



# In-depth Analysis for L-2 Frames and Tunnel Protocols using GNS3 dan Wireshark

(Ethernet, VLAN 802.1Q, QinQ, PPPoE, EoIP, L2TP, EoIP over L2TP, VLAN over EoIP)

Yohanes Gunawan Yusuf  
MikroTik Certified Trainer

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

1

1



## Topics of Discussion

1. We are going to look and learn Ethernet and L-2 Frames
2. Analyse L2 frames dan Tunnels using GNS3 and Wireshark, such as:
  - Ethernet
  - VLAN (802.1Q)
  - VLAN Tunnel (QinQ)
  - PPPoE
  - EoIP Tunnel
  - ARP
  - L2TP VPN Tunnel
  - VLAN over EOIP Tunnel
  - Demo and Discussion

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

2

2



## About Me

(yohanesgunawan@staff.ubaya.ac.id)



- My Name is Yohanes Gunawan Yusuf, from Indonesia. I am a full time lecturer of University of Surabaya (Ubaya).
- I have learn and teach in Department of Electrical Engineering (EE) and IT since 1986.
- MikroTik Certified Trainer (TR0639) and Mikrotik Academy Trainer (ACTR0244) for EUTC with certifications: MTCNA, MTCRE, MTCUME, MTCWE, MTCTCE and MTCINE



Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

3

3



## University of Surabaya (Ubaya)



Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

4

4



## Universitas Surabaya (Ubaya)



Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

5

5



## Elektro Ubaya (te.ubaya.ac.id)



Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

6

6



# Akreditasi A



- Universitas Surabaya (Ubaya) ,terakreditasi A dari BAN-PT dan merupakan Perguruan Tinggi Swasta terbaik (ranking 1) di Jawa Timur
- Program Studi Teknik Elektro Ubaya juga terakreditasi A



Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

7

7

## GNS3

Vlan 40 50 and Wireshark - GNS3

File Edit View Control Node Annotate Tools Help

Topology Summary

| Node             | Console               |
|------------------|-----------------------|
| Cloud-1          | none                  |
| EthernetSwitch-1 | telnet 127.0.0.1:5021 |
| EthernetSwitch-2 | telnet 127.0.0.1:5025 |
| EthernetSwitch-3 | telnet 127.0.0.1:5037 |
| MikroTikCHR-1    | telnet 127.0.0.1:5022 |
| MikroTikCHR-2    | telnet 127.0.0.1:5030 |
| PC-1             | telnet 127.0.0.1:5016 |
| PC-2             | telnet 127.0.0.1:5018 |
| PC-3             | telnet 127.0.0.1:5027 |
| PC-4             | telnet 127.0.0.1:5035 |
| PC-5             | telnet 127.0.0.1:5033 |
| PC-6             | telnet 127.0.0.1:5038 |

Servers Summary

| Node              | Console          |
|-------------------|------------------|
| GNS3 VM (GNS3 VM) |                  |
| JCHN-ASUS-X555QA  | CPU 56.5%, RA... |

Console

GNS3 management console.  
Running GNS3 version 2.1.15 on Windows (64-bit) with Python 3.6.8 Qt 5.12.1 and PyQt 5.12.  
Copyright (c) 2006-2019 GNS3 Technologies  
Use Help -> GNS3 Doctor to detect common issues.

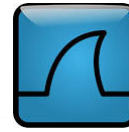
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

8

8

# Wireshark



\*Standard input [MikroTikCHR-2 Ether3 to MikroTikCHR-1 Ether3]

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

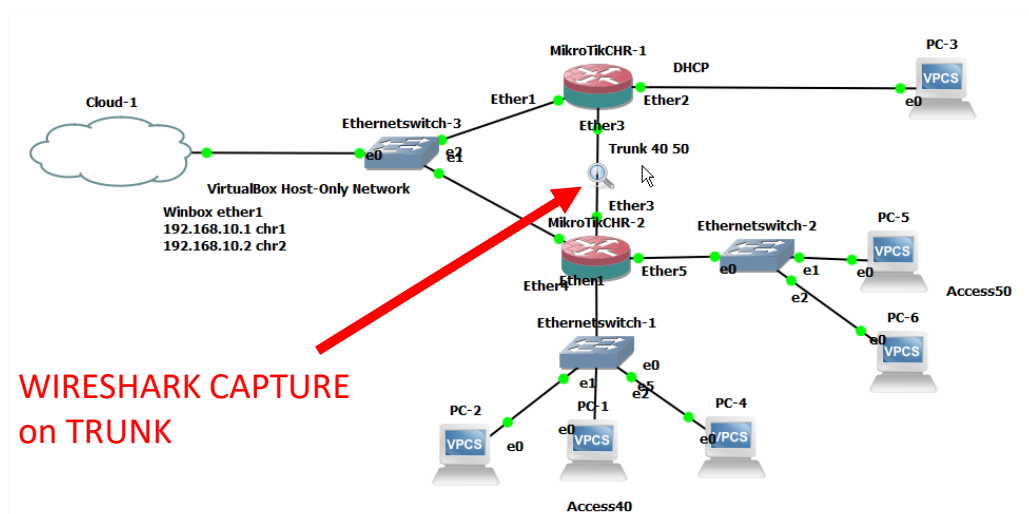
Apply a display filter ... <Ctrl-/>

| No. | Time       | Source            | Destination                | Protocol | Length                                                       | Info                                                                     |
|-----|------------|-------------------|----------------------------|----------|--------------------------------------------------------------|--------------------------------------------------------------------------|
| 190 | 136.137998 | 192.168.50.254    | 192.168.20.254             | ICMP     | 102                                                          | Echo (ping) request id=0x4c74, seq=5/1280, ttl=64 (reply in 191)         |
| 191 | 136.191915 | 192.168.20.254    | 192.168.50.254             | ICMP     | 102                                                          | Echo (ping) reply id=0x4c74, seq=5/1280, ttl=63 (request in 190)         |
| 192 | 136.993685 | 0c:12:8f:0c:66:02 | Spanning-tree (for-- STP   | 57       | RST. Root = 32768/0/0c:12:8f:0c:66:04 Cost = 0 Port = 0x0002 |                                                                          |
| 193 | 136.993639 | 0c:12:8f:0c:66:02 | Spanning-tree (for-- STP   | 57       | RST. Root = 32768/0/0c:12:8f:0c:66:03 Cost = 0 Port = 0x0002 |                                                                          |
| 194 | 137.506696 | 0c:12:8f:07:62:02 | Private_66:68:03           | ARP      | 46                                                           | who has 192.168.50.254? Tell 192.168.50.1                                |
| 195 | 137.708684 | Private_66:68:03  | 0c:12:8f:07:62:02          | ARP      | 64                                                           | 192.168.50.254 is at 00:50:79:66:68:03                                   |
| 196 | 138.746965 | 10.0.0.2          | 255.255.255.255            | MNDP     | 135                                                          | 5678 + 5678 Len=93                                                       |
| 197 | 138.747398 | 0c:12:8f:0c:66:02 | CDP/VTP/DTP/PagP/UD... CDP | 106      | Device ID: CHR 2 Port ID: ether3trunk                        |                                                                          |
| 198 | 138.747776 | 0c:12:8f:0c:66:02 | LLDP Multicast             | LLDP     | 109                                                          | TTL = 120 System Name = CHR 2 System Description = MikroTik RouterOS 6.4 |
| 199 | 138.748548 | 0.0.0.0           | 255.255.255.255            | MNDP     | 138                                                          | 5678 + 5678 Len=92                                                       |

> Frame 194: 46 bytes on wire (368 bits), 46 bytes captured (368 bits) on interface 0  
 > Ethernet II, Src: 0c:12:8f:07:62:02 (0c:12:8f:07:62:02), Dst: Private\_66:68:03 (00:50:79:66:68:03)  
 > 002.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 50  
 000. .... = Priority: Best Effort (default) (0)  
 ...0 .... = DEI: Ineligible  
 .... 0000 0011 0010 = ID: 50  
 Type: ARP (0x0806)  
 > Address Resolution Protocol (request)  
 Hardware type: Ethernet (1)  
 Protocol type: IPv4 (0x0800)  
 Hardware size: 6  
 Protocol size: 4  
 > ARP request (1)  
 0000 00 50 79 66 68 03 0c 12 8f 07 62 02 81 00 00 32 .Pyfh... ..b....2  
 0010 00 06 00 01 00 00 06 04 00 01 0c 12 8f 07 62 02 .....b  
 0020 c0 a8 32 01 00 00 00 00 00 00 c0 a8 32 fe ..2.....2  
 Yohanes Gunawan Yusuf (TR0639) MUM Kuta, BALI 24-25 Oct 2019

9

# GNS3 and Wireshark



Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

10

10

# Frames to be analysed

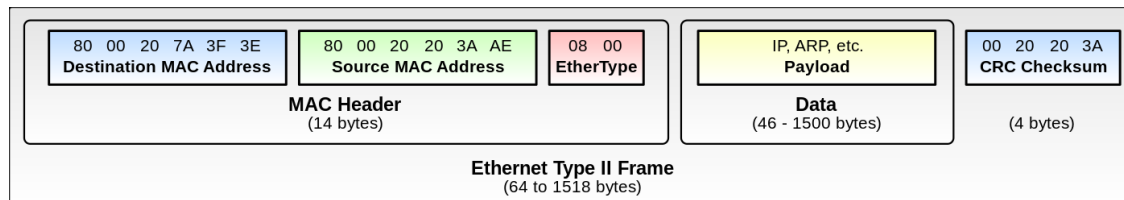
- Ethernet Standard
- VLAN (802.1Q)
- VLAN in VLAN (QinQ)
- PPPoE
- EoIP
- L2TP
- Tunnel in Tunnel  
(EoIP o L2TP and VLAN o EoIP)

11

## Ethernet Standard (Type II) Frame

12

## Ethernet Frame (Standard Type II)



- Destination MAC (6 byte)
- Source MAC (6 byte)
- Type (2 byte)
- Payload (46 – 1500 byte) → IP, TCP or UDP, ARP, DHCP, ICMP, HTML etc

13

## Ether Type

(It is used to indicate which [protocol](#) is [encapsulated](#) in the payload of the frame.)

- 0x0800 : IPv4 - Internet Protocol V4
- 0x0806 : ARP - Address Resolution Protocol
- 0x8100 : VLAN - Virtual LAN (with tag id)
- 0x86DD: IPv6 - Internet Protocol V6
- 0x8847 - 0x8848 : MPLS
- 0x8863 - 0x8864: PPPoE
- 0x9100 : VLAN (double tagging)

14

## Ethernet Standard IPv4 Frame (0x0800)

```

> Frame 5: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface 0
Ethernet II, Src: Private_66:68:02 (00:50:79:66:68:02), Dst: 0c:12:8f:87:62:01 (0c:12:8f:87:62:01)
  > Destination: 0c:12:8f:87:62:01 (0c:12:8f:87:62:01)
  > Source: Private_66:68:02 (00:50:79:66:68:02)
  > Type: IPv4 (0x0800)
Internet Protocol Version 4, Src: 192.168.20.254, Dst: 192.168.20.1
Internet Control Message Protocol

0000  0c 12 8f 87 62 01 00 50 79 66 68 02 08 00 45 00  ...b..P yfh...E.
0010  00 54 17 50 00 00 40 01 d9 08 c0 a8 14 1e c0 a8  .T.P..@. ....
0020  14 01 08 00 cf 11 50 f7 00 03 08 09 0a 0b 0c 0d  ....P. ....
0030  0e 0f 10 11 12 13 14 15 16 17 18 19 1a 1b 1c 1d  ....
0040  1e 1f 20 21 22 23 24 25 26 27 28 29 2a 2b 2c 2d  .. !"#%&'()*+,-
0050  2e 2f 30 31 32 33 34 35 36 37 38 39 3a 3b 3c 3d  ./012345 6789:;<=
0060  3e 3f                                     >?
  
```

15

## Ethernet Standard Frame Analysis (for ICMP)

- ICMP Data = 56 bytes
- ICMP Header (reply) = 8 bytes
- IPv4 Header = 20 bytes
- Total byte Ping = 56 + 8 + 20  
= 84 bytes
- Ethernet Header = 14 bytes
- Total Ethernet Frame = 14 + 84 = 98 bytes

```

PC-> ping 192.168.20.254
84 bytes from 192.168.20.254 icmp_seq=1 ttl=63 time=259.066 ms
84 bytes from 192.168.20.254 icmp_seq=2 ttl=63 time=349.087 ms
84 bytes from 192.168.20.254 icmp_seq=3 ttl=63 time=504.129 ms
84 bytes from 192.168.20.254 icmp_seq=4 ttl=63 time=269.068 ms
84 bytes from 192.168.20.254 icmp_seq=5 ttl=63 time=138.036 ms

> Frame 5: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) o
Ethernet II, Src: Private_66:68:02 (00:50:79:66:68:02), Dst: 0c:12:8
  > Destination: 0c:12:8f:87:62:01 (0c:12:8f:87:62:01)
  > Source: Private_66:68:02 (00:50:79:66:68:02)
  > Type: IPv4 (0x0800)
Internet Protocol Version 4, Src: 192.168.20.254, Dst: 192.168.20.1
Internet Control Message Protocol
  
```

16

# VLAN (802.1Q) Frame

Yohanes Gunawan Yusuf (TR0639)

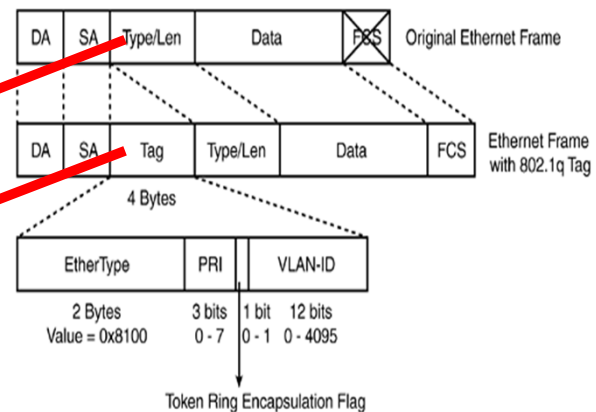
MUM Kuta, BALI 24-25 Oct 2019

17

17

## Ethernet Type (Standard vs VLAN)

- 0x0800 --> IPv4 ethernet packet type
- 0x8100 --> VLAN ethernet packet type



Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

18

18

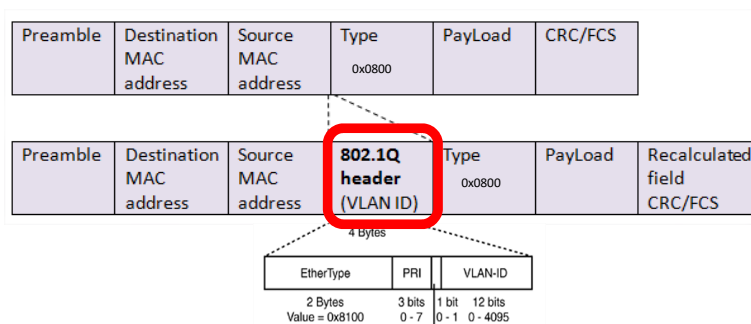
## How VLAN work ?

