NR Profiles

December 11th, 2017

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Outline

- Problem statement
- NR Profiles – proposal
- NR Profiles – standardisation
- Conclusions

- Appendix A: ensuring backwards compatibility
- Appendix B: NR parameters

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Problem Statement

NR flexibility and complexity

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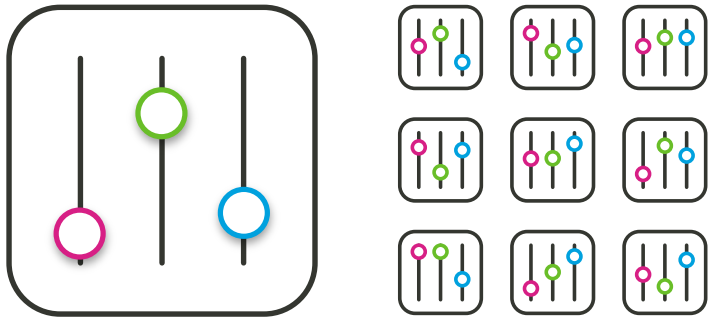
Problem Statement – Flexibility-induced complexity



X parameters *Y configurations*

Standards flexibility

Release 15

- NR AS requires *hundreds of configurable* parameters
  - See Appendix B
- Each parameter has a given range
- Thousands of different configurations are possible
- With hundreds of band combinations

- Flexibility-induced complexity
- Testing & validation: substantial time and effort
- TTM challenge
- Increased risk of wrong implementations due to untested/untestable, unvalidated configurations

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NR Profiles
Proposal

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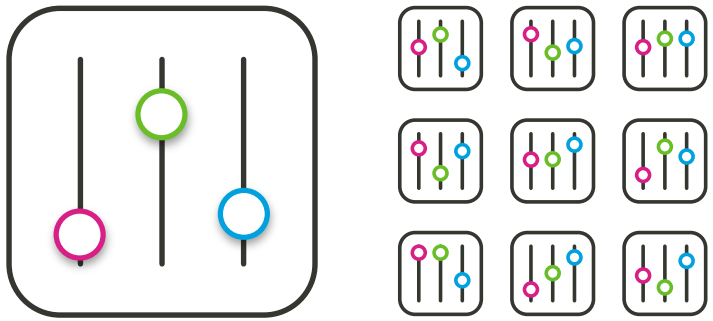
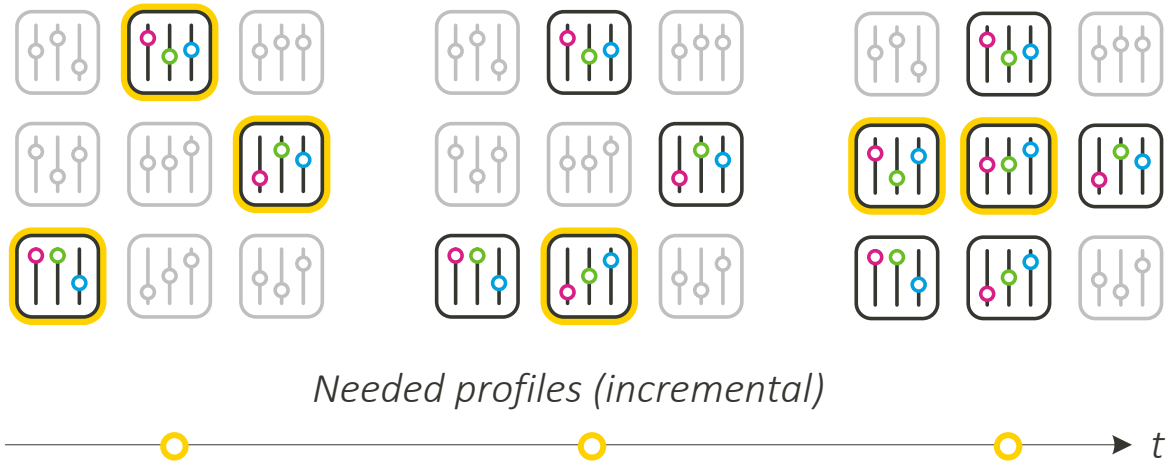
NR Profiles – Proposal in a nutshell



