Wi-Fi Troubleshooting Workshop

May 26th, 2020

Agenda

01 | 5 Tenets of Wi-Fi Troubleshooting

02 | Layer 1 Wi-Fi Troubleshooting

03 | Layer 2 Wi-Fi Troubleshooting

04 | Data Science

05 | Machine Learning, Artificial Intelligence and Troubleshooting

06 | Introducing Co-Pilot

Five Tenets of Wi-Fi troubleshooting

- Follow troubleshooting best practices
- Move up the OSI model
- Most Wi-Fi problems are client issues
- Wi-Fi performance problems can usually be avoided with proper WLAN design
- Wi-Fi always gets the blame!

Troubleshooting Best Practices

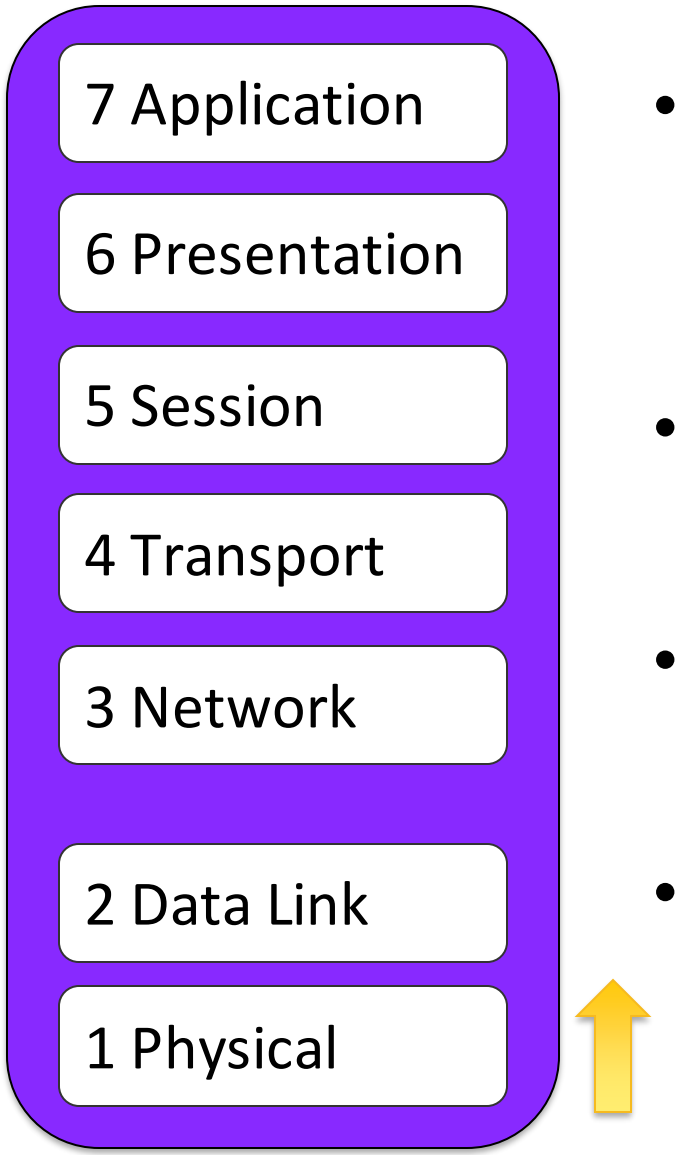
Identify the issue by asking questions:

- When is the problem happening?
- Where is the problem happening?
- Does the problem affect one client or numerous clients?
- Does the problem reoccur, or did it just happen once?
- Did you make any changes recently?

Troubleshooting Best Practices

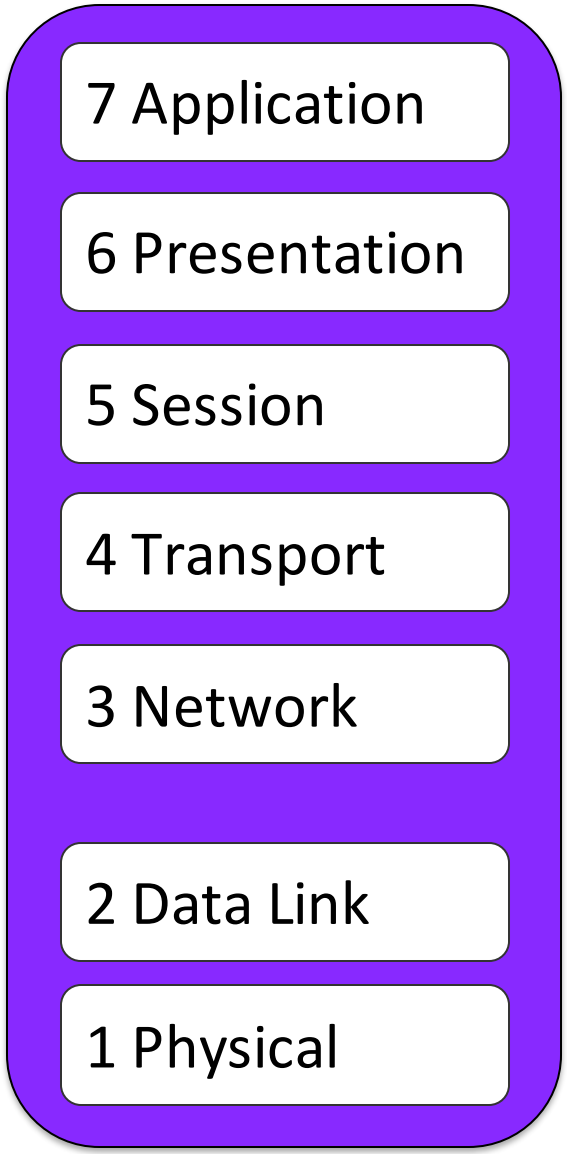
- Identifying the issue (ask questions)
- Recreate problem (ask questions)
- Locate and isolate the cause (ask questions)
- Solve the problem
- Test to verify the problem is resolved
- Document the problem and the solution
- Provide feedback to the user

OSI Model



- Troubleshoot the Wi-Fi network just like you would troubleshoot a wired network
- Move up the OSI model
- 802.11 technology only operates at Layer 1 and 2
- If the problem does not exist in the first two layers, it is not a Wi-Fi problem

OSI Model

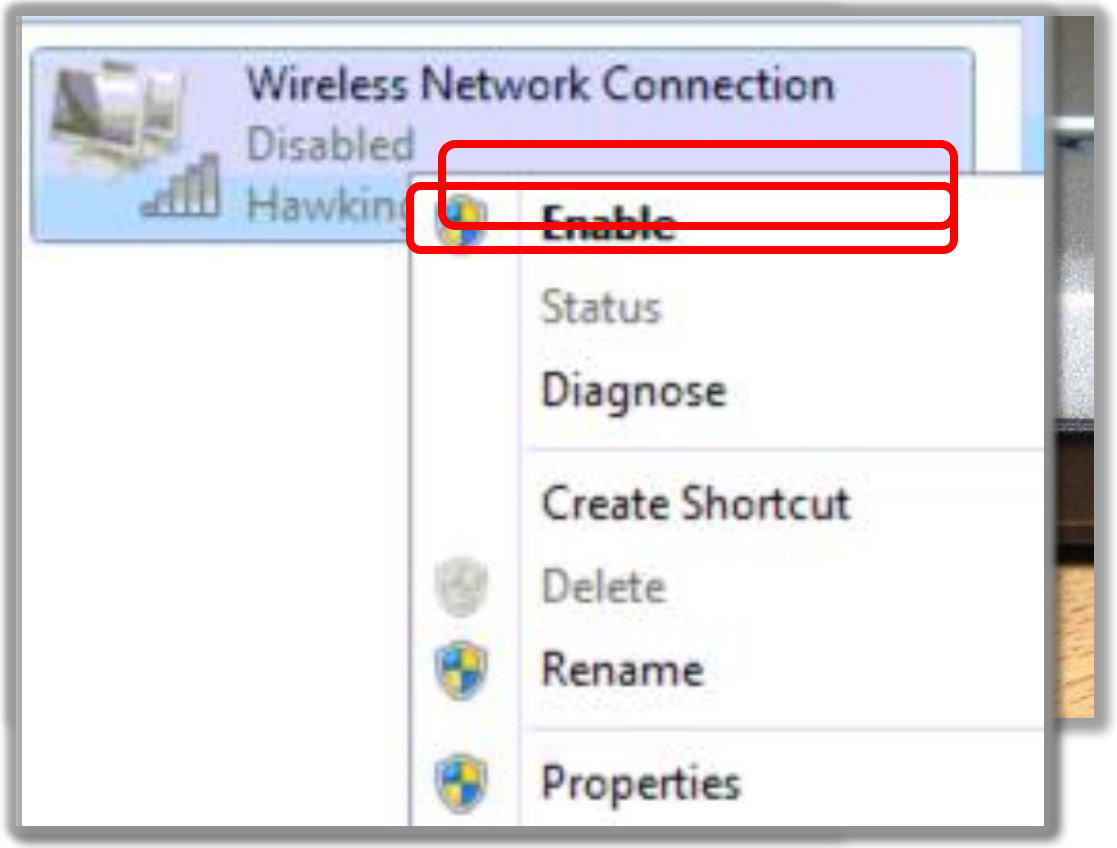


RADIUS, Active Directory, DNS, DHCP, NTP and user applications

IP address, routing, ports firewalls

Wi-Fi: RF and configuration, drivers, WLAN security sessions, WLAN design, VLANs, etc.

The client device is usually the culprit



- Is the radio on?
- Disable the WLAN NIC
- Enable the WLAN NIC

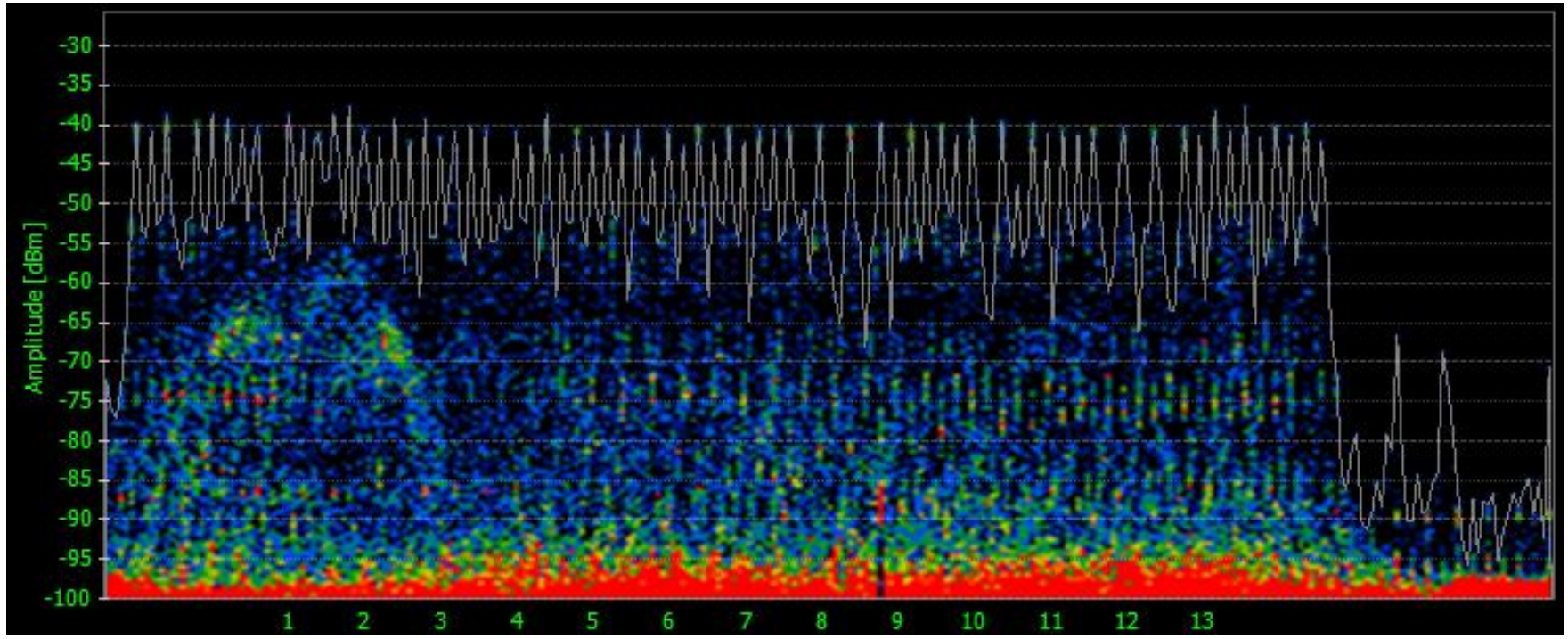
But it’s backward compatible

- Legacy client devices often cannot connect when new 802.11 technology is introduced
- Client drivers do not know how to handle new Information Elements in Beacons
- Example: Fast BSS Transition IE

Upgrade your clients first

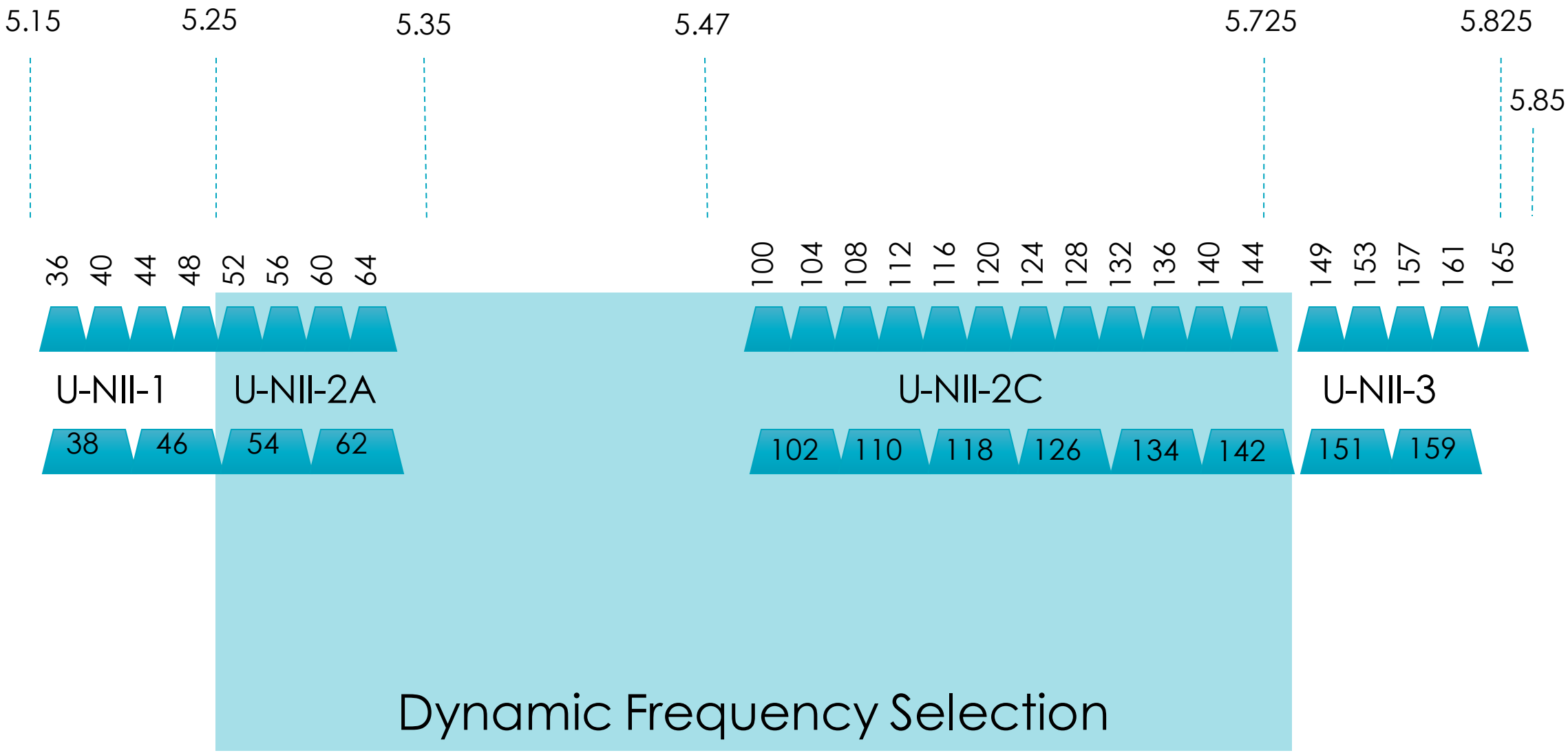
ExtremeCloud IQ – Maximum Client Capabilities

