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5G Standards and Outlook for 5G Unlicensed

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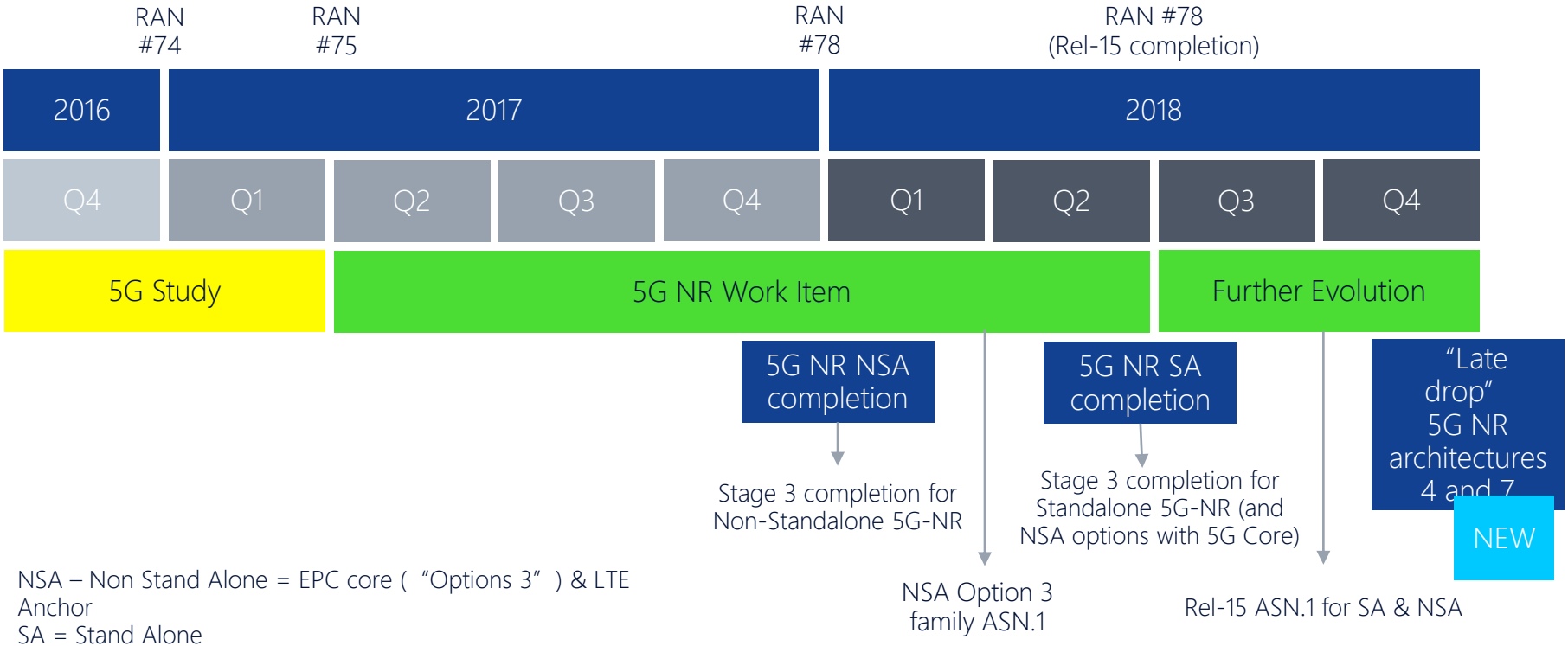
June 2018

3GPP RAN Release 15 Schedule – both 5G SA and NSA specs now available!

