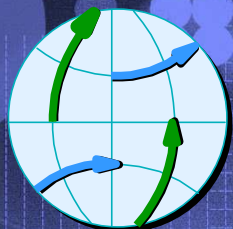




IBM Research

From RFID to the Internet of Things: Bridging the gap between Research and Business in the on demand era

Dr. Krishna Nathan
VP Services
Director Zurich Research Laboratory
IBM Research



EU IST Conference

March 6, 2006

© 2006 IBM Corporation

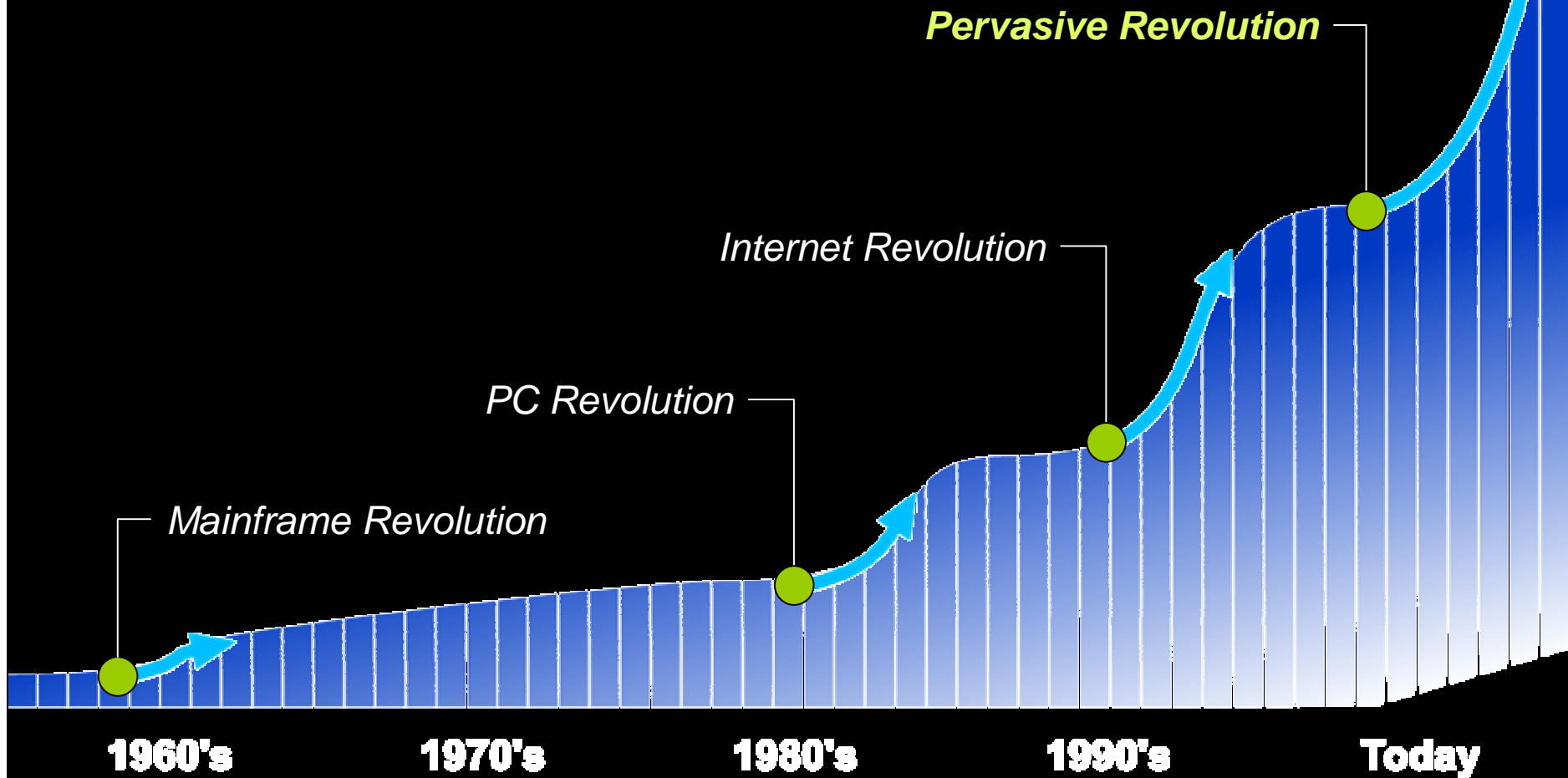


Outline

- **Pervasive Revolution**
- **Enabling On Demand Business**
- **Technology Challenges**