X parameters *Y configurations*

Standards flexibility

Release 15



Focus on realistic deployments

Release 15

- Define NR profiles gradually according to needs
- Accelerate time-to-market accordingly

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NR Profiles – Intended Benefits

- To drive harmonisation
- To reduce the gap between 3GPP standards and IODT
- To guarantee conformance and interoperability
- To timely respond to market needs and
  to accelerate time-to-market
- To simplify deployments in a controlled step-wise fashion
- To stimulate and accelerate (wide) NR adoption via 3GPP industry consensus

- By-product: potentially simplify signaling (indicate support of profiles)

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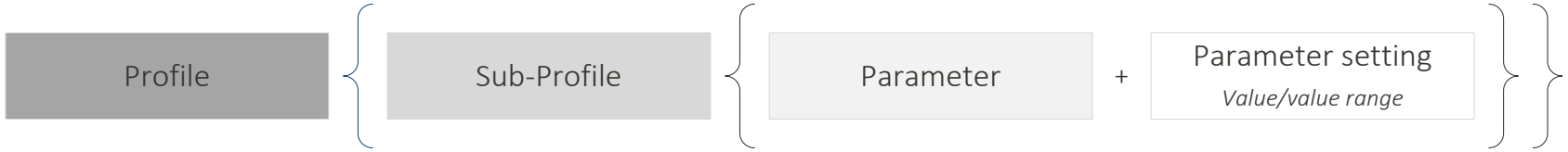
NR Profiles – Definition

- Hierarchical definition based on
  Profile, Sub-Profiles, Parameters and Parameter settings

- A *Profile* is a set of one or more *Sub-Profiles*
- A *Sub-Profile* is a *single* full(1) consistent set of *Parameters* with given *Settings*



Sub-Profile = Pre-defined NR configuration

(1) Intended – in practice, maybe only a subset

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NR Profiles – Definition

- A *Sub-Profile* is either *Non-Band Specific (NBS)* or *Band-Specific (BS)*
  - *NBS Sub-Profile:* applicable to more than one band / band combo
  - *A BS Sub-Profile:* applicable to a single band / band combo
- A NBS Sub-Profile contains
  - Parameters with common settings i.e. settings applicable to all bands to which the Sub-Profile applies
  - Parameters with band-specific settings
  - Applicable bands / band combos
- A BS Sub-Profile is for bands requiring specific tailored configuration

- A Sub-Profile is inclusive of all lower Sub-Profiles (whether defined or implicit)

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NR Profiles – Requirements

- NR Profiles may be not mutually exclusive
- A UE may support one or more NR Profiles
- A UE supporting a given NR Profile:
  - shall fully support all NBS NR Sub-profile(s) of this NR Profile in one or more of the indicated bands
  - shall fully support all BS NR Sub-profiles of this NR profile (i.e. in all corresponding bands)
  - is not required to support any other NR Profile, unless explicitly stated otherwise

- Applicability
  - NR Configurable parameters
  - NR Features (mandatory, optional)

