The road to 6G

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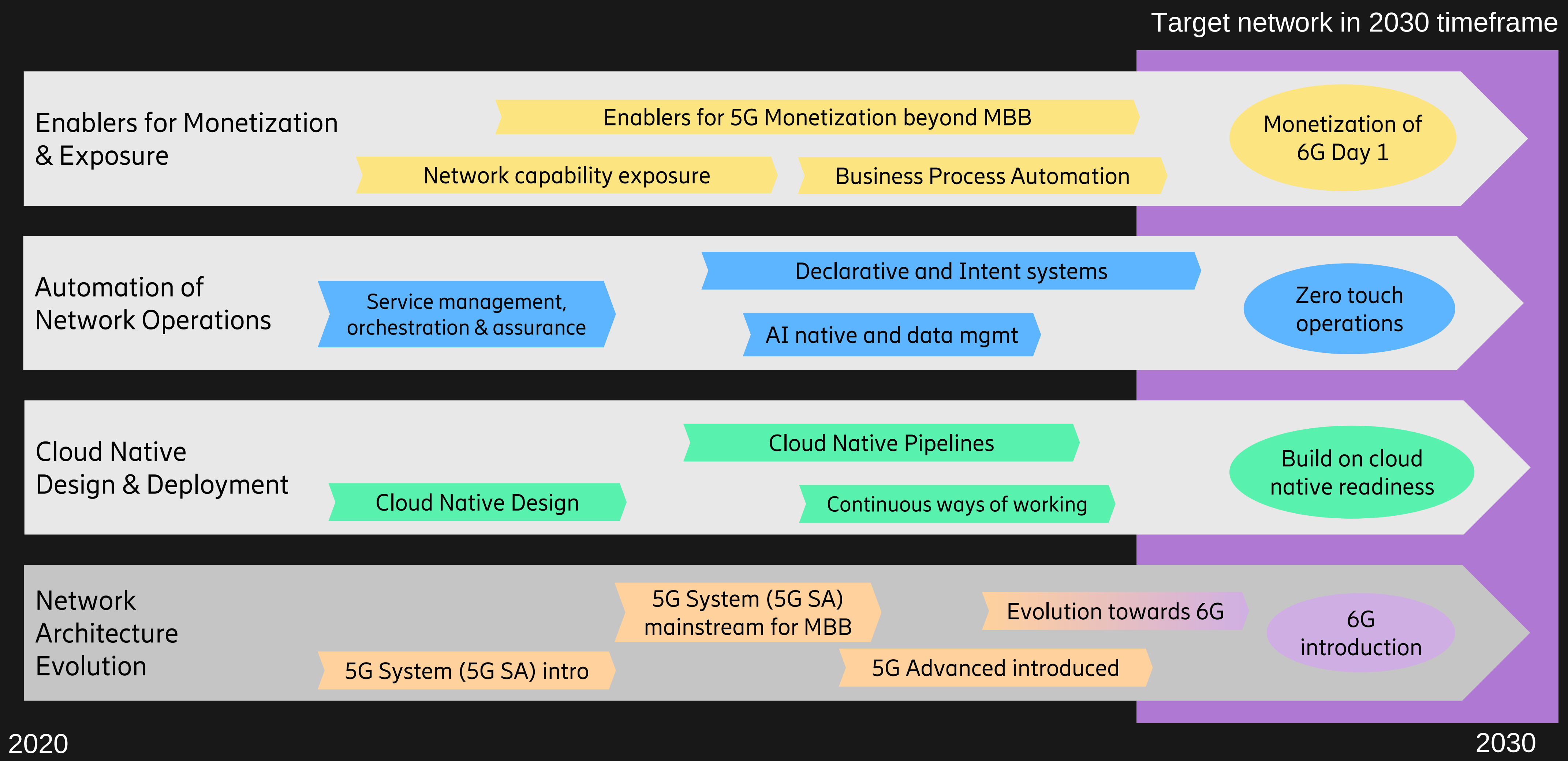
