From virtualization, thru' multi-vendor sharing to 5G RAN modularization

Mark Grayson
Distinguished Engineer
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Radio Network Evolution

Hyper Dense Outdoor Network

- Coverage and capacity for enhanced mobile broadband
- Higher frequencies, larger bandwidths
- Smaller cell sites (100s per km^2)
- Integrated fronthaul transport

Digitized Enterprise

- Supporting enterprise vertical value chains
- Edge compute with API based value exposure
- Multi-operator/Neutral host
- As-a-service consumption

Sliced, Virtualized, Orchestrated and Automated

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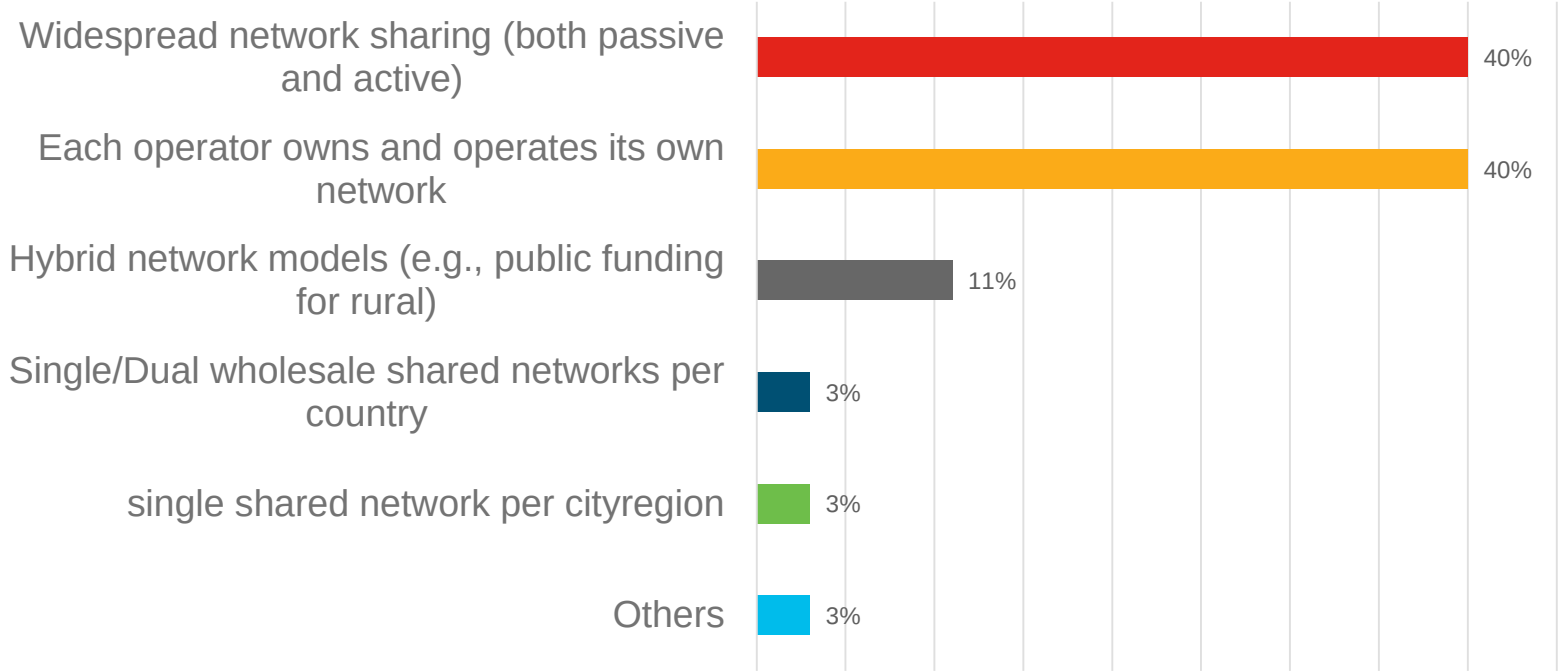
Indoor and Densification Challenges – the rise in Network Sharing



Source: GSMA Survey of 750 Operator CEOs (2017)
Question on 5G Industry Structure and Infrastructure Ownership

