

CABLE-TEC EXPO® 2017

SCTE • ISBE

# THE NEXT BIG...

DEAL  
CONNECTION  
INNOVATION  
TECHNOLOGY  
LEADER  
NETWORK



DENVER, CO  
OCTOBER 17-20



# Optimizing and Protecting the Value of Unlicensed Spectrum

**Narayan Menon**

Founder and CTO/EVP of Engineering  
XCellAir



DENVER, CO  
OCTOBER 17-20

## Multiple Vectors of Wi-Fi Evolution

### Massive Densification

- “Wi-Fi First” strategies
- New services over Wi-Fi
- Multi-Dwelling & Multi-AP deployments
- Community Wi-Fi

### Spectrum Sharing scenarios

- Unlicensed band – LTE-U, LTE-LAA
- Other bands
- Coexistence with cellular and other systems

### Internet of Things (IoT)

- Wi-Fi is the connection today, and will play central role in IoT



## Congestion a Key Issue in Dense Deployments

Wi-Fi works on Listen-Before-Talk basis

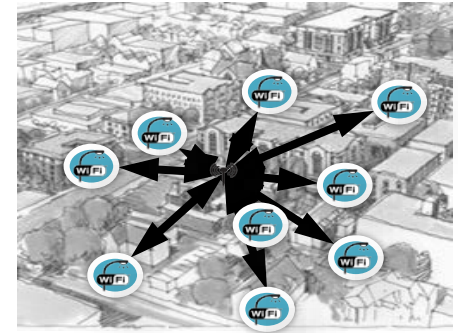
- Devices check to see if medium is free, before transmitting

In a dense environment, you can have congestion

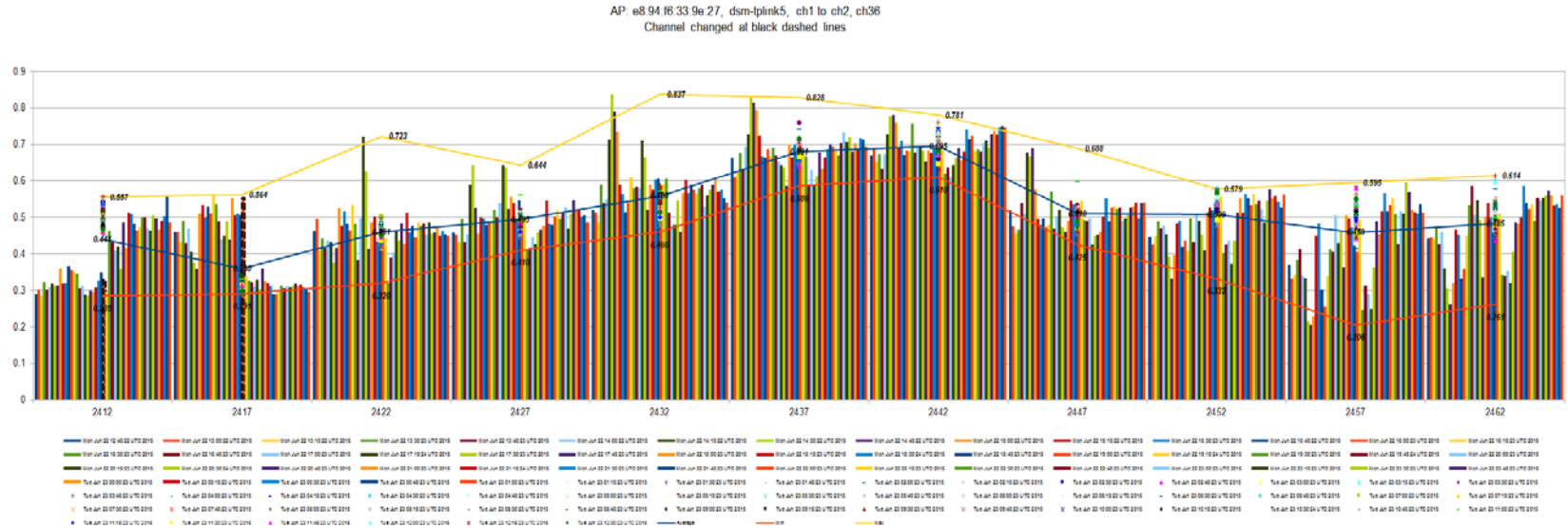
- Managed & unmanaged networks on same channels
- Long lines of users “waiting to talk”
- High latencies, sub-optimal QoE
- Spectrum sharing, IoT will aggravate issues

