

# SharkFest '16

## Troubleshooting with Layer 2 Control Protocols



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# Agenda

- Background
- Gotchas and Challenges with Layer 2 Control Protocols (L2CP)
- Layer 2
  - LACP
  - UDLD
  - Configuration Test Protocol (loopback)
  - Ethernet Flow-Control
- Between the lines
- Wrap-up



# Background



# About me

- From Germany (sorry the accent)
- More than 10 year Dual-CCIE (R/S, Security)
- Sniffer Certified Master
- Wireshark Certified Network Analyst
- VMware Certified Professional
- IPv6 Forum Certified Engineer (Gold)
- More than 18 years in the networking area



# My first data network analyzer

- Wandel & Goltermann DA-30C – still working 😊



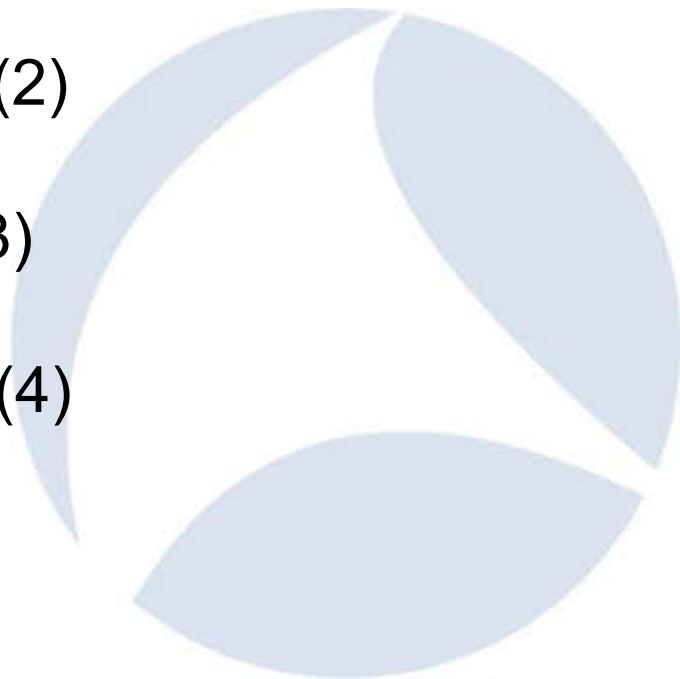
# Gotchas & Challenges with L2CP

**Capture Files:**

**<https://app.box.com/v/sharkfest2016-layer2>**

# Interference

- Physical Layer (1)
- Data Link Layer (2)
- Network Layer (3)
- Transport Layer (4)



# BTW - what is a Link with Ethernet?

- Speed
- Duplex
- MTU
- Auto-Negotiation
- Flow-Control
- MDI/MDI-X
- Remote-Fault / Local-Fault / FEFI
- Carrier-Delay
- Debounce Timer
- EEE





# Challenge 1 - Different kind of links

- **Copper**

- 10/100/1000/10000 traffic

- **Fiber**

- 10BASE-FL
- 100BASE-FX
- 1000-BASE-X
- 10G/40G/100G
- ...



# Challenge 1.1 - Copper links

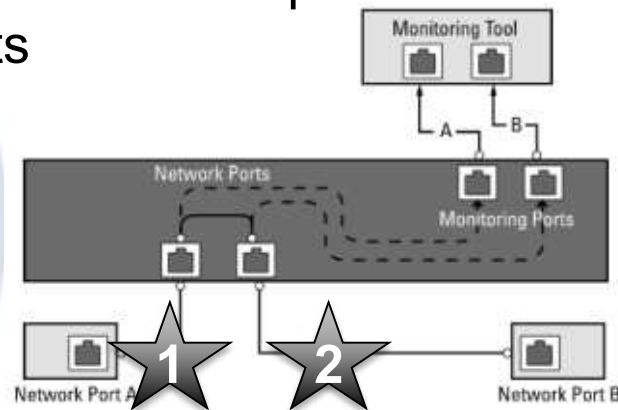
- Copper – 10/100/1000/10000 traffic
- Taps – Gotchas
  - The Tap negotiates separately with each side of the full-duplex link
  - One Link before – with Tap two Links segments

- **SPAN – Gotchas**

```
SW_2520(eth-25)# monitor  
25: Cannot monitor a dynamic LACP trunk.  
SW_2520(eth-25)#
```

- **Link Loss Carry Forward or Link Failure Propagation**

- **PoE (e.g for 802.11ac Wave 1 and Wave2 APs)**



# Challenge 1.2 - Fiber Links

- Duplex/Simplex
- Single strand BiDi
- Power Level / Split Ratio
- Multi-Wavelength Tap (CWDM/DWDM)
- Taps – the best for single data stream
  - Passive Optical Fiber TAPs
- QSFP+
  - BiDi Transceiver
- CFP, CFP2, CFP4, CXP
- SPAN – Gotchas



# Challenge 1.3 – DAC & AOC

- **Direct-Attach Cable**
  - also known as a twinax cable
- **Active Optical Cable (AOC)**



# Challenge 2 – Display Environment

- Know your MAC-Addresses and write it down
- Use aliases and well-known names



```
ethers - Editor
Datei Bearbeiten Format Ansicht ?
00:26:b9:bc:9c:87      EIGENE-MAC-WF
00:0e:83:16:f5:10     SWITCH-A--PORT25
00:13:c4:12:0f:0d     SWITCH-B--PORT22
00:19:aa:d9:e1:80     SWITCH-B-SYSTEM
00:19:aa:d9:c7:00     SWITCH-A-SYSTEM
00:80:c8:37:a1:1b     USB-101
00:80:c8:3b:53:cc     USB-104
00:1d:45:7f:63:04     SW1
00:1c:b0:83:a2:84     SW2
```



- Use Profiles

# Challenge 3 – General

- **Location**

- Local versus different Data centers
- LAN versus WAN / MAN
- Layer 2 VPNs
- Virtualization

- **Time stamping / correlation**

- **Cluster Systems**

- Multi-Chassis
- Fabrics



# Time for Questions



# Link Aggregation Control Protocol (LACP)





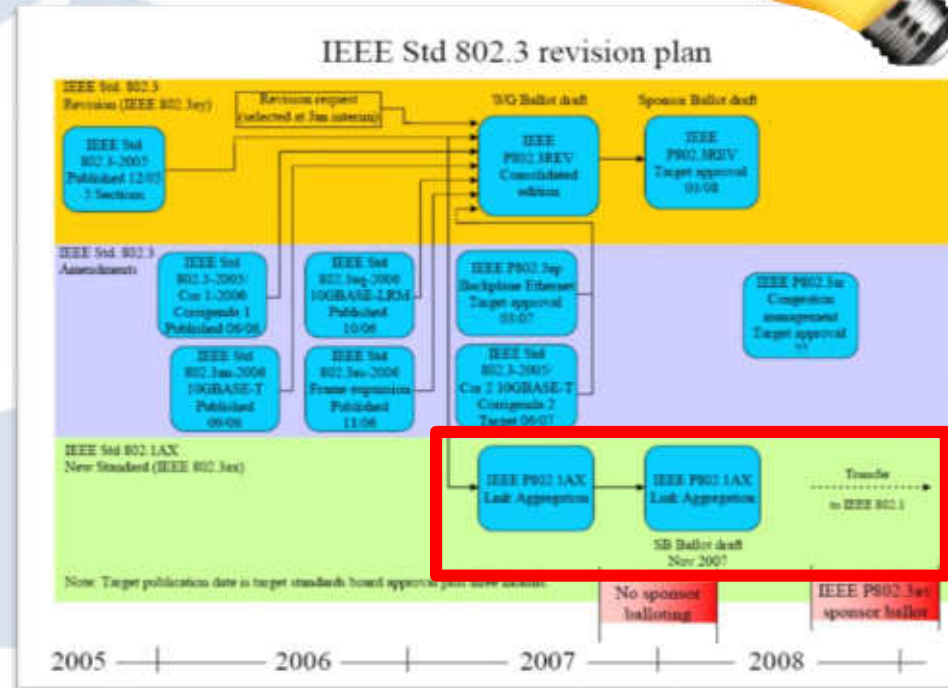
# Link Aggregation Control Protocol (LACP)



- **What is LACP?**
  - A Layer 2 protocol to logically bundle multiple physical ethernet links into one
- **Why LACP?**
  - for increasing bandwidth and build-in redundancy
- **Who need it?**
  - Everyone from the networking field
- **Benefits?**
  - Failover, load-sharing, acting as one
- **Requirements**
  - “... all interfaces in the channel group must be the same type and speed”

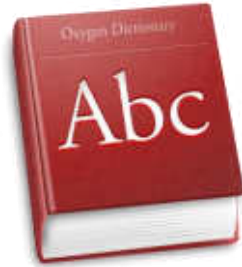
# LACP Standards

- IEEE Std 802.3, 2000 Edition - Clause 43
  - 802.3ad
- IEEE Std 802.1AX™-2008
  - 802.1AX not 802.3ax
- IEEE Std 802.1AX™-2014
  - Revision of IEEE Std 802.1AX-2008



# Terms

- Link Aggregation
- Link Aggregation Group (LAG)
- Link Aggregation Control Protocol (LACP)
- Link Aggregation interface
- Member interface (member link)
- Active, inactive and standby interfaces
- Aggregator port
- Actor / Partner
- Active / Passive
- Upper / Lower threshold for the number of active interfaces



# LACP Requirements

- “... all interfaces in the channel group must be the same type and speed”
  - “... as either Layer 2 or Layer 3 interfaces”
  - the interfaces that participate in a Port-Channel can include both the copper and fiber-optic ports
  - interface attributes
- 
- Really – nothing forgotten ?
    - Please remember the Slide “what is a Link with Ethernet”



# LACP Notes



- Link Aggregation Control and Marker Protocols are encoded with Ethertype
  - 0x8809
  - Destination Multicast MAC Address: 01-80-C2-00-00-02
- multiple physical links to provide a single logical link between exactly two entities
- in LACP there is no explicit confirmation from a neighbor that he had received LACPDU
- LACP selects a port for each frame

# LACP Load-Balancing



- IPv4 packets
  - IPv6 packets
  - MPLS packets
  - Layer 2 Frames except IPv4, IPv6 and MPLS packets
    - TRILL packets
    - FCoE packets
- The Load-Balancing code is platform dependent and most use a hashing algorithm by the LAG
- LACP isn't "additive", it's a LB mechanism!