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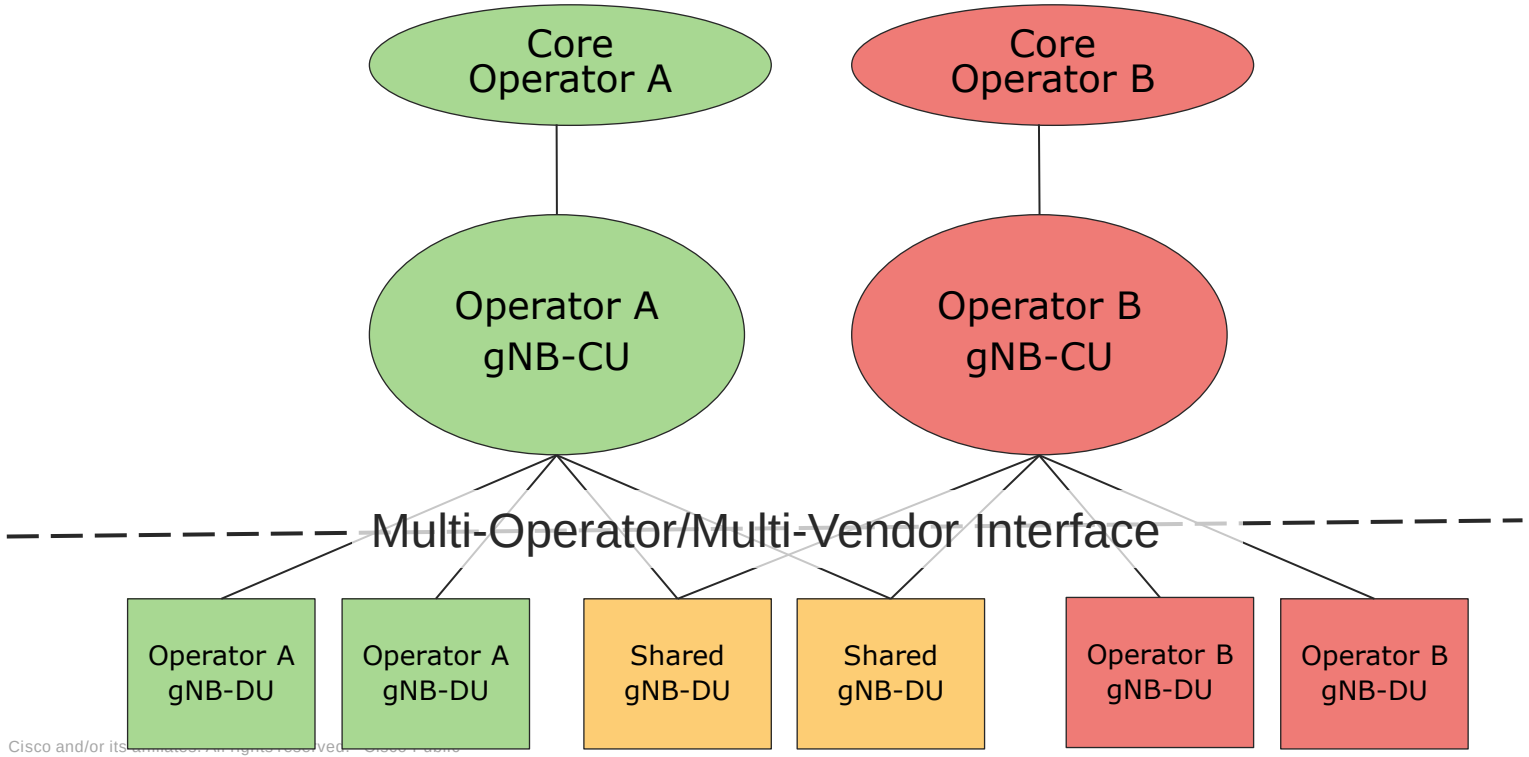
How Best to Share the RAN?
If the RAN splits, then we need to be able to share the PNF



