TOMORROW
starts here.

CISCO

MPLS
Workshop

ISIS Fundamentals and Troubleshooting

BRKRST-2327

MPLS
Workshop

ISIS Fundamentals and Troubleshooting

Agenda

- Overview

- Hierarchical Areas

- Addressing

- MTU and Hello Padding

- Attach-bit and Route Leaking

- LSP Flooding and Convergence

- SPF and Network Stability

- Route Redistribution

- Narrow and Wide Metrics

→ Reference slide

MPLS
Workshop

What Is IS-IS?

- Intermediate System to Intermediate System

- An "IS" is ISO terminology for a router

- IS-IS was originally designed as a dynamic routing protocol for ISO CLNP, defined in the ISO 10589 standard

- Also called as "Integrated IS-IS" or "Dual IS-IS"

- Encodes the packet(s) in TLV (Type, Length, Value) format

MPLS
Workshop

     Cisco Public

IS-IS for IP Routing

- Easily adapted to carry IP prefix information, as specified in RFC1195

- Flexible protocol in terms of tuning and easily extensible with to new features with TLVs

    - IS-IS extensions for MPLS -TE, IPv6

- It runs directly over Layer 2

- Proven to be a very stable and scalable, with very fast convergence

MPLS
Workshop

     Cisco Public

Encapsulation of IS-IS

- IS-IS is **not** encapsulated in IP!

- Encapsulated directly in the data link layer

- Protocol family is OSI: 0xFEFE is used in layer 2 headers to identify it

IS-IS:

Data-link header (OSI family 0xFEFE)	IS-IS fixed header (first byte is 0x83)	IS-IS TLVs

MPLS
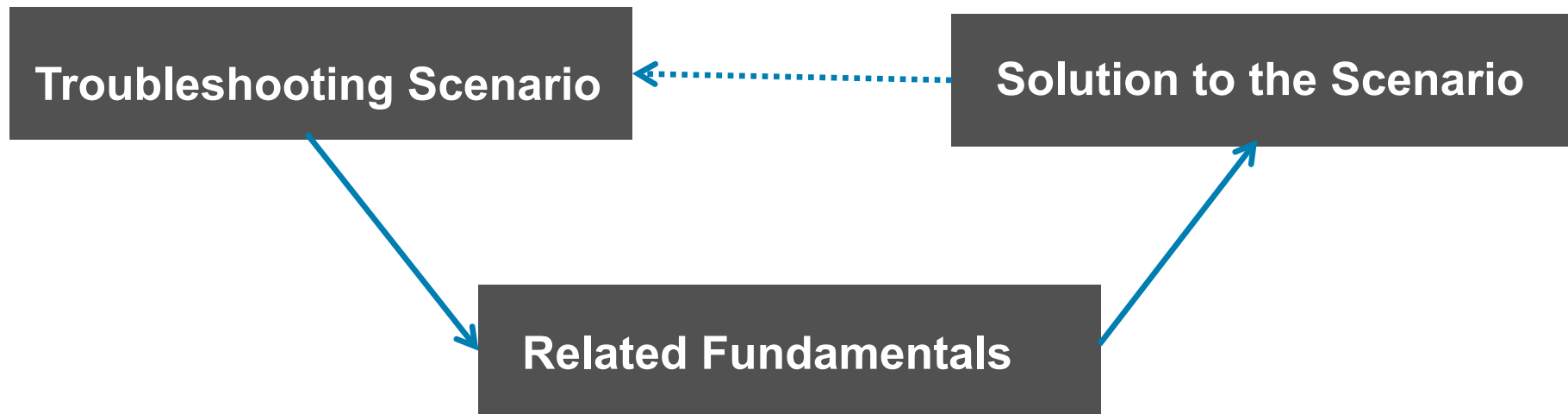Workshop

Cisco Public

ISIS Fundamentals and Troubleshooting

Agenda

- Overview

- IS-IS Hierarchical Areas

- Addressing

- MTU and Hello Padding

- Attach-bit and Route Leaking

- LSP Flooding and Convergence

- SPF and Network Stability

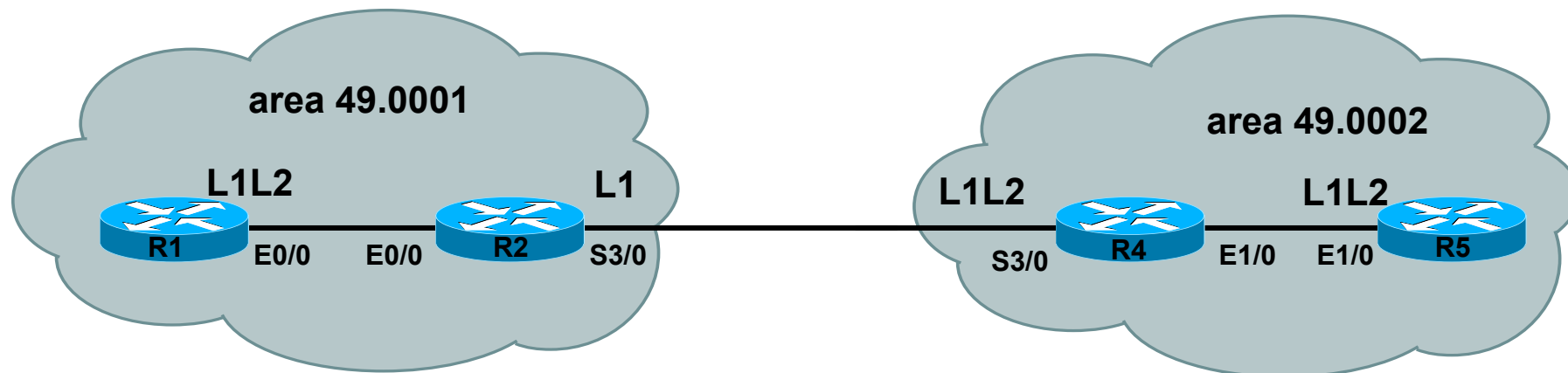- Route Redistribution

- Narrow and Wide Metrics

MPLS
Workshop

ISIS Fundamentals and Troubleshooting

Flow of the presentation

Troubleshooting Scenario ← **Solution to the Scenario**

Related Fundamentals

MPLS
Workshop

 Cisco Public

Scenario 1 :
R2 and R4 Peering showing as ES-IS instead of IS-IS?


```
R2#show clns neighbors
System Id    Interface    SNPA           State   Holdtime   Type
Protocol
R1           Et0/0        00d0.58eb.ff01  Up      26         L1    IS-IS
R4           Se3/0        *HDLC*          Up      280        IS    ES-IS
```

MPLS
Workshop

Hierarchy Levels

- IS-IS presently has a two-layer hierarchy
  - The backbone (level 2)
  - The areas (level 1)

- An IS (router) can be either:
  - Level 1 router (intra-area routing)
  - Level 2 router (inter-area routing)
  - Level 1–2 router (intra and inter-area routing)

MPLS
Workshop

      Cisco Public
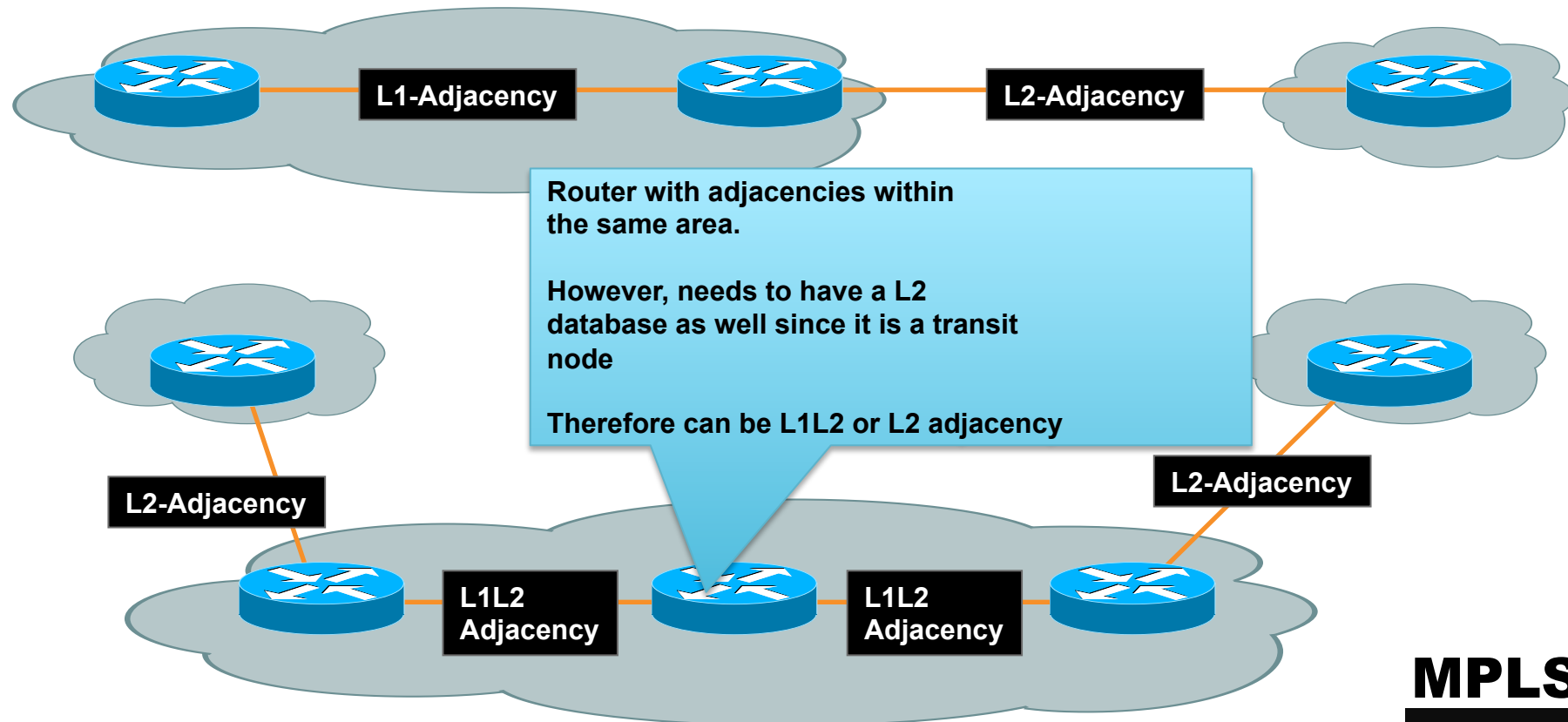
Level 1 Routers

- Neighbors only in the **same** Level 1 area

- Level 1 LSDB only carries intra-area information

- Level 1 only routers look at the attached-bit to find the closest Level 1–2 router

- Level 1 only routers install a default route to the closest Level 1–2 router in the area

Cisco Public

MPLS
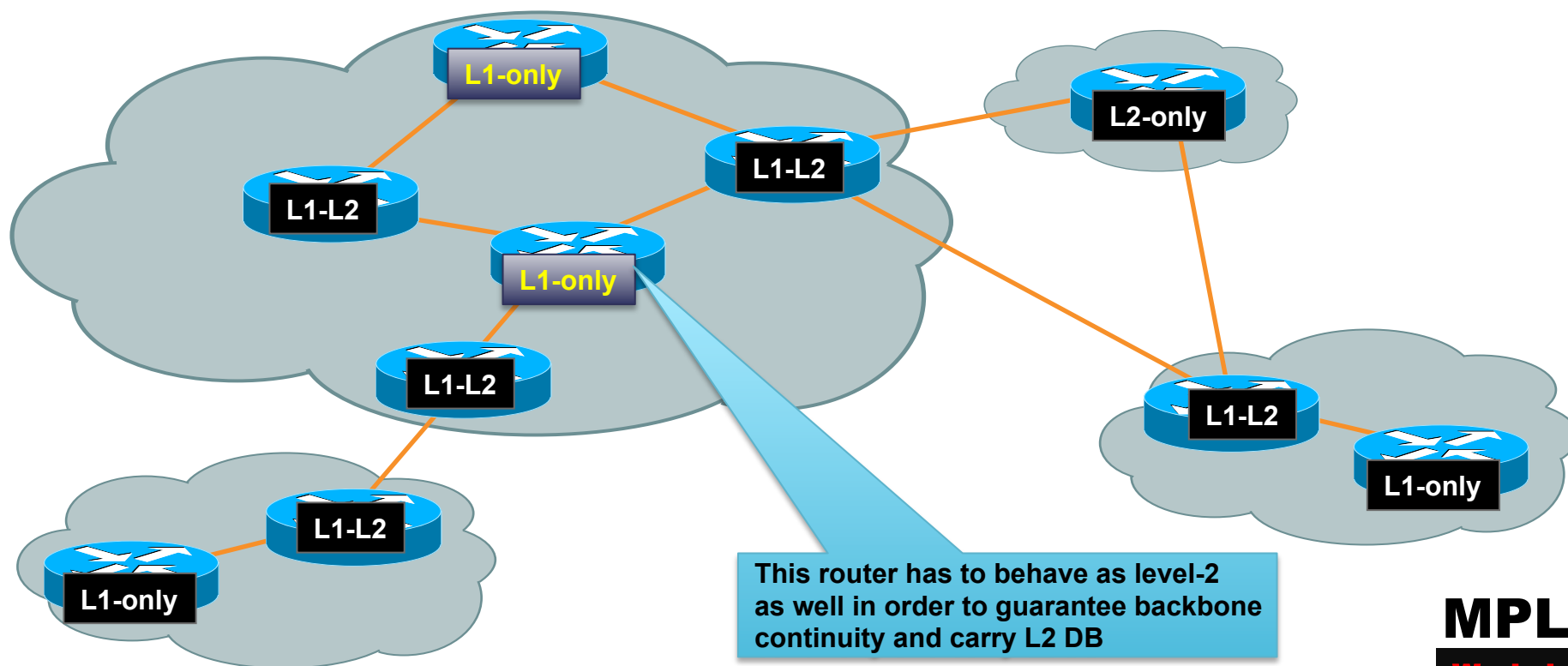**Workshop**

Level 2 Routers

- May have neighbors in other areas

- L2 has information about L2 topology

- L2 has information about which L1 areas are reachable and how to reach them via the L2 topology

- L2 routers often may also perform L1 routing
  - called **L1L2** routers

 Cisco Public

MPLS
Workshop

Adjacency Levels

L1-Adjacency

L2-Adjacency

L2-Adjacency

L2-Adjacency

L1L2 Adjacency

L1L2 Adjacency

Router with adjacencies within the same area.

However, needs to have a L2 database as well since it is a transit node

Therefore can be L1L2 or L2 adjacency

MPLS
Workshop

Level 1, Level 2 and Level 1–2 Routers

Backbone **Must Be** L2 Contiguous

L1-only

L2-only

L1-L2

L1-L2

L1-only

L1-L2

L1-L2

L1-only

L1-only

This router has to behave as level-2 as well in order to guarantee backbone continuity and carry L2 DB

Cisco Public

MPLS
Workshop

Can an IS Determine Its Level?

"I'm in area 2 and ALL my neighbours are in the same area. I must be a L1-only router ?"

Area 1

Area 2

Area 3

Area 4

!! NO !!
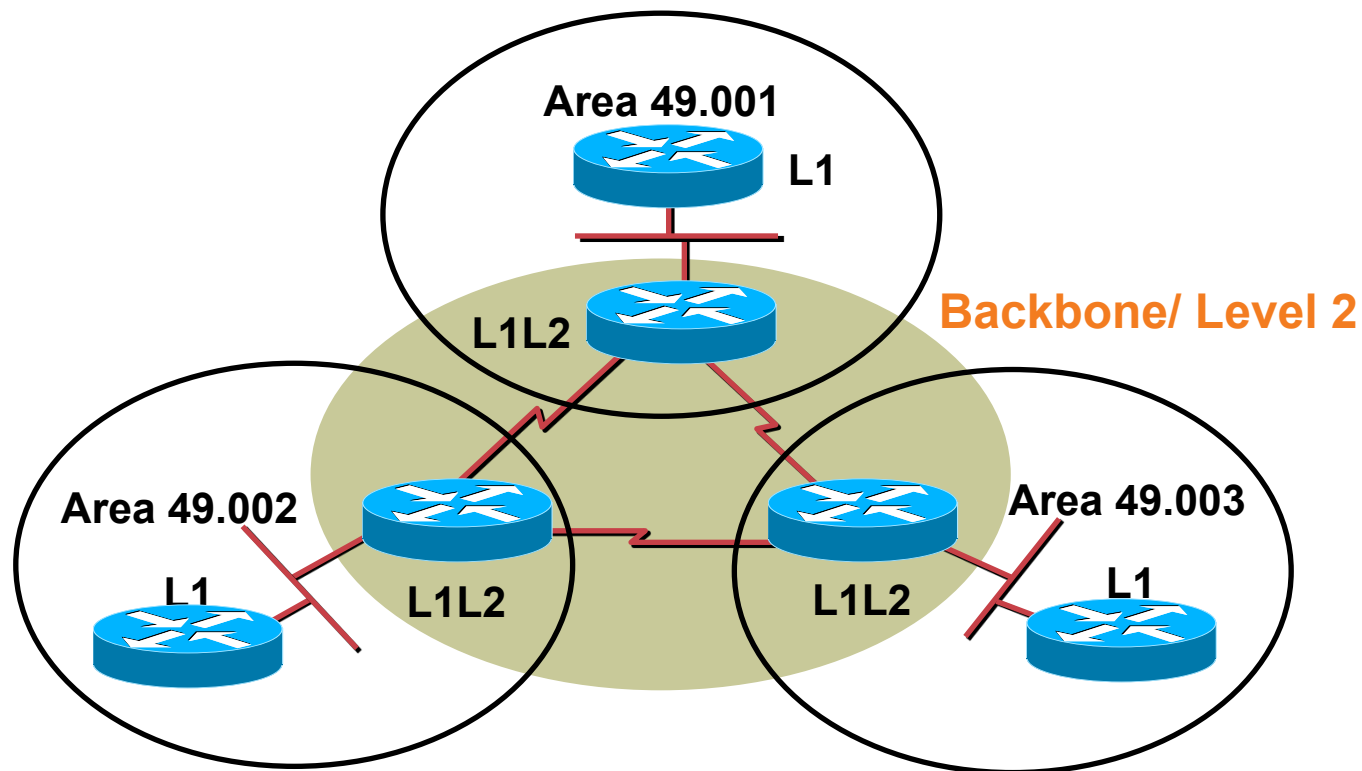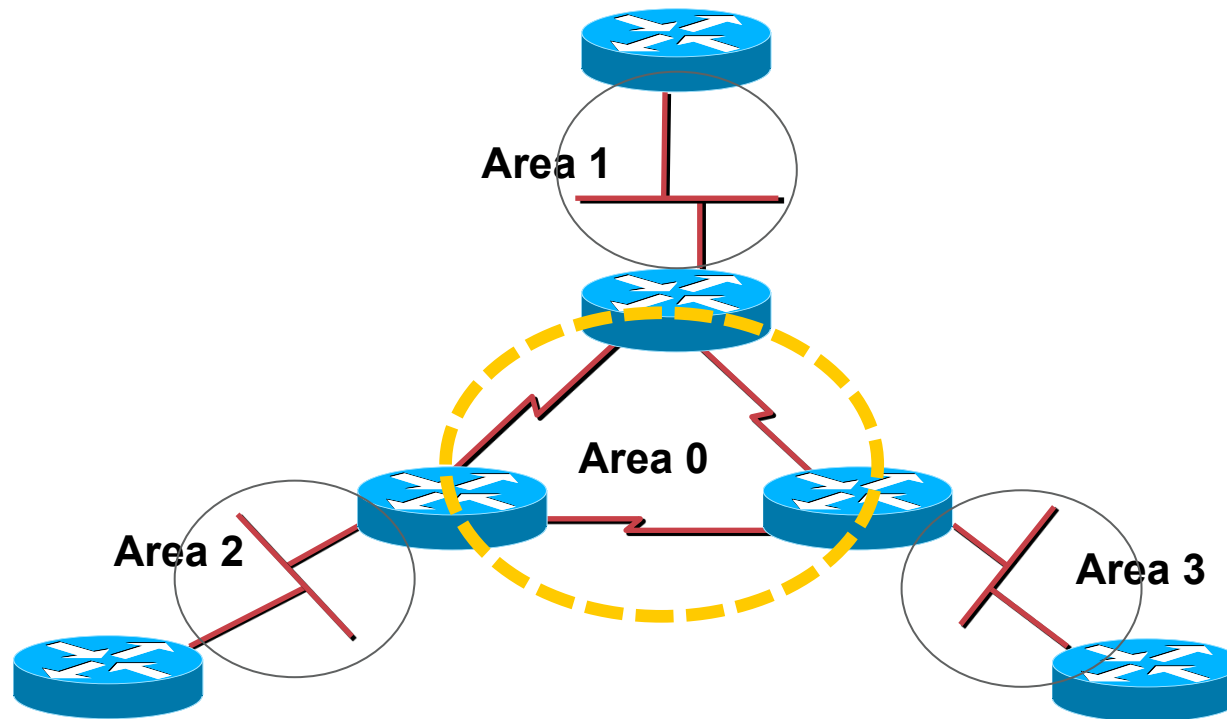Rtr must have a full L2 LSDB to route between areas 1, 3 and 4. Remember, the backbone must be contiguous.
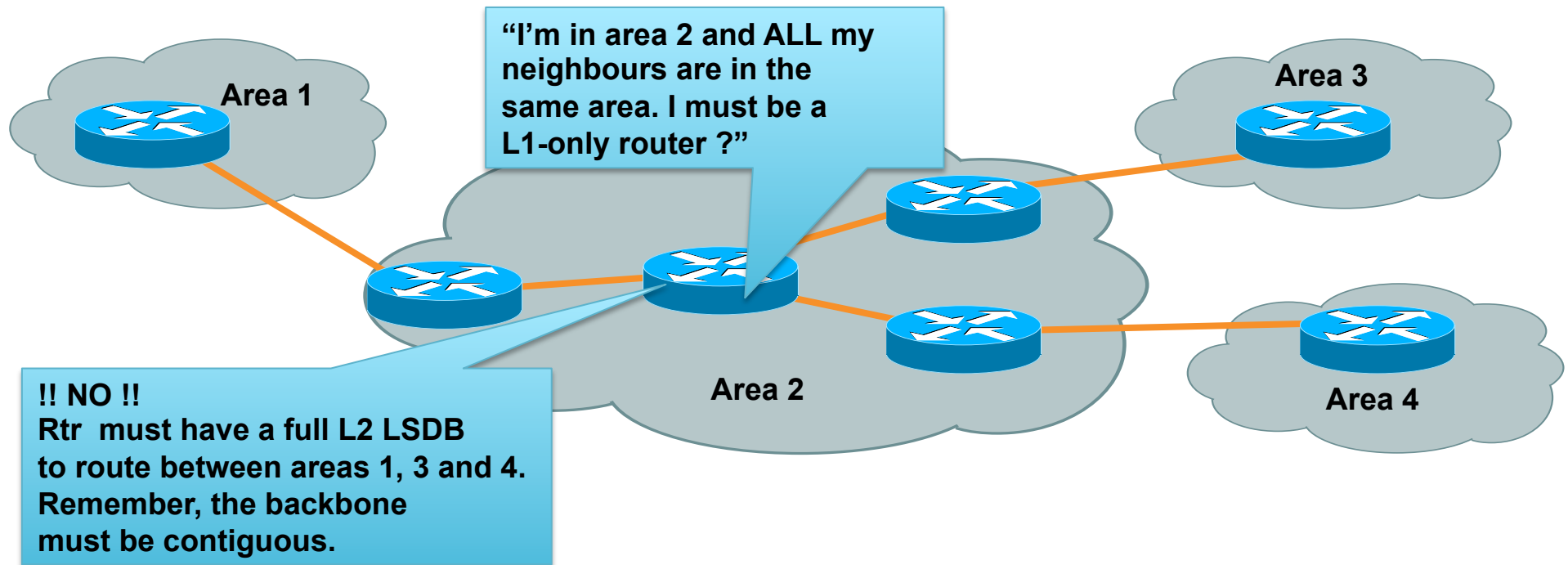
- IS-IS router cannot determine if they need to be L1 or L2; therefore, by default all Cisco routers will behave as L1L2
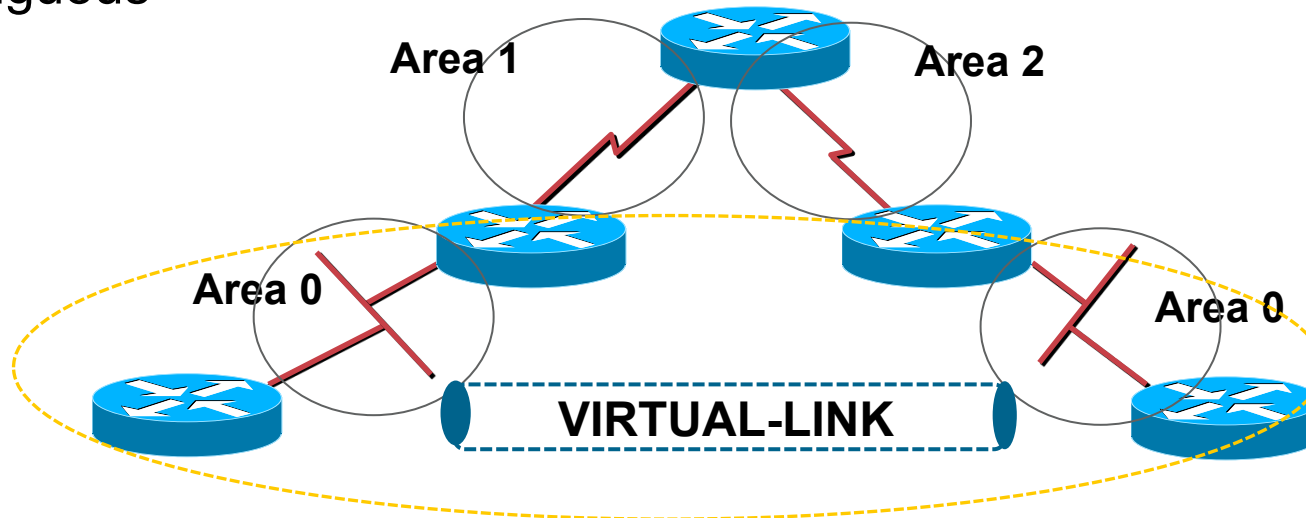
MPLS
Workshop

