802.1aq Shortest Path Bridging March Recap

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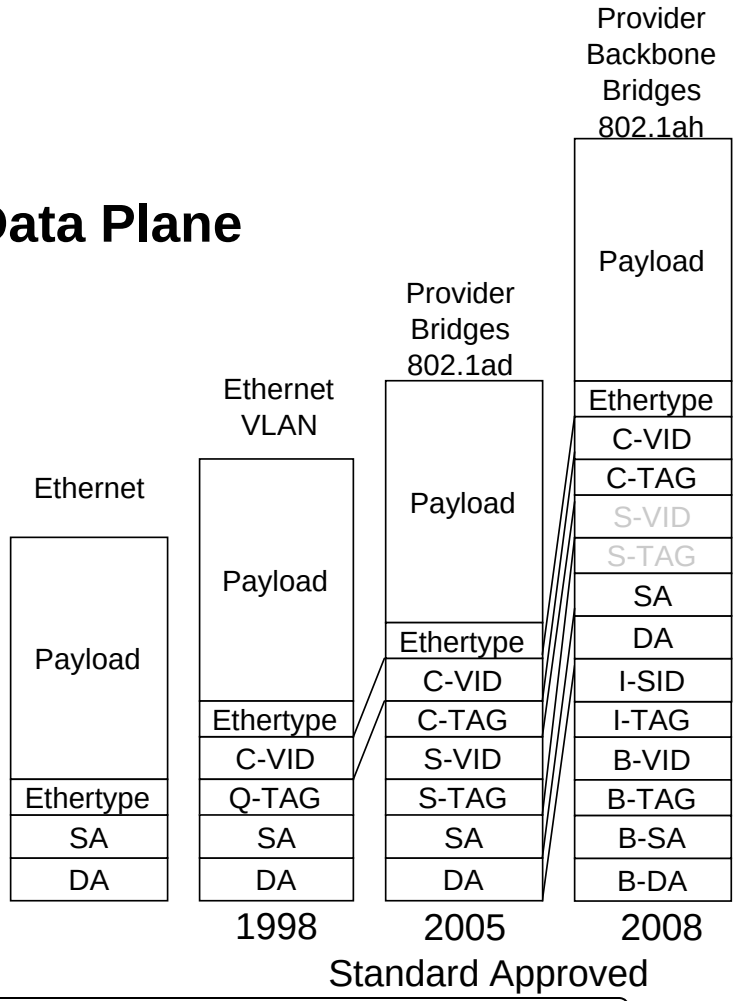
Shortest Path Bridging Project Authorization Request

- Scope :VLAN Bridges
  - Shortest Path within a region
  - Interwork with Spanning Tree Protocols, RSTP, MSTP bridges
    - This standard specifies shortest path bridging of unicast and multicast frames, including protocols to calculate multiple active topologies that can share learnt station location information, and support of a VLAN by multiple, per topology, VLAN identifiers (VIDs).
  - Compatibility
    - This amendment will not change the conformance of IEEE Std 802.1Q to Std 802. Overview and Architecture, or its relationship to that specification.

802.1Q Data Planes

We have a long standing Data Plane

SA = Source MAC address
DA = Destination MAC address
VID = VLAN ID
C-VID = Customer VID
S-VID = Service VID
I-SID = Service ID
B-VID = Backbone VID
B-DA = Backbone DA
B-SA = Backbone SA



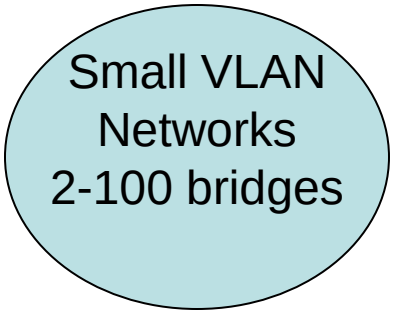
Supports Data Plane OAM (CFM, MIP, MEPs)

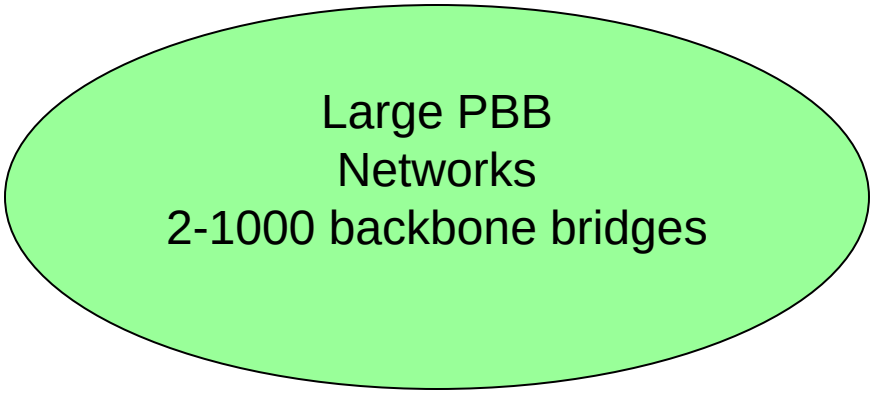
Applicability

IEEE 802.1aq

Shortest Path Bridging (SPB)

Shortest Path Backbone Bridging (SPBB)





Plug and play
Efficient
Low delay
Backwards Compatible

Carrier Grade
Fast convergence
Efficient use of resources
B-VLAN Partitioned Forwarding Compatible

E-Line, E-Tree, E-LAN Services

Provider E-Line, E-Tree, E-LAN Services

What is unique about SPB?

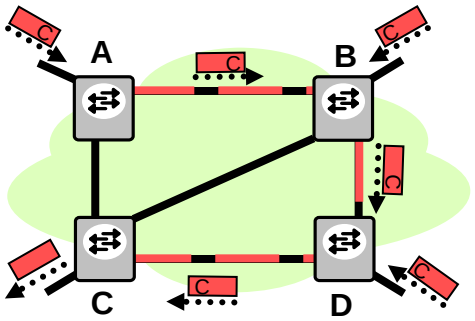
- Link state application to shortest path trees compatible with 802.1 architecture
  - Link state versus lots of messaging (BPDUs)
  - Computation replaces messaging
    - All pairs shortest path
- SPBB provides fast and robust PBB B-MAC topology
  - Service Discovery via the I-SIDs
  - Efficient Multicast Trees
  - The most comprehensive control plane for PBB

What SPB is not about

- Traffic engineering
  - PBB-TE is available
  - MSTP is available
- Multi-Domain
  - Single Level ISIS-SPB
  - No inter domain protocols

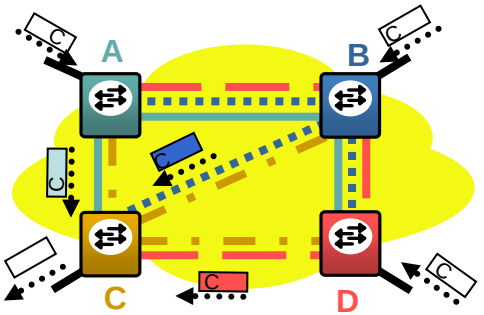
Motivation

- RSTP/MSTP forwarding
  - Detours appear
  - Manual configuration is needed for disjoint trees
  - Forwarding can be only optimized by manual configuration