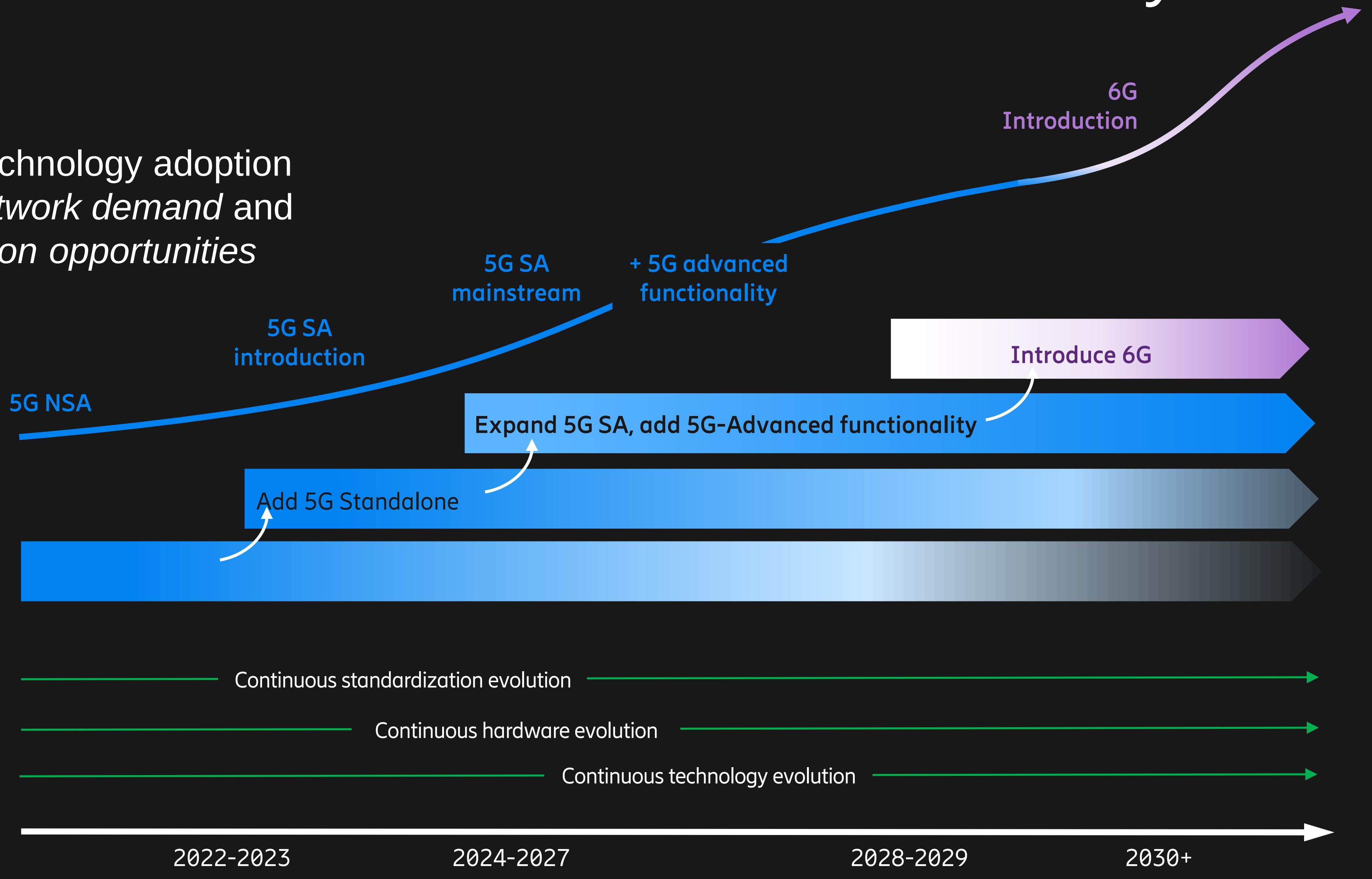
Multiple evolution paths towards 6G timeframe

