Next generation mobile communication infrastructure:
UMTS and WLAN – who will succeed?

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1 ABSTRACT
Tremendous importance is given in Europe to the implementation of 3G telecommunications systems as well as the other broadband platforms. It is expected that mobile and personal communications will become a key driver for growth and innovation in the next millennium, as well as being a necessary building block of the eEurope 2005: Information Society for all. The purpose of this paper is to study the development, implementation and rollout of two different communication platforms; Universal Mobile Telephone System (UMTS) and Wireless Local Area Network (WLAN). By applying a common framework for studying infrastructures, we aim at identifying some of the characteristics that UMTS as well as WLAN resemble.

Our analysis of the two platforms reveals that a number of obstacles have to be managed before they may public infrastructures. Both UMTS as well as WLAN have a long way to go, in spite of the high ambitions and efforts that are put into their development. Our concern is not so much how the technical development and implementations efforts will progress, but rather how to manage the process of change and evolution. We believe that the future of UMTS as well as WLAN is very much contingent upon how the large group of stakeholders with rather different interests will influence these processes.

2 INTRODUCTION
The telecommunication and data-communication landscape has changed dramatically during the last two decades by powerful forces; among them the emergence of wireless mobile communication and the growth of Internet. We have witnessed an explosive growth in the use of these different communication technologies.

Today, it is being claimed that we are on the brink of a similar next wave of innovations in communications that will create ubiquitous access to end-user services. We see the emergence of new communication platforms, including third generation (3G) mobile communication systems and as well as extensions of LAN through WLAN access. In the EU action plan ‘eEurope 2005’,

framework to support the delivery of pan-European E-government services to citizens.” Broadband connections will include a variety of different technologies, as 3G, various types of WLAN, satellite communication and others.

In this paper, we examine two of these communication platforms: Universal Mobile Telephone System (UMTS) and Wireless Local Area Network (WLAN). They have quite different technological origin as they belong to distinct industrial traditions. Their trajectories of development and diffusion also tend to follow distinct patterns because of their different innovation structures and implementation strategies. UMTS origins from the traditional large, monolithic, monopoly-like corporations in the telecommunication sector, while WLAN has its roots in the more dynamic, younger and fragmented computer industry. The UMTS implementations have until recently followed a traditional top-down oriented development approach corresponding to e.g. its predecessor GSM, while the WLAN implementation patterns may be characterised more like the un-coordinated, open trajectories which characterise the development of computer technologies.

On the basis of the efforts invested by many single organisations, nations as well as by the EU, it should be fair to assume that both UMTS and WLAN are intended to be public infrastructures, or at least a part of one. We claim, however that it is not at all evident that either of them will become one as there are some inherent problems and barriers in the development and diffusion of both platforms.

By applying a common framework we aim at identifying some the characteristics of infrastructures that UMTS as well as WLAN is supposed to resemble. This framework focuses on the users and usage the infrastructures are to support, as well as the important issues determining the state in the development of both platforms. In the paper, we aim at answering these questions:

- For whom and what type of applications are they intended to serve?
- What types of infrastructures are UMTS and WLAN aimed to be?
- What is required for UMTS and WLAN to become infrastructures?

Our research is based mostly on a qualitative approach. We have collected data from various sources: Articles in journals, reports from Norwegian and international public agencies, documents available at various web-sites, articles in the trade press, interviews along with current observations on how these two technologies are being implemented and rolled out. These data are partly ‘facts’ describing technical characteristics, standards etc. along with the institutional and political setting in which these developments take place. But mostly we are referring to the assessment and discussions going on in this field in combination with our own interpretations and evaluations and judgements. In this way, we are combining quantitative data with more qualitative data and analysis as more an interpretative approach.

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2 See e.g. The IST Programme (http://www.cordis.lu/ist/)
The structure of this paper is as follows: In the next section we present our theoretical basis along with the research issues and methodological approach. In chapter 3 and 4 we describe the basic characteristics of the particular platforms; followed by our analysis and discussions. Finally we present some concluding remarks and suggestions for further research.

3 THEORETICAL BASIS

What is an infrastructure?
The terms like infrastructure, information infrastructure and corporate infrastructures are much used in current discussions, but often without taking into account the distinction between them. The emphasis has been on either very large infrastructures, such as national information Infrastructures initiative in 1993, as described in Kahin and Abbate (1995), or on infrastructures confined in the organisational context\(^3\). While a public infrastructures aim is to support a very large or unlimited community of users and all types of applications, a corporate infrastructure will have a restricted set of users and usages, and aims at interconnecting and integrating the different information and communication systems within the organisation.

Our focus will be on public infrastructures. In this paper we understand a general ICT infrastructure as a multi-layered collection of various resources for communication and interchange of data, consisting of hardware, software and services along with the necessary support organisation and personnel to develop and maintain it. An important part of an infrastructure is the standards and conventions that are linked to its development as well as to its use. An infrastructure is not an end it itself, it is a mean or facility that helps the achievement of something else; it is often viewed as an invisible structure that becomes visible only in breakdowns.

