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**3GPP TSG-RAN1 Meeting #42bis  
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**Agenda Item: 8.3**  
**Source: Nortel**  
**Title: Proposal for the Downlink Synchronization  
Channel for E-UTRA**  
**Document for: Discussion**



>THIS IS **THE WAY**

## Proposal for the Downlink Synchronization Channel Design for E-UTRA

Nortel  
Oct, 2005

>THIS IS ~~N~~ORTEL



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# Design Principle

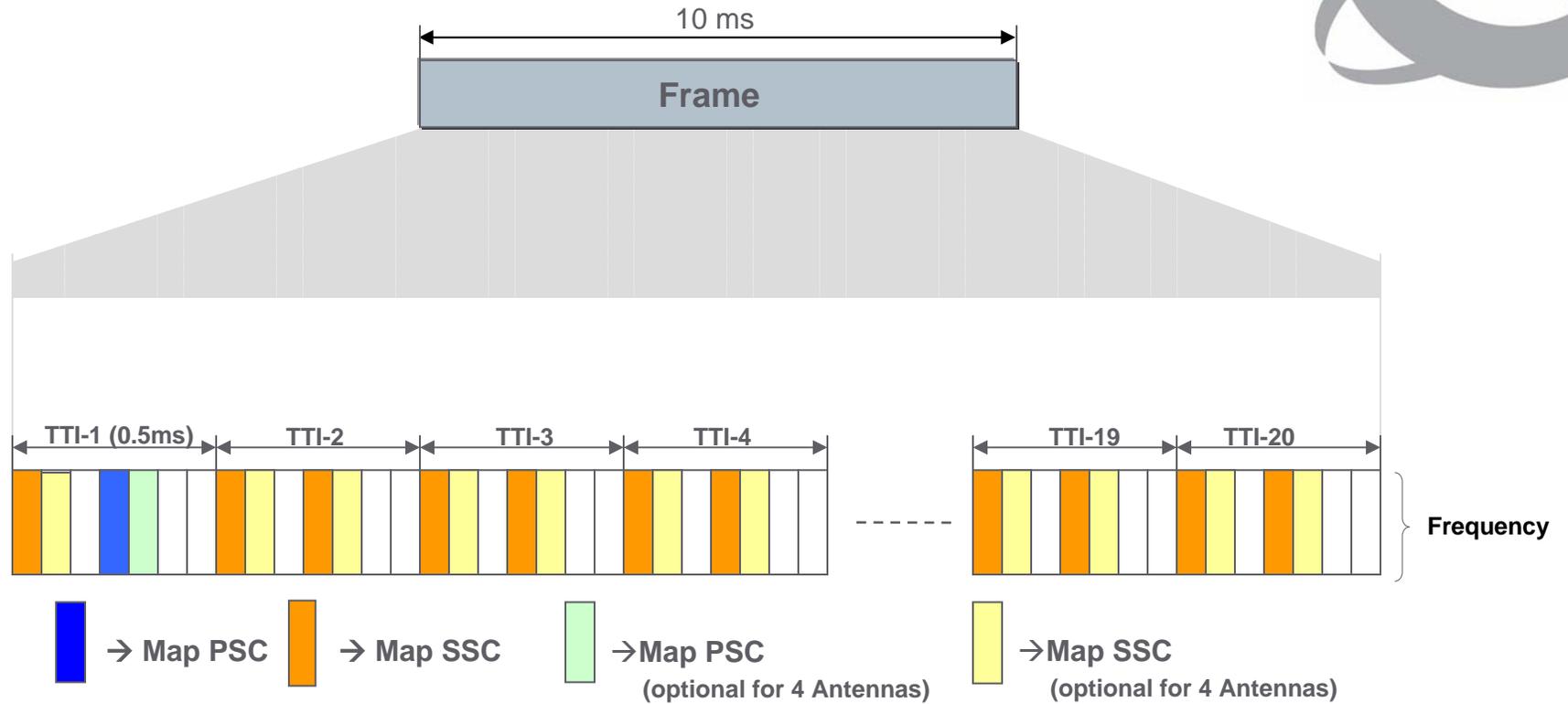
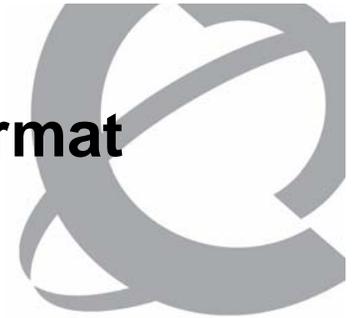
- > The introduction of the synchronization channel enables:
  - Fast initial system access
  - Timing and frequency synchronization and tracking
  - To support fast cell selection and re-selection
    - Low complexity
  - To assist DL CQI measurement
  - To assist channel estimation
- > Support non-MIMO and MIMO
  - Enhanced performance with MIMO transmission
  - Transmit antenna configuration detection (desirable)
- > Synchronization channel sequence selection
  - Common sequences and cell-specific sequences
- > Common pilots can be reused as synchronization channel

