

Intelligent Edge



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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. This brings a unique opportunity to enhance the subscriber experience and to develop additional network usage, far beyond existing voice and messaging services.

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

service and business machine that enhances present packet core networks. Intelligent Edge gives operators new tools for maintaining greater control over services and revenues, providing new possibilities for positioning themselves in the value chain, beyond the basic access charging as in today’s fixed networks. 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 subscribers. Operators can now develop a full portfolio of exciting services and subscribers 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 and access aware differentiated charging of the Intelligent Edge supports online charging of packet traffic for post and pre-paid subscribers, hence solving one of the most burning challenges of many operators.

Nokia Intelligent Edge also drives new applications. For example, IP Multimedia Subsystem specified by 3GPP/3GPP2 enables direct terminal-to-terminal IP

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 an open architecture, supporting multivendor implementations, including common functions and built as an integral part of the standardized 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 personalized 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 maximize 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 find, subscribe to, personalize 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.

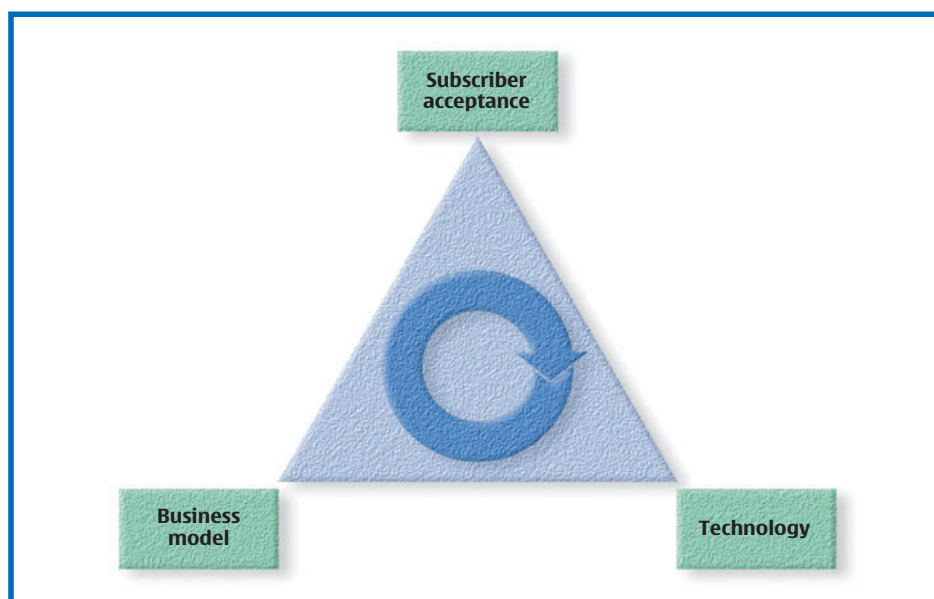


Figure 1. The triangle of service success

Elements for Service Success

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

- **Subscriber 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 configure and 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 subscriber 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 subscriber 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 standardized services has been ring tone and logo download. This business has been a success for the following reasons:

- Numerous content creators
- Simple subscriber 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-standardized 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 subscribers to accept and use this huge array of possible services, simplified subscriber 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 access points when mobile browsing or streaming, will prove a barrier to using the service for many subscribers.

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

Furthermore, the value to the subscriber 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