A fruitful distinction can be made by decomposing infrastructures into subsystems. Hanseth (2002) proposes two different layers: application infrastructure and support infrastructures upon which an infrastructure is implemented. Furthermore, the support infrastructure can be split into two categories: transport infrastructure as e.g. IP/TCP in Internet and service infrastructure, as e.g. a domain name server, directory, security or accounting functions, etc. In our analysis we will primarily address the lower levels of such communication infrastructures, corresponding to the support subsystems as described above. We will particularly focus on the distinct characters of transport and service infrastructures.

Infrastructures as relations between actors
An infrastructure is intended to support certain communities of users and thereby also supporting established, generally accepted procedures or practices. Or it may break with existing conventions of use, as can be illustrated by how communication patterns changed by the introduction of mobile communications. Such changes may be the result of some shared intentions among its developers of the infrastructure. But it may also happen that the changes are the unintended consequences of a new infrastructure. Rolland

\(^3\) See also http://iitf.doc.gov/
(2002) describes how the work routines at each local office in a global company had to be adjusted after the implementation of a new, company-wide application infrastructure.

Star and Ruhleder (1996) claim that: “… infrastructures are fundamentally and always a relation.” emphasizing the relational and interdependence between the objects or artefacts and actors, how they mutually shape and reshape the infrastructure. Following this understanding, an infrastructure can’t be designed by traditional software engineering; from specification to construction and implementation as a linear process. Rather, it will evolve through a complex interplay between various actors, among them the designers of standards, the product developers, the service provider and the different user groups along with the organisational and institutional context it is growing into. It is important to emphasize the role of the users, individuals as well as user organisations, as its value to a large extent is defined by its users (Hanseth 2002). Star and Ruhleder (op. cit.) furthermore focus on the context of the users, and the local way of working. In this way the infrastructure will be different for distinct user groups, and for these different user groups it may not make sense to talk about the same infrastructure.

**What categorises an infrastructure**

In the literature we find a range of terms that are used to describe or characterise infrastructures. McGarthy (1992), associated with an engineering community claim that these aspects as essential: *shareable, common, enabling, physical embodiment, enduring, scale, and economic sustainable*. Star and Ruhleder (1996), on the other hand hold that among others the following aspects are crucial: *Embeddedness, transparency, reach of scope, learned as part of membership, links with conventions of practice, embodiment of standards* and *built on installed base*. Thus, they put an emphasis its evolving nature.

For the purpose of this paper we will focus on the following aspects; *enabling, shared, open, heterogeneous and build on installed base*, which largely conform to the key aspects applied by Hanseth and Monteiro (1997). These are discussed in chapter 5.

**Infrastructure building and network economics**

For some actors the building of an infrastructure can be an end in itself. Its nature of being shared and open gives everyone the opportunity to access and use the infrastructure. Its nature of being enabling provides the potentials for a range of new applications. In Europe, UMTS is seen a important mean to foster further economical development, and investments in infrastructures can be justified by this reason alone.

One the other hand, infrastructures can be analysed in terms of network economics. In the commercial world, the rationale to implement an infrastructure is more likely to be justified by the economical nature of such networks.

Network economies are basically characterised by critical mass, path-dependency and network externalities. The nature of critical mass creates disruptions (Hohn and Schneider 1991): When few have adopted an infrastructure the value of the infrastructure for the next new user to adopt the infrastructure is low. This both concerns the limited number of other users accessible through the network, also called direct network externalities, as well as low number of varieties and high prices for components and
services, called indirect network externalities (Economides and White 1994). When a
certain amount of users have adopted an infrastructure, the value for potential new users' 
passes a threshold and the critical mass is achieved (Granovetter 1978). At this point, the 
adoption of the infrastructure will continue disruptively by itself, and efforts to overcome 
the critical threshold, as subsidising end-user equipment and services and further more 
market research and management of expectations (Hohn and Schneider 1991; Hanseth 
and Aanestad 2002) becomes unnecessary. As the infrastructure extends further, the 
disruptive force created by critical mass is replaced with stability. The adoption of the 
infrastructure creates a self-stimulating environment which locks out alternatives and the 
choice of new users becomes path-dependent (Hohn and Schneider 1991): The 
infrastructure becomes sticky\(^4\) as the switching cost becomes high for the users. Utilizing 
this nature of an infrastructure is thus a way to achieve a critical mass of sticky users, 
potentially delivering significant revenues based on investments in infrastructures.

4 **THE TWO STORIES**

Although UMTS and WLAN are quite different as platforms, they have some 
characteristics in common: They both provide broadband communication\(^5\), they offer a 
certain degree of mobility, and they are based on radio communication technology. These 
mobile, radio communication system is composed of fixed base-stations\(^6\) and mobile 
handsets or terminals. A base-station is further connected to a fixed network that might 
include other base-stations, furthermore fixed telephone networks, and Intranets or 
Internet. The base-station relays communication between the mobile devices and other 
nodes in the network. Each base-station covers a limited geographical area, also called a 
cell. The size of the cell depends on the frequency used, the effect of the transmitter, the 
bandwidth provided, and thus the number of needed cells to cover a given area.

