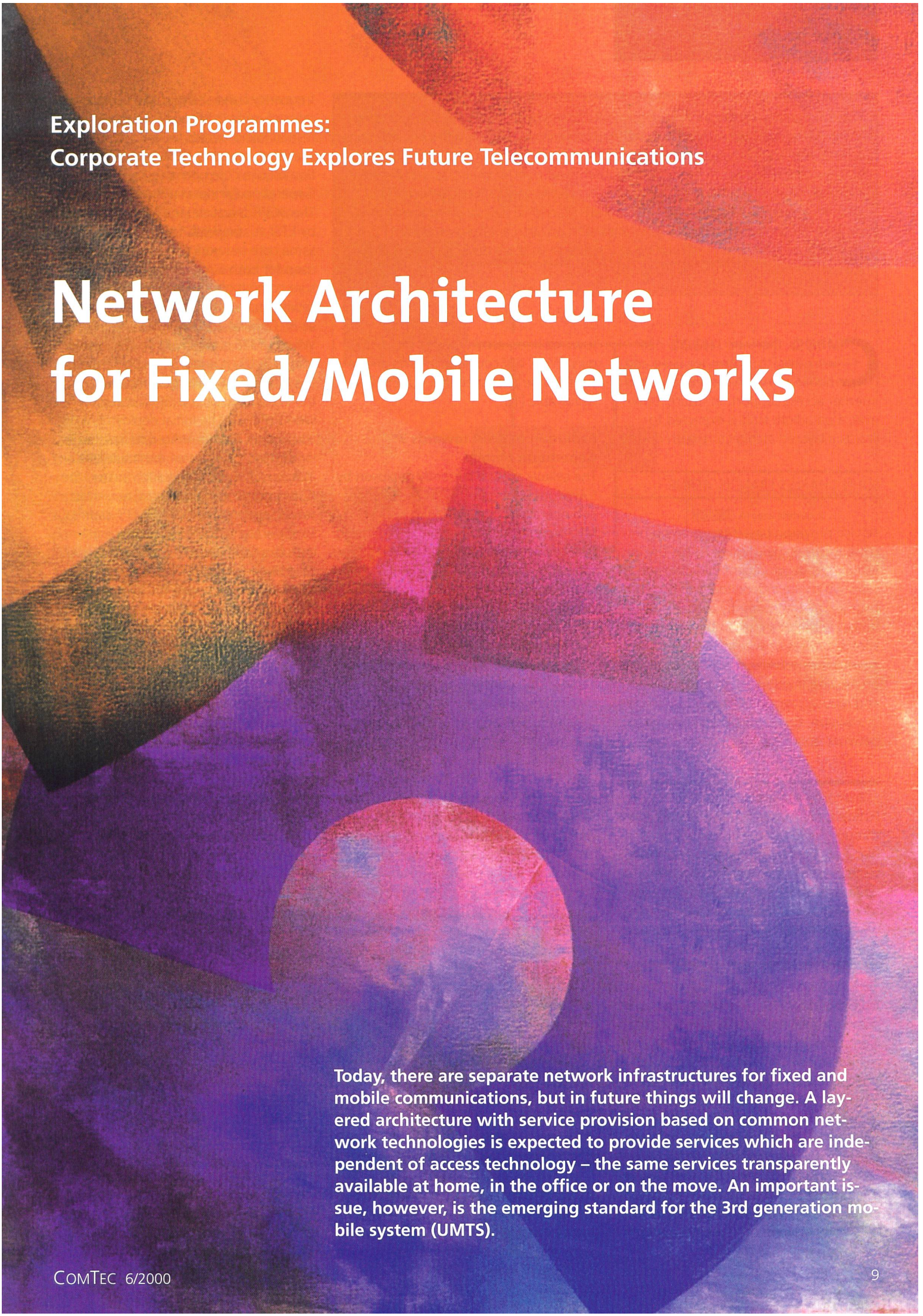
Network architecture for fixed/mobile networks

Exploration Programmes:
Corporate Technology Explores Future Telecommunications

Network Architecture for Fixed/Mobile Networks



Today, there are separate network infrastructures for fixed and mobile communications, but in future things will change. A layered architecture with service provision based on common network technologies is expected to provide services which are independent of access technology – the same services transparently available at home, in the office or on the move. An important issue, however, is the emerging standard for the 3rd generation mobile system (UMTS).

