



Intelligent Edge

NOKIA
CONNECTING PEOPLE

Contents

Executive Summary	2
Introduction	3
Elements for service success	3
Maximum Profitable Service Mix	4
Industry Business Ecosystem	4
Service Solution Areas	5
Person to person(s) services	5
Content to person services	6
Business connectivity	6
Intelligent Edge Implementation	6
Service aware packet connectivity	7
Session Control	8
Dynamic Subscription Management and Registers	8
Intelligent Charging Control	9
Service Enablers	9
Openness in the Intelligent Edge	9
Conclusion	9
Abbreviations	10

Executive Summary

The mobile industry is moving into a new phase. Terminals have vastly outgrown the concept of a telephone. Today's most advanced terminals can present rich content and run sophisticated applications. No doubt, this will influence the way people communicate. They will no longer view mobile devices as just telephones. We can now start seriously developing additional network usage, far beyond saturated voice minutes.

To meet the demands of this changing environment the core network must be reshaped. The Intelligent Edge is a new 'service aware' capability that

enhances present packet core networks. Intelligent Edge gives operators new tools for maintaining greater control over revenues, providing new possibilities for positioning themselves in the value chain. Service awareness enables precise differentiation of the traffic carried as well as engaging content owners to revenue sharing with an unprecedented flexibility.

Intelligent Edge also brings a major driver for ease of use for the users. Operators can now develop a full portfolio of exciting services and users can easily navigate and discover them without having to make complex configuration settings in their mobile devices. This flexibility is provided by an innovative single access point solution of the Intelligent Edge.

By introducing 'service-aware' enhancements to existing packet core networks, operators can charge differentiated prices for data services. This means that rather than charging a single fixed price-per-bit for all traffic, operators can charge subscribers according to perceived value of different services. Service aware differentiated charging of the Intelligent Edge supports prepaid on-line charging of packet traffic, hence solving one of the most burning challenge of many operators.

Nokia Intelligent Edge also drives new applications. IP Multimedia service specified by 3GPP/3GPP2 enables direct terminal-to-terminal connections. People can get connected in many more ways than just talking. New person to person applications allow

mobile devices to share media such as video streaming or instant direct-call voice service, as well as provide interaction such as the exchange of game data. These new network capabilities, matched with the present and emerging mobile device capabilities, far beyond simple voice and messaging, will drive new usage.

Only a planned open framework including common functions and built as an integral part of the standardised packet core can provide scalability and lifetime maintainability. Intelligent Edge implementation is the key strategic decision that network operators have to take in order to provide end-to-end solutions and to secure the evolution of subscriber services and their delivery machinery with multi-access capabilities.

Introduction

The business environment for network operators is undergoing a fundamental change. To return the industry to growth, network operators need solutions to the following questions:

- How to enable the widest profitable service portfolio?
- How to build position in the value chain to maximise profit?
- How to differentiate the pricing of different kinds of applications and services?

At the same time, driving the number of services being delivered into the mass-market phase will require that services become easier to subscribe to and use, with easy to understand tariffing.

To succeed, network operators need to introduce services quickly and with reasonable cost. A key element in solving these challenges is to enhance the functionalities of the core network.