One of the most important issues in radio communication is the administration and 
sharing of the radio frequencies spectrum. Certain frequency bands are licensed as some 
parts of the spectrum are more useful and therefore crowded and shared among a multiple 
of users. WLAN operates in an unlicensed frequency band (2.4 -2.5GHz), while UMTS 
operates within a licensed band (approx 1.9 GHz - 2.2 GHz\(^7\)). The unlicensed use of 
WLAN requires a maximum effect of only 100mW (in Europe, 1W in U.S.), while 
UMTS communication has the flexibility to optimize the range of communication with 
suitable effect, implying that while a typical WLAN cell has the range of 50 meters, a 
UMTS cell can reach up to 6 kilometres. An important issue in wireless communication 
is **roaming**, which briefly means the moving of a wireless node between two adjacent

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\(^4\) **Stickiness** is commonly used in telecommunication to denote the nature of services that by its nature 
becomes frequently used by users in preferences of others. The number of users who discontinue the use of 
a service are respectively denoted by **churn**.

\(^5\) Whether UMTS in particular really provide broadband is controversial. Some will argue that the 
bandwidth is not high enough to enable real broadband services, as well as the theoretical bandwidth 
presented is far from the actual bandwidth provided to the end-user

\(^6\) Access-point is used as the term for base-stations when it comes to WLAN.

\(^7\) In Norway the frequency allocation is allocated to 1885MHz – 2025MHz and 2110MHz – 2200 MHz by 
the Norwegian Post and Telecommunication authority. It’s requested that frequencies used by GSM in the 
future also will be allocated to UMTS. See //www.ptt.no/
cells. Roaming occurs in infrastructure networks built around multiple cells, and is not only a technical matter as it also has economic and organizational aspects as well. Roaming between different networks requires contractual agreement between the operators of each base-station, and schemas for access, authentication and exchange of accounting data, billing procedures etc., supporting the handover procedures. <ref??>

4.1 Wireless Local Area Networks (WLAN)

WLAN is a flexible data communication system implemented as an extension to or as an alternative for a wired LAN within a building or campus. The simplest arrangement comprises one WLAN enabled device (e.g. a laptop or a PDA), and a single access-point that receives, buffers and transmits data between the WLAN and the fixed LAN. Even simpler, the arrangement can comprise only two devices, communicating in an “ad-hoc” per-to-per manner without any connection to a fixed LAN. Over the last years, WLAN have gained popularity in a number of sectors, including the health-care, retail, manufacturing, warehousing, and academic arenas. Today WLANs are becoming more widely recognized as a general-purpose connectivity alternative for a broad range of business customers.

Users, actors and key drivers

WLAN is designed to be deployed in homes and small enterprises as well as in large organizations, campuses and public “hot spots”. In addition, real estate owners, as hotels, airports and restaurants provide connectivity to their guests. The main advantage of WLAN is flexibility as there is no need for cabling. This is in particular a cost advantage for firms subjected to expansion and relocation, as new users easily can get access, and the network can easily be relocated. Flexibility also includes the possibility to establish ad-hoc networks anywhere. The access points are usually maintained by IT-departments if deployed in a corporate campus, or by third parties when located at public spaces. Such third parties also provide billing solutions for public “hot spots”, as well as security with authentication and cryptography.

Standardisation

In 1979 the concept for Wireless Ethernet and Networking was adopted by IEEE, and resulted in the committee 802. The Wireless approach later came under committee project 802.11. It grew out of the computer industry, and the WLAN standards 802.11x corresponds to other LAN standards as e.g. Ethernet 802.3, and fits into the 2 lower levels of the OSI model (the physical and the link layer). ⁸

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⁸ (See e.g. Graham (2002), //w2forum.com, //www.wi-fi.org, //www.Ieee.org/)

⁹ Various industry groups have addressed WLAN, and among others the Wireless Ethernet Compatibility Alliance (WECA) have adopted IEEE 802.11b and certify interoperable WiFi-products with their interoperability test suite. Another industry group, the Wireless LAN Interoperability Forum (WLIF) also test product interoperability, and can be considered more independent as no WLAN vendors are members. WLIF also provides inter-operability test facilities for 802.11b products. Other alliances as the Wireless LAN Alliance (WLANA) provide customers with information concerning WLAN technology. As a non-profit educational trade association, it is supposed to inform end-users, customers, press and analysts.
WLAN entered the business environment in the early 1990s. But expensive equipment, bandwidth limitations, lack of hardware compatibility and vendor inexperience made market penetration low (Kane et. al. 2002). IEEE was at the same time under way with a framework to provide structure to both the industry and the technology to enable products from different vendors to be used over the same infrastructure. By 1997, IEEE 802.11b was introduced as the first internationally recognized standard for WLAN: A standard that allows WLAN to interoperate without collaboration between vendors. Today there exist different WLAN standards. The standard described here is the most frequently used IEEE 802.11b or Wi-Fi. Other standard are IEEE 802.11a (not compatible with 802.11b), Bluetooth, HiperLAN/2, SWAP and OpenAir.

By introduction of the Wi-Fi logo, the interoperability alliance WECA have played an important role in creating the WLAN market by using the standard of IEEE 802.11b. One of the major contributions is their development and offering of interoperability test suites. By successful test, devices implementing the standard in an interoperable manner are certified and granted the use of the Wi-Fi logo. This has resulted in WLAN products purchased from a number of vendors functions together. As WECA provide test facilities and certification according to the standard, interoperability will also improve in the future (see http://www.wi-fi.org/).

