Preamble Sequence For Fast Cell Search, Low Computational Complexity, and Low PAPR

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Assist in clarifying C802.16e-04/265r1 contribution document.

Preamble Sequence for Fast Cell-searching, Low Computational Complexity, and Low PAPR

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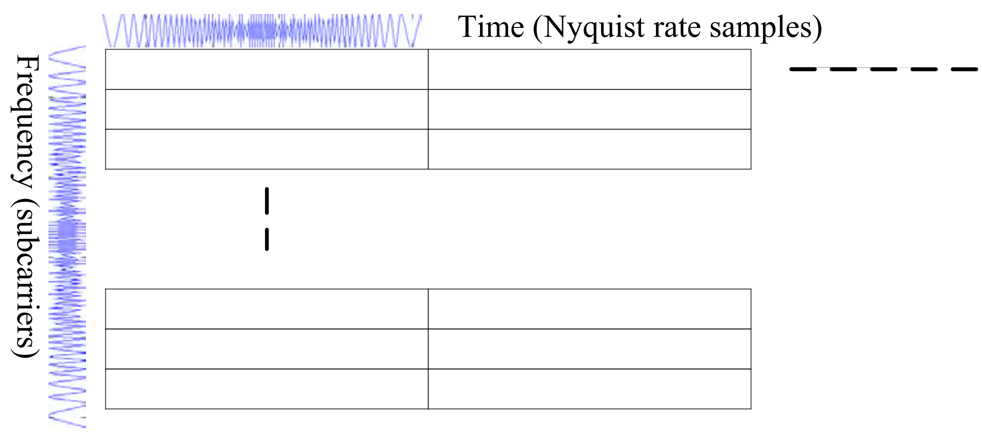
Addresses the Needs for Mobile Devices

- **Single preamble sequence needed for an entire network**
- **Different code phases represent IDcell, very low computational complexity**
- **Inherently low PAPR .**
- **Provide a mechanism for fast-cell searching during HO.**
- **Reduced processing power to extend battery standby time.**
- **One preamble scan operation process provides DL channel information of all segments such as CIR, TOA, CQI, IDcell, etc.**
- **Allow MSSs to automatically adjust for DL RX timing to reduce ISI and UL TX timing to maintain subchannel slot timing orthogonality due to the readily available TOA info.**
- **Reduce the need for frequent ranging requests.**

CAZAC Frequency-Time Duality

- **CAZAC: Constant Amplitude Zero Auto-correlation Coefficients.**
- **Main mathematical properties**
  - All cyclic shifts of the sequence form an orthonormal basis of .
  - CAZAC in time domain if and only if CAZAC in frequency domain (see contribution for details).

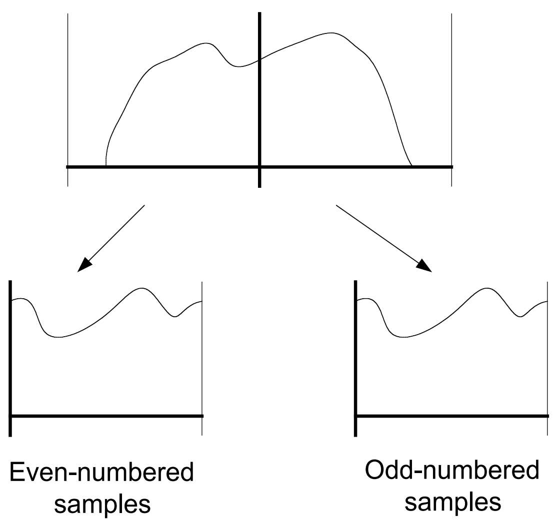


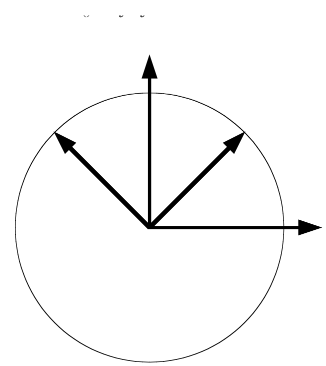
CAZAC Sequences

- **Chu sequence (L=8,32,128,512,…)**
- **Frank-Zadoff sequence (L=16,64,256,1024,…)**
- **Frequency-time offset ambiguity**
  - Chu sequence
    - Frequency offset of
    - Frequency offset of k subcarriers ($k/(LT_s)$)->time offset of -k Nyquist samples.
  - Frank-Zadoff sequence
    - Exhibits Chu-like frequency-time ambiquity (not exact).
    - Frequency offset of k subcarriers->time offset of –k Nyquist samples.

