CSN & 802.11 BSS Bridging

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Abstract

This presentation describes how CSNs and 802.11 BSS could be modelized as Distributed L2 Bridge

The issue

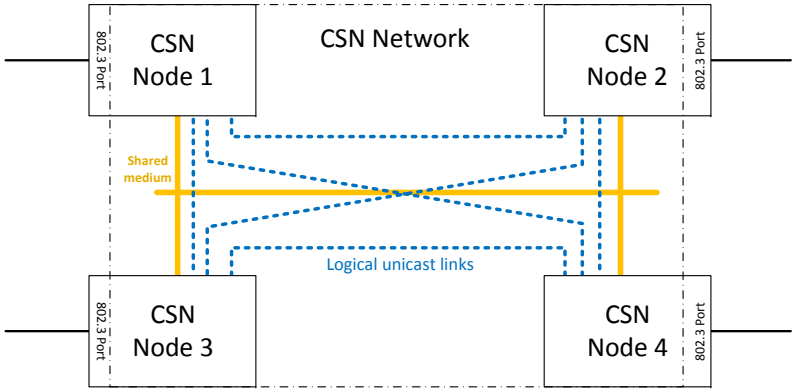
802.11 non-AP STA devices are end devices that do not bridge to external networks. This:

- limit the topology of 802.11 BSS to “stub networks”
- do not allow a (STA-)AP-STA wireless link to be used as a connecting path (backbone) between other networks

Partial solutions exist to overcome this lack of bridging functionality but these solutions are:

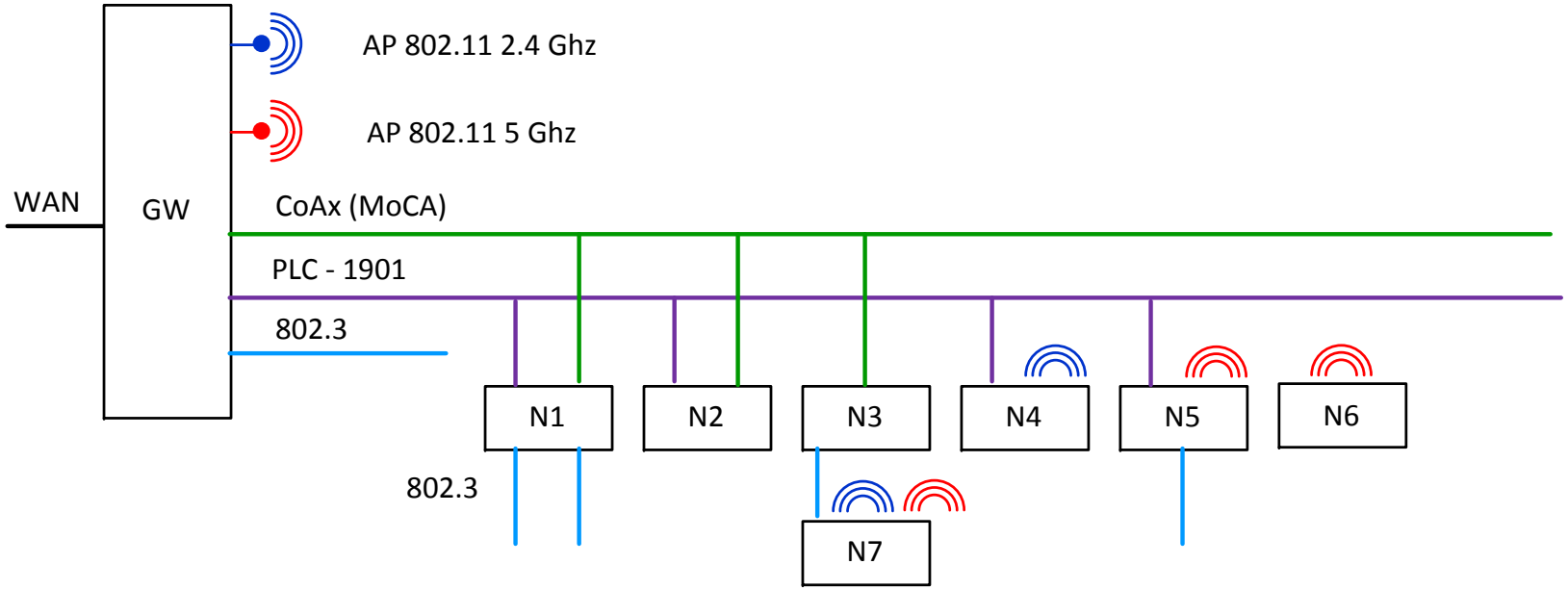
- proprietary only
- limited to certain type of traffic
- or/and based on Layer 3 (such IP Multicast to MAC Multicast translation, NAT - Network Address Translation)

Coordinated Shared Network (CSN)

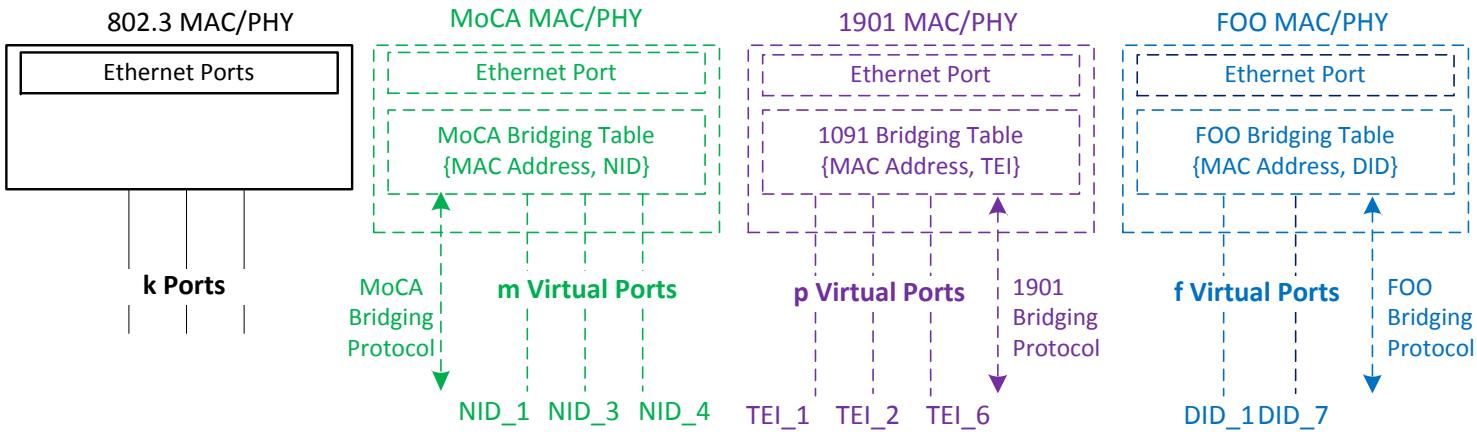


- Contention-free, time-division multiplexed-access, network of devices sharing a common medium and supporting reserved bandwidth based on priority or flow (QoS).
  - one of the nodes of the CSN acts as the network coordinator, granting transmission opportunities to the other nodes of the network.
- Physically a shared medium, in that a CSN node has a single physical port connected to the half-duplex medium, but logically a fully-connected one-hop mesh network, in that every node can transmit frames to every other node over the shared medium.
- Supports two types of transmission:
  - unicast transmission for point-to-point (node-to-node)
  - transmission and multicast/broadcast transmission for point-to-multipoint (node-to-other/all-nodes) transmission.