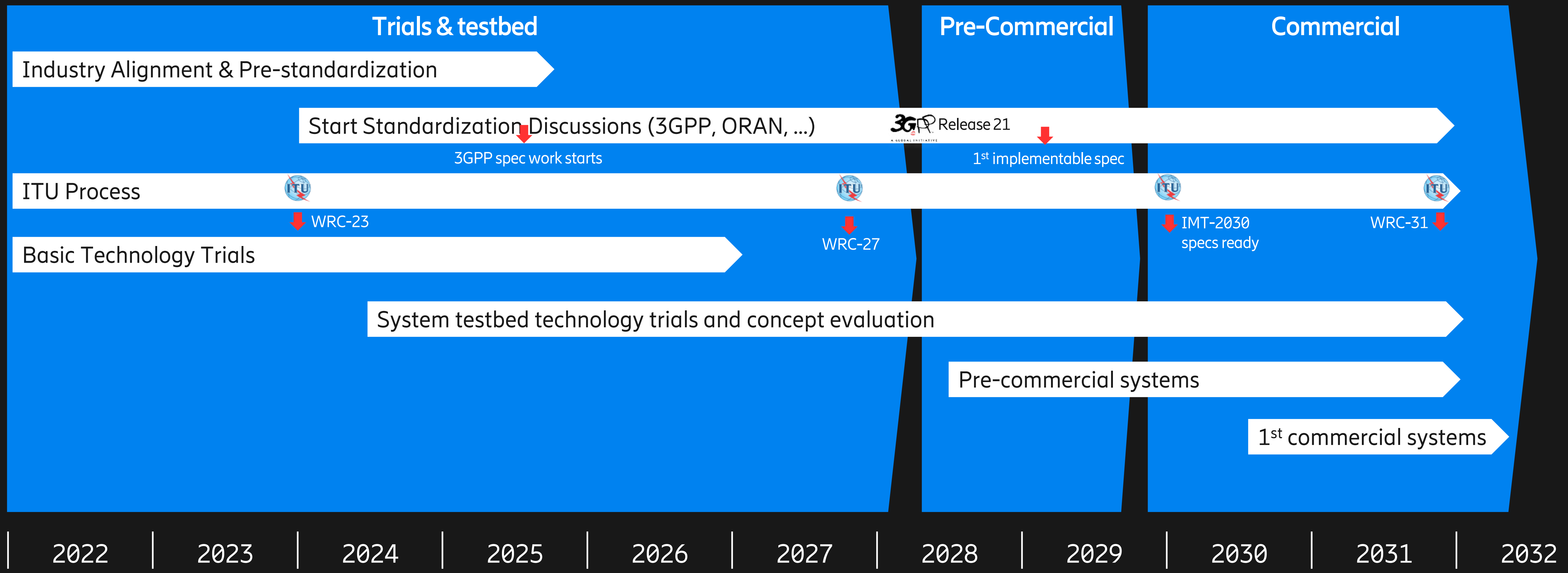


Continuous evolution towards 2030 and beyond

Step-wise technology adoption driven by *network demand* and *monetization opportunities*



6G timeline

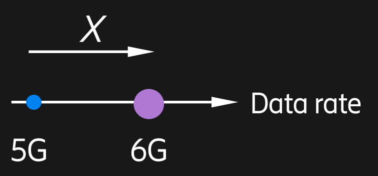

Trials & testbed
Pre-Commercial
Commercial
Industry Alignment & Pre-standardization
Start Standardization Discussions (3GPP, ORAN, ...)
3GPP spec work starts
Release 21
1st implementable spec
ITU Process
WRC-23
WRC-27
IMT-2030
specs ready
WRC-31
Basic Technology Trials
System testbed technology trials and concept evaluation
Pre-commercial systems
1st commercial systems
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032

6G requirements

Don't

scale individual metrics with a factor of *X*

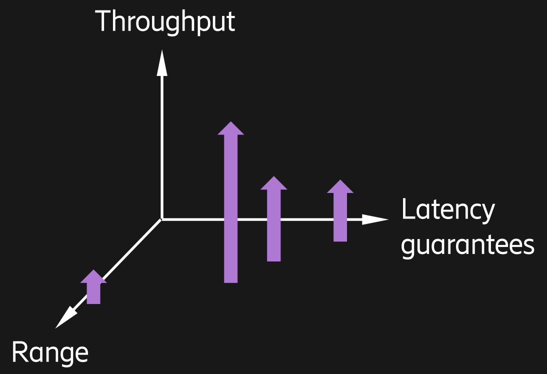
Can result in extreme numbers with limnited relevance to actual applications