Clients are not happy on 2.4 GHz



- 2.4 GHz is a disaster zone
- Only three usable channels
- Impossible to prevent CCI
- Low SNR
- Oversaturation of 802.11 devices
- Non-802.11 transmitter interference

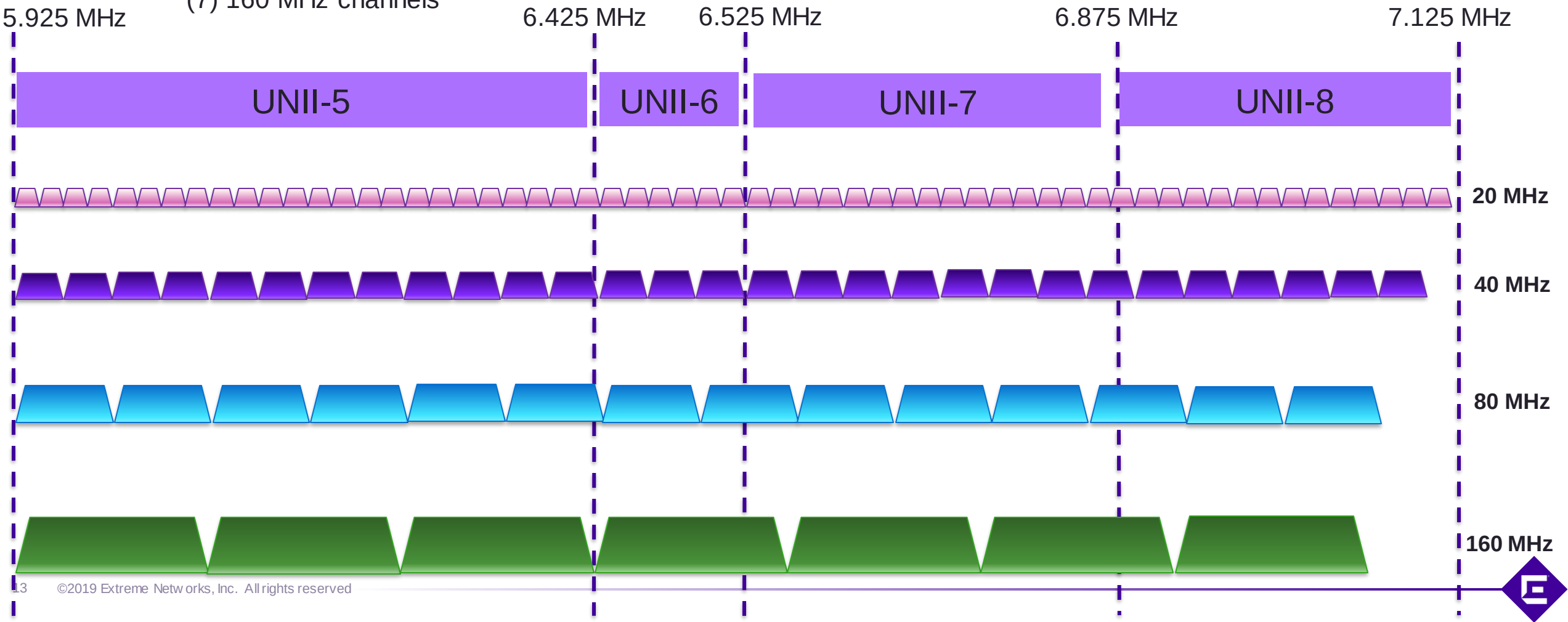
5 GHz is the answer



6 GHz is coming

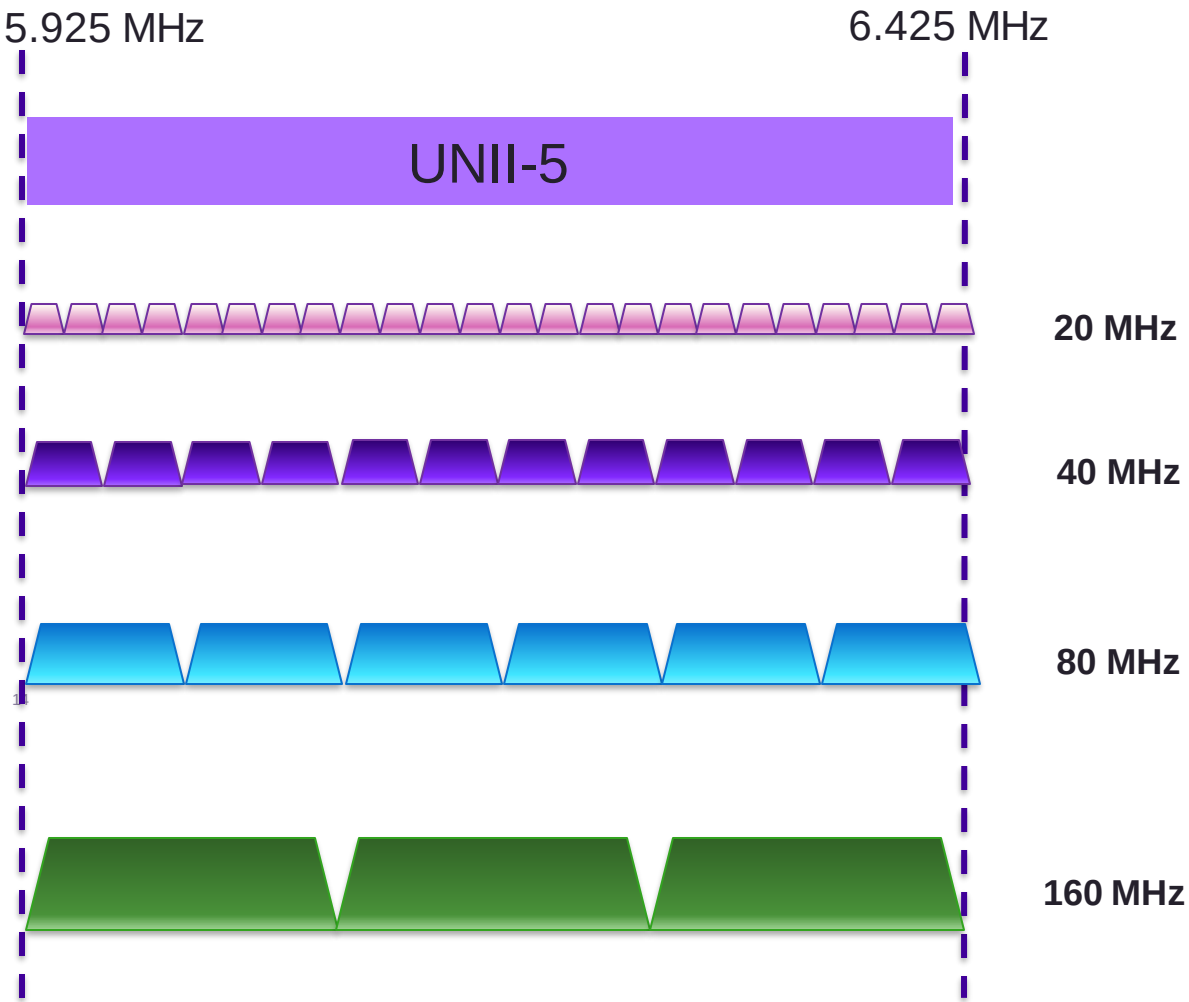
(59) 20 MHz channels
(29) 40 MHz channels
(14) 80 MHz channels
(7) 160 MHz channels

1200 MHz of new frequency spectrum



(24) 20 MHz channels
(12) 40 MHz channels
(6) 80 MHz channels
(3) 160 MHz channels

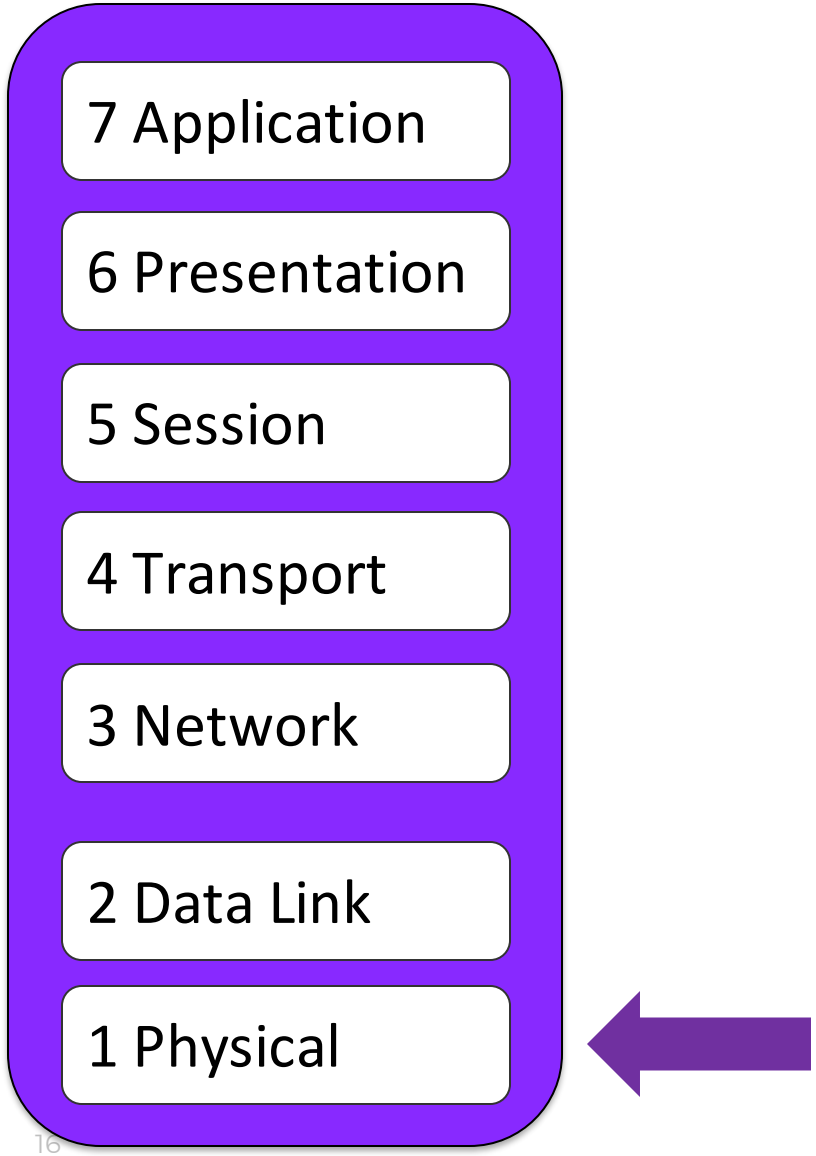
500 MHz of new frequency spectrum



The Wi-Fi always gets the blame

Your Wi-Fi sucks!

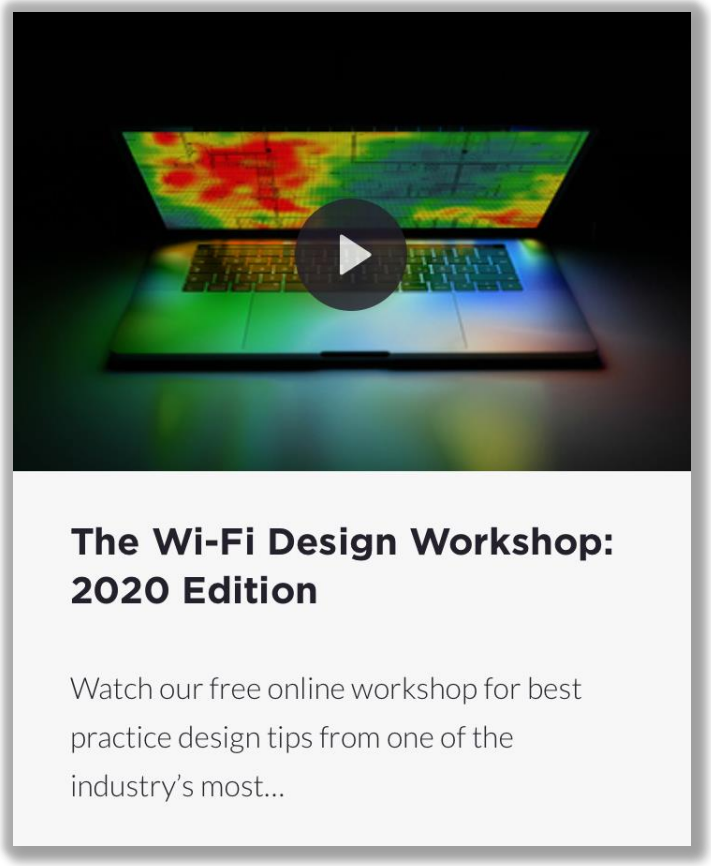
Layer 1 Troubleshooting



70 % of problems are at Layer 1

- Client radio and driver problems
- Poor WLAN Design
- RF Interference
- Transmit power – too high
- Misconfigured client (supplicant) security settings
- Firmware issues on Access Points (Bugs)
- Power Over Ethernet (Poe)

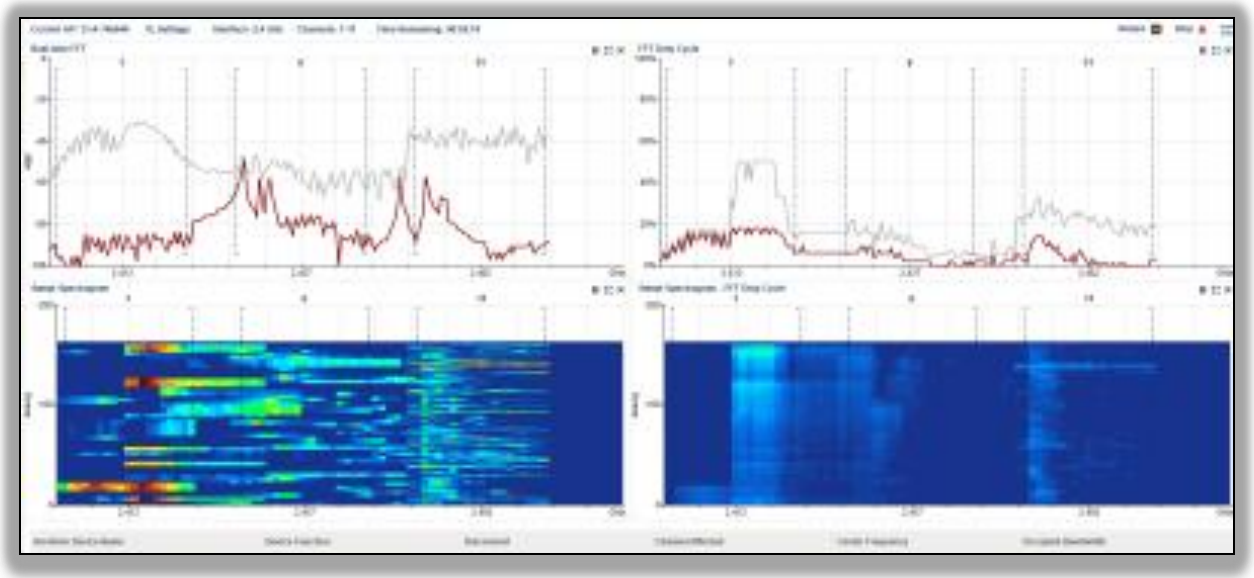
Proper Wi-Fi Design reduces support calls