Areas and Backbone Routers - Example

Area 49.001

L1

L1L2

Backbone/ Level 2

Area 49.002

L1

L1L2

Area 49.003

L1L2

L1

MPLS
Workshop

How IS-IS Area is different from OSPF ?

Area 1

Area 0

Area 2

Area 3

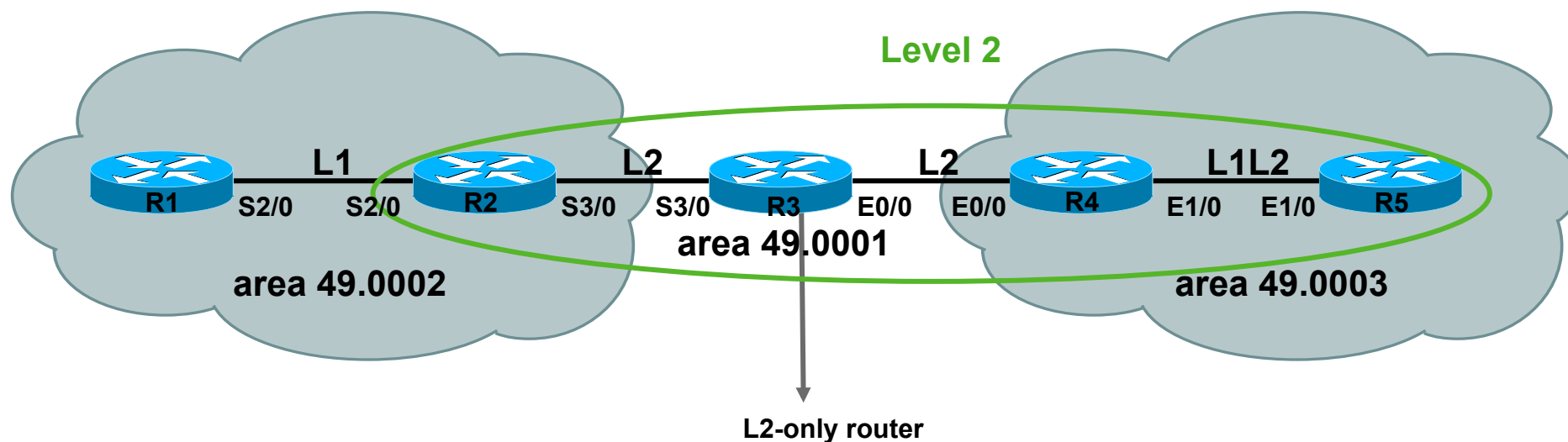**MPLS**
Workshop

Cisco Public

How IS-IS Area is different from OSPF ?

- OSPF allows dis-contiguous backbone, a virtual link can be used to bridge them
- There is no Virtual-link in IS-IS, L2 areas / Backbone must be contiguous
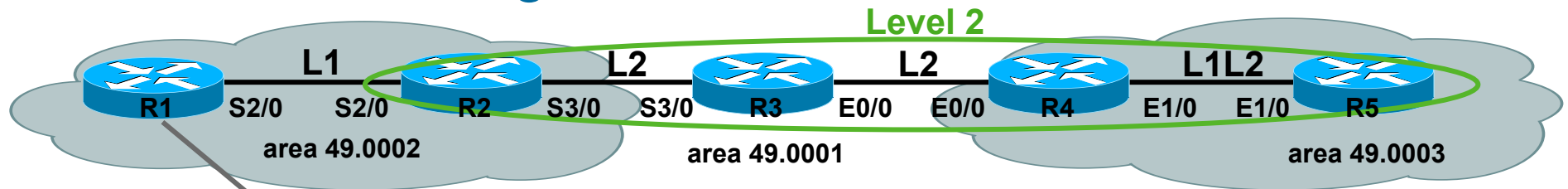

Area 1   Area 2

Area 0   Area 0

VIRTUAL-LINK

MPLS
Workshop

Cisco Public

Basic IS-IS Configuration for IP Network

Level 2

R1 — L1 — S2/0 — S2/0 — R2 — L2 — S3/0 — S3/0 — R3 — L2 — E0/0 — E0/0 — R4 — L1L2 — E1/0 — E1/0 — R5

area 49.0002

area 49.0001

area 49.0003

L2-only router

Area 49.0001 does not need to have level 1 enabled

MPLS
Workshop

Basic IS-IS Configuration for IP Network – R1

Level 2

L1 — R1 S2/0 — S2/0 R2 S3/0 — L2 — S3/0 R3 E0/0 — L2 — E0/0 R4 E1/0 — L1L2 — E1/0 R5
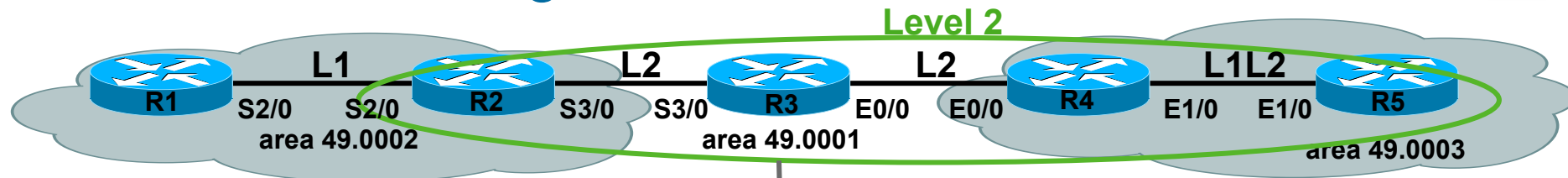
area 49.0002   area 49.0001   area 49.0003

```
interface Loopback0
 ip address 10.1.100.1 255.255.255.255
!
interface Serial2/0
 ip address 10.1.5.1 255.255.255.0
 ip router isis
!
router isis
 net 49.0002.0000.0000.0001.00
 is-type level-1
 log-adjacency-changes all
 passive-interface Loopback0
```

MPLS
Workshop

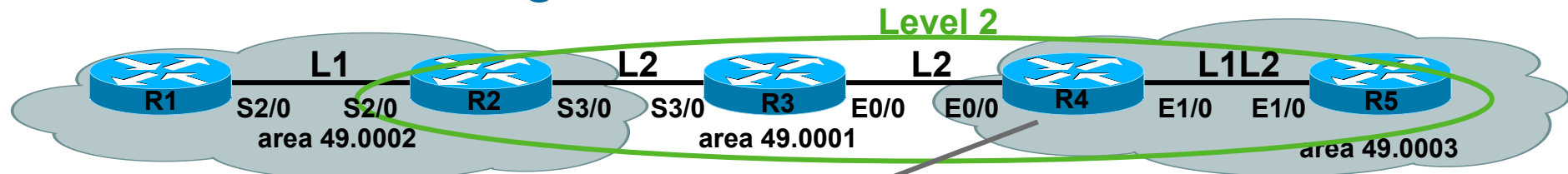# Basic IS-IS Configuration for IP Network – R2
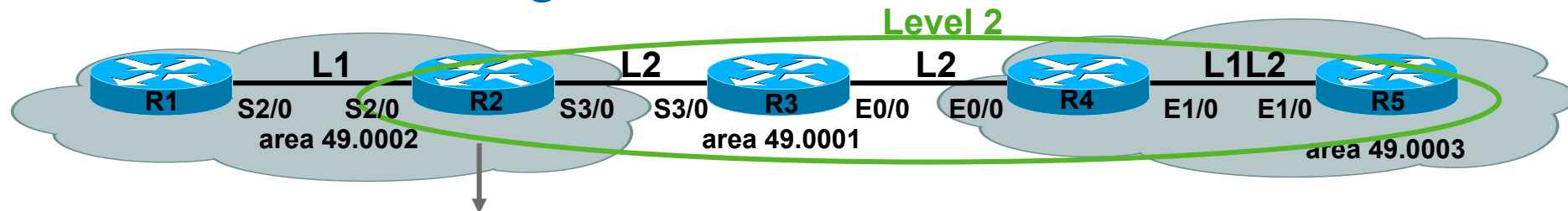

```
interface Serial2/0
 ip address 10.1.5.2 255.255.255.0
 ip router isis
 isis circuit-type level-1
!
interface Serial3/0
 ip address 10.1.1.2 255.255.255.0
 ip router isis
 isis circuit-type level-2-only
!
router isis
 net 49.0002.0000.0000.0002.00
 log-adjacency-changes all
```

MPLS
Workshop

    Cisco Public

Basic IS-IS Configuration for IP Network – R3

Level 2

L1 R1 S2/0 — S2/0 R2 **L2** S3/0 — S3/0 R3 **L2** E0/0 — E0/0 R4 **L1L2** E1/0 — E1/0 R5

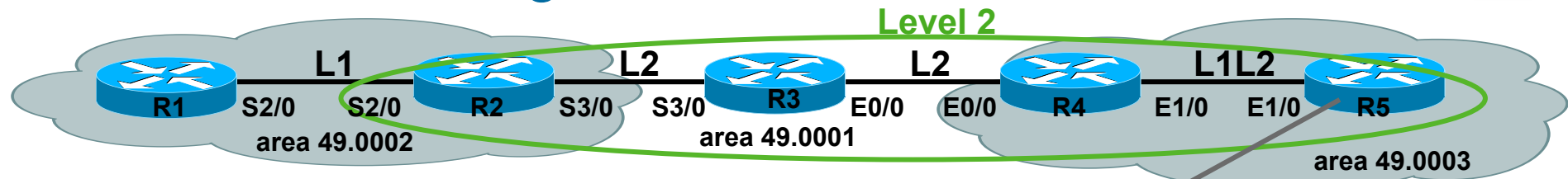area 49.0002   area 49.0001   area 49.0003

```
interface Ethernet0/0
 ip address 10.1.2.3 255.255.255.0
 ip router isis
!
interface Serial3/0
 ip address 10.1.1.3 255.255.255.0
 ip router isis
!
router isis
 net 49.0001.0000.0000.0003.00
 is-type level-2-only
 log-adjacency-changes all
```

MPLS
Workshop

Basic IS-IS Configuration for IP Network – R3

Level 2

L1 L2 L2 L1L2

R1 S2/0 S2/0 R2 S3/0 S3/0 R3 E0/0 E0/0 R4 E1/0 E1/0 R5

area 49.0002 area 49.0001 area 49.0003

```
interface Ethernet0/0
 ip address 10.1.2.4 255.255.255.0
 ip router isis
 isis circuit-type level-2-only
!
interface Ethernet1/0
 ip address 10.1.4.4 255.255.255.0
 ip router isis
 isis network point-to-point
!
router isis
 net 49.0003.0000.0000.0004.00
 log-adjacency-changes all
 passive-interface Loopback0
```

Cisco Public

MPLS
Workshop

Basic IS-IS Configuration for IP Network – R5

Level 2

R1 — L1 — S2/0 | S2/0 — R2 — S3/0 | L2 | S3/0 — R3 — E0/0 | L2 | E0/0 — R4 — E1/0 | L1L2 | E1/0 — R5

area 49.0002   area 49.0001   area 49.0003
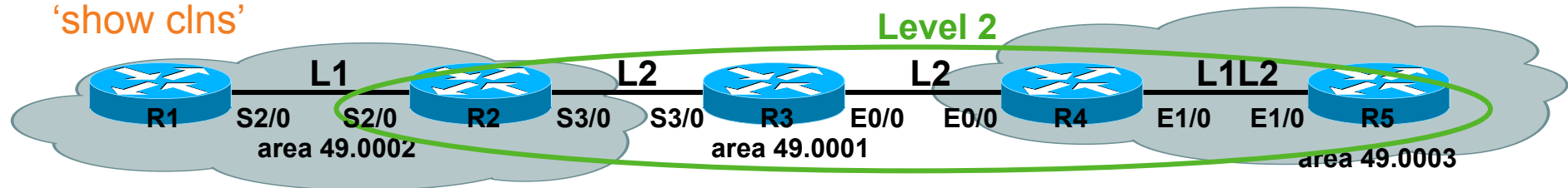
network type point-to-point

```
interface Loopback0
 ip address 10.1.100.5 255.255.255.255
!
interface Ethernet1/0
 ip address 10.1.4.5 255.255.255.0
 ip router isis
 isis network point-to-point
!
router isis
 net 49.0003.0000.0000.0005.00
 log-adjacency-changes all
 passive-interface Loopback0
```

MPLS
Workshop

Basic IS-IS Configuration for IP Network

'show clns'

Level 2

L1   L2   L2   L1L2

R1 S2/0 S2/0 R2 S3/0 S3/0 R3 E0/0 E0/0 R4 E1/0 E1/0 R5

area 49.0002   area 49.0001   area 49.0003

Check the interfaces enabled and mode with 'show clns' command

```
R3#show clns
Global CLNS Information:
  2 Interfaces Enabled for CLNS
  NET: 49.0001.0000.0000.0003.00
  Configuration Timer: 60, Default Holding Timer: 300, Packet
   Lifetime 64
  ERPDU's requested on locally generated packets
  Running IS-IS in IP-only mode (CLNS forwarding not allowed)
```
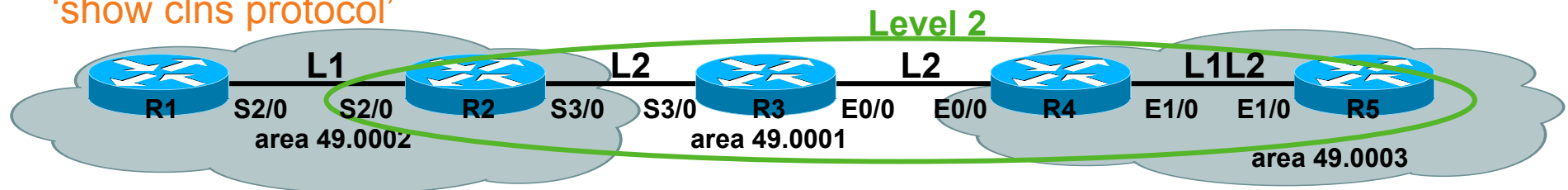
"clns routing" is not configured

MPLS
Workshop

Basic IS-IS Configuration for IP Network

'show clns protocol'

