M ZONES

Deliverable D3.1: WP3 Report

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1 Introduction

This document is the first deliverable of work package three – Modelling and Design. It covers white papers that have been produced and peer-reviewed by the M-Zones partners by the end of July 2003. Purpose of this document is to provide a holistic view of accomplished work regarding the modelling and design of management concepts/systems for smart spaces and to evaluate the research quality of this work. The methodology for the quality assurance is defined in a quality document developed by all partners for the work packages two, three and four.

Following the Technical Annex, the white papers have been published for the Research Themes. This document includes only white papers that reflect modelling and design aspects, while other aspects are covered by the deliverables D2.1 and D4.1 for the work packages two and four respectively. The aims of this process are:

- To provide feedback to researchers on how their research work as presented in the whitepapers can be improved to represent high-quality research work.
- To provide a mechanism for the project, theme leaders, researchers and supervisors to monitor improvement in the research output of individuals, theme teams and the project as a whole.
- To provide an opportunity for individual researchers to be involved in peer-review of research output.
- To provide an accurate view of the progress of individual items of research over the course of the project.
- To provide a mechanisms for selecting whitepaper to be published on the M-Zones web-site
- To help groom whitepapers into a form suitable for submission to publications, conferences, workshops etc.

The rest of the paper is organised as follows. Section 2 gives an overview of the general methodology that was discussed on M-Zones meetings and gives the criteria for including white papers in this deliverable. Section 3 introduces the quality criteria that are used to assess the white papers.

2 Requirements and Context

The primarily goal of work package three is to provide guidelines, recommendations and rules for the modelling and design of solutions for managed zones. Targeted results are methodologies, design models, algorisms and processes that are based on the architectural approaches of WP2 enabling to engineer a smart space instead of having it crafted.

The criteria for including white papers in this document are that these papers need to deal with one of the following aspects of modelling and design:

- Object models – the composition of interacting objects that concentrates on clearly identified aspects of the real world
- Semantic information – beside concrete object models, that focus on the syntax of an object, the specification of a smart space must be qualified with semantic information
- Repositories – information bases and repositories for smart spaces in form of (usually distributed) virtual data store supporting the specific requirements of the research themes.
- Notations – languages that are used for the specification of smart spaces and M-Zones that can be either formal notations or semi-formal notations.
- Development tools – supporting the modelling as well as the design phases.
- Communication services, protocols, formats – mechanisms and data to be exchanged in order to allow management activities to disappear.
- Mathematical models – models of devices, systems, and networks that populate a smart space described in the language of mathematics, which facilitates analytical evaluation and comparison with model implementation within an experimental platform, that is computer simulation environment
- Core services – (probably) standardised services that allow M-Zones to be used and operated and that enable control of seamless interoperability as well as administration and maintenance of co-operation activities.
- Application Programming Interface(s) – define easy to use mechanisms to access resources of a smart space and its management for new service creation and deployment.

Following the evaluation of this paper, the M-Zones programme will be able to develop a holistic view on modelling and design aspects for the rest of the programme (three years).

3 Assessment Criteria

This is the first draft of suggested quality assessment criteria to be use when assessing Research Theme work under WP3. The goals of WP3 are:

- To ensure that all the researchers use technique for modelling and designing Smart Spaces that are understood by all participants of the M-Zone programme

- To ensure a common understanding what modelling and design of Smart Spaces and M-Zones means
- To ensure that the applied techniques for modelling and design 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.

The major question for all WP3 activities is: How to solve a (given or identified) problem based on Architectural Approaches (WP2) and as a basis for Experimental Testbeds (WP4)? The 'solution' can be any type of paper, a presentation, a demonstration or a piece of code. However, to ensure a high level of quality, each 'solution' needs to be described in form of a paper that can be further evaluated by WP3. Those papers are furthermore called white papers.

The major result of WP3 is a development framework (or a variety of frameworks), which can be seen as a set of model, rules and processes for M-Zone developers (within out outside of the programme).

Both, major question and result, must follow the overall goals of WP3 as defined in the working plan. Those goals include (currently) definition or identification of appropriate object models, semantic information, repositories, formal and semi-formal notations, development tools, communication services/protocols/formats, mathematical models, core services and application programming interfaces (API). If, during the lifetime of the programme, these goals need to be reviewed, the quality criteria described within this document should still be able to capture the new goals.

