Tassen:
Towards a Next-Generation BNG CUPS API

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ONF Spotlight - Broadband, July 2020

Motivation from the operator perspective

Motivation for Tassen (1/2)

- **Deutsche Telekom project Access 4.0**
  - Transformation of access network based on SEBA
  - Multi service implementation at the edge starting with BNG
  - Open for extension - need flexibility
- **Status quo: on the way for disaggregated BNG**
  - Separate hardware from software
  - Open source hardware developed - upcoming Magenta Switch
  - Still software block from vendor running on device

Motivation for Tassen (2/2)

- **Control and User Plane separation - CUPS**
  - Separate the software block into pieces: BNG-CP and BNG-UP
  - Scalability and redundancy
  - Independent lifecycle management
  - (centralised) control plane shall use various hardware
- **How to?**
  - Requirements, architecture and first proposal from BBF: PFCP
  - Want alternatives, competition for innovation
  - Data centre inspired approach: P4 and gNMI

Tassen Overview

Tassen = German for “cups”

Options for BNG Disaggregation

Traditional chassis-based vendor Broadband Network Gateway (BNG)

Specialized router
QinQ, PPPoE, IPoE, accounting, HQoS, lawful intercept, wholesale tunnel relay (L2TP), multicast, etc.

SDN-ize

Equivalent features, but different pipelines! Known problem with SDN v1 and OpenFlow

BNG-CP → Intelligence
Choice of programming language and architecture

Open CUPS API *Provides silicon-independence & facilitates interoperability*

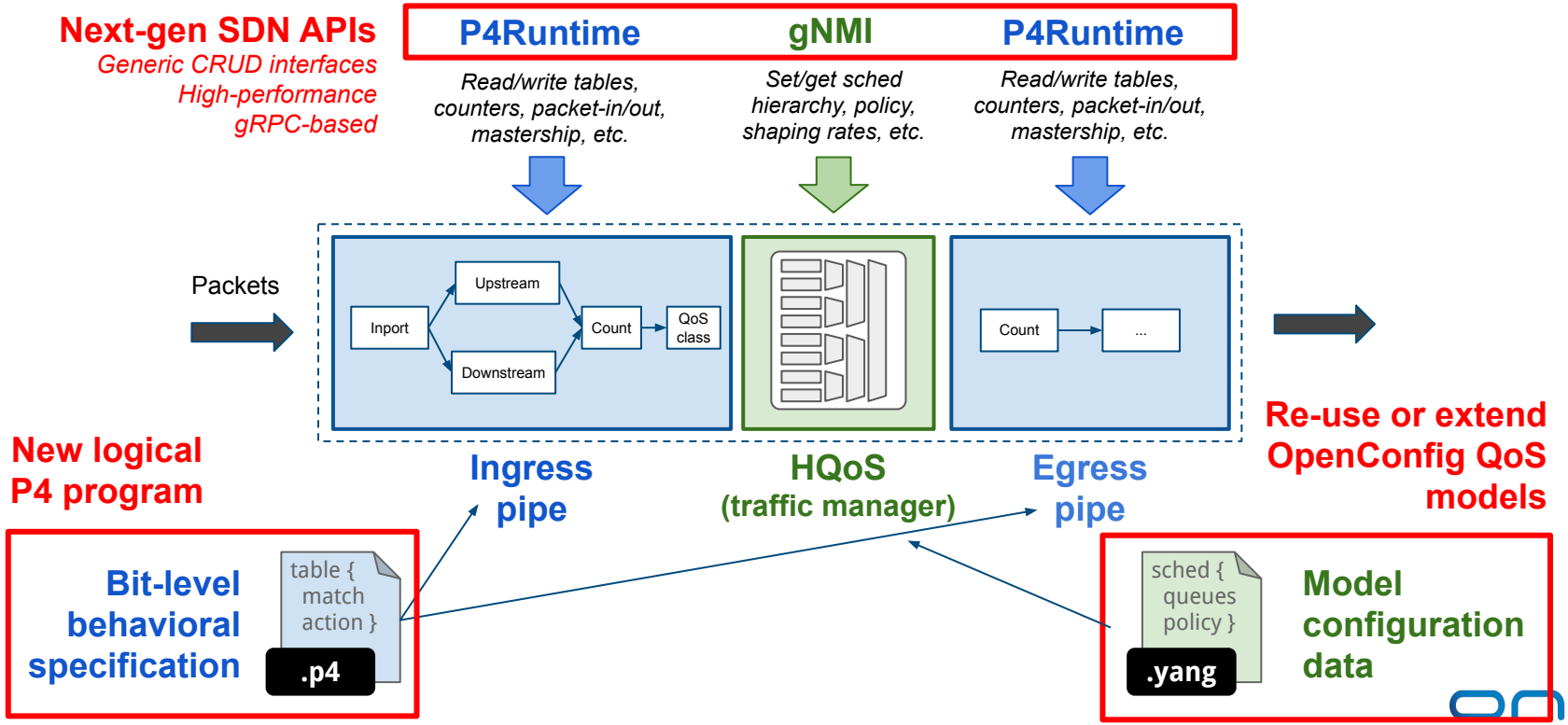
BNG-UP → High-speed forwarding
Choice of merchant silicon and port configuration