Construction of Low PAPR Sequences

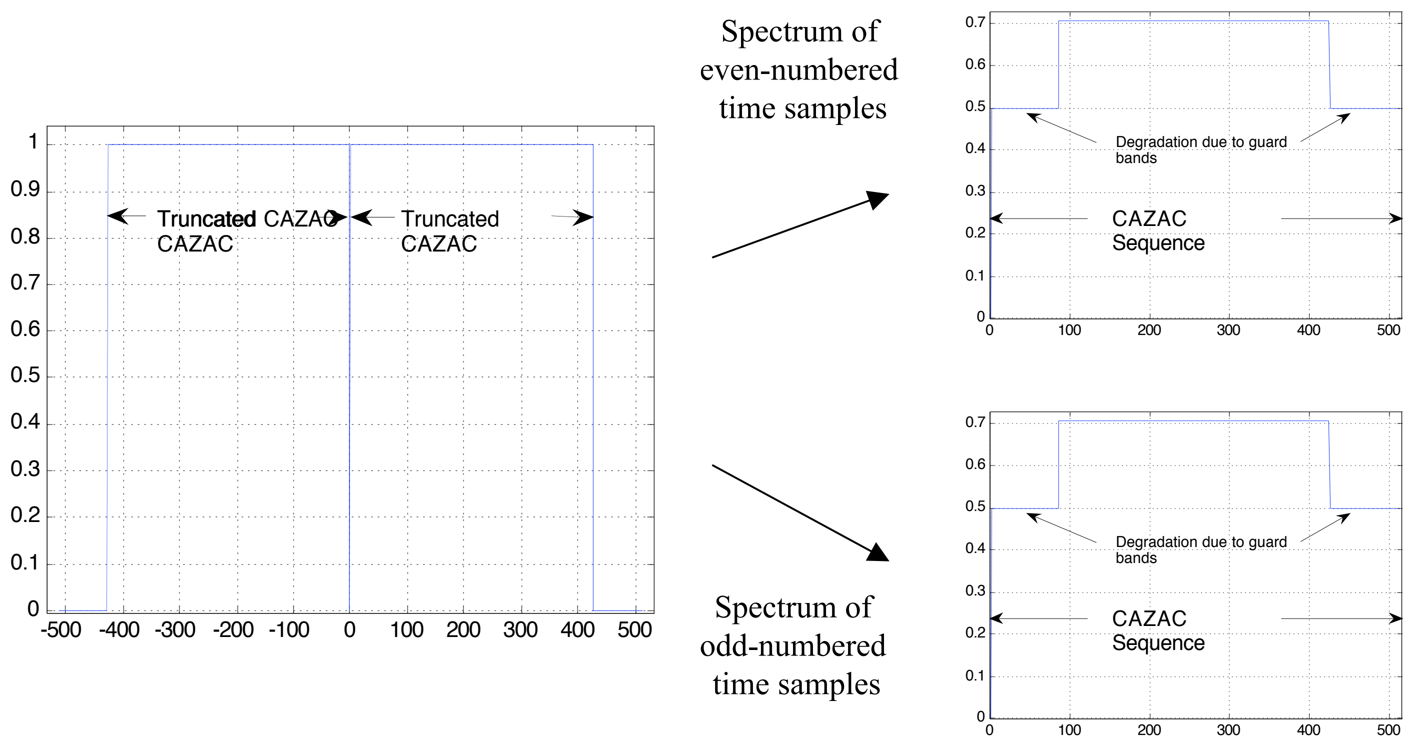
- **Straight adoption of CAZAC sequences cannot be done due to guard bands in OFDMA.**
- **Utilize spectrum folding to inherit CAZAC properties with moderate rise of PAPR due to exclusion of guard bands.**