Beside the goals, WP3 identified three major cycles of modelling and design. Those cycles are development, execution environment and deployment. Modelling and design regards to providing the introduced solutions for every combination of cycles.

4 Quality Assessment

The criteria presented above 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 WP3 evaluation, though these may not accurately reflect the final drafts of the white papers included with this deliverable due to their ongoing refinement.

4.1 Present and Future Organisational Models for Wireless Networks

[oconnor03] Robert O'Connor, Sven van der Meer: *Present and Future Organisational Models for Wireless Networks*

Also published in: IEE/IEEE Telecommunications Systems Research Symposium, ITSRS 2003, Dublin, Ireland, May 6, 2003

Also published in: International Symposium on Information and Communication Technologies, ISICT 03, Dublin, Ireland, September 24-26, 2003

Overview: This white paper examines the evolution of business models in wireless networks, namely GPRS, WLAN and UMTS. The paper aims to address organisational aspects that are relevant for managed zones. Starting with an introduction, the paper examines currently employed business models by means of a case study for services, pricing, provision of connectivity and cost (risk) management. The requirements of users are also given. The second step in the examination is a brief reflection of historic business models focusing on the increasing amount of service providers as the number of access networks has increased. The discussion of future business models shows that it is most likely that the number of operators will decrease, mainly by operators merging into consortia. An important aspect of the business models is given examining the relationship of network services, services and content. The paper is concluded by example scenarios for future business models.

Relevance to WP3: Probably a basis for object models (roles), semantic information (to enable business models and to model the two concepts of service and content) and core services (such as AAA services).

Quality: It is understood that this paper is based on a case study and an extrapolation based on assumptions from the case study. The examination of future business models is rather ambitious. The most interesting outcome of the paper is the statement that the visibility of networks will disappear and that questions like quality content and useful services are key to future wireless networks. These aspects directly impact modelling and design of managed zones (and smart spaces) in terms of abstracting from communication environments while maintaining a (logical) view to available network capabilities (especially important for QoS provisioning).

Technical Quality: Affiliation is available, abstract and keywords are missing. Uses numbered reference style.

4.2 Topic Maps for Context Management

[power03] Ruaidhri Power: *Topic Maps for Context Management*

Also published in: International Symposium on Information and Communication Technologies, ISICT 03, Dublin, Ireland, September 24-26, 2003

Overview: This paper presents the concept of a dynamic topic map as an overlay information network enabling the management of interconnected information objects. The paper also introduces the interconnection of different context maps as one mechanism of managing ubiquitous computing environments. The first part of the paper gives an introduction to the targeted environment and an introduction to context information and topic maps. The bigger part of the paper focuses on the design of adding value to context data through the use of topics maps, a case study and the implementation. The paper is understood to describe a first evaluation of the area with more detailed research work to follow.

Relevance to WP3: modelling of entities (user, objects, concepts), information access (through topic maps), information repository (in form of topic maps), communication protocol (in form of information query mechanisms)

Quality: The introduction of the paper clearly identifies the open issues in handling (complex and massive) context information and the problem of today's approaches, which do not separate the information from information and/or storage structures. The introduction of context is concise, but for the aim of the paper appropriate. The introduction of topic maps focuses mainly on semantic web and W3C developments

leaving for instance the ISO topic map standard out of scope. Design and case study follow this approach giving XML topic maps as example and discussing the association of information. The paper asks a number of important questions for further research.

Technical Quality: one author says 'we'. Abstract and affiliation are included, keywords are missing. Uses numbered reference style.

4.3 Towards a Natural Interface to Adaptive Service Composition

[odonnell03] Tony O'Donnell, Steffen Higel, Aoife Brady, Vincent Wade: *Towards a Natural Interface to Adaptive Service Composition*

Also published in: International Symposium on Information and Communication Technologies, ISICT 03, Dublin, Ireland, September 24-26, 2003

Overview: This white paper describes an architecture that combines adaptive service composition system with natural interface system. Service composition is viewed from the perspective of the W3C, with the paper introducing WSDL (and HTTP, SOAP) and DAML-S (RDF based) as background technologies. The concept of adaptive technologies is represented by a discussion of Agents (or Assistants), high-level languages for web programmers (PHP, ASP) and Candidacy (as a platform for adaptive hypermedia). The background is concluded by a reflection of ubiquitous computing for education. For the actual research, the paper identifies orthogonality, efficiency and usability as the ultimate requirements. The core of the paper is the link between smart space management technologies, he manipulated physical environment and other data. This includes discussions on abstraction layers, interpreting user activities and service availability. The paper is concluded by a sound scenario discussion (education environment).

