Instrumented Environments

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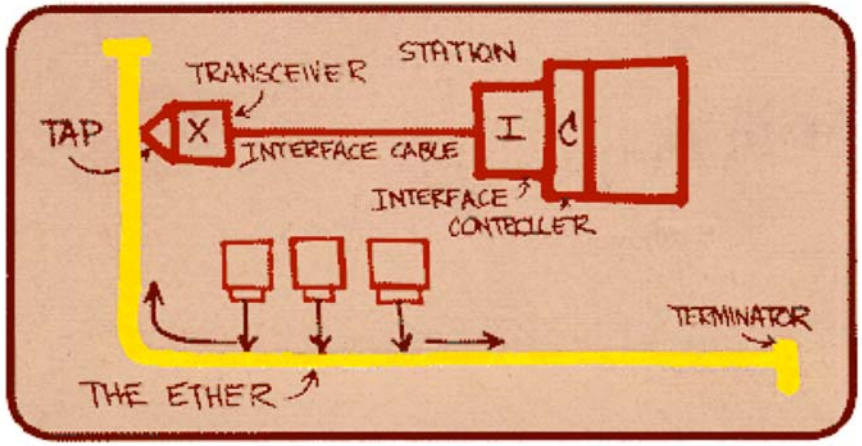
Fri, 12:15-13:45, Theresienstr. 39, Room E 045

Topics today

- Networking
  - Wire-based
    - Ethernet
    - 1-wire-bus
    - Network surface: Pin& Play
    - Power Line
  - Wireless
    - WLAN
    - Bluetooth
    - Custom
  - Infrared

Ethernet (here: 10Base2)



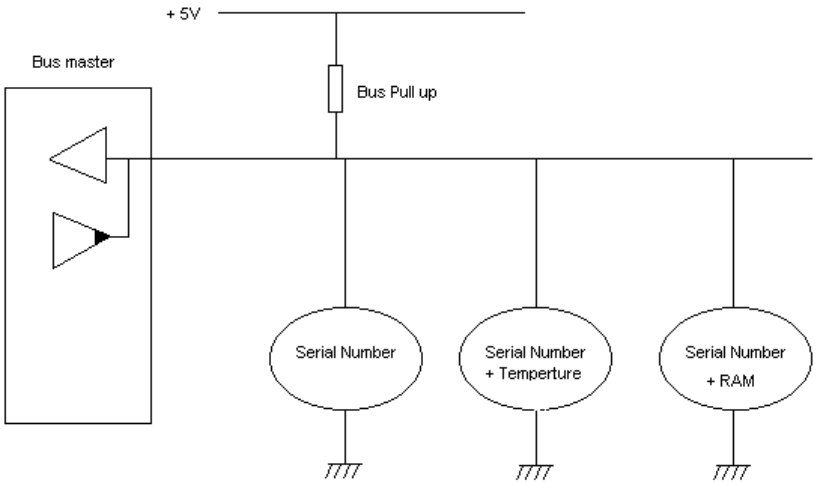
First sketch of the Ethernet by Bob Metcalf in 1976

- Developed by Bob Metcalf (Xerox PARC)
- Open standard since 1980 (DEC, Intel, Xerox)
- IEEE standard since 1986
- Main Components:
  - Physical medium (cable)
  - Access rules inside the Ethernet interface
  - Ethernet frame with well-defined number of bits
- No central component
- CDMA/CD: Carrier Detect Multiple Access with Collision Detectio
- Deal with collissions by random timeout

1-Wire bus

- Ethernet needs a separate power supply for each connected device
- Problem with Ubicomp: lots of small devices with low power consumption
- Solution: Use the data cable to supply power (i.e. power over Ethernet or 1-Wire bus)
- 1-Wire bus needs only one cable (+ ground)

1-Wire bus



- Developed by Dallas Semiconductor
- Bidirectional communication
- “master” provides “slaves” with power

- The slave obtains power over the data cable
- The slave uses a capacitor to store the energy needed for proper operation (starting with 2,8 Volts)
- To send a logical 1: pull down voltage on data cable for less than 15 µs and…
- To send a logical 0: pull down voltage on data cable for more than 60 µs

