

EPoC Downstream Pilot Proposal

Christian Pietsch, Qualcomm

Avi Kliger, Broadcom

FDD Downstream Pilots

- Previous contributions presented pilot types and number of pilots in the downstream direction for FDD
- Two pilots types proposed
 - 32 Staggered(“Regular”) pilots
 - 32 Continuous pilots
- Pilot usage is implementation dependent
- This presentation provides more details on the pilots specifications

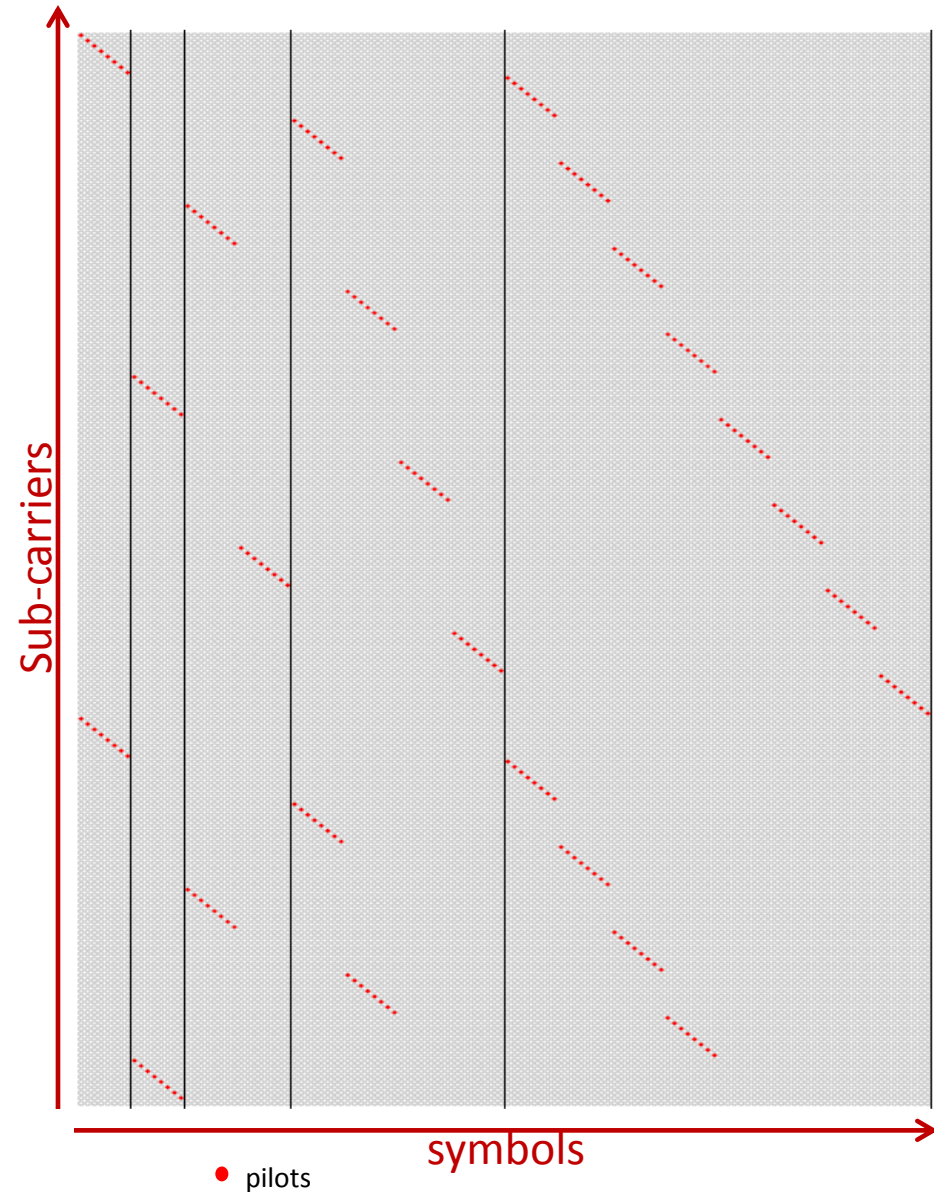
Staggered Pilots

- Every 128 subcarriers in 4K mode (pilot on every subcarrier)
- Every 128 subcarriers in 8K mode (pilot on every second subcarrier)
- Pilot locations designed to allow fast acquisition
- Use PRBS with BPSK/QPSK constellation
- Pilots repeat every 128 4K-symbols and 64 8K-symbols
 - 2.752mSec and 2.656 mSec with 1.5 uSec CP size for 4K and 8K symbols, respectively
- Not transmitted in excluded sub-carriers
- Transmitted on nulled sub-carriers

FFT size	pilot spacing	pilots / symbol	symbols / cycle
8192	128	64	64
4096	128	32	128

