a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

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## The Program

One of the primary functions of an HVAC system is to provide a suitable environment for building occupants. Until recently, a BMS had no way to of knowing exactly when those occupant needs might occur. Traditionally, building management systems operate based on a pre-programmed schedule, regardless of occupancy. Some technical solutions to this issue exist, but all have drawbacks such as high cost, or poor reliability or accuracy. Recent research by a PhD candidate at the University of British Columbia, however, makes use of wifi data as a method to determine occupancy.

The technique uses existing wifi infrastructure, and locational data generated in the Cisco wifi platform. By passing this information into software developed in collaboration with the researcher's spin-off company, it is possible to approximate how many occupants are in a space such as a lecture theatre or meeting room. This occupancy count is then passed to the BMS, where it can be treated like any other sensor input, and used to reduce the supply of air during under-occupied or unoccupied times.

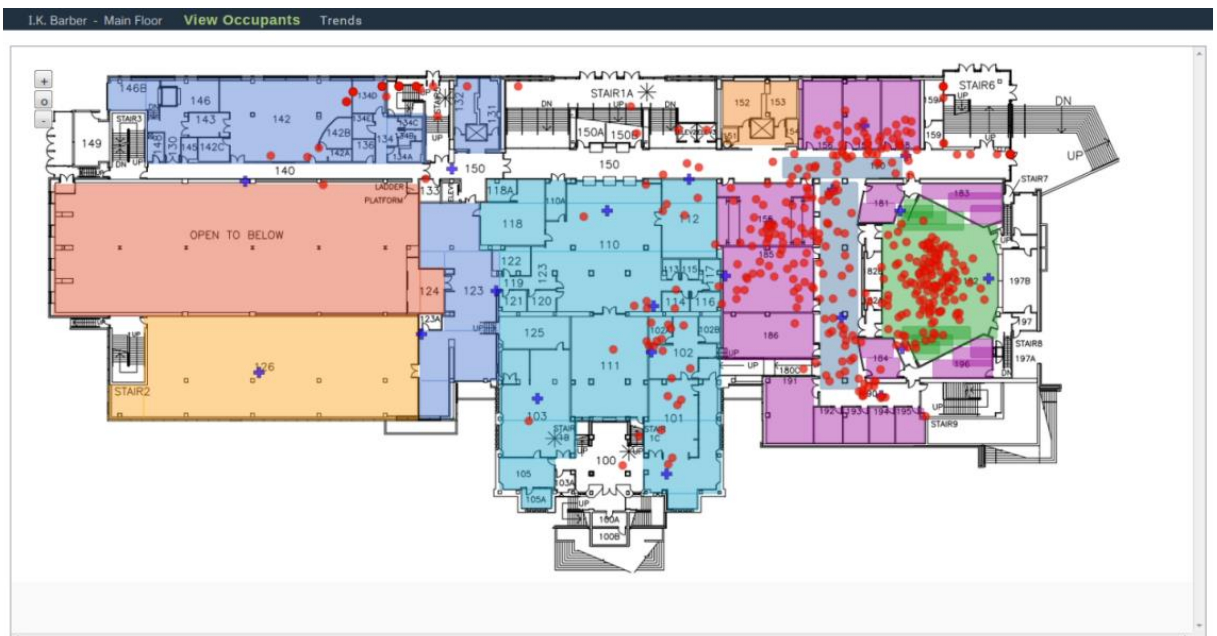


**Figure 1: A screenshot from the software – circles represent devices while crosses represent wifi access points**

A pilot program conducted in one of UBC's libraries showed that the method had potential to reduce energy consumption by approximately 5%. Through the use of more nuanced BMS programming, it's expected that more savings could be realized in other buildings.

## Institutional benefits

The University of British Columbia has set for itself some of the most ambitious GHG emissions targets of any public sector organization in the world. In 2010, the university announced it would reduce emissions by 33%, 67%, and 100% below 2007 levels by 2015, 2020, and 2050 respectively. With roughly 90% of the campus' emissions due to building HVAC loads, demand-side efficiency will play a large role in achieving those targets. And while some savings can be realized through equipment optimization, building operation is usually aimed at providing conditioned spaces, rather than occupant comfort.

