

## **R1-105986: On ACK/NACK bundling ways in LTE-A TDD**

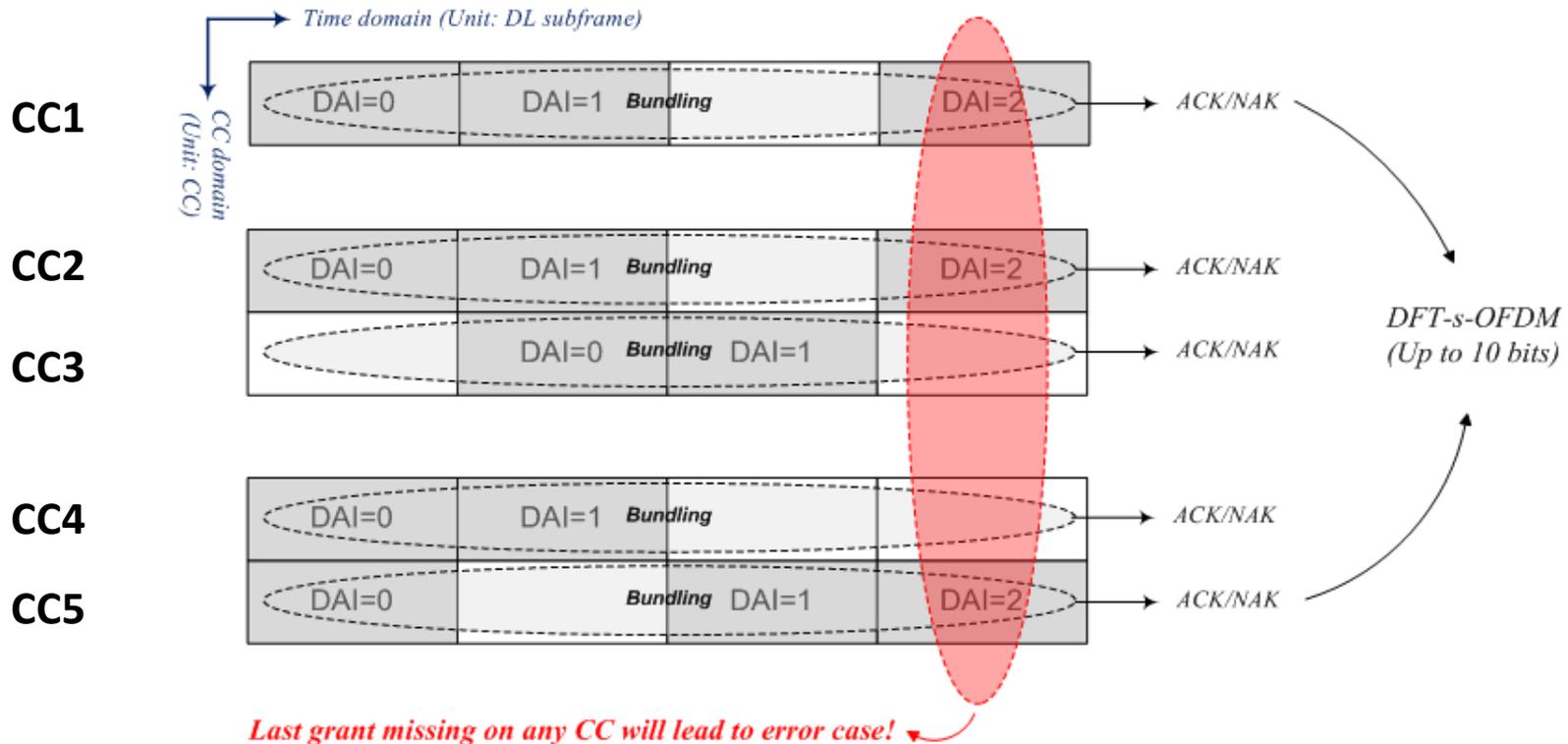
Nokia, Nokia Siemens Networks

# ACK/NAK Bundling Ways for LTE-A TDD

- The following ways of partial bundling have been discussed in order to limit the maximum number of ACK/NACK feedback bits in LTE-A TDD
  - *Time-domain bundling (up to 10 ACK/NACK bits)*
  - *CC-domain bundling (up to 12 ACK/NACK bits)*

# Error Case handling for Time-domain bundling

- Error Case needs to be handled, e.g., last grant missing on ANY CC will lead to error case.
  - Considerable effort spent in Rel-8 TDD ACK/NACK bundling on error case handling.



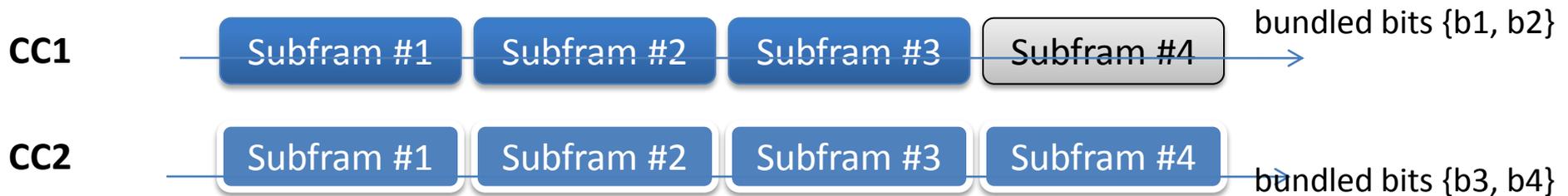
**Fig. 1 Error cases for time-domain partial bundling, each CC needs error case handling as in Rel-8 TDD**

