Integrated Networks featuring Transparent Discovery & Seamless Provision of Services

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Abstract. Significant advances in recent years in the areas of handheld devices and wireless communications and the infiltration of the Internet in all aspects of our lives have not been accompanied by an equivalent evolution in services for mobile customers. To aid in bridging this gap, the NOMAD project targets to provide a solution that is service/user-centric rather than network/technology oriented. This is achieved by developing a middleware platform capable of seamlessly integrating non-homogeneous wireless network technologies, including 2/3G cellular and wireless LAN access, as well as IP-compatible, multi-hop ad-hoc networks. NOMAD platform will enable the decoupling of users from their terminal equipment - be it phones or PCs - featuring uninterrupted inter-device and inter-network roaming, thus utilising the full capacity of any available device and network infrastructure. Furthermore, NOMAD deploys transparent service discovery by means of an intelligent service location and configuration mechanism, whereby service / user-profiles as well as positioning information are appropriately integrated in the system. The overall goal is to enable the provision of composite mobile eCommerce services, activating novel business models and revenue opportunities. NOMAD targeted products will ensure that different 3G value chain entities can discover each other transparently and interact with the least possible overhead.

1 Introduction: NOMAD drivers & objectives

A business model designates how a company generates revenue, by specifying an allocation of the business entity (i.e. the company) in a value chain. One-dimensional business models - which are typically in use today - have proven inefficient and not viable as demonstrated by the many Dot Com failures over the past years. Current trends propose lasting business models should function on more than one levels [1]. This is effectively demonstrated by the few successful e-businesses (e.g. amazon.com), which continuously expand their product palette to include a maximum range of services and products. To remain competitive, companies will have to expand their business to include concepts critical to the success of eCommerce ventures, such as integrated business models, ubiquitous wireless access and comprehensive support of a maximum range of internet devices. These ask for mobility related concepts in eCommerce. First attempts to provide eCommerce services for emerging mobile market segments resulted in the commercial availability of WAP (Wireless Application Protocol, [2]). It is not in the scope of this paper to illustrate the shortcomings of this technology, however due to various technical and service related reasons [3], WAP failed to achieve a satisfactory breakthrough at the initial roll-out. Various renowned telcos were either giving away WAP phones, or making them available for a negligible price. Examples include major operators such as British Telecom [4] (330,000 WAP phones in 2000 through its online banking partners), and ePlus [5] (offering packages with WAP phones and free WAP use

up to 500 minutes), as well as travel agencies (e.g. “Going Places” offering competitions for "dream holidays" and thousands of WAP phones). The overall picture being that WAP phones and services try to gain value through offers, rather than demonstrate their added value. Figures from BT show that only 2.2% of BT-Cellnet’s total 8.1 mil. subscribers [6] were WAP phone users in 2000, i.e. less than 40% of the anticipation for only the first quarter of 2000. WAP subscribers soon realised that the new “state of the art” in mobile communications had its own set of limitations. Slow connections, a non-user friendly interface and high charges were only part of the problem. The lack of meaningful WAP services was in the centre of this unsuccessful market entry.

Taking the discussion to a larger scope, one may identify a discrepancy in today’s evolutions: Significant technological advances in recent years in the areas of palm-sized computers / handheld communication devices and wireless networks, are accompanied by an infiltration of the Internet in all aspects of our lives. However, the rapid growth of these technologies has not been accompanied by an equivalent evolution in the services available to mobile customers. For example, existing systems do not maintain the capacity to adapt to changes in the user’s location and preferences. It is understood that such added-value services –which bear the potential to attract the mass market of mobile users - can only be realised through intelligent service delivery and advanced positioning mechanisms. This is the reason why such functionalities are included as standard system capabilities in emerging 3G specifications [7]. Still, the evaluation of such information is rarely enough for the resolution of service discovery services (necessary for local content / services deployment), mostly because there is no direct correspondence between the virtual (Internet) and physical (real-world) space.

