Faced with the declining revenues from commodity-based connectivity services and confronted with the gloomy economic climate, telecommunications providers are scanning new opportunities in the area of value-added services in order to unlock new potential revenue streams. Multimedia services such as multi-party conferencing and content delivery (for example, video on demand (VoD), video broadcast), home automation, security management (for example, home surveillance), and managed home networking are just some examples from the emerging service basket. Next-generation services require next-generation network infrastructure. In this perspective, a major trend is the evolution towards the IP-based digital home where a myriad of devices and appliances (such as set-top boxes, IP video-phones, domotics bridges, etc.) connected on a residential home gateway will be reachable via broadband connectivity. Value-added services will be delivered from next-generation back-end service virtual private networks (VPNs) such as logical IP clouds housing VoD cluster servers, soft-switching platforms, gaming servers, etc. In order to turn the potential revenue streams into profits, the operator must provide subscribers with self-provisioning and behind-the-scenes service activation at minimal expense, track and bill for these new IP services, and enable third-party providers and content providers to deliver their services across the infrastructure of the broadband core network and the digital home network. The key missing piece to allow for all this, is a strategic service enabling platform (SEP) to be exploited by the operator. This paper elaborates on the requirements and possible implementation of such a platform.

**Introduction**

Today, Belgacom has reached with its ADSL-based product portfolio a broadband penetration of considerable momentum (at the end of 2003, over 800,000 households were broadband connected through ADSL). However, the services offered over ADSL are in fact basic connectivity services such as fast Internet and teleworking. Today, the suite of ADSL-based access products is entering its phase of saturation in terms of volumes and take-up rates and the time has come to lift DSL broadband to a next stage such that DSL ARPU is boosted again. At the heart of this next stage is the introduction of new value-added services that differentiate DSL to much more than just a broadband bit pipe.

In this transformation to a broadband service company, there are a number of trends and facts that have to be taken into account and on which we have to put focus:

**The need for a multi-service/multi-device/multi-user environment**

Very gradually, multiple devices and applications are entering or will enter the office or residential home. Increasingly, residential homes are being equipped with multiple PC(s) hosting data and multimedia files, game consoles for the kids, laptops from the office, personal digital assistants (PDAs), and surveillance cameras, and more devices will appear such as set-top boxes, IP phones, etc. All of these devices and the services they enable contend for the broadband connection, and family members desire the ability to use all existing and future services at the same time in an easy and flexible way (daddy is teleworking, while son is on the Internet, while mom is video streaming). On top of the broadband sharing, they want to share content (data and multimedia) between all these devices (look on the TV screen at my pictures stored on my PC, share the files on my laptop with my other PCs and my PDA, etc.).

**The never-ending customer demand for ease and simplicity**

Who has never had the horrible and dreadful experience of spending three hours
on a Sunday afternoon to connect an extra PC on his broadband DSL connection, or to get internal communication between multiple PCs, and to share a printer between them. For most people, networking is in its current form far too complex and they don’t want to be bothered with terms such as PPP sessions, IP addresses, HTTP proxies, or whatsoever. People want to get home with a new device, plug it in, hook it up in a zero-touch way, and use it seamlessly in an integrated way with their installed base. The same is true for the installation and usage of telecommunication services. Therefore two aspects are to be taken into account:

- Connecting new devices in the home is a matter of plug and play. The customer should be enabled when installing a new device without having to dive into complex technical issues. This will help attract customers without IT knowledge into new services.
- Having an installed set of devices in the home environment, subscribing to value-added services on these devices should be as zero-touch as possible (for example, subscribe to a remote surveillance service, or a new premium broadcast channel): the customer can do it in no time from any device in the home (PC, PDA, TV set, etc.) without manual interventions from technicians.

Preservation of quality and reliability
Alongside the introduction of value-added services (VAS), the end-to-end network truly has to support the convergence of voice, video and data (triple play). Service sessions with different demands for quality of service (QoS) (packet delay, jitter and loss) and bandwidth will run in parallel right from the home network via the access and backbone network towards the enabling back-end service centres (hosting server clusters). The end-to-end network has to be prepared and enhanced to support this multi-service concept and new mechanisms and network configurations will be required to ensure that each service usage session gets the quality it deserves without impact from other sessions.

