Nokia Siemens Networks Flexi Network Gateway

Prepare for Mobile Broadband Growth

Nokia Siemens Networks

Brochure

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1. Towards the flat all-IP Network

Internet usage is a global, constantly increasing phenomenon. Nokia Siemens Networks expects five billion people to be connected to the Internet by 2015. For mobile operators, this offers huge subscriber potential for mobile services.

With mobile broadband networks, advanced handheld and laptop integrated terminals and simple data subscriptions, mobile networks are becoming a serious alternative for fixed broadband access. Although mobile access bit rates remain lower than fixed bit rates, current mobile networks already deliver data speeds and service quality enabling convincing end user experience.

Operator revenues are not following at the rate of data traffic's phenomenal growth, which means operators seek more cost-efficient solutions to implement subscriber connectivity to Internet, operator services and corporate networks. Requirements include improved cost efficiency, simplicity and the ability to provide all services using a single networking technology.

The response to this demand is 3GPP R8 that introduces evolved UTRAN (UMTS Terrestrial Radio Access Network) radio technology, generally referred to as LTE (Long Term Evolution). Correspondingly, 3GPP R8 Evolved Packet Core (EPC) is specified to support all 3GPP and non-3GPP accesses and interworking between these types of access. The 3GPP R8 common core concept allows existing 2G and 3G access networks to use the same gateway as the LTE access network. LTE radio technology offers highly efficient use of the radio network frequency, which together with 3GPP R8 flat all-IP network architecture brings down OPEX (operating expenditure) for all services.

The development is towards a single IP-based networking technology that will be able to provide all services to subscribers, including the operator's primary voice service and other high-quality real-time and multimedia services. This sets new requirements for mobile network gateways; that is, the core element carrying all user data and services in 3GPP R8 architecture and providing access to content and service networks.

2. Preparing the Gateway for Mobile Broadband Era

2.1 Reduction of Cost per Bit for sustainable Profitability

Average revenue per user (ARPU) is not predicted to grow significantly in most markets in the coming years; it may even be declining in heavily contested markets. Operator revenue growth will thus build on expanding the subscriber base. In order to remain profitable, the price per transmitted bit has to be brought down.

The evolution towards a more cost-efficient network structure has already started by upgrading existing 2G and 3G GPRS networks to all-IP. 3GPP Release 7 takes this a step further by specifying Flat Architecture and Direct Tunnel that allows user plane traffic to be transmitted directly from the radio network to the GPRS Gateway Support Node (GGSN) to conserve the transmission network's resources. Operators who begin to evolve their network early will benefit from investments for a long time into the future as 3GPP R8 mandates both all-IP and Direct Tunnel.

2.2 Traffic Profile Evolution

The most commonly known change that LTE will introduce to the traffic profiles in mobile networks is the higher transmission speed. In addition to this, the flat network architectures, where NSN has demonstrated market leadership already in 3G with Direct Tunnel, will change the connectivity architecture of the EPC gateways. Intra-LTE and inter-system handovers will be directly visible to the gateways. This will increase the amount of signaling per subscriber.

When mobility management signaling is combined with additional signaling for AAA, offline & online charging and policy control, the overall processing requirements related to signaling will increase from 2G/3G substantially.

The subscriber density will also increase considerably due to LTE always-on connectivity that multiplies the signaling by the amount of attached subscribers. All these will impact the gateway and MME load profile. All three dimensions, throughput, signal and subscriber session density need to be taken account in the network design.

Higher transmission speeds resulting in increased demand for network capacity in conjunction with higher subscriber density and signaling traffic due to always-on bearers and flat network architectures is challenging operators more and more to stay in control of network resource usage.

Service intelligence is business critical, since it allows service and subscriber differentiation. It ensures end user experience while optimizing network usage and thereby helps operators to generate added value in a highly competitive market.