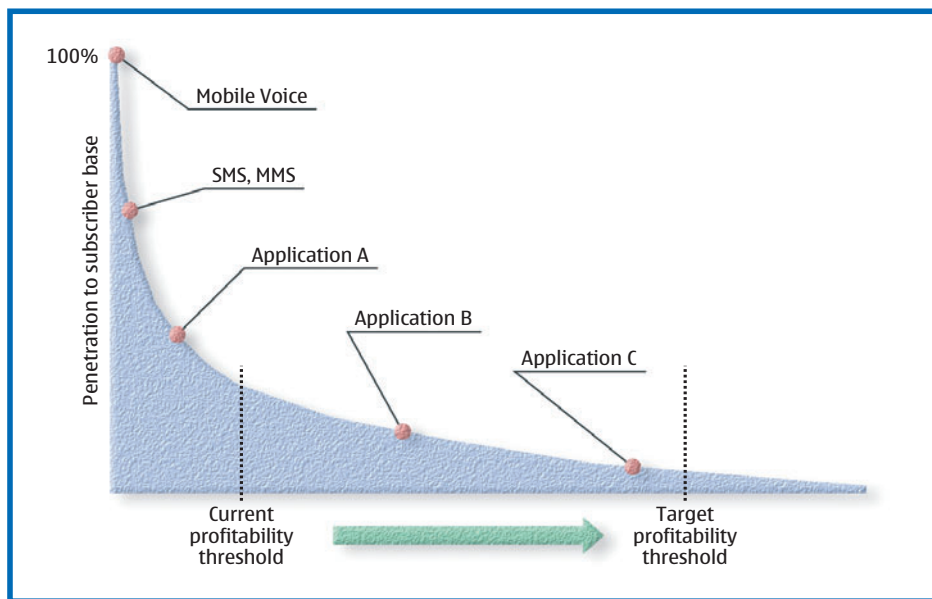


Figure 2. The maximum profitable service mix

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 subscriber, 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, transaction and event based charging
- Time based charging
- Subscription based charging
- Access based charging (the same service can be a different price when used via different access networks)
- Subscriber based charging (the same service can be a different price for different subscriber groups)
- Charging based on combinations of the above.

Additionally it should be possible to bar services, so that children do not have access to adult services, or that companies can bar employee access to premium-rate content.

Finally it should be recognised that these are only the technical possibilities, these should be utilized to create intuitive pricing models for subscribers, to maximize usage and hence revenues.

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 customer relationship through billing, plus essential supporting enablers, such as the ability to configure subscribers' 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 have profitable relationships with **third party content providers**, covering content such as ring-tones,

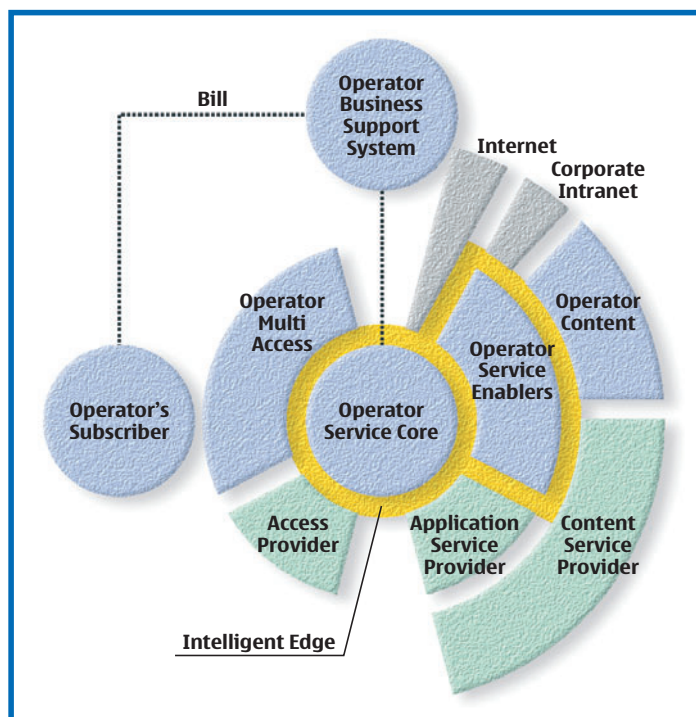


Figure 3a. Mobile Industry Ecosystem. The Intelligent Edge is located at the heart of the business ecosystem – enabling many different business models.

