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Taking Collaboration to the Next Level

Presented by
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Phoenix, A Collaborative Sensor-Rich Application Development/Deployment Framework

by

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Motivation

- The number of mobiles exceeds the number of PCs
  - Samsung projects mobile market size of 1.2 billion units in 2008
  - Gartner reported about 271 million units of PC sold in 2007
- Information is playing an increasingly important role in mobile applications
- Increased use of low cost sensors in commercial and consumer environments
- Information age versus Integration age
  - Too much information. Need integration and relevancy.
- Increase interests in real-time collaboration for social networks

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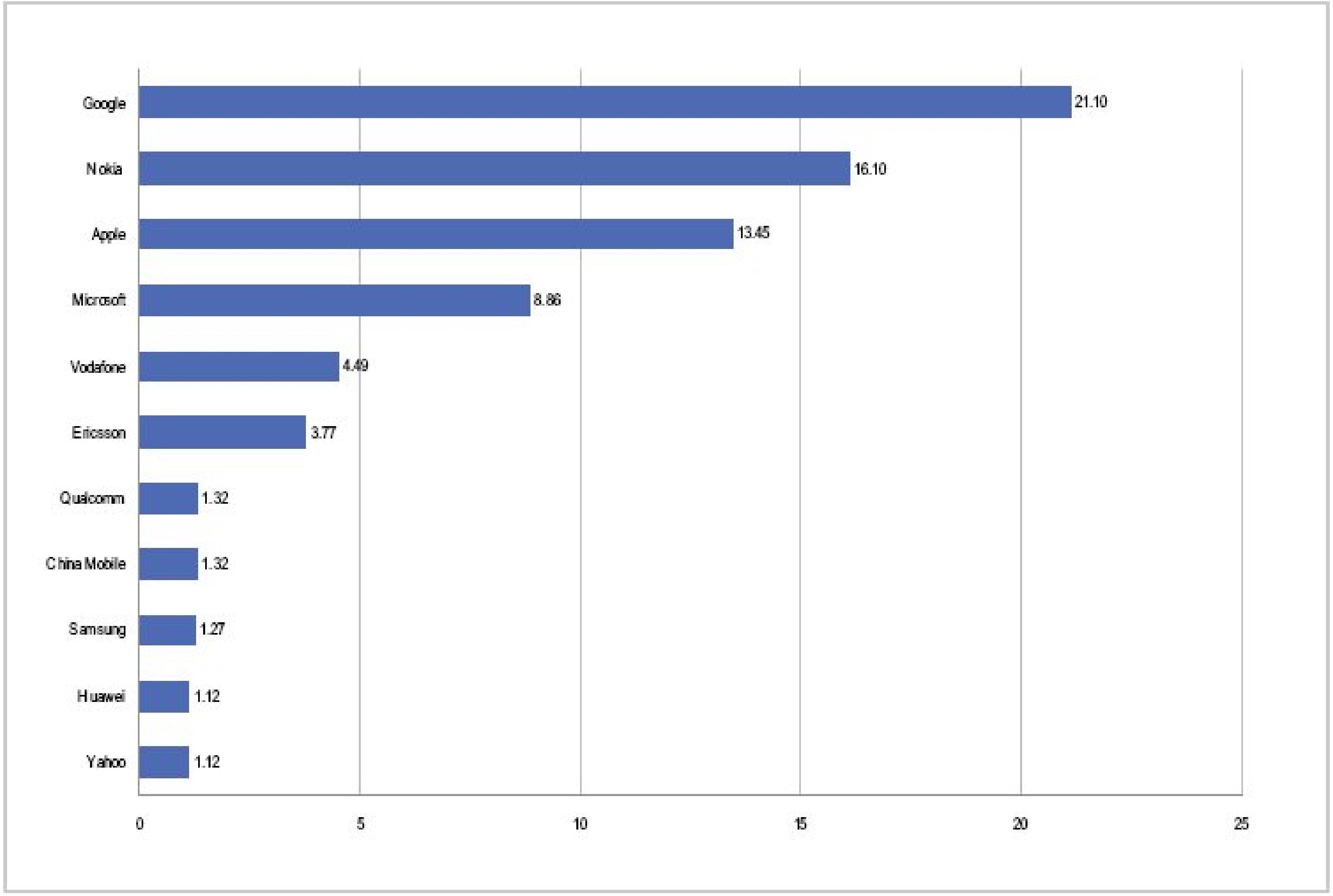
Global Mobile Survey Sponsored by Qualcomm & Telco 2.0

- Which companies have the most impact in shaping the future of mobile communications?



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Quest for Dominance in Mobile Application Development Platforms

- Nokia Symbian – open
- Google Android - open
- Apple iPhone – restricted open

Open systems ensure

- application openness is maintained on the mobile Internet
- takes about 20% off a mobile's cost (software)
- facilitates growth of third party applications to drive adoption

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- This talk does not focus on what is and may be a killer app.
- We focus on providing a framework that facilitates a world of talented developers to build and deploy creative and potentially killer-applications easily on
  - low power, battery-based devices such as a mobile handset, and
  - an open platform that is designed for smart mobile devices such as Symbian

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Understanding Application Framework Requirements from an Application Perspective

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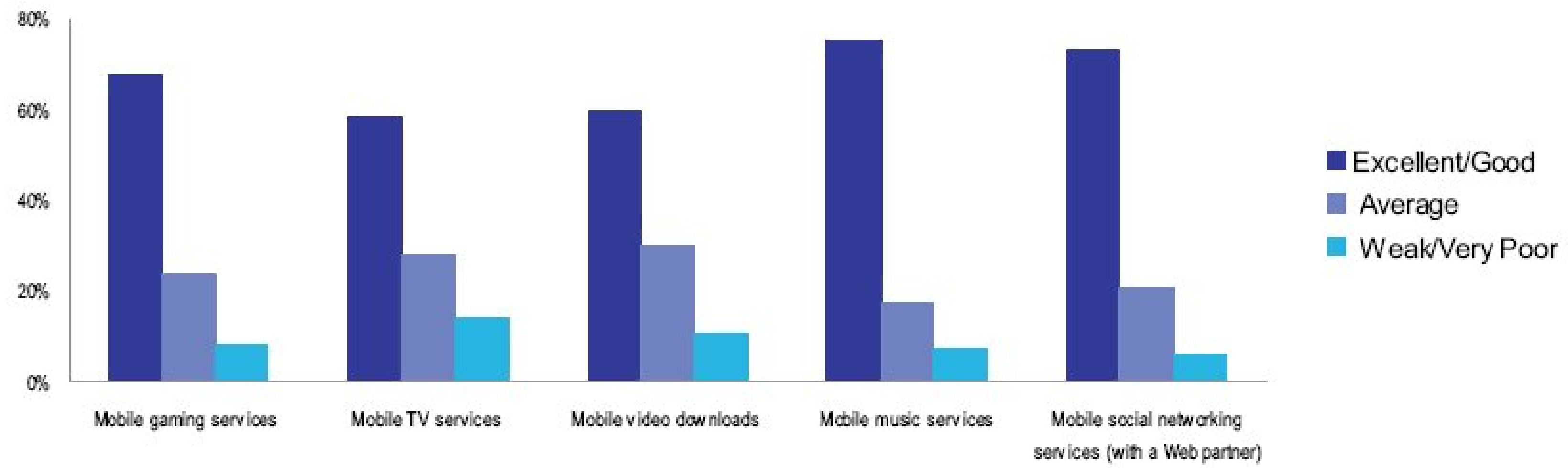
Global Mobile Survey Sponsored by Qualcomm & Telco 2.0

- What are the opportunities for growth in the mobile service and application areas?



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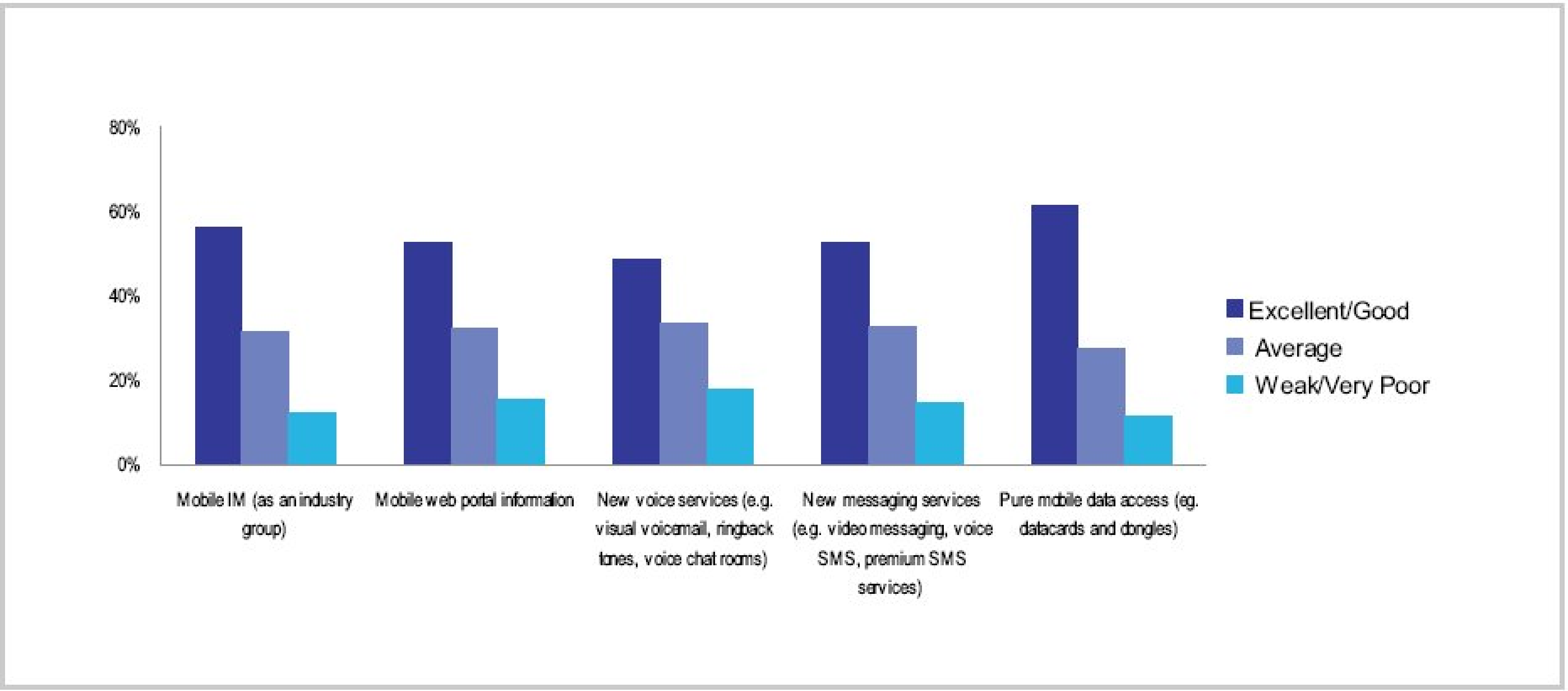

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Some Sample Sensor-Centric Android Applications

- Accelerometer and Compass
  - Open Google Map's StreetView functionality streaming over a 3G network
  - Using the built-in 3D accelerometer and compass, a user can take a "look"around a street and location simply by holding the handset and moving it around.

