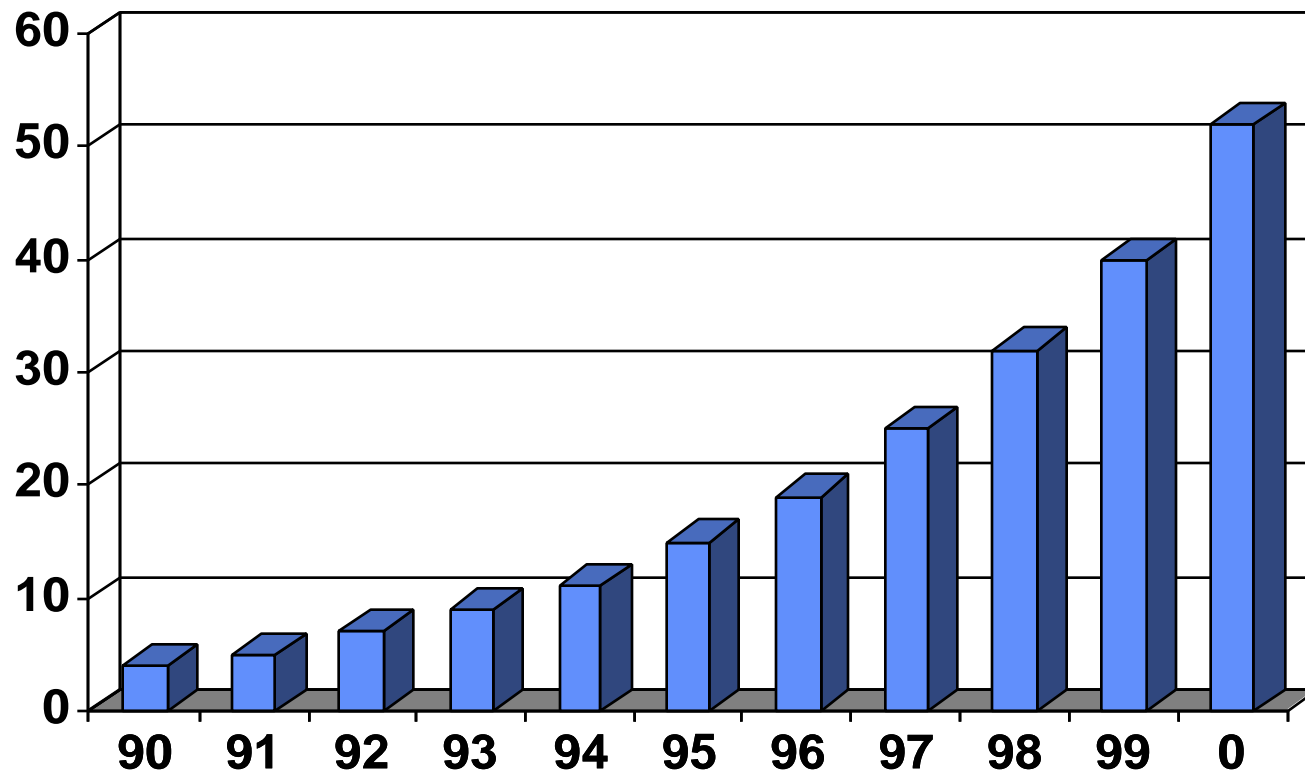


Lecture 35: Portable Computer— System Design and Packaging Issues

**Professor Randy H. Katz
Computer Science 252
Fall 1995**

Global Markets for Portable Computers

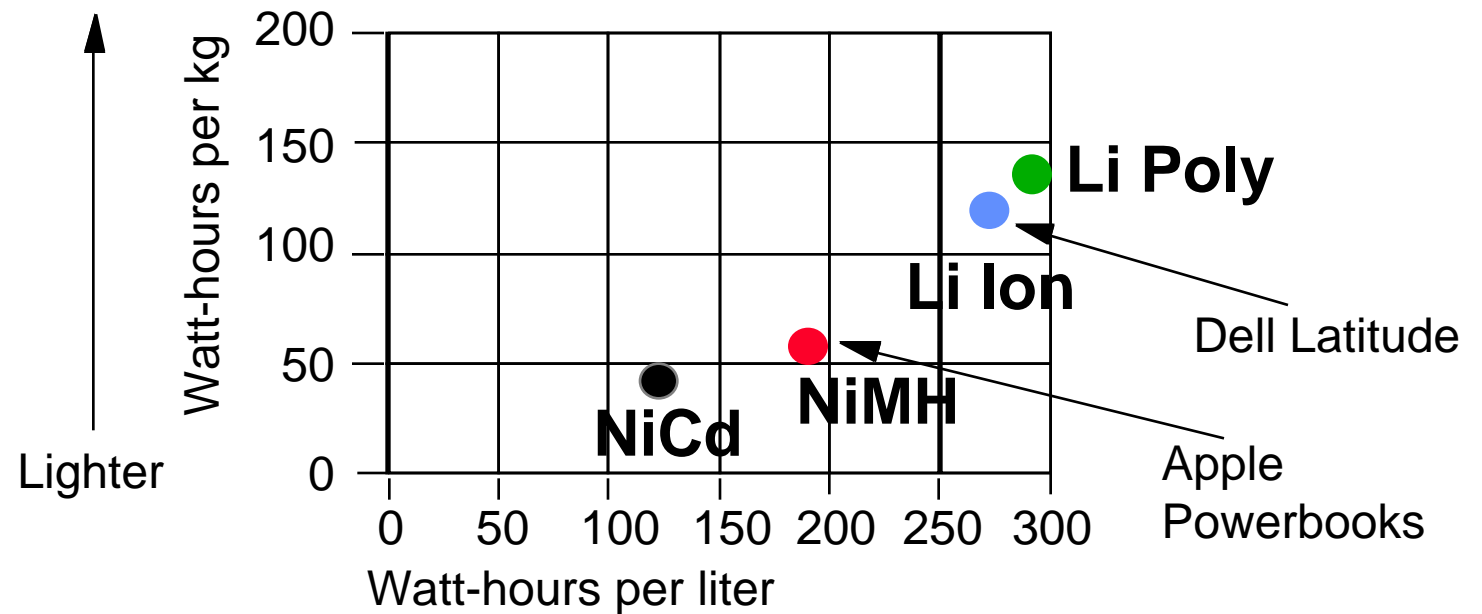
\$ Billions



Portability Issues

- **It's the power, stupid!!**
- **Batteries**
 - **Weight, volume determine lifetime**
 - » **20 W-hrs per pound**
 - » **2 pounds, 10 hours = 2 W power consumption!**
 - **Power consumption: CV^2f**
 - » **Reduce C by increased VLSI integration and MCM technology**