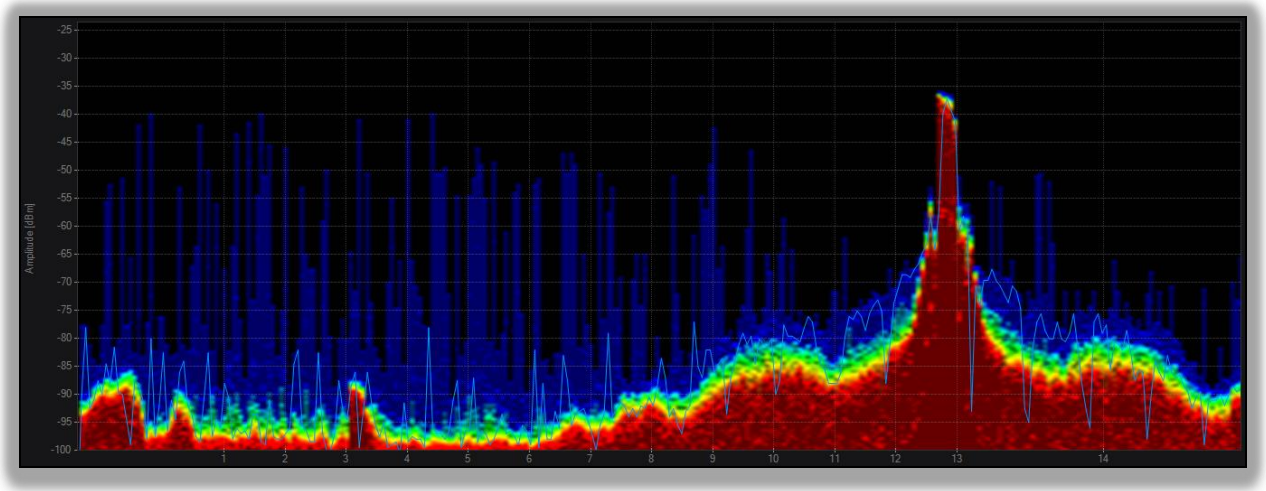


- Reduce Airtime Consumption
- Reduce CCI
- Reduce L2 overhead
- Data Rate Pruning (Disable Lower rates)
- 20 MHz Channels is normal
- 40 MHz – DFS required
- Static channel/power settings in complex environments

https://www.extremenetworks.com/resources/webinar/the-wi-fi-design-workshop-2020-edition/

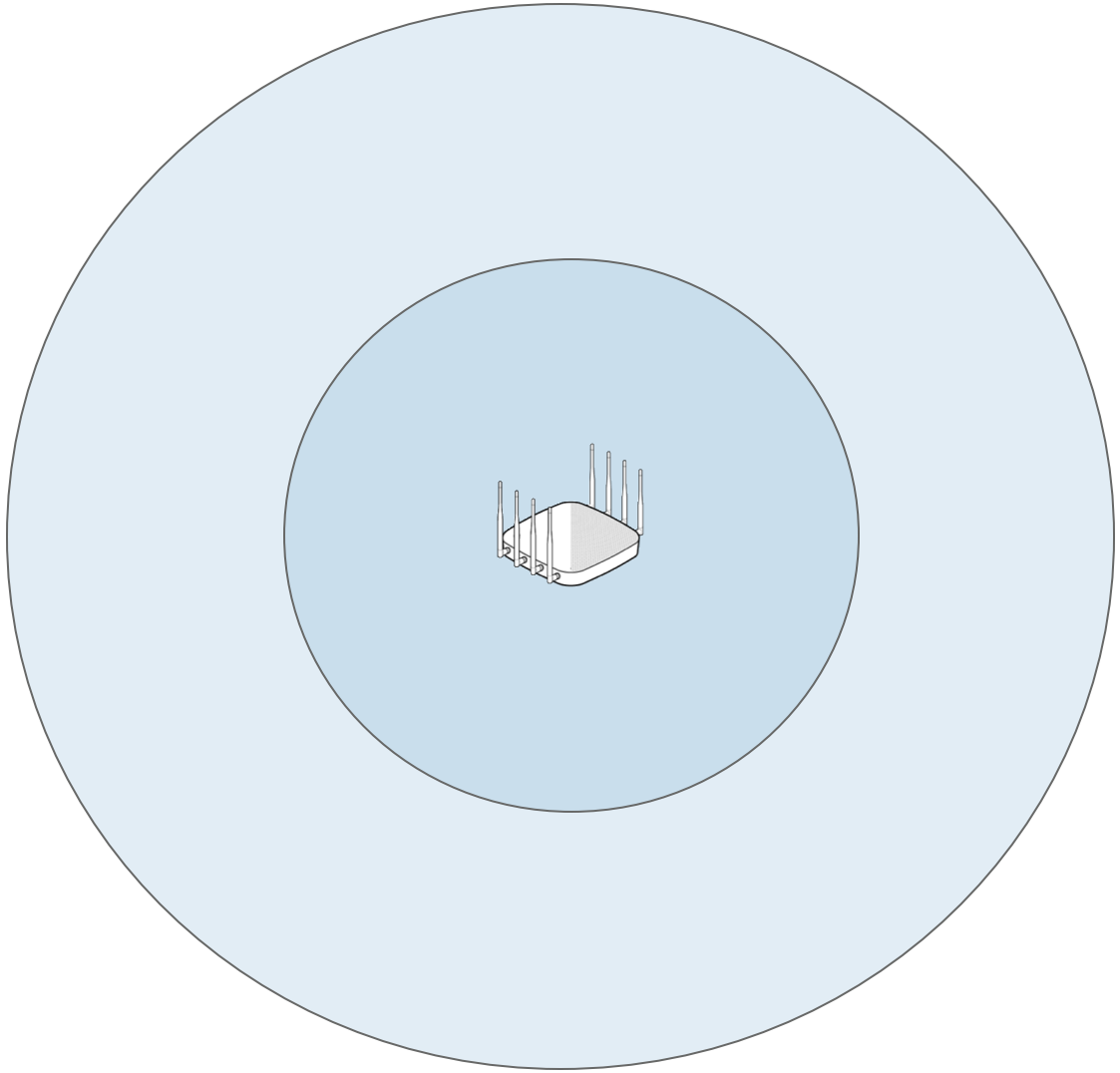
RF interference





- Spectrum analysis will find RF inference
- Learn basic Wi-Fi shapes: (HR)-DSSS, OFDM
- Learn to recognize narrow band and wide band interferers.
- Bring a hammer with you.

High power is bad!

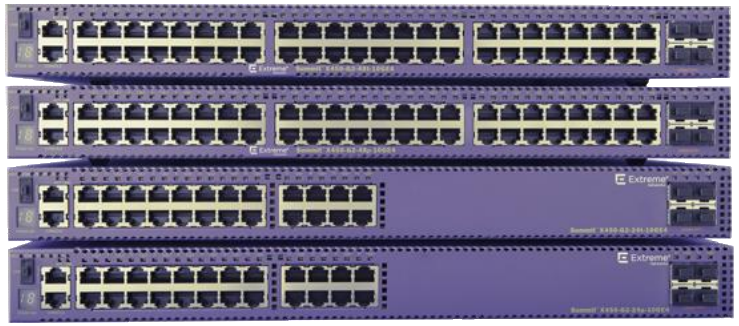


- Capacity Problems
- Increase CCI
- Hidden Node
- Mismatch power between clients and AP
- Roaming – Sticky problems
- Turn down the power!

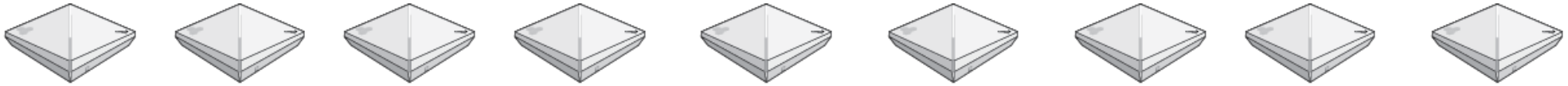
Bugs

- Often occurs after AP firmware updates
- Supply Wi-Fi vendor with packet captures and tech data logs

Poe Power budget



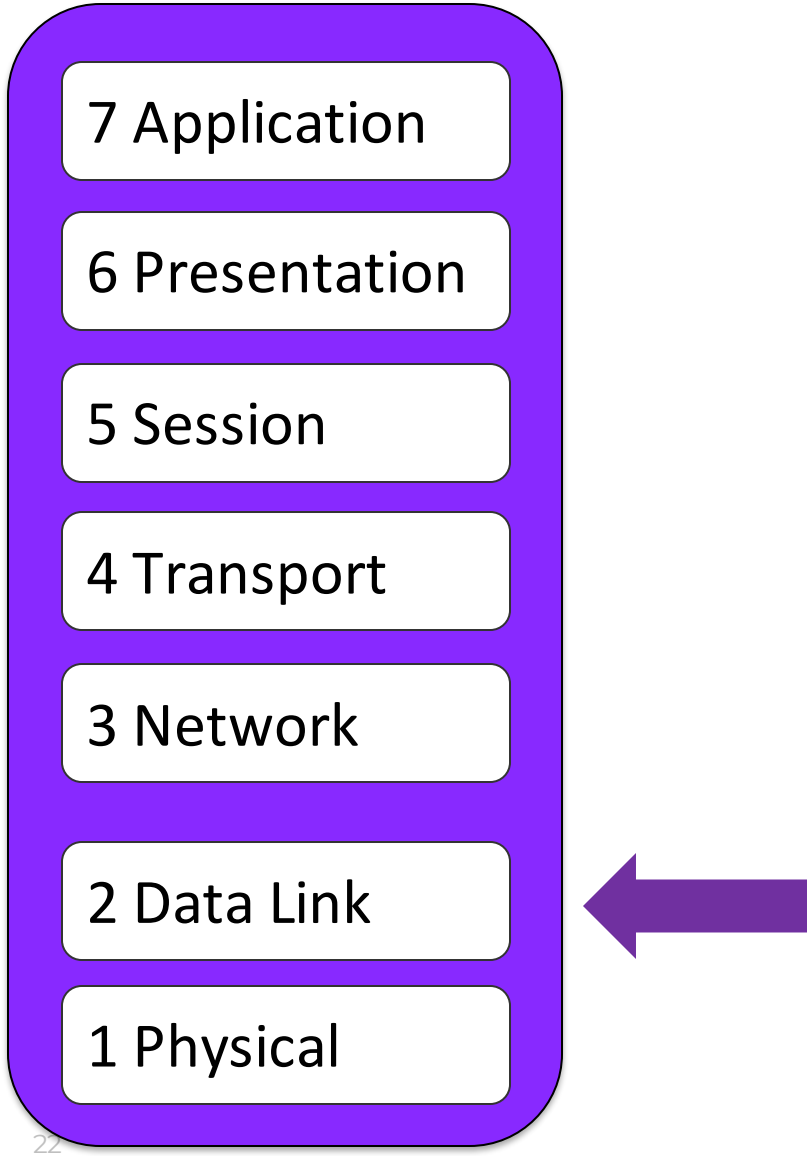
- PoE problems will grow with the deployment of more 4x4:4 MIMO APs that require more than 15.4 Watts.
- 802.3at (PoE+) is needed



- Careful PoE budget planning is a must

- Access points will randomly reboot if a power budget has been exceeded and the APs cannot draw their necessary required power

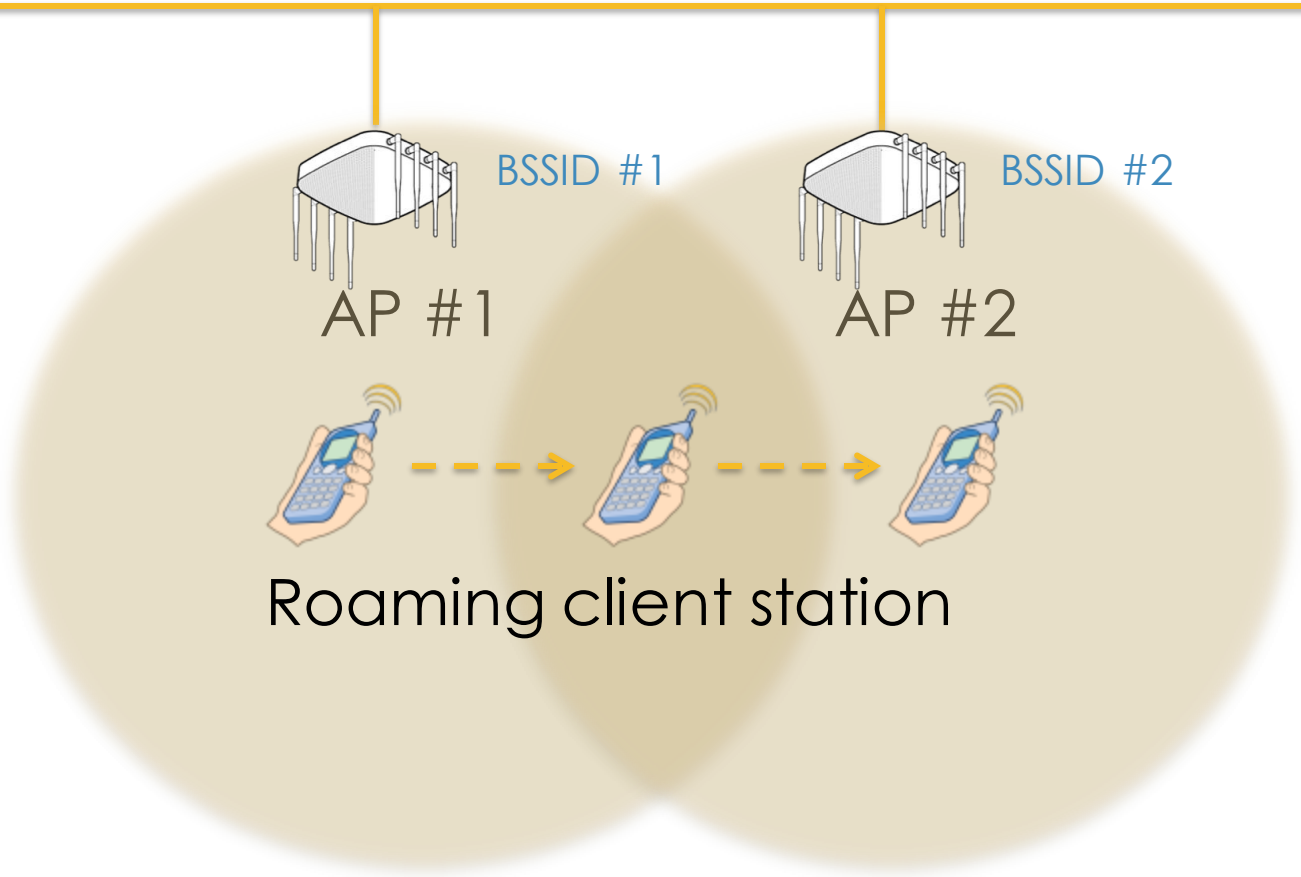
Layer 2 troubleshooting



Time to move up the OSI model

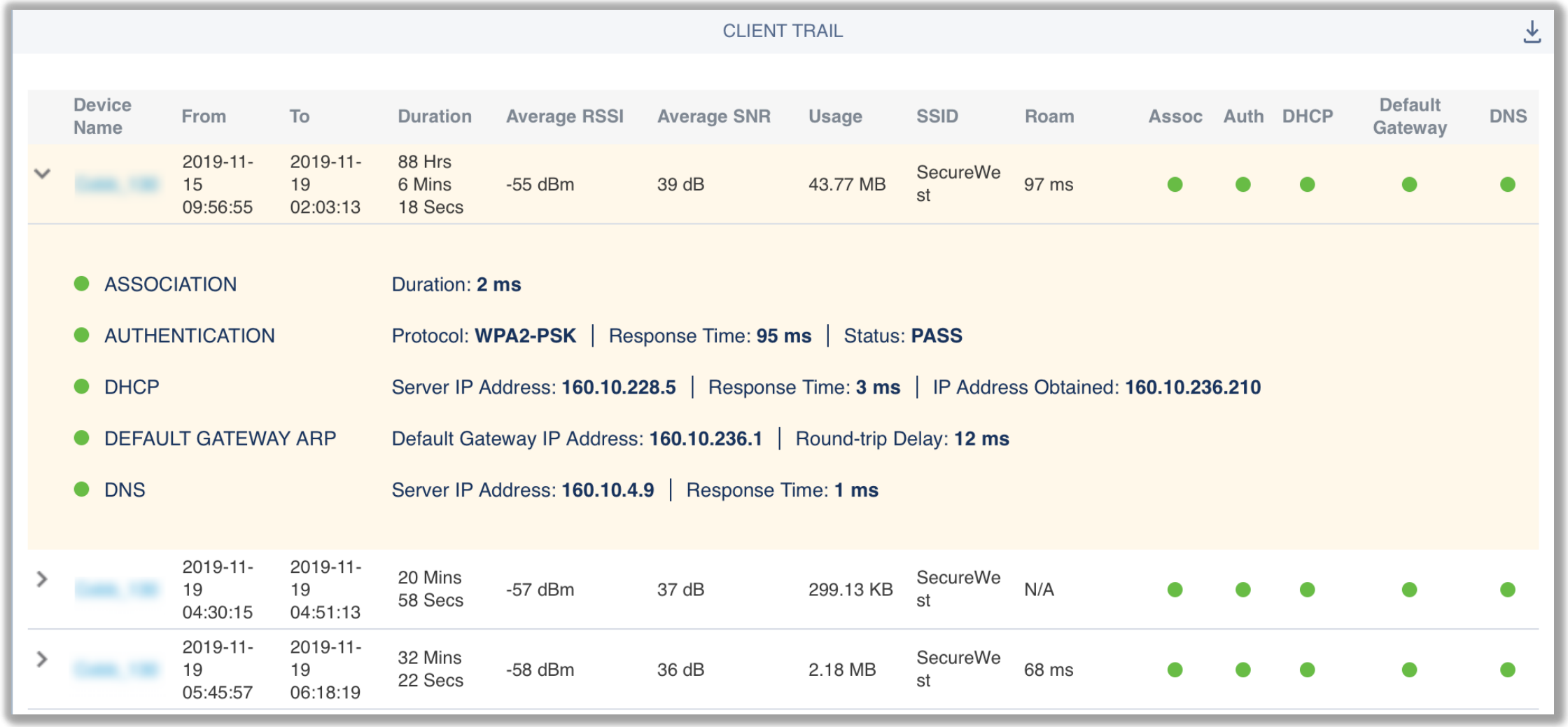
- Roaming
- Layer 2 retries
- Connectivity problems:
  - Authentication – PSK or 802.1X
  - Association