- Tagged Ethernet frame with VLAN ID tag
- UnTagged Ethernet frame from VLAN ID tag

19

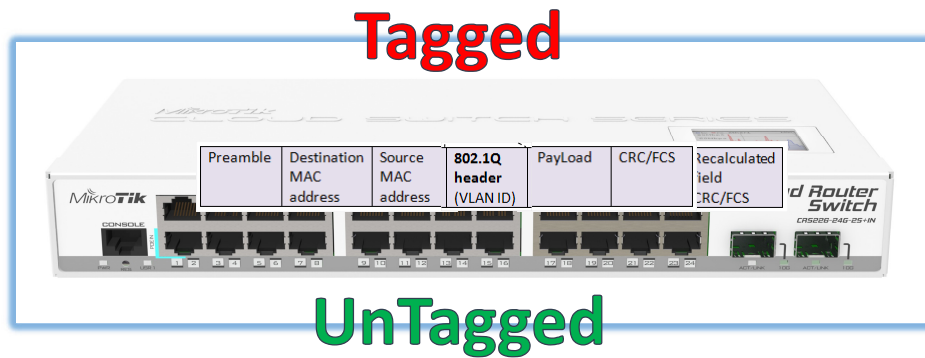
## IEEE 802.1Q

- IEEE **802.1Q** is a standardized encapsulation protocol that defines how to insert (tagged) a **four-byte VLAN identifier** into Ethernet header.
- RouterOS supports up to **4095 VLAN** interfaces, each with a unique **VLAN ID**, per interface (exception: 0,1 and 4095)



20

## IEEE 802.1Q



Ether Type: 0x0800 (IP4) , 0x8100 (802.1Q)

Yohanes Gunawan Yusuf (TR0639)

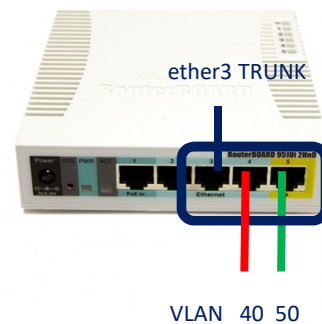
MUM Kuta, BALI 24-25 Oct 2019

21

21

## VLAN Example (Trunk) CHR1

```
/interface ethernet
set [ find default-name=ether3 ] name=ether3-trunk
/interface vlan
add interface=ether3-trunk name=vlan40-eth3 vlan-id=40
add interface=ether3-trunk name=vlan50-eth3 vlan-id=50
/interface bridge port
add interface=ether3-trunk
/interface bridge vlan
add tagged=ether3-trunk vlan-ids=40
add tagged=ether3-trunk vlan-ids=50
add address=10.0.0.1/30 interface=ether3-trunk network=10.0.0.0
add address=192.168.40.1/24 interface=vlan40-eth3 network=192.168.40.0
add address=192.168.50.1/24 interface=vlan50-eth3 network=192.168.50.0
```



Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

22

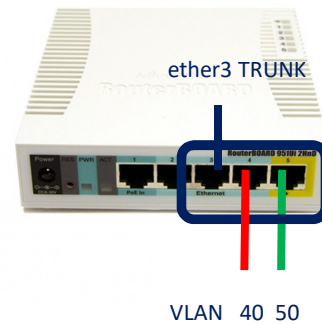
22

## VLAN Example (Access) CHR2

```

/interface bridge
add fast-forward=no name=bridge1a40
add fast-forward=no name=bridge2a50
/interface ethernet
set [ find default-name=ether3 ] name=ether3trunk
/interface vlan
add interface=ether3trunk name=vlan40-eth3 vlan-id=40
add interface=ether3trunk name=vlan50-eth3 vlan-id=50
/interface bridge port
add bridge=bridge1a40 interface=ether4
add bridge=bridge1a40 interface=vlan40-eth3
add bridge=bridge2a50 interface=vlan50-eth3
add bridge=bridge2a50 interface=ether5

```



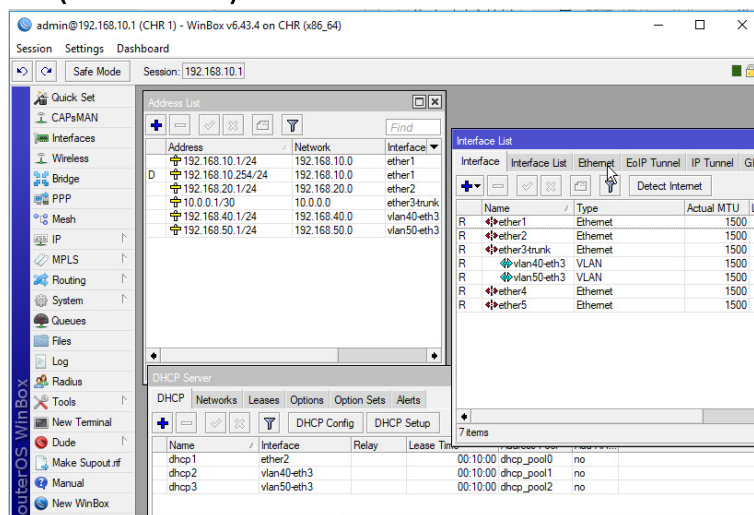
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

23

23

## Trunk (ether3) and DHCP Server on CHR1



Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

24

24

## Trunk (ether3) and Access on CHR 2

The screenshot shows the WinBox interface for a MikroTik CHR 2 device. The Address List window displays two IP addresses: 10.0.0.2/30 assigned to ether3trunk and 192.168.10.2/24 assigned to ether1. The Interface List window shows a table of interfaces, including bridge1a40, bridge2a50, ether1, ether2, ether3trunk, vlan40-eth3, vlan50-eth3, ether4, ether5, and pppoe-out1. A Bridge configuration window is open, showing a table of bridge ports.

| # | Interface   | Bridge     | Horizon | Trusted | Priority | h... | Path |
|---|-------------|------------|---------|---------|----------|------|------|
| 0 | ether4      | bridge1a40 |         | no      | 80       |      |      |
| 1 | vlan40-eth3 | bridge1a40 |         | no      | 80       |      |      |
| 2 | vlan50-eth3 | bridge2a50 |         | no      | 80       |      |      |
| 3 | ether5      | bridge2a50 |         | no      | 80       |      |      |

MUM Kuta, BALI 24-25 Oct 2019

25

## PC5 ping to PC3 thru Trunk

```
Welcome to Virtual PC Simulator, version 0.6.1
Dedicated to Daling.
Build time: Jun 1 2015 11:42:32
Copyright (c) 2007-2014, Paul Meng (mirnshi@gmail.com)
All rights reserved.

VPCS is free software, distributed under the terms of the
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC-3> ip dhcp
DORA IP 192.168.20.254/24 GW 192.168.20.1

PC-3>

PC-5> show ip
NAME       : PC-5[1]
IP/MASK    : 192.168.50.254/24
GATEWAY    : 192.168.50.1
DNS        :
DHCP SERVER : 192.168.50.1
DHCP LEASE  : 562, 600/300/525
MAC        : 00:50:79:66:68:03
LPORT      : 10034
RHOST:PORT  : 127.0.0.1:10035
MTU        : 1500

PC-5> ping 192.168.20.254
84 bytes from 192.168.20.254 icmp_seq=1 ttl=63 time=259.066 ms
84 bytes from 192.168.20.254 icmp_seq=2 ttl=63 time=349.087 ms
84 bytes from 192.168.20.254 icmp_seq=3 ttl=63 time=504.129 ms
84 bytes from 192.168.20.254 icmp_seq=4 ttl=63 time=269.068 ms
84 bytes from 192.168.20.254 icmp_seq=5 ttl=63 time=138.036 ms

PC-5>
```

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

26

26

## Wireshark – Captured Trunk

\*Standard input [MikroTikCHR-2 Ether3 to MikroTikCHR-1 Ether3]

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

icmp

| No. | Time       | Source         | Destination    | Protocol | Length | Info                                                             |
|-----|------------|----------------|----------------|----------|--------|------------------------------------------------------------------|
| 179 | 144.110752 | 192.168.50.254 | 192.168.20.254 | ICMP     | 102    | Echo (ping) request id=0xc20f, seq=1/256, ttl=64 (reply in 184)  |
| 182 | 146.129174 | 192.168.50.254 | 192.168.20.254 | ICMP     | 102    | Echo (ping) request id=0xc40f, seq=2/512, ttl=64 (reply in 185)  |
| 184 | 147.353432 | 192.168.20.254 | 192.168.50.254 | ICMP     | 102    | Echo (ping) reply id=0xc20f, seq=1/256, ttl=63 (request in 179)  |
| 185 | 147.353868 | 192.168.20.254 | 192.168.50.254 | ICMP     | 102    | Echo (ping) reply id=0xc40f, seq=2/512, ttl=63 (request in 182)  |
| 187 | 148.030147 | 192.168.50.254 | 192.168.20.254 | ICMP     | 102    | Echo (ping) request id=0xc60f, seq=3/768, ttl=64 (reply in 188)  |
| 188 | 148.094118 | 192.168.20.254 | 192.168.50.254 | ICMP     | 102    | Echo (ping) reply id=0xc60f, seq=3/768, ttl=63 (request in 187)  |
| 190 | 149.342836 | 192.168.50.254 | 192.168.20.254 | ICMP     | 102    | Echo (ping) request id=0xc70f, seq=4/1024, ttl=64 (reply in 191) |
| 191 | 149.578749 | 192.168.20.254 | 192.168.50.254 | ICMP     | 102    | Echo (ping) reply id=0xc70f, seq=4/1024, ttl=63 (request in 190) |
| 193 | 150.878577 | 192.168.50.254 | 192.168.20.254 | ICMP     | 102    | Echo (ping) request id=0xc80f, seq=5/1280, ttl=64 (reply in 195) |
| 195 | 151.015441 | 192.168.20.254 | 192.168.50.254 | ICMP     | 102    | Echo (ping) reply id=0xc80f, seq=5/1280, ttl=63 (request in 193) |

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

27

27

## Ethernet with VLAN Frame (0x8100)

> Frame 179: 102 bytes on wire (816 bits), 102 bytes captured (816 bits) on interface 0

✓ Ethernet II, Src: Private\_66:68:03 (00:50:79:66:68:03), Dst: 0c:ae:62:9d:f3:02 (0c:ae:62:9d:f3:02)

> Destination: 0c:ae:62:9d:f3:02 (0c:ae:62:9d:f3:02)

> Source: Private\_66:68:03 (00:50:79:66:68:03)

Type: 802.1Q Virtual LAN (0x8100) **14 bytes**

✓ 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 50

000. .... = Priority: Best Effort (default) (0)

...0 .... = DEI: Ineligible

.... 0000 0011 0010 = ID: 50

Type: IPv4 (0x0800)

> Internet Protocol Version 4, Src: 192.168.50.254, Dst: 192.168.20.254

> Internet Control Message Protocol

0000 0c ae 62 9d f3 02 00 50 79 66 68 03 81 00 00 32 ..b....P yfh... 2

0010 08 00 45 00 00 54 0f c1 00 00 40 01 a1 9b c0 a8 ..E..T... @.....

0020 32 fe c0 a8 14 fe 08 00 5d fb c2 0f 00 01 08 09 2..... ].....

