Interpreting Protocol Trace Files

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Source	Destination	BSSID	Flags	Protocol	Signal dBm	Data Rate
Cisco:FC:C7:FF	Mobile Client	Access Point	W	802.11 WEP Data	-64	36.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-65	36.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-65	36.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-65	18.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-64	18.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-65	18.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-64	18.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-65	12.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-65	12.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-64	12.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-65	12.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-65	12.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-65	12.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-65	12.0
Mobile Client	Access Point	Access Point		802.11 Null Data	-41	11.0
Access Point	Mobile Client		#	802.11 Ack	-59	2.0
Mobile Client	Cisco:07:AC:96	Access Point	W	802.11 WEP Data	-43	11.0
Access Point	Mobile Client		#	802.11 Ack	-59	2.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W	802.11 WEP Data	-63	36.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-64	36.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-63	36.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-64	36.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-63	18.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-63	18.0
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Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-63	18.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-63	12.0
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Access Point	Mobile Client		#	802.11 Ack	-59	2.0
Mobile Client	Cisco:07:AC:96	Access Point	W	802.11 WEP Data	-47	11.0
Access Point	Mobile Client		#	802.11 Ack	-60	2.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-64	36.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-63	36.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-63	18.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-63	18.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-63	12.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-63	12.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-63	12.0

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Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-64	36.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-63	36.0
Cisco:FC:C7:FF	Mobile Client	Access Point	W+	802.11 WEP Data	-64	36.0

The Packets Never Lie!

But often our interpretation of the packets do

Agenda

- Which channel?
- Which packets should be acknowledged?
- What do corrupted packets mean?
- How important is location?
- Where is my data?
- Getting the complete picture

Which channel?

Where we see channel information?

Source	Destination	BSSID	Flags	Signal dBm	Data Rate	Delta Time	Protocol	Channel	Size
Cisco:43:3F:60	Ethernet Broadcast	Cisco:43:3F:60	*	-44	12.0	0.006232	802.11 Beacon	6	246
			#CW+	-84	6.0	0.004749	802.11 Control	6	34
Cisco:1A:6F:40	Ethernet Broadcast	Cisco:1A:6F:40	*PC	-84	1.0	0.007421	802.11 Beacon	6	231
06:18:0A:79:F0:D6	Ethernet Broadcast	06:18:0A:79:F0:D6	*P	-77	1.0	0.002924	802.11 Beacon	6	253
84:18:3A:15:5A:38	Ethernet Broadcast	84:18:3A:15:5A:38	*	-69	12.0	0.000159	802.11 Beacon	6	177
84:18:3A:55:5A:38	Ethernet Broadcast	84:18:3A:55:5A:38	*	-69	12.0	0.000156	802.11 Beacon	6	177
DA:E4:54:9D:07:00	84:18:3A:56:06:A8		C+	-83	24.0	0.001331	802.11 QoS CF-Poll	6	36
Cisco:1A:6F:44	Ethernet Broadcast	Cisco:1A:6F:44	*	-84	1.0	0.007513	802.11 Beacon	6	209
Cisco:1A:6F:42	Ethernet Broadcast	Cisco:1A:6F:42	*P	-89	1.0	0.013074	802.11 Beacon	6	231
0A:18:0A:79:F0:D6	Ethernet Broadcast	0A:18:0A:79:F0:D6	*	-79	1.0	0.003006	802.11 Beacon	6	199
0C:27:24:E6:16:01	Ethernet Broadcast	0C:27:24:E6:16:01	*PC	-80	12.0	0.000254	802.11 Beacon	6	290
	6C:8D:C1:55:E3:BD		#	-86	24.0	0.004208	802.11 CTS	6	14
84:18:3A:16:06:A8	6C:8D:C1:55:E3:BD		#	-85	24.0	0.000007	802.11 BA	6	32
	E8:50:8B:CB:CD:30		#	-86	24.0	0.002492	802.11 Ack	6	14
A6:2B:87:FB:98:28	3alityDigi:9B:8B:92	1C:1D:1F:6E:6B:3E	C+	-69	12.0	0.001934	802.11 Data	6	290
Meraki:79:F0:D6	Ethernet Broadcast	Meraki:79:F0:D6	*P	-74	1.0	0.042629	802.11 Beacon	7	253
	Xerox:00:00:00		#	-42	1.0	0.012262	802.11 Ack	7	14
0A:18:0A:79:F0:D6	Ethernet Broadcast	0A:18:0A:79:F0:D6	*	-75	1.0	0.040196	802.11 Beacon	7	199
Meraki:79:F0:D6	Ethernet Broadcast	Meraki:79:F0:D6	*P	-75	1.0	0.049946	802.11 Beacon	7	253
Cisco:1A:6F:45	FF:FF:FF:FF:3F:93	C8:F9:39:76:6F:45	*PC	-83	1.0	0.008336	802.11 Beacon	7	231
	Xerox:00:00:00		#	-83	1.0	0.003875	802.11 Ack	7	14
06:18:0A:79:F0:D6	Ethernet Broadcast	06:18:0A:79:F0:D6	*P	-74	1.0	0.013386	802.11 Beacon	7	253
0A:18:0A:79:F0:D6	Ethernet Broadcast	0A:18:0A:79:F0:D6	*	-73	1.0	0.025206	802.11 Beacon	7	199
Cisco:1A:6F:42	FF:FF:33:61:F2:FF	C8:61:F4:1A:6F:42	*PC	-77	1.0	0.002059	802.11 Beacon	7	231
	Xerox:00:00:00		#						
Meraki:79:F0:D6	Ethernet Broadcast	Meraki:79:F0:D6	*P						
Cisco:1A:6F:45	Ethernet Broadcast	Cisco:1A:6F:45	*C						
	Xerox:00:00:00		#						
5C:E0:C5:EF:50:A1	Ethernet Broadcast	Ethernet Broadcast	*						
06:18:0A:79:F0:D6	Ethernet Broadcast	06:18:0A:79:F0:D6	*PC						
0A:18:0A:79:F0:D6	Ethernet Broadcast	0A:18:0A:79:F0:D6	*						
Meraki:79:F0:D6	Ethernet Broadcast	Meraki:79:F0:D6	*P						
	Xerox:00:00:00		#						
06:18:0A:79:F0:D6	Ethernet Broadcast	06:18:0A:79:F0:D6	*P						
0A:18:0A:79:F0:D6	Ethernet Broadcast	0A:18:0A:79:F0:D6	*						

