3GPP TSG RAN #84
Newport Beach, USA
June 3-6, 2019

RP-191364

NR Evolution in R17

creating the living network. *together*

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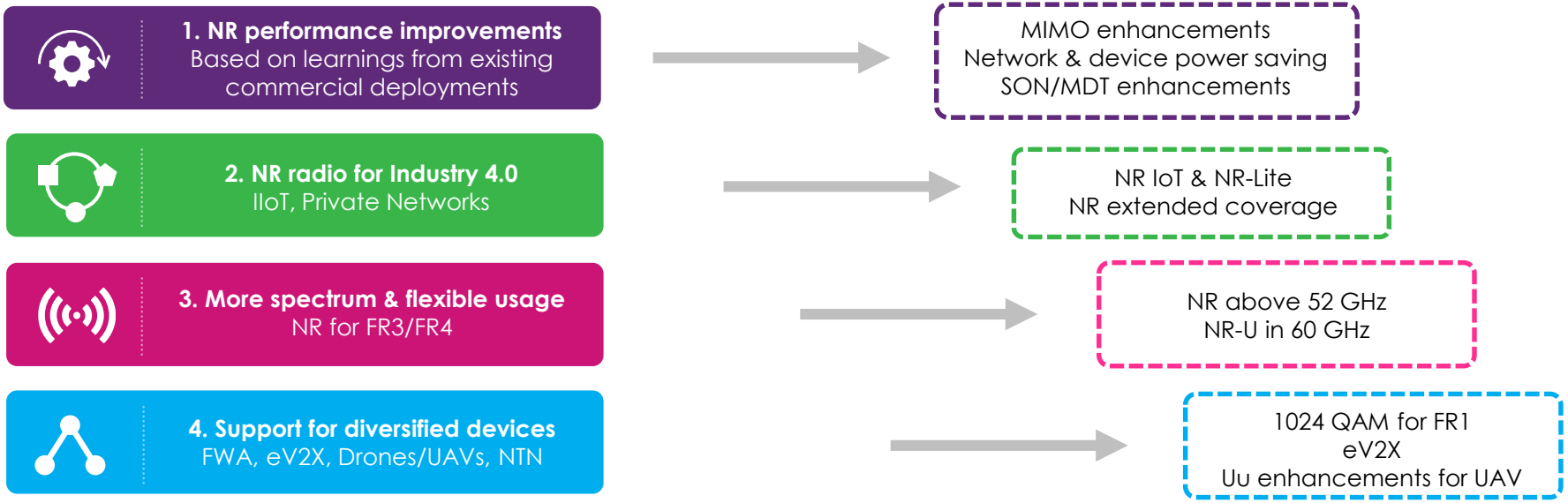
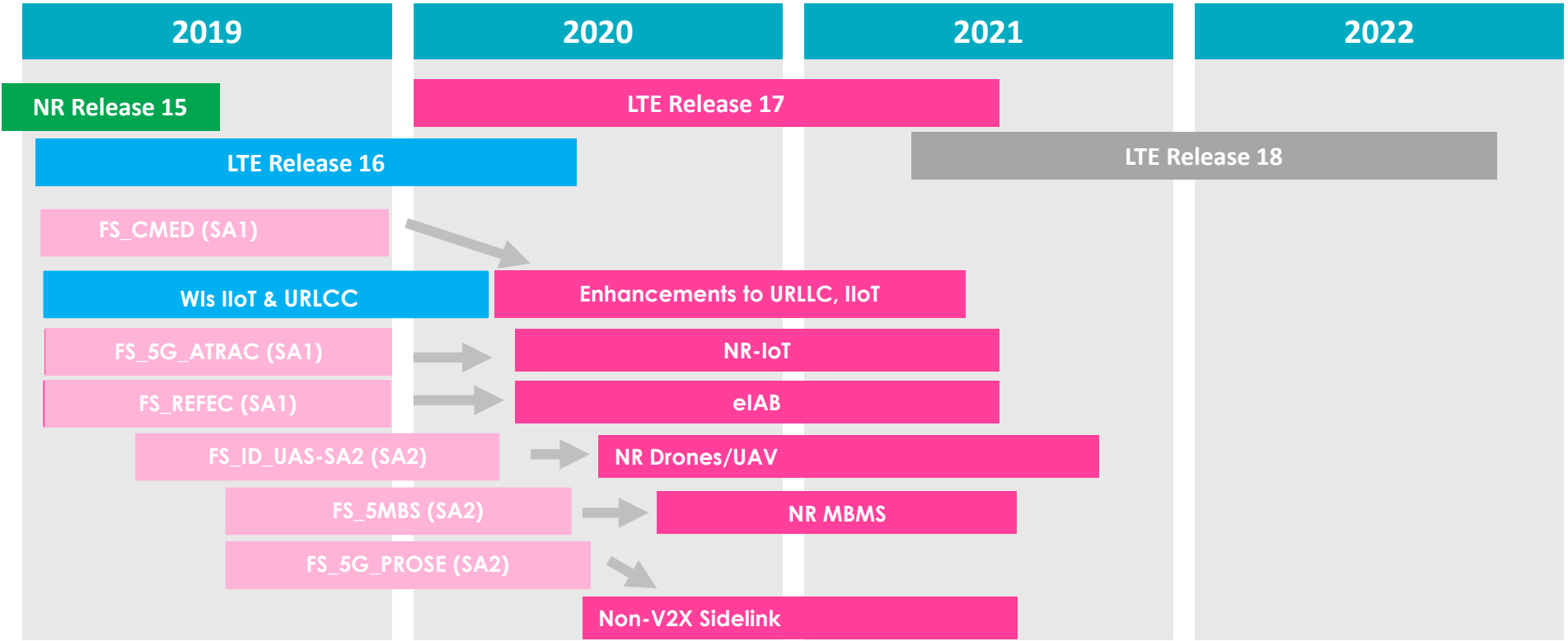
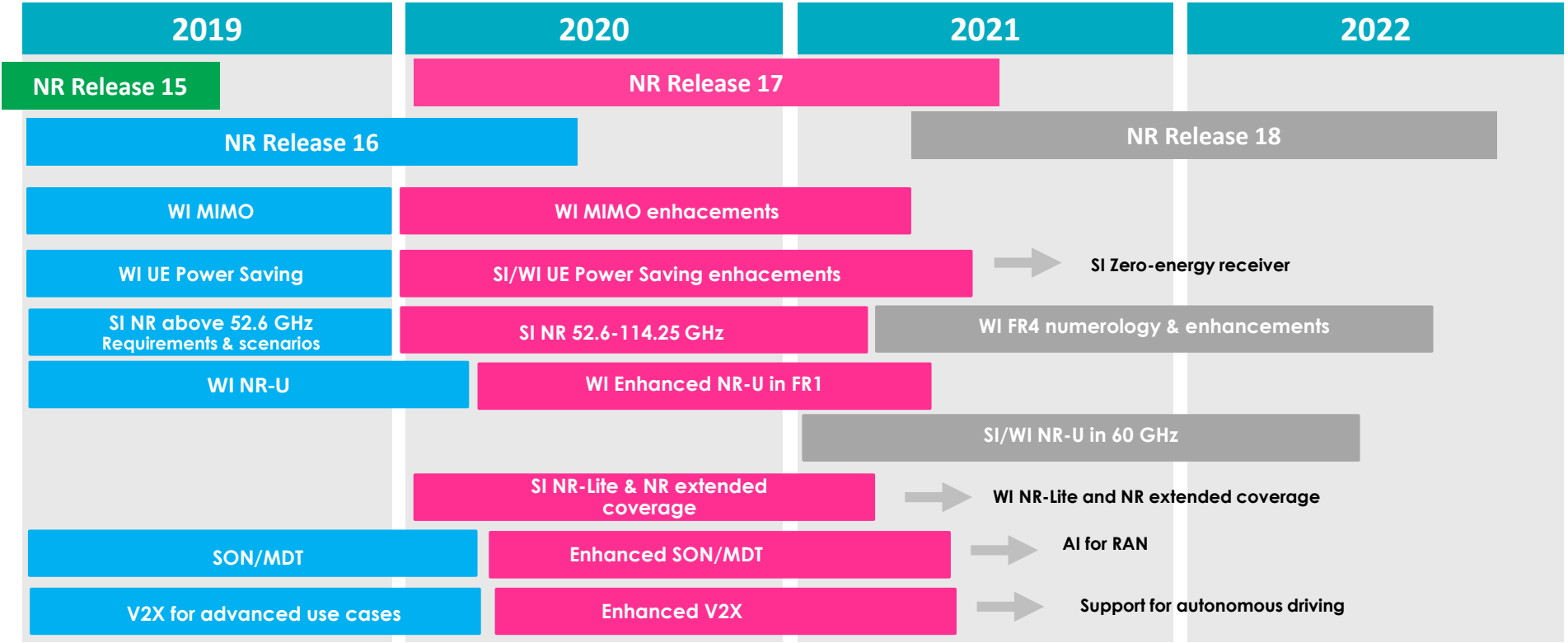
Priorities


