Ericsson Mobile Operator WLAN solution

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Wireless LAN is a complementary service offering for mobile operators. The Ericsson Mobile Operator WLAN solution combines the wide-area benefits of second- and third-generation mobile systems, including unlimited roaming and mobility, with additional throughput and capacity in indoor hot-spots via wireless LANs. The solution gives broadband mobile public access to the Internet and to corporate intranets from relatively little additional investment.

The authors present WLAN as a complement to GPRS and UMTS and explain the market drivers of the solution. They describe the Ericsson Mobile Operator WLAN – Release 1 in detail and give an overview of ongoing standardization.

WLAN as a complement to GPRS and UMTS

Wireless LAN (WLAN) technology is being used more and more in homes, offices and indoor public areas. Mobile service providers are exploring opportunities to extend their service portfolios by providing limited, indoor WLAN hot-spot access. The same basic configuration—that is, a laptop computer with a WLAN adapter—can be used to gain access in indoor public and private environments. End-users can thus access their office environments without any noticeable change in network performance.

Market drivers

The WLAN market is currently undergoing very rapid expansion. At the office it is being used to increase organizational flexibility, and in homes it is replacing obtrusive cables. While these market segments are conceptually relatively straightforward, there is a third market segment that is still in its infancy: indoor public WLAN access—that is, the ability to access the Internet from indoor public places, such as airports lounges, hotels and conference centers. This segment has attained considerable interest over the past few years and several entrepreneurs have set up public WLAN networks in major US and European cities. So far, however, the number of subscribers is still low, due to

- poor coverage—users might be able to use WLAN services at the airport of departure, but not at the airport of arrival, or at the hotel;
- a lack of brand recognition—the service operators are often new start-ups, which causes end-users to hesitate to use the service; and
- a lack of roaming agreements—end-users are forced to locate different service providers at the places they roam to.

As has been demonstrated time and again during the history of wireless service, coverage is the single most important factor for making a new wireless technology a success. This is where cellular mobile operators come into the picture. They already have an infrastructure that covers wide areas. Therefore, with little extra investment, they can add indoor WLAN access to their present offerings. In addition, they have management systems for billing, authentication and subscriber handling. They also have a very large base of mobile subscribers who would be prime targets for a high-speed data offering. Given this background, Ericsson believes that mobile operators are in a very good position to add indoor WLAN service as a complement to their existing wide area service. Business professionals are expected to be the first important group of users of a combined cellular/mobile WLAN service. They already use mobile phones and they usually bring their laptop computers along when they travel.

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WLAN is a complementary service offering for mobile operators. GPRS and UMTS operators can provide two kinds of access to mobile packet-data services: via the wide-area GPRS/UMTS network, and through

BOX A, ABBREVIATIONS

3GPP	Third-generation Partnership Project
AP	Access point
APIS	Application program interface server
ASN	Access serving node
BGW	Billing gateway
CABS	Customer administration and billing server
CDR	Charging detail record
ETSI	European Telecommunications Standard Institute
GPRS	General packet radio service
GSM	Global system for mobile communication
HiperLAN	High-performance LAN
HiSWAN	High-speed wireless access network
HLR	Home location register
IAPP	Inter-access point protocol
IETF	Internet Engineering Task Force
IP	Internet protocol
ISDN	Integrated services digital network
ISP	Internet service provider
LAN	Local area network
MAC	Medium access control
MMAC	Multimedia mobile access communication
MSISDN	Mobile station ISDN
OTP	One-time password
PDA	Personal digital assistant
RADIUS	Remote authentication dial-in user service
SAS	Statistics and accounting server
SCS	Service control server
SIM	Subscriber identity module
SMS	Short message service
SMS-C	SMS center
SOHO	Small office/home office
SSL	Secure socket layer
UMTS	Universal mobile telecommunications system
WAN	Wide area network
WLAN	Wireless LAN

the high-capacity WLAN access network. WLAN access is a particularly suitable form of alternative access at indoor public hot-spots, such as airport lounges, hotels, and conference areas. What is more, the packet-data service can be provided seamlessly (with some trade-off in performance and possibly service) between GPRS/UMTS and WLAN. Ericsson's Mobile Operator WLAN solution, for example, fully integrates WLAN into the mobile operator service offering. It ensures easy subscriber handling and integrates WLAN network management into existing network management routines.

