Communication Schemes to Guarantee Quality-of-Service in Networks-on-Chip

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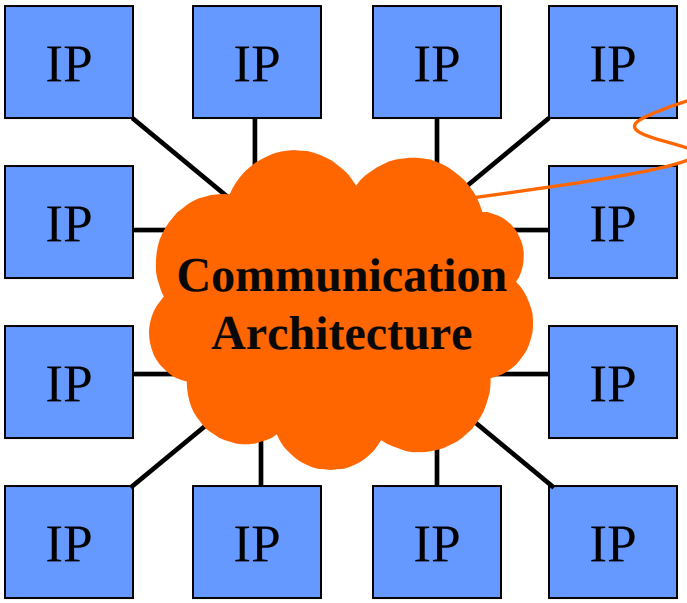
Motivation



On-chip communication is becoming an important issue

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Networks on Chip

↓

Predictable Communication

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Quality of Service

How to provide Quality of Service in Networks on Chip?

- ❑ Connection-oriented ?
- ❑ Connection-less ?

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Outline

- Predictability in On-Chip Communication
- Quality-of-Service (QoS)
  - QoS in computer networks
  - QoS in NoCs
- Connection-less vs. Connection-oriented Communication in Networks-on-Chip (NoC)
- Case Study (MPEG-2 Decoder)
- Conclusion

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System-on-Chip Communication

- Increasing number of processing blocks on a die.
- How to meet growing communication needs?

Buses	Networks
+ Low area + Low complexity + Wide interfacing support	+ Efficient bandwidth utilization + Traffic parallelization + Organization of wires
– Not scalable – Arbitration slow – Share of single bandwidth	– Occupy space – Higher complexity – New interface definition