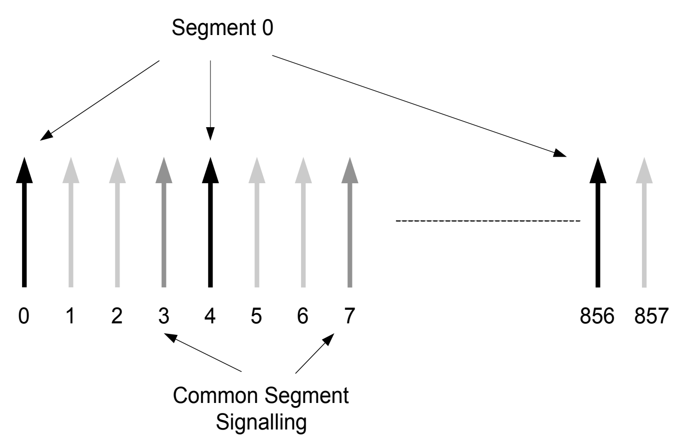
Principles of Constructing Low PAPR Sequences

- **Method to construct constant-amplitude frequency sequence and low PAPR time waveform**



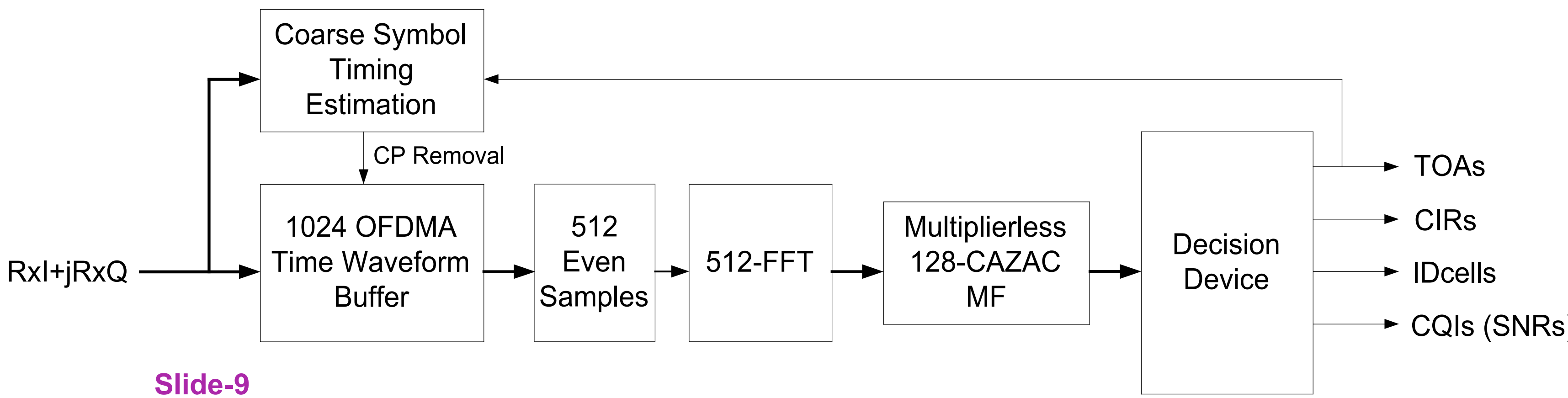
Preamble Sequences for PUSC

- **Subcarriers are divide into four carrier-sets**
  - Segment 0 uses set 0, segment 1 uses set 1, segment 2 uses set 2
  - All sets use the same CAZAC sequence. *IDcell* is characterized by the code-phase (number of cyclic shifts) of the CAZAC sequence.
- **Carrier-set 3 is used for common segment signaling without boosting by all segments.**
  - For 1024-FFT with 128-Chu, segment 0 sends 0-shifted CAZAC, segment 1 sends 42-shifted CAZAC, and segment 2 sends 84-shifted CAZAC.
  - Used for establishing a timing reference and not for channel estimation.
  - Non-boosted to reduce PAPR degradation



