Please stand by for realtime captions.
>> [The captioner is standing by for event to begin]
>> [Music]
>> Welcome, and thank you for standing by. At this time, all participants are in listen and only mode. After the presentation, there will be a question and answer session. To ask a question at that time, please press star one. Today's conference is being recorded. If you have objections, disconnect at this time. I will now turn the meeting over to Mr. Keith [Indiscernible last name].
>> Hello, I would like to welcome you to the third CISE lecture talk, and it was a pleasure to introduce [Indiscernible name]. He is the chair of the science computer division department at the University of California San Diego. He is also the professor of the QUALCOMM embedded Microsystems. He received his bachelor of technology from IT [Indiscernible name]. I am not going to tell you when. After I got mine.
>> [Indiscernible]
>> And a PhD from Stanford University. Earlier, he worked at Intel Corp., on three successful design teams. And for the life of me, I don't know why he went to UC San Diego, but he did. His focus is on mobile computing systems, he has co-authored over 150 articles -- for patents on PLL design, data processing business, and data chip design.
>> He is a recipient of the [Indiscernible] award. He has one in career award, to departmental achievement awards, and a [Indiscernible] achievement award at Intel. As many other things that could go on Tuesday. He is also an advisor at [Indiscernible name], real and 10, Calypso and package design Corporation. I will let him talk about his research.
>> Thank you, Keith. And welcome. What I want to do is start by telling a story. And this is a story of the weekend in April 2009. About three years ago. Some of you have probably seen this slide. It is a very busy slide, but what it says is that the probability of warming, global warming, is pretty high, too too and have degrees of global morning. -- Global warming. And it will have bad effects. We have only been able to see one third of what global warming is committed to. This is one of those slides which is often times seen as one that scares a lot of policymakers.
>> And it does ask us to think, whether we believe these numbers or not, but what we are doing to the planet. So, as a part of my other role as in associate director for Cal IT 2, an institution between UC Irvine and UC San Diego, we got together for a weekend to solve the problem. You can see this as a visualize notetaking. [Indiscernible]
>> I said, you have a global warming that you are committed to. You have to and have degrees, only one third has been realized, and it is a global problem. At that time, Tom Friedman had come onto the books about -- and [Indiscernible - heavy accent]. What can we do? What kind of problems are we going to be facing and what can we do, both as a society, and also as an Institute, which is pretty interdisciplinary.
>> We can make a difference, and we can make a difference by turning facilities into research laboratories. And there are many opinions and things that came out during the summer. In the short term, you have the smart grid, and smart buildings. This is the opinions of some of the participants I just picked up. We should reconsider the relationship of heat and work and what work means today, which is what works meant to go -- 200 years ago.

>> Based on that, we said, okay, what are the next sweet spots in the next 3 to 5 years. This is the technology that we use in deciding what problems to solve. It is not just one person's opinion. We give people ballots to vote on, and so on. What turned out was that the solicitation -- visualization and turning campuses into facilities where you can run experiments or say something that is in the list of sweet spots.
>> Today I'm here to give you a few of what has transpired since then. We have done work before them, the graphic you just saw was Dr. [Indiscernible name]'s work, and that happened at UCC Nieto -- at UN -- UC San Diego. Officially, unofficially, and with the structures that we have in our research, the entire campus that UC said Diego into one giant lap.
>> There are many parts to it. One aspect of that love is called the micro-grid. I am a computer scientist, at the end of the day. It was a big change of solving the problems that we do. How do the computer scientists look at this great? This micro-grid? And what kind of problems does it create? That is basically what my talk is about today.
>> There are three points I want to make today. This, by the way, is my last slide. And so, if you get this, then we are home free, and we can talk for the rest of the time. But, the main three points I want to make art, one, when it comes to energy use, especially on the global scale, you must focus on what are the longest poles in the tent. What are the things that will make the most compact? Buildings are a great starting point. And, you know, generally speaking, you don't talk to a computer scientist about buildings or anything physical. They are so used modularity and abstraction. But here is one object in society that actually has become a center focus of some of the computer scientist at -- scientists.
>> The second point, and hopefully you will see this as a coach of the talk, there are two main capability achievement happening because of computer science. One is that the bandwidth of the power consumption is increasing. People call it radiation and power users, you could look at it this way. [Indiscernible - heavy accent]
>> To the point we are coming with power supplies, both the supply as a consumer, they are all becoming higher, if you were to look at the density, you would find much higher bandwidth.
>> And the second one, but more subtle, is that our responses are becoming much more fine-grained than he used to be. Today, when you get the electricity bill, you see what you did last month. Already? Going from that to a day, which is [Indiscernible - heavy accent], in real-time, which is usually real-time which means once per second. And the third point, which I hope you all relate to, and this is a point I worry about a lot of my role of chair in the Department in computer science, computer science is a discipline that is changing. It is much more societal in nature, and global in scale.
>> The nature of the work we do has to do with efficiency and scalability. And that changes how computer scientist to -- computer scientist on, who doesn't, how it is done, and energy has a strong role in that. And some of that, I will touch on.
>> I like to keep my talks very interactive. I know we are being recorded and there are questions at the back, but please feel free to stop me and ask questions as you see. In fact, some statements I make or to intentionally keep you awake. I just don't know where they are.

