Information Appliances

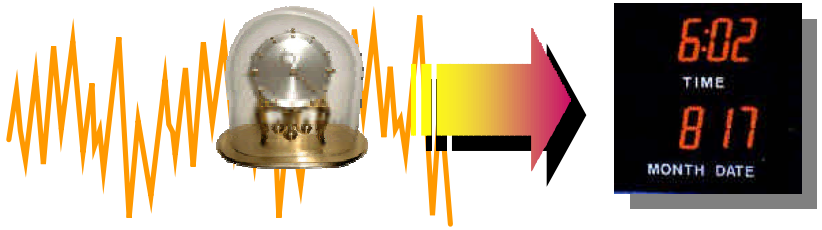
Strategic Applications

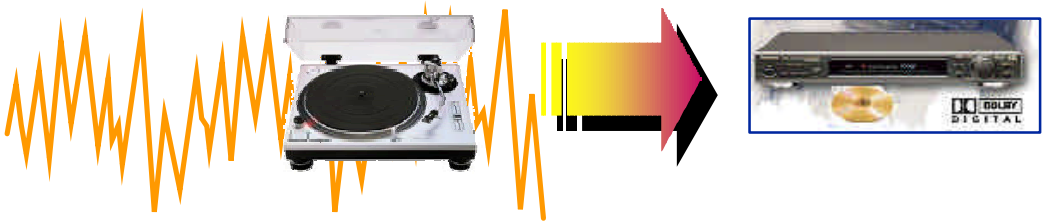
Agenda

- Introduction
- Home networking - the complete vision
- Information appliances
- Types of information appliances
- Xilinx solutions enable information appliances
- Summary

Introduction

The Digital Age of Consumer Electronics





Digital technology brings

Higher accuracy

Higher reliability

Faster speed

Lower power

Lower cost

Digital Logic Spawns New Consumer Products

Replay TV

Revolutionizing the way we watch television

Consumer Satellite Modems

Revolutionizing high speed home Internet access

Desktop Video Editing

Delivering video editing to the home

Smart Card

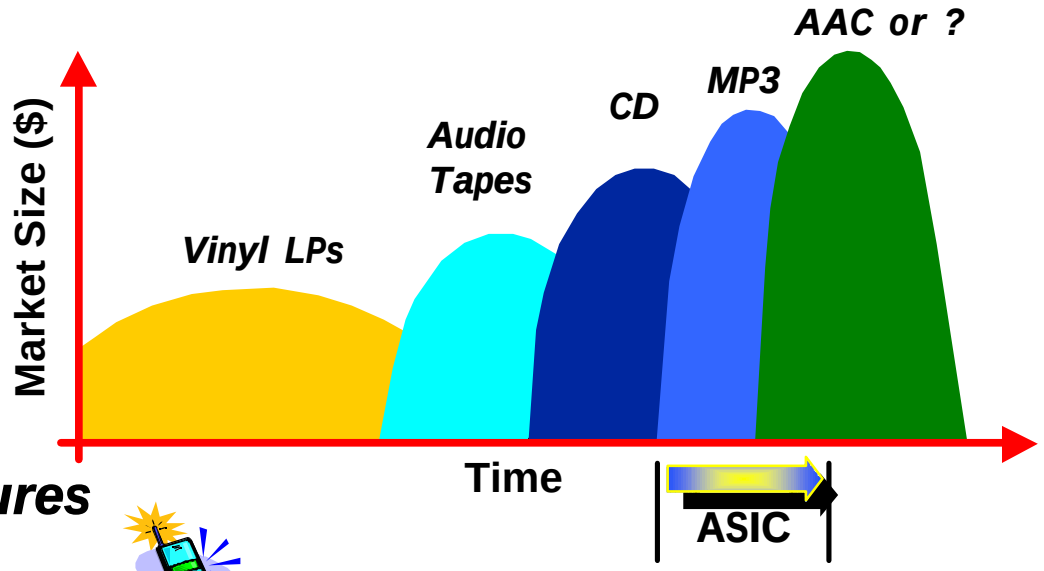
Revolutionizing the way we purchase products

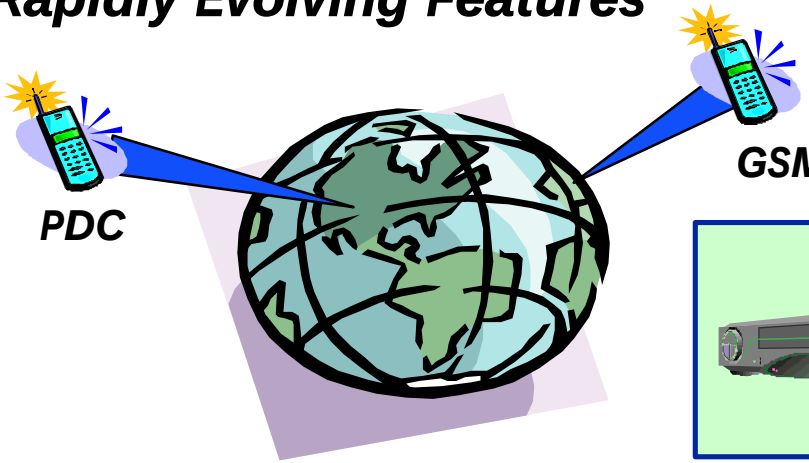
MP3 Players

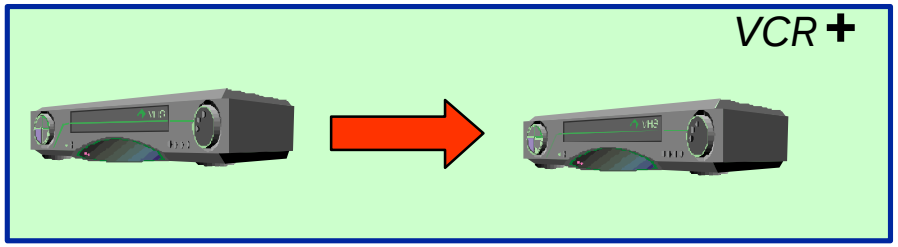
The new revolution in portable digital music

ASICs Cannot Meet Consumer Market Requirements

- ***Short Product Life Cycles***
- ***Changing Standards***
- ***Multiple Standards***
- ***Rapidly Evolving Features***







New Dimensions to Home Internet Access

- Internet revolution
  - New ways to communicate, entertain & educate
  - Millions of users rushing to Gain Internet access
- Applications & services are fueling demand for high-speed Internet access
  - E-mail, instant messaging, shopping, games, research
- Home users are embracing a variety of new services
  - Broadband access will evolve to bring new dimensions to the Internet experience

Device Networking in a New Age

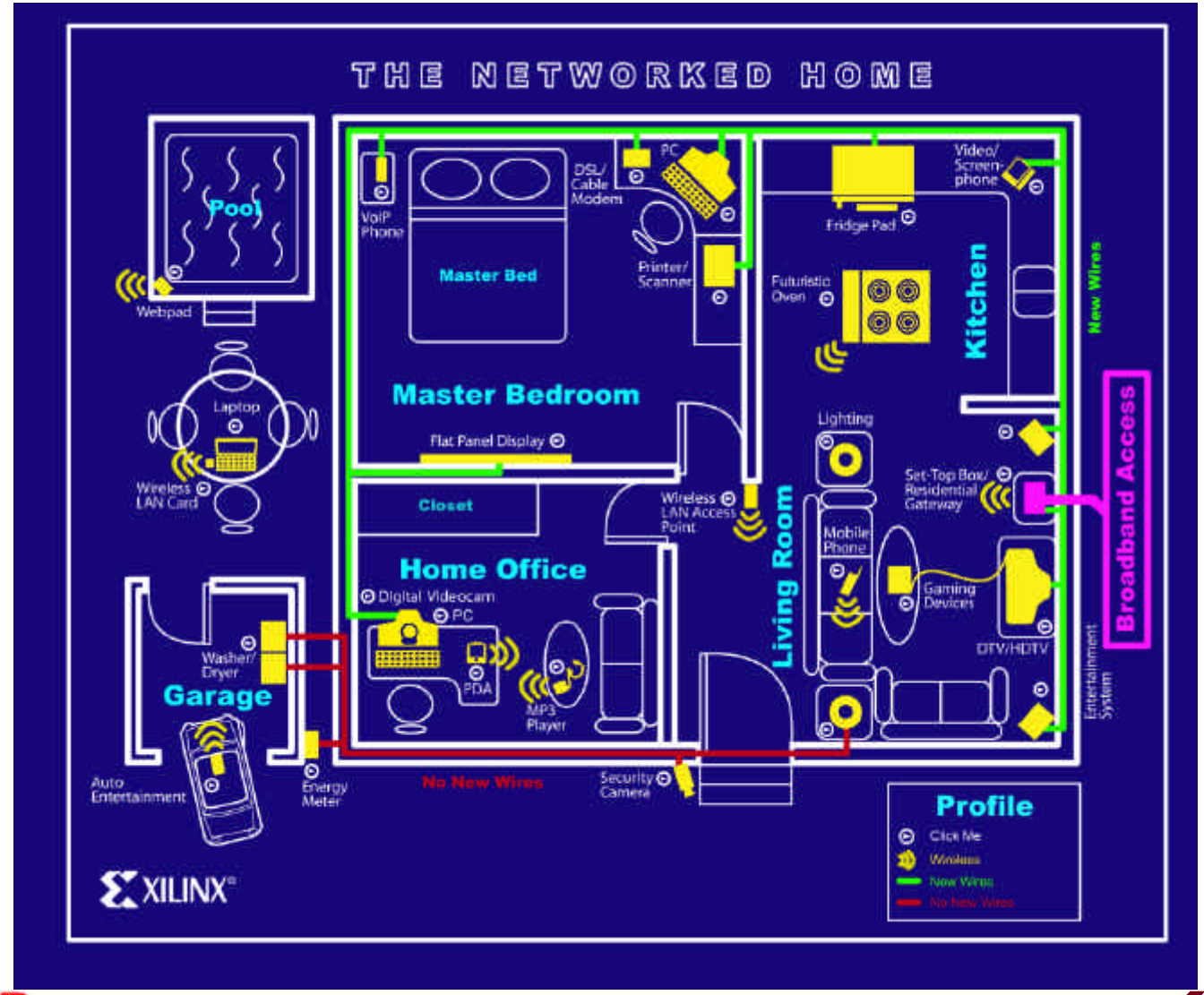
Networking Solution for Controlling & Managing Smart Devices

- The “new age of information” or “new age of communication” - Whatever you want to call it!
  - Ubiquitous computing
  - Post-PC age
  - e-Business
  - e-Commerce
  - e-Services

Convergence Is Happening!

- Invisible computing embedded within everyday devices
  - Increasing intelligence of everyday appliances
- Digital revolution
  - Infrastructure: Circuit-switched to IP-based networks
  - Analog TV to Digital TV
- Internet is ubiquitous
  - Being deployed within commercial channels
    - Business-to-Business commerce, secure transaction processing, banking
- Deregulation of global infrastructure
  - Multiple industries such as telecom, cable and utilities

Problem: Islands of Technology



The Push for Home Networking

- Rapid growth in multiple-PC household penetration (by Dataquest)
  - PC penetration exceeds 50% in US households
  - Multi-PC households growth: 15M (in 1998) to 26M (in 2003)
- Increasing Internet usage (by Yankee Group)
  - Nearly 90% of PC households will be online by 2001
  - Online households growth: 20% (in 1997) to 47% (in 2001)
- Broadband Internet access (by Forrester Research)
  - Broadband penetration growth: less than 1M (in 1998) to more than 15M (in 2002)
  - % Penetration of online households: increases from 2% (in 1998) to 26% (in 2002)

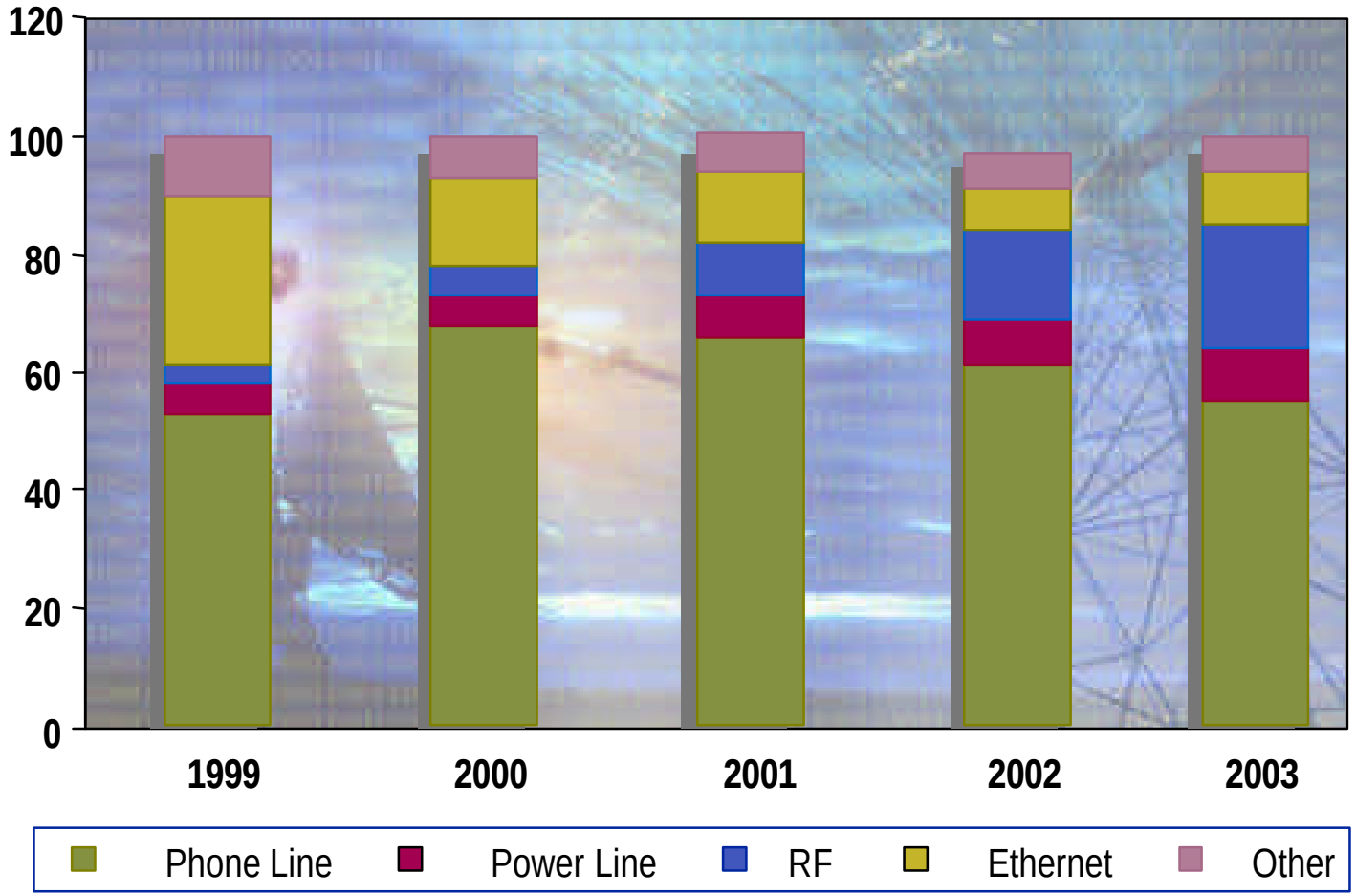
The Push for Home Networking

- More digital appliances are coming into the home (by IDC)
  - DSS, DVD, Digital TV
  - Web-Top boxes, set-top boxes
  - PDAs, mobile (cellular) phones
  - Digital cameras
  - Installed base of internet appliances will exceed 50M by 2001
- More digital content entering the home
  - Published Content
    - CD-ROMs, DVDs, DVRs, digital photography
  - Networked Content
    - DTV, DBS, VoIP, MP3, movies-on-demand, streaming media

History Repeats Itself Again...

- Television
  - There was a time when one television set per home was considered a luxury
  - Today 76% of US households have two or more television sets
  - Three factors contributed to multiple TV ownership
    - Purchase of newer/bigger/ better television
    - Additional television to reduce conflicts over TV use
    - Television in bedroom / kitchen
  - Replace the word “TV” with “PC” and history repeats itself again!

Applications Driving Home Networking



Source: Cahners In-Stat Group

State of the Internet Connectivity Market

- Most homes access the Internet via dialup modems at 28.8kbps or 56kbps
  - Not an “always on” connection
    - Requires modem synchronization
    - Users hope that connection is established right away
  - Phones & faxes cannot be accessed while on the Internet
- Broadband connectivity
  - Simpler & significantly faster Internet access
  - Always on connection
    - No dialing & synchronization required
  - No worry about the phoneline
    - Data & telephone can share the same line at the same time

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Home Networking - The Complete Solution

Vision

What is Home Networking?

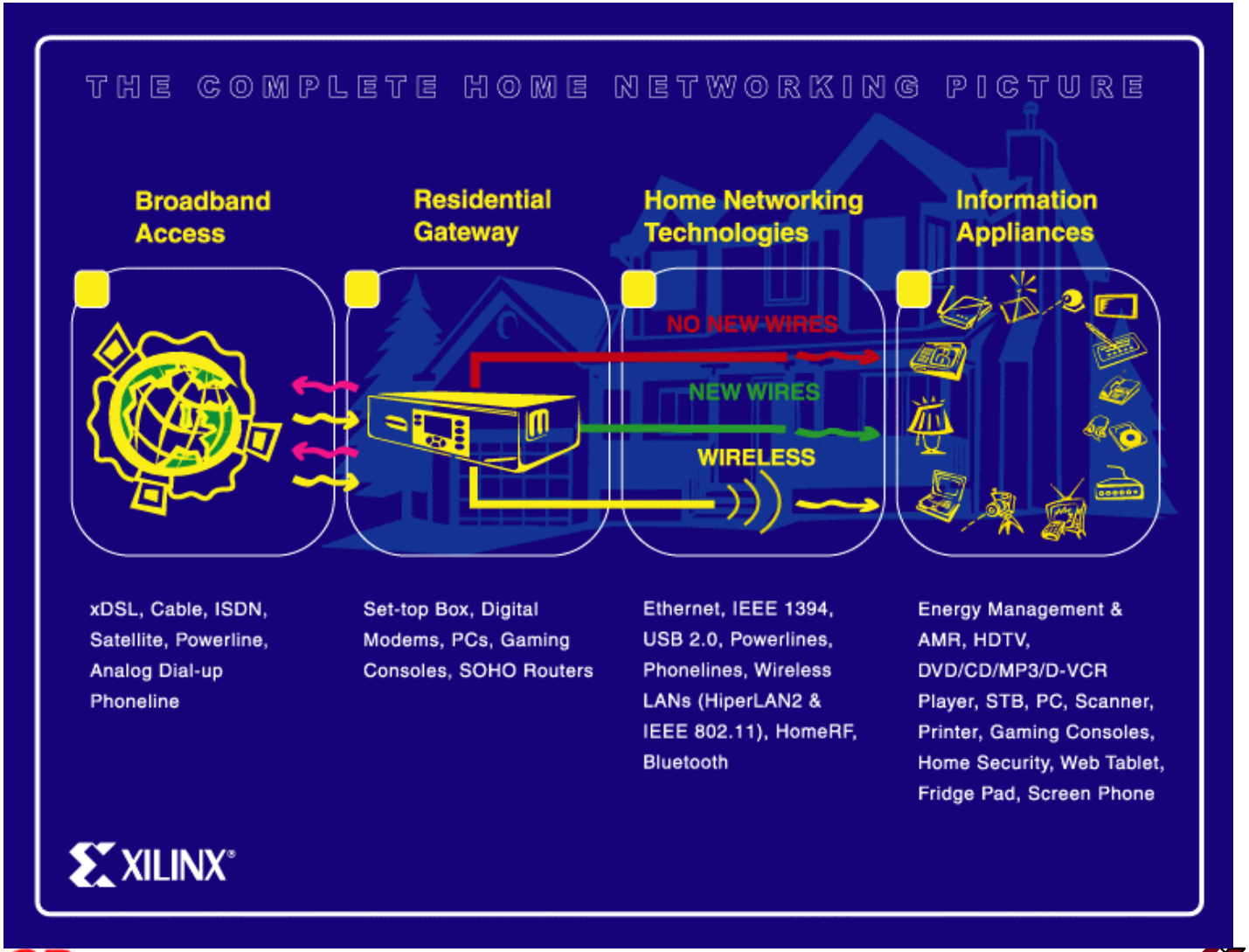
- The distribution of information (Audio, Video, & Data) around the home and their interface with attached devices and external services
- The interconnection and interoperation of
  - Home appliances
  - Entertainment devices
  - PC hardware
  - Telecommunication devices
  - Security, lighting and environmental control systems

Its All About Convergence

Goal of Home Networking

- Provide the ability to access information, entertainment and communicate anywhere, anytime
  - Bring the Internet to the hands of the consumer
  - Interconnect people in data, voice and video
    - Enables users to communicate & share data
  - Bring interconnectivity to intelligent devices
  - Always on, anytime, anywhere access to the home network

Four Aspects to Home Networking



Market Requirements and Solutions Available

	Market Requirements	Solutions Available
Broadband Access	High Speed Access for Data, Voice and Video, Always on, Simultaneous Up-link &Down-link Communication, Support Simultaneous and Multi-User Access	xDSL, Cable, Powerline, Satellite, Mobile/Wireless
Residential Gateway	Provides Access into the Home, Remote Management Access Platform, Bridging between Different Networks, Firewall and Security, E-Services Capabilities	Open System Gateway initiative (OSGI), Jini, UPnP, HAVi, DVI
Home Networking Technologies	Low Cost, Speed, Mobility, Quality of Service, Security, Reliability, Ubiquity, Ease of Use	No new wires (Phonelines, Powerlines), New wires (Ethernet, 1394, USB2.0, Optic Fiber), Wireless (HomeRF, Bluetooth, Wireless LAN)
Information Application Networks	Digital electronics with advanced computational capabilities that add more value and convenience when networked	Digital TV, HDTV, set-top box, internet screen phones, digital VCR, gaming consoles, MP3 players, cordless phones, security systems, utility meters, PCs, web pads & terminals, PDAs, digital cameras, auto PCs etc.

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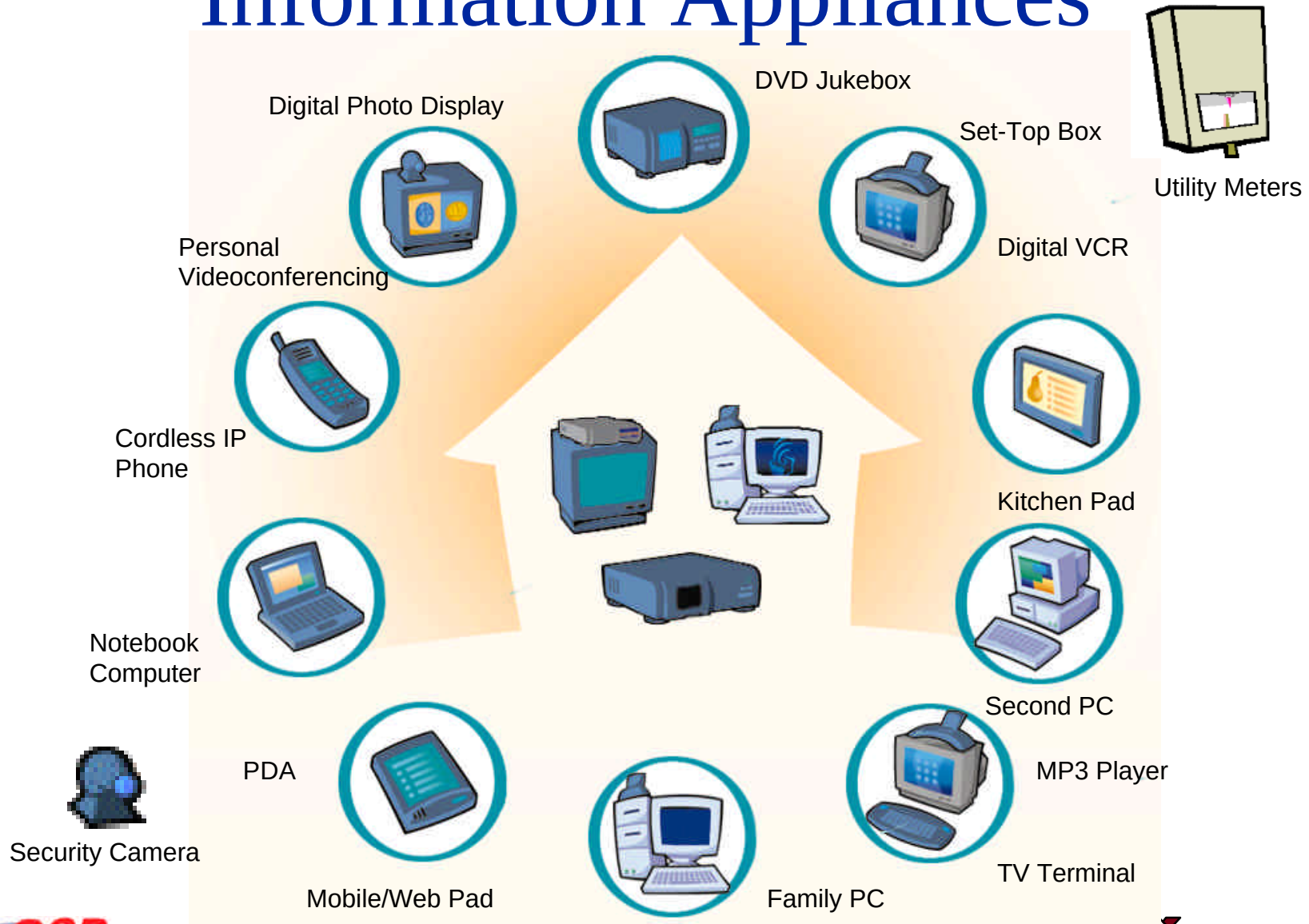
Information Appliances (IA)

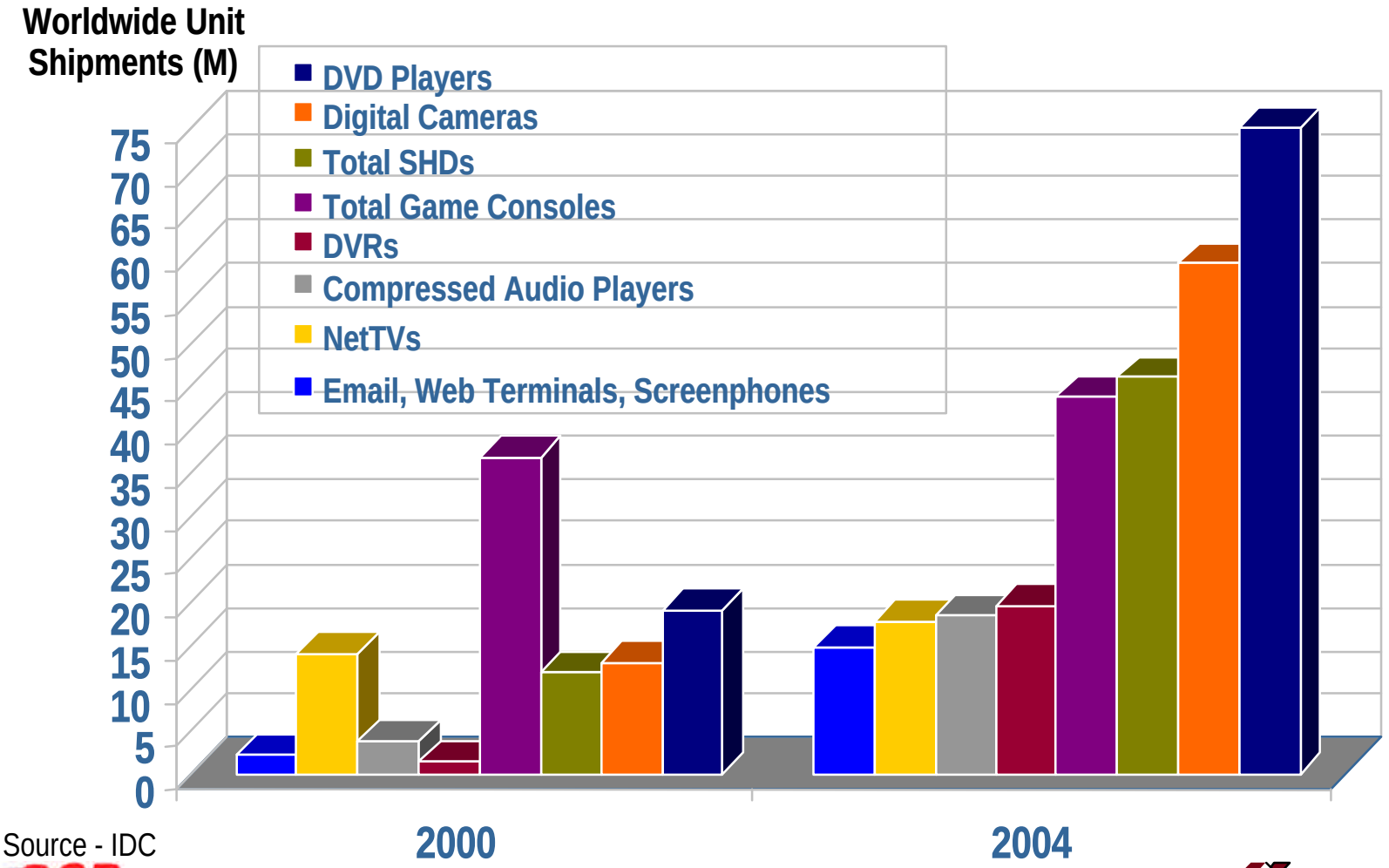
Definition

- Information appliances (a.k.a. Internet appliances) are
  - An emerging category of digital consumer electronics that provide the consumer with a low-cost, easy-to-use, instant-on device, lightweight, reliable, special-purpose access to the features and benefits of the Internet
- Enabling infotainment
  - Accessing email on the move
  - Checking driving directions when on the road
  - Managing appointments & schedules when waiting at the doctor's office
  - Playing video games when relaxing on the sofa

Information Appliances



WW IA Unit Shipments - Information Appliances



Source - IDC

Market Forecast and Analysis

- 18.5 million IAs will ship in the U.S. by 2001, compared with 15.7 home PCs
- IA market will hit $15.3 billion by 2002
- 55 million handheld/notebook devices will be sold by 2002, up from 13.9 million in 1999

Source - IDC

Don’t Need the PC!

- Access to the Web and e-mail was the exclusive domain of the PC until the arrival of IAs
  - IAs are an alternative to the PC and are designed to benefit from network services
- IAs are rapidly outgrowing PCs
  - Lack of PC portability
  - Heavy price tag associated with the PC
  - Complicated software installation involved in the PC

Market Forecast and Analysis

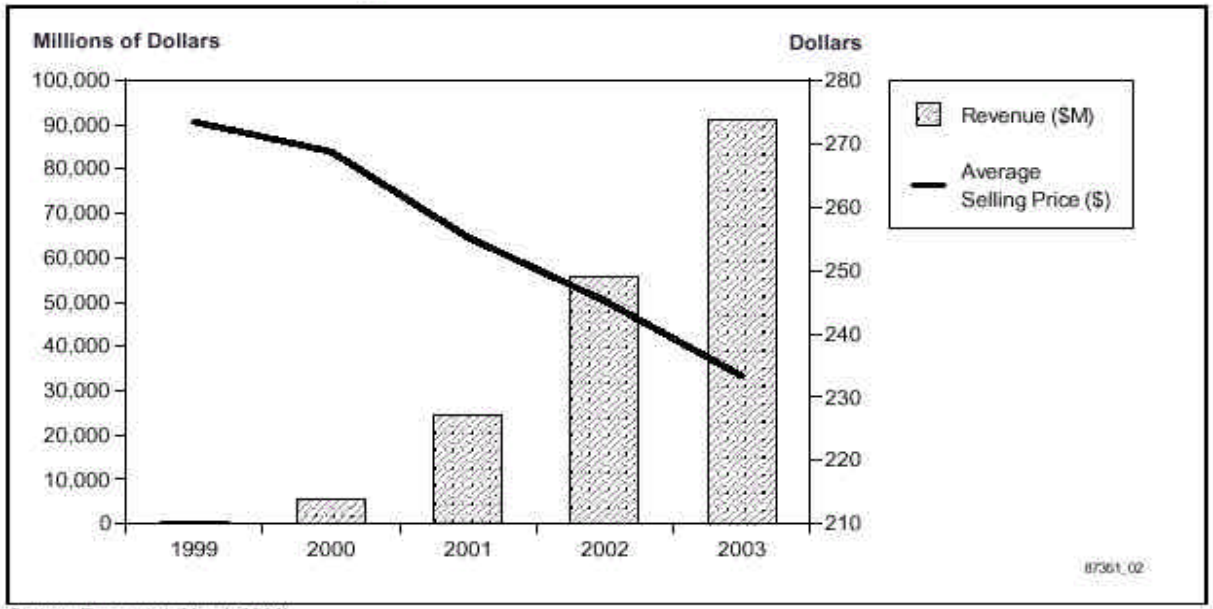
- IAs will out-ship PCs in the US, with PC revenues falling below IA revenues
  - Home IAs will out-ship PCs
    - 22 million in-home IAs (excluding Internet-enabled mobile phones & telematics systems) will ship in the US, compared with 18 million home PCs in 2001
  - IA revenues will rise above falling PC revenues
    - By 2005, total revenues from all IAs (including Internet-enabled mobile phones and telematics systems) will reach $33.7 billion

Source - Parks Associates

Market Forecast and Analysis

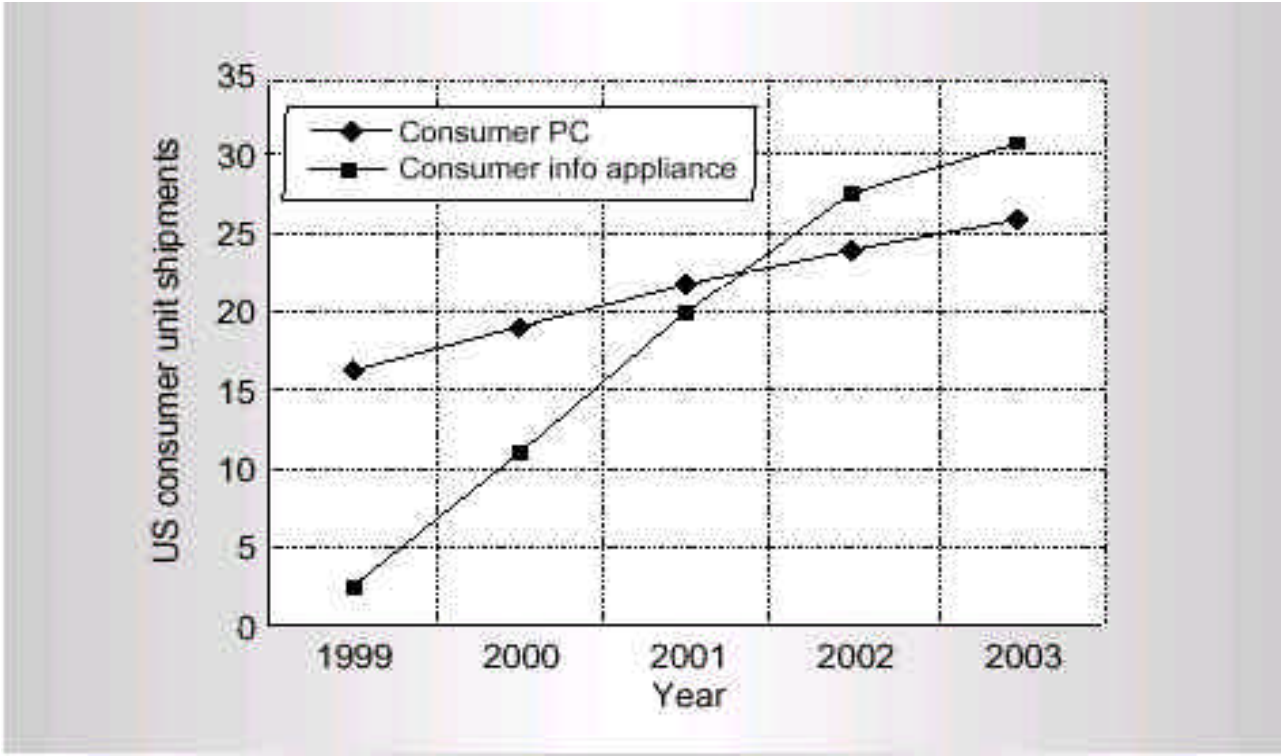
- WW production of IAs will explode from 1.8 million units in 1999 to 391 million units in 2003
- WW revenue for IAs is forecast to grow from $497 million in 1999 to $91 billion in 2003

Worldwide Information Appliance Production Forecast



Source: Dataquest (March 2000)

Growth in PCs and IAs



IDC predicts that the IAs will grow rapidly, eventually far exceeding the number of PCs in the home -

Web & e-mail access will no longer be the exclusive domain of the PC

Source - IDC

Trends: Adding Utility to Consumer Devices

Today

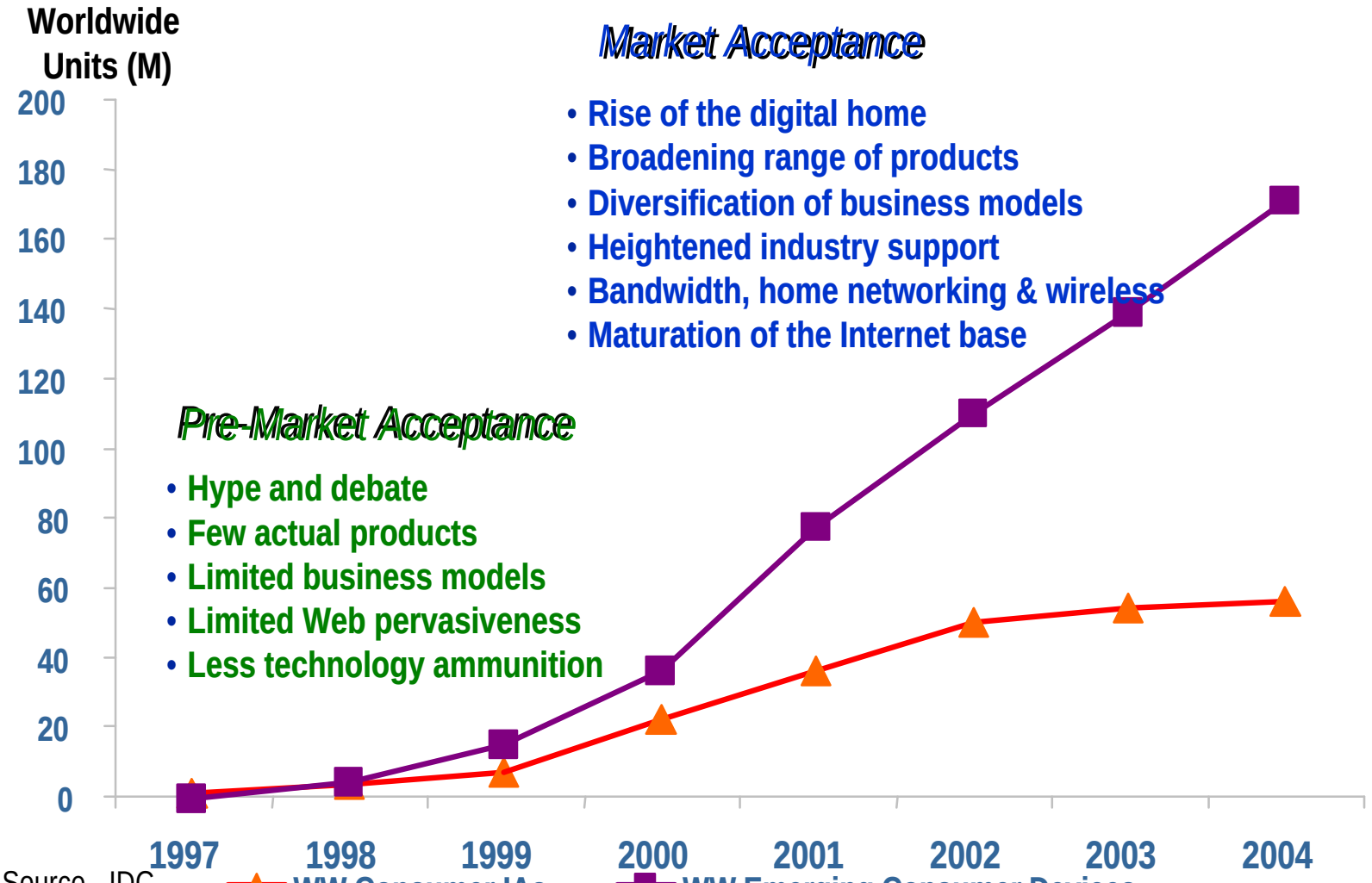
Tech Trend

- ✓ Higher performance
- ✓ Lower power requirements
- ✓ Lower pin count

Tomorrow

- ✓ GPS in 2000
- ✓ Voice navigation in 2001
- ✓ Affordable wireless PAN and WAN in 2001
- ✓ eBook readers in 2000
- ✓ media players in 2000

Phases of Market Acceptance of Consumer Devices / IAs



Source - IDC

Information Appliances

Factors for the Success of IAs

- "Services" are the offering
- Product design must achieve elegance
- Branding and channels
  - Established names & established channels are key
- Business models
  - Low-cost solutions backed by partnerships & sustainable services

- Critical, supporting technologies must hit their strides
  - Broadband, wireless & home networking
- Heightened industry investment must continue
- New product concepts must gain significant consumer awareness

Functional Requirements

Functional Requirements of Information Appliances	
Ubiquity	Prevalence of network access points
Reliability	Operational consistency in face of environmental fluctuation such as noise interference, multipath
Cost	Affordable for mass market
Speed	Support high speed distribution of media rich content (>10Mbps)
Mobility	Must support "untethered" devices
QoS: Quality of Service	Must support scalable QoS levels for application requirements of individual devices
Security	User authentication, encryption, & remote access protection
Remote Management	Ability for external network management (queries, configuration, upgrades)
Ease of Use	Operational complexity must be similar to existing technologies, such as TVs and telephones

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Types of Information Appliances

Different Information Appliances

- Digital TV / HDTV
- Digital set-top box
- Internet screen phones, cordless phones, VoIP phones
- Internet-enabled cell phones
- Interactive DVD players
- Digital VCR
- Internet gaming consoles
- MP3 / Internet audio players
- Security systems
- Utility meters
- PCs (desktop & notebook)
- Web (kitchen) pads / tablets
- Web / email terminals
- Smart handheld devices
  - PDA (personal digital assistant)
- Digital cameras
- Auto PCs
- White Goods
  - Washer, Dryer

Digital TV

Digital TV (DTV), HDTV (High Definition TV),
TFT - LCD (Liquid Crystal Displays),
FPD (Flat Panel Displays)

Why Change Today's TV Systems to Digital?