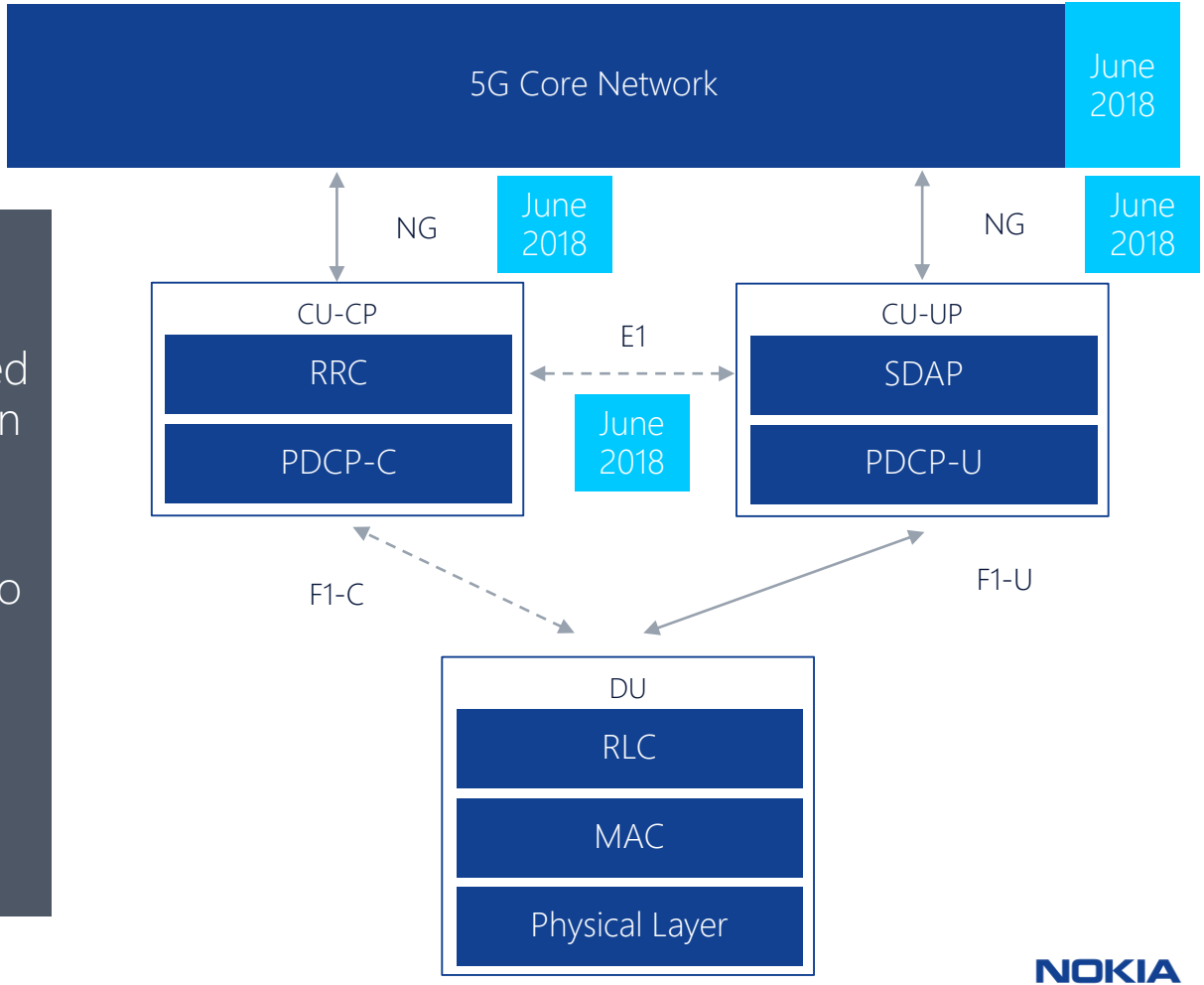
Building the baseline for next phase of 5G, including unlicensed



NSA – Non Stand Alone = EPC core ("Options 3") & LTE Anchor
SA = Stand Alone

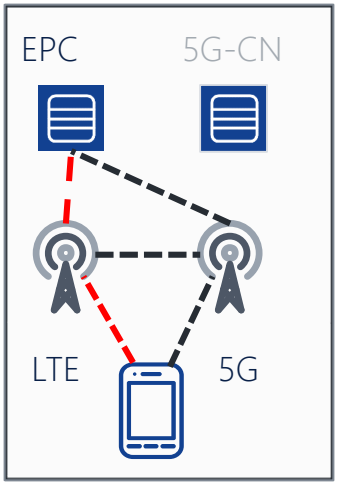
5G RAN architecture
Functional split

- Release 15 will contain higher layer split
- Lower layer split was studied as well. Study is currently on hold.
- December 2017 version supports only connection to LTE based core (EPC)
- Interface to 5G Core (5GC) in June 2018 specifications
- Also E1 interface part of June 2018 specifications