>> That was my last slide. And now you get the picture. So, focused on the longest poles in the tent, first message. How big is the tent? Well, here is my tent. I will give you much -- my picture. It is a fuel cell, a plant on the California campus. Imagine a small city. And this is La Jolla, and really, it is always this sunny. It looks foggy, it is always foggy, too. It's a beautiful place to be. It is a place that we often write other schools to have people come to this climate.

>> 12,000 acres, 45,000 occupants, 8000 living on campus. Two hospitals, not one. And hospitals by law, are required to have their own power supply. Not only that, we actually hold we -- proclaimed the frozen always. They cannot be melted. They have to be totally into -- uninterruptible.

>> 450 buildings, 11,000,000 ft.&²; for building space. We spent about a quarter of $1 billion of capital expense every year. It generates 80% of its own electricity. We could actually go, like three years ago 100%. It did not make much sense because all it meant was the next process would set us back. So, we never put that as a goal.

>> 2.8 million megawatts of fuel cells, over 2 MW of PV, last time, it was 1.2, and then somehow I heard three. We have a wind powered windmills, and 15% of our daily usage of electricity is actually stored in tanks. Because we have local generation, one of the byproducts of hot water. And the hot water loop runs across the campus.

>> 5000 of the meters are controlled with [Indiscernible - heavy accent]. We have stations with cameras in the sky that track the movements of the clouds from one end of the campus to the other. And based on that, the movement of the satellite cells is storage. Whether they are going to be stored or used. And then we can do shifting, at the order of 50 kW per second, to 1 kW. But most important of all, we live in a low half, but we don't need any [Indiscernible - heavy accent].

>> We regulate ourselves. And, I was in China, and they said, well, we decided to make something happen, and it happens. We are little bit more chaotic than that as a country. But, this allows us to build a lab in which you can run experiments, you can put a solar cells, combinations of things without having to worry about approval process.

>> And we do. Methane, for example, we run it back to the campus from point Loma, and this is the largest commercial fuel turbine. We have this historic 2.5 gallons of storage, that is the most efficient storage for the shifting. So, this is a campus that provides you with a whole bunch of objects from Mike your -- micro fuel cells to storage tanks, two transmission, for doing arbitration between its usage. It is a giant laboratory.

>> And then, you can go online and you can monitor every single water being used by the campus. You can break down by campus, by parts, we have six colleges, you can break it down by school, but buildings, as to what energy is being used at every second. And you can get a total. So here is 30 MW, you know you are using this much at this point.

>> We built this dashboard. If you go online, in fact, if you're online right now, you can go online and it will give you a heads up. It'll play at any moment how much energy is being used. This one is not on currently. It is at the supercomputer Center, which is almost always that hot. How much energy is being used per square feet, and whether it is high or low.

>> So, we said, okay, we have a buildings being monitored at a much more detailed level, and very different types. Let me take these buildings,

and of course I did not want to put 50 lines across, so I said, I am going to take five types of buildings, looking across five types, [Indiscernible - heavy accent]. Computer science building, just like an office building, the gymnasium, and the residential hall. And then you plot them and look at the different sizes.

>> So, I will plot one per square feet. Those of you who practice, you know that needed certification is about 5 to 6 per square feet. And if you look at the watts per square foot, San Diego science building is between 10 and 11, so it has no chance in hell of being [Indiscernible - heavy accent], just looking at the density that you have.

