Enabling the Fixed Relay and Mesh Capabilities to Enhance IEEE802.16e

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Purpose:

    To present the benefit of Fixed Relay and Mesh to enhancement IEEE802.16e performance.

Background

- Building on the success of the 802.16e technology, we propose to introduce two networking modes
  - Fixed relaying station and inter-BS meshing capabilities
- FRS allows low cost solution to increase the wide area high speed data rate coverage
  - Improve coverage, capacity and MS battery life
- Inter-BS meshing enables advanced backhaul solution to meet the challenges of
  - NLOS requirement
  - Reliability and resilient
  - Capacity scaling and low cost deployment

New Networking Modes and Topologies
(Fixed Relay Station)

BM

Node-B

BR **RM**

Relay cache

Down Link

MB

Node-B

RB **MR**

Relay cache
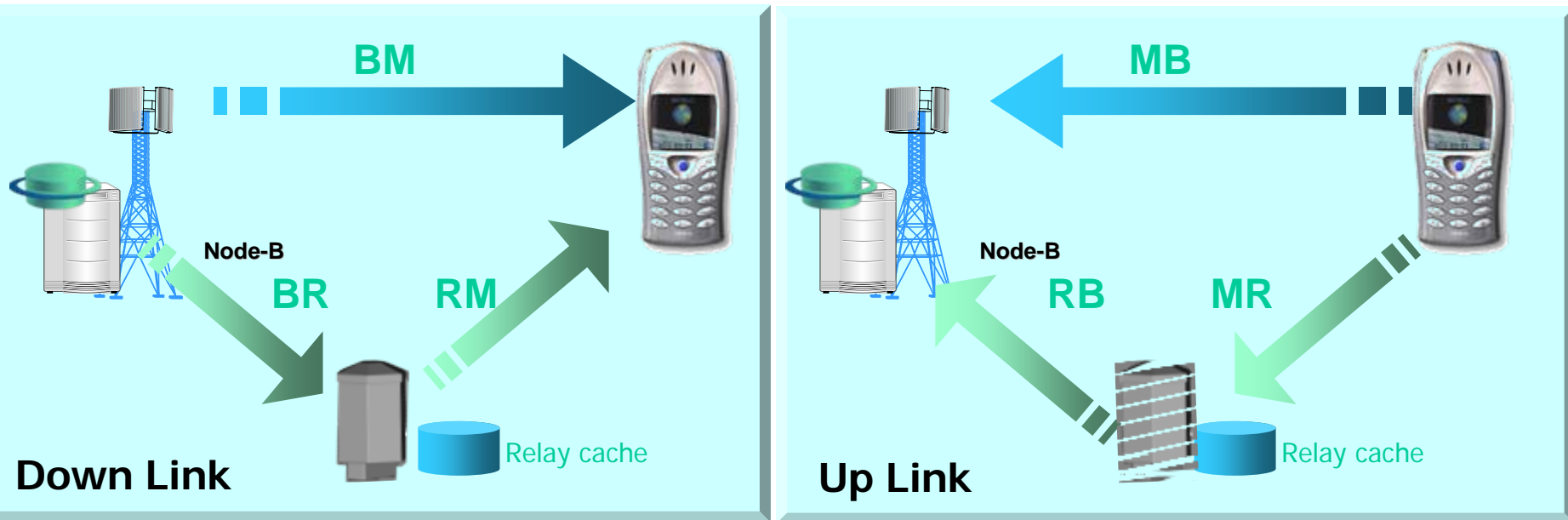
Up Link

- **Down link direction**
  - BS to MS (BM)
  - BS to FRS (BR)
  - FRS to MS (RM)

- **Up link direction**
  - MS to BS (MB)
  - MS to FRS (MR)
  - FRS to BS (RB)

Goal should be for maximum reuse of mechanics and building blocks in the existing 802.16e to enable new link modes in both UL and DL

New Networking Modes and Topologies
(Inter-BS Meshing)

Requirement

- **NOLS mesh technology for packet backhaul**
- **Very low latency requirement**
- **Resilient and self heal requirement**

