Towards an

WLAN Infrastructure

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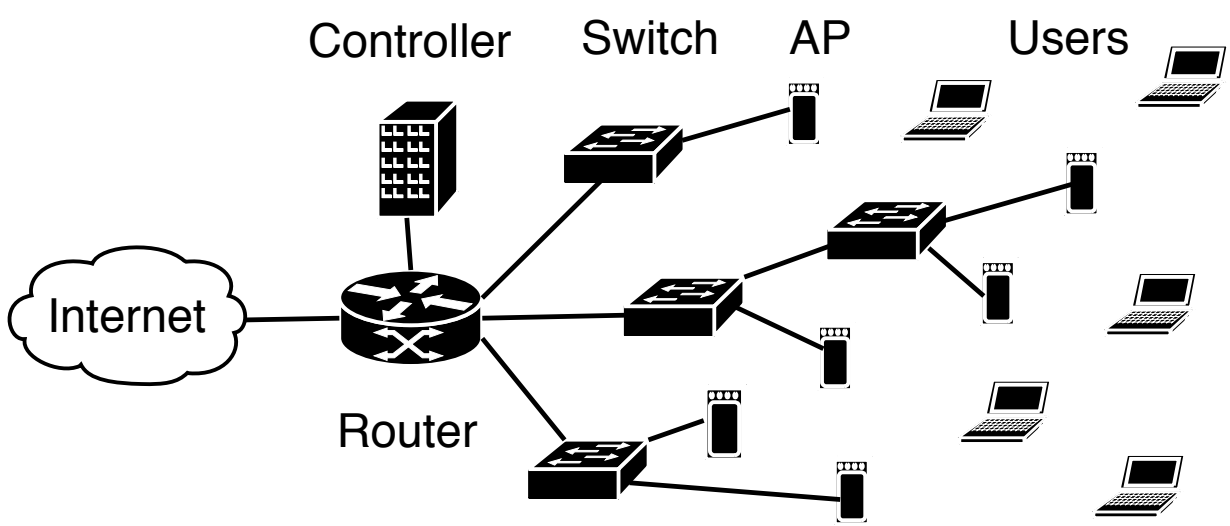
Wireless Network Proliferation

- Wireless networks are everywhere
  - Wireless LANs, Metro-scale mesh, WiMax, ...
- High-density of hundreds to thousands of access points (APs)
  - E.g., Dartmouth has 1300, Microsoft has 5000 APs
- WLANs provide ..
  - Overlapping coverage, mobility, high capacity, and reliability

Centralized Management

- Several startups: Aruba, Airespace, Meru, Symbol, Trapeze
  - Facilitate large-scale wireless network deployments
- Central controller manages APs, switches, and other controllers
  - APs and controller communicate via GRE tunnels
  - Central global network view allows easier management