>> And you look at the residential hall, and you can see it here on the scale, they should either be sleeping or in classrooms. Maybe they have some machines or something. Then, you have this green line, which is about 3 to 4, more like 4 W per square feet, and it is putting much plot because it operates on the giant air handlers, -- and they can't just be interrupted, and so on.

>> This is computer science building -- let me see. The blue one is the computer science building, and the computer science building you can see Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday. [Indiscernible - heavy accent]

>> What you notice though? The more you have, -- the more IT you have, the more -- how densely we have done packing and scaling of IT equipment. So, the other extreme is the [Indiscernible]. It also tells you that if you are looking at types of buildings where it is most residential types and so on, you're not looking at the right target.

>> So, buildings have been such a fascinating topic for the computer science community. This is the third or fourth this year -- a conference, a census conference, and it is very clear that the buildings consume 70% of electricity use. More importantly, much of the electricity, the primary fuel of that is cool -- coal. Our transporting has changed to oil, the heating and electricity has changed to gas, but the electricity itself is actually not that clean.

>> Let's look at it across the year. This is the computer science building, and you know, if you are going to turn my campus into a testbed, I am going to turn my building into an even bigger test bed. This is probably the most heavily instrumented building. [Indiscernible]

>> It has something called [Indiscernible name], which is another big monitoring network. So, this is for every week. You will see this Monday, Tuesday, Wednesday, Thursday, Friday. This is a whole year. We have several years worth of data for this building, and you can see. You can't read this, I can read it. It is just under 600 kW for this building. But most importantly, look at this.

>> And never goes below 320 kW. We are in the period is to let -- we are in La Jolla, if the electricity goes off, you're not going to boil or freezer something. And don't tell me that everybody is working 24/7, that doesn't happen. So, what is going on? Let's look at this building again.

>> I will give you some data. One week, Monday to Friday, Saturday and Sunday. You'll see it is about 320 here, and it goes up to 600. So we ask, why is it 300 and not 100? Well, we asked. And of course, we did not want to guess, so instrumented the hell out of this building. You know, going into the instrument panels and into the laboratory. So I went to the campus and said, you have to give me an electrician, and I have to put in money here because I cannot do -- and so on.

>> I am going to simplify that for you. The machine room, the plug Lo, there were 22,000 of those. This is a summary of all of the plug loads coming out of those. By name, and mechanical. This is the lighting, about 50 kW. This is the machine room, maybe there was some sick time or deadline here. So, 150 W. This is the plug Lo, which in the computer science building is only two things. Printers and PCs, desktop. Okay?

>> This is the air handlers, [Pause] and these air handlers, if anything. If you fly over the United States and look at the top of the buildings, like the top of our heads, you will see a lot of these big fans. Do you know why? Because the guidance from the OE, which was built in the last [Indiscernible], happened in 1973. All things said, a building is not as efficient if it is transferring energy from one place to another. My -- the primary mechanism is blending. You take the air and funded through this. Which is why, you live in La Jolla, you live in San Diego. You open the window. Do you know why? Because it is more energy efficient to shut the building and put more fans on it.

>> That was then in 1973 when there were no PCs. There were no laptops. And so, all of the load was heating, or usage, and everything else was miscellaneous. We are looking at miscellaneous here. That miscellaneous is about 50% of the peak load. Which is the miscellaneous. Just the desktops and machine rooms. They are enormous.

>> How far behind are we in the federal regulatory regime, where our actual use is happening? So then you ask the question, what can we do? After all, we look for solutions. What can we do? This is where we spent about a decade, and algorithms for power management. And it wasn't in the days of how to make chips more efficient, but the same thinking applies. The next two slides are although we have done in the 10 years. The only two ways in which you save energy, only two ways.

>> One is shut down. You can think of any project, any object as a service provider. It provides some service, it does some work. And the requests can be queued up. And then you have this power manager that is watching everybody. And it is issuing one single command. On, off. On, off. That's what happens on your cell phone when you're talking. The radio is going on and off, even when you are talking. That is how we save power. That is generally known as power management.

>> The other method is slow down. You must have some kind of a control not that allows you to change the level of service you're going to get for different power consumption. In order to do that, you must have some idea of what work you are doing, because you don't want to get something done when somebody is trying to do some more work.