Requirements and basic principles

Requirements for the Mobile Operator WLAN solution

The most important requirements pertaining to the Mobile Operator WLAN solution[1], users, operators, and system are as follows:

- WLAN interworking with GPRS and UMTS must adhere to standards;
- it must be possible to reuse GPRS/UMTS authentication mechanisms for WLAN access without degrading the security of the GPRS/UMTS network or its subscribers;
- an enhancement to the GPRS/UMTS subscriber base must be specified so that existing subscribers can easily obtain WLAN services;
- roaming must be specified between wide-area cellular radio access and WLAN radio access networks. Moreover, roaming between different Mobile Operator WLANs must be supported; and
- user data in the WLAN must be protected to the same extent that it is in GPRS/UMTS.

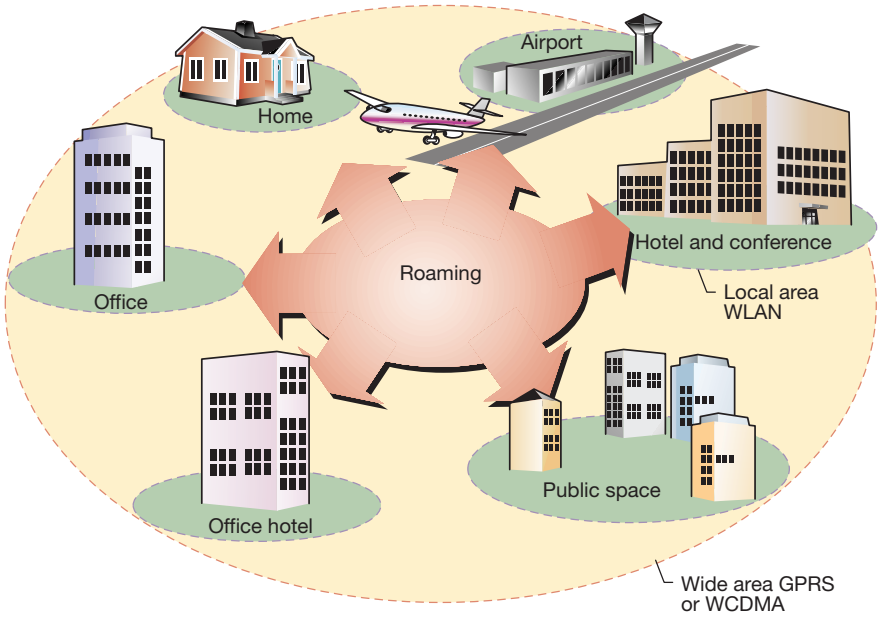
Basic principles of interworking with WLAN

As stated above, the Mobile Operator WLAN solution combines the wide-area benefits of second- and third-generation mobile systems, including unlimited roaming and mobility, with additional throughput and capacity in indoor hot-spots via WLANs. Users of public WLAN will be part of the mobile operator's subscriber base. Thus, with little additional investment, mobile operators can further expand a second- or third-generation packet service. However, the standardization of WLAN interworking needs to be limited to a very small set of items, such as the reuse of existing subscriber management mecha-

BOX B, TERMINOLOGY

Access point
Device responsible for the centralized control of the resources in a radio cell.
Authorization
The act of determining if a particular right, such as access to some resource, can be granted to the presenter of a particular credential.
BRAN project
ETSI project preparing standards for equipment providing broadband (25 Mbit/s or more) wireless access to wire-based networks in private and public environments, operating in either licensed or license-exempt spectrum. These systems address both business and residential applications.
HiperLAN/2
High-performance radio LAN type 2 is a short-range wireless LAN that provides local broadband access. HiperLAN/2 is being standardized by ETSI (see BRAN project).
Home network
A network where a user is known to the authentication system of that network.
Mobile terminal
End-system equipment that provides the interface to human beings through a set of applications. In the context of this document, the MT includes the functions and protocols necessary to provide and handle communication with the WLAN network and other networks (GPRS, UMTS), services and applications.
Private network
A network under the administrative control of a single entity, such as a corporation or family. Network services are basically only offered to the users employed by that entity.
Public network
A network under the administrative control of a legal entity, often referred to as the network operator. The network services offered to the customer base are defined by the operator (and possible partners).
Roaming
The ability of a user to function in a serving network other than the home network.

