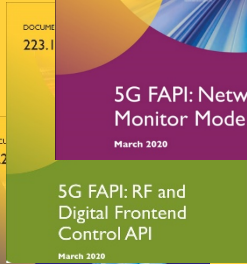
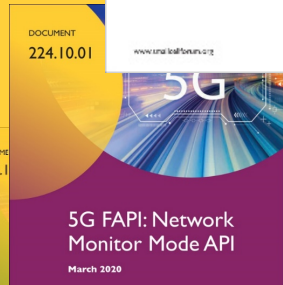




# 5G FAPI: Network FAPI 1.0

Ganesh Shenbagaraman, Radisys  
Andrei Radulescu, Qualcomm

Key contributors





- Small Cells

- A small cell is a cellular base station that transmits and receives 3GPP-defined RF signals with small power and small form factor. In most cases, it services a small coverage area.
- Find more at: <https://www.smallcellforum.org/5g-product-definition-report>

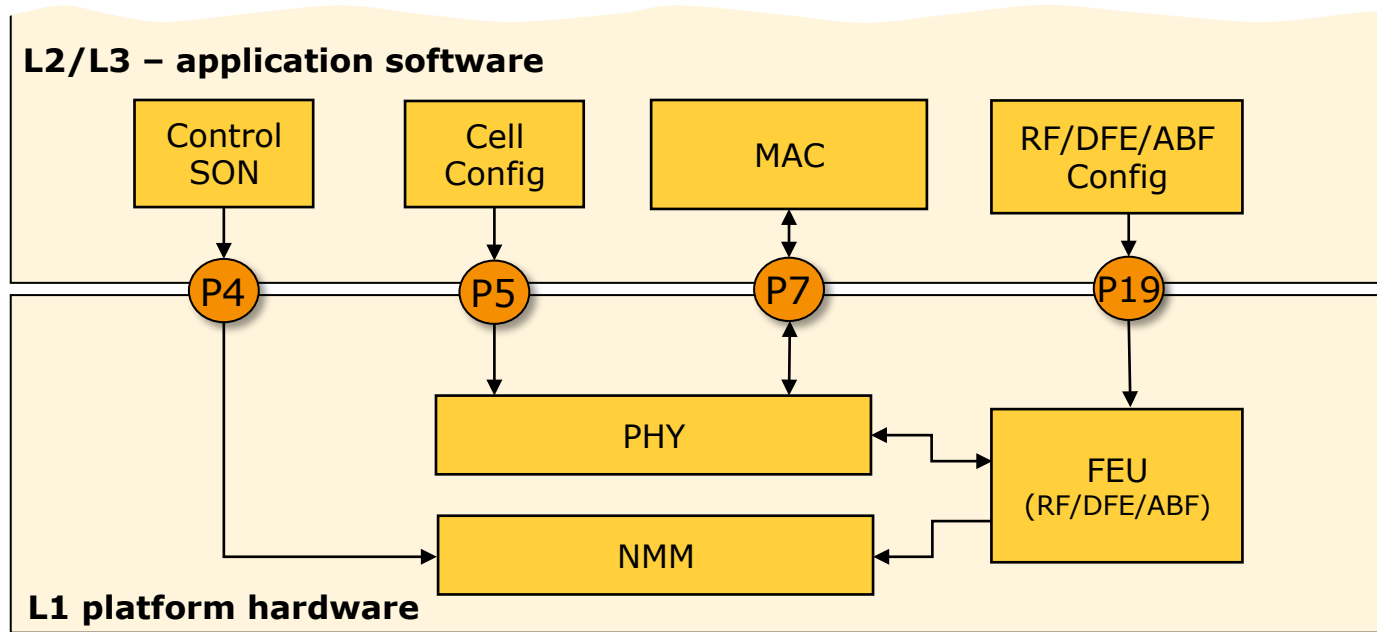
- FAPI:

- The functional application platform interface (FAPI) is an initiative within the small cell industry to encourage competition and innovation among suppliers of platform hardware, platform software and application software by providing a common API around which suppliers of each component can compete.

# 5G FAPI Interfaces

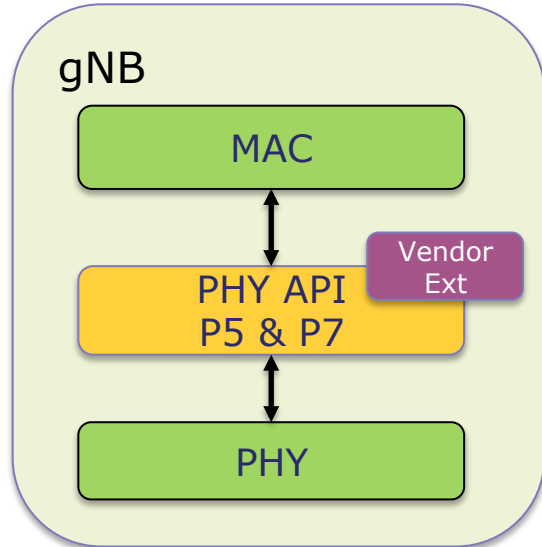


## Small cell internal architecture



SON (Self Organising Networks), MAC (Medium Access Control), NMM (Network Monitor Mode)  
FEU (Front End Unit) including DFE (Digital Front End) and ABF (Analog Beam Forming)