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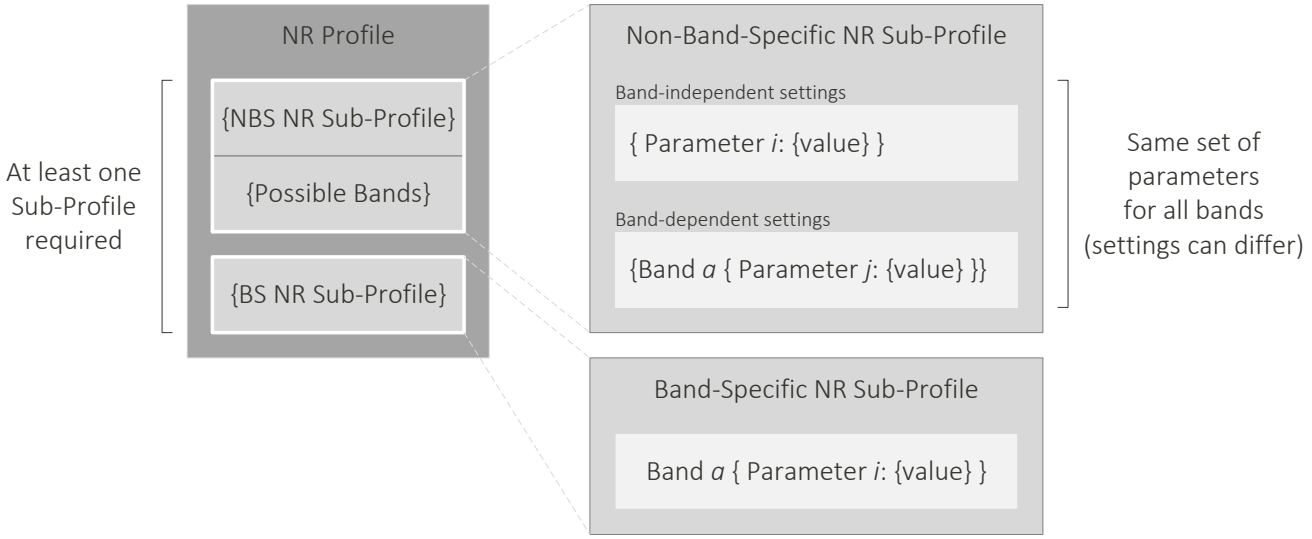
NR Profiles – Definition



Proposal

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NR Profiles – How to

How to expedite the definition of new NR profiles

- RRC parameters into a **parent tree structure**
  - Identify parameters dependencies / relationships
  - Enable automation so update can be made easily
  - Identify conflicts and errors
- Compile **feature set** for each sub-profile
- For each sub-profile **trim the parent tree structure** based on the **feature set**
  - Some branches/parameters can be pruned entirely
  - Some parameters will have their value range reduced

Example main branches

- MIMO incl. CSI and beam management
- Initial access
- Control
- Scheduling, ARQ
- etc.

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NR Profiles – example (high level)

High / Low freq. example

- Focusing on MIMO, CSI and BM related parameters
- Low Frequency Baseline Profile
  - No Beam Failure Recovery (BFR) procedure
- High Frequency Baseline Profile
  - No IMR (Interference Measurement Resource)
  - No Type-II CSI
  - Type-I CSI limited to 2 CSI-RS ports

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NR Profiles
Standardisation

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Background – LTE/SAE Trial Initiative

- [May 2007] LSTI Forum – LTE/SAE Trial Initiative:
  Global, collaborative technology trial initiative focused on accelerating the availability of commercial and interoperable next generation LTE mobile broadband systems.
  - *Fostering the development of a global LTE ecosystem that will include a wide range of LTE devices that will function consistently on all LTE networks worldwide.*
  - *Increased industry synergies, consolidated 3GPP specifications, smoother LTE network launches, and improved LTE time to market.*
  - *Based on NGMN requirements*
- All milestones completed[1] by 2010 – reported at MWC2011
  - Proof of concepts (in 2009)
  - Interoperability development tests (IODT)
  - Interoperability tests (IOT)
  - Friendly customer trials (FCT)

