Impact of Virtualization and SDN on Emerging Network Coding

https://datatracker.ietf.org/doc/draft-khasnabish-nwcrg-impact-of-vir-and-sdn/

(Current Version: draft-khasnabish-nwcrg-impact-of-vir-and-sdn-03.txt)

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IETF 92 NWC RG Mtg., Royal Suite

9 - 11:30 AM CDT, Friday, 27 March 2015

Outline

- **Updates** since IETF 91 (Nov. 2014)
- **Plan** for next version (ver.-04) of the draft
- **Request** for further Comments, Thoughts, Suggestions, Guidance, Volunteers, etc.
- **Q & A**, and **THANKS!**

Plan for version 04

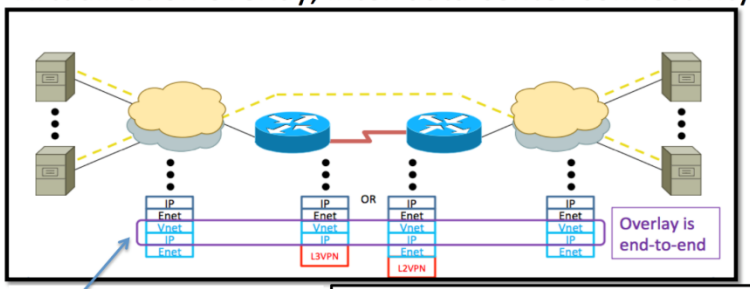
- In version 03:
  - We added what was presented last time related to:
    - **Where** to use SDN and NC?
    - **Why** use SDN and NC?
    - First steps of "**How** to implement SDN and NC?"

- Planned in version 04:
  - Further work on "**How** to implement SDN and NC?"
  - Consider the 5 use cases of "Network Coding Architecture – use cases protocols, and building blocks" in SDN context and consider "How to implement?"
    - E.g. NC shim through different layers of SDN architecture, etc.

Where to use SDN and NC ?

- In version 03: some examples
  - SDN typical use in datacenters or in RAN (implies: subsets of use cases of NC)

- – Virtualization overlay, inter-data-center connectivity

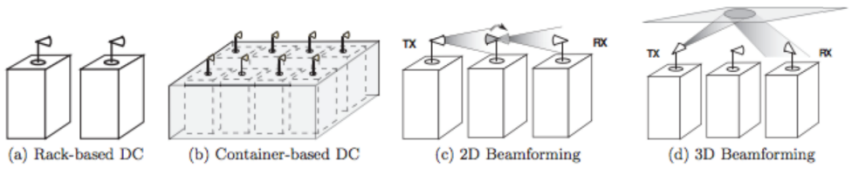


- Original payload (packets) at the edges are encapsulated in other IP packets w/ header
- sent on an overlay

Taken from: D. Black presentation at NVO3 BOF, IETF-83
http://www.ietf.org/proceedings/83/slides/slides-83-nvo3-1.pdf

Example:
in architectures such as NVO3,
on inter-datacenter overlays

- – (several) propositions of 60 GHz wireless data-centers
  - Incl.: Xia Z. et al, "Mirror Mirror on the Ceiling: Flexible Wireless Links for Data Centers", SIGCOMM, 2012



(a) Rack-based DC (b) Container-based DC (c) 2D Beamforming (d) 3D Beamforming

Source: http://conferences.sigcomm.org/sigcomm/2012/paper/sigcomm/p443.pdf

Example:
In (specific) scenarios loosely related to RAN: wireless in datacenter (60 GHz)

Why use SDN and NC ?