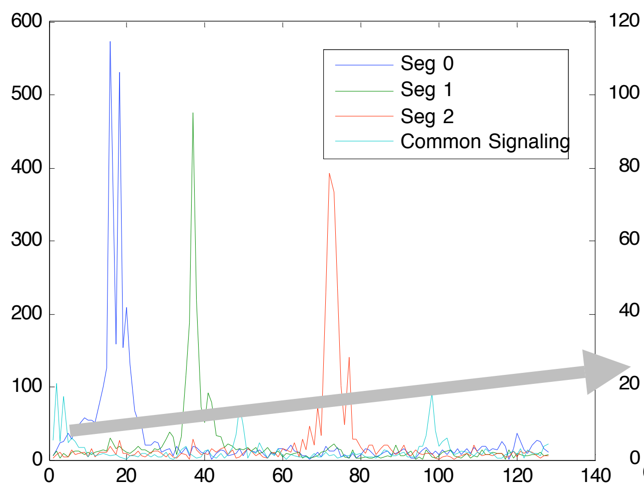
Low Computational Complexity

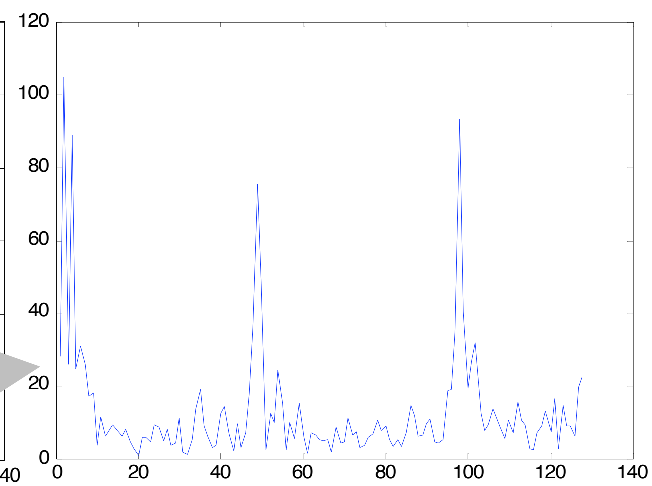
- **Operation can be done solely in frequency domain.**
- **CAZAC MF can be implemented as a multiplierless tap-delay line filter with reduced taps (CORDICs and adders).**
- **CORDICs can be shared with channel estimators.**
- **Further hardware complexity reduction by exploring CAZAC symmetry (for example, 16-element Frank-Zadoff are ±1 and ±j).**

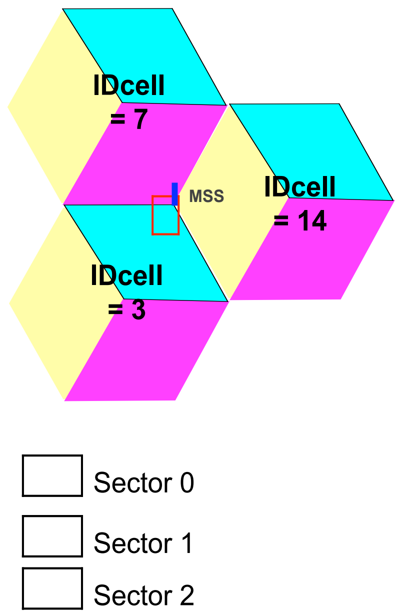


Example of PUSC In SUI-3 With the 3 Adjacent Sectors of 3 BSs

- **1024-FFT PUSC (frequency locked)**
- **Robust *IDcell* identification of all segments**

