

# Looking into the Future

## Technology Visions

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# Pervasive Revolution (or is it a Vision?)



## The Technology

## User Benefits



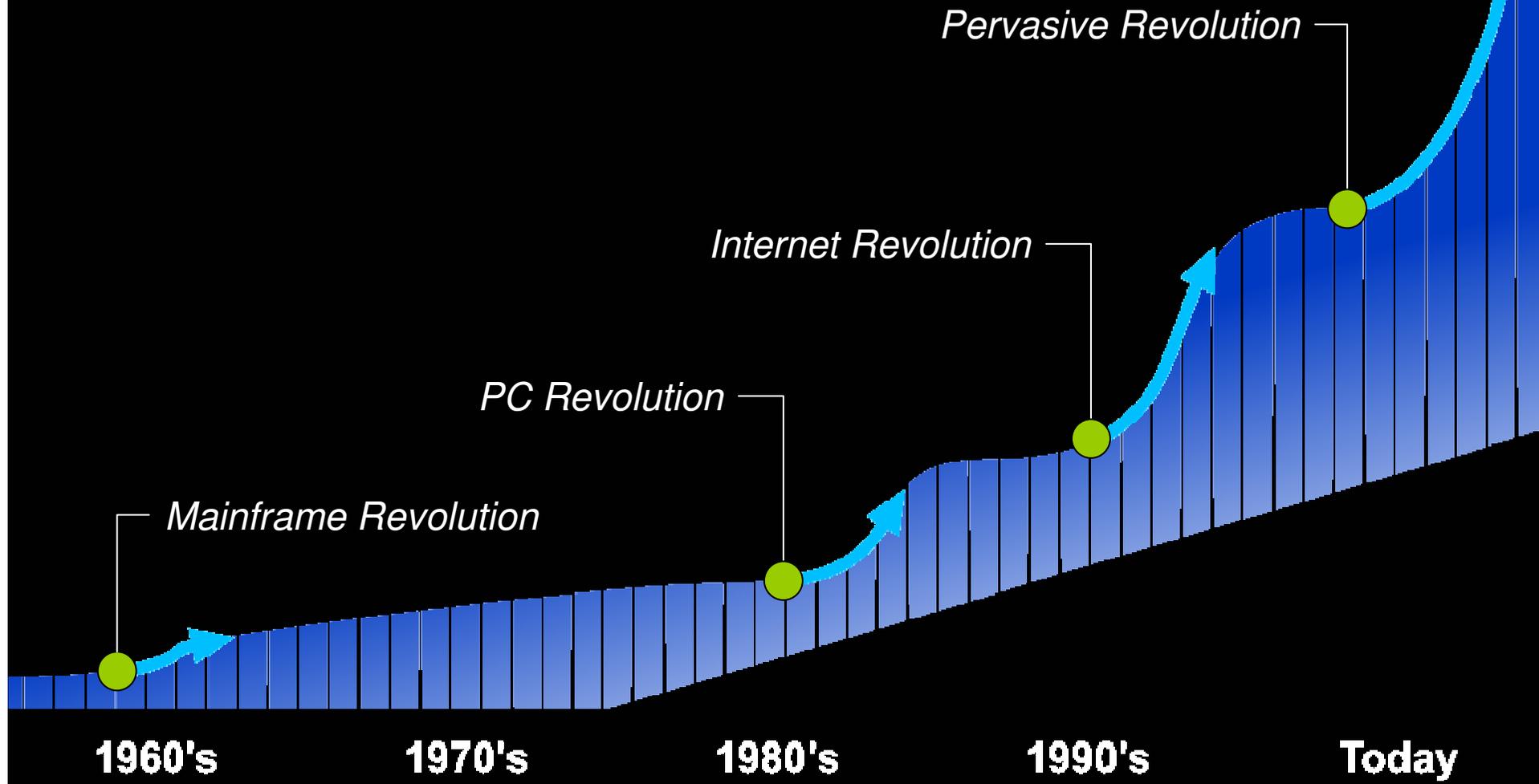
# Agenda

- The Pervasive Revolution
- Smart Interconnected Devices
- Sensor-based Applications
- Multimodal User Interactions
- Balancing Privacy and Benefits
  
- Conclusions

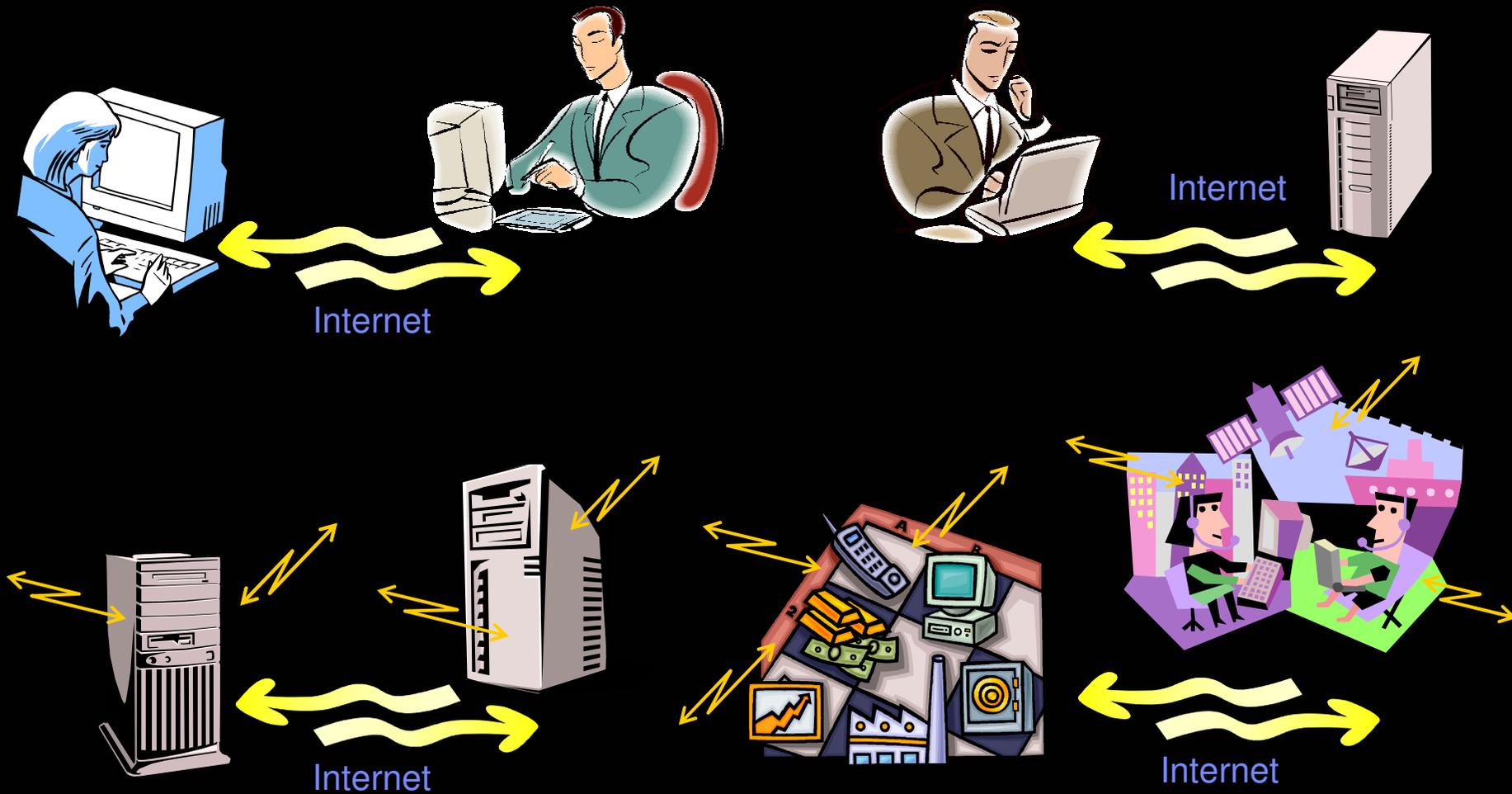


# The Pervasive Revolution

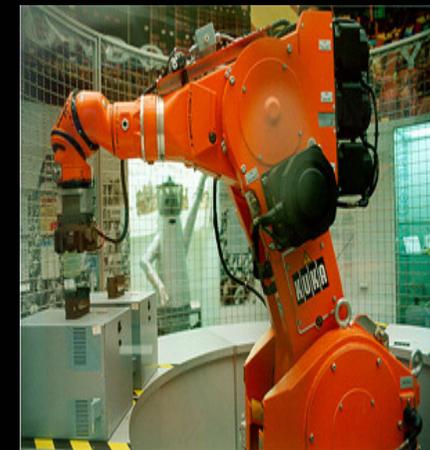
# Technology Revolutions



# From the Birth of the Internet to PvC



# The Pervasive World



# Key Factors Driving Pervasive Adoption

## Microelectronics

- speed x2/18 month
- human capacity in 2015
- memory density x 1.35/ y.
- 1.000 movies in my pocket

## Enterprise IT Environment

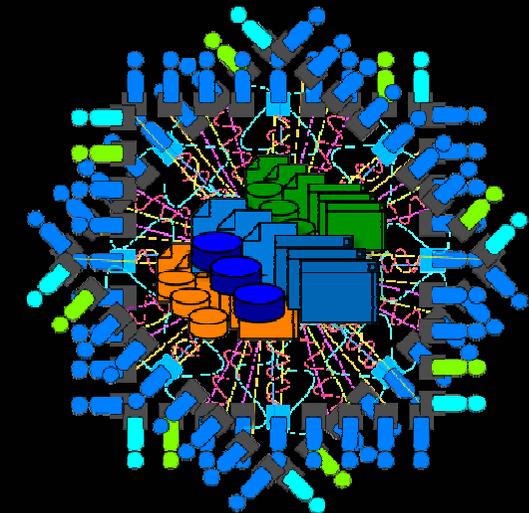
- working in a global, highly competitive world
- e-business on demand
- utility computing
- open standards middleware architectures