Level 2

L1 R1 S2/0 S2/0 R2 S3/0 L2 S3/0 R3 E0/0 L2 E0/0 R4 E1/0 L1L2 E1/0 R5

area 49.0002   area 49.0001   area 49.0003

```
R3#show clns protocol
IS-IS Router: <Null Tag>
   System Id: 0000.0000.0003.00   IS-Type: level-2
   Routing for area address(es):
        49.0001

   Interfaces supported by IS-IS:
        Ethernet0/0- IP
        Serial3/0 - IP          no "OSI"
...
Generate narrow metrics: level-1-2
Accept narrow metrics:   level-1-2
```
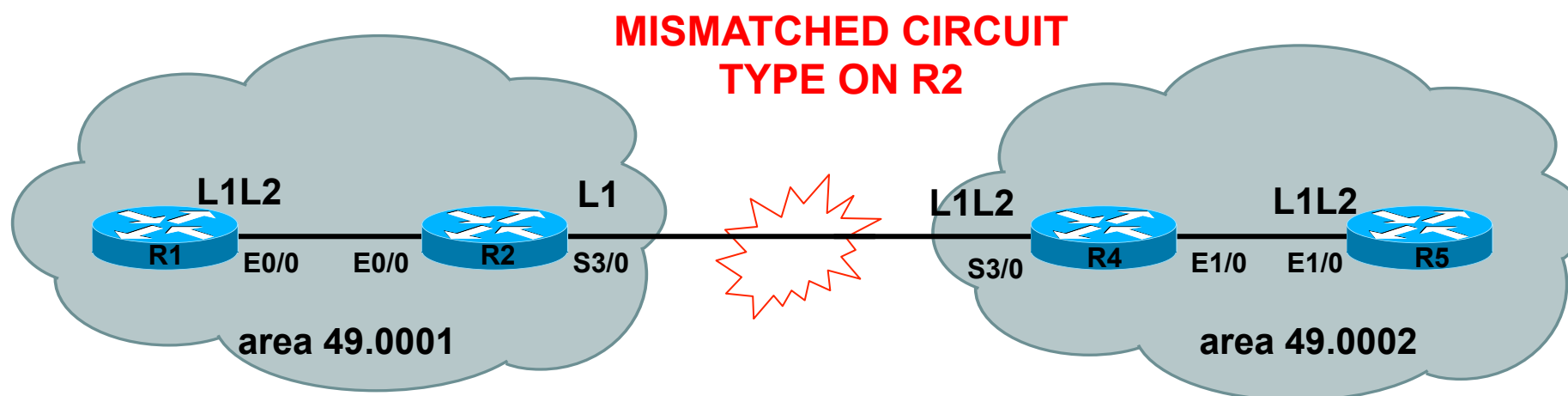
   Cisco Public

MPLS
Workshop

Solution to Scenario 1 – Session showing ES-IS

MISMATCHED CIRCUIT TYPE ON R2

L1L2 **R1** E0/0 E0/0 **R2** **L1** S3/0

area 49.0001

L1L2 S3/0 **R4** E1/0 E1/0 **R5** **L1L2**

area 49.0002

```
R2#show clns neighbors
System Id    Interface      SNPA         State   Holdtime   Type    Protocol
R1           Et0/0      00d0.58eb.ff01   Up      26         L1      IS-IS
R4           Se0/0         *HDLC*        Up      280        IS      ES-IS
```
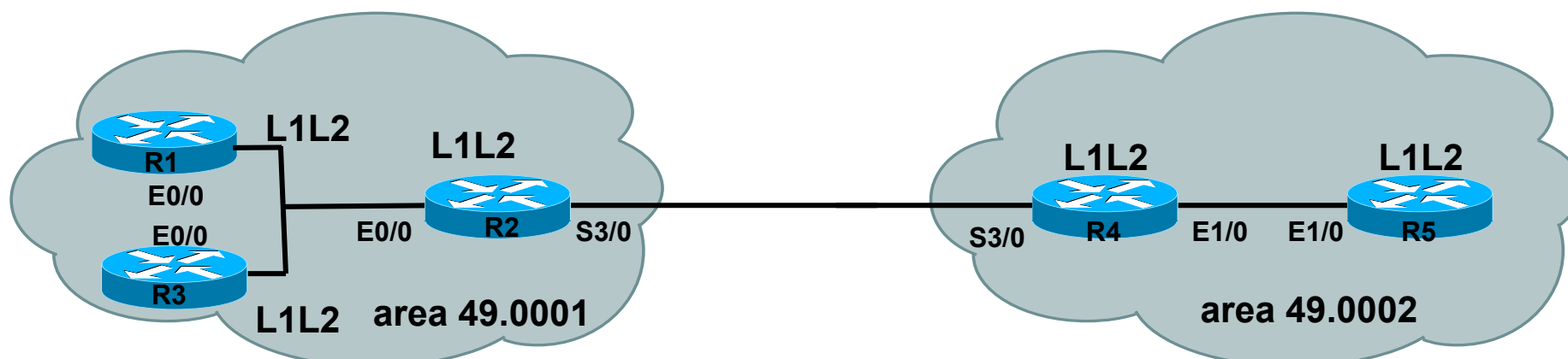
MPLS
Workshop

ISIS Fundamentals and Troubleshooting

Agenda

- Overview

- IS-IS Hierarchical Areas

- Addressing

- MTU and Hello Padding

- Attach-bit and Route Leaking

- LSP Flooding and Convergence

- SPF and Network Stability

- Route Redistribution

- Narrow and Wide Metrics

MPLS
Workshop

Scenario 2 : R1 sees other routers only as L2 peers


```
R1#show clns neighbors
System Id    SNPA            Interface   State   Holdtime   Type  Protocol
R2           0000.0c76.f098  Et0         Up      27         L2    IS-IS
R3           0000.0c76.f096  Et0         Up      26         L2    IS-IS
```
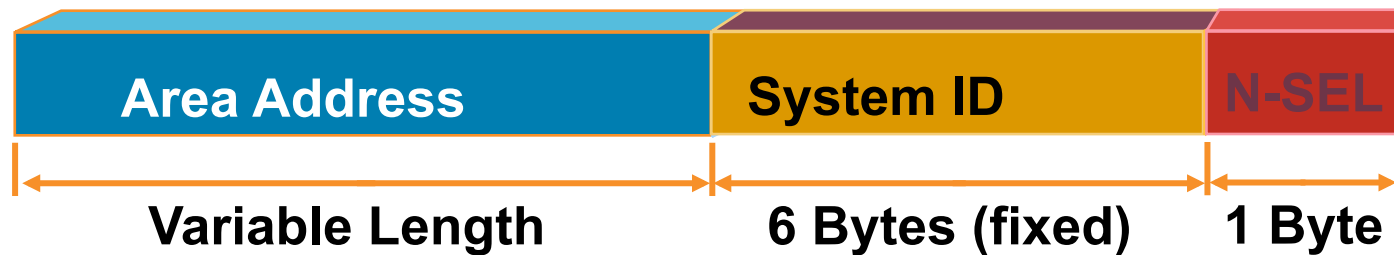
MPLS
Workshop

Integrated IS-IS: Addressing

- The address at which the network service is accessible is known as the **NSAP**:
  - **N**etwork **S**ervice **A**ccess **P**oint

- One NSAP per router, not per interface

- An NSAP can be a total of 20 bytes long

MPLS
Workshop

Basic NSAP Format

- An NSAP mainly consists of three parts:

Area Address	System ID	N-SEL
Variable Length	6 Bytes (fixed)	1 Byte

- Total length is between eight and 20 bytes

- Example: 49.01. 0000.0000.0007. 00

  Area   System ID   N-SEL (always zero for a Router)

MPLS
Workshop

NETs versus NSAPs

- NET: Network Entity Title
  - Is the address of the network entity itself

- A NET is an NSAP where N-selector is 0 (common practice)
  - A NET implies the routing layer of the IS itself (no transport layer)

- ISs (routers) do not have any transport layer (so, always selector=0). N-Sel is a Non-zero value only for Pseudonodes

- Multiple NETs are like secondary IP addresses
  - Proper use is to only use them when merging or splitting areas

MPLS
Workshop

NET Address Examples

Total length of NET can be between 8 and 20 bytes

- Example 1:
  – 47.0001.aaaa.bbbb.cccc.00

Area = 47.0001
SysID = aaaa.bbbb.cccc
NSel = 00

- Example 2:
  – 39.0f01.0002.0000.0c00.1111.00

Area = 39.0f01.0002
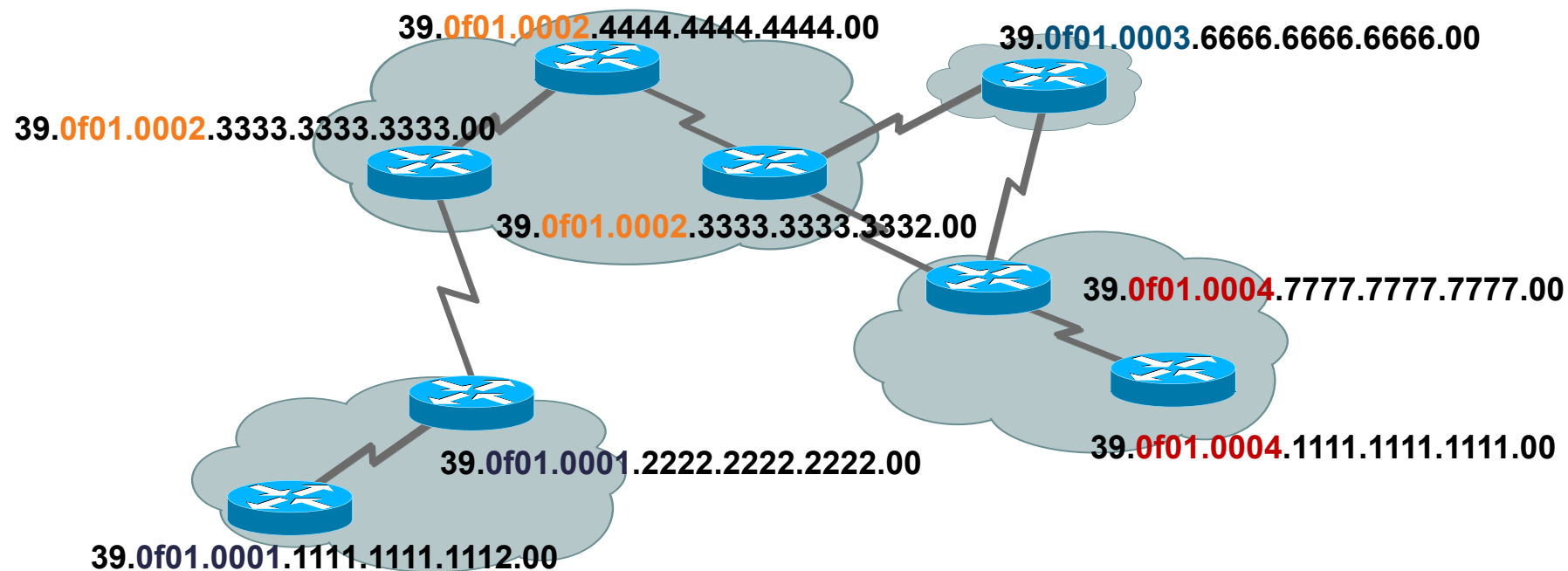SysID = 0000.0c00.1111
NSel = 00

- Example 3:
  – 49.0002.0000.0000.0007.00

Area = 49.0002
SysID = 0000.0000.0007
Nsel = 00

Cisco Public

MPLS
Workshop

CLNS Addressing: Example

39.0f01.0002.4444.4444.4444.00

39.0f01.0003.6666.6666.6666.00

39.0f01.0002.3333.3333.3333.00

39.0f01.0002.3333.3333.3332.00

39.0f01.0004.7777.7777.7777.00

39.0f01.0004.1111.1111.1111.00

39.0f01.0001.2222.2222.2222.00

39.0f01.0001.1111.1111.1112.00

MPLS
Workshop

 Cisco Public

Creating Unique SystemIDs

- SystemID is 6 bytes

- Some methods to create unique SystemIDs:

  - Start numbering 1, 2, 3, 4 …. etc
  - Use MAC addresses
  - Convert a loopback IP address
    - **192.31.231.16 -> 192.031.231.016 ->1920.3123.1016 -> systemID**

Cisco Public

MPLS
Workshop

One Way of Defining NSAPS

- Take the loopback IP address of the router and make it SystemID

- Define the area
  - Process:

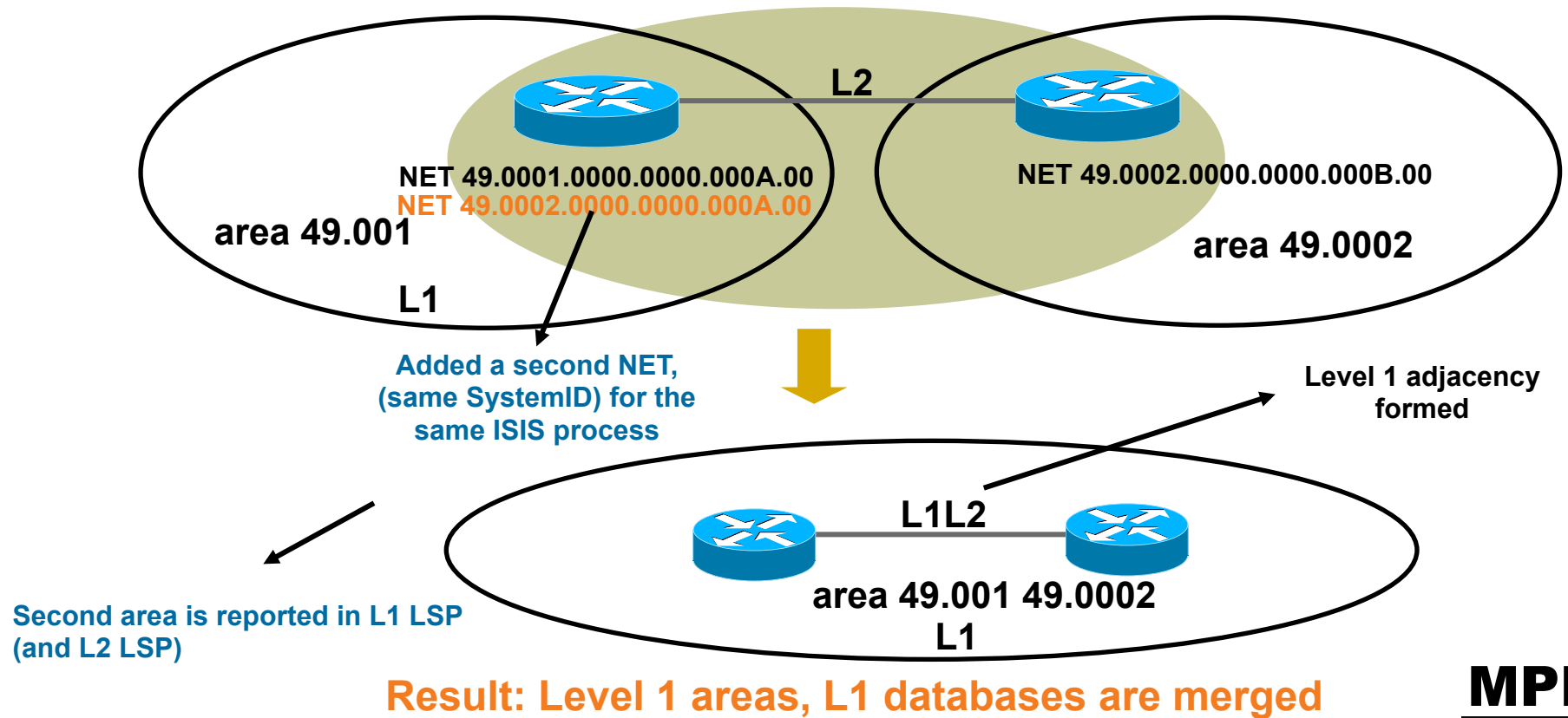|	
Take the loopback IP address	**10.1.3.120**
Fill up with zero's to reach three digits between dots	**010.001.003.120**
Move dots to have three groups of 4 digits to form address	**0100.0100.3120**
Merge area and address	**49.0123.0100.0100.3120**

MPLS
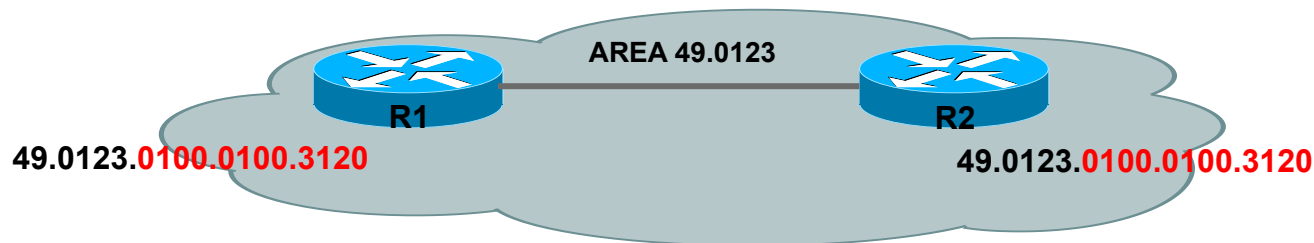**Workshop**

Multiple NETs

- Configuring multiple NETs on one ISIS router leads to merging those areas
  - The result is one level-1 area
  - All NETs must have the same System ID
  - Otherwise each router would originate multiple LSPs

- Up to three NETs can be configured in IOS

- Reasons:
  - Multiple NETs can be used to merge areas in the transition period
  - Multiple NETs can be used to split areas in the transition period
  - Can be used to change the area address
  - More than one addressing authority for one area

- Two L1 ISIS routers become adjacent if they share at least one area in the different NETs

   Cisco Public

MPLS
Workshop

Multiple NETs: Example

L2

NET 49.0001.0000.0000.000A.00
NET 49.0002.0000.0000.000A.00

NET 49.0002.0000.0000.000B.00

area 49.001

area 49.0002

L1

Added a second NET,
(same SystemID) for the
same ISIS process

Level 1 adjacency
formed

L1L2

area 49.001 49.0002

L1

Second area is reported in L1 LSP
(and L2 LSP)

Result: Level 1 areas, L1 databases are merged

MPLS
Workshop

Cisco Public

Duplicate System id

AREA 49.0123

R1 — R2

49.0123.0100.0100.3120   49.0123.0100.0100.3120

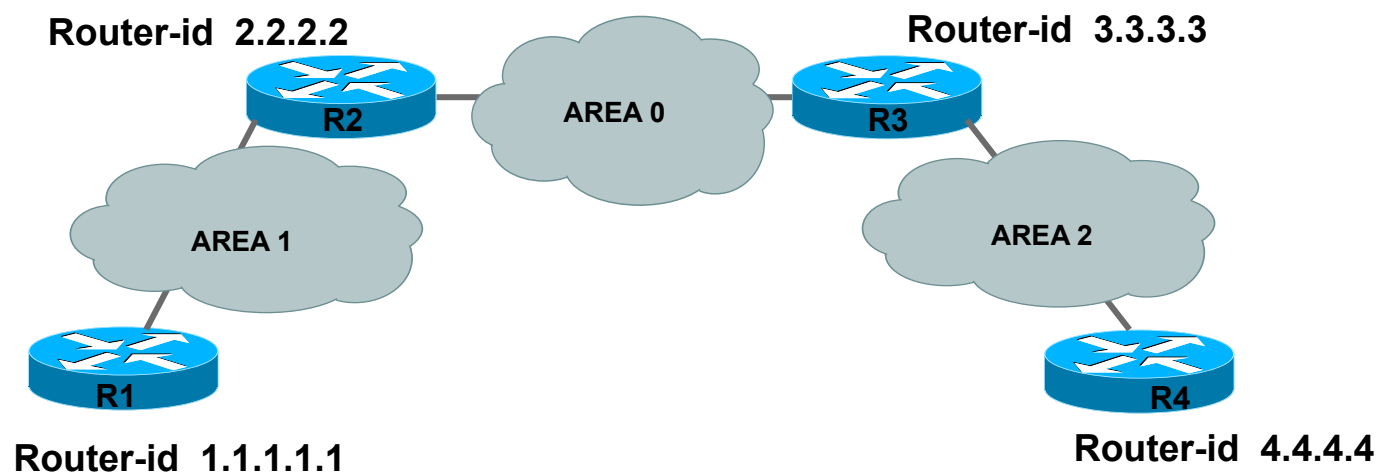## Duplicate System ID Errors in logs :

```
R1#show logging | i Duplicate
Apr 9 16:41:20: %CLNS-3-BADPACKET: ISIS: LAN L1 hello, Duplicate system ID det)
Apr 9 16:42:22: %CLNS-3-BADPACKET: ISIS: LAN L1 hello, Duplicate system ID det)
Apr 9 16:43:21: %CLNS-3-BADPACKET: ISIS: LAN L1 hello, Duplicate system ID det)
```

