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Palette

Pedagogically sustained Adaptive LEarning Through the exploitation of Tacit and Explicit knowledge

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Executive Summary

This document considers and analyses innovative ways to facilitate and enhance collaboration within CoPs. In particular, it focuses on issues related to ubiquitous and context-sensitive computing, personalization, security and serious games. These issues are tackled from both a pedagogical and a technological viewpoint. While the pedagogical viewpoint aims at identifying the relevant axes of change in the context of collaboration and the associated opportunities, the technological one aims at elaborating related requirements. Part of the technological viewpoint is also a review on the current state of the art with respect to related technologies. Finally, the

document discusses the implications that these technologies may have for the project's collaboration support tools, namely CoPe_it! and eLogbook.

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1 Introduction

This document reports on the analysis and exploration of innovative ways to facilitate and enhance collaboration within CoPs, which was conducted in the context of Palette's WP4 (Task 4.7), the ultimate aim being to shape a "design space" for emerging collaborative learning environments. More specifically, we have investigated current tools and their possible evolutions towards incorporating more innovative collaboration means. Keeping the above as the main interest of this deliverable, our interest turns into several concrete topics, subject for further consideration.

The deliverable adopts both a pedagogical and a technological approach to innovative collaboration. We first adopt a pedagogical perspective on the issues of innovative collaboration. In particular, the relevant section (Section 2) emphasizes on the changes that occur when new technologies are introduced in learning contexts. In Section 3, we describe what may be regarded as innovative collaboration. This is achieved turning the focus on several desired features concerning an innovative collaborative environment. These features are broken down to prescribe *ubiquitous*, *context-sensitive* and *adaptive*, *personalized* and *secure* tools. Each of the above features is presented through the presentation of examples of use. Section 4 follows a technological perspective by considering mobile applications. We present technologies that meet global acceptance and discuss the reasons why a developer of a collaboration support tool should take them under consideration. During the current analysis, a new direction towards a possible exploitation of Palette tools came up concerning serious games. A dedicated section (Section 5) investigates the current usage of serious games and its possible application to the currently developed WP4 tools. A brief description of serious games (i.e. definition, benefits) is provided and an analysis of both serious and collaborative games is performed. Section 6 relates the aforementioned technologies to users' and CoPs' needs, while Section 7 discusses their implications to the tools being developed in the context of WP4 (namely, CoPe_it! and eLogbook). Finally, Section 8 provides a list of concluding remarks.

2 Nodes and axes of change in the way technology is used in learning

The aim of this section is to explore trends in the development strategies of online tools and services and how they relate to leading-edge practices in collaborative working and learning. In line with the efforts of the Palette project, where the combination and integration of a wide range of online services and pedagogical approaches is seen as the most adequate response to the needs of CoPs, we pay particular attention to mechanisms by which various functions are combined to provide more complex, tailor-made solutions on a flexible, personalized basis. This reflection is grounded on a survey of existing practices and trends as found and discussed online.

When talking of future developments we need to be aware of what Chaos Theory calls "path dependency" (the extreme importance of the starting point for the nature of outcomes of future paths in complex situations). For this reason, we have chosen, in this section, not to limit ourselves to any one particular set of existing tools or services. In addition, we have sought to detect emerging lines of force in the present situation as the best way to approach the future rather than speculate about future uses and tools.

At the same time, the widespread success of certain emerging technologies does condition what will be acceptable in the near future. Users who are accustomed to the possibilities and the ease of use offered by platforms like Google Docs, Last FM, Flickr, Diigo, etc. will not want to use tools that don't have comparable performance and ease of use. While the number of users acquainted with these new tools remained small, developers could afford to ignore such changes, but as levels of adoption rise and users become familiar with and then take for granted these new possibilities, developers may no longer be able to ignore the demands of users.

Two of the greatest challenges in working on the usage of technology are the rate at which both the technology and its usage change and the complex relationship between usage and technological development. The apparent acceleration of change raises methodological problems both for research on learning and organizational practices as well as for software development, in particular when that rate of change is faster than the pace of development or research. In this case, there is a risk that development produces software that is no longer needed and research produces knowledge about situations that is no longer pertinent. These problems are made all the more difficult if the change is not linear, but involves the emergence of unexpected shifts in paradigm.

Evidence would seem to indicate that just such a paradigm shift is underway in the uses of technology for exchange, collaboration and knowledge building. On the one hand there is the incumbent, insular approach, building closed islands of software that can do a considerable number of tasks and that are aimed to capture clients, locking them in to a given logic and blocking them from changing because of the investments made. Such services have longer development times limiting their ability to respond to change. They also require a longer learning curve for potential users and new versions, although welcome, are also a disruption of use. On the other hand, there are micro-applications that are open, supple, flexible, modular and interconnected allowing combinations of functions and services that offer new possibilities each time: never twice the same solution. These applications, which generally need a platform to work, are easy to use and require very little effort on the part of the user.

A similar paradigm shift would seem to be underway in learning. The traditional institutional approach to learning is closed and complex, making learners dependent on the incumbent organization for learning. It involves delivering the same pre-packaged knowledge to whole groups of learners. Note that even in those places where a more personalized approach has been adopted, it is still geared to the institutionalization of learning. Learners are seen as individuals and their acquisition of knowledge is carried out and tested individually. Learning takes place in fixed locations, at fixed times, with approved content and with officially appointed people who also have the right, the duty and the power to assess and certify what has been learnt. The new learning paradigm is much more open and flexible. It opens the door to non-institutional and informal learning. It involves collaborative learning that pursues tailor-made paths dictated by individuals and groups. It also shifts emphasis from distributing tasks and sharing ideas to monitoring progress and refining goals [1]. Learning takes place at any time and in any place. Any person is a potential source of learning. The value of much learning, as in CoPs is "measured" by its usefulness in solving concrete problems and explaining and improving the way things are done. It can also be assessed by its contribution to the strength of the identity of the CoP and its capacity to assimilate new members and new ideas.

On closer scrutiny, however, this image of the paradigm shift oversimplifies our understanding of the situation: with a before and an after and a rift in perspective or approach between. As a model on which to base understanding and to pilot change, it is too limited and too limiting. In reality, there are a whole series of axes and nodes of tension along and around which usage is evolving and it is the combination and the interaction of these axes and nodes of change that make up the overall evolution of the situation. As an example of such axes of tension, there is that between processes and results: both in terms of use of software services but also in terms of learning, different approaches range from emphasis on results to an accent on the process, and why not a combination of both. Another axe would be between the privileged place of learning, working and connecting like the school or the workplace or the home and the "here, there and everywhere" in the vision of "ambient" learning and "pervasive" technology. Confronted with this complexity and the related uncertainty, the piloting of work on developing usage of technology for learning purposes lacks a holistic approach to the emergence of new usage that could provide guidance for technological development and the pedagogical and organizational support to communities of practice.

It is interesting to note that predictions of major technological advances [2], unless they be in publications specifically centered on education, make no mention of learning. An intriguing paradox: in the so-called society of information (and knowledge) learning is not seen as at the forefront of technological development. Pursuing that paradox, while highly worthy of exploration, would take us beyond the scope of the current publication.

The present section sets out to explore a number of current nodes and axes of change that punctuate, traverse and shape the usage of technologies for exchange, communication and learning by structured as well as ad-hoc groups and communities. It does so not so much in terms of specific technologies but rather in terms of generic characteristics of usage and tools related to the evolving technology. Examples are given, however, of existing technologies that illustrate aspects of these forms of usage.

