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Overview

• There is no one-to-one mapping between usage models, RS types, and deployment strategies
• Different types of RSs can be used to implement any usage model
• We define separately:
  – RS Types
    • Based on complexity/cost of implementation and deployment
  – Usage Models
    • Based on usage in the network
  – Deployment Strategies
    • Based on ways to plan cell site locations
RS Types

• **Simple RS**
  – Low cost RS
  – One transceiver
  – No control functionality, but:
    • Transmits preamble
    • Relays broadcast and control messages
  – Antenna switch to optionally support multiple antennas

• **Full Function Fixed/Portable RS**
  – operates on multiple OFDMA channels
  – optionally supports MIMO
  – implements distributed control functions

• **Mobile RS** – Full function RS with mobility
Usage Models

• **Enhanced Data Rate Coverage**
  – Provide higher SINR to MSs in low SINR areas of cell
  – Provide higher SINR to MSs in “coverage holes”

• **Range Extension**
  – Provide coverage to users outside edge of the cell

• **Capacity Enhancement**
  – Increase system capacity by enabling more aggressive frequency reuse
Enhanced Data Rate Coverage Topology

- Higher SINR at cell edge
- Good SINR in coverage hole
Enhanced Data Rate Coverage Model

• Frequency Usage
  – Capacity not an issue, thus aggressive frequency reuse not required
  – If interference not an issue
    • Channel can be shared among access and MMR links
    • Separate channels can be used for access and MMR links
  – If interference is an issue
    • Separate channels for MMR and access links
    • TDM partitioning and coordination to reduce

• Implementation by Simple RS
  – One channel for both access and MMR links
  – TDM partitioning of transmit opportunities if interference is a problem

• Implementation by Full Function RS
  – Can use one channel for both access and MMR links
  – Can use different channels as well
Range Extension Topology

MMR-BS

RS

RS

Range Extension
Capacity Enhancement Topology Example 1

Hexagon represents area within which MMR-BS or RS provides coverage to MSs.

MMR-BS and RSs can communicate even though RSs are outside the area in which MMR-BS provides coverage to MSs.

Colors indicate access link frequencies (1x1x3 reuse).
Capacity Enhancement Model

• Frequency Usage
  – Aggressive frequency reuse assumed
  – Actual distribution of channels across MMR and access links depends on topology, coordination capabilities, etc.

• Implementation by Simple RS
  – One channel for both access and MMR links
  – Each RS on separate channel, reuse pattern to increase capacity
  – Small MMR cell to enable centralized control

• Implementation by Full Function RS
  – Multi-channel support (i.e. access and MMR links can reside on different channels) provides maximum flexibility in frequency planning
  – Distributed control
Deployment Strategies

• LOS deployment strategy
  – RS locations and antenna placement are carefully planned in order to achieve LOS links between MMR-BS and RSs and between RSs.

• NLOS deployment strategy
  – RS locations and antenna placement are not constrained by the need to achieve LOS links between MMR-BS and RSs.
  – Techniques such as MIMO are used to provide sufficient capacity or link budget enhancement on MMR links

• Mobile RS deployment strategy
Backup
## Major RS Capabilities

<table>
<thead>
<tr>
<th></th>
<th>Simple RS</th>
<th>Full Function Fixed/Nomadic RS</th>
<th>Mobile RS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of OFDMA channels</strong></td>
<td>1</td>
<td>&gt;1</td>
<td>&gt;1</td>
</tr>
<tr>
<td><strong>Duplexing on MMR and access links</strong></td>
<td>TDD</td>
<td>TDD or FDD</td>
<td>TDD or FDD</td>
</tr>
<tr>
<td><strong>Frequency sharing between access and MMR links</strong></td>
<td>Yes</td>
<td>Yes or No</td>
<td>Yes or No</td>
</tr>
<tr>
<td><strong>Control Functions</strong></td>
<td>Centralized in MMR-BS</td>
<td>Centralized in MMR-BS or distributed in RSs</td>
<td>Centralized in MMR-BS or distributed in RSs</td>
</tr>
<tr>
<td><strong>Mobility</strong></td>
<td>Fixed/Nomadic</td>
<td>Fixed/Nomadic</td>
<td>Mobile</td>
</tr>
<tr>
<td><strong>Antenna support</strong></td>
<td>SISO</td>
<td>MIMO</td>
<td>MIMO</td>
</tr>
</tbody>
</table>
Range Extension Model

- Frequency Usage
  - Similar to Enhanced Data rate Coverage Model

- Implementation by Simple RS
  - Similar to Enhanced Data rate Coverage Model

- Implementation by Full Function RS
  - Similar to Enhanced Data rate Coverage Model
Capacity Enhancement Example Topology 2
## Usage Model Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Enhanced Data Rate Coverage Model</th>
<th>Range Extension Model</th>
<th>Capacity Enhancement Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RS Location</strong></td>
<td>Outer donut in MMR-BS cell; coverage holes within MMR-BS cell</td>
<td>Usage clusters outside the perimeter of the MMR-BS cell</td>
<td>Environment Dependant. High capacity demand locations within the MMR-BS cell</td>
</tr>
<tr>
<td><strong>MMR Link Capacity</strong></td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td><strong>Frequency Reuse in MMR Cell</strong></td>
<td>Not required but possible</td>
<td>Not required but possible</td>
<td>Required</td>
</tr>
</tbody>
</table>
## Deployment Strategy Characteristics

<table>
<thead>
<tr>
<th></th>
<th>LOS Strategy</th>
<th>NLOS Strategy</th>
<th>Mobile RS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Expected Channel Conditions</strong></td>
<td>LOS, Ricean</td>
<td>NLOS</td>
<td>Varies</td>
</tr>
<tr>
<td><strong>RS Deployment</strong></td>
<td>Carefully planned</td>
<td>Convenient location near traffic demand</td>
<td>Random</td>
</tr>
<tr>
<td><strong>RS Antenna Location</strong></td>
<td>Tower, building</td>
<td>Tower, building, light post, other</td>
<td>Bus, train</td>
</tr>
<tr>
<td><strong>RS Mobility</strong></td>
<td>Fixed, carefully placed portable</td>
<td>Fixed, portable</td>
<td>Mobile</td>
</tr>
<tr>
<td><strong>MMR-BS Deployment</strong></td>
<td>Carefully planned</td>
<td>Carefully planned</td>
<td>Carefully planned</td>
</tr>
<tr>
<td><strong>MMR-BS Antenna Location</strong></td>
<td>tower</td>
<td>tower</td>
<td>tower</td>
</tr>
</tbody>
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