Ambiguous terms in IEEE 802.11s/D0.03

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Please see http://802wirelessworld.com for the original version in PowerPoint format.

Abstract

[1] defines several variants of a Mesh Point (MP). However, besides the definition of the entity called MP all other definitions are vague and unclear. The imprecise introduction of new entity categories leaves too much room for interpretation thus putting a risk on a successful letter ballot of a draft amendment of IEEE 802.11s. To simplify future work and to achieve better consistency we propose to limit the scope of IEEE 802.11s on the definition of an MP. Any other functionality can be either co-located with an MP or can be achieved by an according configuration that allows for implementation with a reduced set of features. These principles allow to achieve the same variety of devices as described in [1], however without the need for the complexity of defining the interdependency of the entities of [1].

Entities defined by 802.11

Devices currently defined by 802.11 and its amendments

Abbreviation	Full description
STA	Station
AP	Access Point
PC	Point Coordinator
?	Portal
QSTA	QoS Station
nQSTA	Non-QoS Station
QAP	QoS Access Point
nQAP	Non-QoS Access Point
HC	Hybrid Coordinator

Station (STA)

- **“Any device that contains an IEEE 802.11-conformant medium access control (MAC) and physical layer (PHY) interface to the wireless medium (WM)”**

Access Point (AP)

- **“Any entity that has station functionality and provides access to the distribution services, via the wireless medium (WM) for associated stations”**
- **“An access point (AP) is a STA that provides access to the DS by providing DS services in addition to acting as a STA”**

Point Coordinator (PC)

- **No dedicated definition**
- **Several remarks spread across the standard**
- **Usually co-located with the AP**
- **Uses the Point Coordination Function during the Contention Free Period**
  - Polling based medium access

Portal

- **“The logical point at which medium access control (MAC) service data units (MSDUs) from a non-IEEE 802.11 local area network (LAN) enter the distribution system (DS) of an extended service set (ESS)”**

Quality of Service (QoS) Station (QSTA)

- **“A station (STA) that implements the QoS facility. A QSTA acts as an non-QSTA (nQSTA) when associated in a non-QoS basic service set (nQBSS)”**

Non-QoS Station (nQSTA)

- **“A station (STA) that does not support the quality of service (QoS) facility”**

Quality of Service (QoS) Access Point (QAP)

- **“An access point (AP) that supports the QoS facility specified in this amendment. The functions of a QAP are a superset of the functions of a non-QAP (nQAP), and thus a QAP is able to function as an nQAP to non-QoS stations (nQSTAs)”**

Non-QoS Access Point (nQAP)

- **“An access point (AP) that does not support the quality of service (QoS) facility”**

Hybrid Coordinator (HC)

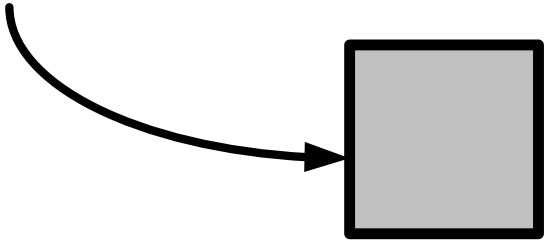
- **“A type of coordinator, defined as part of the quality of service (QoS) facility, that implements the frame exchange sequences and medium access control (MAC) service data unit (MSDU) handling rules defined by the hybrid coordination function (HCF). The HC operates during both the contention period (CP) and contention-free period (CFP). The HC performs bandwidth management including the allocation of transmission opportunities (TXOPs) to QoS stations (QSTAs). The HC is collocated with a QoS access point (QAP)”**

A lot of entities …

- **In 802.11, every entity has a part that is a station**
  - A Station is the part that is sink or source of any traffic
- **Some entities are closely related**
  - AP & PC & HC & Portal …
  - HC & QAP
- **There is some understanding that 802.11 works like LEGO**
  - Add another brick → Add another functionality
  - An AP could work as a STA when AP functionality is turned off
  - A Portal becomes an AP when e.g. “Ethernet” (most often used as non-WLAN) cable is unplugged
  - …

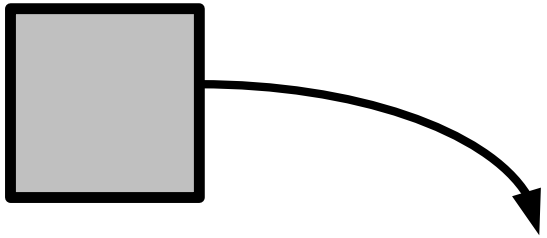
Sink of traffic

- **An entity that is sink of traffic**
- **The frame ends here**
  - It will not be relayed
- **→ A Station**



