Demystifying the Role of AI in Your Cisco Wireless Deployments

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Principal Engineer, Cisco Wireless

Session ID: BRKEWN-3007

The machine does not isolate man from the great problems of nature but plunges him more deeply into them

- Antoine de Saint-Exupéry

Source: Wind, Sand and Stars (Chapter III)

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Vishal Desai

Principal Engineer

New Speaker

Expertise

AI-Driven Wireless Solutions, Wi-Fi PHY Optimizations, Distributed Systems, Resource Management

Experience

19+ years experience in the Wi-Fi industry. Holds 219 patents in the areas of wireless communications and distributed systems

Education

BS/M.Eng in Computer Science from Cornell University

Hobbies

Hiking, scouting and backyard gardening with my son.

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Agenda

1 Understanding AI Landscape

2 AIOps in Cisco Wireless

3 System Architecture

4 Real-World Examples

Financial Services

Intelligent RF Management

Retail

Proactive Assurance

Education

AI-Driven Config Guidance

5 Key Takeaways

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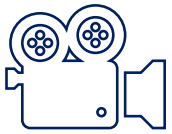
Understanding AI Landscape

Omnipresent AI: Silently Shaping Life Before the Hype

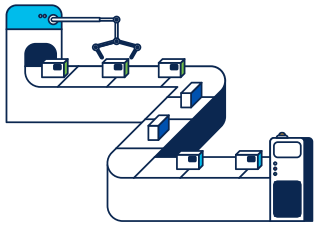
Spam Filters



Movie Recommendations

Shopping

Face Recognition



Factory Automation

Biometrics

Diagnose Illness

Maps - Direction

Text to Speech

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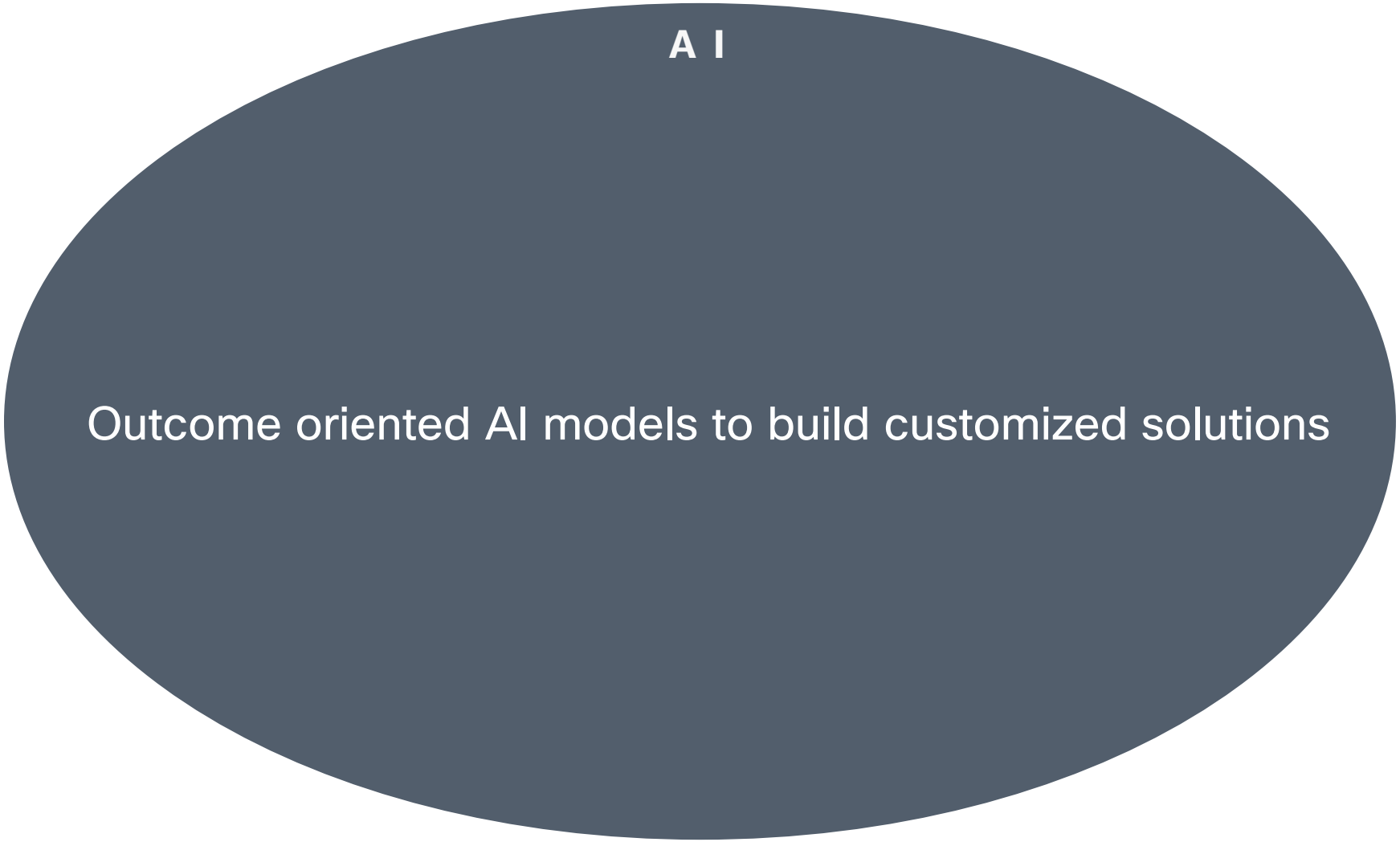
Understanding AI Landscape



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Understanding AI Landscape

A I

M L

K-nearest neighbor
Busy Hours

XGBoost
Baseline, RCA

Random Forest
Automatic RCA, Dynamic Grouping, Performance Advisories

Reinforcement Learning
Auto Recalibration, Channel Planning, Threshold Generation,

Online ARIMA
Client Anomaly Detection

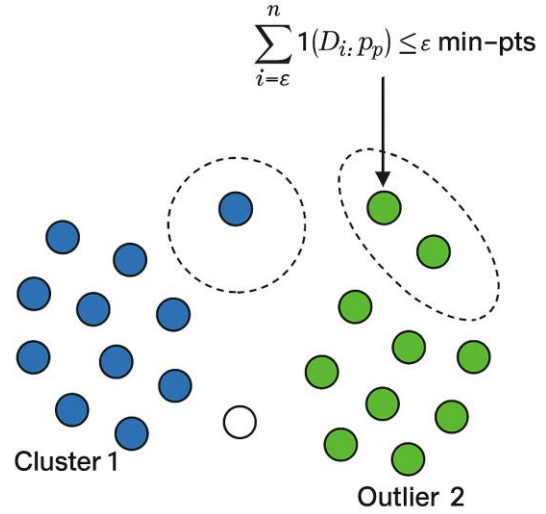
K-Means Clustering
Network Comparison

Bayesian Changepoint Detection
Trend Analysis

DBSCAN
Device Classification
QoE deviation

Classification
Impersonation/Honey Pots

SVM
Spoofing Detection



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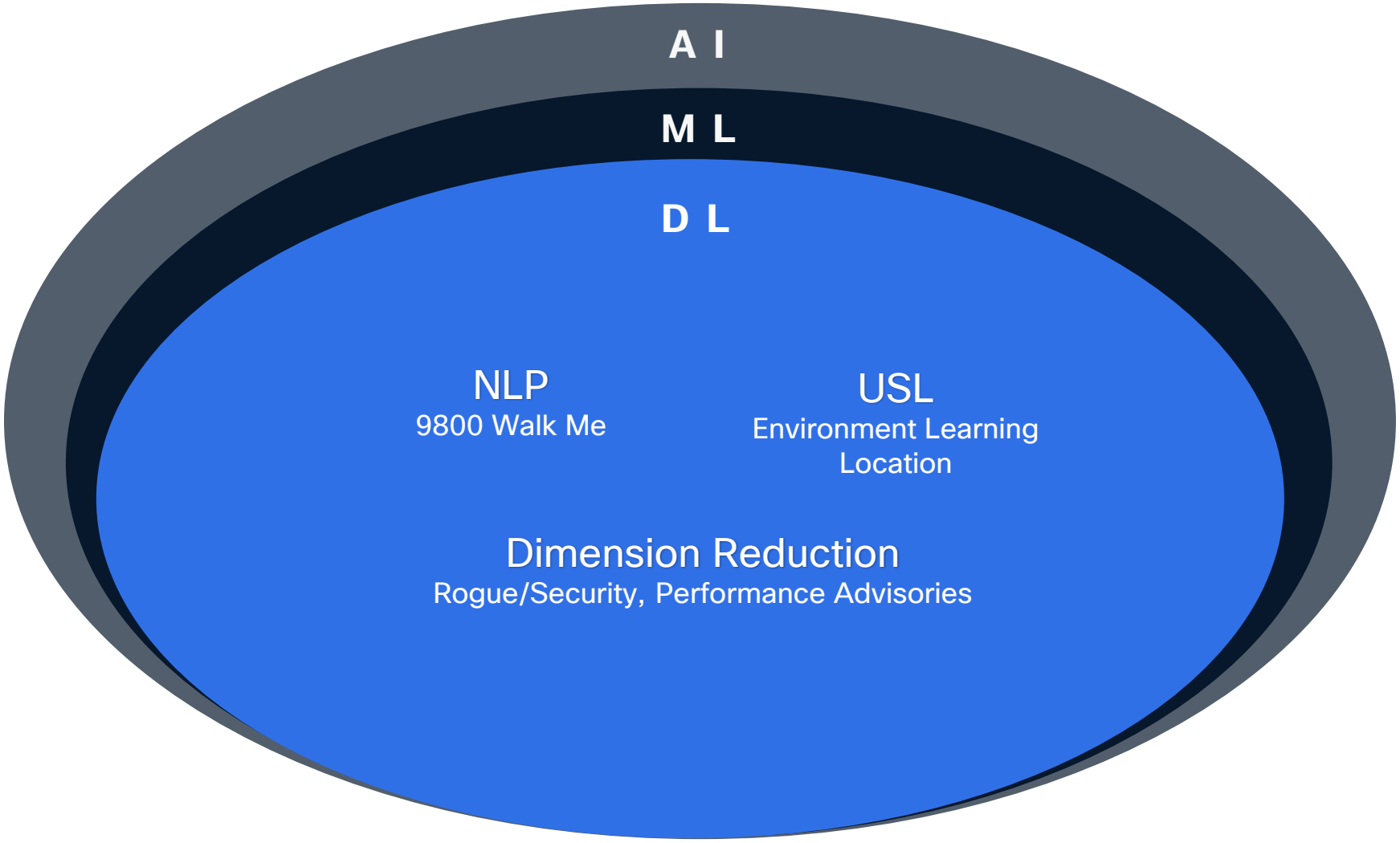
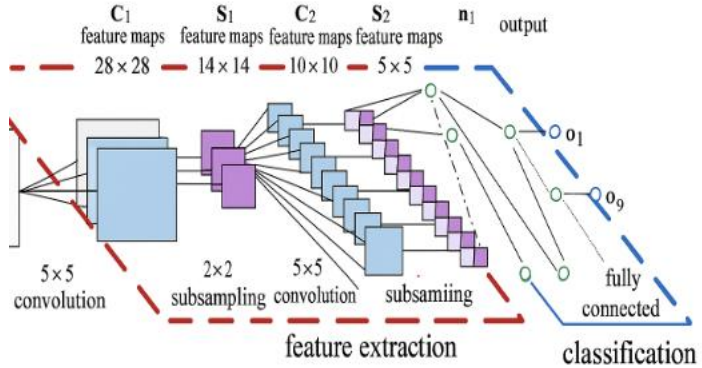
Understanding AI Landscape





$$p_j = \sum_{i=b}^{a_i} x_i \frac{\exp a_i^{\ p_j}}{\sum \exp a_k}$$

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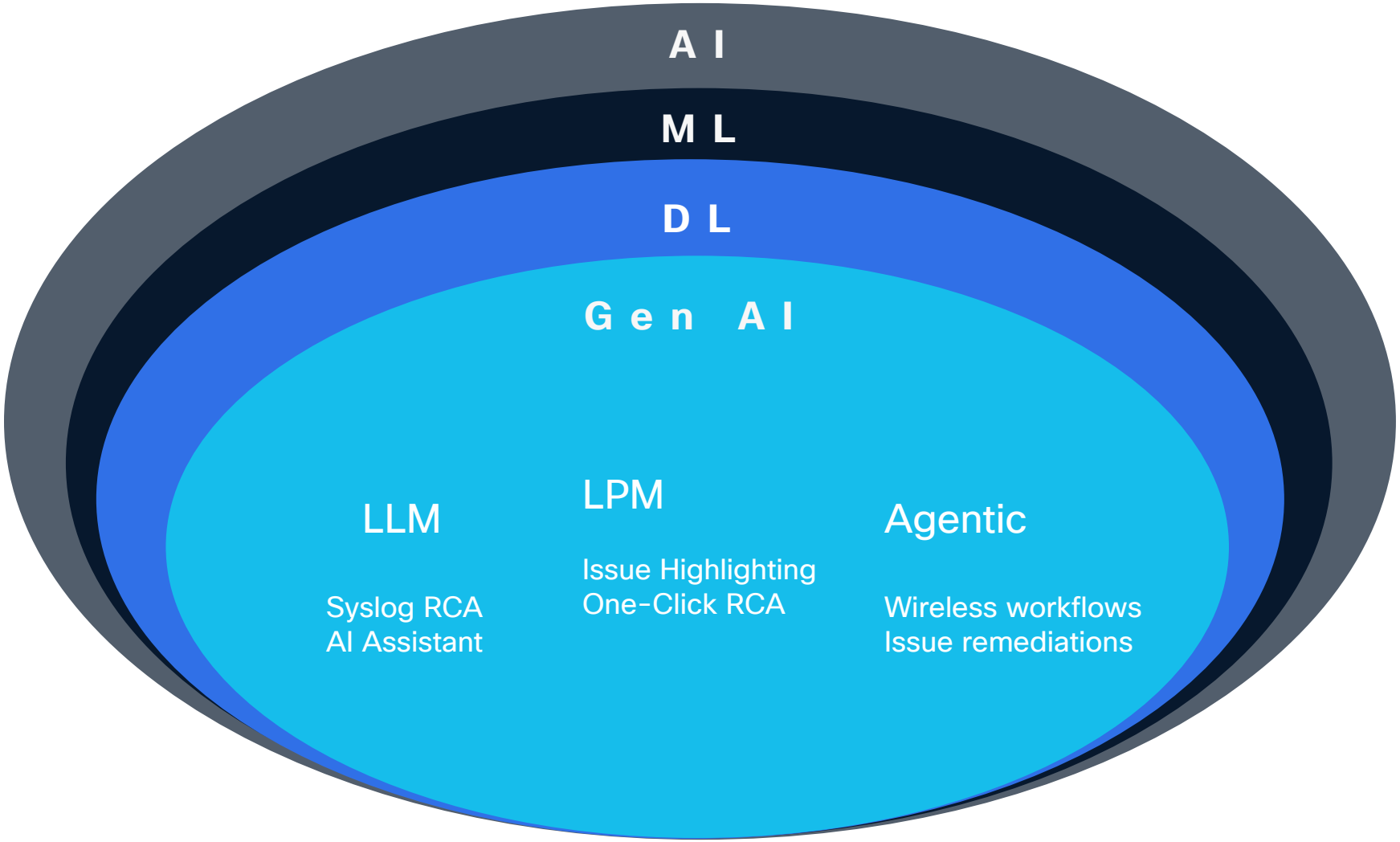
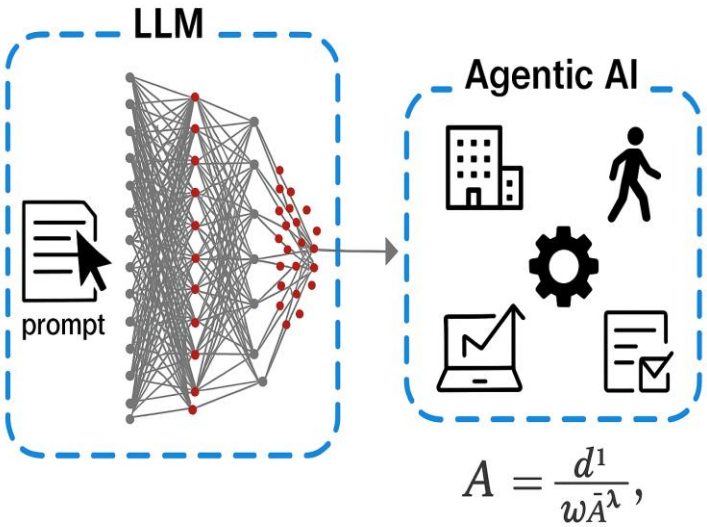
Understanding AI Landscape





