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Proposal for Multi-path Forwarding of Control Data Frames

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Overview

- Scenarios and Assumptions
- Goal and Starting Point
- Main Functionalities
- L2 Routing Region (visualized multipath routing concept)
- Comparison SPB-V vs. SPB-M wrt. Industrial Scenario
- Combination of SPB-V and SPB-M
- L2 Routing Filtering Database example
- Summary

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Different Scenarios

Different Scenarios for audio, video, control streams

- data communication (home, IT network)
- industrial communication (factory floors etc.)
- in-car communication

Different ways for setting paths desirable

- dynamic and automatically setup
- centrally configured and centrally setup
- simple and static

⇨ *These different ways for setting paths are desirable even within the industrial communication scenarios alone!*

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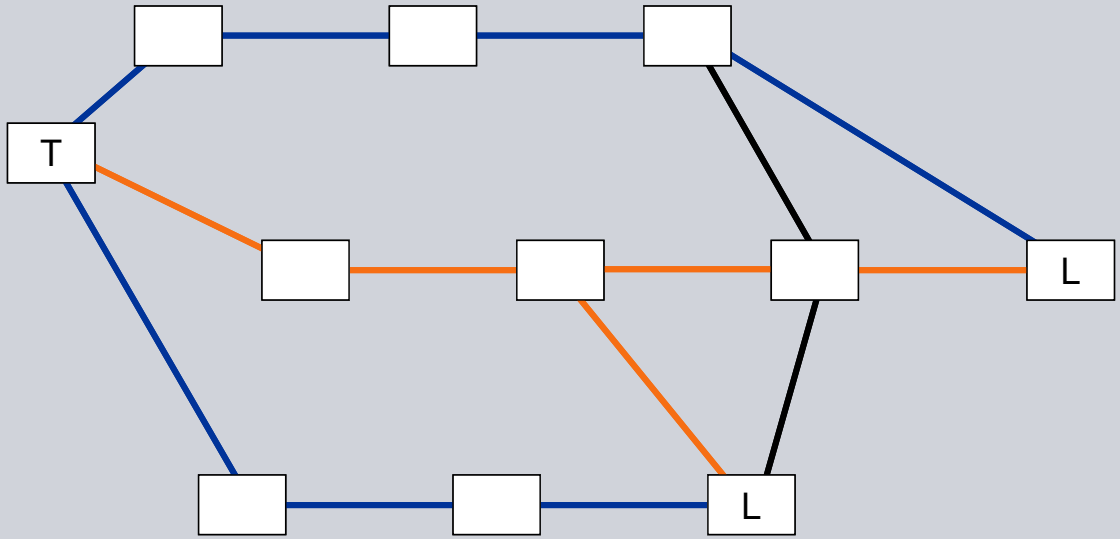
Assumptions



T and L
correspond to
end device + first/last bridge

- unidirectional streams of control data from talker T to listener L
  - reserved streams
  - bidirectional streams are two unidirectional streams in opposite direction
  - typically multicast traffic
- typically engineered multicast addresses (one talker, many listeners)
- support of single path and multi-path (shortest)
  - maximally node / link disjoint paths for multi-path