Figure 1
Ericsson Mobile Operator WLAN vision—bridging local-area and wide-area networks.



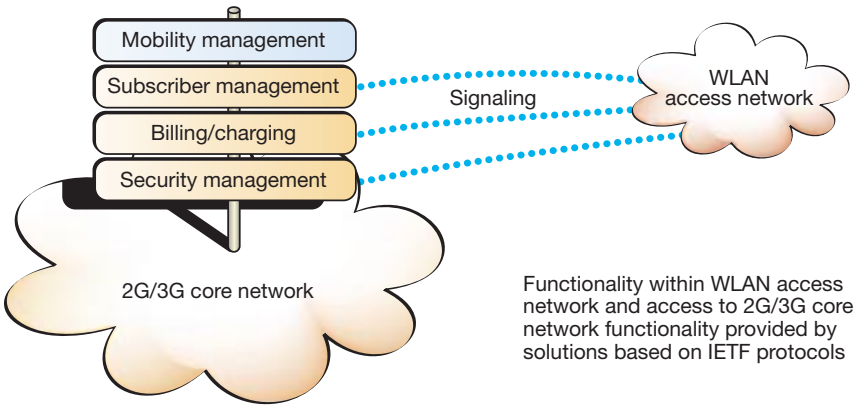


Figure 2
Reuse of core network functionality.

nisms, authentication and security functions, and billing functions (Figure 2).

In this way, the WLAN becomes a complementary IP access network of the current GPRS/UMTS packet-switched domain. If the cellular mobility management is not reused, then only signaling messages need to be exchanged between the WLAN radio access network and the GPRS/UMTS core network. This minimizes the impact of WLAN on GPRS/UMTS and reduces the need for standardization work within the 3GPP. In addition, the architectural solution, with its IETF-defined interfaces to GPRS/UMTS networks, has the advantage of being generically suitable for all WLAN technologies. This is in line with ongoing work in the ETSI BRAN project.

Mobile Operator WLAN—Release 1

Ericsson will provide Mobile Operator WLAN solutions to UMTS, CDMA2000 and GSM/GPRS operators. GPRS-WLAN interworking pilot projects were conducted during Q4/2001.

Mobile Operator WLAN Release 1 has been designed for mobile operators who want to deliver combined GPRS and WLAN service offerings (Figure 3). The solution follows the basic principles described above. All integration is done in back-end systems—that is, it has no impact on the existing GSM/GPRS network. This approach, in combination with the reuse of the GSM transport network, billing gateway, and GPRS RADIUS server, reduces operating and capital expenses. The system architecture assumes that a GPRS infrastructure has been deployed and is in service. The supported WLAN standard is IEEE 802.11b, which is already widely deployed in the market.[2] However, the limited number of frequencies for WLAN and other systems at 2.4 GHz complicates the issue for systems that reuse frequencies. Moreover, massive use of frequencies at 2.4 GHz can severely degrade service. Consequently, plans have been made to expand the Mobile Operator WLAN offering into the 5 GHz range where more spectrum has been reserved for WLAN systems and where the spectrum requirements in Europe enable contention-free access to spectrum.

Functionality and features

The system gives mobile operators a set of tools that they can use to exploit the WLAN business opportunity. These tools include different authentication and billing models, service differentiation, roaming, corporate network access, localized content, and support for captive portals.

Billing models

The system gives operators a choice of four billing models: flat-fee, consumption-based, voucher-based (similar to pre-paid subscription), and free service.

- Flat-fee billing—the user has a subscription with the operator and is charged a fixed amount each month, regardless of usage.
- Consumption-based billing—the user

has a subscription with the operator and is charged according to usage. Charges can be based on time or volume (minutes logged in or megabytes of data transferred).