 - » **Reduce V to lower operating voltages: 5 V to 3.3V to 2.5V and below**
 - » **Reduce f by reducing clock frequency, standby and suspend power modes**
 - » **Intelligent operation: spin-down disk drives**

Battery Technology

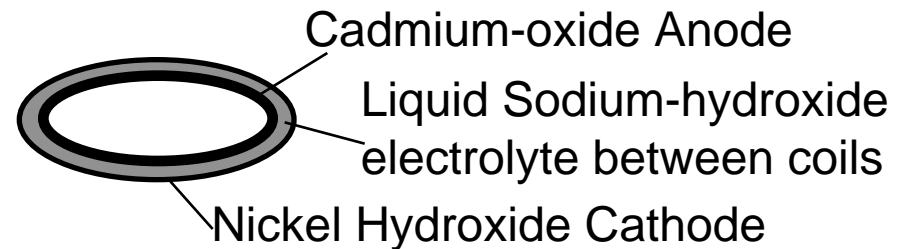


- **Other Battery Types:** Smaller →
 - Lead Acid
 - Nickel Zinc
 - Rechargeable Alkaline-Manganese
 - Zinc Air

Battery Technology

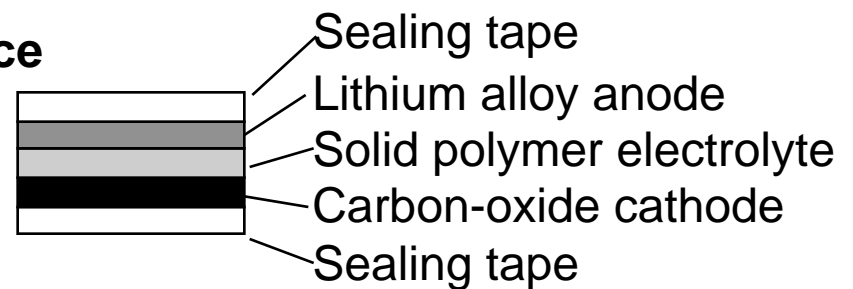
- **Nickel-Cadmium**

- Most widely used
- Require cylindrical steel cylinders containing hazardous liquid electrolytes



