


Introduction and Issues Regarding Mobile Computing

Fantastic Breakthrough Technology

- **Wireless communication networks**
 - multiple networks “covering” the globe
 - world-wide deregulation and spectrum auctions
 - standard communication systems and air link interfaces
- **Portable information appliances**
 - laptops, notebooks, sub-notebooks, and MNCs
 - hand-held computers
 - PDAs and Smartphones
- **Internet:**
 - TCP/IP & *de-facto* application protocols
 - ubiquitous web content

New Forms of Computing

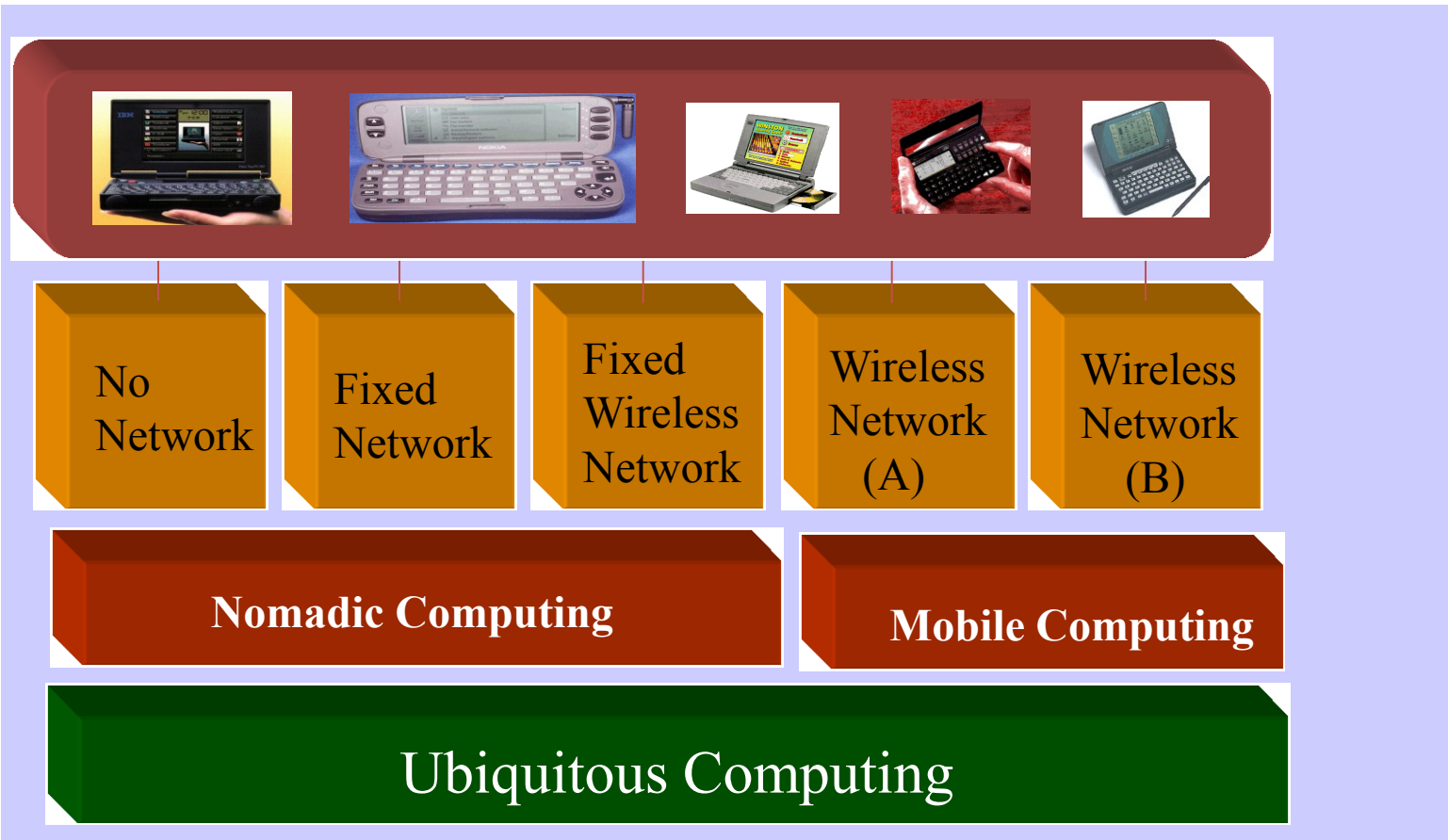
- Distributed Computing (Client/Server)
- 

- Wireless Computing
- Nomadic Computing
- Mobile Computing
- Ubiquitous Computing
- Pervasive Computing
- Invisible Computing

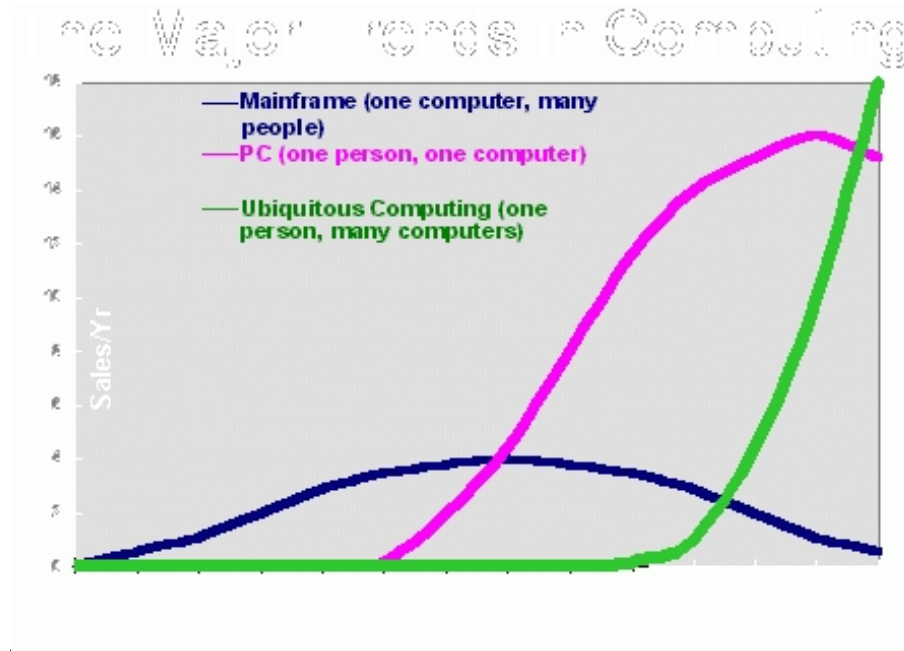
Mobile Computing

- Using:
 - small size portable computers, hand-helds, MNC, and other small wearable devices,
- To run stand-alone applications (or access remote applications) via:
 - wireless networks: IR, BlueTooth, W-LANs, Cellular, W-Packet Data networks, SAT. etc.
- By:
 - nomadic and mobile users (animals, agents, trains, cars, cell phones,)