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AIOps in Cisco Wireless

Wireless Engineering Strategy on Applied AI

Focus on Problem Definition

Evaluate AI Suitability

Customized AI Solutions

Integration with Existing Systems

Iterative Approach

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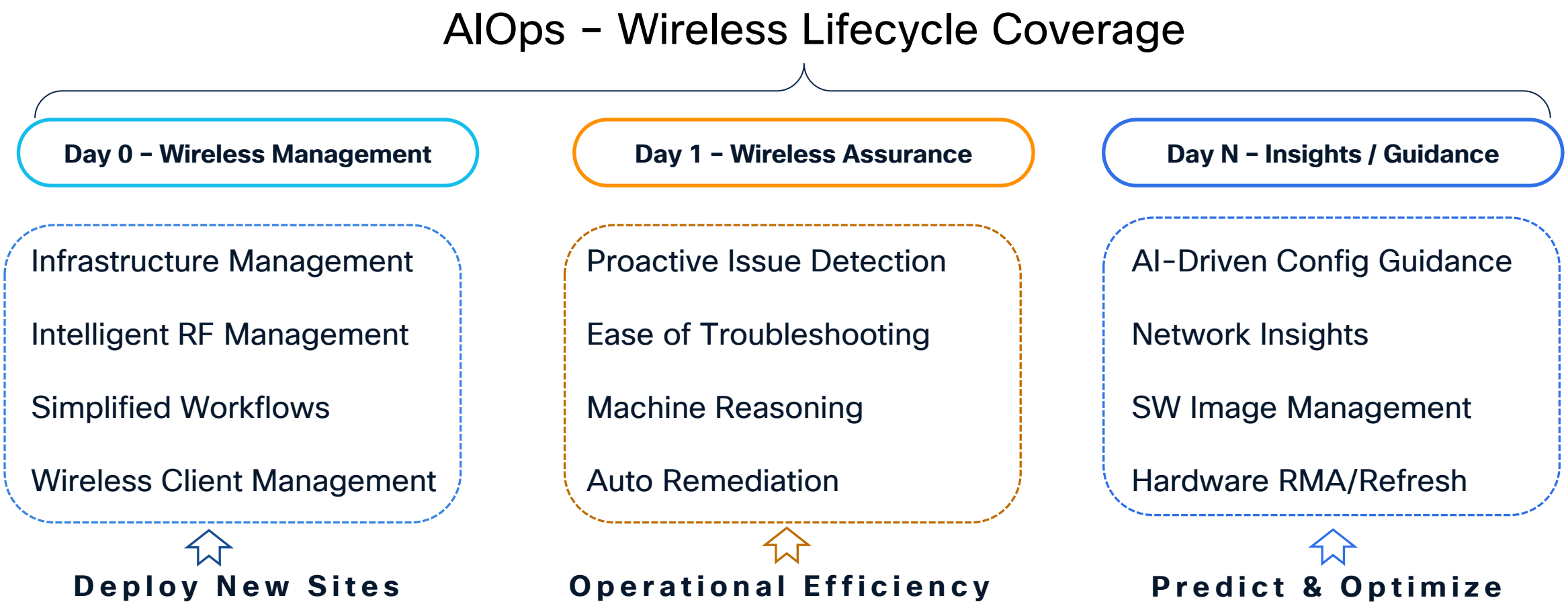
AIOps for Network Lifecycle



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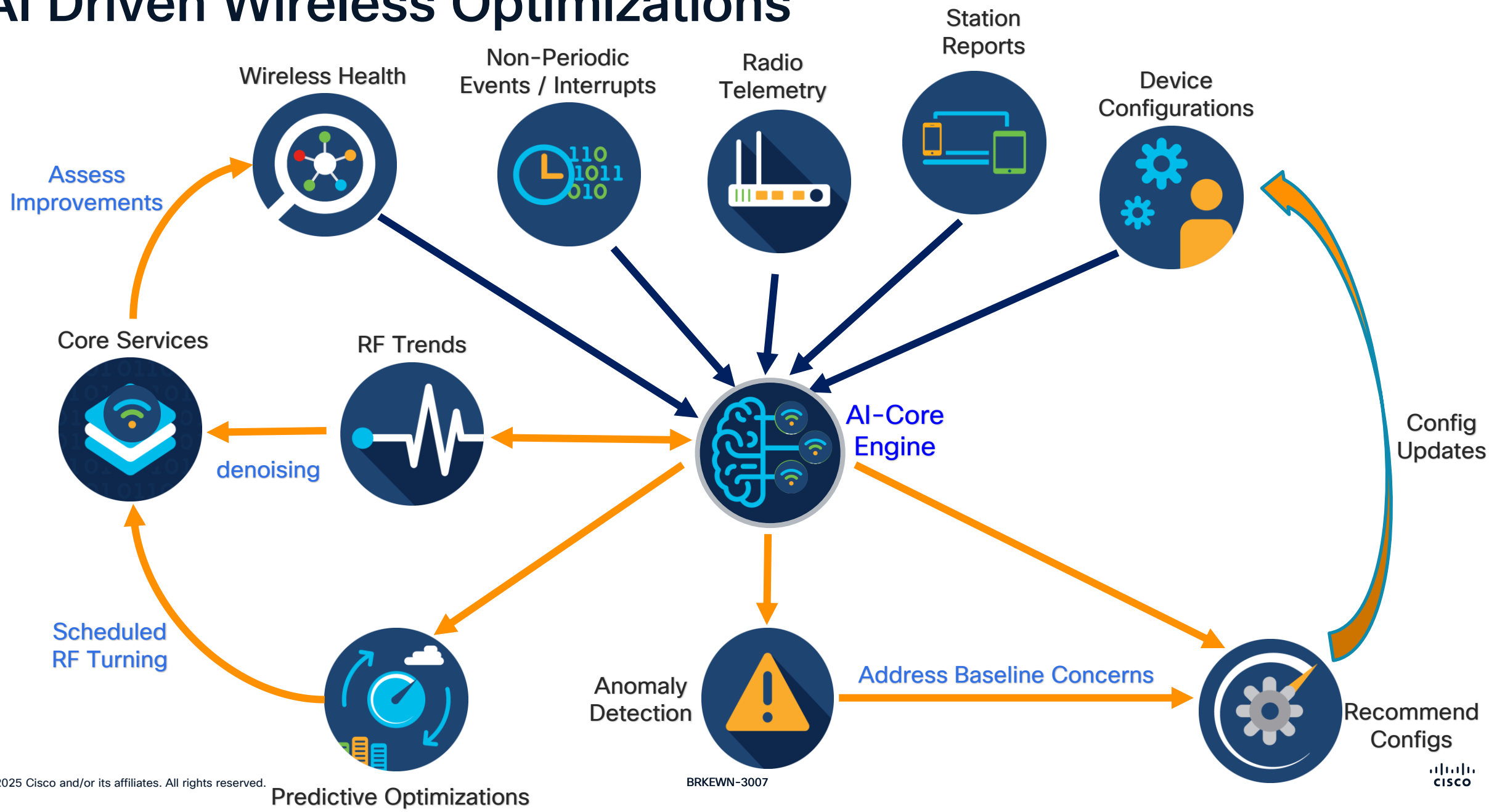
AI Driven Wireless Optimizations



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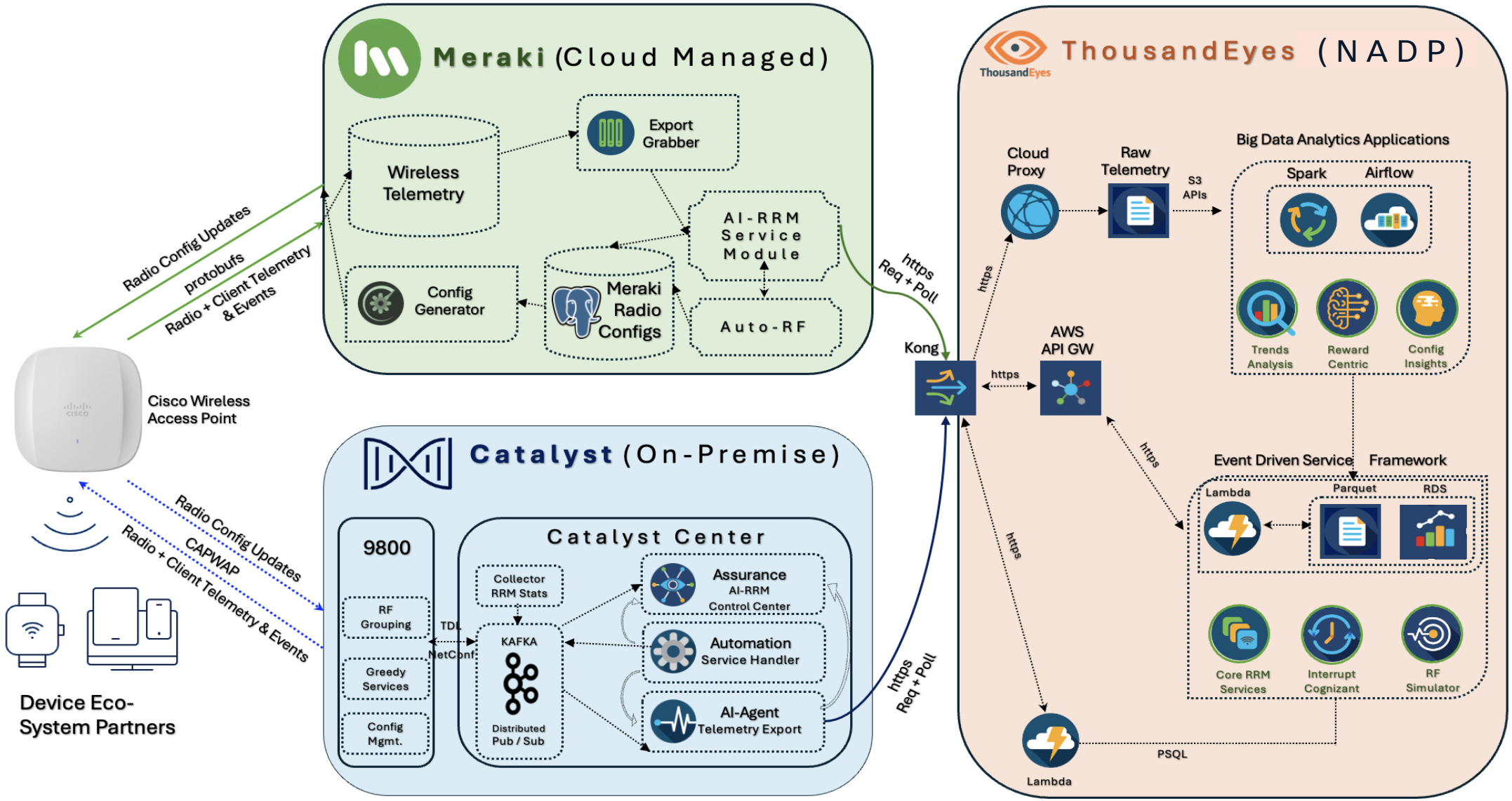
System Architecture

Applied AI Systems Architecture



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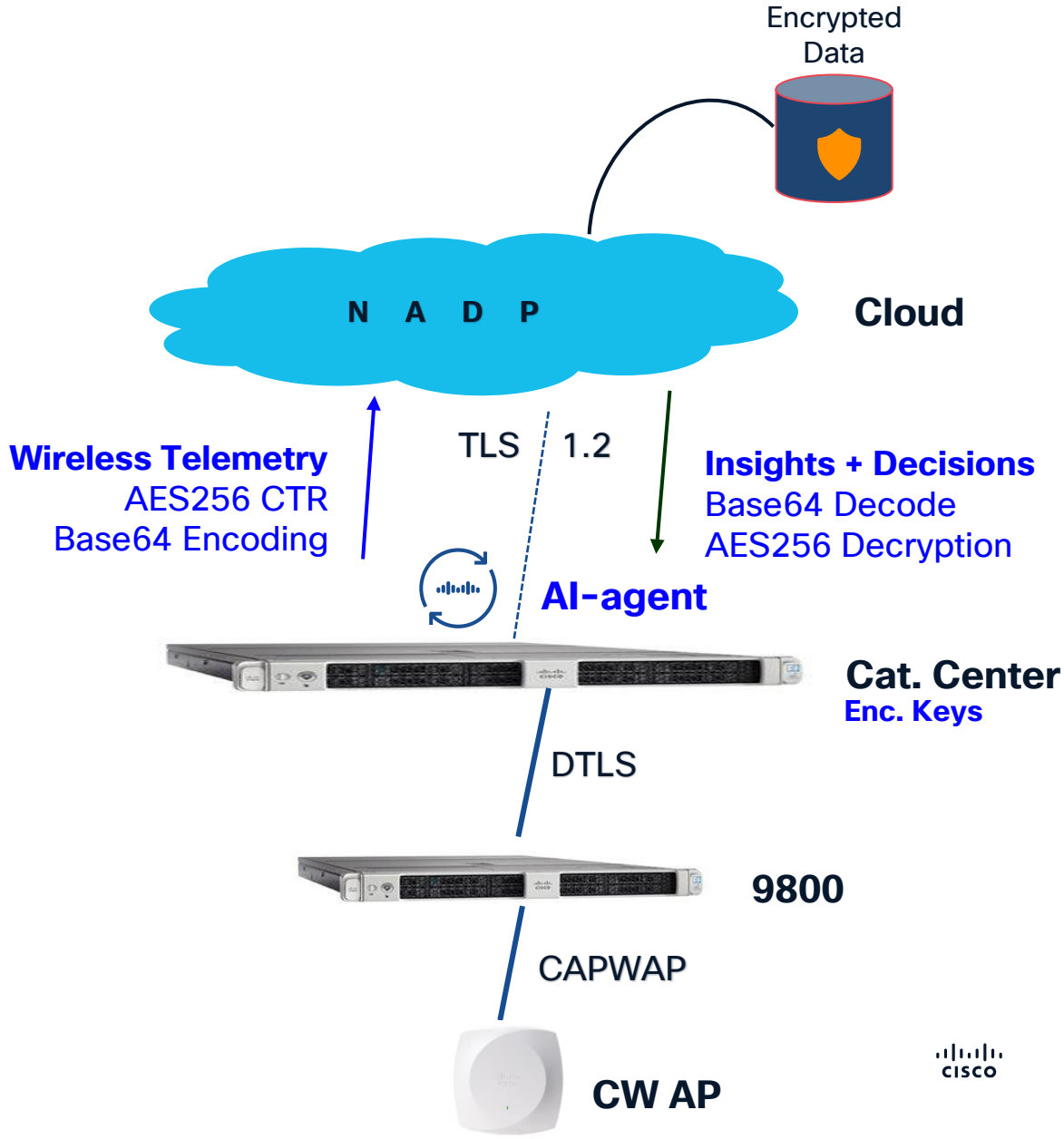
On-Prem Anonymization & Secure Data Handling

- **Secure tunnel:** between CW AP and the NADP Cloud
- **On-prem security**: Data is encrypted (AES-256) and Base64 encoded locally before cloud transfer.
- **End-to-end encryption**: Keys are stored on Catalyst Center; cloud data remains encrypted via AWS-native controls.
- **Real-time rendering**: Decryption occurs on-prem at runtime for secure UI display.



