Resource dimensioning in a large-scale campus WiFi Network

Janet Barkdoll
Angela Reyes Cervantes
Danielle Rossetti Dos Santos
Shayne Rothman

Advisor: Vasanta Chaganti

Swarthmore College

Projected Growth in Mobile devices

Wireless network traffic dominated by mobile devices

Source: Cisco Mobile Visual Networking Index, 2016 - 2021

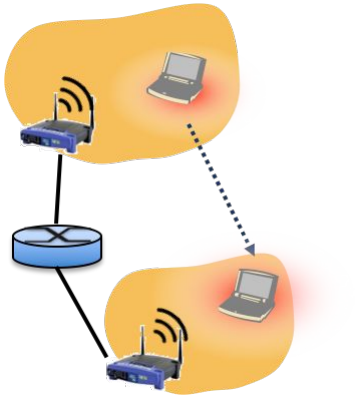
Research Problem

Measure the impact of user mobility on network resource management.

- How have network usage patterns changed with more mobile devices?
- When are network access points (APs) most overloaded?
- Can we improve AP load-balancing by learning distinct user mobility patterns?

User Mobility

When a user moves from one wireless access point to another that user changes points of attachment to the network.



Access Point

A device within reach of the wireless network communicates with Access Points to join and disconnect from the WiFi network.

Related work: Network usage patterns

Henderson, Tristan, David Kotz, and Ilya Abyzov. "The changing usage of a mature campus-wide wireless network." Computer Networks 14.52 (2008): 2690-2712.

- First large-scale WiFi campus measurement with published open-source traces.
- Measure: network log messages
- Show: Load per AP, types of devices, types of network traffic

Related work: Network usage patterns

Henderson, Tristan, David Kotz, and Ilya Abyzov. "The changing usage of a mature campus-wide wireless network." Computer Networks 14.52 (2008): 2690-2712.

- Network usage patterns follow class schedules
- Access Points have higher utilization (# users per AP)
- Wireless streaming of audio and video is up by nearly 200%!
- Growth of mobile phones showed that users traveled across multiple APs while connected to the WiFi Network.

Limitations of previous studies

- Previous literature (2004 - 2016) has not:
  - modeled user mobility to learn device specific usage patterns
  - Use user mobility models to predict future network usage

Focus of our work

1. Use the Dartmouth traces to show network utilization
2. Compare the Dartmouth traces (2008) to recent traces at UMass, Amherst (2014).
3. Build user mobility models that inform resource allocation.

Expected changes in network usage:

1. “rapidly diversifying devices including Personal Digital Assistants, or PDAs, audio layers, and printers”

Today: mobile devices will account for significant portion of network usage patterns.

Expected changes in network usage:

2. “50% of those users spend more than 98.7% of their time at a home location ”

Today: Devices will connect to a lot of different access points.

Expected changes in network usage:

3. “The average percentage of active APs has risen from 66.4% to 67.4%

Today: We can improve accuracy of AP load distribution based on classifying users’ visit patterns.