The Programme "Network Architectures & Technologies" explores the emerging IP functionalities supporting fixed and mobile services, and identifies key solutions to engineer and plan next generation packet based networks. The objective is to achieve cost reduction in network investment and operation and to transfer new network capabilities into revenue generating converged network services.
With its Exploration Programmes, Corporate Technology is exploring telecommunication technologies and new service possibilities with a long-term view of 2–5 years. Further, the expertise built up in the course of this activity enables active support of business innovation projects.

Currently, there are separate network infrastructures for fixed and mobile communications, and for Internet access support. In future, however, a paradigm shift is expected towards a layered architecture with diverse

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service provision based on common network technologies (figure 1). For the customer, this development will offer services which are independent of access technology-transparently available at home, in the office or on the move. High speed cordless or wireline access to 3rd generation mobile services will capitalise on existing investment in the local loop and reduce stress on the cellular system. In addition, there will be cost savings in network operation and infrastructure.

Future mobile services, whether accessed through radio or copper will be multimedia. And, in the context of the new investment for these services, the opportunity exists to achieve the goal of diverse service provision based on common network technologies.

EURESCOM P919 "Evaluation of Integrated Fixed and Mobile Networks"
Corporate Technology has specified and is currently leading the EURESCOM P919 project "Evaluation of Integrated Fixed and Mobile Networks". Work is performed in collaboration with eight other operators and with involvement of several engineers from Corporate Technology. The project is specifically addressing the paradigm shift away from separate infrastructures for fixed, mobile, voice and data networks, and their evolution towards integrated network technologies. Work will conclude in June and results will be published in a EURESCOM deliverable [1].

Evolution of GSM towards 3rd Generation Mobile
The cellular system currently deployed by Swisscom is based on GSM technology and operates in the 900 MHz and 1800 MHz frequency bands. GSM is supported by a circuit-switched core network corresponding to specifications from the European Telecommunications Standards Institute (ETSI).
The General Packet Radio Service (GPRS) is a new service standardised by ETSI as an add-on to GSM networks. It utilises a packet radio principle and can be used for carrying end user's packet data protocols (such as IP and X.25). ETSI has also standardised an evolved GSM radio technology, the Enhanced Data rates for GSM Evolution (EDGE), which uses the existing GSM frequency bands to achieve bitrates of up to 384 kbit/s.
The Universal Mobile Telecommunication System (UMTS) uses a new radio access technology which operates in a higher frequency band (2 GHz) and achieves bitrates of up to 2 Mbit/s. The UMTS Terrestrial Radio Access Network (UTRAN) is specified, together with the 3rd Generation mobile core network, by the 3rd Generation Partnership Project (3GPP). The 3GPP specifications will be endorsed by ETSI as standards for Europe and the same core network specifications will be used for both EDGE and UTRAN, to ensure compatible services. Systems and services based on UTRAN are referred to as 3rd Generation (3G).
When UMTS is deployed by GSM operators in 2002, it is highly probable that the UTRAN will be interconnected with the existing GSM and GPRS core networks (fig. 2). The initial deployment of UMTS may well be limited to isolated islands (e.g., city centres, business areas, industrial plants) and in such a case, the GSM infrastructure will provide limited service support between UMTS islands. To allow the UTRAN to communicate with the GSM and GPRS networks, so-called Inter-working Units are needed. The interface between the UTRAN and the core network is called the *Iu*-interface and is based on ATM-technology in the currently approved 3GPP specifications, *Release '99*.

3GPP Release 2000
At the beginning of this year, work started within 3GPP on *Release 2000*. The new specification should largely be completed by the end of the year and will include functional enhancements and transport-independent support of UMTS with an "all-IP" option. Below are some of the 3GPP architectural principles for Release 2000.