Relevance to WP3: semantic information (ontologies for service composition) notations and tools (for developing the proposed architecture)

Quality: It is understood that the paper describes an ongoing research activity. The ambiguous goal of using natural interfaces within smart spaces is vital for the acceptance of smart spaces at all. The background in adaptive services seems to be sound (and reflects other white papers that act in the same area). The introduction of natural interfaces should be done in more detail. For instance, the reduction of the cognitive load of user tasks is not discussed. A natural interface (tactile, audio-visual) should recognise the dependencies of information in a smart space while not overloading a user. A good interface should reduce the skills needed to use the system, which includes individual user tasks. Missing elements in the paper are a justification for the new paradigm (introduction) and some aspects of HCI.

Technical Quality: Abstract is available, keywords and affiliation are not. The date of preparation is given. Uses a reference style similar to Harvard, but with square brackets. Some formatting problems (page 5 and 7). Uses non-introduced acronyms/concepts (like TSUNAMI on page 9 vs. page 12).

4.4 Investigating Macro and Micro Mobility Support in Smart Environments

[barrett03] Keara Barrett, Ray Carroll, Sven van der Meer: *Investigating Macro and Micro Mobility in Smart Environments*

Also published in: IEE/IEEE Telecommunications Systems Research Symposium, ITSRS 2003, Dublin, Ireland, May 6, 2003

Overview: This white paper describes a mobility architecture for smart spaces, which integrates macro as well as micro mobility. The architecture is based on two IP concepts for mobility. Here, mobile IP serves macro mobility aspects and cellular IP for micro mobility, the later one mainly for local networks. The paper provides an in-depth analysis of mobile IP and cellular IP features. For mobile IP, the difference between IPv4 and IPv6 is explained. For cellular IP, the paper and the used references show that no consistent standard is agreed yet. In the second part of the paper, the two mobility concepts are integrated into a single architecture for mobile devices. A given example shows how roaming nodes and traffic routing benefit from the integrated approach. The last part of the paper gives an idea of how this integrated approach can be applied to support roaming devices or users in multiple smart spaces. Future work includes implementing and testing the envisaged architecture for smart spaces and applying security mechanisms to it.

Relevance to WP3: Communication services/protocols (mobility and IPv4/IPv6), core services (mobility/roaming, security), API (for accessing IP)

Quality: The paper gives a very detailed description of the two mobility solutions, while the integrated architecture is discussed relatively short. It is understood that this paper discusses ongoing research work that has not yet reached the status of an extended white paper. However, the given approach for inter- and intra smart space roaming and the identification of (mostly standardised) enabling technologies are promising.

Technical Quality: Abstract and keywords and affiliation are available. Uses Harvard reverence style.

4.5 Semantically Driven Service Interoperability for Pervasive Computing

[osullivan03] Declan O'Sullivan, Dave Lewis: *Semantically Driven Service Interoperability for Pervasive Computing*

Overview: The white papers objective is to analyse the usage of service-oriented architectures and ontologies for addressing interoperability problems in pervasive computing environments. The authors deal with this objective by applying semantic techniques to solve key issues such as service composition and service discovery. Starting with Mark Weiser's theory of ubiquitous computing the paper clearly describes the current interoperability problems, which are based on serious structural challenges instead of solely technical issues. Service Interoperability is analysed for CORBA and Web Services followed by the presentation of research challenges. For ontologies, as an important aspect of service interoperability, the paper states that 'design-time' solutions for semantic conflicts are no longer sufficient. XML and related technologies are described as appropriate solutions for addressing this interesting issue. Semantic service integration is discussed by means of DAML-S, based on Web Services. The first part of the paper is finished by a roadmap with different scenarios (short-, mid- and long-term) for different roles (service user, service composer and atomic service developer). The second part of the paper discusses the dynamic auto-generation of gateways (that deal with semantic interoperability) that can mediate between two domains (here topic maps are used as a concept) and semantic engineering in terms of DAML+OIL, UML and CASE tools. The benefits of software engineers are nicely explained.

Relevance to WP3: object models (for specifying ontologies), semantic information (ontologies and interoperability), notations (XML and XML based ontology

languages), development tools (for engineering; DAML+OIL, UML and CASE tools), core services (ontology, intra and inter domain), API (XML).

