# 802.1aq Shortest Path Bridging May Recap

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# Forward

- Shortest Path Bridging is a large Project
- This summary contains some repeated material.
- For those who would like the delta we have marked the sides with

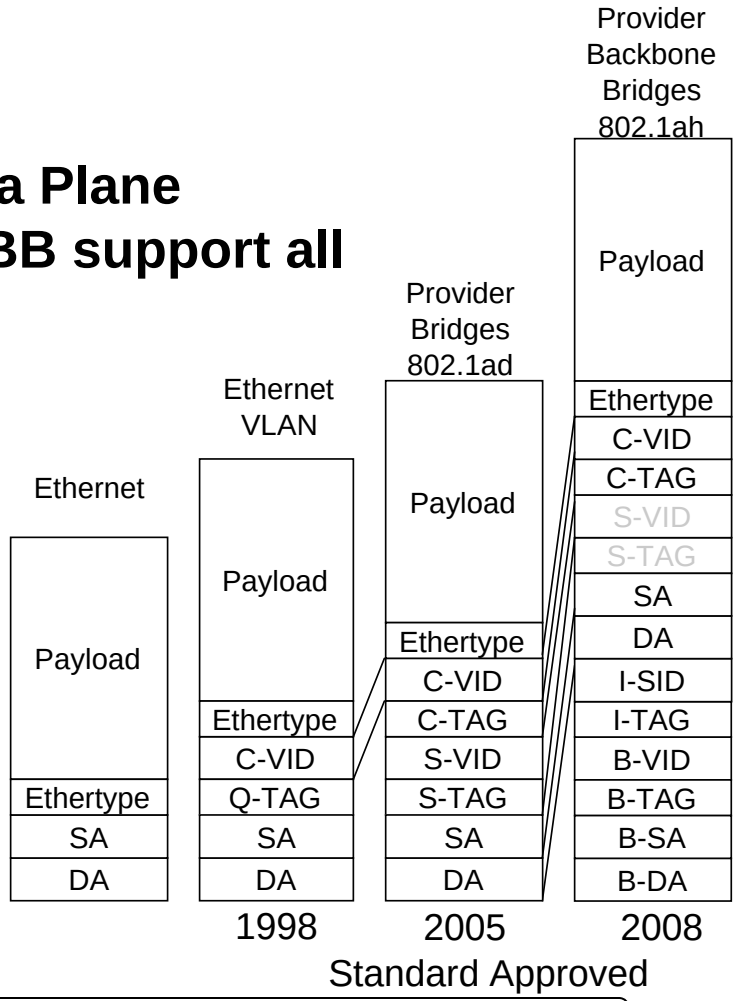
# Shortest Path Bridging Project Authorization Request

- 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**
**Combination of SPB and SPBB support all**

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



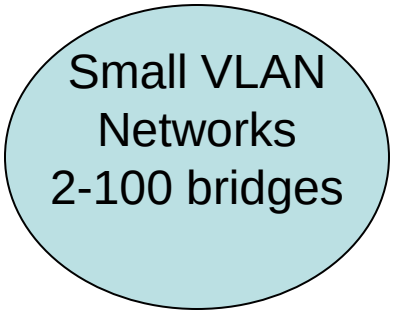

**Supports Data Plane OAM (CFM, MIP, MEPs)**

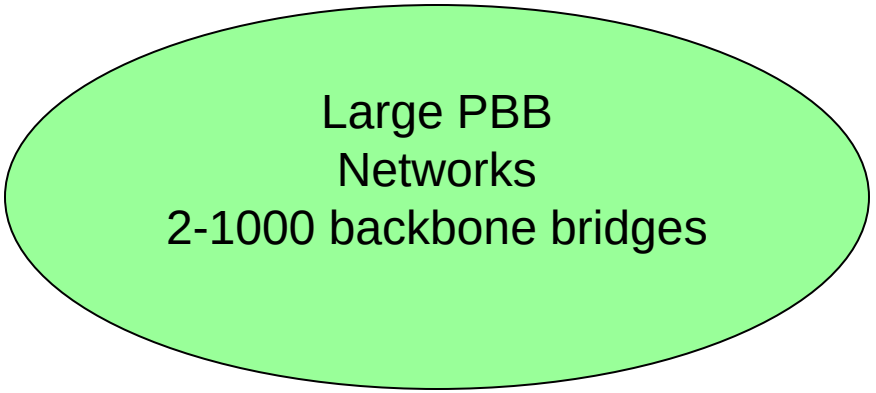
# Applicability

IEEE 802.1aq

Shortest Path Bridging (SPB)

Shortest Path Backbone Bridging (SPBB)




Plug and play
Efficient
Low delay
Backwards Compatible

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

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

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

# What is unique about SPB?

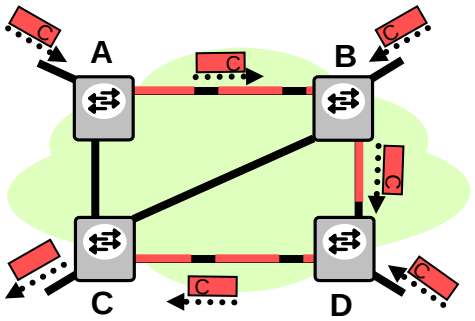
- Link state application to shortest path trees compatible with 802.1 architecture
  - Link state versus lots of messaging (BPDUs)
  - Computation replaces messaging
    - All pairs shortest path
- SPBB provides fast and robust PBB B-MAC topology
  - Service Discovery via the I-SIDs
  - Efficient Multicast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