- **Lithium Polymer**

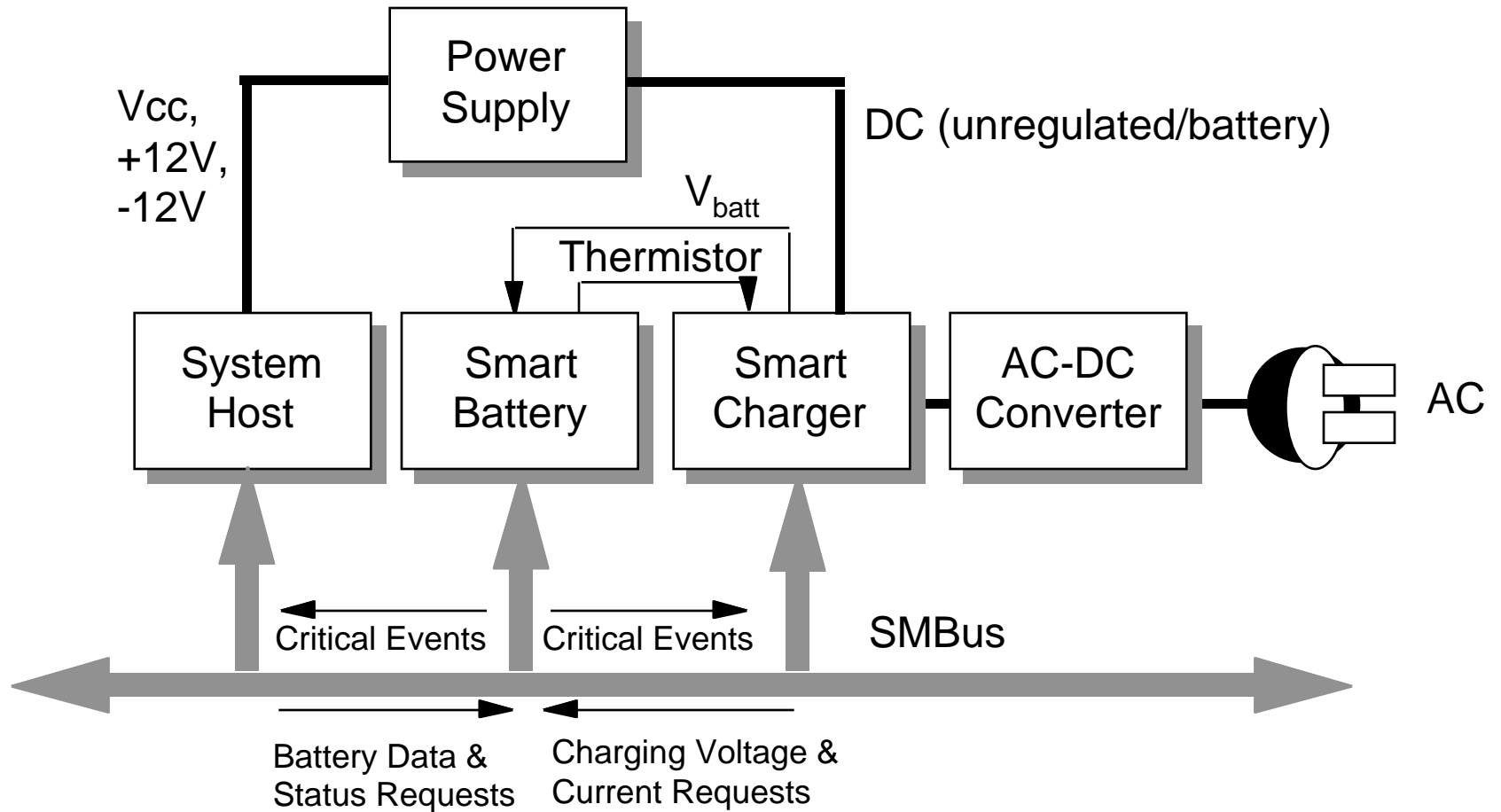
- Solid electrolyte
- Formed to fill available space



Smart Battery Specification

- **Collaboration of Duracell and Intel**
- **Better visibility of battery state:**
 - How much operating time is left?
 - Enough power to perform certain tasks, like disk spin-up?
 - Universal smart battery chargers, independent of battery chemistry
 - State information, like number of recharges, stored with battery

