

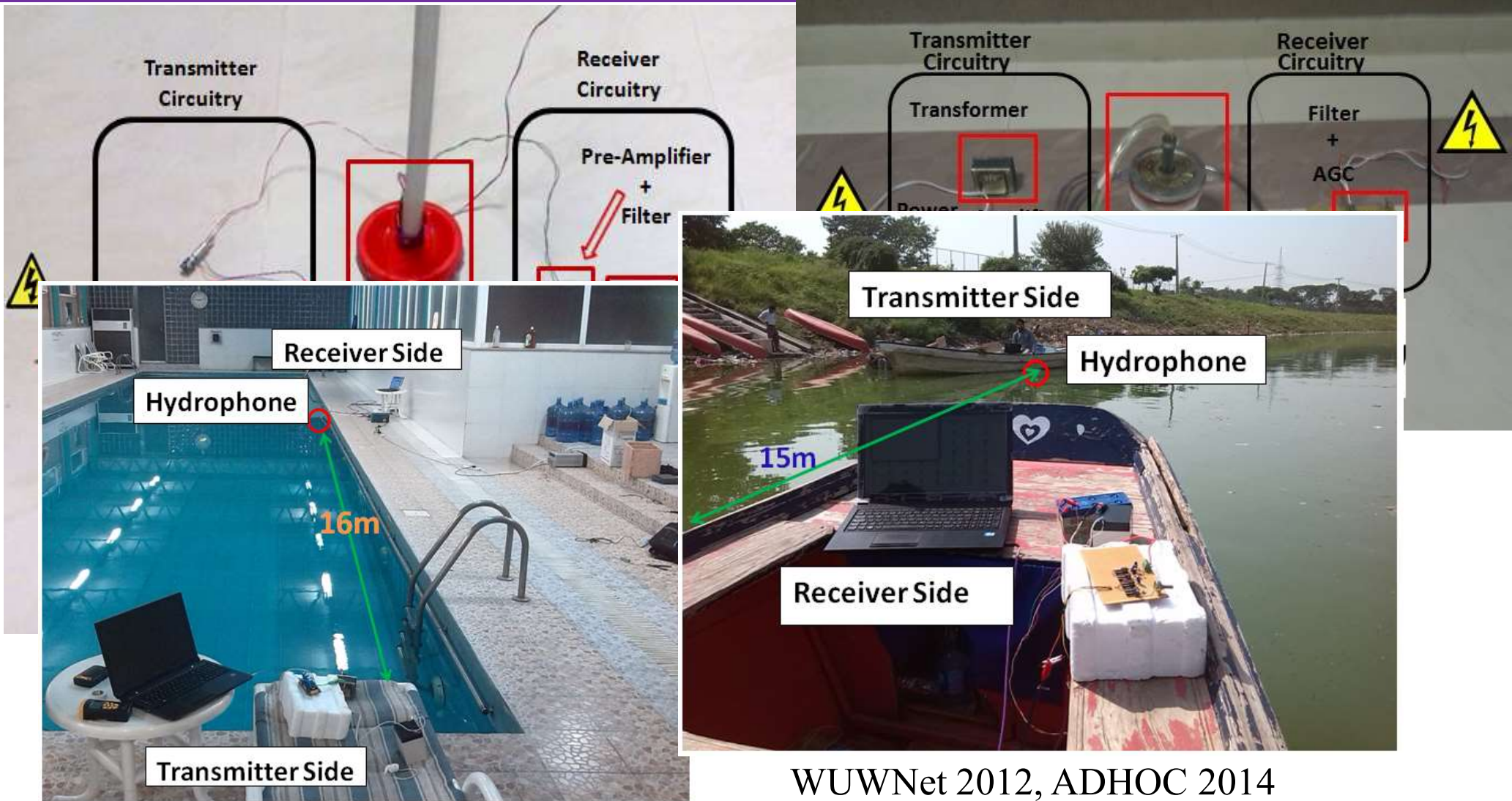
IoT for Smart-Buildings: An opportunity for Pakistan

Affan A. Syed

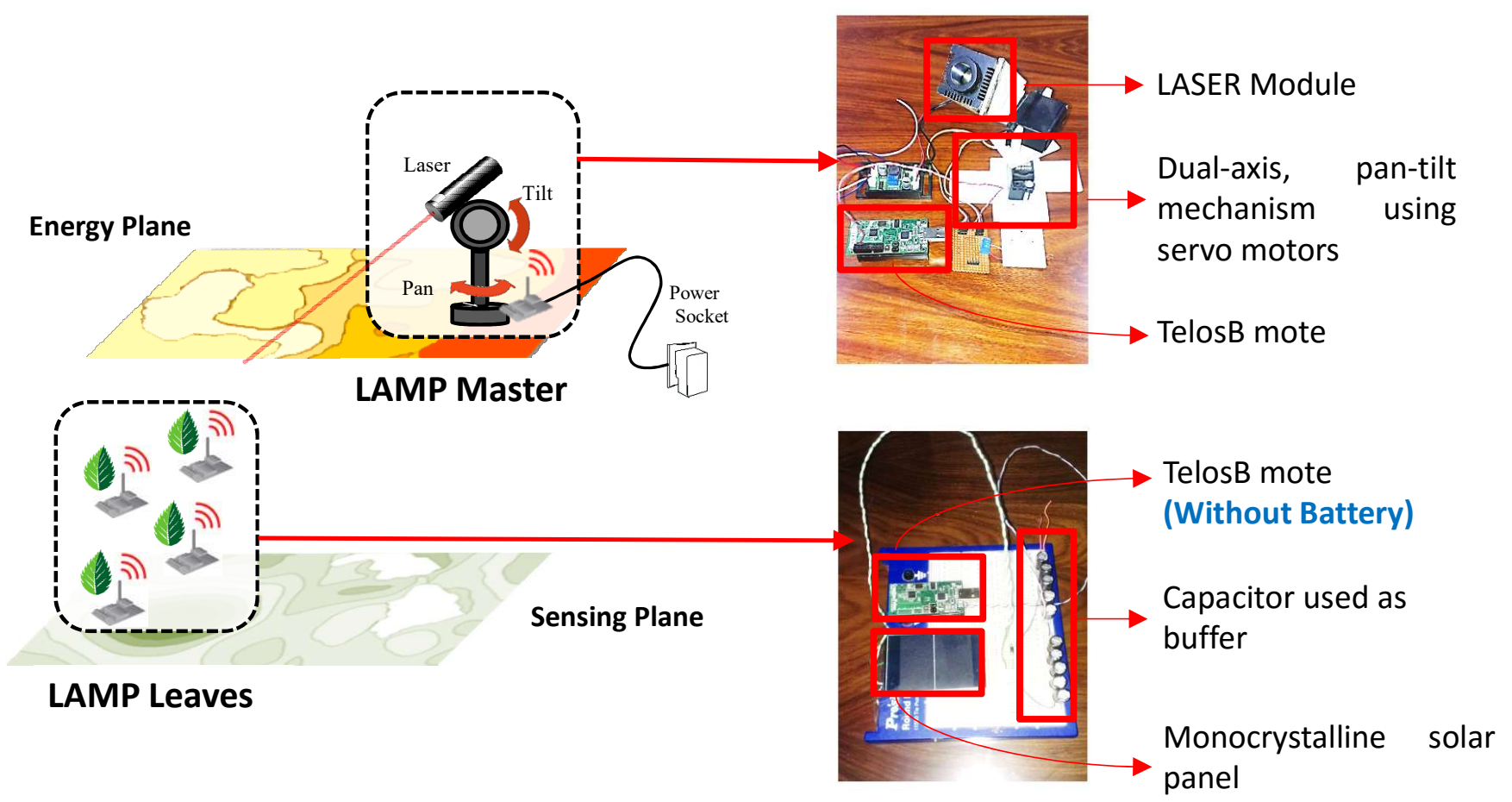
Director Engineering,
PLUMgrid Inc.