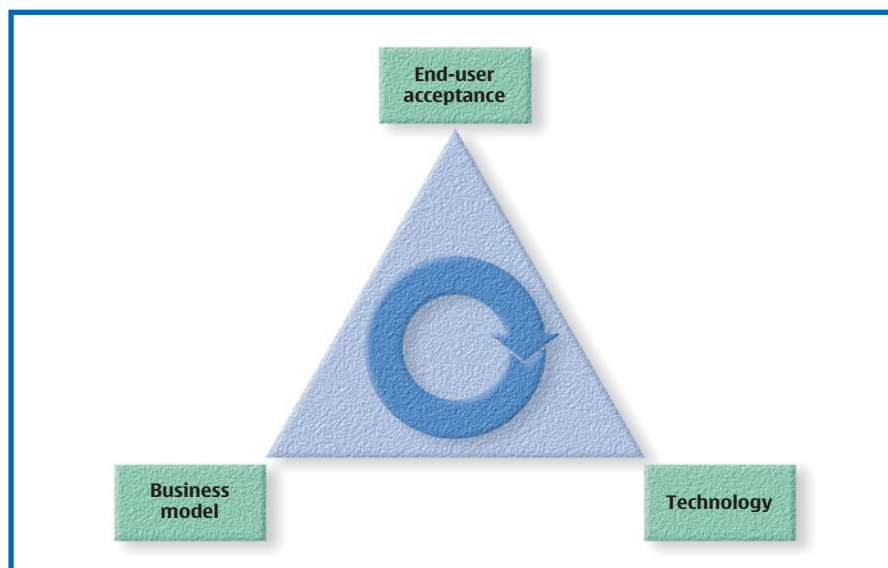


Figure 1. The triangle of service success.

Elements for service success

For any mobile service to succeed, three key elements must be in place:

- **End-user acceptance.** Services must be appealing to the target group and easy to discover. The service must be simple to subscribe to and use, and have simple intuitive usage tariffing. Services that are complicated to use will never achieve mass-market penetration. It is not enough to simply launch a new service and hope it 'catches on'; rather, subscribers must be taught how to use new services.
- **Business model readiness.** Person to person services (like voice and person to person MMS) are well understood by the industry – however the business models for content to person services are still evolving. Many of these new services will introduce third parties into the value-chain, for example as content providers. Network operators must pro-actively work within these new business models, in order to take a wider role than simply being an access provider.

- **Technology maturity.** As well as the terminal and access network technology required to support particular services, specific technology is required to enable the end-user acceptance and business models of the services. Examples include an open service creation environment, a subscriber management system capable of efficiently supporting millions of subscribers using hundreds of different services, and so on. These technology enablers are equally (or it could be argued, more) critical to the success of services than the capabilities of the access network.

The mobile industry has perhaps been guilty of focussing too much on the technology, and placing too little emphasis on developing the business models and ensuring end-user acceptance. To get the industry back on the growth path requires solving all three parts of the 'service success triangle'. To meet these requirements, network operators need an open business environment, plus a set of tools that enable them to meet these requirements cost effectively. Subscriber acceptance must be addressed by the industry from end-to-end.

Maximum Profitable Service Mix

The mobile business model has evolved around standardised communication services: voice & SMS. One major success outside the standardised services has been ring tone and logo download. This business has been a success for the following reasons:

- Numerous content creators
- Simple end-user charging models
- Win-win relationships between network operators and content providers
- Individual content for different consumers

The key lessons from the success of ring-tones and logos should now be applied to the huge variety of non-standardised services that are enabled by available and coming terminal and network technologies. Network operators need to support an increasing number of services profitably, many of which will only be used by a small segment of subscribers, and some of which will be transitory, existing only for a few days or weeks.

For end-users to accept and use this huge array of possible services, simplified end-user terminal settings are required, ideally fully configured by the network automatically and with only a single terminal setting to access all services. For example, having to manually select between different PDP contexts when accessing a corporate intranet or connecting to a sports service, will prove a barrier to using the service for many end-users.

