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LLDP & LLDP-MED

What is IEEE 802.1AB - LLDP?

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Defines the Link Layer Discovery Protocol (LLDP)

- One-way neighbor discovery protocol with periodic transmissions
- LLDP frames are not forwarded but constrained to a single link
- LLDP frames contain formatted TLVs (type, length, value)
  - System and port identification
  - Time-to-Live information for ageing purposes
  - Optional system capabilities
  - Optional system name and description
  - Optional management address
  - Optional organizationally specific extensions
- Receiver stores information in an SNMP MIB
- Receiver ages MIB to ***insure only valid*** network device data is available

Standard completed and momentum in place for LLDP rollout by many vendors...

LLDP History...

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- Strong industry need identified for link layer discovery
- ***Numerous proprietary discovery protocols exist today, notably Cisco Discovery Protocol (CDP). None of these interoperate!***

A first start at IETF ...

- An IETF Working Group (PTOPOMIB) addressed this problem beginning in 1996, focusing on common framework/model for describing physical topology
- Completed an Informational MIB (RFC 2922, Physical Topology MIB, published Sept 2000), but didn't progress the discovery protocol

Enter IEEE ...

- IEEE effort was first proposed to 802.1 in January 2002 to pick-up where the IETF effort left off, driven largely by Paul Congdon (ProCurve/HP)
- IEEE 802.1AB-2005 "Link Layer Discovery Protocol" (LLDP) is now complete!

What Does *LLDP* Provide?

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Network Management

- Simplify and enhance the ability of network management tools in multi-vendor environments
- Enables discovery of accurate physical network topologies
  - What devices are neighbors and through what ports they connect
  - Even with multiple VLANs where all subnets may not be known
- Ensure proper aging so only valid network device data is presented

Network Inventory Data

- Most implementations are expected to support optional system name, system description, system capabilities and management address
- System description can contain the device's full name, version of hardware type and operating system
- Can provide device capability such as switches, routers and WLAN access points

Network troubleshooting

- Accurate topologies simplifies troubleshooting of enterprise networks
- Discover devices with misconfigured or unreachable IP addresses
- Detect speed and duplex mismatch (IEEE 802.3 extension)

How Does *LLDP* Work?

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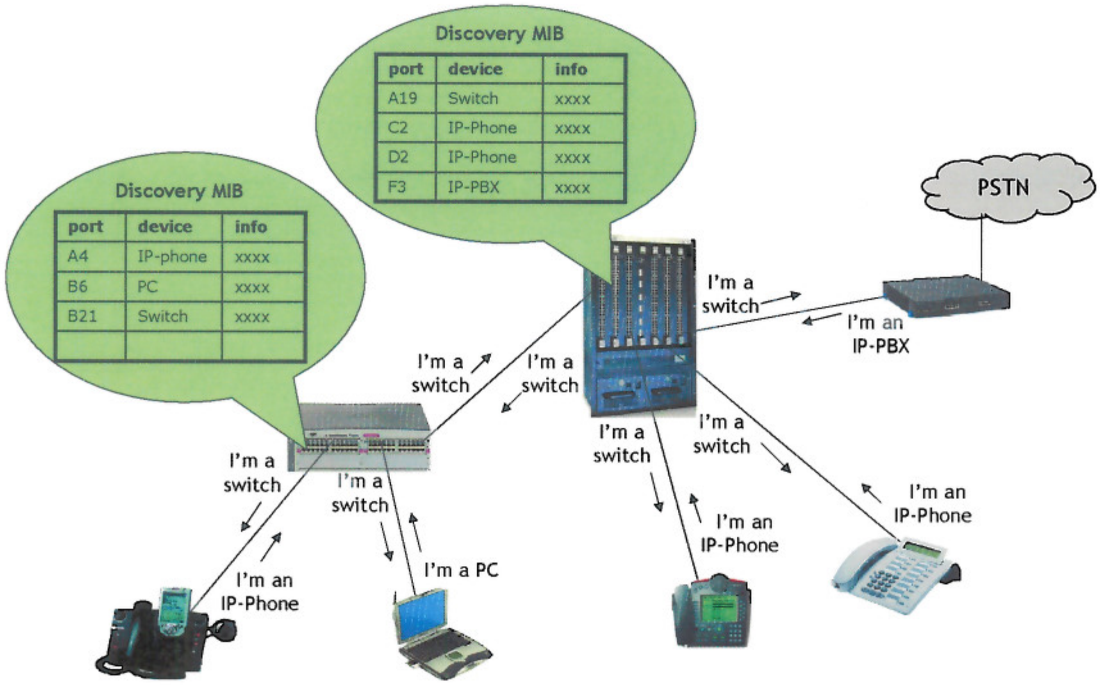

