

Nokia Siemens Networks Flexi Network Server

Ushering network control into the LTE era



1. Moving towards LTE

Rapidly increasing data volumes in mobile networks, pressure to reduce the cost per transmitted bit and the heavy competition in voice tariffs compel operators to make the most of their licensed radio spectrum. 3GPP Release 8 specifies Evolved Packet System (EPS) consisting of evolved UTRAN, commonly known as the Long Term Evolution (LTE) radio network, and Evolved Packet Core (EPC), also known as System Architecture Evolution (SAE).

3GPP R8 LTE/SAE introduces a high-data-rate, low-latency, all-IP system that supports multiple radio access technologies. The focus is on the packet-switched domain, assuming that packet-switched networks will also support operator-provided voice services in the future. LTE/SAE will provide an all-purpose mobile broadband network that can be applied to carry various bandwidth demanding and delay critical services cost efficiently. LTE/SAE supports subscriber mobility within the LTE radio network and handovers to existing 2G/3G and non-3GPP technologies.

LTE radio offers excellent spectral efficiency for both data and voice and it is designed for always-on use, which is necessary so subscribers are available for incoming calls. LTE radio technology more than doubles the number of calls that can be served per MHz compared to WCDMA circuit-switched voice.

The ultimate voice efficiency and the possibility to gradually migrate all operator services to a single packet switched all-IP network will drive down network operating expenditure (OPEX), justifying the required technology investments.

2. Architectural implications of the Evolved Packet System

3GPP R8 Evolved Packet System introduces flat network architecture where the evolved NodeB (eNodeB) connects directly with the core network nodes. The Mobility Management Entity (MME) assumes the role of the current 2G/3G SGSN and inherits more mobility management functionality from the Radio Network Controller that merges with the eNodeB. Flat radio network architecture deployed in 3GPP Release 8 strengthens the MME's role as a mobility management engine. It acts as a pure control element, taking care of the following key tasks:

- Subscriber authentication and authorization
- Control plane traffic handling and security functions
- Session and mobility management within the LTE radio network and between 2G/3G or CDMA and LTE radio networks

The GGSN equivalent in EPS is Serving Gateway and PDN Gateway (S/P-GW). The S/P-GW acts as a user plane gateway towards operator services and the Internet. It interfaces with policing and charging control systems and with 3GPP and non-3GPP radio networks.

