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Interference Group Discovery for FDX DOCSIS

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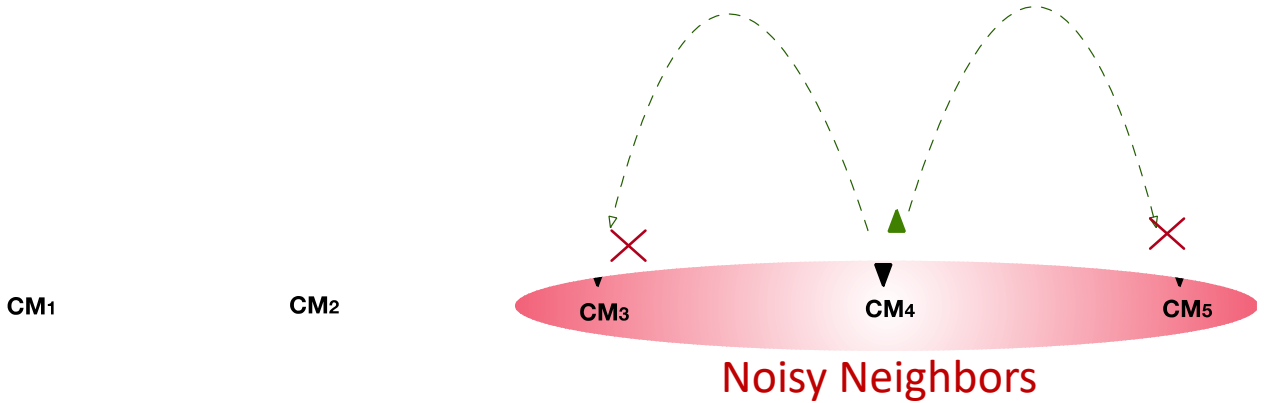
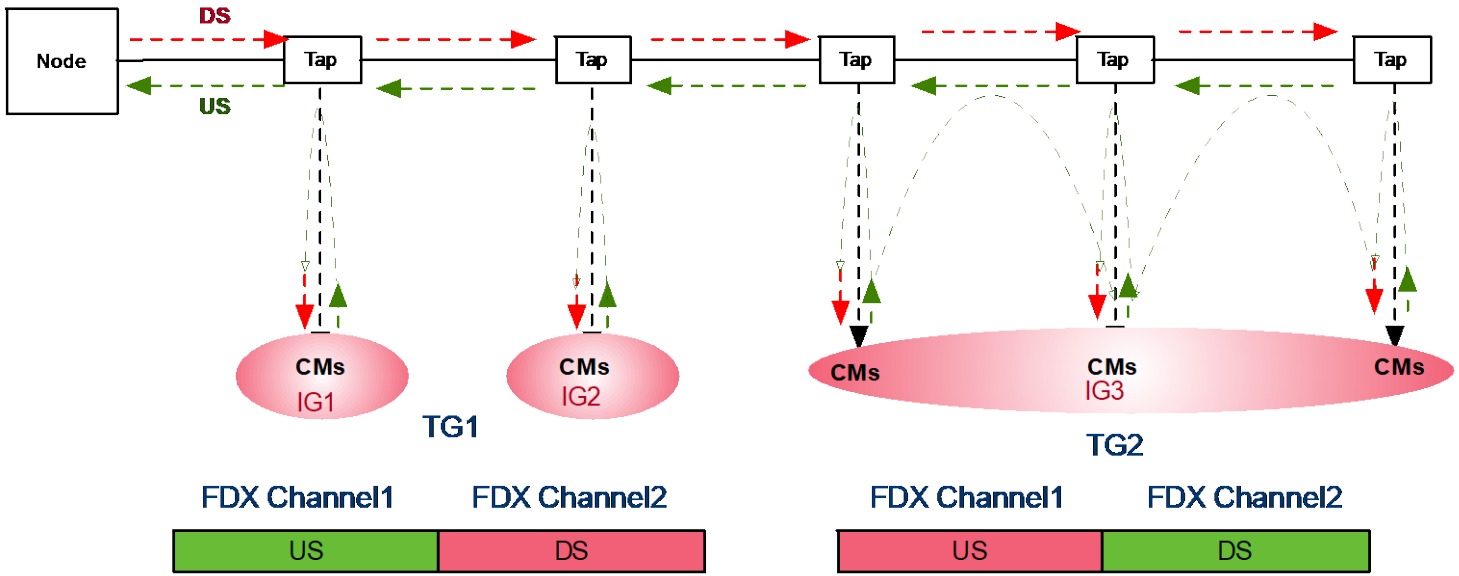


