Personal Computing & Communication the virtual convergence of telecom and datacom for new services

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The Future Course – Scandinavian Executive Seminars by Telia

World Telecom'99

12 and 13 October 1999

Geneva, Switzerland

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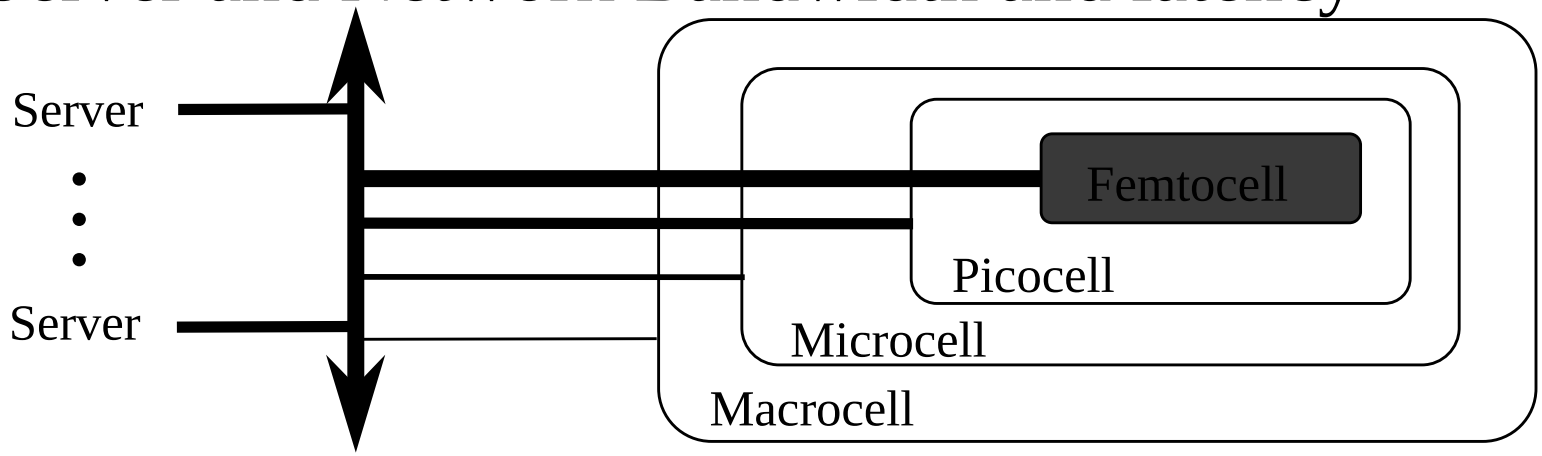
Bottlenecks

- Server and Network Bandwidth and latency



- User Bandwidth and latency

- Power and Energy → O(energy)

Imagination!

Infinite Bandwidth on the backbone

Guilder's Law: network speeds will triple every year for the next 25 years.

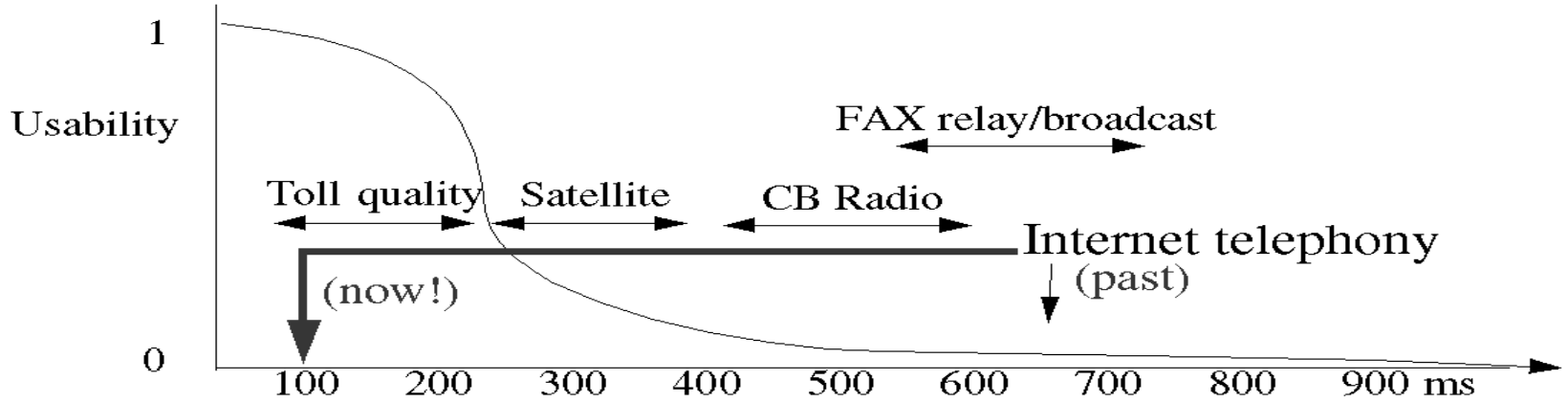
-- This dwarfs Moore's law!

Status

- 1999 many backbones at or above 40 Gb/s
- by 2000 Dense Wavelength Division Multiplexing

  WorldCom will use Nortel Networks' OPTera* 1600G technology (transmits 10 Gbps over 160 parallel channels on a single fiber, making total capacity 1.6 terabits per second) in Q4'1999

Latency



Usability of a voice circuit as a function of end-to-end delay

(adapted from Cisco http://www.packeteer.com/solutions/voip/sld006.htm)

Round-trip	min (ms)	avg (ms)	max (ms)	hops
Local LAN	1	1	3	0
to northern Sweden (basil.cdt.luth.se)	21	25	41	8
to Austria (freebee.tu-graz.ac.at)	73	109	353	18
To server in US network	131	306	526	19
To my machine in the US (~30 ms is the ISDN link)	175	328	600	21
To KTH's subnet at Stanford University in the US				
(ssvl.stanford.edu)	166	170	217	20

Deregulation ⇒ …

Deregulation ⇒ New regulations

Not only are there lots of new regulations, but we now see governments announcing that they are **not** going to regulate certain things (and they are expecting the industry to do it themselves)!

Deregulation ⇒ …

Deregulation ⇒ New operators

Lots of new actors as operators:

- many with very large amounts of money and no existing infrastructure
- many with an investment cycle typical of computers (3-5 years) and not telecoms (15-30 years)
- many with lots of specific expertise

Deregulation ⇒ …

Deregulation ⇒ New Suppliers

Lots of new actors as equipment suppliers:

Cisco, 3Com, USR, Nortel Networks(Nortel + Bay Networks), Lucent (+Ascend), Ericsson (+ACC), Alcatel(+DSC Communications+Packet Engines), …

Deregulation ⇒ …

New services and new roles:

Billing, bandwidth, operations and maintenance, … -- all become available as services

Just as we have FABless VLSI companies[1], stockless distributors[2], …

⇒ networkless data/telecom operators!

[1]VLSI Technology, …

[2]Amazon.com, …

Challenges

One of the major challenges is that “everything is possible” or at least it seems that way -- the main limits are our imagination and inertia.

However, to achieve commercially viable systems we have to include many factors:

- cost (along with who is paying!)
- culture (this may effect the acceptance of some systems)
- education required to use/install/maintain the systems
- technology
- volume
- ...

Were are were going?