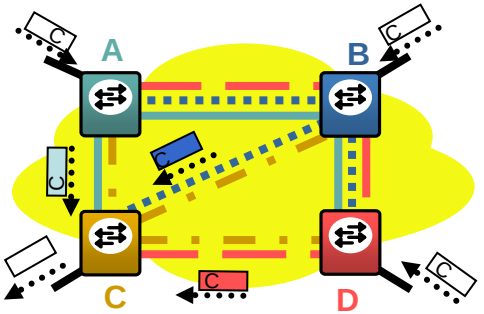
# Motivation

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



Spanning tree forwarding

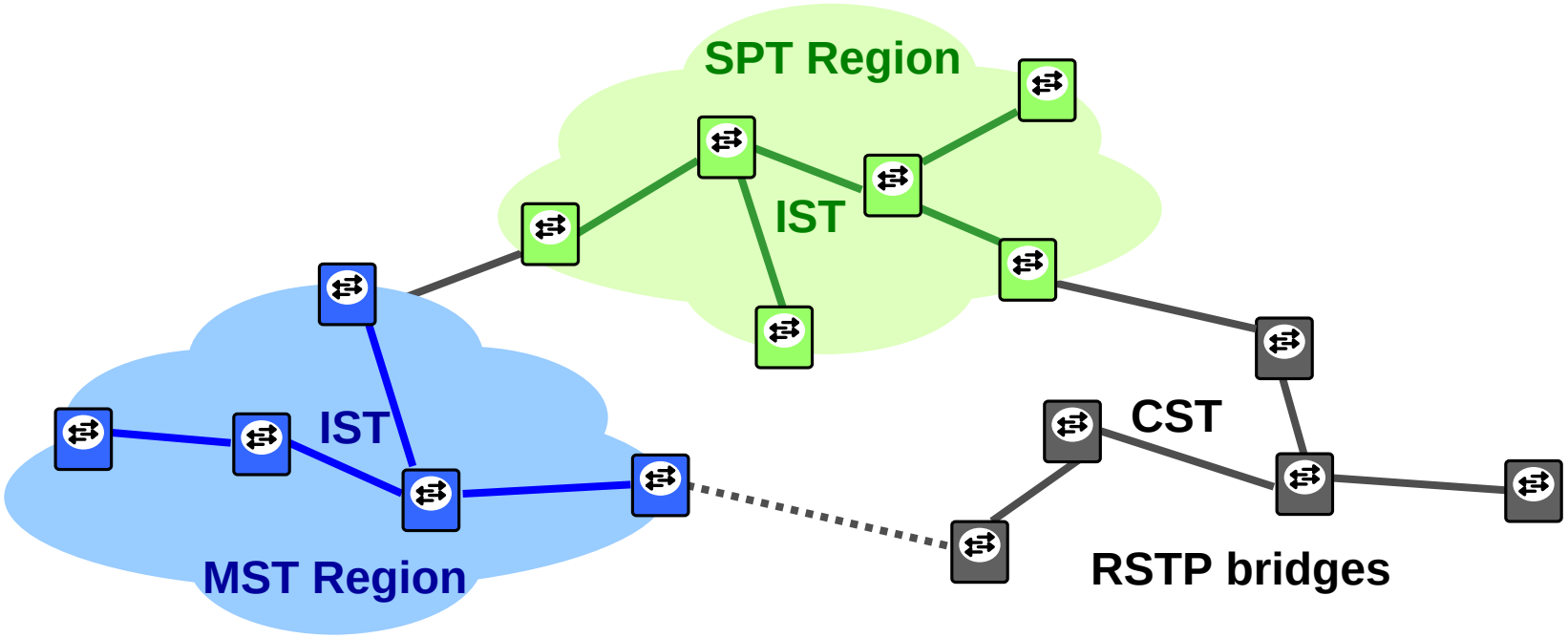
- Shortest path forwarding
  - Each bridge only sends frames on its own Shortest Path Tree (SPT)
  - Automatic SPT management
  - Controlled by IS-IS



SPB forwarding

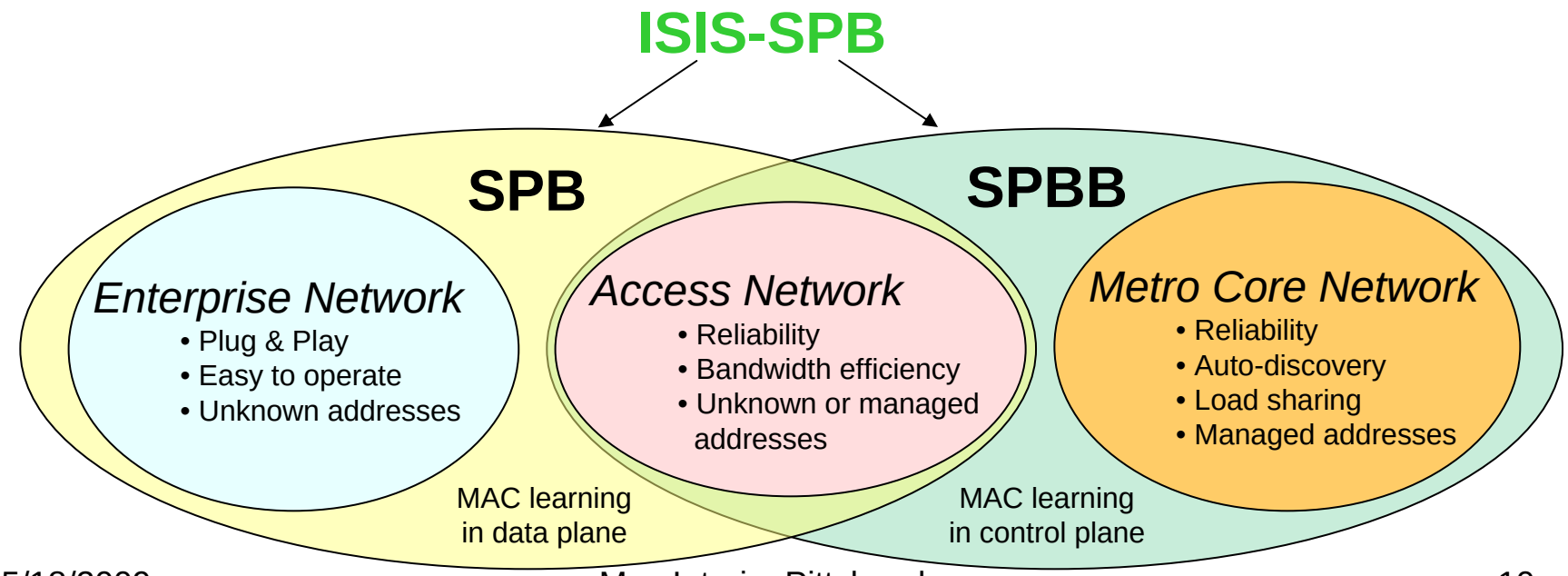
# Interworking with RSTP and MSTP

- 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 (SPTID)