Packet Info

Packet Number:	288
Flags:	0x00000000
Status:	0x00000000
Packet Length:	113
Timestamp:	14:42:31.019826500 08/12/2016
Data Rate:	2 *1.0 Mbps*
Channel:	2 *2417MHz 802.11b*
Signal Level:	100%
Signal dBm:	-47
Noise Level:	10%
Noise dBm:	-86

Node	Type	Channel	Band	Encryption
Riverwalk NOLA	ESSID	1, 3, 60, 132		
6C:AA:B3:03:D5:18	AP	1	802.11b	
6C:AA:B3:05:33:48	AP	3	802.11b	
6C:AA:B3:05:33:4C	AP	60	802.11a	
6C:AA:B3:03:D5:1C	AP	132	802.11a	
HHCOperations	ESSID	1, 3, 60, 132		
6C:AA:B3:43:D5:18	AP	1	802.11b	CCMP
6C:AA:B3:45:33:48	AP	3	802.11b	CCMP
6C:AA:B3:45:33:4C	AP	60	802.11a	CCMP
6C:AA:B3:43:D5:1C	AP	132	802.11a	CCMP
Guests	ESSID	1, 149		
CC:16:7E:52:B1:A1	AP	1	802.11b	
CC:16:7E:52:B1:AE	AP	149	802.11a	
W2L3	ESSID	1, 149		
CC:16:7E:52:B1:A0	AP	1	802.11b	CCMP
CC:16:7E:52:B1:AF	AP	149	802.11a	CCMP
IT Admin	ESSID	1, 6, 11		
0C:27:24:E6:98:E1	AP	1	802.11bg	TKIP
	STA	1	802.11bg	
	STA	1	802.11bg	
	AP	1	802.11bg	
	AP	1	802.11bg	TKIP
	AP	6	802.11bg	TKIP
	STA	6	802.11bg	
	AP	6	802.11bg	TKIP
	AP	11	802.11bg	
	AP	11	802.11bg	

Channel Information – Beacon

- Packet Info
  - Packet Number: 288
  - Flags: 0x00000000
  - Status: 0x00000000
  - Packet Length: 113
  - Timestamp: 14:42:31.019826500 08/12/2016
  - Data Rate: 2 *1.0 Mbps*
  - Channel: 2 *2417MHz 802.11b*
  - Signal Level: 100%
  - Signal dBm: -47
  - Noise Level: 10%
  - Noise dBm: -86

Channel the packet was capture on

Channel the packet was transmitted on

- Direct Sequence Parameter Set
  - Element ID: 3 *Direct Sequence Parameter Set* [60]
  - Length: 1 [61]
  - Channel: 1 [62]

Which packets should be acknowledged?

CTS / ACK

```
802.11 MAC Header
    Version:                0 [0 Mask 0x03]
    Type:                   %01  Control [0 Mask 0x0C]
    Subtype:                %1100  Clear To Send (CTS) [0 Mask 0xF0]
  Frame Control Flags:      %00000000 [1]
                              0... .... Non-strict order
                              .0.. .... Non-Protected Frame
                              ..0. .... No More Data
                              ...0 .... Power Management - active mode
                              .... 0... This is not a Re-Transmission
                              .... .0.. Last or Unfragmented Frame
                              .... ..0. Not an Exit from the Distribution System
                              .... ...0 Not to the Distribution System
    Duration:               118  Microseconds [2-3]
    Receiver:               A8:5B:78:3B:6A:16 [4-9]
FCS - Frame Check Sequence
    FCS:                    0x9D871EAF [10-13]
```

```
802.11 MAC Header
    Version:                0 [0 Mask 0x03]
    Type:                   %01  Control [0 Mask 0x0C]
    Subtype:                %1101  Acknowledgment (ACK) [0 Mask 0xF0]
  Frame Control Flags:      %00000000 [1]
                              0... .... Non-strict order
                              .0.. .... Non-Protected Frame
                              ..0. .... No More Data
                              ...0 .... Power Management - active mode
                              .... 0... This is not a Re-Transmission
                              .... .0.. Last or Unfragmented Frame
                              .... ..0. Not an Exit from the Distribution System
                              .... ...0 Not to the Distribution System
    Duration:               0  Microseconds [2-3]
    Receiver:               A8:5B:78:3B:6A:16 [4-9]
FCS - Frame Check Sequence
    FCS:                    0x629E8FE2 [10-13]
```

Client Troubleshooting

Packet	Source	Destination	Flags	Channel	Signal dBm	Data Rate	Protocol
1268	Wireless Client	Wireless AP	*	112	-57	6.0	802.11 Auth
1269	Wireless AP	Wireless Client	#	112	-61	6.0	802.11 Ack
1270	Wireless AP	Wireless Client	*	112	-61	6.0	802.11 Auth
1271	Wireless Client	Wireless AP	*	112	-55	6.0	802.11 Assoc Req
1272	Wireless AP	Wireless Client	#	112	-62	6.0	802.11 Ack
1273	Wireless AP	Wireless Client	*	112	-61	6.0	802.11 Assoc Rsp
1274	Wireless AP	Wireless Client	*	112	-62	6.0	802.11 Action
1275	Wireless AP	Wireless Client		112	-64	6.0	EAP Request