Radio Resource Management (RRM) mitigates congestion

- Dynamic channel management
- Band steering – load balancing, increased 5GHz use
- Power control



## Observed Actual 2.4GHz Channel Utilization in Dense Urban Area



X-axis: 2.4GHz channels, points in time

Y-axis: Channel utilization – 0–1.0, or 0-100%

## Observations – 2.4 GHz Band

- Utilization spikes observable in several channels across a period of time
  - Points at which channel congestion can be high, and service quality can start to degrade
- However, at any time, headroom is available on some channel or the other
  - Not all channels experience high utilization levels at the same time
- Considering allocation pool of 5 channels, ~ 2 channels' worth bandwidth available on average
- A dynamic channel algorithm can unlock this bandwidth by moving access points to less congested channels

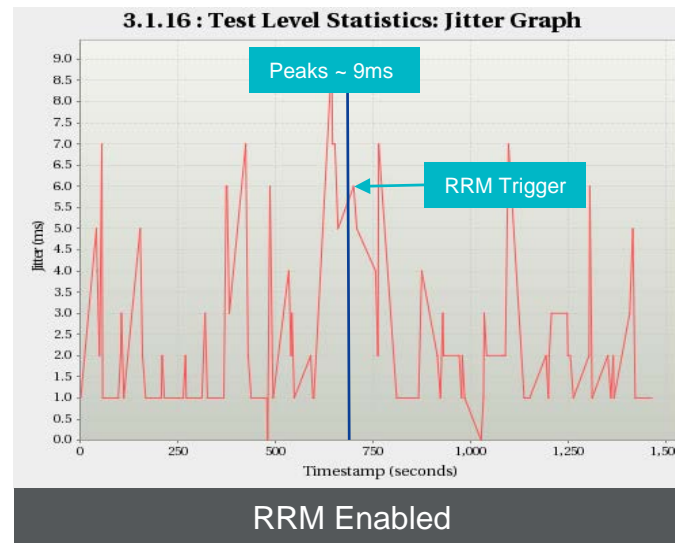
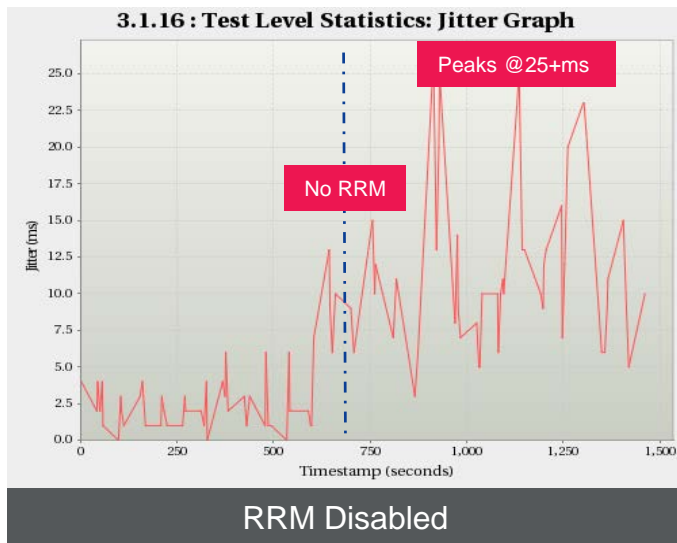
## Dynamic Channel Management

### Test Setup & Methodology

- Test setup to create congestion scenarios and observe impact on key metrics – latency, jitter, throughput etc.
- Target AP used for observation with multiple clients connected
- Mix of VoWiFi and video traffic run through target AP
- Separate “aggressor” AP set up to create channel congestion – running iPerf, YouTube traffic
- Key metrics observed on Target AP using ixChariot tool:
  - See impact of congestion buildup on metrics (without RRM)
  - Observe service congestion mitigation & quality improvement (with RRM enabled)