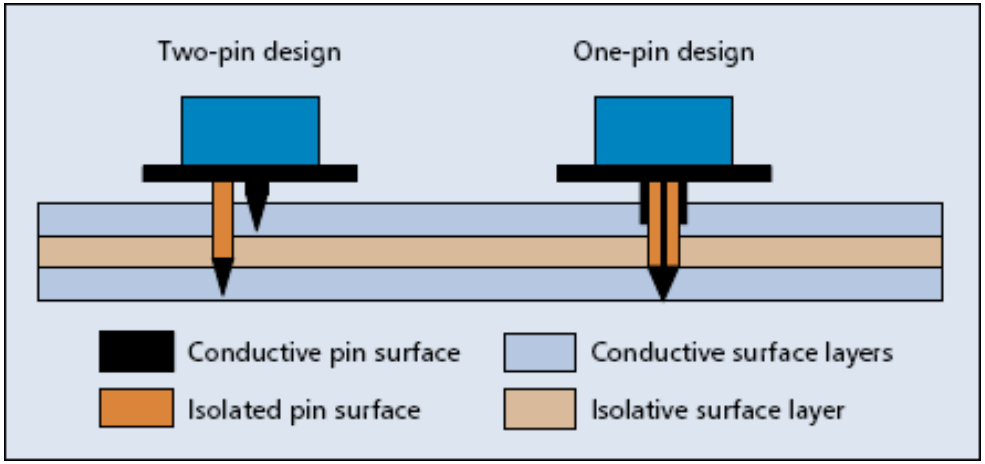
1-Wire bus

- Each slave has a unique (48-bit) Id
- Different types of slaves are available: NVRAM, EEPROM, temperature sensors, simple clocks, etc...
- Data cable may reach up to 300 meters
- Theoretically infinite number of slaves, but since reading is sequential there is a practical limit (e.g. Reading of 500 ids takes approx. 12 s).

- Some applications:
  - identification of persons
  - sense real world states
- Advantage: Integrity of data cables can be tested easily.

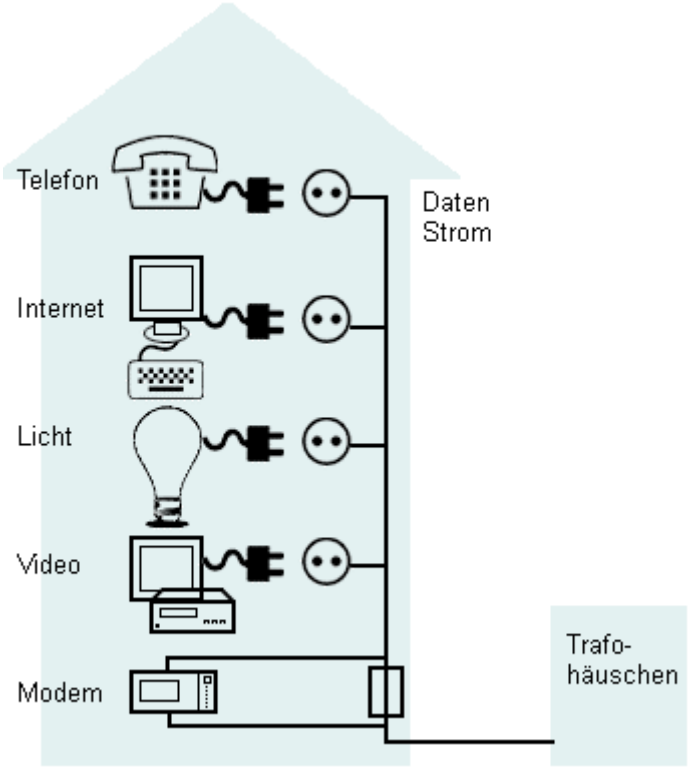
Pin & Play

[http://ubicomp.lancs.ac.uk/pin&play/]



Power Line Communication

- Uses existing in-house power cables
- E.g., PLC-ethernet bridge with 14MBit/s
- Some Applications:
  - LAN, Internet access
  - Telephone – Voice over IP
  - Video on Demand, surveillance
  - Reading out energy counters
  - Remote control of devices
- http://www.homeplug.org/



Problems of Power Line

- Quality of connection depending on
  - Different circuits and phases (fix by adding a capacitor between them)
  - Background noise
    - Household appliances: e.g. TV, Radio (narrow bandwidth noise)
    - Electrical engines (e.g., drill: broad bandwidth noise)
    - Switches (e.g., for lights: single bursts)

Radio-based technologies

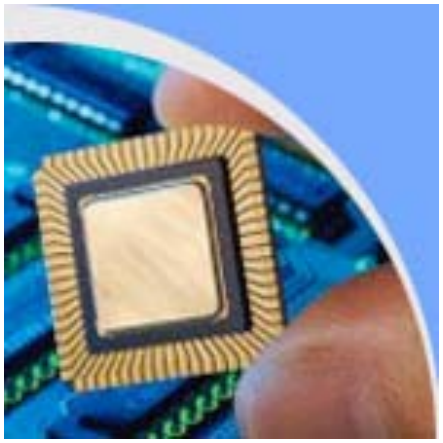
- Large cells (>100 m): e.g. WLAN, GSM, UMTS
- Small cells (10 - 100 m): e.g. Bluetooth
- Very small cells (1 - 30 m): RF module

WaveLan IEEE 802.11b

- Basically like ethernet on air (2.4 GHz)
- All stations send and receive on the same frequency.
- Repetition on collision
- High frequency means small range (50-500 m)
- Advantage: already widespread

Bluetooth http://www.bluetooth.com/

Idea: radio networks with small range replace today's cables and provide a bridge to existing networks.



