Configuring DHCP Leases in the Smartphone Era

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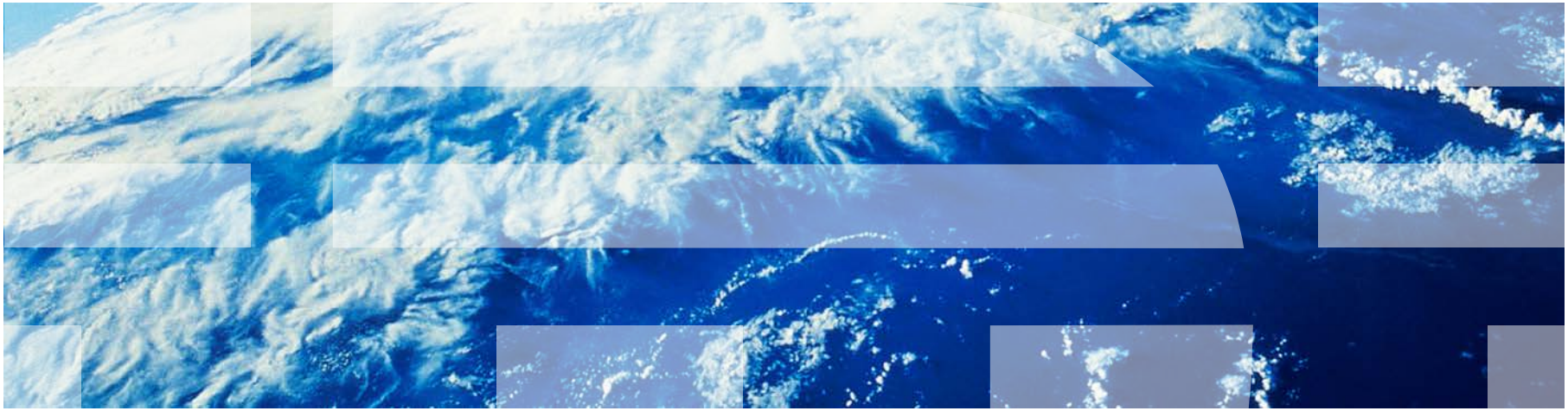


Motivation

Huge growth in the number of smartphones and tablets

- These devices connect to the network using DHCP
- However, DHCP requires manual configuration of access policies

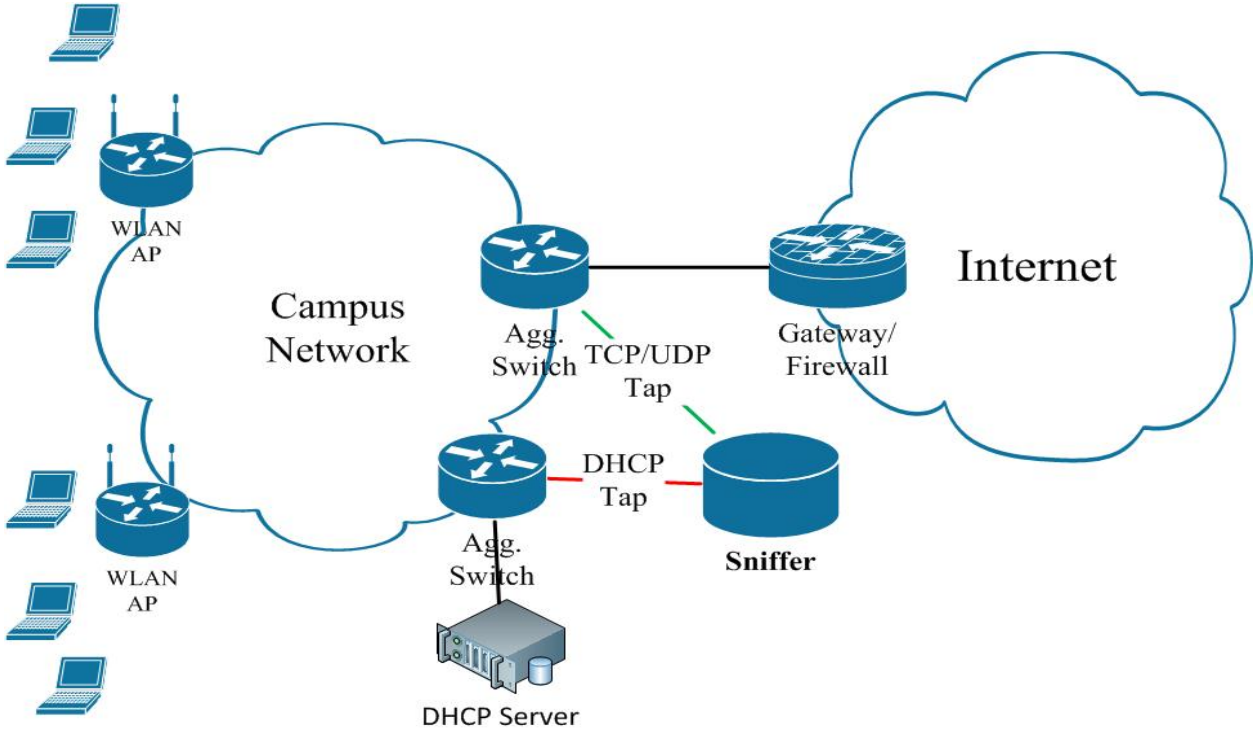
What is the proper value for the lease time?