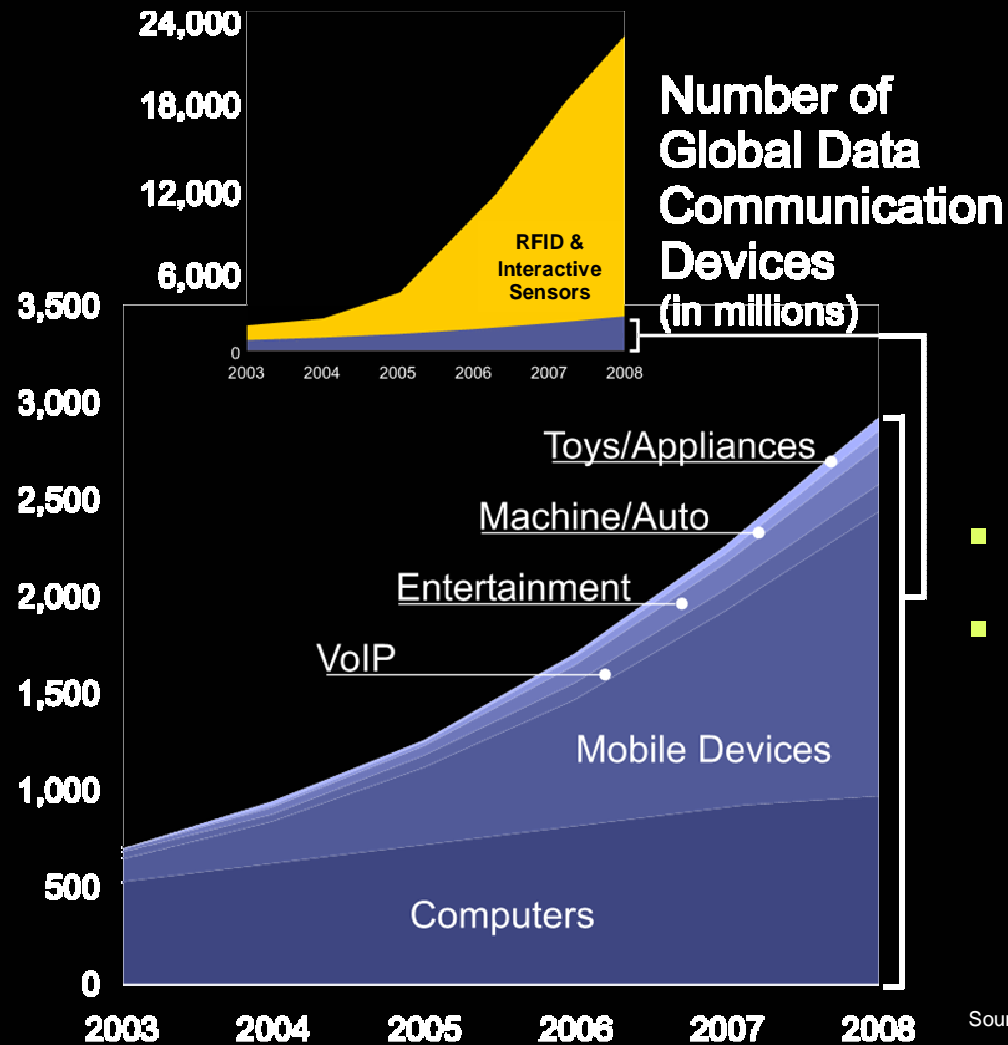
Technology Revolutions





Any Device over Any Network

All devices can communicate with and understand one another



- Over one trillion devices
- Number of **communicating** data devices growing from 2.4 billion to 23 billion in 2008 and one trillion by 2012

