

Network Processor Based Packet Processing In 3G-SGSN

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Objectives

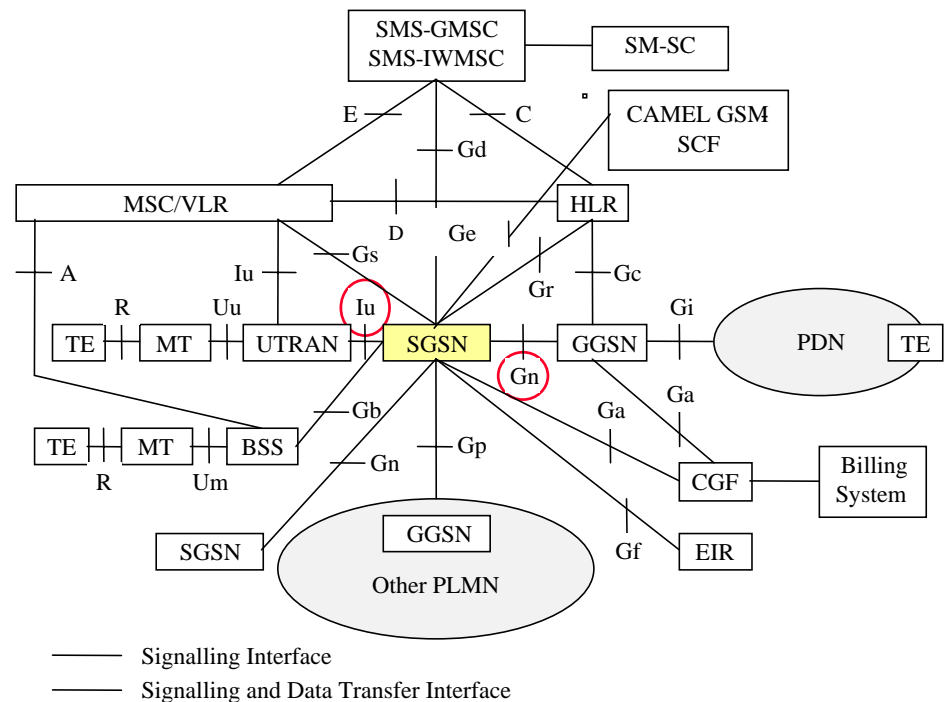
The main objective of this thesis is to study the feasibility of using network processor solution for both tunnelling and forwarding functionalities of 3G-SGSN while achieving the primary requirements specified for them, Specifically,

- Identifying the requirements for the solution on a general level
- Conducting a market survey to look for possible network processor candidates
- Evaluation of candidate network processors
- Selection of the final solution satisfying the requirements for both, the Tunnelling Unit TU, and the Forwarding Unit FU of 3G-SGSN

Introduction

- 3G-SGSN (3rd Generation-Serving GPRS Support Node), and the GGSN (Gateway GPRS Support Node) implement the packet domain core network functionality
- SGSN has to support a variety of protocols and interfaces at wire-speed. Iu interface is an ATM (STM-1), and Gn interface is an Ethernet (GE or FE)