Acknowledgements: Zohaib Sharani, Noman Bashir, Khusboo Qayyum, Naveed Bhatti, and Aftab Rashid and the SysNet lab for their work and Microsoft Research for their funding

Do you know what I did (last summer!) ...



Do you know what I did (last summer!) ...



Talk outline

What I plan to do today

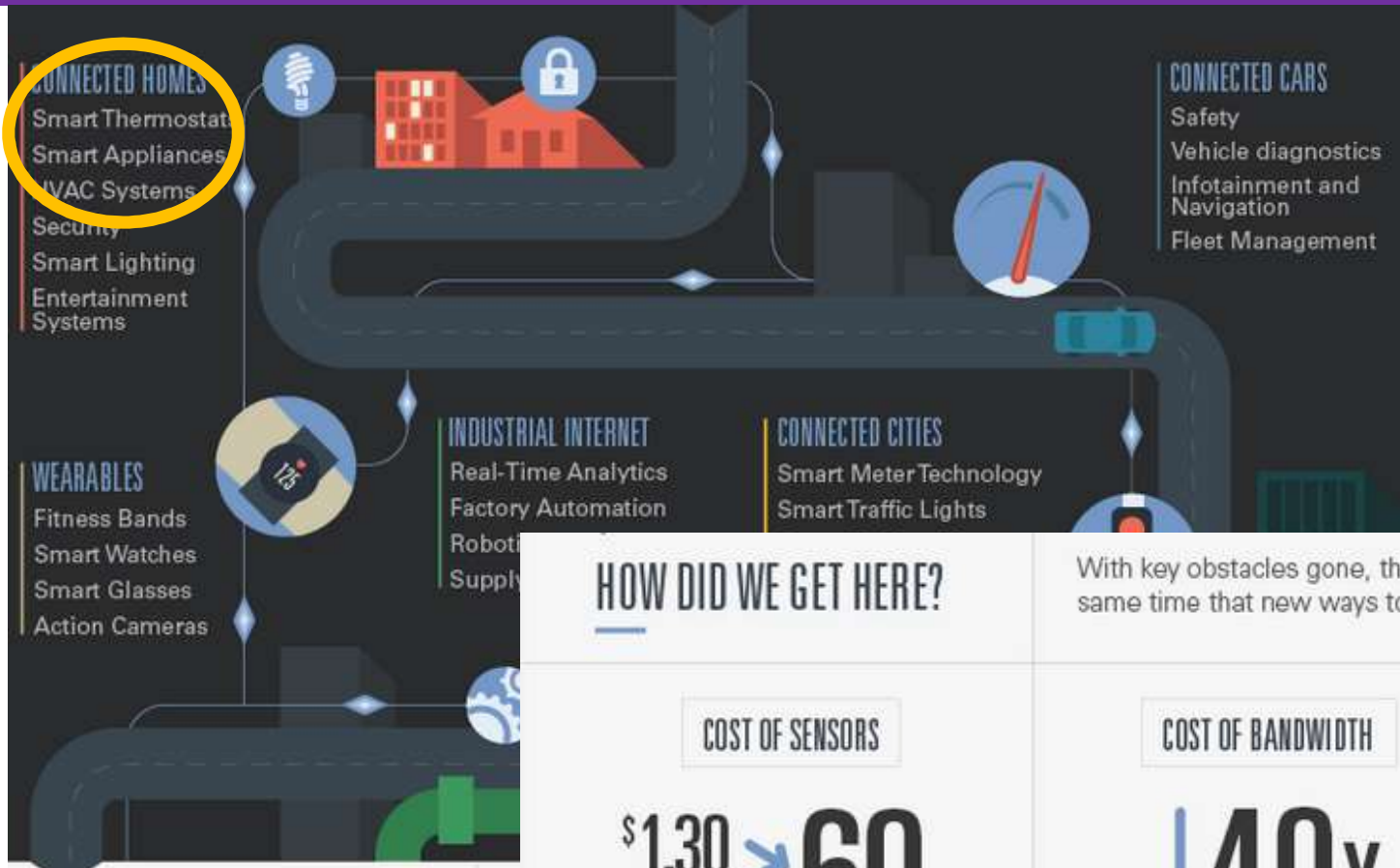
What are IoTs?

Think differently: IoT opportunity for our part of the world!