4.2 Universal Mobile Telecommunications Service (UMTS)

UMTS is decided to be the European standard for third generation mobile telephone system (3G). It was preceded by the first generation NMT mobile telephone network, and the second generation of GSM. 3G offers broadband, packet-based transmission of text, digitized voice, video, and multimedia at data rates up to 2 megabits per second (Mbps). UMTS provides a consistent set of services to mobile computer and phone users no matter where they are located in the world. UMTS has been endorsed by major standards bodies and manufacturers and was the planned standard for mobile users around the world by 2002, but is delayed due to various problems (EU 2002). Until UMTS is fully implemented, users are expected to have dual-mode handsets that switch to GSM where UMTS is not (yet) available. The European Council has decided that all member states (including Norway), within the existing regulatory framework, shall prepare for a collaborative development and introduction of a wireless, mobile telecommunication services (Europe 2002).

Today's mobile telephone systems (GSM) are basically circuit-switched, implying that connections always are dependent on availability of free circuit. Packet-switched connection, using the IP (Internet Protocol), means that a virtual connection is always available to any other end point in the network. The higher bandwidth of UMTS also implies a promise of new services such as e.g. video conferencing. The political vision of UMTS is to realize the Virtual Home Environment, in which a real mobile user can have the same services whether at home, in the car or in the office. This is to be provided through a combination of transparent terrestrial and satellite connections. This will require new functions, such as alternative billing methods (pay-per-bit, pay-per-session, flat rate, asymmetric bandwidth, and others).
The launch of UMTS services heralds a new, "open" communications universe, with players from many sectors coming together harmoniously to deliver new communications services, characterised by mobility and advanced multimedia capabilities. The successful deployment of UMTS will require new technologies, new partnerships and the addressing of many commercial and regulatory issues (Europe 2002b).

**Standardisation**

The work on the UTMS standard started in the 1980s by the International Telecommunication Union (ITU). The ITU initiative resulted in the global IMT-2000 standard later adopted by the European Telecommunications Standards Institute (ETSI) in 1991. ETSI established the SMG5 group with the mandate to form UMTS. In other parts of the world, as in the U.S. and Asia similar local efforts are initiated. After pressure from ITU to harmonize the different standards that emerged from these efforts, the Third Generation Partnership Project (3GPP) was established in 1998, with its mission to produce globally applicable technical specifications. ¹⁰

In an EU report “Towards the Full roll-Out of Third-generation Mobile Communication, (EU 2002b), the Commission have described the relations between the different players in the future 3G in figure 1.

Figure 1. illustrates that this market has 3 major components: i) the network itself, ii) the handsets or user terminals and the iii) services, all aimed at serving the customer, being an individual, or a business. In order to offer 3G services, market players must roll out network networks and operate them, provide attractive content and services, and make suitable terminals available. User terminals may be handsets with video camera, PDA type terminal, plug-in interface for PCs, etc. Important requirements will be high resolution colour screens, better energy efficiency to support large colour screens, integration of multimedia functions etc.

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¹⁰ 3GPP™, is a collaboration of standards development organizations, industry associations and over 450 individual member companies. ETSI was a founding partner of 3GPP, which was created in December 1998. The resulting UMTS specifications cover mobile communications systems that deliver seamless customised multi-media services from a converged network of fixed, cellular, wireless and satellite components. The specifications produced by 3GPP may be given formal standards status by each of the participating standards development organizations, including ETSI, through a process of transposition. Each standards development organization is at liberty to apply its own procedures for transposition: in the case of ETSI, it is a simple and rapid adoption and publication of the specifications.
Technical characteristics
The key features of 3G systems are a high degree of commonality of design worldwide, compatibility of services, use of a wide range of small pocket handsets with world-wide roaming, provision for Internet and other multimedia applications, and a wide range of services. UMTS is conceived as a multi-function, multi-service, multi-application digital mobile system that will provide personal communications at rates ranging from 144 kbps up to 2 Mbps according to the specific environment. UMTS will support universal roaming, and will provide for broadband multimedia services. Low mobility users, those based in or near buildings travelling at less than 10kmph or stationary can expect 2 Mbps\(^\text{11}\). Full mobility users, those travelling at less than 120kmph and in urban outdoor environments can expect 3.84kbps. High mobility users, classed as users travelling over 120kmph in rural areas can expect data rates of 144Kbps. UMTS is designed to have a terrestrial and a satellite component with a suitable degree of commonality between them, including the radio interfaces

\(^{11}\) This numbers are only theoretical, and thus not necessarily what the users experience. The user experience will be determined both by interference and the number of other users connecting to the base-station
5 DEVELOPMENT OF AN INFRASTRUCTURE

Both WLAN and UMTS face a number of challenges in order to meet their original intentions as well as the requirements of becoming an infrastructure. The realization of UMTS requires the building of a complete new physical network, including base-stations with antennas and transmitter/receiver equipments etc., as the existing GSM infrastructure cannot be used for this purpose. As the services is supposed to be provided over a large area, ideally and finally everywhere, a multiple of base-stations as well as satellites must be rolled out. The implementation includes a range of specifications and protocols, for example to handle handoffs for global roaming. In addition, the traffic is controlled and billed by mechanisms of call management and micro billing implementations. It requires furthermore a new support and maintenance organization. Not at least, this requires huge financial investments amplified by costly licences. We observe that the implementation of the complex UMTS infrastructure is assessed as very expensive by the licensees, resulting in more or less strategic delays of the rollout in most countries in Europe (EU 2002b).