- In version 03:
  - Benefits from NC:
    - Reliability (multipath, inter-datacenters)
    - Performance in case of multicast (butterflies…)
  - SDN benefits for NC:
    - Central knowledge (controller)
    - Possible implementation without apps/stack modification
  - Open question: feasible/useful to use the reliability of network coding to improve latency (treat late packets as lost packets)

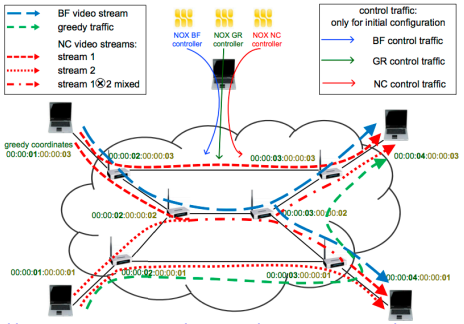
    Open question: possibility of "cross-domain" routing e.g., mixing NC in storage and NC in the network.

How to implement NC ?

- In order to support network coding, **one entity** has to code/decode somewhere, but who? (needs further investigations)

(Academic) proofs of concept of modification of SDN switches for NC

Németh et al. "Towards SmartFlow: Case Studies on Enhanced Programmable Forwarding in OpenFlow Switches", demo SIGCOMM 2012



Source: http://qosip.tmit.bme.hu/~gulyas/personal_page/openflow_demo.pdf

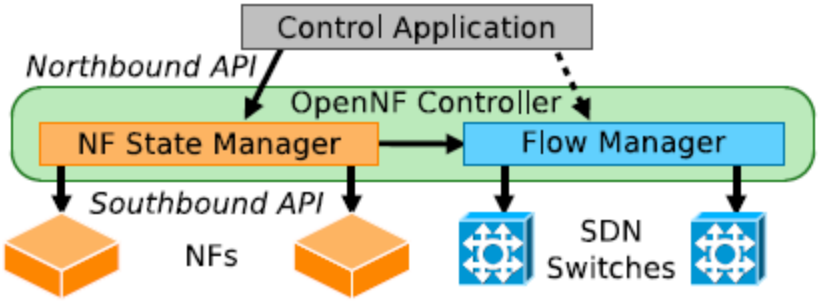
Sicheng Liu, Bei Hua, "NCoS: A framework for realizing network coding over software-defined network", IEEE LCN2014, Sep 2014.

Can the coding/decoding function be implemented using a Virtual Network Function (NFV)?
(what are the impacts on overall performance?)

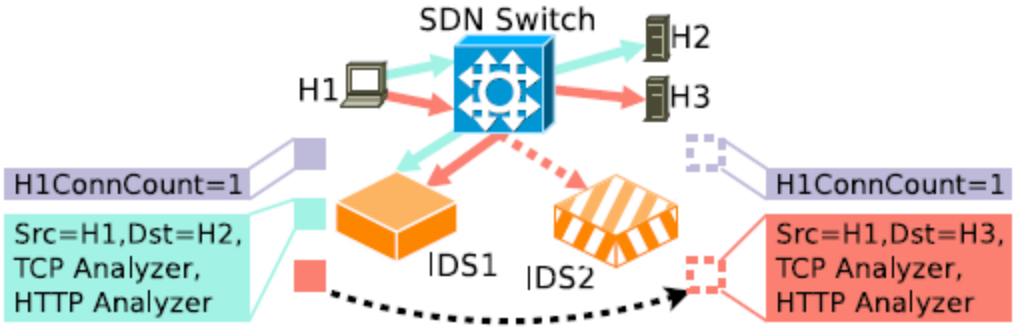
Any other approaches?
(what are the pros and cons?)

How to implement NC ?

- In order to support network coding, **multiple entities can co-operatively perform encoding/decoding** in different layers of SDN using virtualized components (needs further investigations)



Aaron Gember-Jacobson et al,
OpenNF: Enabling Innovation in Network Function Control.
Proc. ACM SIGCOMM, Chicago, IL, USA, August 2014.



http://opennf.cs.wisc.edu/overview

What's Next?

- Comments
- Thoughts
- Suggestions
- Guidance
- Volunteers / Contributors / Reviewers,
- Anything else ?!

Q&A, and Discussion

THANKS!

