3GPP TSG RAN Meeting #91e
Electronic Meeting, March 16-21, 2021

RP-210615

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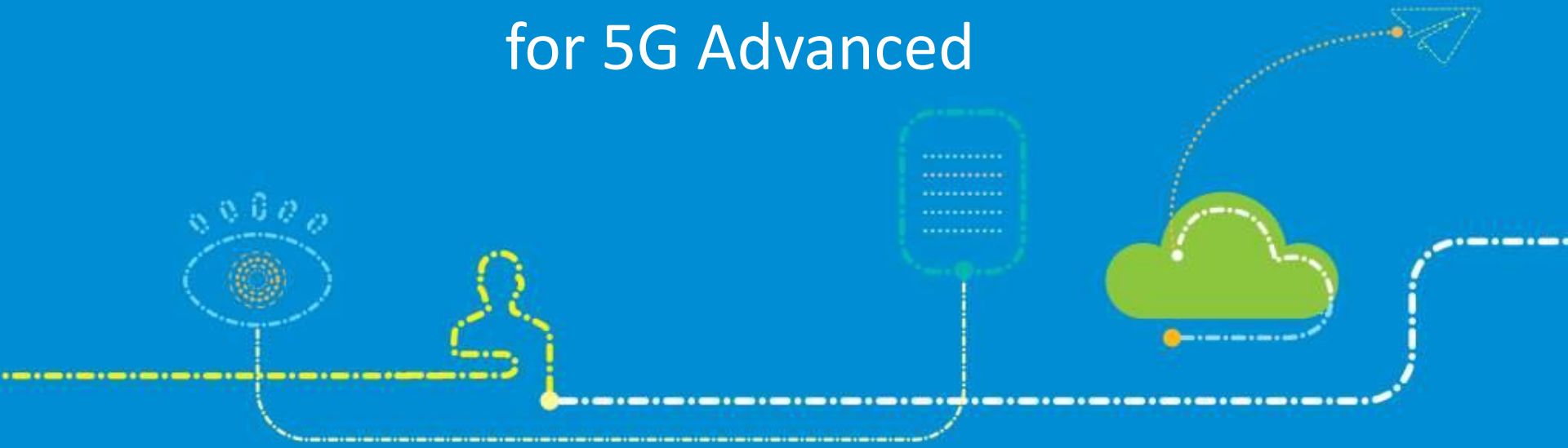
Agenda: 9.13

Evolution of massive NR based IoTs for 5G Advanced



NR based massive IoTs - Scenarios

- **Wide area sensor monitoring and event driven alarms [TR 22.891, 5.20]**
  - The sensor sends its information unsolicited and infrequently with no expectation of a response from the network.
  - The 3GPP System shall support efficient transfer of infrequent uplink data for low power devices which only participate in mobile-originated communication scenarios.
  - The system shall support efficient data transmission with limited resource and signalling usage.
  - The system shall support high density massive connections (e.g.1 million connections per square kilometre) in an efficient manner.
- **Advanced smart metering require both high connection density and reliability, good coverage, and decent data rate [TR 22.867, Table 5.2.6-1]**

User experienced Data rate (bps)	Latency (ms)	Reliability [%]	Connection density	coverage
UL:<2M DL:<1M	Accuracy fee control: < 100; General information data collection: <3000	>99.99	<[x]*10000/km2	<40km (city range)

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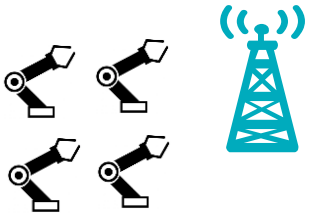
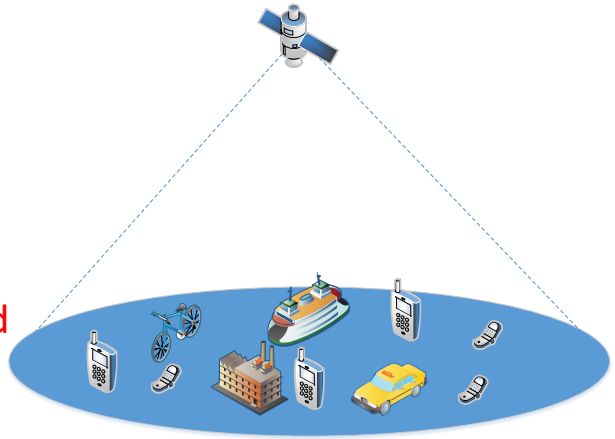
NR based massive IoTs - Scenarios



- Factories of the Future (from TR22.804)
  - Support of massive connections (e.g. 1 millions per km^2 with small data) considering certain URLLC requirements.
  - Use cases include: Condition monitoring for safety, Packaging machine, process automation, motion control, mobile robots…



- NTN scenarios (from TR 38.821)
  - For NTN, the maximum user density is one of the key for profitability. However, the user density for connected mode UE is quite limited due to the large cell size.
  - In NTN, a cell may be covered by one or multiple beams, and the footprint diameter of a beam is 200–3500 km for GEO and 100–1000 km for non-GEO.