Correspondingly, WLAN faces similar challenges. Its primary target today is the LAN market, as the main advantages of WLAN is flexibility and mobility within a limited geographical area, typical in a building or campus. The secondary target, as e.g. the development of public “hot-spots”, is slow and has faced multiple setbacks. The main challenges are the lack of services concerning security issues, roaming, billing and ease of configuration. WLAN does not provide seamless roaming (interoperability) or automatic transfer of connectivity between base-station as the device moves between different ranges or micro-cells owned by different operators. With the issues of security and roaming management in mind, the configuration of WLAN eventually becomes complex for the user. The user must configure SSID (Service Set Identifies), WEP (Wired Equivalent Privacy) keys, and probably a multiple of configurations to get access to a multiple of networks, and at the same time change these preferences as roaming between networks. When different billing policy among the access points is added to this, the picture becomes even more complicated. Credit card purchases on minute based increments, Wi-Fi PC Card sold with unlimited permanent access, account based per minute or unlimited per month or prepaid debit accounts. Roaming provided by wireless ISPs by not requiring the user to open separate accounts for each network is available to some extent. Different WISPs (Wireless internet providers) are in operation, as Telenor ASA and Telia HomeRun in Norway.

To summarize the features of the two platforms presented above:

<table>
<thead>
<tr>
<th>Issue</th>
<th>UMTS</th>
<th>WLAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic characteristics</td>
<td>A set of standards for wireless communication of voice, streaming video and all types of data, including global roaming, handover, security and billing in standard.</td>
<td>Standard for wireless and mobile access to fixed LAN. Supports all types of communication, but lacks security functionality, accounting/billing and other services</td>
</tr>
<tr>
<td>Roaming</td>
<td>International roaming as central idea – optimised for easy roaming.</td>
<td>Not implemented in the standard. Users must manually connect to different</td>
</tr>
</tbody>
</table>
Built on mature mobility management handling including handover and roaming.

<table>
<thead>
<tr>
<th>Security</th>
<th>Risk of having private, customized data in ‘easy-to-steal’ handset.</th>
<th>Low security in current standard, focus from IEEE to enhance standard, third parties delivers additional security.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Billing/business models</td>
<td>Billing as with GSM, but also other models for data. In addition new revenue sharing models with third parties as content service providers.</td>
<td>No billing functionality in standard. Different suggestions for billing models: Fixed, volume, per logon or none. Third parties may provide functionality for billing (WISPs).</td>
</tr>
<tr>
<td>Content services</td>
<td>Key driving factor and producer of revenue. Developed by third parties. Source for uncertainty.</td>
<td>Service provision on the same basis as connected to the fixed LAN.</td>
</tr>
<tr>
<td>Terminal types</td>
<td>A mobile device enabled for utilizing the services provided by UMTS.</td>
<td>Laptop, PDA, desktop computer and peripheral equipment.</td>
</tr>
<tr>
<td>Mobility</td>
<td>High, global.</td>
<td>Low, local.</td>
</tr>
<tr>
<td>Relative bandwidth</td>
<td>Low.</td>
<td>High.</td>
</tr>
<tr>
<td>Cost</td>
<td>1MNok per Base-station, low availability of technology. License and frequency use fees. Expensive handsets.</td>
<td>5000Nok per Base-station, Price competition among vendors – price decreases and market expands.</td>
</tr>
<tr>
<td>Regulating policy</td>
<td>Regulated frequency spectrum, licenses provided with obligations.</td>
<td>Unregulated spectrum.</td>
</tr>
<tr>
<td>Standardisation process</td>
<td>ETSI Standard frozen in 2002.</td>
<td>Multiple, IEEE802.11a, b and g, Hiperlan/2, BlueTooth etc.</td>
</tr>
<tr>
<td>Examples of implementations</td>
<td>Multiple test networks, no commercial networks</td>
<td>Hospitals- provide access to patient information everywhere; in warehouses to check if an item is in the stock, Hotels provide access to its guess; academic institutions for all employee.</td>
</tr>
</tbody>
</table>

Table 1 Main characteristics of the two communication platforms.

5.1 UMTS AND WLAN AS INFRASTRUCTURE

Is it possible that to predict whether WLAN or UMTS is likely to become an infrastructure? In order to address this issue we discuss the following questions:

- For whom and what type of applications are they intended to serve?
- What types of infrastructures are UMTS and WLAN aimed to be?
- What is required for UMTS and WLAN to become infrastructures?

