



The Residential Gateway

(Home Gateway or Services Gateway)

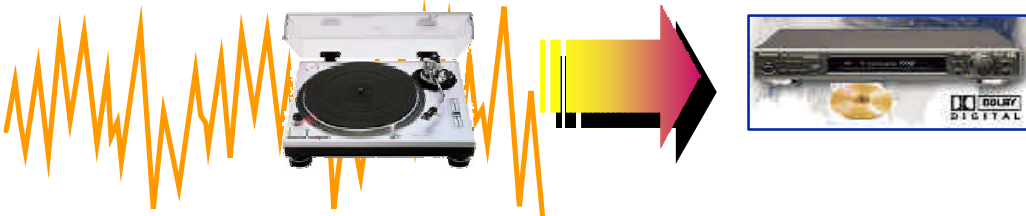
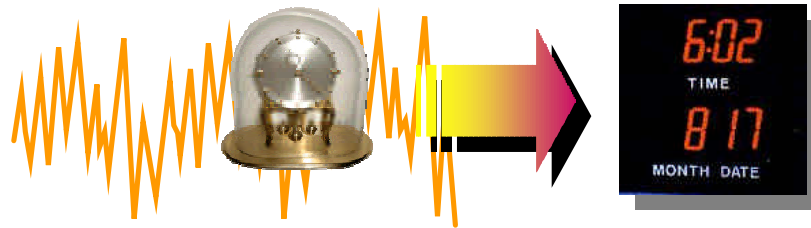
Customer Tutorial

Agenda

- ◆ Introduction & state of the market
- ◆ The complete home networking solution
- ◆ Residential gateways (RGs) - definition, purpose & types
- ◆ Phased deployment of RGs
- ◆ Consortiums
- ◆ RG solutions available today
- ◆ Xilinx solutions for RGs
- ◆ Summary

Introduction

The Digital Age of Consumer Electronics



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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

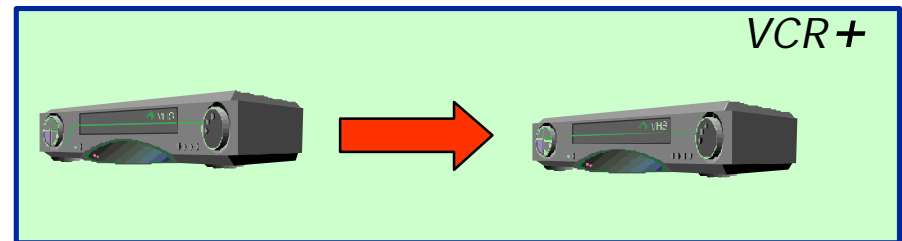
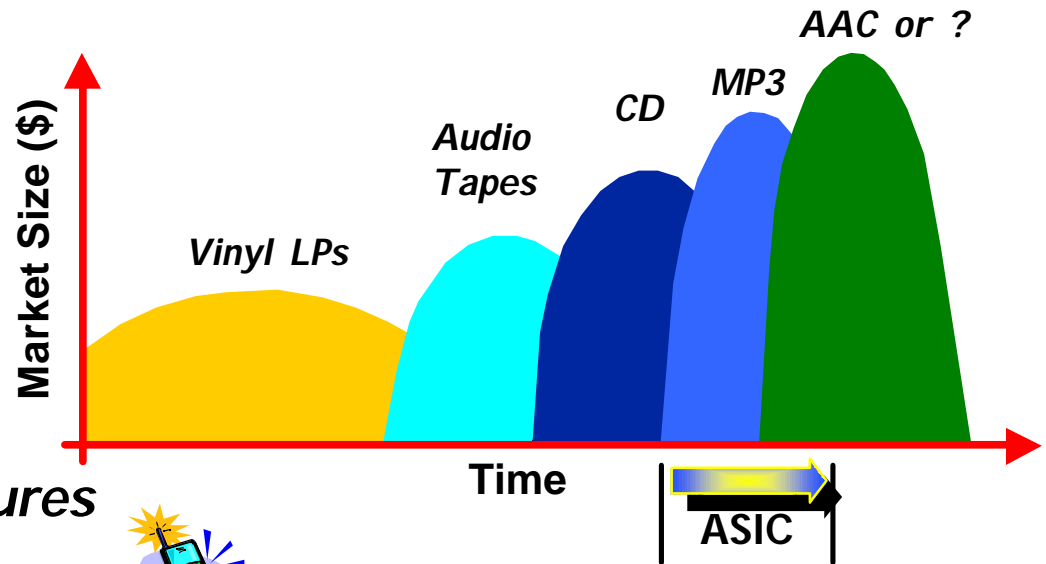


