

# The Move to the Mobile: Challenges in coordination in Organizations

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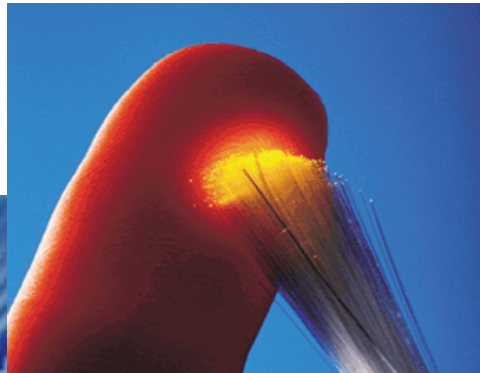
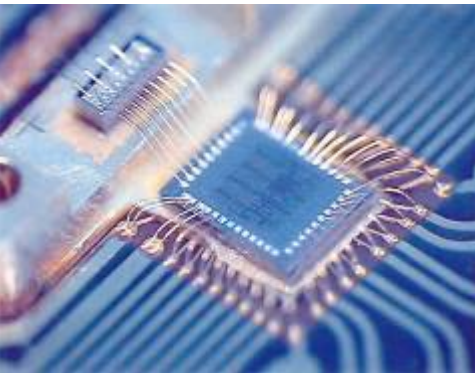


# Agenda

- The new, brave environment
- Examples of ubiquitous applications
- Transformation:
  - coordination and control
  - productivity
- Conclusions



# A Series of Waves of Innovation have defined the applications we use.



Connectivity



Mobility



Embedd  
edness



# Ride the technological waves

1970- The wave of mainframe computing

Large scale transaction systems, Business Automation and effectiveness

1980- The wave of microcomputers

Personal support, office automation of clerical tasks

1990- The wave of network computing (Internet)

Universal information access, electronic commerce, group applications

2000- The wave of digital convergence and net-centric computing

Any time, any place digital services, service integration, peer-to-peer computing, context dependency



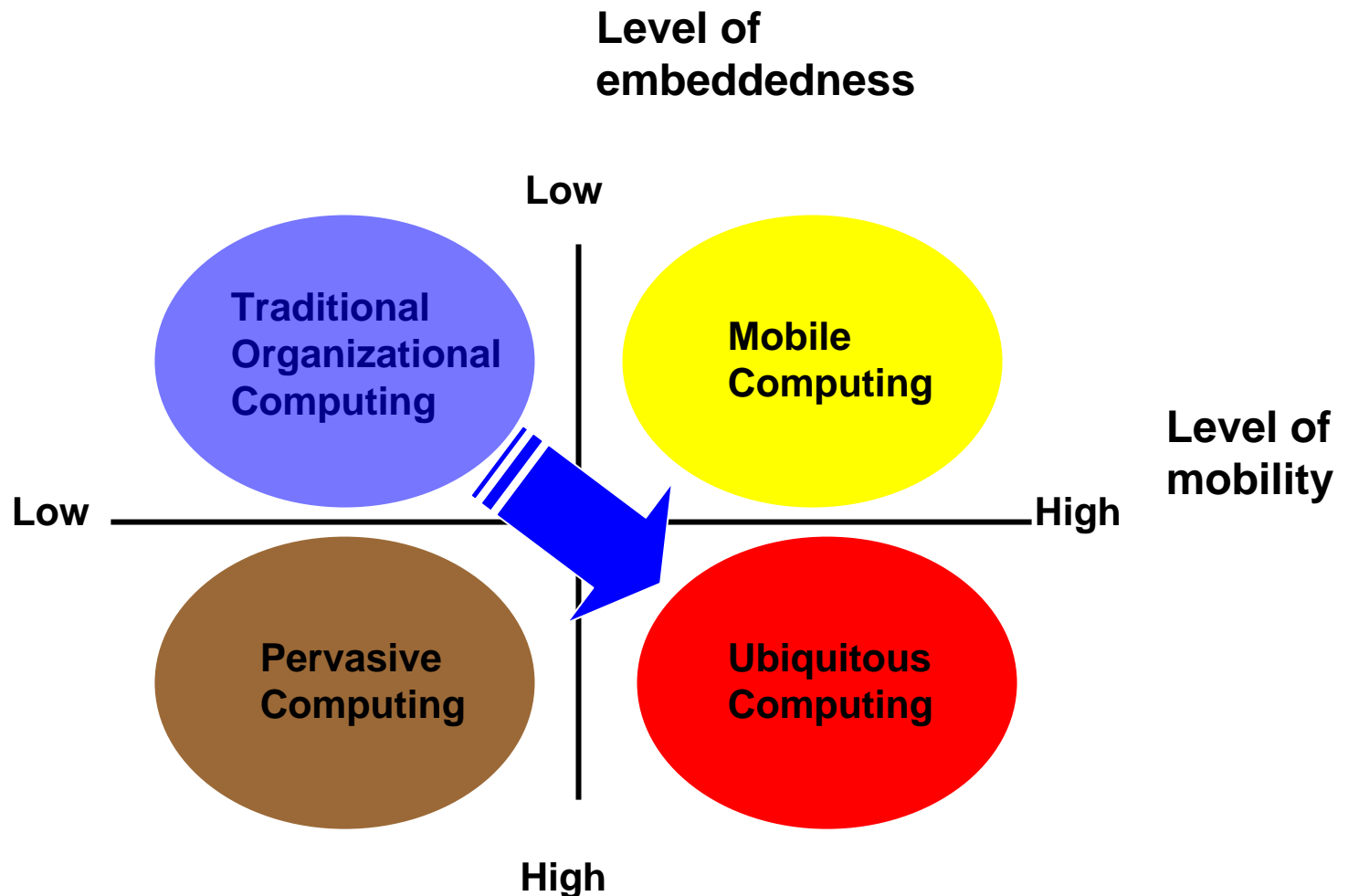
# Definition

## **Ubiquitous Computing:**

An assemblage of interconnected technological elements embedding computing services into our natural movement and interaction with the environments - both physical and social.