Walking the walk: Two unique ways IoT can help address these challenges

This talk was originally given to a primarily “western” audience, at the Microsoft Research Faculty Summit

IoT: What's the buzz



Disaster recovery
Wildlife monitoring

HOW DID WE GET HERE?

With key obstacles gone, the cost of connectivity has declined at the same time that new ways to analyze mountains of data have developed.

COST OF SENSORS

\$1.30 → .60
AVG. COST
over the past 10 years.

COST OF BANDWIDTH

↓ 40x
over the past 10 years.

COST OF PROCESSING

↓ 60x
over the past 10 years.

Src: Goldman Sachs

IoT: Connectivity Overlay

Computer: automating repetitive number crunching

Sensor Networks: automating collection of sensory data

IoT: Connectivity of sensory data from/to anywhere

Thinking differently!

First World Problems: Loss of *connectivity*

Lack of broadband has crippling effect

By Sharon Strover

http://www.utexas.edu/know/2011/04/08/strover_sharon_yonder/

Published: April 8, 2011

http://www.huffingtonpost.com/cp-Gurnani/the-role-of-connectivity-in-reshaping-the-world_b_4665180.html

The Role of Connectivity in Reshaping the World

For many of us, the idea of leaving home without our mobile phone or tablet, or having no access to the Internet or to our e-mail, for any great length of time, is unthinkable. In today's tech-driven world, the latest electronic gadgetry -- be it a

Posted: 01/25/2014 10:39 am EST | Updated: 03/27/2014 5:59 am EDT

OPINION INTERNET

The Internet As a Human Right

The Washington Times

Facebook's Zuckerberg: Web access a 'human right'



GOGO UNLIMITED
UNLIMITED
INTERNET ACCESS
WHEN YOU FLY

PROJECT LOON

WHAT IS LOON?

HOW LOON WORKS

WHERE LOON IS GOING

 Google

BALLOON-POWERED INTERNET FOR EVERYONE

Another loss of (power) connectivity



Load Shedding to Continue Across Maharashtra

<http://www.outlookindia.com/news/article/Load-Shedding-to-Continue-Across-Maharashtra/842950>

MUMBAI | JUN 02, 2014



Province: KwaZulu-Natal
City: Mandeni
Suburb: Equmeni
Month: 30-06-2014 to 27-07-2014

Home What is load shedding Interpreting schedules

1
Stage 1

●

Up to 1000 MW to be shed
From 06:00-22:30 Monday
to Saturday

2
Stage 2

○

Up to 2000 MW to be shed
From 06:00-22:30 Monday
to Saturday

3
Stage 3

○

Up to 4000 MW to be shed
24hrs from Monday to
Sunday

Mon, 30 Jun	Tue, 01 Jul	Wed, 02 Jul	Thu, 03 Jul	Fri, 04 Jul	Sat, 05 Jul
-	20:00 - 22:30	-	10:00 - 12:30	-	20:00 - 22:30

Nepal Loadshedding Schedule

30

Load shedding compounds summer heat

April 22, 2014 | Filed under: Electricity, Energy | Posted by: bchronicle



The daily production of electricity has reportedly been reduced to bring down the cost of buying power from rental plants

Summer 2013 it got really bad in Pakistan!