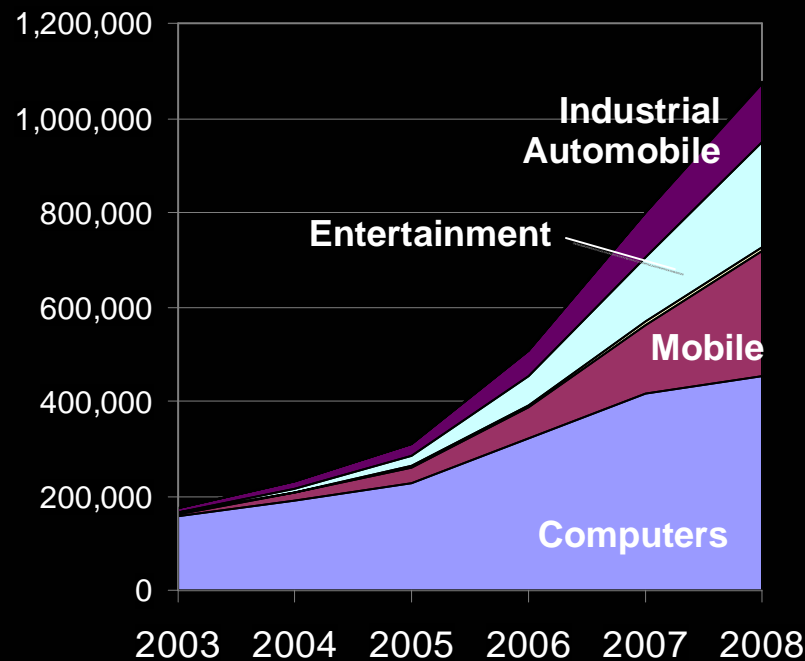
Source: IDC Research 02/2004



Any Data from Any Location

Seamlessly communicate exploding amount of data on demand, to support people and business processes

Amount of data received or transmitted by device (in Petabytes/Day)



- Amount of data accessed will explode to a Zettabyte (**10¹⁸**) by 2008
- Variety of Data
- Driving the need for a flexible architecture
- **Creating opportunity for business transformation**