2.1 From castles to Lego bricks and back again

On the one hand, there are the applications. The metaphor for these applications might be the castle with its wall of protection, its guarded access to the outside world and a whole life that goes on within its walls that is largely self-sufficient. These integrated applications are generally multi-functional, invariably complex, frequently proprietary and often closed. They work on a computer and require a specific OS. They may be able to connect to other applications on the machine or beyond to the Internet, but that interaction is limited. The data is often in a format that is specific to the application and can only be used by another application if it is transformed into another format. You have to pay for these applications and they are periodically up-dated, at a price. New versions need to be seen to be new. If they weren't why would you pay for them? Learning how to use them takes time and amongst the plethora of their functions many are frequently not used. In the area of learning, much of the commercial but also open source response to the need for online tools has pursued the integrated application paradigm, with the development of learning platforms, learning management systems and other VLEs (Blackboard, Moodle, ILIAS, First Class, WebCT, etc.). The use of such integrated applications could be seen to correspond to more formal and institutional settings, providing what would appear to be a stable and trusted place for learning.

On the other hand, there are the micro-applications. The metaphor here might be the Lego bricks that plug together and are interchangeable. Each brick has its own function, shape and color. And thanks to the base-sheet provided with the bricks, you can build any number of things with them. Micro-applications are generally mono-function. They are modular, open and designed to communicate and interact with other apps and APIs across the Internet and between machines. They are OS independent, although they generally require a platform online. They often separate function, content and layout such that content can be dealt with by any number of micro-apps and appearance and language can be dictated by the user without affecting content. As a result, micro-apps are potentially interchangeable. The short development cycle for such micro-apps makes them more suited than larger integrated applications to a fast changing context in which practices evolve rapidly. As a result, these micro-apps are likely to be more used in less formal and informal learning and in contexts that require rapid adjustment to complex, fast changing situations as in the case of many professional CoPs.

There is however, not necessarily an opposition between the two "paradigms", provided they can work together. Modular micro-applications allow easily modifiable chains of actions to fit a wide variety of customizable working scenarios, but certain fixed chains of actions, as in more complex integrated applications can also be useful and convenient.

2.2 Layout and interaction

The Web was initially invented by workers at CERN to help publish and exchange results of research. HTML was designed to permit a minimum structure for text documents. Progressively other elements have been added to text on the Web page and the layout of these elements has become more flexible and complex. By "layout" we mean the physical positioning of "objects" (such as blocks of text, photos, videos, sound) with relationship to each other. Applications like Dreamweaver or iWeb enable the creation and positioning of such blocks for web pages. With time, some of the "objects" included in the layout may be computed on the basis of data taken from elsewhere. The 2D metaphors used in this work include the page, the window, the desktop, and the workspace.

One result of the use of platforms that enable the composition of "computed" objects together on one web page [3] is that the user can "compose" his or her own "environment", aggregating personalized sources of information and selected functions. In so doing, such modular, flexible environments potentially challenge the existing monolithic learning environments mentioned above, although, to the best of our knowledge, no one has yet created such a platform dedicated to "learning" (or social networking for knowledge development).

In terms of “layout”, much of what is presented is the result of a process rather than the process itself: web pages, articles, photos, videos, statistics, etc. There is some depiction of processes as with mind-mapping using sites like Bubbl.us [4] or software like Inspiration [5]. In these cases the relationship between objects is not just a question of position but also of the nature of the relationship depicted by arrows, lines and symbols. For the moment, there is very little dynamic depiction of processes. This would involve the interaction between "objects" in terms of use or transformation of data from one by another with changes taking place in real time. One could imagine a tool for peer exchange and group learning, for example, that graphically represented the process of a project with its phases and outcomes (linking in to other applications for collective editing, assessing and publishing material as well as planning and managing work) and, at the same time, helped identify shortcomings in knowledge within the group in relationship to the project (linking to evaluation tools) and assisted the formulation of suitable learning strategies (scenario building tools) as well as pointing to possible sources of knowledge (sophisticated search engines for documents and a social networking context for sharing knowledge and experience).

On a different level, in terms of the interaction between micro-apps in relationship to learning, particularly in CoPs, one of the consequences of the modularity of such apps, their relative simplicity, their mobility and the portability of data, is that so-called "learning scenarios" can be mapped out with a combination of apps in a much more flexible way at a finer level of granularity, tailor-made on a case-by-case basis by the users themselves. Such "interactive" learning scenarios might also combine a limited number of larger integrated apps or platforms with a multitude of micro-apps. Each new learning situation is then an occasion to combine and re-combine a series of functions using apps and micro-apps. That the combination might be different each time implies that the contractual relationship between the user and the makers of apps will probably be different, involving a much shorter-term relationship and looser ties on the part of the user and a much more compelling necessity for the programmer to respond to users' needs and propose new and better ways of doing things. Simplicity, ease of use, intuitiveness, high level of integration, reliability, capability, minimum user investment, etc. will be major user-based criteria for judging the quality of apps.

2.3 Here, there and everywhere

Let's look at the notion of "place" with respect to computing, seen from a (simplified and very approximate) historical perspective. Stage one: there is the computer and a limited "something" inside it that is relatively inaccessible to most people. Stage two: as graphical interfaces appear, "place" shifts to the computer screen and becomes more accessible and richer in terms of content. The creation of the computer "mouse" links the hand to the eye and makes moving around the screen easier. At the same time, computers begin to communicate with each other and can exchange certain documents, albeit clumsily. Stage three: the Web is born and any computer can access the web. With the advent of the Web, a metaphorical virtual world comes into existence that is accessible from anywhere, although content is limited mainly to text documents in the beginning. The computer remains the privileged window onto that virtual world, although access is only possible when the computer is connected to the

Internet. Stage four: the virtual world can be embedded in the computer resulting in a first blurring of the frontier between the computer as the home foyer and the Internet as the big outside virtual world. Widgets, calendars and other gadgets synchronize with data online creating the illusion that the Web is in the computer. Updating only occurs when the computer is online and it is only automatic one-way from the Internet to the computer. Stage five: offline working synchronizes automatically when connected, up-dating material online. Google Gears [6] and Adobe Air [7], for example, are working on this [8]. So the distinction between here and there fades even further as the computer increasingly becomes a possible anchorage of the virtual world - one that is here, there and everywhere.

2.4 Mobility

A number of inventions have influenced our notion of mobility. Ranging from the sandwich to the portable phone and including such things as the portable radio, the Walkman, the Discman, the portable computer and the PDA, these inventions all favor more or less instant access to resources that otherwise would have remained out of reach. The key factors as far as mobile communications are concerned are decreasing size of access devices, ubiquitous access via wireless links and "rich" content. As key functions and critical information covering a large range of activities in life are increasingly more readily available online, the need to access this information and those functions becomes more pressing. From a user perspective, this implies the constant availability of a "virtual" world and the related activities, even when one is on the move. One of the challenges in accessing the Internet from multiple devices in various places is the need to control access to your documents, programs and working environment in secure but user-friendly ways (the single sign-on).

But mobility is not just about machines and access, it also about data and access to that data. Data itself needs to be mobile so that it can move from one platform to another, from one application to another. Data needs to be in a format that can be used by all similar types of apps. Data also needs to be potentially available both online and offline. Google Gears, for example, works with a local cache that acts as a temporary store when the machine is not connected to the Internet. There is also the question of functional mobility, freeing micro-apps from platforms and operating systems that they can function in many different environments. As a result, the operating system or the platform used could well become less important.

2.5 Individuals and groups

There is a double movement underway both in terms of learning systems but also in terms of technological possibilities. On the one hand, the individual is increasingly enabled (technologically) and empowered (pedagogically, institutionally and socially) to pilot his or her own learning. "Personalization" has become a buzz word and the concept has driven efforts to personalize learning in schools. The degree of personalization ranges from a limited choice between a series of options dictated by an institutional (and technological) context and complete freedom extending to non-institutionalized and informal learning supported by all manner of technologies, many of which were not initially conceived for learning.