Considering the above, this paper addresses critical factors that differentiate services, and on one hand add value to existing conventional mobile service paradigms, while on the other, enable the introduction of novel service concepts, with the potential to address a mass market of tomorrow’s demanding mobile consumers. This work carried out in the context of the NOMAD[1] project approaches the aforementioned issues from an integration perspective, i.e. best practice, COTS[2] solutions are used instead of innovative ones, while keeping the focus on interoperability. The axes, upon which NOMAD work is based, maintain that services should be based on mainstream industry standards to ensure wide acceptance, be user-centric rather than technology oriented, and at the same time provide mobility and location awareness [8]. This is achieved by developing a middleware platform capable of seamlessly integrating non-homogeneous wireless network infrastructures, including 2/3G cellular and wireless LAN access, as well as IP-compatible, multi-hop ad-hoc networks. Coupled with an intelligent service discovery and configuration mechanism and advanced personalisation features, the goal of the NOMAD solution is to enable the delivery of composite value-added services in a context-aware and user-transparent manner. The paper is organised as follows: Section 2 provides the methodology adopted and initial key findings of the user & market assessment conducted at the first stage. Section 3 introduces the concept and functionalities of the NOMAD integrated network platform, while section 4 focuses on transparent service discovery and provision concepts. Section 5 elaborates on the business aspects of the project specific products, including value chain and stakeholders description. Section 6 concludes and identifies future work items.

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[2] Commercial-Off-The-Shelf

2 Users Requirements Assessment

The objective of this first stage in NOMAD work, was to identify the expectations and requirements of both end-users (consumers) and system stakeholders (service & network providers), regarding the middleware system to be developed.

Collecting such requirements bears a certain degree of abstraction, mainly because the targeted system components are not directly "visible" to end-users. The NOMAD platform objective itself is to "hide" diverse functionalities employed for providing a composite service. The method used was quantitative (60 responses to questionnaires) and qualitative (20+12 semi-structured interviews) survey, based on ISO 13407 principles for "user centered" design. Collection of user views was conducted by asking questions related to the functionality used to perform tasks, on the basis of pre-defined scenarios. A major event (CeBit 2002) involving mobile consumers was used as grounds for the field study, plus discussion with travellers at the Helsinki airport. In addition, an extensive desk survey was conducted, reviewing user requirements assessed in relevant studies in IST projects (TRUST [9], MOBIVAS [10]) and market fora (UMTS-F [11]).

The key findings of the field research and consequent statistical analysis [14] were primarily requirements related to usability, lifestyle, privacy & security, and the capability to shop in the Web. Frequent travellers using mobile devices, are seen as a critical target group. Such users are interested in services tailored to their personal preferences and ubiquitously available. Most customers required a user-friendly overview of locally available / advertised services. Then users wished to be able to select the language and the modality for interacting with the service. An important conclusion was that new technology is rejected if it violates privacy or if it is unreliable / difficult to initiate and use. Usability is critical when the user needs something daily / hourly. There were a lot of users who wanted to have information on upcoming technologies, considering it as a lifestyle indicator. Regarding service categories promoted by different target groups, these include entertainment & leisure, e-shopping, health monitoring, and emergency notifications, as well as facilities for the disabled. Furthermore, some basic features were the possibility to roam services and profiles between countries, to download software to portable / mobile devices in both outdoors and indoors environments. Future services of interest for the consumer would be a mixture of audio, text and multimedia and mostly asymmetrical in nature.

The project studied the current trends in business modelling for the envisaged NOMAD products and services (this work is mainly reported in [12]) and identified the market players involved in the conceptual NOMAD value chain. Business entities such as the Wireless Application Providers (WASP), Mobile Network Operators (MNO), Virtual Operators (VO-like ISPs) and Portals comprise the "core" group of NOMAD stakeholders. To collect their requirements and also get their views on the evolution of the value chain and their role in it, we used structured interviews as well as, for the value chain representatives involved as partners in NOMAD, a "Vision" Workshop based on the Metaplan [13] method. Stakeholders actually confirmed the original approach on system concept, i.e. the need to disseminate content and applications through an integrated network that will bring forth the realization of the "pervasive" internet, the increasing role of operators as Infrastructure rather than Service Providers, the need for integration of available access interfaces, for profiling facilities, service discovery and device mobility to reinforce user-centricity.

One should also note that findings in both end-users and stakeholders' domains, were quite similar with results from the desk survey conducted in parallel. This fact is interpreted as a validation of the NOMAD study and consolidation of the requirements to be fed into the next stage of work in the project.