- Vouchers—the system supports the generation and recognition of vouchers, which enable time-limited accounts (per day, week, and so on) with randomly generated login and password information. This information can be printed on scratch cards, which can be distributed and sold, for example, at the WLAN hotspot. The voucher concept can be employed to advantage when the WLAN service is first being introduced, to heighten user awareness of the capabilities of the service.
- Free services—the system supports services for non-paying users. The scope of the services restricts access to specific sites. The user is granted access to local information, such as gate info at an airport, special offers from local shops, or redirection to the operator portal with information on subscription types and pricing.

Authentication models and WLAN service access

The system uses Web login and supports two authentication models:

- SIM-based authentication by a one-time password (OTP) delivered via SMS; and
- static password-based authentication.

The SIM-based authentication model uses a secure and authenticated channel to distribute one-time passwords for WLAN service access.[3] The concept, which uses the GSM subscription (SIM card + GSM phone) as an authentication token, uses SMS to distribute OTPs via GSM to SIM-authenticated users. The WLAN service-access scenario is as follows: The user starts a browser that is redirected to a WLAN service login page. The login page prompts the user to provide his credentials. After the user presents his identity (GSM phone number), the Web page is updated and prompts the user to provide the OTP. In the meantime, the system delivers an OTP to the user's phone via SMS. If the OTP has been entered correctly on the Web page, the system grants the user access.

With static password-based authentication, the user launches the Web browser application that is automatically redirected to a WLAN service login page. The login page prompts the user for username and password. The user enters the username and password that was supplied with the subscription confirmation or voucher. SSL in server-authentication mode is used during the transfer to protect sensitive data con-

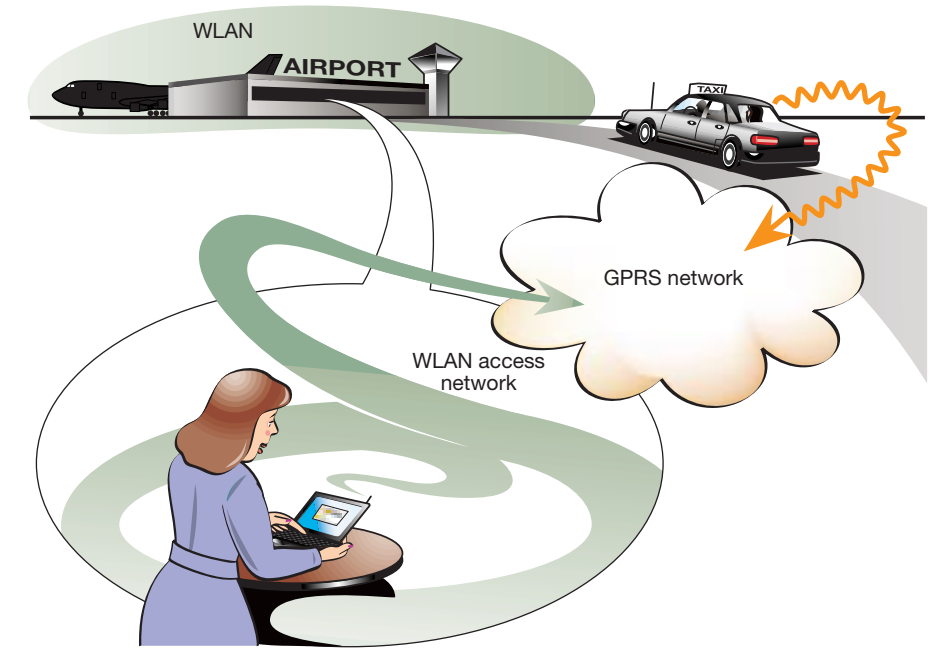


Figure 3
Complementing GPRS with WLAN service.

taining user credentials. If the login is successful, a session control window is displayed. The user terminates the session by clicking on a logout button in the session control window. A logout window then appears displaying a summary (statistics) of the session.