# Synchronization Channel Structure

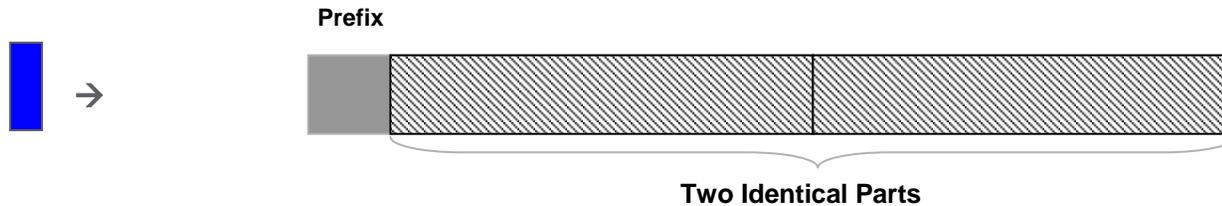


- > Synchronization channel consists of primary common synchronization channel and secondary cell-specific synchronization channel.
  - Primary Common Sync Channel (PSC) is mapped with the common PN codes across the network
    - To enable the fast system access and cell search
  - Secondary Cell specific Sync Channel (SSC) is mapped with the cell-specific PN codes assigned to each cell
  
- > To reduce the additional overhead introduced by Sync Channel, pilot channel can be reused as synchronization channel.
  - For scattered pilot format, common pilot sub-carriers are shared by PSC and SSC
    - PSC is only carried by the 4<sup>th</sup> (and optional 5<sup>th</sup> for four antennas case) pilot symbols in the first TTI in each frame.
      - To enable the fast system access, only half of the sub-carriers are modulated in PSC symbol.
      - Time domain repetition structure can enable *fast* coarse frame synchronization
      - Negligible additional overhead caused by the null sub-carriers in PSC symbol