# Issues with Time-domain bundling

bundled bits {b1, b2} on PUCCH linked with the last received grant



**Example #1 Error case handling in Rel-8 TDD full bundling mode**



**Example #2 PUCCH format 1b with channel selection not possible due to error case**



# Issues with Time-domain bundling (cont.)



**Example #3 Bundled 10 bits on DFT-S-OFDM, 5 out of 10 bits may be consumed for error case handling**



## Issues with Time-domain bundling (cont.)

- Rel-8 error case handling mechanism is NOT workable for time-domain partial bundling in CA
  - For less than 4 bits cases, PUCCH Format 1b with channel selection cannot be re-used
  - For greater than 4 bits cases with DFT-S-OFDM, half of the feedback bits may be consumed for error case handling if Rel-8 DAI design is reused

Observation #1: Time-domain partial bundling in CA  $\neq$  Re-use Rel-8 way

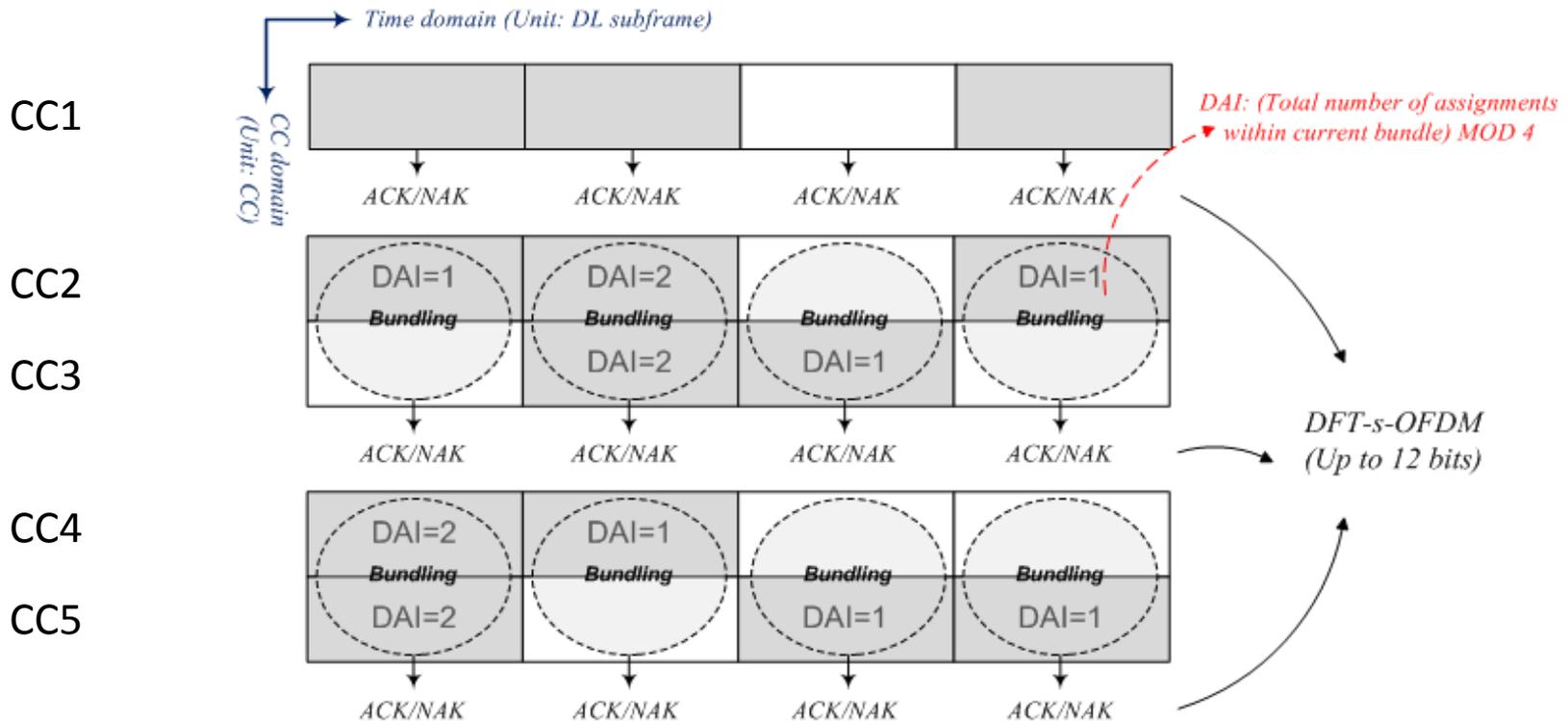
# Issues with Time-domain bundling (cont.)

Observation #2: So far there is NO clear solutions to handle the related error cases for time-domain partial bundling in CA.

- **Potential error case handling methods need more discussions as well as standardization efforts, e.g.,**
  - **New DAI design**
    - Increased overhead or scheduling restriction
  - **Keep Rel-8 DAI**
    - Effective A/N bits for TDD will be reduced significantly which compromises the TDD system performance

# On CC-domain partial bundling

- Clear solution with effective error case handling is available [1]
  - 2-bits DAI design with no scheduling constraints



**Fig. 2 CC-domain bundling, 5 CCs, 4 subframes**

# Conclusion

- Error cases handling mechanism for time-domain partial bundling needs to be clarified.
  - No clear solution so far discussed in Ran-1 working group.
- CC-domain partial bundling has clear DAI design and error case handling.
- It is proposed to consider CC-domain partial bundling as a way of limiting the maximum ACK/NACK bits in LTE-A TDD.

# Reference

- [1] R1-105085, Proposals on UL ACK/NAK Feedback in LTE-A TDD, Nokia, Nokia Siemens Networks
- [2] R1-104431, “UL ACK/NAK Feedback in LTE-A TDD”, Nokia, Nokia Siemens Networks
- [3] R1-104433, “UL ACK/NAK feedback for power-limited UE in LTE-A TDD”, Nokia, Nokia Siemens Networks