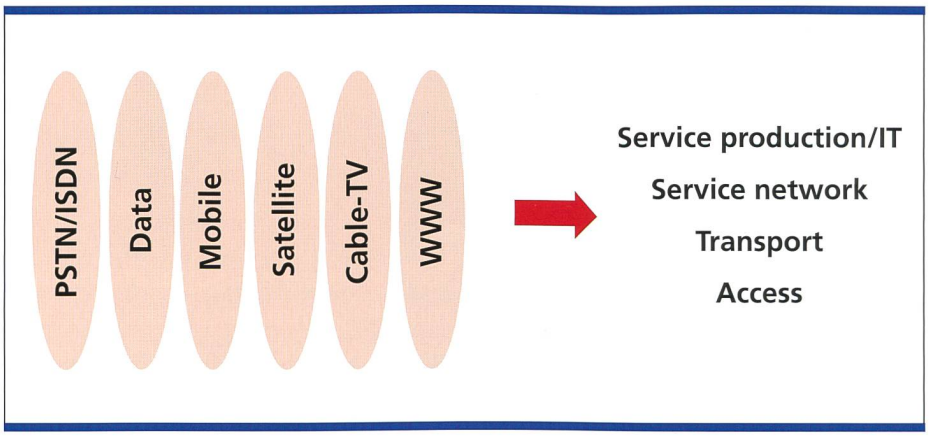

Fig. 1. Paradigm shift from dedicated service networks towards a layered architecture with common network technologies. Currently, there are separate network technologies as shown on the left, but in future this is expected to change.

Transport Independence *(to control heterogeneous bearer mechanisms)*
The GSM/UMTS core network architecture is independent of the underlying transport mechanism (e.g. STM, ATM or IP). Furthermore operators have the freedom to utilise a single or any combination of transport technologies.

Standardised Alternatives for Transport Mechanisms
Alternatives for the signalling transport (e.g. SS7, SIGTRAN) for the service control, call control and bearer control protocols as well as the alternatives for the user plane transport will be standardised for relevant transport mechanisms.

Decomposition of Network Functions
The GSM/UMTS reference architecture all-IP option will be defined in terms of separate functions and clear interfaces such that it is possible to separate transport from signalling. This has the objective of separation of call/session, mobility and service control. This is intended to give operators the freedom to provision, dimension and upgrade these network functions in a modular fashion, providing flexibility and scalability of network implementations.

Flexible Traffic Processing Function Placement
The GSM/UMTS reference architecture will allow operators to place the traffic processing function in the most practical, cost-effective part of the network.

Use of Internet Protocols
The GSM/UMTS reference architecture will use, as appropriate, existing/evolving Internet Protocols e.g. to support multimedia services, interoperability with other next generation fixed or mobile networks, and media gateway controllers.

Support for a Variety of mobile Equipment
The GSM/UMTS reference architecture will support a range of different terminal types (simple speech-only terminals, multimedia terminals, PDAs, Laptops, etc.). One particular aspect is that not all terminals may be able to support end-to-end IP capabilities.

Independence of Access Technologie
The GSM/UMTS reference architecture will be designed to ensure that a common core network can be used with multiple wireless and wireline access technologies (e.g. xDSL, cable, wireless LAN, digital broadcast, all IMT2000 radio access technologies).