- Camera, GPS, Motion Sensor and web services
  - Lay and display location services over live imagery.
  - By pointing a camera at a building a user will be presented with the building's name/location, and distance from the user.

- Camera and GPS
  - Social network around geographical content
  - Search for places to go, exciting routes
  - Create navigation by picture and share

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Samples Collaborative Android Applications

- Collaborative Painting
  - Share a canvas and invite friends to draw
  - Draw on photographs
- Instant Messaging App
  - Location-aware mobility communication among friends
  - Interactive and synchronous map sharing
- Jigsaw: Image-processed Whiteboard Sharing
  - Utilizing image processing techniques like edge detection, geometric transformation and image enhancement to capture whiteboard data
  - Share the whiteboard and its data

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Observations on mobile applications

- Interested in collaboration and sharing
- Sensor-Rich
- Access outside services like maps, music, TV, GIS

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What do the observations really mean for mobile apps?

- Social network is important. A framework that has built-in support for comprehensive, effective and efficient collaboration will enable more addictive social networks.
- Environmental sensor information from mobiles are of interest. Mobiles are naturally globally distributed. The capability to harness and manage distributed sensor streams and at the same time supporting real-time sharing in an application development and deployment framework will substantially simplify and make it much easier for developers to focus on building the next Myspace-like killer-app by leaving the complex distributed deployment and information management task to the framework.
- Take full advantage of the mobile network. Not everything need to be done on mobiles for mobile apps. Some tasks are preferred and better done outside mobiles. Supporting easy access to outside services like maps, music etc is an important aspect of the mobile Internet. It will even be more compelling if mobile apps running on an Nokia-led mobile Internet could be enriched with transparent access to and interaction with any outside services, including the zillions of existing software capabilities that normally run on multi-cores or servers, in addition to supporting retrieval of multimedia data like other competitors.

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Test Case 1: How about an interesting yet challenging cross-device mobile application? Can it be done easily?

- Do all the great things with mobile camera, GPS, maps, GIS, compass ….
- Capture the lovely view with other environmental data of the surroundings
- Add annotations and overlays
- Share it synchronously with not only social networks on mobiles but also devices like a digital picture frame in grand-parents house

Test Case 2: For the sake of stimulating thoughts and deriving architectural requirements, how would one develop an Android Jigsaw-like whiteboard application **easily** on Symbian?

Question: What is a viable, consistent architecture to support easy development and deployment of these test case applications and all others we looked at earlier?

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A Side Track
WHY COLLABORATION

"Many of us envisioned an online world where constellations of PCs, servers, smart devices, and Internet-based services can collaborate seamlessly. Business will be able to share data, integrate their processes, and join forces to offer customized, comprehensive solutions to their customers. And the information you or your business need will be available wherever you are - whatever your computing devices you are using.

That vision has not yet been achieved."

- Bill Gates, 2005

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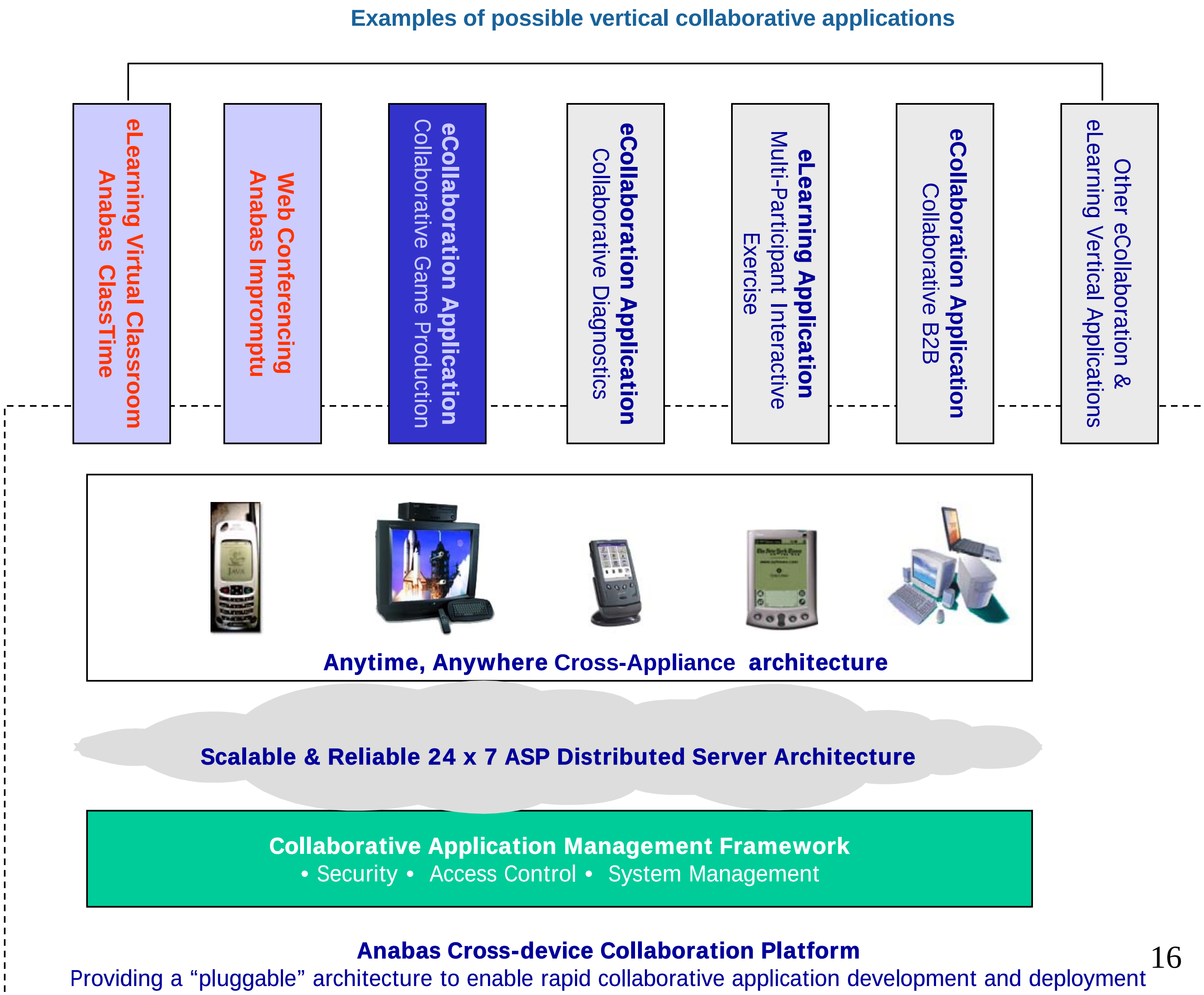
ENABLING A NEW CLASS OF CROSS-DEVICE, INTERACTIVE, RICH MEDIA APPLICATIONS



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Some Earlier Work in Cross-Device Collaboration

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Some screen shots of Anabas/IU CGL collaboration demos.

1. On PCs, Sprint Treo 600, Compaq iPaq, Nokia 3650 and Polycom.
2. On PCs, Sprint Treo 600, Compaq iPaq, Sprint Samsung Sph i300.
3. On PCs, Nokia N800, Lego Mindstorm NXT robots and Webcam.
4. On PCs, RFID, GPS, Ultrasonic, Sound, Light and Touch and Webcam video sensors

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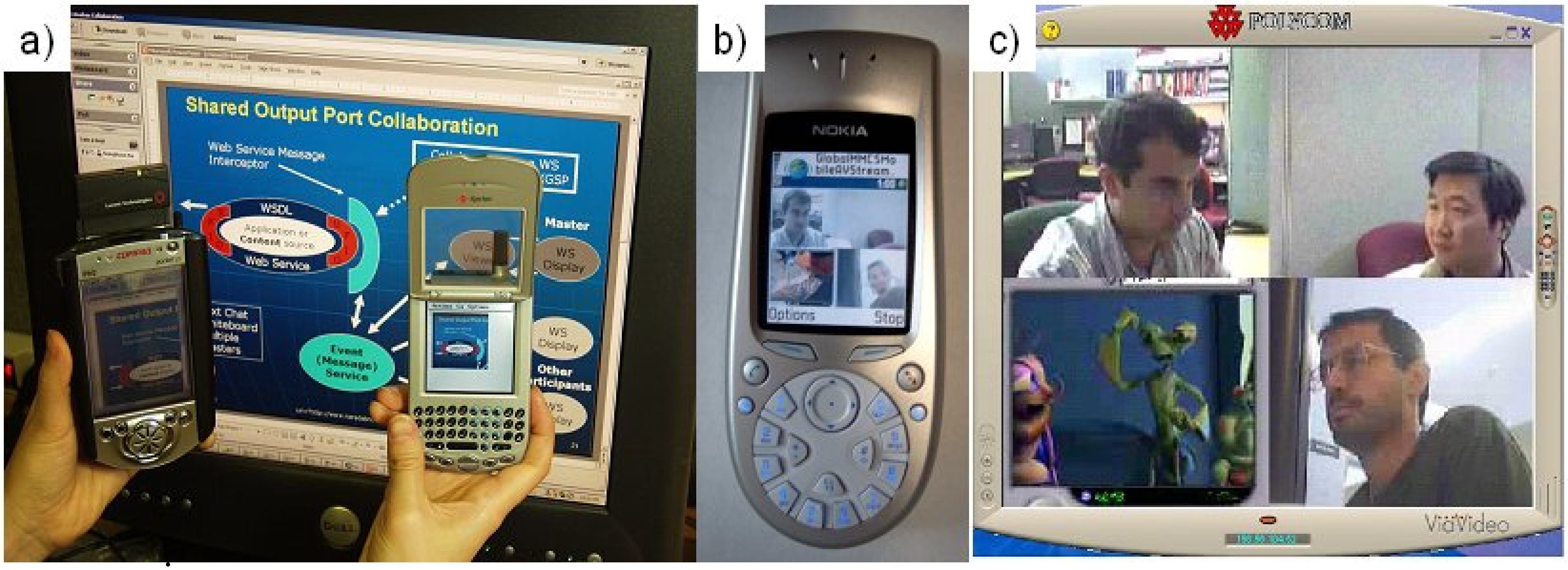
Cross-device collaboration – Anabas/IU



(1) *Figure a: An Impromptu collaboration client runs on a **PC** and shares with a **Sprint Treo 600** handset and a **Compaq iPaq** PDA.*

(2) *Figure b and c: 3 Webcam streams and an animation stream being shared between a **Nokia 3650** and **Polycom** device.*

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Anabas/IU CGL Cross-Device Collaboration

An Anabas Impromptu collaboration client runs on a ***PC*** *and shares a presentation with a* ***Sprint Treo 600*** *handset, a S**print Samsung Sph i300*** *handset and a* ***Compaq iPaq*** *PDA.*

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Back to the questions:

How about a cross-device mobile application?

