Using Existing* Networks For Energy Purposes

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("existing" can be either those already in place today, or those installed in future for non-energy purposes)*

Much activity in energy efficiency revolves around *real* data about actual conditions in buildings; this applies to both research and implementation. In some cases such data can be extracted from building control systems, particularly for HVAC. Otherwise, this has generally required new equipment, that must be bought, installed, and maintained; the costs and difficulties in all this is a large barrier to obtaining such data.

There is another approach that has rarely been taken but holds great potential for commercial buildings – to use existing (non-energy) networks. This does not replace the general need for energy-centric sensor networks, but provides a cheaper and more available complement and may substitute for some. In the long run, we should look for all building networks to converge over IP technology and so be able to share information as useful, so this approach is a key step towards realizing that better future.

We do not yet have a full inventory of such networks, but the most important ones are familiar. The most typical type of data that can be gleaned is binary occupancy. In a few cases, more nuanced notions of activity can be gleaned.

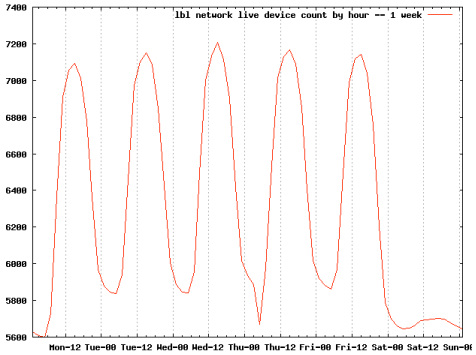
Telephones (analog and digital)

Call activity provides an indication of when a room is occupied. Microphones could be used to assess occupancy even when the phone itself is not in use.[1] The central phone switch is the most likely point of contact, though IP phones could in principle communicate directly with energy infrastructure.

PCs

PCs provide direct indication of occupancy through keyboards and mice, and indirect indication through use of cameras and microphones. They also provide power state, as presumably when a system is *asleep* or *off*, the occupant is not present (*on* only means the person might be around). A PC can also store and summarize sensor and activity data. Finally, it can pass details of its activity across the network.

Network equipment



Whether an Ethernet or WiFi connection is to a PC or a phone, a link is either up or down. Even if a *link* is up, a network device can actively or passively see if a device is responding to basic network presence inquiries such as ARP (the figure at left shows how ARP counts at LBNL vary across a week; the minimum is almost 80% of the peak). A next level of analysis is to look at the *quantity* of network traffic to and from a PC to draw conclusions about occupancy. A final level of detail is to look at the *content* of the traffic (e.g. which protocols) to determine what a person is doing that may be energy-relevant (e.g. a VOIP call, a video conference, etc.). For wireless access points, a device may roam from one to another, showing location. Mobile

[1] An example of this just showed up recently: http://www.cisco.com/web/solutions/axpdev/bugsbernie.html — the approach is to turn on IP phone microphones for security, not energy purposes, but the principle is the same.

phones with WiFi capability can be expected to provide particularly good indications of the location of a person, either by the access point being used, or from the phone's GPS capability.

Displays

Televisions are increasingly shipped with ambient light sensors, used to automatically control their output light level. They also increasingly have network connections, to enable broadband applications. Computer monitors are likely to gain touch capability. In general, we should expect displays to also have more and more sensing ability which could be communicated out to the network. In some cases it might take working with a manufacturer to update the internal firmware to demonstrate this; if successful, this could be a standard feature.

Other

Security cameras can indicate occupancy in various ways, from simply noting when there is presence in the space being watched, or through actual counting of people entering and leaving a space (e.g. a hallway) that connects to others. Elevators are a very crude indicator of occupancy, but has source and destination floors. ID card readers track the identify of people incoming, and sometimes also outgoing; by association people with spaces, this is an indication of occupancy.

Discussion

Building exist to provide services to people. Optimal delivery of this requires knowing where people want services (for offices, keyed from the individuals associated with them), and what they want (based on type of activity). This is occupancy or "presence". Spaces like offices are most typically associated with a single person; zones or floors of buildings, or common spaces, may be best represented by counts of people. For group areas, data from individual sources can be aggregated to represent that for the larger space.

Existing networks can provide data on typical, current, and forecast occupancy patterns. This data can be used for research purposes, or to inform or direct actual building operation. It can be compared to other data about buildings, such as end-use energy consumption, to assess how well consumption tracks occupancy.

The data from these networks are often individually identified and so raise serious questions of privacy. In general, the fact that these data exist is not new, but their usefulness for energy may make them more available or last longer. Energy-directed purposes need to be mindful of privacy concerns and act appropriately.

Research Plan

- Inventory and describe existing and potential sources of data for existing networks
- Assess the usefulness of these various types of data
- Describe how such data could be used for research purposes
- Describe how such data could be used to optimize building operation

In all cases, examples from actual buildings will be shown to illustrate the potential.

Goals

- Save money on future research by using existing resources
- Save capital in buildings by investing in less new equipment
- Reduce energy use by better matching services delivered to those required
- Doing this all faster than otherwise by using existing facilities
- Make building performance more reliable by linking energy information to infrastructure maintained for other functional reasons.