## Dynamic Channel Management

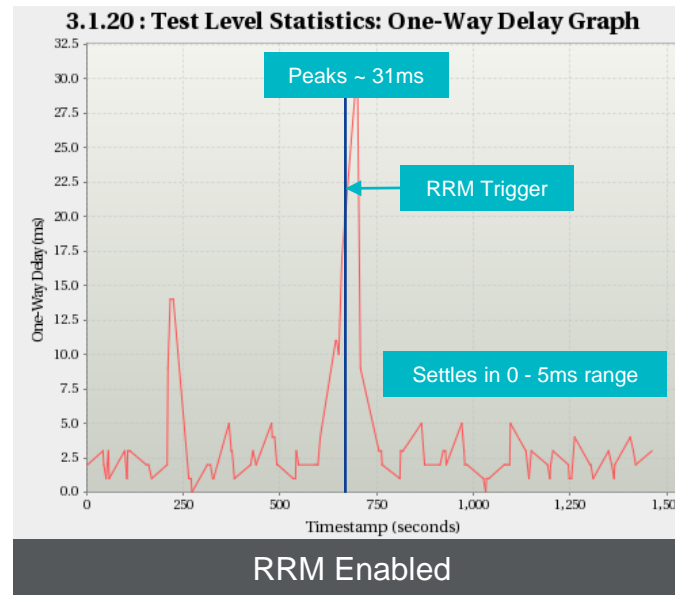
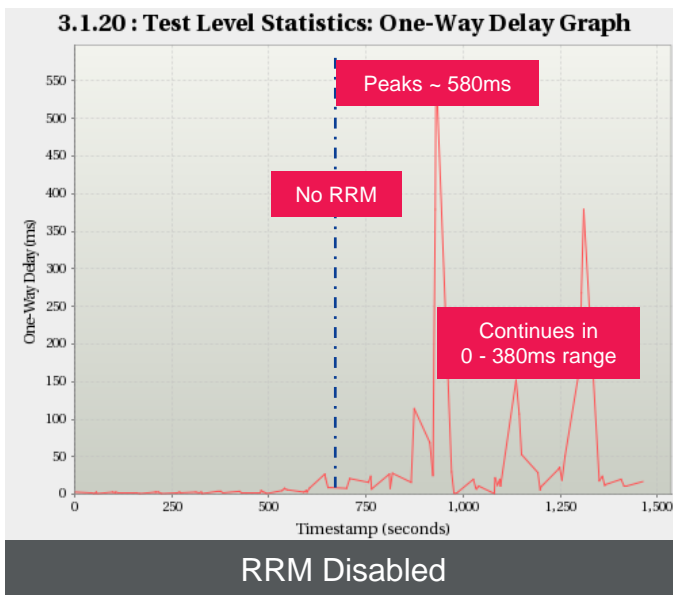
### Impacts on Jitter





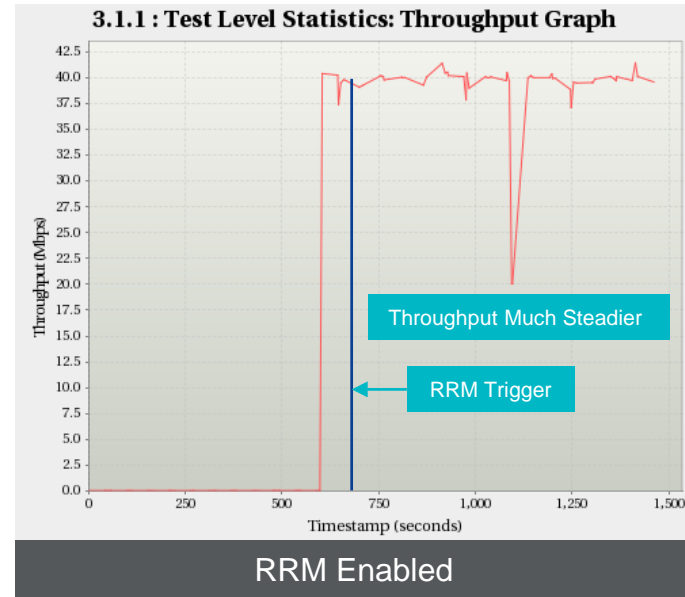
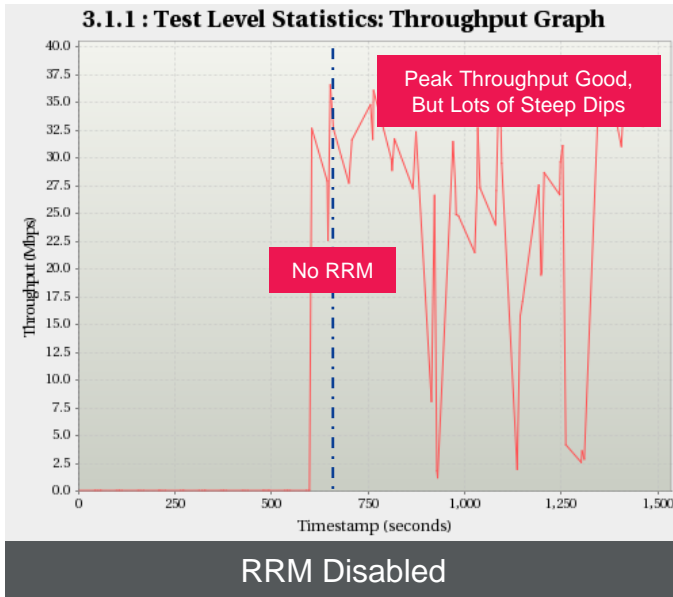
## Dynamic Channel Management

