

Mesh Networks in Fixed Broadband Wireless Access

IEEE 802.16 Presentation Submission Template (Rev. 8.3)

Document Number:

IEEE C802.16-03/10r1

Date Submitted:

2003-07-21

Source:

Barry Lewis

Radiant Networks

The Mansion, Chesterford Park

Little Chesterford, Essex CB10 1XL, UK

Voice: +44 1276 479087

Fax: +44 1276 479087

E-mail: barry.lewis@radiantnetworks.co.uk

Venue:

Session #26, San Francisco

Base Document:

None

Purpose:

Present during the "Proposed New Concepts" item following opening plenary.

Notice:

This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.

Release:

The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.

IEEE 802.16 Patent Policy:

The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <<http://ieee802.org/16/ipr/patents/policy.html>>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <<mailto:chair@wirelessman.org>> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <<http://ieee802.org/16/ipr/patents/notices>>.

Mesh Networks in Fixed Broadband Wireless Access

Multipoint enhancements for the 802.16 standard

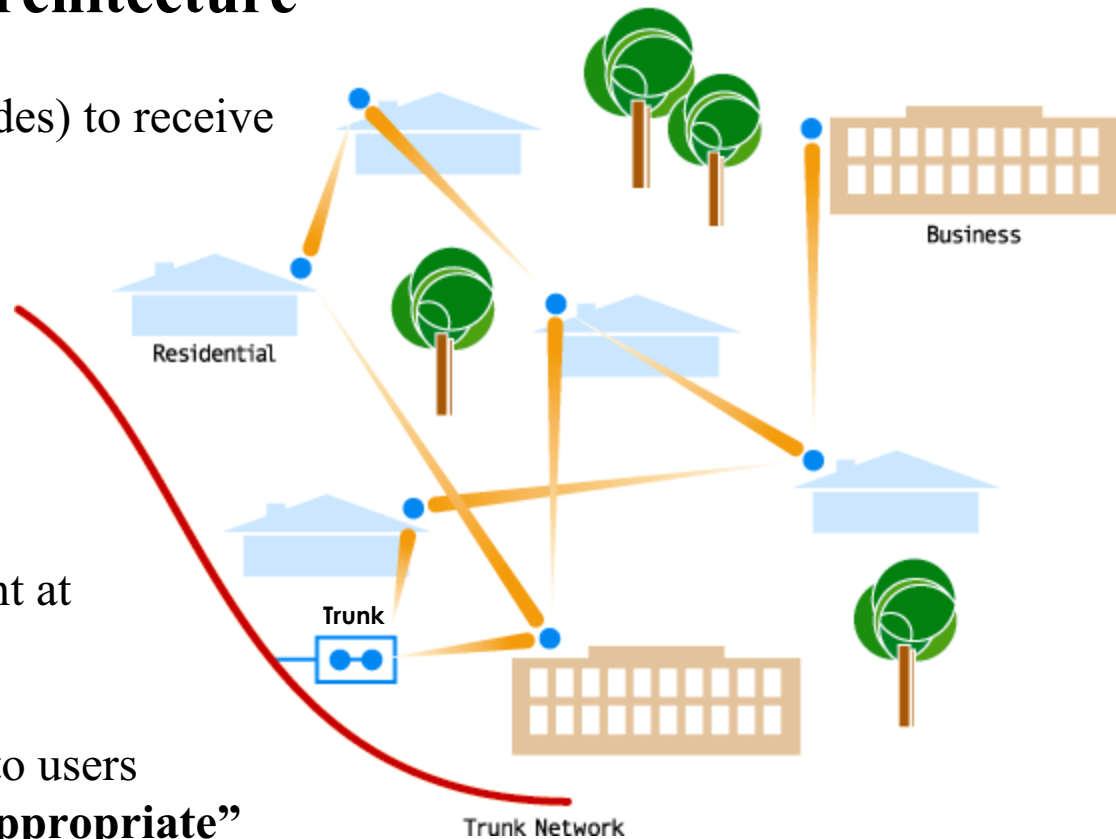
July 2003

Paul Piggin, Barry Lewis and Phil Whitehead; Radiant
Networks PLC, Essex UK

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



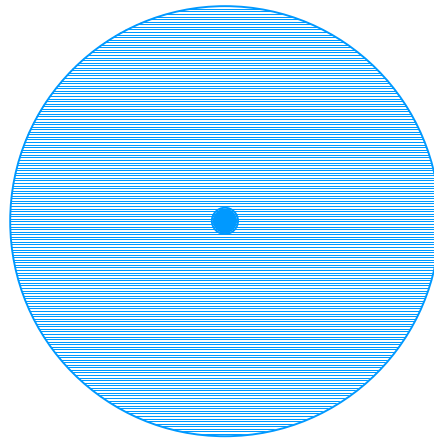
Mesh systems

- 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

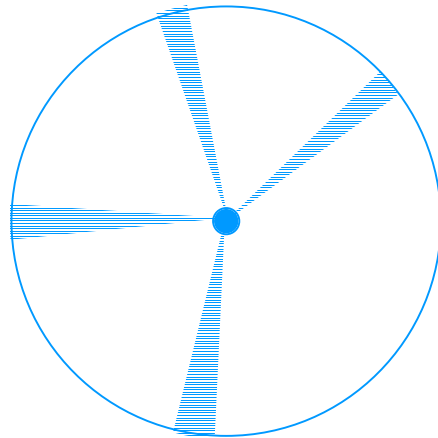
- Typically use **omni-directional** antennas to minimize complexity.
- Range is constrained owing to lower antenna gains, (although this may not be a bad thing).
- Figure below shows a node and its “nominal” coverage.



