OpenSDWN: Programmatic control over home and enterprise Wi-Fi

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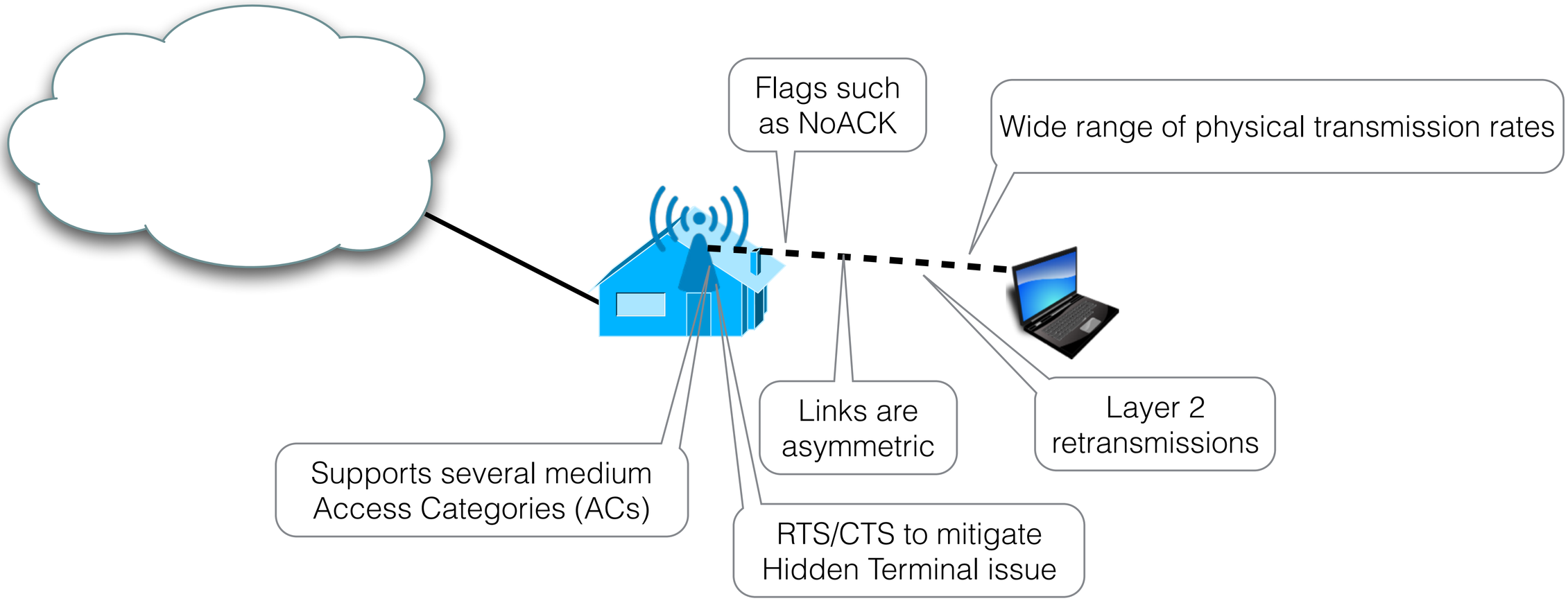
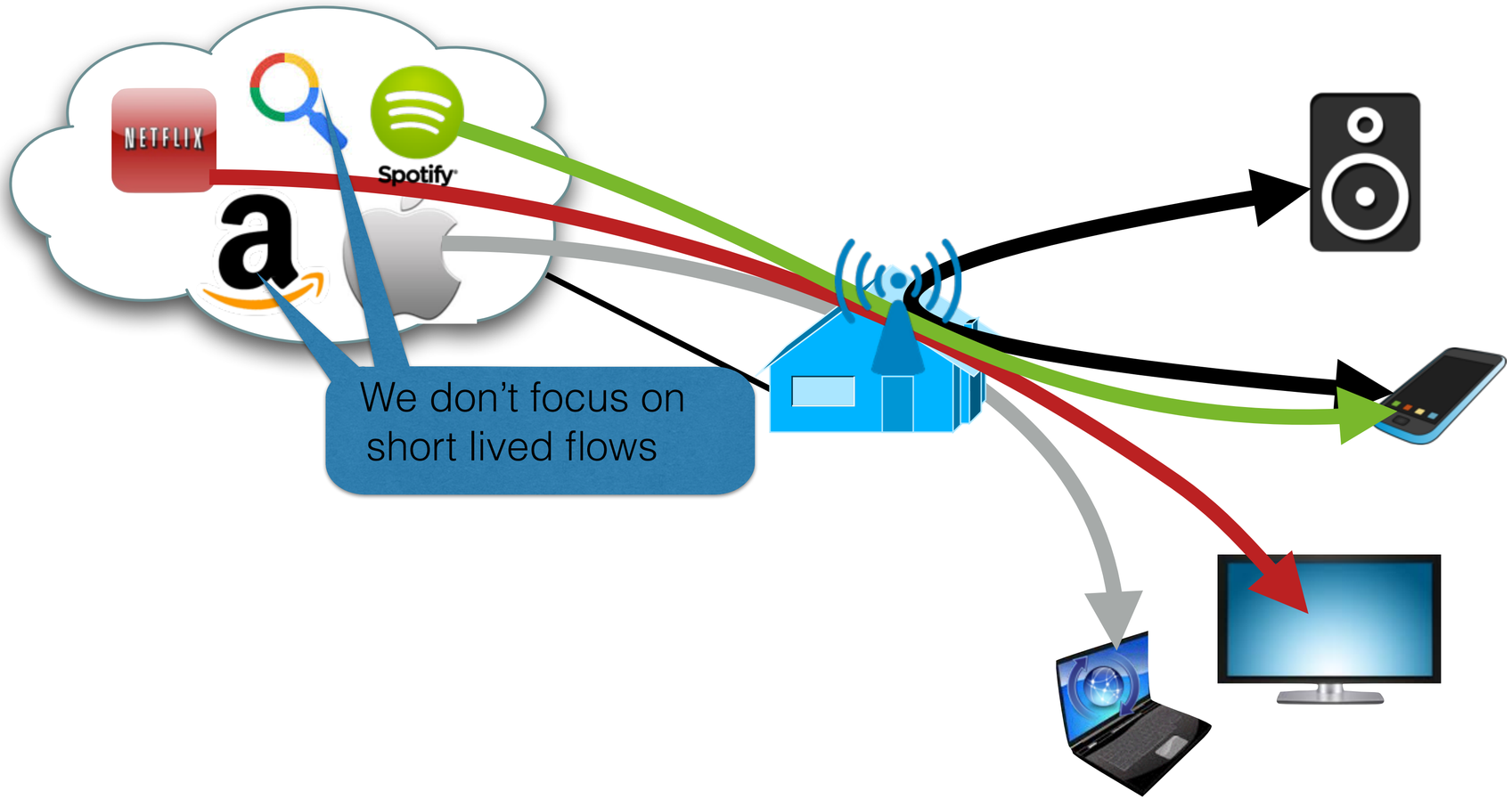
Link Characterization

