Intelligent Wi-Fi Multicast for NDN AR

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NAMED DATA NETWORKING

Summary

- Limitations of current Wi-Fi for NDN AR
- Resilient Wi-Fi multicast for NDN AR
- Intelligent Wi-Fi with learning & reasoning capabilities
- Prototype integration of new wireless with NDN AR

Motivation and Introduction

Current Wi-Fi cannot well support NDN & AR

- **Unicast-based design over a broadcast media**
  - Not NDN friendly
  - Not scalable for AR
- **Black-box operations at low MAC & PHY**
  - Do not know what happens when things go right/wrong
  - Do not understand why it happens when things go right/wrong

Root Cause

- **Restrictive Wi-Fi multicast support**
  - In standards
  - In vendor implementations and smartphones
- **Current Wi-Fi lacks intelligence**
  - Limited learning
  - No reasoning

Issues

- **Wi-Fi multicast related**
  - Multicast rate locked at low rate
  - Power-save (PS) mode limits multicast throughput
  - No frame aggregation (FA) for multicast
  - No channel bonding (CB) for multicast
  - No retransmissions for multicast delivery
  - Limited support on smartphones
- **Wi-Fi intelligence related**
  - No learning & reasoning @device or AP
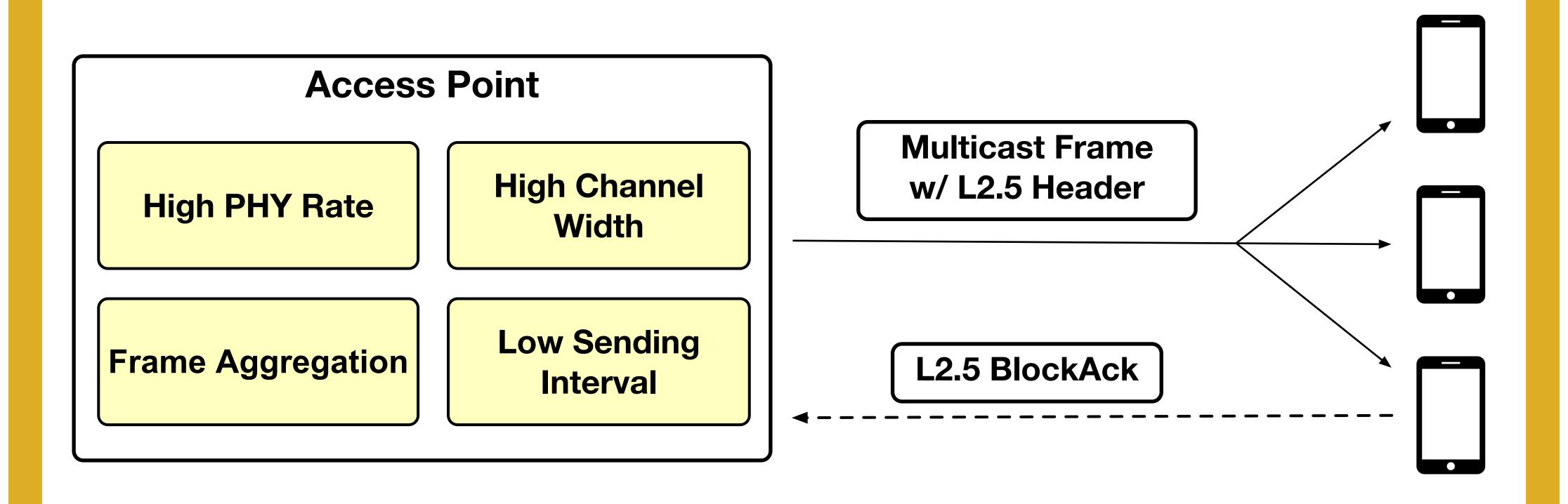 - No exchange of Inference and reasoning btw. AP & clients

System Design

Design goals

- Wi-Fi standard compliant
- Support for smartphones
- Enabling both multicast and intelligence over Wi-Fi for NDN & AR

