What can SDN do for IoT?

Kotaro Kataoka (kotaro@iith.ac.in)
Indian Institute of Technology Hyderabad

IoT over Enterprise Network

- Connecting Sensors to Campus LAN or Wi-Fi
  - Alternative connectivity in addition to Bluetooth, ZigBee, PLC and etc.
  - Quality of IoT will be manageable

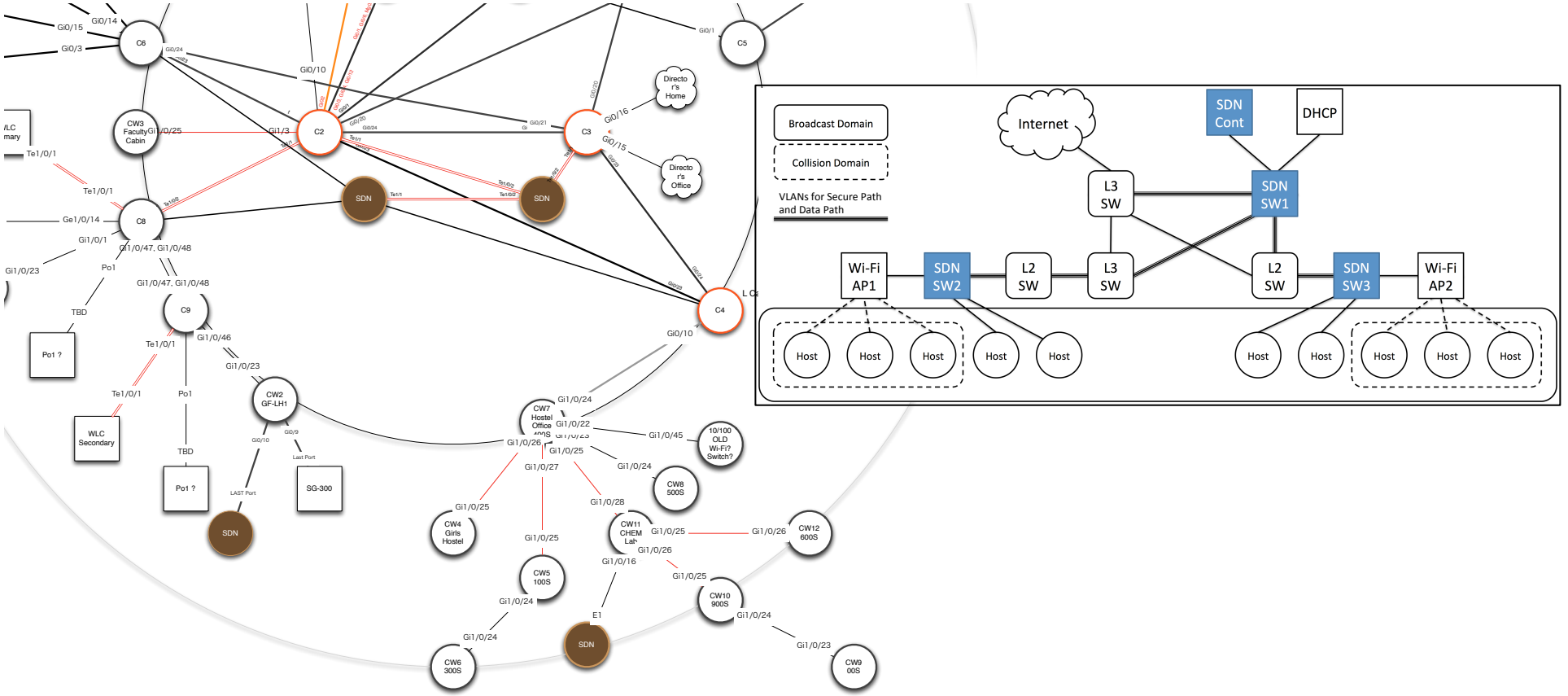
- Challenges
  - Scalability: Large number of devices
  - QoS: Coexistence with commodity traffic
  - Mobility: Smartphone works as IoT device
  - Security: Heterogeneity of supported mode of authentication
  - Mission Critical Data: No mistake in commanding system
  - etc

A Big Setup as Target Field

- Permanent Campus of IIT Hyderabad
  - Academic Buildings
  - Hostel Buildings

Current SDN Deployment in IIT Hyderabad

- SDN switches are deployed at core and edges of the campus network
  - Overlaying SDN switches on traditional LAN
- IITH network is ready for testing developed codes
- Hardware: HP 3800-24G-Poe+-2SFP+, HP 5400zl with 8 x 10Gbe Ports