Strategic positioning
The telecom landscape is continuously changing in a rapid way. A major trend in these changes is that plenty of players will try to offer VAS directly to end-users across the best-effort broadband pipe. In this model, the DSL operator is in fact only a bit-pipe provider and can only create revenues and value from the transport layer (for example, through volume packs, bandwidth-on-demand (BoD) sessions, etc.). However, there are a number of key internal strengths we can leverage in order to play the service game in a more extensive way. To these new players we could offer generic capabilities such as controlled access to our customer base (customer profiles, preferences), differentiated billing and payment methods (e-wallets, pre-paid, post-paid, etc.), end-user authentication and service authorisation, control of network resources as needed for high-quality service sessions, extensive service usage reporting, hosting of content and service logic. In other words, we have the capability to control the whole service delivery process comprising not only bit transport, but all other steps in the process as well: billing, customer relationship management (CRM), content hosting, authentication, etc. Playing this service-enabling role will enforce our position in the emerging service value chains, with more revenues as a result (through commissions on third-party service offers).

Operator Vision Towards Introduction of New Value-Added Services
So, what are the new type of services we can expect? We can subdivide them into the following classes each contributing to a next-generation type of lifestyle:

Enhanced fast Internet
On top of the traditional Internet access service, the enhanced fast Internet service comes with new features such as:
- bandwidth on demand (BoD: the ability to temporarily boost the upstream and/or downstream bandwidth of the access line),
- anti-virus anti-spam (AVAS),
- PC back-up (the ability to back-up data on one or more PCs within the home network on back-end storage area networks (SANs)), and
- hosted email exchange service (a customer manageable email service where email boxes can be requested and created online for different users in the home network).

Multimedia video services
This class of services is also named iDTV services (interactive digital TV services). The device via which the iDTV services portfolio is delivered is a set-top box (STB). In an initial stage, only one STB will be supported in the home. In a later stage the home network will be able to support multiple STBs; that is, be able to bring iDTV services on multiple TV sets within the home. The iDTV services comprise the following service components:
- Broadcast TV: TV channels are digitally broadcast to every digital subscriber line access multiplexer (DSLAM) in the network. The customer can switch a channel to its ADSL access line and bring the content to its STB. Channel content is either traditional TV programmes or premium content such as sports, cartoons, adult TV, etc.
- Video on demand: VoD allows the customer to order a movie on demand in an online way from the home TV platform. Video content (encoded in either MPEG-2 or MPEG-4) is streamed from video servers in the network to the home TV platform.
- Personal video recording (PVR): The PVR feature allows a customer to record digital video content on a storage device. This storage device is either a video server located in the network (network PVR) or the customer’s STB which is equipped with a disk or flash memory (local PVR).
- Electronic programme guide (EPG): The EPG allows the customer to consult in an online way information about scheduled TV programmes through a menu-driven electronic information guide. The information database can be searched and scanned and the EPG application allows the customer to schedule programme recordings on its local PVR or in the network PVR.

Next-generation network communication services
The next-generation network (NGN) is a new concept for IP-based communication services designed around a new set of open signalling protocols such as H.323, Megaco, multimedia gateway control protocol (MGCP) and session initiation protocol (SIP). However, SIP will be the ultimate NGN protocol adopted by the industry. SIP will pave the way to the ultimate integration of data, voice and video driven communication services as it will be integrated in PC-based communication tools as well as in dedicated IP devices such as STBs, PDAs, IP phones, etc. NGN services will enter the network in niche areas such as video calling, conferencing and computer-telephone integration, but, in the end, the NGN concept and its attractive cost structure will drive a major change in telco networks: the evolution from PSTN to VoIP. Below, some new NGN services and features are enumerated:
- Video telephony and conferencing services: These are the first examples of value-added communication services that will be introduced on IP/DSL. Video telephony adds a video component to the voice signal. Together they constitute an IP packet stream of 384 kbit/s. Initially, the service is peer-to-peer, but with the inclusion of IP multicast capable SIP; it may evolve to a multi-party audio/video conferencing service.
• **Presence services:** The NGN network ‘knows’ whether a user is logged on, and, if so, via which device. This allows for optimal call routing; that is, the caller does not need to know on which device or network the user is connected or registered. Up-to-date presence information is integrated in the address book of an NGN device or end-user application.

• **Instant messaging:** Is a service allowing the asynchronous transfer of messages.

**Home security services**
One of the primary home security services is remote home surveillance which allows the customer to watch their house from a remote location (the office, a second residence, the car, etc.). Remote surveillance is enabled through a number of video cameras spread all over the home environment (the front door, the garden, the living room, the baby’s room, etc.). The surveillance application brings several added-value features:

- The customer can program monitoring scripts that take snapshots at regular timestamps for different preset positions on different cameras. These snapshots are stored on a home-based web server and can be consulted via the home portal.
- The customer can remotely ‘log-in’ on one of the cameras (typically via the home portal) and see the video stream captured by the camera while they control its positioning.
- The customer can be alerted (for example via messaging, or via an incoming voice or video call on a GSM or UMTS device) when motion is detected by one of the home cameras. As such, the customer can follow in real-time what is happening at home and command the recording of the camera’s video stream.
- The customer can configure the recording of video streams of one or more cameras at certain time spans.