Examples:

BT Headset for mobile phones

Phones, Fax, PDA, Computer, keyboard, printer, joystick, fridge, microwave, heating, car.....

Bluetooth

Principle: establish, enlarge and shut down ad-hoc networks, depending on proximity of Bluetooth enabled devices

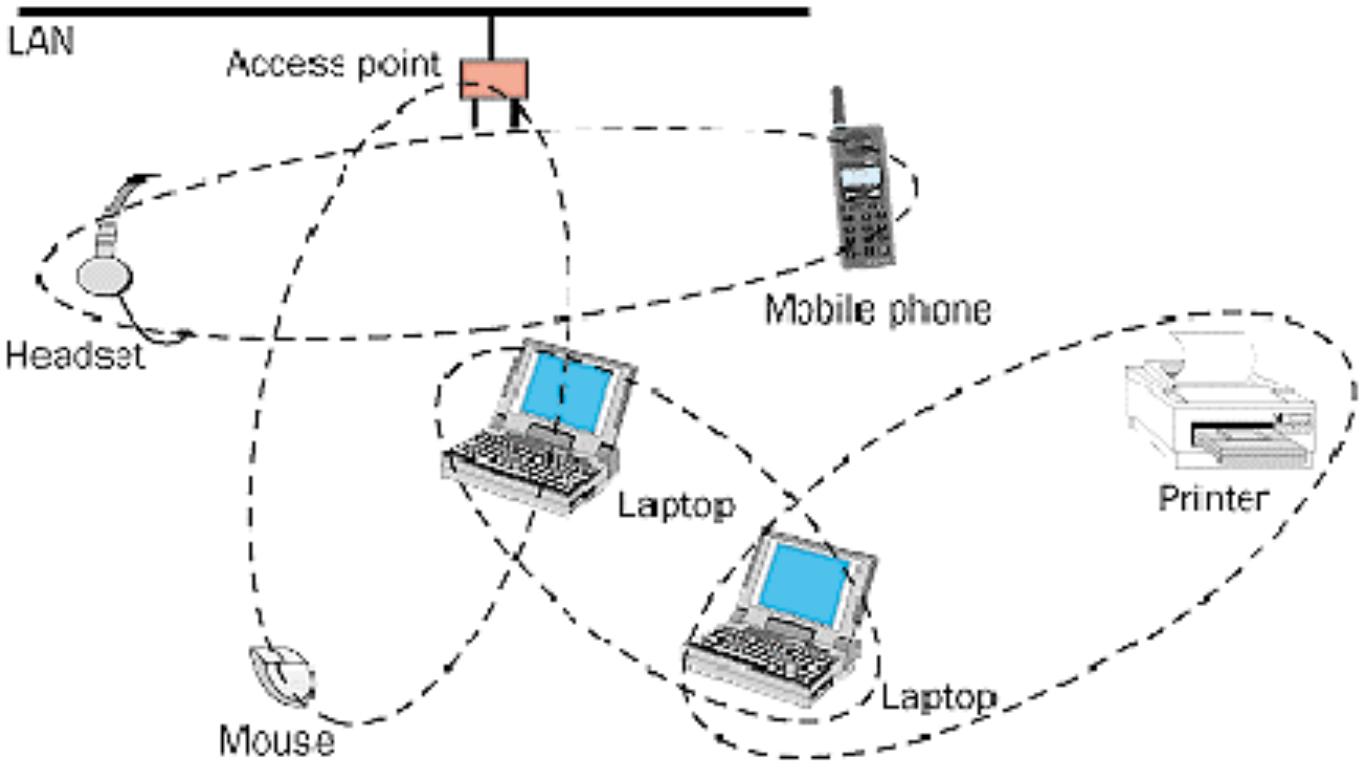
Technical facts:

Speed	ca. 1 MBit/s
Size of cell	10 or 100 Meter
Frequency	2.4 GHz

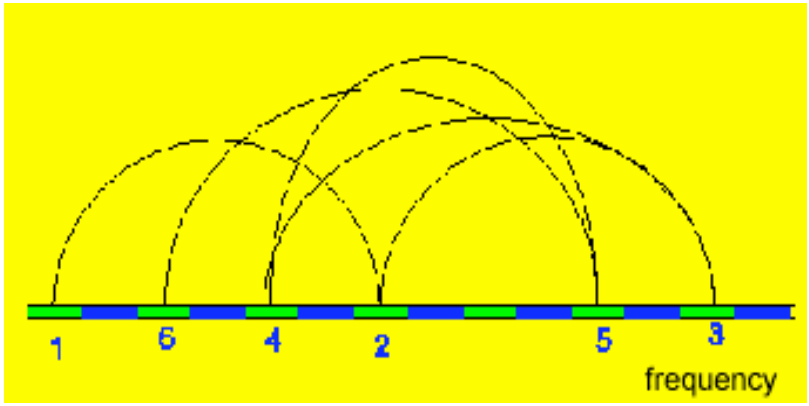
Consortium: 3Com, Ericsson, IBM, Intel, Lucent, Microsoft, Motorola, Nokia und Toshiba

