



# Multiple Spanning Trees IEEE 802.1s

**Mario Baldi**

Politecnico di Torino

<http://staff.polito.it/mario.baldi>

**Pietro Nicoletti**

Studio Reti

<http://www.studioreti.it>

Based on chapter 5 of:

M. Baldi, P. Nicoletti, "Switched LAN", McGraw-Hill, 2002, ISBN 88-386-3426-2



# Nota di Copyright

This set of transparencies, hereinafter referred to as slides, is protected by copyright laws and provisions of International Treaties. The title and copyright regarding the slides (including, but not limited to, each and every image, photography, animation, video, audio, music and text) are property of the authors specified on page 1.

The slides may be reproduced and used freely by research institutes, schools and Universities for non-profit, institutional purposes. In such cases, no authorization is requested.

Any total or partial use or reproduction (including, but not limited to, reproduction on magnetic media, computer networks, and printed reproduction) is forbidden, unless explicitly authorized by the authors by means of written license.

Information included in these slides is deemed as accurate at the date of publication. Such information is supplied for merely educational purposes and may not be used in designing systems, products, networks, etc. In any case, these slides are subject to changes without any previous notice. The authors do not assume any responsibility for the contents of these slides (including, but not limited to, accuracy, completeness, enforceability, updated-ness of information hereinafter provided).

In any case, accordance with information hereinafter included must not be declared.

In any case, this copyright notice must never be removed and must be reported even in partial uses.

## General overview

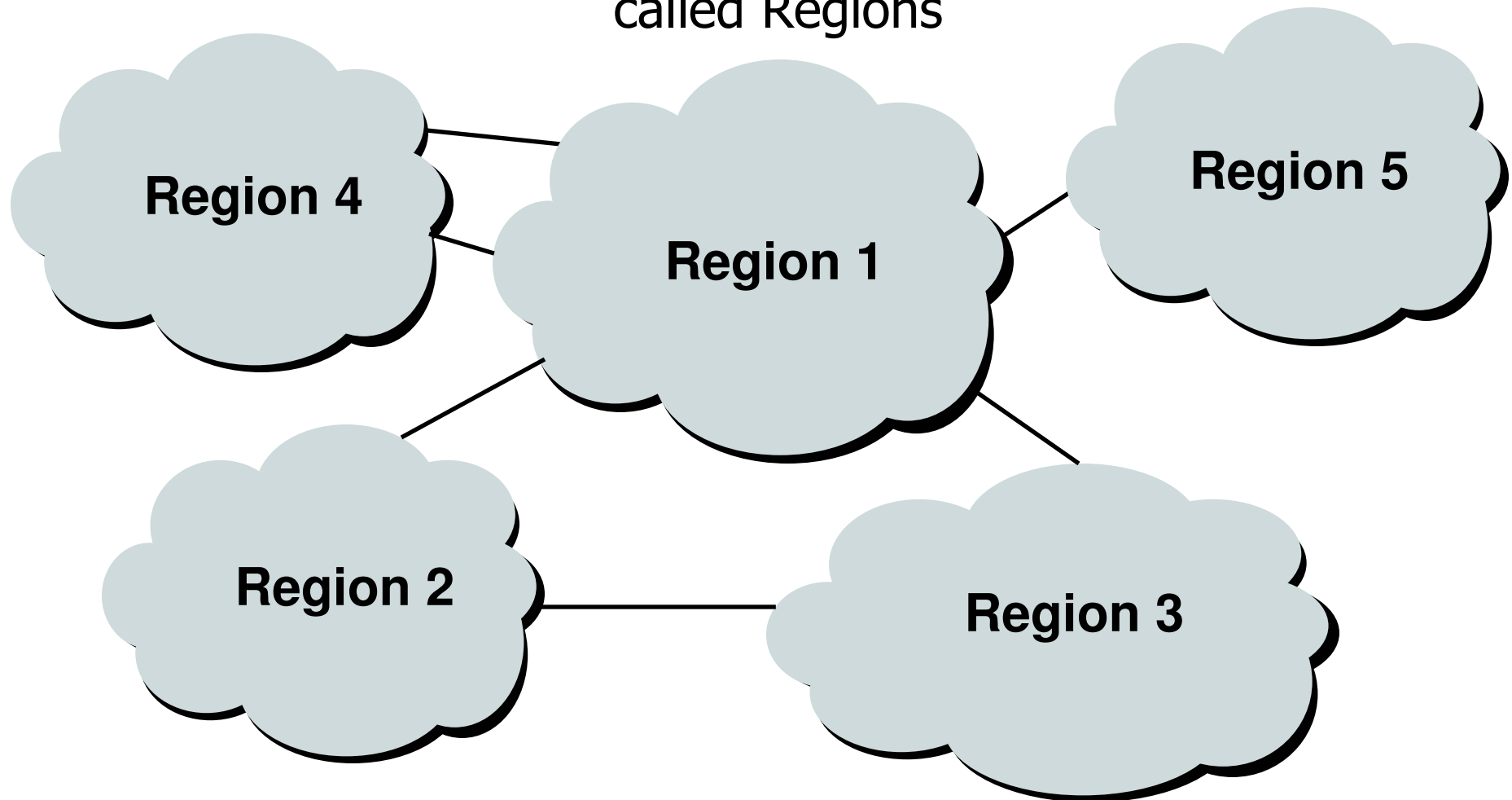
- Extremely flexible solution that provides multiple spanning tree instances that can be bound to various VLANs
- Uses the rapid spanning tree protocol (RSTP, standard 802.1w)
- Enables the realization of switched networks with many cascade switches
- The best solution for big campus networks or metropolitan networks (MAN)