Nomadic, Mobile & Ubiquitous

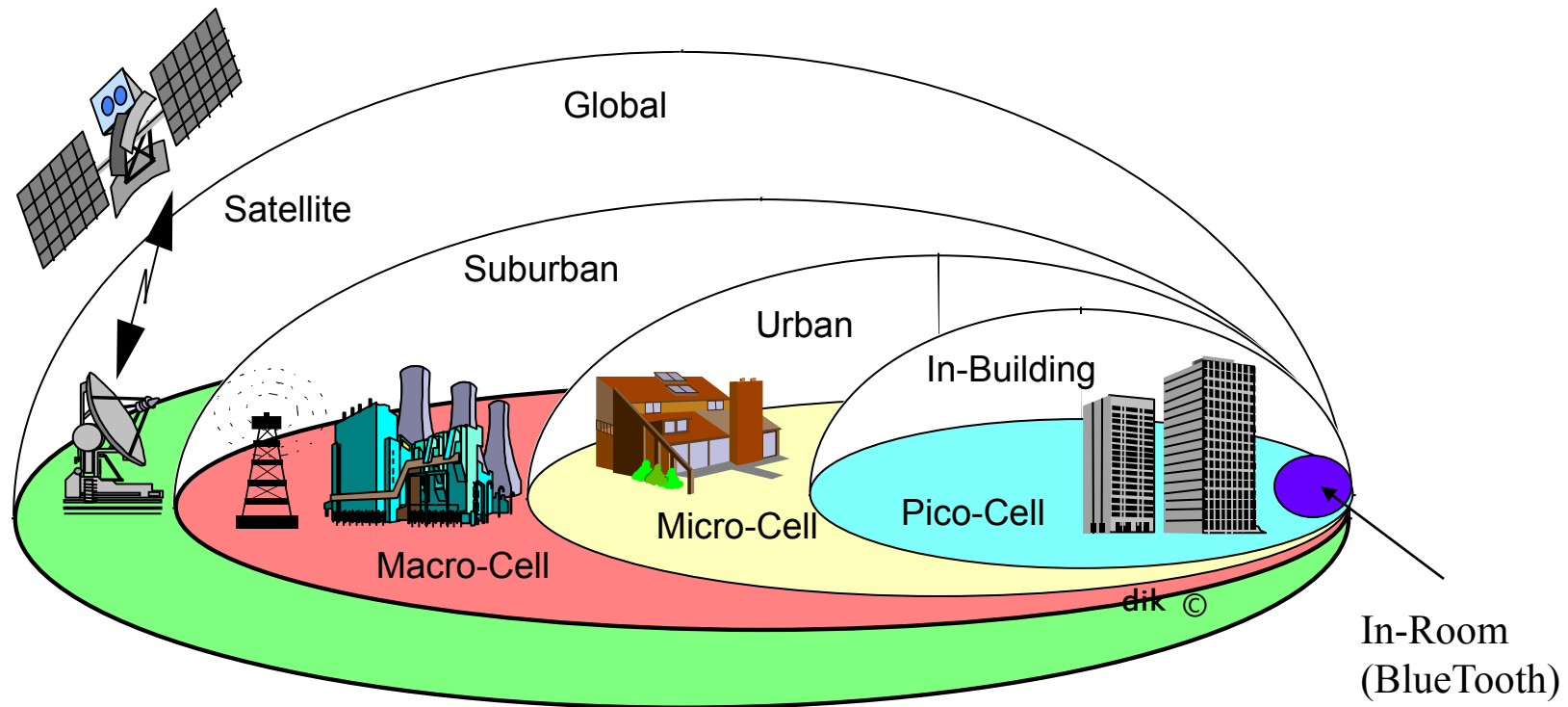


Another View of Ubiquitous Computing

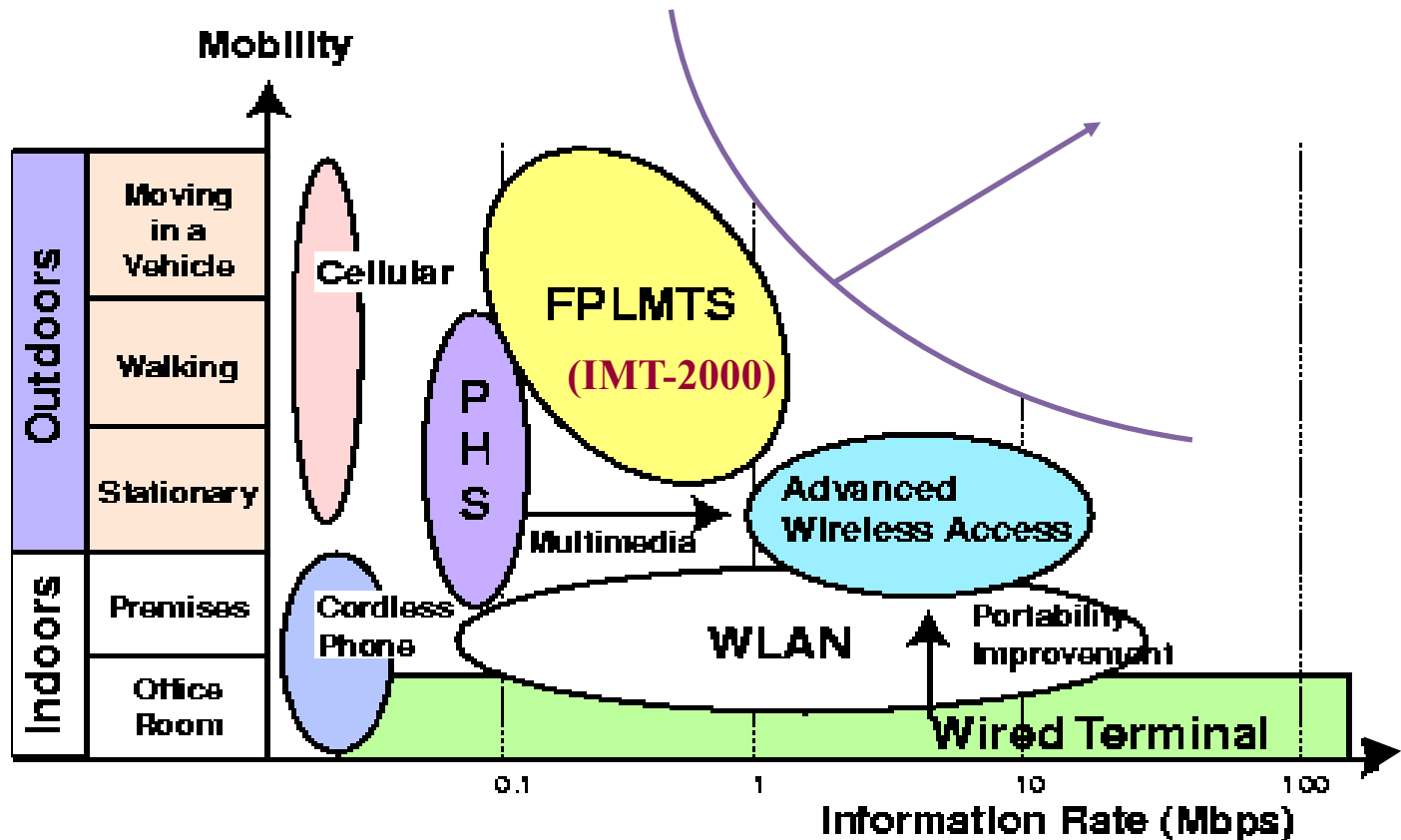


- Mark Weiser's views
- <http://www.ubiq.com/hypertext/weiser/UbiHome.html>

Impressive Wireless Infrastructure!