- Too long: leads to exhaustion of the IP address space pool
- Too short: leads to
  1) increase in broadcast traffic, which wakes up wireless interfaces;
  2) Lower response time, since the user waits for the 4-way DHCP handshake;
  3) Increase in DHCP server load.

Setting the proper lease time has been an art, rather than a science

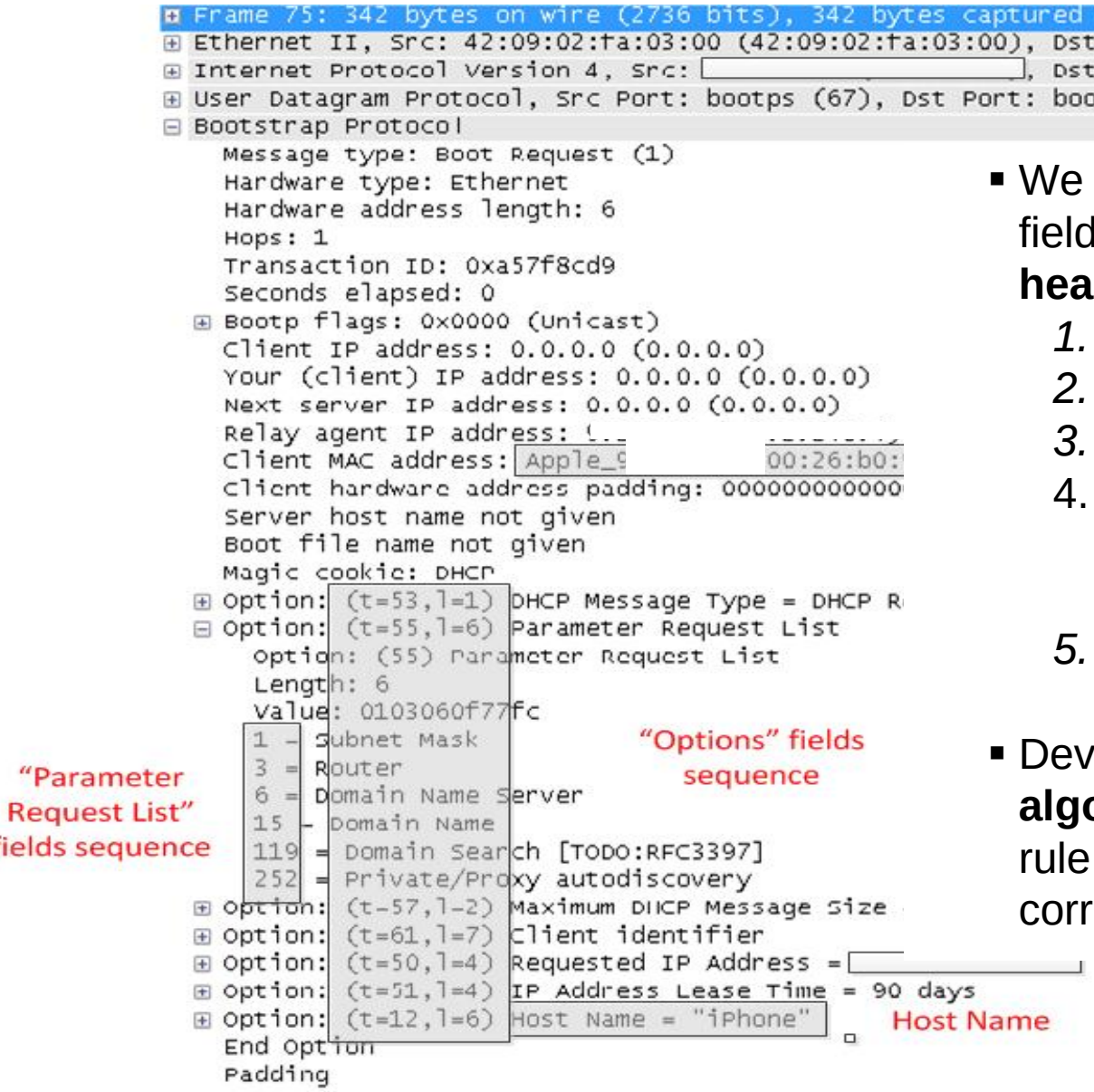
- Do handheld devices behave differently?
- Can we exploit that for DHCP lease allocation?

Dataset Properties



Trace Type	Corporate	Educational
Dates (2012)	Feb 29 – Mar 25	Jan 15 – Feb 15
Client MAC address	2980	8726
Wireless Subnets	8 * /23 = /20	/21
DHCP Leases	12h	15 min
TCP/UDP Bytes	2.5TB	4.9TB
Software Used	Bro IDS 2.0	