Quality: The paper has almost no descriptive part. It is a discussion of aspects of service interoperability within pervasive computing having in mind common environments. The possible benefits of applying ontologies on a service-oriented level, thus providing service interoperability, are nicely described. The given roadmap seems to be reasonable, the introduction of gateways is aligned to other work in M-Zones (here basically conducted by TCD) and investigations in relevance for service engineering are sound.

Technical Quality: Abstract and keywords are available, keywords not. An identical footnote is used on every page of the paper. Uses Harvard reference style.

4.6 Organisational modelling in policy based management systems

[feeney03] Kevin C Feeney: *Beyond the role model: Organisational modelling in policy based management systems*.

Overview: This paper examines Rule-Based Access Control (RBAC) models and organisational analysis and describes a system for managing and distributing policy definition rights within organisations. The new approach for access control can be used to control access to organisations and to improve the structure of an organisation at the same time. This is realised through the fact that this approach is able to dynamically model the structure of an organisation. Beside an introduction, the paper provides an overview of policy specification approaches (including a policy language PONDER and addressing problems with policy-based management), applies policy driven systems to organisational studies (in terms of real-world organisations), demonstrates a solution for the identified problems and states further research directions.

Relevance to WP3: semantic information (definition of necessary semantic information) for organisational modelling

Quality: This white paper represents original work, not used within M-Zones before. The paper clearly addresses the need to new management mechanisms in less structured environments, such as smart spaces, from an organisational perspective. Based on a long introduction of policy techniques (RBAC96, ARBAC97, OASIS, PONDER), the paper adapts these mechanisms to existing organisational structures addressing issues such as who defines policies, how they can be applied to describe the operation of an organisation and the limitation of today's policy techniques. With the given further research directions, the paper discusses M-Zones related questions from a very interesting point of view. However, the paper misses to state the objectives in a clear way and to summarise (reflect) the accomplished work and its end.

Technical Quality: mix of UK and US English, inconsistent use of upper/lower case characters in headlines, a single author says 'we', paper has no conclusion and no abstract.

4.7 Next Generation Context Aware Adaptive Services

[conlan03] Owen Conlan, Ruaidhrí Power, Steffen Higel, Declan O'Sullivan, Keara Barrett: *Next Generation Context Aware Adaptive Services*

Also published in: International Symposium on Information and Communication Technologies, ISICT 03, Dublin, Ireland, September 24-26, 2003

Overview: This paper discusses the application of context awareness to adaptive services. Based on the three aspects of integrating situational information with adaptive services (capturing user requirements, design adaptive services and combining those services), the authors identify a number of research challenges and discuss them. With the given challenges, the paper concisely introduces context and the different ways of gathering contextual information, finalised by the introduction of the concept of context ware adaptive services. The second part of the paper is dedicated to accomplished research activities for the areas of (adaptive) service composition, service discovery and a case study of the results in an eLearning environment. As the conclusion of the paper states, applying contextual information to a number of discrete services can lead to truly personalised services

Relevance to WP3: identification of the semantic of information, information gathering (technical) and basic services for service composition and service discovery

Quality: This white paper is a combined effort of TCD and WIT. It clearly identifies the research objectives and the challenges of the targeted area. It can be seen as one of the various integrated projects within the M-Zones programme. The context related sections are re-used material generated for work package one (state of the art) and M-Zones workshops. The integrated approach (context information, adaptive services, eLearning environment) shows how different individual research activities can be bundled in a logical way. Furthermore, the integration interoperability from an interesting point of view – here not on the basis of systems but on a conceptual level.

Technical Quality: uses US English, states an ACM copyright from 2000. Abstract, affiliation and keywords are available. Uses numbered reference style.

4.8 Usability of Mobile Devices and intelligently adapting to a User's needs

[greene03] Stephen Greene and Jason Finnegan: *Usability of Mobile Devices and intelligently adapting to a User's needs*

Also published in: International Symposium on Information and Communication Technologies, ISICT 03, Dublin, Ireland, September 24-26, 2003

Overview: This paper investigates in usability aspects of mobile service development. It describes a concept and a system that uses context information combined with learning capabilities to support users. Basic issue here is to model and evaluate relationships between objects and data. The first part of the paper deals with usability. It examines the capabilities of devices with a graphical user interface in order to estimate appropriate strategies to present services (and related information). The second part of the paper describes the intelligent user interface system, developed by the authors, that is capable of learning user behaviour. Core of this system is an Ambient Intelligence Engine, which combines this learning capability with features such as autonomous self-configuration. The user interface is demonstrated in form of an email service that automatically applies (learned) rules to incoming emails. Future work in this area includes access to more contextual information (provided by sensors and other devices) and the integration of other legacy information (such as IM).