### Impacts on Latency



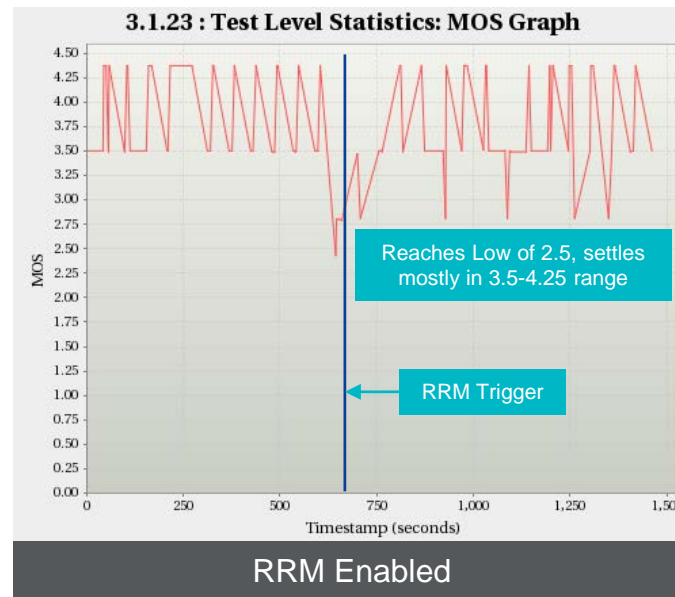
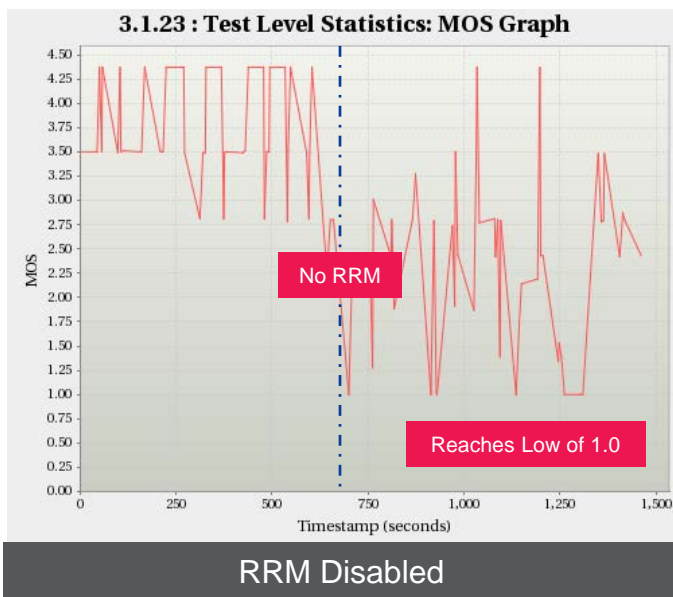
## Dynamic Channel Management

