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## Deliverable D2.3: WP2 Report

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### 1 Introduction

This document reviews from a WP2 perspective the whitepapers produced in the M-Zones programme at the end of June 2004 and forms part of the programme's research quality assurance process.

The overall goal of the quality assessment process conducted collectively by WP2, 3 and 4 is to provide a mechanism for incrementally improving the quality of the research work conducted in M-Zones. This is performed by guiding the development of a set of research whitepapers towards completion for each co-released WP2, WP3 and WP4 deliverable. This guidance complements that of individual supervisors of researchers, but also through collective peer review of papers, which aims to assess and improve the quality of the resulting research.

WP2 is primarily concerned with ensuring that all research work has a clear statement of its assumptions and context, thus providing a high level architectural view of the research from a number of viewpoints, i.e. the business viewpoint, the logical/structural viewpoint, the technology viewpoint and the reuse viewpoint. These viewpoints remain unchanged from D1.2 and are included in Annex 1 for reference, with the specific assessment criteria used, which is also unchanged, included in Annex 2. Section 2 presents the overall results and observations from the assessment of the whitepaper submitted with this deliverable. As some of the white papers are continuations of work reviewed for WP2 in D2.1, only reference of relevant changes will be made to avoid repetition between deliverables. Section 3 presents a current synthesis of the work in the whitepapers on requirements and research context. This is not an attempt to define an overall view of M-Zone's concepts, but aims to provide a concise feel of the direction in which the research, as represented by this set of white papers, is progressing, again only as a delta on the synthesis already presented in deliverable D2.3. It should not therefore be interpreted as definitive or prescriptive, but as an aid to an understanding of the project's overall requirements and research context and to assist individual researchers within the project in identifying further potential synergies.

## 2 Overview of Whitepapers

The criteria presented annex 2 have been used to review draft whitepapers in an ongoing dialogue aimed at improving their overall research content. Below are summaries of the status of these drafts based on this WP2 evaluation, though these may not accurately reflect the final drafts of the white papers included with this deliverable due to their ongoing refinement:

*Truly Balanced Step Recovery Diode Pulse Generator with Single Power Supply* (Barrett & Rulikowski 2004a) This paper presents improvement in key components of a UWB transmitted using existing, inexpensive RF components.

*The dynamic adaptation of security policies in pervasive environments, with contextual information as the catalyst* (Barrett 2004a) This paper explores the requirements for security and privacy in smart spaces. It identifies that security and privacy decision in smart spaces will need to be context aware and that this will result in a highly complex and dynamic decision making process. It proposes therefore that high-level security and privacy policies are automatically refined to generate low-level enforcement policies.

*Dynamic Composition and Personalisation of PDA-based eLearning – Personalised mLearning* (Brady et al 2004a) This paper examines the issues involved in modifying adaptive hypermedia (AH) applications from desktop usage to presentation in wireless PDAs. Issues related to axes of adaptivity in AH systems, assessment of user interface design and PDA interface design are discussed. An evaluation of a port of an existing personalised eLearning application based on the ApeLS AH system is reported.

*Automated Policy-Refinement for Managing Composite Services* (Carey et al 2004a) This paper extends work presented in (Carey et al 2003a) in addressing the refinement of user level policies to policies targeting individual service components within a service composition. An architecture for a policy refiner is described. This takes user level policies described at the level of abstraction consistent with the composite service being used, a model of the service composition and finite state machine (FSM) models of the components that implement the constituent service, with the aim of automatically generating corresponding policies for those components. Automated refinement of policies is reported where a manual mapping from a composite service FSM to the constituent FSMs is provided and further work on automating the FSM mapping is indicated.

*Information Modelling for a Smart Space Personal Information Management System* (Carroll 2004a) This paper outlines a Personal Information Model that can be used as a common format for personal information required in smart space applications. The proposed model is to draw on existing models such as DMTF's CIM and TM Forum's SID. Issues of information gathering, distribution, privacy, identity management and access control are discussed and a system architecture is outline that accommodates a 3<sup>rd</sup> party manager of personal information.

*Ad Hoc Service Delivery* (Cummins and O'Reilly 2004a) This paper presents an evaluation of the application Jini in smart spaces, and in particular the extent to which the Jini Surrogate Architecture allows Jini service discover and invocation capability to be made available to devices that would otherwise have insufficient computing resources to support Jini directly. Performance was measured for a file server and an instant messaging application implemented via JINI services.

