Mesh Networks in Fixed Broadband Wireless Access

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Mesh Networks in Fixed Broadband Wireless Access

Multipoint enhancements for the 802.16 standard

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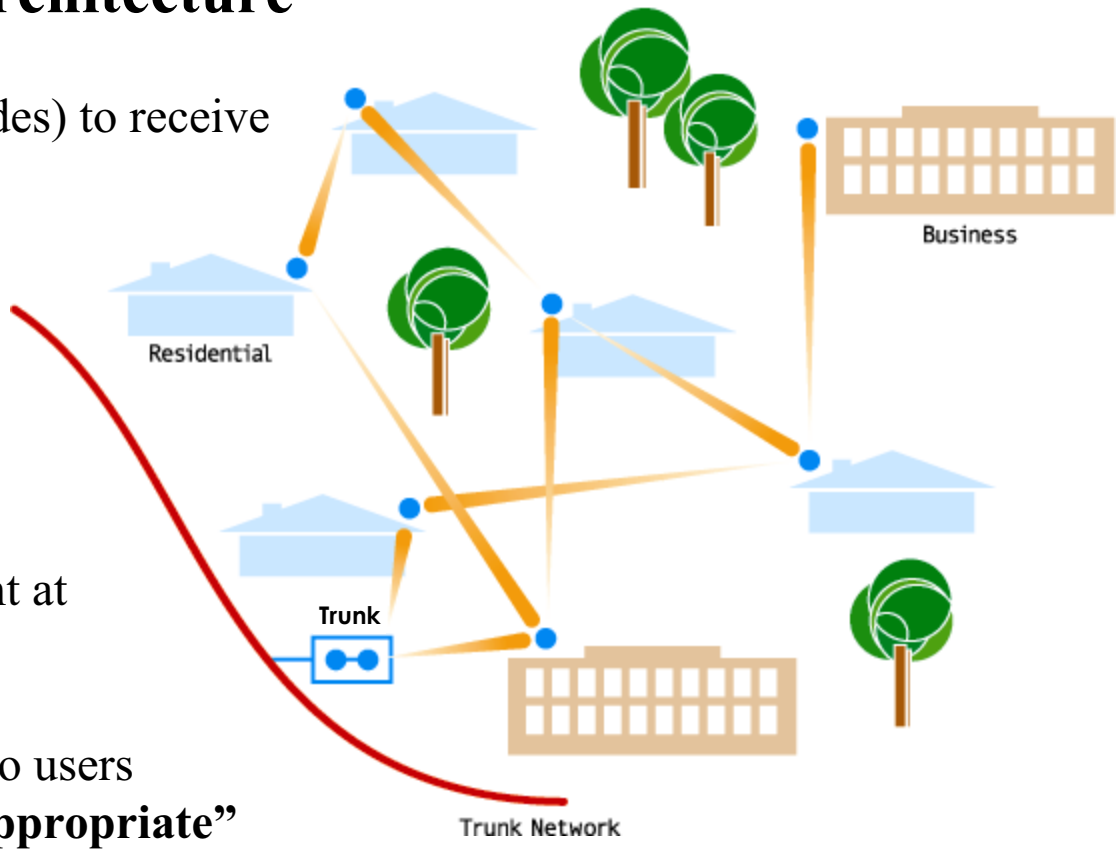
Mesh Networks Variant – A reminder

Innovative Radio Architecture

- ✓ Allow customer unit (nodes) to receive and pass on information
- ✓ Use multiple links between nodes
- ✓ Apply a link structure to form a mesh of nodes
- ✓ Use same node equipment at trunk connection
- ✓ Carry traffic from trunk to users across mesh via **"most appropriate"** route