Acknowledgment

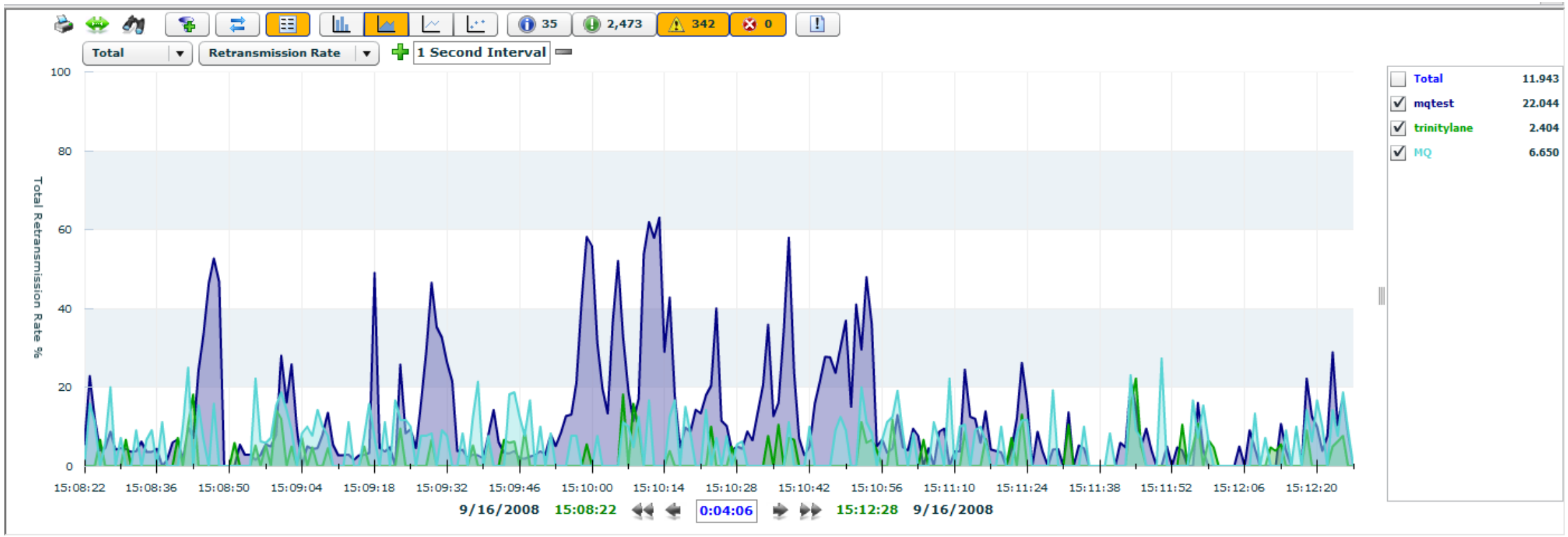
- Packet Info
  - Packet Number: 1300
  - Flags: 0x00000001
  - Status: 0x00000000
  - Packet Length: 14
  - Timestamp: 13:23:39.594567900 01/22/2015
  - Data Rate: 12 *6.0 Mbps*
  - Channel: 112 *5560MHz 802.11a*
  - Signal Level: 83%
  - Signal dBm: -63
  - Noise Level: 6%
  - Noise dBm: -5
- 802.11 MAC Header
  - Version: 0 [0 Mask 0x03]
  - Type: %01 *Control* [0 Mask 0x0C]
  - Subtype: %1101 *Acknowledgment (ACK)* [0 Mask 0xF0]
  - Frame Control Flags: %00000000 [1]
    - *0... .... Non-strict order*
    - *.0.. .... Non-Protected Frame*
    - *..0. .... No More Data*
    - *...0 .... Power Management - active mode*
    - *.... 0... This is not a Re-Transmission*
    - *.... .0.. Last or Unfragmented Frame*
    - *.... ..0. Not an Exit from the Distribution System*
    - *.... ...0 Not to the Distribution System*
  - Duration: 14 *Microseconds* [2-3]
  - Receiver: 2C:F0:EE:DC:07:01 *Wireless Client* [4-9]
- FCS - Frame Check Sequence
  - FCS: 0x699CD512 *Calculated*

What do corrupted packets mean?

CRC Errors

acket	Source	Destination	Flags	Channel	Signal dBm	Data Rate	Protocol
1200		B0:16:80:26:F6:63	#C	8	-65	36.0	802.11 Ack
1201	33:05:7D:BC:67:4B	2D:2E:B9:56:F6:DC	*CW	8	-63	18.0	802.11 Deauth
1202	2F:DD:AD:8A:7B:91	A3:96:3C:C6:09:A0	CW+	8	-65	18.0	802.11 Frag
1203	D9:17:F2:14:31:6B	AE:58:A7:7F:49:41	CW+	8	-63	12.0	802.11 Frag
1204			C+	8	-65	48.0	802.11
1205	34:E3:9A:EC:83:A2	56:DD:67:31:75:58	CW	8	-63	48.0	802.11 Frag
1206	0F:00:8B:85:81:DB	6D:B7:38:3F:5E:42	CW+	8	-64	18.0	802.11 Frag
1207	CC:EC:4C:84:E9:40	58:C5:08:B7:98:09	*CW+	8	-65	12.0	802.11 Management
1208	AB:A5:0B:57:33:EA	80:94:F0:B2:AA:75	*C+	8	-65	36.0	802.11 Probe Req
1209	B1:A0:7F:2A:1D:AC	6D:E6:89:45:C1:C1	*C+	8	-64	54.0	802.11 Management
1210			CW+	8	-64	48.0	802.11
1211	85:73:62:44:CA:AB	0B:C0:29:0B:0F:9F	CW+	8	-65	54.0	802.11 Frag
1212	46:19:DD:47:37:22	2D:4F:AD:D5:C4:59	C+	8	-67	18.0	802.11 Null Data
1213		42:8D:30:22:51:F8	#C	8	-64	18.0	802.11 CTS
1214			#C+	8	-66	48.0	802.11 Control
1215	CD:94:4F:90:E2:E4	1C:A4:40:10:AE:B3	C+	8	-66	48.0	802.11 Frag
1216	79:95:85:A5:D3:21	E9:59:11:08:B0:11	#CW+	8	-64	48.0	802.11 BAR
1217	7B:8E:8F:32:04:87	4F:3E:65:5F:59:03	*C+	8	-65	48.0	802.11 Management
1218	D1:91:6C:F0:7F:1B	2D:05:78:2F:13:BB	*C	8	-64	18.0	802.11 Assoc Rsp
1219	E6:CE:89:21:2D:98	11:13:E8:E4:02:29	*CW	8	-64	18.0	802.11 Reassoc Req
1220	CD:EE:89:AC:48:BF	D6:C7:71:3D:37:ED	CW	8	-64	48.0	802.11 Frag
1221	A8:7B:AC:C2:F9:07	8D:CB:40:7E:F8:56	*CW	8	-64	12.0	802.11 Disassoc
1222	62:99:10:84:B5:72	24:ED:C8:33:1A:3B	#C	8	-65	18.0	802.11 Control