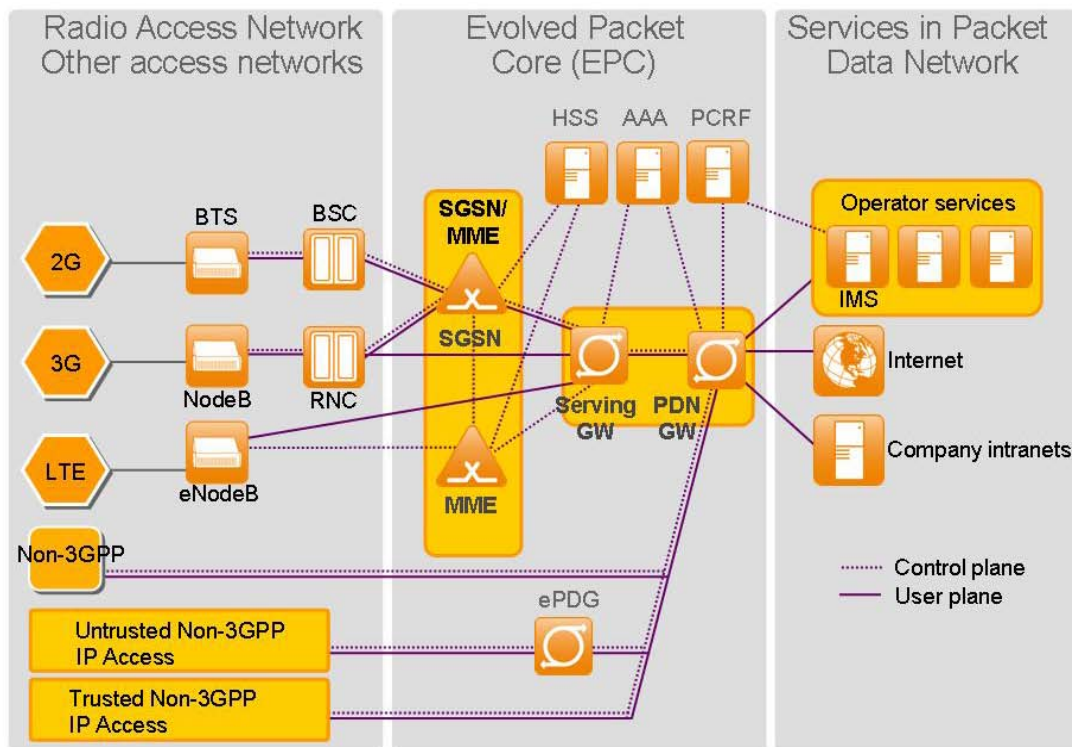


Figure 1: 3GPP Release 8, Evolved Packet System

3. Principal requirements for network control in LTE networks

The all-IP flat architecture introduced in 3GPP Release 8 poses new demands for network control elements. It specifies mandatory separation of user plane and control plane traffic that has already been introduced as a Direct Tunnel option in 3GPP Release 7.

3.1 Optimized for all-IP networking environments

From the control layer perspective, the networking environment in LTE networks differs fundamentally from that of the currently deployed 2G/3G networks. Legacy Frame Relay, ATM and E1/T1 interfaces are still widely deployed in 2G/3G GPRS networks even though IP-based interface variants are also offered towards the radio network and core network elements.

New generation network control elements are targeted for an optimized all-IP environment. All-IP introduces a major network simplification, which is also reflected in the opportunity to simplify product design and hardware.

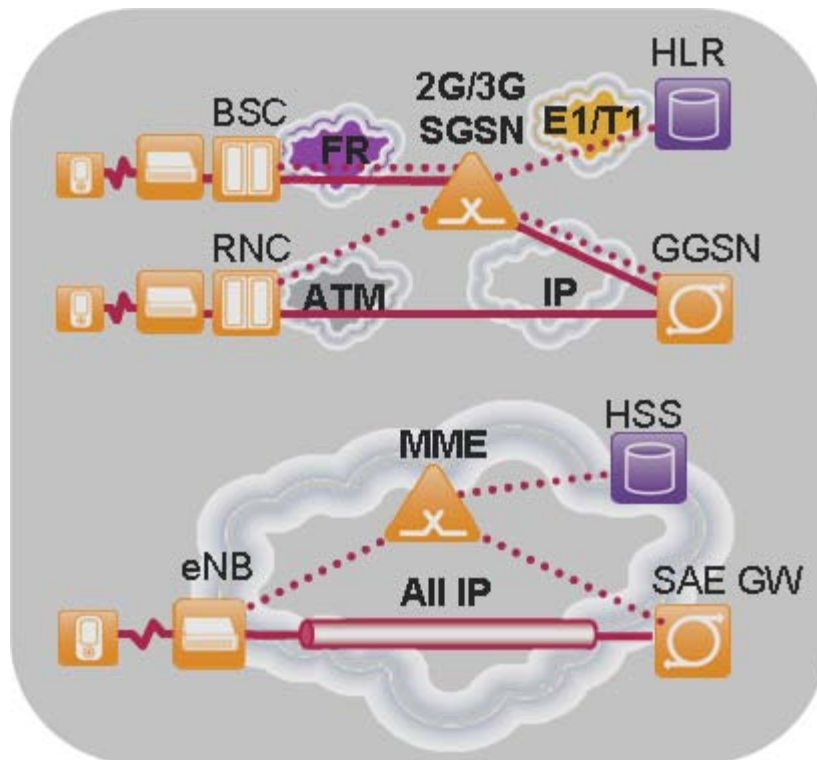


Figure 2: 2G/3G SGSN and LTE/SAE MME are designed for different network environments

3.2 Dedicated control plane element

The MME is devoted to serving control plane traffic, whereas in 2G/3G the SGSN also traditionally handles user plane traffic. In 2G GPRS, the SGSN also ciphers and compresses Gb interface traffic, which sets two-fold requirements to the node implementation. With a clear separation of control and user planes in separate physical elements, the MME may be optimized and scaled solely based on the control plane needs.