>> So, all of the work that we have done in this area has been to choose the right combination states. You can imagine. Shutdown is when you simply shut something down. You don't do any work. In slowdown, you are working. You are active, but working at a different rate. So, what is the correct, nation of shutdown in slowdown? One way to do shutdown is to do recycling. So, we have done quite a bit of work, and this is just a bit of just pumping here, these things should not mean much to you, except for fuel.

>> The main thing that we have done is how do you recycle things aggressively? Aggressively means not a small amount, a big amount. And as fine as you can. Recycle computers, recycle CPUs, radios, for example, buildings, what are the limits that you can reach? How do you do it optimally? And how do you do it time sparingly? With effective quality insurance?

>> Of all that work, two main lessons come out that I want to relate to you. I won't go into the reasons for those lessons, but those lessons are important for what I will talk about next.
>> One is that heterogeneity is a factor of life. You pick up a cell phone and have eight or nine radios on it. Why does it have that many? Sensory processes as. You can take all of the processors in the world and my mama up -- and line them up for what kind of metric. You'll find that there are two clusters. One cluster is a general-purpose processors, and these numbers of course are shifting. This is more like now 10 MIPS per MW, this is the platform machines, and be -- the [Indiscernible] machines.
>> This one is pushing a lot more bits than a [Indiscernible] radio, for example. They're pushing bits and doing different things. This is a factor of life. Therefore, you must choose the right operating point, those as the architecture and operation. How'd you do that? I will relate to you how we do that next.
>> And the second, and this is a more subtle point, but look at it this way. The numbers have changed on the text -- desktop today. They're more like 60 or seven. Take a normal item, no CPU frequency, 97.4 W, and don't do anything on it, just let Windows run or something, you get 93 W.
>> And if you put it into suspend, it goes to 1.2 W. And so what happened close to -- and so what happened? I am ready to do something or I'm not ready to do anything. That is the only difference. You can think of it like the cost of abstraction being a life. Right?
>> And that is the number one component to achieving the -- has been on the mindset for a wild. -- Has been in the mindset for a while. But, these are a couple of things that we can do and we have done. Going on these two lessons, slowdown in shutdown, and then how do you manage abstraction. While achieving a better operational efficiency. You still want to keep the abstraction. So, one, -- and these are what the final polls have been, to increase the bandwidth usage and decrease the granularity of her sponsored
>> One is on IT equipment, how do you duty cycle machines in a network, for example, that is meant to be on. Your intranet is always meant to be on, except for the last 24 hours. And that was for a good reason.
>> [Laughing]
>> How do you duty cycle computers aggressively while maintaining availability? Or the illusion of maintainability, if that is what you need. And then we build machines like Somniloquy -- I'll talk about those in a second. And then here, we talk about HVAC. It is even less proportional because it is doing air movement. Because of the 1973 crisis and what you have to do.
>> It actually causes the energy to move, and secondly, it is highly controllable. We just don't do it. Today, we can make air flows in which we can fill bottles around you of comfort. But we actually make comfortable not here but there. So, how do you use occupancy at HVAC systems and very fine spatial scales in this room? In his person or in this zone, for example? Not just whole buildings.
>> And finally, managing the consumption of plug loads. The dark clothes, and so on. That is in response to -- it is more expensive. We have a crisis, whatever it is, we can respond to them not ahead of time, not a month ahead of time, for one hour, one minute, 1 second at a time. Can I adjust that?

