Mobile Multi-hop Relay Networking in IEEE 802.16

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None

Purpose:
Proposal of a new study group for mobile multi-hop relay networking in IEEE 802.16 systems

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Outline

• Scope of Proposed Relay Project
• Purpose
• Network Topology in IEEE802.16
• Classification
  - Mesh vs. Relay
  - Fixed / Nomadic / Mobile RS
• Concept of Proposed Relay mode
• Schedule
• Summary
Scope of Proposed Relay Project

- Develop Proposed Relay mode for fixed / mobile terminal
  - PHY: Enhance normal frame structure
  - MAC: Add new protocols for the Relay networking
Purpose

- **Coverage extension**
  - Expansion for coverage area

- **Throughput enhancement**
  - Higher throughput over multi-hop paths

![Diagram](image)
Network Topology in IEEE802.16
- PMP and Mesh mode -

• PMP mode
  - Mandatory topology in 802.16-2004 and 16e
  
  - “traffic only occurs between BS and SS“

• Mesh mode
  - Optional topology in 802.16-2004 (OFDM PHY only)
  
  - “traffic can be routed through other SSs and can occur directly between SSs“
### Network Control Configuration of Mesh mode in 802.16-2004

<table>
<thead>
<tr>
<th>Mesh scheduling</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distributed</td>
<td>Coordinated</td>
</tr>
<tr>
<td></td>
<td>Un-coordinated</td>
</tr>
</tbody>
</table>
| Centralized     |                     | • Mesh BS  
|                  |                     |  Determination of flow assignments by \textit{resource requests} from SSs  
|                  |                     | • SS  
|                  |                     |  Determination of \textit{actual schedule} from Mesh BS’s flow assignments |
### Classification – Mesh vs. Relay –

<table>
<thead>
<tr>
<th>Infra-structure</th>
<th>Mesh</th>
<th>Relay</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Mesh Structure" /></td>
<td><img src="image2.png" alt="Mesh Mode" /></td>
<td><img src="image3.png" alt="Relay Structure" /></td>
</tr>
</tbody>
</table>

**Client**

![Client Structure](image4.png)

- Mesh mode in 802.16-2004 may be classified into this category.

- “Infrastructure” means that an operator provides dedicated equipment that has Mesh or Relay function.
- “Client” means that a user terminal has Mesh or Relay function.
# Classification – Mesh vs. Relay – (cont’d)

<table>
<thead>
<tr>
<th></th>
<th>Mesh</th>
<th>Relay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Infrastructure</td>
<td>Client</td>
</tr>
<tr>
<td>Network topology</td>
<td>Multi-connection to other nodes</td>
<td>Tree</td>
</tr>
</tbody>
</table>
| Purpose          | Inter-BS communication for backhaul | Inter-SS/MS communication (such as ad-hoc mode) | • Coverage extension  
|                  | All of BS/RS               | All of SS/MS                                    | • Throughput enhancement  
| Who is the repeater? | All of BS/RS           | All of SS/MS                                    | Fixed RS or Nomadic RS  
|                  | Fixed RS or Nomadic RS    | • Nomadic RS  
|                  | • SS/MS that has relay function |
| Licensed band?   | Business use: Licensed band   | Other one: Unlicensed band                      |
### Classification – Fixed / Nomadic / Mobile RS –

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Relay Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure</td>
<td>Fixed RS</td>
</tr>
<tr>
<td>Coverage extension for non-service area</td>
<td>Temporal / portable installation</td>
</tr>
<tr>
<td>Coverage extension by SS that has relay function</td>
<td>• Allow user to enable/ disable relay function • Coverage extension for indoor</td>
</tr>
<tr>
<td>Higher Layer</td>
<td>• Out of scope of IEEE 802</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MAC</th>
<th>Infrastructure</th>
<th>Client</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Optimal route selection (L2 Routing) • Control of relayed SS by BS or RS</td>
<td>• Substitute route selection *Avoidance of service interruption by SS power off</td>
<td>Control of relayed SS by BS</td>
</tr>
<tr>
<td>• Dynamic / optimal route selection • Centralized control by BS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PHY</th>
<th>To fixed terminal</th>
<th>(802.16-2004) OFDM 256, OFDMA 2048</th>
</tr>
</thead>
<tbody>
<tr>
<td>To mobile terminal</td>
<td>(TGe) OFDM 256, OFDMA :128, 512, 1024, 2048</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RF Band</th>
<th>Infrastructure</th>
<th>Client</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay mode and PMP mode share a same frequency band or use different but adjacent frequency bands</td>
<td>Relay mode and PMP mode share a same frequency band</td>
<td></td>
</tr>
</tbody>
</table>