(GW Centric) Heterogeneous Home Network



Heterogeneous Network Bridge Model



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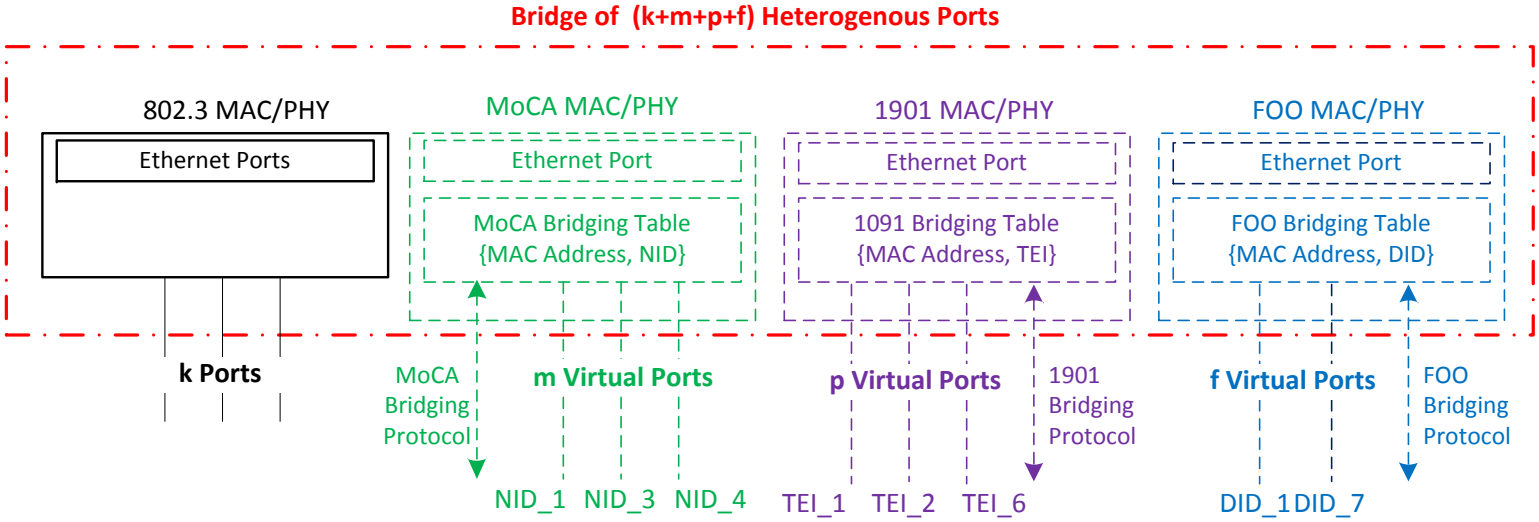
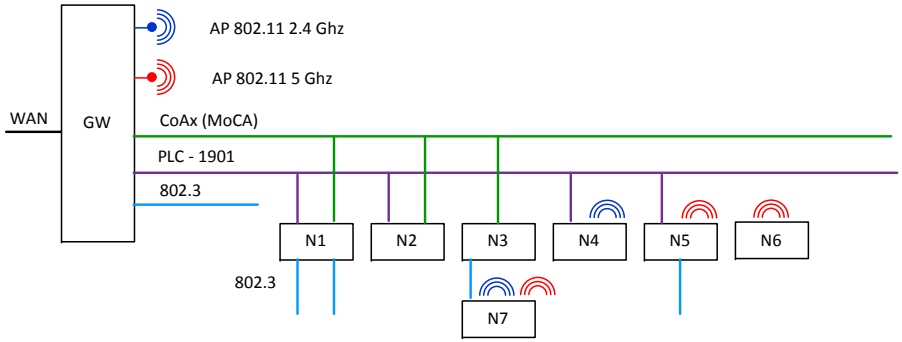
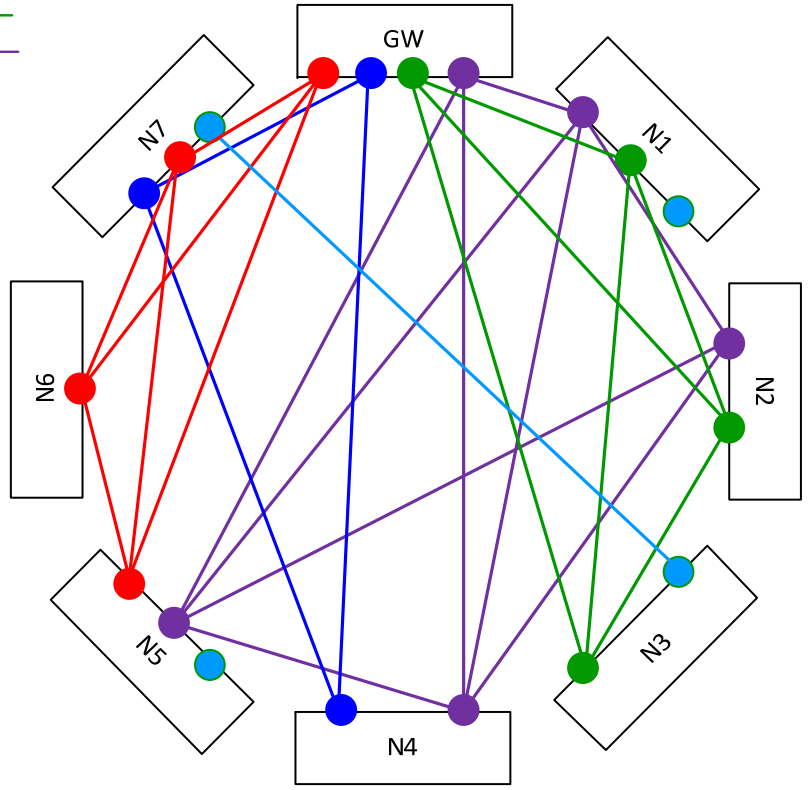
Heterogeneous Network Bridge Model - 1



GW Centric Home Network – P2P Model

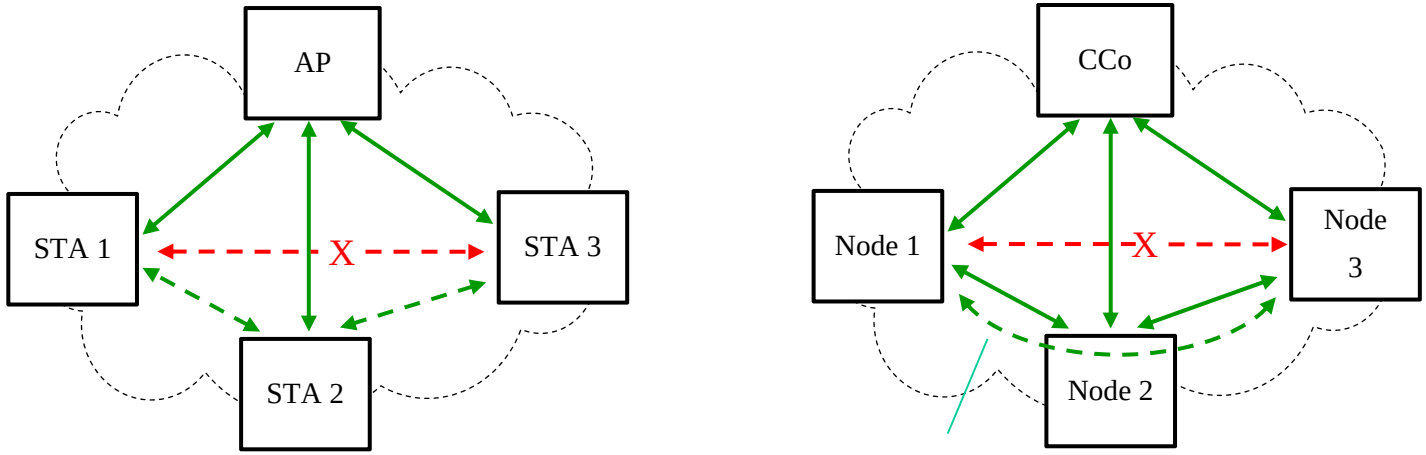




Hidden Nodes…

On both 802.11 and 1901 networks, nodes could be hidden to other nodes…

…but both 802.11 AP and 1901 CCo see all nodes



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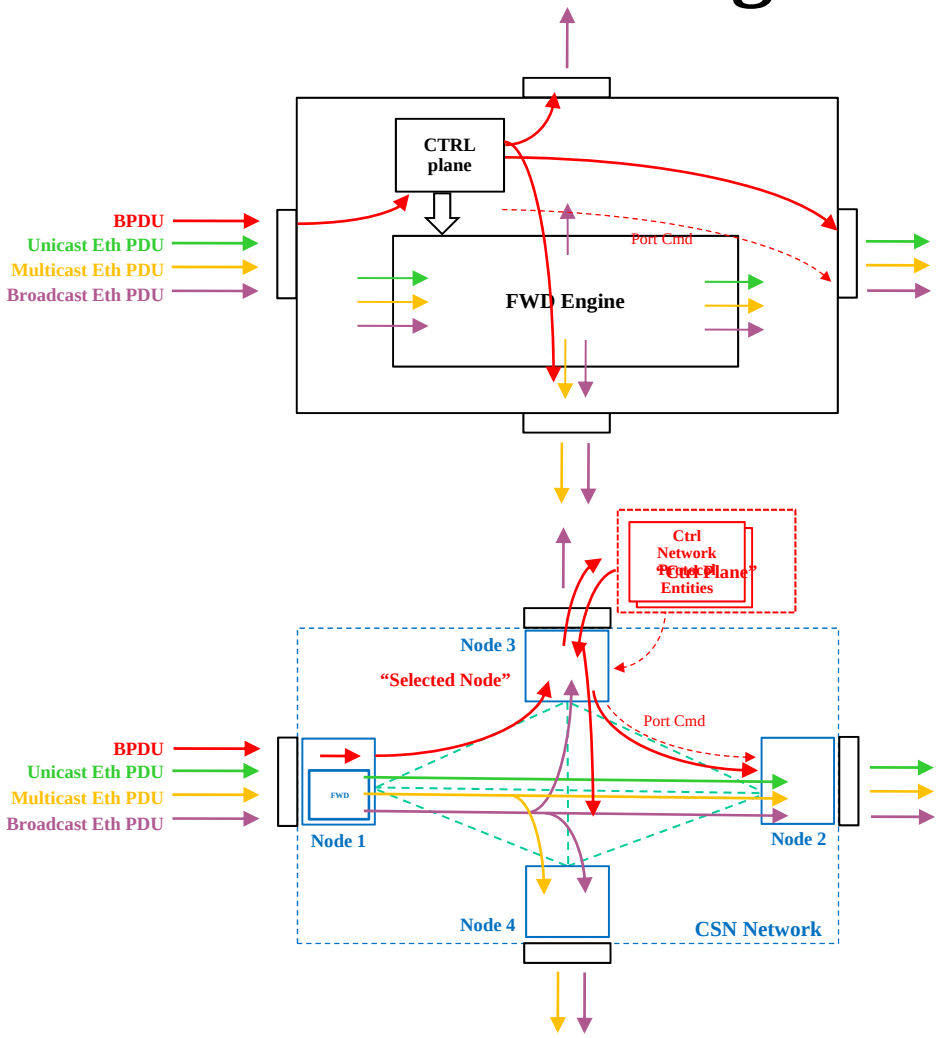
CSNs behave as L2 Bridges…

L2 Bridge

CSN Network



CSN as Distributed Bridge - Pros

Scalable:

Single bridge per CSN regardless # of nodes

vs P2P mesh where each node is a bridge

Optimized for "heavy"/"light" nodes

(single ctrl plane node + n-1 "dumb" ports rather than n bridges)

No duplication of resources

1 single Ctrl plane entity per CSN

Reuse of standard L2 Ctrl protocol entities

requires only a simple adaptation layer

(cf "White Paper: Control Plane Implementation on Coordinated Shared Networks (CSN)"
http://www.ieee802.org/1/files/public/docs2011/avb-phkl-wp-csn-ctrl-plane-1111-v01.pdf)

CSN as Distributed Bridge – Pros (cont.)

