg.org) and through web-based searches for commercial organisations developing AmI technologies. The vendors have been classified as falling into one of three categories, CE Manufacturers (8 companies), Software and Services Production or Research and Development (R&D) (12 companies), and Telecommunications Service Providers (8 companies). While the specific number of organisational informants depends on both relevance to the study and site access, the current objective is to gain access to four CE Manufacturers, to between three and six Software and Services Production or R&D, and to between two and four Telecommunications Service Providers. Once all responses to initial contact have been received, the number of organisational informants will be determined based on the completion of their analysis.

5 CONCLUSION AND NEXT STEPS

To progress this study a number of steps are required. Firstly, elements of the proposed research framework require operationalisation in order to allow the completion of the case study protocol. Next, a number of individuals responsible for the evaluation and selection of interoperability standards, and those with responsibility for standards based strategy development within the target organisations remain to be identified. Both documentary and interview based information is to be used as a means of investigating the issues impacting the adoption process. The number of informants from within each organisation is dependant on company size, and the numbers involved in the adoption process.

6 ACKNOWLEDGEMENTS

This paper is based on research funded by the European Commission via IST Project 004337, CALIBRE (http://www.calibre.ie).

7 REFERENCES

AARTS, E. & MARZANO, S. (2003) *The New Everyday: Views on Ambient Intelligence,* Rotterdam, The Netherlands, 010 Publishers.

ABOWD, G. & MYNATT, E. (2000) Charting past, present and future research in ubiquitous computing. *ACM Transactions on Computer-Human Interaction,* 7**,** 29-58.

ABOWD, G., MYNATT, E. & RODDEN, T. (2002) The Human Experience. *IEEE Pervasive Computing,* 1**,** 48-57.

AFUAH, A. (2003) Redefining Firm Boundaries in the Face of the Internet: Are Firms Really Shrinking? *Academy of Management Review,* 28**,** 34-53.

ATTEWELL, P. (1992) Technology Diffusion and Organizational Learning: The Case of Business Computing. *Organization Science,* 3**,** 1-19.

BENBASAT, I., GOLDSTEIN, D. & MEAD, M. (1987) The Case Research Strategy in Studies of Information Systems. *MIS Quarterly,* 11**,** 369-386.

BESEN, S. M. & FARRELL, J. (1994) Choosing How to Compete: Strategies and Tactics in Standardization. *Journal of Economic Perspectives,* 8**,** 117-131.

CHAU, P. Y. K. & TAM, K. Y. (1997) Factors Affecting the Adoption of Open Systems: An Exploratory Study. *MIS Quarterly,* 21**,** 1-24.

CHRISTIAANSE, E., VAN DIEPEN, T. & DAMSGAARD, J. (2004) Proprietary versus Internet Technologies and the Adoption and Impact of Electronic Marketplaces. *Journal of Strategic Information Systems,* 13**,** 151-165.
DAMSGAARD, J. & TREUX, D. (2000) Binary Trading Relations and the Limits of EDI Standards: the Procrustean Bed of Standards. *European Journal of Information Systems,* 9**,** 173-188.
DARKE, P., SHANKS, G. & BROADBENT, M. (1998) Successfully Completing Case Study Research: Combining Rigour, Relevance and Pragmatism. *Information Systems Journal,* 8**,** 273-289.
DAVIES, N. & GELLERSEN, H.-W. (2002) Beyond Prototypes: Challenges in Deploying Ubiquitous Computing Systems. *IEEE Pervasive Computing,* 1**,** 26-35.
DEDRICK, J. & WEST, J. (2003) Why Firms Adopt Open Source Platforms: Grounded Theory of Innovation and Standards Adoption. *MISQ Special Issue Workshop: Standard Making: A Critical Research Frontier for Information Systems*. Seattle, Washington, USA.
DUCATEL, K., BOGDANOWICZ, SCAPOLO, F., LEIJTEN, J. & BURGELMAN, J.-C. (2001) Scenarios for Ambient Intelligence in 2010. IN ISTAG (Ed.), European Commission.
FARRELL, J. & SALONER, G. (1985) Standardization, Compatibility, and Innovation. *Rand Journal of Economics,* 16**,** 70-83.
FENG, P. (2003) Studying Standardization: A Review of the Literature. IN EGYEDI, T. M., KRECHMER, K. & JAKOBS, K. (Eds.) *Proceedings of the 3rd IEEE Conference on Standardization and Innovation in Information Technology.* Delft, The Netherlands, IEEE.
FICHMAN, R. G. (2000) The Diffusion and Assimilation of Information Technology Innovations. IN ZMUD, R. (Ed.) *Framing the Domains of IT Management: Projecting the Future Through the Past.* Pinnaflex Publishing.
FUNK, J. L. & MEHTE, D. T. (2001) Market- and Committee-Based Mechanisms in the Creation and Diffusion of Global Industry Standards: The case of mobile Communication. *Research Policy,* 30**,** 589-610.
GABEL, H. L. (1991) *Competitive Strategies for Product Standards: The Strategic Use of Compatibility Standards for Competitive Advantage,* Berkshire, England, McGraw Hill Book Company.
GALLIVAN, M. J. (2001) Organizational Adoption and Assimilation of Complex Technological Innovations: Development and Application of a New Framework. *ACM SIGMIS Database,* 32**,** 51-85.
GARLAN, D., SIEWIOREK, D. & STEENKISTE, P. (2002) Project Aura: Toward Distraction-Free Pervasive Computing. *Pervasive Computing,* 1**,** 22-31.
HELAL, S. (2005) Programming Pervasive Spaces. *Pervasive Computing,* 4**,** 84-87.
HENRICKSEN, K., INDULSKA, J. & RAKOTONIRAINY, A. (2001) Infrastructure for Pervasive Computing: Challenges. *Proceedings of the Informatik 2001: Workshop on Pervasive Computing.* Vienna.
ISLAM, N. & FAYAD, M. (2003) Toward Ubiquitous Acceptance of Ubiquitous Computing. *Communications of the ACM,* 46**,** 89-92.
ISTAG (2002) Software technologies, embedded systems and distributed systems: A European strategy towards an Ambient Intelligent environment. *ISTAG, July 2002, Available from: ftp://ftp.cordis.lu/pub/ist/docs/istag_kk4402472encfull.pdf*.
IVERSEN, E. J. (2001) Raising Standards: Innovation and the Emerging Global Standardization Environment for ICTs. *Proceedings of the 2nd IEEE Conference on Standardization and Innovation in Information Technology, SIIT 2001.* Bolder, CO, USA, IEEE.
KARLSBJERG, J. (2002) Staying outside the Mainstream: An Empirical Study of Standards Choices. *Proceedings of the 35th Hawaii International Conference on System Sciences.* Hawaii, USA, IEEE.
KOUROUTHANASSIS, P., SPINELLIS, D., ROUSSOS, G. & GIAGLIS, G. M. (2002) Intelligent Cokes and Diapers: MyGROCER Ubiquitous Computing Environment. *First International Mobile Business Conference.*
KRECHMER, K. (2005) The Meaning of Open Standards. *Proceedings of the 38th Hawaii International Conference on System Sciences.* Hawaii, USA.