0030 0a 0b 0c 0d 0e 0f 10 11 12 13 14 15 16 17 18 19 ..... ! "%&'()

0040 1a 1b 1c 1d 1e 1f 20 21 22 23 24 25 26 27 28 29 ..... \*+,-./01 23456789

0050 2a 2b 2c 2d 2e 2f 30 31 32 33 34 35 36 37 38 39

0060 3a 3b 3c 3d 3e 3f 40 41 42 43 44 45 46 47 48 49

0070 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65

0080 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81

0090 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97

00a0 98 99 9a 9b 9c 9d 9e 9f a0 a1 a2 a3 a4 a5 a6

00b0 a7 a8 a9 aa ab ac ad ae af b0 b1 b2 b3 b4 b5

00c0 b6 b7 b8 b9 ba bb bc bd be bf c0 c1 c2 c3 c4 c5

00d0 c6 c7 c8 c9 ca cb cc cd ce cf d0 d1 d2 d3 d4 d5

00e0 d6 d7 d8 d9 da db dc dd de df e0 e1 e2 e3 e4 e5

00f0 e6 e7 e8 e9 ea eb ec ed ee ef f0 f1 f2 f3 f4 f5

0100 f6 f7 f8 f9 fa fb fc fd fe ff

MUM Kuta, BALI 24-25 Oct 2019

28

28

## VLAN (802.1Q) Tag

Frame 179: 102 bytes on wire (816 bits), 102 bytes captured (816 bits) on interface 0

- Ethernet II, Src: Private\_66:68:03 (00:50:79:66:68:03), Dst: 0c:ae:62:9d:f3:02 (0c:ae:62:9d:f3:02)
  - Destination: 0c:ae:62:9d:f3:02 (0c:ae:62:9d:f3:02)
  - Source: Private\_66:68:03 (00:50:79:66:68:03)
  - Type: 802.1Q Virtual LAN (0x8100)
- 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 50
  - 000. .... = Priority: Best Effort (default) (0)
  - ...0 .... = DEI: Ineligible
  - ... 0000 0011 0010 = ID: 50
  - Type: IPv4 (0x0800)
- Internet Protocol Version 4, Src: 192.168.50.254, Dst: 192.168.20.254
- Internet Control Message Protocol

Hex dump (0000 - 0050):

```

0000  0c ae 62 9d f3 02 00 50 79 66 68 03 81 00 00 32  ..b...P yfh...
0010  08 00 45 00 00 54 0f c1 00 00 40 01 a1 9b c0 a8  ..E..T...@....
0020  32 fe c0 a8 14 fe 08 00 5d fb c2 0f 00 01 08 09  2.....].....
0030  0a 0b 0c 0d 0e 0f 10 11 12 13 14 15 16 17 18 19  .....
0040  1a 1b 1c 1d 1e 1f 20 21 22 23 24 25 26 27 28 29  .....! "#$%&'()
0050  2a 2b 2c 2d 2e 2f 30 31 32 33 34 35 36 37 38 39  *+,-./01 23456789

```

29

## 802.1Q Frame Analysis (for ICMP)

- ICMP Data = 56 bytes
- ICMP Header (reply) = 8 bytes
- IPv4 Header = 20 bytes
- Total byte Ping = 56 + 8 + 20 = 84 bytes
- 802.1Q VLAN (Id 50) = 4 bytes
- Ethernet Header = 14 bytes
- Total VLAN 802.1Q = 4 + 14 + 84 = 102 bytes

PC-5> ping 192.168.20.254

```

84 bytes from 192.168.20.254 icmp_seq=1 ttl=63 time=259.066 ms
84 bytes from 192.168.20.254 icmp_seq=2 ttl=63 time=349.087 ms
84 bytes from 192.168.20.254 icmp_seq=3 ttl=63 time=504.129 ms
84 bytes from 192.168.20.254 icmp_seq=4 ttl=63 time=269.068 ms
84 bytes from 192.168.20.254 icmp_seq=5 ttl=63 time=138.036 ms

```

Frame 179: 102 bytes on wire (816 bits), 102 bytes captured

- Ethernet II, Src: Private\_66:68:03 (00:50:79:66:68:03), Dst: 0c:ae:62:9d:f3:02 (0c:ae:62:9d:f3:02)
- 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 50
- Internet Protocol Version 4, Src: 192.168.50.254, Dst: 192.168.20.254
- Internet Control Message Protocol
  - Type: 8 (Echo (ping) request)
  - Code: 0
  - Checksum: 0x5dfb [correct]
  - [Checksum Status: Good]
  - Identifier (BE): 49679 (0xc20f)
  - Identifier (LE): 4034 (0x0fc2)
  - Sequence number (BE): 1 (0x0001)
  - Sequence number (LE): 256 (0x0100)
  - [Response frame: 184]
  - Data (56 bytes)

30

# VLAN in VLAN (QinQ) Frame

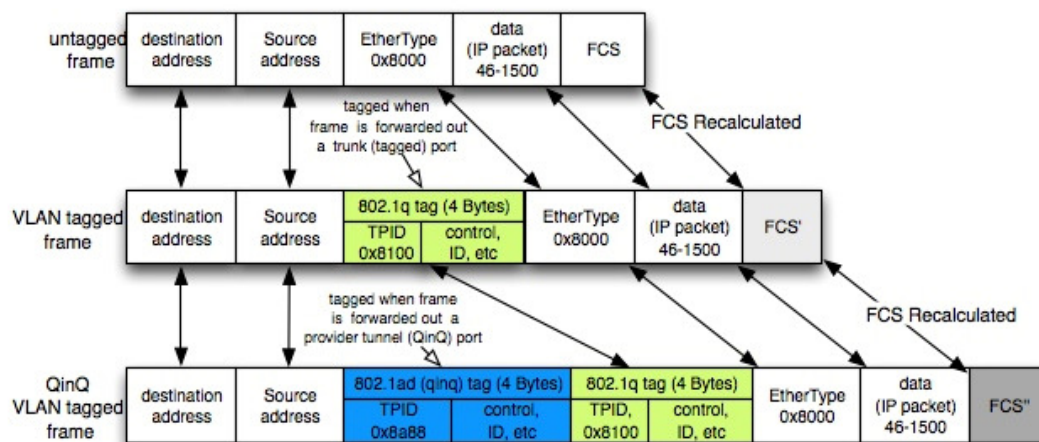
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

31

31

## IEEE 802.1ad



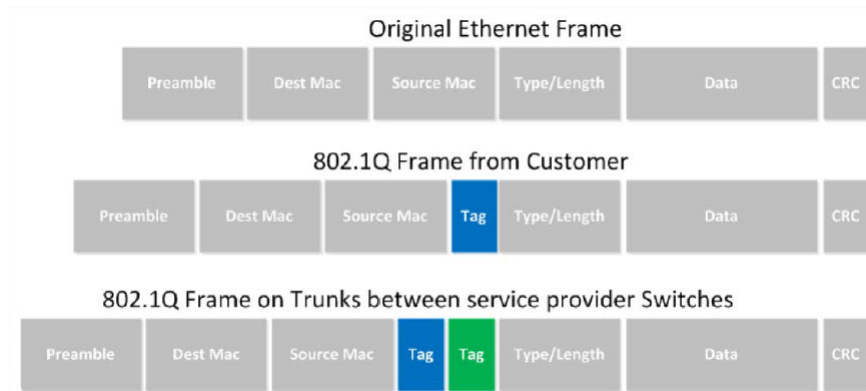
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

32

32

## QinQ @ MikroTik



Yohanes Gunawan Yusuf (TR0639)

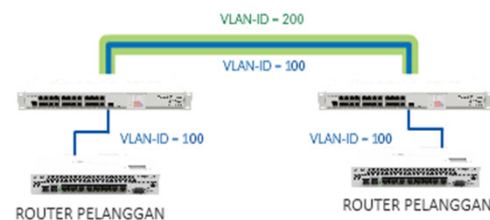
MUM Kuta, BALI 24-25 Oct 2019

33

33

## Why QinQ ?

- QinQ is tunnelling 802.1Q
- Often used by Ethernet Providers as a layer2 VPN for customers.
- Easy to implement, you don't need exotic hardware and we don't have to run any routing protocols between the service provider and customer.
- From the customer's perspective, it's just like their sites are directly connected on layer2 (Switch)



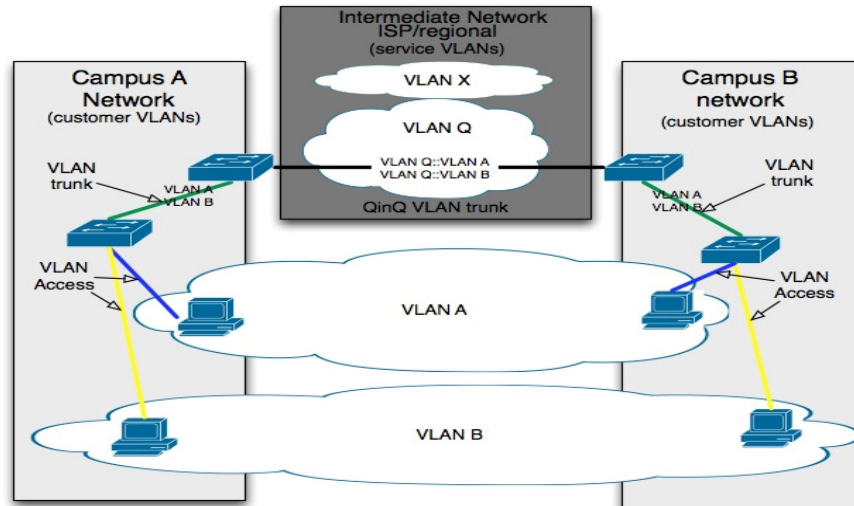
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

34

34

## QinQ Implementation



Yohanes Gunawan Yusuf (TR0639)

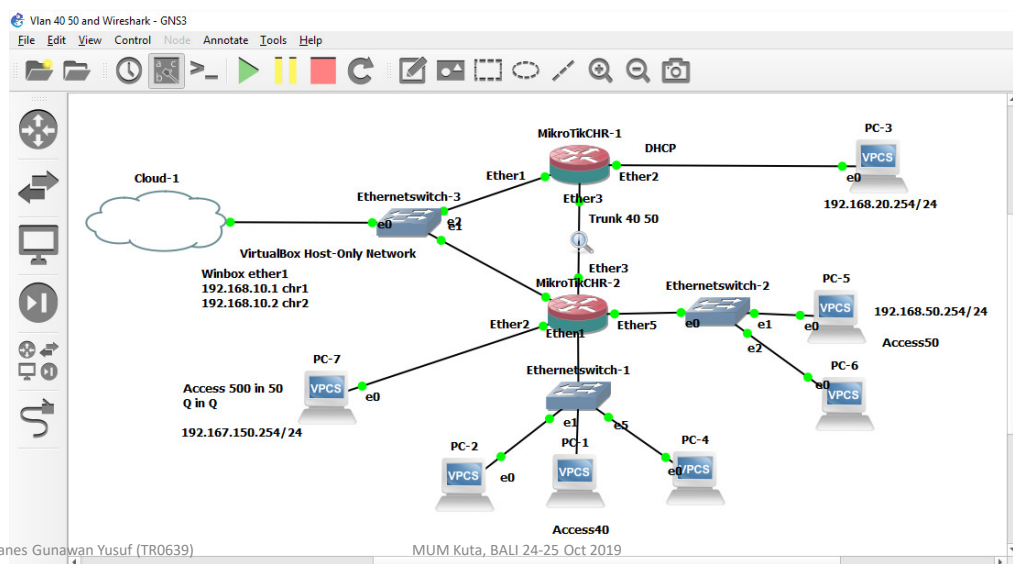
MUM Kuta, BALI 24-25 Oct 2019

Source -> <https://groups.geni.net/geni/wiki/QinqResults>

35

35

## QinQ Simulation on GNS3 (Vlan 500 in 50)



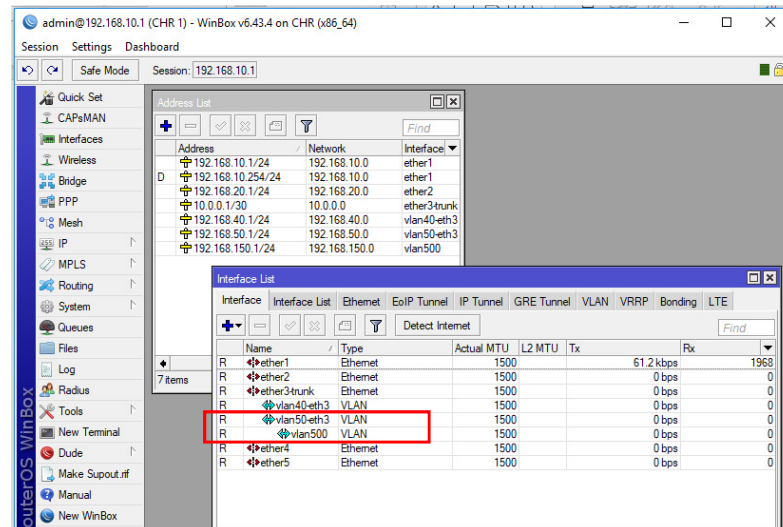
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

36

36

## Setting QinQ (Access 500 in 50) CHR1



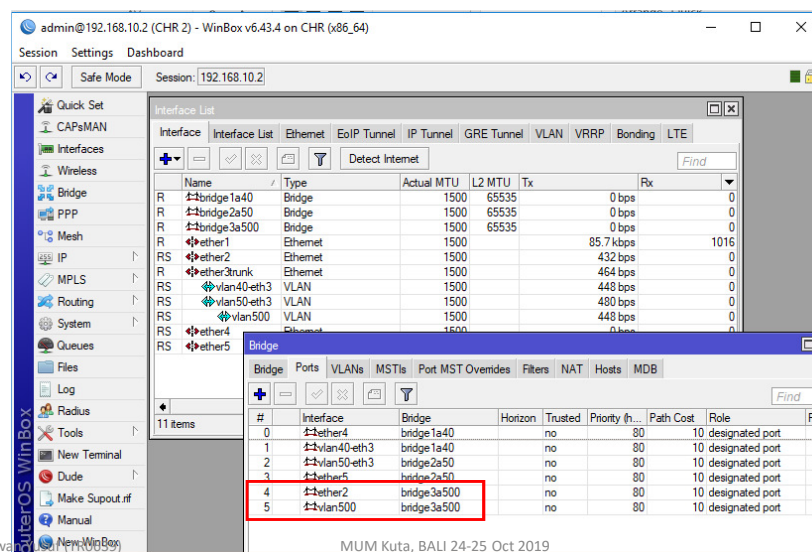
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

37

37

## Access 500 on CHR2 (Ether2)



Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

38

38

## PC7 ping to PC3 thru Trunk Q in Q (500 in 50)

```
VPCS is free software, distributed under the terms of the "BSD" licence.
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.
```

```
Press '?' to get help.
```

```
Executing the startup file
```

```
PC-3> ip dhcp
DDORA IP 192.168.20.254/24 GW 192.168.20.1
```

```
PC-3> █
```

```
PC-7> ping 192.168.20.254
84 bytes from 192.168.20.254 icmp_seq=1 ttl=63 time=360.079 ms
84 bytes from 192.168.20.254 icmp_seq=2 ttl=63 time=701.177 ms
84 bytes from 192.168.20.254 icmp_seq=3 ttl=63 time=355.094 ms
84 bytes from 192.168.20.254 icmp_seq=4 ttl=63 time=486.122 ms
84 bytes from 192.168.20.254 icmp_seq=5 ttl=63 time=520.125 ms
```

```
PC-7> █
```

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

39

39

\*Standard input [MikroTikCHR-2 Ether3 to MikroTikCHR-1 Ether3]