- Task Driven Service Composition for Pervasive Computing Environments* (Davey 2004a) This paper give a brief state of the art covering Task Representation, Service Semantics and Service Composition and describes how these ideas can be integrated with the existing policy-based management system based on the COPS protocol and CIM information model that is part of the current WIT smart space testbed. This would provide access control management for the services used for such user task driven service composition.
- Resources Discovery and Management using Policies in Smart Spaces* (Ghamri-Doudane et al 2004a) This paper describes the problems associated with managing multiple smart spaces and how this can be subdivided into administrative domains termed M-Zones. It then describes a n architecture for the policy-based management of M-Zones before presenting specific results on how an existing COPS infrastructure has been extended to also support service discovery in a smart space.
- Dynamic Web-Service Composition: eBusiness Just for You!* (Higel et al 2004a) This paper extends the portion of the work in (O'Donnell et al 2003a) that addressed automated service composition. This reviews the advantages of combining workflow technology and AI planning to provide automated service composition for adaptive B2B and B2C web service applications. It proposes automated service composition of OWL-S services on patterns that integrates representations of verified human knowledge of compositions. The paper describes experiments in progress to assess potential gains in planning and execution efficiency.
- An Active, Ontology-driven Network Service for Internet Collaboration* (Lewis et al 2004a) This paper outlines an architecture that combines ontology-based queries with content-based networking to provide a scaleable persistent semantic query network. It describes how such a network can be used as the basis for a collaborative information space service, as well as for the policy-based self-management of the network and the collaborative service. This service uses the community-based policy management approach described previously in (Feeney et al 2003b).
- Influence of People Shadowing on Bit Error Rate IEEE802.11 2.4GHz Channel* (Mathur et al 2004a) and *Indoor Channel Model for Link BER Estimation* (Klepai et al 2004a) These papers present results of extending 802.11 signal propagation simulations to take into account the impact of people and other moving obstacles, factors not addressed by other existing simulations.
- Intelligent Network Access and Inter-System Handover Control in Heterogeneous Wireless Networks for Smart Space Environments* (Murray & Pesch 2004a) This work builds on that in (Murray and Pesch 2003) and (Murray 2003a) in addressing policy-based admission control for heterogeneous wireless networks. This paper presents results on the use of fuzzy logic based on policies representing network capacity surfaces to make decision for handing over a user from one wireless network to another.
- Policy Based Access Management and Handover Control in Heterogeneous Wireless Networks* (Murray & Pesch 2004b) This work also builds on that in (Murray and Pesch 2003) and (Murray 2003a) and focuses on how the combination of fuzzy logic and network capacity surface policies enables additional contextual information and handover history to be used in making predictive handover decisions.

*Using Event Aggregation to Provide Autonomic Mixed Initiative Personalized Service Support in UbiComp Environments* (O'Donnell et al 2004a) This paper extends the work on user intent inference presented in (O'Donnell et al 2003a) by providing details of an initial implementation of the intent inference engine using Bayesian Networks and of how it was assessed in a trial involving a simple simulated environment.

*Influence of Network Merger on Address Assignment Strategies for Mobile Ad Hoc Networks* (O'Grady et al 2004a) This paper builds on the issues of IP routing in mobile ad hoc networks discussed in (Cummins et al 2003) by examining in more detail the efficiency of various approaches to IP address assignment in situations where ad hoc networks merge. Efficiency is assessed through simulation measuring the latency and packet transmission overhead in address assignment and merger detection.

*Resolving Queries in a Heterogeneous Context Rich Environment* (Power et al 2004a) This paper continues work towards the use of ontologies in obtaining context information from heterogeneous sources introduced in (Power 2003a). The focus is on providing a context querying API that relieves developers from anticipating and integrating the schemas of all the possible context information sources that might be available to a deployed application. The revised approach describes the service as peer-to-peer network of context service nodes where queries assume context sources publish meta-data in OWL. Crucial issues of query decomposition and query routing are discussed and an initial experiment is described to test the service interface using OWL queries expressed in the XQuery language.

*Policy driven Composition of Trustworthy Web Services* (Quinn et al 2004a) This paper introduces the problem of using ontologies and user policies to assess the overall trust that a user should place in a dynamically composed service based on various available trust metrics associated with its constituent services. It reviews state of the art in semantic web services, expressions of trust and policy and then outlines an initial experiment to define an ontology for trust calculations for composite web services.

*Aperiodic Cache Exchange for New Network Nodes in Wireless Mobile Ad Hoc Networks* (Rea et al 2004a) This paper examines the problem of route discovery for new nodes joining a mobile ad hoc networks. It aims to improve on flooding-based route discovery of current on-demand protocols by allowing new nodes to immediately receive and start using routing caches held by its new adjoining nodes.

