White-Box for NREN

GN4ph3: Objective and strategy

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STF meeting, Bucarest, 26/02/2019

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White Box: What is it?

• A Buzzzzzzzzzz Word ......

• A **pragmatic approach driven by NREN use cases**

• Put in « **production** » if operation constraints are satisfied
White Box: What is it?

• A switch/router that is able to run different Network Operating System (NOS)

• The key idea is to be independent from traditional hardware vendors. Disaggregation trend between Network Operating System and hardware

→ 2 levels of independence:
  • independence from the hardware
    • you can change the hardware vendor and keep the software
  • independence from the NOS
    • you change the NOS and keep the hardware
Proprietary design

- Business model
  1. Hardware design Proprietary
  2. Proprietary NOS (embedded)
  3. Hardware maintenance
  4. NOS maintenance

- Dependence from one vendor
White-box Design

• Same ASICs as in many well-known vendors which use off-the-self/commodity ASICs
  • Juniper/Cisco use the same chipset
• Performances and features depend on forwarding chipset (switching ASIC) and the NOS
  • Trident, Trident 2, Tomahawk, Qumran, Jericho
  • Commercial and open source NOS
• New business model
  1. Hardware design Proprietary and Hardware maintenance
  2. NOS (embedded) and NOS maintenance
Current White Box

• Issue mainly from the data-center world

• Switch with very powerful forwarding capacity and limited number of features

• Cost effective

• New product for network provider

• The architecture of data-center, regional network and telecom carrier become very similar
Routing landscape is changing fast

- Router vendors use ASICs as in many well-known vendors which use off-the-self/commodity ASICs

- **The market is driven by data-center**
  - Architecture of data-center, regional network and telecom carrier become very similar

- **Traditional data-center switch vendor want to enter into the market**

- **Very cost effective**

- Classical vendors will not stay without any reactions
  - Price of legacy vendor box is already decreasing a lot
  - They have already a white offer
White Box: a trend

- ACCTON, Edge-Core, DELL, ...
  - Cloud, Large Data-Centers

- But also traditional router vendor start ...
  - JUNOS OS FOR WHITE BOX DATA CENTER SWITCHES
  - Enabling IOS-XR on Third-Party Network Hardware

![Diagram of Juniper Networks](https://www.juniper.net/assets/us/en/local/pdf/datasheets/1000641-en.pdf)
## Network Operating System

<table>
<thead>
<tr>
<th>NOS</th>
<th>commentaires</th>
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<tbody>
<tr>
<td><strong>DELL</strong></td>
<td>O9 ou OS10 (Free BSD)</td>
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<tr>
<td><strong>Cumulus Networks</strong></td>
<td>IP Infusion</td>
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<td><strong>IP Infusion</strong></td>
<td>OcNOS</td>
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<td><strong>NetVisor</strong></td>
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<td><strong>Open Network Linux</strong></td>
<td><strong>Open / Free</strong></td>
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<td><strong>Barefoot networks</strong></td>
<td><strong>Sur chipset Tofino</strong></td>
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<td><strong>Pica8</strong></td>
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<td><strong>Big Switch Networks</strong></td>
<td><strong>SwitchLight</strong></td>
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<td><strong>Canonical Snappy</strong></td>
<td><strong>Ubuntu Core</strong></td>
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<tr>
<td><strong>Software for Open Networking in the Cloud</strong></td>
<td><strong>SONIC</strong></td>
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<td><strong>OpenNetwork in the Cloud</strong></td>
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<td><strong>Open Network Foundation Atrium SDN</strong></td>
<td><strong>Distribution</strong></td>
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<tr>
<td><strong>Open Compute Project</strong></td>
<td><strong><a href="http://www.opencompute.org/projects/networking/">http://www.opencompute.org/projects/networking/</a></strong></td>
</tr>
<tr>
<td><strong>Microsoft and co-contributors to OCP</strong></td>
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<tr>
<td><strong>Orienté cloud pour AZUR</strong></td>
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<tr>
<td><strong>SONIC</strong></td>
<td></td>
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<tr>
<td><strong>Switch Abstraction Interface (SAI)</strong></td>
<td></td>
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</tbody>
</table>
White-box architecture

In general, 1 routing engine
Chipset characteristics

- Buffer and memory
  - Packet queue length
- Route number limited in FIB
  - For instance, Trident2 is limited to around 200 000 FIB routes
- The same limitation can be seen traditional vendor device that use Trident2 (FIB, TCAM ACL rules, ECMP on VXLAN)
Example cost analysis gathered on the Web

Traditional, White-Box and Brite-Box switching models

$300 to $400 per Port

Integrated
Traditional Switch

Software (Vendor A)
(E.g., Cisco, HP, Juniper, Dell and Extreme)

Hardware (Vendor A)

Disaggregated

White-Box Switch

Software

Hardware (Vendor A)
(E.g., software: in-house, Cumulus, Big Switch and Pica8)
(E.g., hardware: Quanta, Acton and Edge-Core)

Brite-Box Switch

Software (Vendor B)

Hardware (Vendor A)
(E.g., software: Cumulus, Big Switch and Pica8)
(E.g., hardware: Dell)

Source: Gartner (December 2014)

“brite box” = branded white box
Our approach

- Assess white-box use in NREN context → **WB deployment**
  - Explore NREN-relevant use cases: Data-centre, IX router, CPE, P router, ...
  - With the objective to deploy them in production

- White box programmability → **Data Plane Programming**
  - New usage: Monitoring, Security
  - Router for Academic, Research and Education (RARE)

- Concentrate the effort over the next 2 years
Lessons learnt

• Management Plane (Operation, automation, security), documentation, maintenance model are mandatory

• White Box adoption/uptake strategy is a key point

• Do not expect better than you have
  • Same will be a great result
  • New usage/feature will be a breakthrough
Lesson learnt

• White box will not replace our Juniper or Cisco boxes in a first stage
  • Instead move specific services on white box: GIX, LHCONE, ...