## General overview

- Allows the establishment of one or more spanning tree instances
- associates or maps a VLAN to a desired instance
- The creation of two single instances of STP is enough to build two separate trees that execute prunings in different points of the mesh

# Architecture

IEEE 802.1s divides the network in zones or areas called Regions



# Multiple Spanning Tree (MST) region

- Features of the MST Region:
  - Uses the Rapid Spanning Tree Protocol (802.1W) and MSTI BPDUs packages
    - MSTI = Multiple Spanning Tree Instance
  - Each Region can have no more than 64 spanning tree instances
    - This behavior avoids an excessive flood of MSTI BPDUs
  - Each spanning tree instance is identified by the MSTID parameter that can assume values in the range starting from 1 up to 4094
  - A MSTI Regional Root Bridge is selected for each spanning tree instance in a Region
- A network can have many MST Regions

## How to define a MST Region

- A MST Region is a network part, whose switches have the following features:
  - Same configurations of spanning tree instances:
    - Instance numaration
    - Related VLANs
- If a switch has a different configuration of STP instances or the operating mode differs from MSTI, the inclusion in a Region is not possible
  - the connection to this switch is considered an edge connection (boundary) towards another Region
- Information concerning a shared spanning tree instance and multiple spanning tree instances are stored in a table named *MST Configuration Table Entry*

## Single Spanning Tree (SST) Region

- Includes bridges or switches that do not allow multiple spanning trees since they are not compliant to the 802.1s standard
  - SST may use STP or RSTP
- Only one is present

