Personal Computing and Communication: A Status Update

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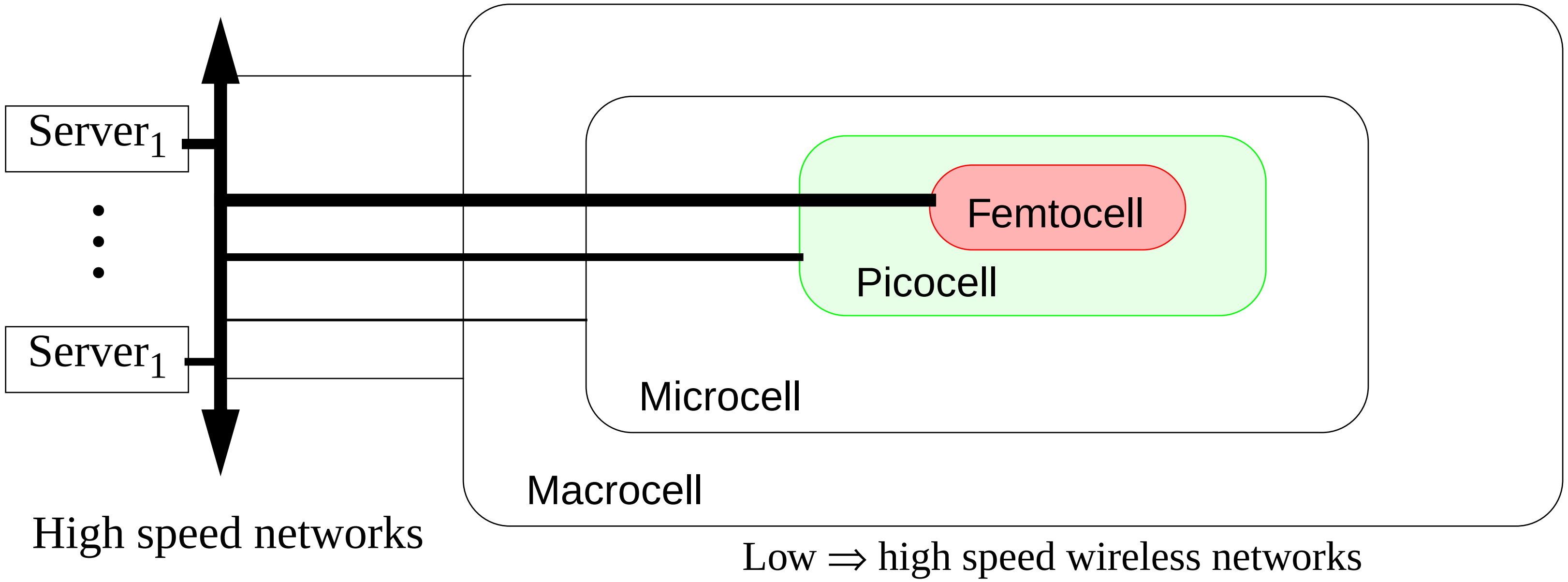
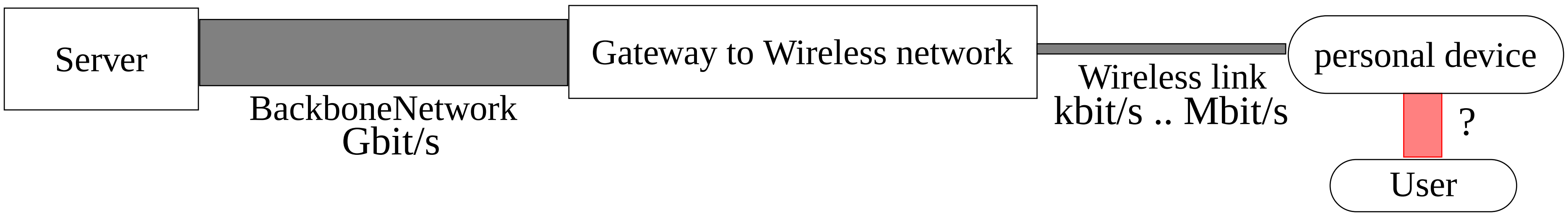
Bottlenecks

- Server and Network Bandwidth and latency



- User Bandwidth and latency



- Power and Energy ⇒ need a computational theory of O(energy)
- Imagination!

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[1]

Who are the competitors?

