802.16m E-MBS and MIMO Transmission

IEEE 802.16 Presentation Submission Template (Rev. 9)

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Venue:

Session 57, Osaka, Japan

Base Contribution:

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

Notice:

Release:

Patent Policy:

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:

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

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.)

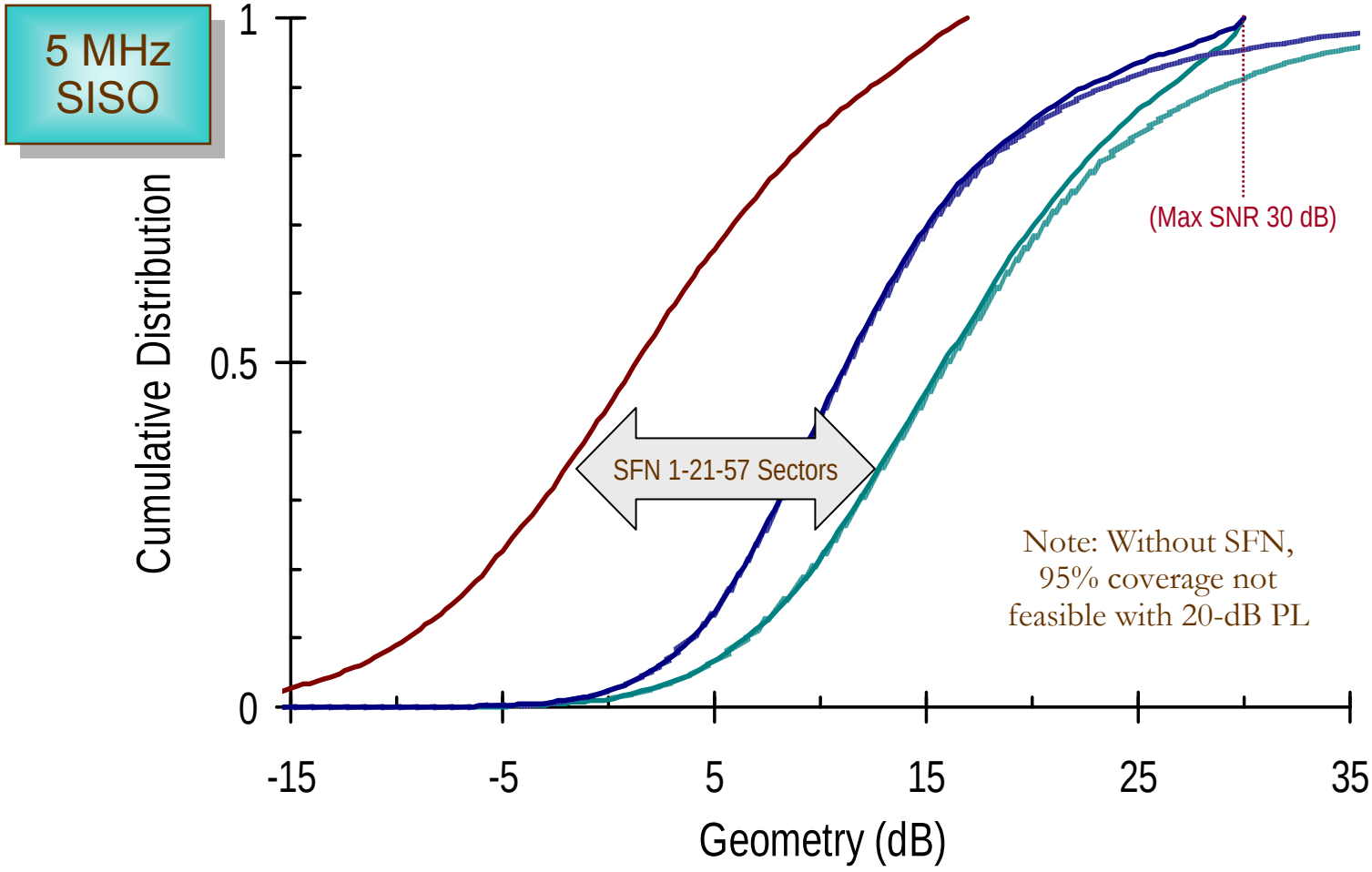
SFN Operation

- Synchronous simulcasting from all sectors. All signals arriving within the CP are combined by the OFDM receiver.
  - CP of 16.67 μsec 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