By integrating DPI (Deep Packet Inspection) into the gateway, Nokia Siemens Networks does not just provide a high capacity element – it is setting the foundation for Mobile Broadband with a solution that is extremely powerful and highly scalable at the same time.

2.3 Key Requirements for next-generation Mobile Gateways

Bandwidth-hungry Internet and multimedia services are driving bandwidth demand to tens of megabits per individual user. When operators introduce voice service in the packet-switched network, Voice over IP (VoIP) will increase the number of small packets, requiring even greater packet forwarding and processing capability to guarantee the voice quality commonly known and expected from circuit-switched networks. The mobile gateway, as the only user plane element, must be able to handle this increased load.

Flat network architecture sets increasing requirements for signaling performance in the gateway element. When 3GPP R7 Direct Tunnel is applied, user plane traffic is carried directly from the Radio Network Controllers (RNC) to the GGSN. Internet HSPA (I-HSPA) and LTE radio network architectures are even flatter as the RNC functionalities are merged with the base station and the RNC as a network element is removed from the mobility management architecture. Thus the gateway element is directly connected to all the base stations it serves.

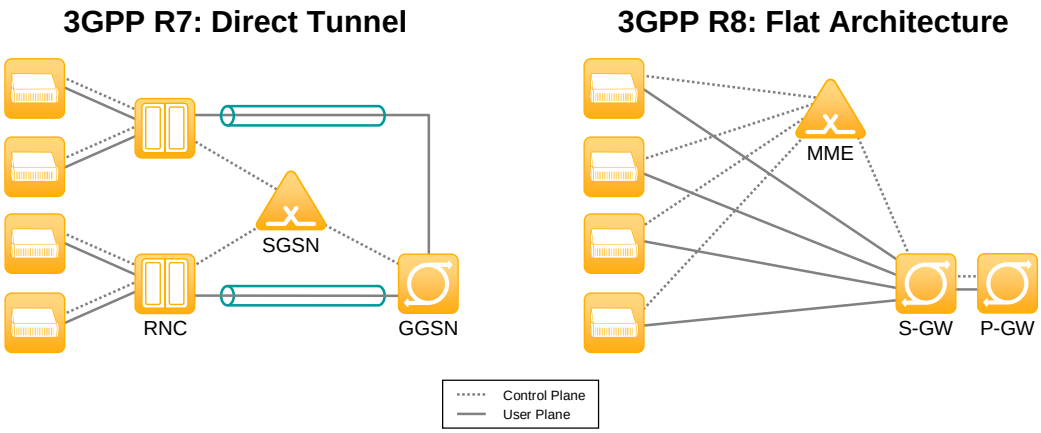

Figure 1: 3GPP R7 Direct Tunnel and R8 Flat Architecture

Scalability will be needed in multiple dimensions. Future network architecture requires flexibility for a centralized or distributed gateway deployment and capacity to support traffic growth and always-on bearers.

Packet-switched networks will need to fulfill the reliability requirements of circuit-switched networks over the longer term as VoIP emerges as a viable alternative for circuit-switched voice. The ultimate goal is to packet-switch all traffic, so even emergency calls have to be provided over VoIP.

Operators need to be able to manage the traffic in their networks to add value and manage their costs in offering connectivity to Internet and services. The importance of both static and dynamic policy control is increasing together with the increasing usage of real-time services. Flexi NG allows the operator to charge flexibly for different subscriptions and to enforce policies according to subscriptions. The trend in operator business models is towards simplified and easily understandable charging, similar to the models prevailing in fixed broadband networks.

Easy operability drives down OPEX. Flexi NG is a high capacity network element that allows the number of managed network elements in the network to be minimized. Well-designed and intuitive configuration management simplifies everyday operations. Connectivity breaks are minimized with robust redundancy mechanisms and in-service maintenance procedures and software upgrades (ISSU).