Source of traffic

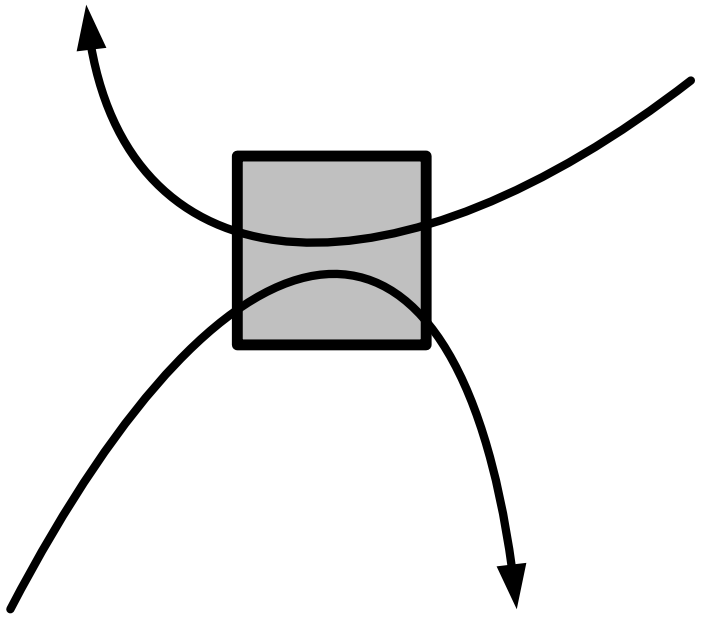
- **An entity that is source of traffic**
- **The entity generates the frame**
  - It is the first time that the frame appears
- **→ A Station**



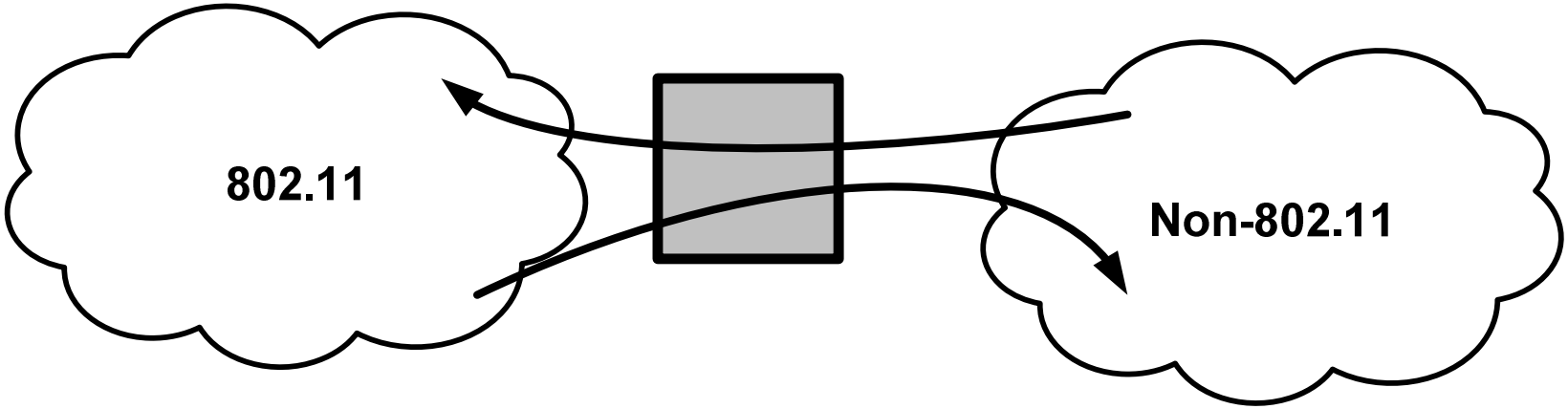
A relaying entity

- **The entity has one more ports**
- **The entity receives a frame on a port**
- **It relays the frame**
  - On the same port

    or
  - To another port
- **At least one of the ports is connected to a WLAN**
- **→ An AP or a Portal**



A Portal



- **The portal has at least two ports**
  - It interconnects a 802.11 an a non-802.11 LAN
  - It relays frames (MSDUs) between the different LANs

“Systems” defined by 802.11

And there is the surroundings …

- **IEEE 802.11 entities can be grouped**
  - 802.11 uses different names for different sets of entities
  - The name of a set depends on the entities that are part of set

Basic Service Set (BSS)

- **“A set of stations controlled by a single coordination function”**

Distribution System (DS)

- **“A system used to interconnect a set of basic service sets (BSSs) and integrated local area networks (LANs) to create an extended service set (ESS)”**

Independent Basic Service Set (IBSS)

- **“A BSS that forms a self-contained network, and in which no access to a distribution system (DS) is available”**

