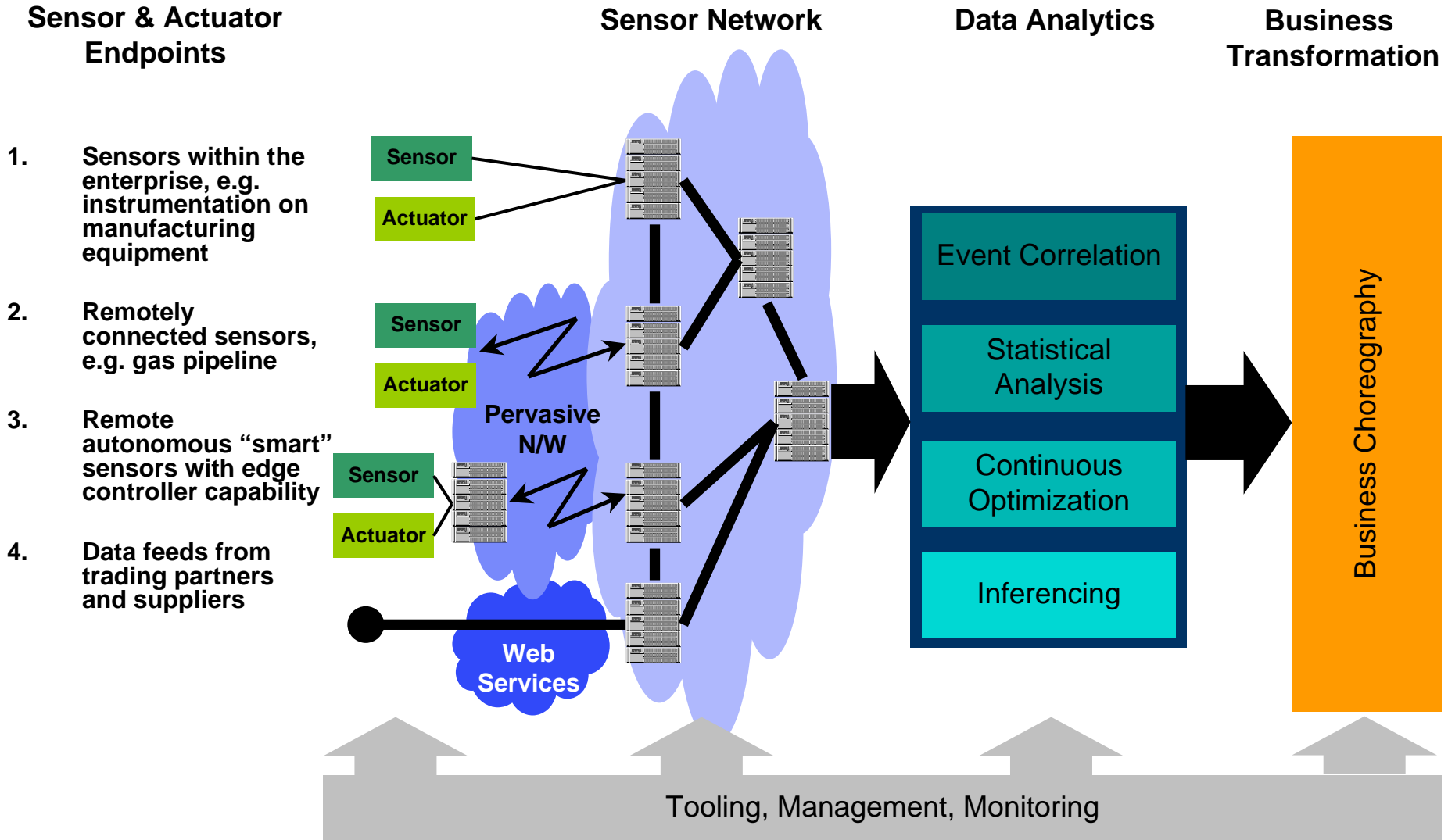# Ubiquitous Computing Research at IBM
RFID and Beyond
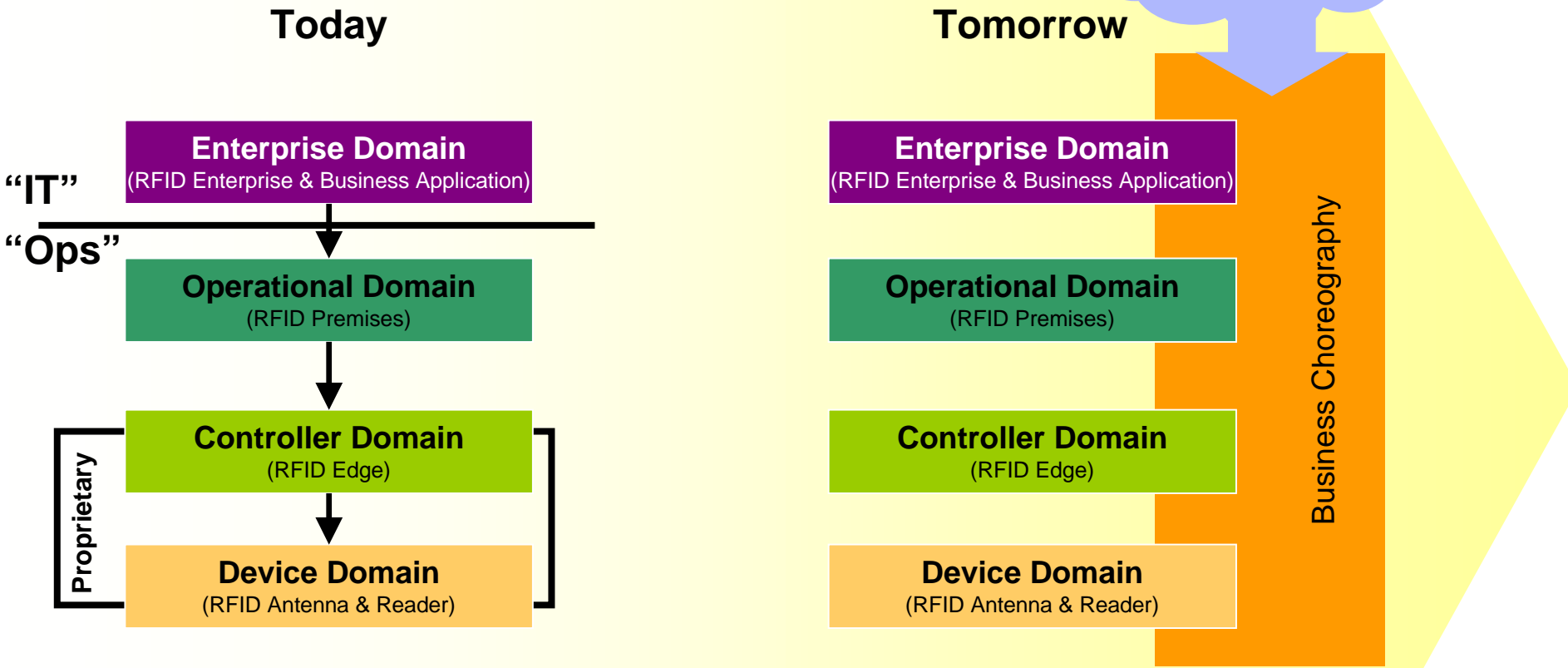
Dr Stefan G Hild
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IBM TJ Watson Research Center