Layer 2 roaming problems

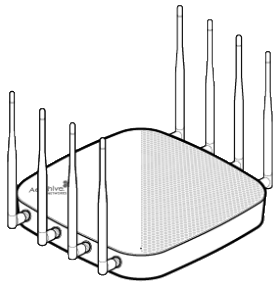


- Drivers (client problem)
- Sticky problems (bad design)
- Do clients support 802.11k for AP neighbor reports?
- 802.11r compatible clients are needed for Layer 3 roaming

Roaming trail visibility



Layer 2 retransmissions

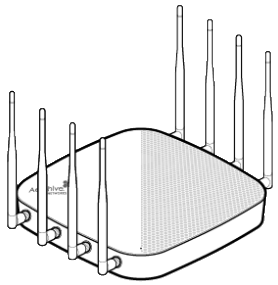


Transmitting radio sends a unicast frame

CRC passes

Receiver radio sends L2 ACK frame

Layer 2 retransmissions



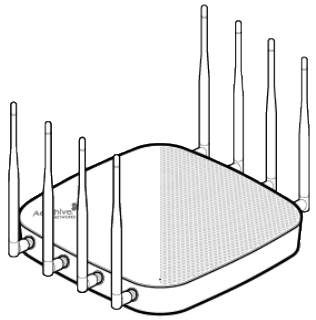
Transmitting radio sends a unicast frame

CRC fails

No ACK frame sent by receiver

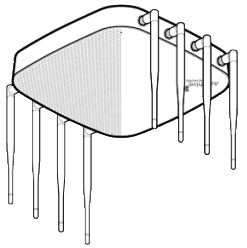
Transmitting radio sends L2 retransmission

Layer 2 retransmissions – negative effect



- Throughput goes down
- Latency goes up

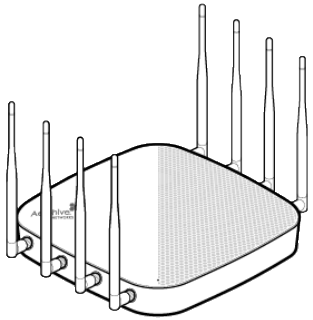
Layer 2 retransmissions - VoWiFi

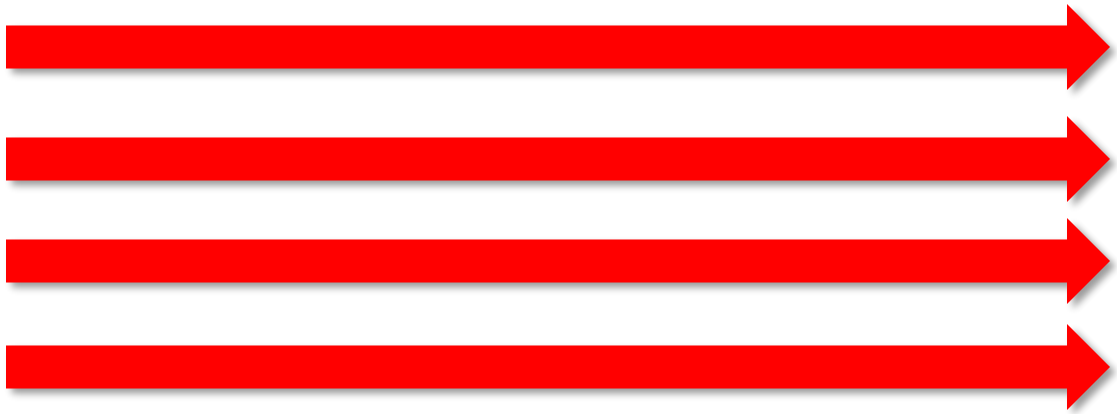


- Latency is the time it takes to deliver a packet from the source device to the destination device.
  - Increase latency results in echo problems.

- Jitter is a variation of latency. Jitter measures how much the latency of each packet varies from the average
  - Jitter will result in choppy audio communications

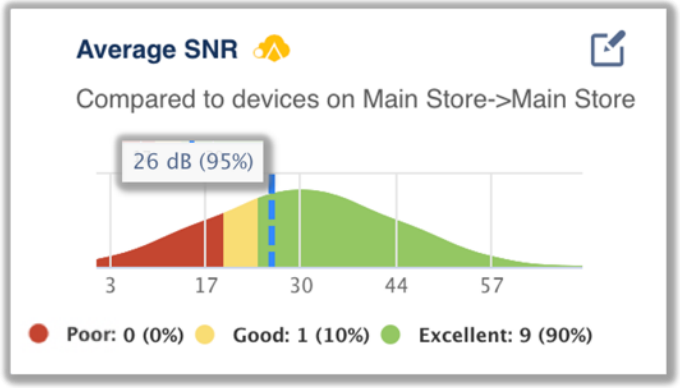
Layer 2 retransmissions - causes

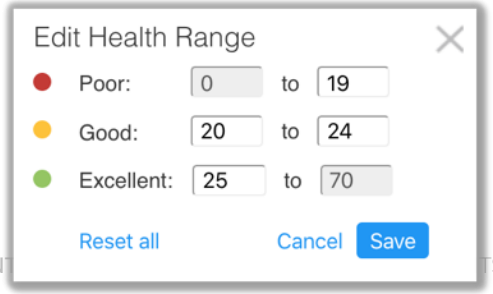




CRC fails

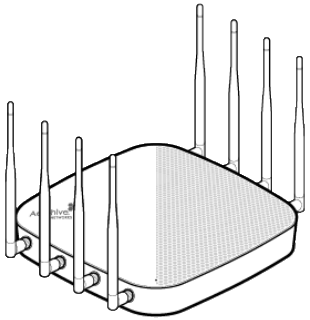
- RF interference (Layer 1)
- Low SNR (Layer 1) (bad design)
- Adjacent cell interference (bad design)
- Hidden Node (bad design)





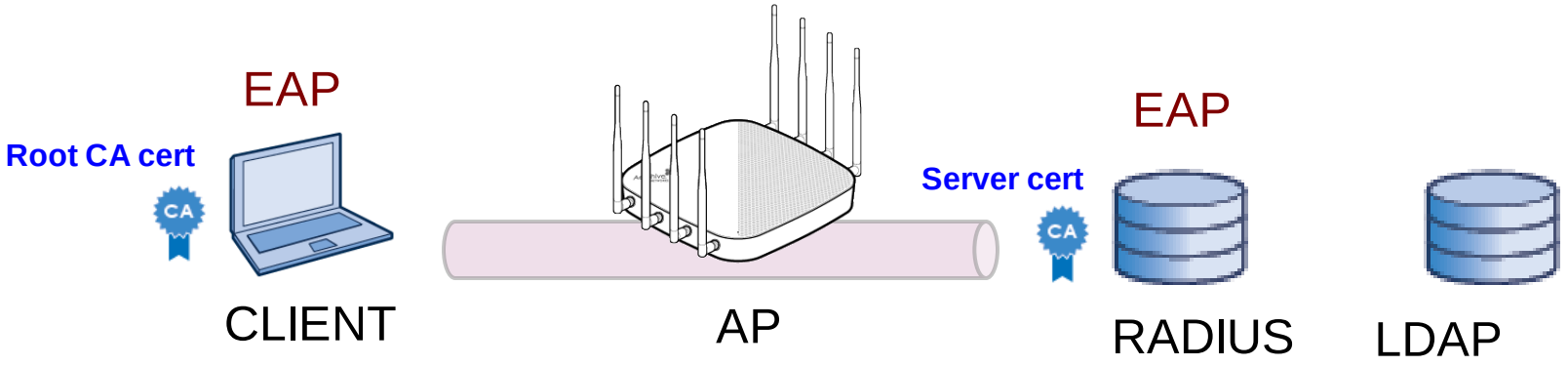
Connectivity troubleshooting – PSK (PPSK)

2016-02-22 16:06:48	05-A-764fc0	08EA44764FD4	Info	WPA-PSK auth is starting (at if=wifi0.1)
2016-02-22 16:06:48	05-A-764fc0	08EA44764FD4	Info	Sending 1/4 msg of 4-Way Handshake (at if=wifi0.1)
2016-02-22 16:06:49	05-A-764fc0	08EA44764FD4	Info	Received 2/4 msg of 4-Way Handshake (at if=wifi0.1)
2016-02-22 16:06:52	05-A-764fc0	08EA44764FD4	Info	Sending 1/4 msg of 4-Way Handshake (at if=wifi0.1)
2016-02-22 16:06:52	05-A-764fc0	08EA44764FD4	Info	Received 2/4 msg of 4-Way Handshake (at if=wifi0.1)



- ❿ Passphrase mismatch
- ❿ PMKs never properly created
- ❿ 4-Way Handshake fails

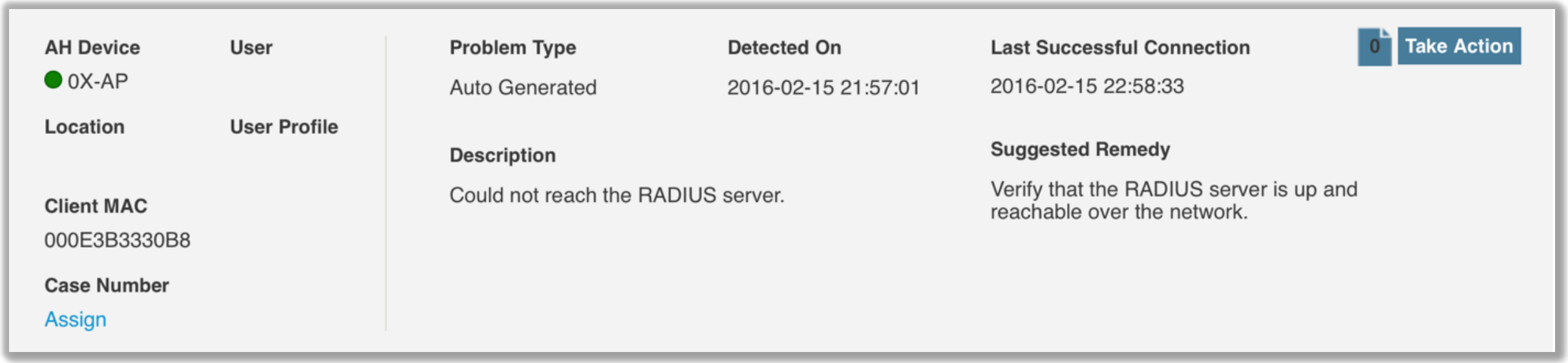
Connectivity troubleshooting – 802.1X



- 802.1X: Port based access control
- Authorization Framework
  - Supplicant
  - Authenticator
  - Authentication Server
- Integrates with LDAP

- Extensible Authentication Protocol (EAP)
- Server certificate and Root CA certificate
- Tunneled authentication using SSL/TLS

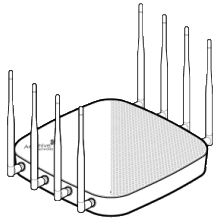
802.1X troubleshooting - backend



shared secret ⟷ shared secret

192.168.100.10 ⟷ 10.5.1.10

Port: 1812 ⟷ Port: 1645



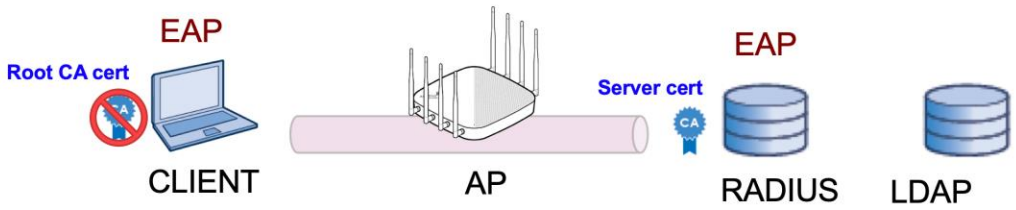
AP

RADIUS LDAP

- Shared secret mismatch
- Incorrect IP settings on AP or RADIUS server
- Authentication port mismatch (default is 1812)
- LDAP communications error

802.1X troubleshooting - Certificates

```
Send message to RADIUS Server(10.5.1.129): code=1 (Access-Request) identifier=
RADIUS: SSL negotiation, send server certificate and other message
Receive message from RADIUS Server: code=11 (Access-Challenge) identifier=109
Sending EAP Packet to STA: code=1 (EAP-Request) identifier=3 length=280
received EAP packet (code=2 id=3 len=208) from STA: EAP Reponse-PEAP (25)
Send message to RADIUS Server(10.5.1.129): code=1 (Access-Request) identifier=
RADIUS: SSL connection established
Receive message from RADIUS Server: code=11 (Access-Challenge) identifier=110
Sending EAP Packet to STA: code=1 (EAP-Request) identifier=4 length=65
received EAP packet (code=2 id=4 len=6) from STA: EAP Reponse-PEAP (25)
Send message to RADIUS Server(10.5.1.129): code=1 (Access-Request) identifier=
RADIUS: SSL negotiation is finished successfully
Receive message from RADIUS Server: code=11 (Access-Challenge) identifier=111
Sending EAP Packet to STA: code=1 (EAP-Request) identifier=5 length=43
received EAP packet (code=2 id=5 len=59) from STA: EAP Reponse-PEAP (25)
Send message to RADIUS Server(10.5.1.129): code=1 (Access-Request) identifier=
RADIUS: PEAP inner tunneled conversion
```



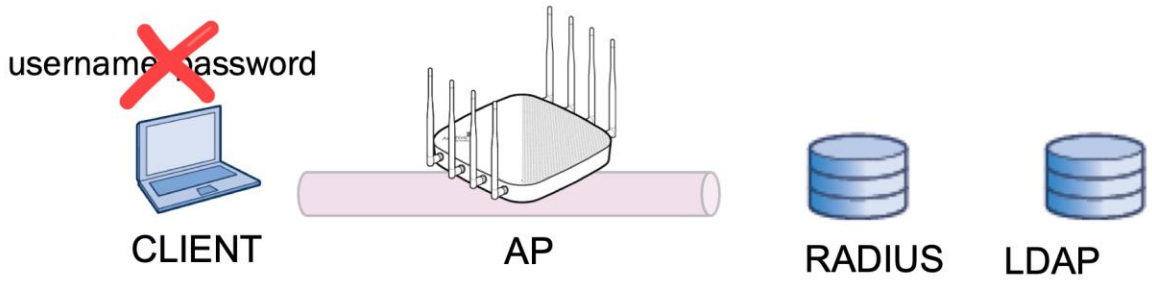
SSL/TLS tunnel fails = certificate problem

- Expired certificate
- Root certificate installed in wrong store
- Incorrect clock settings
- Mismatched EAP types