3.3 Adapted to flat architecture

LTE architecture is flat, meaning that the eNodeBs connect directly to the core network without an aggregating Radio Network Controller (RNC) layer. Therefore the MME must support higher connectivity in terms of a large number of eNodeBs. When active mode subscribers are moving in the network this is visible to MME, requiring more mobility transaction capacity from the element compared to current 2G/3G GPRS networks.

3.4 Able to support all services

As an all-IP technology, LTE is designed to carry all services including broadband data, various multimedia services and operator-provided Voice over IP (VoIP). EPS is optimized for carrying large traffic volumes as there are only two elements on the user plane data path: the eNodeB and S/P-GW. It is likely that in most operator networks the S-GW and P-GW functions will be provided in a single physical node.

Operator VoIP sets new requirements to the packet core network. From the MME perspective, this means that whenever the user is receiving a voice call, the MME has to activate the bearer by paging the subscriber. During the voice call, the network must support seamless mobility between different eNodeBs and handovers from LTE to 2G/3G or CDMA networks. This again makes the MME a more transaction-oriented element compared to the SGSN.

LTE/SAE as such does not bring new services but a more cost efficient way to offer the existing and new services.

3.5 Interoperability with existing 2G/3G networks

In EPC introductory phase, the preferred approach is to deploy EPC as an overlay solution. In this way, the existing production network remains untouched when the new technology is introduced.

3GPP R8 defines interworking with existing 2G/3G networks. Subscriber sessions can be handed over from LTE network to 2G/3G network when the subscriber moves outside of LTE radio network coverage area and vice versa. Initially these handovers can be supported transparently to the existing 2G/3G network using existing Gn interface from the SGSN and GGSN. Later on the SGSN can be upgraded to R8 level to provide the S3 and S4 interfaces towards MME and S-GW.

4. Nokia Siemens Networks Flexi Network Server

Nokia Siemens Networks introduces MME functionality with the Flexi Network Server (Flexi NS). Flexi NS is designed to serve as a pure control plane element for flat all-IP networks. It builds on AdvancedTCA (ATCA) hardware that allows utilizing common off-the-shelf HW components to rapidly introduce latest HW technology advances to the product.

4.1 Nokia Siemens Networks, a forerunner in Direct Tunnel implementation

As the first vendor in the industry, Nokia Siemens Networks has already implemented Direct Tunnel functionality in our SGSN according to 3GPP Release 7 specifications. Deploying Direct Tunnel in existing GPRS networks, the operator can start migrating the network towards 3GPP Release 8 LTE/SAE architecture.

Our early Direct Tunnel implementation, over 105 Direct Tunnel deployments, and more than 65 Direct Tunnel networks in commercial operation (as of December 2010) have allowed us to gather valuable live experience that has been directly re-used in developing MME.