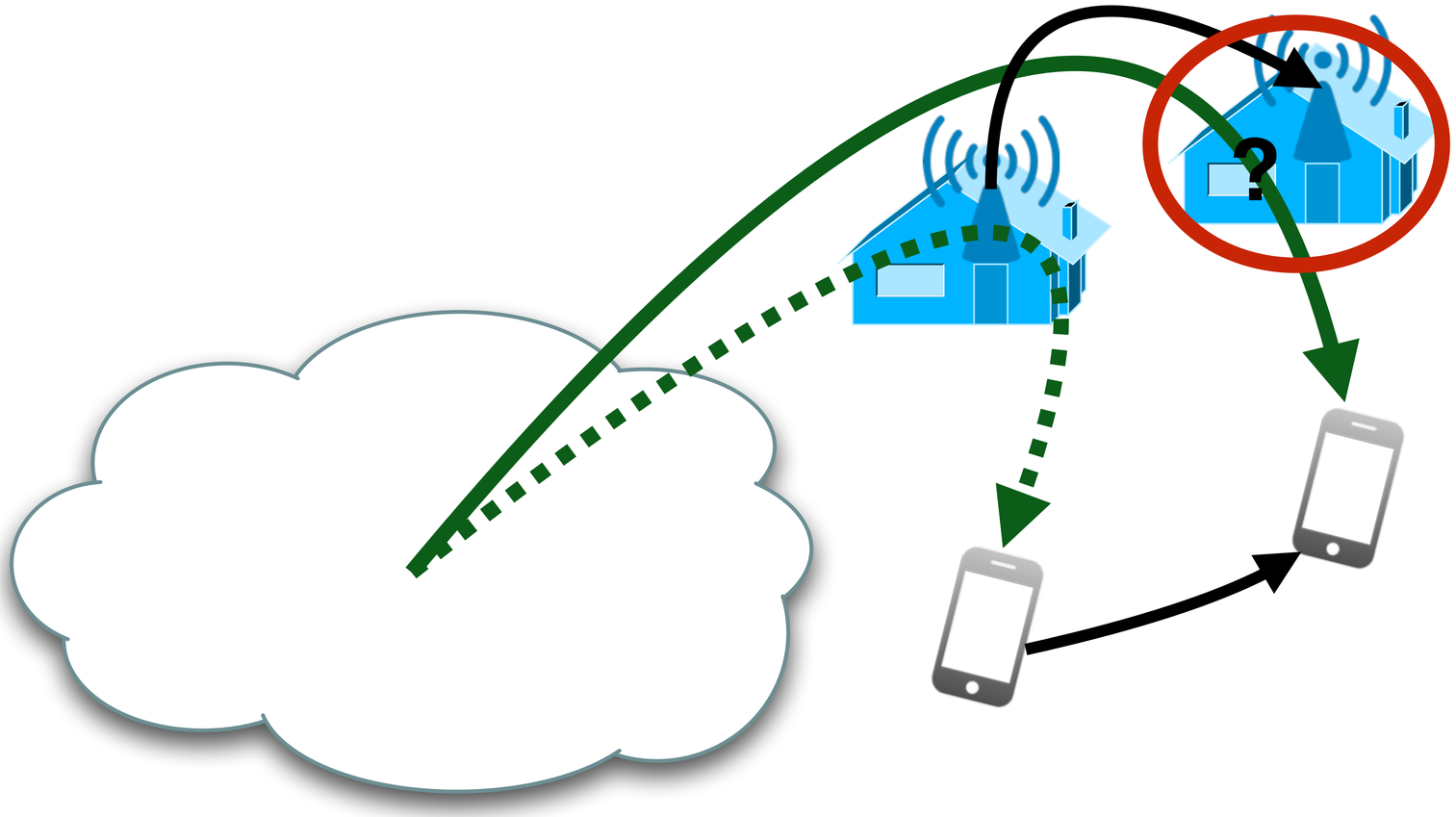


Home Network Example



Mobility and State Migration

MB state migration

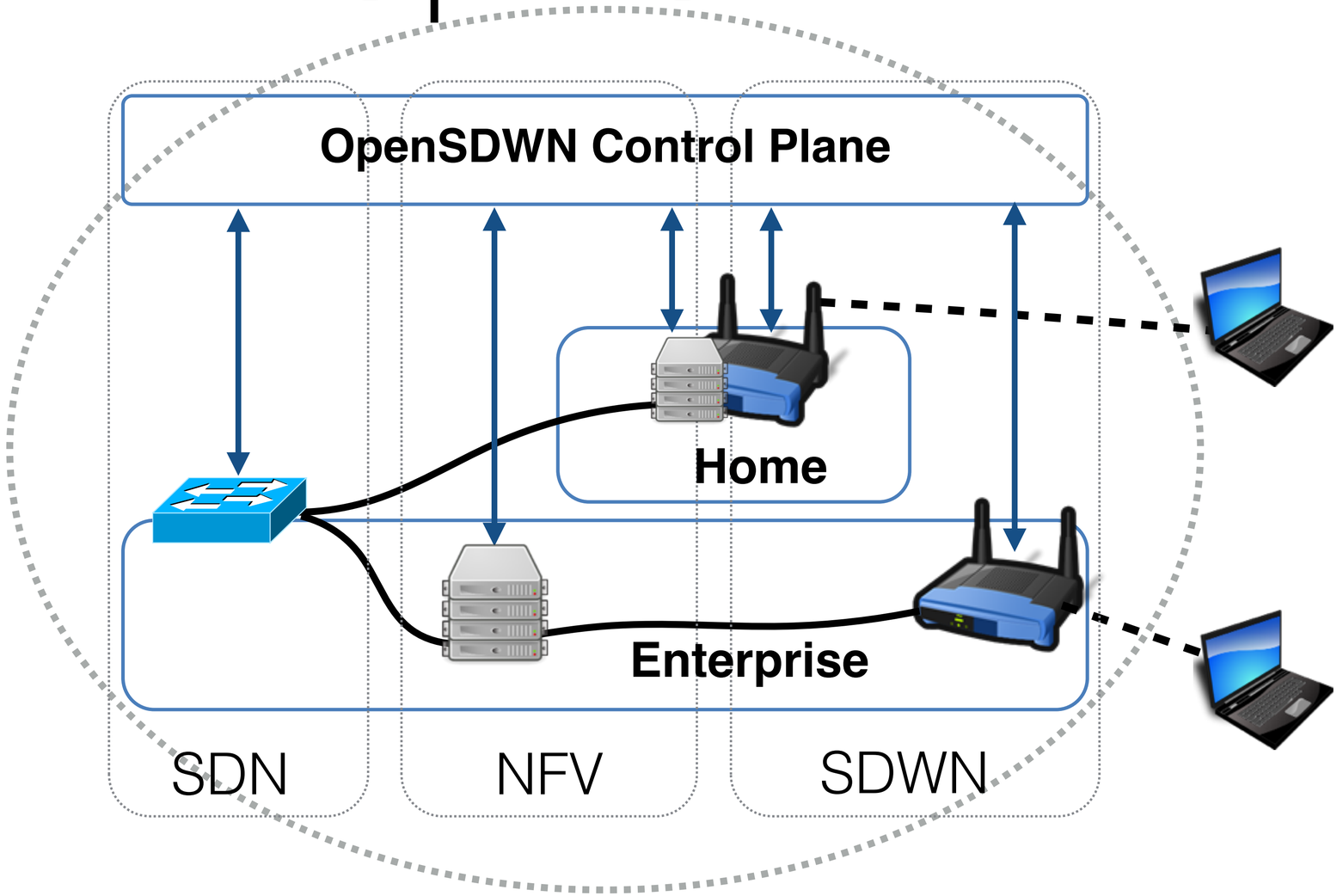


- Client mobility:
  - New stateful firewall (FW) lacks connection state
  - Connections break
  - State migration required
- State needs to be migrated from one MB instance to another

Motivation

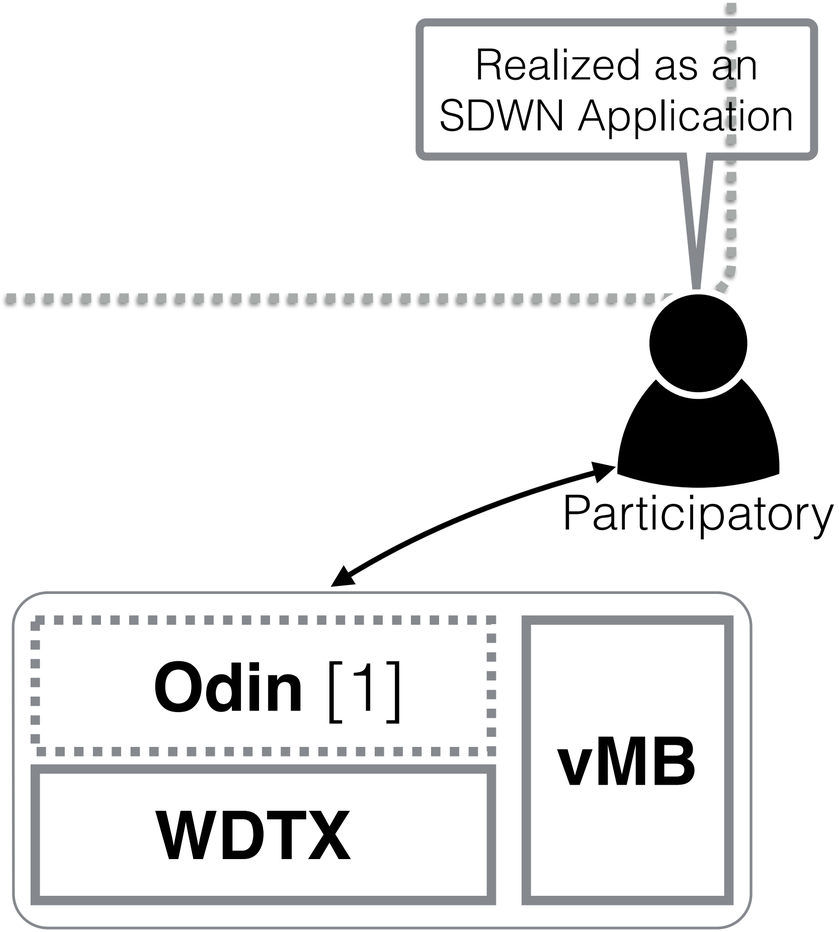
- Application-specific requirements are not considered at the wireless access
  - Application-specific sensitivity to latency or packet loss
  - Today's rate control is traffic agnostic
- Group related data traffic
  - Multicast always sent at basic rate (typically lowest physical rate)
  - No smart 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 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



[1] J. Schulz-Zander, L. Suresh, N. Sarrar, A. Feldmann, T. Hühn, and R. Merz. Programmatic Orchestration of WiFi Networks. In *Proc. USENIX ATC '14*.

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.