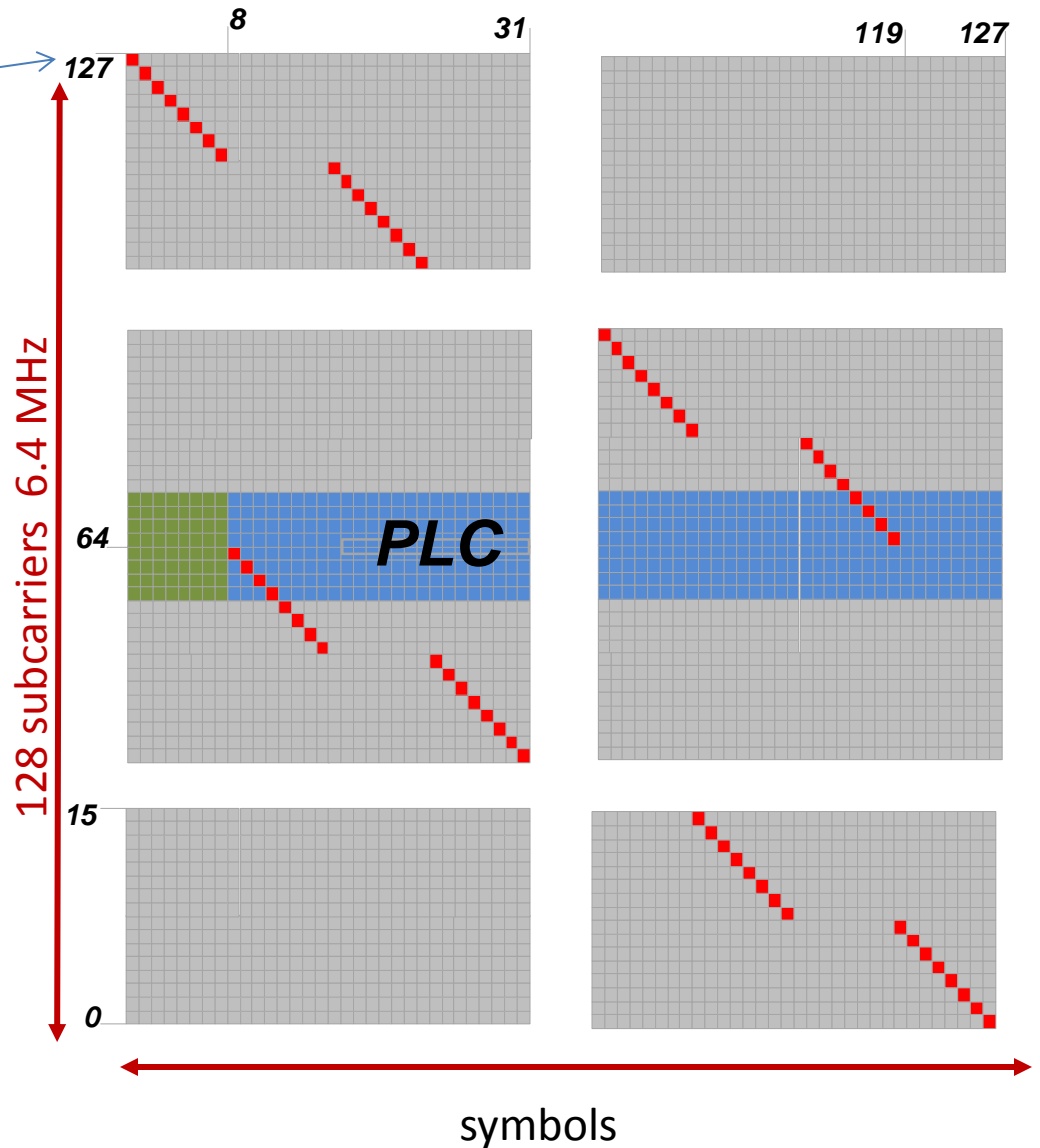
Staggered Pilot Sequence

- Pilots are grouped into subsets of eight as shown in the figure
 - Subsets of eight are recommended to balance ease of phase detection and speed of acquisition by interpolation
- Each successive group of subset increases interpolation granularity (or channel length) by a factor of 2
- Subsets allow for fast acquisition of scattered pilot phase
- Figure example assumes 4K symbols
- With 8K symbols every second subcarrier is skipped