**Home automation services**
Within the realm of home automation, many things are possible. Home automation features vary from lighting control, heating control, shutter control, to monitoring of energy consumption, control of home appliances and white goods such as ovens and washing machines, and distributed audio-visual systems such as multi-room systems. All of these control features are enabled from one or multiple touchscreens and many handheld devices such as PDAs and universal remote controls.

**Integrated service features boost customer added value**
The above described services are in a sense standing sets of service features. However, added value for the customer really comes into play when we succeed in building true integrations between all of these service features. The example scenarios described below just describe a number of integrated usage scenarios:

- The kids are arriving home. When they ring the doorbell, a door camera takes a snapshot and mom gets an alert on her multimedia messaging service (MMS) phone with the picture and a message that someone is at the front door. She presses a button on her handset to open the door and to let the children in. In this example, three types of service features collaborate: home surveillance, NGN messaging and home automation (open the front door).
- My traditional alarm system detects motion via a classic infrared detector. A fixed camera is triggered to start recording its video stream and a number of people are alerted. Through presence information, they are alerted on the appropriate device (GSM, fixed line, PC at home or office). Here again, home surveillance and NGN features collaborate in one session.
- I am driving home from office late in the evening and do not want to miss the news and a great movie. I consult the EPG from my general packet radio service (GPRS) handset, and request the recording of both programmes on the nPVR. Here we have a collaboration of web features and iDTV features.
- I am watching a broadcast programme on my home TV platform. Suddenly, I get a notification at the bottom of the plasma screen mentioning an incoming video call. I put the programme on time-shifted viewing and switch to the video call on the TV screen. On completing the call, I resume my programme in time-shifted VoD mode from the video server. Here we see a collaboration of iDTV features and NGN features.

---

**The Cornerstones of the Service Factory—The Home Concept**

**The home network and the home gateway**
The first step towards the home concept is the introduction of the notion of a home network. Although there are multiple types of home networking or home wiring solutions (IEEE.1394, HPNA, etc.), the general trend is to evolve towards an Ethernet-based home network. The heart of the home network is the home gateway platform which acts as the operator’s single point of entrance in the residential home or office. The home gateway (HGW) is an enhanced DSL router which interconnects the multitude of home LAN devices via wired or wireless Ethernet, and which supports all upstream and downstream service flows (Internet data flows, voice flows and video flows) with the required quality of service. The home gateway platform will be introduced in two phases, and the type of gateway we encounter in each phase is referred to as the v1 and v2 gateway. The features of each are shortly described further below.

The services as described and classified above are supported in the home (or office) through a multitude of devices connected via a home network. These devices can be classified into four device clusters:

**The home office cluster**
The home office device cluster comprises the different PCs and laptops in the household as well as traditional office equipment such as shared network printers, file servers, etc. All of these devices connect to the HGW via wired or wireless Ethernet (Wi-Fi).

**The entertainment cluster**
Within the entertainment cluster we can identify the following types of devices:

- enhanced multimedia communication devices such as videophones and IP phones;
- set-top boxes for video-based iDTV services; and
- other IP devices that use fast Internet access connectivity: game consoles such as the Microsoft Xbox or Sony’s PS2, Internet hi-fi devices such as the Philips Streamium or the Linx, etc.

As of today, most of these devices are still connected to the HGW via wired Ethernet; however, wireless solutions are underway (for example, IEEE 802.11-g, UWB).

**The surveillance and security cluster**
The surveillance cluster contains devices such as traditional alarm systems with an Ethernet connectivity to the home local area network (LAN), and remote surveillance systems comprising one or more video cameras. Either each camera is an Ethernet device with an embedded web server (for example, the camera solutions from Axis), or different cameras are wired (typically via coaxial cable) to a central control hub. The latter connects via Ethernet to the home LAN (for example, surveillance solutions from Aritech).

**The home automation cluster**
Typically, home automation solutions are based on a domotics system, which is integrated in the electrical powering system of the house. Home automation systems are
implemented in either a centralised way (a central embedded computer in the power rack: for example, solutions from X10, Teletask, Lutron, Crestron, Legrand, etc.), or in a distributed way where control logic is spread all over the powering network (for example, EIB or LonWorks). No matter which system is in use, more and more domotics vendors are commercialising so-called domotics bridges which interconnect the domotics control network via Ethernet with the home LAN. These bridges host an embedded control server which receives control commands over TCP/IP and translates them into powerline domotics signals.

Through a domotics system, many assets in the house can be managed, controlled or monitored: control of heating, lighting, air conditioning, shutters, energy and electricity meters, household equipment, etc.

