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Introduction

The telecommunications industry is currently changing at a rapid pace. This is driven to a very large degree by the emergence of new technologies that are rewriting the business cases and cost models upon which telephony has been based for years. Faced with such an environment, carriers are changing their strategies, and convergence has become a keyword in the industry. These new technologies mean that it is now possible for a carrier to move away from running separate networks for services such as mobile telephony, fixed telephony, data and broadband and, instead, to deploy a converged network which can support all of these services. Furthermore, the deployment of a converged network lends itself to converged services with all the opportunities for revenue that they bring. This book looks at the issues and provides detailed coverage of the key protocols and architectures that will support Converged Multimedia Networks.

1.1 Motivation for Network Convergence

Convergence aims to enable both new and legacy services to be delivered by one core network, minimising the number of network layer protocols and combining the transport of all types of network traffic across a single multi-service common core network. Already a subscriber can roam transparently between wireless, mobile and fixed networks. Soon, the subscriber will no longer be able to clearly identify the services being carried over a Public Switched Telephone Network (PSTN) from those which are being carried over a mobile cellular network or a Broadband Internet connection. New services will assume seamless access to the Internet and the PSTN, and a multimedia session will be able to transfer across different types of access network, without any obvious change, or interruption, in the services being offered.

The fast, “always on” Broadband Internet is a key driver for these changes, pushing forward and enabling the delivery of multimedia applications in all types of networks. The Session Initiation Protocol (SIP) is another key driver, because SIP provides the ability to combine different multimedia flows in a single session, and simplifies the management of parallel user services. A third key driver is the industry’s agreement on a standard architecture, the Internet Multimedia core network Subsystem (IMS) which enables many different types of access network to interwork across a converged core.

Converged Multimedia Networks Juliet Bates, Chris Gallon, Matthew Bocci, Stuart Walker and Tom Taylor

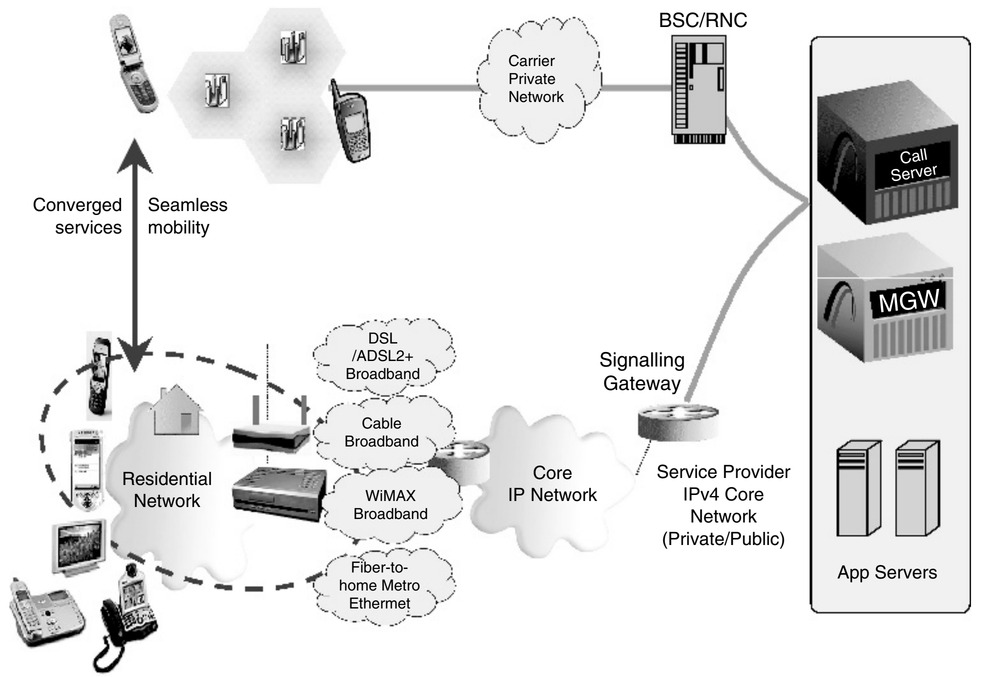

Figure 1.1 Towards Triple and Quad Play

Figure 1.1 illustrates how new Triple Play Services will provide Broadband Internet, combined with Voice and Video/Television in an "all inclusive" package. The so-called "Quad Play" will add mobile services. Imagine starting a voice call on your home phone line and transferring it seamlessly to your mobile as you drive to work. Or watching a movie on a TV, pausing it in mid-show and then watching it on a wireless Personal Digital Assistant (PDA) as you relax in the garden. Imagine having a cell phone conversation with two or three friends and simultaneously sharing a video of the football match you are attending. Then imagine that all of these things can be done with a single account, on a single login, with multiple devices over different types of access networks. These are only a few examples of the seamless multimedia services that can be accessed by users "anywhere" at "anytime".