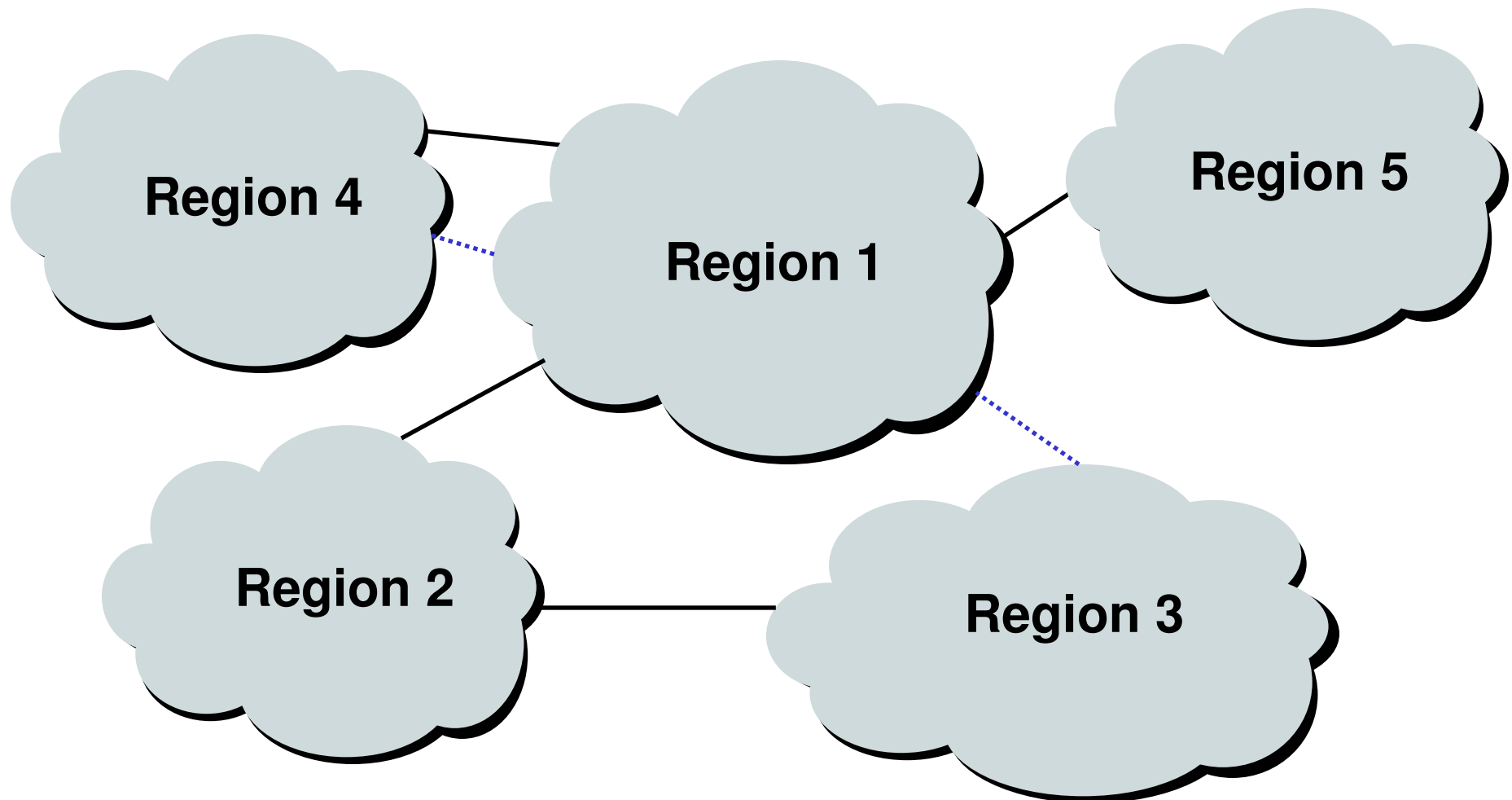


# Common Instance Spanning Tree (CIST)

- CIST includes all the MST regions and the SST region (if present)
- CIST has a single root bridge
  - The bridge with the lowest identifier on the network
  - CIST root
- A whole MST region is seen as a single bridge
  - Identifier of the CIST Regional Root bridge
  - The root path cost and message age parameter are increased only if the receiving port is the root port of the bridge selected as CIST Regional Root