“Omni” and “Directional” Mesh Variants

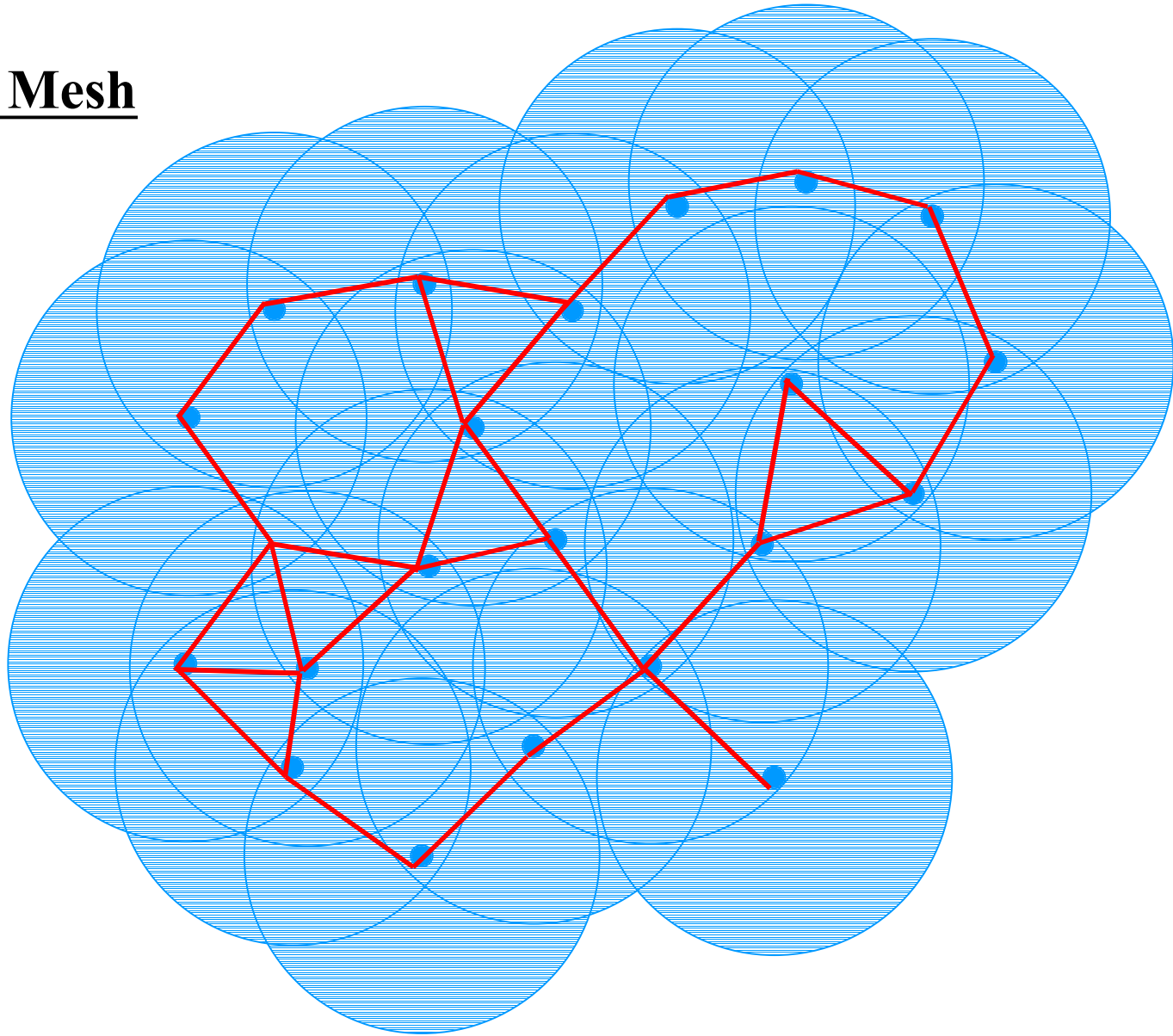
“Directional” Variant

- 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.



