

802.16m E-MBS and MIMO Transmission

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IEEE C802.16m-08/1003, 802.16m E-MBS and MIMO Transmission

Purpose:

PHY aspects of enhanced MBS; in response to the TGM Call for Contributions and Comments 802.16m-08/033 for Session 57

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The Multicast Channel

A single transmitter wants to send a common message several (k) different receivers.

The transmitter and/or receivers may be multiantenna.

Spectral efficiency determined by worst receiver (within coverage).

Shannon capacity in AWGN:

$$C = \max_{\mathbf{\Phi}: \mathbf{\Phi} \succeq 0, \text{Tr}\{\mathbf{\Phi}\} \leq 1} \min_{\ell=1, \dots, k} E \left[\log \det \left(\mathbf{I} + \frac{\text{SNR}_\ell}{n_T} \mathbf{H}_\ell \mathbf{\Phi} \mathbf{H}_\ell^\dagger \right) \right]$$

No analytical solution, but it is a convex problem that can be solved efficiently using semidefinite programming algorithms.

For fixed n_T and $k \rightarrow \infty$, optimum $\mathbf{\Phi}$ becomes scaled identity. (Deviation from $\mathbf{\Phi}=\mathbf{I}$ to favor specific user always has negative impact on another one.)

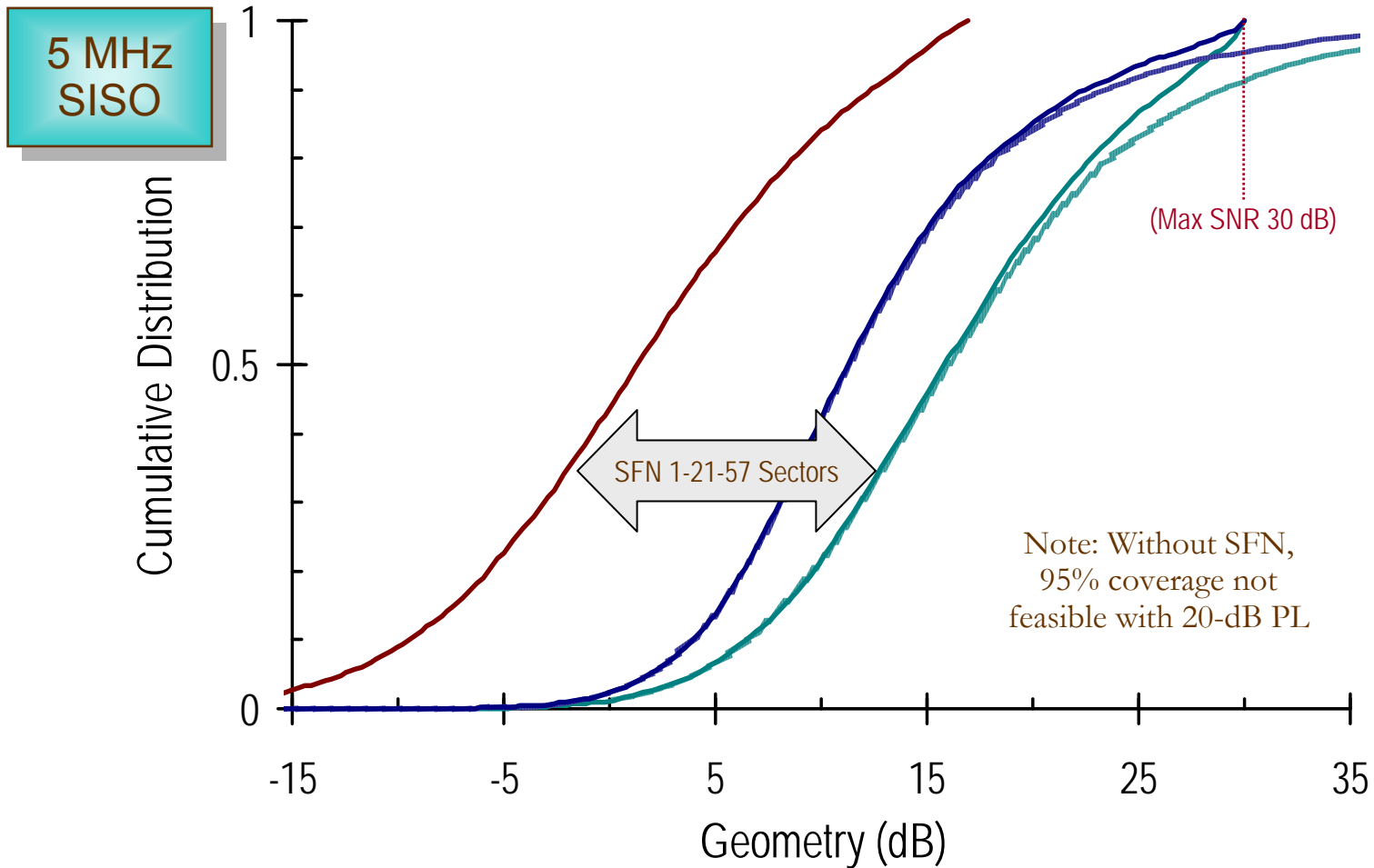
SFN Operation

- Synchronous simulcasting from all sectors. All signals arriving within the CP are combined by the OFDM receiver.
 - CP of 16.67 μ sec used for E-MBS. (This may need to be increased further)
 - Between 1 and 57 sectors soft-combined depending on synch tightness. Relative delays enhance frequency diversity.
 - Common pilot in every sector allows for composite channel estimation at receiver.

Requirements

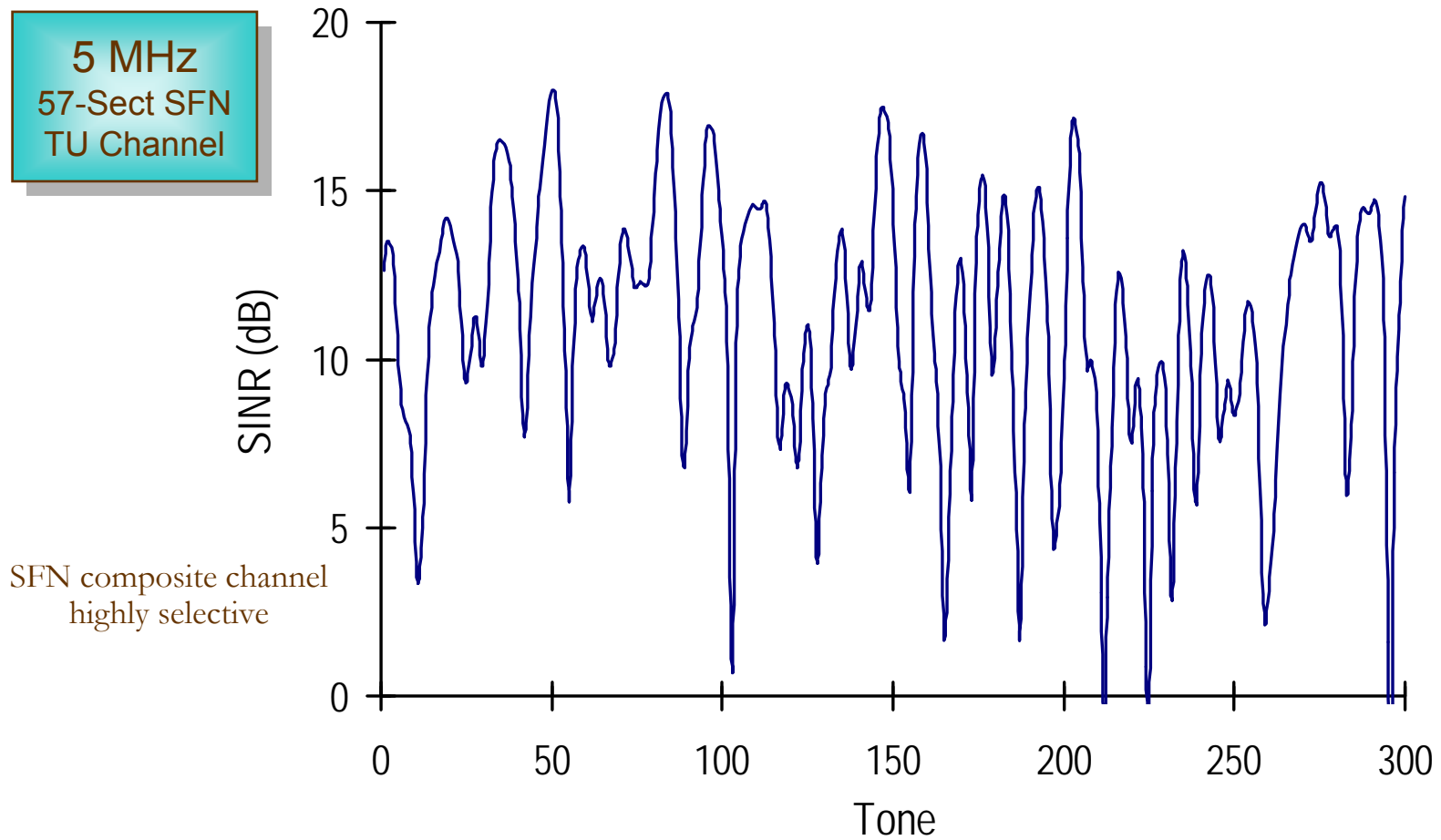
- Performance requirement: 1% average FER.
- Coverage target: 95% of locations.
- Desire for spectral efficiency to exceed 1 bit/s/Hz. Higher efficiencies will translate onto lower duty cycle and, in turn, less impact on unicast capacity and less power consumption at handhelds.
- 20 dB penetration losses per user mandated on all simulations. (60%-70% of usage takes place indoors.)