Some efforts have been made to change this approach already. Occupancy sensors, $CO_2$ sensors, and people counters are all increasing in prevalence. But all of these solutions require the installation of an additional piece of equipment, are somewhat unreliable, and add to building maintenance cost.

By using wifi-based occupancy, UBC has managed to gain the benefits of occupancy-based control without the drawbacks. The conventional issues surrounding sensor installation are avoided, as the existing wifi access points (APs) effectively fill that role. Furthermore, because the system acts in near-real-time (occupancy is updated every five minutes), the energy savings can be achieved with minimal impact to occupant comfort. This energy conservation technique has had no noticeable impact on hot or cold complaints from buildings in which it has been implemented. Another advantage is that through reducing equipment runtimes, UBC can expect reduced maintenance costs and longer equipment lives.

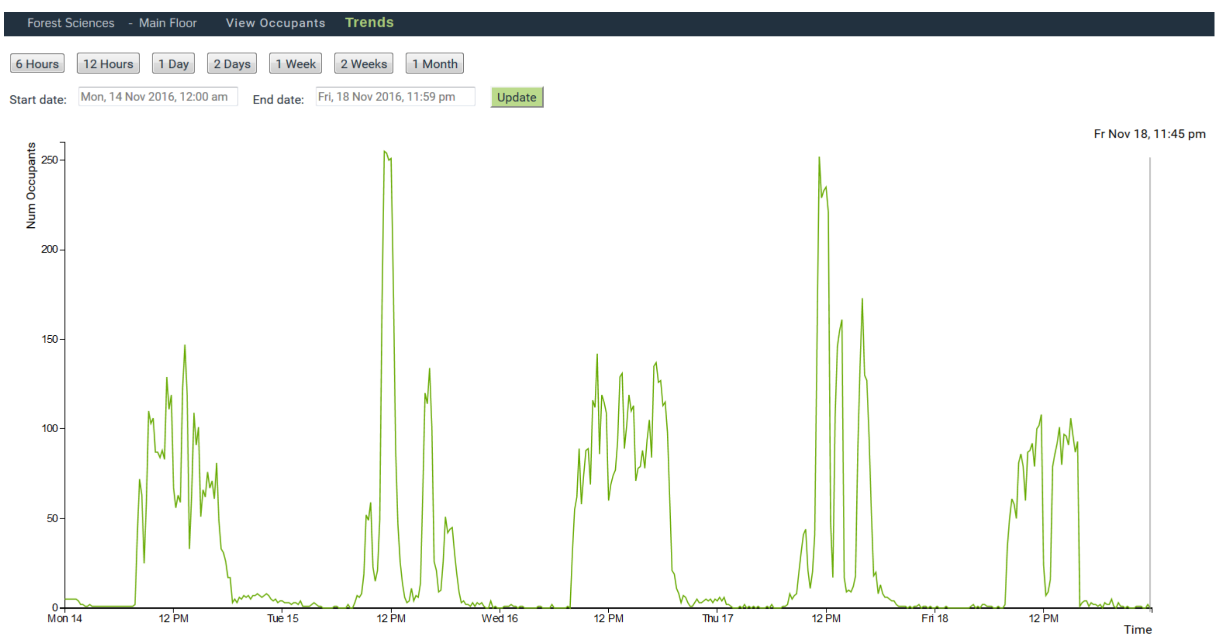


**Figure 2: Occupancy trends offer insights on the true use of a lecture theatre**

Although UBC has only used this solution to date to pursue energy savings, using wifi data as a proxy for occupancy has other exciting applications as well. It is possible to envision its use in directing the effort of custodial crews, inform classroom services on which learning spaces are available or underused, instruct planners on how campus facilities are utilized, or even in providing supplemental information in emergency response situations.

## Characteristics or qualities that make this program or practice different or innovative

Although efforts have been made in recent years to use occupancy data to drive HVAC operation, it has proven difficult and expensive to tie occupancy data into the BMS. Rather than relying on additional sensors to obtain occupancy information, the approach taken by UBC instead leverages existing infrastructure and data. The idea of wifi based occupancy controls has been suggested in the past, but purely on a hypothetical basis. Evidence suggests that UBC is the first to actually implement such a system.