- Today's TV systems have been around for 3 generations
  - Additional features and functions have been added
    - Color, stereo sound, remote control, cable channels, closed captioning, etc.
  - DTV is the most significant development in TV technology since the advent of color TV in 1950s
- Transition to digital is occurring in all media technologies
  - Direct broadcast satellite (DBS) offers digital service
- Short comings of the 50-year old analog technology used by broadcasters are increasingly apparent
  - Limited resolution and color rendition
  - "Ghosting" and interference from other radio sources

What is DTV?

- New “over-the-air” digital TV system providing new and higher quality services
  - Transmits TV programs in wide screen, high resolution formats known as HDTV (high definition TV)
  - Transmission in SDTV (standard definition TV) format providing picture resolution similar to existing TV service
- Will be used by 1600+ broadcast TV stations in the US
- Based on the Advanced Television System Committee (ATSC) standard A/53
- Both HDTV & SDTV formats will have significantly better color performance than existing analog TV system

So What Does DTV Get Us?

- DTV system has the capability to provide
  - Clearer and sharper cinema-like pictures
  - Multi-channel (up to 5 channels / program), CD-quality sound
  - Broadcasters the ability to simultaneously transmit multiple video programs using a single TV channel
    - TV stations will be able to transmit multiple SDTV or two HDTV programs depending on the type & source of programming
  - Simultaneous delivery of digital data services with TV & audio programming
    - Publications (local electronic newspaper), program schedules, computer software, specific product information, email, Internet

Distinct Features of DTV

- Digital signals provide 1080-line or “full-HDTV” features
- Permits multicasting
  - DTV signals are carried over a wider bandwidth and can be split into sub-segments of an original channel but of lower resolution programming
- New services
  - Data communications
  - Video conferencing
  - High-speed modem access or datacasting

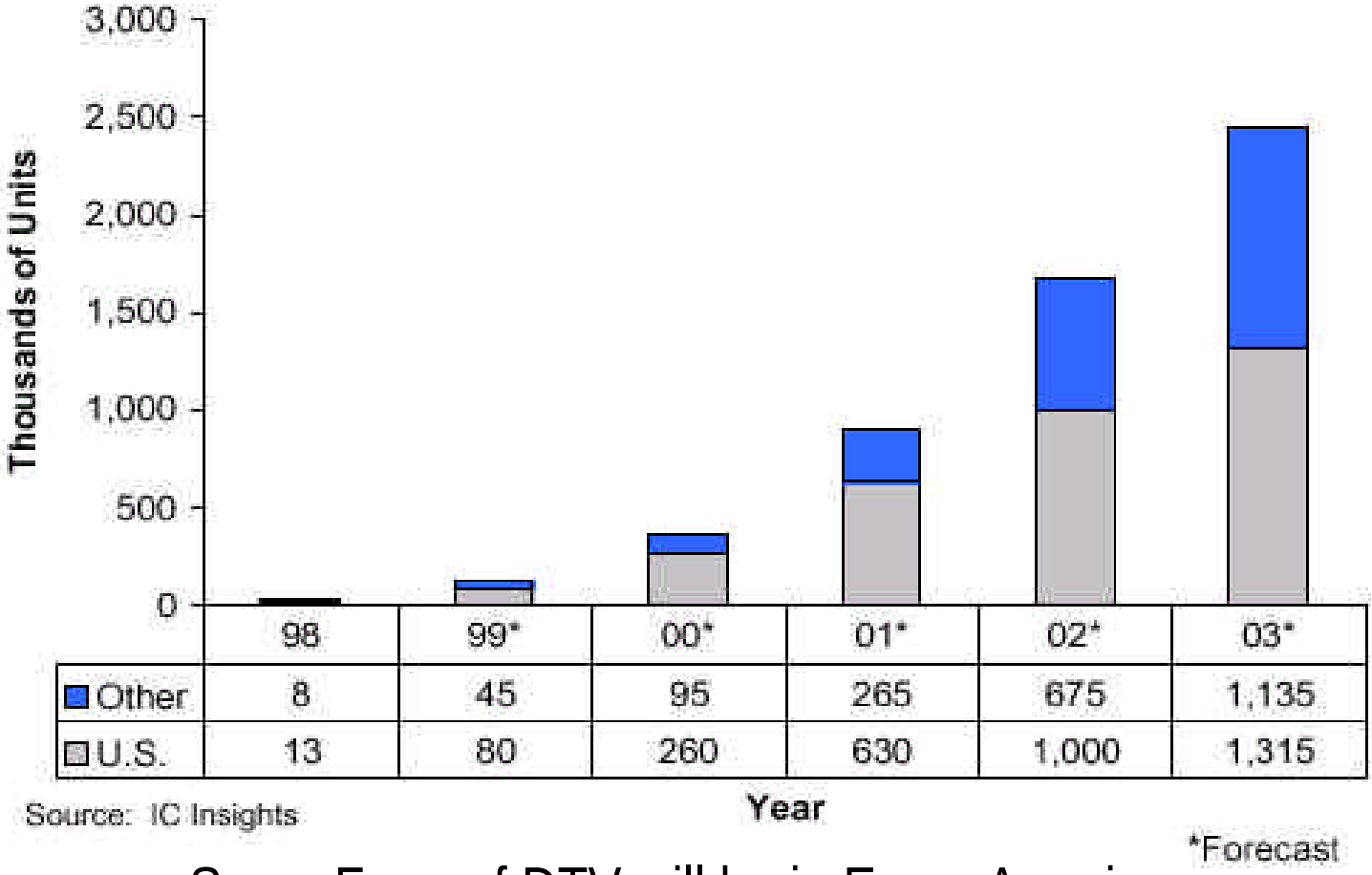
How Does DTV Provide These Improvements?

- TV images, sound, data services are transmitted digitally rather than as analog signals
- Digital compression techniques
  - Allows more information to be transmitted in the same amount of spectrum used by an existing TV channel
    - Data rate of the DTV signal in the 6 MHz broadcast TV channel is 19.44 Mbps, compared with data rates of today's telephone modems of between 28-56 kbps

Transitioning to DTV

- During the transition TV stations (broadcasters) will operate two channels
  - Analog programming
    - Allows the ability to use current TV sets
  - New DTV channel
    - New improved services with DTV sets
    - Digital set-top (converter) boxes allow some DTV programs and services to be viewed on existing analog sets

DTV Market Forecast



	98	99*	00*	01*	02*	03*
Other	8	45	95	265	675	1,135
U.S.	13	80	260	630	1,000	1,315

Some Form of DTV will be in Every American Household by year 2006

Early Difficulties of DTV

- High costs of equipment associated with transitioning to digital broadcasting
- Cable industry adaptability
  - Ability of cable wires to carry digital signals
- Interference hinders the ability to see clear, perfect pictures
  - Interference disrupts the signal to DTV sets when coupled with an indoor antenna
- Newly introduced DTV sets cost several thousand dollars

Early Difficulties of DTV

- Live digital broadcasting is a problem
  - Signals must be transmitted from the event to a broadcast center and across the network
  - With limited digital equipment available, the process can be very complex
- Standards
  - Continuing conflicts over broadcasting standards may confuse consumers & could cause problems with picture quality at the major U.S. networks
- Consumers will view decoded digital images on analog TV sets, and have them look worse than standard broadcasts

DTV Technologies

- Plasma display panels (PDPs)
- Liquid crystal display (LCD)
- Digital light processor (DLP)

Plasma Display Panels (PDPs)

- Technology
  - Contains a panel that consists of many tiny cells filled with neon xenon gas
  - When voltage is applied between two electrodes inside a cell, ultraviolet radiation excites the phosphors lining the cell and light is produced
  - Inside each plasma panel, a series of red, green and blue cells are grouped in a precise matrix
  - These cells are activated individually and hence they emit light individually, creating a precise pixel on the viewing area

PDPs
Advantages over the CRT TV

- Plasma displays have accurate cell structures producing a geometrically perfect picture
  - CRT (cathode ray tube) has geometric distortion due to inability of the beam of electrons to focus on all points
- Plasma displays are evenly illuminated without the typical dark/hot spots observed from CRTs
- Plasma displays can achieve perfect focus whereas the CRT has regions that are less focused than others
- Plasma displays are not susceptible to magnetic fields
  - CRT's electron beam is influenced by the earth's magnetic fields
- Form factor
  - A plasma monitor/TV is never more than 4" thick & lightweight
  - This allows plasma panels to be hung on the wall making it an excellent solution when dealing with space restrictions

PDPs - Disadvantages

- Costly manufacturing leading to higher consumer prices
  - Plasma technology is complex & the plasma manufacturing process is time consuming
  - Hence, the yield when producing a line of plasma panels in a factory is very low
  - Currently incapable of taking significant volumes of sales away from CRT TV due to the $10,000 cost
- Older generations of color plasma TV/monitors have experienced gas pixels burning out on the panel creating a visible black spot on the screen
  - Leads to frustrated customers who need to pay for the display's repair

Flat Panel Displays (FPD) Shipments

- Growing from 10 million units (‘97) to 17 million units (‘01)

Source: Business Communications Co.

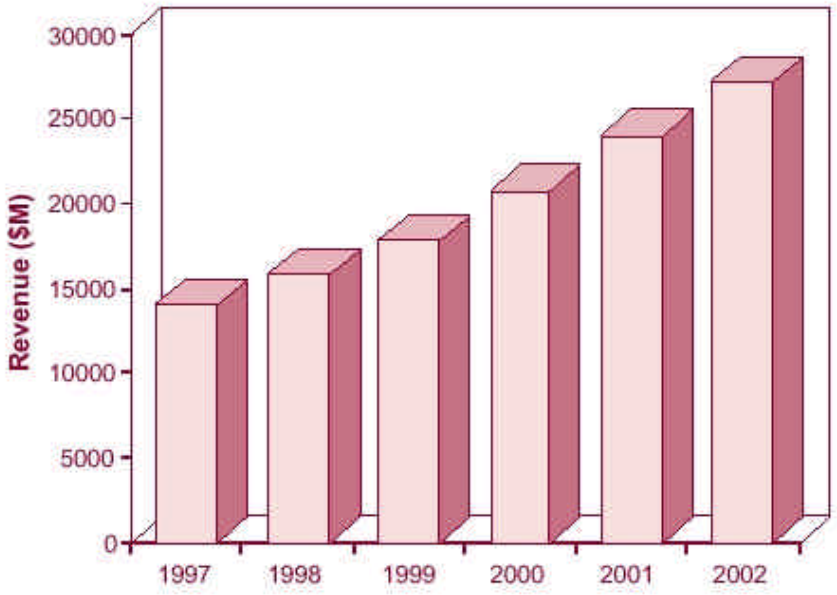
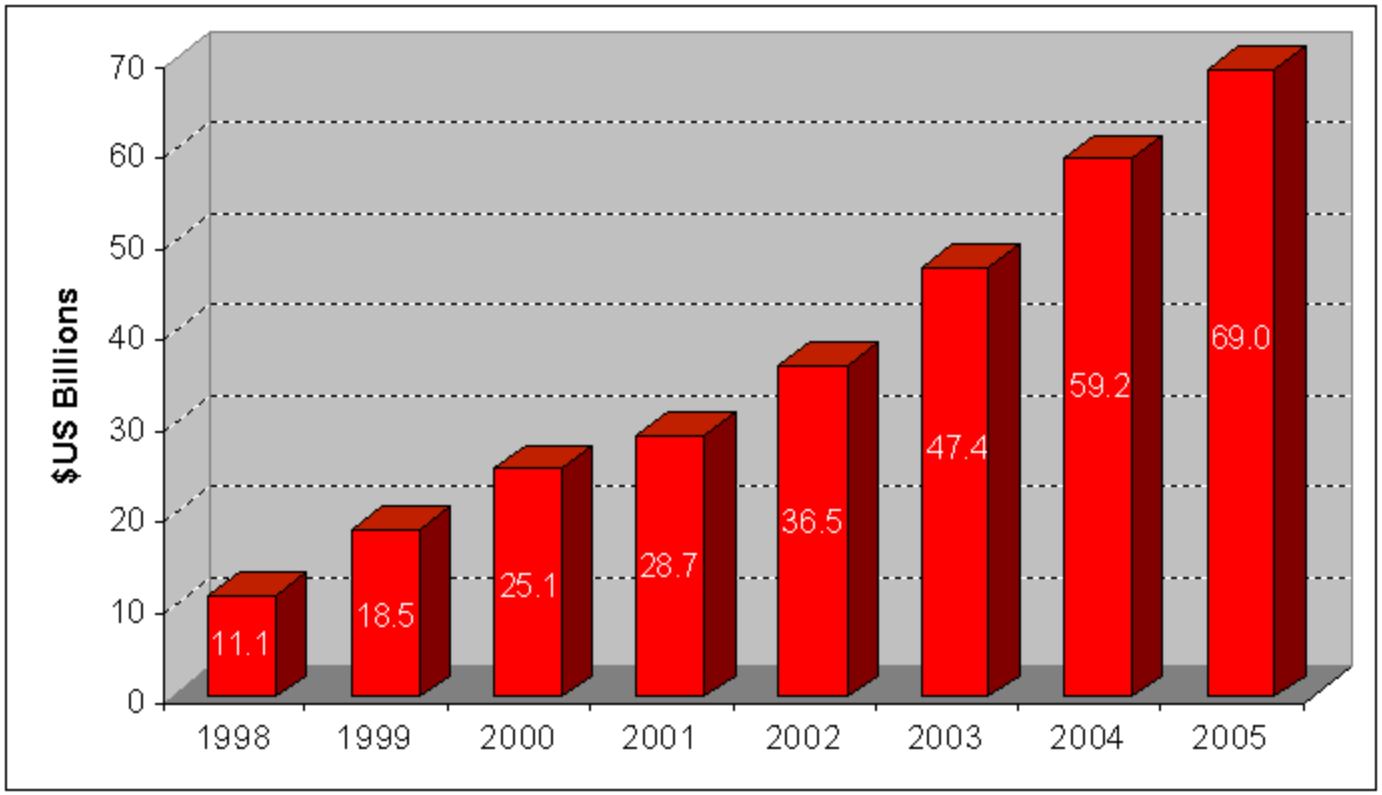


Figure 1 Worldwide FPD Revenue, 1997–2002

Source: Electronic Trend Information Appliances

FPD Revenues: 1998 - 2005



Source: FPD Expo Korea 2000

DLP (Digital Light Processor)

- Technology
  - Next generation of DLP enables TV to be all digital and provide superior video performance required by home entertainment enthusiasts
  - Texas Instruments (TI) has developed & patented this new technology (includes the semiconductor chip and the engine)
  - Can be designed into both front and rear projection TV
  - TI DLP includes the Digital Micromirror Device (DMD)
    - Optical semiconductor chip that has an array of 480,000 (SVGA), 786,000 (XGA) or 1,310,000 (SXGA) hinged, microscopic mirrors mounted on a standard logic device
    - Tiny mirrors operate as optical switches to create a high resolution, full color image

DLP Products

- Large screen, HD-upgradeable home entertainment systems-based products on DLP technology from Hitachi and Mitsubishi

Liquid Crystal Display (LCD)

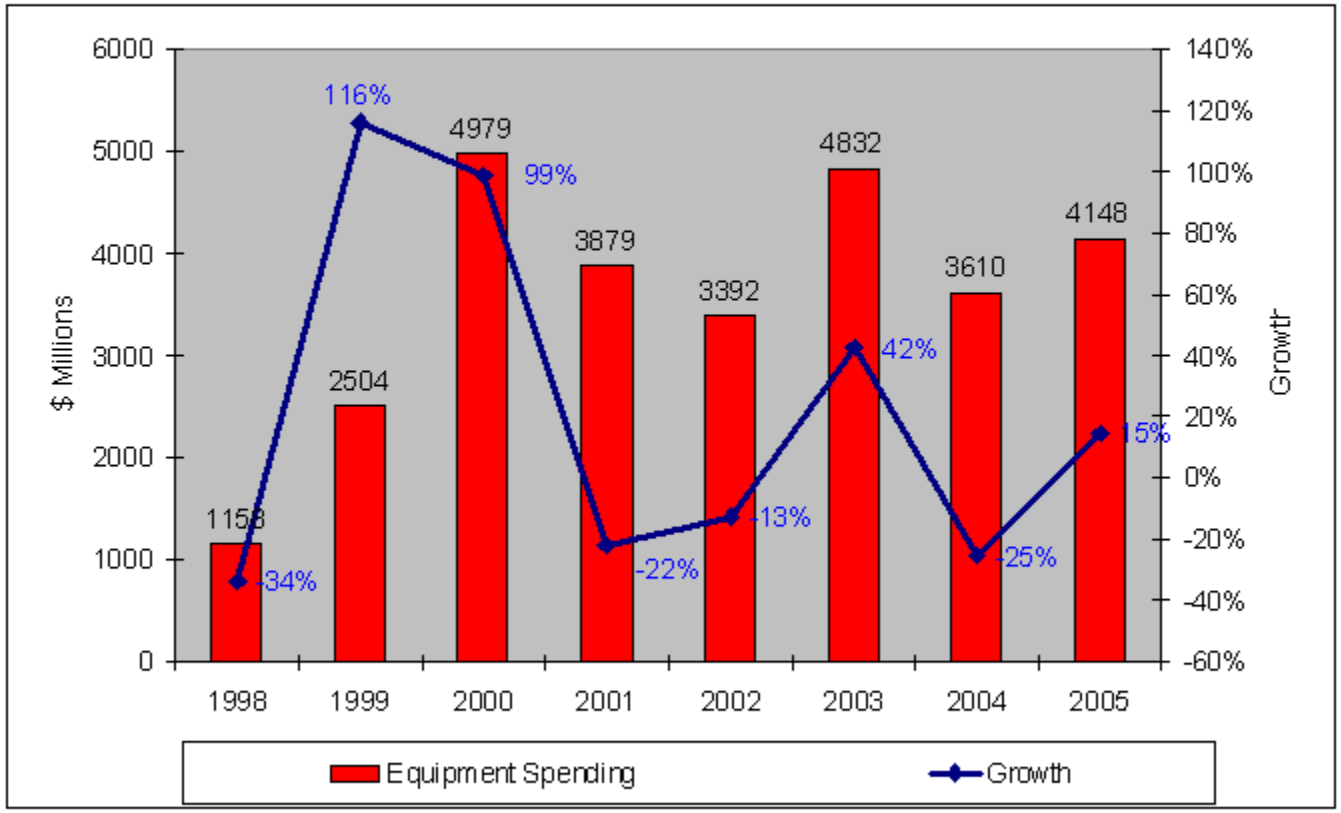
- Technology
  - An LCD consists of two glass plates with liquid crystal material (transparent organic polymers) between them
  - An LCD has an array of tiny segments (called pixels) that can be manipulated to present information
  - There is no bulky picture tube
  - LCDs use much less power than their CRT counterparts
  - Many LCDs are reflective, meaning that they use only ambient light to illuminate the display

WW LCD Monitor Shipments

- 1.25 million units shipped (CY 01, 2000)
  - 14% sequential rise
  - 224% year-over-year rise
  - 50% shipped to Japan, 29% to Europe, 18% to North America, 3% ROW
- LCD ASPs
  - $1124 in 3rd qtr of '99 to $1027 in 4th qtr of '00
- Portable PCs account for 80% of the consumption of LCDs

Source: DisplaySearch & International Data Corp. (IDC)

TFT LCD Equipment Forecast*



* Includes array, cell, module and automation equipment

Source: FPD Expo Korea 2000

LCD - Pros & Cons

- Advantages
  - LCDs are practical for applications where size & weight are important
- Drawbacks
  - Problems with viewing angle, contrast ratio & response time still need to be solved before the LCD could replace CRTs

HDTV (High Definition TV)

- HDTV is one of many (18) subsets in the DTV standards
- Represents the premier method of transmitting, receiving & viewing digital broadcasts
  - It is the highest-quality version of DTV providing a sharp, bright and crystal-clear picture on a wide-screen TV set
- Began its commercial life in July 1997
  - WRAL-HD in Raleigh, North Carolina, became the nation's first commercial, over-the-air, HDTV station
- Market size for wide format and HDTV display systems
  - 8 million units in 1999 and 14.2 million units in 2003*

* - Source: Stanford Resources

HDTV - Features

- Provides resolution of about twice that of conventional TV in both horizontal (H) and vertical (V) dimensions
  - Full HDTV signal requires a much wider bandwidth than a regular digital signal
  - HDTV signal is compressed before transmission
- Picture aspect ration (H x V) of 16:9
- High definition approved formats
  - 1080 horizontal lines of resolution interlaced
  - 720 horizontal lines of resolution progressive
- Contains dolby digital audio within the HDTV set

HDTV Formats

HDTV Formats
Table III From ATSC Standards Document

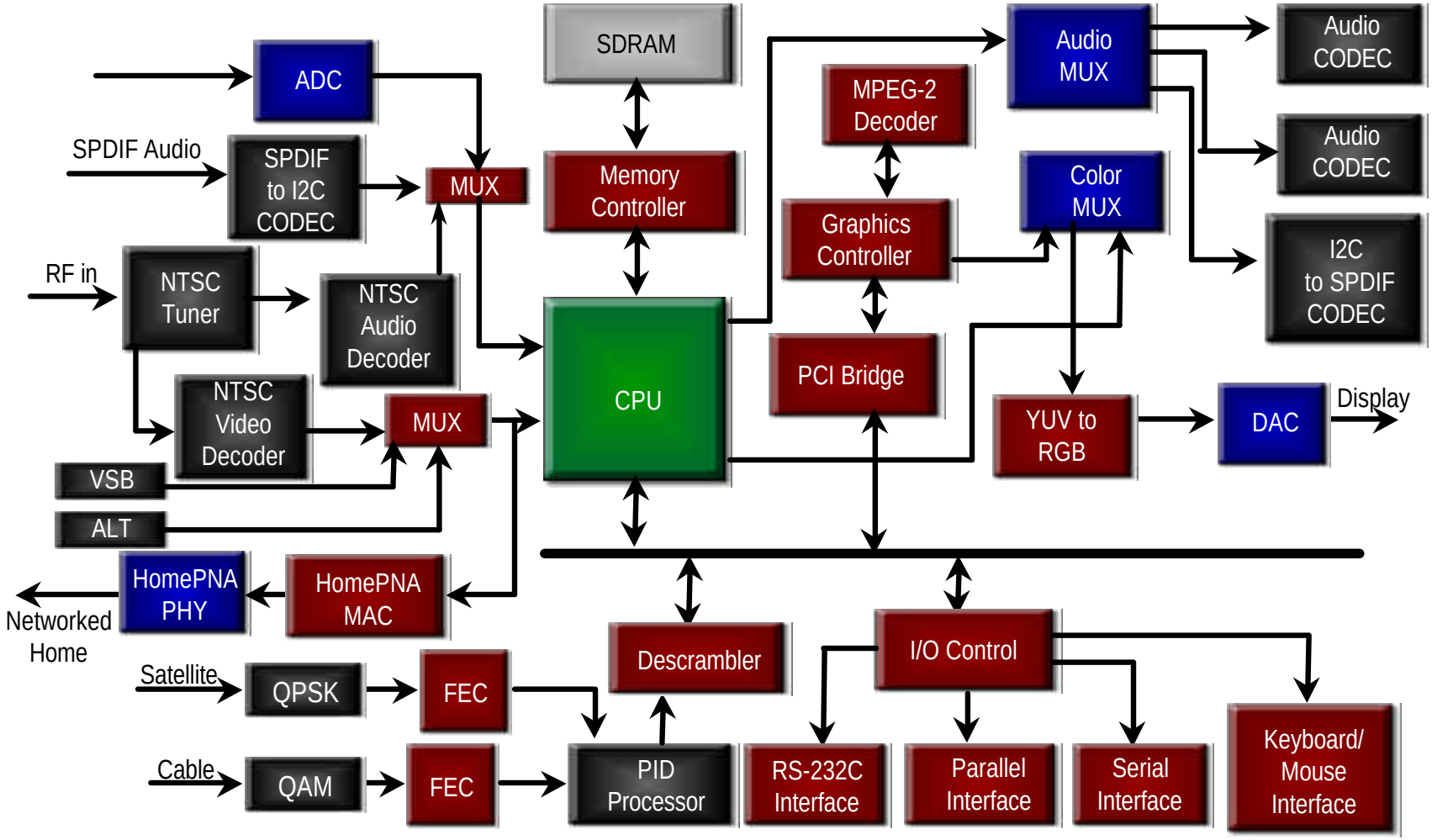
Definitions	Active Lines	Horizontal Pixels	Aspect Ratios	Picture Transmission Rate	Number of Formats
High (HD)	1080I	1920	16:9	30I, 30p, 24p	3
High (HD)	720	1280	16:9	60p, 30p, 24p	3
Standard (SD)	480	704	16:9, 4:3	60p, 30I, 30p, 24p	8
Standard (SD)	480	640	4:3	60p, 30I, 30p, 24p	4

Source: International Data Corporation, 1998

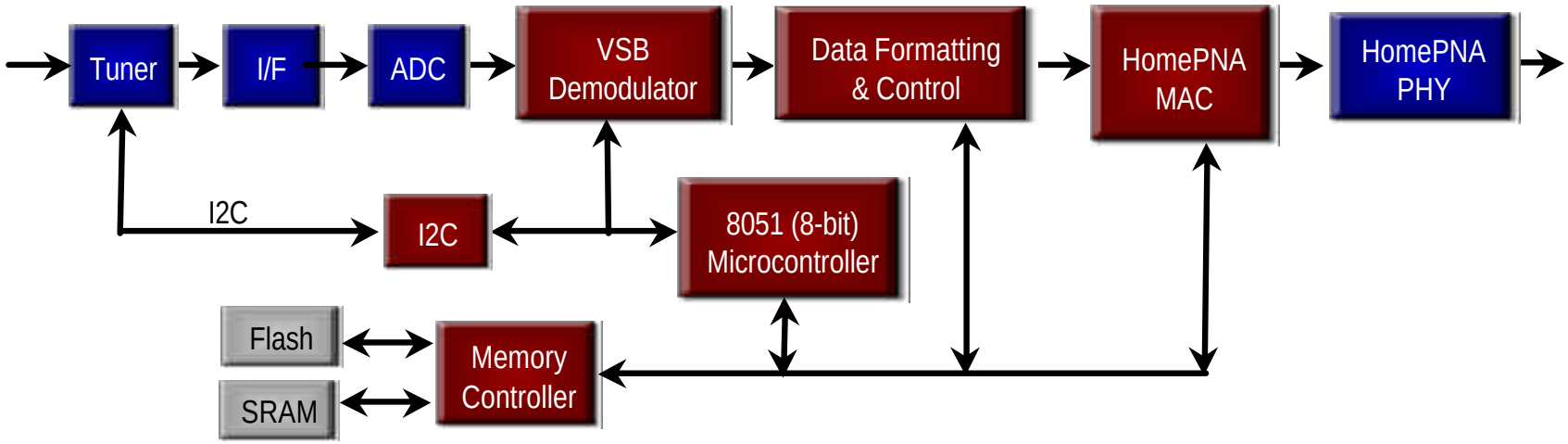
HDTV Vendors

- Hitachi
- Konka
- Matsushita (Panasonic)
- Mitsubishi Digital
- Philips
- Pioneer
- Samsung
- Sharp
- Sony
- Thomson
- Toshiba
- Zenith

Digital TV


ADC
SPDIF Audio
SPDIF to I2C CODEC
RF in
NTSC Tuner
NTSC Audio Decoder
NTSC Video Decoder
VSB
ALT
MUX
MUX
SDRAM
Memory Controller
CPU
MPEG-2 Decoder
Graphics Controller
PCI Bridge
Audio MUX
Color MUX
YUV to RGB
DAC
Display
Audio CODEC
Audio CODEC
I2C to SPDIF CODEC
HomePNA PHY
HomePNA MAC
Networked Home
Satellite
QPSK
FEC
Cable
QAM
FEC
Descrambler
PID Processor
I/O Control
RS-232C Interface
Parallel Interface
Serial Interface
Keyboard/ Mouse Interface

Digital TV


Tuner
I/F
ADC
VSB Demodulator
Data Formatting & Control
HomePNA MAC
HomePNA PHY
I2C
I2C
8051 (8-bit) Microcontroller
Flash
SRAM
Memory Controller

Common DTV Related Acronyms

ATSC	Advanced Television Systems Committee
CAS	Conditional-Access System
COFDM	Coded Orthogonal Frequency-Division Multiplexing
DAVIC	Digital Audio Video Council
DAVID	Digital Audio/Video Interactive Decoder
DBS	Digital Broadcast Satellite
DSS	Digital Satellite System
DTV	Digital Television
DVB	Digital Video Broadcast
EDTV	Enhanced-Definition Television
EPG	Electronic Programming Guide
HDTV	High Definition Television
IRD	Integrated Receiver-Decoder
MPEG	Motion Pictures Experts Group
NTSC	National Television Systems Committee
PAL	Phase-Alternation Line
OSD	On-Screen Display
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase-Shift Keying
SDTV	Standard Definition Television
STB	Set-Top Box
VSB	Vestigial Sideband

Source: EDN

Set-Top Boxes

Digital Set-Top Box (STB)

- Device that acts as a receiver / tuner for TV signals or service access
  - Controls access to premium channels & provides other features such as pay per view
  - There are separate STBs for cable & satellite systems
  - Receives digital broadcast channels and converts signals (decode) to display on analog or the standard TV format
  - Pure Internet Gateways and other network PCs are not strictly set-top boxes, although the term is often used

Market Overview

- Different types
  - Cable, xDSL, Satellite, Terrestrial
- Provides improved quality
  - Support for HDTV
  - Allows broadcasters flexibility in terms of bandwidth vs. quality
- Total market for set-top boxes is estimated to be greater than $16.9B
  - Includes Cable, Satellite and Terrestrial

Trends

- More Channels
  - Increased choices
    - More specialist channels
    - Immediate feedback to broadcasters
  - New services
    - Improved Pay-as-you View
    - Online shopping
    - Interactive TV
    - Hard-drive storage
    - Instant replay
    - Near Video-on-demand
  - Maximum use of available bandwidth
- Improved Quality
  - Support for HDTV
  - No “ghosting” or other interference effects
  - Allows broadcasters flexibility in terms of bandwidth vs quality
- Possible Internet Gateway
  - Some set-top boxes allow Internet access
  - Simpler to use than PC based tools

Set-Top Box Chipset Manufacturers

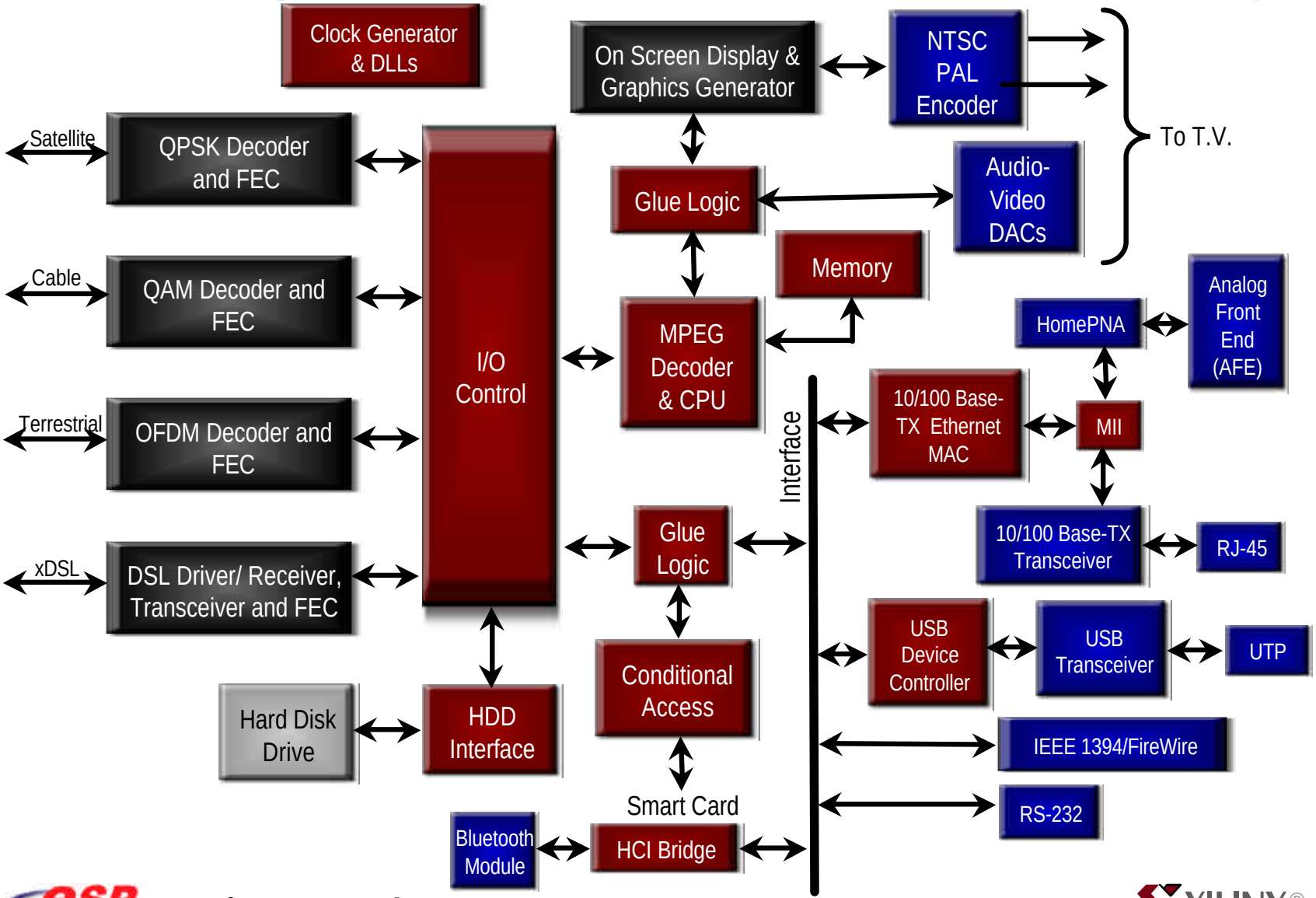
- C-Cube
- IBM
- LSI Logic
- Lucent-Mitsubishi
- Motorola-Sarnoff
- Philips
- STM Microelectronics
- Sony
- TeraLogic
- Texas Instruments
- Toshiba