Spanning tree forwarding

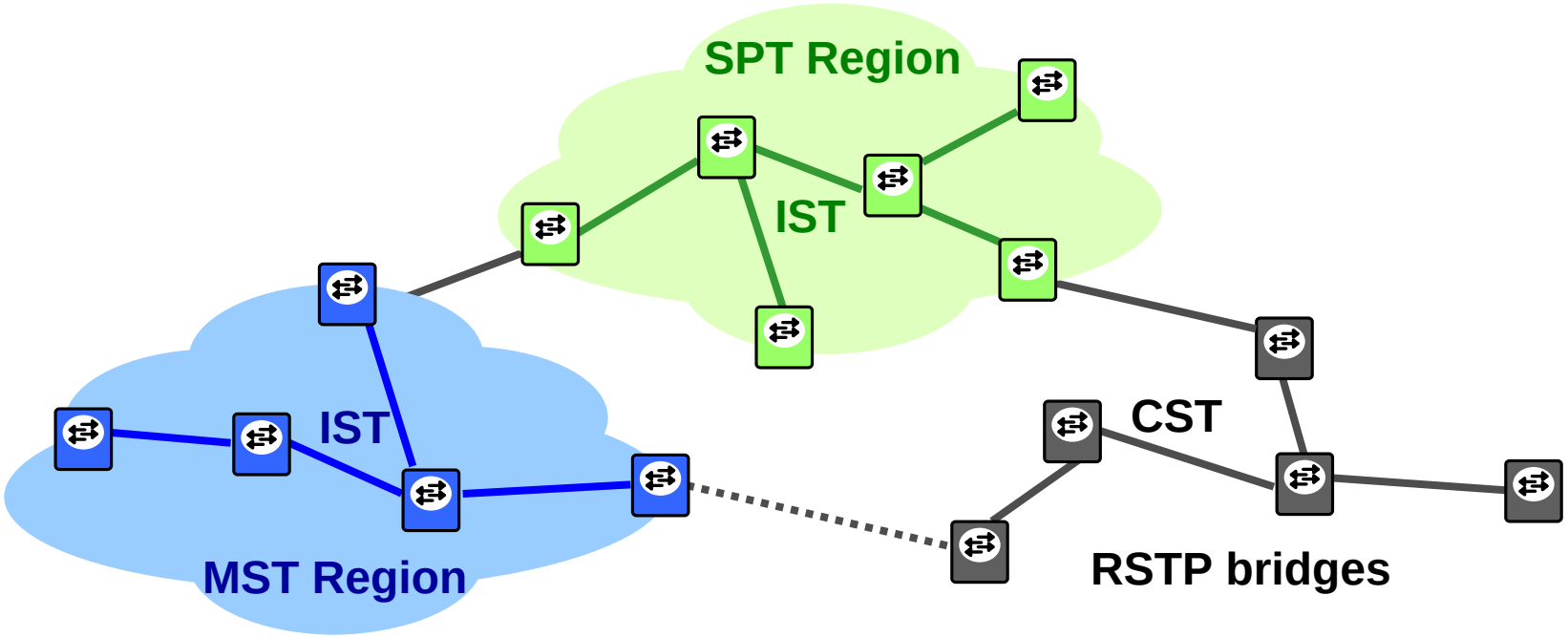
- Shortest path forwarding
  - Each bridge only sends frames on its own Shortest Path Tree (SPT)
  - Automatic SPT management
  - Controlled by IS-IS



SPB forwarding

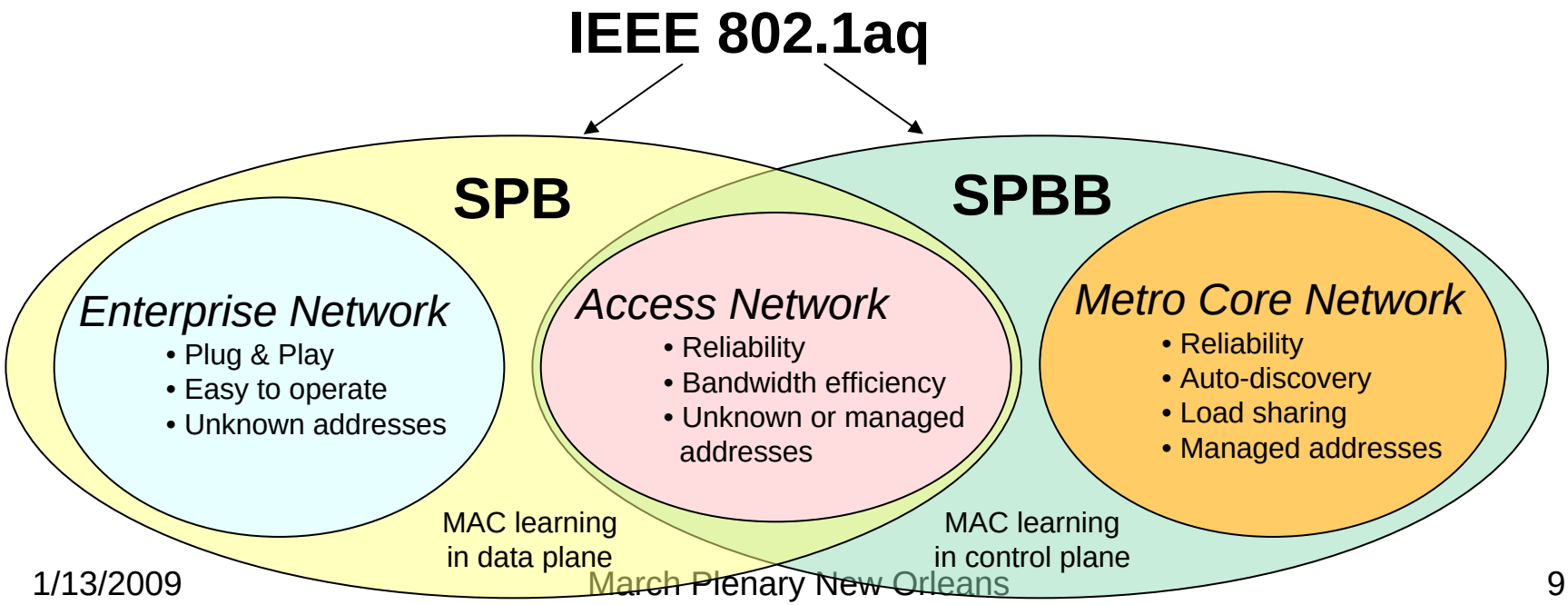
Interworking with RSTP and MSTP

- Common Spanning Tree (CST)
- Internal Spanning Tree (IST)
- Common and Internal Spanning Tree



IEEE 802.1aq variants

- Shortest Path Backbone Bridging (SPBB) is aimed to be deployed in PBB networks where all addresses are managed
- Shortest Path Bridging (SPB) is applicable in customer, enterprise or storage area networks



IS-IS controls IEEE 802.1aq

- Topology discovery
  - Each bridge is aware of the physical topology of the SPT Region
- Service discovery
  - I-SID registrations are included into a new TLV
- Shortest Path Tree computation
- Maintenance of SPTs and CIST
- SPTs can be set according to the discovered I-SID membership information
  - MRP is not needed
- VID allocation to VLANs

