Performance Analysis of Internet High Speed Packet Access

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Agenda

- Background
- Objective
- GPRS Core Network Overview
- 3GPP Network Evolution
- Introduction to I-HSPA
- I-HSPA impact on core network Elements
- Conclusion

Background

- New broadband technology and intelligent services are being launched by the operators. So the operators has to invest for the increase of additional resources and cost to support today's growing data consumption and better data services.
- To achieve a system beyond third generation for the growing, faster and cheaper data services, 3GPP has launched the project called Long Term Evolution(LTE)/Service Architecture Evolution(SAE).
- Nokia/Nokia Siemens Networks has introduced Internet High Speed Packet Access (I-HSPA) as an interim solution and as a pre step for 3GPP LTE/SAE.
- I-HSPA will support Direct Tunnel or One tunnel solution of 3GPP. But its flat architecture will move the RNC functionality to the Base Station/NodeB.
- I-HSPA will support all services via PS domain, no CS domain support. But it will not impact on legacy devices or services.

Objective

- Introduction of the new proposed architecture of 3GPP to support LTE/SAE.
- Background of the GPRS Network architecture and Nokia/NSN Flexi Intelligent Service Node (Flexi ISN)
- Introduction of the NSN I-HSPA solution.
- Analyse the effect of I-HSPA to the Flexi ISN that includes

  - Control Plane signaling effect

  - User plane signaling effect
- I-HSPA effect on other related network elements like SGSN, Charging Gateway and Authentication, Accounting and Authorization server.
- This thesis will cover only GTP based mobility which is GPRS specific, multiaccess based mobility will not be covered.

GPRS Core Network Overview (1/3)

Introduction

- GPRS is a service that provides packet radio access for GSM users
- It brings few network elements to GSM network that are Serving GPRS Support Node (SGSN), Gateway GPRS Support Node (GGSN), Charging Gateway Function (CGF)
- Signaling exchange and data transfer between SGSNs, and an SGSN and a GGSN is based on GPRS Tunneling Protocol (GTP)
- Gn interface connects the SGSN and GGSN and supports both GTP-C and GTP-U tunnel.
- Gi interface connects GGSN and Public network.
- Flexi Intelligent Service Node is the GGSN by Nokia Siemens Network. It has multiple interface blades and service blades to provide high availability, scalability and load balancing.
- It functions like GGSN with some intelligence like, it can handle data traffic of different OSI layer and analyze them.

GPRS Core Network Overview (2/3)

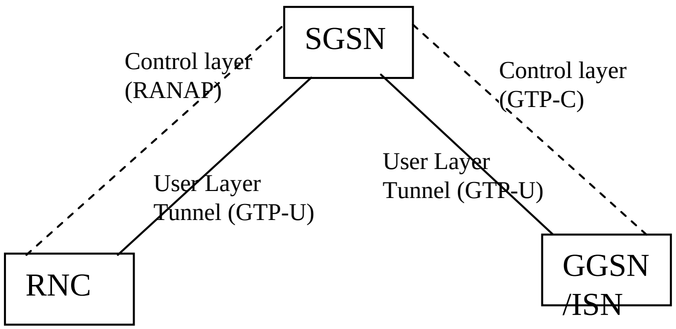
Terminologies:

- **PDP context**: PDP context is a set of information stored in MS and GSN nodes. A subscriber needs to activate the PDP context to send and receive data through GPRS network. PDP context can be activated, updated deactivated.
- **Access Point**: It is the connection point between terminals and Packet Data network. PDP context carries the access point information related to different services
- **GTP:** GPRS tunneling protocol (GTP) is a GPRS-specific IP based protocol designed to tunnel user data and signaling between GPRS support nodes (GSNs) in the GPRS backbone network. The GTP consists of control plane signaling protocol GTP-C and user-plane tunneling protocol GTP-U.
- **HA:** ISN has several interface blades and service blades that handle signaling and traffic. They provide high availability, scalability and load balancing. Gn/Gp interface is used for GTP traffic