As Star and Ruhleder (1996) emphasize, an infrastructure is always related to its intended users and other relevant actors, and must be understood in their context. Both in the case
of UMTS and WLAN there are a number of actors or players that are involved in the development and deployment activities, including network operators, equipment vendors, third party service providers and end-users along with policy-makers at other stakeholder nationally and internationally. Below we present an overview of some of these different actors:

<table>
<thead>
<tr>
<th>Actors/factors</th>
<th>UMTS</th>
<th>WLAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardization bodies</td>
<td>ITU, ETSI (Europe), national radio frequency administrations and national license providers</td>
<td>IEEE, WECA (Wi-Fi), national radio frequency administrations.</td>
</tr>
<tr>
<td>Basic infrastructure operators</td>
<td>Telecommunication operators</td>
<td>In-house LAN operators, Wireless Service Providers (WISPs), ..</td>
</tr>
<tr>
<td>Equipment manufacturers,</td>
<td>Providers of end-user terminals /handsets etc., providers of base-stations (hardware/software)</td>
<td>Wi-Fi (hardware/software) access points vendors, mobile device cards vendors,</td>
</tr>
<tr>
<td>Third parties</td>
<td>Service and content providers (e.g. entertainment, travel information, location and context based services, portals,</td>
<td>Real estate, hotels, restaurant, airport owners, “no-biz” providers, providers of roaming, customer accounts and billing, and security functionality</td>
</tr>
<tr>
<td>End-users</td>
<td>Segments of mobile (roaming) professional users, Transport/logistics, consumers of entertainments services,</td>
<td>LAN market in general, ‘semi-mobile’ (travelling) professional users, home office workers, ad-hoc networks</td>
</tr>
<tr>
<td>Drivers of technology development and diffusion</td>
<td>Telecommunication operators, product manufacturer, third party developers of content services, end-user need for mobile multimedia service market</td>
<td>Product manufacturer competition, industry group, certification bodies, wireless portals, increased employee mobility.</td>
</tr>
</tbody>
</table>

Table 2: The actors involved in the development and implementation process

Departing from this table, we will briefly discuss the key aspects of an infrastructure.

**Enabling**

*Enabling* means that it is designed to support a wide range of activities, and is generic, not tailored to one type of application.

The rationale behind the UMTS development is to establish a general, enabling basis for third-party service providers. It’s also intended to be available for all end-users in a

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12 As NYCwireless, providing free wireless Internet service to mobile devices in public areas in New York City metropolitan area. (http://nywireless.net)
standardised and open way. However, without the availability of a broad range of third-party services, the UMTS networks will at most be a transport-infrastructure. It is also some concern arising from the fact that part of the intelligence needed to support sophisticated applications is network resident, which bears a risk that proprietary network architectures become stumbling blocks for application developers (EU2002b).

WLAN is intentionally a part of a transport infrastructure, in that it is developed to provide the same basic functionality (interface) as wired LANs. However, the kind and level of services will depend on the environment in which it is installed, which may differ among corporate and campus infrastructures, various types of hot-spots, ad-hoc networks etc., as most of these installation requires additional services. Thus, WLAN will need the availability of additional services (access, authentication and accounting), and these services should be seen as part of the support infrastructure, similar to the services as part of UMTS.

**Shared**

*Shared* by all members of a community, implies that the same ‘object’ is accessible to all users.

UMTS is intended to be shared by all users, at least as a transport infrastructure providing same basic services. However, each of the UMTS network operators will have to build their own physical network, and no network sharing between them may be allowed\(^\text{13}\). It is then most likely that the operators will invite the third party service providers to develop specialised services for each network. Thus, the additional service-infrastructures provided by the network operators (in cooperation with these third-party service providers) will not necessarily be shared by all. A customer of one network may not get access to the same services as offered in another network. Accordingly, there may not be any uniform set of services across the UMTS infrastructure. However, the access to the Internet will hopefully make general services available.

WLAN is providing standard LAN transport services which are shared by all users that are connected to an access-point. These will, however not be found everywhere. In addition, the user must plug in the WLAN-card, which must be configured correctly. To be used in different locations it requires different configurations. The WISPs are expected to handle this by making interoperability agreements, which however remain to be seen.

**Open**

*Open* is to be understood that there are no limits for number of user or other actors involved.

UMTS is principally open to everybody. But this also depends on the coverage of the base-stations, which is separate for the different network operators. The questions related to interoperability and network sharing is not settled yet, see St. mld. 32 (2001-02).

\(^\text{13}\) Network infrastructure sharing is an unresolved issue both nationally and in EU, and currently being handled by the PTT I Norway
WLAN is restricted and discrete in the sense that it is provided by specific hot-spots, hotels, airports and WISPs, and comprises thereby not an open infrastructure. WLAN may thus be viewed as one component of a public transport infrastructure aiming at selected market segments. This requires that third parties are developing additional services to enhance the service level, as e.g. to provide a security level that is acceptable when allowing access to corporate infrastructures.

Both platforms have the inherent problems of handling limited bandwidth associated with capacity problems of the frequency spectrum, as discussed above. The problems can anyway be solved by decreasing the cell size by introducing higher density of base-stations/access points. This is also a question of network planning and coverage strategy focused on maximising the operator revenue.