# 5G FAPI: PHY API

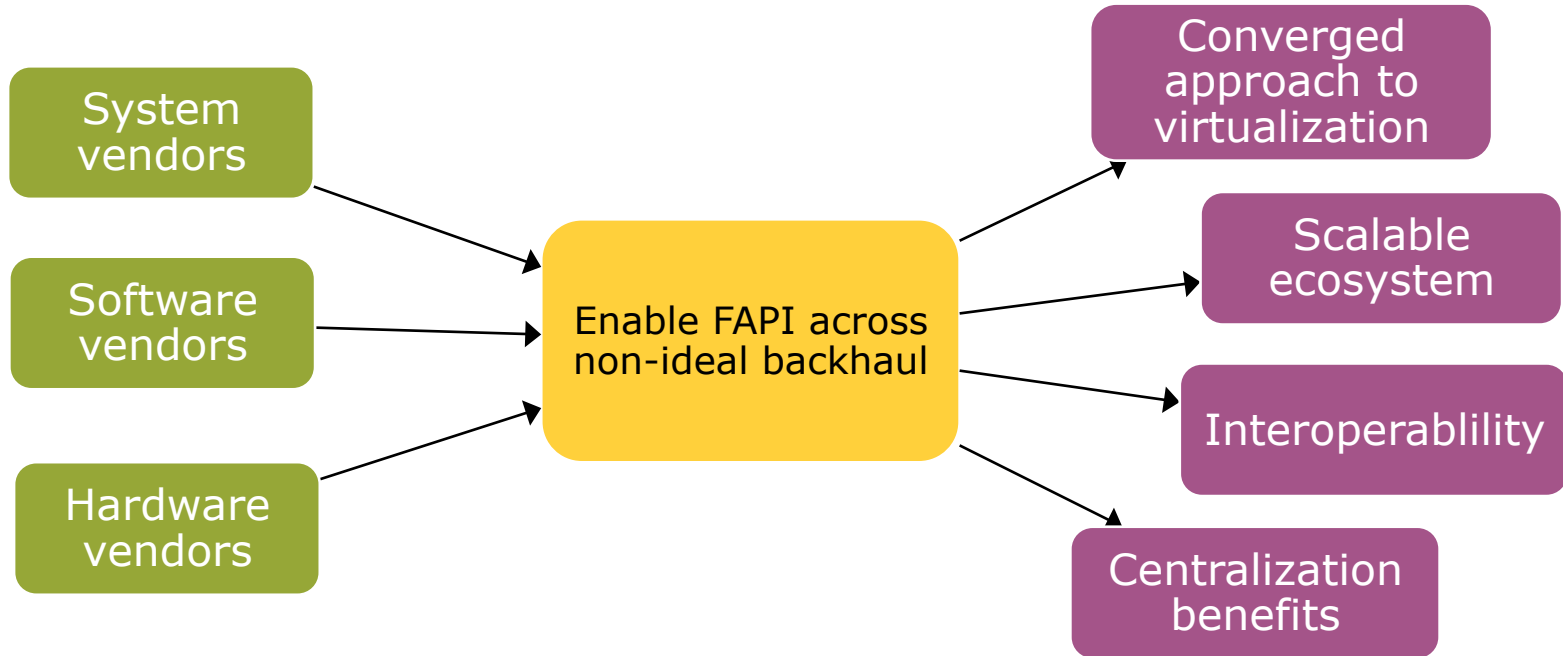


- Interface is abstracted from underlying architecture
- Control messages (P5) move PHY through a state machine to RUNNING state where a small cell becomes active
- Per Slot/TTI messages (P7) define what is transmitted and received over the air every subframe

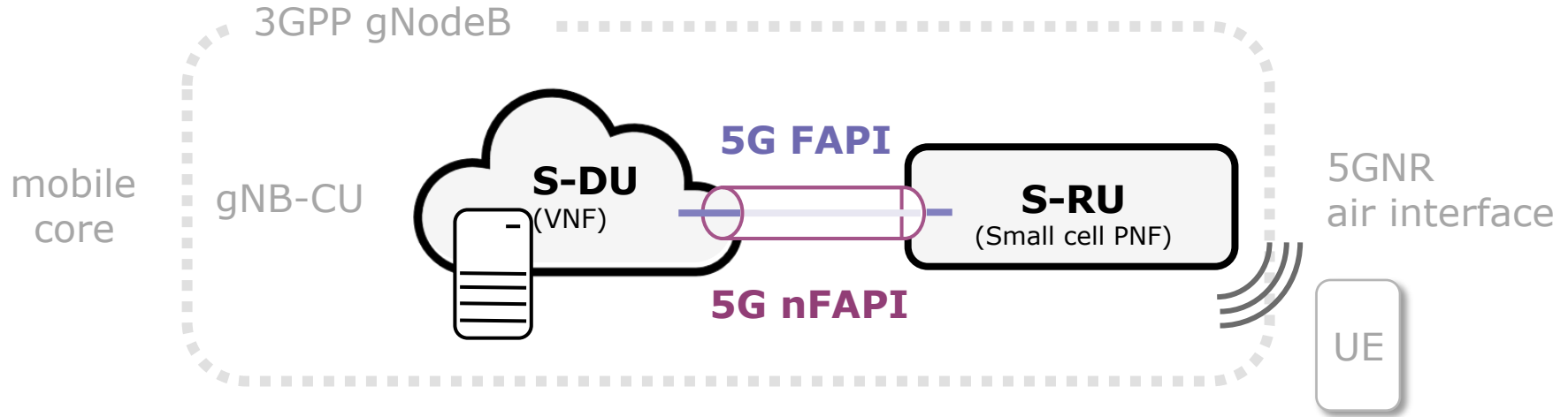
# 5G Network FAPI (nFAPI)



nFAPI Motivation: Disaggregated RAN architecture



# nFAPI Overview



**5G nFAPI 1.0 adds a network transport wrapper around the 5G FAPI PHY API to create the split option-6 interface between S-RU and S-DU network nodes**

# SCF Option 6 (nFAPI) based solutions

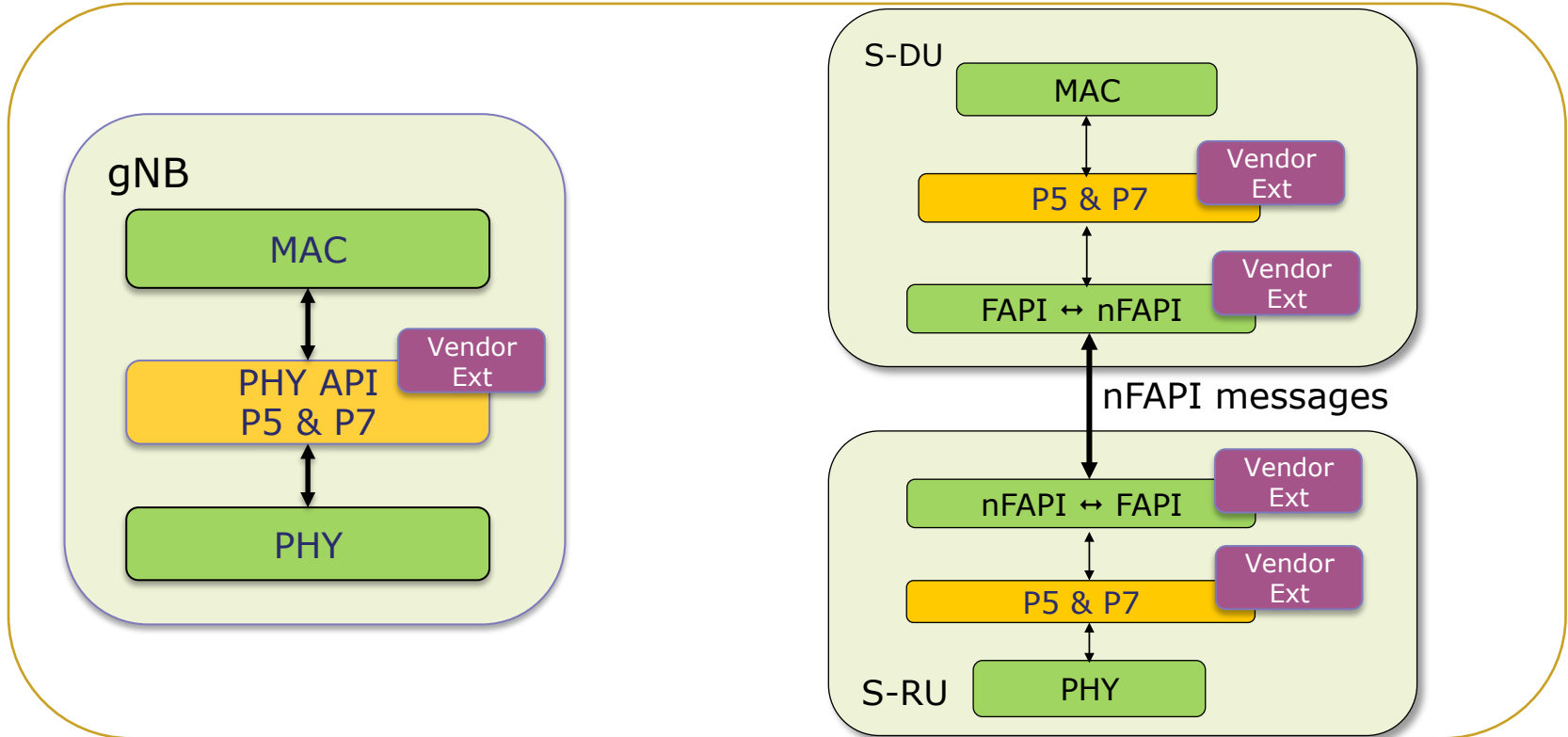


S-CU: The central unit includes the SDAP, PDCP and RRC protocols.