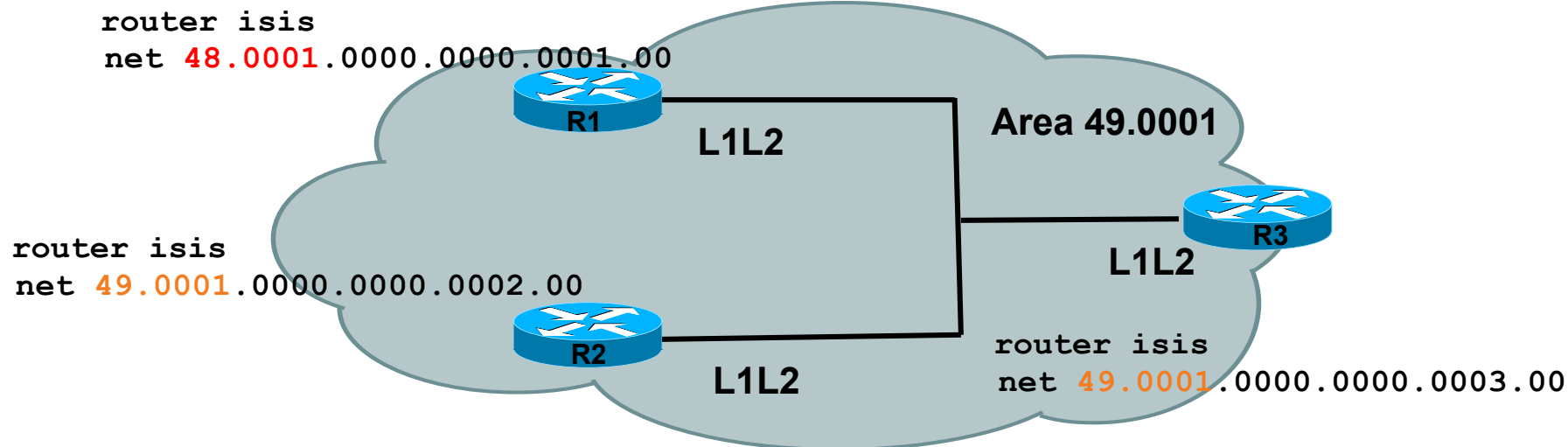## Duplicate System ID in debugs :

```
R1#debug isis adj-packet
Apr 9 16:41:53: ISIS-Adj: Sending L1 IIH on Ethernet0/0, length 1497
Apr 9 16:41:55: ISIS-Adj: Rec L1 IIH from 00d0.58eb.ff01 Ethernet0/0)
Apr 9 16:41:55: ISIS-Adj: Duplicate system id
```

MPLS
Workshop

    Cisco Public

IS-IS SystemID and OSPF RouterID

Router-id 2.2.2.2

R2

AREA 0

Router-id 3.3.3.3

R3

AREA 1

AREA 2

R1

Router-id 1.1.1.1.1

R4

Router-id 4.4.4.4

- One systemID / RouterID per router
- Globally unique across areas

MPLS
Workshop

Cisco Public

Solution to Scenario 2 :
R1 sees other routers as 'L2 only' !

```
router isis
  net 48.0001.0000.0000.0001.00
```

R1

L1L2

Area 49.0001

R3

L1L2

```
router isis
  net 49.0001.0000.0000.0002.00
```

R2

L1L2

```
router isis
  net 49.0001.0000.0000.0003.00
```

```
R1#show clns neighbors
System Id   SNPA            Interface    State   Holdtime   Type Protocol
R2          0000.0c76.f098     Et0         Up      27         L2    IS-IS
R3          0000.0c76.f096     Et0         Up      26         L2    IS-IS
```
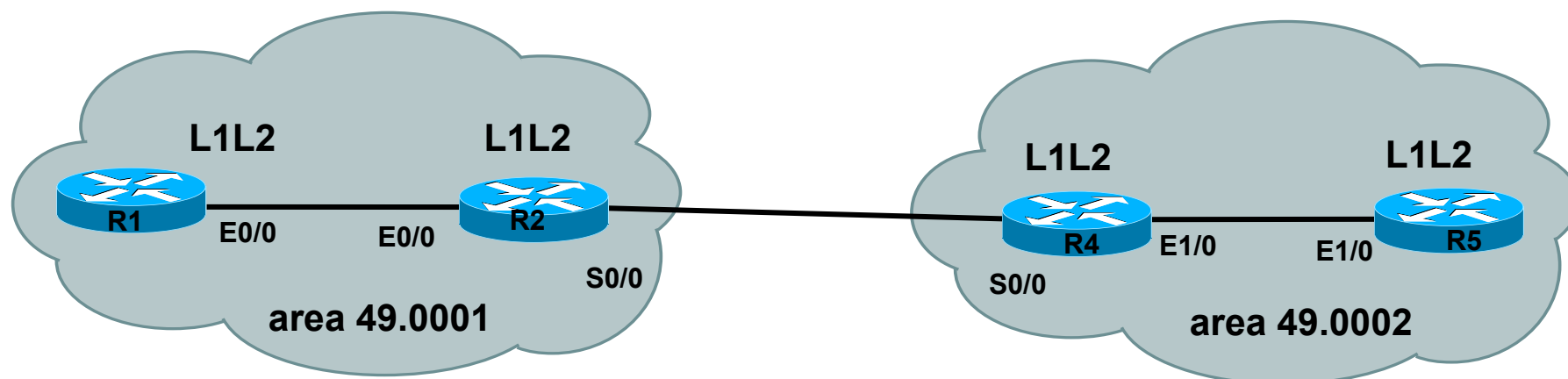
MPLS
Workshop

ISIS Fundamentals and Troubleshooting

Agenda

- Overview

- IS-IS Hierarchical Areas

- Addressing

- MTU and Hello Padding

- Attach-bit and Route Leaking

- LSP Flooding and Convergence

- SPF and Network Stability

- Route Redistribution

- Narrow and Wide Metrics

MPLS
Workshop

     Cisco Public

Scenario 3 : One way IS-IS, other way ES-IS


```
R2#show clns neighbors
System Id       Interface     SNPA        State     Holdtime      Type      Protocol
R4              Se0/0         *HDLC*      Up        280           IS        ES-IS
R4#show clns neighbors
System Id       Interface     SNPA        State     Holdtime      Type      Protocol
R2              Se0/0         *HDLC*      Init      27            L2        IS-IS
```

MPLS
Workshop

Hello Padding

- IS-IS by default pads the Hellos to the full interface MTU size to detect MTU mismatches

- Useful to detect miconfigurations or underlying layer problems
  - Example: EoMPLS scenarios: a link over AToM might have MTU of 4k on the edges, but a lower MTU in the MPLS core

- If the operator is sure of the MTU on the link, the padding of the Hellos can be turned off
  - Avoid using bandwidth unnecessary
  - Reduced Buffer Usage
  - Reduced processing overhead when using authentication

MPLS
Workshop

Hello Padding

- Turn on/off the Hello-Padding either per interface level or globally

- Two ways of disabling :

  > Under router isis CLI
  > **[no] hello padding [multi-point|point-to-point]**
  > Under interface CLI
  > **[no] isis hello padding**

- Even if padding is disabled, at the beginning, the router still sends a few hellos at full MTU. 'always' option which is hidden can be used to prevent it.

MPLS
Workshop

     Cisco Public

Hello Padding – Check MTU with 'show clns interface'

```
R1#show clns interface Ethernet 0/0

Ethernet0/0 is up, line protocol is up

Checksums enabled, MTU 1497, Encapsulation SAP

ERPDUs enabled, min. interval 10 msec.

Routing Protocol: IS-IS

Circuit Type: level-1-2

...

Number of active level-1 adjacencies: 1, if state UP

Level-2 Metric: 10, Priority: 64, Circuit ID: R1.01

Level-2 IPv6 Metric: 10

Number of active level-2 adjacencies: 1, if state UP

Next IS-IS Hello in 1 seconds

if state UP
```
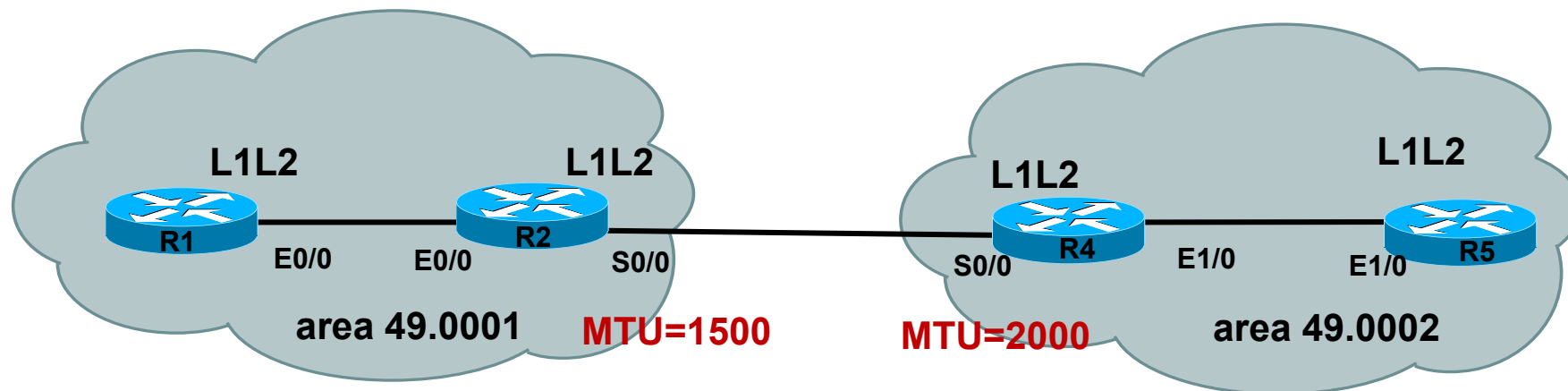
CLNP, ES-IS, IS-IS use SAP encapsulation -> MTU = 1497

DSAP: 1 byte
SSAP: 1 byte
Control field: 1 byte

MPLS
Workshop

Solution to Scenario 3 : One way IS-IS, other way ES-IS

L1L2
L1L2
R1
E0/0
E0/0
R2
S0/0

L1L2
L1L2
S0/0
R4
E1/0
E1/0
R5

area 49.0001
MTU=1500
MTU=2000
area 49.0002

```
R2#show clns neighbors
System Id      Interface    SNPA      State    Holdtime   Type   Protocol
R4             Se0/0        *HDLC*    Up       280        IS     ES-IS


R4#show clns neighbors
System Id      Interface    SNPA      State    Holdtime   Type   Protocol
R2             Se0/0        *HDLC*    Init     27         L2     IS-IS
```

Cisco Public

MPLS
Workshop

Reason for one way ES-IS

- R4 receives and processes the smaller 1499-byte hellos from R2 and puts the IS-IS adjacency in 'init' state, hoping to complete the three-way handshake to establish full IS-IS adjacency.

```
R4#debug isis adj-packet
Apr 9 20:44:16: ISIS-Adj: Sending serial IIH on Serial0/0, length 1999
Apr 9 20:44:21: ISIS-Adj: Rec serial IIH from *HDLC* (Serial0/0)
Apr 9 20:44:21: ISIS-Adj: rcvd state DOWN, old state UP, new state INIT
( Moved to INIT after peer's hello received )
Apr 9 20:44:21: ISIS-Adj: Action = GOING DOWN
```

MPLS
Workshop

Reason for one way ES-IS

- After three hellos are ignored by R2's Interface due to higher size, the hello hold time expires on R2, the adjacency is dropped, and an adjacency change event is logged. ES-IS does not pad hellos !

```
R2#debug isis adj-packet
Apr 9 20:43:56: ISIS-Adj: Sending serial IIH on Serial0/0, length 1499
Apr 9 20:44:05: ISIS-Adj: Sending serial IIH on Serial0/0, length 1499
Apr 9 20:44:13: ISIS-Adj: Sending serial IIH on Serial0/0, length 1499
Apr 9 20:44:22: ISIS-Adj: Sending serial IIH on Serial0/0, length 1499
( no hellos received as the peer is sending 2000 byte )
Apr 9 20:44:29: %CLNS-5-ADJCHANGE: ISIS: Adjacency to RT2 (Serial0/0)
Down
( Tearing down ISIS peering )
```

MPLS
Workshop

     Cisco Public

ISIS Fundamentals and Troubleshooting

Agenda

- Overview

- IS-IS Hierarchical Areas

- Addressing

- MTU and Hello Padding

- Attach-bit and Route Leaking

- LSP Flooding and Convergence

- SPF and Network Stability

- Route Redistribution

- Narrow and Wide Metrics

MPLS
Workshop

Scenario 4 :
Rtr A in Area 1 taking the Longer path to Rtr B in Area 2

Cisco Public

MPLS
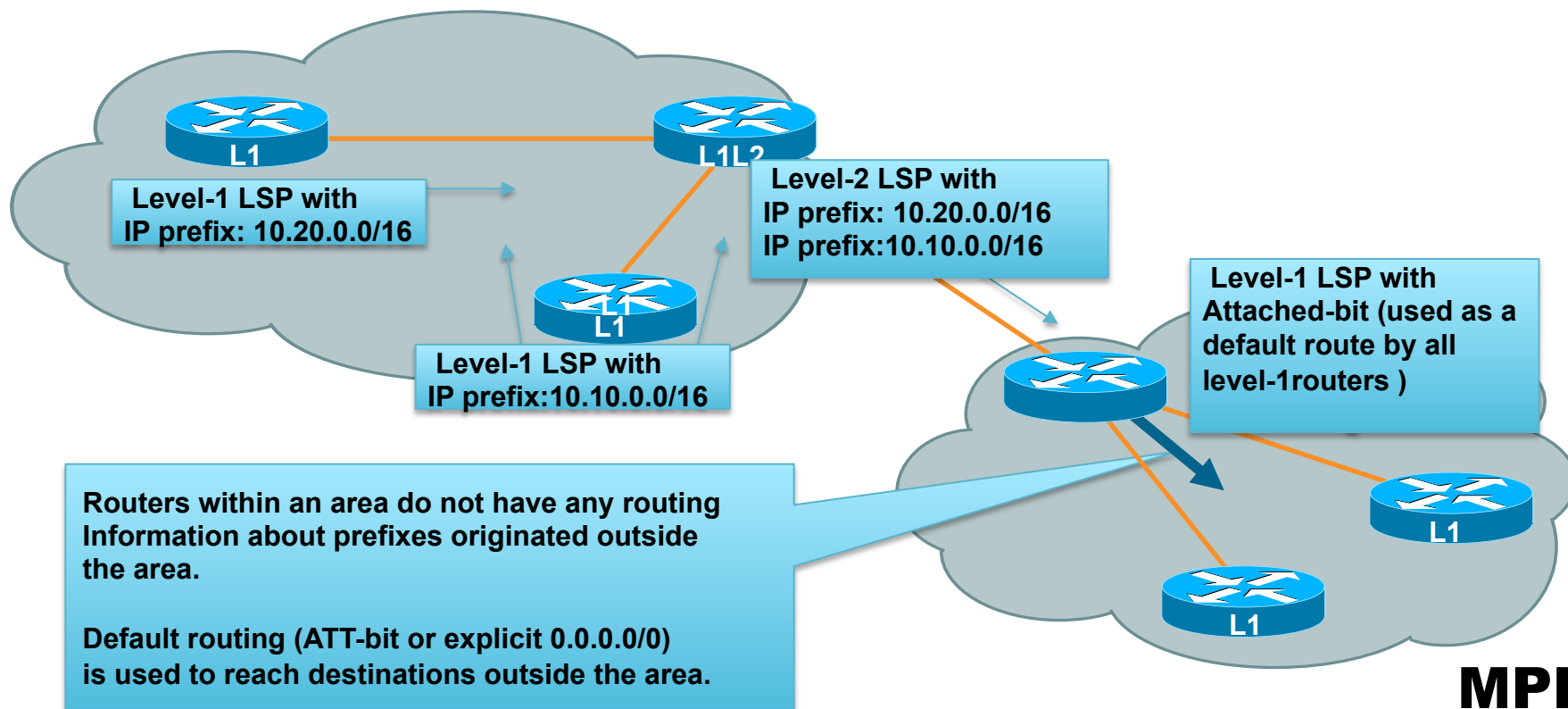**Workshop**
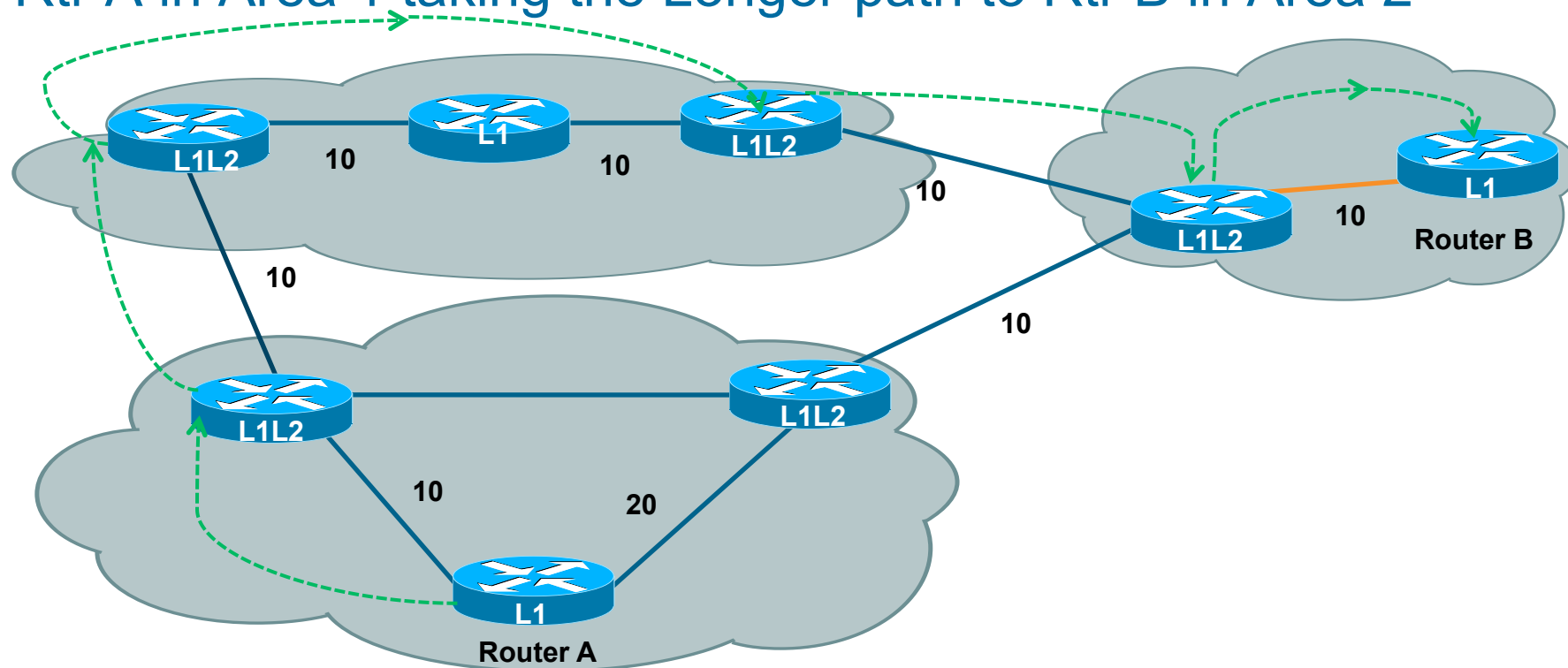
Level-1 Routing

- L1-only routers know only topology of their own area

- Traffic to other areas is sent via the closest L2 IS
  - Can result in suboptimal routing

- L1L2 ISs set the "attached-bit" in their L1 LSP

- L1-only routers look at the attached-bit in L1 LSPs to find the closest L1L2 router

- L1-only routers install a default route to the closest L1L2 router in the area
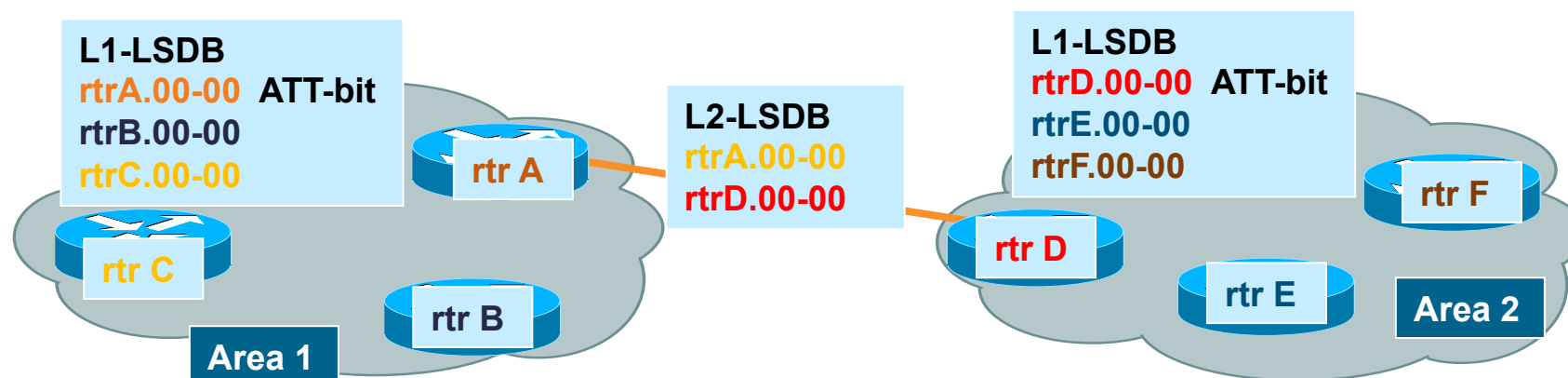
MPLS
Workshop

L1 Advertised into L2

- All L1L2 routers advertise all the IP prefixes they learn via L1 into L2

- Only advertise routes you use
  - Inter-level routing goes via the RIB. In other words, If it is not in the routing table, it is not advertised from L1 to L2

- Summarization :
  - possible at L1->L2 or when redistributing
  - Internal ISIS routes are summarized only on L1-2 (from L1 to L2). External routes can be summarized even within the L1 area.
  - All level 1-2 routers in an area must summarize equivalently into the backbone to avoid traffic being sent to the same router (based on longest match)

MPLS
Workshop

IS-IS Routing Levels

L1

L1L2

Level-1 LSP with IP prefix: 10.20.0.0/16

Level-2 LSP with IP prefix: 10.20.0.0/16 IP prefix:10.10.0.0/16

L1

Level-1 LSP with IP prefix:10.10.0.0/16

Level-1 LSP with Attached-bit (used as a default route by all level-1routers)

L1

L1

Routers within an area do not have any routing Information about prefixes originated outside the area.