- Do all the great things with mobile camera, GPS, maps, GIS, compass ….
- Capture the lovely view of the surroundings with environment data
- Add annotations and overlays
- Share it synchronously with not only social networks on mobiles but also devices like a digital picture frame in grand-parents house

What is a viable, consistent architecture to support this application and all others ?

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Objectives for a Collaborative Sensor-Rich Application Development Framework

To enable easy

- development
- deployment
- management
- real-time visualization
- organization
- presentation

of collaborative sensor-rich applications.

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Our definitions:

• A sensor is a time-dependent stream of information. A sensor is a resource. The sensor could be external, such as a TV stream.

• Grid computing enables any level of virtualization of resources so that users/applications do not need to know where the resources are before accessing to or interacting with them.

•A sensor grid virtualizes distributed, heterogeneous sensors allowing transparent access to, sharing of and interaction with any deployed sensors, any time, any where.

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Introduction – Grid & Services

- Grids and Cyber-infrastructure have emerged as key technologies to support distributed activities that span scientific data gathering networks with commercial RFID or (GPS enabled) cell phone nets.
- Phoenix extends the Grid implementation of SaaS (Software as a Service) to SensaaS (Sensor as a service) with a scalable architecture consistent with commercial protocol standards and capabilities.
- Phoenix further extends the support of Software as a Sensor, in which case SensaaS includes Software as a Service in a unified framework.

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Background

Commercial Backdrop

- XaaS or X as a Service is dominant trend
- X = S: Software (applications) as a Service
- X = I: Infrastructure (data centers) as a Service
- X = P: Platform (distributed O/S) as a Service
- Grids are any collection of Services and manage distributed services or distributed collections of Services i.e. Grids to give Grids of Grids
- We added
- X = C: Collections (Grids) as a Service and
- X = Sensors as a Service

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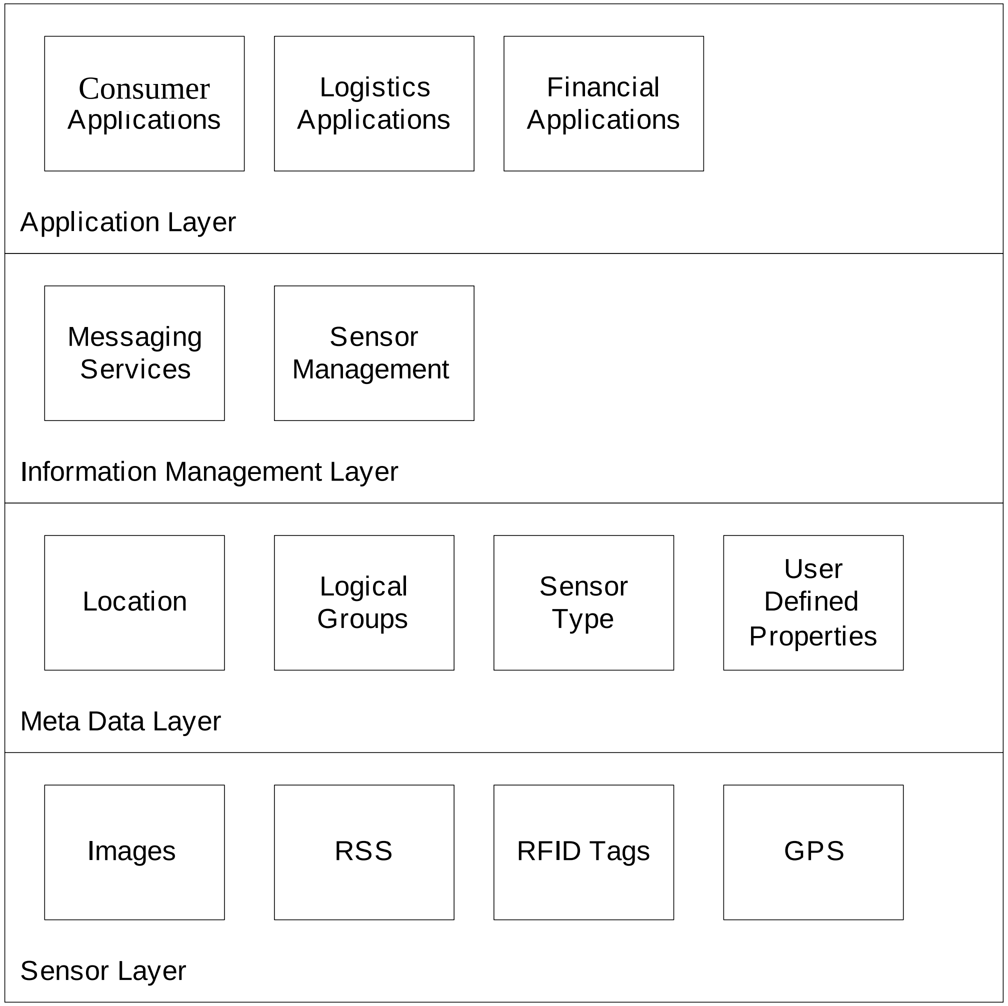
High-level Phoenix System Architecture



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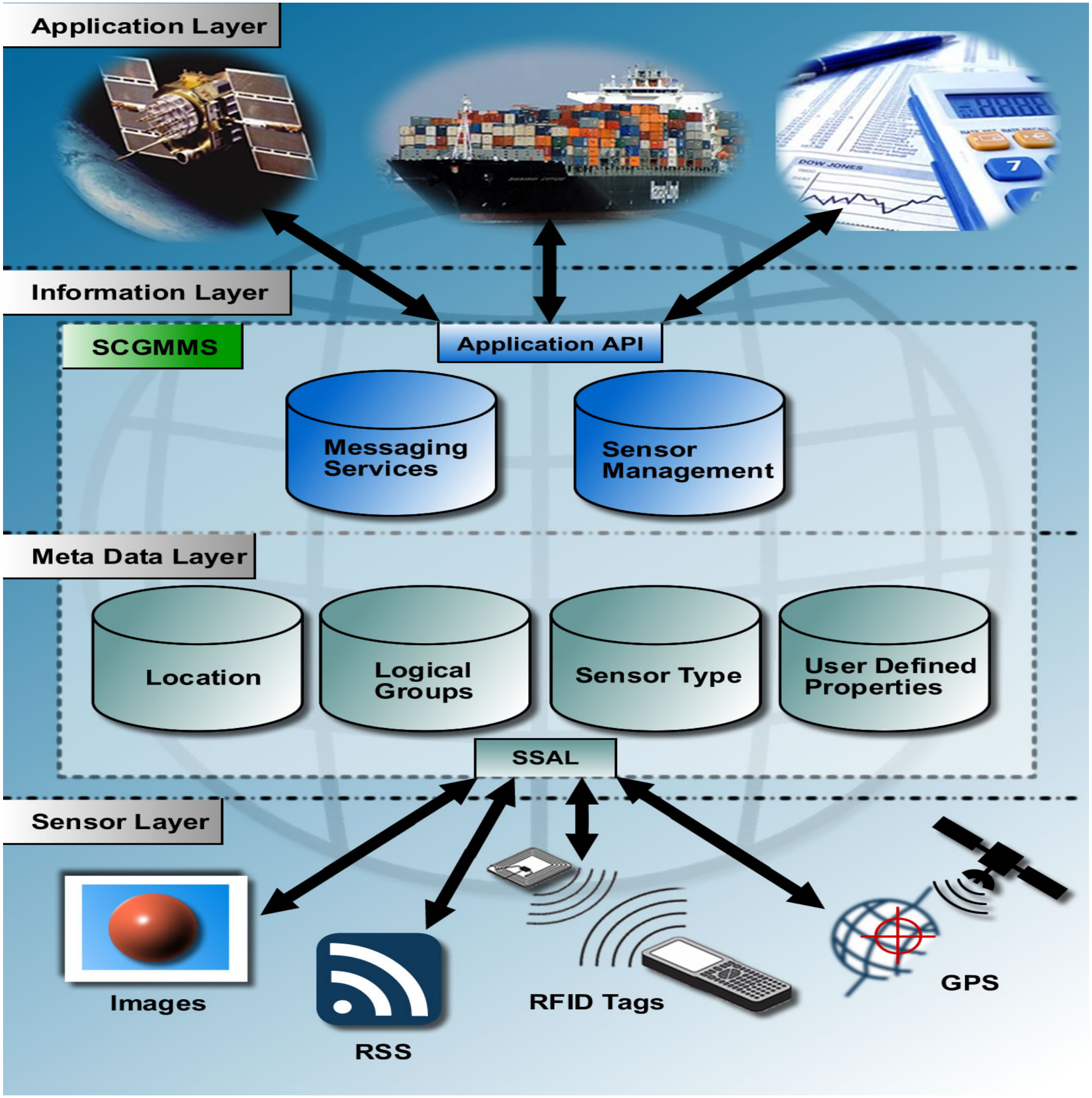

Application Layer
Information Layer
SCGMMS
Application API
Messaging Services
Sensor Management
Meta Data Layer
Location
Logical Groups
Sensor Type
User Defined Properties
SSAL
Sensor Layer
Images
RSS
RFID Tags
GPS

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Sensor Layer

• Sensors provide raw information which is captured dynamically in different environments.

Metadata Layer

• Describes the properties of sensor; gives meaning to raw data collected from sensors. Makes information filtering possible.

