TCP/IP in hardware

- using SME

Mark Jan Jacobi & Jan Meznik

University of Copenhagen

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Background and Motivation

Dedicated hardware needs to transmit data in real time, but OS network stacks are usually not enough!
Dedicated Network cards are not perfect either:

Weaknesses of network cards

- Only basic programmability
- Incompatible APIs
- Licensed VHDL code blobs
- Seldom swap-able
- **Price!**

Figure: An Intel FPGA NIC

A performant, efficient, and flexible network stack in FPGA!

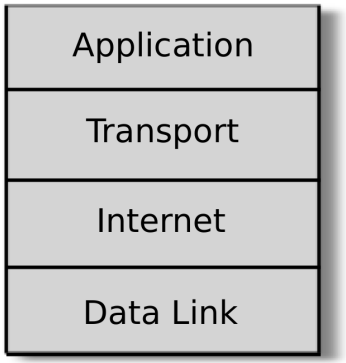
How? Using SME!

- Easy & intuitive hardware modelling
- Implicit clock
- Built-in simulation utilities
- VHDL code generation
- Verification by comparing VHDL signals with C# simulation

SME and FPGA

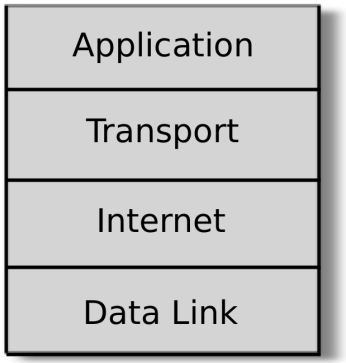
Skip this if SME has been covered

Internet Protocol Suite (TCP/IP)



Application FTP, DHCP, SSH, etc.

Internet Protocol Suite (TCP/IP)



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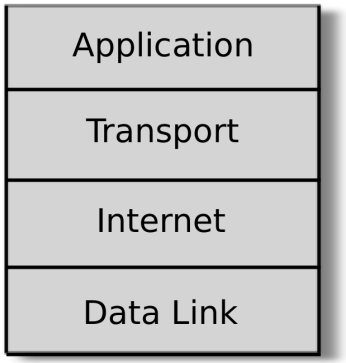

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Internet IPv4, IPv6, ICMP, etc.