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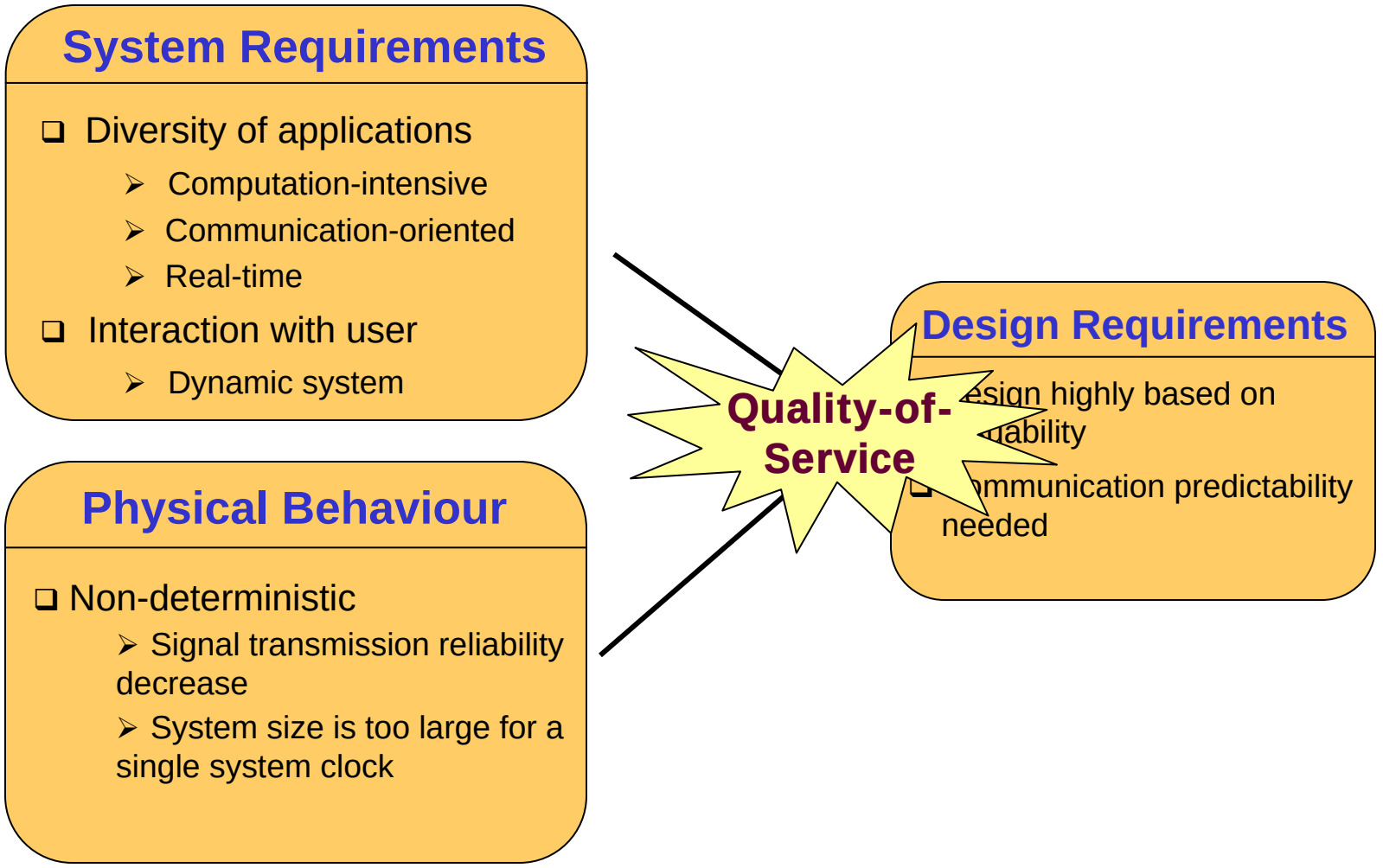
Predictability in on-chip communication



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Quality-of-Service(QoS) in Computer Networks

- Quality of Service is characterized by parameters such as
  - delay, jitter;
  - availability, packet loss;
  - throughput;
- Providing QoS means to control one or more of these parameters:
  - Integrated Services (IntServ)
  - Differentiated Services (DiffServ)

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IntServ vs. DiffServ

	Integrated Services	Differentiated Services
Communication Scheme	Connection-oriented	Connection-less
Memory requirement	Proportional to number of connections	Proportional to number of classes
Connection setup overhead	Yes	No
Resource utilization	Low	High
Service guarantee	Absolute	Relative
Scalability	Low	High