Smart Battery Specification



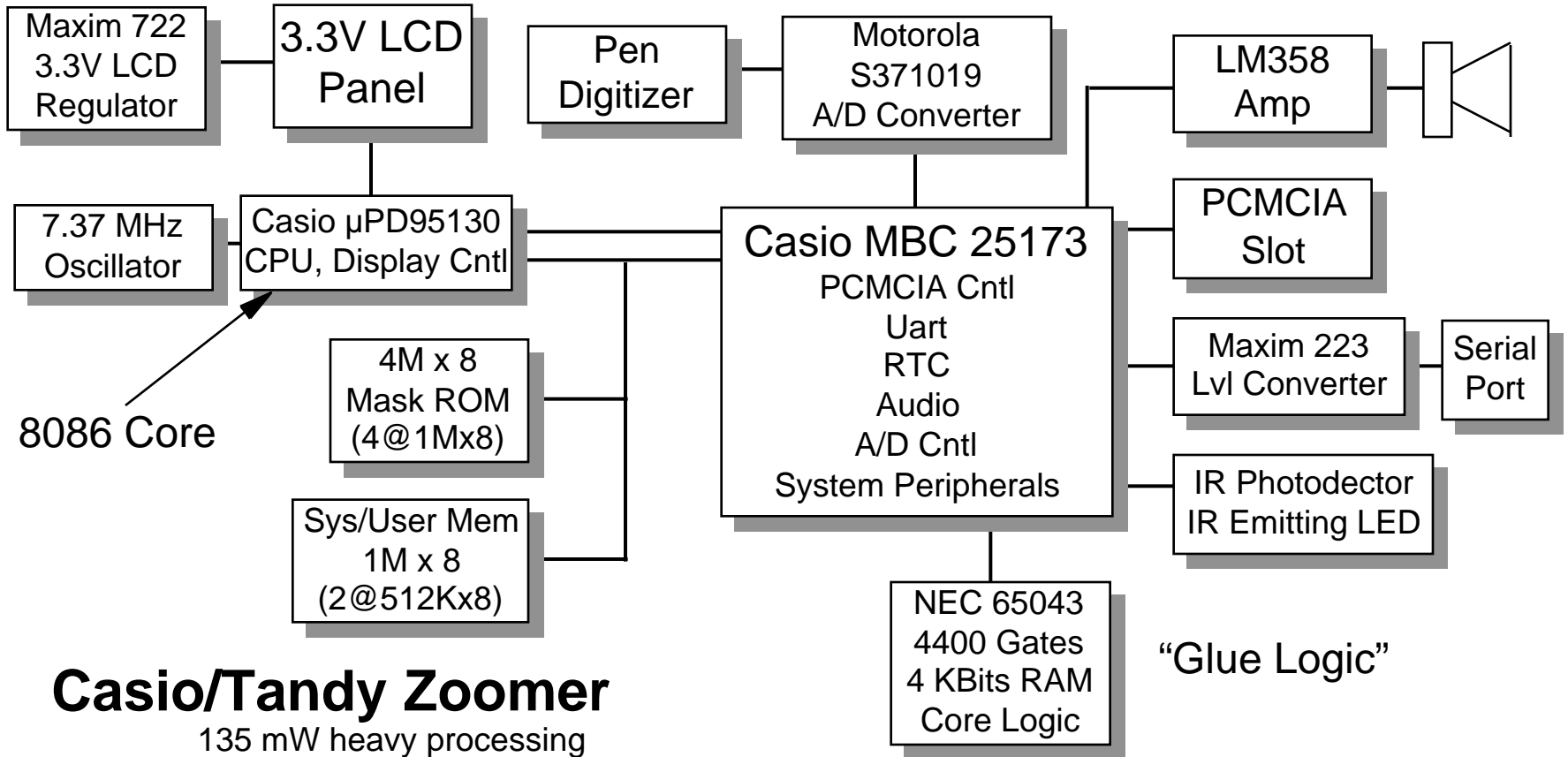
Some PDA Product Parameters

	Mem Size	MHz	Proc	Batteries		lbs.	Display	
				# Hrs	Type		Pixels	sq in
Armstad Pen Pad PDA 600	128 KBytes	20	Z-80	40	3 AAs	0.9	240x320	10.4
Apple Newton Message Pad	640 KBytes	20	ARM	6-8	4 AAAs	0.9	240x336	11.2
Apple Newton 110 Pad	1 MByte	20	ARM	50	4 AAs	1.25	240x320	11.8
Casio Z-7000	1 MByte	7.4	8086	100	3 AAs	1.0	320x256	12.4
Sharp Expert Pad	640 KBytes	20	ARM	20	4 AAAs	0.9	240x336	11.2