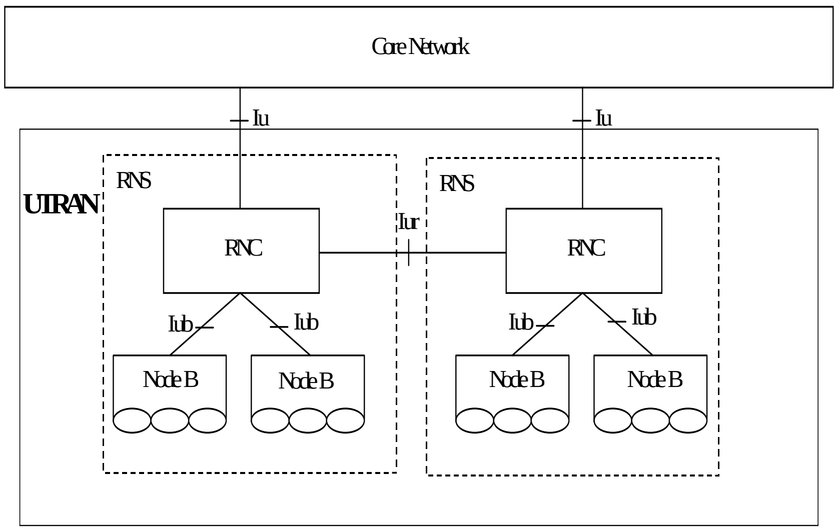
GPRS Core Network Overview (3/3)

GTP tunnel Architecture:

- Control plane signaling GTP-C is implemented only by SGSN and ISN. It is used for GTP tunnel setup like to create, modify and delete tunnels. GTP-C is related to Mobility Management functions like GPRS attach, PDP context activation, Routing area update.
- GTP-U is a user plane protocol and is implemented by SGSNs and ISNs in UMTS/GPRS backbone and by Radio Network Controller in the UTRAN to carry user data.
- GTP’ is the protocol to carry charging data from charging gateway.



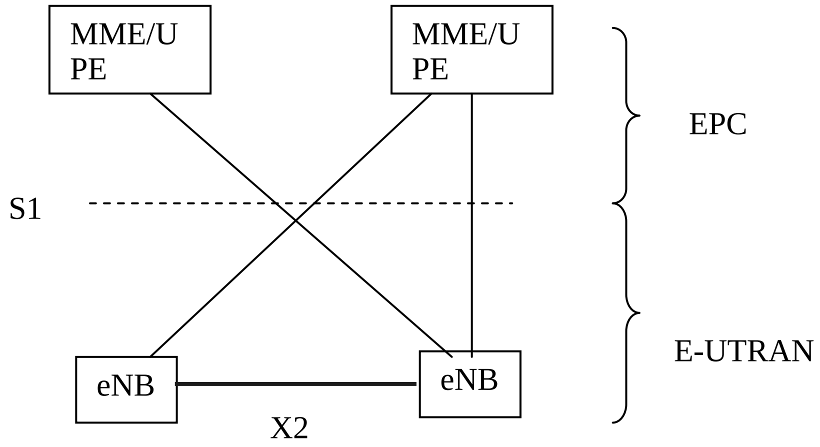
3GPP Network Evolution (1/7)



UTRAN Architecture (Rel 6):

- Radio network is connected to the core network through Iu interface.
- NodeB and RNC are separate network elements connected through Iub interface
- Radio network subsystem is connected via Iur interface to support Handover signaling to the UE.
- No direct interface between NodeBs

3GPP Network Evolution (2/7)
(LTE/SAE Architecture)



Objective:

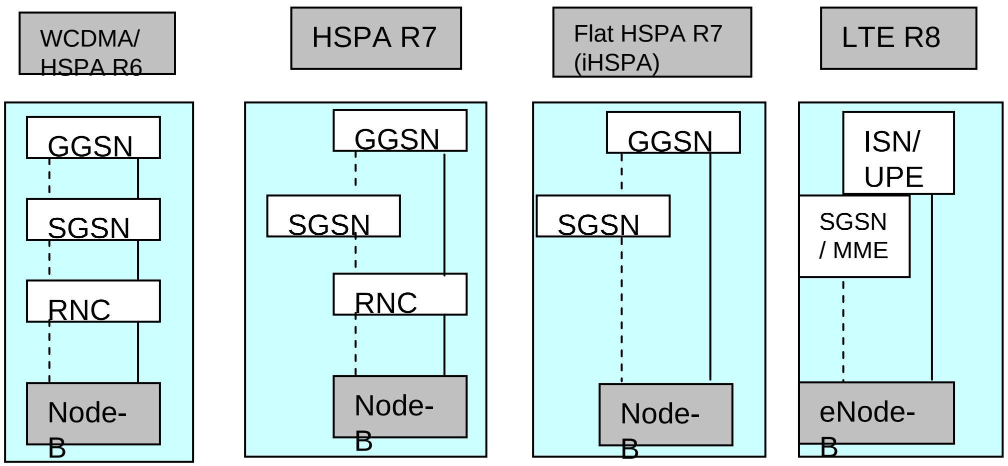
- Support higher data rate with HSDPA/HSUPA to comply with new air interface
- Support high quality of services with reduced control plane latency and reduced round trip delay.
- Flexibility to use old and new frequency bands

Architecture

- Evolved Packet Core consists of Mobility Management Entity/User Plane Entity
- Evolved UTRAN having new eNB
- eNBs are connected to each other via X2 interface which is not present in 3GPP rel6 architecture
- Each eNBs are connected to MME/UPE via S1 interface.

