



Low-power systems for wireless ICT applications

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Overview: Low Power Systems

- Power & Power Consumption
- Desktop vs. low-power systems
- Low-power Systems
 - Hardware
 - Storage
 - Software
 - Operational strategies
- Vendors

Power: Terminology

- Volts – Potential (force needed to overcome resistance)
- Amperes(Amps) –Current or Rate of Flow
- Watts – Power available(volts X amps)

Power consumption in a typical desktop PC

- Mainboard 20–30 W
- 600Mhz CPU 45 W
- RAM 10 W per 128MB
- IDE Disk 5–15 W per disk
- IDE CDROM 5–15 W
- PCI 5 W per slot
- Network 5 W
- Video 5–25 W



120-160 W

(Without Monitor)

195-235 W

(With 17" Monitor)

Runtimes on a Battery

- (Graph or something here)

Low-power("embedded") systems

- Consume 1–15W power from a 3–5 V, 0.5–5A input
- low-power, often older CPU
- No or limited expansion capability
- Use flash memory for storage instead of hard disk
- Limited or no video output
- I/O ports use custom connectors, cables

Power Inputs

- Most of the systems we'll discuss use one of:
- Power “Brick”
- Battery pack
- “Power Injector”
- Power over Ethernet(POE)

- Power Over Ethernet (POE)
- Defined by IEEE standard 802.3af
- Provides 48V @ 350 mA, supplying
- 15W
- Uses non-data pairs in RJ-45 cable

System Types

- Commercial APs (Linksys, Netgear, etc.)
- PC-104 board stacks
- Soekris-style wireless appliances
- Mini / Nano-ITX single-board systems