Infrastructure

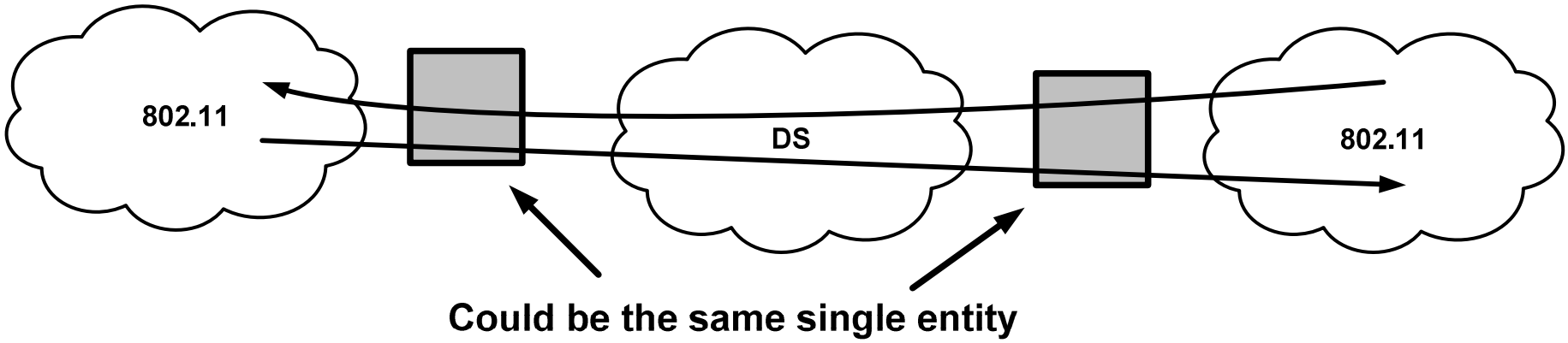
- **“The infrastructure includes the distribution system medium (DSM), access point (AP), and portal entities. It is also the logical location of distribution and integration service functions of an extended service set (ESS). An infrastructure contains one or more APs and zero or more portals in addition to the distribution system (DS)”**

Extended Service Set (ESS)

- **“A set of one or more interconnected basic service sets (BSSs) and integrated local area networks (LANs) that appears as a single BSS to the logical link control (LLC) layer at any station associated with one of those BSSs”**

The Distribution System

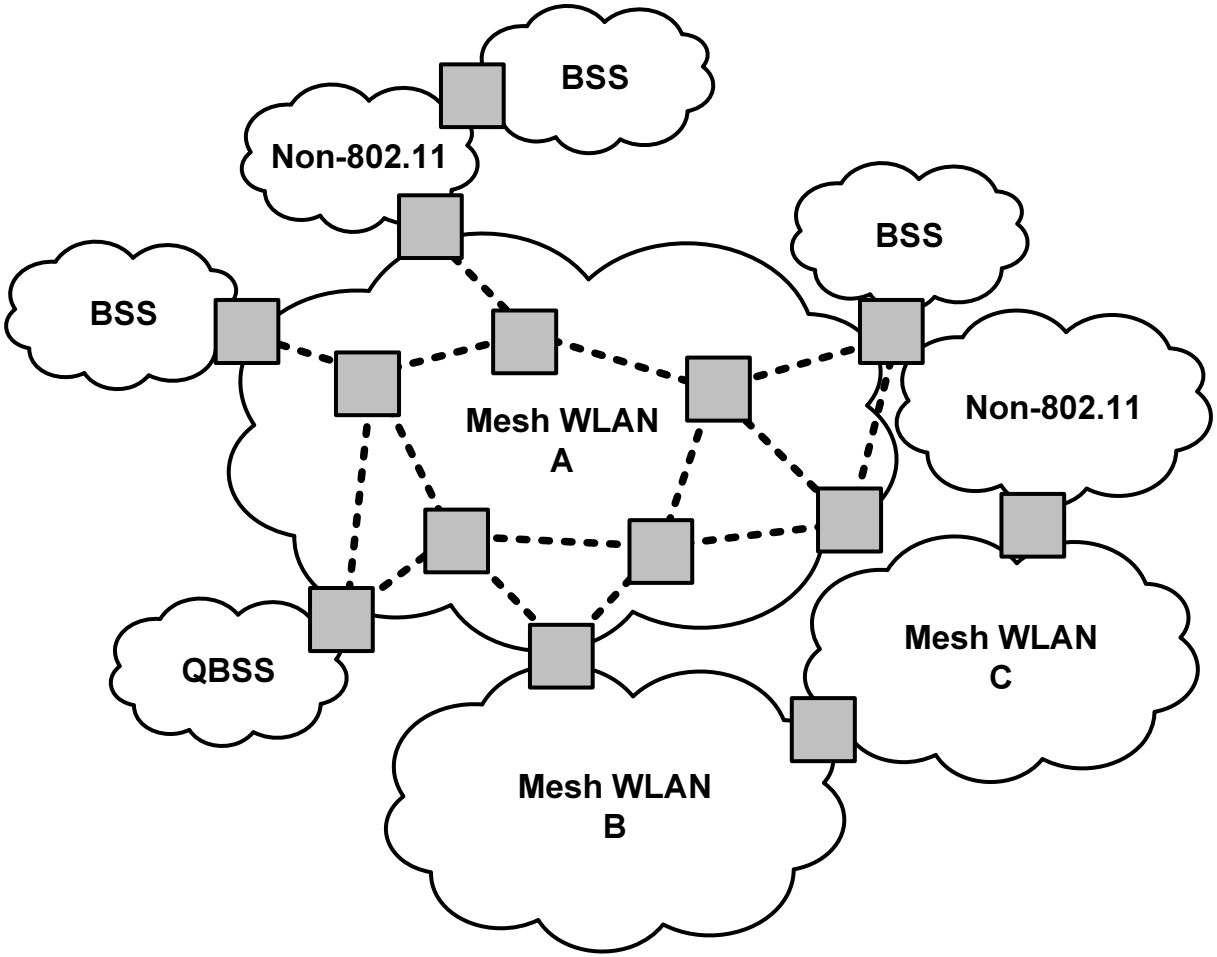
- **Interconnects different 802.11 BSSs**
- **Creates the Extended Service Set (ESS)**
- **May exist solely within an entity (AP, Portal …)**