Device Identification



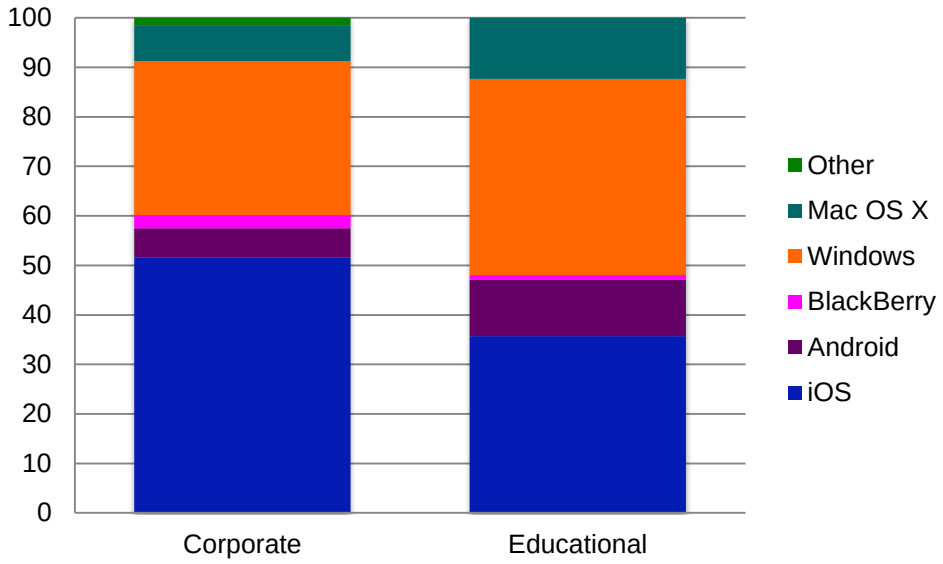
- We found correlation between the fields of the **DHCP Request header** and the **device**
  1. *Host-Name*
  2. *Vendor-Name*
  3. *Parameter-Request-List*
  4. Organization Unique Identifier (OUI – First 3 bytes of MAC address)
  5. *Options* parameter sequence

- Developed a **data mining algorithm** based on association rule mining that quantifies the correlation.

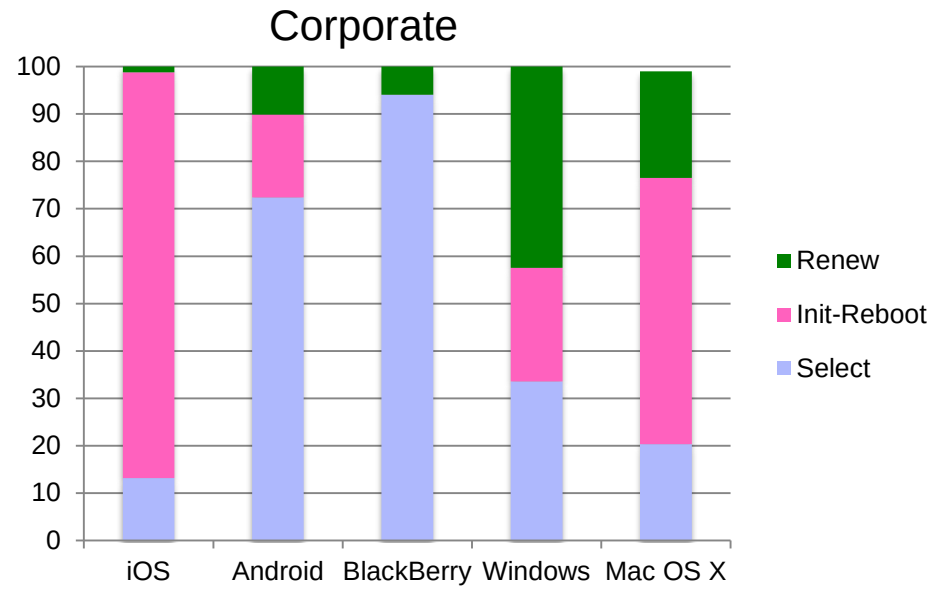
Classification Outcome

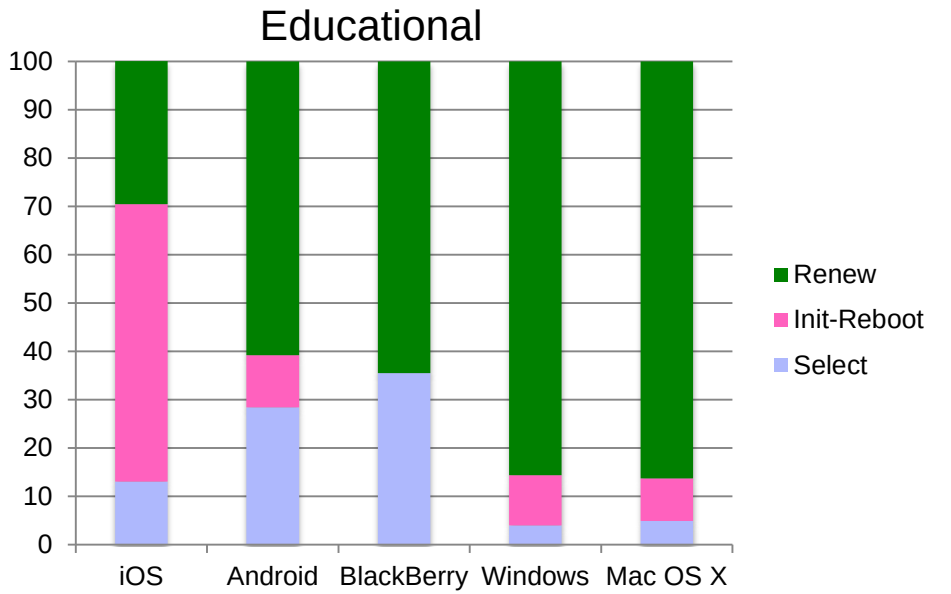
		Corporate		Educational	
Device	OS	#	%		
Laptop	All	**2176**	**73.02**	**3970**	**45.50**
	Windows	1787	59.92	2819	32.31
	Mac OS X	385	12.92	1131	12.96
	Linux	4	0.13	20	0.23
Smartphone	All	**735**	**23.66**	**4489**	**51.44**
	iPhone/iPad/iPod	577	19.36	3069	35.17
	Android	126	4.24	1336	15.29
	BlackBerry	31	1.04	84	0.96
	Windows Mobile	1	0.03	2	0.02
Other	All	**69**	**2.32**	**267**	**3.06**
	Cisco VoIP	9	0.32	-	-
	Unidentified	60	2.01	267	3.06
All		2980	100	8726	100