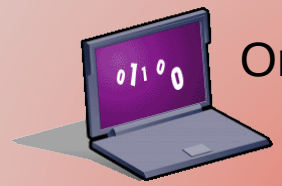
Retries tell a better story



How important is location?

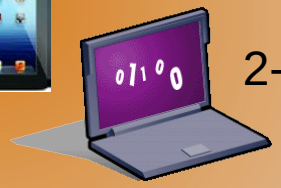
Capture location

Capture location



Only AP traffic seen here

Is there a problem?



2-way traffic seen here

Where is my data?

No data

Missing Data

Source	Destination	Protocol	Delta Time
Meru:02:5B:A2	D4:F4:6F:05:E6:74	802.11 RTS	0.000491
D4:F4:6F:05:E6:74	Meru:02:5B:A2	802.11 CTS	0.000000
D4:F4:6F:05:E6:74	Meru:02:5B:A2	802.11 BA	0.001636
D4:F4:6F:05:E6:74	Meru:02:5B:A2	802.11 RTS	0.000000
Meru:02:5B:A2	D4:F4:6F:05:E6:74	802.11 CTS	0.000002
Meru:02:5B:A2	D4:F4:6F:05:E6:74	802.11 BA	0.000245
Meru:02:5B:A2	D4:F4:6F:05:E6:74	802.11 RTS	0.000120
D4:F4:6F:05:E6:74	Meru:02:5B:A2	802.11 CTS	0.000001
D4:F4:6F:05:E6:74	Meru:02:5B:A2	802.11 BA	0.001506
D4:F4:6F:05:E6:74	Meru:02:5B:A2	802.11 RTS	0.000001
Meru:02:5B:A2	D4:F4:6F:05:E6:74	802.11 CTS	0.000000
Meru:02:5B:A2	D4:F4:6F:05:E6:74	802.11 BA	0.000117
Meru:02:5B:A2	D4:F4:6F:05:E6:74	802.11 RTS	0.000250
D4:F4:6F:05:E6:74	Meru:02:5B:A2	802.11 CTS	0.000001
D4:F4:6F:05:E6:74	Meru:02:5B:A2	802.11 BA	0.001504
D4:F4:6F:05:E6:74	Meru:02:5B:A2	802.11 RTS	0.000001
Meru:02:5B:A2	D4:F4:6F:05:E6:74	802.11 CTS	0.000001
Meru:02:5B:A2	D4:F4:6F:05:E6:74	802.11 BA	0.000241
Meru:02:5B:A2	D4:F4:6F:05:E6:74	802.11 RTS	0.000001
D4:F4:6F:05:E6:74	Meru:02:5B:A2	802.11 CTS	0.000001
D4:F4:6F:05:E6:74	Meru:02:5B:A2	802.11 BA	0.001380
D4:F4:6F:05:E6:74	Meru:02:5B:A2	802.11 RTS	0.000001
Meru:02:5B:A2	D4:F4:6F:05:E6:74	802.11 CTS	0.000001
Meru:02:5B:A2	D4:F4:6F:05:E6:74	802.11 BA	0.000243

Duration time between CTS and Block Ack is an indication of the data transmission