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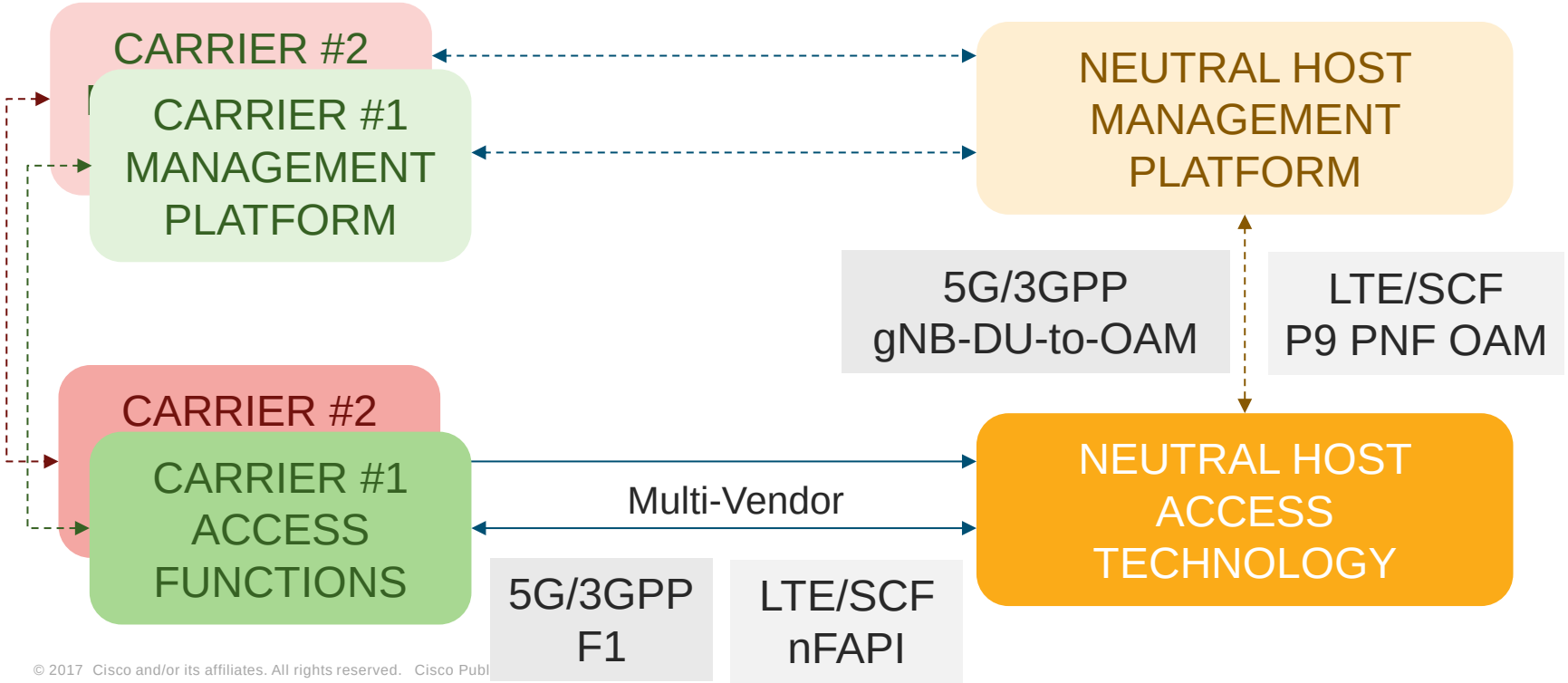
Neutral Host – driving architectural convergence and Multi-Vendor support



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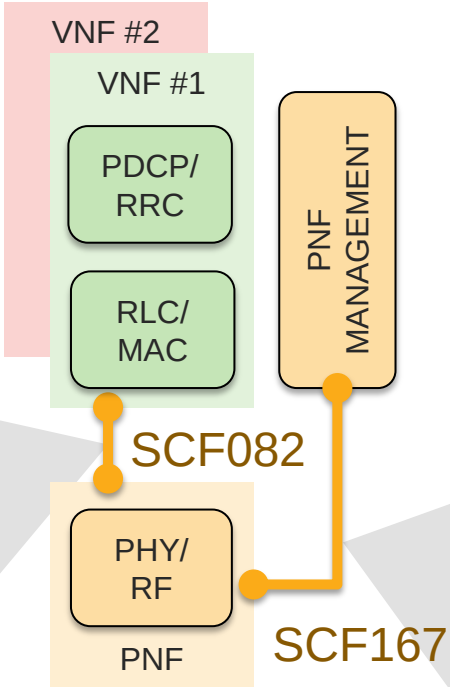
nFAPI Multi-Vendor Specifications: SCF082 & SCF167
available from scf.io