DHCP Traffic: Percentage of Requests

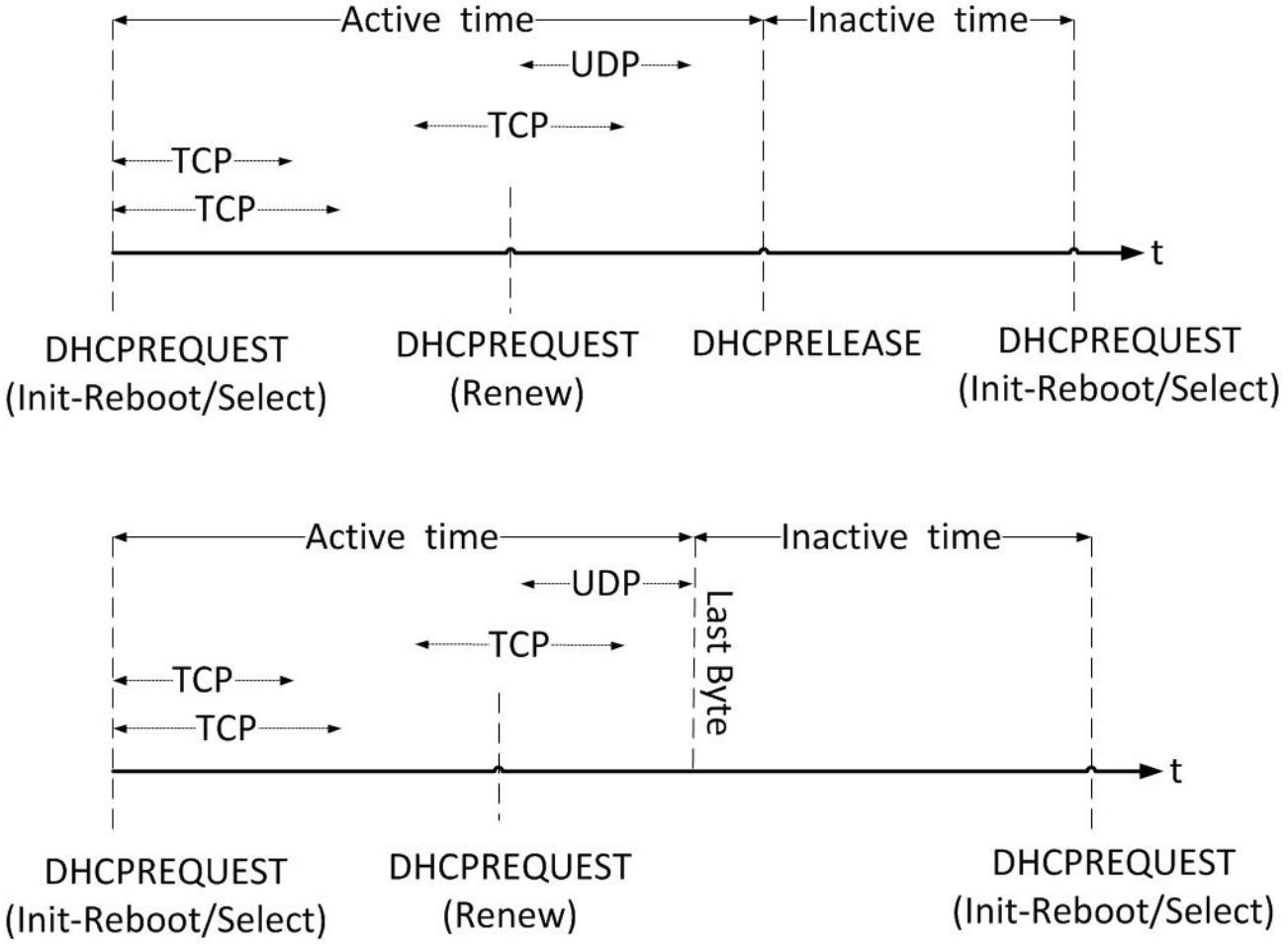


- Trace Lease Settings
  - Corporate: 12h
  - Educational: 15min
- Lease Time:
  - Long: exhausts address space.
  - Short: increases broadcast traffic.