On the other hand, learning is less and less perceived as an individual activity. From a theoretical perspective, learning is increasingly considered to be situated, embedded in a context with individuals, groups, devices, objects, tools, etc. At the same time, learning is seen to be distributed, i.e. the knowledge is shared amongst the members of a group or community. [1] Amongst other things, growing interest in peer exchange and communities of practice reflect that change. Sharing and collectively working on resources become key activities, with tools like Wikis and platforms for social bookmarking supporting it. In this context, resources need to be either individual or shared at a flick of a switch.

2.6 Content creation

An axe of change crosses the field of content, stretching from the "broadcast" paradigm in which unified content is made available centrally for all learners to the distributed paradigm where content is created by a large number of actors and freely chosen from by those who are interested in it. The textbook is typical of the broadcast paradigm and the Internet characterizes the distributed paradigm. The broadcast paradigm builds on the idea that the creation of content is the province of experts and that people learn by assimilating existing knowledge through pre-designed content. In some respects this can be assimilated to surface learning, that is to say, the tacit acceptance of information and the memorization of isolated and unlinked facts. But it may also embrace pre-determined learning paths and pre-supposed ways of understanding that are applied to all. [9] In technological terms, the vehicle employed corresponds to certain VLEs and elearning platforms designed to deliver set content according to a curriculum or course and carry out standard testing using methods like multiple choice questions. In the distributed paradigm, much of the content is produced by the learners themselves. In creating content and sharing it with others, learning is achieved through the negotiation of understanding and the reification of that understanding in the material published (this is known as in-depth learning). From the perspective of the experts of the broadcast paradigm, the distributed paradigm raises the question of quality control. From the perspective of the champions of distributed paradigm, the content produced is the fruit of authentic learning. In technological terms the distributed paradigm implies enabling the creation of web pages, providing tools for social bookmarking, enabling exchange and collaboration, facilitating the storing and recovery of multiple documents, and so on. It also implies the provision of diagnostic tools and tools for self-evaluation. It is interesting to note that that learning platforms generally embed an implicit pedagogical choice.

A second axe of change crosses the content field: one that stretches from knowledge embedded in content as a complex, interrelated whole to modular content where small parts of knowledge are articulated and can be combined to make more complex knowledge. This second, modular paradigm in technical terms is epitomized by the "learning" object, in which small manageable units of content and, in some cases, related software functions are stored in a repository and can be retrieved and combined to construct a multitude of learning scenarios. This paradigm might even be called "industrial" in that it follows an industrial metaphor of construction using standard spare parts. Much of the meaning in the embedded paradigm lies in the relationships between the different ideas in the overall content. This meaning is lost in the industrial model if no provisions are made to represent the relationships between objects.

3 Innovative collaboration and emerging types of CoPs requirements

As new technologies come into existence and current ideas are seen through different prisms, CoPs are re-examined, in order to be improved, and new CoPs also emerge. Existing and emerging CoPs both drive and are driven by technology at the same time. Taking these facts into account, we look into potential technologies that could be used in the collaboration services being developed for Palette and discuss how such technologies could impact the applicability and adoption of these services. This section focuses on four collaboration aspects, which are delineated by ubiquitous, context-sensitive & adaptive, personalization, and privacy issues.

3.1 Improving existing CoPs and creating non-traditional new CoPs

As the use of mobile devices is spreading, existing CoPs are pushing for the idea of connected informal learning at any time and in any place. With these facts in mind, existing CoPs could benefit from the use of mobile devices, as an innovative collaboration technology, as informal learning could go beyond the working environment. The flexibility of using mobile devices builds stronger social and knowledge networks, which allows workers to be connected, even when they are not physically at the work place, and thus increase the number of available workers who have a strong network of peers. Furthermore, being able to work from any place and at any time, as well as being always connected, allows workers to be able to multitask and work on more projects with greater efficiency, thus increasing productivity. The benefits derived from using mobile devices within CoPs go beyond the working paradigm. CoPs of any setting could benefit from more “information hubs” in the community as well as from the fact that increased connectivity allows for CoPs to always be up to date. The Palette tools developed in WP4 could potentially benefit from using mobile technologies and having mobile interfaces so that their services could be accessed from a remote location and with a mobile device.

Another technology, which we will discuss in a later section, that is starting to shape as an innovative collaboration mean from which CoPs could benefit from is serious games. Serious games provide the means to learn more effectively and with greater engagement, which in turn could help members of CoPs to convey their meanings and ideas more easily as well as be more attached to the community. Moreover, the combination of mobile devices with serious games, in the future, could lead to the combination of the aforementioned benefits from both technologies. As serious games are a varied and large field, Palette services could potentially benefit from exploiting some aspects of this field to increase effective learning and engagement.

Apart from improving existing CoPs, non-traditional new CoPs could also appear through the use of the innovative collaboration means discussed. Although it is difficult to force the creation of CoPs and "you can not replicate the end point of an evolutionary process, you can [always] stimulate similar starting conditions" [10]. As such, using this new technology new CoPs appearing could include wandering nomads, disabled people, drug & alcohol addicts, as well as elderly people [11] to name a few. Wandering nomads, as their name suggests, are on the move most of their lives and as such could use mobile technologies to collaborate, even with distant friends. Disabled, elderly people and addicts could use mobile technologies, to create CoPs to support others with relevant difficulties to find solutions, as well as serious games, to create support games with learning outcomes for new or existing members.

In order to improve existing CoPs and push for the creation of new ones mobile devices are required to fulfill a number of requirements. These requirements, which are discussed in separate sections of their own, rely on the assumption that mobile devices have underlining ubiquitous technology, are context-sensitive and adaptive, personalized, as well as cater for privacy of the user.

3.2 Ubiquitous computing

Ubiquitous computing is a model where information processing using computing becomes an integral part of everyday objects and life. Opposing the contemporary desktop paradigm, where there is a single user operating a single device for a specialized purpose, ubiquitous computing would allow the user to engage many computational devices without even being aware of doing so. In general, ubiquitous computing has as its goal the non-intrusive availability of computers throughout the physical environment, virtually, if not effectively, invisible to the user. Even though current research is still at an early phase and is for the most part focused on the mobile infrastructure for wireless networking, ubiquitous computing is considered to have a greater impact on all aspects of computer science and thus it is wise to claim that ubiquitous computing has a broader scope and cannot be tackled efficiently solely through the above research areas [12]. The core idea behind ubiquitous computing is the use of small, inexpensive, robust and networked devices that are distributed in our everyday lives.

Mobile devices, as we know them today, fulfill this core idea. Apart from being small, inexpensive, robust and networked, they can also capture text, images, video and audio, which allows for interactive collaboration and collective intelligence on the go [13]. By collective intelligence we mean the combined intelligence that derives from the collaboration of many individuals. At present most ubiquitous related applications are information mashups, which means that they combine information from different sources to deliver a service that could not have been created otherwise. For example, the University of Oregon uses mobile devices, equipped with a geographic information system (GIS) and a global positioning system (GPS), "to collaborate with the community to develop resources such as safe walking route maps, local area conditions, and sidewalk walkability surveys" [13, 14].

Although mobile devices have come a long way in the last few years, the vision of ubiquitous computing is still far away. This is due to a number of reasons, not all of them related to technology. Mobile devices should have inexpensive widespread sufficient bandwidth, which is currently not the case even with technologies such as 3G and Wi-Fi, which even though they have sufficient bandwidth, are expensive. Furthermore, the power consumption as well as the life of the batteries used in mobile devices must be improved in order to cope with the demands of improvement. The cost of sensors, which can range from a few cents to hundreds of euros, is another reason why mobile devices and the environment in general are not equipped with all the censors needed to enable ubiquitous computing. Finally, apart from the hardware aspect that needs to cater for mobility and ubiquity, data itself needs to be pervasive and mobile so that it can move seamlessly from one platform to another, from one application and device to another. Data needs to be in a format that can be used by all similar applications and devices, online and offline.