Sensors Deployment Model

Sensor & Actuator Endpoints

Sensor Network

Data Analytics

Business Transformation

1. **Sensors within the enterprise, e.g. instrumentation on manufacturing equipment**

2. **Remotely connected sensors, e.g. gas pipeline**

3. **Remote autonomous "smart" sensors with edge controller capability**

4. **Data feeds from trading partners and suppliers**

Sensor

Actuator

Sensor

Actuator

Pervasive N/W

Sensor

Actuator

Web Services

Event Correlation

Statistical Analysis

Continuous Optimization

Inferencing

Business Choreography

Tooling, Management, Monitoring

Towards Business Choreography

Sensor **Actuator**
Network

Today	Tomorrow

"IT"
"Ops"

Enterprise Domain
(RFID Enterprise & Business Application)

Operational Domain
(RFID Premises)

Proprietary

Controller Domain
(RFID Edge)

Device Domain
(RFID Antenna & Reader)

Enterprise Domain
(RFID Enterprise & Business Application)

Operational Domain
(RFID Premises)

Controller Domain
(RFID Edge)

Device Domain
(RFID Antenna & Reader)

Business Choreography

- **Limited vertical integration enables only localized optimization**
- **Reduced ability for enterprise to react to sensed changes**

- **Increased awareness of existing business processes and dependencies within the enterprise**
- **Improved ability to optimize processes across the enterprise**
- **Improved ability to react to changes**

Business Choreography Research Agenda

- **Horizontal Integration**
  Infrastructure needs to accommodate varying requirements at different parts of the enterprise
  - Research in enterprise-wide, reliable messaging
  - Research activities on extending business process modeling tools (WBI) for the embedded space

- **Remote Management**
  Increased reliance on large number of diverse, remote equipment
  - Research on remote management of large scale sensor deployments
  - Large number of research projects addressing security implications and concerns

- **Security**
  Perceived increase in infrastructure and application complexity due to increased interdependence
  - Research on improved business modeling and application authoring
  - Research on novel simulation and verification techniques