- SCF082: “nFAPI” open and extensible interface between VNF and PNF for multi-vendor interoperability and multi-operator use cases



- SCF167: An open and extensible TR-069 based PNF management, enabling a neutral host to manage the PNF and partition/slice resources between multiple operators

NFAPIService:1.0 Data Model

Name	Type	Write	Description	Object Default	Version
X_SCF_org_NFAPIServiceNumberOfEntries	unsignedInt	-	The number of entries in the X_SCF_org_NFAPIService table.	-	1.0
X_SCF_org_NFAPIService.{i}.	object	-	The top-level object for device with nFAPI capabilities. At most one entry in this table can exist with a given value for Alias.	-	1.0
Alias	string(64)	W	A non-volatile handle used to reference this instance. Alias provides a mechanism for an ACS to label this instance for future reference. If the CPE supports the Alias-based Addressing feature as defined in [Section 3.6.1/TR-069a4] and described in [Appendix II/TR-069a4], the following mandatory constraints MUST be enforced: • Its value MUST NOT be empty. • Its value MUST start with a letter. • If its value is not assigned by the ACS, it MUST start with a "cpe-" prefix. • The CPE MUST NOT change the parameter value.	-	1.0
DNPrefix	string(256)	W	The Distinguished Name prefix (DNPrefix) is an operator-configurable prefix string that is pre-pended to object distinguished names in the ManagedObjectInstance parameters of the [TR-181i2] FaultMgmt objects. See [3GPP-TS.32.300] for the formal definition and examples of DNPrefix as applied to 3GPP alarm objects.	-	1.0
NFAPIInterfaceNumberOfEntries	unsignedInt	-	The number of entries in the NFAPIInterface table.	-	1.0
X_SCF_org_NFAPIService.{i}.Capabilities.	object	-	This object contains parameters relating to the hardware capabilities of the service.	-	1.0

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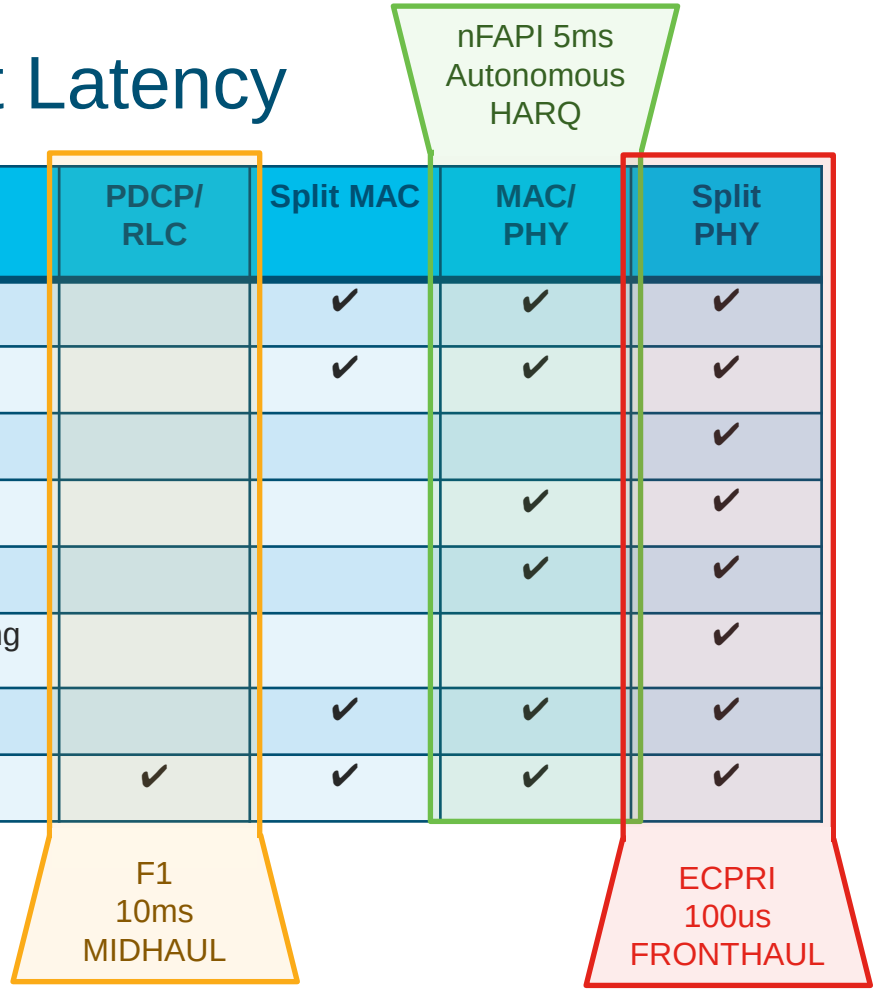
Splits, CoMP and Transport Latency