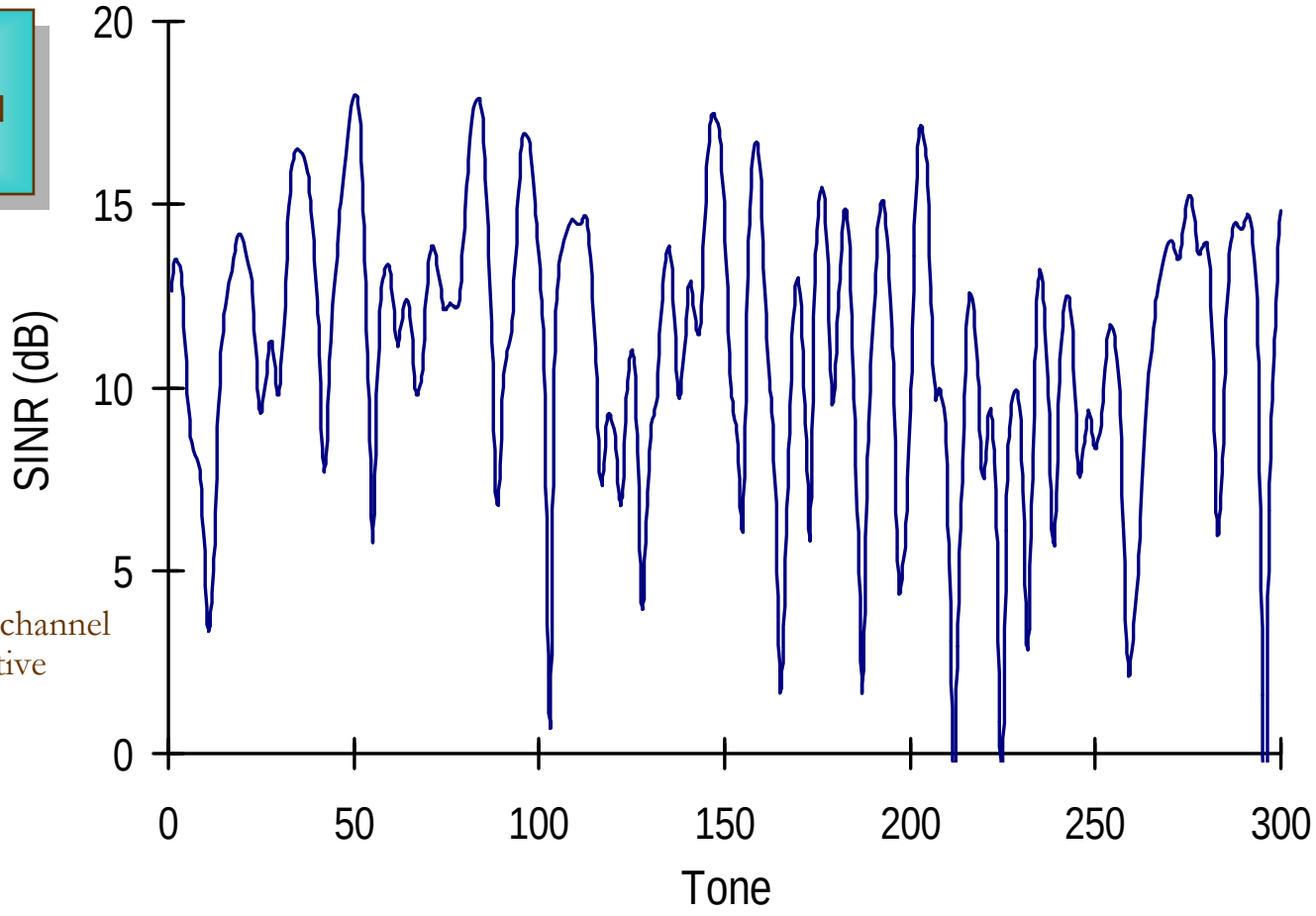
- Performance requirement: 1% average FER.
- Coverage target: 95% of locations.
- Desire for spectral efficiency to exceed 1 bit/s/Hz. Higher efficiencies will translate onto lower duty cycle and, in turn, less impact on unicast capacity and less power consumption at handhelds.
- 20 dB penetration losses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

Geometries


5 MHz SISO
Cumulative Distribution
1
0.5
0
-15
-5
5
15
25
35
Geometry (dB)
SFN 1-21-57 Sectors
(Max SNR 30 dB)
Note: Without SFN, 95% coverage not feasible with 20-dB PL

Frequency Selectivity

5 MHz
57-Sect SFN
TU Channel



SFN composite channel
highly selective

MIMO for E-MBS

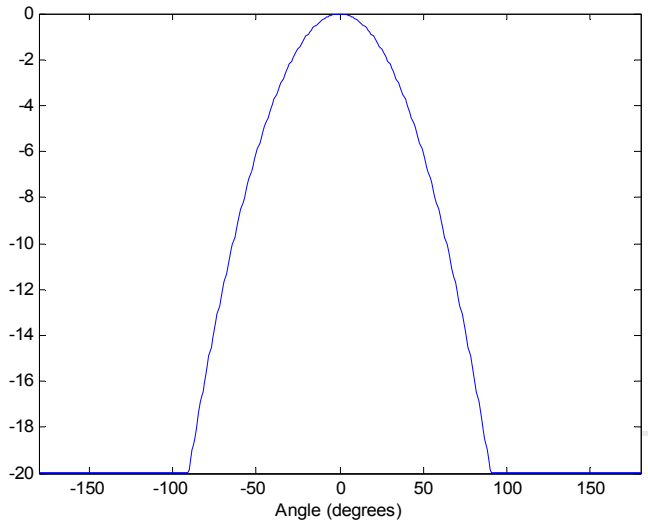
E-MBS baseline is 1×2 SIMO.