There are two common answers to this question:

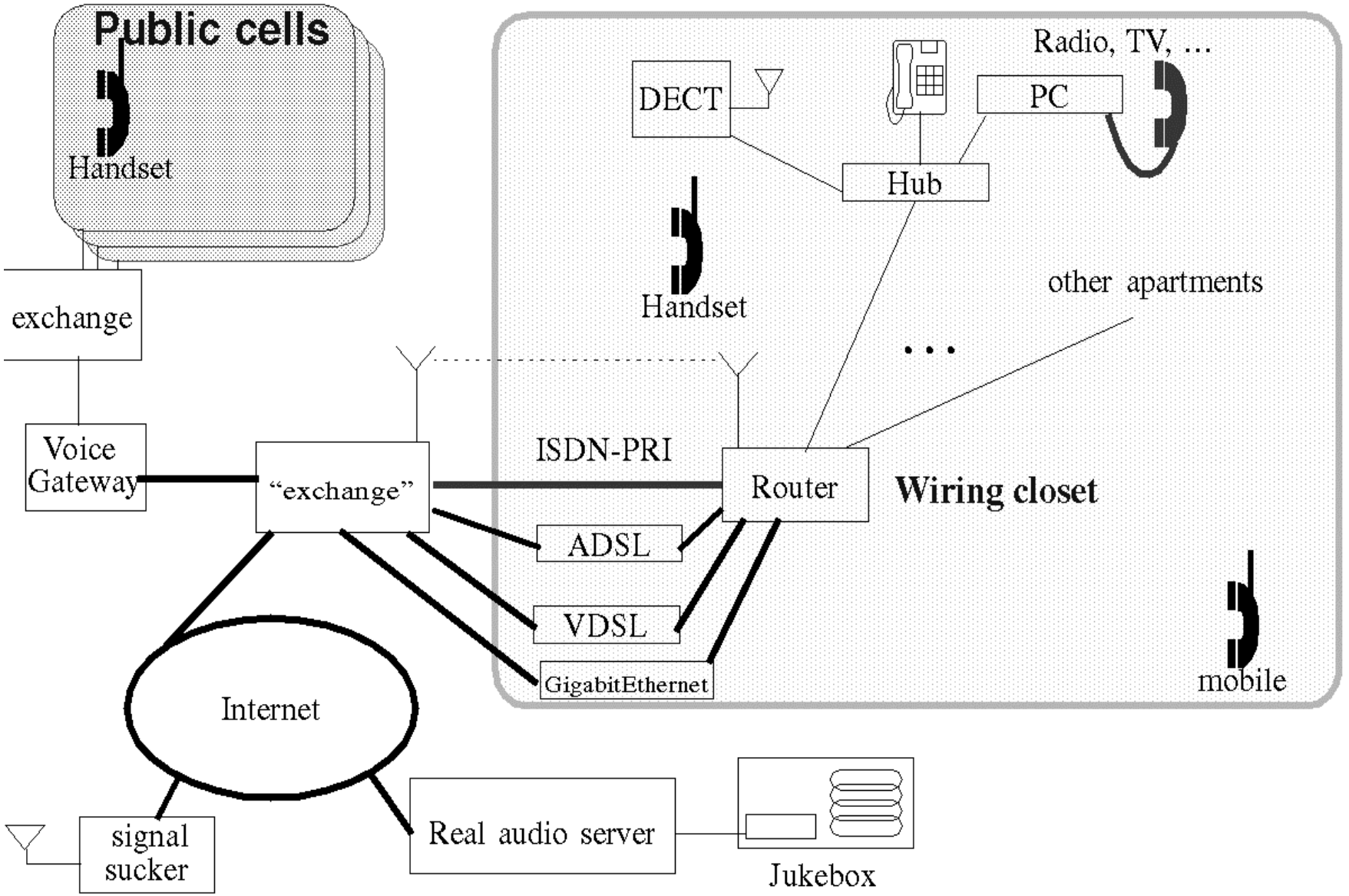
Answer 1: “I don’t know, but we are sure getting there fast!”

Answer 2: “I don’t know, but I think this is the direction to go!”

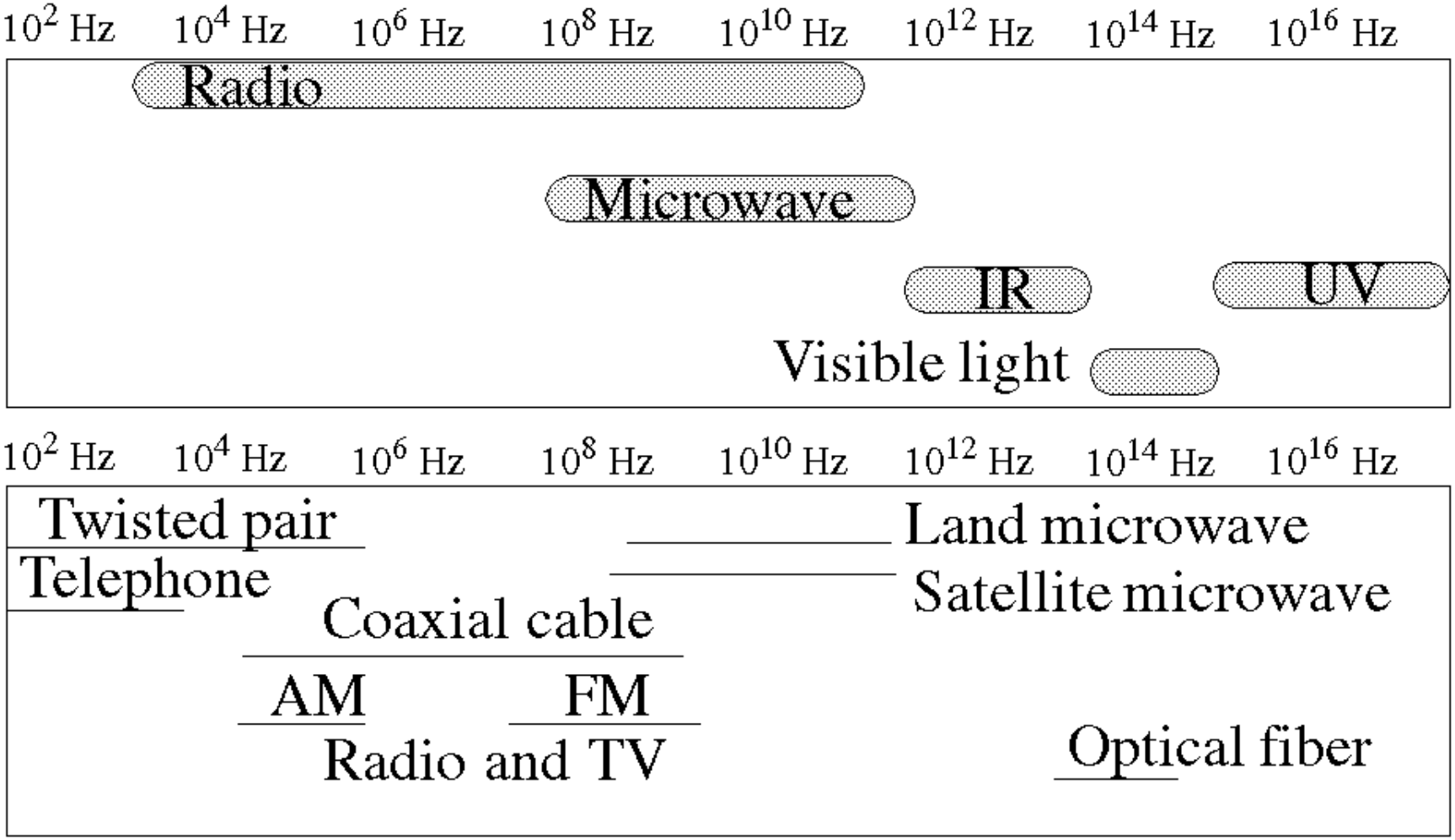
Deregulation ⇒ Trends

- replacing multiplexors with Routers/Switches/… << 1/10 circuit switch cost
- Standard telco interfaces being replaced by datacom interfaces
- New Alliances
  - coopetition

New Infrastructure



Electromagnetic spectrum



Cordless or Cellular?

In an “office” environment - more than 50% of the time people are away from their desks ⇒ Mobile phones may become a standard feature in offices.