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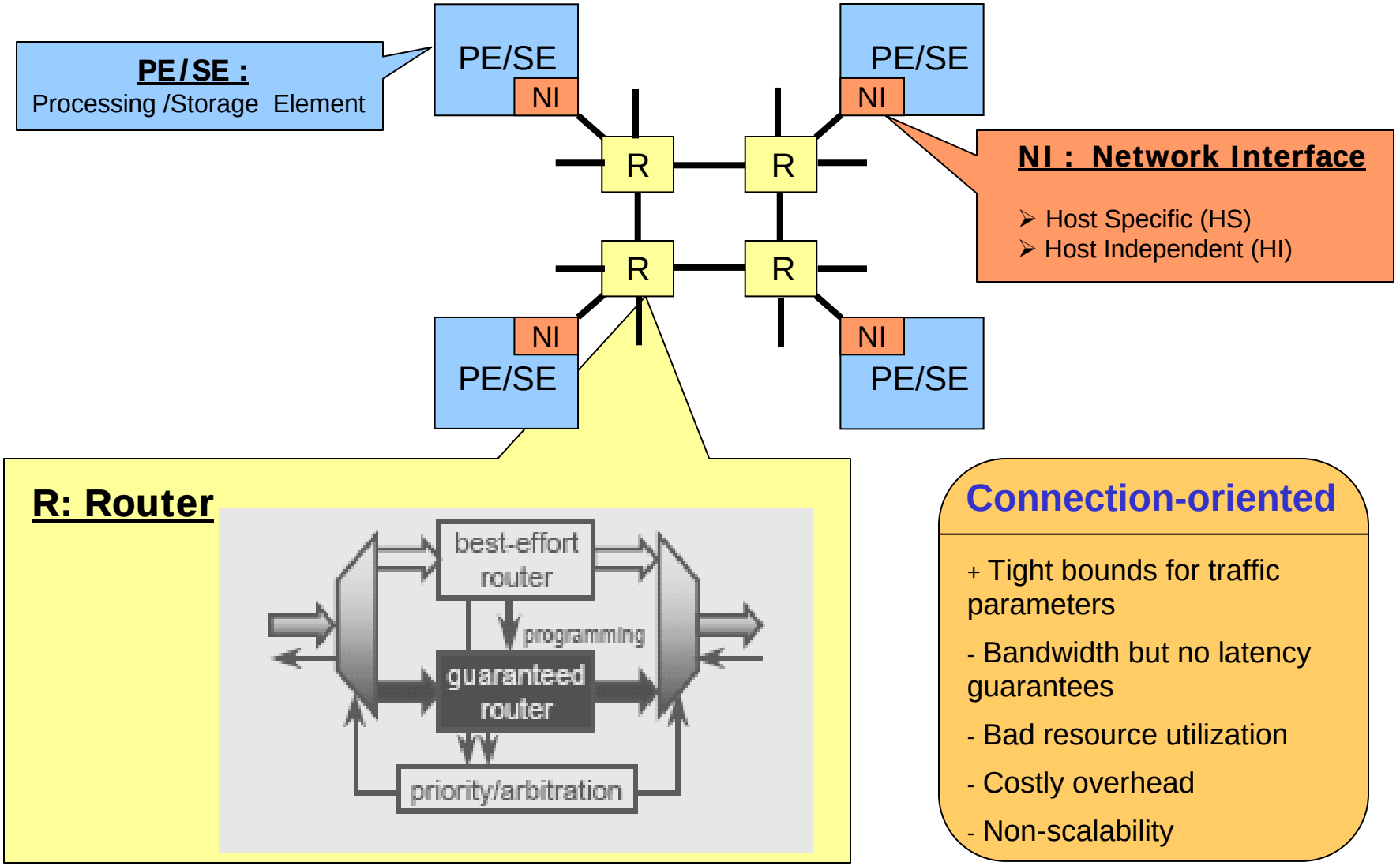
Æthereal based NoC (connection-oriented)