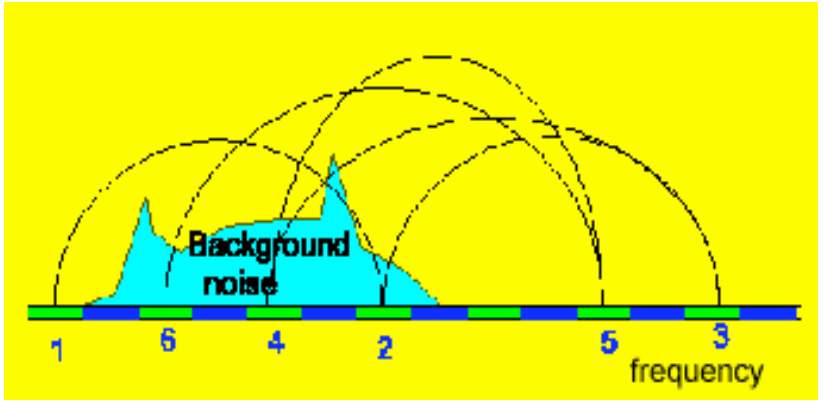
Bluetooth Pico-nets (ad-hoc networking)

Each Pico-net has one master and up to 6 slaves



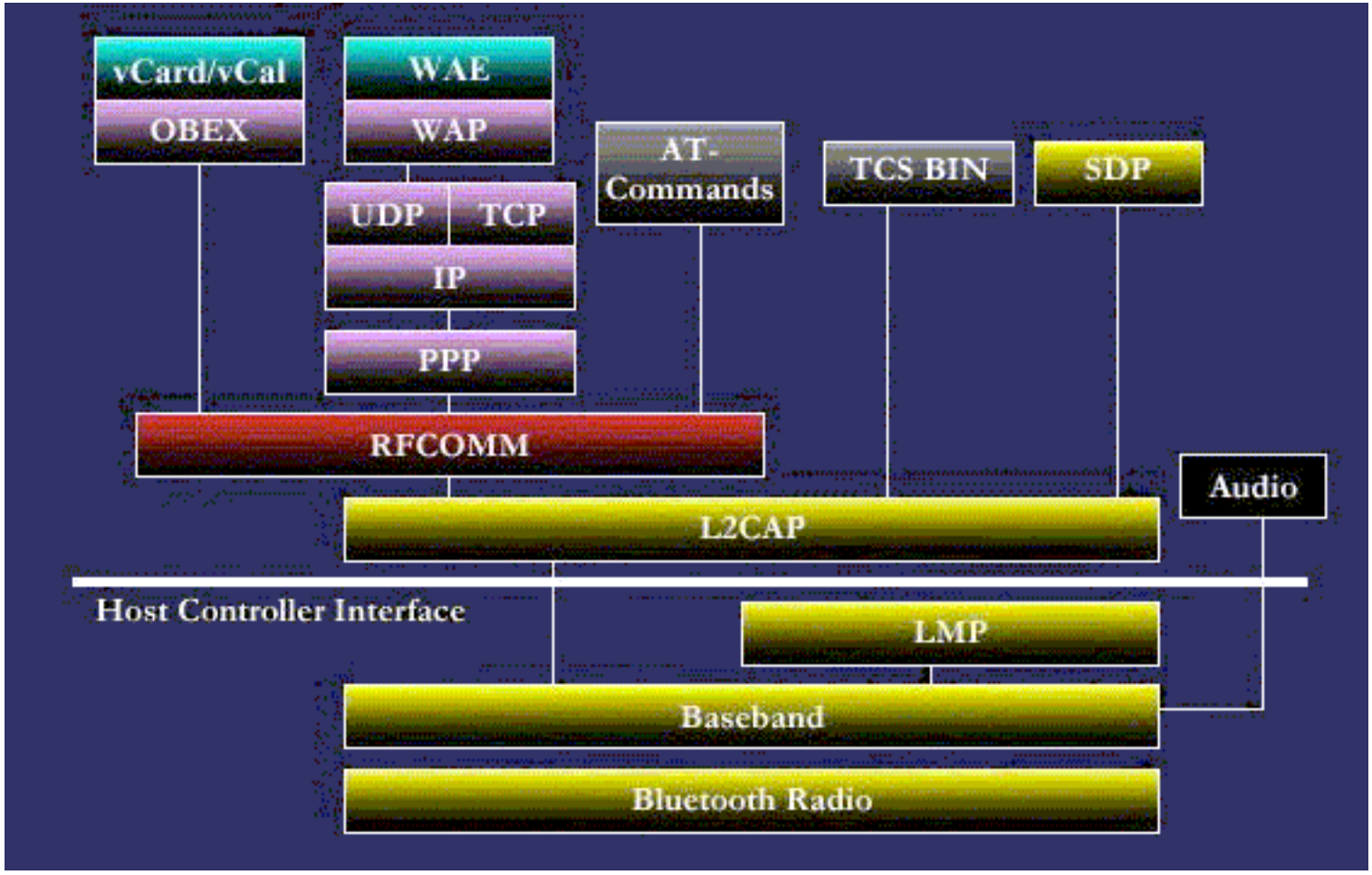