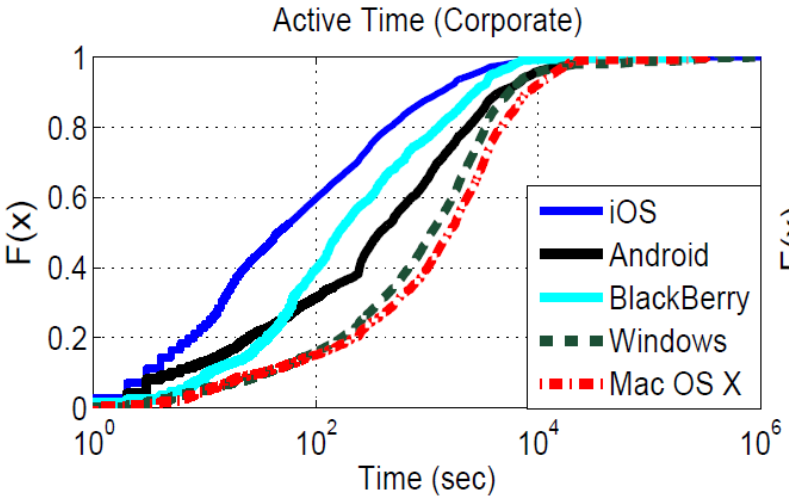


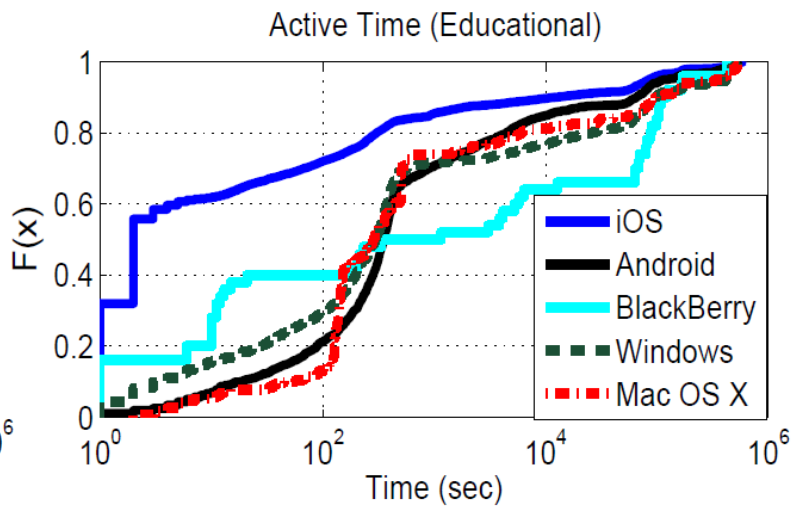
Calculating Active and Inactive times

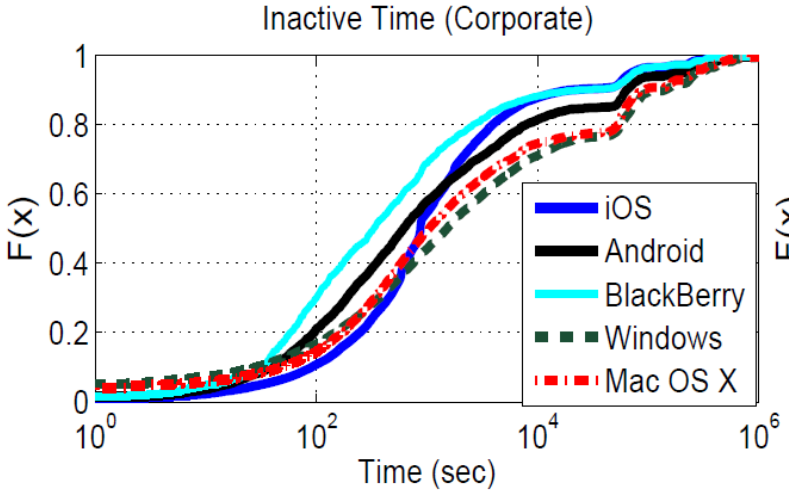


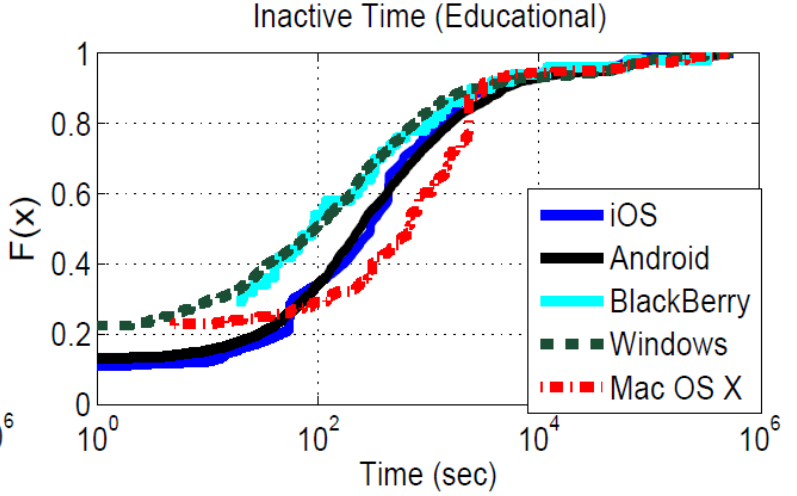
- Trivial to calculate if we see a DHCP release
- Otherwise, use the last packet seen for that MAC/IP lease combination

Active and Inactive Times









- **iOS** have short active times:
  - Device disconnects from WiFi after 30sec in idle
  - Use DNAv4 to speedup re-association (RFC 4436)
- **Android** and **BlackBerry** have medium active times:
  - Most do not disconnect from WiFi when in idle (set CPU in lower state)
- Laptops (**Windows** and **Mac OS X**) have long active times.

