Intro to Smart Cities

Gregg Vesonder

2017

Today

- Discussions of expectations
- The concept of a city and why it is important
- Early attempts at studying modern cities
- Smart City approaches
- Recent Experience
- Lessons learned
- Readings next week
  - https://theurbantechnologist.com/2012/09/26/the-new-architecture-of-smart-cities/

Course Overview

- Explore Smart Cities and introduce underlying technologies
- There is a strong social component
- There is a strong infrastructure component
- Hope also to touch on modeling
- There will be some exposure to hardware and software

Course Grading

- Homework 10%
- Mid Term 15%
- Final 25%
- Project 30%
- Paper 20%

Papers are individual, projects can be a team

Cities attract population

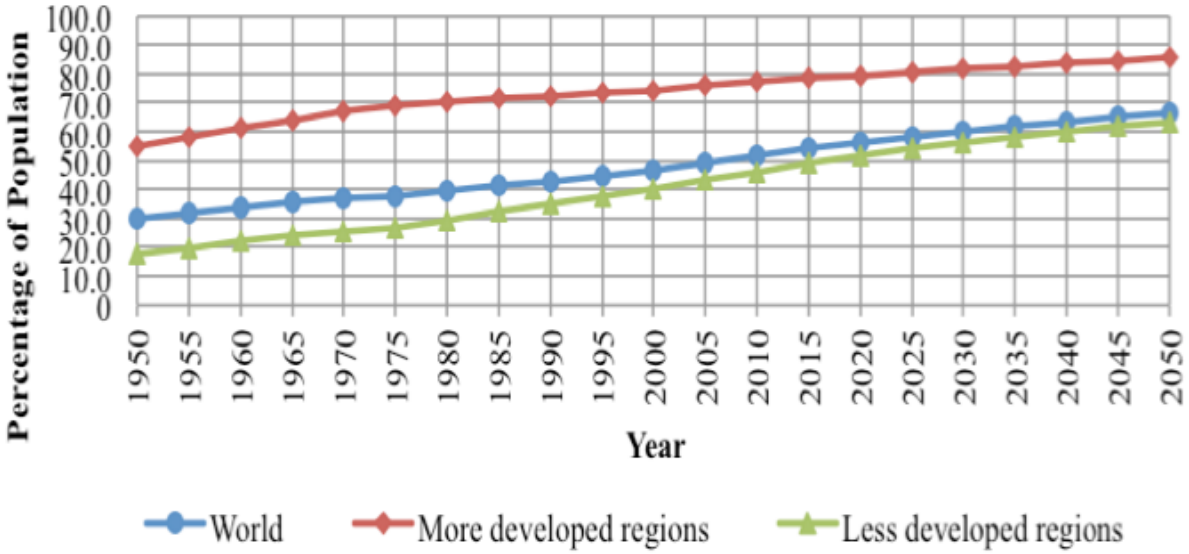


Figure 1: Percentage of the World Population Residing in Urban Areas, Separated by More and Less Developed Regions from 1950 to 2050

Hoong Yan See Tao

2017

What is a city – Jane Jacobs

1. Mixed Primary uses
    1. Business districts + residences + shops
    2. Short Blocks
        1. Explore new paths, discover new businesses
    3. Aging Buildings – a diversity of ages
    4. Population Density is good