MU-MIMO Data Exchange

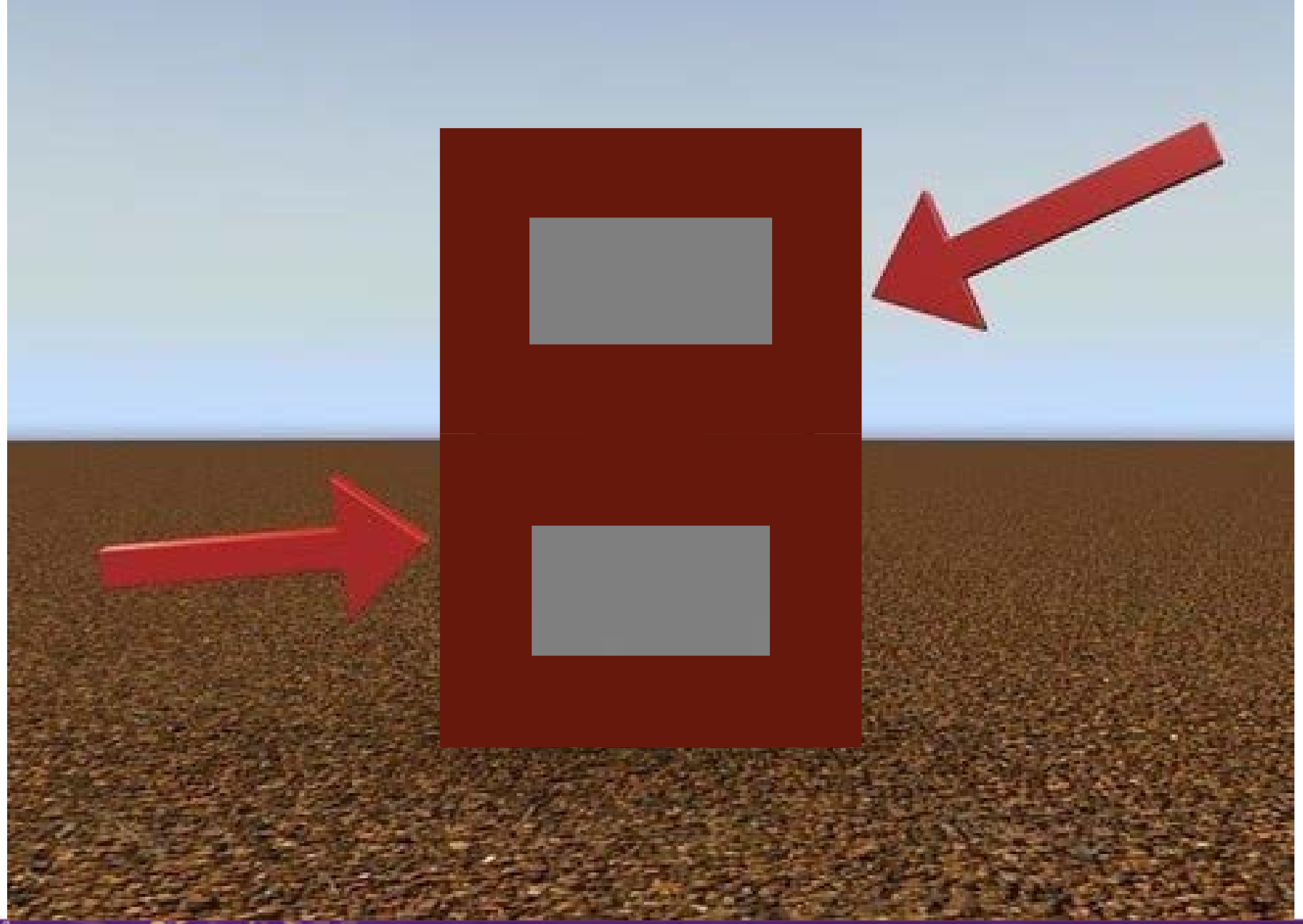
MU Sounding Exchange

MU Data

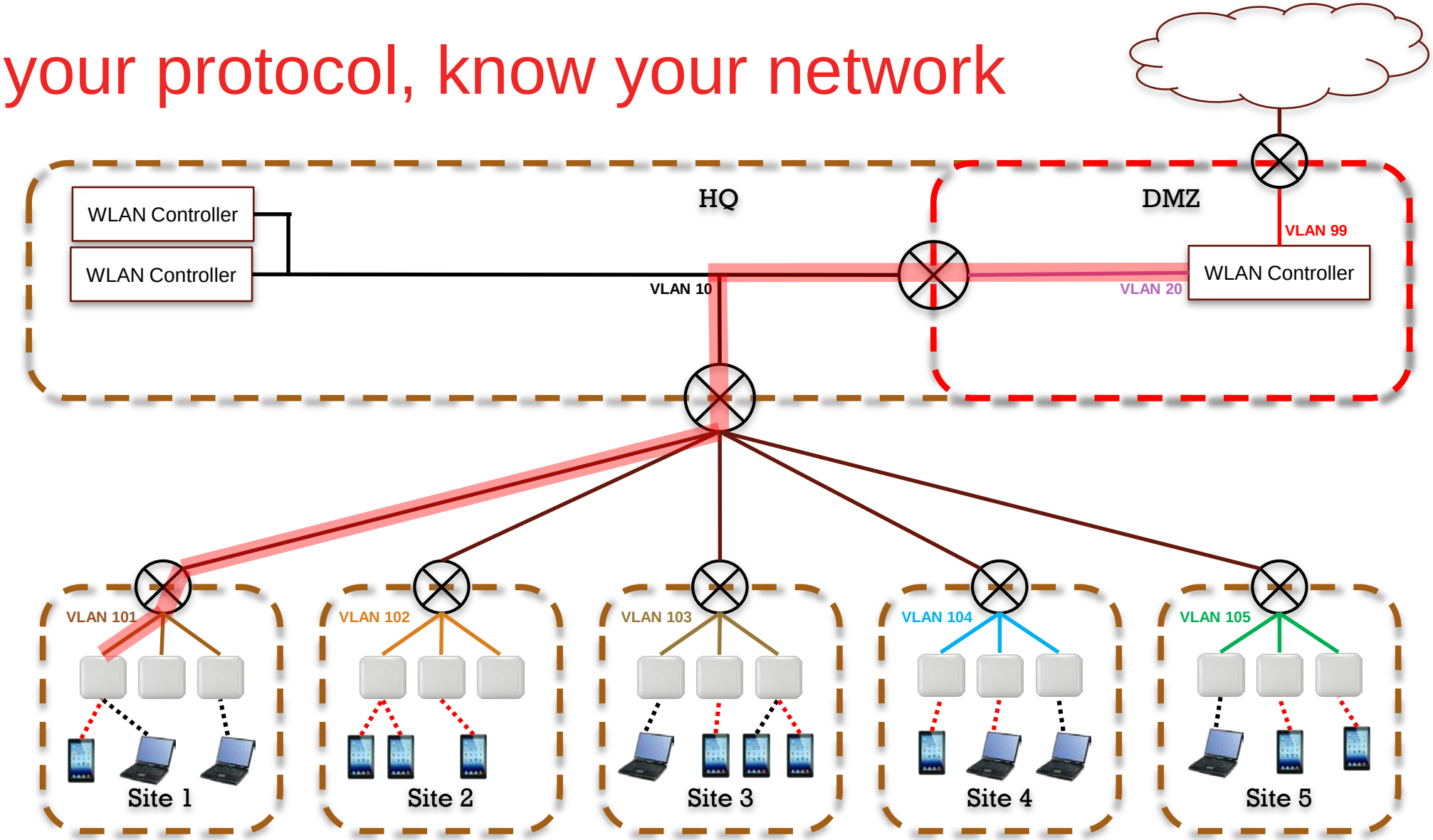
Data Ack

Source	Destination	Protocol	Decode: Subtype	Delta Time
Access Point MU	Ethernet Broadcast	802.11 Control	%0101 VHT NDP Announcement	0.00055a
Client #3	Access Point	802.11 Management	%1110 Action No Ack	0.000542
Access Point MU	Client #1	802.11 Control	%0100 Beamforming Report Poll	0.000009
Client #1	Access Point	802.11 Management	%1110 Action No Ack	0.000512
Access Point MU	Client #2	802.11 Control	%0100 Beamforming Report Poll	0.000009
Client #2	Access Point	802.11 Management	%1110 Action No Ack	0.001988
Client #3	Access Point	802.11 BA	%1001 Block Acknowledgement (BlockAck)	0.001901
Access Point	Client #1	802.11 BAR	%1000 Block Acknowledgement Request (BlockAckReq)	0.000008
Client #1	Access Point	802.11 BA	%1001 Block Acknowledgement (BlockAck)	0.000004
Access Point	Client #2	802.11 BAR	%1000 Block Acknowledgement Request (BlockAckReq)	0.000005
Client #2	Access Point	802.11 BA	%1001 Block Acknowledgement (BlockAck)	0.000026
Client #2	Access Point	802.11 CTS	%1100 Clear To Send (CTS)	0.000187
Client #3	Access Point	802.11 BA	%1001 Block Acknowledgement (BlockAck)	0.001934
Access Point	Client #1	802.11 BAR	%1000 Block Acknowledgement Request (BlockAckReq)	0.000009
Client #1	Access Point	802.11 BA	%1001 Block Acknowledgement (BlockAck)	0.000004
Access Point	Client #2	802.11 BAR	%1000 Block Acknowledgement Request (BlockAckReq)	0.000028
Client #2	Access Point	802.11 BA	%1001 Block Acknowledgement (BlockAck)	0.000004
Client #2	Access Point	802.11 CTS	%1100 Clear To Send (CTS)	0.000207