Localized content and captive portals

The login page for the WLAN service can adapt according to user location. The user is always presented with localized information, such as departure information at the airport, the menu of the day at the hotel, and local advertisements. The system can also be configured to present a specific home page for authorized users. The home page functions as a captive portal that can be tied to the user's subscription type and current location.

Service differentiation—product profiles

The system can offer different services to different users—for instance, Gold, Silver or Bronze subscriptions. Differentiation is made according to application type and geographical availability. Occasional users (bronze) get limited Web access, whereas no limitation of traffic type is put on regular users (Silver). Similarly, users with a special subscription (Gold) might receive additional services. Another example could be vouchers sold through a hotel chain that solely grant access on the hotel premises.

Roaming

The system allows roaming with other service providers who offer WLAN services that support RADIUS.[4] Roaming can be achieved with coherent service differentiation, provided that the roaming partners define the product profiles in the same way.

Corporate access

Corporate access is a vital end-user service. Indeed, business professionals will be the first to adopt WLAN service. Corporate access gives users secure access to e-mail, the Web and company file structures (documents and presentations). Ericsson provides verified corporate-access solutions that operate over GPRS and WLAN.

System overview

The Ericsson Mobile Operator WLAN Release 1 assumes that a GSM or GPRS infrastructure has been deployed and is in service. To deploy the WLAN service, an additional set of components must be added to the GSM/GPRS infrastructure. These components are installed at

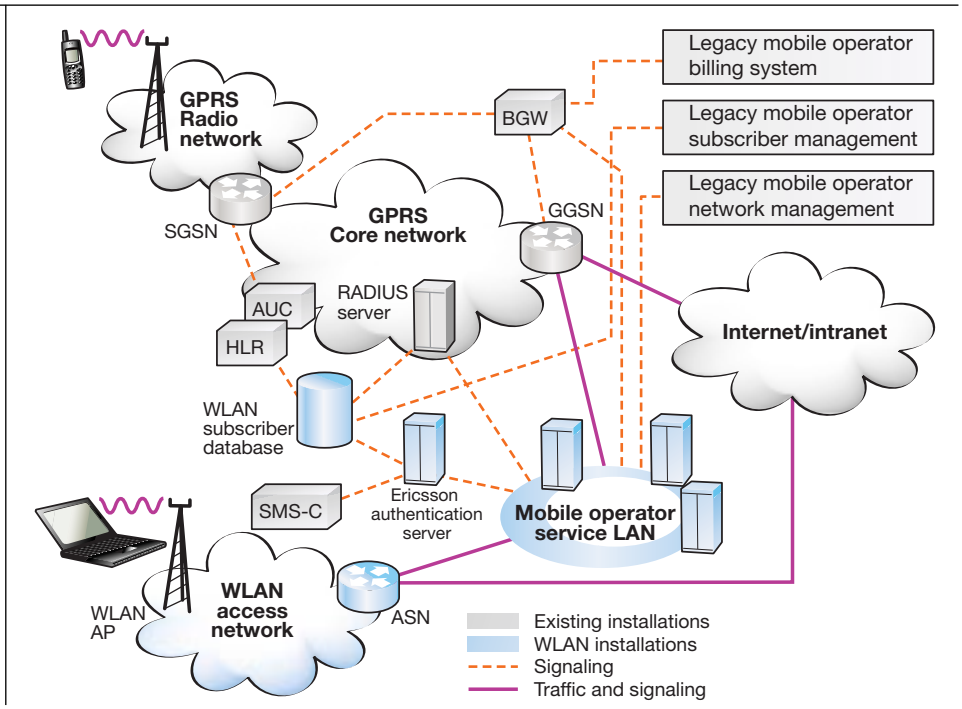


Figure 4
Ericsson's Mobile Operator WLAN solution (Release 1).

- indoor sites where the WLAN service is to be offered (hot-spots); and
- a central location where the access management system is located.

Figure 4 illustrates the system architecture of the Ericsson Mobile Operator WLAN solution (Release 1).