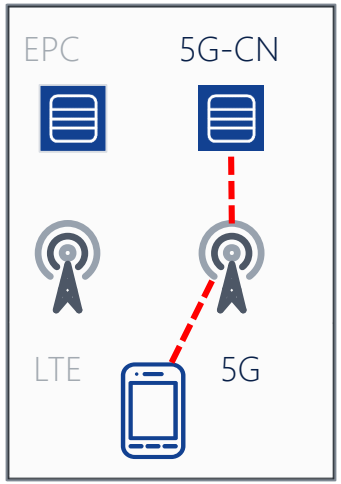


5G RAN Architecture Options & Schedule - Option 3 Supported First

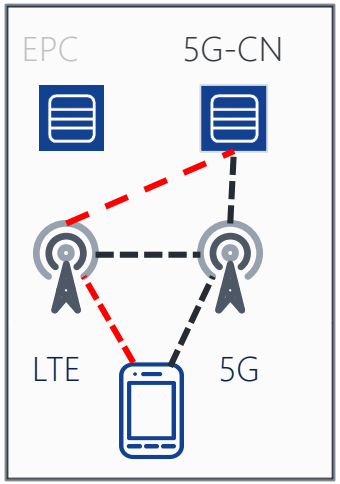
Non-standalone Option 3X — Dec 2017



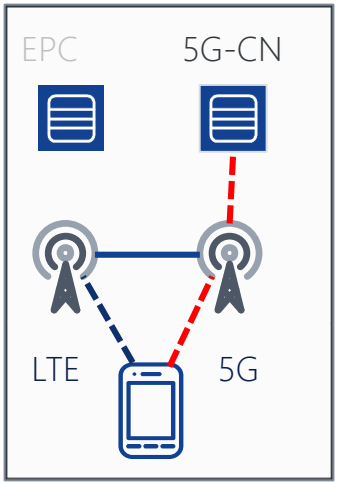
Standalone Option 2 — June 2018



Non-standalone Option 7X — Dec 2018



Non-standalone Option 4 — Dec 2018



Option 5 = LTE connected
To 5G core (Known also as eLTE)

= Control plane only
= User + control plane
= User plane only

In 2Q/2018 focus on options 2 and 3, options 4 and 7 to be introduced as Release 15 late drop 12/18 (ASN.1 03/19)

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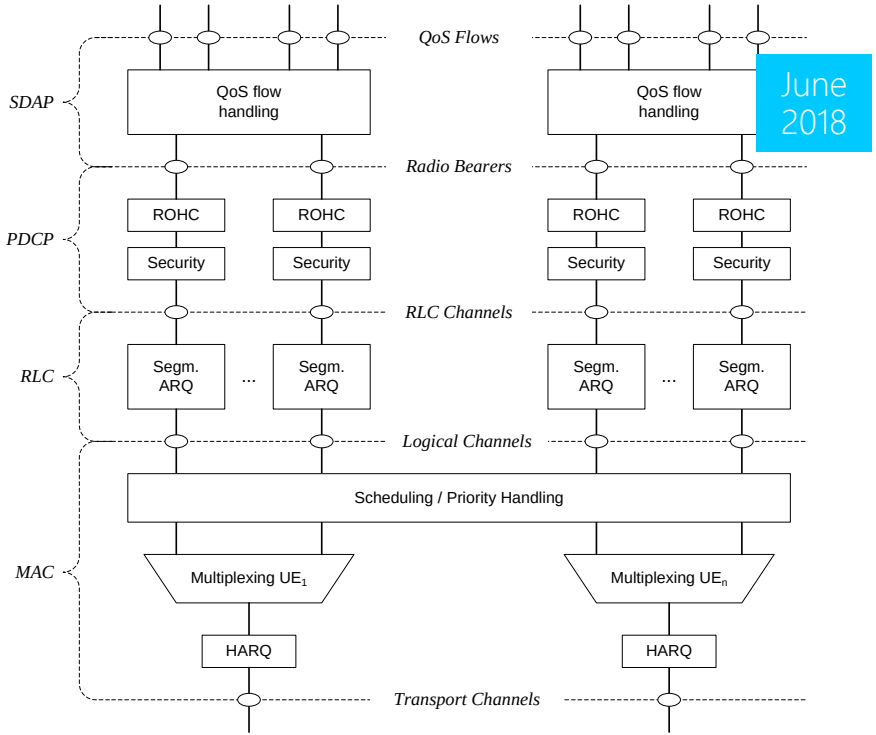
5G Release 15