Simulation: Differentiated Lease Policy

Wrote a trace-driven simulator to evaluate different lease policies:

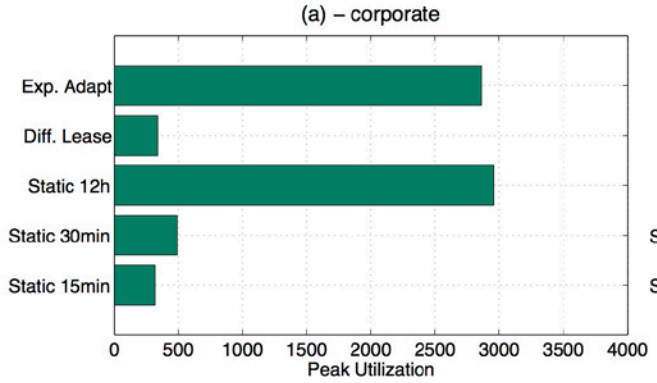
a) **Static Policies**: Fixed lease of 15 min, 30 min or 12 hours (most common case).

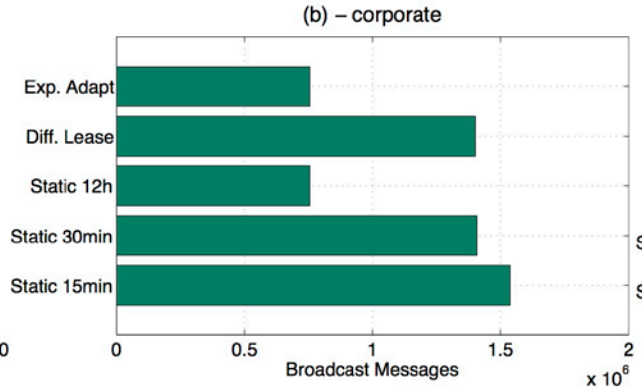
b) **Exponential Adaptation**: Allocates a short lease to client once it arrives, and doubles the lease time every time the client renews the lease [GaTech IMC 2007]

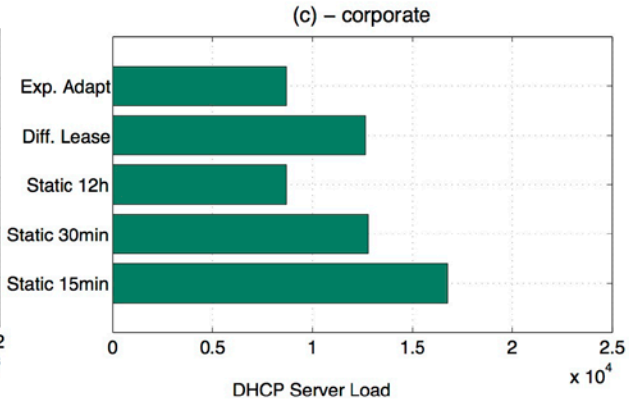
c) **Differential Lease:** Allocates different lease values based on device:

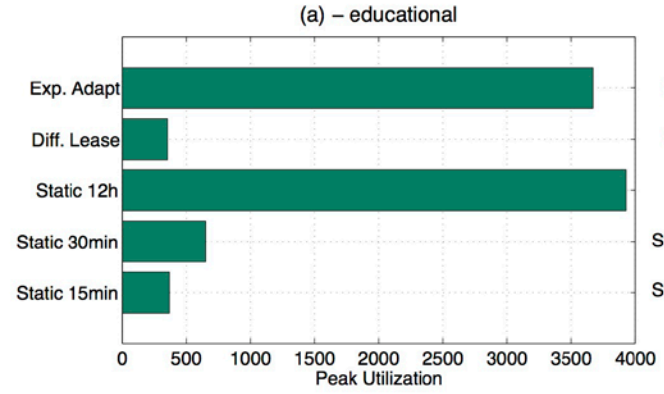
Trace	iOS	Android	RIM	Windows	MAC
Corporate	1000	2000	2000	4000	4000
Educational	500	1000	1000	2000	2000

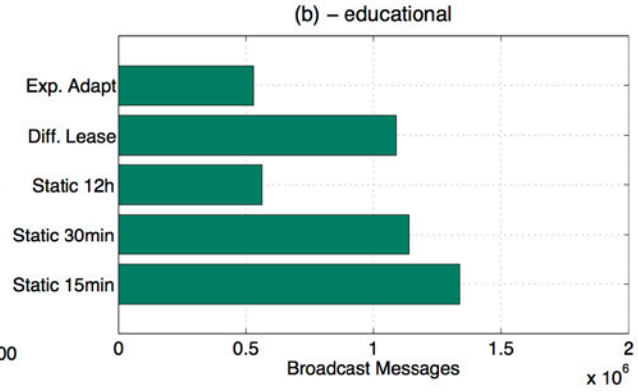
Simulation Results

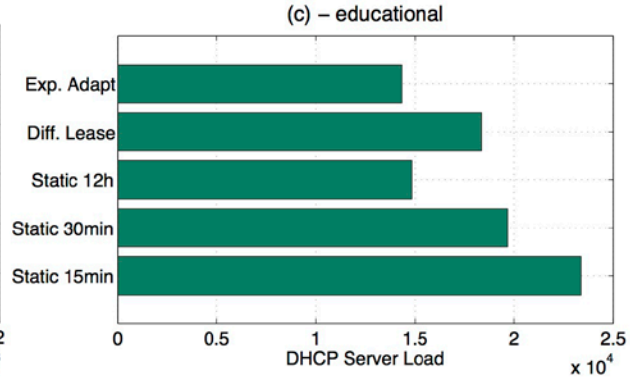












- Differential lease policy performs well:
  - Achieves low address space utilization (comparable to short lease time)
  - Reasonable number of broadcasts (compared to short lease times)
  - Reasonable server load