3 Integrated Network Platform (network & device mobility)

The lack of considerations for mobility management in the original Internet Protocol design indicate that a mobile node would be reachable by all communication peers only as long as it remained within the boundaries of a given IP administrative domain. This significant restriction forces users to remain under the influence of a single service provider, or network technology (i.e. GSM), in spite of utilising mobile, or portable devices. Still, the availability of wireless and wireline communication media will continue to increase accompanied by a plethora of access devices that need to roam around networks. In addition, the turn of operators towards license-free frequencies [15] and their eventual congestion will lead to the realisation of solutions based on the common convention that users may utilise one another's resources to mutually form a dynamic network structure (ad-hoc). This solution poses as a low-cost, high-complexity alternative to conventional systems that dictates a significant complexity shift from the network towards the end-devices, thus giving rise to a new generation of user equipment with several access interfaces allowing simultaneous connectivity over a range of providers and technologies.

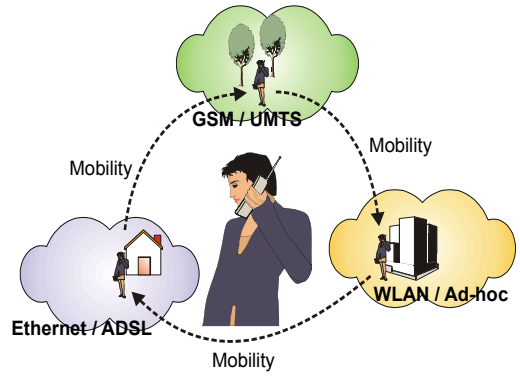

Figure 1 - Integrated Network Platform

In this environment of multiple providers and access media, NOMAD provides the enabling technology that allows the integration of IP, cellular 2/3G access, WLAN, and ad-hoc technologies into a single platform capable of supporting user roaming between them. The basic functionality of the platform is Internet Mobility Management, resolved through a NOMAD implementation of Mobile IP (in both IPv4 & IPv6 context - [16]) in line with the IETF specifications.

Mobile IP and its capability to maintain a single point of attachment to the Internet, is also the basis of the NOMAD mechanism providing mobility between devices (fig. 2). The increasing availability of a wide range of access devices will dictate the decoupling of users from the terminal, be it mobile phone, or PDA / PC. In that case, users will be able to roam between devices, without interrupting active connections, and taking advantage of the full capacity of each access device without further customisation, to increase efficiency in a manner that matches their individual preferences. To achieve this, further changes are required to Mobile IP that involve: issuing a new process on the new device capable of undertaking the communication; transferring the state of the communication from the previous to the new device; adapt the communication at both ends and adapt the content to match the capabilities of the new device.