MP3 Players

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

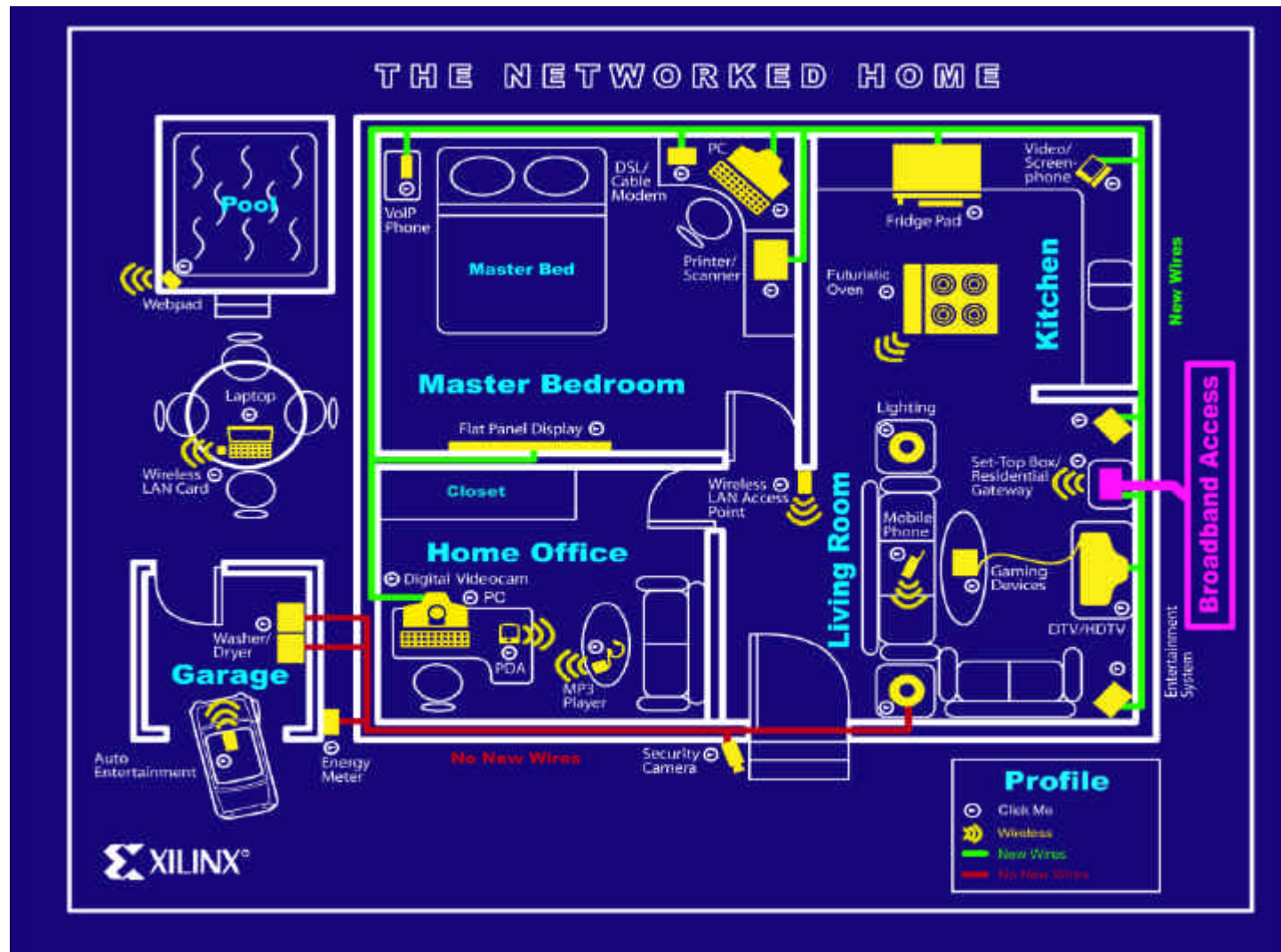
Networking Solution for Controlling & Managing Smart Devices