(1) Min 3 vendors for each case

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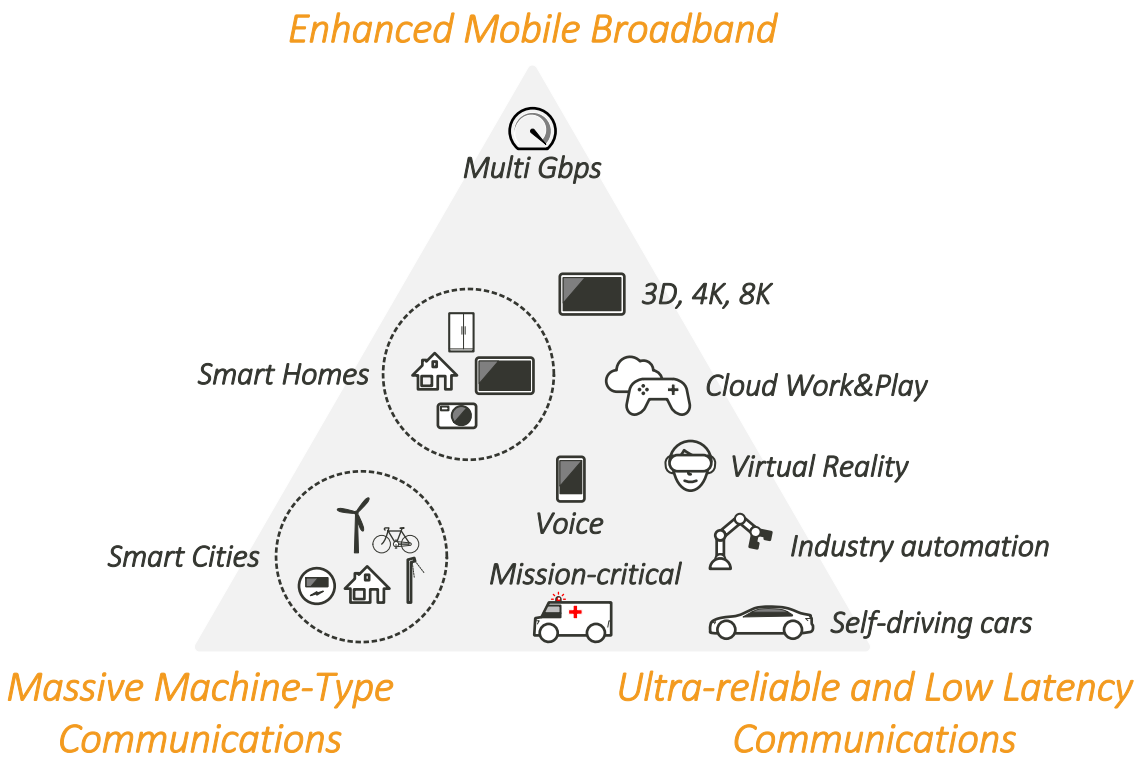
Harmonisation through standardisation

- LSTI was essentially driven by mobile broadband
- 5G (NR) though initially eMBB-focused will be much more than that
- Harmonisation is critical for eMBB and will be especially critical for other domains
- Independent harmonisation spin-off per industry / use case risks yielding fragmentation

► Prepare the stage *now* for the widest possible harmonization across industries/use cases



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NR Profiles – 3GPP Standardization

- 3GPP – best aggregator
  - Wide industry coverage (operators, UE vendors, infra vendors, verticals)
  - Quarterly TSG updates: offers timely definition and availability of NR Profiles
  - Inputs from external foras with well established Liaisons (eg. GSA, GSMA, NGMN)
  - Technical leadership and expertise
  - Minimal administrative overhead – can start now

- Who
  - TSG Plenary (workload may be an issue); or
  - Dedicated Ad-Hoc; or
  - Dedicated WG
- What
  - TS incl. all NR Profiles and NR Sub-profiles
- RAN4/RAN5 to define & prioritize requirements and conformance testing accordingly

NGMN, ITU, Misc.
Requirements

3GPP
1) Technology
2) Profiles

3GPP MRPs/IMs
1) Promotion
2) Adoption

Misc. industries
1) Adoption
2) Services

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NR Profiles – Standardization Workflow

TSG Plenary N
1) Endorse need for profiles with given KPIs and sub-profiles
2) Kick-off profiling activity

Profiling Activity
3) Define parameters settings for required profiles and sub-profiles

TSG Plenary N+1
4) Approve profiles and sub-profiles

RAN4
5a) Prioritize req. according to set profiles

RAN5
5b) Prioritize TC definition according to set profiles

1 → 2 → 3 → 4 → *t*

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Conclusions

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Conclusions [1/2]

- Hundreds of configurable parameters, thousands of different configurations with hundreds of possible band combinations
- Need for Harmonisation
  - To reduce the gap between 3GPP core specs and IODT
  - To guarantee conformance and interoperability
  - To timely respond to market needs and to accelerate time-to-market
  - To simplify deployments in a controlled step-wise fashion
  - To stimulate and accelerate (wide) NR adoption via 3GPP industry consensus
- Need for NR Profiles to generate harmonisation
- 3GPP to take responsibility for NR Profiles