Source tree identification

VLAN ID

- An SPT is identified by the SPVID assigned to the source bridge

✓ Applicable to both 802.1Q and 802.1ah bridges

✓ Ingress check on VID

✗ Consumes VLAN space

✗ Unidirectional VIDs

MAC address

- B-SA and its Nickname incorporated into Group MAC DA identifies an SPT

✓ Two VIDs only used for a whole set of Shortest Path Trees (Base VID and another VID)

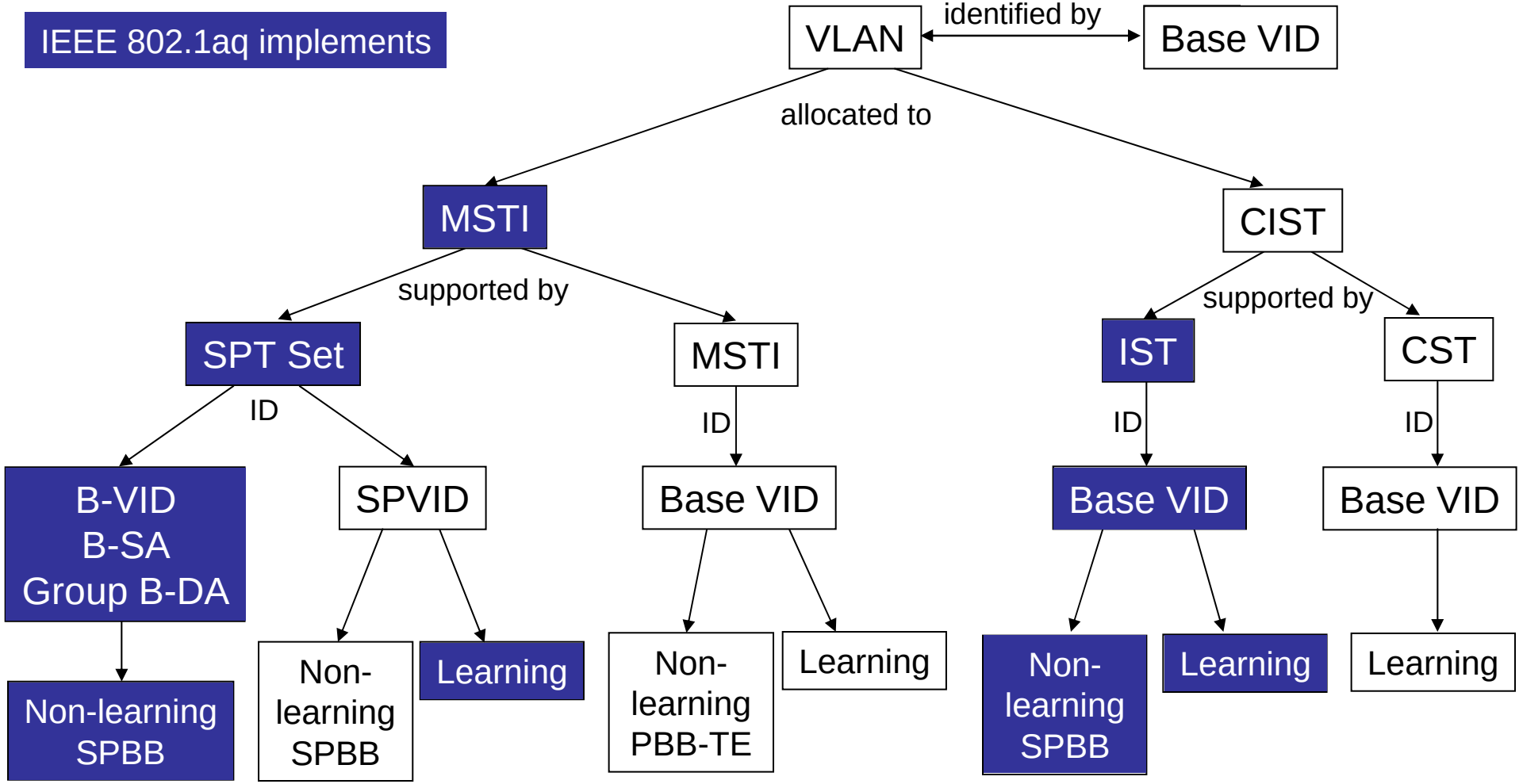
✓ Bidirectionality of VID is preserved

✗ Only applicable to 802.1ah bridges

✗ Ingress check on SA

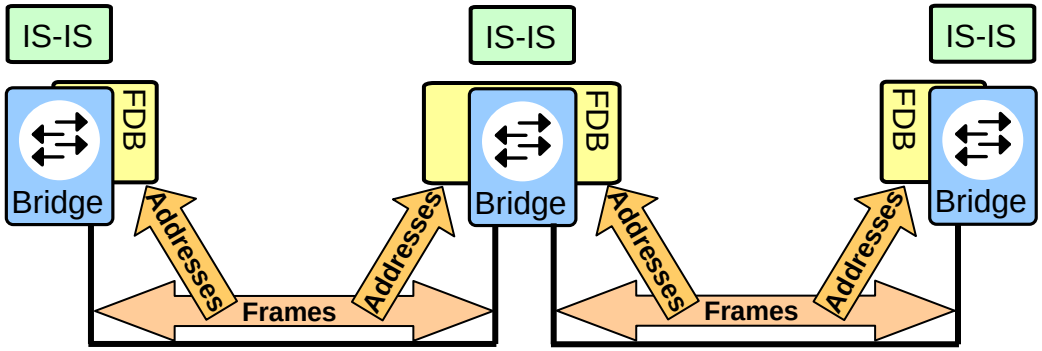
✗ All group MAC addresses take the local bit mapping

VLAN assignment



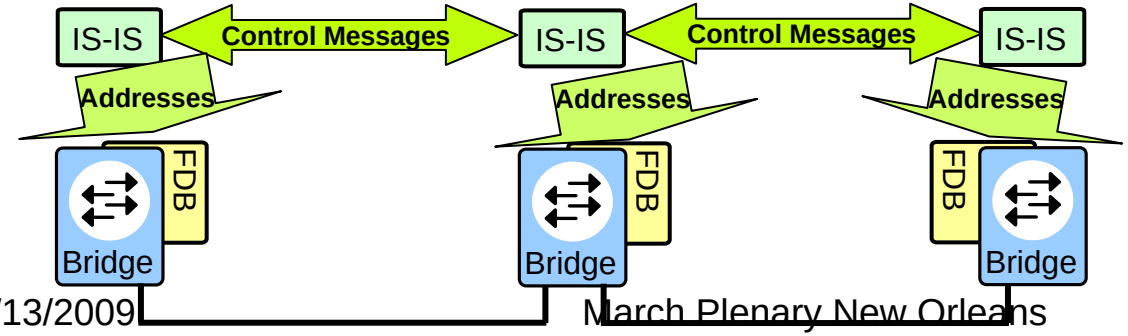
MAC learning

- MAC learning in the data plane (Learning)



SPB

- MAC learning in the control plane (Non-learning)