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Real-World Examples

AI Focus Areas for Cisco Wireless

Day 0 – Wireless Management	Day 1 – Wireless Assurance	Day N – Insights / Guidance
Infrastructure Management	Proactive Issue Detection	AI-Driven Config Guidance
Intelligent RF Management	Ease of Troubleshooting	Network Insights
Simplified Workflows	Machine Reasoning	SW Image Management
Wireless Client Management	Auto Remediation	Hardware RMA/Refresh

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Business Vertical	**Financial Services**
Site Location	**Europe**
Managed Sites	**46 Buildings**
AP Count	**652**
Wireless Clients	**Avg ~5500, Peak 7862**

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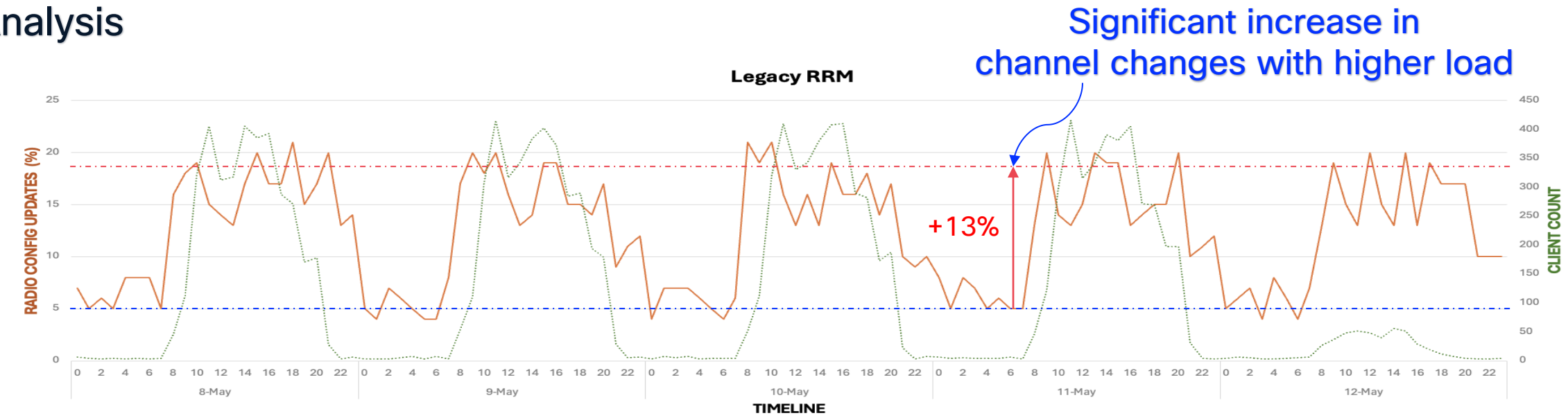
Problem Statement

- Areas of Concern
  - **Primary:** Frequent disconnects of the wireless clients
    - Predominantly observed on the larger sites
  - **Secondary:** Slow Wi-Fi performance on certain buildings

- Analysis



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Classic Dilemma of RF Management Systems

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How is it achieved today?

On-Premise (9800)

Configuration > Radio Configurations > **RRM**

6 GHz Band | 5 GHz Band | 2.4 GHz Band | FRA

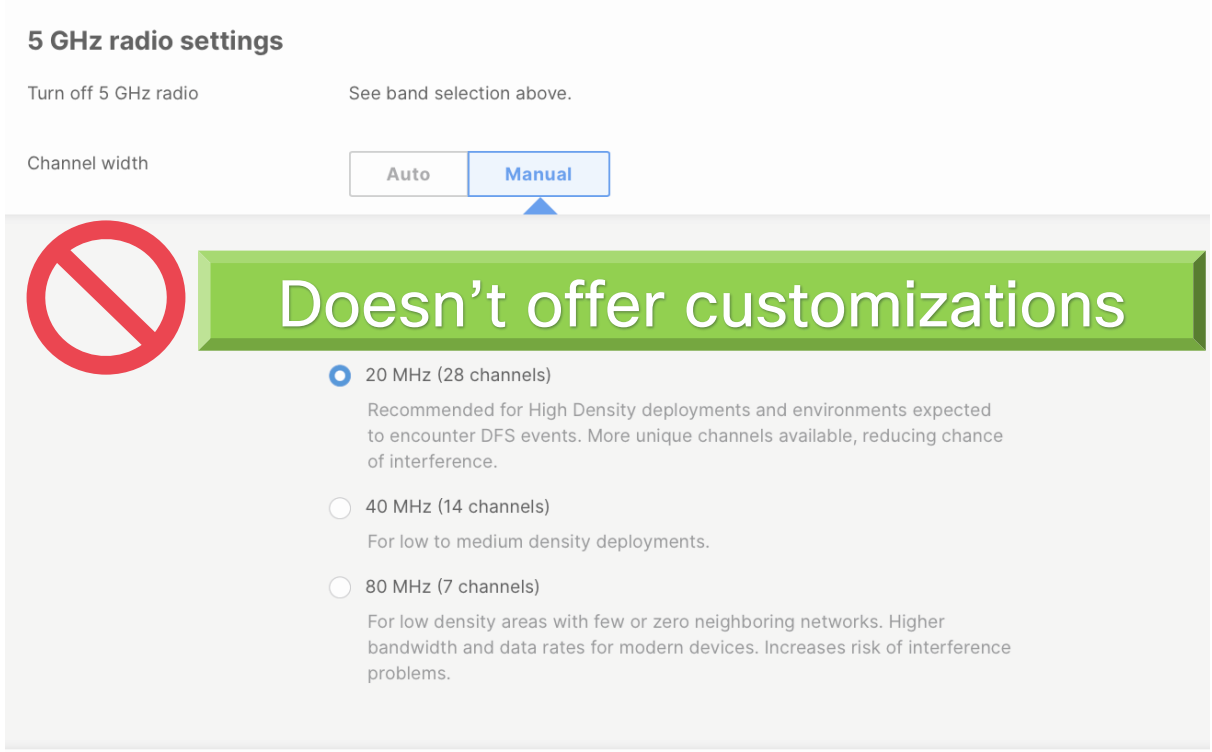
General | Coverage | **DCA** | TPC | RF Grouping | Spatial Reuse

Dynamic Channel Assignment Algorithm

Channel Assignment Mode	Automatic / Off
Interval	8 hours
Anchortime	4
Channel Assignment Leader	CA-C9800 (10.10.105.240)
Last Auto Channel Assignment	410 second(s) ago
DCA Channel Sensitivity	medium

Optimize Wi-Fi every 8 hours at 4 am 12 noon & 8 pm

Cloud-Managed (MR Dashboard)



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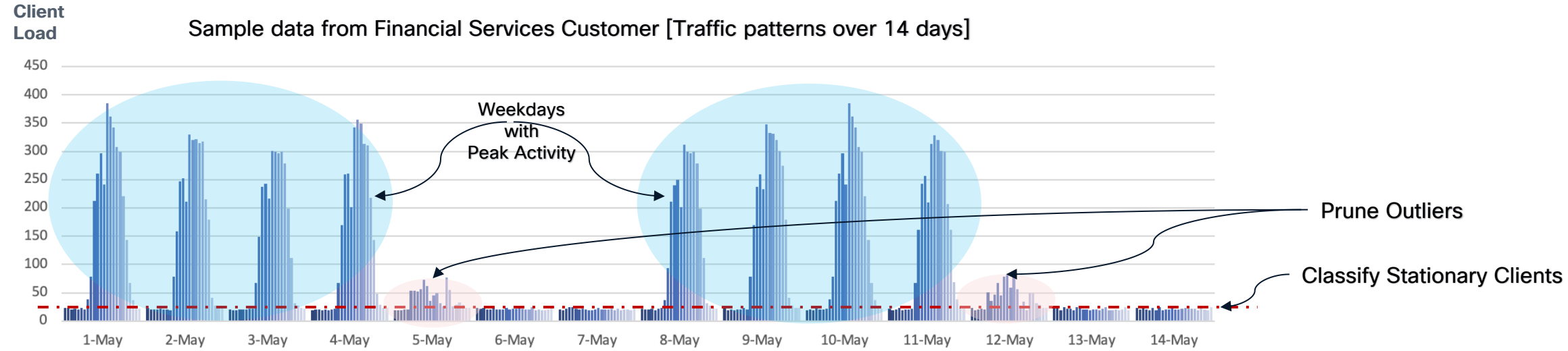
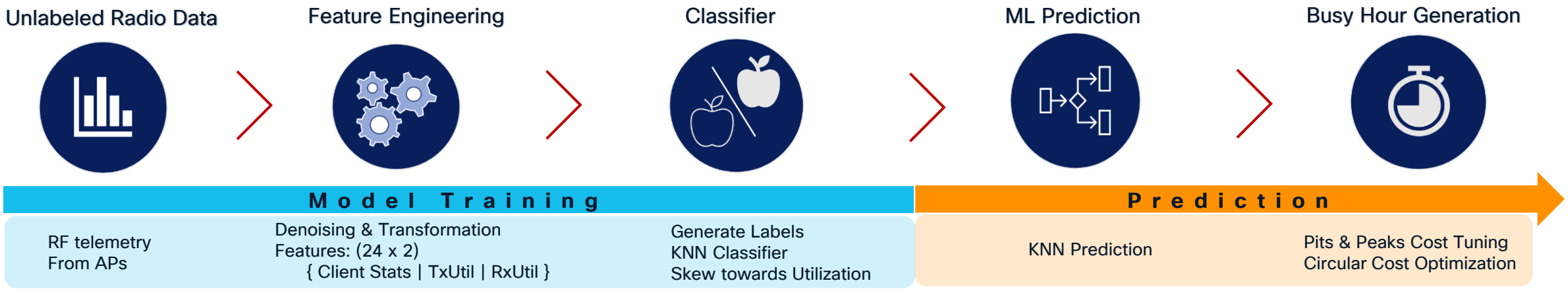
Introducing AI Generated Busy Hours





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K-Nearest Neighbor (KNN)

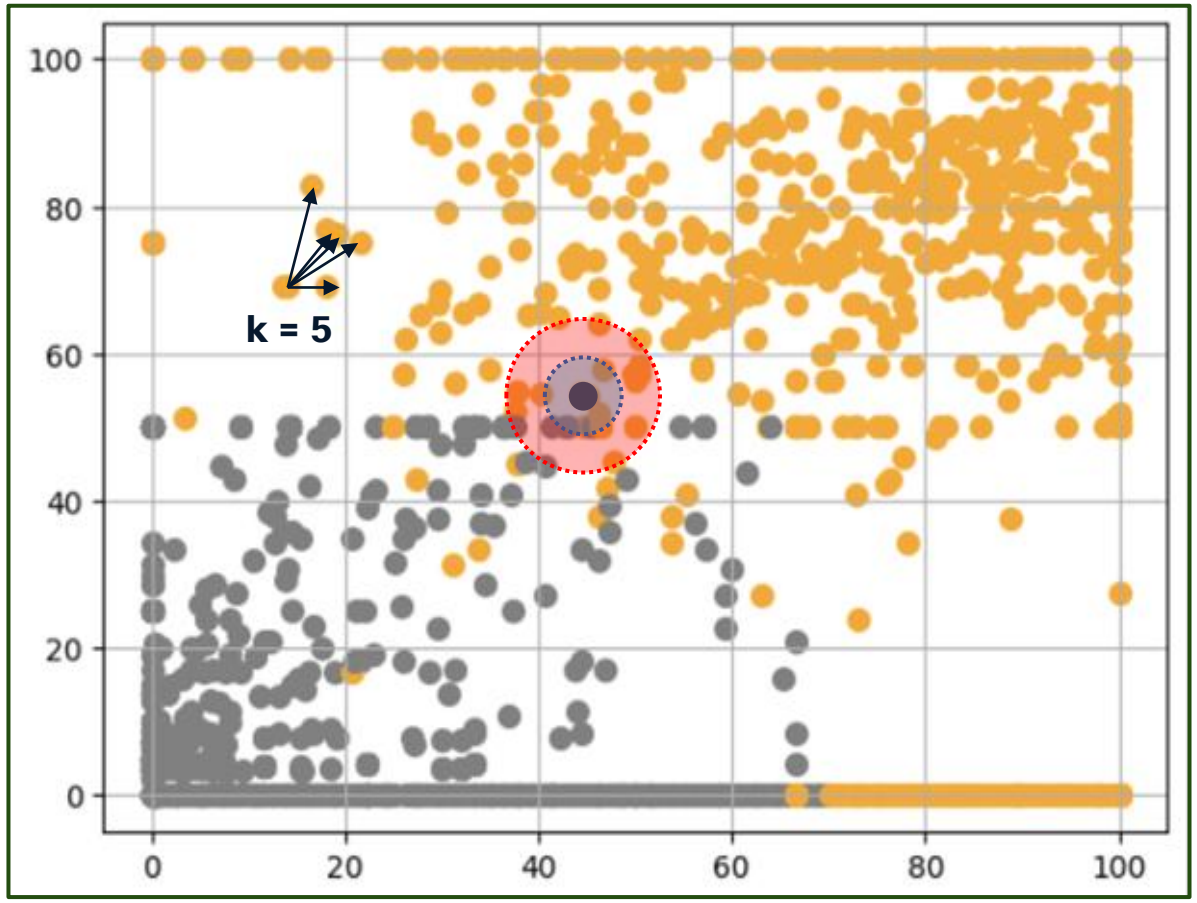
$$k = |x + \frac{\alpha}{x} - 2\beta|$$

x = non-stationary count

α = Wi-Fi utilization

β = inverse of session time

- Machine Learning algorithm for classification and regression
- Classification using data points' relation to their nearest neighbors
- Crucial to careful evaluate optimal value of K
- Higher K reduces noise but can obscure patterns
- Busy Hours k value biased towards station, utilization and session length