1. NR performance improvements
Based on learnings from existing commercial deployments
2. NR radio for Industry 4.0
IIoT, Private Networks
3. More spectrum & flexible usage
NR for FR3/FR4
4. Support for diversified devices
FWA, eV2X, Drones/UAVs, NTN
MIMO enhancements
Network & device power saving
SON/MDT enhancements
NR IoT & NR-Lite
NR extended coverage
NR above 52 GHz
NR-U in 60 GHz
1024 QAM for FR1
eV2X
Uu enhancements for UAV

Rel-17 Timeline and SA dependencies



Rel-17 Timeline and feature evolution



Rel-17 topics
NR performance and device improvements, new spectrum/deployments and new markets

InterDigital

New spectrum, deployments, and device improvements

NR-U enhancements for FR1 & NR-U in 60 GHz
- Support of beam management with directional LBT
- Increased standby times for IoT using NR-U in < 6 GHz
- Coexistence evaluation with 802.11ad/ay in 60 GHz

Enhanced UE power saving
- Enhancements to Rel-16 baseline
- Power efficient beam forming operation in FR2
- Power-saving for RRC_IDLE mode

In-device coexistence
- RRC configuration for UE autonomous denial
- UE reporting: desired TDM config & victim frequencies

NR above 52.6 GHz
- Introduce OFDM numerology for 60 GHz operation
- Study low-complexity waveform for bands >81 GHz
- Enhancements to beam management operation

NTN
- Support for long propagation delays & moving cells
- Support for large cell sizes with GEO and LEO networks

NR mixed mode broadcast/multicast
- Support dynamic switching between B/M and unicast
- Dynamic multiplexing of SC-PtM and unicast resources
- B/M reception for RRC_IDLE/INACTIVE

NR performance improvements

Further enhanced MIMO
- Enhancement of multi-TRP operation
- Reduced overhead and latency for beam management
- Frequency-selective precoder for UL MIMO
- Non-linear precoder for MU-MIMO

Data collection
- Enhancement to R16 Baseline (MDT, MRO, load balancing, load sharing..)
- Techniques to further handle URLLC and mMTC
- Techniques to further handle other verticals (V2X, IIOT)

IAB enhancements and Mobility
- Enhancements to baseline IAB Rel-16 functionality
- Mobility and DC/CA depending on Rel-16 status

1024 QAM
- MCS tables & CSI reporting; RAN4 requirements

NR extended coverage
- Improved DL & UL coverage to meet 164dB MCL for FR1
- Further FR2 coverage enhancements