Geometries



Frequency Selectivity

5 MHz
57-Sect SFN
TU Channel



MIMO for E-MBS

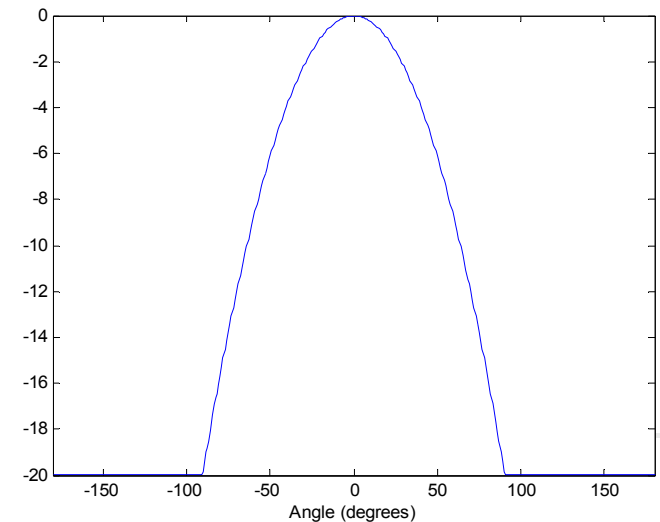
E-MBS baseline is 1×2 SIMO.

2×2 MIMO studied to increase spectral efficiency.

No significant gains from transmit diversity due to ample system diversity. Focus on spatial multiplexing with multi-codeword transmission (to enable SFN operation even if not all the bases are MIMO-equipped).

System Simulation Parameters (1/2)

Layout	19 cells, 3 sectors per cell
Minimum distance UE - BS	35 m
BS-to-BS distance	1.73 Km
Antenna pattern	70° sectored beam (14 dBi gain)
BS power per sector	20 W
Distance-dependant path loss	$128.1 + 37.6 \log_{10}(d)$
Shadowing standard deviation	8 dB
Shadowing correlation between BSs	50%
Penetration Losses	20 dB
RX noise figure	9 dB
SFN combining	57 sectors



System Simulation Parameters (2/2)