# Common Spanning Tree

A tree connecting Regions is created



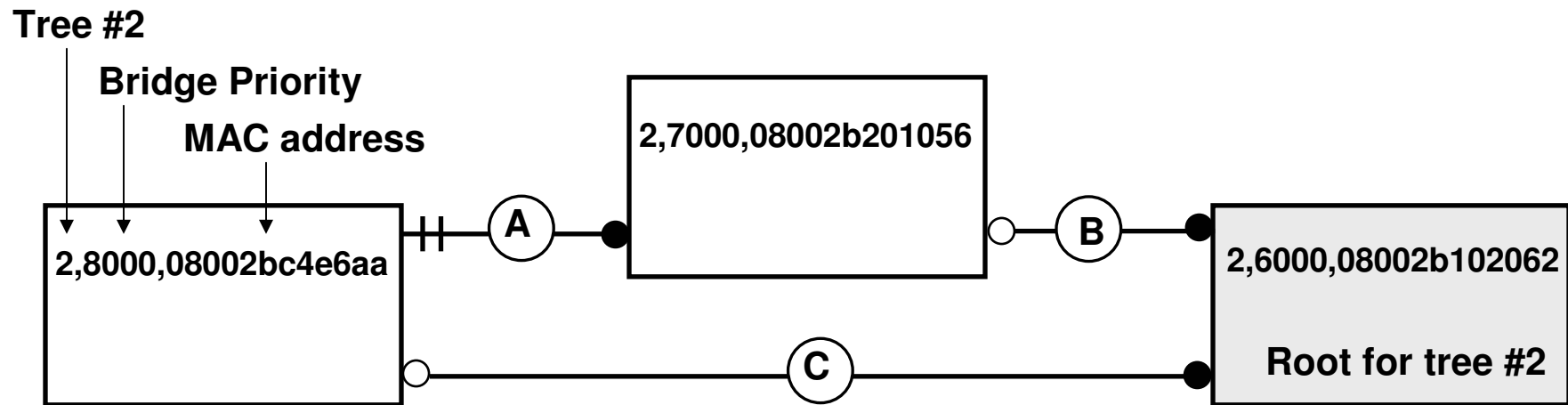
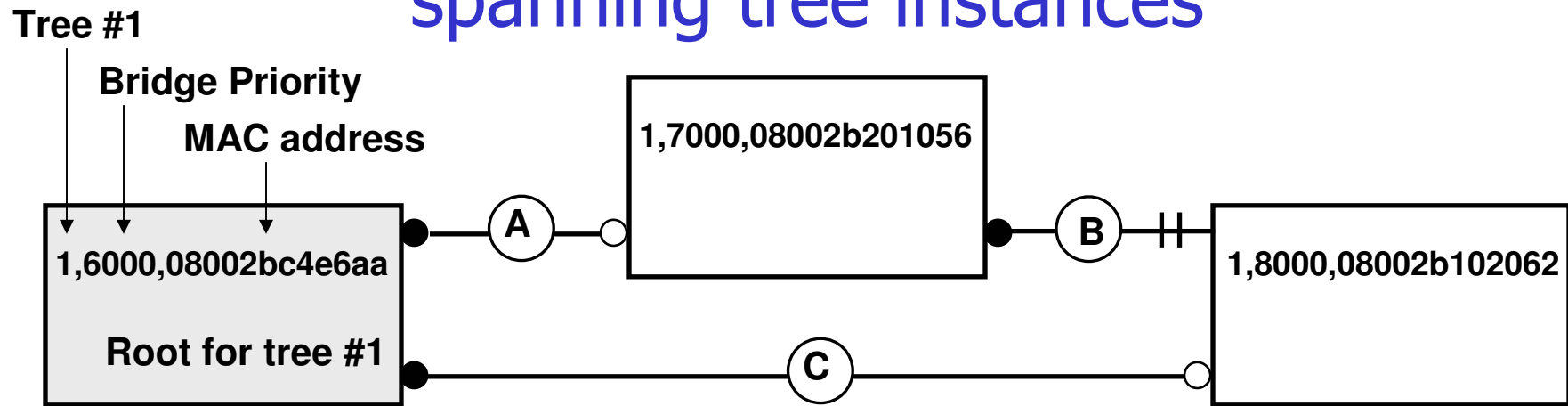
## In each MST region

- A common spanning tree instance called CIST takes part to the Common Spanning Tree
  - CIST = common and Internal Spanning Tree
  - There is a CIST *Regional Root* bridge
- One or more multiple MSTI spanning tree instances
  - One or more *MSTI Regional Root* bridge

