

BABEL for IEEE 802.11 (Wi-Fi) Mesh

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About BABEL

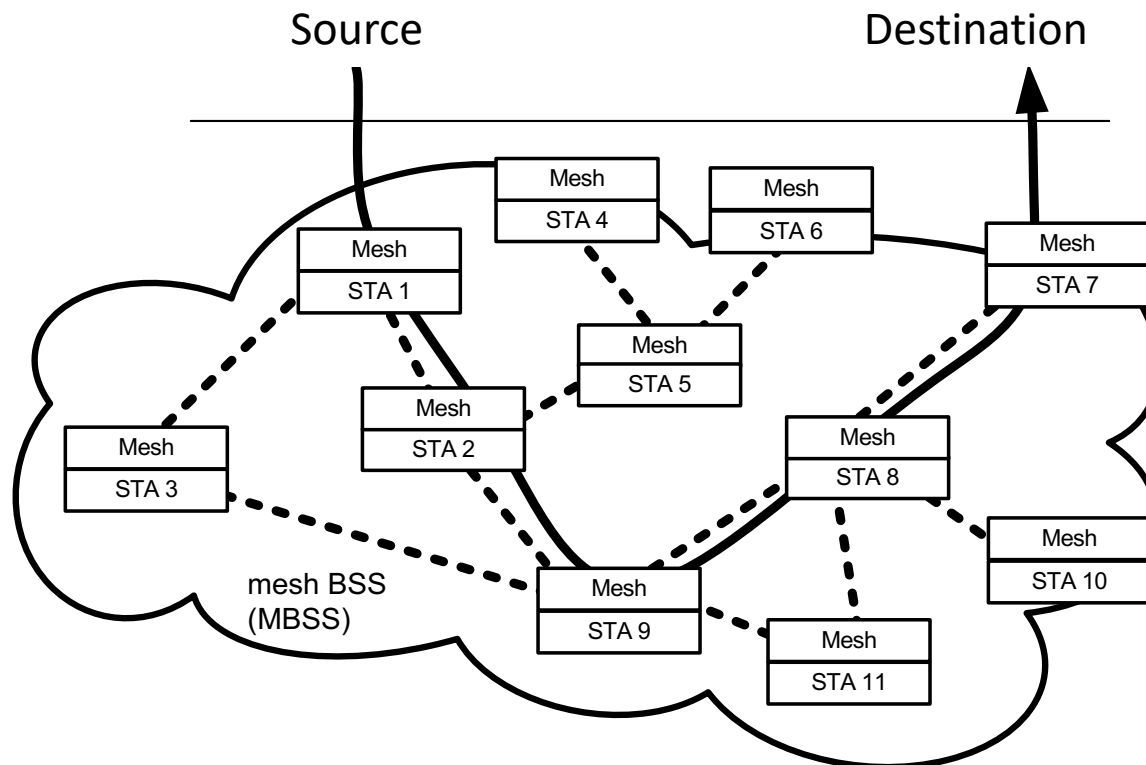
- Babel is based on the distance-vector algorithm (also known as distributed Bellman-Ford) augmented with mechanisms for loop avoidance and starvation avoidance. Babel has been described as “RIP on speed” since it is based on the same principles but has refinements that make it react much faster to topology changes.
- In practice, Babel had proven to be particularly effective in networks consisting of a mixture of high and low quality links such as wireless or hybrid wireless/wired networks.

About BABEL (continued)

- Babel is standardized in **RFC 8966**:
- It has done well in the European Battlemesh contests. See <https://battlemesh.org/BattleMeshV8> (Results tabs).
- Multiple opensource implementations:
 - BIRD <https://gitlab.nic.cz/labs/bird/tree/master/proto/babel>
 - FRR <https://docs.frrouting.org/en/latest/babeld.html>
- See [https://en.wikipedia.org/wiki/Babel_\(protocol\)](https://en.wikipedia.org/wiki/Babel_(protocol))
- Babel in depth:
 - <https://www.irif.fr/~jch/software/babel/babel-20150804.pdf>
(References earlier RFC 6126 which has been obsoleted by RFC 8966)

About IEEE 802.11 Mesh (cont.)

- Mesh was generalized and, while still useful for wireless backhaul, is visualized more like this, appearing to be a link:

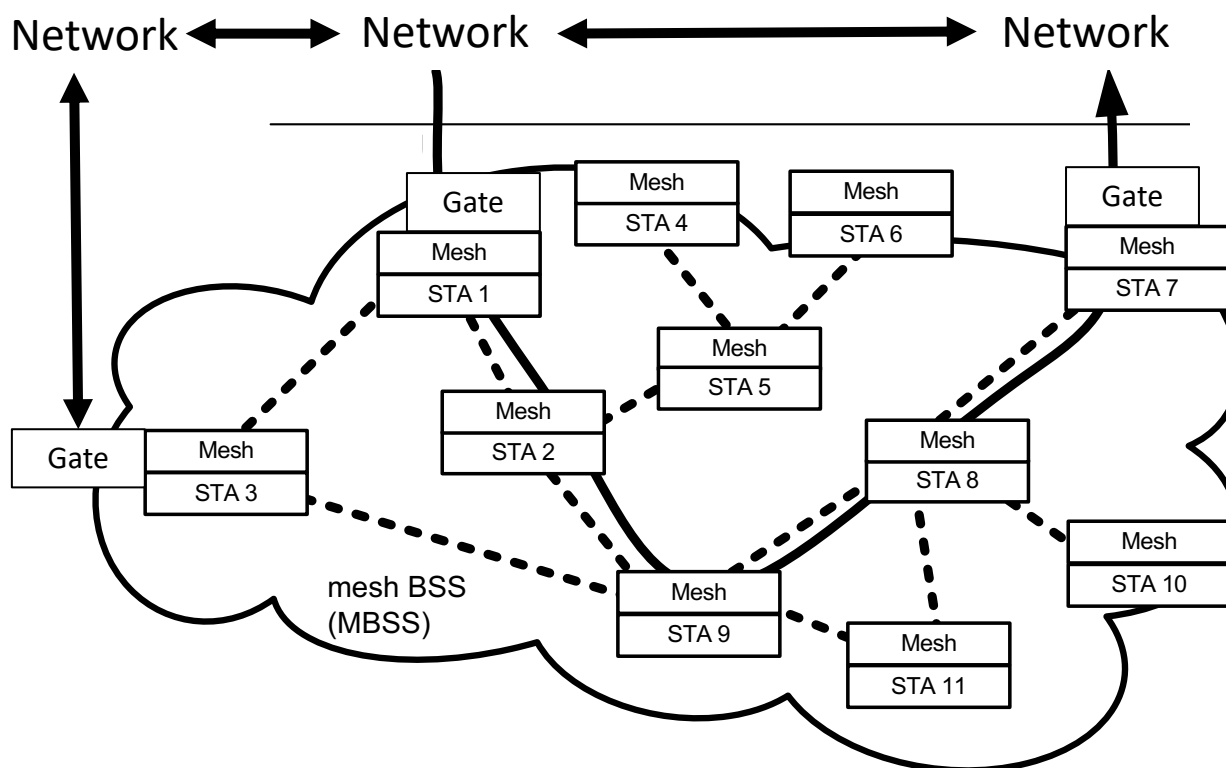


About IEEE 802.11 Mesh (cont.)

- In an 802.11 mesh, all stations send beacons periodically including Mesh ID, Path Selection Protocol & Path Metric ID, etc.. Matching mesh STAs peer with each other, negotiate pairwise keying. Each distributes its group key to its peers.
- The entire mesh appears from outside to be a layer 2 link.
- Frames sent over a radio link inside an 802.11 mesh have up to 6 MAC addresses.
 - SA = Source Address, DA = Destination Address
 - MSA = Mesh Source Address (where frame enters mesh or originated inside mesh)
 - MDA = Mesh Destination Address (where frame exits mesh or terminated inside mesh)
 - TA = Radio Transmitter Address, RA = Radio Receiver Address

About IEEE 802.11 Mesh (cont.)

- How are loops through networks outside the mesh stopped?
This is all layer 2 so it just uses spanning tree if needed.



About IEEE 802.11 Mesh (cont.)

- 802.11s mesh depends on the Path Selection Protocol and link metric to determine how to forward frames.
- It was realized, when 802.11s was developed, that different path selection protocols would be suitable for different mesh conditions and/or mesh station types. Thus 802.11 mesh was designed to be extensible by additional Path Selection Protocols and link metrics, including those developed outside of 802.
- The default path selection protocol and the only one specified in the 802.11 Standard is HWMP (Hybrid Wireless Mesh Protocol) based on AODV with tree-based additions. (Early in the standardization effort for 802.11s it also had a “Radio Aware OLSR” based alternate Path Selection Protocol.)

About IEEE 802.11 Mesh (cont.)

- There are implementations/uses of 802.11s mesh and HWMP.
 - See https://en.wikipedia.org/wiki/IEEE_802.11s
- The most recent IEEE 802.11 Std 2020 is available through the Get 802 Program.
 - See <https://ieeexplore.ieee.org/browse/standards/get-program/page>
- (Like most major features added to 802.11, 802.11 mesh also has its own power save and congestions management facets.)

BABEL for 802.11 Mesh

What could BABEL for 802.11 encompass?

- Primarily, an IETF RFC specifying how to use the fundamental BABEL routing method inside IEEE 802.11 Mesh as a Path Selection Protocol.
- Secondarily:
 - An IETF RFC specifying how to use one or more BABEL link metrics inside IEEE 802.11 Mesh.
Example:
 - <https://datatracker.ietf.org/doc/draft-ietf-babel-rtt-extension/>
- Tertiarily (more like 802.11 for BABEL):
 - Specify how to use the 802.11 Air Time link metric in BABEL.

BABEL for 802.11 Mesh

- An 802.11s Path Selection Protocol based on BABEL would be simpler than the existing RFC 8966 network layer specification.
 - There would be no need to carry prefixes, just sets of MAC addresses.
 - There would be no need to distinguish between router-id and address – the MAC address can serve as both.
 - Would not need BABEL Security (RFC 8967 and RFC 8968) since 802.11 has its own security.
 - Thus it would be a simpler protocol.
- BABEL is very flexible on the link metric used as long as it is monotonic and thus should work well with the 802.11 Air Time metric.

We Have Explicit Permission from IEEE 802.11 to Do This

- Presentation to 802.11 May 2023 Meeting
 - <https://mentor.ieee.org/802.11/dcn/23/11-23-0769-00-0000-babel-for-802-11-mesh.pptx>
- Liaison to the IETF from IEEE 802.11
 - <https://www.ietf.org/lib/dt/documents/LIAISON/liaison-2023-06-07-ieee-802-11-babel-liaison-to-ietf-babel-wg-on-alternative-path-selection-protocol-attachment-1.pdf>

“... While the IEEE 802.11 WG has no view on whether such an activity is justified or not, the IEEE 802.11 WG has no objection to such work being undertaken in the IETF. Such work is possible because the IEEE 802.11 standard was designed to enable the development of a variety of mesh path selection protocols and/or link metrics to extend the range of conditions for which an IEEE 802.11 mesh is suitable. ...”

Next Step

- Some person or persons should write a draft !

END

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