

# Wearable Computing

## (personal organic systems)

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# Wearable Computing Vision

You are tired. Be careful !



# Wearable Computing Vision

You should be bending your knees a bit more



**,personalized, nonintrusive monitoring‘,**

# Wearable Computing Vision



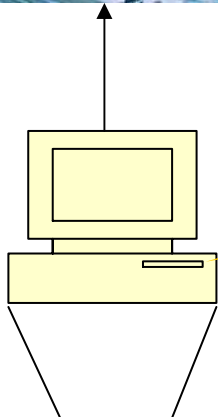
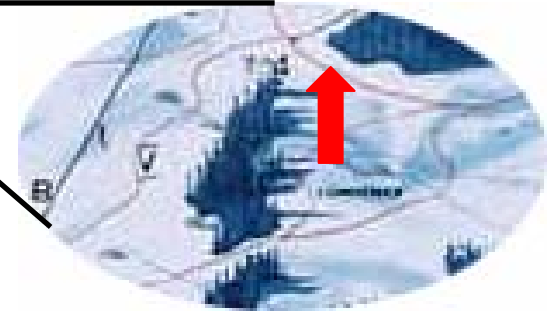
Your friends are having a break around the top



# Wearable Computing Vision



Take the right route. No fog there



***,just in time information', any time, any place***

# Wearable Computing Vision



good run, just 10 s slower than worldcup average



enjoyed a great view

average speed 70km/h, 1 turn per sec

getting sloppy and tired

**,personalized, multimedia recording and annotation'**

# Key Architecture Question

**What does integration with the outfit mean ?**

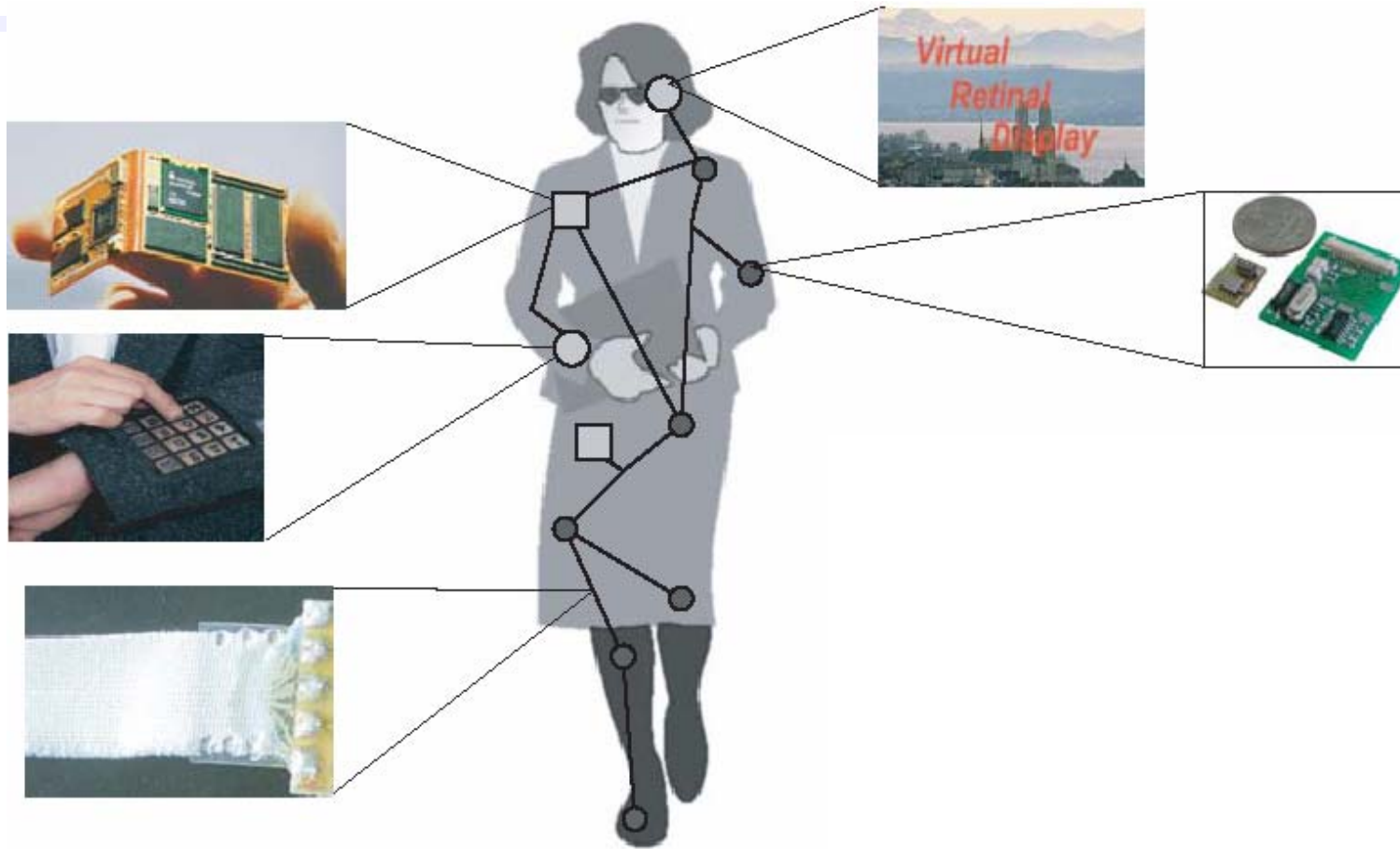
**Observation: clothing is a heterogeneous, distributed, dynamically reconfigurable system**

