Programmable BitPipe

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How do you program a switch / router today?

- High variety of
  - different operation systems,
  - software development kits,
  - API

- Specific per system vendor and per system generation

- Closed solutions
  - Usually integration done by vendors
  - Most of software can not be used for other systems or other vendors

Hardware - vendor specific software “ECO-systems“!
Modularization of software: Learn from principles of IT. Massive lowering of market and innovation barrier.

Today: Monolithic box.

Multifunctional switch/router

Software & controller

Data forwarding & processing

Proposal of Split Architecture.

Network application plane

Open flow controller

Forwarding plane

Data processing plane

Split of software centric and hardware centric part;
Split of application and control (software); Split of forwarding and processing (hardware).
Give support for data processing: Network processors.

Example 1: Tilera 100 core network processor

Example 2: Netronome programmable line-card


Enormous progress in chip technology enables highly programmable forwarding / processing hardware.

Source: http://www.tilera.com/products/processors/TILE-Gx_Family

Evolution of forwarding elements.

The revolution just started . . .
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SDN – Landscape.

Home network

Telco infrastructure

SDN for wireless LANs
Mobile Radio Network

Access Network
Aggregation Network

Global Packet Core Network

Optical Transport Network (Metro/Regio)

Optical Transport Network (Backbone)

Datacenter Interconnection

Datacenter

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## Carrier Class SDN

### Focus Areas of „SPARC“

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<th>Potential Issues Identified</th>
<th>Concrete Solutions proposed</th>
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<td>Yes</td>
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<td>Flow OAM</td>
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<td>Resiliency</td>
<td>Yes</td>
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<td>Topology Discovery</td>
<td>Yes</td>
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<td>Openness &amp; Extensibility</td>
<td>Yes</td>
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<td>Interoperability</td>
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<td>Sustainability</td>
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<td>Multilayer Aspects</td>
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<td>QoS</td>
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<td>Network Management</td>
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<tr>
<th>Deployment Scenarios Considered</th>
<th>Access &amp; Aggregation Networks</th>
<th>Backbone / Multilayer Networks</th>
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<tr>
<td></td>
<td>Yes</td>
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<td></td>
<td>• Service Creation</td>
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<td>• Transport Control Schemes</td>
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<td>• Scalability Aspects</td>
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<td>• Extension to other link technologies</td>
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<td>• Multilayer optimization</td>
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Enhanced OpenFlow controlled MPLS software switches with 1:1 Protection, BFD based OAM support and PseudoWiresOpenFlow controller cooperating with legacy distributed MPLS control plane

- Provisioning of end-to-end tunnels through IP/MPLS core and OpenFlow Aggregation domains
  - Best effort tunnels for internet services
  - Multicast tunnels for IPTV
  - Protected tunnels for premium services (e.g., PWE)
Open source approach

- Demonstrations at
  - GENI Engineering Conference (US, 15\textsuperscript{th} March)
  - Future Internet Assembly (Budapest, EU, 17-19 May)
  - IPoP 2011 (Japan, 3-4 June)
  - Future Network and Mobile Summit (Warsaw, EU, 15-17 June)

- Open Source components at
Distributed BRAS function.
Authentication with Software Defined Networking.

Example of alternative AAA approach.

**BRAS**

**RADIUS**

AAA & user profile server

**RGW**

**PPPoe**

AAA inform.

**AGS2**

**AGS1**

**DSLAM with PPPoe intermediate agent**

**AAA inform.**

**AAA App**

**Resource configuration**

Includes port information

* Or via OF controller
Future option in access/aggregation: Virtualized infrastructure and core network services.
What is missing?
Beyond standard x86 server + OpenVSwitch.

- Reference design for SDN compliant forwarding network element and controller that fulfill carrier requirements
  - Complex processing beyond basic forwarding
  - Scalable configuration
    - Thousands of ports
    - Terabit throughput, millions of flows
  - Manageability and integration in large-scale infrastructure
- Harmonize paradigms for ISP and data center
- Overall architecture and definition of Application Programming Interfaces

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What is missing?
A general hardware abstraction Layer.
OpenStack: Open source cloud management / orchestration.

- OpenStack is a cloud management and orchestration platform
- Comparable to essential Amazon Web Services offering (initially with compatible API)
- Initiated by Rackspace and NASA, who combined their respective virtualization technologies
- In production use (RackSpace, NASA, HP, Mercado Libre, Korean Telecom, NTT, AT&T, ...)
- Backing and contribution from over 155 companies
- OpenSource (Apache 2 License)
- Many community projects extending the core functionality

"OpenStack is a community and a project as well as a stack of open source software to help organizations run clouds for virtual computing and/or storage."

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Thank you for your attention!

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