3.3 Context-sensitive and adaptive computing

Context-sensitive devices refer to devices that can sense their physical environment and adapt their behavior accordingly. By context we refer to the user's location but also who the user is with, what resources are available nearby and other aspects of context that are also mobile and changing. Such aspects that might change with time include connectivity, communication costs and bandwidth, lighting, noise level, etc. There are four main techniques for context-sensitive applications that can be combined together: proximate selection, automatic contextual reconfiguration, contextual information and commands, and context-triggered actions [15].

Proximate selection, as the name suggests, is a user interface technique that emphasizes nearby located objects relevant to a user's task but does not select them automatically. Objects may include other users as well. An example where this technique can be used is for the recommendation of selection of computer input and output devices that require co-location for use, such as printers, displays, speakers and so on.

Automatic contextual reconfiguration denotes the process of adding or removing components or altering their connections automatically. Components are mainly servers and connections are communication channels to clients. An example of automatic contextual reconfiguration, which is based on both the location of the user as well as the other people present in a room, is the availability of a virtual whiteboard when these people are in a meeting as a group. This availability would make virtual whiteboards, for example, more powerful than their physical analogues since the former would persist throughout meetings. Although automatic contextual reconfiguration is useful it must be dealt with care since "if the context is changing rapidly it may be distracting to the user … [and] certain adaptations may confuse the users" [15].

Contextual information and commands exploits the fact that people actions can often be predicted by their situation (e.g. where they are located or with whom they are interacting with). The user interface would change to suit the situation better. For example, non-intrusive useful awareness information such as ads from stores and malls could be sent to a user wandering around shops [16].

Finally, context-triggered actions are simple IF-THEN clauses indicating how context-sensitive devices should adapt. They are basically context-triggered action commands that are invoked automatically depending on previously specified rules and used for notification. For example, such rules could include "next time I see Maria remind me to tell her about Jack" or "next time I am in my house remind me to wash the clothes", and so on.

Mobile devices are not as "standardized" as stationary computers but much more diverse with respect to computing resources, connection bandwidth and display capabilities. As such, adaptive and device-independent applications need to be developed [17, 18, 19]. Furthermore, mobile usage is spontaneous and applications should be fast to install, start, and use in mobile devices and wireless networks. This all sets requirements for client and server-side adaptation methods that can provide more usable and efficient applications for specific users, contexts, and services available on the Web [19]. In [19] a composition technique is introduced, which is based on the content adaptation model of the World Wide Web Consortium (W3C), and looks at how dynamic composition of adaptive applications can be exploited. The technique supports automatic and user-directed adaptation and speculative adaptation. Speculative adaptation prepares applications for potential future context by using prediction models and information pre-fetching so that information that the user may need, predicted by previous user behaviour, is already available. If the prediction fails, this failure must be recognized and the prediction model updated.

3.4 Personalization

On the whole, mobile devices are mainly used by individuals and not by groups. That is, every individual has his/her own mobile device. This fact, as well as that they are cheap, makes mobile devices more personal than desktop PCs [20, 21]. By personalized devices, we mean the tailoring of the device hardware and software to a user, based on personal details and characteristics. These personal details may be given explicitly or be generated automatically by inspecting user behavior. It is argued [22] that “the best way to know what users prefer is certainly not to ask them, but to extract meaningful patterns from what they naturally do when using a service”. That is, that implicit personalization is better than explicit. However, a combination of the two would provide the best user experience, allowing the user to allow, deny or change any automatic implicit personalization rule that the system would want to create [23]. This would provide the user with greater security as he would opt-in for any rule, but leave the underlying creation of the rule to the system, instead of having the system automatically generating rules without the user’s consent.

Moreover, user preferences, profiles and their management should be application-independent so that profile data is the same for all applications and the modification of user data does not end up being a tedious and time-consuming task for the user [23]. There should be a general preferences module that would store a list of user preferences and rules, which would be consulted every time an event arrived.

"The main challenge is how to structure and represent the rules in such a way that they are easily readable by the user that wants to maintain them, easily extensible for future situations, and are general enough so that preferences can be specified in a way that they will be applicable for many events (if desired)" [24]. Thus, there are several technologies needed for the creation of an application-independent context sensitive personalization module. There needs to be a technology dealing with the representation and management of the user profile. Another technology that allows the personalization module to learn through the actions of the user, and finally a technology that would provide recommendations to the user based on his history and his current context.

3.5 Privacy

Mobile devices, being personal devices, often contain considerable amounts of personal information and data about the user. As such, on the one hand, it is imperative that the privacy protection measures in place are sufficient, which will allow the user to trust the system more. On the other hand the privacy protection measures should not prevent the user from sharing any information and data in a straightforward and efficient manner with groups of people he/she wishes to do so. Thus, the privacy of the user should be on his/her hands; that is user-centric [23]. The user must always be in charge of how his/her data is shared, with whom and under what rules.

We define privacy as "the claim of individuals, groups and institutions to determine for themselves when, how, and to what extent information about them is communicated to others" [25]. Privacy issues have already been tackled in WP5 and technical solutions have been proposed and implemented (for more details, see [26]).

The core of privacy is how much information is revealed to others. With context-sensitive applications personal information needs to be shared in order for them to function and the user needs to decide who to trust and in what extend. Users tend to give more personal information to trusted groups, such as family, than to less trusted groups, like work-mates, although there are cases when users do not want to share some information, such as location, even with trusted groups for a time period. Another fact to consider is that people "do not behave rationally or consistently to the extent that can be modeled … in terms of rules" [23]. For example, although most users understand privacy concerns they sometimes are willing to compromise their long-term privacy for short-term insignificant benefits.

The trade-off between privacy management and personal information management is a hard problem to eliminate; this is due to the volume of information, but also due to the fact that users have different reactions concerning their privacy. Personal information about a user in a collaborative environment should be managed by the user in a controlled disclosure manner; the user should be able to determine the people who are able to view/comment on his/her data. When adding data to a collaborative environment, the user should clearly understand what data will be available to other users, as well as to which other users.

Furthermore, there is the need for trustworthy communications. Since a user using his mobile device in a ubiquitous environment will interact with various parties, such as service providers, and ad-hoc groups, such as other users or group of users, there must be mechanisms to ensure the trustworthiness and privacy of the interaction. There are a number of threats, such as identity theft, personalized spamming or eavesdropping, which could potentially jeopardize the communication between groups.

Finally, the amount of privacy that a user witnesses in an application must not be extensive. If this is the case, "privacy management features can work against their original intensions" [23]. It has been shown that overwhelming presence of privacy makes users concerned and instead of trusting the application more, they trust it less.

Table 1 provides a summary of the collaboration aspects elaborated above.

Aspects	Requirement examples
Ubiquitous	GIS devices; GPS enabled applications
Context-sensitive and adaptive	Sensors; Contextual reconfiguration; Contextual information and commands; Context-triggered actions
Personalization	Both implicit and explicit collection of user preferences; Application independent profiles
Privacy	Users control the amount of information they want to share as well as the information receivers

Table 1: Summary of collaboration aspects

4 Mobile and ubiquitous technologies and methodologies

4.1 Common standards and mobile communication

Early web applications were mainly a set of web pages –usually static- provided by some navigational mechanisms forming a web site. The purpose of those early web applications was strictly informational and was conducted through the adoption of HTML and limited JavaScript functionality.