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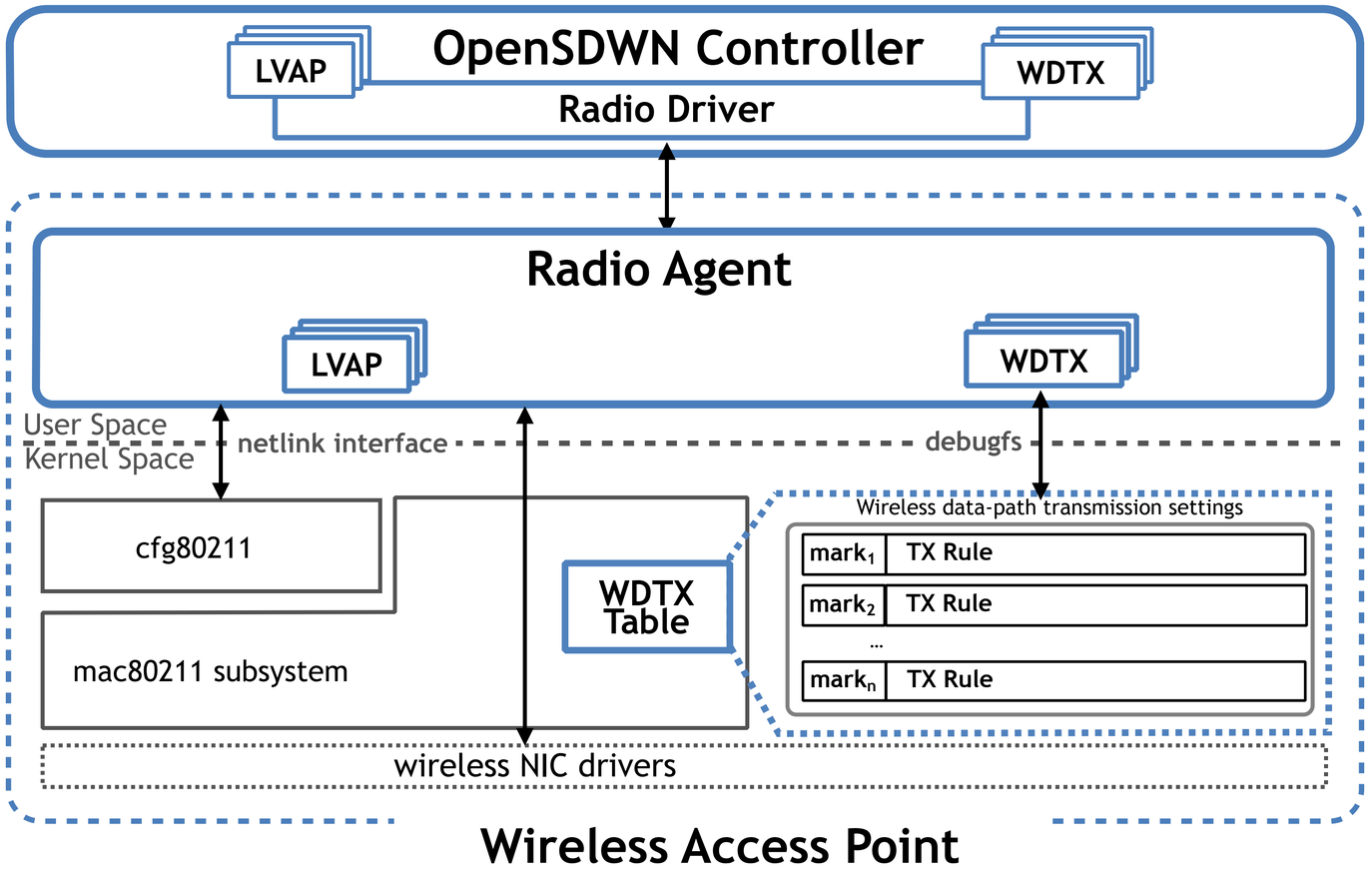
Wireless Datapath Programmability