Frequency Hopping



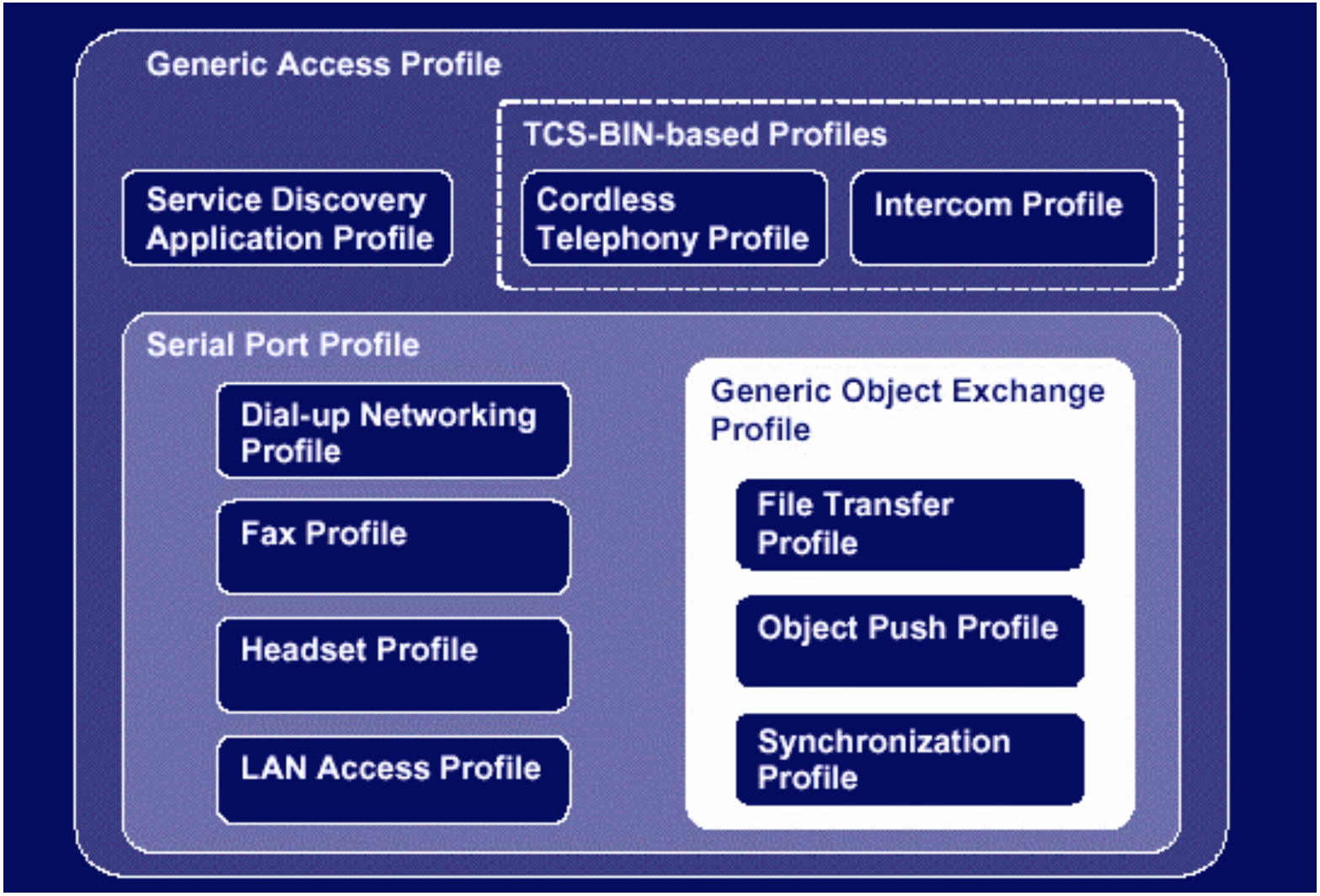


- Schema-based change of frequencies
- Fast hopping and small package sizes reduce the probability of collisions