“Today, we’re seeing 20 percent of mobile calls being made indoors. Within five years, 25 percent of all calls will use indoor systems.…”

– Sven Hellström, Ericsson product manager for micro base stations

Intranet Telephone System

- Symbol Technologies' NetVision™ wireless LAN handset with H.323 VOIP
- uses wireless LAN (IEEE 802.11) infrastructure
- voice gateway to/from POTS

Wireless LANs

"… through the acquisition of Global Cast Internetworking. The company will primarily enhance Telia Mobile's offering in wireless LANs and develop solutions that will lead to the introduction of the wireless office. A number of different alternatives to fixed data connections are currently under development and, *later wireless IP telephony will also be introduced.*…

The acquisition means that Telia Mobile has secured the resources it needs to maintain its continued expansion and product development within the field of radio-based LAN solutions. *Radio LANs are particularly suitable for use by small and medium-sized companies as well as by operators of public buildings such as airports and railway stations.*

Today's radio-LAN technology is based on *inexpensive products that do not require frequency certification*. They are *easy to install* and are often used to replace cabled data networks in, for example, large buildings.…"

VOIP ⇒ Future developments

New Services: Fax broadcast, Improved quality of service, Multipoint audio bridging, Text-to-speech conversion and Speech-to-Text conversion, Voice response systems, …

Replace wireless voice network's infrastructure with IP: U. C. Berkeley's ICEBERG: Internet-based core for CEllular networks BEyond the thiRd Generation

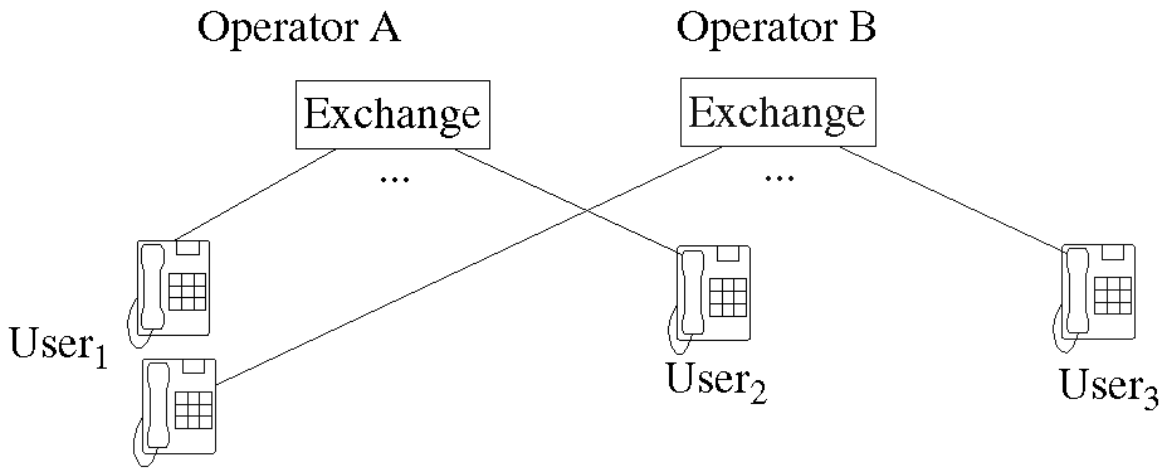
VOIP from the handset

- eliminates need for transcoding in cellular base stations
- encryption and authentication for all calls

IP everywhere -- Is this the future?

Yes, but it is only the beginning.

Initial telephone systems and users



Initially: For two users to communicate they must have telephones connected to the same operating company; the operator provided the mapping between an incoming call and the outgoing line (subscriber telephone).

What could be done?

The plug board version of this system featured mobility support, speaker recognition and speech recognition:

- Caller: Put me through to Chip?
- Operator: Hi Sam! He is at the barbershop now, I'll put you through to there.

Mobility

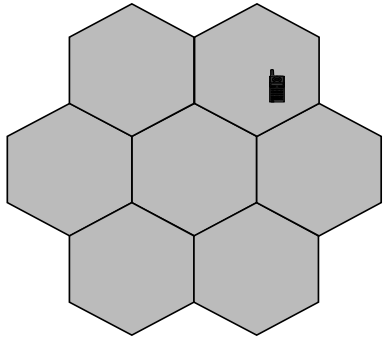
- Mobility does not necessarily mean that the device uses wireless communication, only that the device has different locations over time.
- Similarly not all wireless devices are mobile (for instance Wireless Local Loop).
- However, wireless communication can aid in facilitating user mobility.

Locating the user

If only mobile users originate calls, then it does not matter where the user is!

However, if we want to reach a mobile user, then:

- we can track the user continuously, or
- we can start looking for the user where we last saw them and then expand our search, or
- we can guess where the user might be
  based on their patterns of movement (past behavior)
- the user tells us where they are
  - based on a schedule the user can tell us where they are (e.g., every one minute tell the system where you are now) or
  - the user can listen for something which causes them to check in (for example we a page)



More than just a communication link

HLR & VLR: information about where the terminal is via 1 BS

Mobile positioning systems:

higher accuracy location information via multiple BSs

or use GPS (see for example: www.SiRF.com)

⇒ Location dependent services

- emergency services - such as E911
- warning services
- advertisements for nearby hotels, restaurants, shops…
- maps and directions

Speaker recognition and Speech recognition

- Speech interfaces are now becoming main stream technology
- Speaker recognition from a limited set of speakers (whom you have heard before)
- Speech recognition getting good enough

What if your telephone/PDA/… were always listening to you ?

- It knows what you sound like
  - very good model of your voice and speech
- if you want to speak with someone you might first exchange synthesizers
  - then you only have to send annotated text -- very low bandwidth, but high quality speech
- coupled with translation technology you will have real-time foreign language translation

- you can have a database of all your calls/meetings/mumblings/…
  - help augment your memory and will also help the recognition systems to work better and better
- you can buy/rent/… a voice which you like
  - you too can sound like James Earl Jones or Marilyn Monroe
- read your voice mail or listen/browse e–mail/web pages/…
- hands -free interfaces to many devices

Listening to others

With a DB of all your “callers” the system can recognize them and treat them as you want them to be treated

- greet them by name
- remind you of who they are
- remind you of the probable context

Is all this speech stuff for real?

Microsoft® Cordless Phone - http://www.microsoft.com/products/hardware/phone/overview/default.htm

- voice commands
- voice mail
- (only a serial connection to attached PC)

BBN demonstrated speaker recognition technology in the early 1980s

More and more audio on-line

- MP3 players - http://www.mp3.com/hardware/
  - Diamond Multimedia's Rio PMP300 Portable Music Player, ...
- Mobile RealAudio - http://www.audible.com/audible/tour/real.html

More Images on-line

- Network attached “copiers” == scanner + printer
- HP CapShare - Handheld scanner - with automatic stitching - produces PDF
  - With network attached handheld scanners
    How long before 90% of all books are scanned?
- CrossPad® - Personal Digital Notepad
  - from pen strokes to digital stroke info to text
- Web cameras - networked cameras, cameras on notebooks, cameras on your eyeglasses

Camera/Scanner + Connectivity

computed by:
http://www.milk.com/ barcode/

User agent can get details at http://051000029522.upc.org
or http://029522.051000.upc.org {hypothetical domains}

Returning “item.manufacturer” for further lookups:
dietary information, recipies, check with the fridge, ...

Location+Orientation+Image DB

"Given the large numbers of digital cameras, if they labelled their pictures with the location and orientation of the camera at the time of the picture, then how long would it be before you could do a virtual walkthrough of San Francisco?"

– Dr. Mark T. Smith, HP Labs

Personal Entertainment/Info/...

Personalised data: text, picture, audio, ads, ... play lists

burst download in hotspots (WLAN) …

faster than “real-time” (DAB/DSS/… + GPRS) …

download in the background (GPRS)

Evolution of new varieties of networks

Already we have: WANs (Wide Area), MANs (Metropolitan Area), LANs (Local Area Networks)

VANs Vehicle Area Networks

Very local networks

DANs Desk Area Networks

The computer/printer/telephone/… will all be part of a very local area network on your desk.