To/From Metro/BSC
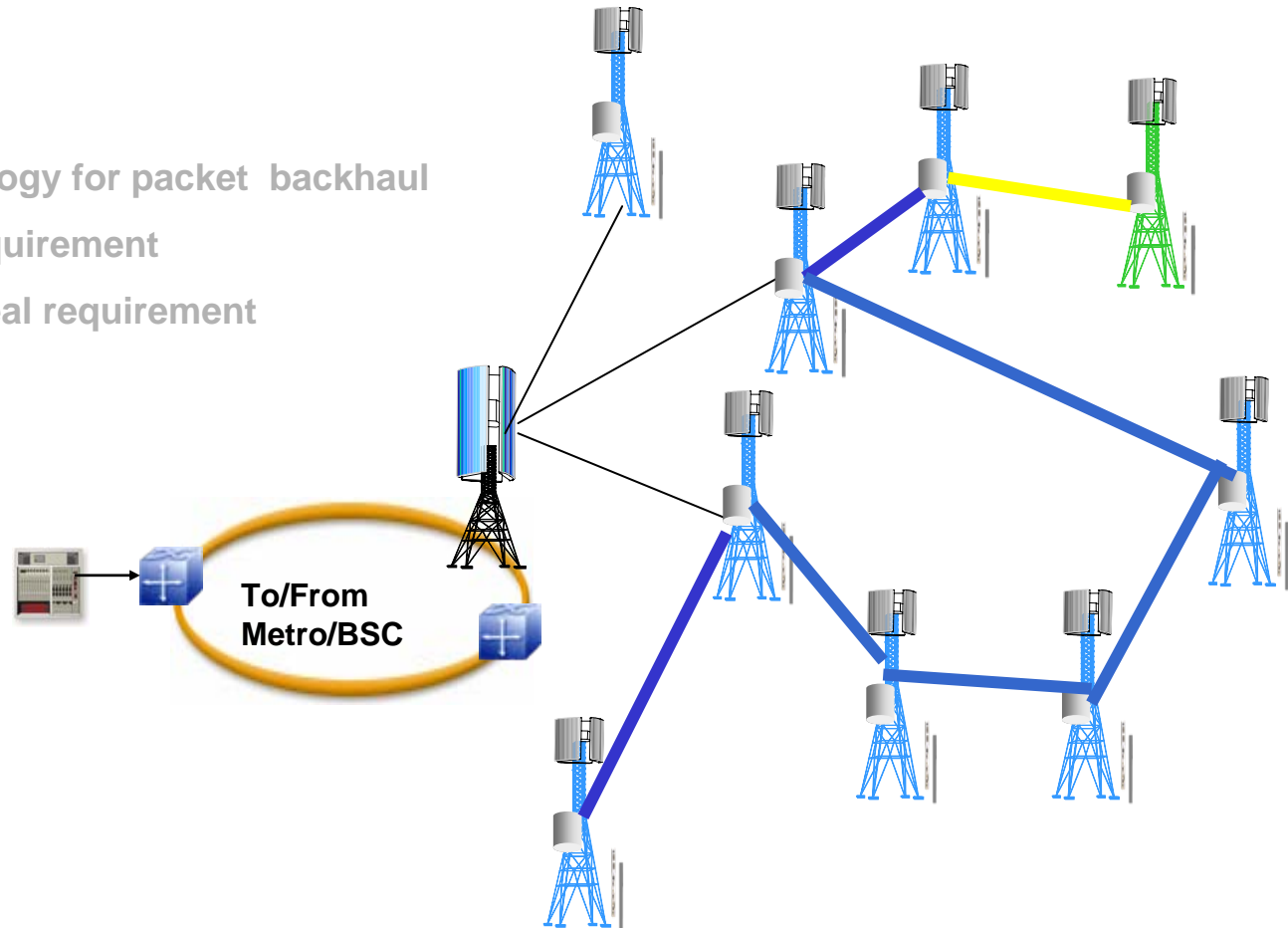
Load Balancing
Layer 2 switching (not routing)
Requires neighbor discovery and neighbor list at each node
Auto-configuring for initial setup and for slow traffic variations

SDMA (3-beam/sector)

SDMA with SHO (802.16e)