- function
- technology
- user expectation

**Solution: 4 layers of integration reflecting relation between clothing and electronic**

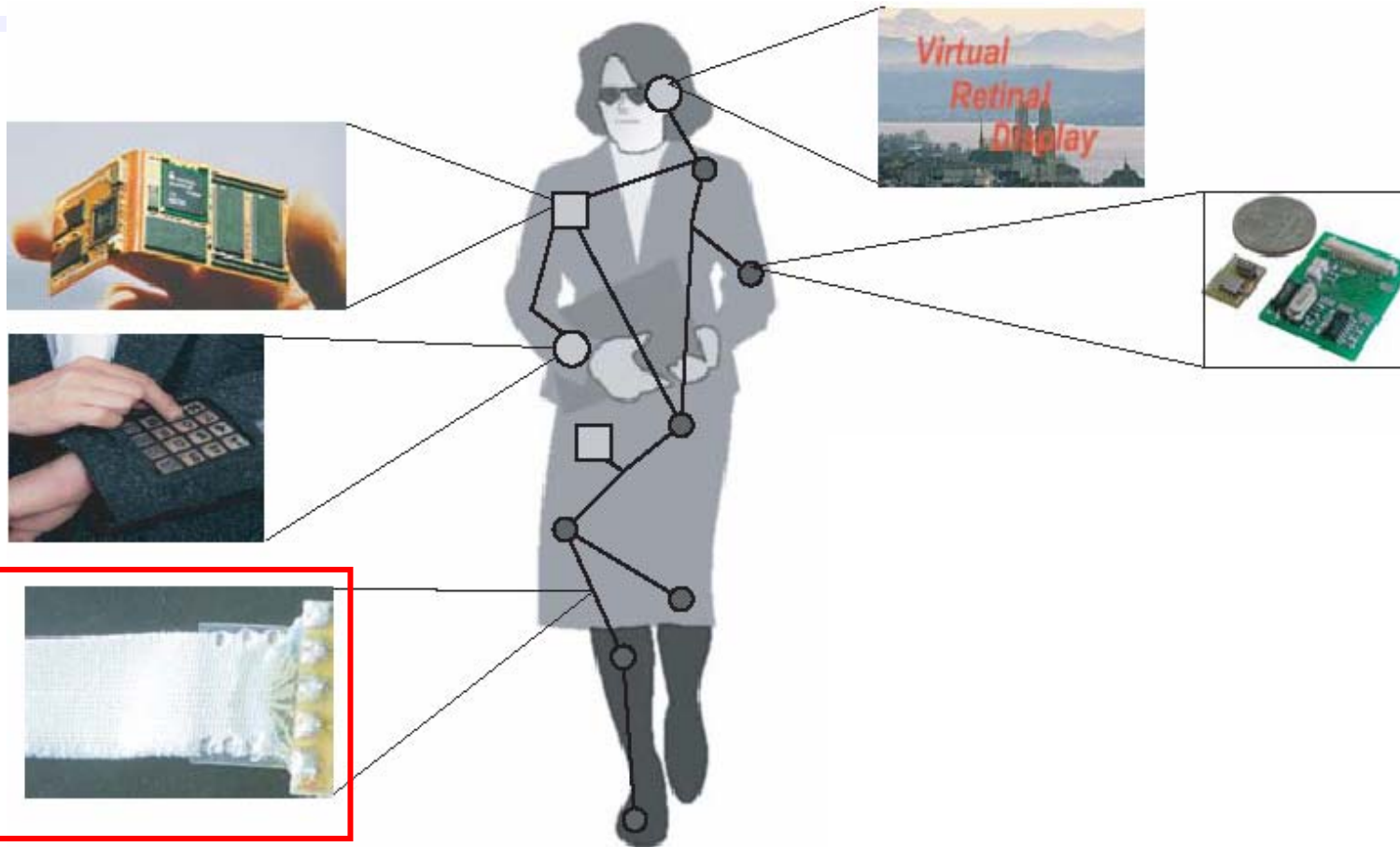
- dynamically reconfigurable
- self organizing