	Advanced RF Combining Capability	PDCP/ RLC	Split MAC	MAC/ PHY	Split PHY
1	Carrier Aggregation		✔	✔	✔
2	Cross Carrier Scheduling		✔	✔	✔
3	High Order MIMO				✔
4	Down Link Joint Processing –Joint Transmission (JT)			✔	✔
5	Up Link Joint Reception (JR) independent PHY decoding			✔	✔
6	Up Link Joint Reception (JR) joint equalization PHY decoding				✔
7	Join Processing – Dynamic Point Selection (DPS)		✔	✔	✔
8	Coordinated Scheduling/Beamforming (CS/CB) UL and DL	✔	✔	✔	✔

Source: Small Cell Forum SCF106



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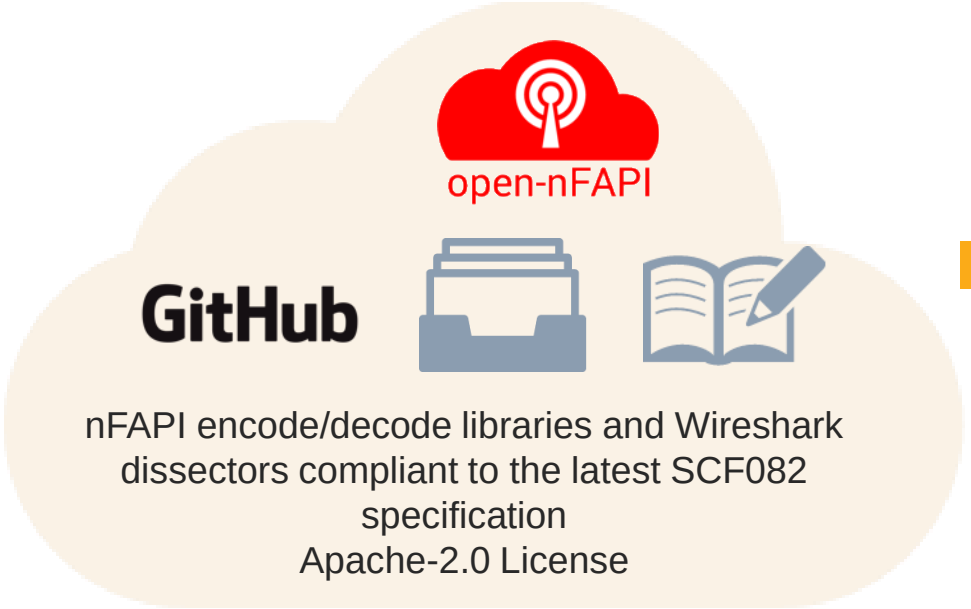
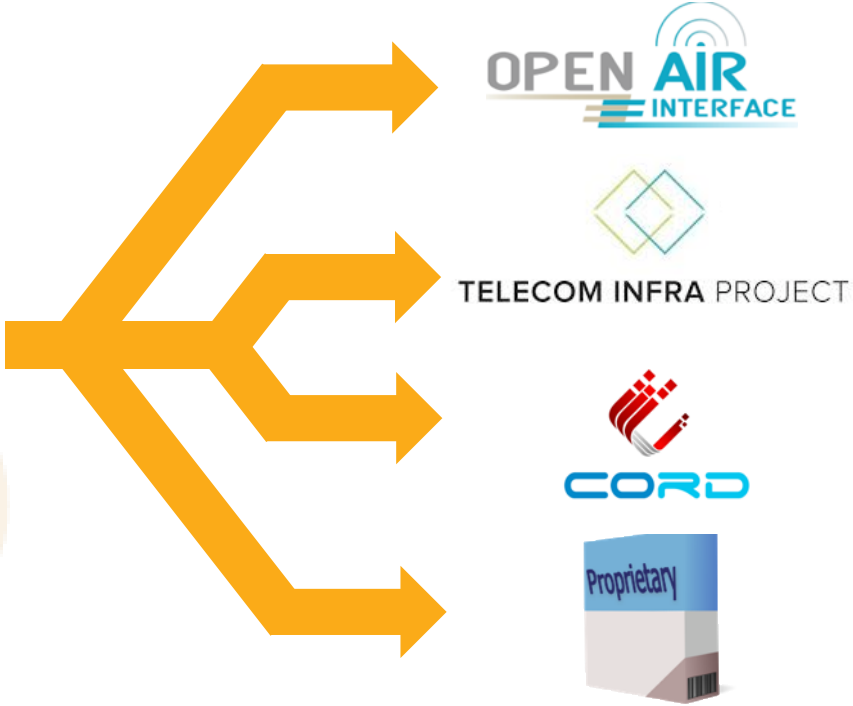
Thinking differently about multi-vendor RANs:
How can open source complement standardization to improve market adoption?