Connection-oriented

+ Tight bounds for traffic parameters

- Bandwidth but no latency guarantees

- Bad resource utilization

- Costly overhead

- Non-scalability

Source: Goossens, © 2003

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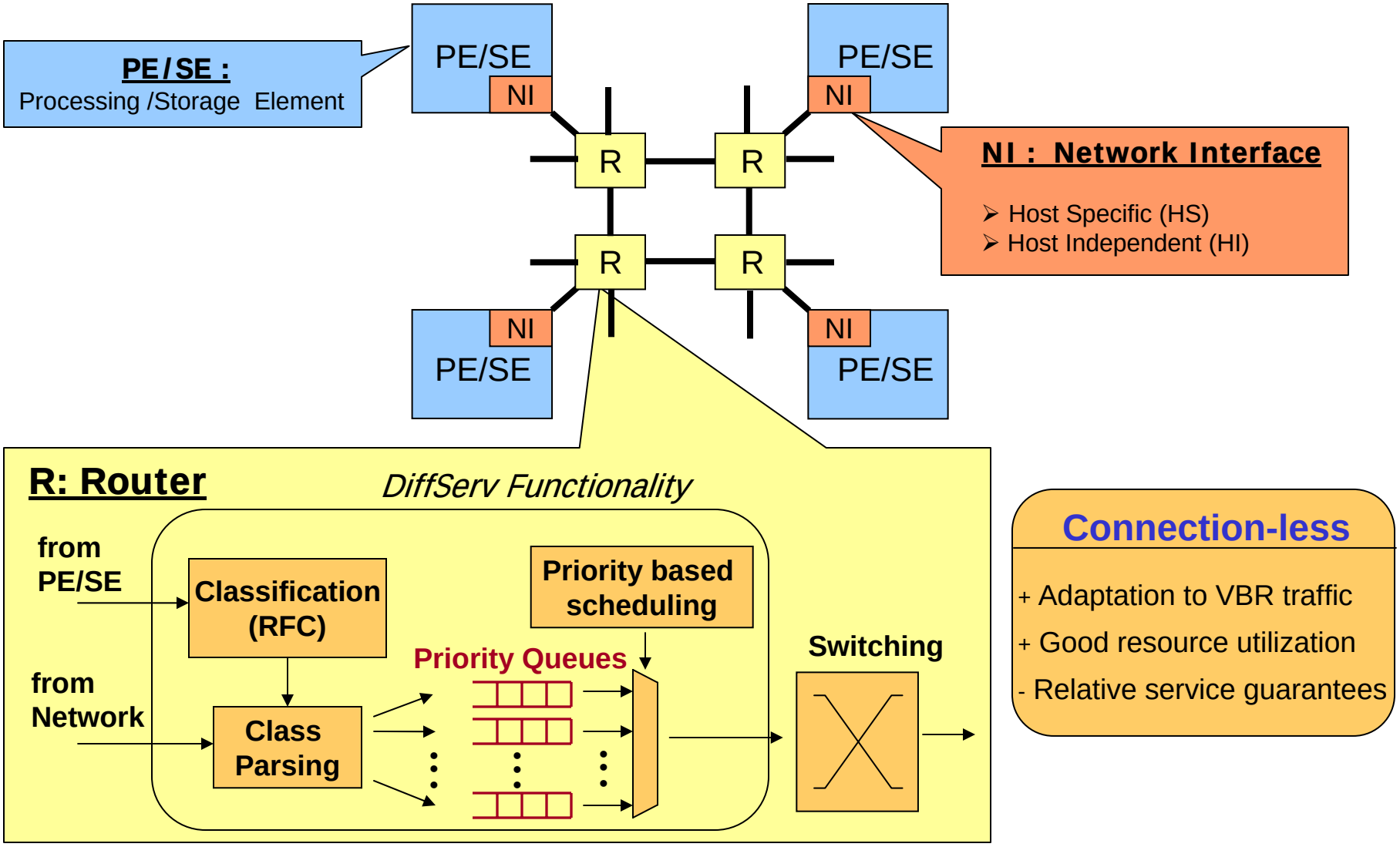
DiffServ NoC (connection-less)