Discovery MIB

port	device	info
A19	Switch	xxxx
C2	IP-Phone	xxxx
D2	IP-Phone	xxxx
F3	IP-PBX	xxxx

Discovery MIB

port	device	info
A4	IP-phone	xxxx
B6	PC	xxxx
B21	Switch	xxxx

LLDP Entities & Agents
A peak under the hood*

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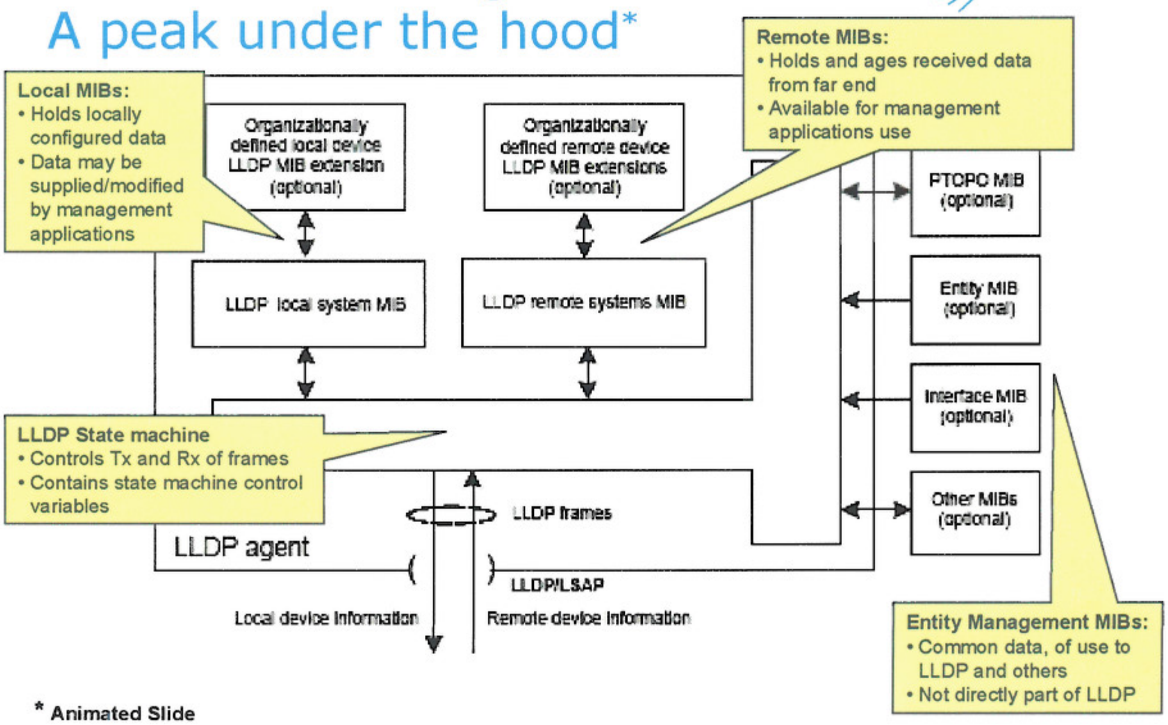

* Animated Slide

LLDP Frame Format

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IEEE 802.3 LLDP frame format

DA	SA	LLDP Ethertype	Data + pad	
LLDP_Multicast address	MAC address	88-CC	LLDPDU	FCS
6 octets	6 octets	2 octets	1500 octets	4 octets

LLDP Multicast = 01-80-C2-00-00-0E (same as STP except for last octet)

LLDPDU format

Chassis ID TLV	Port ID TLV	Time To Live TLV	Optional TLV	...	Optional TLV	End Of LLDPDU TLV
M	M	M				M

M - mandatory TLV - required for all LLDPDUs

LLDP Extensibility

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Organizationally specific TLVs allow extensions to be easily defined in a consistent way

Extension TLV type 111 1111	TLV string length	Organizationally unique identifier (OUI)	Group-defined TLV subtype	Group-defined information string
7 bits	9 bits	3 octets	1 octet	$0 \leq n \leq 507$ octets
TLV header		TLV information string 4 - 511 octets		

Figure 9-12—Basic format for organizationally-defined extension TLVs

There are currently three organizational extensions:

1. IEEE 802.1
   – Port VLAN, Port & Protocol VLANs, VLAN Name, Protocol Entity
2. IEEE 802.3
   – MAC/PHY configuration, Power, Link Aggregation, Maximum Frame Size
3. TIA TR-41.4, VoIP Infrastructure - LLDP-MED (*covered later*)

Useful LLDP CLI Commands

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Show neighbor info:

```
# show lldp info remote-device
# show lldp info remote-device <port-list>   (Device Detail)
```