## Devices

- capacity increase (storage,...)
- cheaper than storage on paper
- display (pixels disappear)
- sensors, RFID tags ubiquitous
- all kind of new devices
- computing built into social fabric

## Infrastructure

- wired – fiber cap. x 2/y.
- wireless – UMTS, UWB
- emergence of public access
- broadband access to consumers
- reduced costs of data/ flat rates



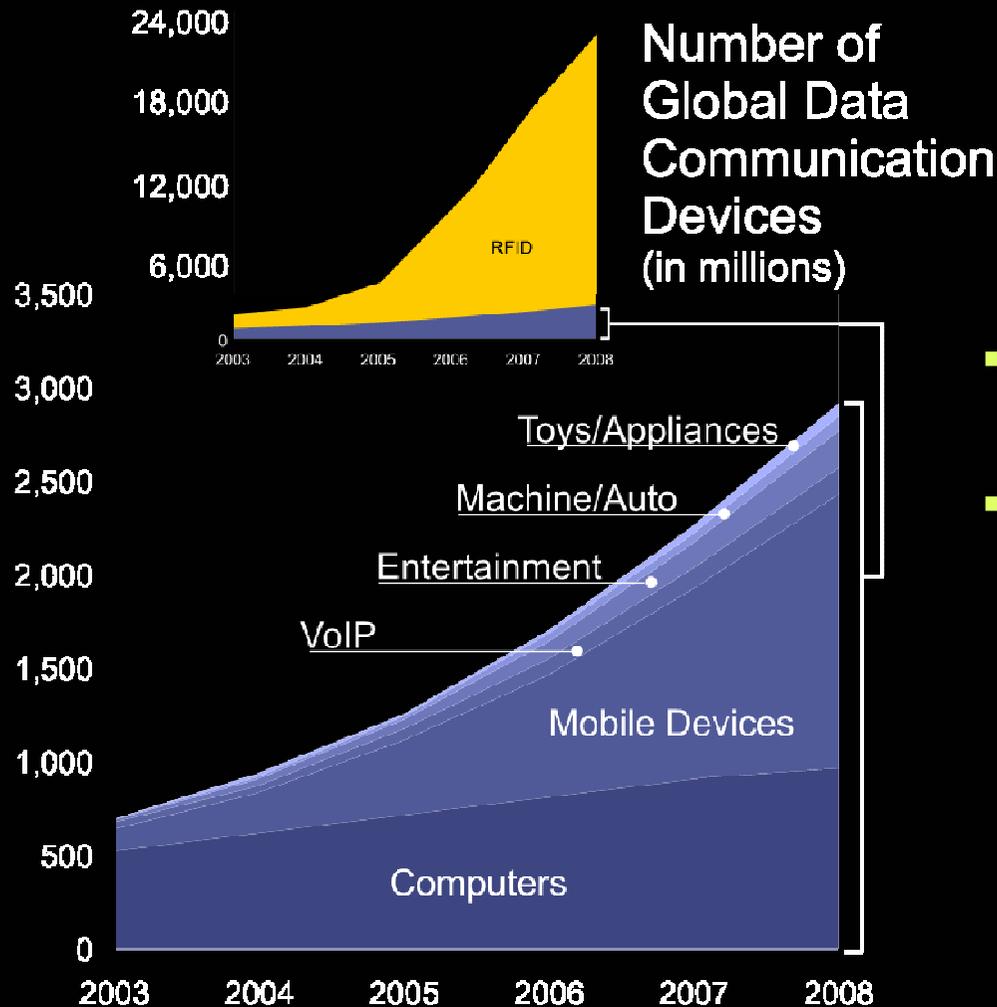
## Societal

- wireless generation
- changing work patterns
- new life-work concepts
- social acceptance

# Smart Interconnected Devices

# Any Device

All devices can communicate with and understand one another



- There will be over a trillion wireless enabled devices by 2005
- Number of **communicating** data devices growing from 2.4 billion to 23 billion in 2008 and a trillion by 2012

Source: IDC Research 02/2004

# Any Network

Provide optimized access seamlessly to user or machine over any network

**Personal Space**

(Office, Briefcase, Person, Broadband)

**On-Campus / Public**

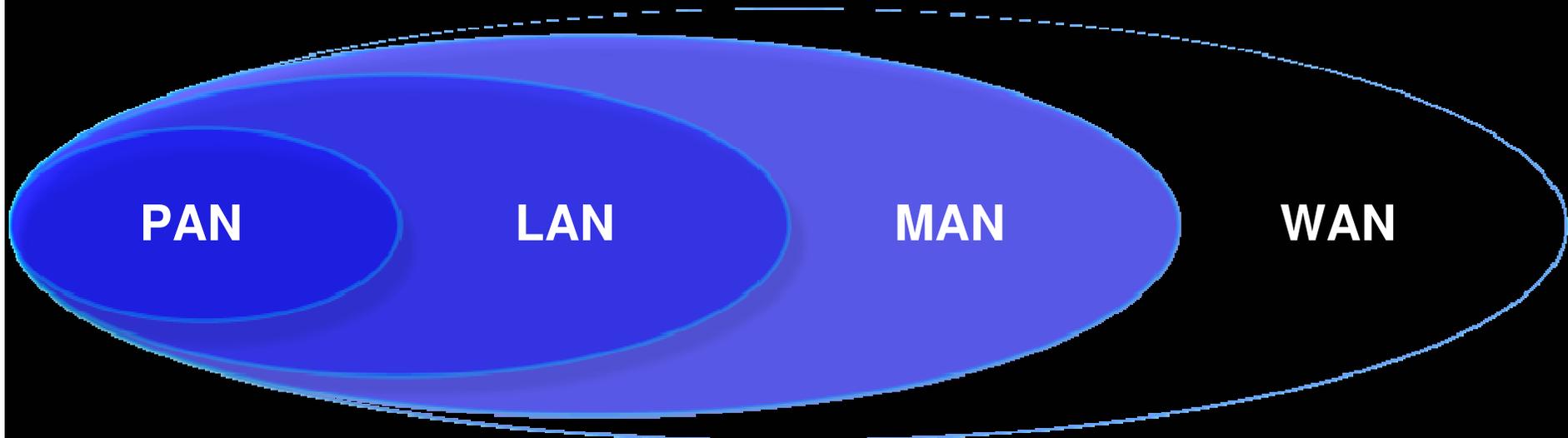
(Office, SOHO, Airport, Hotel, Coffee Shop, Broadband)

**City, Community**

(Last Mile, Remote Coverage, Fixed and Mobile Broadband)

**Cellular/ PCS /Satellites**

(Miles / Regions, National, Continents, Fixed and Mobile Narrowband)



**Bluetooth**

Feet to 10's of feet

**WLAN 802.11X**

(10's, 100's of feet)