Background Materials

Virtualization

- Computing Resources Virtualization (*Software-defined Computing resources*)
  - ***DMTF and Open Compute/Cloud/Stack Specs may be useful***
- Network Function Virtualization (*Software-defined Network functions*)
  - ***ETSI/ISG NFV started developing the Requirements and gaps in the Industry and Standards***
- Storage Virtualization (*Software-defined Storage resources*)
  - ***SNIA specs may be useful***
- Service Function Virtualization (*Software-defined Service function*)
  - ***ETSI/ISG NFV started developing the Requirements and gaps in the Industry and Standards***

Virtualization of Network-Level Resources

- Network Node virtualization
  - ***This refers to developing Templates for Deploying (Allocating, Managing, and Releasing the Functions that Reside in Network Nodes; the Functions may include Addressing, Forwarding, Monitoring, Management, etc.)***
- Router virtualization
  - ***This refers to developing Templates for Deploying (Allocating, Managing, and Releasing the Functions that Reside in Routers; the Functions may include Route creation and management for packets/flows, etc.)***
- Network Topology virtualization
  - ***This refers to developing Templates for physical (and virtual) interconnection among the network nodes (routers and others) and utilizing them for networked services***
- RIB/TIB (Routing /Topology information base) virtualization
  - ***These refer to virtualizing (developing the templates and utilizing the instances) the databases that store Topology and Routing information***
- Network service (policy, security, quality, load-balancer , etc.) virtualization
  - ***This refers to developing Templates for advanced network services and utilizing instances of those templates in general COTS servers for services***

Virtualization of Network Coding

- Network Coding support of virtualization
  - ***Network codes that can utilize both physical and virtual Transport, Routing, Forwarding, etc. entities***

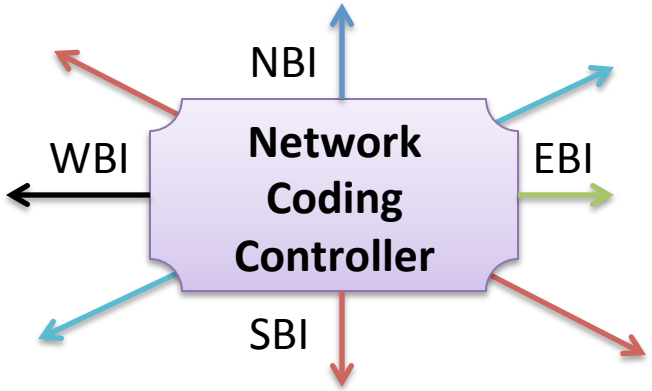
- Virtualization Support in Network Coding
  - ***Virtualization of Network codes for any combination of Transport, Routing, Forwarding, etc. entities***

Network Coding Controller (NCC)