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Conclusions [2/2] – Way forward

- Proceed step-wise
  1. [TSG#78] Confirm the need for NR Profiles
     Confirm 3GPP as home for NR Profiles
  2. [TSG#78~79] Consolidate 3GPP Framework
  3. [TSG#79] Kick-off definition of NR Profiles

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Appendix A
Ensuring Backwards Compatibility

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NR Profiles – Backwards Compatibility

- Profile evolution – What happens to “legacy” profiles in future releases?
- Proposal – incremental support and backwards compatibility
  - Profile *X* in Rel-*n* shall be supported in subsequent releases
  - Profile *X* in Rel-*n+i* may feature additional NR-sub-profiles vs. Profile *X* in Rel-*n*
  - Sub-profile *Y* in Rel-*n* shall be supported in subsequent releases
  - Sub-profile *Y* in Rel-*n+i* may feature additional Rel-*n+i* NR parameters and parameters settings
  - A UE/Network supporting Profile X in Rel-*n+i* shall support Profile X in Release [*n*; *n+i*]
  - If NR profiles are signalled by the UE to the network, a Release marker is required (UE to network)
    - To enable the network to understand the Release of the supported profiles by the UE, and to operate accordingly
    - A UE of a later release than the network will be operating according to the network release, by way of the above
  - New profiles can be added

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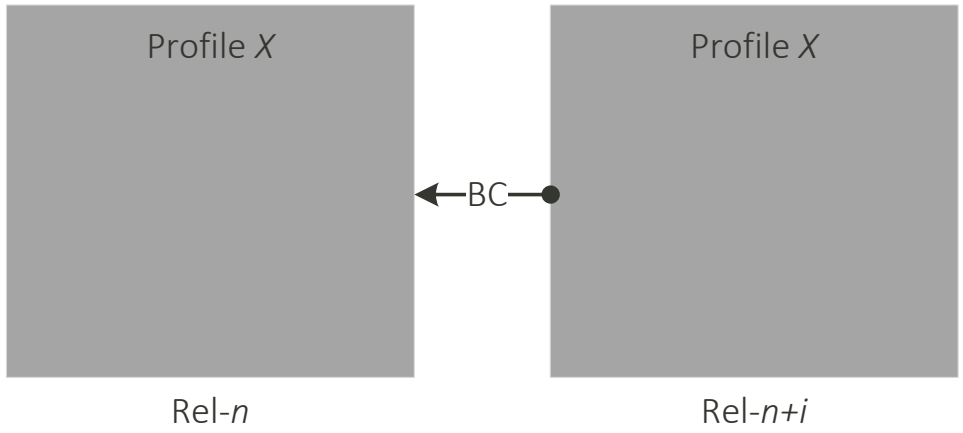
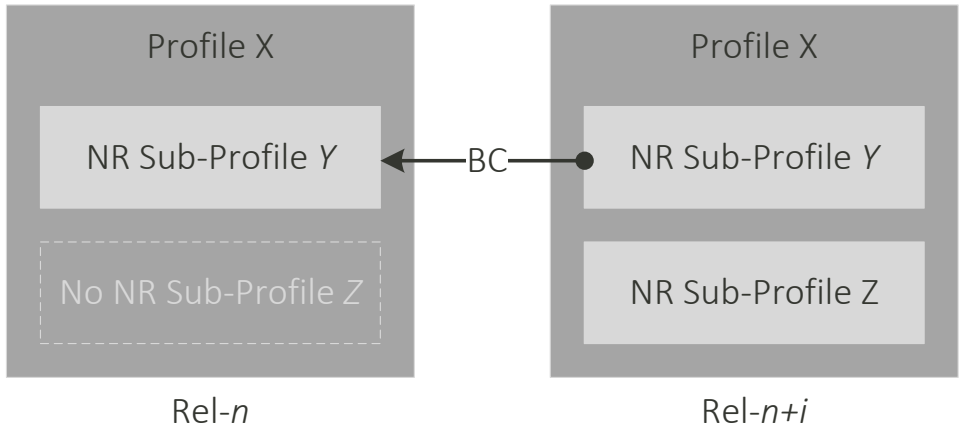
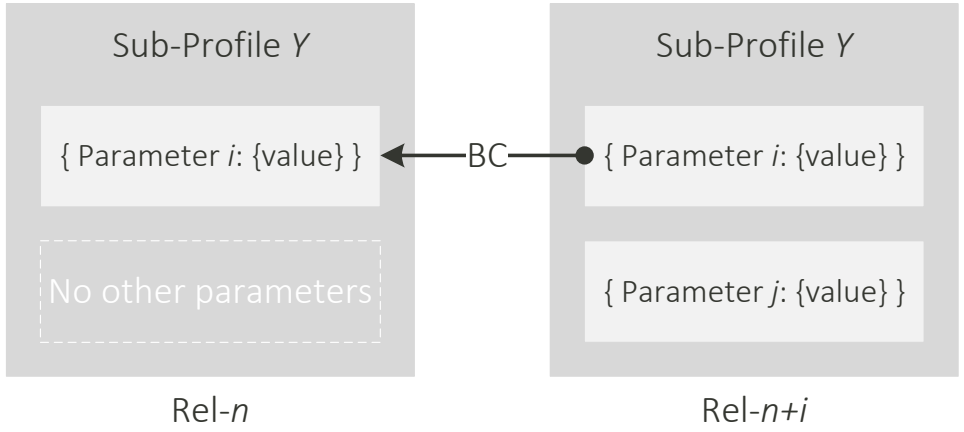
NR Profiles – Backwards Compatibility