Some PDA Product Parameters

	Mem Size	MHz	Proc	Batteries		lbs.	Display	
				# Hrs	Type		Pixels	sq in
Tandy Z-550 Zoomer	1 MByte	8	8086	100	3 AAs	1.0	320x256	12.4
AT&T EO 440 Pers Comm	4-12 MBytes	20	Hobbit	1-6	NiCd	2.2	640x480	25.7
Portable PC	4-16 MBytes	33+	486	1-6	NiCd	5-10	640x480	40

Anatomy of a PDA



Casio/Tandy Zoomer

135 mW heavy processing
 55 mW in low power idle
 0.5 mW when "off"

Processor Cores for PDAs

- **Intel**
 - Polar chip set
 - » 386 processor core
 - » System logic and peripheral interfaces
 - » Runs Windows or DOS
 - Draco chip set
 - » 2 chip system based on low power 486
- **AMD Elan**
 - 386SC, incorporates all logic for simple PDA on chip
- **Motorola Dragon**
 - 68349 = 68020 core + 6K on-chip memory + system logic
 - Astro PDA system logic chip

Other Commercial Developments

- **NEC V800 Architecture**
 - 16-bit & 32-bit instructions to improve code density and reduce memory accesses
 - V805, 810 basic CPUs with small on-chip cache
 - V820 integrates simple system logic
 - V810 used in Nintendo CD-ROM systems
- **Hitachi SH7000 Architecture**
 - SH7032, 7034 on-chip RAM, ROM, simple system logic
 - New architecture: 16-bit instructions only (32-bit datapaths)
 - Used in Sega game systems

Some PDA Processor Comparisons

	AT&T Hobbit			Intel	AMD
	92020S	92020M	92020MX	Polar	Elan
Clock Rate	20 MHz	20 MHz	20 MHz	33 MHz	33 MHz
Drystone MIPS	16 MIPS	13.5 MIPS	11.5 MIPS	6 MIPS	6 MIPS
On-Chip Cache	6K	6K	3K	2K	none
Memory Bus	32 A,32 D	32 mux'd	32 mux'd	22A,16D	22A,16D
Voltage	3.3 V	3.3 V	3.3 V	3.3 V	3.3 V
CPU Power	210 mW	250 mW	290 mW	550 mW	550 mW
Number of Chips	4	3	2	3	1
PCMCIA Slots	3	2	1	1	2
Serial Ports	3	3	3	2	1
Parallel Ports	none	none	none	none	1
LCD Support	640 x 480	640 x 480	640 x 480	640 x 480	640 x 480
CRT Support	1024 x 768	1024 x 768	none	none	none
Frame Buffer	separate	separate	shared	shared	separate
Chip Set Power	530 mW	490 mW	390 mW	600 mW	550 mW
Chip Set Price	\$101	\$80	\$63	\$58	\$49
Availability	1Q94	1Q94	1Q94	1Q94	2Q94

Some PDA Processor Comparisons

	ARM 700/710	Hobbit 92020S	NEC V810	NEC V820	Hitachi SH7032
Clock Rate	20 MHz	20 MHz	16 MHz	25 MHz	12.5 MHz
Drystone MIPS	18 MIPS	16 MIPS	11.5 MIPS	18 MIPS	10 MIPS
Voltage	3V	3.3V	3.3V	5V	3.3V
CPU Power	120mW	210mW	100mW	750mW	130mW
On-chip Math	none	none	FPU	FPU	MAC
On-chip MMU	64 entry	64 entry	none	none	none
System Logic	none	none	none	some	some
Peripherals	none	none	none	serial	some
On-Chip Mem	8K cache	6K cache	1K cache	1K cache	8K RAM
External Bus	32 mux'd	32A,32D	32A,32D	32A,32D	16 mux'd
Transistors	341,000	640,000	240,000	380,000	593,000
Die Area	46 mm ²	125 mm ²	53 mm ²	114 mm ²	92 mm ²
IC Process	0.8μ, 2M	0.6μ, 2M	0.8μ, 2M	0.8μ, 2M	0.8μ, 2M
Est Manu Cost	\$15	\$25	\$12	\$35	\$20
CPU Price (10K)	\$35	\$37	\$20	\$80	\$32
Vol. Availability	2Q94	1Q94	3Q93	1Q94	4Q93