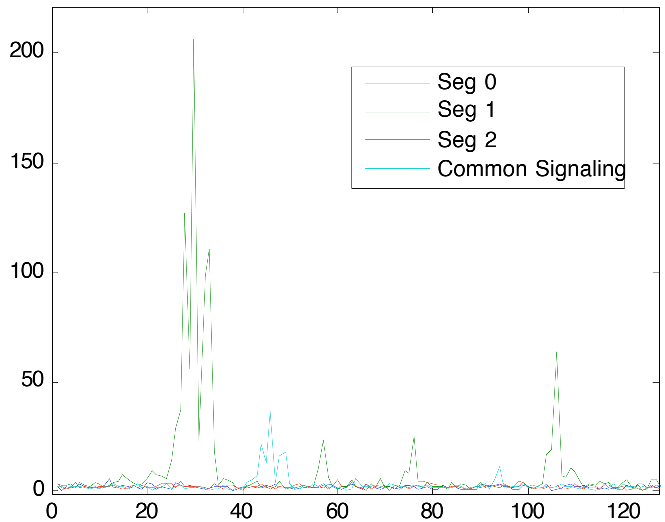


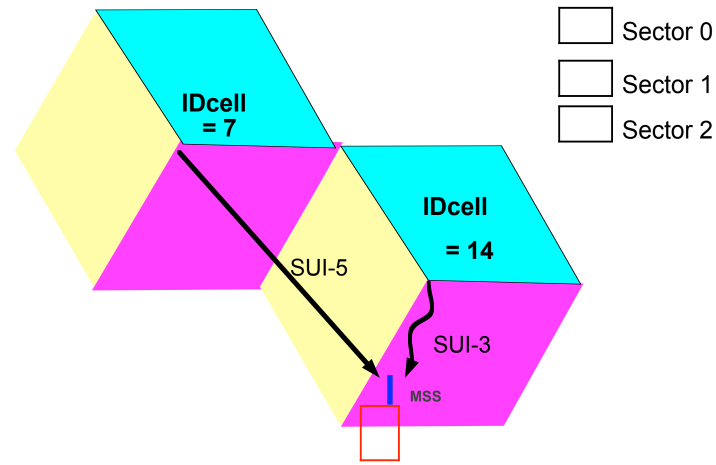




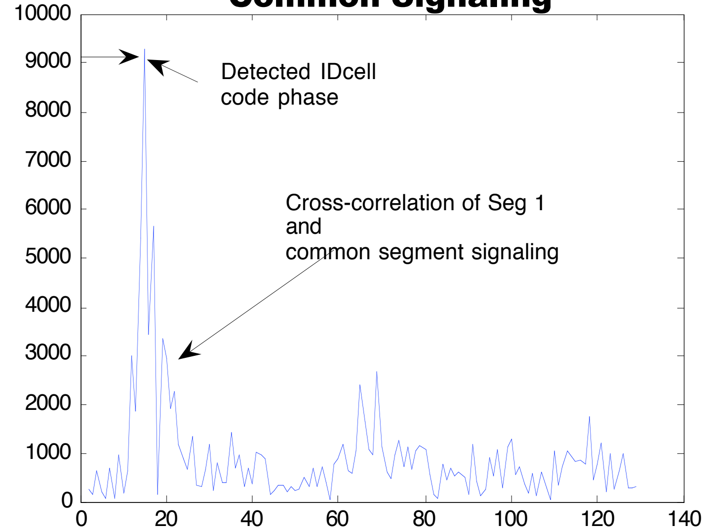
Example of Same Segment Interference In PUSC, Scenario 1