Entities defined by 802.11s

What does 802.11s provide?

- **802.11s tries to define "some" of the "grey boxes"**
  - Some seem to be more complicated than others
  - Some are pretty easy



Devices currently defined by 802.11s/D0.03

Abbreviation	Full description
MP	Mesh Point
?	Non-forwarding Mesh Point
?	Light-weight Mesh Point
MAP	Mesh Access Point
MPP	Mesh Point collocated with a Mesh Portal

Mesh Point (MP)

- **“Any IEEE 802.11 entity that contains an IEEE 802.11–conformant Medium Access Control (MAC) and Physical Layer (PHY) interface to the Wireless Medium (WM), that is within a WLAN Mesh, and that supports WLAN Mesh Services”**

Non-forwarding Mesh Point

- ?

Light-weight Mesh Point

- ?

Mesh AP (MAP):

- **“Any Mesh Point that is also an Access Point”**

Mesh Point collocated with a Mesh Portal (MPP)

- **“A point at which MSDUs exit and enter a WLAN Mesh to and from other parts of a DS or to and from a non-802.11 network. A Mesh Portal can be collocated with an IEEE 802.11 portal”**

The “environment” of 802.11s

IBSS vs. Ad hoc BSS vs. Mesh WLAN

- **Infrastructure BSS**
  - Centralized, needs AP
  - All communication via AP
  - Stations communicate with AP only
  - Stations synchronized to AP
    - AP sends beacon frames
  - Any traffic goes via the AP
  - A portal may connect to other networks (bridging)
    - Usually co-located with AP
  - Star topology
  - Has a common identifier
- **Ad hoc BSS**
  - All stations must be in mutual communication range
  - Stations do not forward frames on behalf of others
  - Closed network
  - Any topology
  - Distributed synchronization scheme
    - All stations participate in beacon frame generation
  - Has a common identifier
- **Mesh WLAN (or Mesh BSS?)**
  - Entities need not be in mutual communication range
  - Entities may mutually forward frames
  - Any topology
  - May synchronize whole Mesh
  - Has a common identifier

What is a Mesh WLAN?

- **802.11 defines a BSS as “A set of stations controlled by a single coordination function”**
  - Is a Mesh WLAN some kind of a BSS?
  - The BSS definition has nothing about communication ranges, amount of hops etc.
- **Does [1] define a Mesh BSS instead of a Mesh WLAN?**
- **In which “space” do MPs communicate?**
  - Do they communicate in the DS?
  - Do they communicate in the ESS?
- **Is a Mesh WLAN an ESS Mesh, see [2]?**

Ambiguous definitions in IEEE P802.11s/D0.03

Example: Mesh WLAN that consists of MPs only

- The example has no MAPs
- → Therefore, there are no APs
- Every Infrastructure BSS has an AP (See Infrastructure definition)
- → Hence, the example doesn't form an Infrastructure BSS
- A Distribution System (DS) interconnects BSSs to create an Extended Service Set (ESS)
- → Hence, the example Mesh WLAN has no/does not form a DS?
- → Thus, the example Mesh WLAN does not form an ESS?

What's the difference? Is there any?

- **Example ①**
  - A "Mesh Point" co-located with a "Portal"
  - A "Mesh Portal"
- **Example ②**
  - A "Mesh Access Point"
  - A "Mesh Point co-located with an "Access Point"
- **Example ③**
  - A "Mesh Point" that advertises Null-routing
  - A "non-forwarding Mesh Point"
- **Example ④**
  - "Mesh Portal" co-located with a "Mesh Access Point"
  - "Mesh Portal" co-located with an "Access Point"
  - "Mesh Access Point" co-located with a "Portal"
  - "Access Point" co-located with a "Mesh Portal"
  - "Access Point" co-located with a "Portal" and a "Mesh Point"

Are there combinations possible?