- ◆ 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



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

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

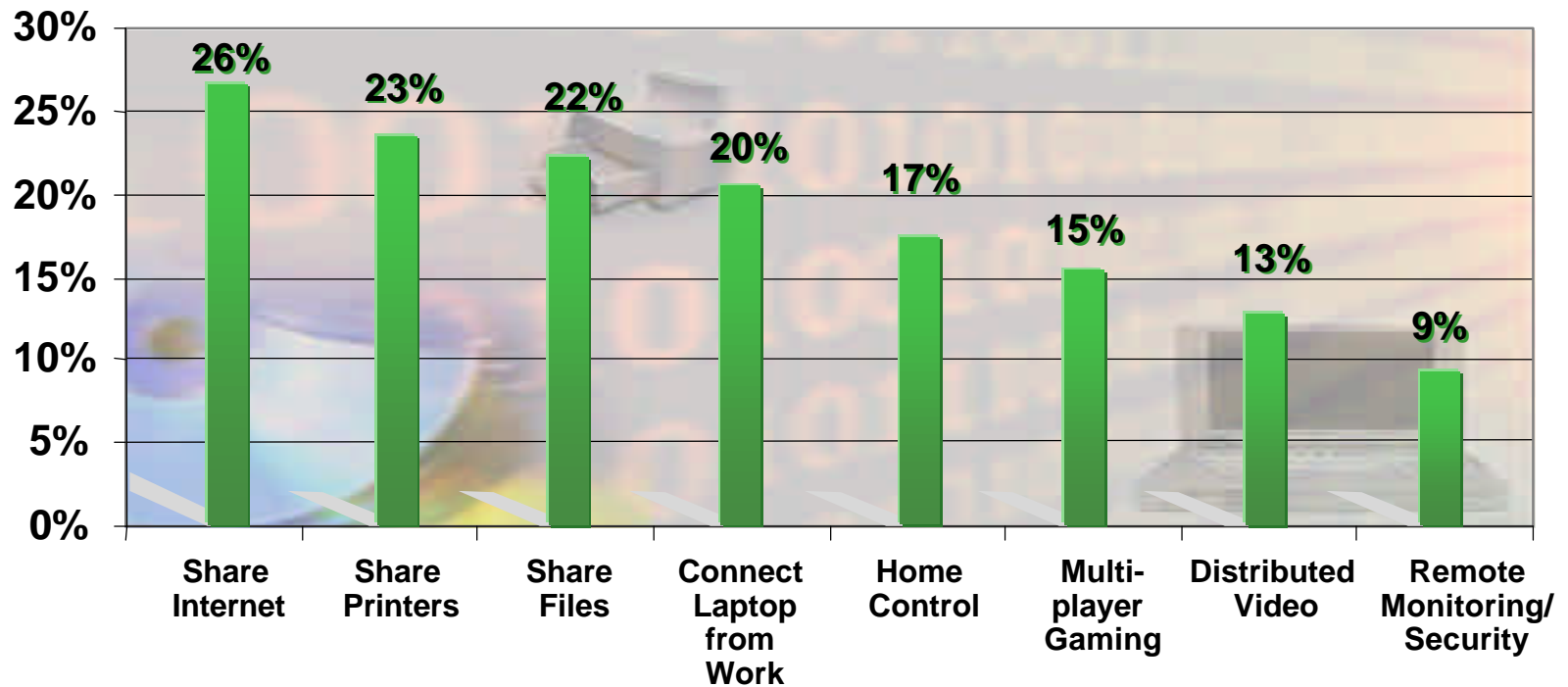
- ◆ More digital appliances are coming into the home (by IDC)
 - DSS, DVD, Digital TV
 - Web-Top boxes, set-top boxes
 - PDAs, mobile (cellular) phones
 - Digital cameras
 - Installed base of internet appliances will exceed 50M by 2001
- ◆ More digital content entering the home
 - Published Content
 - 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