Enhancements to RRC_INACTIVE state
- Direct data transfer including security handling
- Inter-RAT cell-reselection/resume in RRC_INACTIVE

Network energy-saving
- Evaluation of energy savings achievable using NR R16

New markets and verticals

SL enhancements for non-V2X use cases

- Support for NCIS (network controlled interactive services), including AR/VR, robots in factories, etc. Low power and high data rate requirements
- Support of UE-Network & UE-UE relays incl. discovery
- Ultra-reliability for public safety

V2X enhancements

- Support of beam management in FR2
- Improvements for Vulnerable Roadside User (VRU) case
- Support for power efficient SL for pedestrian and VRU
- Support of V2X relative positioning techniques

NR-Lite

- New use cases (industrial sensors, robots, video assisted applications)
- For requirements and use cases not met by eMTC/NB-IoT
- Data rates 10-100 Mbps, 10-20 ms latency, and high density
- Reasonably better battery life than eMBB devices

Uu enhancements for UAV/Aerials

- Uu enhancements to improve gNB-UAV communication
- RAN mobility improvements for UAV

Industrial IoT and URLLC enhancements

- Enhancements to Rel-16 baseline functionality
- Address more stringent requirements for low latency, higher reliability, and higher communication service availability

Additional details for some WIs/SIs

NR beyond 52.6 GHz

Motivation

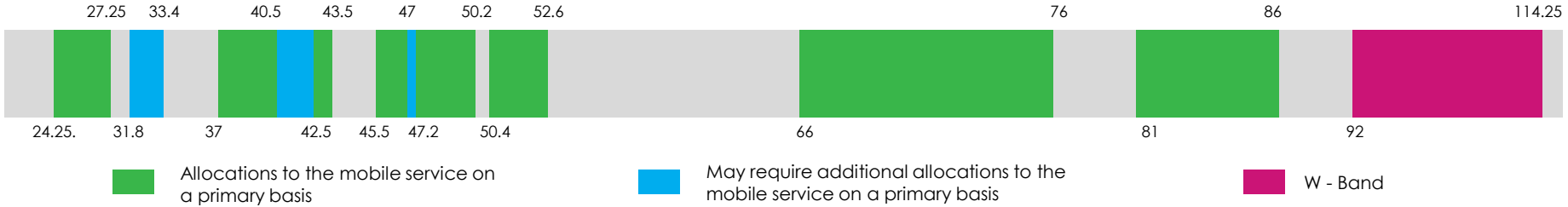
- Extension of 3GPP core specifications to support NR operation up to the W-band (<114.25 GHz)
- Foundation for NR-U in 60 GHz, V2X in the ITS extension band, IIoT and more
  - New use case: NR Proximity radio for 60 GHz – NR radio for CE-Type applications similar to 802.15.3c/e
- NR > 52.6 GHz more than doubles the accessible BW for NR when compared to FR1 & FR2

Design Aspects

- Support of at least 2.16 GHz UE single-channel BW
- Study low complexity single-carrier waveform
- For OFDM: evaluation of SCS > 120 kHz for PDSCH/PUSCH
- Better beam management: faster and more beams
- Not in scope: NR-U, V2X or IIoT-specific aspects

Band allocations

- Bands already allocated to mobile services on a primary basis by ITU (66-76 GHz and 81-86GHz)
- WRC-19 may identify bands beyond 52.6GHz for terrestrial component of IMT
- W-band – not in scope of WRC-19 but suitable for longer term spectrum needs of 5G