# Election of the root bridges

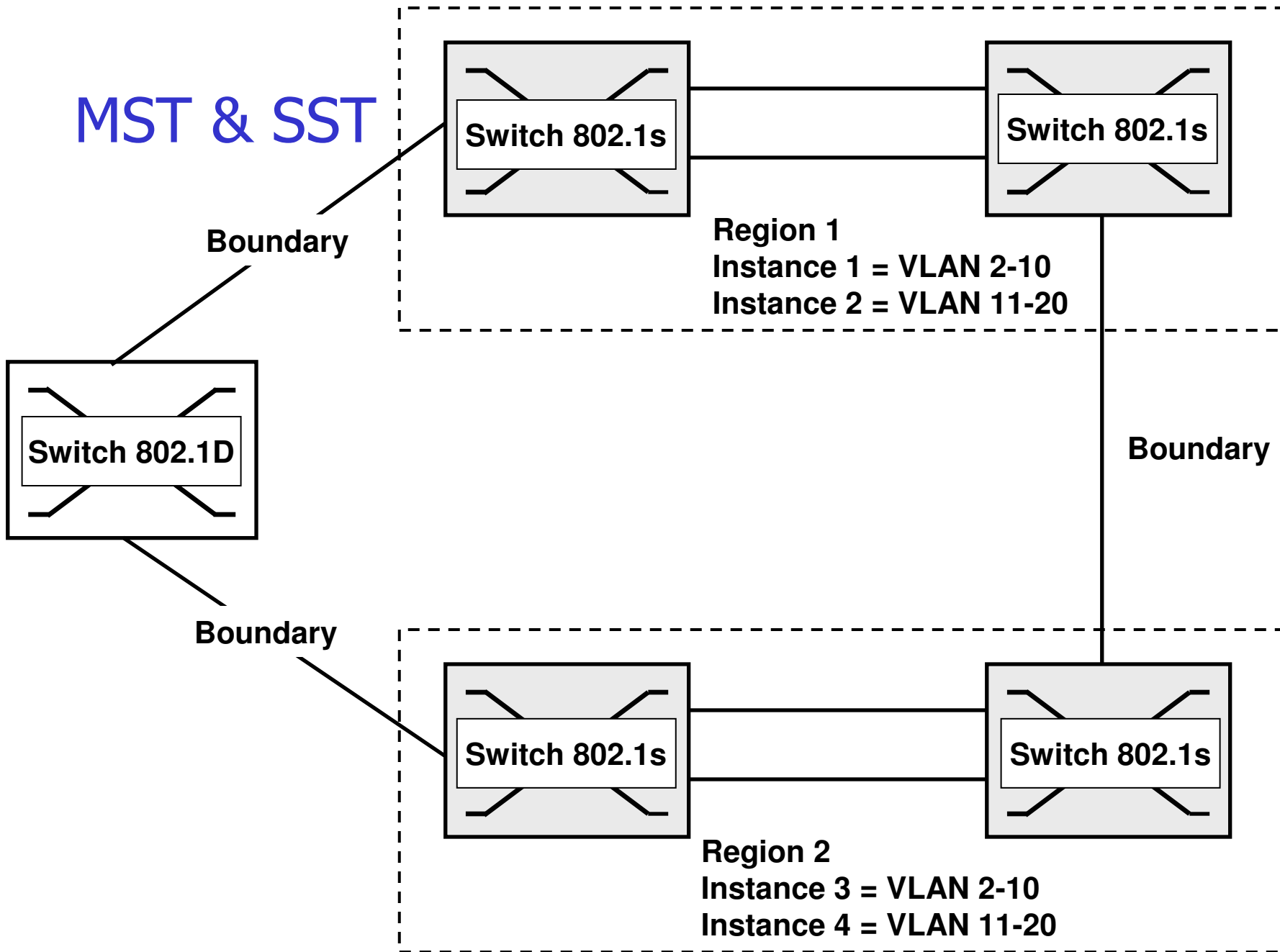
- Common spanning tree:
  - The bridge with the lowest identifier in the network becomes the root
  - It is the general root bridge of the network
- MSTI Regional Root:
  - The bridge with the lowest identifier in that instance becomes the root
- CIST Regional Root:
  - The closest bridge to the general root bridge becomes the root bridge for the common and internal spanning tree
    - It can be the bridge that is the closest to the Region where the general root bridge is placed
    - It can be the bridge that is the closest to the SST area where the general root bridge is placed