3GPP Network Evolution (3/7)

(3GPP SAE Evolution)



Objective:

- To simplify Network Architecture to support high throughput,
- Low latency with mobility in heterogenous network

Architecture

- Control plane and user plane signaling passes through all the elements (RNC,SGSN,GGSN) in Release 6
- HSPA R7 specifies direct tunneling user plane solution between RNC and GGSN
- NSN Flat I-HSPA introduces flat architecture solution without the presence of seperate RNC in network, but the RNC functionalities are integrated in NodeB. Direct GTP-C signaling between NodeB to SGSN and GTP-U between NodeB and GGSN

3GPP Network Evolution (4/7)

Direct Tunnel in 3GPP

- Direct Tunnel is the first step to LTE/SAE
- It introduces LTE where RRM and GTP links to BTS and BTS-BTS interface was introduced. Previously RRM and GTP was handled by RNC.
- ISN can be upgraded to support UPE and 3GPP Anchor and SGSN to MME

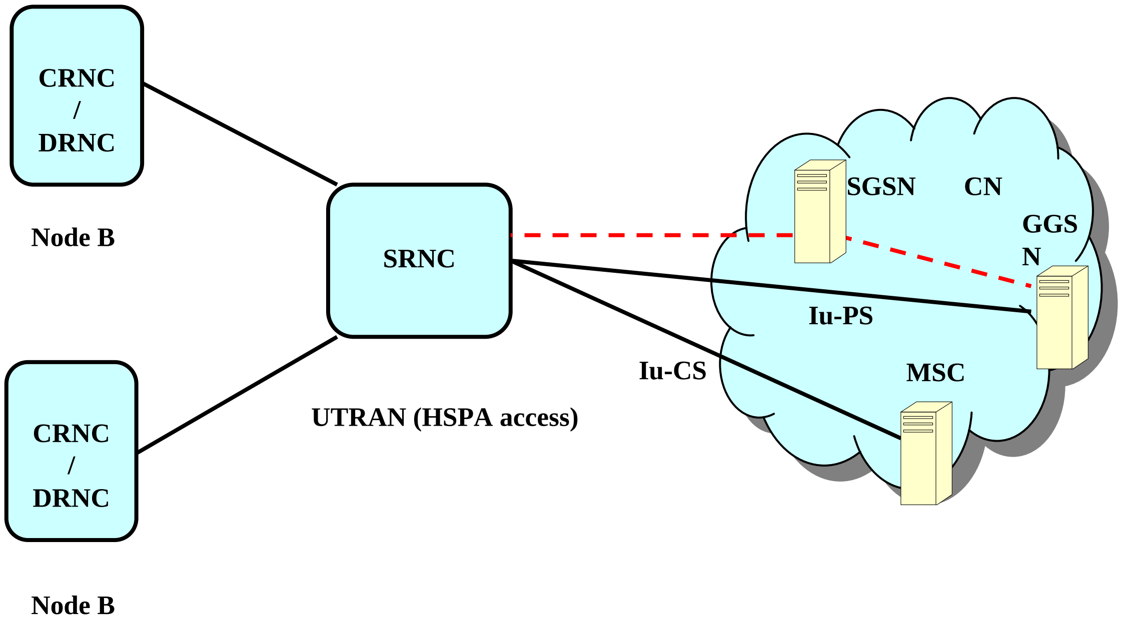
Evolved HSPA Proposal at 3GPP

- Direct tunnel with retained RNC
- Direct tunnel with RNC Control plane
- Direct Tunnel with Collapsed RNC

3GPP Network Evolution (5/7)