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

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

| No. | Time       | Source            | Destination            | Protocol | Length | Info                                                             |
|-----|------------|-------------------|------------------------|----------|--------|------------------------------------------------------------------|
| 516 | 278.127815 | 0c:12:8f:8c:66:02 | Spanning-tree-(for-... | STP      | 57     | RST. Root = 32768/0/0c:12:8f:8c:66:04 Cost = 0 Port = 0x8002     |
| 517 | 278.715049 | 192.168.150.254   | 192.168.20.254         | ICMP     | 106    | Echo (ping) request id=0x4da7, seq=5/1280, ttl=64 (reply in 518) |
| 518 | 278.884209 | 192.168.20.254    | 192.168.150.254        | ICMP     | 106    | Echo (ping) reply id=0x4da7, seq=5/1280, ttl=63 (request in 517) |
| 519 | 279.234007 | 0c:12:8f:8c:66:02 | Spanning-tree-(for-... | STP      | 57     | RST. Root = 32768/0/0c:12:8f:8c:66:03 Cost = 0 Port = 0x8002     |
| 520 | 279.234692 | 0c:12:8f:8c:66:02 | Spanning-tree-(for-... | STP      | 61     | RST. Root = 32768/0/0c:12:8f:8c:66:01 Cost = 0 Port = 0x8002     |
| 521 | 279.579181 | 0c:12:8f:87:62:02 | Private_66:68:06       | ARP      | 50     | who has 192.168.150.254? Tell 192.168.150.1                      |
| 522 | 279.631921 | Private_66:68:06  | 0c:12:8f:87:62:02      | ARP      | 68     | 192.168.150.254 is at 00:50:79:66:68:06                          |
| 523 | 280.366751 | 0c:12:8f:8c:66:02 | Spanning-tree-(for-... | STP      | 57     | RST. Root = 32768/0/0c:12:8f:8c:66:04 Cost = 0 Port = 0x8002     |
| 524 | 281.460071 | 0c:12:8f:8c:66:02 | Spanning-tree-(for-... | STP      | 57     | RST. Root = 32768/0/0c:12:8f:8c:66:03 Cost = 0 Port = 0x8002     |
| 525 | 281.460903 | 0c:12:8f:8c:66:02 | Spanning-tree-(for-... | STP      | 61     | RST. Root = 32768/0/0c:12:8f:8c:66:01 Cost = 0 Port = 0x8002     |

> Frame 517: 106 bytes on wire (848 bits), 106 bytes captured (848 bits) on interface 0

> Ethernet II, Src: Private\_66:68:06 (00:50:79:66:68:06), Dst: 0c:12:8f:87:62:02 (0c:12:8f:87:62:02)

802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 50

0000 ..... = Priority: Best Effort (default) (0)

.... = DEI: Ineligible

.....0000 0011 0010 = ID: 50

Type: 802.1Q Virtual LAN (0x8100)

802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 500

0000 ..... = Priority: Best Effort (default) (0)

.... = DEI: Ineligible

.....0001 1111 0100 = ID: 500

Type: IPv4 (0x0800)

> Internet Protocol Version 4, Src: 192.168.150.254, Dst: 192.168.20.254

0000 0c 12 8f 87 62 02 00 50 79 66 68 06 31 00 00 3d .....b-P yfh...

0010 31 00 00 3d 08 00 45 00 00 54 a7 49 00 00 40 01 .....E...T-I-...

0020 a6 12 c0 a8 96 fe c0 a8 14 fe 08 00 d2 5f 4d a7 .....M.....

0030 00 05 08 09 0a 0b 0c 0d 0e 0f 10 11 12 13 14 15 ..... ..

0040 16 17 18 19 1a 1b 1c 1d 1e 1f 20 21 22 23 24 25 ..... !"#%&

4 bytes (Id 50)

4 bytes (Id 500)

QinQ

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

40

40

## QinQ Frame Analysis (for ICMP)

- ICMP Data = 56 bytes
- ICMP Header (reply) = 8 bytes
- IPv4 Header = 20 bytes
- Total byte Ping =  $56 + 8 + 20 = 84$  bytes
- 802.1Q VLAN (Id 500) = 4 bytes
- 802.1Q VLAN (Id 50) = 4 bytes
- Ethernet Header = 14 bytes
- Total VLAN 802.1Q =  $4 + 4 + 14 + 84 = 106$  bytes

```
PC-7> ping 192.168.20.254
84 bytes from 192.168.20.254 icmp_seq=1 ttl=63 time=360.079 ms
84 bytes from 192.168.20.254 icmp_seq=2 ttl=63 time=701.177 ms
84 bytes from 192.168.20.254 icmp_seq=3 ttl=63 time=355.094 ms
84 bytes from 192.168.20.254 icmp_seq=4 ttl=63 time=486.122 ms
84 bytes from 192.168.20.254 icmp_seq=5 ttl=63 time=520.125 ms
PC-7> []
```

```
> Frame 517: 106 bytes on wire (848 bits), 106 bytes captured (848 bits) on
> Ethernet II, Src: Private_66:68:06 (08:00:79:66:68:06), Dst: 0c:12:8f:87
  802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 50
    000. .... = Priority: Best Effort (default) (0)
    ...0 .... = DEI: Ineligible
    .... 0000 0011 0010 = ID: 50
    Type: 802.1Q Virtual LAN (0x8100)
  802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 500
    000. .... = Priority: Best Effort (default) (0)
    ...0 .... = DEI: Ineligible
    .... 0001 1111 0100 = ID: 500
    Type: IPv4 (0x0800)
  Internet Protocol Version 4, Src: 192.168.150.254, Dst: 192.168.20.254
```

## Frame Analysis – 802.1Q and QinQ

| use                          | header size | tag size | MTU  | FCS | total frame size |
|------------------------------|-------------|----------|------|-----|------------------|
| standard ethernet            | 14          | 0        | 1500 | 4   | 1518             |
| 802.1q VLAN trunk            | 14          | +4       | 1500 | 4   | 1522             |
| 802.1ad (QinQ) VLAN "tunnel" | 14          | +4 +4    | 1500 | 4   | 1526             |

- Ethernet MTU = IP Header + TCP Header + Payload = 1500 bytes
- IP Header = 20 bytes
- TCP Header = 20 bytes
- Payload = 1460 bytes
- If packet size more than MTU will be fragmented

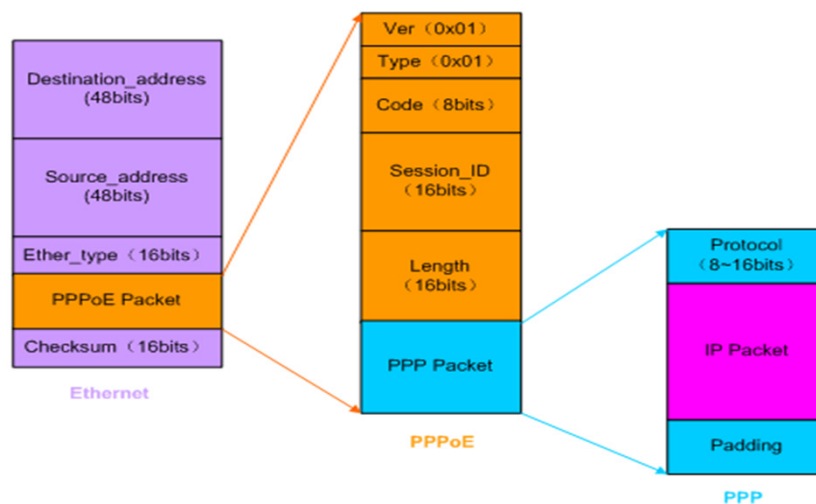
# PPPoE Frame

**Point-to-Point Protocol over Ethernet (PPPoE)** is a network protocol for encapsulating PPP frames inside Ethernet frames.

43

## PPPoE Frame

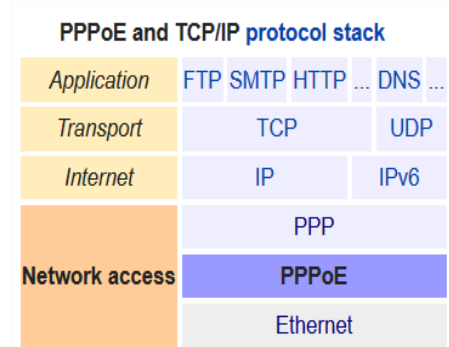
(source: [www.h3c.com.hk](http://www.h3c.com.hk))



44

## PPP Packet

- **Point-to-Point Protocol (PPP)** is a data link layer (layer 2) communications protocol between two routers directly without any host or any other networking in between.
- PPP may include the following LCP options. It can provide connection **authentication**, **transmission encryption**, and **compression**.
- **Point-to-Point Protocol over Ethernet (PPPoE)** is derivatives of PPP



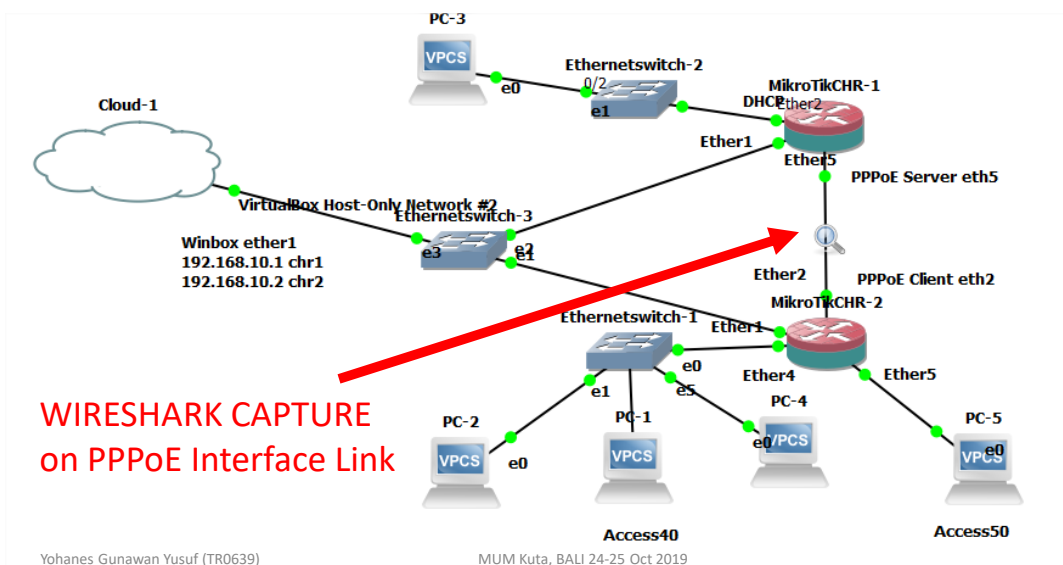
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

45

45

## PPPoE Server and Client



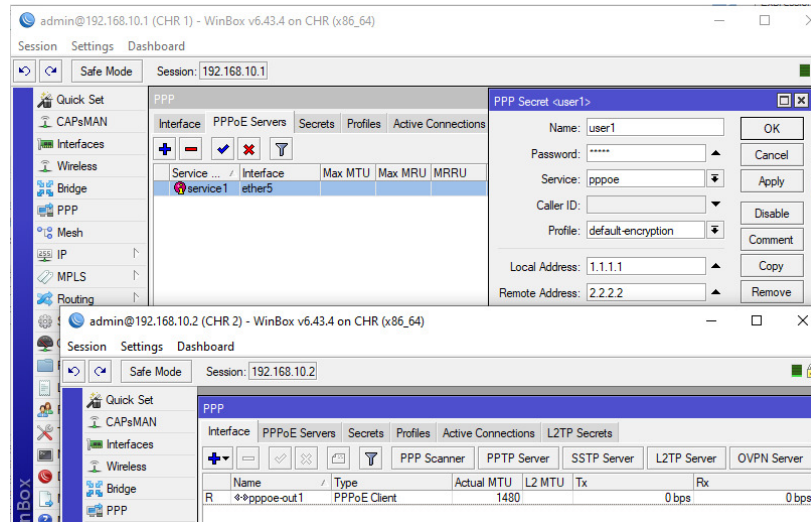
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

46

46

## PPPoE Setting



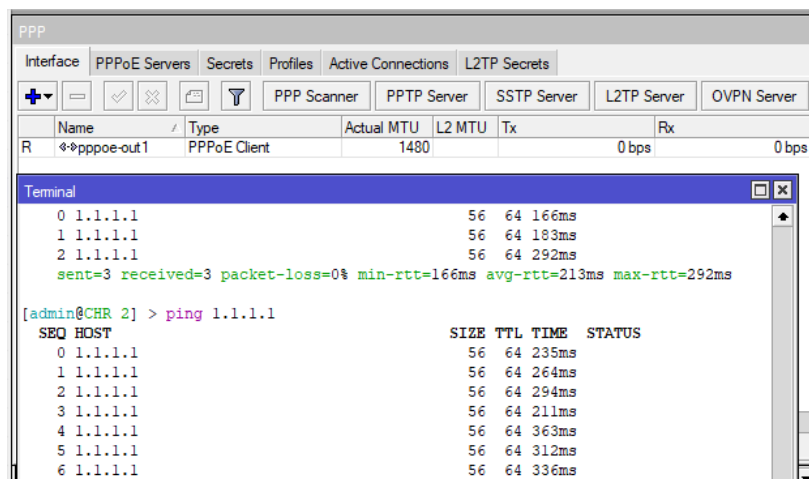
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

47

47

## Ping from PPPoE Client to Server



Yohanes Gunawan Yusuf (TR0639)