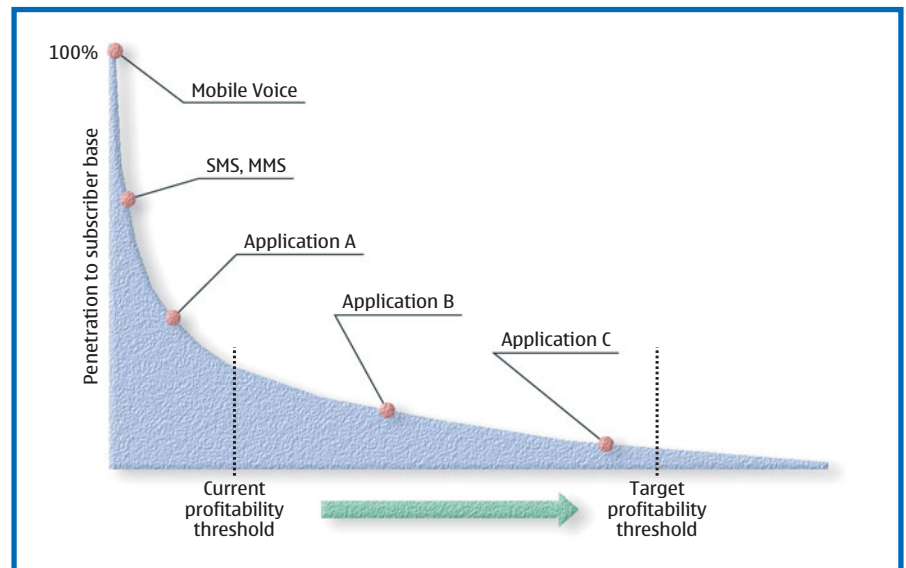


Figure 2. The maximum profitable service mix.

If network operators cannot adopt the widest possible service portfolio, they will face reduced profit and potential subscriber churn.

Furthermore, the value to the end-user of many of the forthcoming services is not related to the access transport cost to deliver the service. For example, the perceived value per bit is relatively low when web browsing, whereas for an SMS message the perceived value per bit is extremely high. Clearly, operators need to be able to charge for the perceived value of the service delivered to the end-user, satisfying both parties. This requires enhancements in the charging mechanisms within mobile networks – as a minimum, the following charging capabilities should be available:

- Different access charge (€/kbit) for different services
- Content based charging
- Transaction based charging
- Charging based on combinations of the above.

Industry Business Ecosystem

The structure of the mobile industry ecosystem is shown in Figure 3, bringing together subscribers, network operators, content partners and several other parties. Network operators have the huge assets of a subscriber base, with which they have a billing relationship, plus essential supporting enablers, such as the ability to configure end-users' terminals to support new services.

The Intelligent Edge sits at the heart of the business ecosystem; its aim is to enable network operators to exploit the widest possible mixture of different business models, at a mass-market volume. As well as network operators hosting their own content and providing their own services, many emerging business models will require increased interaction with third parties. Some of the most important focus areas of the Intelligent Edge are outlined below:

- Currently, network operators already

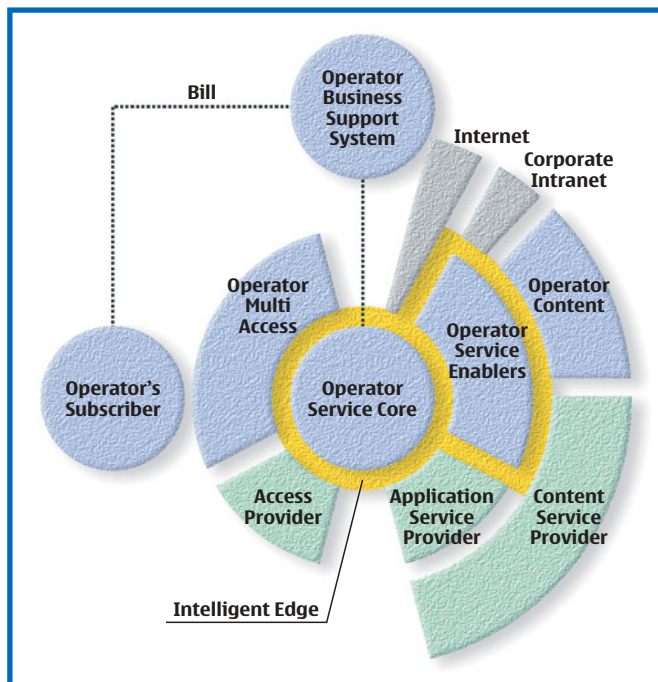


Figure 3a. Mobile Industry Ecosystem. The Intelligent Edge is located at the heart of the business ecosystem – enabling many different business models.