- 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

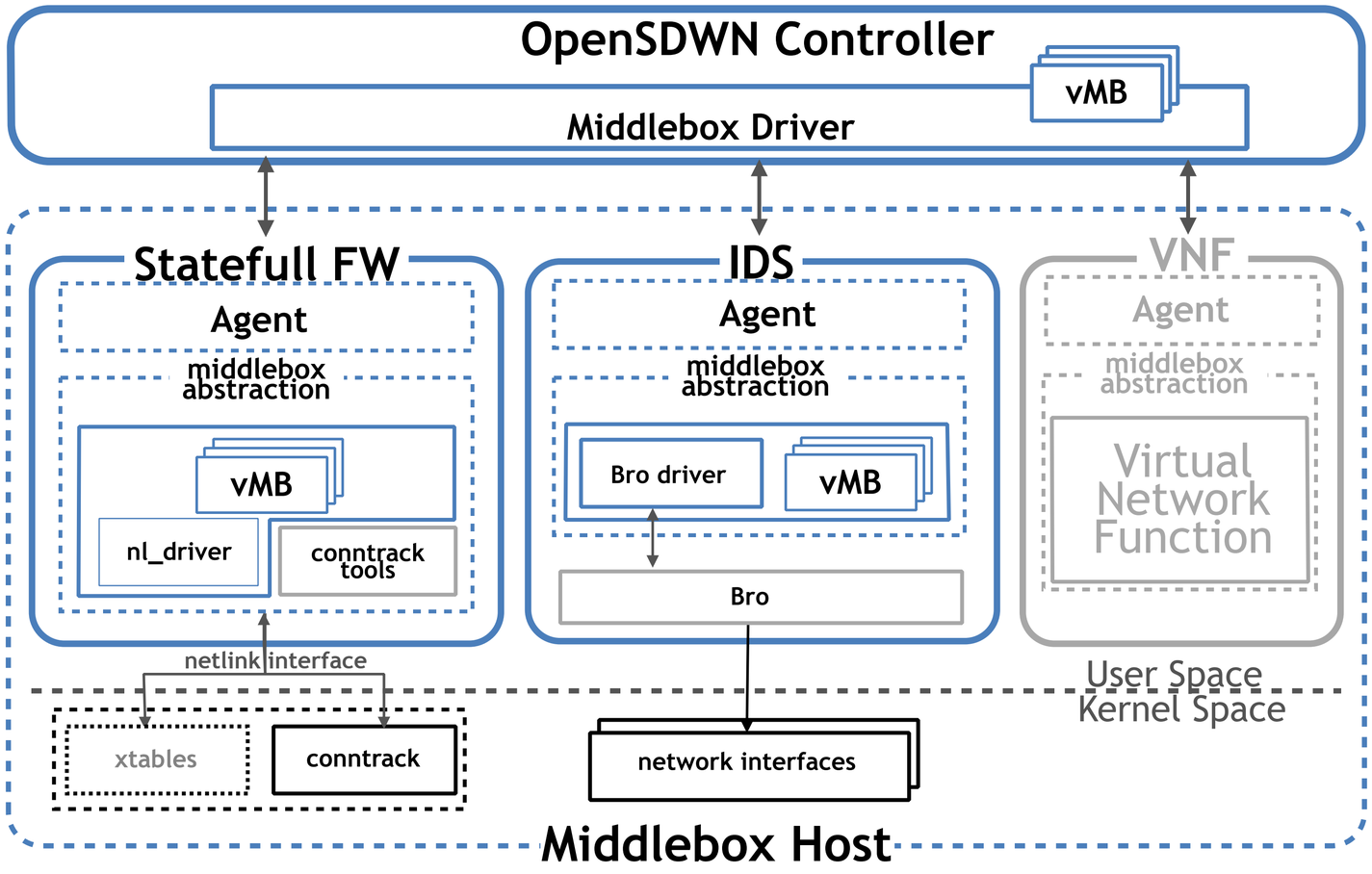
SDWN Interface



virtual Middlebox

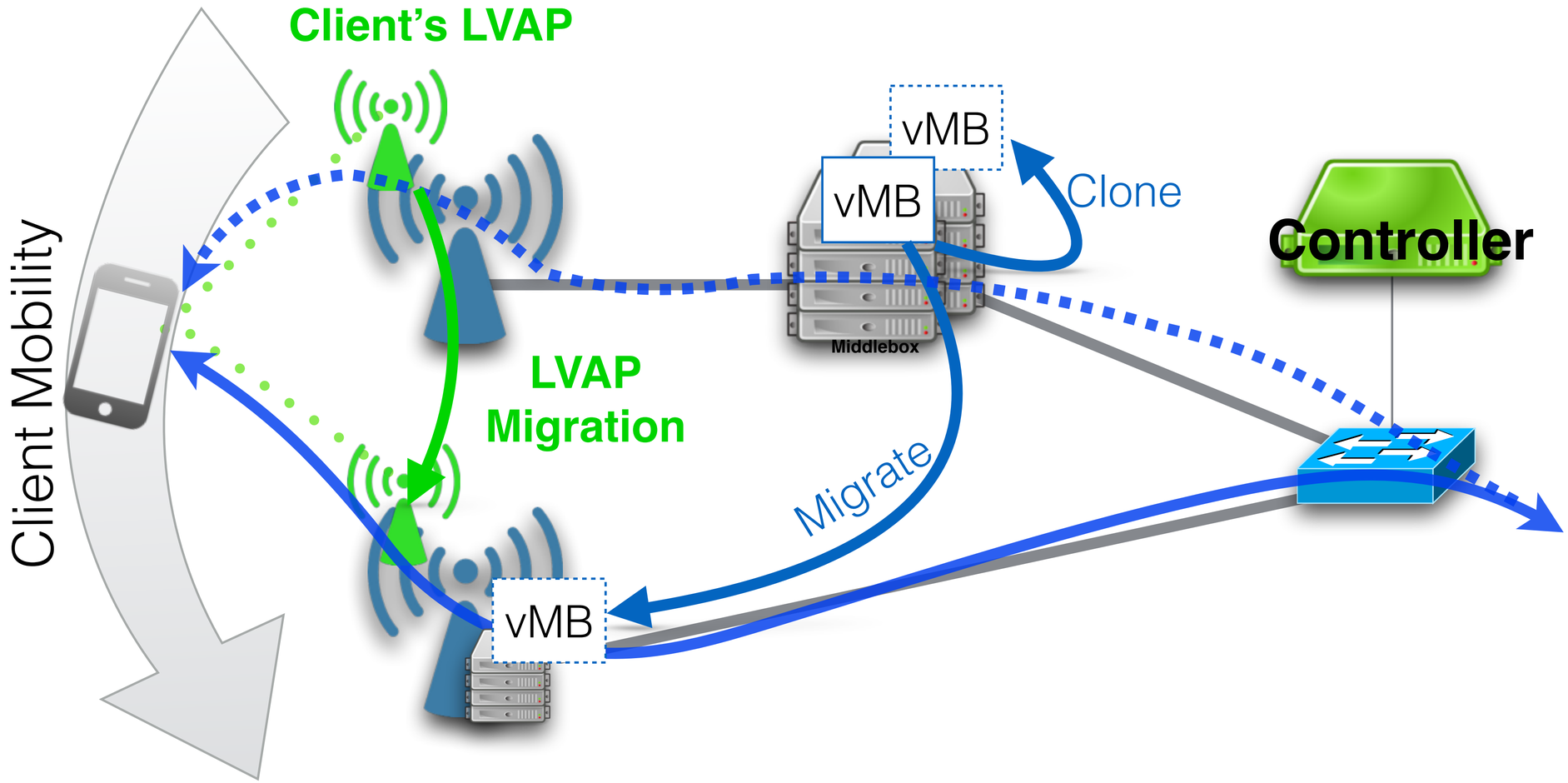
- Abstraction from the inner workings of a specific middlebox
- Per-client state abstraction
- Simplifies device/user handling, e.g.,
  - Mobility can be handled easier
  - Per-device/class rules (e.g. for BYOD)