# Load-Balancing - Values in the frame/packet header

- Source MAC address
- Destination MAC address
- Source IP address
- Destination IP address
- Source port
- Destination port
- IPv6 Flow label
- MPLS label(s)



# LACP – Marker Protocol

- Marker Generator
- Marker Responder
- Wireshark can dissect it
- The 802.3ad standard also provides two methods to ensure that packets are not disordered when moving conversations. They are time-outs and the Marker Generator
- Never captured by me – and I capture very often





# LACP – Marker Protocol

- IEEE Standard versus Dissection



```
Frame 192: 124 bytes on wire (992 bits), 124 bytes captured (992 bits) on interface 0
Ethernet II, Src: CiscoInc_7f:63:02 (00:1d:45:7f:63:02), Dst: Slow-Protocols (01:80:c2:00:00:00)
Slow Protocols
  Slow Protocols subtype: Marker Protocol (0x02)
Marker Protocol
  Version Number: 0x01
  TLV Type: Marker Response Information (0x02)
  TLV Length: 0x14
  Requester Port: 32768
  Requester System: CiscoInc_7f:63:00 (00:1d:45:7f:63:00)
  Requester Transaction ID: 98304
  TLV Type: Unknown (0x3c)
  TLV Length: 0x00
  Requester Port: 0
  Requester System: MS-NLB-PhysServer-20_80:00:00:1c (02:14:80:00:00:1c)
  Requester Transaction ID: 2961416832
  TLV Type: Unknown (0x80)
  TLV Length: 0x00
  Requester Port:
  Requester System:
  Requester Trans
```

IEEE Std 802.1AX-2014  
IEEE STANDARD FOR LOCAL AND METROPOLITAN AREA NETWORKS—LINK AGGREGATION

Marker PDU	Octets	Marker Response PDU
Subtype = Marker	1	Subtype = Marker
Version Number	1	Version Number
TLV_type = Marker Information	1	TLV_type = Marker Response Information
Marker_Information_Length = 16	1	Marker_Response_Information_Length = 16
Requester_Port	2	Requester_Port
Requester_System	6	Requester_System
Requester_Transaction_ID	4	Requester_Transaction_ID
Pad = 0	2	Pad = 0
TLV_type = Terminator	1	TLV_type = Terminator
Terminator_Length = 0	1	Terminator_Length = 0
Reserved	60	Reserved
FCS	4	FCS

Figure 6-27—Marker PDU and Marker Response PDU structure

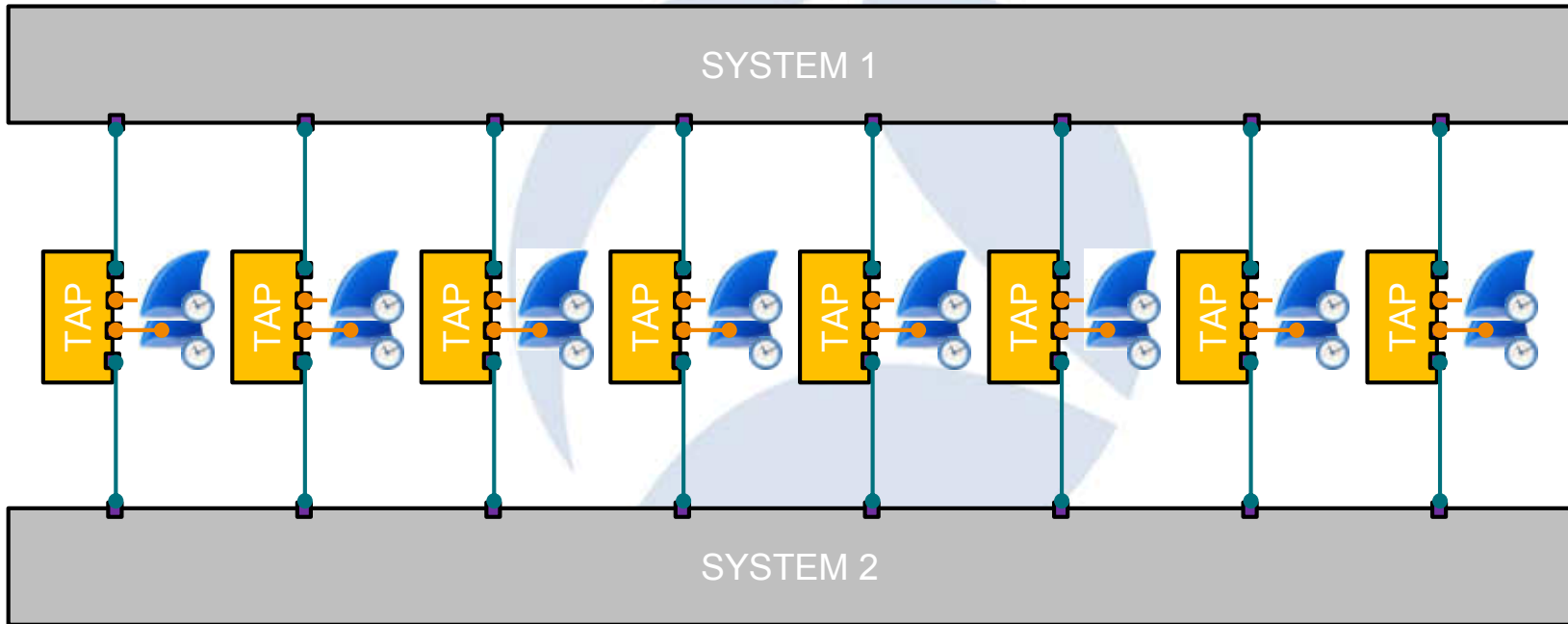
**Adjusted by Packet Editor - no real frame**



# Capturing LACP



**Keep all your capture points in time sync**

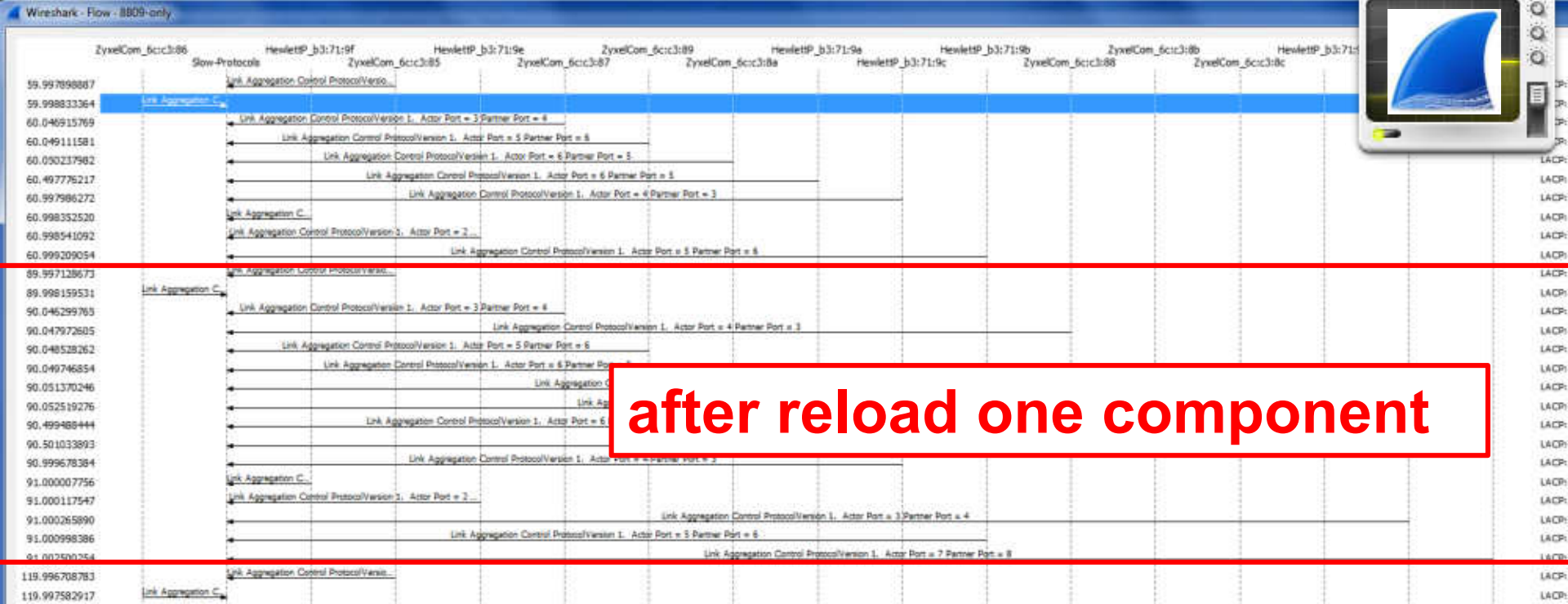


# Capturing LACP - Reality



- Lab Environment
- The Hardware Ethernet Analyzers provides different methods to capture packets inline and full-duplex.
- Copper or Fiber – up to Gigabit
- Wireshark used for further analysis

# LACP - Flow Graph



after reload one component

# LACP – Capture and Display Filter



Capture filter for selected interfaces: ether proto 0x8809

Compiled Filter Output

```
LAN-Verbindung (000) ldh [12]
(001) jeq #0x8809 jt 2 jf 3
(002) ret #262144
(003) ret #0
```

slow

No.	Time	DELTA	SRC-MAC
3	12.538944000	0.000000000	00:16:35:b3:71:9f
4	12.581696000	0.042752000	b0:b2:dc:6c:c3:86
6	134.384160000	121.802464000	b0:b2:dc:6c:c3:86

▶ Frame 3: 124 bytes on wire (992 bits), 124 bytes captured (992 bits) on interface 0  
▶ Ethernet II, Src: HewlettP\_b3:71:9f (00:16:35:b3:71:9f), Dst: 01:00:5e:00:00:00 (01:00:5e:00:00:00)  
▶ Slow Protocols  
    Slow Protocols subtype: LACP (0x01)  
▶ Link Aggregation Control Protocol

eth.src[0:3] == b0:b2:dc

lACP

No.	Time	DELTA	SRC-MAC
3	12.538944000	0.000000000	00:16:35:b3:71:9f
4	12.581696000	0.042752000	b0:b2:dc:6c:c3:86
6	134.384160000	121.802464000	b0:b2:dc:6c:c3:86

▶ Frame 3: 124 bytes on wire (992 bits), 124 bytes captured (992 bits) on interface 0  
▶ Ethernet II, Src: HewlettP\_b3:71:9f (00:16:35:b3:71:9f), Dst: 01:00:5e:00:00:00 (01:00:5e:00:00:00)  
▶ Slow Protocols  
    Slow Protocols subtype: LACP (0x01)  
▶ Link Aggregation Control Protocol

Packets: 36 · Displayed: 20 (55.6%) · Load time: 0:0.2

# LACP in Wireshark 2.0



Wireshark - Display Filter Reference

WIRESHARK News Get Acquainted ▾

slow.esmc.version.compliance	Expert Info	integer, 1 byte	1.12.9
slow.lacp.actorinfo	Actor Information	Unsigned integer, 1 byte	1.0.0 to 1.12.9

Wireshark - Display Filter Reference

WIRESHARK News Get Acquainted ▾ Get Help

Display Filter Reference: LACP

Protocol field name: lacp

Versions: 2.0.0 to 2.0.2

[Back to Display Filter Reference](#)

lacp.actorInfo	Actor Information	Unsigned integer, 1 byte	2.0.0 to 2.0.2
lacp.actorInfoLen	Actor Information Length	Unsigned integer, 1 byte	2.0.0 to 2.0.2



# LACP – Flags (Actor)



Actor State: 0x3d, LACP Activity, Aggregation, Synchronization, Collecting, Distributing

.... ...1 = LACP Activity: Yes

.... ..0. = LACP Timeout: No

.... .1.. = Aggregation: Yes

.... 1... = Synchronization: Yes

...1 .... = Collecting: Yes

..1. .... = Distributing: Yes

.0.. .... = Defaulted: No

0... .... = Expired: No



Activity control value for this link. Active = 1, Passive = 0 (lACP.actorState.activity), 1 Byte

Timeout control value for this link. Short Timeout = 1, Long Timeout = 0 (lACP.actorState.timeout), 1 Byte

Aggregatable = 1, Individual = 0 (lACP.actorState.aggregation), 1 Byte

In Sync = 1, Out of Sync = 0 (lACP.actorState.synchronization), 1 Byte

Collection of incoming frames is: Enabled = 1, Disabled = 0 (lACP.partnerState.collecting), 1 Byte

Distribution of outgoing frames is: Enabled = 1, Disabled = 0 (lACP.partnerState.distributing), 1 Byte

1 = Actor Rx machine is using DEFAULT Partner info, 0 = using info in Rx'd LACPDU (lACP.partnerState.defaulted), 1 Byte

1 = Actor Rx machine is EXPIRED, 0 = is NOT EXPIRED (lACP.partnerState.expired), 1 Byte



# LACP – Lua script for the flags

- **Lua dissectors** are a great way to enhance **Wireshark**



No.	Time	Source	Destination	Protocol	Length	LACP Flags
7	19.000995712	HewlettP_b3:71:9b	Slow-Protocols	LACP	128	**DCSG*A,**DCSG*A
8	121.845225892	ZyxeCom_6c:c3:86	Slow-Protocols	LACP	128	EF***G*A,*FDC***S*
9	121.848485247	HewlettP_b3:71:9f	Slow-Protocols	LACP	128	**DCSG*A,*F***G*A
10	122.037726486	ZyxeCom_6c:c3:87	Slow-Protocols	LACP	128	EF***G*A,*FDC***S*
11	122.060262887	HewlettP_b3:71:9c	Slow-Protocols	LACP	128	**DCSG*A,*F***G*A
12	122.198438937	ZyxeCom_6c:c3:89	Slow-Protocols	LACP	128	EF***G*A,*FDC***S*
13	122.221484901	HewlettP_b3:71:9a	Slow-Protocols	LACP	128	**DCSG*A,*F***G*A