Do

consider *joint* capabilities in a multi-dimensional space

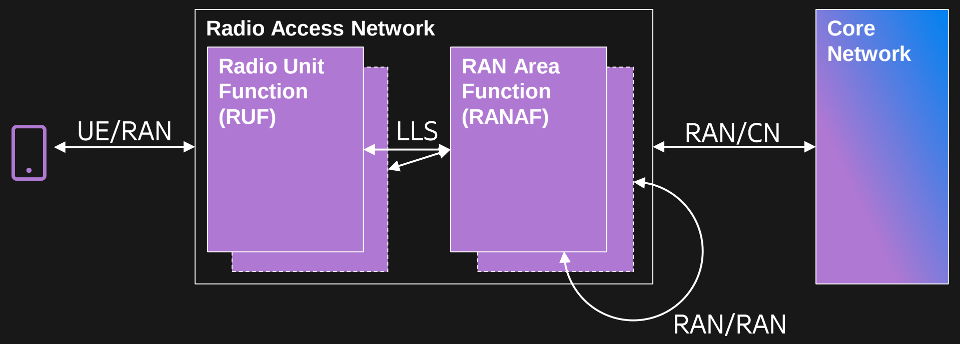
Different applications have different requirement points in the multi-dimensional space

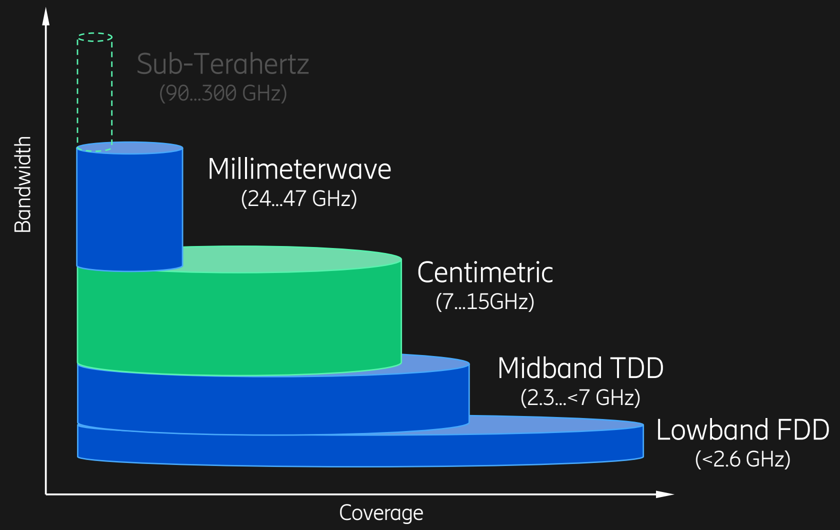


Key 6G principles

Minimize complexity, Maximize performance

- 6G RAN shall have a **standalone** architecture only
- 6G RAN shall interface an **evolved 5G Core**
- 6G architecture shall be **intent-based and programmable**
- 6G architecture shall include selected **open interfaces**
- 6G shall **operate in all existing 3GPP bands** and in **new cmWave** bands
- **Spectrum sharing** shall be supported between 5G and 6G
- 6G shall support **new and evolved use cases**, efficiently & sustainably

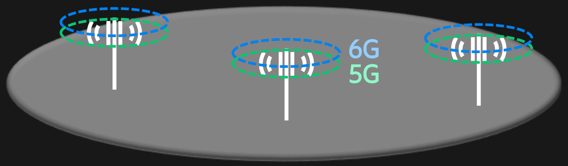


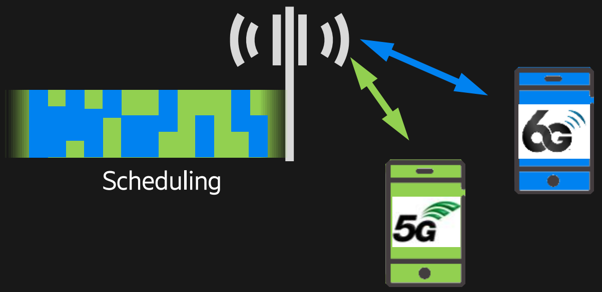


Spectrum sharing

5G/6G intra-operator sharing (MRSS)