Beyond the innovative nature of the energy savings method itself, this project is also different in how it came about. In most instances, a university identifies a need and seeks out vendors of solutions, or a company may approach the university with a proposal. In this case, the progenitor of the method was still working on his PhD when he approached the UBC with his idea. The use of wifi data for HVAC control is therefore an excellent example of the Campus as a Living Lab philosophy which UBC strives to embody. Research being performed at UBC was demonstrated here on campus to be viable, and spurred the start-up of a private company. UBC is still collaborating closely with the start-up to help develop the product.

Finally, this energy conservation solution is unique in the level of inter-departmental collaboration it has engendered within the university. To implement the pilot required a coordinated effort between the Energy Conservation, BMS, Wireless, and IT Systems groups. Ordinarily, most of these groups operate independence of one other, and generally do not work in tandem to achieve a single goal. However, without each group offering their unique insights on the challenges faced in implementing the pilot, wifi-based controls would not be the outstanding opportunity for UBC that it is today.


**Figure 3: Occupancy Trends in UBC's Hugh Dempster Pavilion**

## How this practice can be used by others

One exciting notion of this project is the broad applicability of it for other institutional spaces. Any place with a centralized wifi management platform (such as Cisco CMX, in UBC's case) could potentially implement wifi-based controls.

There are a number of variables which impact its viability, however. First and foremost is what Cisco has labeled "location readiness". Wifi coverage needs to be relatively dense, with a device ideally having line-of-sight to at least three APs. While this may present a large challenge at present, many universities have aggressive wifi infill programs, and this may offer a reasonable incentive for the expense. Figure 4 shows an example of locational readiness for one of UBC's buildings.

Another aspect is simply the types of space for which wifi-based controls are appropriate. Because confidence in the method increases for larger occupancy counts, the method is more appropriate for spaces which will host a large number of people. And because the occupancy count updates only every five minutes, and HVAC systems can be slow to respond, the method is more appropriate if occupants will remain for a longer time. These two aspects point to lecture theatres, classrooms, and large meeting rooms being the most appropriate spaces in which to implement wifi-based controls. Therefore an institution with a larger percentage of its space devoted to these uses will see more benefit and savings from its implementation. Larger spaces may also be appropriate, but UBC's experience shows that potential savings are lower than for a discrete space.