2.4 How to differentiate from the Competition?

The key question still remains for the operators: How do we differentiate ourselves from the competition? In early 2G networks, operators provided only their walled garden service portals and differentiated themselves from the competition with unique service offerings. However, only a few operators have been able to use the attractiveness of their service offering to compete against the Internet, where any company, community or individual can act as a content creator.

The differentiating factor in mobile broadband networks will be how end users experience service quality. Reliability and fair sharing of network resources are important factors for non-real-time services. When HSPA+, I-HSPA and LTE networks are launched, it is essential to guarantee interoperability with current networks.

When the operator migrates to packet-switched real-time services, especially VoIP, high service quality and the network's ability to offer differentiated treatment to traffic flows according to application needs becomes even more important.

3. Gateway Offering to meet Mobile Broadband Needs

Nokia Siemens Networks Flexi Network Gateway (Flexi NG) is a gateway element that can be deployed as a high capacity GGSN and – following the 3GPP R8 standard – as a Serving Gateway (S-GW) and/or Packet Data Network Gateway (P-GW). It is designed to serve 3GPP R8 network architecture that allows LTE and 2G/3G access networks to use the same core network nodes for optimized implementation of LTE subscriber mobility and service connectivity. In addition to connectivity, Flexi NG provides advanced traffic categorization / flow classification, policy enforcement, and service awareness capabilities.

All these functionalities are implemented on top of ATCA (Advanced Telecommunications Computing Architecture) blade hardware and Nokia Siemens Networks FlexiPlatform (operating system and middleware). They use common gateway functionalities for service authentication, routing and tunneling, policy charging control, security and lawful interception.

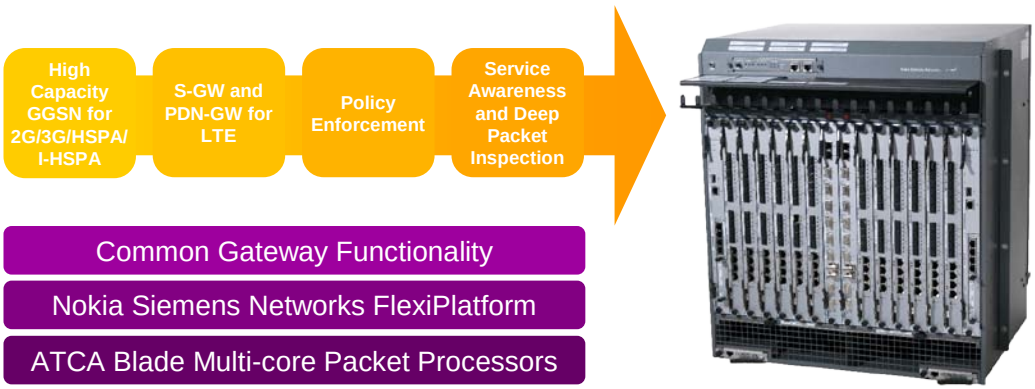

Figure 2: Flexi NG implements a common Gateway offering Service Connectivity for 3GPP and non-3GPP Accesses

3.1 Multiple Use Cases for a high capacity Mobile Gateway

Flexi NG implements a high capacity gateway for mobile networks. It aims primarily to serve HSPA, HSPA+, I-HSPA and LTE networks. For LTE subscribers, it provides inter-system mobility between LTE and 2G/3G access networks.

In addition to smartphones, mobile broadband networks will be accessed using laptop data cards, USB dongles for laptops and laptops with built-in mobile network access support. During LTE technology's introductory phase, it is likely that most access devices will be LTE modems for laptops. Availability of handheld LTE terminals will afford operators the opportunity to start migrating their voice service to an all-IP LTE network.

Flexi NG aims to support mobile broadband networks including 3G, HSPA, I-HSPA, and LTE accesses. It meets the high signaling capacity requirements set by LTE flat network architecture where all eNodeBs are directly visible to the gateway.