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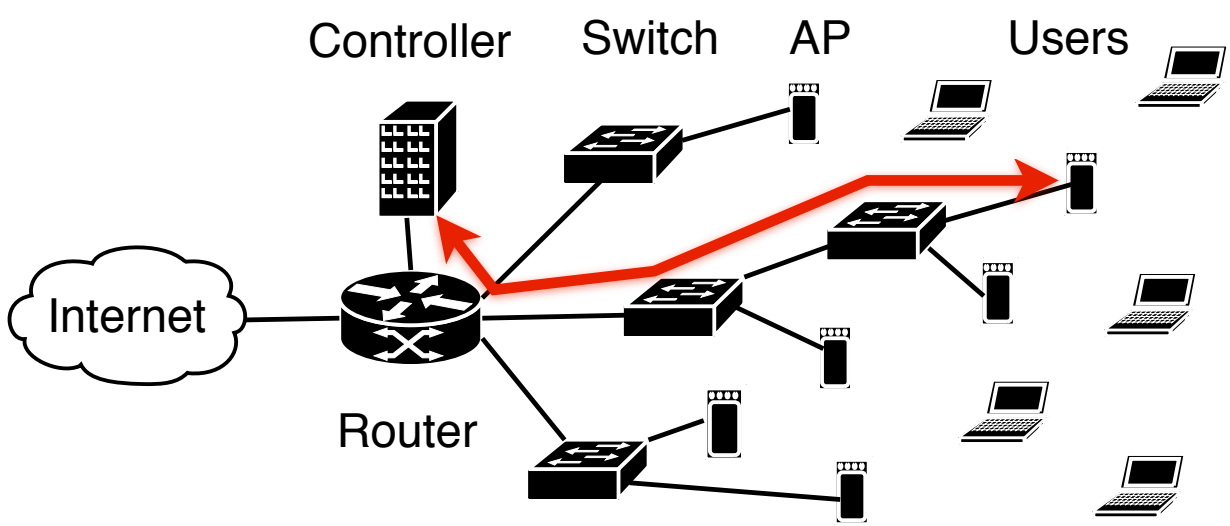
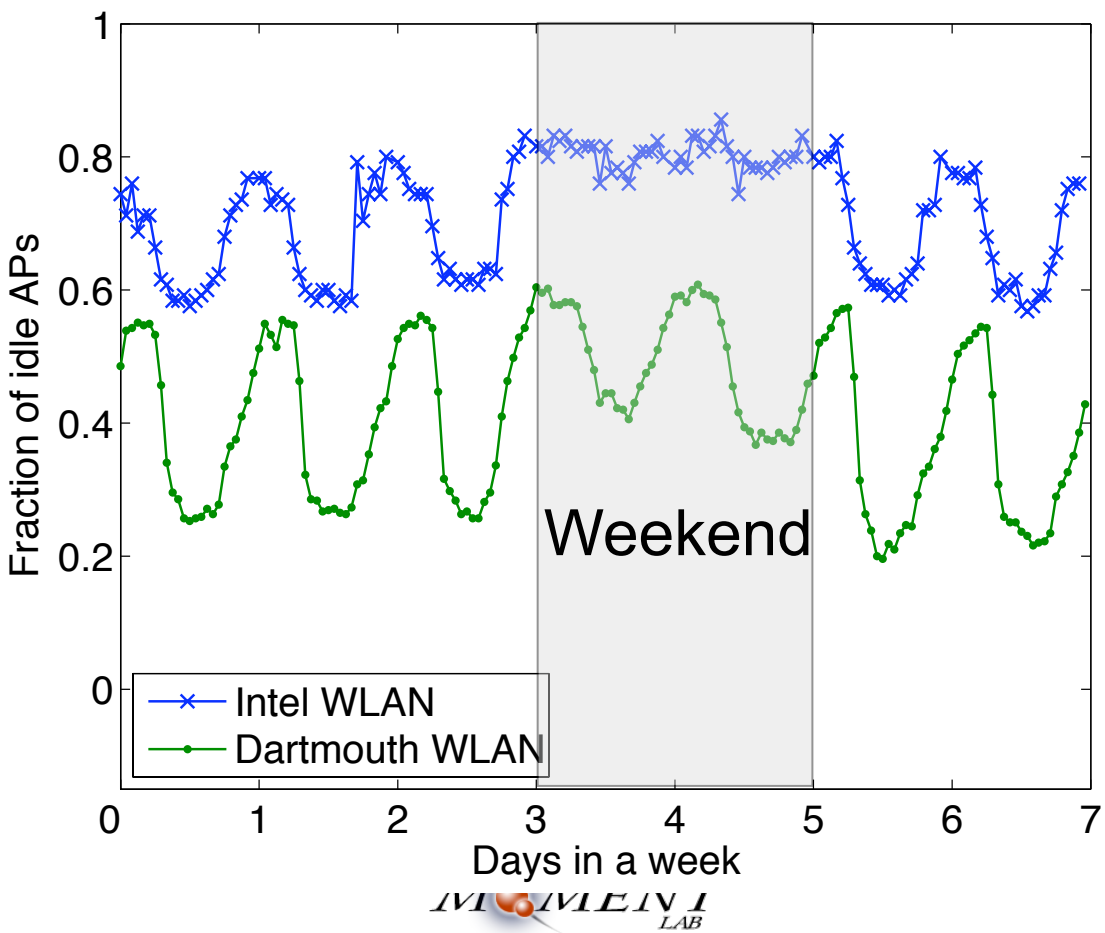