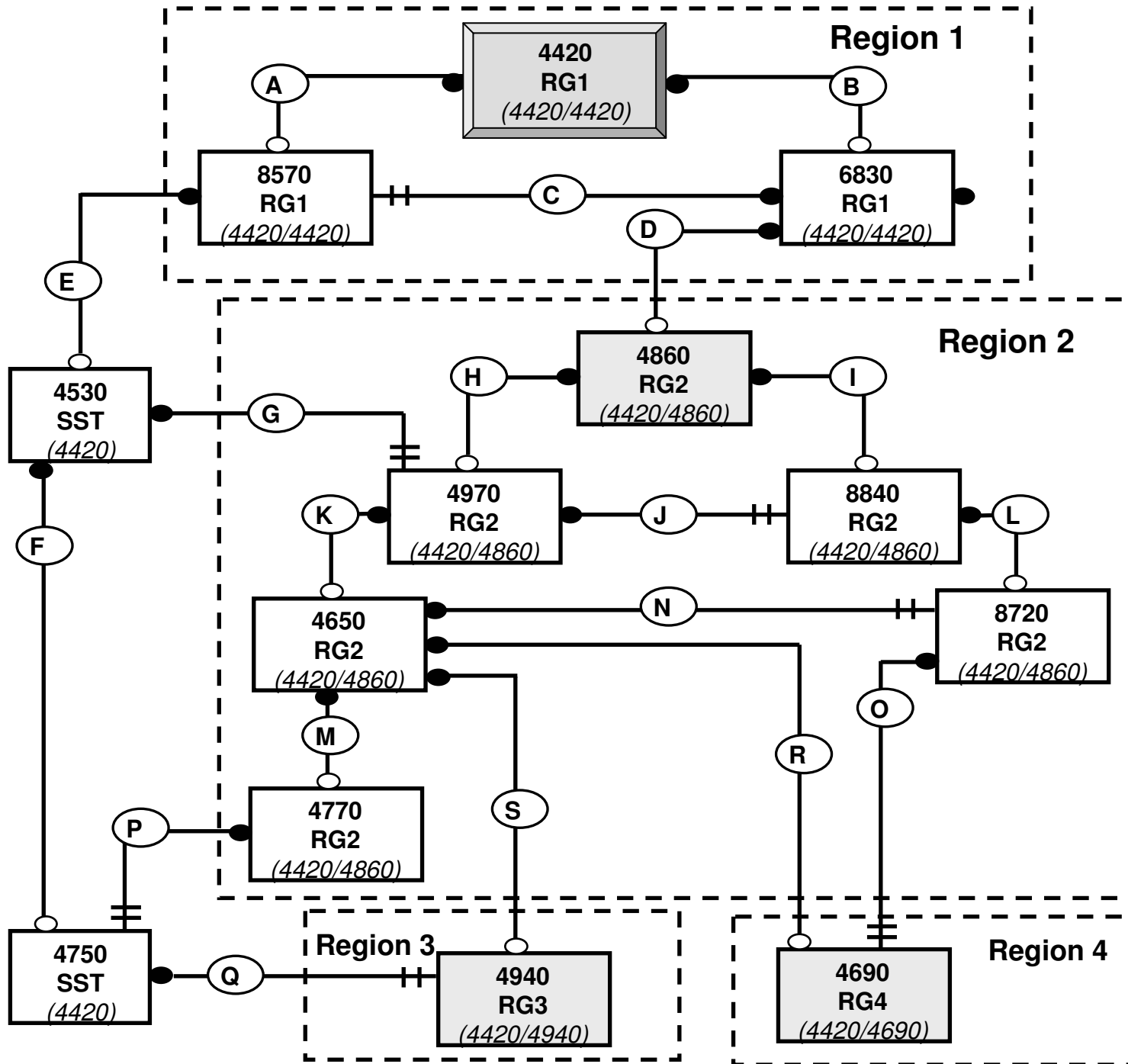
# Example: Region with two separate spanning tree instances