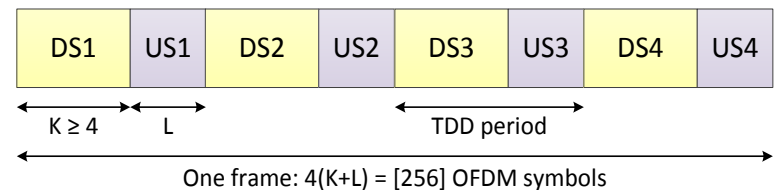
Staggered Pilots are Aligned to the PLC

First pilot in the staggered pilots cycle



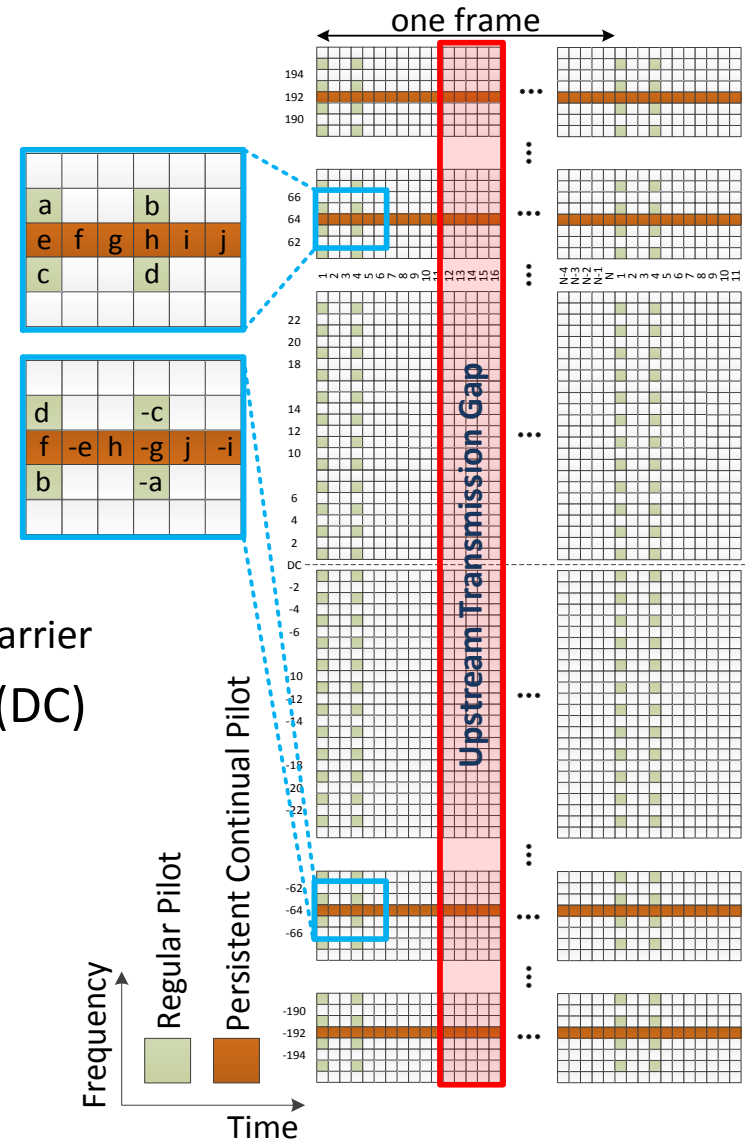
TDD Downstream Frame Structure

- A TDD downstream frames is composed of N OFDM symbols with
 - $N = [256]$ for a subcarrier spacing of 50 kHz
 - $N = [128]$ for a subcarrier spacing of 25 kHz
- The frame is segmented into $J = [1, 2, 4, 6, 8]$ TDD periods
 - A TDD period has a duration of $1/J$ of the frame duration
 - A TDD period contains N/J OFDM symbols
 - A TDD period consists of
 - One downstream transmission window DS_i with $K \geq 4$ OFDM symbols
 - One upstream transmission window US_i with $L = N/J - K$ OFDM symbols
- By fixing the sum of upstream and downstream OFDM symbols in a frame the downstream/upstream split and the number of TDD periods in a frame will only have a secondary effect on the frame duration. The differences will be cause by
 - Switching times between downstream/upstream transmission
 - Different CP duration for upstream and downstream transmissions
- Example (see figure):
 - The frame has 256 OFDM symbols
 - There are 4 TDD periods in the frame, i.e., each TDD period has 64 OFDM symbols



TDD Downstream Pilot Structure

- Regular pilot symbols:
 - Two modes:
 - Regular mode: Regular pilot symbols are transmitted in OFDM symbols 1 and 4 of a TDD downstream frame
 - Robust mode: Regular pilot symbols are transmitted in OFDM symbol 1 and 4 of every downstream transmission window DS_i
 - Fixed pilot density in the frequency domain:
 - 50 kHz subcarrier spacing: On every subcarrier
 - 25 kHz subcarrier spacing: On every second subcarrier
- Pilots are symmetric around center frequency (DC)
- Pilots are BPSK/QPSK constellation points



Continuous Pilots

- Usage of continuous pilots:
 - Exclusion bands are bounded by continuous pilots
 - Eight continual pilots symmetrically around the PLC
 - Up to 30 additional continual pilots configurable and position is communicated via PLC
- Two options for the Continuous pilots according to subcarriers availability constraints
 - (1) Only eight subcarriers of the PLC channel are guaranteed to be always available
 - (2) All subcarriers in the 6MHz band around the PLC center frequency are guaranteed to be always available
- Continual pilots that fall into exclusion bands are not transmitted.

Continuous Pilots Locations

- With option 1
 - Up to 30 Continuous Pilots are configurable by the CLT PHY according to actual available sub-carriers and their location is communicated via the PLC channel
- With option 2
 - Eight subcarriers are used as Continuous Pilots in the 6MHz band around the center frequency of the PLC. Their offsets from the center frequency are fixed in the spec
 - Up to 30 Continuous Pilots are configurable by the CLT PHY according to actual available sub-carriers and their location is communicated via the PLC channel
- Exclusion bands are always bounded by Continuous Pilots
- Rules for selecting Continuous Pilots by the CLT shall be defined

Thank You