*Multi-metric Routing Decision for Ad Hoc Networks using Fuzzy Logic* (Rea & Pesch 2004a) This paper examines route cache optimisation in mobile ad hoc networks needed to maintain the most useful routes in caches and reduce the need for rediscovery of routes. An approach is proposed that places weightings on discovered routes based on a number of metrics that are subjected to fuzzy logic rules in deciding on which route to cache.

*Access Control in Smart Space Environments* (White 2003a) This paper outlines the problems related to security and access control in smart spaces that result from the unpredictable sets of users and networks involved. It identifies the need for a more dynamic approach to access control and for this to allow for different level of user authentication, including anonymous usage, as appropriate to the service requested and the usage context.

### **3 Synthesis and Observations**

The following sections outline new or changed observations on common or parallel threads identified across these white papers within the WP2 area, when compared against the observations in D2.1.

#### **3.1 Business Viewpoint**

Broadly, the network provision business model assumptions behind most of the current work in the M-Zones research programme has shifted further away from ones where telecommunication providers play a central role in smart space management. They focus instead on addressing the needs of business models that assume smart spaces will be administered largely by local organisations who own local wireless access networks and information appliances, which must interact with other networks, often in separately administered smart spaces, in an ad hoc manner (O’Grady et al 2004a) (Rea et al 2004a) (Rea & Pesch 2004a). Only (Murray & Pesch 2004b) addresses inter-network handover between heterogeneous network types within a single provider, including cellular network typically operated by telecoms providers.

The heterogeneity of smart space providers is also reflected in the focus on the need to establish trust between users and multiple different service provider domains (Quinn et al 2004a) and also on the problems of access control over changing user populations (White 2003a) within a smart space domain. Similarly, the need to author policies across user communities that are not structured around single organisations is highlighted in the use of community-based policy management in (Lewis et al 2004a).

A business model that assumes a wide heterogeneity in the sources of software and service is also more common across the project. This has resulted in fewer assumptions about common information models and more attention given to models that span standards (Carroll 2004a) and the use of ontologies (Davey 2004a)(Higel et al 2004a)(Lewis et al 2004a)(Power et al 2004a) (Quinn et al 2004a) that provide wider support for managing the mapping between models.

A stronger focus can also be observed on meeting the needs of the individual user through a variety of means, namely: personalised presentation of adaptive hypermedia content (Brady et al 2004a); mapping of user policies to modify the behaviour of service compositions (Carey et al 2004a); modelling of personal information (Carroll 2004a); driving service composition from user tasks (Davey 2004a)(Higel et al 2004a); more flexible access control policies (Lewis et al 2004a)(White 2003a); the use of individual context and history in wireless network handover decisions (Murray & Pesch 2004a); inference of user intent (O’Donnell et al 2004a) and use of user policies in calculating trust (Quinn et al 2004a). The human factor in radio signal propagation is also the subject of (Mathur et al 2004a) and (Klepal et al 2004a).

#### **3.2 Logical/Structural Viewpoint**

Across the project the focus on service-oriented architectures and the use of dynamic service composition has widened, being visible as: the subject of subsequent policy based management (Carey et al 2004a); in accessing services from limited resource devices (Cummins and O’Reilly 2004a); the primary means of adaptive service provision (Davey 2004a)(Higel et al 2004a); the means for implementing inferred user intent (O’Donnell et al 2004a); and the subject of trust calculations (Quinn et al 2004a).

The focus on the use of policies to control and constrain the adaptive behaviour of smart spaces is also being explored in more depth than previously as: the means of managing context aware security and privacy (Barrett04a); automated policy refinement of composite service management (Carey et al 2004a); smart space resource management and service discovery (Ghamri-Doudane et al 2004a); community-based access control for collaborative services (Lewis et al 2004a); wireless network access control and handover decision (Murray & Pesch 2004a) (Murray & Pesch 2004b); the use of user policies in trust calculation over composite services (Quinn et al 2004a) and the requirements for flexible access control policies in smart spaces (White 2003a).

The importance of ad hoc routing has also widened in the project. Work has continued to address assignment in merging ad hoc networks (O'Grady et al 2004a) and expanded into routing caches in mobile ad hoc networks (Rea et al 2004a) (Rea & Pesch 2004a). However, a need has emerged for knowledge based ad hoc routing, both in decomposing context queries and integrating the responses (Power et al 2004a) and in knowledge driven content-based networks in (Lewis et al 2004a). The relationship between the more mature area of mobile ad hoc networks and the emerging field of knowledge based networks needs to be explored further within the project.

