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RP-232127

Multi-carrier Enhancements in Rel-19

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Our Proposals for Rel-19 WS

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Background - 1

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Multi-carrier technologies in NR

Carrier Aggregation: The most essential functionality for LTE-A and NR

- Achieving higher throughput
  - FDD-FDD, TDD-TDD, TDD-FDD
- Avoiding degradation in cell edge by inter-site CA

Dual Connectivity: Used to aggerate two carriers which have different characteristics

- E-UTRA – NR
- FR1 – FR2
- Inter-vendor
- At maximum 2 legs

Example of issues

Differentiation from LTE is brought by "add-on" functionalities external to legacy CA framework

- e.g. UL switching/SUL

CA functionality is one of the biggest contributor to make the RAN1/2 specification complicated

- e.g. CA with different SCS carrier, collision handling

Complicated RAN4 specs

- DL: Large amount of band combinations
- UL: Combination of CA, MIMO, power class and Tx switching/SUL

Multi-carrier functionalities are the most important technology in NR
Clear evolution in the next generation is required!

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Background - 2

Our observation 1 (for RAN1 and 2):
The complication in 5G was caused because single carrier operation is the baseline for NR

⇨ **Multi-carrier native system design may be beneficial to achieve clear distinction**

Our observation 2 (for RAN4):
The complication in NR spec is caused because RAN4 had no common understanding on the UE architecture

⇨ **RAN4 should spend more time to discuss the baseline (and simplification) discussion before the 6G discussion starts**

Study on the fundamental design of multi-carrier operation is important in Rel-19 for the successful 6G standardization

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Example area for improvements

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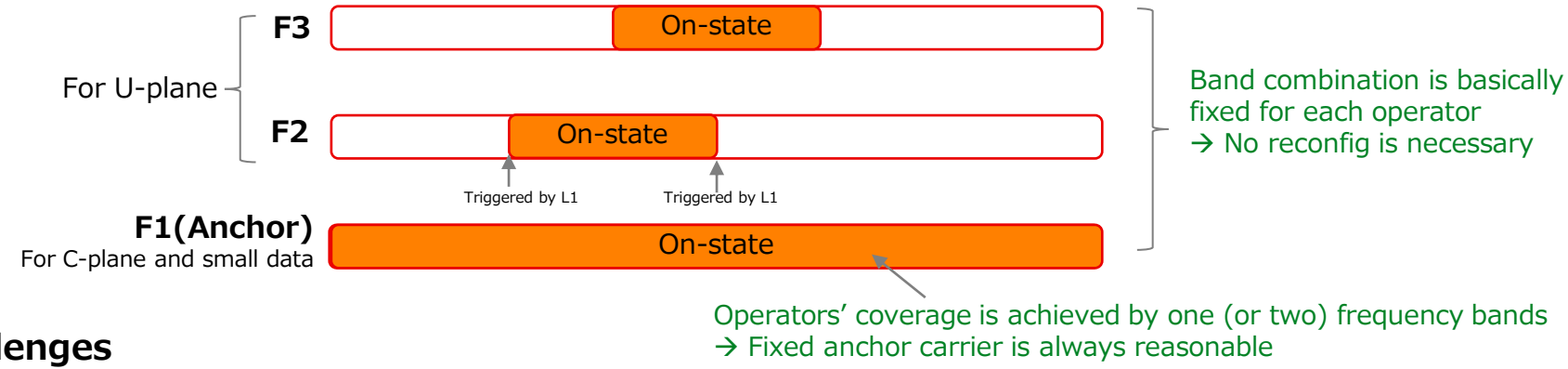
Example of 4G/5G functionalities caused by single carrier native design

- IDLE/Connected mode load balancing
- Use of additional carriers based on RRC-reconfiguration

Example of design goal for next generation multi-carrier system

- Subsequent CA (i.e. do not require RRC reconfiguration for CA)
- Introduction of C-plane specific anchor carrier