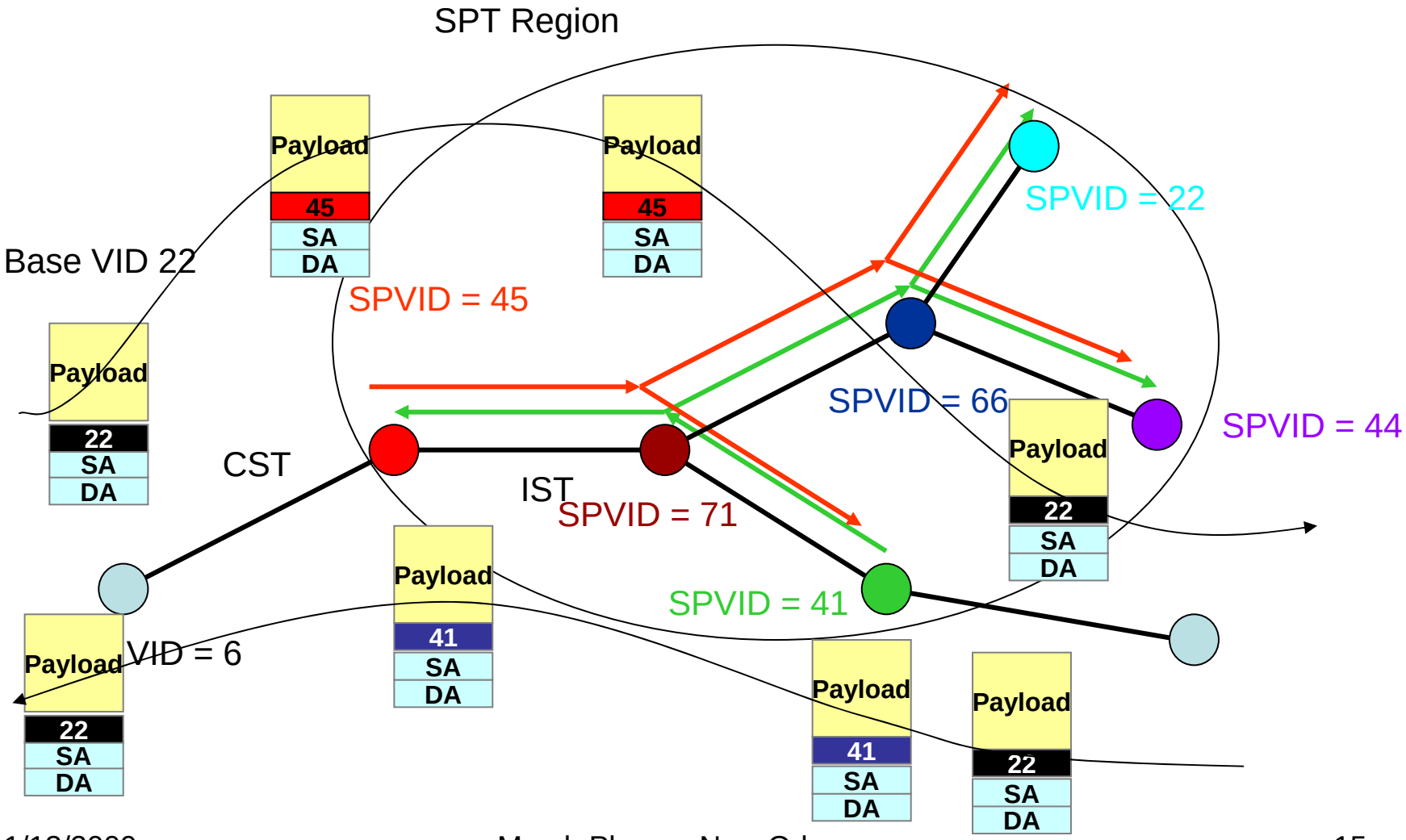


SPBB B-MACs

SPB

- SPB (802.1Q compliant)
  - Uses VID for source identification, don’t own the C-MAC
  - Solution Attributes
    - VID Trees, one source per bridge, distributed in IS-IS
    - SVL learning of unicast forwarding supported
  - Solution Requirements
    - Must Interwork at edges with RSTP, MSTP
    - The region may default to a single instance MSTP (associated with the “Base VID”) if the VID allocation fails or detects errors
    - Must support loop prevention, may support ingress check