- wireless links ⇒ No longer will you have to plug your printer into your computer (PDA/…) into your computer
- active badges ⇒ No longer will you have to sign in/out of areas, write down peoples names at meetings, … the system can provide this data

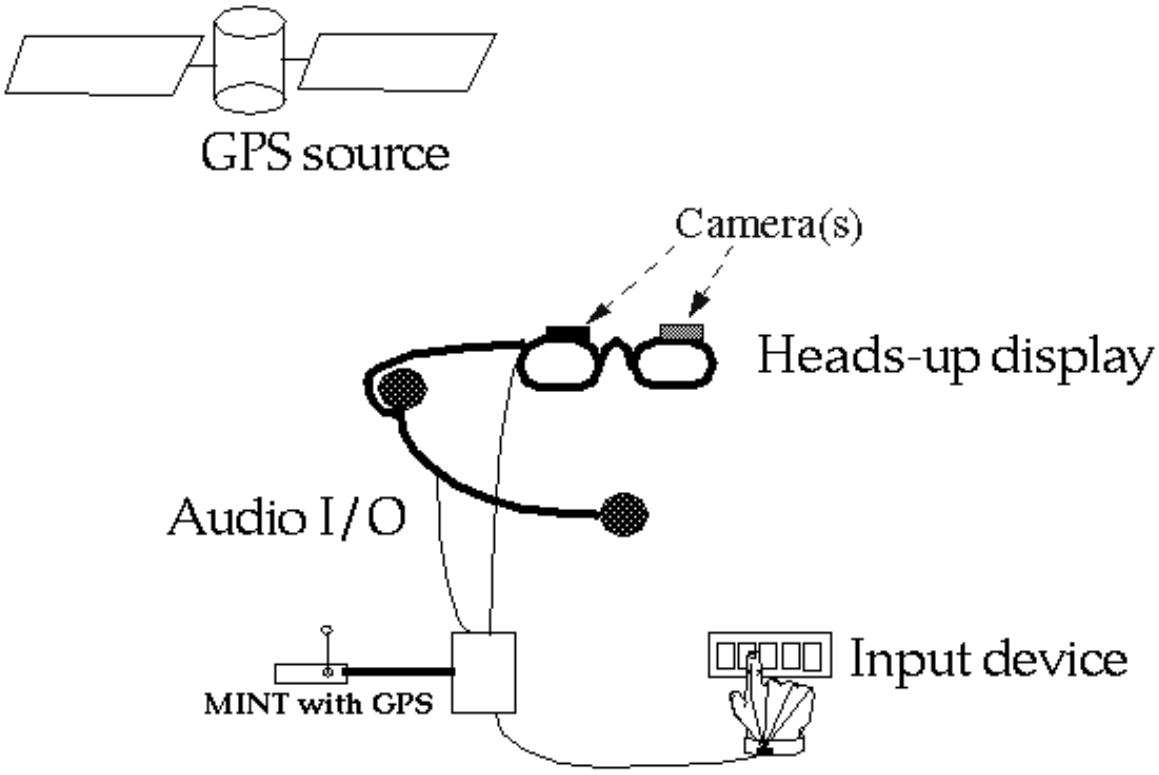
Olivetti and Xerox are exploring “Teleporting” bring your working context to you where you are

BANs Body Area Networks

Users will be carrying multiple devices which wish to communicate:

- thus there will be a need for a network between these devices which you carry around; and
- personal devices will wish to interact with fixed devices (such as Bankomat machines, vehicle control systems, diagnostic consoles (for a "mechanic" or repairman), …) and other peripherals.

Near Future systems (on the user's side)



2000 - high level of integration

Wearables

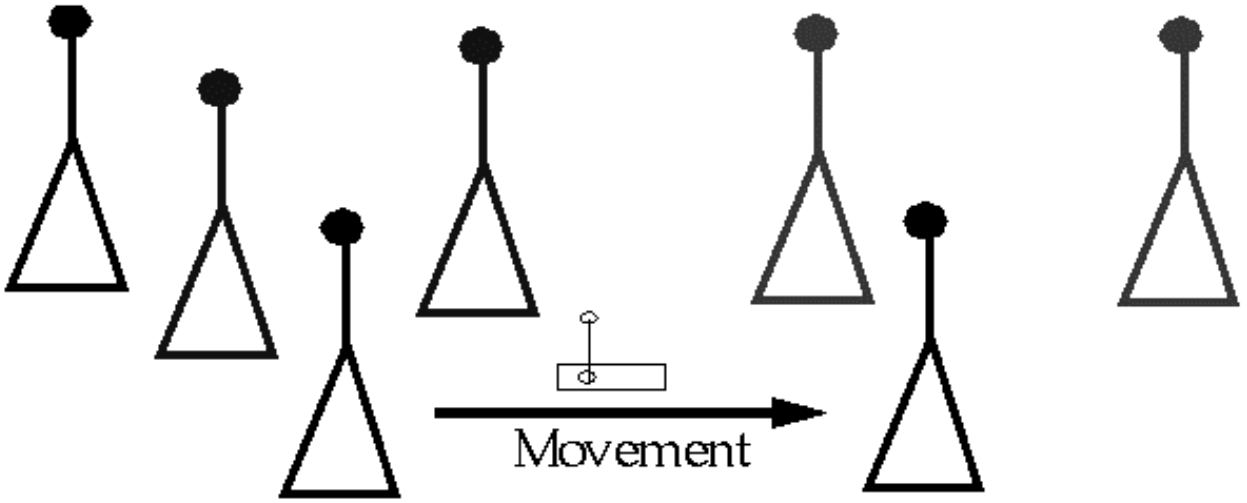
"… It will be possible to put a 100+ MIPS CPU and a 0.5 GFLOP DSP in a $200 Nintendo Game Boy within 2 years, for less than $25 bucks of Si cost. With this kind of cheap, available cycle time, how hard would it be to add a communications cartridge/dongle into a game slot? …"

– John Novitsky of MicroModule Systems
and of Microprocessor Report -- From Wearables mailing list
Wed, 17 Sep 1997 19:22:17 -0700.

Who <u>are</u> the competitors?

Ericsson, Lucent, Nokia, Siemens, … or Nintendo?

Situational awareness and Adaptability



Where am I? What am I? Who am I?

Where am I going? When will I be there?

What should I become?

Who should I become?

- Location dependent services
- Predicting location to reduce latency, reduce power, hide position, …
- Adapting the radio to the available mode(s), purposely changing mode, …
- Reconfigure the electronics to adapt, for upgrades, for fault tolerance, …;
- Reconfiguration vs. powering up and down fixed modules (what are the “right” modules, what is the “right” means of interconnect, what is the “right” packaging/connectors/…, needed speed of adaptation)
- “right” level of independence; spectrum from Highly Independent $\Rightarrow$ Very Dumb

Human centered

Computer - human interaction is currently focused on the computer (computer-centric)

- Currently computers know little about their environment
  - Where are we?
  - Who is using me?
  - Is the user still there?

Evolving Environment awareness

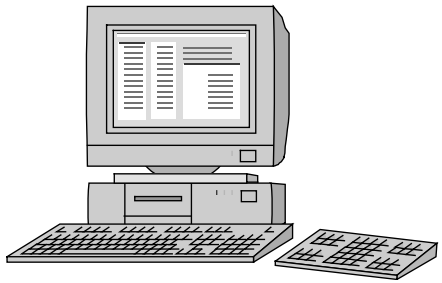
- Give computers senses via sensors
  - Environment
  - User identity and presence

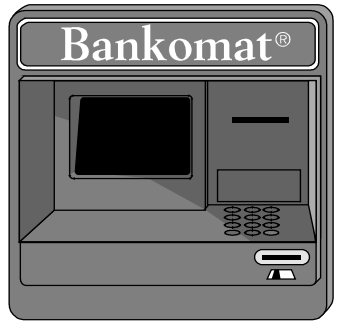
- You wear your own personal user interface
  - interface can be consistent across all appliances
    - not because each appliance supports the interface, but because the user's own interface provides consistency
- Make the human the focus of the computer's interaction ($\Rightarrow$ human-centric)

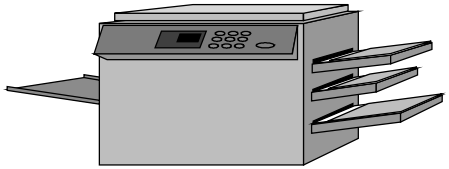
Secure IDs

Authenticate the user

Personalize the device automatically







Consider a hotel without a check-in/out desk!

Personal information space

Where are my { friends, employees, pets, socks

What is the state of my { . . .

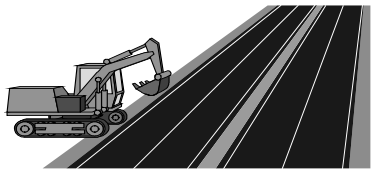
?