S-DU: The distributed unit includes RLC and MAC.

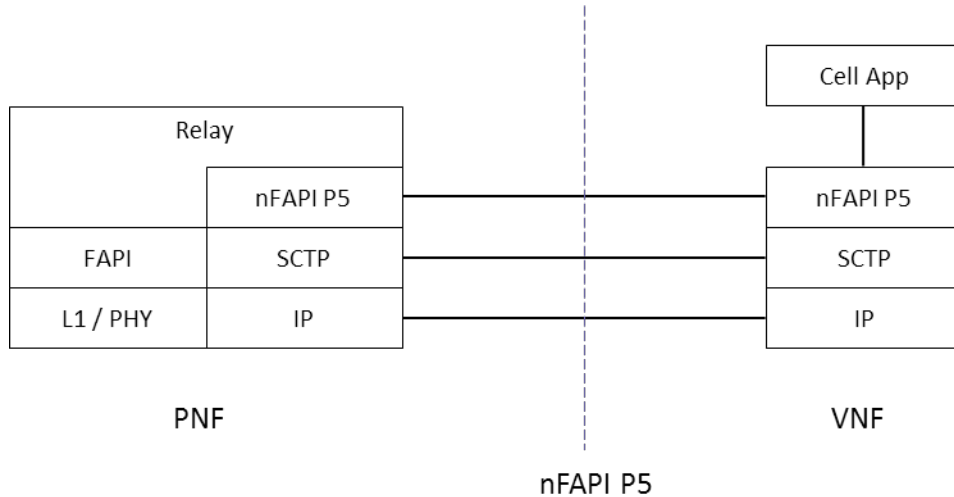
S-RU: The radio unit includes PHY and Radio Front End Unit.

# FAPI and nFAPI





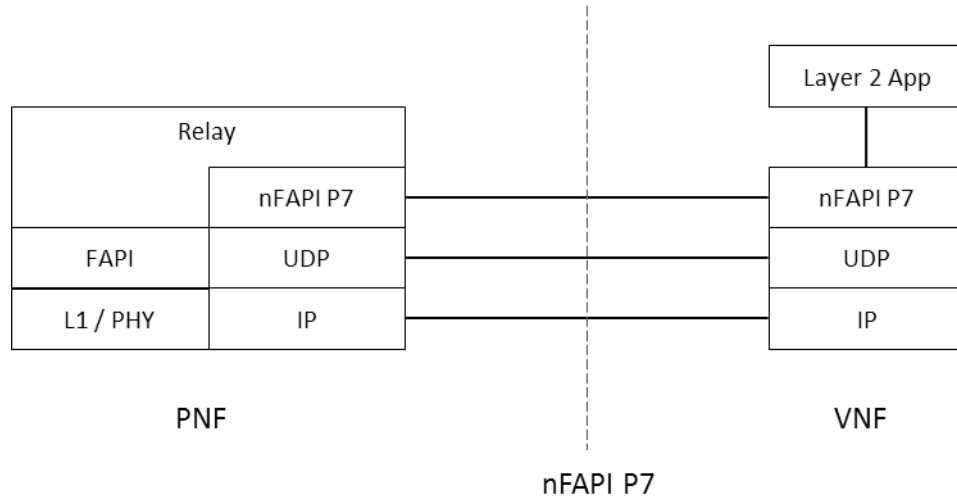
# P5 interface



**P5 procedures configure and control the PNFs and PHY instances within a PNF**

**New SCTP Payload Protocol Identifier (PPI) for 5G nFAPI (To be assigned by IANA)**

# P7 interface



**P7 procedures provide PHY Sync, Delay management and DL/UL data transfer**

**P7 interface aligns slot, timing and jitter between VNF and PHY instance**

# 5G nFAPI



- nFAPI framework evolved and optimized for 5G NR
- Based on 5G FAPI (SCF222.10.02) Mar 2020 release
- Support for 3GPP Rel 15