Updated

**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 SPSourceID 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

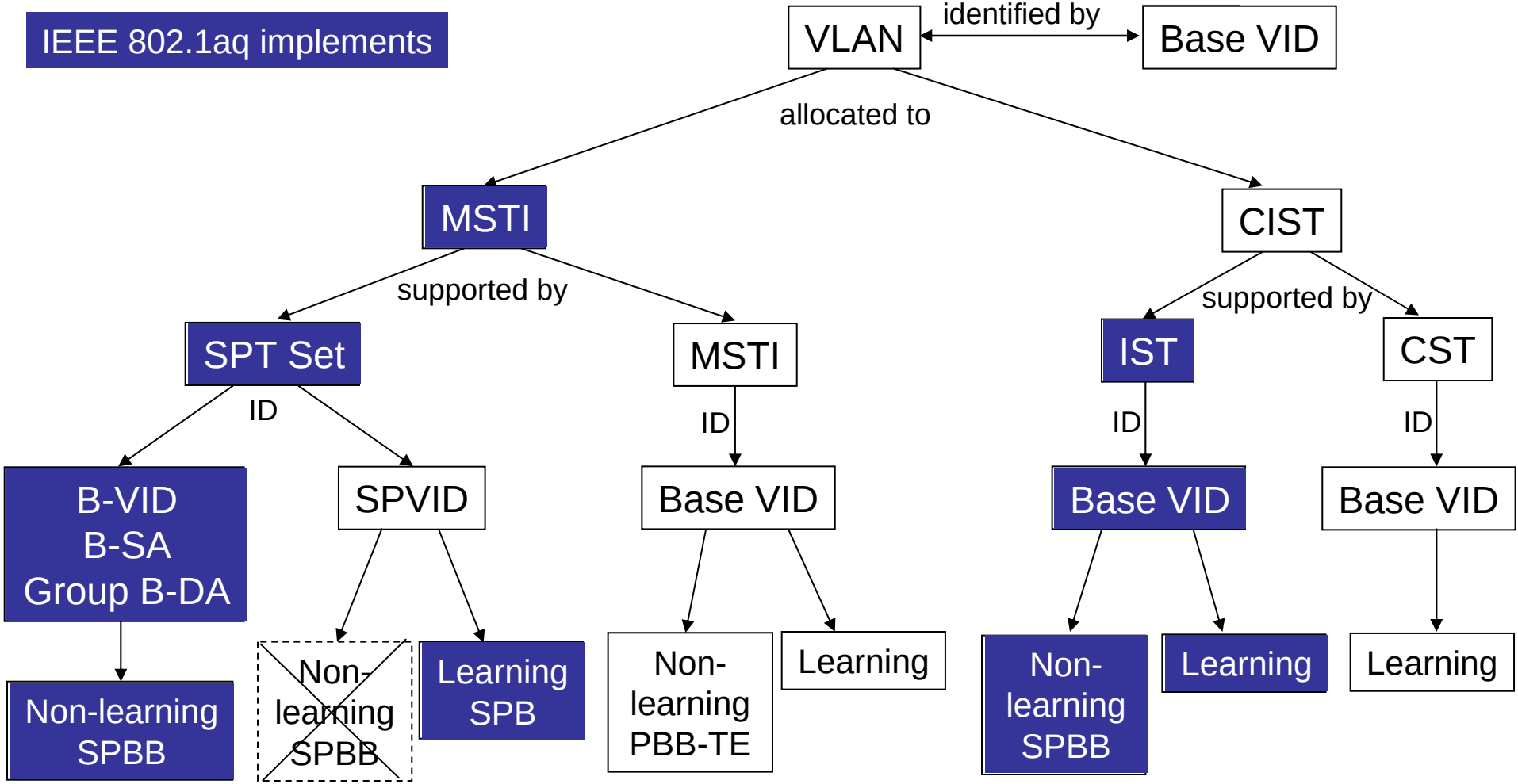
✗ Only applicable to 802.1ah bridges

✗ Ingress check on SA

✗ All group MAC addresses take the local bit mapping

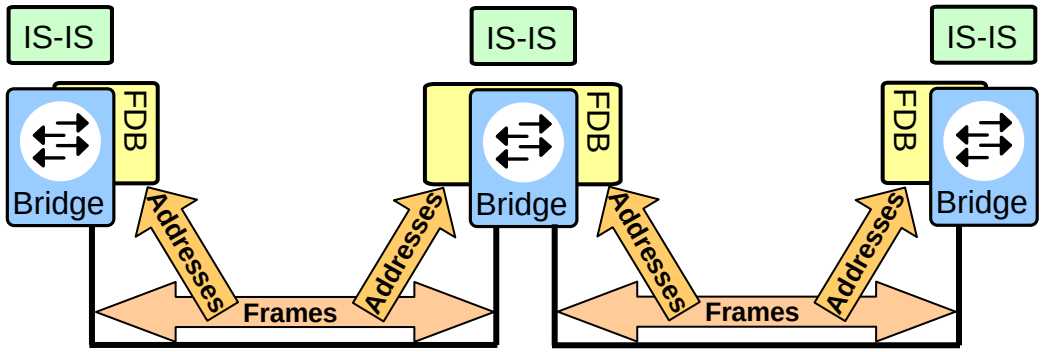
# VLAN assignment

Updated



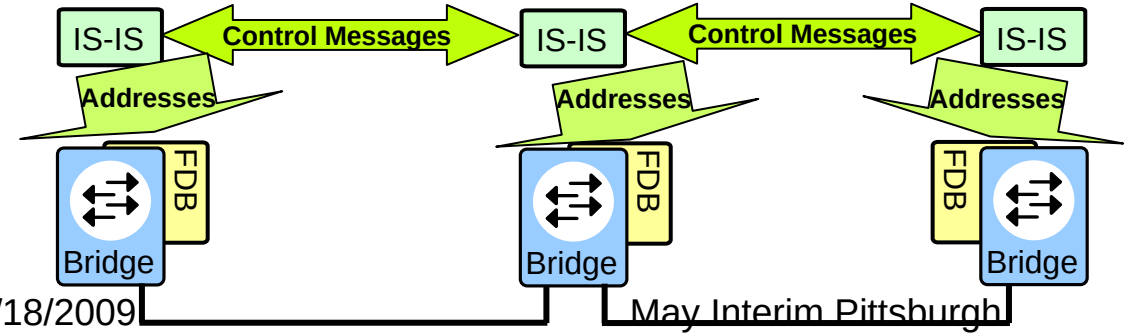
# MAC learning

- MAC learning in the data plane (Learning)