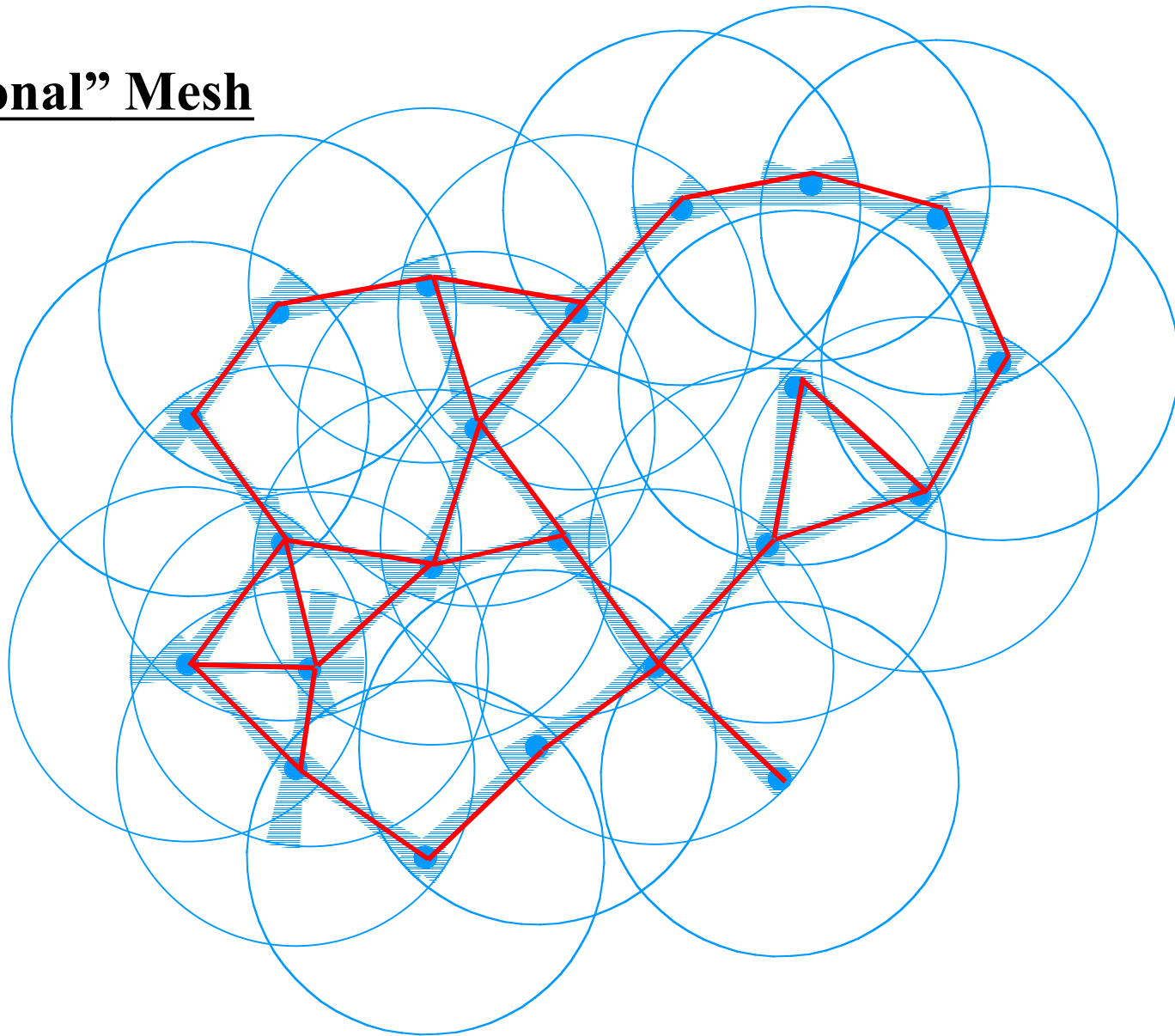
“Omni” and “Directional” Mesh Variants

“Omni” Mesh



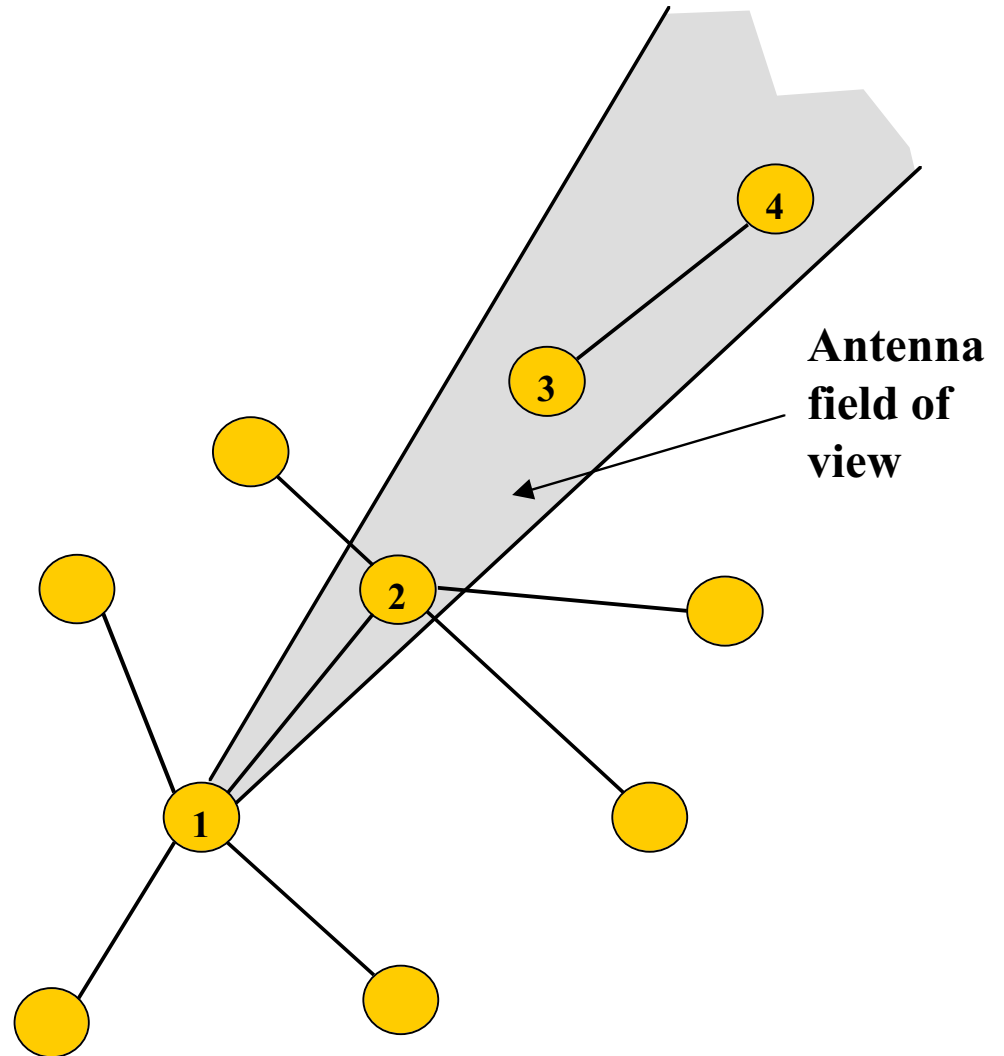
“Omni” and “Directional” Mesh Variants

“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).*
- Scalable – *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.

