X-Informatics: Sensors

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http://www.infomall.org/X-InformaticsSpring2013/index.html

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2013

Big Data Ecosystem in One Sentence

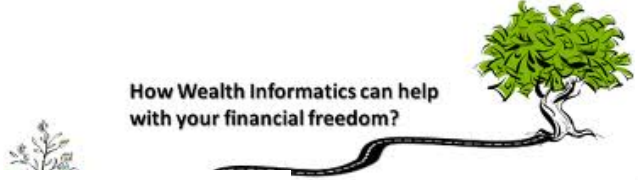
Use Clouds running Data Analytics Collaboratively processing Big Data to solve problems in X-Informatics (or e-X)

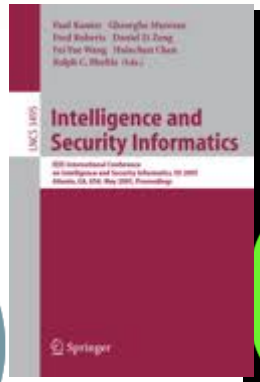
X = Astronomy, Biology, Biomedicine, Business, Chemistry, Climate, Crisis, Earth Science, Energy, Environment, Finance, Health, Intelligence, Lifestyle, Marketing, Medicine, Pathology, Policy, Radar, Security, Sensor, Social, Sustainability, Wealth and Wellness with more fields (physics) defined implicitly

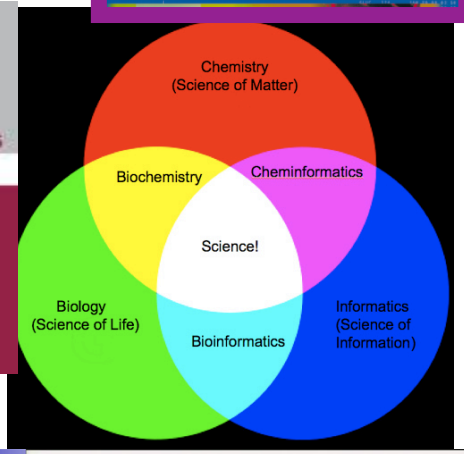
Spans Industry and Science (research)

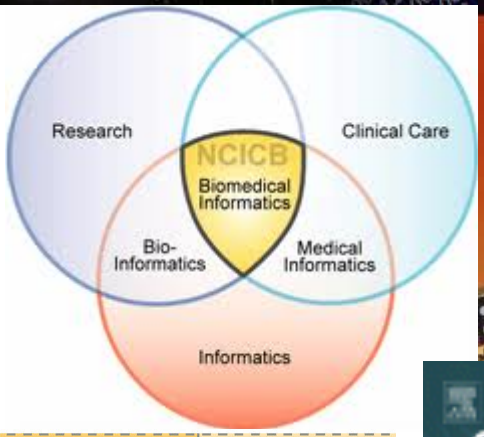
Education: Data Science see recent New York Times articles

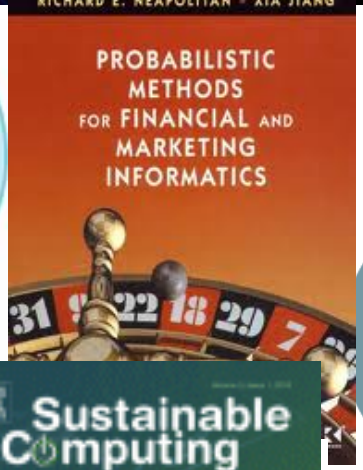
http://datascience101.wordpress.com/2013/04/13/new-york-times-data-science-articles/

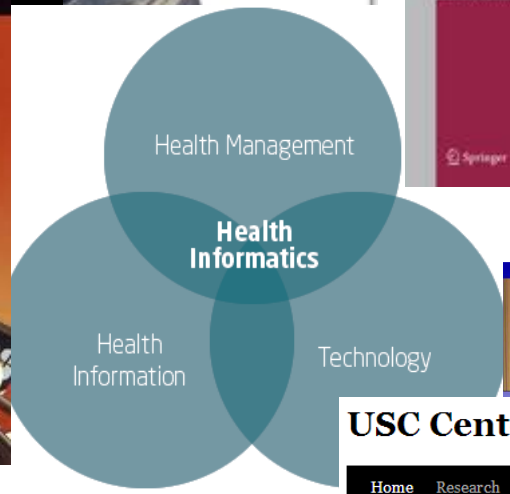


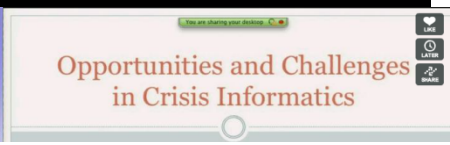


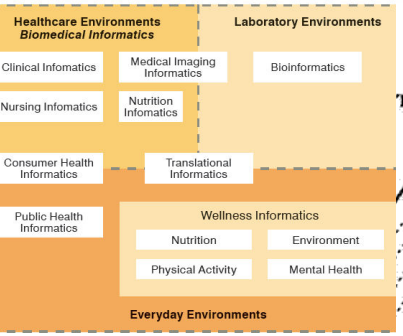


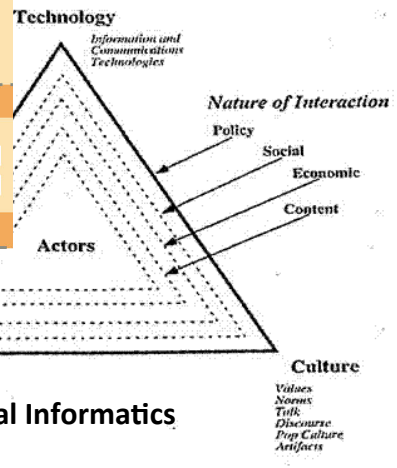








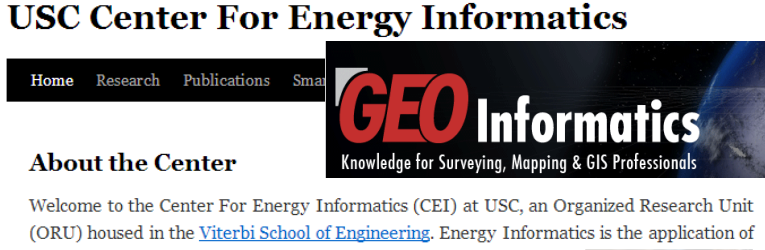


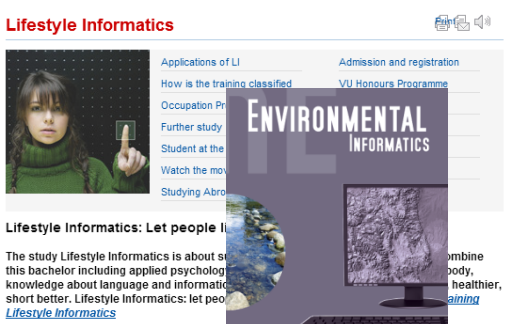


Noelia Penelope Greer (Ed.)

Business Informatics

Information technology, Management,





Internet of Things

Internet of Things and the Cloud

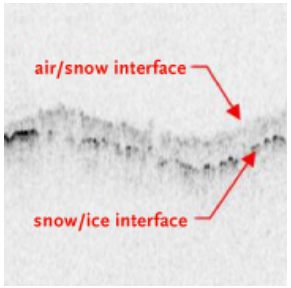
- It is projected that there will be **24 billion devices** on the Internet by 2020. Most will be small sensors that send streams of information into the cloud where it will be processed and integrated with other streams and turned into knowledge that will help our lives in a multitude of small and big ways.
- The **cloud** will become increasing important as a controller of and **resource provider for the Internet of Things.**
- As well as today's use for smart phone and gaming console support, "Intelligent River" "smart homes and grid" and "ubiquitous cities" build on this vision and we could expect a growth in cloud supported/controlled **robotics**.
- Some of these "things" will be supporting science
- Natural parallelism over "things"
- "Things" are distributed and so form a Grid