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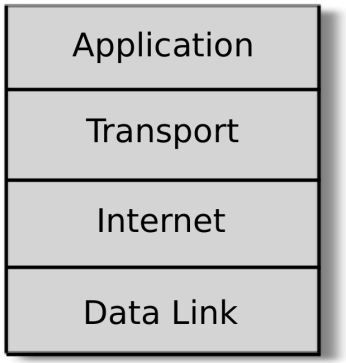
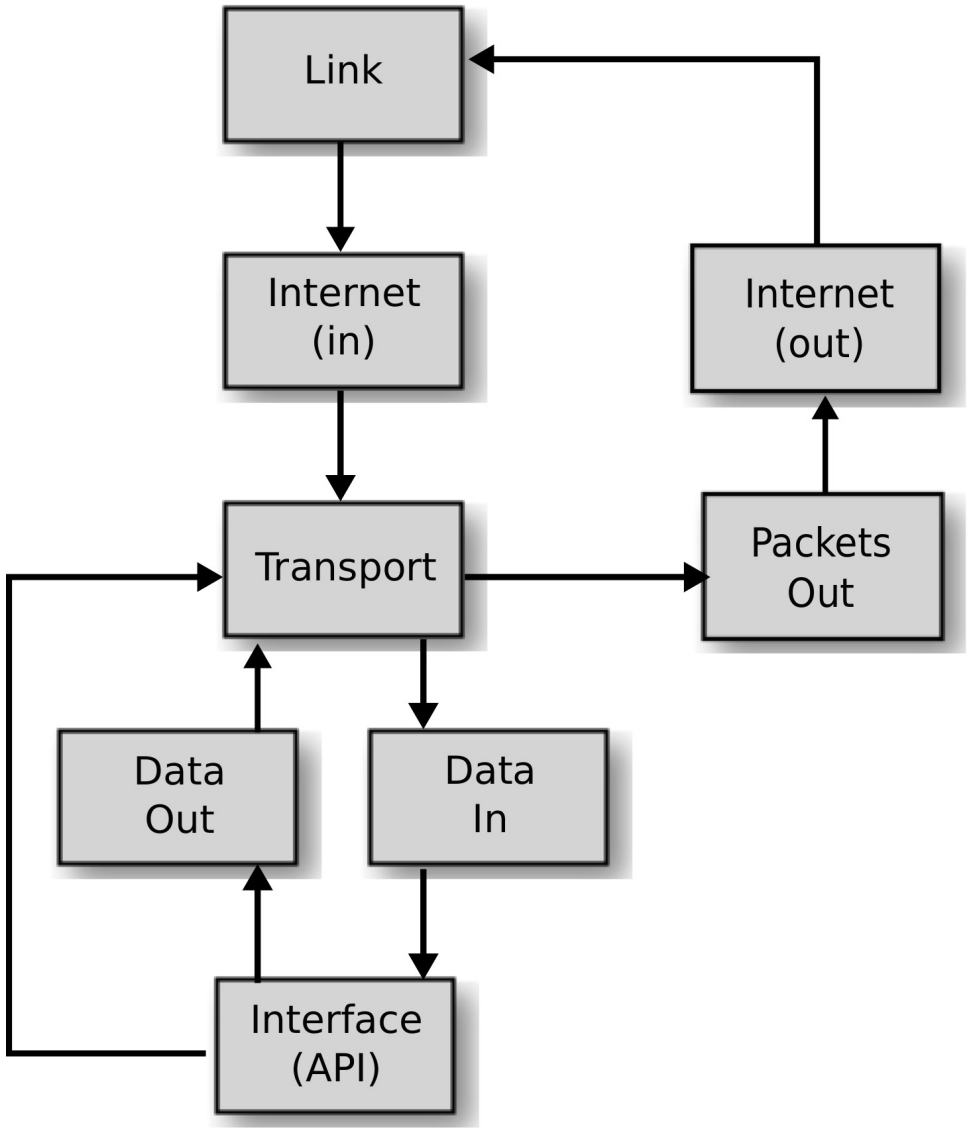


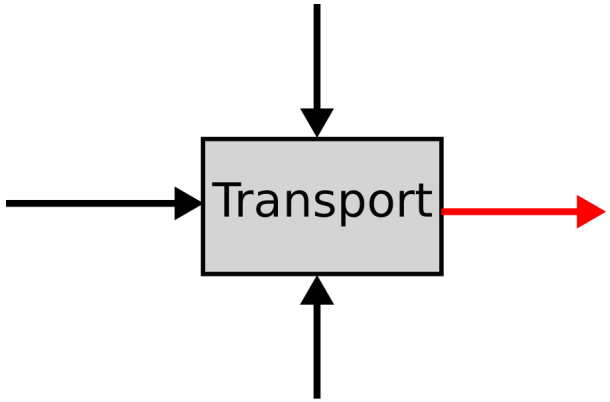
Application	FTP, DHCP, SSH, etc.
Transport	TCP, UDP, DCCP, etc.
Internet	IPv4, IPv6, ICMP, etc.
Data Link	ARP, MAC (Ethernet, Wi-Fi), etc.

Architecture



Challenges

- Clock-delays and congestion



Challenges

- Clock-delays and congestion
- Limited subset of programming language utilities

```
// These are not allowed
O.M = new Func<int>(() =>
{ return 42; });

void Method(ref int x) {}

int* p1 = &x;
```

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- Data de-multiplexing

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- Limited (fast) memory

Packets up to 65,535 bytes!

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- Limited subset of programming language utilities
- Data de-multiplexing
- Limited (fast) memory
- Information sharing is by design hard in SME
- Fragmented IP packets

Questions

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