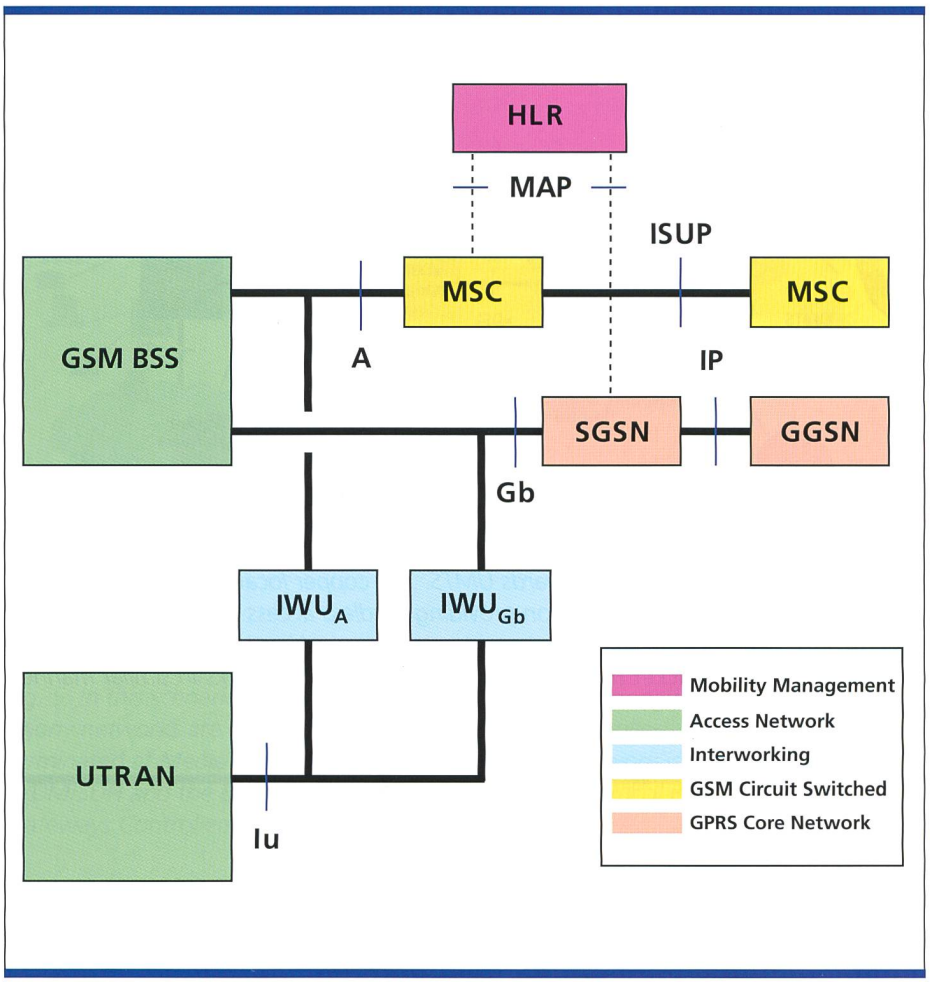

Fig. 2. Interconnection of a UMTS Terrestrial Radio Access Network (UTRAN) with existing (legacy) GSM/GPRS core networks using Inter-working Units (IWU's). The Iu reference denotes an ATM-based interface to the UTRAN, while A and Gb denote the interface to the GSM circuit switched and GPRS networks, respectively.

Support for Roaming onto other 2G and 3G mobile Networks
The GSM/UMTS reference architecture will be designed to facilitate roaming between different network types.

Support of Service Requirements
The GSM/UMTS reference architecture will include mechanisms for operators and third-parties to rapidly develop and provide services and for users to customise their service profile.

Support of regulatory Requirements
The GSM/UMTS reference architecture will include features to support regulatory requirements such as legal intercept, number portability, and other regional requirements, to all terminal types and communication types (Circuit Switched and Packet Switched) as appropriate.

Separation between Bearer Level, Call Control Level and ServiceLevel
– *Use of different access technologies to connect the "IP multimedia core network subsystem":* The IP multimedia domain is connected to the bearer network at a fixed reference point (anchor point) thus hiding the micro mobility of the user equipment (terminal), but it does not hide roaming. This reference point will be independent from the access technology that can be GPRS, UMTS Packet Switched or any relevant wireless, wireline access technology as long as they provide transport of user packets up to this reference point and as they hide micro-mobility of the user equipment. As a consequence, the behaviour of the multimedia call control server can be the same whatever the access technology (radio or wireline).