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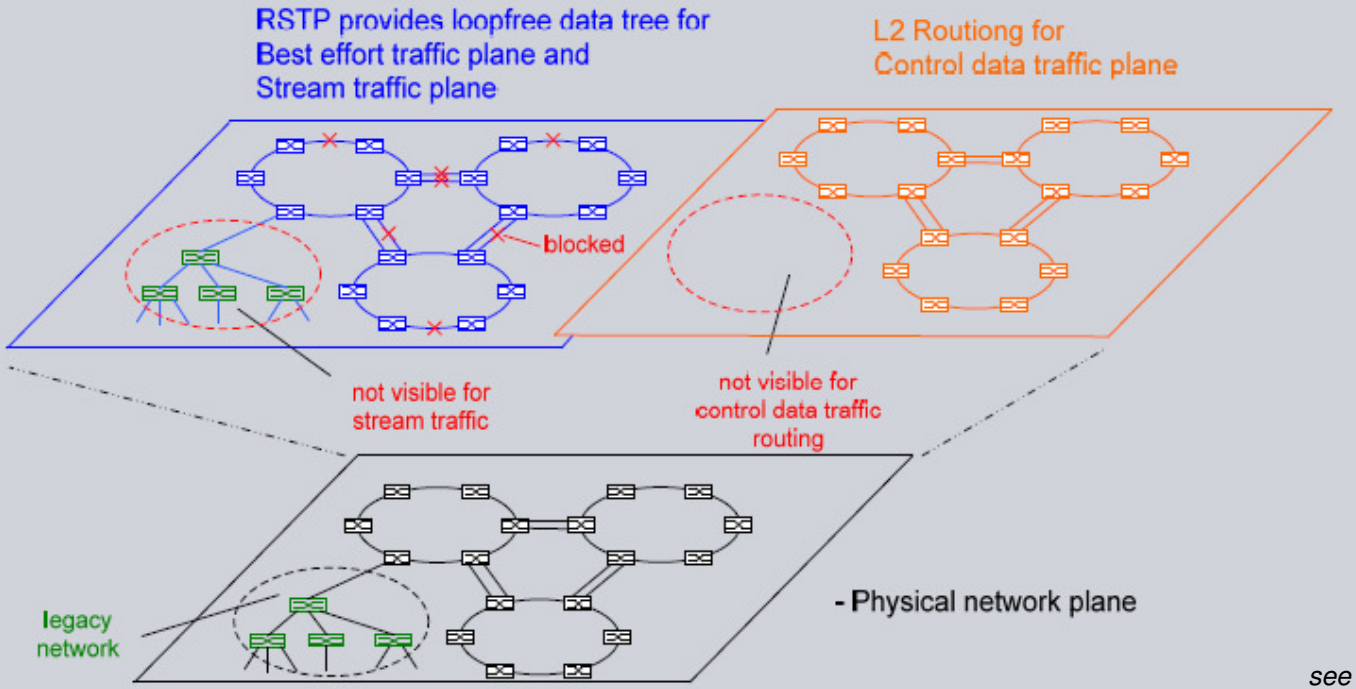
Assumption

- L2 Routing only for specific services (Control Data)
- L2 Routing region is an overlay network
  - similar to RSTP/MSTP region and SPB region
  - runs simulataneously with RSTP/MSTP or SPB or other protocols, differentiated bv VLAN ID



see also [1]

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Goal and Starting Point

The Goal:

- reliable transmission of Control Data frames in case of single point of failures in a bridged network

The Starting Point:

- use link-state information provided by ISIS-SPB to compute
  - single shortest path for highly delay-sensitive flows of Control Data
  - maximally node disjoint multiple (two) shortest paths for highly delay-sensitive flows of Control Data
- shortest path transmissions (shortest pair) and recovery
- redundant transmission of Control Data frames an both paths
  - if one path breaks, the information of the Control Data frames reaches the destination through the other path within the time limit
- unicast and multicast transmission supported
- applied to region only
  - multipath region similar to SPB region
  - IS-IS area 1 routing only

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Main functionalities

Distribution of link state information

- use ISIS-SPB from IEEE 802.1aq
- extend ISIS Link State TLV with necessary information for Multipath Forwarding of Control Data Frames
  - available capacity/bandwidth for Control Data Frames on a link / port

Distribution of communcation relationships

- not every device is talking to every other device
- →small number of communication relations (source / destination or talker / listener)
- extend MSRP or ISIS-SPB with necessary functionality
  - talker / listener information for unicast/multicast transmissions of Control Data frames distributed to all bridges in region
  - necessary because every node determines locally whether it is part of the unicast path/ multicast tree by computing the paths with a link-state algorithm for the distributed talker / listener