• A long term approach is necessary
  • Linux does not replace Solaris in one year
  • The landscape is changing continuously

• Not a reversible path?
  • For White Box
  • For data plane programming
WB deployment: Scope of our work

- Switch with Linux on which you can download your NOS
- Switch with ONIE
  - DELL, Edge Core, ...
- A X86 server than run several NOS
R&E use cases

• NREN backbone (PE and P routers)
• Regional network
• Campus network
• Science project
• Global Internet eXchange (GIX)
• Cloud Fabric
• New usages
  • Monitoring, Telemetry
  • Security
Use cases handled by WP6T1 WB deployment

• Internet eXchange point
  • SFINX, RENATER Internet eXchange point (Paris/2 locations)

• CPE
  • High school in Normandy Region (France) - RENATER
  • FUnet

• Data Center
  • Normandy Region (France) – RENATER
  • GRnet

• P router - PSNC
CPE project in France

- A X86 server with a NOS can be considered as White Box
- Limited number of use-cases due to performance

Example of CPE design
Internet eXchange Point

Transition Model

Paris1 : paris1-rtr-131

Paris2 : paris2-rtr-131

STEP 3:
- Migrate client from old device to white boxes

RSTP

Root Bridge

Client migration

IX1 – sfinx1-sw1-201

TH2 – sfinx2-sw1-201

ISP

ISP

France-IX

France-IX

Vlan 99 ADMIN-SFINX2
Vlan 98 ADMIN-SFINX1
Vlan 2 SFINX-ISP
Vlan 5 Multicast
Vlan 4 France-IX
Physique
Data-center Normandy project

WB : Datacenter switching

Goals

· Cost reduction
  - this is the main objective: the initial vendor solution cost 200k€ for around 1500 1Gbit ports

· Interoperability
  - separate hardware from software is interesting when upgrading or extending part of the infrastructure
  - avoid vendor lock situation especially when it comes to big infrastructure

· Automation and orchestration
  - no more CLI configuration
  - network configuration will be driven by application services
GRNET data center projet - IP Fabric topology

- **Spine & Leaf topology**
  - **SPINE:** Tomahawk ASIC
    - nx40G uplink to GRNET DC routers
    - nx100G uplink to GRNET L2 core SDN
  - **LEAF:** Trident2+ or Maverick
    - 2x40G uplink

- **Server:**
  - 2x1/10G UTP
    - **Multihoming:** In pairs of racks
    - LACP or Active-Backup
Condition to adopt white-box model?

• Identify a first use case
  • The same services that NRENs provide to theirs end-users?
  • OR a new service?

• Use Case validation
  • Feature?
  • Performance?
  • Maturity and Reliability?
  • What is missing in an open network operating system before going into production?
    • Manageability, Open network operating system security, Documentation, Maintenance model
  • ...

• Transition model that could be put in place in order to go in production?
• What is the total cost ownership for such technology?
WB deployment strategy

- Identify appropriate use cases that will be put in production
  - White Box adoption/Uptake strategy
- Technical validation
  - Methodology
- Business model
  - Licence model and TCO
- Deployment plan
- Qualification for production
- Production
White Box Programming – Data Plane Programming

• Data Plane Programmable – P4 language
  • Based on PISA architecture [Protocol-Independent Switch Architecture], FPGA, Open VSwitch Tofino chipset barefoot network (https://www.barefootnetworks.com)

• Application
  • Monitoring: Advanced Network Monitoring/Telemetry
  • Security: In-Network DDoSDetection
  • Performance: Layer 4 Load Balancer
  • Analytics

P4 Workflow
Data Plane Programming (DPP) and P4 language

- **DPP advanced feature**
  - Coordinator: Mauro Campanella
  - Objectives: Explore new feature provided by programmable white box
    - Monitoring
    - Security (DDOS)

- **Router for Academic, Research and Education (RARE)**
  - Coordinator: Frédéric Loui
  - Objectives: Demonstrate the feasibility of a router for academic community
    - Data plane: DPP
    - Interaction control plane and Data plane
Summary

• The routing landscape is changing fast
  • Especially in data-center ...
  • Business model – Cost - New NRENs (African countries, ....)

• WB deployment
  • Test and put in production WB in NREN use cases context

• WB programmability
  • Investigate new usage: first Monitoring and security
  • Open source router for academic and research
  • Universities are very interested for its own research in developing P4 usage

• Build a community around white-boxing
Building a community around white boxing

• **Workshop and dissemination:**
  • White-Boxing: 4th April 2019, SUNET, Stockholm, (before SIG-NGN)
  • P4 Programming: 20th June TNC19, BoF - exploring R&E community use cases

• **Feedback from our community**
  • NREN
  • Education and Research community
Thank you

Any questions?

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