Uu enhancements for UAV/Aerials

Motivation

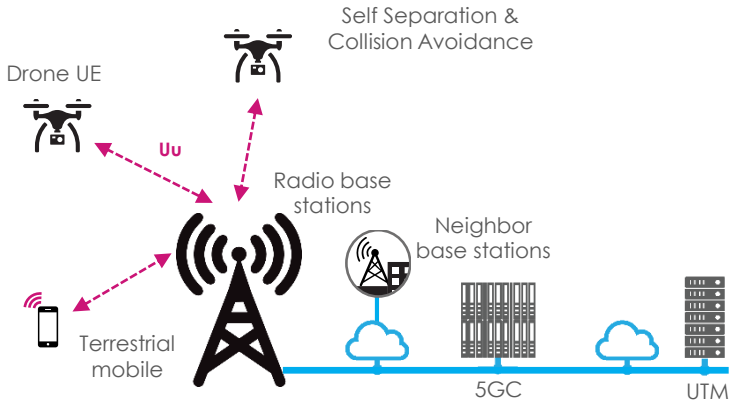
- Commercial regulations under development require anti-collision and situational awareness features implemented for Drones
- Uu enhancements for UAV are necessary to meet latency budgets and to provide a scalable solution

R16 SA requirements in TS 22.125

- Support of UAS Traffic Management System (UTM) for identification and tracking of Unmanned Aerial System (UAS)
- SA2 SI to analyze if enhancements to existing mechanisms are needed to provide connectivity between UAV controller(s) and UAV(s)
- Direct UAV- UAV local broadcast communications for self-separation in out of coverage, inter-PLMN scenarios and identification

Key Technical Areas

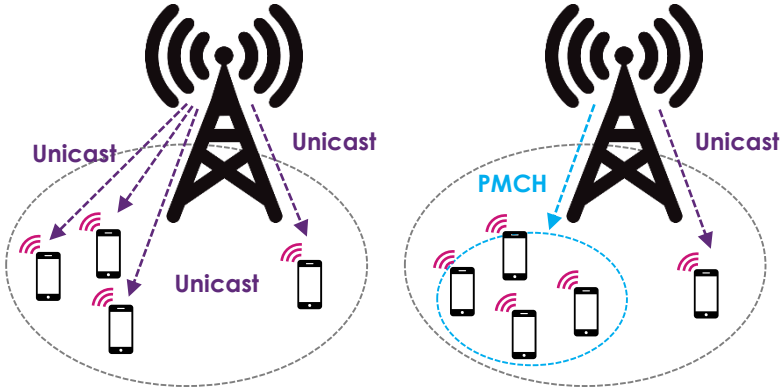
- NR Uu enhancements to improve gNB-UAV communication
- RAN mobility enhancements for UAV



NR mixed mode broadcast/multicast

Motivation

- 38.913 includes NR supplemental service-related requirements related to multimedia broadcast/multicast service
- LTE-B/EnTV terrestrial broadcast solution is designed for large and static transmission areas
- A mixed mode broadcast/multicast solution would serve multiple 3GPP NR features: video distribution, eV2X, IoT and public safety
- SA2 studying potential enhancements to 5G system architecture to provide broadcast/multicast services for different vertical businesses



Design Aspects

- Support for dynamic switching between B/M & unicast bearers
- Dynamic multiplexing of radio resources for B/M & unicast traffic
- Broadcast/multicast reception when in RRC_IDLE/INACTIVE
- Support for link adaptation on DL broadcast/multicast channel
- Prioritize single-cell PtM distribution and small gNB clusters
- Minimize the impacts to L1; introduction of SFN mode only if justified

Zero-energy receiver

Motivation

- LTE-M in RRC_IDLE requires up to a few milliwatts of power even with the R15 WUS & dedicated WUR option
- Observed battery life times for eMTC/NB-IoT devices using (e)DRX and PSM are inconsistent and vary greatly
- PSM makes devices unreachable for hours/days, and paging is important for many IoT device classes