SDMA with FR

C/I CDF

2-way SHO

Relay with d1 = 214

Relay with d2 = 50
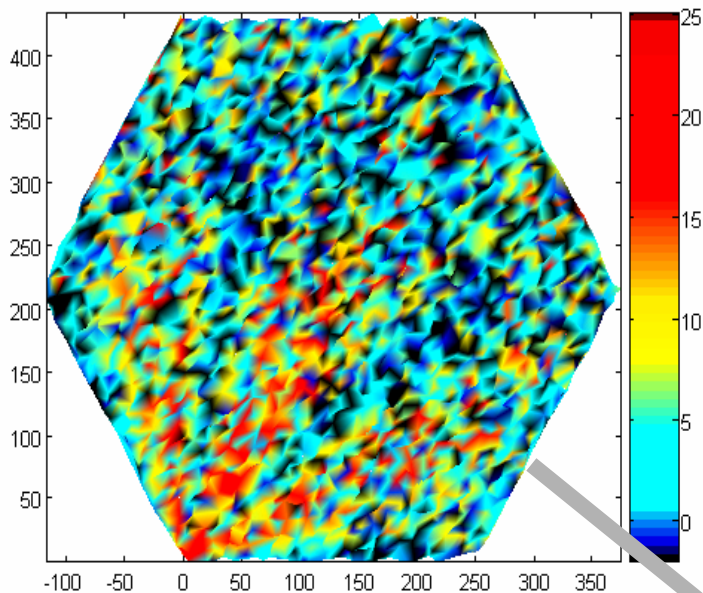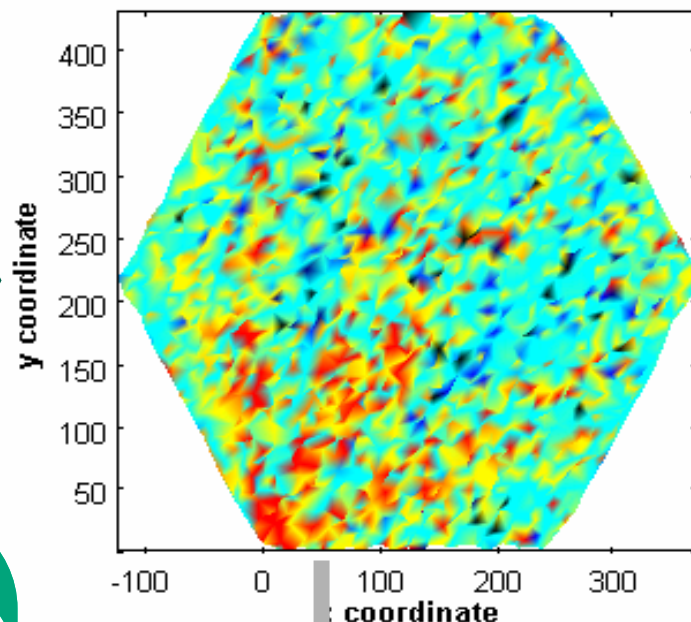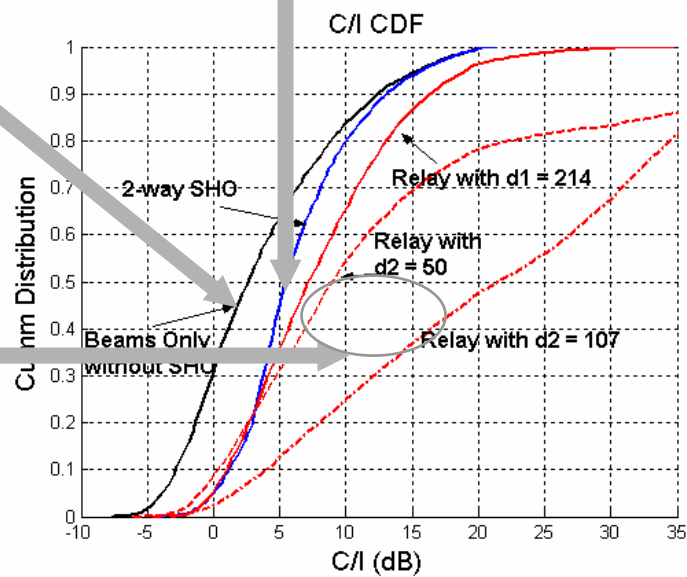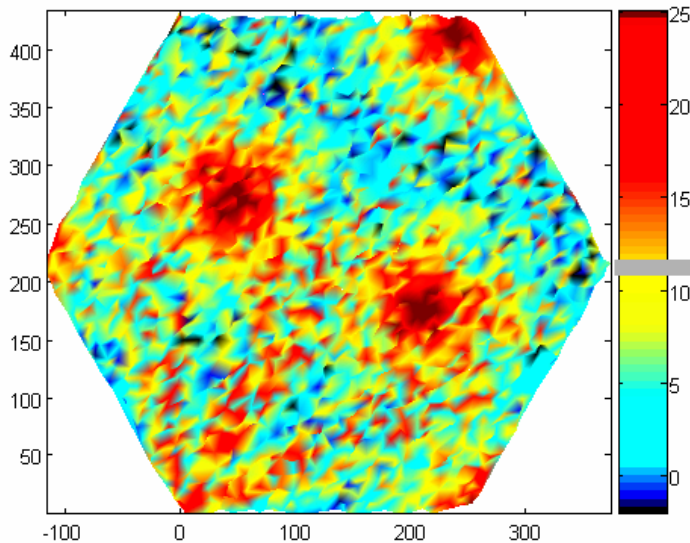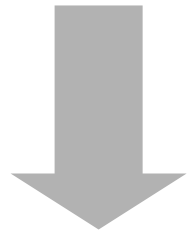
Beams Only without SHO