Ericsson, Lucent, Nokia, Siemens, … or Nintendo

1. From Wearables mailing list Wed, 17 Sep 1997 19:22:17 -0700.

Near Future systems

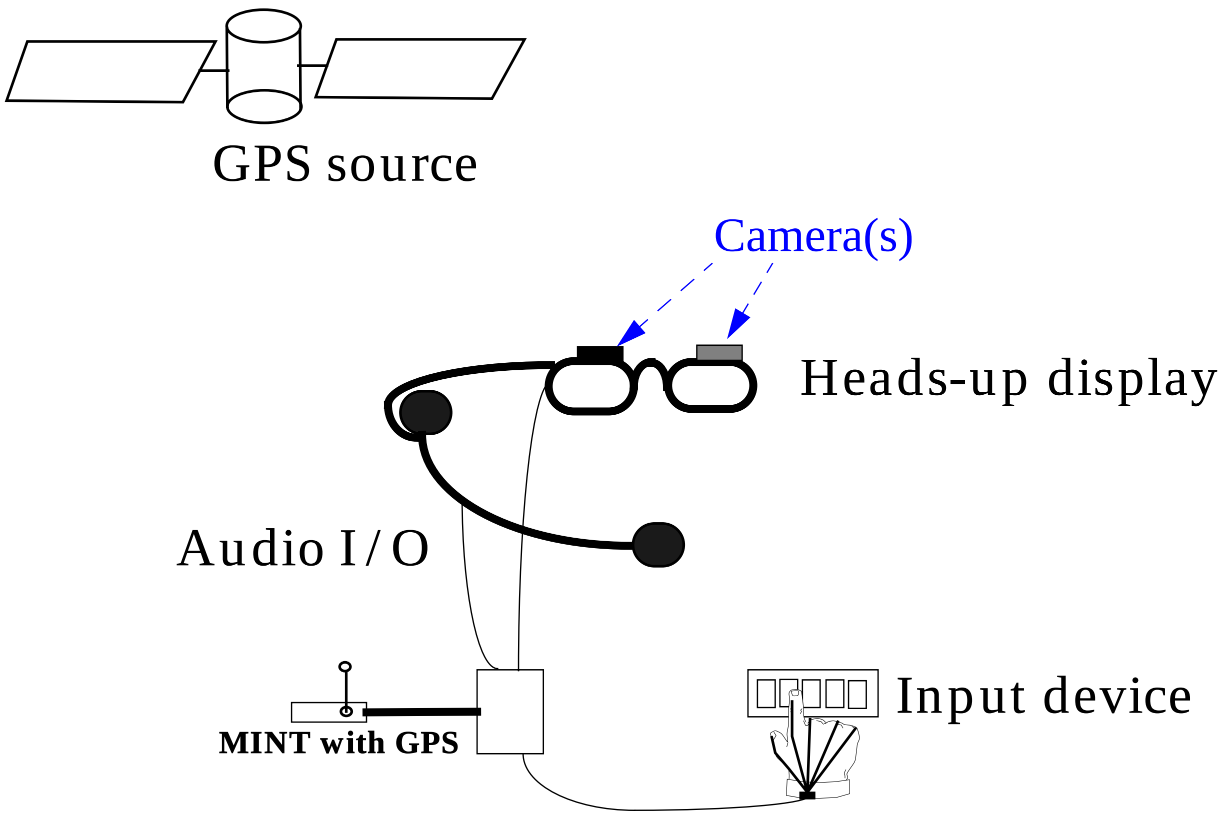


Figure 1: Vision-2, 2000 - high level of integration

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
- Badge as a smart card replacement
    - biometric signature of the person currently using the badge
    - the badge ensures that only you can use it
- 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)

Requirements

- Systems with which humans wish to interact:
  - traditional computers, desktop workspaces, domestic appliances, building and automotive systems, doors, elevators (lifts), environmental control, seats and mirrors, etc.
- Systems to provide sensor data:
  - location, orientation, light, heat, humidity, temperature, gas analysis, biomedical, …
- Systems to correlate the sensor information and provide it in a useful way to the computer systems:
  - Spatial and temporal sensor fusion,
  - 3D and 4D databases,
  - Machine Learning, and
  - Prediction (based on pattern extraction)
- Agents and actuators to provide intelligent control of the environment
- wireless/wired/mobile communications infrastructures to link it all together
  - must assure privacy and security

Dumb Badge, Smart Badge, and Intelligent Badge

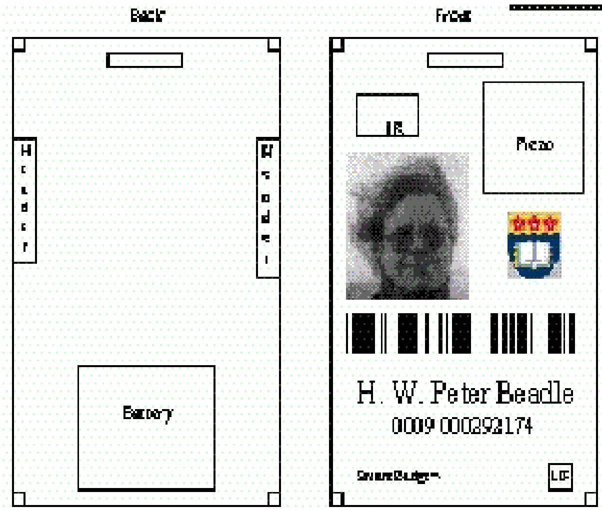
- Dumb Badge just emits its ID periodically
- Smart Badge - [an IP device] Location and Context Aware (i.e., a sensor platform)
- Intelligent Badge - add local processing for local interaction by the user

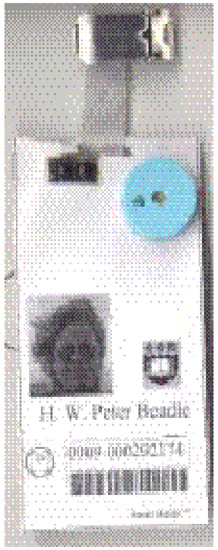
Acknowledgment:

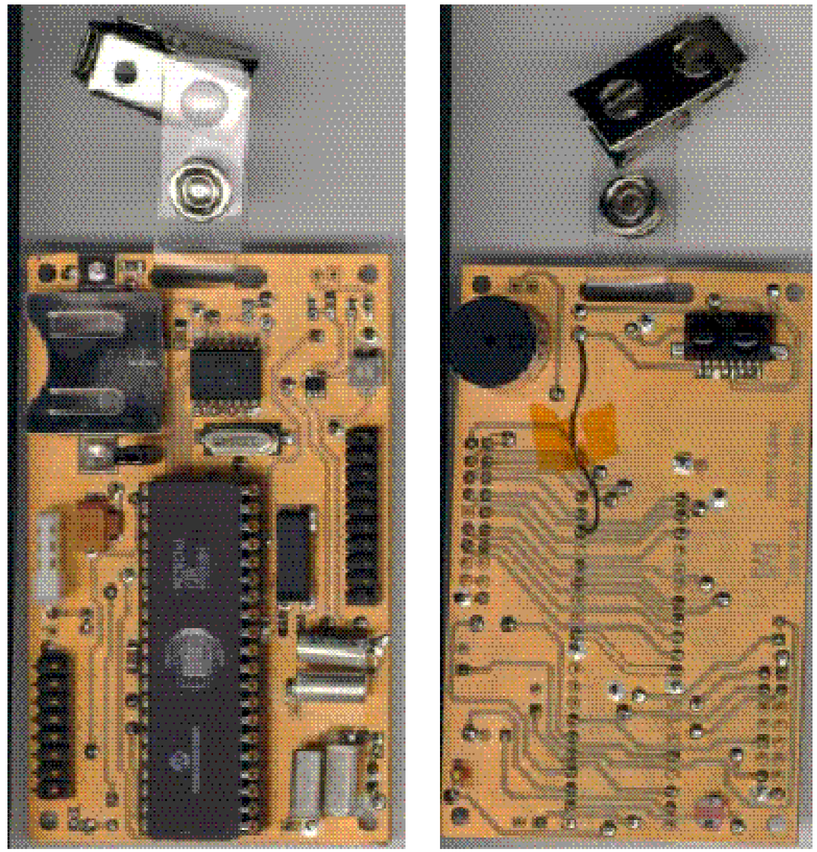
All of the badge work is done in cooperation with:

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

Badge Prototype and Badge 1

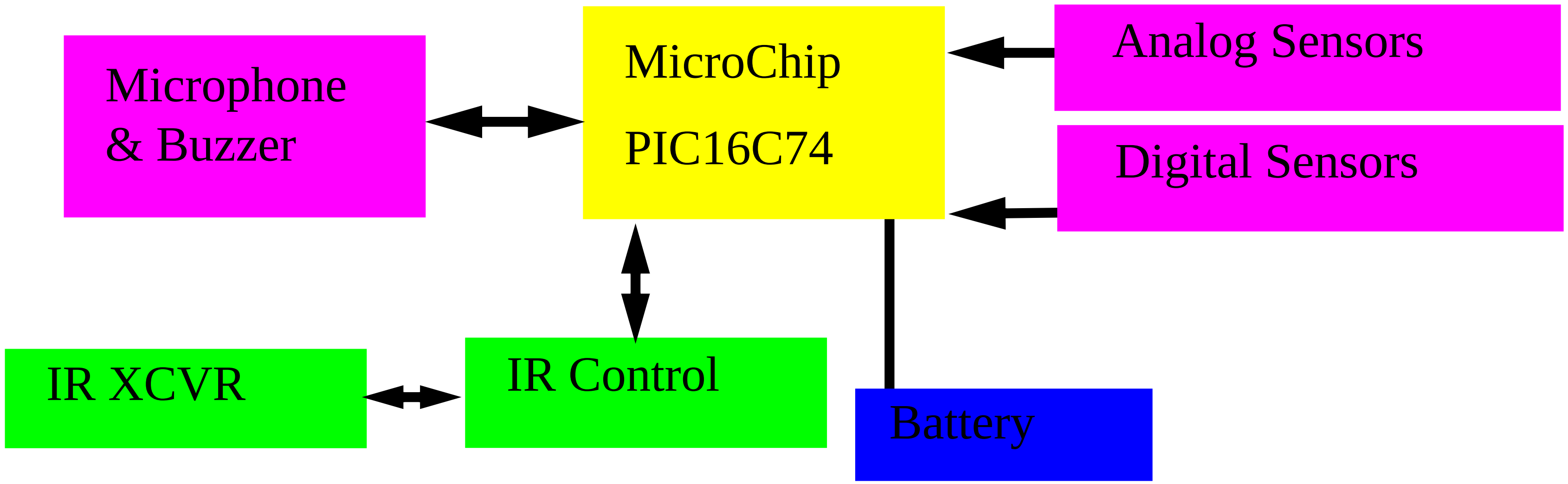






- Sound, Light, Temperature, Humidity, Orientation, Adjacency
- Beeps
- PIC 16C74A-jw based
- 5 MIPS
- 4m range
- 98mA average power

Smart Badge 1



Conceived in January 1997; Used in the “finger” course in May 1997

URL: http://www.it.kth.se/edu/gru/Fingerinfo/telesys.finger/Mobile.VT97/mobile.vt97.html

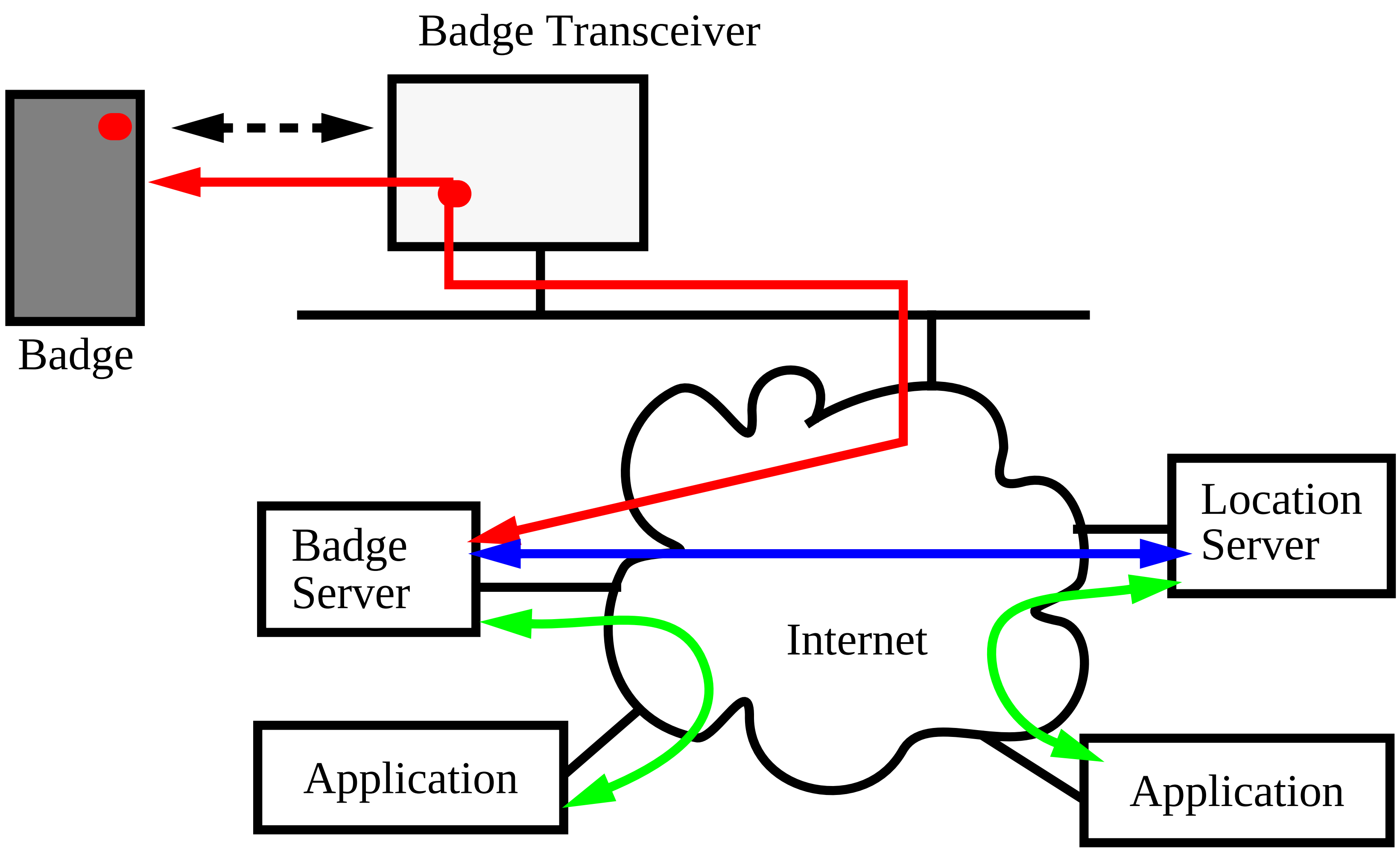
85x55mm $\Rightarrow$ 46.75 mm^2 - component cost ~US$30