Default routing (ATT-bit or explicit 0.0.0.0/0) is used to reach destinations outside the area.

MPLS
Workshop

The 'Attached' Bit

L1-LSDB
rtrA.00-00 ATT-bit
rtrB.00-00
rtrC.00-00

L2-LSDB
rtrA.00-00
rtrD.00-00

L1-LSDB
rtrD.00-00 ATT-bit
rtrE.00-00
rtrF.00-00

rtr A

rtr C

rtr B

Area 1

rtr D

rtr E

rtr F

Area 2

- L1L2 routers set the ATT bit in their L1 LSP

- L1 routers use ATT bit found in L1-LSDB as possible area exit point
  – ISIS for IP: level-1 router will install a 0.0.0.0/0 route toward the L1L2 with ATT-bit set

- Shortest metric to the L1L2 who sets the ATT bit wins

MPLS
Workshop

     Cisco Public

Route Leaking (L2 to L1)

- New ISIS feature/capability described in draft-ietf-isis-domain-wide

- Allows L1L2 routers to insert in their L1 LSP IP prefixes learned from L2 database if also present in the routing table

- ISIS areas are not stubby anymore

MPLS
Workshop

        Cisco Public

Route Leaking - Solution for Several Issues

- Optimal inter-area routing

- BGP shortest path to AS exit point

- MPLS-VPN (PEs loopback reachability)

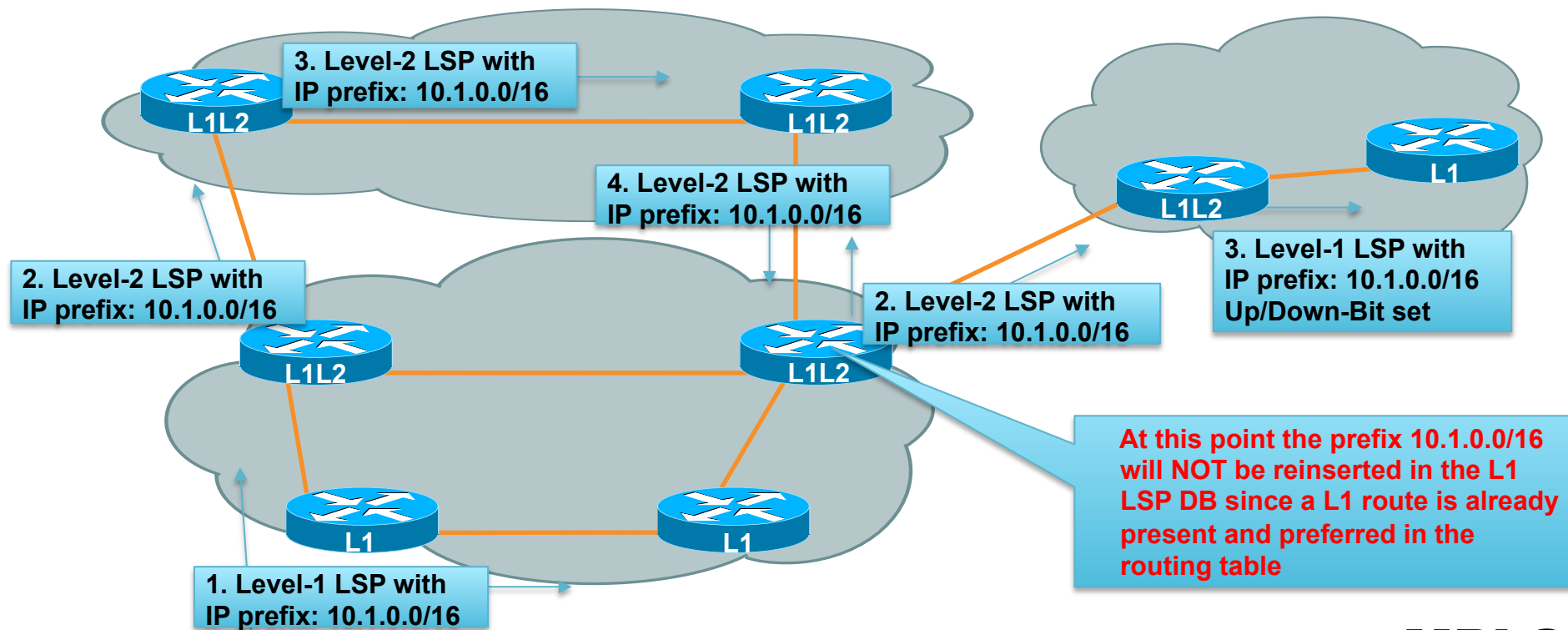 **Cisco Public**

MPLS
Workshop

Route Leaking – Loop avoidance

- When leaking routes from L2 backbone into L1 areas a loop protection mechanism needs to be used in order to prevent leaked routes to be re-injected into the backbone

- UP/Down bit
  - Extended IP Reachability TLV (135) contains Up/Down bit

- UP/Down bit is set each time a prefix is leaked into a lower level

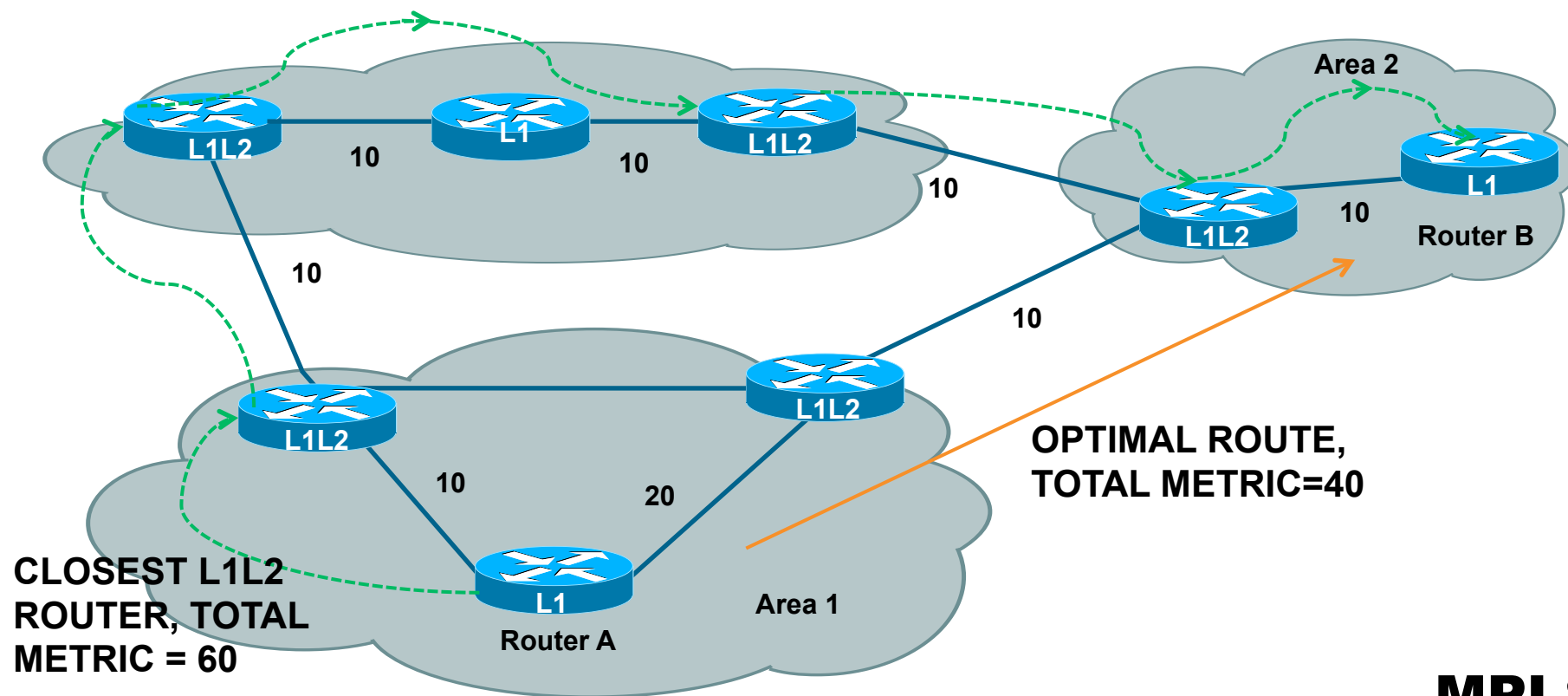- Prefixes with Up/Down bit set are NEVER propagated to a upper level

     Cisco Public

MPLS
Workshop

Route Leaking and Up/Down-bit

1. Level-1 LSP with IP prefix:10.14.0.0/16

2. Level-2 LSP with IP prefix:10.14.0.0/16

3. Level-1 LSP with IP prefix:10.14.0.0/16 Up/Down-bit set

At this point prefix 10.14.0.0/16 will be inserted in L1 LSP since route leaking is configured AND the prefix is present in the routing table as a L2 route

At this point prefix 10.14.0.0/16 will NOT be inserted in L2 LSP since it has the Up / Down-bit set

MPLS
Workshop

Route Leaking – Reinsertion prevented by default

3. Level-2 LSP with IP prefix: 10.1.0.0/16

4. Level-2 LSP with IP prefix: 10.1.0.0/16

2. Level-2 LSP with IP prefix: 10.1.0.0/16

2. Level-2 LSP with IP prefix: 10.1.0.0/16

3. Level-1 LSP with IP prefix: 10.1.0.0/16 Up/Down-Bit set

1. Level-1 LSP with IP prefix: 10.1.0.0/16

At this point the prefix 10.1.0.0/16 will NOT be reinserted in the L1 LSP DB since a L1 route is already present and preferred in the routing table

L1L2 L1L2 L1L2 L1 L1L2 L1L2 L1 L1

MPLS
Workshop

Cisco Public

Solution to Scenario 4 : Why Longer path ?

L1L2   10   **L1**   10   **L1L2**

10

Area 2

L1L2   10   **L1**   Router B

10

L1L2

10

10

L1L2

OPTIMAL ROUTE, TOTAL METRIC=40

10   20

L1 Router A   Area 1

CLOSEST L1L2 ROUTER, TOTAL METRIC = 60

MPLS
Workshop

Configuring Route Leaking

On the L1-L2 Routers :

```
RtrA#(conf)router isis
RtrA#(conf-router)redistribute isis ip level-2 into level-1
distribute-list <100-199>
```

A distribute-list could be used if we want to leak only a set of routes

On L1 router, the routes leaked by L1-L2 Router are seen as Inter-Area:

```
RtrA# show ip route
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-
IS inter area * - candidate default,

i ia 1.0.0.0/8 [115/30] via 55.55.55.1, Serial1/0
i ia 2.0.0.0/8 [115/30] via 55.55.55.1, Serial1/0
```

MPLS
Workshop

Scenario 5 : L1 to L2 route not leaked
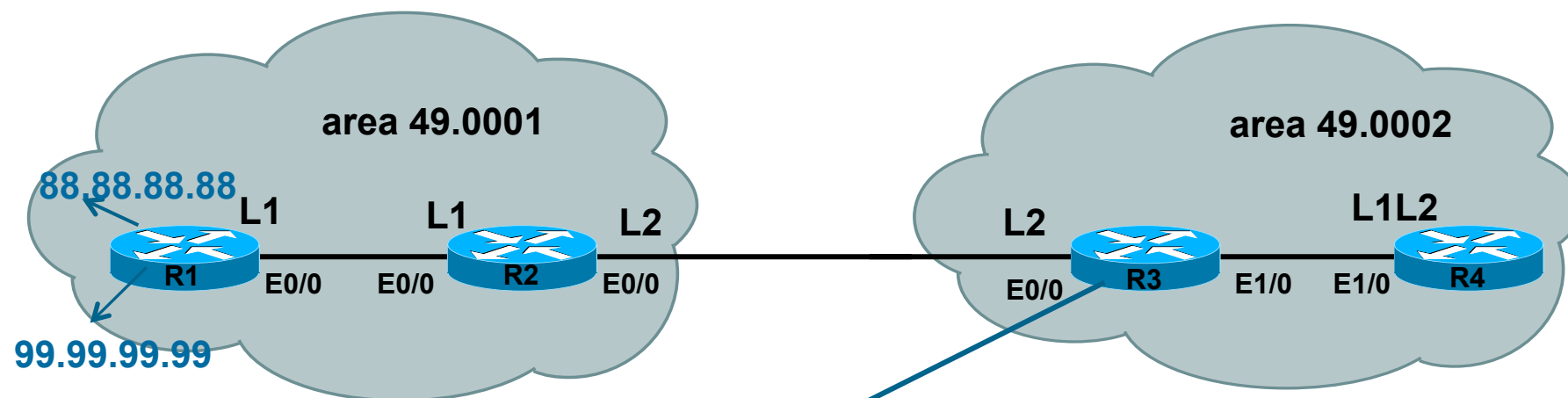

```
R3#sh ip route 88.88.88.88
% Network not in table

R3#sh ip route 99.99.99.99
Known via "isis", distance 115, metric 30, type level-2
* 172.16.2.2, from 172.16.2.2, 00:10:07 ago, via Ethernet0/0
```
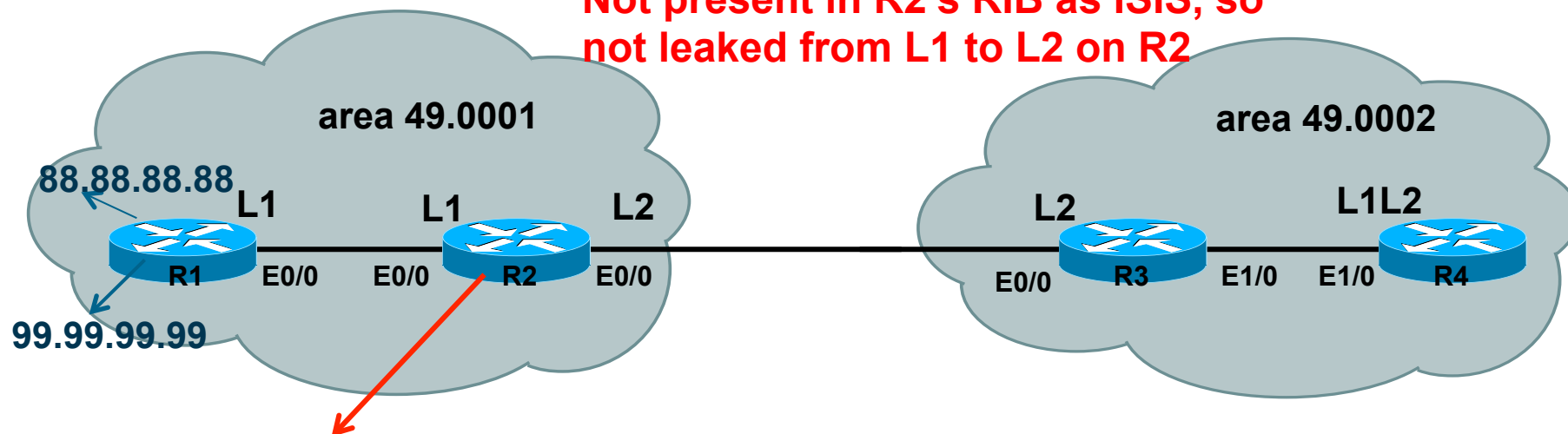
MPLS
Workshop

 Cisco Public

Inter-level routing goes via the RIB

- Though L1 to L2 leaking is done by default, routes need to be in the RIB as ISIS route for the leaking to succeed on the L1 / L2 Router

- L1 / L2 router advertises only the routes it uses

- The same holds true for L2 to L1 as well, though leaking needs to be manually configured in this case

MPLS
Workshop

 Cisco Public

Solution to Scenario 5 :
Why 88.88.88.88 is missing on R3 ?

Not present in R2's RIB as ISIS, so not leaded from L1 to L2 on R2

area 49.0001

area 49.0002

88.88.88.88

99.99.99.99

L1 R1 E0/0
L1 E0/0 R2 L2 E0/0

L2 E0/0 R3 E1/0
L1L2 E1/0 R4

```
R2#show ip route 88.88.88.88
Routing entry for 3.3.3.3/32
   Known via "ospf 1" , distance 110, metric 2, type intra area
```

MPLS
Workshop

ISIS Fundamentals and Troubleshooting

Agenda

- Overview

- IS-IS Hierarchical Areas

- Addressing

- MTU and Hello Padding

- Attach-bit and Route Leaking

- LSP Flooding and Convergence

- SPF and Network Stability

- Route Redistribution

- Narrow and Wide Metrics

Cisco Public

MPLS
Workshop

Scenario 6 :
R5 does not have routes to Networks behind R1

LSP Info not reaching
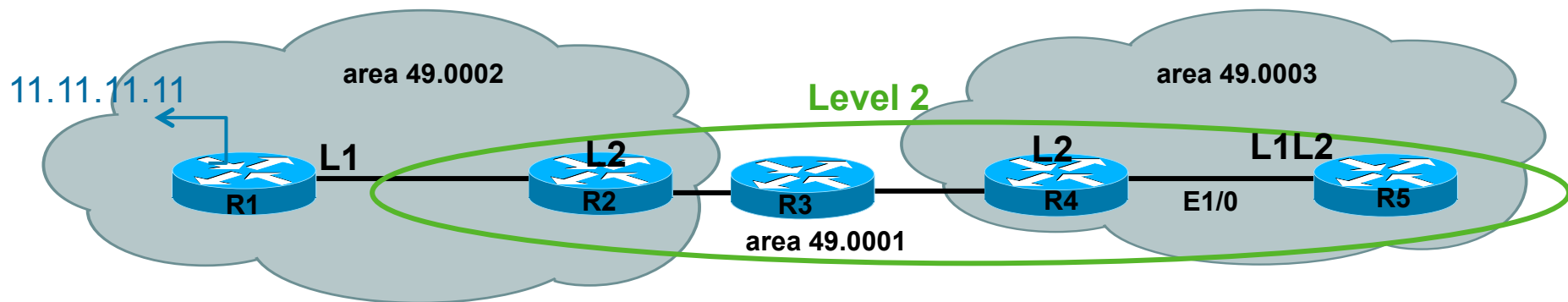

```
R5#sh ip route 11.11.11.11
% Network not in table
```

Cisco Public

MPLS
Workshop

IS-IS Packet Types

- Hello Packets (IIH)
  - Used to form adjacencies

- Link State Packets (LSP)
  - Describes the state of each router

- Sequence Number Packets (SNP)
  - PSNPs: Used for acknowledgements
  - CSNPs: Used to describe the LSPDB

- In ISO terminology, packets are referred to as Protocol Data Units (PDUs)

MPLS
Workshop

IS-IS Hello Packets

- Also called IIHs

- Used for maintaining adjacencies

- Different on point-to-point links and LANs

- By default, IIHs are padded to full MTU size
  - To maintain link integrity
  - Padding can be removed by configuration

MPLS
Workshop

Link State Packets

- Also known as Link State PDUs

- Contains all information about one router

- One (set of) LSP(s) per router

- One (set of) LSP(s) per LAN network

     Cisco Public

MPLS
Workshop

Sequence Number Packets

- Used when flooding the LSDB. Also known as Sequence Number PDUs.