vMB Interface

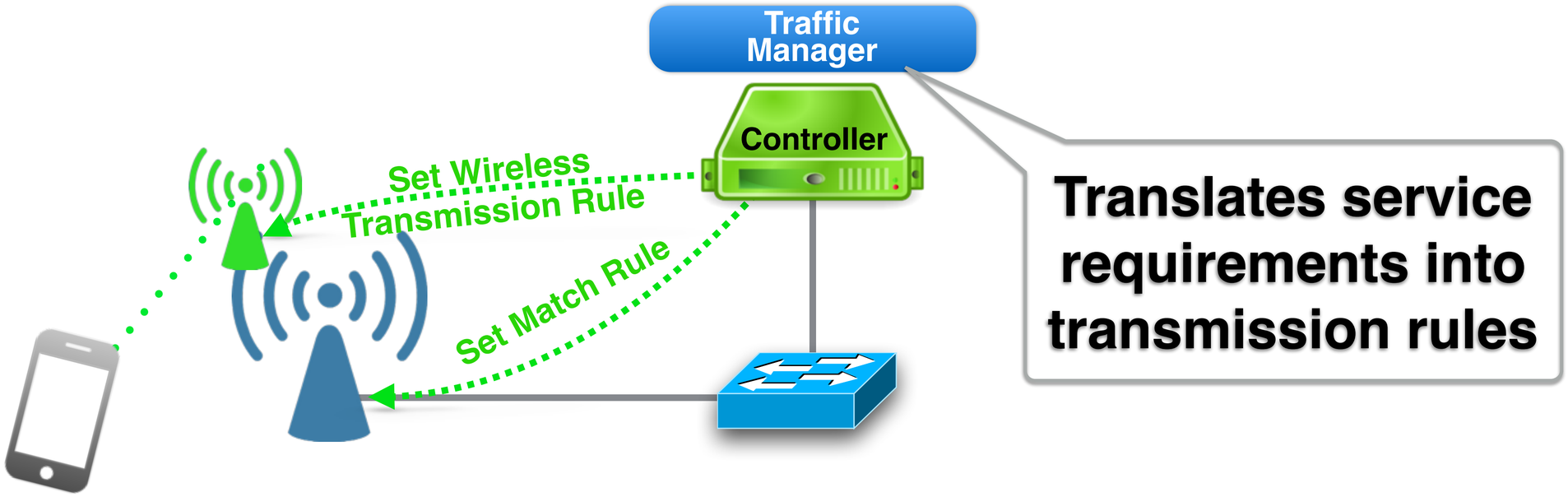


Thee basic operations supported by OpenSDWN

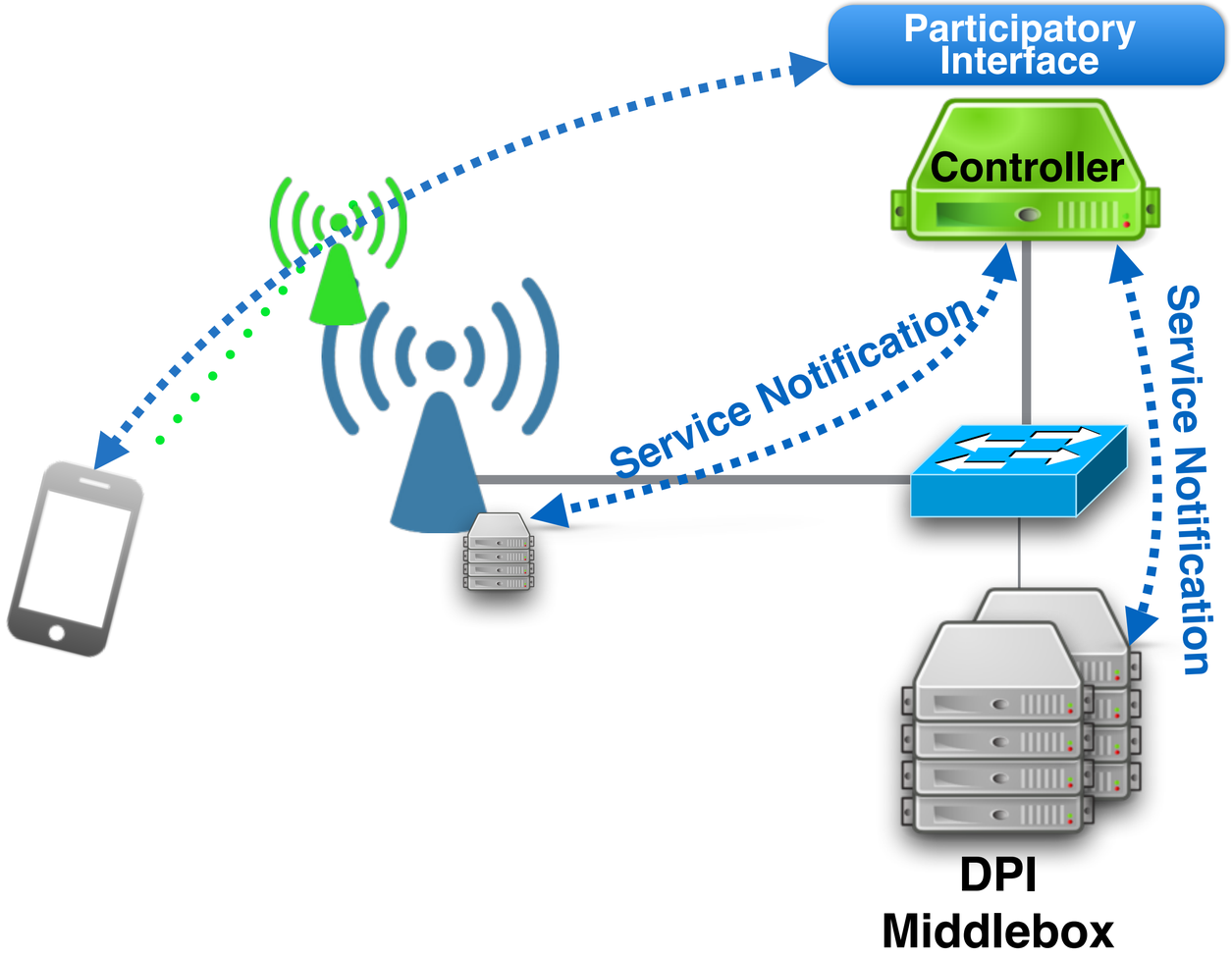
Operation: Mobility and Migration



Operation: Transmission Control



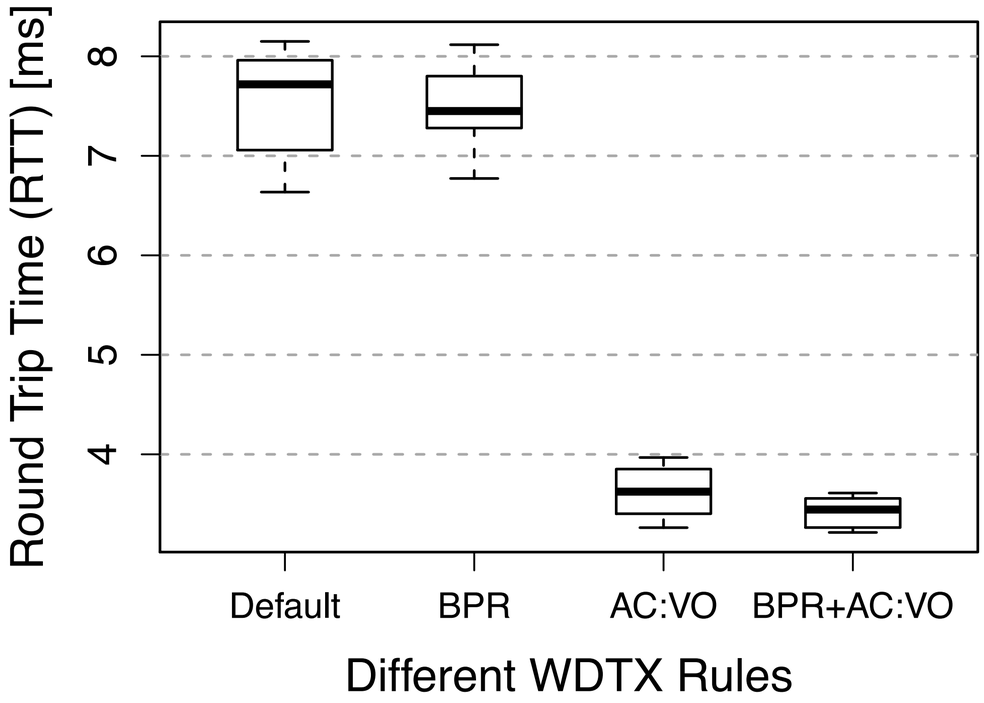
Operation: Service Differentiation



Evaluation

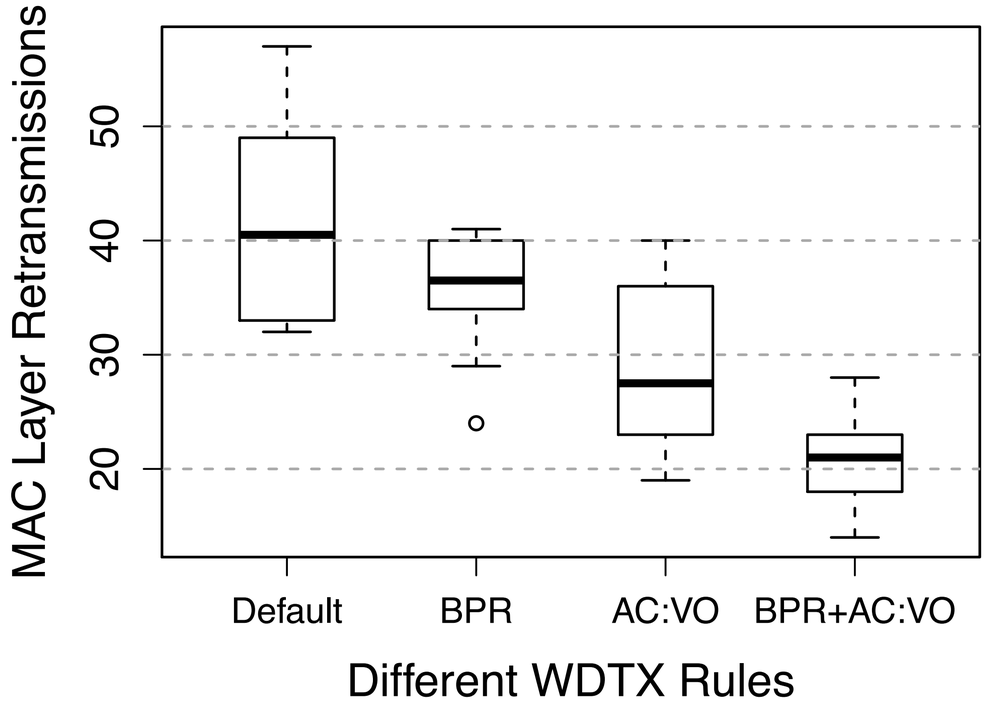