1.2 The Core Network

For the core network, convergence means using a common network layer protocol between the edges of the core to carry all services. This protocol must be flexible enough to meet all the requirements of the current and foreseeable future services. The use of a common protocol is a major element in developing a fixed cost network infrastructure, and generating revenues from the broadest range of traditional and emerging services over this is the underlying argument for convergence. This vision is fundamentally business driven, because service providers must achieve profitability objectives while exposing themselves to the least risk. For example, the deployment of any new service has associated risk, which is increased if the operator introduces new communications protocols or deploys new network elements in the core network in order to deliver the service.

In addition to reducing risk, a converged network may reduce the number of deployed network elements that need to be managed and maintained as well as the number and complexity of network management and operations support systems. This is because network, nodes and management systems have historically specialised in supporting one or only a few protocols. For example, Time Division Multiplex (TDM)-based private line and voice services required TDM switches, while Ethernet services required the deployment of Ethernet switches, and IP services required IP routers. Such nodes would typically be interconnected by separate transport network connections and managed by different specialised divisions within a network operator. An objective of convergence is, therefore, to support all these protocols and their associated interfaces on a single platform, managed by one network management system.

Reducing the number of physical overlay networks, the associated network elements and management systems will naturally reduce the number of skilled personnel required to operate and maintain the network. It can also improve the utilisation of equipment since the consolidation of all services on a single network reduces the inefficiencies due to asset fragmentation; that is, inefficiencies associated with having similar equipment deployed in multiple, service-specific networks. Cost is therefore removed from the network, both in terms of Operating Expenditure (OPEX) and Capital Expenditure (CAPEX).

Network convergence not only simplifies operations but also improves an operator's multi-service capability. A single, converged network provides continuity of service for the operator's complete service portfolio. It also introduces the concept of service convergence into the operator's business; the ability to offer new, innovative services is facilitated by having different service traffic physically integrated over the same network infrastructure. This can also improve the time-to-market deployment of new service offerings and increase the responsiveness to customer service requests.

These are compelling arguments that help explain why operators and equipment vendors are driving towards this vision. However, it should be noted that convergence also introduces uncertainties and compromises in its own right. While it may be obvious, a point that cannot be over-emphasised is that for network convergence to be a viable solution today, and in the future, it must support the breadth of services currently offered in addition to those planned.

As introduced above, the need to eliminate risks associated with forecasting service mix and growth rates is a key driver for a converged network. Operators need to be able to develop an investment evolution strategy that allows them to adapt their infrastructure to support service changes. However, it is challenging to anticipate and forecast future service requirements at the best of times. A single, converged network has the potential to satisfy this requirement only if the current and forecast service mix is readily supported by current technology. It is important to assess this assumption on a case-by-case basis because mitigating forecasting risks with a single, converged network, by definition, implies that there is only one network upon which to support all services.

Service breadth is perhaps the main issue in determining whether network convergence using the available technology in today's solutions is an appropriate deployment option for service providers. Each service provider must therefore evaluate the business requirements and individually assess the applicability of a converged network.

1.3 Legacy Service Requirements

Legacy Services include the following:

- Traditional Public Switched Telephone Network (PSTN) voice services Plain Old Telephone System (POTS)
- Mobile voice services, for example, GSM and UMTS
- Leased line services such as TDM, Frame Relay and ATM
- Next Generation Network (NGN) services including Internet (both access via xDSL, WiFi, WiMAX, dial-up and peering)
- IP Virtual Private Networks (IP VPNs)
- Ethernet Private Lines and Ethernet Virtual Private LAN Services (VPLS).

Traditionally, each legacy service has been supported by a separate network, which was specifically engineered to meet the requirements of its service. For example, the PSTN was originally only designed to support voice services and, thus, required a network that could support a single quality of service (QoS) with strict delay and loss guarantees, but the same set of guarantees for all users and the same bandwidth for all calls.[1]

Private line services, such as Frame Relay, require more flexibility in bandwidth and delay, and are thus often supported using ATM networks that use flexible traffic management schemes to support this service breadth.