- > Frame 7: 128 bytes on wire (1024 bits), 128 bytes captured (1024 bits)
- > Ethernet II, Src: HewlettP\_b3:71:9b (00:16:35:b3:71:9b), Dst: Slow-Protocols (01:80:c2:00:00:02)
- > Slow Protocols
- > Link Aggregation Control Protocol
- ▼ LACP Actor Flags
  - LACP Flags: \*\*DCSG\*A
- ▼ LACP Partner Flags
  - LACP Flags: \*\*DCSG\*A

**See Lua Script “TCP Flags for Wireshark”  
by Didier Stevens - modified for LACP**



# LACP – System-ID

```
4 Link Aggregation Control Protocol
  LACP Version Number: 0x01
  Actor Information: 0x01
  Actor Information Length: 0x14
  Actor System Priority: 32768
  Actor System: SWITCH-A-SYSTEM (00:19:aa:d9:c7:00)
  Actor Key: 10
  Actor Port Priority: 32768
  Actor Port: 274
  Actor State: 0x7d, LACP Activity, Aggregation, Synchronization, Collecting, Distributing, Defaulted
  Reserved: 000000
```

System-ID



**System-ID** = **System Priority** plus **System MAC** address

- The endpoint with the lower **System-ID** makes the decision about which ports are actively participating in the port-channel at any given time.
- **The lower the value** becomes the **Actor** and determines the links between the LACP partner switches that are in active and standby states for each LACP port channel.
- When the **System Priority** is same, the device with lower **System MAC** will have higher system-priority.

# LACP – Actor Key

```
4 Link Aggregation Control Protocol
  LACP Version Number: 0x01
  Actor Information: 0x01
  Actor Information Length: 0x14
  Actor System Priority: 32768
  Actor System: SWITCH-A-SYSTEM (00:19:aa:d9:c7:00)
  Actor Key: 10
  Actor Port Priority: 32768
  Actor Port: 274
  Actor State: 0x7d, LACP Activity, Aggregation, Synchronization, Collecting, Distributing, Defaulted
  Reserved: 000000
```

**KEY**



## Actor Key

- Value assigned to aggregator ports and physical ports that are candidates for joining a LAG.
- Only ports with matching keys are allowed to aggregate.

# LACP – Port-ID

## Link Aggregation Control Protocol

```
LACP Version Number: 0x01
Actor Information: 0x01
Actor Information Length: 0x14
Actor System Priority: 32768
Actor System: SWITCH-A-SYSTEM (00:19:aa:d9:c7:00)
Actor Key: 10
```

```
Actor Port Priority: 32768
Actor Port: 274
```

```
Actor State: 0x7d, LACP Activity, Aggregation, Synchronization, Collecting, Distributing, Defaulted
Reserved: 000000
```

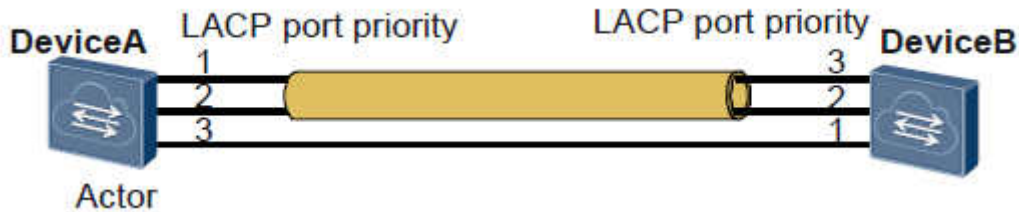
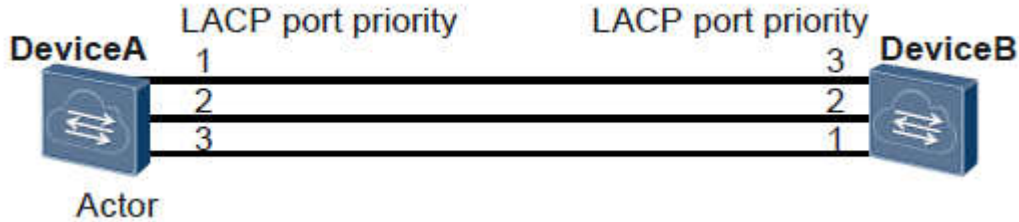
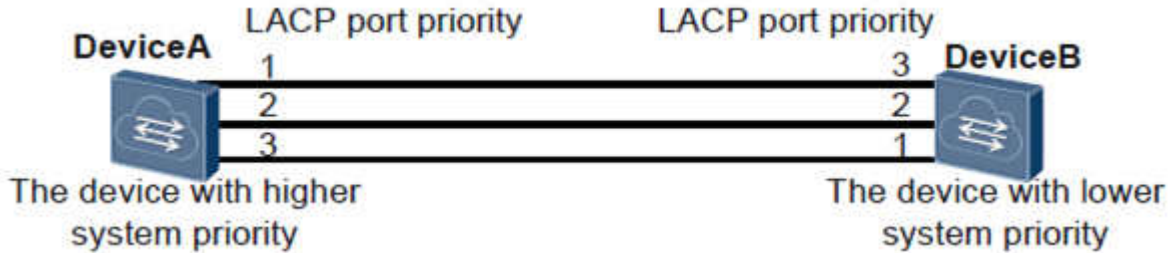


**Port-ID**

**Port-ID = Port Priority plus Port Number**

- The lower the range of the **Port-ID**, the more likely that the interface will be used for LACP transmission
- **Port Priority** decides which ports should be put in **standby mode** when there is a limitation that prevents all compatible ports from aggregating and which ports should be put into **active mode**.

# LACP – Actor Election



**Decision Maker →**  
**Which ports are part of**  
**the aggregation**

# LACP interaction with LLDP



```
└─ Link Layer Discovery Protocol
  └─ Chassis Subtype = MAC address, Id: 00:1e:58:b4:0f:c3
  └─ Port Subtype = Locally assigned, Id: 1/1
  └─ Time To Live = 120 sec
  └─ Port Description = RMON Port 1 on Unit 1
  └─ System Name =
  └─ System Description = Gigabit Ethernet Switch
  └─ Capabilities
  └─ IEEE 802.3 - MAC/PHY Configuration/Status
```

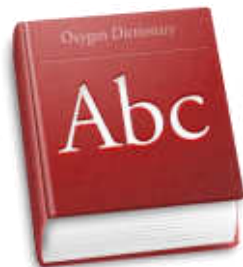
```
└─ IEEE 802.3 - Link Aggregation
  1111 111. .... = TLV Type: Organization Specific (127)
  .... ..0 0000 1001 = TLV Length: 9
  Organization Unique Code: IEEE 802.3 (0x00120f)
  IEEE 802.3 Subtype: Link Aggregation (0x03)
  └─ Aggregation Status: 0x01
    .... ..1 = Aggregation Capability: Yes
    .... ..0. = Aggregation Status: Disabled
  Aggregated Port Id: 0
```

```
└─ IEEE 802.3 - Maximum Frame Size
└─ End of LLDPDU
```

```
└─ IEEE 802.3 - Link Aggregation
  1111 111. .... = TLV Type: Organization Specific (127)
  .... ..0 0000 1001 = TLV Length: 9
  Organization Unique Code: IEEE 802.3 (0x00120f)
  IEEE 802.3 Subtype: Link Aggregation (0x03)
  └─ Aggregation Status: 0x03
    .... ..1 = Aggregation Capability: Yes
    .... ..1. = Aggregation Status: Enabled
  Aggregated Port Id: 6
```

# MC-LAG with LACP

- MC-LAG - LAG terminate on separate chassis
- MC-LAG is not covered under IEEE standard
- Multi-homing for redundancy
- Active-active to utilize all links which otherwise may get blocked by Spanning-Tree
- no modification of LAG partner
- Temporary loops or duplicates not acceptable
- Split brain handling
- One the way for multi-vendor implementation



# MC-LAG – different vendors – different names

- **Cisco:**
  - StackWise
  - Virtual Switching System (VSS)
  - Virtual Port Channel (vPC)
- **Juniper**
  - Virtual Chassis (VC)
- **HP**
  - Intelligent Resilient Framework (IRF)
- **Extreme Networks**
  - Inter-Switch-Connection
- **Force10**
  - Virtual Link Trunking
- **Avaya (Nortel)**
  - Split multi-link trunking
- **Cumulus Networking**
  - Multi-Chassis Link Aggregation
- **Arista Networks**
  - MLAG
- ... and many others