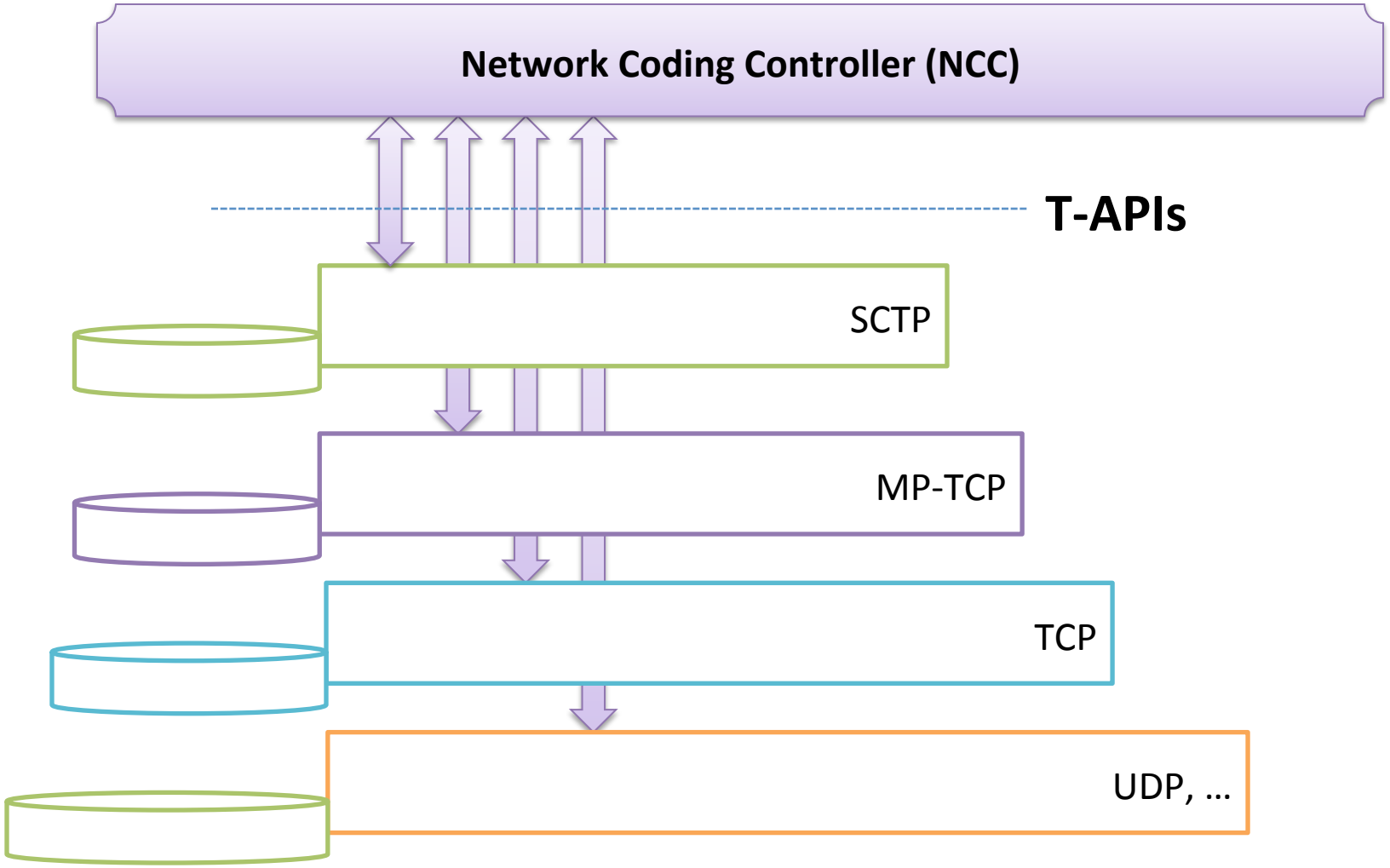
- Logically Centralized Physically Distributed
  - ***Clustered or Hierarchically organized NCCs (physical and/or virtual)***
- Physical NCC
  - ***A Physical device/host that contains the NCC functions***
- Virtual NCC
  - ***A virtual machine that hosts/contains an instance of the NCC function***

