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LLDP & LLDP-MED

[redacted]

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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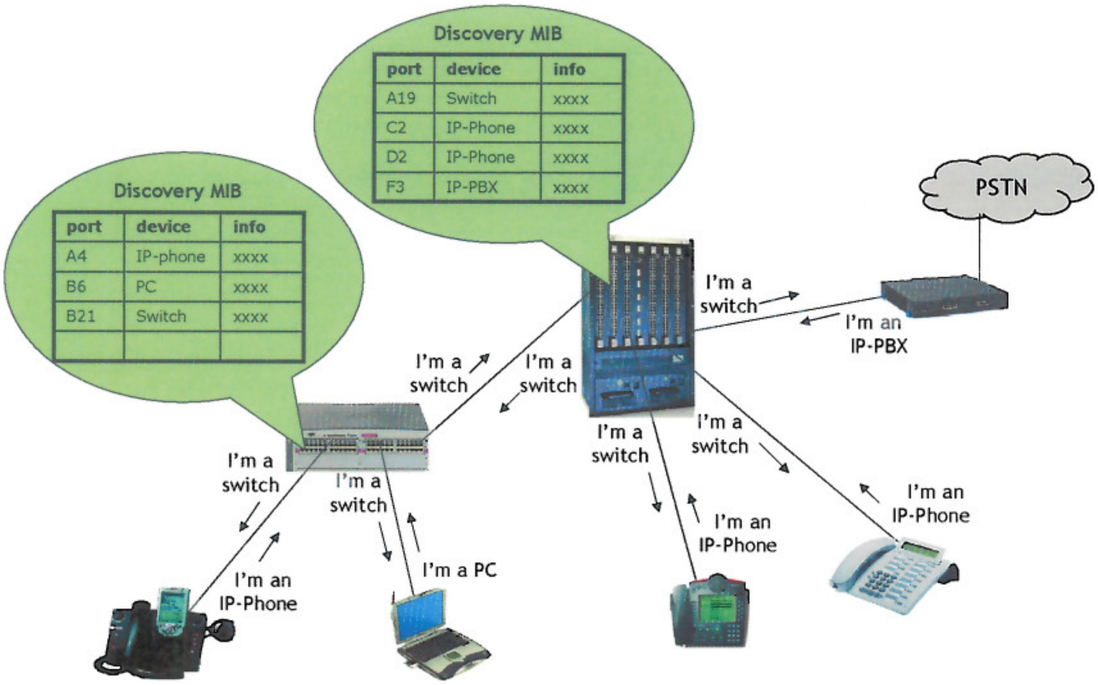

LLDP Entities & Agents
A peak under the hood*

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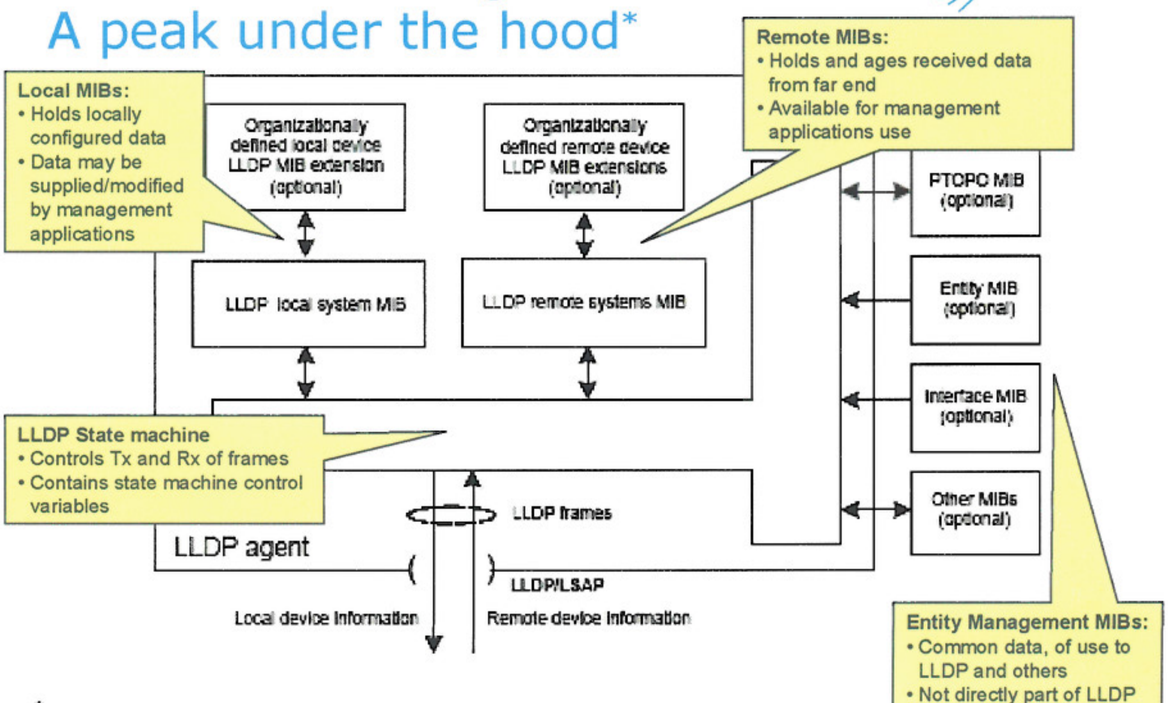