# Locations of PSC and SSC for Scattered Pilot Format

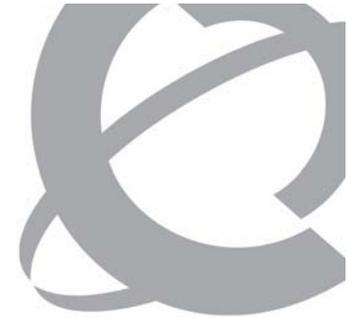


## Time Domain Structure of PSC Symbol for Scattered Pilot Format



# Frequency Domain Synchronization Channel Structure Based on Scattered Pilot Format

## Antenna Mapping and Sequence Mapping

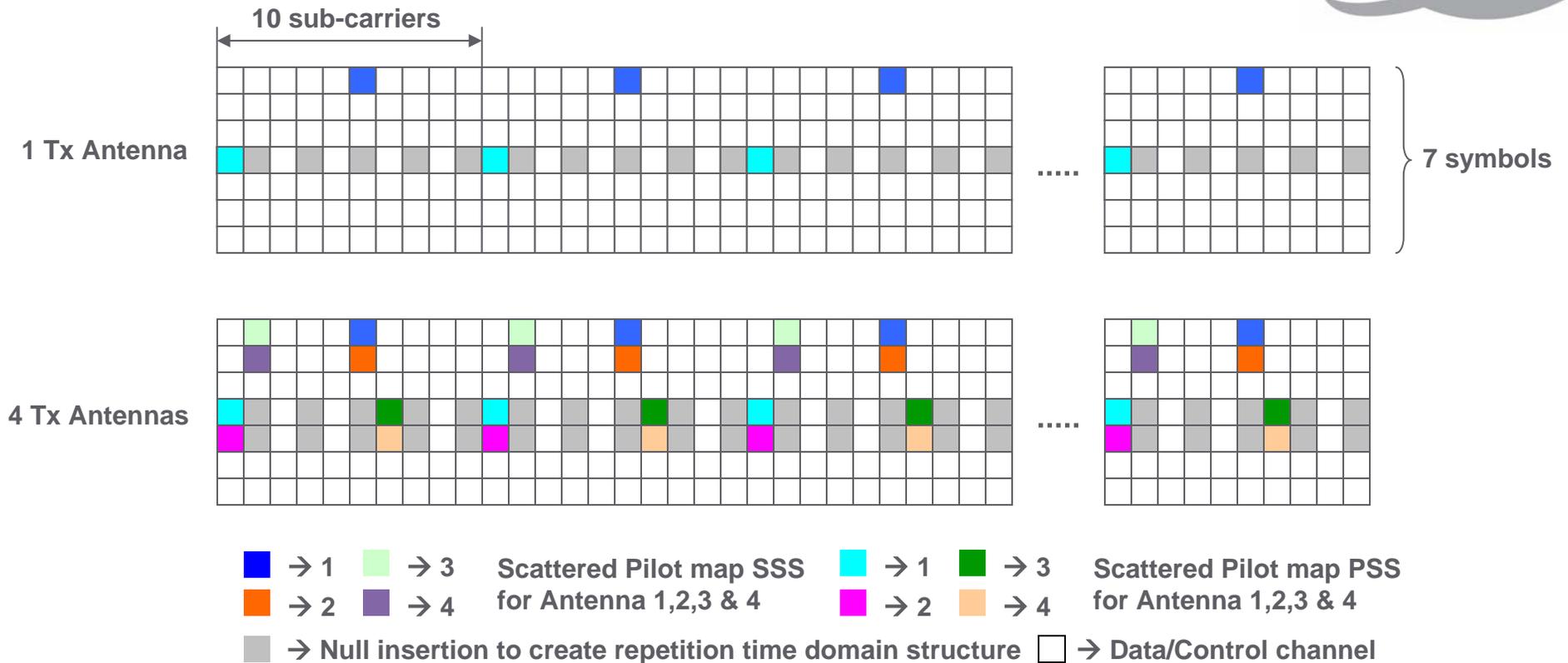


- > Common pilot sub-carriers assigned to PSC are modulated by two primary sync sequences (PSS)
  - PSS-1: unique sequence applied to all cells
  - PSS-2: unique sequence or multiple sequences carrying antenna configuration information (Optional)
- > Common pilot sub-carriers assigned to SSC are modulated by secondary sync sequence (SSS)
  - Cell-specific sequences determined by Cell\_ID
- > The length of PSS and SSS is the integer times of the number of pilot sub-carriers per antenna per symbol.
  - For multiple antennas scenario, all antennas transmit the same PSS and SSS
- > Support up to 4-transmit antennas
  - Orthogonality is maintained between different antennas in the frequency domain.



# Examples of Frequency Domain Mapping Structure of PSC

(Common Pilot Overhead: 1/35 per Antenna, First TTI in the 10 ms radio frame)