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nFAPI Timeline

JUN 2014

SCF Operators Initiate Virtualization Study

JUN 2015

Virtualization Study Complete

AUG 2015

nFAPI definition program commences

NOV 2016

SCF Virtualization Release, including nFAPI spec

FEB 2017

Open-nFAPI public repository

NOV 2017

Initial integration of Open-nFAPI into OAI

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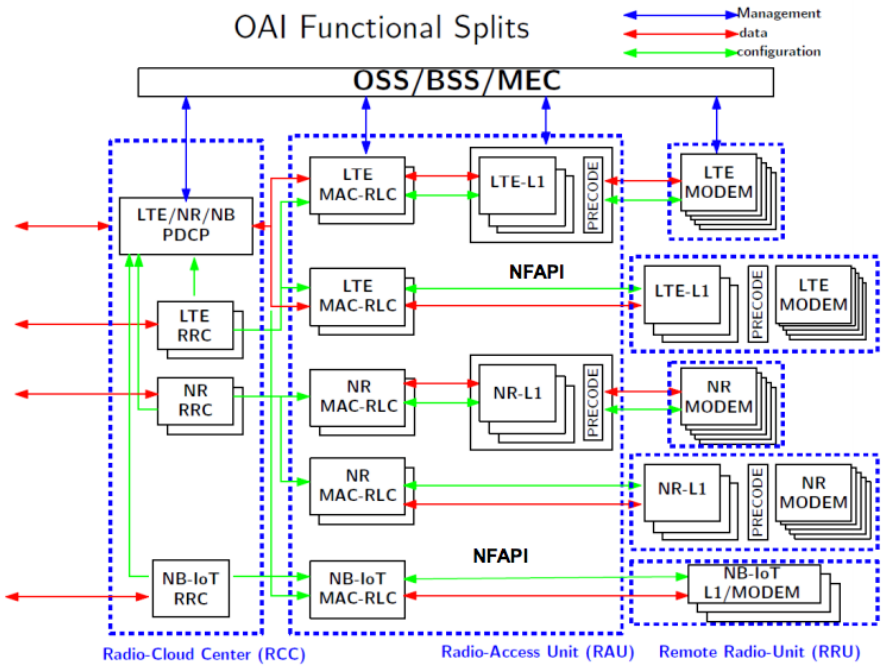
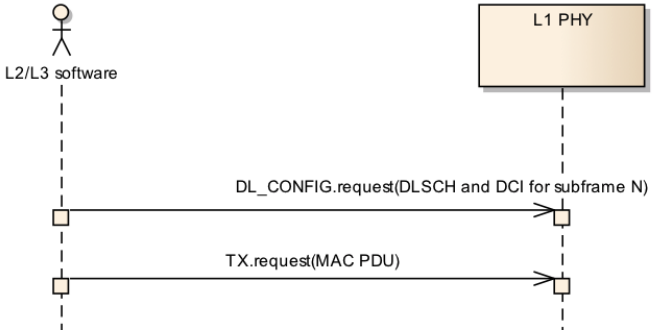
Moving from open source libraries to Multi-Vendor Implementation