**WMAN 802.16, 802.20,**

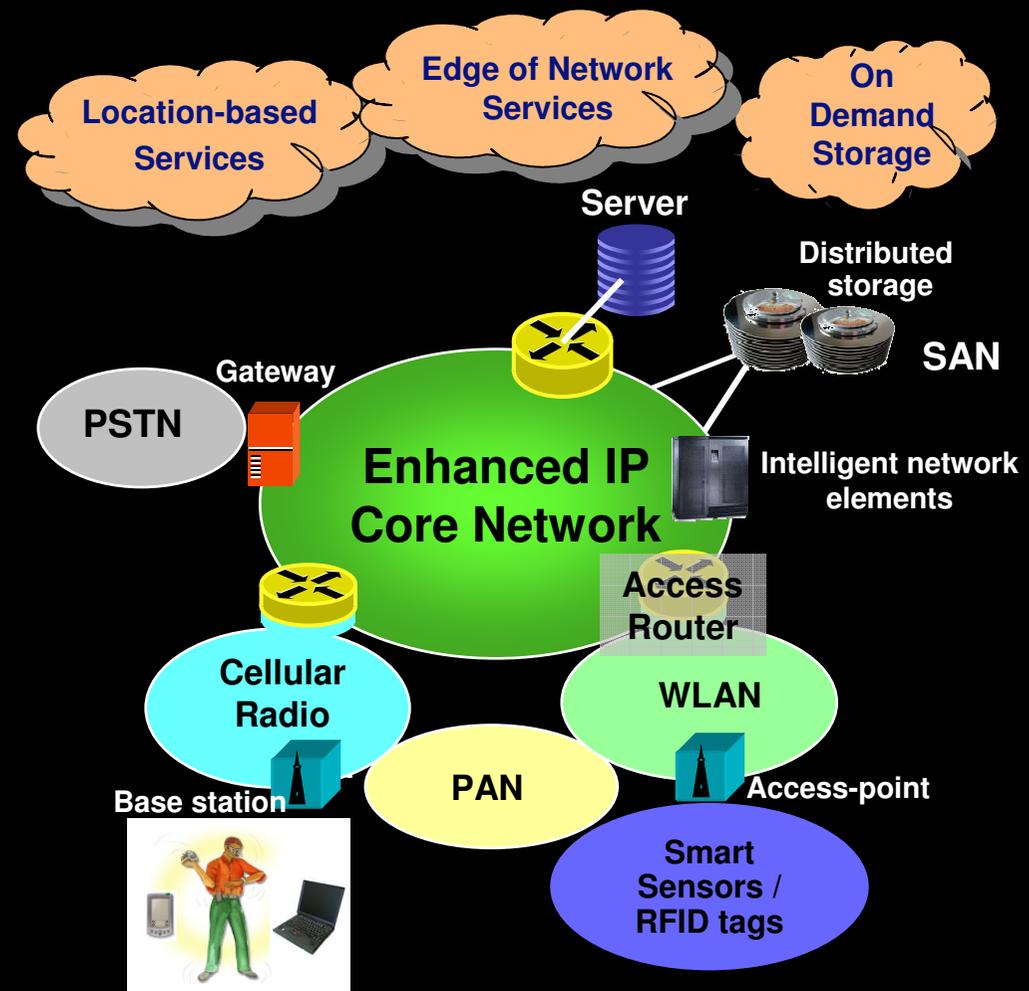
**Ad-hoc, Beam Forming**

**Cellular/Satellite**

# Future Networks

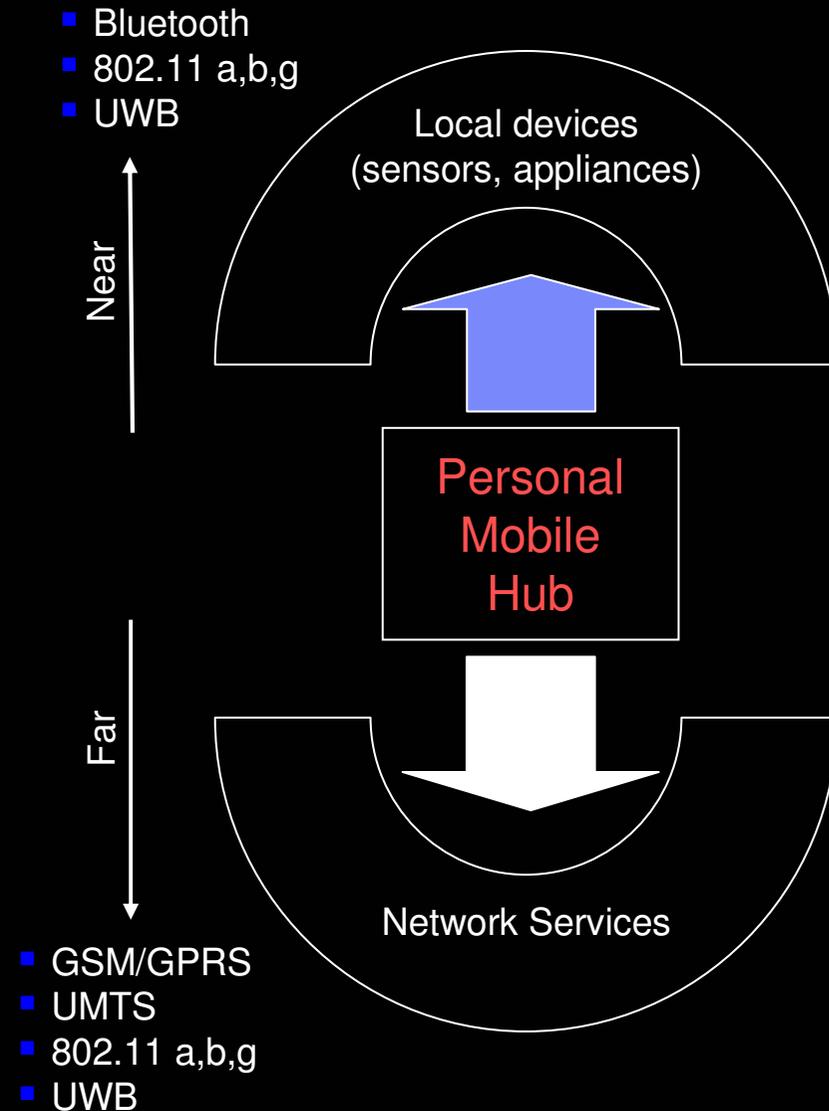
Data, voice and multimedia will be carried over a heterogeneous physical network running IP

- Supports large number of devices...
  - Wireless communicators: Cell phones, PDA's, pagers, etc.
  - Interactive "smart" sensors (health monitors, environmental sensors, etc.)
  - RFID tags
  
- "True" mobile computing will be enabled
  - Complete range of service (internet, TV, VoIP, etc.)
  - Self-configuring
  - Seamless roaming
  - On demand remote storage



# Personal Mobile Hub

- **Open platform for**
  - Providing open interfaces to service infrastructure to appliances, accessories, sensors, etc.
  - Extending (third party) services & applications to the mobile user
  - Enabling (third party) services & applications provisioning on the mobile device
  - Running on Symbian and Linux OS
  
- **And offering the following advantages**
  - Short time-to-market for new applications based on specialized, tailored devices
  - New functionality inexpensive to attach
  - Opens up niche market
  
- **Applications**
  - Entertainment, education, logistics, maintenance, monitoring, healthcare, well-being, ....



# Personal Mobile Health Hub

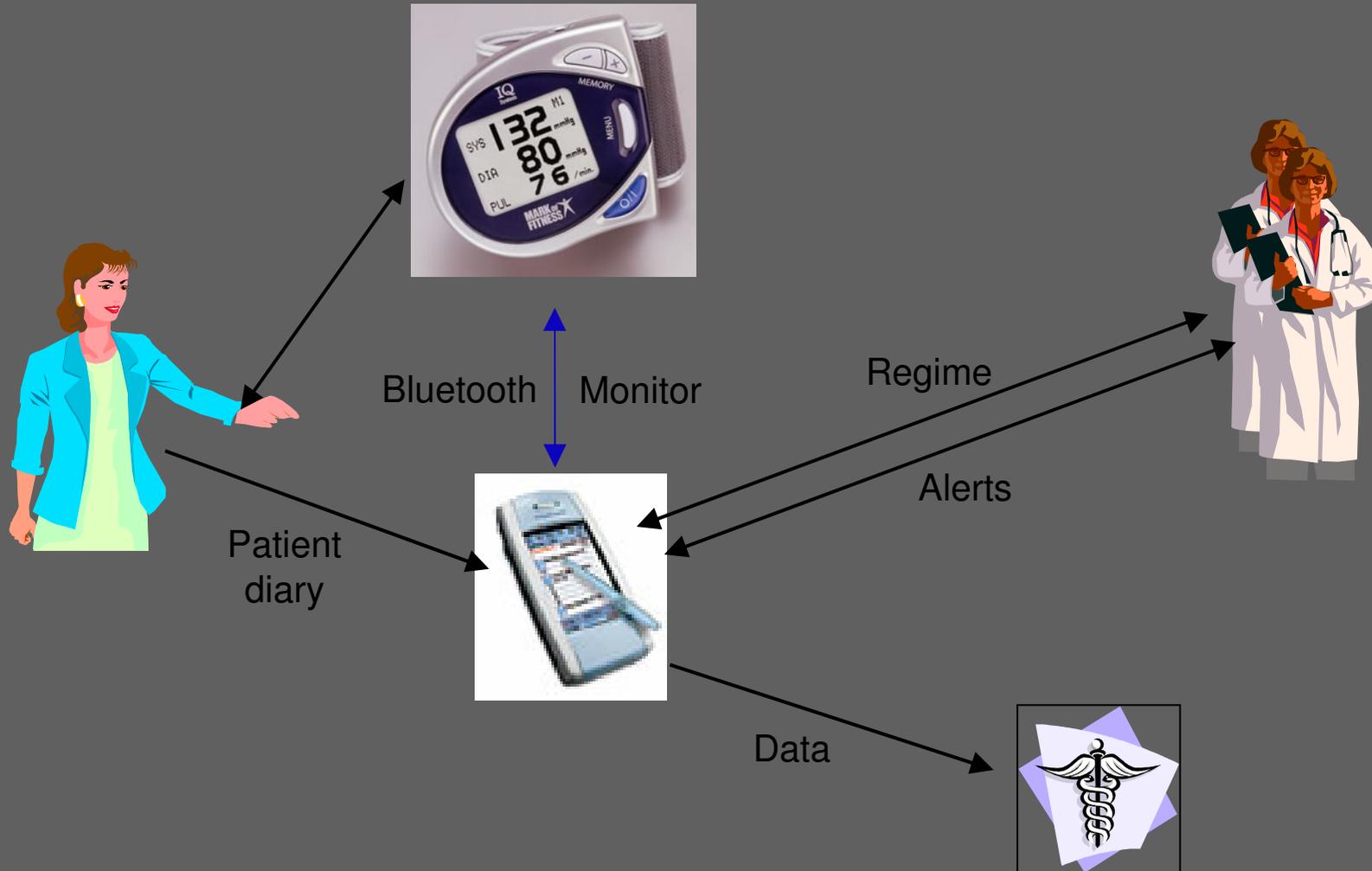


# m-Health Toolkit

- Architecture based on Personal Mobile Hub that delivers a set of adapters and libraries enabling
  - flexible, scalable, and integrated mobile health applications
  - interoperation of multiple device suppliers by providing a common infrastructure
  - use of specialized user devices for self care, monitoring and trials
- Solution for clinical drug trials
  - Monitoring of trial participants
  - Certified, automated data trail (end-to-end)
  - Ensure compliance with regulations
- Solution for monitoring & assisting long term patients
  - (Semi-)automatic sensor data collection
  - Compliance monitoring & alerting of patients/doctors/health professionals
  - Patient information if health is deteriorating
  - Emergency assistance