Getting the complete picture

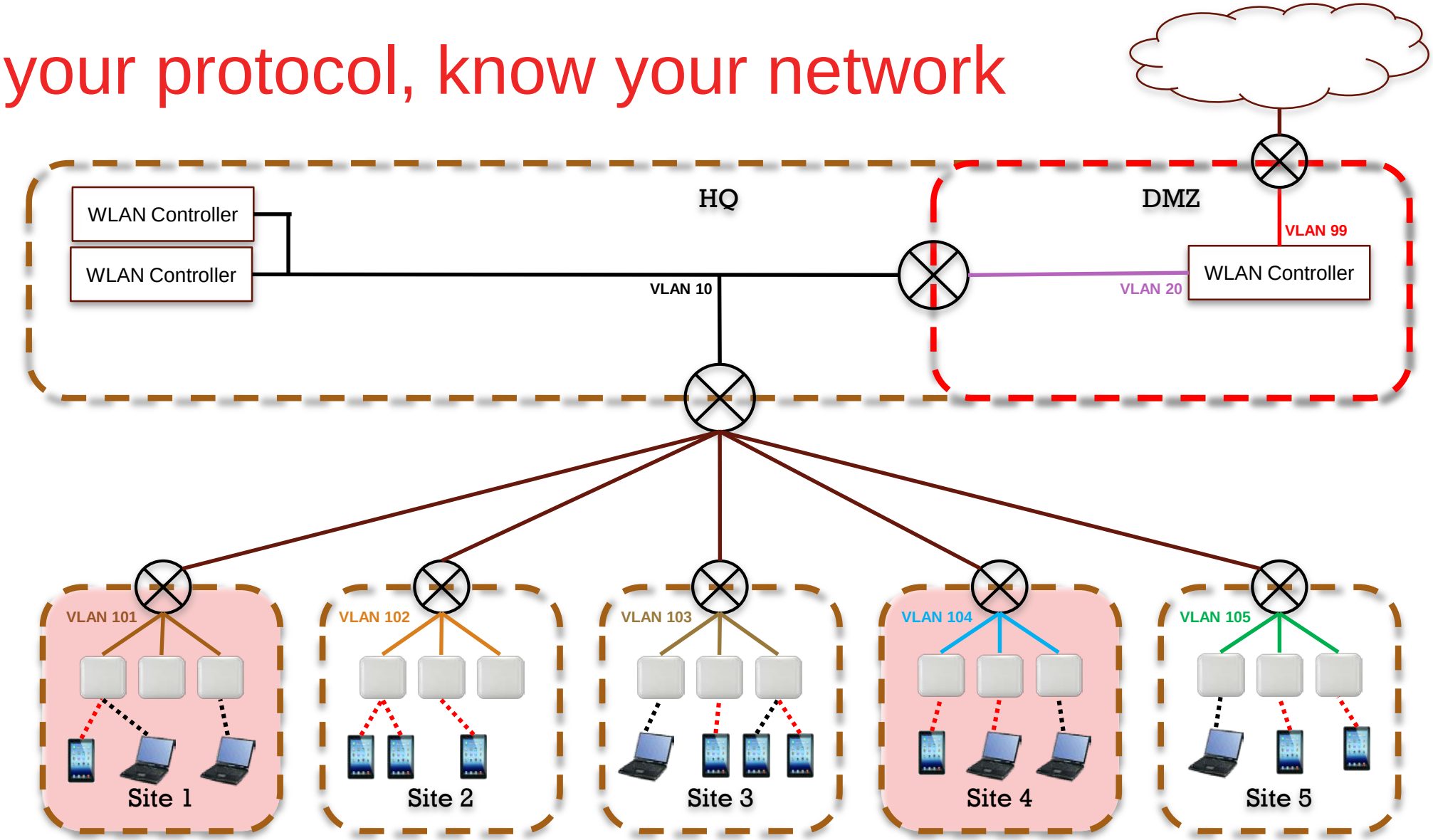


Know your protocol, know your network



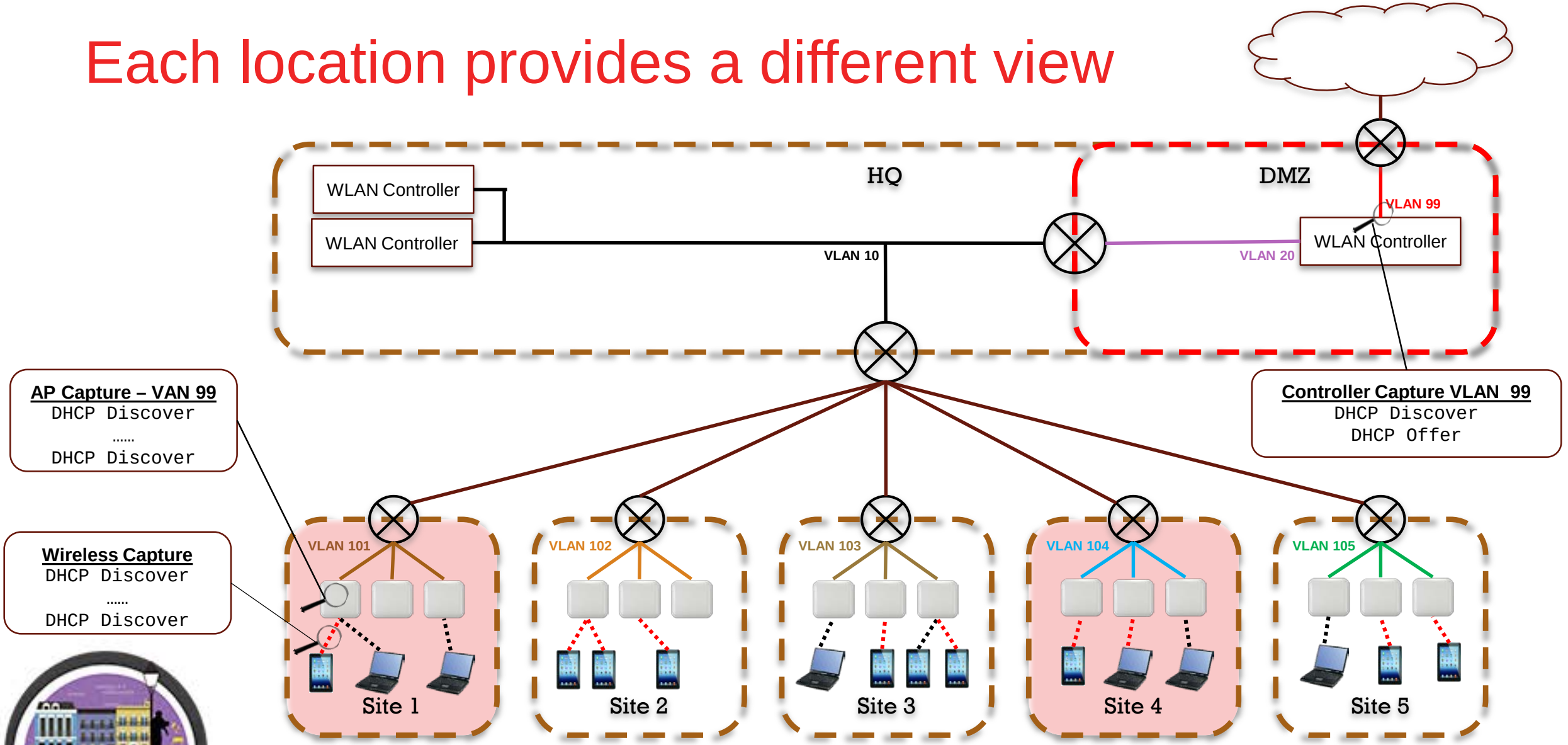
Site WLANs	