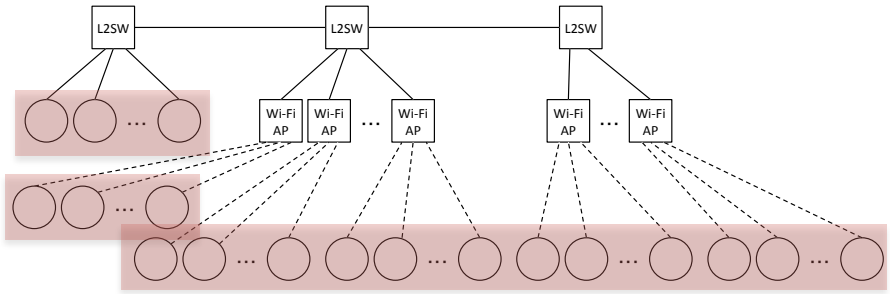
Some SDN Works in IIT Hyderabad

- Scaling Ethernet Broadcast Domain
- Freedom of Authentication Mode and Per-device Access Control
- Application-aware Multipath Packet Forwarding

Scaling Ethernet Broadcast Domain (1/2)

- Large-scale LAN
  - Wired: Full Duplex, Wireless: Half Duplex
- Broadcast messages from many hosts will make LAN busy
  - Performance restriction
  - Unwanted broadcast traffic to Wireless network
- Small LAN for Wireless Networks?
  - Routers and switches will be busy due to too may subnets and VLANs
  - Utilization of address space will be less
- Solution: Filter and Isolate the broadcast messages!!

BEFORE



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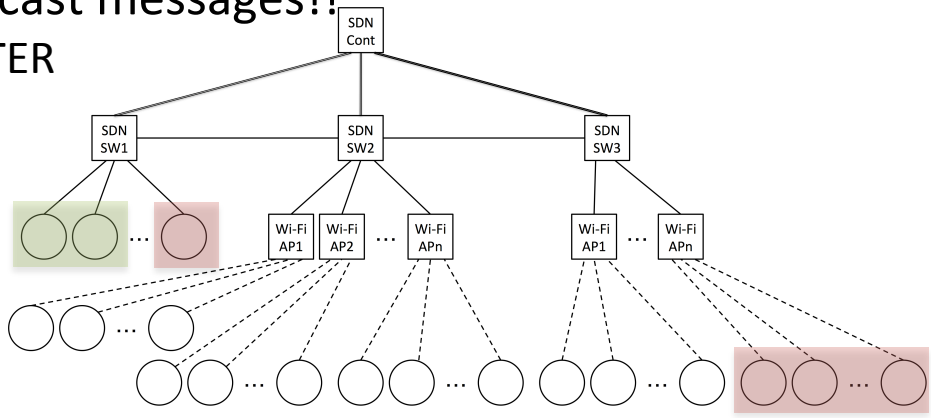
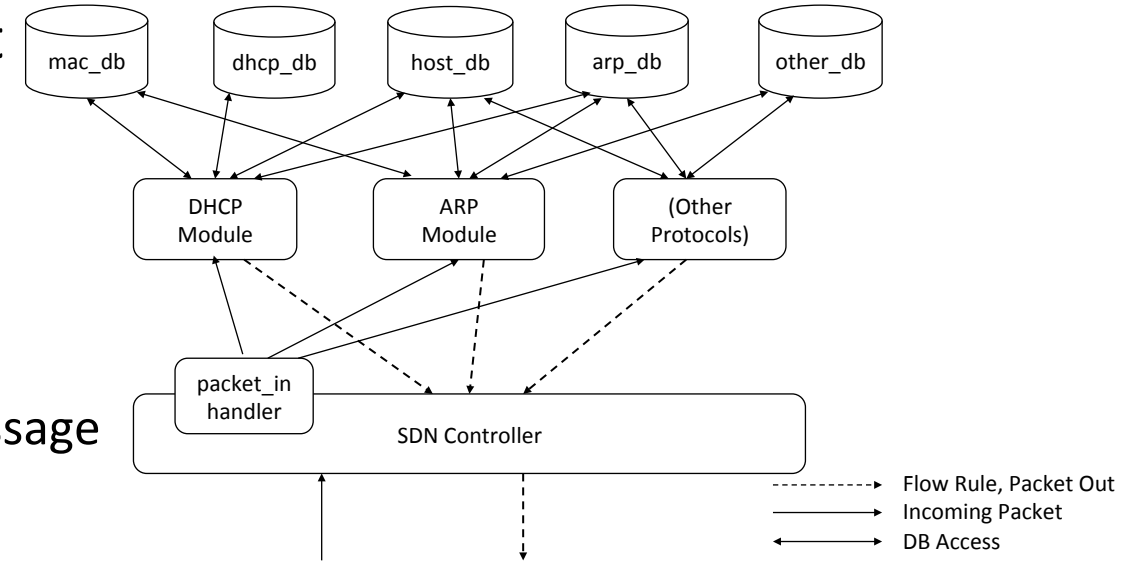
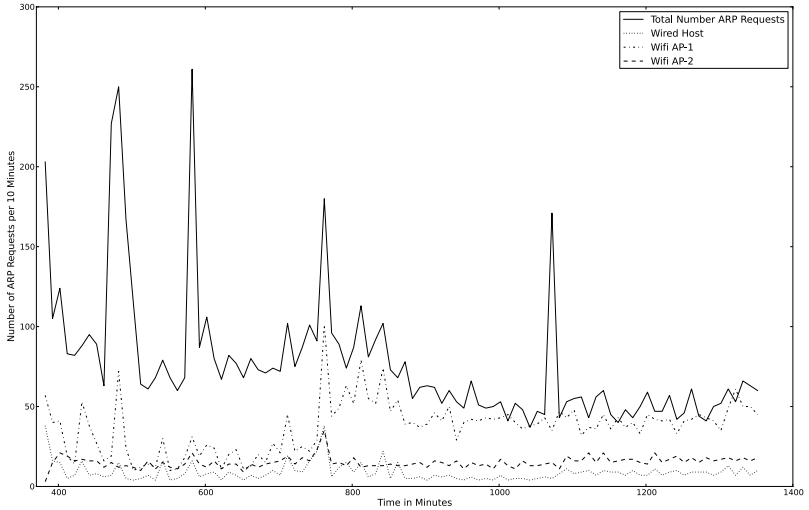
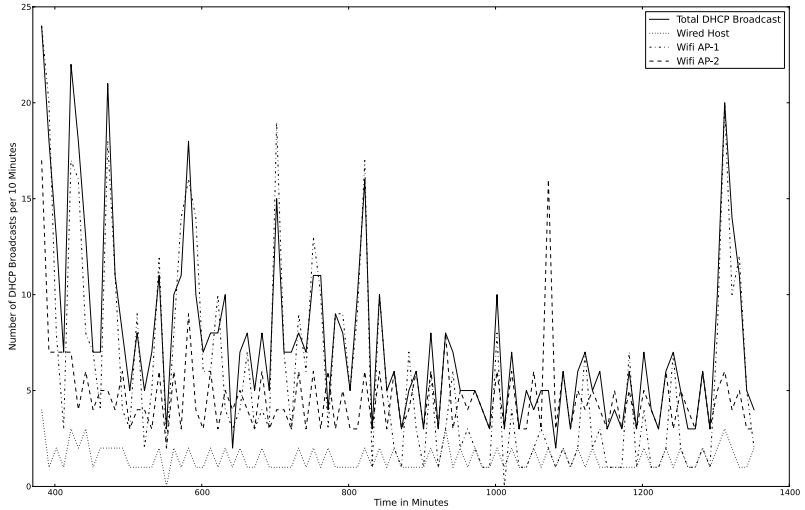


