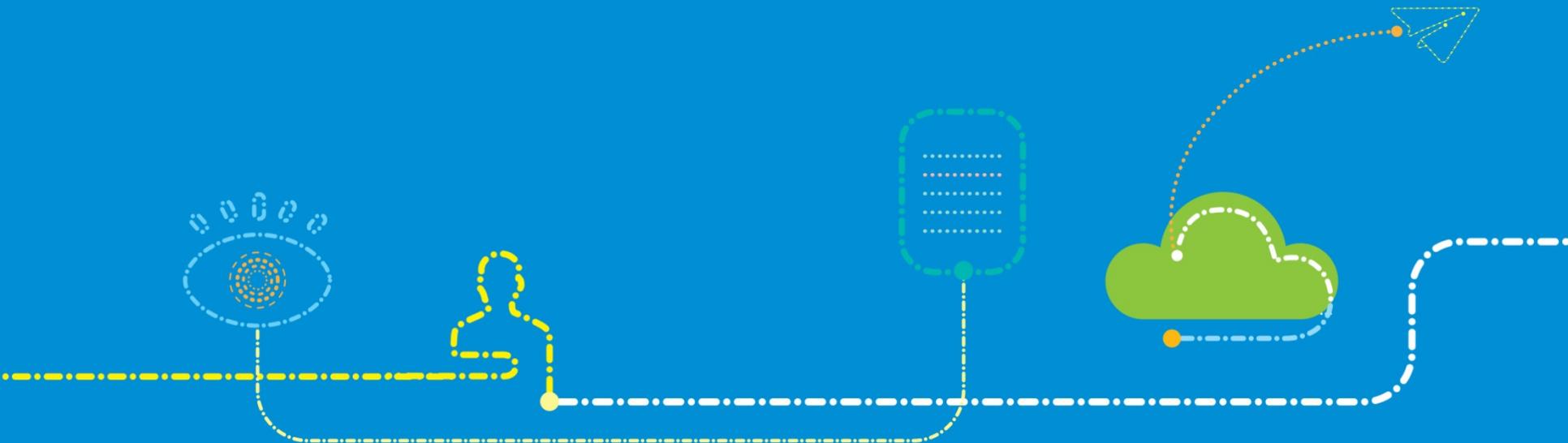


Source: ZTE, Sanechips  
Agenda: 9.13

# Enhancements on FR2 and Ultra Dense Networks



# FR2&Ultra Dense Network (UDN)

- FR2 - *a key enabler for 5G advanced*
  - FR2 will unlock wider bandwidth, higher throughput, lower latency and larger capacity
  - FR2 will become more widespread worldwide in Rel-18 timeline
- Although FR2 is supported from Rel-15, there are still lots of challenges in the FR2 deployment and the following enhancements will help realizing the full potential of FR2
  - Robustness improvements
  - Interruption reduction
  - Fast failure detection and recovery
  - Dynamic UE capability sharing among CCs

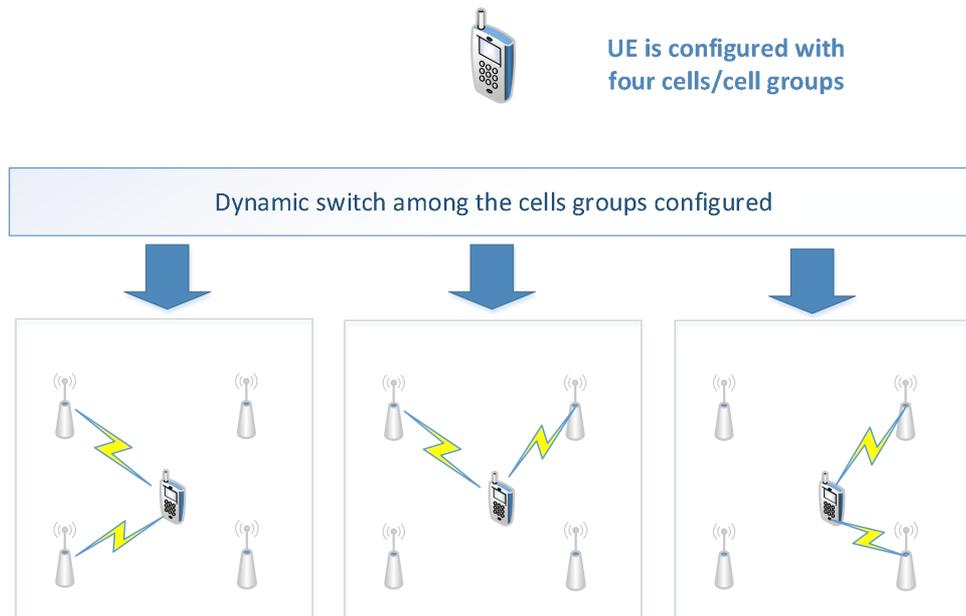
NOTE: The enhancements proposed in these slides can be used in FR1 cells as well.