Support ranking

without modification of the underlying network protocol

Network agnostic interface to underlying network

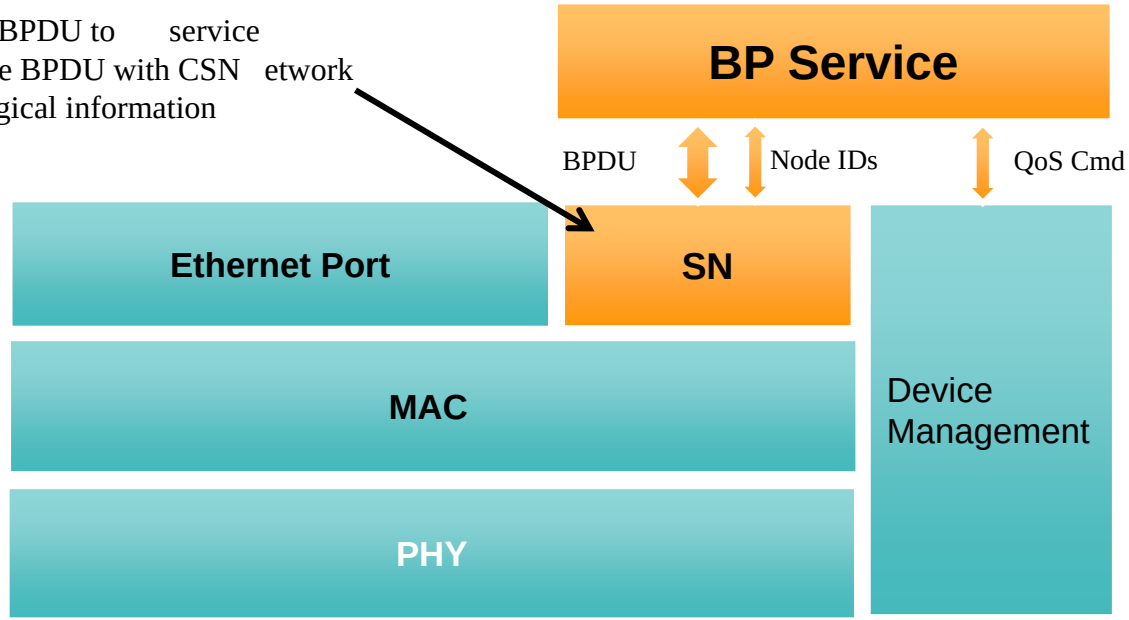
simple interface

CSN bridging method is kept "internal" *(including "node relaying" when applicable)*

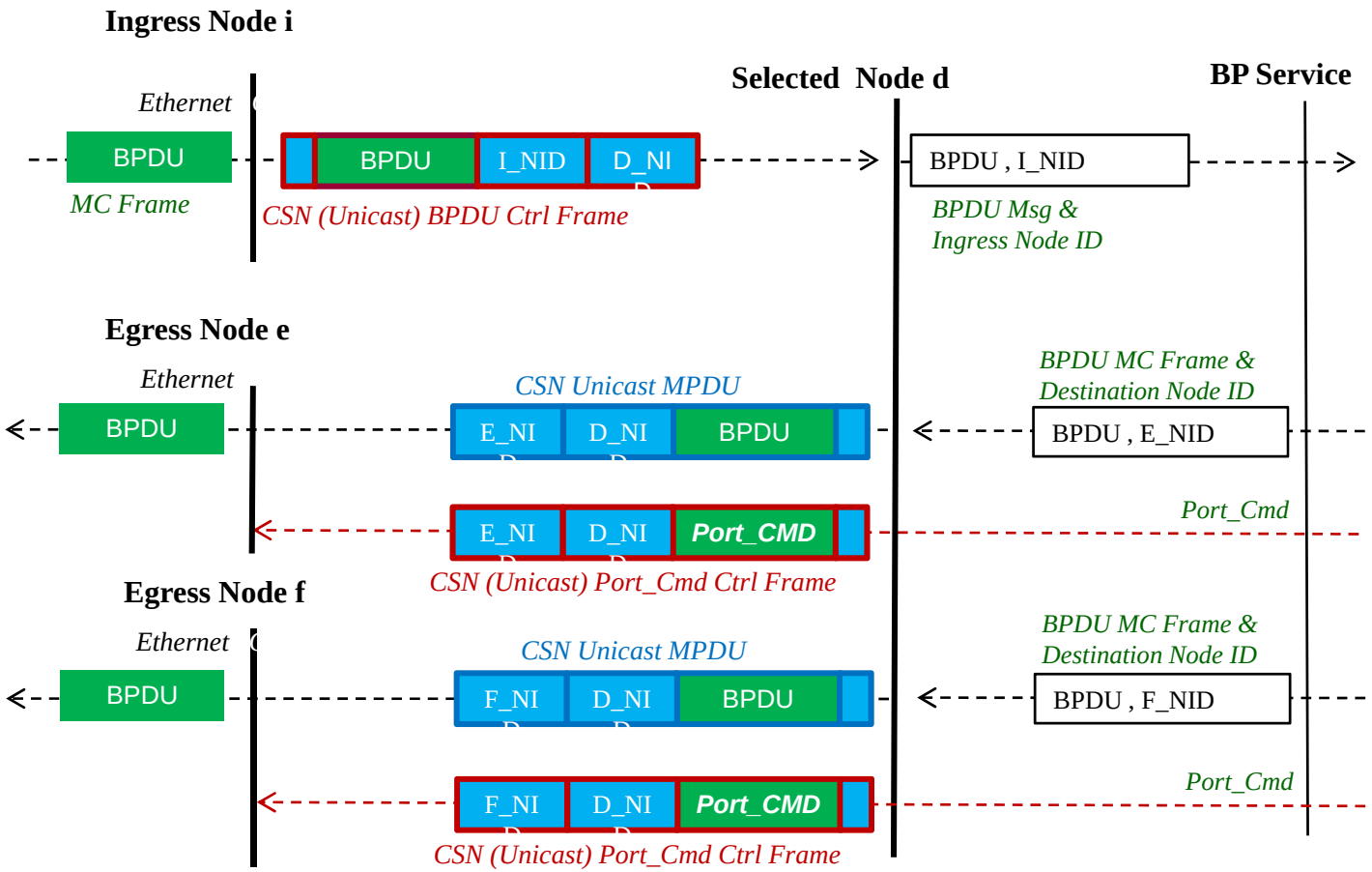
This model is already used by MSRP for CSN and 802.11 BBS (IEEE 802.1Q-2011, Annex C)

Selected Node Architecture

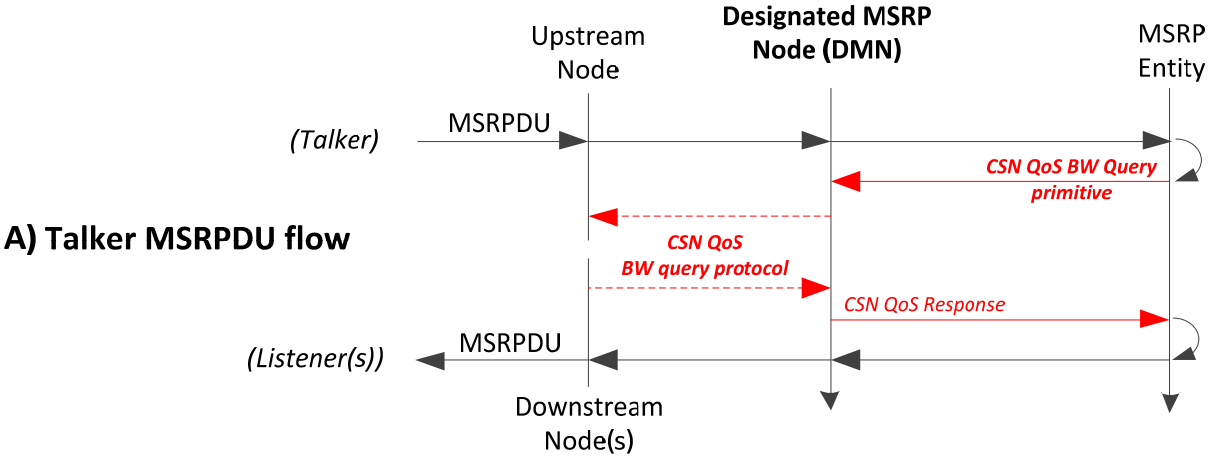
- Route BPDU to service
- Provide BPDU with CSN etwork topological information

