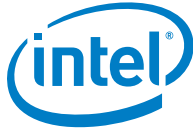


FlexRAN Reference Solution L2-L1

nFAPI Specification

July 2018

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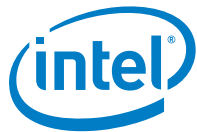
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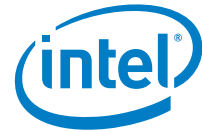
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Revision History

Document Number	Revision Number	Description	Revision Date
576423	1.2	Added support for MEASUREMENT P5 messages.	July 2018
576423	1.1	Update to the API message order.	April 2018
576423	1.0	Initial release.	February 2018

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1 Introduction

This document describes the Network Functional Application Platform Interface (nFAPI) of the FlexRAN reference Physical Layer (PHY) for a Long Term Evolution (LTE) wireless base station using Intel® Xeon® processors. This interface is between the L2+ and the PHY of an LTE base station.

The L2/L3 protocols that are expected to use this API are the Radio Resource Control (RRC) layer (refer to [Table 3](#), [36.331]), Media Access Control (MAC) layer (refer to [Table 3](#), [36.321]), and the scheduler. It's assumed that these also run on an Intel® Xeon® processor device on a different core.

The nFAPI is defined using the reference architecture shown in [Figure 1](#).

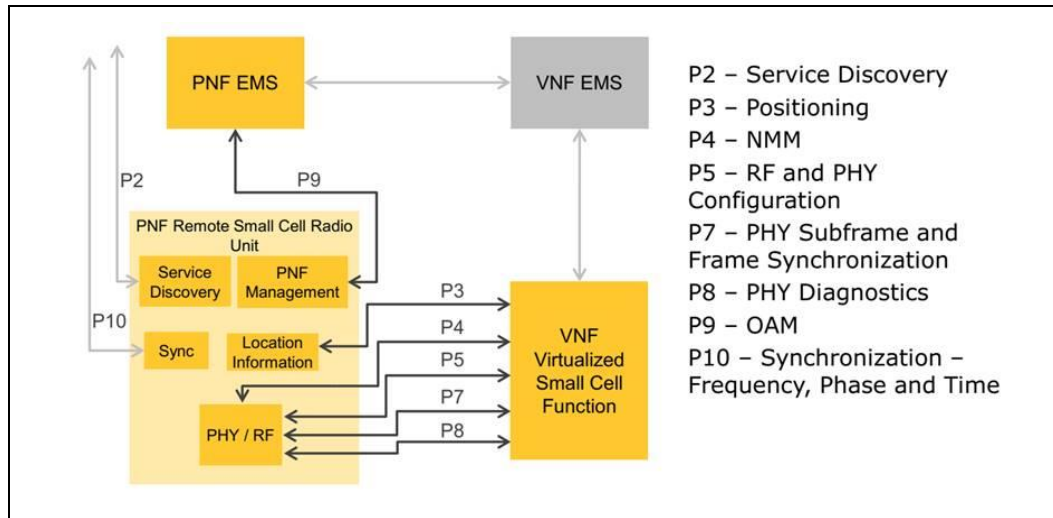
The interfaces in [Figure 1](#) are defined as follows:

- P2 – service discovery interface
- P3 – positioning interface
- P4 – Network Monitor Mode (NMM) interface
- P5 – PHY mode control interface
- P7 – main data path interface
- P8 – PHY diagnostics interface
- P9 – Operations, Administration and Management (OAM) interface
- P10 – synchronization, frequency, phase, and time

Note: Only P5 and P7 are currently supported in this release.

For more details, refer to Section 2.1 of the *SCAPI Small Cell Forum nFAPI and FAPI Specifications* document (see [Table 2](#)).