A set of IEEE 802.11b access points, installed to give indoor hot-spot coverage, is connected through an Ethernet network to the access serving node (ASN). The ASN, in turn, is connected to the IP backbone. The prime functions of the ASN are to restrict services to authorized end-users and to enforce the corresponding service policies (product profiles). The ASN is a generalized access server that authenticates users who want to access services from a hot-spot site. It controls access by filtering all packets coming from, and directed to, the WLAN access network. The ASN also creates accounting data. The access management system consists of the following components:

- service control server (SCS);
- authentication server;
- statistics and accounting server (SAS);
- customer administration and billing server (CABS);
- application program interface server (APIS); and
- WLAN manager.

The SCS assists the ASNs, performing authentication and authorization. For redundancy purposes one ASN is associated with two SCSs. Each time a user logs in, the ASN contacts the SCS using RADIUS to authenticate the user. The SCS either directly answers the authentication request (voucher account) or functions as a RADIUS proxy to the authentication server or the external RADIUS server (post-paid subscriber). The SCS also provides the ASNs with access policies, in the form of product profiles, using LDAP.[5] The product profile is enforced in the ASN after the user has been authorized.

The authentication server enables SIM-based authentication. When it receives an authentication request from the ASN, it looks up the user in the subscriber database, creates a one-time password, and communicates with the associated SMS center (SMS-C) in order to deliver an SMS with the one-time password. When the user has provided the password, the ASN performs a second authentication request. If the entered password matches the OTP delivered via SMS the system grants access. The authentication server functions as a back-end RADIUS server in the GPRS home network.

The SAS provides accounting and statistical functions. It aggregates accounting data from all ASNs and compiles data for statistics. The aggregated billing data is sent to the GSM/GPRS billing gateway (BGW) as WLAN-specific CDRs and retrieved by the legacy billing system.

The CABS is used as the administrative interface for vouchers and product profiles. It includes a Web-based interface and a CORBA interface to the APIS.

The core function of the APIS is to store original data (product profiles, voucher parameters such as identities, passwords and limits). It constitutes the storage from which the SCSs replicate data. However, configuration data on regular post-paid subscribers is administered and stored in the authentication server or the RADIUS database of the GSM/GPRS network. The authentication server or GSM/GPRS RADIUS server contains a duplicated set of information from the HLR (that is, the MSISDN). All WLAN post-paid users must have additional tags or fields which relate to the WLAN service entered and which specify the product profile that should be enforced. The APIS comprises a CORBA interface that connects it with the CABS and which can also be used for integration with legacy back-end subscriber management and provisioning systems.

The WLAN Manager is the integration point for all WLAN-related management in the Ericsson Mobile Operator WLAN solution Release 1, including network management, element management, and systems management.

Standardization

Ericsson has strong presence in standardization bodies and is one of the initiators of the 3GPP work item on WLAN-UMTS interworking. Besides the 3GPP, other standardization bodies actively defining essential functionality for WLAN-UMTS interworking are the IETF, IEEE, ETSI and MMAC. Ericsson has the goal of ensuring that any WLAN terminal has the technical possibility of securely connecting to any GPRS/UMTS-WLAN network (subject to commercial agreements), and that all required functionality is in place to allow global roaming, charging and billing, and operation and maintenance. The WLAN systems will complement the current GPRS/UMTS packet-switched domain.

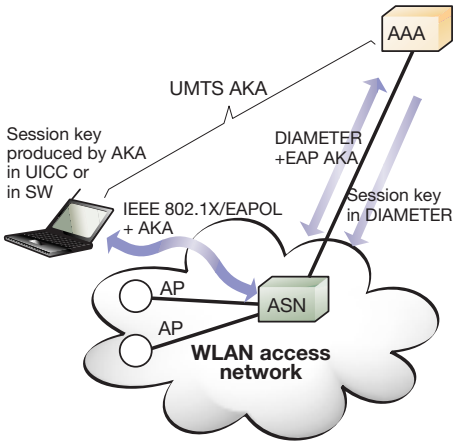


Figure 5
Example of UMTS AKA authentication between a mobile terminal and WLAN service.