# Architecture



**invisible, intelligent  
personal assistant**

# Layer 1: Part of Textiles



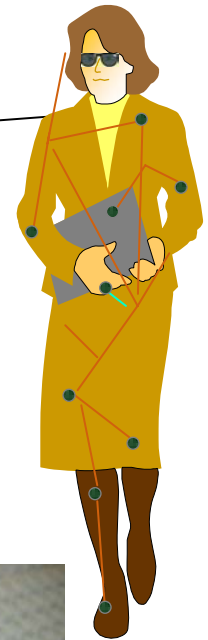
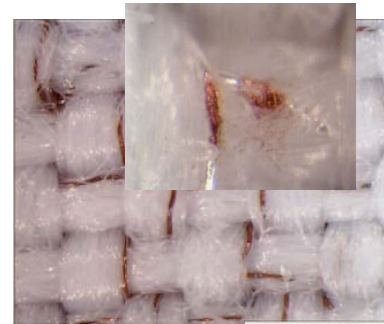
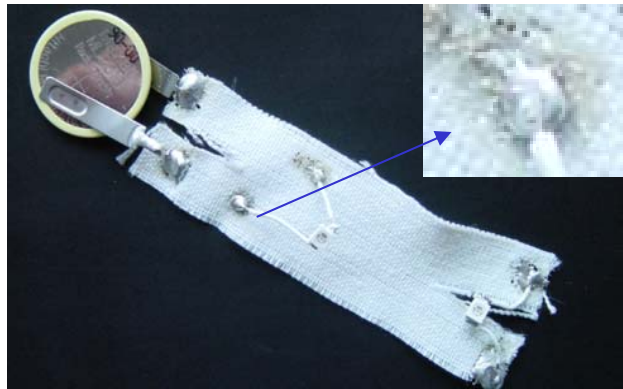
**invisible, intelligent  
personal assistant**

## functional textiles

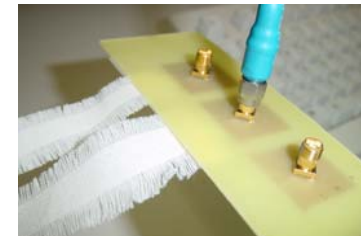
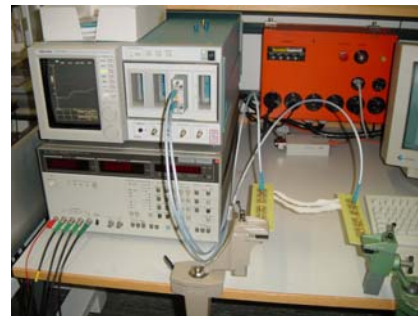
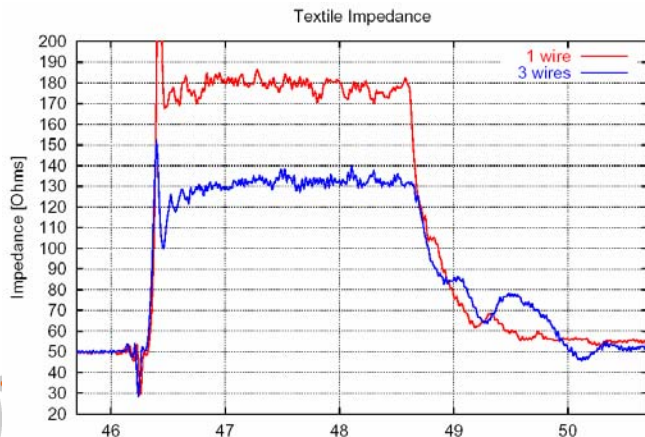
- data and power lines, interface to electronics — 1
- sensing
- power generation