DAWN.com

Sui Northern suspends supplies for industrial, CNG sectors

December 11, 2013 | Safar 7, 1435

HOME LATEST PAKISTAN WORLD SPORT BUSINESS SCI-TECH ENTERTAINMENT MULTIMEDIA
OPINION IN-DEPTH ARCHIVE

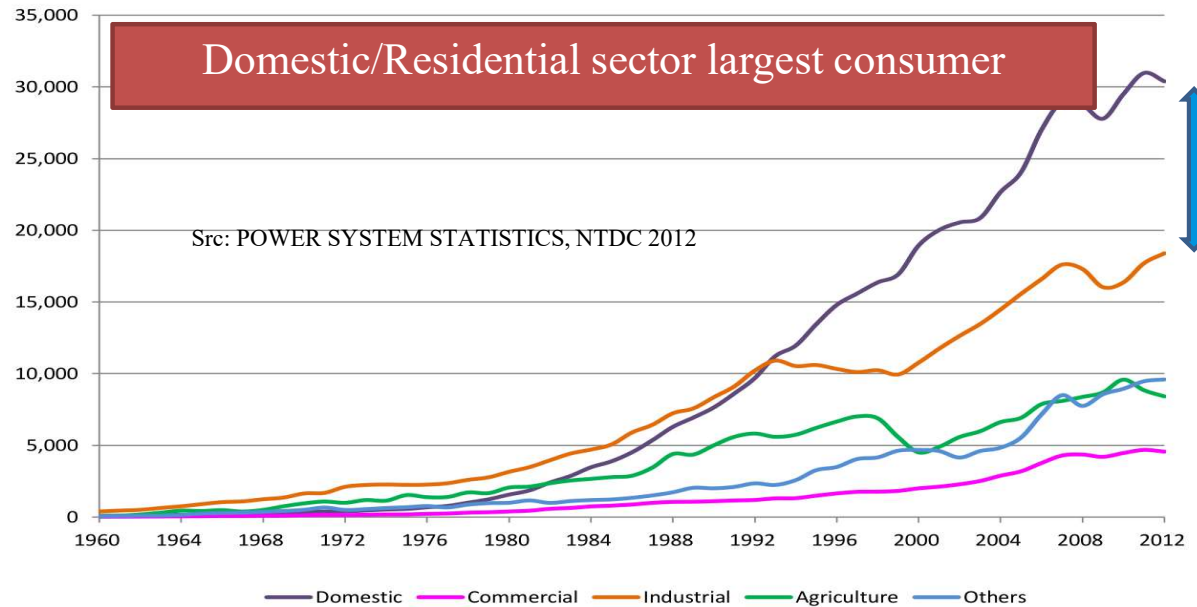
Home Newspaper Lahore

14 to 18-hour loadshedding

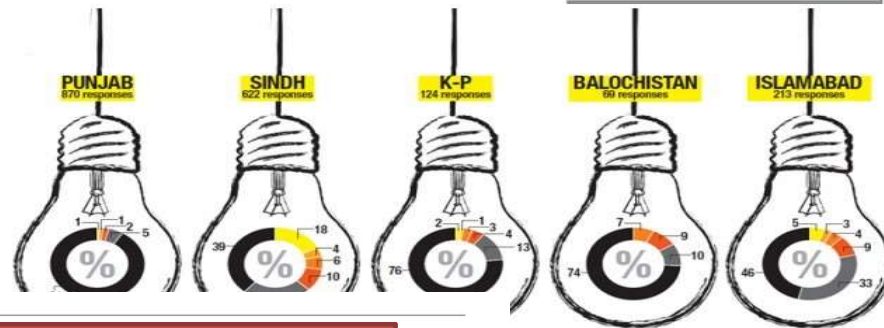
THE NEWSPAPER'S STAFF REPORTER

Like 0 Tweet 0 +1 0 Share Email 0 Comment(s) Print

LAHORE, April 16: With weather warm for electricity has risen above 14,000MW 9,000MW. As a result, urban feeders at loadshedding and rural ones close to 1

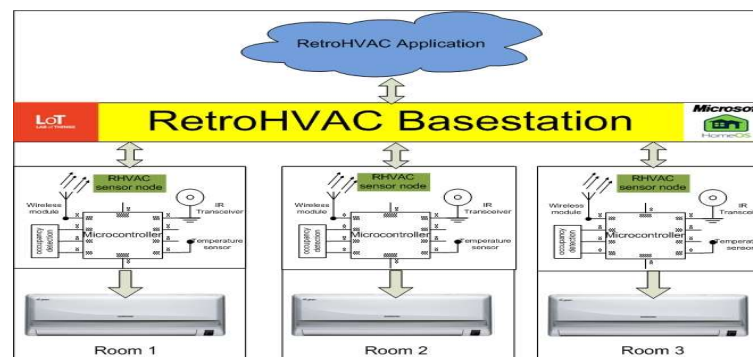


THE EXPRESS
TRIBUNE
WITH THE International New York Times



Agenda

1. Removing the inefficiencies of UPS backups
2. Reducing consumption in old office buildings



Both using an IoT inspired, LoT enabled instrumented home

Walking-the-walk! SoftUPS and SmartHomes



Local energy backups: managing load-shedding



Naïve soln: store energy from grid; use to power *essential* appliances during *load-shedding*



Load shedding

In effect we voluntarily move our homes to a low power state

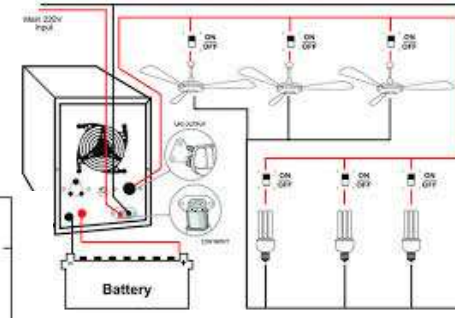
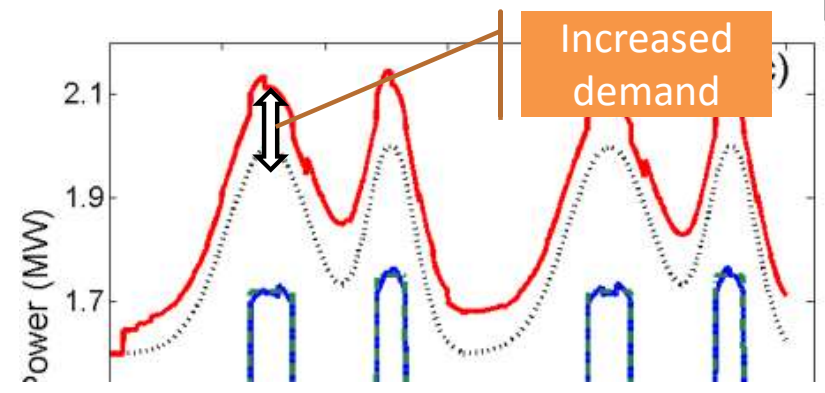
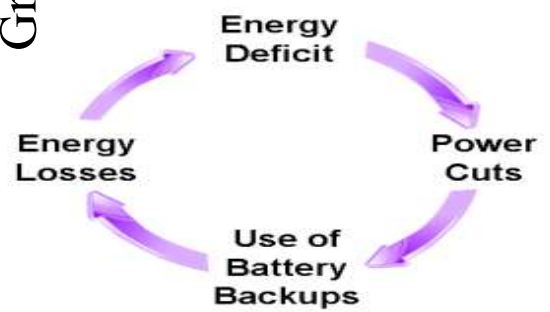


Problems of a UPS+battery backup

- Consumer**
- Cost (initial \$300, recurring \$100*)
 - Limited capacity
 - Rigid selection of appliances (hard-wired)



- Grid/Govt**
- Increased total load on grid (inefficient)