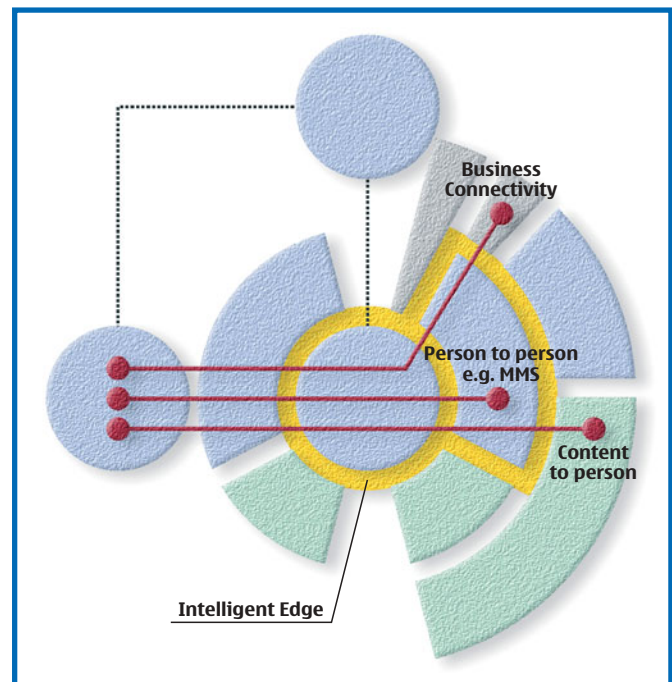


Figure 3b. Flexible business models.

have profitable relationships with **third party content providers**, covering content such as ring-tones, icons, and so on. A growth in the amount and types of third party content and content providers will mean that operators' current systems are no longer manageable.

- Many operators are recognising that further business opportunities may be opened by working with **third party application service providers**, such as a third party hosting an on-line game and its 'high score table'.
- Buying and selling access capacity may also become an attractive business for many network operators in the future. For example, mobile operators may choose to sell access capacity to a Mobile Virtual Network Operator (MVNO). In this case the MVNO 'owns' the relationship with the subscriber, and the network operator has a different position in the value chain. Mobile operators may also choose to buy access capacity from a third party, for example from a WLAN local access zone service provider.

To meet these requirements, network operators require new tools that provide them with advanced business enabling machinery – the Intelligent Edge. The Intelligent Edge is a framework that provides operators with greater control, allowing new innovative business models at a mass-market level.

Service Solution Areas

The evolving end-user service mix will require revenues to be collected from many different services, from three different areas:

- Person to person(s) services
- Content to person services
- Business connectivity services

Solutions in each of these areas use the functionalities of the service core, plus selected service enablers depending on the particular solution.

Person to person(s) services

Services in this solution area build upon the basic voice call and SMS messaging capabilities. They address the basic human desire to communicate with others, particularly with family and friends. MMS is the first step in moving person to person services into the multimedia era. The next step is to enable IP connectivity directly between terminals – the IP Multimedia Subsystem provides this capability.

Examples of evolving person to person(s) services are:

- Games will be redefined as social experiences within a peer group, instead of the present concept of a solitary pastime, or playing with an unknown opponent via a game server. The game session will be enriched with additional communication channels like text chat or push to talk.
- 'See-what-I-see' is a one-way video streaming experience. One communicating party uses the built