Relay with d2 = 107

y coordinate

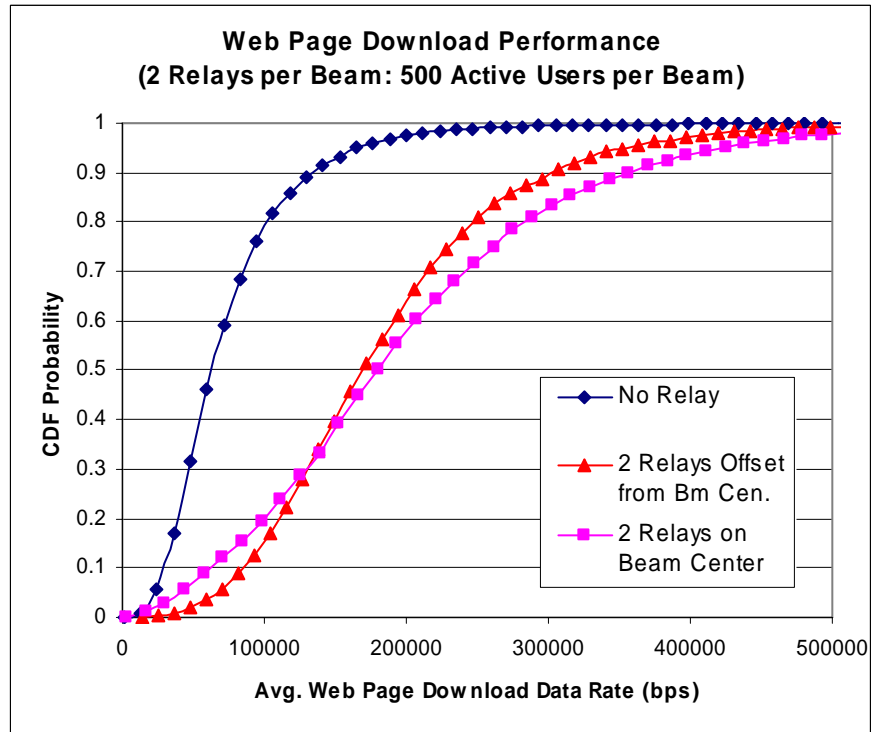x coordinate

Cumm Distribution

C/I (dB)