Flat architecture allows efficient use of network resources, with SGSN/MME concentrating in signaling traffic handling and the gateway connecting directly to the radio network in the user plane. Nokia Siemens Networks leads the industry in Direct Tunnel capability.

With mobile broadband, operators are simplifying their charging models. Mobile charging models for data are approaching fixed broadband charging models, where the maximum allowable access rate is the defining parameter. Flexi NG helps operators do profitable business with Internet access by allowing them to set fair usage limits for each subscriber. Offline charging solution is supported for postpaid subscribers' billing (bearer level volume or time). Online charging (or credit control) is available for both pre-paid and post-paid subscribers (and supports monitoring and controlling of bearer usage). In addition to flat-rate subscriptions, charging based on volume, time, and application or service is supported (differentiated charging). Charging can also be based on location and type of access network.

With LTE access mobile broadband services are extending to cover also operator primary voice and high quality multimedia services. The requirements of voice service are taken into account in Flexi NG that has high packet processing, signaling and subscriber capacities. As a high capacity mobile gateway Flexi NG is capable of accommodating the increasing traffic volumes from Internet and corporate intranet access.

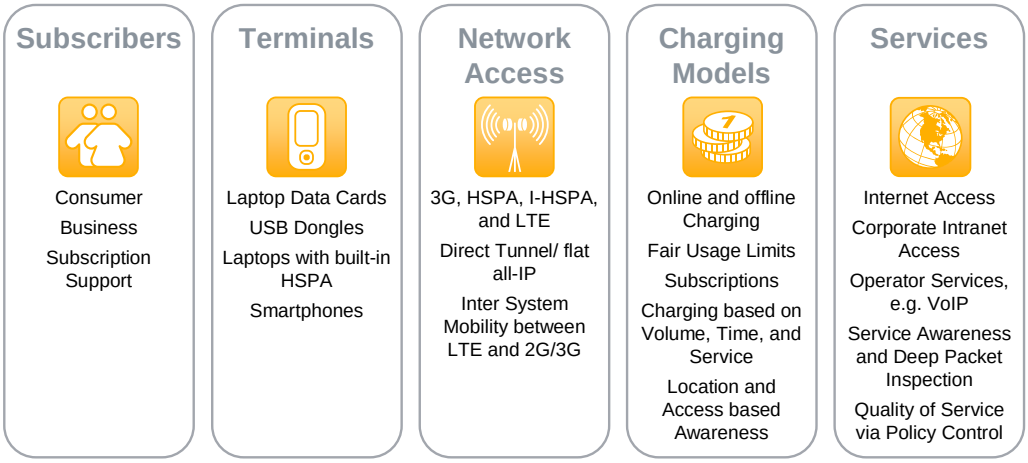

Figure 3: Flexi NG used as a high capacity Mobile Data Gateway

3.2 Flexi NG as S-GW and P-GW for LTE

In LTE networks, the network element corresponding to GGSN in GPRS networks consists of two functional entities, the Serving GW (S-GW) and Packet Data Network Gateway (P-GW). Flexi NG allows these functionalities to be deployed in a single element or in two separate network elements.

This separation offers network designers greater flexibility for:

- Subscriber mobility between S-GWs to serve geographically larger networks
- Different types of access to Internet, corporate, etc. using dedicated P-GWs

The S-GW provides a common user plane node for the 2G/3G access system and the LTE access system in common core architecture. In other words, the S-GW also serves LTE subscribers when coverage is limited to a 2G/3G network. When operators support roaming between LTE networks, the S-GW resides in the visited network and provides charging correlation, bearer level QoS and lawful interception.

The P-GW is a gateway towards the Internet, corporate intranets and operator services. It acts as a user plane anchor for mobility between 3GPP and non-3GPP access systems (Home Agent). P-GW performs policy and charging enforcement, packet filtering and lawful interception.