Figure 1. nFAPI Reference Architecture



1.1 Terminology

Table 1. Acronyms

Term	Description
3GPP	3 rd Generation Partnership Project
API	Application Programming Interface
eNB	E-UTRAN Node B
FAPI	Femtocell Application Platform Interface
EPDCCH	Enhanced Physical Downlink Control Channel
HARQ	Hybrid Automatic Repeat Request
LTE	Long Term Evolution
L1	Layer 1
L2	Layer 2
MAC	Media Access Control
nFAPI	Network Functional Application Platform Interface
NMM	Network Monitor Mode
PHY	Physical Layer
PNF	Physical Network Functions
SCAPI	Small Cell Application Platform Interface
SFN/SF	System Frame Number/Subframe Number
UE	User Equipment
VNF	Virtual Network Functions



1.2 Related Documents

Table 2. Reference Documents and Resources

Title	Document Number/Location
<i>FlexRAN Reference Solution L1 User Guide</i>	570228
<i>FlexRAN Reference Solution RefPHY</i>	572318
<i>FlexRAN Reference Solution L1 XML Configuration User Guide</i>	571741
<i>FlexRAN Reference Solution Software v1.5.1 Release Notes</i>	575822
SCAPI Small Cell Forum "LTE eNB L1 API Definition"; release 9	http://scf.io/en/documents/082_-_LTE_eNB_L1_API_definition.php
SCAPI Small Cell Forum "nFAPI and FAPI Specifications"; Version SCF082.09.05	https://scf.io/en/documents/082_-_nFAPI_and_FAPI_specifications.php

Table 3. 3GPP 36 Series Standard Document References

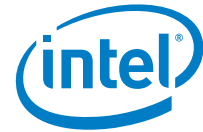
Reference	Title	Number	Version
[36.331]	3GPP Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control	TS36.331	10.10.0 († 11.4.0)
[36.321]	3GPP Evolved Universal Terrestrial Radio Access (E-UTRA); Medium Access Control (MAC) protocol specification	TS36.321	10.9.0 († 11.3.0)
[36.300]	3GPP Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN) Overall Description; Stage 2	TS36.300	10.10.0
[36.401]	3GPP Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Architecture description	TS36.401	10.4.0
[36.304]	3GPP Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode	TS36.304	10.6.0
[36.213]	3GPP Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Layer procedures	TS36.213	10.10.0 († 11.4.0)
[36.104]	3GPP Base Station (BS) Radio Transmission and Reception	TS36.104	10.9.0
[36.211]	3GPP Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channel and Modulation	TS36.211	10.7.0 († 11.3.0)
[36.212]	3GPP Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding	TS36.212	10.8.0 († 11.3.0)



Reference	Title	Number	Version
[36.306]	3GPP Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio access capabilities	TS36.306	10.10.0
[36.214]	3GPP Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer; Measurements	TS36.214	10.10.0
[36.141]	3GPP Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing	TS36.141	11.11.0

Note: † Enhanced Physical Downlink Control Channel (EPDCCH)

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2 L1 nFAPI Procedures

2.1 Physical Network Functions (PNF) Configuration Procedures

The current implementation only supports the initialization procedure among the PNF configuration procedures. It does not support other PNF configuration procedures such as reset, restart, and reconfigure. For more details, refer to Section 2.2.1 of the *SCAPI Small Cell Forum nFAPI and FAPI Specifications* document (see [Table 2](#)).

2.2 P5 PHY Configuration Procedures

Initialization and query procedures are supported. Other P5 configuration procedures such as termination, restart, reset, reconfigure, or notification procedures are not supported.

For more detail, refer to Section 2.2.2 of the *SCAPI Small Cell Forum nFAPI and FAPI Specifications* document (see [Table 2](#)).

2.3 P7 Subframe Procedures

For more detail, refer to Section 2.2.3 of the *SCAPI Small Cell Forum nFAPI and FAPI Specifications* document (see [Table 2](#)).

2.3.1 SUBFRAME Signal

A SUBFRAME indication is sent from the PHY to the L2/L3 software indicating the start of a 1 ms frame.

2.3.2 System Frame Number/Subframe Number (SFN/SF) Synchronization

Use the same SFN/SF synchronization procedures as FAPI. PHY acts as the master.

2.3.3 API Message Order

The API message order described for FAPI also applies in nFAPI.

`DL_CONFIG.request`, `UL_CONFIG.request`, `TX.request` messages must be sent in every subframe. The `HI_DCIO.request` message is optional.

The `TX.request` message should be the last one sent to PNF in every subframe. This indicates the end of message transmission from Virtual Network Functions (VNF) to PNF.

2.3.4 Semi-static Information

In nFAPI all cell-specific and UE-specific semi-static information is stored in the MAC.