# Layer 1 at the ETH Wearable Lab

- electronics on textiles

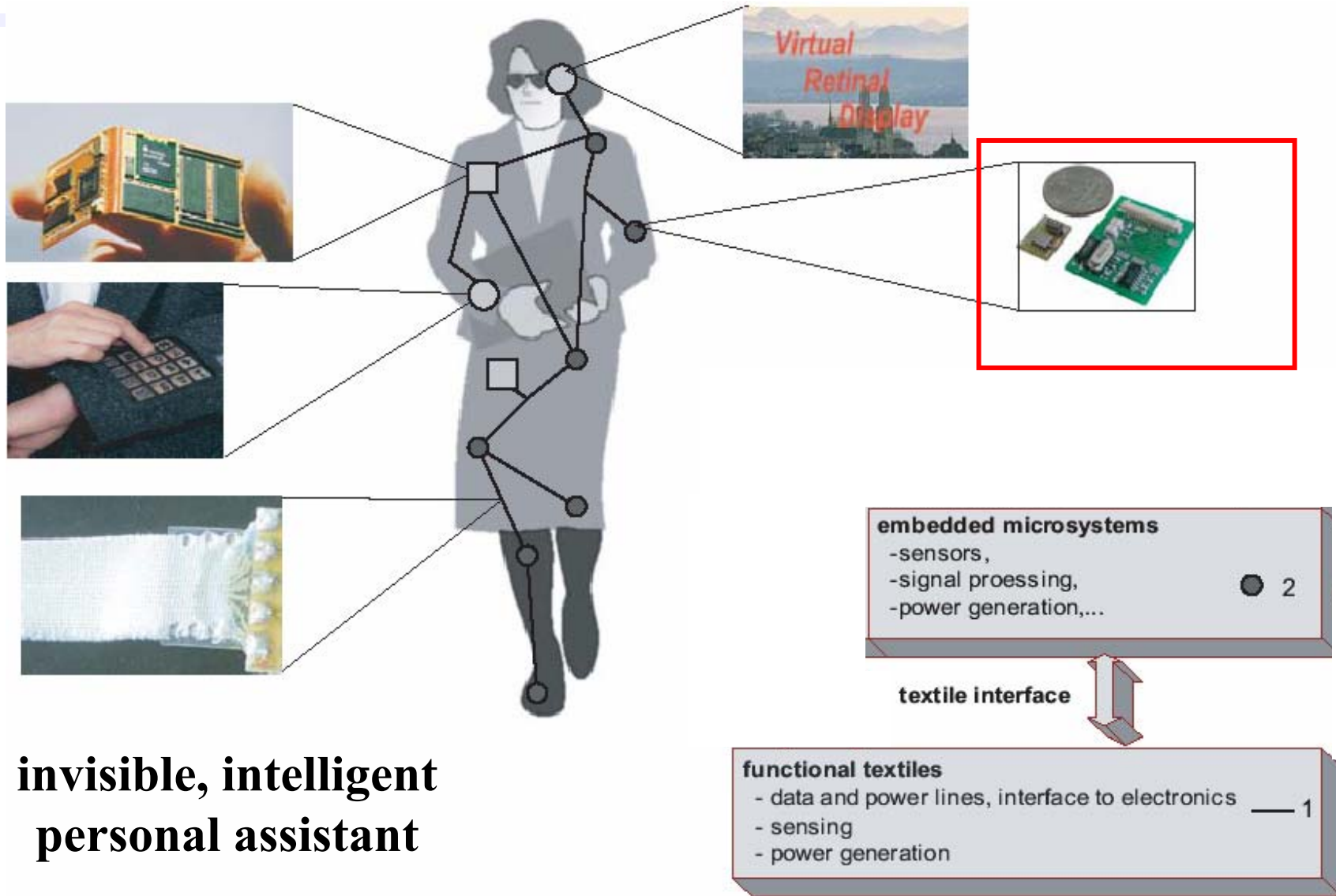


- electrical characterization of conductive textiles



Dr. Tünde Kirstein

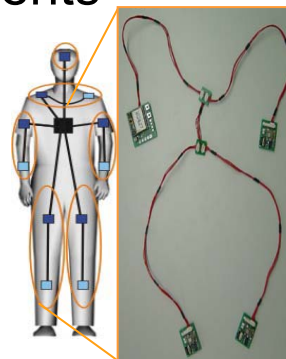
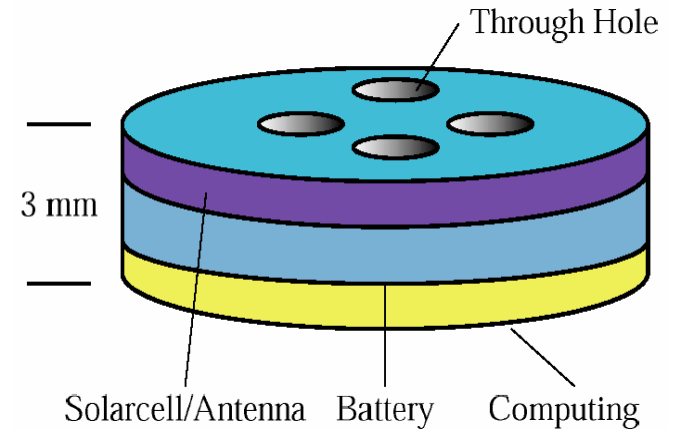
# Layer 2: Permanent Integration



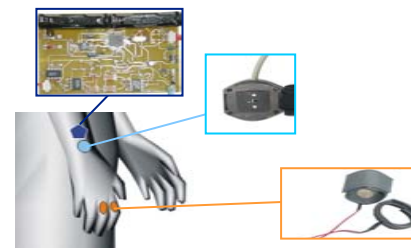
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# Layer 2 at the ETH Wearable Lab

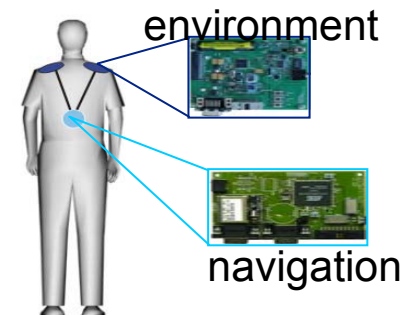
- **autonomous, miniaturized sensor unit design**
  - ultra low power features extraction implementation
  - energy scavenging as power source
  - ultra wide band communication interface
- **situation awareness:**
  - *WearNET* experimental platform implementation
  - context experiments