>> Of course, when I do that, I'm going to have to make some [Indiscernible]. How do you capture that? So, the first question, I will present the Somniloquy system and other companies. We said, well we own the computers, we can shut them down whenever we want. So when I get home, I can just put them to sleep. Of course, they have people working in the middle of the night like me and need to be on. And if we shutdown the machine at that time, they are not going to be very happy.
>> And then if you shut it down and I turn it back on, now you have two separate levels of control. So, just simply powering down is not really an option. Why is that? Because firstly, our machines work in an abstraction, in an environment which is supposed to be always on. The connector is always on. I make light bulbs. Well, you can say, turn it off when you're not in the room. In fact, by the time that you know that the HVAC has been turned off, it is too late. Because then the next thing you do is to file a complaint. You don't just clap your hands.
>> It takes 5 to 10 minutes to change the temperature in a zone. So, the model of the application and the user is very different. And so, I am going to skip the details of how we did the magic, but we did this magic where we come up proxy and network levels, we create systems which are combinations. For example, this is connected over a year's report. To a laptop. And it is no longer needed now, because now many machines are actually coming integrated with dual processors of two different types.
>> Or, you can have an enterprise deployment for your actually have a machine that dishes out sleep cycles to all of the machines. And recall that sleep systems. All of them together do one thing. The power management community, which we included did not realize what we were doing power management. Remember when I talked to you about sleep shut down and slowdown? In shutdown, you have many sleeping states. In none of which you do any work.
>> In the case of a slowdown, you have many active states. All right? And therefore, you are either active or not. But really, you don't want that. You want a hybrid. You want a slowing state. So how do you create a hybrid? That is all we do. You create a hybrid state by actually maintaining illusions of responding to network requests. For example, I could have a machine here responding to e-mails and it could be application semantics, where I'm waiting for a package or one operation to complete before.
>> So, what sleep servers do is if you go onto the website, you can actually see that there are many monitors and machines being tracked. This is what happens before sleep server deployment. You take one desktop, and you have -- over time. I cannot say how many papers I have written in this range. If doing something to reduce power and doing something differently. But they are in this range. Of course, if I took it to [Indiscernible], it will look very may -- very nice.
>> The same machine maintains its natural persons, maintains what it is doing, managing and so on, and it never goes down to zero, by the way, but it does this. This is a nightmare to a power system engineer. Oh, now you have a power supply. But that is a problem that we will create and solve it to, at some point.
>> But this, when you do it, you go to 96 W to 26 W. This is what I mean when I say aggressive. You can do the same thing to the [Indiscernible] system. That is my next point. This is 68% savings. We did it across the pond. We said, wow, this is great. And we said, in my own building, I could be saving $57,000 a year in just doing that. That is quite a bit of

money. And of course, my administration at the University, my chancellor, they were saying, this is great, let's do it.

>> But in fact, as I speak to you, we were working on a pilot to deploy across by buildings that on average, this is a rule of thumb for you. Making change across the country. Usually, it is $2-$5 per square foot is the annual energy bill. They are looking at 1,000,000 ft.&^{2};, even if you do more smaller buildings, which we spent a quarter of $1 million a year building new buildings. So, you will still have $2 million a year in electricity bills. Okay? We can reduce it even down to 50% penetration if -- turn off.

>> Of course, there is cost of deployment, cost of everything else. But, that is what we are doing. So no, you get ambitious. We can take on problems which could be too risky for industry stake. So, this was some time ago, I said, well, let's suppose that we do the best. We put in sleep servers and during the load down, we do some better fans, better than control, speed control. Lighting is -- but let's go LED. Cost is not a problem. So I said, okay, and we do motion control, licensing and so on. What can we get to?

>> And by the way, please, the units, they use different set of units. So I said, okay, you can go by 1000 GBP per square feet, to about 42. And then of course, you always have the ridiculous question, because the cost of asking those questions is not really high. You can take the risk. So I said, what happens if you make it a row?

>> Well, in order to make it zero -- you know you are in San Diego, you get a lot of heat and sunshine. In fact, we have annual radiation. So we took those models and said, okay, you can get to about 20 2K BP use for that. But I won't do it. Well, this is where you're going into an unrealistic range. So I said, we can prevent hacking, don't mind the cost. At 30% a radiance. But I want to see her. Well, then you have to meet it TV 29% efficient. We have no idea about solar -- of course.

>> But, if you get even more heat from the sun, or better, you could go zero. I am a computer scientist. With global warming to better solve itself. Is that the way we are going to save energy? Of course not.

>> And that led us to a whole new range of exploration in buildings. I said, well, just like work, in computers, from an energy point of view, what if I made buildings where there are less people in the room, you useless. For example, in this lecture hall, I am actually glad to see so many people. Usually you have less people. And so you say, fine, you don't have to run HVAC at that level. And so, if there are less, you've can reduce -- you can reduce cooling. And more than reduce cooling, maintain cover -- maintain comfort.

>> People take off for bricks, people do things at different times. Some of which is the verbal. Just like laundry at home can be shifted to 10 PM. You can actually shift some computation, and that is what we do.

>> They happen by the convenience -- usually happens at night. So, what happens if I have a demand response question Mark and I change this [Indiscernible - heavy accent]. Yes?