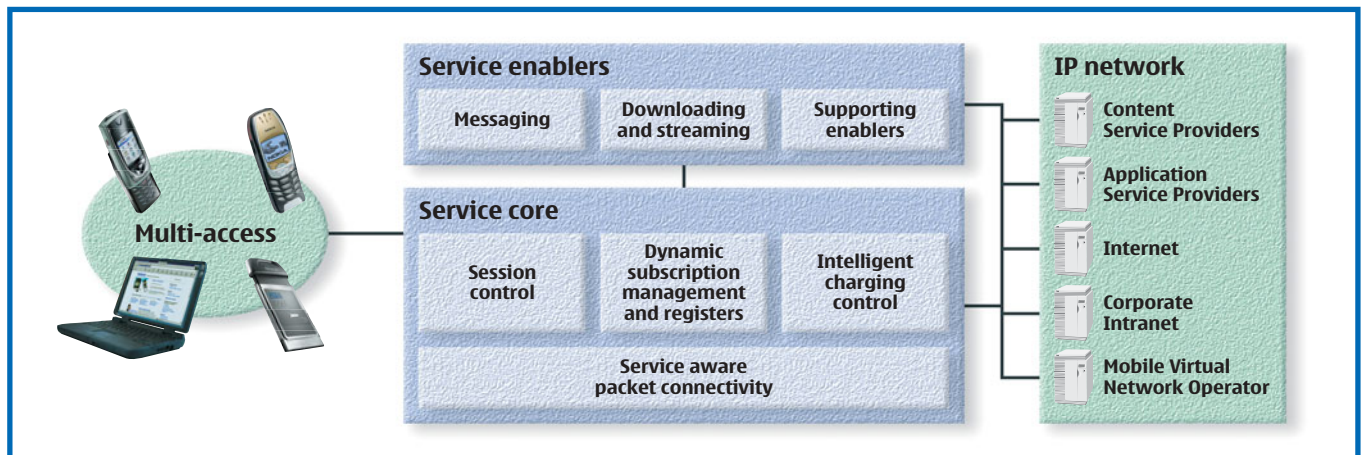


Figure 4. The Intelligent Edge.

in camera by panning the view or maybe centring on an object of interest during the conversation. The other party views the stream. Push to talk interaction allows the parties to exchange comments about the subject.

Voice will continue to be the number one person to person service for sometime to come, and so the Intelligent Edge must be able to work with the circuit switched domain.

Content to person services

Content to person services encompass all the services where content or applications are delivered to the end-user; this includes browsing, streaming and downloading. Largely driven by new terminal features, the coming months will see a rapid increase in the number of end-users using download services and the number of third party content providers the operator must interface with.

Key requirements in this solution area are:

- A simple end-user experience with easy service discovery and ideally 'one click access' to services.
- Different traffic charging and flexible charging for service access and service content. Support for prepaid billing, enabling online charging for both content and traffic.
- Revenue sharing between network operator and content providers

Business connectivity

Business people on the move need access to business services, such as corporate e-mail and calendar synchronisation. As well as cellular access, WLAN is increasing in importance as an access medium, hence service mobility and multi-access are important functionalities of the Intelligent Edge based network.

Business connectivity solutions should provide the ability to charge based on customer-specific profiles, as well as specific use cases. Additional needs are support for service enablers, such as authentication, Virtual Private Network (VPN) tunnelling and support for private/business subscription for the same SIM.

Intelligent Edge Implementation

The Intelligent Edge is a new 'service aware' capability that enhances present packet core networks. In Intelligent Edge, intelligence is concentrated at the network edge, at the border between the basic routing network and service-access networks. Currently, the GGSN is the main element located in this strategic position – the Intelligent Edge will grow from the GGSN as additional functionality is added. At this transition point, key factors such as service authentication, Quality of Service, inter-operator Service Level Agreements, pre-paid balance check and charging can be determined.

The functionality of the Intelligent Edge is based on a framework with open interfaces, to provide end-to-end interoperability and maximum flexibility in implementation. The framework outlines all the functionalities that are needed to provide a centralised, cost-effective way to deliver services through multiple access networks. Rather than implement new elements and functionalities in an ad-hoc way,

Function	Role
Service Aware Packet Connectivity	Standardised packet core functionality (2.5G, 3G, WLAN) Service switching with charging data generation Application level charging data generation Advice of charge and scheduled delivery
Session Control	Peer to peer IP connectivity Operator Wireless LAN (OWLAN) access authentication
Dynamic Subscription Management and Registers	Registers for: <ul style="list-style-type: none"> • Bearer access control • Packet connectivity service control • SIP service subscriptions and scripts Consistency management of registers and self-service management interface
Intelligent Charging Control	Charging data correlation Online credit control Single interface to prepaid and postpaid billing systems
Service Enablers	For example: Messaging, Browsing, Downloading, Streaming, Presence, Location, Terminal configuration, Alternative payment

Table 1. Roles of functionalities within the Service Core and example Service Enablers.

operators need a planned framework to map their existing and future service machinery into. This will ensure:

- The full set of controls is available, including those related to end-user acceptance & business model support.
- Functionalities are not duplicated and synergies between services are maximised
- Scalability and lifetime maintainability

Without a framework there is a risk of short term and duplicated investment. The same basic challenges must be solved for person to person, content to person and business connectivity services, so it makes sense to solve these together. For example, there should only be one charging solution that supports the charging requirements of all services.