Relevance to WP3: semantic information (definition of necessary semantic information), mathematical models (relevance, Fuzzy logic, connections), core services (ambient intelligence)

Quality: The usability part of the paper is based on state of the art research work and off-the-shelve interface technology. The examination focuses mainly on graphical user interfaces, leaving natural interfaces out of scope. Open questions for future devices are presented, with regard to usability and user requirements. The core functionality of the developed system is presented with the mathematical background. The introduced concept of (qualified) connections and notes fit with the usage of topic maps in other white papers, thus promising to enable an integration of final components.

Technical Quality: Abstract available, affiliation and keywords are missing. Uses Harvard style references. Paragraphs are not justified.

4.9 A Policy-based Approach to Composite Service Assurance for Ubiquitous Computing

[carey03] Kevin Carey, Brian Cullen, Dave Lewis, Vincent Wade: *A Policy-based Approach to Composite Service Assurance for Ubiquitous Computing*

Overview: This white paper aims to give an overview of managing issues for smart spaces that offer composed services. The basic mechanism applied here is policy based management. Beside the introduction into the area, the paper comes with an overview of QoS (network oriented with DiffServ and IntServ and application server oriented with ERDoS, OMEGA and QUARTZ) and an overview of policy based management systems for QoS assurance, which is basically introduces the joint effort of IETF (PBMS, LDAP, COPS) and DMTF (policy language and CIM methodology). Composite services are reflected in terms of services composition and software components, mainly with W3C developments such as WSDL, UDDI and SOAP and related work such as BPEL4WS and PBML with a detailed discussion of DAML-S. The paper is concluded by a comprehensive case study and an evaluation of the finished research work, including refining SLAs into low-level policies.

Relevance to WP3: modelling of information (using or integrating standard object models such as DMTF CIM, IETF PBMS, TMForum), semantic information (discussing ontologies), repositories (in form of policy data bases and object models), notations (for policies), core services (processing policies).

Quality: This white paper is based on the interesting assumption that many services in smart spaces are composed services. A second very interesting statement is that ubiquitous computing environments are equal to smart spaces. This is an important aspect for the definition of smart spaces within the M-Zones programme. The used concepts are state of the art (as can be seen in WP1 deliverable) and are all relevant for future work in M-Zones. With the sound case study, the authors provide a very good basis for adapting policies and policy based management to smart spaces. The relevance of the DMTF CIM concept is not clear, especially while having in mind that the CIM concept was not (yet) successful in deployment.

Technical Quality: Abstract and affiliation are available, keyword not. Uses numbered reference style.

4.10 Components of a smart device and smart device interactions

[davy03] Alan Davy: *Components of a smart device and smart device interactions*

Overview: This paper aims to develop a methodology for smart devices (physical aspect) and the functionality and the interactions of smart devices (logical aspect). This

methodology is than used to ease the access to devices (by means of having a generic mechanism available) and to enable efficient configuration and fault management. The paper is based on a variety of device access, control and modelling technologies (Oxygen, NSFS, DMTF-CIM, HPnP, UPnP, WSDL). Based on an evaluation of the technologies, the paper starts identifying the physical components of a smart device. Four general components are specified, limiting the complexity of modelling a smart device. Next, current device service and interaction methods are examined (HPnP, UPnP and WS). The reflection of this examination provides an understanding of basic problems while handling hundreds (or even thousands) of devices in a heterogeneous environment. The last part of the paper describes an architecture that comprises devices and the necessary interactions to control and use them. This architecture covers core services of a smart space (related to device access and service discovery) and access to the actual modelled smart devices.

Relevance to WP3: object models (using standardised object models for modelling smart devices, UPnP, HPnP, WS), semantic information (probably identifying the semantic of device access/control), notations (WS and XML), communication protocols (access to devices), core services (device and service access, discovery and advertisement), API (device access)

Quality: It is understood that this paper provides the results of a first experimental development of a consistent approach for modelling the access to devices. The evaluated technologies represent the state of the art (although developments like Salutation are missing). The interesting exercise of combining the simple device model with device interactions, formalising an integrating architecture while using standard interoperability technologies, seems to be promising.