In relation to software architectures there has been no move to define strict logical division or viewpoints in how smart space systems and their management software are structured, reflecting the heterogeneity of resources, services, models and solutions that is expected to confound any overly prescriptive architecture. Instead the focus has been on establishing a view of how the *elements* of a smart space may be structured. Previously, (Lewis et al 2003b) presented an Adaptive Service Element, that was designed to present an ontological view of smart space components exposing services, using services and exposing rule modifiable behaviour – the latter being explored in more detail in (Carey et al 2004a). This model is abstract in that it is intended to model elements from small ubicomp devices to application service components or agents on application servers. This model is designed to support the management of heterogeneity in adaptive systems using ontologies, but the work does not yet address the grounding issues needed to make such management a reality. A smart space component model is presented in (Ghamri-Doudane et al 2004a) is similar in that it supports a service-oriented view of functionality and policy-based management of resources. However this model does not exploit ontologies to provide a high level of abstraction and is more concrete, being targeted at the level of a single smart space device, with implementations integrated with specific policy-based management mechanisms using existing IETF/DMTF and DENng models.

### **3.3 Technological Viewpoint**

The set of white papers continues to encompass an impressive array of technologies relevant to smart spaces from electronic devices to the user interfaces and AI techniques. However, apart from the widening assumption of TCP/IP as the transport layer and the wider use of the solidifying OWL and OWL-S specifications for ontology and semantic service specification respectively, there has been no new strong convergence in technologies used across the project.

### **3.4 Reuse Viewpoint**

Though existing models are widely used in the project's research there continues to be little convergence amongst the various research activities about which models are used. However it is becoming increasingly clear that this is and will continue to be the natural situation in smart

space management, and, as already observed, several research activities address this heterogeneity directly.

## 4 Conclusions

D2.1 raised several questions that we attempt to answer here in the light of the current set of white papers:

- *How can commercial mobile service providers use the integration of quality of service and novel applications to attract subscribers to use the unlicensed band in the face of free access competition?* This question has to some extent already been bypassed by events, with a rapidly growing mixture of free, subscription and local payment WLAN access services being made available – so the market is now in a position to deliver its verdict.
- *How does peer-to-peer and ad hoc networking impact on the design of application services?* This question is of increasing importance as we examine ad hoc knowledge based routing for the communication of application-level information, and as noted above further work is required to determine if there can be fruitful reuse of ad hoc networking techniques, e.g. route caching, to the knowledge-based network domain. The impact of ad hoc networking on request-response style service is still not clear, though the clear need for dynamic service discovery in such situations has already been addressed within the project.
- *How can runtime bindings between services and different network types be effectively configured?* This has been addressed by (Murray & Pesch 2004b) in that broad classes of applications can be factored into the decisions made about inter-access network handover. In addition, the increasing assumption of TCP/IP transport makes the choice of wireless access technology less crucial to QoS unaware services. The separation of abstract service specification from concrete protocol grounding as defined for the OWL-S service ontology offers a more general mechanism for addressing this problem, as this language become more mature and widely used across the programme.
- *How can knowledge be easily shared between individual developers and between software entities to avoid the constraints of slowly developed standards while encourage enough conceptual convergence to avoid a chaotic body of reusable knowledge?* An increasing focus on service and resource meta-data semantics, captured either in XML schema or ontologies, offers a mechanism for such sharing, but specific understanding of suitable guidelines are yet to emerge within the project. The exchange of schema for testbed integration between partners in WP4 may offer some practical experience in these issues.
- *What level of commonality is possible or useful between knowledge-based representations of services, shared information and behavioural rules?* This is still an open issue, but as the discussion of architectural issues above reveals, solutions would seem to lie in models of individual components that bring together segments of service, resources and policy rules centred on a deployable and reusable smart space element.

These discussions raise further issues that would be fruitful to address in the programme's ongoing research activities:

- Can a useful common meta-model of a smart space component be agreed? What aspects should such a model encompass and what level of intelligence should such components embody?
- Can ad hoc routing principles be applied to knowledge-based routing and distributed context querying?
- Can the range of policy-based management approaches addressed across the project be addressed in a single approach covering user, smart space operator and network service provider requirements?
- Is dynamic service composition sufficient for adaptive application behaviour in smart spaces and is it suitably manageable?