# Movement to Ubiquitous Computing





# Technological Change

- **Computing Technology factors**
  - Integration of wireless technologies to computing (access, SDR)
  - Increased computing power/cost and miniaturization of chips
  - Developments of truly handheld devices and small scale sensors
  - Miniaturization and decreased cost of memory
  - Power technologies / batteries
- **Computing architectures**
  - Heterogeneous and distributed computing (grids, 1 \$/hour SLAs)
  - Novel technology kernels (hardware, telecom, system software-standards)
  - Heterogeneous interoperability (services, semantics, metadata, ontologies)





# Enabling technologies

- Wired networks
  - 10G to 40 Gbits becoming standard in backbone networks
- Wireless Networking
  - PAN: UWB, Bluetooth, Zigbee (low cost 1-2 \$, speed up to 2-8 Mbits)
  - LAN: IEEE 8.11. a/b/g (speeds to 80 Mbits)
  - WAN: 3G (hstpda), 4G, wide band networks (WIMAX) speeds from 10 to 70 Mbits)





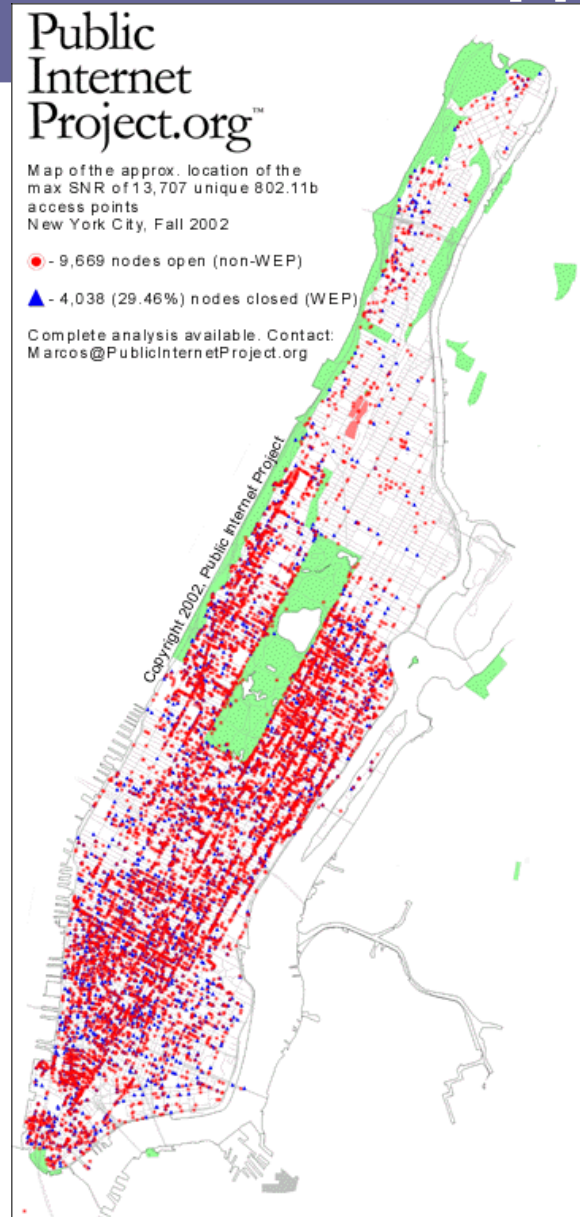
# Exponential growth of availability of broadband technologies like Wi-Fi

New wireless communities

-Over 70 in the U.S.

-OneCleveland, free covers metropolitan of Cleveland

-First trial for “unlawful” competition- Philadelphia



Manhattan:

13,707 WLANs detected with street-by-street radio sweep

9,669 (70%) with no encryption

60% growth from 2001-02



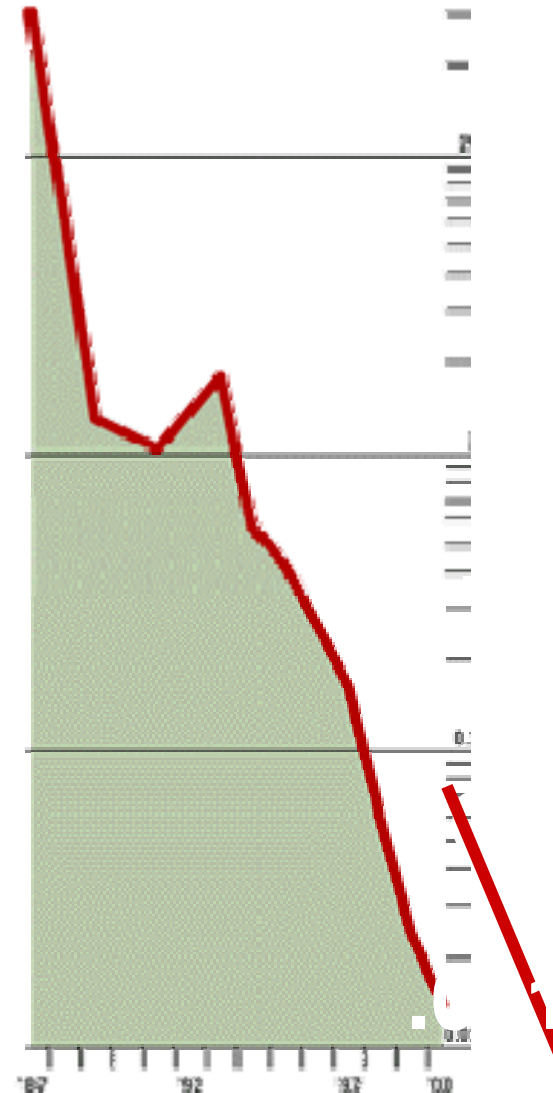
# Storage cost

## Cost of Storage:

- 100 GB = \$60 = 100 hour video cache, large music collection
- 1 TB = ~ \$600 = 500 movie collection or roughly one quarter of Rhapsody's streaming music service collection
- 18 TB = \$10.8K = All syndicated TV shows available in 1998 or most recorded music.
  - ~ \$1000 in 2010?
  - ~ \$10 in 2015?
- IBM Millipede will offer 1 TB on a device of a size of your thumbnail! (2007-2008)

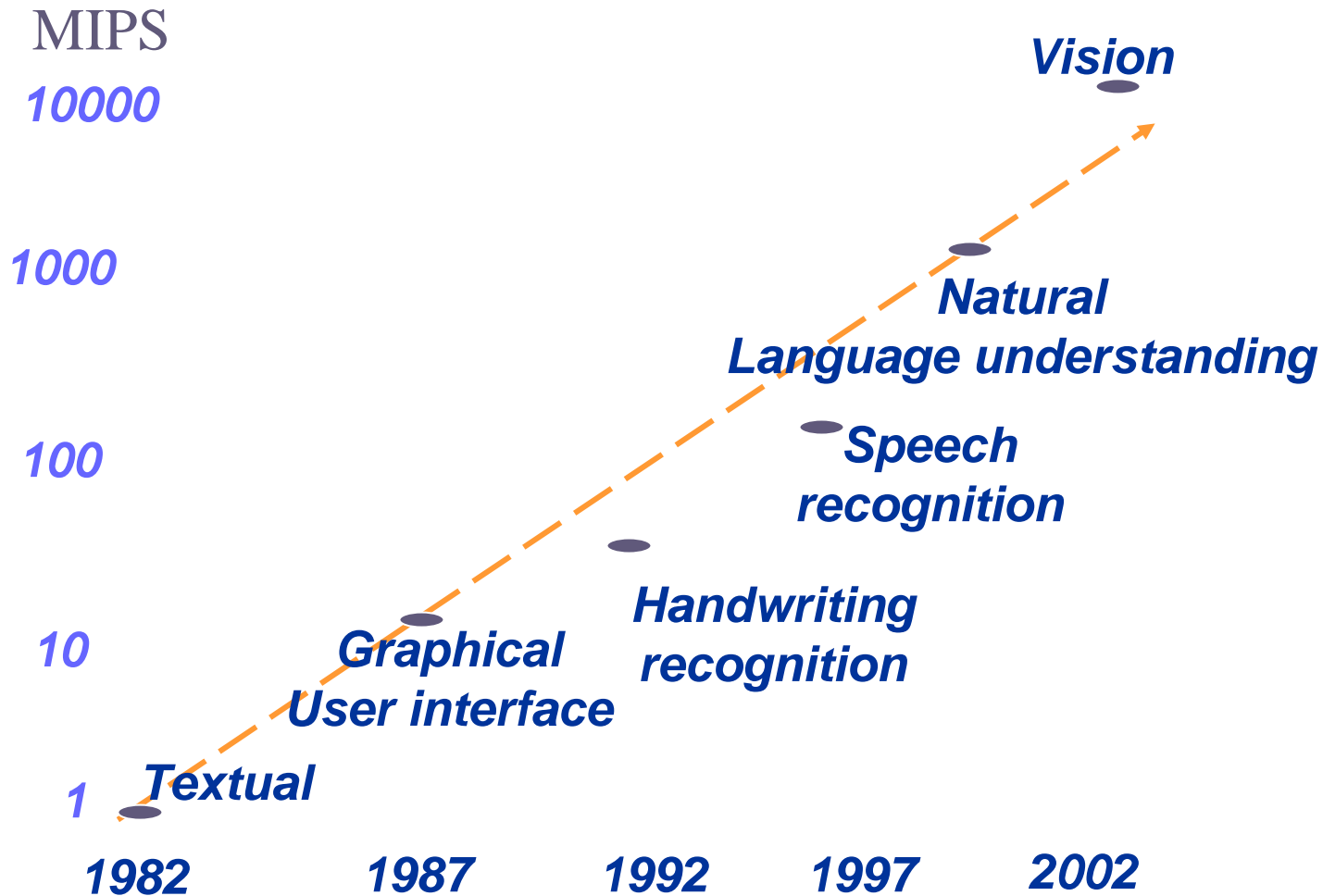
*How many different devices need to afford to have significant storage? A phone?*

*What level of service can different devices provide at different storage levels?*