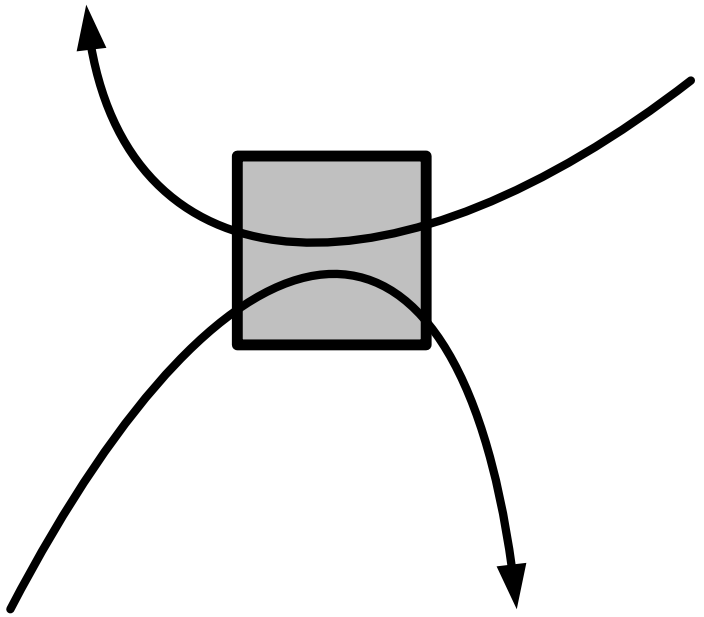
- **What could be a non-forwarding Mesh Access Point (MAP)?**
- **What could be a non-forwarding Mesh Portal (MPP)?**

Proposed changes to definitions in IEEE P802.11s/D0.03

Mesh Point → A relaying entity

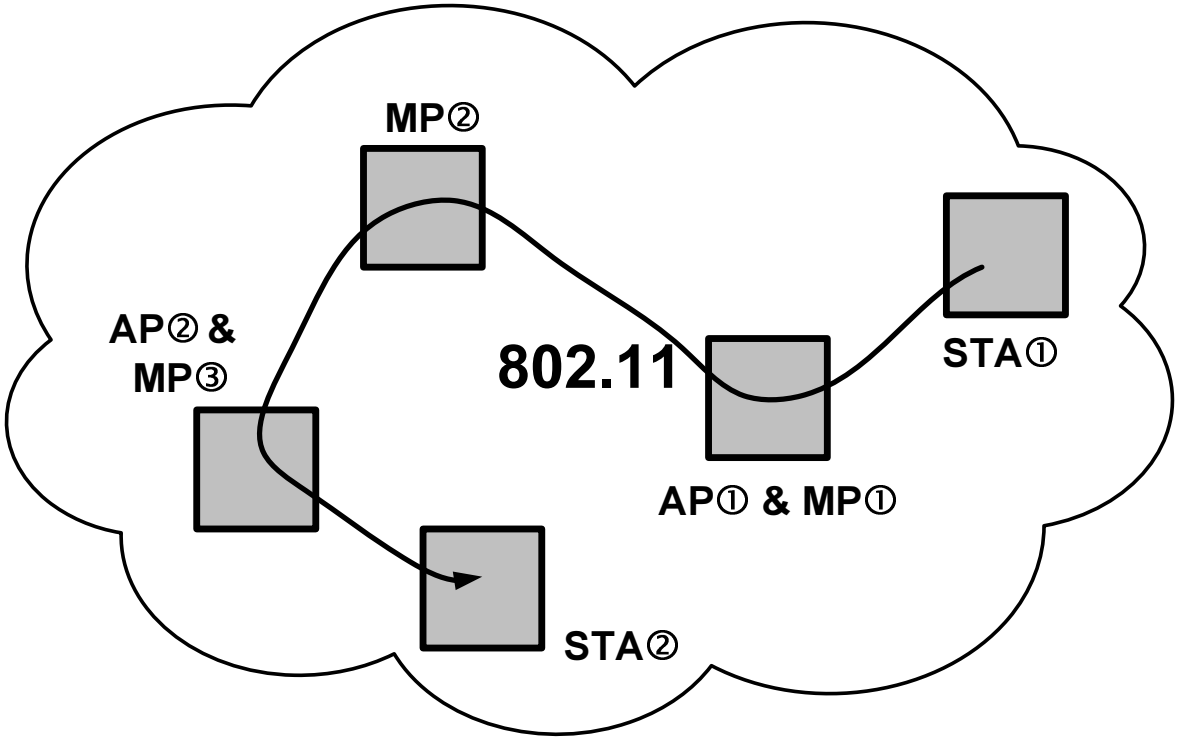
- **The entity has one more ports**
- **The entity receives a frame on a port**
- **It relays the frame**
  - On the same port

    or
  - To another port
- **At least one of the ports is connected to a WLAN**
- **[1] → An MP or MPP**