* Animated Slide

LLDP Frame Format

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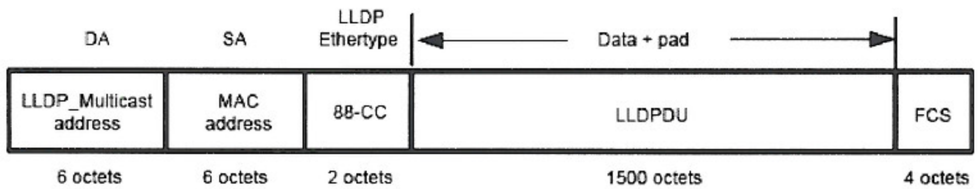
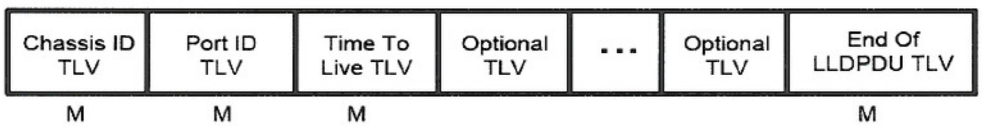
IEEE 802.3 LLDP frame format



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

LLDPDU format



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

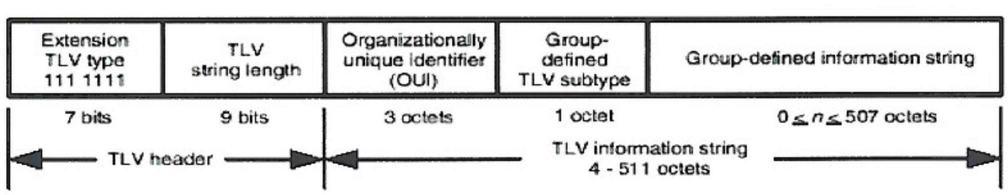

Figure 9-12—Basic format for organizationally-defined extension TLVs

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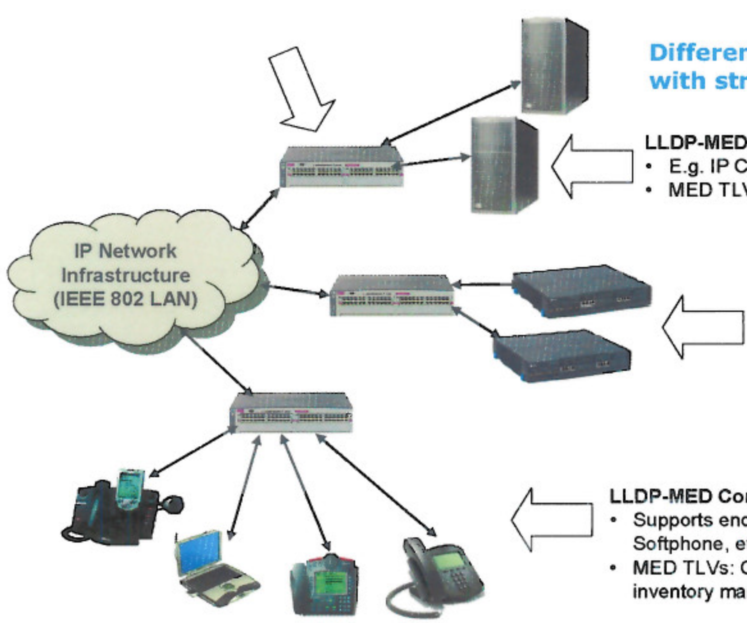
LLDP-MED Network Connectivity Devices
- Provide network access to LLDP-MED endpoints
- E.g. L2 / L3 switch, WLAN, etc