Overall Radio Protocol Architecture

- New Service Data Adaptation Protocol supports per packet QoS
- Processing friendly to support extremely high bit rates
- Supports very low latency transmissions and efficient power saving techniques
- Full 5G radio protocol specifications in June 2018 for standalone 5G operation

In December 2017 version only parts necessary for the "early drop"



What is 5G in Release 15? Radio Design (NR)

A new set of technologies for a generation leap in capabilities

	3G	4G	5G
Downlink waveform	CDMA	OFDM	OFDM, SCFDMA
Uplink waveform	CDMA	SCFDMA	OFDMA, SCFDMA
Channel coding	Turbo	Turbo	LDPC (data) / Polar (L1 contr.)
Beamforming	No	Only data	Full support
Spectrum	0.8 – 2.1 GHz	0.4 – 6 GHz	0.4 – **52.6** GHz*
Bandwidth	5 MHz	1.4 – 20 MHz	Up to 100 MHz (200 or 400MHz for >6GHz)
Network slicing	No	No	Yes
QoS	Bearer based	Bearer based	Flow based
Small packet support	No	No	Connectionless
In-built cloud support	No	No	Yes

June 2018

June 2018

* More after Release 16

What Are the Challenges with the First Version of 5G?

Physical Layer (L1)

Lot of parameters & features

Determining mandatory L1 feature set

Protocols

Parameterizing large number of L1 parameters
Dealing with new procedures (beam management etc.)

Spectrum

Finalize 5G frequency bands

Finalize band combinations (many!)

- Any of the area not done right by March 2018 will require corrections in later version of specifications
- UE capability (what is mandatory and what not) also being worked still, some until 09/2018
- In 2018 lot of time is needed for full Release 15 finalization in 3GPP
    - Especially Radio Resource Control (RRC) specifications require lot of attention still in 2018

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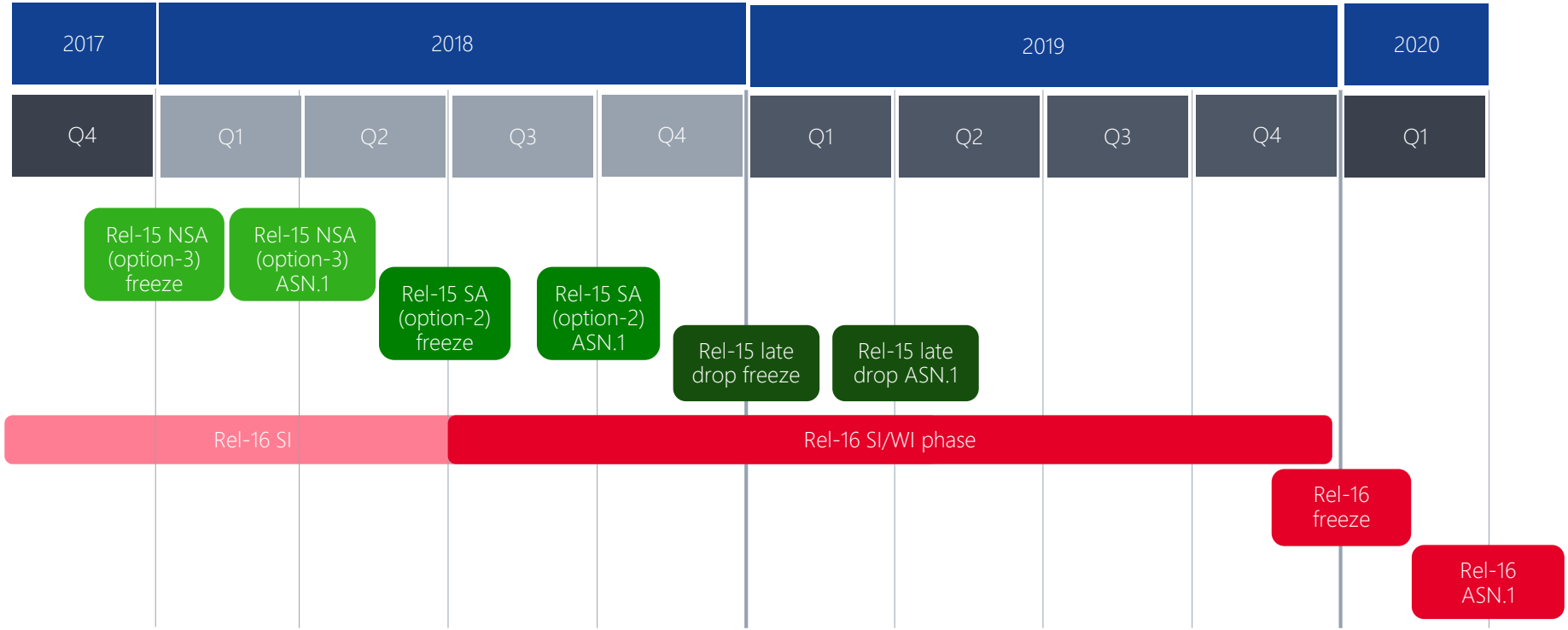
Release 16 Timeline Unchanged