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)

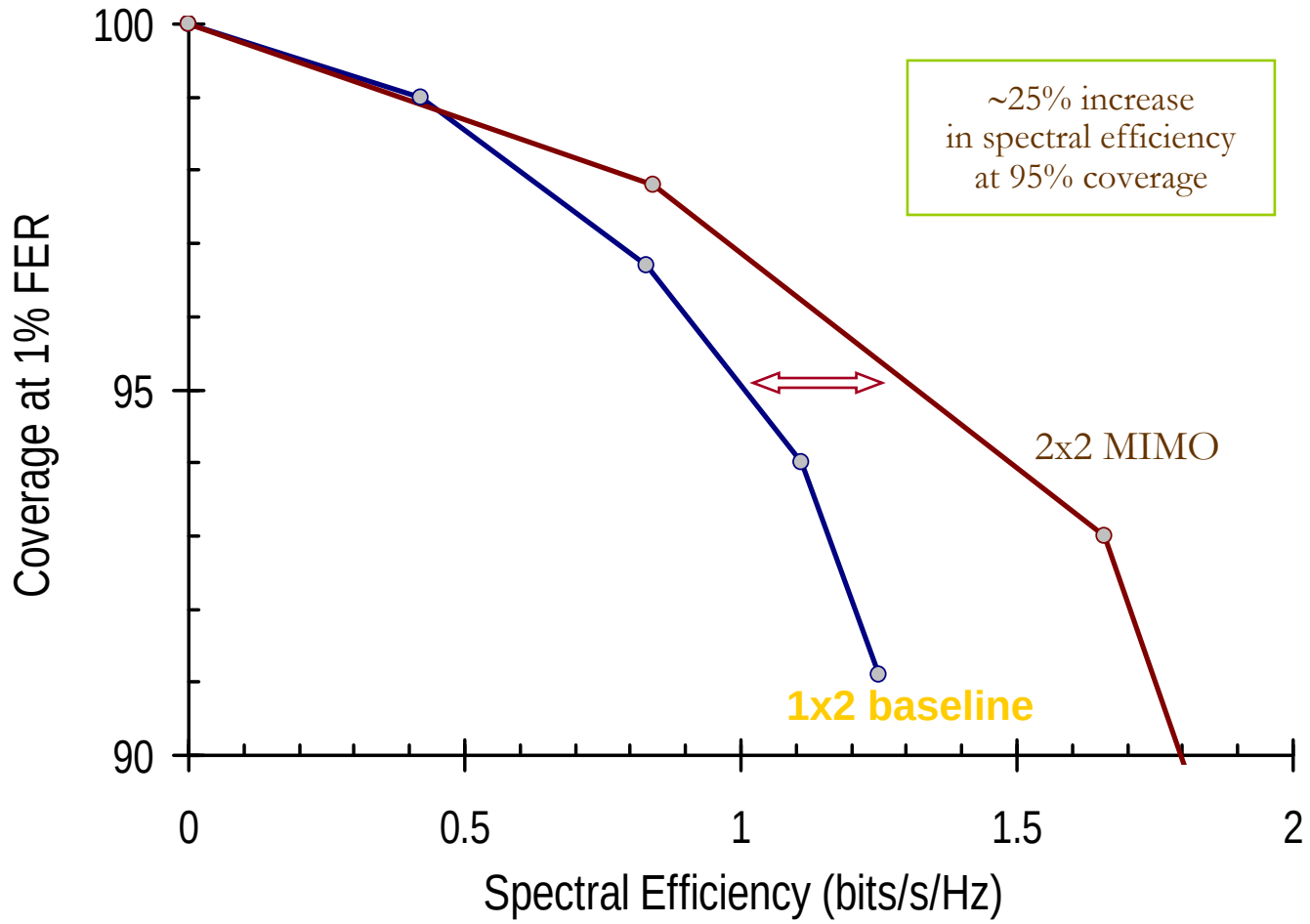
Bandwidth	5 MHz
Tone spacing	15 kHz
Number of tones	300
Channel model	Typical urban, 3 Km/h
Target FER	1% (inner turbo code, no outer code)
TX antennas	1,2
RX antennas	2
Spatial correlation	None
RX channel estimation	Perfect
Receiver	MMSE-SIC
Link-to-system mapping	MIESM
Pilot overhead	16.7%

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:

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

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.)