24 systems made using milling machine and hand assembly

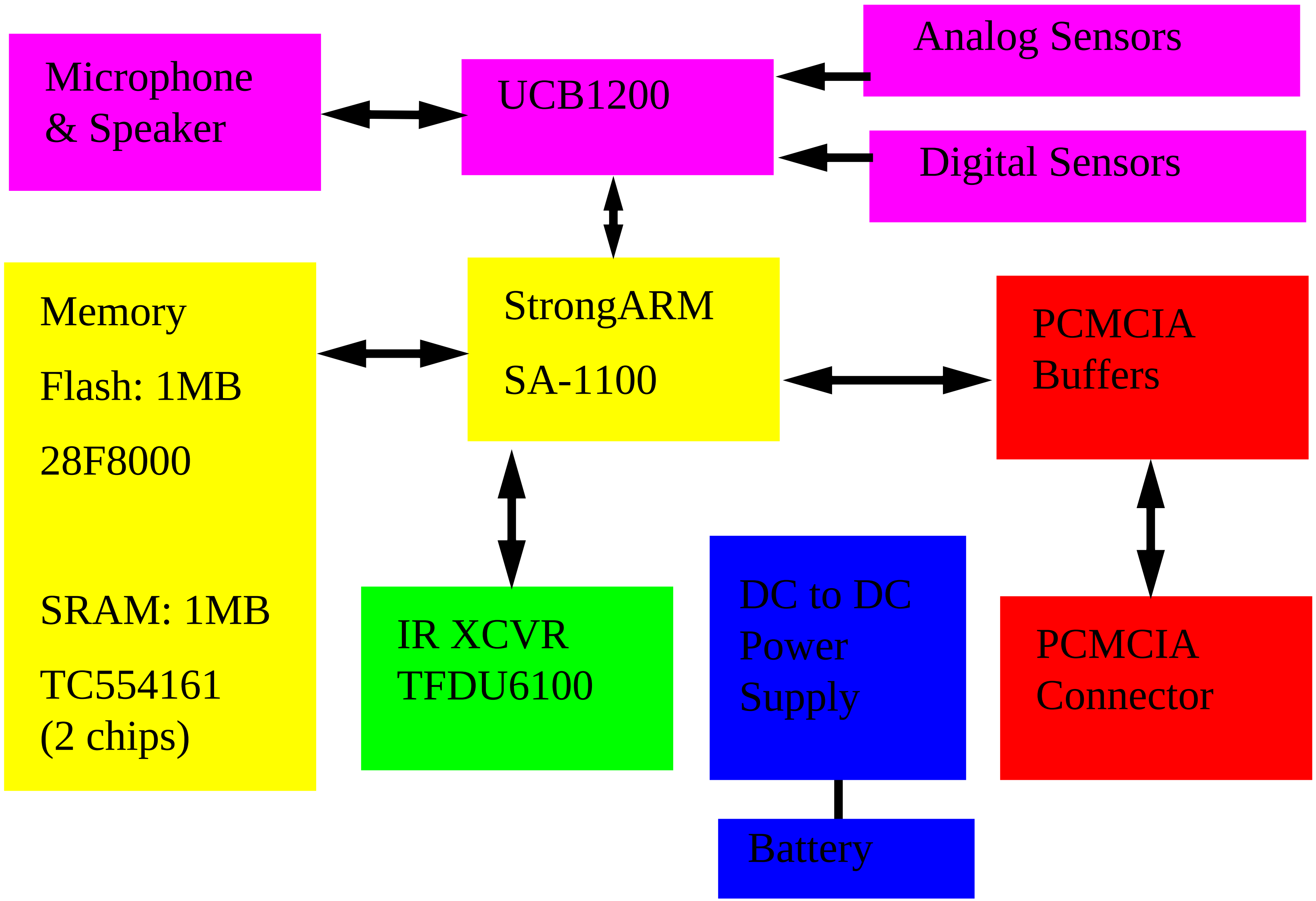
Subsequently used for course at Univ. of Wollongong and thesis projects at: KTH, Wollongong, Ellemtel, Ericsson Radio, …