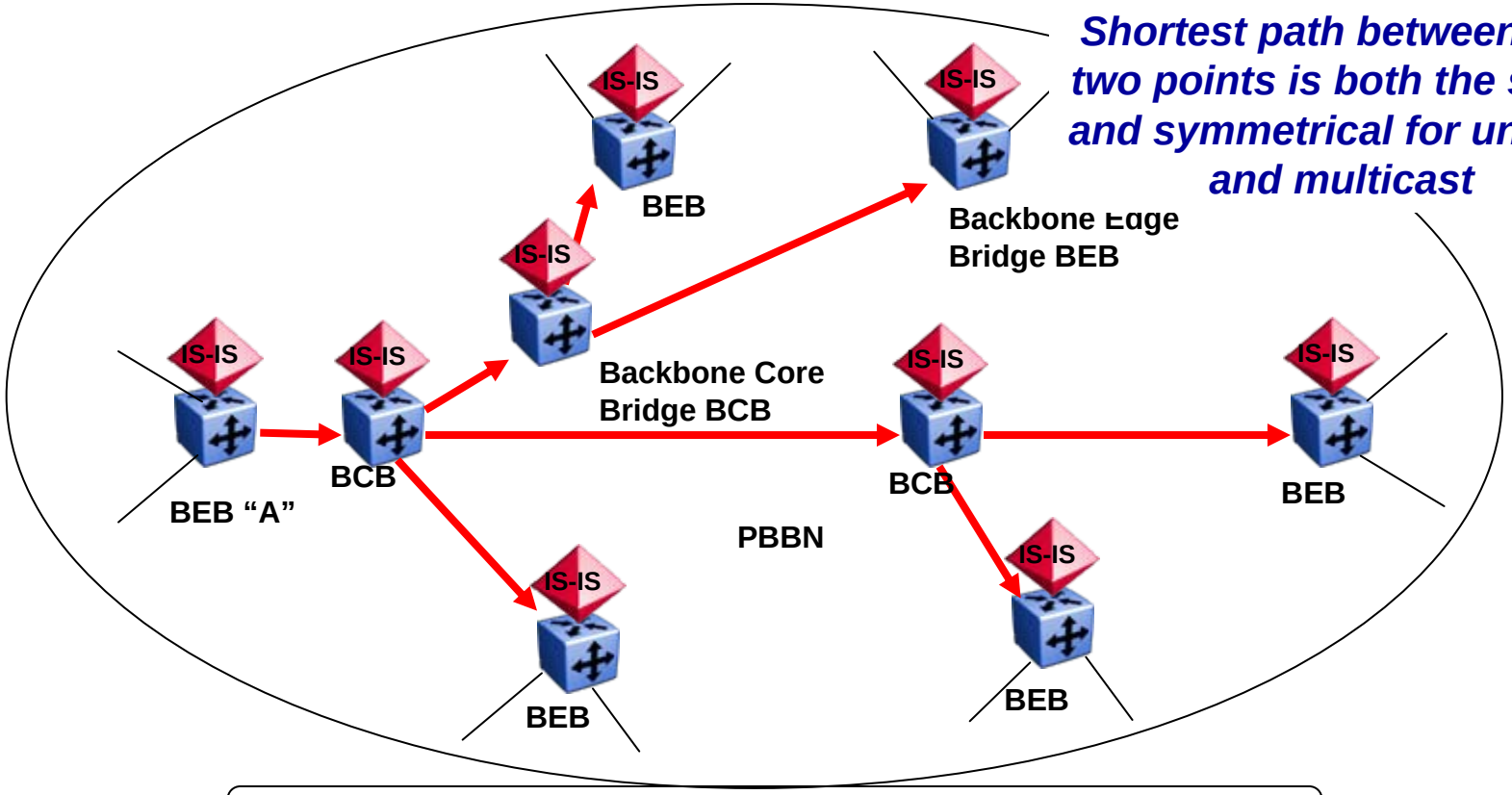
SPB Concepts



SPBB

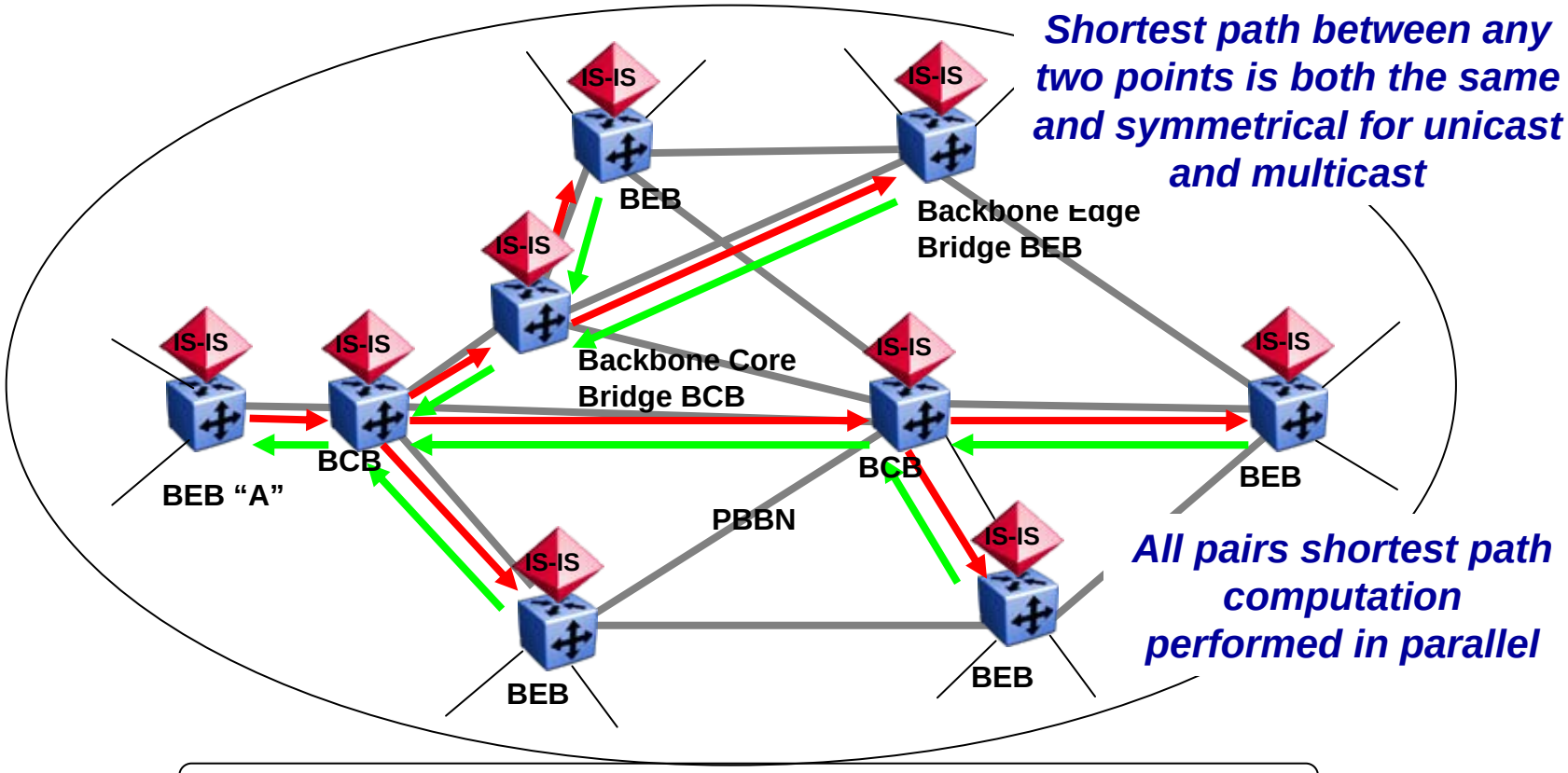
- SPBB (Shortest Path Backbone Bridging)
  - Solution Attributes
    - Single VID for an SPT Region (may use VID Trees)
    - Does not use learning of B-MACs
      - Provider addresses will all be known allows for more efficient flooding (no B-MAC broadcast storms),
    - Reduction in forwarding space Shared Forwarding,
  - Solution Requirements
    - Must use Multicast loop Prevention,
    - Must use ingress check for unicast