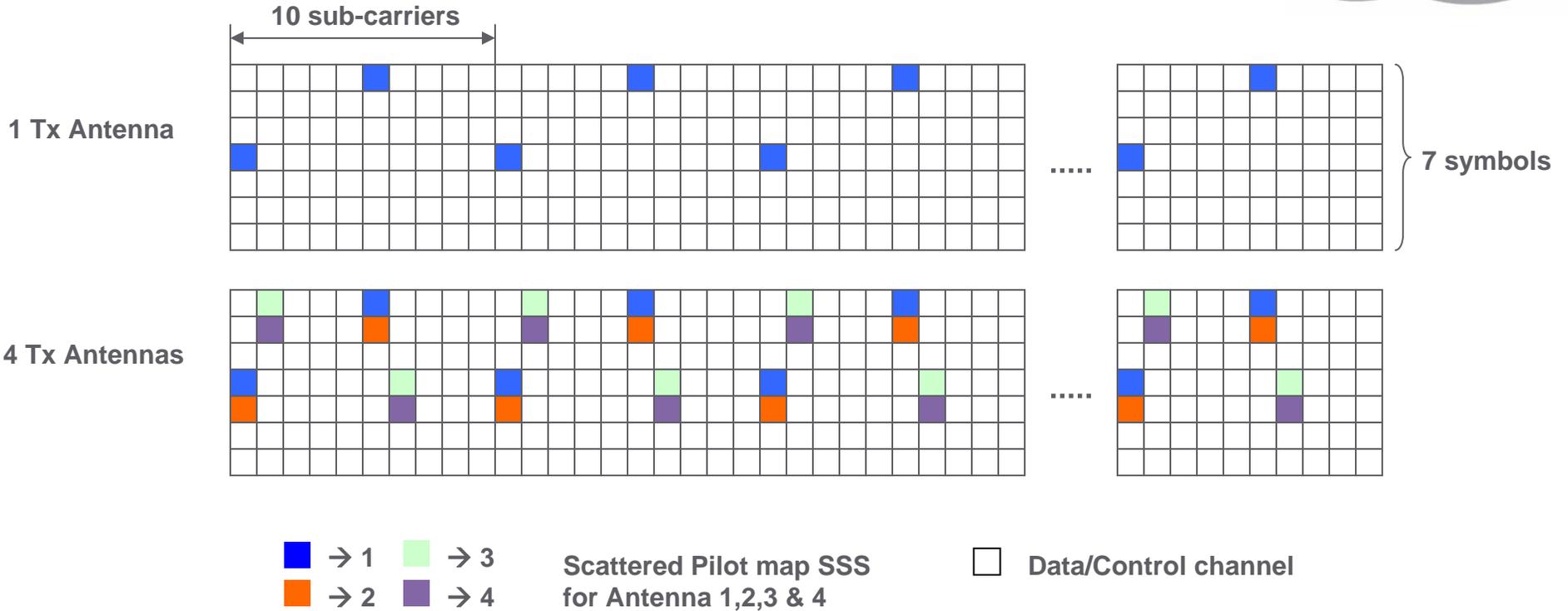


**Each Antenna Transmits the Same Primary Cell Specific Sequence**

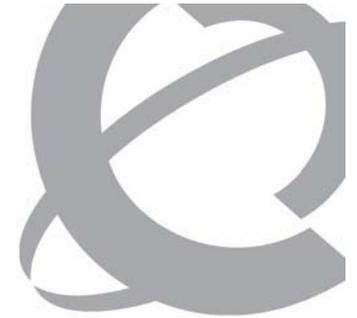


# Examples of Frequency Domain Mapping Structure of SSC

(Common Pilot Overhead: 1/35 per Antenna, all TTIs except the first TTI in each radio frame)