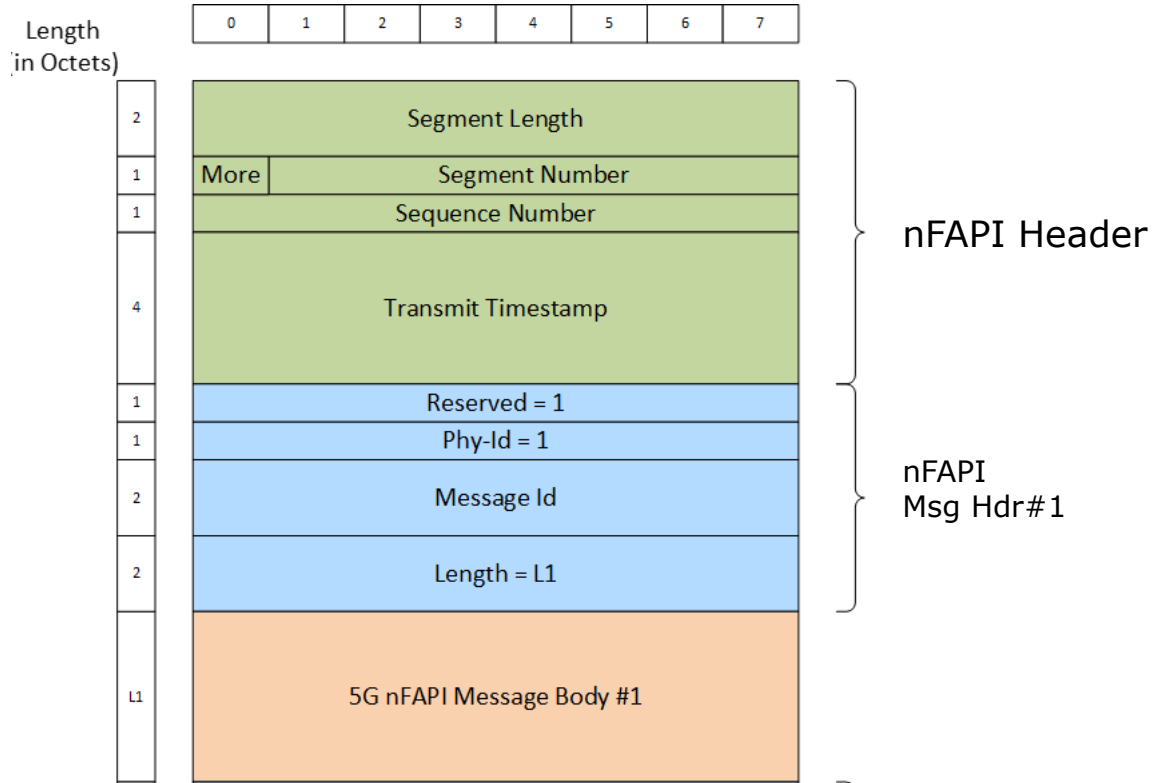


# 5G nFAPI message types

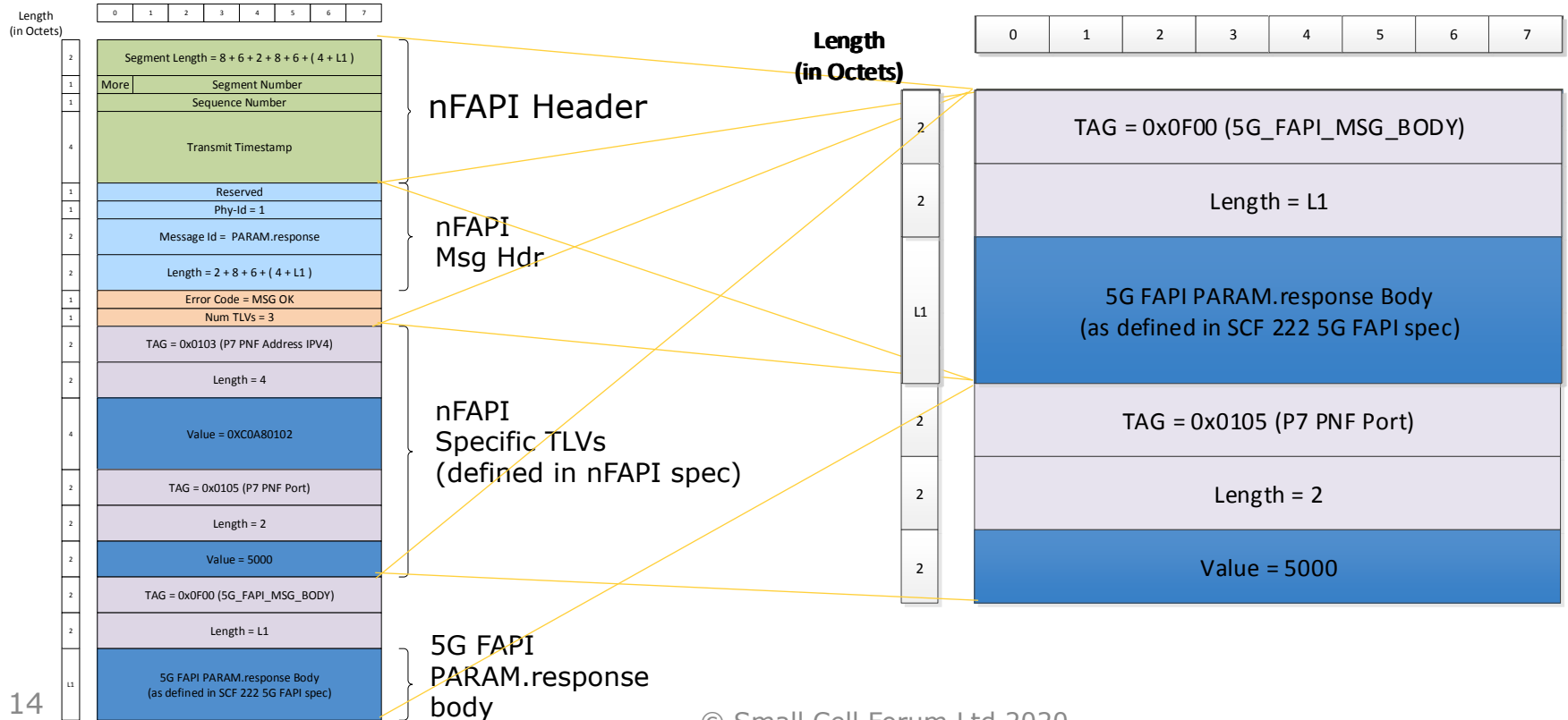


- **Dedicated nFAPI messages:** These are messages defined solely in the nFAPI protocol, e.g., PNF\_XXX messages
- **Transparent messages:** These are messages that are defined in the FAPI specification, and carried by the nFAPI protocol, as is. That is the nFAPI only provides a transport of these messages and does not modify these messages.
- **Combined messages:** These messages are defined by the FAPI specification, but the nFAPI specification adds new values and TLVs to these messages.