The framework for the Intelligent Edge is shown in Figure 4.

The service core provides the fundamental elements required to connect subscribers to services, control the session and charge for it. Service enablers provide the additional service enabling functionalities required to provide particular services.

The network operator does not necessarily have to host all the service enablers itself, but may decide to outsource some service enablers to third parties. Typically network operators will themselves host the key service enablers, such as messaging.

Table 1 details the roles of each of the functions within the service core and example service enablers.

In the short and medium term, the critical performance issues in the Intelligent Edge are functionality and the support of many users (PDP contexts) with low traffic per user. Throughput will not be a major issue in the Intelligent Edge for some years to come. What is important is the use of scaleable platforms with balanced routing and processing power (i.e. not a 'super router' with applications added as an afterthought). End-to-end solutions will be key to success in the Intelligent Edge – 'box solutions' may be excellent short-term solutions, but in the long-term may not prove viable.

Service aware packet connectivity

Packet connectivity in mobile networks is currently provided by the GGSN. To manage the transition of content to person services into the mass-market phase successfully, mobile operators must enhance the packet connectivity functionalities of their Intelligent Edge.

Charging of third party content can be achieved in different ways, for example, it can be based on information acquired directly from the third party application server, including or not including the price information. This solution is manageable for relatively low volumes of subscribers and content providers and for a few types of relatively static content, but faces some challenges in the mass-market phase of content services. An alternative way of identifying the usage or delivery of third party content is by analysing the user-plane traffic itself. For example, the destination IP address, traffic type and URLs can then be used as charging criteria. This **content analysis** approach to differentiated content charging offers better scalability to mass-market levels, and reduces the amount of work required to integrate third party systems to the network operator's domain.

Hence, enabling the new business models and value based subscriber charging of the Intelligent Edge requires that the network does not blindly route packets without any understanding of the packets' content or destination. Instead, the connectivity functionality must become **Service Aware**, that is, it will understand something of the content and destination of each packet and make use of this, for example to create a

Services	Charging Models	Business Models
<ul style="list-style-type: none"> • Cost control and charging information • Profile based barring • Personalized access to services • Scheduled content delivery 	<ul style="list-style-type: none"> • Charging per value of data • User profile vs. service charging • Charging per protocol 	<ul style="list-style-type: none"> • Sponsoring and advertisement insertion • Profile brokering • Revenue sharing models – based on events, downloads and page views

Table 2. New services, charging models and business models enabled by service awareness.

Charging Data Record (CDR), or to bar usage of a particular service.

Additionally, to meet the requirement of mass-market end-user acceptance, services must not require the end-user to change terminal settings to use different services. Currently, different access points must be selected for different services. The Service Aware packet connectivity must provide a single access point, behind which all services can be accessed simply.

Examples of the new services, charging and business models enabled by service awareness are given in Table 2.

The functionalities required for full service awareness are:

- Traffic Detection & Analysis (Layer 4/Layer 7 analysis)
- Content Detection & Analysis
- Transaction/Event based Charging

To function efficiently, traffic analysis functionality must be located within the traffic flow itself. Although it is easy to implement traffic analysis outside the mobile packet core as an 'add on' (so called 'Gi based solutions'), this approach offers some critical limitations to functionality. The optimum solution is to include

the service awareness functionality in the GGSN. This creates a 'service aware GGSN' and offers the following advantages:

- Service Switching & Selection
- Support for pre-paid
- Only traffic requiring content analysis is actually analysed

The role of the SGSN and GGSN in mobile networks is becoming something rather different from that intended when the mobile packet core was originally specified. The role of the SGSN is becoming clearly focussed as a 'mobility machine', where quality and stability are the key requirements. By contrast, the GGSN functionality will increase and become the 'service machine' of the network, playing the pivotal role in the majority of services provided by mobile networks.

The GGSN is not only the link between the access network and the content, but is also the link to other functions in the service core, such as session control, dynamic subscription management and intelligent charging control. Hence, the choice of vendor in the expanded GGSN functionality space is a critical strategic decision faced by network operators.