Dartmouth Dataset

- ARUBA WiFi Data: 2001 - 2005
- Compared data between 2001 and 2005 data

Data Analysis

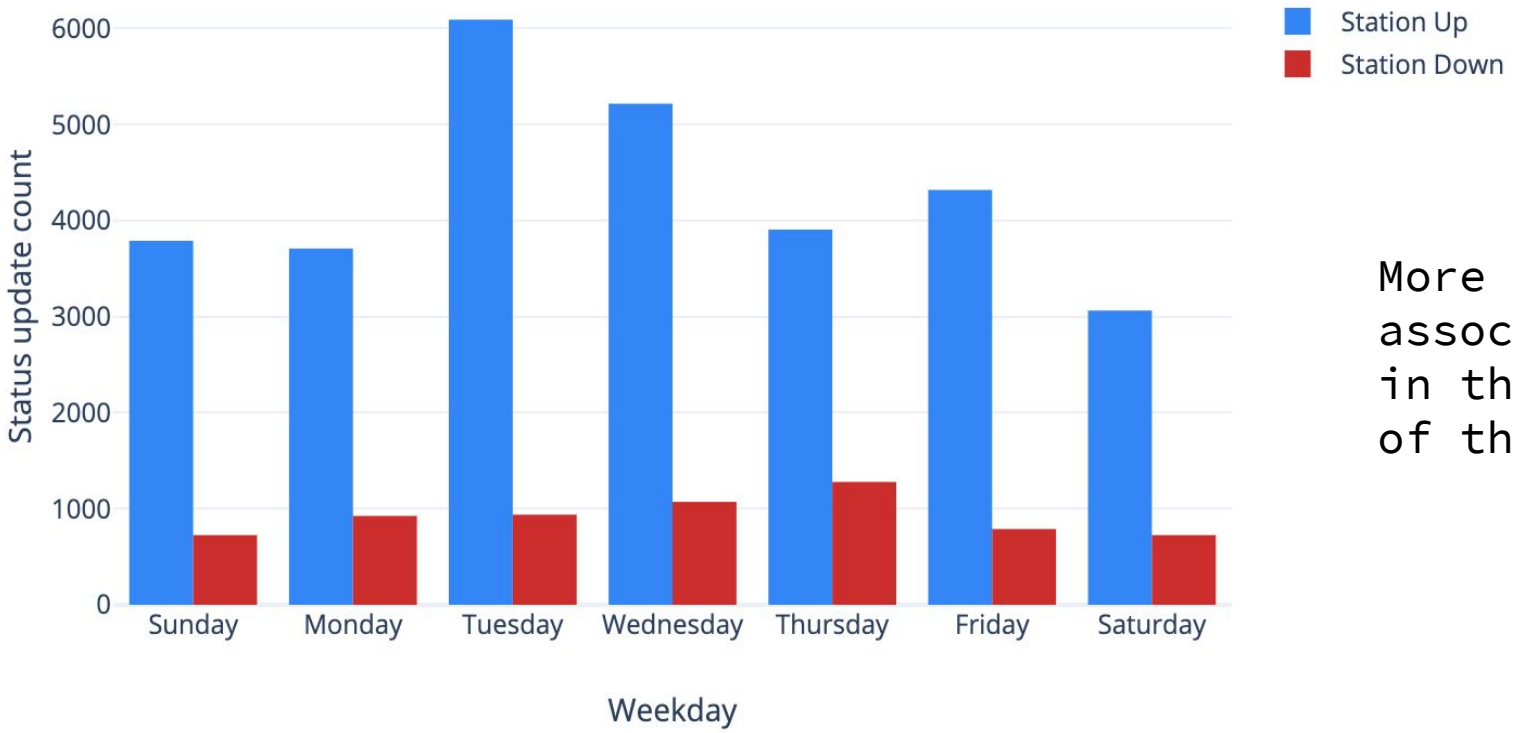
- Create a database of the data using SQLite and Pandas
- Plots using Plotly and Matplotlib.
- Plots displayed in Jupyter Notebooks

Limitations reproducing results

- Inconsistent data fields
- No unique user identifiers
- Building names anonymized: can’t find associations to nearby buildings.
- Network logs unclear: “station up”, “station down”
- Data associated with plots hard to identify

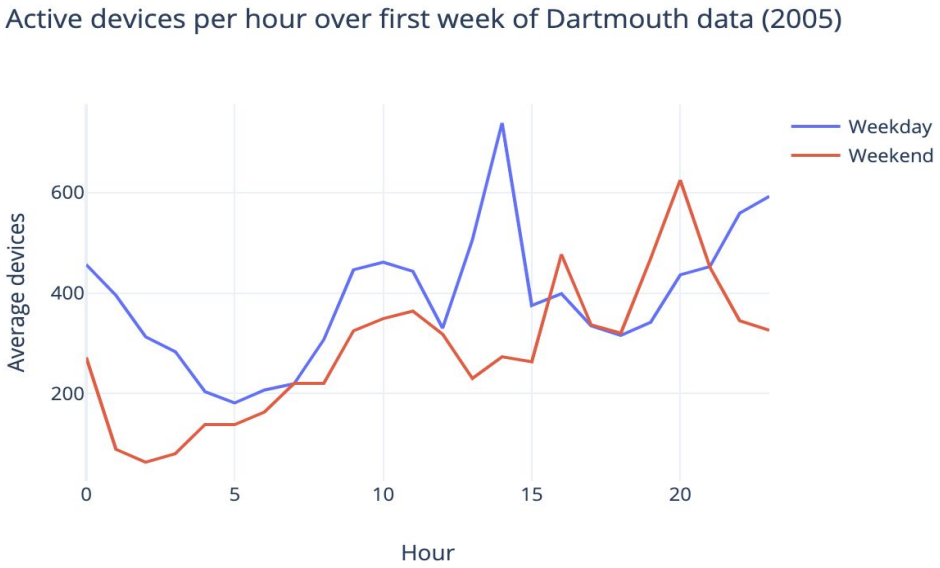
Results: Status updates across one week of data