# MC-LAG with LACP

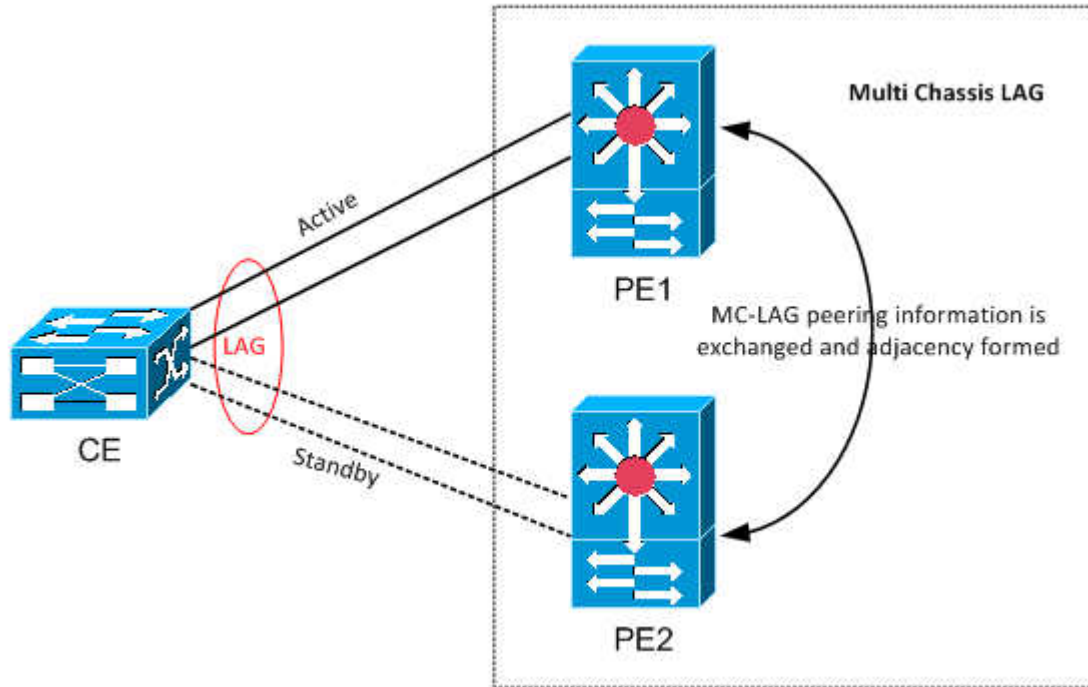
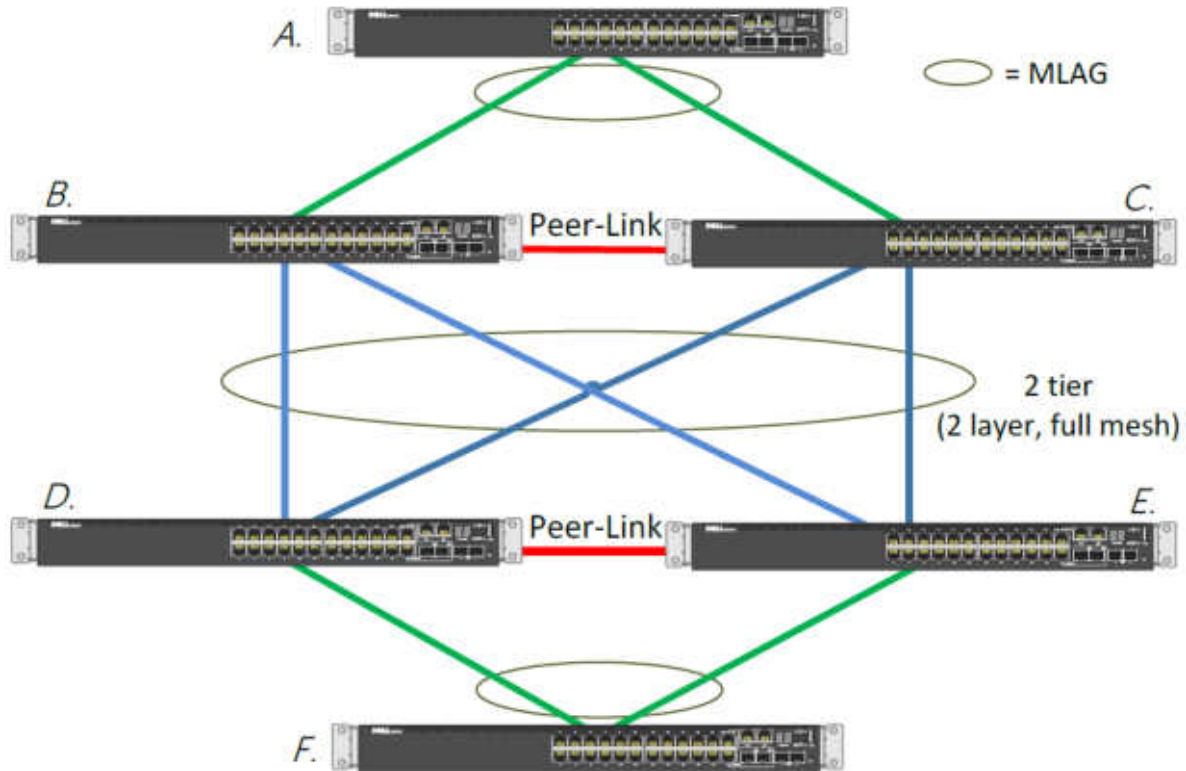
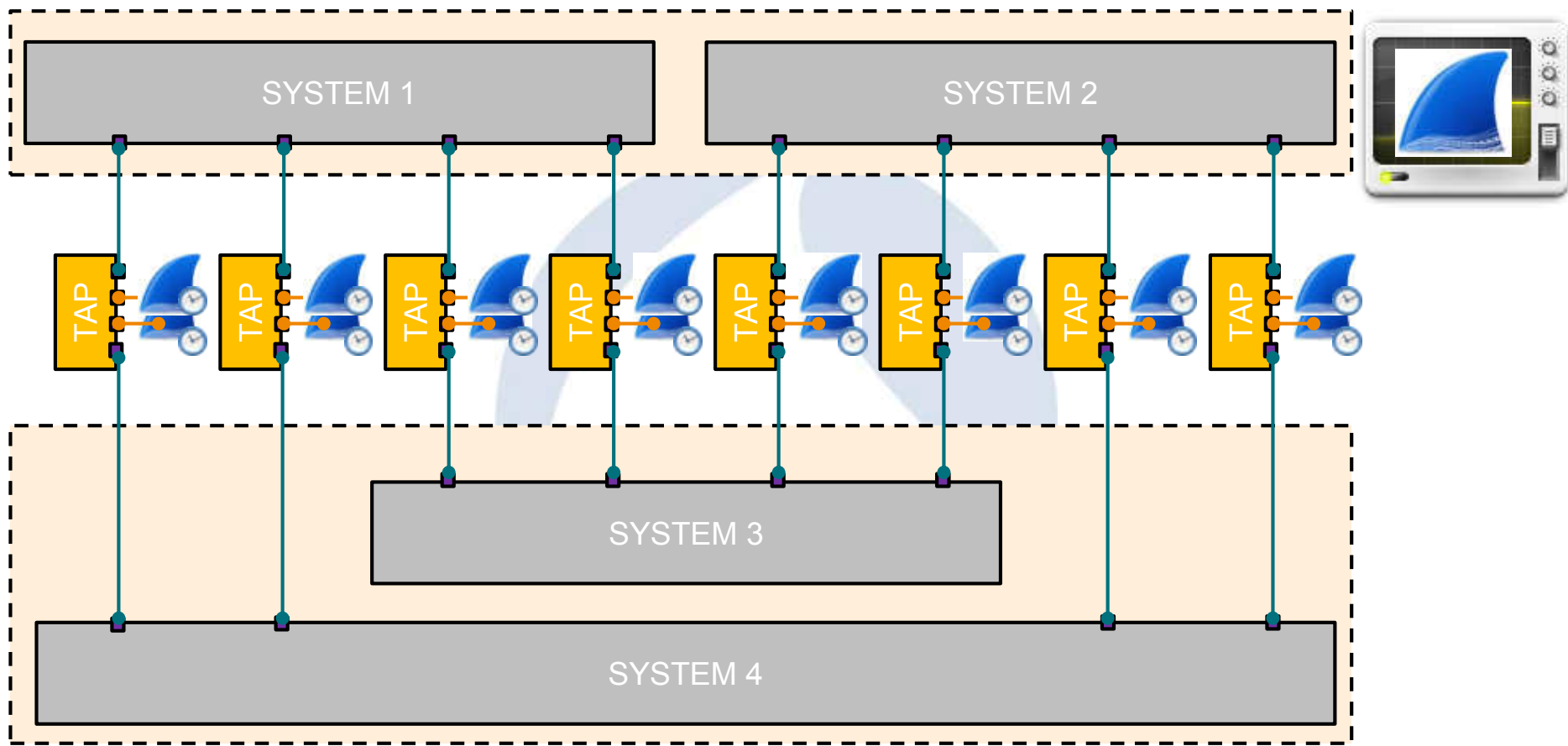


Figure 1. A basic MC-LAG Example

# MLAG with LACP



# LACP in Fabric/Cluster/vPC/Switch Stacking





# LACP Challenges from the field

# Frame Size different



Destination	Protocol	Length	Info
Slow-Protocols	LACP	124	Link Aggregation Control ProtocolVersion 1. Actor Port = 1 Partner Port = 7
Slow-Protocols	LACP	126	Link Aggregation Control ProtocolVersion 1. Actor Port = 7 Partner Port = 1
Slow-Protocols	LACP	124	Link Aggregation Control ProtocolVersion 1. Actor Port = 1 Partner Port = 7
Slow-Protocols	LACP	124	Link Aggregation Control ProtocolVersion 1. Actor Port = 1 Partner Port = 7
Slow-Protocols	LACP	126	Link Aggregation Control ProtocolVersion 1. Actor Port = 7 Partner Port = 1
Slow-Protocols	LACP	124	Link Aggregation Control ProtocolVersion 1. Actor Port = 1 Partner Port = 7
Slow-Protocols	LACP	124	Link Aggregation Control ProtocolVersion 1. Actor Port = 1 Partner Port = 7
Slow-Protocols	LACP	126	Link Aggregation Control ProtocolVersion 1. Actor Port = 7 Partner Port = 1
Slow-Protocols	LACP	124	Link Aggregation Control ProtocolVersion 1. Actor Port = 1 Partner Port = 7
Slow-Protocols	LACP	124	Link Aggregation Control ProtocolVersion 1. Actor Port = 1 Partner Port = 7
Slow-Protocols	LACP	126	Link Aggregation Control ProtocolVersion 1. Actor Port = 7 Partner Port = 1
Slow-Protocols	LACP	124	Link Aggregation Control ProtocolVersion 1. Actor Port = 1 Partner Port = 7
Slow-Protocols	LACP	124	Link Aggregation Control ProtocolVersion 1. Actor Port = 1 Partner Port = 7

# Timer different – not short or long

203.881216000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
204.881248000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
205.534944000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 7 Partner Port = 1
205.881216000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
206.881248000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
207.534976000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 7 Partner Port = 1
207.881248000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
208.881280000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
209.534944000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 7 Partner Port = 1
209.881280000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
210.881312000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
211.534944000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 7 Partner Port = 1
211.881312000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
212.881312000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
213.534944000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 7 Partner Port = 1
213.881312000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
214.881344000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
215.534944000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 7 Partner Port = 1
215.881344000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
216.881376000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
217.534944000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 7 Partner Port = 1
217.881376000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
218.881376000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7
219.534944000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 7 Partner Port = 1
219.881376000	Link Aggregation Co	LACP: Link Aggregation Control Protocol/Version 1. Actor Port = 1 Partner Port = 7



Every two seconds from the link partner

# Time for Questions



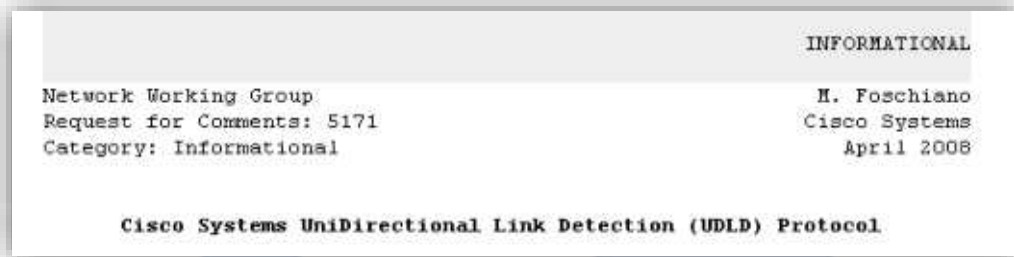
# Unidirectional Link Detection (UDLD)





# UDLD Basics

- Cisco UDLD feature is documented in RFC 5171



- Different names and implementations
  - Device Link Detection Protocol (DLDP)
  - D-Link Unidirectional Link Detection (DULD)
- Three Paket Formats
  - Probe
  - Echo
  - Flush

# UDLD Basics

- Many vendors have their own proprietary solution
  - LACP protocol in a single member LAG
  - Own Ethertype
- Layer 1 "fault" indication is the "loss of light"
- Why it is needed – we use Auto-Negotiation with Remote-Fault?
  - Different wavelengths of optical signaling (10/100/1000)
  - EoSDH
- Used for miswiring detection

# Cisco UDLD Notes

- Cisco UDLD are encoded with LLC, standard Subnetwork Access Protocol (SNAP) format and Protocol ID 0x111
- Destination Multicast MAC Address: 01:00:0C:CC:CC:CC
- Fast Hello enhancement available