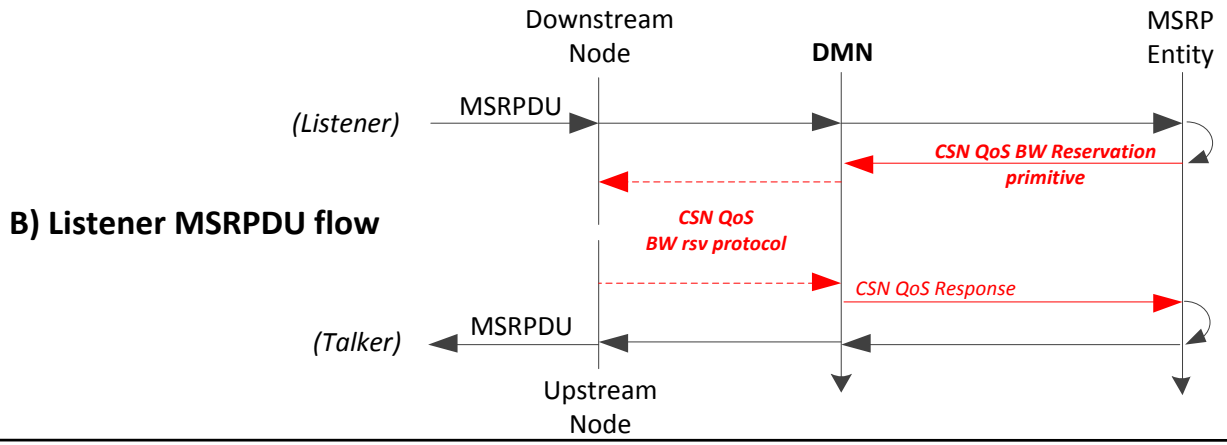


BPDU Propagation over CSN

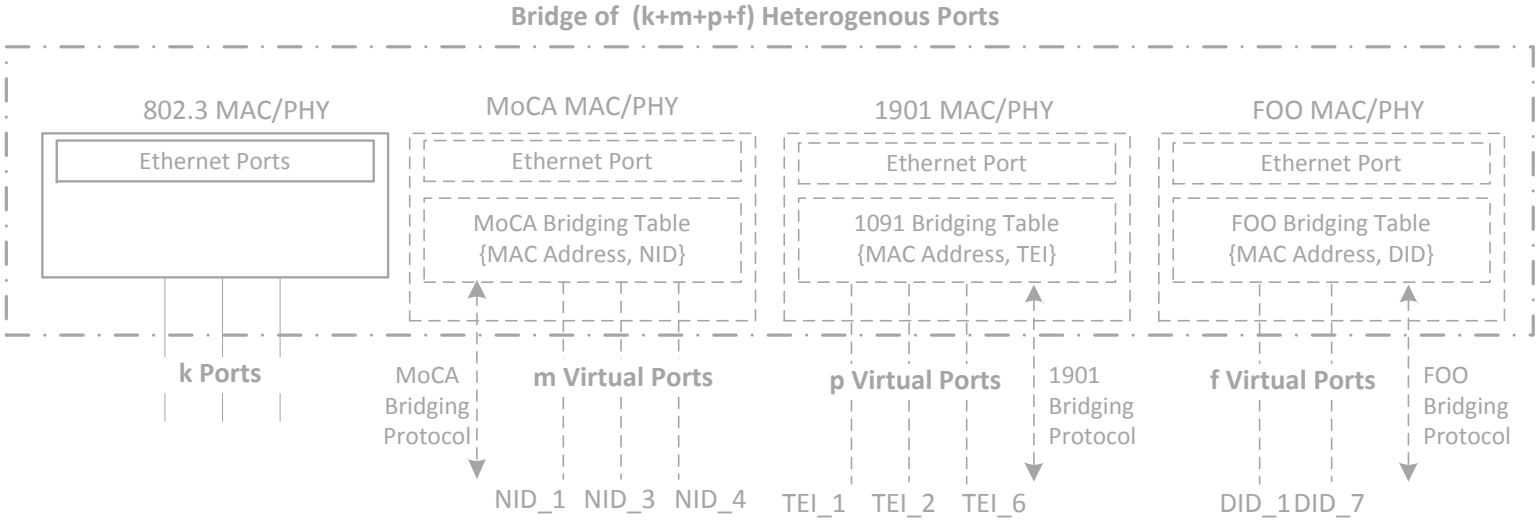


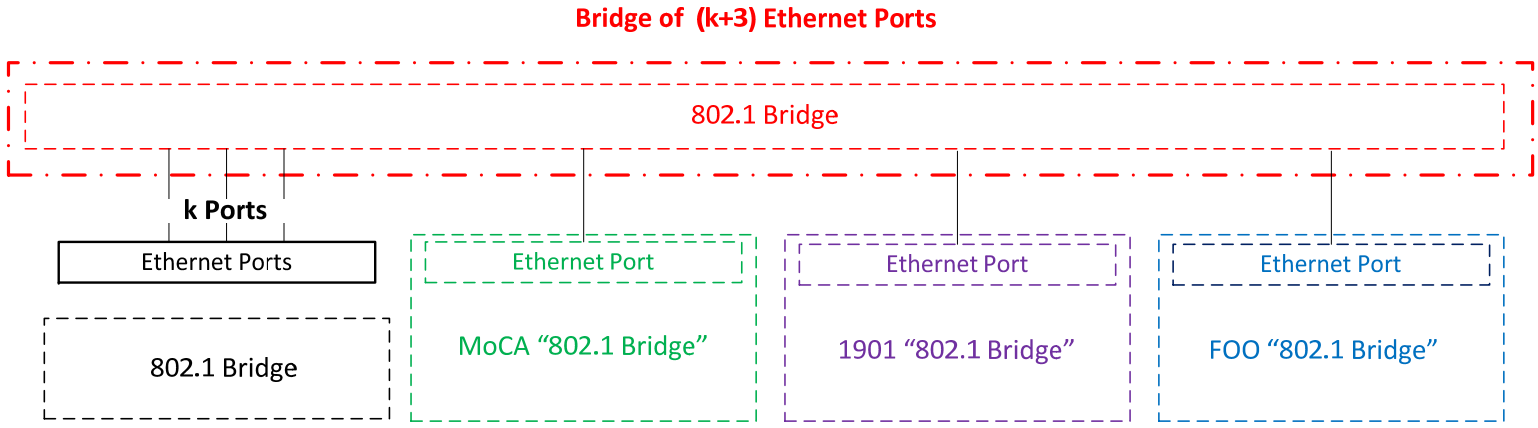
MSRP Example



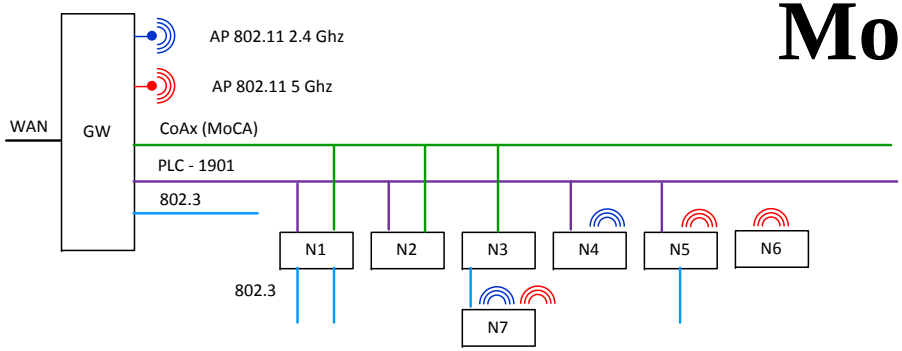


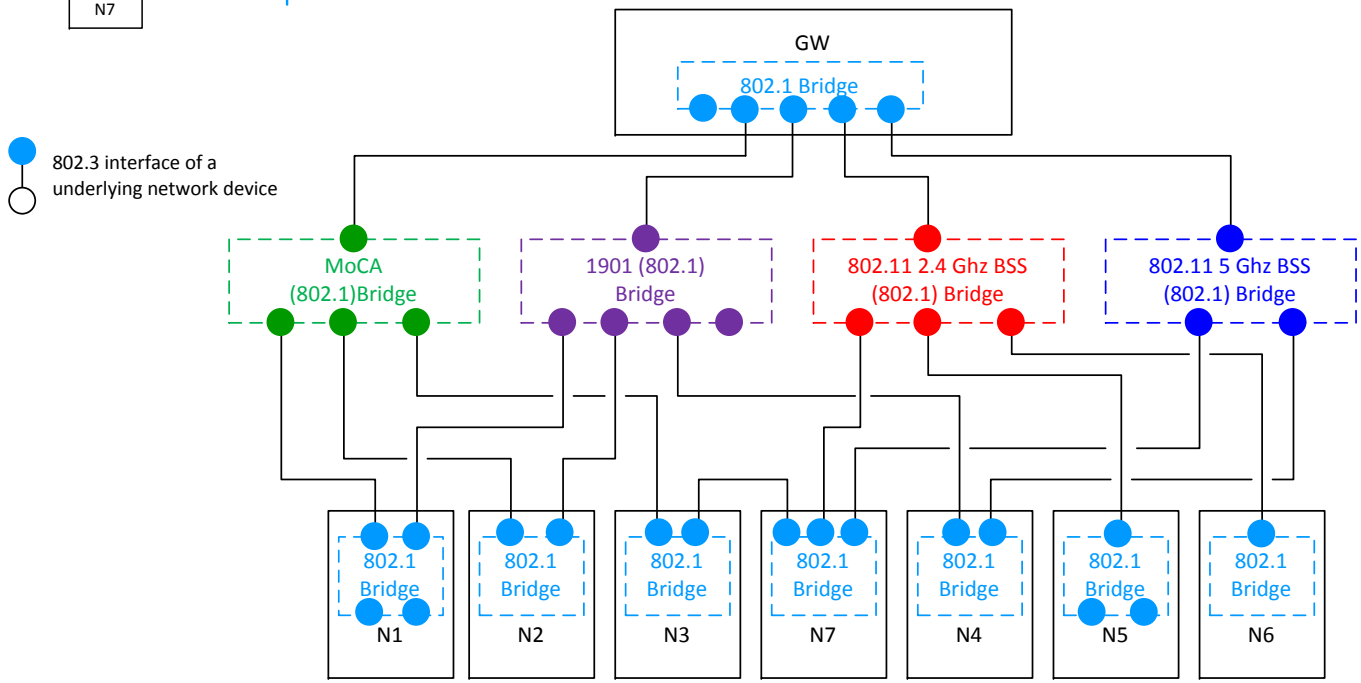
Heterogeneous Network Bridge Model - 2





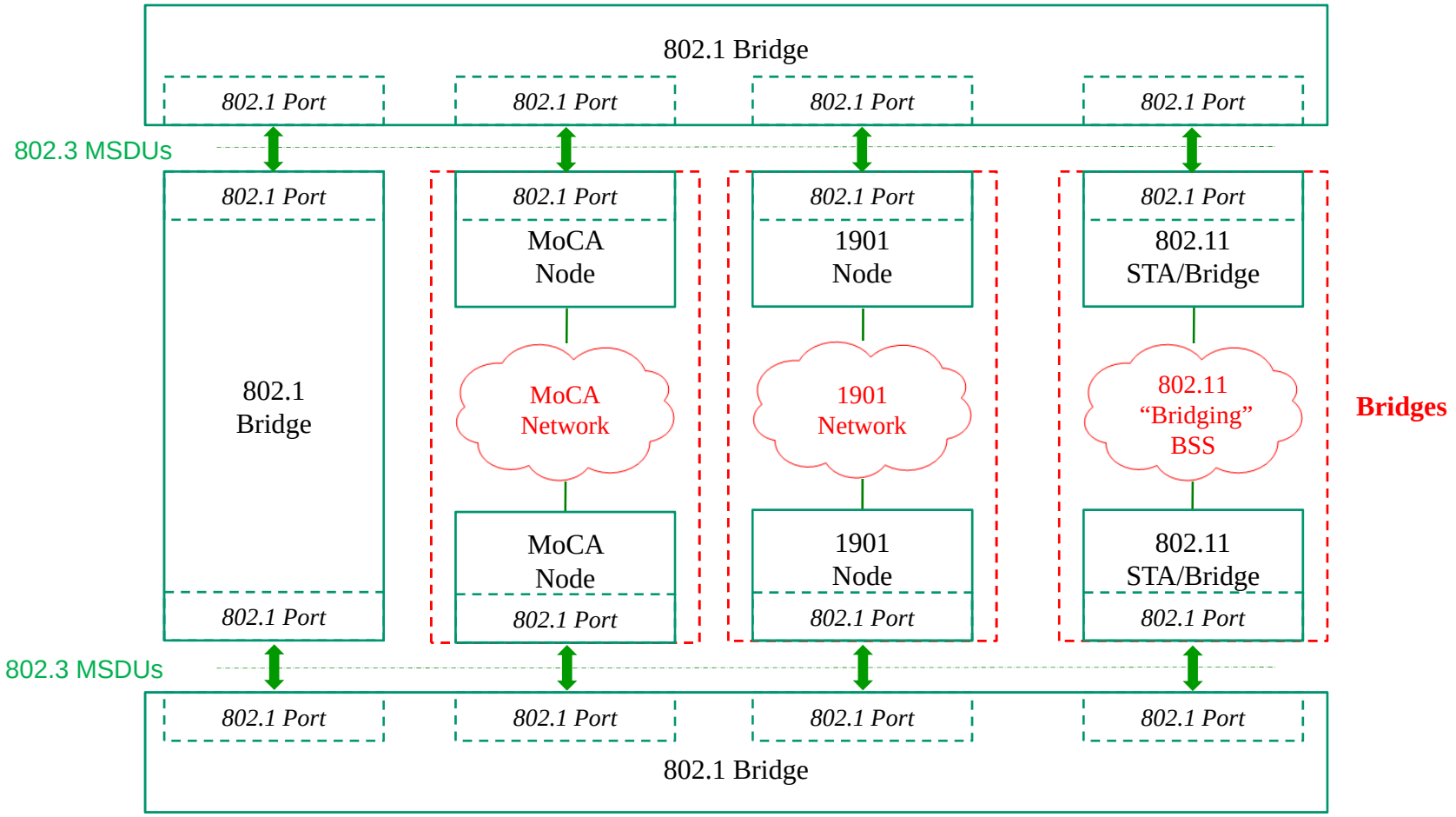
GW Centric Home Network – Bridge Model





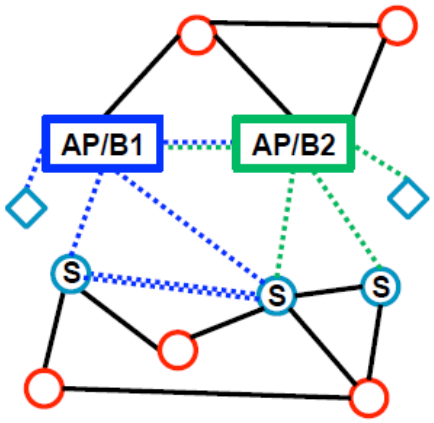
Heterogeneous Networks are Bridged LANs

802.11 BSS handled as other CSN networks



Reminder – Model #1: P2P Link Model

Set of point-to-point links



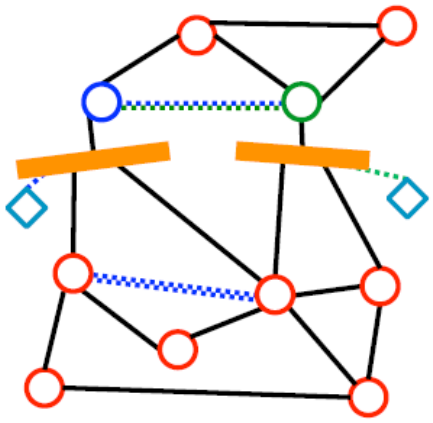
- The Access Points and their co-resident bridging functions become integrated AP bridges (AP/Bs).
- Devices with non-AP station capability(ies) and wired connections become "non-AP station bridges" (S).
- Of course, not all stations are bridges. (The diamonds are non-bridge non-AP stations.)