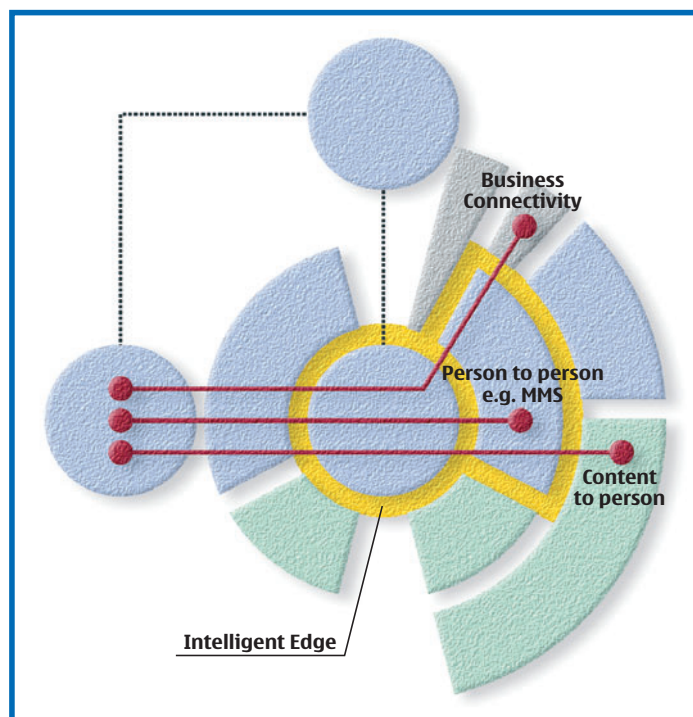


Figure 3b. Flexible business models.

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 a new service and business machine – the Intelligent Edge. The Intelligent Edge provides operators with value and control points, allowing new innovative, profitable business models for all parties in the value chain at a mass-market level.

Service Solution Areas

The evolving subscriber 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, such as work colleagues, family and friends. MMS is the first step in moving person-to-person services into the multimedia era. The next step is terminal applications that utilize IP connectivity directly between terminals – the IP Multimedia Subsystem, as part of the Intelligent Edge, 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, it will be possible to invite a known opponent for a gaming session.
- Push to talk over Cellular will provide instant voice communication between individuals and groups. This is not a substitute for circuit switched voice, but provides a truly different service.

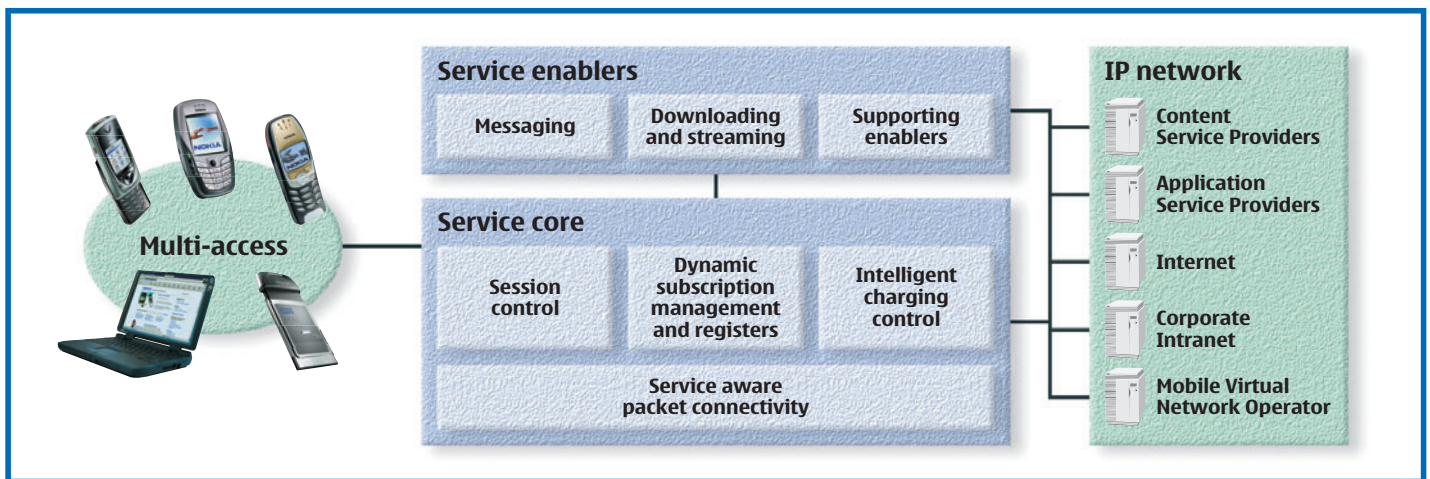


Figure 4. The Intelligent Edge.

The key issues are that the same infrastructure is used for all services and that services can be seamlessly combined, for example, a game session will be enriched with additional communication channels like text chat or push to talk. Voice calls will continue to be the number one person-to-person service for a long time, and so the Intelligent Edge must be able to work with the circuit switched network.

Content-to-person services

Content-to-person services encompass all the services where content or applications are delivered to the subscriber; this includes mobile browsing, streaming and downloading. Largely driven by new terminal features, the coming months will see a rapid increase in the number of subscribers 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 subscriber 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 online charging to reduce the fraud window for pre-paid subscribers and provide cost control for post-paid subscribers.
- 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 access type, customer-specific profiles and specific use cases. Additional needs are support for IP security, authentication, Virtual Private Network (VPN) tunnelling and support for private/business subscription for the same SIM.