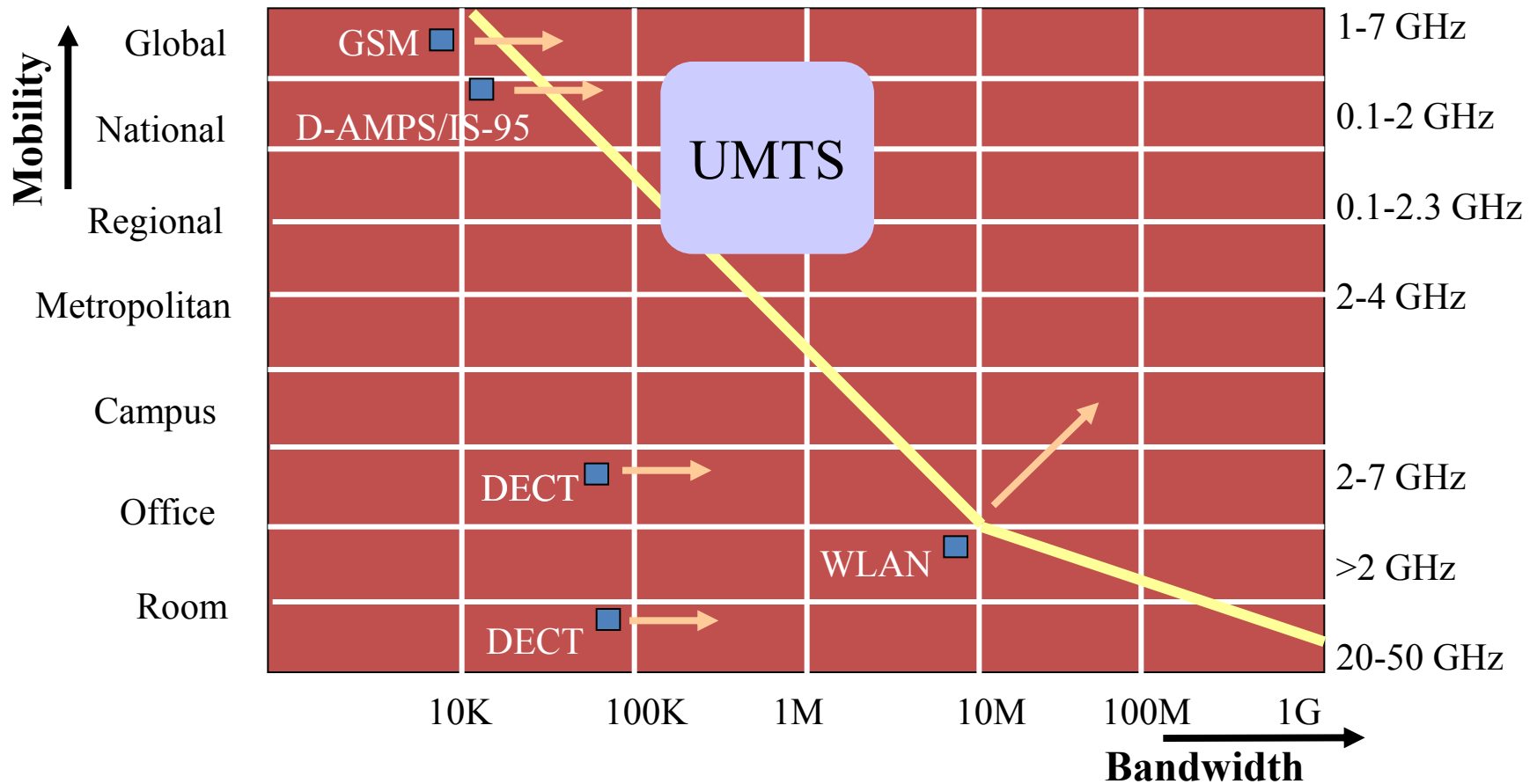


Wireless Communication Technology

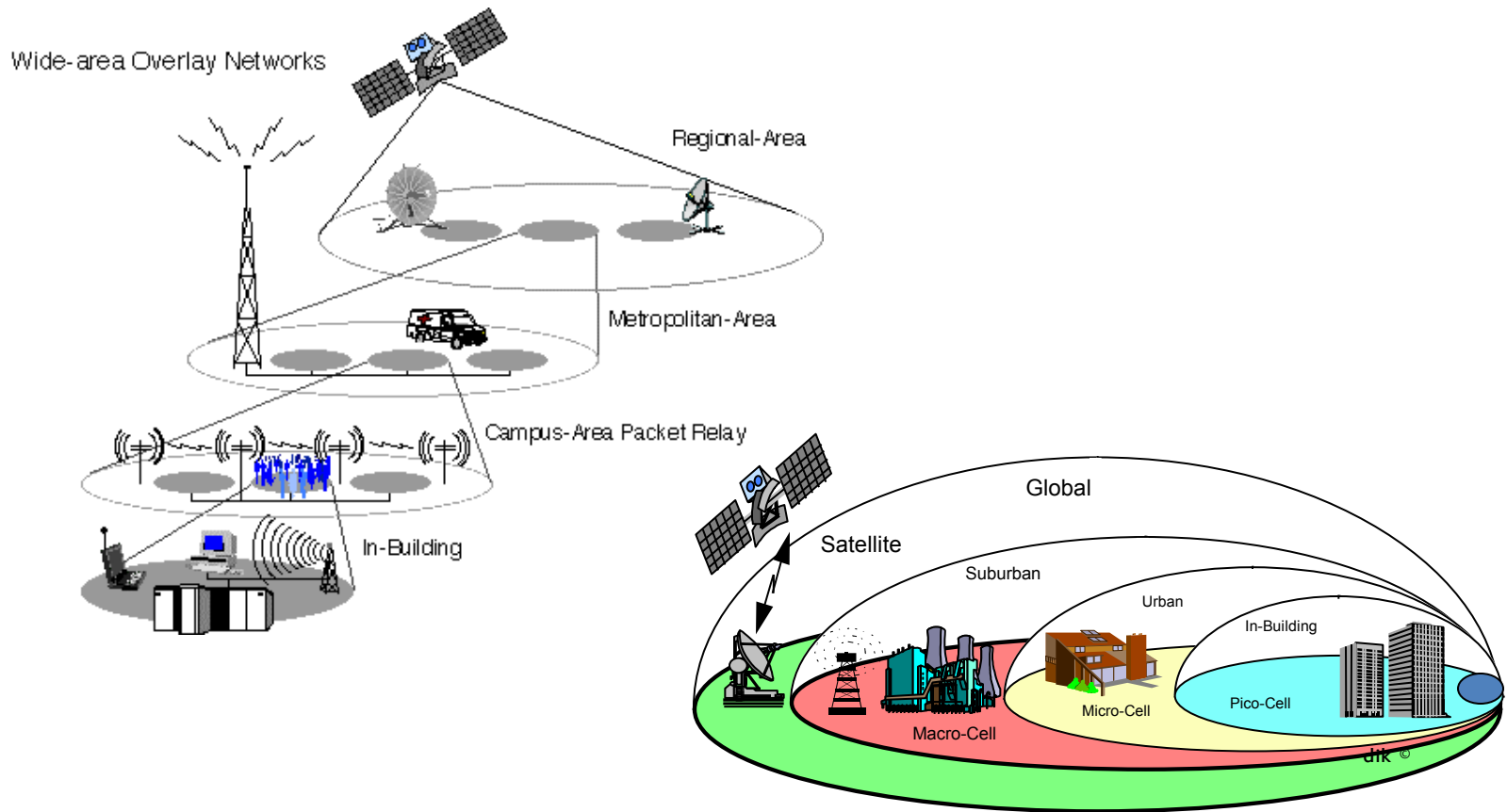


Wireless Network Convergence

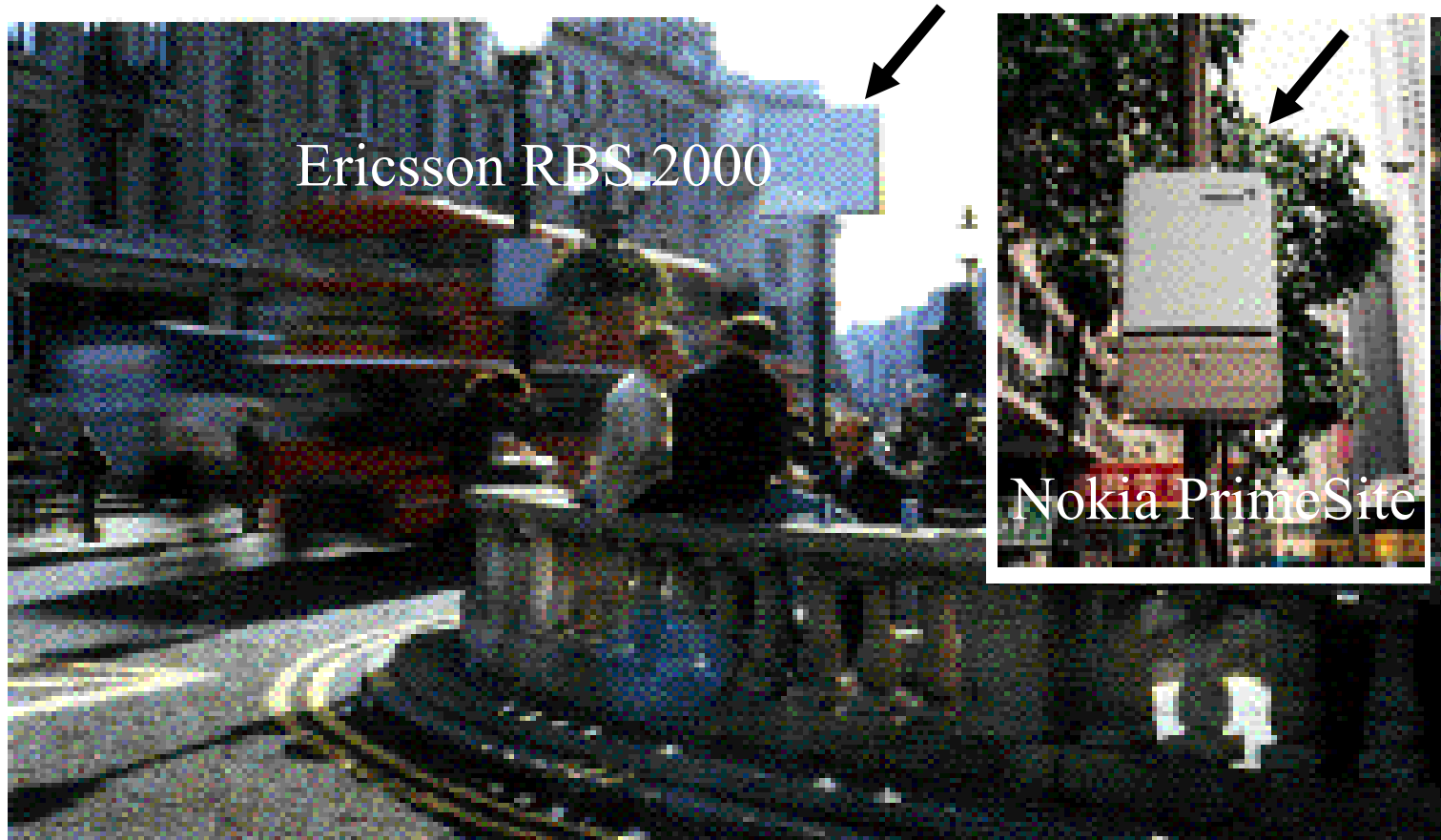
2G/3G Mobility-Bandwidth Trade-off



Wireless Network Overlay



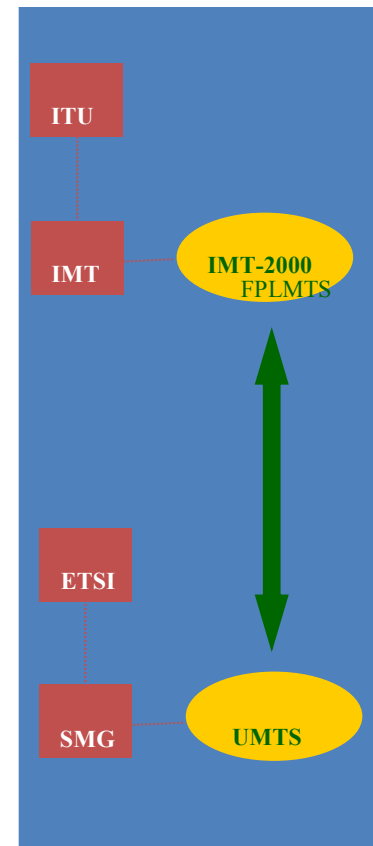
GSM Base Stations in Europe



September 1997

UMTS: Universal Mobile Telecomm. Standard

- Global seamless operation in multi-cell environment (SAT, macro, micro, pico)
- Global roaming: multi-mode, multi-band, low-cost terminal, portable services & QoS
- High data rates at different mobile speeds: 144kbps at vehicular speed (80km/h), 384 kbps at pedestrian speed, and 2Mbps indoor (office/home)
- Multimedia interface to the internet
- Based on core GSM, conforms to IMT-2000. Deployment as early as 2002.



Apple's Newton



1987

The Palm

1990



Motorola Marco



1995

Specs

- Newton OS 1.3
- 4MB ROM
- 687KB Flash RAM
- 320x240 Monochrome LCD resistive touchscreen
- RS422 serial port
- Localtalk support
- 1 PCMCIA Slot (5V or 12V)
- 1 Sharp ASK infrared port
- 4 AA batteries, rechargeable NiCd batteries may be used
- First released January 1995
- It weighs 1.8 pounds and is 7.5 inches high, 5.8 inches wide and 1.4 inches deep
- Street price: USD 900-1400

Motorola Envoy

1996



The Pocket PC

1998



The Nokia 9000 Communicator



1996

The Hand-Held Computer: Sharp Zaurus



1998

The Vadem Clio: Hand-Held?, Tablet? Other?