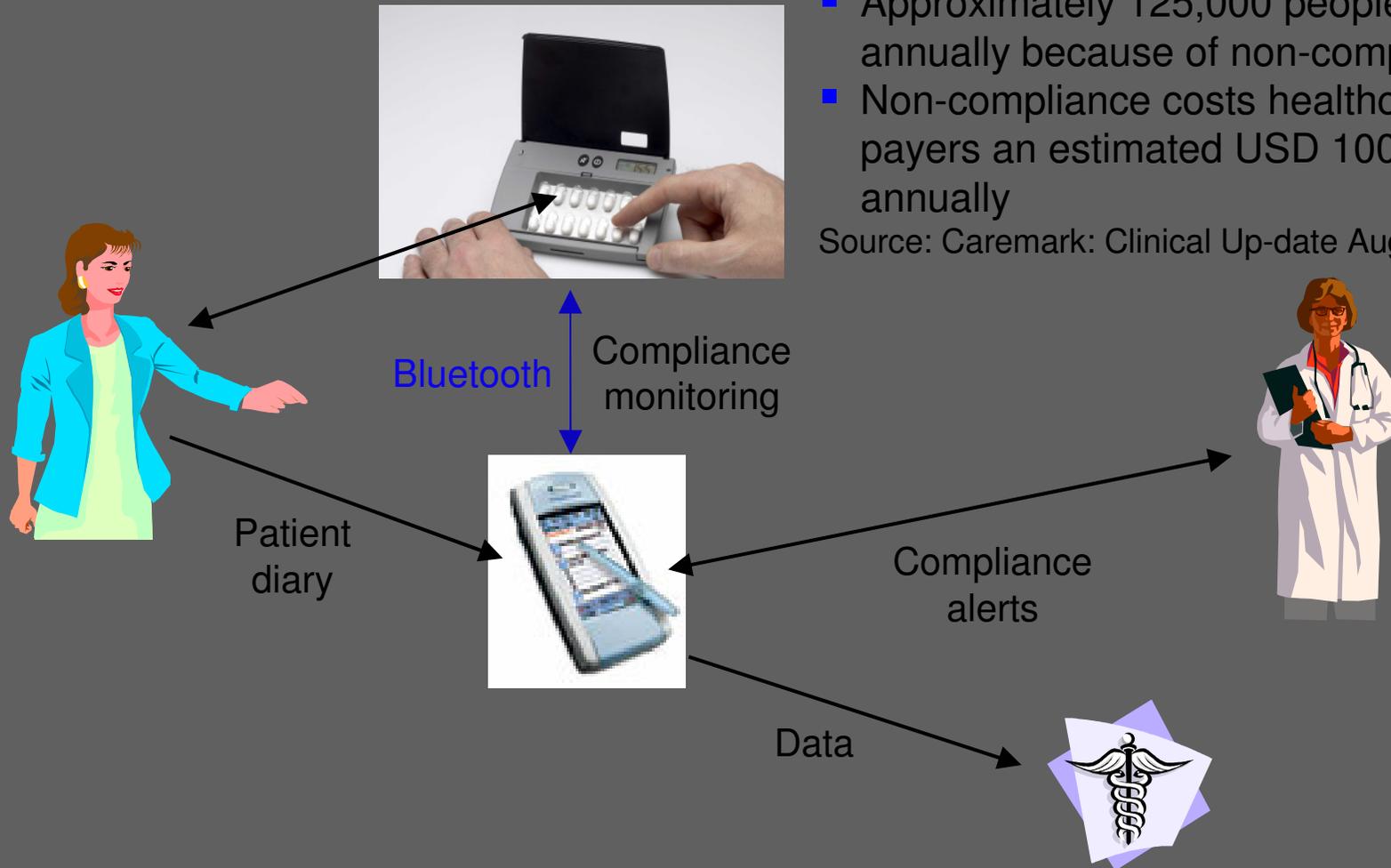
# Healthcare Scenario – Patient Monitoring



# Healthcare Scenario - Compliance Management

- Approximately 125,000 people die annually because of non-compliance
- Non-compliance costs healthcare payers an estimated USD 100 billion annually

Source: Caremark: Clinical Up-date Aug. 2001



# Sensor-based Applications

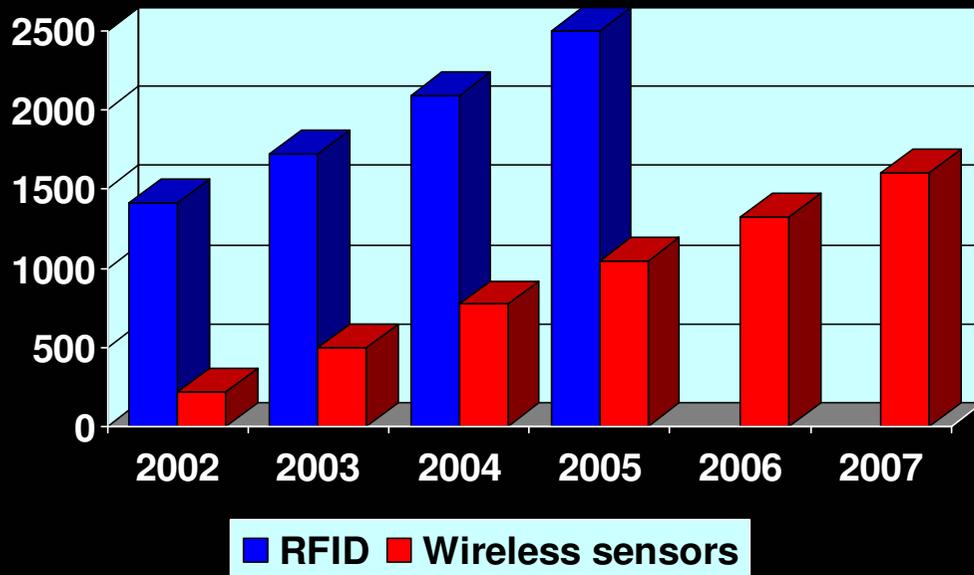
# Scenarios and Applications



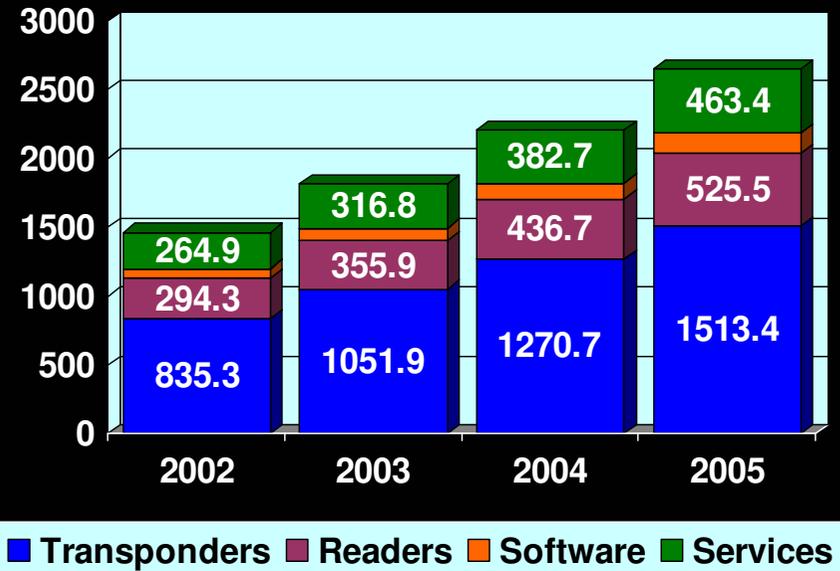
# Wireless Sensors and RFID Tags

Wireless sensors and RFIDs growing rapidly, fueled by industry initiatives and government mandates