Show local info:

```
# show lldp info local-device
```

Show statistics:

```
# show lldp stats
# show lldp stats <port-list>   (Shows invalid & unrecognized)
```

Show configuration:

```
# show lldp config
```

Configure advertised mgmt IP (only needed if multiple defined on a port)

```
# lldp config <port> ipAddrEnable
```


LLDP-MED History…

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LLDP provides the base capabilities, but is not sufficient for IP Telephony

LLDP-MED (Media Endpoint Discovery) initiative formed …

- ProCurve approached Mitel and several others leading vendors to extend LLDP to address additional needs, early '04
- TIA (*Telecommunications Industry Association)* TR-41.4 subcommittee was selected
  - Co-authored by Mitel, ProCurve, Avaya and Enterasys

On track to be published as TIA-1057

- *Final ballot successfully passed TIA and ANSI – July 5, '05*
- *Pending copyright and legal IPR review*

What Does *LLDP-MED* Provide?

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Interoperability
- Provide vendor-independent management capabilities, enabling different IP telephony systems to interoperate on one network

Automatic deployment of convergence network policies
- Voice VLAN
- Layer 2 and Layer 3 QoS policies

Location Services, including Emergency Call Service (ECS)
- Enablement of E-911 for IP telephony through location information

Detailed Inventory Management Capabilities
- Location information and accurate topology is made available
- Switch acts as proxy to collect model, manufacturer, software, firmware and asset information – since few phones support SNMP

Advanced PoE
- Fine grain power management and backup power conservation

IP telephony network troubleshooting
- Detect speed and ***duplex mismatch****
- Detect improper static voice policy configurations

* **Frequent cause of voice quality issues, but very hard to diagnose**

LLDP-MED Reference Model

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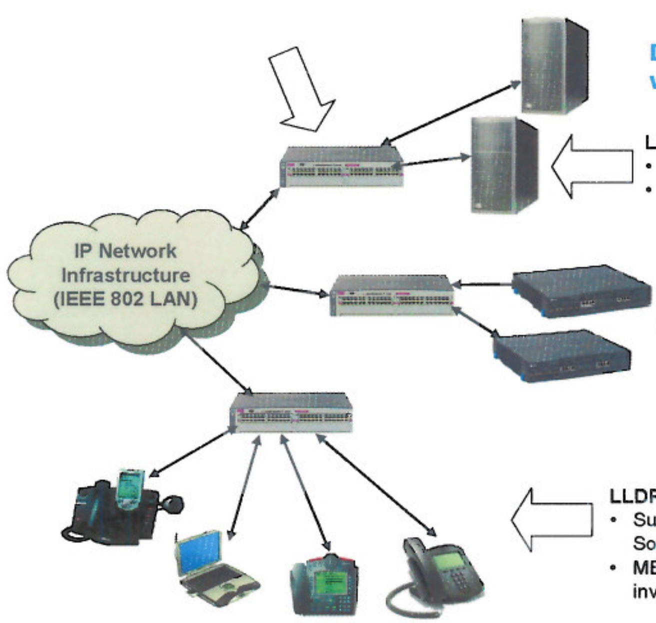
LLDP-MED Network Connectivity Devices
- Provide network access to LLDP-MED endpoints
- E.g. L2 / L3 switch, WLAN, etc



Different requirements for Endpoints, with strict hierarchy

LLDP-MED Generic Endpoints (Class I)
- E.g. IP Communications Controller, etc.
- MED TLVs: Device capabilities, others optional

LLDP-MED Media Endpoints (Class II)
- Supports media streams (e.g. Media Gateway, Conference Bridge, etc.)
- MED TLVs: Class I + network policy, others optional

LLDP-MED Communication Device Endpoints (Class III)
- Supports end user IP communication (e.g. IP Telephone, Softphone, etc.)
- MED TLVs: Class II + location ID (E911), embedded L2, inventory management