These networks have also begun to support more and more voice traffic as legacy PSTN networks are being replaced. The current TDM narrowband voice switching system has proved very effective and reliable but is coming towards the end of its economic life. The future solution will be packet voice, which, for broadband customers, will mean voice in the broadband service payload but there will be a large community of users who will wish to retain their PSTN service using their existing handset and without having to purchase additional equipment. Unless an operator wishes to run the rump of the PSTN, for many unprofitable years, a way has to be found to bring these legacy users seamlessly onto the new network. While this is a major concern for a fixed network operator, a still bigger worry is the increasing mobility of workers in the business environment. This means that mobile handsets are now often preferred as the most convenient communication device, and this presents a challenge for fixed-line operators seeking to retain customers. Market trends bear this out, as revenues for fixed voice services run relatively flat, while mobile voice revenues continue to show significant growth.

However, while mobile subscribers are using more services from their mobile phones and mobile network traffic has increased significantly, sharp competition on pricing has caused both fixed and mobile service providers to experience a cut in the Average Revenue Per User (ARPU) and both fixed and mobile Service Providers are being forced to differentiate themselves by offering new Multimedia Services to increase profits and, at the same time, also find ways to reduce the cost of provisioning all services on their networks. Convergence of fixed and mobile traffic can provide a way to make much better use of a service provider's available capacity; for example, the busy hour for voice traffic is often not the same as the busy hour for data traffic. Furthermore, the greater bandwidth

[1] Differences may exist at the call level, for example, emergency service calls may be prioritised over non-emergency calls.

available for fixed-line access (even if the last hop is delivered via a wireless router) means that fixed network operators who have successfully integrated support for mobile traffic into their architecture can differentiate themselves from pure mobile operators by offering high bandwidth multimedia services to mobile subscribers when they are in the range of a fixed network access point.

Services must also meet strict, and in many cases regulated, levels of availability. For example, the PSTN voice platform provides a very important lifeline service and provides a very high degree of service protection, which a replacement PSTN must at least equal. Typical Service Level Agreements (SLAs) specify that a user must not experience an unplanned outage of the service more than 0.00001% of the time, equating to an availability of 99.999%, or "five nines". NGN services compound the requirement for service flexibility and availability; Triple and Quad Play services require that voice, video and data and television be delivered reliably and with appropriate levels of QoS to potentially the same user and eventually using the same converged network.

1.4 New Service Requirements

The new converged network must not only meet the service capabilities of existing networks but also enable new services to be deployed more economically than today. This must be achieved without forcing operators to build a separate network for each service, thus requiring that the network is more flexible, scalable and cost-effective than today.

Transparency to both existing and new services is required if operators are to maintain and grow revenues from the existing services while reaping the CAPEX and OPEX benefits of convergence.

There are two elements in the evolution of a converged core network. The first is where existing services are consolidated onto the same infrastructure as newer IP services. The second is where existing services are extended alongside the new services, utilising the same infrastructure. From an operator's perspective, the future vision is a network that allows operators to reduce CAPEX though shared functionality and reuse of infrastructure for multiple services and, at the same time, provides for the reduction of OPEX through simplified architecture and reuse of the same infrastructure for multiple services:

- A network that allows operators to mix and match services to address specific market segments and enables the rapid deployment of new products.
- A network that allows operators to open up their networks to third parties in order to enhance tailored services to their customers and limit loss of customers to competitors.

A business case showing the long-term savings in OPEX must be developed that shows the savings both in cost reduction for existing services and for cost-reduced deployment of new services. Indeed, it is arguable that the greatest justification for, and requirement on, a new converged core network is the ability to support new services with lower operating costs than today.

The first major implication of these general requirements is that the network must be able to cost-effectively cope with traffic growth. This means that it must be possible to allocate network resources to rapidly growing new services, without impacting the QoS of existing services, while remaining sensitive to the incremental costs of increasing the available bandwidth in the network. The underlying network architecture must enable the operator to adapt the utilisation of the infrastructure to both the current and future changes in service diversity and demand. This task is made easier if a certain amount of intelligence is built into the edge of the network, allowing service-aware policies for routing customer traffic at the edge. The network edge must have the visibility of, and the capability to, select specific core network resources. Simplifying the core of the network reduces the cost and increases the scalability of the core. These capabilities assist operators by enabling them to offer different services with different performance objectives (e.g. Virtual Leased Lines, Internet access) or multiple grades of the same service (e.g. Gold, Silver) and thus generate new revenue streams from the converged network. A performance objective might specify an allocation of bandwidth for a downlink (network to subscriber) and a different allocation for the uplink (subscriber to network). Part of that allocation in each direction can be reserved for high-priority traffic and the rest for non-priority traffic. Network operators can also charge for policy upgrades.