Emotional

Toys + communications

Telecom products for children (of all ages!)

Even more sensors



Temperature

Humidity

Barometric pressure

Light level

Solar radiation

Weight

Acceleration

...

- Distributed Weather data collection
- Environmental monitoring
- Energy and building management (HVAC)
- Intelligent appliances
- Automated customer care

Other sensor applications

- with a “chemlab” {a chip with an array of chemical sensors, polychromator, …) -- environmental or personnel monitoring
- golf clubs than can diagnose a player’s swing
- running shoes which track distance, pace, and stress
- …

Examples of new services developed by projects in my recent course

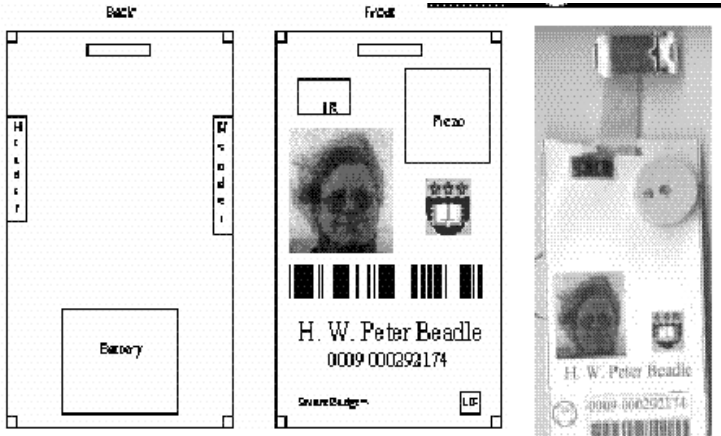
- itTraveler, globalAssistant, MobileMap
- Mobile Audio Distribution (MAD),MobileMedia,NEAT
- Securiteam, Epitropos, and SecureID
- MeICQ
- WeatherCast
- King of the Hill
- Emocon

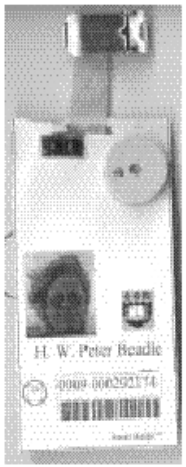
Acknowledgment

All of the badge work done in cooperation with:

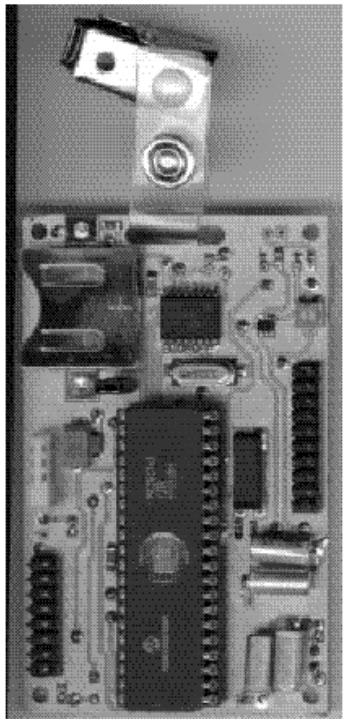
- Dr. Mark T. Smith - Hewlett-Packard Research Laboratories, Palo Alto, California, USA
- Dr. H. W. Peter Beadle
  - Formerly: University of Wollongong, Wollongong, Australia
  - Currently: Director, Motorola Australian Research Centre, Botany, NSW, Australia

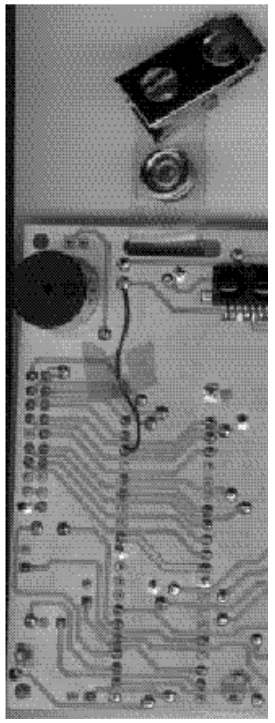
Badge Prototype and Badge 1





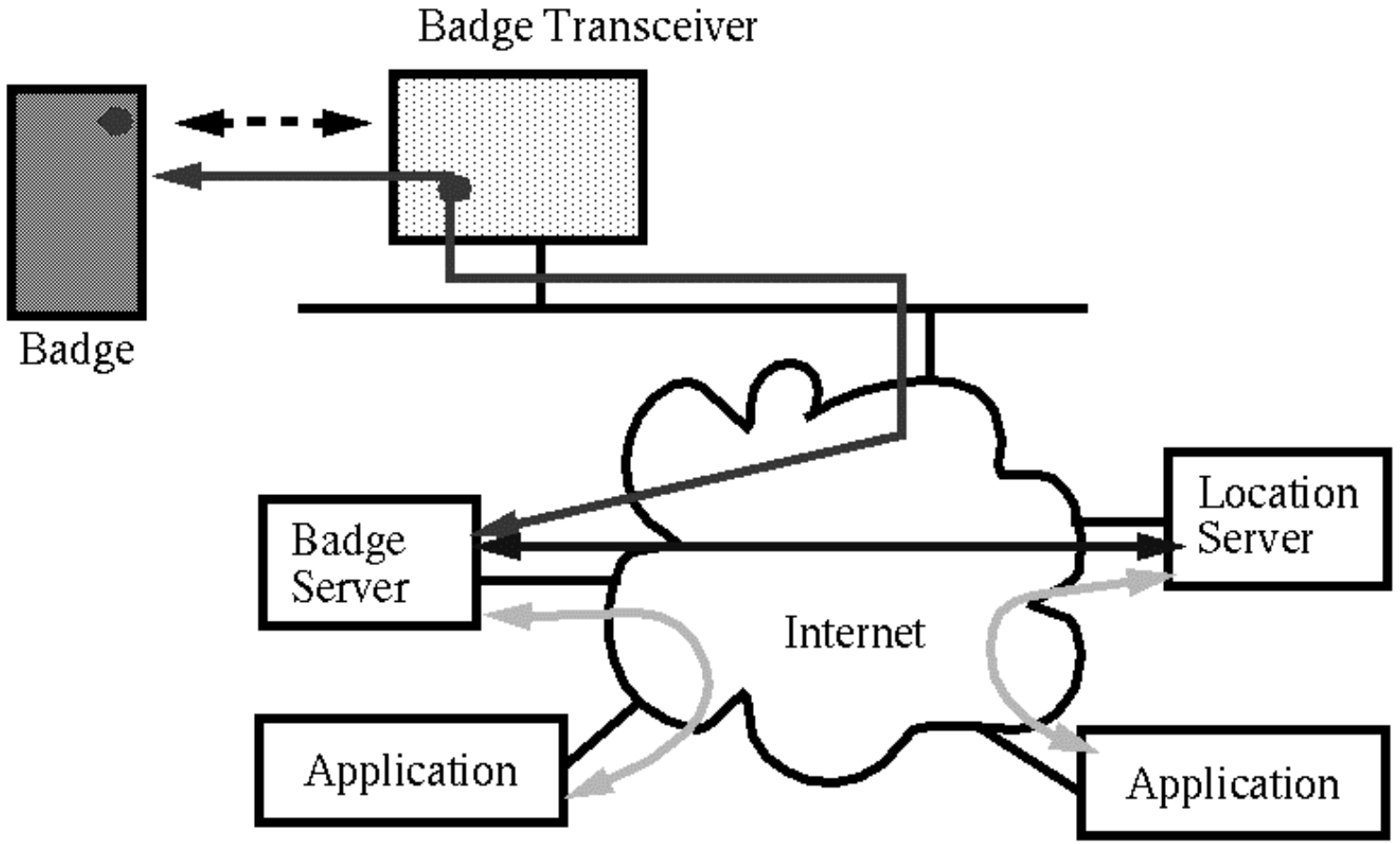
- Sound, Light, Temperature, Humidity, Orientation, Adjacency
- Beeps
- PIC 16C74A-jw based
- 5 MIPS
- 4m range
- 98mA average power