Magenta Switch Single-chip Qumran 2C  *Deutsche Telekom*	**SmartNIC** Single-chip FPGA  *Dell, Intel, Benu*
Tofino + Qumran AX Dual-chip, HQoS in OLT (WIP)  *ONF*	**Tofino + FPGA** Dual-chip, HQoS in FPGA  *TU Darmstadt*

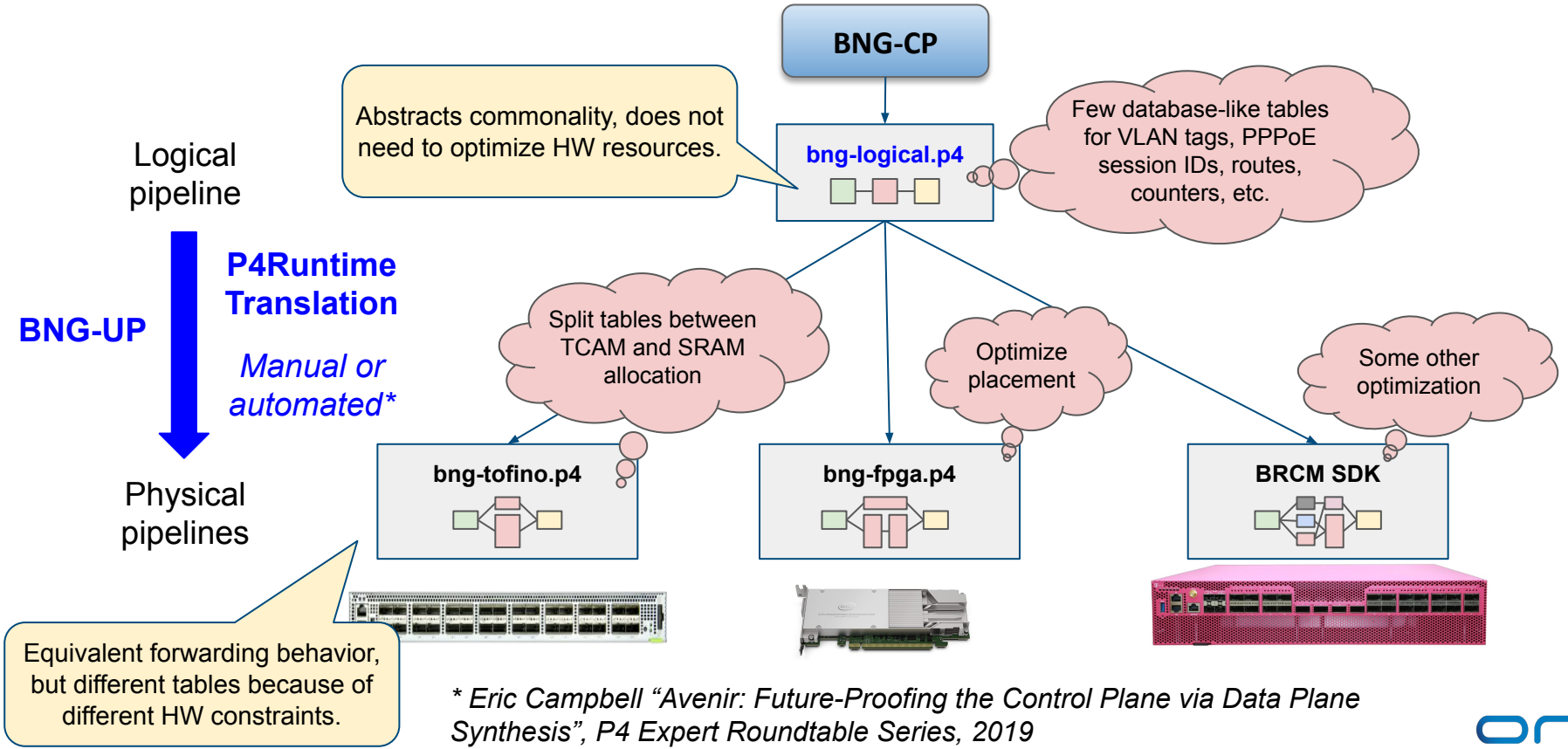
Example of HW-based implementations existing today. Others are possible, including SW-based processing.