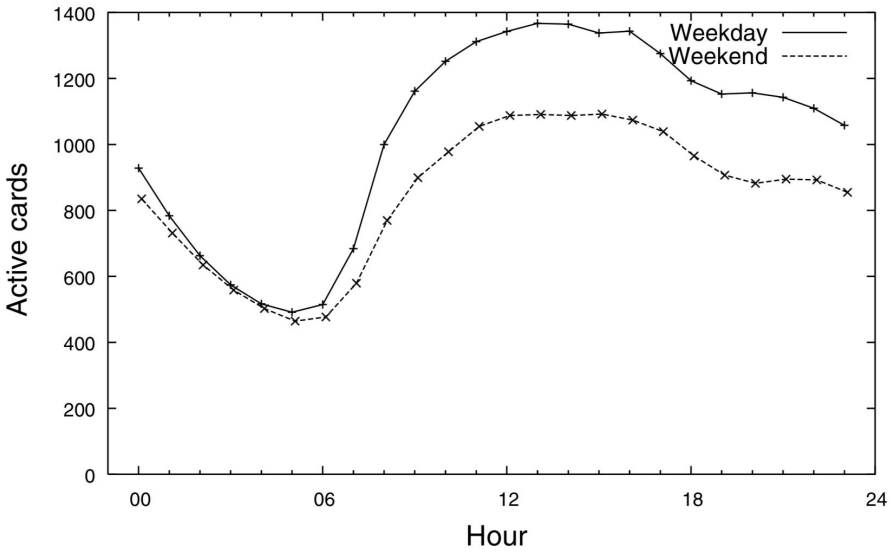
Connections across all APs per weekday over first week of Dartmouth data (2005)



More associations in the middle of the week

Results: Active devices per hour: Comparison with Dartmouth data

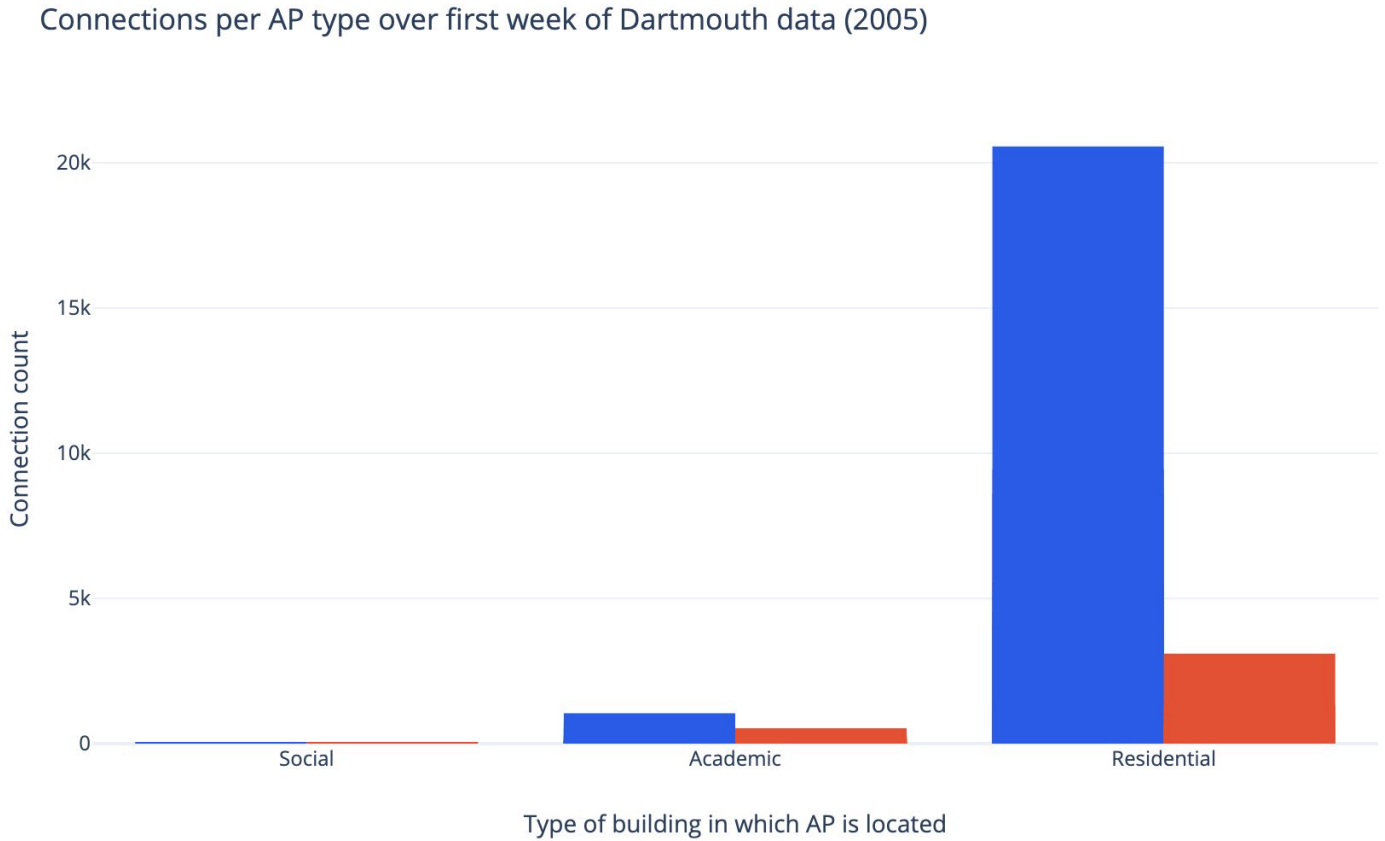




Active devices drop between midnight and 9AM

Similar trend observed:
Dartmouth results averaged over several weeks.