• The considered scope in a new relay mode is filled with cyan color
Concept of Proposed Relay mode

- Fixed RS for infrastructure relay

- RS is located within BS coverage
- RS connecting with BS shares radio resource with other SS/MS
Concept of Proposed Relay mode (cont’d)

- Nomadic RS for infrastructure relay
  - Providing BWA service for an event, exhibition etc.
  - Nomadic RS shall be installed by a operator
Concept of Proposed Relay mode (cont’d)

- Nomadic RS for client relay
  - Coverage extension to SS/MS which is indoors
  - Nomadic RS could be installed by a user, or semi-stationary user terminal might be a nomadic RS
  - Centralized scheduling by BS
Concept of Proposed Relay mode
(cont’d)

• Mobile RS for infrastructure relay
  • Mobile RS is located within BS coverage
  • Optimal route change according to a situation

NOTE: Inter-SS/MS communication like ad-hoc network is out of scope.
Distinctions

• Current Mesh mode in Std 802.16-2004
  - No compatibility with PMP mode
    - PHY Different frame structure (not compatible to PMP mode), OFDM only (for both licensed and unlicensed bands)
    - MAC Different Network Entry procedure (not compatible to PMP mode)
  - No support for TGe MS (no a fast route change for MS)

• Main differences between Proposed Relay mode and the Mesh mode
  - Efficiently provide Relay connection to SS/MS
  - Support OFDMA as well as OFDM PHY mode
  - Backward compatible to PMP mode
  - One of the end of relay path should be at BS
## Tentative Schedule

### Starting new Study Group / Task Group

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>802.16 session</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>July</td>
<td>#38 Plenary</td>
<td>Propose to form SG – Approved</td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>#39 Interim</td>
<td>SG: the 1st meeting</td>
</tr>
<tr>
<td></td>
<td>Nov.</td>
<td>#40 Plenary</td>
<td>SG: the 2nd meeting</td>
</tr>
<tr>
<td>2006</td>
<td>Jan.</td>
<td>#41 Interim</td>
<td>SG: the 3rd meeting – Complete a PAR</td>
</tr>
<tr>
<td></td>
<td>Mar.</td>
<td>#42 Plenary</td>
<td>802 EC endorses PAR approval</td>
</tr>
<tr>
<td></td>
<td>May</td>
<td>#43 Interim</td>
<td>TG: the 1st meeting</td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>#44 Plenary</td>
<td>TG: the 2nd meeting</td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>#45 Interim</td>
<td>TG: the 3rd meeting</td>
</tr>
<tr>
<td></td>
<td>Nov.</td>
<td>#46 Plenary</td>
<td>TG: the 4th meeting</td>
</tr>
</tbody>
</table>
Summary

• Propose a new SG of Relay mode for fixed / mobile terminal

• Working scope
  - PHY: Enhance normal frame structure
  - MAC: Add new protocols for the Relay networking

• Main features
  - Tree structure: one of the end of relayed data path should be at BS
  - Efficiently provide Relay connection to SS/MS (with small number of hops)
  - Support OFDMA as well as OFDM PHY mode
  - Backward compatible to PMP mode
  - PMP & Relay modes : share a same band, or use different but adjacent bands

• Considered RS types
  - Fixed Infra RS, Nomadic Infra/Client RS, Mobile Infra. RS

❖ dot16 “forum” website: http://dot16.org/forum/