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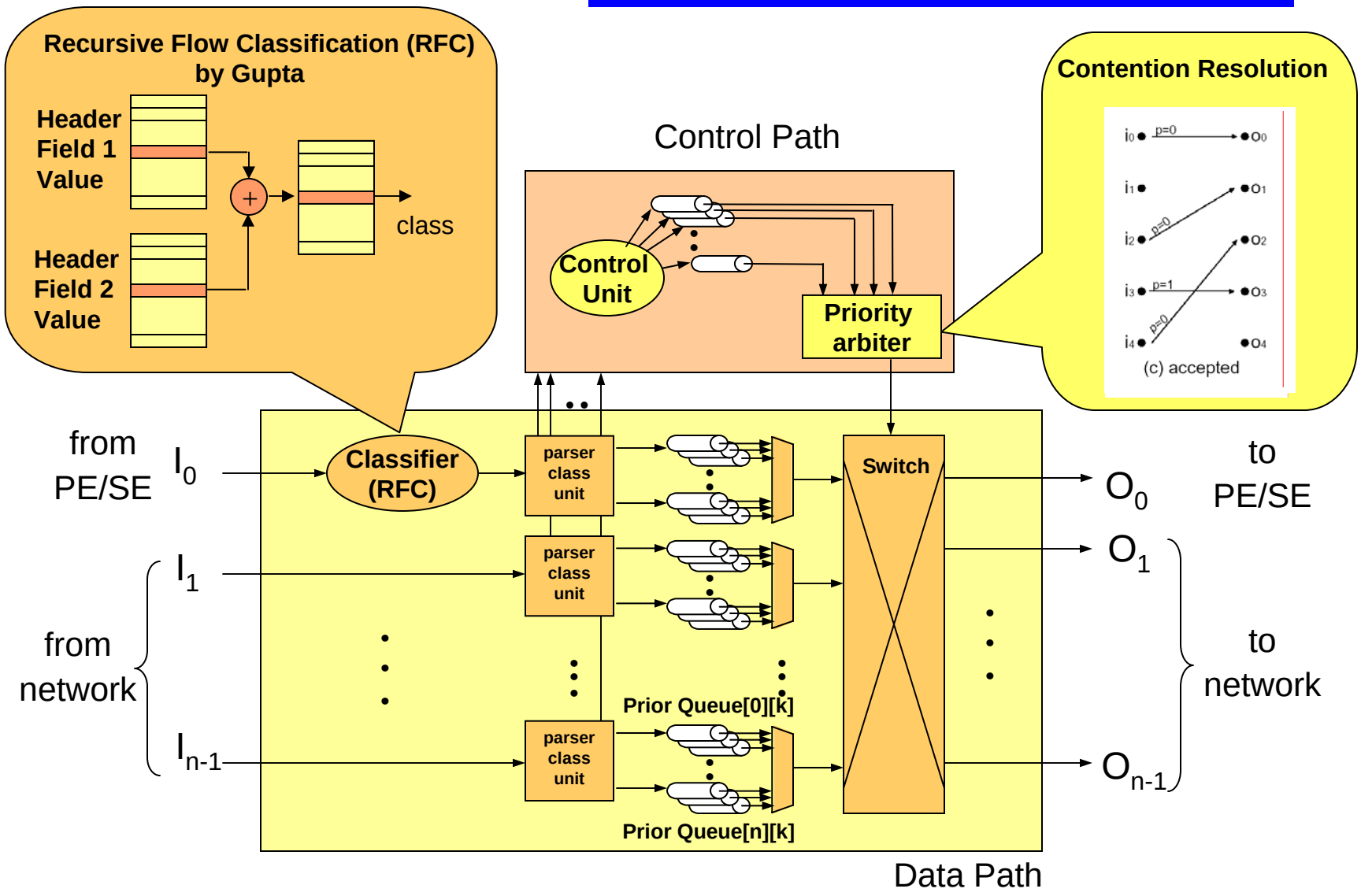
Router Architecture for DiffServ NoC