Information Management Layer

• Transport messages from sensors to applications
• Messaging facilities that supports multi-protocol
• Facilities for sensor management such as deploying and disconnecting sensors

Application Layer

• Applications access to virtualized, distributed resources

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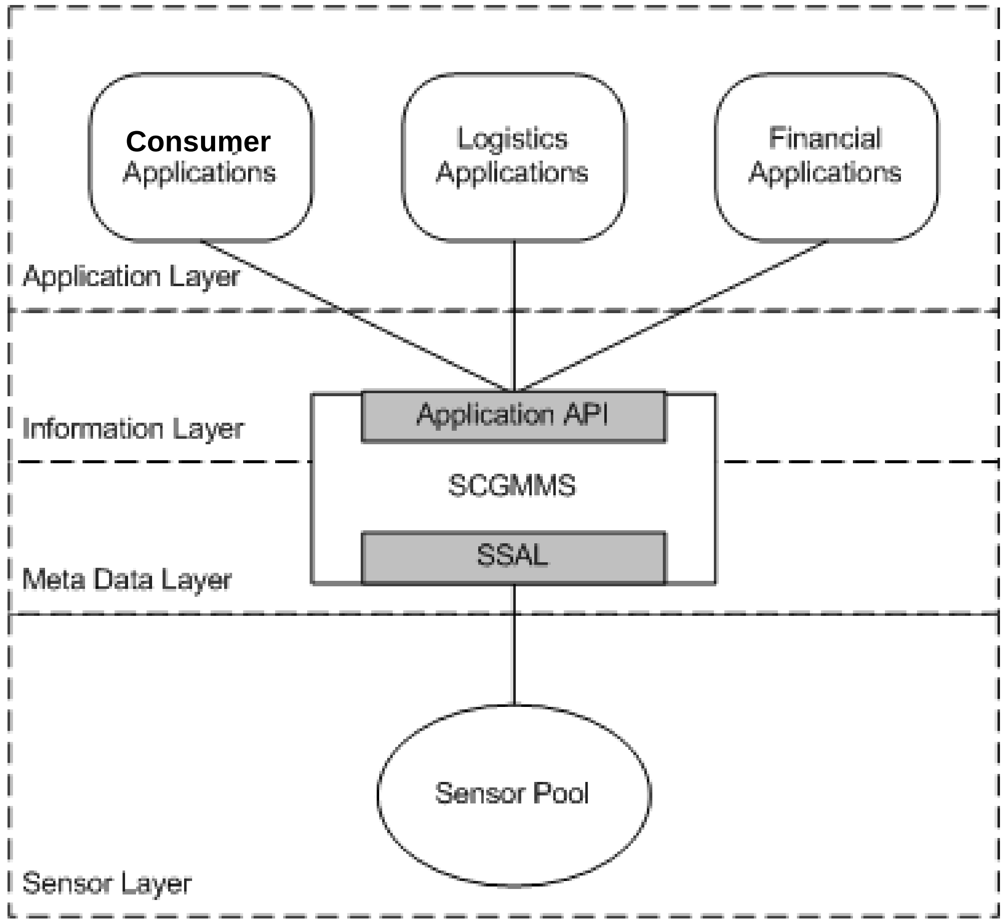
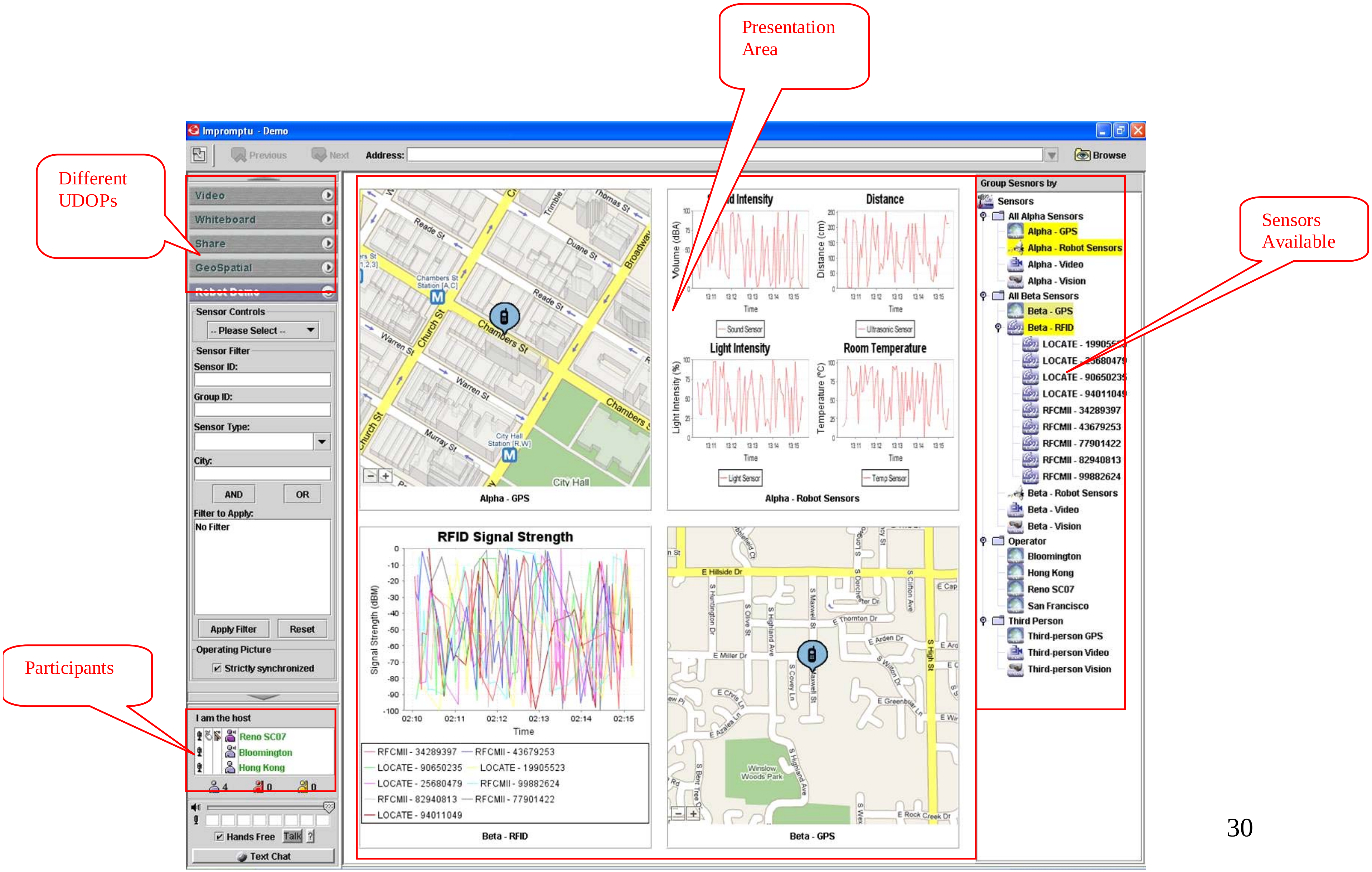
Phoenix: A Collaborative Sensor-Centric Application Development Framework



Phoenix API allows application developers to retrieve sensor data and metadata about sensors. The Phoenix SSAL facilitates sensor developers to define sensor metadata for application-level filtering and exposes sensor services to applications.

Typical Sensor Grid Interface



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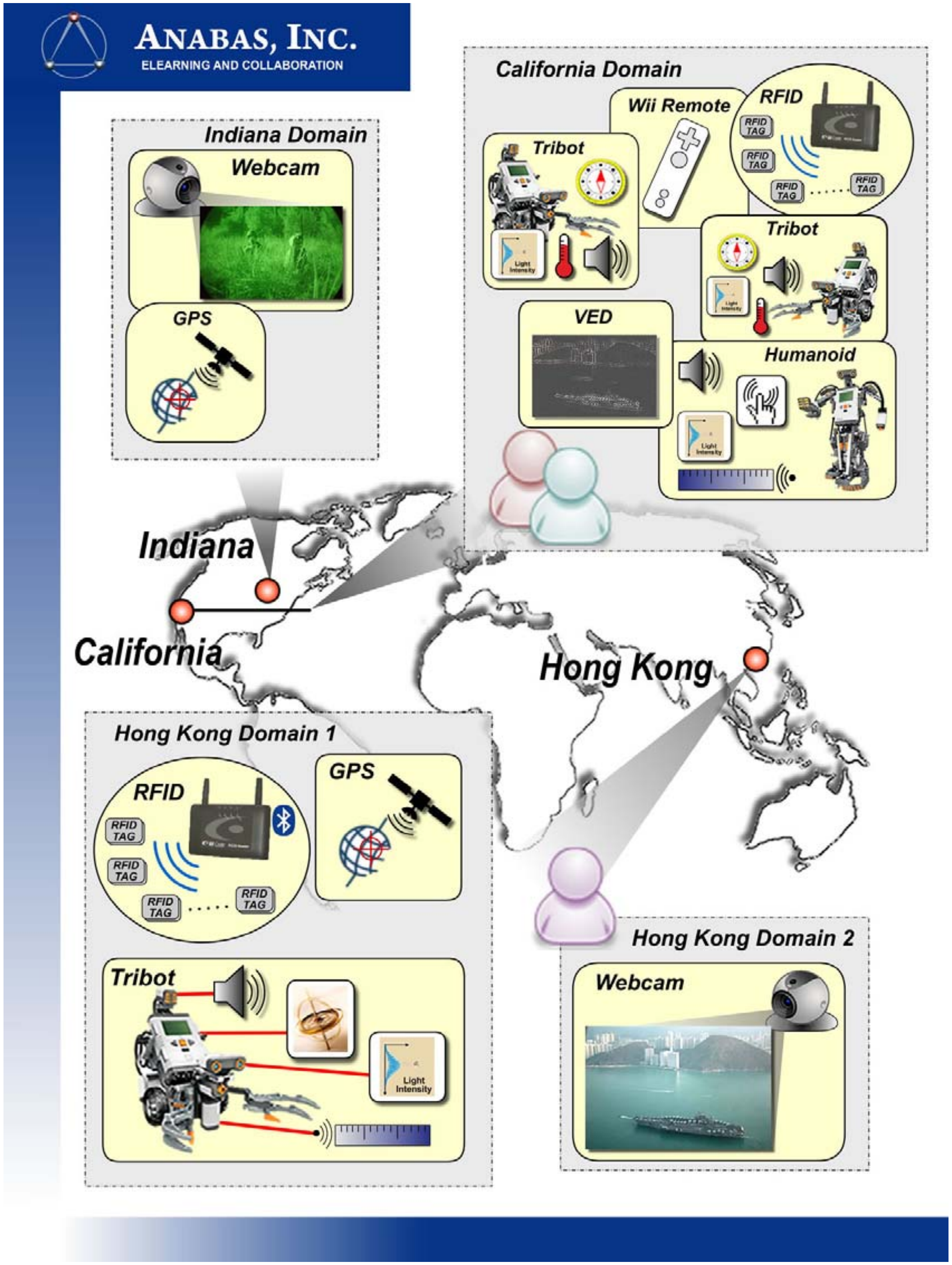
A Sneak Preview of A Sample Collaborative Sensor-Centric Grid Demo Scenario

- The robots in the demo are Lego NXT Mindstorm robots.
- Each NXT robot carries some sensors – just like some new mobiles do.