Scaling Ethernet Broadcast Domain (2/2)

- Extensible Transparent Filter (ETF)
  - MAC-based approach
  - Detect device
  - Learn location
  - Forward broadcast message like Unicast

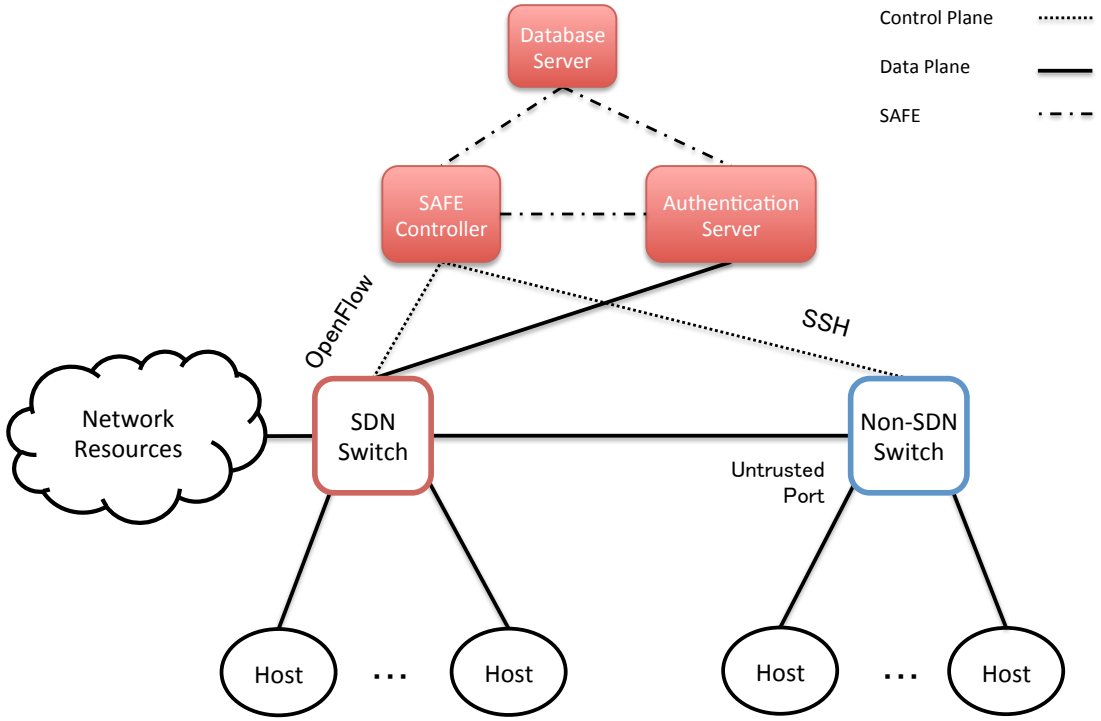






SAFE (1/2)

- Software-defined Authentication Framework
  - Device-level isolation in SDN
  - Separating **Authentication** and **Access Control**
  - More freedom on mode of authentication
  - Supporting non-SDN switches