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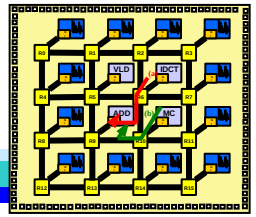
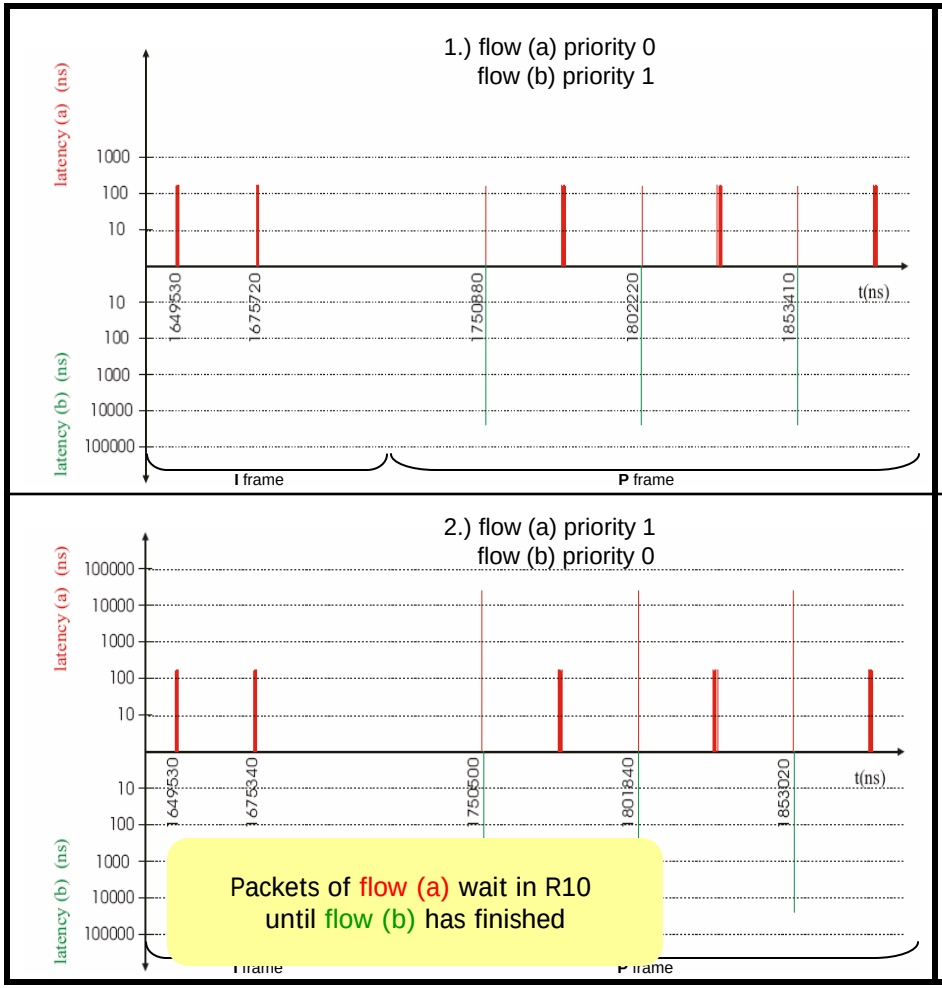
Results