Supported Services

Sensor Services:

- RFID
- GPS
- Wii remote
- Webcam video
- Lego Mindstorm NXT
  - Ultrasonic
  - Sound
  - Light
  - Touch
  - Gyroscope
  - Compass
  - Accelerometer
  - Thermistor
- NOKIA N800 Internet Tablet

Computational Service

- VED (Video Edge Detection)

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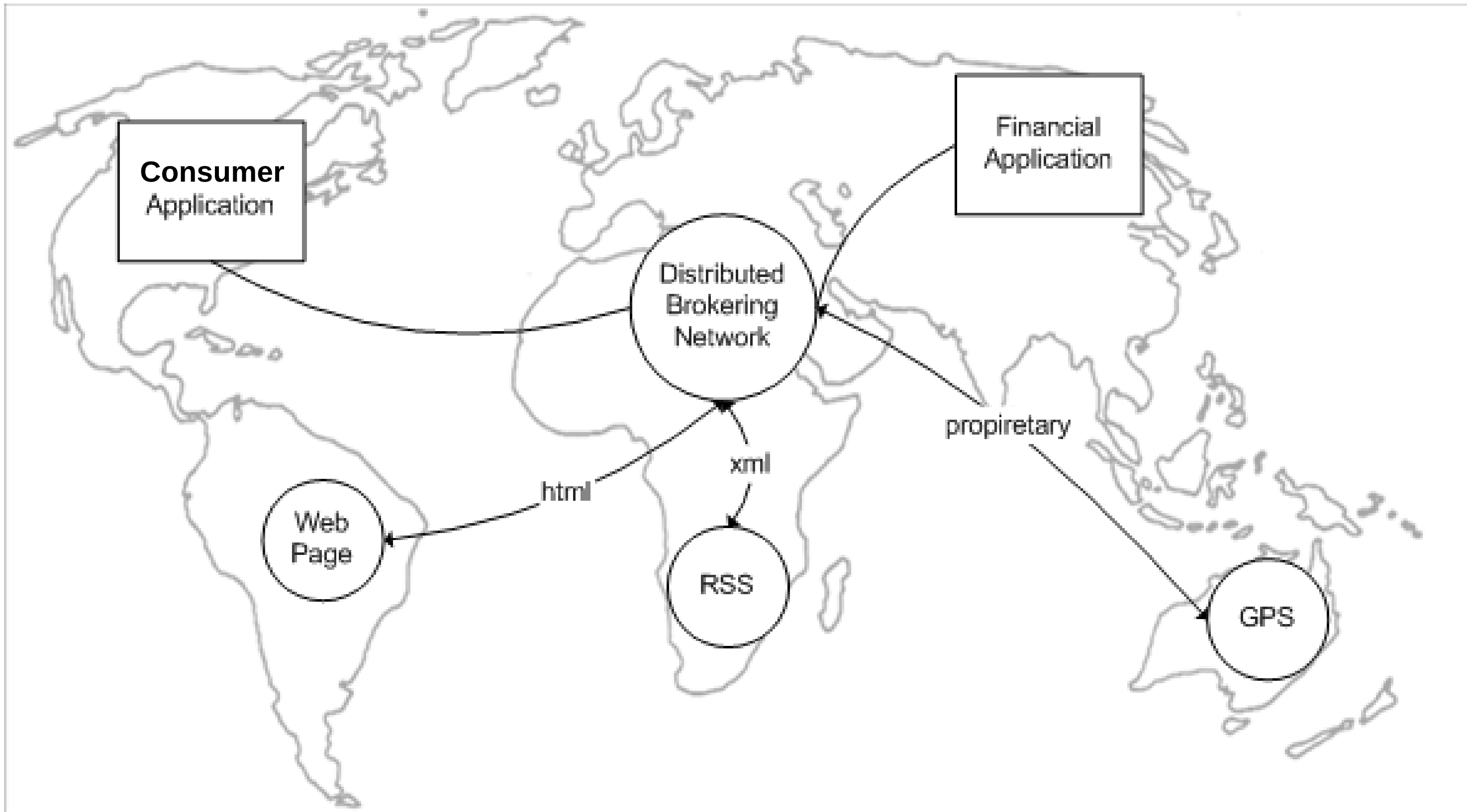
Distributed Architecture for Data Access



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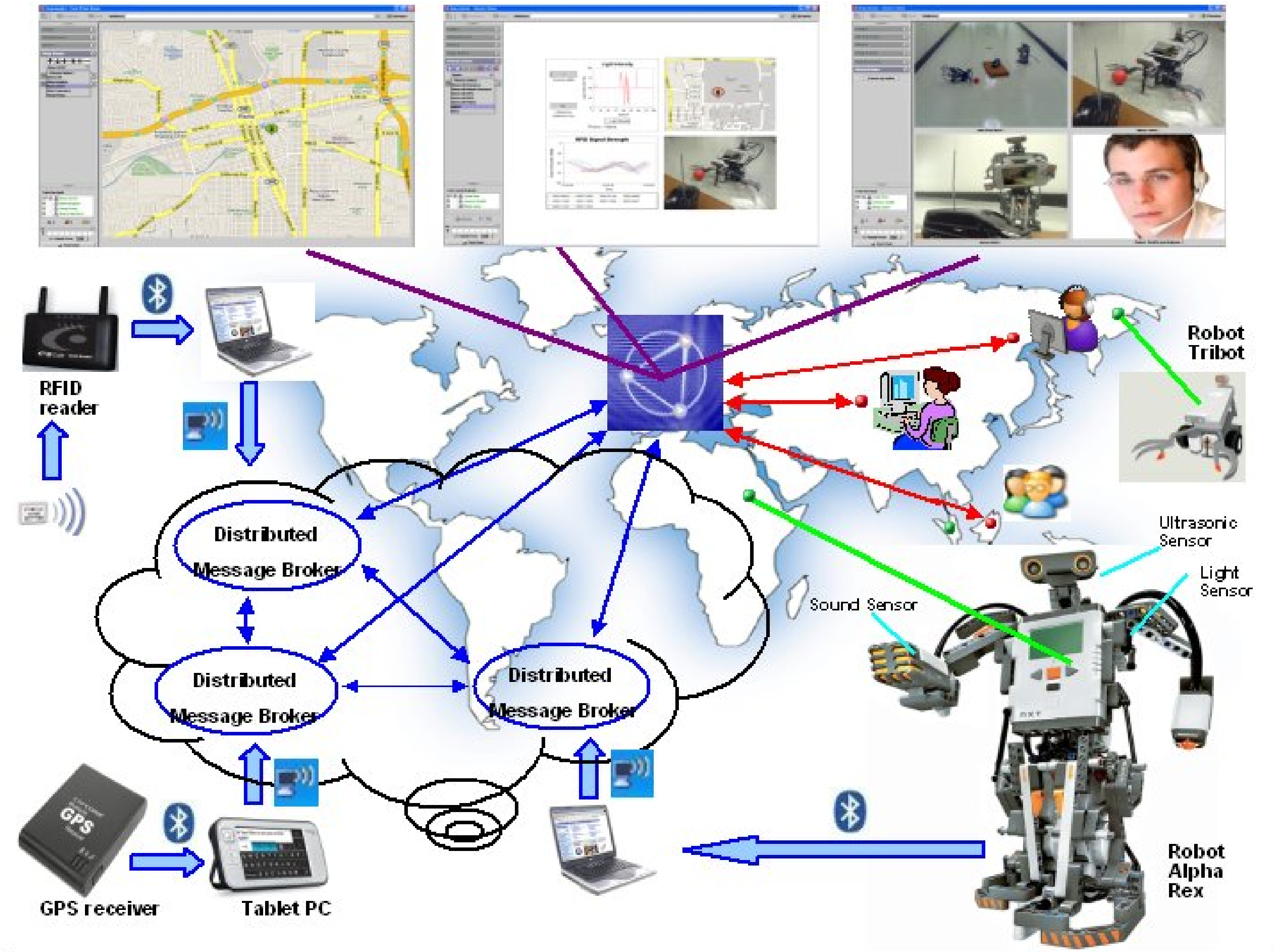
Illustrative Distributed Architecture for Data Access

(including a Nokia N800)



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Data Model

• Sensors in different geo-spatial locations continuously publish data into the distributed brokering network.

• Phoenix routes relevant data to all connected applications according to their client-side requirements.

• Applications are notified for each data arrival.

• Some sensors are capable of receiving requests from applications and perform some actions in return.

• Sensors data could be routed to other computational services for further processing.

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Data Selection and Filtering

- Each Phoenix client application is only interested in certain domain-specific information extracted from the large raw data pool supported by Phoenix.

- Filtering mechanism allows
  - an application user to define “filters”
  - a filter is sent to Phoenix
  - Phoenix responds with sensors data that match the filter
  - the application subscribes to data of these sensors through the Phoenix API

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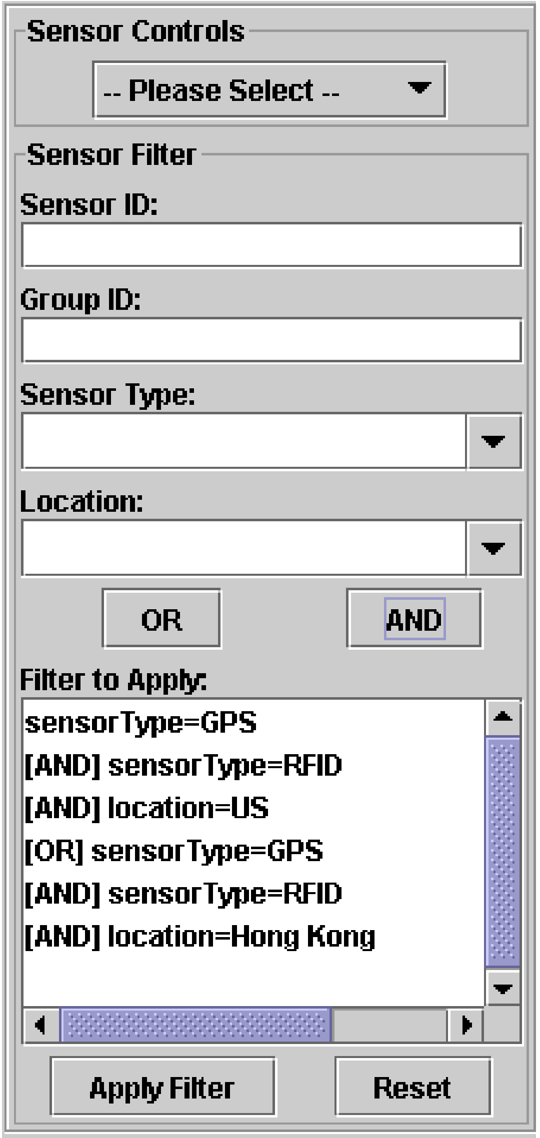
An example of a filter in Phoenix

A decision-maker wants to locate all GPS and RFID sensors in US or UK, the corresponding query looks like:

$$\text{sensorType=GPS} \cap \text{sensorType=RFID} \cap \text{location=US} \cup$$
$$\text{sensorType=GPS} \cap \text{sensorType=RFID} \cap \text{location=UK}$$

A sample Phoenix-capable sensor-centric application provides a GUI to support ease of filtering.