Xilinx Solutions in Set-Top Boxes

- System Logic
- Clock Distribution
- SDRAM Interface
- FLASH Memory Adapter
- Conditional Access Unit
- Error Correction
- HDLC Controller
- FIR Filter
- DCT/IDCT
- I/O Control
  - HCI Bridge
  - PCI
  - USB Controller
  - IrDA Interface
  - UART

You can implement all these in a Spartan-II FPGA

Set-Top Box: Residential Gateway

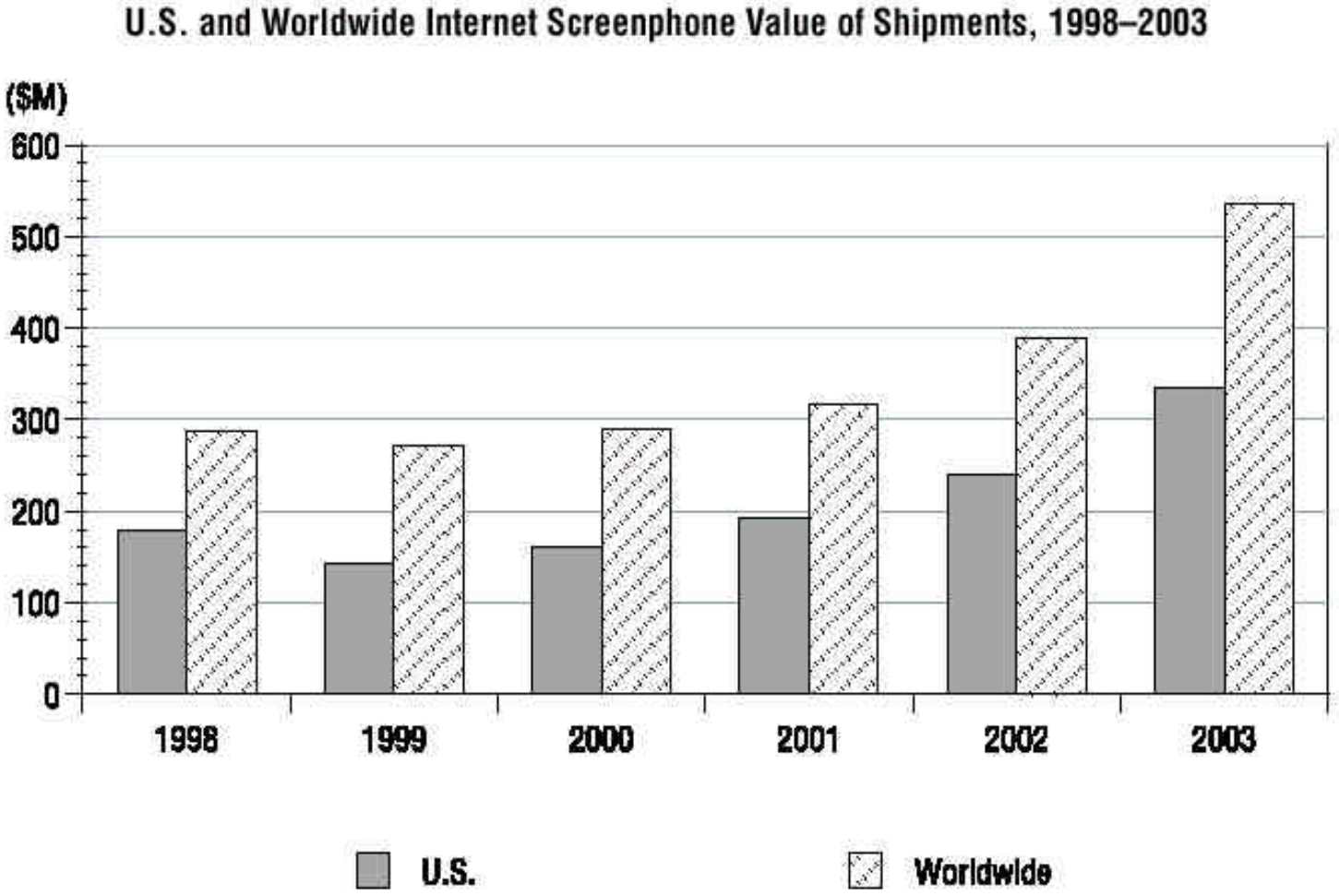


Internet Screenphones

Internet Screenphones

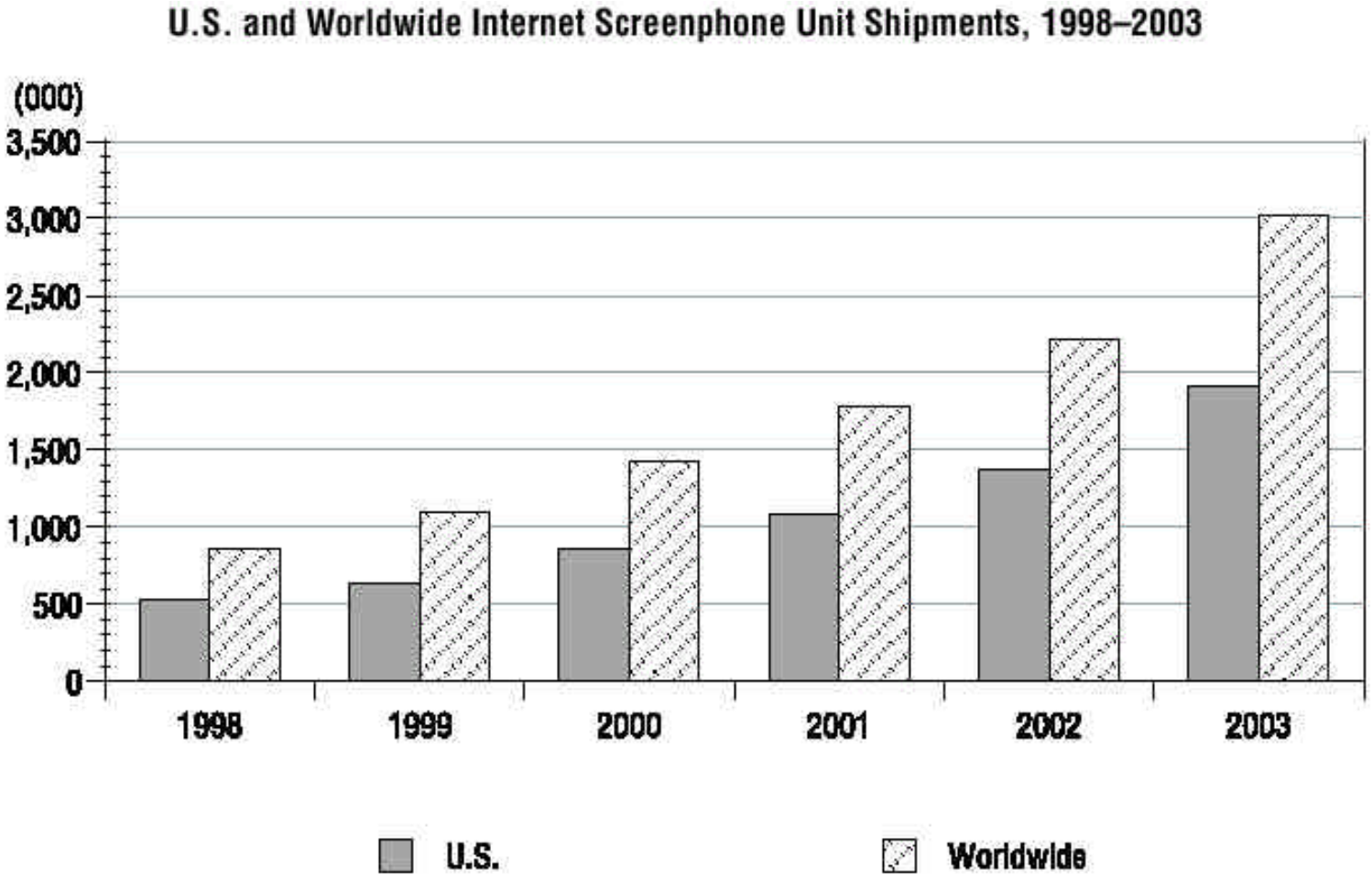
- Type of information appliance built around a telephone-like form factor
  - High end desktop telephones with LCD screens
  - Offer Internet access for email message checking and informational services and/or Web browsing
  - Includes
    - Base module
    - Voice communications module (corded or cordless handset and/or speakerphone)
    - Keypad
    - Screen display

Internet Screenphones Shipments



Source: International Data Corporation, 2000

Internet Screenphones Shipments



Source: International Data Corporation, 1999

Internet Screenphones Categories

- Three key screenphone product categories
  - Low-end products (Range $100 - 150)
    - Use a very small LCD display
    - Provide the most basic access to limited Internet content such as text email or news
  - Midrange products (Range $199 - 399)
    - Larger screen with a miniature keyboard
    - Interactive email or news feeds from the Internet
      - Web-browsing capabilities are limited
  - High-end products (Range $400+)
    - Color screen of 7-8 in with graphics & touch-screen capabilities
    - Email, web browser

Internet Screenphones Products

- Low end
  - Casio Communications
- Mid range
  - Nortel PowerTouch Series
  - CIDCO CST2100
  - Inventec (BT Easicom 1000)
  - Cybiolink 8000
  - CPS Europe P-112 Pronto Mail
- High End
  - InfoGear iPhone
  - Alcatel WebTouch
  - Matra Nortel i3210
  - Samsung Anyweb
  - Vestel Internet.Phone
  - Acer IP 100
  - Daewoo XP102
  - Panasonic KX-T7700
  - IBM ESBU Screenphone
  - IPM Group Smilephone
  - UMEC ISP2000
  - Mitsui Comtek Interactive Phone

Growth Accelerators for Internet Screenphones

- More vendors with more products, leading to competition
- Big vendors with large marketing departments help validate the screenphone concept & help in promotion
- Increasing demand for Internet at multiple points in the home
- Service provider distribution and promotion of devices

Growth Inhibitors for Internet Screenphones

- Uncertain business model
- Shift to IP resulting in higher bill of materials
- Minimal consumer awareness
- Lack of a killer application
- Competing information appliances
- Issues with form factors
  - Small screens, smaller keyboards, large physical sizes

Trends

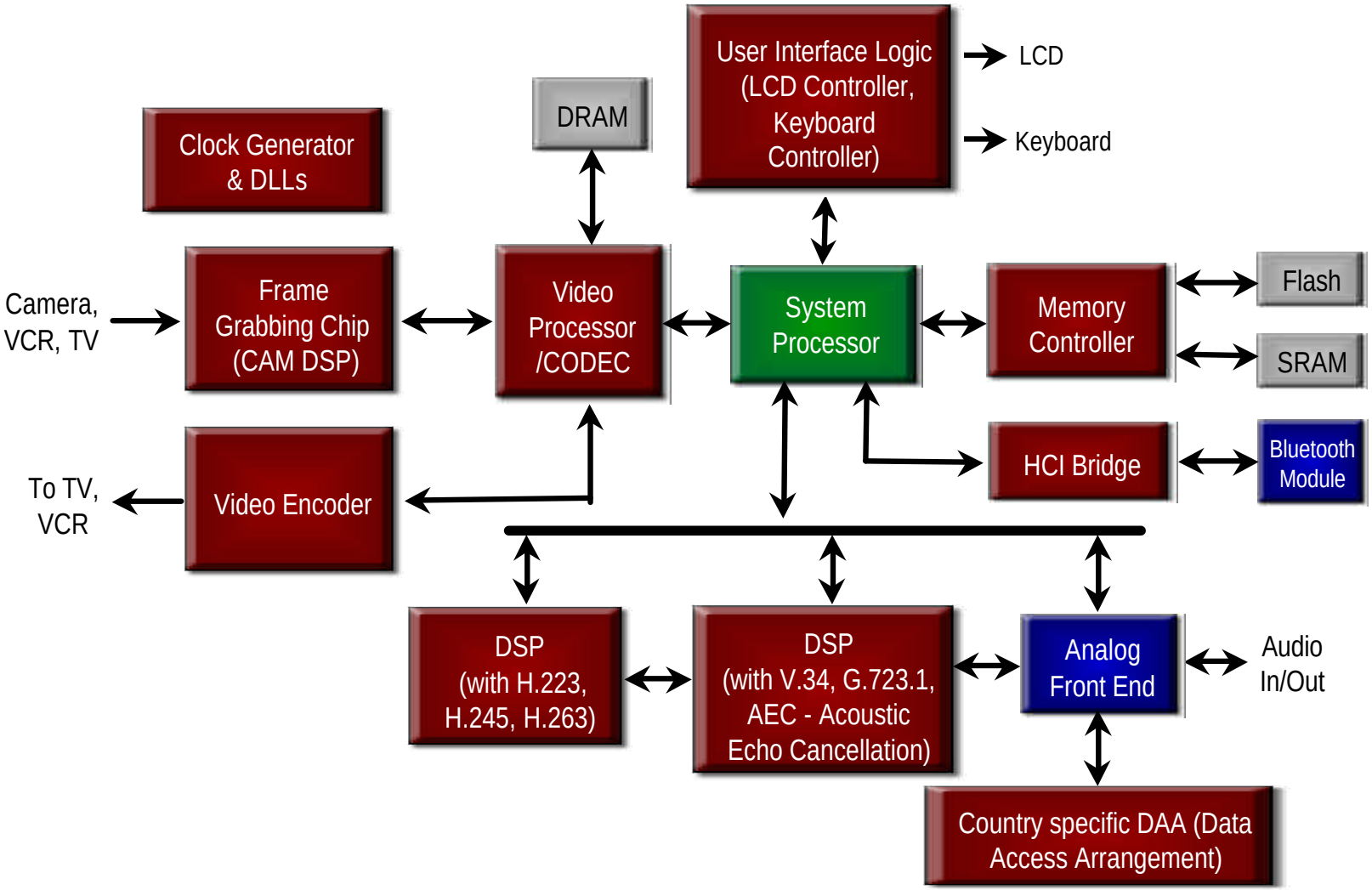
- Touchscreen control
- Biometric security features
- Speech recognition
- Evolving standards in security and data processing
- Advanced LCD technology

Xilinx Solutions for Digital Video Phone

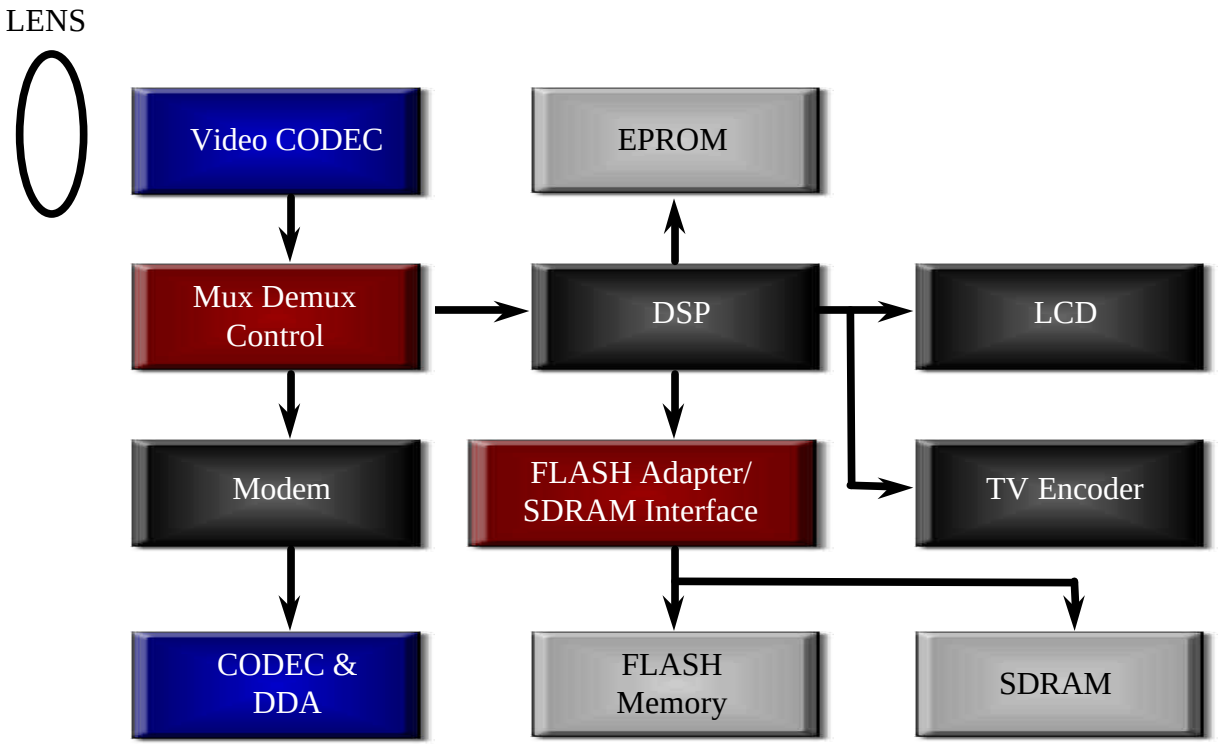
- System Logic
- Clock Distribution
- SDRAM Interface
- FLASH Memory Adapter
- Power Management
- Error Correction
- HDLC Controller
- FIR Filter
- DCT/IDCT
- Display/Keyboard Control
- I/O Control
  - HCI Bridge
  - PCI
  - USB Controller
  - UART

You can implement all these in a Spartan-II FPGA

Digital Video Phone



Internet Screen Phone/ Digital Video Phone



VoIP Phone

VoIP Phones - Market Overview

- VoIP - Voice over IP (Internet Protocol)
- Transmission of voice traffic in packets
- Integration of voice, video & data in multiple applications
- Bandwidth consumption 8:1 in favor of packet-based networks
- Rising communications cost reduction
- Enhanced features
  - More flexible call routing
  - Multimedia Support
- According to Cahners In-Stat the VoIP gateway market will see exploding growth
  - 1998 worldwide gateway market = $61 million
  - 2003 worldwide gateway market = $3.8 billion
  - 280% CAGR

Trends in the VoIP Phone Market

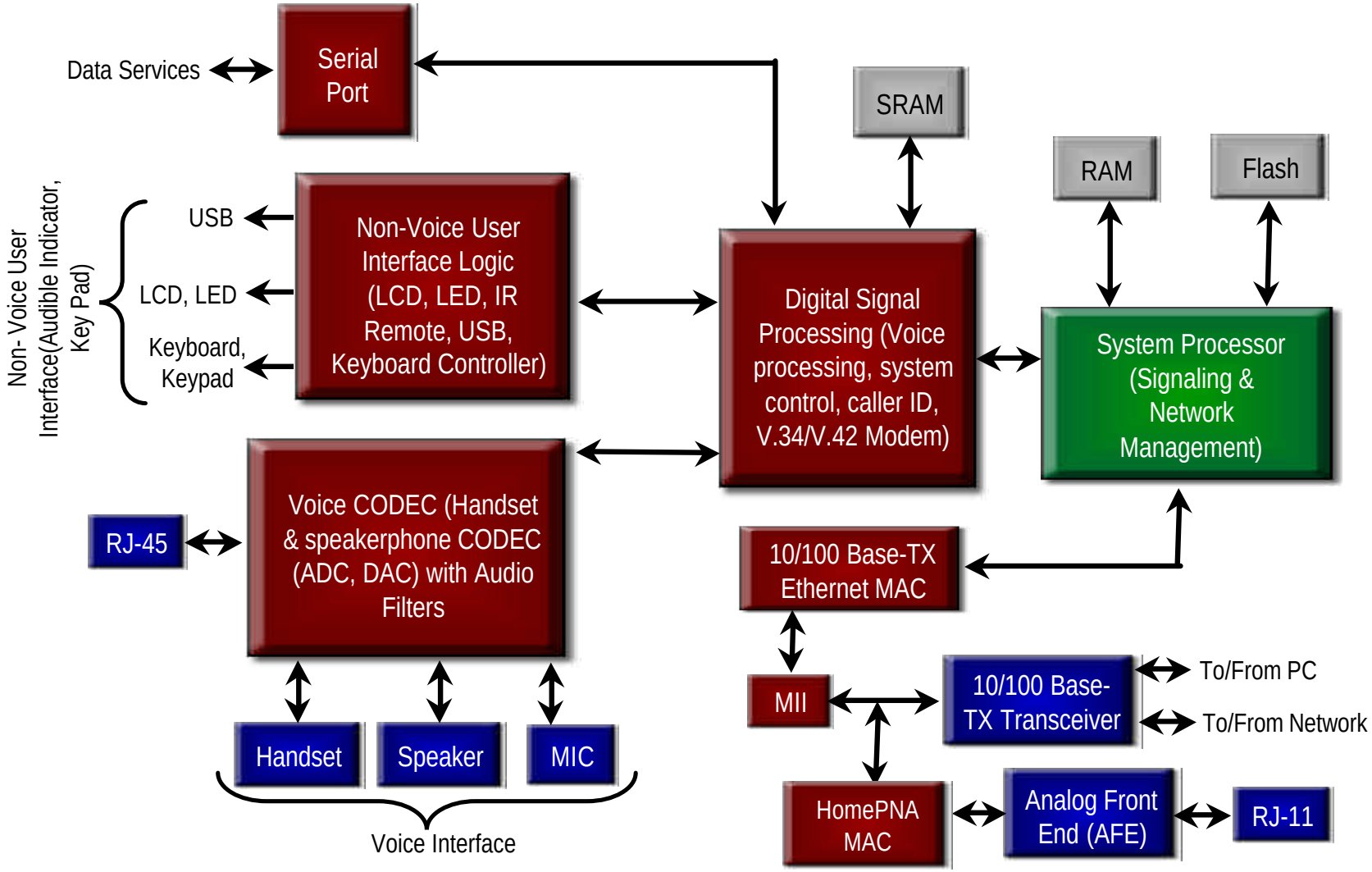
- Touchscreen control
- Biometric security features
  - Fingerprint
  - Palm print
  - Retinal Scan
- Speech recognition
- Evolving standards in security and data processing
- Advanced LCD technology

Xilinx in VoIP Phones

- System Logic
- Clock Distribution
- I/O Control
  - Bluetooth HCI Bridge
    - UART
    - SPI
    - I2C
  - PCI
- USB Controller
- FLASH Memory Adapter
- SDRAM Interface
- Display/Keyboard Control
- Error Correction
- DCT/IDCT
- Power Management
- HDLC Controller
- FIR Filter

You can implement all these in a Spartan-II FPGA

VoIP Phone


Data Services
Serial Port
SRAM
RAM
Flash
Non-Voice User Interface(Audible Indicator, Key Pad)
USB
LCD, LED
Keyboard, Keypad
Non-Voice User Interface Logic (LCD, LED, IR Remote, USB, Keyboard Controller)
Digital Signal Processing (Voice processing, system control, caller ID, V.34/V.42 Modem)
System Processor (Signaling & Network Management)
RJ-45
Voice CODEC (Handset & speakerphone CODEC (ADC, DAC) with Audio Filters
10/100 Base-TX Ethernet MAC
MII
10/100 Base-TX Transceiver
To/From PC
To/From Network
Handset
Speaker
MIC
Voice Interface
HomePNA MAC
Analog Front End (AFE)
RJ-11

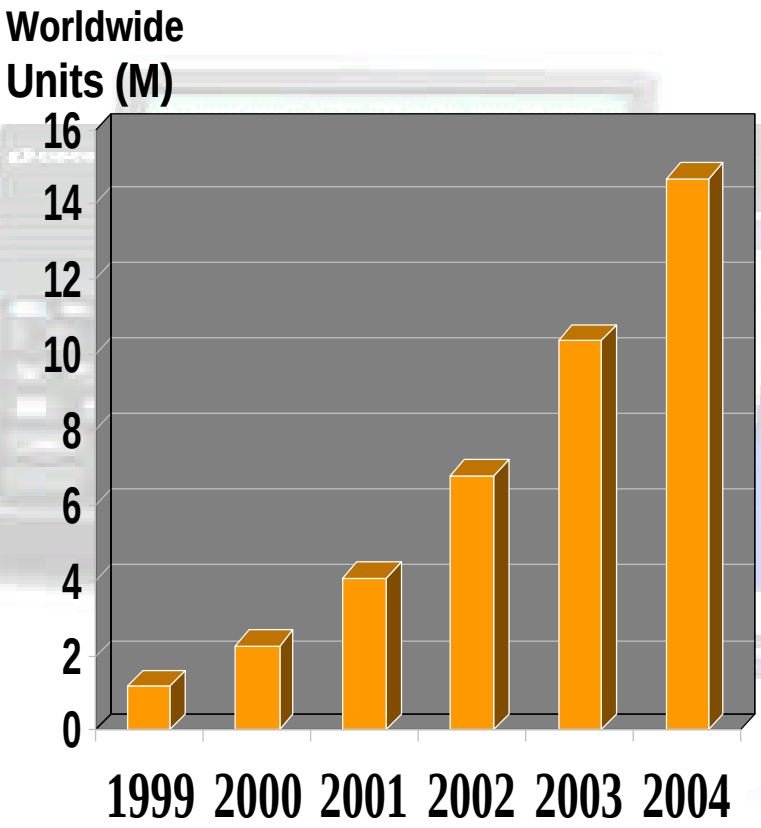
Web Terminals and Web Tablets

Web Pad / Fridge Pad

Web Terminals & Tablets

- Stand-alone devices used primarily for web browsing and email
  - Can exist in both tethered & tablet (cordless) forms
    - Tethered: Web terminals
    - Wireless: web tablets / web pads / fridge pads
- Typically based on embedded OS
- All-in-one form factor including a monitor

Growth Accelerators & Inhibitors



- Accelerators
  - Web terminals & email stations
  - Low cost and refined utility
  - Varied deployment
- Inhibitors
  - Questions about support from service providers
  - Lower PC prices and new subsidized distribution models

Web Pad / Web Tablet

- Wireless, portable, low-cost, easy to use, tablet-shaped consumer-focussed information appliance
  - Touch-screen user interface
- Browser-based interface to simplify and enhance the internet experience
- Subcategory of web terminals
- Consists of 2 separate components
  - Portable LCD built in a tablet shaped device
  - Base station
    - Plugged into the Internet via an analog or broadband connection
    - Sends/receives wireless (RF) transmissions from the tablet

Vendors & Products

- Netpliance - i-opener
- MSN - Web Companions
- Merinata - iBrow
- Acer - I-Station
- Qubit Technology Company - Qubit
- Nokia - MediaScreen

Issues Facing Web Tablets

- High BOM
  - High cost of wireless technologies & an LCD display causes significant consumer price-point issues
  - $500 BOM results in a discouraging end user pricing of $799+
- Value proposition
  - Unique value proposition of web tablet is providing the mobile connection to the Web
  - Is not enough to drive mass-market success of the device

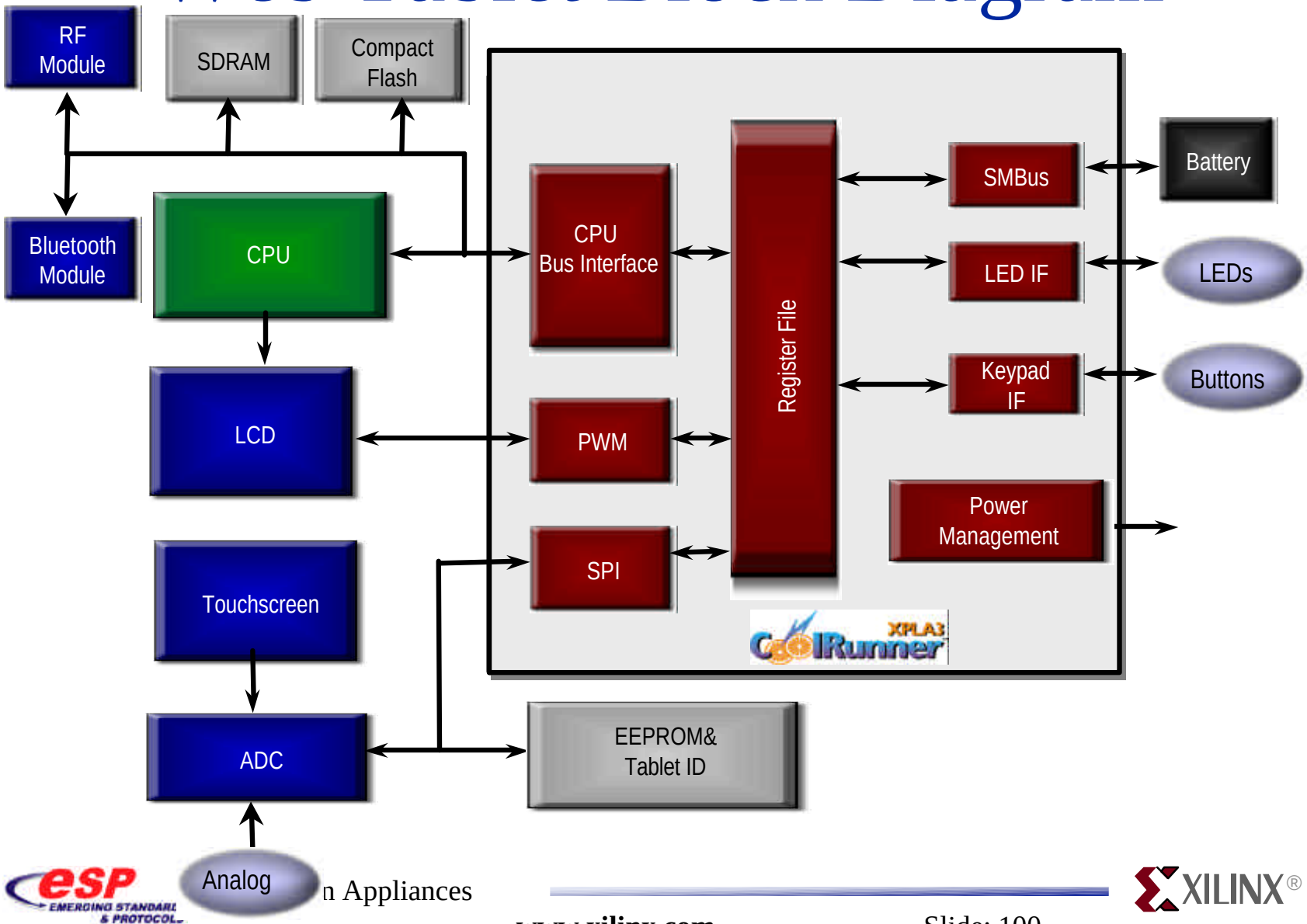
Issues Facing Web Tablets

- Lack of vendor support
  - Top consumer electronics & PC manufacturers have not embraced this technology
- PC Competition
  - PCs and notebook PCs destroy the single, unique value proposition presented by the Web tablet

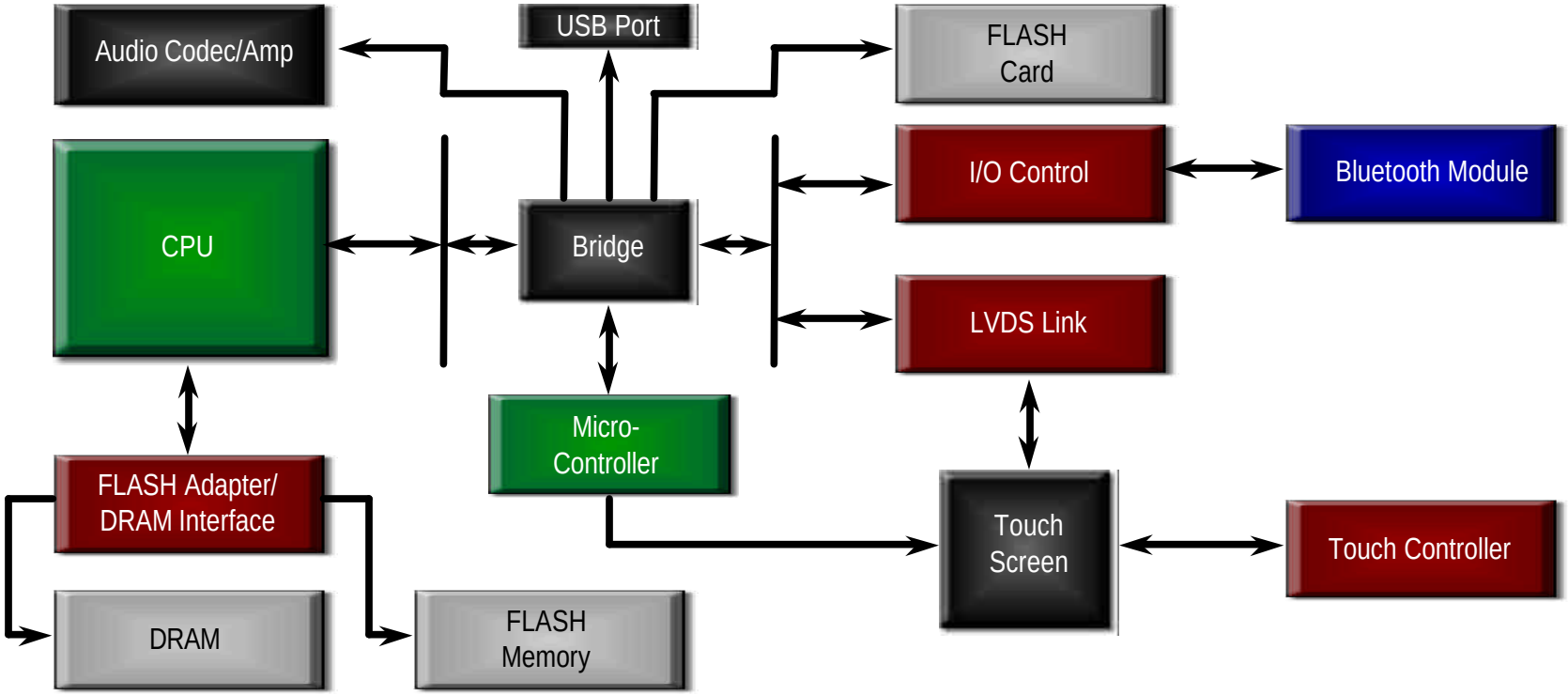
Web Tablet / Web Pad - Uses

- Can be used for
  - Internet Browsing
  - Email
  - Inventory Control
  - Order Entry Systems
  - Internet Enabled Appliances
- Uses an RF interface (such as Bluetooth, HomeRF, Wireless LAN)
  - Allows users the capability of operation within range of a base station transceiver

Web Tablet Block Diagram



Web Pad


Audio Codec/Amp
USB Port
FLASH Card
CPU
Bridge
I/O Control
Bluetooth Module
LVDS Link
Micro-Controller
FLASH Adapter/ DRAM Interface
Touch Screen
Touch Controller
DRAM
FLASH Memory

Xilinx Solutions for Web Tablet/ Web Pad

- System Logic
- Clock Distribution
- SDRAM Interface
- FLASH Memory Adapter
- Power Management
- Error Correction
- Display Driver
- I/O Control
  - HCI Bridge
  - PCI
  - USB Controller
  - IrDA Interface
  - UART

You can implement all these functions in a Spartan-II FPGA

Email Terminals

Email Terminals

- Standalone, non-portable, consumer-oriented devices
- Dedicated for accessing email without web browsing capabilities
  - Do not include Web browsers or additional applications
- Include
  - keyboard, small LCD screen, some soft function keys
- Vendors & products
  - CIDCO - MailStation
  - Landel Telecom - MailBug
  - VTech - e-mail PostBox

Gaming Devices

Electronic Gaming Devices

- Videogame consoles
  - Machines that deliver electronic games-based entertainment for household consumption
  - Feature proprietary hardware designs and software OS
  - Rely primarily on AC power as primary energy source & must be plugged into an external video display such as a TV
  - Can also provide Internet & email access
- Vendors & products
  - Sega - Dreamcast, Saturn
  - Sony - PlayStation 2
  - Nintendo - N64, N128
  - Microsoft - X-Box