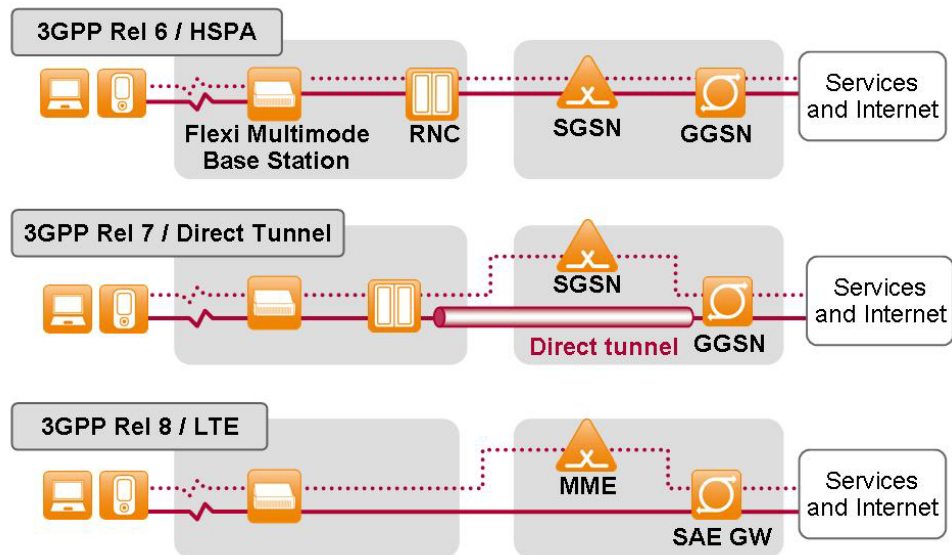


Figure 3: Network evolution towards flat architecture

4.2 Flexible AdvancedTCA hardware platform

Flexi NS is based on Nokia Siemens Networks AdvancedTCA (ATCA) hardware. ATCA is designed to provide telecom-grade reliability. It provides fast time to market with common off-the-shelf components. New technology updates like 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.

4.3 Flexi Network Server architecture

Flexi NS design is based on the field-proven Nokia Siemens Networks Combined SGSN architecture in which both the hardware and software are based on a modular, distributed structure. Flexi NS architecture allows 2G/3G SGSN functionalities to be added to the product later on as SW upgrade.

The MME and SGSN functions share a common subscriber database and have transaction/mobility handling and operations and maintenance capabilities in common. The distributed SW architecture makes product configurations flexible and easy to extend. The standard configuration steps consist of common blades and an appropriate number of capacity extensions constructed from different functional blades. The key functional units of the Flexi NS are:

- Control Plane Processing Unit (CPPU): Transaction-based mobility management and S1-MME, S11, S3/Gn and S10 interfaces
- Mobility Management and DatabaseUnit (MMDU): stores visiting subscriber information into the visiting subscriber database. It also controls the EPS mobility management and EPS system management level functions for LTE subscribers
- IP Director Unit (IPDU): Loadbalancing and connectivity
- Marker and Charging Unit (MCHU): Offers statistics functions
- Operation and Maintenance Unit (OMU)

Due to new control plane-only architecture, it is possible to implement session redundancy within a single Flexi NS network element. In case of failure of any single hardware unit, the subscriber session can be preserved. Flexi NS architecture also allows a minimum IP addresses to be used for a multi-blade node.

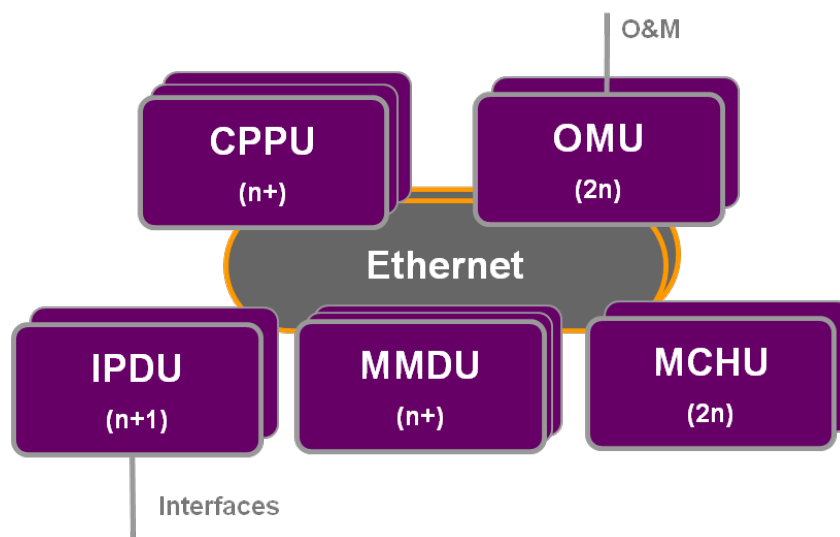


Figure 4: Flexi NS architecture

4.4 MME design highlights

Our strong track record in Direct Tunnel implementation ensures us a premium position in LTE/SAE flat architecture implementation. Nokia invented and also initiated Direct Tunnel standardization in 3GPP. We also were the major contributor to Direct Tunnel standardization, which has provided us with in-depth understanding of this major architecture update in mobile packet core networks.