Overview of the Packet Domain Logical Architecture



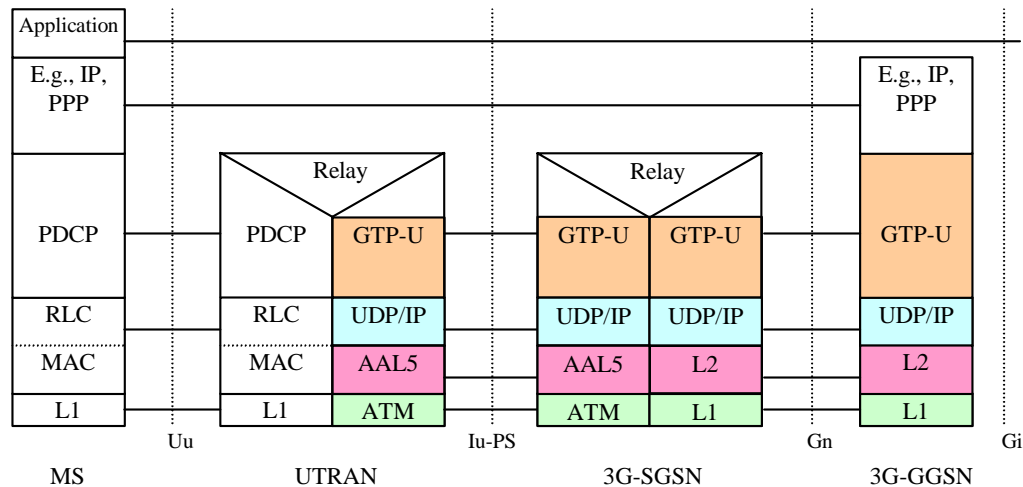
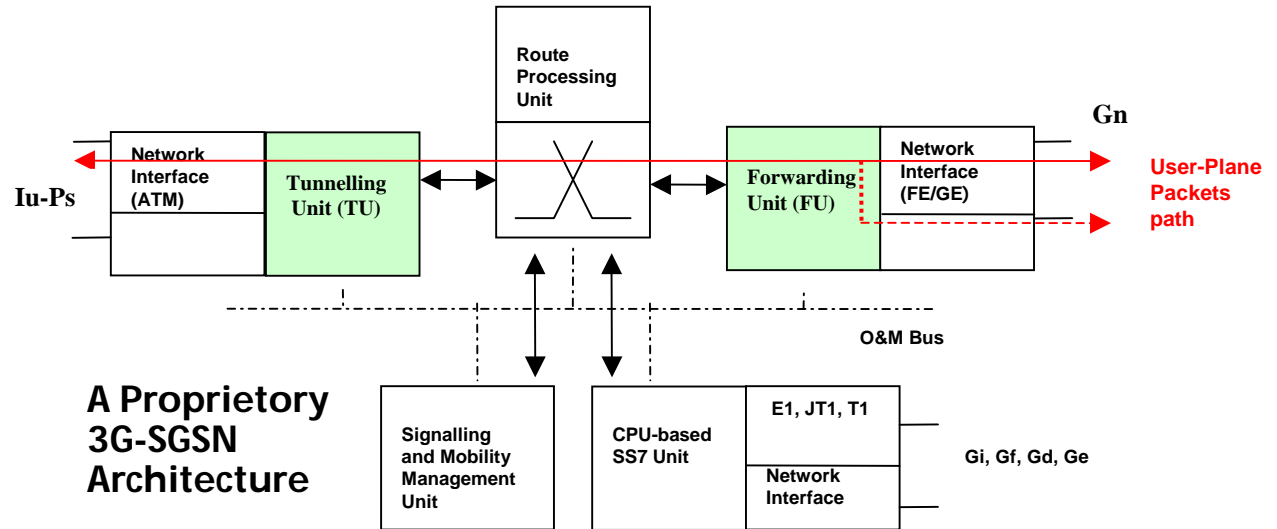
Introduction- 3G-SGSN Architecture

- User-Plane data is processed by:
Tunnelling Unit, that supports:

- ATM
- AAL5
- IPv4 and IPv6
- UDP
- GTP-U

Forwarding Unit, that supports:

- Ethernet
- MAC
- IPv4 and IPv6
- UDP



User Plane Protocols in UMTS

Limitations of conventional packet processing techniques

- **Throughput:**

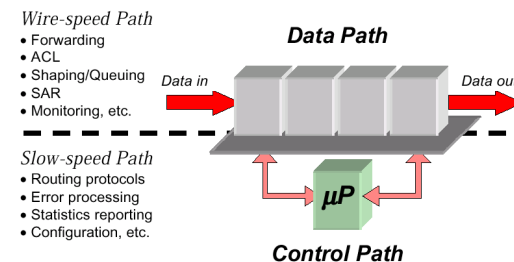
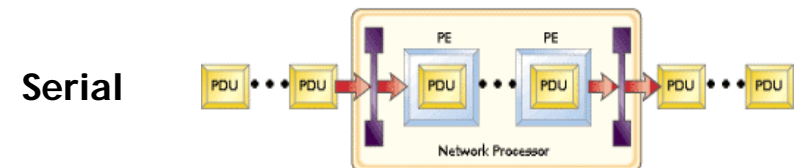
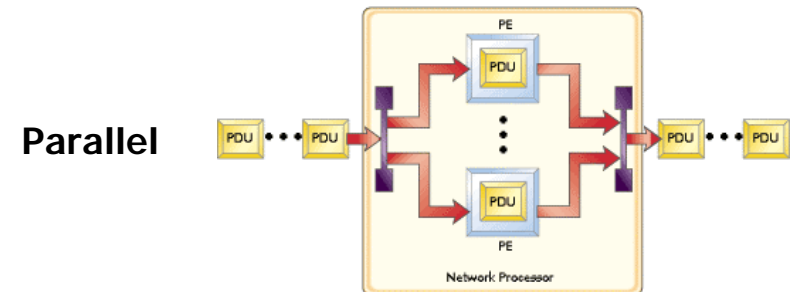
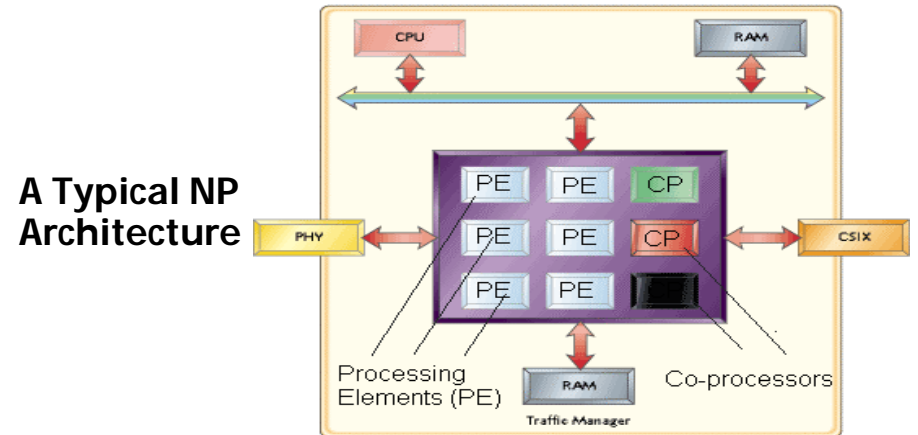
- "Standard" (e.g. Intel) microprocessors
 - The development in the speed of RISC/CISC CPUs may not be coping in the long run with traffic growth.
 - Also, the processor faces increasing capacity demand due to possible growth of complex end-user services (Multimedia, QoS), and the complex protocols to be processed (IPSec,GTP-U)