APIs

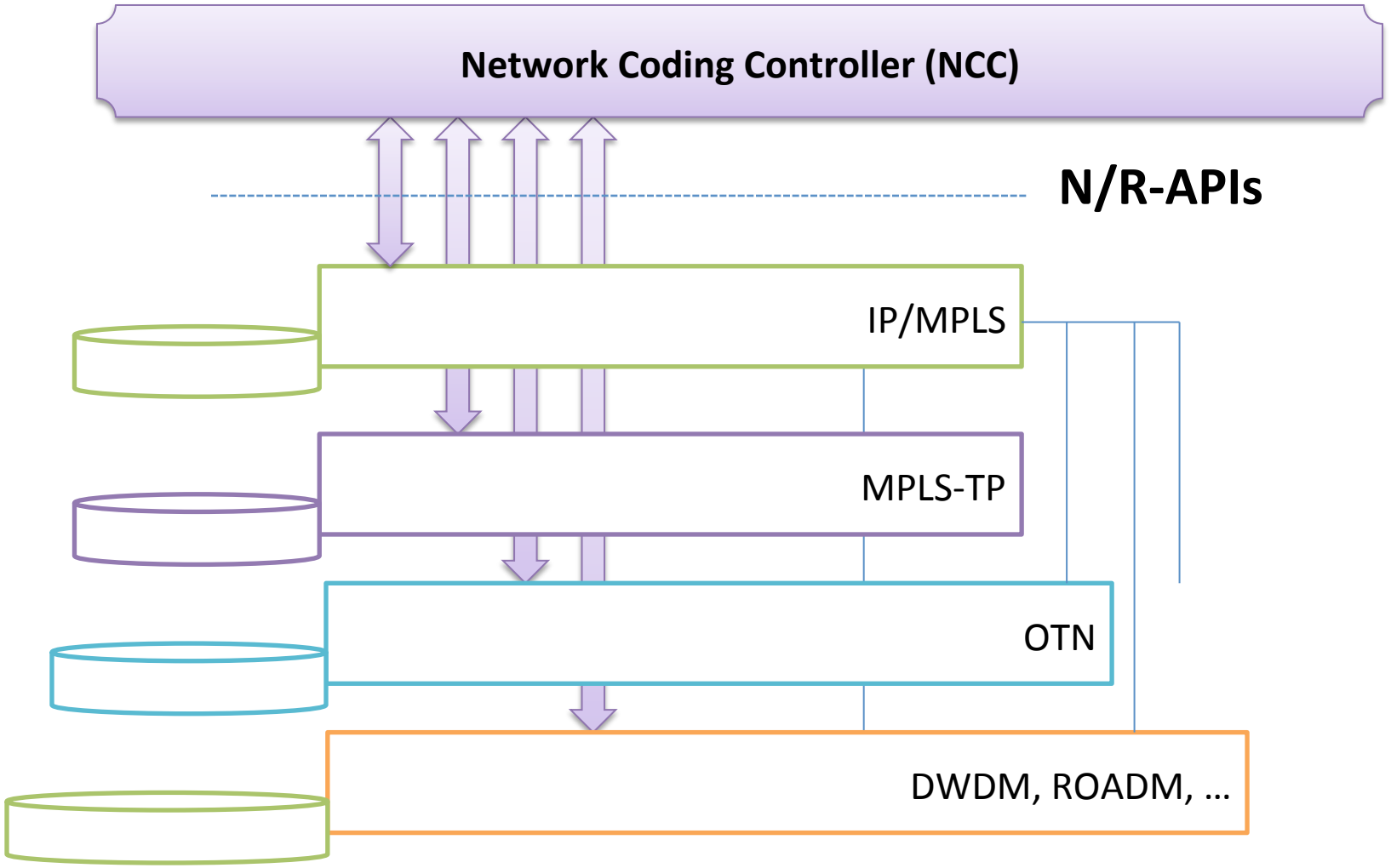
- North-Bound APIs (NBIs)
  - ***Interfaces to/from Applications and Services***
- South-Bound APIs (SBIs)
  - ***Interfaces to/from {Transport, Network, Forwarding, Physical Devices/Links, Location, etc.}***
- East-Bound APIs (EBIs)
  - ***Interfaces to/from Management and Orchestration***
- West-Bound APIs (WBIs)
  - ***Interfaces to/from Access-Network (Consumer Device)***
- Other APIs
  - North-East
    - Surveillance Interface
  - North-West
    - ***In progress … Alien intelligence service***
  - South-East
    - Counter Surveillance Interface
  - South-West
    - ***In progress … Native Intelligence Service***