Flexi NS provides market leading transaction capacity, which is a prerequisite for serving a large subscriber base with an optimal number of network nodes. This is achieved with innovative HW and SW architectures that are optimized for flat architecture. Transaction capabilities are needed, for example, to set up and maintain sessions and support subscriber mobility.

Flexi NS has high subscriber (10M subscribers) and session (30M bearers) capacities to accommodate the increasing number of subscribers and sessions in the network. The ultimate target of LTE technology is to support operator-provided voice services. To manage in this role, MME has to have extensive subscriber management capabilities.

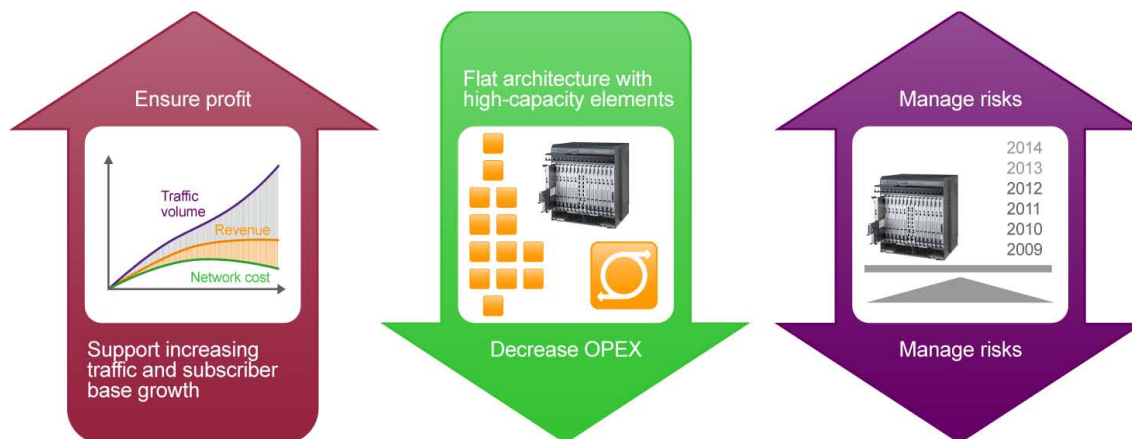


Figure 5: Flexi NS benefits

4.5 Flexi Network Server benefits

The Nokia Siemens Networks SGSN has demonstrated market-leading reliability levels in live networks over several years. The same operating software platform is applied also as a base for the Flexi NS.

With the experience from over 180 implementations of combined 2G/3G SGSN in operators' live networks, Nokia Siemens Networks has solid experience in implementing network control and solving potential technical challenges in multivendor network environments and with diverse terminal behavioural patterns.

Flexi NS implements high transaction and connectivity capacity to accommodate the increased signalling load and higher service penetration in operators' subscriber base. The product's footprint is small, allowing up to three high-capacity units to be installed in a standard 23" rack. Flexi NS is power-efficient, offering savings in energy consumption.

5. Why Nokia Siemens Networks?

Nokia Siemens Networks has a proven track record already spanning a decade in providing packet core solutions. As of December 2010, we have over 280 packet core commercial references.

Preparing for network migration towards E-UTRAN and EPC, Nokia Siemens Networks is able to provide the most complete end-to-end solution in the industry. Nokia Siemens Networks works closely with all main terminal vendors to ensure early interoperability for operator trials.

Nokia Siemens Networks takes a solution-driven approach to our system offering. This means we provide pre-integrated and verified solutions to solve operators' technical and business challenges in their networks. In addition to the offering of off-the-shelf solutions, our services division offers tailored services from network planning to hosting. We have solid experience in complex network implementation projects and currently boast 500+ references for customer implementations.

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