SPBB Operation



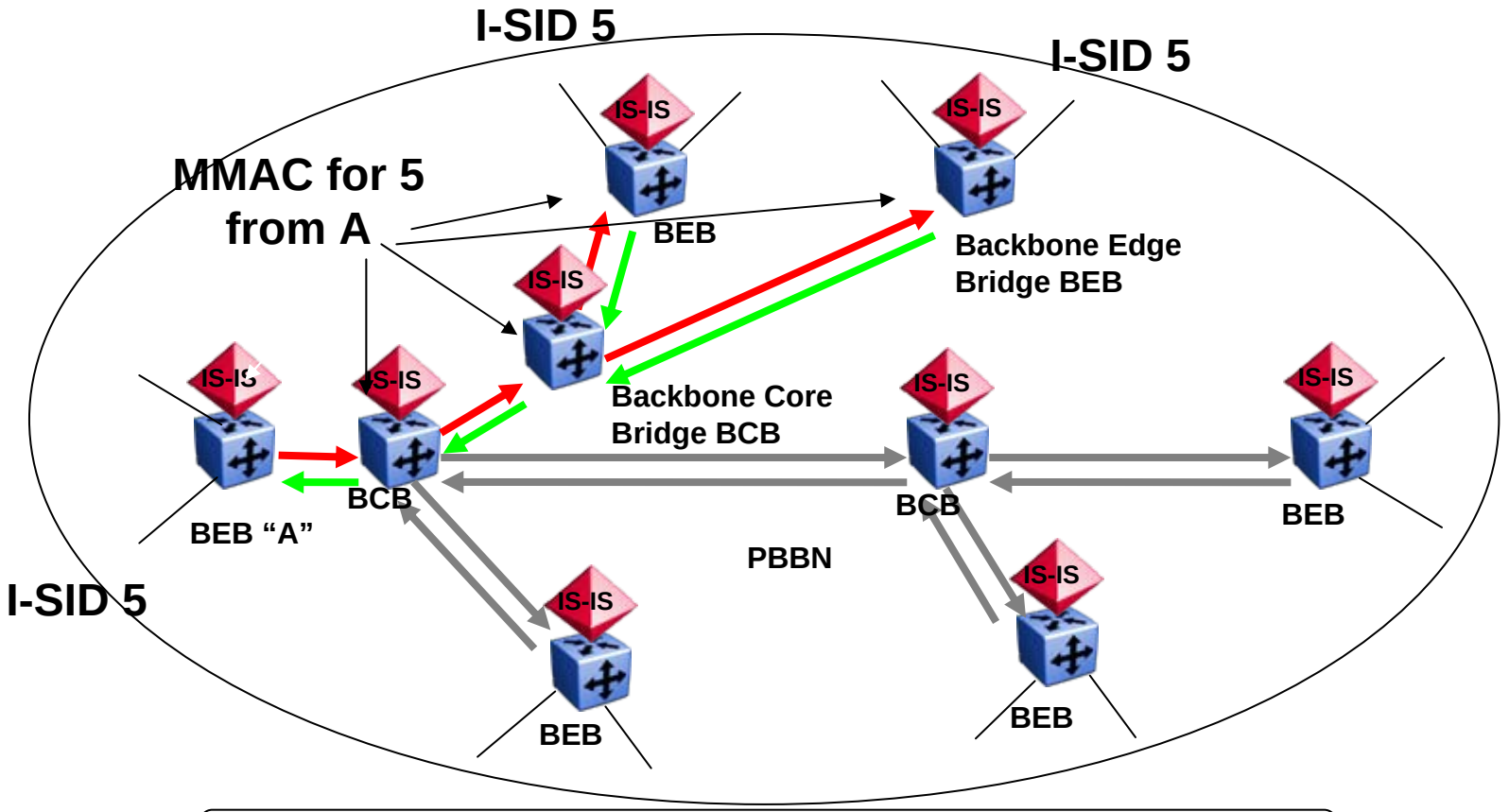
Shortest Path Tree from "A"

SPBB Shortest Path Tree to/from “A”