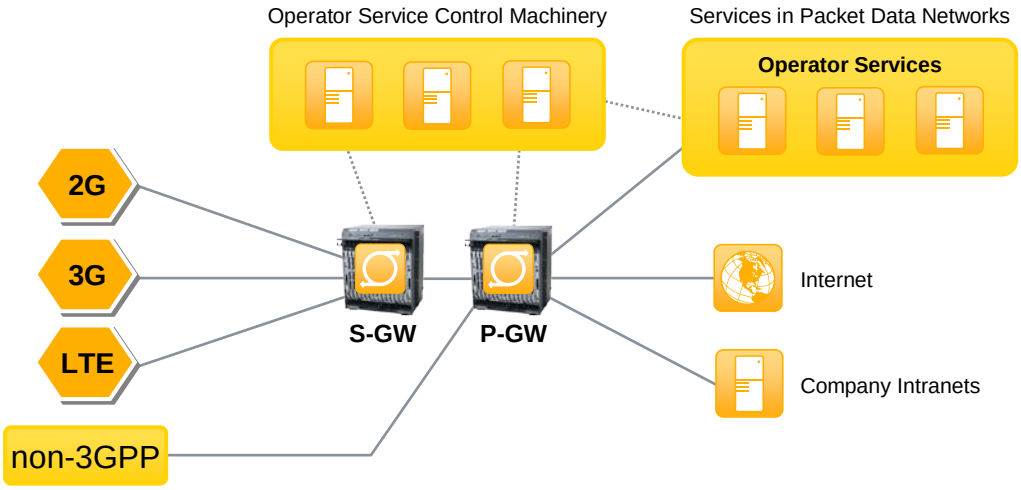

Figure 4: Flexi NG implements S-GW and P-GW Functionalities

3.3 Staying in Control of the Network Usage

Flexi NG supports service awareness on L4 based on IP 5tuple (source IP address and port number, destination IP address and port number and the protocol) directly within the Service Blades with no impact on dimensioning.

Deep Packet Inspection (DPI) is supported for L7+ analysis in own processor on dedicated Service Aware Blades (same hardware as Service Blade, without external interfaces, and with different software only). These flow classification methods include port and signature based methods. Generic signature methods can be used to differentiate mobile access to Internet and operator/partner services (e.g. MMS, e-mail, streaming). L7+ analysis includes heuristic analysis

that is typically applied to track proprietary protocols like peer to peer applications and services.

With service awareness and DPI capabilities Flexi NG is capable of differentiating service treatment within the same Access Point, for example the Internet access point. The operator may for example control the access to selected services and apply flow based charging to differentiate the tariffs for different services. Service Awareness and DPI also provide valuable information for service and network planning.

DPI can detect the majority of user traffic and protocols used in the Internet today (e.g. peer-to-peer communication). More than 600 protocols can be identified currently. Dynamic changes in applications and Internet protocols may require updates of DPI functionality, which can simply be enhanced by software independent of actual the Flexi NG software. End user connections are kept alive also during updates of DPI engine by help of ISSU (in-service software upgrade).

Policy enforcement is supported on 3GPP R8 compliant Gx and Gxc interfaces. It is based on Diameter Credit Control Application (DCCA). For PMIP based S5 interface between S-GW and P-GW, Gxc interface is supported between the S-GW and Policy Control and Charging Rules Function (PCRF).

With DPI and service aware policy enforcement the operator is able to make online changes to the traffic treatment policies. An example for data services is limiting excess usage by bandwidth limiting or even blocking certain bearers or services. For voice and multimedia services service aware policy enforcement can be applied to enforce real-time Quality of Service (QoS) and to ensure enough capacity on the transmission path. Dynamic QoS optimizes the use of network resources as real-time QoS can be allocated and capacity reservations can be made for preferred real-time services.