What is a successful city? -Jacobs

https://curbed.com

Your ideas on what makes a city work and move to greatness

William Holly Whyte

Whyte film

Sun
Trees
Water
Food
Seats

ROADMAP

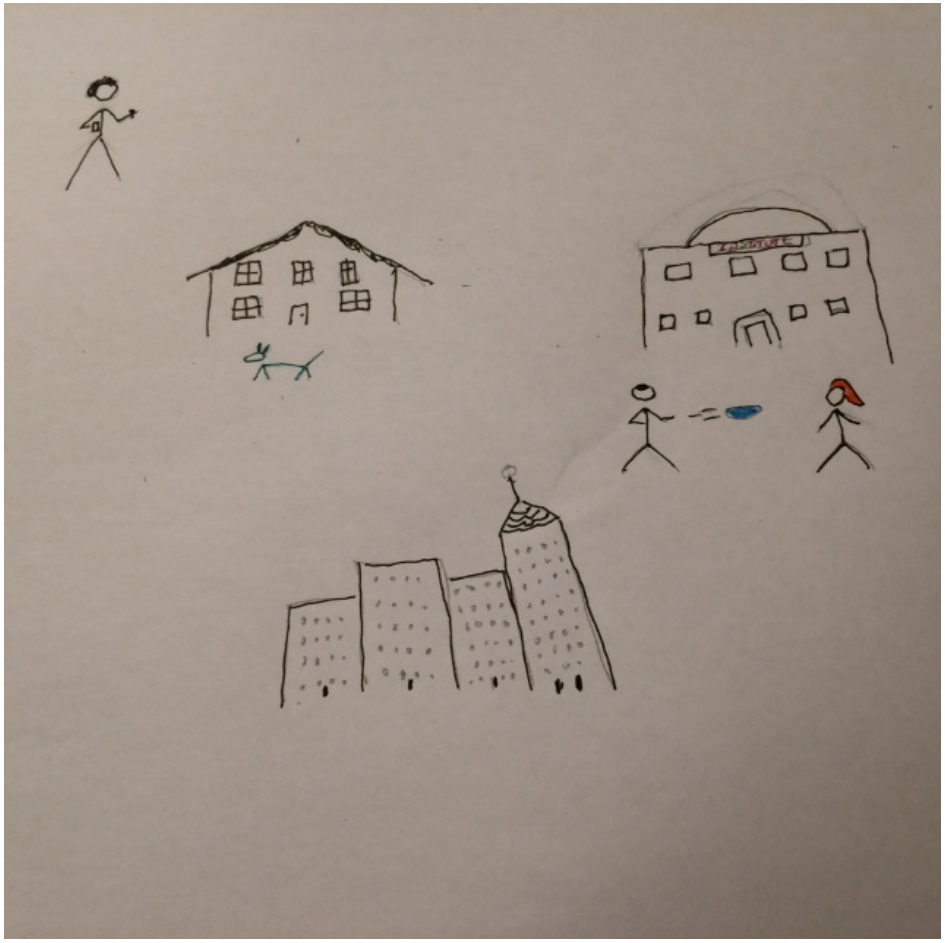
- "Architecture" of Smart Cities
- Sensored