user activity

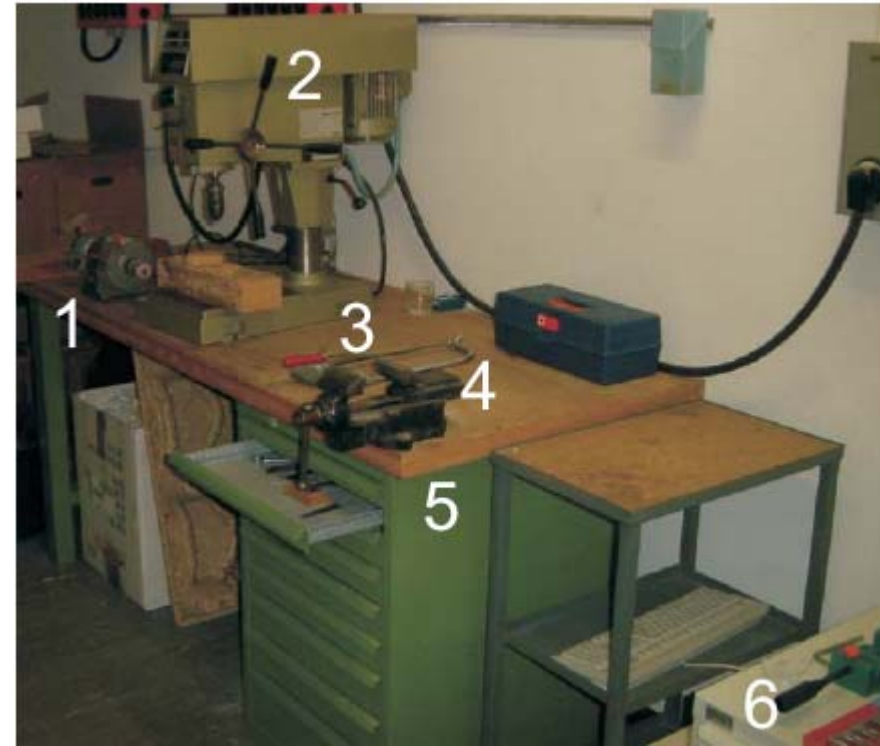


user state



navigation

# Experiment: Wood Workshop



**Joint effort with Thad Starner, Georgia Tech**

# Continuous Results

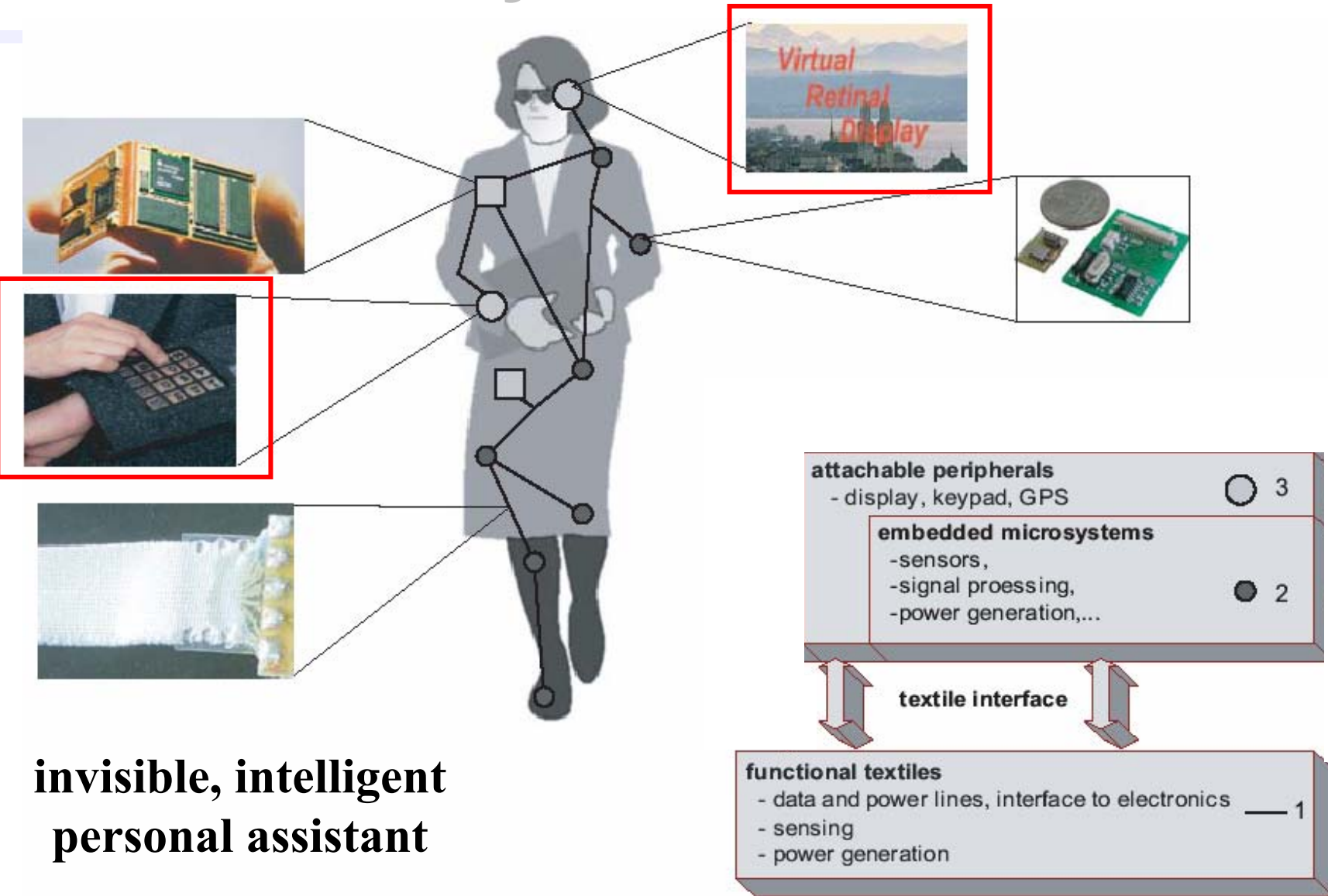
Correct (C), Insertions (I), Deletions (D), Substitutions (S)