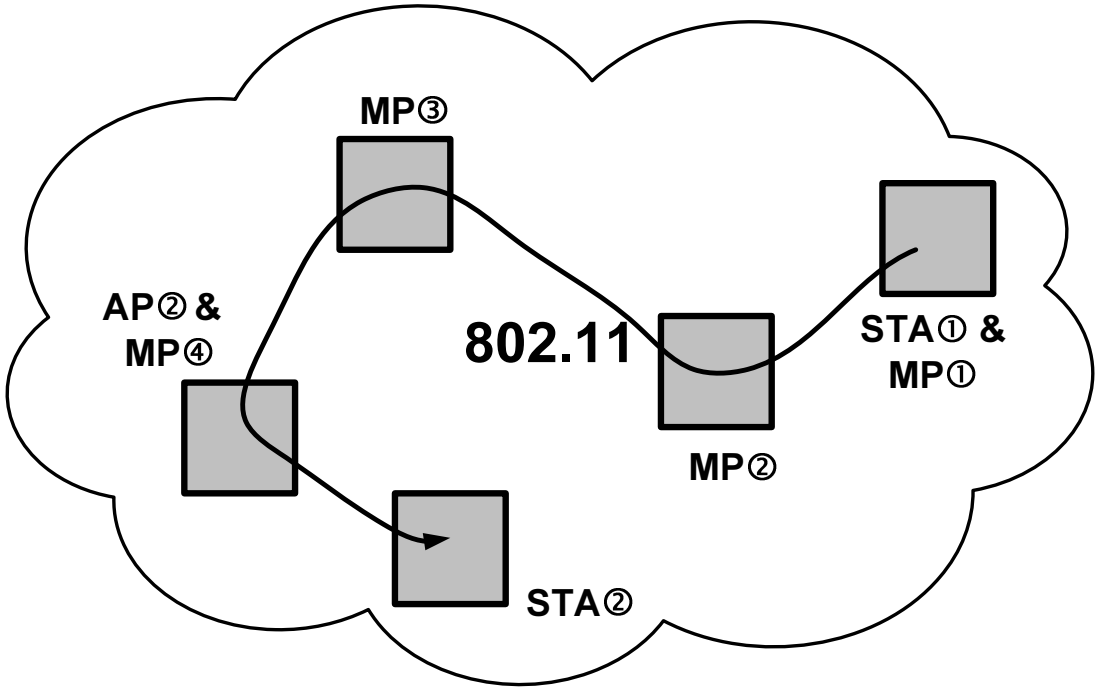
Mesh Point in a Mesh WLAN

- **An MP solely connects with other MPs**
- **An MP may be co-located with an AP**
  - Then it provides the AP service to stations
  - Then, [1] calls it an MAP



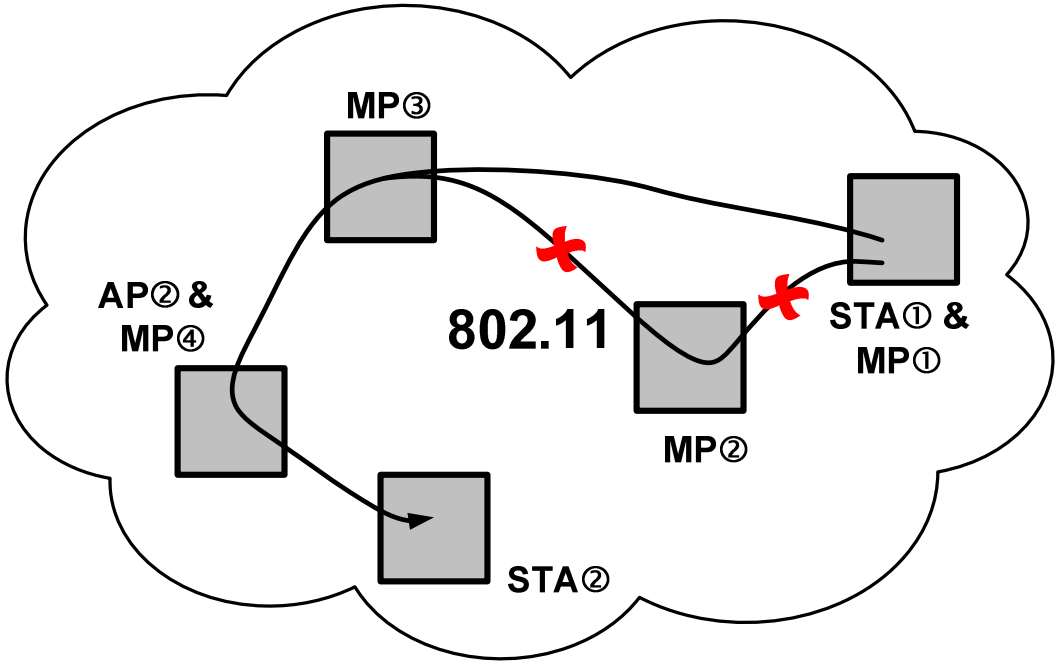
Frames to or from an MP

- **An MP "may be" or "is always" co-located with a station**
  - The station part of this merged entity can generate or consume frames
  - It uses the MP part to have the frames being relayed