New-nfinn-11-medium-choice-0812-v02.ppt For IEEE 802.1/802.11 bridging study groups, Aug. 2012 4

Source - Norm Finn's presentation www.ieee802.org/1/files/public/docs2012/new-nfinn-11-medium-choice-0812-v02.pdf

Reminder – Model #2 : Emulated LAN Model

802.11 LAN emulation

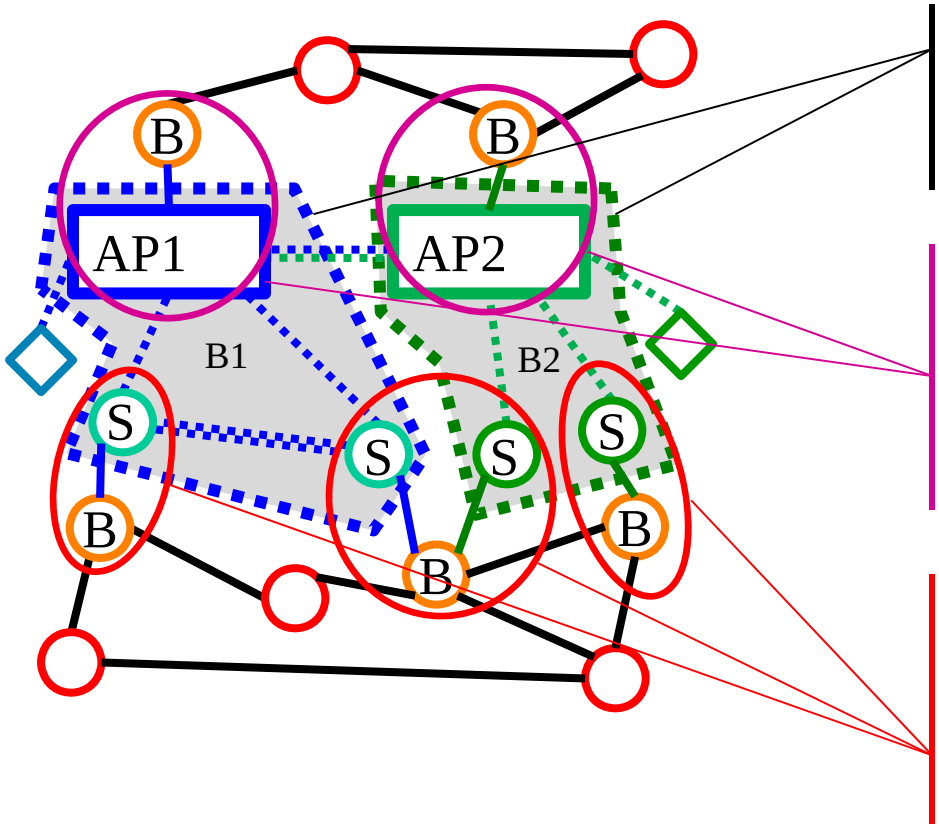


- Each AP and its stations emulate a shared medium LAN (fat yellow coax), as seen by the wired bridges.
- Each AP uses its bridge knowledge to optimize forwarding through the 802.11 medium, rather than broadcasting every frame.
- Direct AP-AP links have to be modeled separately from "coax". Station-station links can be separate (shown) or part of emulated LAN.

New-nfinn-11-medium-choice-0812-v02.ppt For IEEE 802.1/802.11 bridging study groups, Aug. 2012 5

Source - Norm Finn's presentation www.ieee802.org/1/files/public/docs2012/new-nfinn-11-medium-choice-0812-v02.pdf