Technical Quality: Affiliation and abstract are available, keywords are missing. Uses Harvard style references with square brackets. Mix of UK and US English.

5 Synthesis and Observations

5.1 General Subjects

The assessed white papers address an important paradigm in managing complex and dynamic systems and services. This paradigm can be described as *integrated management* aiming to overcome the distinction between a control plane and a management plane. While we can not yet be sure whether this is a paradigm shift or a new paradigm, we are now able to give the paradigm's characteristics:

- Address converged networks by means of data networks (IP), entertainment, information and telecommunication
- Introduce semantic information for usage and operation of services and systems and provide a holistic view of semantics for administration and maintenance
- Use of adaptive policies for usage, operation and control of services and systems
- Recognise the user as the central point of focus for service and system development
- Provide unified concepts for engineering services and systems (instead of crafting them)
- Offer concepts for modular services that enable (automatic) service composition

The white papers show that there exists a common understanding of these characteristics among the M-Zones partner. Furthermore, the characteristics show that M-Zones is not just about integrating more or less traditional concepts and legacy technologies to enable the management of smart spaces. Instead, the researchers have chosen the more ambitious approach of analysing these concepts and technologies (documented in work package 1 deliverable 1 – state of the art) and to adapt this new knowledge to the problem of managing smart spaces. This resulted in original work that promises to unveil fundamental questions for this area of management (and probably will influence other management areas as well).

5.1.1 Terminology

The papers show that there is (still) no uniform terminology among the partners. We recognise that the available definitions for ubiquitous computing, pervasive computing, smart spaces and managed zones are not commonly agreed (neither in M-Zones nor in the relevant international research communities). For the second year of the programme, it will be necessary to establish a commonly agreed and appropriate terminology. Work in this issue has already been started (a straw-man document is available). Some examples for different terminologies used:

- Pervasive computing synonymously to ubiquitous computing
- Pervasive environment as synonym for smart spaces
- Ubiquitous computing environments as synonym for smart spaces
- Smart space definition of NIST

For a common terminology, it will be necessary to clarify the definitions of the following terms, probably with qualifiers (e.g. management service instead of service). Please note that all of these terms are already in use in M-Zones:

- Pervasive vs. ubiquitous computing
- Smart space
- Managed zone
- Service (and smart space service)
- Task (user task, system task)
- Adaptivity
- (Service) Composition
- Smart device
- Smart service
- Service interoperability
- Smart environment
- Context and context management

5.1.2 Technical Quality

In terms of presentation and organisation of the papers we made the following observations:

- *All papers reach a standard above average (compared to standard conferences)*
- A common layout of papers is not present, not even for the papers from one partner organisation
- The usage of affiliation, abstract, conclusion/summary (including future work and acknowledgements), keywords and page numbering is not consistent
- We see three different reference styles (Harvard, name and numbered) and some variations of them in use
- Assignment of white papers to research themes is in almost all papers unclear
- Mix of UK English and US English in a number of papers

It would be helpful for the researchers that provide white papers to offer common rules and one or more accepted styles for these papers. Similar to terminology, some work has been done for ensuring a uniform technical quality (in terms of email discussion).

5.1.3 Criteria for Quality Assessment

The criteria to assess the quality of white papers for work package 3 need to be refined. Furthermore, there we can identify a need for a better promotion of these criteria within the M-Zones programme. The criteria themselves are twofold; general research related criteria and work package 3 specific criteria. The general criteria provide a very good instrument for an IEEE or ACM type peer-review of the white papers. The work package 3 specific criteria address mainly categorisation. Here, further work is needed to clearly identify the fundamental issues of work package 3 and to provide the individual researchers an instrument that enables them to provide high quality input for the work package. The promotion of the quality criteria should be enforced within each of the partner organisation supporting the process of writing the papers.

5.2 Specific Subjects

Specific subjects cover the individual aspects of work package three as introduced in section two of this document. These aspects cover all three cycles of software engineering by means of development (object models, semantic information, repositories, notations, mathematical methods and tools), execution environment (APIs and core services) and deployment (tools and core services). It is commonly agreed that the engineering of a smart space will lead to loosely coupled components (compared to a monolithic M-Zones system). Here, the object models and the semantic information play the most important role in terms of development. For the execution environment, APIs and core services need to be harmonised. For the deployment of services, tools are the most important factor (but these tools can be domain specific and need not to serve a general purpose).