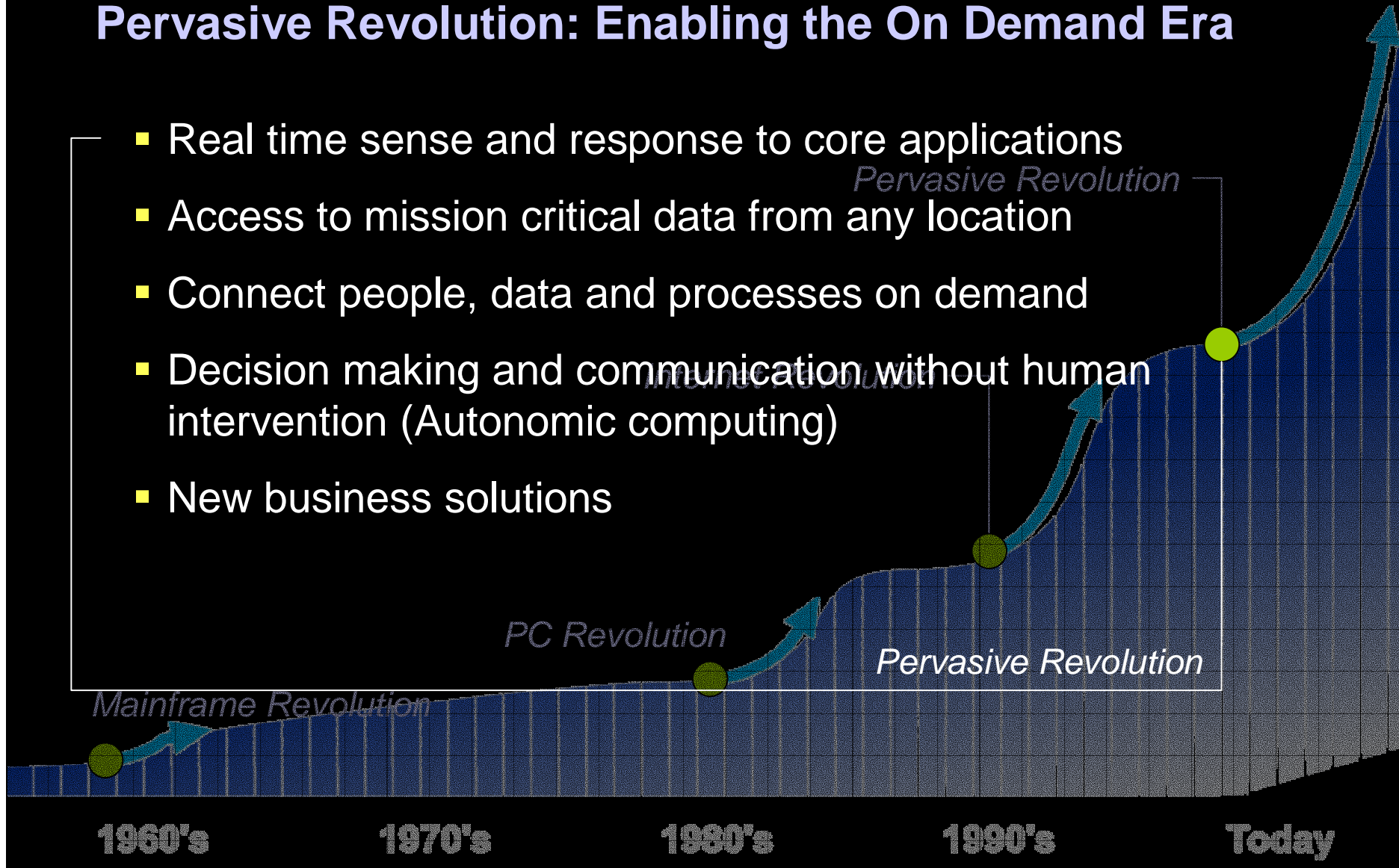
Outline

- Pervasive Revolution
- **Enabling On Demand Business**
- Technology Challenges



Pervasive Revolution: Enabling the On Demand Era

- Real time sense and response to core applications
- Access to mission critical data from any location
- Connect people, data and processes on demand
- Decision making and communication without human intervention (Autonomic computing)
- New business solutions