802.1X troubleshooting - Supplicant

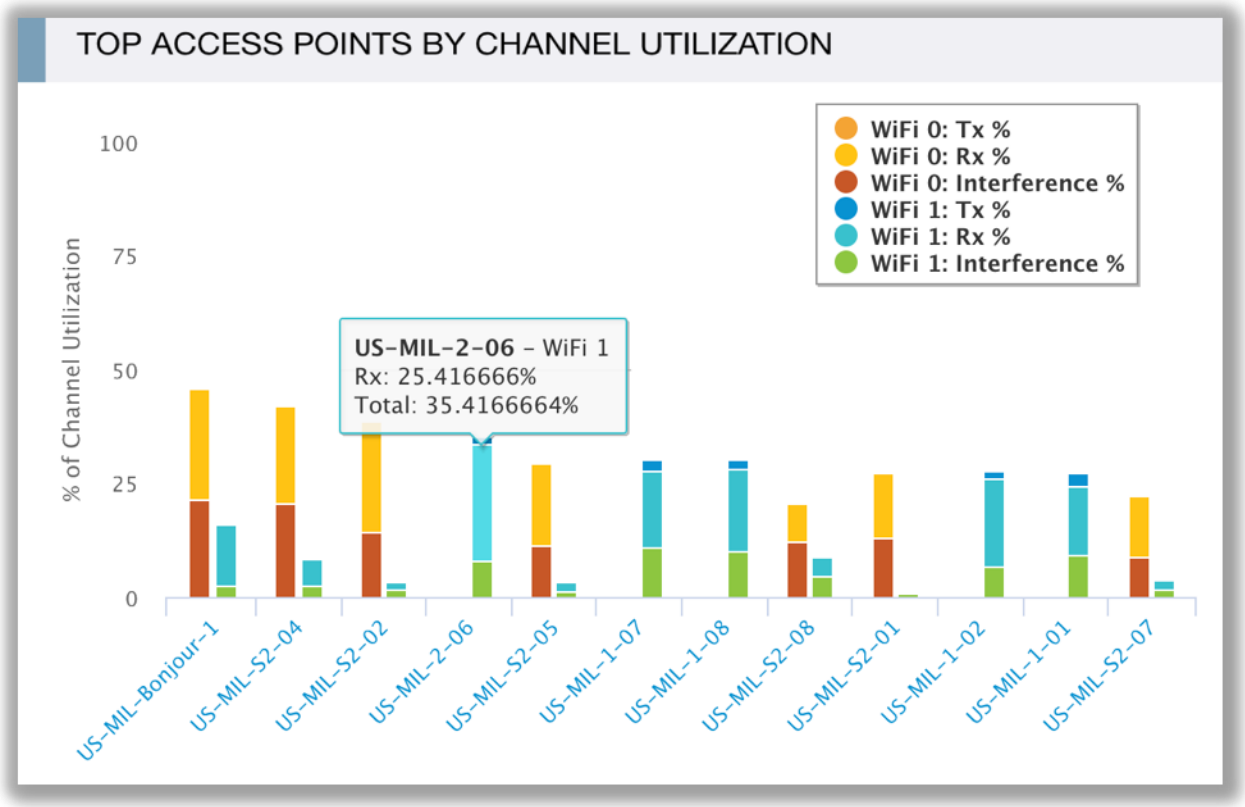
```
Send message to RADIUS Server(10.5.1.129): code=1 (Access-Request) identifier=151 length=203,
RADIUS: SSL negotiation, send server certificate and other message
Receive message from RADIUS Server: code=11 (Access-Challenge) identifier=151 length=340
Sending EAP Packet to STA: code=1 (EAP-Request) identifier=4 length=280
received EAP packet (code=2 id=4 len=17) from STA: EAP Reponse-PEAP (25)
Send message to RADIUS Server(10.5.1.129): code=1 (Access-Request) identifier=152 length=214,
RADIUS:
RADIUS: rejected user 'host/TRAINING-PC16.ah-lab.local' through the NAS at 10.5.1.129.
Authentication is terminated (at if=wifi0.1) because it is rejected by RADIUS server
Sending EAP Packet to STA: code=4 (EAP-Failure) identifier=4 length=4
Sta(at if=wifi0.1) is de-authenticated because of notification of driver
```

External RADIUS server could not accept the access request from the client - Credential problems



- ❿ Expired password or user account
- ❿ Wrong password
- ❿ User does not exist in LDAP
- ❿ User authentication or machine authentication

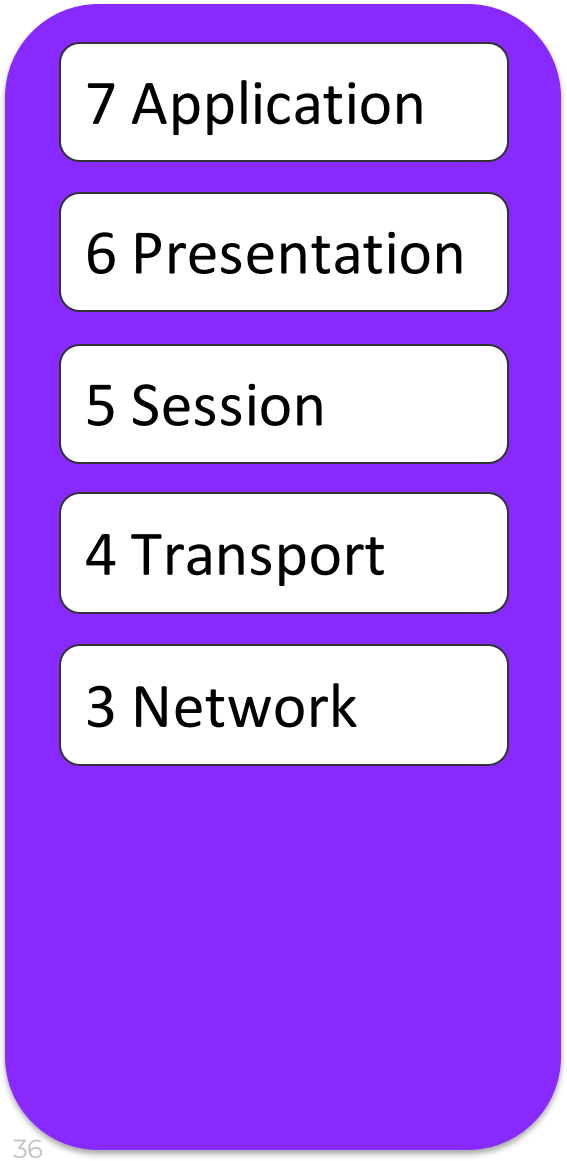
Channel Utilization



Some good channel utilization thresholds to live by:

- 80 percent channel utilization impacts all 802.11 data transmissions.
- 50 percent channel utilization impacts video traffic.
- 20 percent channel utilization impacts voice traffic.

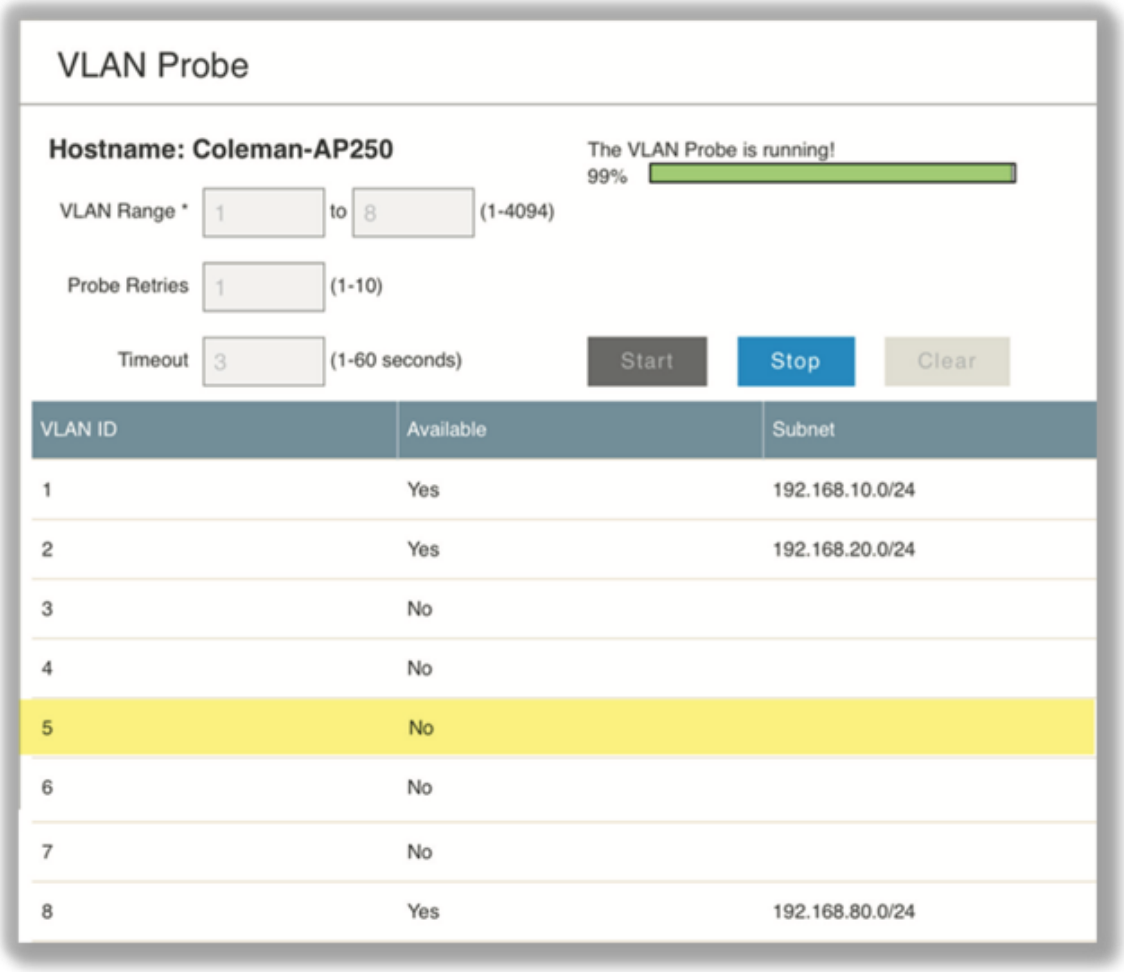
Upper Layer Troubleshooting



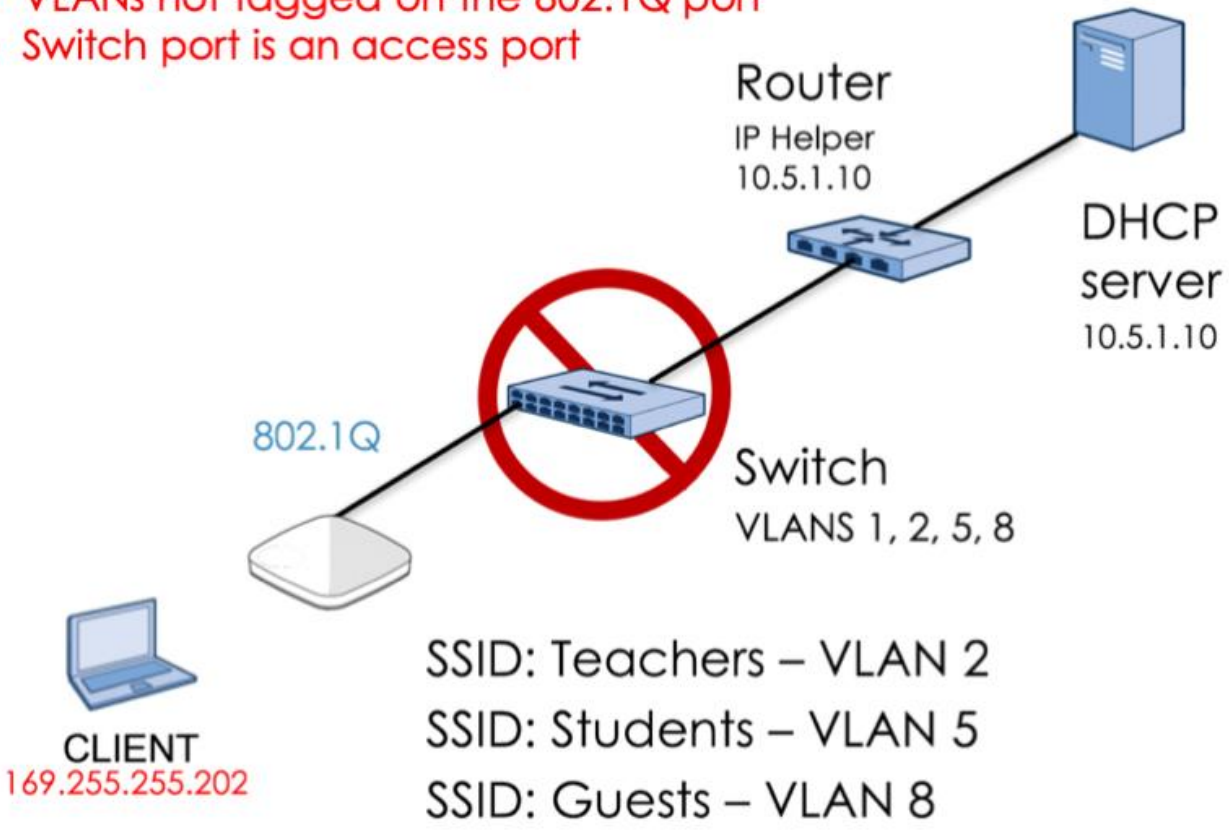
Not a Wi-Fi problem

- Networking problem
- Firewall problem
- Application problem

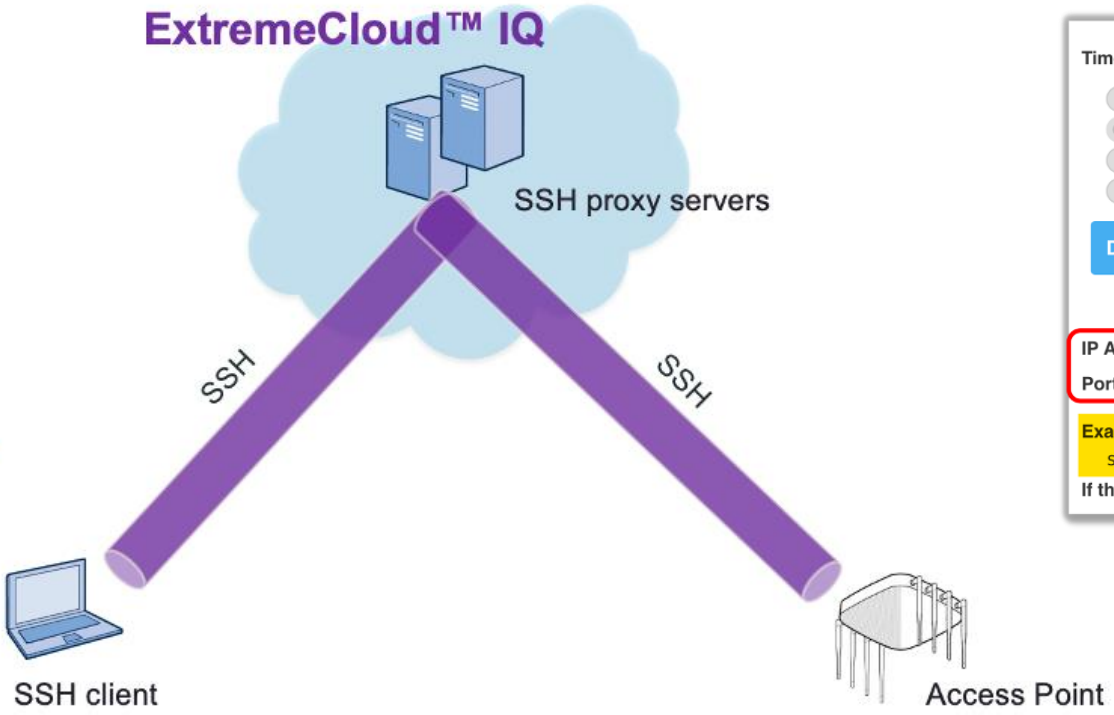
VLAN Probe

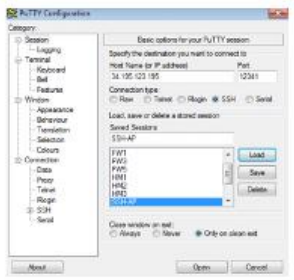


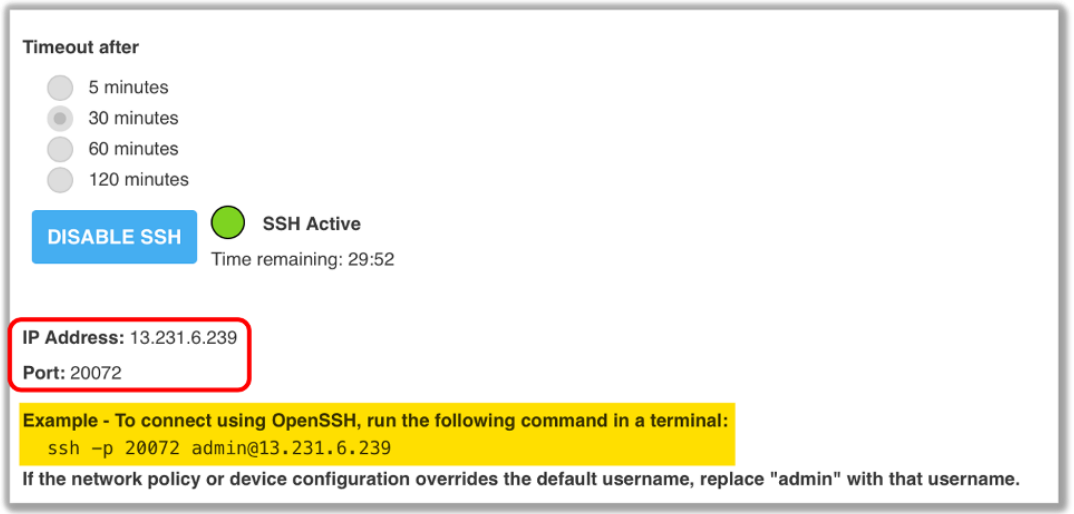
- VLANs not configured on the access switch
- VLANs not tagged on the 802.1Q port
- Switch port is an access port