Macro-Cell with FRS Network RF Modeling

- Beam Tx power is 15 watts. Fixed relay Tx power is 3 watts
- Beam Tx EIRP is 60.5 dBm. (FCC EIRP limit 62.0 dBm minus 1.5 dB margin)
  Tx power + antenna gain = 41.76 dBm + 18.77 dB = 60.53 dBm
- Base Height = 34 meters; Relay Height = 12.5 meters
- Path loss and shadowing
    - Base to MS (SCM macro path loss)
    - Base to FRS (802.16 Type C)
    - FRS to MS (SCM micro path loss model)
- Nomadic Rician Fading (K factor = 10 dB for all three links
  BS to MS, BS to FRS and FRS to MS)
- 1 X 1 Antenna
- In-band OFDM/TDM relay mode
- Intra-cell & Inter-cell interference (globally synchronous timing)
    - BS to MS time slot : Interference at UE only from BSs
    - BS to FRS time slot : Interference at FRS only from BSs
    - FRS to MS time slot : Interference at MS only from FRS
- Channel quality C/I measurement and reporting
- Adaptive modulation and coding (AMC)

Performance Benefits

Web Page Download Performance (Data Routing: 500 Active Users per Beam) — CDF Probability vs. Avg. Web Page Download Data Rate (bps). Series: No Relay, Static Route, Dynamic Route.

Web Page Download Performance (2 Relays per Beam: 500 Active Users per Beam) — CDF Probability vs. Avg. Web Page Download Data Rate (bps). Series: No Relay, 2 Relays Offset from Bm Cen., 2 Relays on Beam Center.
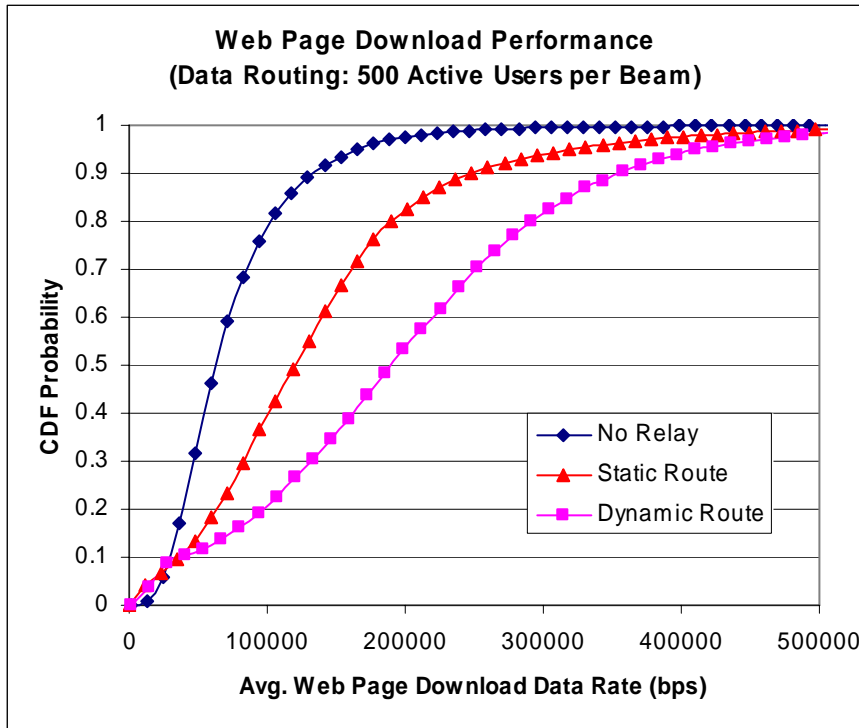
Fixed Relay and Mesh technologies for 802.16e provides significant enhancement for the 802.16e system
FSR improves the high speed data rate coverage
FSR increases the user throughput and experience
FSR is a lower CAPX/OPEX solution

Backup

Macro-Cell with FRS Network System Modeling

- Full queue traffic
- TCP/IP data traffic models with TCP/IP
- Timer based MAC state transitioning
- Routing (BS to MS, or BS to FRS to MS)
  - Dynamic
  - Static
- Proportional Fairness Scheduling centralized at BS (FIFO at relay)
- 19 macro cells (1Km cell to cell separation)
- Macro cell SDM beam pattern (3 beams per sector)
- Serving beam: Center beam of a sector in center cell
- Relay locations (0.5 cell radius from BS unless specified)
- Relay antenna pattern
  - FRS to BS
  - FRS to MS