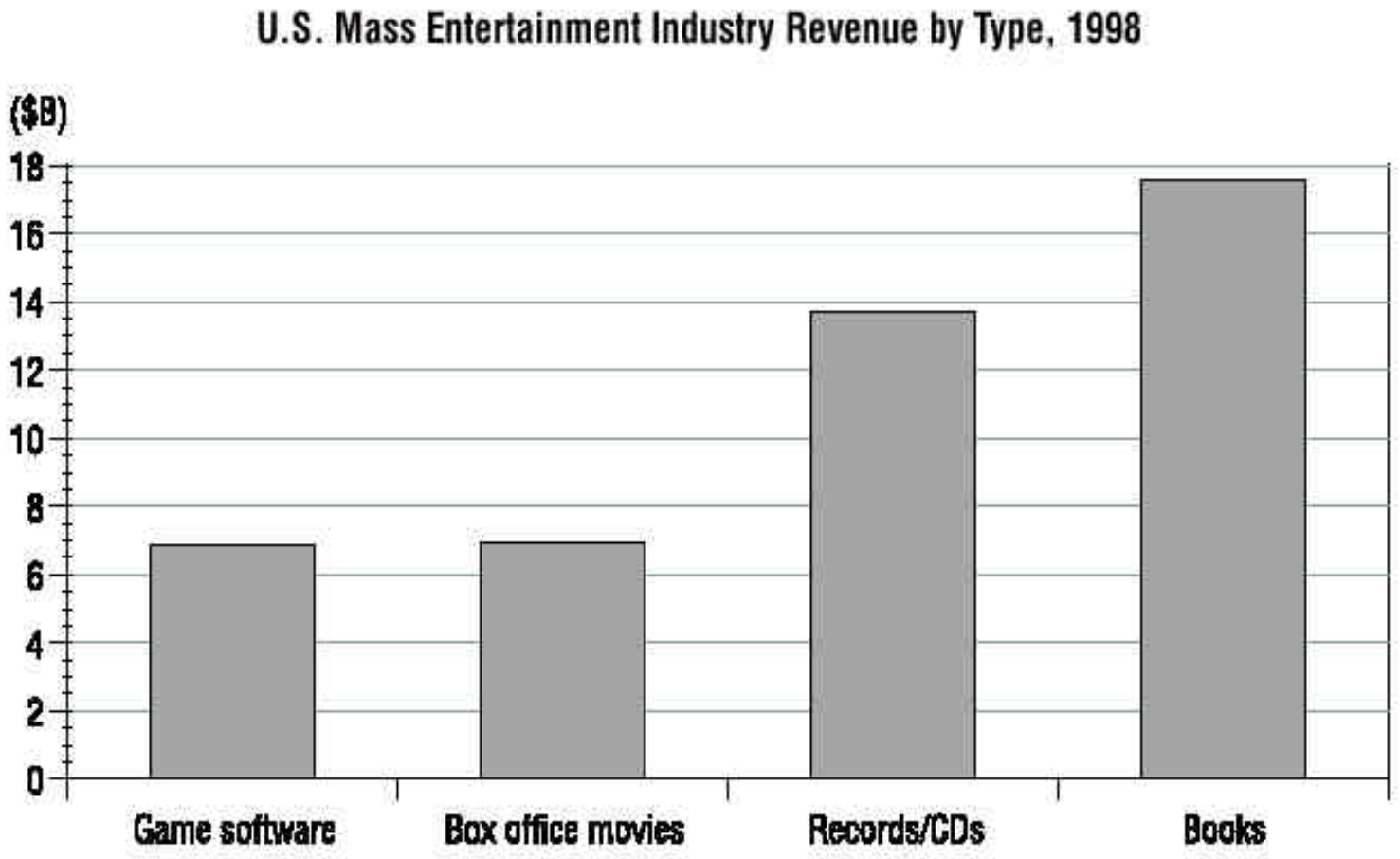
Handheld Gaming Devices

- Primarily for mobile, household use
- Rely on DC power as the primary energy source
- Include an embedded video display, such as an LCD
- Examples
  - Sega's GameGear
  - Nintendo's Game Boy

Online Gaming

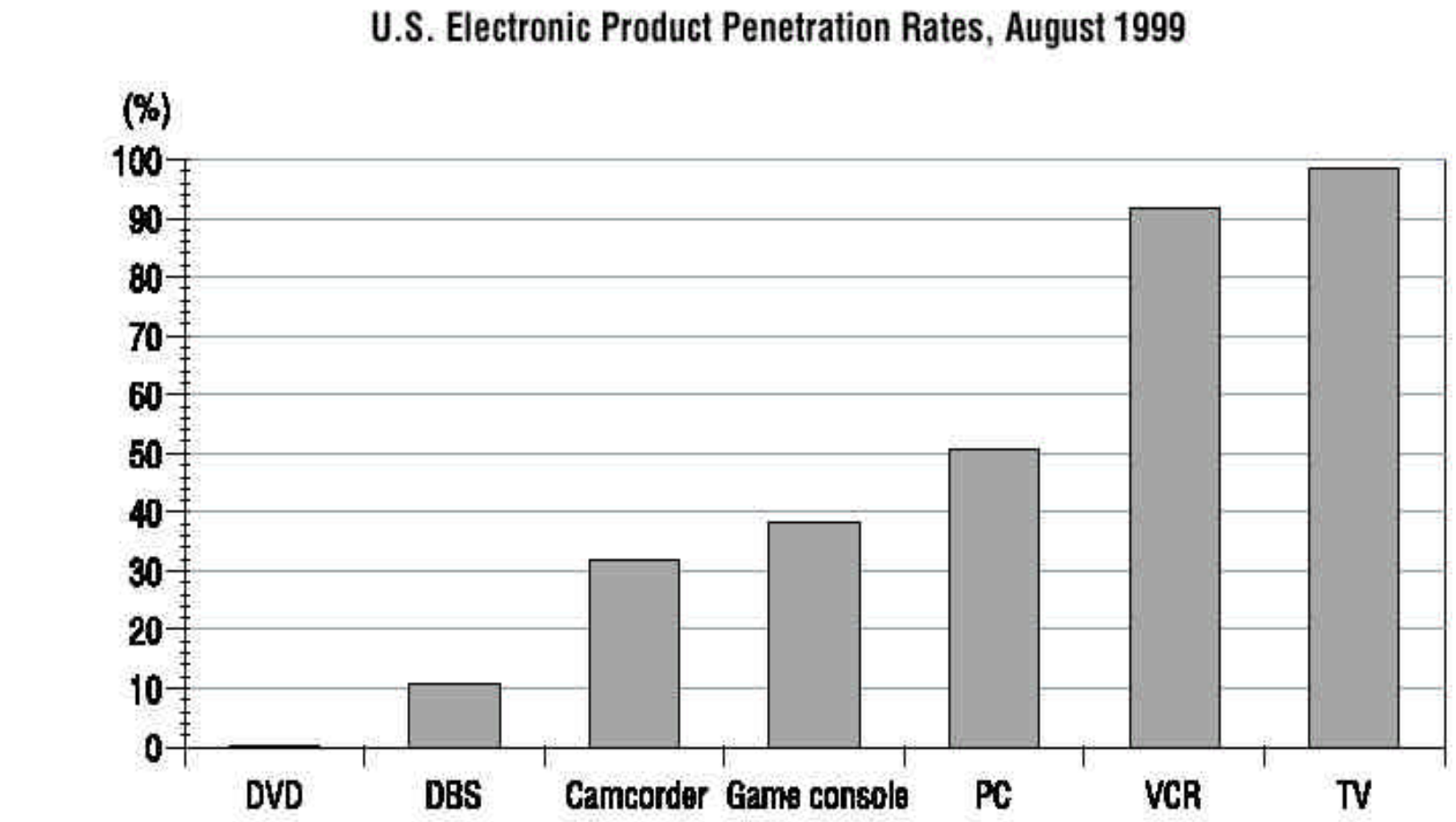
- Interactive electronic game play involving offsite, independent variables
  - Another human opponent or an offsite PC
- Platform independent
  - PCs, videogame consoles, NetTVs
- Medium independent
  - Internet, cable television, DBS

Interactive Gaming Goes Mainstream



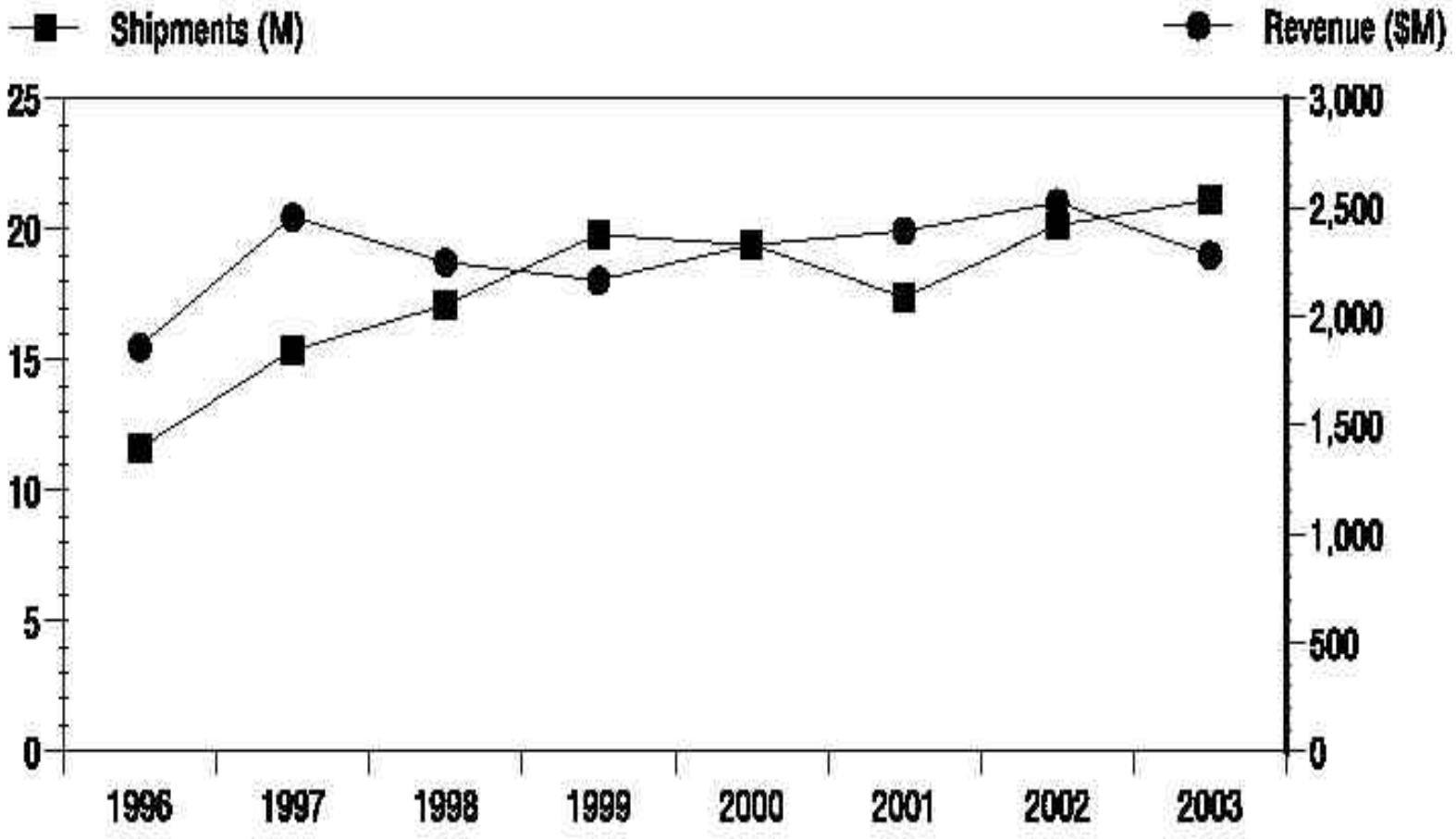
Source: International Data Corporation, 1999

Product Penetration Rates



Source: International Data Corporation, 1999

U.S. Game Console Shipments and Revenues

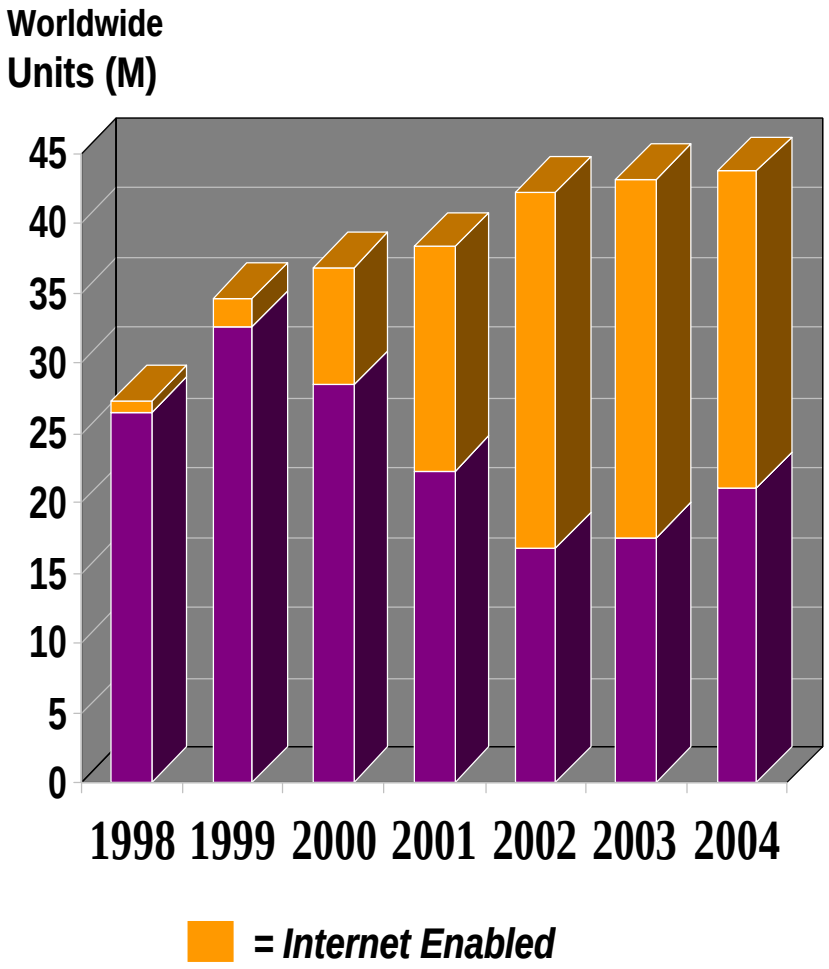


Source: International Data Corporation, 1999

Market Trends

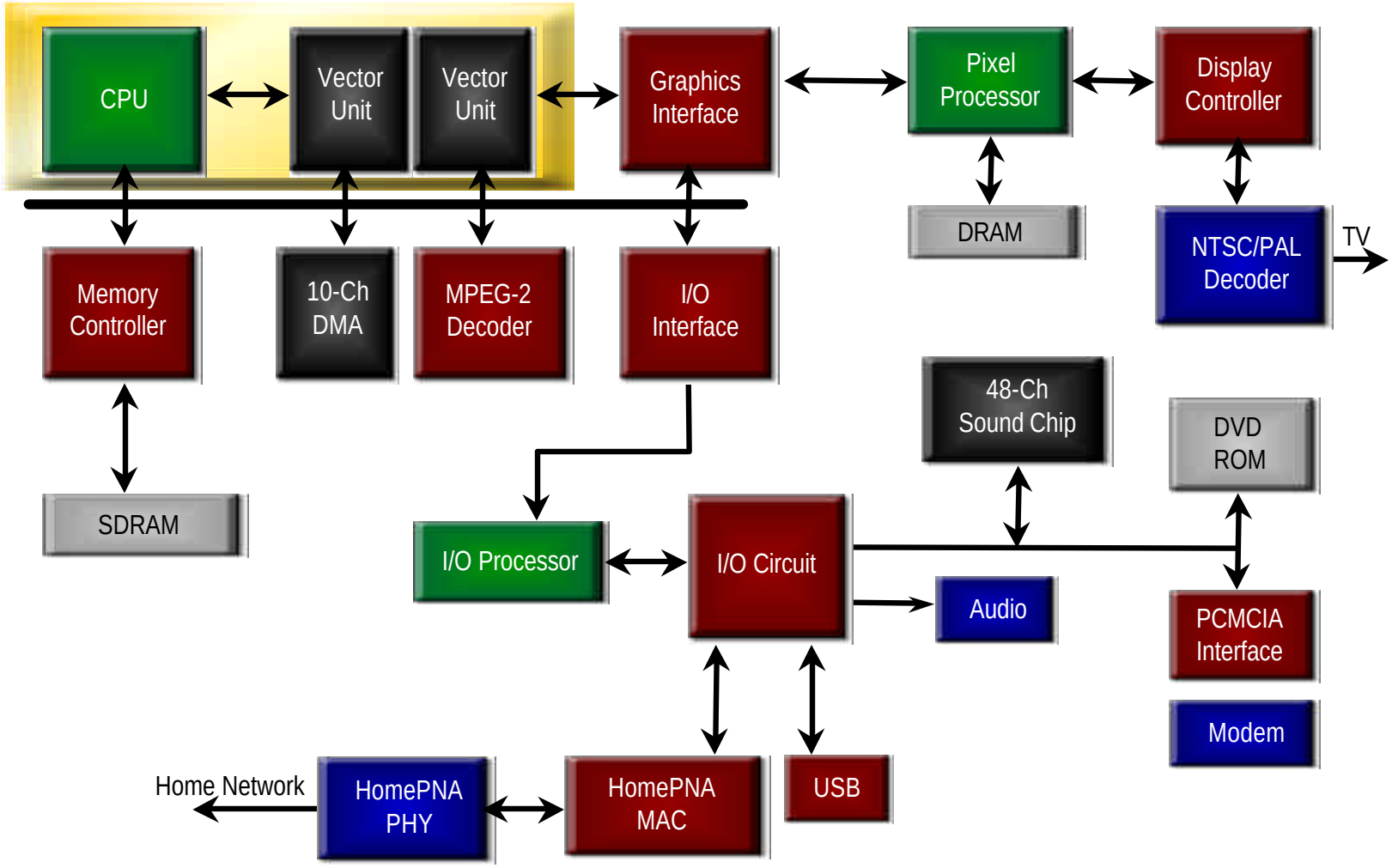
- Generation Y is entering the teenage years with a keen interest in games and interactive entertainment
- Growing pervasiveness of the Internet will help online gaming
- Home networking and broadband access
  - Online gaming with a high-speed access
  - In-home gaming between consoles and PCs
- Digital TV, high definition TV (HDTV) & set-top box
  - High quality video & gaming enhances the viewer experience
  - Interactive capabilities through cable, satellite, xDSL

Growth Accelerators & Inhibitors



- Accelerators
  - Next generation product cycle
  - Installed base
  - Internet / Web access feature
- Inhibitors
  - Limited success of on-line, console-based gaming
  - PCs: low-cost & performance improvements
  - Higher prices

Gaming Console



Internet Audio Players

MP3 Players, DVD-Audio (DVD-A),
Super Audio CD (SACD), MiniDisc (MD),
Compact Disc (CD)

What is an Internet Audio Player?

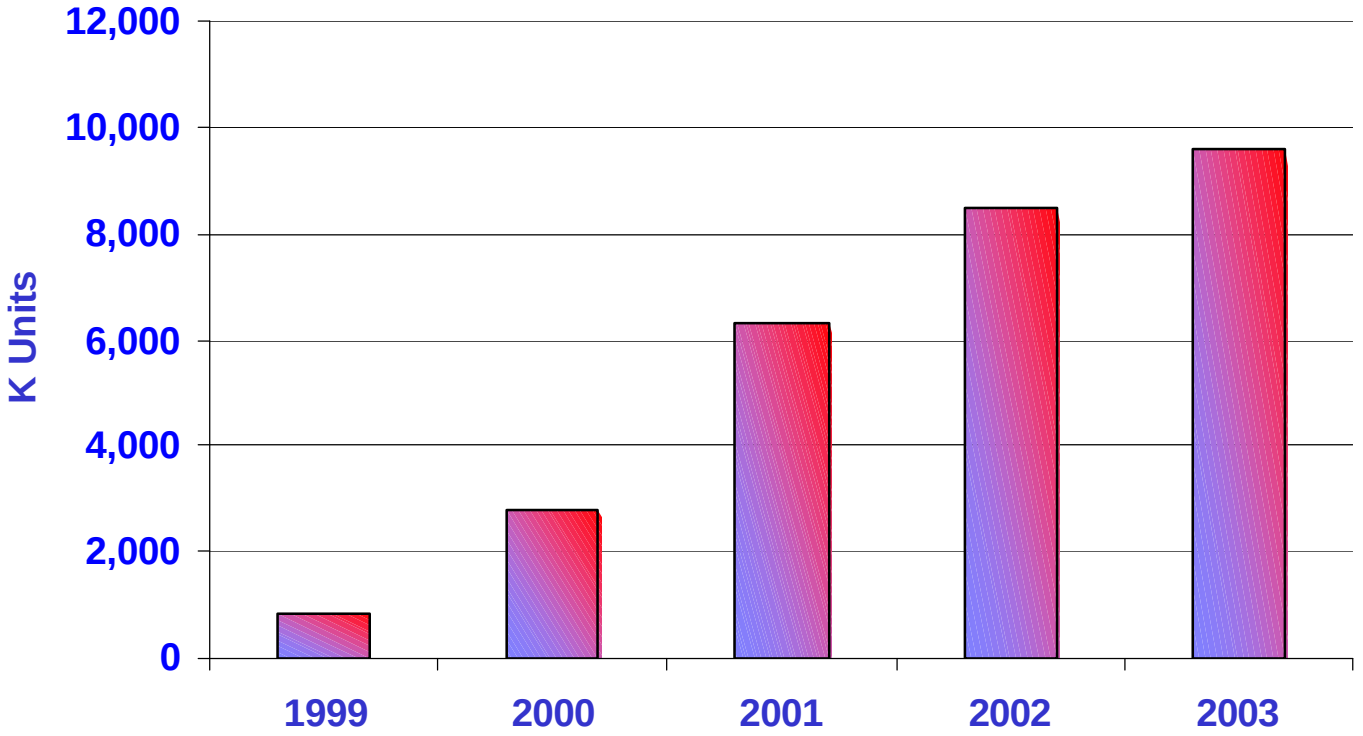
- A portable music player resembling a WalkMan
  - Best known is the Diamond Rio
- Plays back compressed music stored in flash memory
  - Players contain 32 to 64MB or more
  - CD quality but one eleventh of the size
    - CD requires 650MB
    - MP3 requires 55MB !

What is an Internet Audio Player?

- Music is downloaded to player from a PC
  - Cable connected to printer port
  - USB
  - Bluetooth allows the system to exchange music files
    - Untethered with the PC
    - Untethered between the device & headpiece
- Music sources
  - Can be compressed from CDs
  - Can be downloaded from Internet

Market for Internet Audio Players

- All sources forecast tremendous growth for Internet audio players



Source: In-Stat

Market Analysis

- Current State
  - Growing major CE vendor support.
- Growth
  - WW unit CAGR of 48% (2000-04)
  - 18M WW units in ’04.
- Drivers
  - High consumer awareness & growing popularity for digital downloads
- Challenges
  - Security and content

Technology Today - Formats

- Dominated by CD (compact disc)
  - In 1998, over 1 billion prerecorded CDs were sold in the US*
    - Accounted for 81% of prerecorded music sales
    - It took 10 years for the CD format to overtake the cassette in terms of unit shipments
- Already here and more coming
  - MP3 (dominates)
  - DVD-A (DVD-Audio)
  - Super Audio CD (SACD)

* Source - IDC

Internet Audio Player Issues

- Several audio format standards are rapidly emerging
- Copyright protection
  - Driven by recording industry
  - Digital CD format offers much higher quality than previous analog cassette format, but the industry did not include security protection in the standard
    - Technologies like CD-R and MiniDisc allow consumers to make digital copies
    - For new formats copyright protection is a key consideration
- Features
  - Value added features
  - Product differentiation

Trends in the Music Industry

- Tremendous consolidation at every level increases market power for the remaining players
  - Number of top-tier music labels have reduced
  - Consolidation is due to corporations seeking economies of scale and profitability in the mature industry
  - Leads to artists & independent labels to search for new ways to promote & distribute music
    - Efficient systems provide lower costs and higher profits for the labels
    - New medium provides an opportunity for promotion & exposure to artists

Trends in the Music Industry

- Shift towards digital formats
  - Communication, entertainment & information is all transitioning from analog to digital
  - Shift has been occurring in the music industry for decades through CD formats as consumers expect great fidelity, depth and range in the music
  - Easier to copy without losing quality
  - PCs aid in making digital files easy to store and replicate
- Internet becoming a mass-market phenomenon
  - Superb distribution channel for anything that can be digitized
  - New medium for music promotion & distribution

Trends in the Music Industry

- Digital compression
  - Reducing music files to a fraction of their size, makes them easier to manage and distribute, without sacrificing quality
- New (non-traditional / experimentation) business models
  - Knowledge of consumer information removes distance between the consumer (fans) & artists
    - Focussed marketing allows closer relationship while increasing profits for everyone
  - Electronic distribution: per-play fees, limited-play samples, subscription models
- Broadband (high-speed) access to the home will promote electronic music distribution over the Internet

Audio Formats

- Internet audio formats fall into two categories
  - Streaming formats
    - Playback is real time across the Internet
    - Music file is not saved
    - Assume low bit rates ~ 16 Kbps
    - Emphasis: real time playback
  - Download formats
    - Audio is downloaded to PC and then played
    - Music file is saved on PC
    - Assume higher bit rates ~ 64 to 128 Kbps
    - Emphasis: Near CD quality sound

- Some audio formats have built in copy protection

Format - MP3

- MP3 is the de facto standard on the Internet today
  - Millions of users and free PC-based codec widely available
    - MP3 is not a free technology: Algorithms are licensed to companies that develop codec products for $0.05 per player
- MP3 = MPEG Audio Layer 3
  - MPEG-1 & MPEG-2: standards for audio & video compression
  - MPEG-1 standard (and MP3) was approved in 1992
  - Layer III uses most advanced coding, gives best results
  - Created by partnership between French consumer electronics company Thomson and German Fraunhoffer Institute

Format - MP3

- MP3 is a variable-bit codec
  - Users can determine the sampling rate for encoded audio
  - Higher sampling rates means that the audio maintains better fidelity to the original but results in less compression
    - Better the quality, larger are the resulting files & vice versa
    - For most consumers MP3 files encoded at reasonable rates (96kbps or 120kbps) are distinguishable from CDs
- MP3 features
  - Sample rates from 16 to 48 KHz
  - Up to 5 main channels (MPEG-2 only)
  - Has no built-in security, no safeguards or usage policies to govern its use
  - Algorithm uses 50% performance of a 74MHz ARM7 CPU

Format - Secure MP3

- Companies are working to add security in the format
  - Intertrust, IBM, Sony
- Approaches
  - Packing the MP3 files in a secure container that can opened with a key
    - Key can be associated with a particular system or sent to the user separately
    - Issues: Tracking the keys and lack of consumer flexibility
  - Encryption technology combined with encoded file
    - Key could be the drive ID to user information
    - Information held in the encryption code ensures copyright protection, establishment of new business models, specific uses of songs

Format - Liquid Audio

- Company was formed in 1996
  - Developed end-to-end solutions to provide high-quality, secure music
    - Enable music to be encoded in a secure format, compressed to a reasonable file size, purchased online, downloaded & played
    - Created back-end solutions to manage & track payments - acted as a clearinghouse for downloaded music
- 200+ powerful partners & affiliates - Liquid Music Network
- Hindered by its PC-only playback capabilities
  - Recently gained support from silicon vendors & consumer electronics companies to introduce products
    - Texas Instruments, Sanyo

Format - Windows Media Player

- Microsoft has been involved with audio for many years
  - Multimedia incorporation in OS since Windows 95
  - Basic support for CDs and WAV files
  - Recently introduced MS Audio format
- Windows Media Player
  - Multimedia platform that comes with Windows
  - Default front end for playing audio & video files

Format - Windows Media Player

- Microsoft is aggressively working to develop new technologies for the secure download of music
  - Goal: Make its technology as pervasive as possible
  - WMA or Windows Media Audio
    - Recently developed codec that is twice as effective as MP3
    - Variable-rate technology: New compression technology providing good quality in very small files
  - Licensed its codec to other software providers
  - Incorporated WMA on server-side technology in Windows NT Server OS (royalty-free)
  - Working on support for other Microsoft products such as Windows CE OS for hand-held devices & set-top boxes
    - Already used in Win CE-based Casio's Cassiopeia

Format - Others (Here & Coming)

- a2b
  - Compression and security technology supported by AT&T
  - Web site promotes the a2b codec with free players and available content
  - Limited installed base of players & little momentum in the market, prevents a2b in becoming a widely supported format
- EPAC (Enhanced Perceptual Audio Coder)
  - Codec developed by Lucent Technologies
  - Originally created at Bell Labs, the technology compresses audio at a rate of 1:11
  - Supported by RealNetworks in its popular G2 player
    - Few content owners/distributors support it

Format - Others (Here & Coming)

- TwinVQ
  - Developed by NTT Human Interface Labs in Japan
  - New compression technology called Transform-Domain Weighted Interleave Vector Quantization, or TwinVQ
  - Has attracted high industry interest due to its quality and compression capabilities
    - The codec can compress audio at rates of 1:18 to 1:96, which implies a near CD-quality file size of about 0.55MB per minute
- MPEG-4
  - Developed by same group supporting MPEG-1 and MPEG-2
  - New A/V codec with better compression capabilities than previous standards & additional interactive support

MPEG AAC: The Next Generation

- MPEG Advanced Audio Coding (AAC)
  - An optional algorithm for MPEG-2
  - The core algorithm for MPEG-4
- Features
  - Sample rates from 8 to 96 kHz
  - Flexible multi channel support: mono, stereo, up to 48
  - Same quality as MP3 at 70% of the bitrate
- Three Profiles, in order of coding complexity
  - LC (Low Complexity), SSC (Scaleable Sampling Rate), Main
- Core algorithm for: a2b, WMA, Liquid Audio etc.

Major Formats Compared

- Most of the newer download formats are based on MPEG-2 AAC
  - a2b, Liquid Audio, Windows Media Audio
  - Copy protection features are key value addition
- Streaming audio formats are evolving rapidly
  - Better quality with integration of graphics and video

Format	Developer	Notes	Type	Secure
Windows Media Audio (WMA)	Microsoft	Supported by Creative Labs NOMAD II	Both	Yes
G2	RealNetworks	Streaming audio market leader	Streaming	No
QDesign Music Codec	QDesign	Ships with Apple's QuickTime 4	Streaming	No
LiquidAudio	Liquid Audio	Based on AAC	Download	Yes
TwinVQ	Yamaha	Incorporated into MPEG-4	Download	No
a2b	AT&T	Based on AAC	Download	Yes
AAC (MPEG-2 AAC)	Fraunhofer Institut	Part of MPEG 2 standard	Download	No
MP3 (MPEG-1 Layer III)	Fraunhofer Institut	Part MPEG 1 and 2 standards	Download	No

Trends in Digital Audio

- Will probably not converge on a single standard
  - Different standards optimized for different
    - Applications
    - Bit-rate vs quality
    - Business agendas

- Players will have to support multiple standards
  - Buyers will want ability to play anything
- Players will have to support emerging “Metadata”
  - Information included with audio
    - Track information
    - Cover Art
    - Ads

Copyright Protection

- MP3 files can be easily distributed through the Internet
  - MP3 format has no inherent copy protection
- Recording industry fears widespread piracy of copyrighted material
  - Sued to stop sale of Rio players
- Legitimate MP3 material available on web is limited
  - Garage bands
  - Samples of tracks from mainstream artists
    - Listen before you buy concept

Secure Digital Music Initiative SDMI

- Consortium of 150+ member companies
  - Technology & music companies
  - Started by the RIAA in response to the momentum that MP3 has built in the market
- Goal: Establish a technology framework for the secure distribution of copyrighted material
  - Has not identified a single technical solution for the implementation of the framework
  - Instead has defined a set of parameters that technologies must meet to be considered SDMI compliant
- Compliant implementations are available from
  - Liquid Audio & InterTrust

SDMI Technology

- Consists of ‘phased’ rollout
- Phase I watermarking of material
  - Devices will be able to detect protected material
  - Device must be upgraded to play protected material
  - Available for “Holiday 99”
- Phase II protection of material
  - Devices will be able to play protected material
  - Availability TBD
- The big question
  - What device resources will be needed to support Phase II?

Internet Audio Player Feature Flux

- Vendors will be driven to differentiate and add value
  - Largest cost component in player is FLASH memory
  - Everyone will have a similar cost structure
- Value added differentiation
  - User interface
  - Video
  - Games
  - Day-timer features
- Will Internet Audio Players evolve into PDAs for teenagers?

Many Types of MP3 Players

- PC/MAC based software
  - MusicMatch
    - Free downloadable MP3 player and ripper
  - RealPlayer
- MP3 cartridge for Nintendo's GameBoy
  - Developed by SongBoy
- Casio Wristwatch MP3 Player

MP3 Form Factors

- Portable players
  - Small player size
  - Leverage a PC for content storage, encoding, download
  - Cost between $100-300
  - Examples
    - Creative Labs Nomad
    - Diamond Multimedia Rio SE
    - Thomson Lyra

MP3 Form Factors

- Home systems
  - Must support multiple output formats and have robust storage capabilities
  - Higher cost designs
  - Examples: AudioRequest from ReQuest, Brujo from netDrives
- Automotive products
  - Require broad operating environment support
  - Require specific industrial design specifications
  - Require multiple format support including radio & CD
  - Examples: Empeg car player, Clarion AutoPC

Product Differentiation and Trends

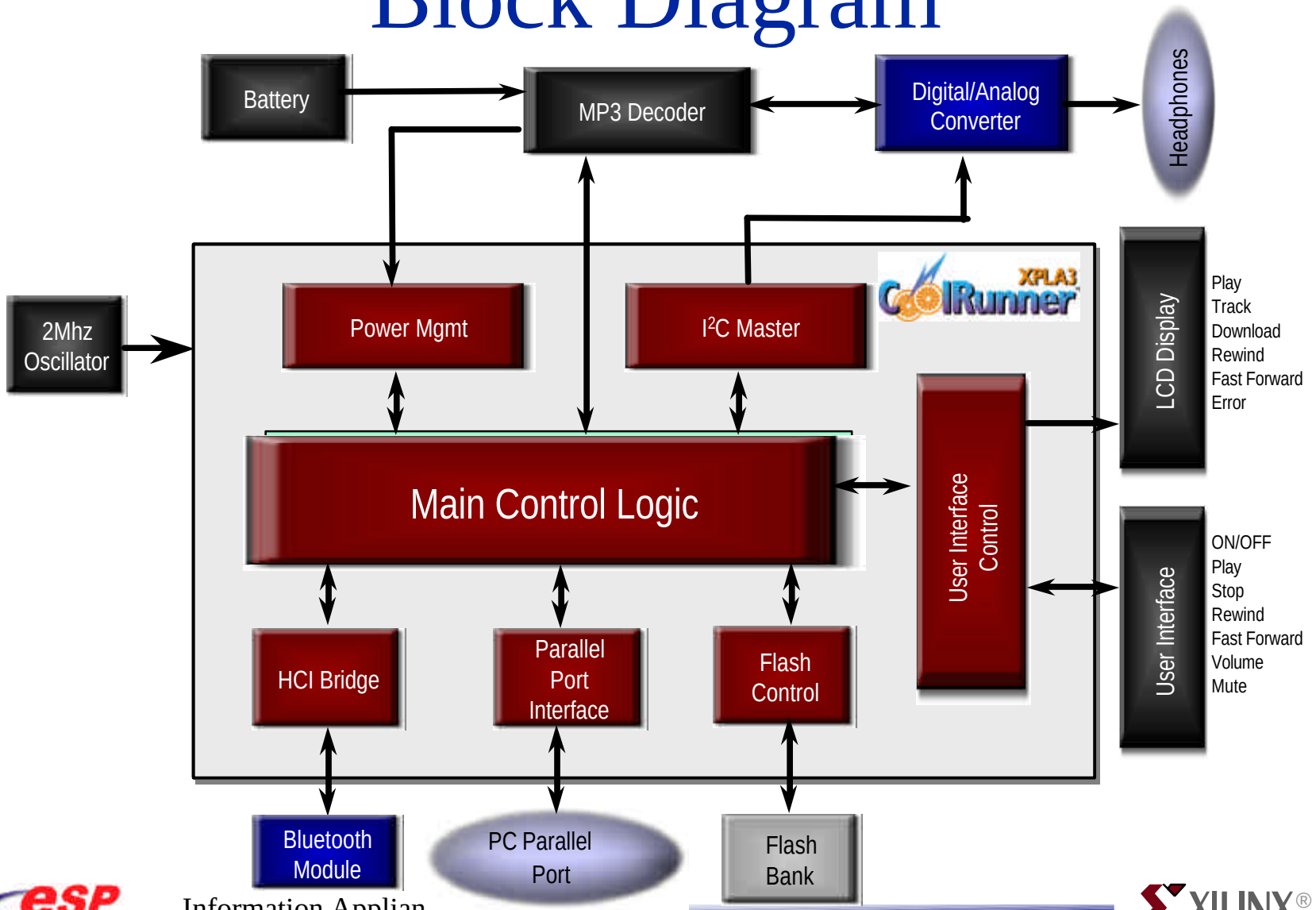
- Vendors are driven to differentiate and add value
  - Bluetooth enabled
  - User interface
  - Video
  - Games
  - Day-timer features
  - Hard Disk Drive based
  - CD-ROM based
- Evolving format, copyright & security issues
  - MP3 dominates
  - Others are rapidly emerging
    - a2b, MPEG AAC, Windows Media Audio
  - Copyright protection
    - Driven by recording industry
    - Digital distribution

Xilinx Solutions in MP3 Players

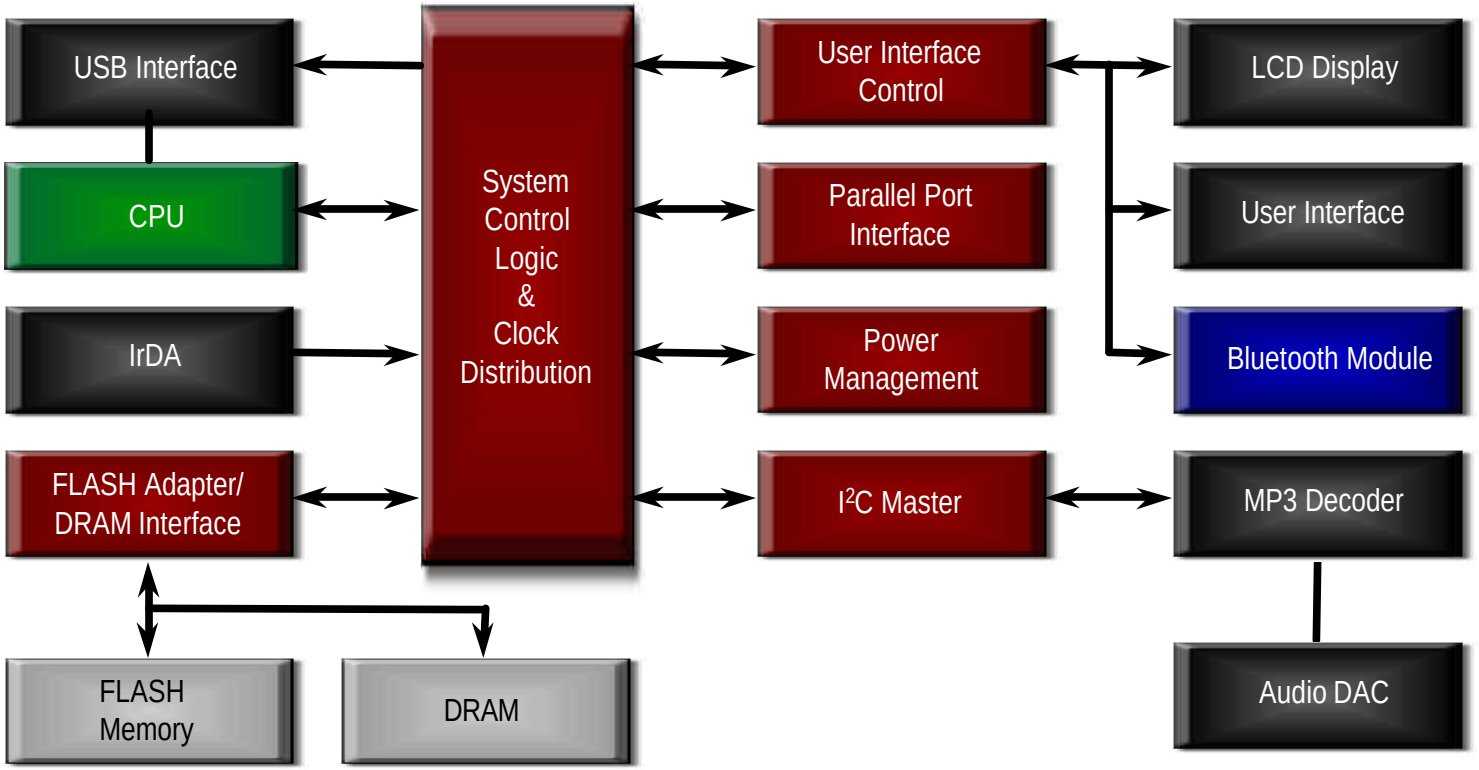
- System Logic
- Clock Distribution
- SDRAM Interface
- FLASH Memory Adapter
- Power Management
- I2C Master
- HDLC Controller
- Display Controller
- Keypad Decoder
- I/O Control
  - HCI Bridge
  - PCI
  - USB 2.0 Controller
  - IrDA Interface
  - UART

You can implement all these in a Spartan-II FPGA

CoolRunner MP3 Portable Player - Block Diagram



MP3 Player


USB Interface
CPU
IrDA
FLASH Adapter/
DRAM Interface
FLASH
Memory
DRAM
System
Control
Logic
&
Clock
Distribution
User Interface
Control
Parallel Port
Interface
Power
Management
I2C Master
LCD Display
User Interface
Bluetooth Module
MP3 Decoder
Audio DAC

Physical Media Formats

- Future of music industry is not all about digital distribution
  - Several new physical media formats will be coming to market shortly
    - MiniDisc, DVD-Audio, Super Audio CD (SACD)

Advanced Recording Media Specifications

	MiniDisc	DVD-Audio	Super Audio CD
Media description	Disc enclosed in cartridge	CD-sized disc	CD-sized disc
Media size	72 x 68 x 5mm	12cm x 1.2mm	12cm x 1.2mm
Recording capability	Full	None yet	None
Programmable time	60 minutes/74 minutes*	77–133 minutes for six channels; 136 minutes for two channels; 67 minutes for five channels; two channels on same layer	74 minutes for six channels and two channels
Number of high-density channels	Two	Six	Six
Other format compatibility	None	CD-Audio	CD-Audio
Other features	–	Supports Dolby Digital and DTS	Plays in existing CD players

* Two media options exist.