Tassen BNG-UP Logical Model and API

High-level pipeline model common to all BNG-UP options



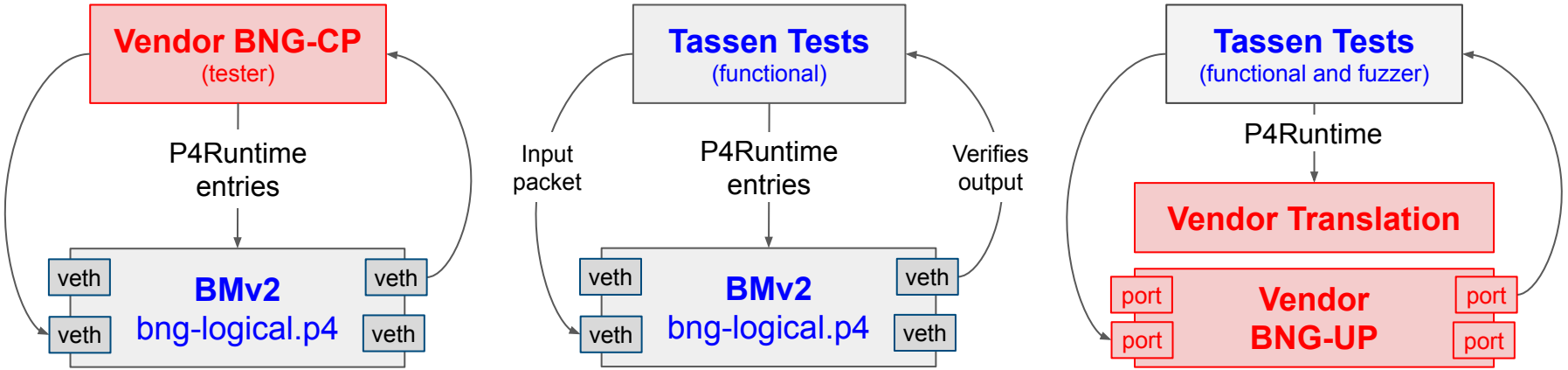
Logical vs. Physical Pipelines



** Eric Campbell "Avenir: Future-Proofing the Control Plane via Data Plane Synthesis", P4 Expert Roundtable Series, 2019*

Test Everything!

- **Validate logical pipeline and P4Runtime API via packet-based test**
  - Functional tests: set up PPPoE termination, punt control pkts, accounting, etc.
- **Tests as reference for CP and UP implementers**
  - Discover hard-to-catch bugs via fuzz testing based on P4 program analysis *



* Google talk at P4 Workshop 2019 "Leveraging P4 for Fixed Function Switches"
* Andres Nötzli, et al. "p4pktgen: Automated Test Case Generation for P4 Programs", SOSR 2018

Project Status

- **Tassen Brigade: bi-weekly meetings since March 2020**

  Participants: Carmelo Cascone (ONF), Mario Kind (DT), Craig Stevens (Dell), Daniele Moro (Politecnico di Milano), Ralf Kundel (TU Darmstadt)
- **Initial code on GitHub**

  https://github.com/opennetworkinglab/tassen
- **Logical P4 pipeline (bng.p4)**

  Basic downstream & upstream for PPPoE & IPoE, and accounting
- **Functional tests**

  Python test suite based on Packet Test Framework (PTF)
- **Reference P4Runtime translator (mapr)**

  Written in golang, with support for ONF's fabric.p4 and extensible architecture

What about PFCP?

BBF Disaggregated BNG Architecture (WT-459)

- **PFCP**
  - **3GPP-defined protocol** — *Requires extensions for BNG*
  - **Heavyweight OpenFlow-style API** — *Defines wire protocol, Packet Detection Rules (PDR), Forwarding Action Rules (FAR), keep-alives, reliable delivery (retransmissions), etc.*
  - **Ambiguous pipeline model** — *Sort of "one big ACL-like table", specified in English and figures.*
  - **Makes interoperability hard** — *Possible only with extensive manual testing*