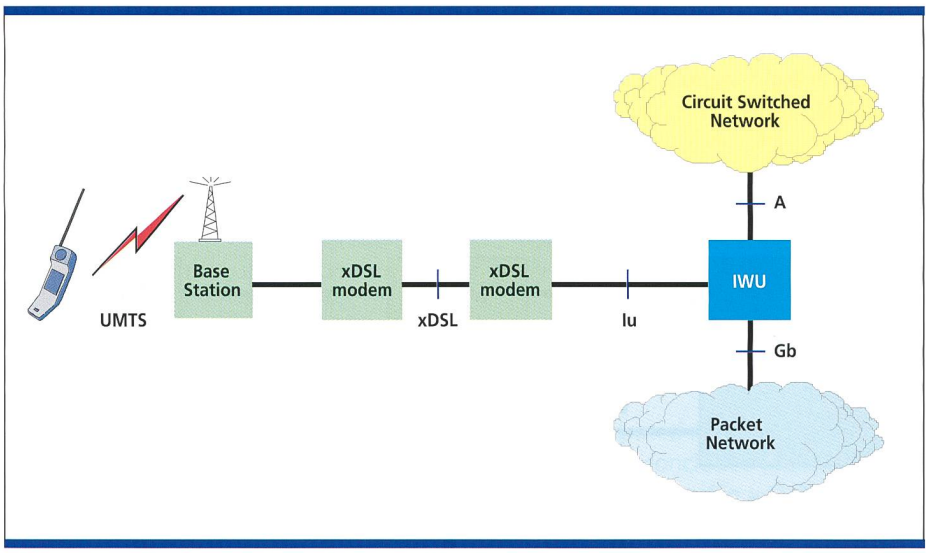

Fig. 3. Fixed network evolution towards UMTS. The copper local loop has been upgraded to xDSL. A UMTS base-station providing cordless access has been added at the customer premises. At the operator side, an Inter-working Unit (IWU) separates circuit-switched and packet traffic into respective (legacy) networks in similar manner to figure 2.

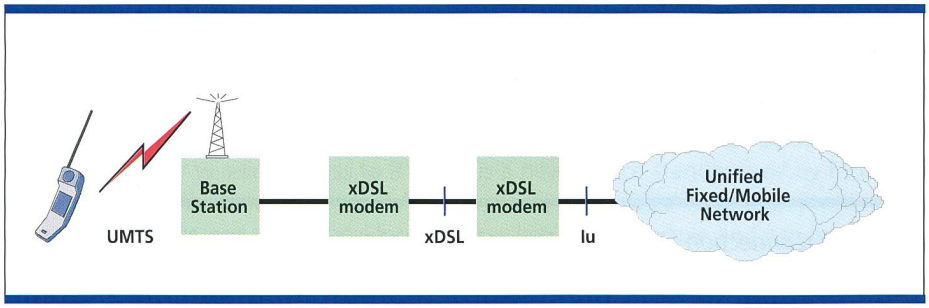

Fig. 4. Alternatively, xDSL is connected directly to an Iu-compliant core network which handles both circuit-switched and packet traffic. The core network is the "Unified Fixed/Mobile Network".

Multimedia call control and mobility management will not be aware of the access technology: the multimedia call control does not handle notions such as handover.

– *The access to the IP multimedia core network subsystem is supported by the packet switched domain at the, so-called, Gi interface:* The packet switched domain provides bearers that are used by the user equipment for its signalling and provides user plane exchanges with multimedia (H323/SIP) call control servers and gateways. These servers/gateways are located behind the GGSN acting as an anchor point for the mobility which means that when the terminal is moving, the call control server is not changed as long as the user equipment (terminal) is registered on this server. The bearer network is made up of radio access and a backbone (SGSN and GGSN).

The Specifications need to Support Both, Circuit-Mode and Packet-Mode Domains

– Considering the traffic mix resulting from the set of 3G services and the need for flexible evolution paths, it is necessary to have separate circuit switched domain and packet switched domain.
– Each domain will handle its own signalling traffic, switching and routing.

Keep Network Functions separate from Radio Access Functions

The same network should support a variety of access choices, and access technologies may evolve further. Therefore, network functions such as call control, service control, etc., should remain separate from access functions and ideally should be independent of the choice of access. This implies that the same core network should be able to interface with a variety of radio access networks.

Wireline and Cordless Access to 3rd Generation Mobile Services

In the new paradigm, wireline and wireless access are just different ways of accessing the same services. So how can the fixed network be brought into the future mobile picture? In the first instance *xDLS* modems can be introduced to upgrade the capability of the copper local loop allowing a bandwidth of several Mbit/s. A UMTS, or other *Iu*-compliant, base-station can be added at the customer site to provide cordless access to 3G mobile services. An Inter-Working Unit (IWU) can be introduced at the *Iu*-interface to separate traffic into circuit switched and packet legacy networks (fig. 3). This is analogous to the separation of traffic types in the mobile network into GSM circuit switched and GPRS, as shown in figure 2.
Direct connection to a *Iu*-compliant core network integrates connection-oriented and packet-based traffic. This situation is shown in figure 4, where the core network is the "Unified Fixed/Mobile Network".