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Main functionality

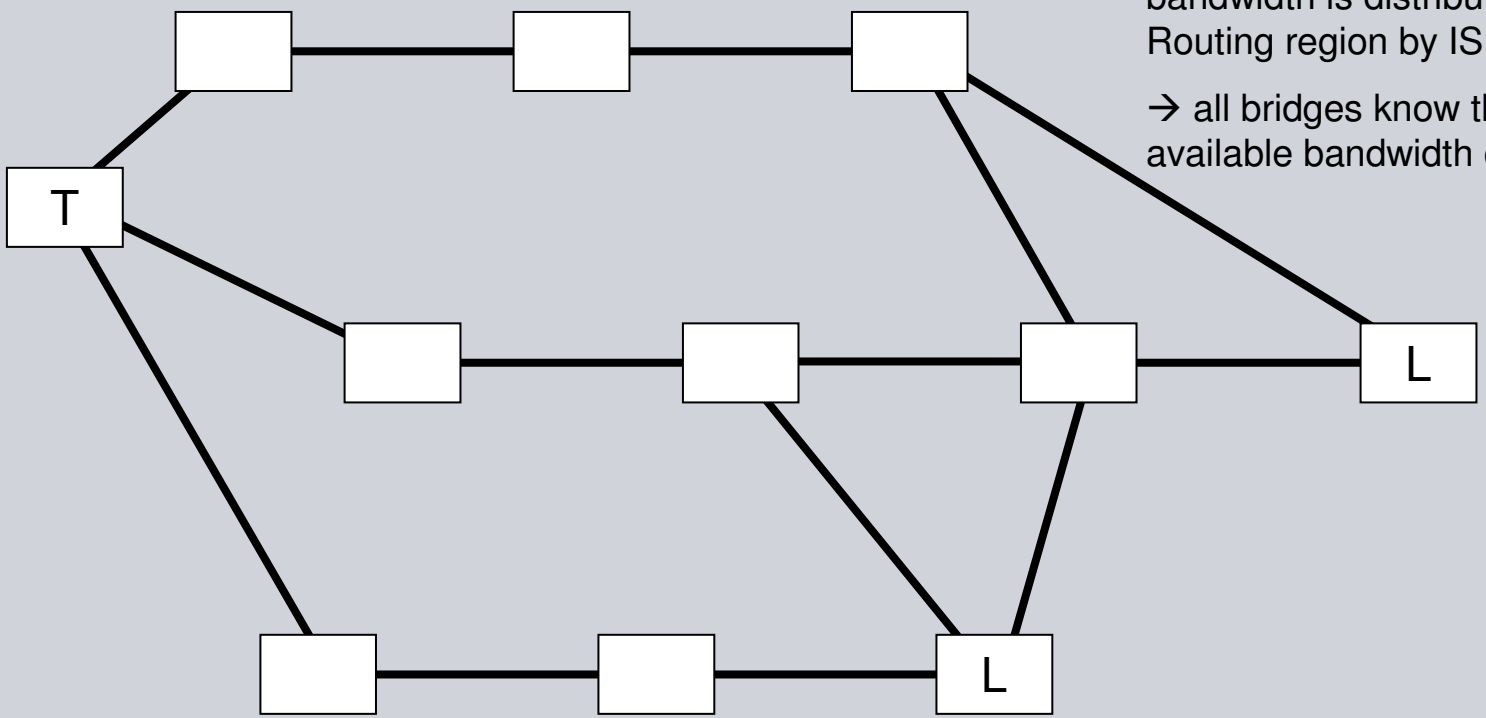
Bandwidth reservation

- available capacity/bandwith is communicated to all bridges through extended ISIS Link State TLVs / frames
- available capacity/bandwith is considered for routing, but not a trigger for re-routing
- bridges on the path perform the reservation and distribute their updated link-state information
- bridges not on the path save the information for future routing calculations and update their link state database with the received link-state information containing the new reservation