With its enhanced policy enforcement and charging capabilities, Flexi NG is able to help mobile operators to improve their end user’s quality of experience, to maximize own revenue opportunities, and to give better customer care. The various use cases supported by Flexi NG are: Fair Use Policy, Bill Shock Prevention, Subscriber Prioritization, Application Prioritization, Self Subscription, Location Policies & Charging, Device Policies & Charging, Time Policies & Charging, End User Notification, 3rd Party Service Support, DPI Reporting, DPI Protocol Updates, and Traffic Steering.

3.4 Flexible Hardware Design

Flexi NG is based on ATCA hardware that brings multiple benefits for the carrier environment. It provides the Telco-grade reliability and enables fast time to market with common off-the-shelf components. New technology updates like new shelf sizes, computing blades and interface options are available along with industry evolution, meaning that new technologies can be brought to market faster, and component lifetime in operation will be longer.

The key to Flexi NG’s performance is using multi-core packet processor (MPP) technology in the control plane and user plane. MPPs are designed for fast networking applications and contain several hardware units that accelerate packet data processing. MPP technology is highly flexible and scalable, and enables faster development cycles. It also allows scalable user and control plane handling within each Service Blade.

The ATCA platform deployed in Flexi NG provides high performance computing power which can be flexibly allocated for different purposes simply by software adaptations. This capability combined with the modular hardware structure offers customization possibilities to Flexi NG. Standard interfaces of the product enable operator or their partners to implement specific charging and network management solutions inside the node for instance.

Flexi NG utilizes the NSN FlexiPlatform, which provides a common operating system and middleware which is currently used in various NSN products.

3.5 Managing Flexi NG

Flexi NG provides up to twelve Service Blades for handling traffic in a single element. These blades are managed via central Management Blades using an intuitive user interface.

Flexi NG enables in-service maintenance and software upgrades (ISSU) to ensure high availability and session continuity for always-on connections.

In order to maximize system uptime, Flexi NG can be deployed in high availability redundant configurations, where gateway hardware malfunctions will also not impact end user sessions.

4. Flexi NG Benefits

Flexi NG is a best of breed mobile gateway. It is purposely designed for mobility support, high subscriber density and high throughput capacity. These are the three mandatory requirements for mobile broadband networks. Fail to scale in any in of these three dimensions leads to sub-optimal mobile broadband solution. Flexi NG provides a perfect balance of subscriber, signaling and throughput performance designed for HSPA, flat architecture and LTE.

Flexi NG provides integrated high capacity Deep Packet Inspection. Fully integrated solution enables easy deployment of DPI without affecting external network at all. Flexi NG deploys best of breed DPI software which can be scaled according to analysis needs without impact on gateway throughput. DPI scaling is invisible to external network elements outside the Flexi NG.

Flexi NG supports the operator in ensuring profit in the ever-changing business environment. It allows the operator to accommodate increasing mobile traffic and to provide a viable alternative to fixed broadband access. Flexi NG is designed as a best of breed mobile gateway that is capable of supporting high traffic volumes, subscriber densities and signaling loads. It drives down network cost per transmitted bit and supports a growing subscriber base that increases revenue.

Nokia Siemens Networks is a forerunner in flat architecture implementation allowing operators to bring down network costs as the traffic increases. Combined with high capacity elements, flat architecture drives down the number of elements in the networks and thus also the operator’s (OPEX).

Flexi Network Gateway is designed to serve as a common gateway for mobile broadband networks and support subscriber mobility even beyond the broadband coverage area. It can support high-volume traffic as well as high packet

processing loads from VoIP traffic and signaling requirements in flat network architecture. Optimized introduction timing of the new network element maximizes its lifetime in commercial use.