2.3.5 Uplink Hybrid Automatic Repeat Request (HARQ) Signalling

In nFAP I all cell-specific and UE-specific semi-static information is stored in the MAC.

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3 L1 nFAPI Messages

This chapter provides a description of the L1 nFAPI message formats. For more detail, refer to Section 2.3.3 of the *SCAPI Small Cell Forum nFAPI and FAPI Specifications* document (See [Table 2](#)).

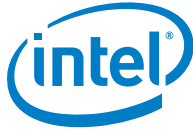
3.1 nFAPI P5 Message

For more details, refer to Section 2.3.3 of the *SCAPI Small Cell Forum nFAPI and FAPI Specifications* document (see [Table 2](#)).

The following table lists the P5 messages currently supported by this release.

Table 4. Supported P5 Messages

P5 Message
PNF_PARAM.request
PNF_PARAM.response
PNF_PARAM Errors
PNF_CONFIG.request
PNF_CONFIG.response
PNF_START.request
PNF_START.response
PNF_START Errors
PNF_STOP.request
PNF_STOP.response
PNF_STOP Errors
PARAM.request
PARAM.response
PARAM Errors
CONFIG.request
CONFIG.response
START.request
START.response
START Errors
STOP.request
STOP.response
STOP Errors
MEASUREMENT.request
MEASUREMENT.response



Note: The parameters in PARAM.response are dummy parameters. VNF should not evaluate the capability of PHY by the PARAM.response message but instead refer to the *FlexRAN L1 Doxygen Code Reference Document* (see [Table 2](#)).

Note: For parameter differences with the nFAPI and FAPI specification, refer to [Appendix A](#).

3.2 nFAPI P7 Message

For details, refer to Section 2.3.4 of the *SCAPI Small Cell Forum nFAPI and FAPI Specifications* document (see [Table 2](#)).

The following table lists the P7 messages currently supported by this release.

Table 5. Supported P7 Messages

P7 Message
DL_CONFIG.request
UL_CONFIG.request
HI_DCI0.request
TX.request
RX_ULSCH.indication
HARQ.indication
RX_SR.indication
RX_CQI.indication
RACH.indication
SUBFRAME.indication

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Appendix A Parameter Differences with the nFAPI Specification

The table below lists the parameter differences with the nFAPI specification document.

Note: Locations are subject to change (table numbers in the nFAPI specification) with each document release. Also, "PHY" in [Table 6](#) refers to the FlexRAN 4G reference PHY.

Table 6. Parameter Differences

Table Number in nFAPI Specification	Parameter	Difference
2-4	Location Coordinates Length	Not supported by PHY
2-4	Location Coordinates	Not supported by PHY
2-4	OUI[3]	Not supported by PHY
2-24	EARFCN	EARFCN of RRU is set during power on. This value should match that one.
2-32	DL RS TX Power measurement	Not supported by PHY
2-32	Thermal noise power measurement	Not supported by PHY
4-3	Duplexing mode	PHY does not support HD_FDD and for TDD but only supports DL/UL configuration 2
4-3	DL cyclic prefix type	PHY does not support CP_EXTENDED
4-3	UL cyclic prefix type	PHY does not support CP_EXTENDED
4-3	Downlink and Uplink channel bandwidth	PHY only tests values 50 and 100
4-3	Tx and Rx antenna ports	PHY only supports antenna ports 1, 2, and 4
4-3	Hopping mode	PHY does not support PUSCH hopping
4-3	Configuration index	PHY only supports PRACH format 0
4-3	SRS config	PHY does not support SRS
4-3	Uplink RS hopping	PHY does not support uplink RS hopping
4-3	Subframe assignment	PHY only supports 2
4-3	Special sub-frame patterns	PHY only test value 7
4-3	LAA config	PHY does not support LAA
4-3	eMTC config	PHY does not support eMTC
4-3	NB-IOT config	NB-IOT parameters are not supported in this specification