A first version home gateway
The currently used xDSL modems with routing and Wi-Fi capabilities will evolve towards a real home gateway. In a first phase this v1-HGW should have some important new features that are mentioned below:

Support for multiple ATM VCs
Today, ADSL modems connected to the network terminate only one asynchronous transfer mode (ATM) virtual circuit which supports the fast Internet service. In phase 1 (2004–2005), service QoS differentiation between data, voice and video services will still take place at the ATM level. This implies that every service (fast Internet, video telephony and iDTV services) will be deployed on a separate ATM virtual circuit (each offering the required bandwidth and packet prioritisation) and hence the v1-HGW has to be capable of terminating each of these transport ATM virtual channels (VCs).

Support for parallel routing and bridging
Traditionally, ADSL Internet access is configured in a PC-centric way implying that PPP client software is installed on the PC while the DSL modem acts as a simple layer-2 bridge, that is, it is IP agnostic. From the moment multiple PCs or IP devices (for example, some PCs, a game console and an Internet hi-fi device such as Philips Streamium) need Internet access, the situation becomes problematic as more PPP sessions should be possible on the access line. To alleviate this problem, the v1-HGW supports Internet access for multiple IP devices in a gateway-centric way. Through an embedded PPP client, the HGW is configured with the fast Internet public IP address on the wide area network (WAN) sub-interface which terminates the fast Internet VC. Further, it acts as a router performing network address translation (NAT) to a privately addressed LAN IP segment. The gateway runs a DHCP server for the LAN IP devices. This type of set-up is called a routed configuration. However, for certain services, still a bridged configuration is needed either because this is the only model with which the service implementation can work (for example, iDTV middleware or SIP signalling which cannot live with NAT on the HGW) or because of performance reasons (for example, iDTV video streams transmitted over NATed routing may not reach the required throughput). In a first phase, the actual technology for iDTV and NGN services will still require a bridged configuration, hence the v1-HGW has to offer support for dual operation: routed for Internet access and bridged for iDTV and NGN videotelephony.

A v1-HGW should support multiple virtual subinterfaces on the physical WAN interface. For each ATM circuit to be terminated, a subinterface has to be created in the HGW configuration. Depending on the service carried by the ATM VC, the subinterface is connected to the internal bridge, or to the internal router.

Firewalling capabilities and parental controls
Along with the routing capabilities of the HGW (used for fast Internet access (FIA) service), the v1-HGW supports firewalling features such as access control lists (ACLs)
and protocol proxies. ACLs allow IP packets to be filtered on the complete IP flow address quadruple (source/destination port/address). A v1-HGW will also support basic forms of parental controls such as URL filters (in order to deny access to certain web sites).

Support for zero-touch configuration
A v1-HGW should provide open management and control APIs (for example, SNMP or telnet/CLI based) such that all the service configurations can be easily created from a ‘programming machine’. The latter could be a PC in the home network (running easy configuration software on CD-ROM as in the support-soft model), or a control server in the network which interacts remotely with the gateway via some overlay management connectivity.

The v1-HGW will be able to integrate the home office cluster and the entertainment cluster into the Ethernet home LAN. As mentioned earlier, some devices will be interconnected via wireless Ethernet (Wi-Fi base station either integrated in the v1-HGW or within Wi-Fi enabled hubs wired to the HGW) or will be directly wired to the HGW. The v1 home network will be capable of interconnecting only one STB and one videophone (the QoS services); however, it will be possible to interconnect multiple IP devices that only need best-effort Internet access (PCs, game consoles, Internet radios, etc.).

The v2 home gateway
In a later phase, the home gateway should support additional capabilities:

Support for IP QoS
As mentioned earlier, multi-service QoS support will initially be implemented through multiple ATM VCs in the access network spanning from DSLAM to broadband remote access server (BRAS). However, because of different reasons, this is not an optimal solution. The longer-term target architecture is based on service QoS differentiation at the IP flow level. This implies that all service flows (be it NGN voice flows, VoD flows or Internet access flows) will be carried on the same ATM VC. QoS differentiation and flow bandwidth assignment will happen at the IP level at two places in the access network: the IP HGW (IP QoS handling for upstream traffic) and the BRAS (IP QoS handling for downstream traffic). The technologies that have to be implemented in a v2-HGW in order to support IP QoS are integrated service (IntServ) or differentiated services (DiffServ).

Support for downloadable Java code
One of the key differentiators between a v1-HGW and a v2-HGW is the inclusion of a Java Virtual Machine (JVM) in the home gateway platform. Through this JVM, the HGW becomes a flexible platform on which new services can be easily and quickly deployed in a dynamic way via the download of some Java software components. The life cycle management (installation, activation, deactivation, deletion, update) of these software modules happens via a management platform located at the

---

**Figure 2** Home gateway (version 2) architecture
backend of the network. OSGi (Open Service Gateway initiative) is one of the major initiatives in the industry to provide a standardised Java framework for life-cycle management and execution of downloadable service bundles. Other initiatives in this area are J2ME (Java 2 Micro Edition) and Sun’s Java Client Programming Model (JSR124).