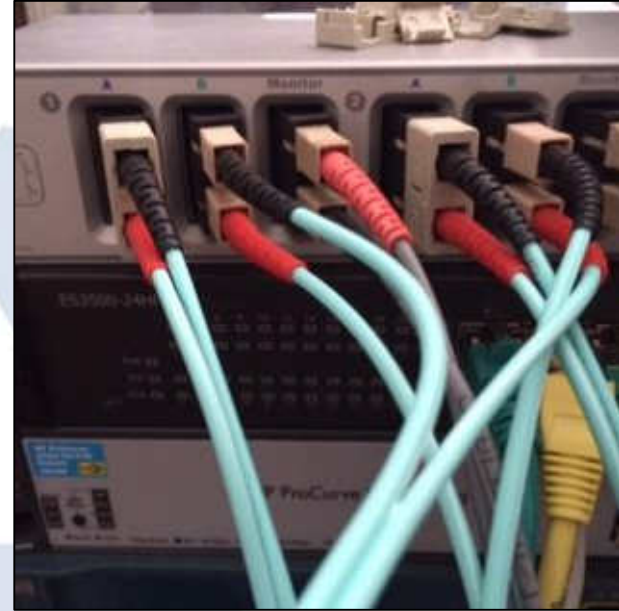
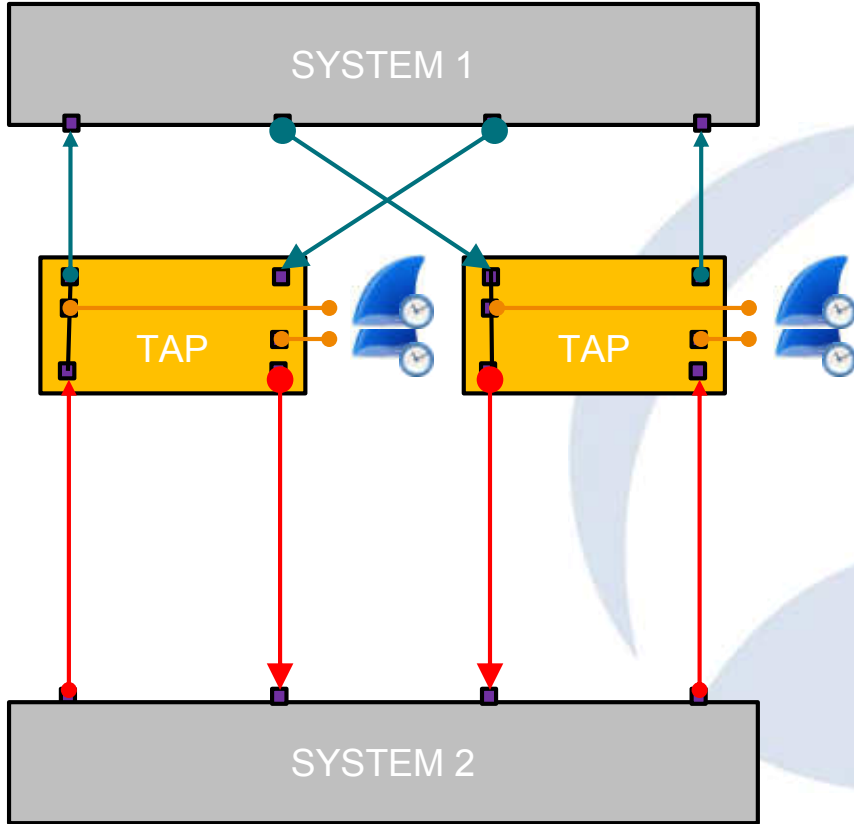


# UDLD Modes

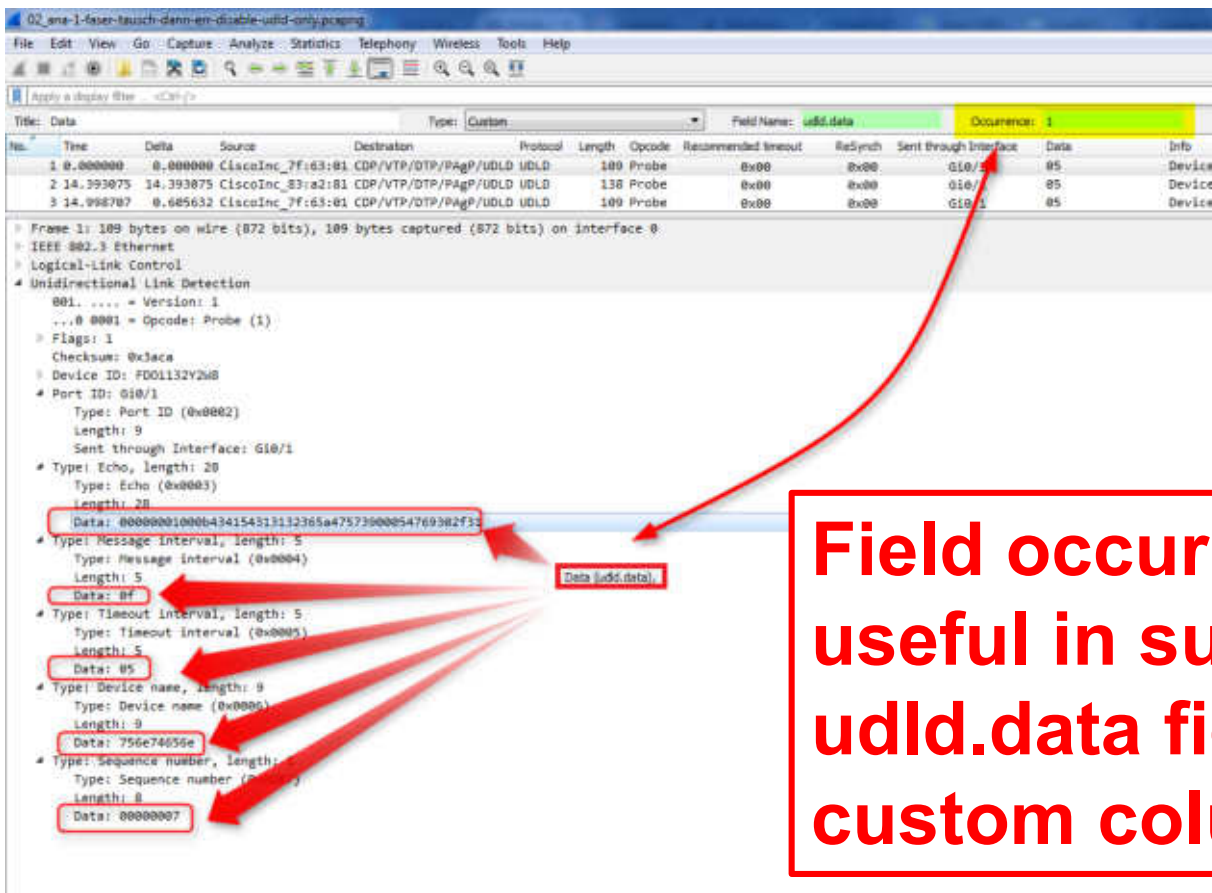


- **Aggressive Mode:**
  - UDLD will declare link as unidirectional and will disable interface, if no reply has been received for subsequent 8 PDU message transmitted at an interval of 1 sec.
- **Normal Mode:**
  - Link will be disabled immediately if PDU reply has not been received within predefined timeout interval.

# UDLD Capture



# UDLD in Wireshark – Custom Columns



The screenshot shows a Wireshark capture of UDLD traffic. A custom column named 'udld.data' is visible in the packet list pane, with a value of '05' for the first packet. The packet details pane shows the structure of the UDLD message, with several fields highlighted in red boxes and arrows pointing to the 'udld.data' column. The highlighted fields and their values are:

- Data: 000000010006434154313132365a47573900054769382f32
- Data: 0f
- Data: 05
- Data: 756e746556e
- Data: 00000007

The 'udld.data' column in the packet list pane is highlighted in yellow, and its value '05' is also highlighted in yellow. A red arrow points from the 'udld.data' column to the 'Data: 05' field in the packet details pane.

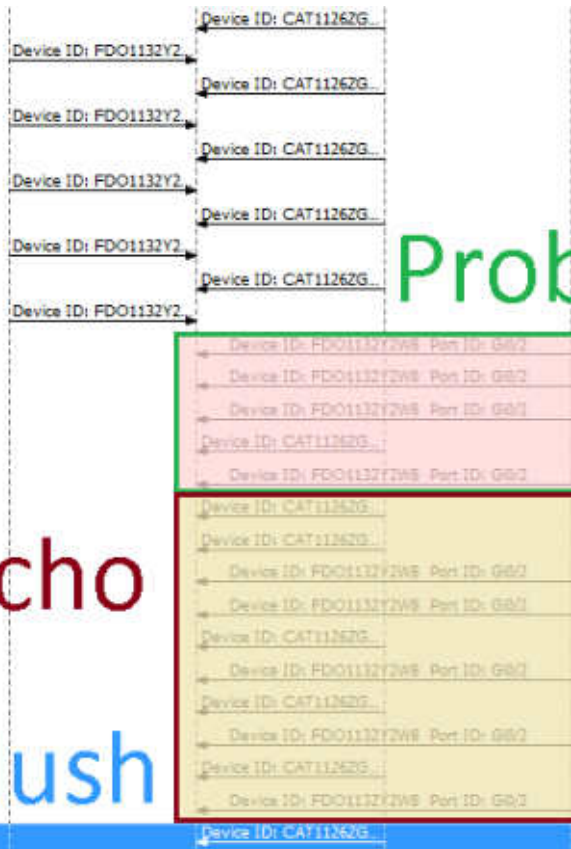


**Field occurrence is very useful in such case. Every udld.data field as a custom column**

# UDLD in Wireshark – Flow Graph



134.563434102  
135.168474881  
149.562451852  
150.167414688  
164.561503964  
165.166358685  
179.560506628  
180.165306035  
194.559523539  
195.172638535  
205.378001108  
206.170202971  
207.168430621  
207.516455014  
207.584936676  
207.612269501  
207.616646038  
207.632495271  
208.166862767  
208.560288496  
209.165082036  
209.566990135  
210.171749313  
210.565205214  
211.169982830  
211.563434540



Probe

Echo

Flush

UDLD: Device ID: CAT1126ZGW9 Port ID: G0/1  
UDLD: Device ID: FDO1132Y2W8 Port ID: G0/1  
UDLD: Device ID: CAT1126ZGW9 Port ID: G0/1  
UDLD: Device ID: FDO1132Y2W8 Port ID: G0/1  
UDLD: Device ID: CAT1126ZGW5 Port ID: G0/1  
UDLD: Device ID: FDO1132Y2W8 Port ID: G0/1  
UDLD: Device ID: CAT1126ZGW9 Port ID: G0/1  
UDLD: Device ID: FDO1132Y2W8 Port ID: G0/1  
UDLD: Device ID: CAT1126ZGW9 Port ID: G0/1  
UDLD: Device ID: FDO1132Y2W8 Port ID: G0/1  
UDLD: Device ID: CAT1126ZGW9 Port ID: G0/1  
UDLD: De

Wireshark - Display Filter Expression

Field Name	Relation	Value
UDLD - Unidirectional Link Detection	is present	3
udld.checksum - Checksum	=	
udld.data - Data	!=	
udld.device_id - Device ID	>	
udld.flags - Flags		
udld.flags.rsy - ReSynch		
udld.flags.rt - Recommended timeout		
udld.opcode - Opcode		
udld.sent_through_interface - Sent throu...		
udld.thv.len - Length		
udld.thv.len.invalid - Expert Info		
udld.thv.type - Type		
udld.version - Version		

Search: udld  
udld.opcode == 3  
Click OK to insert this filter



# UDLD Challenges from the field



# UDLD non-Cisco

\*udld-mrv-os904-port3-fiber-interface.enc [Wireshark 2.0.3 (v2.0.3-0-geed34f0 from master-2.0)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save | MP-MRU | KEIN-FRAGMENT | CONFREQ