Smart *
Architecture

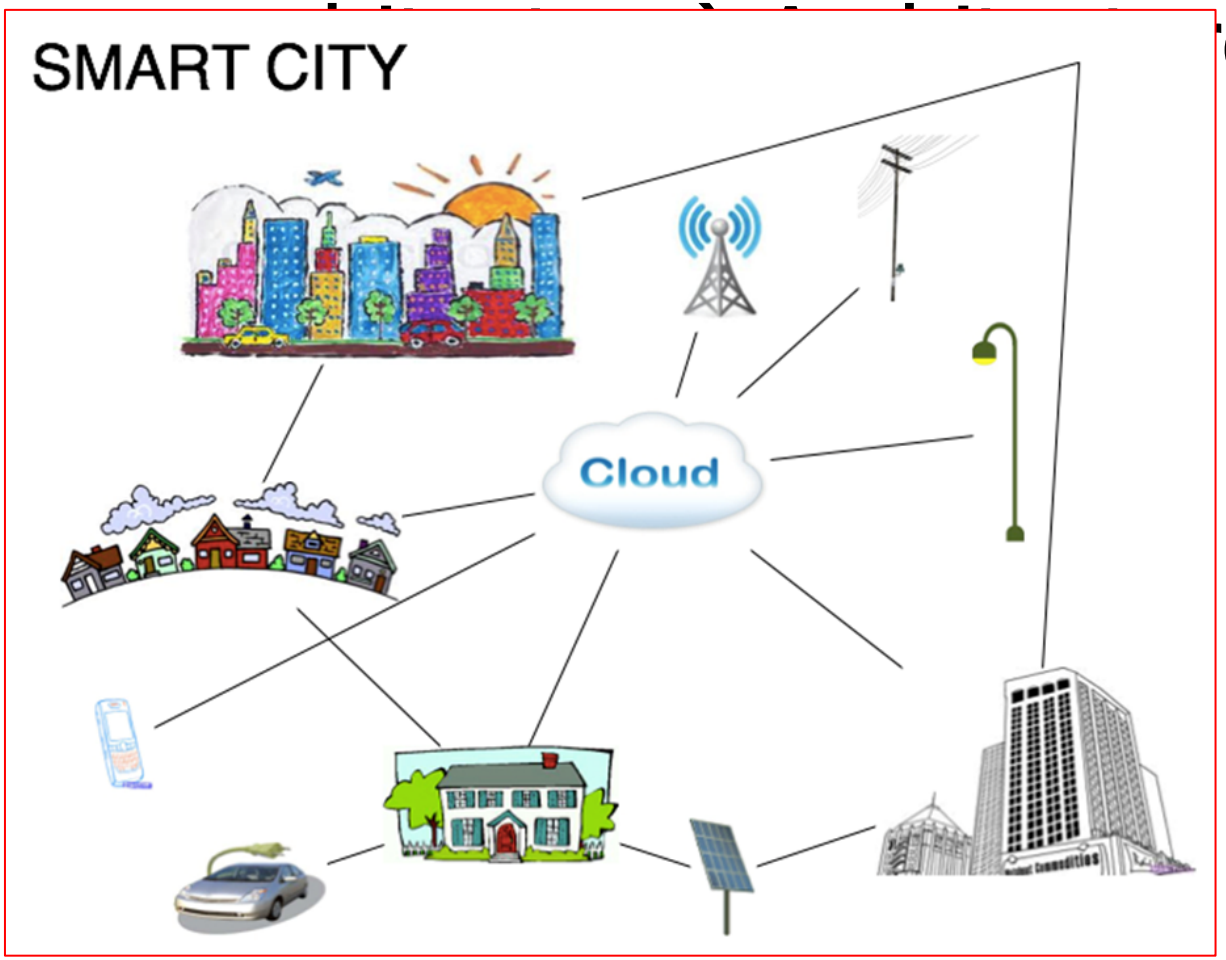
WHY Smart City Architecture?

- Many of the models and simulations of smart cities are based on data
- Understanding the provenance and issues with the data are essential to build your model
- As you will see:
  - Missing data – why am I missing it?
  - Inaccurate data – why and how can I correct it?
  - Maintenance issues
  - Security issues
  - …
- In short in this instance it is good to understand how much trust you can place in the data by understanding the architecture and its issues

Smart House, Campus or Neighborhood and City



Smart City (very notional



Radio!

Cloud!

RADIO

- ZigBee
- Z-Wave
- Wi-Fi
- LTE, 3G, 2G

Cloud – where the data is being sent

Ubiquitous and sharded

-resiliency

Reliable

Near Unlimited Storage Capacity

Scaling on Demand

Analytics

Secure (VMs, Containers)

Cost effective, e.g, erasure coding

My Experience

- indoor sensors using t-mote skys
- MAPS Department at AT&T Labs – Research
  - cloud research too
- smart Hoboken prototype
  - Digital|virtual Hoboken too
- beacon project and smart homes for elder care

T-mote sky projects

- Placed all around our building ~40 motes
- ZigBee radios
- Temperature, humidity and light sensors
- Later added power, “bump in the line” sensors for our servers

Recurrent Issues

- Power
- Location
- Communication
- Calibration
- Security
- Storage
- *Maintenance*
- Analysis
  - Big Data

Smart Hobo

- 19 libellium sensor installations
  - 6 additional meshlium servers
  - Arduino like
  - ZigBee
- Several streets in Hoboken particularly
  - Washington and Sinatra

Recurrent Issues

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Solar panels, batteries, and tre