Proposal - Model #3 : Emulated Bridge Model



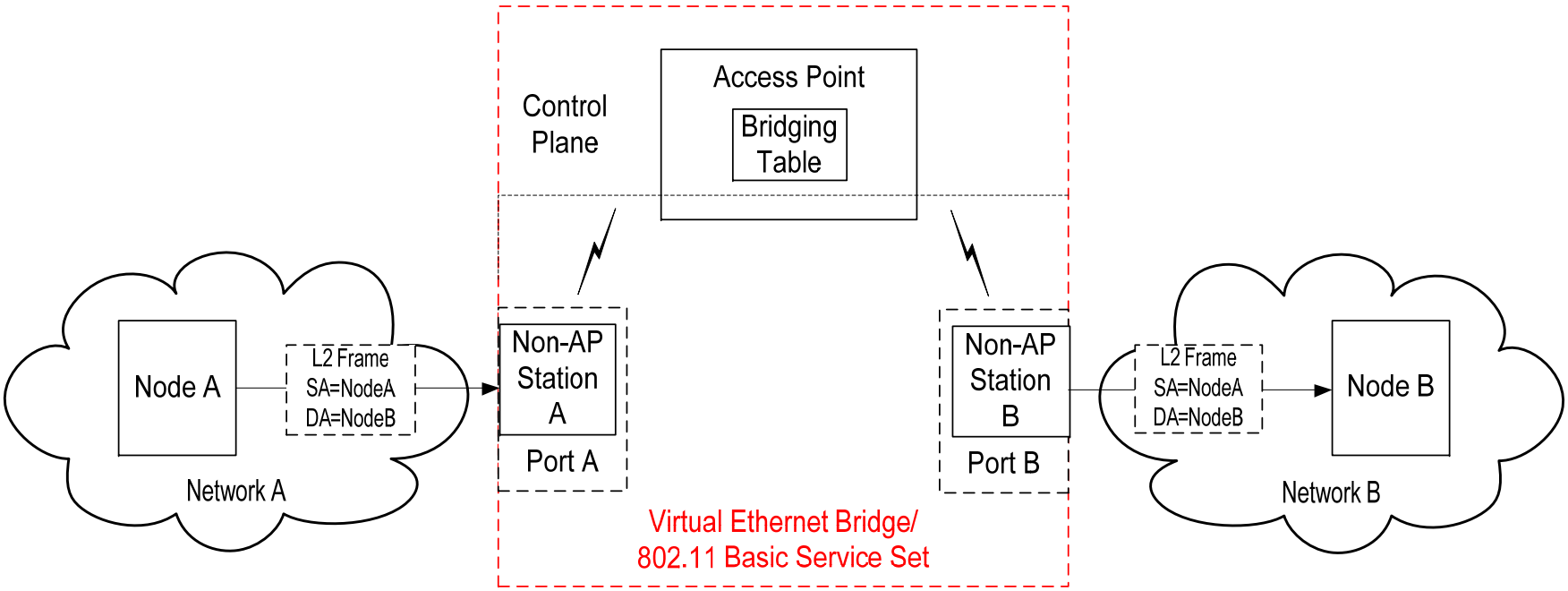
Each BSS (Access Point and its non-AP stations) emulate a single, separated bridge [B1] [B2].

An AP with wired connections is logically separated into an BBS bridge port (AP) and a wired bridge (B).

Each non-AP station/bridge is logically separated into an BSS bridge port and a (virtual) wired bridge (B) (with wires to each component).

