To be smart or not to be?

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State of the network

• Plenty of bandwidth
  – Optical core

• Increasing demand for services
  – Gateways
  – Network Service nodes
  – Content Switches
  – Network Caches

• Evolving network
Evolution of the network

- Core
- Edge
- Virus Scanning
- Load Balancing
- QoS
- Network Monitoring
- Routing
- VPN
- Firewall
- Intrusion Detection

Instructions per Packet vs Complexity

Edge - Core - Edge

C
Current Mode of Operation

- Application specific solutions
- Hardware/Software design and deployment cycles takes years
- Ad-hoc solutions create complex networks
- Multiple network management solutions
Answer – Part I

• Flexibility
• Programmability (open interfaces)
Need for Power

- Computational Complexity
- 32-bit Processor @ 500 MIPS
- How much can you do with it?

<table>
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<th></th>
<th>Time/Word</th>
<th># Insts</th>
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<td>100BaseT</td>
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<td>160</td>
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<tr>
<td>OC48</td>
<td>13ns</td>
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- Need for high performance computing technology deeper in the network
Answer – Part II

• High Performance Computing Technologies
  – Configurable Computing
  – Parallel Processing
• Configurable Computing: Programmable logic (FPGA) coupled to Processor (CPU)
• Customized for each application
How does CC work?

- Customised hardware operations
- Concurrent operations

```c
float D, I, K, R;
int A = 100;
...
while ( A != 0 ) {
    temp = I * K;
    D = R + temp;
    A --;
}
```
The power of CC

• DCT implementation
  – Xilinx FPGA 180 times faster than 32-bit processor @ 266MHz

• Vector computations
  – 50MHz FPGA roughly 10 times faster than 300MHz Pentium CPU
Evolution of routers – Phase I

Centralized CPU-based Router

- Control + Forwarding functions combined
- Slow

Forwarding Processor based Router

- Control separated from Forwarding
- Wire-Speed
Towards Open Networking

Control Plane
- Java-based Network Services
  - Java Runtime Support
  - Forward API
- CPU System

Forward Plane
- Switching Fabric
  - Forwarding Processor
  - Forwarding Rules
  - Traffic Packets
Node Architecture

Control Plane

- Compute Services
- Compute API
- Compute Plane

Forward Plane

Forward API

Network Services
Evolution of Routers – Phase II

- Control, Compute and Forward planes
- Forward-only flows are not seen by Compute plane
- Control plane can modify behavior of Compute and Forward planes
Open Networking

- Abstract Compute & Forward Plane interfaces
- Technology reuse over a range of NORTEL platforms
Work in progress…

• NORTEL R&D activities
  – POLARIS lab
  – OPENET lab
• Research Target
  – “Smart” node architectures
  – Open architectures
  – High Performance Computing technologies
Summary

• Future network node architecture
  – Open networking
  – Programmable networking
  – High performance computing

• Benefits to NORTEL
  – Rapid service deployment
  – Third-party value-added services
  – Increased market penetration
To learn more …

- http://www.openetlab.org/
- http://www.ieee-pin.org/
- http://comet.columbia.edu/openarch
- http://comet.columbia.edu/opensig
- http://www.cpixforum.org/