SPB

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

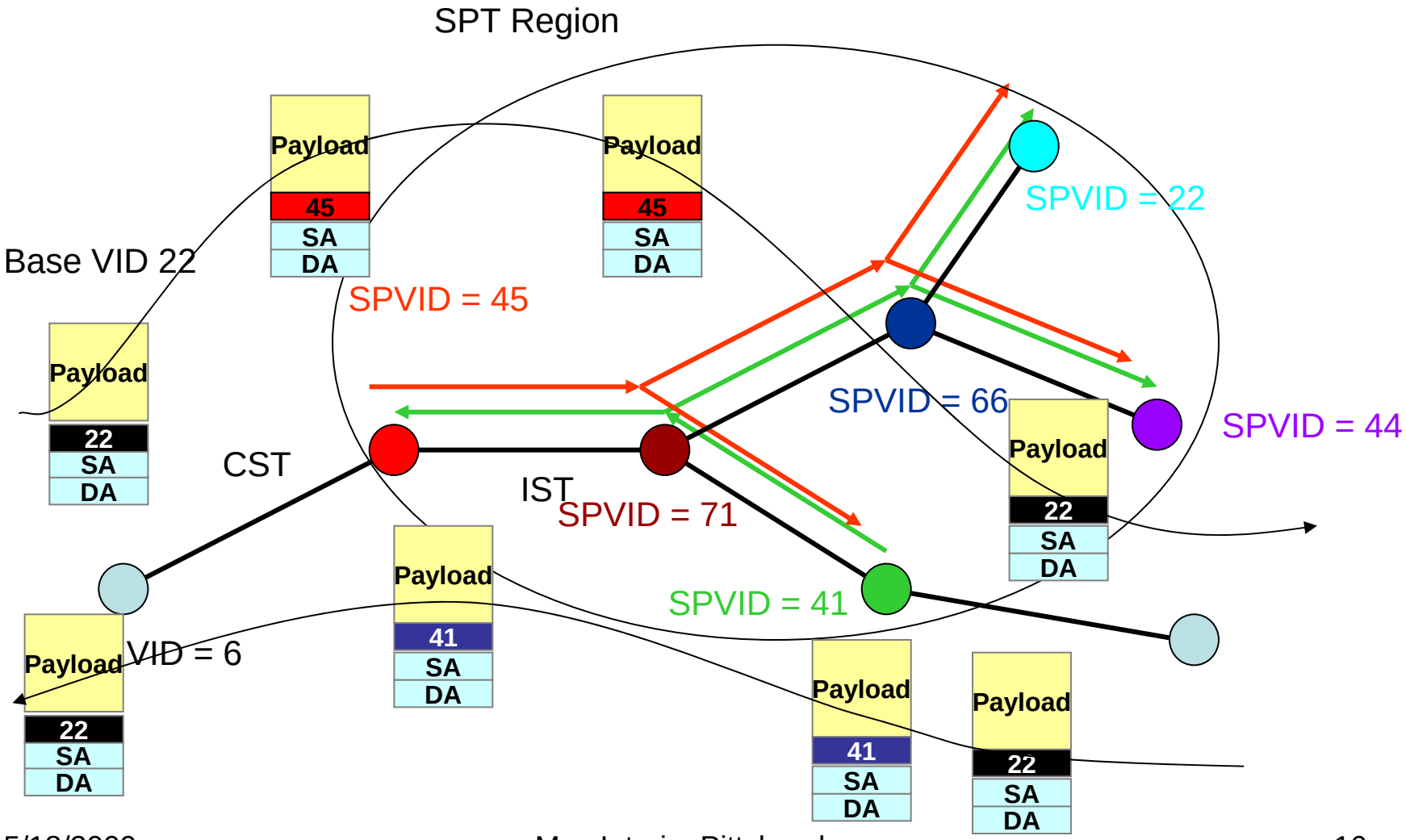



SPBB B-MACs

# 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

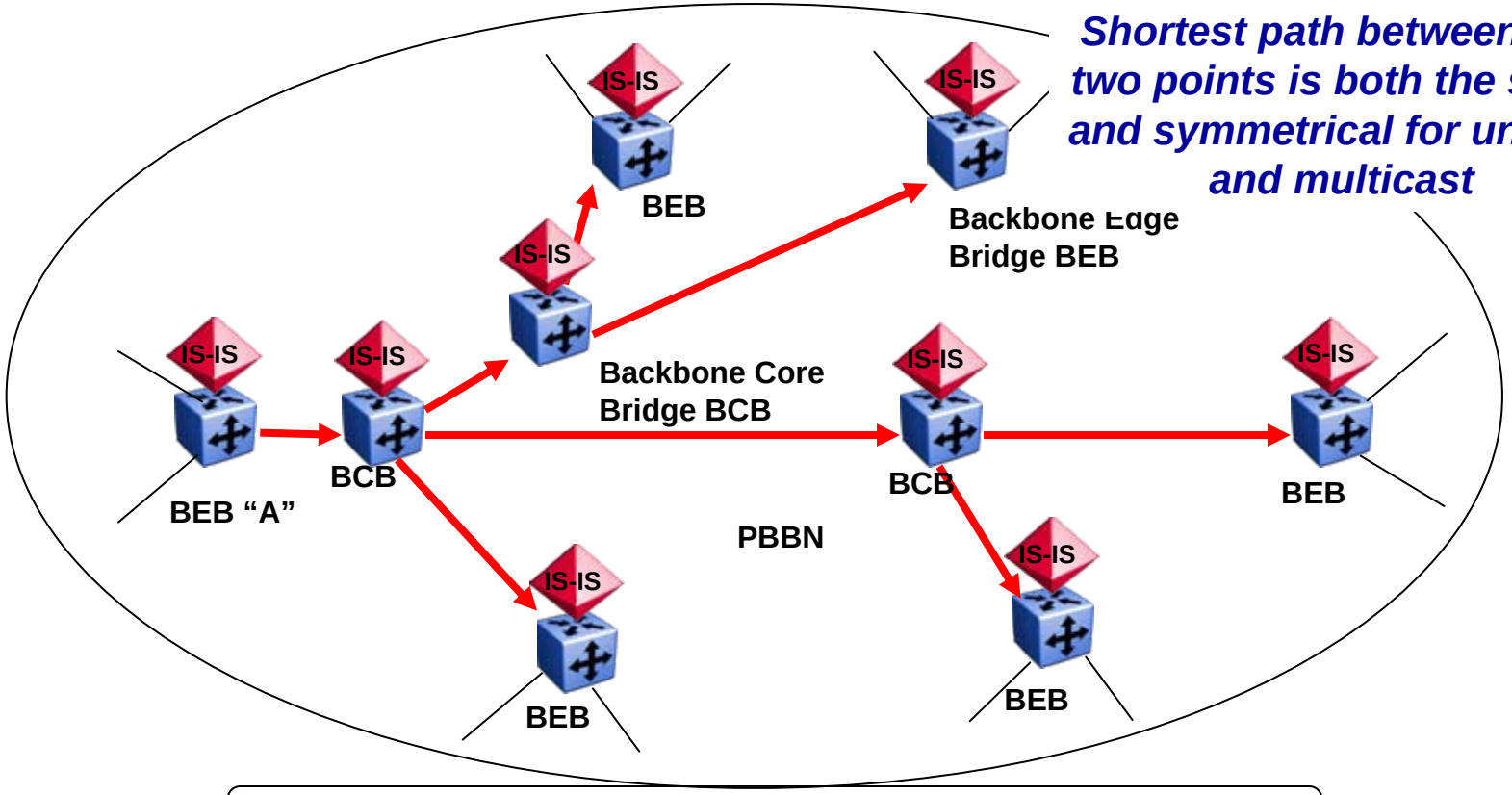
# SPB Concepts



# SPBB

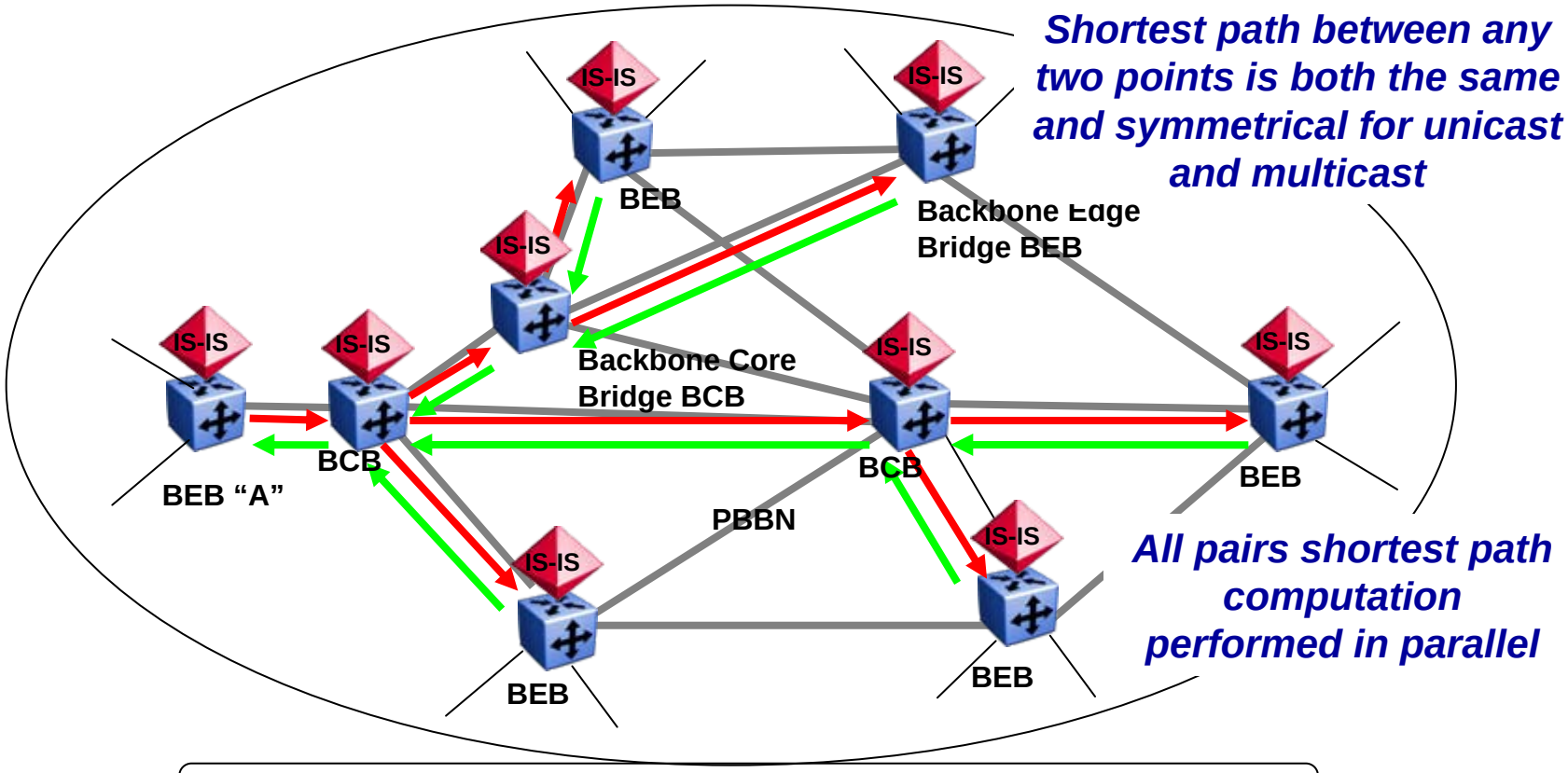

- SPBB (Shortest Path Backbone Bridging)
  - Solution Attributes