SSH Proxy







Cloud-based remote trouble-shooting for the power user

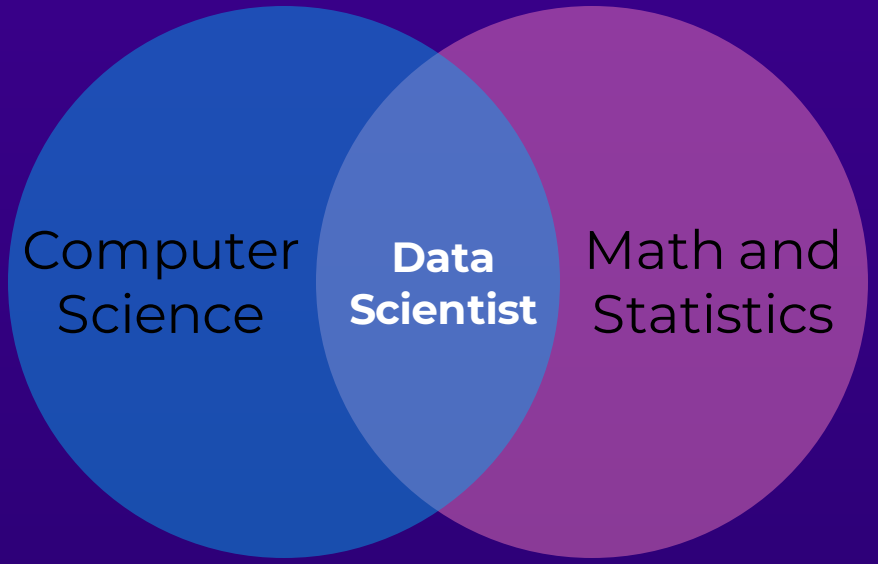
On Data Science

Data Science

Data science is a technology discipline combining math and statistics with computer science and coding.

"Data Scientist (n.): Person who is better at statistics than any software engineer and better at software engineering than any statistician."

-Josh Wills

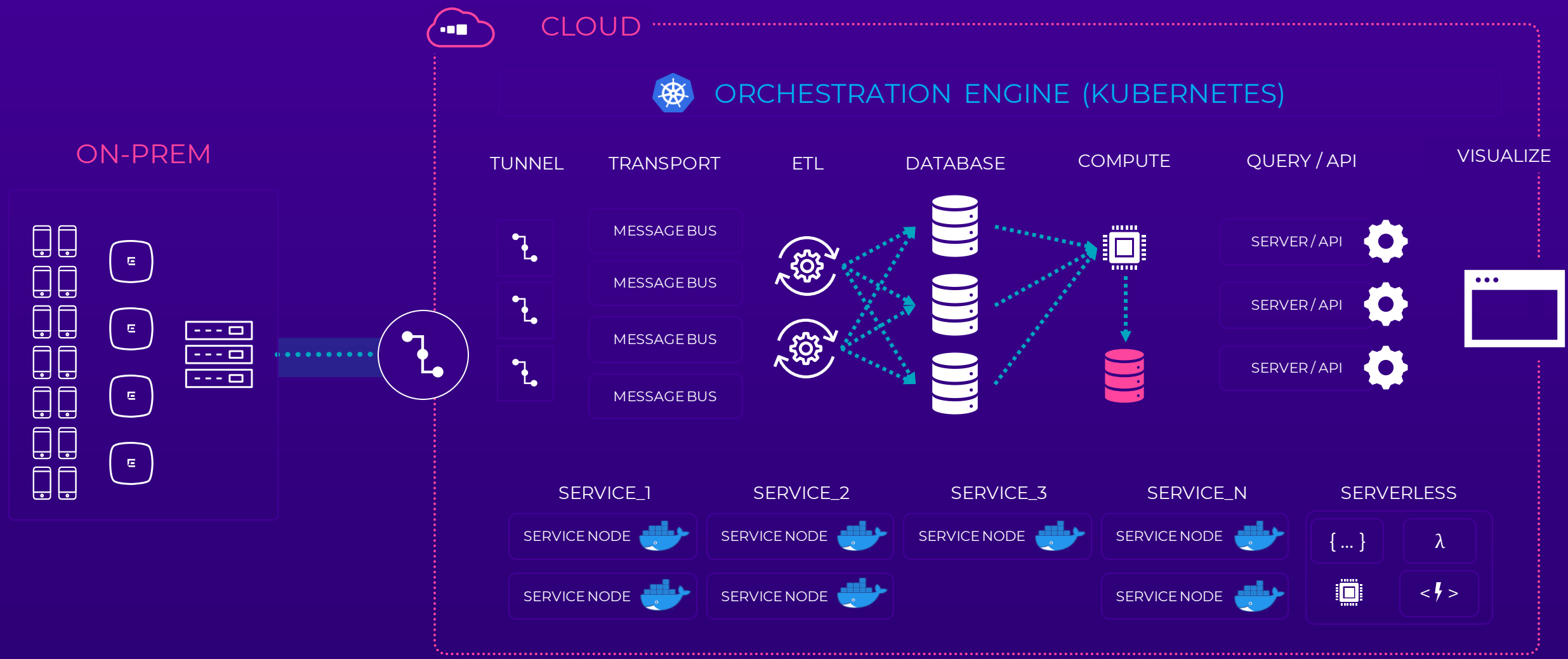


Data Pipeline Stages

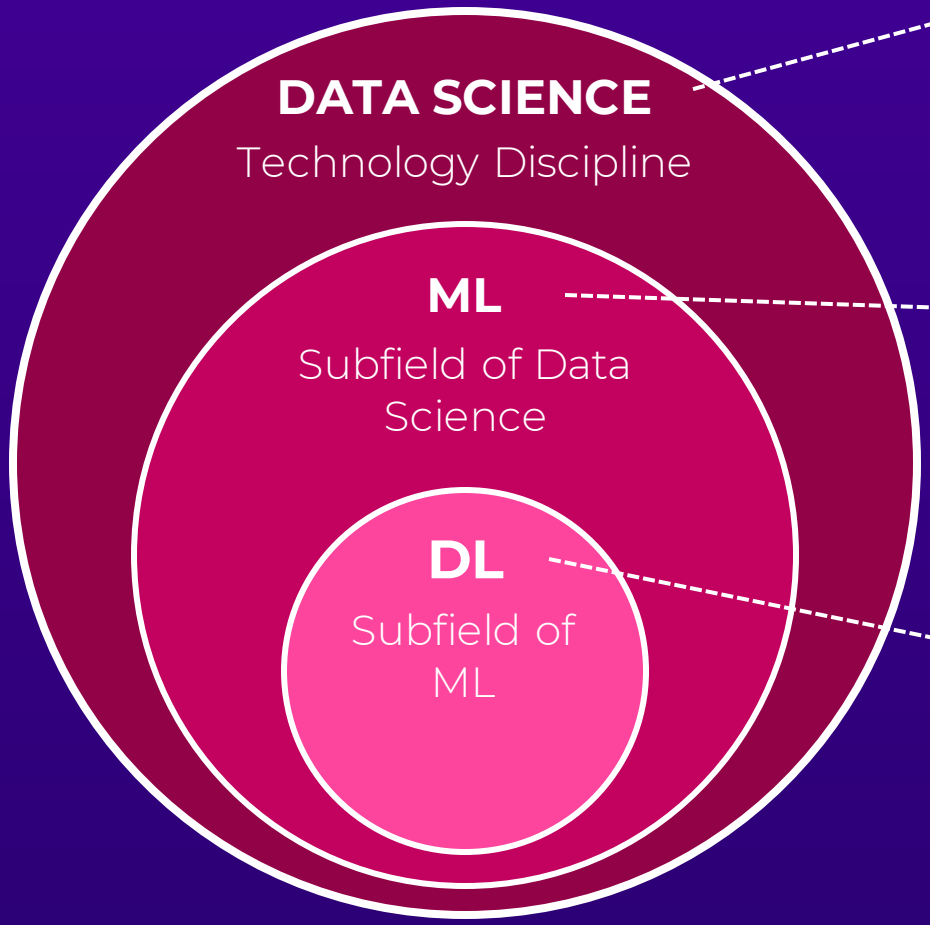
Collect	Transport	ETL	Compute	Storage	Query	Visualize
Endpoints measure and collect device, app, health, usage, and network data	Data is packaged and published (sent) to data systems	During ingestion, source data is processed, modified, and loaded to a DB	Data may be further processed through ML/AI or other logic functions	Databases store data and make it available for add'l compute or direct query	APIs are made available to the application or 3rd party systems for data query	UI layers are built to present processed data in useful ways

	Transport	ETL	Compute	Storage	Query	Visualize
Examples	MQTT	Spark	AWS Lambda	Elastic Search	SQL	JS

Conceptual Cloud Data Stack



Data Science



Data Science

Analyze data with math, statistics, and computer science skills

Machine Learning (ML)

Leverages math, stats, heuristics, and algorithms to analyze data

Deep Learning (DL)

Complex algorithms combined with large-scale compute to build human-like intelligence (conflated with “AI”)

Misconceptions and Pop-Culture Influence

1 Robot Uprising

AI = The Machine Uprising

Truth: AI imperfectly models subsets of ”intelligence”

2 Data in a Blender

ML/AI algorithms magically solve problems (black box)

Truth: AI is equal parts science, art, and domain skill

3 Data in a UI is AI

Pretty data must be ML/AI

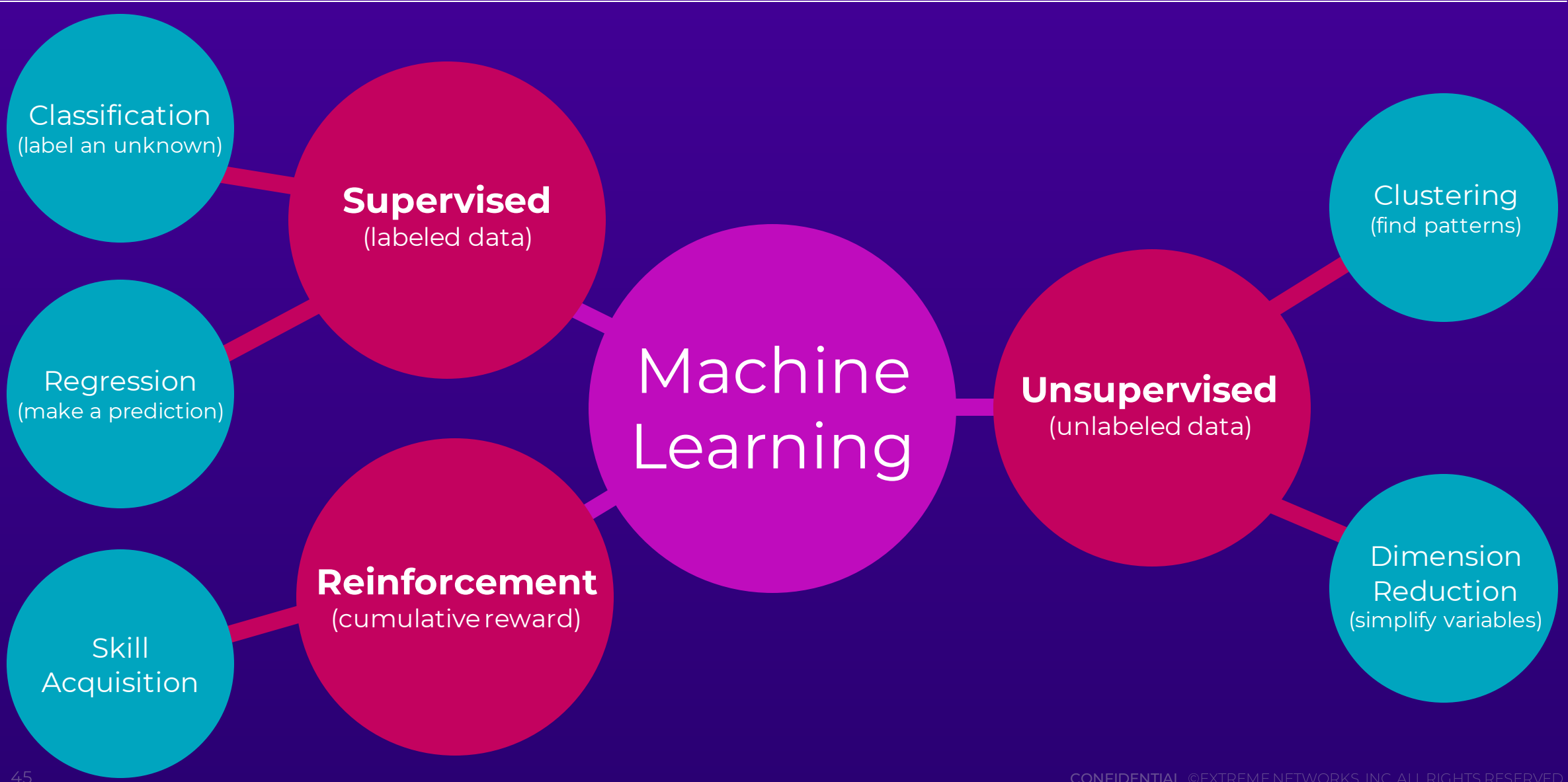
Truth: Data science needs UI presentation. Not all data visualization is ML/AI.

4 Everything Needs AI

AI makes everything better

Truth: AI has a cost. Each problem space has different data requirements.