High-density WLANs

- Dartmouth WLAN: 500 APs on a 4km x 5km campus
- Intel WLAN: 125 APs in a 4-floor 250ft x 90ft building
- Advantages:
  - Provide users with capacity and mobility
  - Prepared to handle peak user demand

Trade-off: Peak demands are rare!

- ... and sometimes isolated to some areas of the WLAN
- Majority of the APs remain “idle” = 0 users associated
- Idle APs equate to energy losses!!



Energy problem

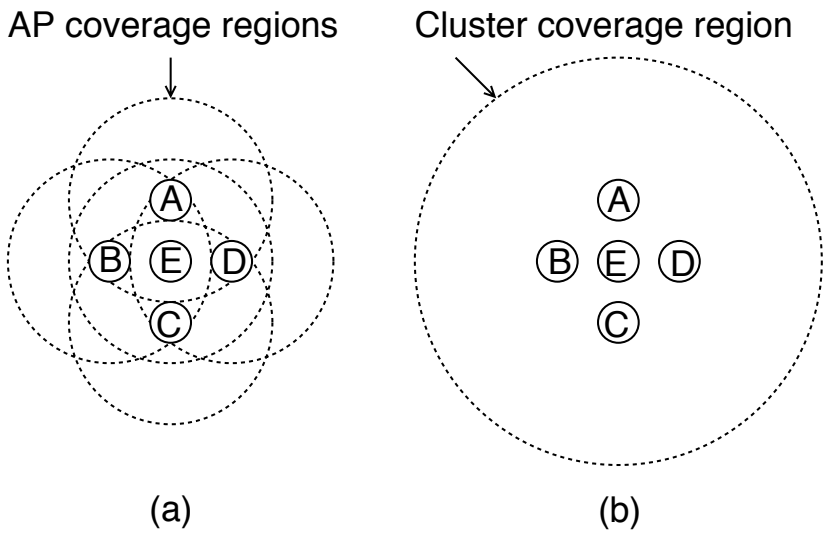
- Consumers of energy in a WLAN are:
  - APs consume 10 W each hour via PoE ports on switches
  - Switches consume 350 W each hour
  - A set of 100 idle APs in a month cost $108 in electricity costs
  - Idle resources equate to energy wastage
- Does it matter?
  - Energy loss is far from negligible for a single WLAN
  - But very significant if one considers WLANs globally
  - Loss will increase with increasing size and number of WLANs
  - Energy wastage is a new and quickly rising concern!

Energy-star WLANs

- Objective
  - Save energy by powering on and off WLAN resources
- Basic idea
  - Energy consumption should “scale” with load
  - APs and switches should be powered “on demand”
  - Only necessary, but sufficient resources should be powered
- Constraints
  - WLAN coverage should not shrink
  - User performance should not suffer

Green-clustering APs

- Simple strategy for high-density energy-star WLANs
- Dynamically scales the number of APs based on load
- 3 Stages:



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2. Keep a single AP powered on to maintain coverage, and others are powered off to begin with
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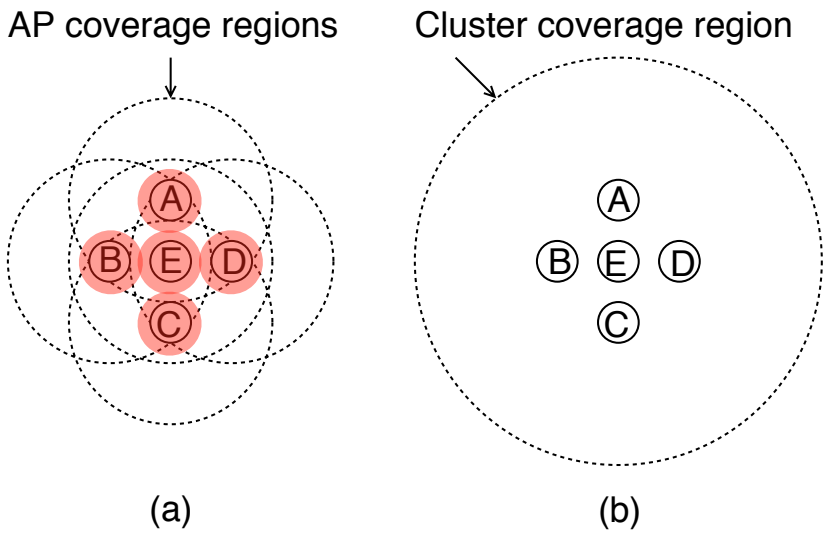

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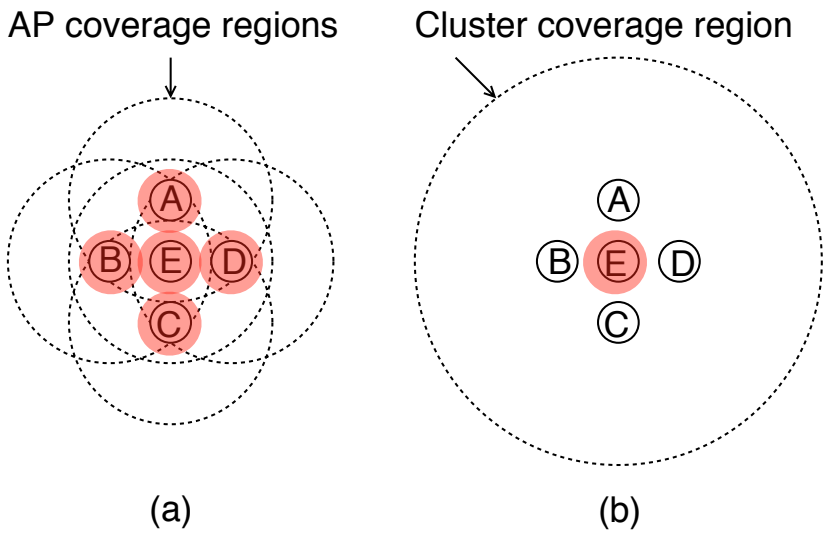

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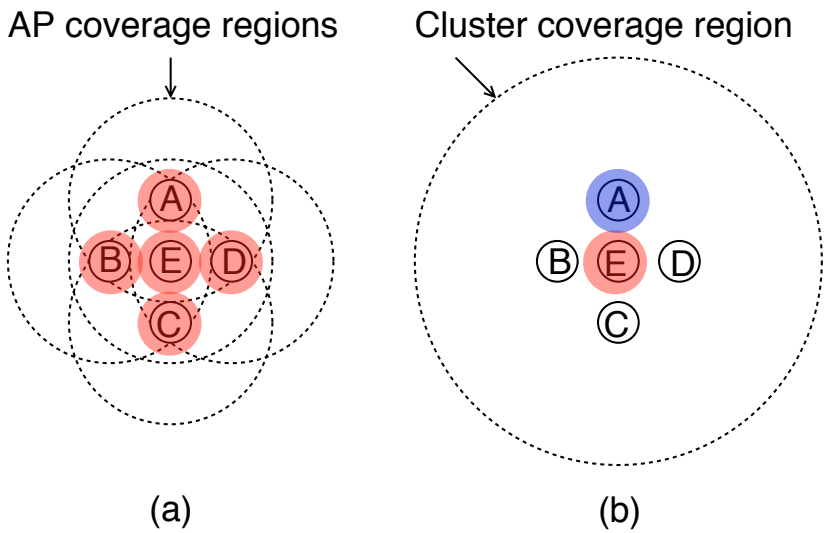