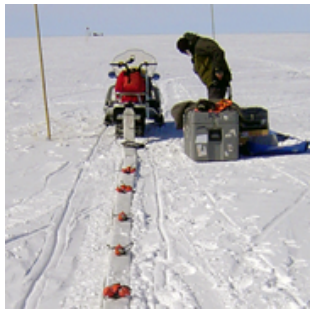
Sensor Grids and Clouds

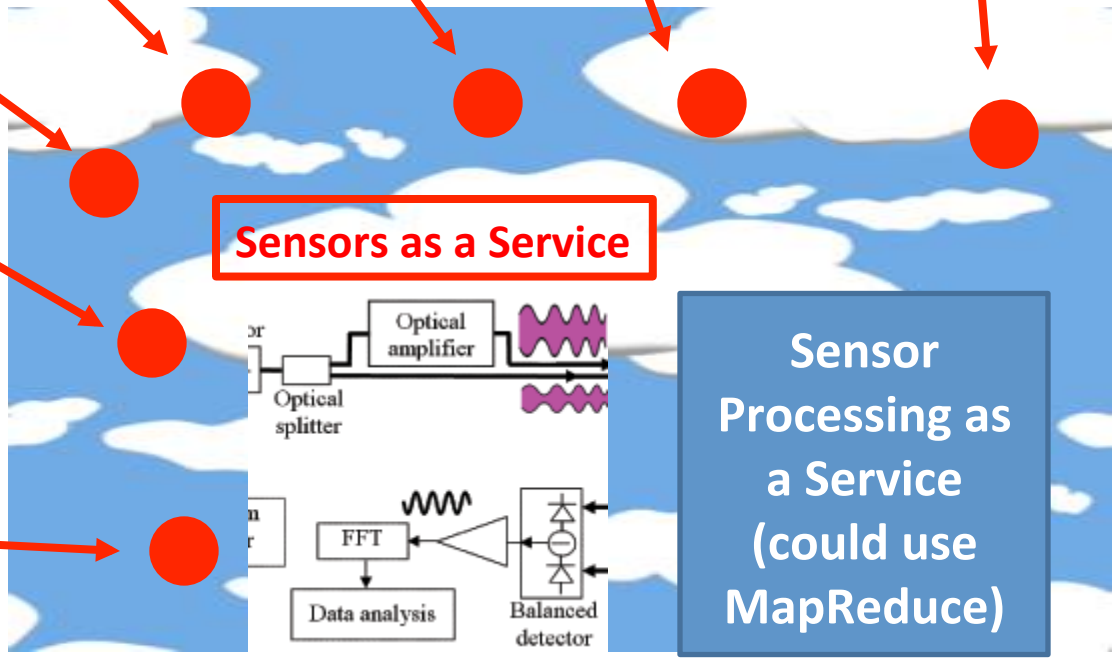
- A **sensor** is any source or sink of time series
  - In the thin client era, smart phones, Kindles, tablets, Kinects, web-cams are sensors
  - Robots, distributed instruments such as environmental measures are sensors
  - Web pages, Googledocs, Office 365, WebEx are sensors
  - Ubiquitous Cities/Homes are full of sensors
- Sensors – being intrinsically distributed are **Grids**
- However natural implementation uses **clouds** to consolidate and control and collaborate with sensors
- Sensors are typically "small" and have **pleasingly parallel cloud implementations**
  - LHC is a large sensor but breaks up into small ones!

Sensors (Things) as a Service

Output Sensor







A larger sensor ……

https://sites.google.com/site/opensourceiotcloud/ Open Source Sensor (IoT) Cloud

Scale of Industrial Internet

Social media versus electric generating power source

2012 Twitter Usage

80 Gigabytes per day

enabling social connections

vs.

Gas Turbine Compressor Blade Monitoring potential*

588 Gigabytes per day

enabling capital asset productivity

Data volume potential is 7x greater from a gas turbine than current Twitter usage

imagination at work

0MW are equipped with Blade Health Monitoring capabilities

Ruh VP Software GE http://fisheritcenter.haas.berkeley.edu/Big_Data/index.html

Value of Data & Analytics

Monitor fleet of ~25,000* engines ... 3.6MM flight records/month

B777

Prognostics

- ✓ Dispatch reliability
- ✓ Preventive maintenance
- ✓ Asset utilization

Prevent failures = customer efficiency

+

GE90

Asset Productivity

- ✓ Enhanced service offerings
- ✓ Airline cost structure
- ✓ Fuel performance

Streamline operations = increased airline productivity

=

DATA

90,000 flight records analyzed

~200 parameters per flight record

~18MM parameters per month

System & Optimization

- ✓ Time & space management
- ✓ Fuel efficiency
- ✓ Airspace capacity

Integrated systems = value-added services

Drives strong alignment with customers

Creates productivity in long-term service agreements

Value-added services fuels growth

MM = Million

imagination at work

Ruh VP Software GE http://fisheritcenter.haas.berkeley.edu/Big_Data/index.html

is 50/50 JV with Pratt & Whitney

Dublin City Centre Increases Bus Transportation Performance

Capabilities Utilized:

Stream Computing

- Public transportation awareness solution improves on-time performance and provides real-time bus arrival info to riders
- Continuously analyzes bus location data to infer traffic conditions and predict arrivals
- Collects, processes, and visualizes location data of all bus vehicles
- Automatically generates transportation routes and stop locations

Results:

- Monitoring 600 buses across 150 routes
- Analyzing 50 bus locations per second
- Anticipated to Increase bus ridership

Dublin City
Baile Átha Cliath

Anjul Bhambhri, VP of Big Data, IBM

A Car or a Computer on Four Wheels?

It's a Bird, It's a Plane, It's a Mini-Drone…

Use Cases of Low-Cost Drones

Agriculture

GPS-Enabled Photos Help Pinpoint Potential Crop Damage Early On

Sports / Entertainment

Unique Angle of View Provides Insights for Training + Broadcast Audience

Public Safety / Disaster Relief*

Providing Aerial Video Coverage / First-Aid / Other Supplies in Challenging Conditions

· Drone carrying cameras + other
thquake in Lushan, China (4/13).

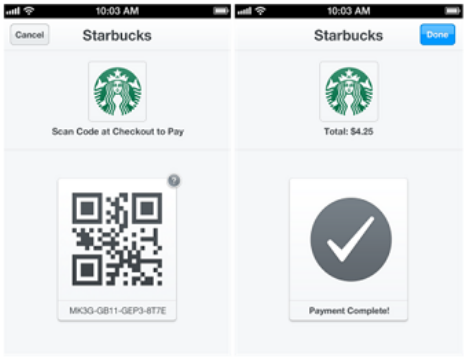
QR Codes =
Scan & Be Scanned to Get Stuff…

SCAN

Quick Scan w/ Smartphone For Info on Nutrition / Product / Price…

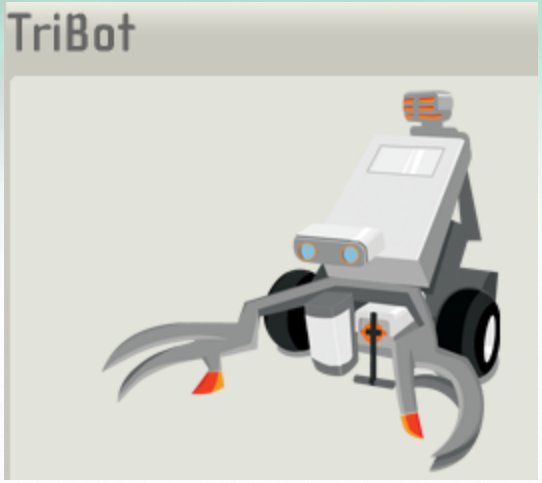
BE SCANNED

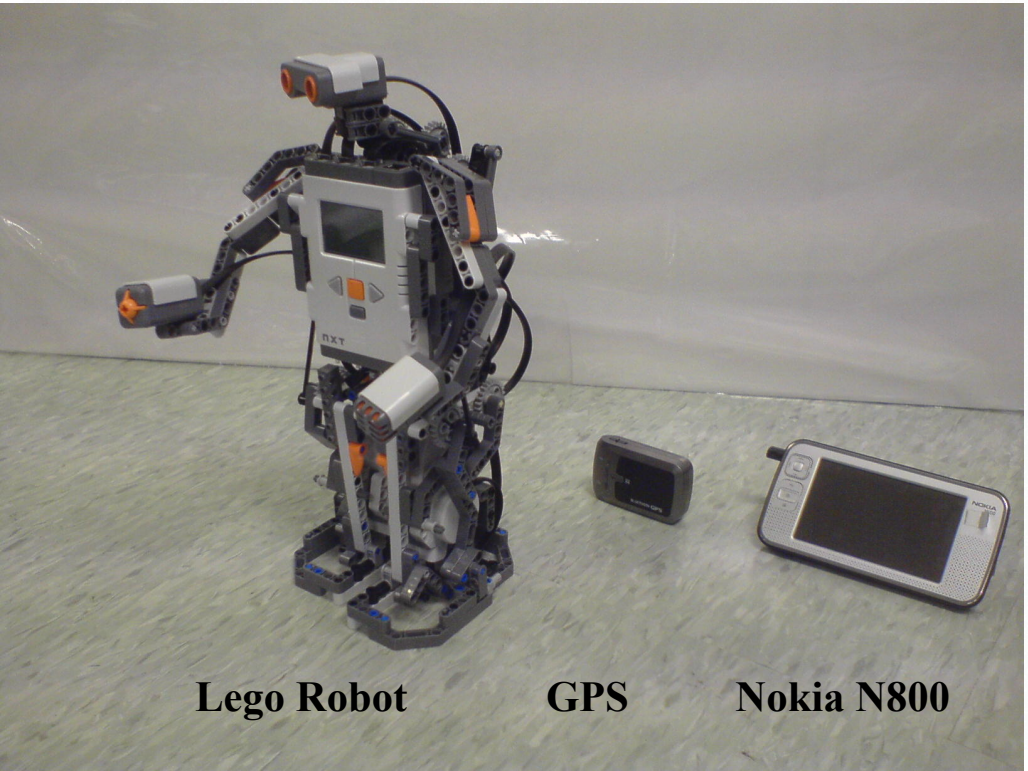
Smartphone-Generated Codes For Boarding Pass / Ticket / Payment / Rewards…