US Signal from a transmitting CM becomes interference to neighboring CMs

CM-to-CM CCI Mitigation Solution : Interference Groups



IG = Interference Group. Group of CMs that interfere with each other.
Sounding is used to measure all CM to CM interference and to sort CMs in IGs.
TG = Transmission Group. Group of IGs grouped together for scheduling

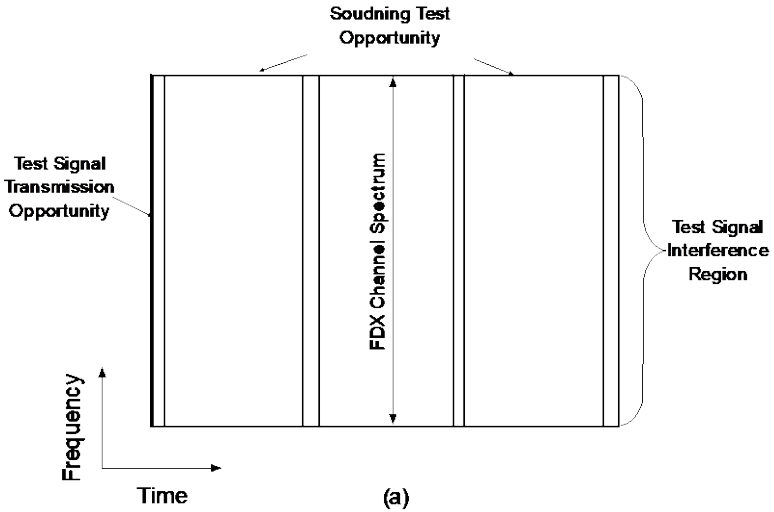
Interference Measurement Technique - Sounding

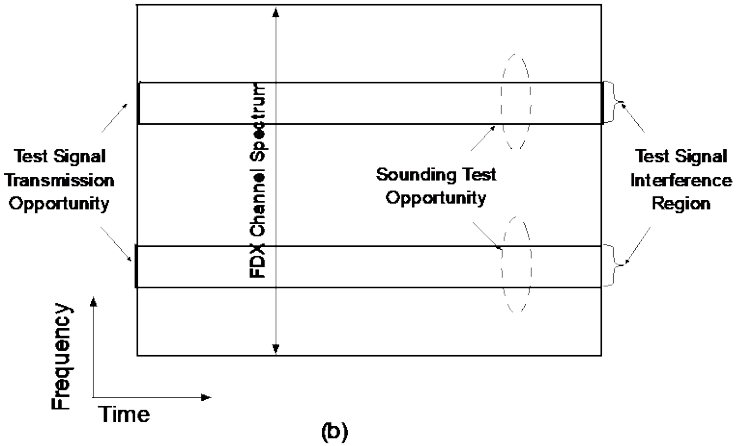
Sounding is used to pair CMs in terms of interference relationships.

During sounding, a CM transmits a test signal and other CMs listen and measure RxMERs.

Sounding can be done at multiple locations across the FDX frequency band.