Linksys WRT-54G AP

16MB Flash Memory

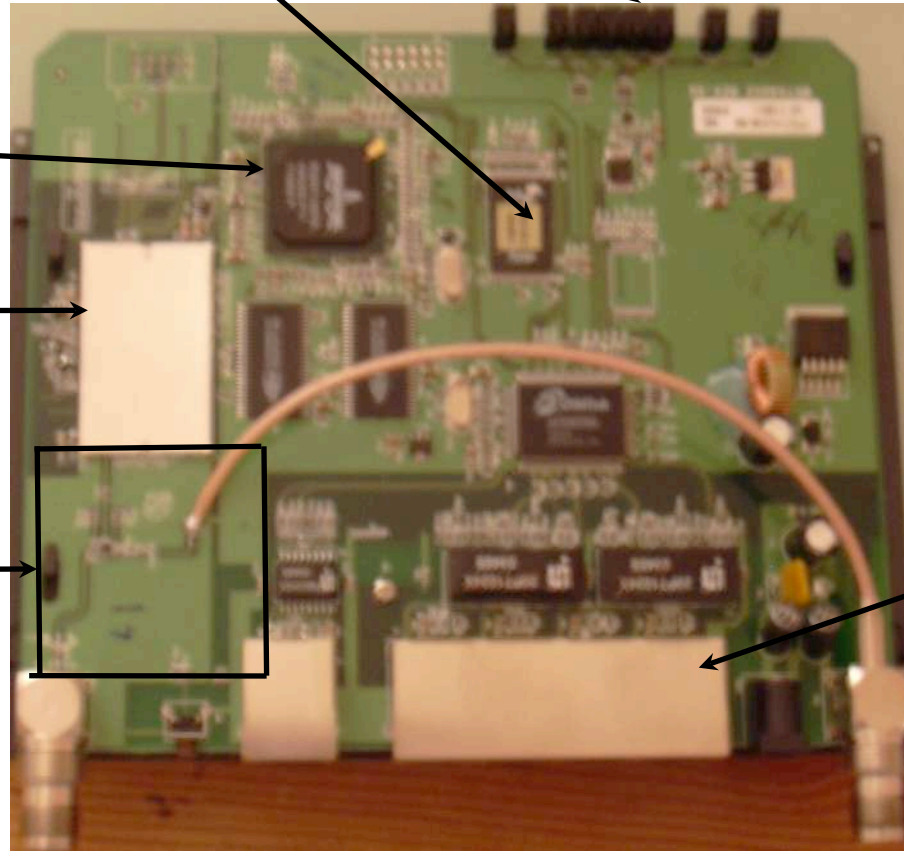
Power/Status LEDs

802.11 controller

802.11g radio

antenna traces

LAN ports

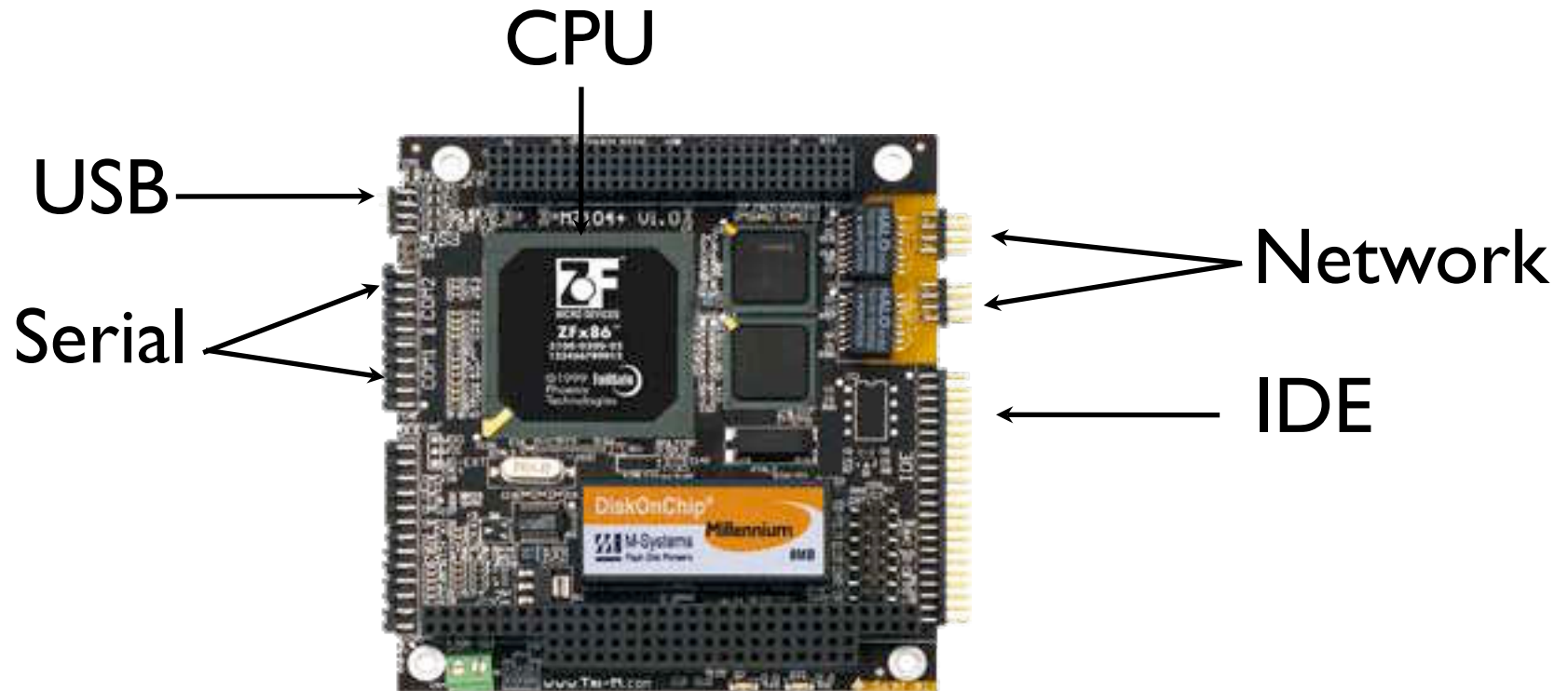


Antenna connectors(RP-TNC)