Conclusions

The technical work for the evolution of the GSM towards UMTS is carried out by the 3rd Generation Partnership Project (3GPP) and the currently approved specifications are referred to as Release '99. The specifications have been developed from a GSM-operator perspective and are aligned with the ETSI Special Mobile Group work on GSM evolution based on EDGE radio technology. As ETSI core network standards for 3rd generation mobile are based on 3GPP specifications, the 3GPP work is critical for both future GSM and UMTS. Mobile telecommunications in Europe is constrained by ETSI standards as appropriate international signalling for roaming users and common terminal standards must be supported. The specifications for Release '99 have been based on Inter-working to the legacy GSM/GPRS network, but the work for release 2000 is looking to transport-independent solutions including an all-IP option.
In considering converged services for 3G mobile, the primary issue is to bring wireline/cordless access into the 3rd generation mobile perspective. Options exist to upgrade the fixed network to provide

a 3G cordless service and a variety of radio access technologies are available including UMTS, BLUETOOTH and BRAN. What is important for the customer is that the mobile services are independent of access media.
The use of wireline/cordless access to 3G mobile services will offer several benefits. For the operator, it reduces the demand on the cellular infrastructure and utilises existing investment, the local loop. For the customer, wireline or cordless access to 3G mobile services offers a dedicated high-speed link which can provide access at potentially higher bitrates than the cellular system.
The future mobile services, whether based on UMTS or EDGE, will be multimedia. In the context of the new investment for these services, the opportunity exists to add wireline/cordless access and achieve the goal of diverse service provision based on common network technologies.

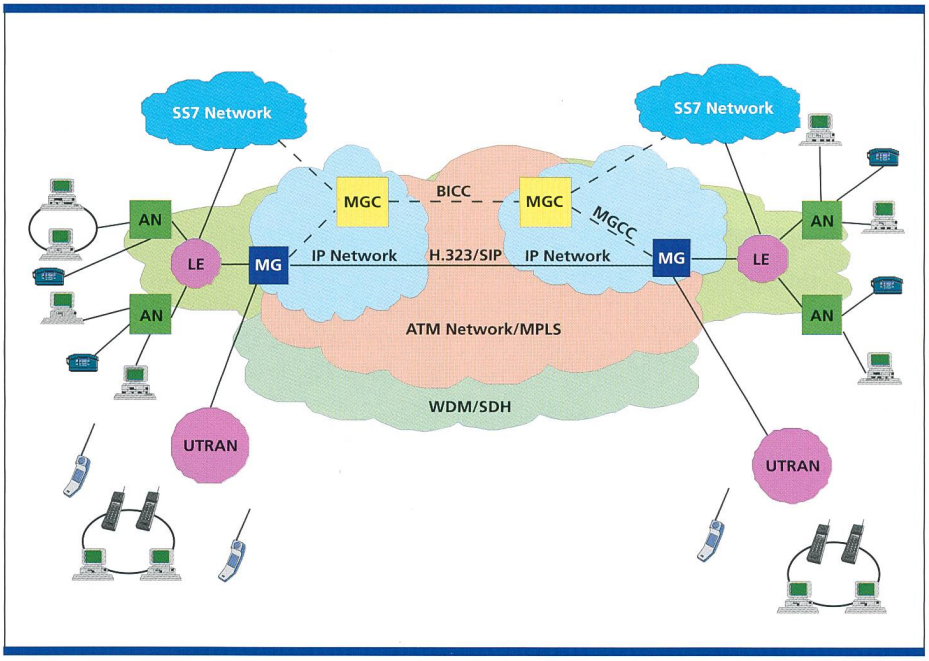

Fig. 5. In this scenario, SS7 signalling trunks from the national/international telephony networks are connected to Media Gateway Controllers, while voice trunks are terminated at Media Gateways. An ATM/MPLS core network is supported by WDM/SDH and the Bearer Independent Call Control protocol is used between Media Gateways Controllers.