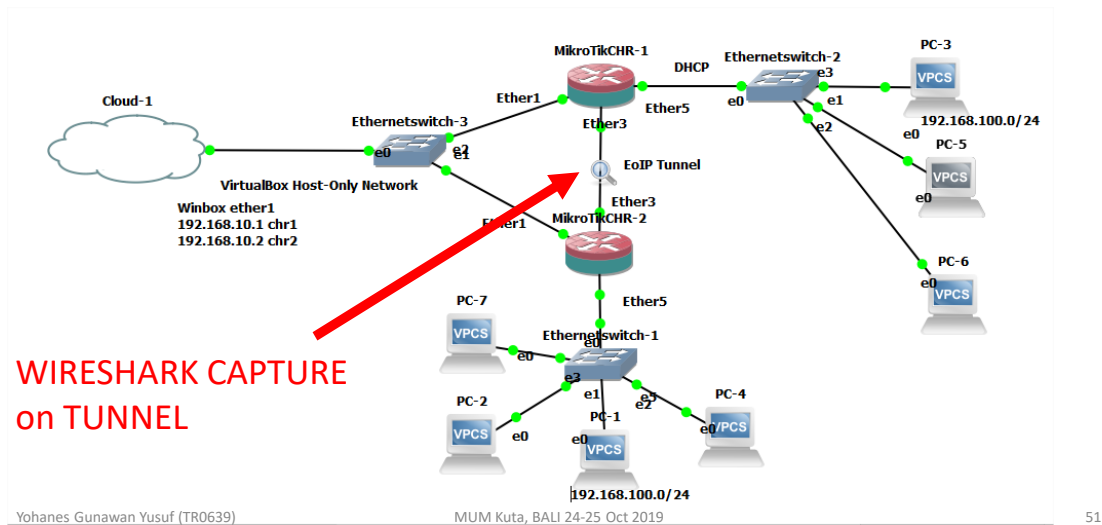
MUM Kuta, BALI 24-25 Oct 2019

48

48

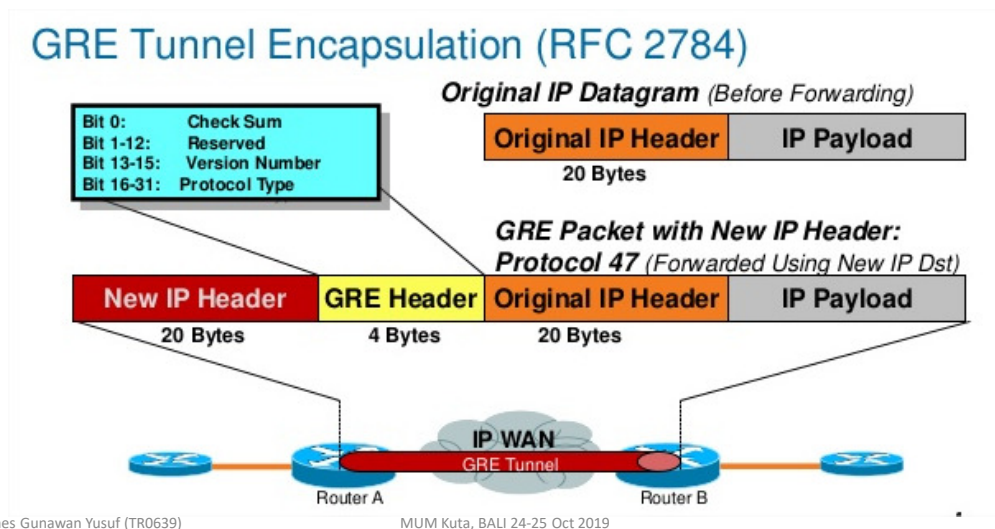


## EoIP Tunnel



51

## EoIP Frame (Using GRE Protocol)



52

## EoIP Setting

The left screenshot shows the WinBox interface for session 192.168.10.1. The 'Interface List' tab is active, showing a table with columns: Name, Type, Actual MTU, L2 MTU, Tx, and Rx. The table lists several interfaces, including ether1, ether2, ether3, and ether4. The 'Bridge' tab is also visible, showing a table with columns: #, Interface, Bridge, Horizon, Trusted, Priority, Path Cost, Role, and Root Pat. The 'Local Address' field is set to 10.0.0.2, the 'Remote Address' field is set to 10.0.0.1, and the 'Tunnel ID' is set to 51.

The right screenshot shows the WinBox interface for session 192.168.10.2. The 'Interface List' tab is active, showing a table with columns: Name, Type, Actual MTU, L2 MTU, Tx, and Rx. The table lists several interfaces, including ether1, ether2, ether3, and ether4. The 'Bridge' tab is also visible, showing a table with columns: #, Interface, Bridge, Horizon, Trusted, Priority, Path Cost, Role, and Root Pat. The 'Local Address' field is set to 10.0.0.1, the 'Remote Address' field is set to 10.0.0.2, and the 'Tunnel ID' is set to 51.

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

53

53

## Ping PC1 to PC5 thru EoIP Tunnel

The left screenshot shows the terminal window for PC1. The configuration is as follows:

```

address [mask] [gateway]
address [gateway] [mask]
Set the VPC's ip, default gateway ip and network
Default IPv4 mask is /24, IPv6 is /64. Example:
ip 10.1.1.70/26 10.1.1.65 set the VPC's ip to 10
the gateway to 10.1.1.65, the netmask to 255.255
In tap mode, the ip of the tapx is the maximum h
of the subnet. In the example above the tapx ip v
10.1.1.126
mask may be written as /26, 26 or 255.255.255.19
Attempt to obtain IPv6 address, mask and gateway
dhcp [OPTION] Attempt to obtain IPv4 address, mask, gateway, D
-d Show DHCP packet decode
-r Renew DHCP lease
-x Release DHCP lease
dns ip Set DNS server ip, delete if ip is '0'
domain NAME Set local domain name to NAME

PC-1> ip 192.168.100.1 255.255.255.0
Checking for duplicate address...
PC1 : 192.168.100.1 255.255.255.0

PC-1> ping 192.168.100.5
84 bytes from 192.168.100.5 icmp_seq=1 ttl=64 time=539.038 ms
84 bytes from 192.168.100.5 icmp_seq=2 ttl=64 time=439.110 ms
84 bytes from 192.168.100.5 icmp_seq=3 ttl=64 time=301.076 ms
84 bytes from 192.168.100.5 icmp_seq=4 ttl=64 time=376.095 ms
84 bytes from 192.168.100.5 icmp_seq=5 ttl=64 time=321.083 ms

```

The right screenshot shows the terminal window for PC5. The configuration is as follows:

```

PC-5>
PC-5> ip ?
ip ARG ... [OPTION]
Configure the current VPC's IP settings
ARG ...:
address [mask] [gateway]
address [gateway] [mask]
Set the VPC's ip, default gateway ip and netw
Default IPv4 mask is /24, IPv6 is /64. Exampl
ip 10.1.1.70/26 10.1.1.65 set the VPC's ip to
the gateway to 10.1.1.65, the netmask to 255.
In tap mode, the ip of the tapx is the maximu
of the subnet. In the example above the tapx
10.1.1.126
mask may be written as /26, 26 or 255.255.255
Attempt to obtain IPv6 address, mask and gate
dhcp [OPTION] Attempt to obtain IPv4 address, mask, gateway
-d Show DHCP packet decode
-r Renew DHCP lease
-x Release DHCP lease
dns ip Set DNS server ip, delete if ip is '0'
domain NAME Set local domain name to NAME

PC-5> ip 192.168.100.5 255.255.255.0
Checking for duplicate address...
PC1 : 192.168.100.5 255.255.255.0
PC-5>

```

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

54

54

## EoIP Encapsulated Frame

Standard input [MikroTikCHR-2 Ether3 to MikroTikCHR-1 Ether3]

Apply a display filter: <Ctrl-F>

| No. | Time       | Source            | Destination                | Protocol | Length                                                       | Info                                                              |
|-----|------------|-------------------|----------------------------|----------|--------------------------------------------------------------|-------------------------------------------------------------------|
| 104 | 105.028663 | Private_66:68:03  | Private_66:68:00           | ARP      | 106                                                          | 192.168.100.5 is at 00:50:79:66:68:03                             |
| 105 | 105.137539 | 192.168.100.1     | 192.168.100.5              | ICMP     | 140                                                          | Echo (ping) request id=0xc49c, seq=1/256, ttl=64 (request in 106) |
| 106 | 105.512767 | 192.168.100.5     | 192.168.100.1              | ICMP     | 140                                                          | Echo (ping) reply id=0xc49c, seq=1/256, ttl=64 (reply in 105)     |
| 107 | 106.593428 | 192.168.100.1     | 192.168.100.5              | ICMP     | 140                                                          | Echo (ping) request id=0xc69c, seq=2/512, ttl=64 (request in 109) |
| 108 | 106.597274 | 02:e1:6e:a8:a3:b0 | Spanning-tree (for...) STP | 95       | RST, Root = 32768/0/0c:38:84:9a:44:02 Cost = 0 Port = 0x0002 |                                                                   |
| 109 | 106.697283 | 192.168.100.5     | 192.168.100.1              | ICMP     | 140                                                          | Echo (ping) reply id=0xc69c, seq=2/512, ttl=64 (reply in 107)     |
| 110 | 107.781947 | 192.168.100.1     | 192.168.100.5              | ICMP     | 140                                                          | Echo (ping) request id=0xc79c, seq=3/768, ttl=64 (request in 111) |
| 111 | 107.937130 | 192.168.100.5     | 192.168.100.1              | ICMP     | 140                                                          | Echo (ping) reply id=0xc79c, seq=3/768, ttl=64 (reply in 110)     |
| 112 | 107.937588 | 0c:38:84:a3:5f:02 | 0c:38:84:9a:44:02          | ARP      | 42                                                           | Who has 10.0.0.2? Tell 10.0.0.1                                   |
| 113 | 107.947661 | 0c:38:84:9a:44:02 | 0c:38:84:a3:5f:02          | ARP      | 42                                                           | 10.0.0.2 is at 0c:38:84:9a:44:02                                  |

Frame 109: 140 bytes on wire (1120 bits), 140 bytes captured (1120 bits) on interface 0

Ethernet II, Src: 0c:38:84:a3:5f:02 (0c:38:84:a3:5f:02), Dst: 0c:38:84:9a:44:02 (0c:38:84:9a:44:02)

Internet Protocol Version 4, Src: 10.0.0.1, Dst: 10.0.0.2

Generic Routing Encapsulation (MIKROTIK EoIP)

Ethernet II, Src: Private\_66:68:03 (00:50:79:66:68:03), Dst: Private\_66:68:00 (00:50:79:66:68:00)

Internet Protocol Version 4, Src: 192.168.100.5, Dst: 192.168.100.1

Internet Control Message Protocol

Yohanes Gunawan Yusuf (TR0639) MUM Kuta, BALI 24-25 Oct 2019 55

55

## EoIP Tunnel and Payload

| No. | Time       | Source            | Destination       | Protocol | Length | Info                             |
|-----|------------|-------------------|-------------------|----------|--------|----------------------------------|
| 109 | 106.697283 | 192.168.100.5     | 192.168.100.1     | ICMP     | 140    | Echo (ping) reply id=0x...       |
| 110 | 107.781947 | 192.168.100.1     | 192.168.100.5     | ICMP     | 140    | Echo (ping) request id=0x...     |
| 111 | 107.937130 | 192.168.100.5     | 192.168.100.1     | ICMP     | 140    | Echo (ping) reply id=0x...       |
| 112 | 107.937588 | 0c:38:84:a3:5f:02 | 0c:38:84:9a:44:02 | ARP      | 42     | Who has 10.0.0.2? Tell 10.0.0.1  |
| 113 | 107.947661 | 0c:38:84:9a:44:02 | 0c:38:84:a3:5f:02 | ARP      | 42     | 10.0.0.2 is at 0c:38:84:9a:44:02 |

Frame 109: 140 bytes on wire (1120 bits), 140 bytes captured (1120 bits) on interface 0

Ethernet II, Src: 0c:38:84:a3:5f:02 (0c:38:84:a3:5f:02), Dst: 0c:38:84:9a:44:02 (0c:38:84:9a:44:02)

Internet Protocol Version 4, Src: 10.0.0.1, Dst: 10.0.0.2

Generic Routing Encapsulation (MIKROTIK EoIP)

Ethernet II, Src: Private\_66:68:03 (00:50:79:66:68:03), Dst: Private\_66:68:00 (00:50:79:66:68:00)

Internet Protocol Version 4, Src: 192.168.100.5, Dst: 192.168.100.1

Internet Control Message Protocol

Tunnel Payload

Yohanes Gunawan Yusuf (TR0639) MUM Kuta, BALI 24-25 Oct 2019 56

56



## EoIP Frame Analysis (for ARP Request)

| No. | Time       | Source            | Destination            | Protocol | Length | Info                                        |
|-----|------------|-------------------|------------------------|----------|--------|---------------------------------------------|
| 101 | 104.484909 | 10.0.0.2          | 10.0.0.1               | GRE      | 42     | Encapsulated MIKROTIK EoIP                  |
| 102 | 104.486949 | 02:e1:6e:8a:8a:3b | Spanning-tree-(for-... | STP      | 95     | RST, Root = 32768/0/0c:38:84:9a:44:04, Cost |
| 103 | 104.956682 | Private_66:68:00  | Broadcast              | ARP      | 106    | Who has 192.168.100.5? Tell 192.168.100.1   |
| 104 | 105.020663 | Private_66:68:03  | Private_66:68:00       | ARP      | 106    | 192.168.100.5 is at 00:50:79:66:68:03       |

- ARP Request = 28 bytes
- Inner Ethernet Header = 14 bytes
- Inner Ethernet Trailer = 22 bytes
- Total ARP = 28 + 14 + 22 = 64 bytes
- GRE (MikroTik EoIP) = 8 bytes
- Outer IP Header = 20 bytes
- Outer Ethernet Header = 14 bytes
- EoIP Tunnel = 14 + 8 + 20 = 42 bytes
- Total EoIP ARP Frame = EoIP Tunnel + Total ARP = 42 + 64 = 106 bytes

```

> Frame 103: 106 bytes on wire (848 bits), 106 bytes captured (848 bits) on interf
> Ethernet II, Src: 0c:38:84:9a:44:02 (0c:38:84:9a:44:02), Dst: 0c:38:84:a3:5f:02
> Internet Protocol Version 4, Src: 10.0.0.2, Dst: 10.0.0.1
> Generic Routing Encapsulation (MIKROTIK EoIP)
  > Ethernet II, Src: Private_66:68:00 (00:50:79:66:68:00), Dst: Broadcast (ff:ff:ff:ff)
    > Destination: Broadcast (ff:ff:ff:ff:ff:ff)
    > Source: Private_66:68:00 (00:50:79:66:68:00)
    > Type: ARP (0x0806)
    > Trailer: 0000000000000000000000000000000000000000000000000000000000000000
  > Address Resolution Protocol (request)
    > Hardware type: Ethernet (1)
    > Protocol type: IPv4 (0x0000)
    > Hardware size: 6
0000  0c 38 84 a3 5f 02 0c 38 84 9a 44 02 08 00 45 00  .8...8...D...E:
0010  00 5c 2b 01 00 00 ff 2f 7c 6f 0a 00 00 02 0a 00  .\+.../ |o.....
0020  00 01 20 01 64 00 00 40 33 00 ff ff ff ff ff ff  ..d...@ 3.....
0030  00 50 79 66 68 00 08 06 00 01 08 00 06 04 00 01  .Pyfh...d.....
0040  00 50 79 66 68 00 c0 a8 64 01 ff ff ff ff ff ff  .Pyfh...d.....
0050  c0 a8 64 05 00 00 00 00 00 00 00 00 00 00 00  .d!.....
0060  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .

```

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

59

59

## L2TP Tunnel Frame

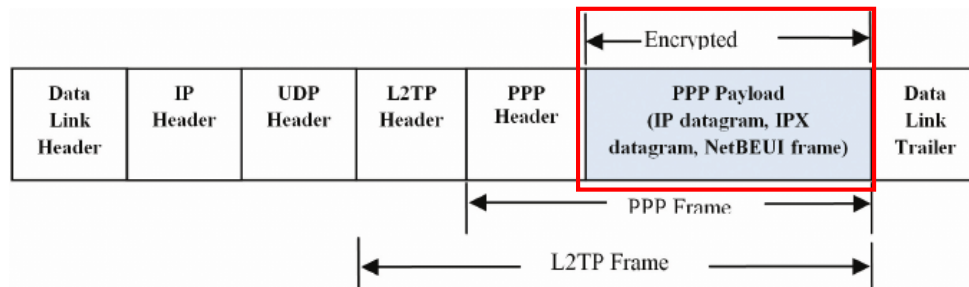
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

60

60

## L2TP Frame Format (use PPP packet frame)



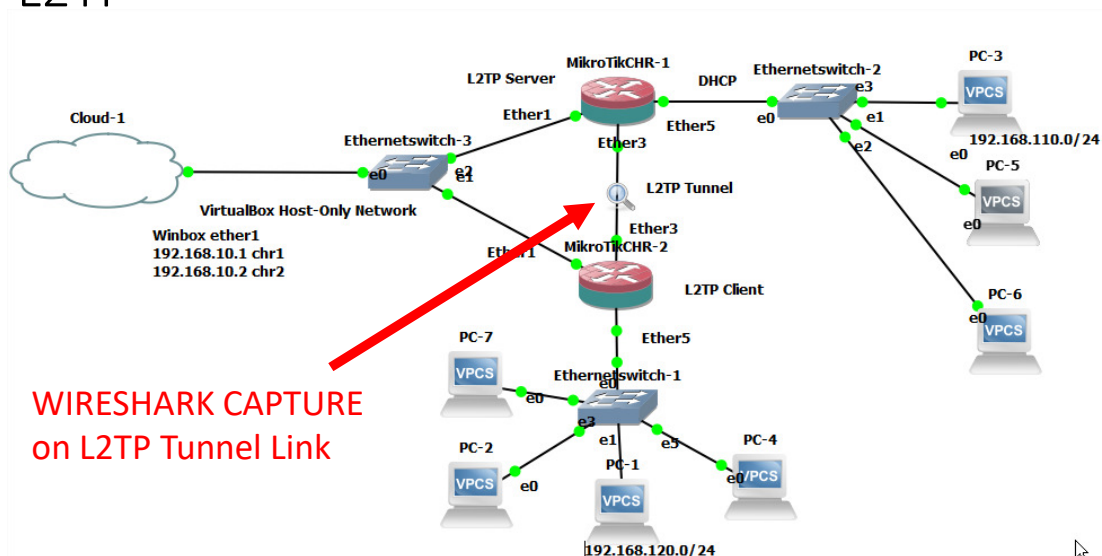
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

61

61

## L2TP



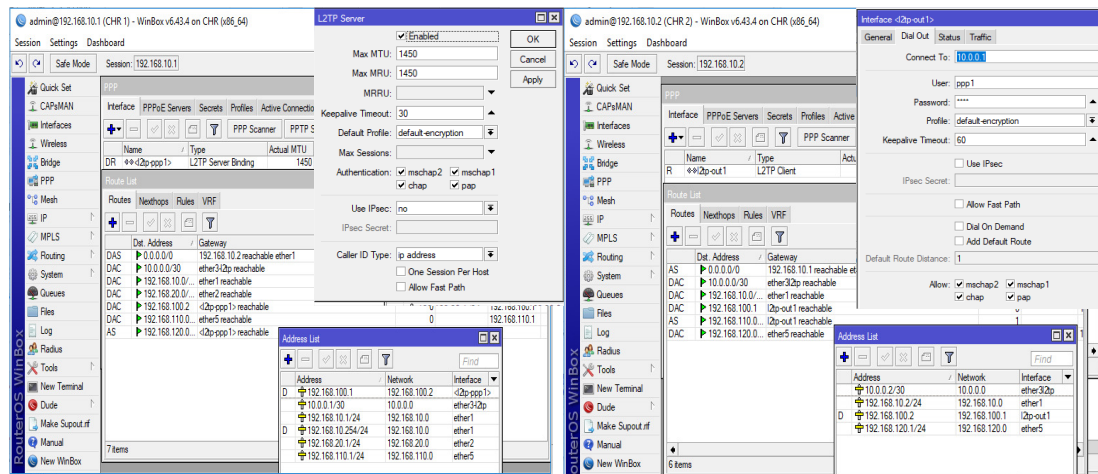
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

62

62

## L2TP – Server and Client (No IPsec)



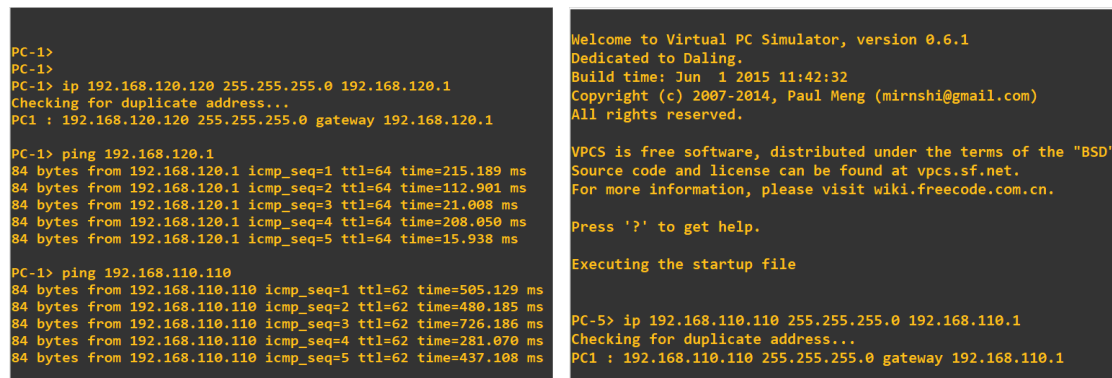
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

63

63

## Ping PC1 to PC5



Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

64

64

## L2TP Tunnel Setup

Wireshark L2TP.pcapng [MikroTikCHR-2 Ether3 to MikroTikCHR-1 Ether3]

Apply a display filter: <Ctrl>/>

| No. | Time      | Source            | Destination       | Protocol              | Length | Info                                                                   |
|-----|-----------|-------------------|-------------------|-----------------------|--------|------------------------------------------------------------------------|
| 1   | 0.000000  | 10.0.0.2          | 10.0.0.1          | L2TP                  | 62     | Control Message - Hello (tunnel id=1, session id=0)                    |
| 2   | 0.200517  | 10.0.0.1          | 10.0.0.2          | L2TP                  | 54     | Control Message - ZL8 (tunnel id=1, session id=0)                      |
| 3   | 1.366214  | 10.0.0.1          | 10.0.0.2          | L2TP                  | 62     | Control Message - Hello (tunnel id=1, session id=0)                    |
| 4   | 1.528726  | 10.0.0.2          | 10.0.0.1          | L2TP                  | 54     | Control Message - ZL8 (tunnel id=1, session id=0)                      |
| 5   | 4.517910  | 10.0.0.1          | 255.255.255.255   | RNDP                  | 135    | 5678 → 5678 Len=93                                                     |
| 6   | 4.518384  | 0c:f0:c9:b0:e7:02 | 0c:f0:c9:b0:e7:02 | CDP/VTP/DTP/PAP/UD... | 106    | Device ID: CHR 1 Port ID: ether3-l2tp                                  |
| 7   | 4.519536  | 0c:f0:c9:b0:e7:02 | 0c:f0:c9:b0:e7:02 | LLDP_Multicast        | 109    | TTL = 120 System Name = CHR 1 System Description = MikroTik RouterOS 6 |
| 8   | 6.504560  | 0c:f0:c9:f7:2a:02 | 0c:f0:c9:b0:e7:02 | ARP                   | 42     | Who has 10.0.0.1? Tell 10.0.0.2                                        |
| 9   | 6.665338  | 0c:f0:c9:b0:e7:02 | 0c:f0:c9:f7:2a:02 | ARP                   | 42     | 10.0.0.1 is at 0c:f0:c9:b0:e7:02                                       |
| 10  | 10.661110 | 10.0.0.1          | 10.0.0.2          | PPP LCP               | 60     | Echo Request                                                           |

Frame 1: 62 bytes on wire (496 bits), 62 bytes captured (496 bits) on interface 0  
 Ethernet II, Src: 0c:f0:c9:f7:2a:02 (0c:f0:c9:f7:2a:02), Dst: 0c:f0:c9:b0:e7:02 (0c:f0:c9:b0:e7:02)  
 Internet Protocol Version 4, Src: 10.0.0.2, Dst: 10.0.0.1  
 User Datagram Protocol, Src Port: 1701, Dst Port: 1701  
 Layer 2 Tunneling Protocol  
 Packet Type: Control Message Tunnel Id=1 Session Id=0  
 Length: 20  
 Tunnel ID: 1  
 Session ID: 0  
 Ns: 18  
 Nr: 16  
 Control Message AVP

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

65

65

## L2TP – LCP (link Control Protocol)

| No. | Time      | Source            | Destination       | Protocol | Length | Info                             |
|-----|-----------|-------------------|-------------------|----------|--------|----------------------------------|
| 8   | 6.504560  | 0c:f0:c9:f7:2a:02 | 0c:f0:c9:b0:e7:02 | ARP      | 42     | Who has 10.0.0.1? Tell 10.0.0.2  |
| 9   | 6.665338  | 0c:f0:c9:b0:e7:02 | 0c:f0:c9:f7:2a:02 | ARP      | 42     | 10.0.0.1 is at 0c:f0:c9:b0:e7:02 |
| 10  | 10.661110 | 10.0.0.1          | 10.0.0.2          | PPP LCP  | 60     | Echo Request                     |
| 11  | 10.716158 | 10.0.0.2          | 10.0.0.1          | PPP LCP  | 60     | Echo Reply                       |
| 12  | 19.982941 | 0c:f0:c9:b0:e7:02 | 0c:f0:c9:f7:2a:02 | ARP      | 42     | Who has 10.0.0.2? Tell 10.0.0.1  |

Frame 10: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0  
 Ethernet II, Src: 0c:f0:c9:b0:e7:02 (0c:f0:c9:b0:e7:02), Dst: 0c:f0:c9:f7:2a:02 (0c:f0:c9:f7:2a:02)  
 Internet Protocol Version 4, Src: 10.0.0.1, Dst: 10.0.0.2  
 User Datagram Protocol, Src Port: 1701, Dst Port: 1701  
 Layer 2 Tunneling Protocol  
 Packet Type: Data Message Tunnel Id=1 Session Id=1  
 Tunnel ID: 1  
 Session ID: 1  
 Point-to-Point Protocol  
 Address: 0xff  
 Control: 0x03  
 Protocol: Link Control Protocol (0xc021)  
 PPP Link Control Protocol

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

66

66

## L2TP – Use UDP (port 1701)

```
> Frame 23: 140 bytes on wire (1120 bits), 140 bytes captured (1120 bits) on interface 0
> Ethernet II, Src: 0c:f0:c9:b0:e7:02 (0c:f0:c9:b0:e7:02), Dst: 0c:f0:c9:f7:2a:02 (0c:f0:c9:f7:2a:02)
> Internet Protocol Version 4, Src: 10.0.0.1, Dst: 10.0.0.2
  User Datagram Protocol, Src Port: 1701, Dst Port: 1701
    Source Port: 1701
    Destination Port: 1701
    Length: 106
    Checksum: 0xad29 [unverified]
    [Checksum Status: Unverified]
    [Stream index: 0]
  Layer 2 Tunneling Protocol
  Point-to-Point Protocol
  PPP Compressed Datagram
0000  0c f0 c9 f7 2a 02 0c f0 c9 b0 e7 02 08 00 45 00  ....*....E
0010  00 7e 2c 00 00 00 40 11 3a 6d 0a 00 00 01 0a 00  ~.,...@.:m
0020  00 02 06 a5 06 a5 00 6a ad 29 00 02 00 01 00 01  .....9.....
0030  ff 03 00 fd 90 07 39 a4 fd a1 e6 fa de c6 b1 c9  .....PNP^...2../
0040  f2 1a 50 4e 50 5e 11 eb 13 1f 8e 32 f1 90 2f 8e  .....fR..4.u
0050  0f 0f ae d8 df 03 90 72 66 c7 52 14 c9 34 a7 75  .....8^.../ 2...U2-
0060  04 fe 38 5e c3 ef c6 2f 32 eb c4 a9 f5 55 32 2d  .....{...o..a
0070  d6 a4 86 a4 7b d8 e5 ec cf f1 b2 ec 6f f5 00 61  .....>.4.(VF..6Z
0080  27 3e e6 34 e3 28 56 66 f9 36 5a ad
```