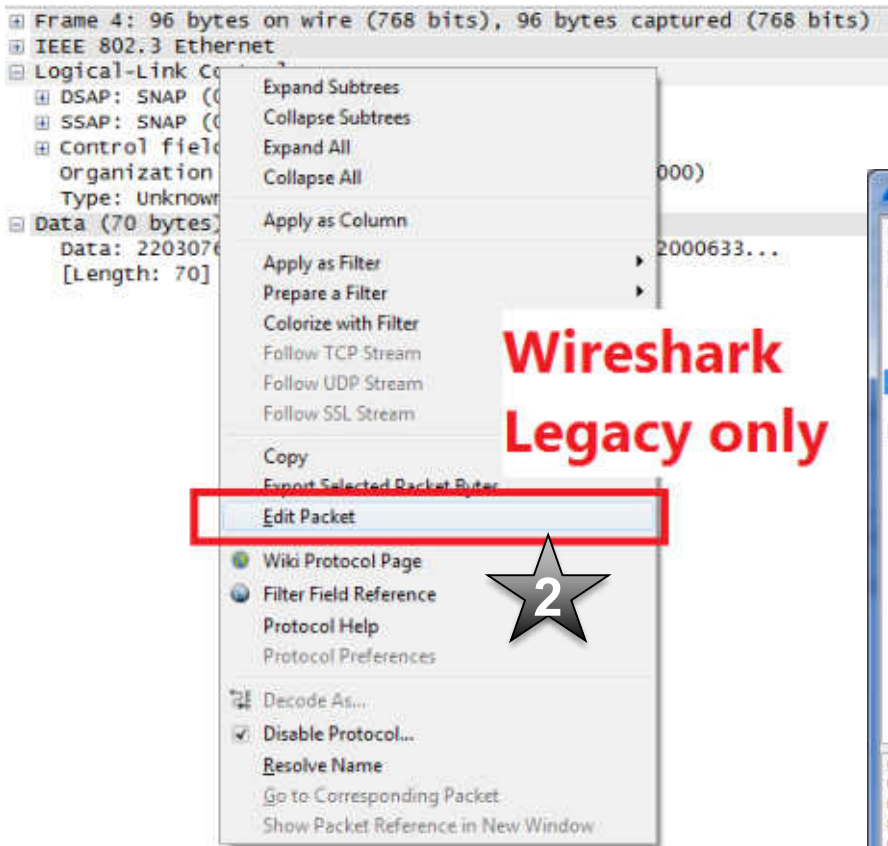
No.	Time	DELTA	SRC-MAC	DST-MAC	Source	Destination	Protocol	Length	Info
1	0.000000000	0.000000000	3c:a7:2b:02:25:ce	01:00:0c:cc:cc:cc	MrvCommu_02:25:ce	CDP/VTP/DTP/PagP/UDLD LLC	96	U, func=UI; SNAP, OU	
2	0.987850346	0.987850346	3c:a7:2b:02:25:ce	01:00:0c:cc:cc:cc	MrvCommu_02:25:ce	CDP/VTP/DTP/PagP/UDLD LLC	96	U, func=UI; SNAP, OU	
3	1.978028084	0.990177738	3c:a7:2b:02:25:ce	01:00:0c:cc:cc:cc	MrvCommu_02:25:ce	CDP/VTP/DTP/PagP/UDLD LLC	96	U, func=UI; SNAP, OU	
4	2.967884832	0.989856748	3c:a7:2b:02:25:ce	01:00:0c:cc:cc:cc	MrvCommu_02:25:ce	CDP/VTP/DTP/PagP/UDLD LLC	96	U, func=UI; SNAP, OU	
5	3.957929313	0.990044481	3c:a7:2b:02:25:ce	01:00:0c:cc:cc:cc	MrvCommu_02:25:ce	CDP/VTP/DTP/PagP/UDLD LLC	96	U, func=UI; SNAP, OU	
6	4.947967089	0.990037776	3c:a7:2b:02:25:ce	01:00:0c:cc:cc:cc	MrvCommu_02:25:ce	CDP/VTP/DTP/PagP/UDLD LLC	96	U, func=UI; SNAP, OU	
7	5.938009056	0.990041967	3c:a7:2b:02:25:ce	01:00:0c:cc:cc:cc	MrvCommu_02:25:ce	CDP/VTP/DTP/PagP/UDLD LLC	96	U, func=UI; SNAP, OU	

Frame 4: 96 bytes on wire (768 bits), 96 bytes captured (768 bits)

- IEEE 802.3 Ethernet
- Logical-Link Control
  - DSAP: SNAP (0xaa)
  - SSAP: SNAP (0xaa)
  - Control field: u, func=UI (0x03)
    - Organization Code: Encapsulated Ethernet (0x000000)
    - Type: Unknown (0x0111)
- Data (70 bytes)
  - Data: 220307640001000f31313438313030333830000002000633...
  - [Length: 70]

**There is a workaround 😊  
Use Wireshark Legacy  
with Packet Edit**

# UDLD non-Cisco

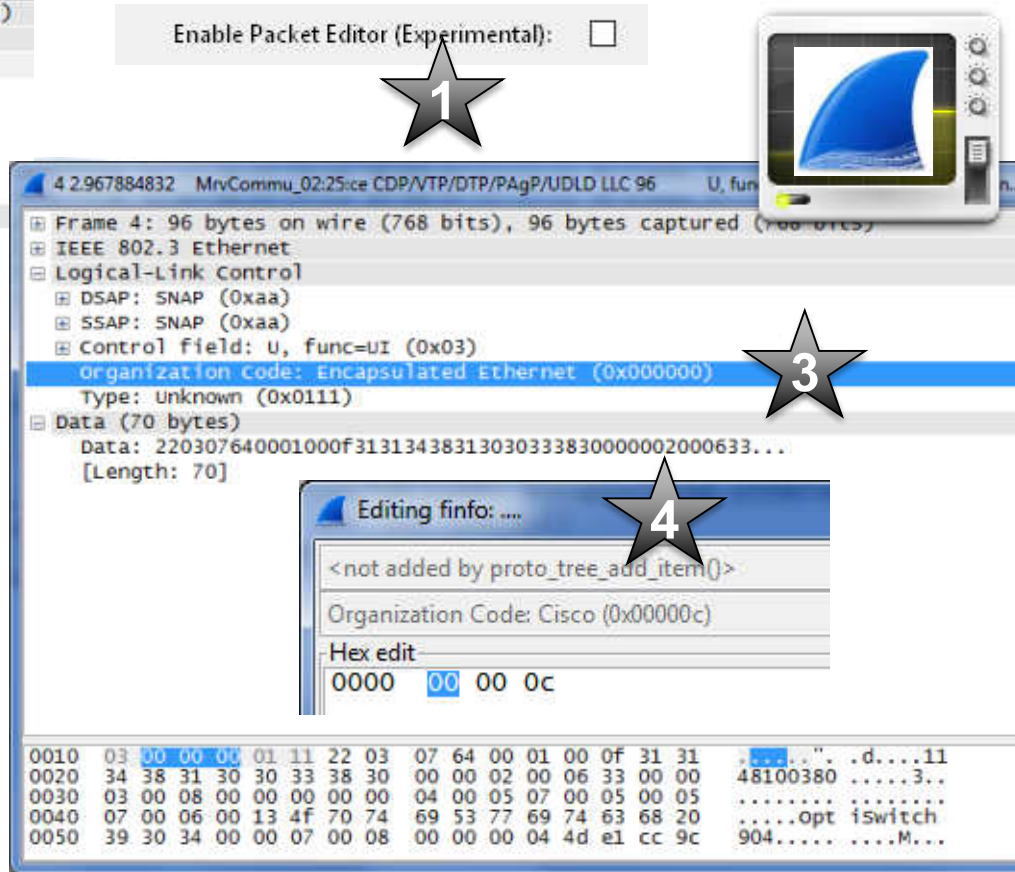


Frame 4: 96 bytes on wire (768 bits), 96 bytes captured (768 bits)  
IEEE 802.3 Ethernet  
Logical-Link Control  
DSAP: SNAP (0x00000000)  
SSAP: SNAP (0x00000000)  
Control field: U, func=UI (0x00000000)  
Organization Code: Encapsulated Ethernet (0x00000000)  
Type: Unknown (0x00000000)  
Data (70 bytes)  
Data: 220307640001000F313134383130303338300000002000633...

- Expand Subtrees
- Collapse Subtrees
- Expand All
- Collapse All
- Apply as Column
- Apply as Filter
- Prepare a Filter
- Colorize with Filter
- Follow TCP Stream
- Follow UDP Stream
- Follow SSL Stream
- Copy
- Export Selected Packet Bytes
- Edit Packet**
- Wiki Protocol Page
- Filter Field Reference
- Protocol Help
- Protocol Preferences
- Decode As...
- Disable Protocol...
- Resolve Name
- Go to Corresponding Packet
- Show Packet Reference in New Window

**Wireshark Legacy only**

2



Enable Packet Editor (Experimental):

1

3

4

4 2.967884832 MvCommu\_02:25:ice CDP/VTP/DTP/PAGP/UDLD LLC 96 U, func=UI

- Frame 4: 96 bytes on wire (768 bits), 96 bytes captured (768 bits)
- IEEE 802.3 Ethernet
- Logical-Link Control
  - DSAP: SNAP (0xaa)
  - SSAP: SNAP (0xaa)
  - Control field: U, func=UI (0x03)
  - Organization Code: Encapsulated Ethernet (0x000000)**  
Type: Unknown (0x0111)
- Data (70 bytes)  
Data: 220307640001000F313134383130303338300000002000633...  
[Length: 70]

Editing info: ...

<not added by proto\_tree\_add\_item()>

Organization Code: Cisco (0x00000c)

Hex edit

0000 00 00 0c

0010	03	00	00	00	01	11	22	03	07	64	00	01	00	0f	31	31	.....". .d....11
0020	34	38	31	30	30	33	38	30	00	00	02	00	06	33	00	00	48100380 .....3..
0030	03	00	08	00	00	00	00	00	04	00	05	07	00	05	00	05	.....
0040	07	00	06	00	13	4f	70	74	69	53	77	69	74	63	68	20	.....Opt iSwitch
0050	39	30	34	00	00	07	00	08	00	00	00	04	4d	e1	cc	9c	904.....M...

# UDLD non-Cisco

```
4 236788482 / MrvCommu_02:25:ce.CDP/VTP/DTP/PagP/UDLD LLC W  u func=UI SNAP, OUI 0x000000 [In...
Frame 4: 96 bytes on wire (768 bits), 96 bytes captured (768 bits)
IEEE 802.3 Ethernet
Destination: CDP/VTP/DTP/PagP/UDLD (01:00:0c:cc:cc:cc)
Source: MrvCommu_02:25:ce (3c:a7:2b:02:25:ce)
Length: 78
Trailer: 4de1cc9c
Logical-Link control
DSAP: SNAP (0xaa)
SSAP: SNAP (0xaa)
Control field: u, func=UI (0x03)
organization code: cisco (0x00000c)
PID: UDLD (0x0111)
Unidirectional Link Detection
001, ..., = version: 1
...0 0010 = opcode: Echo (2)
Flags: 3
Checksum: 0x0764
Device ID: 1148100380
Type: Device ID (0x0001)
Length: 15
Device ID: 1148100380
Port ID: 1\000
Type: Port ID (0x0002)
Length: 6
sent through interface: 3
Type: Echo, length: 8
Type: Echo (0x0003)
Length: 8
data: 00000000
Type: Message Interval, length: 5
Type: Message Interval (0x0004)
Length: 5
data: 07
Type: Timeout Interval, length: 5
Type: Timeout Interval (0x0005)
Length: 5
data: 07
Type: device name, length: 19
Type: Device name (0x0006)
Length: 19
data: 4f7074695377697463682039303400
Type: sequence number, length: 8
Type: Sequence number (0x0007)
Length: 8
data: 00000004
0000 01 00 0c cc cc cc 3c a7 2b 02 25 ce 00 4e a3 aa .....c.+.N..
0010 03 00 00 0c 01 11 22 03 07 64 00 01 00 0f 33 31 ..... .d...11
0020 34 38 31 30 30 33 38 30 00 00 02 00 06 33 00 00 48100380 .....3..
0030 03 00 08 00 00 00 00 00 00 04 00 05 07 00 05 00 05 .....Opt iSwitch
0040 07 00 06 00 13 4f 70 74 69 53 77 69 74 63 68 20 .....Opt iSwitch
0050 39 30 34 00 00 07 00 08 00 00 00 04 4d a1 cc 9c 904.....M..
```



**Works for this vendor  
Maybe a bug – will discuss  
that with the wireshark  
developers 😊 afterwards**

# Time for Questions



# Configuration Test Protocol (loopback)



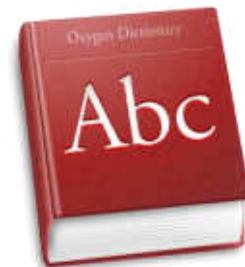
# Loop Detection Protocol



- Loop detection protocol
  - Pro Port
  - Pro VLAN (Trunk)
- Ethertype 0x9000
- Different Destination MAC Adresses
  - CF-00-00-00-00-00
  - 01-0F-E2-00-00-07
  - 00-00-F4-27-71-01
  - 01-A0-C5-AA-AA-AB
  - ...

# Loop Detection Protocols

- CTP from the archive



## ETHERNET SPECIFICATION: Configuration Testing Protocol

### 8. ETHERNET CONFIGURATION TESTING PROTOCOL

The *Ethernet Configuration Testing Protocol* provides a minimum testing capability of communication between stations on an Ethernet. It is the only Client Layer protocol specified in this document and has the only assigned Ethernet type field value in this document. All Ethernet stations must support the configuration testing functions.