Direct tunnel with retained RNC

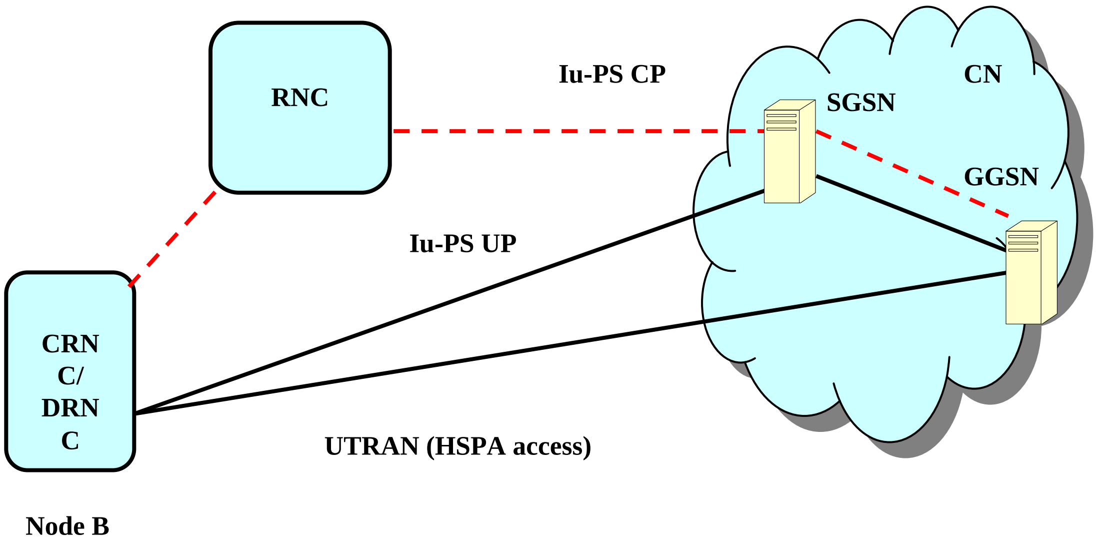
- CRNC and DRNC functionality has moved to NodeB and user plane establishes from SRNC to GGSN to support direct tunnel.



3GPP Network Evolution (6/7)

Direct tunnel with RNC Control plane

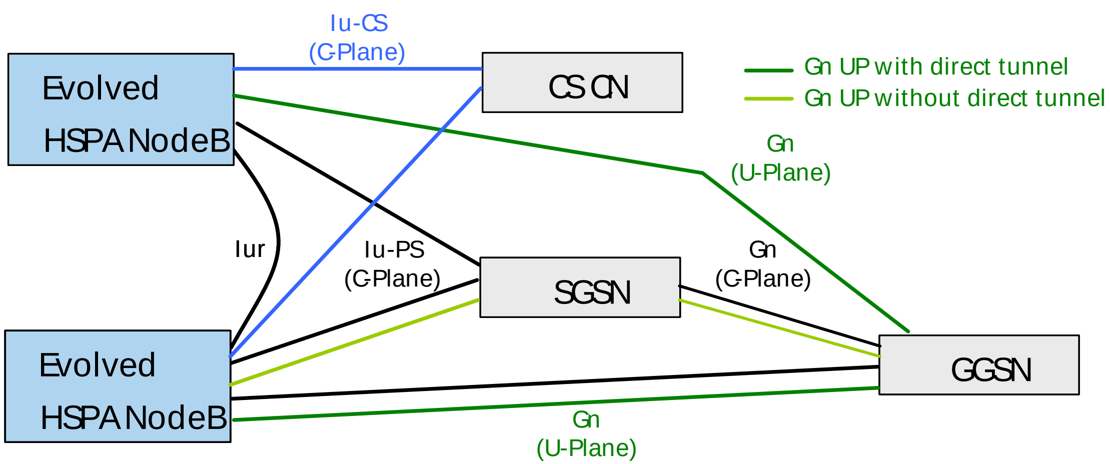
- User plane and control plane functions in seperate nodes and the user plane path has terminated at NodeB(at CRNC/DRNC)



3GPP Network Evolution (7/7)

Direct Tunnel with Collapsed RNC

- Known as evolved HSPA in 3GPP where RNC functionality has moved to NodeB. This is same as Internet-HSPA architecture.



Introduction of I-HSPA(1/3)

Need for Mobile Broadband

- New end-user devices encouraging data usage
- Flat-fee based subscriptions
- Bandwidth hungry applications primarily from internet

I-HSPA provides a cost optimised way to offer Broadband access

- Utilises 3GPP HSPA air interface supporting without changing terminals from Release 5. So it will support multivendor elements and operation.
- RNC functionality integrated to Node-B to optimize the cost
- 50% capex savings with flat RAN and flat PaCo, significant opex savings with IP/Ethernet based transport and less elements.