In order to satisfy the requirements of the specified availability and performance objectives which have been specified in SLAs, flexibility in the way that resources are allocated needs to be complemented with flexible levels of protection and restoration. Existing "legacy" services have well-defined availability objectives. New services must be differentiated from these to generate new revenue opportunities, requiring enabling new services with different availability commitments (e.g. Best Effort residential Internet versus Premium guaranteed services for peering Internet Service Providers). There must also be flexibility in the way in which an operator can deliver that commitment. For example, the operator should be able to provide local protection (link by link, or node by node) or end-to-end protection, as required by their network design and service delivery model.

Operations and Maintenance (OAM) procedures are key contributors to enabling flexible levels of service assurance. Proactive OAM procedures alert operators to, for example, network faults, thus allowing remedial action to be taken, minimising or eliminating any impact on the SLA. Reactive OAM procedures allow fault localisation and diagnosis to take place.

Seamless interworking with the new core network is the key to the migration of existing services. This interworking is needed at the user, control and management planes. Bocci *et al.* (Ref. 6 of Chapter 7) provide an in-depth review of the development of these interworking techniques in international standards bodies, and Chapter 7, of this book, explains the principles underpinning the design of the converged core network architecture.

1.5 Architectures

The IMS developed by the Third Generation Partnership Project (3GPP) provides a network infrastructure to support fixed and mobile convergence. The IMS is an open-systems architecture designed to support a range of IP-based services employing both wireless and fixed access technologies. The IMS model adds call session control to a network to enable peer-to-peer real-time voice, video and data services over a packet-switched domain. Chapter 5 explains the evolution of the IMS and shows how the IMS architecture will be integrated with different types of access networks. Progress towards a full IMS core solution is likely to take another two to three years, but recent significant changes in access networks already provide much greater interoperability and by 2008/2009, we may have the same IMS implementation for fixed, mobile and wireless networks.

1.6 Moving to SIP

While IMS is a significant architecture for the implementation of multimedia services, undoubtedly the most influential enabler is SIP. SIP (RFC 3261) is a client–server protocol used for the initiation and management of communications sessions between users and can run over a variety of transport protocols, including Transmission Control Protocol (TCP), User Datagram Protocol (UDP), and the Stream Control Transmission Protocol (SCTP). In SIP, Internet endpoints, called *User Agents* (UAs), discover one another and agree on a characterisation of a session they would like to share. SIP UAs register with Registrars and use these in addition to Proxy Servers to help them locate and send invitations to other prospective session participants. Typically, multimedia architectures will include other protocols as well as SIP, such as the following:

- The Session Description Protocol (SDP) (RFC 4566) for describing multimedia sessions
- The Real-time Transport Protocol (RTP) (RFC 3550) for transporting real-time data and providing QoS feedback
- The Real-time Streaming Protocol (RTSP) (RFC 2326) for controlling delivery of streaming media
- The Media Gateway Control (MEGACO) Protocol/H.248 protocol for controlling gateways to the PSTN.

SIP is a principal component of multimedia architectures and the viability of converged networks will depend upon the economical implementation of SIP-signalling servers that are capable of meeting real-time performance constraints. Chapter 2 expands further on the role of SIP in call control in the PSTN and in converged networks. The nature of any packet network, with its widespread use of Network Address Translation (NAT), and related security risks, provide additional challenges to a voice service provider. Chapter 3 covers some of the measures that are required to secure the network from denial of service and theft of service attacks. Designers of the NGN have accepted the necessity for the NGN and the PSTN to coexist at least for the next decade. The description of how this is achieved is covered in Chapter 4 which divides naturally into three topics: PSTN interworking, PSTN emulation and PSTN simulation.

1.7 Growing Revenue

Adoption of a converged network infrastructure can provide cost savings for service providers, thereby increasing their competitiveness and profitability. However, increased competition for communication services continues to drive down service prices, resulting in lower and lower margins for service providers. In the not-so-distant future, service providers in competitive markets will be faced with the choice of either becoming the low-cost “communications” utility (the so-called Cheap Fat Pipe) or attempting to grow revenue by providing additional value to their customers.