Re-routing

- re-routing shall not disturb ongoing flows of Control Data frames (if possible)
- re-routing for single shortest paths immediately
- re-establishment of second redundant path
  - manually driven (explicit trigger for re-establishment)
  - no immediate re-routing on link-breaks or bridge failures for multiple shortest paths if alternative path is still active
  - make before break

L2 Routing Region



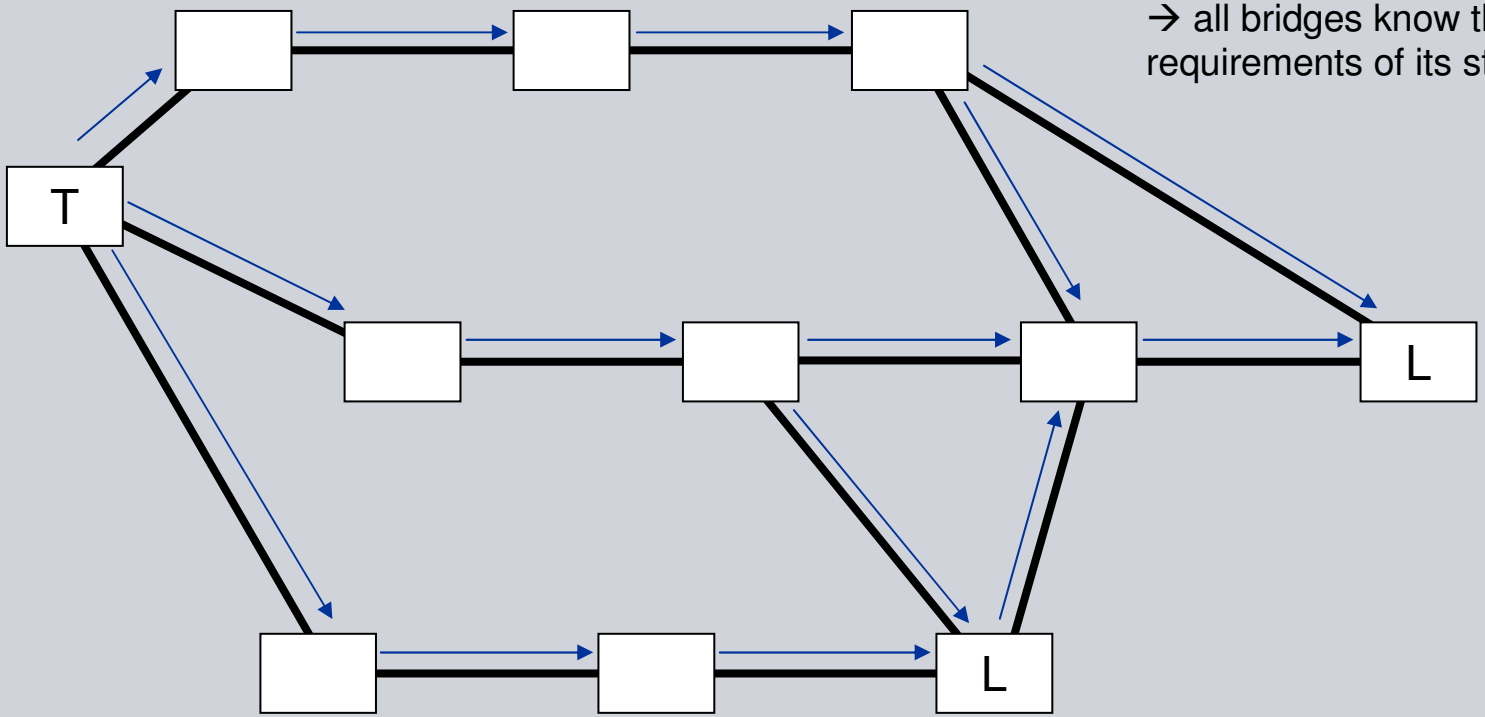
Topogology information (link state) as well as information on available bandwidth is distributed in the L2 Routing region by ISIS-SPB