Results of CAZAC Matched Filtering In Frequency Domain



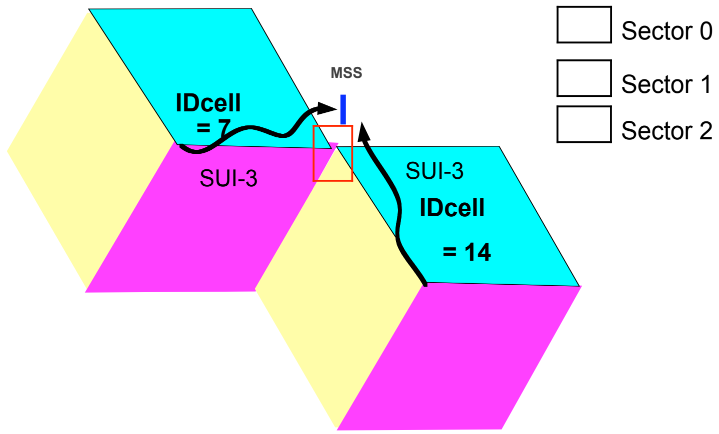


Cross-correlation of Seg 0 and Common Signaling

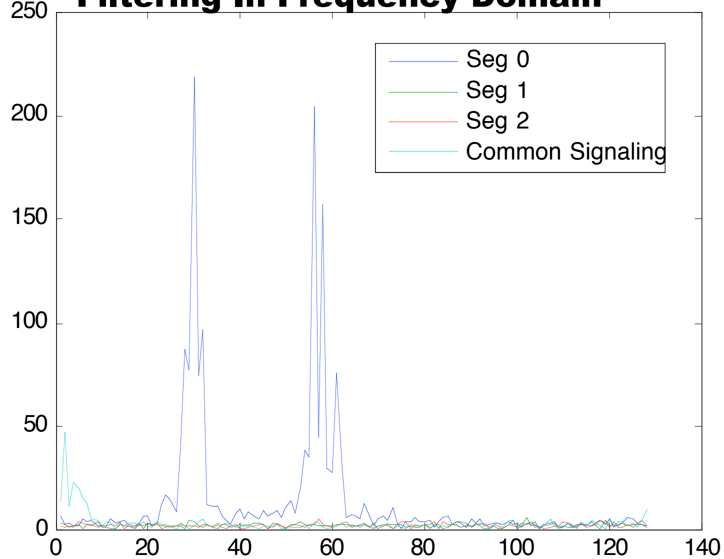


IDcell detection using cross-correlation of CAZAC MF outputs of Seg 0 and common segment signaling

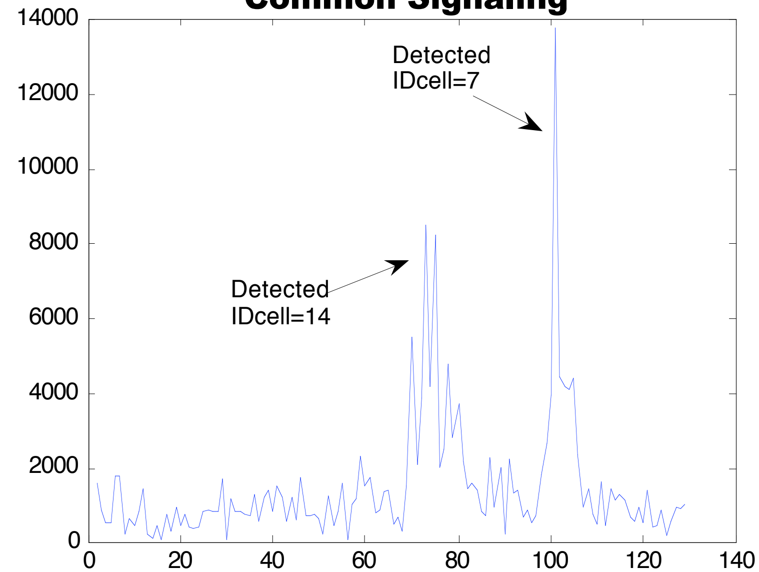
Example of Same Segment Interference In PUSC, Scenario 2