Some Sensors

Hexacopter





Lego Robot GPS Nokia N800

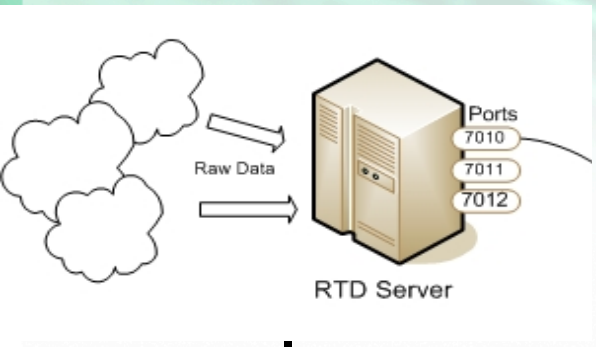
Surveillance Camera

Laptop for PowerPoint

RFID Reader

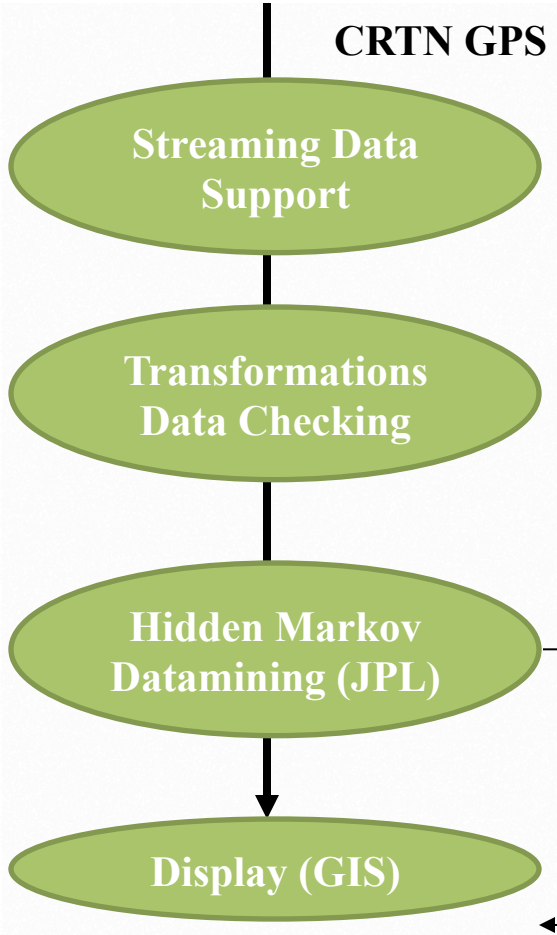
RFID Tag

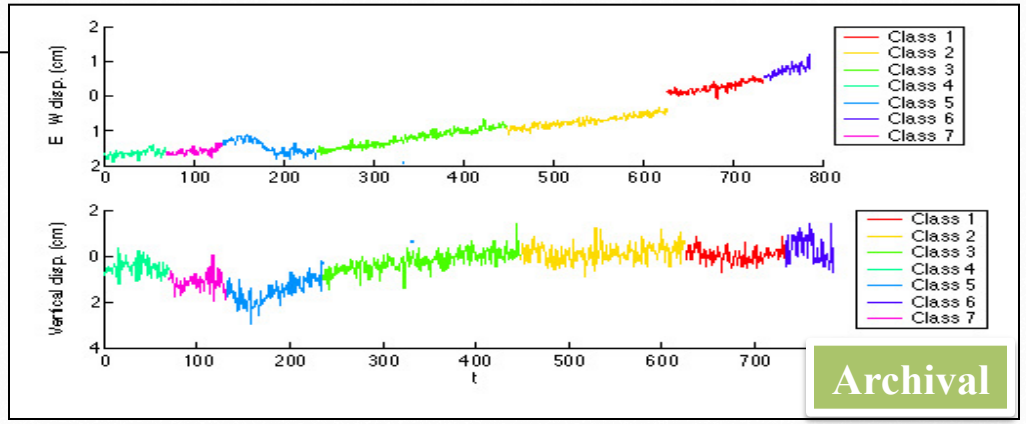
Real-Time GPS Sensor Data-Mining

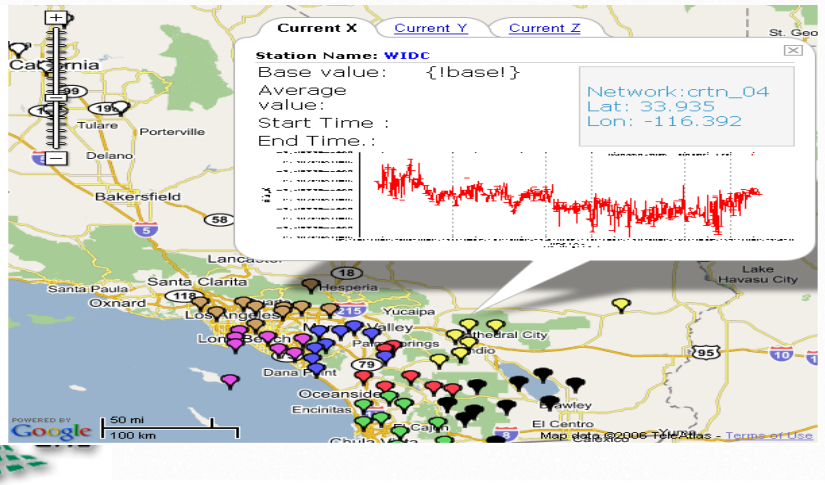


Services process real time data from ~70 GPS Sensors in Southern California

Brokers and Services on Clouds – no major performance issues