- **Data Analytics**
  Need for more sophisticated optimization techniques
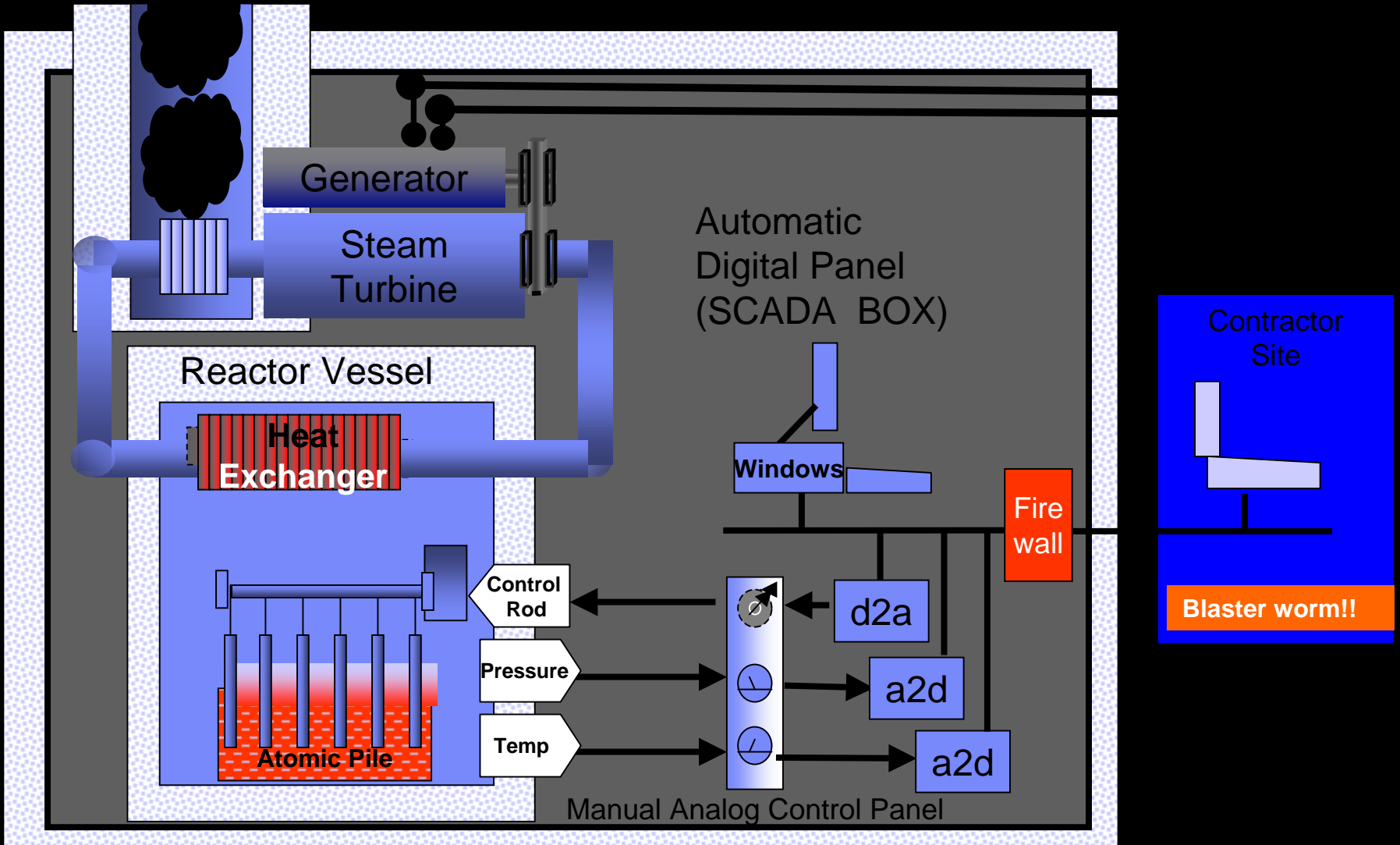 - Collaborative research activities between the S&A research teams and the IBM mathematics department

- **Data Management**
  Increased need to collaboration and data sharing
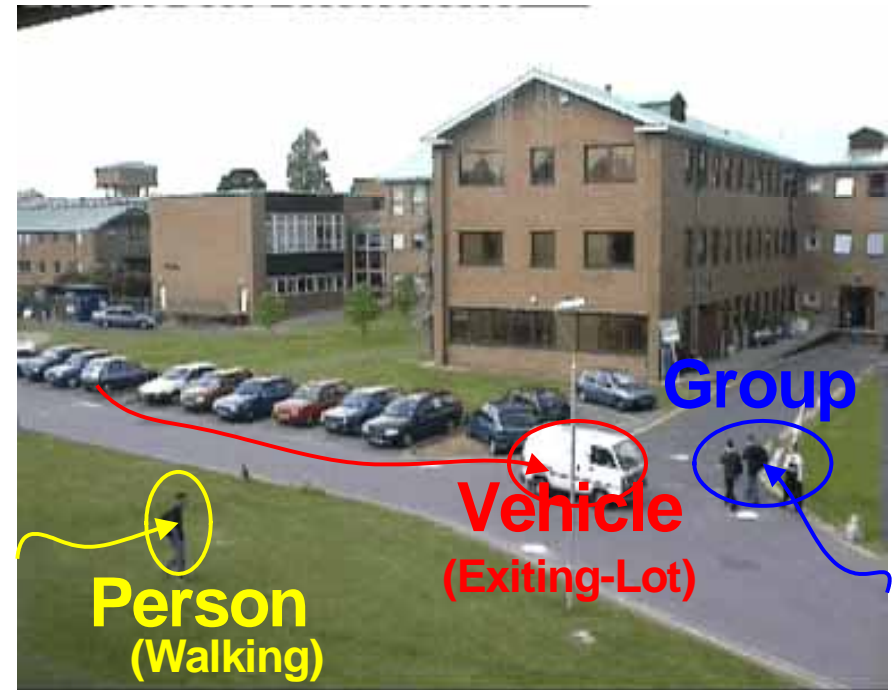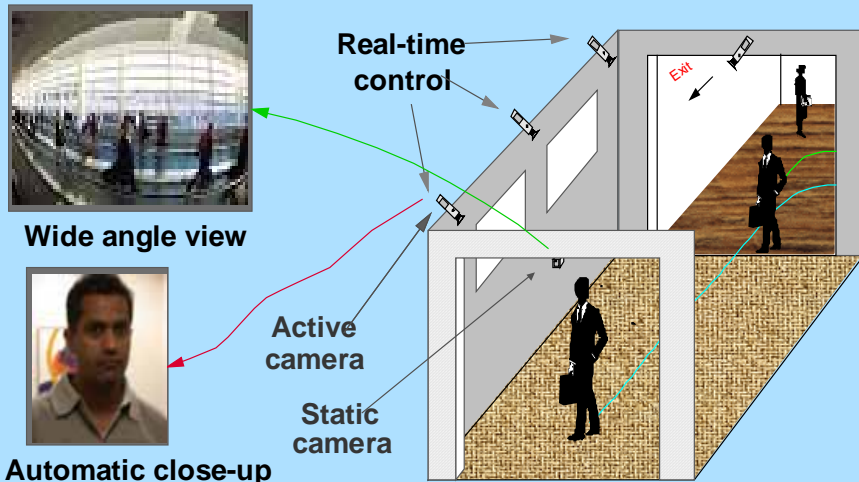 - Research on data access and privacy