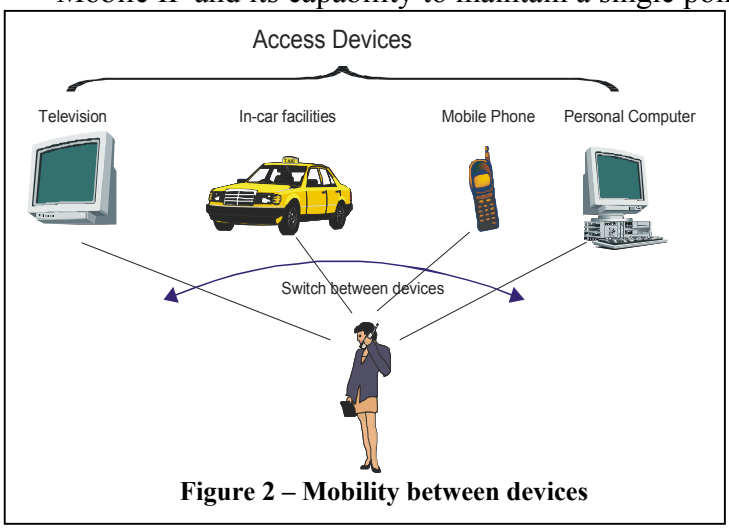

Figure 2 – Mobility between devices

4 Integrated Services (discovery & delivery of composite personalised services)

A major issue with integrated network platforms is that different segments of such a platform operating on different network technologies, effectively constitute different Internet administrative domains, termed here as planes. Two users in the same room accessing the network via different planes, may need to traverse vast ranges of Internet fabric in order to reach each other. This effectively demonstrates the discrepancy (fig.3) between physical space and the virtual world of the Internet. Bridging this gap in a transparent manner is a critical requirement of service discovery on integrated network platforms. Implementing a solution capable of achieving wide-spread acceptance depends on the utilization of widely accepted standards as building blocks. Internet standards in this area providing relevant mechanisms, include the Service Location Protocol [17], the Lightweight Directory Access Protocol [18] and the Dynamic Host Configuration Protocol [19], all of which operate on different layers. These protocols cover basic requirements of service discovery such as a means to specify the required service and formulate queries as well as ways for locating and communicating with the appropriate service provider. These protocols however focus on Intranet resource discovery. The NOMAD solution will be Directory Server-based (like LDAP), to take advantage of "referrals", i.e. relegation of queries to other servers, until the client gets a meaningful answer to it's request. Directory and Service Agents will be integrated, to extend and improve referral functionality. Service Discovery in NOMAD will be closely linked with personalisation features, covering aspects like multi-modal / lingual facilities and use of customisable profiles for both services and users in meta-data format to facilitate machine-to-machine communication. These features coupled with appropriate positioning functionality (e.g. GPS in the terminal - [20]) will ensure minimisation of user interaction, while maximising efficiency. To help illustrate the concept of composite services in NOMAD, the following (working Use Case) scenario is provided:

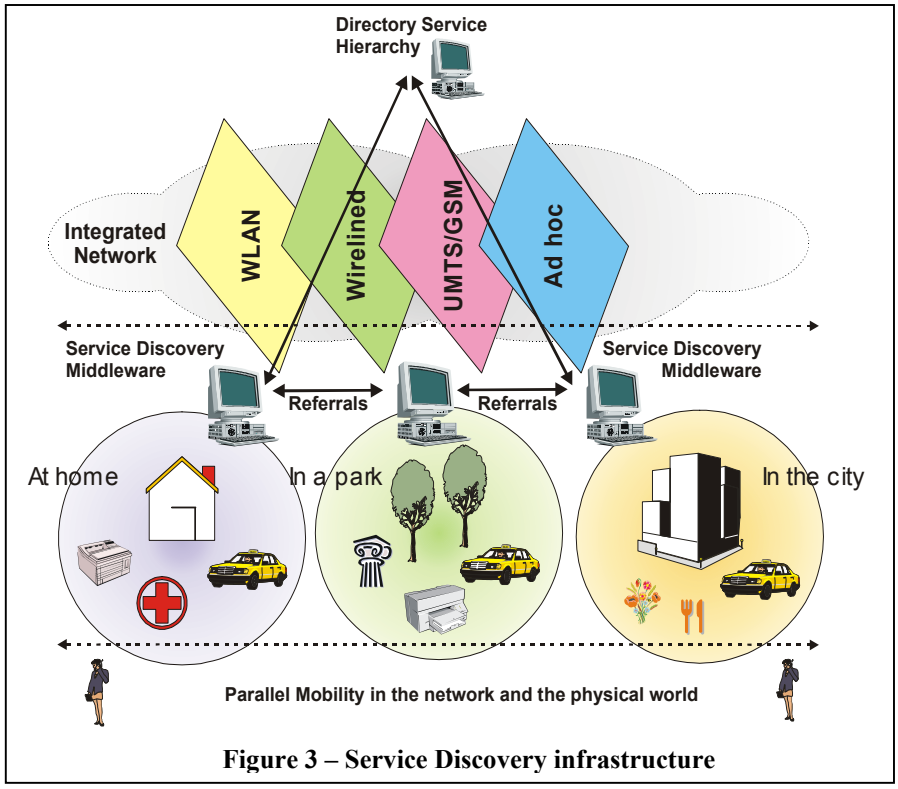

Figure 3 – Service Discovery infrastructure

"Reingard Peters a consultant that spends much of her time travelling across Europe is on a business trip, staying at a hotel in the city where her customers headquarters are located, and is making some last preparations for the presentation she is going to hold the next morning. After having set up her equipment she realises that the portable projector she has brought with her is out of order. The device has been so reliable up till now that she has unfortunately stopped printing slides as a precaution a