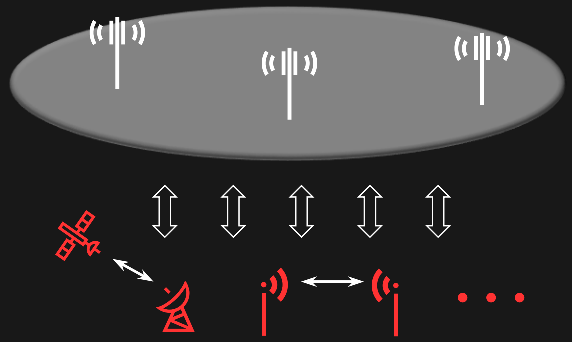
- Absolutely necessary (at least for FR1) due to limited availability of new spectrum
- Dynamic and highly efficient (5G "lean design")
- Smooth transition and mix of 5G/6G deployments





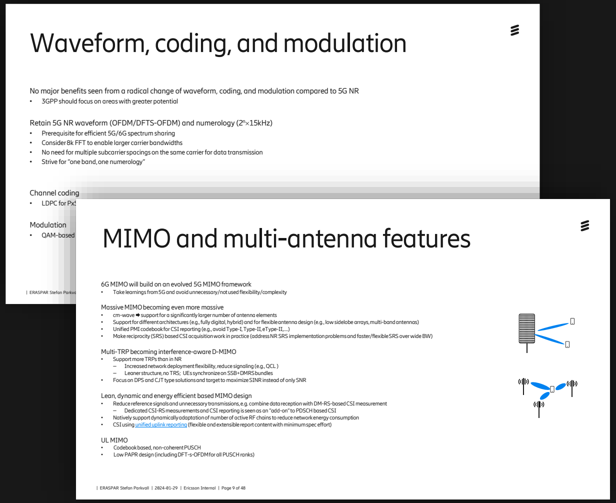
Co-existence with other usages

- "Sharing by design"
- Important for access to cm-wave band
- Slower time scale than MRSS