Source: IDC, September 1999

MiniDisc (MD)

- Pioneered by Sony in 1993
  - Strong market in Japan
    - Most mini-component systems sold sold in Japan today include an MD drive
    - Portable MD players are offered by a number of manufacturers in a variety of designs
    - Heavy advertising by Sony & low prices for players & media
  - In the US, MD has been much slower to take off
- MD is a small-format optical storage medium with read/write capabilities
  - Positioned as a new consumer recording format with smaller size and better fidelity than audio

DVD-Audio (DVD-A)

- New DVD format providing multi-channel audio in a loss-less format
  - Industry confirmed standard in mid-1999
- Positioned as a replacement for the CD
  - Bringing new capabilities to audio
    - Opportunity for additional content such as video, lyrics
  - Supports 5.1 channels
  - Quadrupled capacity

Super Audio Compact Disc (SACD)

- Developed by Sony and Philips to compete with DVD-A
- Format is the same size as both the CD and DVD media but offers potential for higher sampling rates
  - SACD is fully compatible with CD format
  - Can play SACDs in today's CD players
- SACD is considered an audiophile format, while DVD-A is positioned as the mass-market option

Internet Smart Handheld Devices

Internet Smart Handheld Devices

- Vertical application devices that provide direct Internet access capabilities using an add-on or integrated modem
- Vendors & products
  - Palm Computing - Palm Vx, Palm VII
  - Compaq - Compaq Aero Series
  - Nokia - Nokia Communicator Series
  - Hewlett-Packard - HP Jornada Series
- Subcategories
  - Handheld companions
  - Smart handheld phones
  - Vertical application devices (VADs)

Handheld Companions

- PDAs, personal companions, PC companions
- Applications
  - Personal information management (PIM)
  - Data collection
  - Light data creation capabilities such as word processing for memos

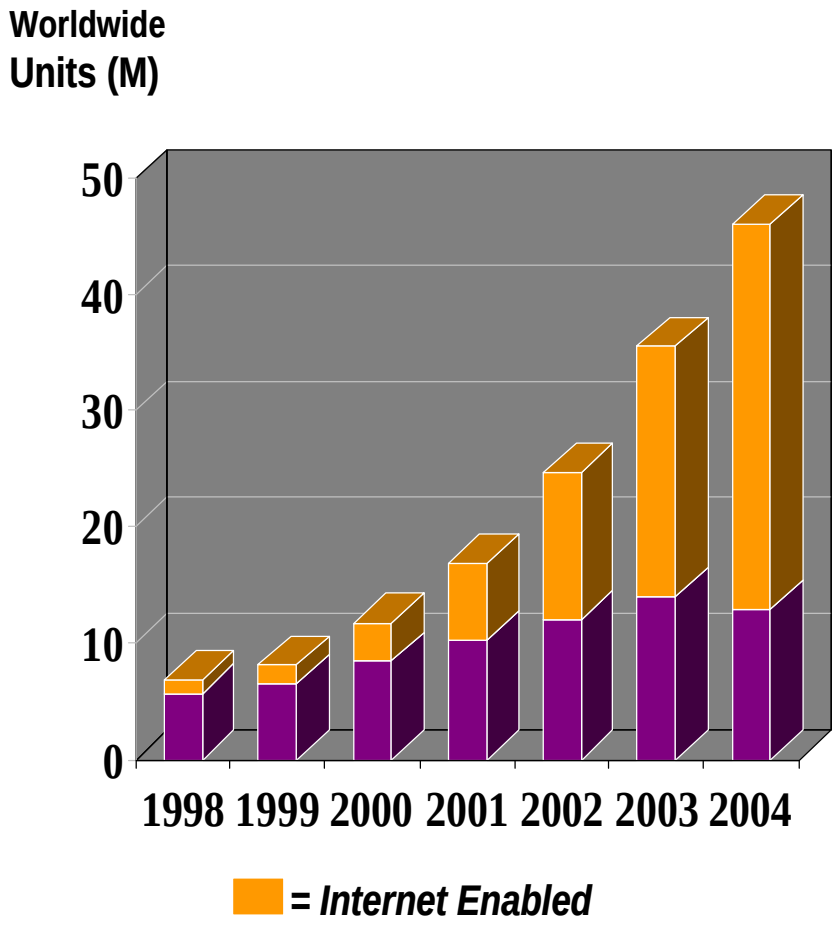
Smart Handheld Phones

- Includes emerging enhanced, super-portable cellular phones that enable both voice & data communications
- Applications
  - Cellular voice communications
  - Internet access
  - Store light calendaring and Rolodex data such as names, addresses & phone numbers

Vertical Application Devices (VADs)

- Pen or keypad based used in specific vertical applications in a variety of industries
- Examples
  - Route delivery data collection for a vendor in the transportation industry
  - Physician accessing patient's records in a hospital

Smart Handheld Devices:
Increasingly Gaining Market Acceptance



- Accelerators
  - Personal companions drive volume
  - Corporate acceptance
  - Internet content + email = need for SHDs
    - Stocks, news, weather
- Inhibitors
  - Slow going for Windows CE

PDA - Market Overview

- PDA is primarily a productivity and communications tool that is lightweight, compact, durable, reliable, easy to use, and integrates into existing operations
- PDAs fall into four categories
  - Handheld PCs (HPCs)
  - Palm-size PCs (PPCs)
  - Smart phones
  - Handheld instruments

PDA - Market Overview

- PDA shipments are expected to display impressive growth through the year 2003
  - From 4 million units in 1998 to more than 19 million units by 2003 an average annual growth rate of 37% (IC Insights)
- Average IC content in a PDA, in terms of dollars, is about 40%
  - A $456m market in 1998 with an average annual growth rate of 33 percent expected to reach about $1.9 billion by 2003

Trends

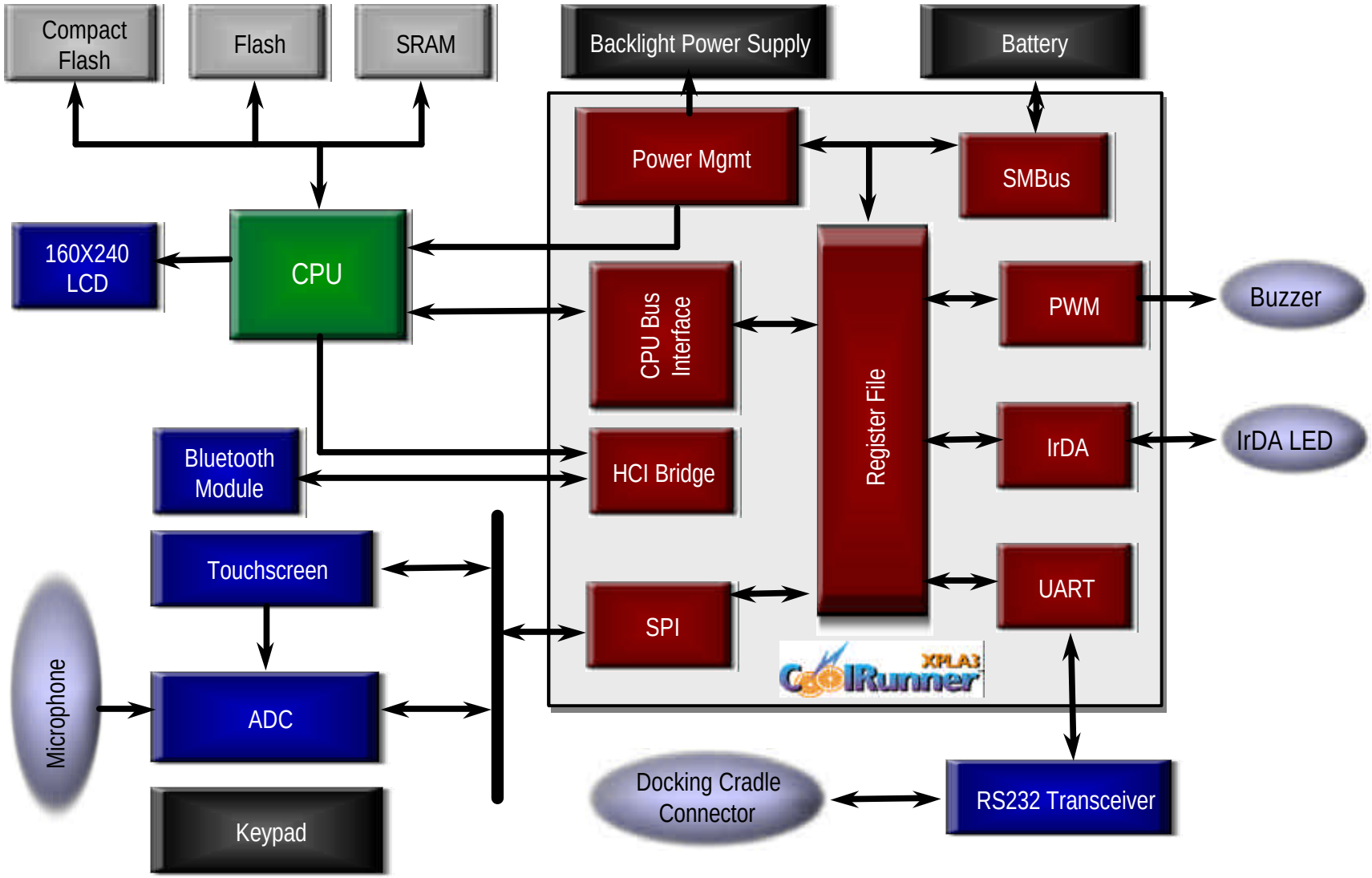
- Wireless Connectivity
  - Bluetooth
- Auto-synchronization
- Multimedia Emerging
  - Color
  - Audio
  - Voice Recoder
- High-Capacity Storage
  - FLASH
  - Micro HDD

Xilinx Solutions for PDAs

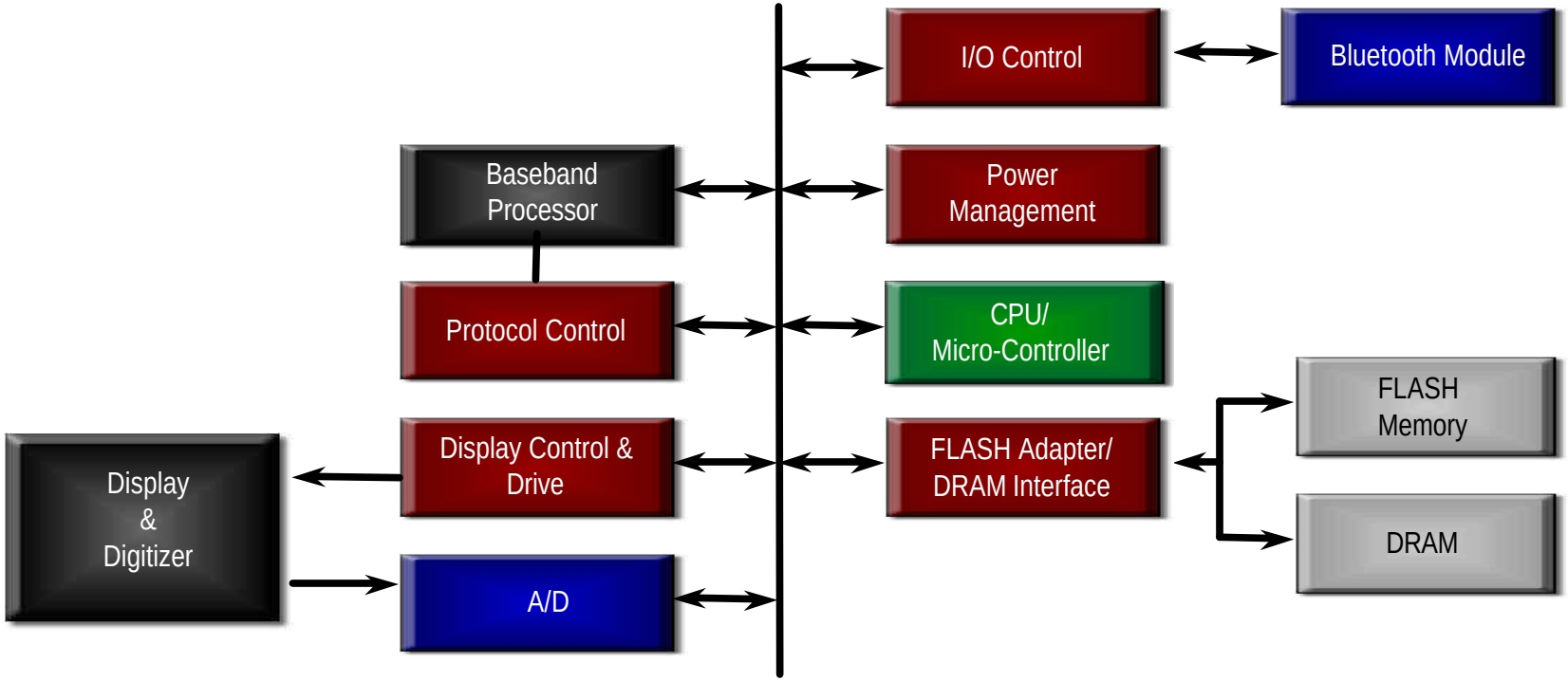
- System Logic
- Clock Distribution
- SDRAM Interface
- FLASH Memory Adapter
- Power Management
- Error Correction
- Display Driver
- I/O Control
  - HCI Bridge
  - PCI
  - USB Controller
  - IrDA Interface
  - UART

Implement all these in a Spartan-II FPGA

CoolRunner PDA Block Diagram



Personal Digital Assistant



Digital Video Recorder (DVR)

DVR

- Definition
  - Product that uses local storage to enable the user controlled storage and playback of live digital video streams on a real-time basis
  - Functionality includes the ability to simultaneous record & playback of separate video streams or different portions of the same stream in real time
- Application: Television broadcast control
- Other names
  - Personal video recorders (PVRs), digital VCR, DVR-enabled set-top boxes

DVR

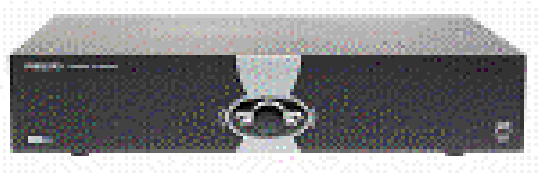
- Key companies with DVR solutions: TiVo, ReplayTV
  - Microsoft WebTV, Megabyte Networks, NDS Group, Jovio
- Fast growth is being predicted for DVR-enabled products
  - 13 million shipments in the US in 2004
  - US installed base totaling 32.1 million units
- Functionality can be incorporated directly inside the TV set or included in set-top boxes
- Built-in modem the DVR-enabled device
  - Dials a service provider
  - Download the programming guide & software updates

DVR's Capabilities

- Using a hard drive instead of a tape gives the DVR the following capabilities
  - Real-time recording
  - Storing in digital video (high) quality
  - Instant access
  - Proactive and quick TV management
  - Simultaneous use of multiple data streams

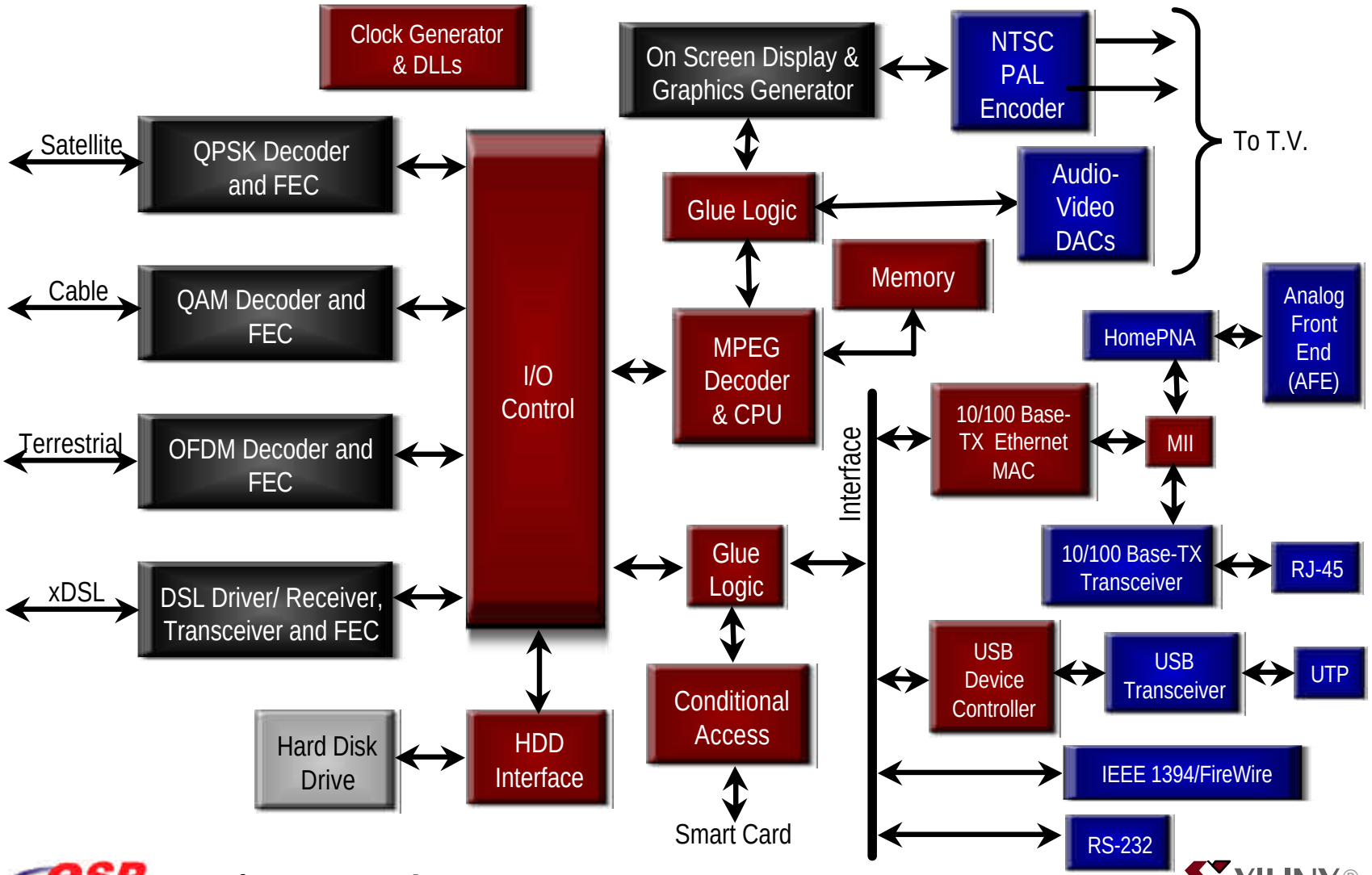
Market Forecast / Analysis

- Current State
  - Hot category, growing vendor support
- Growth
  - WW unit CAGR of 91% (2000-04)
  - 19M WW units in ’04.



- Drivers
  - Single functionality, vendor support, component cost declines
- Challenges
  - Raising consumer awareness & price

Digital VCR


Clock Generator & DLLs
On Screen Display & Graphics Generator
NTSC PAL Encoder
To T.V.
Satellite
QPSK Decoder and FEC
Glue Logic
Audio-Video DACs
Cable
QAM Decoder and FEC
Memory
I/O Control
MPEG Decoder & CPU
HomePNA
Analog Front End (AFE)
Terrestrial
OFDM Decoder and FEC
10/100 Base-TX Ethernet MAC
MII
Interface
xDSL
DSL Driver/ Receiver, Transceiver and FEC
Glue Logic
10/100 Base-TX Transceiver
RJ-45
USB Device Controller
USB Transceiver
UTP
Conditional Access
Hard Disk Drive
HDD Interface
IEEE 1394/FireWire
Smart Card
RS-232

NetTV

NetTV

- TV-centric IAs that provide Internet access
  - Use the TV as their primary display
  - Standalone products that are set on top of the TV (“set-top”)
  - TVs with Internet connectivity built in at the time of manufacture
  - Examples: set-top boxes, integrated TVs, enhanced traditional cable boxes, direct satellite devices
- Include
  - Communications module (modem), core processor, OS, display driver, usage-specific applications such as Web browser, email client

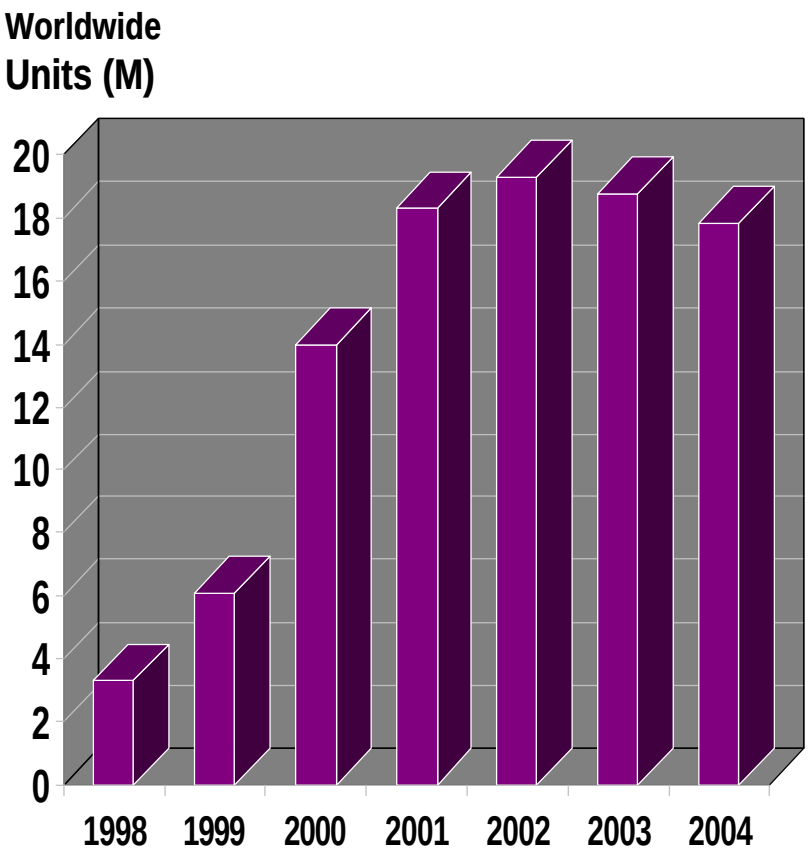
NetTV

- Offerings provided
  - Basic
    - Limited interactive electronic programming guides or customized information tickers
  - Advanced
    - Full graphical Web browsing, video email
- Bluetooth functionality will be integrated to 8% of NetTV shipments by 2004 in the US
  - Bluetooth will be used for data transmission in set-top boxes

NetTV

- Vendors and products
  - Microsoft - WebTV Plus Receiver
  - Worldgate - Worldgate
  - Liberate - eNavigator
  - OpenTV - OpenTV
  - Sony/Philips/Ecostar - WebTV
  - AOL - AOL TV
  - Wink
  - Echostar
  - AT&T

Growth Accelerators & Inhibitors



- Accelerators
  - Infrastructure upgrade: back end to clients
  - Consumer interest in the Internet and new services
  - Intense competition and drive for new revenue
- Inhibitors
  - Consumer interest in interactive services
  - Costs
  - Regulatory issues

DVD Players

DVD Technology

- Digital Video / Versatile Disk
- DVD Technology
  - Provides storage capacity that is about 6-7 times greater than that of CD technology with the same aerial space
  - Provides multiple languages on movies, with multiple language subtitles
  - Beam of laser light touches the disc
    - Data portion of a DVD disc is never touched by a mechanical part when played eliminating wear characteristics on the disc

DVD Disc

- DVD disc can be used for data storage for use in a PC through the use of a DVD ROM drive
  - Using similar format each DVD can store up to 17 GB of data
  - CD-ROM disc stores 650 MB of data
- Single layer DVD disc can hold 4.7 GB of data
  - Greatly increased storage capacity is accomplished by using both sides of the disc & storing two layers of data on each side
- New technology is being developed by many vendors
  - Blue laser technology to provide superior quality video
  - Capable of achieving higher data densities with 12-30GB capacity

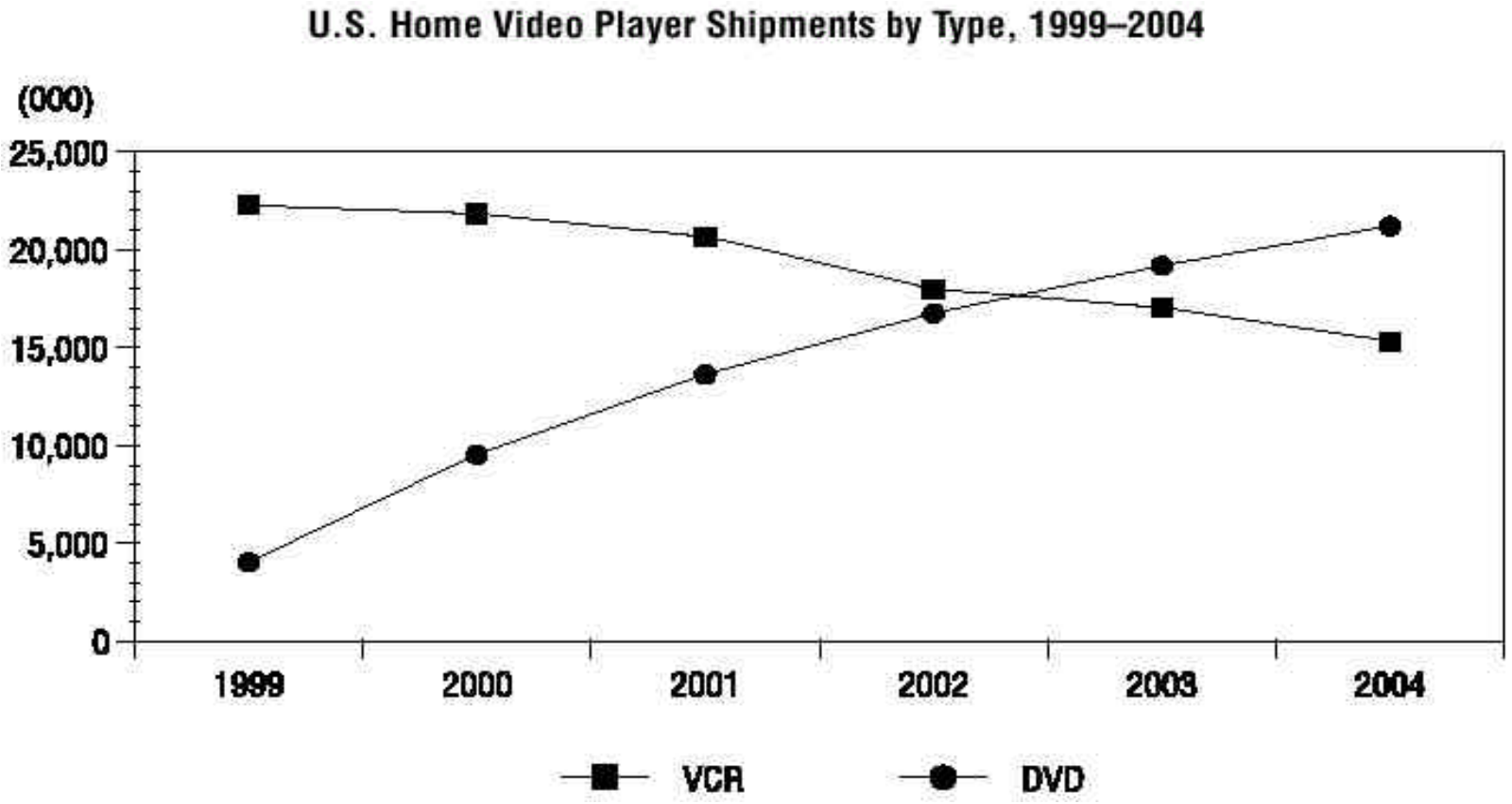
DVD Video Players

- Features
  - MPEG2 video compression
  - Digital Theatre Systems (DTS) Dolby Digital Sound
  - Up to eight audio tracks
  - At least 133 minutes per side video running time
  - Disk changers
  - Backward compatibility with CD and/or CD-ROM
  - Still motion, slow motion, freeze frame, jump-to-scene finding
  - Interactive/programming capable: story lines & subtitles

DVD Video Players - Major Components

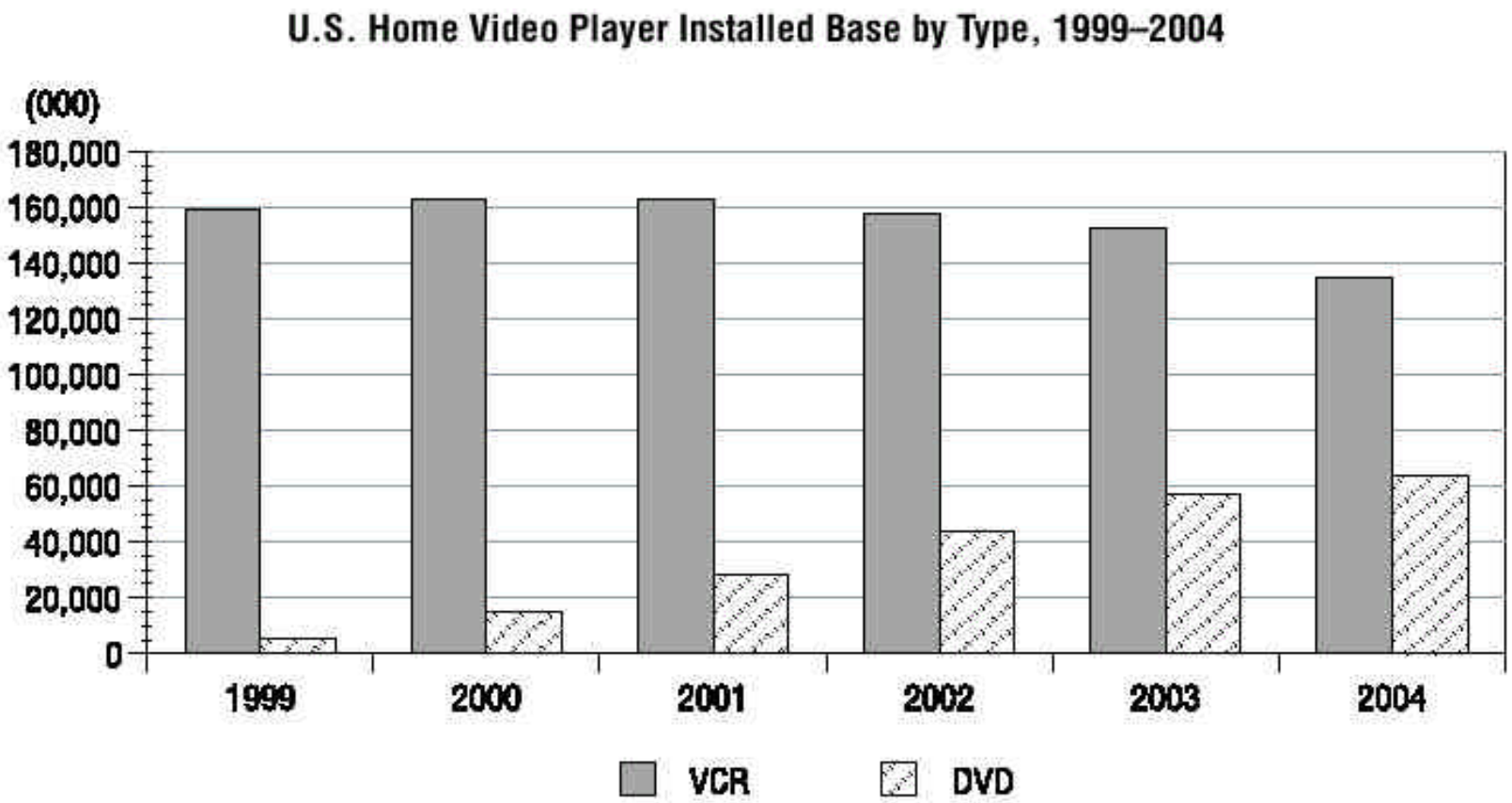
- Disc reader mechanism
  - Motor that spins the disc and the laser that reads the information from it
- DSP (digital signal processor) IC
  - Translates the laser pulses back to electrical form that other parts of the decoder can use
- Digital audio / video decoder IC
  - Decodes & formats the compressed data on the disc
  - Converts data into superior-quality audio & video for output to TVs and stereo systems
- Microcontroller
  - Controls operation of the player & translating user inputs from remote control or front panel into commands for audio/video decoder and disc reader mechanism

DVD vs. VCR Shipments



DVD players are becoming quickly adopted. Unit shipments of DVD players will exceed the total shipments of VCR shipments by 2003.

DVD vs. VCR Installed Base



DVD players installed base will grow to 63.5 million units by end of 2004, representing an installed base rise from 5.5% of the estimated 100 million total US households in 1999 to 63.5% in 2004.