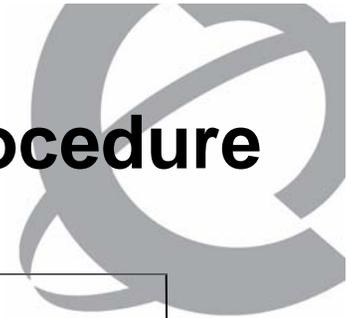


**Each Antenna Transmits the Same Secondary Cell Specific Sequence**

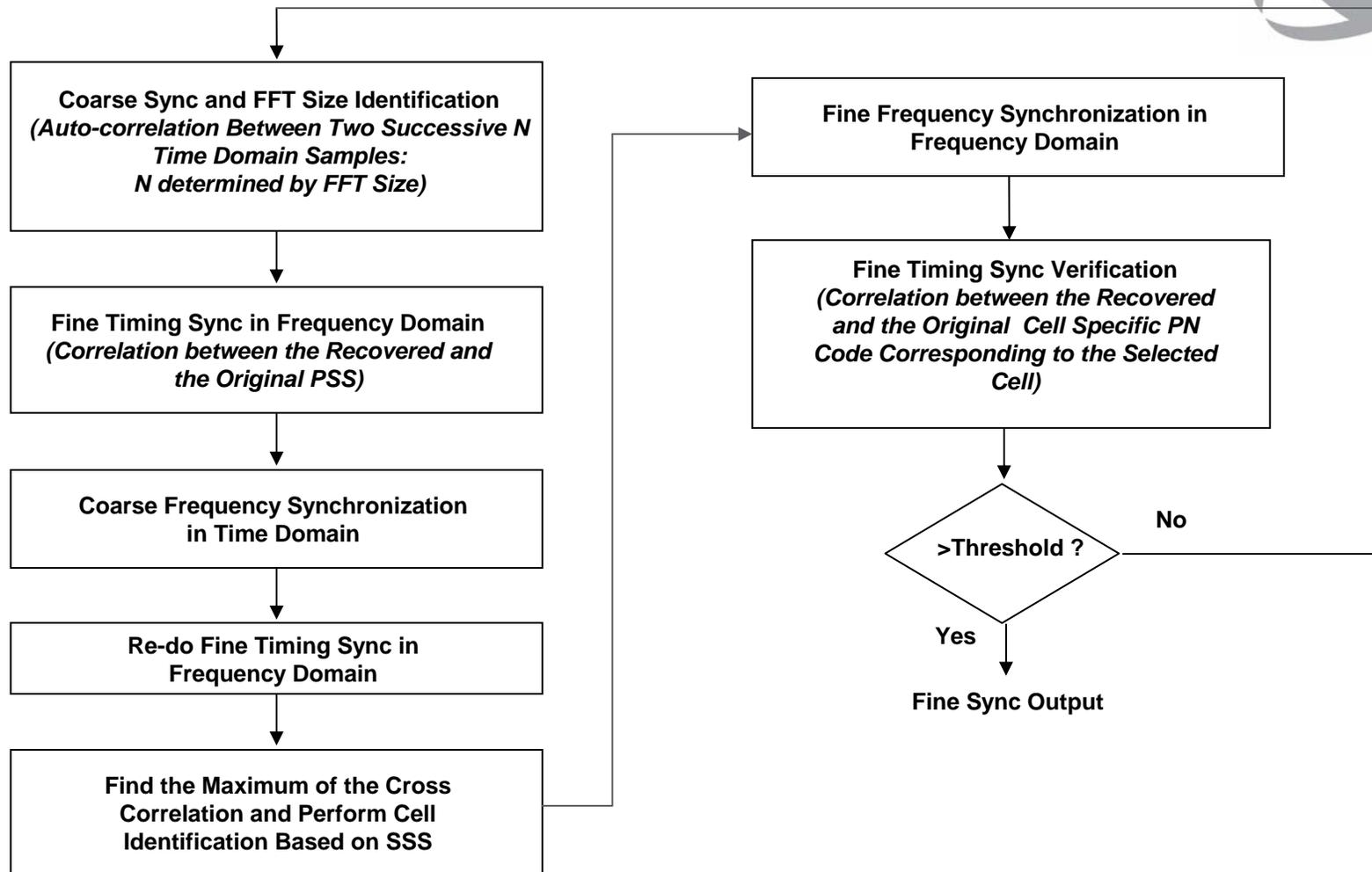


# Initial Acquisition and Synchronization

- > UE can perform initial acquisition and synchronization based on the Sync symbols in the synchronization channel.
  1. FFT size identification
    - channel bandwidth scan
  2. Frame acquisition
    - coarse timing synchronization based repeat PSS sequence structure
  3. Timing acquisition
  4. Frequency acquisition
  5. Cell identification and selection
  6. Fine frequency synchronization
  7. Fine timing verification
  
- > A number of algorithms can be applied by UE, next slide gives an example of the processing procedure for initial acquisition and synchronization.



# Initial Acquisition and Synchronization Procedure





## Summary

- > DL synchronization channel structures are proposed with
  - Primary common Sync channel and secondary cell-specific Sync channel
  - PSC and SSC mapping
- > Common pilots are *reused* as synchronization channel.
- > Support MIMO and different channel bandwidth