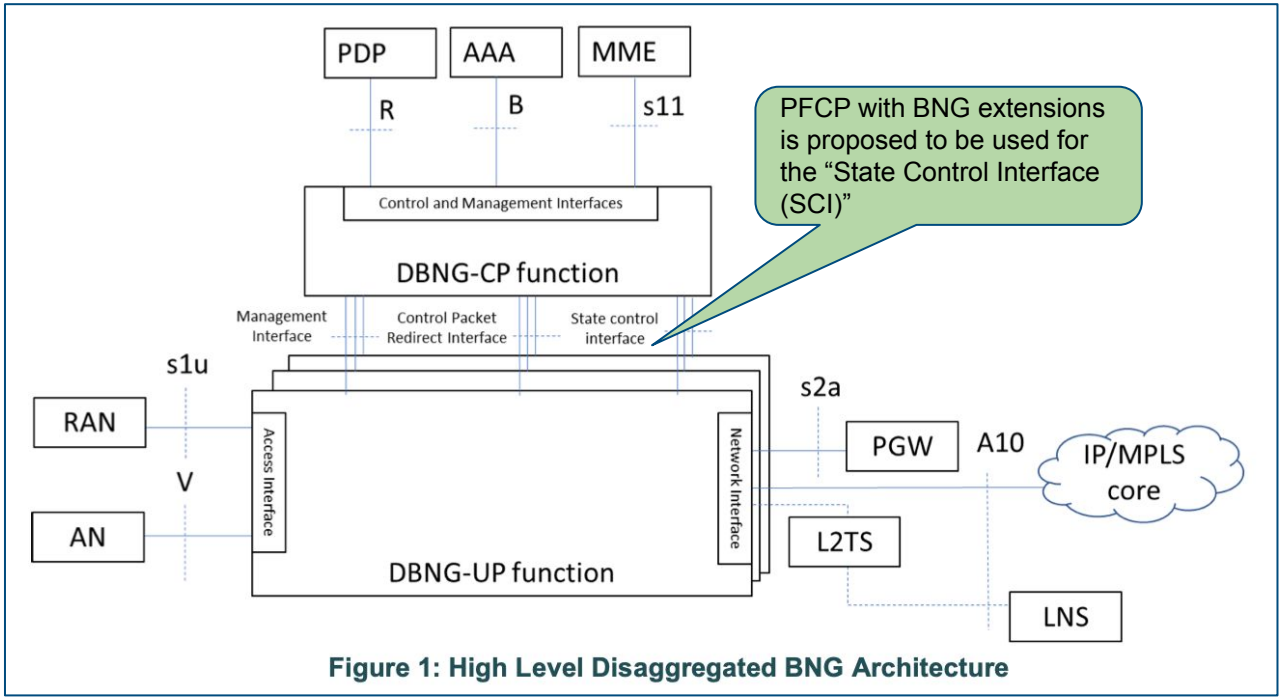
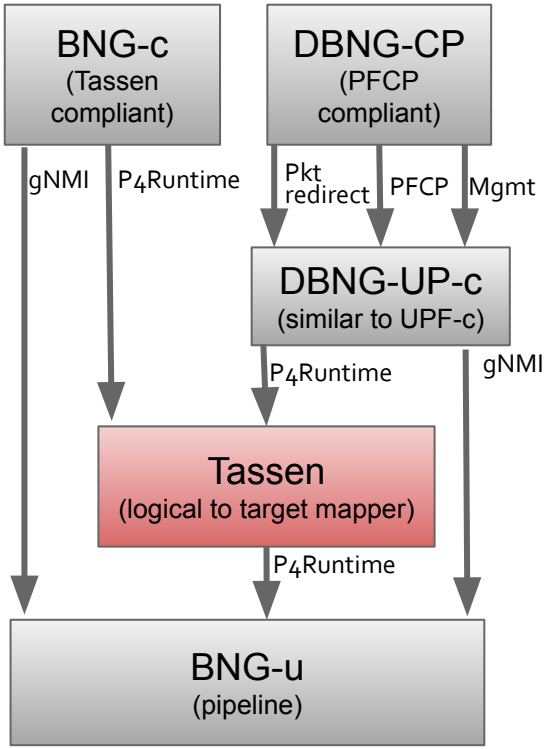


Figure 1: High Level Disaggregated BNG Architecture

Note: This diagram is from the BBF WT-459 specification

CUPS API: From PFCP to Tassen

- **Learn from the OpenFlow experience**
  - Formally specifying the forwarding pipeline is essential to achieve silicon-independence… lots hardware platforms coming
  - Re-use proven cloud native technologies (gRPC) and focus on the important stuff (pipeline data models)
  - Allows forwarding pipeline to be fully tested… "Test everything"
- **Native Tassen based BNGs**
  - BNG-c components that support Tassen's south bound interfaces (i.e. P4 Runtime and gNMI) can talk natively through the mapper to the BNG-u
- **BBF based BNGs**
  - DBNG-CP will communicate normally with the DBNG-UP-c using BBF interfaces (i.e. SCI, Pkt redirect & Mgmt)
  - DBNG-UP can then be split into a DBNG-UP-c that will communicate southbound with the BNG-u using the Tassen interfaces (i.e. P4 Runtime & gNMI)… similar to 5G UPF-c and UPF-u split