Badge Communications Model

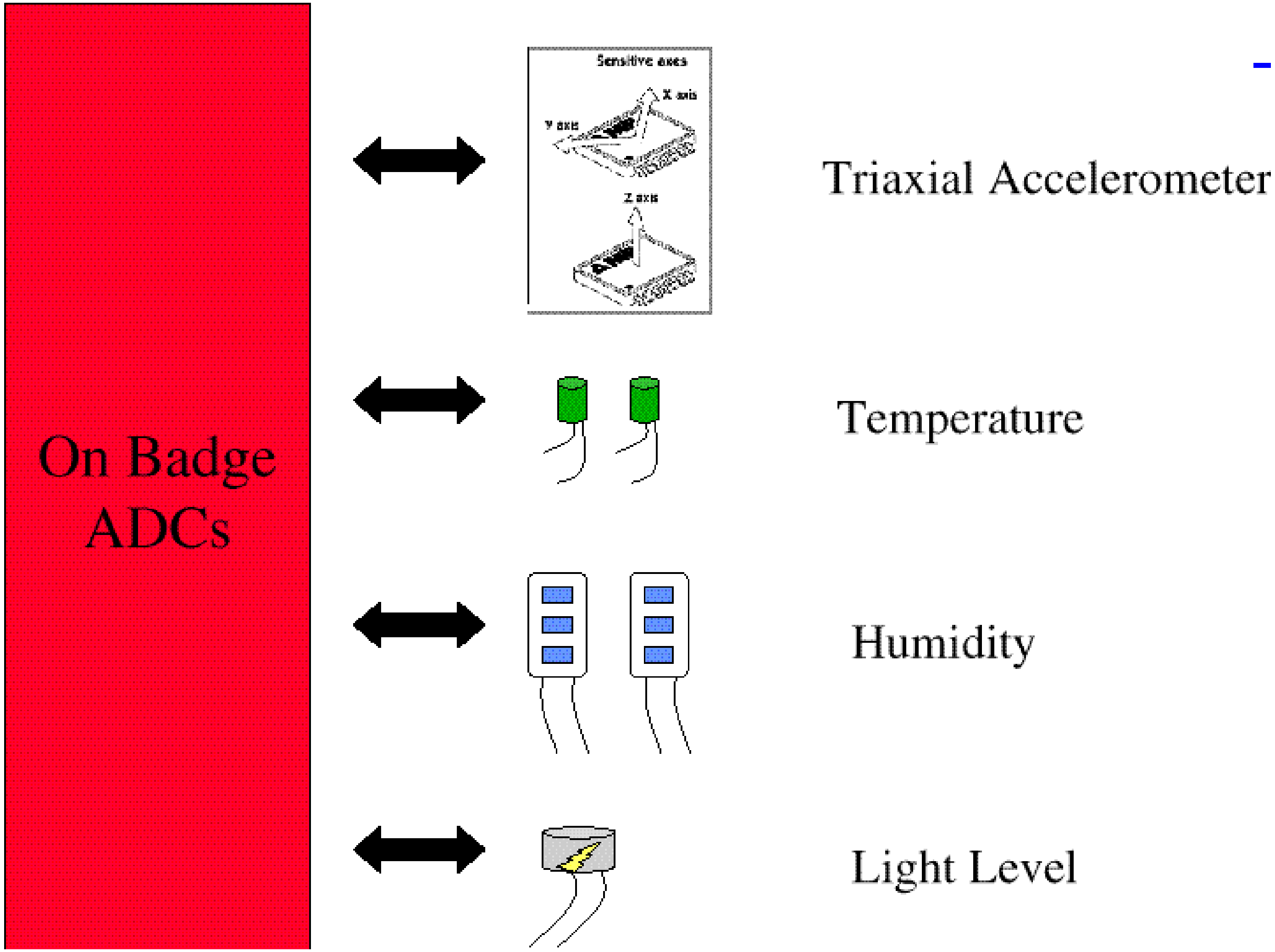
Badges are IP devices (or should be), they communicate via network attached access points.