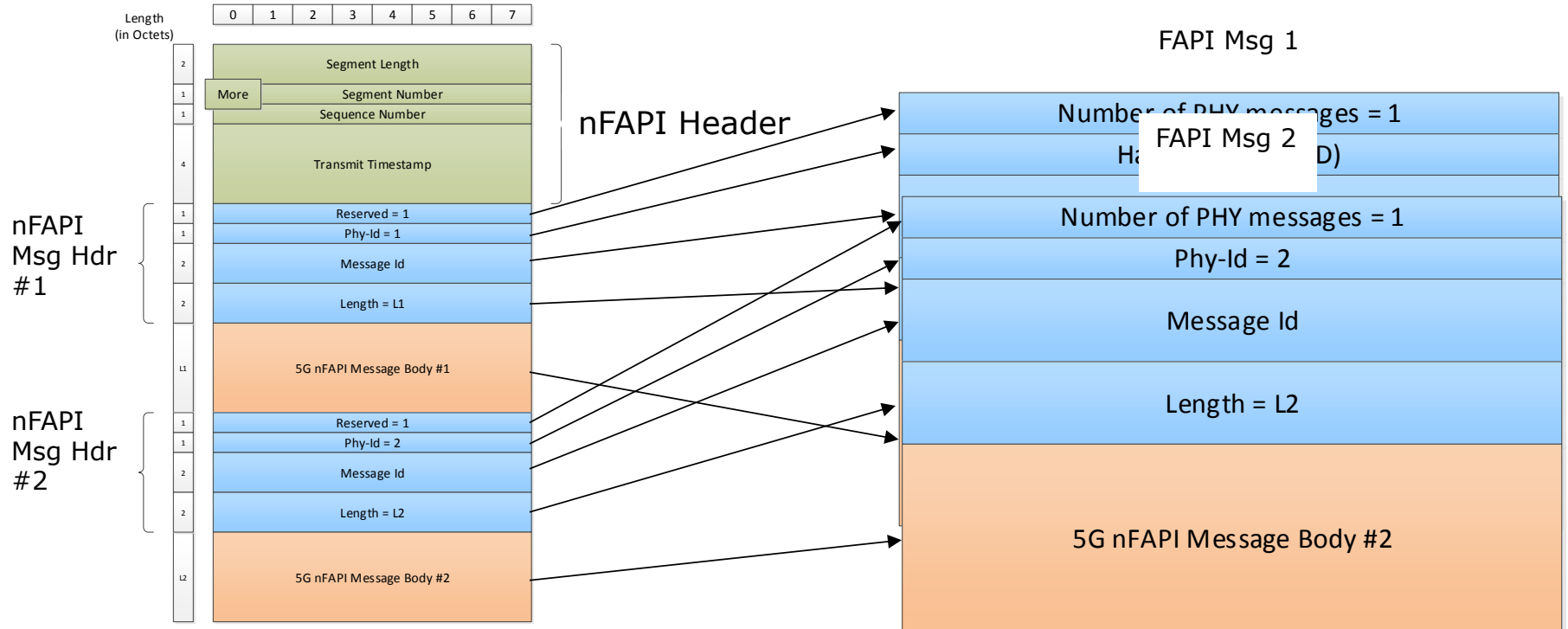
# 5G nFAPI header



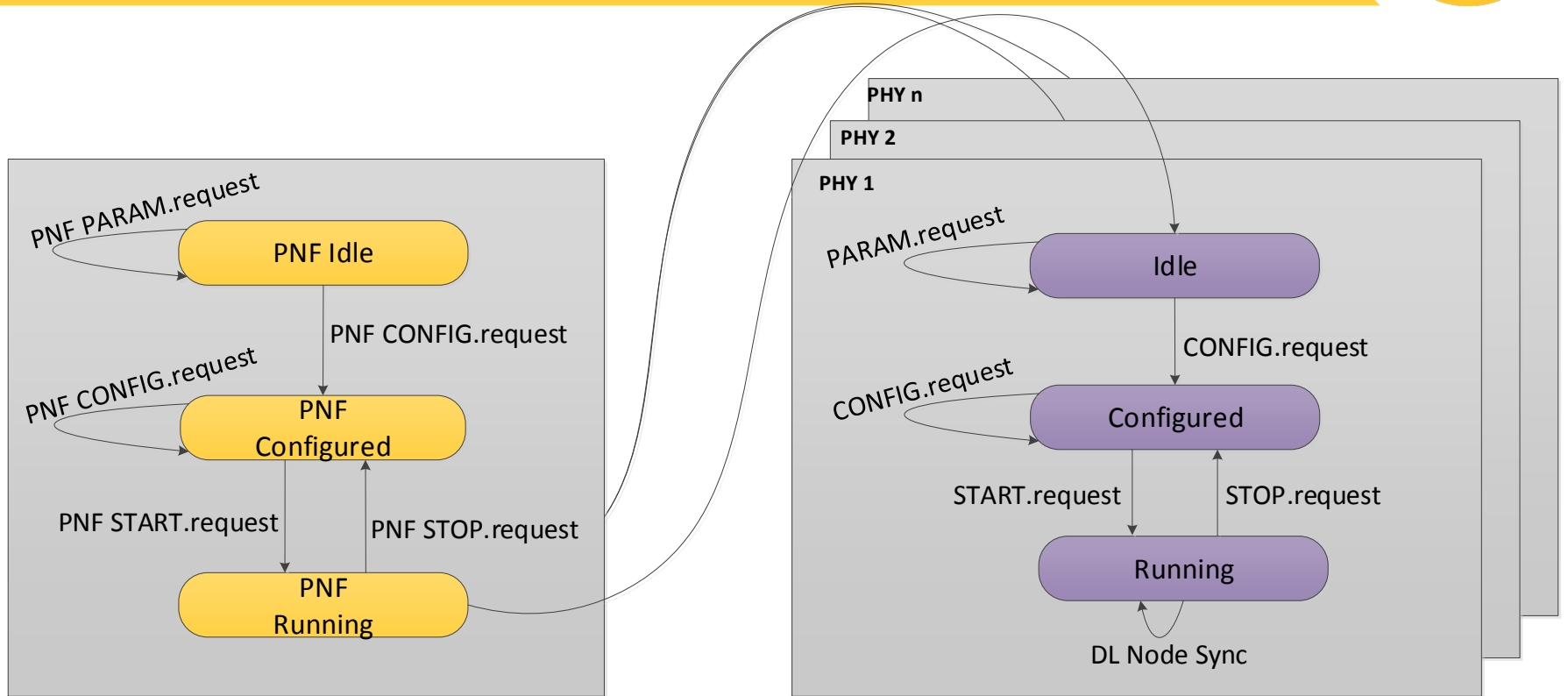
# Combined nFAPI message



# Extraction of FAPI messages from nFAPI message

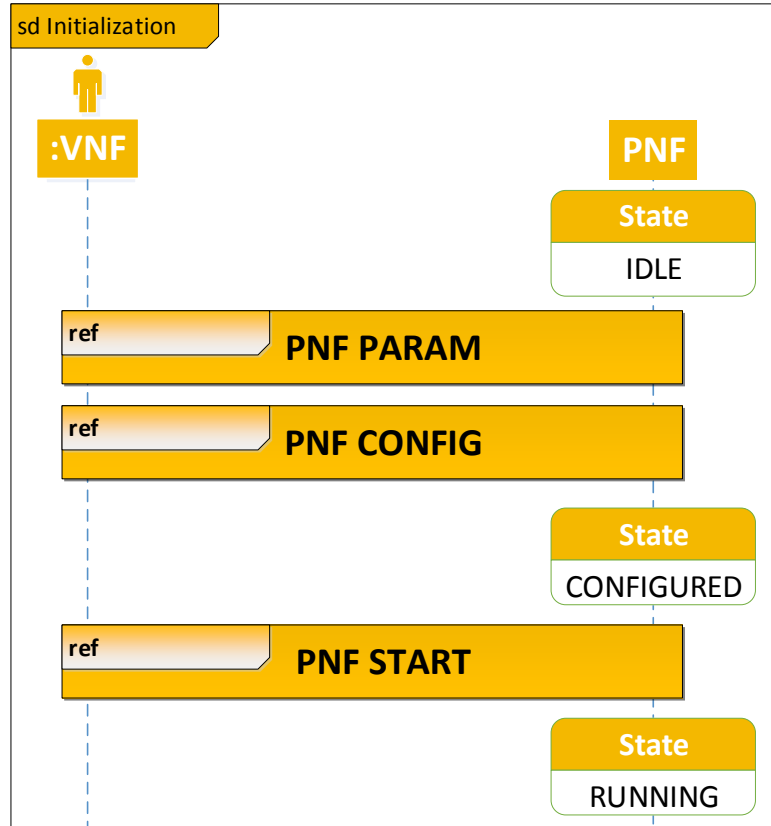


# PNF Procedures

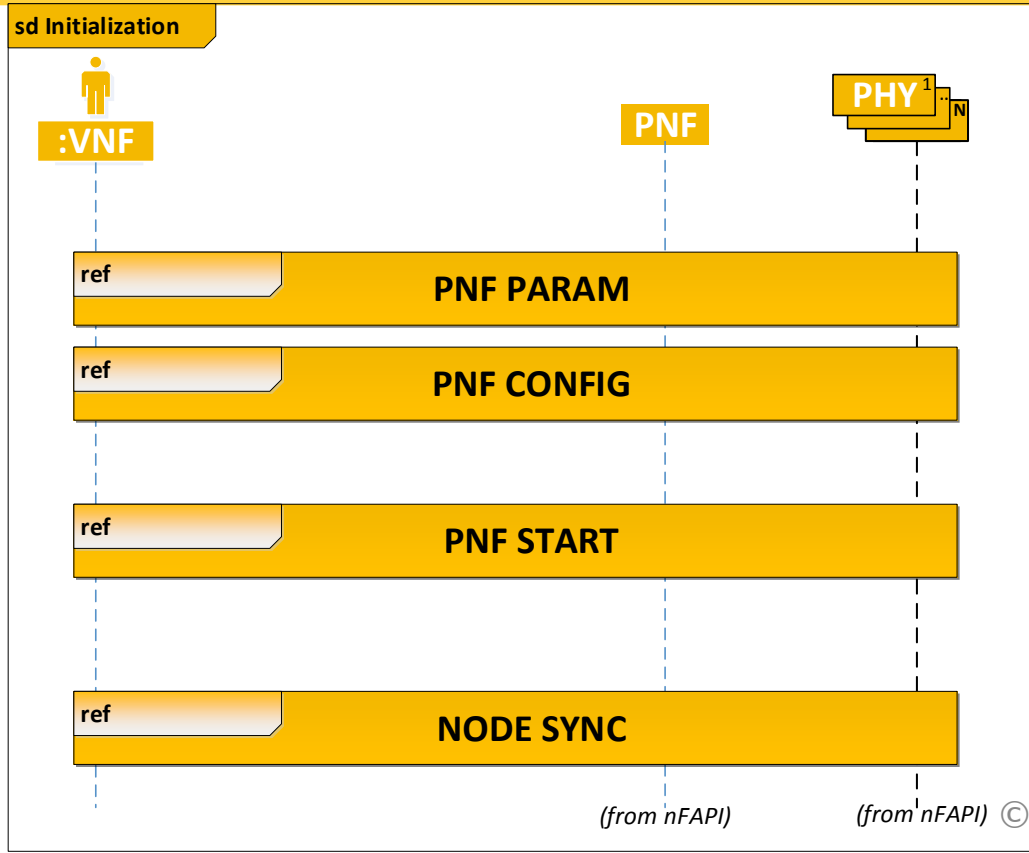




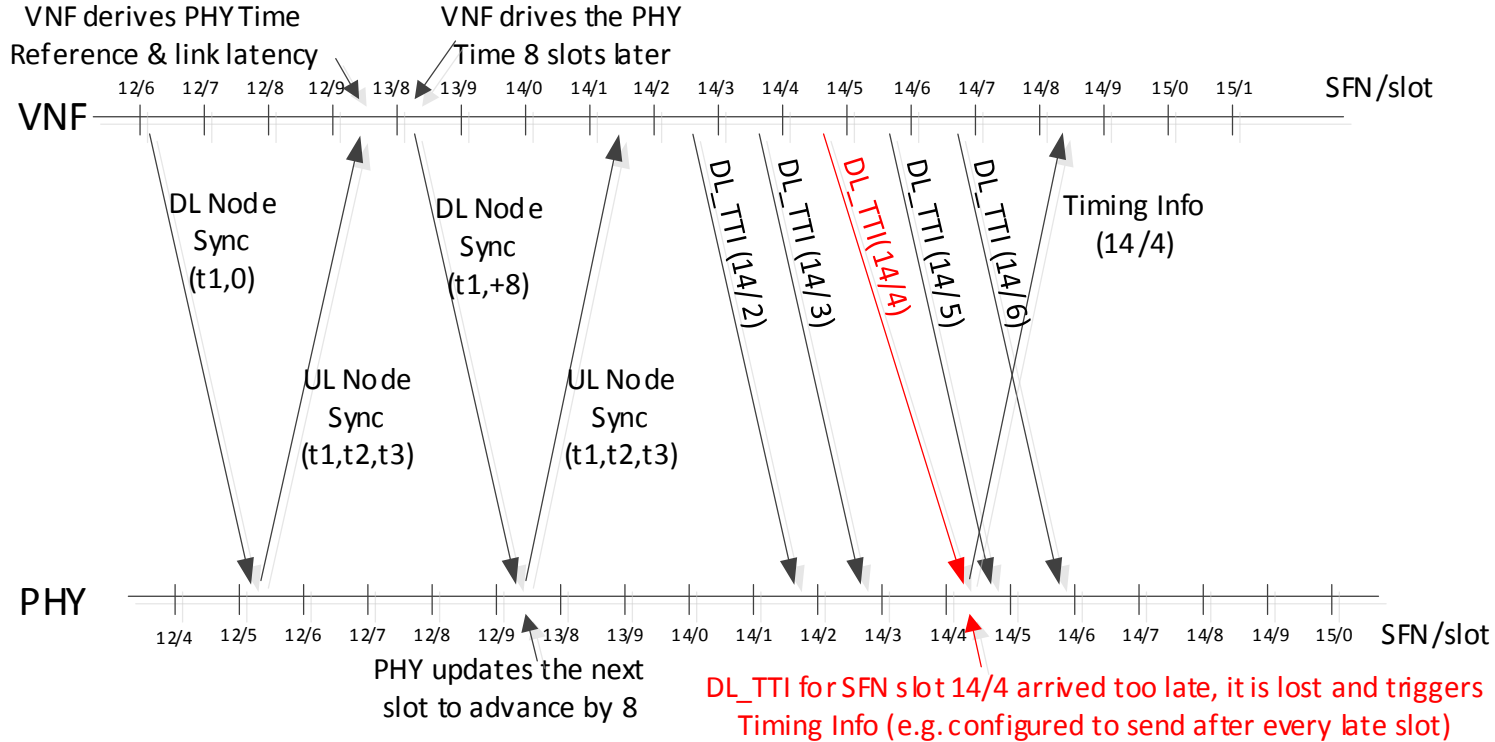
# PHY Procedures – PNF initialization



# PHY Procedures – PHY initialization



# Delay management on P7



# Planned for next releases



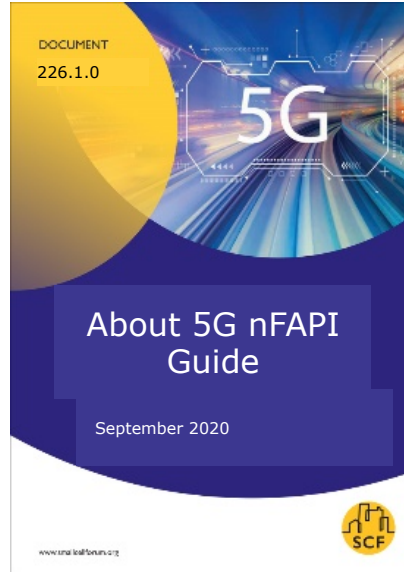