Spectrum Resource Required for Sounding



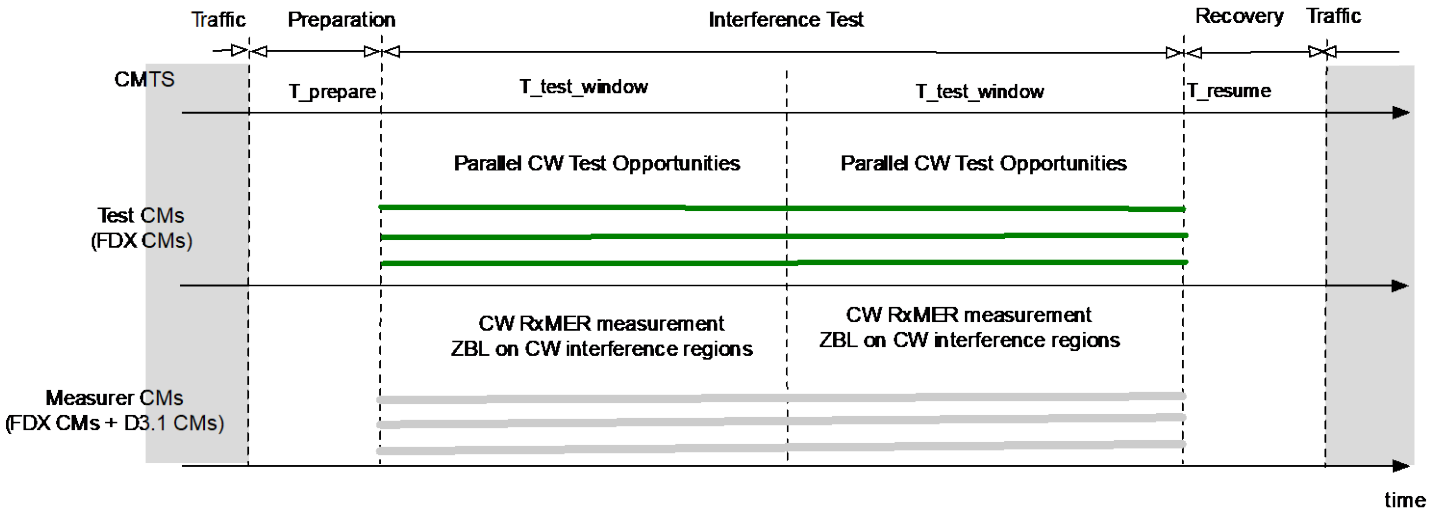


OUDP sounding:

- CM pairing: D3.1/FDX CM Tx, FDX CM Rx
- Wide in spectrum, short in time
- Sounding subcarrier percentage: 100%
- Traffic is interrupted

CW sounding:

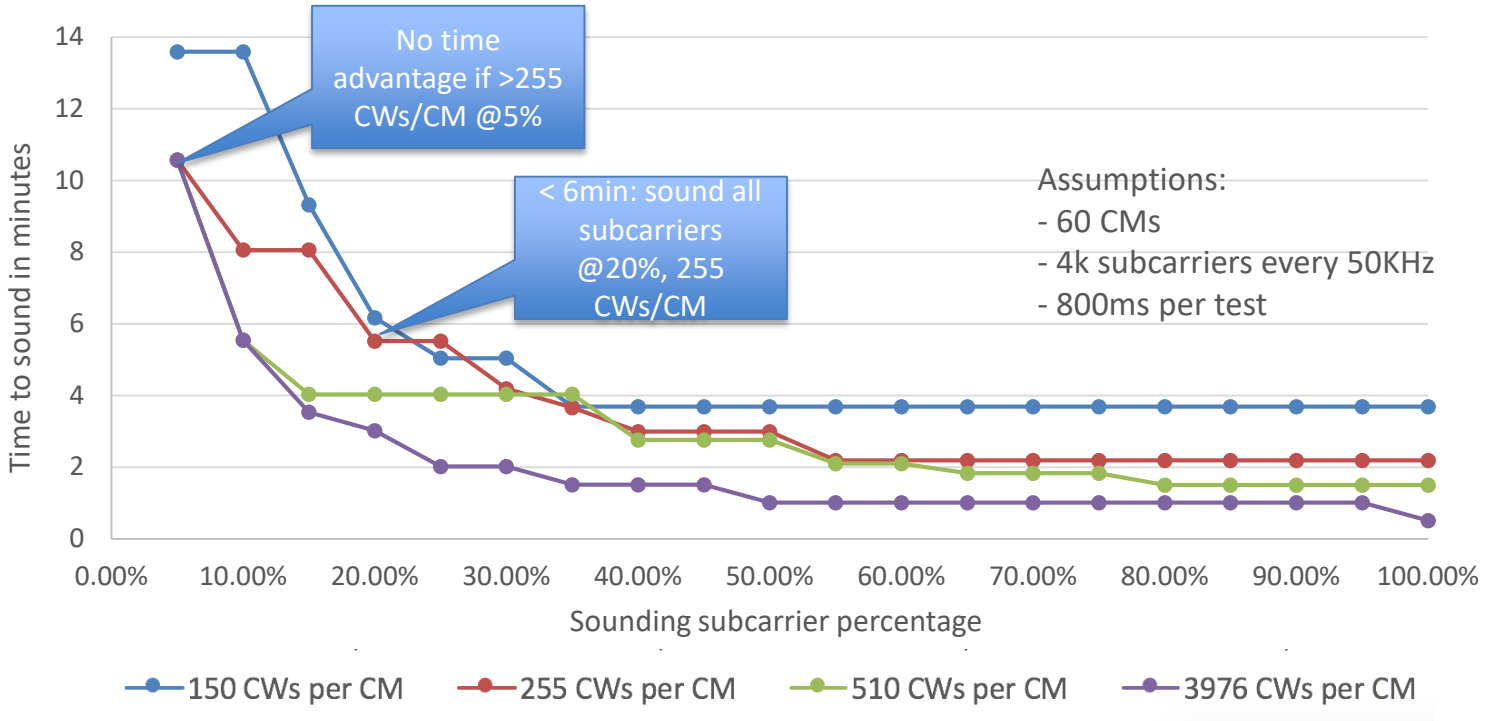
- CM pairing: FDX Tx, D3.1/ FDX CM Rx
- Narrow in spectrum, long in time
- Sounding subcarrier percentage: adjustable
- Traffic is not interrupted



$$T_{sounding\_cycle} = T_{prepare} + N * T_{test\_window} + T_{resume}$$

The less number of test windows and shorter test duration, the faster to sound

Sounding Spectrum Overhead v.s. Time to Sound



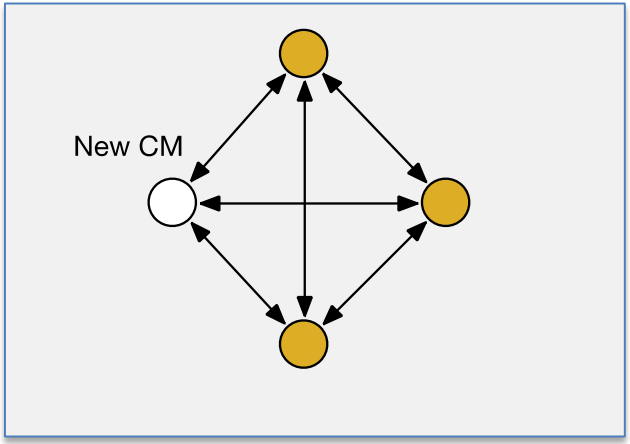
Sounding optimization objectives:

- Quick to detect
- Minimum traffic impact
- Sufficient resolution
- Adaptive to change

Time and spectrum constraints results in conflicted design considerations:

- Tx-RX CM pairing permutations
- Testing granularity in frequency
- Measurement uncertainties