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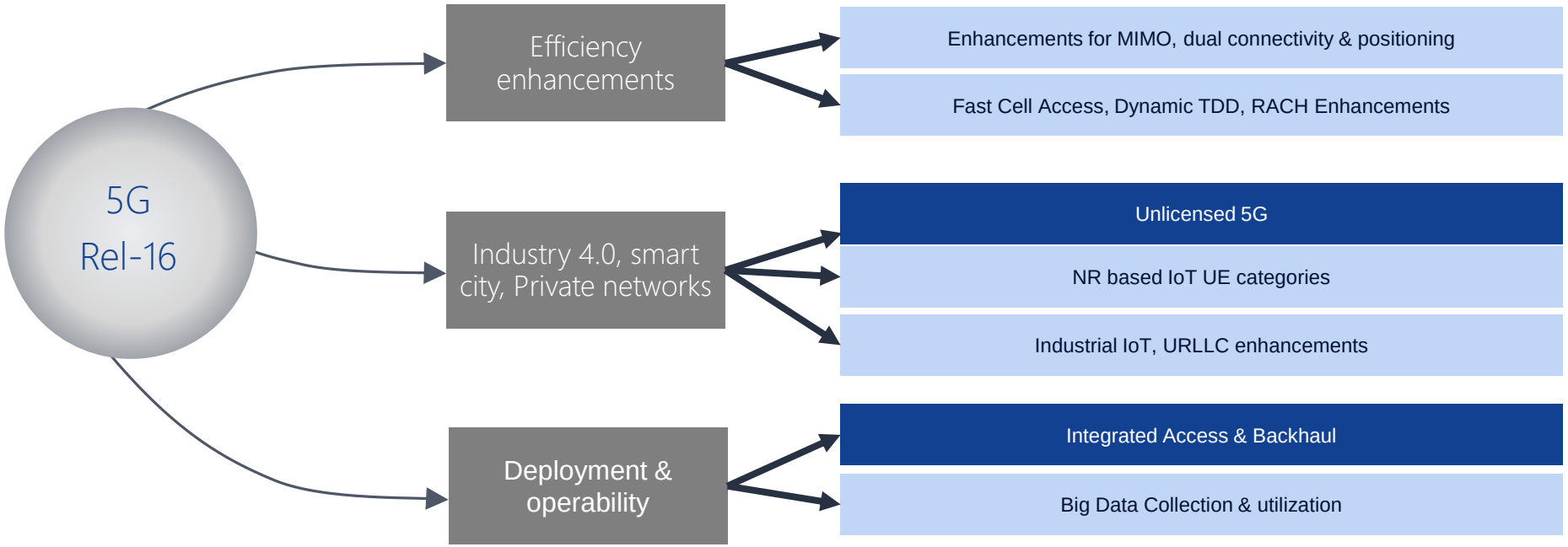