- **Programmability & Time to Market :**

- ASICs and FPGAs programmability resulting from changing standards and requirements is not flexible enough.
- Getting modifications and changes to the market is not as fast as may be desired with ASICs and FPGAs.

What is a Network Processor ?

- Network processor is a programmable silicon based device that is designed and optimized for the processing of network data (packets). Network processor optimizations include hardware and instruction set support for high-speed packet classification and packet modification
- Network processor often has multiple PE (Processing Element) architecture. A multiprocessor architecture has the potential to multiply the amount of processing time that a network processor can devote to a packet by the number of PE's. Packet processing can be either in serial or in parallel
- SW is divided between user data-plane (NP) and control plane (Host CPU)



Why Network Processor ?

- **Throughput:** Currently as high as 10Gbps
- **SW programmability:** many use C/C++, Assembly, or microcode
- **Fast design changes** and adaptation to new standards:
 - Code portability makes use of already developed code
 - Common HW and SW interfaces: NPFU is establishing common specifications as CPIX (Common Programming Interface) and CSIX (common Switch Interface) which allow third party companies to take a market share and thus make design cycle faster
- **Scalability:** NP can scale to different types of networks. Same processor provides high speed routing at Core, or alternatively QoS, VPN, or IPsec at Edge or Access network

Who is Who in Network processing ?

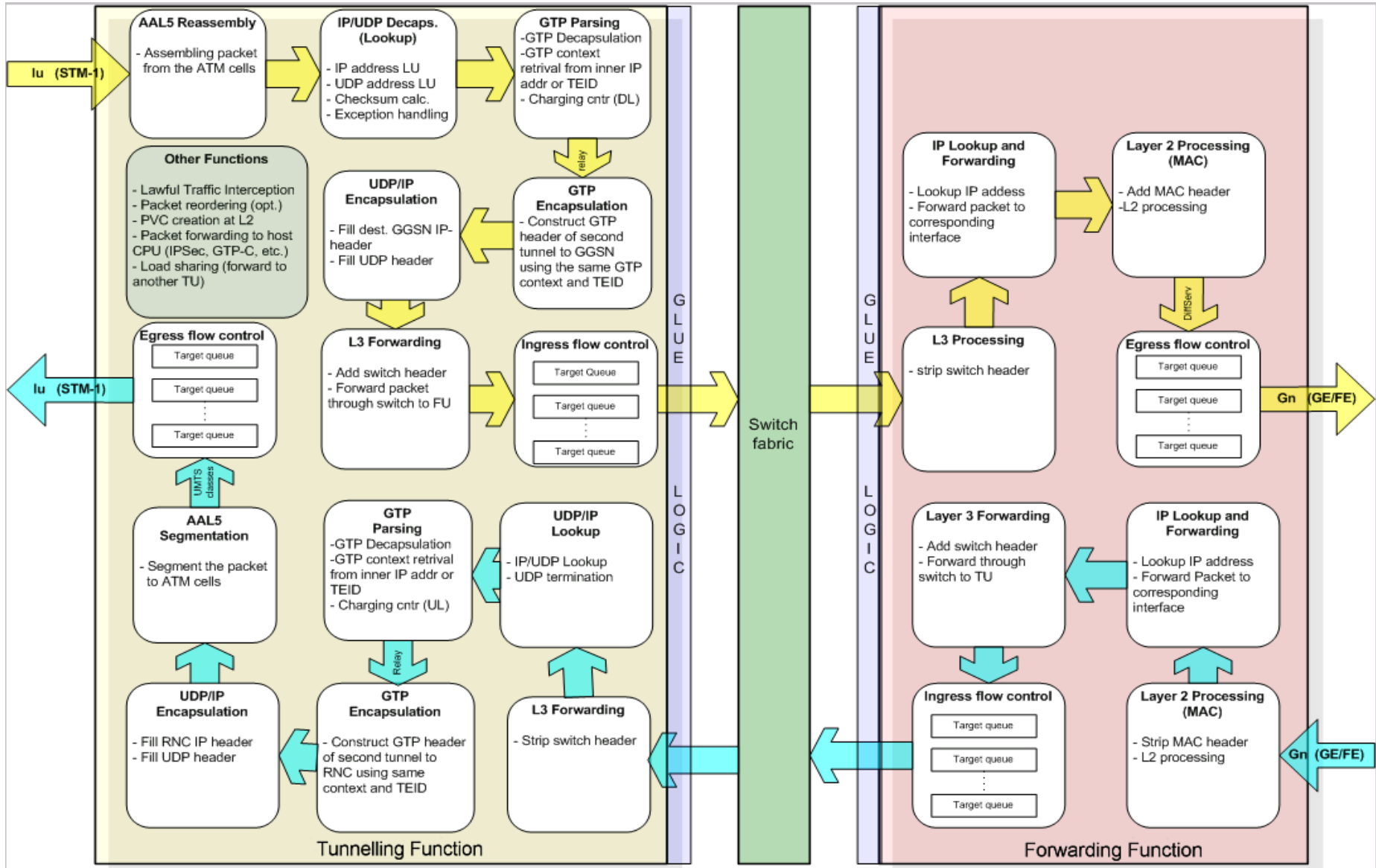
OC-48 (2.5Gbps) Network Processors:

- **Agere APP550**
- **IBM PowerNP NP4GS3**
- **Intel IXP2400**
- **Motorola C-Port C5e**
- Others

OC-192 (10Gbps) Network Processors:

- AMCC nP7510
- Intel IXP2800 & IXP2850
- Agere Payload Plus 10G
- EZ-Chip NP-1
- Silicon Access iFlow
- Others

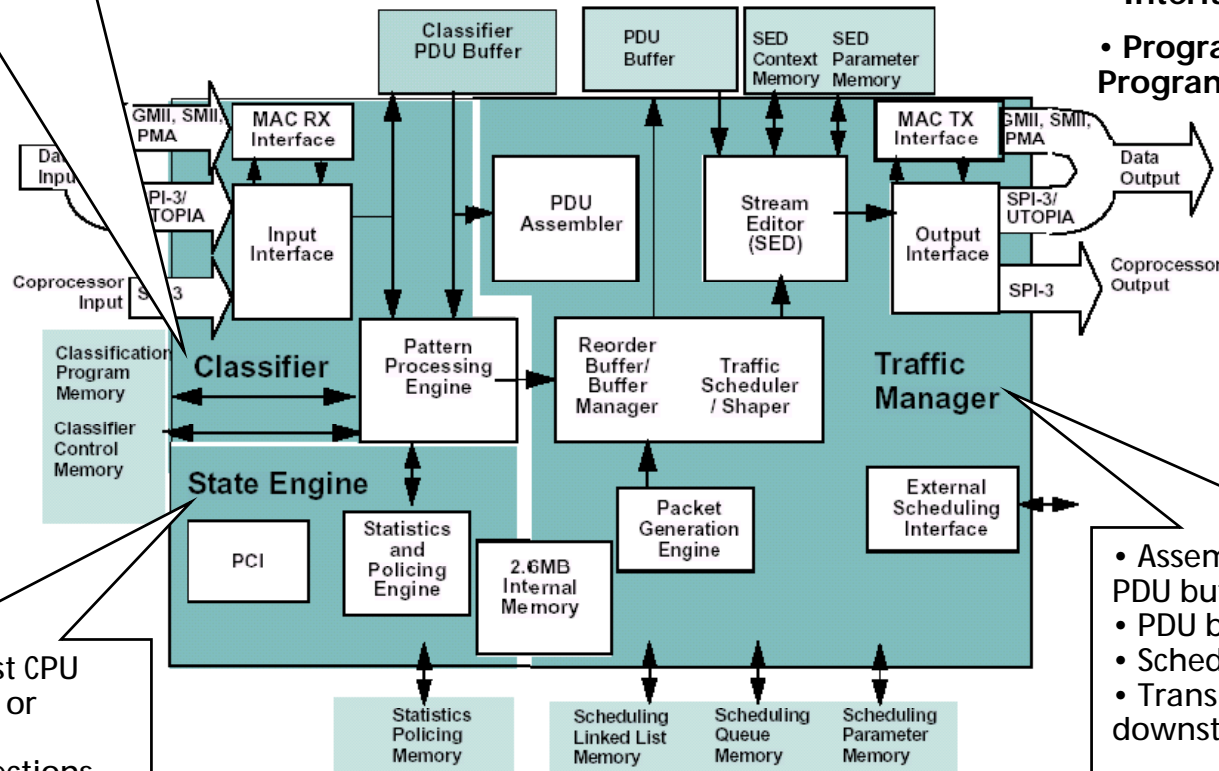
Processing Expected by Network Processor



Agere APP550 Network Processor

- Identify protocols
- Reassembly of packets (IPoATM)
- CRC calculations
- Deterministic lookups