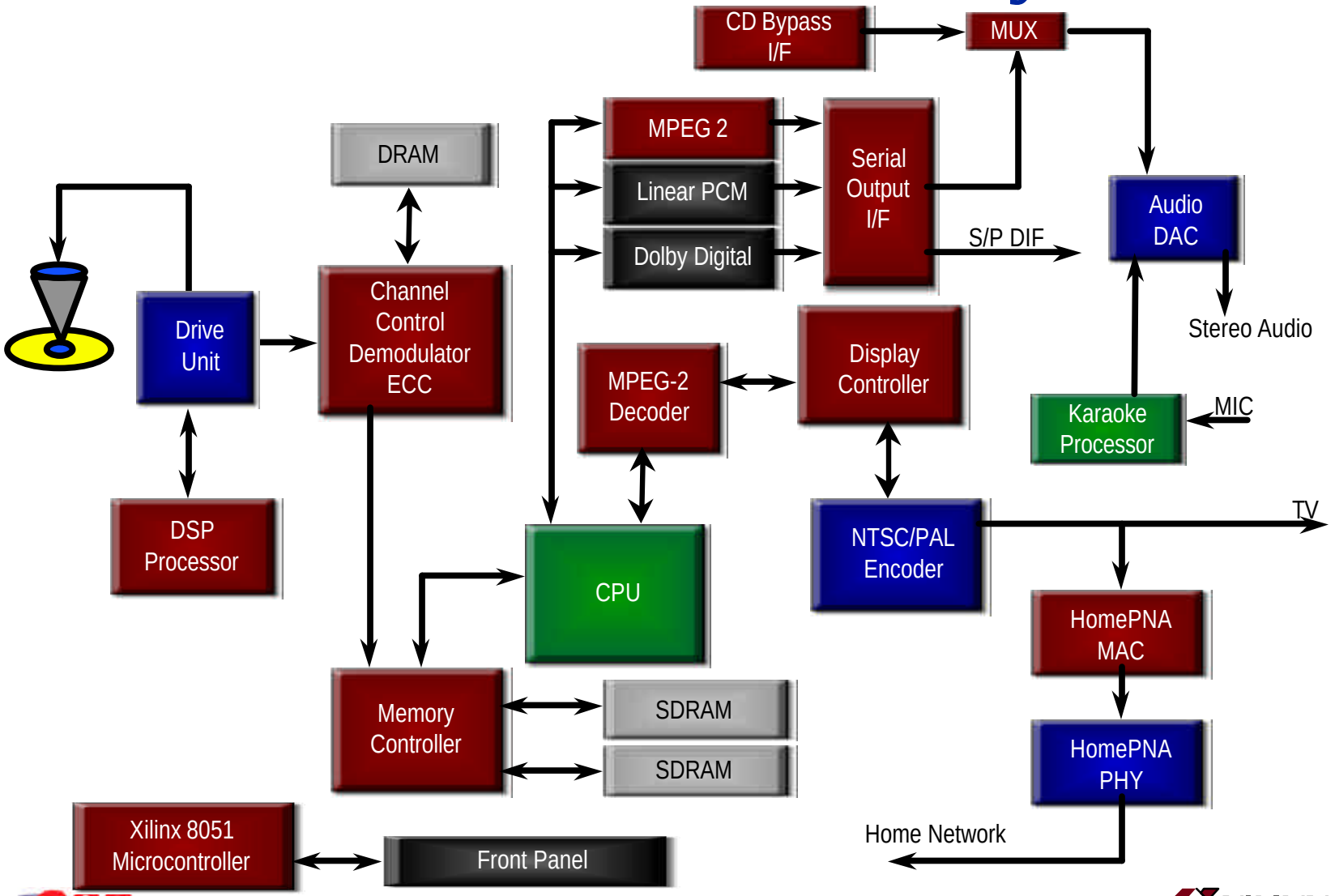
Market Forecast / Analysis

- State of the current market
  - High volume, declining prices, broadening vendor support, more interactive features (gaming, Internet)
- Growth
  - WW units CAGR of 41% (2000 – 04)
  - 75 million WW units in 2004
- Drivers
  - Low-cost, consumer awareness & content availability
- Challenges
  - DeCSS, consumer confusion, DVD on other devices

Emerging DVD Video Players

- DVD-Video players combined with DVD-A
  - Enables the DVD player to achieve higher-quality audio
    - DVD-A is a new music format that provides a major advance in audio performance
      - Enables the listener to have advanced resolution stereo (2 channels) or multi-channel surround sound (6 channels) music or both
- DVD-Video players combined with recordability feature
  - Supports 4.7GB DVD+RW technology
- Interactive DVD (DVD players supporting the Internet)
  - Includes DVD Gaming Consoles
- PC DVD-ROM Drives & PC DVD-Rec Drives

Interactive DVD Player

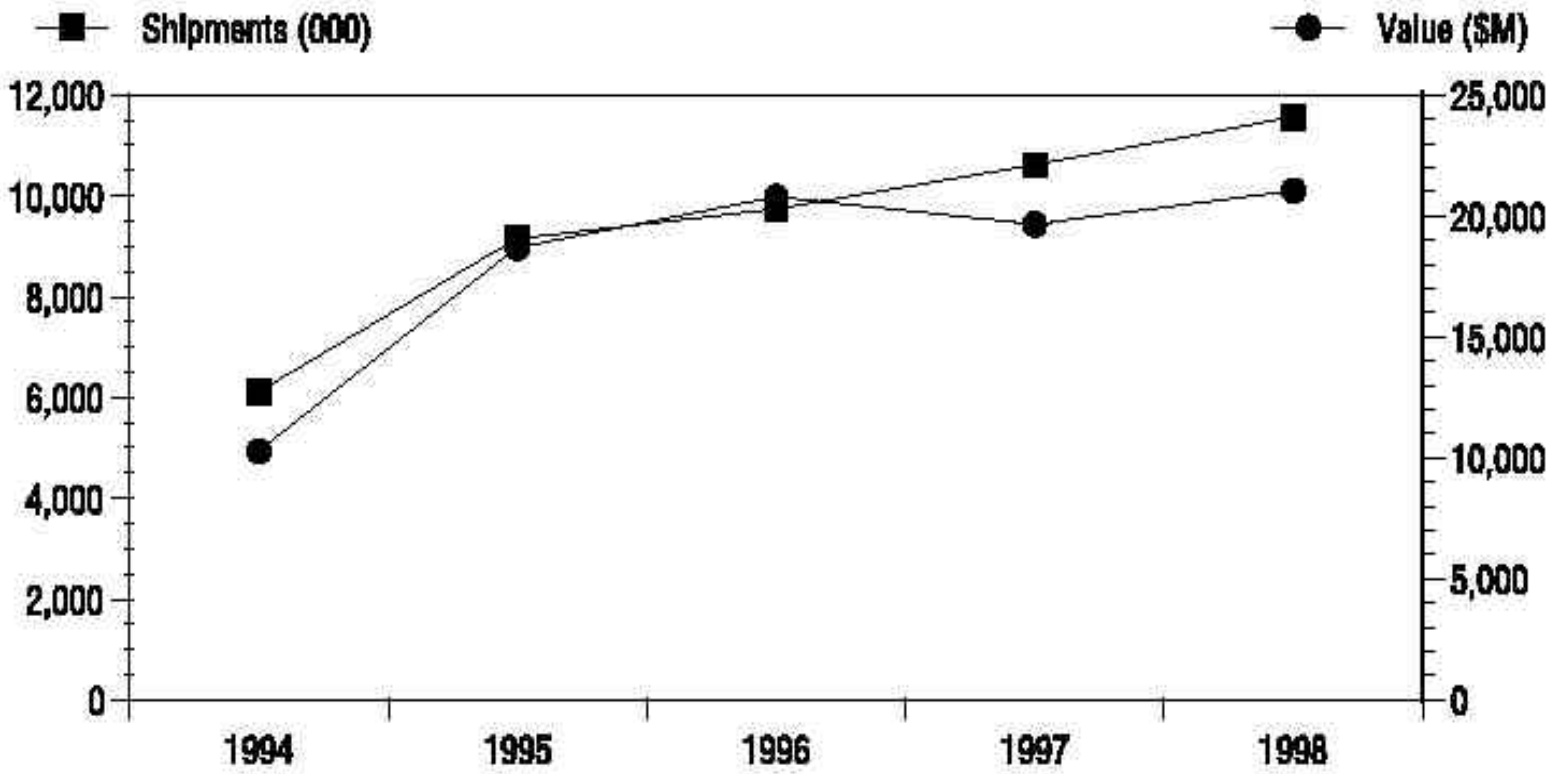


PCs (Desktop & Notebook)

The State of Today's Consumer PC Market

- Strengths
  - Healthy demand
  - Ongoing price / performance improvements
  - PC position as productivity tool
- Weaknesses
  - Complex
  - Buggy
  - Confusing
- Opportunities
  - Multiple PC households
  - New business models
  - New & innovative PC designs
    - Examples: Apple iMAC
  - Expansion of Internet
- Threats
  - Web-based services & applications
  - Saturation in key markets
  - Information appliances
  - Low margins

PC Shipments & Value

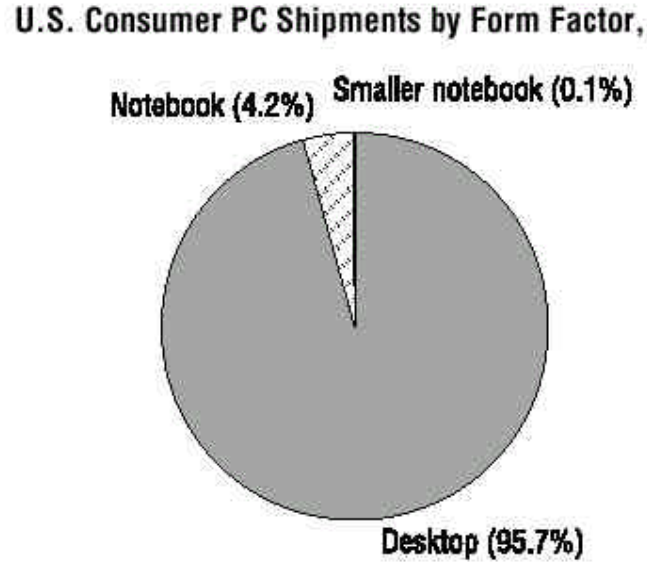


Source: International Data Corporation, 1998

- U.S. consumer PC market (1998)
  - 11.6 million unit shipments, $21 billion of market revenue

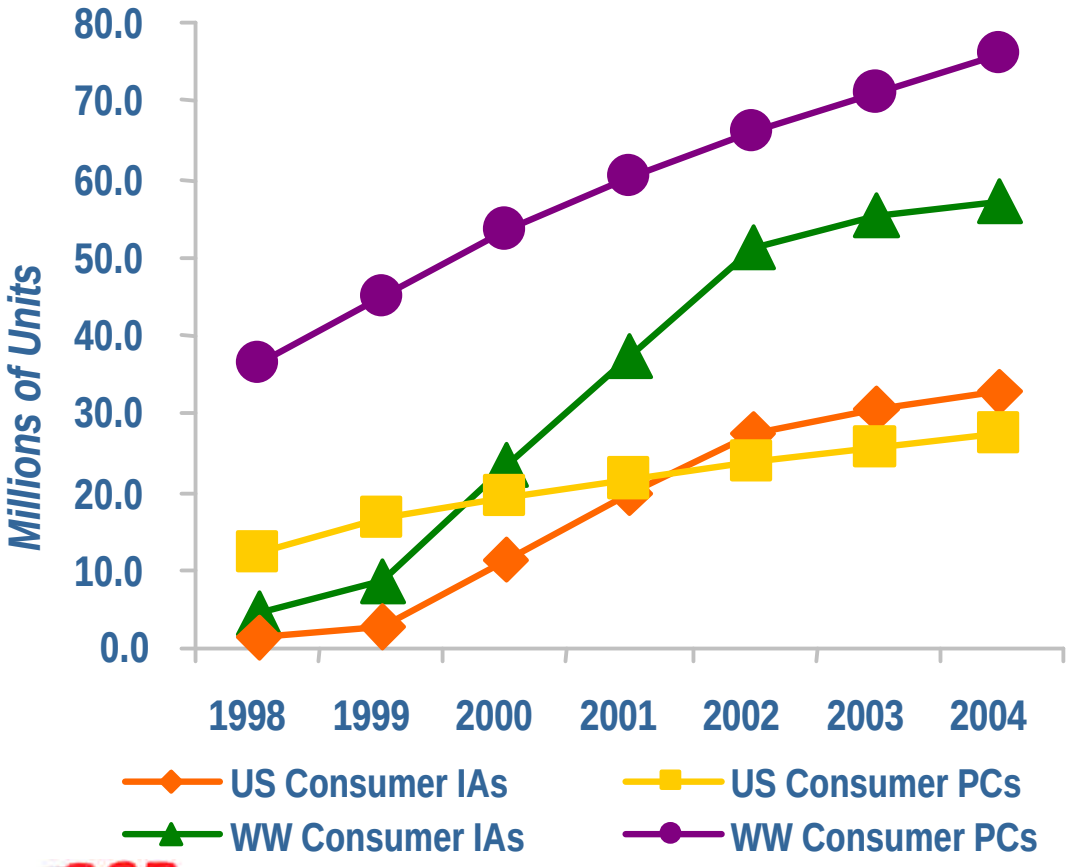
PCs (Desktop & Notebook)

- Desktop consumer PCs - champion platform for the consumer
  - Supported by large number of vendors vying to maintain dominance and profitability
    - Top 23 vendors accounted for only 80% of the market
    - Top 7 vendors accounted for 63% of the market



PCs vs. Information Appliances

U.S. and W.W: Home PC Shipments vs. Consumer Information Appliance Shipments



- The Issues
  - IA momentum & diversity in the U.S.
  - PC adaptability
  - The Internet
  - Getting business models figured out

The Enemy: Information Appliances

- IAs are being promoted by non-PC vendors seeking an opportunity to capture the $21 billion market
  - Low cost, consumer focussed, easy to use
  - Provide Internet access
- Leading to lower cost PCs
- IAs target 3 key areas
  - Replace PCs
    - Provide robust Web browsing, email & interactivity
  - Supplement PCs and coexist
  - Sidestep PCs - Not a significant threat to PCs
    - Examples: set-top boxes, cellular phones

IAs are Driven by a Number of Factors

- Aggressive vendor pursuit
- Consumer market demands
- Advancing bandwidth capacity
- Lower product costs
- Consumer needs
- Device distribution subsidized by service contracts rather than retail or direct-sales like in PCs
  - Examples: Microsoft WebTV

PCs Will Live On Because

- Compatibility
  - Interoperability between documents with business, education, government PC industry
  - IAs support open standards, or proprietary, non-PC supportive media standards
- Flexibility in the PC platform
  - Video editing, music authoring, Web hosting, gaming, etc. can all be done in one PC
  - Comparatively IAs are dedicated for one function
- Momentum
  - Huge installed base, high revenue & annual shipments

PCs Will Live On Because

- Awareness
  - 50% of consumer homes have PCs
- Investment protection & reluctant to discard
- Pace of improvement
  - Faster processors, bigger hard drives, better communication
- Established industry
  - Corporate momentum will continue
  - PC vendors, software developers, stores, support networks

PC Trends

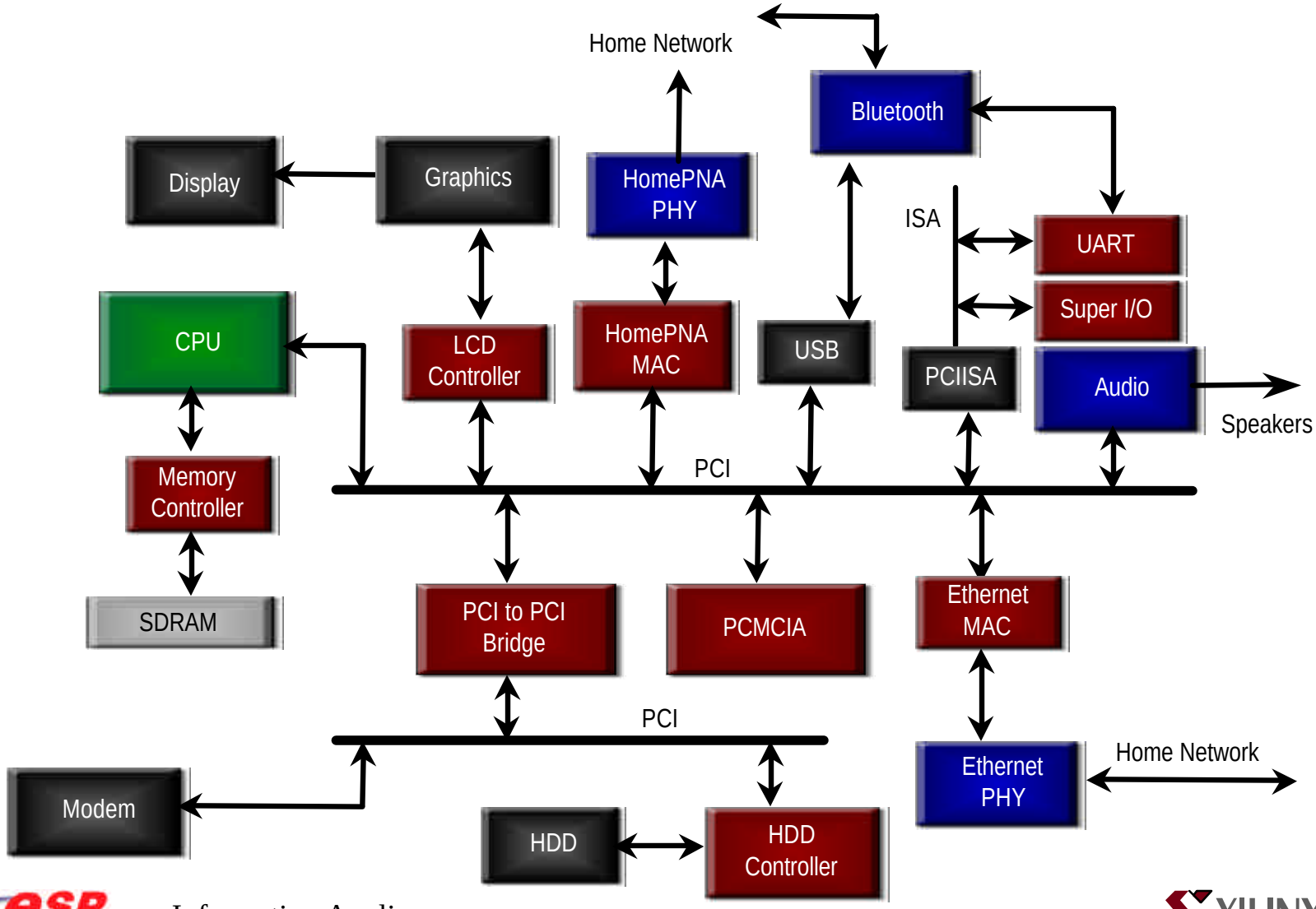
- Lower price points
  - Rapidly moving below $500
  - Blurred lines between PCs and IAs
- New downstream revenue opportunities
  - Internet services, financing/leasing & e-commerce options
- Super-efficient distribution via the Internet
- Offsetting profit products such as servers, services & workstations enable aggressive prices on consumers

Notebook PC Shipments

- 5.9 million units shipped WW (1st quarter of 2000)
  - 32% growth over 1st quarter of 1999
- 19.6 million units shipped (all 1999)
  - 32% growth over 1998 shipments
  - Projected increase to 22.3 mil units in year 2000 & 25.2 mil in year 2001

Source: Gartner Group - Dataquest, IDC

PC


Home Network
Bluetooth
Display
Graphics
HomePNA PHY
ISA
UART
Super I/O
CPU
LCD Controller
HomePNA MAC
USB
PCIISA
Audio
Speakers
Memory Controller
PCI
SDRAM
PCI to PCI Bridge
PCMCIA
Ethernet MAC
PCI
Ethernet PHY
Home Network
Modem
HDD
HDD Controller

Printers

Printer - Market Overview

- Extremely competitive market
  - Total printer cost especially for Inkjet & Laser printers
  - Printing cost per page
- Feature driven
  - Bluetooth , USB, Firewire
  - Print quality - resolution
  - Support for various printing media - plain paper, photographic paper, glossy paper, overhead film, transfers etc.
  - Scalable fonts
  - Speed
- Proprietary technology abounds - resolution enhancement

Trends

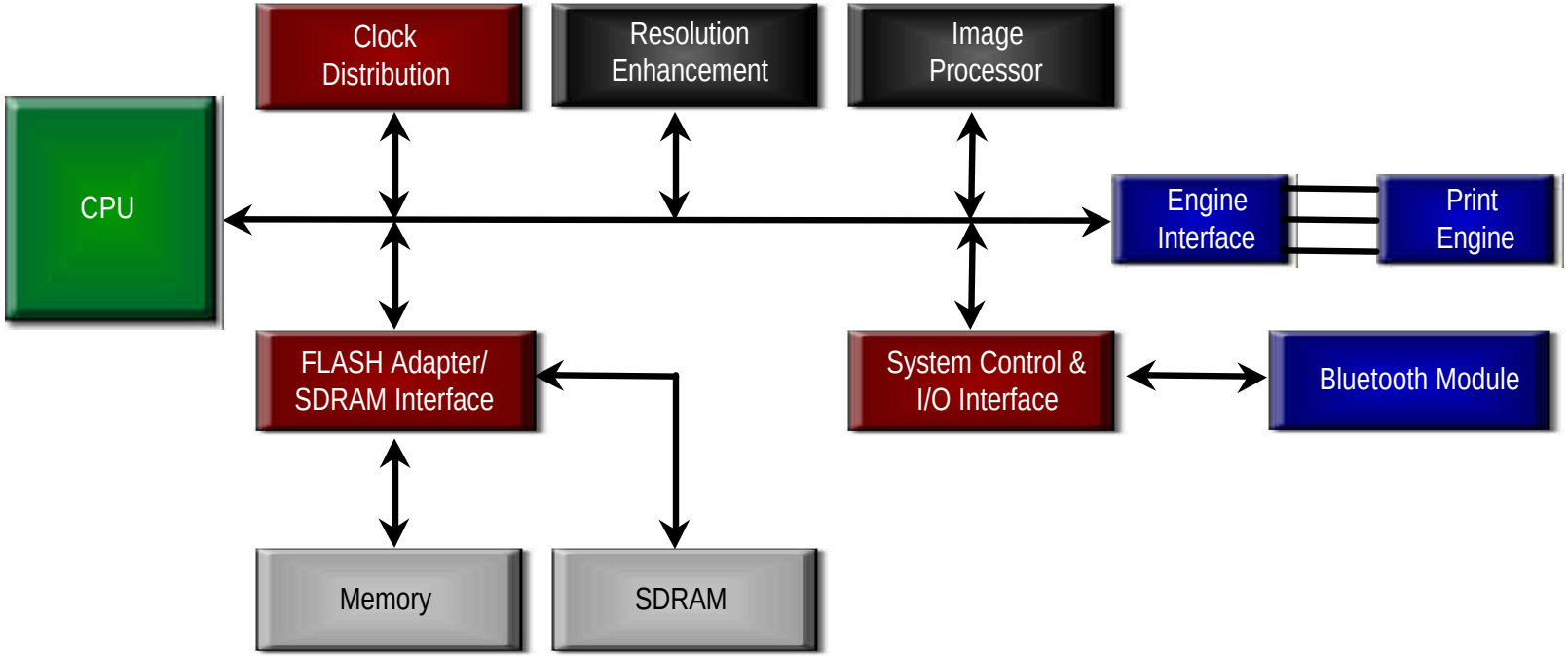
- Xilinx Programmable Logic ties it altogether
- Interfacing the internal printer bus to the various DRAMs, EPROMs, switches, panel indicators, etc.
- Delivering the clocks and control strobes to the various functional blocks
- Still keeping the Energy Star rating intact, with power management functions
- Keeping the price down and the features up

Xilinx Solutions for Printers

- System Logic
- Clock Distribution
- SDRAM Interface
- Power Management
- I/O Control
  - HCI Bridge
  - PCI/PCI-X
  - USB Controller
  - IrDA Interface
  - UART
  - LVDS Link
  - Serial Peripheral Interface
  - Parallel Port

You can implement all these in a Spartan-II FPGA

Printer


Clock Distribution
Resolution Enhancement
Image Processor
CPU
Engine Interface
Print Engine
FLASH Adapter/ SDRAM Interface
System Control & I/O Interface
Bluetooth Module
Memory
SDRAM

Digital Camera

Digital Camera - Market Overview

- Steadily rising market for semi-conductor content in digital cameras
  - 13% of value per digital camera in 1999 and expected to be 23% by 2003 (IC Insights).
- 22% annual growth for digital cameras is expected until 2003

Digital Camera - Market Overview

- Five Classifications of Digital Cameras:
  - Soft-Display Mobile Cameras
    - Low-end cameras starting at 320x240 pixels to 640x480
  - Basic Point and Shoot
    - Comparable to low-end film cameras (at least 640x480 pixels)
  - Photo Quality Point and Shoot
    - 0.8 to 3 Megapixels - equivalent to 35mm film camera pictures
    - Highest market potential
  - Professional Mobile Cameras
    - > 2 Megapixels for Professional Documentation Photography
  - Pre-press, Portrait and Studio Cameras
    - Image for profit applications

Trends

- Lower cost higher quality image processing
  - Attain picture quality of 35mm cameras
- Increase speed for capturing images
- Need for inexpensive, removable compact storage FLASH
- Support for multiple back-end interfaces
  - Bluetooth
  - USB
  - IEEE1394 Firewire
- Provide seamless functionality with other equipment vendors

Digital Cameras

- Current State
  - Emergence of entry-level and toy categories
- Growth
  - WW unit CAGR of 46% (2000 – 04)
  - 59M WW units in 2004

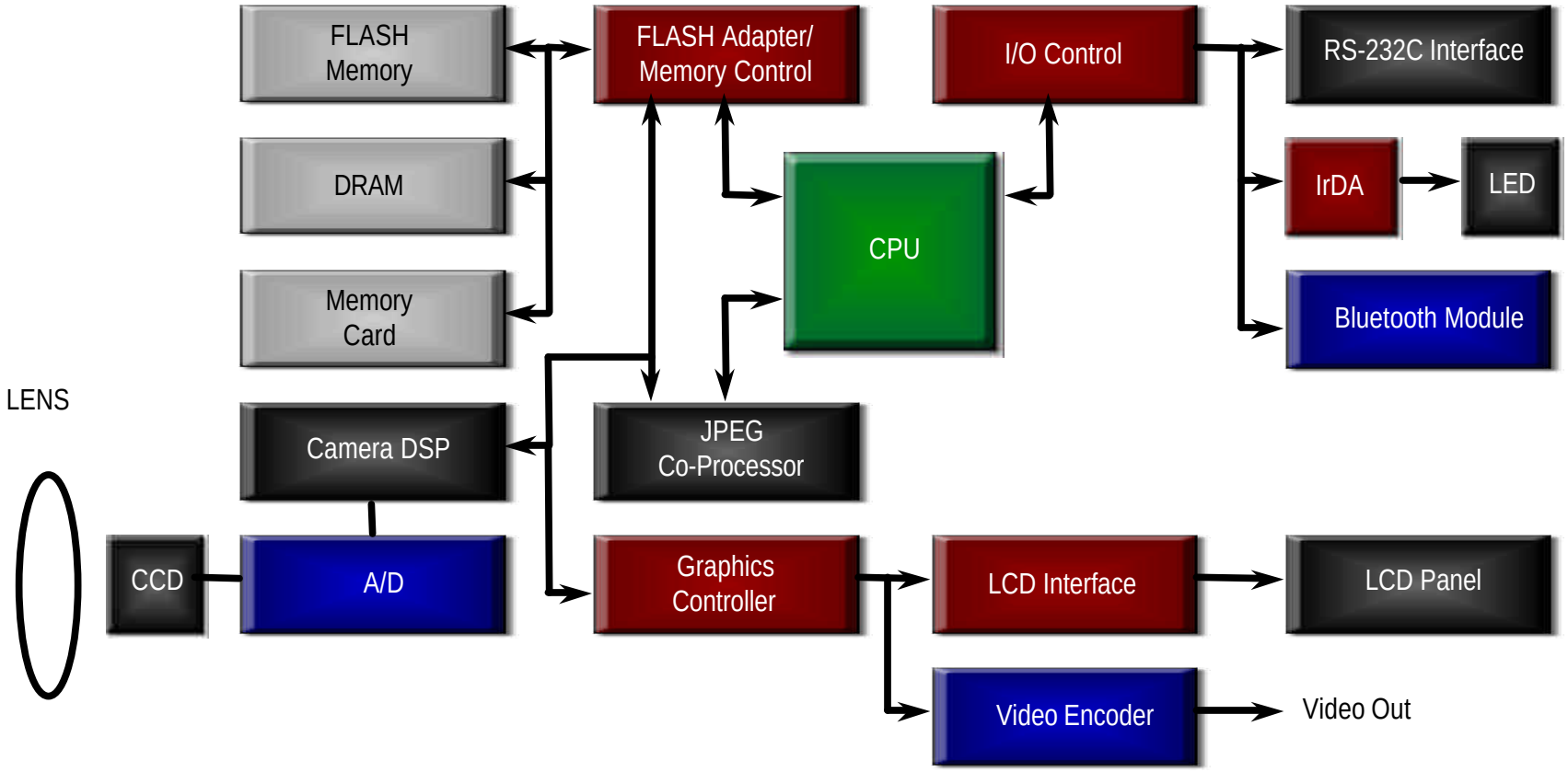
- Drivers
  - Declining prices, PC penetration & improving digital infrastructure
- Challenges
  - Consumer awareness, pervasiveness of digital infrastructure

Xilinx Solutions for Digital Cameras

- System Logic
- Clock Distribution
- SDRAM Interface
- FLASH Memory Adapter
- Power Management
- Error Correction
- HDLC Controller
- FIR Filter
- DCT/IDCT
- I/O Control
  - HCI Bridge
  - PCI
  - USB Controller
  - IrDA Interface
  - UART

You can implement all these in a Spartan-II FPGA

Digital Camera



Scanners

Scanner - Market Overview

- Uses electronic camera lens to capture a digital image
- Types of Scanners
  - Flat-bed (80%) - Ubiquitous scanners
  - Transparency - For 35mm slides to 4x5 inch transparencies
  - Handheld - Portable scanners
  - Drum - Used for professional quality scanning
- Double-digit growth rate expected through 2003 (IDC)
- Internet explosion in both home and business environments is a key driver for the worldwide scanner market

Trends in the Scanner Market

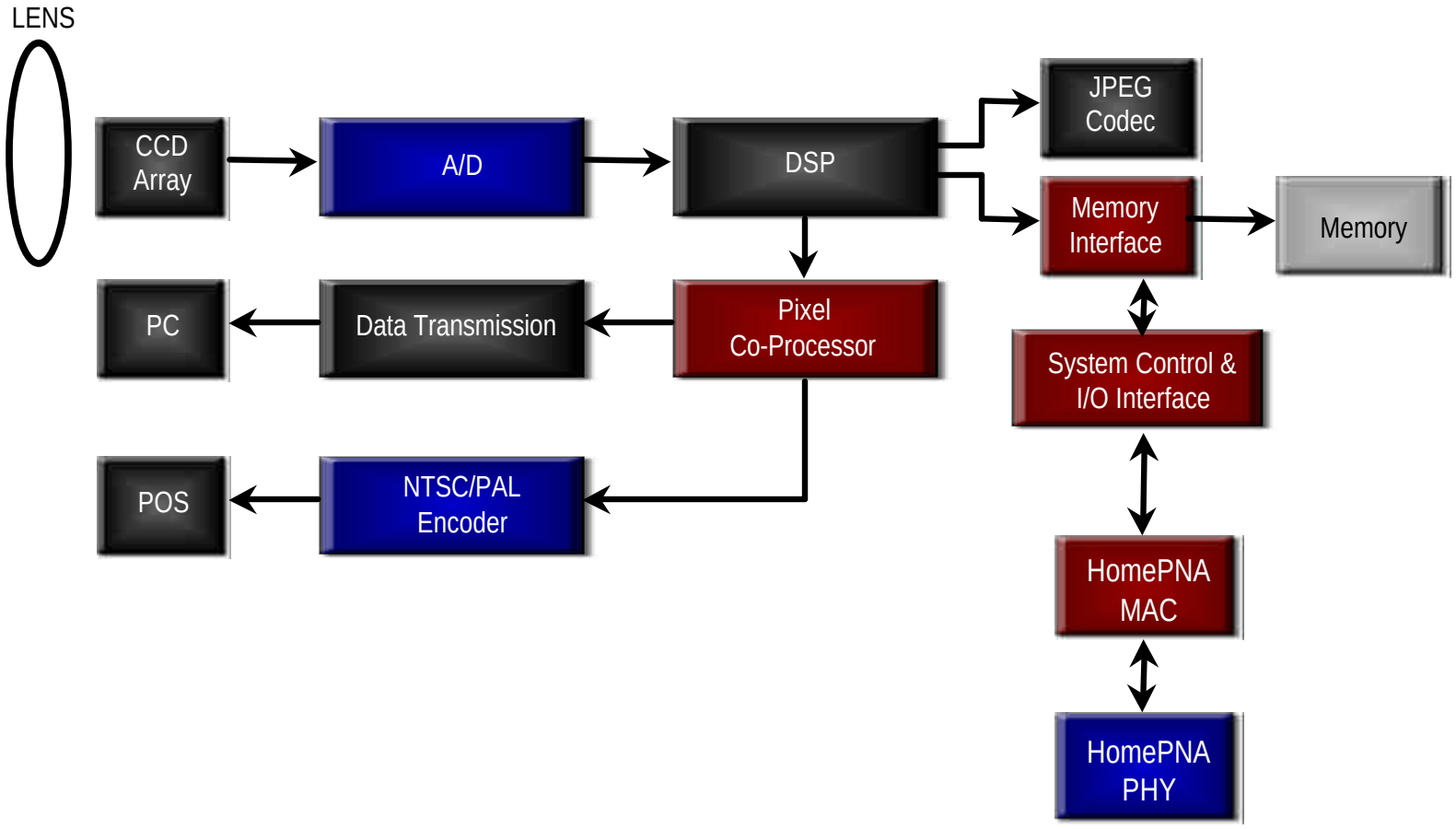
- Higher Quality
  - Accuracy
  - Thresholding
  - Resolution
- Lower scanner prices
  - Provides an opportunity for consumers with limited to no scanner knowledge to learn how to take advantage of scanner technology
- Bluetooth Enabling flat-bed scanners
- Handheld scanner as an information appliance
  - Wireless enabled

Xilinx in Scanners

- System Logic
- Clock Distribution
- I/O Control
  - Bluetooth HCI Bridge
    - UART
    - SPI
    - I2C
  - PCI
  - IrDA Interface
  - LVDS Link
- USB Controller
- SDRAM Interface
- Power Management

You can implement all these in a Spartan-II FPGA

Scanner


LENS
CCD Array
A/D
DSP
JPEG Codec
Memory Interface
Memory
PC
Data Transmission
Pixel Co-Processor
System Control & I/O Interface
POS
NTSC/PAL Encoder
HomePNA MAC
HomePNA PHY

Smart Card Readers

Smart Card Reader - Market Overview

- Dataquest forecasts 3.4 billion smart cards in use by 2001
- Average growth 30% a year for smart cards
- Essential part of the smart card system is the card reader
  - The card reader is used to exchange or transfer information
- Two type of Card Readers
  - Contact smart card reader
  - Contactless smart card reader

Smart Card Applications

- Pre-payment for vending, payphones and parking
- Electronic Purse
  - Retail Sales, cafeteria, taxis
- Multimedia kiosks
  - Telephone, internet access, fax
- Transport ticketing
  - Trains, airlines, buses
- Credit and Debit Cards
- Access Control & Toll Roads
- Healthcare records
- Mondex Cards - store up to five currencies
- Pay TV
- Utility Meter pre-payment
- Gaming Machine
- Personal ATMs

Benefits of Smart Cards

- Reduce Cash Theft
- Eliminate Fraud
- Eradicate Counterfeiting
- Allow Personal Identity Building
  - e.g. Biometirc ID
- Increase Transaction Speed
- Convenience
  - Eliminate coin usage
- Easier Record Keeping
  - Less paperwork
- Simplicity
- Smart Cards store a lot more information
  - Finger prints data
  - Credit, debit, and loyalty card details
  - Self authorization
  - Access control information
- Superior to Magnetic Strip cards
  - 100+ times more information
  - Wider range of applications
  - Compatible with portable electronics
  - Evolves with semiconductor technology
  - Reduces Tampering and Counterfeiting