- Two Types of SNPs
    1. Partial Sequence Number Packets (PSNPs)
    2. Complete Sequence Number Packets (CSNPs)

- PSNPs are like ACKs on point-to-point links

- CSNPs are used for LSDB sync over LANs

- CSNPs are also used to sync LSDB over **new** point-to-point (p2p) adjacencies
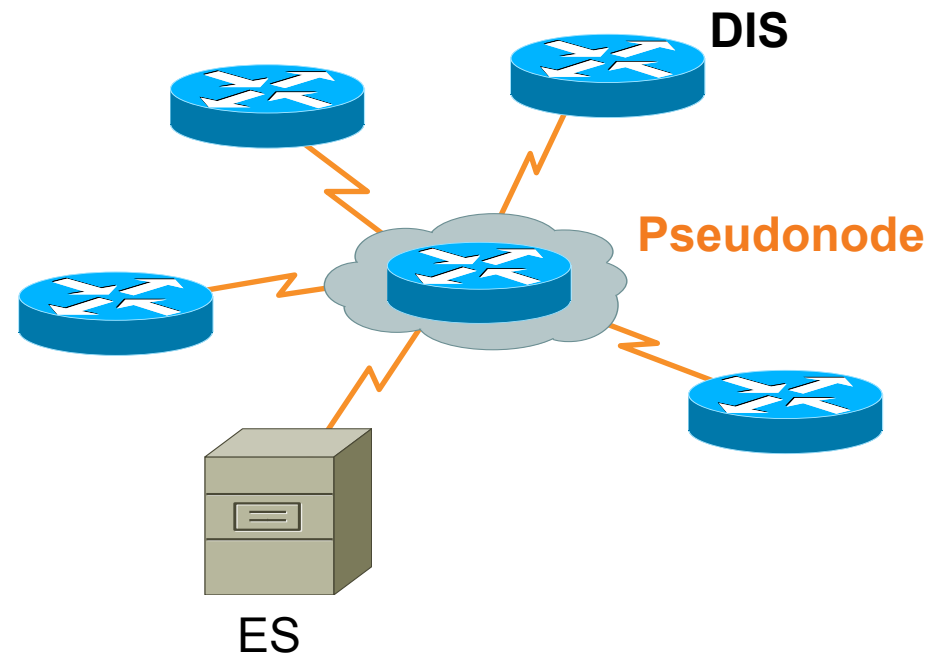
MPLS
Workshop

Cisco Public

What is a Pseudonode ?

• For SPF, the whole network must look like a collection of nodes and p2p links, however Multi-access networks are different.

• Create a virtual node, or **Pseudonode**

• Not a real router, but extra LSP in IS-IS

• Allows for smaller, more stable LSPs

• Similar to 'Network LSA' created by OSPF DR

Cisco Public

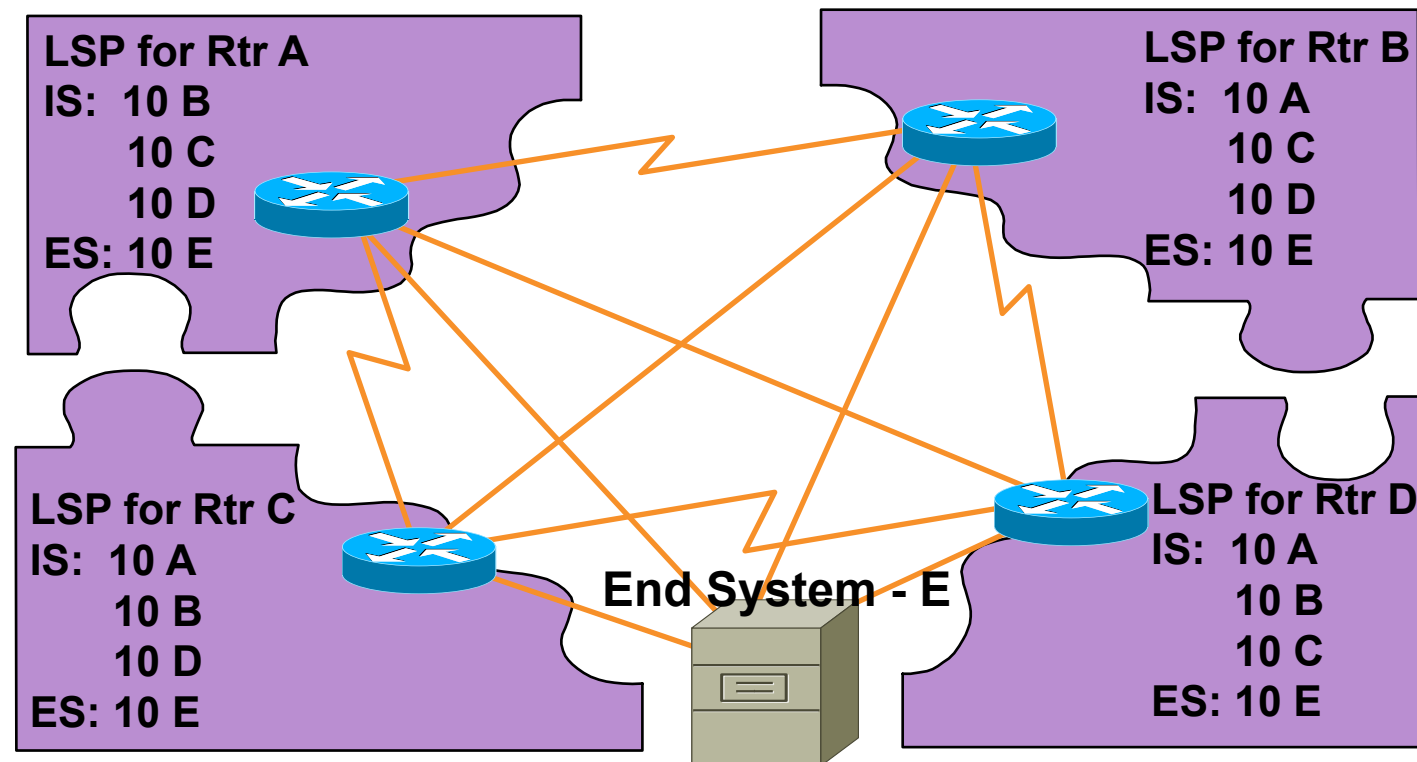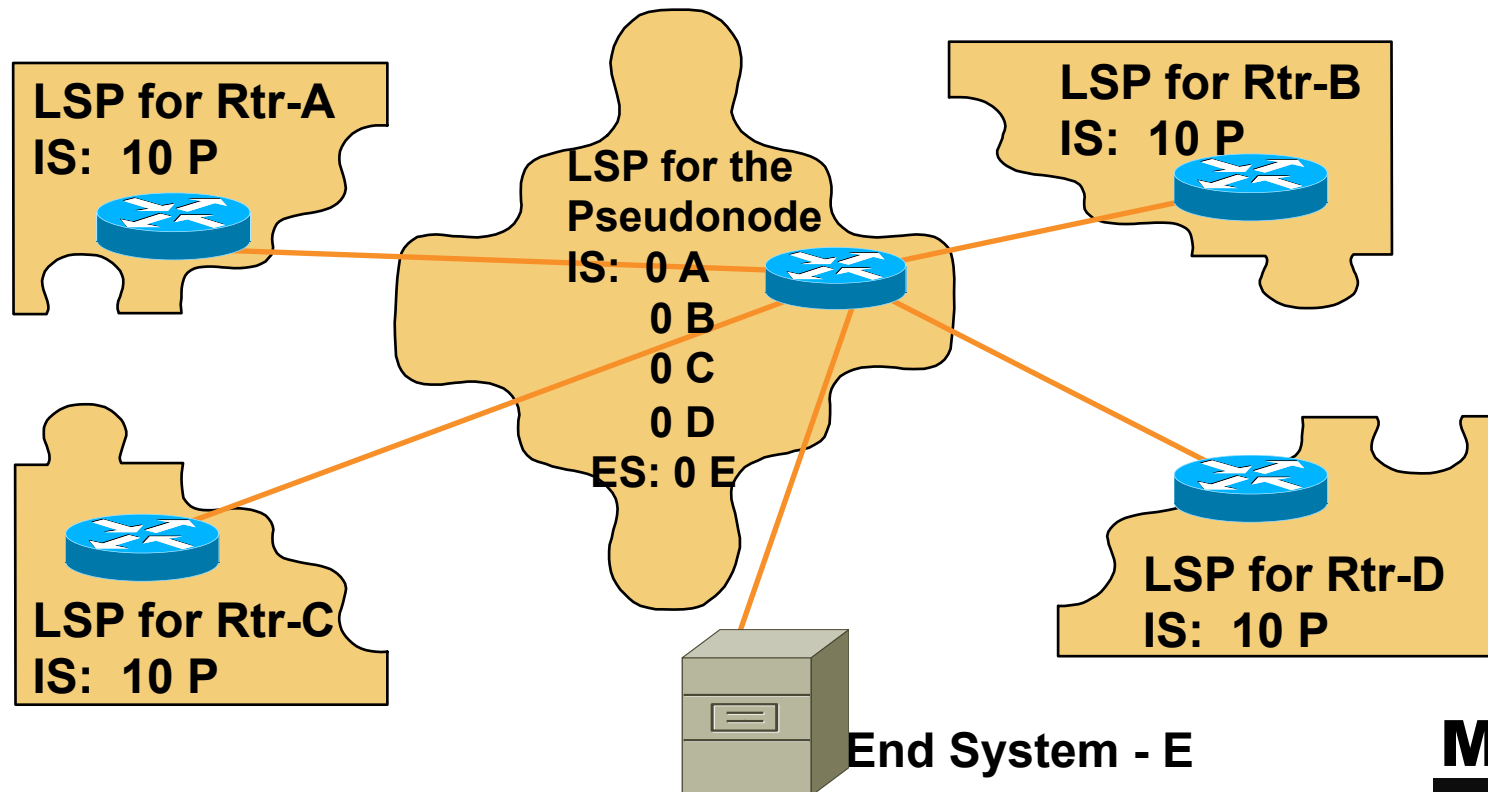**MPLS**
Workshop

Pseudonode on a LAN

Physical View

DIS

LAN

ES

Logical View

DIS

Pseudonode

ES

Cisco Public

MPLS
Workshop
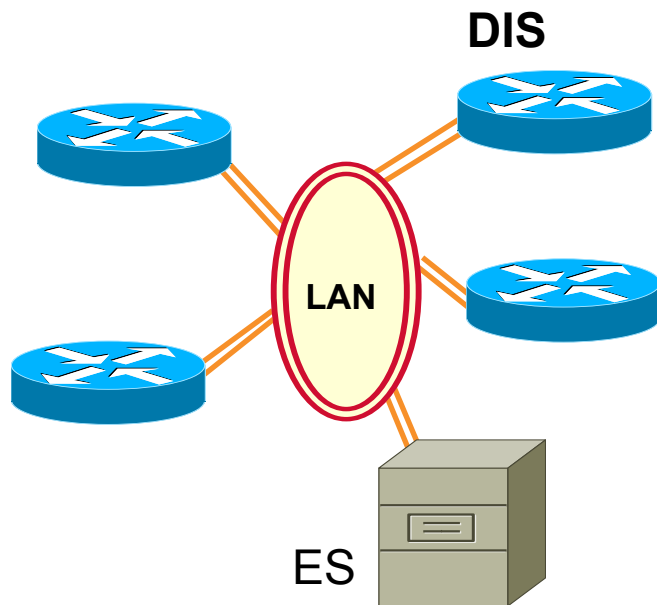
LSDB without Pseudonode

LSP for Rtr A
IS: 10 B
    10 C
    10 D
ES: 10 E

LSP for Rtr B
IS: 10 A
    10 C
    10 D
ES: 10 E

LSP for Rtr C
IS: 10 A
    10 B
    10 D
ES: 10 E

End System - E

LSP for Rtr D
IS: 10 A
    10 B
    10 C
ES: 10 E

MPLS
Workshop

Cisco Public

LSDB with Pseudonode

LSP for Rtr-A
IS: 10 P

LSP for the Pseudonode
IS: 0 A
    0 B
    0 C
    0 D
ES: 0 E

LSP for Rtr-B
IS: 10 P

LSP for Rtr-C
IS: 10 P

LSP for Rtr-D
IS: 10 P

End System - E

MPLS
Workshop

Cisco Public

Who Creates the Pseudonode?

- Created by Designated Router (DIS)

- The DIS reports all LAN neighbors in the pseudonode LSP

- All LAN routers report connectivity to the pseudonode in their LSPs

MPLS
Workshop

        Cisco Public

ISIS DIS

- On broadcast multi-access networks, a single router is elected as the DIS

- In a segment, one of the routers elects itself the DIS, based on interface priority (the default is 64)

  – SNPA is compared if the interface priority is the same for all routers

  – SNPA is the mac address in LAN and DLCI in case of frame relay

  – System-id acts as a tie-breaker if SNPA is the same as well (in DLCI scenario)

MPLS
Workshop

     Cisco Public

ISIS DIS versus OSPF DR

- Unlike OSPF, there is no Backup DIS elected in ISIS

- Unlike OSPF, the DIS election is **preemptive**

  – If a new router boots on the LAN with a higher interface priority, the new router becomes the DIS

  – It purges the old pseudonode LSP and floods a new set of LSPs

  – one unstable router can potentially make the network unstable with flooding

Cisco Public

MPLS
Workshop

What Triggers a New LSP?

When Something Changes…

- Adjacency came up or went down

- Interface up/down with IP prefix

- Redistributed IP routes change

- Inter-area IP routes change

- An interface is assigned a new metric

MPLS
Workshop

Basic Flooding Rules

When Receiving a LSP, Compare with LSP in LSDB :

- verify that checksum is correct

- If LSP received is newer, install it in the LSDB and flood to **all other neighbors** and then check if you need to run SPF

- If older, send newer LSP from our LSDB

- If we have same LSP, only send an 'ack'

MPLS
Workshop

     Cisco Public

Types of Flooding

- Flooding on p2p links with positive acks
  - Each LSP is acknowledged with a PSNP

- Flooding on LANs with negative acks
  - DIS multicasts a full list of LSP descriptions in a CSNP packet
  - Re-transmission requests are done via PSNP

- General background flooding

Cisco Public

MPLS
Workshop

Flooding on a LAN

- LAN flooding is reliable due to the DIS
  - Creates and updates Pseudonode LSP

- DIS broadcasts CSNPs every 10 seconds
  - Negative acks
  - No backup DIS

MPLS
Workshop

     Cisco Public

Remaining Lifetime

- Used to age out old LSPs

- Periodic refresh needed to keep stable LSPs valid

- IS-IS counts down from 1200 seconds to 0
  - Time is configurable

- When lifetime expires, the LSP is purged from the network

MPLS
Workshop

    Cisco Public

Remaining Lifetime: Purging LSPs

- When Remaining Lifetime is zero, LSP is purged

- Detecting router removes LSP body and floods the header with RL=0

- All other routers then remove this LSP from their database

- On LANs, a new DIS purges pseudonode LSP

MPLS
Workshop

 Cisco Public

LSP Refresh

- Specifies the number of seconds a router will wait before refreshing its own LSP

- Only the originating router can re-create and re-flood its own LSP

- Can cause unnecessary overhead and limit scalability

- Default refresh is 15 minutes

MPLS
Workshop

Reading ISIS Database

Level 2

R1 — L1 — R2 — L2 — R3 — L2 — R4 — L1L2 — R5

S2/0   S2/0   S3/0   S3/0   R3   E0/0   E0/0   R4   E1/0   E1/0   R5

area 49.0002   area 49.0001   area 49.0003
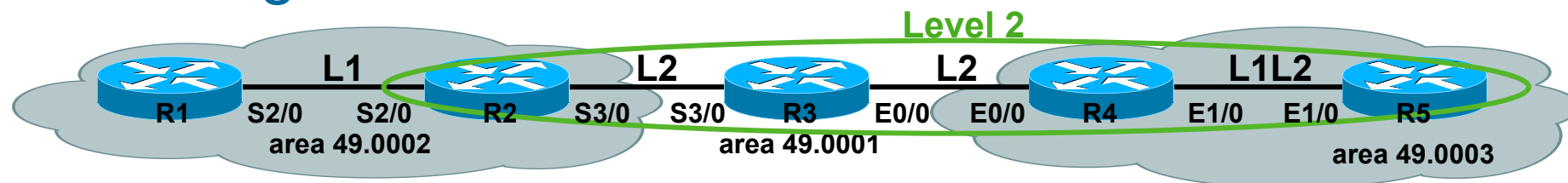
```
R4#show isis database                                    * means "this router"
IS-IS  Level-1  Link State Database:
LSPID          LSP Seq Num    LSP Checksum    LSP Holdtime    ATT/P/OL
R4.00-00    *  0x0000007F     0x27D1          762             1/0/0
R5.00-00       0x00000076     0x42BC          760             1/0/0     Attach bit is set on L1
IS-IS  Level-2  Link State Database:                                    LSPs from R4 and R5
LSPID          LSP Seq Num    LSP Checksum    LSP Holdtime    ATT/P/OL
R2.00-00       0x0000007C     0x548D          814             0/0/0
R3.00-00       0x00000081     0x28A1          820             0/0/0
R4.00-00    *  0x0000007A     0xFF38          761             0/0/0
R4.02-00    *  0x00000065     0x7CF1          758             0/0/0
R5.00-00       0x0000000A     0x6CFB          757             0/0/0
```

pseudonode LSP

MPLS
Workshop

Reading ISIS Database
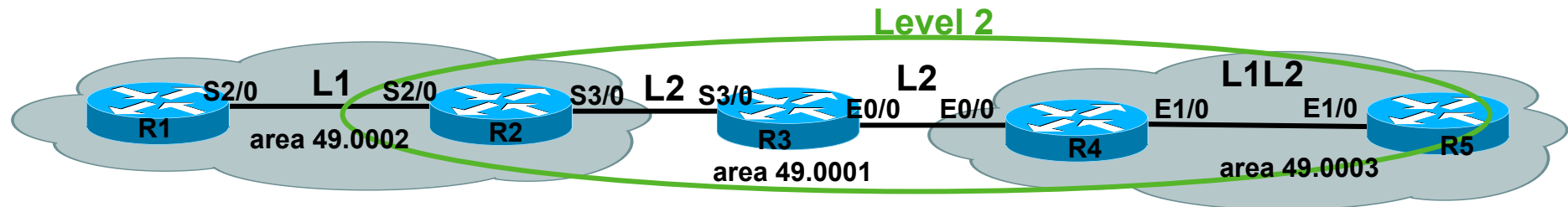

```
R3#show isis database
IS-IS Level-2 Link State Database:
LSPID             LSP Seq Num    LSP Checksum    LSP Holdtime    ATT/P/OL
R2.00-00          0x0000007D     0x528E          1022            0/0/0
R3.00-00        * 0x00000082     0x26A2          952             0/0/0
R4.00-00          0x0000007B     0xFD39          925             0/0/0
R4.02-00          0x00000066     0x7AF2          975             0/0/0
R5.00-00          0x0000000B     0x6AFC          938             0/0/0
```

(Please note R3 only has L2 LSP database)

MPLS
Workshop

Reading ISIS Database

Level 2

L1 R1 S2/0 S2/0 **L2** R2 S3/0 S3/0 R3 **L2** E0/0 E0/0 R4 **L1L2** E1/0 E1/0 R5

area 49.0002 area 49.0001 area 49.0003
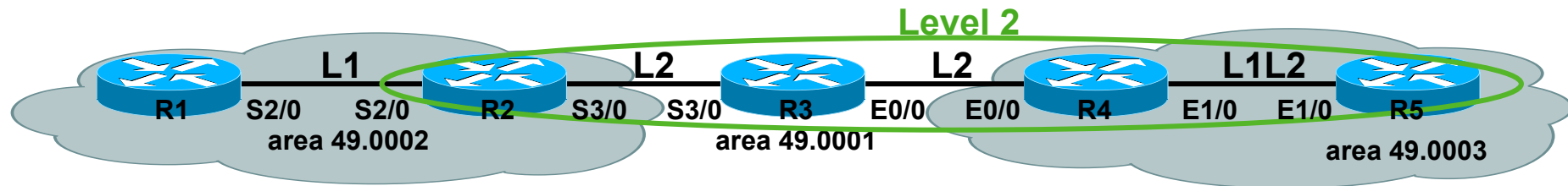
```
R1#show isis database

IS-IS Level-1 Link State Database:
LSPID            LSP Seq Num    LSP Checksum    LSP Holdtime    ATT/P/OL
R1.00-00       * 0x0000006F     0xD44D              664         0/0/0
R2.00-00         0x0000007D     0xCB3B             1154         1/0/0
```

Attach bit is set on L1 LSP from R2

(Please note R1 only has L1 LSP database)