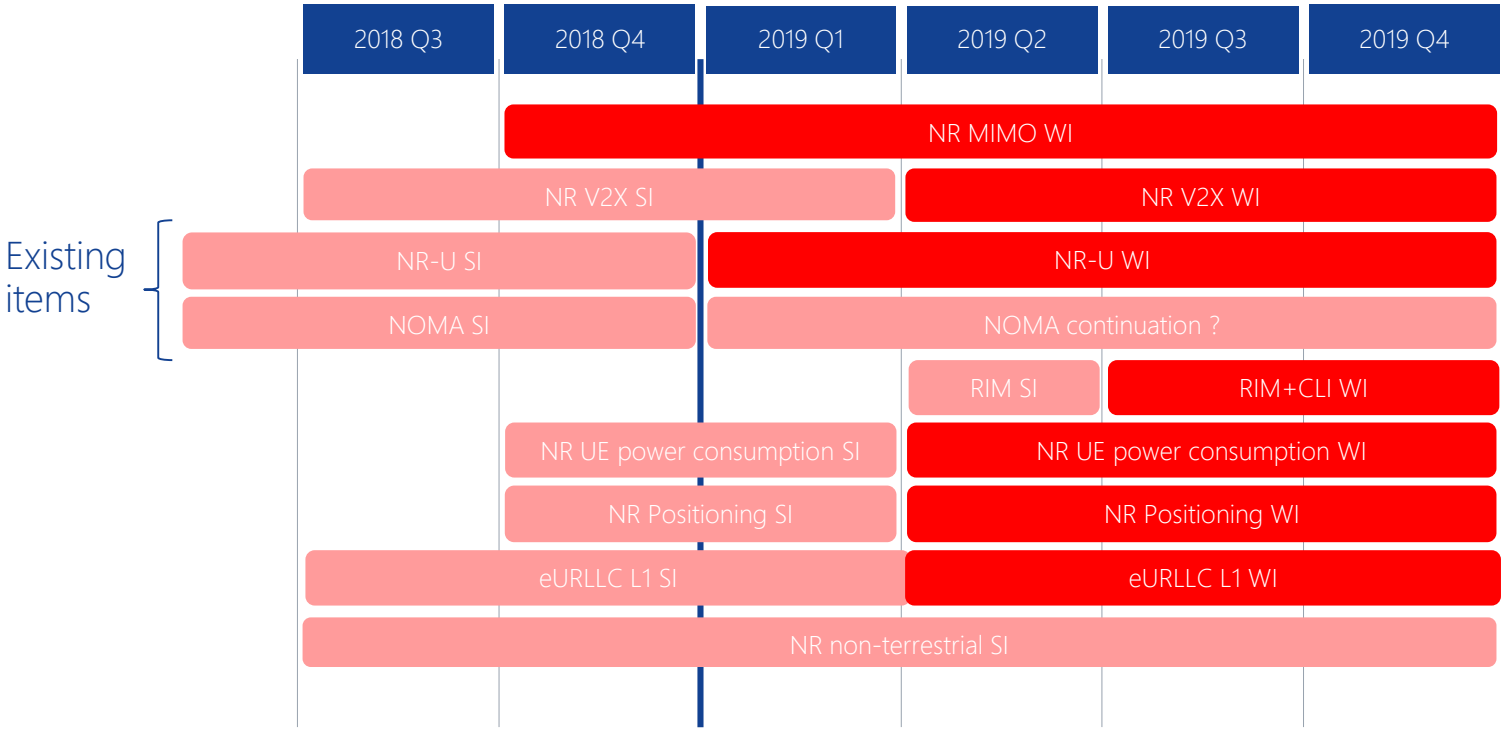
Release 16 Nokia Key Themes – 5G Radio