Approx. 486-33 performance

Some PDA Processor Comparisons

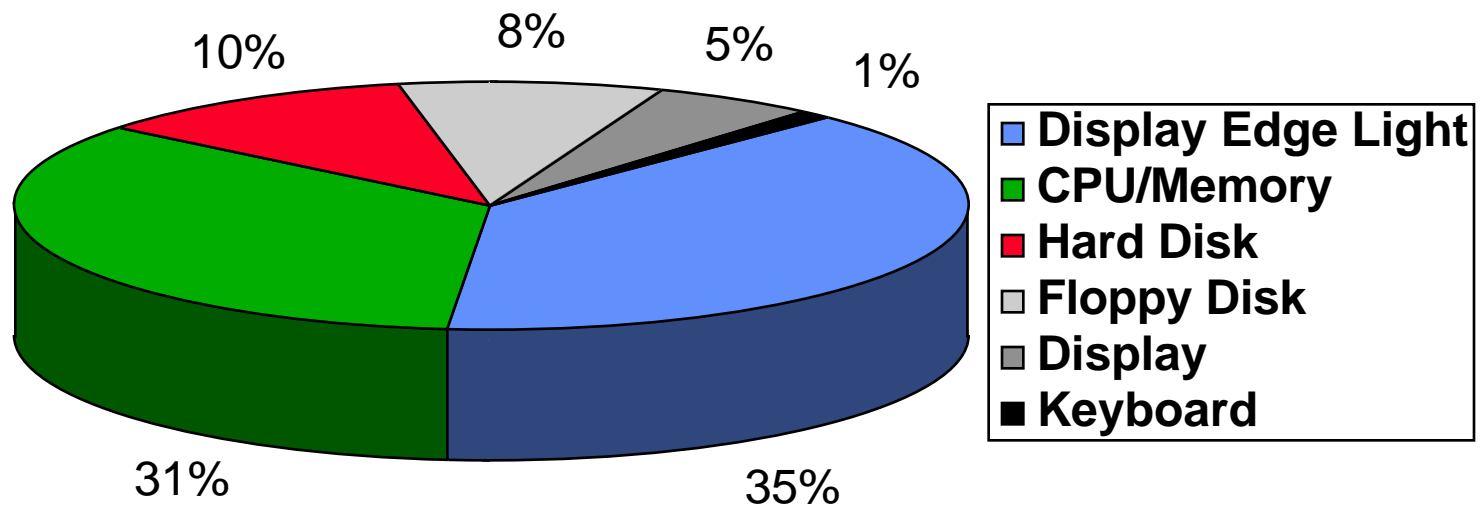
	ARM 610	Motorola 68349	Intel Polar	AMD Elan 386SC
Clock Rate	20 MHz	16 MHz	33 MHz	33 MHz
Drystone MIPS	11 MIPS	6 MIPS	6 MIPS	6 MIPS
Voltage	5V	3.3V	3.3V	3.3V
CPU Power	500mW	300mW	550mW	550mW
On-chip Math	none	none	none	none
On-chip MMU	32 entry	none	yes	yes
System Logic	none	yes	yes	yes
Peripherals	none	serial	many	many
On-Chip Mem	4K cache	6K mixed	2K cache	none
External Bus	32 mux'd	32A,32D	22A,16D	32A,16D
Transistors	359,000	550,000	910,000	335,000
Die Area	71 mm ²	98 mm ²	138 mm ²	??
IC Process	1.0μ, 2M	0.8μ, 2M	0.8μ, 3M	0.7μ, 2M
Est Manu Cost	\$13	\$23	\$35	approx \$30
CPU Price (10K)	\$20	\$28	\$50	\$49
Vol. Availability	2Q93	4Q93	1Q94	2Q94

Typical Laptop Power Consumption

Base System (2 MB, 25 MHz)	3.650 W	1.8 in PCMCIA hard drive	0.7-0.3 W
Base System (2 MB, 10 MHz)	3.150	Cell telephone (active)	5.400
Base System (2 MB, 5 MHz)	2.800	Cell telephone (inactive)	0.300
Screen backlight	1.425	Infrared network	0.250
Hard drive motor	1.100	PCMCIA modem, 14.4 kbps	1.365
Math co-processor	0.650	PCMCIA modem, 9.6 kbps	0.625
Floppy drive	0.500	PCMCIA modem, 2.4 kbps	0.565
External keyboard	0.490	GPS receiver	0.670
LCD screen	0.315		
Hard drive active	0.125		
IC card slot	0.100		
Additional Mem (per MB)	0.050		
Parallel port	0.035		
Serial port	0.030		

Power Consumption

Compaq LTE 386/s20



InfoPad Power Consumption