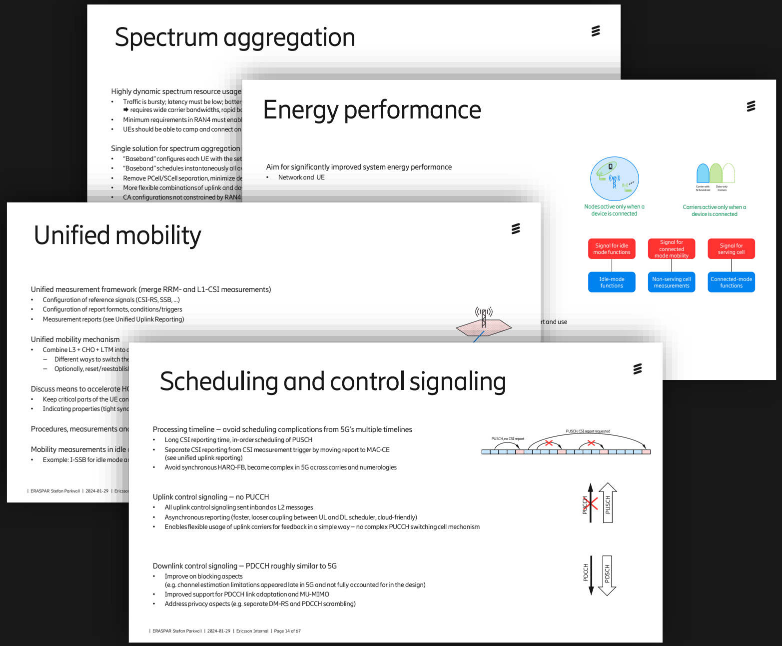


Overall design guideline

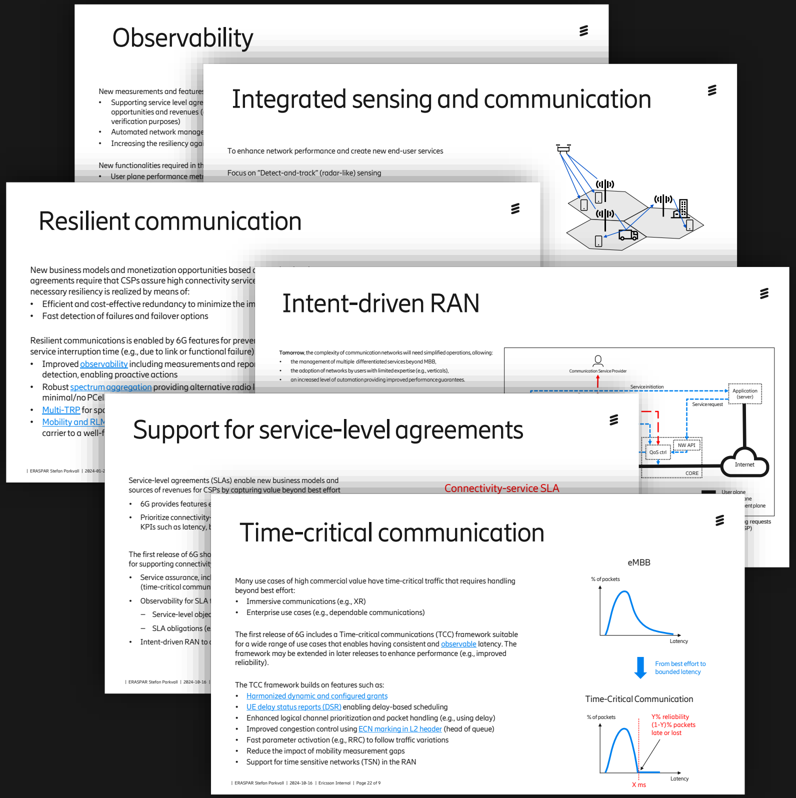
Keep
aspects of 5G that work well



Change
when motivated by significant performance enhancements



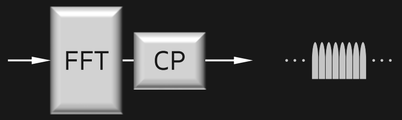
Add
selected functionality for new use cases



Examples of technology components

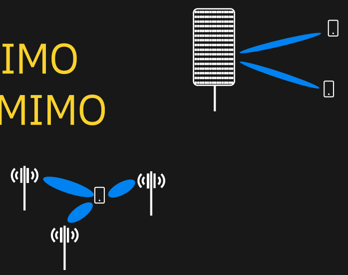
Keep basics of 5G PHY

OFDM, LDPC coding



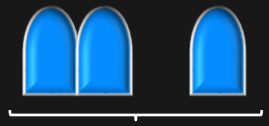
MIMO

Extremely massive MIMO
Interference-aware D-MIMO



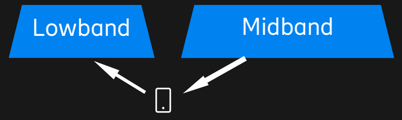
Carrier aggregation

CA with loosely coupled carriers
No dual connectivity



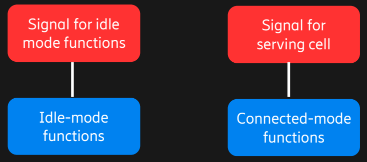
UL-DL decoupling

Best DL band might not be best UL band



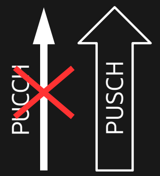
Energy efficiency

Separate signals for idle and connected mode



Unified uplink reporting

Asynchronous reports
Minimize scheduling restrictions



...and more!

Day 1 verticals and deployments

Support high-value verticals/use cases and deployments
with the general 6G radio access solution

- Economy-of-scale – leverage mass-market products
- In later releases, evolve solutions ***when needed*** for use cases that gained ***market traction***
- Focus on needs of the verticals not on technology evolution