→ all bridges know the topology and the available bandwidth on all links

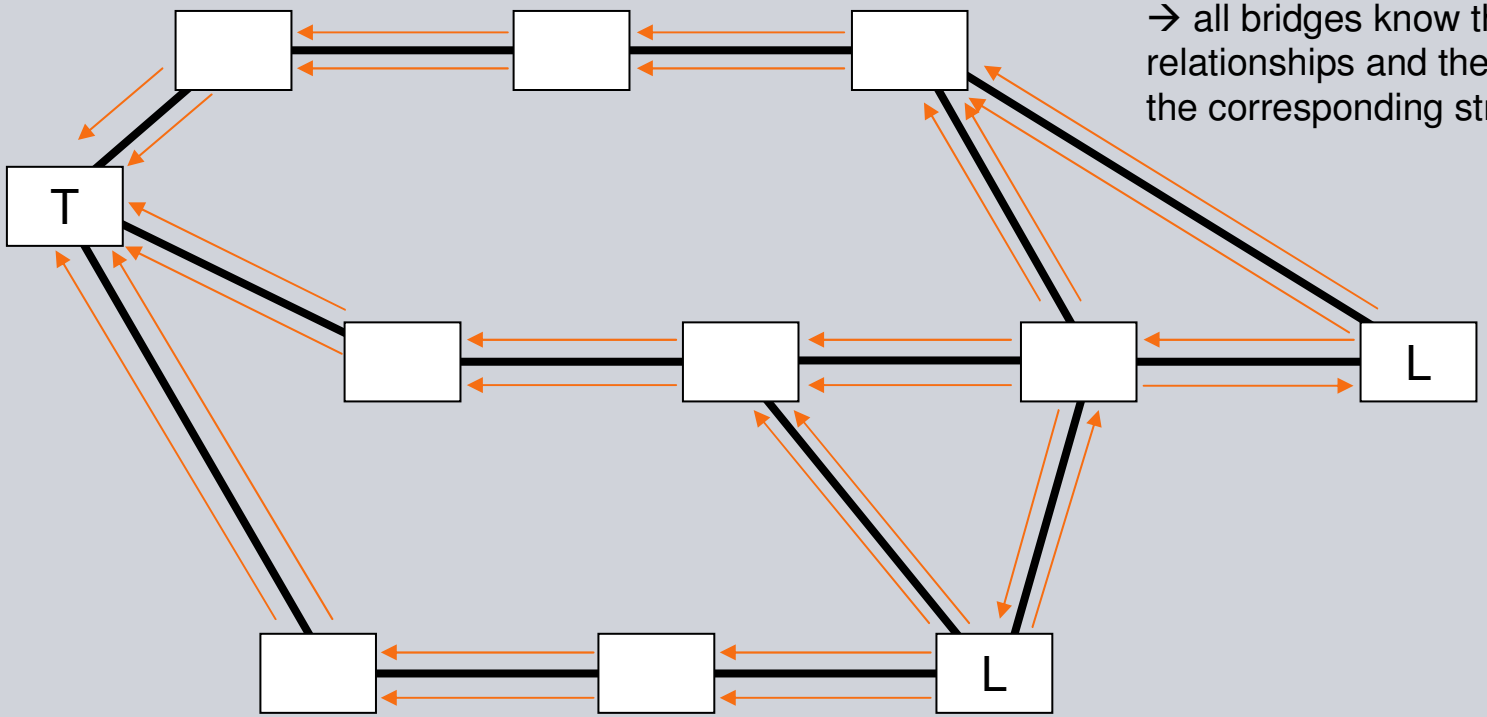
L2 Routing Region

Talker T announces its streams and their requirements to all bridges

→ all bridges know the talker and the requirements of its streams



L2 Routing Region

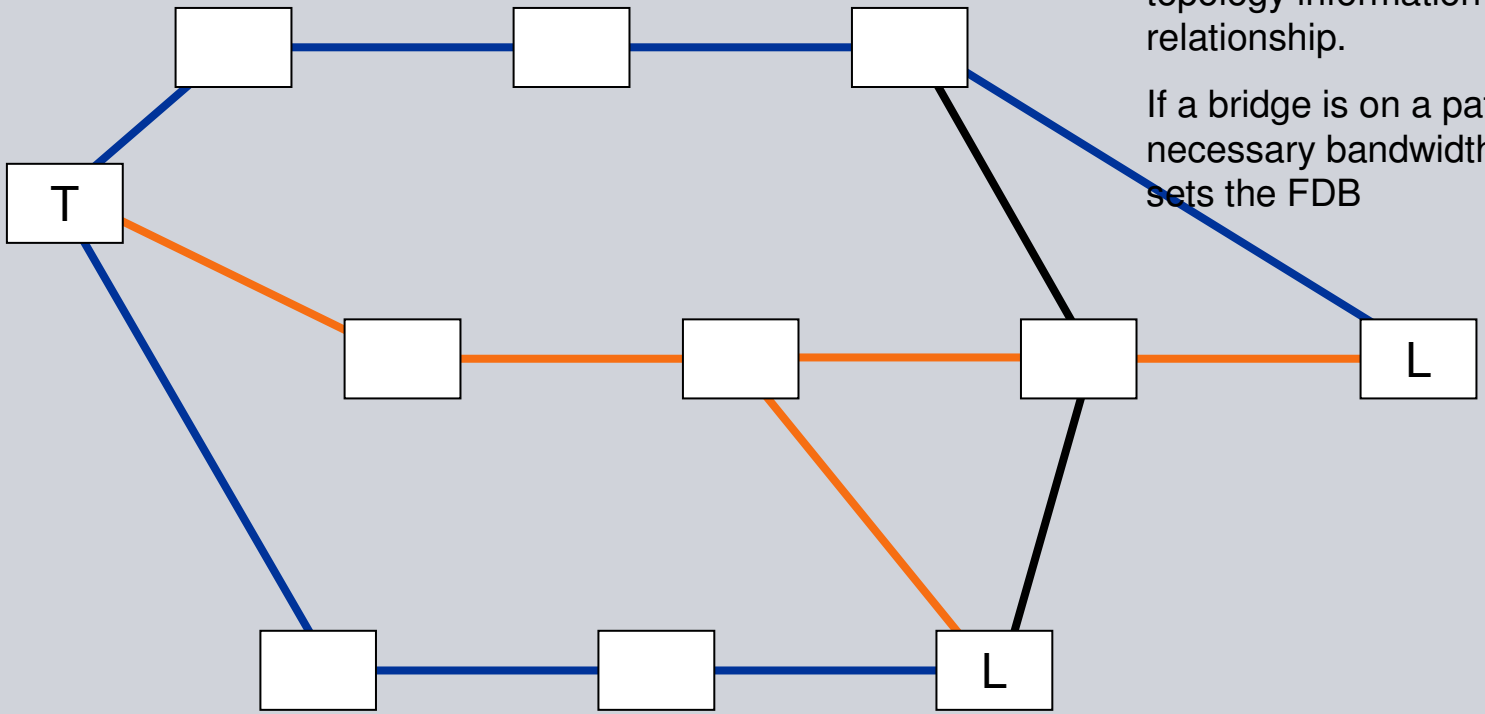


Listener L announce their join to all bridges

→ all bridges know the talker / listener relationships and the requirements of the corresponding streams

Announcements can be done by extended ISIS-SPB or extended MSRP

L2 Routing Region



All bridges compute the paths between talker T and listeners L based on topology information and talker/listener relationship.