Nevertheless, development of contemporary web applications is a task a lot more complex and challenging. Nowadays web applications are designed developed and deployed crossing multiple disciplines from diverse areas: systems analysis and design, software engineering, hypermedia/hypertext engineering, requirements engineering, human-computer interaction, user interface, information engineering, information indexing and retrieval, testing, modelling and simulation, project management, and graphic design and presentation. A term coined to sum up all of the above tasks is commonly met as “web engineering” [27].

Within the context of Palette, a number of applications have been developed and operate over the web. These applications are rather complementary to each other, since all of them are aiming at providing a collaboration environment to the same Communities of Practice. The above remark must be taken into account and is expected to prescribe a set of requirements and specifications for the aforementioned applications.

Before proceeding to a more detailed examination of technologies that should interest Palette tools development, the term “web application” needs to be further elaborated. From now on, when referring to term “web application” we will refer to two different cases: the first case is where the application is accessed via any web browser, whereas the other maybe any kind of application which utilizes network resources to be fully operational. An example for the first case may be CoPe_It! [28] whereas for the second case may be any desktop application which operates using web services.

For the first case -i.e. web application which run on a web browser-, developing a web application introduces several advantages regarding its portability, usage and in general applicability comparing to classic desktop applications. Applications that operate over the WWW were firstly thought to run on standard personal computers, but it is common ground that a large volume of devices provide browser support as well and thus become a web application environment as well. Even though technologies used to develop web applications are designed to be machine independent (operating system, browser), a large number of differences are found when switching the end user's platform. In order to insure that a web application will remain operational at heterogeneous environments, all development effort must be put towards complying with common web standards.

When thinking of web standards, a lot of technology specifications arise. It is not the purpose of this document to provide an exhaustive list of those specifications but rather mention the central topics of interest for the above:

- ***Correctness***

If the web application is web document, *Doctype, Character Set, valid (X)HTML, CSS, correct links, valid JavaScript* are the starting points for ensuring a fast page rendering, non-botched document for the majority of web browsers.

- ***Semantic markup***

The above requirement is commonly met through the adoption of CSS (Cascading Style Sheets) and XML (Extensible Markup Language). CSS will include all presentation information while data is kept in separate XML-formatted files. The above will allow programs like search engine bots or custom-made tools to extract easier the content off the web page and allow reusage more sufficiently. It is important to note that RSS (Rich Site Summary) feeds are always a good feature for a web application as well, since it allows the better monitoring of the web application activity taking place.

For the second case –i.e. web application that makes use of web services-, systems being developed are separated to clients and servers. In this case, those two tiers may be implemented to any platform supporting web services (we follow common definition for web service which is "a software system designed to support interoperable Machine to Machine interaction over a network") and designed according to service-oriented architecture discipline. Web service deployment is achieved by publishing a WSDL (Web Service Description Language), which may be indexed and published to a UDDI registry (Universal Description, Discovery and Integration) for more convenient access. Information exchanged between server and client may be either through REST (Representational state transfer) or SOAP (Simple

Object Access Protocol). In general, the adoption of SOAP -even though it may responsible for slower performance- is considered one of the most well-known techniques to allow the development of various end-user applications.

Within the Palette project, collaboration tools developed are not developed for mobile devices accessibility. In order to ensure that a web page is accessible to as many devices as much possible, developers should test its performance against several clients. This includes modern and older browsers. Moreover web pages without CSS support should result to a tolerant outcome (a very popular test tool for this is a text browser called Lynx). In order to make sure that a web application may be deployed safely to a mobile device, web pages must load on small window sizes, ensure desired printing. A very popular repository of specifications for mobile web applications is considered the W3C Mobile Web Initiative [29], which contains a set of documents, online courses and tools regarding the proper design of a mobile web page. All of the above resources along with several other tools (MobiReady Report, W3C mobileOK Basic Checker [30]) may assist developers test their mobile web pages against the mobile-friendly requirements. Moreover, new efforts have been put to get more reliable and accessible pages for mobile devices. Those efforts –strived from the fact that it is very hard to get one page properly for all devices- focus on creating a common, public device standards [31] repository. This repository will record information like entries from every mobile device vendor which will be valuable for the development. Entries include the useful mobile device properties namely Vendor, Model, Version, Display Width, Display Height, Display Color Depth, Input Devices, Markup Support, Stylesheet Support, Image Format Support, Input Mode Support, Cookie Support and Script Support.

4.2 Security mechanisms

Trusted computing and security mechanisms are becoming increasingly important in the era where information is closely related to money. There is more than one player involved in this part of mobile computing and their interests, as well as their idea of trusted computing, greatly differ. There have been various initiatives, which we will look at, to address the issue of security. During the last decade mobile devices have evolved and from single purpose closed platforms they have become flexible open platforms that allow the users to install any kind of software from different vendors, connect to the internet and are equipped with media players, digital cameras, organizers and gaming devices. Furthermore, mobile devices offer Personal Area Network connectivity using protocols such as Bluetooth. Although this enriches the capabilities of the mobile devices it also introduces security risks, such as worms, viruses and Trojan Horses. These have all been around the desktop PC market for some time and it is only natural that they will appear in mobile devices as they are used more and more and increasingly contain sensitive information. In order for these risks to be minimized, as much as possible, device manufacturers and mobile operators need to use countermeasures.

Most players involved in the mobile devices market are interested in creating open but secure systems. Mobile device manufacturers are concerned in that their reputation is at stake, which largely affects their profit. For example, if a security flaw appeared in a "Nokia" mobile device, then Nokia would be blamed as far as most users are concerned. Mobile operators are even more concerned in the security of mobile devices as if these devices are compromised they can generate useless traffic load on the network, for which users will be unwilling to pay, and thus reduce service quality. Users will be unwilling to pay since they expect the mobile operator to be responsible for a clean network as well as to provide countermeasures for privacy-invasive software. Finally, there will be more need for customer support, which is provided by the operators, and that will result in an extra cost. Content providers (i.e. producers of downloadable digital content such as games, ringtones, software, etc.) are interested in the security of their intellectual property rights as well as secure payments. As such, they are relying on security of mobile devices in order to continue making profit. Corporate buyers are also very interested in the security of their networks. Corporate buyers are IT managers and administrators given the task to provide IT solutions to a company. They are the most security concerned costumers and they do not want mobile devices to create security holes in their systems. Private customers and corporate users on the other hand are usually not concerned with any security issues of their mobile devices and rather look for functionality and design.

In order to cater for mobile security various companies in the market have created alliances with other companies. Through these affiliations various work groups to enhance security and create standards have developed. For example, the Mobile Phone Work Group, from the Trusted Computing Group [32], is such a group. It is made up from mobile service and content providers, as well as component providers, and it aims at adapting existing security standards to mobile device platforms.

Another work group, comprised from IBM, Intel and NTT DoCoMo, worked on the Trusted Mobile Platform project [33] which used the Trusted Computing Group Platform Module to define a set of hardware and software components that can be used to establish different levels of security in mobile devices. The Open Mobile Terminal Platform work group [34], founded by mobile operators, deals with standardization of application interfaces for consistency and improved user experience. In this work group security comes into play when application security is concerned. The work group provides the security requirements to protect users and networks from rogue applications.

Adapting existing security standards to mobile device platforms is, unfortunately, not as straightforward as it would appear. For example, HTTP/SSL, a cryptographic protocol that provides secure communication on the Internet, which is used for e-commerce on desktop PCs, has complications for its use on mobile-commerce. One of these complications is that SSL connections are not supported by all available phones. This makes development of systems that support SSL unpopular on mobile devices. Even with devices that support SSL connections most use out of date symmetric ciphers because they are the easiest to develop. However, these ciphers, such as the SSL/RC4 are easily crackable [35]. Finally, a large number of handsets do not have all of the root certification authority certificates installed and thus are not allowed to connect to a number of popular sites. Since installation of new certificates is unavailable, on almost all mobile devices, this problem cannot be overlooked.