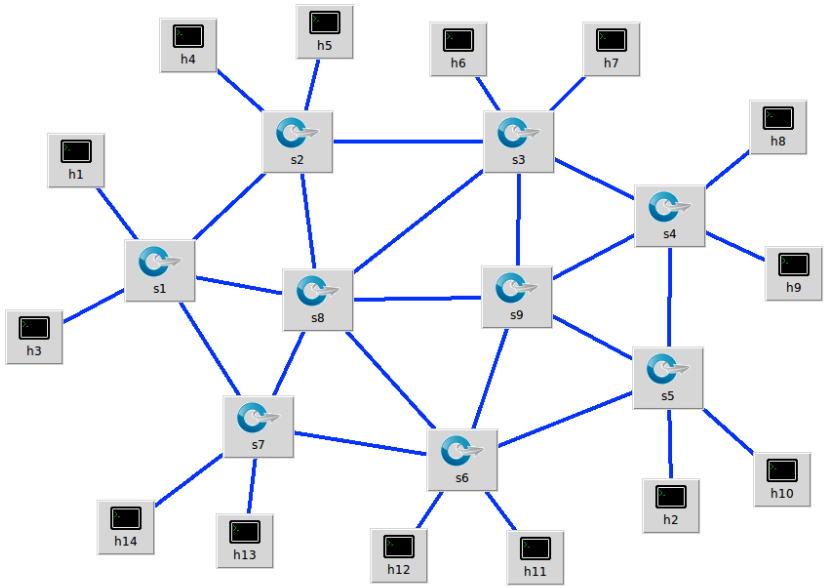
SAFE (2/2)

- Any mode of authentication can be used only if it can trigger SAFE server (has DB to maintain authenticated hosts and location)

- What is an interesting mode of authentication?
  - IoT: Reading MAC address using RFID, QR Code and Photograph
  - Smartphone: Rich information (user profile)
  - Inter-campus roaming by shared database

QoS using Machine Learning and Multipath Packet Forwarding (1/2)

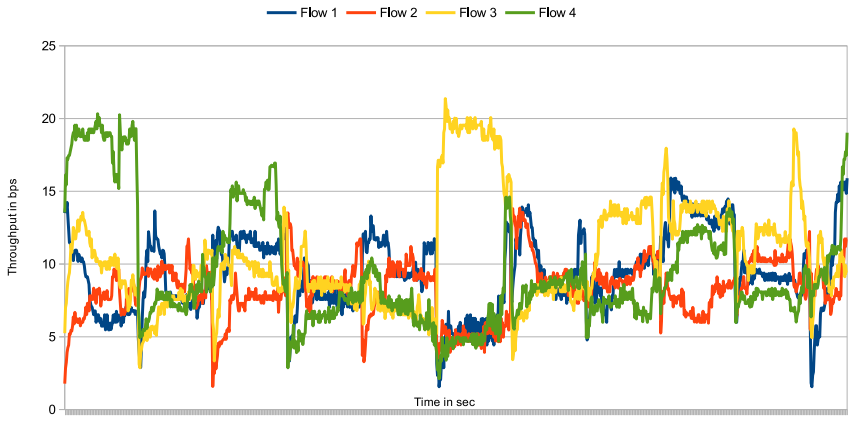
- Awareness of Applications
  - Fundamental part for QoS
  - Machine Learning can go beyond the traditional mode (Proto/Port#)
- Why QoS + Multipath Packet Forwarding?
  - Prioritize the traffic
  - Achieve high utilization of network in more aggressive manner
- Solution
  - Automatically classify the input traffics and apply QoS policy to each of them
  - Let each of traffic travel different paths

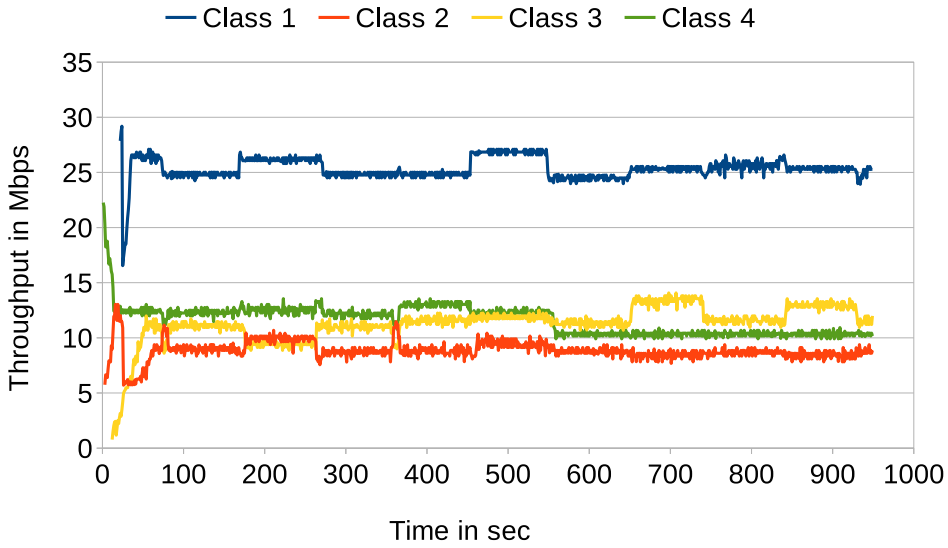


QoS using Machine Learning and Multipath Packet Forwarding (2/2)