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Grid Builder (GB)

GB is a sensor management module which provides services for

- Defining the properties of sensors
- Deploying sensors according to defined properties
- Monitoring deployment status of sensors
- Remote Management - Allow management irrespective of the location of the sensors
- Distributed Management – Allow management irrespective of the location of the manager / user

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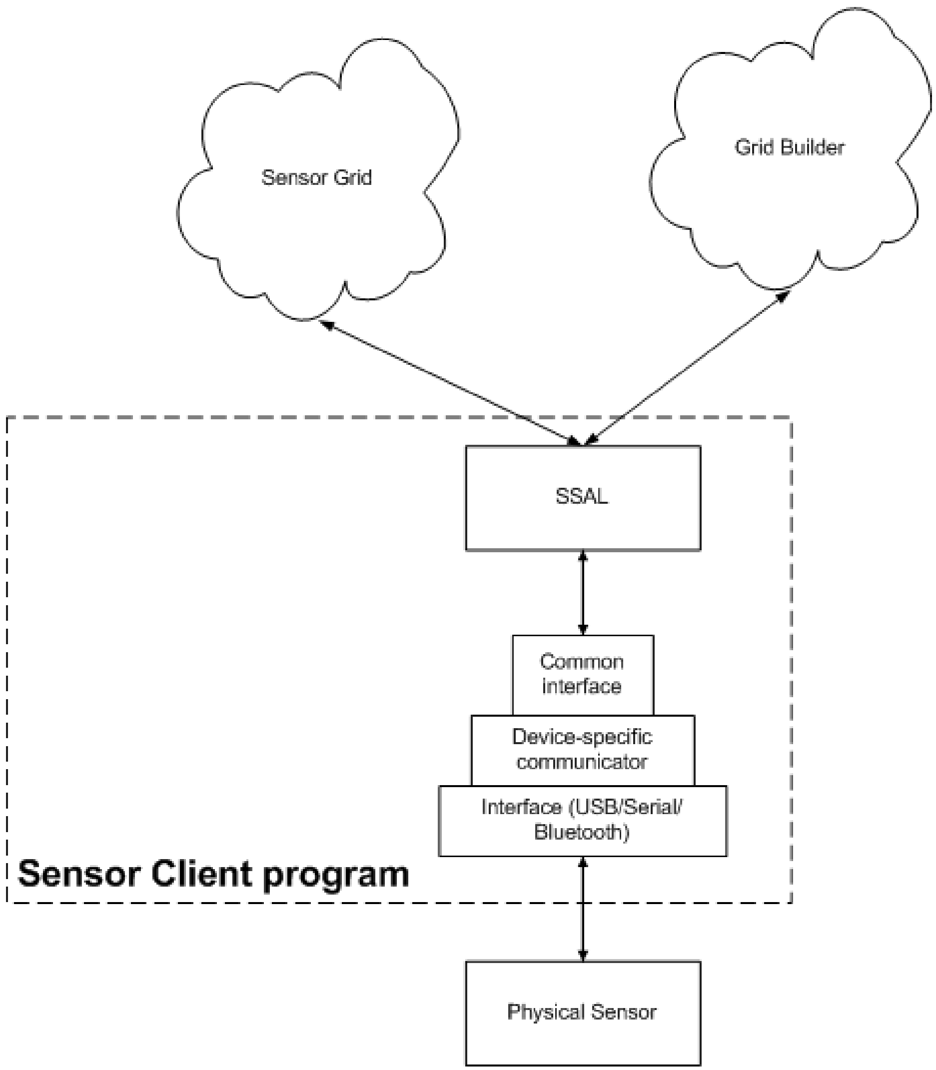
Sensor Grid (SG)



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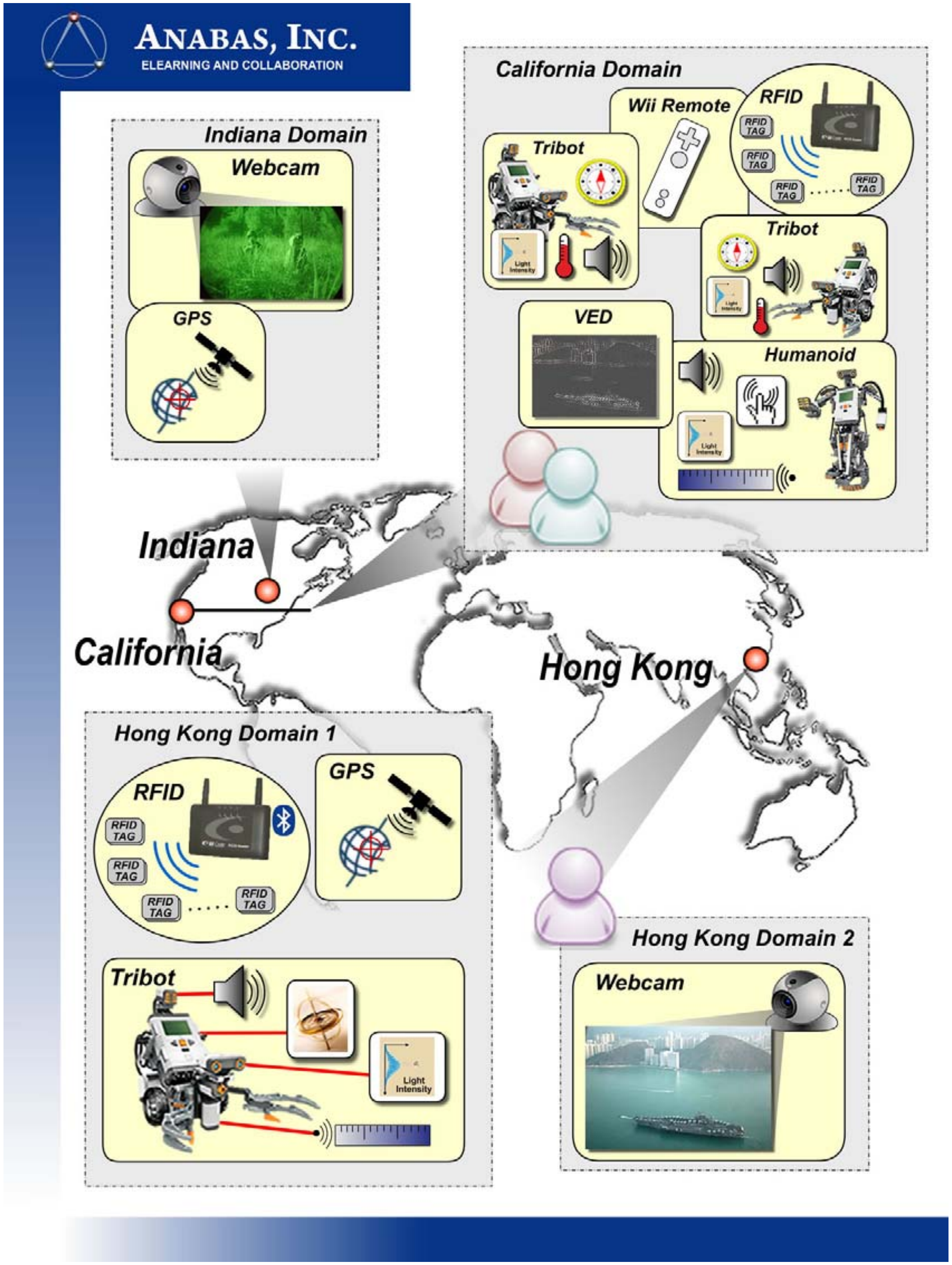
A Collaborative Sensor-Grid Demo