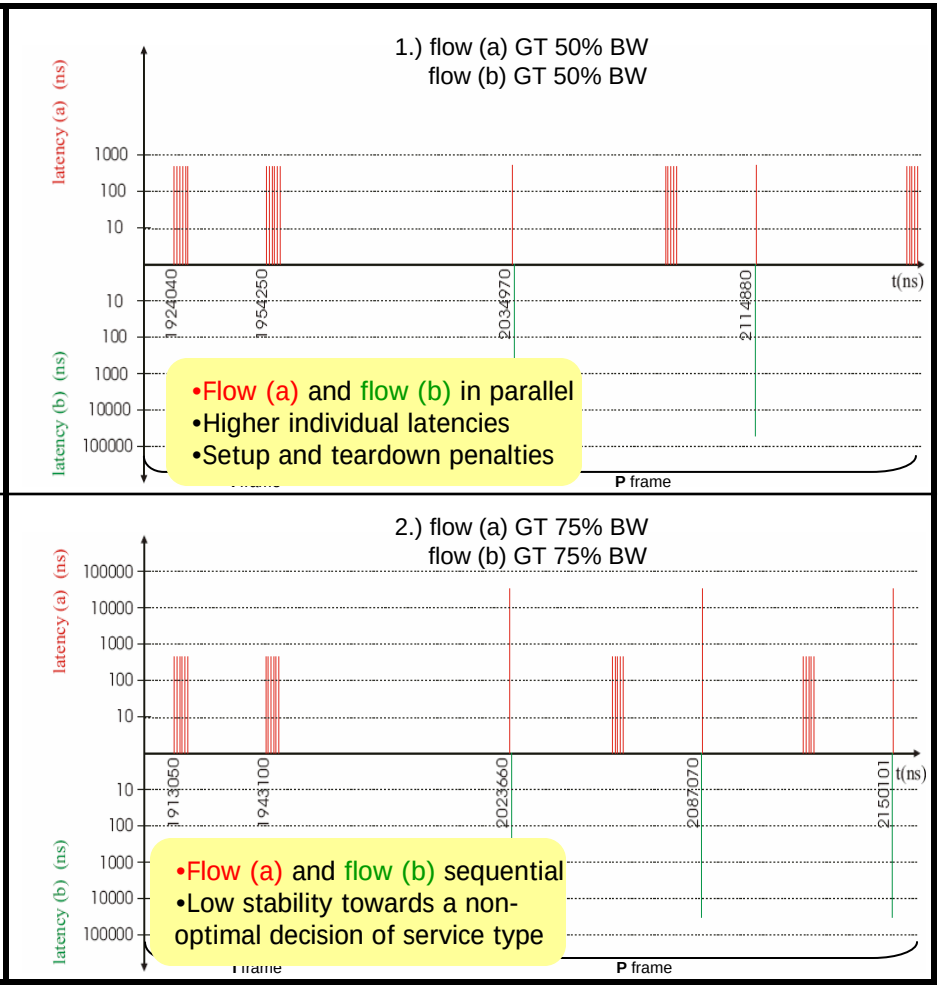


I. Connection-less Scheme



i.) low priority noise

II. Connection-oriented Scheme



i.) BE noise

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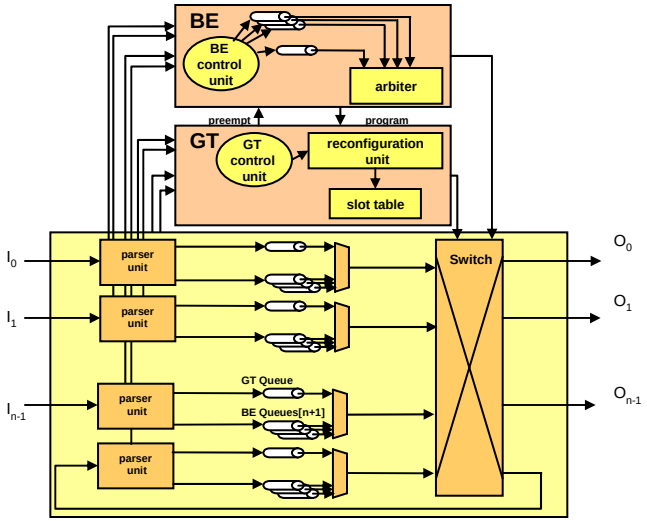
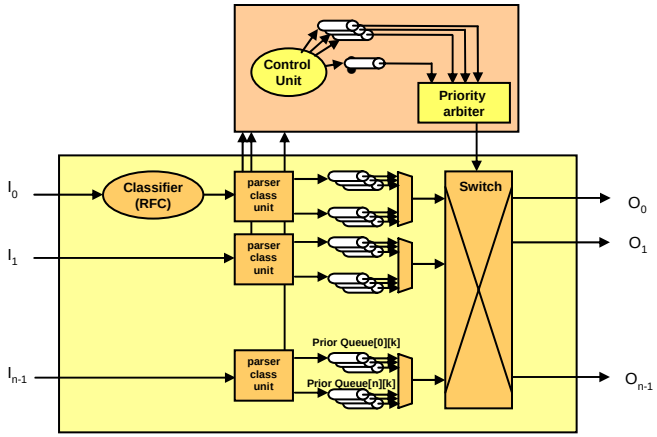
Hardware Cost Comparison

	Æthereal based NoC	DiffServ Noc
Router		
Control Path Units	GT control unit, reconfiguration unit, slot table BE control unit, arbiter	Control unit, priority arbiter
Data Path Queues	(num_output+1) x (num_input+1)	num_output x num_input x num_prior
Network Interface	GT connections management (e.g. set-up, tear-down) Packetization, source routing	Packetization, source routing





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Conclusion

- NoCs are promising for System-on-Chip communication problems
- Importance of providing QoS in NoCs:
  - Predictability
  - Reusability of IP blocks
- Integrated Services vs. Differentiated Services in on-chip networks
- Differentiated Services approach for NoC
  - Feasible hardware implementation
  - Provide link bandwidth according to priority level of flows.
- Connection-less vs. connection-oriented schemes to guarantee QoS on NoC:
  - Better adaptation to VBR applications (e.g. MPEG2)
  - Higher stability towards a non-optimal decision of service type

Next ...

- How to profit from a predictable communication approach for optimizing power consumption on multiprocessor systems-on-chip?

THANK YOU!