Trends in the Smart Card Market

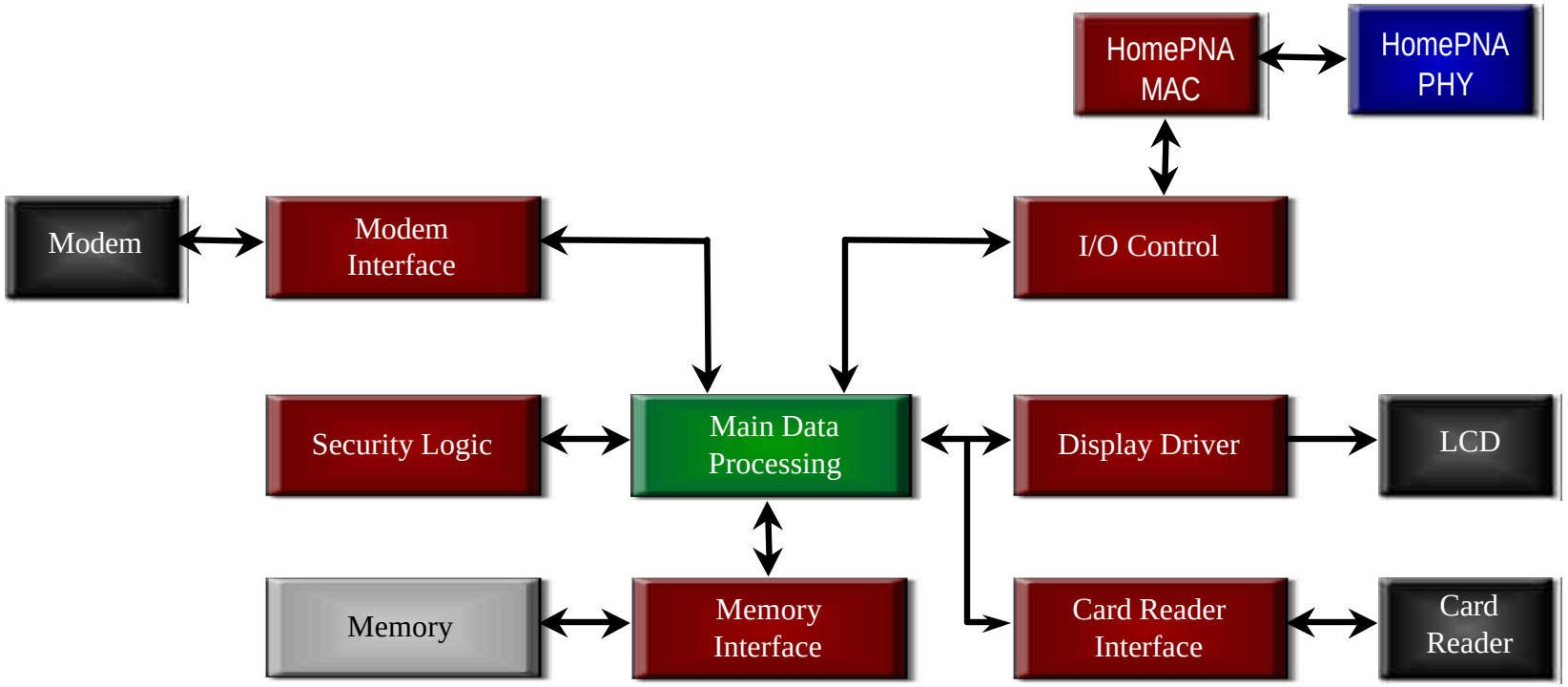
- Super Smart Card
  - Integrated keyboard, a display and solar cells or batteries.
- Contactless Cards
  - Cards that can interact with the reading device without the need for contact - usually via RF.
- Hybrid Cards
  - Cards that have two or more interfaces, e.g. magnetic strip, contacts, contactless or an optical memory
- Enable smart card readers to be bluetooth enabled

Xilinx in Smart Card Readers

- System Logic
- Clock Distribution
- I/O Control
  - Bluetooth HCI Bridge
    - UART
    - SPI
    - I^2C
  - IrDA Interface
- SDRAM Interface
- Display Driver
- Power Management
- Smart Card Interface

You can implement these in a CoolRunner and/or Spartan-II

Smart Card Reader



Multi-function Peripheral

Multi-Function Peripheral - Market Overview

- Peripheral equipment for a PC
  - Copier
  - Printer
  - Scanner
  - Fax
- Advantages
  - Less installation space
  - Cost at purchasing
  - Running cost
  - Integration
- $20 billion plus market in copying, faxing and printing

Trends in the Multi-Function Peripheral Equipment

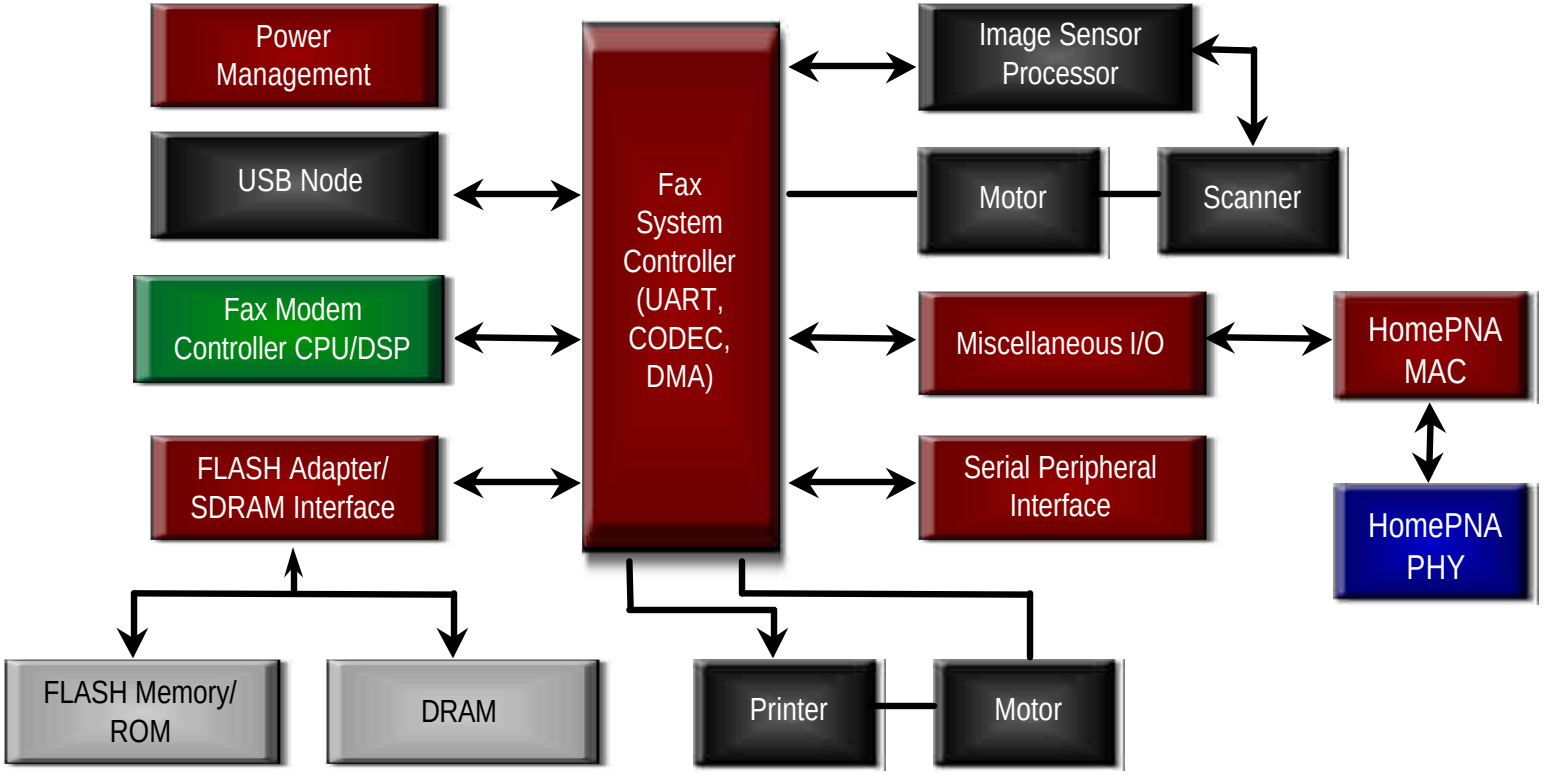
- Wireless connectivity eliminating cables
  - Bluetooth
- Increased resolution in scanning, printing and copying
- Internet Enabled Copying Center
- Voice Recognition Commands
- Reduction of equipment size

Xilinx in Multi-Function Peripherals

- System Logic
- Clock Distribution
- I/O Control
  - Bluetooth HCI Bridge
    - UART
    - SPI
    - I^2C
  - PCI
  - LVDS Link
- USB Controller
- FLASH Memory Adapter
- SDRAM Interface
- Display Driver
- Power Management
- Error Correction

You can implement all these in a Spartan-II FPGA

Multi-Function Peripheral



Automotive Entertainment (Internet Access) Devices

Auto PCs, Telematics, Web on Wheels, Automotive Net Devices, Intelligent Transmission Systems (ITS)

Auto PCs

- Vehicles registered in the US every year: over 100 million
- Average daily commute: 82 minutes
  - Opportunity for productivity while driving is huge
- Potential applications
  - Communication
  - Music-on-demand
  - Real-time traffic information
  - Remote vehicle maintenance

Opportunity for Automotive Manufacturers

- Product differentiation
- Recurring revenues from monthly services
- Mobile commerce enabled by GPS
  - Advertisements/promotions based on location
- Multimedia specialized content transmission
  - Stocks, news, weather, sports

Vendors

- Microsoft - AutoPC software
  - Windows CE based Auto PC products
  - Speech recognition
  - Synthesis for hands-free operation
  - Access to information such as address book & email
  - GPS
  - Interoperability with portable PCs and handhelds
  - Supported by Alpine, Daewoo, Delphi Automotive Systems, Harmon Kardon, Hyundai, Infinity, JBL, Nissan, Peugeot, Citroen, Samsung, Volkswagen

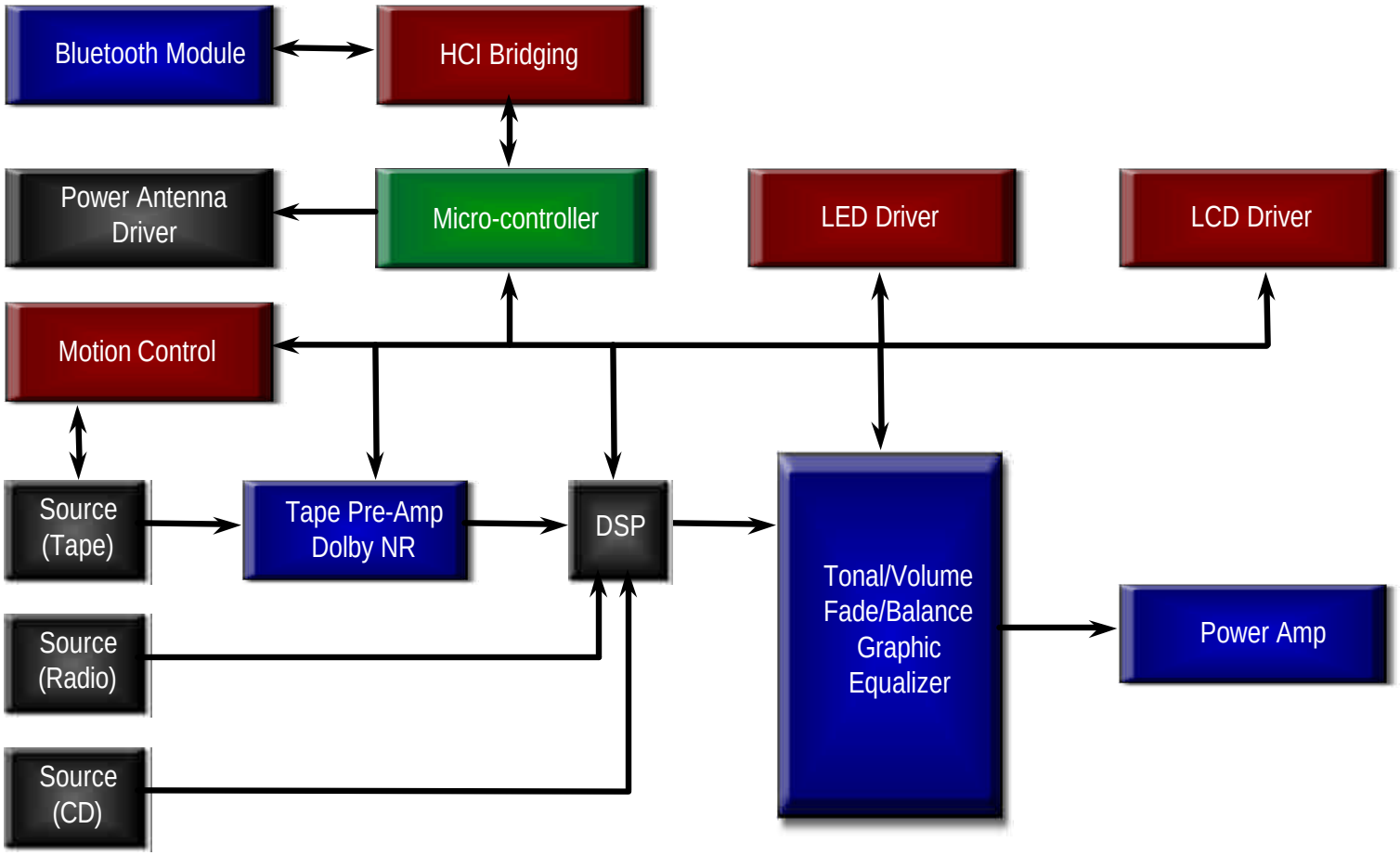
Vendors

- Clarion - AutoPC 310c
- General motors / OnStar
- Delphi Automotive Systems
- Ford Motors
- Visteon
- InfoMove
- Intel
- IBM
- BMW
- Motorola
- Ericsson
- Nokia
- LoJack
- DamlerChrysler's Mercedes-Benz

Issues

- First-generation products need improvements
- High cost of ownership
  - Up front costs and service fees
- Safety issues with the vehicle in motion
- Underdeveloped wireless infrastructure
  - Slow data transmission speeds and spotty cellular coverage
- Substitutes are a plenty
  - Cellular phones: Increase in cellular subscribers & increase in cellular services offered
  - PDAs and pagers (handhelds) with wireless access (Palm VII)

Car Audio System



Summary

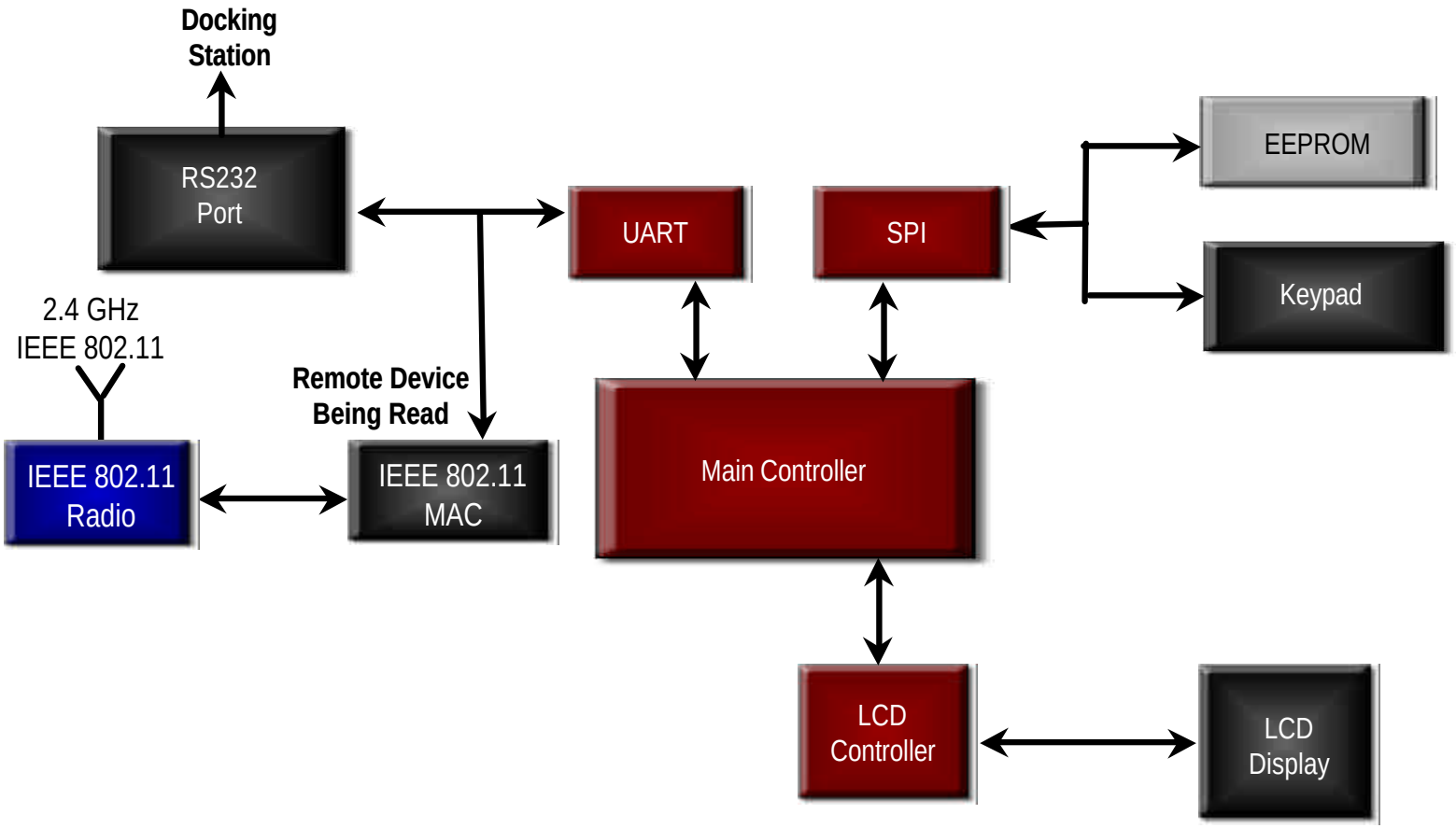
- Usage
  - Navigation, entertainment, security/emergency, PIM, email/messaging, web access, news/info, e-Commerce
- Current State
  - After-market products (Clarion, others), partnerships, and positioning for standards and working out feature mix
- Outlook
  - Low-volume, high end niche in auto add-on and auto market for next several years

Energy Management Systems

Automated Meter Reading (AMR)

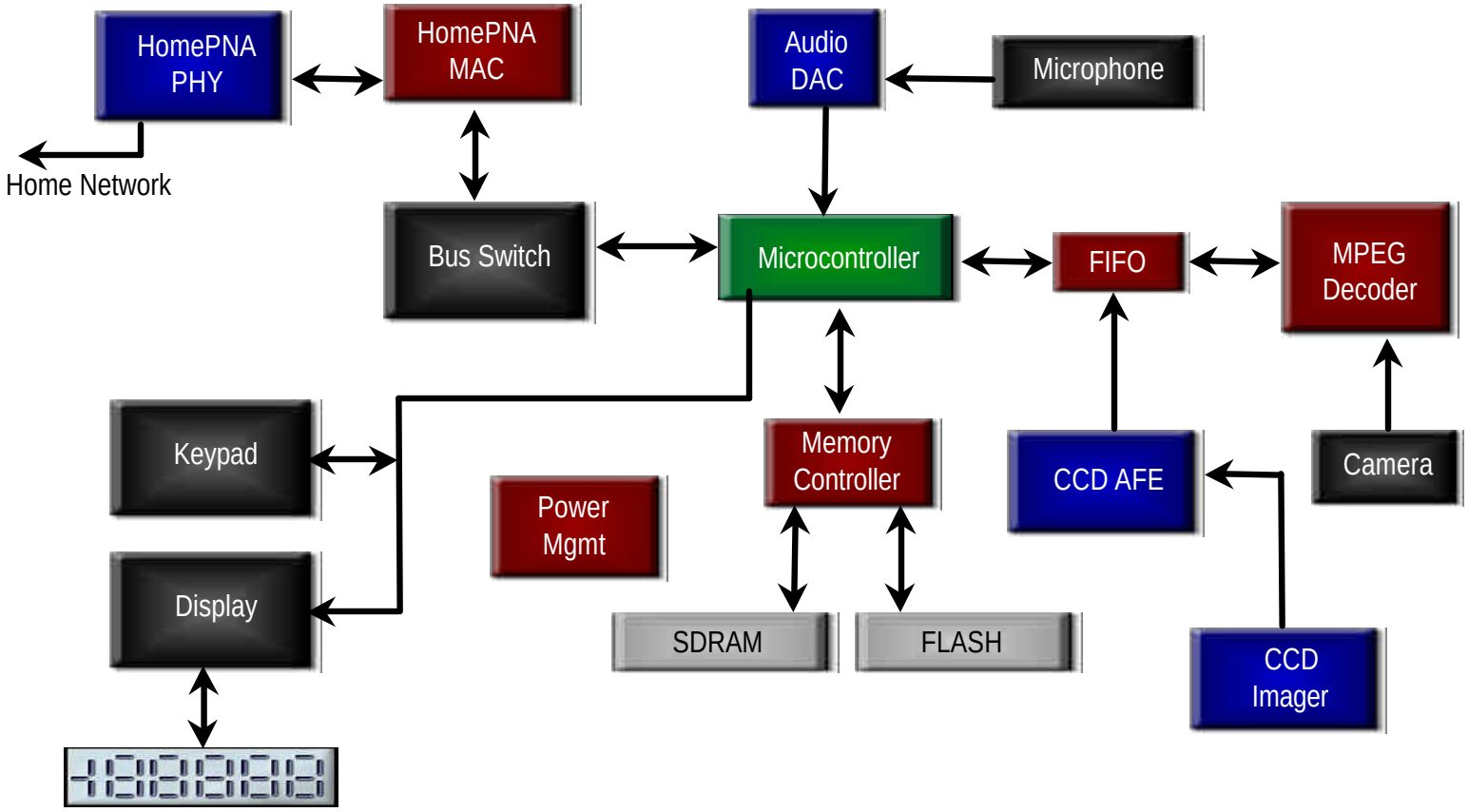
RF Metering

RF Metering


Docking Station
RS232 Port
UART
SPI
EEPROM
Keypad
2.4 GHz IEEE 802.11
Remote Device Being Read
IEEE 802.11 Radio
IEEE 802.11 MAC
Main Controller
LCD Controller
LCD Display

Home Security Systems

Home Security

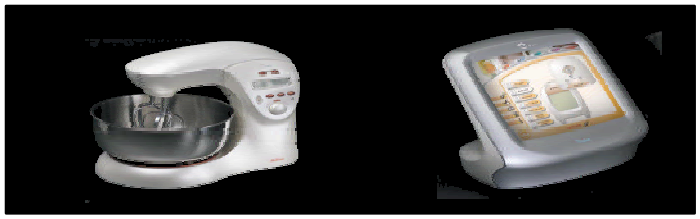


White Goods

Networked Dishwashers, Washing Machines,
Dryers, Microwaves, Ovens, Toasters

White Goods - Summary

- Usage
  - Operation, service and support, information output and receipt, interconnection
- Current State
  - Partnerships, announcements, rush to develop-Sunbeam, GE, Whirlpool, Sharp, Electrolux, Maytag, Merloni Eletrodomestici
- Outlook
  - Niche, high-end, interesting to watch, but needs infrastructure



Advanced Pay Phone (Access Point)

Public Phone Access Point - Market Overview

- Payphone market is still growing
  - Predicted growth for the year 2000 is 5.5% *
- Major growth is anticipated in the interactive payphone market
  - Services include Internet access, fax-on-demand & electronic commerce charged via a Smart Card or Credit Card
- Payphone calls are still cheaper than cell phone calls
- Wired interactive payphones are quicker and offer more bandwidth than cell phone technology

Trends

- Payphones are evolving into Multimedia Terminals providing
  - Internet access
    - Soon with Bluetooth wireless connectivity
  - Voice & video phone calls
  - Fax & data transfer
  - Email services
  - Personal ATM (transfer of cash onto smartcards)
  - Internet kiosks sales will rise from 20,000 (1997) - 445,000 (2003*)

Trends

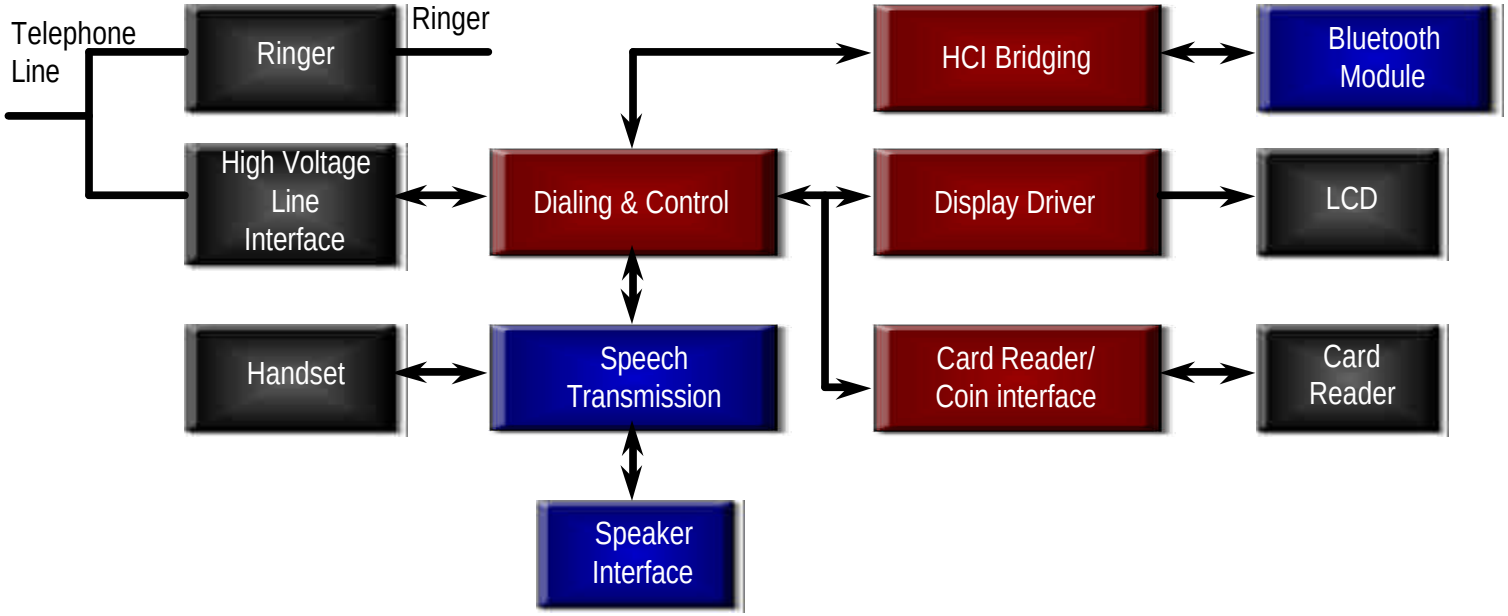
- Wireless & cellular payphones
  - Ideal for remote areas
  - Developing markets: Far East, Oceania & Asia
  - Easy to install
- Cash less
  - Smart Card payment system

Xilinx in Public Pay Phone Access Point

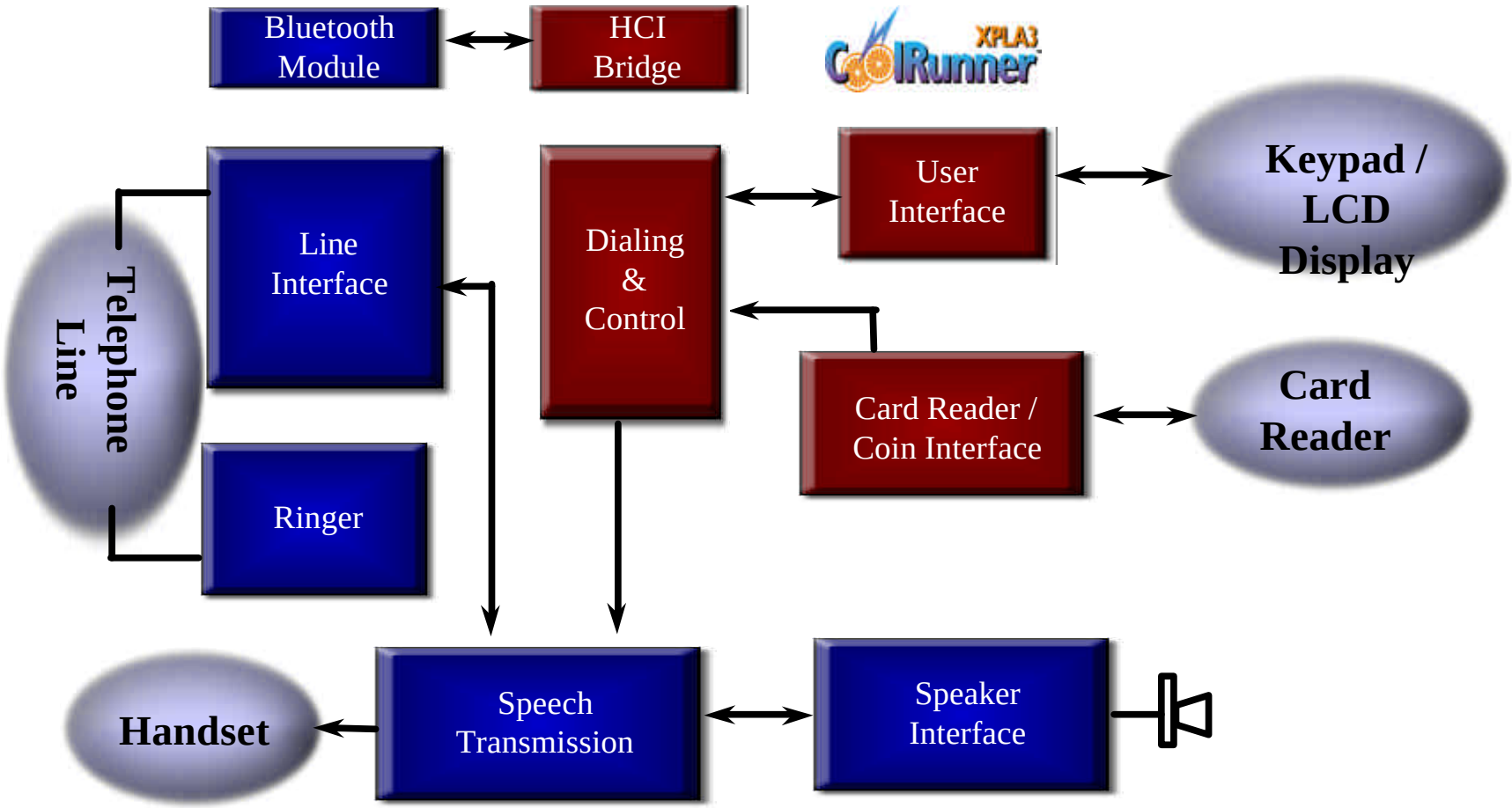
- System Logic
- Clock Distribution
- SDRAM Interface
- FLASH Memory Adapter
- Conditional Access Unit
- Smart Card Reader Interface
- Keyboard/Display Interface
- I/O Control
  - HCI Bridge
  - PCI
  - USB Controller
  - IrDA Interface
  - UART

You can implement all these in a Spartan-II FPGA

Public Phone Access Point



Advanced Feature Low Power Pay Phone

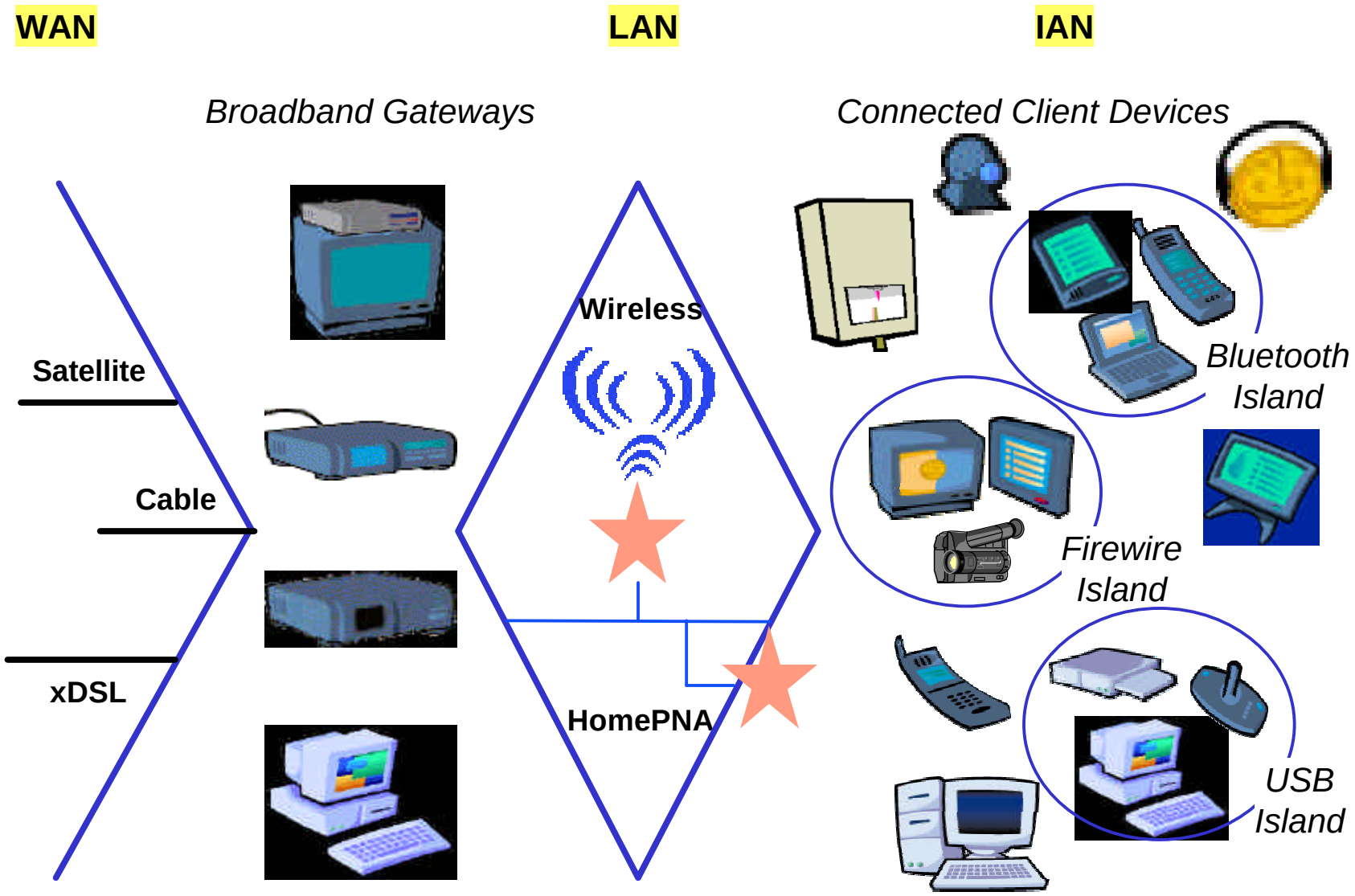


Networked Content

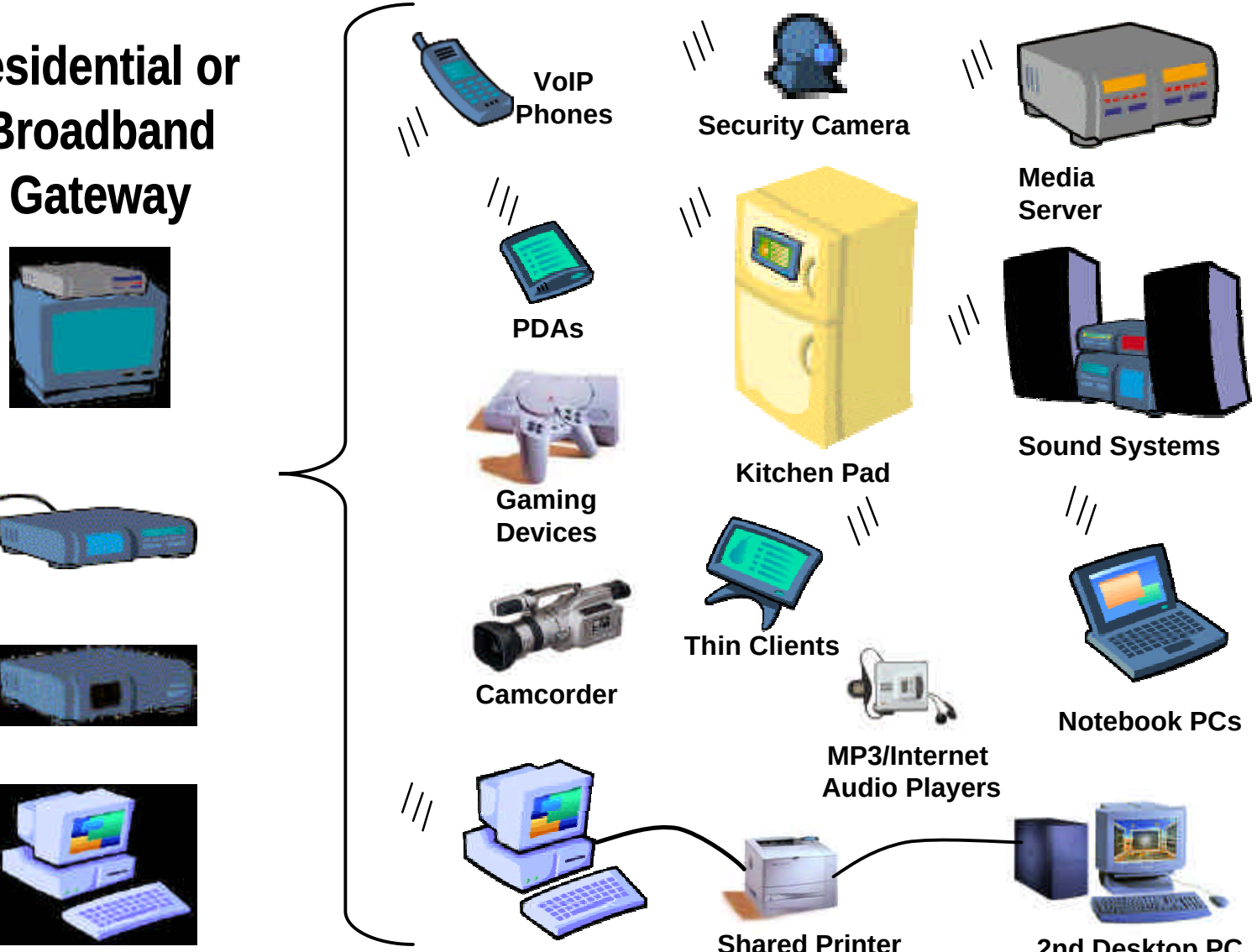
Networked Content

- Digital television
- MP3 audio files
- Video on demand (VOD)
  - Represents a wide set of technologies & companies that have the goal of enabling customers to select videos from a central server for viewing on a TV or PC screen
  - Videos are available at the customer's discretion
  - VOD service providers must have network infrastructures that can handle the large volumes of data storage and delivery required by video

Home Networking Solutions



Broadband Residential Gateway Usage



Agenda

- Introduction
- Home networking - the complete vision
- Information appliances
- Types of information appliances
- Xilinx solutions enable information appliances
- Summary

Xilinx Programmable Logic Solutions Enable Information Appliances

Value Proposition

Chaos in the HN Marketplace

- Multiple broadband & multiple home networking technologies

	RF - Wireless	Phoneline	Powerline
Pros	Mobility - UNTETHERED Broad geography support at specific frequencies Can compliment a wired network with bridging	Low cost and fast (10Mbps+) Strong Industry Alliance (HPNA) Dedicated home bandwidth Voice and data share existing lines	Electrical outlets in every room easy connection for non-PC appliances Low cost - will drop with silicon integration High performance (up to 10Mbps)
Cons	Relatively expensive - getting cheaper Distance limits & wall attenuation (150 ft/10 barriers) Security must be addressed Prone to narrowband interference	Phone jacks not near every PC in home Different phone lines (numbers) isolated International deployment issues	Must be robust in hostile environment (noise, stubs, vnet) International deployment issues (Regulatory issues) Security must be addressed Standards need to be addressed
Snapshot Take Away	International Solution, Mobile in North America	Low-cost desktop solution for North America	Ideal for non-PC devices

Chaos in the HN Marketplace

- Three major wireless consumer home networking campaigns are racing in separate directions
  - Wireless LAN/Ethernet, HomeRF & Bluetooth technologies vary in data rate, range, frequency & marketplace aimed for

Technology		Data Rate (Mbits/sec)	Range (meters)	Frequency (GHz)	Technology Aimed For
Wireless LAN/ Wireless Ethernet	802.11	2	100	2.4	Office Enviornments
	802.11b	11	100	2.4	
	802.11a	~40	TBD	5	
Bluetooth	802.15 (Bluetooth)	<1	10	2.4	Consumer, short-range, wireless personal-area technology
	802.15 (high-rate)	20+	TBD	2.4/5	
Home RF	HomeRF	1.6	50	2.4	Home Space
	HomeRF (next gen)	10	50	2.4	

Home Networking Today

- Growing chaos in this emerging technology
  - Solutions are just coming to market
  - Leading players are showing indecisiveness towards different varying technologies
    - Building independent solutions
    - Participation in multiple consortiums
    - Different wireless standards for same frequency band
- Interoperability is a key factor to market success
- Future revisions already in the works
  - HomePNA is already out with v2.0

Implications of this Chaos...