-- An illustrative demo in CTS 2008



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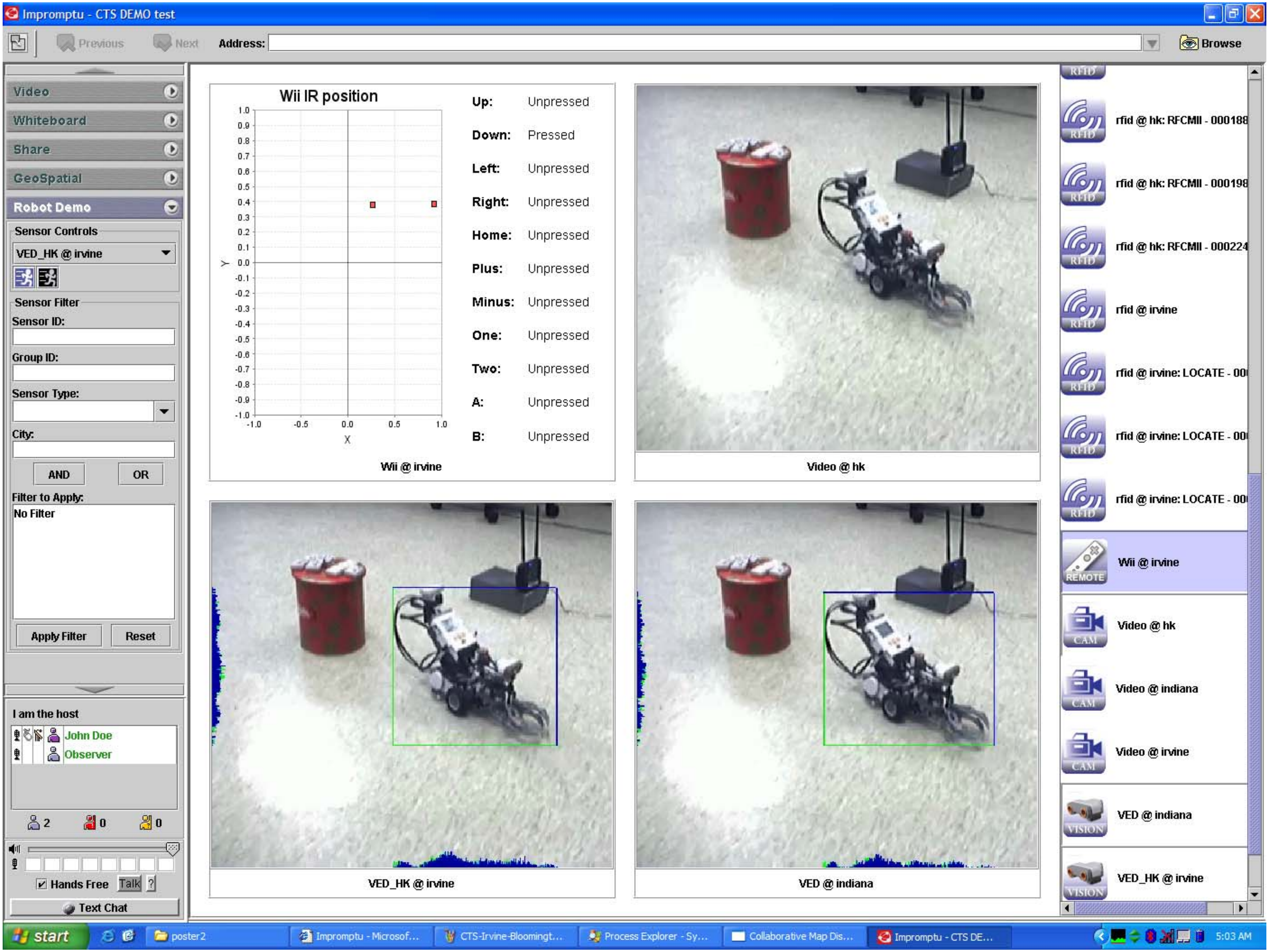
Impromptu - CTS DEMO test
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Browse
Video
Whiteboard
Share
GeoSpatial
Robot Demo
Sensor Controls
VED_HK @ irvine
Sensor Filter
Sensor ID:
Group ID:
Sensor Type:
City:
AND
OR
Filter to Apply:
No Filter
Apply Filter
Reset
I am the host
John Doe
Observer
Hands Free
Talk
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Wii IR position
Up: Unpressed
Down: Pressed
Left: Unpressed
Right: Unpressed
Home: Unpressed
Plus: Unpressed
Minus: Unpressed
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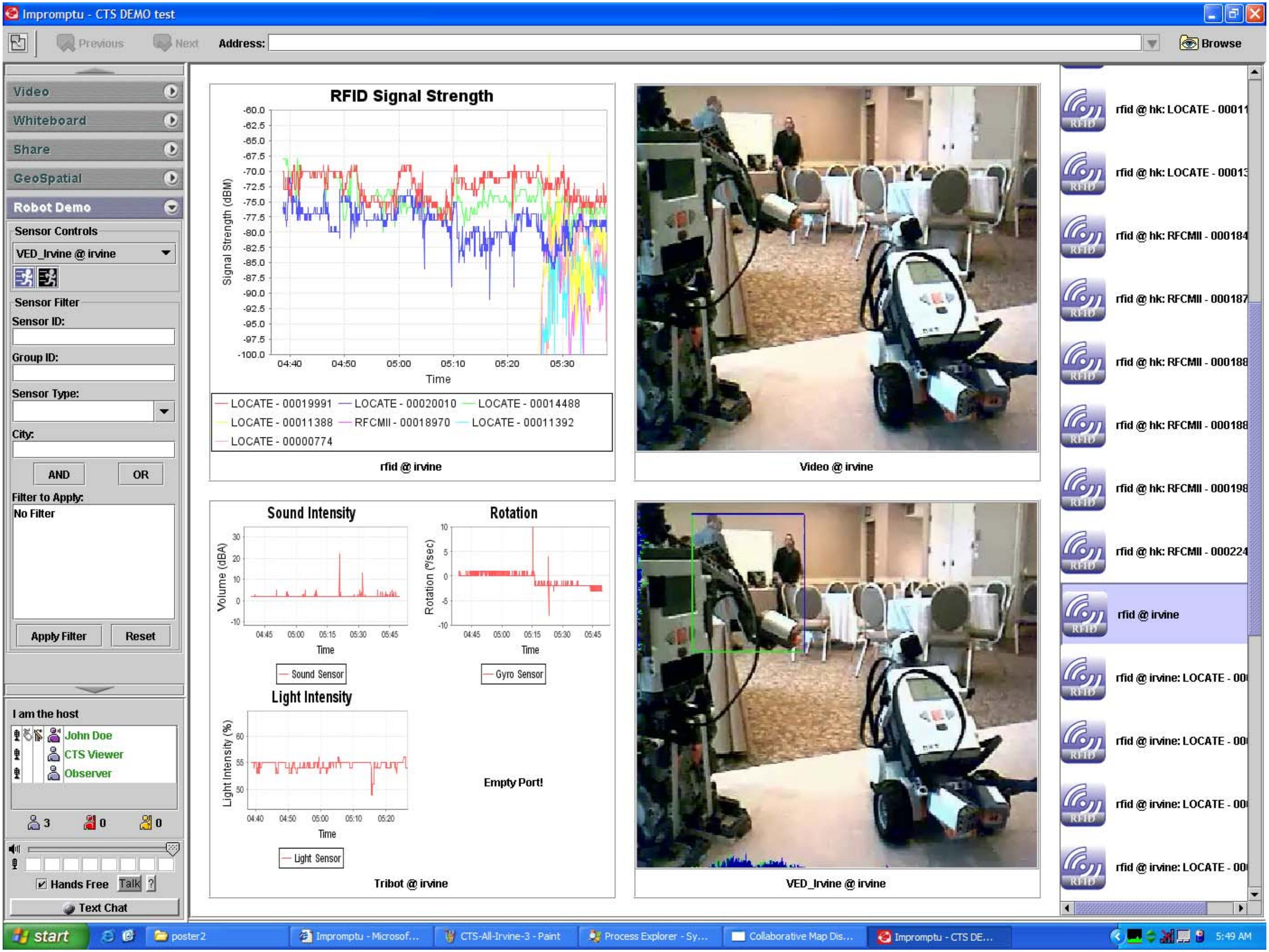

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Hands Free
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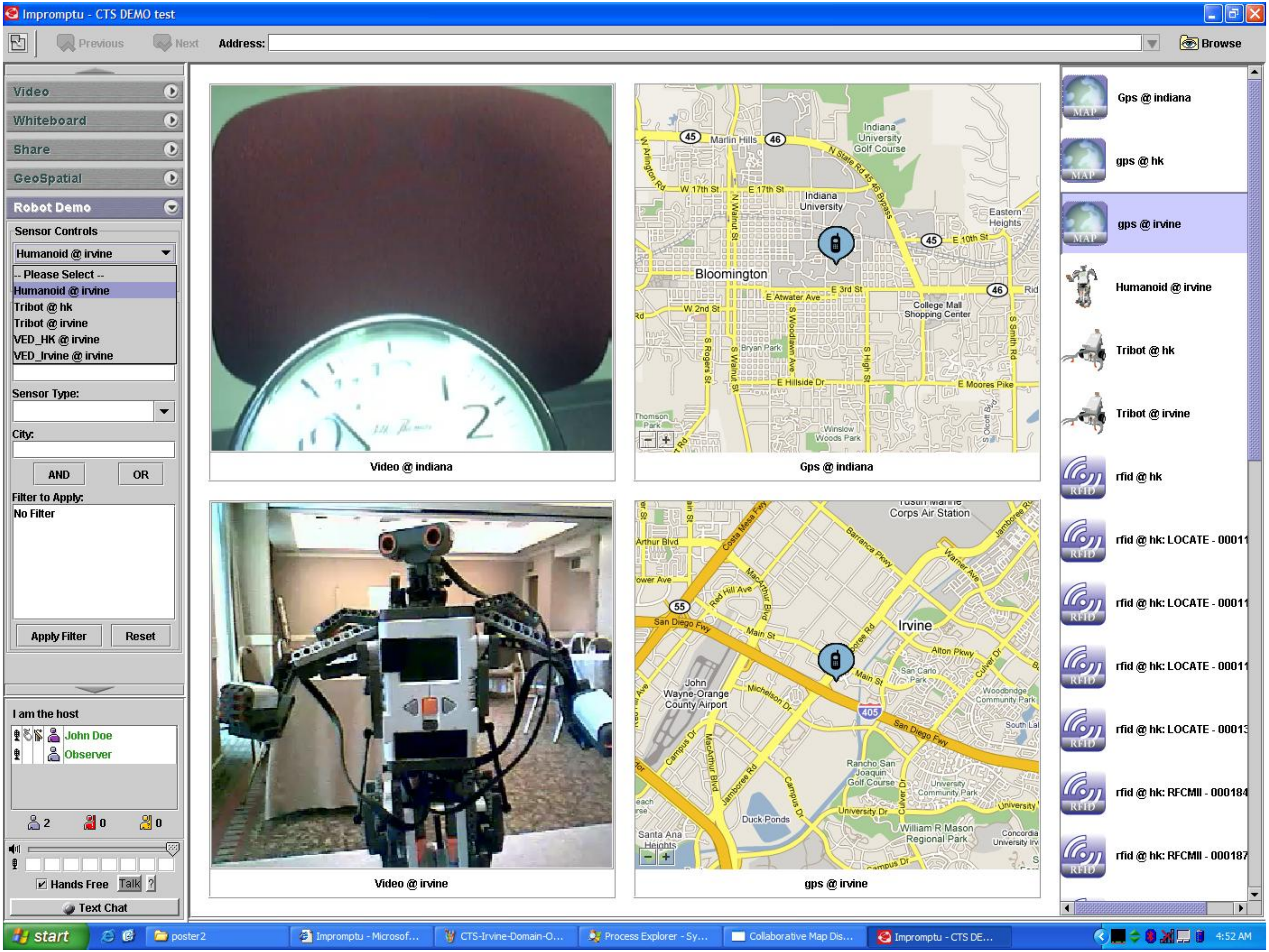
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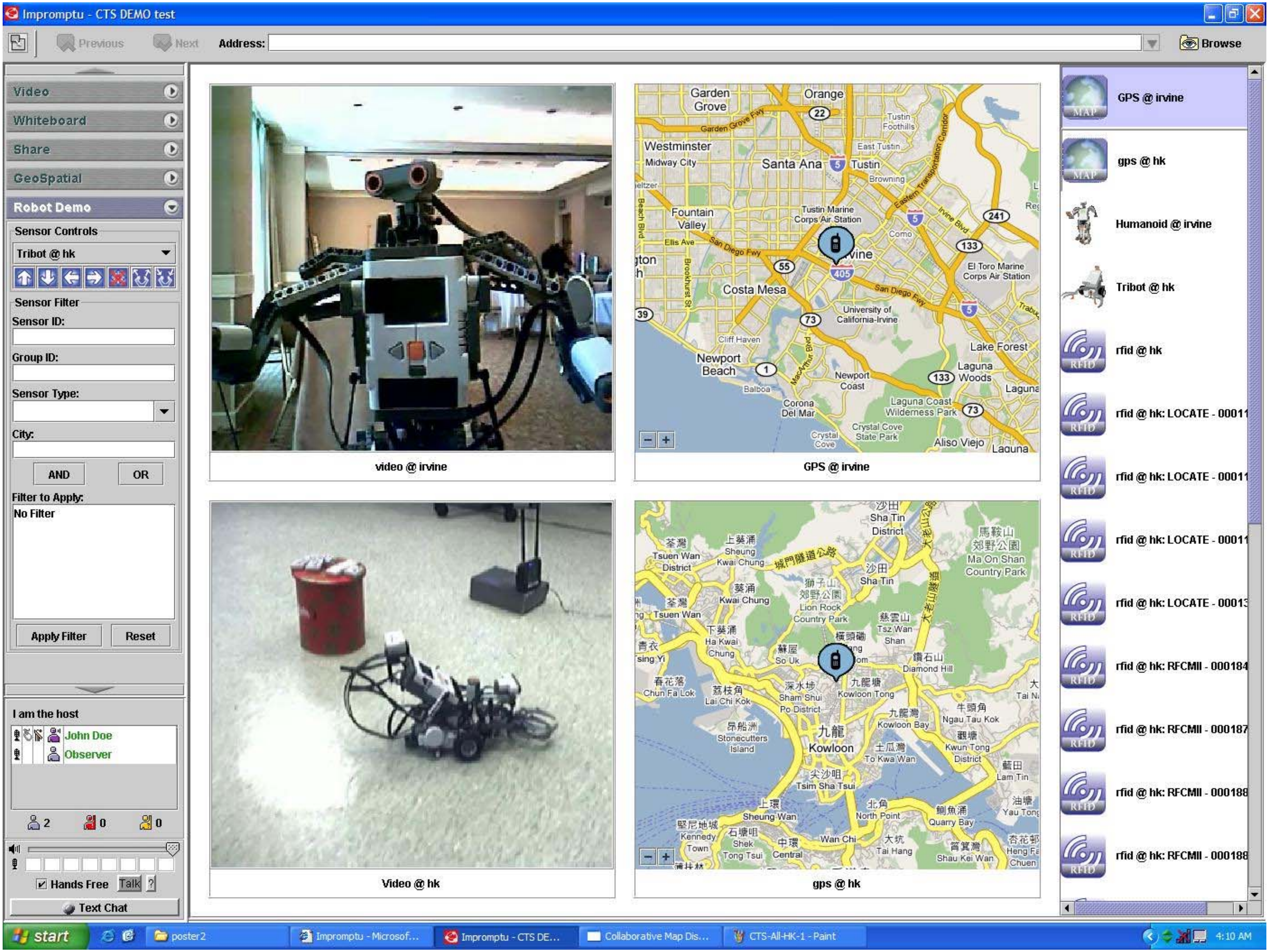