Apart from workgroups and specifications involved in dealing with security threats it is also imperative that individuals and organizations take actions of their own. They should password-protect all devices, encrypt sensitive data and avoid automatic scripts for virtual private network (VPN) login. Privileges of mobile users should also be restricted to only necessary information.

Mobile security has no single security mechanisms solution, since putting technology aside human aspects in security play a large factor. This is so for if the users are careless, whatever security measures are used, the mobile and network security could be compromised. It is in an individuals and organizations own interest to have users understand the security measures available to them, how to enforce them, as well as the consequences of failing to comply. Regular backups of mobile device data on a desktop PC should also be enforced to avoid data being destroyed by viruses and worms. Security-aware users will also provide the best defense against unavoidable lost devices and are thus an important part in security mechanisms for mobile devices.

5 Serious games

5.1 Definition and history

Serious games have numerous application areas were they have been adopted successfully and their precise definition seems to vary depending on the area of practice in which they are applied. A core meaning, however, that most would agree upon, is that "*serious games* are (digital) games used for purposes other than mere entertainment" [36]. With this in mind, it must be noted that serious games are not a new genre but rather a new perspective on how to use gaming hardware and software for the betterment of our everyday lives and jobs instead of just a diversion from them.

Games have been developed for non-entertainment purposes from the 1980s with the first notable example being *Battlezone*, a 3D wire frame tank game, published by Atari and used by the U.S. Army as a simulator. With the growth of the personal computer market the term *edutainment*, which stands for education through entertainment, became popular. Compared to the serious games concept, edutainment was mainly involved with developing software for improving the education of young children, but failed to succeed as it resulted in tedious and uninspiring learning. The application of games to the whole area of learning was re-examined in the late 1990s when technical advancements in the computing industry took place, which produced the ability to provide low cost realistic settings as well as multiplayer capabilities. In 2002 the Woodrow Wilson Center for International Scholar in Washington, D.C. founded the *Serious Games Initiative* [37], which "is focused on uses for games in exploring management and leadership challenges facing the public sector" and thus the term *serious games* became widespread. This term continued to grow and gain acceptance and more initiatives came into existence. Examples of such initiatives are the *Games for Change* [38] and *Games for Health* [39] that were created by CoPs interested in social and health care issues respectively. Serious games differ from edutainment in that edutainment is a subset of serious games. Serious games include edutainment software and extend it in a way that it can be used for any audience and in any setting and not just for primary or secondary education.

Serious games have gained hype over the past few years and, to understand why that is so, game impact theory [40] proposes five forces that are driving their adoption. These forces are: the cost advantage of hardware platforms, software power, social acceptance, industry successes, and innovative internal experiments.

The *cost advantage of hardware platforms* force exists because unlike specialized software and hardware products, serious games, using gaming technologies can be deployed on consumer-grade computers and not professional workstations, which makes them cheaper. These savings can be significant for companies that want to deploy their applications to hundreds of employees. Also, single users, who could not afford specialized products on their own, also benefit, since they can use serious games to get the same result cheaper.

The *software power* force exists because games are addressing some core problems of software usability that exist across a number of industries. One of the goals of a game is to create a user interface that is easy to be understood and handled without ever reading an instruction manual. Any instruction needed is build into the game itself, which allows the user to learn while using it. Games also provide sophisticated and adaptive artificial intelligence, 3D engines, physical models, networking and persistent worlds, which allow producers to build realistic scenarios, all for simple consumer-grade computers.

The *social acceptance* force exists because as the children who grew up in a generation of digital games become industry leaders in companies and organizations, the level of acceptance of digital games is increased. These people do not view games as just toys but also understand the benefits that can derive from them.

The *industry successes* force exists because as serious games become available their benefits are discovered and success stories created, more and more industries are willing to invest in them.

The *innovative internal experiments* force exists because, as serious games are adopted, more research takes place on the subject and new products and services are created to aid established practices.

5.2 Benefits

An important aspect of serious games is the benefits that one derives from using them and this is why we are interested in potentially extending the Palette tools towards this direction. Although there are some concrete benefits that we will discuss, the majority of the acclaimed benefits lack measurable evidence and although they certainly exist [41] we know “little about the consequences of game play on the cognition of those who play them” [42].

The main concrete benefit that derives from the use of serious games is the ability to create environments that could be dangerous, costly, or difficult to recreate in real life. For example, in the case of firefighters it would be difficult, if not impossible, to recreate burning buildings or hazardous spills at chemical plants if not for serious games [43].

Another benefit of serious games is the immersion and engagement they attain and sustain from the users [44]. A successful serious game will motivate the user so that she will be interested in it and play it again and again; an action termed *replayability*. With replayability learning is more efficient as the users will repeat the tasks they need to learn and thus learn them better. Furthermore, engaging games provide a unique learning experience aiding recall and information retrieval. Strategic skills, analytical skills and insight for a task can also be acquired by using serious games, in a cost effective way, since users can deal with the task through a simulation before dealing with the task in real life [44]. This way training times and instructor load is reduced since serious games are far more interactive than lectures and there is no need for many lectures on the task. As such, “serious games fill a gap between lectures and field training” [45].

Social skills, such as negotiation, collaboration and decision making, particularly when using multiplayer technology with serious games, can increase [44] and multiplayer technology in on-line community games also fosters the creation of collaborative knowledge and develops information-seeking habits [46].

We have to note however that although serious games are an effective way of learning, “[not] all games are good for all learners and for all learning outcomes” [42]. As such, more research on the reasons why serious games are engaging and effective has to be undertaken as well as when and how serious games should be integrated to the learning process.

5.3 Examples of serious games

Although this tasks focus is not to provide an exhaustive list of collaborative serious games, we will, nevertheless, point two noteworthy examples; *Second Life*, and *Hazmat: Hotzone*.

Second Life is an [online] 3-D virtual world entirely created by its Residents, [which are real world people]. Since opening to the public in 2003, it has grown explosively and today is inhabited by millions of Residents from around the globe. Second Life, which started as a game, is entering the realm of collaborative serious games as more and more institutions and companies use it to create learning environments. Parts of "land" in this virtual world can be bought on which anything can be build and for any purpose. A series of examples of how Second Life has been used as a collaborative serious game follow. The first such example is a company that specializes in tank leak detection at gasoline stations. They train their employees by building gas station models and allowing them to walk around and look at the underground pipe architecture in order to gain better understanding. Another real-world example of the use of Second Life as a collaborative serious game is the initiative to build a virtual island for adults with Asperger's syndrome to allow them to experiment with interacting with each other. These adults reportedly have used this system to better overcome their fears of interacting with humans in game and in some cases outside the game as well. Furthermore, various classes and schools have also registered with Second Life and have created virtual lectures and classrooms.

Another noteworthy example of a collaborative serious game is Hazmat: Hotzone, an instructor-based simulation that uses video game technology to train first responders about how to respond to hazardous materials emergencies. It is a practical example of how serious games can be used to train people in situations that would be difficult, if not impossible, to create in real life training sessions. Being a multiplayer game, which allows a number of trainees to participate at the same time, helps the learning experience of the situation to be as it would in real life.

5.4 Collaborative serious games

As in this task we focus on the analysis and exploration of innovative collaboration means within CoPs, we will look into how serious games can be specifically build for collaboration purposes.