$$\%Accuracy = \frac{Correct - Insertions}{TotalSamples}$$

Gesture	acceleration					sound					combined					
	C	I	D	S	Acc	C	I	D	S	Acc	C	I	D	S	Acc	P(G Class)
Hammer	8	2	0	1	66.7	9	1	0	0	88.9	8	0	1	0	88.9	1.00
Saw	9	0	0	0	100	9	1	0	0	88.9	9	0	0	0	100	1.00
Filing	10	0	0	0	100	9	7	0	1	23.2	9	0	1	0	90	1.00
Drilling	9	7	0	0	22.2	9	1	0	0	88.9	9	0	0	0	100	1.00
Sanding	8	0	0	1	77.8	9	8	0	0	11.1	8	0	1	0	88.9	1.00
Grinding	11	13	0	0	-18.2	9	0	0	2	81.8	9	0	2	0	81.8	1.00
Screwing	5	1	0	4	44.4	9	75	0	0	-733.3	4	0	5	0	44.4	1.00
Vice	42	0	0	1	97.7	34	1	2	7	76.6	36	0	7	0	83.7	1.00
Overall	102	23	0	7	72.5	97	94	2	10	2.8	92	0	17	0	84.4	1.00

**all recognised activities correct**

# Layer 3 Attachable

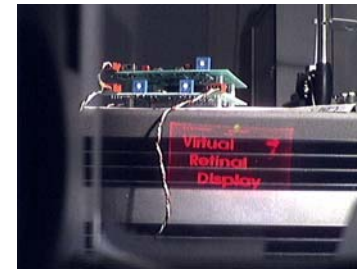
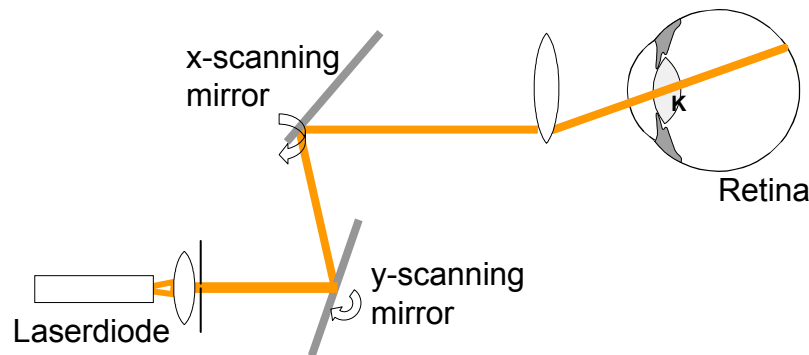


**invisible, intelligent  
personal assistant**

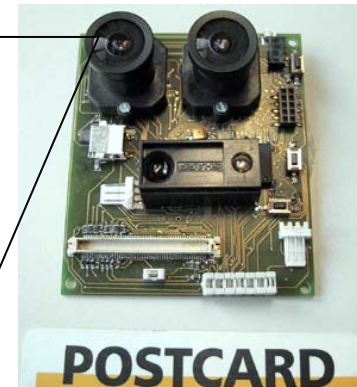
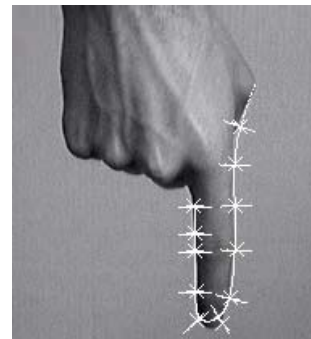
# Layer 3 at the ETH Wearable Lab