Bluetooth Specification (part of) Protocol Stack



Bluetooth Profiles



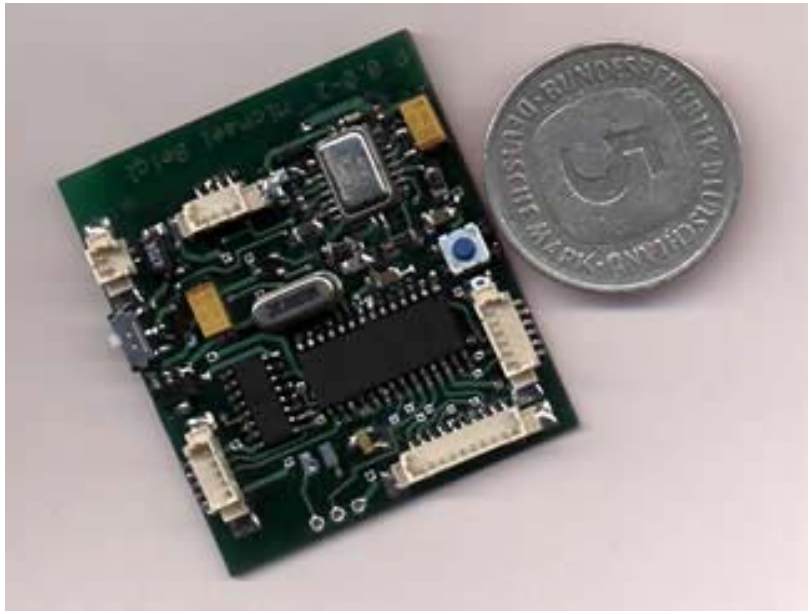
Each profile is a vertical cut of the bluetooth protocol stack

Problems of Bluetooth

- Lots of noise on 2.4 GHz (e.g. microwave oven and WLAN)
- Small bandwidth (worst case < 1/7 MBit/s)
- Still complicated interfaces
  - Inconsistency of supported profiles
  - Partially implemented profiles

Custom RF Devices

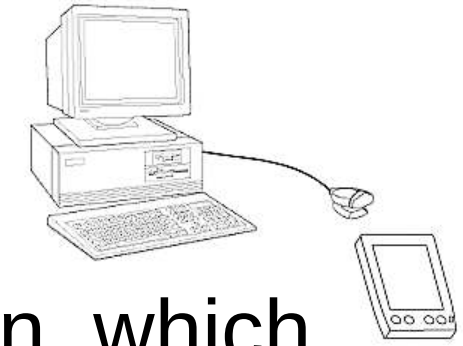
- Cheap solution, needs individual adjustments
- Small range (1-30m), low power consumption
- low bandwidth: 115 KBit/s
- Small form factor
- Examples:
  - Smart-Its
    www.smart-its.org/
  - Berkeley Motes
    www.tinyos.net/



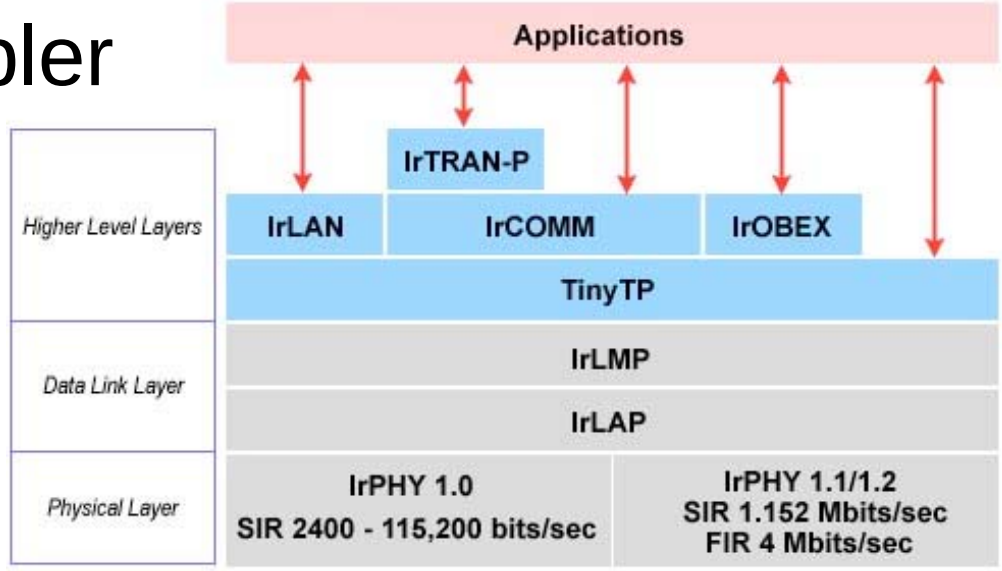
Infrared communication

- Uses invisible light (900nm)
- Does not travel through objects (needs line of sight)
- Analog: IrRemote
  - Modulated carrier
  - Good range (up to 20 m), small bandwidth
- Digital (IrDA)
  - Uses single light flashes for 1 and 0
  - Small range, high bandwidth (up to 4 Mbit/s)
  - Bidirectional communication between 0 and 2 meters