Non-forwarding MP

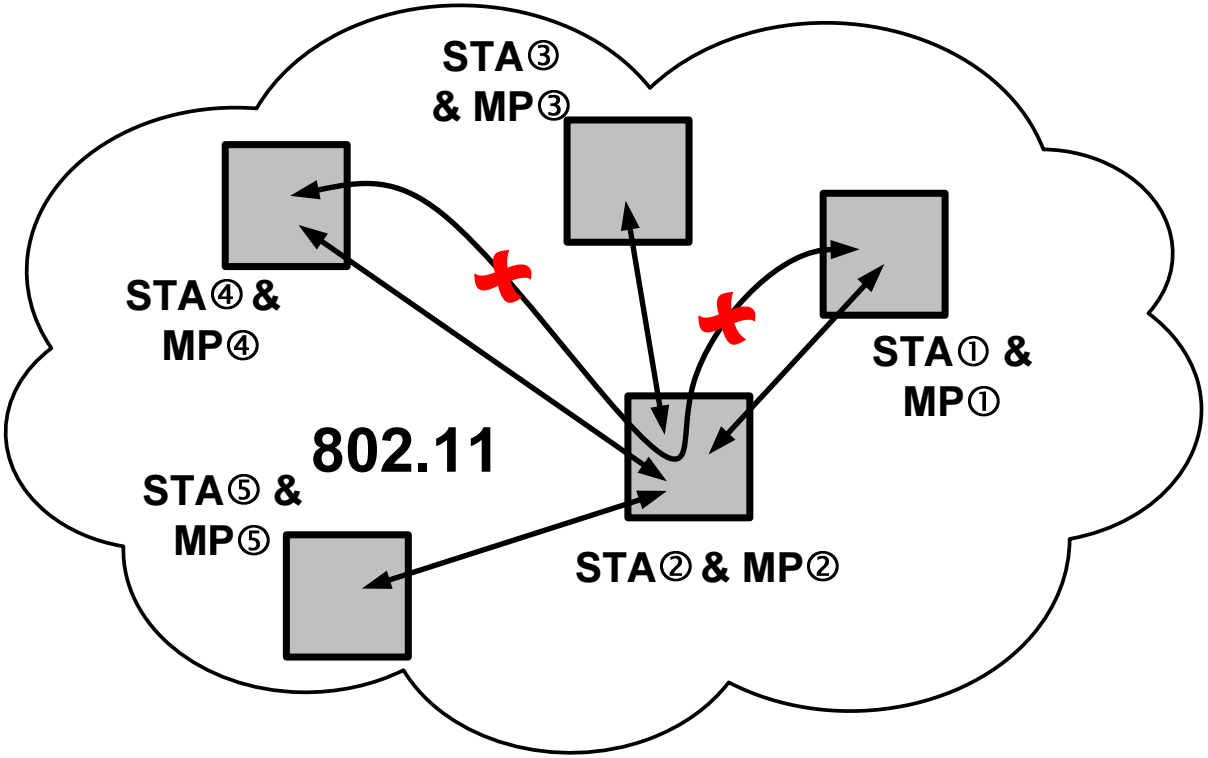
- **Is configured to not to relay frames**
- **The MP propagates a "Null route"**
  - Reason for null-routing is hidden to others →Not important
  - It is a configuration choice
  - A vendor may choose to implement an MP without routing capability



  - Routing is a matter of capabilities
  - Participation in Mesh in not affected

Light-weight Mesh Point

- **Communicates with anything in its range**
- **Never requests frames to be forwarded**
  - Key difference to a non-forwarding MP
- **Does not relay frames**



- **Is a configuration choice**
  - Does not need to be separately defined

Configuration choices allow for variety

- **MPs may have different configuration**
  - Non-forwarding & Light-weight MPs use “Null”-Routing
  - Light-weight MP never requests frame forwarding
- **Configuration determines implementation and vice versa**
  - Non-forwarding MP has no routing capability ↔ A device that is configured to not forward needs no routing capability
- **Implementation hidden to other devices**
  - No interesting
  - Black box
  - Devices need to distribute configuration settings only
  - No differentiation of device classes needed
    - An MP that is not capable of forwarding is the same as an MP that chooses not to forward

Co-location in 802.11: Access Point

- **May be co-located with**
  - Station
    - AP itself may be addressed for maintenance etc.
  - Point Coordinator (PC)
    - Implements PCF
  - Hybrid Coordinator (HC)
    - Implements HCCA → QoS guarantee
  - Portal
    - Provides bridging to other networks

Break functions into parts

- **Let (.) denote the set of functions provided by the according type of entity**
  - (AP) = “The set of AP functions”
  - (MP) = “The set of MP functions”
  - Accordingly for Portal, STA …

- **Assumption 1**
  - (AP) ∩ (MP) = ∅
  - (Portal) ∩ (AP) = ∅
  - …

- **Assumption 2**
  - (AP) ∩ (MP) = (STA)
  - (Portal) ∩ (AP) = (STA)
  - …

- **Difference between Assumption 1 & 2 unimportant for our discussion**
  - However, separation of STA functionality (1) provides benefits

Which definition of an MAP is correct?