Types of ML



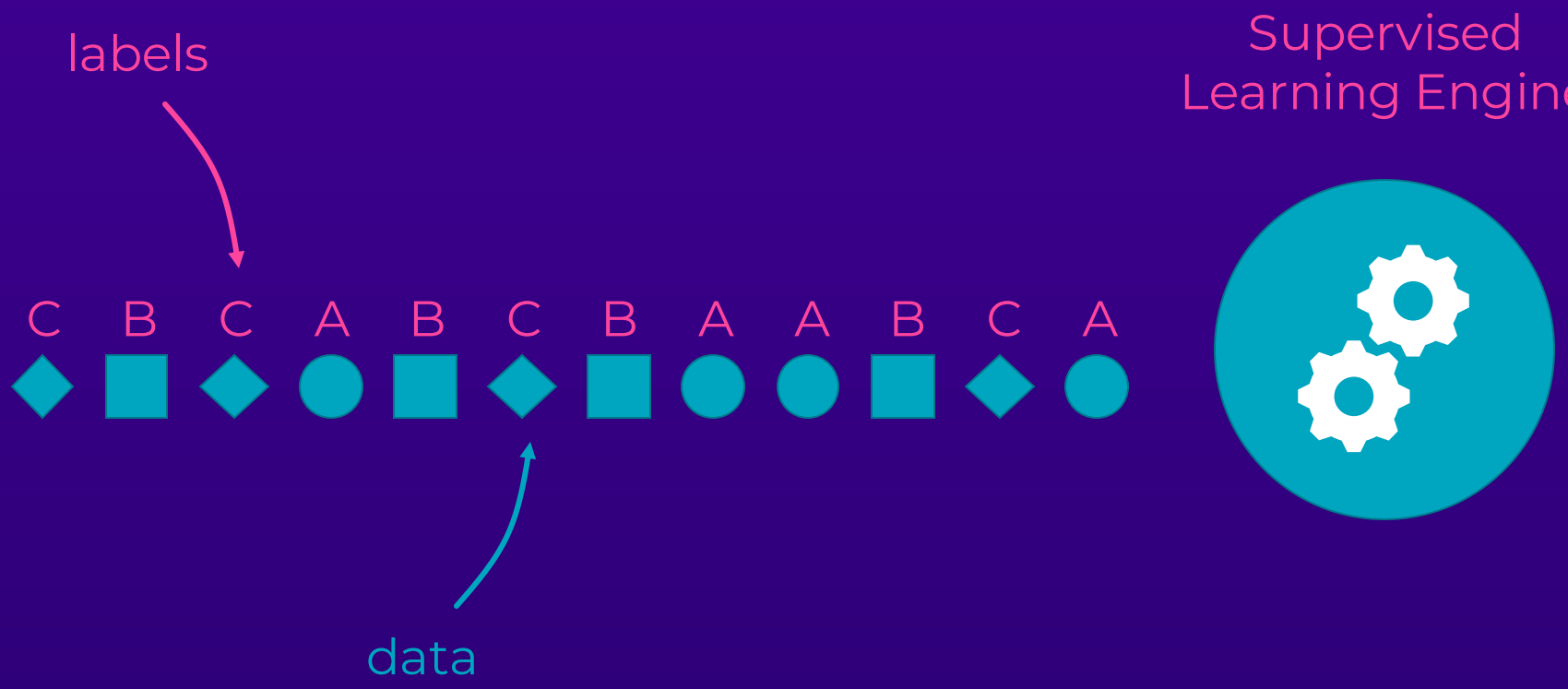
Types of ML

Supervised
(labeled data)

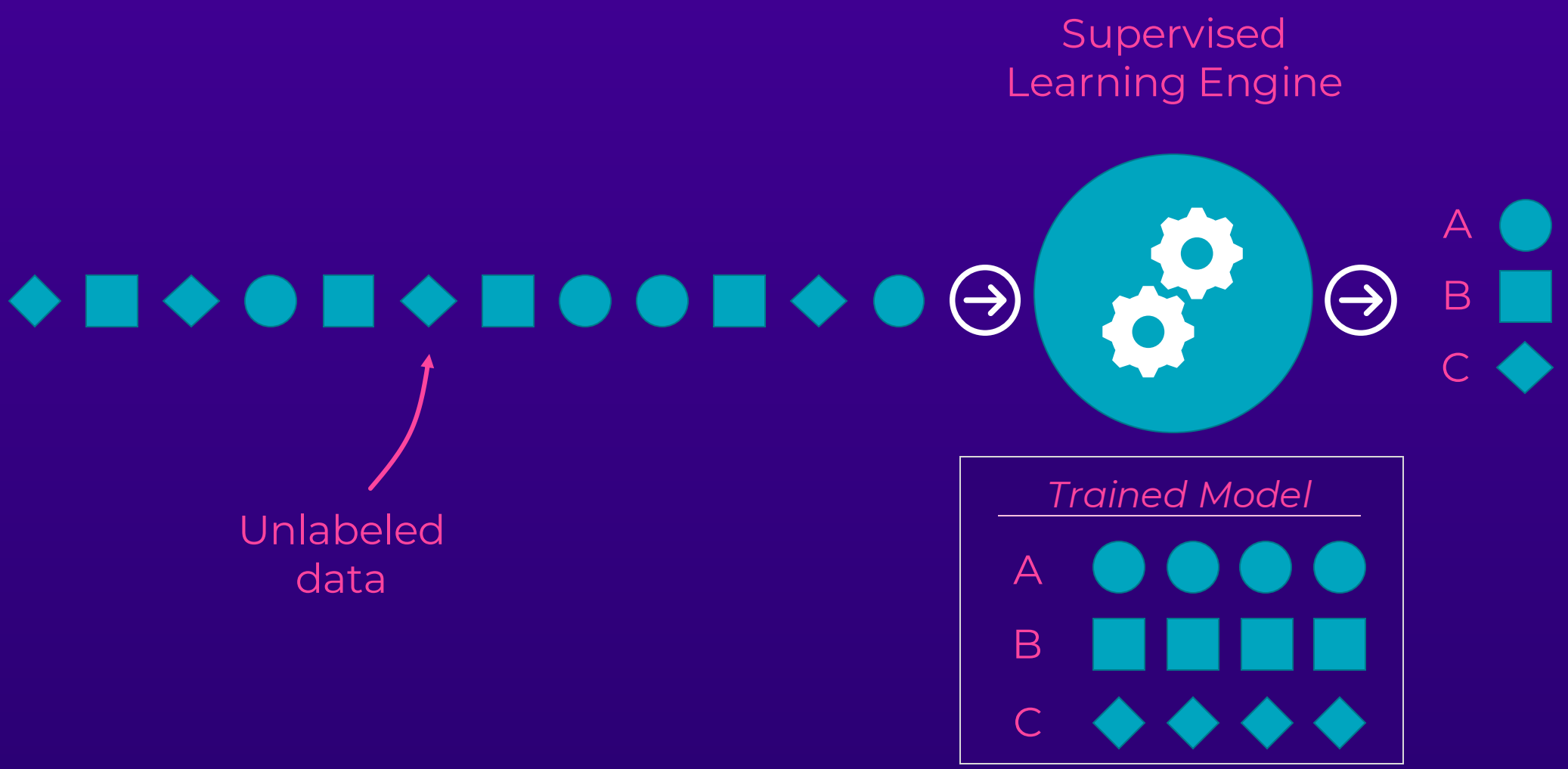
Unsupervised
(unlabeled data)

Reinforcement
(cumulative reward)

Supervised Learning



Supervised Learning



Supervised Learning in Practice

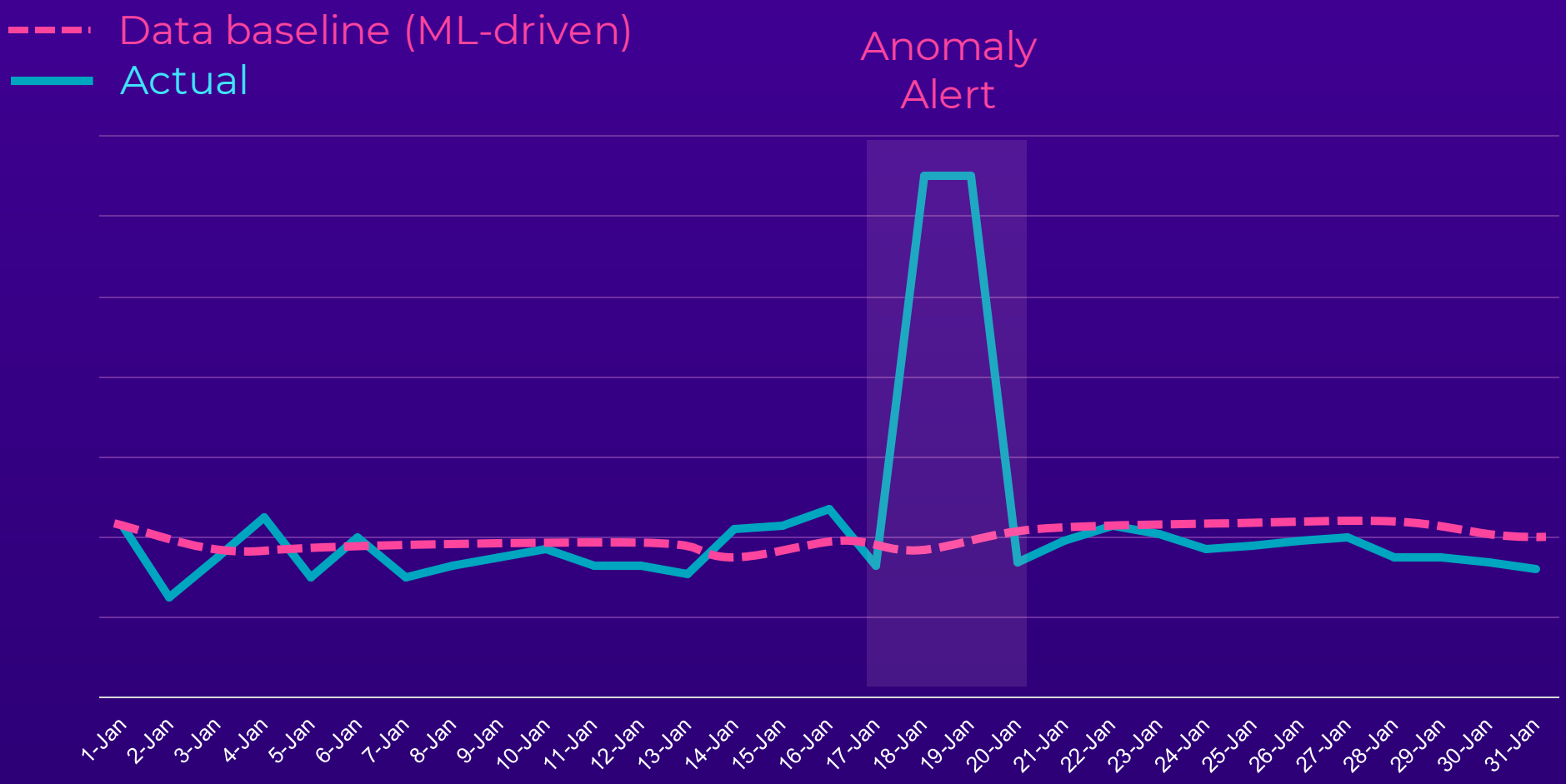
Alt Text: A dog sitting in the grass

Alt Text: A picture containing indoor, bullet, missile, table

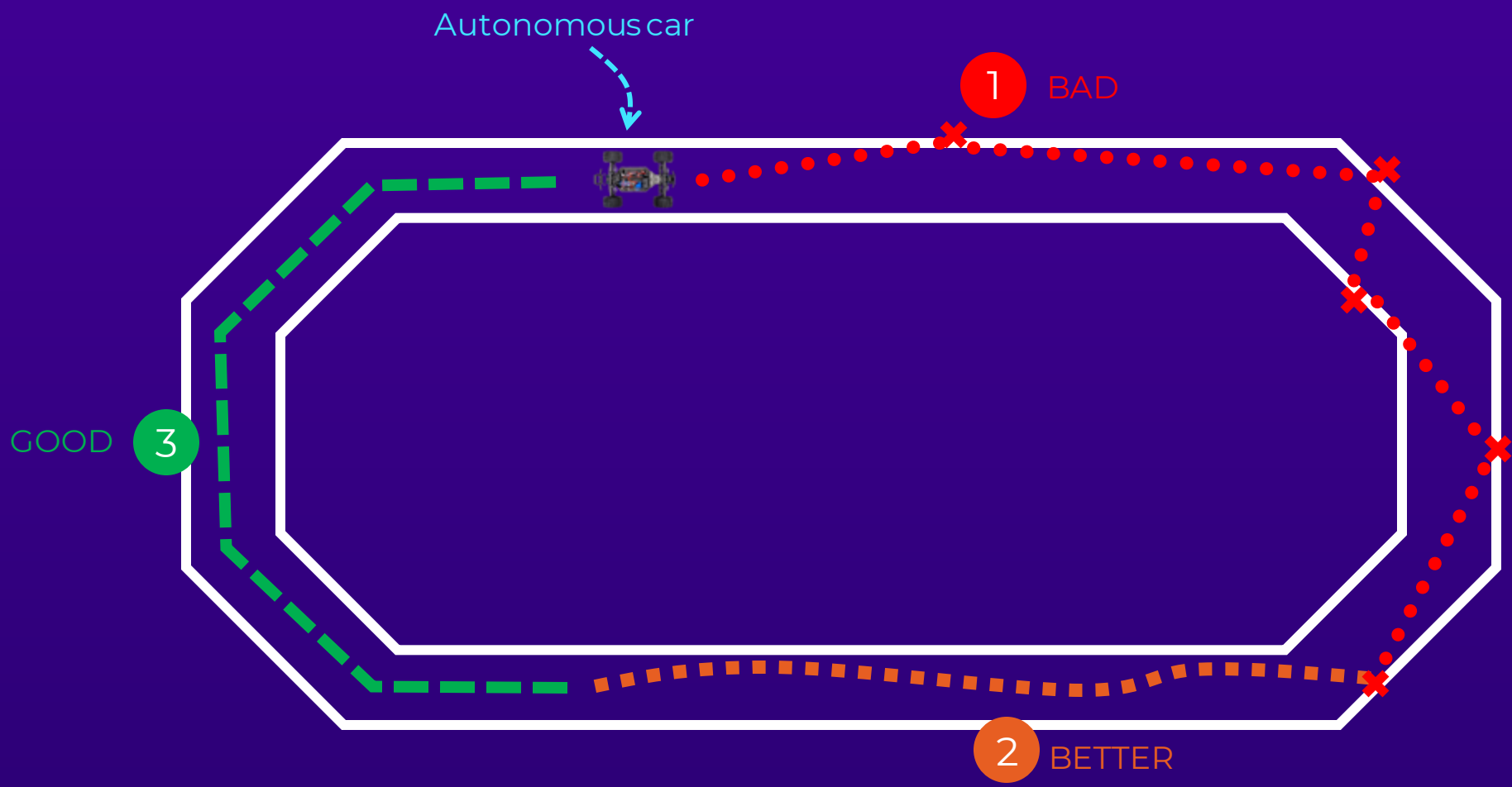
Alt Text: A person wearing a suit and tie

Alt Text: A picture containing aircraft, balloon, transport, accessory

Unsupervised Learning - Anomaly Detection



Reinforcement Learning



Data Modeling Toolkit

Rule-Based

- Thresholds
- High/Low Watermarks
- Strict Failure Conditions
- Service Level Monitoring

Statistical

- Averaging
- Distributions
- Outliers
- Deviations

Unsupervised (ML)

- K-Means Clustering
- Association Rule Learning
- Singular Value Decomposition
- Principal Component Analysis
- Independent Component Analysis

Supervised (ML)

- Decision Trees
- Naïve Bayes Classification
- Random Forest
- Regression (Linear and Logistic)
- Ordinary Least Squares
- Support Vector Machines
- K-Nearest Neighbor

Reinforcement (ML)

- Policy Optimization
- Q-Learning
- Model-based RL

Deep Learning (AI)

- Convolutional Neural Networks
- Recurrent Neural Networks
- Natural Language Processing
- Autoencoders
- Deep Belief Net

Some Cautions

1 Cost / Value Tradeoffs

ML/AI requires more data (collection, transport, storage, and processing), time to train and retrain, and additional cost.

2 Probability and Confidence

%

ML/AI are based on statistics and are never 100% accurate. Every ML output comes with a confidence factor.

3 Guard Your Expectations

ML/AI will keep improving. Don't expect artificial general intelligence. Expect a data-driven guide. Data science is NOT the same as AI.