Table Number in nFAPI Specification	Parameter	Difference
4-3	Timing window	Timing window is not used
4-3	EARFCN	This EARFCN should match the one used by RRU
4-8	PDU Type	PHY only supports 0, 1, 3, 4
4-10	DCI format	PHY support and fully test following format: 1, 1A, 2A
4-10	CCE index	PHY does not support EPDCCH
4-10	Aggregation level	PHY does not support EPDCCH
4-10	Virtual resource block assignment flag	PHY does not test distributed type
4-11	MCCH flag, MCCH change notification	PHY does not support MCCH
4-11	Scrambling identity	DCI format 2B is not fully tested
4-13	(all parameters)	PHY does not support DCI DL PDU Release 11 parameters
4-14	(all parameters)	PHY does not support DCI DL PDU Release 12 parameters
4-15	(all parameters)	PHY does not support DCI DL PDU Release 13 parameters
4-19	(all parameters)	PHY does not support MCH
4-20	(all parameters)	PHY does not support MCH
4-22	Virtual resource block assignment flag	PHY does not test distributed type
4-22	Modulation	PHY does not support 256QAM
4-22	Transmission scheme	Only value 0, 1, 2 are fully tested
4-22	Number of layers	Only 1, 2, 4 layers are fully tested
4-22	Transmission mode	Only TM 1, 2, 3 are fully tested
4-26	(all parameters)	Not supported by PHY
4-27	(all parameters)	Not supported by PHY
4-28	(all parameters)	Not supported by PHY
4-30	Virtual resource block assignment flag	PHY does not support distributed type
4-30	Transmission scheme	Antenna port 5 is not fully tested
4-31	(all parameters)	Not supported by PHY
4-32, 4-33	(all parameters)	Not supported by PHY
4-34, 4-35, 4-36	(all parameters)	Not supported by PHY
4-37, 4-38, 4-39	(all parameters)	Not supported by PHY



Table Number in nFAP1 Specification	Parameter	Difference
4-40, 4-41	(all parameters)	Not supported by PHY
4-42, 4-43	(all parameters)	Not supported by PHY
4-44, 4-45	(all parameters)	Not supported by PHY
4-46, 4-47	(all parameters)	Not supported by PHY
4-51	Frequency hopping enabled flag, Frequency hopping bits	PHY does not support PUSCH hopping
4-52	Disable sequence hopping flag	PHY does not test value 0
4-53	(all parameters)	Not supported by PHY
4-54	(all parameters)	Not supported by PHY
4-64	(all parameters)	Not supported by PHY
4-68	HARQ Size	PHY only supports tested Format 1a/1b
4-68	ACK_NACK mode	PHY only supports tested 0,1, 2
4-69	(all parameters)	Not supported by PHY
4-79	(all parameters)	Not supported by PHY
4-80	(all parameters)	Not supported by PHY
4-83	(all parameters)	Not supported by PHY
4-84	(all parameters)	Not supported by PHY
4-91	ACK_NAK mode	PHY only support value 0, 1
4-92	(all parameters)	Not supported by PHY
4-93	(all parameters)	Not supported by PHY
4-95	(all parameters)	PHY does not test
4-96	(all parameters)	PHY does not test
4-97	Number of Combs	Not supported by PHY
4-102, 4-103, 4-104, 4-105	(all parameters)	Not supported by PHY
4-106, 4-107	(all parameters)	Not supported by PHY
4-109	PDU Type	PHY only supports HI PDU and DCI UL PDU
4-114	DCI format	Only format 0 is fully tested
4-116	(all parameters)	Not supported by PHY
4-119	(all parameters)	Not supported by PHY
4-121	(all parameters)	Not supported by PHY
4-122	(all parameters)	Not supported by PHY
4-133	Timing advance R9	Not supported by PHY
4-136	Mode, Number of ACK/NACK, HARQ data	PHY does not test format 3



Table Number in nFAPI Specification	Parameter	Difference
4-138	(all parameters)	Not supported by PHY
4-139	(all parameters)	PHY only support value 1, 2
4-144	Mode, Number of ACK/NACK	PHY does not test format 3
4-145	(all parameters)	Not supported by PHY
4-154	Timing Advance R9	Not supported by PHY
4-158	Timing Advance R9	Not supported by PHY
4-159	RACH resource type	Not supported by PHY
4-161 ~ 4-166	(all parameters)	Not supported by PHY
4-169 ~ 4-171	(all parameters)	Not supported by PHY
4-172 ~ 4-174	(all parameters)	Not supported by PHY
4-175 ~ 4-186	(all parameters)	PHY does not support LBT

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