Most games of any kind developed are individual in nature, with limited multiplayer abilities, and competitive [48]. As network capabilities have improved and have allowed for the creation of massively online multiplayer games, such games have been developed with great success over the years. However, they still remain competitive in nature, while some of the attempts to create collaborative games have resulted in the games degenerating to competition. As such one has to look at the factors that would make a collaborative serious game worthwhile, interesting and attractive.

In a *collaborative serious game* all the participants work as a team, everybody shares the payoffs and outcomes and tries to maximize the team's utility. Human players are by their nature competitive however and as such the design of a collaborative game has to take into account this competitiveness that players introduce [48]. This competition is not necessarily competition to win something or to be the first. It is also competition to gain power within a group, or to make one's own place, role or position. Competition could also be related to the negotiation of the domains of competence of each member; indeed, each member searches for acknowledgement of his/her skills and competence, each member needs to be recognized as the expert of something within the group. This personal expertise allows members defining his/her own identity within the group. In order for player competitiveness to be depicted, as it will exist in real life scenarios, a tension has to be introduced between the utility of the player and that of the team. As such players should have their own, individual, utilities (apart from the team utility) and be able to make decisions and take actions without the consent of the team. Since collaborative serious games are created to aid in improving collaboration skills players should be able to understand how their decisions affect both their personal and team utilities as well as to be able to trace these decisions throughout the game after it has finished. As it is true in real life teams, in order to avoid competitiveness within the team, as much as possible, it is advisable to be able to assign each team member a different responsibility. This way the team members would collaborate and make selfless actions for the well being of the team. Furthermore, as it is also true in most real life scenarios, collaborative serious games should be sufficiently difficult and complicated so that one player does not make all the decisions for the team. Collaborative serious games, as all games, should also cater for engagement and not forget that the players must care about the outcome of the game as well as provide a different experience each time a new instance of the game is played in order to improve replayability.

5.5 Mobile serious games

As the trend in our era is to create smaller, faster and better technology, it is only natural to combine the three state of the art technologies discussed; mobile, ubiquitous and serious game technologies. Although these technologies have evolved throughout the years, creating powerful mobile devices, transparency in computer usage, and sophisticated learning environments, respectively, their combination is still in its infancy. Nonetheless there is increased interest in the combination of these technologies due to a number of reasons [49]. Firstly, there is a massive scope of economic opportunity to be gained by the companies involved. Secondly, since there is a large number of mobile device users there are large commercial and consumer communities that would be interested in the development of the aforementioned combination. Finally, it is a win-win situation as all related parties have something to benefit from. Network service providers that will provide the bandwidth and the services will gain more revenue, mobile device users will have all the power and benefits of serious games on the move and both game developers and mobile device manufacturers will see the demand for their services increase. Thus, we expect to witness more interest in the mobile serious game sector in the forthcoming future.

6 Users' and CoPs' needs

In this section, we describe how the previously presented technologies and methodologies can help address CoP needs, especially as these have been identified within the Palette project [52]. In general, the aforementioned technologies can be a catalyst to address issues, relevant to CoPs such as their distributed nature [50] and their focus towards creating and making available content, engaging in and managing conversations and making social connections [51]. In the following we will briefly report on how the above technologies are related to particular CoP needs.

The use of ubiquitous mobile technologies provides the backbone for users to be able to communicate at any time and from any place. By removing such traditional hurdles to collaboration, ubiquitous mobile technologies improve participation and increase the coherence of the CoP. Context sensitive and adaptive computing mobile technologies play an important role in improving the exploitation of common resources, as individual users are able to tailor the environment to their needs. Privacy and personalization improves commitment as the personalization and profile options in particular contributing in establishing trust between CoP members.

Finally, serious games provide an engaging context that motivates participation as they contribute in removing involvement barriers that can be traditionally be observed in collaborative environments.

Table 2 summarizes the CoP need [52] which each technology presented in this document addresses.

CoP Need	Technology
To improve participation	Ubiquitous mobile technologies Serious games
To improve exploitation and ease of retrieval of common resources	Ubiquitous mobile technologies Context sensitive and adaptive computing
To support commitment	Privacy, Personalization

Table 2: Proposed technologies in relation to CoPs needs they address.

7 Implications for the WP4 tools

In this section we look into how the aforementioned technologies and methodologies could impact the applicability and adoption of the collaboration services being developed for Palette. The services we are interested in are CoPe_it! and eLogbook.

7.1 Implications for CoPe_it!

In order to further elaborate towards some enhanced versions of CoPe_It!, it is more productive to think of specific requirements and scenarios where all of the above features may actually find use. One step towards this is thinking of specific CoPs with several restrictions, like limited time or space participation in collaborative activities. Furthermore, it is useful to notice that most of the aforementioned features describe an environment where several tools (not specifically in the Palette context) are mashed up and provided to the users. Thus, one crucial aspect towards achieving all of the above is putting effort towards broadening CoPe_it! functionality for usage from external resources. Common standards, standards for mobile communication must be followed. Functionality is highly recommended to be exported in a modular way, so that the multiples levels of granularity allow more convenient tailoring. To sum all of the above, it may be claimed that developing an innovative collaboration tool like CoPe_it! is dependent on two axis: the first is the technological axis, where all implementation of the tool is taking place with regard to several standards and the second expresses the design and description of a usable scenario that may be applied to a specific CoP in an environment with several descriptions. Those 2 axes are not orthogonal, but rather dependent to each other; by adopting several technology standards, we envision a specific environment and vice versa.

7.1.1 Ubiquitous computing

We first look at CoPe_it! and, in particular, how ubiquitous computing could influence it. Some elements of ubiquitous computing technology are already evident in CoPe_it!. There is user and partially data interoperability between CoPe_it! and the rest of the tools being developed, which allows users to switch seamlessly from one tool to the other. Furthermore CoPe_it! uses information mashups as one can access search and instant messaging services from within the tool's user interface. CoPe_it! could potentially improve by using more aspects of ubiquitous computing such as, for example, using biometric sensors to sense the reaction of the user to a specific argument within a discussion. A more tangible example would be the creation of a light version of CoPe_it! that would allow the user to access it through a mobile device.

7.1.2 Context-sensitive computing and personalization

Context-sensitive and adaptation techniques could potentially be used in CoPe_it! in a number of ways. To name a few, the user interface could automatically adapt depending on the environment the user is in. The user could select the desired output (mobile device, computer monitor, projector, etc.) and CoPe_it! would be displayed in the correct format respectively. This will be needed since the user interface of CoPe_it! would be radically different when it will be used in a large computer monitor compared to a small mobile device display. Content delivery mechanisms should take under consideration the user's environment and provide content in a more convenient way (data compression for reduced and cheap transmission, image resizing etc). Furthermore, when a user is close to other users CoPe_it! could show to the user how he collaborates with the other users in his vicinity and if any collaboration matters need attention.

The combination of contextual information, adaptation and personalization could be used to assist the user when using CoPe_it!, especially in limited user interfaces, such as with mobile devices and small screens. The user interface could prompt the user, depending on his/her current situation and history, on future probable actions. The user would then be able, in most cases, to navigate to the appropriate part of the user interface quickly and efficiently. He/she could also manually create a user interface with the shortcuts most used to design a completely personalized user interface. At the moment CoPe_it! uses personalization techniques in that it has user profiles that are tool-independent.

7.1.3 Privacy

As far as privacy is concerned, CoPe_it! must provide privacy using sign-in security measures and authentication, but must not exceed the limit that turns privacy against the application it is being designed for. To avoid this, it allows for a single sign-in to allow for users to seamlessly transfer from one application to the other and a mechanism for credentials that allows users to use every feature of the application without having to re-authenticate themselves every time.