## nFAPI enhancements

- nFAPI framework robustness enhancements
- P7 transport enhancements
- Support for FAPI P19 Front End Unit Control [SCF223]
- Support for FAPI P4 Network Monitor Mode [SCF224]

## Ecosystem support

- Management models
- Transport Network Requirements
- Sync and timing design
- Test and Measurement support

# For further information



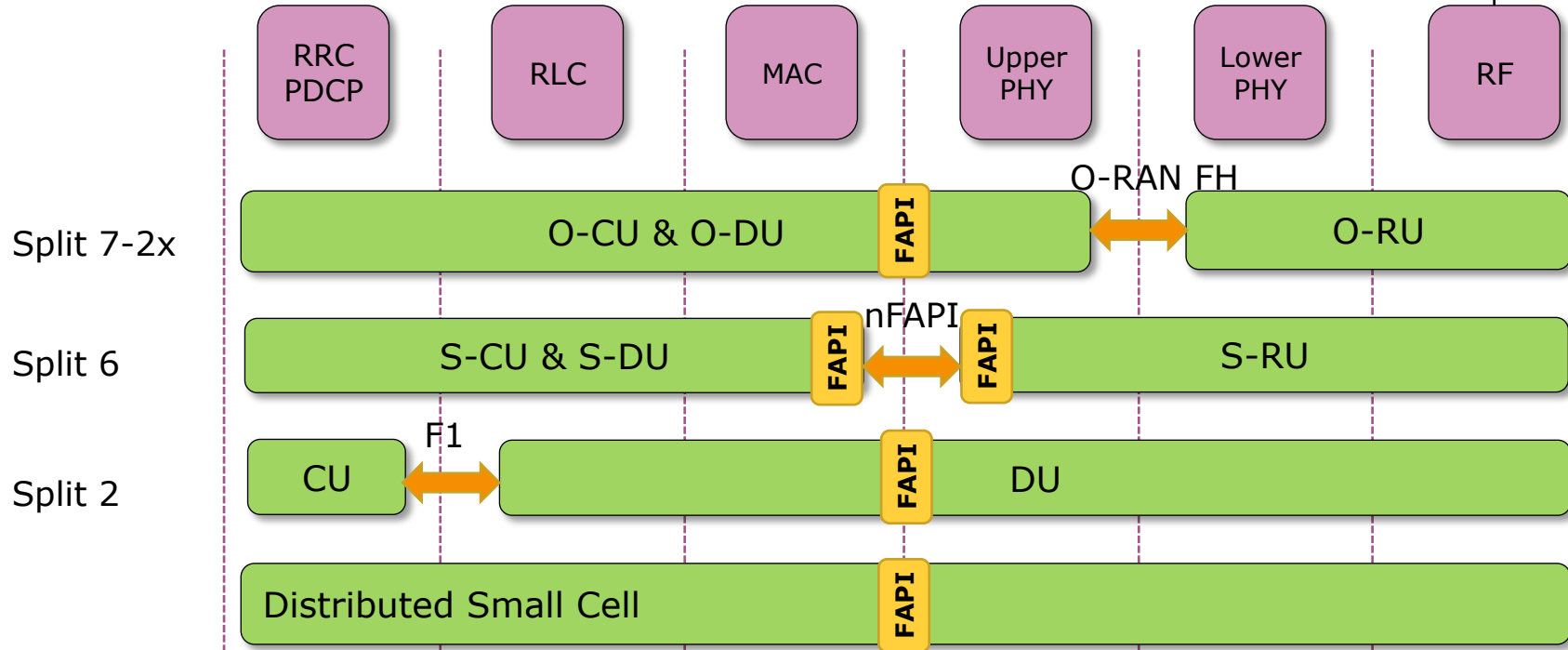
Downloadable from our nFAPI page:  
<https://www.smallcellforum.org/5g-network-fapi-specifications/>