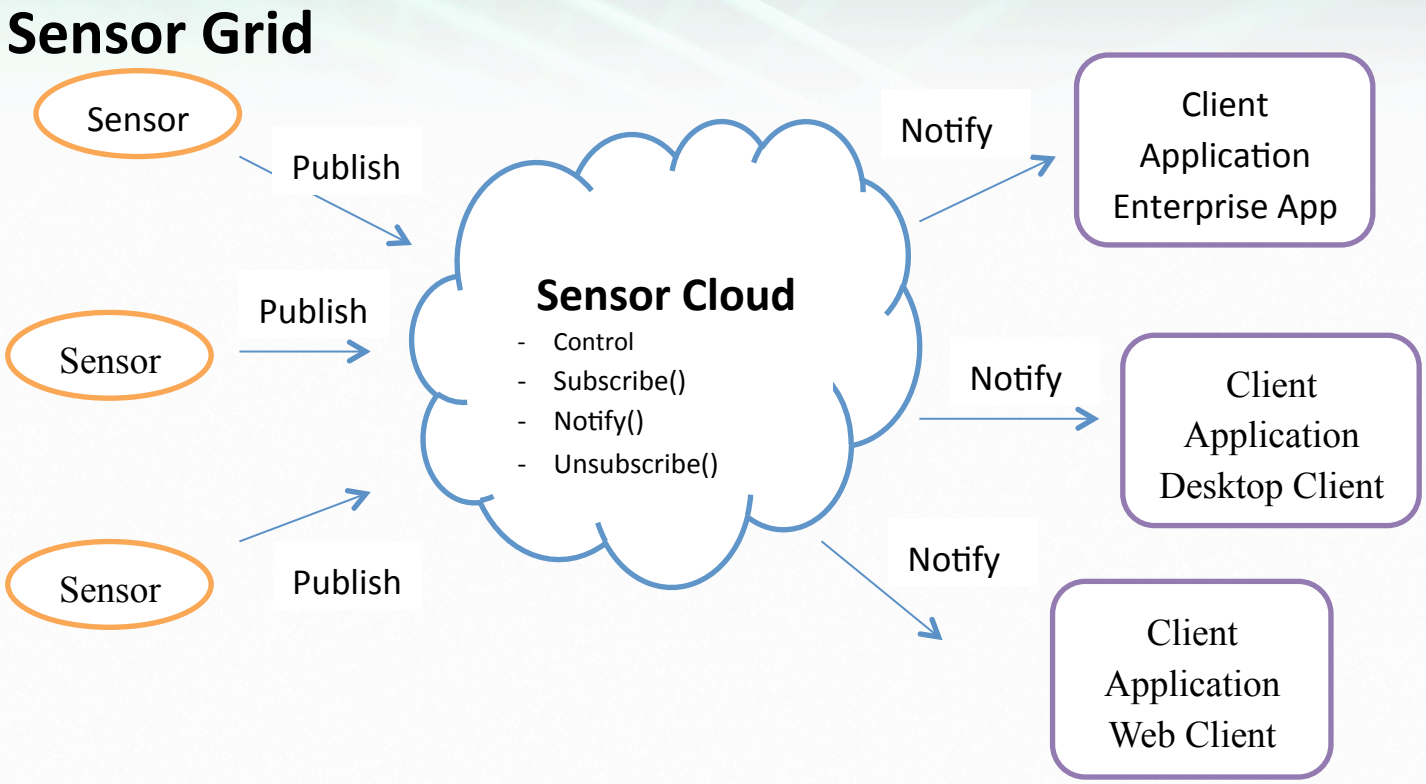






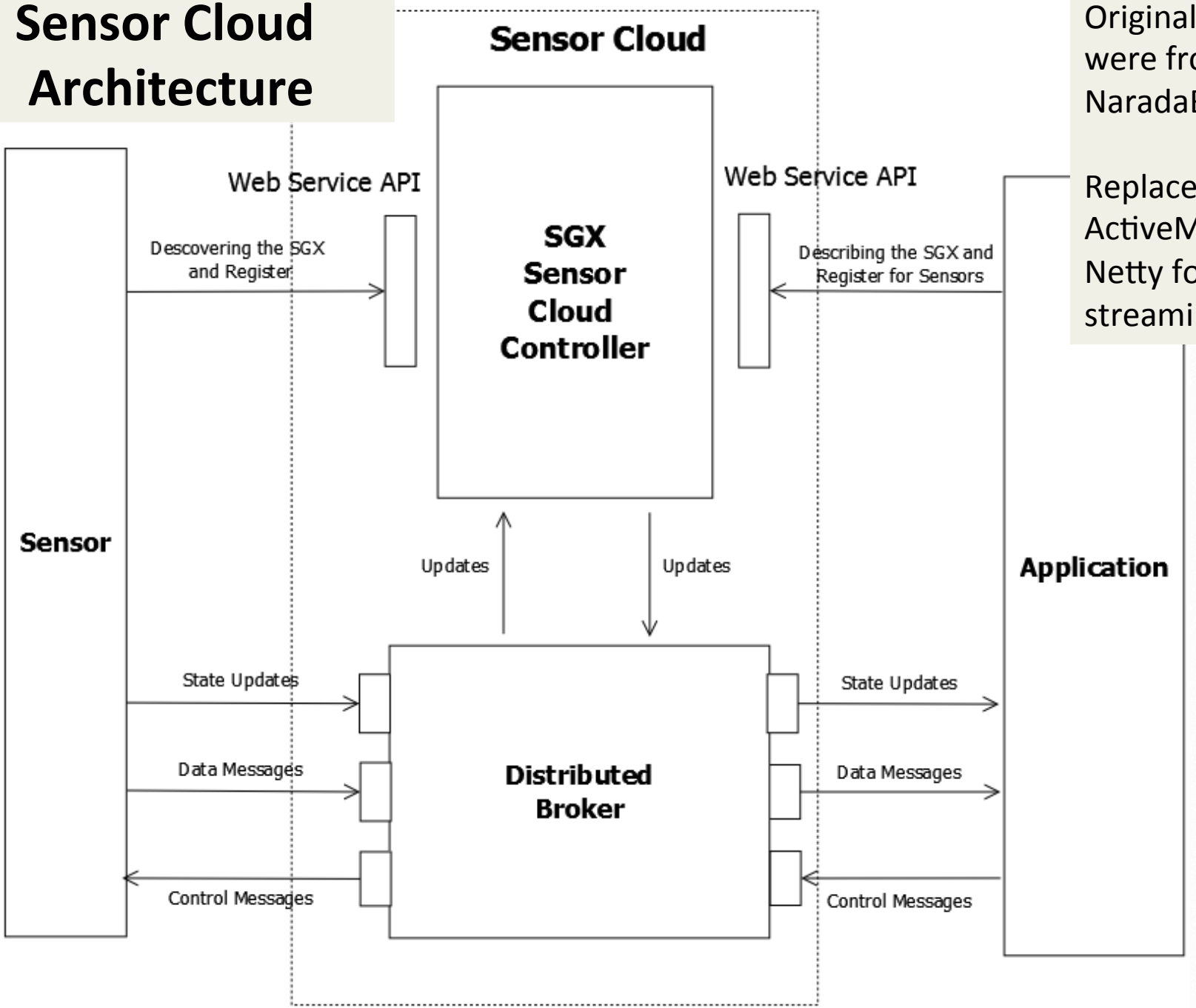
Sensor Clouds

Sensor Grid supported by Sensor Cloud



- Pub-Sub Brokers are cloud interface for sensors
- Filters subscribe to data from Sensors
- Naturally Collaborative
- Rebuilding software from scratch as Open Source – collaboration welcome

Sensor Cloud Architecture



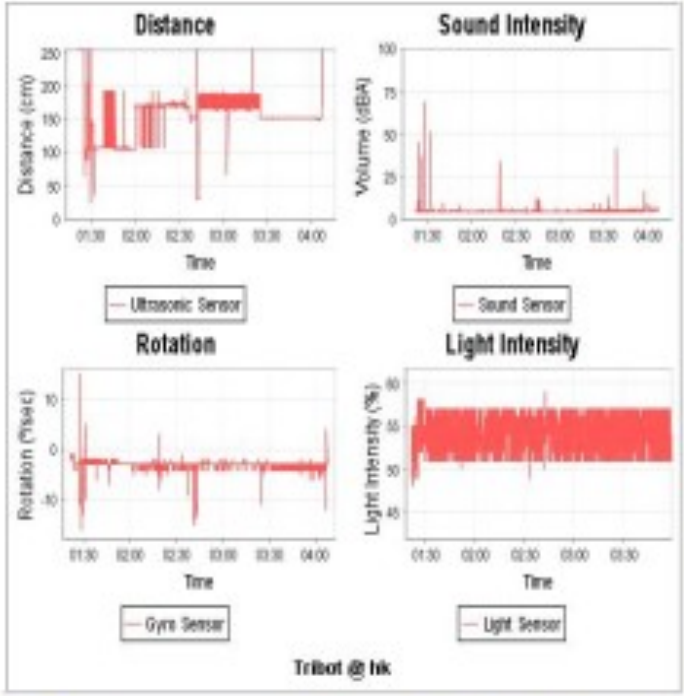
Originally brokers were from NaradaBrokering