Summary

- **BNG disaggregation essential part of SEBA broadband access solution**
- **BNG CUPS interoperability can be painless**
  - *By formally specifying the logical pipeline in P4 and writing tests against it*
  - *Promising P4 research: automated P4RT translation, fuzz testing, verification, etc.*
- **Can be used with or without SEBA**
  - *Tassen app on ONOS, or standalone translator*
- **ONF currently exploring the same approach for 5G UPF (Aether)**

Next Steps

- **Model more pipeline capabilities**
  - *Multicast, lawful intercept, L2TP, etc.*
- **Validate OpenConfig QoS model or extend/create a new one**
  - *Based on BNG requirements for multi-level scheduling, etc.*
- **Implement reference P4RT translation for more targets**
  - *Magenta Switch, SmartNIC, Tofino+FPGA, SW-based vBNG, etc.*
- **Run automated test case generation (p4pktgen)**
- **And more… Join the effort!**
  - *Reach out to Carmelo to join the brigade meetings*

Thank You

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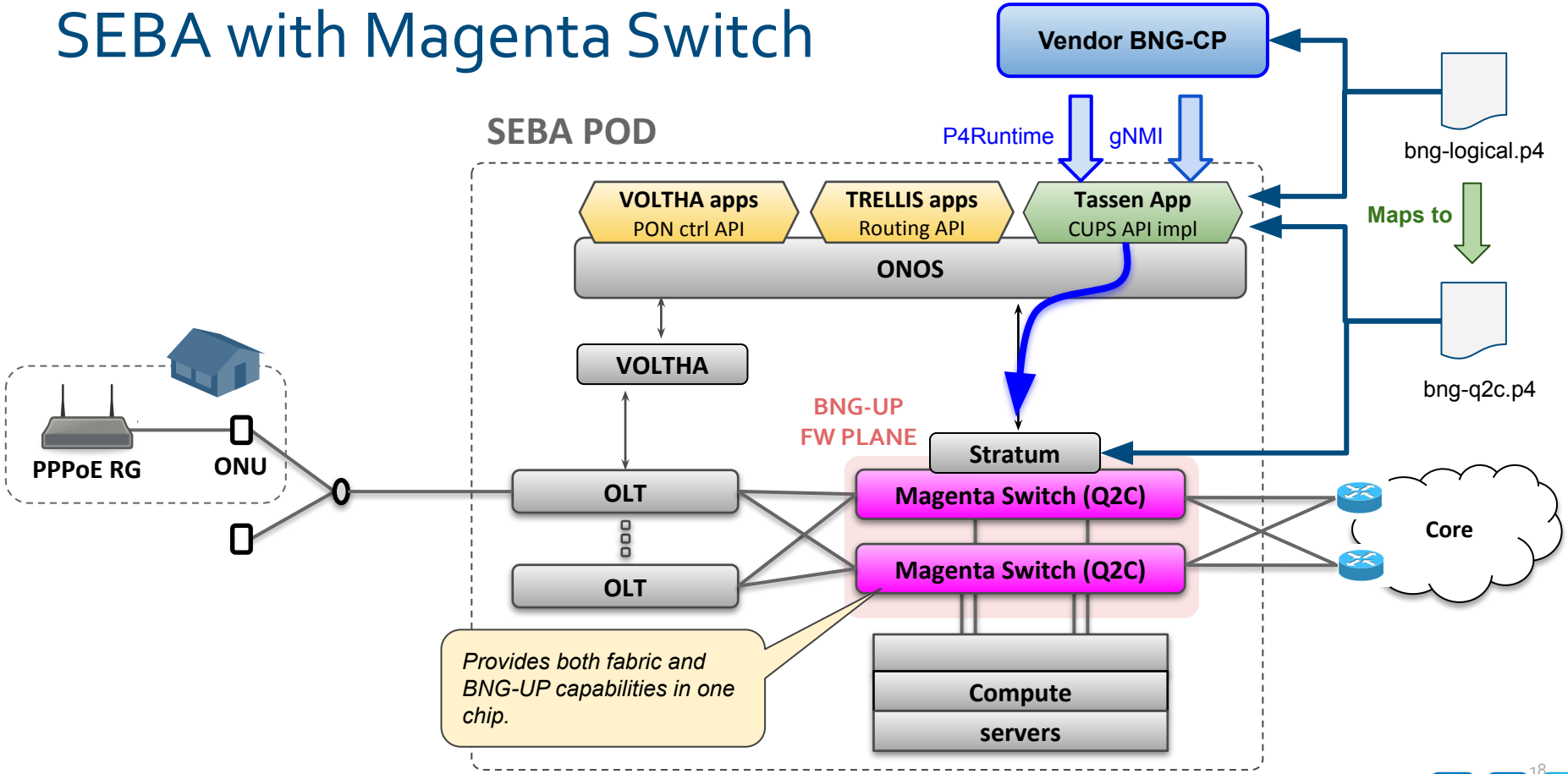
https://github.com/opennetworkinglab/tassen