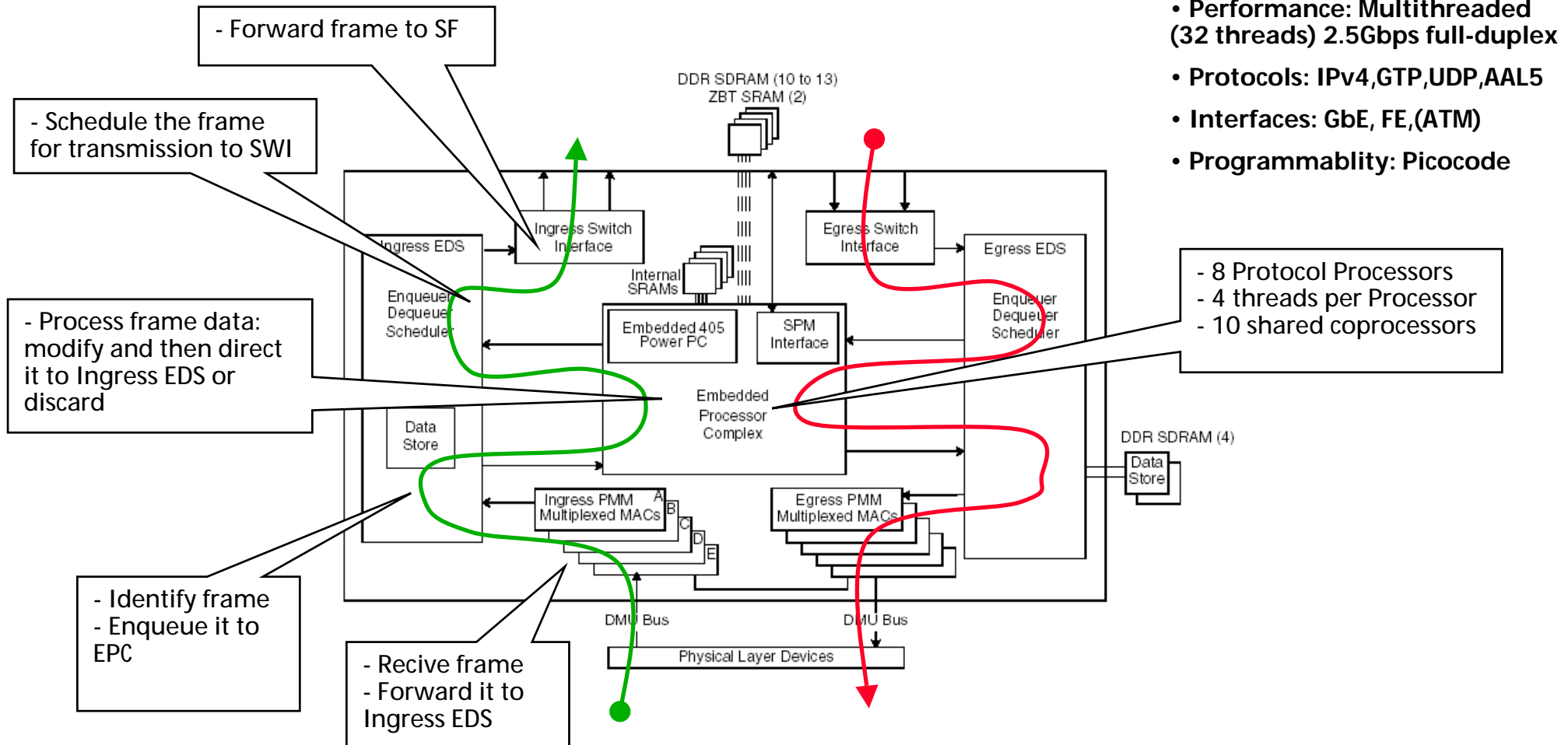
- Performance: Multithreaded (64 threads) 2.5Gbps full-duplex
- Protocols: IPv4,6,UDP,GTP,AAL5
- Interfaces: GbE,FE,ATM
- Programmability: Functional Programming Language (FPL)



- Communicates with host CPU
- Maintains state of flows or connections
- Policing of media connections

- Assembling PDU into Scheduler PDU buffer
- PDU buffer management
- Scheduling
- Transmitting PDUs to downstream logic