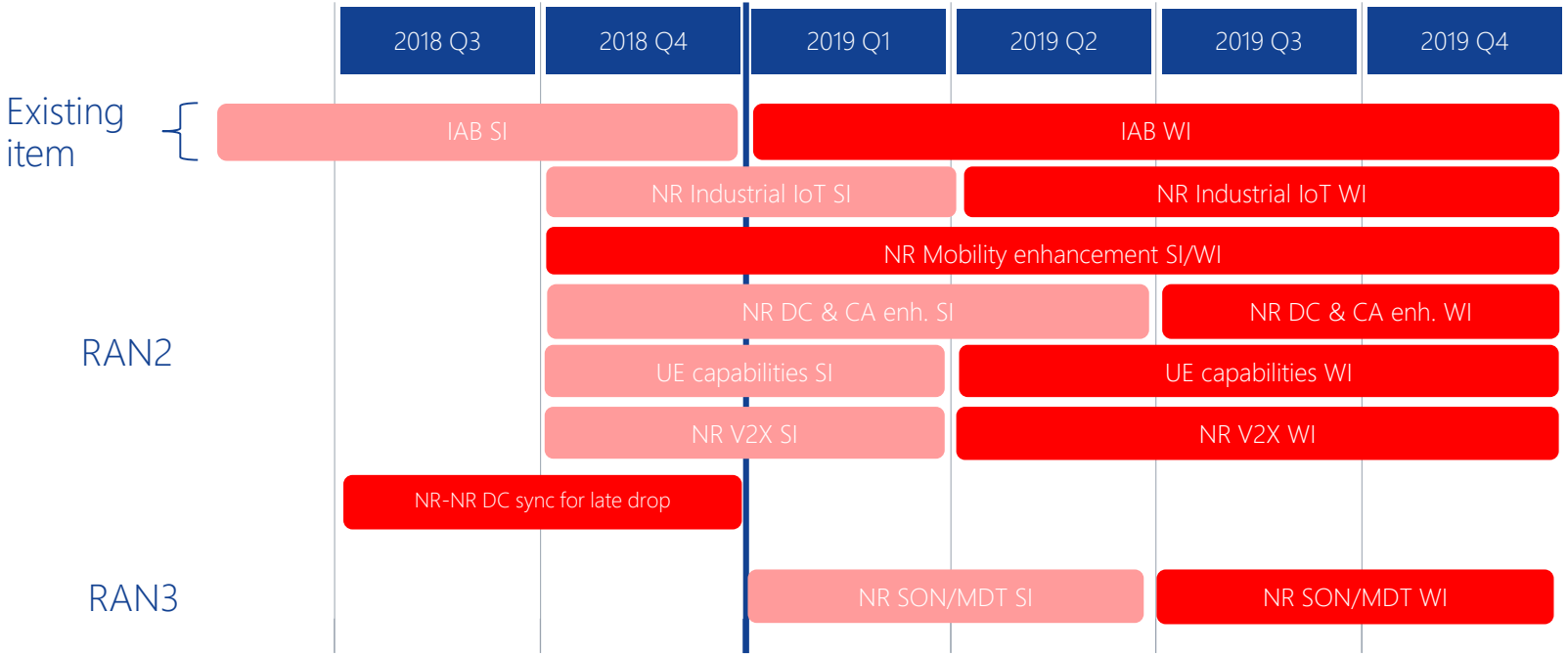
On-going SID/WID

New Release 16 topic

Release 16 Timeline – 5G/ Physical Layer Items



Release 16 Timeline – 5G Protocol/Architecture Items



Ref: RP-181339

5G Unlicensed Scenario Under Work in 3GPP
- Both standalone and LAA cases covered

- An NR-based LAA cell(s) connects with an LTE or NR anchor cell operating in licensed spectrum
  - The study assumes the techniques for linking between Pcell (LTE or NR licensed CC) and Scell (NR unlicensed CCs) according to the NR WI
- An NR-based cell operating standalone in unlicensed spectrum, connected to a 5G-CN network, e.g., for private network deployments;
- Study how to ensure from a RAN level that connection and security management can be integrated with the E-UTRAN, NG RAN and 5G CN architecture, including service continuity requirements for users moving between cells of licensed and unlicensed frequency bands, liaising with SA2 as required

