Introduction to ISIS

AFNOG 2013 AR-E Workshop

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IS-IS Standards History

- ISO 10589 specifies OSI IS-IS routing protocol for CLNS traffic
  - A Link State protocol with a 2 level hierarchical architecture
  - Type/Length/Value (TLV) options to enhance the protocol
- RFC 1195 added IP support
  - Integrated IS-IS
  - I/IS-IS runs on top of the Data Link Layer

IS-IS Standards History

- RFC5308 adds IPv6 address family support to IS-IS
- RFC5120 defines Multi-Topology concept for IS-IS
  - Permits IPv4 and IPv6 topologies which are not identical
  - (Required for an incremental roll-out of IPv6 on existing IPv4 infrastructure)

ISIS Levels

- ISIS has a 2 layer hierarchy
  - Level-2 (the backbone)
  - Level-1 (the areas)
- A router can be
  - Level-1 (L1) router
  - Level-2 (L2) router
  - Level-1-2 (L1L2) router

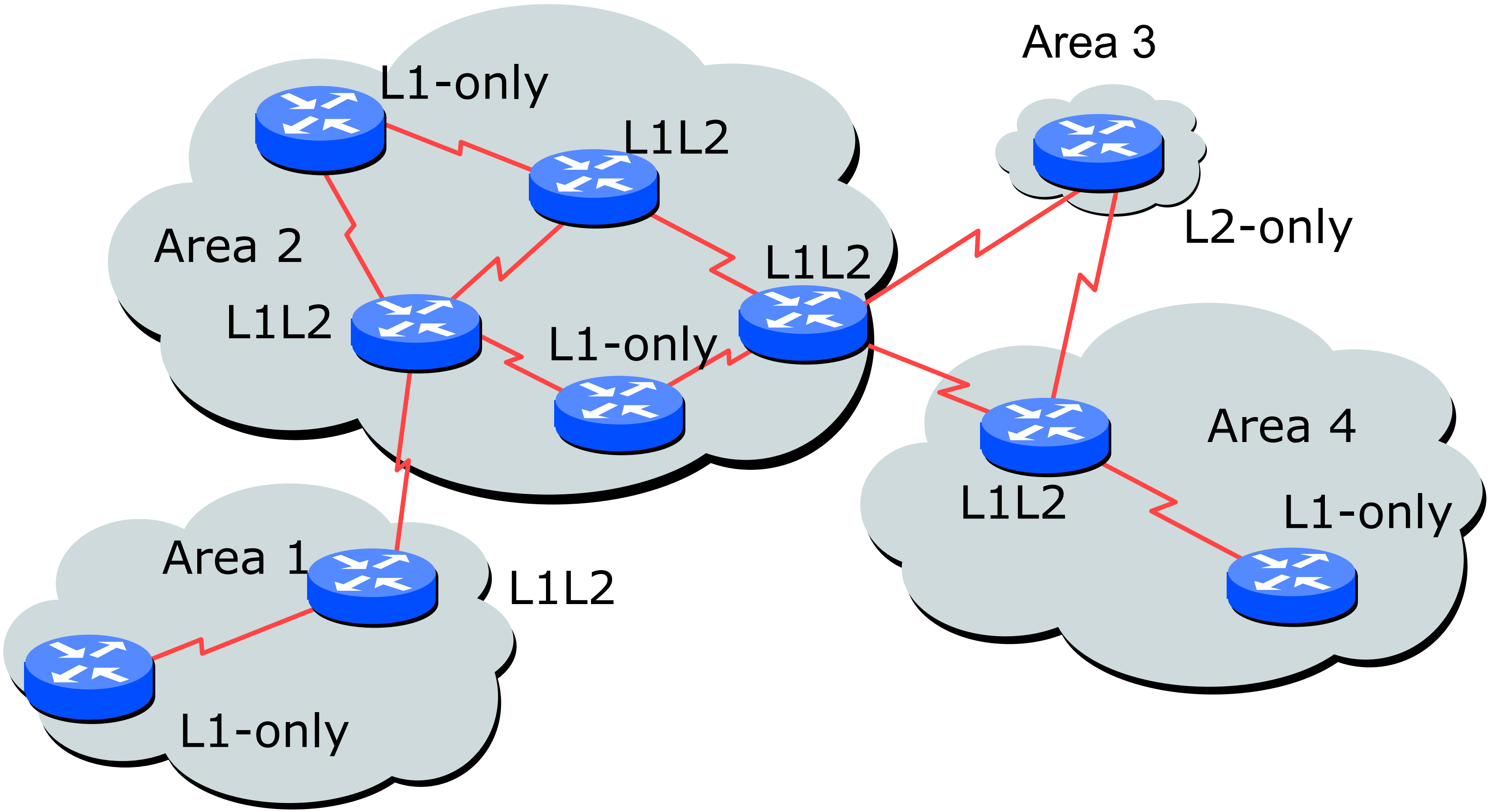
ISIS Levels

- Level-1 router
  - Has neighbours only on the same area
  - Has a level-1 LSDB with all routing information for the area
- Level-2 router
  - May have neighbours in the same or other areas
  - Has a Level-2 LSDB with all routing information about inter-area
- Level-1-2 router
  - May have neighbours on any area.
  - Has two separate LSDBs: level-1 LSDB & level-2 LSDB