**Market Forecast (M\$)**



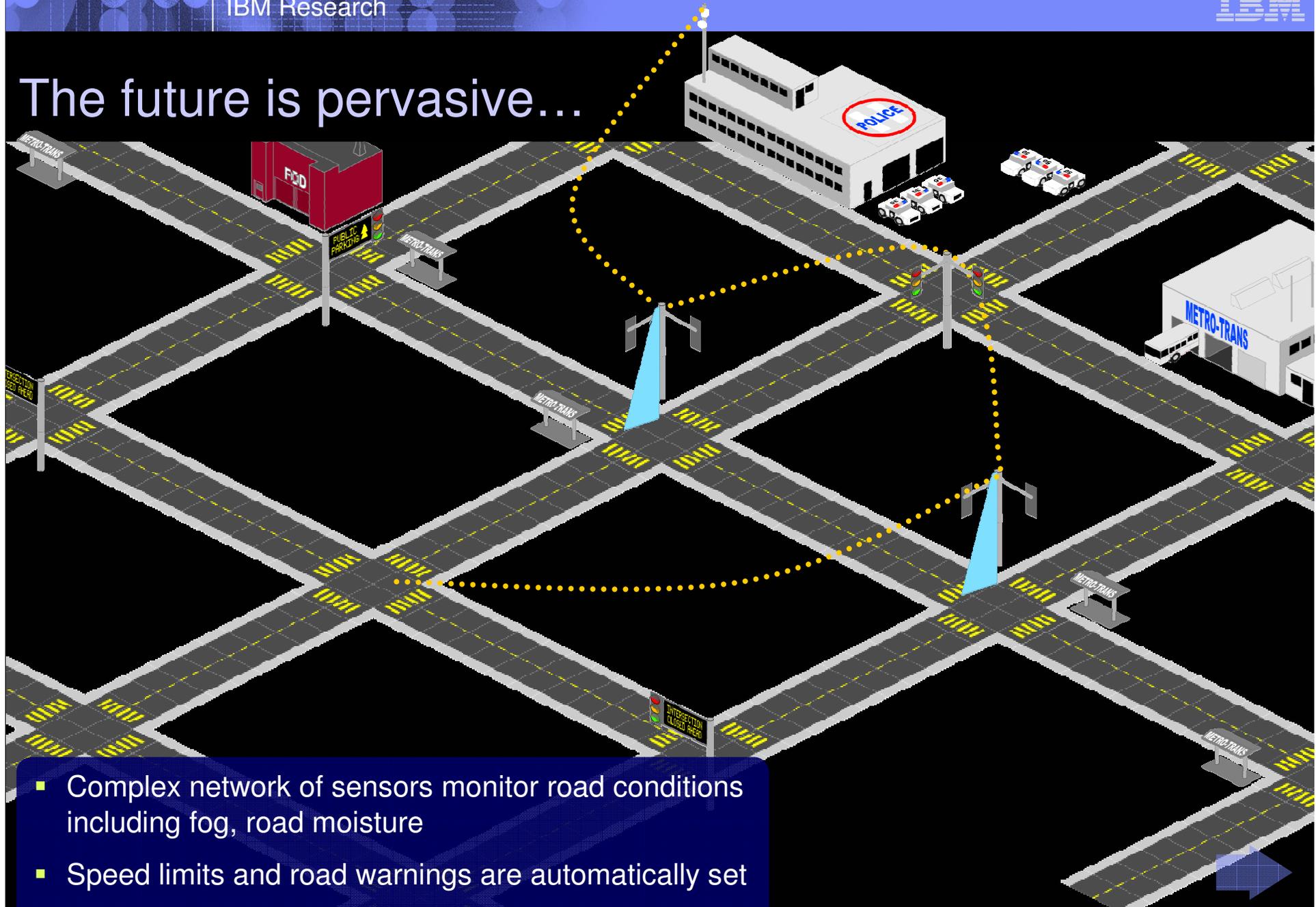
**Breakdown of RFID Market**



*Venture Development Corp., 2000-06*

Source: RFID from Venture Development Corp, Wireless sensor data from Frost & Sullivan

# The future is pervasive...



- Complex network of sensors monitor road conditions including fog, road moisture
- Speed limits and road warnings are automatically set
- Condition information sent directly to vehicles

# The future is pervasive...

- Sensors on the bus and in the roadway report an accident
- Sensor data and real time images are transferred to the dispatch center
- Traffic signal control is modified to begin routing around the incident

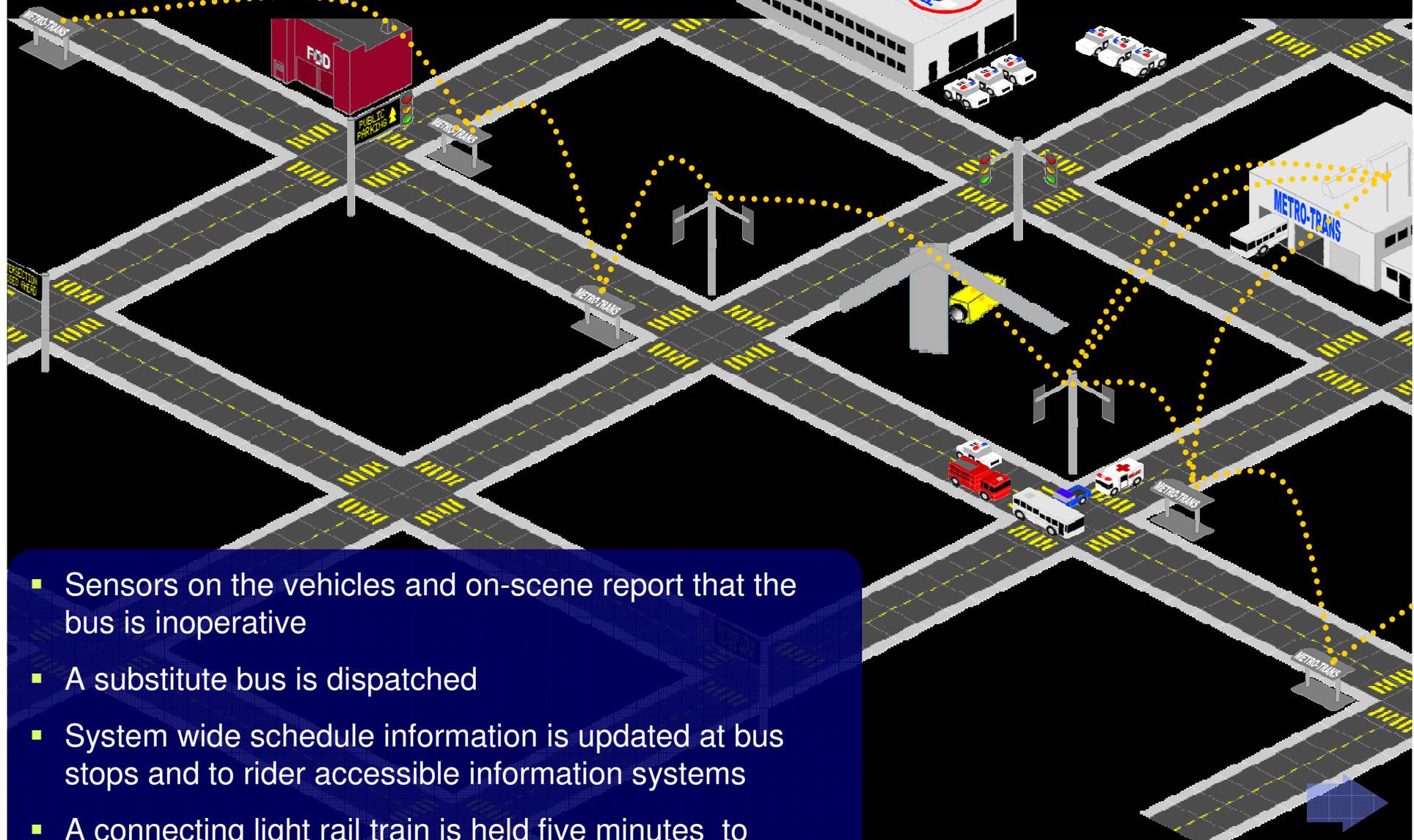
INTERSECTION  
CLOSED AHEAD

# The future is pervasive...



- Predefined automated incident response plan for public transit traffic incidents is activated
- Nearest police, fire and emergency medical teams are activated
- Traffic signal control facilitates arrival of first responders

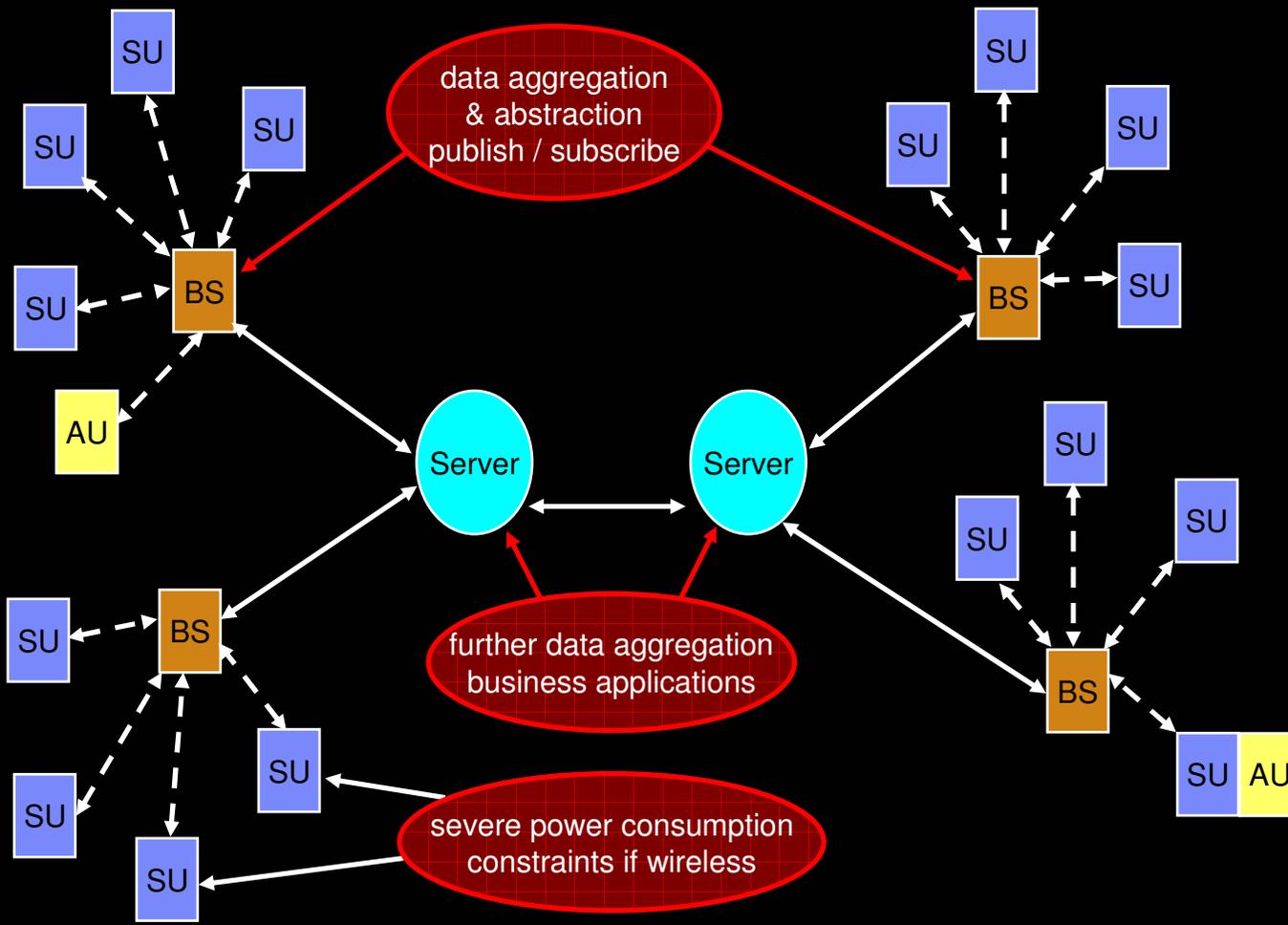
# The future is pervasive...