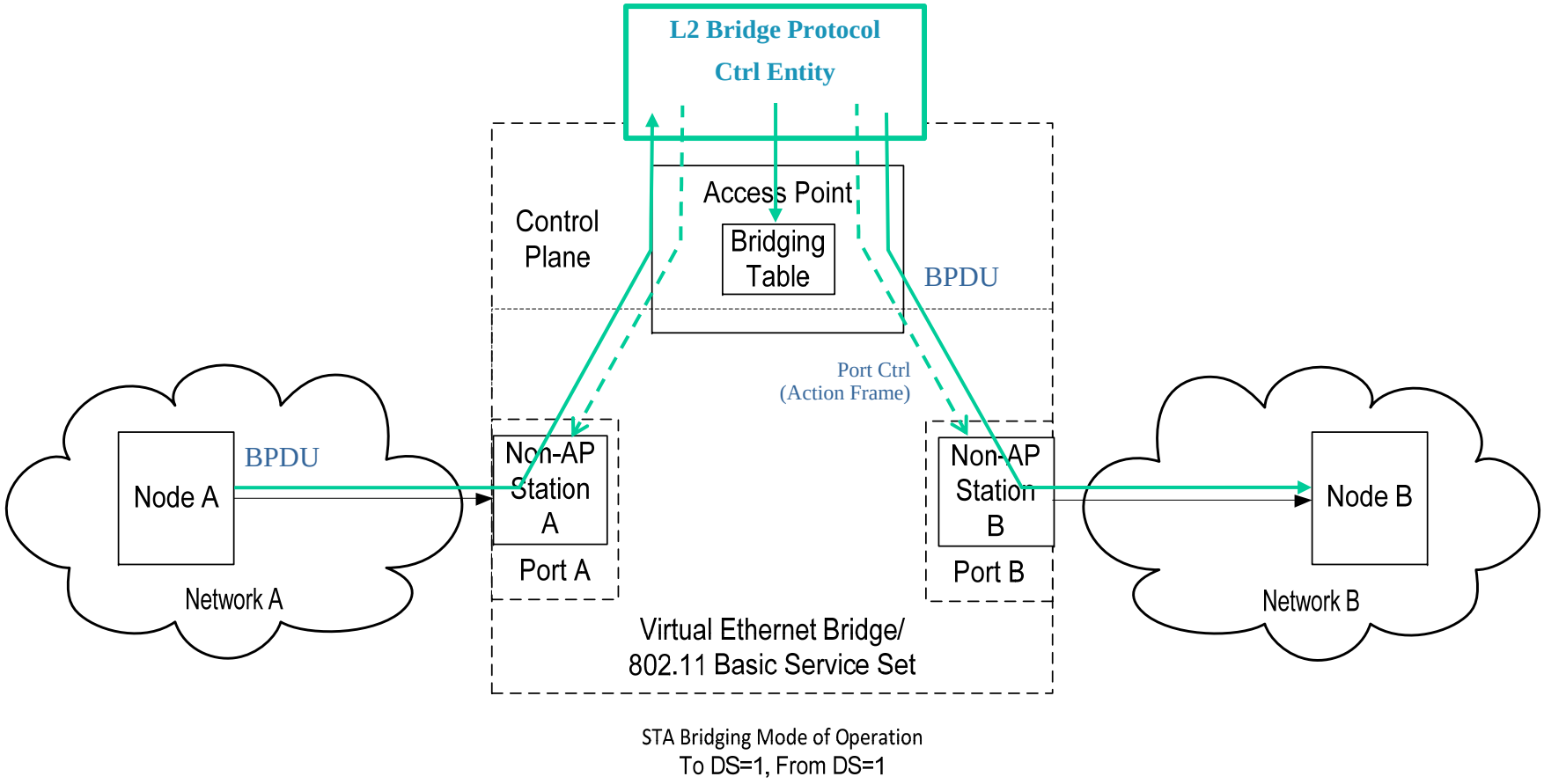
Based on slide, courtesy of Norm Finn

BSS Bridging Model

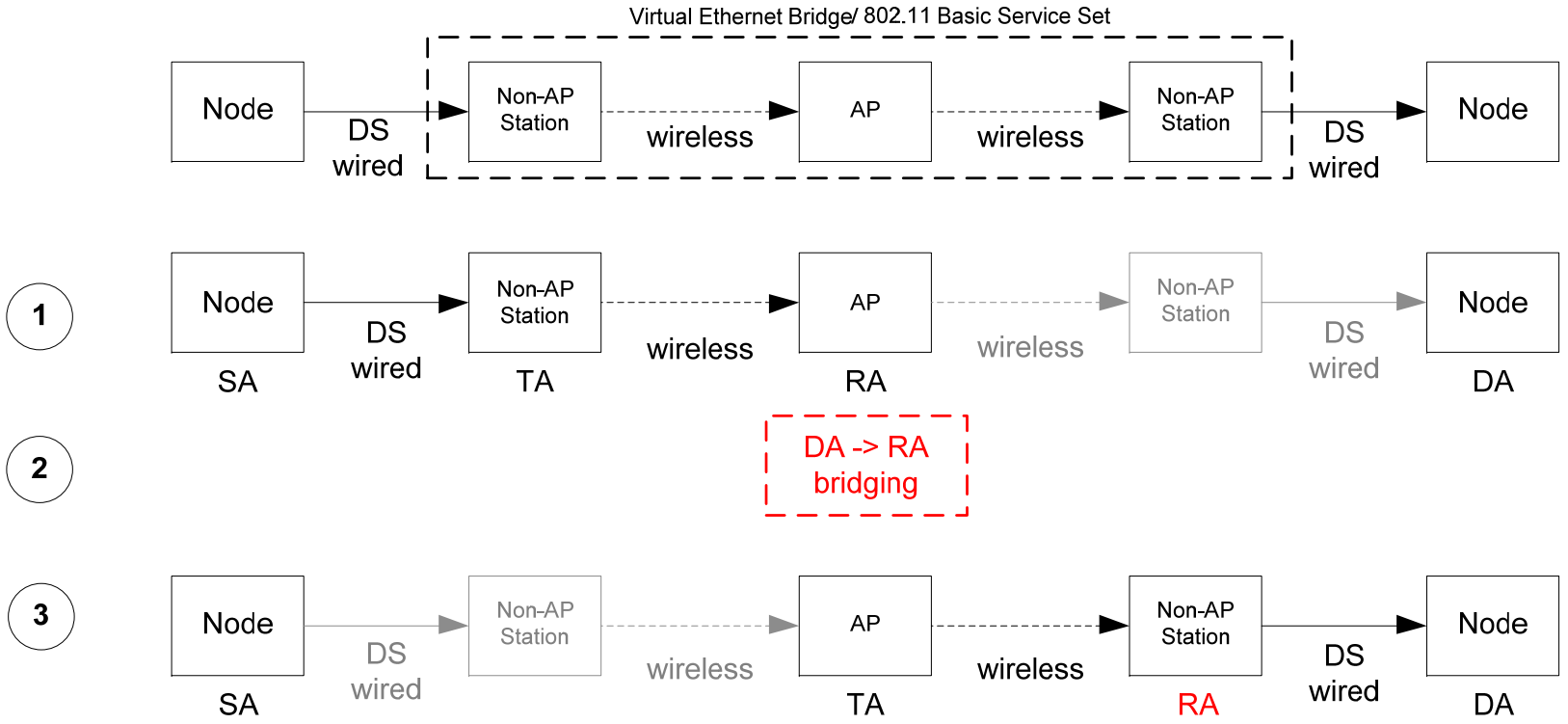


STA Bridging Mode of Operation
To DS=1, From DS=1

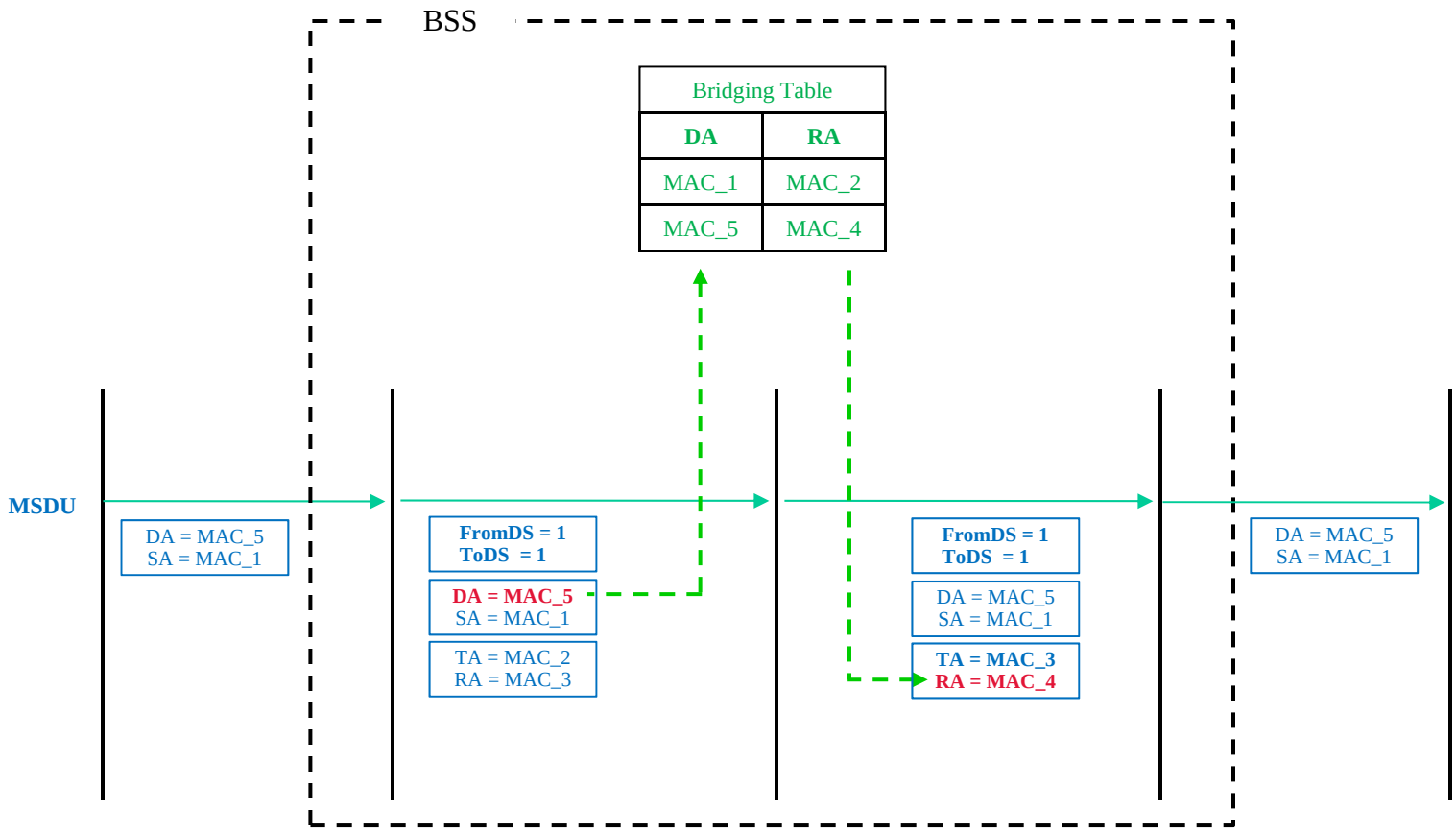
BSS Bridging Model (Single Ctrl Plane)



New AP Bridging Traffic Type



AP Bridging


BSS
Bridging Table
DA
RA
MAC_1
MAC_2
MAC_5
MAC_4
MSDU
DA = MAC_5
SA = MAC_1
FromDS = 1
ToDS = 1
DA = MAC_5
SA = MAC_1
TA = MAC_2
RA = MAC_3
FromDS = 1
ToDS = 1
DA = MAC_5
SA = MAC_1
TA = MAC_3
RA = MAC_4
DA = MAC_5
SA = MAC_1

BSS Bridging

The whole BSS is modeled as a distributed bridge overlaying the 802.11 protocol

- AP acts as the Bridge's Control Plane
- Non-AP Stations act as Bridge Ports

BSS Bridging (cont.)

Modifications to 802.11 are limited to:

1. [ToDS=Set , FromDS=Set] mode behavior redefined at ingress AP and ingress non-AP Stations
2. Broadcast "Echo Cancellation" Method <TBD>
   Could be:
   - *APs broadcast MSDUs without modifying the Sequence Number & non-Stations filter out broadcasted MSDUs they originated on SN matches*
   - *Non-Stations filter out broadcasted MSDUs they originated on TID matches*
3. Additional Parameters to MLME-DLS primitives

Addition to the 802.11 Standard

New Element in Beacon and Probe Response

AP indicates it BSS Bridging Capability in a new BSS Bridging Element in Beacon and Probe Response

AP BSS bridging Capability is controlled by a dot11BSSBridgingCapabilityEnabled parameter

New Action Frames <TBD>

AP control to non-Station ports (i.e. block port…)

New [To DS = Set, From DS = Set] Handling

Non-AP Station originated MSDU received by AP:

AP performs a lookup to the AP Bridging table with the Destination Address (DA) to retrieve the MAC address of the non-AP Station bridging the DA and use it as the Receiver Address (RA) of the forwarded MSDU

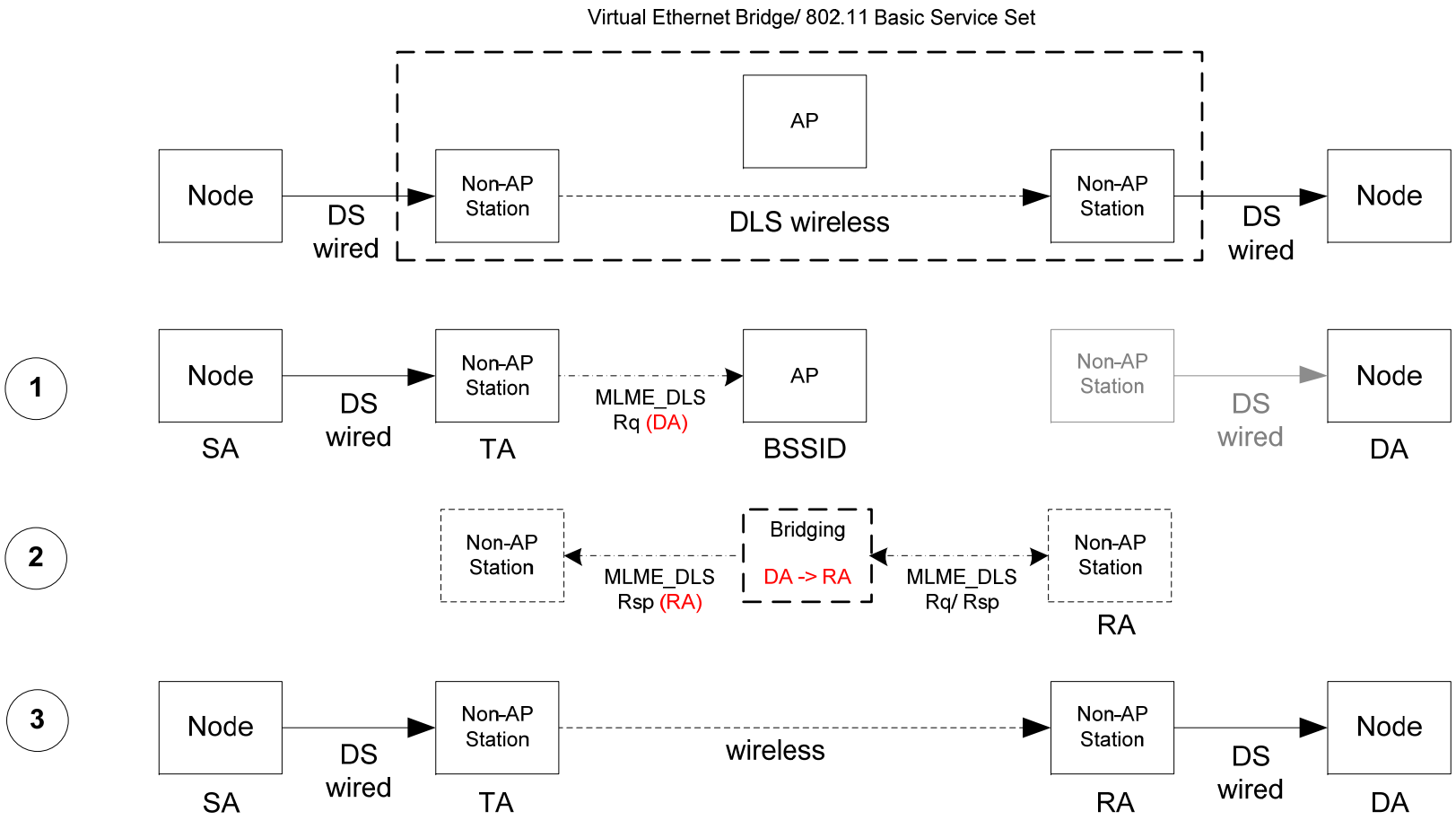
MSDU with unknown or Multicast DA addresses are broadcasted by the AP

AP originated MSDU received by non-AP Station:

If the DA is a Broadcast/Multicast Address, the non-AP Station checks the MSDU Sequence Number or TDI (to match any of the SNs (or TIDs) of the latest Multicast MSDUs by this non-AP Station:

- If match, the non-AP Station discards the receive frame
- Otherwise the non-AP Station extracts the (DA,SA) and uses them as the (DA,SA) of the MSDU bridged by the non-AP Station