Commercial APs useful in ICT

- Linksys: WRT54G, WAP54G, WAP11(Get list off net)
 - Run Linux, Flash upgradeable, Source code available from Linksys under GPL license
 - Web-based admin interface
 - Very limited storage
 - Relatively inexpensive(\$49–99 US)

PCI04 System



- Single-board system
- Expandable by plugging additional boards on top
- Uses +5V @ 0.98Amps
- Good for rapid-prototyping other systems

PCI04 System Stack

Serial Console

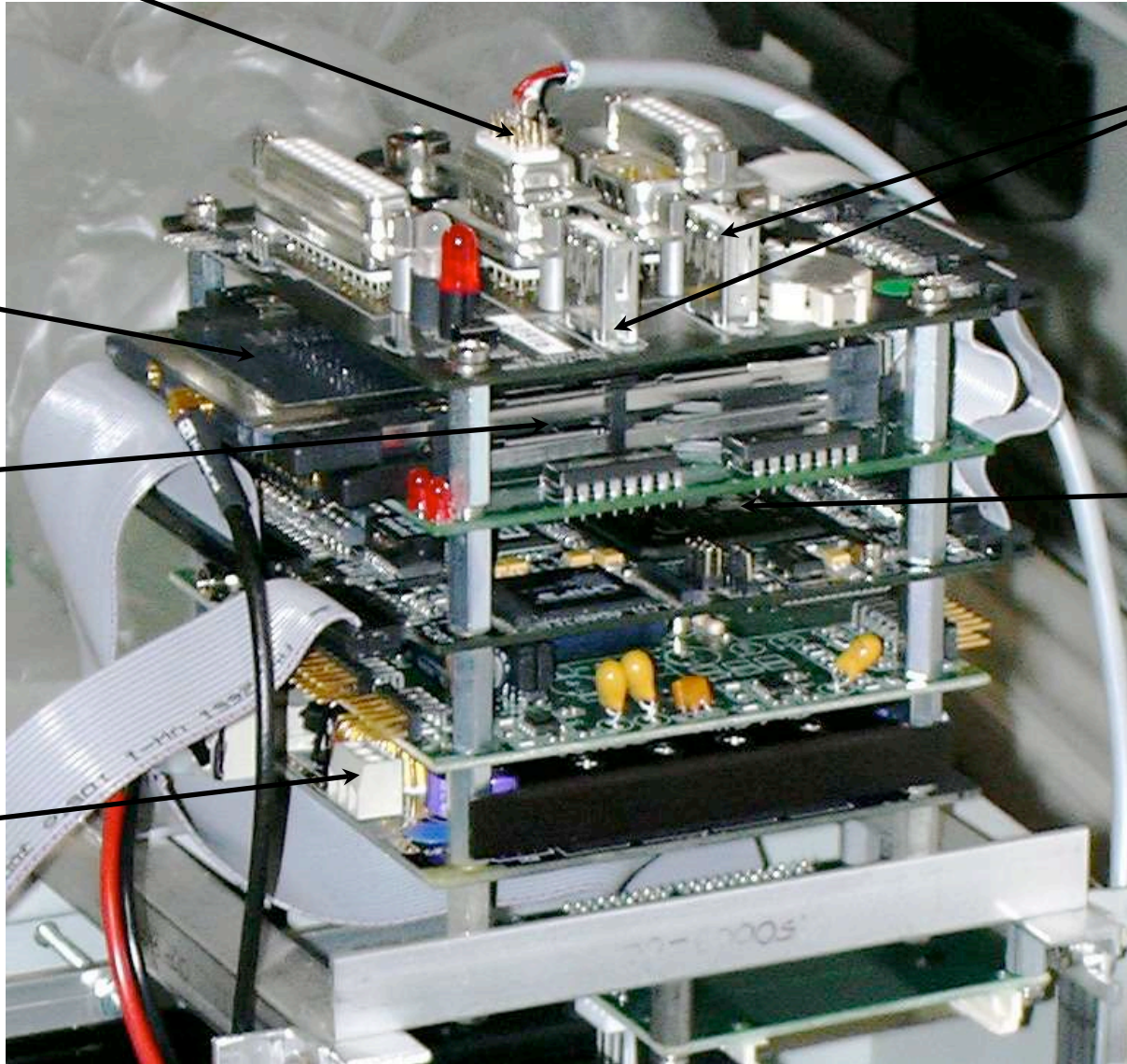
USB

802.11b card

PCMCIA

CPU

+5V
Power



Soekris Single-Board System



Ethernet

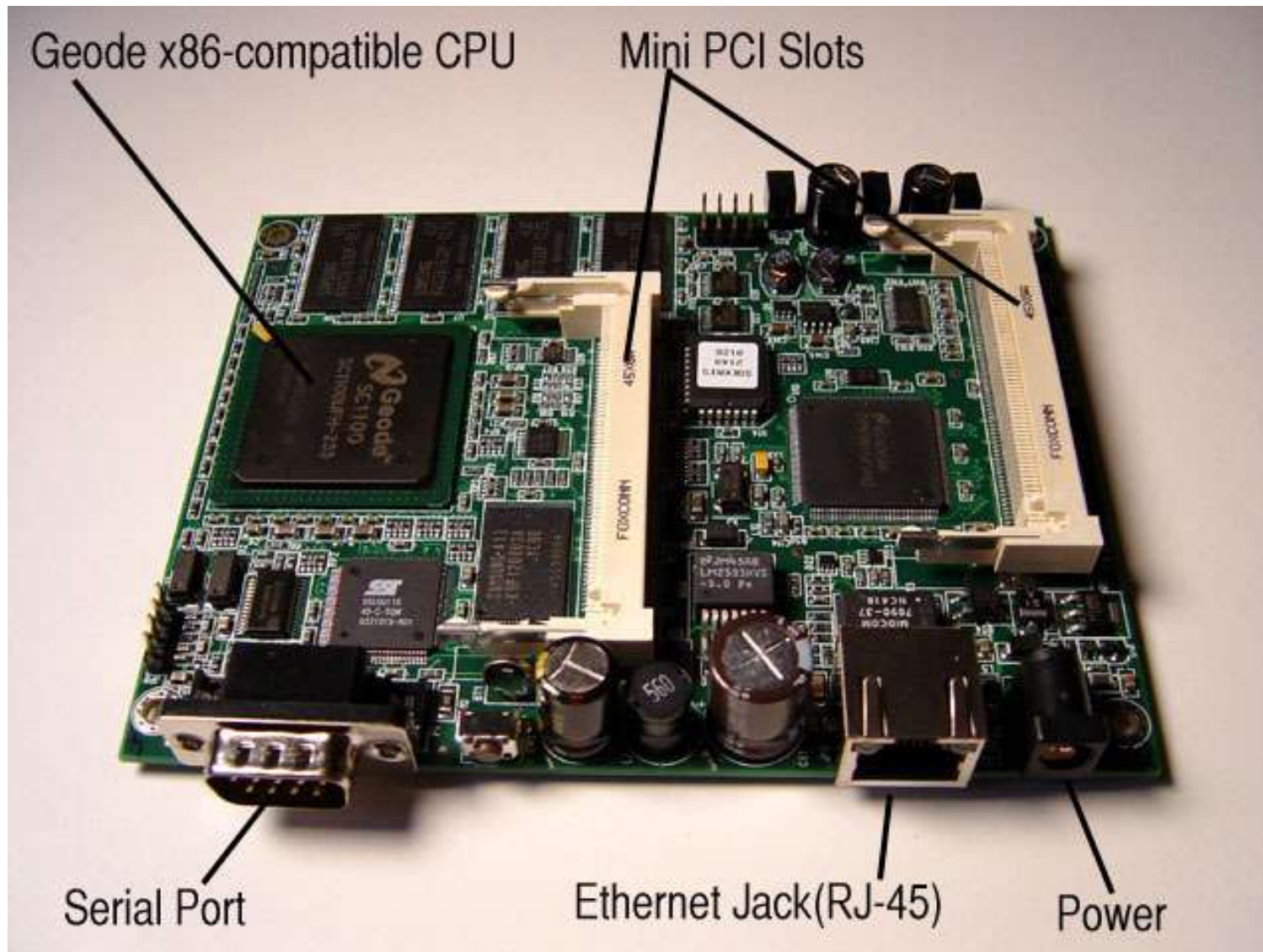
Serial

Mini PCI

CF card

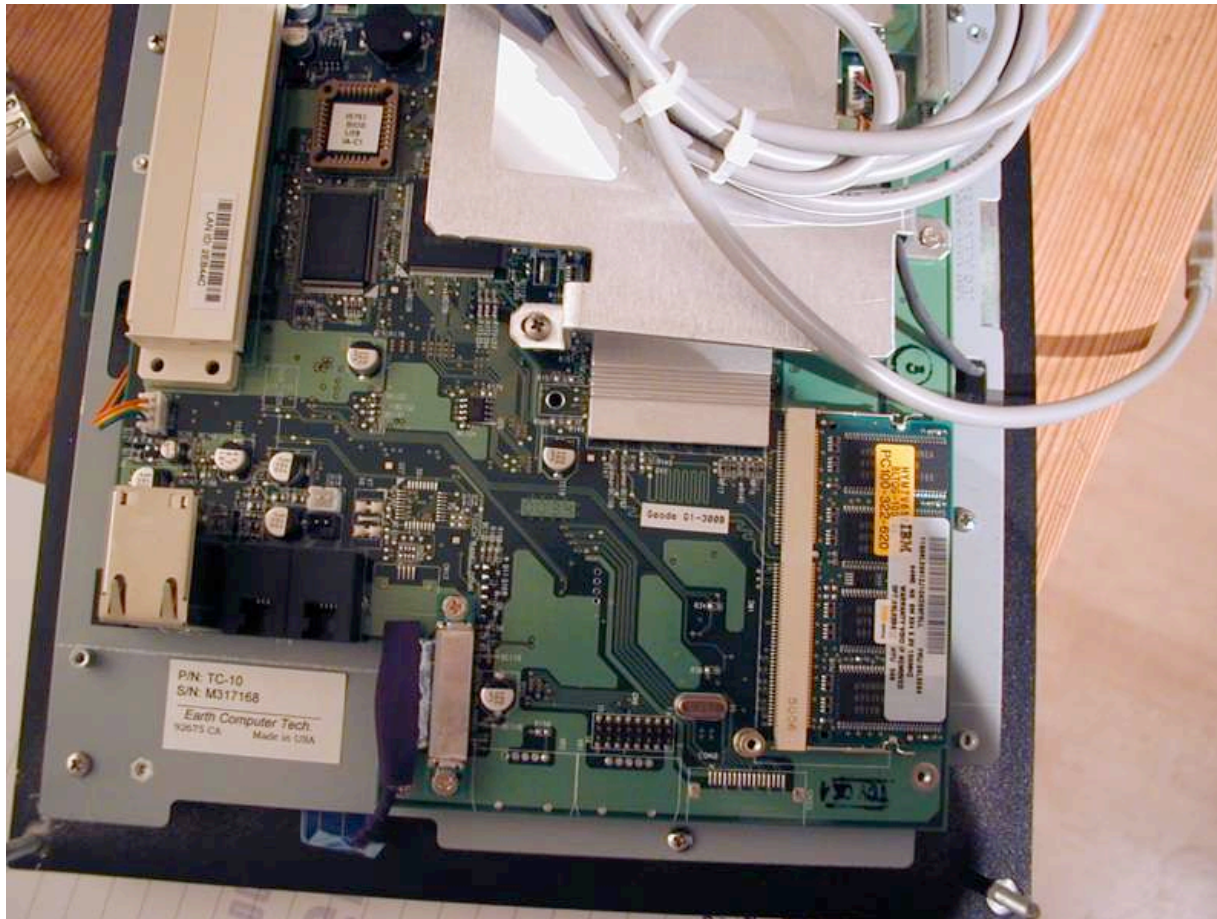
PCI slot w/ 802.11b card

Soekris Single-Board System