The initial defence of most service providers against revenue erosion is the bundling of services. The Triple and Quad Play business models are attractive because delivery through a converged network is more efficient and the customer benefits from the convenience of a single bill. However, this approach alone does not allow service providers to differentiate their service offering from that of competitors; in this scenario the only differentiation becomes price resulting in another downward price and margin spiral, as competitors strive to take market share from each other.

Service differentiation and revenue growth are ultimately to be found in the form of Value-added Services delivered over and above the basic communication services. Much attention has been given to the service layers of converged network architectures and, in particular, how to enable the delivery of the best-in-class applications in a timely and cost-effective manner. Since there is little indication that the application vendor community is gravitating towards a single technology for the creation of applications and services, most service providers will require the ability to deliver services from application platforms based on different technologies, in order to provide themselves with the widest set of application vendors, from which to select the best-in-class applications to deliver to their customers.

Next generation service architectures must also support two other key enablers for service provision, these being *Service Velocity* and *Service Agility*. Service Velocity is quite simply the ability to get new service offerings into the market in much shorter timescales than was possible with traditional service creation and delivery technologies and techniques. This provides two benefits to service providers. Firstly, and most obviously, the time to revenue is reduced; service providers receive revenue from services much earlier. Secondly, the service provider's competitor may launch a successful service before the service provider does; service velocity enables service providers to react rapidly and release their version of that service quickly, curtailing the period of market exclusivity enjoyed by their competition and thereby reducing any impact in terms of subscriber and revenue churn.

Service Agility is the ability to maximise the utilisation of any application a service provider deploys. Typically this means enabling the inclusion of any deployed application into different service bundles aimed at different market demographics. Service Agility distributes the cost of an application across multiple service propositions. Together, Service Velocity and Service Agility can reduce the cost, time and effort needed by service providers to deliver new services. This in turn can extend the "economic reachability" of the value-added services market, and open up new market opportunities for service providers.

Traditional service deployment methods, being relatively both costly and time consuming, have restricted service deployment to those services that could be sold to a large proportion of the subscriber base and would be active in the network for an extended period of time. Reduction in cost and increase in the time-to-market speed allow service providers to profitably launch services with limited penetration (targeted at a particular subscriber niche) or a limited lifespan (e.g. a service associated with a reality TV program). Each individual service may yield less revenue than a traditional service; however, the service can still be profitable in its own right, and there are likely to be many more of these. It is also important to consider that services with the traditional penetration-duration demographics can still be deployed, but at a lower cost, and the new niche market and ephemeral services represent additional revenue over and above that provided by these traditional services. The reduction in cost to deploy new services also permits service providers to take a much more entrepreneurial role with new services. Service providers can put new services into the marketplace with considerably less market planning and testing since the business consequences of unsuccessful services are considerably reduced.

Chapter 6 provides a detailed insight into the new architecture that service providers are turning to, in order to economically deliver new and innovative services to their subscribers. Chapter 8 reminds the reader that the user's perspective of satisfactory QoS is an essential consideration, but the complexity required to manage and enforce differentiated levels of QoS, with sufficient granularity, must be weighed against a previous remedy, which is over-provisioning the network. Chapter 8 sets out different strategies for the implementation of QoS.

1.8 Network Operators – Dealing with Convergence

This last section of this chapter deals with several real-life scenarios, which are intended to illustrate why, and how, Converged Multimedia Networks will be implemented, and should also help you to find your way around this book.

1.8.1 Scenario 1 – A Cable Operator

A cable operator currently provides "Triple Play" bundled services, including a range of broadband and dial-up Internet services, local, long-distance and international telephone services, and digital and analogue cable television, to residential customers, and provides a range of retail and wholesale voice, data and Internet products and services to the business market.

The Cable Operator is considering merging with a Mobile Network Operator (MNO) or a Mobile Virtual Network Operator[2] (MVNO) to provide Quad Play Services. The mobile operator should be able offer a reduced tariff for mobile calls, which originate in the "home" cell, to compete with those charges applied by a fixed PSTN operator (approximately 30% of calls from home are made on a mobile). A further aim of the Cable Operator is to provide one phone, one phone number, one bill and one mailbox, and additionally they also would like advice on the best way to protect the QoS of each of the services.

The Cable Operator should deploy a single service layer for both the fixed-line access and mobile access, using the emerging IMS architecture as described in Chapter 5, which explains how the IMS model facilitates the one phone concept, and this chapter also looks at how broadband data wireless technologies can provide a "bridge" between fixed and mobile networks.