>> [Indiscernible - low volume]

>> Yes, exactly. The thermostat -- I actually went to a meeting last year to talk about it, and in fact, let me to you a secret. Honeywell will not admit this, and they don't like to say this. Many of the steps are decorative pieces. And they don't really control too much. And by the way, you can go from one end to the other, and the total temperature is

about 3%. But more importantly, it does not differentiate. If there is one person in the room [Indiscernible - heavy accent].
>> So the way it does it is through a very -- control loop, by actually monitoring the amount. And I will talk little bit about the actual data that we get from buildings. But you are right. You're not completely dumb when it comes to -- by the way. But, a lot more. Something for nothing can be had. And I come from the ADA world where somebody says, what you do with a tool? I give you money and I may get better faster. Well, most of the time. So, you can do something from nothing, almost.
>> So, HVAC system. If you look at those plots, they are very fixed schedules. At 5:15 AM they start. All right? And because it takes time for the time to come and come in at 6:30 PM it goes off. But people come at different times. In fact, this is the actual ground data -- but, you know, people come, staff members, we get some data of where people are in their employment or not.
>> If you change the granularity at which you respond, you can make use of this. That is what we are doing on CPU today. We are changing frequencies at very low skills. And that allows us to get you to this. So, here is a control experiment. The first question you ask, is there any room there for optimization? It's okay. Remember, we actually are able to be connected to the campus level control system. Which, by the way, gives us a lot more power than people realize. And sometimes if people realized it, they would probably stop doing that.
>> But, we can spoof presence in the building. Because we can say, in this room, there is [Indiscernible]. Okay, what if I took my own building and I did a control experiment where I said, I am going to monitor two types of loads. By the way, this is a modern heating and cooling system, especially in California climate, where you have heating and cooling expressed simultaneously.
>> You defended for one mortality at first. It was designed for a heating mentality at first. Or it was designed for a cooling mortality at first. There are dampers actually float in the air, and when somebody finds it too cold for comfort, what it does is it opens up a fan on top of a hard water loop that cools the chilled air. Okay. So if we cool it down, then we heated up.
>> And people do their math and we say, well, this is more efficient. But what do we do? We actually have an electrical offense which can go down low, and then you have a thermal expense. Thermal expense is a loss. So you can work that into electrical unit and so on. So, okay, the total expense and electrical loads, and through this experiment, you want to do it all weekend just in case anything goes wrong, nobody blames you.
>> So, I will run that HVAC system normally and on the weekend, take each of the four floors, and after one hour, declare that they are occupied, and declared in a way to which the HVAC system will respond. So we say, from 10 AM to 11 AM, 14 is occupied. Then another four is occupied. Then another. And you can see the consumption changing accordingly. So, it is not their -- a macro scale. At this point, you can actually have control.
>> Now, it is easier said than done. If I ask you to instrument this building so that they can count how many people are there and so on, we have some weird camera systems or some complicated system or counting systems, something, that is a cost. $300 votes per measurement are good for writing papers and doing some bench experiments, but you cannot really run these experiments. If I have to run a load in every room endeavor Pueblo, good luck.

>> So, this is where we actually did our own system where we have monitors and they are not totally -- they are binary. You could be in the room and closed the door and it says that you're not there and it turned off and so on. So, you combine it with sequential data. Basically, if you put in a switch, we actually found that the cheapest sensor was taking one of the air works. [Indiscernible - heavy accent]
>> At some point, in San Diego, -- you can imagine why. Because you're using them. Then it says that we have to cover a little bit more surface, and we actually have our own data and opponent.
>> We put in a meter which has the ability which is not a major concern -- [Indiscernible - heavy accent]. They all have the ability of shutting down. It also has the control and so on. And we are working with [Indiscernible name] to protect these. So we said, okay, now, we took a look at some case, and we took the symbol because it is ours now, but we put all of this stuff here -- it was accurate for 1 kW over 99% and so on. So we said, here is our system -- and then we have a whole bunch of policies, measurement, and utilization, and based on that, we can decide what we want to implement. Okay?
>> So, you have an architecture where you are monitoring this. And what are you doing? You are changing the opening and closing of the dampers. And based on this building management system, we did that. Presence is easy. Once that you -- once you know a person is present, you can look at the IP addresses were IP traffic and find out if this person was doing anything or sign. But in the plug loads, it turns out that they plug both also have a very nice signature. In this signature is also improved to detect. We have found that in our plug loads, we can detect. And so we did that detecting and found that some staffers were using space heaters. And with that, why are they? It was because of the HVAC system.
>> The occupancy does affect energy use when a person is in the office, and plug loads can vary. So, here is what we find. And this is the deployment. I don't remember the number. This is just one floor. And again, electrical using thermal use for the baseline. And then, within occupancy based on HVAC control.
>> It basically shows about 30% electrical usage savings. This is total, not just this floor. And 15% over thermal. So, when you extrapolate it, it costs around 40% in savings. More importantly, in this by the way is important. One of my staff members, she is disabled, she fell in her four on Friday. And it was discovered barely alive on Monday. Actually, I am sorry. She fell on Monday, and was discovered on Wednesday, something like that. It happened over a two day time. She fell on Wednesday, and we discovered her on Friday, and if we would have been gone, she would have been dead. You have something knowing where people are, that is important data.
>> And you have security, privacy and we deal with that. So we said, okay, you can use that occupancy information for other purposes, too. Under federal protections. So, let's put these things together. You have HVAC systems that can duty cycle. I hope that you can at least agree on his part. There is some room for improvement. They want to improve that anyway.
>> Then, you have a building in which you have people coming, and they're somewhat correlated. What is exactly that correlation? We don't know. We're still experimenting with that. There is some correlation between the work that gets done, competition works, as well as people's work. And sometimes you have causative. It can be deferred from people can come in