5.2.1 Object Models

An object model is the composition of interacting objects that concentrates on clearly identified aspects of the real world. Object models can be abstract or concrete. An abstract object model identifies basic characteristics of objects. The client/server paradigm and the manager/agent relationship can be denoted as abstract object models. A concrete object model adds specific recommendations and rules. A concrete object model identifies the semantic of objects. Furthermore, it can restrict the abstract model by eliminating entities or placing additional restrictions.

The evaluated white papers focus on concrete object models. This indicates that the white papers deal with relatively concrete application areas. The adopted object models are mostly based on XML focusing on IP based communication environments (in terms of HTTP, SOAP and Web Services). All these models are based on a component-centric approach with request/response communication between components. The manager/agent paradigm, which further restricts an object model and often predefines operations, is not considered in the white papers. An interesting approach is to use the DMTF-CIM that addresses basic aspects of configuration management by allowing the definition of object instances within an object model.

Three interesting activities can be observed:

- Evaluation of real world actors

- Domain-specific collection of user requirements
- Re-use and adaptation of existing concrete object models

An interesting question for further work in this area is whether these concrete object models are sufficient to enable managed zones or if it would be necessary to look at abstract object models. General idea is to have a meta-meta model and a meta model for managed zones (to follow the OMG's MDA terminology) that allow and enable ontology and the formalisation of semantic information. Furthermore it might be useful to agree on a reference model for object modelling.

5.2.2 Semantic Information

The whit papers indicate a need for modelling semantic information on users, services and smart spaces. The employed concepts are based on RDF and DAML. This goes far beyond the traditional approach of introducing semantic information in middleware and management (such as the natural language descriptions in TINA and SNMP).

The semantic information is decoupled from the object model. It can be questioned if this encourages system engineers to use common semantic (and a common notation for semantic) within managed zones. Since this question is fundamental for the interoperability of managed zones, a more stringent solution seems to be needed. The DMTF-CIM object model for instance offers a mechanism of integrating semantic information in the object model and providing, at the same time, a open mechanism that enables all kind of semantic information to be described (and automatically processed). Again, a meta schema (to follow the CIM terminology) would be needed for a uniform approach of semantic information modelling, exchange and processing across managed zones.

5.2.3 Repositories

The repositories in the evaluated white papers are specific to a certain problem-domain. They are not general to smart spaces or managed zones. For the engineering of smart spaces we need to investigate into mechanisms for global *and* local naming and addressing of repositories and their content. A look at traditional concepts helps to understand solved issues:

> Management Information Bases and Interface/Object Repositories are (usually distributed) virtual data stores that manage information about an object-oriented system. A MIB defines the naming conventions for stored objects. In middleware, the term repository describes a database that holds interface/object signatures. For CORBA and SOAP (WSI), these repositories contain information about an object's signature and its actual implementation. Middleware for the control of appliances, such as Jini and UPnP, add information about the semantic of interfaces/objects.
>
> Management architectures define a central naming scheme in which names (or parts of names) are assigned by an authority. The names are arranged in a hierarchical structure reflecting a hierarchy of managed objects. The CIM mechanisms for naming and object databases facilitate the task of sharing management information between varieties of platforms. The major issue of naming is the enterprise-wide addressing of objects.

Topics maps promise to provide the needed functionality to enable interoperability, scalability and portability of concepts and deployed managed zones. *Interesting here is the combination of an object model, semantic information and repository functionality.* A number of papers address this indicating an important trend within the M-Zones programme.

5.2.4 Notations

The notations used in the white papers are languages used for the specification of objects and their interfaces. They do not depend on actual implementations. These languages are built of a number of definitions that explain syntax and semantic of an object model. Almost all specifications are coded as plain text files. This gives a number of intrinsic characteristics (assuming that XML is used as a meta model for formal notations):

- Platform independence (every platform is able to handle plain text files);
- Extendibility (every platform supports tools for editing plain text files);
- Automated processing (no additional re-formatting is necessary); and
- Readability (as long as the reader is familiar with the formal notation).
- No need for additional grammar definitions in BNF (or ABNF, EBNF)

All languages are designed following a concrete object model. The applicability of the languages within this thesis depends on the concrete object model of the specific focus of each white paper. Therefore, each language has specific characteristics that need to be considered and that might hinder interoperability.