Transport  
Layer UDP

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

67

67

## L2TP – Ping as PPP Compressed Datagram (Encrypted)

```
22 48.396200 10.0.0.2 10.0.0.1 PPP Comp 140 Compressed data
23 48.503094 10.0.0.1 10.0.0.2 PPP Comp 140 Compressed data
24 49.616125 10.0.0.2 10.0.0.1 PPP Comp 140 Compressed data
25 49.834306 10.0.0.1 10.0.0.2 PPP Comp 140 Compressed data
<
> Frame 23: 140 bytes on wire (1120 bits), 140 bytes captured (1120 bits) on interface 0
> Ethernet II, Src: 0c:f0:c9:b0:e7:02 (0c:f0:c9:b0:e7:02), Dst: 0c:f0:c9:f7:2a:02 (0c:f0:c9:f7:2a:02)
> Internet Protocol Version 4, Src: 10.0.0.1, Dst: 10.0.0.2
  User Datagram Protocol, Src Port: 1701, Dst Port: 1701
    Layer 2 Tunneling Protocol
      Packet Type: Data Message Tunnel Id=1 Session Id=1
      Tunnel ID: 1
      Session ID: 1
    Point-to-Point Protocol
      Address: 0xff
      Control: 0x03
      Protocol: Compressed datagram (0x00fd)
    PPP Compressed Datagram
0000  0c f0 c9 f7 2a 02 0c f0 c9 b0 e7 02 08 00 45 00  ....*....E
0010  00 7e 2c 00 00 00 40 11 3a 6d 0a 00 00 01 0a 00  ~.,...@.:m
0020  00 02 06 a5 06 a5 00 6a ad 29 00 02 00 01 00 01  .....9.....
0030  ff 03 00 fd 90 07 39 a4 fd a1 e6 fa de c6 b1 c9  .....PNP^...2../
0040  f2 1a 50 4e 50 5e 11 eb 13 1f 8e 32 f1 90 2f 8e  .....fR..4.u
0050  0f 0f ae d8 df 03 90 72 66 c7 52 14 c9 34 a7 75  .....8^.../ 2...U2-
0060  04 fe 38 5e c3 ef c6 2f 32 eb c4 a9 f5 55 32 2d  .....{...o..a
0070  d6 a4 86 a4 7b d8 e5 ec cf f1 b2 ec 6f f5 00 61  .....>.4.(VF..6Z
0080  27 3e e6 34 e3 28 56 66 f9 36 5a ad
```

Tunnel

Encrypted

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

68

68

## L2TP Frame Analysis (for ICMP as PPP Dtgrm)

- PPP Datagram (ICMP) = 88 bytes
- PtPP Header = 4 bytes
- L2TP Header = 6 bytes
- UDP Header = 8 bytes
- Total UDP Length =  $88 + 4 + 6 + 8$   
= 106 bytes
- IPv4 Header = 20 bytes
- Ethernet Header = 14 bytes
- L2TP frame length =  $20 + 14 + 106 = 140$  bytes

```
> Frame 23: 140 bytes on wire (1120 bits), 140 bytes capture
> Ethernet II, Src: 0c:f0:c9:b0:e7:02 (0c:f0:c9:b0:e7:02), D
> Internet Protocol Version 4, Src: 10.0.0.1, Dst: 10.0.0.2
  > User Datagram Protocol, Src Port: 1701, Dst Port: 1701
    Source Port: 1701
    Destination Port: 1701
    Length: 106
    Checksum: 0xad29 [unverified]
    [Checksum Status: Unverified]
    [Stream index: 0]
  > Layer 2 Tunneling Protocol
  > Point-to-Point Protocol
    PPP Compressed Datagram
```

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

69

69



## EoIP over L2TP Frame

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

70

70

## EoIP over L2TP

The image shows two screenshots of MikroTik WinBox. The left screenshot shows the configuration of 'eip-tunnel1' on Router 1 (192.168.10.1). The right screenshot shows the configuration of 'eip-tunnel1' on Router 2 (192.168.10.2). Red arrows indicate the configuration details being shared between the two routers.

**Router 1 (192.168.10.1) Configuration:**

- Interface: eip-tunnel1
- Type: EoIP Tunnel
- MTU: 1408
- L2 MTU: 65535
- MAC Address: 02:3C:94:DC:95:AC
- ARP: enabled
- Local Address: 192.168.100.1
- Remote Address: 192.168.100.2
- Tunnel ID: 100
- IPsec Secret: (empty)

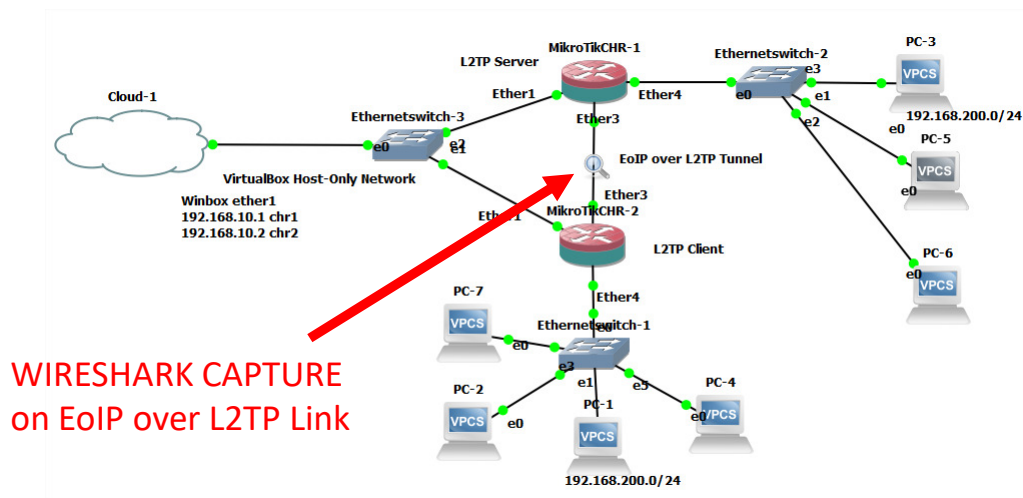
**Router 2 (192.168.10.2) Configuration:**

- Interface: eip-tunnel1
- Type: EoIP Tunnel
- MTU: 1408
- L2 MTU: 65535
- MAC Address: 02:85:A6:46:1C:D7
- ARP: enabled
- Local Address: 192.168.100.2
- Remote Address: 192.168.100.1
- Tunnel ID: 100

Yohanes Gunawan Yusuf (TR0639) MUM Kuta, BALI 24-25 Oct 2019 71

71

## EoIP over L2TP Tunnel



Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

72

72

## EoIP over L2TP Tunnel

```
> Frame 271: 182 bytes on wire (1456 bits), 182 bytes captured (1456 bits) on interface
> Ethernet II, Src: 0c:f5:4c:83:a0:02 (0c:f5:4c:83:a0:02), Dst: 0c:f5:4c:47:87:02 (0c:
> Internet Protocol Version 4, Src: 10.0.0.1, Dst: 10.0.0.2
> User Datagram Protocol, Src Port: 1701, Dst Port: 1701
> Layer 2 Tunneling Protocol
> Point-to-Point Protocol
> PPP Compressed Datagram
```

**EoIP and ICMP as compressed Datagram**

```
0000 0c f5 4c 47 87 02 0c f5 4c 83 a0 02 08 00 45 00 ..LG....L....E.
0010 00 a8 49 00 00 00 40 11 1d 43 0a 00 00 01 0a 00 ..I...@..C.....
0020 00 02 06 a5 06 a5 00 94 05 45 00 02 00 02 00 01 .....E.....
0030 ff 03 00 fd 90 38 96 21 ee 1e 7c d8 08 75 eb 64 ....8.!...|...u.d
0040 08 85 83 30 c2 e9 c5 44 fe 41 bf f7 60 22 fa 22 ...0...D.A...".
0050 54 c1 44 32 ba 43 aa ca f4 b7 20 2a e6 50 31 01 T.D2.C... *P1.
0060 c1 9d b8 69 7b 86 7f ed af 7b 60 35 06 7a e3 97 ...i{... {`5.z..
0070 10 ec 6d 25 30 05 d9 73 eb 99 1c 58 7c ee 63 e2 ...m%0...s...X|.c.
0080 2d 9b 19 ee 6f e2 0c 30 35 18 a4 8f 5a 08 e6 71 ....o..0 5...Z..q
0090 c7 7c a4 d9 f9 9f 37 a2 7d b9 14 41 f4 5a 8d 10 .|...7. }..A.Z..
00a0 14 15 4d 52 d0 19 82 03 30 2b 11 dd 2d a8 fc 05 ..MR....0+.....
00b0 70 9e 0a 30 f4 17 p..0..
```

PPP Compressed Datagram (comp\_data), 130 bytes

L2TP Tunnel

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

73

73

## Ping PC4 to PC5

```
PC1 : 192.168.200.4 255.255.255.0

PC-4> ping 192.168.200.5
84 bytes from 192.168.200.5 icmp_seq=1 ttl=64 time=586.140 ms
84 bytes from 192.168.200.5 icmp_seq=2 ttl=64 time=324.921 ms
84 bytes from 192.168.200.5 icmp_seq=3 ttl=64 time=401.102 ms
84 bytes from 192.168.200.5 icmp_seq=4 ttl=64 time=394.101 ms
84 bytes from 192.168.200.5 icmp_seq=5 ttl=64 time=403.102 ms

PC-4> ping 192.168.200.5
84 bytes from 192.168.200.5 icmp_seq=1 ttl=64 time=443.114 ms
84 bytes from 192.168.200.5 icmp_seq=2 ttl=64 time=380.071 ms
84 bytes from 192.168.200.5 icmp_seq=3 ttl=64 time=206.055 ms
84 bytes from 192.168.200.5 icmp_seq=4 ttl=64 time=289.075 ms
84 bytes from 192.168.200.5 icmp_seq=5 ttl=64 time=310.080 ms

PC-4> █
```

```
Copyright (c) 2007-2014, Paul Meng (mirnshi@gmail.com)
All rights reserved.

VPCS is free software, distributed under the terms of the
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC-5> ip 192.168.200.5 255.255.255.0
Checking for duplicate address...
PC1 : 192.168.200.5 255.255.255.0

PC-5> █
```

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

74

74

## EoIP over L2TP Frame Analysis

Ping and EoIP (as PPP Compressed Datagram = 130 bytes)

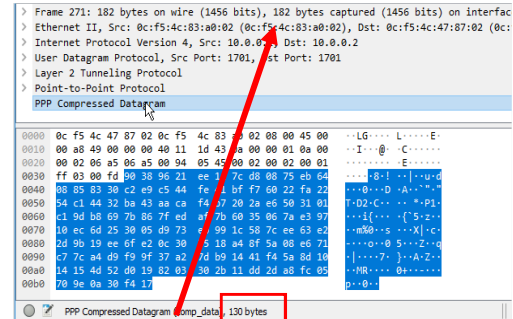
- **PPP Compr Datagram 130 bytes:**

- Ping (ICMP) total = 84 bytes
- PPTP Header = 4 bytes
- EoIP Header = 42 bytes

- PPTP Header = 4 bytes
- L2TP Header = 6 bytes
- UDP Header = 8 bytes
- IPv4 Header = 20 bytes
- Ethernet Header = 14 bytes

- **EoIP over L2TP frame length = 130 + 18 + 20 + 14 = 182 bytes**

```
PC> ping 192.168.200.5
84 bytes from 192.168.200.5 icmp_seq=1 ttl=64 time=443.114 ms
84 bytes from 192.168.200.5 icmp_seq=2 ttl=64 time=380.071 ms
84 bytes from 192.168.200.5 icmp_seq=3 ttl=64 time=206.055 ms
84 bytes from 192.168.200.5 icmp_seq=4 ttl=64 time=289.075 ms
84 bytes from 192.168.200.5 icmp_seq=5 ttl=64 time=310.080 ms
```



Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

75

75

## Actual MTU Decreased for EoIP over L2TP

- **Actual MTU For Single Tunnel**

- EoIP = 1458 bytes
- L2TP = 1450 bytes

- **EoIP Header length = 42 bytes**

- **Actual MTU for EoIP over L2TP:**  
= Actual Bridge Interface  
= 1450 – 42 = 1408 bytes

| Name | Type        | Actual MTU | L2 MTU | Tx    | Rx  |
|------|-------------|------------|--------|-------|-----|
| R    | Bridge      | 1458       | 65535  | 0 bps | 0   |
| RS   | EoIP Tunnel | 1458       | 65535  | 0 bps | 0   |
| R    | Ethernet    | 1500       | 65535  | 0 bps | 984 |
| R    | Ethernet    | 1500       | 65535  | 0 bps | 0   |
| R    | Ethernet    | 1500       | 65535  | 0 bps | 0   |
| RS   | Ethernet    | 1500       | 65535  | 0 bps | 0   |

| Name | Type                | Actual MTU | L2 MTU | Tx       | Rx    |
|------|---------------------|------------|--------|----------|-------|
| DR   | L2TP Server Binding | 1450       | 65535  | 0 bps    | 0     |
| R    | Bridge              | 1408       | 65535  | 0 bps    | 0     |
| RS   | EoIP Tunnel         | 1408       | 65535  | 0 bps    | 0     |
| R    | Ethernet            | 1500       | 65535  | 77.5 bps | 7.0 k |
| R    | Ethernet            | 1500       | 65535  | 0 bps    | 0     |
| RS   | Ethernet            | 1500       | 65535  | 0 bps    | 0     |
| R    | Ethernet            | 1500       | 65535  | 0 bps    | 0     |