Clio™ 
The ideal PC Companion

1999

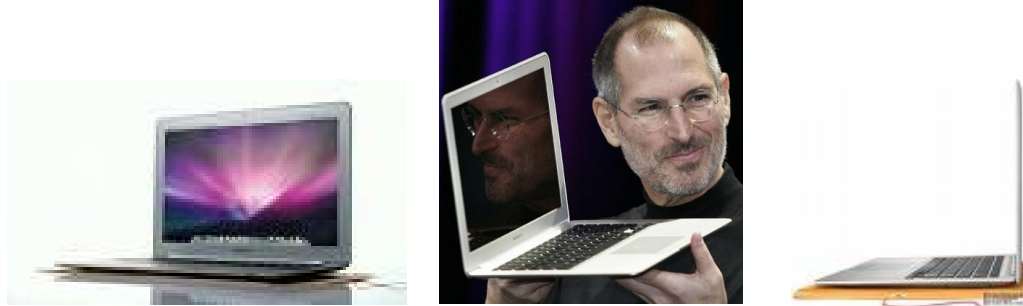
The Tablet PC

Fujitsu Stylistic 2300/3400



2002

Laptops, Notebook, Sub Notebooks & Netbooks



Laptops: 1991
Notebooks: 1996
Netbooks: 2006

The First Wrist PC: Rputer

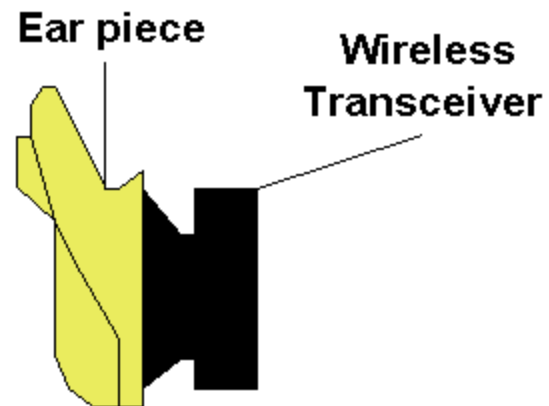


Japan's PHS Phone, Year 2001



Ear Phone

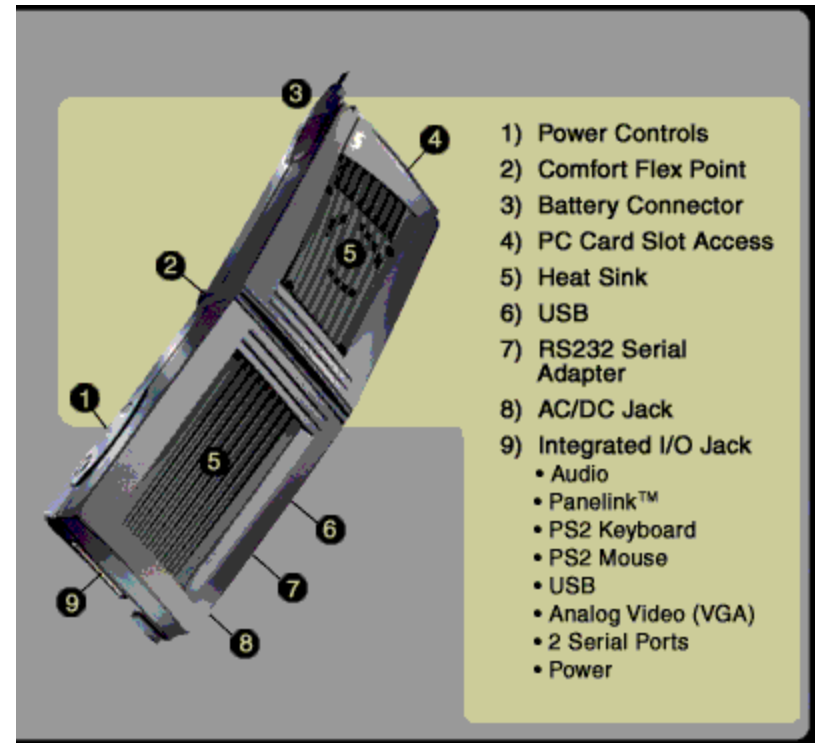
- Hearing aid form factor
- Integrated microphone & speaker
- Low power / short range RF (like Blue Tooth)
- Embedded IP address
- Voice processing: external to unit, controlled by software agents



Wearable Computers



More Wearable -- Via PC



[Http://www.via-pc.com](http://www.via-pc.com)