MPLS
Workshop

     Cisco Public

ISIS Database Detail


```
R4#show isis database R4.00-00 detail
IS-IS Level-1 LSP R4.00-00
LSPID        LSP Seq Num   LSP Checksum   LSP Holdtime    ATT/P/OL
R4.00-00  * 0x00000080    0x25D2         783             1/0/0
  Area Address: 49.0003
   NLPID: 0xCC
   Hostname: R4
   IP Address: 10.1.100.4
   Metric: 10   IP 10.1.4.0 255.255.255.0
   Metric: 0    IP 10.1.100.4 255.255.255.255
   Metric: 10   IS R5.00 ( continued on next slide )
```
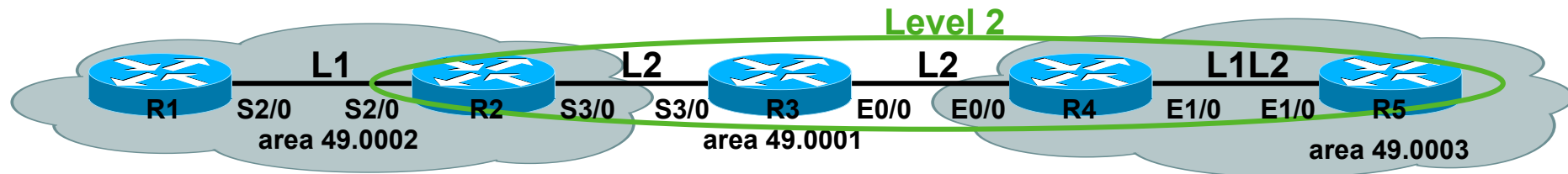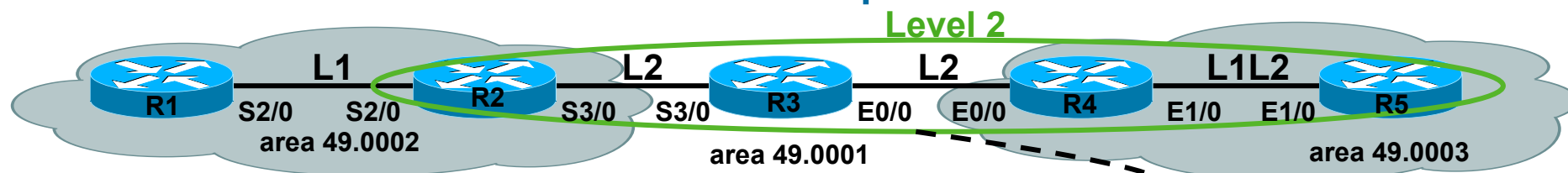
MPLS
Workshop

ISIS Database Detail - continued


```
IS-IS Level-2 LSP R4.00-00
LSPID          LSP Seq Num   LSP Checksum   LSP Holdtime        ATT/P/OL
R4.00-00  * 0x0000007B   0xFD39         666                 0/0/0
   Area Address: 49.0003
   NLPID:        0xCC
   Hostname: R4
   IP Address:   10.1.100.4
   Metric: 10        IP 10.1.2.0 255.255.255.0
   Metric: 10        IS R4.02
   Metric: 10        IS R5.00
   Metric: 10        IP 10.1.4.0 255.255.255.0
   Metric: 10        IP 10.1.100.5 255.255.255.255
   Metric: 0         IP 10.1.100.4 255.255.255.255
```

MPLS
Workshop

ISIS Pseudonode-LSP Example


```
R4#show isis database level-2
IS-IS Level-2 Link State Database:
LSPID            LSP Seq Num    LSP Checksum    LSP Holdtime    ATT/P/OL
R2.00-00         0x00000003     0xDA80          954             0/0/0
R4.01-00        *0x00000001     0x4C87          954             0/0/0
R5.00-00         0x00000003     0x0E61          956             0/0/0


R4#show isis database level-2 R4.01-00 detail
IS-IS Level-2 LSP R4.01-00
LSPID        LSP Seq Num   LSP Checksum   LSP Holdtime    ATT/P/OL
R4.01-00   0x00000001    0x4C87           914              0/0/0
  Metric: 0        IS R4.00
  Metric: 0        IS R3.00
```
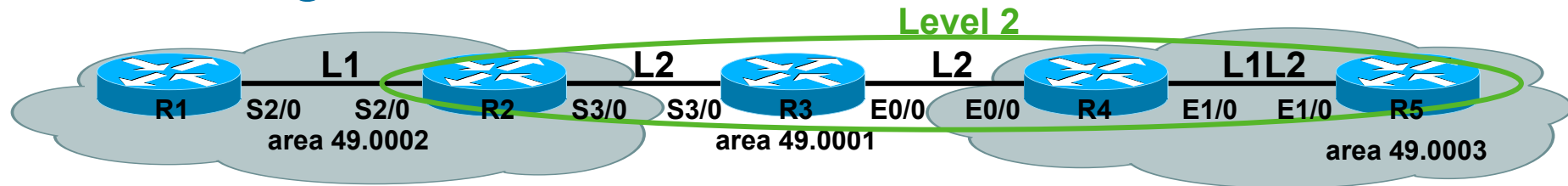
IS neighbors of the DIS: R4 and R3 (L2!)

MPLS
Workshop

ISIS Fragmented LSP


```
R5#show isis database level-1
IS-IS Level-1 Link State Database:
LSPID            LSP Seq Num    LSP Checksum    LSP Holdtime    ATT/P/OL
R4.00-00          0x00000019     0xF36B           1005           1/0/0
R5.00-00        * 0x0000001F     0xCF9F           1100           1/0/0
R5.00-01        * 0x00000002     0x5BD7           1100           0/0/0
```

Two fragments of R5.00-00

Segment 0 always contains the critical data

MPLS
Workshop

ISIS Fragmented LSP – First Segment
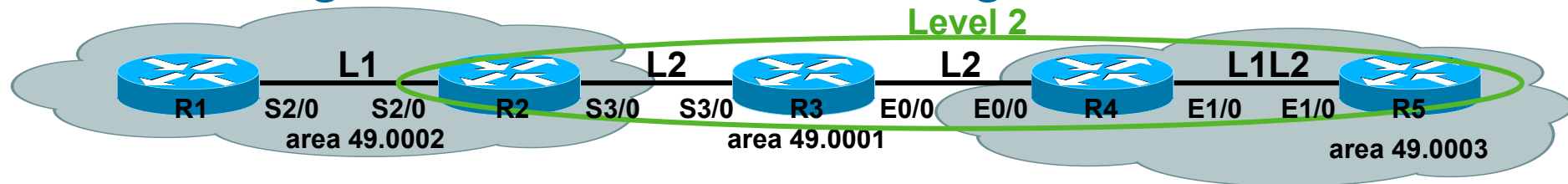

```
R5#show isis database level-1 R5.00-00 detail
IS-IS Level-1 LSP R5.00-00
LSPID       LSP Seq Num   LSP Checksum   LSP Holdtime     ATT/P/OL
R5.00-00 * 0x0000001F   0xCF9F          976              1/0/0
  Area Address: 49.0003
  NLPID:        0xCC
  Hostname: R5
  IP Address:   10.1.100.5
  Metric: 10   IP 10.1.4.0 255.255.255.0
```

MPLS
Workshop
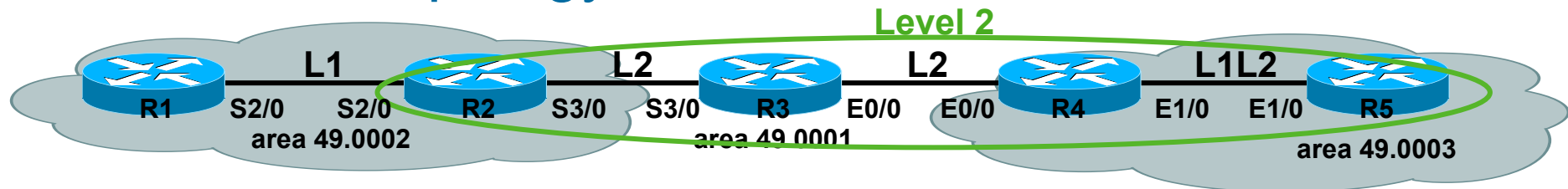
Show ISIS Topology

Shows the List of all L1 routers in the area and L2 routers along with the metric

```
R4#show isis topology
IS-IS paths to level-1 routers
System Id          Metric          Next-Hop          Interface          SNPA
R4                 --
R5                 10              R5                Et1/0              aabb.cc00.0501
IS-IS paths to level-2 routers
System Id          Metric          Next-Hop          Interface          SNPA
R2                 20              R3                Et0/0              aabb.cc00.0300
R3                 10              R3                Et0/0              aabb.cc00.0300
R4                 --
R5                 10              R5                Et1/0              aabb.cc00.0501
```

     Cisco Public

MPLS
Workshop

Solution to Scenario 6 :
R5 does not have routes to Networks behind R1

```
R5#show isis topology level-2 R2
Translating "R2"
IS-IS level-2 path to R2
System Id       Metric        Next-Hop      Interface     SNPA
R2              20            R4            Et1/0         aabb.cc00.0401
```

Level 2

L1 — R1 — area 49.0002 — L2 R2 — Level 2 — L2 R4 — E1/0 — L1L2 R5 — area 49.0003

```
R5#sh isis topology R1.00-00
R5#
R5#sh isis topology R1
Translating "R1"
R5#
```

The node owning this LSP R1 must be isolated from the calculating node

Upon further tracking the Database and topology hop by hop, we could trace that the problem is between R1 and R [MPLS]
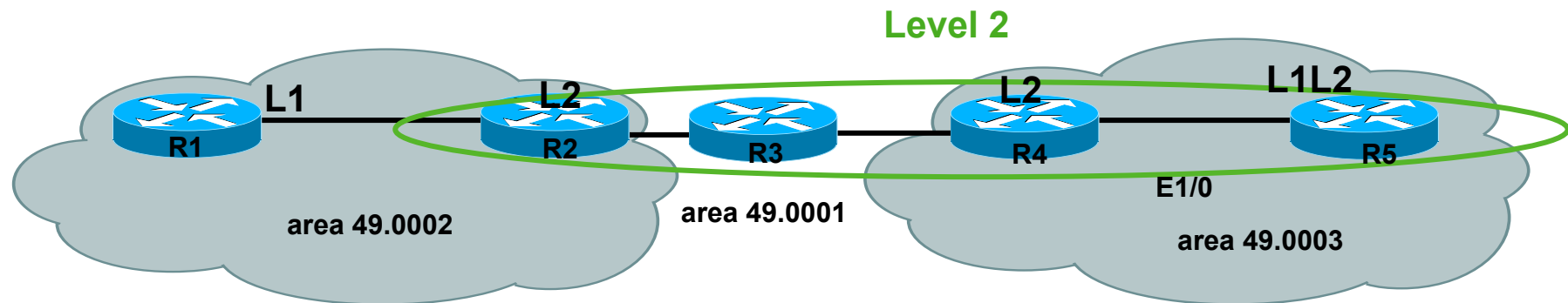
MPLS
Workshop

ISIS Fundamentals and Troubleshooting

Agenda

- Overview

- IS-IS Hierarchical Areas

- Addressing

- MTU and Hello Padding

- Attach-bit and Route Leaking

- LSP Flooding and Convergence

- SPF and Network Stability

- Route Redistribution

- Narrow and Wide Metrics

MPLS
Workshop

Scenario 7 :
Frequent SPF runs and Network Instability

Level 2

L1   L2   L2   L1L2

R1   R2   R3   R4   R5

E1/0

area 49.0002   area 49.0001   area 49.0003

MPLS
Workshop

Cisco Public

Start with 'Show isis spf-log'

Gives two key information :

- How often are SPFs run ?
  - frequent SPFs can indicate a problem in the network
  - in a stable network SPF should only run periodically

- Who triggered the SPF ?
  - see LSPid of first trigger LSP
  - helps find the source of the problem

MPLS
Workshop

 Cisco Public

Start with 'Show isis spf-log'

```
R4#show isis spf-log
 level 1 SPF log
 When       Duration   Nodes   Count   First trigger LSP   Triggers

 00:48:48     0          2       1                           PERIODIC
 00:01:39     0          1       2       R4.00-00            DELADJ TLVCONTENT
 00:01:34     0          2       2       R4.00-00            NEWADJ TLVCONTENT
 00:01:24     0          2       2       R5.00-00            LSPHEADER
```

**LSP ID of first LSP causing SPF
older IOS shows last trigger LSP**

What in LSP triggers ?

MPLS
Workshop

Check 'Show isis lsp-log'

- Not the same as ''Show isis spf-log'

- Gives two key information from LSP
    - How often do we generate new LSP ?
    - Why did it generate a new LSP ?

- One router can potentially influence the whole network

- Flapping adjacency is shown by interface involved

MPLS
Workshop

Cisco Public

LSP-Log

```
R4#show isis lsp-log
Level 1 LSP log
 When          Count      Interface        Triggers
 20:12:40        1         Ethernet1/0      DELADJ
 20:12:35        1         Ethernet1/0      NEWADJ
 20:10:18                                   ATTACHFLAG
 19:59:48        1         Loopback0        CONFIG
 19:54:05                  Loopback0        IPUP
 19:53:53        1         Loopback0        CONFIG
 00:49:11        2         Ethernet1/0      CLEAR DELADJ
 00:49:06        1         Ethernet1/0      NEWADJ
```

**event that triggered the
LSP to be flooded**

**up to 20 occurances
are kept**

Interface that causes the LSP generation

MPLS
Workshop

Debug ISIS spf-triggers
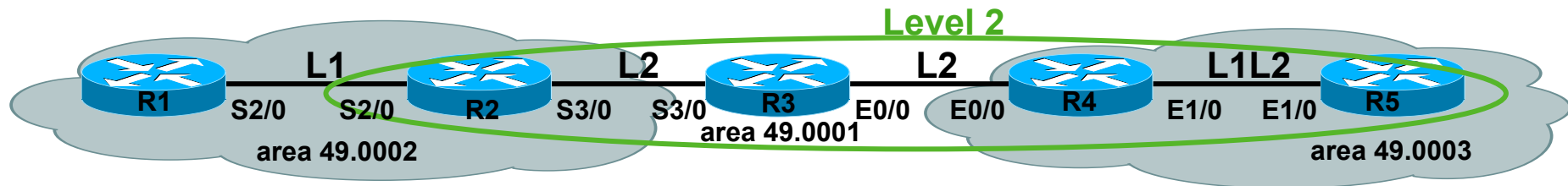

```
R5#debug isis spf-triggers

IS-IS SPF triggering events debugging is on
Apr 9 15:19:31.179:ISIS-Spf: L1 SPF needed, periodic SPF  from 0xA8508
                             periodic SPF in L1

Apr 9 15:19:31.179:ISIS-Spf: L2 SPF needed, periodic SPF  from 0xA8508
                             periodic SPF in L2

Apr 9 15:11:18.551:ISIS-Spf: L1 SPF needed, L2 attach changed
from 0xA9ED1C                 R4 loses L2 with R3
```
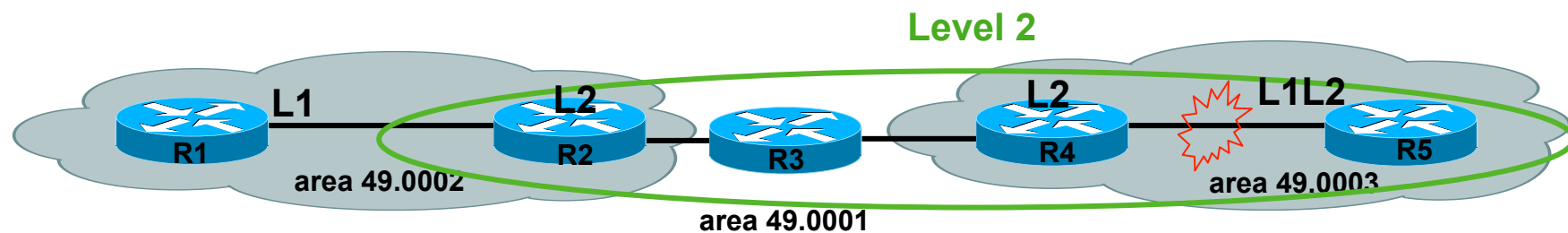
MPLS
Workshop

Solution to Scenario 7 :
Frequent SPF runs and Network Instability

Flapping interface on R5 triggering frequent SPFs

Show commands and debugs discussed will help locate the offending LSP in large networks
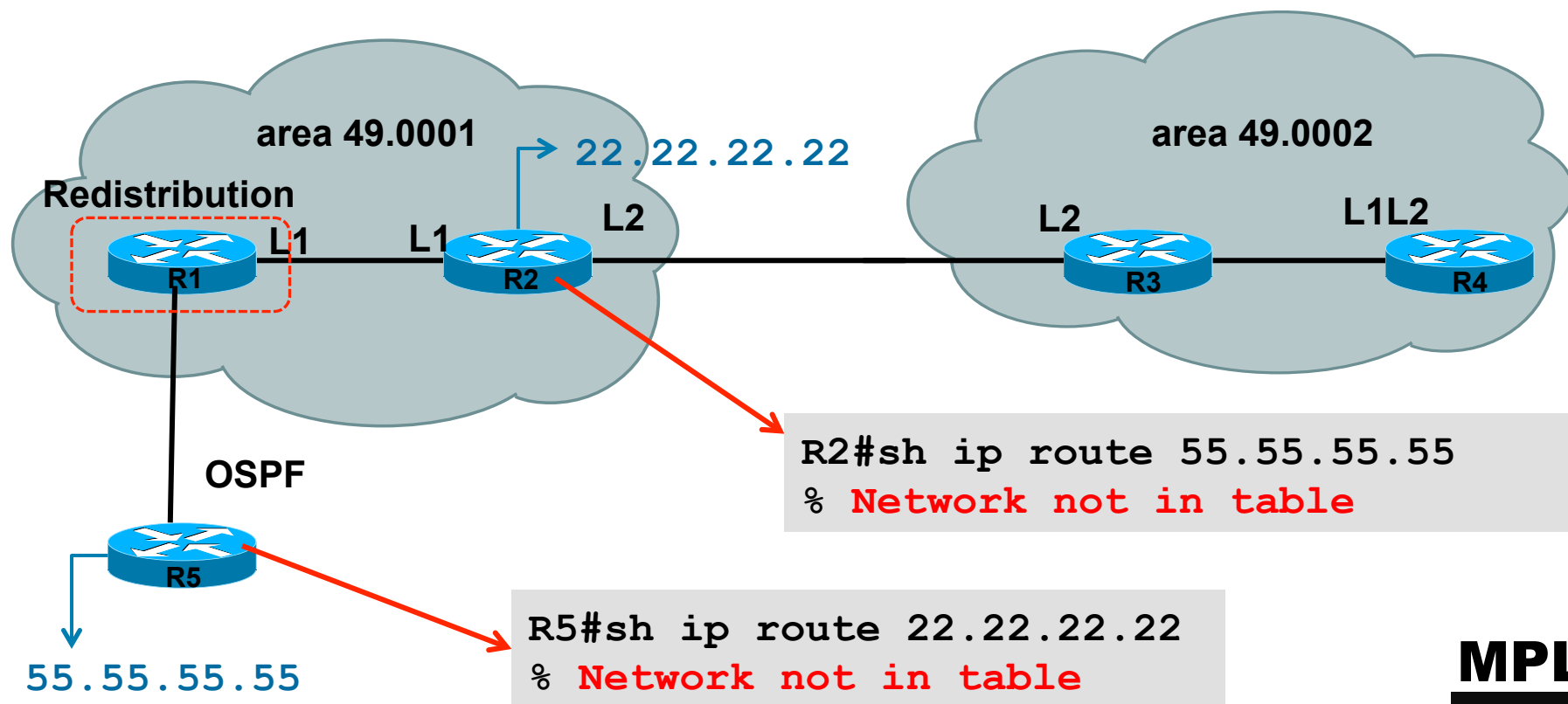
MPLS
Workshop

ISIS Fundamentals and Troubleshooting

Agenda

- Overview

- IS-IS Hierarchical Areas

- Addressing

- MTU and Hello Padding

- Attach-bit and Route Leaking

- LSP Flooding and Convergence

- SPF and Network Stability

- Route Redistribution

- Narrow and Wide Metrics

MPLS
Workshop

Scenario 8 : Redistribution to / from IS-IS failing

area 49.0001

area 49.0002

Redistribution

→ `22.22.22.22`

L1 **L1**

L2

L2

L1L2

R1 **R2**

R3 **R4**

OSPF

R5

↓

`55.55.55.55`

```
R2#sh ip route 55.55.55.55
% Network not in table
```

```
R5#sh ip route 22.22.22.22
% Network not in table
```

