Measurement-based, Practical Techniques to Improve 802.11ac Performance

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Wireless networks have been undergoing changing
  - more capacity, higher speed, denser networks
  - new 802.11 standards have been introduced

New techniques are required
  - take advantage of the wireless evolution

Why is this talk important?

What can we do about it?
• **Large scale wireless measurement study**
  - shows changing trend in today’s wireless networks

• **TurboCA - A new channel planning algorithm**
  - reduces wireless TCP latency by up to 40%

• **FastACK – A TCP over wireless enhancement**
  - increases wireless throughput by up to 38%
• Large scale wireless measurement study
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What is 802.11ac?

- A wireless standard published in Dec 2013
  - wider channel width (up to 160 MHz)
  - more antenna usage (4x4 MIMO)
  - higher data rate (up to 3.39 Gbps)

- Rapid adoption of 802.11ac
  - default in new wireless devices
  - more than 50% of Meraki APs
  - 45.7% of the client devices

27.7% more clients support 802.11ac
Measurement Framework
More than One Million Networks

Management Networks

Live data

Uplink traffic

Current clients

Associated for

Tools

Current mesh routes

This access point has had no routes for the current timespan.
100K active APs
1.7M associated clients
50G packets

Channel Width

- 45.7% supporting 80MHz now

Band

- Significant usage of 2.4GHz devices

Multiple Antennas (MIMO)

- Multi-antenna devices gaining traction

* Large-scale Measurements of Wireless Network Behavior, SIGCOMM 2015
Spectrum Trend

2.4GHz is much more congested than 5GHz

Median # of interferers is similar for both bands
Traffic Analysis

Distribution of Packets

Bit rate (Mbps)

Distribution matches types of clients seen in the field
More and more 802.11ac devices

Wireless spectrum getting more crowded
Agenda

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802.11ac introduces **extended channel width**
  - channel width is manually configured lower with 35% of the Meraki 802.11ac APs.

802.11ac makes **RTS/CTS** enforced
  - RTS/CTS changes the behavior of neighbor APs on the same channel
Traffic trend indicates frequent channel switch

Channel switch disrupts traffic flow
• Carrier sensing based channel model

• User-experience based optimization
  o AP load
  o channel quality
  o channel switch

• Aggressive channel re-evaluation to catch up with environment change

• Details in the paper

TurboCA – System
TurboCA – Evaluation

• **Test networks**
  - museum (171 of 201 APs supporting 802.11ac)
  - university (653 of 735 APs supporting 802.11ac)

• **Comparison**
  - baseline (default before Nov. 2016)
  - TurboCA (default after Nov. 2016)

• **Duration**
  - 03/25/17 -- 05/07/17
TurboCA – Evaluation

• Usage (throughput)

Uplink saturated for the university from ISP constraint
TurboCA improves peak hour usage by 27% in the museum
TurboCA – Evaluation

- TCP latency

TurboCA reduces the TCP latency by 40%
TurboCA

Better channel assignment
• Large scale wireless measurement study
  o shows changing trend in today’s wireless networks

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TCP is most popular protocol for transmission

But TCP proposed for wired networks
  - not aware of the variable latency introduced in wireless
  - not aware of the aggregation used in 802.11ac

Key Insight
802.11 latency << TCP latency
strong hint for correct reception
FastACK – System

- Exploit 802.11 ACK hints for larger aggregates
- TCP end-to-end semantics maintained
- No client modification
- Details in the paper
FastACK – Evaluation

• Testbed – 40, 3x3 clients

• Ixchariot is used to measure the throughput
FastACK – Evaluation

• Single-AP multiple clients test

Up to 38% aggregate throughput improvements
FastACK – Evaluation

- **Multi-AP multiple clients test**

  - **Baseline**
    - AP1: 251 Mbps
    - AP2: 325 Mbps
  - **FastACK**
    - AP1: 395 Mbps
    - AP2: 325 Mbps
    - Combined performance is 60% better

  FastACK does not suffer in isolation
FastACK

Improved TCP over wireless
Related Work

• **Wireless network measurement**
  Vivek, S [NSDI 11], Ratul M [SIGCOMM 06], Yu-Chung, C [SIGCOMM 06], Sanjit, B [SIGCOMM 15]

  *The largest scale of study for wireless and first evaluation on 802.11ac.*

• **Channel assignment**
  Apurv. B[MOBIHOC 16], Paramvir, B[SIGCOMM 09], Shravan R [MOBICOM 09]

  *TurboCA considers real enterprise challenges.*

• **TCP enhancement**
  A. Bakre [ICDCS 95], Ajav V [MLICS 95], Hari B [MOBICOM 95], Stefan S [SIGCOMM 99]

  *FastACK looks at the impact of 802.11ac aggregation for TCP.*
Conclusion

• We observe interesting trends in today’s wireless networks
  
  o rapid adoption of 802.11ac-enabled devices
  o network densification continues to increase
  o wireless spectrum getting more crowded

• Based on observed trends, we present two fundamental techniques
  
  o TurboCA, a new channel assignment algorithm
  o FastACK, a TCP enhancing technique over 802.11ac

• New techniques show significant potential in enterprise networks