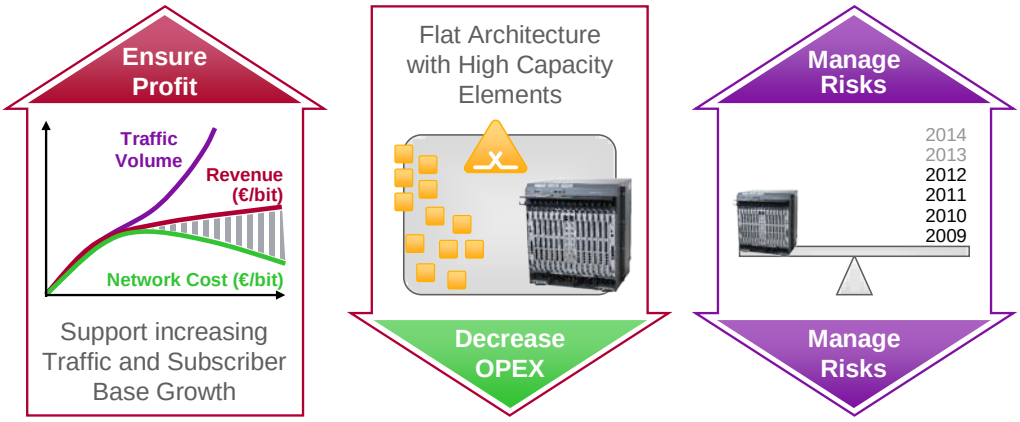

Figure 5: Benefits of Flexi NG from Nokia Siemens Networks

5. NSN as leading Packet Core Provider

With Flexi NG platform, Nokia Siemens Networks is leading in all key performance dimensions required for Mobile Broadband. It provides a scalable and flexible balance between signaling support for mobility, high subscriber density and throughput capacity, and service intelligence. Flexi NG provides technology leadership with 4D scaling.

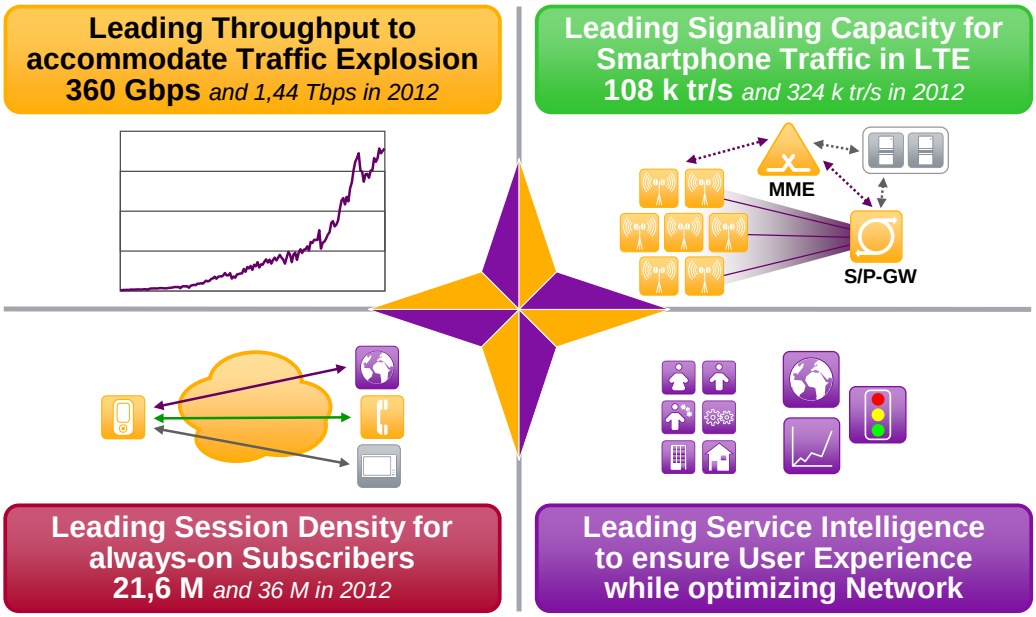

Figure 6: 4D Scaling makes the Flexi NG the most powerful Gateway in the Market

Nokia Siemens Networks has a proven track record in providing Packet Core solutions that already spans a decade. As of January 2011, we have over 280 Packet Core customers in over 110 countries serving over 750 Million mobile Internet subscribers. We currently count 45 customer references with new ATCA-based Flexi NG platform, which became available for pilots and first commercial deployments in August 2010. Six out of these customers went live with Flexi NG already.