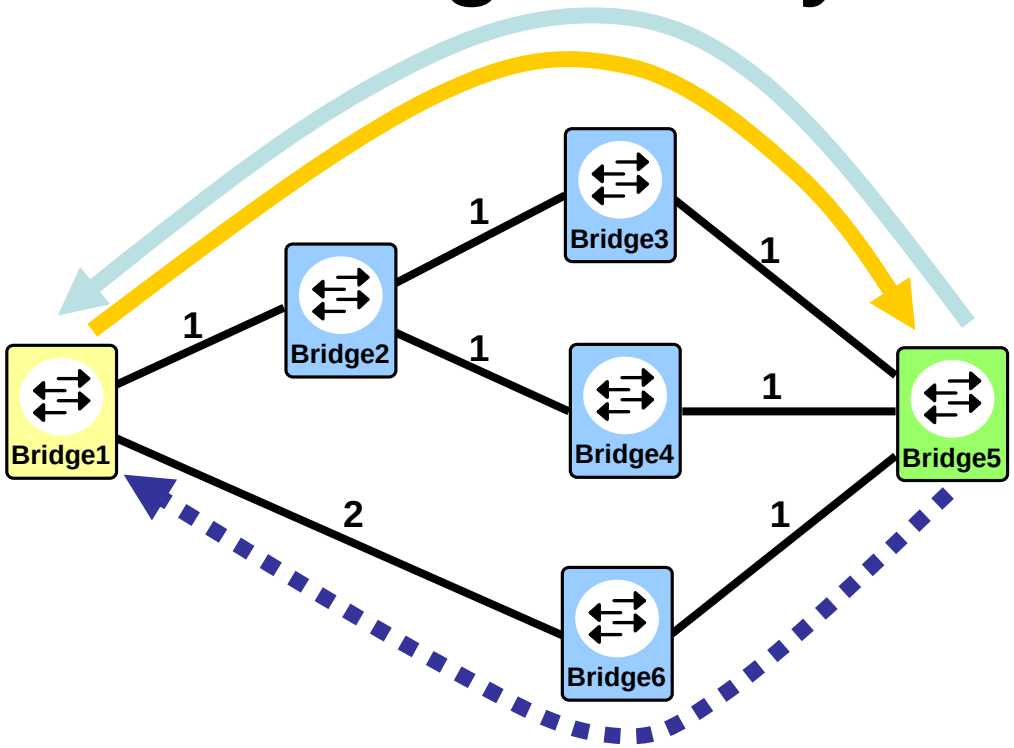
Uses the full mesh network

SPBB Multicast Groups



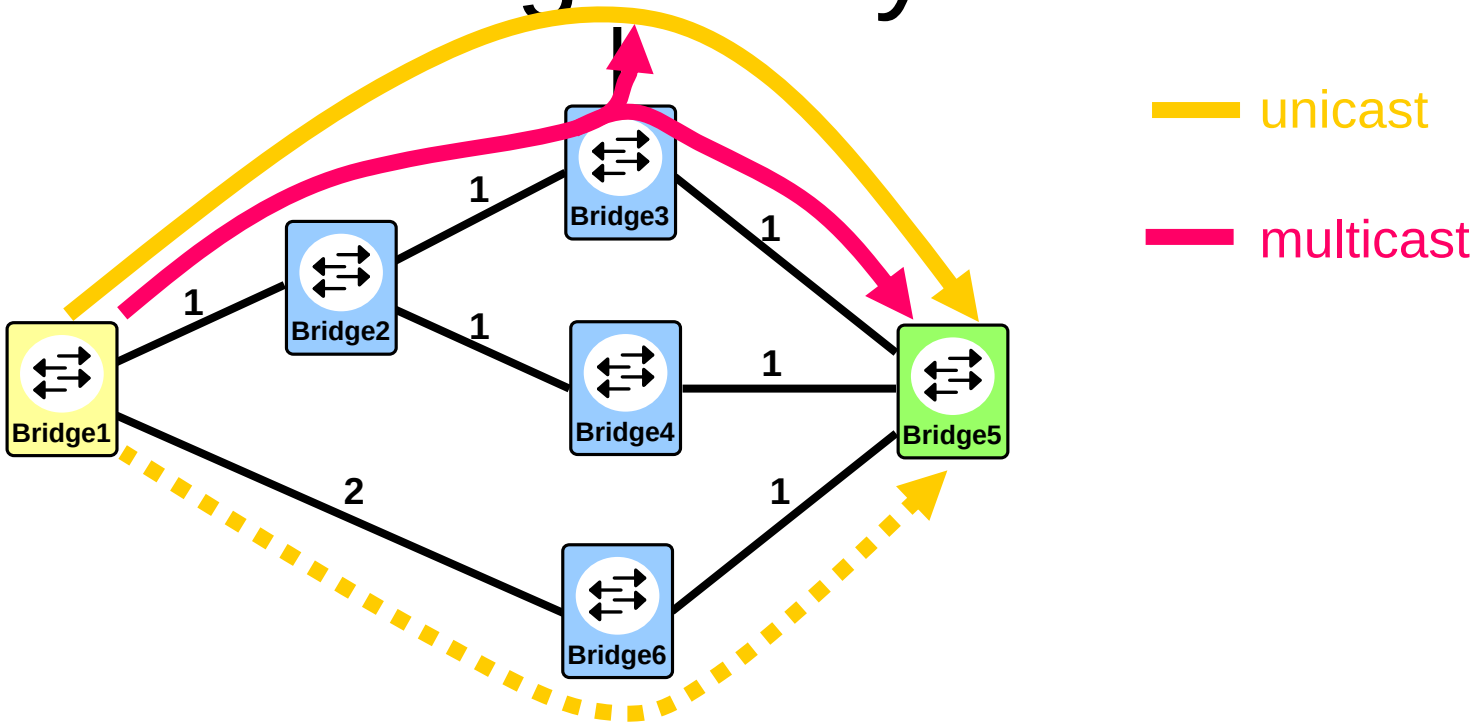
I-SIDs define efficient subsets

Forward and Reverse path Congruency



- Necessary if MAC learning is in the data plane
- Not necessary if MAC learning is in the control plane
- Going to be assured by both SPB and SPBB

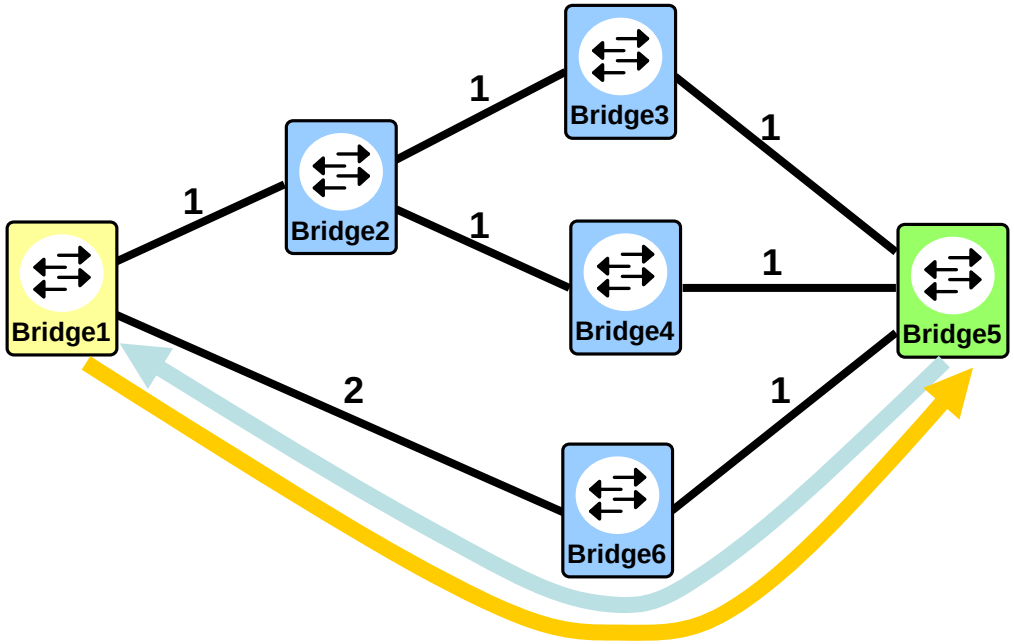
Unicast and Multicast Congruency



- Necessary for MAC learning in data plane
- Necessary for the proper operation of OAM
- Going to be assured by both SPB and SPBB

Implementation of Congruency

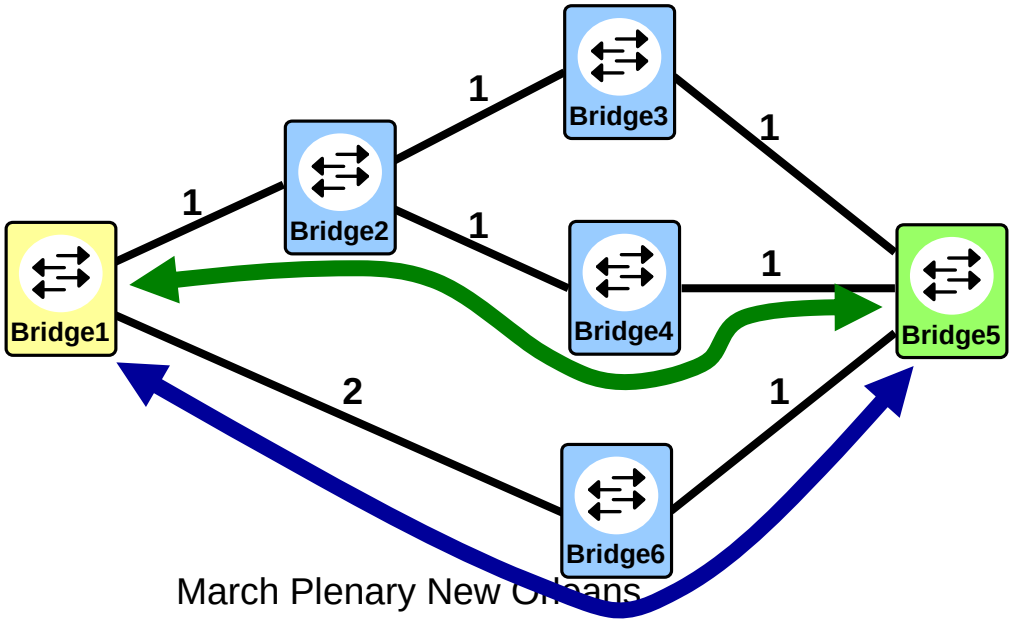
- Tie-breaking extension to Dijkstra for the case of equal cost multiple paths
  - List of node IDs comprising a path are unique
  - {1,6,5} < {1,2,3,5} < {1,2,4,5}



- Same algorithm is used both for unicast and multicast

Load sharing

- Two trees are calculated taking advantage of equal cost multiple paths: {1,6,5} < {1,2,3,5} < {1,2,4,5}
- SPT Primary Set → Primary Base VID
- SPT Alternate Set → Secondary Base VID