Replace with ActiveMQ and Netty for streaming

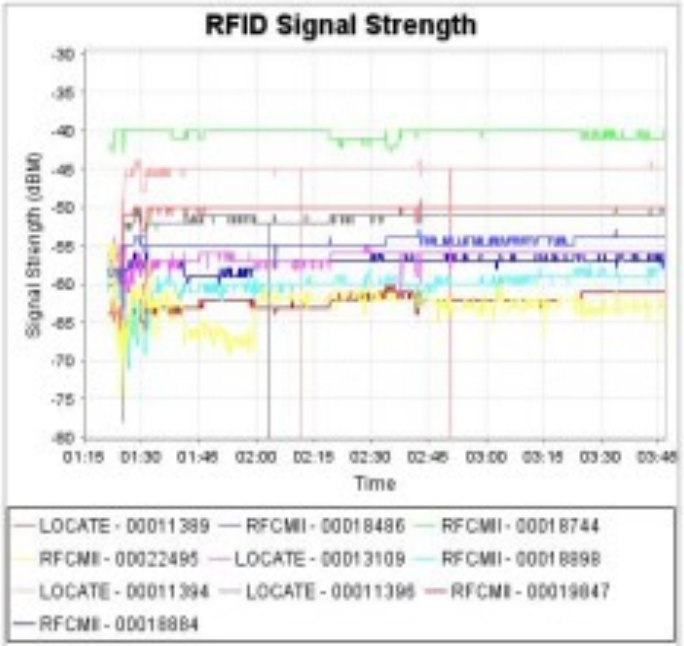
Sensor Grid Client Outputs

Video
4 Tribot
RFID
GPS

Video @ hk



Tribot @ hk

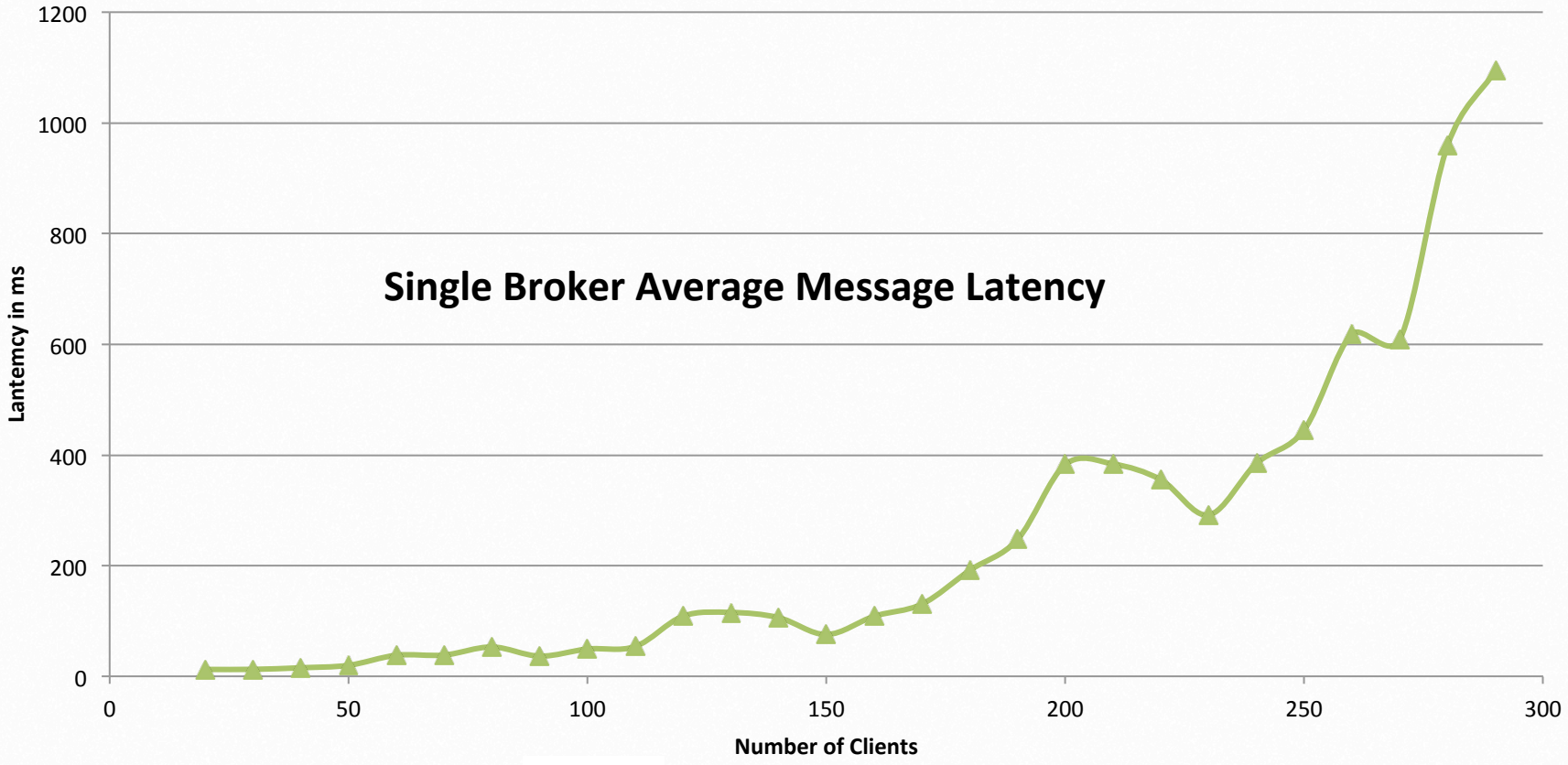


rfid @ hk

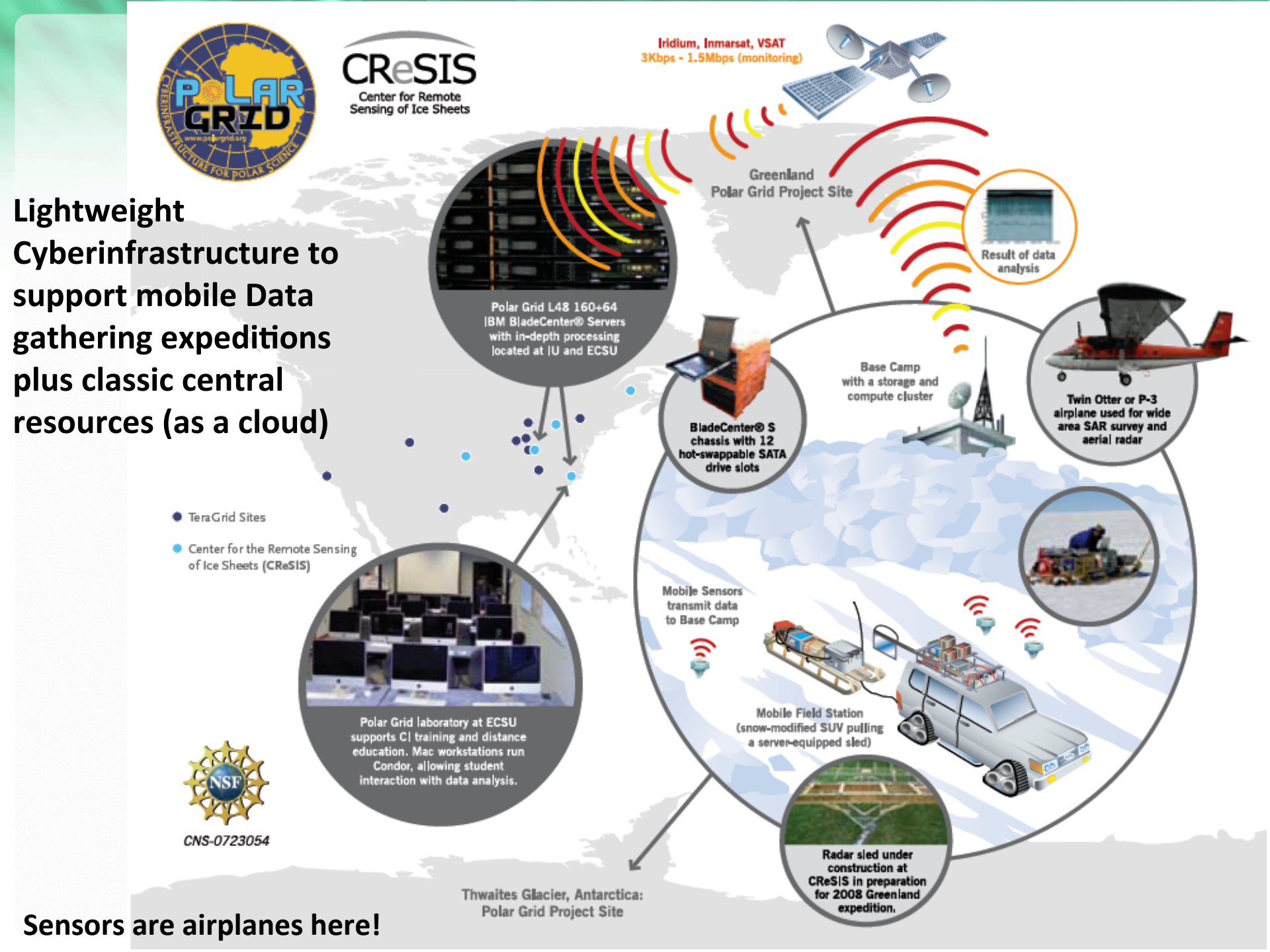
gps @ hk

Performance of Pub-Sub Cloud Brokers

- High end sensors equivalent to Kinect or MPEG4 TRENDnet TV-IP422WN camera at about 1.8Mbps per sensor instance
- OpenStack hosted sensors and middleware



Radar data gathered by Sensors



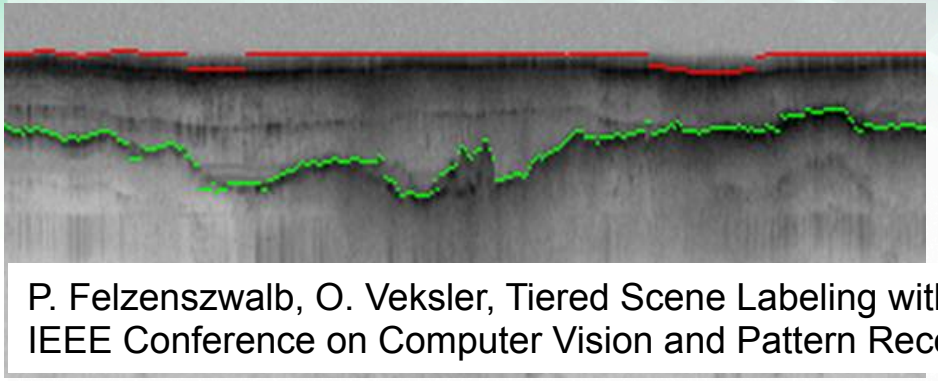
Lightweight Cyberinfrastructure to support mobile Data gathering expeditions plus classic central resources (as a cloud)

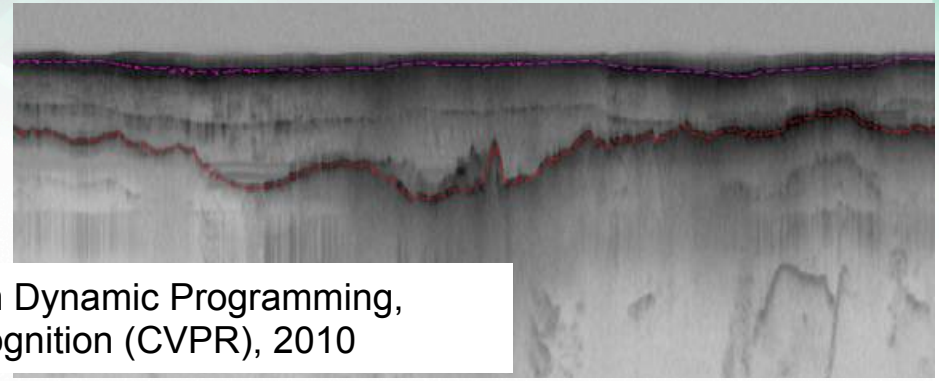
Sensors are airplanes here!