    - Single VID for an SPT Region (only)
    - Does not use learning of B-MACs
      - Provider addresses will all be known allows for more efficient flooding (no B-MAC broadcast storms),
    - Reduction in forwarding space Shared Forwarding,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

# SPBB Operation



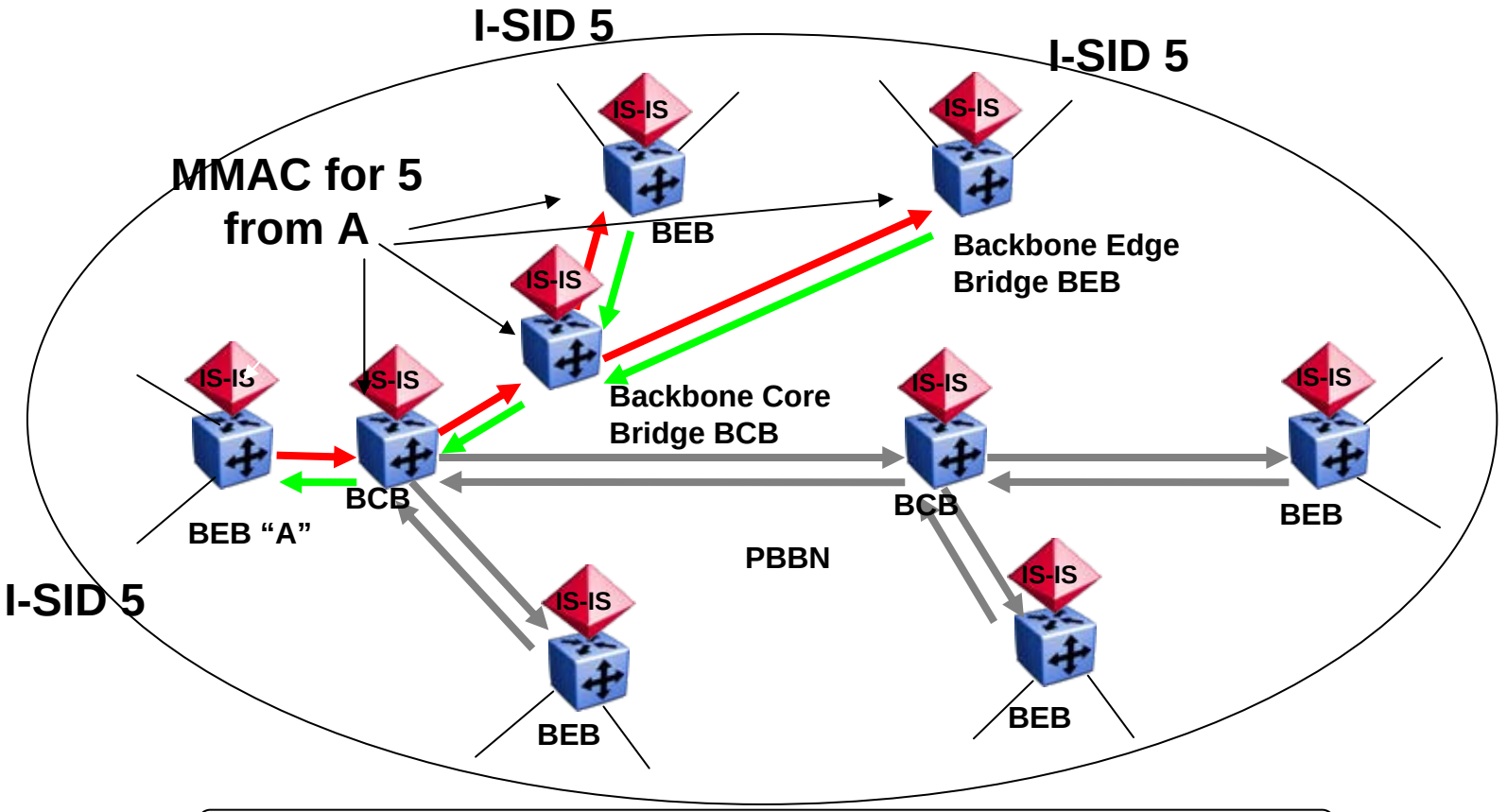

Shortest Path Tree from "A"