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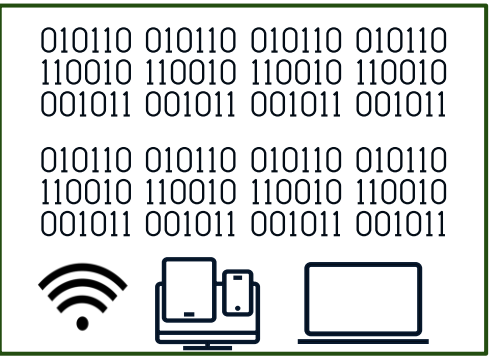
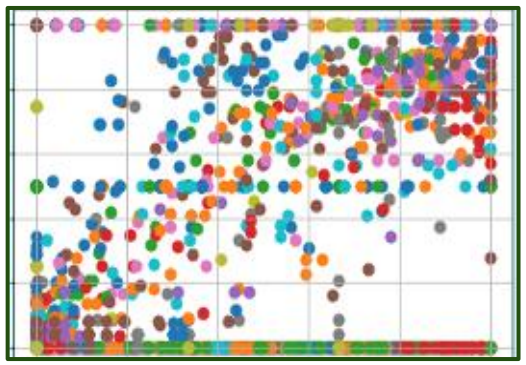
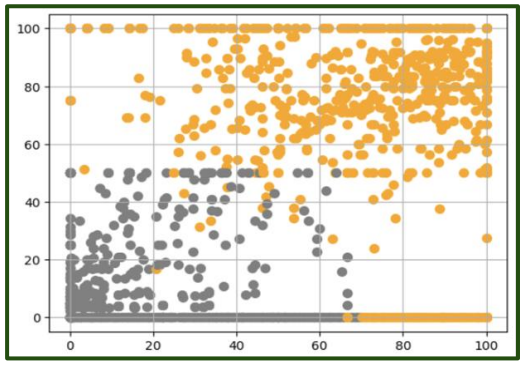
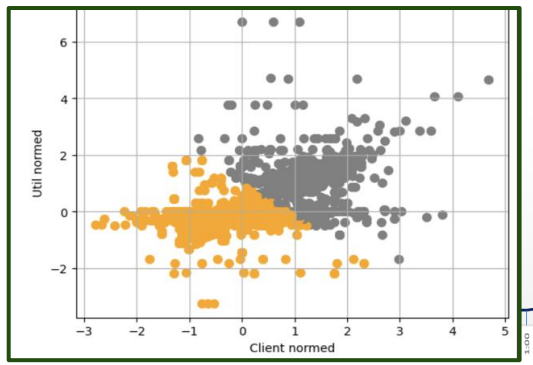
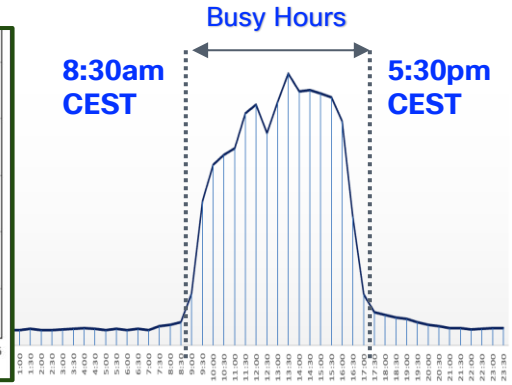
AI Generated Busy Hours



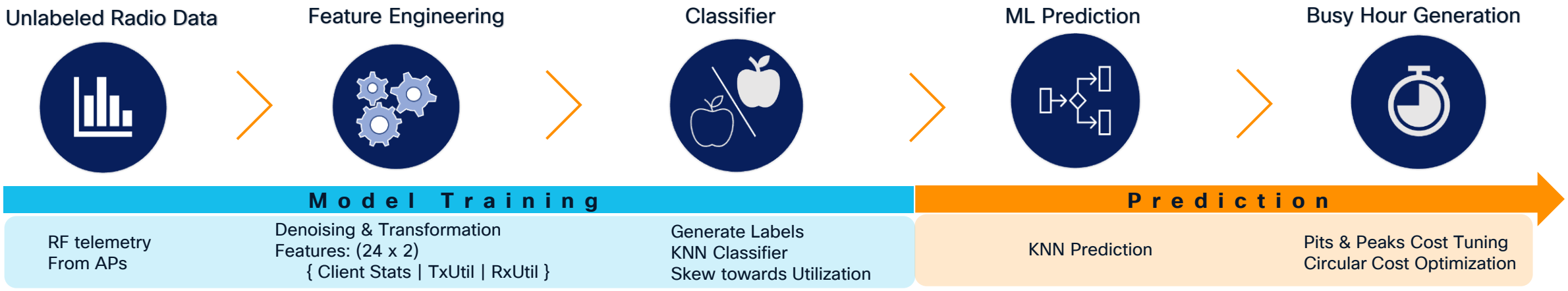








Consider changing busy hours on your building XYZ from 8:30am to 5:30pm



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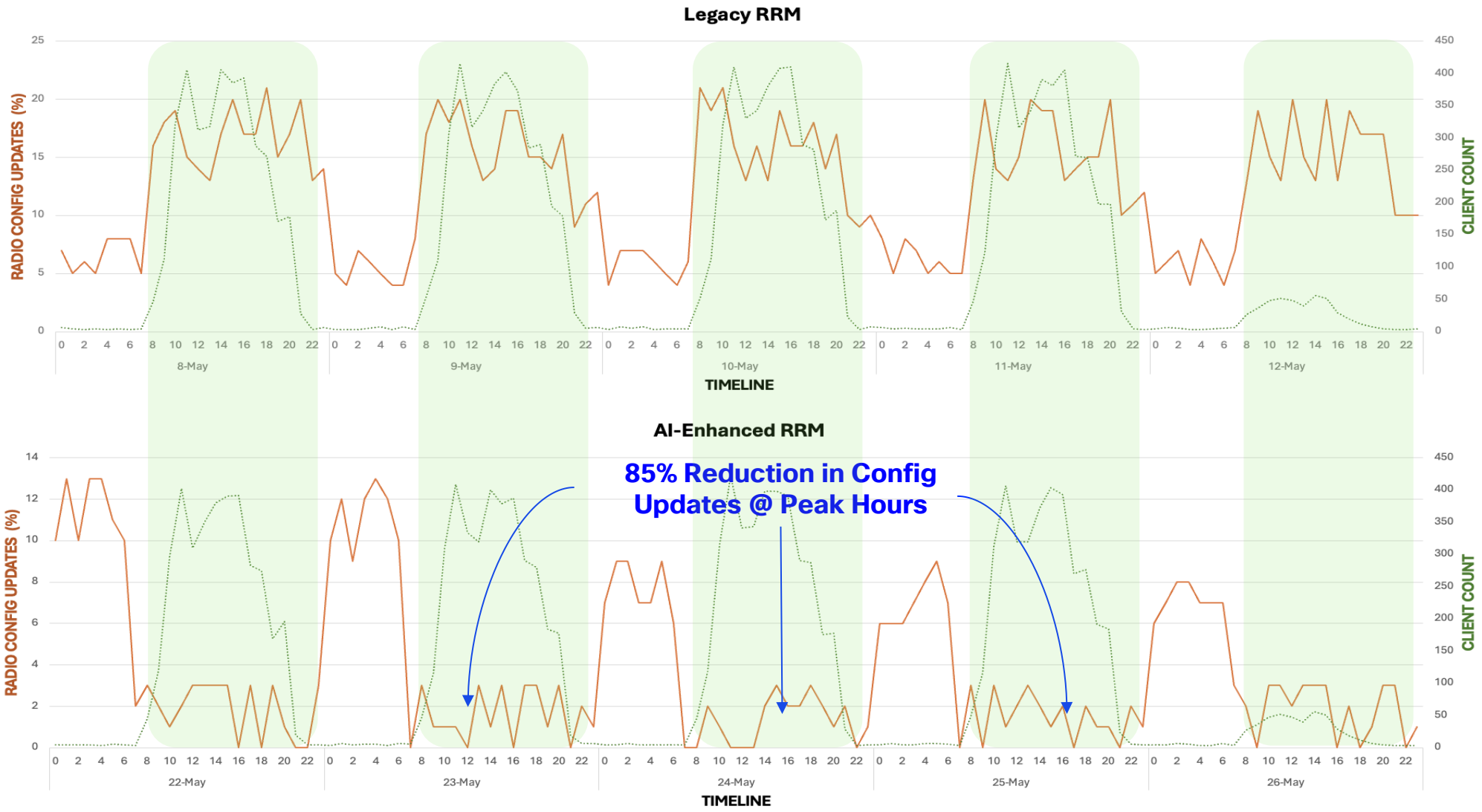
Busy hour optimized trend-based AI-RRM



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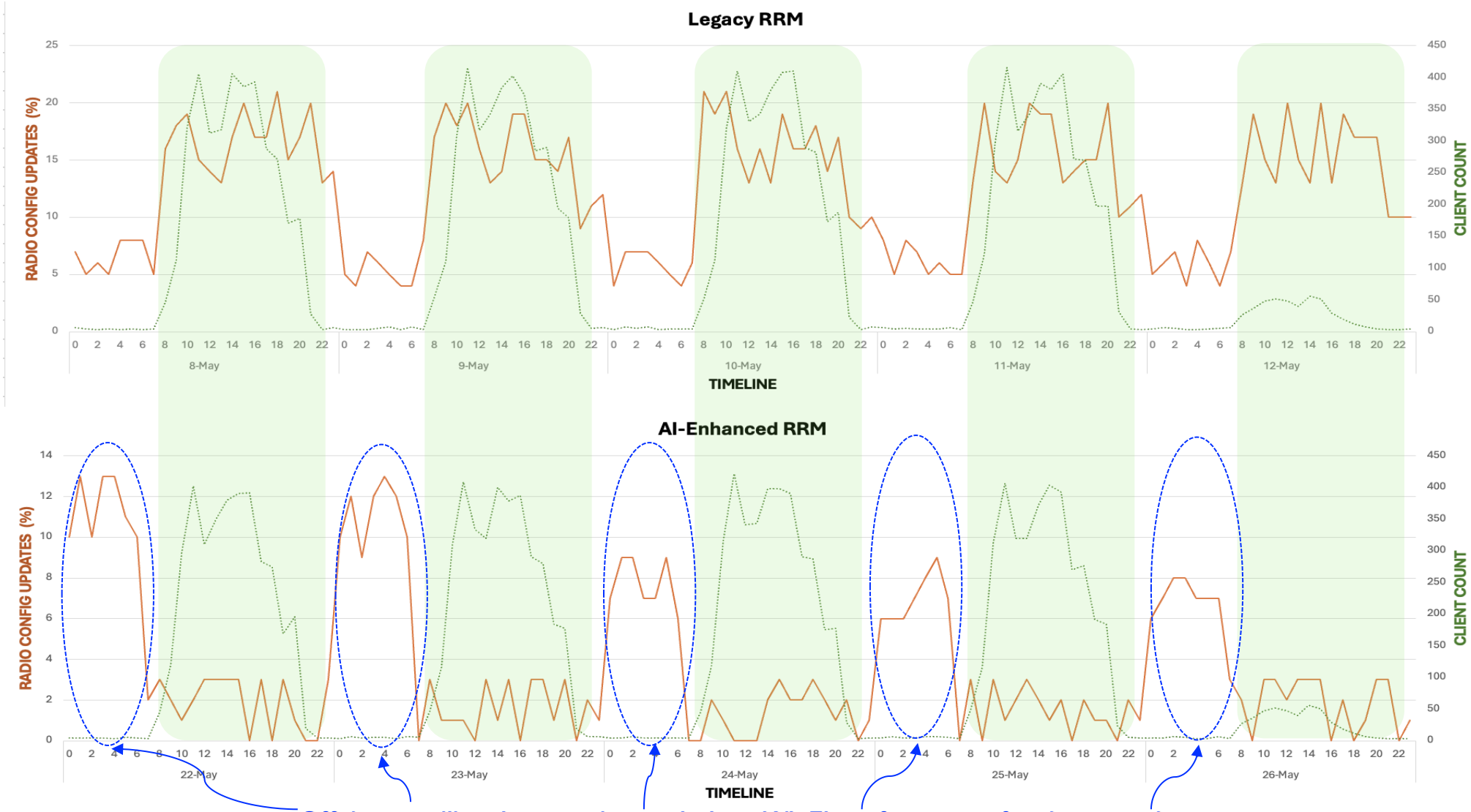
Busy hour optimized trend-based AI-RRM



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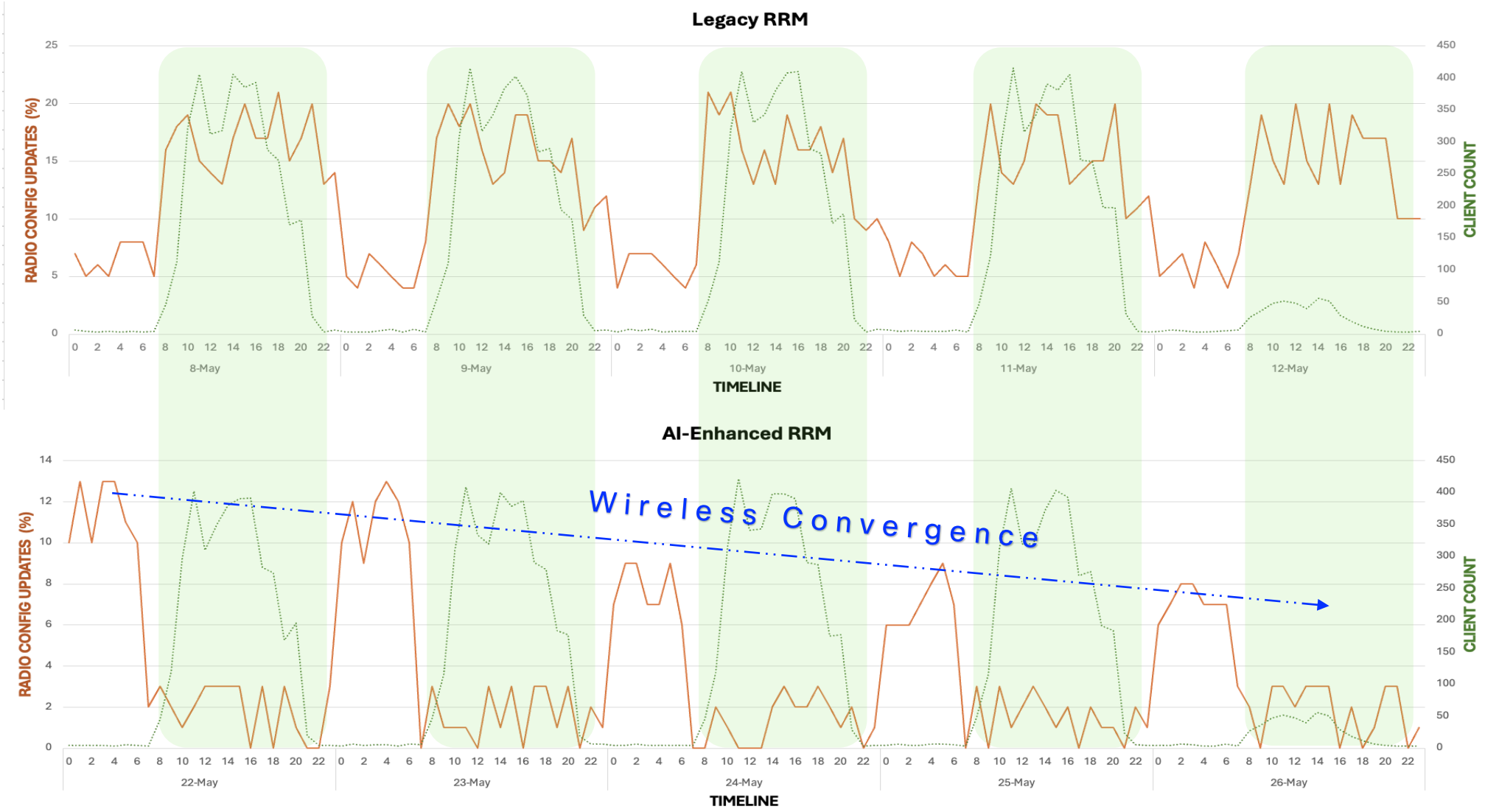
Busy hour optimized trend-based AI-RRM