Wireless Helmet?

Xbox 360

Wireless Helmet

With revolutionary in-sight display menus and multi-dimensional rumble settings, the new Xbox 360 Wireless Helmet brings first person gaming to the next level.

Features:

- AirFlow temperature control
- 5.1 digital surround sound
- Flex-Plasma In-sight Display
- Temple Pressure rumble settings

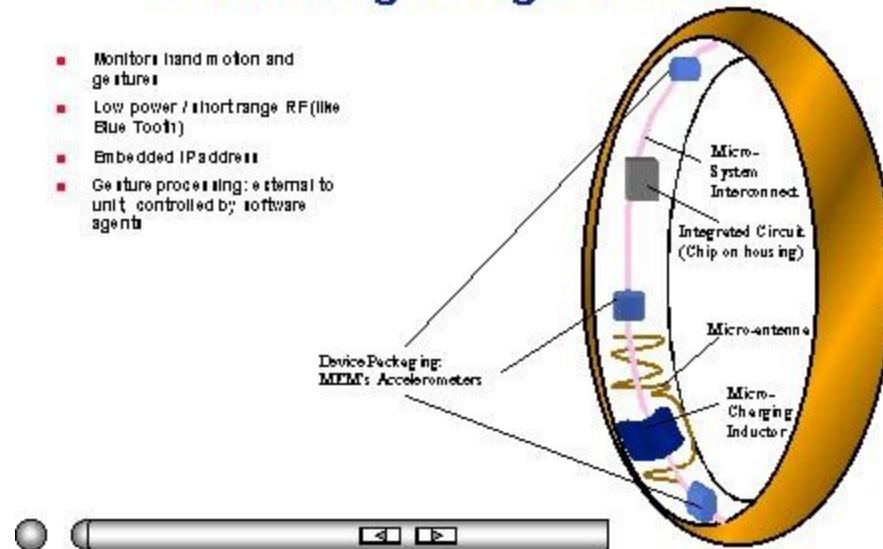
[▶ Learn more](#)



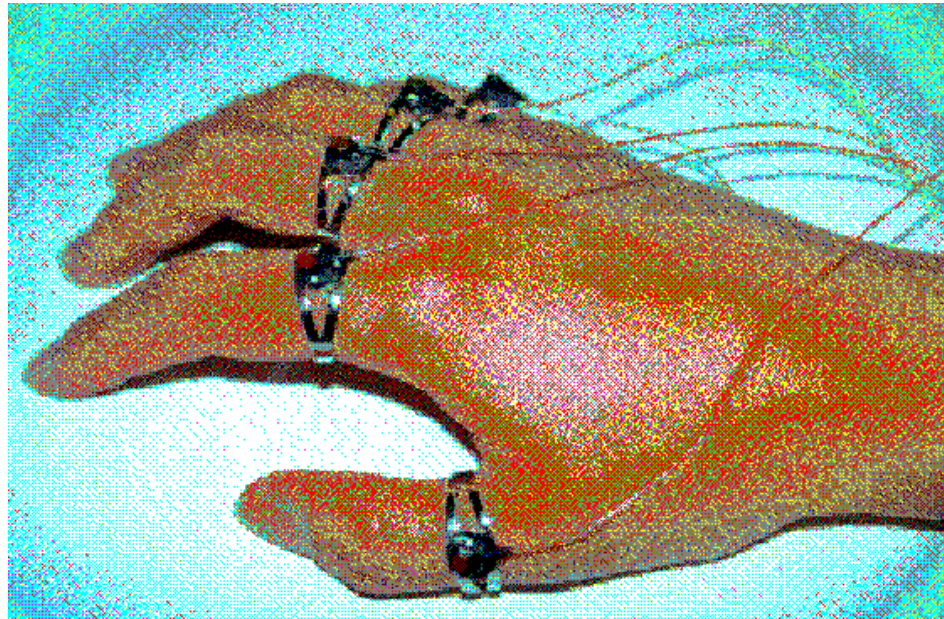
The Power Ring

Power Ring & Magic Wand

- Monitor hand motion and gesture
- Low power / short range RF (like Blue Tooth)
- Embedded IP address
- Gesture processing: external to unit, controlled by software agents