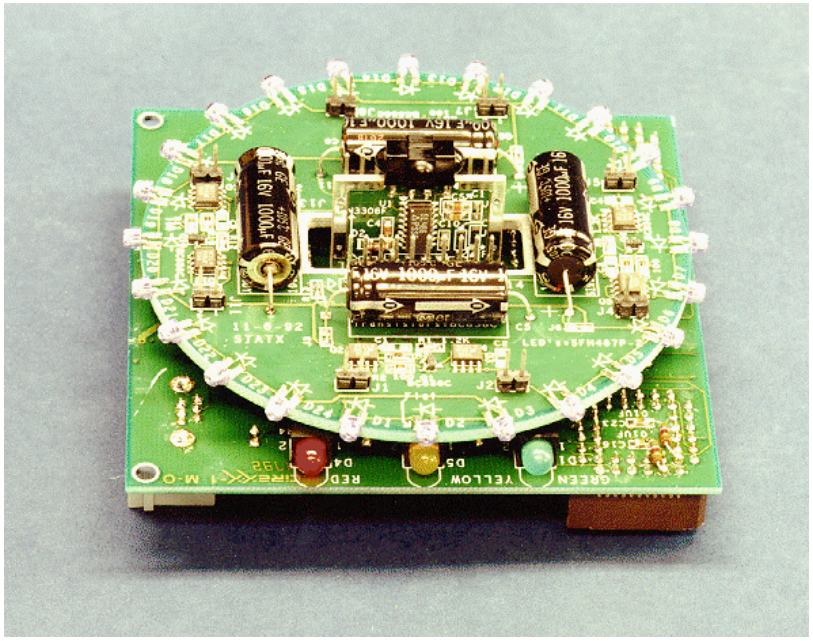
IrDA



- Founded 1993 as an organization, which defines an independent open standard
- The goal was to realize simple point to point solutions to connect devices.
- Protocol stack simpler than Bluetooth
  - LAN
  - Serial
  - ObEX



Long range connections with IR



- Parctab Communication Hub
- Range 7m
- Bidirectional connection
- 9.600/19.200 baud
- analog IR

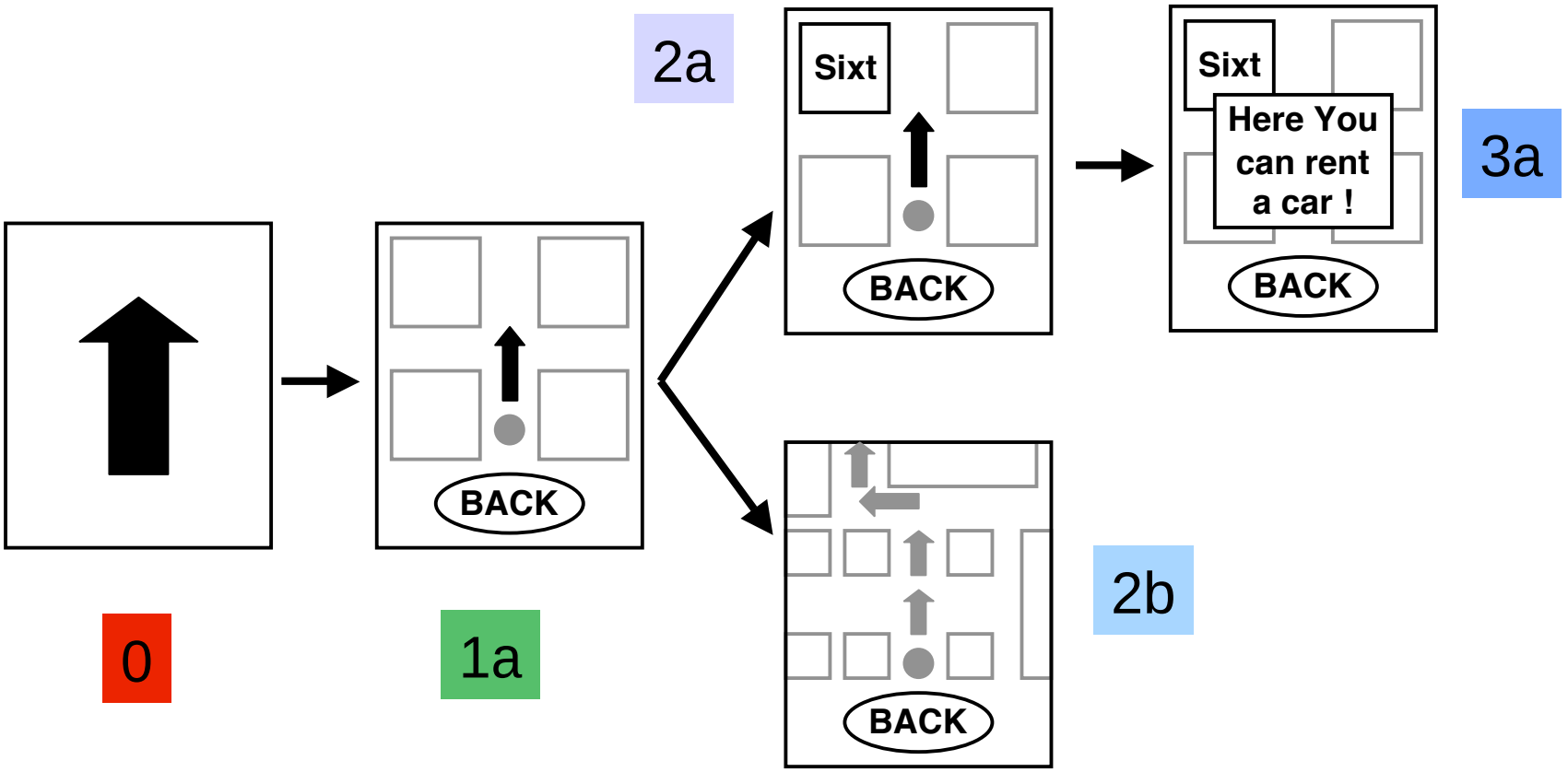
- Eyeled Sender
- Range up to 20 m
- Bi/Unidirectional connection
- 115 Kbaud
- IrDA compatible