Loop Prevention and Mitigation

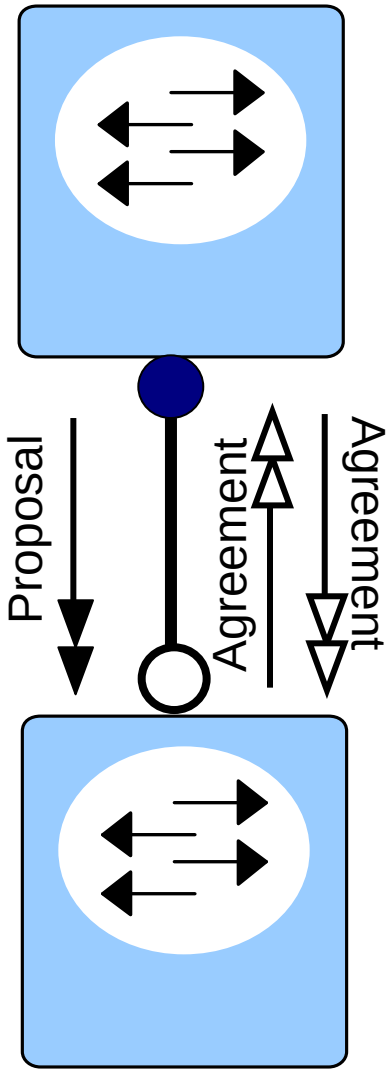
- Inconsistent view on network topology at different nodes may cause transient loops in case of a link-state control protocol
- Loop prevention
  - Tree Agreement Protocol (TAP)
  - Handshake mechanism between neighbors
  - Extension to MSTP's handshake
- Loop mitigation
  - Ingress Checking (e.g. RPFC)
  - Frames not arriving on the shortest path from the Source Bridge are discarded
  - Makes the tree directed
  - Good for loop prevention in most cases
  - Transient loops may appear
    - Severe problem for multicast traffic
    - A chance of network melt-down remains if one does not care
  - Ingress filtering has to be modified

Neighbor handshake mechanism

- Let’s make it sure that bridges having different view on network topology do not exchange frames
- The link between adjacent neighbors has to be blocked after a topology change until they agree that both of them have the same topology database
- The agreement between neighbors is implemented by a handshake mechanism
- A digest of the topology database is exchanged
  - CRC
  - Cryptographic hash function (e.g. SHA-256)
- Agreements at different part of the network are independent of each other

Handshake: MSTP extension

- Tree Agreement Protocol (TAP)
- Two-way Agreement = three-way handshake
- No per tree handshake (SPB)
- BPDUs contain
  - Digest of LSP database
  - Info on the CIST
- Proposal-Agreement
  - Explicit on the CIST
  - Computed for SPTs

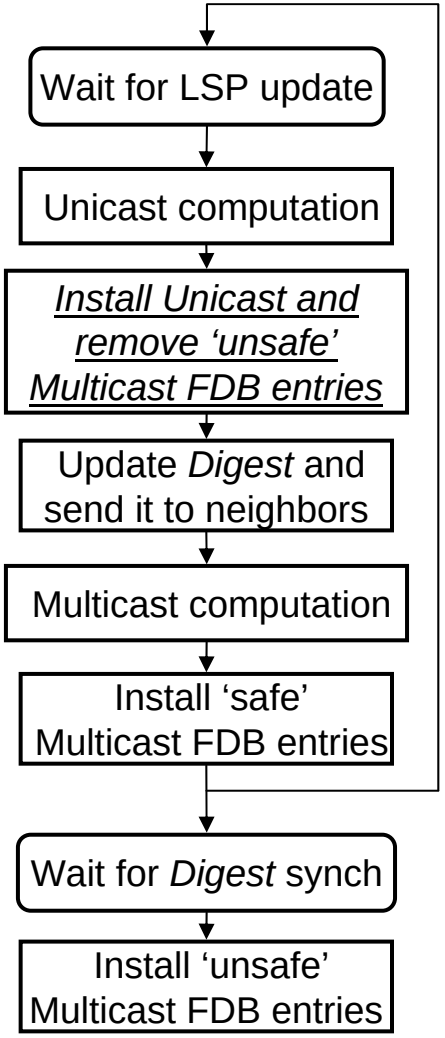


Tree Agreement Protocol

- Exchanged in BDPUs
- Based on Port Roles and neighbor agreements
- Supports rapid transition to forwarding for safe transitions when neighbors agree
  - Agreement is per tree for RSTP, MSTP
  - Agreement is LSP Digest for SPB, SPBB

Handshake: Filtering entry manipulations

- SPBB networks
- STPs are implemented by Filtering Entries
- Do not implement the TAP extension to MSTP
- Implement link-state database synchronization (TAP logic)
- Loops for unicast flows are mitigated by Ingress Checking (RPFC)
- Remove ‘unsafe’ entries if neighbors are unsynchronized



IEEE 802.1aq Project
Where are we now?

- Topology Distribution
  - IS-IS ---------- Only IS-IS need TLVs
- Loop Prevention
  - TAP or SPBB Multicast Loop Prevention ---------- Documenting compliance
- Loop Mitigation
  - Optional Forwarding change Ingress Check ---------- Documenting options
- SPVID allocation
  - Leverage link State ---------- Documenting
- SPBB
  - Multicast Source Tree identification
    - SPVID or B-VID&Source DA ---------- Document Both
    - MRP and Link State ---------- Proposal
- Path Computation
  - Convergence time/algorithms ---------- Proposal
- MSTP/RSTP/STP backwards/forwards interoperability & coexistence — Documented Clause 13
- Provisioning ---------- Documenting
  - Tree types (Shared Trees or Tree per source, etc)
  - MIBs
  - Mis-provisioning
- CFM ---------- No change
  - SPB CFM
  - SPBB CFM

Next Steps

- Update draft with recent material
- One More task group Ballot and move to WG Ballots

What do we need from IS-IS?

- Some TLVs and Sub TLVS
  - Per SPT Region
    - BASE VID (IST)
    - Shortest path tree algorithm
    - Define Single VIDs
    - Digest – SPT Region
  - Per Bridge
    - Bridge Identifier
    - Per Base VID (active Topology)
      - » Define SPVID
      - » Bridge Priority
      - » Supported Multicast Groups/I-SIDs
      - » Supported Unicast
  - Per Port
    - Per Base VID (active Topology)
      - » Link Metric, Port Priority

Other information and Pointers

- http://www.ieee802.org/1/
- http://www.ieee802.org/1/files/public/
- SPB-ISIS mailing list for SPB IS-IS related discussions
  - If you want to subscribe to the spb-isis list you can subscribe by sending to:

  spb-isis-request@ietf.org

  With subscribe in the body.

  So far this list is silent

Glossary

B-MAC Backbone MAC
BEB Backbone Edge Bridge
BCB Backbone Core Bridge
C-VID Customer VID
CFM Connectivity Fault Management
CST Common Spanning Tree
ELINE Ethernet Point to Point Service
ELAN Ethernet LAN Service
ETREE Ethernet Hub and Spoke Service
FDB Filtering Data Base
I-SID (802.1ah) Service Identifier
IGP Interior Gateway Protocol (Typically link state)
IS-IS Intermediate System to Intermediate System (IGP)
IST Internal Spanning Tree
LAN Local Area Network
MAC Media Access Control
MACinMAC see PBB
MEP Maintenance End point
MIP Maintenance Intermediate point
MMAC Multicast MAC
MSTP Multiple Spanning tree protocol
MMRP Multiple MAC Registration Protocol
OAM Operations, Administration and Maintenance
PB Provider Bridges IEEE 802.1ad
PBB Provider Backbone Bridging IEEE 802.1ah
PBB-TE PBB Traffic Engineering IEEE 802.1Qay
QinQ see PB
S-VID Service VID
SPB Shortest Path Bridging IEEE 802.1aq
SPBB Shortest Path Backbone Bridging
SPT Shortest Path Tree
STP Spanning tree protocol
RSTP Rapid Spanning tree protocol
TTL Time To Live
VID VLAN Identifier
VLAN Virtual LAN