Session Control

The current packet switched session control functionalities in mobile networks only allow sessions to be created between terminals and network-based servers. Terminal-to-terminal connectivity will be supported by the next phase in the evolution of session control, the IP Multimedia Subsystem (IMS). This will, for example, allow end-users to invite their friends to take part in interactive game sessions.

The IP Multimedia Subsystem provides a standardised way of establishing IP connections between terminals. The subscriber is given a logical address that can be used whenever they need to be contacted for any IP service (a Session Initiation Protocol (SIP) address, e.g. SIP: John.Smith@operator.com). The IP Multimedia Subsystem provides a single point for registering into the network, as well as centralised session control and charging. This allows the operator to provide several services that require IP connectivity between users, using the same control and charging mechanisms.

From the end-user perspective, the benefit of the IP Multimedia Subsystem – in addition to the vast amount of new interactive services – is the ability to be contacted through the IP network for any interactive services that have been provisioned to the user. An example of the revenue opportunities enabled by this peer-to-peer IP connectivity is shown in Figure 5.

As well as GPRS, EDGE, WCDMA and WLAN radio interfaces, the IP Multimedia Subsystem also enables network operators to provide Session Initiation Protocol (SIP) based services to fixed broadband end-users.

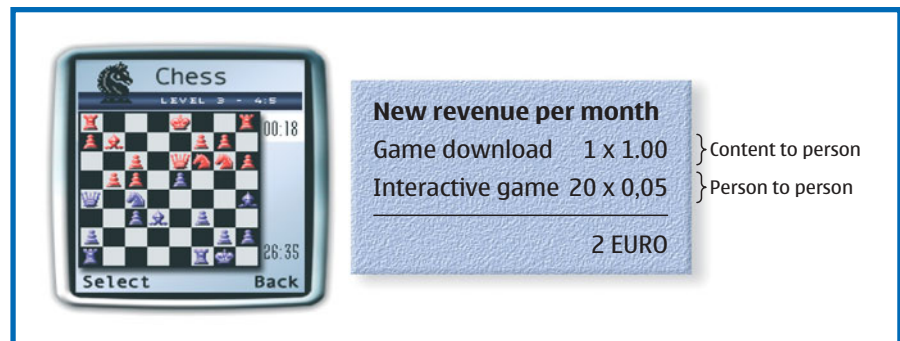


Figure 5. Example of revenue opportunity enabled by peer-to-peer IP connectivity. The end-user is charged a small fixed price per-game. Compared to charging based on the bits transferred, the 'per-game' tariff is both more acceptable to end-users and provides more revenue to the network operator (typically the volume of traffic created by an interactive game will be small).

Dynamic Subscription Management and Registers

Service and subscriber management requirements can be subdivided into the following areas:

- Subscription Management – Providing enriched and consistent subscriber information available across networks
- Service Management – Streamlined service management process
- Device Management – Easy subscription and terminal configuration process.

The Dynamic Subscription Management and Registers functionality within the Intelligent Edge focuses on that part of subscriber information required for bearer level control, such as the service aware packet connectivity user-plane.

To protect current investments, evolution must be built upon operators' existing systems, such as existing subscriber databases and customer care and billing systems. Lifetime system integration cost is a critical consideration – a patchwork of different boxes may not prove viable to maintain in the long term.

Coming services will require that the service provisioning and subscriber management systems are much more dynamic than today, for example, the parameters for SMS are fixed, but for many SIP based services the parameters will not be known in advance, only being set during the session start. Additionally, there is an ever-growing amount of subscriber information, much more than originally stored in the Home Location Register (HLR).

Key requirements in this area of the Intelligent Edge are:

- Providing dynamic subscription information to the network.
- Ensuring consistent and synchronised subscription information across the network
- Providing self-service functionality for subscribers (and so reducing load on the operator's customer care system)
- Interfacing with existing Customer Care & Provisioning systems.
- Maximising operators' usage of existing investments in servers, databases and provisioning systems

One often forgotten, but vital functionality of the subscriber management system is to provide subscriber usage data to be used in

Customer Relationship Management. By knowing the interests of each subscriber, the marketing of new services can be pinpointed exactly to the correct subscribers. This information is immensely valuable.