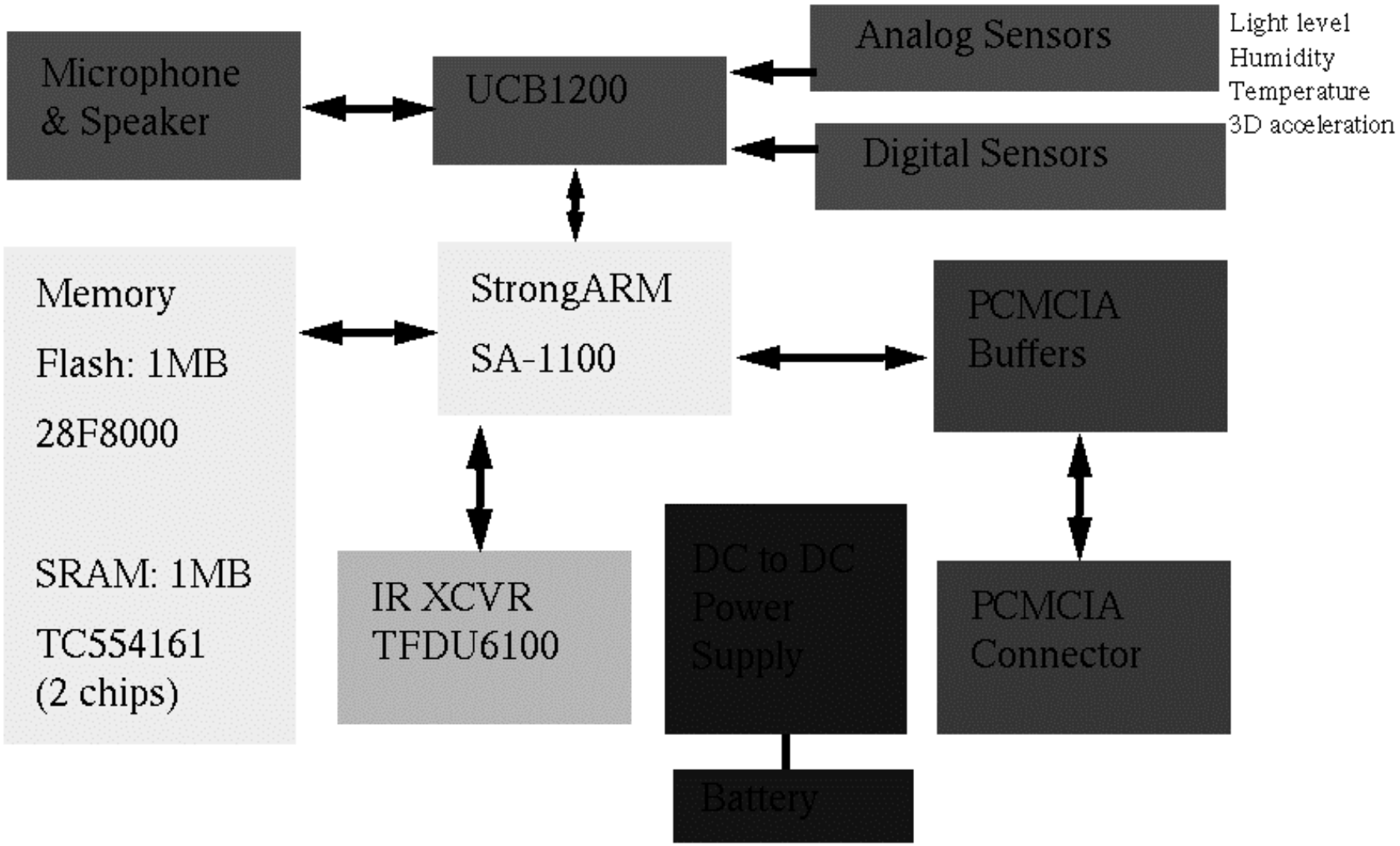


Badge Communications Model

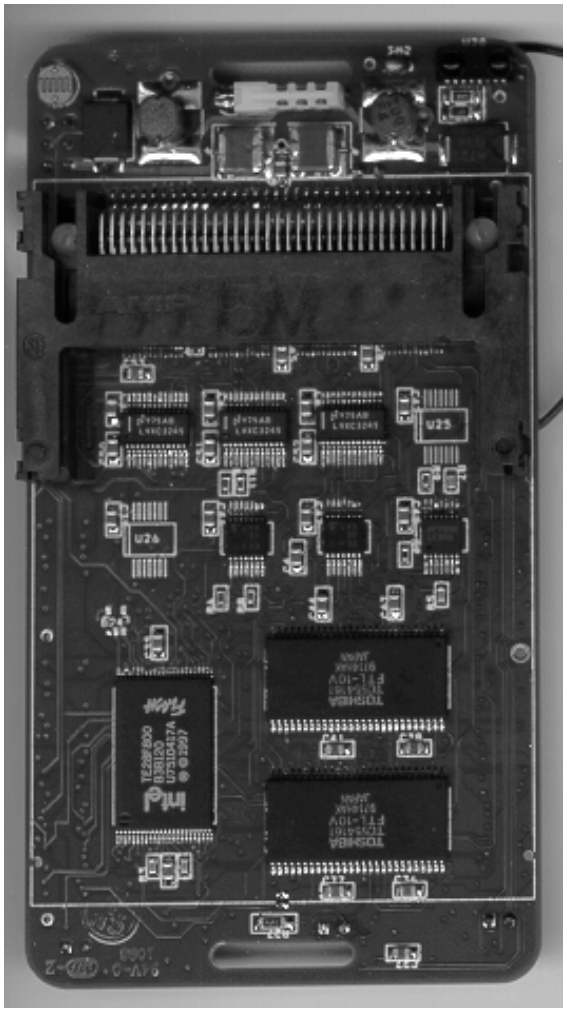
Badges are IP devices, they communicate via network attached access points.

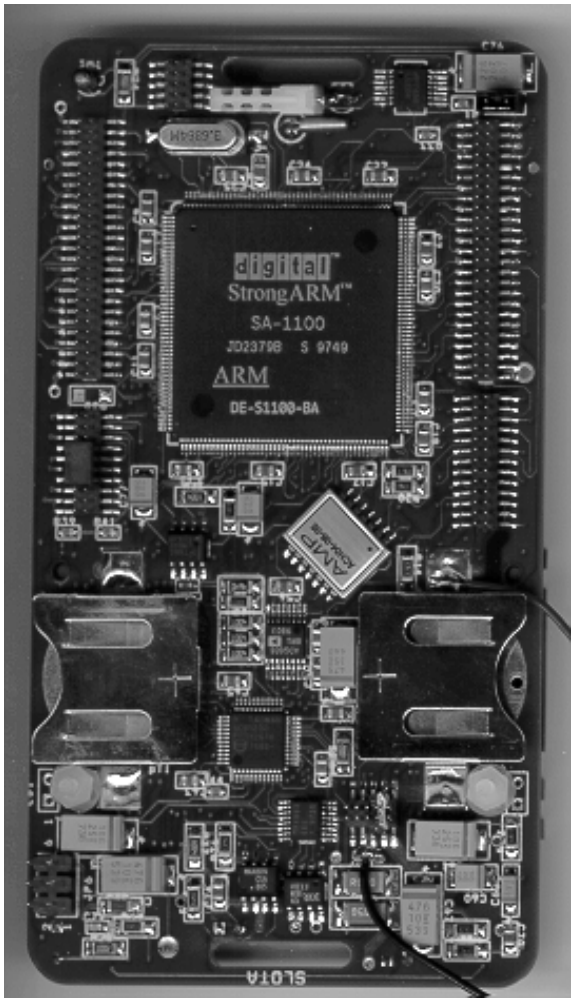


Badge3


Microphone & Speaker
UCB1200
Analog Sensors
Light level
Humidity
Temperature
3D acceleration
Digital Sensors
Memory
Flash: 1MB
28F8000
SRAM: 1MB
TC554161
(2 chips)
StrongARM
SA-1100
PCMCIA Buffers
IR XCVR
TFDU6100
DC to DC Power Supply
PCMCIA Connector
Battery