Recurrent

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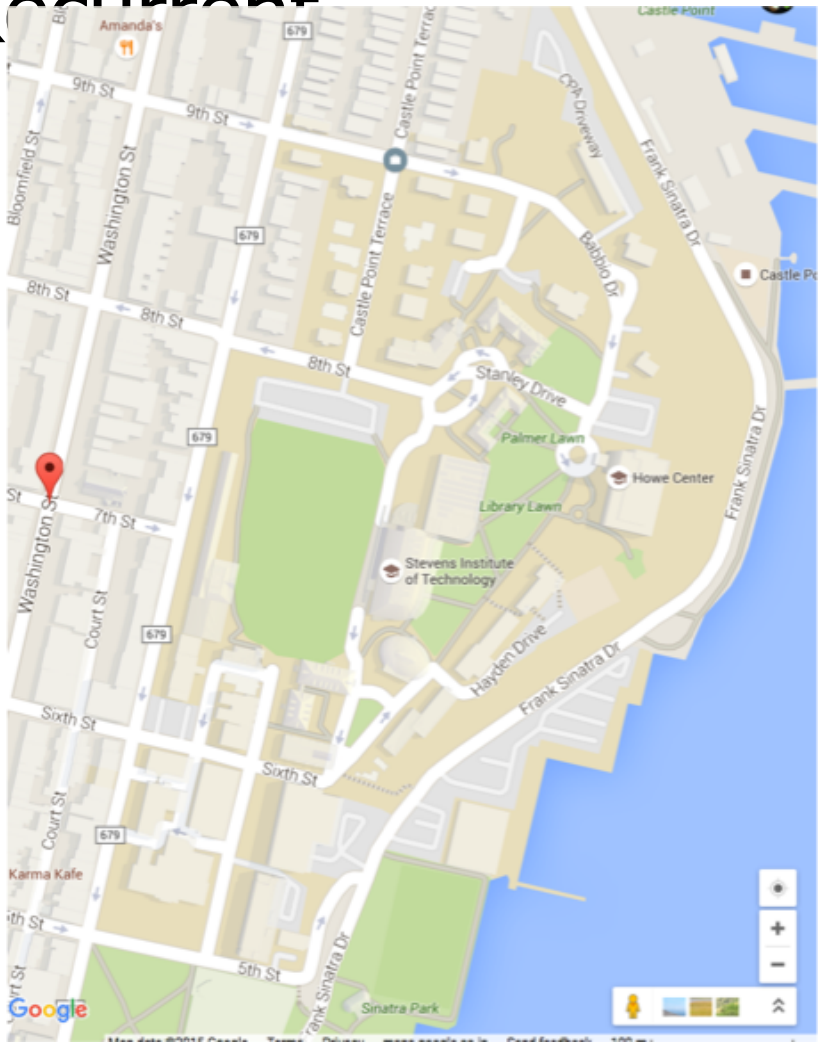

Recurrent Issues

- Power too!
- Location too!
- Communication
- Calibration
- Security
- *Maintenance*
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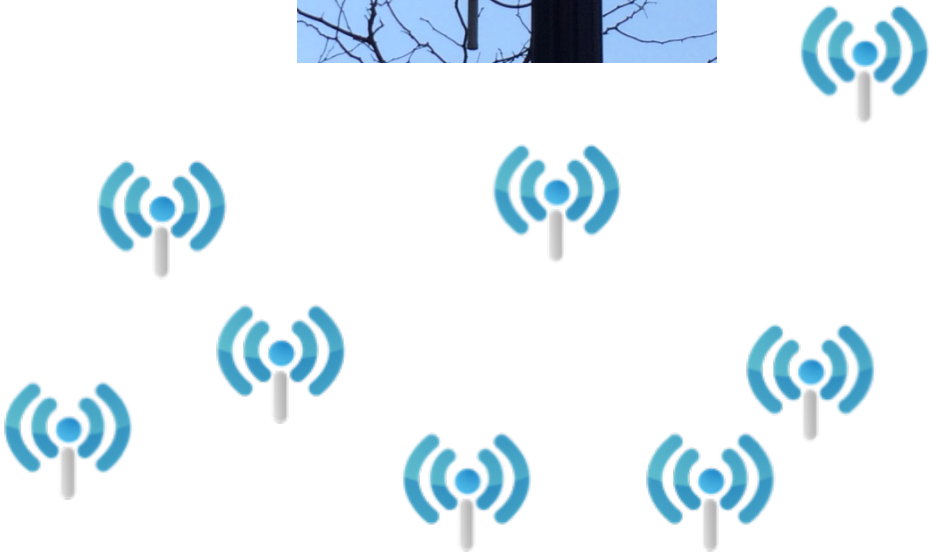