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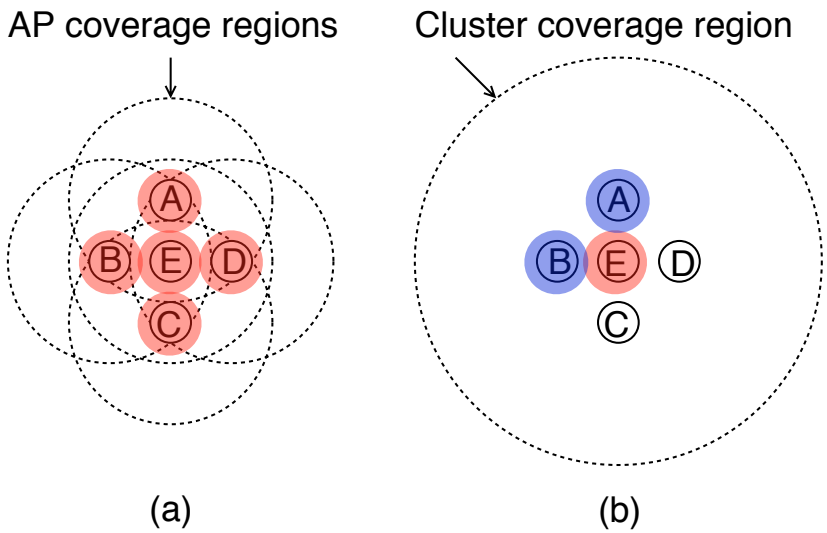

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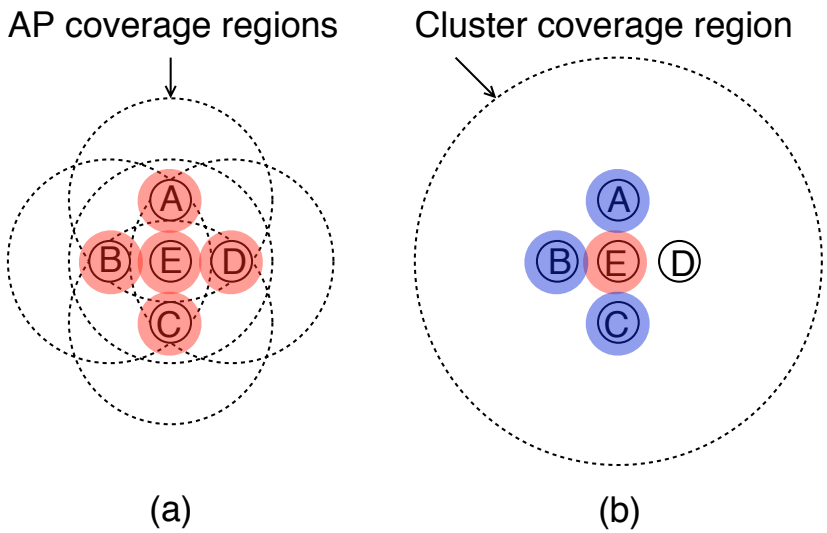