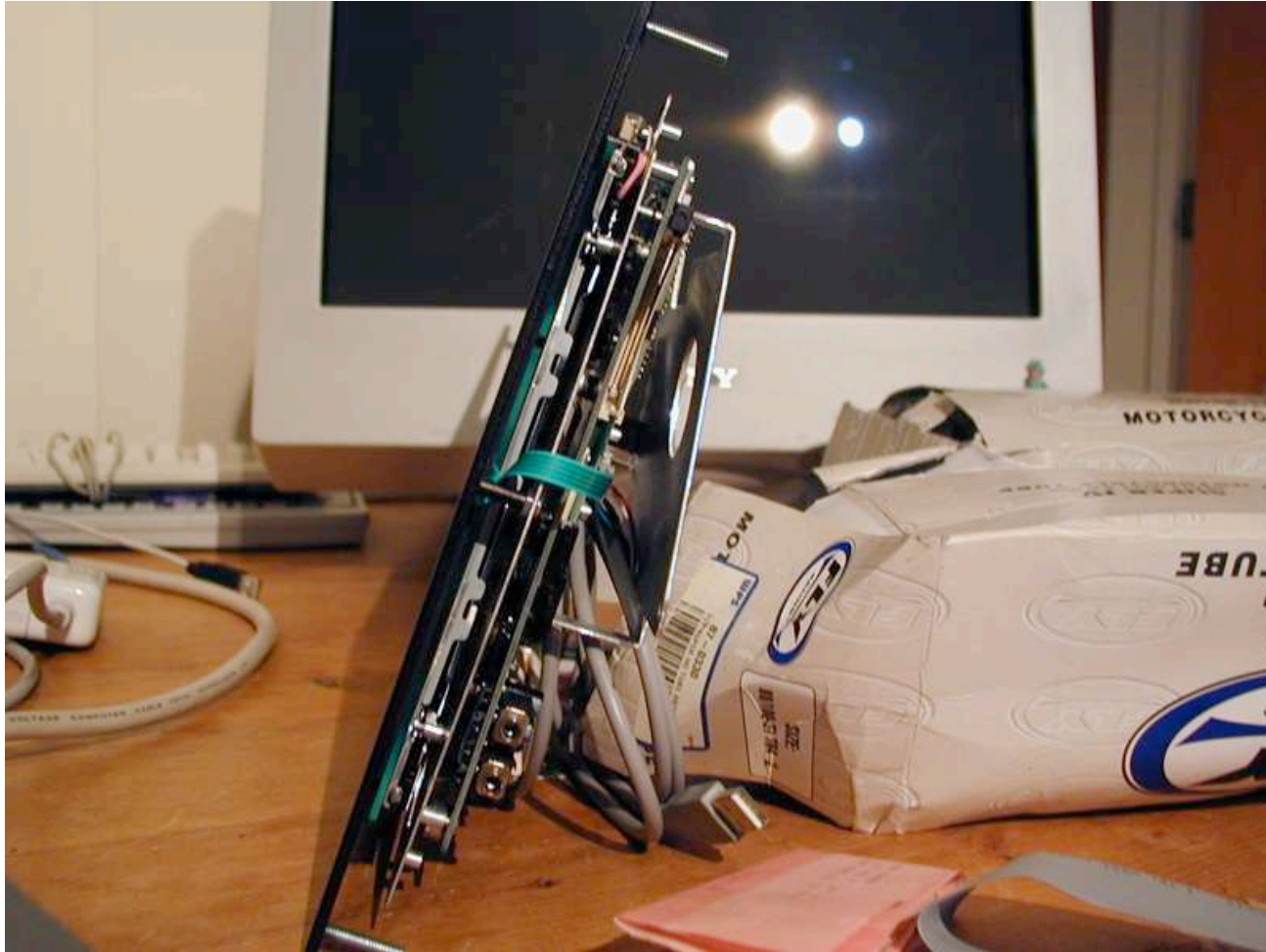
TC-10 “Thin Client” System

“Kiosk” System with built-in LCD



TC-10 “Thin Client” System

“Kiosk” System with built-in LCD



CPUs

- Common low-power CPUs
 - 486
 - ARM
 - AMD Geode
 - Pentium Mobile and Crusoe available, but expensive

Common network chipsets & their Linux Drivers

- Wireless

- 802.11G: Broadcom, Atheros, Prism,