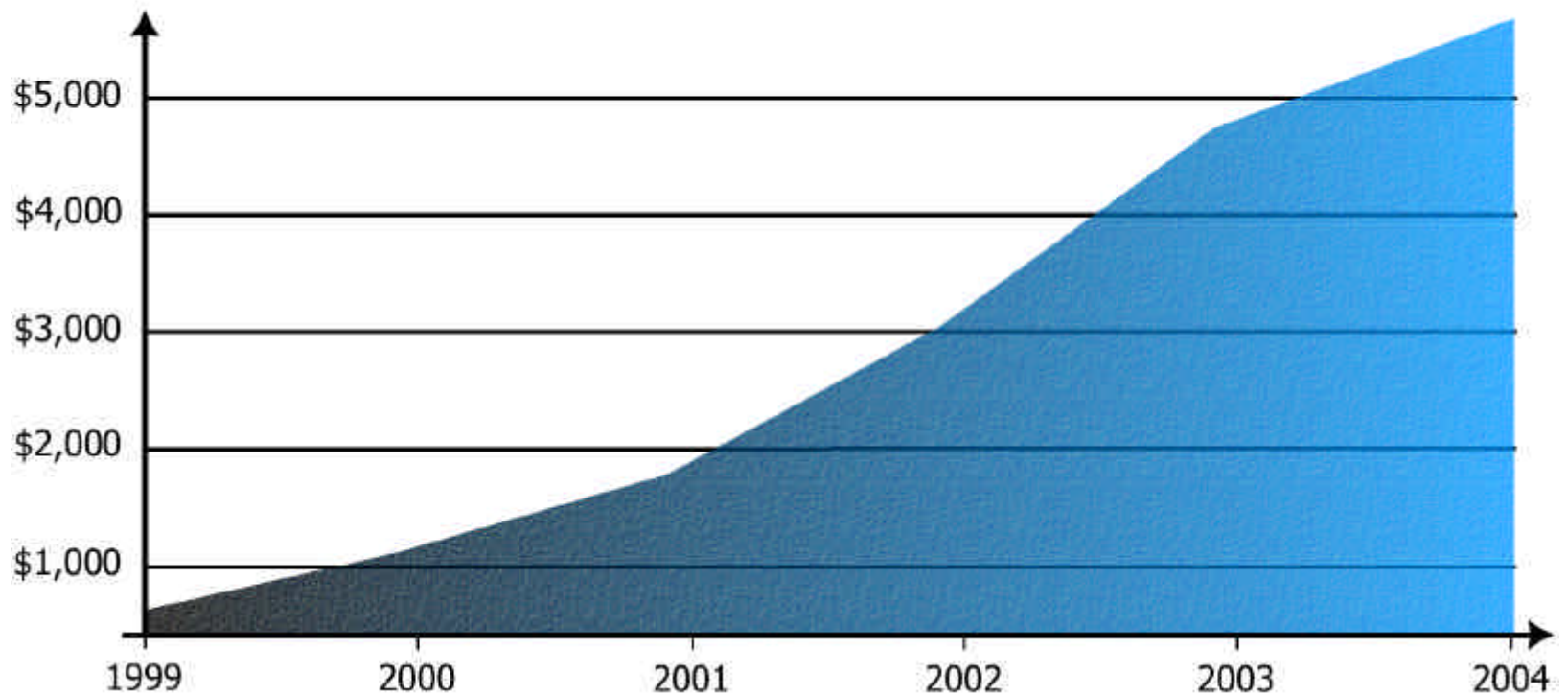
Residential Gateway

The Key Ingredient For Home Networking

- ◆ RGs provide integration of different broadband access types & different home networking solutions
 - Broadband access: xDSL & cable modems
 - Each modem offers an Ethernet port for connecting one computer
 - Increasing number of households have multiple computers
 - Tech-savvy users may install Ethernet hub and pull Cat5 cabling to each computer
 - Most users will not find this a viable option due to installation obstacles or cost
 - Home networking solutions: HomePNA, HomePlug, HomeRF, Wireless LANs, IEEE 1394

Worldwide Home Network & Residential Gateway Forecast

Worldwide Home Network and Residential Gateway Forecast (US \$M)



Source: Cahners In-Stat Group

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Home Networking - The Complete Solution