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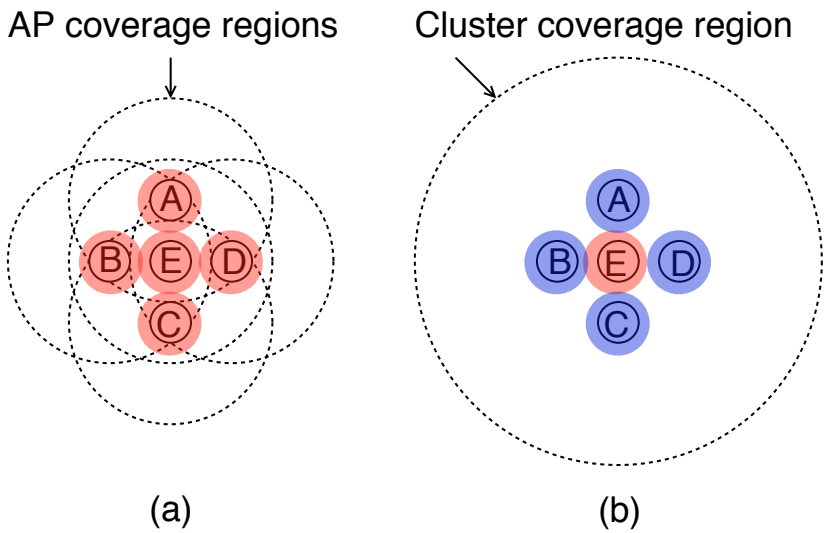

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Energy-savings using Green Clustering

- Custom simulator forms clusters of APs that are 30 meters apart
- 340 clusters in Dartmouth WLAN, and 9 clusters in Intel WLAN
- Ran WLAN traces within the custom simulator
- Extra APs in each cluster are powered for every 4 users

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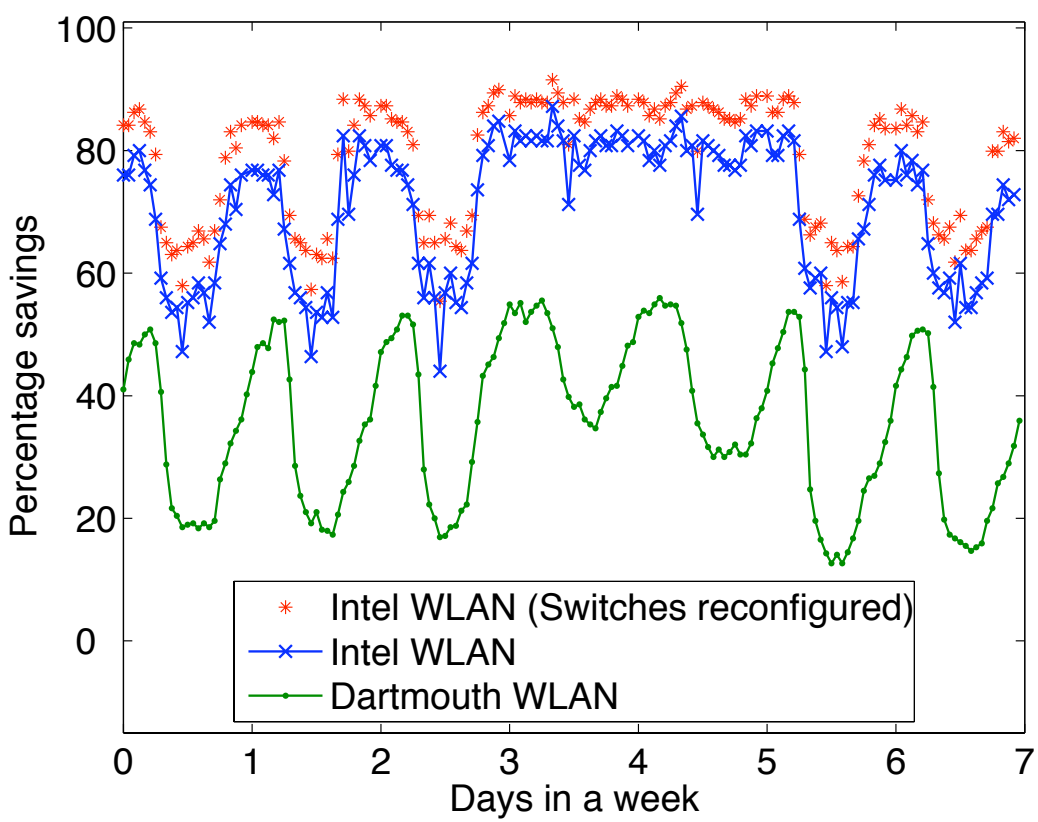