A Java service bundle is a set of Java classes that together implement a certain value-added service. Once multiple devices are present in the home network, a Java framework on the HGW facilitates the deployment of enhanced value-added features in the home network. For example, the doorbell scenario described earlier could be enabled by a service bundle which is able:

- to consume events from a domotics bridge,
- to interact with the web server embedded in the front-door camera, and
- to act as a messaging client which requests the NGN messaging platform to push a camera snapshot to an MMS phone of which the phone number is configured in the service bundle. All these interactions take place over the Ethernet-based home network.

Support for multiple LAN interfaces
The v2-HGW is a device that should support multiple types of physical interfaces to the home network: wired and wireless Ethernet, IEEE.1394 (Firewire), RS232 or even Lonworks/EIB/Conex if it acts itself as domotics bridge. More enhanced platforms will even support multiple interfaces in a modular way via plug-in slots and small interface cards.

The v2-HGW platform should support each of the four device clusters described earlier. In other words, the surveillance device cluster and the home automation cluster are truly enabled by the v2-HGW.

Why is the Introduction of a home gateway platform a strategic step for operators?

- A managed end point: Today, the IT industry is moving from PC-centric services (such as fast Internet) to network- and content-centric services. Projecting this statement on the residential market implies that the home network and the content consumed/handled on the devices within that network will drive new value-added services that can boost DSL ARPU (for example, multi-player gaming, video streaming to multiple STBs in the home, videotelephony, remote surveillance, etc.). The home gateway is an operator-managed end point which facilitates the large-scale remote deployment of value-added broadband services and integrated service features (see earlier) in a flexible, rapid, easy, and robust way. Zero-touch provisioning and automation is key here in order to reduce the amount of truck-rolls needed for service deployment.

- Ease for customers: The home concept will facilitate the customer in installing the home network and connecting new devices. The central paradigms here are zero-touch configuration (no hassle with software installations and cables) and self-installation (with aid from portals and remote configuration from the network). In addition, subscription for new services and updates of subscribed services will be possible in a dynamic way.

- Cooperation with content and service providers: The home platform will allow Belgacom to enter service business models with content and service providers, in which it would otherwise be impossible to play a role. As such, the operator is capable of unlocking new revenue streams by enabling service providers in delivering their service modules. By fostering a managed and controlled home platform, the operator will be able to exploit and fortify its customer ownership in partnerships built with service providers.

The Cornerstones of the Service Factory—The Service Enabling Platform

Strategic drivers for the introduction of the service enabling platform (SEP)

A new architectural concept for session-based services
The services we know today are largely connectivity-oriented and statically configured in the network through business/operational support system (BSS/OSS) based flow-through provisioning. The resources configured in the network are traditionally long-lived (order of months to years).

However, the value-added services that have been described earlier have a much more dynamic character and are executed in a session-based way. The network resources needed in the scope of a service session are rather short-lived (order of minutes to hours) but need to be activated and deactivated in a rapid, say real-time, way. For example, the bandwidth needed for a video-on-demand session needs to be granted within seconds when the user has requested a movie; the upstream bandwidth increase needed for a PC back-up session needs to be delivered at browser-click-time; etc.

In addition to resource activation, certain business logic has to be processed during service session execution in a time-critical way. Session business logic comprises aspects such as the checking of user preferences and policies (for example, payment type), parameter translations (for example, from network ticket and network parameters to billable item and user-service identifiers), triggering of call set-ups or messaging, etc.

Within the billing and payment scope, it may be needed to show the user the price of dynamic IP service sessions either at the beginning or at the end of the session (so-called advice of charge). In addition, the payment for the price to be charged to the user could happen in different ways: post-paid on the invoice, pre-paid, via e-wallet, and via credit or debit cards. Depending on the type of service session, different payment types need to be supported.

Because next-generation value-added services are typically executed in a dynamic session-based way, a new software architecture is needed, which comprises the required components for modelling of user and service subscription data, execution of service logic, dynamic activation of network resources, and flexible pricing, billing and payment.

As each of the new services will need the features of one or more of these components, it makes sense to develop an integrated horizontal platform where these components are reused for all new value-added service implementations. This is as opposed to building dedicated platforms for each new service where these components get service-specific implementations (the so-called stove-pipe approach).

Building the foundation of an effective service company
Besides revenue flows of traditional connectivity services, operators are seeking the unlocking of new revenue streams in value-added services. In order to be able to introduce in a rapid way new commercial bundles of advanced services, a flexible software infrastructure is needed which can be built up and deployed in a smoothly phased way. This platform should be able to seamlessly integrate with existing legacy systems such as ordering systems, billing systems, CRM systems, etc.