- Machine Learning for Application Awareness
  - SVM (Support Vector Machine) looks the best
- Finding multiple paths
  - Yen's K shortest path
  - Find the best path, then proceeds to find *K* – 1 deviations
  - Metrics: Delay + BW

Class	Min. B/W	Max. B/W	Jitter Tolerance	Delay Tolerance
C1	16M	N/A	Low	Low
C2	16M	N/A	Mid	Mid
C3	4M	16M	Mid	Mid
C4	N/A	8M	Mid	Mid





Integrating “Things” to SDN Testbed in IIT Hyderabad

- Testing SDN protocols for wireless devices
  - OpenFlow-capable Wi-Fi in IIT Hyderabad
  - Coexistence of commodity traffic and “Things’ data”
- Open Network Testbed
  - IIT Hyderabad welcomes sensors and networks to be deployed

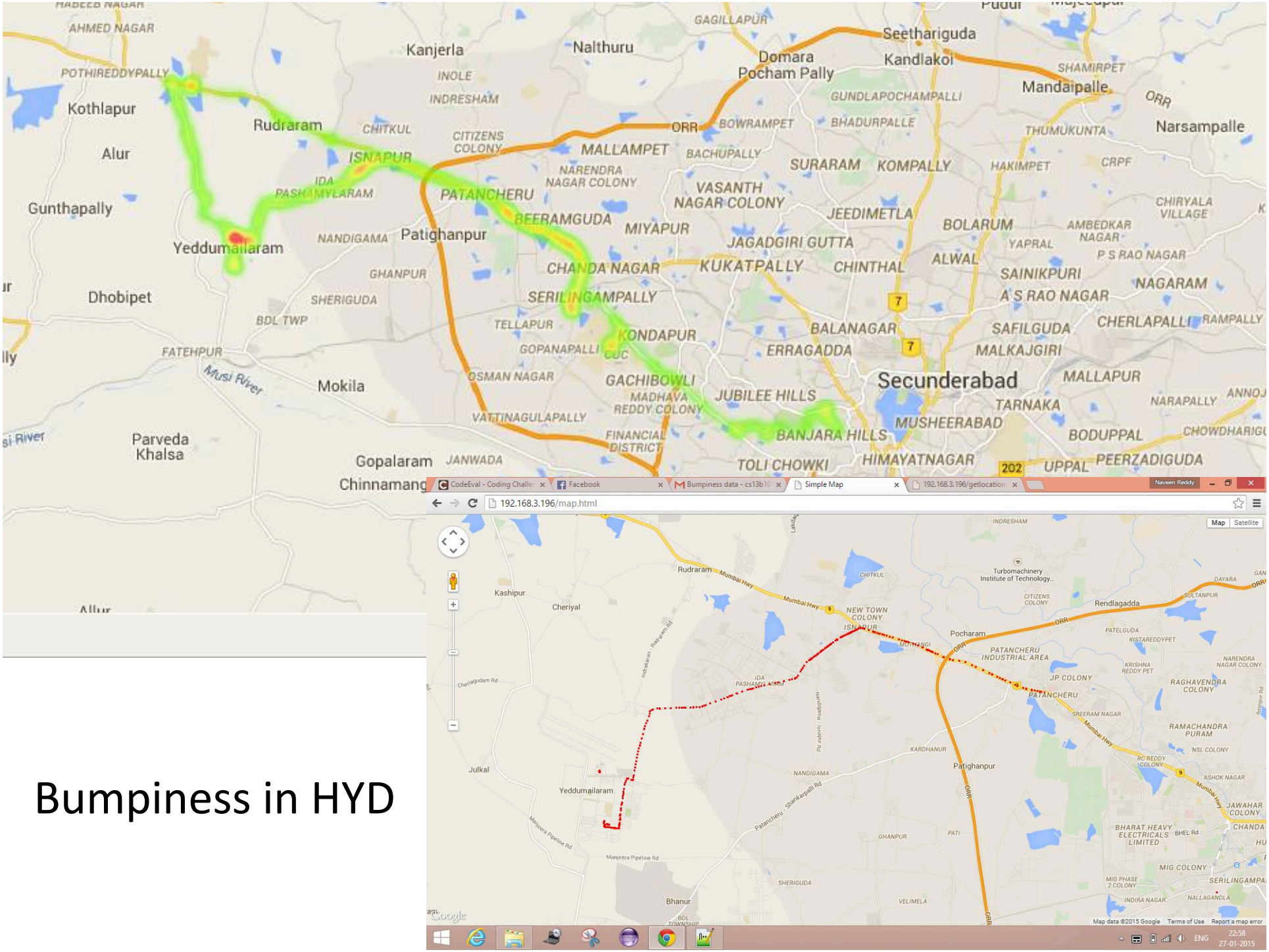
Other On-going Works

- Distributed NFV
  - Cloud, SDN and Awareness
- Packet Tagging: Service-oriented Packet Forwarding in SDN
  - Routing in
- Wireless Mobility in SDN
  - Smaller broadcast domain, location-specific routing, seamless connectivity
- QoS-aware Multicast in SDN
- Speeding-up ICN in SDN (Making change in OpenFlow)