Work item in the 3GPP

The first 3GPP activity within the WLAN area is to conduct a feasibility study

- to define service scenarios;
- to define the interworking requirements put on UMTS;
- to specify the interworking functionality; and
- to identify the need for enhancements in the UMTS specifications.

Following the feasibility study, work will begin on drafting the actual standards. The first set of standards is expected in mid-2003 as part of 3GPP Release 6.

To minimize the workload in 3GPP, a five-phase approach has been defined. The first phase covers common billing between WLAN and UMTS. Later phases will cover interworking (where subscribers can roam between UMTS and WLAN), security aspects, intersystem session continuity, and service mobility. The last step might imply the complete integration of WLAN access into UMTS, where the WLAN access points are connected directly to an evolved RNC.

Service aspects will need to be assessed in terms of service requirements and the support of UMTS services over the WLAN radio access. Man-machine interface aspects should define a minimum set of functions needed to support the choice of access system when both access systems are available.

Security requirements should be specified in such a way that

- the security level of the UMTS platform is not compromised; and
- the security level offered users in the WLAN mode is comparable to that of UMTS.

WLAN standardization in Europe, the US and Japan

Several WLAN standards have been drafted in Europe, the US, and Japan. In Europe, the BRAN project (ETSI) has specified HiperLAN/2 in the 5 GHz frequency band. HiperLAN/1 was a predecessor specification that was never commercially launched.[6]

In the US, the IEEE has specified the 802.11 family of standards with a single medium access control (MAC) protocol and several physical layers[7-8]:

- one infrared physical layer (802.11);
- three 2.4 GHz physical layers (two of which are in 802.11; and one supporting 11 Mbit/s in 802.11b[7]); and
- one 5 GHz physical layer (802.11a).

Further specification work is ongoing within

- 802.11e—to add QoS support to the MAC protocol;

- 802.11f—to specify an inter-access point protocol (IAPP) to transfer information between access points at handover;
- 802.11g—even higher throughput is envisioned on the physical layer for 2.4 GHz;
- 802.11h—the 5 GHz physical layer is being enhanced to support radar detection, dynamic frequency selection, and to fulfill spectrum requirements for power control in Europe; and
- 802.11i—improving the security in the standard.

In Japan, the multimedia mobile access communication (MMAC) specification consists of three different systems in the 5 GHz frequency band:

- high-speed wireless access network (HiSWAN)—similar to HiperLAN/2;
- wireless Ethernet—similar to IEEE 802.11a; and
- wireless home link (based on IEEE 1394, also called FireWire).

The Mobile Operator WLAN solution can be adapted to work with all WLAN standards. Release 1 supports the dominant WLAN standard, IEEE 802.11b, which operates in the 2.4 GHz band at data speeds of up to 11 Mbit/s.

Conclusion

The unlicensed frequencies and high user data rates of WLAN systems make them interesting for cellular operators and ISPs. By connecting a WLAN system to their core network, operators can cover crowded hotspot areas in indoor public environments and provide complementary high-speed data access.

The Ericsson Mobile Operator WLAN solution complements the portfolio of value-added radio-access technologies. The increasing number of WLAN deployments in the corporate and SOHO market segments support this development. Both market segments are early adopters of WLAN technology, in particular because the same technology and set-up apply in the office, at home, and on the road. Public operators can thus offer the same service quality and the low latency currently experienced in the fixed office infrastructure. In addition, the support of roaming between WLAN deployments and between WLAN and the cellular wide-area coverage will further boost growth.

The Mobile Operator WLAN solution will give broadband mobile public access to the Internet and to corporate intranets with relatively little additional investment. WLAN will support all GPRS and UMTS packet services on standard user equipment (laptops).

Work on the architecture and protocols of the Mobile Operator WLAN solution is currently being specified in 3GPP and WLAN standardization bodies. GPRS and UMTS specifications will be enhanced to permit the reuse of subscriber management, security management, and charging and billing functionality.

WLAN technology serves as a broadband complement to GPRS, UMTS and other second- and third-generation systems, bridging the gap, as it were, between different environments and applications. The perceived quality of service over the public WLAN access will not differ from WLAN access in the office.

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