long time ago. Mrs. Peters decides to try and find a shop on a short notice that will print her presentation in high quality slides. In order to accomplish this she uses her laptop, PDA or mobile phone to execute a service discovery query. She specifies that she needs a colour printer able to print on transparencies and that is not located any further that one Km from her current location. The service discovery client "knows" from her profiles that she always chooses to have products she orders sent to her by plain airmail. This preference is clearly marked in the dialog presented to her during configuration of the query. Mrs. Peters manually overrides this preference as she wishes to personally go to the shop herself in order to get the transparencies as soon as possible.

The system then locates all available studios or service providers that offer this kind of service, selects the ones that are currently available and presents them to her. Mrs. Peters could furthermore specify that she wants to send the files to be printed electronically (i.e. per email) to the agency she selected and have them delivered via courier a while later. The system would then automatically select a courier service, provide it with all the necessary data and arrange for the transparencies to be picked up and delivered at the hotel."

5 The NOMAD Business Concept & Value Chain

Fig. 4 depicts the basic software and hardware components targeted in the NOMAD context. Infrastructure components (Network and Service Discovery Middleware) as opposed to client-side hardware & software, are seen as the main exploitable products and directly address the group of NOMAD stakeholders in the area of Internet / Application Service Providers and Operators in general. To better illustrate the NOMAD view on stakeholders, we present an evolution of the "classical" Mobile Value Chain to a Mobile value "Web" of Market players where user/provider roles are not easily distinguished. The archetypal Mobile Value Chain (fig. 5) consists of tightly integrated stakeholders. Key dominant players are the Mobile Operator (undertaking most of other players' roles and functions in some markets) and the User Access Device Provider.

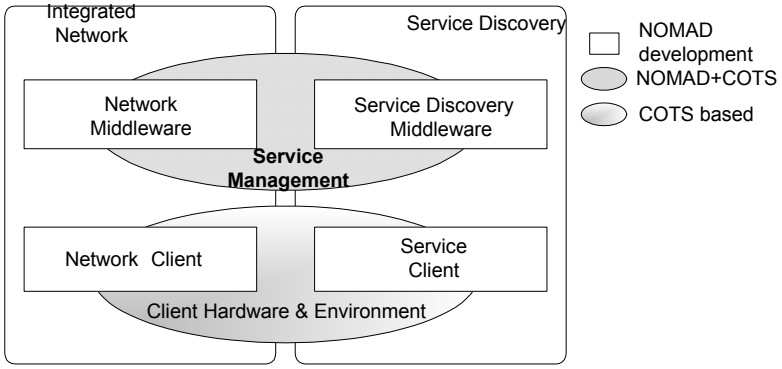

Figure 4 – NOMAD platform SW & HW components

Figure 5 - The Original Mobile Value Chain

As market conditions are changing rapidly, major players in the value chain are constantly repositioning themselves in their market areas and/or change/ acquire new roles in the chain, while at the same time alternative networks and a series of enabling technologies and platforms appear on the market, thus shaping a multi-dimensional fragmented and continuously morphing Mobile Value Chain. As an ultimate consequence the Mobile Value Chain transforms into the Mobile Value "Web" ([21]).