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Appendix B
NR parameters

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NR Profiles – NR parameters [1/3]

New parameters for new NR modules (vs. LTE)

Sub-feature group	Nr. of parameters	New module in NR	New in NR
Bandwidth part	17	Yes	Data BW flexibility on BW, location, CP, and SCS.
CBG (re)transmission	5	Yes	Finer granularity of HARQ feedback indication to improve retransmission efficiency
CORESET	12	Yes	Finer granularity of PDCCH resource configuration
DL preemption	9	Yes	For URLLC enhancement. URLLC data *can* override eMBB one.
UL transmission without UL grant	16	Yes	Grant-free transmission to reduce latency
PTRS Resource Configuration	16	Yes	New RS in NR for DL and UL
CSI & Beam Management Framework	107	Yes	CSI-RS based beam management is a whole new feature in NR.
Timing	11	Yes	Flexible timing relationship between control and data, and between data and ack.
Total	193		

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NR Profiles – NR parameters [2/3]

Enhancements on legacy (i.e. LTE) modules

Sub-feature group	Nr. of parameters	New module in NR	New in NR
Initial access related	15	No	More initial –access parameters carried in SSB, including transmission positions, SSB index, SSB periodicity, RMSI PDCCH configuration, subcarrier spacing for RMSI, Msg.2/4
Mobility related	36	No	CSI-RS based RRM measurement
RACH related	26	No	PRACH with multiple numerology enhancements
CSI-RS Resource Configuration	12	No	configuration of wideband and partial band CSI-RS
SRS Resource Configuration	25	No	Semi-persistent SRS: An UE can be configured to transmit SRS in each OFDM (or sub time unit smaller than OFDM symbol if supported) symbol for semi-persistent SRS transmission
DMRS Resource Configuration	20	No	Configurable DM-RS position and number
PDCCH	12	No	Multiple PDCCH candidates per CCE aggregation level, per DCI format; group PDCCH, preemption DCI
PDSCH	37	No	Transmission Configuration Indicator (TCI) is a new concept in NR,
Total	183		

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NR Profiles – NR parameters [3/3]

Sub-feature group	Nr. of parameters	New module in NR	New in NR
PUCCH	51	No	Configure PUCCH format 0~4
UL power control	43	No	Configure for NR PUSCH and PUCCH
Frame structure	32	No	New kind of TDD sub-frame configuration, multi-slot transmission
CA and DC	4	No	
PUSCH	23	No	Configure NR PUSCH parameters
Total	154		

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Thank You!

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