Cisco Public

MPLS
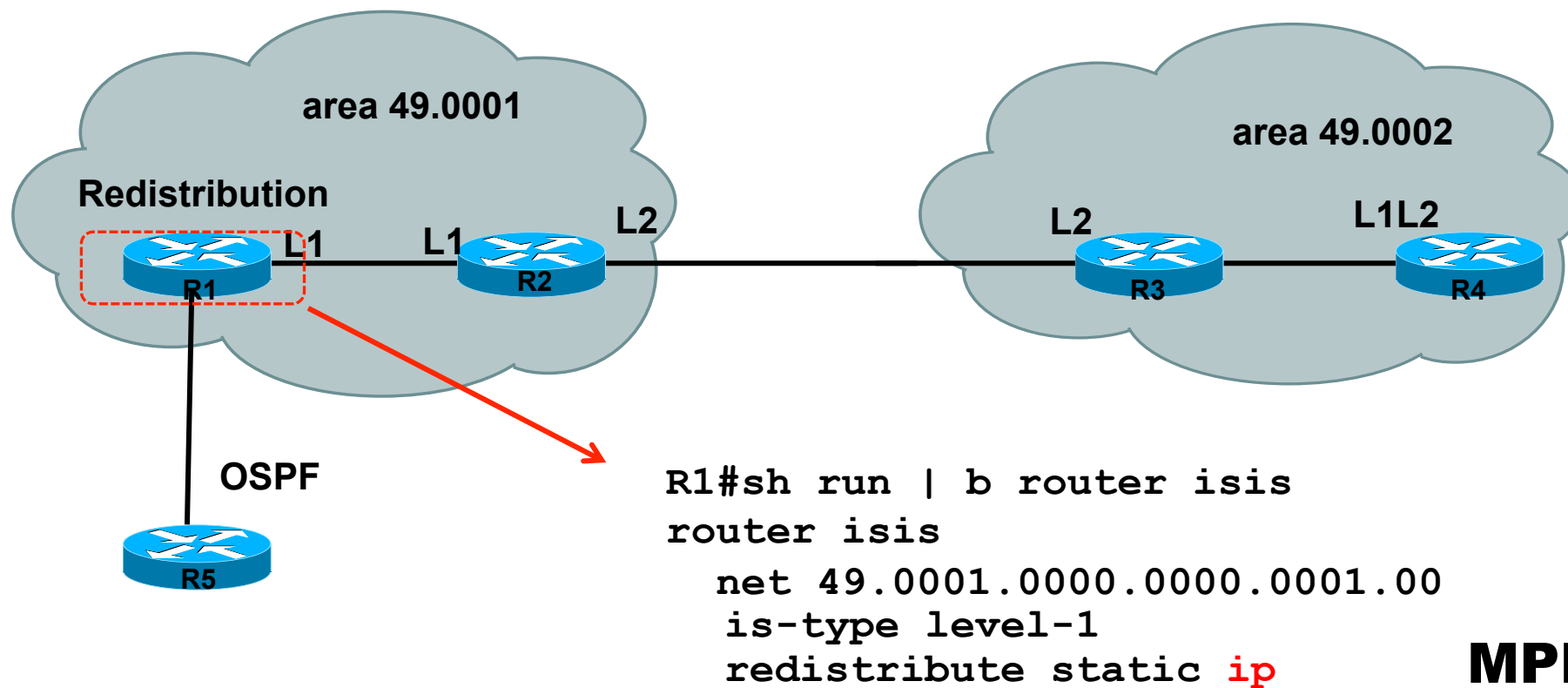**Workshop**

Gotchas in ISIS Redistribution

- Default redistribution is for **only level-2** ISIS routes

  "redistribute <protocol> level-1" needs to be specified for L1 routes to get redistributed
  into any protocol

- **"Redistribute static ip"**

  IP" keyword needs to be explicitly mentioned, otherwise redistribution of IP prefixes from static into ISIS will fail

- Just like OSPF, 'subnets' needs to be added for classless networks to be redistributed

MPLS
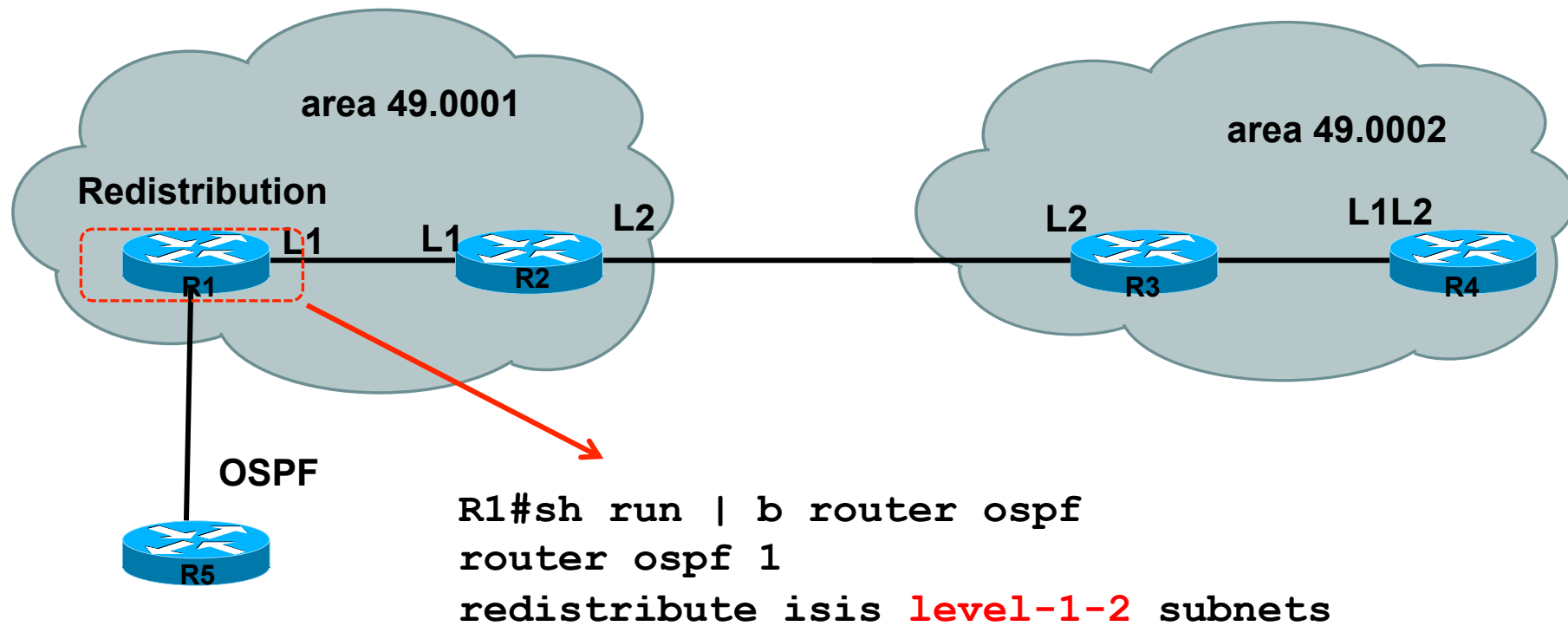**Workshop**

 Cisco Public

Route Comparison in IS-IS

- Between L1 and L2, in case of same routes (same prefix and same mask), Level 1 is preferred over Level 2

- Internal equal to external route-type : no difference based on the route-type itself, redistributed or internal. Metric-type in the next step decides it.
  – Route type is just based on the TLV used to carry the IP reachability information (TLV 128 versus TLV 130)

- Irrespective of route type, Internal metric-type is preferred over external metric-type. Metric-type can be set during the redistribution

- Redistributed routes into ISIS are **L1 and Internal** metric-type by default, They compete with regular IS-IS routes right away

S

Workshop

LTRARC-2002

Solution to Scenario 8 :
Redistribution to / from ISIS failing

area 49.0001

area 49.0002

Redistribution

L1 **L1** **L2**

R1 **R2**

L2 **L1L2**

R3 **R4**

OSPF

R5

```
R1#sh run | b router isis
router isis
  net 49.0001.0000.0000.0001.00
  is-type level-1
  redistribute static ip
```

MPLS
Workshop

Solution to Scenario 8 :
Redistribution to / from ISIS failing

area 49.0001

area 49.0002

Redistribution

L2

L2

L1L2

L1

L1

R2

R3

R4

R1

OSPF

R5

```
R1#sh run | b router ospf
router ospf 1
redistribute isis level-1-2 subnets
```
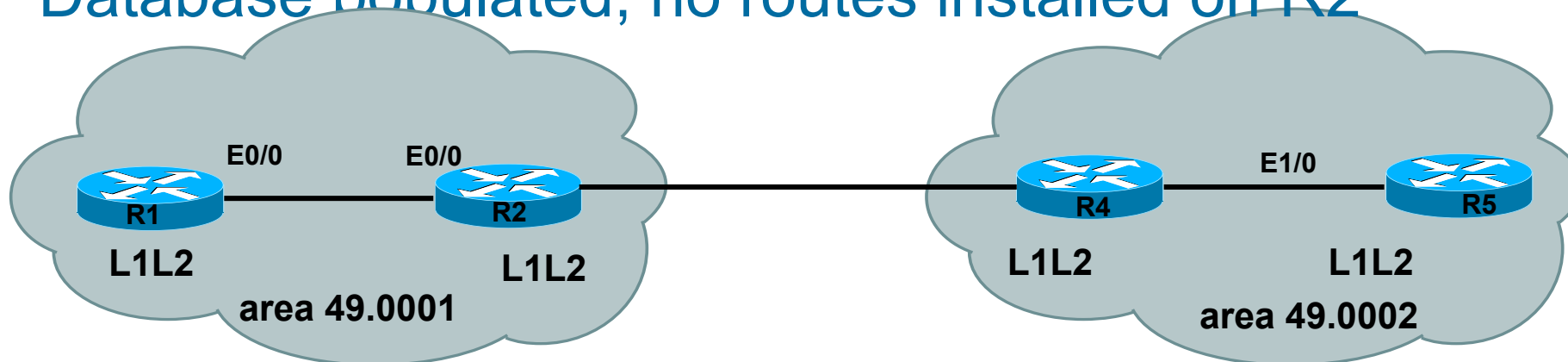
MPLS
Workshop

ISIS Fundamentals and Troubleshooting

Agenda

- Overview

- IS-IS Hierarchical Areas

- Addressing

- MTU and Hello Padding

- Attach-bit and Route Leaking

- LSP Flooding and Convergence

- SPF and Network Stability

- Route Redistribution

- Narrow and Wide Metrics

MPLS
Workshop

    Cisco Public

Scenario 9 :
Database populated, no routes installed on R2


```
R2#sh ip route isis
R2#
R2#sh isis database level-1 R1.00.00 detail
IS-IS Level-1 LSP R1.00-00
LSPID        LSP Seq Num      LSP Checksum   LSP Holdtime    ATT/P/OL
R1.00-00 0x00000009          0x489F         515             0/0/0
   Metric: 10         IP 99.99.99.99/32
   Metric: 10         IS-Extended R1.01
```

MPLS
Workshop

TLVs

- TLV = Type Length Value

- Flexible way of carrying information

- New stuff goes into TLVs

- A router that does not recognize a TLV, ignores it

Cisco Public

MPLS
Workshop

ISIS Packet

Intradomain Routing Protocol Discriminator
Length Indicator
Version/Protocol ID Extension
ID Length
R   R   R   **PDU type**
Version
Reserved
Maximum Area Addresses
Additional Header Fields
TLV Fields

TLV format make IS-IS Flexible in terms of tuning and easily extendable to new features like MPLS-TE, IPv6

variable

MPLS
Workshop

Narrow and Wide IS-IS Metrics

- Narrow Metrics

  – Maximum LINK_METRIC per interface is 63 (only 6 bits)
  – Maximum PATH_METRIC is 1023

- Wide Metrics

  – Extended IS Reachability TLV and Extended IP Reachability TLV introduced wide metrics
  – Max LINK_METRIC is 16777215 ($2^{24} - 1$)
  – Max PATH_METRIC is 4261412864 ($2^{32} - 2^{25}$)
  – Needed for MPLS Traffic Engineering to work

MPLS
Workshop

Mismatch in Metric Style

- Turning on **'metric-style wide'** only on a few routers will break connectivity, as routers running narrow metrics will not understand the newer TLVs

- **"metric-style transition"** will help during Migration - advertise and accept both old and new TLVs

We can use different flavors of transition command, depending on the scenario :

- **"metric-style narrow transition"** - To advertise only old-style TLVs but accept both old and new

- **"metric-style wide transition"** - To advertise only new-style TLVs and accept both

Cisco Public

MPLS
Workshop

Detecting Mismatch in Metric Style

```
R1#sh clns protocol
IS-IS Router:
Redistribute:
    static (on by default)
Distance for L2 CLNS routes:110
RRR level: none
Generate narrow metrics: none
Accept narrow metrics: none
Generate wide metrics:level-1-2
Accept wide metrics :level-1-2
```

```
R2#sh clns protocol
IS-IS Router:
Redistribute:
    static (on by default)
Distance for L2 CLNS routes:110
  RRR level: none
Generate narrow metrics:level-1-2
Accept narrow metrics :level-1-2
Generate wide metrics: none
Accept wide metrics: none
```
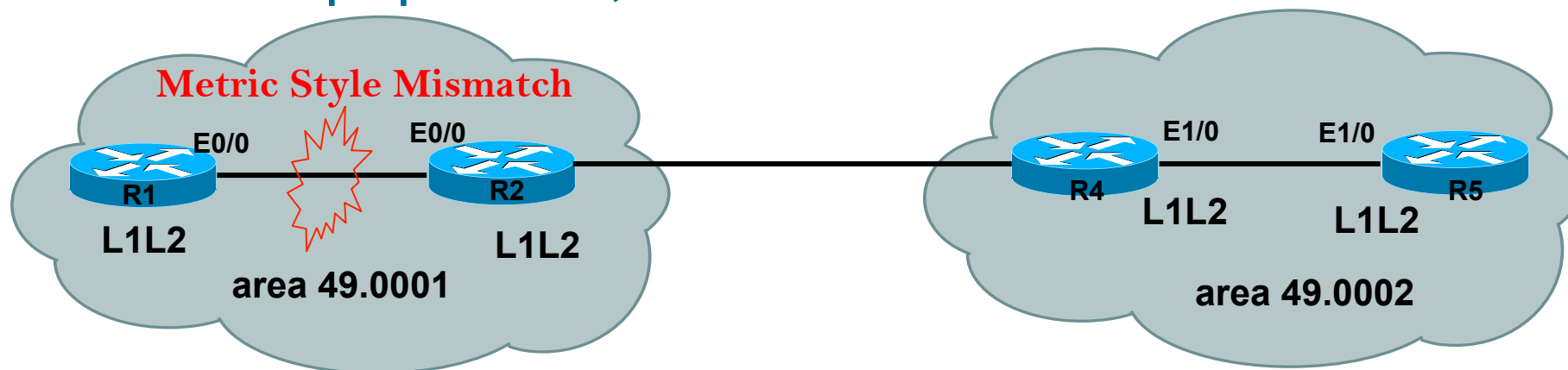
MPLS
Workshop

Detecting Mismatch in Metric Style

```
R2#debug isis update-packets

Apr   9 01:46:21.259: ISIS-Upd: Rec L2 LSP 0000.0000.0001.01-00

Apr   9 01:46:21.259: ISIS-Upd: from SNPA 0025.4531.0980

Apr   9 01:46:21.259: ISIS-Upd: LSP newer than database copy

Apr   9 01:46:21.259: ISIS-Upd: TLV code mismatch (22, 2)

Apr   9 01:46:21.259: ISIS-Upd: TID 0 full SPF required
```

MPLS
Workshop

Solution to Scenario 9 :
Database populated, no routes installed on R2

Metric Style Mismatch

R1 — E0/0 — R2 L1L2
L1L2
area 49.0001

R4 — E1/0 — E1/0 — R5
L1L2   L1L2
area 49.0002

```
R2#sh isis database level-1 R1.00.00 detail
LSPID       LSP Seq Num   LSP Checksum   LSP Holdtime   ATT/P/OL
R1.00-00  0x00000009    0x489F         515            0/0/0
  Area Address: 49.0001
   Metric: 10        IP 172.16.1.0/24
   Metric: 10        IP 99.99.99.99/32
   Metric: 10        IS-Extended R1.01
```
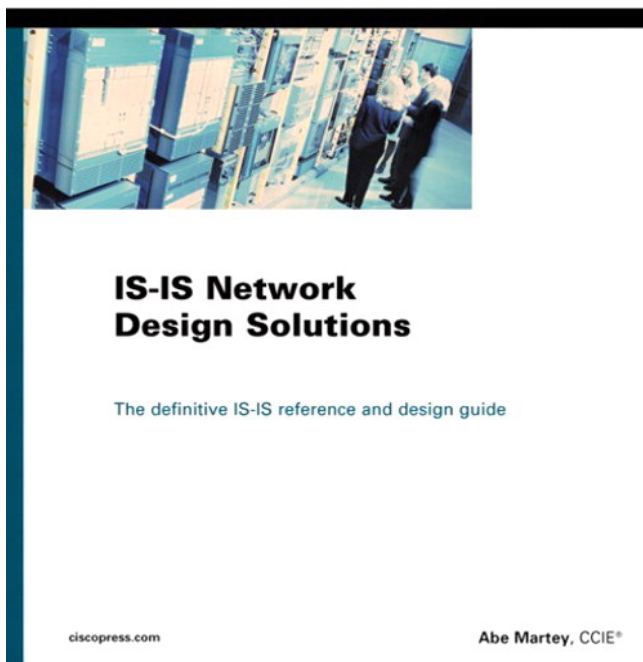
MPLS
Workshop

Review : ISIS vs OSPF

	ISIS	OSPF
Design	2-level hierarchy Originally: Only totally stub areas route leaking makes areas non-stub	2-level hierarchy Multiple types or areas
Encapsulation	Runs directly over layer 2	On top of IP (can be remotely attacked)
Flooding	Reliable on p2p links 1 LSP per router Fexibility via TLVs Unrecognized TLVs are flooded Requesting info and acks (PSNP) DIS	Reliable Many different types (11) of LSAs Fixed LSA formats Unrecognized LSA are not flooded Requesting info and acks (LS Request/Update) DR and BDR
Scalability	Thousands of prefixes	Thousands of prefixes

Cisco Public

MPLS
Workshop 119

Review : ISIS vs OSPF

	ISIS	OSPF
Network types	P2P Broadcast	P2P Broadcast Non-broadcast Point-to-multipoint
Aging	Periodic flooding Aging: counts down Remaining lifetime is configurable Cannot disable aging	Periodic flooding Aging: counts up Maxage is not configurable DoNotAge (DNA) bit cancels aging out
MPLS TE support	Yes	Yes
IPv6	Integrated	Seperate and new protocol: OSPFv3
Authentication	Yes	Yes

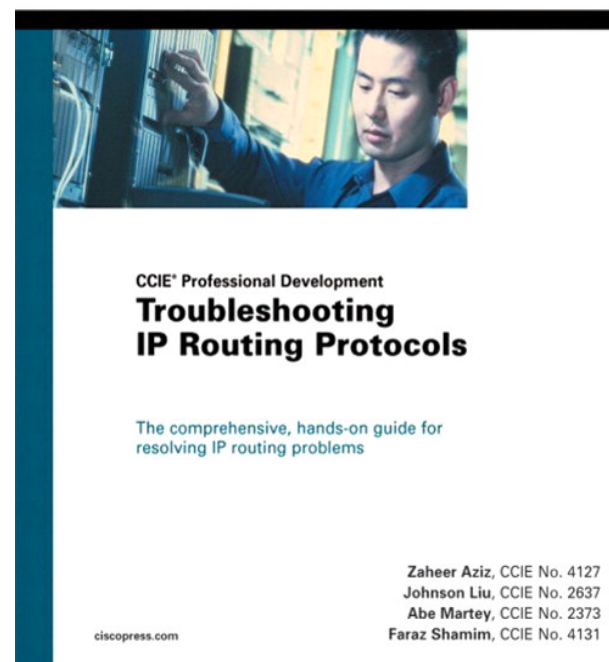**MPLS**

Workshop

Cisco Public

Further Reading

IS-IS Network Design Solutions

The definitive IS-IS reference and design guide

ciscopress.com

Abe Martey, CCIE

CCIE Professional Development

Troubleshooting IP Routing Protocols

The comprehensive, hands-on guide for resolving IP routing problems

ciscopress.com

Zaheer Aziz, CCIE No. 4127
Johnson Liu, CCIE No. 2637
Abe Martey, CCIE No. 2373
Faraz Shamim, CCIE No. 4131

MPLS
Workshop

APPENDIX

MPLS
Workshop

IS-IS Common Recommendations

- Unless required, CLNS should be disabled with "no clns routing" for IP-only networks

- The overload bit should be set with "set-overload-bit" to protect against traffic being "black holed" on initial router bootup. Generally the recommended timeframe is 180 seconds (3 minutes)

- Ensure the router is set to ignore LSP errors with "ignore-lsp-errors", like checksum errors to avoid overload on originating router due to perpetual purge and regeneration – enabled by default

- "Log-adjacency-changes" should be enabled on all platforms across the network to ensure easier troubleshooting

- Ensure "hostname dynamic" command is enabled to create system-ID-to-router-name mapping for easier troubleshooting – enabled by default

MPLS
Workshop

ISIS Master show command List

show commands

show clns
show clns interface
show clns neighbor
show clns neighbor detail
show clns protocol
show clns route
show isis database
show isis database detail
show isis hostname
show isis spf-log
show isis topology
show isis route
show clns traffic
show clns cache

Hidden show commands

show isis timers
show isis private
show isis database private
show isis spf-log detail
show isis tree
show isis lsp-log

MPLS
Workshop

Thank you.