Backbone & Areas

- ISIS does not have a backbone area as such (like OSPF)
- Instead the backbone is the contiguous collection of Level-2 capable routers
- ISIS area borders are on links, not routers
- Each router is identified with a unique Network Entity Title (NET)
  - NET is a Network Service Access Point (NSAP) where the n-selector is 0
  - (Compare with each router having a unique Router-ID with IP routing protocols)

Example: L1, L2, and L1L2 Routers



NSAP and Addressing

IDP		DSP		
AFI	IDI	High Order DSP	System ID	NSEL
Variable length Area address			6 bytes	1 byte

- NSAP: Network Service Access Point
  - Total length between 8 and 20 bytes
  - Area Address: variable length field (up to 13 bytes)
  - System ID: defines an ES or IS in an area.
  - NSEL: N-selector; identifies a network service user (transport entity or the IS network entity itself)
- NET: the address of the network entity itself

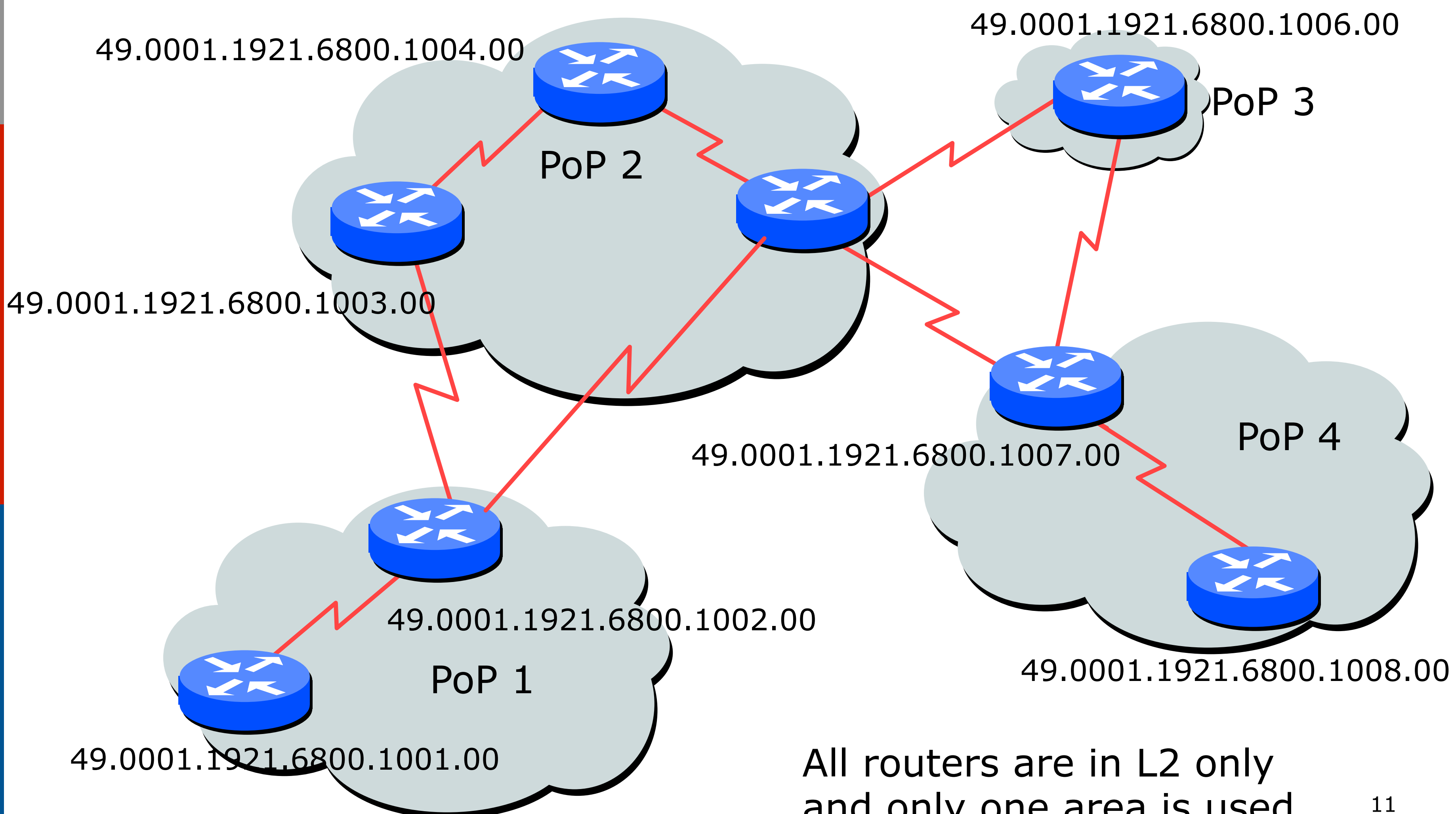
Addressing Common Practices

- ISPs typically choose NSAP addresses thus:
  - First 8 bits – pick a number (usually 49)
  - Next 16 bits – area
  - Next 48 bits – router loopback address
  - Final 8 bits – zero
- Example:
  - NSAP: 49.0001.1921.6800.1001.00
  - Router: 192.168.1.1 (loopback) in Area 1

Addressing & Design Practices

- ISPs usually only use one area
  - Multiple areas only come into consideration once the network is several hundred routers big
- NET begins with 49
  - "Private" address range
- All routers are in L2 only
  - Note that Cisco IOS default is L1L2
  - Set L2 under ISIS generic configuration (can also be done per interface)

Typical ISP Design



All routers are in L2 only
and only one area is used

Adjacencies

- Hello Protocol Data Units (PDUs) are exchanged between routers to form adjacencies

- Area addresses are exchanged in IIH PDUs
  - Intermediate-System to Intermediate System Hello PDUs
  - (PDU is ISIS equivalent of a packet)

Link State PDU (LSP)

- Each router creates an LSP and floods it to neighbours
- A level-1 router will create level-1 LSP(s)
- A level-2 router will create level-2 LSP(s)
- A level-1-2 router will create
  - level-1 LSP(s) and
  - level-2 LSP(s)

The ISIS LSP

- LSPs have a Fixed Header and TLV coded contents
- The LSP header contains
  - LSP-id (Sequence number)
  - Remaining Lifetime (Checksum)
  - Type of LSP (level-1, level-2)
  - Attached bit (Overload bit)
- The LSP contents are coded as TLV (Type, Length, Value)
  - Area addresses
  - IS neighbours
  - Authentication Information

Link State Database Content

- Each router maintains a separate LSDB for level-1 and level-2 LSPs
- The LSDB contains:
  - LSP headers and contents
  - SRM bits: set per interface when router has to flood this LSP