Backup

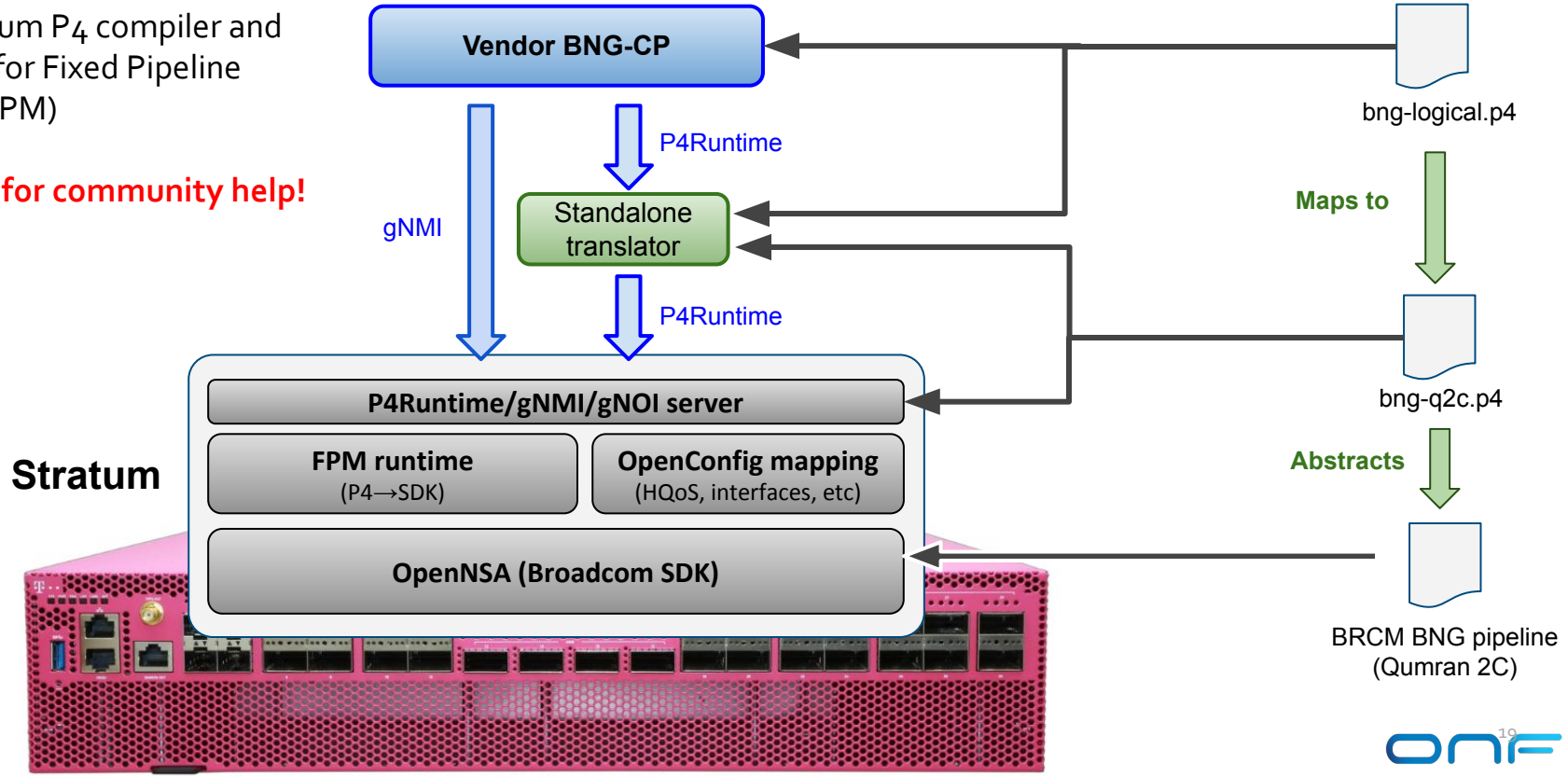
SEBA with Magenta Switch



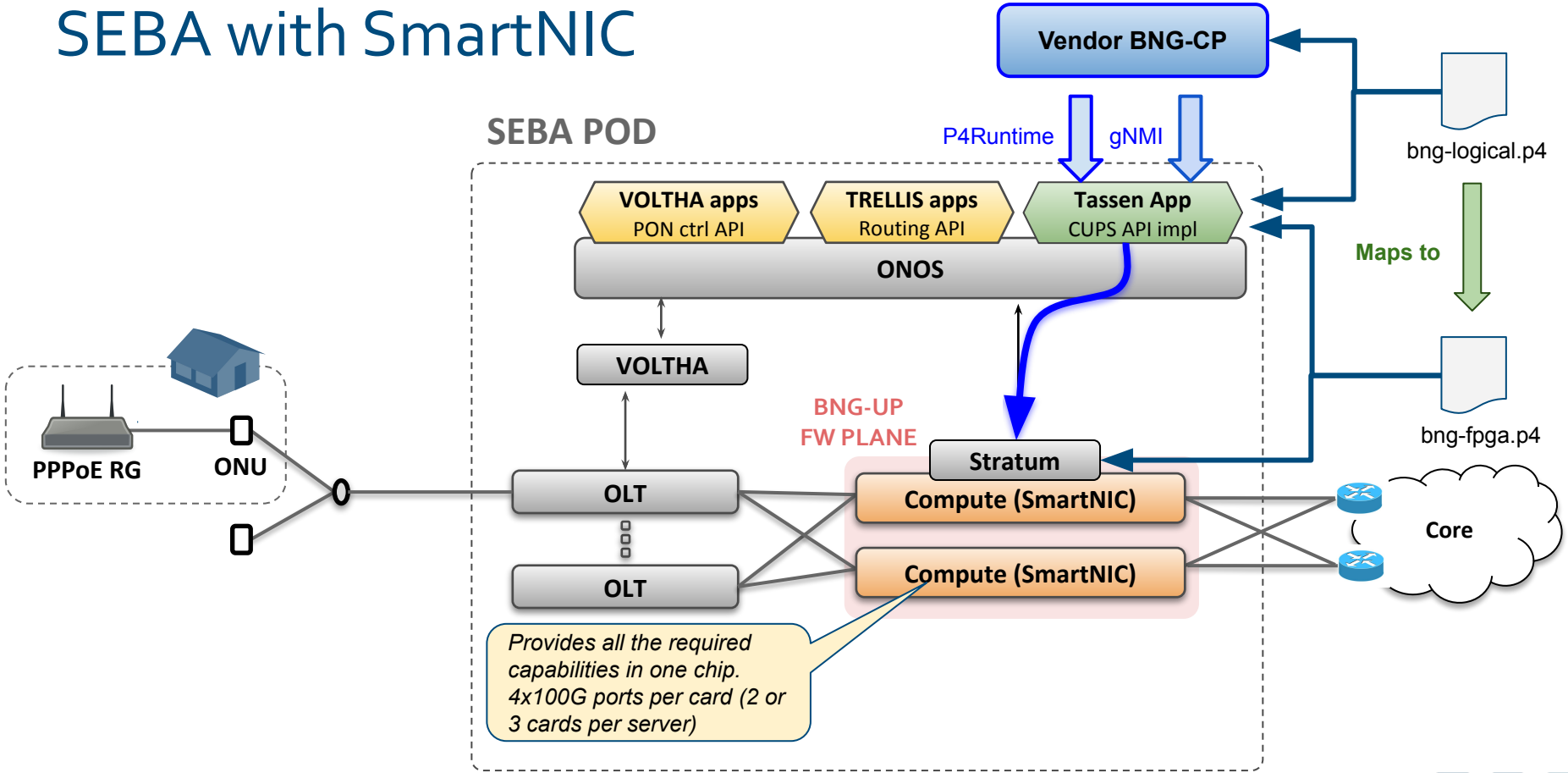
Aside: Proposal for a Stratum-based Magenta Switch

Via Stratum P4 compiler and runtime for Fixed Pipeline Model (FPM)

Looking for community help!