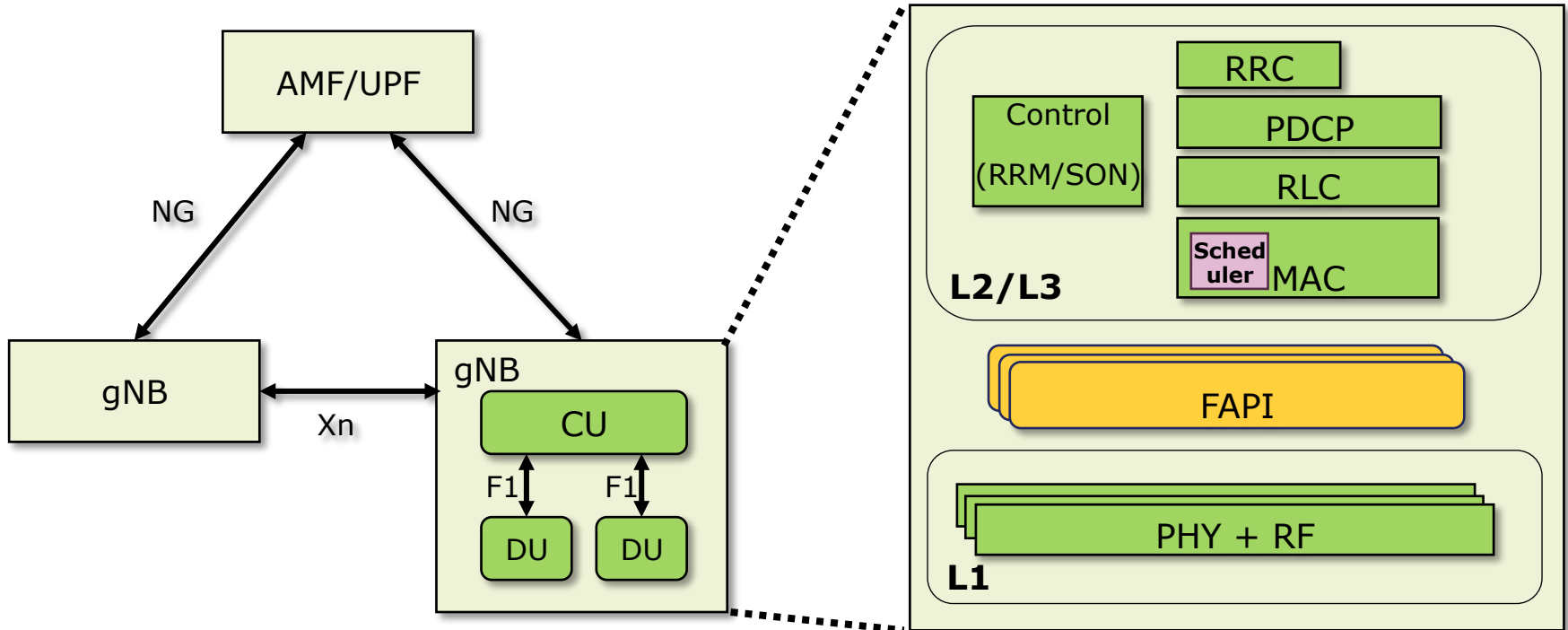


## Annex: 5G FAPI (Architecture & Sample Calls)

# Multiple Architectures for Small Cells

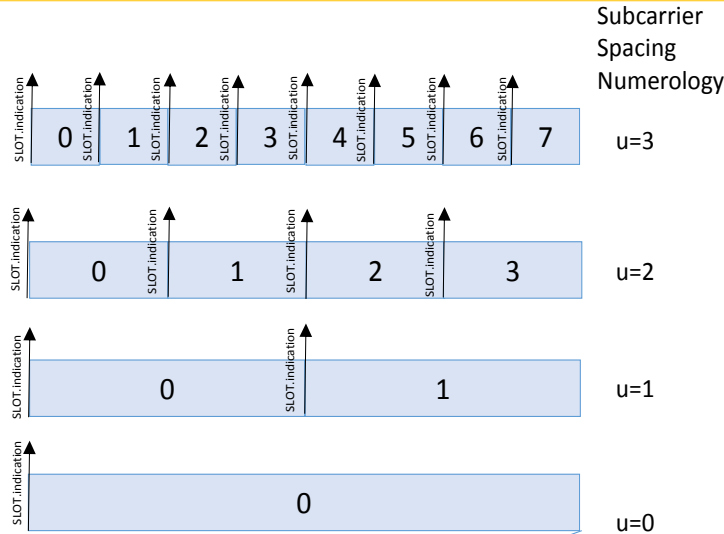


# FAPF Location

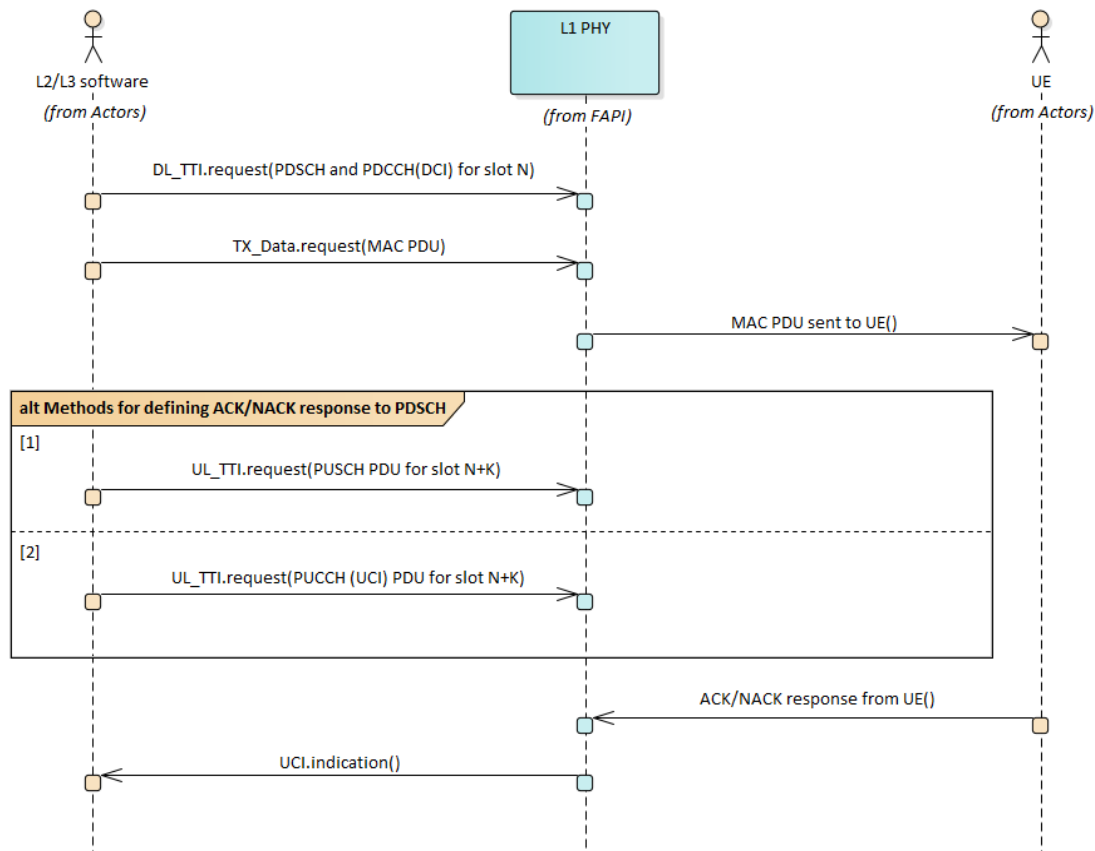




# 5G FAPI Synchronization:



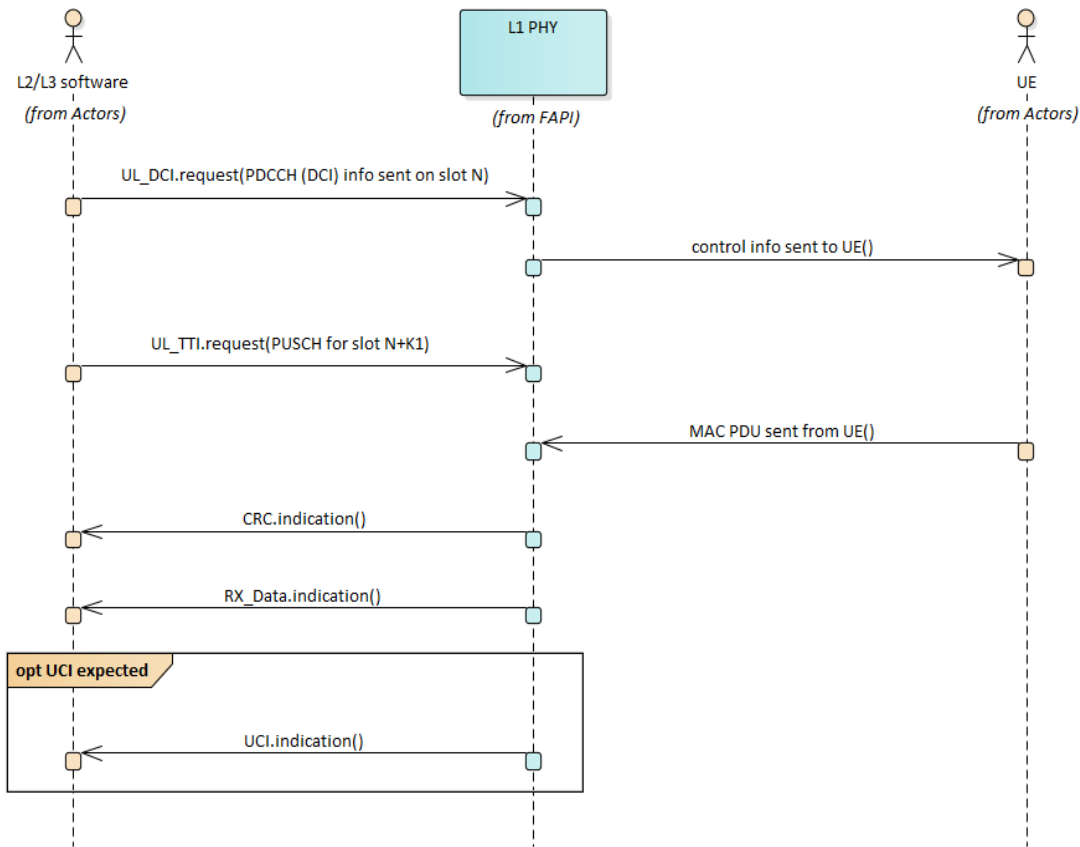
- SLOT.indication
  - PHY → L2/L3
  - Indicating start of a slot.
  - Periodicity depends on numerology
- Sync master determines slot # :
  - L2/L3 masteror
  - PHY Master
  -



## P7: DL Transmission



- Prep & DL Tx for slot N:
  - ➡ PHY Ch in `DL_TTI.req`
  - ➡ MAC PDU in `Tx_Data.req`
- UL ARQ for unicast DL PDU in slot N:
  - ☐ ARQ arrives in slot  $N+K$
  - ➡ PHY Ch in `UL_TTI.req`.
  - ➡ ARQ from UE in `UL_UCI.ind`



## P7: UL Transmission



- Prep for UL slot N:
  - ➡ PHY Ctrl Ch in `UL_DCI.req`
  - ➡ PHY Data Ch in `UL_TTI.req`
- UL Tx in slot N:
  - ➡ MAC PDU in `Rx_Data.req`
  - ➡ CRC outcome in `CRC.ind`
  - ➡ UL CSI in `UCI.ind`
- DL ARQ for unicast UL PDU:
  - ☐ 5G HARQ is asynchronous
  - ➡ NACK: Re-grant in later `UL_DCI.req`.
  - ACK: No regrant needed



## Annex: SCF FAPI: 2G to 5G

# SCF FAPI support for different Radio Access Technologies (RAT)



New for 5G