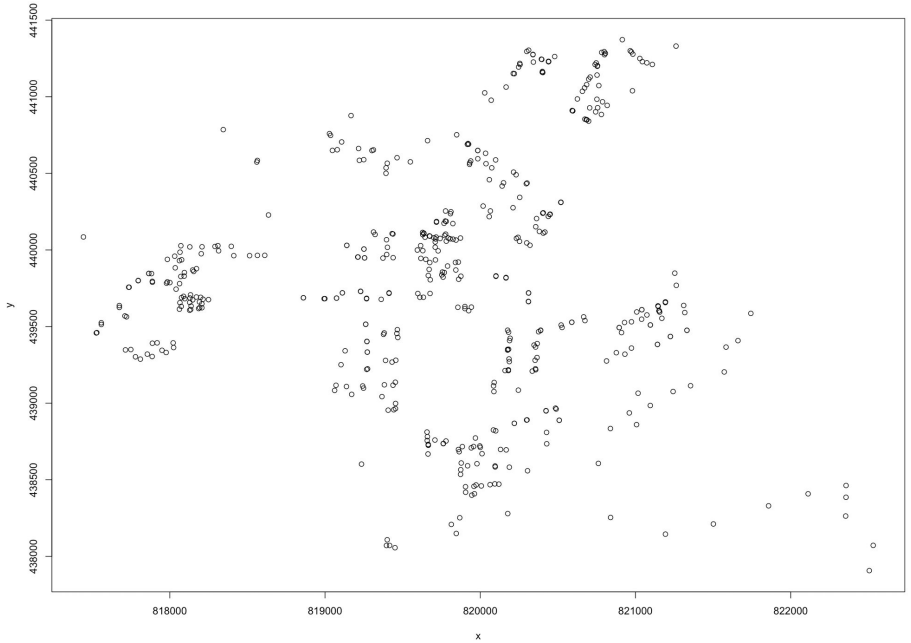
Results: Connections per AP (Access Point)

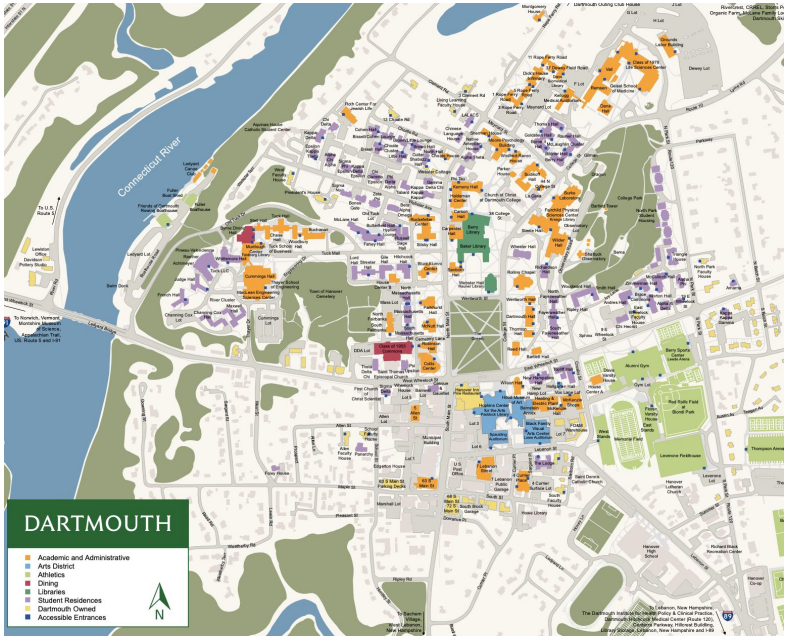


Residential buildings show the highest activity
Similar results reported in Dartmouth traces.

Very few mobile devices

Results: Map of AP locations





AP locations not anonymized!

Future Work: UMass Amherst Dataset

- Draw comparisons of network utilization with more recent WiFi measurement data.
- Build naturally occurring classes of user mobility trajectories.
- Predict Access Point load distribution.

Thank You!

mobility@cs.swarthmore.edu