IBM Research

Digital Networks are Becoming Increasingly More Important
- Nuclear Power Plant (Simplified)

Generator

Steam Turbine

Automatic Digital Panel (SCADA BOX)

Reactor Vessel

Heat Exchanger

Windows

Contractor Site

Fire wall

Control Rod

Blaster worm!!

Pressure

d2a

Temp

a2d

Atomic Pile

a2d

Manual Analog Control Panel

Video Surveillance Systems

Solution Description

PeopleVision: Multi-scale visual tracking technology is the core technology for Smart Surveillance. Smart Surveillance Systems "watch the surveillance video" and automatically alert security personnel upon detecting alarm conditions, perform automatic face capture, and allow for content based retrieval of surveillance footage


Group

Vehicle (Exiting-Lot)

Person (Walking)

Real-time control

Wide angle view

Automatic close-up

Active camera

Static camera

Exit

Value Proposition

→ **Higher Security** – reduces "video daze"
→ **Ability to Preempt** – Generates real time alerts
→ **Effective Intelligence** – Content based queries
→ **Reduced Costs** – Fewer security personnel

mySpace – a Sensor-Rich Workplace

- A portal solution that supports role-based access to content and applications

- An interactive visualization of the user's physical space displaying information at a building, floor or room level

- An application that federates data from different sources into a single, simple, access point for users.
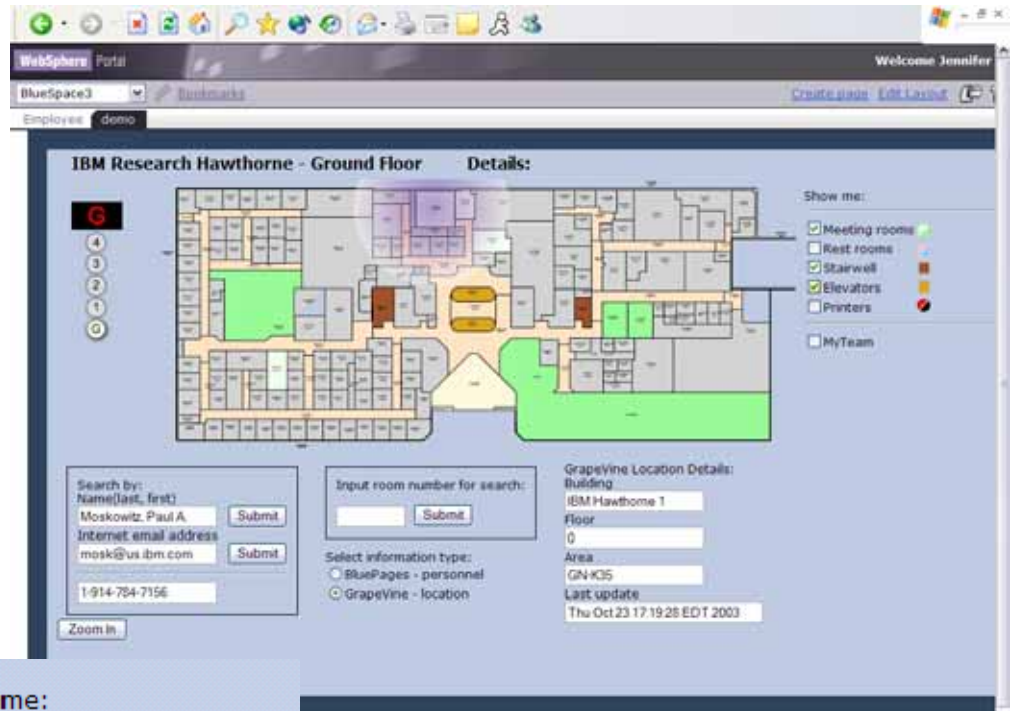
Single-click, context-sensitive communication with colleagues

Identification of resources and assets

The Everywhere Displays Project

Surface Transformation

- The Everywhere Displays project aims to develop systems that allow the transformation of every surface in a space into a projected "touch screen"

- A prototype is being developed where we combine a LCD projector, a pan/tilt mirror, and a camera

- The mirror is used to deflect the image of the projector to surfaces, walls, or the floor of a room

- The projected image is processed to compensate for the perspective distortion

- A pan/tilt video camera is employed to detect hand/body activity on the projected area, so people can interact with the projected image by simply touching the surface.