Need for I-HSPA optimised Core

- Direct user plane tunnel between the Flexi ISN and Node-B
- Connectivity and Signalling enhancements in core elements

Introduction of I-HSPA(2/3)

I-HSPA core Solution Description

Direct tunnel

- SGSN creates direct GTP-U tunnel between the Flexi ISN and the RAN for the user plane
- Both RAN and Flexi ISN "believe" that they are connected to SGSN

SGSN Functional enhancements

- Support for 4095 I-HSPA BTSs, 1000 RNCs to be supported
- Improved serving RNC relocation procedure processing capability to support direct tunnel establishment before RAB establishment.

ISN Functional enhancement

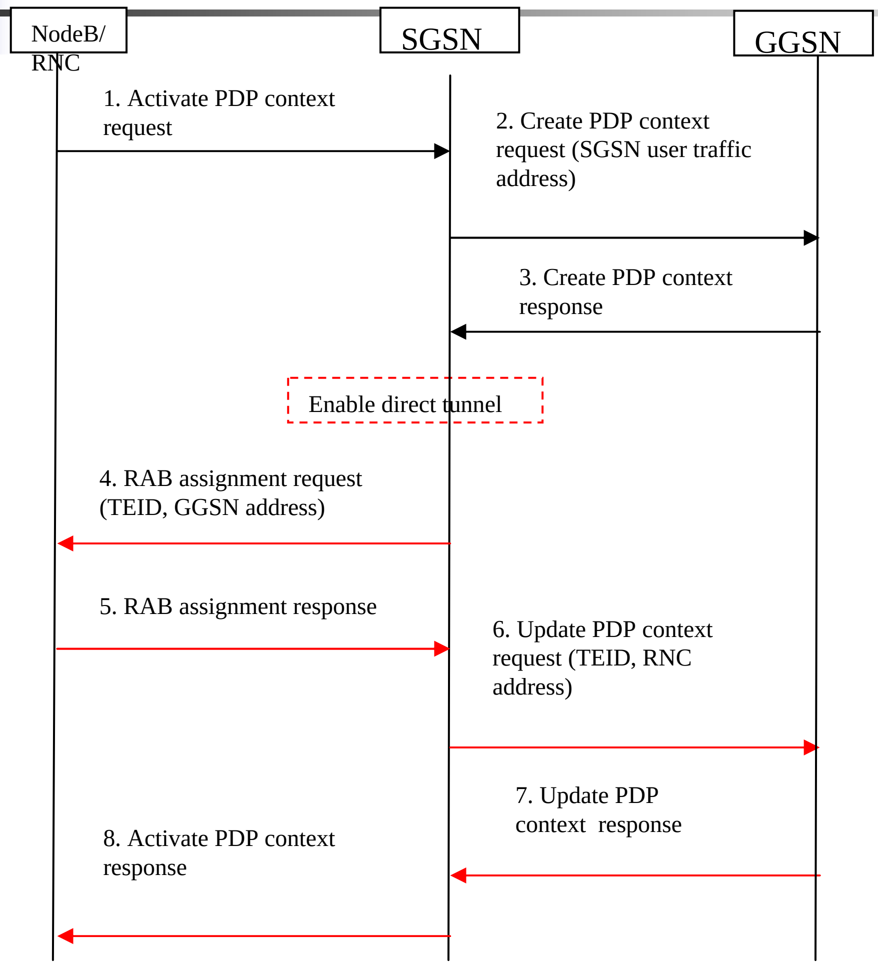
- There is no functional change in ISN
- Control plane signaling load increased that doesn't effect ISN so much

Introduction of I-HSPA (3/3)

Cost Optimized high performance Nokia HSPA solution

- The cost and impact is minimum in existing sites because all the existing HW will be reused. Only BTS needs to be upgraded by installing a compact I-HSPA adapter.
- It is tested that it will support the existing GGSN of other vendors. It also supports other vendor's SGSN, but the capacity and the connectivity needs to be considered. Nokia Siemens Networks SGSN with direct tunnel feature support will bypass user plane.
- This technology can be upgraded smoothly to LTE in future with a simple software. Then BTS, SGSN and GGSN can be upgraded to LTE BTS, MME and SAE GW

I-HSPA impact on core network elements (1/9)