- 802.11B: Hermes, Orinoco, Cisco

- Ethernet

- Intel EtherExpress, RealTek81xx series, National Semiconductor DP8381x series

How do I know what I have?

- Under Linux
 - Check logs like `/var/log/messages`, `dmesg`, etc.
 - `cat /proc/pci/devices` or `/proc/usb/devices`
 - list kernel modules installed w/ `lsmod`
 - examine hardware itself: model numbers, manufacturer, part numbers
 - don't take “unknown device” for an answer!

Storage for low-power systems



Compact Flash

- Most common form factor, 16MB-2GB capacity
- Limited lifespan (approx 100K write ops)
- 5V 40mA Power draw
- \$20-150 US



Microdrive

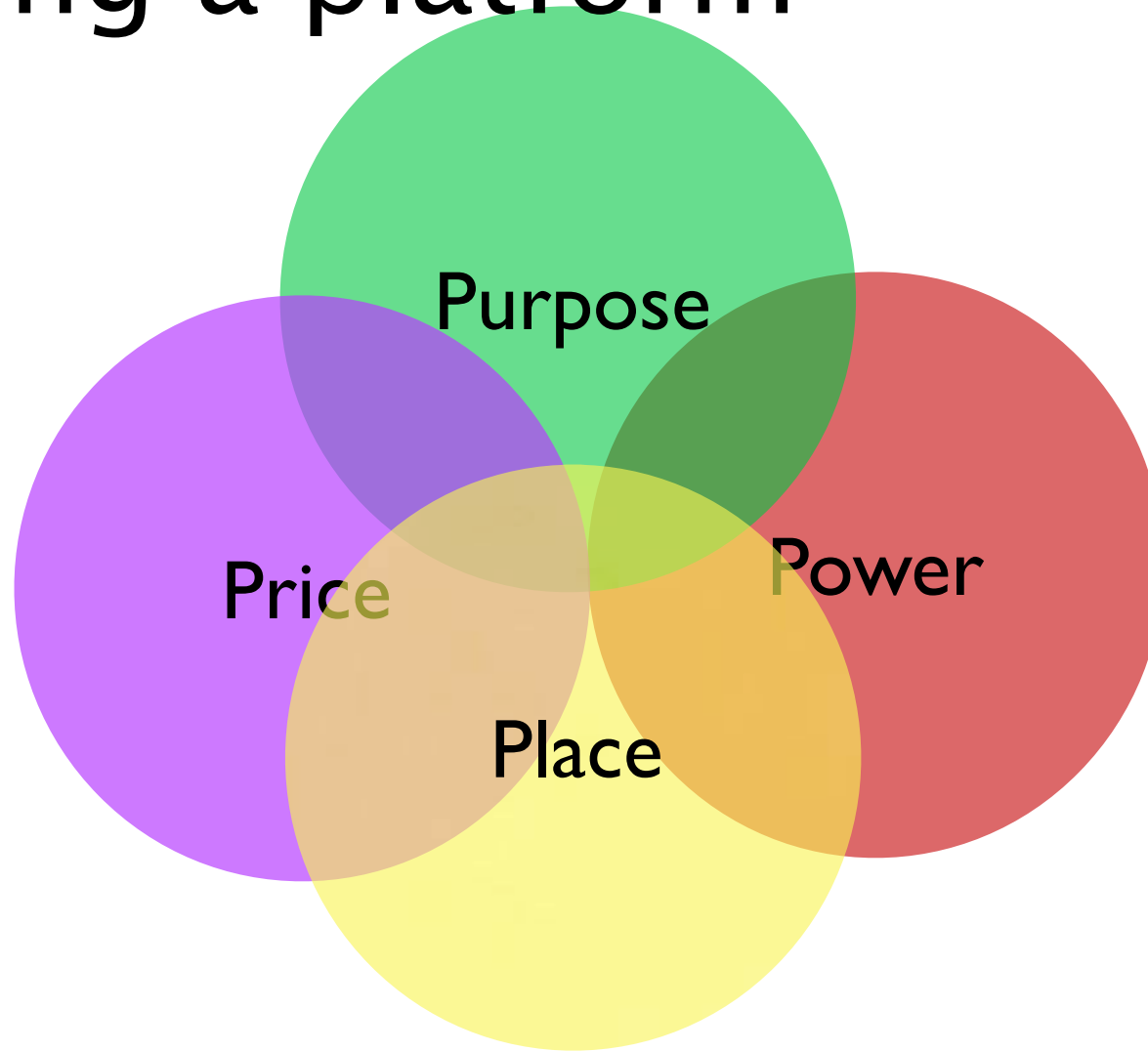
- Hard disk in CF form factor, 1-4GB
- Same power profile as CF card
- \$100-\$180 US