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

76

76

# VLAN over EoIP Frame

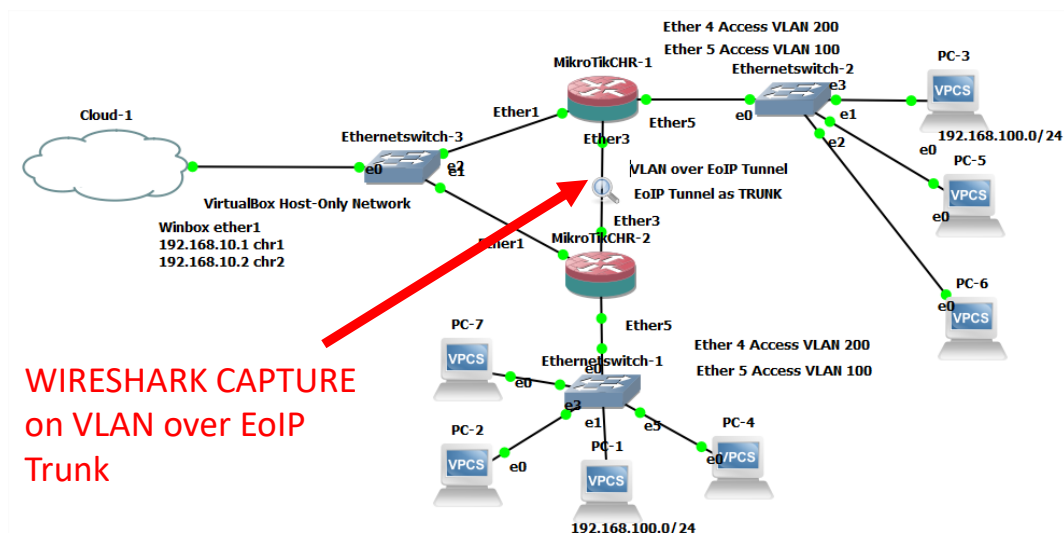
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

77

77

## VLAN over EoIP Tunnel



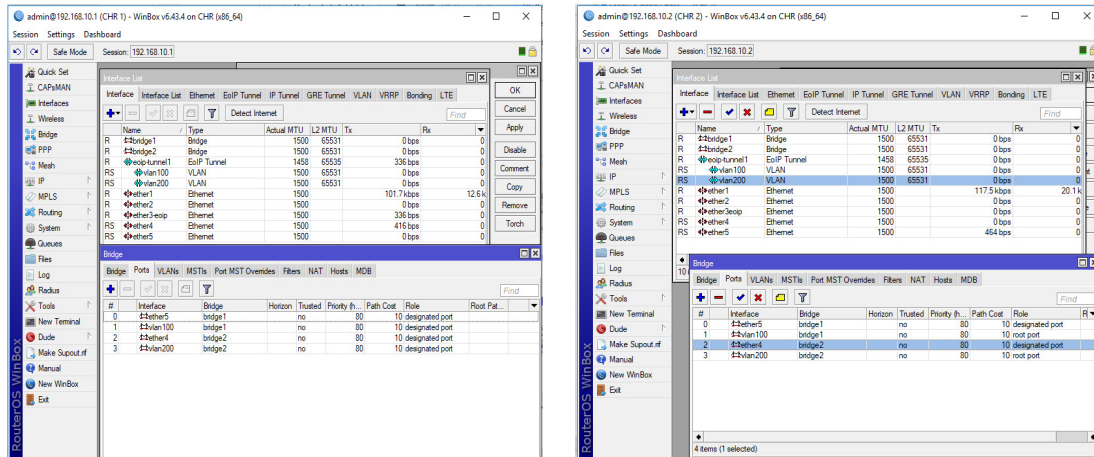
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

78

78

# VLAN over EoIP Setup



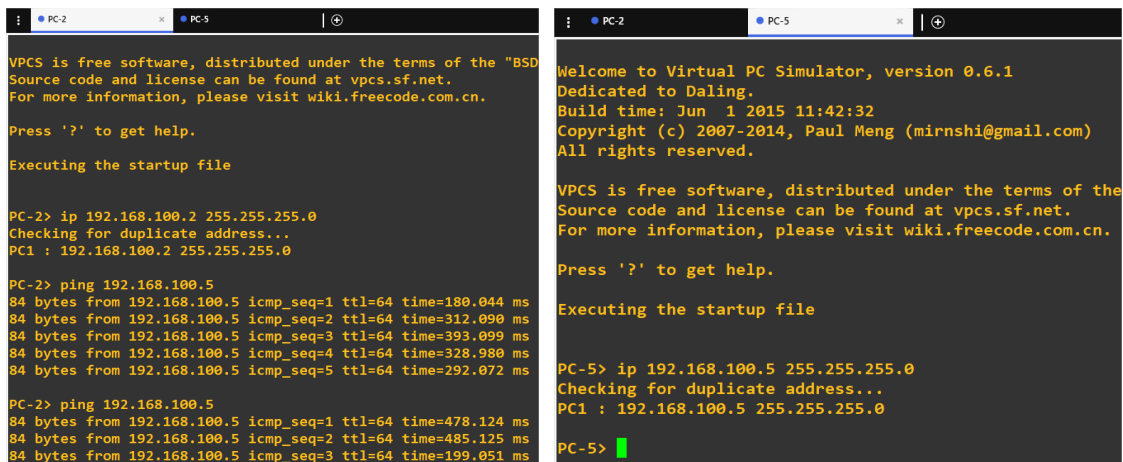
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

79

79

## Ping PC2 to PC5



Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

80

80

## VLAN over EoIP Frame

Frame 144: 144 bytes on wire (1152 bits), 144 bytes captured (1152 bits) on interface 0

Ethernet II, Src: 0c:8a:14:e6:81:02 (0c:8a:14:e6:81:02), Dst: 0c:8a:14:7b:78:02 (0c:8a:14:7b:78:02)

Internet Protocol Version 4, Src: 10.0.0.2, Dst: 10.0.0.1

Generic Routing Encapsulation (MIKROTIK EoIP)

Ethernet II, Src: Private\_66:68:01 (00:50:79:66:68:01), Dst: Private\_66:68:03 (00:50:79:66:68:03)

802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 100

Internet Protocol Version 4, Src: 192.168.100.2, Dst: 192.168.100.5

Internet Control Message Protocol

0000 0c 8a 14 7b 78 02 0c 8a 14 e6 81 02 08 00 45 00 ...{x... ..E..

0010 00 82 20 01 00 00 ff 2f 87 49 0a 00 00 02 0a 00 ... ..I..

0020 00 01 20 01 64 00 00 66 33 00 00 50 79 66 68 03 ...d..f 3..Pyfh...

0030 00 50 79 66 68 01 81 00 00 64 08 00 45 00 00 54 ...Pyfh...d..E..T

0040 a9 f2 00 00 00 01 87 5e c0 a8 64 02 c0 a8 64 05 ...@..^..d..d..

0050 08 00 2d 61 f2 a9 00 01 08 09 0a 0b 0c 0d 0e 0f ...-a... ..

0060 10 11 12 13 14 15 16 17 18 19 1a 1b 1c 1d 1e 1f ..... ..

0070 20 21 22 23 24 25 26 27 28 29 2a 2b 2c 2d 2e 2f ...!#\$%&'()\*+,-./

0080 30 31 32 33 34 35 36 37 38 39 3a 3b 3c 3d 3e 3f ...01234567 89;<=>?

81

## VLAN over EoIP Frame Analysis

- Ping Data (ICMP) = 64 bytes
- IPv4 Inner Header = 20 bytes
- 802.1Q Header = 4 bytes
- Inner Ethernet Header = 14 bytes
- GRE Header = 8 bytes
- IPv4 outer Header = 20 bytes
- Outer Ethernet Header = 14 bytes
- Total frame length = 102 + 42 = 144 bytes

Frame 144: 144 bytes on wire (1152 bits), 144 bytes captured (1152 bits) on interface 0

Ethernet II, Src: 0c:8a:14:e6:81:02 (0c:8a:14:e6:81:02), Dst: 0c:8a:14:7b:78:02 (0c:8a:14:7b:78:02)

Internet Protocol Version 4, Src: 10.0.0.2, Dst: 10.0.0.1

Generic Routing Encapsulation (MIKROTIK EoIP)

Ethernet II, Src: Private\_66:68:01 (00:50:79:66:68:01), Dst: Private\_66:68:03 (00:50:79:66:68:03)

802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 100

Internet Protocol Version 4, Src: 192.168.100.2, Dst: 192.168.100.5

Internet Control Message Protocol

0000 0c 8a 14 7b 78 02 0c 8a 14 e6 81 02 08 00 45 00 ...{x... ..E..

0010 00 82 20 01 00 00 ff 2f 87 49 0a 00 00 02 0a 00 ... ..I..

0020 00 01 20 01 64 00 00 66 33 00 00 50 79 66 68 03 ...d..f 3..Pyfh...

0030 00 50 79 66 68 01 81 00 00 64 08 00 45 00 00 54 ...Pyfh...d..E..T

0040 a9 f2 00 00 00 01 87 5e c0 a8 64 02 c0 a8 64 05 ...@..^..d..d..

0050 08 00 2d 61 f2 a9 00 01 08 09 0a 0b 0c 0d 0e 0f ...-a... ..

0060 10 11 12 13 14 15 16 17 18 19 1a 1b 1c 1d 1e 1f ..... ..

0070 20 21 22 23 24 25 26 27 28 29 2a 2b 2c 2d 2e 2f ...!#\$%&'()\*+,-./

0080 30 31 32 33 34 35 36 37 38 39 3a 3b 3c 3d 3e 3f ...01234567 89;<=>?

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

82

82

## L-2 for EoIP and VLAN Frames

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <pre> &gt; Frame 144: 144 bytes on wire (1152 bits), 144 bytes captured (1152 bits) on i ✓ Ethernet II, Src: 0c:8a:14:e6:81:02 (0c:8a:14:e6:81:02), Dst: 0c:8a:14:7b:78:   &gt; Destination: 0c:8a:14:7b:78:02 (0c:8a:14:7b:78:02)   &gt; Source: 0c:8a:14:e6:81:02 (0c:8a:14:e6:81:02)   Type: IPv4 (0x0800) ✓ Internet Protocol Version 4, Src: 10.0.0.2, Dst: 10.0.0.1   0100 .... = Version: 4   .... 0101 = Header Length: 20 bytes (5)   &gt; Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)   Total Length: 130   Identification: 0x2001 (8193)   &gt; Flags: 0x0000   Time to live: 255   Protocol: Generic Routing Encapsulation (47)   Header checksum: 0x8749 [validation disabled]   [Header checksum status: Unverified]   Source: 10.0.0.2   Destination: 10.0.0.1   &gt; Generic Routing Encapsulation (MIKROTIK EoIP)   &gt; Ethernet II, Src: Private_66:68:01 (00:50:79:66:68:01), Dst: Private_66:68:03   &gt; 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 100   &gt; Internet Protocol Version 4, Src: 192.168.100.2, Dst: 192.168.100.5   &gt; Internet Control Message Protocol </pre> | <pre> Key: 0x00663300 ✓ Ethernet II, Src: Private_66:68:01 (00:50:79:66:68:01), Dst: Private_66:68:03   &gt; Destination: Private_66:68:03 (00:50:79:66:68:03)   &gt; Source: Private_66:68:01 (00:50:79:66:68:01)   Type: 802.1Q Virtual LAN (0x8100) ✓ 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 100   000. .... = Priority: Best Effort (default) (0)   ...0 .... = DEI: Ineligible   .... 0000 0110 0100 = ID: 100   Type: IPv4 (0x0800) ✓ Internet Protocol Version 4, Src: 192.168.100.2, Dst: 192.168.100.5   0100 .... = Version: 4   .... 0101 = Header Length: 20 bytes (5)   &gt; Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)   Total Length: 84   Identification: 0xa9f2 (43506)   &gt; Flags: 0x0000   Time to live: 64   Protocol: ICMP (1)   Header checksum: 0x875e [validation disabled]   [Header checksum status: Unverified]   Source: 192.168.100.2   Destination: 192.168.100.5   &gt; Internet Control Message Protocol </pre> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

83

83



## Conclusion

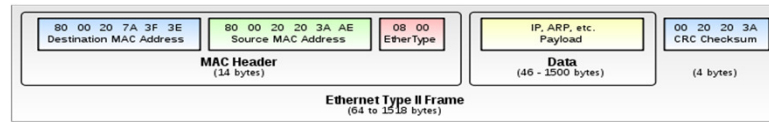
Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

84

84

## Conclusion



- For one **PING Request (ICMP 84 bytes)** the total length L2 Ethernet frame are:

|                     |                    |
|---------------------|--------------------|
| • Ethernet Standard | 98 bytes           |
| • 802.1Q            | 102 bytes          |
| • QinQ              | 104 bytes          |
| • PPPoE             | 82 bytes (ICMP 56) |
| • EoIP Tunnel       | 140 bytes          |
| • L2TP              | 140 bytes          |
| • EoIP over L2TP    | 182 bytes          |
| • VLAN over EoIP    | 144 bytes          |

- Added bytes** in Ethernet frame:

|                     |                        |
|---------------------|------------------------|
| • Ethernet Standard | 0 bytes                |
| • 802.1Q            | 4 bytes                |
| • QinQ              | 8 bytes (for 2 Vlan)   |
| • PPPoE             | 12 bytes (w comp 4B)   |
| • EoIP Tunnel       | 42 bytes               |
| • L2TP              | 50 bytes (with UDP 8B) |
| • EoIP over L2TP    | 84 bytes               |
| • VLAN over EoIP    | 46 bytes               |

Actual MTU = 1500 – (Added bytes) for L3 MTU

If L3 payload include IP header = 20 bytes, TCP header = 20 bytes then

**Maximum Payload (bytes) = Actual MTU – 20 – 20**

If total frames size more than Actual MTU link size, the frame will be fragmented by Router (if the protocol can do fragmentation!), so it will take more delay time and more bandwidth for the link.

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

85

85



Let's discuss it....  
Thank you

Yohanes Gunawan Yusuf (TR0639)

MUM Kuta, BALI 24-25 Oct 2019

86

86