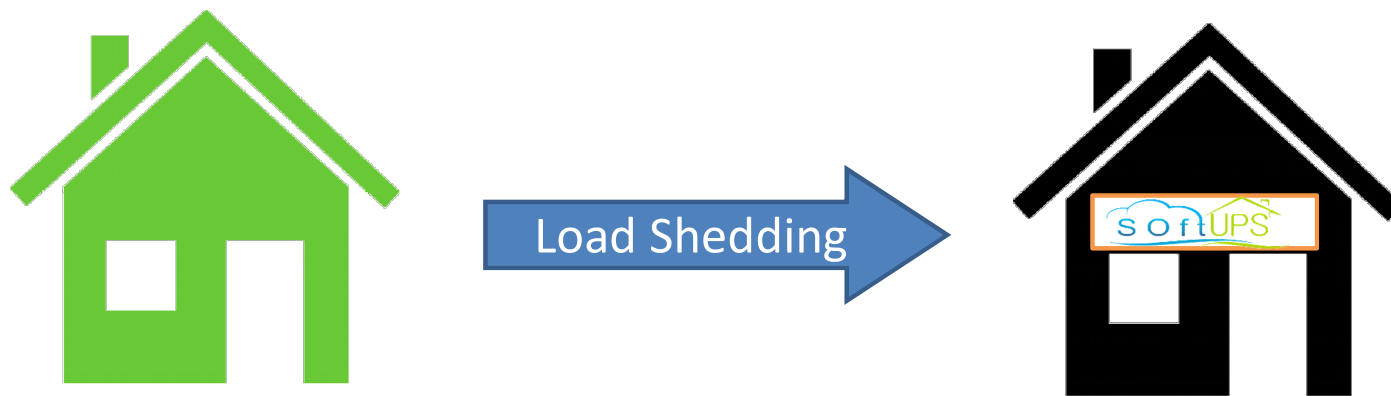
Src: askmohsin.com

“Hidden Costs of Power Cuts and Battery Backups” in e-Energy’13, May 21–24, 2013

Key Idea for SoftUPS

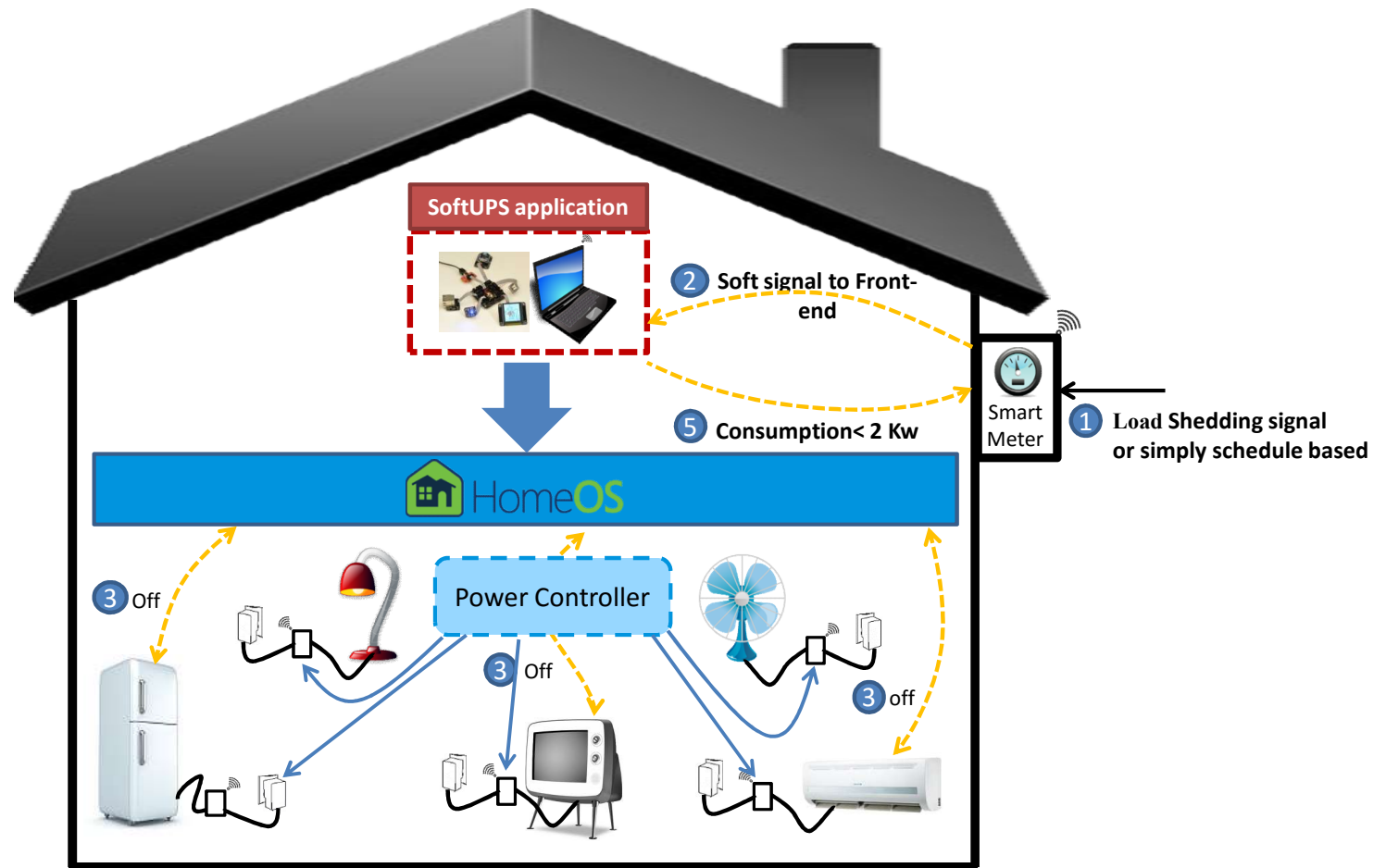
When demands need to be shed, why not *emulate* low power mode of a UPS-based soln?

Something enforces homes to operate at a lower power state
But operate directly off the grid!



Zohaib Sharani, Khushboo Qayyum, Noman Bashir, Affan A. Syed. "**SoftUPS: Eliminating the need and cost of battery backups in the developing world**", ACM e-Energy conference, 2014, Cambridge, UK