LYYTINEN, K. & DAMSGAARD, J. (2001) What's Wrong with the Diffusion of Innovation Theory?: The Case of a Complex and Networked Technology. *Proceedings of the IFIP TC8 WG8.1 Fourth Working Conference on Diffusing Software Products and Process Innovations* Kluwer, B.V.

LYYTINEN, K. & YOO, Y. (2002) The Next Wave of Nomadic Computing: A Research Agenda for Information Systems Research. *Information Systems Research,* 13**,** 377-388.

MARKUS, M. L. (1987) Toward a 'Critical Mass' Theory of Interactive Media: Universal Access, Interdependence and Diffusion. *Communications Research,* 14**,** 491-511.

REIMERS, K., JOHNSTON, R. B. & KLEIN, S. (2004) The Shaping of Inter-Organisational Information Systems: Main Design Considerations of an International Comparative Research Project. *17th Bled eCommerce Conference.* Bled, Slovenia.

RICE, J. (2001) Collaboration and competition in emerging standards: an assessment of the implications for knowledge management. *Proceedings of the 2nd IEEE Conference on Standardization and Innovation in Information Technology, SIIT 2001.* Boulder, CO, USA.

ROGERS, E. (1962) *Diffusion of Innovations,* New York Free Press.

SIRKEMAA, S. (2002) IT Infrastructure Management and Standards. *Proceedings of the International Conference on Information Technology: Coding and Computing (ITCC '02)*. IEEE.

STEGWEE, R. A. & RUKANOVA, B. D. (2003) Identification of Different Types of Standards for Domain-Specific Interoperability. *MISQ Special Issue Workshop: Standard Making: A Critical Research Frontier for Information Systems*. Seattle, Washington, USA.

STRAND, E. J., MEHTA, R. P. & JAIRAM, R. (1994) Applications Thrive on Open Systems Standards. *StandardView,* 2**,** 148-154.

TASSEY, G. (2000) Standardization in Technology-Based Markets. *Research Policy,* 29**,** 587-602.

TOLMIE, P., PYCOCK, J., DIGGINS, T., MACLEAN, A. & KARSENTY, A. (2002) Unremarkable Computing. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Changing our world, changing ourselves.* Minneapolis, Minnesota, USA

TORNATZKY, L. G. & KLEIN, K. J. (1982) Innovation Characteristics and Innovation Adoption Implementation: A Meta-Analysis of Findings. *IEEE Transactions on Engineering Management,* EM-29**,** 28-45.

WEISER, M. (1991) The Computer for the 21st Century. *Scientific American,* 265**,** 94-104.

WEST, J. (2004) What are Open Standards? Implications for Adoption, Competition and Policy. *Standards and Public Policy Conference.* Federal Reserve Bank of Chicago, Chicago, Illinois, USA.

WEST, J. & DEDRICK, J. (2000) Innovation and Control in Standards Architectures: The Rise and Fall of Japan's PC-98. *Information Systems Research,* 11**,** 197-216.

WILLIAMS, R. (1999) ICT Standard Setting from an Innovation Studies Perspective. *First IEEE Conference on Standardisation and Innovation in Information Technology (SIIT '99).* Aachen, Germany, IEEE.