Outlook

It is important to note that the work of 3GPP for release 2000 is currently immature and that solutions for the 3rd generation mobile core network are constrained by the specifications from 3GPP. The following considerations are therefore speculative.
The separation of call control and bearer control could use "Bearer Independent Call Control" (BICC). With BICC the Narrow Band Signalling (ISUP, MAP, INAP) could in principle be transported over MPLS.
The evolution from the present circuit-switched networks to connectionless packet-switched networks could be achieved by the introduction of gateways. Gateways could handle all the inter-working functions, translating information between packet based Voice over IP networks and circuit-switched networks. An entry gateway could encode speech into a set of compressed voice frames, packetise them into Real-Time Protocol (SIP) packets and forward them over the core network. Such gateways could include

- Media Gateways (MG) that handle the conversion of media streams from circuit format to packet format.
- Media Gateway Controllers (Call Agents) that manage the packet network connections. In some configurations the MGC has integrated the Signalling Gateways function.
- Signalling Gateways which constitute the interface to the Circuit Switched Networks with SS7 signalling.

For the communication between the Media Gateway Controllers (MGC) and the Media Gateways, a Media Gateway Call Control Protocol (MGCC) could be used. Currently for the Media Gateway Call Control Protocol the MGCP, SGCP, MEGACO, and the H.248 protocols are standardised.
The SS7 signalling trunks from the national/international telephony networks could be connected to the Media Gateway Controllers. The voice trunks terminate at the Media Gateways. For the

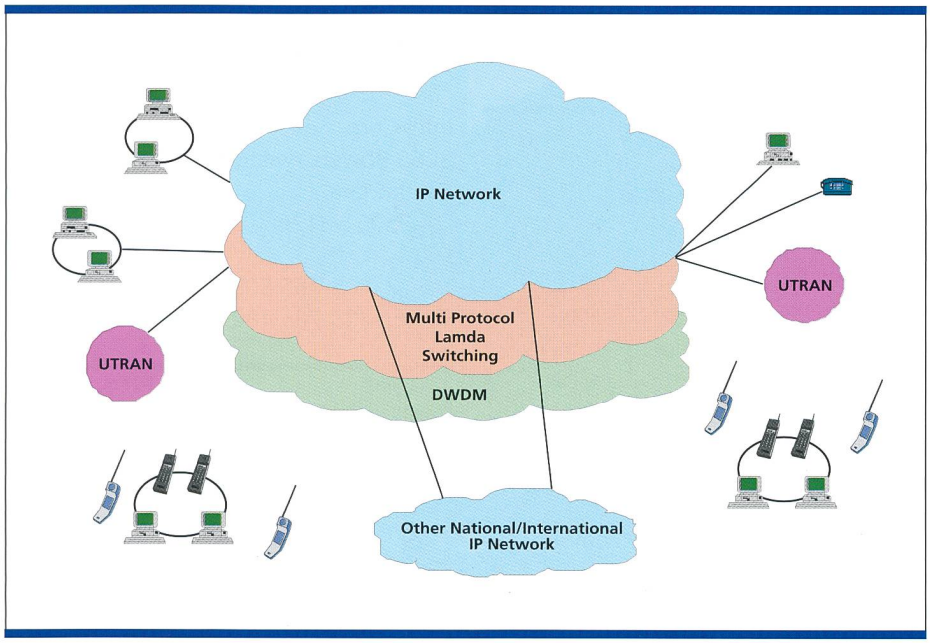

Fig. 6. Future Unified Fixed/Mobile Network? IP-services are supported by MPLS currently implemented in the Swisscom IP-backbone network. The IP network is connected over Multi Protocol Lamda Switching to DWDM (Dense WDM).

transport of the BICC Protocol (between the Media Gateway Controllers) and the Real-Time Protocols (between the Media Gateways), an MPLS Core Network can be used.