SoftUPS: Architectural Overview using HomeOS/LoT



Benefits of SoftUPS

One time cost

No efficiency losses

No resource exhaustion

Dynamic reallocation of power budget



Deployment and practical concerns

Worrying about power dissipation and consumption

Device and system cost

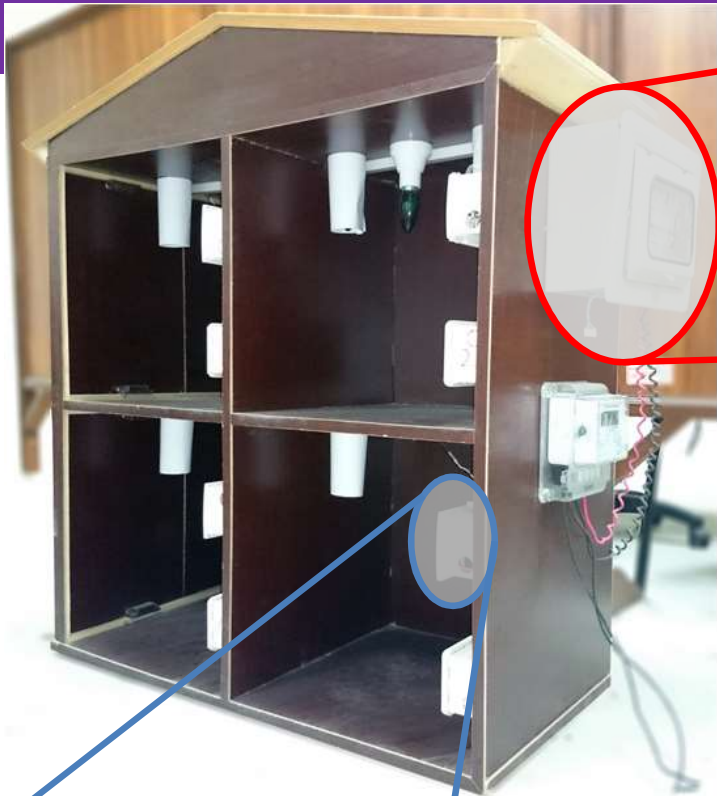
Keep the cost of entire solution under \$300

Power theft and accidental misuse

Detection and response

Application interface for usability

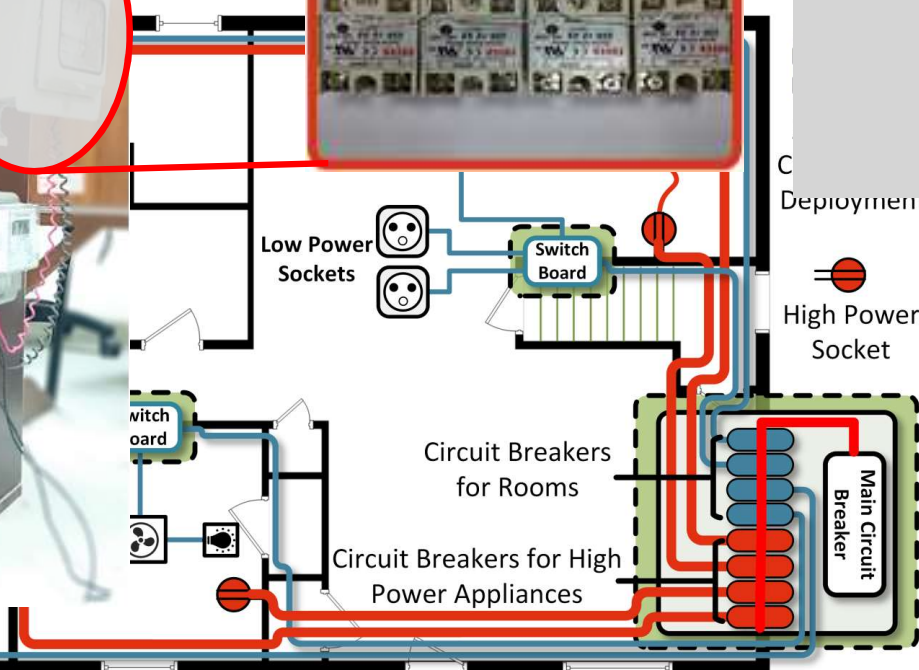
Motivation and incentives for its usability



Total Cost = \$ 28.07
Power = 3.5W



Total Cost = \$18.07
Power = 2.5W



Current Power state: Normal
 Allocated Budget Threshold

Level 1:	150 W
Level 2:	300 W
Level 3:	500 W

Reset
 Settings Load-Shedding

Top Left Room - Level 1

Max Threshold	150 W
Total Consumption During Loadshedding	85 W
Max Room Consumption During Loadshedding	15 W

1 2 3 4 5
 Settings High Load

Deployment
 High Power Socket

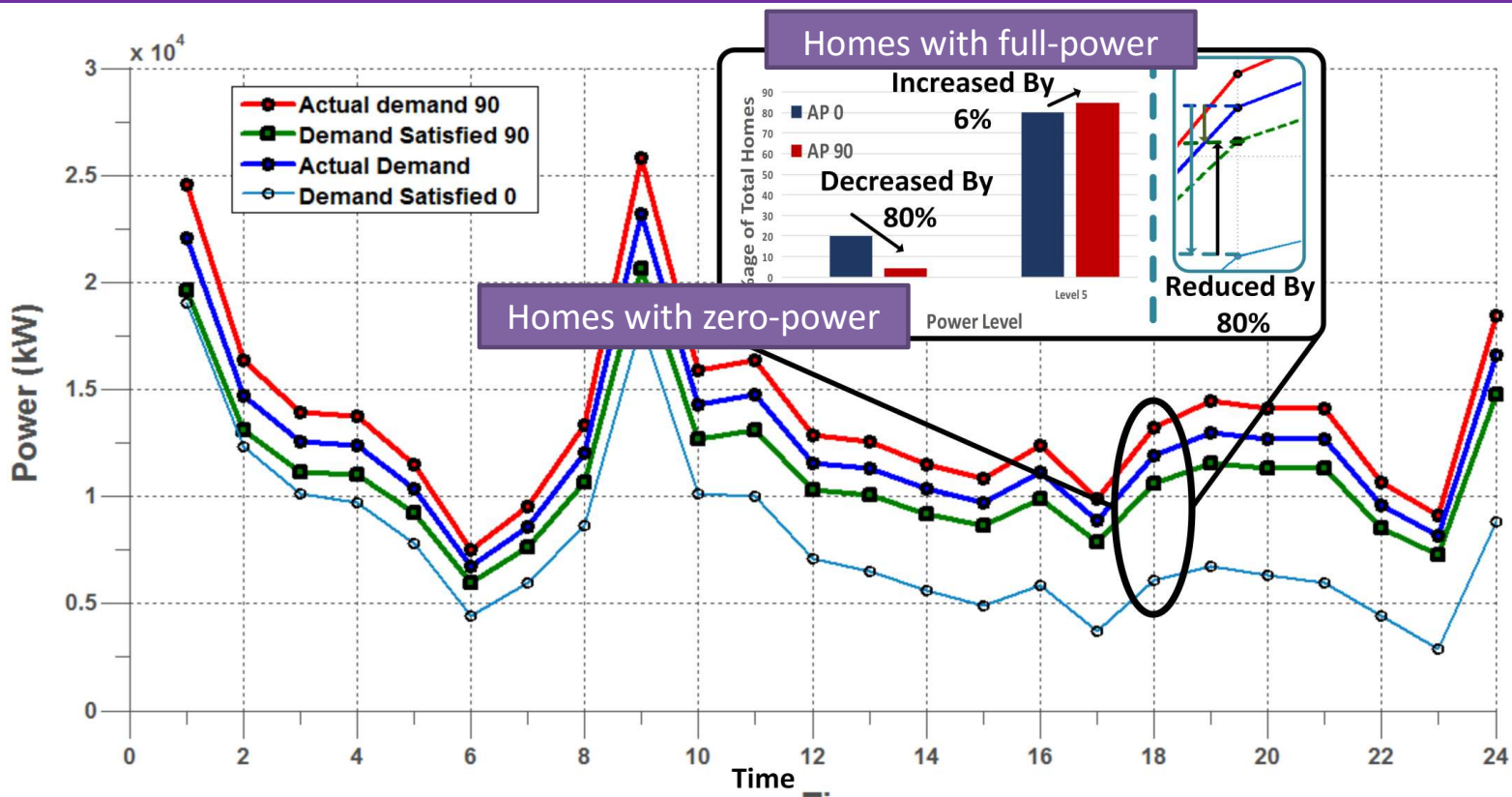
Research Enabled: Intelligent Demand Response (Aashiyana)