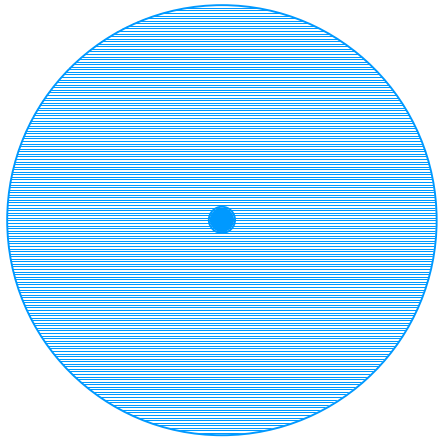
Mesh systems

- A mesh systems is one variant of BFWA, offering significant advantages in several scenarios.
- Efficient operation is available in all frequency bands
- Antenna characteristics can be omni, sectored or substantially directional, for different circumstances (similar to PMP)
- High layer functions (not in IEEE standards) deal with system level management, scheduling etc. (similar to PMP)
- Only small refinements are needed to IEEE 802.16 to widen the scope to become “architecture agnostic”

“Omni” and “Directional” Mesh Variants

“Omni” Variant

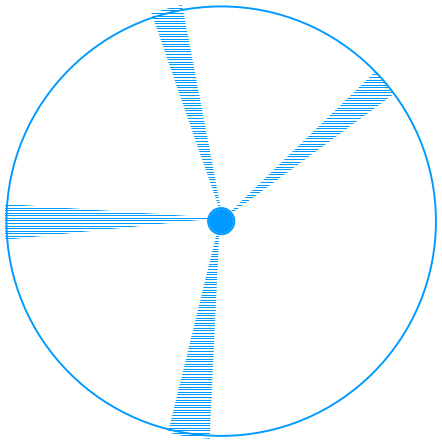
- Typically use **omni-directional** antennas to minimize complexity.
- Range is constrained owing to lower antenna gains, (although this may not be a bad thing).
- Figure below shows a node and its “nominal” coverage.