## IO as the key issue

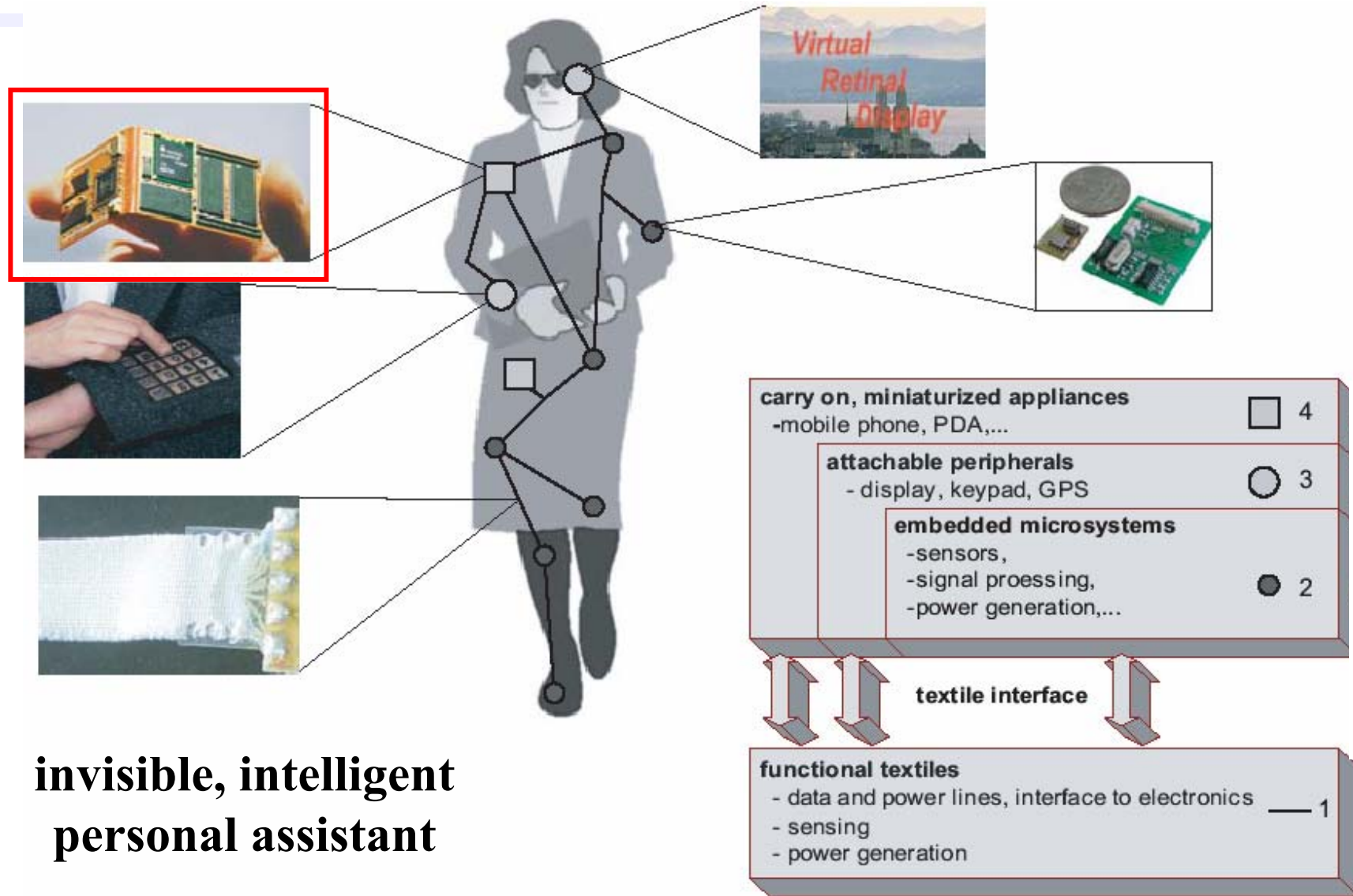
- **intelligent display driver and frame buffer with wireless interface**
  - modeling of computation communication tradeoffs
  - design and implementation of ultra low power system
- **focus free virtual retinal display**



- **'finger mouse'**



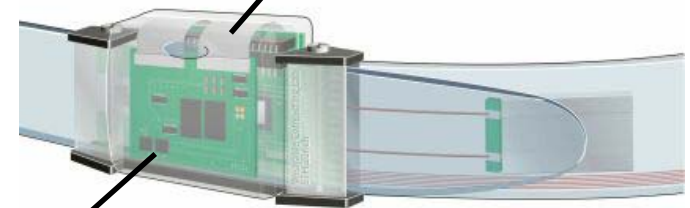
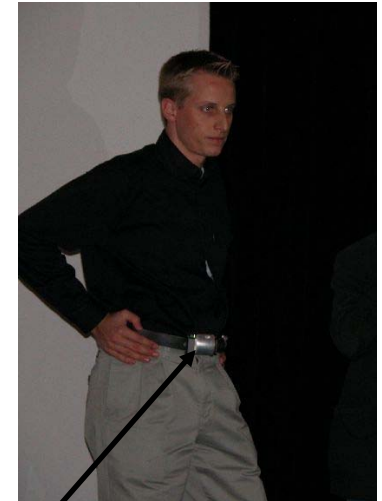
# Layer 4: Add On