# SPBB Shortest Path Tree to/from “A”



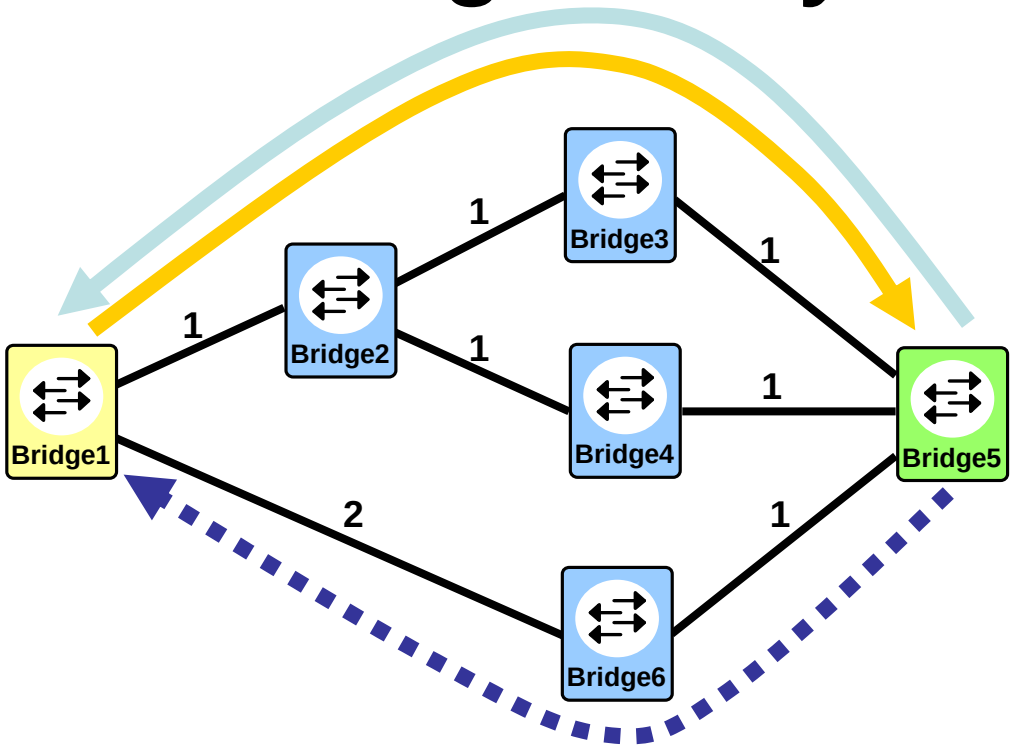

Uses the full mesh network

# SPBB Multicast Groups



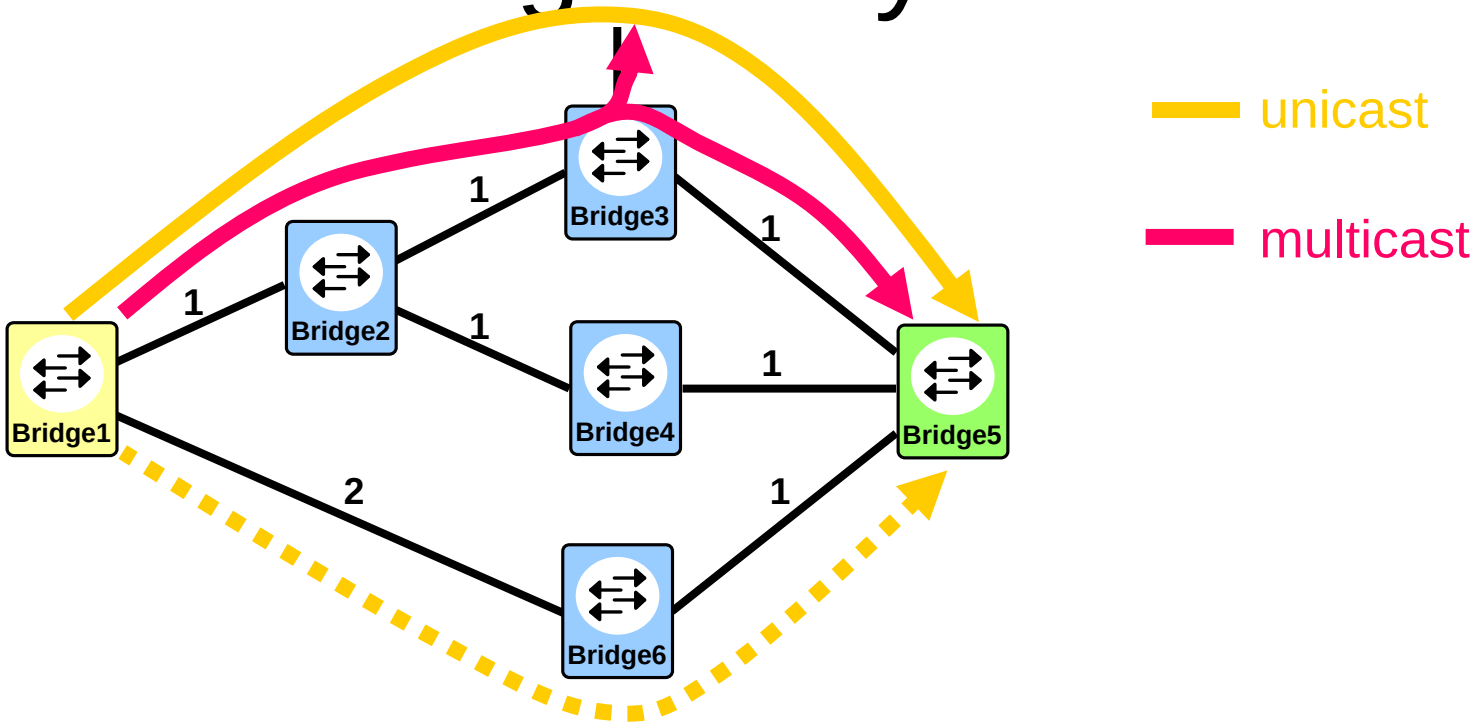

I-SIDs define efficient subsets

# 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

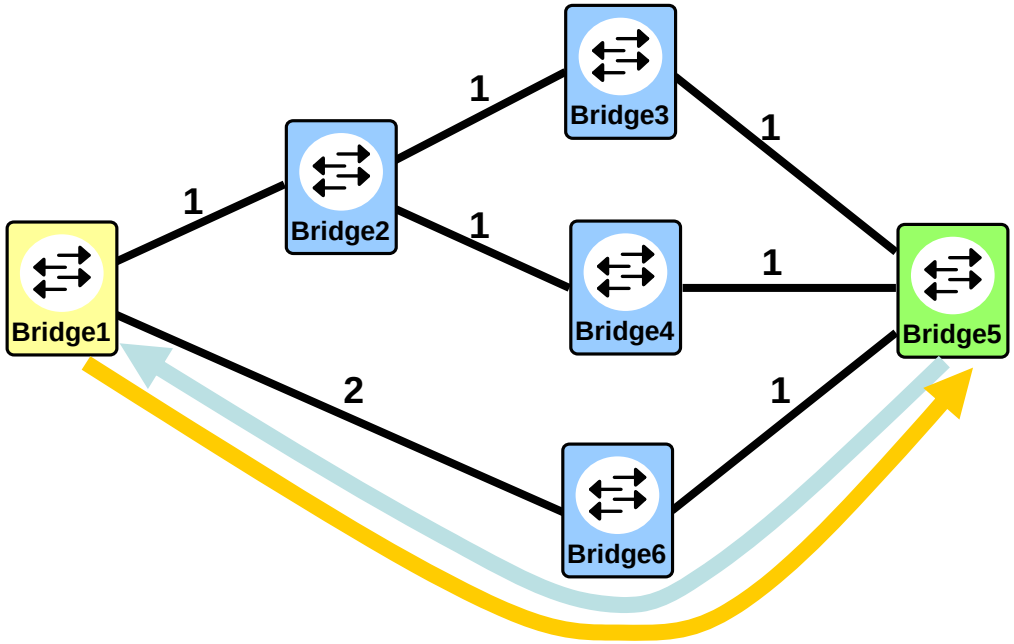
# Unicast and Multicast Congruency




- 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

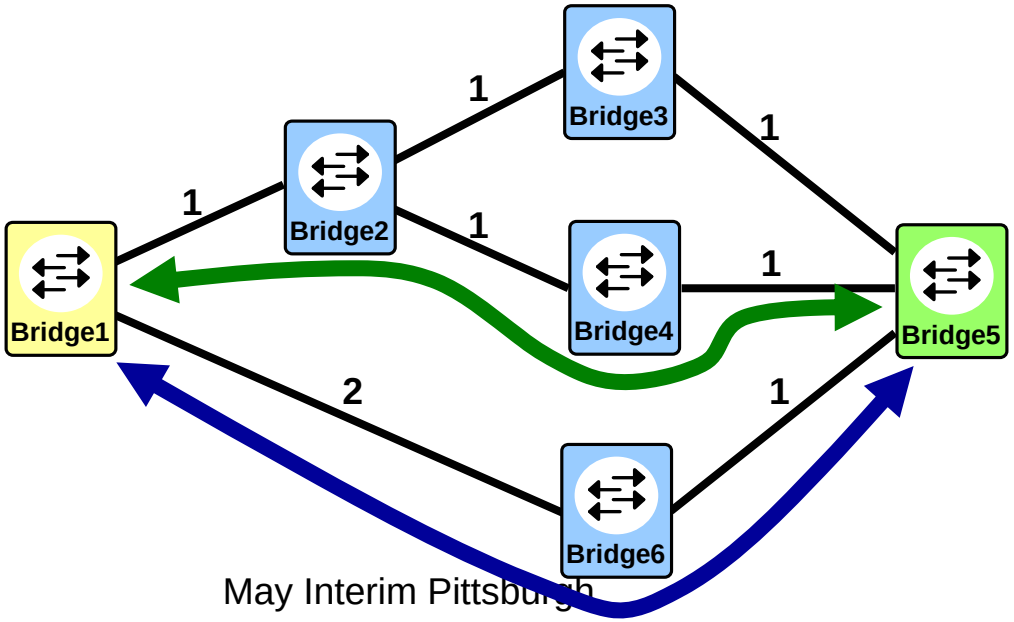
- Tie-breaking extension to Dijkstra for the case of equal cost multiple paths
  - List of node IDs comprising a path are unique
  - {1,6,5} < {1,2,3,5} < {1,2,4,5}




- 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
  - Agreement Protocol
  - 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

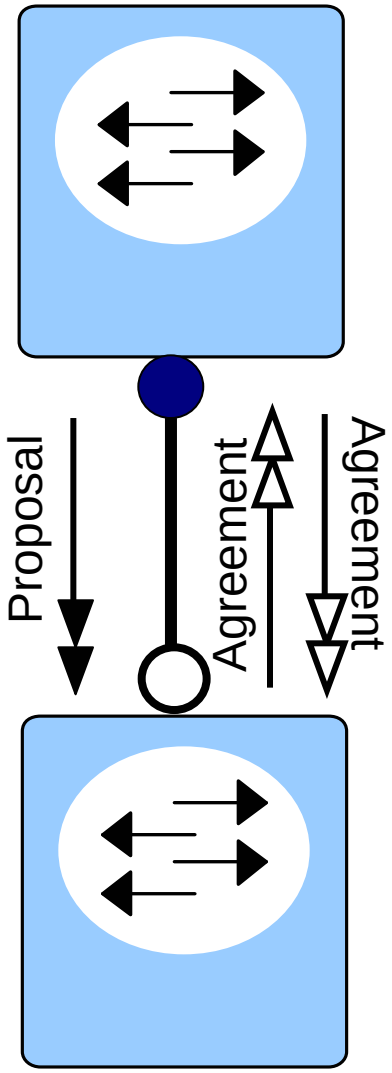
# Neighbor handshake mechanism

- Make sure 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

Updated

- Agreement Protocol