“Omni” and “Directional” Mesh Variants

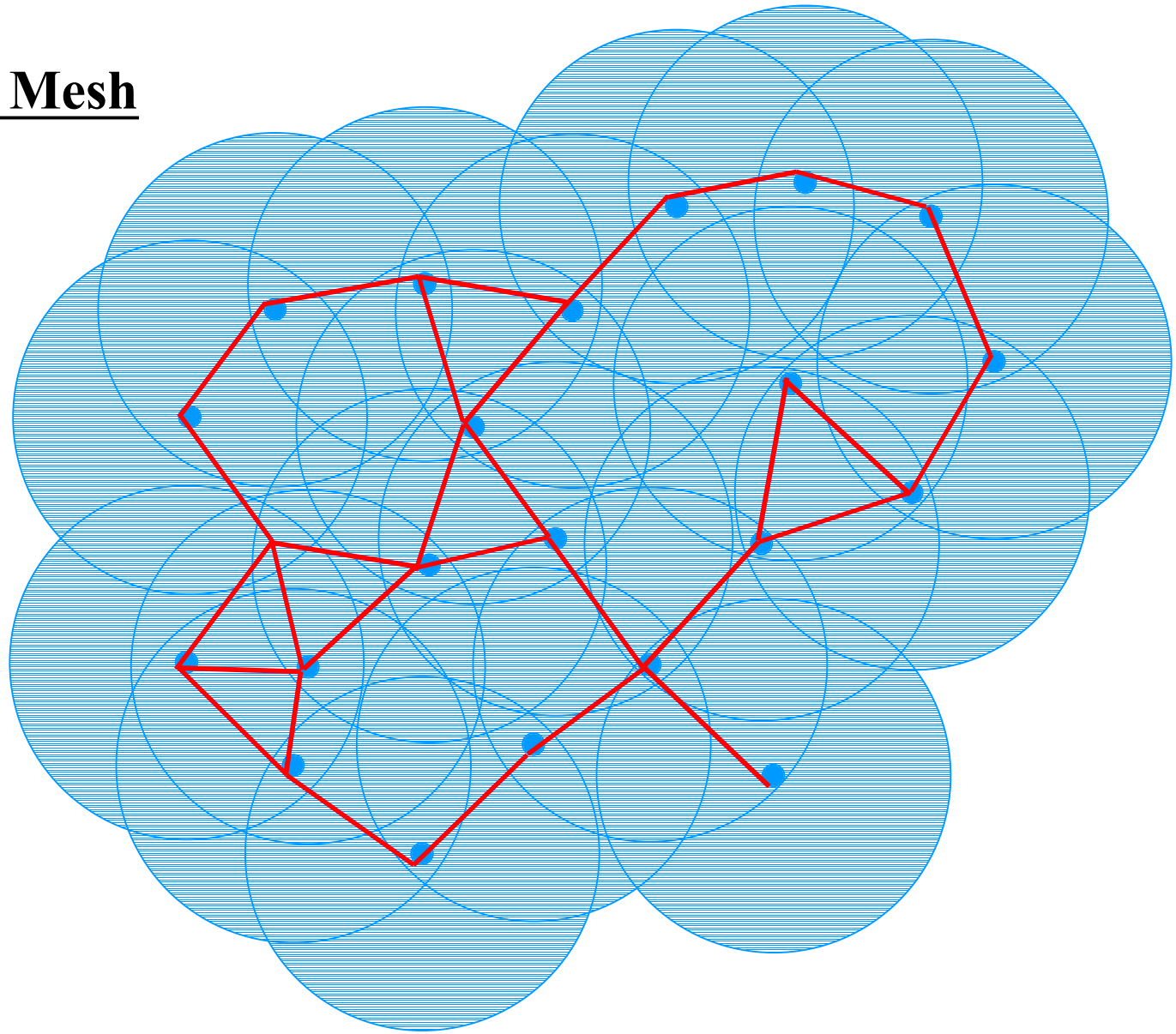
“Directional” Variant

- Use of **directional antennas** helps to minimize intra-system interference.
- Range can be extended owing to higher antenna gains. (Or TX power can be capped at a lower level).
- Figure below shows a node and its “nominal” coverage
- Antennas require steering to achieve connectivity.