Intelligent Edge Implementation

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 and authorization, 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 an architecture with open interfaces enabling multivendor implementation. The architecture outlines all the functionalities that are needed to provide a cost-effective way to deliver services through multiple access networks, that is scalable to support millions of subscribers. Rather than implement new elements and functionalities in an ad-hoc way, operators need a planned architecture to map their existing and future service machinery into. This will ensure:

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

Without an architecture 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 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 specific functionalities required by

| Function | Role |
|---|--|
| Service Aware Packet Connectivity | Standardised packet core functionality (2.5G, 3G, WLAN) Service selection, switching with charging data generation Charging data generation based on deep packet analysis Advice of charge and scheduled delivery |
| Session Control | Peer to peer IP connectivity Wireless LAN (WLAN) 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 and mediation Online credit control Single interface to prepaid and postpaid billing systems Optional interface to external rating engine |
| Service Enablers | For example: Messaging, Mobile Browsing, Downloading, Streaming, Presence, Location, Terminal configuration, Alternative payment |

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

particular services, for example streaming. Typically, the service enabler consists of a network server part plus a client running in the terminal.

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.

The Intelligent Edge is not built in a vacuum in one go, but is built on top of the existing packet core network step-by-step, towards the operator's long-term strategic target. 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

solutions with balanced routing and processing power (i.e. not a 'super router' with applications added as an afterthought).

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

Additionally, to meet the requirement of mass-market subscriber acceptance, services must not require the subscriber

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

Long-term, a packet core integrated solution, tightly linked with IP session control mechanisms such as QoS control, will be the optimum solution. However, a less tightly integrated solution is an alternative way to introduce the service aware functionality. Although this solves some of today's challenges, the solution should allow long-term migration to become an integral part of the packet core. In addition to 2.5G and 3G radio access, support of alternative access such as WLAN and xDSL has to become part of the overall solution.

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 subscribers to invite their friends to take part in interactive applications such as 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

| 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 to third parties • Revenue sharing models – based on events, downloads and page views |

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

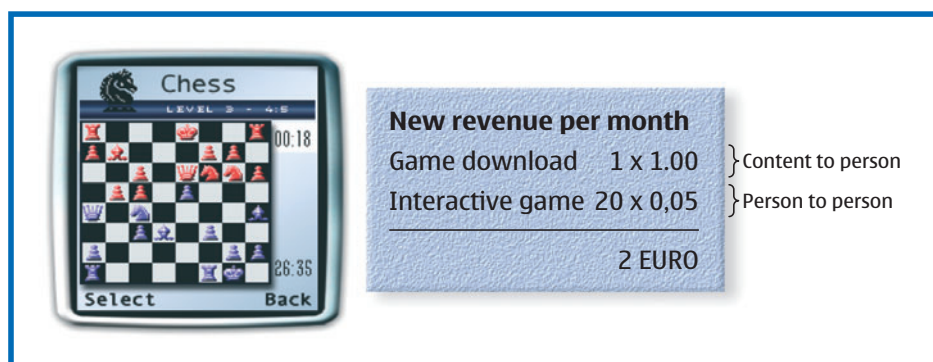


Figure 5. Example of revenue opportunity enabled by peer-to-peer IP connectivity. The end user is charged a small fixed price per-game. Compared to charging based on the bits transferred, the 'per-game' tariff is both more acceptable to subscribers and provides more revenue to the network operator (typically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

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 multiple services that require IP connectivity between users, using the same control and charging mechanisms.

From the subscriber 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 subscribers.

Dynamic Subscription Management and Registers

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. Dynamic subscription will allow subscribed services to be instantly available for use.

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 and linking available services to subscribers
- 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 subscription 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 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 subscriber 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 online 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 subscriber 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 core 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, mobile browsing, presence, location, delivery and streaming servers, to name a few.

Openness in the Intelligent Edge

Interoperability between subscribers 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 innovation, faster time to market for new services, at a lower cost and with an improved subscriber experience

Solutions in the Intelligent Edge follow the Industry forums and standardisation bodies such as 3GPP/3GPP2 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.

Third party content and service providers will benefit from the improved delivery channel Intelligent Edge will enable operators to offer.

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 subscribers. 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 architecture 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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