Info	Comment
RACH.indication	RACH
TX.request	
DL_CONFIG.request	
TX.request	MSG2
DL_CONFIG.request	
UL_CONFIG.request	
TX.request	
DL_CONFIG.request	
CRC.indication	
RX_ULSCH.indication	MSG3
TX.request	RRC Connection Setup
DL_CONFIG.request	
HI_DCI0.request	
UL_CONFIG.request	
TX.request	
DL_CONFIG.request	
TX.request	
DL_CONFIG.request	
HARQ.indication	MSG3 - ACK
HI_DCI0.request	
UL_CONFIG.request	
TIMING_INFO	
TX.request	
DL_CONFIG.request	
CRC.indication	
RX_ULSCH.indication	MSG4 / RRC Connection Setup Complete
HI_DCI0.request	MSG4 - ACK

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Summary

- 5G needs to focus on lowering the barriers for deploying active sharing in order to support multi-operator deployments
- Issue of multi-vendor interoperability of internal RAN interfaces needs to be addressed
- Open source complements the standardization of RAN splits to enable improved multi-vendor interoperability
- Lessons learned with LTE/nFAPI can then be applied to 5G/F1 and other multi-vendor splits

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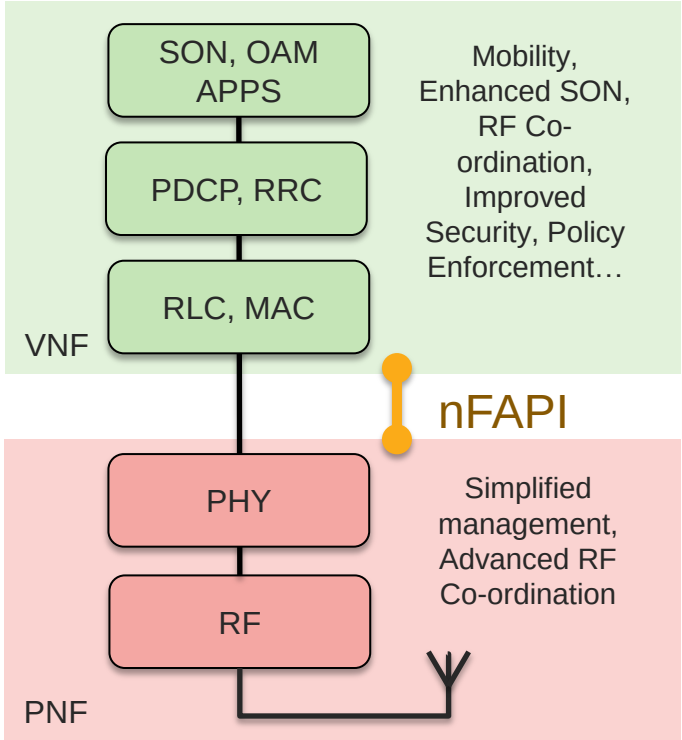
A KEY Virtualization Question: How best to Split? A real engineering compromise!

- SCF concluded that MAC/PHY split delivers key benefits of centralization, enables 75% of possible CoMP techniques to be re-used, without any requirements to increase transport bandwidths.
- Autonomous Hybrid ARQ processing needed to to increase the fronthaul latency budget up to 6ms, BUT there are consequential impacts on the peak single UE throughput.
- The MAC/PHY split is based on the established and successful multi-vendor FAPI platform decomposition



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