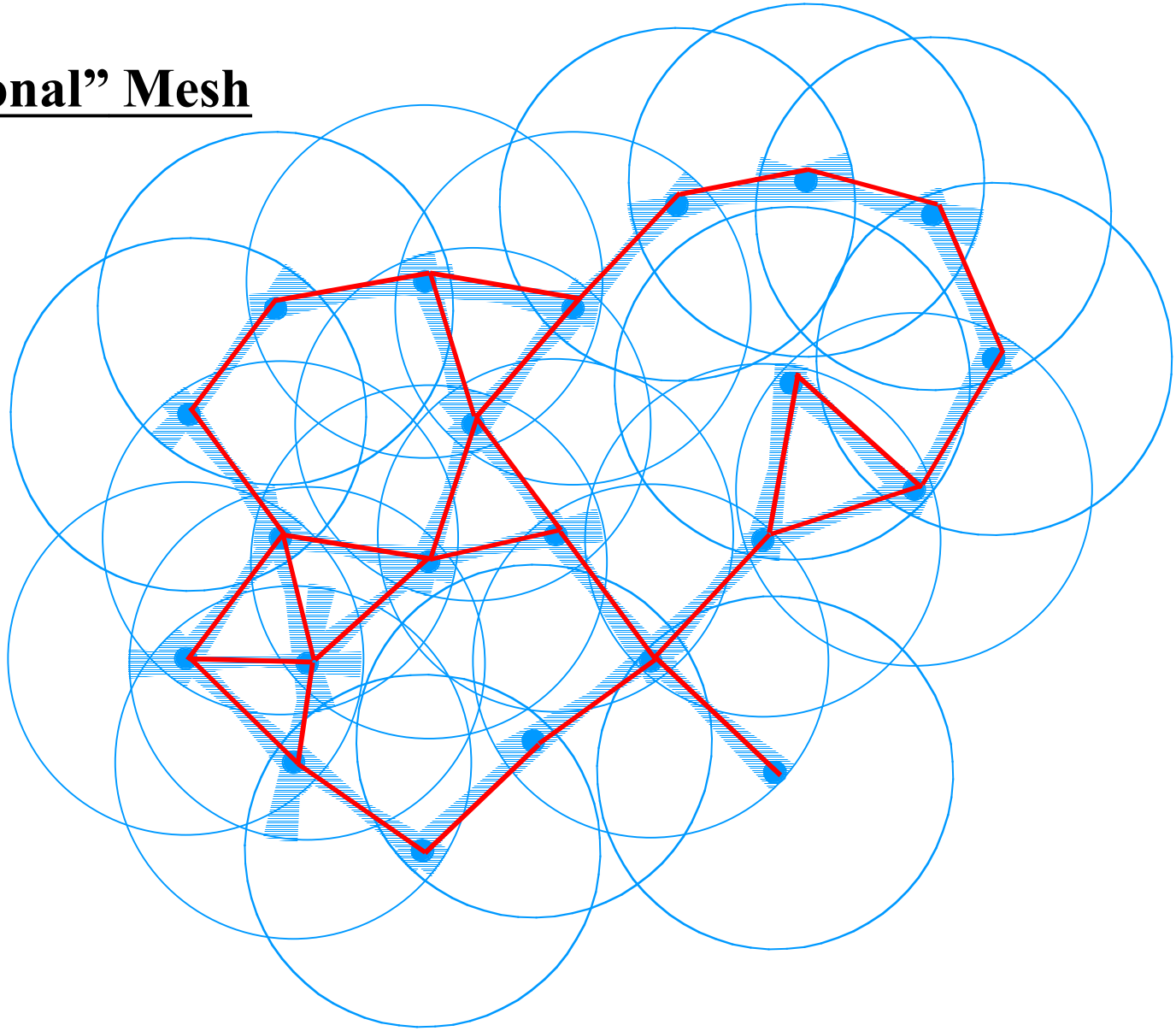
“Omni” and “Directional” Mesh Variants

“Omni” Mesh



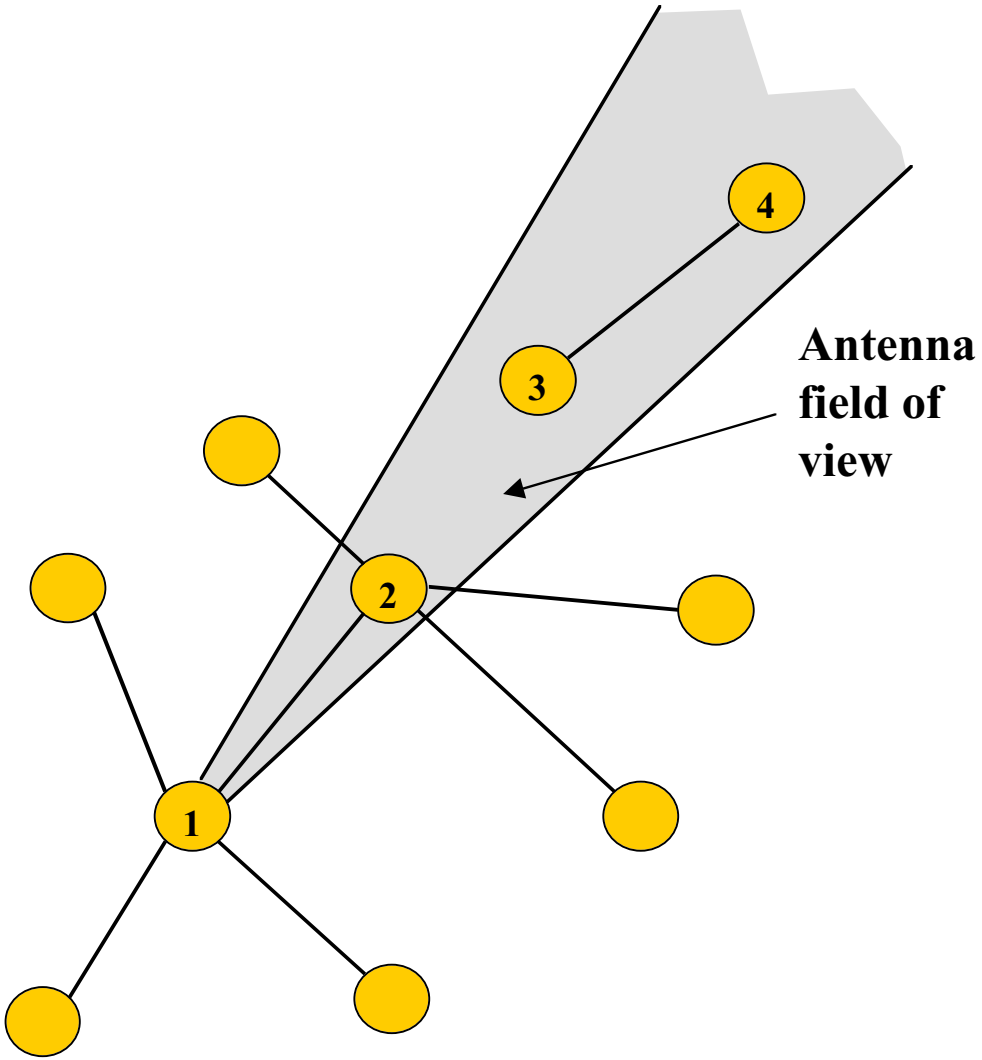
“Omni” and “Directional” Mesh Variants

“Directional” Mesh



Antenna Beamwidth and Spectrum Efficiency

- **Antenna directivity adds an additional degree of freedom.**
- **Spectral efficiency is inversely proportional to the square of the beamwidth**



Key Points for “Directional” Meshes

- Spectrally Efficient – *consistent with highly sectorised P-MP technology*.
- Coexistence – *Equitable coexistence inherent in topology (see 802.16.2)*.
- Scaleable – *Multiple access point networks can cover large areas*.
- Adaptable and robust – *Traffic routing continually optimised*
- Cost Effective- *Cash flow relates more linearly to customer growth*.
- Simple installation - *Automatic antenna pointing simplifies deployment*.