5G

Initial 6G deployments

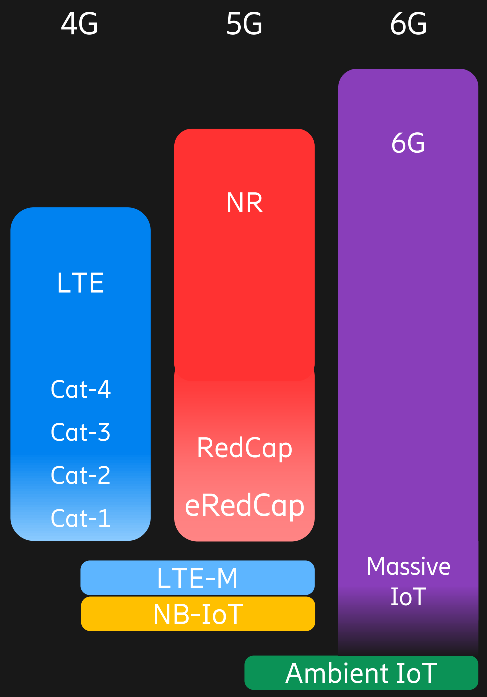
Leverage mass-market products

Later 6G deployments

Specific features if commercially motivated

Support high-value use cases/deployments *with the general 6G solution -* Examples

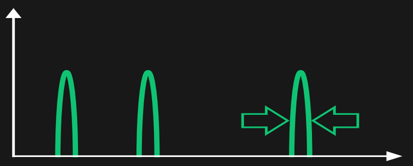
Massive IoT
by low-end 6G device



NTN
integrated in 6G

Fixed wireless access
large traffic volumes

Time-critical communication
“The right packet at the right time”

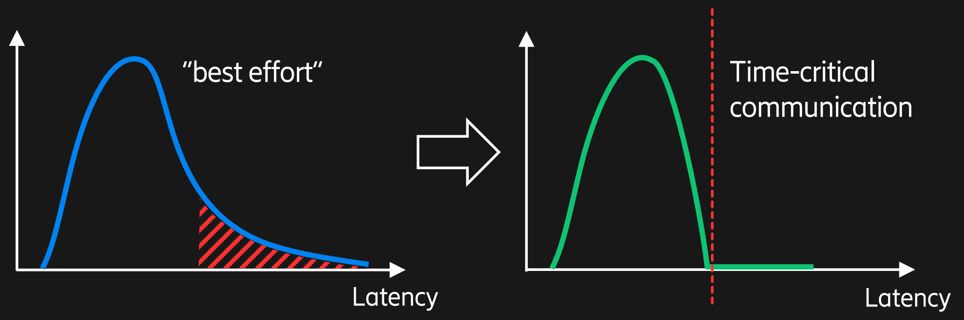


…and more!

Time-critical communication

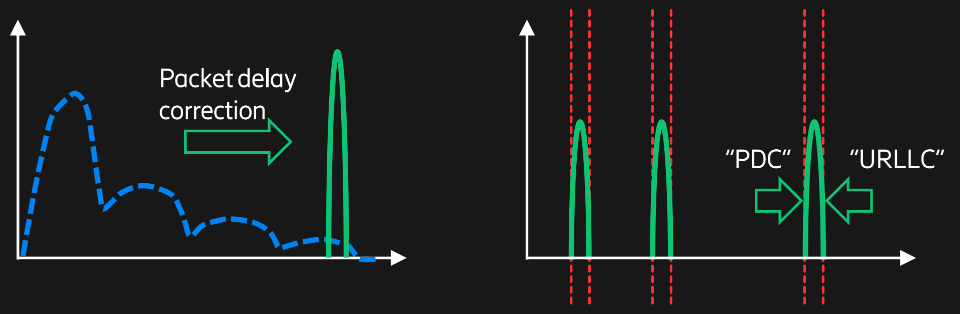
From best-effort to bounded latency

- Immersive communications (e.g., XR)
- Enterprise use cases (e.g., dependable communications)
- …



"The right packet at the right time"

- Low jitter can often be more important than low latency
- Consistent and observable latency