Badge3 front and back





A view of the packaged badge

As shown by HP at Comdex’98, November 1998

How to field a new telecom infrastructure

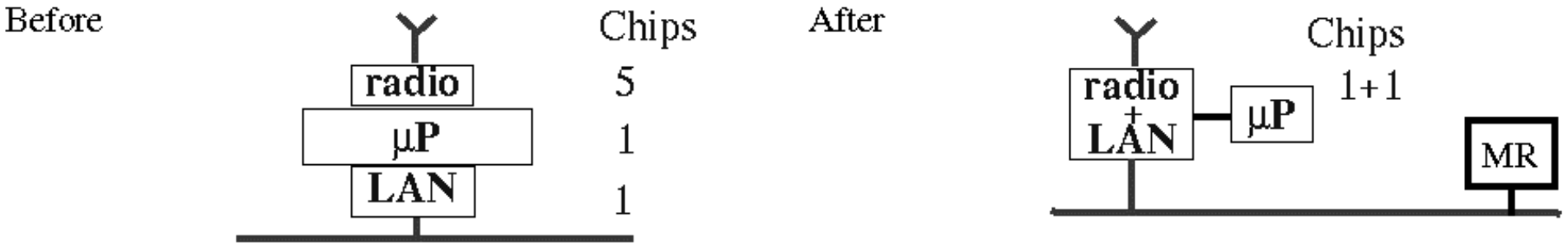
Telecommunication operators and others need to address how they are going to introduce a new infrastructure which supports **low cost mobile** access to new services.

New Viewpoint

- Forget spectrum availability as **the** problem
- Forget limited bandwidth as **the** problem
- Forget error rate as **the** problem
- Problem: Finding the trade off between available high quality bandwidth and the cost of the infrastructure, i.e., if cells shrink (thus increasing capacity, available bandwidth, decreasing error rate, …), then infrastructure cost increases, or is there another way?

Need low cost access points

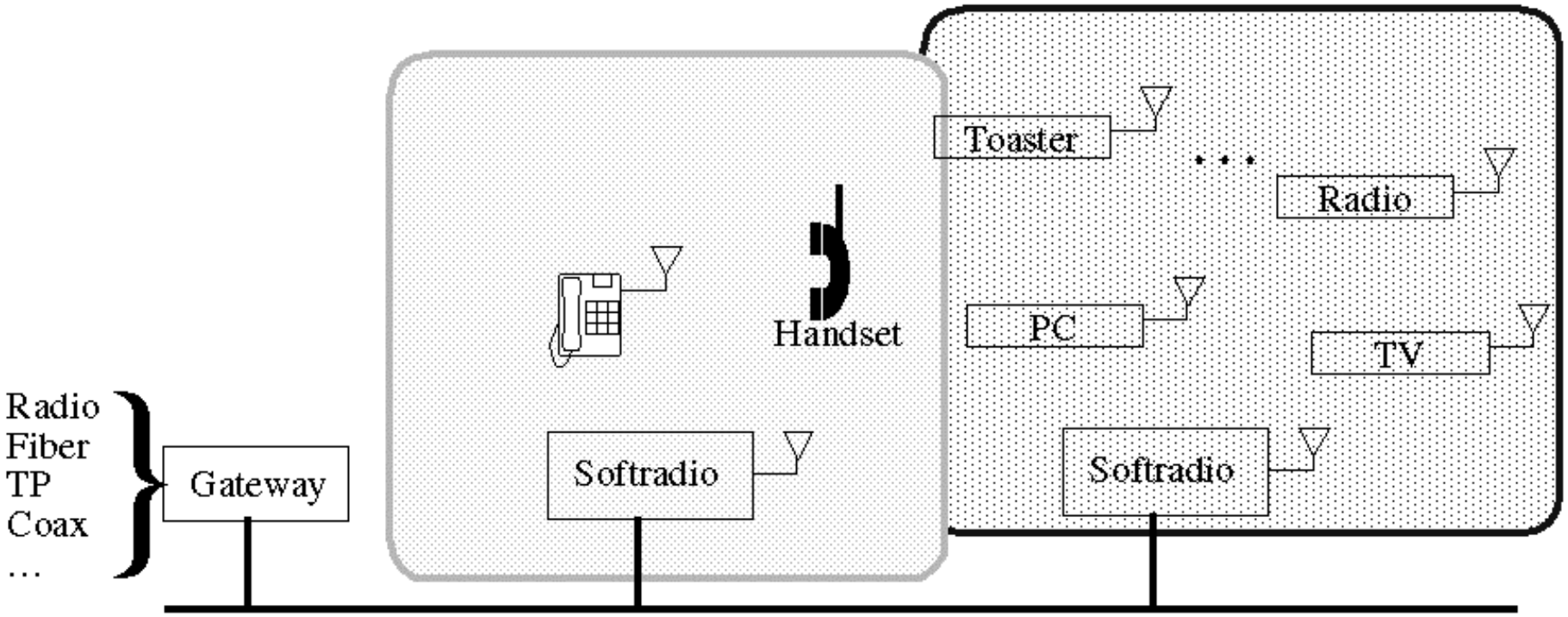
- Apple Airport - 11Mbps WLAN + 56kbps modem + Ethernet for US$299
- EU Media project ⇒ very highly integrated BS



Participants: KTH, TUT, GMD, UBR, IMEC, and ERA

http://www.ele.kth.se/ESD/MEDIA

Future home/office/… network accesspoints



For example Ericsson’s e-box as a network operator oriented home gateway

Looking far into the future

Personal Computing and **Communication**

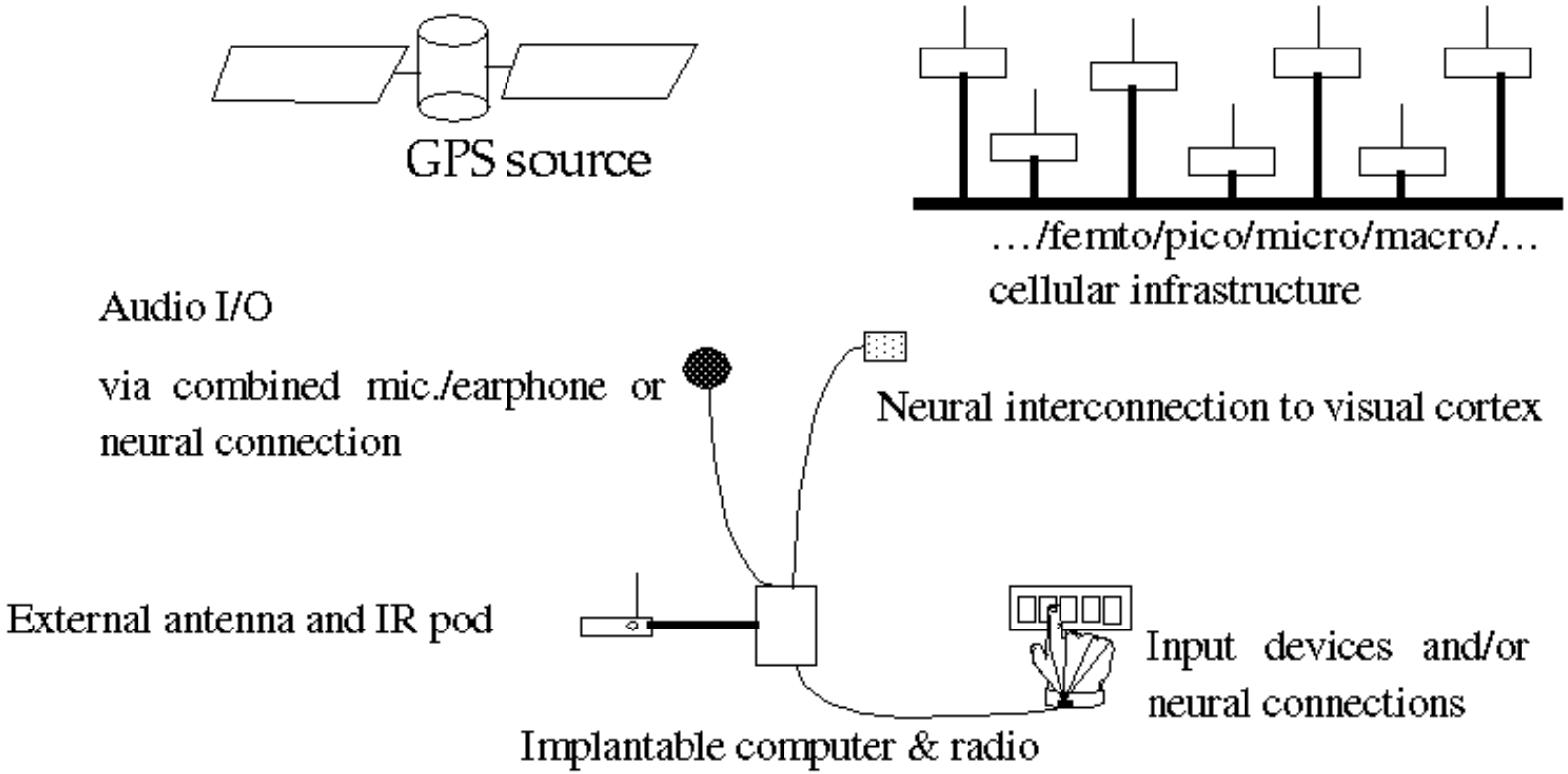
Upper limit on bandwidth to saturate senses:

sight, sound, touch, smell, taste

→ ~1 Gbit/sec/user

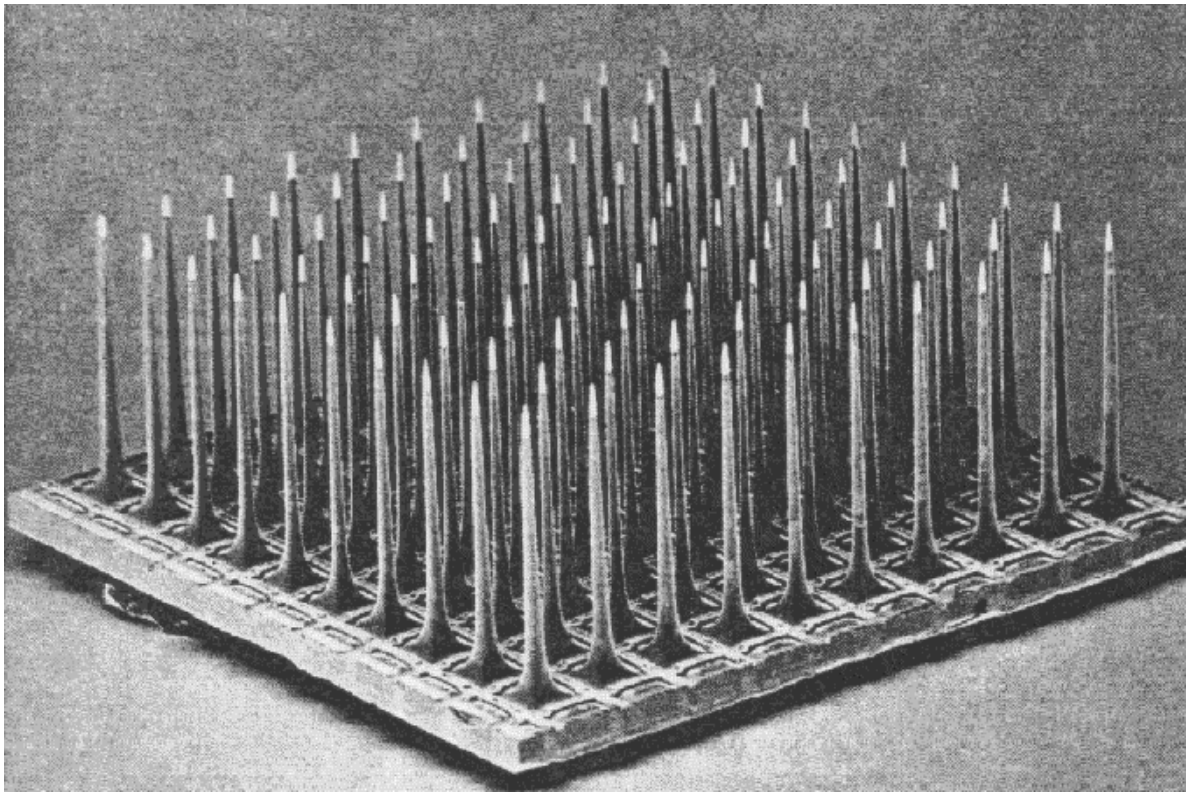
Current workstations shipping with 1 Gbit/sec LAN!

Future Systems



2005-2015 - very high level of integration

Bionic Technologies, Inc.'s Intracortical Electrode Array

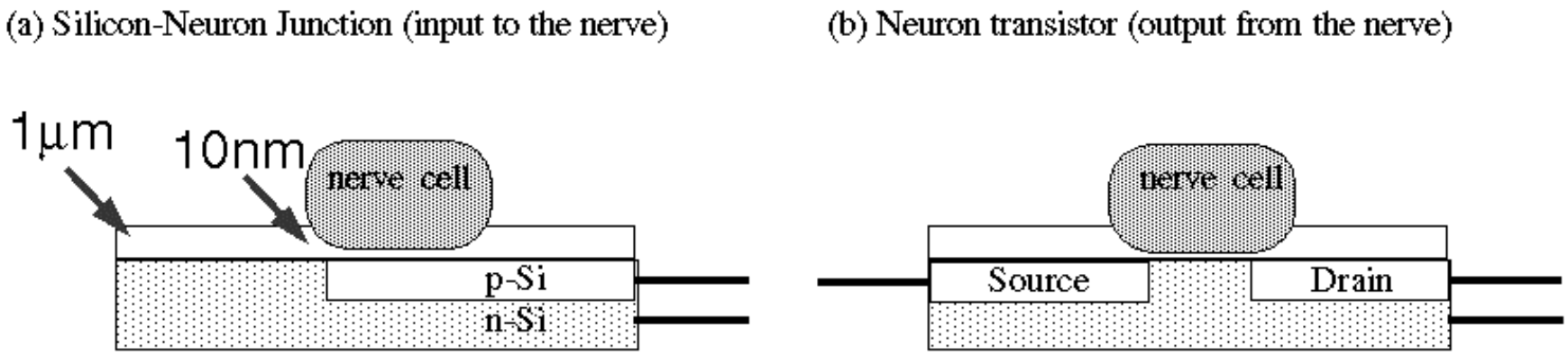


Acute microelectrode assembly

(10x10 array, 100 active electrodes) . . . $1,250

(each electrode: 1.5mm long, 0.08mm wide at base, 0.001mm tip)

Non-metalic bi-directional neural interfaces



(a) Capacitive coupling of data into nerve and

(b) using the charge in the nerve to control a transistor's gate for getting data out of the nerve

Neurochip: Neuron silicon circuits
http://mnphys.biochem.mpg.de/

Telepresense

Telepresense for work is the long-term “killer” application.

--Gordon Bell and James N. Gray

Uploading ourselves to the net

The internet as a way to immortality:

> “Now, for the next 50 years, the web will drive electronic commerce into the information age, ubiquitous computers will disappear into the woodwork, and we’ll start uploading ourselves into the Internet to become at last immortal.”
>
> -- Dr. Robert M. Metcalfe

June 26, 1997

Conclusions

- Telecom operators are reinventing themselves and their infrastructures
- Low cost access points are key to creating a ubiquitous mobile infrastructure with effectively infinite bandwidth.
- Smart Badge is a vehicle for exploring our ideas
- Service is where the money is! $
- Distributed research - means that the project never sleeps; global operations will be part of the key to success
- Personal Communication and Computation in the early 21st century: “Just Wear IT!”
- Coming in 20-30 years: “Just implant IT!”

Don’t waste!
Help stamp out analog phones.

Use each jack as a place to put a base station.

With lots of picocells, everything can and <u>will</u> be on the net.

¿Questions?

Mobile-IP

- A mobile version of the IP protocol first shown in 1989
- Mobile-IP defined by RFCs 2002 .. RFC 2006 (Fall 1996)
- *Mobile IP: Design Principles and Practices* by Charles Perkins or *Mobile IP: The Internet Unplugged* by James D. Solomon.