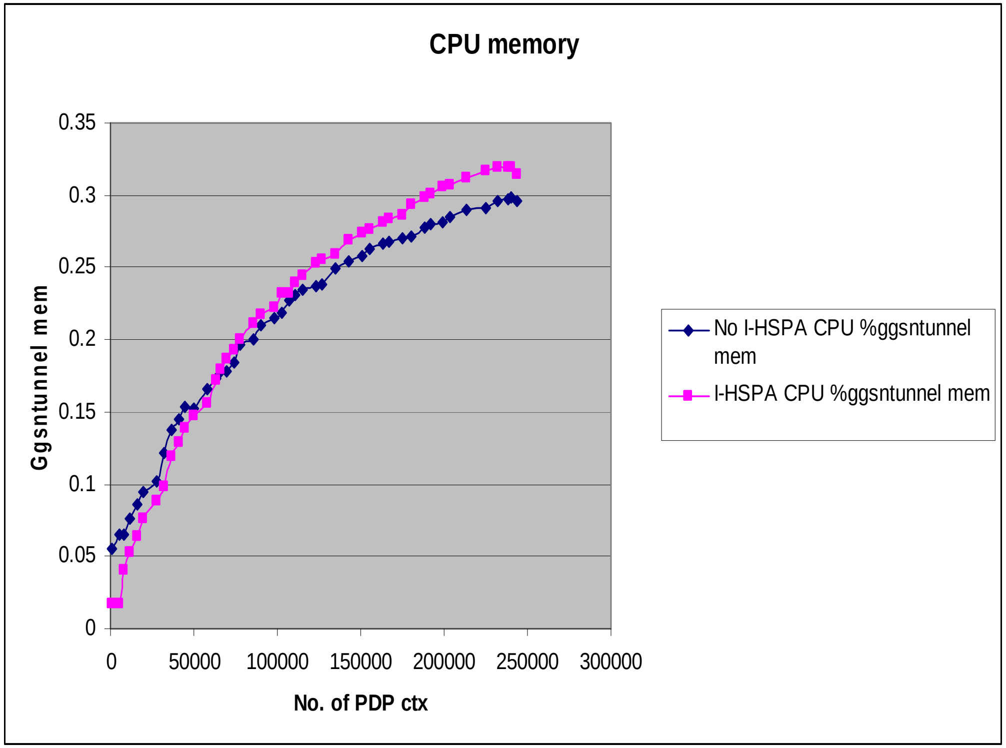
- There is extra 'Update PDP context request' message for tunnel establishment.
- This appears for each PDP context Request and Response message when SGSN notices that there is possibility to create one tunnel between SGSN ad RNC.
- This appears also for each RA update where RAB assignment will create extra PDP update message.

I-HSPA impact on core network elements (2/9)

- The CPU and memory usage increases with the increase of PDP contexts when I-HSPA is used. CPU memory also increases when I-HSPA is not used.
- It can be seen that the use of I-HSPA puts more CPU load compared to when I-HSPA was not used. Because when I-HSPA was used, each PDP contexts creates one direct tunnel and also it includes PDP update message. So the increasing number of ggsntunnel also increases CPU load.

I-HSPA impact on core network elements (3/9)

