Internet of Things: from intelligent to smart building

HKIE Venereee Club Talk

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About the speaker

Affiliations
- PhD (Hong Kong Polytechnic University)
- Founder of MEGA Automation (HK) & FUSQUARE (China)
- ASHRAE 2016-2018 Electronic Communication Chair
- Hon Secretary of iEthics

Latest Publications
- (TII ‘16) Asynchronous and Selective Transmission for DeWiring of Building Management Systems
- (APCBE ‘15) Occupant-participatory Approach to Enhance Thermal Comfort
- (BuildSys ‘13) Carrying My Environment with Me: A Participatory-sensing Approach to Enhance Thermal Comfort
80% Time in buildings

65% Electricity used in buildings

54% Consumed by HVAC system
In Hong Kong, it’s all buildings!
Power Off Everything!

2017 全球響應關燈愛地球

永續山林 生態城市 無塑海洋
Behind the scene...

Building Automation system

- Monitoring & controlling of building systems
  - HVAC
  - Fires
  - Lighting
  - Lifts & escalators
  - Measuring meters
  - Sensors & actuators
Too many systems...
What’s worse...

- Different systems cannot talk with others
- Maintenance Difficulties
- Unable to conduct system optimization
- Low flexibility for retrofit
- Vendors lock-in

Source: http://www.bacnet.org/Tutorial/HMN-Overview/sld002.htm
Moreover...

- Improper management to building facilities leads to
- Sick building syndrome (病態建築綜合症)
- Inefficient energy use
- Rise of energy bill
- Higher CO₂ emission
Emergence of intelligent buildings
Energy Audit Code

- Building Energy Efficiency Ordinance (Cap.610)
- Covers A/C, electrical, lighting & escalator
- ALL HK commercial buildings!
Institutional-driven

- Green building design and assessment
  - Hong Kong
    - BEAM Plus
    - Building Energy Codes
  - China
    - Evaluation standard for green building (绿色建筑评价标准) GB/T 50738-2006
    - China Green Building Label (中国绿色建筑标识)
  - International
    - ISO 50001
    - LEED
What’s required behind ...
Data Flooding – 4V

Volume
- Data at Rest
  - Terabytes to exabytes of existing data to process

Velocity
- Data in Motion
  - Streaming data, milliseconds to seconds to respond

Variety
- Data in Many Forms
  - Structured, unstructured, text, multimedia

Veracity*
- Data in Doubt
  - Uncertainty due to data inconsistency & incompleteness, ambiguities, latency, deception, model approximations

Source: IBM
The era of IoT - Connecting the unconnected
The Internet of Things

The Internet of Things (IoT) connects machines and devices to one another. IoT can help all industries become more efficient, productive and safer.

To become connected an object must be able to:
- Capture data
- Transmit data

2003-2010:
10 - 20 BILLION
things connected to the internet today

By 2020
this number is estimated to grow to
40 - 50 BILLION
That's roughly 5 connected devices per person on earth!

The Rise of Sensors
Sensors enable IoT. Every object, even the human body.

Anything that is hard to monitor can become easy.

Today’s devices have between 6-9 sensors:
- Ambient Light
- Accelerometer
- Magnetometer
- Motion Coprocessor
- Ambient Sound
- Gyroscope
- Proximity
- Temperature & Humidity
- Barometer

A New Economic Age
The 2020 annual global economic potential across all sectors is estimated up to
$14.4 TRILLION
That is the current GDP of the European Union!

Cheap sensors are accelerating the growth of IoT.

The decrease in cost of sensors has fuelled the number of connected devices:

Cost of an Accelerometer
2007 1 Axis: $7
Today 6 Axis: $0.5

IoT Risks:
- Privacy
- Cybersecurity
- Liability

The opportunities generated by IoT far outweigh the risks
For businesses to fully realize the great potential of IoT, they will need to be prepared for the risks that lie ahead.

The Insurance Industry is well positioned to help businesses navigate an IoT world.

Industries currently benefiting from IoT:
- Automotive
- Banking
- Marine
- Property
- Energy
- Aerospace
- Healthcare
- Manufacturing
- Food

Safety
- Driverless cars, worker accident prevention

Efficiency
- Biometric banking, smart TVs & thermostats

Decision Making
- Data driven insights

Infrastructure
- Risk triggers, electrical networks & predictive maintenance

Source: AIG
IoT @ smart buildings
Case 1: New maintenance services model

- Traditional device installed with smart hardware
- Real-time monitoring & enabled remote support after sales
- Predictive maintenance services & potential for new sales lead
What common problem we face today?
Thermal Comfort Control - Challenges

- No thermal comfort sensor - subjective
- People do not know their preferred temperature
- Changing thermal preferences
- Diverging preferences to a group of people

How to tackle the challenge?
Thermal Comfort

“The condition of mind that expresses satisfaction with the thermal environment”

American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)

Factors:

i. metabolic rate
ii. clothing insulation
iii. air temperature
iv. radiant temperature
v. air speed
vi. humidity

How can the facility operator knows?
Thermal Comfort

1. User submits their votes
2. Optimized Setpoint adjustment
3. Machine learning to optimize the system and group thermal comfort

Source: Comfyapp.com
Group comfort improvement

Overall improvement: 33.8%
Smart Office Control App
Smart City Perspective

- Smart Mobility
- Smart Economy
- Smart Government
- Smart Living
- Smart Environment
- Smart People
Thank You!

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