Broadcasting structured information

- Cut down presentations to small packets (similar to Videotext)
  - Use different interaction levels
  - First package starts at level 0
  - => Conceptual presentation graph

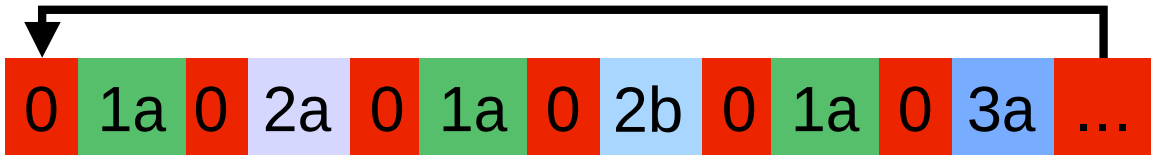
- **Transition between levels:**
  - Qualitative change of information
  - additional information
  - more general or detailed information

Example: Presentation graph



Ideal transmission scheme

- Continuous transmission cycle
- Arbitrary entry point
- Quick availability of level 0
- Levels >0 may take longer
  - Can only be reached by interaction
  - Hide transmission time behind interaction time



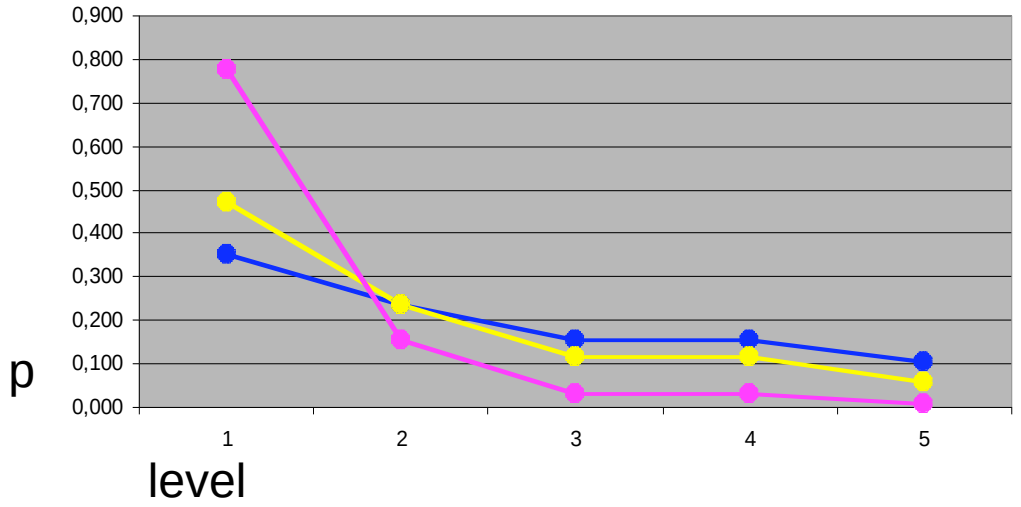
Probabilistic transmission scheme

$$w'_{ik} = \frac{1}{c^{i+1}}, c \geq 1$$

$$S = \sum_i \sum_k w'_{ik}$$

$$w_{ik} = \frac{w'_{ik}}{S}$$

	c= 1,5		c= 2,0		c= 5,0	
	w'ik	wik	w'ik	wik	w'ik	wik
0	1	0,351	1	0,471	1	0,776
1a	0,667	0,234	0,500	0,235	0,200	0,155
2a	0,444	0,156	0,250	0,118	0,040	0,031
2b	0,444	0,156	0,250	0,118	0,040	0,031
3a	0,296	0,104	0,125	0,059	0,008	0,006



Body Network

[e.g., http://www.skinplex.net/]