#### 8.1 Goals

**For more information see**  
**<http://www.mit.edu/~jhawk/ctp.pdf>**

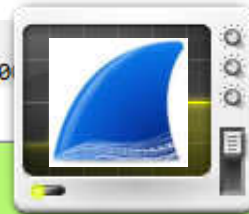


# Loopback from the field

A light blue circular graphic composed of three overlapping leaf-like shapes, arranged in a triangular pattern. The shapes are semi-transparent and overlap each other, creating a central white space.



# Loop Detection Protocols



```

> Frame 3: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0
< Ethernet II, Src: D-LinkCo_b4:0f:c3 (00:1e:58:b4:0f:c3), Dst: Ethernet-Configuration-Test-protocol-(Loopback) (cf:00:00:00:00:00)
  > Destination: Ethernet-Configuration-Test-protocol-(Loopback) (cf:00:00:00:00:00)
  > Source: D-LinkCo_b4:0f:c3 (00:1e:58:b4:0f:c3)
  Type: Loopback (0x9000)
< Configuration Test Protocol (loopback)
  skipCount: 0
  Relevant function: Unknown (256)
  Function: Unknown (256)
< Data (42 bytes)
  Data: 00010000001e58b40fc30fc30000000000000000000000...
  [Length: 42]

```

```

0000 cf 00 00 00 00 00 00 00 1e 58 b4 0f c3 90 00 00 00 ...
0010 00 01 00 01 00 00 00 00 1e 58 b4 0f c3 0f c3 00 00 ...
0020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ...
0030 00 00 00 00 00 00 00 00 00 00 00 00 00 ...

```

```

Packet comments
  [2016-03-26 - Werner Fischer]
  "config loopdetect mode vlan-based"
> Frame 4: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0
< Ethernet II, Src: D-LinkCo_b4:0f:c3 (00:1e:58:b4:0f:c3), Dst: Ethernet-Configuration-Test-protocol-(Loopback) (cf:00:00:00:00:00)
  > Destination: Ethernet-Configuration-Test-protocol-(Loopback) (cf:00:00:00:00:00)
  > Source: D-LinkCo_b4:0f:c3 (00:1e:58:b4:0f:c3)
  Type: Loopback (0x9000)
< Configuration Test Protocol (loopback)
  skipCount: 0
  Relevant function: Unknown (256)
  Function: Unknown (256)
< Data (42 bytes)
  Data: 00010001001e58b40fc30fc30000000000000000000000...
  [Length: 42]

```

```

0000 cf 00 00 00 00 00 00 00 1e 58 b4 0f c3 90 00 00 00 ..... X.....
0010 00 01 00 01 00 01 00 00 1e 58 b4 0f c3 0f c3 00 00 ..... X.....
0020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0030 00 00 00 00 00 00 00 00 00 00 00 00 00 .....

```

# Loop Detection Protocols

- Every vendor has its own solution
  - TLV coded



```
0000 01 a0 c5 aa aa ab fc f5 28 4d 6d 47 90 00 01 00
0010 27 75 4b 01 06 fc f5 28 4d 6d 47 02 02 00 06 03
0020 06 45 53 33 35 30 30 04 04 00 08 c1 40 05 06 45
0030 53 33 35 30 30 00 00 00 00 00 00 00 3e 43 dd 3c
```

```
..... (MmG....
'uK.... ( MmG....
.E53500. ....@..E
S3500... ....>C.<
```

- You should read the HEX-code – also in 2016

# Loop Detection Protocols – Port Testing



- Every vendor has its own solution

```
▷ Frame 1: 64 bytes on wire (512 bits), 64 bytes captured (512 bits)
▷ Ethernet II, Src: AlliedTe_00:00:00 (00:00:cd:00:00:00), Dst: AlliedTe_00:00:01 (00:00:cd:00:00:01)
  Configuration Test Protocol (loopback)
    skipCount: 0
    Relevant function: Unknown (3840)
    Function: Unknown (3840)
  Data (46 bytes)
    Data: 3c54657374696e6720706f7274303e0000000000000000...
    [Length: 46]
```

```
0000  00 00 cd 00 00 01 00 00  cd 00 00 00 90 00 00 00  .....
0010  00 0f 3c 54 65 73 74 69  6e 67 20 70 6f 72 74 30  ..<Testing port0
0020  3e 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  >.....
0030  00 00 00 00 00 00 00 00  00 00 00 00 82 61 e5 ca  .....
```

# Time for Questions



# Ethernet Flow-Control



# Ethernet Flow-Control

- Hard to catch
  - Depends on your capture equipment
- Ethertype 0x8808
- Different Modes
  - No PAUSE
  - Symmetric PAUSE
  - Asymmetric PAUSE
  - Symmetric PAUSE and Asymmetric PAUSE
- With Auto-Negotiation or without it



~~Console Settings~~

Baud Rate:	19200
Data Bits:	8
Stop Bits:	1
Parity:	None
Flow Control:	None
Login:	admin   gtadmin1
Interface:	Menu Driven

# Ethernet Flow-Control Priority Resolution

IEEE  
Std 802.3-2008

REVISION OF IEEE Std 802.3



Table 37-4—Pause priority resolution

Local Device		Link Partner		Local Resolution	Link Partner Resolution
PAUSE	ASM_DIR	PAUSE	ASM_DIR		
0	0	—	—	Disable PAUSE Transmit and Receive	Disable PAUSE Transmit and Receive
0	1	0	—	Disable PAUSE Transmit and Receive	Disable PAUSE Transmit and Receive
0	1	1	0	Disable PAUSE Transmit and Receive	Disable PAUSE Transmit and Receive
0	1	1	1	Enable PAUSE transmit, Disable PAUSE receive	Enable PAUSE receive, Disable PAUSE transmit
1	0	0	—	Disable PAUSE Transmit and Receive	Disable PAUSE Transmit and Receive
1	0	1	—	Enable PAUSE Transmit and Receive	Enable PAUSE Transmit and Receive
1	1	0	0	Disable PAUSE Transmit and Receive	Disable PAUSE Transmit and Receive
1	1	0	1	Enable PAUSE receive, Disable PAUSE transmit	Enable PAUSE transmit, Disable PAUSE receive
1	1	1	—	Enable PAUSE Transmit and Receive	Enable PAUSE Transmit and Receive

# Ethernet Flow-Control



- Depending on the bandwidth of the link, the PAUSE frames are sent at a specific interval of time.
- The PAUSE time is measured in units of PAUSE "quanta" and is defined to be 512 bit times
  - Fast Ethernet 5.12 $\mu$ s, 0.512 $\mu$ s for Gigabit Ethernet, 0.0512 $\mu$ s for 10-Gigabit Ethernet, 0.0128 $\mu$ s for 40-Gigabit Ethernet and 0.00512 $\mu$ s for 100-Gigabit Ethernet (e.g. 512Bits/1.000.000.000Bit/sec for GE)
- $65535 * 512 / 1.000.000.000 = 0.03355392$  seconds  
= 33.55ms.



# Ethernet Flow-Control - Settings



Intel(R) Ethernet Connection I218-LM Properties

General Advanced Driver Details Events Power Management

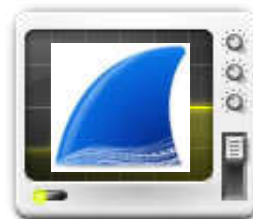
The following properties are available for this network adapter. Click the property you want to change on the left, and then select its value on the right.

Property:	Value:
Energy Efficient Ethernet	Rx & Tx Enabled
<b>Flow Control</b>	Disabled
Jumbo Packet	Rx & Tx Enabled
Legacy Switch Compatibility Mode	Rx Enabled
Link Speed Battery Saver	Tx Enabled
Packet Priority & VLAN	

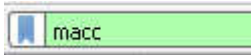
```
Router#sh controller FastEthernet 0/0 | b PHY registers
PHY registers:
Register 0x00: 1000 782D 0040 61E4 01E1 C1E1 000D 2001
Register 0x08: 0000 0000 0000 0000 0000 0000 0000 0000
Register 0x10: 1000 0300 0000 0000 0200 007B 0300 0000
Register 0x18: 003B 851F 9F00 008A 082B 0000 80A0
Bytes_rcvd 2706029297 Bytes_sent 636605627 Frames_rcvd 54499753 Frames_sent 7456645
total_bytes_RX 2706029297 Total_frames_RX 54499753 Bcast_frames_rcvd 18797931
Mcast_frames_RX 21756491 CRC_err 0 Ovr_sized_frames 0
Fragments 0 Jabber 0 collision 0
Late_collision 0 64B frame 26323978; 65_127B_frames 17093799
128_255B_frames 14987201 256_511B_frames 2319326 512_1023B_frames 723842
1023_maxB_frames 508252 Rx_error 0 Dropped_frames 0
Mcast_frames_tx 1488314 Bcast_frames_tx 2839987 Sml_frame_rcvd 0
```

```
# ethtool ens817
Settings for ens817:
Supported ports: [ FIBRE ]
Supported link modes:  1000baseKX/Full
                      1000baseKX4/Full
                      1000baseKR/Full
                      4000baseCR4/Full
                      4000baseSR4/Full
Supported pause frame use: Symmetric Receive-only
Supports auto-negotiation: yes
Advertised link modes: 1000baseKX/Full
                      1000baseKX4/Full
                      1000baseKR/Full
                      4000baseCR4/Full
                      4000baseSR4/Full
Advertised pause frame use: Symmetric
Advertised auto-negotiation: yes
Link partner advertised link modes: 4000baseCR4/Full
Link partner advertised pause frame use: No
Link partner advertised auto-negotiation: Yes
Speed: 40000Mb/s
Duplex: Full
Port: Direct Attach Copper
PHYAD: 0
Transceiver: internal
Auto-negotiation: on
Supports Wake-on: d
Wake-on: d
Current message level: 0x00000014 (20)
link ifdown
Link detected: yes
```

# MAC PAUSE Frames



```
▶ Frame 453: 64 bytes on wire (512 bits), 64 bytes captured (512 bits)
▲ Ethernet II, Src: EIGENE-MAC-WF (00:26:b9:bc:9c:87), Dst: Spanning-tree-(for-bridges)_01 (01:80:c2:00:00:01)
  ▶ Destination: Spanning-tree-(for-bridges)_01 (01:80:c2:00:00:01)
  ▶ Source: EIGENE-MAC-WF (00:26:b9:bc:9c:87)
  Type: MAC Control (0x8808)
▲ MAC Control
  Opcode: Pause (0x0001)
  pause_time: 1664
```



```
0000 01 80 c2 00 00 01 00 26 b9 bc 9c 87 88 08 00 01
0010 06 80 00 00 00 00 00 00 00 00 00 00 00 00 00
0020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0030 00 00 00 00 00 00 00 00 00 00 00 00 ac c3 7a 28
```

```
▶ Frame 455: 64 bytes on wire (512 bits), 64 bytes captured (512 bits)
▲ Ethernet II, Src: EIGENE-MAC-WF (00:26:b9:bc:9c:87), Dst: Spanning-tree-(for-bridges)_01 (01:80:c2:00:00:01)
  ▶ Destination: Spanning-tree-(for-bridges)_01 (01:80:c2:00:00:01)
  ▶ Source: EIGENE-MAC-WF (00:26:b9:bc:9c:87)
  Type: MAC Control (0x8808)
▲ MAC Control
  Opcode: Pause (0x0001)
  pause time: 0
```

```
0000 01 80 c2 00 00 01 00 26 b9 bc 9c 87 88 08 00 01 .....& .....
0010 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0030 00 00 00 00 00 00 00 00 00 00 00 00 97 90 16 84 .....>
```