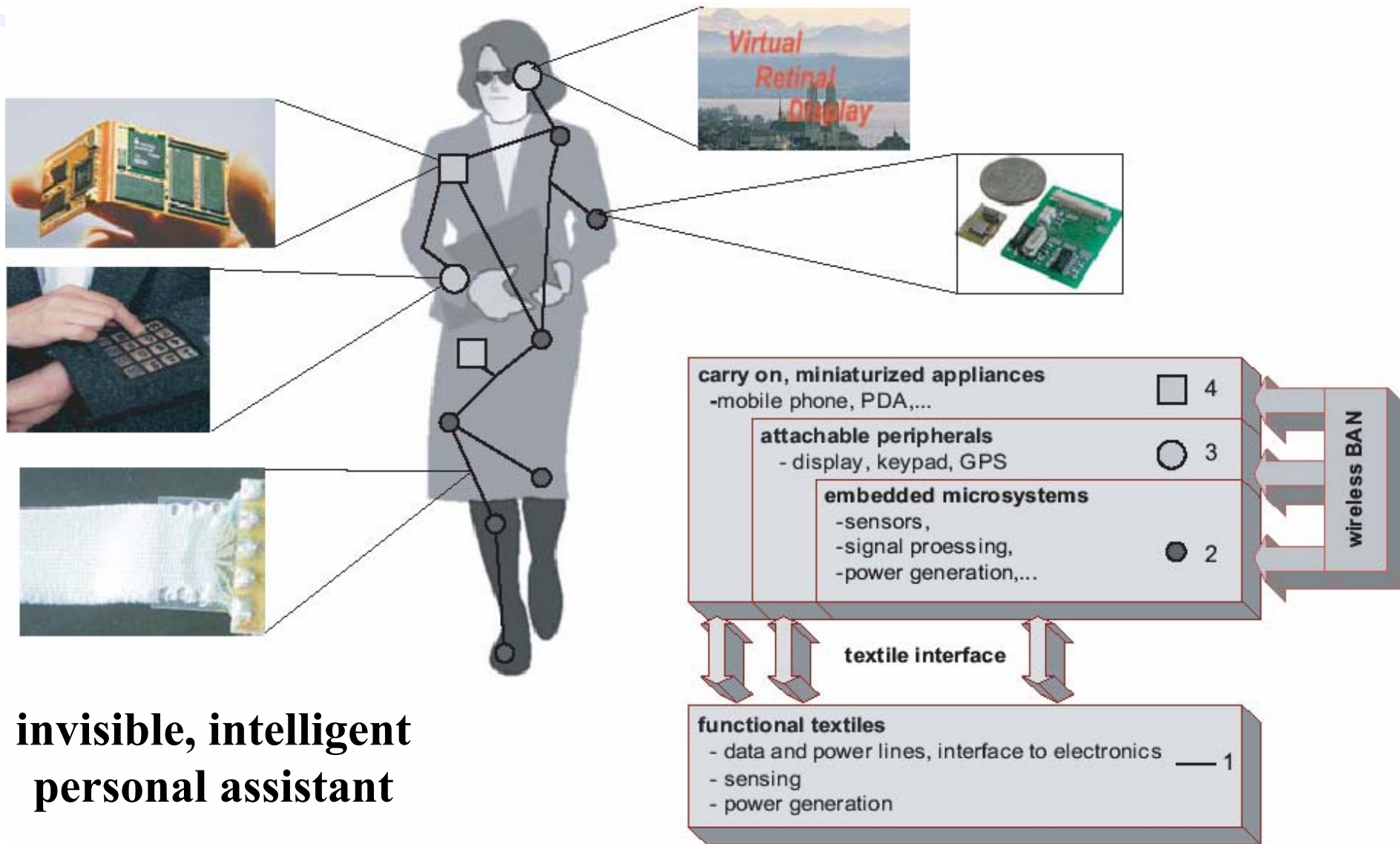
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# Layer 4 at the ETH Wearable Lab

- **WearARM experimental platform**
  - advanced power management and monitoring
  - body shape driven system partitioning and packaging
- **X-Scale based QBIC**
  - 400 MHz XScale
  - 256 MB RAM, 32 MB FIASH
  - BlueTooth, RFM
  - USB, SD-Card
- **power management**
- **system modelling**



# Wireless



**invisible, intelligent  
personal assistant**

# Summary Wearable Computing

ubiquitous, self organizing system integrated in the users outfit

• *invisible*, intelligent, always active, personal assistant

- nonintrusive monitoring
- personalized just in time information
- personalized multimedia recording with annotations
- personalized, adaptive interface to the environment

much interest from industry:

- mobile providers
- medical
- manufacturing

# Layer 3 at the ETH Wearable Lab

## IO as the key issue

- **intelligent display driver and frame buffer with wireless interface**
  - modeling of computation communication tradeoffs
  - design and implementation of ultra low power system
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