While architectural solutions will be constrained by the specifications issued by 3GPP, tentative solutions are shown in figures 5 and 6. 9.3, 9.4

Abbreviations

AN	Access Network
BICC	Bearer Independent Call Control
BSS	Base Station Subsystem
EDGE	Enhanced Data Rates for GSM Evolution
GGSN	Gateway GPRS Support Node
GPRS	General Packet Radio Service
HLR	Home Location Register
IWU	Inter-Working Unit
LE	Local Exchange
MAP	Mobile Application Part
MG	Media Gateway
MGC	Media Gateway Controller
MGCP	Media Gateway Control Protocol
MPLS	Multi-Protocol Label Switching
MSC	Mobile Switching Centre
SGSN	Serving GPRS Support Node
SIP	Session Initiation Protocol
UTRAN	UMTS Terrestrial Radio Access Network
WDM	Wavelength Division Multiplexing
xDSL	DSL (Digital Subscriber Line) technology

References

[1] EURESCOM Deliverable 1 "Recommended Strategies for FMI", June 2000.

EURESCOM www.eurescom.de

3GPP www.3gpp.org

ETSI www.etsi.org

John Charles Francis *studied Computing and Electronic Engineering at the Heriot-Watt University of Edinburgh and received his doctoral degree in 1986. After working as an independent consultant, he joined Ascom and moved to Swisscom Corporate Technology in 1996. Since then, he has worked in the area of UMTS standards and in support of international projects. He is currently EURESCOM Project Leader for the project P919 "Evaluation of Integrated Fixed and Mobile Networks".*

Zusammenfassung

Gegenwärtige Netzinfrastrukturen für drahtgebundene und mobile Kommunikation und für Internetzugang sind getrennt. Für die Zukunft wird aber ein Paradigmenwechsel hin zu einer geschichteten Architektur, basierend auf einer gemeinsamen Netztechnologie für verschiedene Dienste, erwartet. Damit können dem Kunden Dienste unabhängig von der Anschlusstechnologie angeboten werden, sei es zu Hause, im Büro oder unterwegs. Der Zugang zu Mobildiensten der 3. Generation mit hoher Geschwindigkeit wird von den vorhandenen Anschlussnetzinvestitionen profitieren und die Belastung des zellularen Mobilneztes verringern. Für Swisscom ergeben sich zusätzliche Einsparungen in Netzbetrieb und -infrastruktur.
Zukünftige Mobilitätsdienste, ob funk- oder kupferbasiert, werden multimedial sein. Im Zusammenhang mit den Neuinvestitionen für diese Dienste besteht jetzt die Chance, das Ziel einer gemeinsamen Netztechnologie zu erreichen.

Sony verkauft seine Entertainmentelektronik im Internet

Seit Anfang Januar betreibt Sony ein Tochterunternehmen, das die gesamte Audio- und Videopalette auf seiner Website anbietet. Die Muttergesellschaft verspricht sich davon ein genaueres und schnelleres Bild über Markttrends, hofft auf eine Reduzierung der Vertriebskosten und rechnet mit einer Verringerung der Lagerhaltung. In diesem Jahr geht man von einem Umsatzvolumen von etwa 90 Mio. US-$ aus. Der Schritt von Sony dürfte wahrscheinlich rasch von Konkurrenten nachvollzogen werden und mit Sicherheit das gesamte Distributionsnetz für Konsumelektronik in den Grundfesten erschüttern.

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Intel setzt neue Ziele beim E-Commerce

Nachdem Intel schon pro Monat 1 Mia. US-$ Umsatz im Internet macht – zehnmal mehr als ursprünglich geplant – hat Intel-Chef Craig jetzt bekannt gegeben, dass man in zwei Jahren 100% aller Fremdbezüge über das Internet laufen lassen will. Wer nicht im Web ist, bleibt künftig bei Lieferungen unberücksichtigt.

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Bezahlen mit dem Mobiltelefon

Das japanische Postministerium arbeitet gemeinsam mit NTT, Sony, Matsushita und Toshiba an einem speziellen Pay-Card-System für Mobiltelefone. Ab 2001 soll man damit telefonische Interneteinkäufe gleich online bezahlen können. Ein Kartenleser ist im Mobiltelefon ja ohnehin meist schon eingebaut, sodass es vor allem um die Sicherung der Geldtransaktion geht.

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