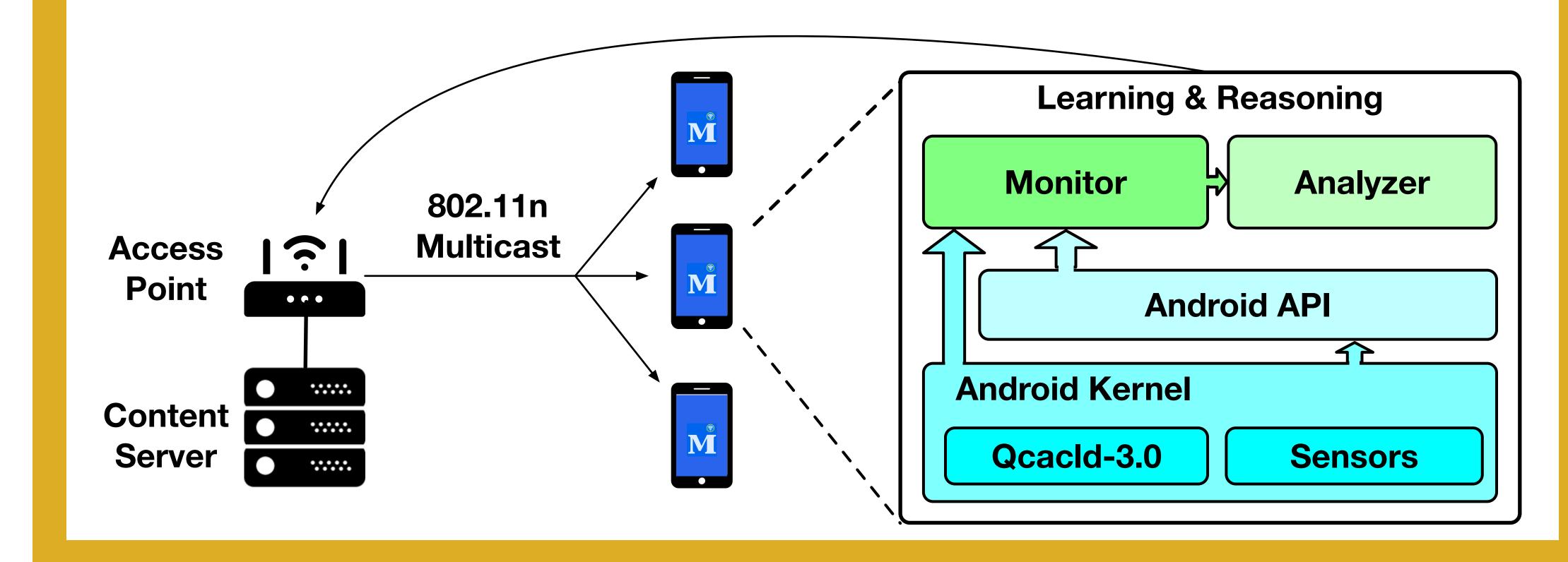### Resilient Wi-Fi Multicast for NDN & AR

- Enabling FA & CB, bypassing PS, activating high MCS rate
- L2.5 retransmissions for better resilience

Access Point

| High PHY Rate | High Channel Width |
| Frame Aggregation | Low Sending Interval |

Multicast Frame w/ L2.5 Header

L2.5 BlockAck

Intelligent Wireless with Learning and Reasoning

- Learning via cross-layer information and reasoning root causes
- Devices report inference results to AP
- AP makes smart decisions for multicast

Access Point — 802.11n Multicast

Content Server

Learning & Reasoning

Monitor → Analyzer

Android API

Android Kernel

Qcacld-3.0 | Sensors

Implementation

On different device drivers

- Linux mac80211 kernel module
- ath9k for Qualcomm Atheros AP
- mwifiex for MS Surface Tablet
- qcacld-3.0 for Google Pixel2 phone

MobileInsight analytics

- Multi-layer information fusion
- Learning and reasoning

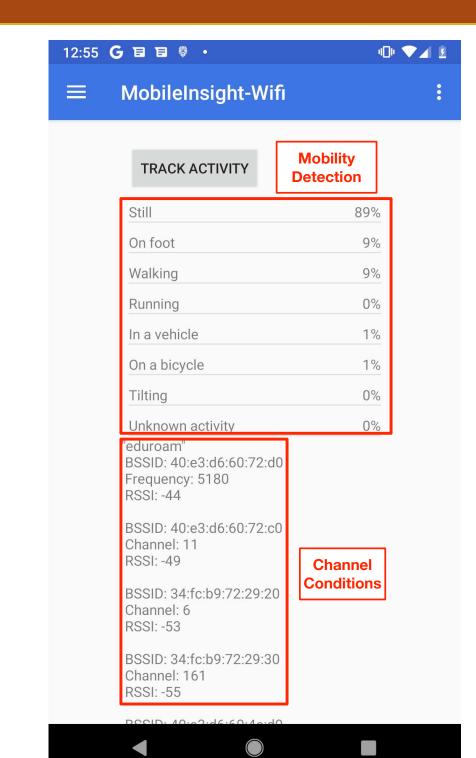## Results

Intelligent Wi-Fi

- Learning via cross-layer information
- Reasoning the root causes of mobility, sudden channel change, and frame loss

Resilient Wi-Fi Multicast

- >110 Mbps UDP multicast throughput for 802.11n at 5GHz
- Enable 8k video streaming
- >50Mbps at 20 meters
- Reduce packet loss by a factor of 10~20

Integration with NDN & AR

- Integrating NDN/AR with link-layer multicast

Next Step

- More cases for learning & reasoning
- Multicast rate adaptation by exploiting learning and reasoning
- Full integration with NDN & AR

References and codebases

https://github.com/anonymous-slave/wifi-multicast

https://github.com/anonymous-slave/MobileInsight-WiFi