- Sensors on the vehicles and on-scene report that the bus is inoperative
- A substitute bus is dispatched
- System wide schedule information is updated at bus stops and to rider accessible information systems
- A connecting light rail train is held five minutes to accommodate the delay

# A Simple Sensor Network

## Challenge: end-to-end system solutions

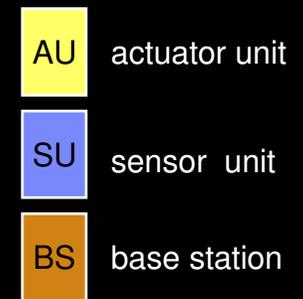


### IBM interest:

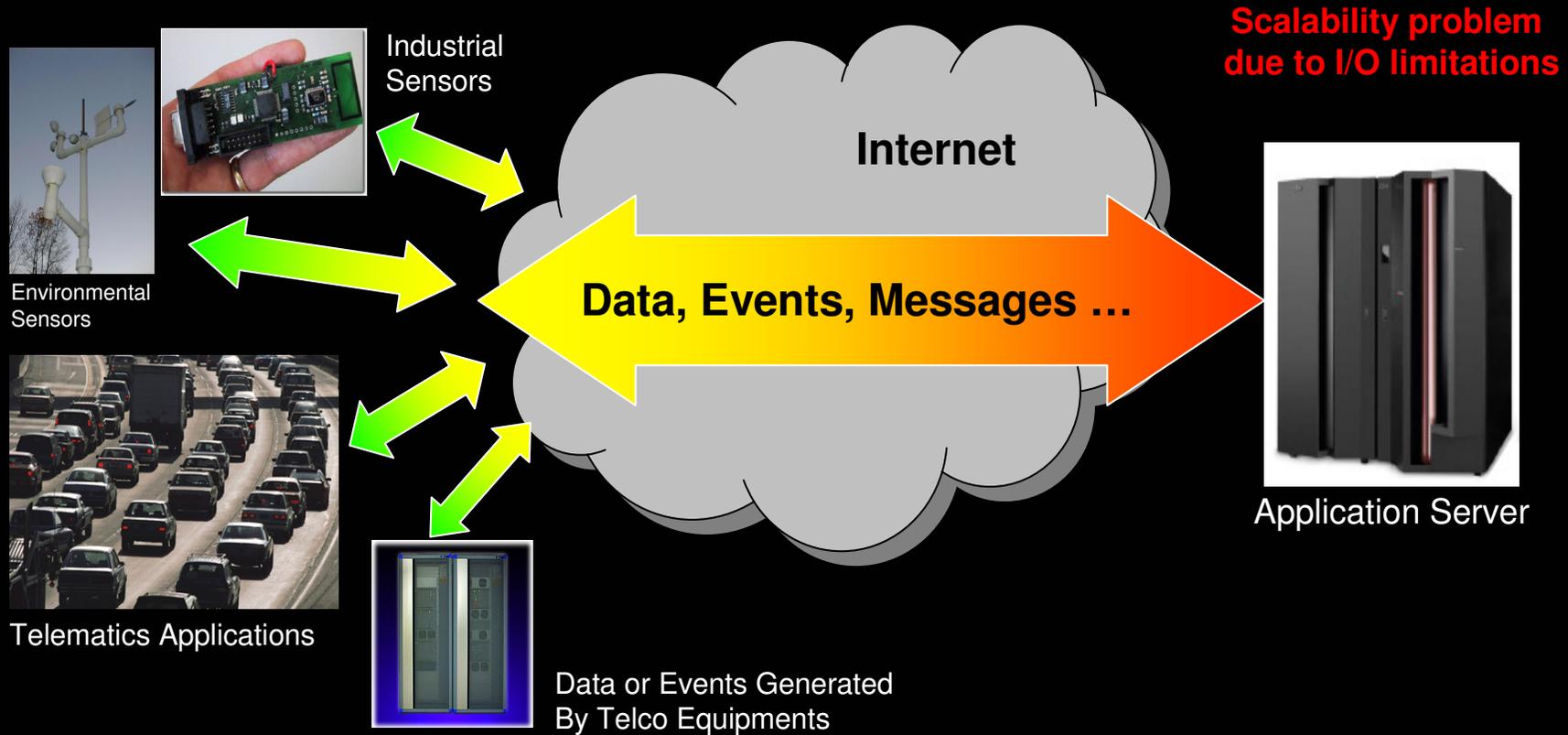
- System integration (IGS)
- Middleware
- Servers
- Custom designed units (E&TS)

### Systems aspects:

- Sensor diagnostics
- System diagnostics
- Remote overview
- Remote configuration
- Remote SW updates
- Sensor data access for business applications

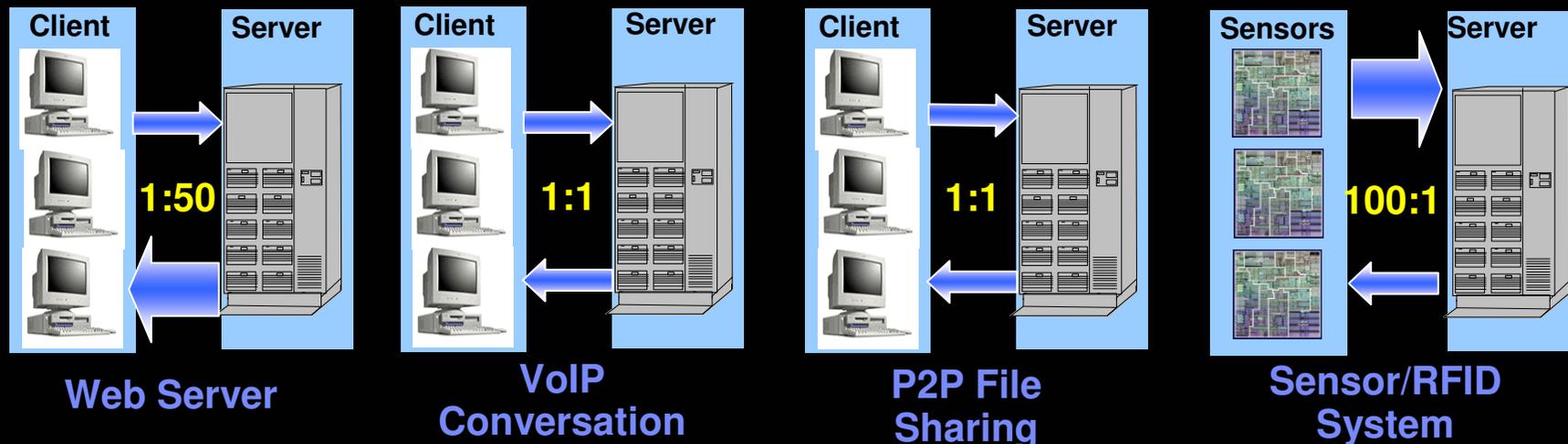


# The problem . . .



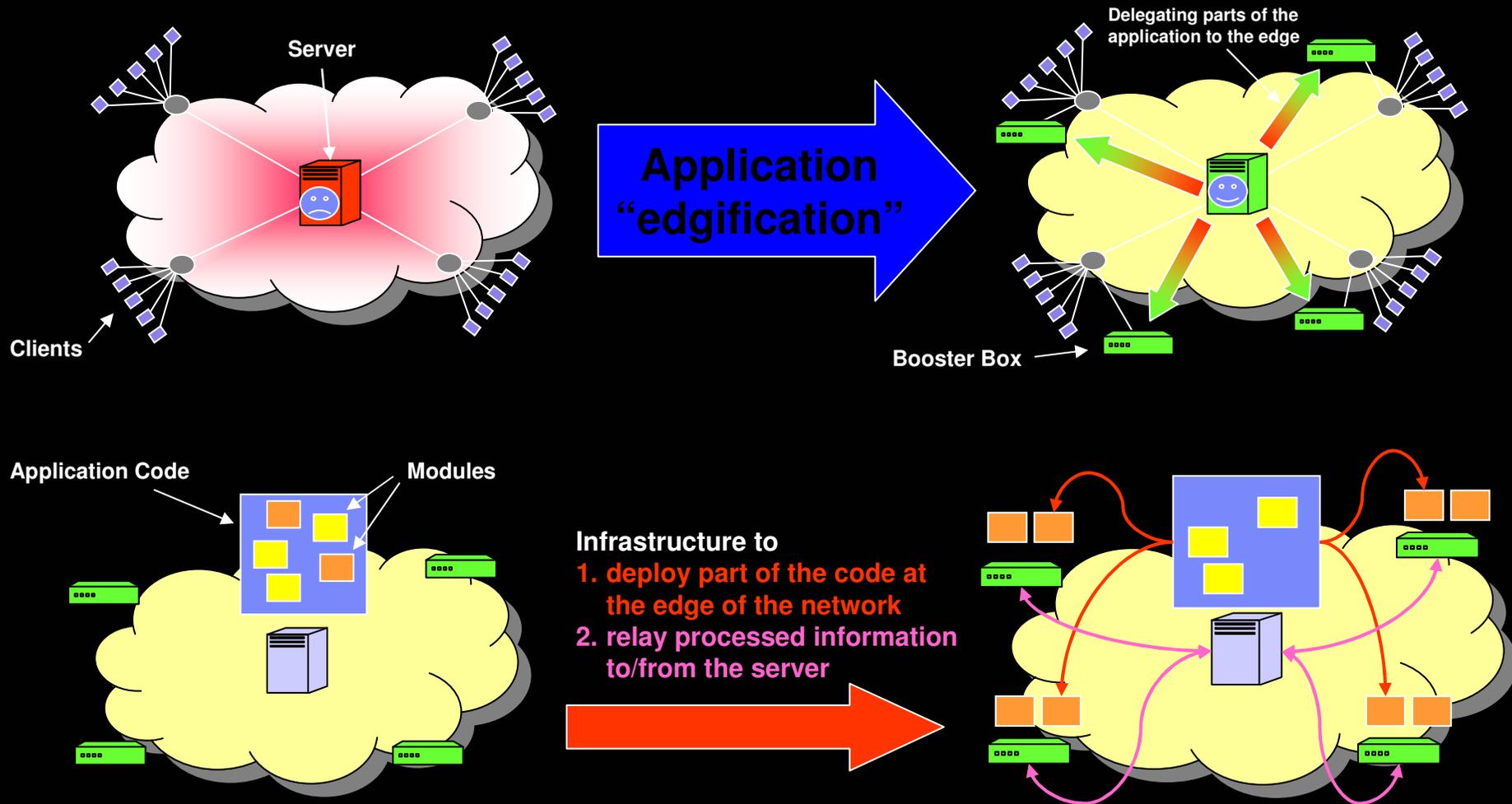
# Directional Shift in Network Traffic

The massive deployment of smart, networked sensors will dramatically affect network volume and traffic patterns