Cooperation with content and service providers
In the coming years, the residential telco business will transform from PC-centric services (for example, basic DSL connectiv-
ity for the PC) to network and content centric services (multi-service home network and content services). Along with this transformation, new business roles will appear in the value chain. The content value chain will comprise the following business stakeholder roles: service and content provisioning, content and service aggregation, connectivity and transport provisioning, home device and home network provisioning. The operator should avoid getting stuck in a pure connectivity provider role. This is possible through a service enabling platform (SEP) concept, together with the home concept which is managed and controlled from SEP. Indeed, SEP will allow the operator: 

- To enable content providers to bring their content to the footprint of broadband customers. The provider’s content delivery process will be enabled by the operator’s content hosting and streaming systems, billing and payment platforms, user CRM and repair platforms, etc.
- To enable service providers (for example, a home automation provider) to bring their applications on the SEP platform and to control their devices (on which the service is based) in a managed way in the home networks of DSL customers.
- To act as content and service provider for local content and in-house developed services.
- To act as aggregator in order to bundle multiple service offers into attractive service packs which ensure and enforce a strong customer loyalty to DSL.

In summary, the SEP concept will allow the operator to play on many different roles of the emerging service business models and value chains, either by offering its own services or by enabling content providers in offering their services to the Belgian footprint of DSL customers.

**Key concepts and modules in SEP**

When implementing the next-generation bundles of value-added services as described above, several new concepts and principles need to be introduced in the network.

**User and identity management**

In today’s network architecture, there are a number of problems in the area of user, profile and authentication management.

Almost every service which is introduced in the network comes with certain forms of user authentication. For Internet access, the customer has its connectivity level PPP login and password, for a PC back-up application there is another set of PIN codes and passwords to be used, on the ISP portal there is yet another password to be remembered, etc. If every new broadband service (iDTV, video telephony, PC back-up, hosted exchange, etc.) comes with an isolated way of authentication and separate passwords and PIN codes, the situation becomes not only unmanageable for an end-user, but also for the network operator: it becomes difficult to figure out who is doing what on the network as activity of the same user enters the network with all kinds of identifiers, logins, passwords, PIN codes, address types, all depending on the type of service or application.

Another issue is that many new value-added services will be used by different members of the household or office, and each will have different usage preferences, ranging from the look and feel of an application to the settings and usage policies of the service (for example, type of movies for VoD, payment type, etc.).

User and identity management (U&IDM) is all about being able to model the different users in a customer realm (a household or office) together with the service subscriptions of each of these users and their personal service usage profiles. When a user subscribes for a new service, the U&IDM module ensures that the right passwords are allocated and configured in the appropriate service specific authentication engine. All these authentication identifiers are stored in the central database of the U&IDM module and linked to a unique user identity in a customer realm. This kind of data structure allows the implementation of portal-based single sign-on, and facilitates efficient mediation of network events and network parameters to billable items.

**Device management**

The device management module (DMM) in SEP is responsible for the control and management of the home network. The DMM holds a database with information for each home network: configuration of the home gateway and an inventory of the devices in the home network. The DMM has knowledge of the gateway commands that have to be remotely activated on the HGW in order to provision a new service in the home LAN, or to enable the HGW for a service session (for example, setting of upstream QoS policies or opening ports). The DMM is also responsible for downloading packages of Java code to the HGW (for example, by interaction with an OSGi backend system; in case of a v2 gateway).

**IP mediation, real-time pricing and payment**

As mentioned earlier, the integrated process of rating, billing and payment of dynamic or session-oriented services is one of the key concepts supported in SEP. In this process, there are three phases and each is supported in SEP through a separate module. This is explained by means of an example: a video-on-demand session launched by a user from his STB. The three phases are:

- **IP mediation**: IP mediation is the phase in which events, tickets or chargeable data records (CDRs) are captured from the network in an asynchronous way, and converted into a billable item. In this phase, a number of actions are required such as correlation of events (for example, start and stop of a session), enrichment of events (for example, addition of user information) and translation of incoming network parameters into data that can be understood by the downstream billing systems (for example, translation of ATM VC parameters into a telephone number).

- **Real-time rating and pricing**: Once the billable item has been created, it has to be rated and priced. This means that certain policies have to be applied to calculate the price of the billable item. These policies are among others: price and rate plans, duration of the session, content items consumed during the session, time of day, discounting schemes, etc.