  
**100 Mbit/s,  
1 Gbit/s,  
10 Gbit/s,  
40 Gbit/s  
or 100 Gbit/s?**

# Flow-Control information with LLDP



```
> Frame 54: 304 bytes on wire (2432 bits), 304 bytes captured (2432 bits)
> Ethernet II, Src: Enterasys_03:10:61 (00:1f:45:03:10:61), Dst: LLDP_Multicast (01:80:c2:00:00:0e)
< Link Layer Discovery Protocol
  > Chassis Subtype = MAC address, Id: 00:1f:45:03:10:60
  > Port Subtype = Interface name, Id: ge.1.1
  > Time To Live = 120 sec
  > Port Description = Unit: 1 1000BASE-T RJ45 Gigabit Ethernet Frontpanel
  > System Name = C3-LABOR-DACHBOEDEN
  > System Description = Enterasys Networks, Inc. C3G124-24 06 01.08.0013
  > Capabilities
  > Management Address:
  > IEEE 802.1 - Port VLAN ID
  > IEEE 802.1 - Protocol Identity
  > IEEE 802.1 - Protocol Identity
  > IEEE 802.3 - MAC/PHY Configuration/Status
  > IEEE 802.3 - Link Aggregation
  > IEEE 802.3 - Maximum Frame Size
  > End of LLDPDU
```

```
< IEEE 802.3 - MAC/PHY Configuration/Status
  1111 111. .... = TLV Type: Organization Specific (127)
  .... 0 0000 1001 = TLV Length: 9
  Organization Unique Code: IEEE 802.3 (0x00120f)
  IEEE 802.3 Subtype: MAC/PHY Configuration/Status (0x01)
  < Auto-Negotiation Support/Status: 0x03
    .... 1 = Auto-Negotiation: Supported
    .... 1. = Auto-Negotiation: Enabled
  < PMD Auto-Negotiation Advertised Capability: 0x6c11
    .... 1 = 1000BASE-T (full duplex mode): Capable
    .... 0. = 1000BASE-T (half duplex mode): Not capable
    .... 0.. = 1000BASE-X (-LX, -SX, -CX full duplex mode): Not capable
    .... 0... = 1000BASE-X (-LX, -SX, -CX half duplex mode): Not capable
    .... 1... = Asymmetric and Symmetric PAUSE (for full-duplex links): Capable
    .... 0.. = Symmetric PAUSE (for full-duplex links): Not capable
    .... 0.. = Asymmetric PAUSE (for full-duplex links): Not capable
    .... 0... = PAUSE (for full-duplex links): Not capable
    .... 0.... = 1000BASE-T2 (full duplex mode): Not capable
    .... 0. = 1000BASE-T2 (half duplex mode): Not capable
    .... 1.. = 1000BASE-TX (full duplex mode): Capable
    .... 1... = 1000BASE-TX (half duplex mode): Capable
    .... 0.... = 1000BASE-T4: Not capable
    .... 1. = 100BASE-T (full duplex mode): Capable
    .... 1.. = 100BASE-T (half duplex mode): Capable
    .... 0.... = Other or unknown: Not capable
  > Same in inverse (wrong) bitorder
  Operational MAU Type: 1000BaseTFD - Four-pair Category 5 UTP, full duplex mode (0x001e)
  > IEEE 802.3 - Link Aggregation
```

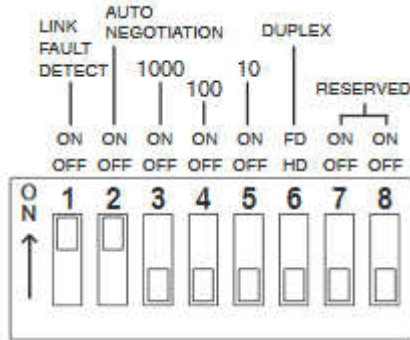
# PFC – Priority Based Flow-Control



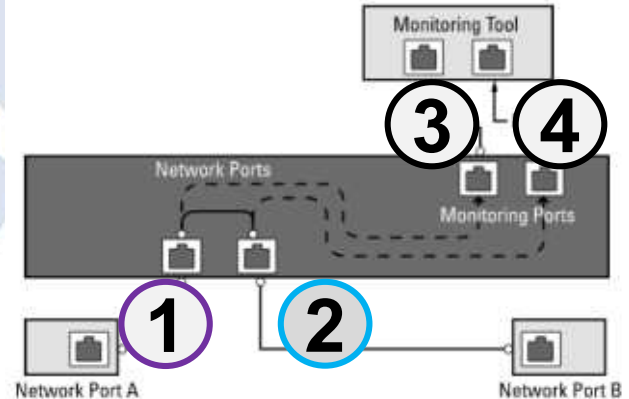
```
▷ Frame 1: 64 bytes on wire (512 bits), 64 bytes captured (512 bits)
* Ethernet II, Src: 0e:fc:00:d5:3d:00 (0e:fc:00:d5:3d:00), Dst: Spanning-tree-(for-bridges)_01 (01:80:c2:00:00:01)
  ▷ Destination: Spanning-tree-(for-bridges)_01 (01:80:c2:00:00:01)
  ▷ Source: 0e:fc:00:d5:3d:00 (0e:fc:00:d5:3d:00)
  Type: MAC Control (0x8808)
* MAC Control
  Opcode: Class Based Flow Control [CBFC] Pause (0x0101)
  * CBFC Class Enable Vector: 0x0008, C3
    .... 0 = C0: False
    ...0. = C1: False
    ..0.. = C2: False
    .0... = C3: True
    1... = C4: False
    ...0 = C5: False
    ..0. = C6: False
    .0... = C7: False
  * CBFC Class Pause Times
    C0: 0
    C1: 0
    C2: 0
    C3: 65535
    C4: 0
    C5: 0
    C6: 0
    C7: 0
```

# Flow-Control with Copper Taps

- Remember the Taps – Gotchas
  - two Links segments for the Network Ports
  - also two Links for the Monitoring Ports



Vendor A		
Line Type	RJ-45	RJ-45
Remote Duplex	Half or Full	Half or Full
Remote Pause	Rx Only	Rx Only
Remote Fault Code	None	None
Vendor B		
Line Type	RJ-45	RJ-45
Remote Duplex	Half or Full	Half or Full
Remote Pause	Tx and Rx	Tx and Rx
Remote Fault Code	None	None





# Flow-Control Challenges from the field

# Strange Flow-Control Implementation



AT900-FLOWCONTROLTEST.enc

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

Apply a display filter ... <Ctrl-F>

No.	Time	DELTA	SRC-MAC	DST-MAC	Source	Destination	Protocol	Length	Info
1	0.000000000	0.000000000	01:80:c2:00:00:01	01:80:c2:00:00:01	Spanning-tree-(for-bridges)_01	Spanning-tree-(for-bridges)_01	MAC CTRL	64	Pause: pause_time: 65535 quanta
2	0.000852401	0.000852401	01:80:c2:00:00:01	01:80:c2:00:00:01	Spanning-tree-(for-bridges)_01	Spanning-tree-(for-bridges)_01	MAC CTRL	64	Pause: pause_time: 0 quanta
3	0.008910637	0.008048236	01:80:c2:00:00:01	01:80:c2:00:00:01	Spanning-tree-(for-bridges)_01	Spanning-tree-(for-bridges)_01	MAC CTRL	64	Pause: pause_time: 65535 quanta
4	0.009773037	0.000852400	01:80:c2:00:00:01	01:80:c2:00:00:01	Spanning-tree-(for-bridges)_01	Spanning-tree-(for-bridges)_01	MAC CTRL	64	Pause: pause_time: 0 quanta
5	0.017822111	0.008049074	01:80:c2:00:00:01	01:80:c2:00:00:01	Spanning-tree-(for-bridges)_01	Spanning-tree-(for-bridges)_01	MAC CTRL	64	Pause: pause_time: 65535 quanta
6	0.018683674	0.000861563	01:80:c2:00:00:01	01:80:c2:00:00:01	Spanning-tree-(for-bridges)_01	Spanning-tree-(for-bridges)_01	MAC CTRL	64	Pause: pause_time: 0 quanta
7	0.026732748	0.008049074	01:80:c2:00:00:01	01:80:c2:00:00:01	Spanning-tree-(for-bridges)_01	Spanning-tree-(for-bridges)_01	MAC CTRL	64	Pause: pause_time: 65535 quanta

▶ Frame 1: 64 bytes on wire (512 bits), 64 bytes captured (512 bits)

- ▶ Ethernet II, Src: Spanning-tree-(for-bridges)\_01 (01:80:c2:00:00:01), Dst: Spanning-tree-(for-bridges)\_01 (01:80:c2:00:00:01)
  - ▶ Destination: Spanning-tree-(for-bridges)\_01 (01:80:c2:00:00:01)
  - ▶ Source: Spanning-tree-(for-bridges)\_01 (01:80:c2:00:00:01)
    - ▶ [Expert Info (Warn/Protocol): Source MAC must not be a group address: IEEE 802.3-2002, Section 3.2.3(b)]
    - Address: Spanning-tree-(for-bridges)\_01 (01:80:c2:00:00:01)
    - .....0..... = LG bit: Globally unique address (factory default)
    - .....1..... = IG bit: Group address (multicast/broadcast)
  - Type: MAC Control (0x8808)
- ▶ MAC Control
  - Opcode: Pause (0x0001)
  - pause\_time: 65535



# Time for Questions

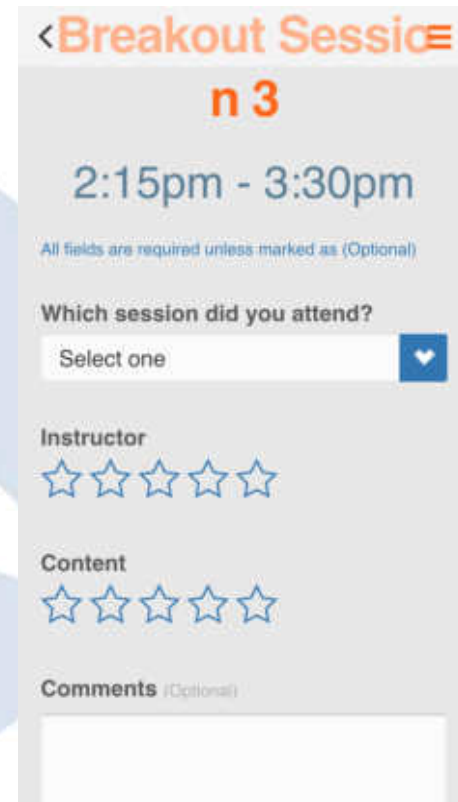
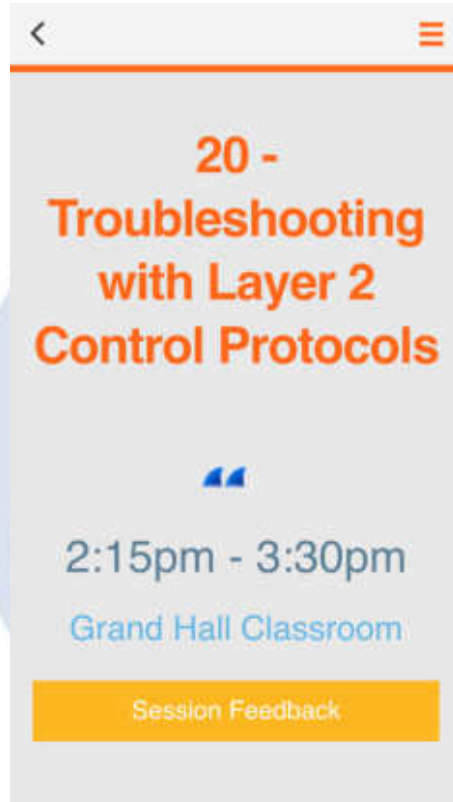




# Session Summary

- Wireshark's capabilities of dissection, filtering and others will help your analysis in a Layer 2 environment
- Pay attention to the capture points and any data that could be used as a "signature" to correlate traces with Layer 2 events
- Time sync of all capture points is a must
- Read standards from IETF / IEEE / MEF – reflex and ask yourself what's going on the wire here

# Please provide Session Feedback



Thank You for  
attending the  
session and  
enjoy the rest of  
the conference /  
party 😊