  - SSN bits: set per interface when router has to send a PSNP for this LSP

Flooding of LSPs

- New LSPs are flooded to all neighbors
- All routers get all LSPs
- Each LSP has a sequence number
- There are 2 kinds of flooding:
  - Flooding on a p2p link
  - Flooding on LAN

Flooding on a p2p link

- Once the adjacency is established both routers send CSNP packet
- Missing LSPs are sent by both routers if not present in the received CSNP
- Missing LSPs may be requested through PSNP

Flooding on a LAN

- Each LAN has a Designated Router (DIS)
- The DIS has two tasks
  - Conducting the flooding over the LAN
  - Creating and updating a special LSP describing the LAN topology (Pseudonode LSP)
- DIS election is based on priority
  - Best practice is to select two routers and give them higher priority – then in case of failure one provides deterministic backup for the other
  - Tie break is by the highest MAC address

Flooding on a LAN

- DIS conducts the flooding over the LAN
- DIS multicasts CSNP every 10 seconds
- All routers on the LAN check the CSNP against their own LSDB (and may ask specific re-transmissions with PSNPs)

Complete Sequence Number PDU

- Describes all LSPs in your LSDB (in range)
- If the LSDB is large, multiple CSNPs are sent
- Used on 2 occasions:
  - Periodic multicast by DIS (every 10 seconds) to synchronise the LSDB over LAN subnets
  - On p2p links when link comes up

Partial Sequence Number PDUs

- PSNPs Exchanged on p2p links (ACKs)
- Two functions
  - Acknowledge receipt of an LSP
  - Request transmission of latest LSP
- PSNPs describe LSPs by its header
  - LSP identifier
  - Sequence number
  - Remaining lifetime
  - LSP checksum

Network Design Issues

- As in all IP network designs, the key issue is the addressing lay-out
- ISIS supports a large number of routers in a single area
- When network is so large requiring the use of areas, use summary-addresses
- >400 routers in the backbone is quite doable

Network Design Issues

- Link cost
  - Default on all interfaces is 10
  - (Compare with OSPF which sets cost according to link bandwidth)
  - Manually configured according to routing strategy
- Summary address cost
  - Equal to the best more specific cost
  - Plus cost to reach neighbour of best specific
- Backbone has to be contiguous
  - Ensure continuity by redundancy
- Area partitioning
  - Design so that backbone can **NOT** be partitioned

Scaling Issues

- Areas vs. single area
  - Use areas where
    - sub-optimal routing is not an issue
    - areas with one single exit point
- Start with L2-only everywhere
  - Future implementation of level-1 areas will be easier
  - Backbone continuity is ensured from start

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