The introduction onto the network, of mobile traffic with its characteristically tight delay requirements, means that the Cable Operator will need to ensure strict separation between delay-sensitive real-time services, and congestion-aware non-real-time services. In cases of failure, careful network design can contain less critical traffic, in favour of higher revenue premium services. Chapter 7 deals with Core Network Architectures and shows how a common network protocol can be used to support a broad range of services, while achieving the required performance objectives.

Chapter 8 on QoS and Bandwidth Management describes how Connection Admission Control (CAC) can guarantee QoS for mission-critical services, both within a single service provider's domain as well as across the multiple domains of different service operators.

[2] A mobile virtual network operator is a company that does not own a licensed frequency spectrum, but resells wireless services under their own brand name, using the network of another mobile phone operator.

1.8.2 Scenario 2 – A Video-on-demand Service Provider

A Video-on-Demand (VoD) network connects regional server centres to the national PSTN operator's local exchanges. Local Loop Unbundling (LLU) and Asymmetric Digital Subscriber Line (ADSL) technology is used to deliver digital television and video services to customers, over a normal telephone line, without affecting the customers' existing telephone service.

VoD The Service Provider would like to extend their service offering to include telephone services. The VoD company wants a single authentication process for all services as well as the ability to provide telephone services and to include personation of all services. They also want communication regarding incoming calls to appear on the subscriber's TV and the ability for the subscriber to divert the calls to another terminal/telephone or to voice mail (Figure 1.2). The VoD company should look to provide a voice solution based on the SIP protocol, and Chapter 2 describes how SIP user registration and authentication is implemented and how peer-to-peer voice services can be supported using SIP. Chapter 6 has examples of how applications can be grouped together into Service Capability Features (SCFs) which can export Call Control and Charging and provide for centralisation of authentication and billing services.

If the VoD company is looking to provide a complete PSTN replacement service (rather than a second-line service), they should deploy an access platform that is capable of handling any xDSL data in addition to terminating the analogue phone line and converting it to voice over IP. The access platform must include an access gateway, which will be controlled by a call control application, using a protocol such as H.248. Chapter 4 looks at access gateways and the H.248 protocol and also describes how an operator can interconnect back into the TDM PSTN in the core of the network, to allow a cost reduction in calls, originating or terminating in the legacy PSTN.

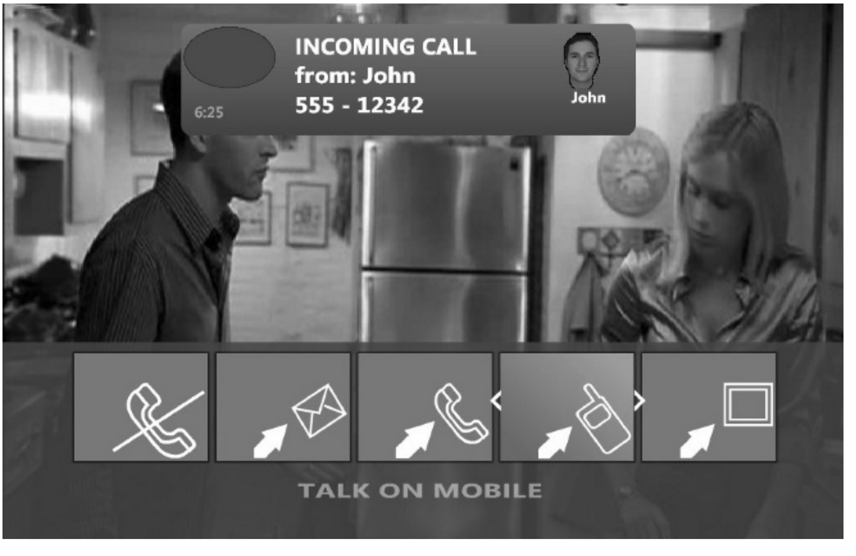

Figure 1.2 Combining Video Conferencing with Telephony

Providing a full PSTN replacement service implies having a very robust solution for QoS. Chapter 8 describes how to protect the network against the kind of overload caused by emergencies or television phone-ins. The network must be able to connect calls to both analogue phones as well as SIP terminals, and a Session Border Gateway should be deployed to secure the network against potentially misbehaving PC based SIP clients. Chapter 3 discusses the role of the Session Border Gateway in securing a network as well as describing some other measures that the company could take to protect themselves against attack.