Exploring the Problem Space for Networks

IoT Security

Using anomaly detection to identify abnormal packet flows with IoT devices (e.g. problematic security behavior by rogue device)

Data-Driven Best Practices

Leveraging client and environment data to build a predictive (or automated) recommendation engine (e.g. enable DFS channels)

Predictive Failure

Learning patterns and training a model to detect failure conditions before failure occurs (e.g. SFP optics failure prediction)

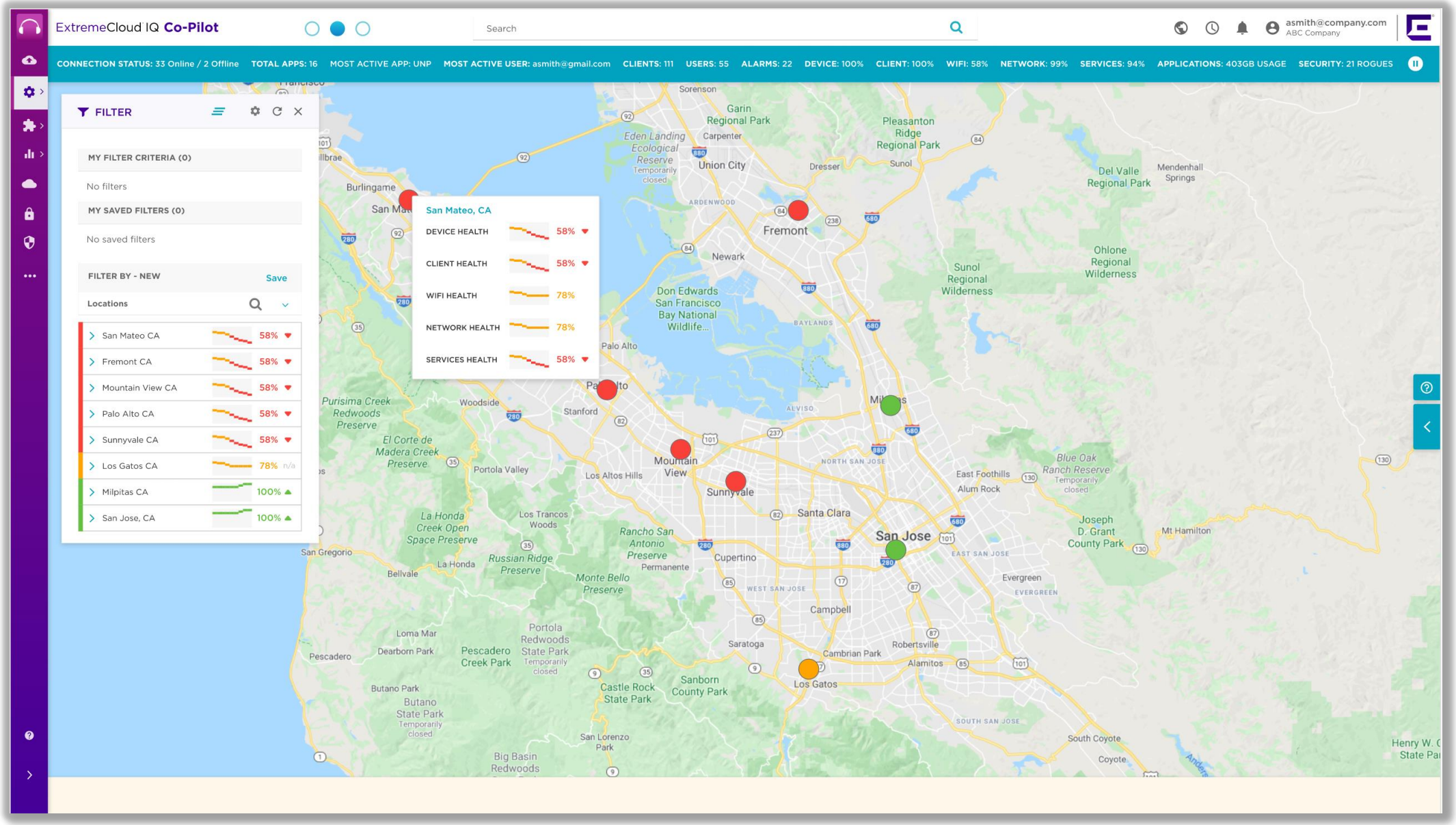
Health Events and Anomalies

Establishing time and spatial comparison baselines for health, then flagging issues automatically (e.g. high reboots in building)

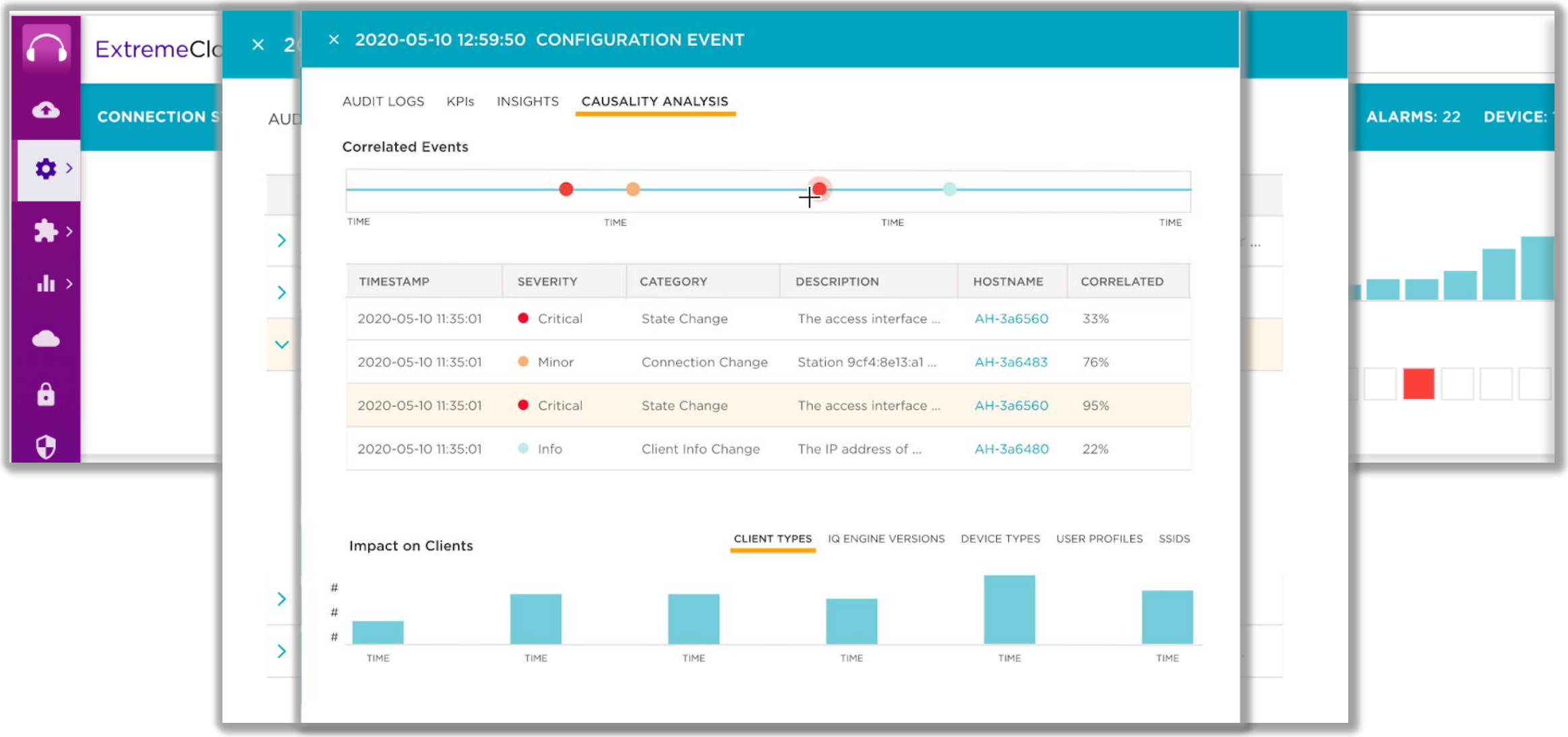
Event Pattern Mining

Mining event sequences for root cause information as well as correlated issues (e.g. config change causes health impact)

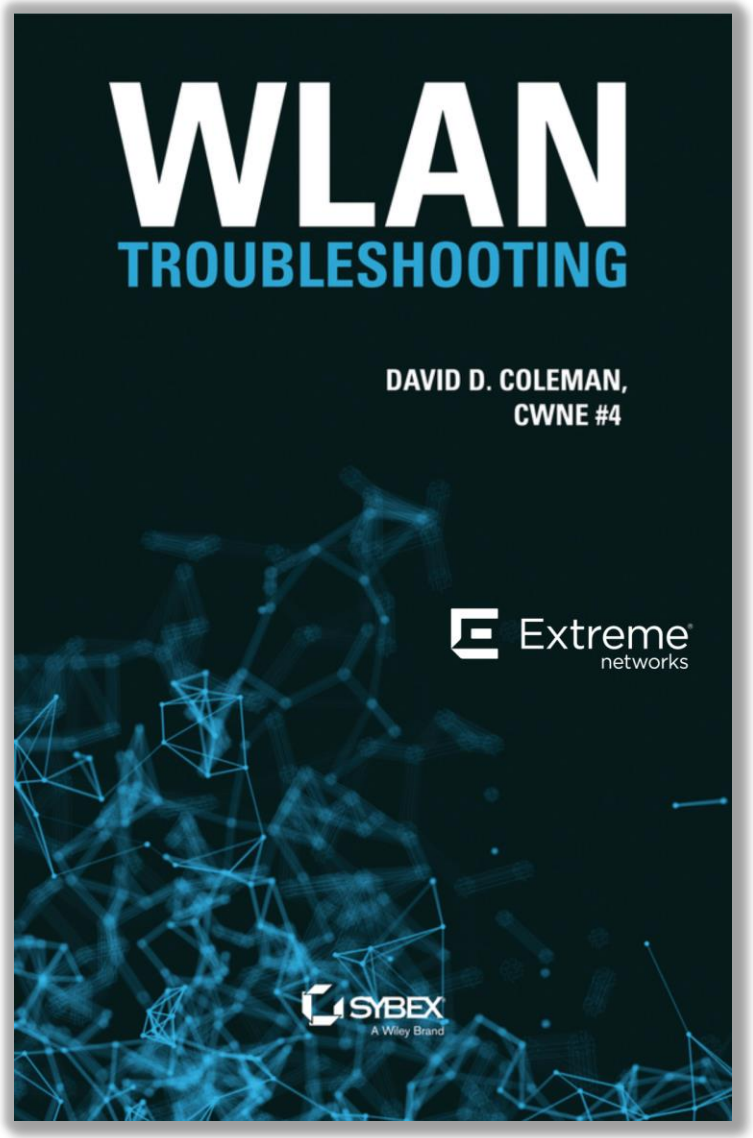
Coming soon: ExtremeCloud IQ's Co-Pilot



Coming soon: ExtremeCloud IQ's Co-Pilot



Other Resources – Free troubleshooting e-booklet

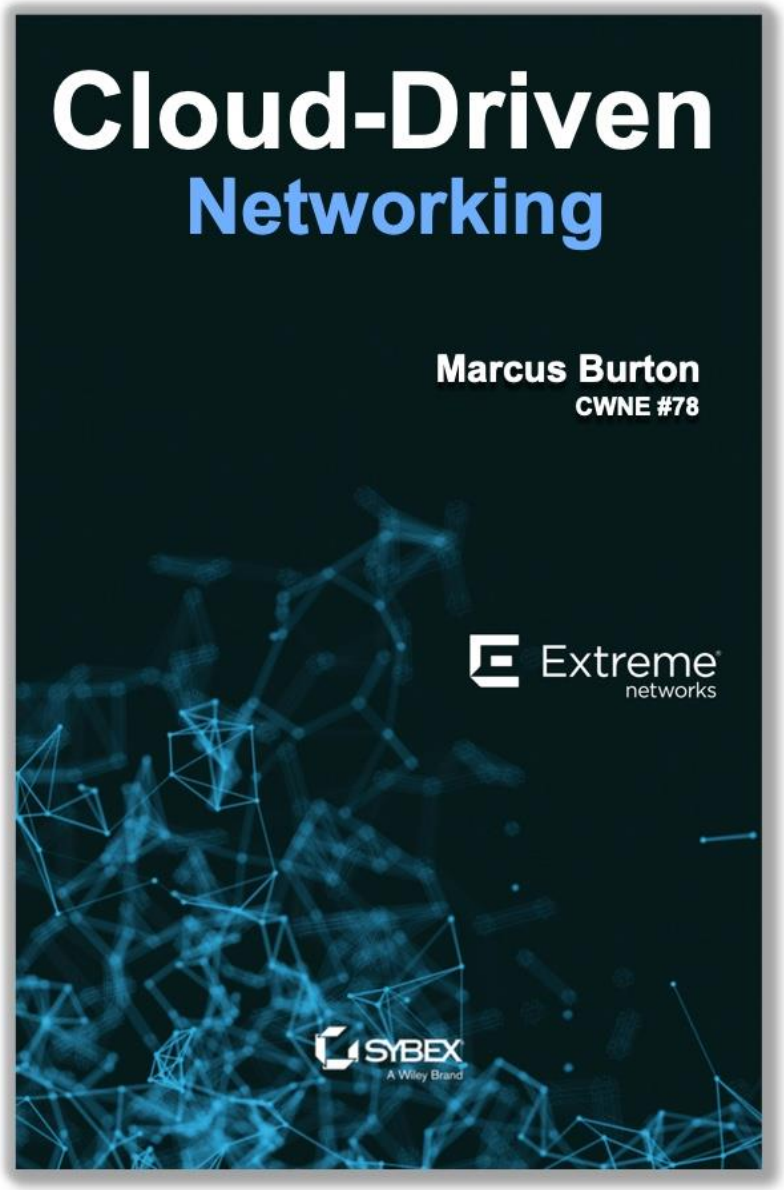


Download here:

https://bit.ly/Troubleshooting-ebook

@mistermultipath

Coming soon: Free cloud e-booklet



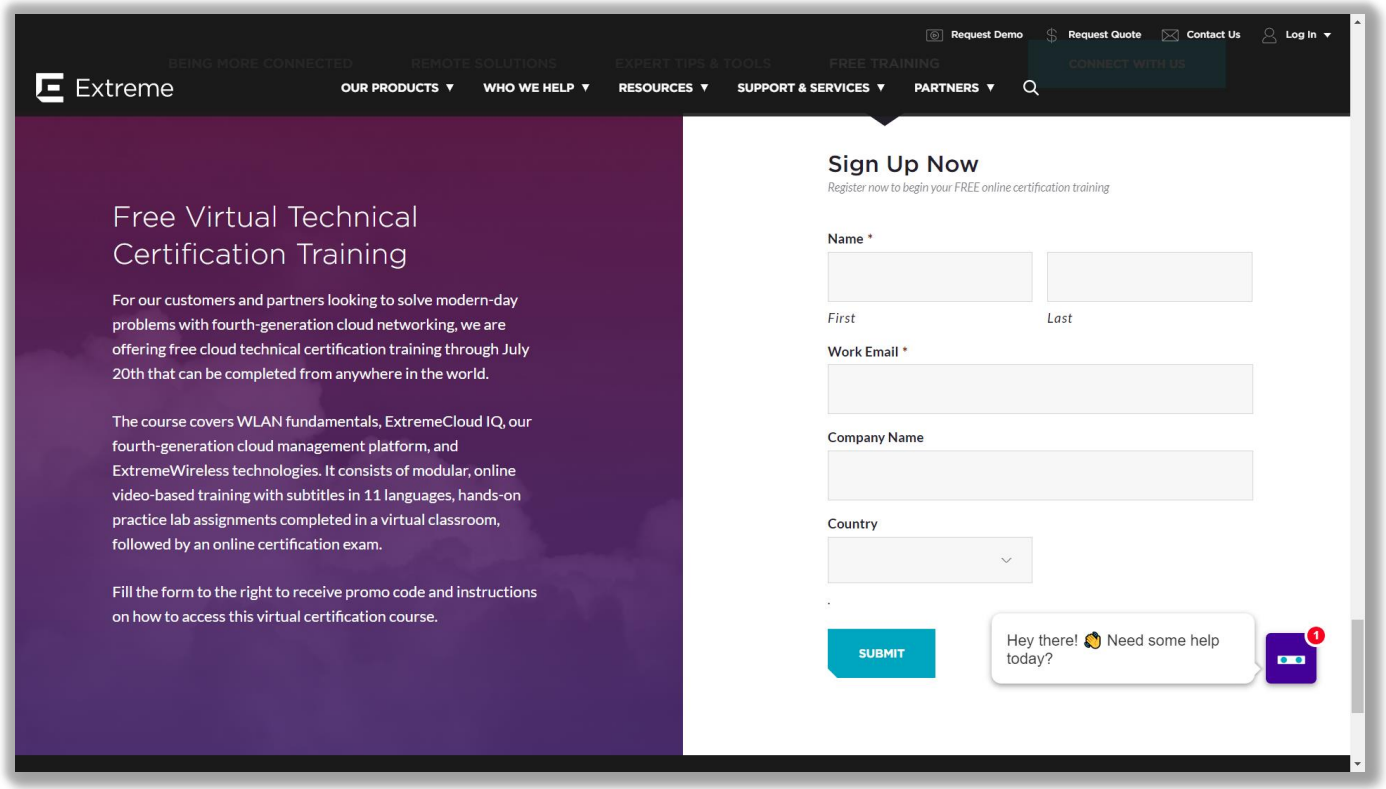
Cloud-Driven Networking e-Book

ECS – ExtremeWireless Cloud Troubleshooting class

- Designed for networking professionals responsible for **supporting** and **troubleshooting** wireless LAN networks.
- Two-day instructor led, hands on, lab-based classes.

https://dojo.extremenetworks.com/ecs-extremewireless-cloud-troubleshooting/

Free Virtual Technical Certification Training



Register for the offer at
www.extremenetworks.com/remote

Instructions and promo code will be sent in an email

*This offer is available through Sept 18th, 2020. It is only available for the ExtremeWireless Cloud technical certification training course, and only available for the self-study training format and not full instructor-led classes

Questions

ADVANCE WITH US™