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

Verify LLDP-MED Operation

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Verify if phone is running LLDP-MED and auto-discovery info:

```
# show lldp info remote-device <port>
  LLDP Remote Device Information Detail

  Local Port    : B2
  ChassisType   : network-address
  ChassisId     : 00 00  00 00
  PortType      : mac-address
  PortId        : 08 00 0f 16 2c 8c
  SysName       : MITEL 5215 DM
  System Descr  : MITEL 5215 DM,h/w rev 0,ASIC rev 0,f/w Boot 02.00.00.08
  PortDescr     : LAN port

  System Capabilities Supported  : bridge, telephone
  System Capabilities Enabled    : bridge, telephone

  MED Information Detail
    EndpointClass            :Class3
    Media Policy Vlan id     :50
    Media Policy Priority    :6       (Auto-discovered by phone)
    Media Policy Dscp        :46
    Media Policy Tagged      :True
    Poe Device Type          :PD
    Power Requested          :47
    Power Source             :Unknown
    Power Priority           :High
```

(MED info is only shown if phone is transmitting LLDP-MED TLVs)

Verify if LLDP-MED is running

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Verify if LLDP-MED TLVs are advertised (factory default is enabled)

```
# show lldp config <port>

 LLDP Port Configuration Detail

  Port : 6
  AdminStatus [Tx_Rx] : Tx_Rx
  NotificationEnabled [False] : False
  Med Topology Trap Enabled [False] : False

  TLVS Advertised:
   * port_descr
   * system_name
   * system_descr
   * system_cap

   * capabilities     ← (Must be enabled)
   * network_policy   ← (Must be enabled)
   * location_id
   * poe
       ...
```

To enable LLDP-MED TLVs on a port

```
# lldp config <port> medTlvEnable network_policy
# lldp config <port> medTlvEnable capabilities
```

Useful CLI Commands

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Show LLDP-MED neighbor info:

```
# show lldp info remote-device <port-list>

              . . .
  System Capabilities Supported  : bridge, telephone
  System Capabilities Enabled    : bridge, telephone

  MED Information Detail
    EndpointClass          :Class3
    Media Policy Vlan id   :50
    Media Policy Priority  :6
    Media Policy Dscp      :46
    Media Policy Tagged    :True
    Poe Device Type        :PD
    Power Requested        :47
    Power Source           :Unknown
    Power Priority         :High
```

Configure the LLDP-MED location:

```
# lldp config <port-list> medPortLocation civic-addr
# lldp config <port-list> medPortLocation elin-addr
Note: Use SNMP to set the coordinate based LCI
```

Show the LLDP-MED location:

```
# show lldp config <port-list>
```


Useful LLDP CLI Commands

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Show neighbor info:

```
# show lldp info remote-device
# show lldp info remote-device all          (All neighbors detail)
# show lldp info remote-device <port-list>        (Port detail)
```

Show local info:

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

Show statistics:

```
# show lldp stats
# show lldp stats <port-list>   (Shows unrecognized TLV counts)
```

Show configuration:

```
# show lldp config
```

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

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

Ethereal/Wireshark Capture

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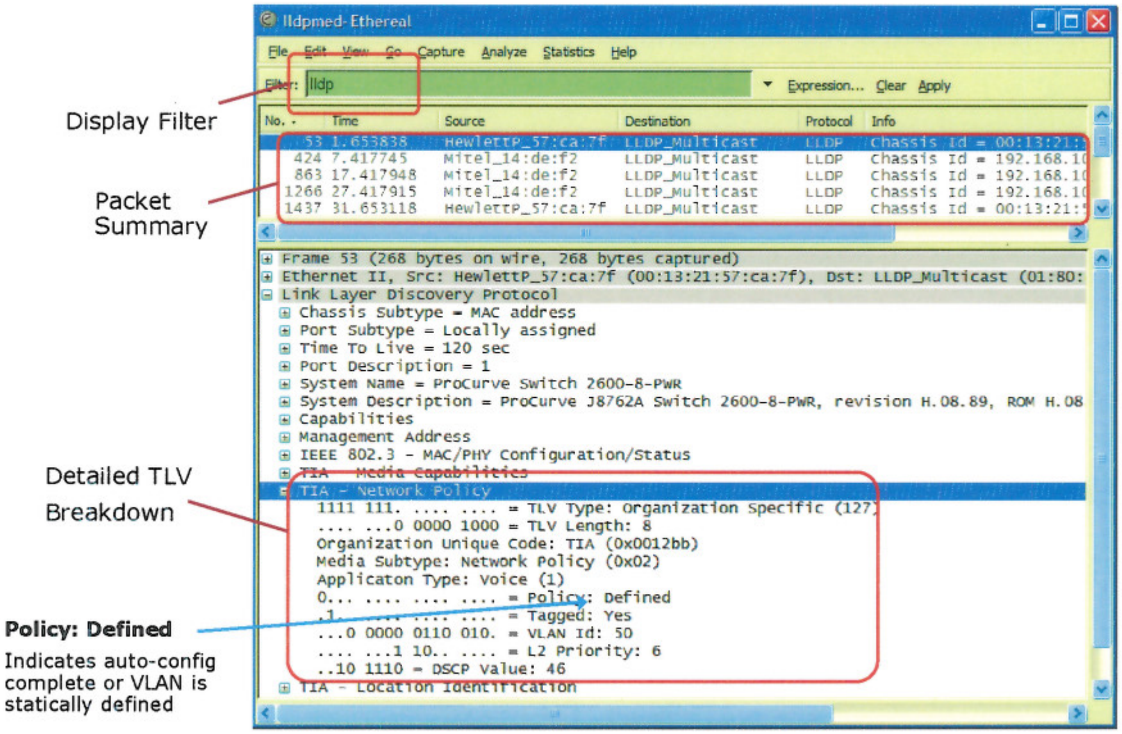