NTT Key Fingers



The Projection Keyboard



<http://www.canesta.com>

Today



The iPhone



The iPad



Android



Plastic Logic QUE

MyVu



22Moo



10 Lumen
BRIGHTNESS

1 Hour
BATTERY

15,000
HOUR LED

Portable projectors

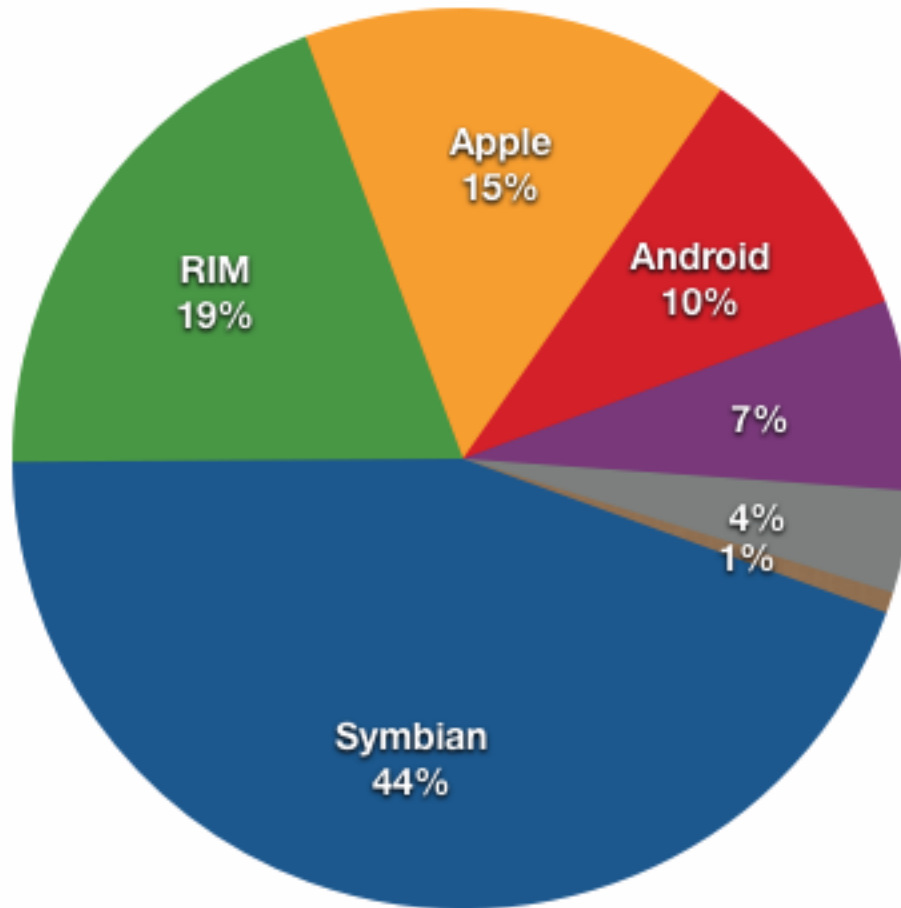
Mobile Technology Wars

The Smart Phone

The Pad

Smart Phones





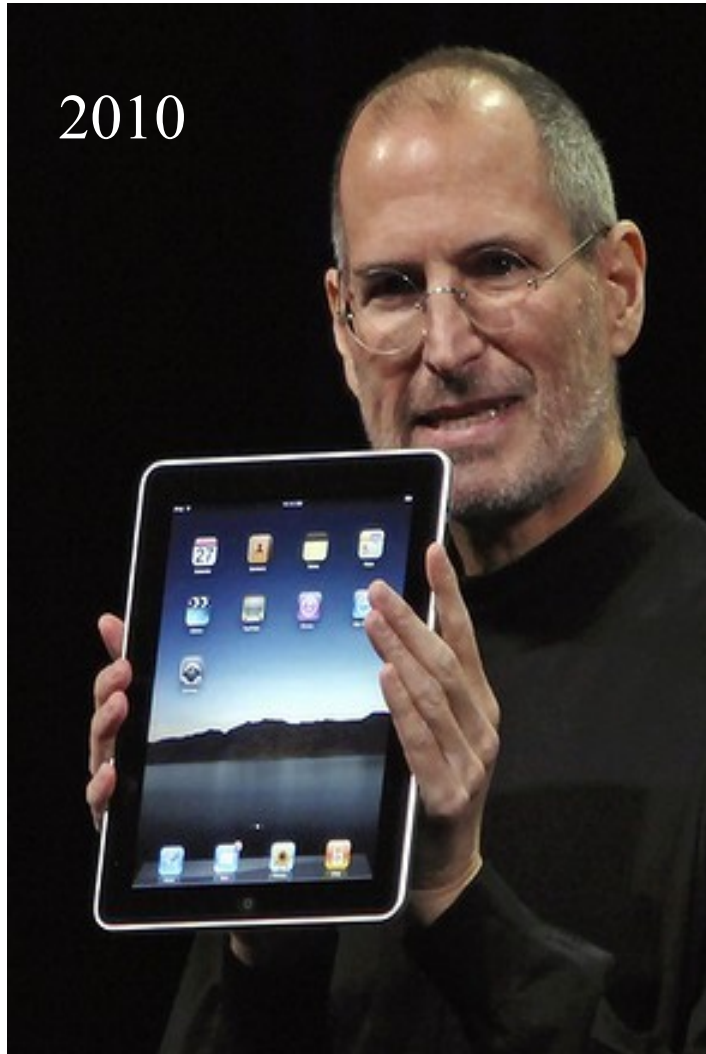
- Symbian
- RIM
- Apple
- Android
- Windows Mobile
- Linux
- Other