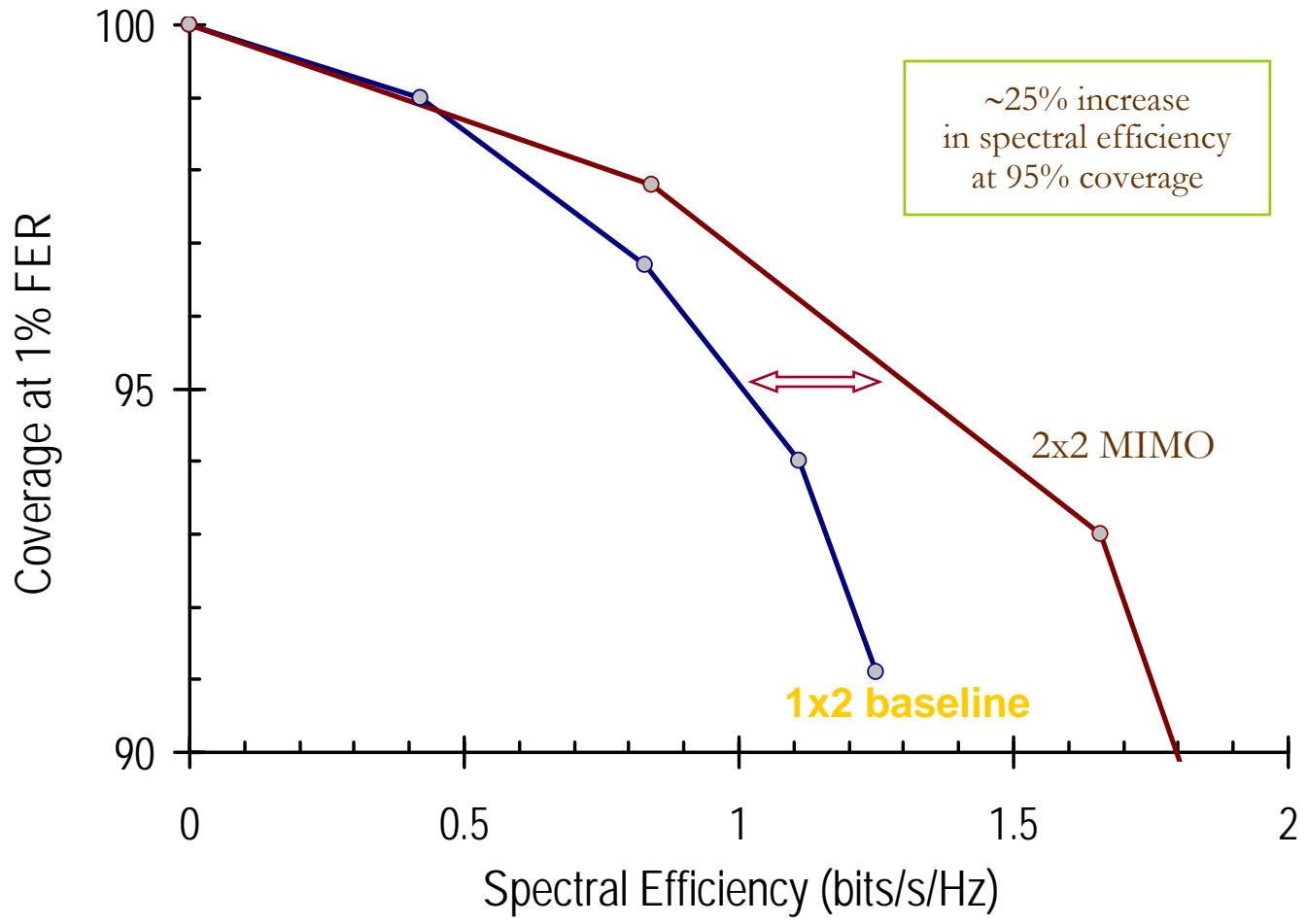
Bandwidth	5 MHz
Tone spacing	15 kHz
Number of tones	300
Channel model	Typical urban, 3 Km/h
Target FER	1% (inner turbo code, no outer code)
TX antennas	1,2
RX antennas	2
Spatial correlation	None
RX channel estimation	Perfect
Receiver	MMSE-SIC
Link-to-system mapping	MIESM
Pilot overhead	16.7%

MCS	Spectral efficiency (excluding pilot overhead)
QPSK ¼	0.42 bits/s/Hz
QPSK ½	0.83 bits/s/Hz
QPSK 2/3	1.11 bits/s/Hz
QPSK ¾	1.25 bits/s/Hz
16-QAM ½	1.66 bits/s/Hz
16-QAM ¾	2.5 bits/s/Hz

MIESM:

$$\text{SNR}_{\text{eff}} = \beta \mathcal{I}^{-1} \left(\frac{1}{m} \sum_{\ell=1}^m \mathcal{I} \left(\frac{\text{SNR}_{\ell}}{\beta} \right) \right)$$

System Simulation Results



Observations

20%-25% increase in spectral efficiency at target coverage with 57-sector SFN.

More substantial improvements if a per-antenna power constrain is applied, rather than a joint power constraint. (In that case MIMO uses more power than SISO/SIMO.)