Wireless Transmission

- A major emphasis in this project is to avoid "wiring" surfaces with monitors or other sensing devices

- Unlike traditional augmented reality applications, users don't need to wear graphics goggles or special input devices

- Everything happens simply by projection and vision processing: light in, light out

- Also, the Everywhere Displays projector can be easily steered to a new surface by a simple software command, thus avoiding fixed setups where projectors or cameras can only perform one specific task

- The pan/tilt mechanisms provide dynamic adaptation to changes in the space usage and to different patterns of people activity
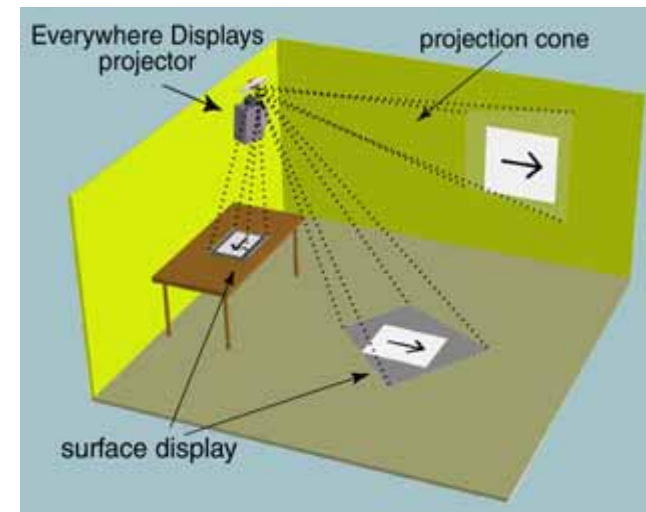
Part 1: Opportunities of enterprise-wide optimization: S&A Value Realization – benefit analysis

Impact of Visibility of Supply Chain Inventory Data - Reduction in stockouts and warehouse Inventory

Simulation Setting & Assumptions:

• Daily Manufacturing quantity decision, daily shipment to a Warehouse (push)
 (1) Without RFID: Manufacturer may have limited inventory visibility at Warehouse and Retailer Store
 (2) With RFID: Manufacturer has real-time inventory visibility at Warehouse and Retailer Store
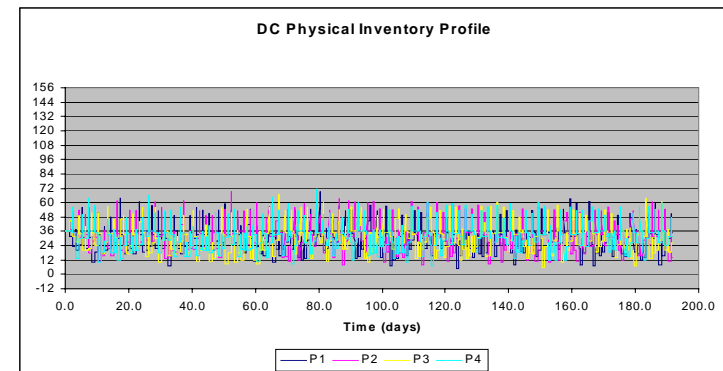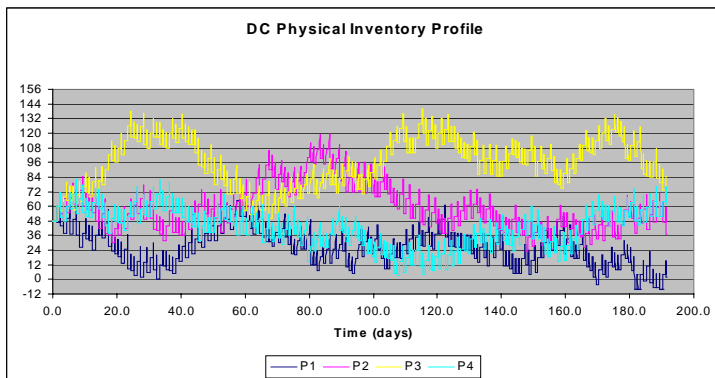
(1) Case Without RFID
Without Inventory Visibility