Challenges

- UE power consumption
- Support of lower-tier UEs (i.e. for IoT)

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Potential area for Rel-19 SI

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- **Study the drawbacks/problems of NR multicarrier functionalities, and develop a simplified multicarrier operation (RAN2, RAN1)**
  - The goal is to develop a mechanism where <u>multiple carrier is a default operation</u>
  - Consider at least the following aspects
    - Solution to completely avoid idle/inactive/connected mode load balancing among carriers, e.g.
      - by introducing C-plane only carrier and C-plane less carrier
    - Solution of easy & fast use of multi-carriers by, e.g.
      - configuring multiple carriers more than UE capability, and control the on-off state of the carrier(s) by DCI
    - Potential drawbacks when multi-carrier operation is a default operation mode, e.g.
      - UE power consumption
      - Support of lower-tier UEs

- **Study UE architecture for multicarrier-native operation in next generation (RAN4)**
  - The goal is to simplify the future RAN4 discussions by having a common understanding on the UE architecture

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Analyses on MCE proposals in Rel-19 Workshop

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Leftovers/enhancements on Multi-cell PDSCH/PUSCH scheduling via single DCI

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- In our view, the core part of multi-cell scheduling via single DCI has been specified in Rel-18. Thus, the remaining issue is definitely minor/optimization
- In June WS, it was claimed that – Enhancement of Enhancement without clear market demand should be ruled out!
  - We are not sure yet if there is a clear market demand for Rel-18 multi-cell scheduling
- **Fujitsu's view**
  - Not supportive

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Fast carrier switching for DL

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- As proposed in slide#3-6, we believe carrier switching using DCI will bring considerable benefit in terms of the simplified multi-carrier operation
  - The target is to design a better multi-carrier operation toward the next generation than 4G/5G
- However the motivation is just to obtain a scheduling gain, the gain should be justified first
  - L1 based switching requires Rx interruption by RF returning, which causes performance loss
  - Dynamic carrier switching may be useful when average SINR for two or more carriers is almost equivalent. It is not clear if such situation is typical in the real network
  - It is expected that only a few high-end UE will equip this feature. If so, such a UE will also be capable of higher-order CA.
- **Fujitsu's view**
  - This scope should start from study phase

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Flexible association between UL and DL carriers

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- This category includes multiple aspects. Hence the necessity should be discussed separately.
- For association between UL and DL in different bands
  - The potential benefit to do so can be achieved by (1) current CA framework, (2) SUL, (3) defining a new band.
- For one cell configured with 1 NUL and two SULs
  - In our understanding, SUL is used for supplementary use, i.e. SUL is used when NUL performance is expected to be bad.
  - More discussion would be required to justify then reason why 2 backup UL carrier is needed
- For simultaneous transmission between UL only cell (“eSUL”) and UL in a normal cell having associated DL in the same cell
  - It would be good to marge the SUL concept into CA framework
  - On the other hand, it is not clear for us if such activity is commercially required if the benefit of eSUL is the same as SUL
  - If the activity is for the design of next generation multi-carrier operation, we support.

- **Fujitsu’s view**
  - Support the study on eSUL

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Enhancements for more efficient multi-carrier operation

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- Cross-carrier HARQ retransmission
  - The benefit to specify at this late stage in 5G is not clear
- Joint CSI measurement across multiple carriers
  - The benefit is unclear and hence more study is needed.

- Especially, considering the fact that the allocated time unit for this potential SI/WI is quite limited, we should focus on more useful functionality

- **Fujitsu's view**
  - Not supportive

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Conclusion

- The allocated TUs for MCE, if available, should be used for designing future proof functionality. Enhancement on enhancement WI/SI should be avoided.
- The following study can be done (if time available) for the design of next generation multi-carrier operation
  - Study the benefit of carrier switching using DCI, including the performance gain and simplification of current CA design
  - Study the design of eSUL: how to merge the SUL concept into CA framework
  - The necessity of normative phase depends on the outcome of study

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Thank you

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