A key service, which the VoD company should consider offering, is the ability to present a call to any number of possible terminals and to provide appropriate notification of an arriving call. This can be achieved using the capabilities of the SIP protocol. Chapter 2 explains how SIP Forking and its redirection services can be used to send incoming calls to more than one device and how to provide an efficient location service. Chapter 6 includes an example of the Whisper connect service which allows the multimedia subscriber to determine who is calling him before deciding whether to interrupt his current call in order to take the new call.

1.8.3 Scenario 3 – A High-speed Internet Service Provider

A new high-speed Broadband Internet Service Provider uses Local Loop Unbundling (LLU) to provide residential customers and businesses with a high-speed Internet service. The Digital Subscriber Loop (DSL) access infrastructure is in place but the company wants to understand the process of interconnecting to the PSTN to find out which other components must be added to their network. Multimedia conferencing is a service they would eventually like to offer (Figure 1.3).

Gateways are needed to interconnect to the PSTN, and SS7 signalling, used in the PSTN, has to be converted to SIP. Chapter 4 explains the principles behind gateways, describing the functions of a Media Gateway (MGW), a Media Gateway Controller (MGC) and a Signalling Gateway (SGW), which are needed to interconnect the Internet to the PSTN.

In the NGN, multimedia sessions are supported by multiple RTP streams, for example, one for video and one for the soundtrack. Chapter 4 describes how Multimedia Conferencing uses RTP to take the contributing sources that make up a media stream and mixes them together while ensuring that each stream maintains its own synchronisation source. Voice services require low delay and delay variation because they are interactive, but voice can usually withstand a limited number of voice samples being lost by the network, whereas Video services require a low packet loss, but they are typically not interactive and so packet delay and delay variation can be higher. Chapter 8 is dedicated to the provision of QoS for multimedia services.

1.8.4 Scenario 4 – A Mobile Operator

A Mobile Operator is currently upgrading the network from 3GPP Release 99 to 3GPP Release 4. Access to the Circuit Domain for standard GSM calls can continue, but eventually more and more circuit-switched services will be offered from the packet domain. The mobile operator is interested in the potential for expanding its service offerings, through a partnership with a fixed operator. The company is also evaluating new wireless technologies such as Unlicensed Mobile Access (UMA) and would like to understand how Broadband wireless might benefit its business (Figure 1.4).

Figure 1.3 Multimedia Conferencing

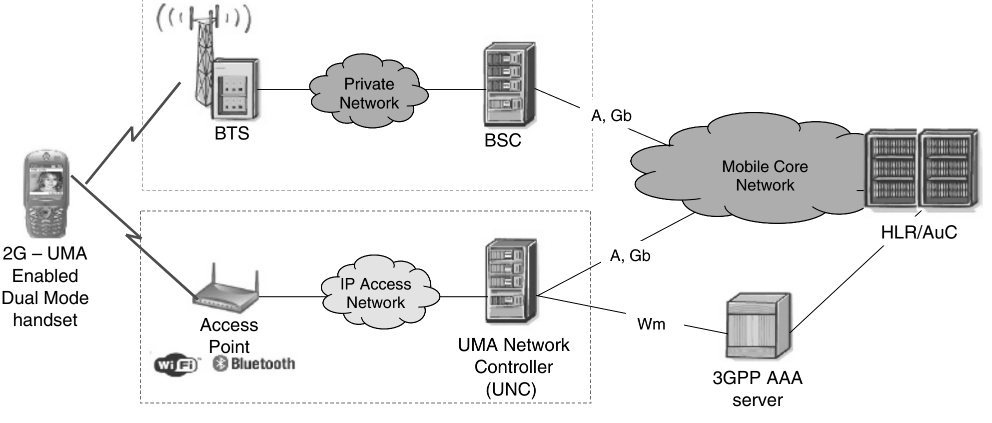

Figure 1.4 Mobile upgrade from Release 99 to Release 4

The Mobile Network Operator (MNO) is planning a package of Rich Services:

- Availability – "on line" (objective), "don't disturb" (personalised), "only urgent calls" (indicative)
- Reachability – "In a call" (network state), "on a broadband connection" (network capabilities), "In the airport" (network location)
- Location – "abroad" (roaming network), "in the station" (place), "00°12'23"N–21°40'11"W" (coordinates)

A variety of rich services can be offered by Application and Media Servers. Chapter 6 shows that by insulating the applications from one another, it is possible for a Service Provider to mix and match application offerings from different vendors, without requiring the vendors to make custom changes, in order to get a particular application to interwork with other applications.