-Warehouse Inventory (avg.) = 54.14
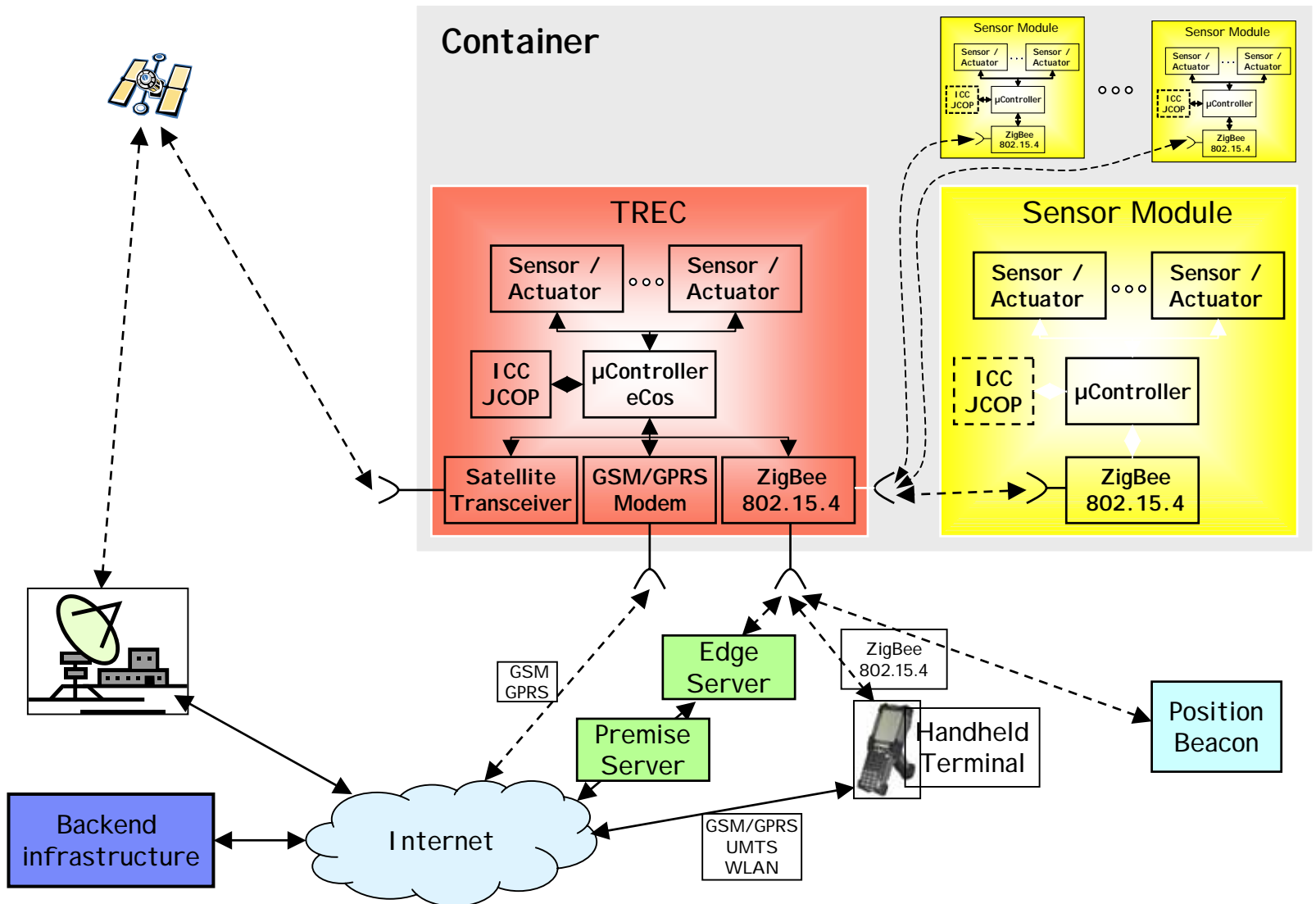-Warehouse Inventory Range: -10 to 140
-Customer Back Order Qty: 44
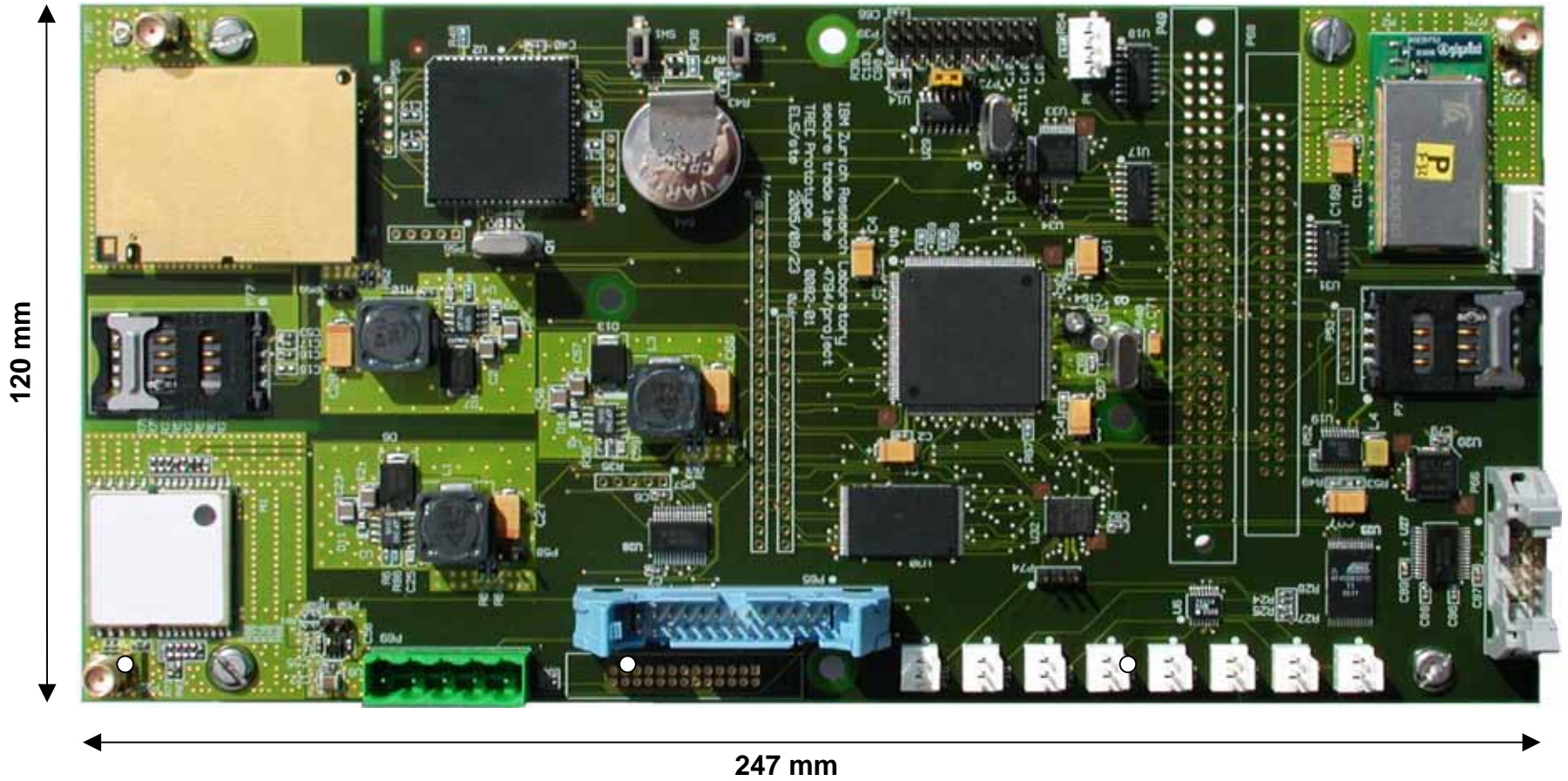
(2) Case With RFID
With Inventory Visibility
→ Better Production Planning & Inventory Policy
-Warehouse **Inventory** (avg.) = 28.52 (**47% reduction**)
- Warehouse Inventory Range: 5 to 72
- Customer **Back Order** = 0   **100% reduction**