[1] defines a Mesh Access Point as "Any Mesh Point that is also an Access Point". Which interpretation is correct?

- **(AP) ∪ (MP) = (MAP)**
  - A MAP is the sum of functionality of an AP and an MP
- **(MAP) \ [(AP) ∪ (MP)] ≠ ∅**
  - An MAP has more capability than the sum of an AP and an MP

The decision is crucial for standardization efforts of 802.11s. If TGs chooses the right hand interpretation, a lot of differentiations are needed (see 802.11e: QSTA vs. nQSTA etc.) If TGs decides for the left hand interpretation, the final 802.11s amendment needs to define an MP only. Anything else can be co-located with an MP.

Principle of Co-location

- **Break things into independent entities**
- **Combine entities to new compositions**
- **MPs may be co-located with**
  - Station
  - AP
  - Portal
  - PC
  - HC
  - Root node
  - …
- **Avoid introduction of unnecessary definitions**

802.11s co-location, example: Mesh Access Point (MAP)

- **Combines MP & AP functionality**
- **AP operates in BSS**
  - Hierarchy: Superior to stations
    - Grants or denies access to BSS
  - Provides stations with AP services
  - Forwards frames on behalf of stations
  - …
- **MP operates in Mesh WLAN**
  - Flat Hierarchy: All MPs are equal
  - Provides frame forwarding
  - Path selection
  - Security services
  - …
- **The Definition how the AP part internally communicates with the MP is outside thes scope of 802.11s**
  - Vendor specific
  - Not important for standard

802.11s – It's all about MPs

- **802.11s veterans may remember:**
  - We merged two proposals
    - One had something about "simplicity" in its name …
      - Introducing more names and dependencies doesn't make it simple …
- **Instead of introducing several different types of entities we should focus on the definition of an MP – nothing else**
  - Configuration options may allow for a "special" MPs
    - A configuration option may be to not to choose to forward (route) frames → Non-forwarding MP
- **All current entities defined by [1] are special configurations of an "Mesh Point" or equal a "Mesh Point" that is co-located with something additional.**

Conclusion

- **IEEE 802.11s should solely define the term Mesh Point (MP)**
  - No other terms needed
  - Reduce amount of newly introduced devices to **1**
  - Makes amendment more stringent
  - Avoid unnecessary confusion
    - 802.11e has “xyz-entities” and “non-xyz-entities”
    - “Non-MAP MP”, “Non-MPP MP”, “Non-forwarding MP” etc.
  - Letter ballot much easier if only **one** new thing is defined
    - 802.11 members know about APs etc. There is a very fixed conception in people’s mind. But how to explain MAPs etc.?

Straw poll

- **Are you in favor of the following decision?**
  - IEEE 802 Task Group “s” shall focus on the definition of the entity called “Mesh Point”, MPs. The definition of any other entity shall be considered out-of-scope of IEEE 802 Task Group “s”. IEEE 802 Task Group “s” shall allow for flexible MP configuration, thus allowing a variety of MPs that have currently different names (e.g. “forwarding MP”, “Light-weight MP” etc.). The flexible configuration shall allow to implement MPs that need a sub-set of functions of IEEE 802.11 only. IEEE 802 Task Group “s” shall allow for co-located entities that alter the definition of an MP (e.g. an MP that is co-located with an AP forms the entity that is currently defined as an MAP). IEEE 802 Task Group “s” shall consider the aforementioned guidelines during its future work and instruct its editor to accordingly form the next draft (P802.11s/D0.04 or P802.11s/D1.0 if the TG decides to go on letter ballot).

CANCELED

- **Yes/No/Abstain:**

Straw poll

- **Shall we reduce the entity terms defined in [1] to the single and only term “MP”?**
- **Yes/No/Abstain: 10/3/19**

References

[1] IEEE P802.11s/D0.03

[2] IEEE 802.11, doc. 11-04-0054-02, PAR for IEEE 802.11 ESS Mesh

Annex

- **Funnies ☺**
  - [1]: “Figure s6: Connecting a WLAN Mesh LAN …”
    - A “**Wireless Local Area Network Mesh Local Area Network**”?
    - Wow! Three different persons may have five different opinions what that could be!
    - Do we really want to define such things?
    - Is a Mesh WLAN LAN something else?
    - What would be a WLAN Mesh MAN?