### Impacts on Throughput



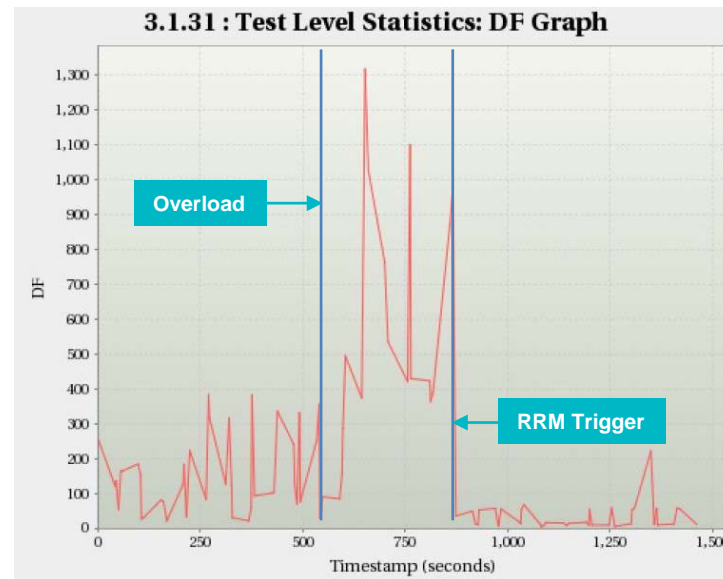
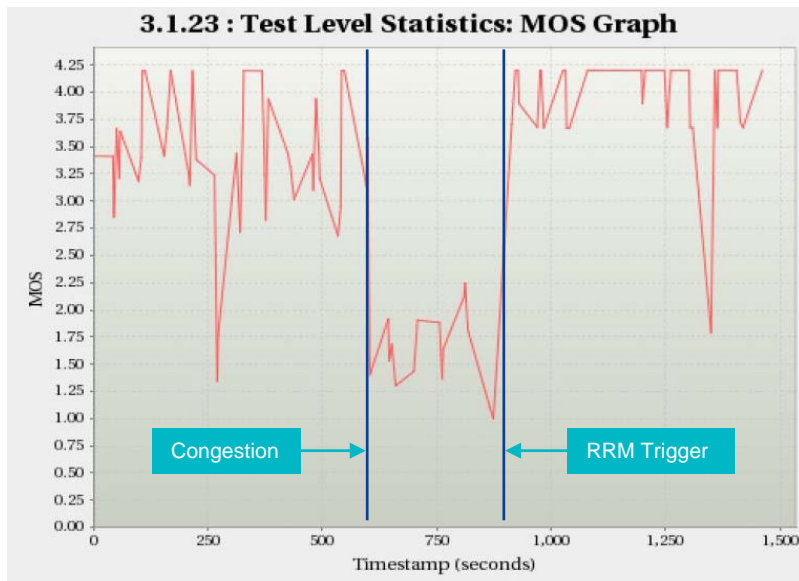
## Dynamic Channel Management

### Impacts on VoWiFi Mean Opinion Score (MOS)



## Band Steering

### Impacts on VoWiFi Mean Opinion Score (MOS) & Delay Factor



## Conclusions From Tests

- Order-of-magnitude improvements with RRM enabled: 3x – 7x improvements in most measured metrics, much higher improvements in some cases
- Significantly lowered peaks/ spikes and average values for voice-impacting metrics such as latency, jitter, lost packets etc. (with RRM on)
- Significantly improved settled operation after RRM trigger
- Without RRM, problems persist/ get worse through duration of test
  - Resulting in drastic impacts on quality of service, and possibly eventual loss of service

## Impact of Spectrum Sharing - LTE-LAA, MulteFire...

### Promise of LTE-LAA



Quality of Experience

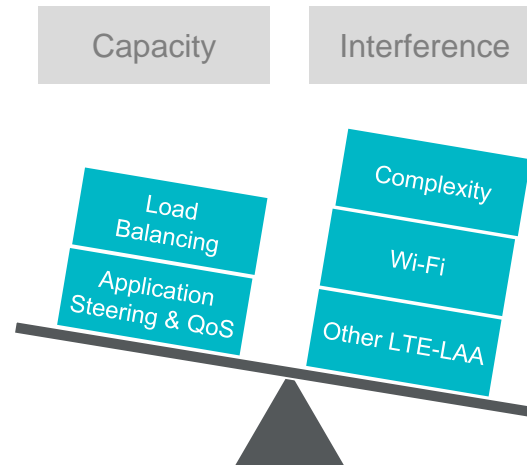
in



Unlicensed Spectrum

**“Best of Both Worlds” – LTE’s Emphasis on QoS + Bandwidth Augmentation via Unlicensed Band**

### Opportunities & Challenges



*Interference Issue Aggravated by Much Greater Number & Diversity of Devices Operating in Unlicensed Band*