Preparing for network migration towards eUTRAN and Evolved Packet Core (EPC), Nokia Siemens Networks is able to provide the most complete end-to-end solution in the industry. Nokia Siemens Networks cooperates closely with Nokia Terminals to ensure early interoperability for operator trials.

Flexi NG provides open interfaces to operator business support systems, e.g. subscription management and charging, and is thus easy to integrate with an operator's existing business management system.

6. Complete Solutions and Customization Projects

Nokia Siemens Networks takes a solution-driven approach to our system offering. This means that we provide pre-integrated and verified solutions to solve operators' technical and business challenges in their networks.

In addition to the off-the-shelf solution offering, our Services business division and its professionals offer tailored services from Network Implementation, Care, and Managed Services. Nokia Siemens Networks offers profound experience in all these areas.

Network Implementation includes the rollout and deployment services attached to new product installations, including project management. Care stretches from hardware and software support to software upgrades for legacy equipment, troubleshooting, repair and replacement services, and competence development. Managed Services includes traditional build-operate-transfer, application hosting services, a "Network on Demand" capacity service, and managed operations services including full network outsourcing.

Acronyms & Abbreviations

2G	2nd Generation of Mobile Telephone Systems (GSM)
3G	3rd Generation of Mobile Telephone Systems (UMTS)
3GPP	Third Generation Partnership Project
4D	4-dimensional
4G	4th Generation of Mobile Telephone Systems (LTE)
5tuple	source & destination IP address, protocol, source & destination port
AAA	Authorization, Authentication, Accounting
ARPU	Average Revenue Per User
ATCA	Advanced Telecommunications Computing Architecture
CDMA2000	Code Division Multiple Access (3G standard competing to WCDMA and mainly used in US and parts of Asia and Africa)
CDx	Change Delivery number x
DCCA	Diameter Credit Control Application
DPI	Deep Packet Inspection
eNodeB	Base Station in LTE
EPC	Evolved Packet Core
eUTRAN	Evolved UTRAN
Flexi NG	Flexi Network Gateway
Gbps	Gigabit per Second
GGSN	Gateway GPRS Support Node
GPRS	General Packet Radio System / Service
GW	Gateway
Gx	Interface between P-GW and PCRF
Gxc	Interface between S-GW and PCRF
HSPA	High Speed Packet Access
HSPA+	Evolved High Speed Packet Access
I-HSPA	Internet - High Speed Packet Access
IP	Internet Protocol
ISSU	In-service Software Upgrade
k	kilo
L4	Layer 4 = Transport Layer (OSI reference model)
L7	Layer 7 = Presentation Layer (OSI reference model)
LTE	Long Term Evolution (or 4G mobile networks)
M	Million
MME	Mobility Management Entity
MMS	Multi-media Message Service
MPP	Multi-core Packet Processor
NSN	Nokia Siemens Networks
OPEX	Operational Expenditure / Operating Expense
OSI	Open Systems Interconnection
PCRF	Policy and Charging Rules Function
P-GW	Packet Data Network Gateway
PMIP	Proxy Mobile IP
QoS	Quality of Service
RNC	Radio Network Controller (in 3G or UMTS)
Rx	Release x
S5	Interface between S-GW and P-GW
SAB	Service Aware Blade
SGSN	Serving GPRS Support Node
S-GW	Serving Gateway
Tbps	Terabit per Second
tr/s	transactions per second (signaling)
UMTS	Universal Mobile Telecommunication System (aka WCDMA)
USB	Universal Serial Bus

UTRAN	UMTS Terrestrial Radio Access Network
VoIP	Voice over IP
WCDMA	Wideband Code Division Multiple Access