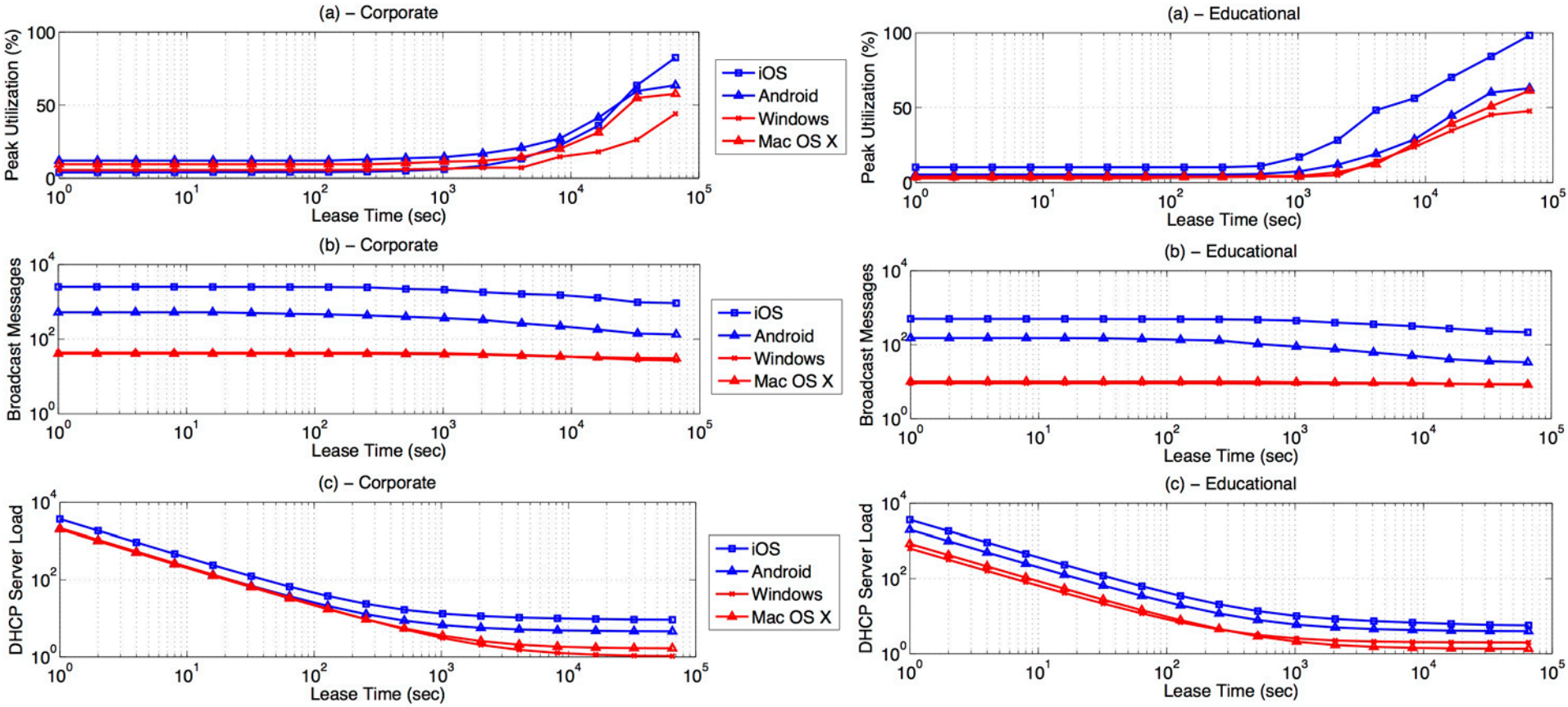
Conclusions & Future Work

- Differentiated Lease policy that assigns different leases to each device type.
  - Removes the burden to manually configure DHCP lease times as the mixture of devices change;
  - Requires no protocol changes;
  - Can be deployed as a software solution in DHCP servers;
  - It makes use of a novel device fingerprinting.

- Device fingerprinting can be leveraged for other uses:
  - Bring Your Own Device (BYOD) business policies;
  - Add layers for finer grain classification and identification of VMs.