Recurrent Issues

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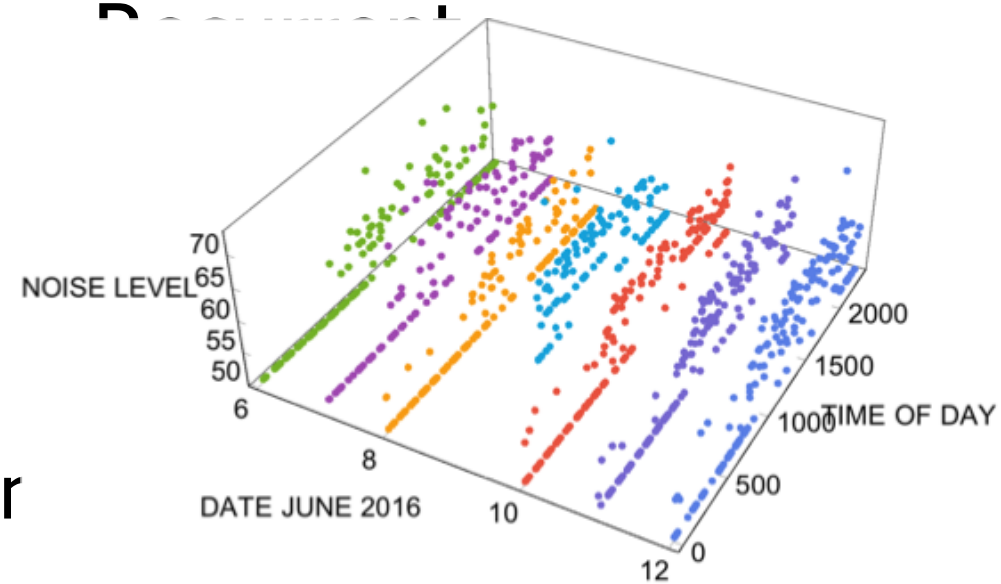