Brand name		3GPP RAT Type [TS29.274]	SCF FAPI Support				
			PHY API	Network Monitor Mode	RF / Digital Front End	network FAPI PHY/MAC split	Small cell (PNF/RU) management model
2G	GSM	GERAN		<a href="#">[SCF224]</a>			
3G	UMTS	UTRAN	<a href="#">[SCF048]</a>	<a href="#">[SCF224]</a>			
3G	HSPA	HSPA Evolution	<a href="#">[SCF048]</a>	<a href="#">[SCF224]</a>			
4G	LTE	EUTRAN (WB-E-UTRAN)	<a href="#">[SCF082]</a>	<a href="#">[SCF224]</a>	<a href="#">[SCF082]</a>	<a href="#">[SCF082]</a>	<a href="#">[SCF167]</a>
4G	LTE-NB-IoT	EUTRAN-NB-IoT	<a href="#">[SCF082]</a>	<a href="#">[SCF224]</a>	<a href="#">[SCF082]</a>	<a href="#">[SCF082]</a>	<a href="#">[SCF167]</a>
4G	LTE-M	LTE-M	<a href="#">[SCF082]</a>	<a href="#">[SCF224]</a>	<a href="#">[SCF082]</a>	<a href="#">[SCF082]</a>	<a href="#">[SCF167]</a>
5G	5G NR	NR	<a href="#">[SCF222]</a>	<a href="#">[SCF224]</a>	<a href="#">[SCF223]</a>	<a href="#">[SCF225]*</a>	<a href="#">[SCF227]*</a>



[www.scf.io](http://www.scf.io)

**SCF FAPI - A suite of APIs between small cell hardware and software from 2G to 5G**

\*currently under development

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