later, some people come in late. Some tasks can be done later. The task can go from one building to another as people go from one building to another. So, you have a giant scheduling going on.
>> And you have zero interest in that. So, when people talk about having a macro great, a microcredit, -- but somehow, one thing that comes up is that integrate, the building -- we normally call it demand response. It could be something else. And so, there is a full effort on putting the ADR improper that allows people to pass these messages. So, we said, let's pass this experiment. At the end of the day, -- let's put the debility that is putting the demand for spots. We have a two-part center, and then we have states, occupied and not occupied. What can we do? And how much gain will it give?
>> This is a busy slide. Please don't read everything here. I just want to make one point. In this particular building, we have 54 tracks on, each floor. That includes one corridor. Each zone is about 260 to 360 W per zone. Okay?
>> So, it is about the level of control that you can have. Not every office, and so on. But in the 54 zones, it is much easier than instrumenting 200 rooms. Let's suppose that you put this plug both, and you have a class, some things can be off only. Lowest priority. Some things, if an occupant is in the room, they have a priority of being turned on. And they should be turned on.
>> Somethings have a high priority of being turned on, when someone is occupying it. And some things should always be on. That is the part to understand. And then you describe a whole bunch of -- [Pause]. You already got a preview. So, you've describe these factors. You say, for this person, if a person has to reach for an HVAC event, that takes five minutes. I'm not very happy. So, [Indiscernible - heavy accent].
>> Here is a good summary of the entire building. And then you describe these policies. What am I looking like now? This looks like an operating system. In fact, don't be surprised -- and fact, in the Microsoft building, there is a company that has a building load. They are coming about because the similarities with what normally an operating system does with what much be done in priorities and cost in choices being made, scheduling and so on are just too much. So, -- we did this deployment, and I just want to summarize this for you. This is a low priority, high-priority event, and you can have occupancy or demand response. And you actually get pretty close. In terms of the energy that you can save. And this demand response is imminent.
>> Right now, we are currently working with [Indiscernible name] on opening buildings. Once we have that format, anybody who did any layout or chip design can share with others. Today, you pick up any -- and the country. You'll find one person with more than once to make the campus green. And they actually have green buildings. It is [Indiscernible]. You will find that. People are generally interested in working with energy buildings. We have no exposure to that data. How bad can it get?
>> So, with that, but create this open deposit for. This was just to clarify three, we can actually do data and storage, and we can actually create now publicly accessible data storage for the building data, and you can do that.
>> I wanted to take the last five minutes and put all of that into perspective of where we are. This is definitely important to me in my role as a chair. But for you, as institution leaders. Look what I just did. I am a computer science guy with training in computer science. I