**Heterogeneous and socio-technical**
An infrastructure is *heterogeneous*, in that it includes not only physical facilities to transmit, store, process and display all type of data, but also user equipment, necessary software in the network and terminal equipment, the standards that are required to facilitate interconnection and interoperability. Furthermore, it will include various types of information such as directories, portals etc., and not at least the people that develop and maintain the systems and services linked to the infrastructure. This implies that an infrastructure must be understood as a socio-technical system, encompassing technological components as well as humans, organizations, and institutions.

We claim that both UMTS and WLAN must be seen a part of such heterogeneous, socio-technical systems, though distinct and different.

The development of UMTS is partly top-down initiated, as managed by the network operators and controlled by the national and international telecommunication authorities. However, the development of user terminals (handsets etc) and third-party-services is entirely market-driven, which is highly dependent on factors out of the control of the initial stakeholders. The current “wait and see” strategy of the stakeholders makes strategic and political decisions highly important. It seems to be a kind of ‘chicken-and-eggs’ problem, as the different actors are waiting for the others to take the next step.

The deployments of WLANs follow rather different patterns, dominated by small-scale service provider and is mostly market-driven. The key issues are linked to the development of additional services as roaming, billing and security, which most likely will be available in rather un-coordinated ways. It is accordingly an open question whether there need to be extended public intervention in this area, and if the increased use of the unlicensed frequency band will continue without breakdowns (already named the “garbage” band).

**Build on Installed Base**
It takes time to build an infrastructure. As all elements are connected, it cannot be changed instantly, but when new requirements appear they have to be adapted to the
existing ones. In this way, an infrastructure must be built on an installed base of previous installations, software systems and applications etc, and evolve rather than being constructed from scratch. On the other hand, it should be capable of enduring for an extensive period of time.

The installed base for UMTS is first of all the existing GSM network, and in addition the parts of Internet that it is assumed to interoperate with. During the first phase, GSM will coexist while UMTS is evolving. This implies that UMTS will have to be built on GSM, and at the same time gradually take over it. This will clearly become a difficult task, currently apparent with the problems developing dual mode (UMTS and GSM) handsets. At the same time it is of critical importance that the UMTS networks are able to provide a satisfactory platform for the development of third-party services. If not, there will be nothing of the earnings that is forecasted.

WLAN has similarly a well-defined installed base in the existing LANs along with Internet, which in the first hand can be seen as an advantage. As the infrastructure building of WLAN is progressing gradually, these investments are shared by many actors, and thus create a larger base for development of new services. However, the limitations inherent in this installed base may create barriers to solve the problems related to roaming, security, billing and other facilities.

6 DISCUSSION AND CONCLUSIONS

Our analysis based on data from the current development and implementations of UMTS and public WLAN reveals that a number of obstacles have to be managed before they may become public infrastructures. Despite the high ambitions and huge efforts put into implementing and diffusing UMTS and the increasing maturity of local implementations of WLAN, both platforms have a long way to go. At the same time, the appearing nature of the different platforms highlights that even if the different platforms have much in common, they may still require different efforts and approaches to become successful.

UMTS was initially supposed to become public, ultimately accessible from any location on earth as a true ubiquitous service infrastructure. WLAN, on the other hand, has initially and successfully been implemented as corporate and ‘So-Ho’\textsuperscript{14} extensions of local Ethernet implementations. Today, this approach has changed to regard the platform as a discrete public transport infrastructure available at a number of hot-spots where ever end-users need access.

The development and diffusion of WLAN as a transport infrastructure has resulted in an ongoing incremental evolution of the technology as well as its implementation. While WLAN has proven useful as local Ethernet extensions, it still lacks important features necessary to become an open public transport infrastructure. The price of initially implementing the platform as a minimal standard is seemingly paid of by difficulties in creating security and seamless interoperability, enabling access to hot-spots without risk and complicated end-user configuration.

\textsuperscript{14} Small offices, Home offices
UMTS on the other hand was and still is intended to be an application infrastructure. This infrastructure will be built on a transport infrastructure which is believed to be well designed, and provides seamless roaming, billing and security without concerns of the end-users. At the same time, to become an application infrastructure for the end-users, third-parties must provide a range of value adding services as well as user-friendly handsets to present the services in a proper manner. At present, UMTS is a technical standard having the potential to create a public infrastructure for multi-purpose mobile, broadband communications. However, we are lacking network implementations, available end-user terminals as well as the content services which can make an infrastructure economic sustainable. Thereby, the usefulness of UMTS is still an open question.

Both platforms have not yet become publicly available infrastructures, and the challenges they are facing are of typical infrastructural nature. The identification of their shortcomings does illustrate the platforms nature of infrastructures, as explained below.

UMTS faces a situation where the responsibility for further development and rollout rests on multiple actors out of any central control. We believe that its success depends upon what is conceived as its users and which business models that will emerge; e.g. whether the infrastructure will open or proprietary for each operator as well as how the implementation of the communication services and information content will emerge as well as received by the end-users. Getting out of the vicious circle to a virtuous one depends on a multiple of commercial actors as well as governmental agencies. Whether less or lessening in regulation policy and licence costs, or more common regulation across Europe will facilitate this is for us an open question.