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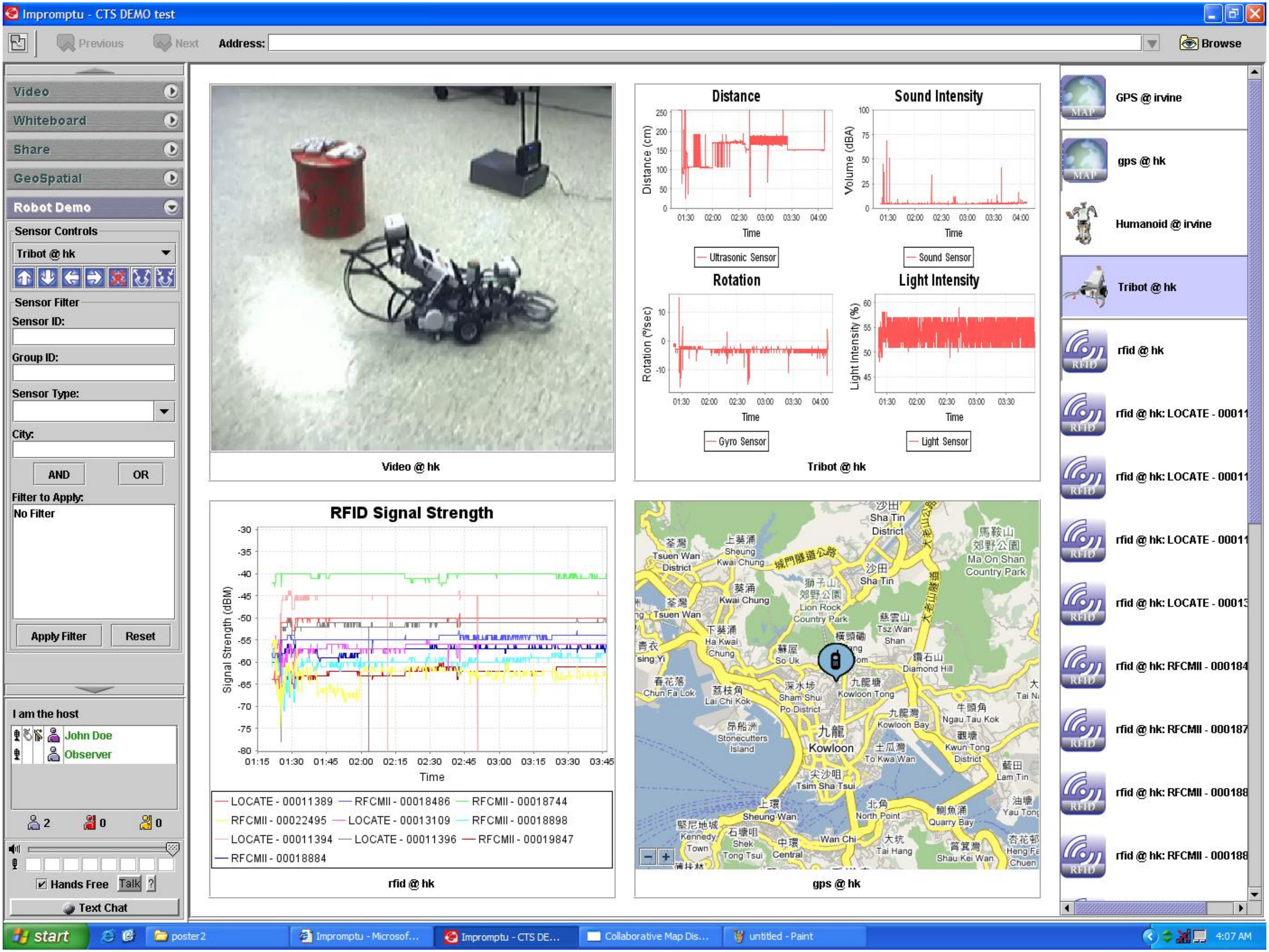

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RFID Signal Strength
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RFCMII - 00022495
LOCATE - 00013109
RFCMII - 00018898
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RFCMII - 00019847
RFCMII - 00018884
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Sheung Kwai Chung
Ma On Shan Country Park
Sha Tin
Kwai Chung
Lion Rock Country Park
Tsuen Wan
Tsz Wan Shan
Ha Kwai Chung
So Uk
Diamond Hill
Chun Fa Lok
Lai Chi Kok
Sham Shui Po District
Kowloon Tong
Ngau Tau Kok
Kowloon Bay
Stonecutters Island
Kowloon
To Kwa Wan
Kwun Tong District
Lam Tin
Tsim Sha Tsui
Sheung Wan
North Point
Quarry Bay
Yau Tong
Kennedy Town
Shek Tong Tsui
Central
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rfid @ hk: LOCATE - 00011
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rfid @ hk: LOCATE - 00013
rfid @ hk: RFCMII - 000184
rfid @ hk: RFCMII - 000187
rfid @ hk: RFCMII - 000188
rfid @ hk: RFCMII - 000188
start
poster2
Impromptu - Microsof...
Impromptu - CTS DE...
Collaborative Map Dis...
untitled - Paint
4:07 AM

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Recap

Test Case 1: How about an interesting yet challenging cross-device mobile application? Can it be done easily?

- Do all the great things with mobile camera, GPS, maps, GIS, compass ….
- Capture the lovely view with other environmental data of the surroundings
- Add annotations and overlays
- Share it synchronously with not only social networks on mobiles but also devices like a digital picture frame in grand-parents house

Test Case 2: For the sake of stimulating thoughts and deriving architectural requirements, how would one develop an Android Jigsaw-like whiteboard application **easily** on Symbian?

Question: What is a viable, consistent architecture to support easy development and deployment of these test case applications and all others we looked at earlier?

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Conclusion

- High level approach to Test Case 1: Cross-device Sharing
  - Develop mobile phone as a SensaaS (just like an NXT robot) .
  - Develop digital picture frame as a SensaaS.
  - Deployed both SensaaS on the Phoenix Sensor Grid.

- High level approach to Test Case 2: Jigsaw-like Whiteboard on Symbian
  - Use the Test Case 1 "mobile phone as a SensaaS".
  - Add annotation and drawing features as Jigsaw.
  - Develop all image processing capabilities as SensaaS on Windows or Linux. Image processing algorithms could be developed much easier and run much faster on Windows or Linux PCs than Symbian on mobiles. These algorithms are most likely even exist in some source form. Just wrapped them as SensaaS and saving all the time to re-invent an optimized implementation on Symbian.
  - Leverage the Nokia mobile Internet.
  - Deploy all relevant SensaaS on the Phoenix Sensor Grid.
  - SensaaS streams can be shared synchronously without additional coding.

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Conclusion

- Phoenix provides a unified architecture to support Collaborative Sensor-Rich applications by treating "XaaS" uniformly. It supplements *Connecting People* with *Connecting Resources*.

- Phoenix enables a new class of sensor-rich, streaming mobile application development, deployment, management and delivery platform for leading mobile service providers. It enables mobile service providers to serve all the mobile streaming needs of their end users and application developers.

- As mobile sensor streaming traffic traverses the Phoenix sensor grid, a StreamingTube™ SensaaS could be added to support storage and asynchronous access to the world of streaming content that originates from or is destined for mobiles.