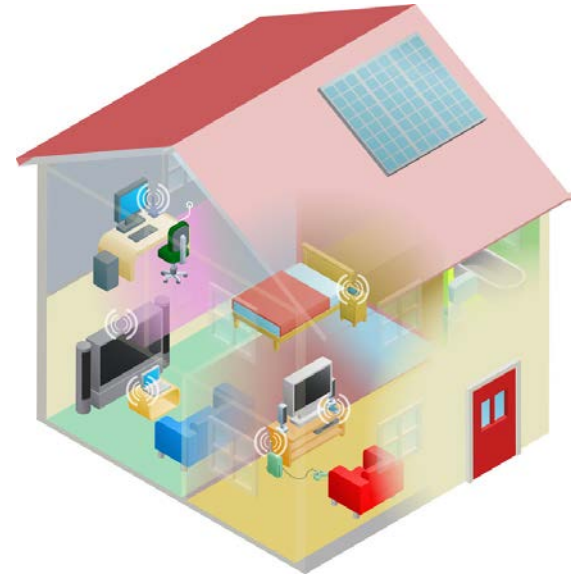
## Impact of IoT

### Dense Deployments of IoT Devices

- Contending for Access Point bandwidth
- Many appliances/ devices in a home sharing AP capacity

### Coexistence of multiple access technologies in same band

- E.g. Wi-Fi, Bluetooth and ZigBee can all use 2.4GHz band
- Interference potentially a big issue



## Applying RRM Strategies to Enable Coexistence

### Channel Management

- Protect Wi-Fi from other Wi-Fi, LTE or IoT systems operating in same band
- Protect LTE systems from other LTE, Wi-Fi or IoT systems in same band

### Band Steering

- Steer Wi-Fi devices out of 5GHz band if congestion caused by LTE
- Steer Wi-Fi devices out of 2.4GHz band if congestion caused by IoT systems
- Move LTE devices between licensed and unlicensed bands

### Power Control

- User power control in Wi-Fi to avoid interference to other systems

BS ID	Type	Owned	Channel	SS
SSID: XCellAir	W-Fi	N	3	-60dbm
Operator A	LTE-U	Y	7	-80dbm
Operator A	LTE-U	Y	7	-80dbm
SSID: Guest	Wi-Fi	N	6	-102dbm
SSID: Free-Wi-Fi	Wi-Fi	N	7	-60dbm
Operator A	LTE-U	Y	7	-80dbm
Operator B	LTE-U	N	8	-72dbm
SSID: Carrier Wi-Fi A	Wi-Fi	Y	5	-80dbm
SSID: Carrier Wi-Fi B	Wi-Fi	N	3	-102dbm
Operator C	LTE-U	N	11	-80dbm
SSID: Carrier Wi-Fi A	Wi-Fi	Y	10	-60dbm



## Overall Conclusions

Significant growth expected in usage of unlicensed band

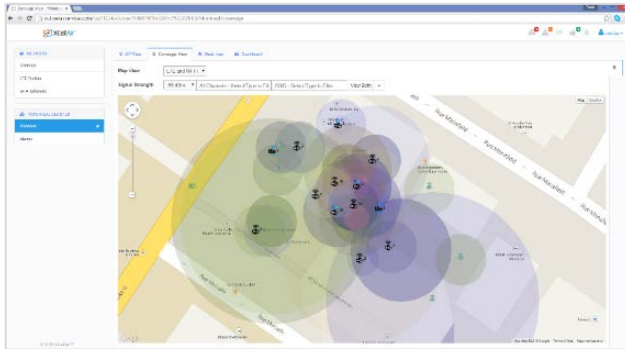
- New services over Wi-Fi – voice, video, IoT
- Community Wi-Fi
- New technologies operating in unlicensed band – spectrum sharing, IoT

Congestion, interference are key issues

- Evident today in Wi-Fi
- Degrades service quality significantly
- Will be aggravated by new technologies in unlicensed band

Radio resource optimization mitigates these issues

- Dynamic channel management, band steering, power control
- Substantiated by test results
- RRM can unlock bandwidth headroom available in unlicensed bands
- Can facilitate coexistence with new technologies



## Vision

- Enable broad and large scale deployment of HetNets for wireless service providers by delivering optimization, automation and analytics

## Focus

- Provide Wi-Fi Assurance for service provider Wi-Fi networks to ensure high Quality of Experience

## Industry Veterans with Proven Track Record

- Executive team brings over 100 years of combined telecommunications expertise, recognized experts and thought leaders

SCTE · ISBE

**THANK YOU!**

**Narayan Menon**

Narayan.menon@xcellair.com

516.343.0027



DENVER, CO  
OCTOBER 17-20