DC Physical Inventory Profile

DC Physical Inventory Profile

Source: Lee & Cheng/IBM Research

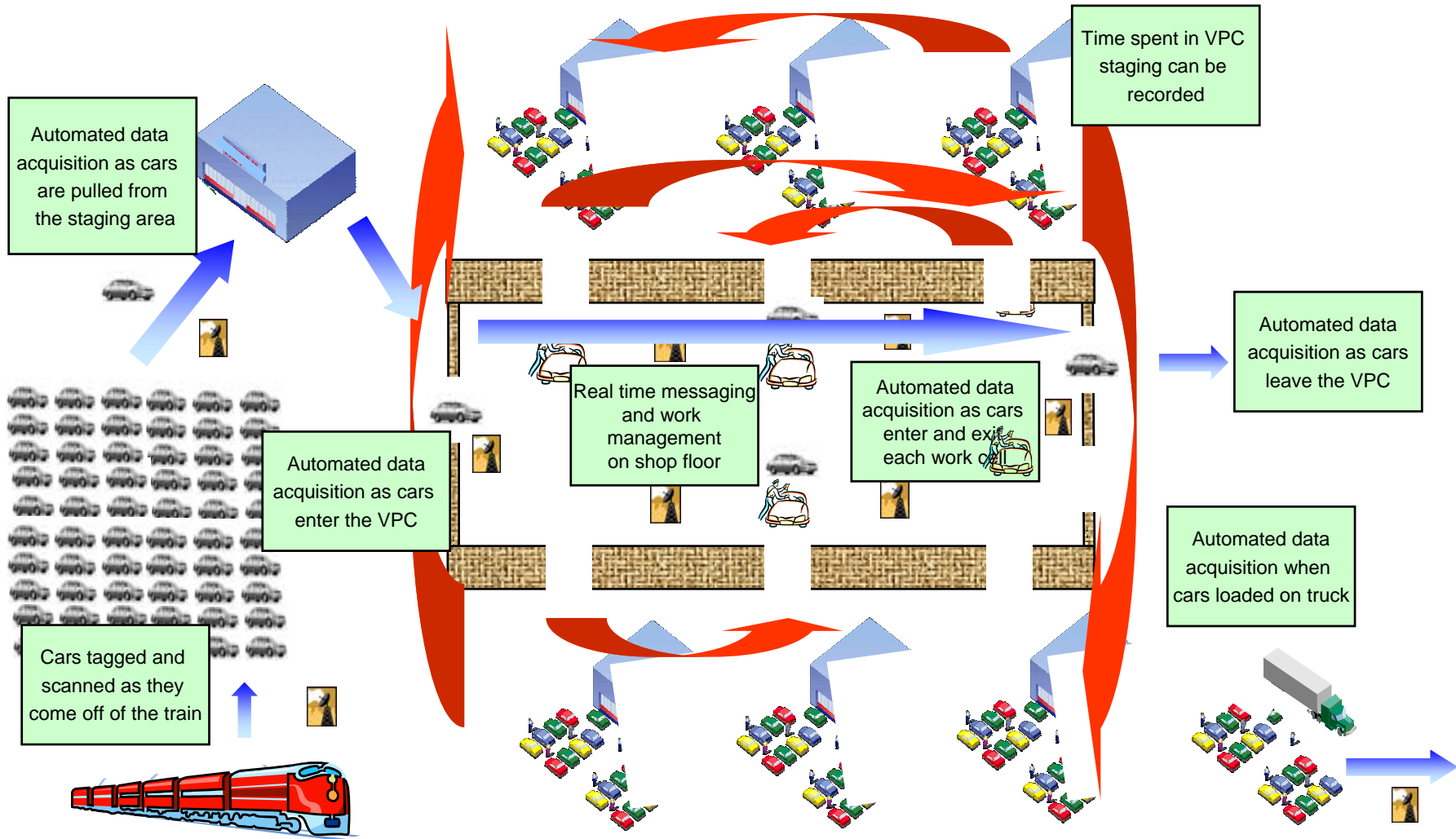# TREC – Smart & Secure Sensor Platform

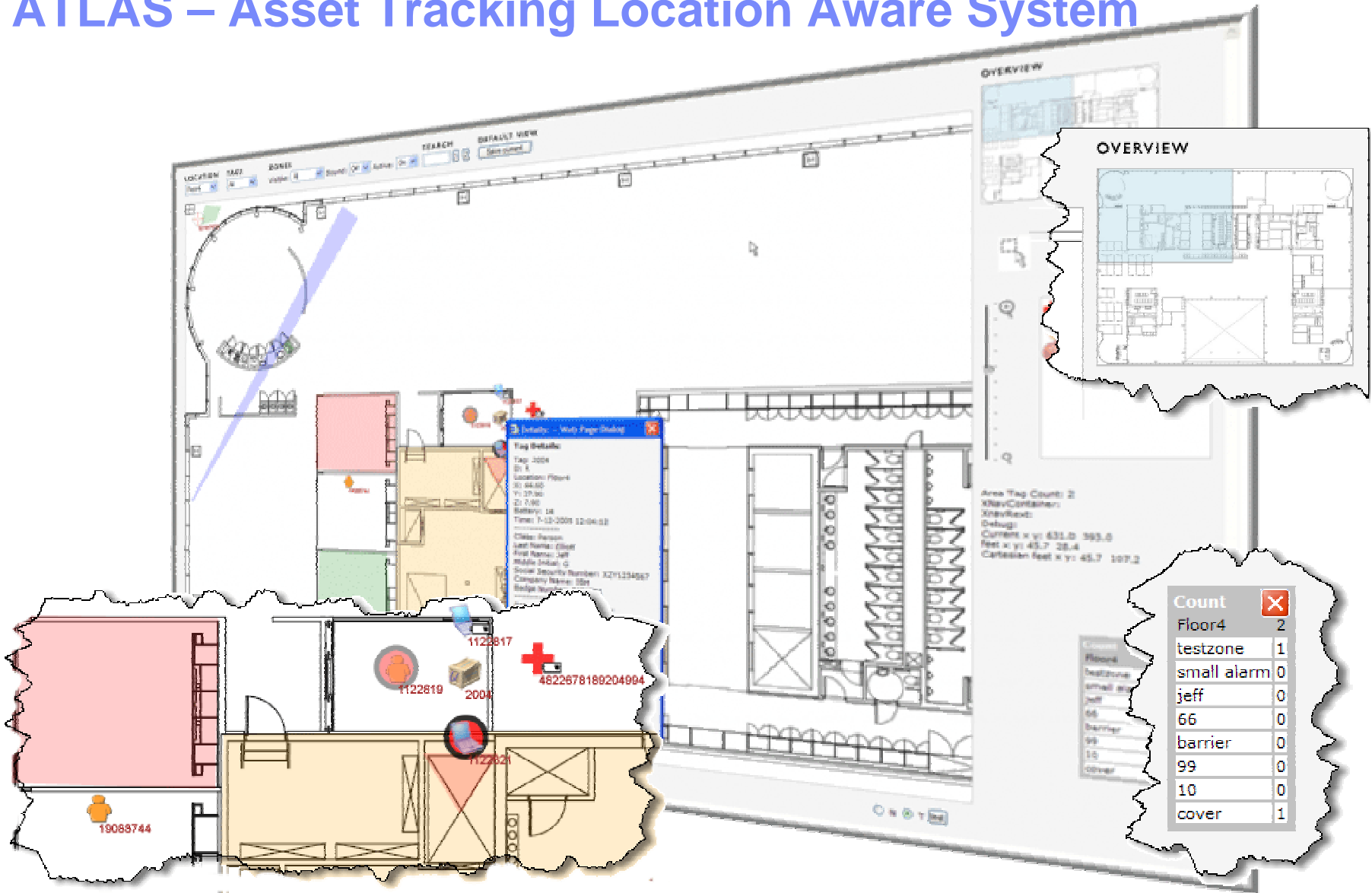# Generation 1.0 – Single Board

120 mm

247 mm

S&A First-of-a-Kind Projects

- **IBM Research is working with selected customers to trial research prototypes and methods in a real-world setting**
  - Provides selected customers early access to new IBM developments
  - Provides IBM Research the ability to gain experience in the field and to set future research direction
- **We have executed a number of "First of a Kind" projects based on Sensor & Actuator technologies, starting in 2002**
  - RFID in Retail and Manufacturing
  - Vertical integration of PLCs
  - Smart sensor technologies and wireless connectivity models

FOAK Example 1: Automotive Yard Management with RFID

Automated data acquisition as cars are pulled from the staging area

Time spent in VPC staging can be recorded

Automated data acquisition as cars leave the VPC

Real time messaging and work management on shop floor

Automated data acquisition as cars enter and exit each work cell

Automated data acquisition as cars enter the VPC

Cars tagged and scanned as they come off of the train

Automated data acquisition when cars loaded on truck

ATLAS – Asset Tracking Location Aware System

Towards the Responsive Enterprises

- **Continue to explore**
  - Application of sensor technology
  - Management of large, distributed deployments
  - Programming of widely distributed applications on heterogeneous runtime environments
  - Security
  - Data Analytics and Information Integration
- **Communicate the message**
  - Sensor technologies (such as RFID) are a means to increase "situational awareness" in the enterprise
  - Benefits are derived by utilizing that situational awareness by building a Responsive Enterprise, through horizontal and vertical integration