# New forms of interactions





# New interactions

**Information  
Representation**

**3D virtual  
reality**

**Multimedia**

**Iconic**

**textual**

**Output**

**Stereographic visual, audio**

**Speech synthesis**

**Graphical display**

**Alphanumeric display**

**Keyboard**

**Click and point**

**Handwriting, speech recognition**

**Gesturing**

**Position sensing**

**Input**



# Many types of computing devices





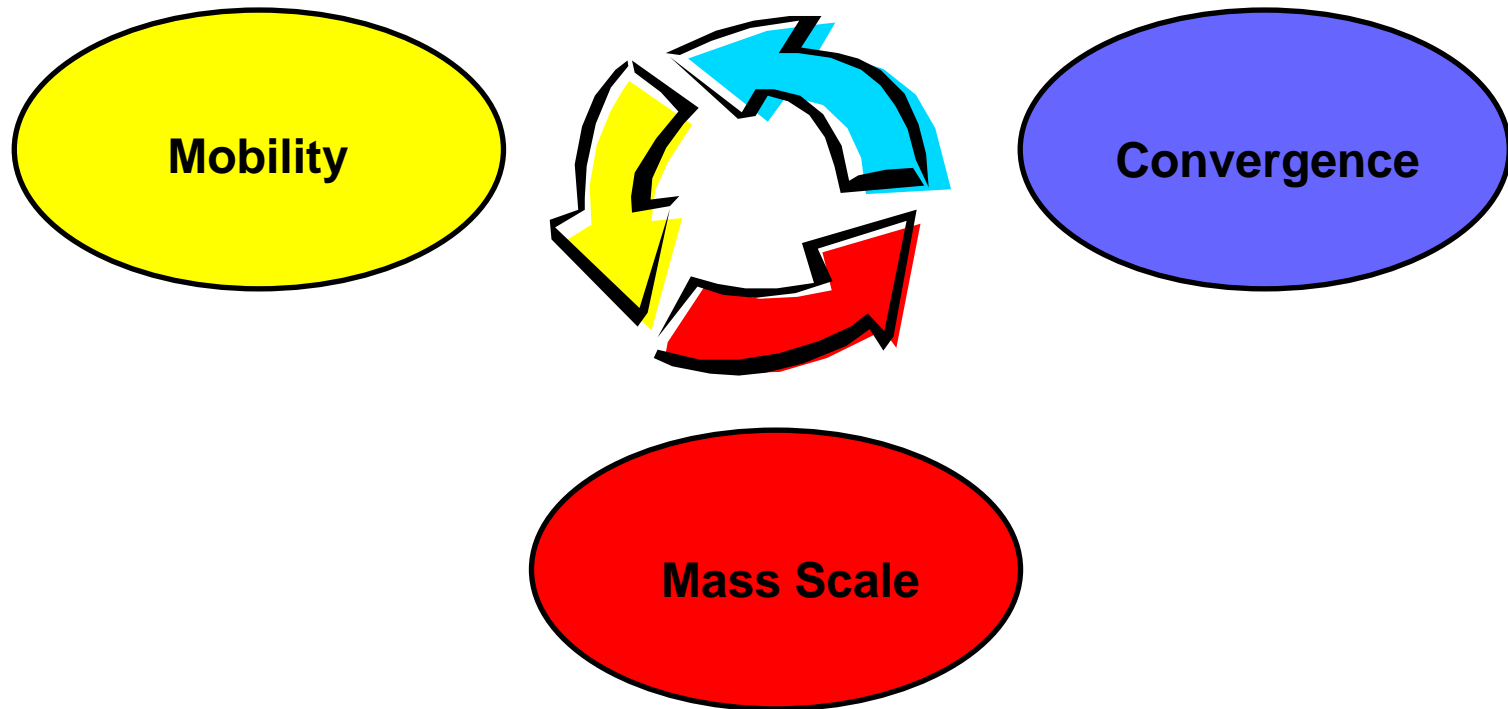


# Will we have a Universal Device?





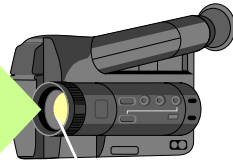
# Three Key Forces



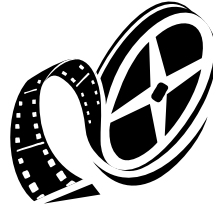


# Convergence

The conversion, processing, movement of all media in digital



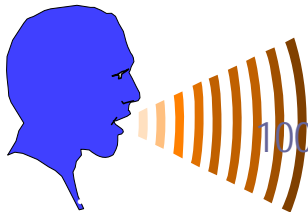
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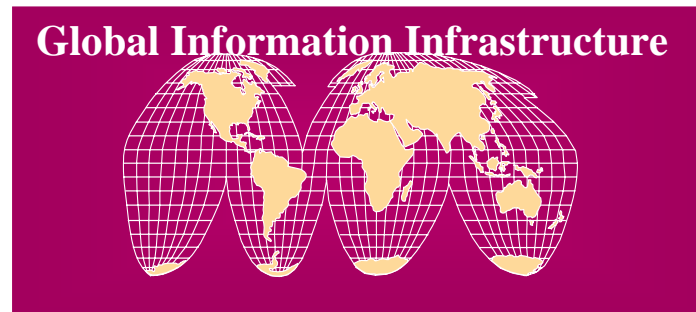
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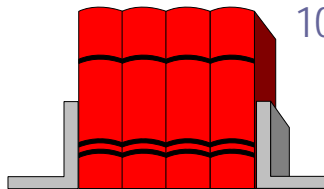
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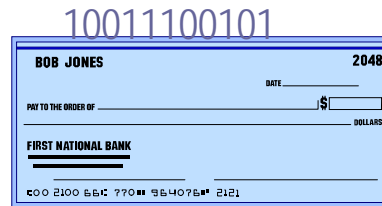
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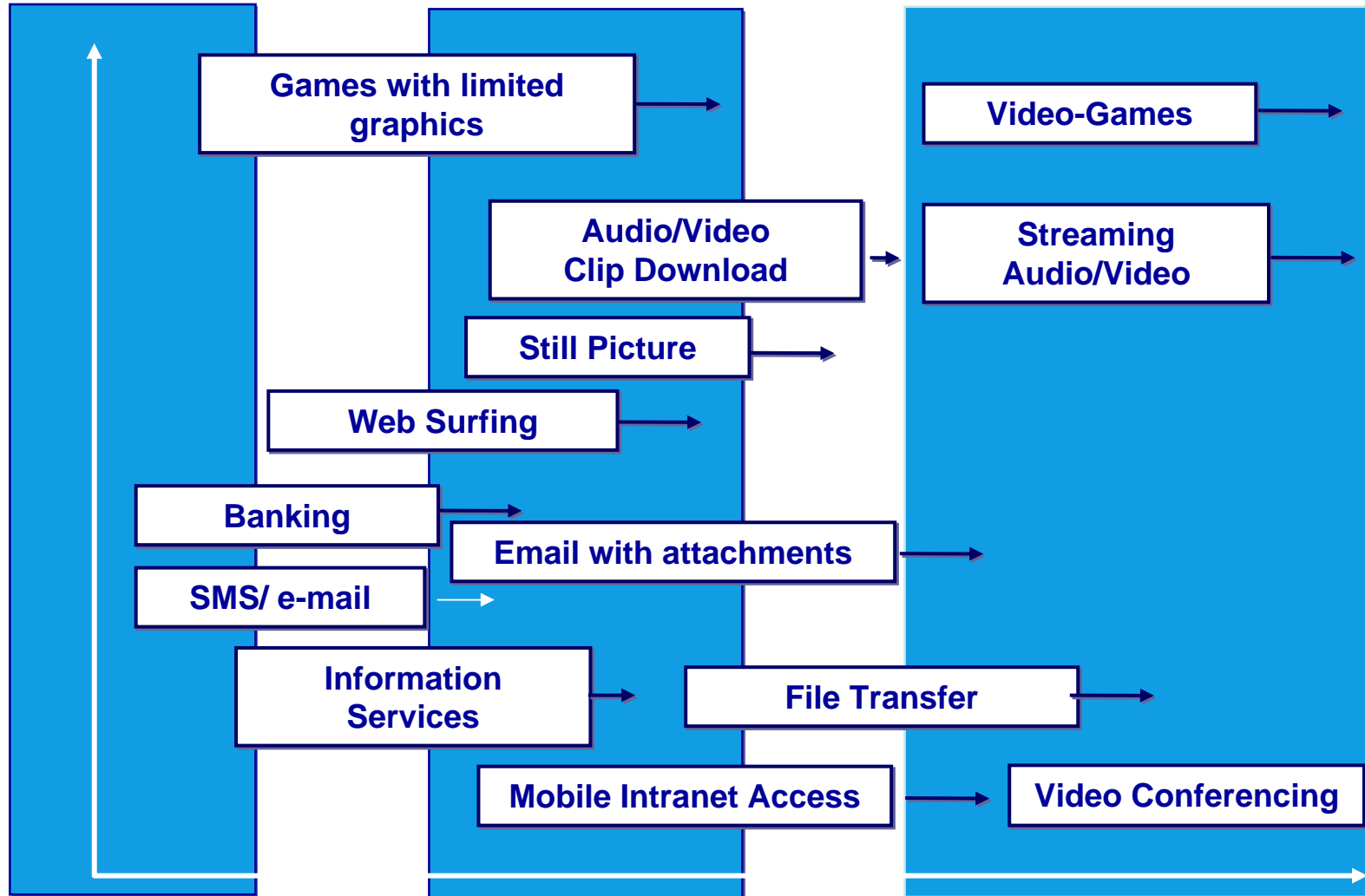


# The range of available services is growing fast

2G

2.5G

3G





# Digital Service Characteristics

- Migration of applications, telecommunications and media to digital services
- New business models and service channels and capability (c.f. Vonage, Skype, Kazaa, Google, E-bay, Autograph)
- New forms of interaction, environments accommodate the user
- “smart” devices in the home, car, and pocket (Docomo’s Felica)
- Device location and context awareness matters (Onstar)



# Mobility

- **Mobility:** both physical mobility and social mobility
  - **Social:** roles, capabilities, rights, preferences while users move one context to another, or within a context to another task
  - **Physical:** micro mobility, local mobility, remote mobility
  - **Technical:** mobility of services across platforms
- Mobility in one drives mobility in other, or demand it
- Mobility increased significantly over the last 20 years
- Enables new digital services as new combinations of
  - service and locations
  - digital service and physical mobility/social mobility
  - Devices and human actors



# Mobility makes things different

- Device location and movement is a completely new dimension
- Devices are different with different mobility features (form factors)
- Usage contexts and needs are different
  - Independence of the content and the medium
  - Devices vary and can use resources also locally
  - Usage contexts embody alternative ontologies

Dilemma:

The digitalization and information ubiquity represents a departure from physical reality **but mobility and at-hand capability** grounds services and users more to the physical world



# Mass scale

- The volume and diversity of computing devices, volume of information transfer and connections grows in exponential scale
- Linear growth in user base (human/non human)
- Linear growth in applications and services that can be connected
- Enables new services, organizational capabilities and business models (service economies)