Photo Provided by Keith Lehigh, Indiana University

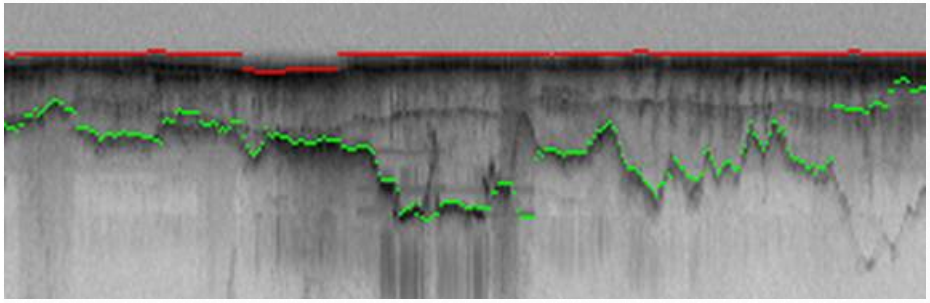

Photo Provided by Keith Lehigh, Indiana University

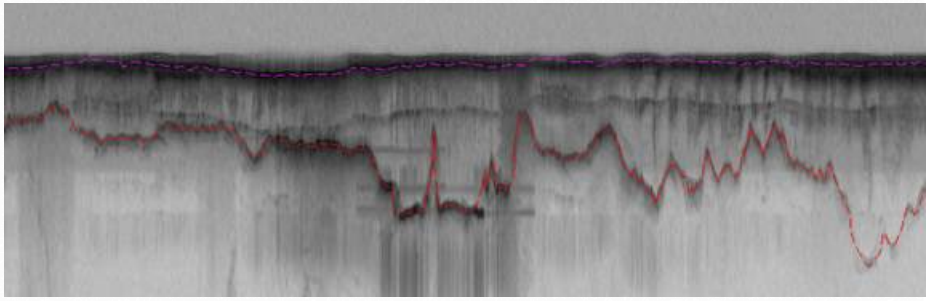
Hidden Markov Method based Layer Finding

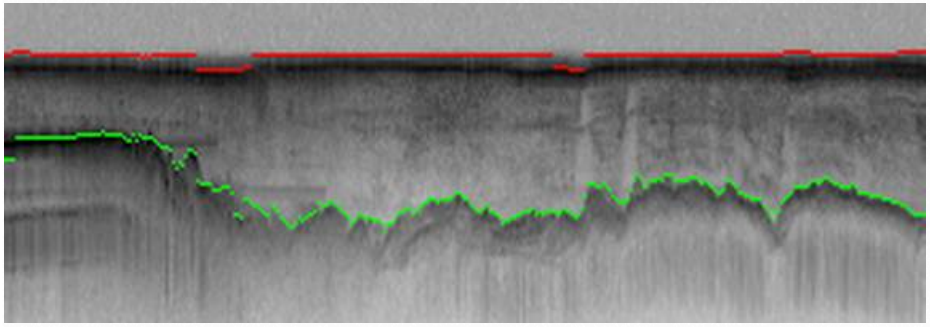


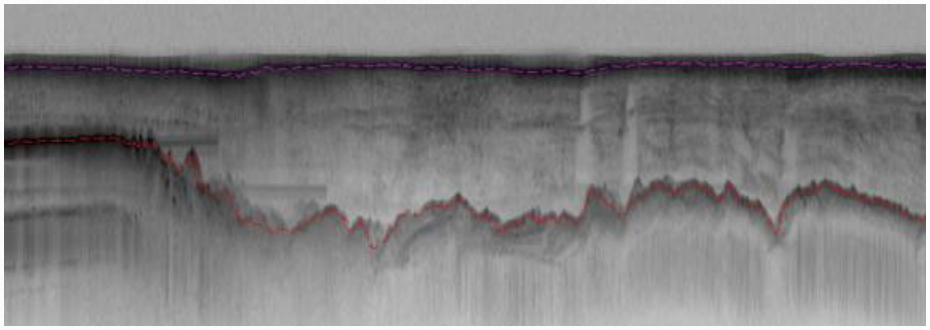


P. Felzenszwalb, O. Veksler, Tiered Scene Labeling with Dynamic Programming, IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2010



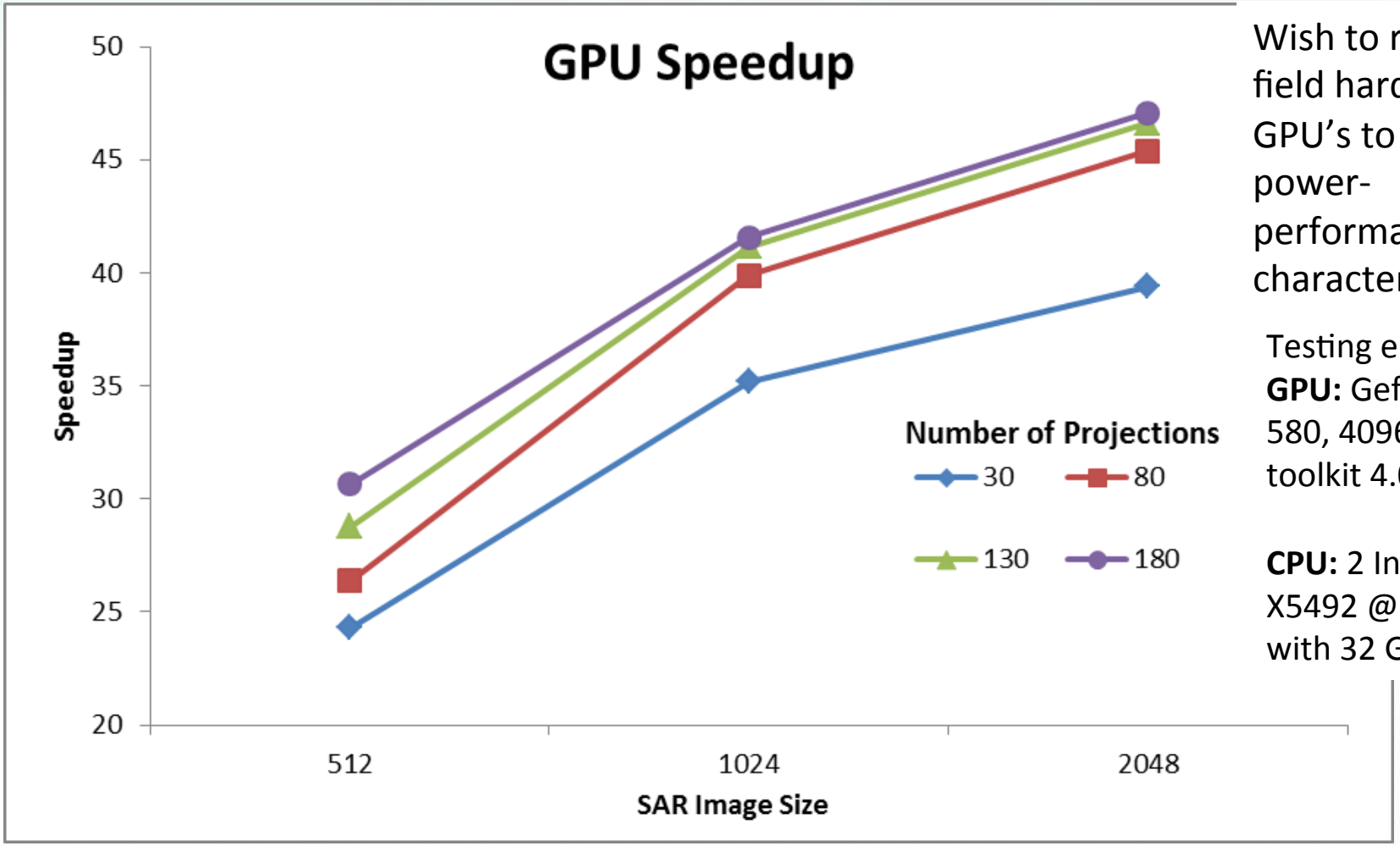






Future Grid

Back Projection
Speedup of GPU wrt Matlab 2 processor Xeon CPU



Wish to replace field hardware by GPU's to get better power-performance characteristics

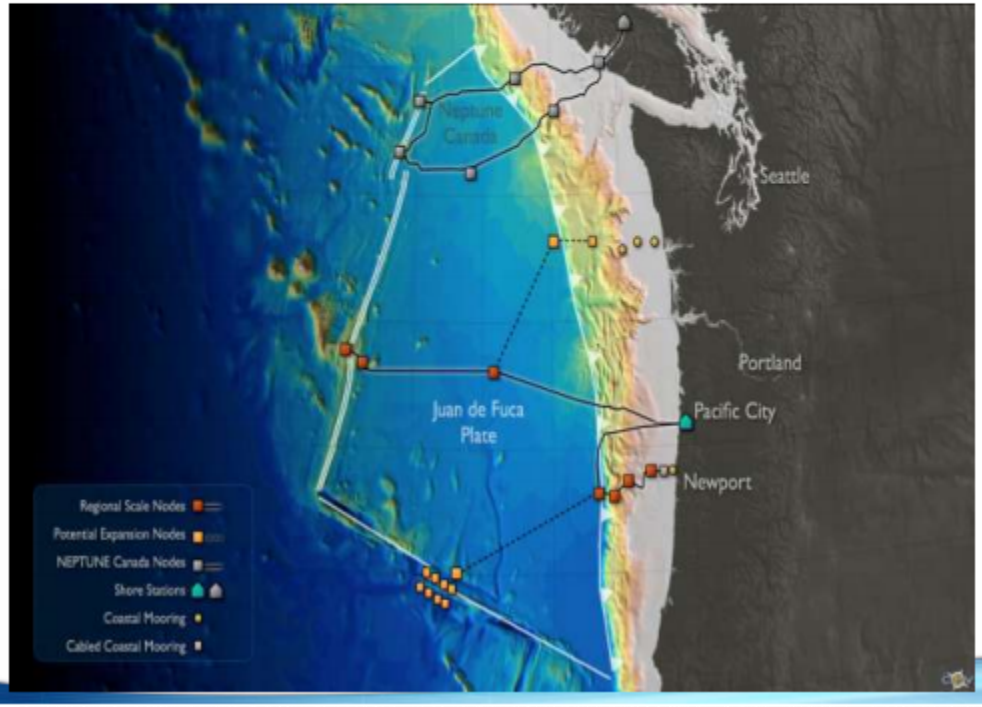
Testing environment:
GPU: Geforce GTX 580, 4096 MB, CUDA toolkit 4.0