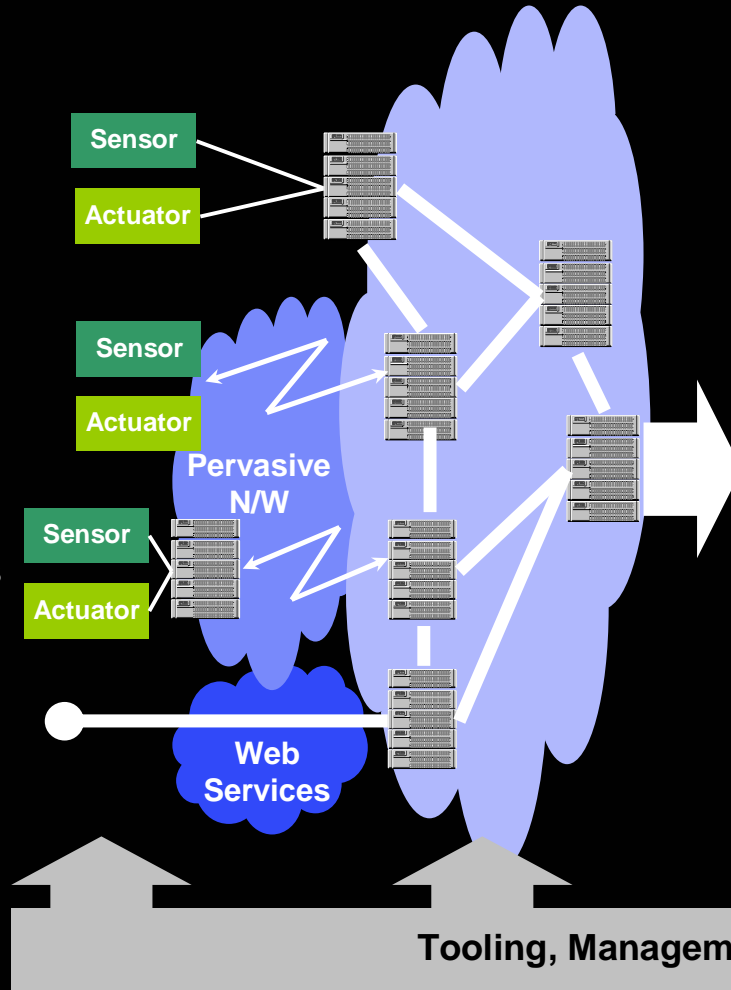


Enabling On Demand Business

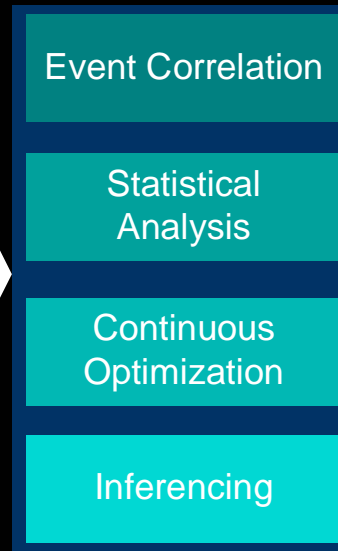
Sensor & Actuator Endpoints

1. S&A 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 Network



Data Analytics

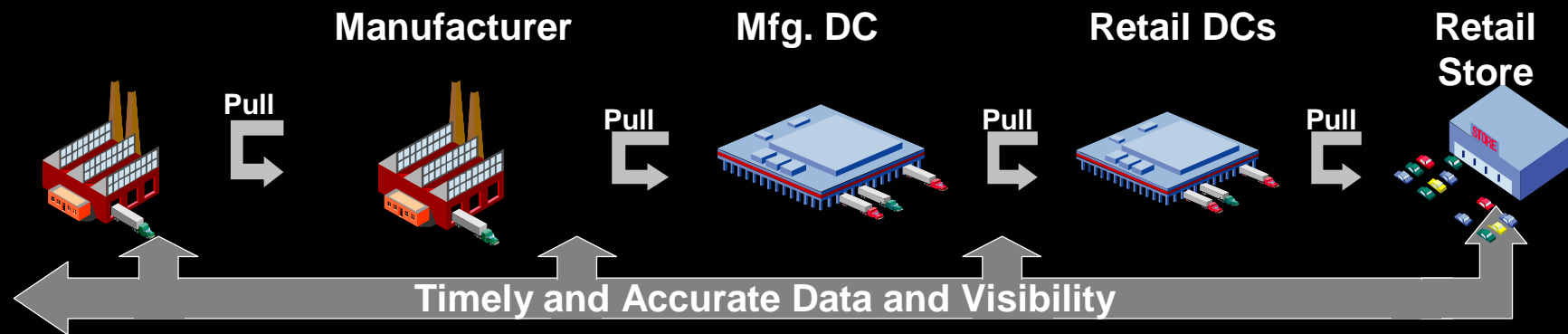


Business Transformation





The essential part of the vision is a seamless supply chain enabled by the integration of physical objects with the digital world through tagging