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5G Unlicensed Physical Layer 3GPP

- Scope of the on-going study in 3GPP, higher frequency bands now removed

- Physical channels inheriting the choices of duplex mode, waveform, carrier bandwidth, subcarrier spacing, frame structure, and physical layer design made as part of the NR study and avoiding unnecessary divergence with decisions made in the NR WI
  - Consider unlicensed bands below 7GHz NEW
  - Consider similar forward compatibility principles made in the NR WI
- Initial access, channel access. Scheduling/HARQ, and mobility including connected/inactive/idle mode operation and radio-link monitoring/failure
- Coexistence methods within NR-based and between NR-based operation in unlicensed and LTE-based LAA and with other incumbent RATs in accordance with regulatory requirements in e.g., 5GHz, 6GHz bands

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Next Steps for 5G Unlicensed in 3GPP

Normative phase to start from beginning of 2019 until end of 2019

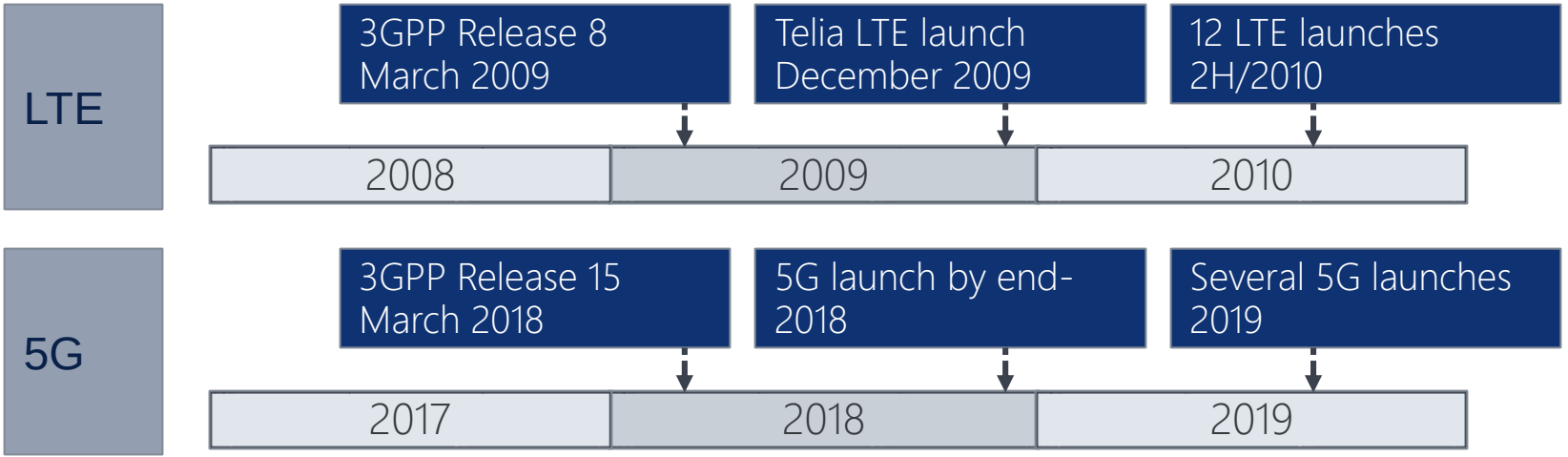
- Study scheduled to be finalized by 12/2018
- This work foreseen to focus only on below 7 Ghz

Regulatory framework for higher bands also being checked in 3GPP

- The current numerology/waveform not intended above 52.6 GHz
- Separate RAN level study on above 52.6 GHz agreed to be started
- Normative work foreseen for high bands (like 60 GHz) foreseen in Release 17

When Can You Buy a 5G Handset?

5G Schedule based on LTE History



- First 3GPP LTE was launched by Telia in December 2009. That was 8 months after 3GPP completed Release 8. Total 12 LTE launches during 2H/2010.
- Note the planned std phase in 3GPP for 5G is very short, only 9 months after study, which gives less development time compared to LTE specification time
- Nokia is working hard to ensure stable specifications from 3GPP side to make this happen

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