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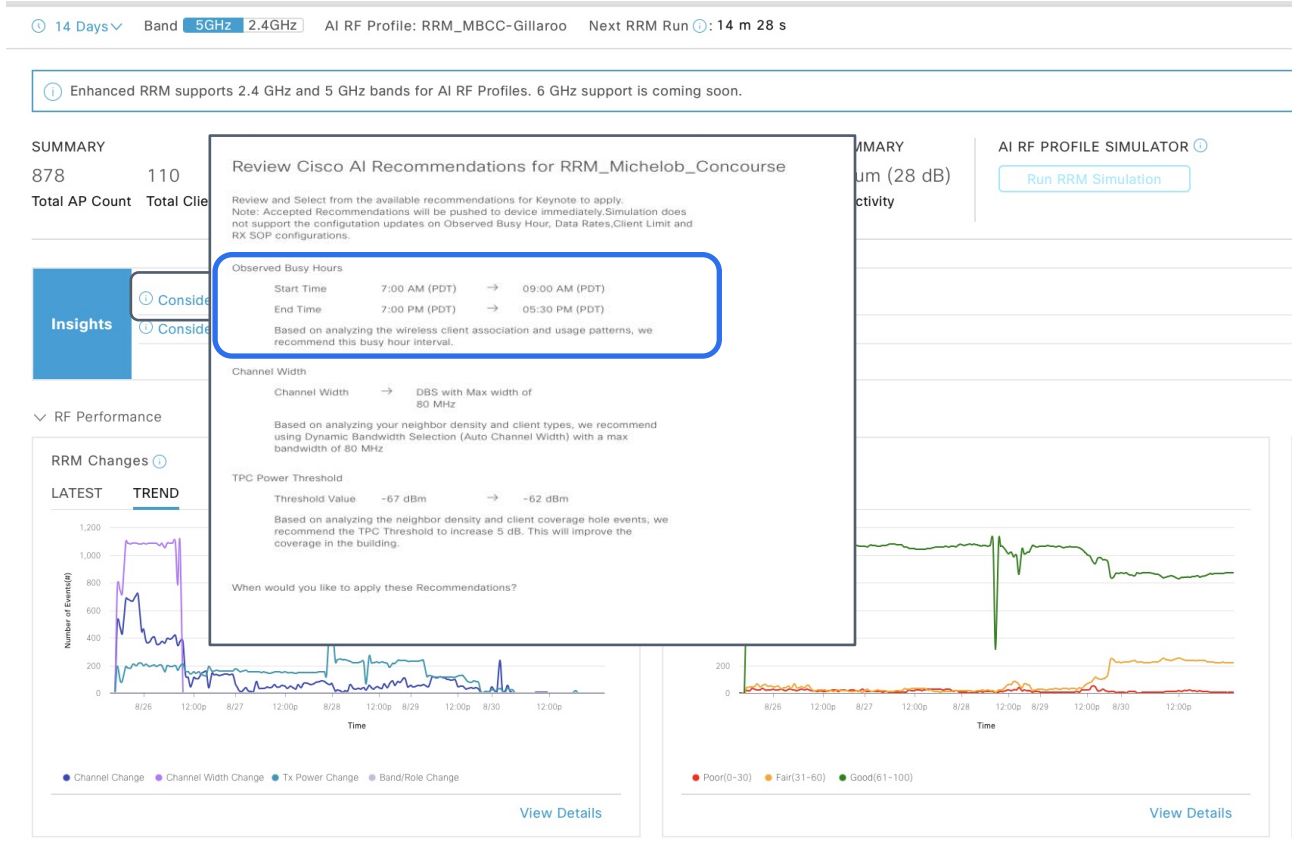
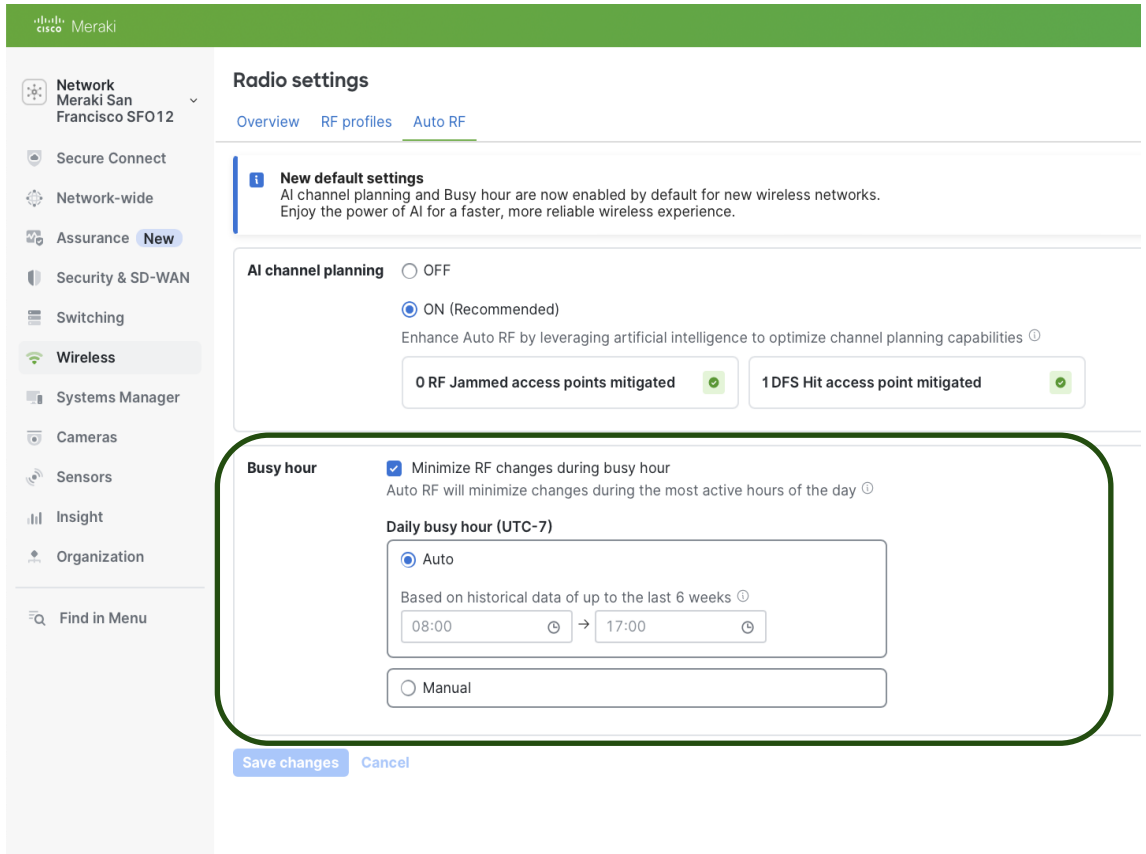
Optimize YOUR network with AI-Driven Busy Hours

Cisco Catalyst Center



Cisco Meraki Dashboard



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AI Focus Areas for Cisco Wireless

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Intelligent RF Management	Ease of Troubleshooting	Network Insights
Simplified Workflows	Machine Reasoning	SW Image Management
Wireless Client Management	Auto Remediation	Hardware RMA/Refresh

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Business Vertical	**Retail**
Site Location	**North America**
Managed Sites	**14**
AP Count	**217**
Wireless Clients	**Avg ~1700, Peak 2852**

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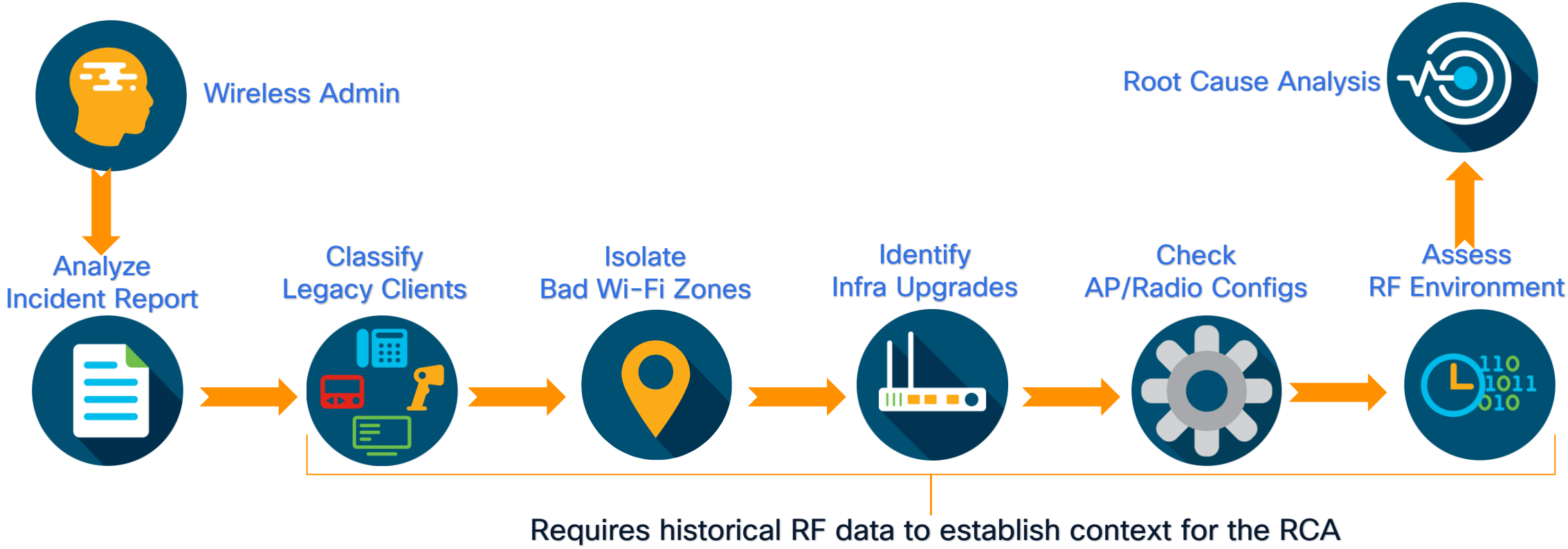
Traditional Analysis Approach

Primary Concern

Loading...

Certain areas reported slow connection speed



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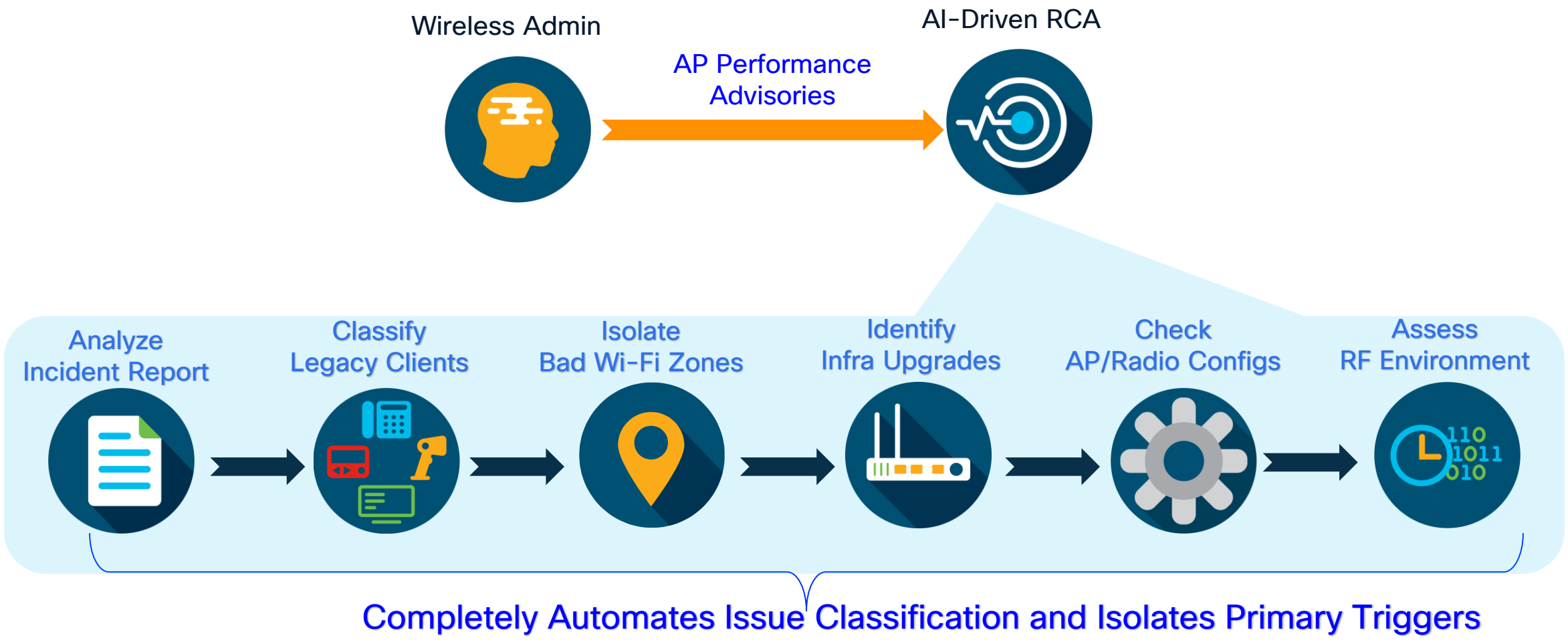
AI-Driven Advisories Simplifies Wireless Troubleshooting



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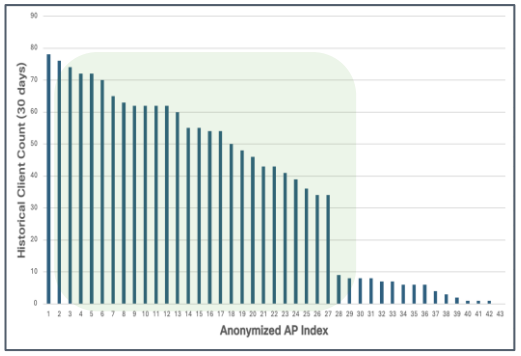
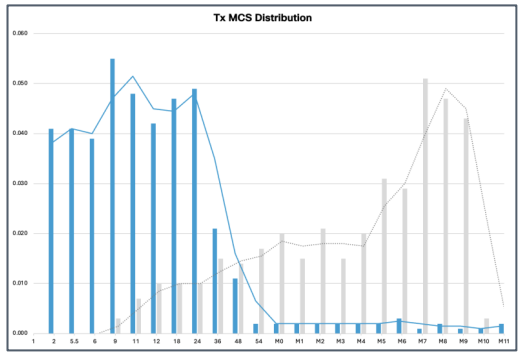
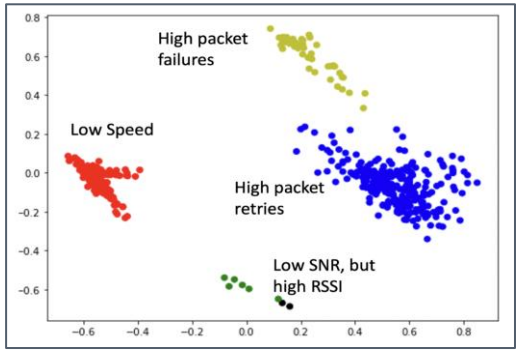
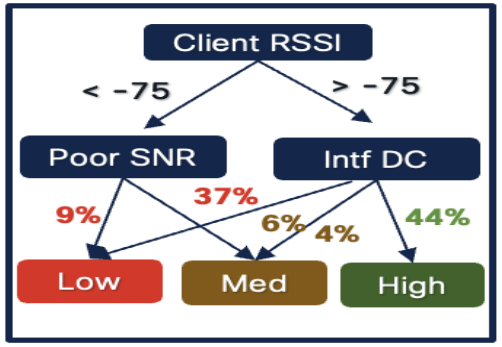
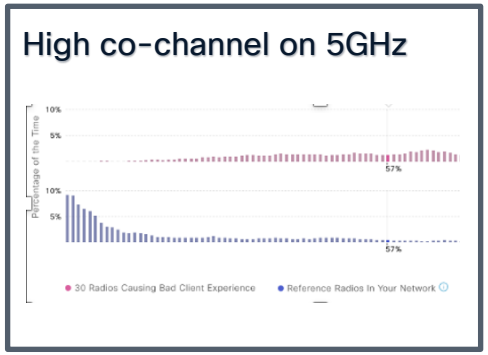
AI-Driven Proactive Advisories Method