# Robustness improvement

- FR2 is highly susceptible to blockage.
- Robustness of FR2 connection is one of the key prerequisites for the success of FR2 deployment
- Multi-connectivity (e.g. more than 2 cell groups) can significantly improve robustness and the following options can be considered
  - **Multiple connections with simultaneous activation** (e.g. three connections)
    - This is basically an extension of dual connectivity with more than one SCG
  - **Multiple connections with selective activation:** More than two connections, but only two of them activated at the same time.
    - This alternative can be considered as a compromise between cost and complexity on the UE side

# Robustness improvement

- **Multiple connections with selective activation**
  - Configuration for more than two connections (e.g. cell groups) can be stored on UE side, and UE can activate two of them in a dynamic manner.
  - The connection switch can be used for either MCG (e.g. handover) or SCG (PSCell change).
  - The connection activation/deactivation/switch can be triggered by either NW or by UE itself based on preconfigured event.
  - DRB primary path switch and duplication activation/deactivation can be triggered by UE.



# Interruption reduction

- **Mobility interruption reduction**

- DAPS HO has been introduced in Rel-16 for NR, but it seems difficult to be used for FR2 cells.
- The make before break HO and RACH less HO are supported in LTE, but are not supported in NR.
  - Some study can be made on the FR2 mobility aspect to identify potential enhancement with reasonable complexity.

- **Fast SCell activation for FR2**

- In Rel-16, SCell dormant state has been introduced to enable a fast SCell activation.
- However, UL SRS transmission is not allowed in dormant state, and reinitializing the best beam in FR2 relies on the RACH procedure
- Lack of UL SRS in dormant state is a bottleneck in achieving full potential of the SCell dormant state for FR2 cells and increases the latency in activation of the FR2 SCells
- Supporting SRS transmission in dormant state will help reducing the latency for activation of FR2 SCells.

# Fast failure detection and recovery

- Fast Failure detection

- The minimum requirement for Radio Link Monitoring evaluation time (i.e.  $T_{\text{Evaluate\_out\_SSB}}$ ,  $T_{\text{Evaluate\_out\_CSI-RS}}$ ) and Beam Failure Detection evaluation time (i.e.  $T_{\text{Evaluate\_BFD\_SSB}}$ ,  $T_{\text{Evaluate\_BFD\_CSI-RS}}$ ) are defined as a function of DRX cycle length.

**Table 8.1.2.2-2: Evaluation period  $T_{\text{Evaluate\_out\_SSB}}$  and  $T_{\text{Evaluate\_in\_SSB}}$  for FR2**

Configuration	$T_{\text{Evaluate\_out\_SSB}}$ (ms)	$T_{\text{Evaluate\_in\_SSB}}$ (ms)
no DRX	$\text{Max}(200, \text{Ceil}(10 \times P \times N) \times T_{\text{SSB}})$	$\text{Max}(100, \text{Ceil}(5 \times P \times N) \times T_{\text{SSB}})$
DRX cycle $\leq 320\text{ms}$	$\text{Max}(200, \text{Ceil}(15 \times P \times N) \times \text{Max}(T_{\text{DRX}}, T_{\text{SSB}}))$	$\text{Max}(100, \text{Ceil}(7.5 \times P \times N) \times \text{Max}(T_{\text{DRX}}, T_{\text{SSB}}))$
DRX cycle $> 320\text{ms}$	$\text{Ceil}(10 \times P \times N) \times T_{\text{DRX}}$	$\text{Ceil}(5 \times P \times N) \times T_{\text{DRX}}$
NOTE: $T_{\text{SSB}}$ is the periodicity of the SSB configured for RLM. $T_{\text{DRX}}$ is the DRX cycle length.		

- Take the  $T_{\text{Evaluate\_out\_SSB}}$  shown above as an example, seconds or tens of seconds may be required before RLF can be declared. Consider the fast changing channel condition in FR2, such a long RLF evaluation time will degrade the RLM performance significantly (i.e. the connection will be lost for a long time before the recovery procedure can be initiated)
- Optimizations to reduce the failure detection time and the interruption time for FR2 are highly desirable.

# Fast failure detection and recovery

- **Fast PCell failure recovery in carrier aggregation**
  - In Rel-16, fast failure recovery is supported for DC case only (i.e. fast MCG failure recovery).
  - For the CA with PCell on FR2, since the signal quality may be decreased sharply due to the blockage, RLF may be detected on PCell.
  - In such case, [a fast failure recovery mechanism through SCell is useful for FR2](#)

# Dynamic UE capability sharing

- MN and SN share the UE capabilities in a rather static way until Rel-17
  - Capability sharing is based on the assumption that the configured SCell/BWP are always used even if they are not activated
  - NW has to ensure that all of possible combinations of the configured BWPs satisfy the FeatureSetCombination requirement
- Considering the resource efficiency and the fast changing channel conditions in FR2, it is proposed to study the feasibility of a more dynamic UE capability sharing mechanism among different CC/CG
  - **Capability sharing based on activated cells/BWPs instead of configured cells or BWPs is useful for FR2**
  - More SCells can be configured, but only the active SCells will be counted towards UE capability sharing
    - With such flexibility, the network can configure more SCells and dynamically activate the ones with better radio conditions
  - More BWPs can be configured, but only the active BWPs will be counted towards UE capability sharing
    - This enables the NW can activate the BWP with higher capability (e.g. 4 layer MIMO) on the cell with better radio condition dynamically, and active BWP with lower capability (e.g. 2 layer MIMO) on the cell with poor radio condition to reserve some capabilities for the cell with good radio condition.

# Thanks



Tomorrow never waits