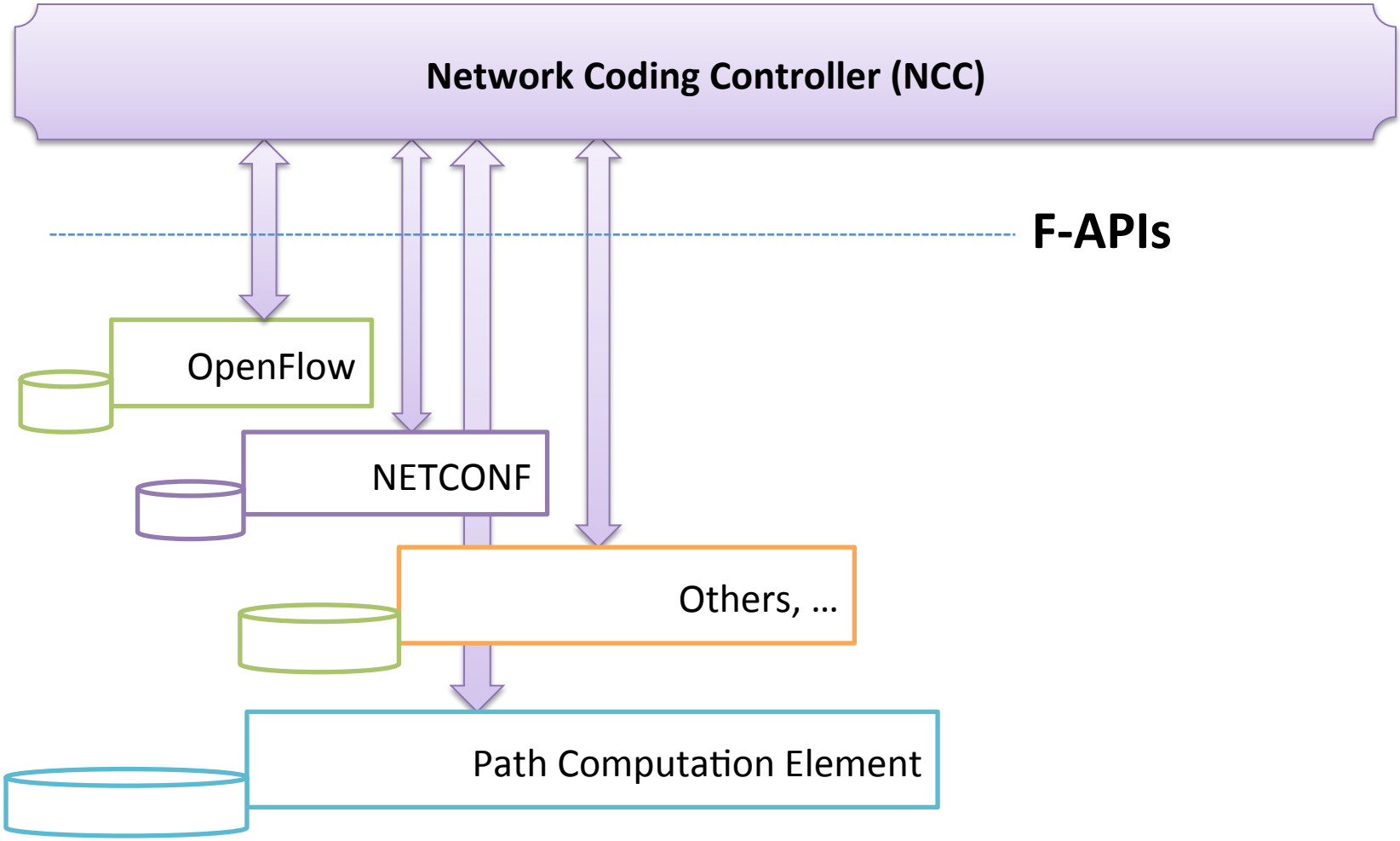
Transport Plane API(s)



Network/Routing Plane API(s)



Forwarding Plane API(s)



Next Steps

- **Initiate a draft, and Invite others to Contribute/Participate**

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- **Comments/Suggestions**

Q & A,

THANKS.