Auto Voice Configuration*

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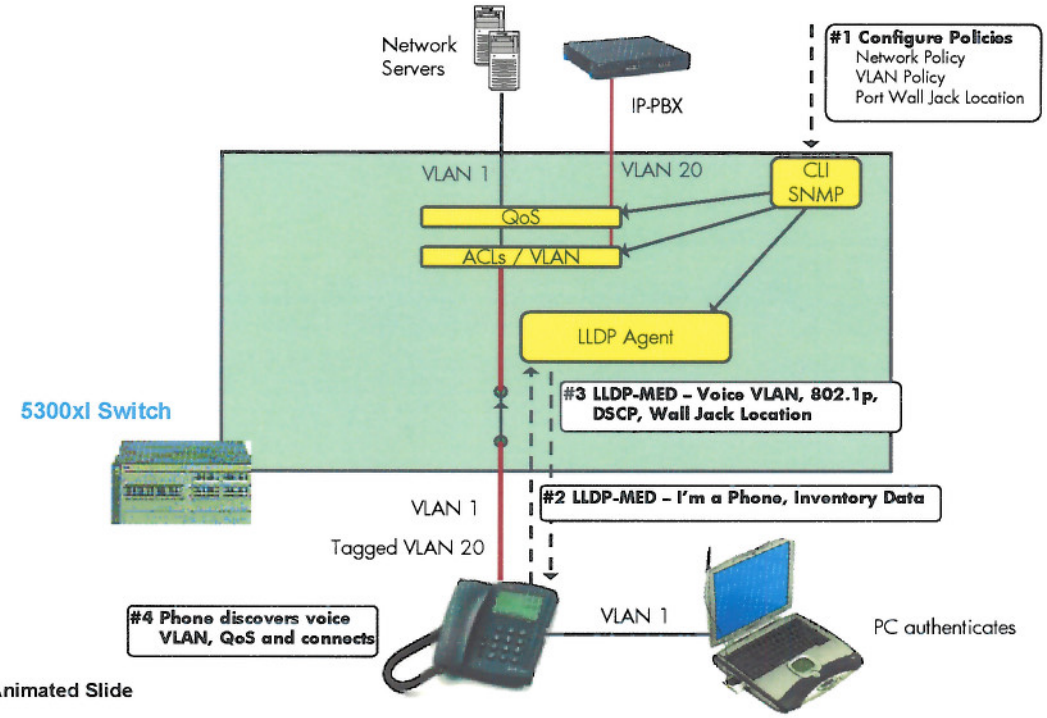

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LLDP-MED Location ID TLV

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Enables E-911 for VoIP by providing location information

Location Identification TLV

- Supports NENA E911 and other location services
  - Service in North America, as described for example by NENA TID 07-501
- Mandatory for Class III MED devices (e.g. IP phones)

Currently supported location formats

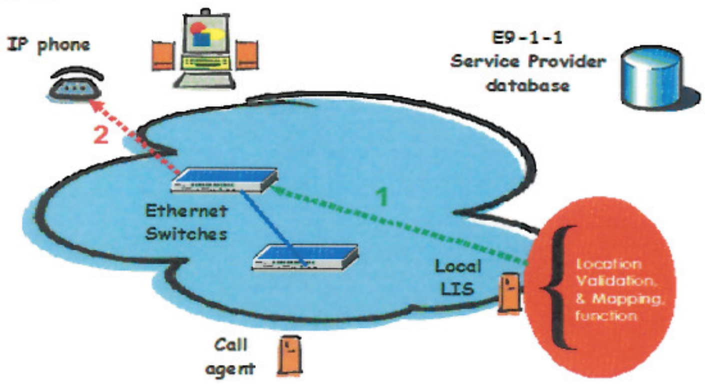
- Coordinate-based LCI subtype as defined by IETF RFC 3825
- Civic Address LCI subtype as defined by draft-ietf-geopriv-dhcp-civil-04
- ELIN subtype, to support traditional PSAP-based Emergency Call
- Future extensions are easily supported, however not specifically defined
- One or more methods may be used simultaneously to support different endpoint requirements

Two supported Emergency Call Service (ECS) methods

- Phone based
  - Switch advertises periodic location info for phone to use
- SNMP notification based
  - Switch sends notification whenever a new IP phone detected

Phone based ECS (E-911)

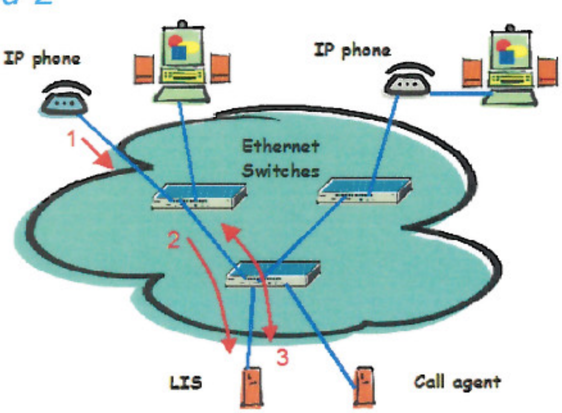
Method 1



1. A management application or an LIS programs the location identification into Ethernet switches using the LLDP-MED MIB
   - Every port may advertise a unique coordinate based, civic based, or ELIN location value
2. Switches advertise periodic LLDP frames containing the location identifier for the IP phone to use in the call setup

Notification based ECS (E-911)

Method 2



1. IP phones advertises their MAC/IP, and telephone capability to Ethernet switches via periodic LLDP frames
2. Switches send an SNMP event notification to a management application or an LIS whenever a new IP phone has directly connected
3. A management application or an LIS will poll the IP phone information from switches using the LLDP-MED MIB

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