- Traditionally, client requests are accommodated by caching
- In future, computation will move to the edge of the network to aggregate, synthesize and filter data

# The Solution: Edge Server Software



# Multimodal User Interfaces

# A Short History of User Interfaces on Desktop

From green screen to web portals



- "Green Screen"
  - ▶ Single screen per machine
  - ▶ Single application at a time

- Windowed Desktop
  - ▶ Visual composition of several applications on a screen



- Browser and Web Site
  - ▶ Integration of local & remote resources



- Portals
  - ▶ Visual composition of multiple web sites into one view



- Evolving Web Services Interfaces
- Integration of multiple information sources and functions



# User Interaction Becomes Multimodal

## Smart Environments

- ▶ Voice & Pointing based interaction from a distance (e.g. GestureTek)
- ▶ Microphone/Camera arrays
- ▶ Person tracking



- ▶ 3D articulated body gestures
- ▶ Multi-scale analysis of user position, orientation, facial features, gestures
- ▶ Steerable user-centric interfaces
- ▶ Multimodal interaction, person id
- ▶ Handwriting capture/reco without touchscreen

## PC/Desktop

- ▶ Head / hand as a mouse (with well-controlled background, glove)
- ▶ Gaze tracking
- ▶ Conversational interaction
- ▶ Ink character and word input



- ▶ 3D gesture based manipulation without glove
- ▶ Monitoring of user focus of attention and user reaction
- ▶ 3D head model capture for facial interface and virtual conferencing
- ▶ Natural, multimodal (voice, GUI, ink, visual)

## Mobile device

- ▶ Laser projected keyboards (e.g. VKB/Siemens)
- ▶ Video capture of face
- ▶ Conversational interaction
- ▶ Ink character input, messaging



- ▶ Increasingly seamless transition between PDA/mobile, PC, smart space
- ▶ 3D head coding for transmission
- ▶ audio-visual speech recognition
- ▶ Voice+pen+gesture interaction

# Office of the Future



# Office of the Future



# Office of the Future



# InfoScope

- Combines pervasive computing with augmented reality
- Information augmentation system based on recognition of objects in scene images
- Provide relevant information to travelers, mobile professionals, wherever they are and when they need it

Automatic text translation

About buildings

About products

About events

...

# InfoScope – Automatic Sign/Text Translation

Client



Server



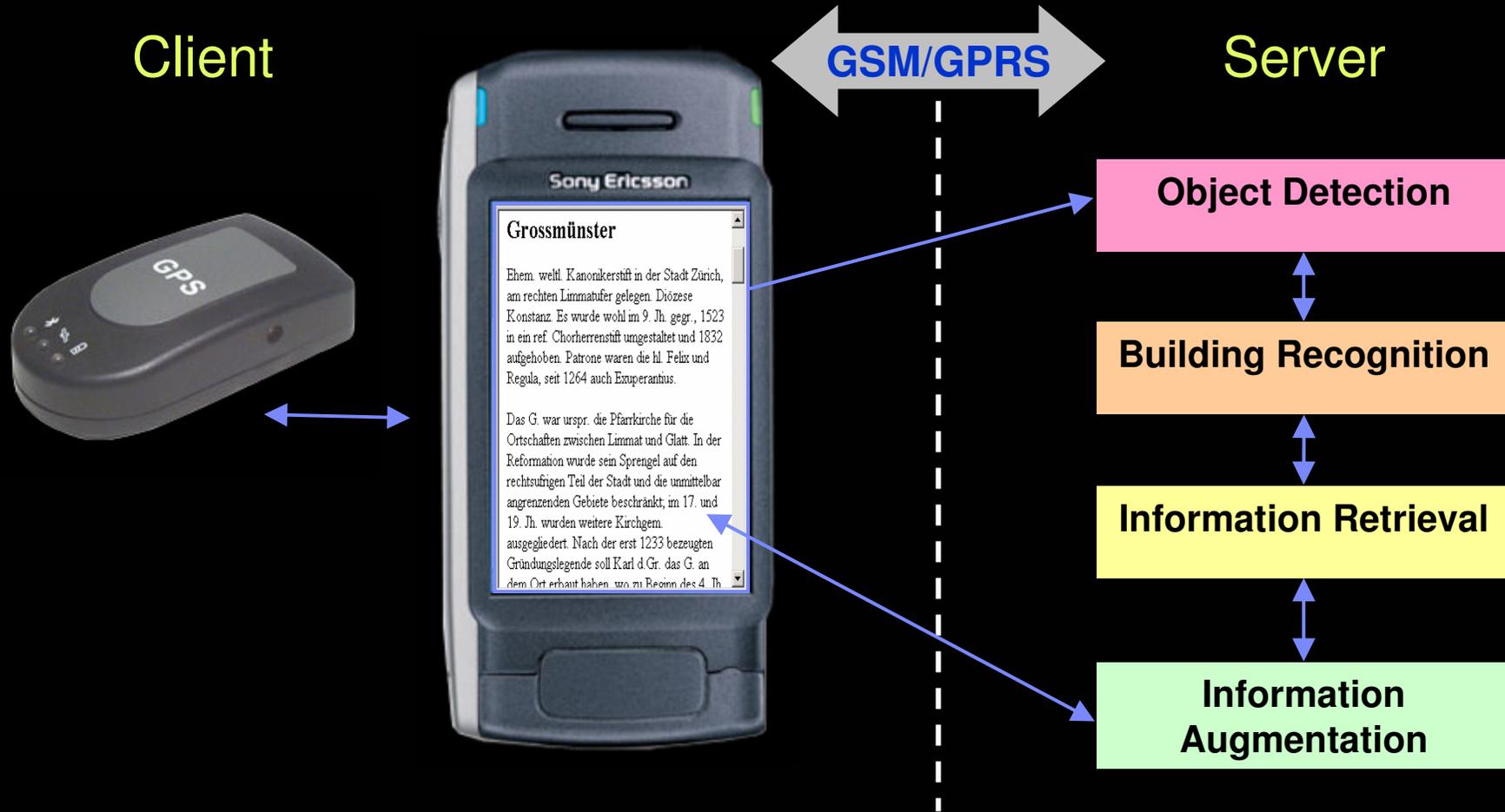
Scene Text Detection

Character Segmentation & Recognition

Language Translation

Text Augmentation

# InfoScope – Information Augmentation in the City



# Balancing Privacy and Benefits of PvC

# Balancing Privacy and Benefits of PvC

## Technology will trigger the erosion of privacy

- Pervasive sensors
- Complete profiling
- Behavior prediction and segmentation
- Privacy-enabling technologies



## Regulation can lead to a market-driven equilibrium

- Balance of Power: Govt. – Business - Individual
- Self-determination & transparency
- Balance (homeland) security & privacy



## Impact on individual:

- Benefits vs. discrimination

## Impact on society:

- Privacy protection => increased trust  
=> higher usage => higher economic growth