New DLS Bridging Traffic Type



DLS Mode Bridging

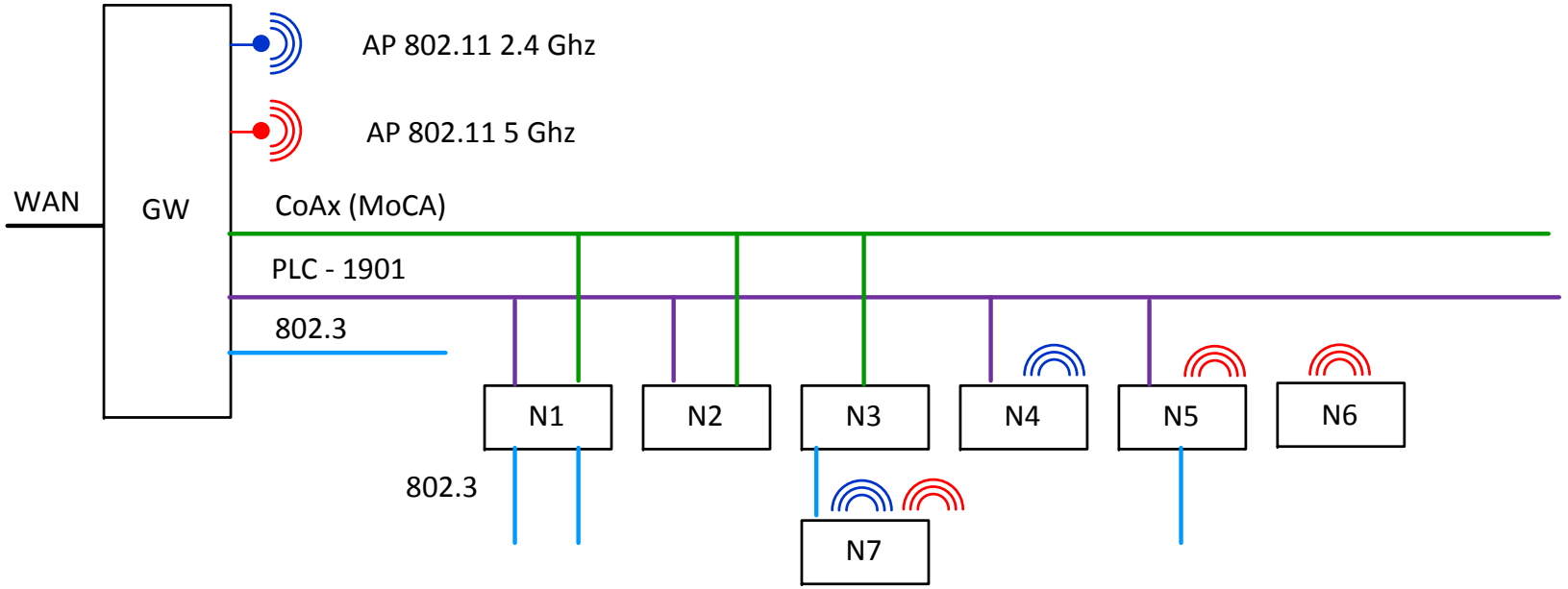
For Direct Link Setup mode, a new MLME-BDLS request primitive could be specified with the DA MAC address replacing the non-AP Station MAC address as parameter:

MLME-BDLS.request (
PeerDAMACAddress,
DLSTimeoutValue,
DLSResponseTimeout)

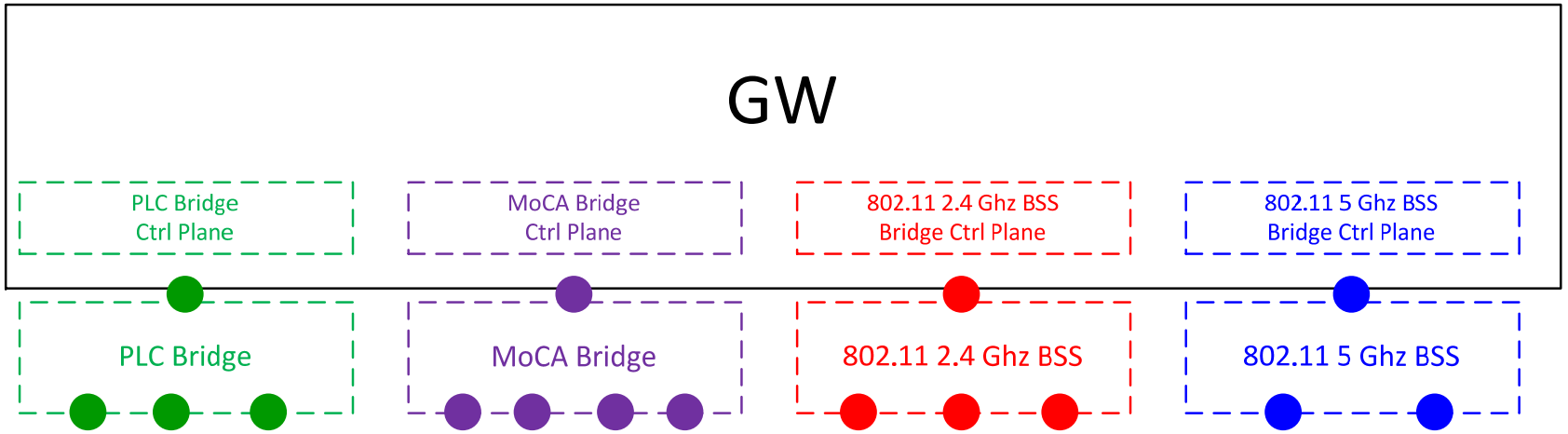
The associated confirm primitive returns the non-AP Station MAC address bridging the DA MAC address :

MLME-BDLS.confirm (
PeerDAMACAddress,
PeerSTAMACAddress,
ResultCode,
CapabilityInformation,
DLSTimeoutValue,
SupportedRates)

GW Centric Heterogeneous Home Network



GW Centric Data Planes



GW is the Designated Node for each CSN:

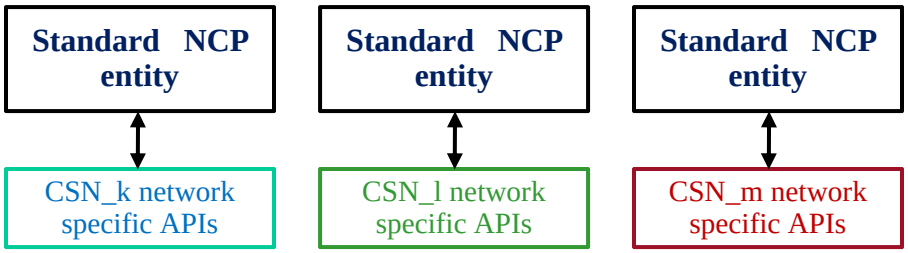
CSN Bridge Data Planes are co-hosted on the GW

GW Centric Data Plane

- **For Network Control Protocols (such RSTP)**

  each CSN bridge runs its owns control plane

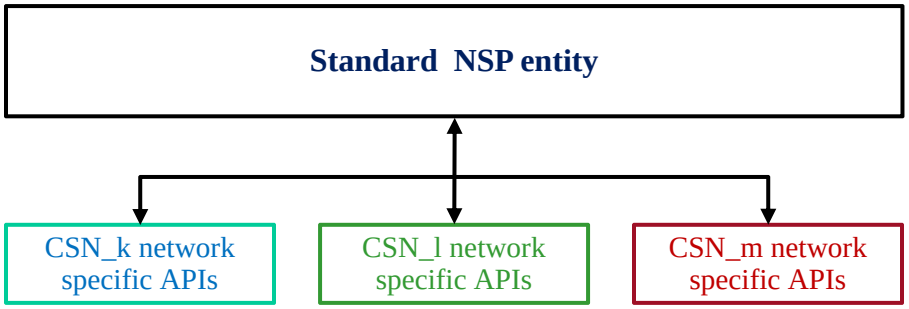
  same 802.1 standard protocol entity instantiated per CSN bridge



- **For Network Service Protocols (such MSRP)**

  a single control plane for all the CSNs

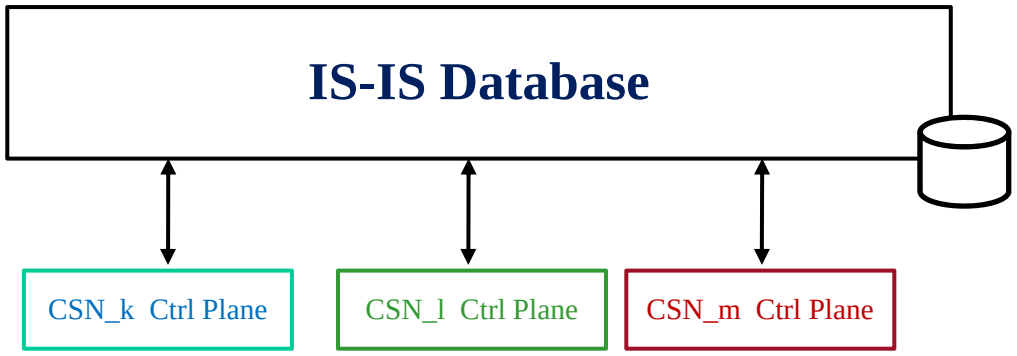
  NSP primitives mapped to each CSN specific APIs



GW Centric Data Plane

Optimized case for IS-IS:

- Single IS-IS Database
- Immediate topology change “propagation”
  - Immediate coherency
  - No traffic overhead between bridges
  - Optimized resource



References

[1] White Paper: Control Plane Implementation on Coordinated Shared Networks (CSN): http://www.ieee802.org/1/files/public/docs2011/avb-phkl-wp-csn-ctrl-plane-1111-v01.pdf

[2] IEEE 802.1Q-2011, Annex C http://standards.ieee.org/getieee802/download/802.1Q-2011.pdf