If a bridge is on a path, it does the necessary bandwidth reservations and sets the FDB

Talker T sends its Control Data onto the paths to the listeners L.

Comparison
SPB-V vs. SPB-M w.r.t. Industrial Scenario

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SPB-V (VLAN ID)

- computes source trees of shortest paths from each (ingress) bridge to all other bridges
- works on customer MAC address ✓
- needs several VLAN IDs [BID+VLAN] (one per source bridge) ✗
- Source MAC address learning ✗ (problem for multiple redundant paths in certain cases)
- loop prevention ✓

SPB-M (MAC in MAC)

- computes shortest paths between all bridges
- encapsulates customer MAC address for better scalability in backbone ✗ (no such scalability issues)
- needs single VLAN ID ✓
- no source MAC address learning, → control protocol ✓
- loop prevention ✓

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Combination of SPB-V and SPB-M for L2 Routing

- use only single VLAN ID for separation of
  - different L2 Routing regions
  - SPB-V regions,
  - RSTP/MSTP regions
  - regions running other protocols
- use customer MAC addresses for forwarding of data frames
- no encapsulation (no MAC in MAC)
- no source address learning
- L2 routing protocol based on ISIS-SPB computes shortest single / multiple paths between some bridges (talker/listener)
- support of engineered multicast addresses
- suggestions for name
  - SPB-M without MAC-in-MAC [2]
  - SPB-M1
  - MAC by region

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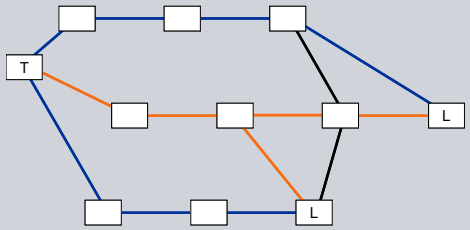
The Filtering Database for L2 Routing

	FDB ID (FID)		MAC address	Port(s)
One entry per Destination MAC Address for unicasts (single path)		VLAN = 5	00:00:0c:00:00:01	3
		VLAN = 5	00:00:0c:00:00:02	15
One / two entries per Destination MAC Address for unicasts (multiple paths)	ingress port ?	VLAN = 5	00:00:0c:00:00:03	3
	ingress port ?	VLAN = 5	00:00:0c:00:00:03	7
	ingress port ?	VLAN = 5	00:00:0c:00:00:04	12
One / two entry per Multicast MAC Address for multicasts (multiple paths)	ingress port ?	VLAN = 5	01:00:0c:00:xx:xx	3, 7
	ingress port ?	VLAN = 5	01:00:0c:00:xx:xx	4, 6, 15
	ingress port ?	VLAN = 5	01:00:0c:00:xx:yy	12, 31

format from [2]



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Proposal Summary

- single path / multipath routing restricted to L2 Routing region
- existing and future protocols can be used simultaneously with different VLAN IDs
- use ISIS-SPB for distribution of topology information and available bandwith throughout L2 Routing region
- control data streams using engineered multicast addresses between selected nodes
- distribute talker/listener relationships throughout L2 region by extended ISIS-SPB or extended MSRP
- bridges compute consistent and best paths and bandwidth reservations locally
- MAC by region
  - one VLAN, forwarding based on customer MAC address (restricted to routing region)
  - no encapsulation of customer MAC (in contrast to SPB-M) since there is no scalability issue as in Provider Backbone
    - region has only scalable number of switches
    - only subset of switches included in routing

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References

[1] Franz-Josef Goetz: L2 Routing for Control Data Traffic @ Industry, March 2012

[2] Norman Finn: More on SPB-V – Shortest Path Bridging V-mode, Ver. 01, April 2012

[3] Oliver Kleineberg: Redundancy for fault-tolerance and AVB – Overview of the simultaneous multi-path proposal, March 2012