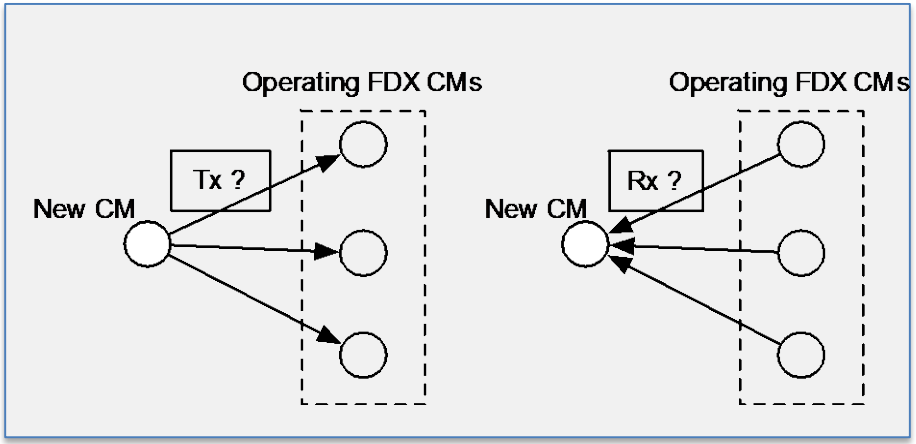
Full Mesh Sounding



Proactive but high cost

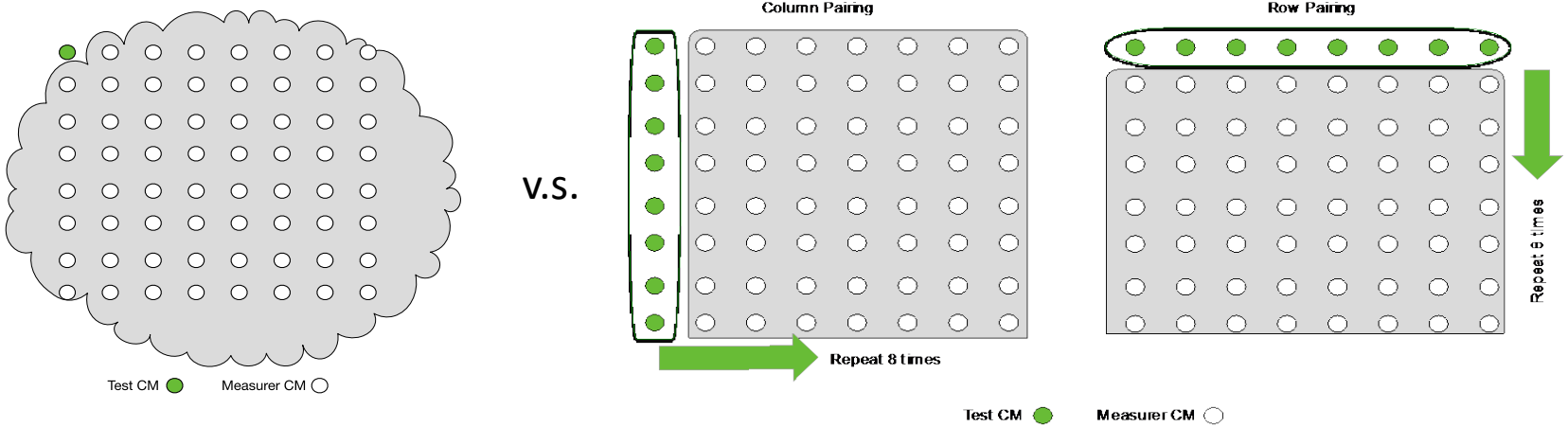
V.S.