talked to you -- I did not talk to about the tools, I did not talk to her about complexity. I talked to you about buildings. 10 years ago, you would have said, this is computer science.
>> Then you ask, what is going on? They do this year the grand challenge, and you can find many grand challenges. On some website. But, engineering, not computer science. Okay? 14 grand challenges. You go on to the website and it will -- on you. Which one do you think is very important? I will ask you that question. Well, I looked at that, and then I looked at it again and again. And what I found is that six out of those are computer center. Guess what? That is computer science.
>> Tools of discovery, guess what, that is e-science? And one's that are more esoteric. These advances are advances in computing. And I don't mean computing hardware or software, computing systems. It is no wonder, if you look at the published literature in the computer science in the last 10 years, you'll find things that are so counterintuitive. For example, security community. Integrity and access and template.
>> You can pick up soft security papers and you won't find a smart grid, yet. You will find some. Why is it? Is it because computer scientist like to worry about equity or access to health care or access to transportation? Are they political scientists? Are they calling us? No, they're not. But the major work that we do, because scalability comes into it. It exposes us to things that typically most people are callous about.
>> In fact, that is how I got into engineering. Interfaces. And what they are thinking. How they deal with things that are hard and the laws of nature. Well, the computer science is finding itself, and the scientists are. There are issues that relate to society. Justice, democracy, health.
>> And that means many things. Let me tell you a few things. But you do already. You may not know this. But, a lot of people copy you. At NSF, we organized this division between CMS and INS and whatever. There are things watching you, and that organizes the computer department accurately. It is not accidental. It is about leadership.
>> Same thing with diversity, same thing with [Indiscernible]. It has a strong draw. I did this exercise in my department. I put up all of the computer areas and I said, if you think of only systems, what our systems? Different kinds of systems. By logical, intelligent, nanoscale, and societal. Each of these draws upon a certain set of skills. That is what we teach.
>> By the way, on top of that, there are six challenges. No matter what we do, by 2020, we must have access or some progress to work on the challenges that our community things and nationwide.
>> This is a document about a department chair making requests to campus, please give a faculty stuff, and the answer is always no. Especially in the California system. But remember, we are unable to know. We are on -- we are on a flight path. Slowing down is not an option. Stopping is not an option. So, I said, okay. Computer scientist on two fundamental changes to public addressing these challenges for the next 20 years?
>> L integrate systems, -- we must integrate systems. So, I am glad to tell you, we have a very supportive campus. We are hiring. And we have lots of priorities, and in case you see any talent in the nation across, definitely refer them to us. And in addition to the areas we are hiding in foundations, computer interactions, physical health care, pilot software, we also have on campus positions now, extra possessions and so on, on energy systems and on bio informatics.

>> Let me summarize. Energy has been a preoccupation. Especially when it comes to sustainability. You know all about it. Given the focus that we have here. Between energy and what we can debate, which is more critical, but together, they are pick components.

>> In fact, 40% of all of what we use for generating electricity, energy is used when and where the work gets done. Buildings provide a structure to that. In fact, they provide more than a structure. They provide an extraction to reason about these things. It is increasingly mixed-use. IT is there. People that use the miscellaneous love, energy plus, is actually very large and growing larger. And none of these, whether it is IT, HVAC systems, or peoples comfort systems are really proportional.

>> Computer science is at the intersection of improving operational efficiency and its scalability. To actually solve some of these problems. It is done by having improved awareness, that is where given -- data-driven things come into place. But, there is a solution. Both in space and time. Whether we can control. I have borrowed liberally from a large number of influences. And it is only fair that I noticed some of them here. I called them part of fact. -- I call them borrowed facts. Some people who have influenced my thinking in computer science and so on. And the number of products that we have done in recent years.

>> So, thank you to them. And thank you for. It is an exciting time in computer science. I would have never put the slide where there is a picture of earth or something, when we are talking computer science that we can actually do things that will change. I asked a friend of mine who is in political science. I said, where do you think political science, that is a strange subject, nothing major. He said, well you can make a difference in society. And that is what I look to do.

>> It has made a difference indirectly. Computer science happens to be in front of the indirect manipulation to direct. And you saw it today. You saw the SOPA and PIPA, there are actually 2 million people, plus, me included. And I said, fine. We have a voice to change things. Thank you so much. He met [Clapping] --

>> Rajesh will be here all day. We have a schedule. So if you would like to see him, please [Indiscernible - low volume]. Thank you very much.

>> Thank you.

>> [Clapping]

>> We ran a bit more.

>> It's okay, it was a good talk. I knew of course about the sleep server but I have never seen a follow-up on it.

>> Hello, how are you? Nice to meet you. Good to see you.

>> [Indiscernible - multiple speakers]

>> [Event concluded]