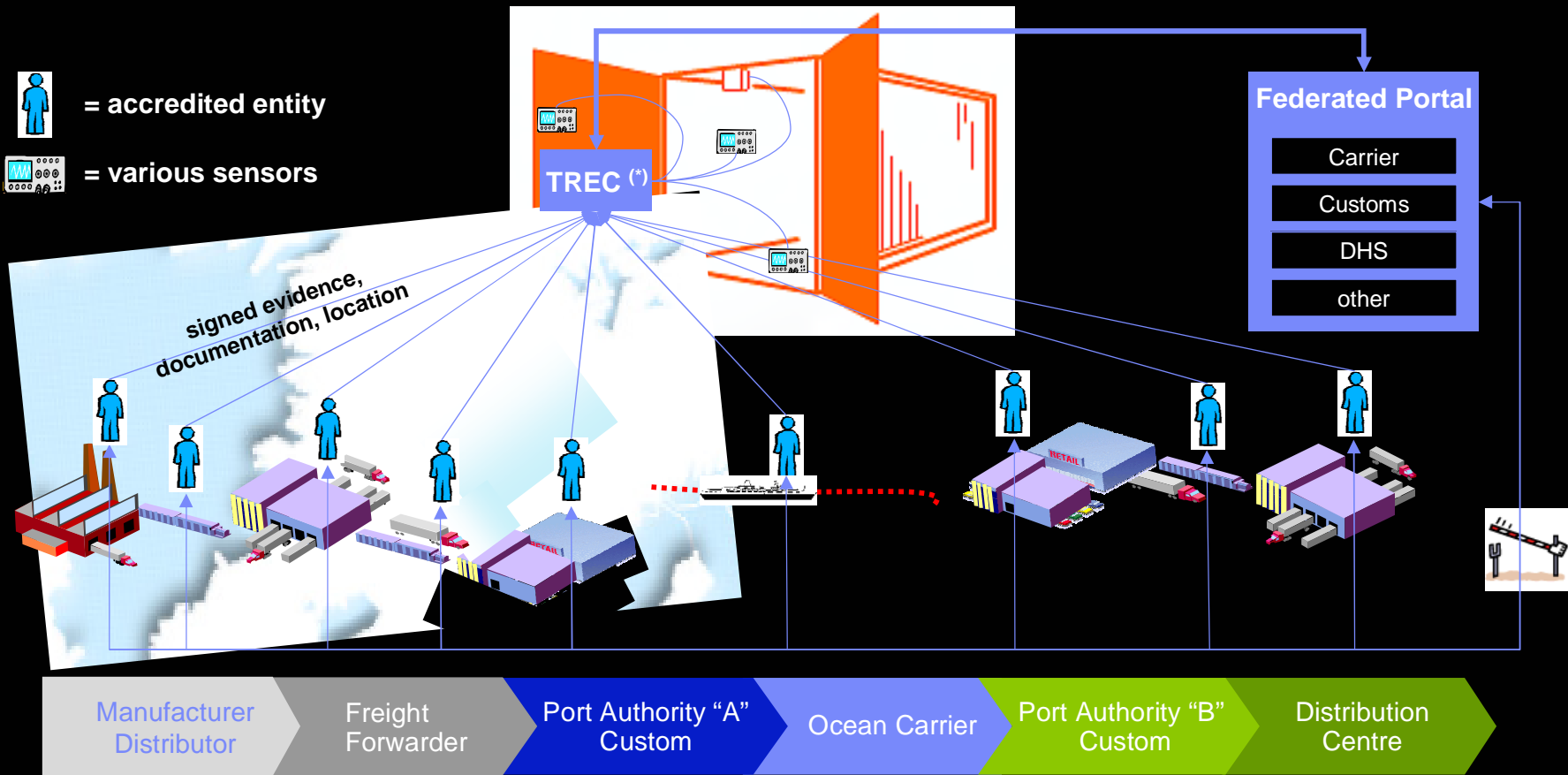


End-to-end real-time visibility and total traceability

- Fundamental changes in every part of a value chain, e.g. retailers no longer own inventory goods as manufacturers take total responsibility in distribution to ensure goods availability
- Businesses will need to respond to market demands in real-time



Shipping - Secure & Intelligent Trade Lane



(*) TREC= Tamper Resistant Embedded Controller



User-Centric Scenario: 'Store of the Future'

Customer device

- Full multimedia capabilities
- Multiple communication interfaces:
 - cellular, 802.11x, BT, ZigBee, infrared ...
- Geolocation functionality (1m accuracy, indoor)
- RFID reader
- Digital camera / video recorder

Shopping applications

- Downloaded / updated at store entrance
- Personal shopping list
- Display advertising
- Location sensing – direction finding
- Event processing and correlation
- Automatic sensor-based check out

Tagged merchandise (RFIDs)