- 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

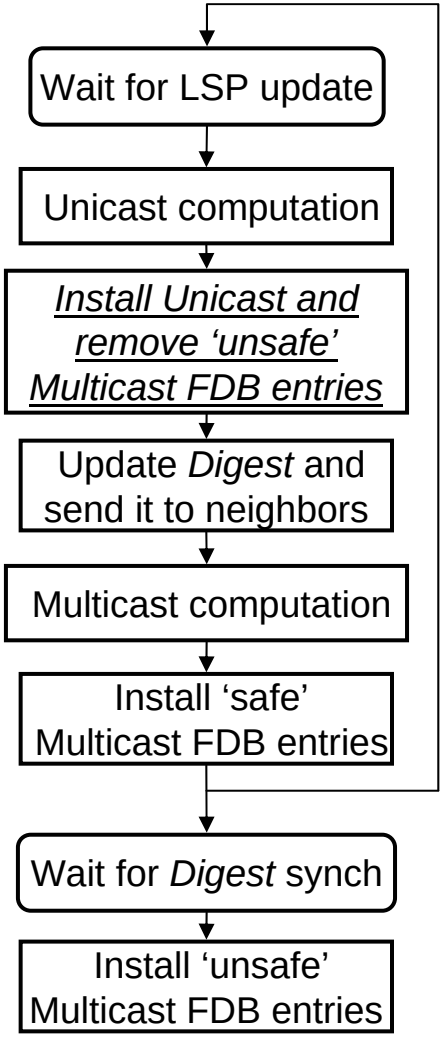


# Agreement Protocol


- 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 Agreement extensions to MSTP
- Implement link-state database synchronization (Agreement 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?

Updated

- Topology Distribution
  - IS-IS ---------- Only IS-IS need TLVs
- Loop Prevention
  - Agreement Protocol or SPBB Multicast Loop Prevention ---------- Documented
- Loop Mitigation
  - Optional Forwarding change Ingress Check ---------- Documented
- SPVID allocation
  - Leverage link State ---------- Documented
- SPBB
  - Multicast Source Tree identification
    - B-VID&Source DA ---------- Document
    - 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
- Draft is being finalized for ballot call this week.

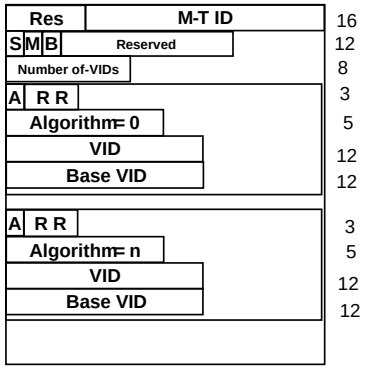
# What do we need from IS-IS?