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12226	2015-07-23 14:13:39	0	1N	382549587	253	59	MCP	65
12225	2015-07-23 14:13:39	0	1N	382549587	253	59	BAT	100
12224	2015-07-23 14:08:33	0	1N	382549587	253	58	MCP	64
12223	2015-07-23 14:08:33	0	1N	382549587	253	58	BAT	100
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12221	2015-07-23 14:03:27	0	1N	382549587	253	57	BAT	100
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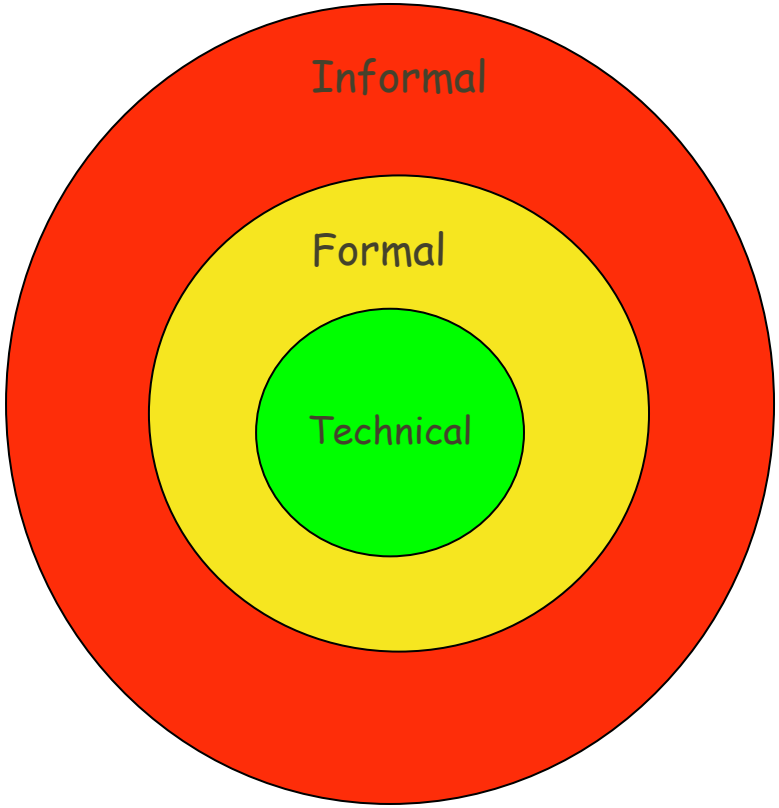
12219	2015-07-23 13:58:21	0	1N	382549587	253	56	BAT	100
12218	2015-07-23 13:53:15	0	1N	382549587	253	55	MCP	61
12217	2015-07-23 13:53:15	0	1N	382549587	253	55	BAT	100
12216	2015-07-23 13:48:09	0	1N	382549587	253	54	MCP	64
12215	2015-07-23 13:48:09	0	1N	382549587	253	54	BAT	100

Addressing Recurrent Issues

- Power
- Location
- Communication
- Calibration
- Security
- Analysis
  - Big Data



Power

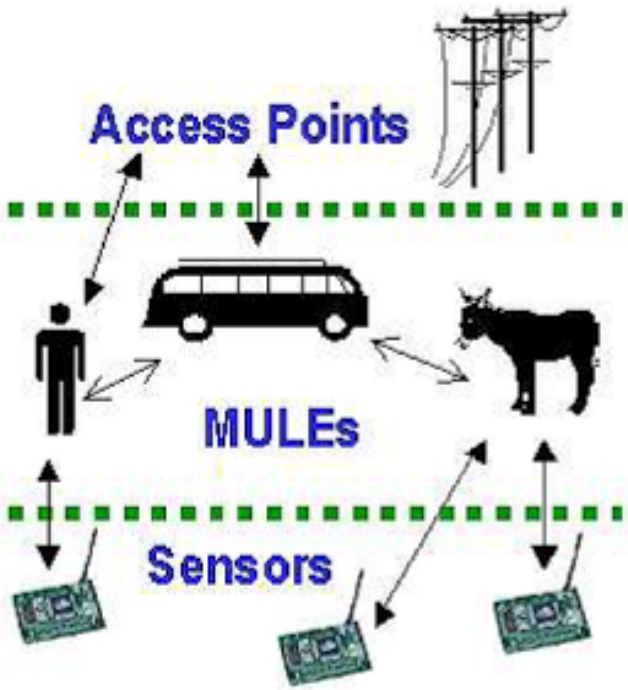
- Technical
  - Whenever possible, line power
  - Solar/wind + battery backup
  - Power and radio related
    - Protocols
- Formal
  - Just enough data – analytics
    - Privacy
  - Active upgrade policy
- Informal
  - Embed (lights, phones, beacons)
- Maintenance – plan and test (lab setup)

Location

- Technical
  - Accurate location reporting
  - Heartbeat – I'm here
- Formal
  - Accurate data bases
  - Consistency audit
- Informal
  - Crowd sourcing

Communi

- Technical
  - Simplify BLE
  - Stanardize – IPv6
  - Minimal radios
- Formal
  - Analysis for just enough
  - Different modes
- Informal
  - Crowd sourced, e.g., data mule



http://rohitagarwal24.blogspot.in/2013/12/a-software-engineer-perspective-on-iot.html