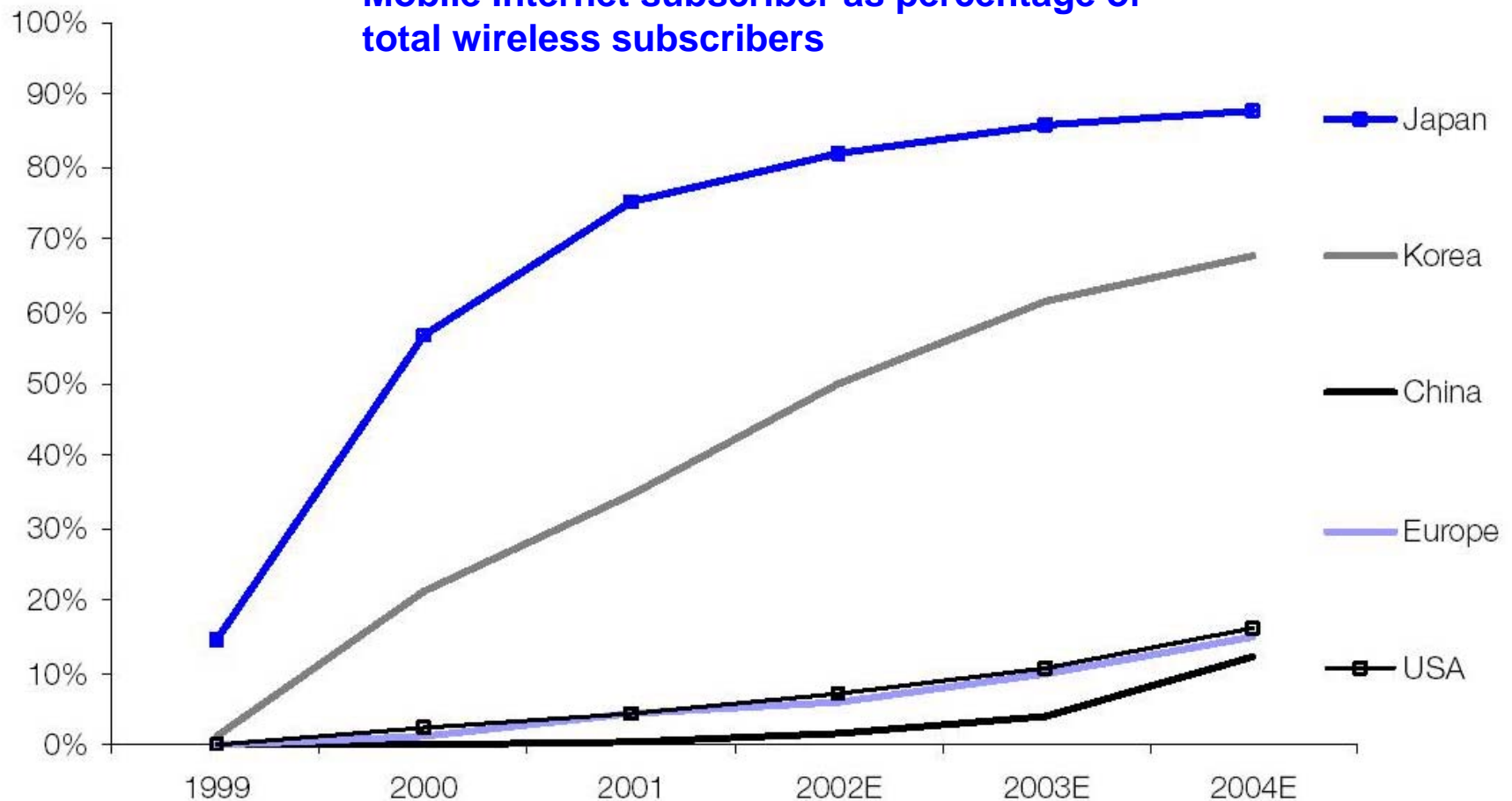
# Mass Scale

- **Mass scale:** services provided at a global level, pervasiveness implies high volumes
  - mainframes  $10^5$  computers; PC's  $10^8$  computers, embedded / mobile  $10^{12}$  -  $10^{14}$  computers
  - Data transfer increasing exponentially, over 60% of that will be non-human by 2010
  - Internet capable mobile devices: 1 billion by 2003
  - 300 million Bluetooth devices in US alone by 2004



# Japan and Korea are leading massive adoption of digital services

Mobile Internet subscriber as percentage of total wireless subscribers





# The New Digital Environment

## Technology

**Information Infrastructure**  
Connectivity and service availability via multiple scalable networks

**Digital Convergence**  
Transformation of physical media into digital format

**Open Standards**  
For transmission, presentation, interaction, security

5 A Service

Any service  
any time, any  
place, any  
device, any  
user

## Use

**Customization**

Tailoring of product/service to unique needs of the user

**Pervasive contexts of use**

High penetration of computers and knowledge to use them

**Information Industries**

Industry transformation and value increasingly dependent on information content





# Examples of emerging new digital services

- Intelligent wearables
- Location based and device based service models
- Intelligent local environments
- Humans as sensors



# Intelligent wearables

- Tasks which are information intensive and demand unobstructed movement and reach
- Complex maintenance tasks and mobile information intensive work (switches, airplane maintenance, power-stations, couriers)



Mortal combat: Steve confronts  
a rival technology.