Partial Sounding



Opportunistic but low cost

Test Opportunity Partition Options – Sequential vs. Parallel



All test opportunities allocated to one CM at a time

- Longer duration
- finer resolution

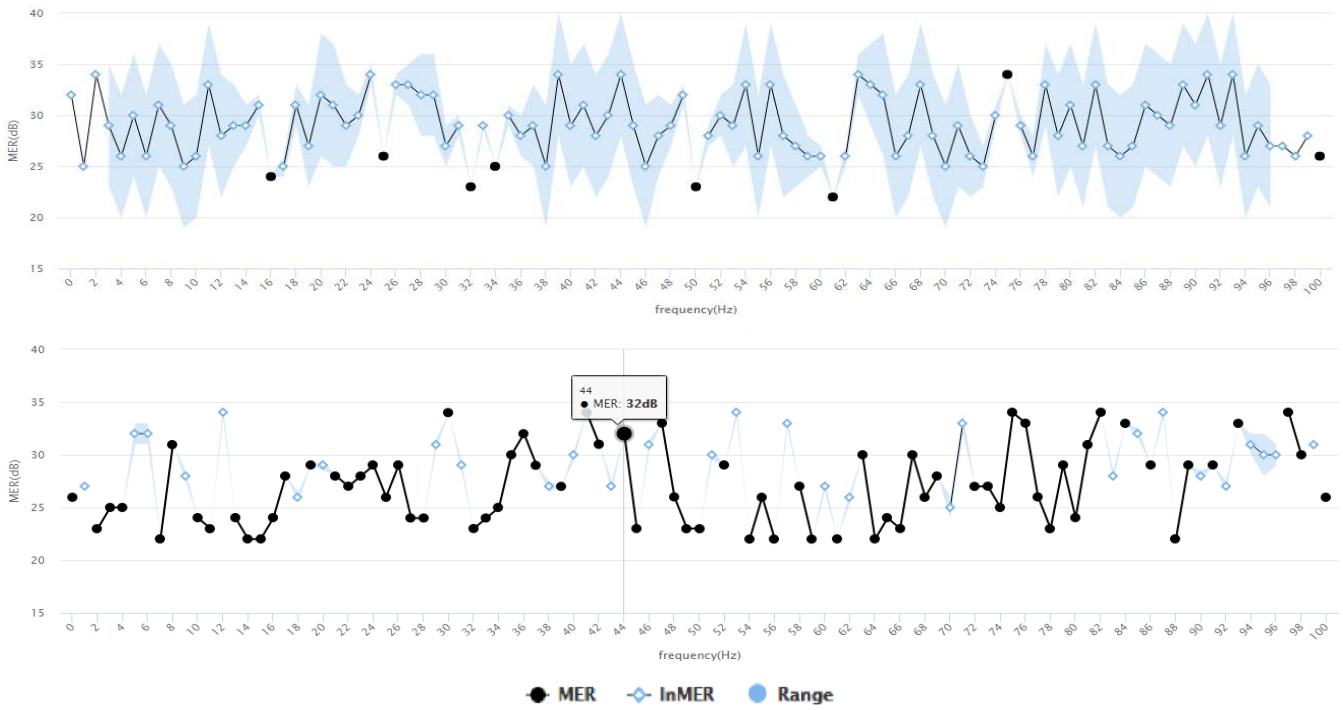
Test opportunities allocated to a group of CMs to test in parallel

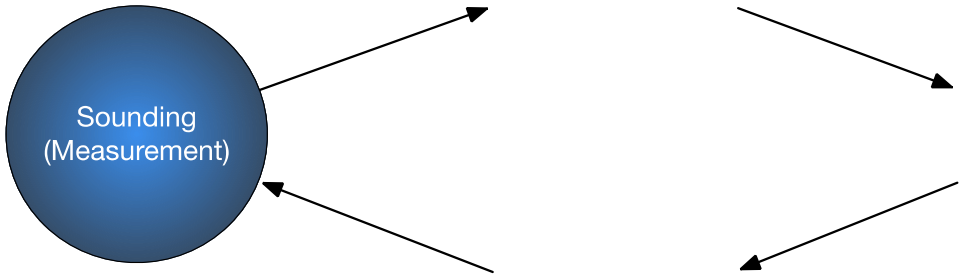
- Shorter duration
- Lesser resolution

Full Sampling v.s. Subsampling With Interpolations

Subsampling with Interpolations at given error margins

Approaching full sampling with cumulative samples





Iteration Cycle: measurement – decision – monitoring – analytics

Conclusions

1. **The operational requirements for IG Discovery results in conflicting design considerations, in terms of spectrum budgeting, time to sound and the IG accuracies**
2. **Optimization techniques exist by trading off performance impacting elements:**
    - Tx-to-Rx CM pairing
    - Frequency resolution
    - Interference detection error margins
3. **IG discovery needs to be iterative to reach to the optimum performance and to adapt to changes in the CM-to-CM interference environment**

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THANK YOU!

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