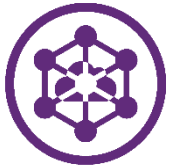
Industrial IoT

Asset Monitoring

Infrastructure Monitoring

Connected Home

Enterprise IoT



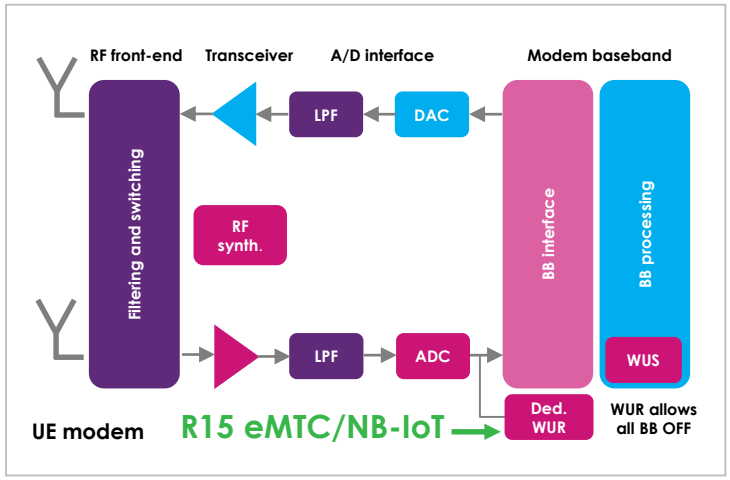
Wearables / Battery-less Implants

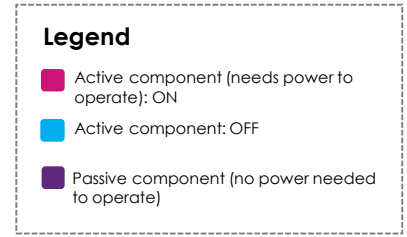
Ultra-Low Power Communications

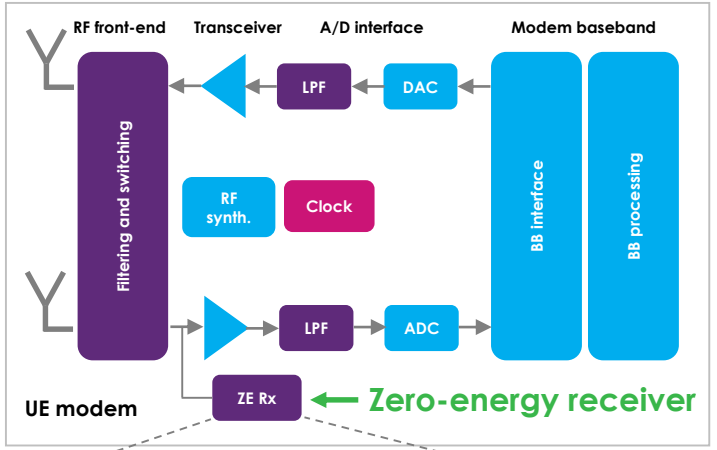
Ultra-low power radio for RRC_IDLE

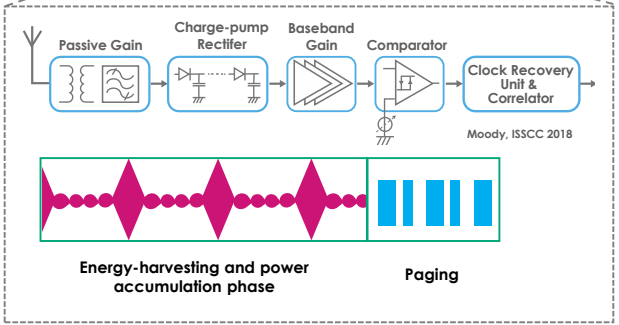
- ✓ ~1000x lower power consumption than regular receiver
- ✓ Virtually unlimited UE standby time in RRC_IDLE
- ✓ Devices reachable for network paging anytime
- ✓ DL link budget of up to 130 dB MCL supported
- ✓ Devices harvest energy using in-band waveform

Zero-energy receiver









Design Aspects

- ZE energy-harvesting waveform and paging signal design
- OFDM 15kHz in-band deployment for R16 LTE-M, LTE & NR as PCell
- Idle Mode procedures: ZE standby mode and UE fallback
- Cell re-selection measurements for ZE standby mode