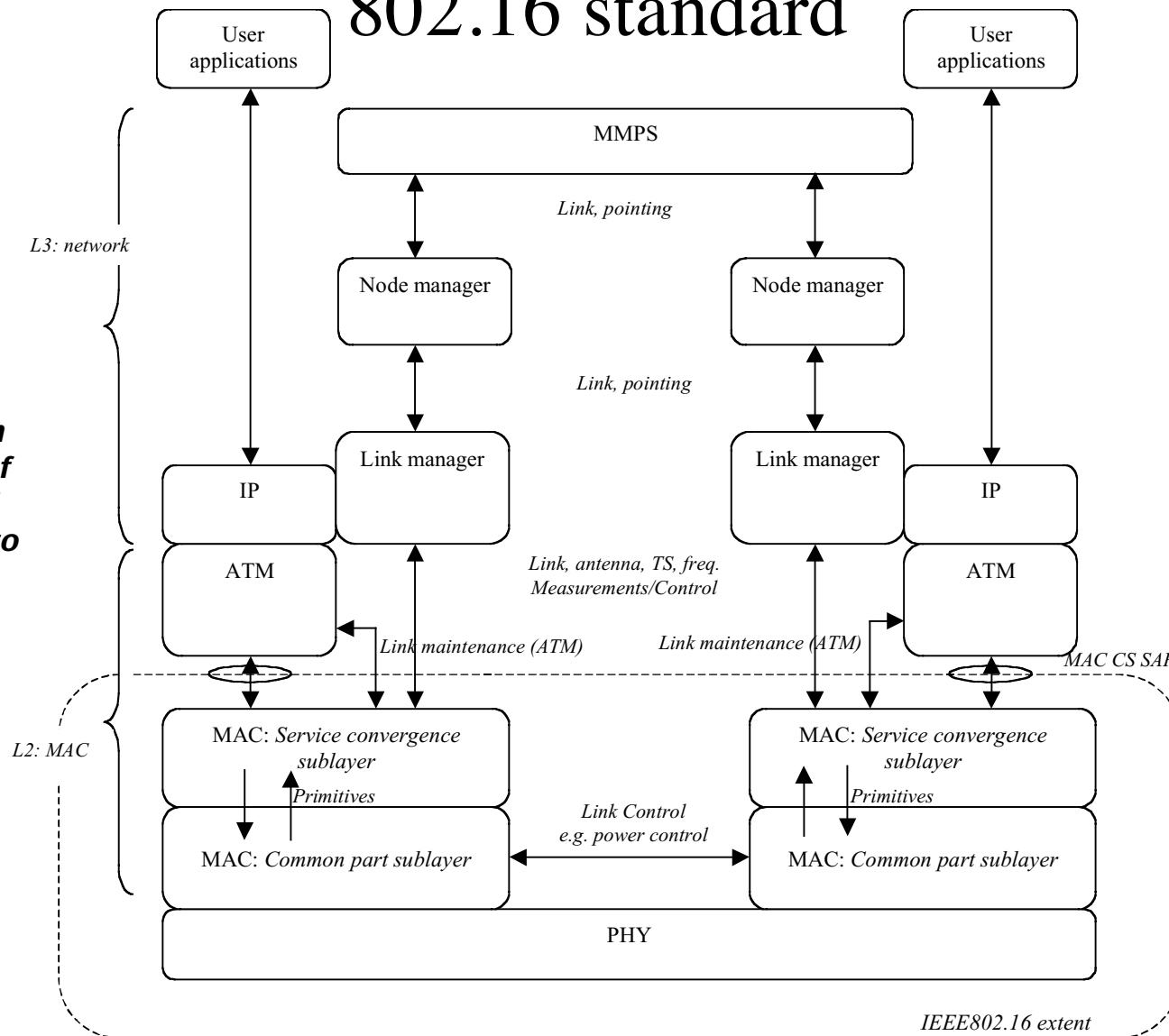
Therefore 802.16 standards only partly address Mesh systems.

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