Configuring multi-user 802.1X

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Statically configure all phone ports to be a static member of tagged voice VLAN and static member of data VLAN.

Enable multi-user 802.1X authentication:

```
# aaa authentication port-access eap-radius
# radius-server host <server IP> key <shared secret>
# aaa port-access authenticator <ports>
# aaa port-access authenticator <ports> client-limit 3
# aaa port-access authenticator active
```

Enable multi-user 802.1X with MAC authentication:

```
# aaa authentication port-access eap-radius
# radius-server host <server IP> key <shared secret>
# aaa port-access authenticator <ports>
# aaa port-access authenticator <ports> client-limit 3
# aaa port-access mac-based <ports>
# aaa port-access authenticator active
```

Note: Set client-limit 1 more than required (current switch firmware counts phones sending tagged and untagged packets as 2 clients)

Configuring multi-user 802.1X

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Verify Configuration:

```
# show port-access authenticator (Lists 802.1X authenticated ports)

# show port-access mac-based     (Lists MAC authenticated ports)

# show port-access authenticator session-counters

 Port Access Authenticator Session Counters

  Port-access authenticator activated [No] : Yes

                                  Session     Session
  Port Frames In   Frames Out  Time(sec.)  Status      User
  ---- ----------- ----------- ----------- ----------- ------------
  7    165852      81195506    0
```

Note: does not currently list status or user when multiple users authenticated

Key Points

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LLDP runs after 802.1X authentication

- Improved security, since unauthorized devices can not learn switch IP, or gain access to the voice network by spoofing discovery frames

802.1D compliant switches never forward LLDP frames

- Even for switches that do not support LLDP
- Proprietary protocols leak across switches depending on implementation or if the protocol is disabled, resulting in less reliable physical topology

LLDP-MED provides "Fast Start" behavior

- Rapid startup and location discovery is an important aspect for IP Telephony
- At startup, endpoints will initially advertise at a faster rate for a limited time
- Network devices only transmit LLDP-MED TLVs after a MED Endpoint is detected, then also at a fast start rate for a limited time

Easy to use, with minimal configuration required

- Assign a "voice" VLAN to ports
  - Advertises actual QoS setting of lowest "voice" VLAN ID on a port
- Assign the wall jack location to ports (for E-911)

ProCurve Device Summary

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Device	LLDP	LLDP-MED	PoE	Multi-user 802.1X
2500	TX-only	-	-	
2600-8-PWR	yes	H.08.89	802.3af, legacy	8 with H.10.20
2600	yes	H.08.89	802.3af	8 with H.10.20
2800cl	yes	-	-	
3400	yes	-	-	M.10.20
3500	yes	yes	802.3af, legacy	up to 32
4100	yes	-	-	
4200	yes	yes	-	
5300xl	yes	yes	802.3af	up to 32
5400	yes	yes	802.3af, legacy	up to 32
6100	yes	-	-	
6200	yes	yes	-	
6400cl	yes	-	-	
7000 WAN routers	yes	-	-	

1. 2500 Series transmits LLDP packets but does not support discovery of connected LLDP neighbor devices
2. 2600 MAC auth does not work with IP Phones on tagged VLANs if phone sends BPDUs

ProCurve QoS Device Summary

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Device	HW Queues Per Port	Recognize 802.1p	Modify 802.1p	Recognize DSCP	Remap DSCP
2500	2	X	Ingress port		
2600	4	X	Classifier	X	X
2800	4	X	Classifier	X	X
3400	4	X	Classifier	X	X
3500	8	X	Classifier	X	X
4100	3	X	Ingress port		
4200	4	X	Classifier	X	X
5300xl	4	X	Classifier	X	X
5400	8	X	Classifier	X	X
6100	4	X	Ingress port		
6200	8	X	Classifier	X	X
6400cl	4	X	Classifier	X	X
9300m	4	X	Classifier	X	X

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