- **Billing and Payment**: Once the billable item has been rated and priced, the payment or billing can occur. If the session or transaction is post-paid (on invoice), the billable item is forwarded to the billing system where it is further processed. If the session or transaction is pre-paid, the money is withdrawn from an e-wallet or pre-paid account. If the payment is online (through credit or debit cards), the user is guided through an online payment dialogue on the end-device. For online payments, this payment dialogue is treated before the start of the session or fulfillment of the service transaction.

**SEP network resource layer**

In order to execute its business logic, SEP has to be able to interact with the network. Therefore, SEP needs interaction interfaces with underlying application platforms such as the NGN platform, the video middleware platform, gateway management platforms (such as OSGi servers or gateway element managers), ASP platforms such as PC back-up systems, email ASP exchange systems (for example, Microsoft Exchange server and Ensym platform). These interaction interfaces are needed for the activation of services or service customisations, and for dynamic network changes needed within the scope of a session. Below are some examples for a number of application platforms:

- **The NGN system**: The SEP network resource layer (NRL) will provide and integrate an adaptor module allowing, through API invocation of the NGN softswitch application server, APIs actions such as the set-up of a multimedia call between two parties,
The network resource control platform device manager, for the user and identity the other core modules in SEP: APIs for the open interfaces and APIs that abstract all program service business logic against a set of billing, rate and price plans, services or service characteristics (such as generation of service logic, enabling as such an interoperability with other market players as content or service provider. For example, this will allow the distribution and billing of the content of these service providers. An example is the feature of service-based and temporary bandwidth increase in the upstream direction on the fast Internet access service. An OLO may demand this feature on its own customer portal with its own branding and boost profiles. Technically, this implies that the application server of the OLO will have to make an invocation on a B2B interface (a simple object application protocol (SOAP) web service) to invoke the dynamic behaviour.

Secondly, the open B2B interface framework can be exposed and offered to developer communities in Belgium that want to develop services for broadband users. Take the following example. Imagine a consumer electronics manufacturer that wants to collaborate with the operator to push software updates for its customers’ Internet hi-fi devices. As SEP platform provider, we could expose a web service which allows the vendor tracking the list of home platforms with the particular equipment, and downloading the software image in a secure and controlled way. This is just one example, but there are hundreds of similar imaginable partnerships that can be built, each generating a revenue stream through revenue sharing or raising commissions.

These open web-service-based B2B interfaces form the cornerstone of the paradigm ‘the operator as a enabling platform provider’.

The global integrated architecture—How will it be built?
Many operators have already a flexible platform in place for network service activation. Increasingly these OSS platforms are being built on open J2EE technology and are evolving along TeleManagement Forum (TMF) standards such as Electronic Telecom Operation Map (eTOM), and are being implemented along implementation principles such as for example Sun’s OSSJ initiative. If we compare the emerging activation platforms and the concepts of SEP, there are some important architectural synergies between both platforms:
- both platforms need access to the same network elements and application platforms;
- both systems will need a workflow and business processing layer;
- both will require an environment for real-time execution of service logic;
- SEP and the activation platform will both be built on a J2EE-based technology;
- for each, authentication, authorisation and single-sign-on features are needed for users of the platform;
- etc.

Hence, it is largely beneficial to exploit these synergies and thus it makes sense to think of an integrated component framework that acts as a development environment and toolbox for both platforms. This implies that the service platform and the OSS activation platform will become logical architectures on the same software framework and that OSS and SEP use cases are handled by the same type of software components (each platform however may have its own software components on dedicated hardware platforms). The advantages leveraged by this implementation strategy are manifold:
- significant lowering of the total cost of ownership for software platforms;
- consolidation of development skills;
- better negotiation power to vendors for component achievement and licensing costs; and
- overall a more strategic architecture which is excellently positioned towards the emerging convergence of management and operations processes on the one hand (the IT space) and service control and execution processes on the other hand (the CT space). Think of the following examples: changing DSL bandwidth is traditionally an OSS process but with services such as VoD and VoD, it becomes a matter of doing it in real-time within the scope of a service session; order-based activation will transform more and more into an instant fulfillment mode based on portal-based e-activation and self-subscription; setting up voice or NGN calls will become a ubiquitous feature integrated with communication tools such as Outlook, and available on web portals accessible from any device; etc.

The integrated development framework applicable for both OSS use cases and SEP use case will consist of the following layers:
- The network resource layer (NRL): As explained earlier, this is the software layer which interacts through adaptors with the e-payment module, for the underlying application servers, etc.

B2B interfaces
SEP disposes of a layer of open B2B interfaces that can be used by external third parties in order to develop their own software and services against SEP interfaces. These B2B interfaces export certain platform capabilities in web-services-based APIs. Of course, the strategy here is to open up the B2B interfaces at the right level, and to allow only strong authentication of the third party before any business method can be called.