## *War of the Cyborgs?*



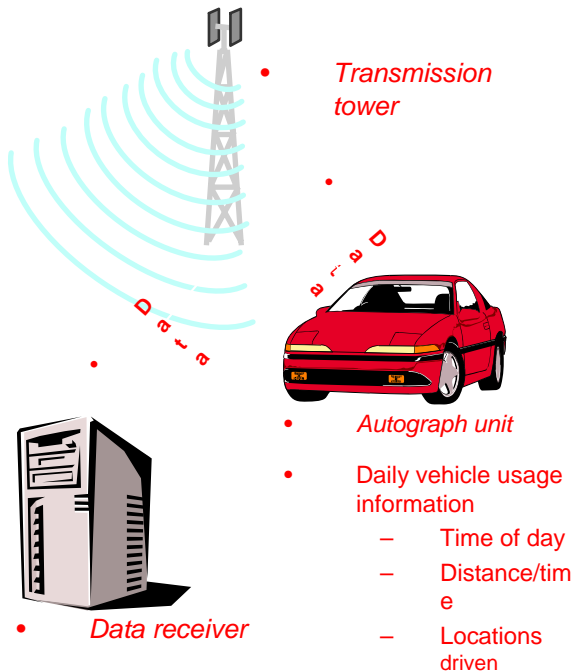
# Progressive “Autograph”

**With Autograph™, insurance bills are calculated monthly based on actual vehicle usage data**  
**HOW IT WORKS**

**•1. Monthly upload of vehicle data by mobile communications**

**•2. Data converted into a monthly premium based on travel zones and time of day**

**•3. Customer billed for usage in past month**



Time of day	Zone 1	Zone 2	Zone 3
Morning	300m	100m	400m
Afternoon	\$120	\$5	\$20
Evening	20m	00m	200m
Late night	\$8	\$5	60m
Total			\$74

• Maps defining zones are given to customers



- In this case, \$74, a savings
- of **22%** from a standard policy

Source: Progressive



# Intelligent local environments

- Environments that embed sensors and enable intelligent adaptation to the computer, user or resource
- Contextual sensing, adaptation, resource discovery and augmentation
- Examples
  - Intelligent shopping assistants (what is available)
  - Intelligent medical cabins and immediate services
  - Intelligent context aware environments (available resources, who is where, how can I do X, where can I find y)





# Mobile Valet: Who do you want to help you?





# Situated Services







# Humans as sensors:

## Cameraphones let us *show* business or organization something.

**Phones were social first.  
Business channels later.**

**Camera phones will  
follow a similar path.**



**Share It When It Happens:** Surprise your family with daily baby pictures . . . share vacation shots instantly . . . create a mobile photo album . . . send a wireless postcard



### **Share your moments instantly.**

After your picture has been placed in your phone's Share mode, you can instantly share the picture with up to 10 people at a time by sending it to email addresses or to other Phones.



### **Put a face to your callers.**

Picture Mail gives your phone's Caller ID personality. In addition to having phone numbers appear when a person calls, you can have his or her picture — or any picture you take with Picture Mail — appear as well.



### **Easily store your memories.**

Storing and managing your pictures is just as easy as sharing them with friends and family. You can save your pictures to your Picture Wallet or upload your pictures to the Picture Mail Web site.





# Humans as Sensors

By 2007 there will be almost 9000 cameraphones per square mile in NYC.

(Assumes 80% of cameraphones sold still in use)

- If each cameraphone sends 1 picture/year to NYC that's 2.7 Million pictures.  
*And we haven't even mentioned video.*

How will any individual or organization – accept and use this media?





# Organizational Transformation

- Time-space in organizing
  - **Coordination and control**: inadequate how time and space relate to coordination, dependent vs. independent variables
  - **Virtuality and physicality**: interacting and meshing of real and virtual



# Coordination and control

- **Coordination:** “management of interdependencies”
- Defined through uncertainty: amount of information needed accomplish the task
- Coordination theory define by
  - types of tasks (sequential / pooled etc)
  - types of mechanisms to increase information processing capacity or reduce uncertainty



# Coordination and control

- Traditionally time and space not recognized in designing coordination **mechanisms**
- **Both are treated as (hidden) factors that impact or moderate interdependencies**
- **Mechanisms largely timeless / space-less (Galbraith 1977)**
  - Rules / standards and plans
  - Hierarchies
  - **Vertical information systems**
  - **Lateral relations**
  - Slack
- IT enters as a means to affect hierarchies (cut down, improve planning), create hierarchical IS (ERP), or promote lateral relations (groupware, e-mail)
- **These are accessible at the office desk- a place, which is accessible locally through movement**



# Coordination and control

- Main impacts of ubicomp
  - **local mobility can be augmented by remote** and uninterrupted access to IT capability (vertical/lateral); changes dynamics between local and remote mobility
  - simultaneous **dynamic central coordination and situated adjustment** (e.g Fedex, UPS))
  - Use increasingly dependent on situated context: **needs of remote access has to be integrated with micro-mobility**
  - Increased **intelligence at the boundary** (intelligent devices, embedding of rules into the basic processes)
  - Organization will increase intelligence by high levels of rule based coordination and lateral communications
  - Mobilization of **representations that enable novelty and expressiveness** (trust, new knowledge)



# Coordination and control

## The Speed and Scale of intelligent reaction



### Size

Will have a coherent view of reality from sensors distributed over regions as large as a nation or the world.

### Time

Will act on insights in real time – as well as trends noticed over years or decades.

### Novelty

Will adapt to the unique conditions of people, objects and businesses.