Smart Badge 3

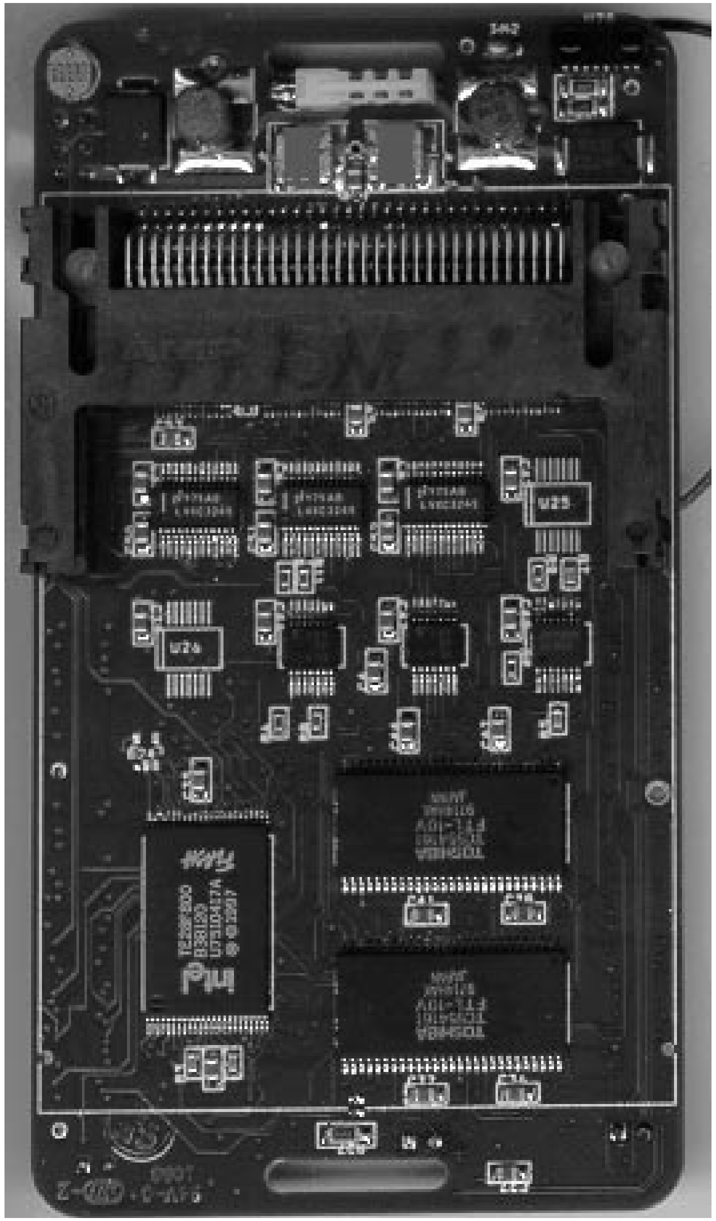


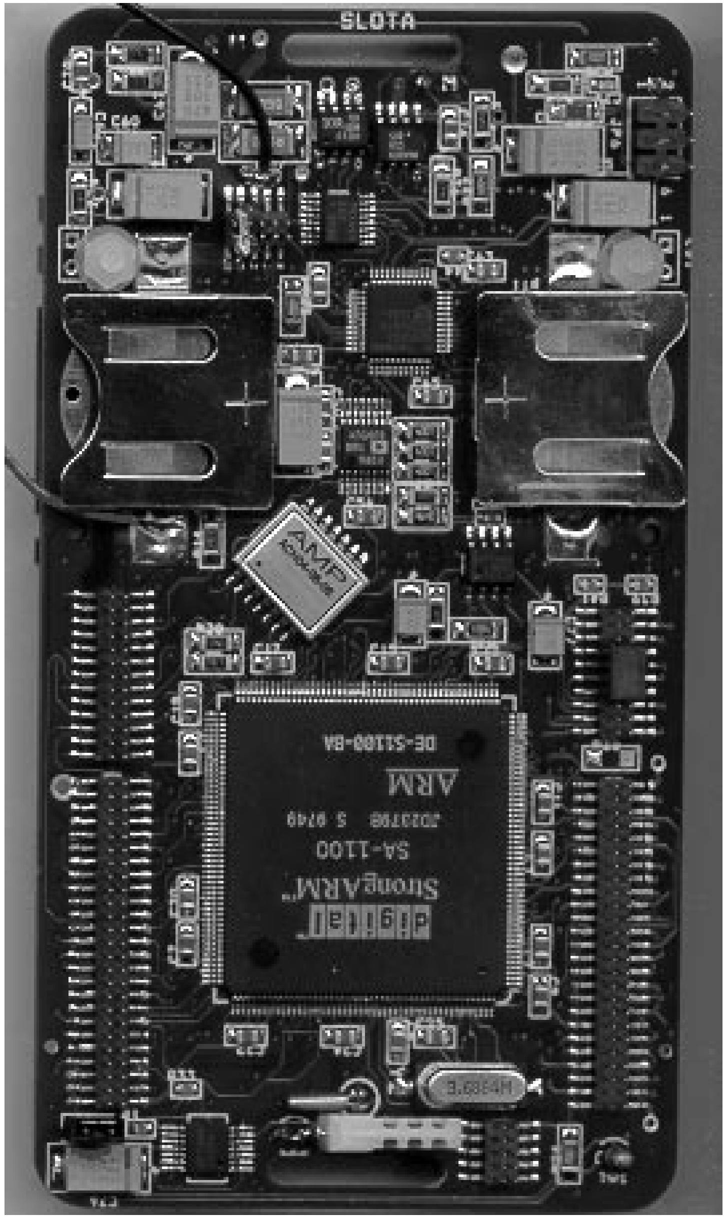
Smart Badge Sensors



Details of the 3rd version:
http://www.it.kth.se/edu/gru/Fingerinfo/telesys.finger/Mobile.VT98/badge3.html

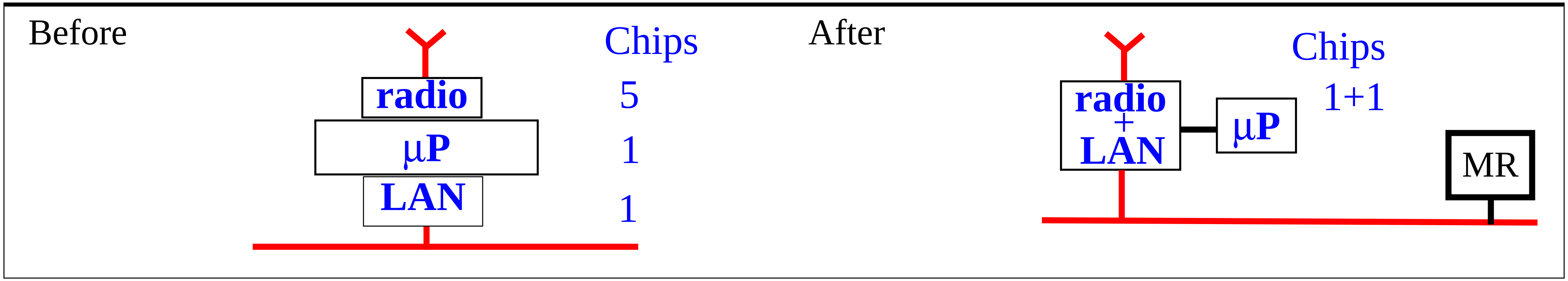
Badge 3 - 65 x 115 x 15mm





MEDIA

High integration (goal of MEDIA project)