Corp	VLAN 10
Guest	VLAN 99

Know your protocol, know your network

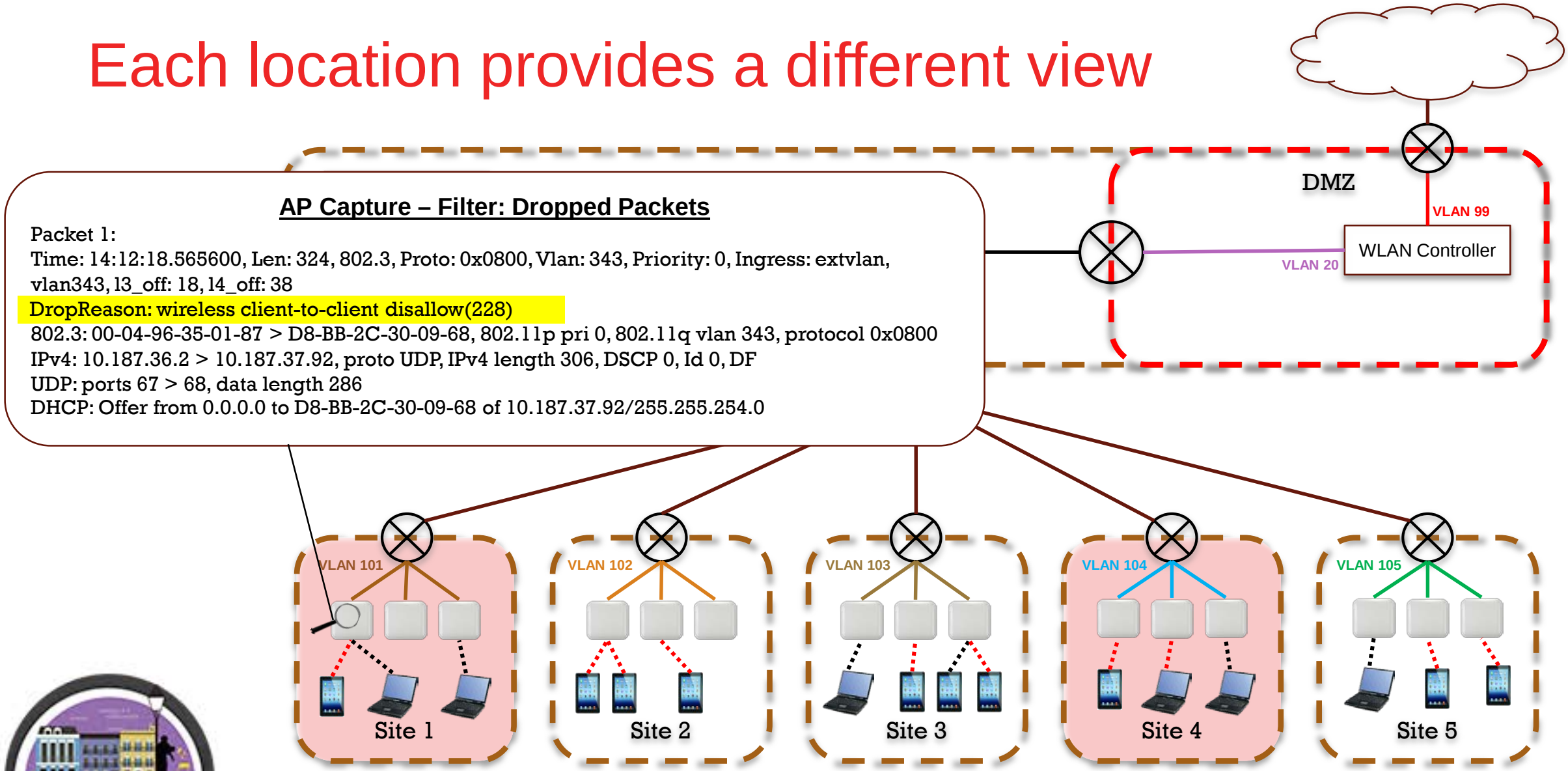


Site WLANs	
Corp	VLAN 10
Guest	VLAN 99