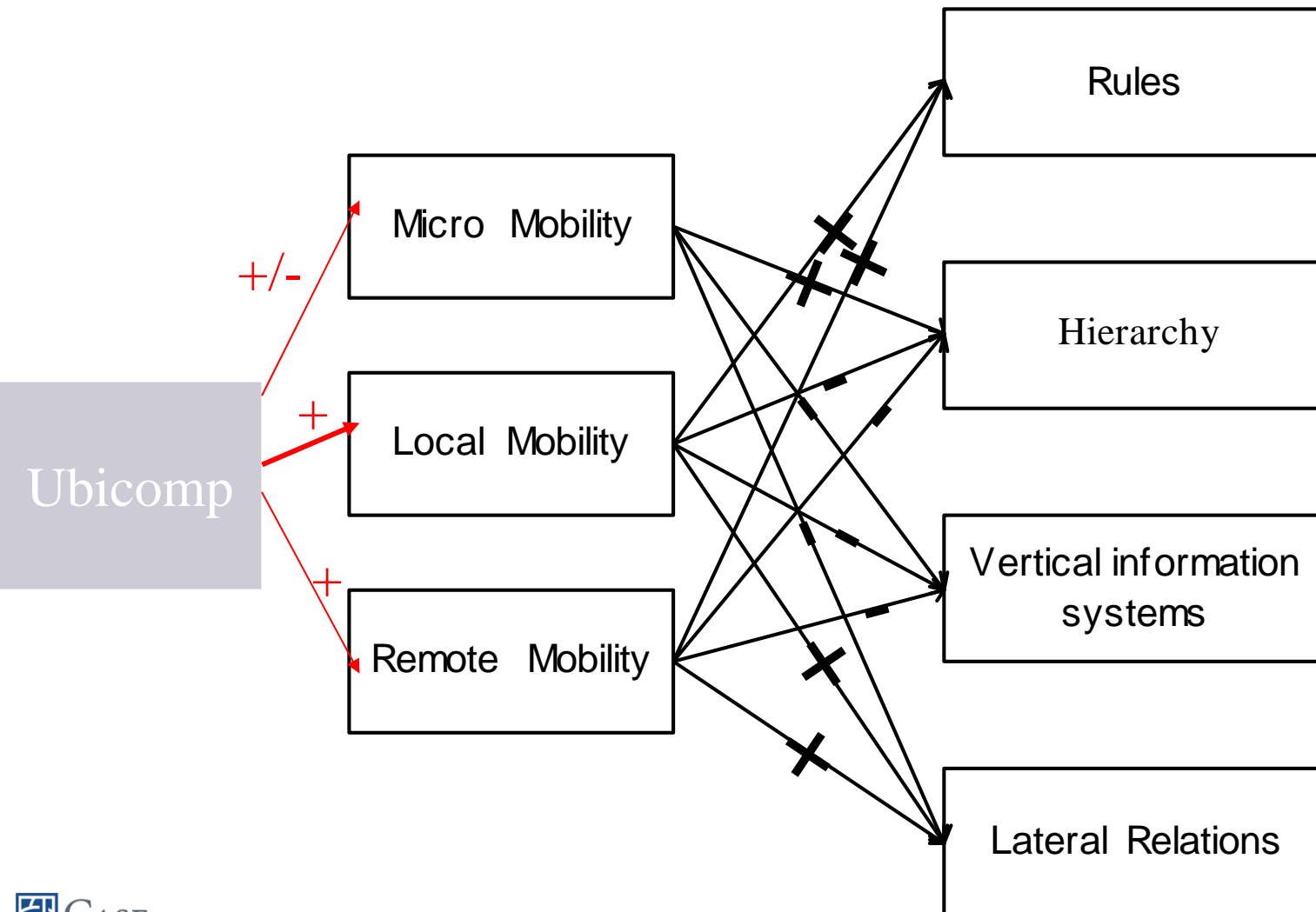
### Reach

Will extend and amplify the reach of human expertise across global organizations.





# Coordination and control







# The Information Access at the Boundary

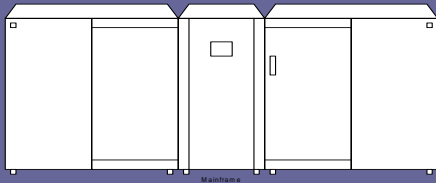




# Change in control and coordination at Fedex

## “On-Line” Courier Architecture - 2003

### FedEx Knowledge Base



Distributed Processing

Package Info  
Business Rules  
Customer Database



Customer

Edge of Network

- + increased centralized control
- + increased network level coordination
- + increased mutual adjustment
- + increased intelligence at the boundary



# Productivity of UIE

- Automating (automation effects)
  - Automated processing at the edge; automated response, machine based processes
- Configuring
  - Fast configuration and utilization of various local computing devices
- Connecting (coordination effects)
  - Real Time communications
  - Access to state information at any time to any process
- Embedding (intelligence effects)
  - Faster response in unusual situations



# The Future of Productivity

- Automating
  - wearables, sensors
- Configuring
  - Service discovery and coordination
  - Voice activation
  - Gesture based interactions
- Connecting and coordinating
  - Totally “unobtrusive” communications and information environment
  - Data, Voice, Video, search and accessing computational capability
- Embedding
  - Creating and negotiating environmental and process models
  - Integrated and dynamic business model at the edge



# Productivity Impacts of UIE

- Automating (automation effects)
  - Fedex will cut c.a. 10-15 % of data capturing time with its Powerpad integrated solution
- Configuration
  - Fast configuration and utilization of local computing resources at car, dock or customer site
- Connecting (coordination effects)
  - Real Time communications
  - Access to state information at any time to any process
  - Heikkila and Lyytinen showed that Metso Co (worlds largest paper machine producer) could cut delivery times by 50%, increase complexity of products by 100%, reduce significantly errors, by using coordination technologies and mobile access over 5 year period
- Embedding (intelligence effects)
  - Faster response in unusual situations
  - Fedex can improve responsiveness of their couriers with a new Powerpad application



# Concluding Thoughts

- Ubicomputing will remain the main intellectual challenge for the design and use of IT in organizational settings in the next decade
- Offers a new way to think about coordination problems and organization design
- Demands integration of digital services social / business contexts within physical world; key to understand how physical gets augmented and supported with the virtual
- Requires new types of theorizing
  - Time-space and coordination
  - Interactions between virtuality and bodily
  - Productivity



Questions?