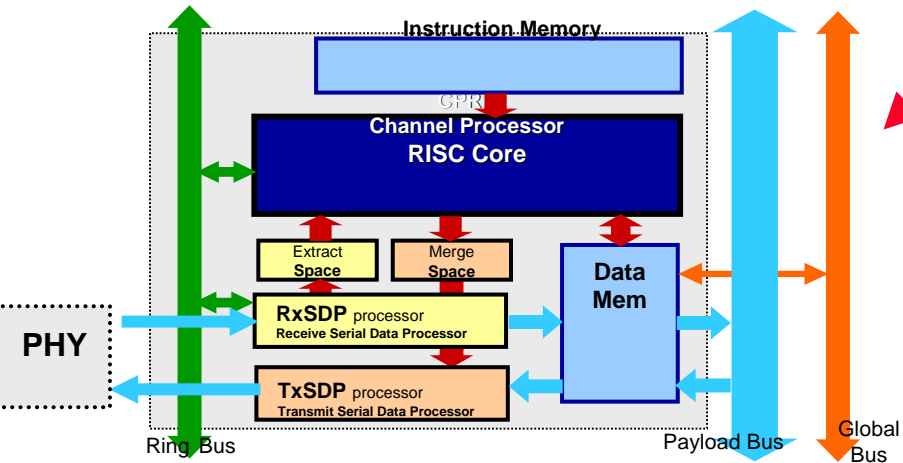
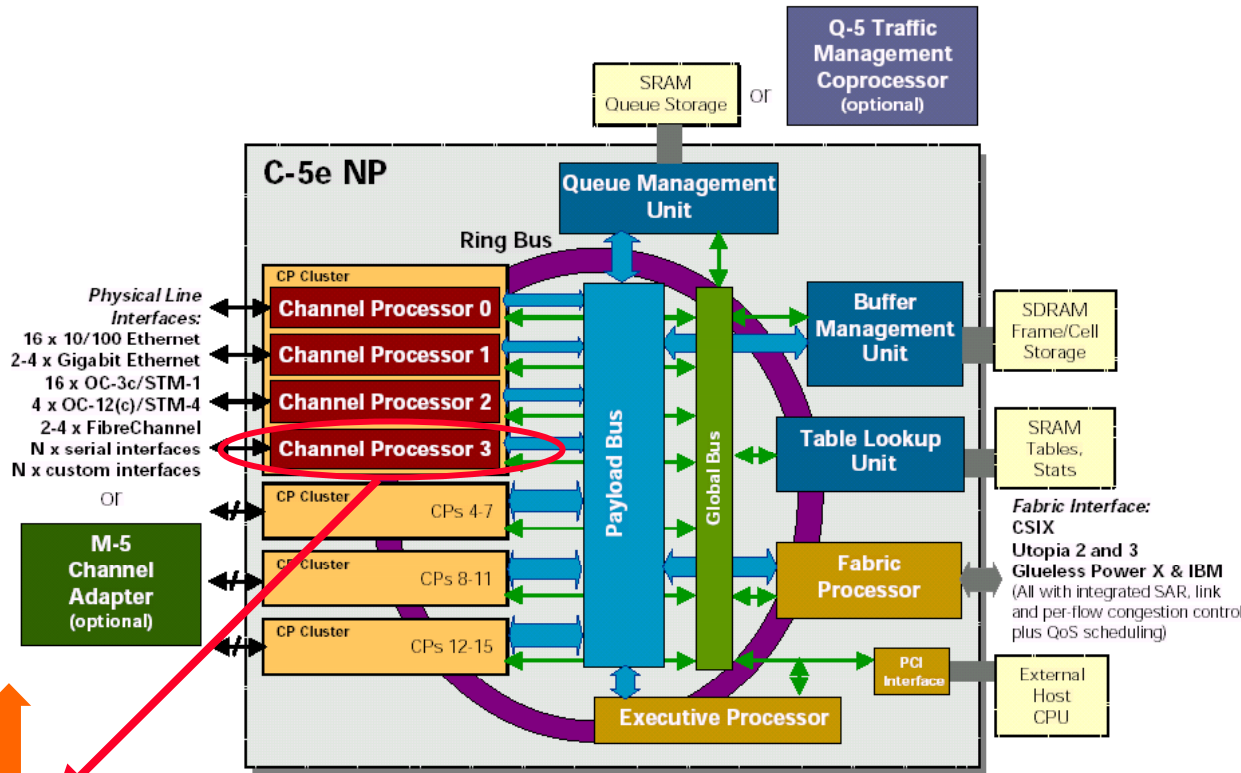
IBM Power NP4GS3 Network Processor



- Performance: Multithreaded (32 threads) 2.5Gbps full-duplex
- Protocols: IPv4,GTP,UDP,AAL5
- Interfaces: GbE, FE,(ATM)
- Programmability: Picocode