Power “*congestion control*” algorithms with an automated demand control implemented at home

Fully distributed

centralized

Some results astonishing results (for the same demand-supply gap)



RetroHVAC: HVAC for old buildings

Old buildings have distributed HVAC elements

Ventilation (fans)

Cooling (ACs)

Heating (Space heaters)



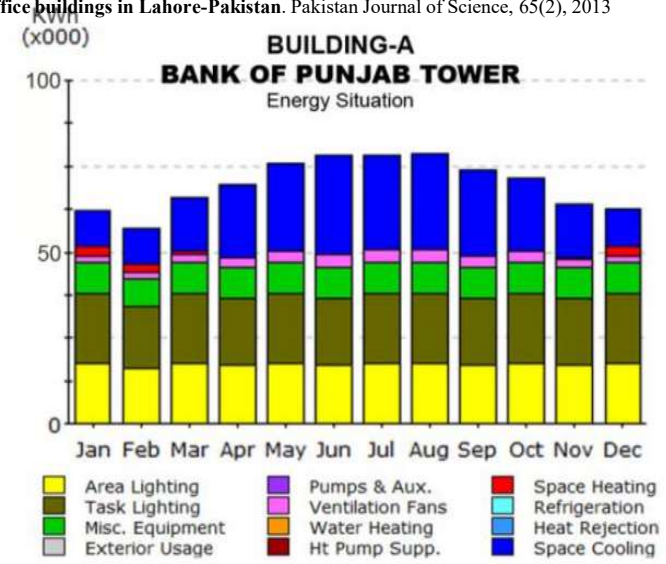
<http://www.wahid-industries.com/>



<http://hvacmarietaco.com/ductless-mini-split-air-conditioning-systems.html/>



A Khan, S Arif, M Mushtaq, et al. **Electricity consumption for energy conservation in office buildings in Lahore-Pakistan.** Pakistan Journal of Science, 65(2), 2013



Scenarios of misuse/waste

Load Shedding



Leaving AC on,
inadvertently or
laziness

Scenarios of misuse/waste

Temp set
point = 18°C



Setting very low
threshold;
Lack of concern

Why not use HVAC to solve these problems?

Large capital cost + inconvenience

Waste of existing distributed elements



<http://www.wahid-industries.com/>

<http://hvacmariettaco.com/ductless-mini-split-air-conditioning-systems.html/>



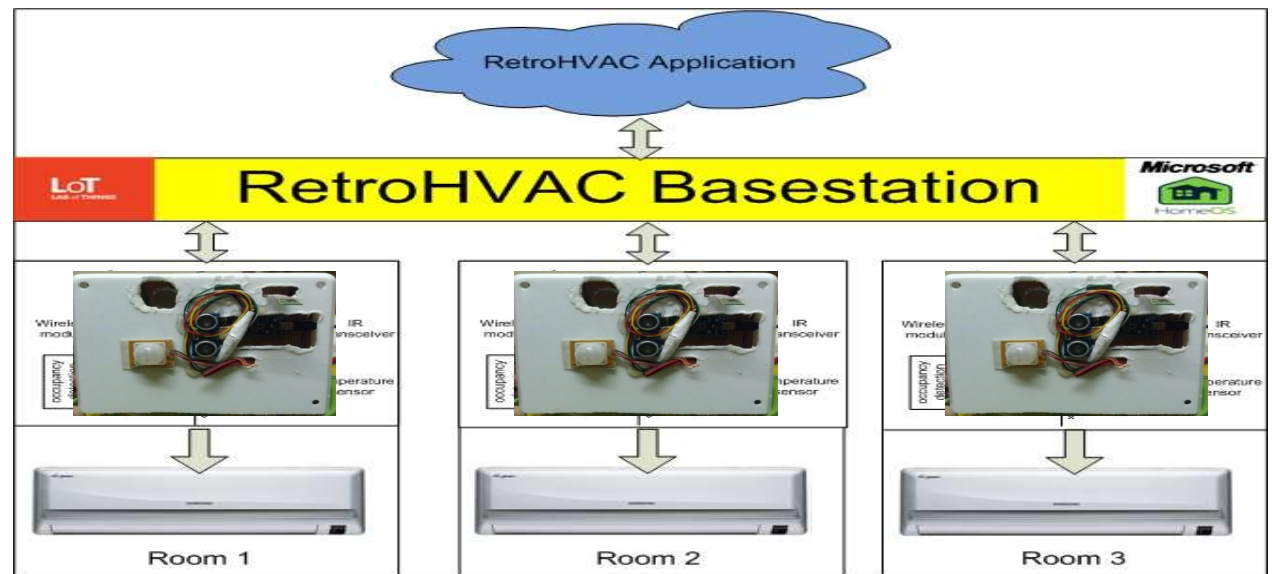
<http://www.homeadvisor.com/rated.M-rehouseImprovements.133377>