Firstly, this B2B interface will allow interoperability with other market players as content or service provider. For example, this will allow the distribution and billing of the content of these service providers. An example is the feature of service-based and temporary bandwidth increase in the upstream direction on the fast Internet access service. An OLO may demand this feature on its own customer portal with its own branding and boost profiles. Technically, this implies that the application server of the OLO will have to make an invocation on a B2B interface (a simple object application protocol (SOAP) web service) to invoke the dynamic behaviour.

Secondly, the open B2B interface framework can be exposed and offered to developer communities in Belgium that want to develop services for broadband users. Take the following example. Imagine a consumer electronics manufacturer that wants to collaborate with the operator to push software updates for its customers’ Internet hi-fi devices. As SEP platform provider, we could expose a web service which allows the vendor tracking the list of home platforms with the particular equipment, and downloading the software image in a secure and controlled way. This is just one example, but there are hundreds of similar imaginable partnerships that can be built, each generating a revenue stream through revenue sharing or raising commissions.

These open web-service-based B2B interfaces form the cornerstone of the paradigm ‘the operator as a enabling platform provider’.

The global integrated architecture—How will it be built?
Many operators have already a flexible platform in place for network service activation. Increasingly these OSS platforms are being built on open J2EE technology and are evolving along TeleManagement Forum (TMF) standards such as Electronic Telecom Operation Map (eTOM), and are being implemented along implementation principles such as for example Sun’s OSSJ
network elements. The software components involved here allow for the rapid development and integration of an adaptor for a new type of equipment entering the network (because of off-the-shelf availability of programming APIs for many protocols and the ease to cope with device specific semantics).

- **The real-time execution layer**: At this layer, business logic can be quickly and easily developed on top of the device adaptor interfaces of the NRL. In addition, this logic can be executed in a real-time way on many parallel sessions. Real-time constraints can be configured. Typically, the business logic at this layer is written in or generated into C/C++ code. Note that the kind of logic executed here is heavily linked to the network resources and network elements and that the logic execution is treated as a kind of network transaction.

- **The non-real-time execution layer**: The non-real-time layer is built on a J2EE platform and executes business logic which is more process or workflow oriented. Stages of such a workflow may be implemented as a separate microflow on the real-time execution layer. Every stage or step in a process workflow may involve calls on multiple software entities such as EJBs, servlets, web services, and database APIs. In the Java world these process workflows are described in BPEL (Business Process Execution Language), an XML-based language for business and enterprise processes. Depending on the application, these process workflows comprise stages with manual interventions.

- **The component layer**: The component layer appears within the J2EE platform and virtually represents the different off-the-shelf Java-based software components that are deployed on the application server. Off-the-shelf components that will be present are the U&IDM, the DMM, a business rules processing engine and a workflow engine.

- **The presentation layer**: The SEP platform could offer a number of graphical user interfaces (GUIs) on itself in order to configure and manage the platform. In addition, it could offer a built-in customisable web portal allowing the creation of customer interaction pages (to bring online processes such as service subscription and service self-management). However, most importantly, the SEP platform will offer a layer of open web-service-based APIs allowing the further vertical integration into the operator’s BSS environment. Indeed, operators have already a BSS infrastructure in space to support in an online way processes such as service subscription, service self-management. Through the SEP APIs, a seamless integration with these existing systems can happen.

**Figure 3** Integrated architecture for OSS-SEP
query of EPG data, or reservation of a PPV session).

- **The persistency layer:** The persistency layer represents all the database systems which serve the above described layers. It comprises traditional SQL-based RDBMS systems as well as LDAP-based data directories (for example, for the U&IDM component). The power of the persistency layer is that it becomes possible to link crucial data in the services realm with more OSS-related data (for example, the link of home network and device level data in the device inventory with user data in the U&IDM LDAP tree and DSL line data in the DSL inventory). Aggregate data queries are possible through the DB-APIs for each of the layers and components in the system.

---

**Biography**

**Filip Vandermeulen**
Belgacom

Filip Vandermeulen graduated in 1996 as an electrical engineer from the Ghent University and then joined the Siemens Switching Labs where he optimised kernel software of the Hicom PBX family. Still in 1996 he joined the INTEC broadband communications research group of the University of Ghent in order to perform fundamental research in the area of next-generation network and service management platforms. In this context he jointly worked with Alcatel on a generic control and management platform for multi-party multimedia value-added services. This platform was life proven on the Belgian Inter-University broadband Atlantis test bed. After obtaining the Ph.D. degree in 2000, he joined Belgacom, the Belgian incumbent telecom operator. After having worked for a couple of years in the area of OSS assurance and fulfilment (specifically with the scope of DSL and IP-based data networks), he worked on new concepts for Belgacom in the area of tomorrow’s digital home and value-added service network. He currently leads the OSS architecture team of the Belgacom wireline department.