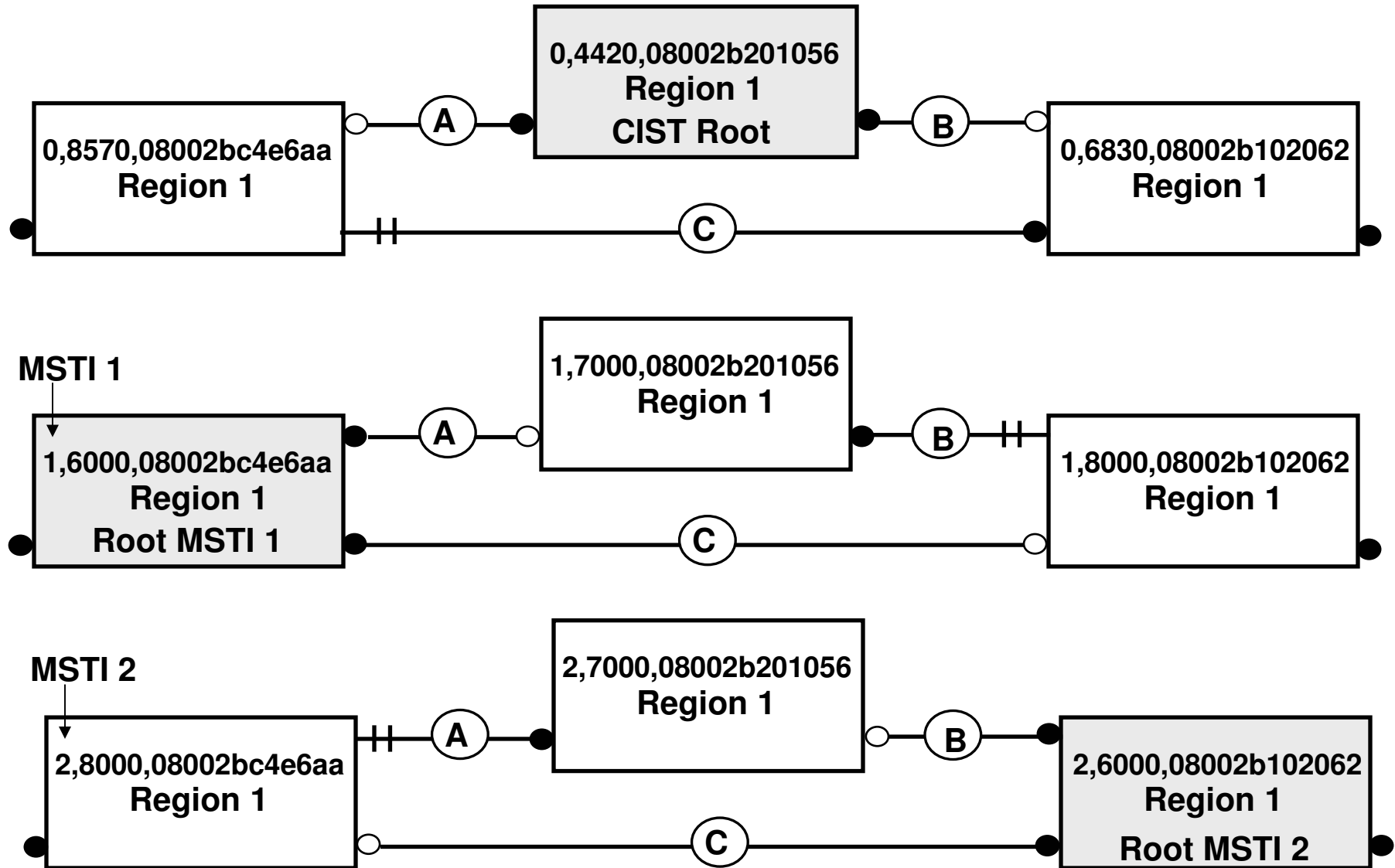
|         |                  |
|---------|------------------|
| Tree #1 | VLAN 1, 3, 8, 10 |
| Tree #2 | VLAN 2, 4, 5, 6  |