Since we looked at mobile collaboration technologies in the previous sections we should note that a mobile version of CoPe_it! would also have to support these security mechanisms discussed. Since files concerned with CoPe_it! are stored in the server, when the user signs off he will not be able to access the files anymore and this will prevent anyone who is accessing his/her mobile device to do so as well. However, any temporary or downloaded files on the mobile device would either need to be automatically deleted or encrypted during sing-off or before being downloaded respectively. Secure communication between the mobile device and the CoPe_it! server would be a responsibility of the user and the network provider and as such there would be no need for CoPe_it! provide such security.

7.1.4 Serious Games

As described in section 5.2 serious games a unique learning experience aiding engagement, immersion, recall and information retrieval. This is the main reason from which CoPe_it! could benefit by having a successful serious game aspect.

Collaboration and decision support is what CoPe_it! is being developed for. As such a successful serious game could potentially be created, having collaboration and decision making at its core and using CoPe_it! for its implementation. As potential serious games that will be developed using CoPe_it! will most certainly contain many collaborative elements, they will have to abide by some of the guidelines described in the collaborative serious games section.

Concerning a mobile serious game interface, a mobile interface will first need to be developed, as well as the aspect of serious games and how it could be used in CoPe_it! explored, and then these two features could be combined.

7.2 Implications for eLogbook

7.2.1 Ubiquitous computing

eLogbook currently supports ubiquitous computing in two ways: email and RSS. First, users can choose to retrieve information of actors, activities and assets through email and/or RSS. Compared to Web browsing, email and RSS are relatively lightweight content delivery means, and thus are more suitable for mobile users. Second, eLogbook supports an interactive email-based command interface. Users can write text commands in email, and send the email to eLogbook. eLogbook would process the commands and reply to the users. The commands include creation of assets, information update and retrieval, etc. This feature is suitable to mobile users whose network bandwidth is limited or costly.

Due to the advance and maturity of wireless networking technologies, Internet connection for mobile devices becomes much cheaper. Many mobile users are willing to browse Web sites as normal. Their major limitation is the reduced display sizes of their pocket PCs or smart phones. Many social applications provide miniature Web sites dedicated for these mobile users. A miniature Web site is a reduced version of the original Web site such that the resolution of the miniature Web site fits the display resolutions of pocket PCs or mobile phones. We can probably apply this approach on eLogbook. However, the design idea of current eLogbook Web interface is to gather different kinds of information in single screen (i.e. people related to the target user, communities and projects in which the latter participates and different assets or resources he/she could access). Developing a miniature eLogbook Web interface, convenient for small screen display, would require splitting the rendered information and simplifying the layout, while still providing intuitive and easy navigation.

7.2.2 Context-sensitive computing

The Web interface of eLogbook is termed as "context-sensitive view". The interface uses graphical cues to indicate status of users' entities and information. It helps users to sense their eLogbook's contexts rather than let eLogbook to sense their environmental contexts.

A majority of context-aware applications refers to location-aware applications. There are applications that integrate social networking and location-aware computing. These location-aware social networking services detect users' locations through their IP addresses or user inputs, so that the users can discover who are nearby. Location-aware computing is not critical to eLogbook, but it could be an interesting feature to trigger interaction between users, as it may motivate them to interact with people around them.

7.2.3 Personalization

Personalization can be achieved in two ways: adoption and adaptation. By adoption, we mean that users can customize their preferences and the system would apply these preferences. Adaptation refers to the fact that the system would learn the users' contexts and adjust preferences for them. eLogbook aims to support personalization in both ways.

Preference management is the basis of personalization. Users should be able to configure their preferences in their profiles. Management of user profile becomes more complicated when the user profiles are used by multiple applications. This requires standard data exchange format of the profile for the applications. On the other hand, each CoP should have a profile to record community-level preferences.

eLogbook is looking into GUI customization for both CoPs and users. This feature will enable CoPs and users to define their personalized GUI layouts.

Moreover, eLogbook is also looking into personalized information filtering and recommendation for users. This is an adaptive feature that ranks users' information based on factors like relevance, frequency of use, ratings, etc. It will improve user experience on information retrieval.

7.2.4 Privacy

Privacy is highly related to preference management. With good preference management, users should be able to define "which personal information to be disclosed" and "who can access the disclosed information". A basic privacy management enables users to configure individual fields of their personal information to be private or public. A more advanced privacy management allows users to define access-control-lists of accessing their personal information. In this way, each user can disclose personal information to his/her selected persons. In eLogbook, access right of an asset can be granted at public, community, role as well as individual level.

Another privacy issue in the Palette project is sharing of personal information among different applications. When a user inputs personal information in an application, he/she usually assumes that the information would be used in that application only, not to be disclosed to other applications. In case other applications are to access the personal information, these applications should obtain delegation from the user first.

The user should have full control on deciding which applications are delegated to access his/her personal information and which are not.

7.2.5 Serious Games

Serious game is a learning design approach rather than an interaction design approach. Its main idea is to use computer or video games to achieve target-oriented learning. From the viewpoint of eLogbook, serious game is a kind of activity. Being an interaction platform, eLogbook should allow CoPs to conduct activities consisting of serious games.

On the other hand, it is popular to integrate certain gaming elements into social applications. For example, some discussion forums deploy some elements of role-playing game. Forum members gain experience points and virtual money through participation in discussion. The members can level up and acquire various titles if they have accumulated enough experience points. They can also use virtual money to exchange various virtual items to decorate their avatars. Deployment of gaming elements is an approach to provide incentives of participation. Within eLogbook, an awareness "game-like" feature is to be considered. It consists of ordering people involved in a community, according to their activeness in the community. This could be measured in terms of how much they have participated in the community, by posting, annotating, ranking shared files, creating activities, managing projects, and interacting with members. As the displayed order of people changes over time, people are held aware and conscious of how much they and other contribute to the survival and development of their community. It is believed that the participation awareness, achieved through a "game-like" ranking of people based on their activeness, would have two benefits: first it would motivate all members to contribute, and second, it drives them to interact more with the passive community members, encouraging the latter to become more active in the community.

8 Conclusions

In this document we have presented a number of innovative collaboration means that can augment the impact of the project's collaboration services CoPe_it! and eLogbook. The issue of innovative collaboration is approached from both a pedagogical and a technological approach.

To justify the need of innovative means, the issue is initially approached from a pedagogical viewpoint. The pedagogical approach identified problems observed in collaboration tools and outlines the relevant axes of change that these tools need to address. The technological approach on the other presented and discussed the available and emerging solutions in the context of these requirements. The purpose of this presentation is to outline a technological "solution space" that guides the design and development of the project's collaboration tools during their efforts to provide innovative means of collaboration.

With respect to innovative "solution space" outlined, the document proposes and investigate five technological key directions: ubiquitous computing, context-sensitive and adaptive computing, personalization, privacy, and serious games. Each technological direction is presented and discussed in detail and is associated with particular CoP needs. Finally, their implication for the WP4 collaboration tools, namely CoPe_it! and eLogbook, is presented.

The analysis shows that the innovative collaboration means presented in this document can be clearly a catalyst in enhancing and leveraging the abilities of the project's collaboration tools. Acknowledging their amplifying power with respect to collaboration, CoPe_it! and eLogbook have already started integrating some of the aforementioned technologies into their systems. In particular, CoPe_it! and eLogbook already deploy advanced privacy and personalization mechanisms via explicit modules in their architecture. eLogbook provides also ubiquitous means for collaboration by actively deploying mobile devices, as demonstrated by the ability to receive notifications of selected events. In addition, eLogbook supports context-sensitive and adaptive computing via its central notion of context-based views of collaboration artifacts.

Nevertheless, since work towards improving the project's WP4 tools with innovative collaboration means is still ongoing, the "solution space" outlined in this document will act as the roadmap of future developments in this field.

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