Calibration

- Technical
  - Redundant sensors
- Formal
  - Plan: periodic tests, syncs
- Informal
  - Crowd sourced – smart phone sensors
  - Social media – hot, noisy, air quality
    - Very least indicate if sensors are sane

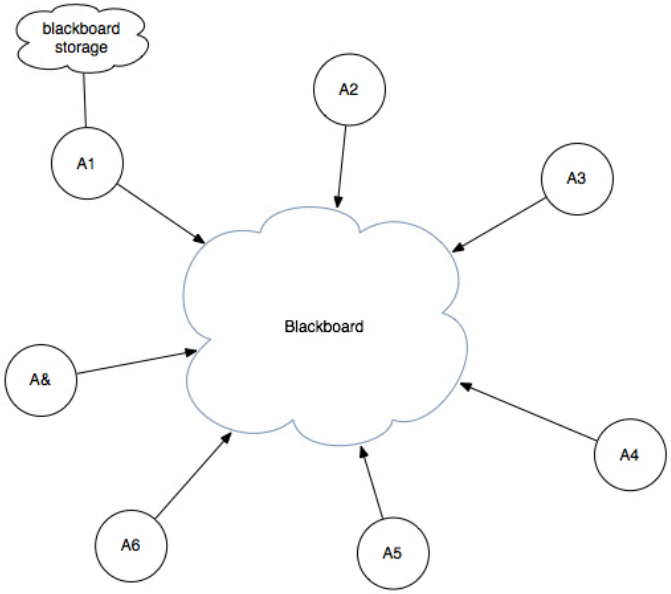
Security

- Technical
  - Embed (beacons)
  - Open
    - Secure communication and software update mechanism (agents)
- Formal
  - Tested infrastructure
  - Educate Public
- Informal
  - Involve

Agent Smith, The Matrix

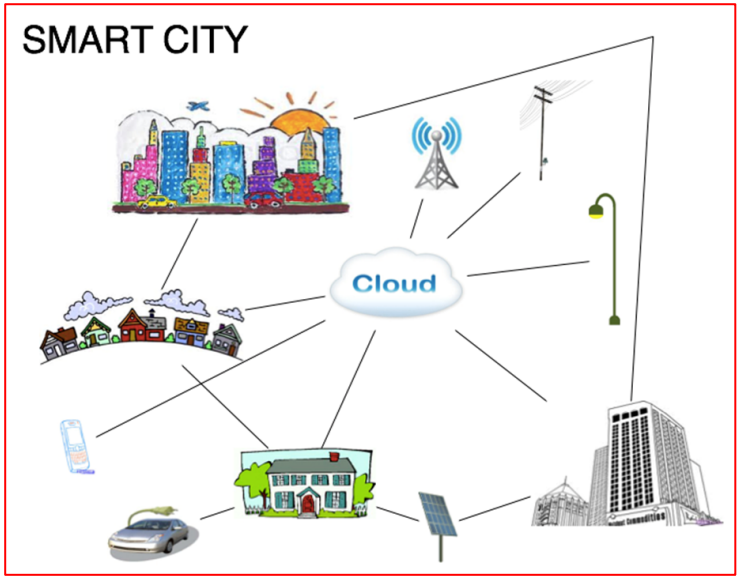
Analysis and Big Data

- Technical
  - Blackboard model
  - Other sources
- Formal
  - Focused analysis
  - Collect only what you use (privacy)
- Informal
  - Communicate the value
  - Crowd source analysis (programmable web)



Cross Cutting – IoT Ecosystem

- Location is important!
- Emulate, Simulate, Lab test
- Beacons
- ***Environment Eggs***
- ***Smart Homes***
- ***STEM***



Citizen Scie

- STEM + Citizen Science
- Environment Egg
- What if we made it a STEM project?

http://momhomeguide.com/wp-content/uploads/2012/03/before_fridge.jpg

http://shop.wickeddevice.com/product/air-quality-egg-v2-no2-co/

Acknowledgements and Resources

- Hoong See Tao's PhD Thesis