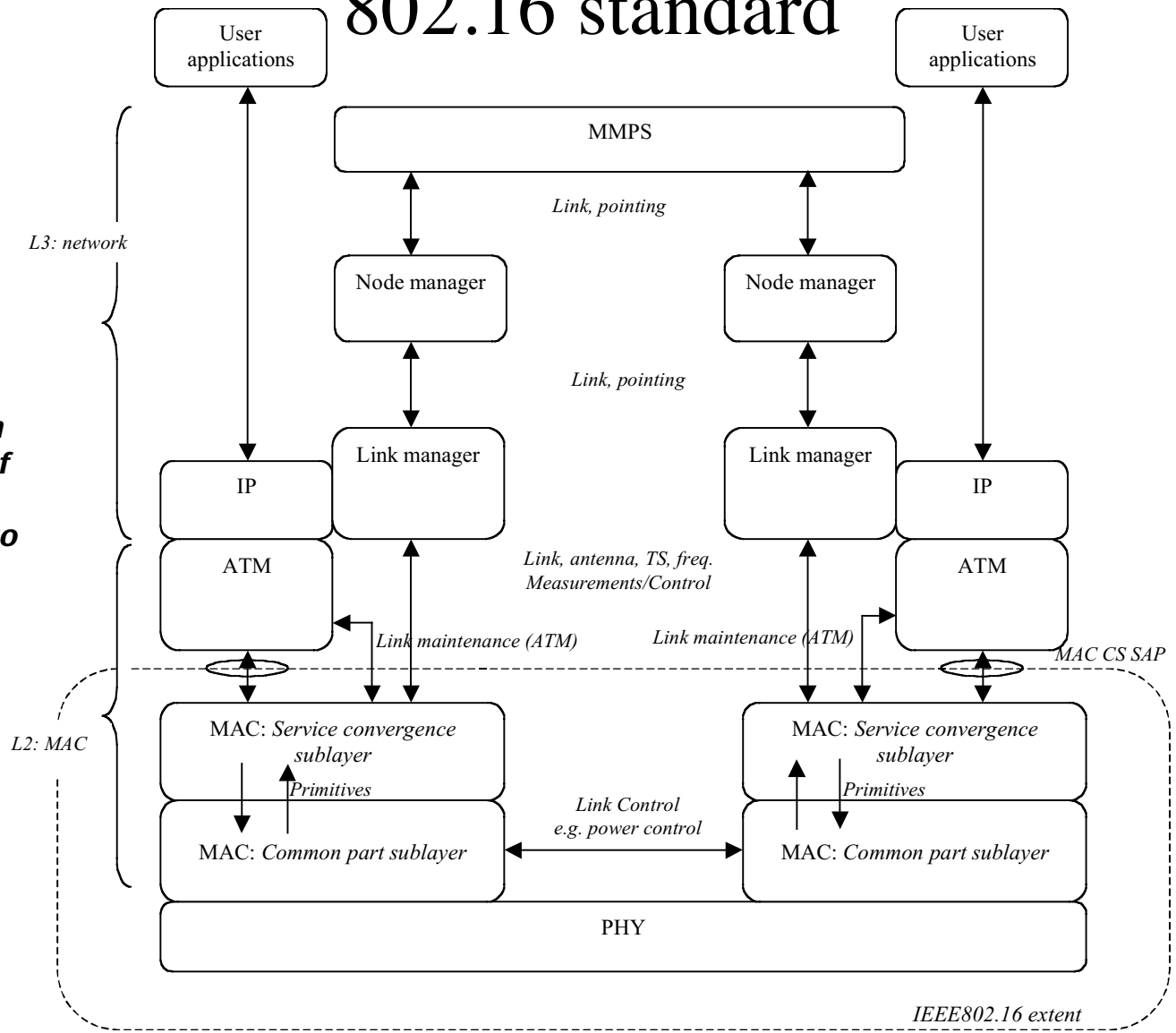
The Mesh mode option in 802.16a

- Unnecessarily limited to OFDM air interface; SC with directional antennas is a very effective alternative.
- Unnecessarily limited to 2-11 GHz range; Similar sized antennas at higher frequencies can further improve efficiency gains.
- These limitations are driven to some extent by the omni-directional antenna implementations in the standard.

Therefore 802.16 standards only partly address Mesh systems.

Mesh architecture could fit onto the core 802.16 standard

Detailed functional representation of the extent of IEEE802.16 and that required to support a physical mesh.



Proposals for enhancement of 802.16

- Mesh management and scheduling can sit above the core 802.16 std (similar to PMP)

But:

- Some elements of detail require enhancement
  - E.g: Antenna pointing MAC messages…..
- Some aspects of PMP mode are not available in the current optional mesh mode.
  - E.g. connection oriented protocol.

Introduce limited refinements that move towards a standard that is architecture agnostic.

Final Considerations

- The Mesh mode option could be fully integrated into the base 802.16 standard to produce a comprehensive “Multipoint” standard.
- Increases choices for vendor implementation.
- Chipsets will have more market (lower cost).
- Other standards bodies have encompassed full range of Mesh possibilities within their scope.
- Tier 1 operators are trialling Mesh systems.
- Regulatory authorities already recognise the Mesh possibilities.
- Easy to do