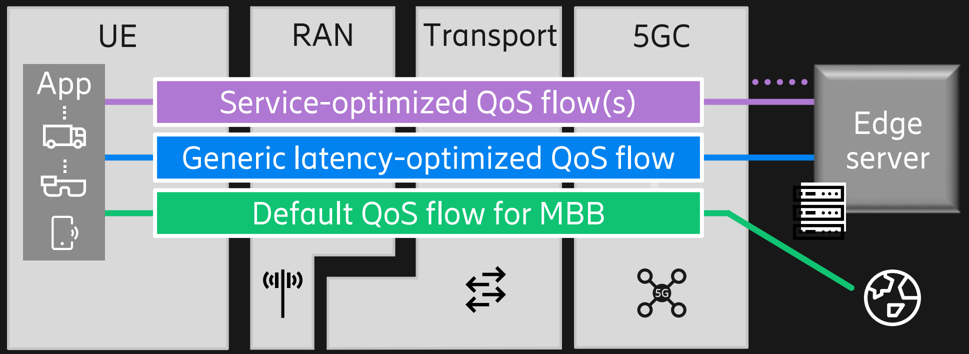
Bounded latency variations

Time-critical communication

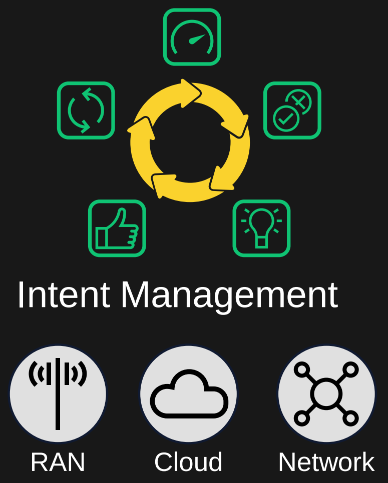
Support of time-critical communication should be part of the first 6G release

Technology examples

- Scheduling – dynamic and configured grants, LCH multiplexing, link adaptation, de-jittering, …
- Time synchronization – end-to-end
- Observability – delay-status reports, …
- Mobility – conditional handover, reduced interruption time, …
- Congestion control – ECN marking in L2 headers, …
- Slicing – separate handling of best-effort and time-critical traffic



Resilient communication

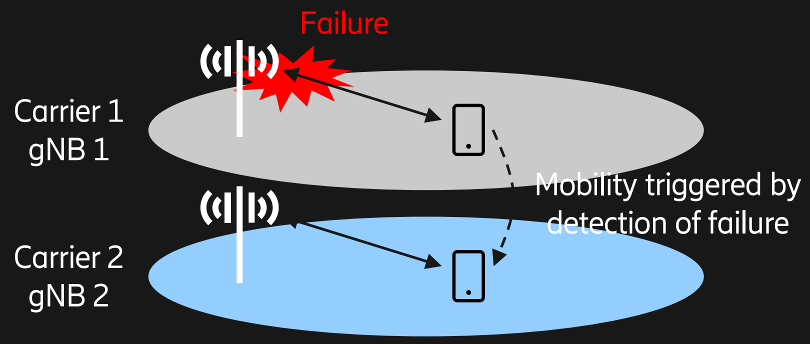


New business models based on service-level agreements and high service availability

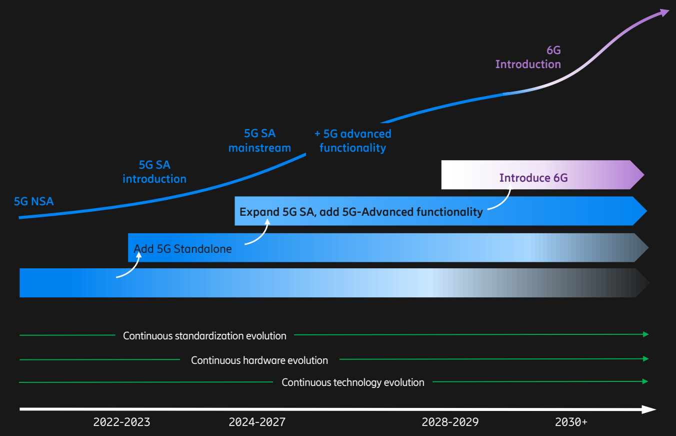
- Efficient and cost-effective redundancy to minimize the impact of failures
- Fast detection of failures and failover options

Technology examples

- Observability – measurements and reports, enabling proactive actions
- Carrier aggregation and D-MIMO providing alternative radio links
- Mobility and RLM procedures allowing for handing over UEs from a failing carrier to a well-functioning one



Conclusion



6G standardization is about to start

Commercial availability ~2030 – continuous evolution from 5G

Key principles

Stand-alone architecture, evolved 5G core, open interfaces, spectrum sharing

Keep
aspects of 5G that work well

Change
when motivated by significant performance enhancements

Add
selected functionality for new use cases

Support high-value verticals/use cases and deployments *with the general 6G radio access solution*