# MST & SST



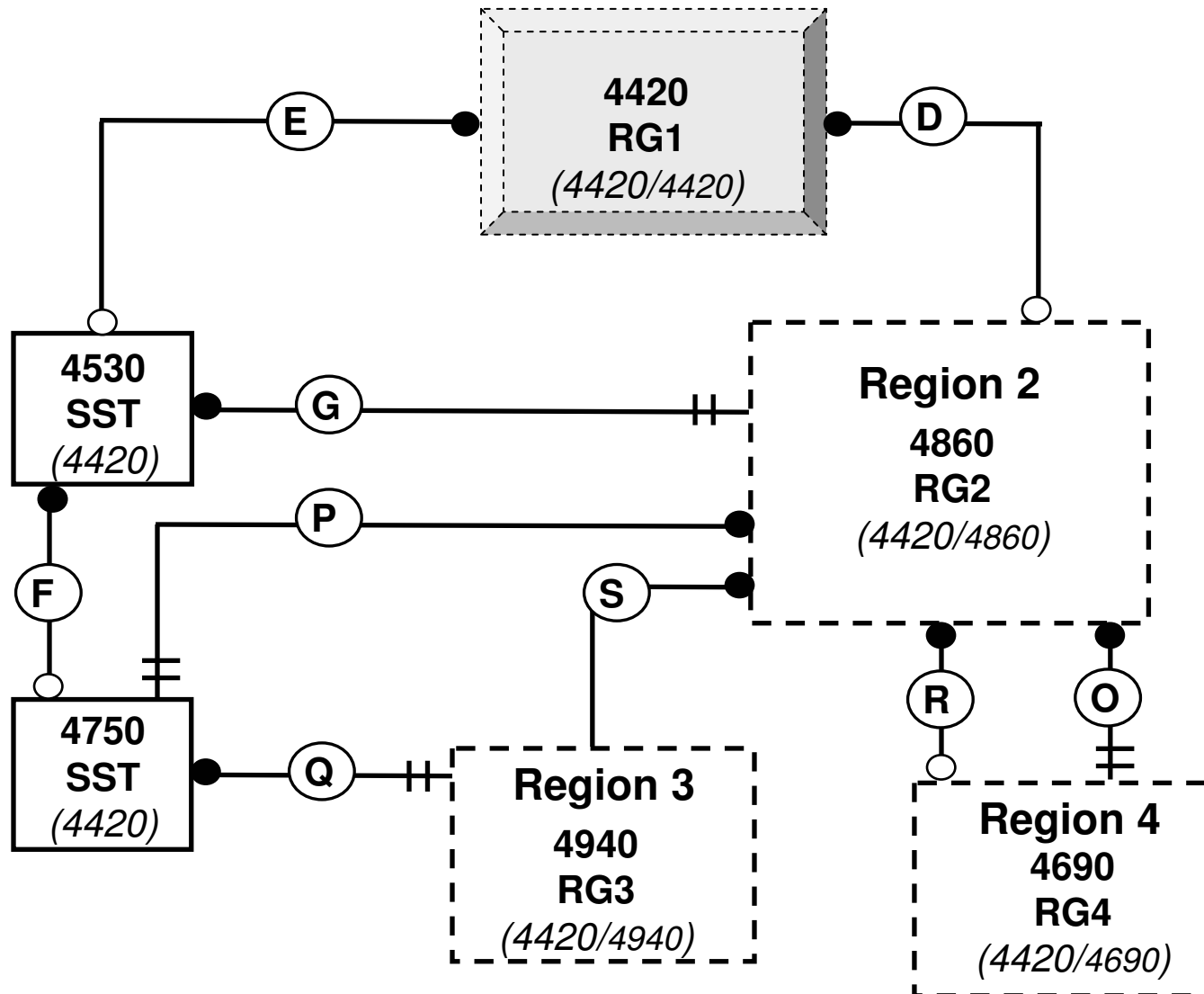


# Instances of Region 1





# Modifying MSTI Regions and Common Spanning Tree



# MSTI BPDUs format

- CIST root Identifier
  - root bridge for the whole network
- CIST Regional Root Identifier
  - root bridge for the common spanning tree inside the Region
- MSTI Regional Root Identifier
  - root bridge for a given instance
- MST configuration identifier
  - VLAN ID (HMAC-MD5 cryptography)

## MSTI BPDUs

|                                                |
|------------------------------------------------|
| Protocol Identifier                            |
| Protocol Version Identifier                    |
| BPDUs Type                                     |
| CIST Flags                                     |
| CIST Root Identifier                           |
| CIST External Path Cost                        |
| CIST Regional Root Identifier                  |
| CIST Port Identifier                           |
| Message Age                                    |
| Max Age                                        |
| Hello Time                                     |
| Forward Delay                                  |
| Version 1 Length = 0                           |
| Version 3 Length                               |
| MST Configuration Identifier                   |
| CIST Internal Root Path Cost                   |
| CIST Bridge Identifier                         |
| CIST Remaining Hops                            |
| MSTI Configuration Messages<br>(may be absent) |

### MSTI Configuration Message

|                               |       |
|-------------------------------|-------|
| MSTI Flags                    | 1     |
| MSTI Regional Root Identifier | 2–9   |
| MSTI Internal Root Path Cost  | 10–13 |
| MSTI Bridge Priority          | 14    |
| MSTI Port Priority            | 15    |
| MSTI Remaining Hops           | 16    |