- How bumpy are Indian roads?
- Real-time Online Counseling for Mental Health Care (To be funded by GoI)

THANK YOU AND Q&A

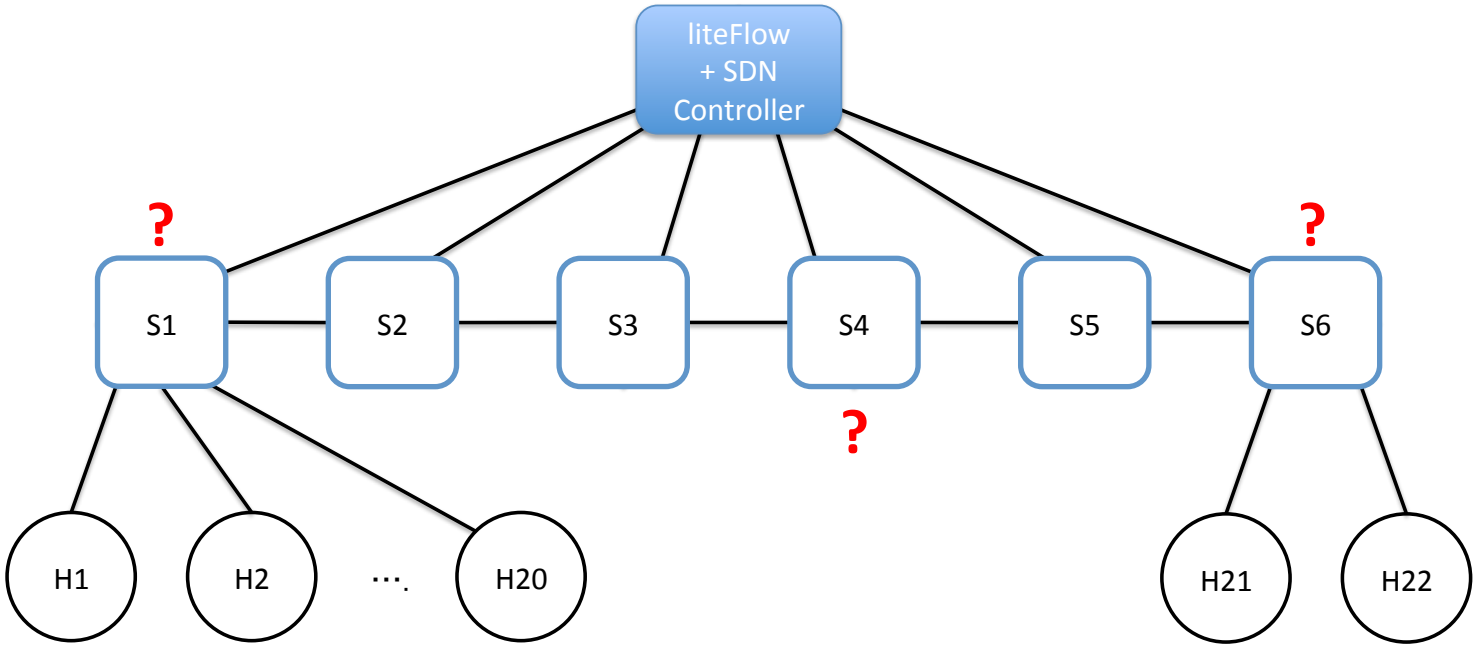
Backup Slides



Bumpiness in HYD

liteFlow (1/2)

- A lightweight and distributed flow monitoring system for SDN
  - Flow-based monitoring with accuracy of packet capturing
  - Less and distributed resource consumption
    SDN at switches on end-to-end path of a flow
    - Resource awareness (TCAM usage)
    - Selection of Authority Switch in charge of monitoring a flow
    - Other switches simply forward packets on a flow



liteFlow (2/2)

- Scenarios
  - Monitor at all switches (F * N flow rules per host)
  - Ingress switch scenario (F + N – 1 flow rules per host)
  - liteFlow scenario (F + N -1 flow rules with load balancing)
- LiteFlow
  - Authority Switch: 5-tuple (srcIP, dstIP, srcPort, dstPort, protocol)
  - Other Switches: 2-touple (srcIP, dst IP)