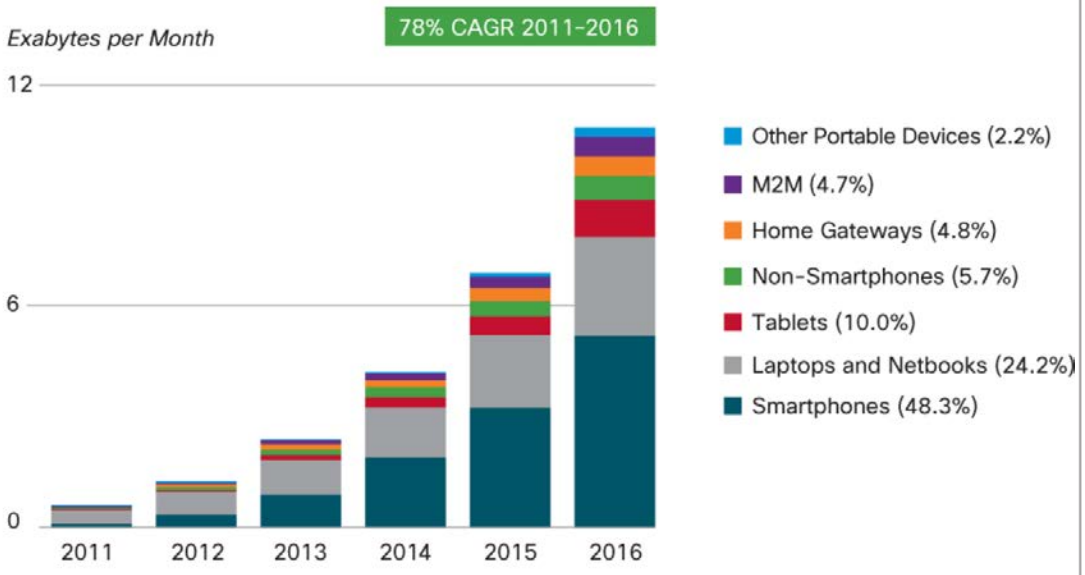
Thank you!

Selecting the proper Lease Value



- We plot the a) address space utilization, b) broadcast message, and c) server load, versus lease time, averaged per day and per device.
- Figure a) for both traces, shows that utilization stays flat, and increases after a specific point. This point is different per device, e.g. in the corporate network, 10^3 for iOS, $2*10^3$ for Android and $4*10^3$ for laptops.

Motivation: The Growth of Mobile Data



Figures in legend refer to traffic share in 2016.
Source: Cisco VNI Mobile, 2012

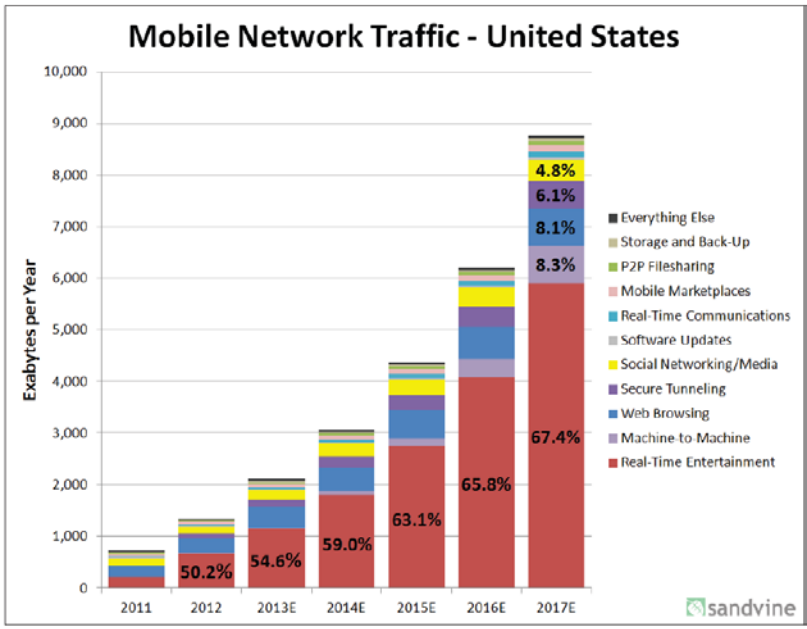


Figure 5 - Projection of Mobile Access Traffic in North America

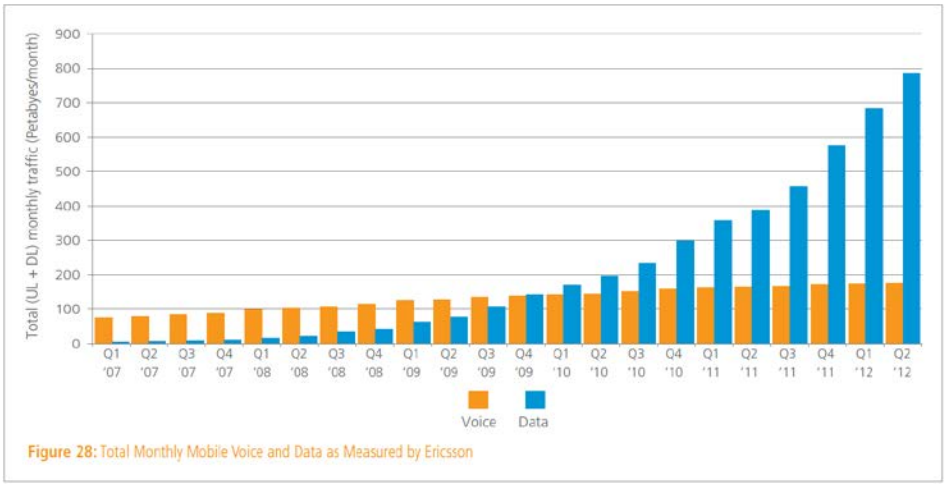


Figure 28: Total Monthly Mobile Voice and Data as Measured by Ericsson

Mobile Data Consumption is exploding

- **Cisco 2012 VNI report**
- **Sandvine 1H 2012 Report**
- **Akamai State of the Internet Report Q2 2012**