Retrofit elements for centralized control

Retrofit existing elements with control and comms

Centralize command to enforce energy policies and ASHRAE standards



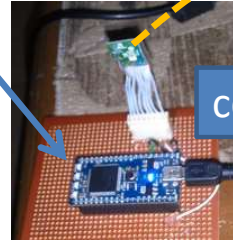
Architecture and Implementation Overview

Three components of RetroHVAC

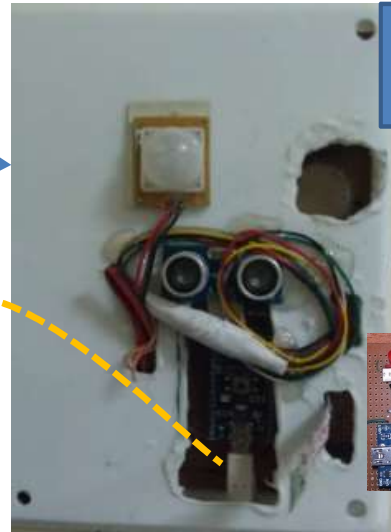
Control nodes

Base station

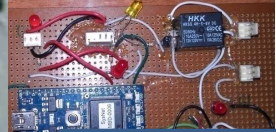
Application



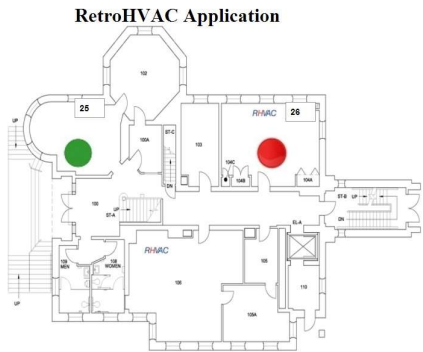
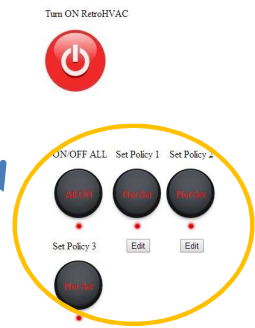
cc2500



PIR, light, ultrasound, and temp sensors



Interface with remote



Evaluation of savings

Three policies

Static time based

Temp Control (+Static)

Occupancy based (+Temp+static)

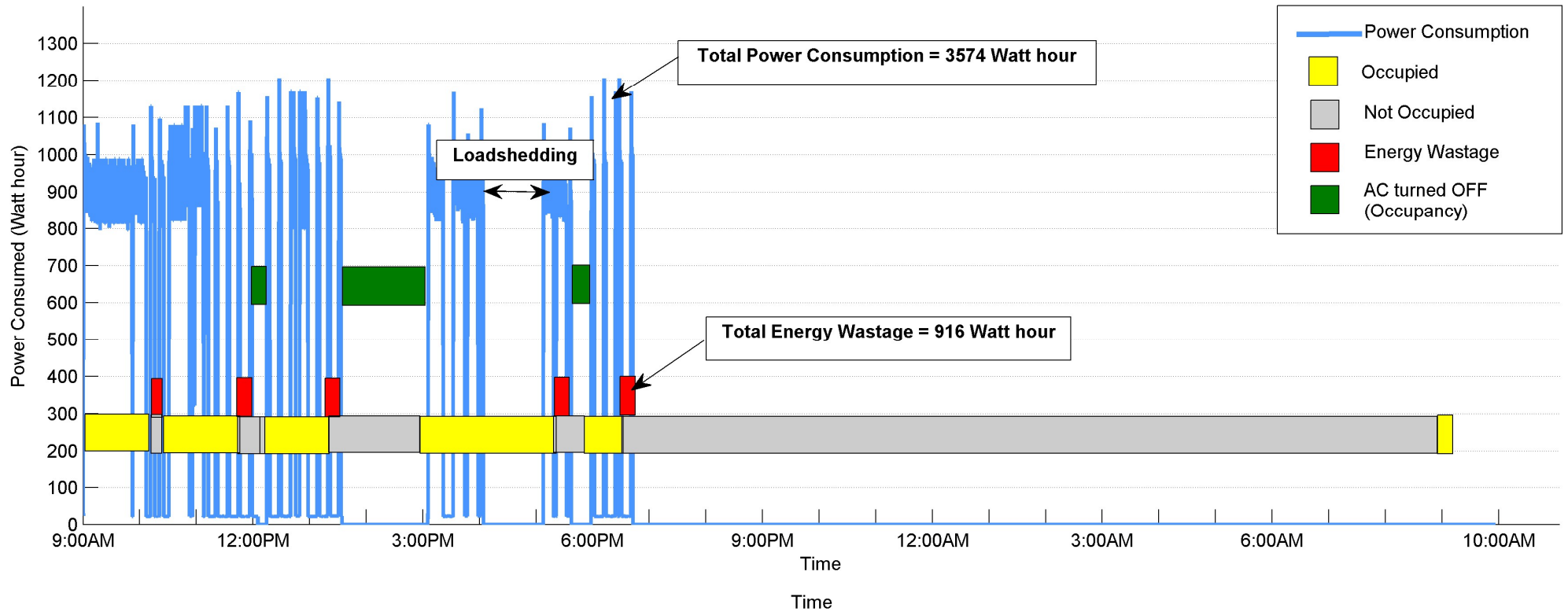
Base day consumption for a faculty office

Comparison with savings for different policies under real evaluation



Energy Savings

24-Hour Power Consumption of an Air Conditioner using RetroHVAC Occupancy Based Policy (23rd May 2014, Temperature=32C)



67.1% savings from base (AC on) day, 33.7% for a normal day

IoT can add smartness to any thing!

Connected buildings are an alternate (shorter?) path to **improve living standards** in *developing economies*

Maturing technologies and bleed back

Note from Experience:
IoT frameworks are essential to allow focus on
impactful applications

For more information
<http://sysnet.org.pk/w/Publications>

Thinking smartly, *“Smart”-ness* can be much more
than convenience!



Questions