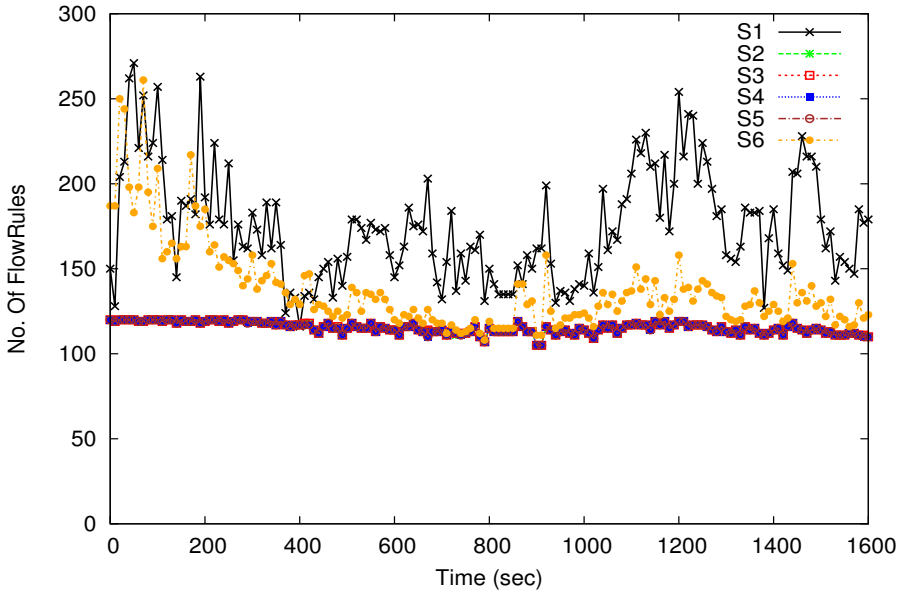


Figure 7: Number of Flow Rules in Ingress Switch Approach

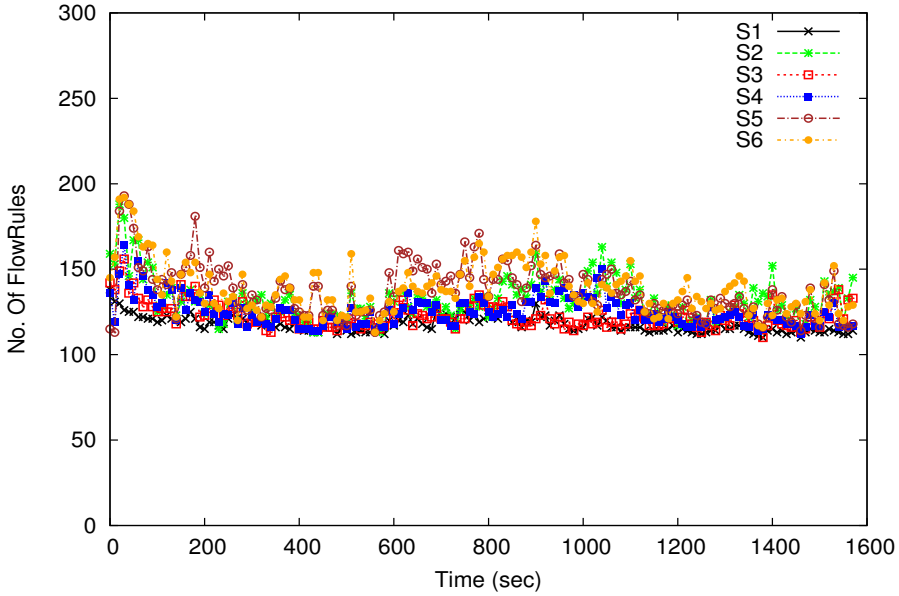
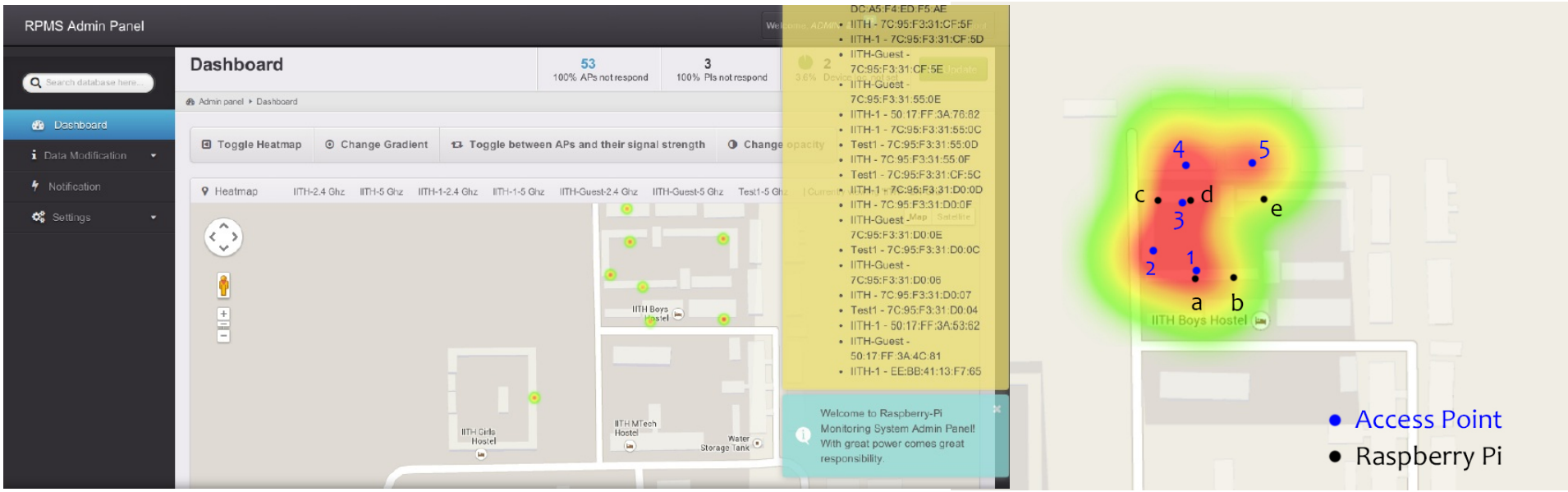