Identify Top APs → Feature Engineering → QoE Clustering → Root Cause Analysis → Insights Generation

Model Training | **Inferencing**

Identify crucial radios by historical clients	Determine under performing radios from the QoE network baseline	Unsupervised Multi-Dimensional Clustering Maximize Inference	Supervised Learning Decision Tree	Insight Generation Associate Impacting QoE

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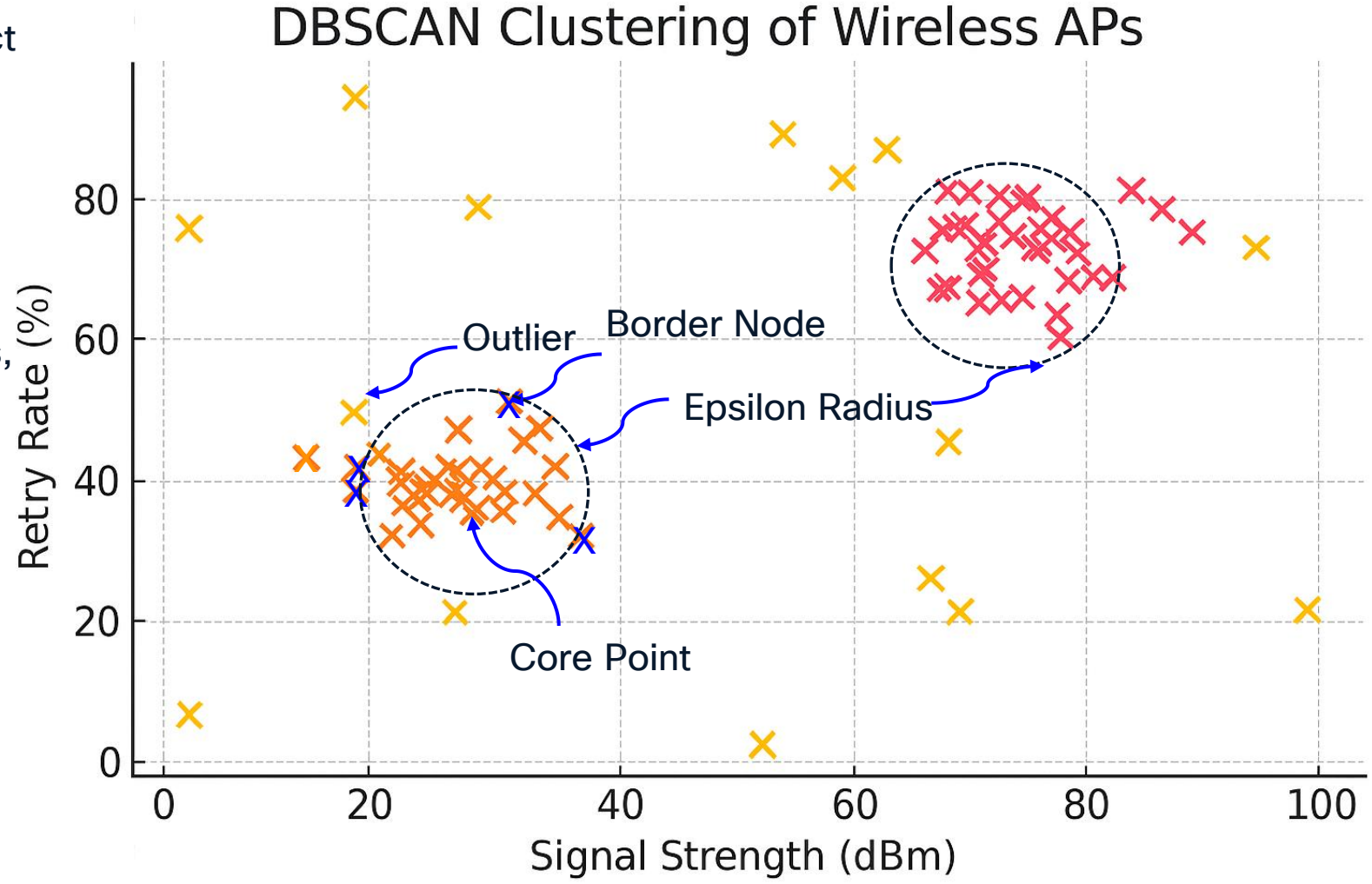
Multi-Dimensional QoE Clustering (DBSCAN)

- Unsupervised clustering algorithm to detect patterns
- Better efficacy to identify arbitrary-shaped clusters (nesting) & outliers
- Optimal for Noisy data, spatial distributions, non-globular clusters.
- Identified Wireless Radios with suboptimal QoE Class
  - High Noise Floor
  - Lower SNR
  - Higher 802.11 Retries
  - Lower MCS Rates



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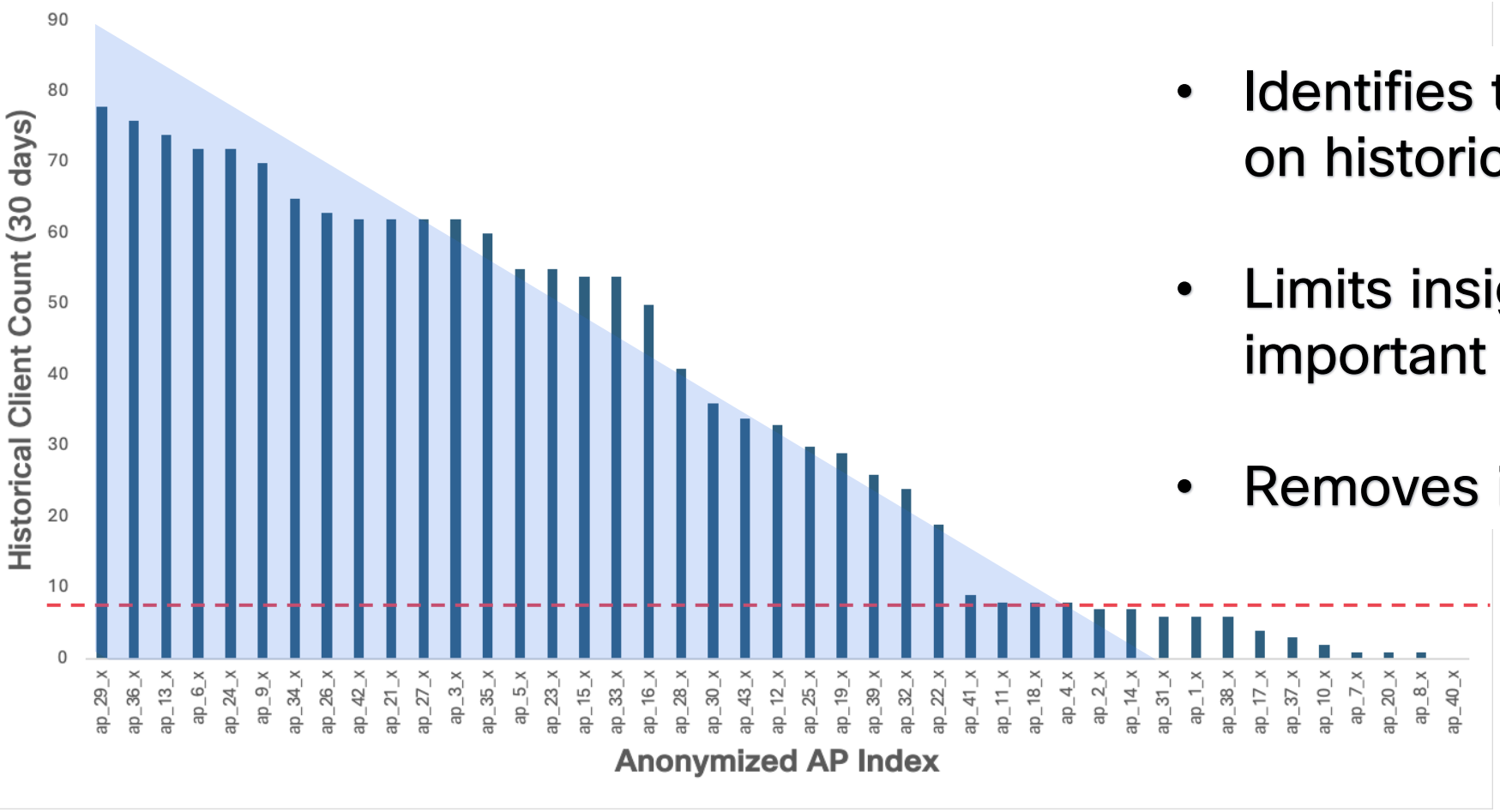
Phase 1: Prune AP List

Constrain analysis within the top radios in the network



- Identifies top radios based on historical data
- Limits insights to the important radios
- Removes inherent bias

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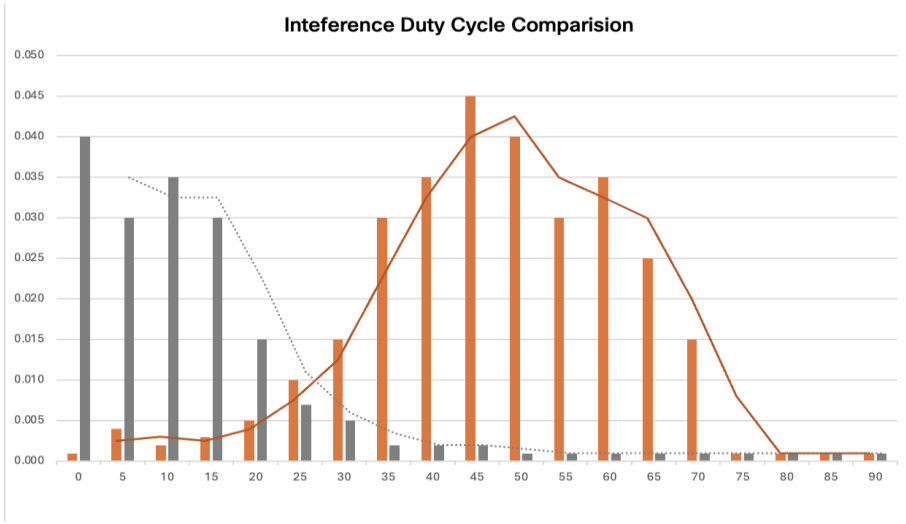
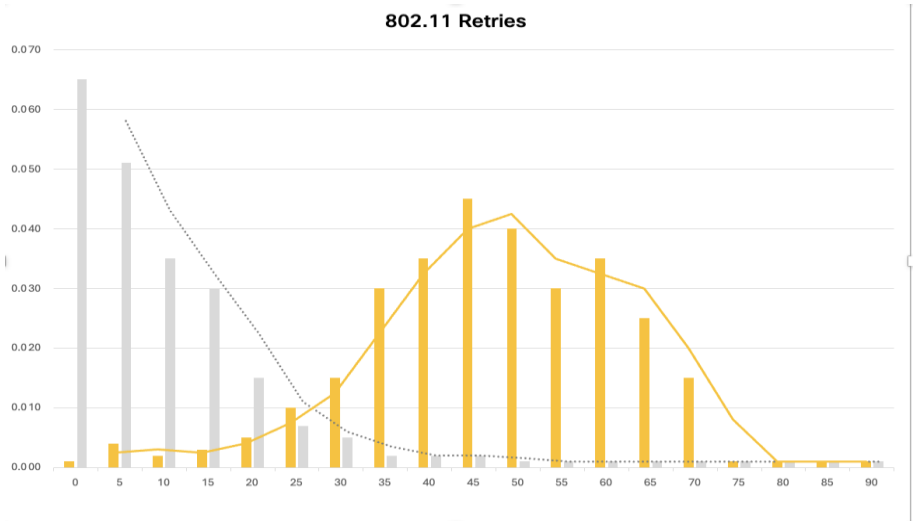
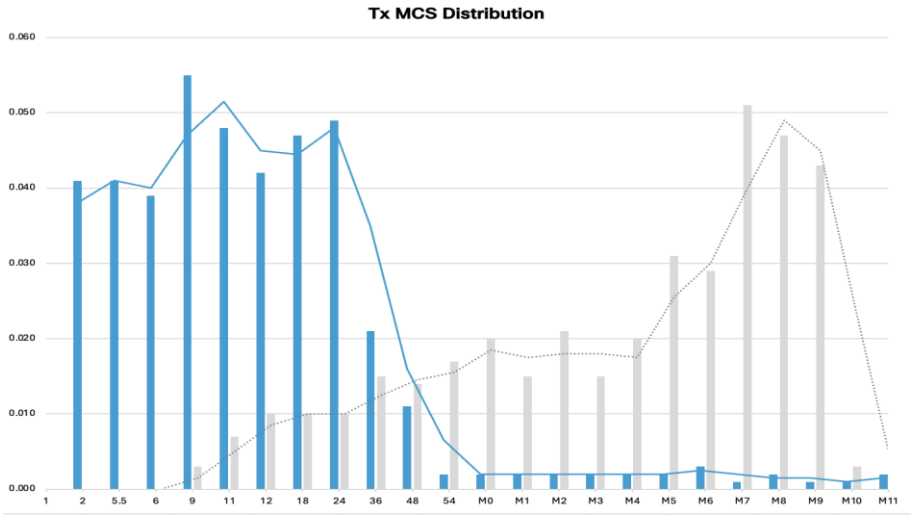
Phase 2: Model Training (QoE Metrics)