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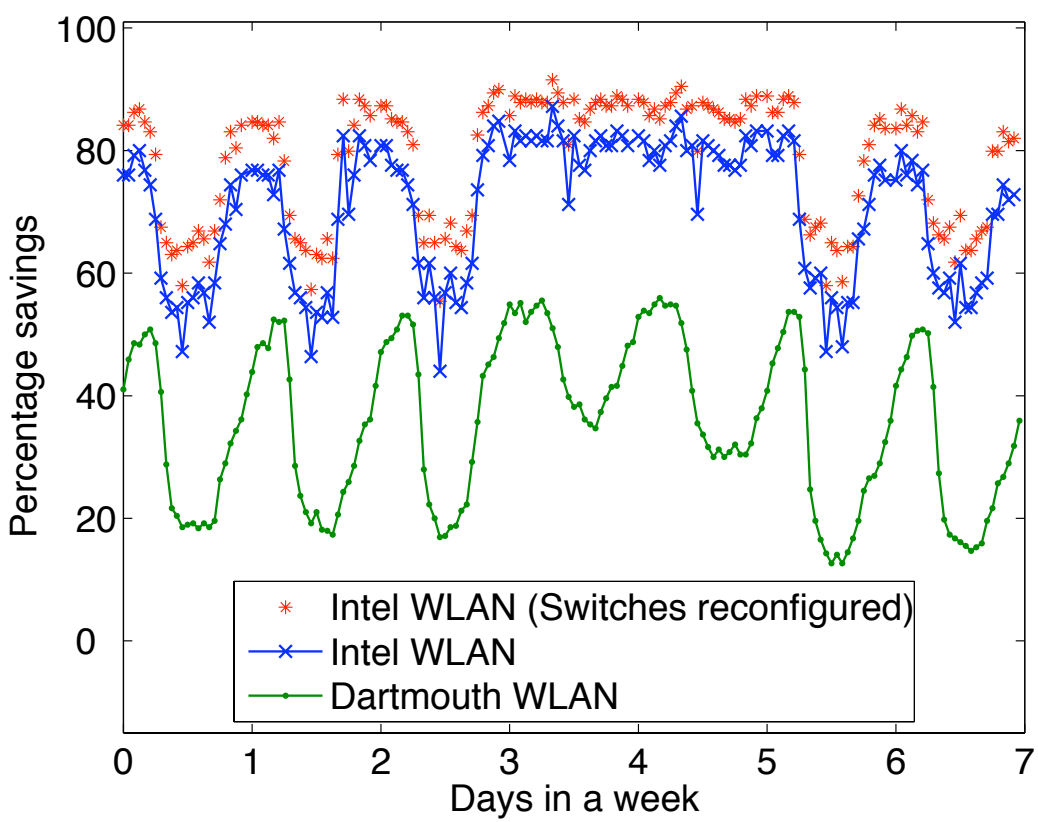
- Additional energy savings are achieved if switches are reconfigured in the Intel WLAN so that minimal switches are utilized



Short-term Improvements

- Accurate cluster formation
  - To ensure complete coverage and minimal impact on end-user connectivity
  - Via site-survey and measurement information
- Smarter offered load and interference detection mechanisms
  - To ensure minimal impact on end-user performance
  - Via metrics such as channel busy time, signal strength, ...

Moving forward

- Devise strategies to select the best set of APs at any time
  - Optimization algorithms at the central controller
- Consider proactive client participation in energy-star WLANs
  - Clients communicate their “intent” or schedules to the WLAN
- Better spectrum management “between” enterprises
  - Redesign network configuration/management mechanisms
  - Channels and transmit power selection

Conclusions

- Wastage of energy is a growing global problem that needs quick attention
- Energy savings are possible in all WLANs - only the adopted policies change
- Energy conservation should be an integral design-goal in all future WLANs
- Strategies such as green-clustering are a first look at energy-star WLANs, and encourage further comprehensive research

Thanks!