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## Annex 1 Requirements and Context

The following assumptions underlie the selected approach assessing research work WP2:

- The Adaptive Smart Space Management problem can be addressed through several different architectural approaches.
- The project needs some level of coherence in the architectural approaches taken across the partners.
- Partners may prefer differing, but equally valid sets of requirements and contexts due to disparate motivating business models, implementation technology selections and research topic choices – the resulting heterogeneity should be exploited in attaining comparative architecture-related results

The following are the viewpoint headings used to structure the WP2 assessments. It is likely that initially not all the whitepaper produced will address all of the suggested viewpoints, depending on the approaches taken by individual researchers. For instance technology driven approaches may have little to say initially about business models or reuse of models. Equally a business-driven approach may not yet have resolved technology or notational issues.

- **Business/Organisational:** This assesses the different types of business organisations and human actors (or business roles) that have a stake in each strand of research. This may include different types of users of smart spaces, operators of smart spaces, providers of services and developers of smart space components. This viewpoint should capture the relationships between these roles, e.g. who buys what from whom, who has responsibilities or obligations to whom, who employs whom etc. Understanding this viewpoint benefits from scenarios capturing the dynamics of relationships between business roles and the distinctness of the roles, in terms of the different benefits they get from the relationships. More depth can be added to this viewpoint by describing business processes involved in the approach, the relationships between the processes (e.g. what signals and information are passed between them) and which business role are involved with which business processes.
- **Logical/Structural:** This addresses the structure of functional and informational elements of any system following the suggested research. This should aim to support the subdivision of the development of the system into units addressable by different development actors, e.g. between developers concerned with networking, HCI and database system aspects. This viewpoint should also capture the broad structure of any common computing or communication platform upon which intended application components will be developed. Concepts in this viewpoint should be defined in a manner that is independent of the implementation technology, with the aim being to potentially support multiple technology bindings to these logical concepts.
- **Technological:** This addresses the binding of elements from the Logical/Structural viewpoint to specific implementation and communication technologies. It should describe the technology or range of technologies applied in following the architectural approach, and the benefit provided by the technological approach taken. Technologies would typically be specific programming languages, communication platforms and protocols. A specific research strand may support more than one set of technology bindings. This viewpoint should also capture the approach taken to mediating between different technology bindings.

- **Reusable Elements:** This covers any existing models, e.g. service definitions, information models, device profiles, software components, policy/business rules etc, that conform with the research strand and which are available for reuse. Initially this viewpoint will be restricted to references to models from outside the project, but over the project lifetime it may relate to the output of other research strands in the project.

## **Annex 2 Assessment Criteria**

This is the first draft of suggested quality assessment criteria to be use when assessing Research Theme whitepapers under WP2. The goals of WP2 are:

- To ensure all the researchers form holistic view of the problem area they are addressing with their research, considering from a number of viewpoints. This consolidated, multi-view description of each piece of research work is what is meant by the “architectural approach”.
- To ensure that the architectural approach taken in describing what each piece of research is based on sound reasoning and a good understanding of the relevant state of the art.
- To assemble a shared view of the problem domain addressed by the project in order to encourage consistency and, where appropriate, convergence between the work of different researchers.

This paper suggests how whitepaper authors to help WP assessors in identifying where criteria are addressed. It also suggests some assessment criteria that related to general research quality be used to cover issues that may not fall into specific WP areas, and might otherwise be missed.

These criteria aim to guide work towards a holistic approach that considers the problem from several angles. These criteria therefore seek answers to the ‘what?’ and the ‘why?’ of the research work. They are not aimed at assessing the development of the solution taken to the research problem (see WP3 which addresses the ‘how?’) or the scientific/experimental approach taken to evaluating the solution (see WP4 which addresses ‘is it any good?’).

### **Business/Organisation Viewpoint**

- 2.1: Are the beneficiaries of a solution to the problem domain clearly identified, e.g. in terms of specific types of individuals, communities and organisations?
- 2.2: Are the roles taken by beneficiaries in the problem domain clearly described in terms of the activities they wish to perform, e.g. through exemplary scenarios or more formally through use cases?

### **Logical Viewpoint**

- 2.3: Are the first class logical concepts in the approach identified and well defined, e.g. networks, services, terminals, tasks, activities, objects, classes, components, processes?
- 2.4: Are the relationships between first class concepts clearly described?
- 2.5: Is any overall structural grouping of first class concepts described, e.g. layers?

### **Technology Viewpoint**

- 2.6: Are any technology selections made clearly reasoned in support of research aims?
- 2.7: Have alternative technology selections been considered?
- 2.8: Have known deficiencies in selected technologies been acknowledged and their relevance assessed?

**Reuse Viewpoint**

- 2.9: Has the relevance of any existing work, e.g. solution, techniques, standards or research results, that is employed in describing the problem domain been clearly reasoned and the work correctly referenced?
- 2.10: Has any work relevant to the problem domain been missed, if so what?