2009

Re-Inventing the Tablet:

The New War of the PADs

2010



2010-2011

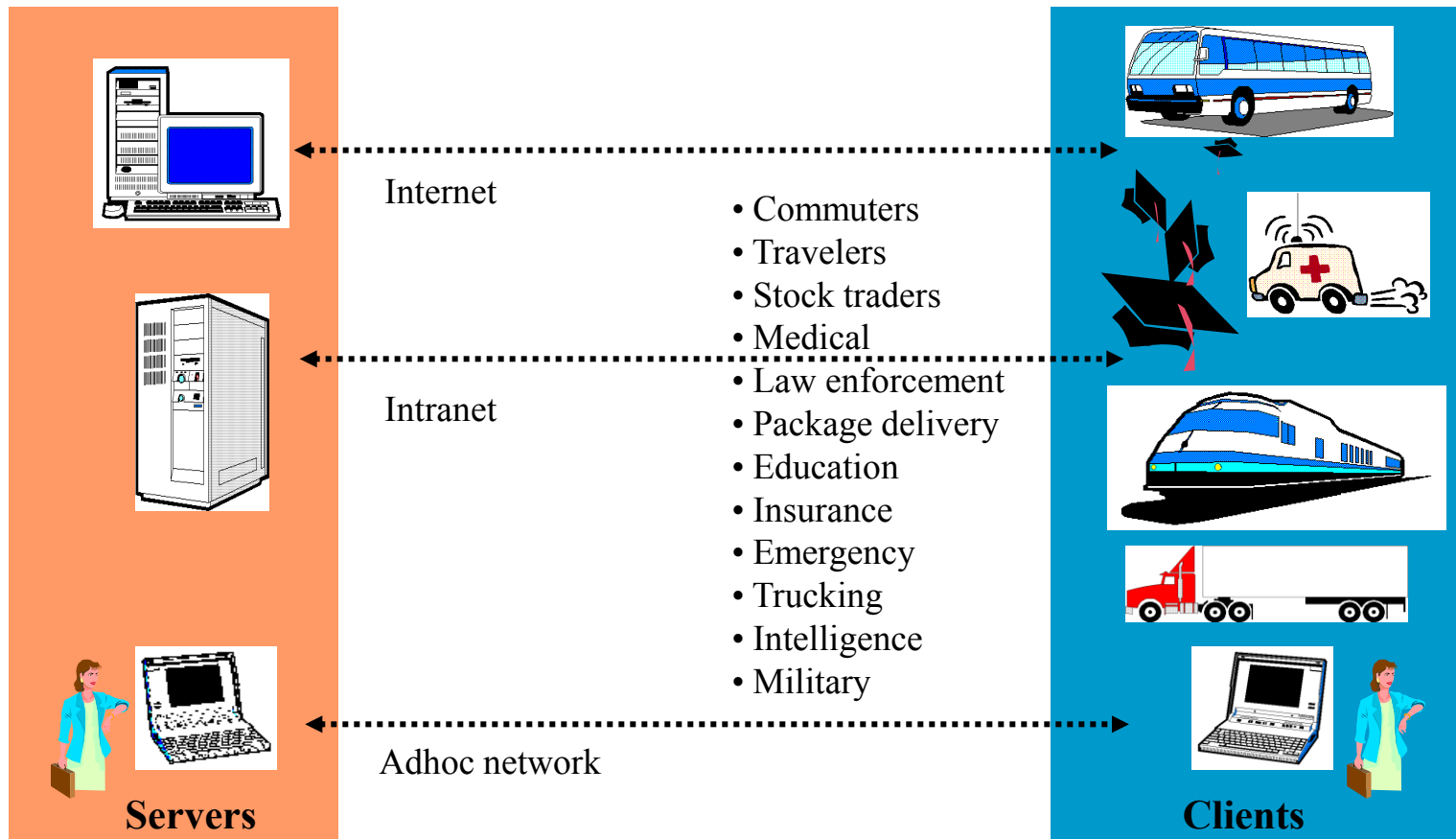


GIZMODO

Microsoft: Soon



Beneficiaries of Ubiquitous Computing



Limitations of the Mobile Environment

- Limitations of the Wireless Network
 - heterogeneity of fragmented networks
 - frequent disconnections
 - limited communication bandwidth
- Limitations Imposed by Mobility
- Limitations of the Mobile Computer

Frequent Disconnections

- Handoff blank out ($>1ms$ for most cellulars)
- Drained battery disconnection
- Battery recharge down time
- Voluntary disconnection (turned off to preserve battery power, also off overnight)
- Theft and damage (hostile environment)
- Roam-off disconnections

Limited Communication Bandwidth

- Orders of magnitude slower than fixed network
- Higher transmission bit error rates (BER)
- Uncontrolled cell population
 - Difficult to ensure Quality of Service (QoS)
 - Availability issues (admission control)
- Asymmetric duplex bandwidth
- Limited communication bandwidth exacerbates the limitation of battery lifetime.

Limitations of the Mobile Computer

- Short battery lifetime (max ~ 5 hours)
- Subject to theft and destruction => unreliable
- Highly unavailable (normally powered-off to conserve battery)
- Limited capability (display, memory, input devices, and disk space)
- Lack of *de-facto* general architecture: handhelds, communicators, laptops, and other devices

Caesar and Brutus



Limitations Imposed by Mobility

- **Lack of mobility-awareness by applications**
 - inherently transparent programming model (object-, components-oriented, but not aspect-oriented)
 - lack of environment test and set API support
- **Lack of mobility-awareness by the system**
 - *network*: existing transport protocols are inefficient to use across heterogeneous mix of fixed/wireless networks
 - *session and presentation*: inappropriate for the wireless environment and for mobility
 - *operating systems*: lack of env. related conditions and signals
 - *client/server*: unless changed, inappropriate and inefficient

Reading Assignment

Pervasive Computing: Vision and Challenges,
M. Satyanarayanan, Carnegie Mellon
University, IEEE Personal Communications,
August 2001