OpenSDWN:
Programmatic control over
home and enterprise Wi-Fi

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Link Characterization

- Wide range of physical transmission rates
- Flags such as NoACK
- Links are asymmetric
- RTS/CTS to mitigate Hidden Terminal issue
- Supports several medium Access Categories (ACs)
- Layer 2 retransmissions
We don’t focus on short lived flows
Mobility and State Migration

MB state migration

- Client mobility:
- New stateful firewall (FW) lacks connection state
- Connections break
- State migration required
- State needs to be migrated from one MB instance to another
Motivation

• Application-specific requirements are not considered at the wireless access

  • Application-specific sensitivity to latency or packet loss

  • Today’s rate control is traffic agnostic

• Group related data traffic

  • Multicast always sent at basic rate (typically lowest physical rate)

  • No smart rate selection for group related traffic (even with just one subscriber)

• Middlebox Management (MB)

  • Mobility requires MB state to be migrated/moved (e.g. FW state on Hotspot WiFi APs)
OpenSDWN

OpenSDWN Control Plane

Home

Enterprise

SDN

NFV

SDWN
OpenSDWN Building Blocks

- Separation between WiFi Control and Data-path
  - Programmability of upper-MAC 802.11 functionalities
  - Slicing of the wireless
- Programmability of the Wireless Datapath
  - Assign Wi-Fi transmission settings to flows
  - Abstraction from the physical transmission settings
- Management of network functions
  - Middlebox-Agents provide a network function interface
  - Per-client middlebox state abstraction

Realized as an SDWN Application

Odin in a Nutshell

• SDWN Applications
  • Mobility Management
  • Client-based Load Balancing
• Per-client Light Virtual Access Point (LVAP) abstraction
  • LVAP abstracts the complexities of IEEE 802.11
  • Provides slicing of the wireless
• Focus on upper-MAC functionalities
  • Client Association, Authentication etc.

Wireless Datapath Programmability

• WiFi Datapath Transmission (WDTX) Rules
  • Assignment of fixed and/or „meta“ transmission settings
  • Control over transmission power, transmission rate as well as tailored retry chains

• Control level of wireless transmission settings:
  • Per-Group level, e.g., maximum common transmission rate
  • Per-station level, e.g., transmission power, RTS/CTS protection
  • Per-application level, e.g., bandwidth/latency requirements
  • Per-flow level, e.g., physical transmission rate, no ACK policy
virtual Middlebox

• Abstraction from the inner workings of a specific middlebox

• Per-client state abstraction

• Simplifies device/user handling, e.g.,
  • Mobility can be handled easier
  • Per-device/class rules (e.g. for BYOD)
vMB Interface
Thee basic operations supported by OpenSDWN
Operation: Mobility and Migration
Operation: Transmission Control

- Set Match Rule
- Traffic Manager
- Set Wireless Transmission Rule
- Controller

Translates service requirements into transmission rules
Operation: Service Differentiation
Evaluation
RTT optimization through WDTX

- 2 APs and two stations
- Two simultaneous flows
  - Best effort background flow
  - Flow with different WTDX
- RTT is decreased by half for flow
  - Highest access category
  - Best Probability Rate
Delay optimization through WDTX

- 2 APs and two stations
- Two simultaneous flows
  - Best effort background flow
  - Flow with different WTDX
- Layer 2 retransmissions decrease
Group transmissions

- Multicast packets are typically sent at basic rate
- Unicast has the potential to reduce the airtime consumption
- Direct Multicast Service (DMS)
  - Switch from Multicast to Unicast
  - Requires a client to signal its DMS capabilities
- OpenSDWN can assign maximum common transmission rate for a group of stations
OpenSDWN DMS App

- IPTV service from a major European ISP
- Stream easily exceeds the available capacity in a IEEE 802.11g network
- Switching to unicast mitigates this issue
vMB Firewall Migration

<table>
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<tr>
<th>Entry count</th>
<th>Mean execution time (ms)</th>
<th></th>
</tr>
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<td>Read</td>
</tr>
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<tr>
<td>10000</td>
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</table>

The table shows the mean execution time for different workloads in milliseconds (ms). The total time of a migrate operation is given by the sum of the time needed to process the operations for a single entry in a vMB object. The vMB object size is increased from 25 entries to 12,800 entries. As shown in Figure 6(a), we first measure the write duration for a single entry in a vMB object. The write duration decreases constantly with the workload, and stabilizes at around 43 ms for 12,800 entries. As shown in Figure 6(b), the write duration increases constantly. The average value stabilizes at around 270 ms for a stateful firewall vMB object read, write and delete operation. Latency in milliseconds (time) is normalized to a per-entry time. vMB extension that utilizes the netlink interface contribute the most to the processing complexity of the vMB abstraction exposes to a network programmer.
vMB FW performance: write
Conclusion

• OpenSWDN enables a wide range of new SDWN applications
  • Direct multicast as a simple application
  • User-defined service differentiation and prioritization
  • vMB abstraction simplifies handling of client mobility

• Future Work:
  • Study service requirements and effect of WDTX
  • Effect of group related WDTX rules on services
Questions?

Code soon available:
opensdwn.com