CPU: 2 Intel Xeon X5492 @ 3.40GHz with 32 GB memory

Future Grid

Supporting Smart Sensors and Data Fusion

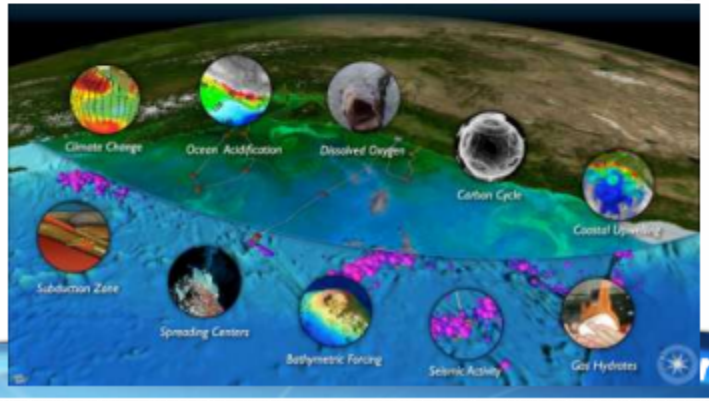
- The NSF Ocean Observing Initiative
  - Hundreds of cabled sensors and robots exploring the sea floor
  - Data to be collected, curated, mined
  - OOI Architecture plan of record, store this data in the cloud



Data collected from:

- Ocean floor sensors, AUV tracks, ship-side cruises, computational models

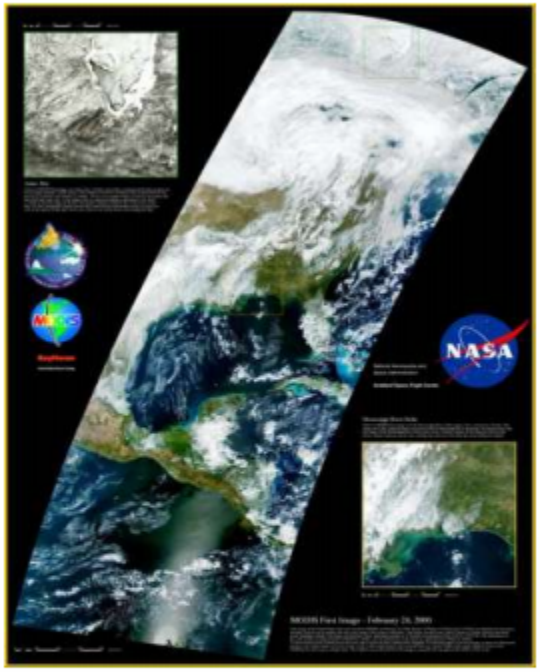
Data moves from **ocean** to shore side **data center** to the **Azure cloud** to your **computer**.



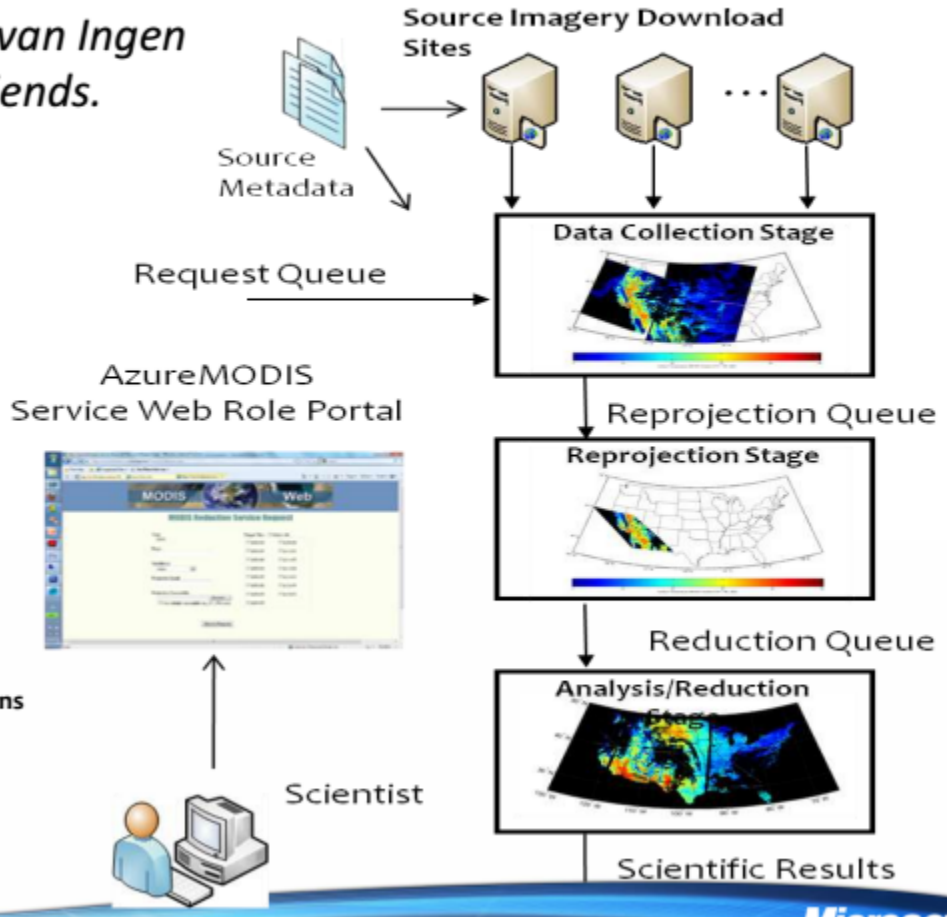
http://www.oerc.ox.ac.uk/downloads/presentations-from-events/microsoftworkshop/gannon

Future Grid

AzureMODIS – Azure Service for Remote Sensing Geoscience



Catharine van Ingen
And her friends.



5 TB (~600K files) upload of 9 different imagery products from 15 different locations (~6 days of download)

4 TB reprojected harmonized imagery ~35000 cpu hours

50 GB reduced science variable results ~18000 cpu hours (~14 hour download)

50 GB additional reduced science analysis results ~18000 cpu hours (~14 hour download)

Microsoft

http://www.oerc.ox.ac.uk/downloads/presentations-from-events/microsoftworkshop/gannon

Future Grid

Ubiquitous/Smart cities

Smart Cities Homes Transportation

- Also Ubiquitous cities …
- Sensors everywhere as in earlier examples as in Dublin from IBM
- See South Korea where small size enables higher technology per person than in USA
- Smart Grids are power networks monitored by sensors with data captured in the cloud
- This is a case where knowledge comes from joining lots of data together
- In Robot controlled by cloud, system is "more localized"

U-Korea
U = Ubiquitous

See
http://www.academia.edu/1731078/Korean_Ubiquitous_Society_Visions

ABOUT KOREA

On a Global Scale

- **1st** in
  - broadband access per capita (Point Topic)
  - e-government (Brown U.)
  - scientific literacy (OECD)
  - **also** in total working hours (OECD)
- **2nd** in
  - annual export growth
  - GDP growth (OECD)
  - granted international patents (WIPO)
- **3rd** in
  - IT industry competitiveness (EIU)
- **5th** in
  - R&D spending (WB)
  - Technological Achievement (UN)
- **6th** in
  - number of PCs (ITU)
- **13th** in
  - nominal GDP
- BUT:
  - Quality of life (30th)
  - Economic freedom (36th)
  - GDP per capita (34th)

KOREAN NEW MEDIA

Strict and refined cell phone etiquette

- *The young have a totally different attitude compared to the older Koreans*

- A device to renew collectivity

Ubiquitous and 24/7 contact potential to family and friends

A cybernetic extension of body, a wormhole to media world and peer group♪

A **perfect** tool to reinforce **Neo-Confucian** collective network

U-KOREA VISION

The Vision

- Pervasive computing, everywhere, anytime
- Ministry of Information and Communication on u-society:
  - *just around the corner*, and *will change everything*
  - *an environment in which anyone can use a computer and network in a convenient, safe manner anytime, anywhere with anyone*
  - *the ubiquitous city truly never sleeps*
  - *filled with human warmth*

CONNECTIONS

Korea's High-Tech Utopia, Where Everything Is Observed

Illustration courtesy of Kohn Pedersen Fox Associates

The U-Life South Korea plans to spend $25 billion on New Songdo, the world's largest "ubiquitous city," with computers linking home life and life on its streets. Construction, 40 miles from Seoul, is to be done in 2014.

By PAMELA LICALZI O'CONNELL
Published: October 5, 2005

IMAGINE public recycling bins that use radio-frequency identification technology to credit recyclers every time they toss in a bottle; pressure-sensitive floors in the homes of older people that can detect the impact of a fall and immediately contact help; cellphones that store health records and can be used to pay for prescriptions.

Circuits

A Special Section: Networking
Networked computing is allowing workers to automate many tasks. Also, how to set up a wireless network in your home.

These are among the services dreamed up by industrial-design students at California State University, Long Beach, for possible use in New Songdo City, a large "ubiquitous city" being built in South Korea.

A ubiquitous city is where all major information systems (residential, medical, business, governmental and the like) share data, and computers are built into the houses, streets and office buildings. New Songdo, located on a man-made island of nearly 1,500 acres off the Incheon coast about 40 miles from Seoul, is rising from the ground up as a U-city.