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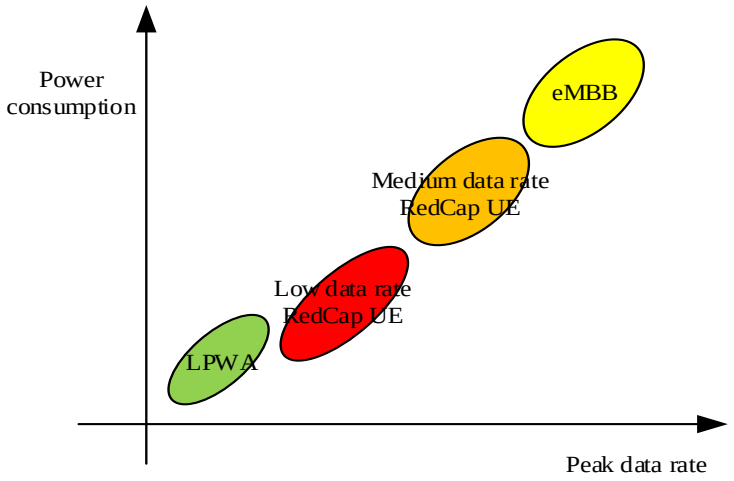
NR based massive IoTs – Evolution of RedCap UEs

- Low data rate Redcap UEs
  - Support of massive connections considering certain low power consumption requirement and low peak data rate requirement.
  - Use cases include: Industrial sensors, logistics control in stores and warehouses etc…



- eMBB UE: high peak data rate larger than 150Mbps
- Medium data rate RedCap UE: data rate(10~ 150Mbps) e.g smart watch, video surveillance, etc.
- Low data rate RedCap UE: data rate(1~10Mbps) e.g. sensor.
  - Normal power Redcap UE
  - Low power Redcap UE
- LPWA(Cat M1/Cat NB2): peak date rate no more than 1Mbps

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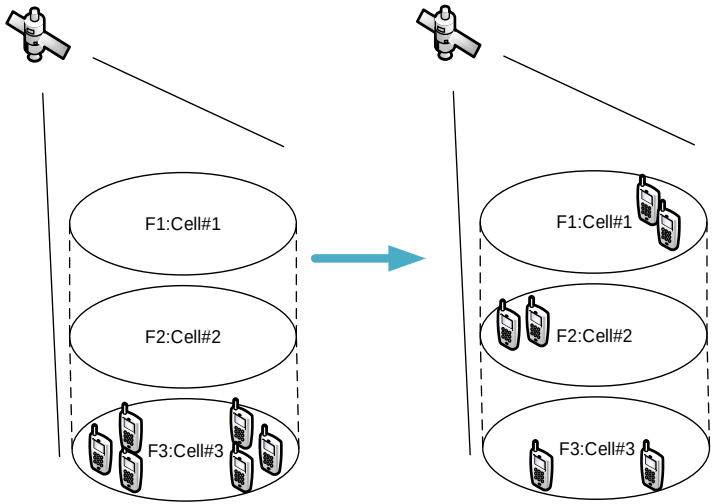
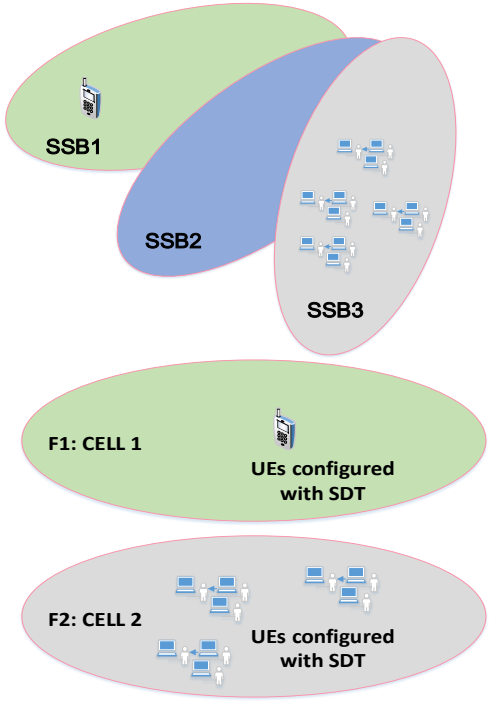
UE distribution for high user density

Distribution of idle/inactive UEs considering high user density



- More overlapping cells in frequency domain e.g. To increase the supported user density
- Multiple inter-frequency NTN cells can be deployed in the same area.



- Load imbalance in different SSBs
- Load distribution for small data transmission in INACTIVE state

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Motivations and Enhancements

- In Rel-16 2-step RACH WI
  - The MsgA channel structure is preamble + PUSCH in different slots, and optimization was not pursued
  - UP data cannot be included in MsgA PUSCH for non-RRC_CONNECTED state
- In Rel-17 small data WI
  - Small data transmission from RRC_INACITVE state is considered
  - RRC based solution for RACH based or configured grant based solution
- For Rel-18, transmission efficiency and connection density can be further enhanced, e.g.
  - For large cells such as NTN, the connected density is limited due to the extremely large cell size, as the configurable resources (e.g. preambles and RNTIs) are not enough for the huge amount of UEs in the cell
    - Some study is needed to understand the gap and identify the potential enhancement.
  - Data transmission through RACH or pre-allocated resources from idle state directly
    - Maintaining the INACTIVE context for massive number of UEs is challenging and hence IDLE mode solutions are useful
  - For small cell, the functionality of preamble and DMRS can be integrated, thus saving resources to support more connections
  - UE distribution for high user density

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Thanks

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