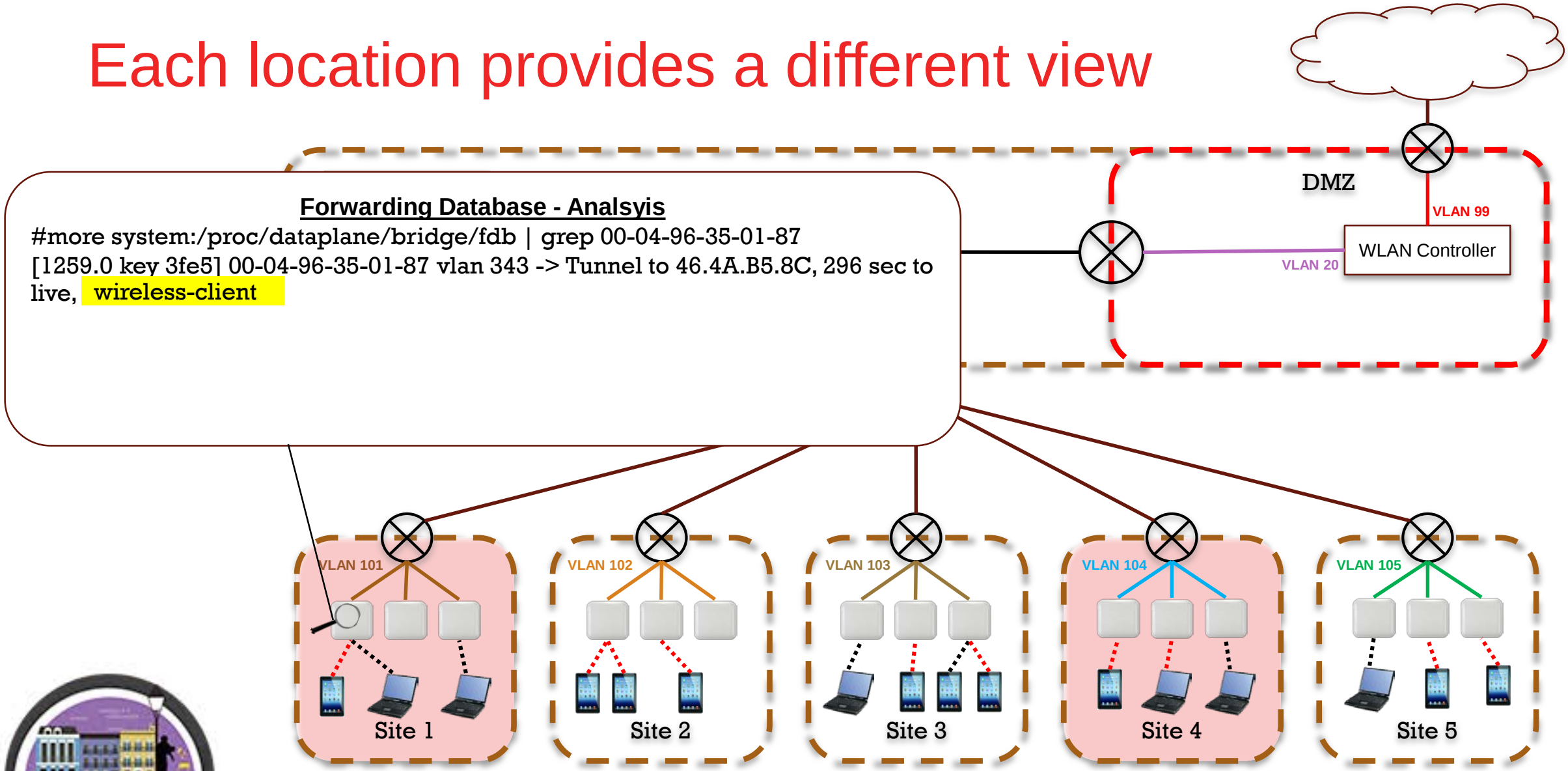
Each location provides a different view



Each location provides a different view



Each location provides a different view



Thank you!