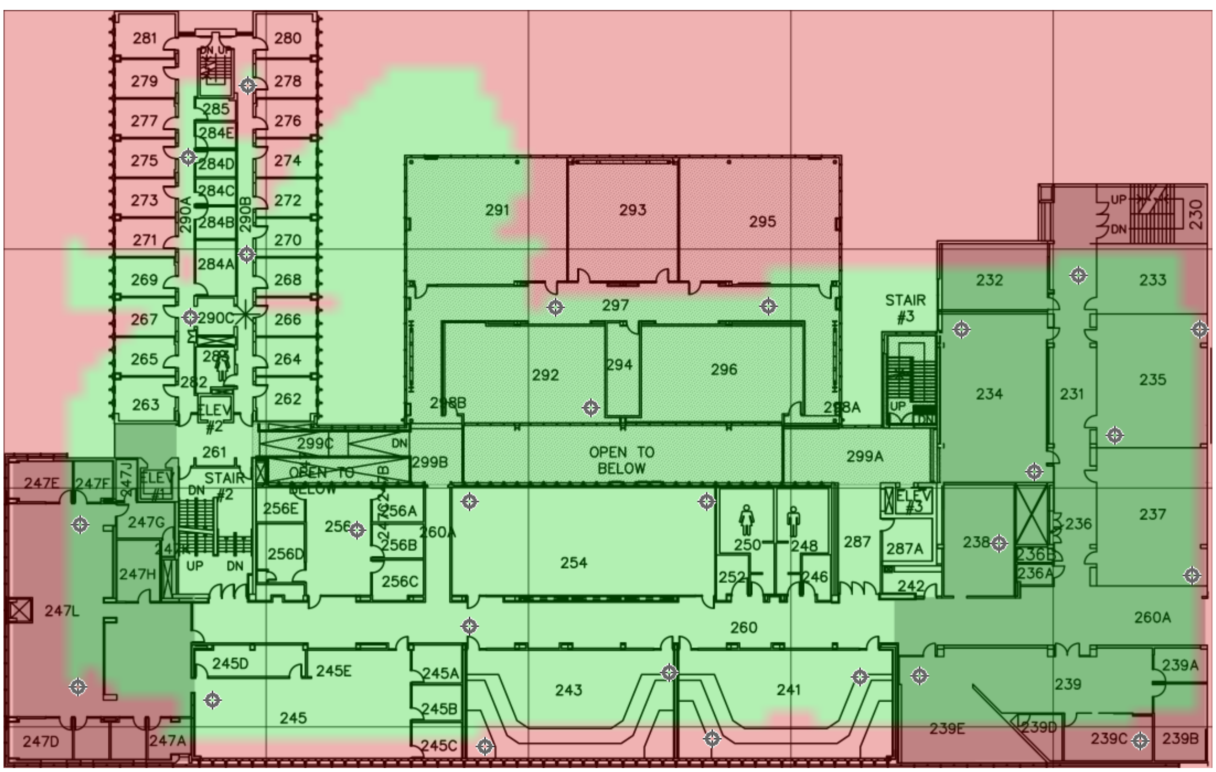


Figure 4: UBC's Henry Angus Building has only moderate location readiness

### Demonstration of management involvement and employee commitment

Without support from managers in the breadth of groups involved in the pilot, wifi-based controls simply would not be a reality. For most of the individuals who leant their support, helping in a project which would allow use of wifi data to control HVAC systems is not part of their jobs, and will not benefit their unit. An idea coming from a PhD candidate at UBC has become a reality, a company, and one of UBC's energy conservation strategies moving forward. The project demonstrates this university's commitment to innovation and energy savings throughout the organization.

By the same token, the individuals who became involved in the project did so out of their own interest. There has been considerable enthusiasm from staff at UBC who heard about the initiative. The BMS group in particular has pushed the project to continue to move forward and develop the platform, such that wifi-based controls can be implemented in as many buildings as possible.

### Documentation of results, analysis, customer feedback, and resulting benchmarks

Fortunately, there has not yet been any negative feedback from customers following the implementation of wifi-based controls in any UBC spaces. This indicates that the energy conservation solution is working as intended, and not disrupting delivery of adequately conditioned spaces to building occupants. UBC Energy and Water Services is presently working on a media release to inform the university community of the initiative, and to demonstrate the positive results and feedback from management and industry.

Results of the initiative have been impressive so far. Figure 5 shows the impact that wifi-based controls have had on the fan speed of an AHU serving a lecture pavilion, which was one of the first buildings to have the method implemented. During operating hours, there has been roughly a 10% decrease in fan speed, resulting in fan energy savings, as well as savings from heating or cooling a lower volume of supplied air.