Results of CAZAC Matched Filtering In Frequency Domain

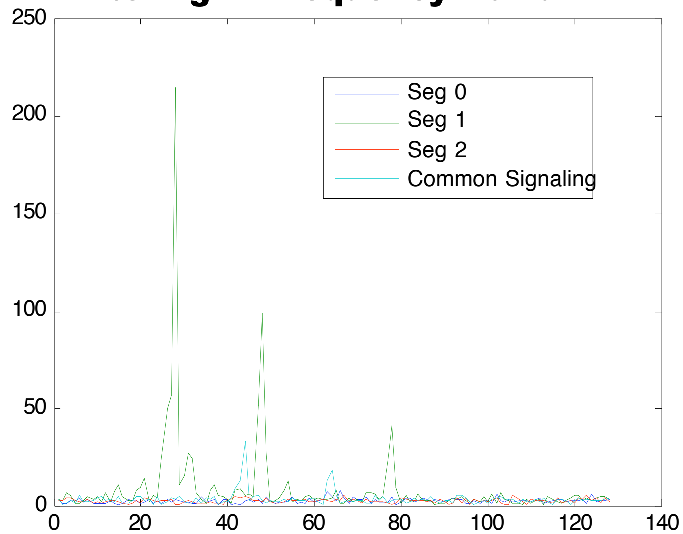


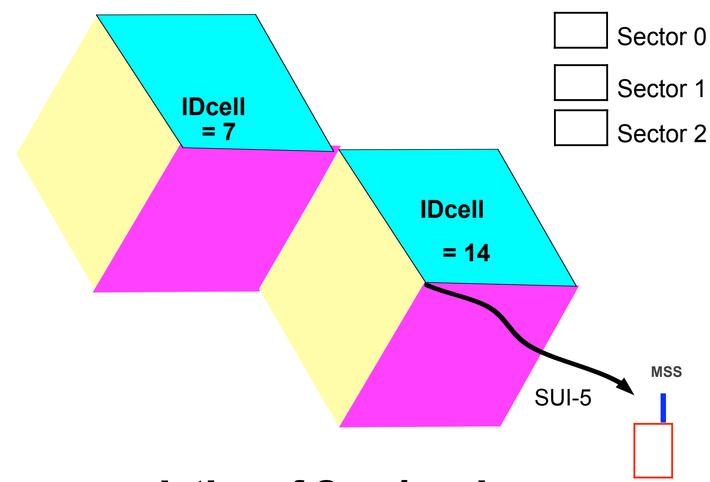
Cross-correlation of Seg 0 and Common Signaling



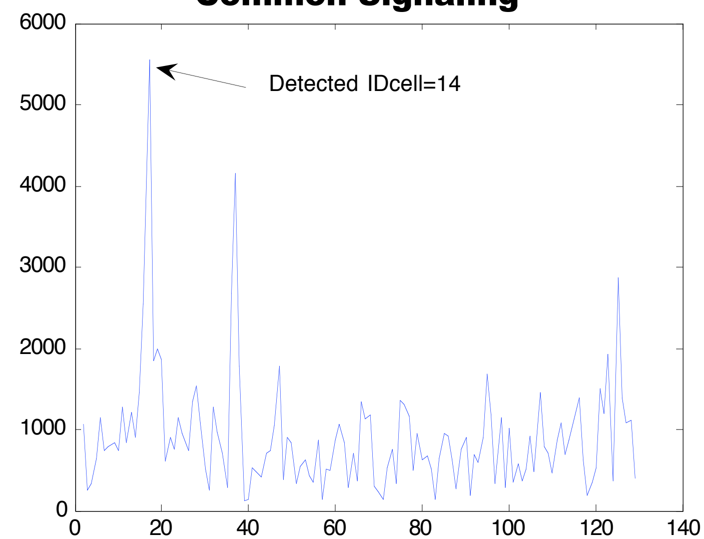
Example of Severe Multipath SUI-5 in PUSC, Scenario 3

Results of CAZAC Matched Filtering In Frequency Domain





Cross-correlation of Seg 1 and Common Signaling



Conclusion

- **Addresses the needs of MSSs where fast cell-searching is essential.**
- **Allows for extended battery time where neighbor and other frequency BS scanning can be done quickly and reliably and hardware complexity is very low.**
- **Allows for accurate adjustment of RX and TX timing to reduce RX ISI and TX multi-user interference in high-speed vehicular mobile environment even during HO.**