- 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

# Current View of TLVs

Updated

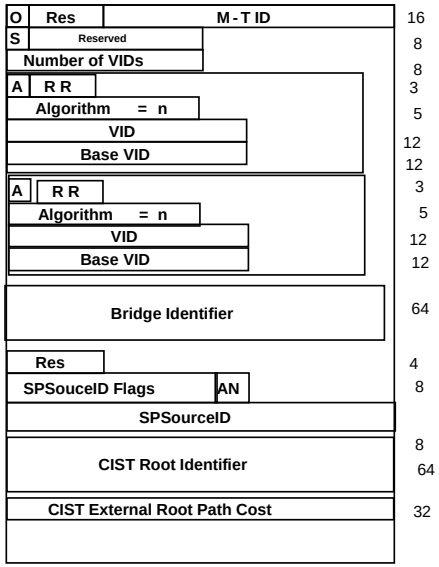
**a) Hello PDU BASE-VID TLV**




Per Bridge

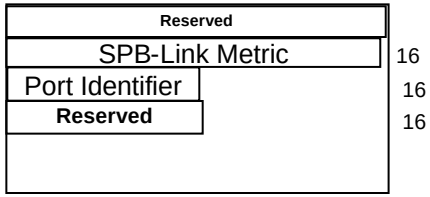
IS-IS Reachability TLV

**b) SPB Instance TLV**



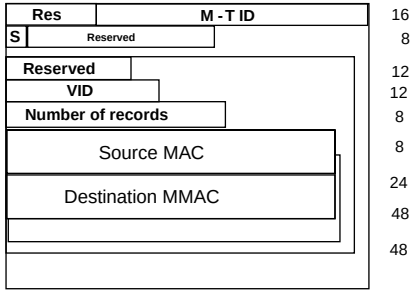

Per Bridge

**c) SPB Link Metric Sub TLV**



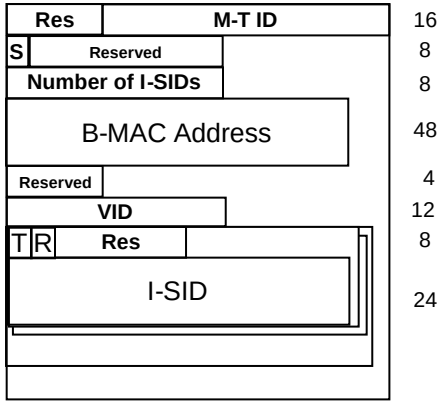

Per Adjacency

**d ) SPB Multicast Group TLV**




Per Bridge

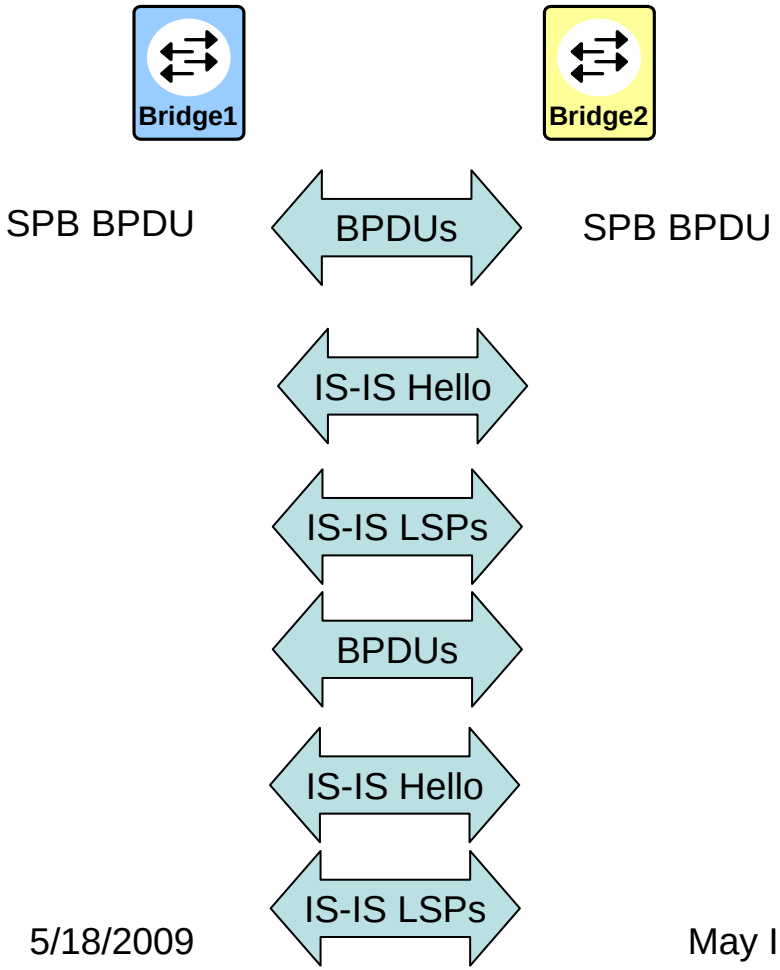
**e) SPBB I-SID and Unicast Address TLV**

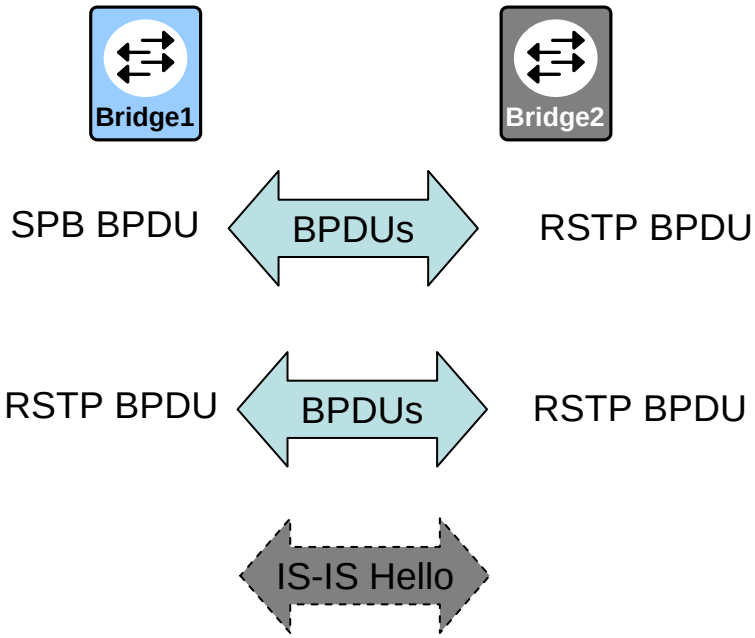



Per Bridge

# Forming an SPB region

Updated

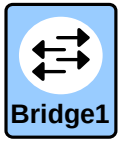


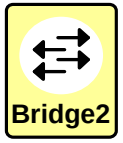




Do we make IS-IS hellos optional in this case?

# Base VID and B-VIDs


SPB




Parameters needing to be Co-coordinated for a Region?

| | | |
|---|---|---|
| MSTIDConf Digest | = | MSTID ConfDigest |
| IS-IS topology instance | = | IS-IS topology instance |
| Base VID | = | Base VID |
| [ My SPVID | != | My SPVID] |
| [Single B-VID(s) | = | Single B-VID(s)] |

# 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
**SPSourceID** SPBB OUI Field
**RSTP** Rapid Spanning tree protocol
**TTL** Time To Live
**VID** VLAN Identifier
**VLAN** Virtual LAN