Intelligent Charging Control

Generally, post-paid charging is easy, but in many markets, 60% of subscribers are pre-paid – this presents a bigger challenge. The critical requirement of network operators is to ensure a ‘zero fraud window’ for pre-paid subscribers. This requirement becomes even more acute when much of the content comes from third party sources.

For mass-market end-user acceptance, the Intelligent Edge supports charging models that provide price indications in advance. The flexibility to charge based on the perceived value of the content or service delivered is also an essential requirement to provide subscribers with consistent value for money.

Enhanced charging solutions must work within the limitations set by the existing billing system. Thus the Intelligent Edge must include **on-line** credit control, which directly interacts in real time with the master pre-paid balance and controls the charges related to the use of a particular service. Credit control is the process of managing the subscriber account in an external balance holder by checking the credit availability, credit reservations, credit reductions after service event confirmation and refunding of reserved credit not used. The same balance information shall be used for the services of both circuit-switched and packet-switched domains.

Charging functionality in the Intelligent Edge must bring together Charging Data Records (CDRs) from both the service enablers (e.g. MMS server) and the service core (e.g. from traffic analysis). Typically these will originate from different vendors’ equipment and in various formats.

Service Enablers

Service Enablers are generic functionalities or “middleware” that are used by end-user applications to provide services. Usually a chain, or network of service enablers is required per service.

In the market-making phase, new service functionality can be quickly brought to the network by adding service enablers. However, scaling up the service to reach the mass-market can only be achieved when the service core has the ability to support the service enabler by providing differential treatment, based on service awareness. Service enabler functionalities and those of the service must support each other.

There are a huge number of current service enablers, and the list is growing based on the requirements of new services – examples are Push to Talk over Cellular, Multimedia Messaging, XHTML Browsing, Presence, Location, Delivery and streaming servers, to name a few.

Openness in the Intelligent Edge

Interoperability between end-users is the key that drives service adoption by the mass-market. Service usage depends on the number of interoperable end-points – this has been the key factor in the success of SMS.

Following open, global standards, protocols and interfaces that are not locked to proprietary technologies from one vendor, will result in faster time to market for new services, at a lower cost and with an improved end-user experience.

Solutions in the Intelligent Edge follow the Industry forums and standardisation bodies such as 3GPP and Open Mobile Alliance (OMA).

Conclusion

In order to exploit the opportunities provided by the changing mobile business ecosystem, network operators need to enhance the capabilities of their packet core network. The Intelligent Edge sits at the heart of the business ecosystem; – its key target is to enable network operators to exploit the widest possible mixture of different business models, at a mass-market volume.

In this new scope of digital content, the value of bits is not equal. The price end-users may be willing to pay for a bit may vary by three to four orders of magnitude. In order to commercialise this, intelligent delivery networks are needed in order to charge the right price for all bits. This will maximize the business potential and satisfy

end-users. Additionally, the ability to create direct terminal-to-terminal IP connections will create a huge new set of application possibilities.

The Intelligent Edge is the new service aware enhanced packet core network, the centre of service intelligence. This is complemented by a set of selected application level enablers. The planned, open framework of the Intelligent Edge will provide scalability and lifetime maintainability. Intelligent Edge implementation is the key strategic decision that network operators have to take in order to provide end-to-end solutions and to secure the evolution of subscriber services and their delivery machinery.

Abbreviations

2.5G	2.5 Generation mobile communications
3G	Third Generation mobile communications
3GPP	Third Generation Partnership Program
3GPP2	Third Generation Partnership Program 2
CDR	Charging Data Record
EDGE	Enhanced Data rates for Global Evolution
GGSN	Gateway GPRS Support Node
GPRS	General Packet Radio Service
HLR	Home Location Register
IMS	IP Multimedia Subsystem
IP	Internet Protocol
MMS	Multimedia Messaging Service
MVNO	Mobile Virtual Network Operator
OMA	Open Mobile Alliance
OWLAN	Operator Wireless Local Area Network
PDP	Packet Data Protocol
SIP	Session Initiation Protocol
SMS	Short Message Service
URL	Uniform Resource Locator
VPN	Virtual Private Network
WCDMA	Wideband Code Division Multiple Access
WLAN	Wireless Local Area Network

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