Signaling load increases During pdp context creation

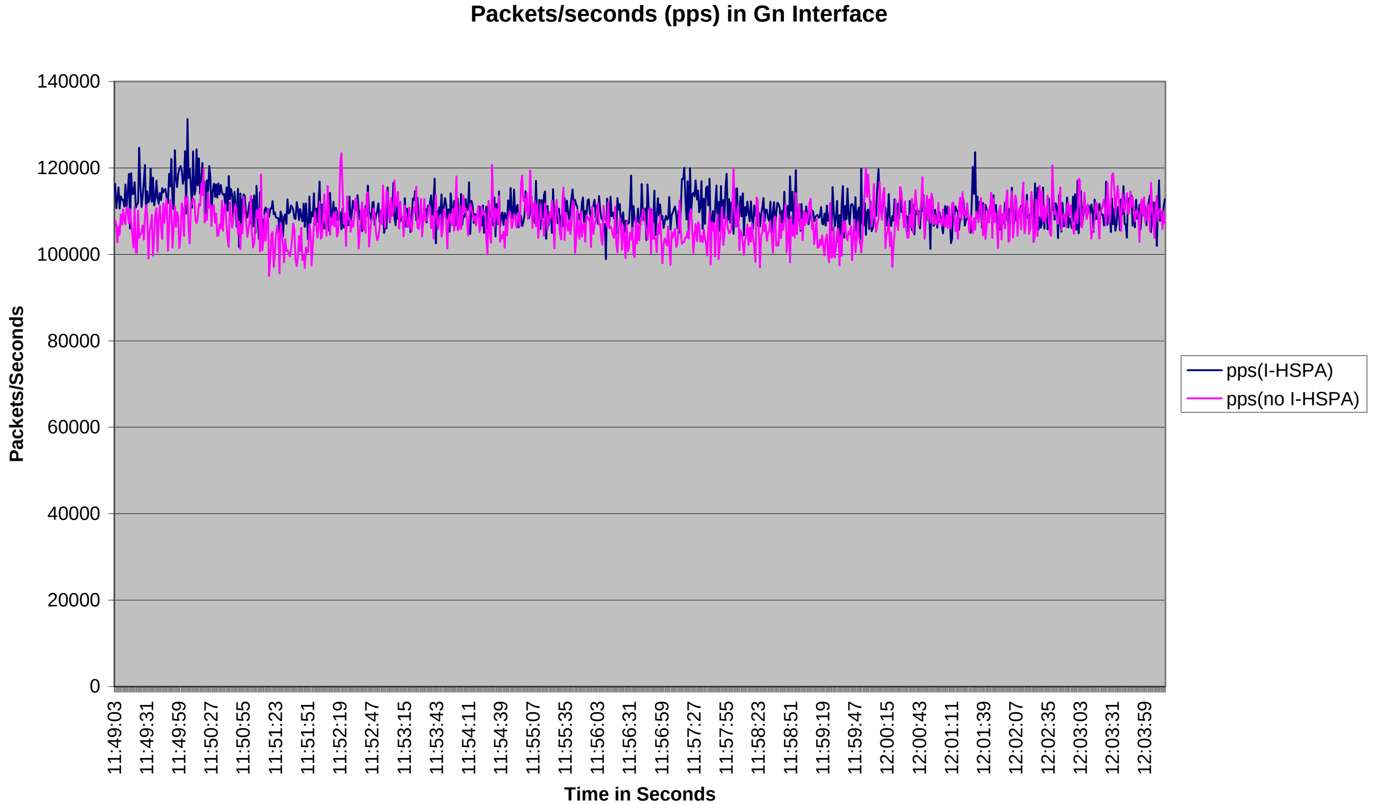


I-HSPA impact on core network elements (4/9)

- This packet sent per second is quite similar in both architectures and was measured from Gn side.
- So the use of I-HSPA in the network did not affect the ISN performance.

I-HSPA impact on core network elements (5/9)

Traffic signaling did not increase when about 110000 Packets were send in 1 second



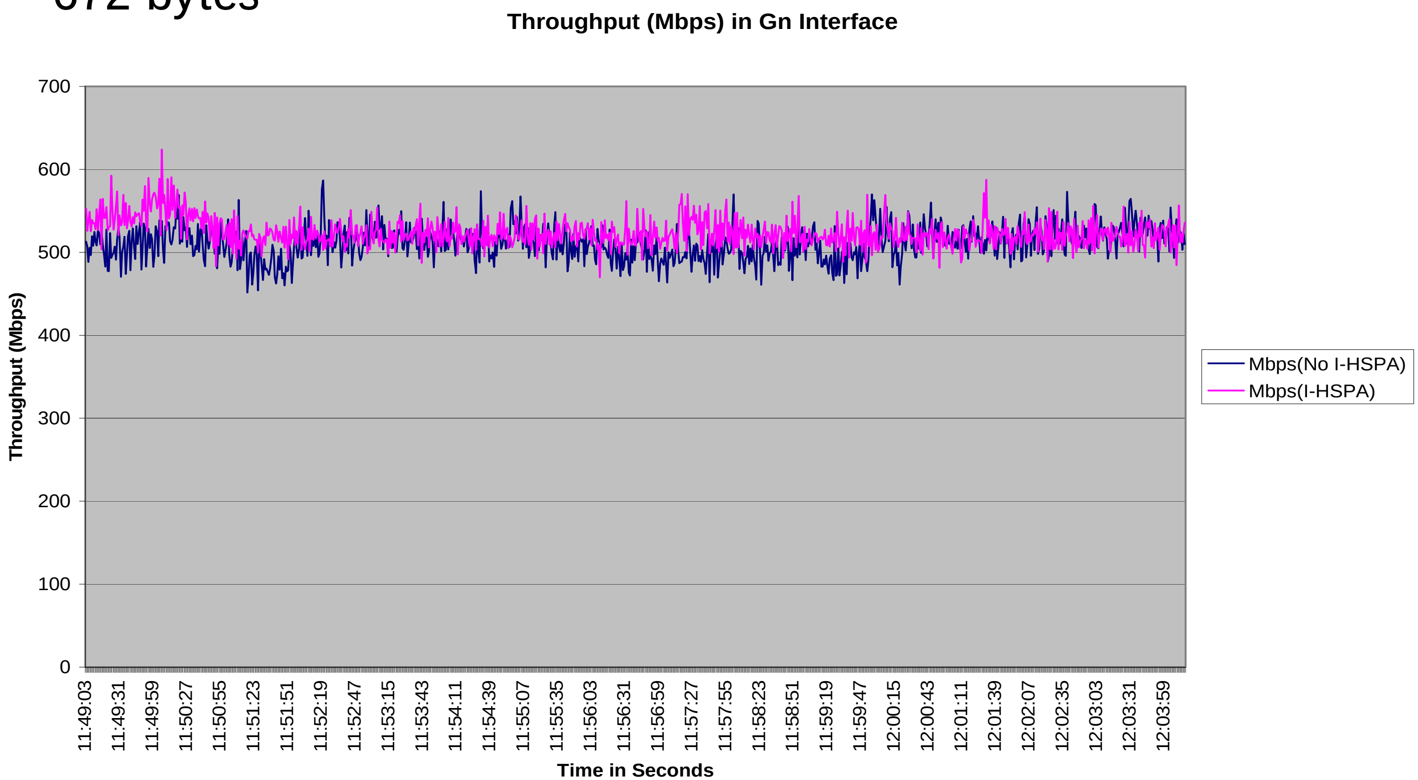
I-HSPA impact on core network elements (6/9)