Outline

- Pervasive Revolution
- Enabling On Demand Business
- **Technology Challenges**



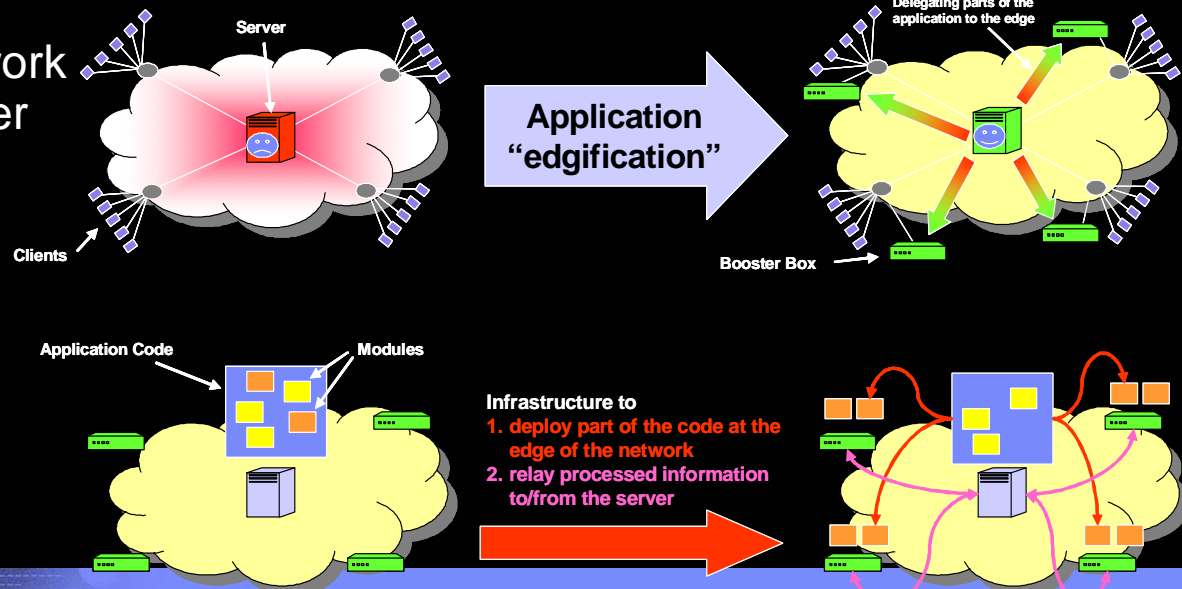
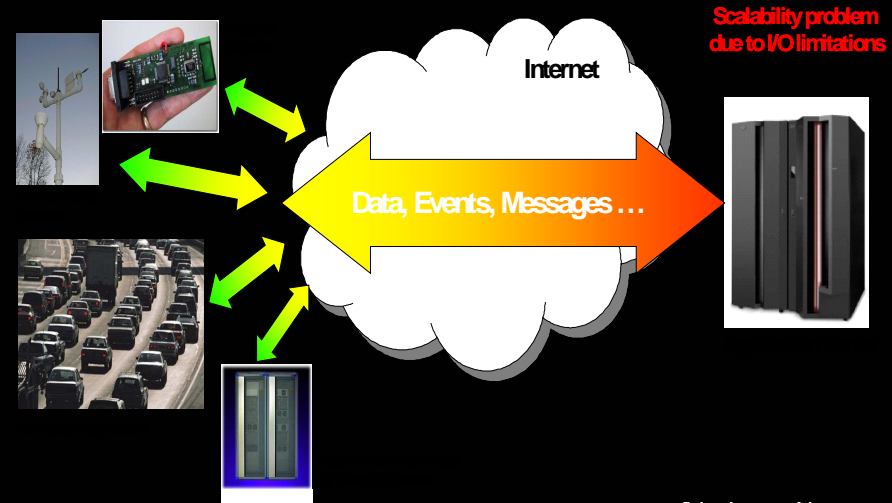
Challenges

- **Scalability**
- **Networking**
- **Middleware**
- **Security & Privacy**



Scalability Challenges

- The massive deployment of smart, networked sensors will dramatically affect network volume and traffic patterns
- Significant architectural changes to global IT infrastructure expected
- Processing moves to network edge to aggregate and filter
 - Distributed application processing
 - Code distribution and management