Identify Underperforming Radios Per QoE Class







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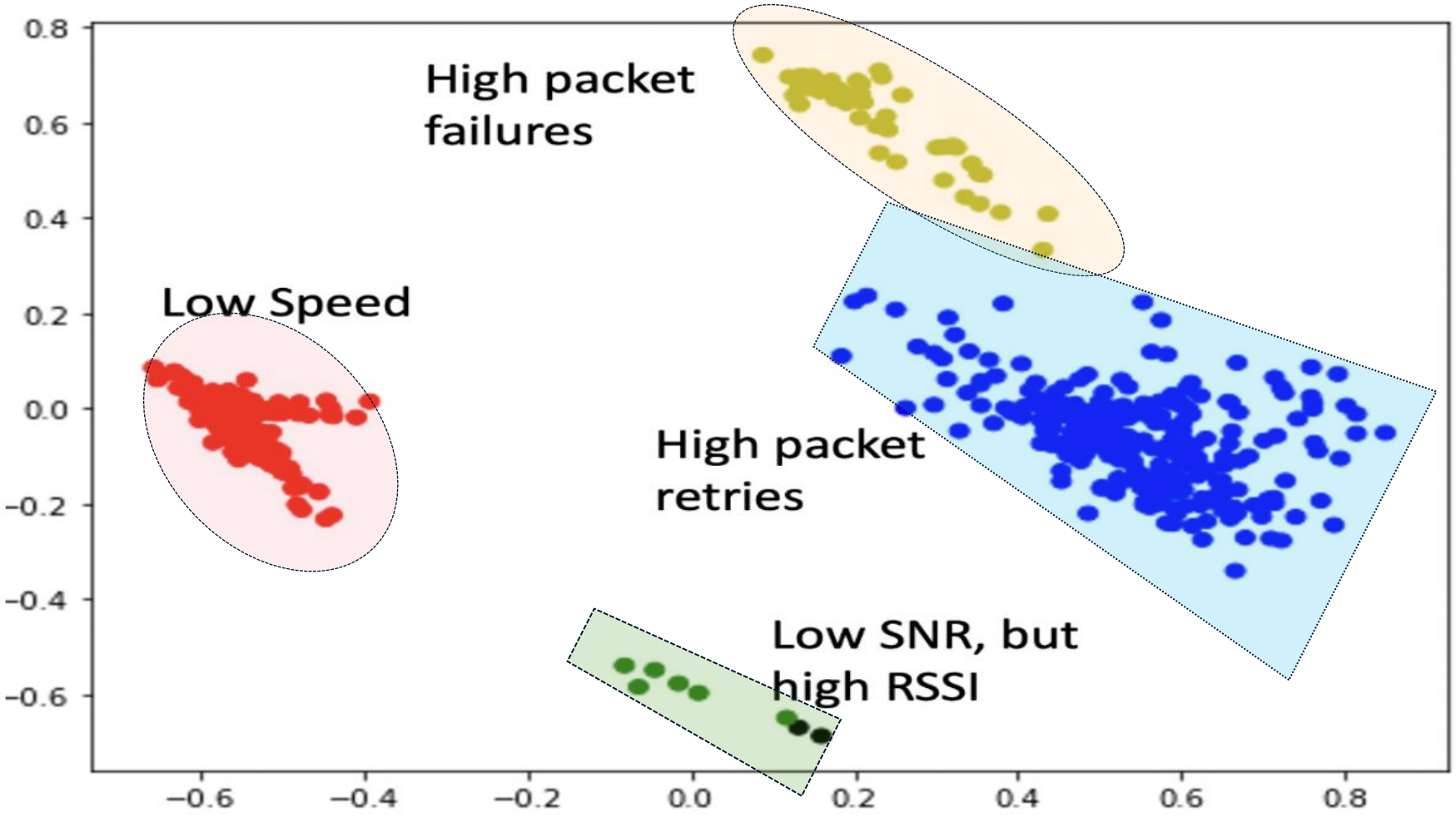
Phase 3: Automatic Radio Clustering

Group radios with similar QoE degradation



- Apply DBSCAN for multi-dimensional clustering
- Groups radios exhibiting similar deprivation on a specific QoE KPI
- Supports candidate ap redundancy to maximize inference

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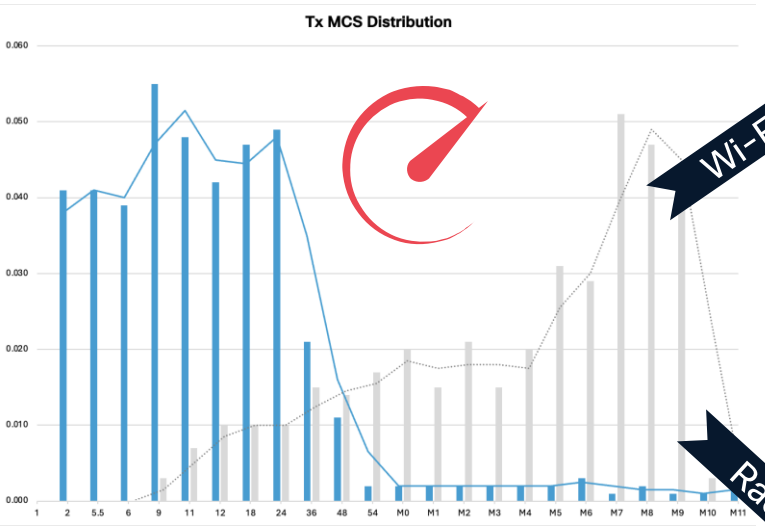
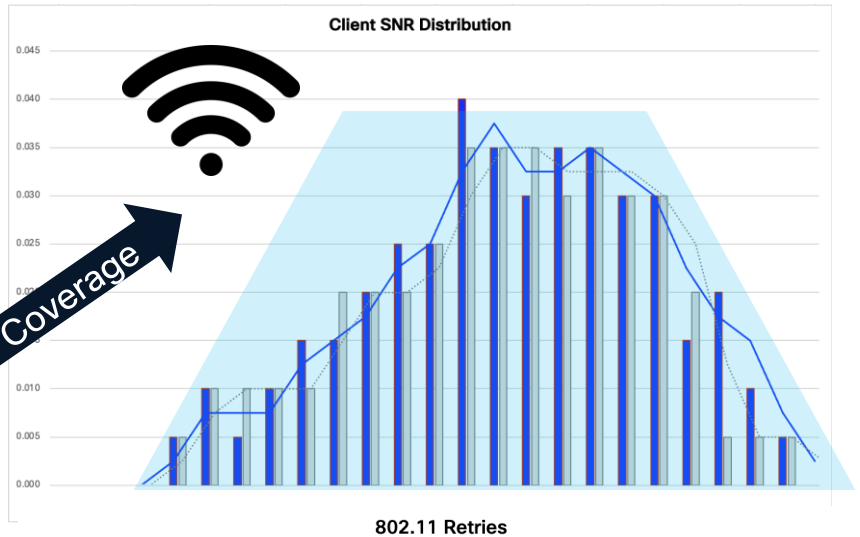
Phase 4: Supervised Learning – QoE Correlation

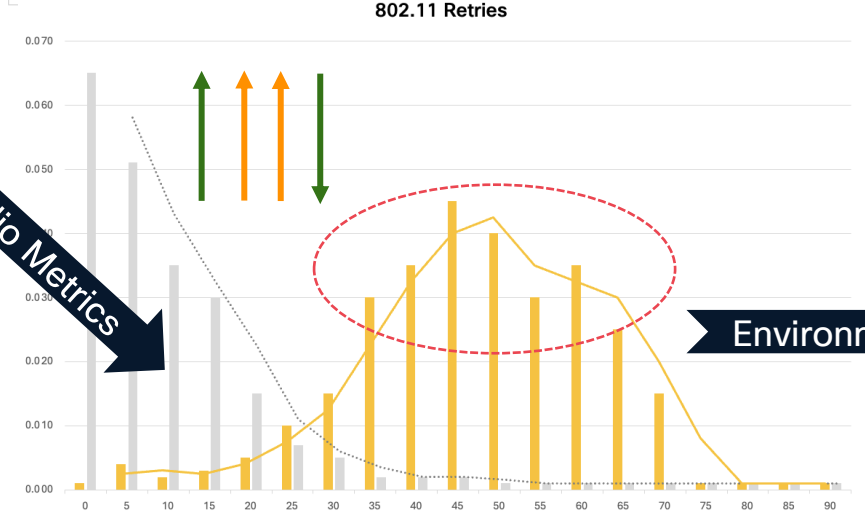
Utilize Random Forest to assess main QoE attributing to poor connection



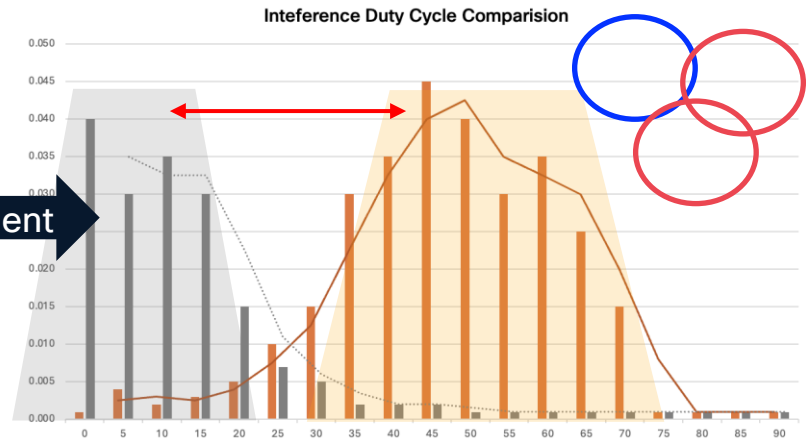
Wi-Fi Coverage



Radio Metrics



Environment



NOTIFY

RCA

Low connection speed due to high co-channel interference, impacting APs x, y, z...

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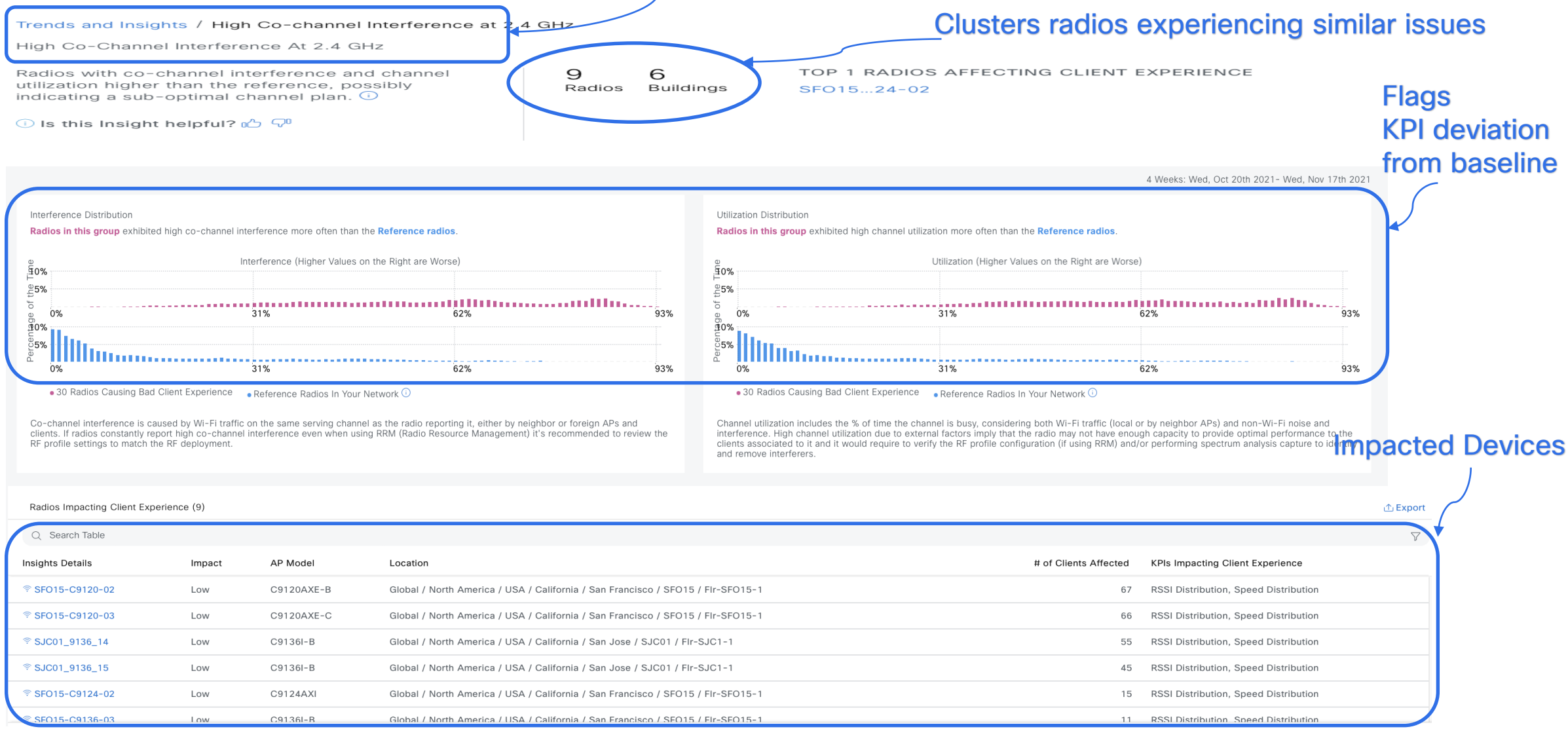
AP Performance Advisories

Highlights primary reason impacting performance

Clusters radios experiencing similar issues

Flags KPI deviation from baseline

Impacted Devices



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AI Focus Areas for Cisco Wireless

Day 0 – Wireless Management	Day 1 – Wireless Assurance	Day N – Insights / Guidance
Infrastructure Management	Proactive Issue Detection	AI-Driven Config Guidance
Intelligent RF Management	Ease of Troubleshooting	Network Insights
Simplified Workflows	Machine Reasoning	SW Image Management
Wireless Client Management	Auto Remediation	Hardware RMA/Refresh

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Business Vertical	**Education**
Site Location	**Oceania**
Managed Sites	**38**
AP Count	**2987**
Wireless Clients	**Avg ~18000, Peak 28663**

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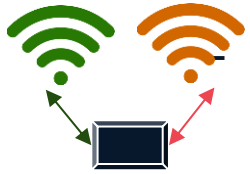
Imbalanced Cell Sizes: A Growing Challenge in Wireless Networks

- **Areas of Concerns**

  - **Primary:** Frequent coverage holes reported
    - Predominantly observed on the large lecture halls and auditoriums



  - **Secondary:** Roaming failures reported in cafeteria and lab/office spaces

- **Analysis**
  - Exact same TxPower Control Threshold (-70dBm) configured across all 38 buildings!
    - Driving coverage holes in auditoriums due to aggressive TxPower backoff
    - Roaming failures attributed mainly due to sticky clients in labs and offices

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Initial Recommendation To Customer

Please customize TPC thresholds for each of your 38 buildings!