- It can be seen that the traffic throughput is close to 500 Mbps. This throughput is quite similar in both architectures and was measured from Gn side.

- The packet size was about 672 bytes when this throughput was measured and the packet includes the header of the packets.

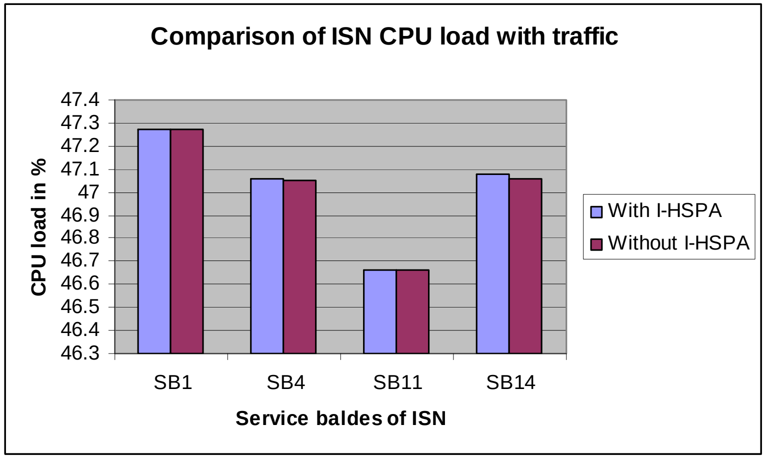
I-HSPA impact on core network elements (7/9)

- L3 Traffic throughput is almost same when traffic was sent at the rate of 672 bytes



I-HSPA impact on core network elements (8/9)

- For the Traffic signaling, the usages of CPU and memory does not increases with the increase of PDP contexts when I-HSPA is used and when I-HSPA was not used.



I-HSPA impact on core network elements (9/9)

- ISN will trigger Radius Interim Message when Routing Area changes or Inter SGSN handover will occur.
- This will also close charging data record which will be sent to the charging gateway for billing purpose.
- Intra SGSN Handover effect is same as PDP context update. it will not trigger Radius Interim message. So it will not overload the AAA server.
- If QoS changes, then ISN will trigger the radius interim message.
- Also QoS change will effect charging gateway and will cause closing of Charging Data Record for charging purpose.

Conclusion

- I-HSPA is the first or pre step towards the LTE/SAE.
- Most of the GGSN/ISN will support the addition of I-HSPA to the radio network. But GGSN/ISN always notices every change in terminal location that is to be taken into account.
- PDP update signal appears every time when tunnel is going to be established, but NSN Flexi ISN can support that load.
- As interface blades and service blades are connected to the external interfaces via Gn interface, so the test was performed mainly in the Gn interface.
- There may have concern about GTP tunnelling protocol versions as one tunnel solution supports GTPv1. If GTPv0 is noticed, then two GTP-U tunnel will be established. This affects CAMEL subscribers too.
- One risk in SGSN is that SGSN has to handle many relocation to handle the mobility in I-HSPA.

Thank You

Questions