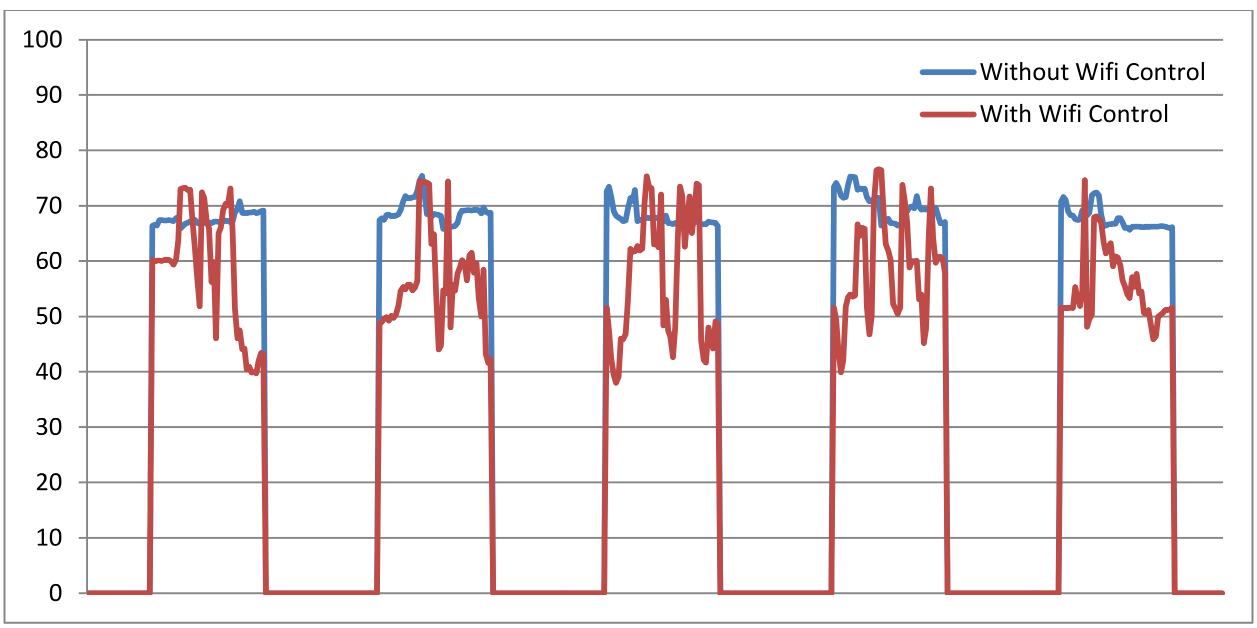


**Figure 5: AHU fan speed for a week before and after wifi control implementation**

If implemented in a larger space, such as a library, different savings may be achieved. A delayed startup or early shutdown of mechanical systems can lead to considerable energy savings, as is shown in Figure 6. This graph demonstrates that while energy consumption is roughly the same for the majority of the day, there is roughly a 1.5 hour delay before major mechanical systems turn on. Over the course of a year, this seemingly-small delay can result in quite significant savings.

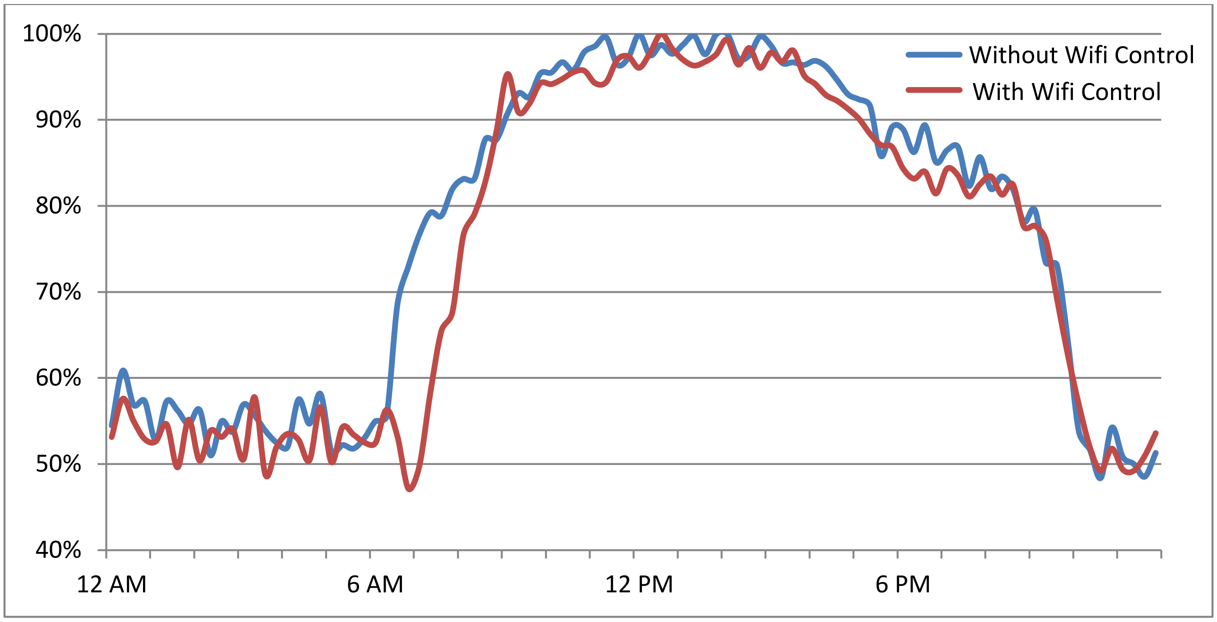


**Figure 6: Daily power consumption as a percentage of the day's peak before and after wifi control implementation**