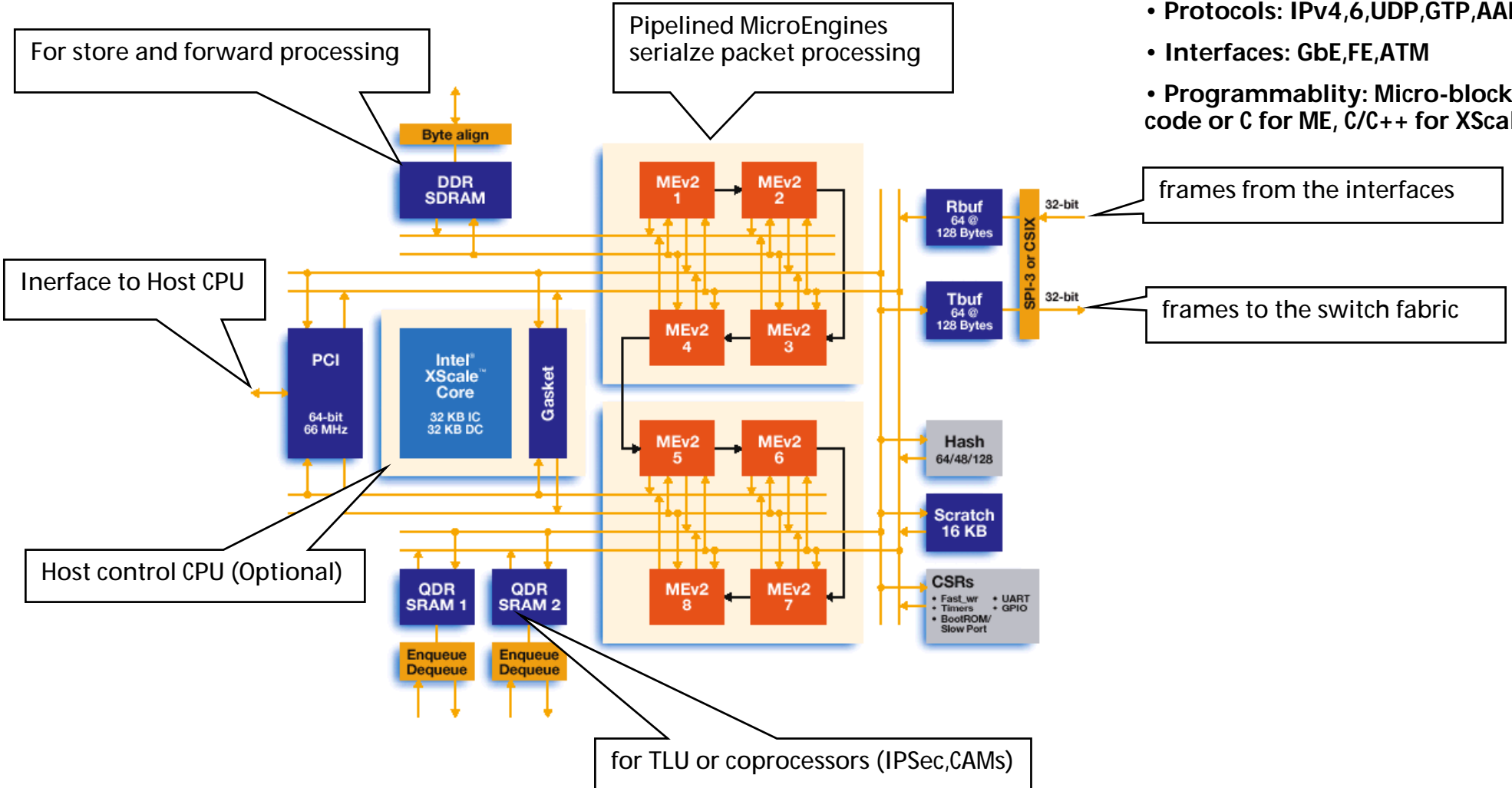
Motorola C-5e Network Processor

- Performance: 2.5Gbps full-duplex
- Protocols: IPv4,GTP,UDP,AAL5
- Interfaces: GbE, FE,ATM
- Programmability: Microcode, and C/C++



Intel IXP2400 Network Processor

- Performance: Multithreaded (8 threads/ME) 2.5Gbps half-duplex
- Protocols: IPv4,6,UDP,GTP,AAL5
- Interfaces: GbE,FE,ATM
- Programmability: Micro-block code or C for ME, C/C++ for XScale



Selected Solution 1/4: Criteria

- Evaluation of the candidate network processors was based on:
 - Own assesment
 - Vendors' offered proposal of the solution (not public)
- Issues evaluated include:

PERFORMANCE	INTERFACES	PROTOCOLS	SOFTWARE	OTHERS
Aggregate Throughput	GE Interface Support	GTP Support	Programmability	Integrity
BW to Switch Fabric	FE Interface Support	AAL5 Support	Code Portability	Power Consumption
No. of concurrent GTP Tunnels required	OC-3 Interface Support	UDP Support	Tools and Services	Cost
Headroom for Future	Switch Fabric Interface	IPv4 Support		Vendor Reliability
	Host CPU Interface	IPv6 Support		Previous Co-operation with Vendor on NP's
	Coprocessor Interface	IPSec Support		
	Memory Interfaces	QoS Support		

Selected Solution 2/4: Comparison

- Intel IXP2400 (Selected in the thesis):
 - + It supports all (except for IPSec, supported in IXP2850) the protocols and interfaces needed by the 3G-SGSN
 - + It has sufficient processing power for the performance needed (dual IXP2400 or single IXP2800)
 - + Intel is a leading electronics manufacturer with less risk, to leave the market at least in the near future
 - + More powerful offering is available for future using IXP2800 with more headroom (SW reuse)
 - + Good software and tools offerings
 - IXP2400 needs external chips such as MAC
 - It has rather high power consumption, 16W max@600MHz
- Motorola C-5e:
 - + It supports all (except for IPSec) the protocols and interfaces needed by the 3G-SGSN
 - + Good software and tools offerings
 - + It has integrated MACs
 - Power consumption is rather high, 13W