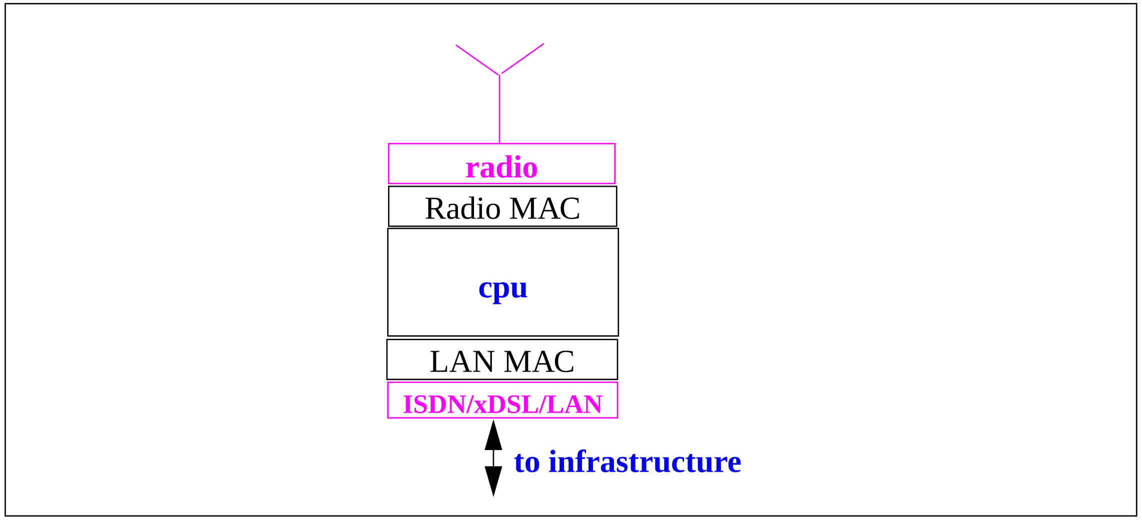


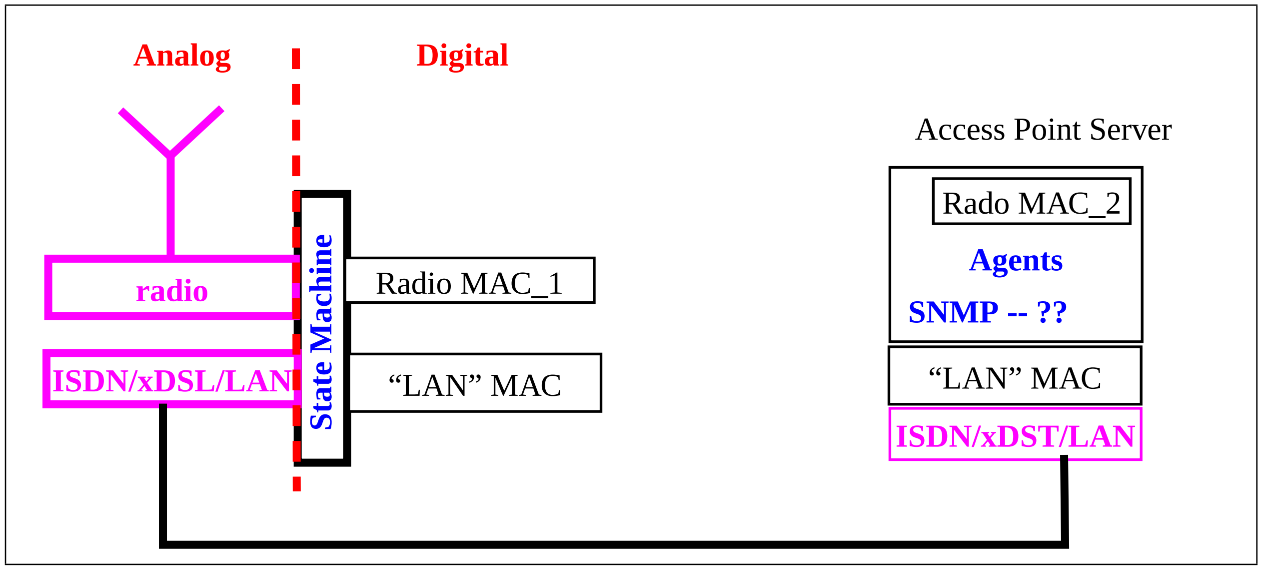
Partners:

- Kungl Tekniska Högskolan (KTH/ELE/ESDlab and KTH/IT/CCSlab)
- Tampere University of Technology (TUT)
- GMD FOKUS (GMD)
- Technische Universität Braunschweig (UBR)
- Interuniversity Microelectronics Centre (IMEC)
- Ericsson Radio Systems AB (ERA)

See http://www.ele.kth.se/ESD/MEDIA for more information

Split the functions between access point and access point server





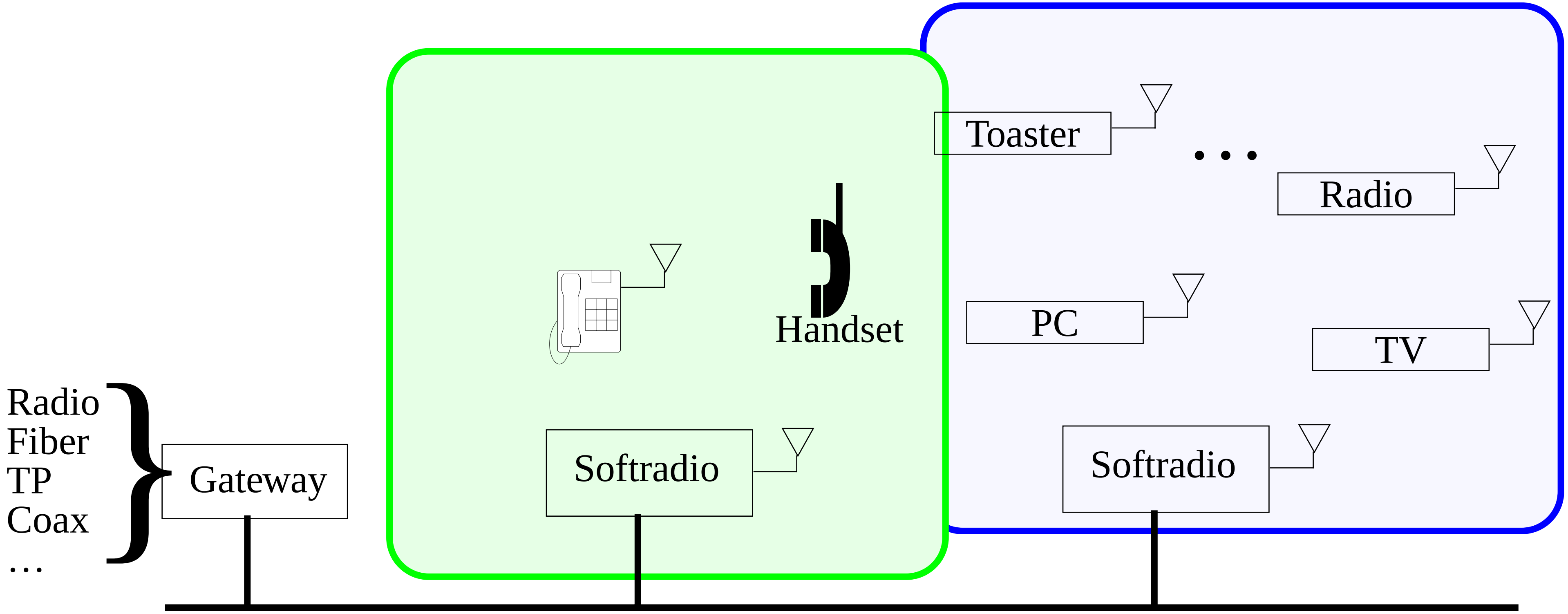
Radio Part MAC

Open questions:

- How many radio we need?
- What is the right number of receivers that a typical mobile user would want to have?
- What is the relationship between the number of radios and: the data rates that a user can source and sink? a user's context switching time?
- We think that its best to have two radios. One is used as the current communication channel and the second is time-multiplexed:
  - ♦ to look for other access points,
  - ♦ when bursts of extra bandwidth are needed,
  - ♦ to acquire information which is used to determine your location and heading,
  - ♦ as a secondary channel to listen to (and perhaps transmit) contents which is not available via the main communication channel,
  - ♦ listen to non-traditional communication emissions in your environment, etc.

It is also important to note that the authentication and privacy features were defined to provide "wire-line" features. However, these features are *optional* and need *not be implemented* in a given device.

Future home/office/… network accesspoints



Personal Computing and Communication (PCC)

Upper limit of bandwidth: saturate the senses: sight, sound, touch, smell, taste

$\Rightarrow$ ~1 Gbit/sec/user

Current workstations shipping with 1 Gbit/sec interfaces for LAN!

> Telepresense for work is the long-term “killer” application
>
> -- Gordon Bell and James N. Gray[1]

1. “The Revolution Yet to Happen” in Beyond Calculation: The Next Fifty Years of Computing, Eds. Denning and Metcalfe, Copernicus, 1997.

Other Wearables

IBM Embedded Systems in Japan: ThinkPad 560X (Prototype)

http://www.watch.impress.co.jp/pc/docs/article/980911/ibm.htm

CPU	Intel Pentium with MMX @ 233MHz
Memory	64MB(EDO)
Framebuffer	NeoMagic MagicGraph 128XD 2MB
Hard disk drive	IBM Microdrive 340MB
Display	320x240with 256 colors - to headsup display
	800x600 - external video
Serial interface	USB
Card Bus Controller	TI1251
	Intel NorthBridge + SouthBridge
Mouse	Trackpoint + 3 buttons on a cord
Audio interface	Crystal CS4237B + external headset+microphone
IR communications	IrDA 1.1
Audio - software	ViaVoice Gold
OS	Windows 95/98
Size	80 x 120 x 26mm
Weight	299g + 50g

Intel Embedded PC

http://developer.intel.com/design/platform/embedpc/index.htm

Support chips:

Northbridge - provides all memory interfaces and control + host to PCI transaction control

- controls cache fetches, write-backs, and coherency
- HX Northbridge: FPM and EDO memories, Error Checking and Correction (ECC) + parity support
- TX Northbridge: FPM, EDO and SDRAM memories;. ECC and parity are not supported

Southbridge (aka PIIXx device)

- Connects the PCI bus to the ISA bus as well as other peripheral devices, including Universal Serial bus (USB) and IDE bus for hard disc drives
- Timers, counters, DMA, BIOS; Interrupt control of legacy ISA devices; PCI reset and interrupt control

IBM MicroDrive 340MB

http://www.storage.ibm.com/hardsoft/diskdrdl/prod/micro/170340/170spec.htm

Capacity	340MB / 170MB
Number of heads	2 / 1
Number of disks	1
Rotational rate	4,500RPM
Seek time (typical read) average	15ms
Voltage	3.3V
Dimensions	36.4x42.8x5.0mm
Weight	20g
Interface	CompactFlash Type II (CF Type II)

IBM Wearable work

User interface and devices - from User System Ergonomic Research:

http://www.almaden.ibm.com/cs/user/userproj.html

The above URL is useful for additional background about TrackPoint devices.

Specifically the TrackPoint Mouse:

http://www.almaden.ibm.com/cs/user/tp/tpmouse.html

Displays

A summary of links is at:

http://lcs.www.media.mit.edu/projects/wearable/display.html

Basically the status is that for low power, small size, low resolution - Kopin's technology is still in the lead (used in the Microoptical eyeglasses display: http://www.microopticalcorp.com/).

Cameras

Adding cameras to eye-glasses

- Forward looking - so the camera sees what the person is looking at
- Backward looking - so the camera can see the person’s eye - for eye tracking, …

Wireless (Radios, IR)

IEEE 802.11

		Cost US$
Freq. Hopping	BayStack 660 Wireless LAN **PC Card**	$569
	BayStack 660 Wireless LAN Access Point	$1,799
Direct Sequence	BayStack 650 Wireless LAN **PC Card**	$499
	BayStack 650 Wireless LAN Access Point	$1,499

See for example: http://www.baynetworks.com/news/press/9808241.shtml

GSM - Ericsson GC25

- PCMCIA Type III card
-

Ericsson Mobile Office DI 27

- clip on IR interface for 900 series phones
- contains an ARM 7 processor

Conclusions

- Low cost access points which exploit existing or easily installed infrastructure are key to creating a ubiquitous mobile infrastructure with effectively infinite bandwidth.
- Smart Badge is a vehicle for exploring our ideas
    - ♦ Exploits hardware and software complexity by hiding it.
    - ♦ Explores allowing devices and services to use each other in an extemporaneous way.
    - ♦ Enables a large number of location and environment aware applications, most of which are service consuming.
    - ♦ Service is where the money is!
- Distributed research - means that the project never sleeps; global operations will be part of the key to success.