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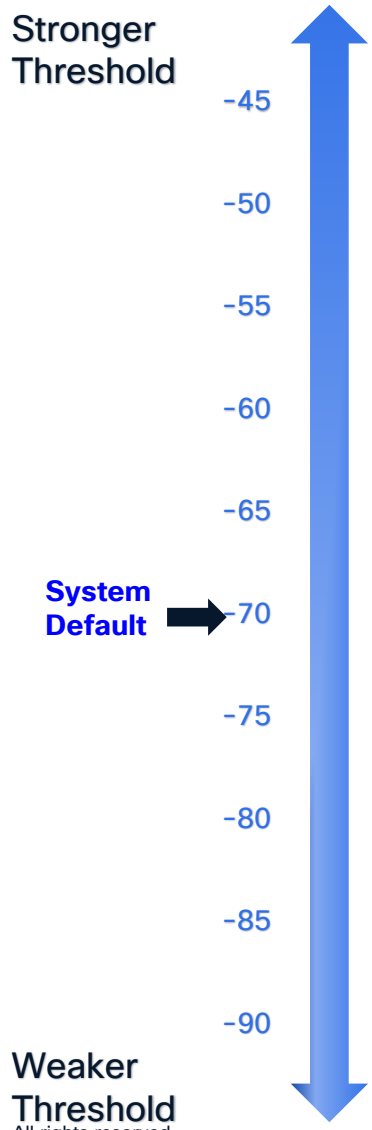
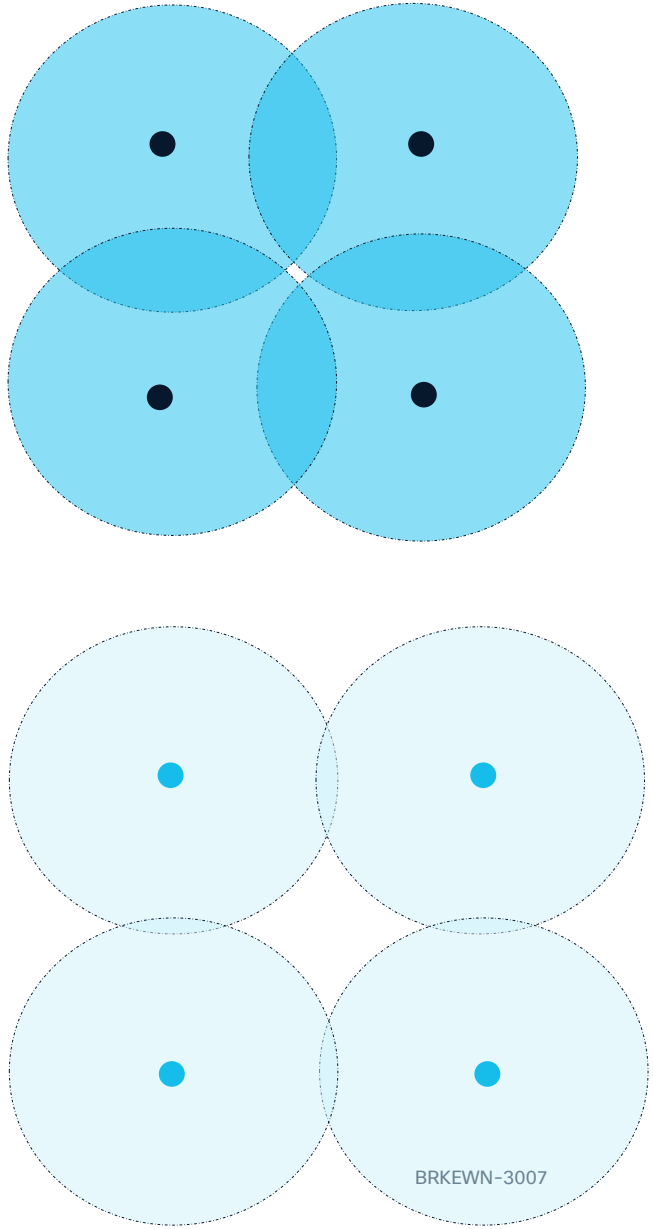
TxPower Control Threshold





Dense Wi-Fi Deployment

Minimize Co-Channel Contention

Avoid Coverage Holes

Sparse Wi-Fi Deployment

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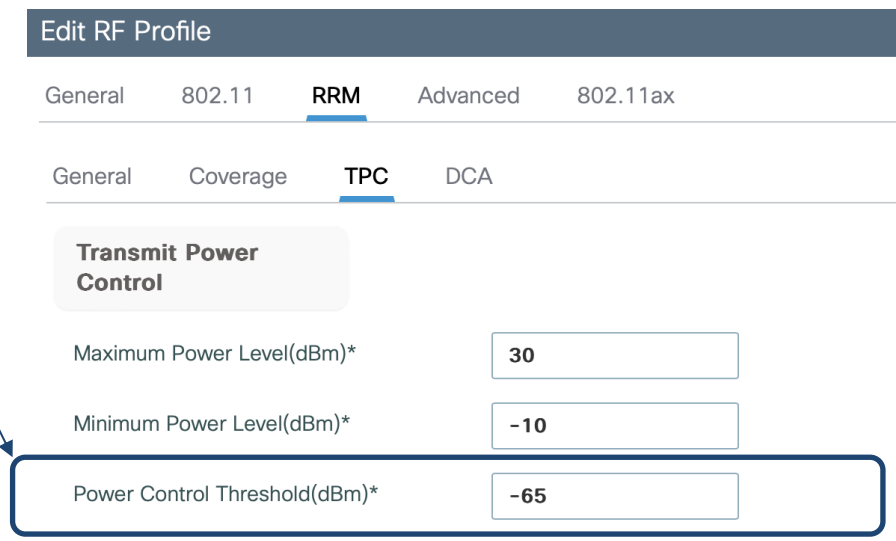
Optimal Tuning Requires RF Expertise!

Power Control Thresholds

Meraki Cloud Dashboard

Radio transmit power range (dBm)

Catalyst Center



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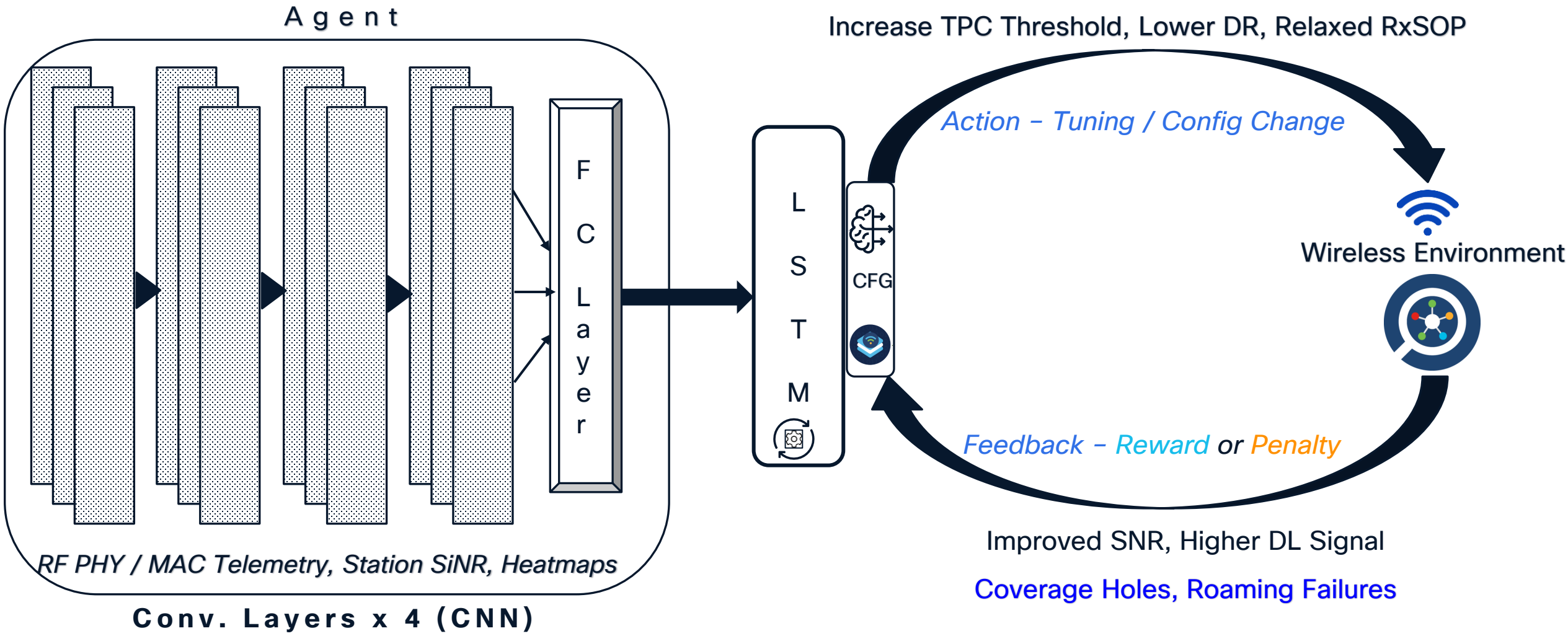
Reinforcement Learning in Wireless Environments



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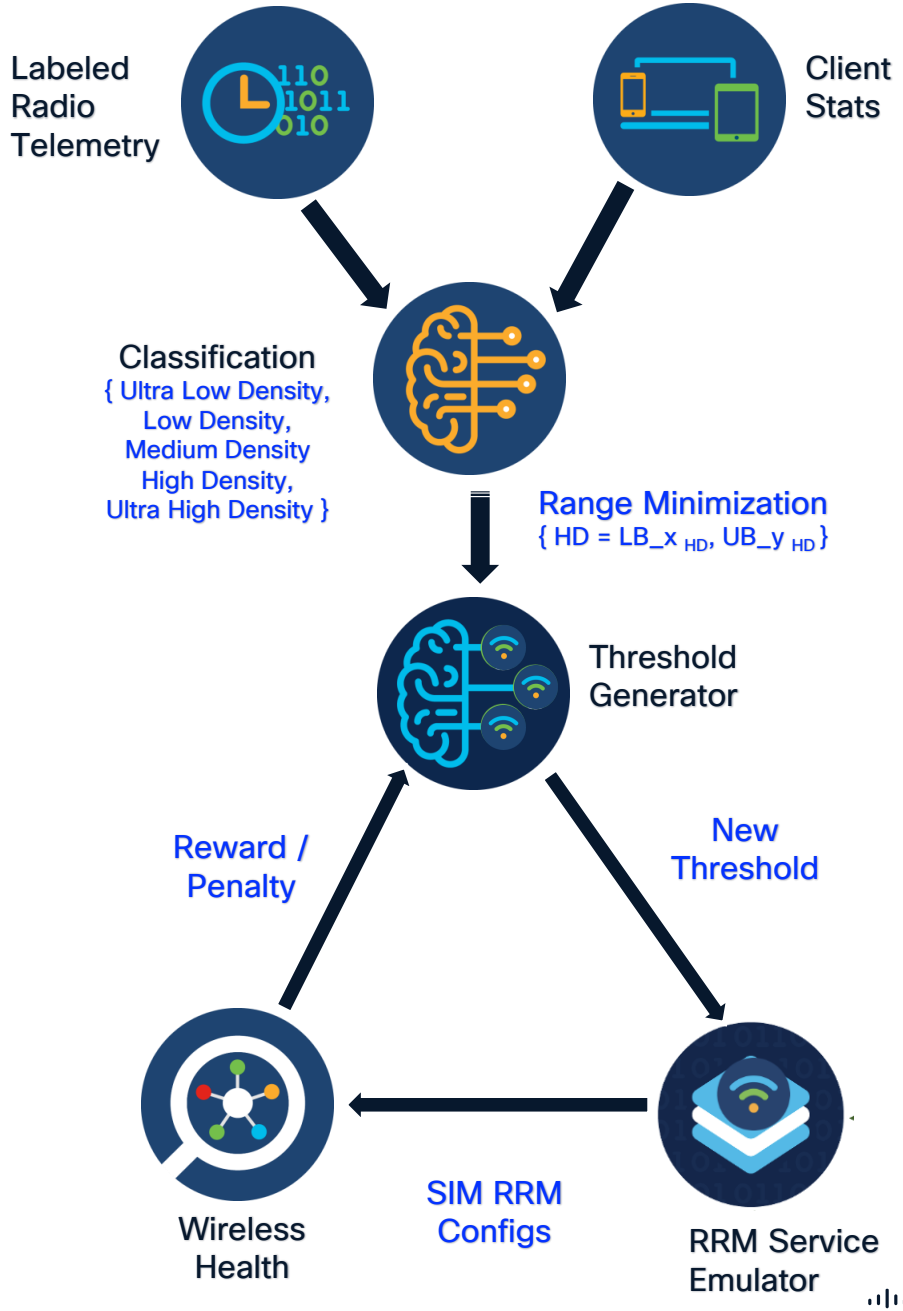
AI Generated TPC Threshold

- Influences **amount of cell overlap** between the adjacent APs
- Needs to get tuned based on overall RF density and associated clients
- AI optimizes threshold leveraging combination of SL & RL
  - Model training is conducted based on labeled data set to achieve power control threshold range minimization
  - SL determines threshold range; RL is enforced to iterate through multiple instances of Transmit Power Control service
  - Threshold generator determines optimal Power Control threshold that maximizes RF health of radios and clients



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Performance Improvements

AI-Core Engine recommended altering TPC thresholds with customized settings for 21 buildings/sites!!

Insights

- Consider changing the configured Busy Hours for RRM to be more effective.
- Consider changing the configured Channel Width for improved performance.
- Consider changing the configured TPC Threshold for improved coverage.

Observed Busy Hours

Start Time	7:00 AM (PDT)	→	09:00 AM (PDT)
End Time	7:00 PM (PDT)	→	05:30 PM (PDT)

Based on analyzing the wireless client association and usage patterns, we recommend this busy hour interval.

Channel Width

Channel Width	→	DBS with Max width of 80 MHz

Based on analyzing your neighbor density and client types, we recommend using Dynamic Bandwidth Selection (Auto Channel Width) with a max bandwidth of 80 MHz

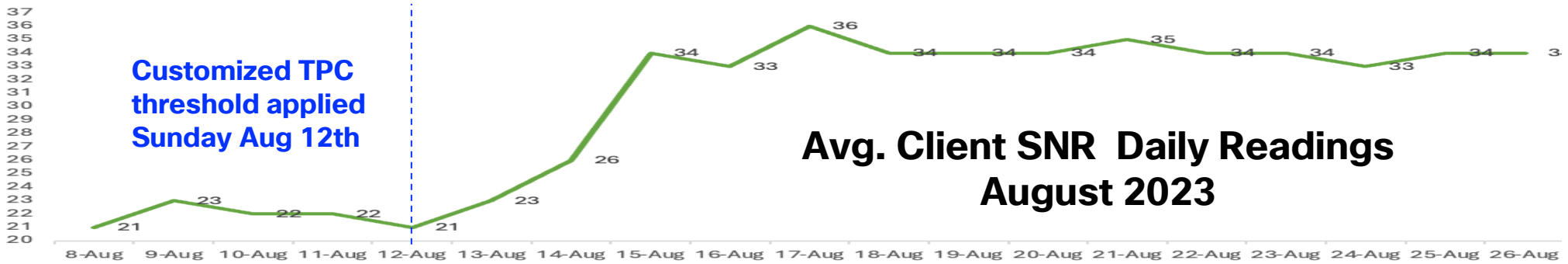
TPC Power Threshold

Threshold Value	-67 dBm	→	-62 dBm

Based on analyzing the neighbor density and client coverage hole events, we recommend the TPC Threshold to increase 5 dB. This will improve the coverage in the building.

When would you like to apply these Recommendations?

No Coverage Holes reported after 1 week



Significant (+8dB) gain in Client SNR

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Diverse Insights for diverse environments

Business Vertical	Financial Services	Retail	Education
Country	Europe	North America	Oceania
Total APs	652	217	2,987
Avg. Clients	~5,500	~1,700	~18,000
	AI-Driven Config Insights		
Busy Hours	8:30am – 5:30pm (UTC+2)	3pm – 10pm (UTC-5)	7:00am – 2:30pm (UTC+13)
5GHz DBS_Max	40MHz	20MHz	80MHz
FRA	Yes	Yes	Yes
TPC_Thresh	-65dBm	-60dBm	-75dBm
Enforce PSC	N/A	Yes	N/A

High Density

Low Density

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Leading to Performance Improvements

Business Vertical	Financial Services	Retail	Education
Country	Europe	North America	Oceania
	Improvements in the Wireless KPIs		
Wireless Performance	51 → 94 Before After	34 → 70 Before After	17 → 91 Before After
Config Updates	85% Reduction	79% Reduction	83% Reduction — Stable Wi-Fi
Client SNR	38 dB (+9 dB)	(39 dB) (+11 dB)	33 dB (+8 dB) — Maximize Performance
Interference	37% Reduction	56% Reduction	65% Reduction — Best Capacity

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Outlook

How can AI support one-click client troubleshooting?

How can AI adapt to the challenges of latest standards?

How can AI provide insights and auto-tune configurations?

How can AI simplify upgrades and reduce downtime?

How can AI enable auto onboarding of new APs and RMAs?

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Key Takeaways

AI provides **tangible benefits** for Cisco Wireless customers

There is no cookie cutter solution that fits all use-cases

We are truly stepping into the next generation Wi-Fi revolution!!!

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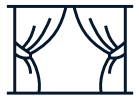

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