RTT optimization through WDTX

- 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

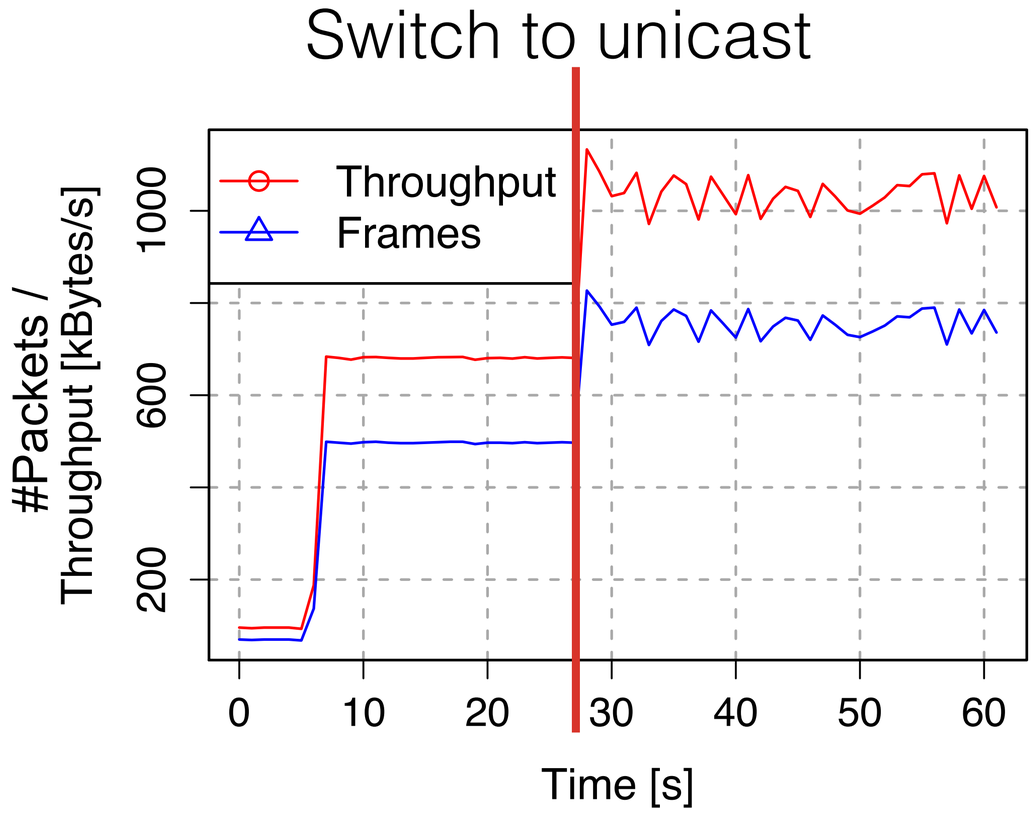


Group transmissions

- 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

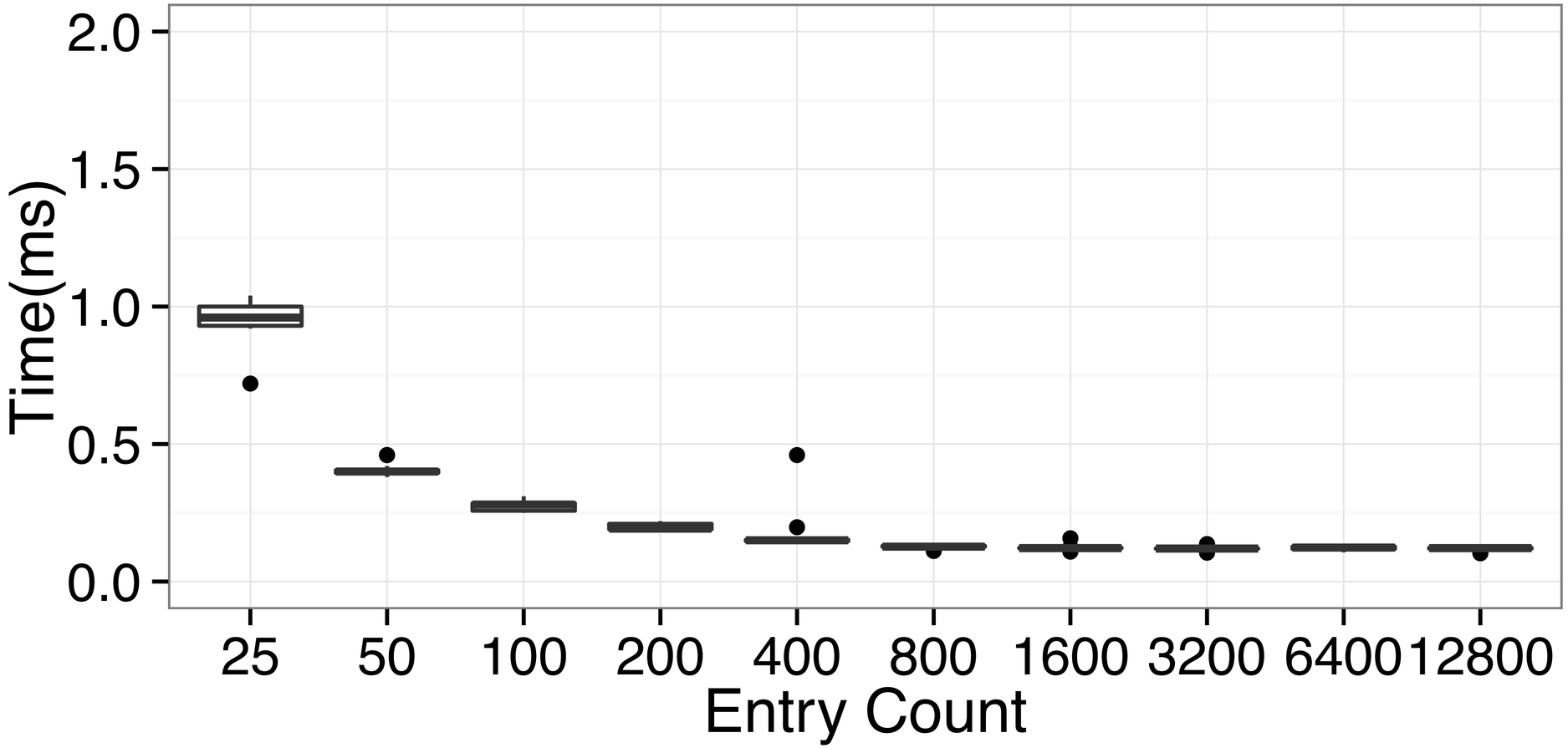
- IPTV service from a major European ISP
- Stream easily exceeds the available capacity in a IEEE 802.11g network
- Switching to unicast mitigates this issue



vMB Firewall Migration

Entry count	Mean execution time (ms)			
	Write	Read	Delete	Migrate
1	11.6	38.4	6.4	45.0
10	12.3	48.6	6.8	60.9
100	20.3	121.6	10.7	141.9
1000	115.9	778.0	43.0	893.9
10000	1119.3	5201.2	385.3	6320.5

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