# Privacy – What needs to happen ?

## Awareness:

- Privacy as problem
- Privacy as advantage

## Assessment

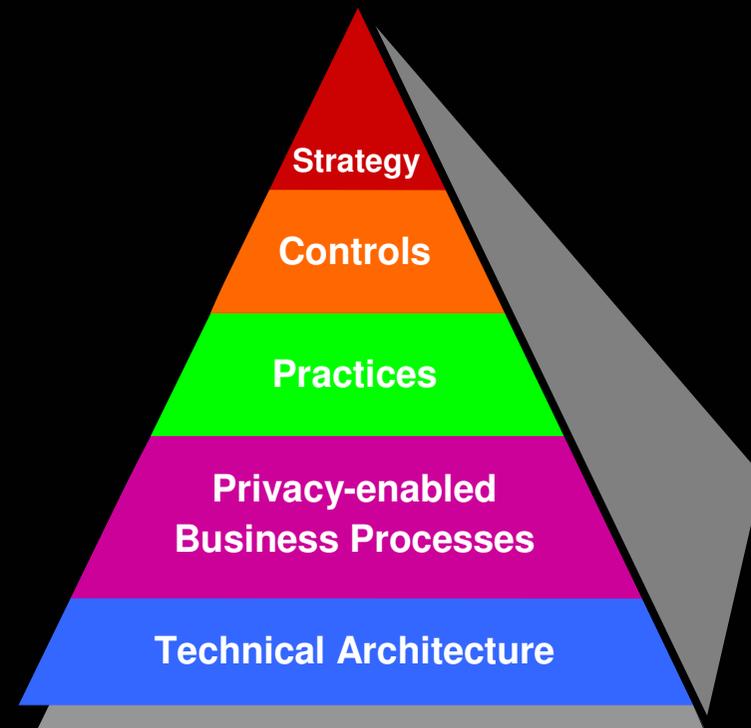
- The privacy impact of what you do

## Business transformation

- Strategy & Controls
- Practices

## Privacy-enabling technologies

- Enforce privacy policies
- Re-engineer your processes



# Conclusion

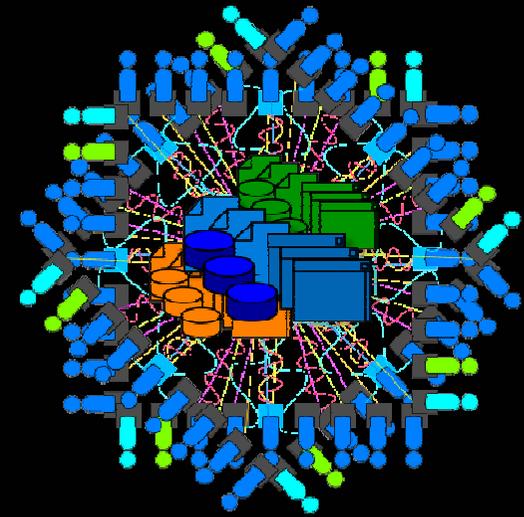
# Pervasive Connectivity

Novel devices, sensors and applications will drive significant architectural changes in the global IT infrastructure.

All kinds of pervasive computing applications are technically realizable.

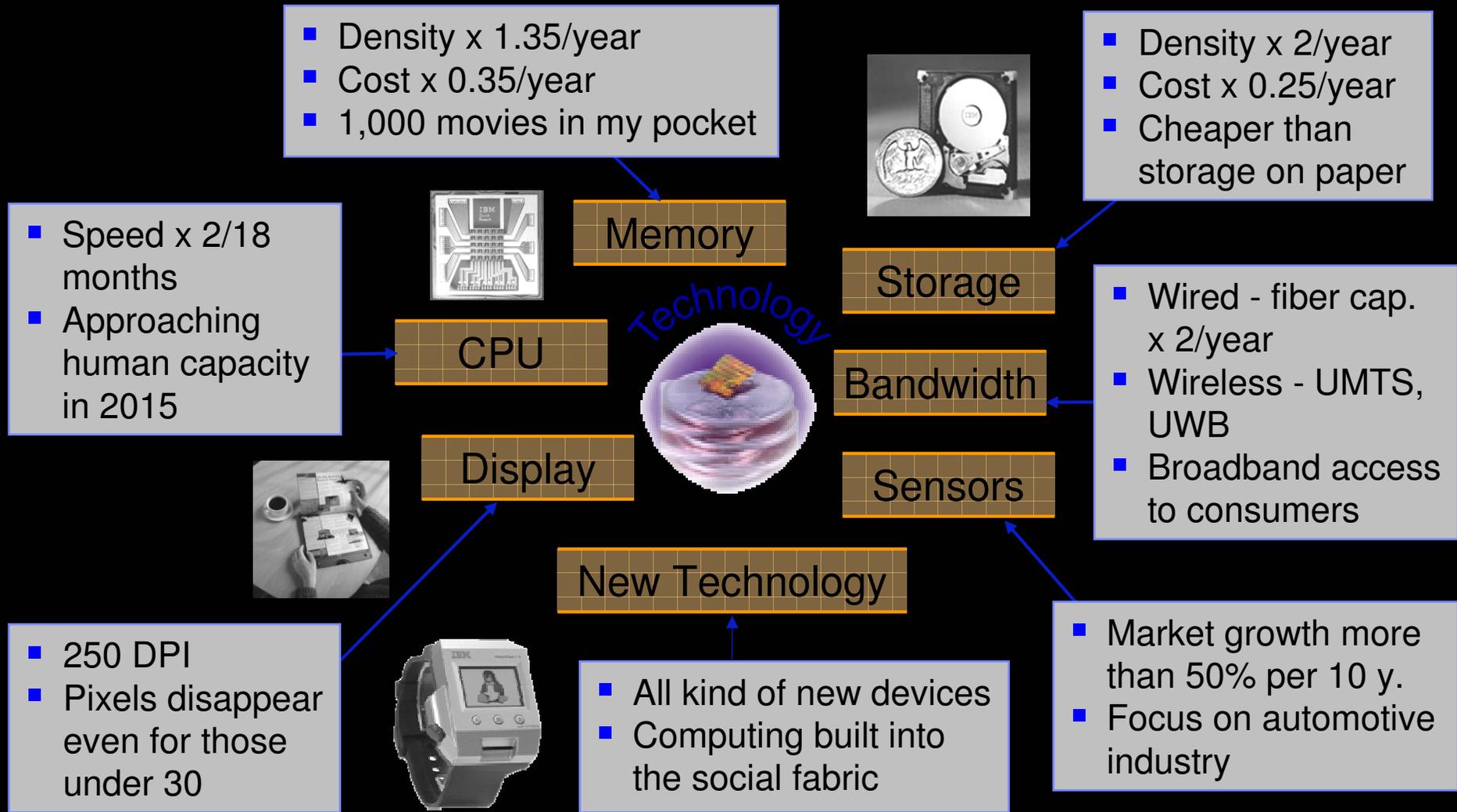
They will become available as they become economically feasible and socially acceptable.

Balancing privacy and the benefits is key to the realization of this vision.





# Technology Evolution - More Capacity For Less Cost



## RFID Example: Automobile Parts Tracking

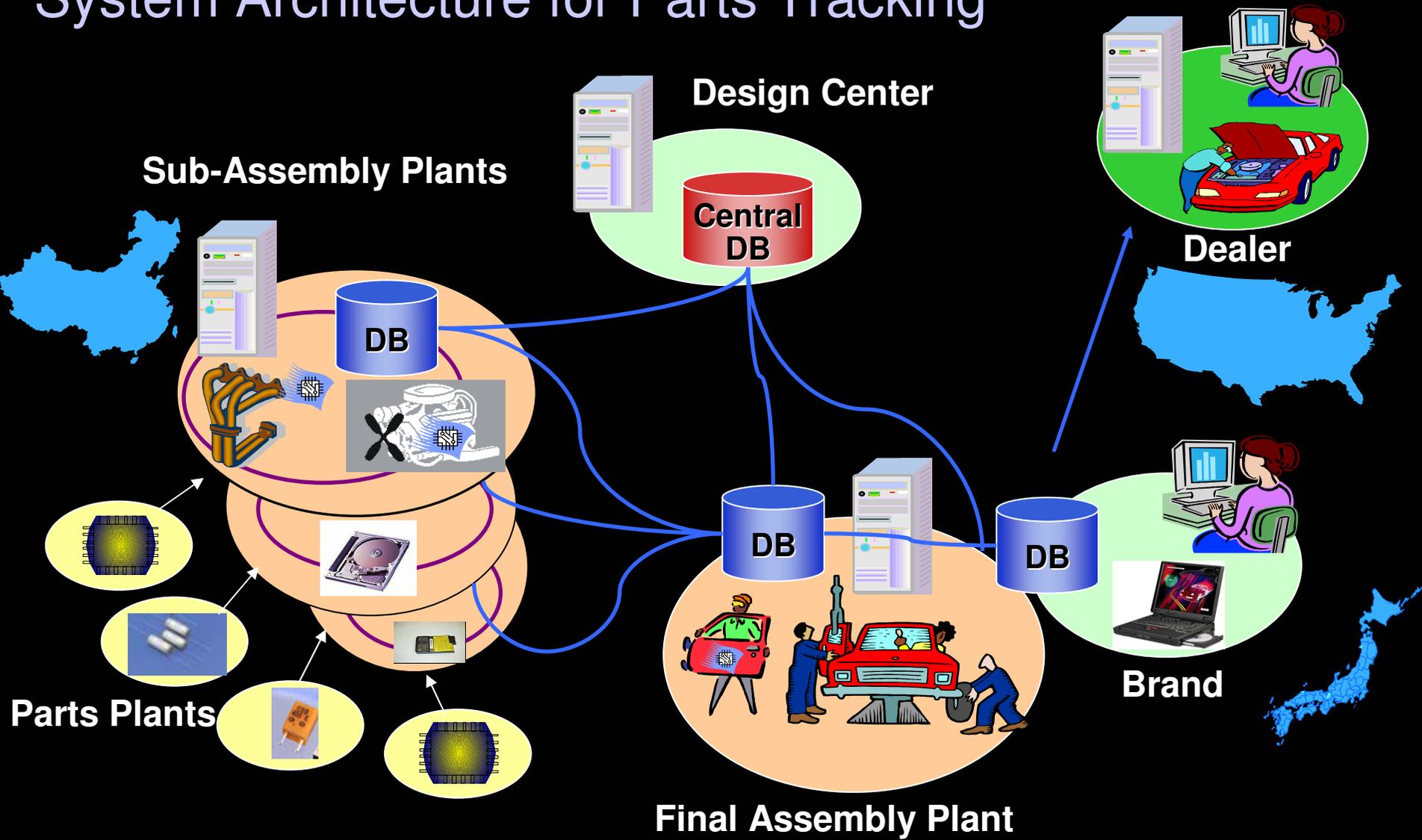
- Automobile procurement practices enable makers to choose vendors from around the world
- Component defects drive highly expensive, open-ended recalls
- RFID will be utilized to automate parts tracking by serial number with origin, process, tool, date, and operator information



- **Limit scope of recall**
- **Reduce costs**
- **Improve brand image and customer satisfaction**



# System Architecture for Parts Tracking



# Possible Network Architecture in Cars