Figure 8: Number of Flow Rules in $liteFlow$ Approach

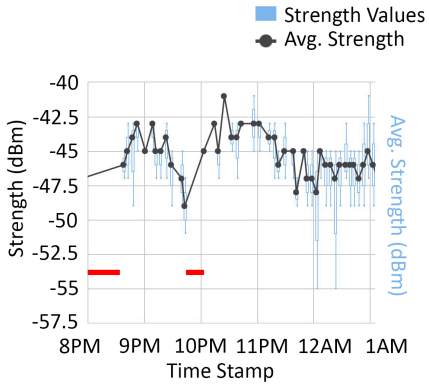
Wi-Pi (1/2)

- Distributed Wi-Fi Performance Assessment using Raspberry Pi
  - Data form user's perspective
  - Cheap, Distributed, Always up, DTN
  - No need of moving around
  - Wi-Fi quality + Pinger (RTT/PacketLoss)
  - Visualization & Management: Heat mapper + UI

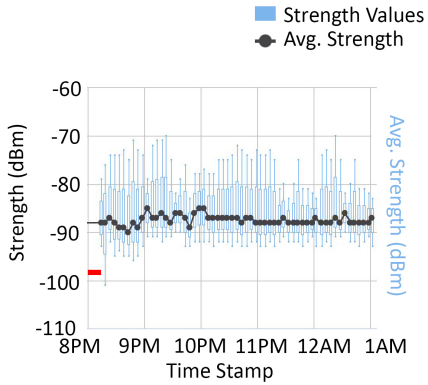


Wi-Pi (2/2)

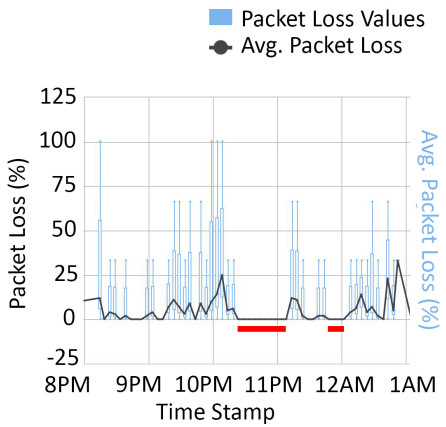
- Historical fluctuation of signal strength and network connectivity
- Android Apps for further cost reduction



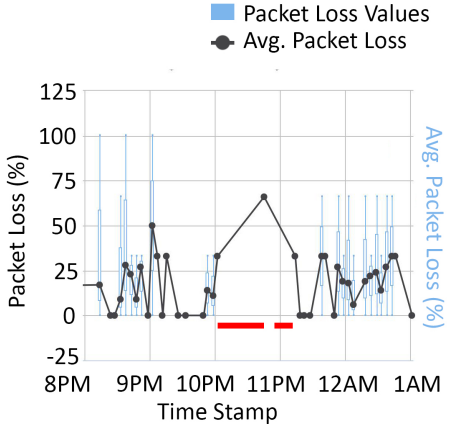
(a) Best hourly strength (per 5 minutes) result between pi(d) and ap(3)



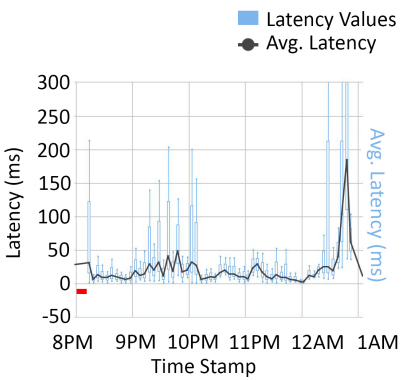
(b) Worst hourly strength (per 5 minutes) result between pi(a) and ap(3)



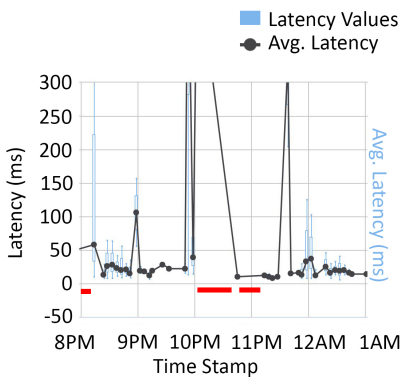
(e) Best packet loss (per 5 minutes) results between pi(a) and ap(1)



(f) Worst packet loss (per 5 minutes) results between pi(c) and ap(2)



(c) Best latency rate (per 5 minutes) results between pi(a) and ap(1)



(d) Worst latency rate (per 5 minutes) results between pi(c) and ap(2)