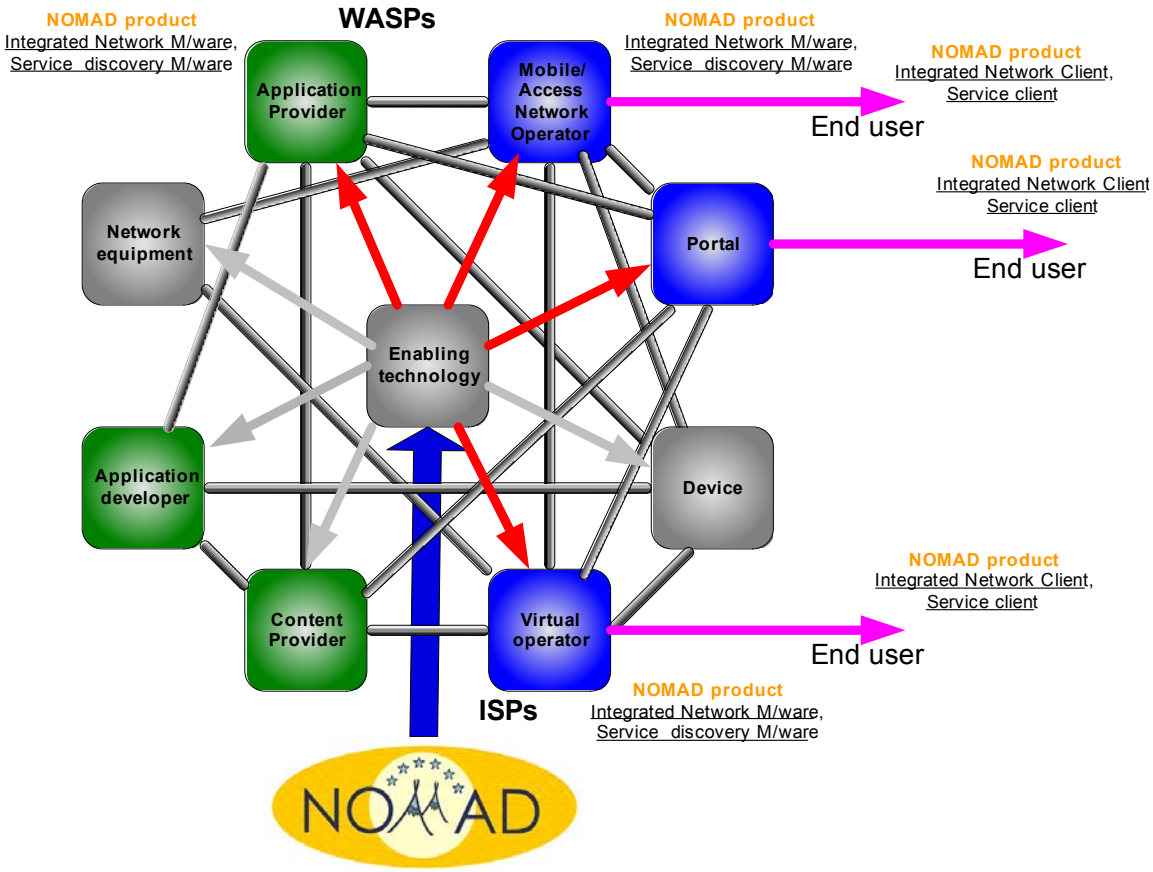

Figure 6 - The NOMAD value web and NOMAD products positioning in the web

Figure 6 illustrates the positioning of the NOMAD products in the value web, considering an **Enabling Technology Provider** (supplying platform components / tools to network operators or WASPS) perspective. Other possible perspectives –currently under consideration in NOMAD- include **WASP** (implementing the NOMAD middleware server and associated hosting service, but also include other enabling platforms, e.g. components related to positioning and security); **Network Operator** managing / operating (**Mobile / Access Op.**) a network, or just providing (**Virtual Op.**) services over a variety of bearers (own / 3rd party operated); and **Portal,** using the NOMAD infrastructure components to allow customers to access a variety of personalised services over a variety of communication channels.

6 Conclusions & Future Work

Weaknesses of current mobile eCommerce practices have been identified, and an overall discrepancy in today's evolutions of technology vs available services. A new perspective on mCommerce based on integrating COTS solutions, user centricity and mobility awareness is proposed, to create a clear and ultimately compelling business proposition to the customer. The NOMAD project attempts to implement this solution, through the development of an middleware platform seamlessly integrating diverse access technologies and transparently discovering services and managing device mobility. The overall goal is to enable the provision of composite context-aware services, in terms of user / service positioning and personalisation. User requirements were assessed, both in terms of end-users and system stakeholders, and a background study was conducted, confirming the original approach on the system concept and providing valuable constraints for its' implementation. Then the decomposition of the targeted platform into

components and their allocation on an extended Mobile Value „Web“ of market players was effected, thus forming the NOMAD business concept. The outcome of the overall user assessment [14] and Business Case study [12], will be fed into the system conception stage by August 2002, and from there to implementation of an early prototype by the end of 2003, and a fully functional pilot trial by mid 2004.

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