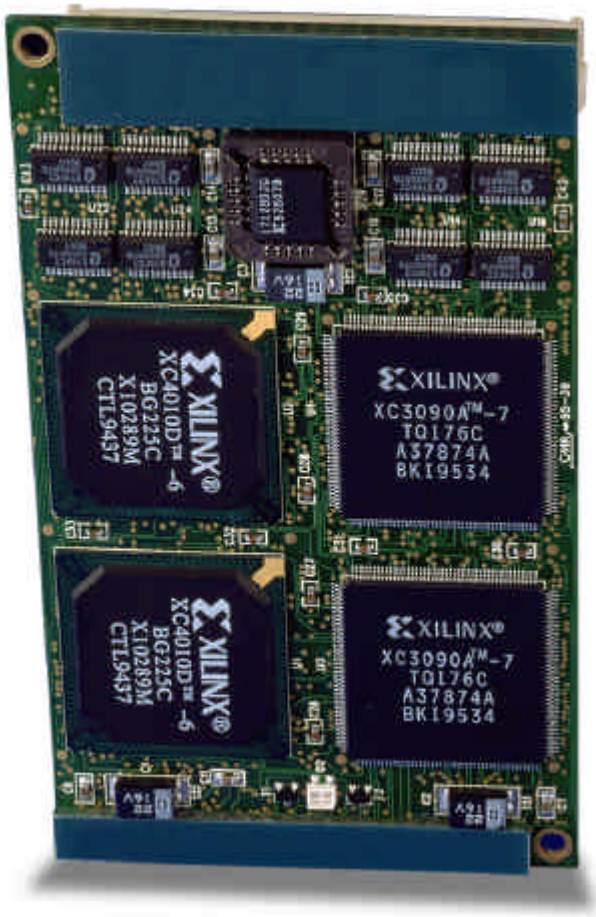
- Brings about an environment that guarantees unanticipated problems
  - Bugs
  - Incompatibilities
  - The Great Unknown about what is going to be the changes
- Translates to a steep learning curve
  - Virtually mandates a “Ready, Fire, Aim” development model
    - Plan products for the longest life cycles
    - Get a product to market “now”
    - Rapidly integrate refinements and enhancements

Where Does Xilinx Fit In the Electronics Industry

Key components of an electronics system:

- Processor
- Memory
- *Logic*

Xilinx is the Leading Innovator of Complete Programmable Logic Solutions



Strategic Business Model Ensures Focus

- "Fabless" strategy
  - Leading edge IC process technology
  - Wafer capacity at competitive prices
  - Fastest, lowest cost, densest parts
- Independent sales organization (Reps & Distributors)
  - Sales is a variable cost
  - Permits greater reach—over 20,000 Customers
  - Over 10,000 "Feet On The Street"
- Focus on key strengths
  - Product design
  - Marketing
  - Applications & Technical Support

Xilinx Steering Consortiums

Home Phoneline Network CERTIFIED

WLANA The Wireless LAN Association

HiperLAN2 Global Forum

LONMARK INTEROPERABILITY ASSOCIATION

Xilinx Product Portfolio

Advanced Products Group

High Performance
High Density

General Products Division

High Volume
Low Cost

CPLD Division

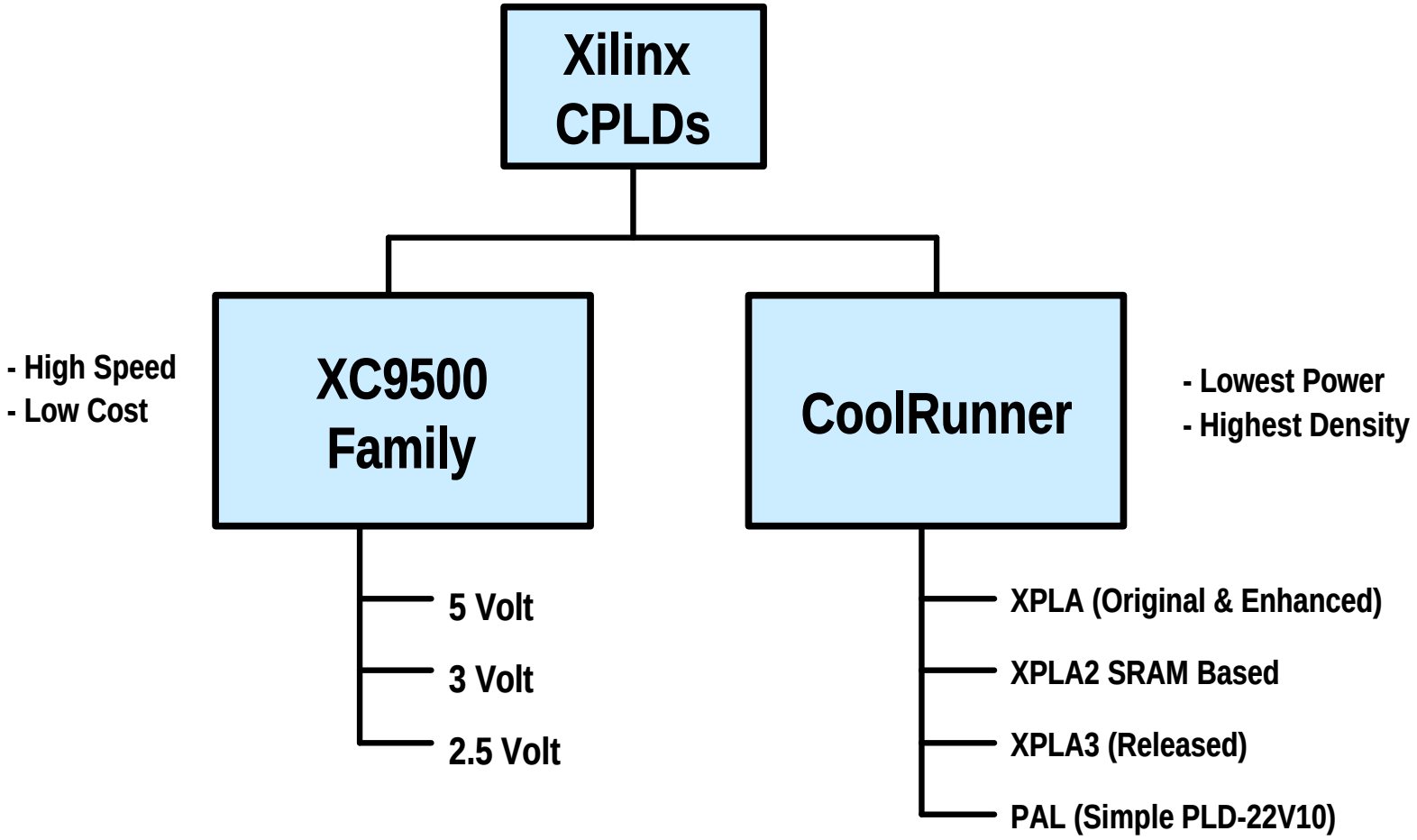
Low Power
Low Cost

Software Solutions

Xilinx - Leader in Core Solutions

	1998	1999	2000	2002	2004
Base Level Functions	- 82xx, UARTs, DMA - 66MHz DRAM, SDRAM I/F - Memory blocks - 29xx - Proprietary RISC Processors	- 8051 - IEEE 1284 - 200MHz SDRAM I/F - SGRAM, ZBTRAM I/F - Multi-channel DMA	- JAVA - Adv 32-bit RISC Processors - 64-bit RISC - DDR/QDR RAM - 622 Mbps LVDS	- 128-bit processors - Reconfigurable processors	
Communication & Networking	- Cell assem/delin - CRC - T1 Framer - HDLC - Reed-Solomon - Viterbi - UTOPIA	- 10/100 Ethernet - ATM/IP Over SONET - Cell scram/descram - SONET OC3/12 - ADPCM - IMA	- Network processors - 1Gb Ethernet - SONET OC48/192 - CELP - VoIP - ADSL, HDSL, xDSL - UMTS, wCDMA	- Software Radio - Modems - Neural networking - Emerging Telecom and Networking Standards	
DSP Functions	- Basic Math - Correlators - Filters: FIR, Comb - Multipliers - FFT, DFT - Sin/Cos	- DCT - Adaptive filters - Cordic - DES - DES - Divider - NCO - Satellite decoders	- MP3 - QAM - JPEG - Speech Recognition - DSP Processor I/Fs - Wavelet	- MPEG - DSP Functions > 200 MSPS - Programmable DSP Engines	
Standard Bus Interfaces	- CAN - ISA PnP - I2C - PCI 32-bit - PCMCIA	- CardBus - FireWire - PCI 64-bit/66MHz - Compact PCI Hot-Swap - PC104 - VME	- AGP - PCI-X 133MHz	- InfiniBand - Emerging High-Speed Standard Interfaces	

Xilinx CPLD Families



CoolRunner Technology

- Full density range 32 to 960 macrocells
- World's only TotalCMOS CPLD
  - Bipolar style sense amps eliminated
  - Virtually no static power dissipation
- Advanced PLA Architecture
  - Product term sharing (no redundant logic)
  - No wasted product terms
- 3.3v and 5.0v devices
- ISP/JTAG compatible & full software support

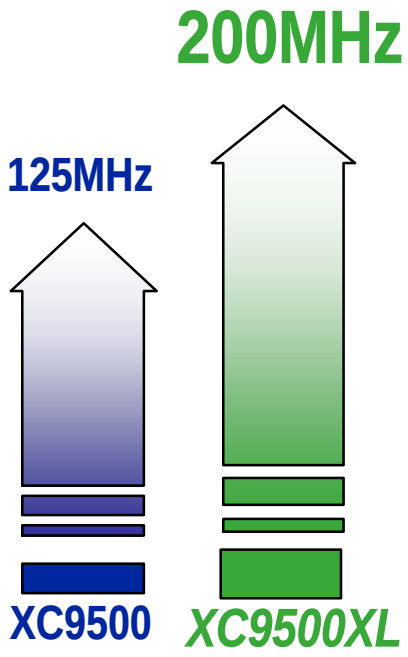
The CoolRunner Advantage

- Industry's lowest power CPLDs
  - Standby current < 100uA
  - High speed TPD = 6 ns
  - Revolutionary XPLA architecture
    - Exceptional routability & pin-locking
    - Fast, predictable timing
  - Small form factor packaging
    - New 0.5mm 56-pin MicroBGA

- No Speed / Power tradeoffs in scaling
  - Can build very large / very fast devices
  - 960 macrocell device @ 7.5 nsec t_{PD}

XC9500XL Key Features

- High performance
  - t_{PD} = 5ns, f_{SYS} = 178MHz
- 36 to 288 macrocell densities
- Lowest price, best value CPLD
- Highest programming reliability
- Most complete IEEE 1149.1 JTAG
- Space-efficient packaging, including chip scale pkg.

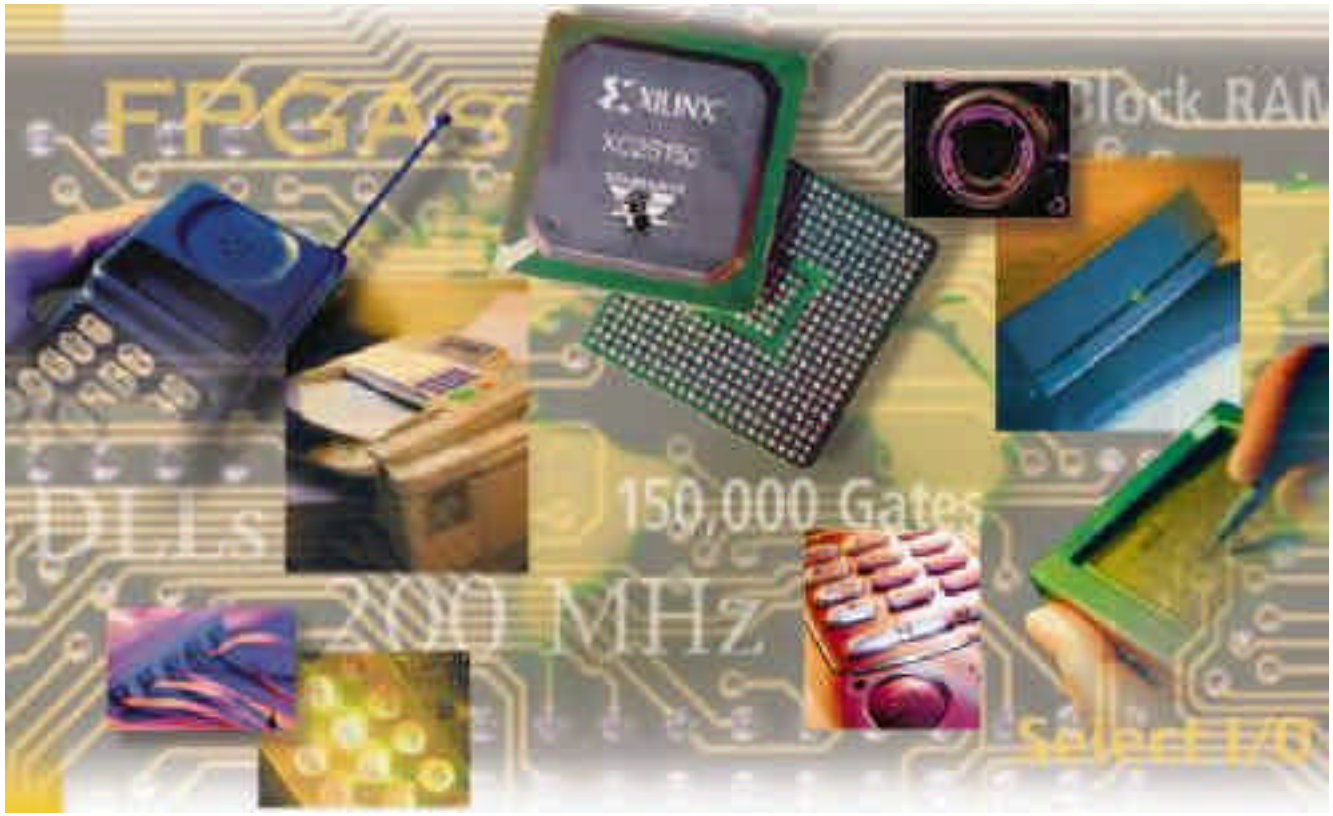


Lowest Price Per Macrocell

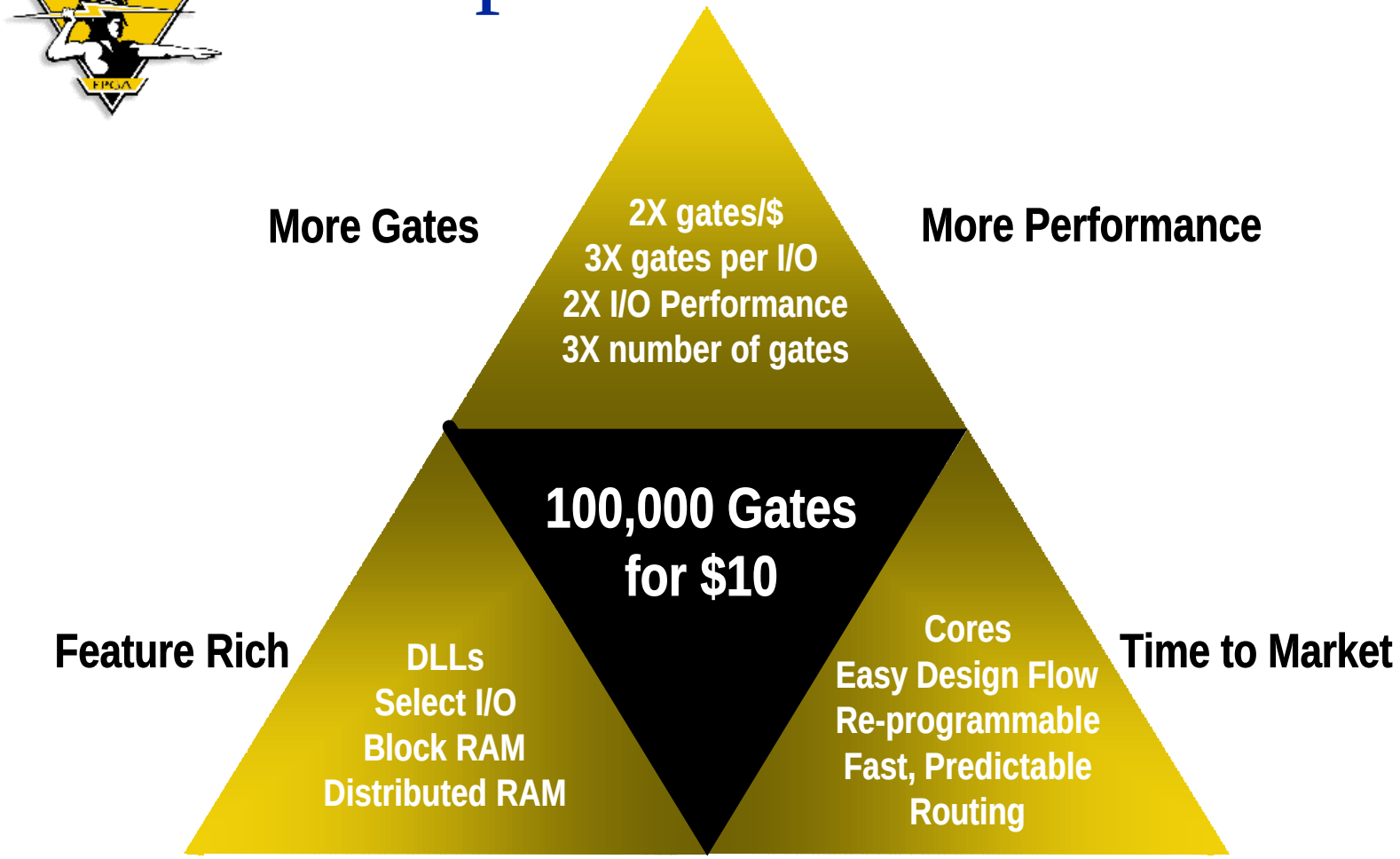
XC9500XL/XV System Features

- I/O Flexibility
  - XL:5v tolerant; direct interface to 3.3V & 2.5V
  - XV:5v tolerant; direct interface to 3.3V, 2.5V & 1.8V
- Input hysteresis on all pins
- User programmable grounds
- Bus hold circuitry for simple bus interface
- Easy ATE integration for ISP & JTAG
  - Fast, concurrent programming times

Introducing the Spartan-II FPGA

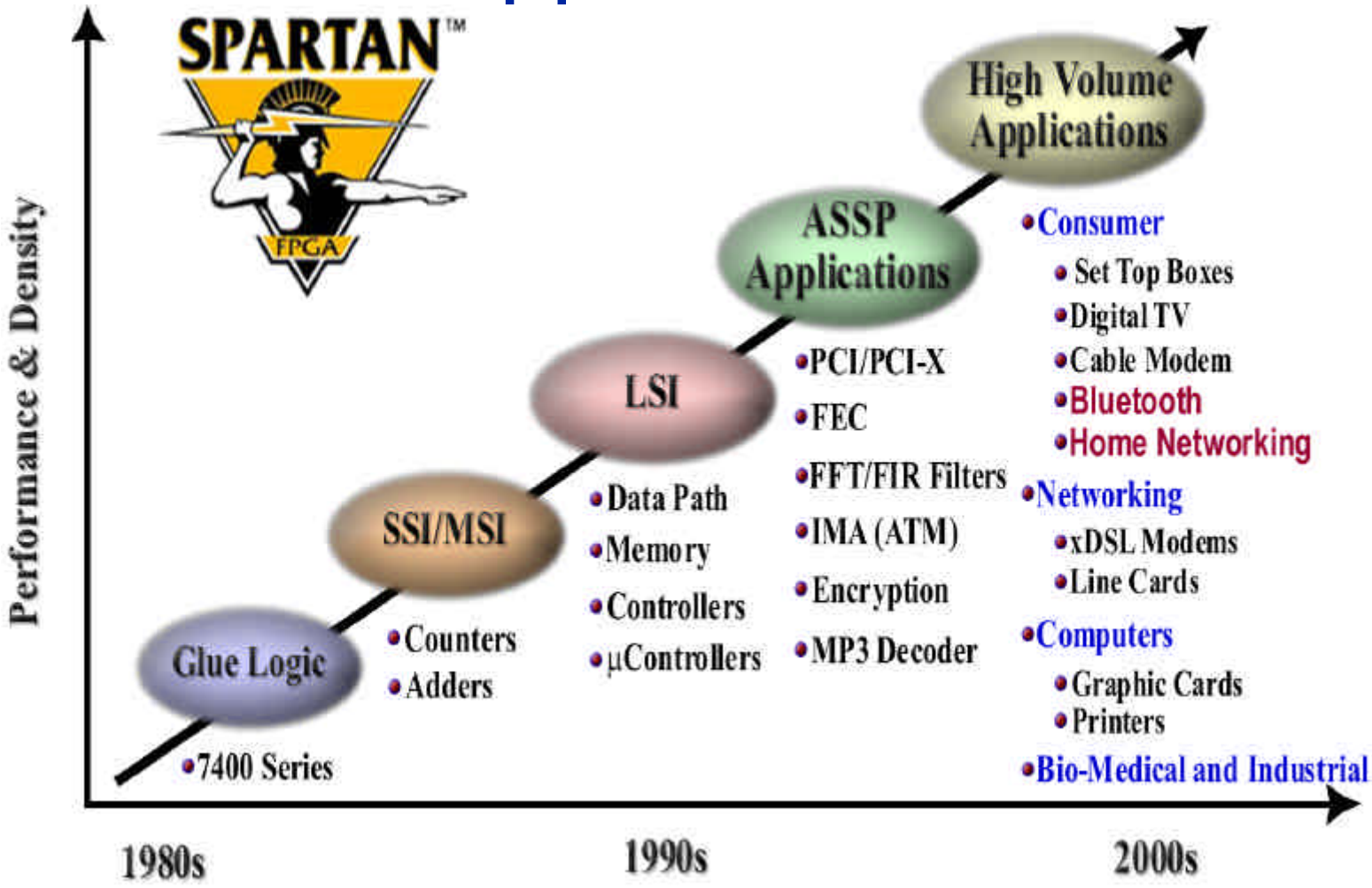


Spartan-II: Extending the Spartan Series



Programmable ASIC/ASSP Replacement!

FPGA Application Trends



Programmable ASIC/ASSP Replacement!

Spartan-II - Architecture Overview

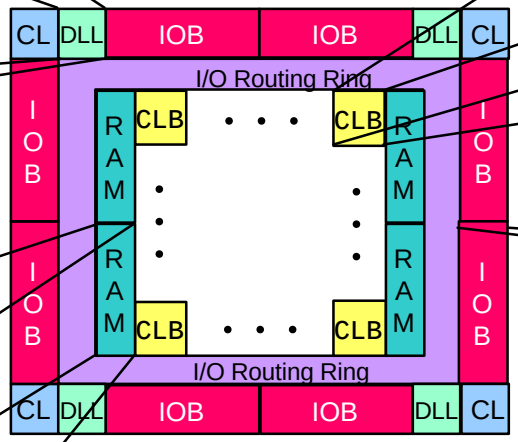
Delay Locked Loop (DLL)

Clock Management:

Multiply clock
Divide clock
De-skew clock

Configurable Logic Blocks (CLB)

Configurable Logic Block Array and Distributed RAM



Select I/O™ Technology

Chip to Backplane
PCI 33MHz 3.3V
PCI 33MHz 5.0V
PCI 66MHz 3.3V
GTL, GTL+, AGP
Chip to Memory
HSTL-I, HSTL-III
HSTL-IV
SSTL3-I, SSTL3-II
SSTL2-I, SSTL2-II
CTT
Chip to Chip
LVTTL, LVCMOS

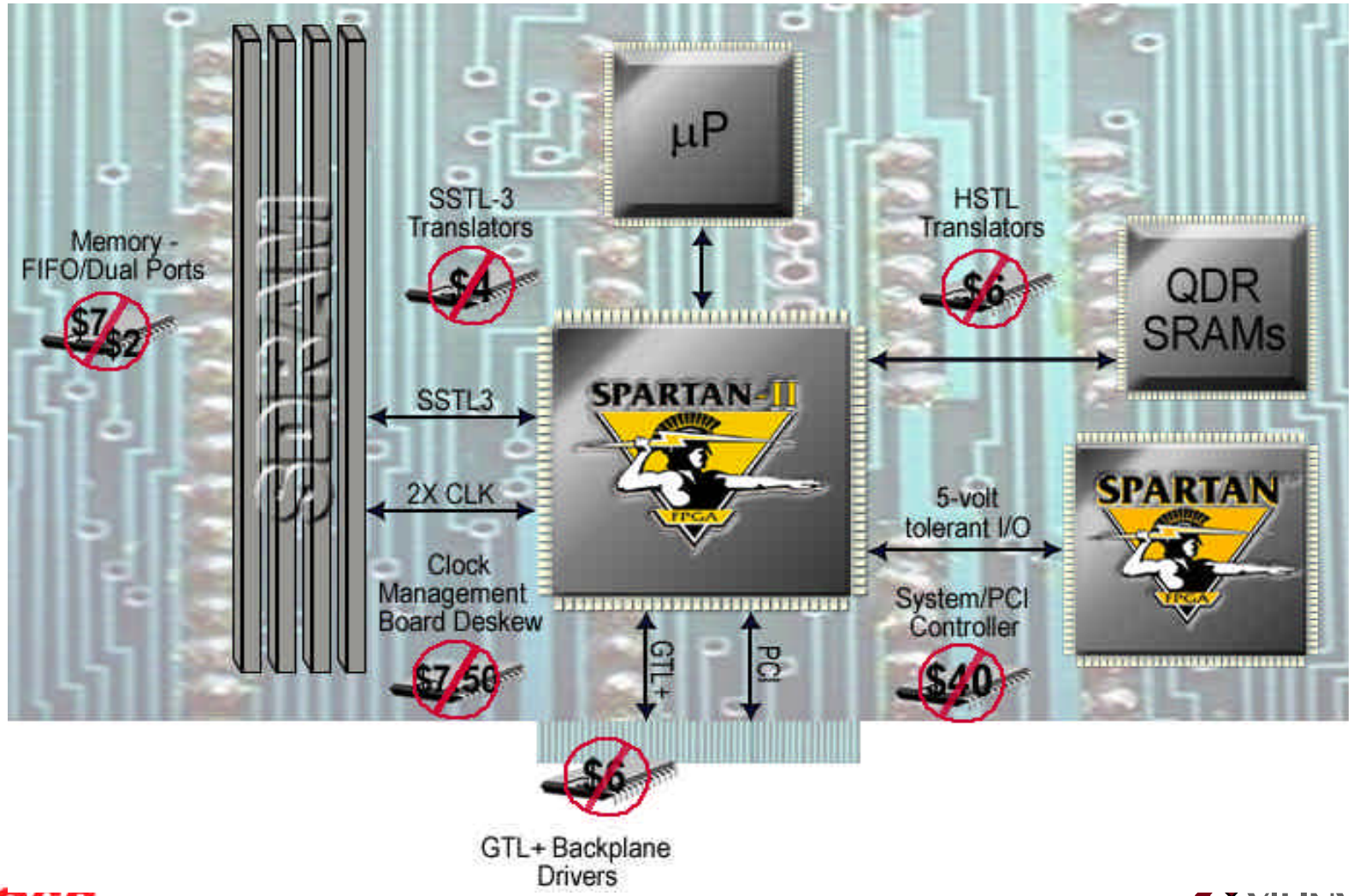
Block Memory

True Dual-Port™ 4K bit RAM

4Kx1
2Kx2
1Kx4
512x8
256x16

"The Spartan-II family, in our opinion, may be the closest that any FPGA has come to being at a low-enough price to compete against an ASIC"
--Dan Niles, Industry Analyst

Spartan-II - System Integration



Spartan-II Core Support

- On-chip memory & storage
  - Distributed, BlockRAM, FIFOs
- Bus products
  - PCI (64- & 32-bit, 33/66MHz), Arbiter, CAN bus interface
- DSP Functions (FIR filter)
- Error correction
  - Reed-Solomon, Viterbi
- Encryption (DES & triple DES)
- Microprocessor
  - ARC 32-bit configurable RISC, 8-bit 8051 microcontroller
- Memory controllers (10+)
  - SDRAM, QDR SRAM
- Communications
  - ATM (IMA, UTOPIA), Fast Ethernet (MAC)
- Telecom
  - CDMA matched filter, HDLC, DVB satellite, ADPCM speech codec
- Video & image processing
  - JPEG codec, DCT/IDCT, color space converter
- UARTs

Spartan-II End Applications

- Consumer
  - Set Top Boxes/Digital VCRs
  - DTV/HDTV
  - Digital Modems
    - xDSL, Cable, Satellite
  - Home Networking products
  - Bluetooth appliances
  - LCD/Flat-Panel Displays
- Networking
  - Telecom linecards
  - DSLAMs
  - LAN Hubs/Switches
  - SOHO Routers
  - Cellular base stations
- Computer/Storage
  - Printer/Scanner
  - Multi-function office equipment
  - Storage devices
  - Home servers
  - Audio/Video add-in cards
- Industrial/Medical
  - Medical Imaging
  - Industrial automation/control
  - Data acquisition
  - Video capture/editing
  - Automated test equipment
  - Automotive Info-tainment systems

Spartan-II Solutions for Information Appliances

- I/O control
  - Multiple front end interfaces
  - Multiple back end interfaces
- Hard disk drive interface
- Clock distribution
  - DLLs
- MPEG decoder
- Ethernet MAC
- Error correction
  - Reed-Solomon, Viterbi
- PCI
- Memory solutions
  - On-chip Distributed memory, BlockRAM
  - Memory controllers
- CPU / microcontroller
- HDLC controller
- ADPCM
- Color Space Converters
- Glue logic & system integration
  - LCD controllers, UARTs, DMA controllers

Programmable Solutions Advantages

Xilinx Programmable Solutions Provide Several Benefits

- Time to market
  - Consumer devices require fast time-to-market
  - ASICs & ASSPs take 12-18 months to spin out
- Flexibility
  - Product customization to meet customer needs
  - Accommodate multiple standards & spec updates/changes
  - Feature upgrades
- Testing and verification
  - Re-programmable allows risk aversion
  - Your solutions are built on a proven FPGA technology with pre-verified silicon and IP that guarantees performance

Xilinx Programmable Solutions Provide Several Advantages

- Xilinx On-line - field upgradability
  - Remote update of software and hardware
  - Results in increased lifetime for a product (time-in-market) and allows new, interesting applications
  - Enable product features per end-user needs
- Issues in creating a stand-alone ASIC/ASSP
  - Choosing the right solution
  - Product customization
  - Development cost and amortization
- Low Cost

Lifecycle Component Logistics

- Xilinx is an assured source of supply
  - Spartan FPGAs are high volume standard parts
  - Xilinx is a Strategic customer to our fab partners
  - If a device is retired, designs are quickly portable
- Xilinx's solutions reduce exposure to component supply issues
  - Designs can be quickly adapted to efficiently address component supply problems
    - NAND to NOR type Flash support for example
  - Gives latitude in maintaining a cost effective BOM in dealing with the allocation, end of life & generational migration realities of today's component market

Specification Changes

- Emerging markets are exposed to multiple standards and specification changes
  - DSL Modem market
    - 6 different variations
  - DTV market
    - 18 different formats

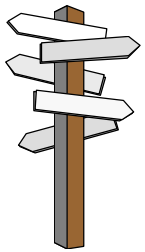
U.S. Networks Select Digital Broadcasting Format

ABC	720-Progressive. For non-HDTV broadcasts, ABC will use 480-line progressive format.
CBS	1,080-Interlaced. Wants to be compatible with HDTV sets as well as normal quality formats on regular analog television sets. Digital broadcasting will begin at select CBS-owned stations in the fall of 1998. By November 1999, CBS plans to be broadcasting digitally into 43% of U.S. households. For other broadcasts, CBS will use the 480-line Interlaced format.
NBC	1,080-Interlaced. NBC is leaning toward 480-line progressive for non-HDTV broadcasts.
FOX	720-Progressive. For non-HDTV broadcasts, Fox will use the 480-line progressive format.
PBS	For HDTV, PBS is undecided. For non-HDTV broadcasts, PBS will use the 480-line interlaced format.
Local Stations	Will have to conform to their network's format for national programming but can select any format for local programming.

Source: IC Insights

OEM/ Vendor

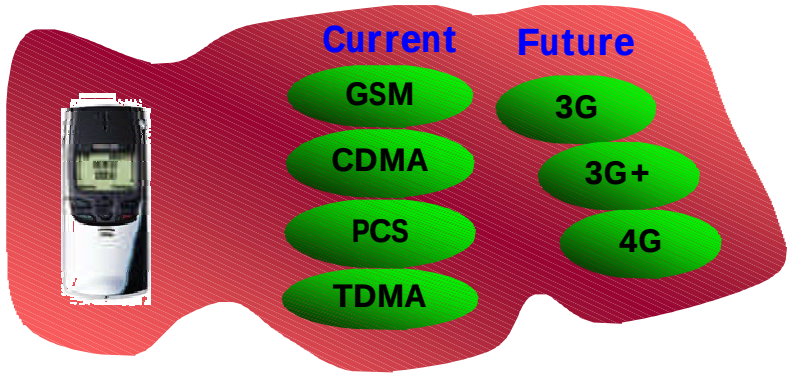
Market



A Programmable Solution Future Proof's Success

New Flexibility from FPGAs

Driving down the cost of consumer products with low cost reprogrammable products



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Enabling a whole new breed of consumer products

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Reprogrammable nature allows
- Field upgrades
- Field fixes
  - Mars probe repair from earth
- Support for numerous standards

Xilinx & Replay TV
- Revolutionizing consumer TV

FPGAs, the Unsung Hero

Driving the Consumer Digital Logic Revolution

- The digital consumer world is here
  - Imperatives driving market success
    - Time to market and time-in-market
    - Flexibility
    - Custom digital logic

- Xilinx - The answer for consumer digital applications
  - Introducing the low cost Spartan-II programmable family
    - Cost reduced for the consumer market
    - Fully programmable at the desktop, in the field or in the application
    - Future proofed for changing standards

Xilinx Digital Consumer Logic
A Natural Fit for Home Networking

- Xilinx solutions enable you to thrive in chaos
  - Fastest time-to-market
    - First to market, gains market share and revenue advantage
  - Xilinx Online provides reconfigurability in the field
    - Allows shipped product to support revisions to the spec
    - Enables unique opportunities to add Value
    - Increases life-cycle revenue yield & hence time-in-market
  - Enables rapid product proliferation
    - New designs can be quickly turned into derivatives
  - Feature superior lifecycle component logistics
  - Testing and Verification
    - Proven FPGA technology, software, test benches
- Cost Effective!!!

Agenda

- Introduction
- Home networking - the complete vision
- Information appliances
- Types of information appliances
- Xilinx solutions enable information appliances
- Summary

Summary

- IAs will out-ship consumer PCs by 2002 in the U.S.
  - Big volume winners IAs: DVD players, digital cameras, SHDs
- Semiconductors enable new devices and players
- Technology becomes invisible
- More functionality will be available at lower price points
- Designs evolve to deliver Web content
- Brands will change from ‘device only’ to service, solutions or customer relationship provider

Summary

- The digital consumer revolution & the Internet are forcing broadband into the home
  - Different networked IAs will be in the home
- Spartan-II FPGAs, CoolRunner & 9500 CPLDs enable IAs
  - IP cores + Spartan-II FPGAs provide solutions like ASSPs
    - Embedded solutions : FPGA logic not used from IP can be programmed with other IP cores
  - Features within the Spartan-II provide system integration
  - Reprogrammability enables time-to-market & flexibility
  - Internet Reconfigurable Logic allows time-in-market as specs in emerging technologies keep evolving
  - Cost effective