On the other hand, public WLAN faces the need for additional services as access, authentication and accounting provided by third parties, that obviously require a critical mass to be justified, as well as a central coordination to be implemented. Provision of these services will be contingent upon further cooperation among network operators and actors providing the services. Using WLAN in such a service environment will also introduce new costs for some end-users that may be rejected.

We argue that infrastructures must be evolving, through incremental development and implementations. However, such type of platforms intended as being public infrastructures implemented incrementally under more or less full central control doesn’t automatically become successful. At the same time, being conceived as local implementations also produces certain challenges. UMTS, conceived in the realm of the traditional telecommunication industry are now facing a reality where one coordinated implementation of the infrastructure has become impossible. Crucially, this approach has from the beginning focused solely on ‘flag-day’, revolutionary replacement of its predecessor where the success of the infrastructure first will be clear after a complete rollout. We thus believe that UMTS would have gained from being implemented in a more incremental manner by a multiple of actors, enabling an implementation where the installed base of services, the existing infrastructure as well as end-user devices could be
taken advantages of. This is also the obvious case today, when the major focus for the actors in the current vicious circle is on further growth of 2.5G services.

The implementation of WLAN has followed such an incremental pattern, but still certain services are missing for the complete implementation of a public infrastructure. What is important is that what is lacking is not always being missed: The technology has by trail and error been found usable by the end-users, as well as its shortcomings have been identified. The shortcomings of UMTS are on the other hand less specific when it comes to the content services: They are missing in the way that with out services there is no need for the infrastructure. But what kind of services the users really ‘want’ is still an open question. On the other hand, WLAN have been conceived and implemented in an environment, where services as access, authentication, and maybe most important accounting, have not been appreciated as a part of transport network implementations. Leaving out such a central structure, along with a common business, revenue sharing model will probably require new implementations as well as the defining of new roles.

These different challenges can be interpreted as appearing according to the nature of transport versus application and infrastructures. We believe that what’s more important is the nature of where the infrastructures have been conceived, as well as their nature of both being a result of convergence between information and mobile communication technologies. If such converging technologies are to become success infrastructures, the stakeholders promoting them have to be more open to learn the history as well as nature of each others technology.

We believe that using theories of infrastructures as a framework for our research has showed fruitful by its emphasis on the volatile and risky nature of infrastructure implementation. The perspective of infrastructures as open and accordingly the distribution of risks and responsibilities provides us with ways of describing the challenges inherent in the two infrastructure buildings we have focused. At the same time, being more specific by describing various infrastructures as of different types, e.g. as transport versus application infrastructures seem fruitful.

On the other hand, the current status of this theoretical framework are not straightforward to apply when analysing these kinds of platforms, as the range of different characteristics and dimensions is vaguely, if defined at all. It’s also not straight forward to say whether the characteristics are the outcomes of an infrastructure or inherent in its very nature. Another issue is whether all these characteristics are mandatory in order to constitute an infrastructure, or should we rather distinguish between different categories of infrastructure have distinct characteristics. It could be that of these difficulties is a result of using these characteristics to describe infrastructural implementation retrospectively, and not as it emerges. We believe that our selection of characteristics has proven applicable for this case, but further research should apply this theoretical basis to further show its usefulness and elaborate its applicability.

Our concern is not so much how the technical development and implementations efforts will progress, but rather as Leiner, Cerf et al. (1997, p 108) emphasizes in their summary
of the Internet history: “… how to find the next social structure to guide Internet, [...] and how to manage the process of change and evolution.”. In the same way, we believe that the future of UMTS and WLAN as public infrastructures is very much contingent upon how the stakeholder with rather different interests will influence the further processes. Not being tempted to make strong prophesies, we believe that there still is an open question concerning if, and indeed in what shape and configuration, UMTS and WLAN finally will end up becoming public infrastructures.
REFERENCES


Hanseth, Ole (2001) Gateways - just as important as standards. How the Internet won the “religious war” about standards in Scandinavia. Accepted for publication in Knowledge, Technology and Policy.


Kane, Jason, David C. Yen, *Breaking the barriers of connectivity: an analysis of the wireless LAN*, Computer Standards & Interfaces, 24, 2002, pp 5-20


St. mld 32 (2001-2002) Om situasjonen i den norske mobilmarknaden, Samferdelsesdepartementet


UMTS forum, [http://www.umts-forum.org/what_is_ums.html](http://www.umts-forum.org/what_is_ums.html):

ETSI Telecom standards, [http://www.etsi.org/getastandard/home.htm](http://www.etsi.org/getastandard/home.htm)

Wireless World forum, [http://w2forum.com](http://w2forum.com)

IEEE, [http://www.ieee.org](http://www.ieee.org)

Wireless (Ethernet Compatibility Alliance WECA © Wireless, [http://www.wi-fi.org](http://www.wi-fi.org)

The 3rd Generation Partnership Project (3GPP), [http://www.3gpp.org](http://www.3gpp.org)

International Telecommunication Union (ITU), http://www.itu.int

Information Society Technologies Programme (IST) [http://www.cordis.lu/ist/home.html](http://www.cordis.lu/ist/home.html)