NAND Flash Drive

- Chip-sized form factor, 16MB-1GB
- IDE/SCSI emulation
- Wear-leveling to extend lifespan
- Hard disk-like read/write times
- Very low physical profile
- \$20-\$799 US

Choosing a platform



General Guidelines

- For basic 802.11 A/B/G APs/Bridges, web servers, etc.
 - Linksys WRT series or Soekris/Metrix embedded system
- For custom systems(i.e. custom low-power PC or prototyping systems)
 - PC-104 or general single-board embedded systems.
 - Surplus “Kiosk” or “Thin Clients” can be useful here

System Design for low-power nodes

- Choose an embedded-friendly OS (such as Linux)
- Run in RAM as much as possible
 - Saves wear on flash media
 - Lower power consumption
 - Faster than disk
- Disable or remove unnecessary programs from install image
- Schedule and batch communications sessions via cron ("Space Probe" model)
- Display
 - LED, serial(RS-232) or LCD, text mode over GUIs
 - Generally avoid when possible

Linux on low-power systems

- Use larger host system
 - Build and Configure image
 - Copy to target system via UNIX tools (tar, cp, dd, etc)
- Loaded to individual machine as a complete OS image
 - Pro:
 - Ensures functionality and integrity
 - Con:
 - Even minor changes can mean a re-install
 - Need more attention to prep & planning

Some Linux distributions for low-power nodes

- Pebble
- Debian
- OpenWRT
- EWRT
- MeshLinux

Environmental Issues

- Weather Damage
- Temperature vs Power
- Pests
- Theft and Vandalism

Any Questions?

Links for low-power systems

- Soekris Engineering www.soekris.com
- Metrix Systems www.metrix.net
- Linksys/Cisco www.linksys.com
- Earth LCD www.earthlcd.com
- Tri-M systems www.tri-m.com
- “Linux Devices”
www.linuxdevices.com
- Sveasoft www.sveasoft.com