1.8.5 Scenario 5 – A Fixed Network Operator

A Fixed Network Operator hopes to integrate Enterprise Private Automatic Branch Exchanges (PABXs) connected to wireless access points, with mobile access, through setting up a partnership with a MNO or by becoming a Mobile Virtual Network Operator (MVNO) (buying airtime from a MNO) (Figure 1.5).

Wireless "Hotspots" can be used to transfer a call from a mobile to a fixed network and recent advances in the development of wireless are a hugely significant player in the advance towards Converged Multimedia Networks. The fixed operator would like to understand the benefits of wireless access. Chapter 5 includes information on the shorter-range wireless protocols such as WiFi and Bluetooth, as well as information on Wireless Local Area Networks (WLANs) and Broadband wireless.

1.8.6 Scenario 6 – The PSTN Operator

A PSTN operator is facing the need to upgrade their existing PSTN switches; in recent years, they have rolled out broadband services successfully, and rather than invest capital

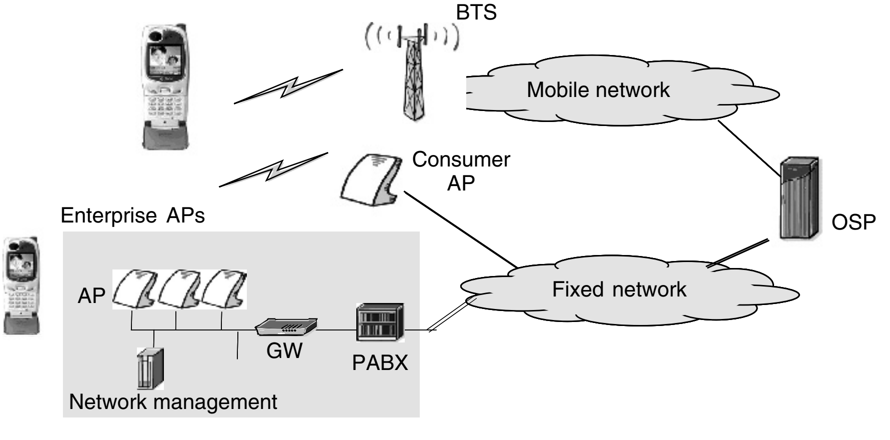

Figure 1.5 Combining fixed wireless access and mobile

in TDM technology, they have decided to migrate to a single converged network based on their broadband infrastructure, while still supporting the PSTN (which is a critical national infrastructure and is regulated).

To achieve this, the network operator must upgrade their xDSL infrastructure to deploy multi-service access nodes that support access gateways. Customer lines must be gradually migrated onto the access gateways from their TDM local exchanges. The carrier needs to upgrade their call control to a SIP-based infrastructure, possibly using SIP with ISUP (SIP-I) (see Chapter 4) for PSTN transparency, and provide a control interface to the access gateways, using the H.248 protocol with the Stimulus Analogue Line Package which guarantees support for the full range of European Telecommunications Standards Institute (ETSI) PSTN services. Because this company currently offers Integrated Services Digital Network (ISDN), they must cater for ISDN user terminals by making use of the Internet Engineering Task Force SIGTRAN architecture, using the ISDN User Adaptation Layer. Chapter 2 looks at some of the strategies that may be used by an operator migrating from broadband to a full PSTN replacement service and describes how the SIP protocol can be used to support voice services over a packet core. Chapter 4 describes the role of access gateways, H.248 and SIGTRAN, and shows how the SIP-I variant of SIP assists in migrating services from the PSTN.

To transport PSTN voice over the same network, as broadband and business services, the operator may look to deploy a technology such as Multiprotocol Label Switching (MPLS), with its support for facilities such as fast re-route, its ability to support Layer 2 private wire services as well as Layer 3 VPN services and its relatively sophisticated QoS technologies such as Traffic Engineered tunnels. Chapter 7 describes the resilient multi-service capabilities of MPLS and Chapter 8 describes how the MPLS network can provide service separation and QoS through MPLS traffic engineering. PSTN replacement, while complex, is probably just the start and the carrier will eventually want to develop new services to take advantage of SIP-based call control, using many of the techniques described in Chapter 6. The carrier could bring mobile communications into their portfolio, and may look at moving their call control to an IMS architecture eventually, as described in Chapter 5.

1.9 Enabling Technologies for Converged Networks

This introductory chapter has looked at the drivers for network convergence and described some example scenarios to show what this really means to network operators and to provide pointers to the key technologies that the network operators will need to use in these cases. The remainder of this book will look at these enabling technologies for converged networks in detail, describing the problems that they solve and characterising the solutions they provide.