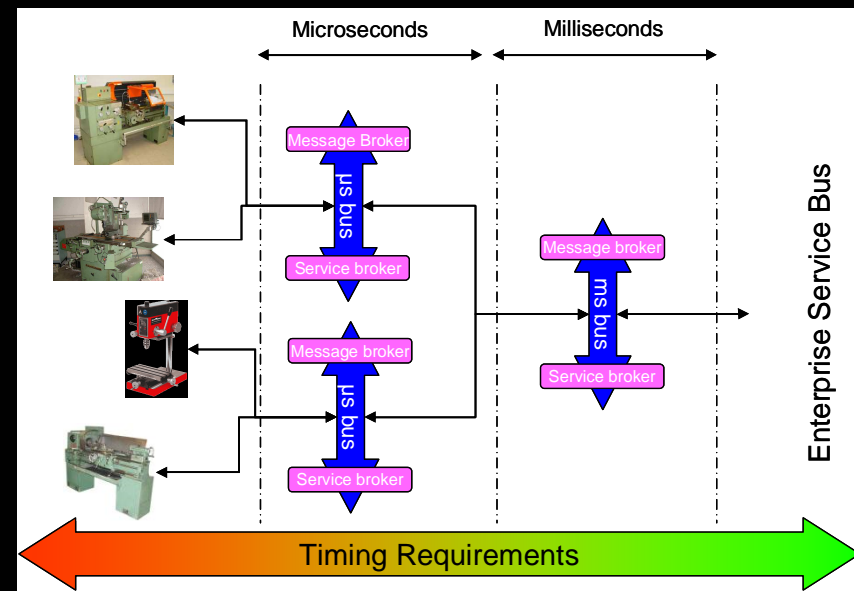
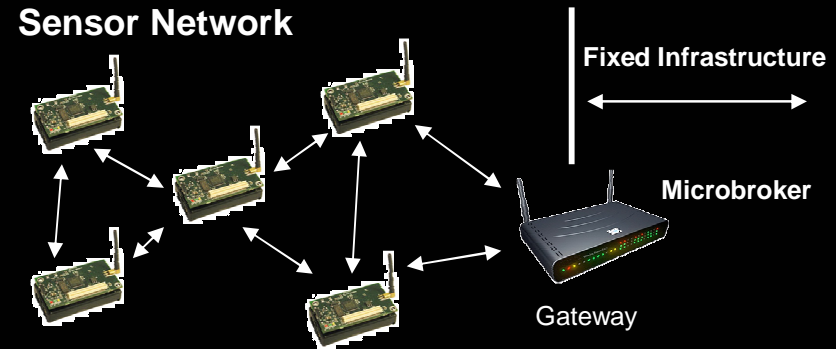




Networking Challenges

- Communication and connectivity functionalities for Sensor and Actuator Networks
 - Low-footprint stack for sensor networking
 - Multi-hop communication and relaying
 - Self-configuration, self-healing
 - Power optimization
 - ...

- Connecting S&A networks with the enterprise computing infrastructure
 - New messaging protocols: resource reservation, admission control, real-time publish/subscribe engine
 - Real-time operation





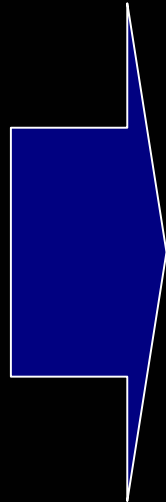
Middleware Challenges: Time-Dependent Event Handling

Sensor /
RFID Data

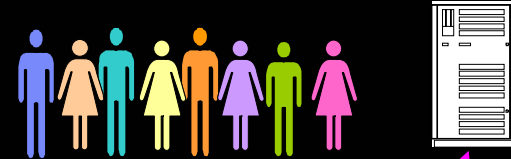
Surveillance

Data feeds
from trading
partners and
suppliers

Other events



An event-based engine routes, sequences, and filters event data in a time-dependent fashion



Selectively
Notify Systems
& Personnel
Event Notification

Event-based Engine

Continuously
Analyze Event
Streams
Event Analysis

Identify Patterns
of Interest
Event Action



TD: Time-dependent



Summary

- **The real world is being captured (through sensors) and modeled at increasing spatiotemporal resolution**
- **On demand businesses need to take advantage of the new sources of data and deal with (monitor, process, store, and respond) the increasingly event-driven world**
- **The massive deployment of smart, networked sensors will dramatically affect network volume and traffic patterns, requiring data to be analyzed and acted on locally at the edge of the network**
- **The accelerating need to handle large volumes of time-dependent events will give rise to new classes of middleware, programming models, and tools**
- **Security and privacy concerns will be strongly amplified and need to be addressed by appropriate policy, legislation, with new software and hardware solutions if there is to be extensive uptake in Europe**
- **Open Standards and interoperability are crucial at all levels**