The combination of SOAP and XML promises a mechanism to access distributed systems from the WWW. XML was originally defined as "[…] a method for putting structured data in a text file". Basically, XML defines no objects or interfaces but documents. Structure of information and content are separated. Structure of information can be declared with tags. A DTD or Schema defines constraints on storage layout and logical structure. XML further distinguishes between well-formed (XML conform) and valid (conform to a well-formed DTD) documents.

Notations from management frameworks (ASN.1, GDMO, SMI, SMIv2) are not considered in the white papers. Notations for policies and access control are considered.

5.2.5 Development Tools

Development Tools play an important role in the development process. They offer a Software Development Kit (SDK) or an Integrated Development Environment (IDE). Both are usually toolsets that include editors, debuggers, and documentation for a programming language, middleware, and/or management architecture. SDK and IDE usually allow the integration of external tools for specific tasks.

The current white papers do not focus on tool developed. However, they recognise the existence of tools for several modelling techniques (UML), standard IDEs (several JAVA IDEs) and standard tools (e.g. for processing XML documents).

5.2.6 Communication services, protocols and formats

A protocol defines mechanisms for the exchange of data between (distributed) components. The white papers address communication protocols (IP, Mobile IP) as well as application protocols (SOAP, HTTP, CORBA). The restriction of management protocols (inspect and alter managed objects) are not considered. Messaging as basic paradigm for protocols is also not considered (by means of asynchronous exchange of event notifications or asynchronous messaging as in message oriented middleware).

The three important subjects of protocols (data encoding, message format and protocol services) are not considered in the white papers. This might indicate that available protocols

are sufficient for the configuration and operation of smart spaces. Further investigations seem to be necessary.

5.2.7 Mathematical Models

Mathematical models play a subordinate role in the white papers. This might be based on the fact that adopted standards already provide the necessary mathematical foundation (such as seen in XML).

5.2.8 Core Services

The evaluated white papers show that three different traditional core services are essential for smart spaces and managed zones:

- Naming and directory services
- Visualisation services
- Management services (by means of FCAPS)

Furthermore, three other core services are presented that are essential for smart spaces:

- Adaptive services
- Automated service composition
- Service discovery (and advertisement)

The later three services are based on W3C and WSI standards. This is another strong indicator that the developments of M-Zones focus primarily on technologies from the Internet. From the perspective of communication services, the white papers favour IP and related services (Mobile IP, DNS, DHCP).

5.2.9 APIs

An API is a convention by which applications gain access to operating systems or other services. One advantage of XML is the availability of two different APIs for the processing of XML documents. DOM is best applicable for applications that modify the structure of XML documents and for sharing access to the DOM tree with other applications. SAX represents an event-driven API best applicable when an application deals with large XML documents that do not fit in memory, for counting the total number of elements in a document, and for extracting the content of specific elements.

Beside the availability of these XML APIs (and APIs for handling domain-specific XML documents), no other API is developed or introduced in the white papers.

6 Conclusions and Suggestions

The white papers evaluated in this document address a wide range of subjects and domain-specific solutions. We understand that most of the work in at an early stage and that many white papers describe work in progress. However, the subjects of work package 3 are well-addressed and the given concepts, architectures and technologies fit in the targeted M-Zones objectives. A number of interesting and essential questions can be extracted from the evaluation of the white papers

- What is the underlying metaphor (paradigm) of a smart space that needs to be addressed by engineering managed zones?

- Can we identify a meta model for loosely coupled components that enables interoperability, scalability and portability of these components?
- To what extend do we need to incorporate semantic information into object models, repositories and formal notations?
- What are the novel management functions that are needed to use, operate, control, administer and maintain a smart space and a group of smart spaces?
- What services, protocols and formats must be provided by the underlying technical environment to enable managed zones?

Section six of this document gives a number of tasks that (might) be interesting (necessary) in order to find answers to these questions:

- Refinement of quality criteria for work package 3
- Identification of a common layout and style for white papers (and general research papers)
- Agreement on a common terminology for managed zones
- Integration of (currently) individual research activities on institutional level as well as on the M-Zones programme level
- Definition of interfaces to work packages 2 and 4 for cooperation and to work package 1 for reuse and new input

7 References

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