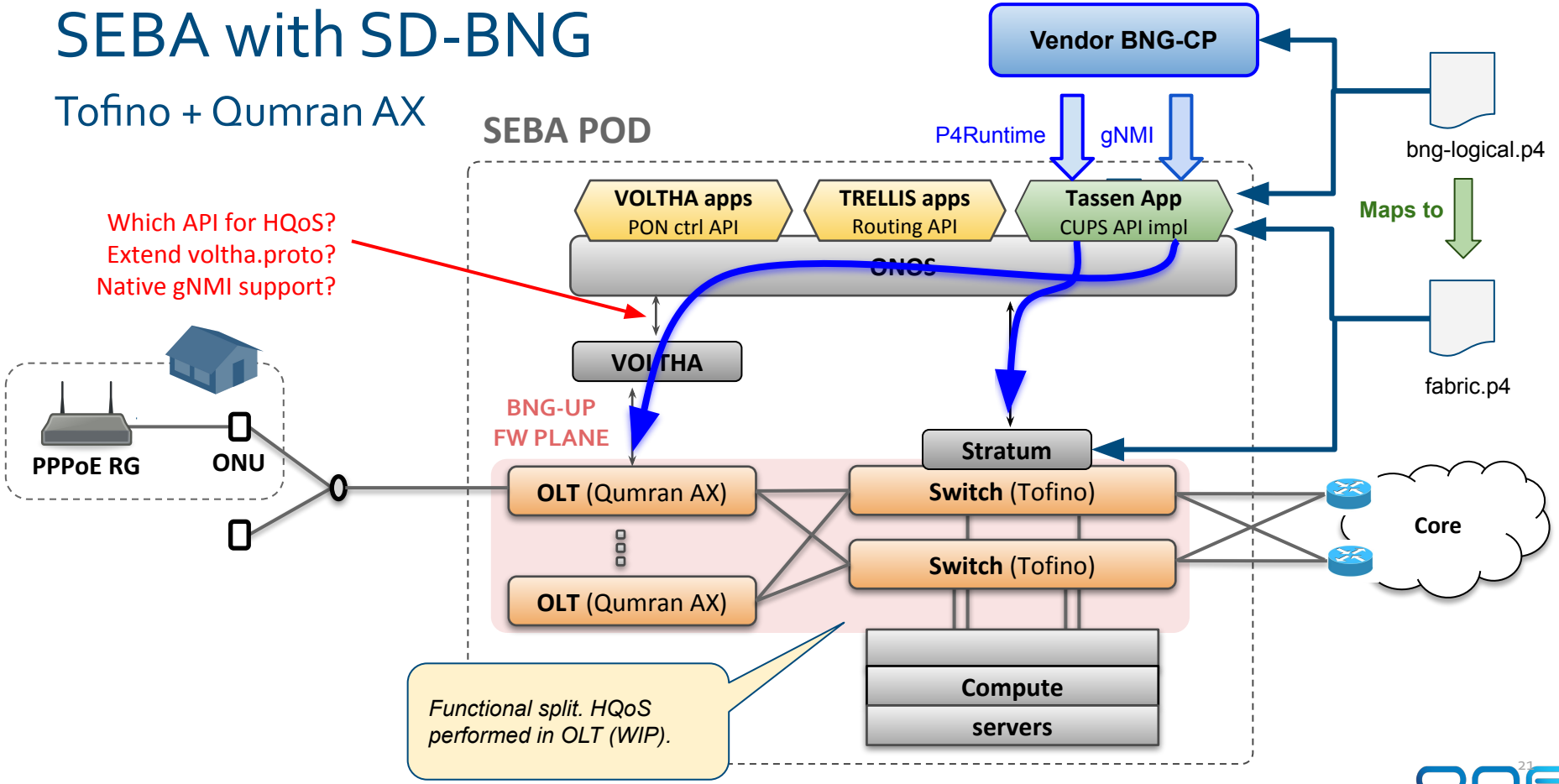


SEBA with SmartNIC

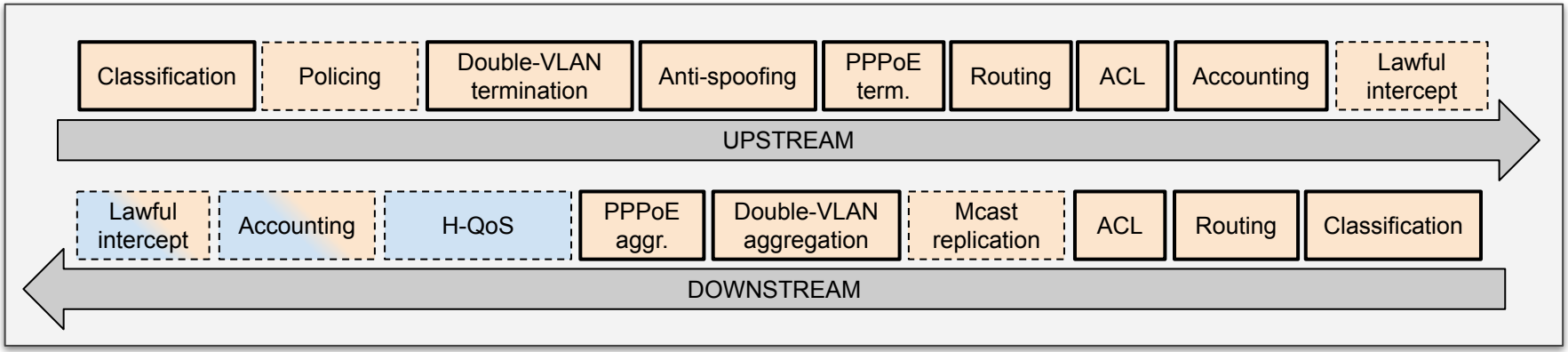


SEBA with SD-BNG

Tofino + Qumran AX



Tofino+QAX Pipeline with Functional Split



BNG-UP

Barefoot Tofino (leaf switch)

Broadcom Qumran AX (OLT)

Work in progress