Although there are other U-city efforts in South Korea, officials see New Songdo as one apart. "New Songdo will be the first to fully adapt the U-city concept, not only in Korea but in the world," said Mike An via an e-mail message. Mr. An is the chief project manager of the Incheon Free Economic Zone Authority, the government agency overseeing the project.

http://www.nytimes.com/2005/10/05/technology/techspecial/05oconnell.html?ex=1286164800&en=4a368c49e8f30bd2&ei=5088

Smart Grid

http://courses.engr.illinois.edu/cs598tar/fa2010/ClassNotes/Grid.ppt

Smart Grid

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US Electricity Grid

- Aged
- Centralized
- Manual operations
- Fragile
- Need to Upgrade with distributed sensors and centralized cloud computing

Northeast Blackout – August 14, 2003

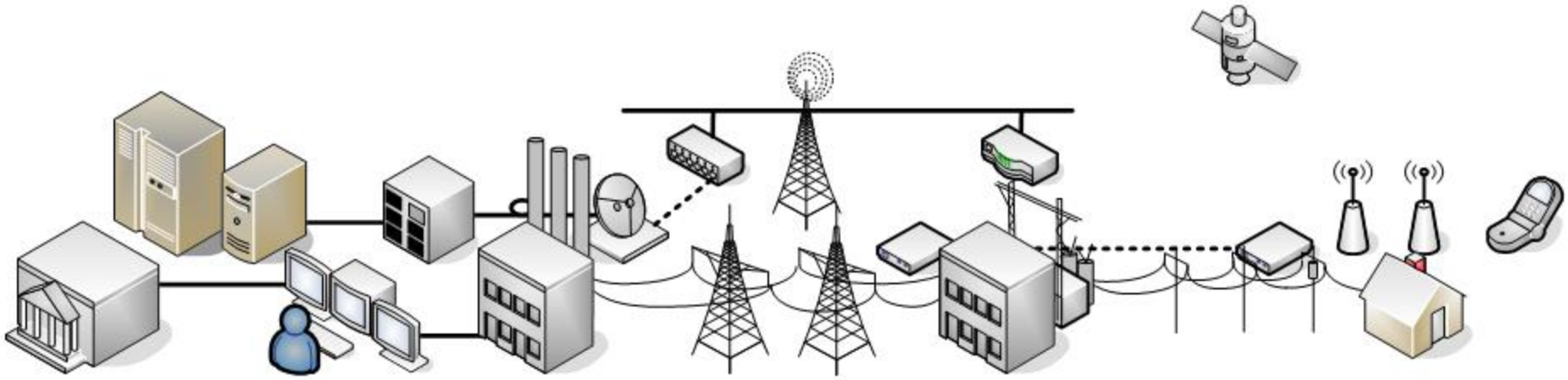
- Affected 55 million people
- $6 billion lost

- Per year $135 billions lost for power interruption

http://en.wikipedia.org/wiki/Northeast_Blackout_of_2003

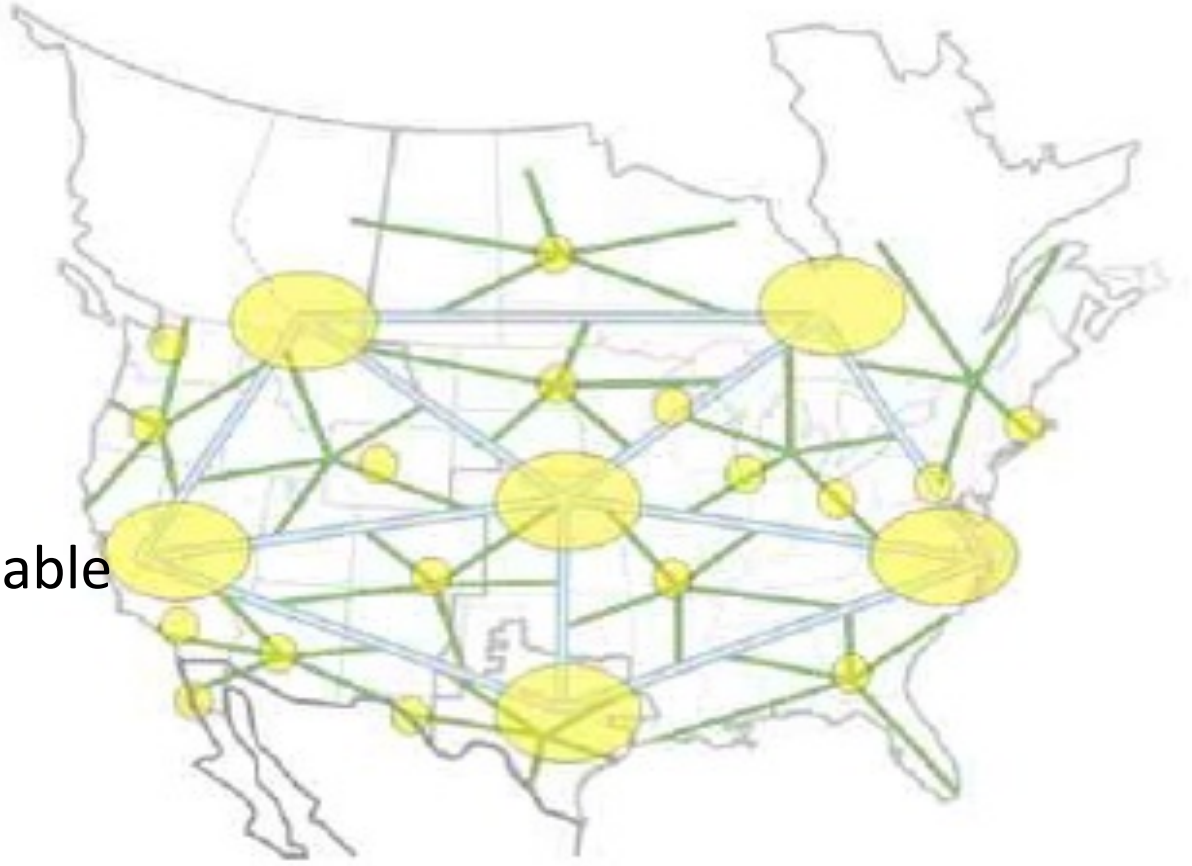
Smart Grid

- Uses information technologies to improve how electricity travels from power plants to consumers
- Allows consumers to interact with the grid
- Integrates new and improved technologies into the operation of the grid



Smart Grid Attributes

- Information-based
- Communicating
- Secure
- Self-healing
- Reliable
- Flexible
- Cost-effective
- Dynamically controllable

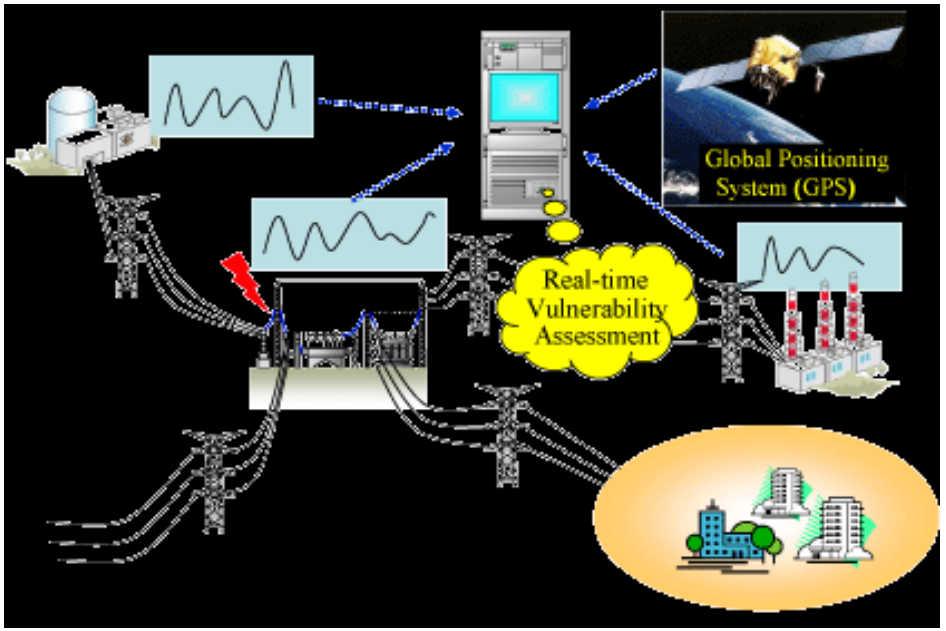


Advanced Sensing and Measurement

- Advanced Metering Infrastructure (AMI)
  - Provide interface between the utility and its customers: bi-direction control
  - Advanced functionality
    - Real-time electricity pricing
    - Accurate load characterization
    - Outage detection/restoration
  - California asked all the utilities to deploy the new smart meter

Advanced Sensing and Measurement

- Health Monitor: Phasor measurement unit (PMU)
  - Measure the electrical waves and determine the health of the system.
  - Increase the reliability by detecting faults early, allowing for isolation of operative system, and the prevention of power outages.



Advanced Sensing and Measurement

- Distributed weather sensing
  - Widely distributed solar irradiance, wind speed, temperature measurement systems to improve the predictability of renewable energy.
  - The grid control systems can dynamically adjust the source of power supply.

APS: Autonomous Power System

- A localized group of electricity sources and loads
  - Locally utilizing natural gas or renewable energy
  - Reducing the waste during transmission
    - Using Combined Heat and Power (CHP)