Selected Solution 3/4: Comparison

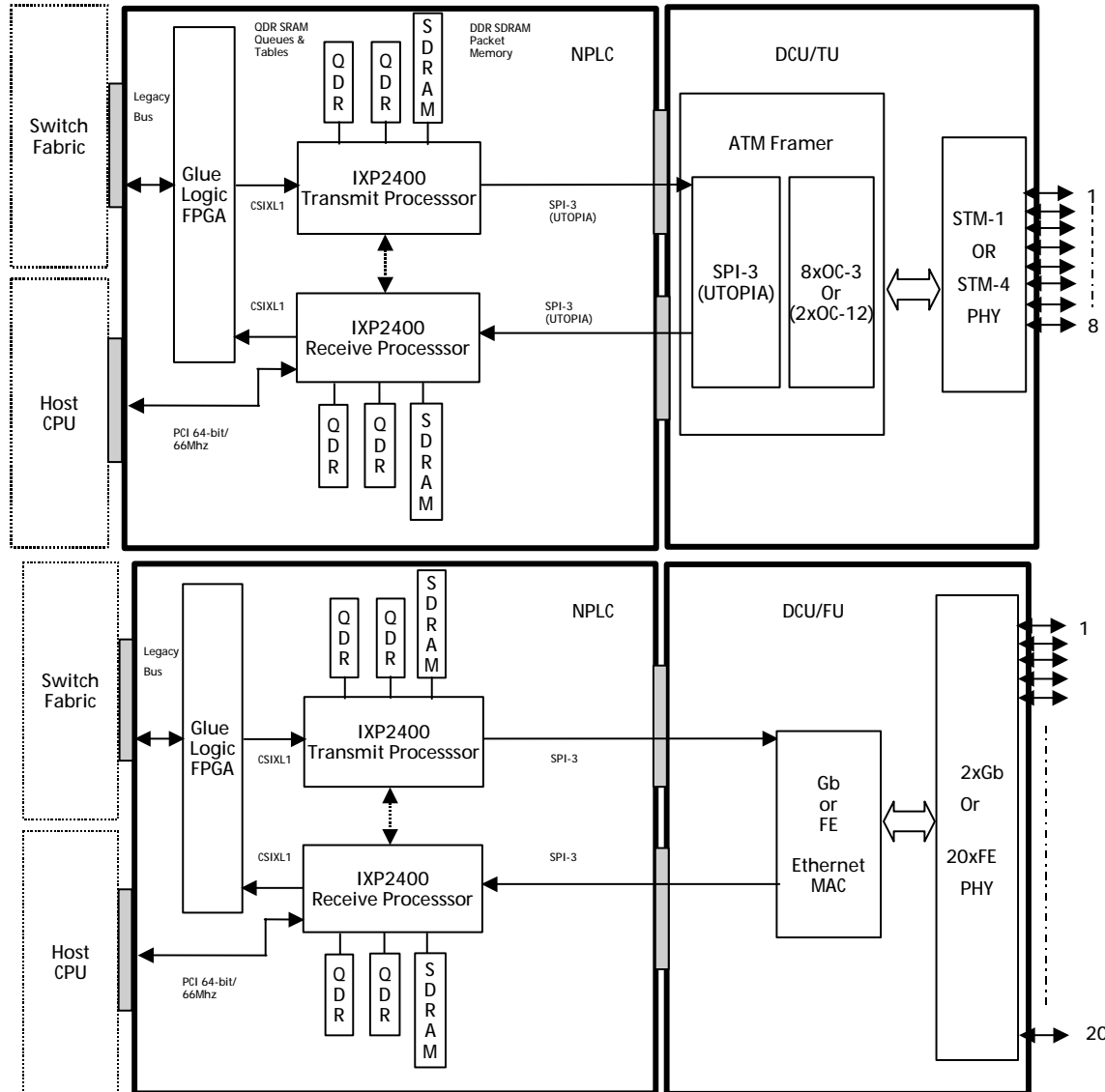
- Agere APP550:

- + It supports all (except for IPSec) the protocols and interfaces needed by the 3G-SGSN
- + Its FPL is efficient for programming the engines.
- The number of GTP tunnels supported per APP550, is less than the set requirement

- IBM NP4GS3:

- + It supports all (except for IPSec) the protocols needed by the 3G-SGSN
- + Good support for Ethernet interfaces with HW integrated MACs
- It does not support ATM interfaces by default. External chips are needed
- IPv6 is not among the SW offerings of IBM, sample IPv6 forwarding code though exist

Selected Solution 4/4: System Architecture with Intel IXP2400



Conclusions 1/2

- Increasing volume of 3G-traffic with user data packets becoming shorter in size (due to RT-apps) , requires higher performance capacity for packet processing with specialized HW and flexible SW in 3G-SGSN
- Network Processors offer performance and flexibility
- Comparison between Network processor is difficult task because:
 - Network Processors have different HW architectures and SW models
 - Shortage of benchmarking data
 - Reluctance of vendors to release detailed information about performance and application implementation, due to strong competition
- The design transition to Network Processor technology raises some issues:
 - High cost (range: \$300-\$500/NP)
 - Learning needs on how to design NP SW, new prog. languages
 - Market stability: vendors lifetime

Conclusions 2/2

- Intel IXP2400 Network Processor is a feasible solution for the 3G-SGSN, offering sufficient performance and headroom for future development

Questions?