Vision

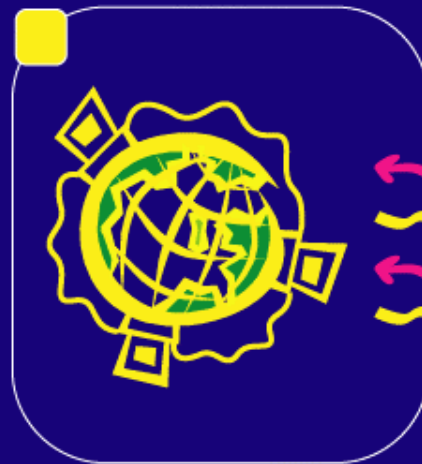
Goal of Home Networking

- ◆ 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

THE COMPLETE HOME NETWORKING PICTURE

Broadband Access



xDSL, Cable, ISDN, Satellite,
Powerline, Analog Dial-up
Phoneline

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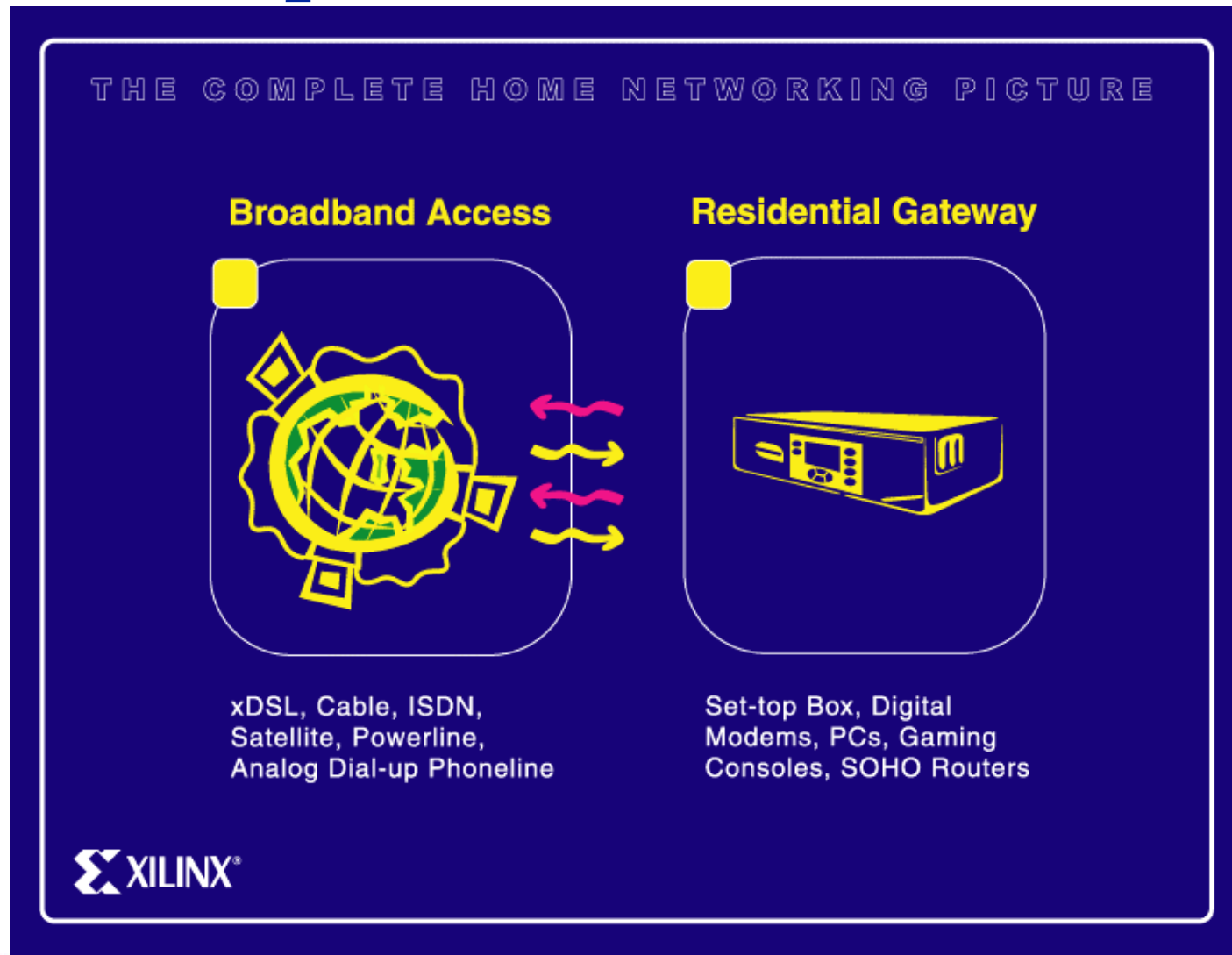
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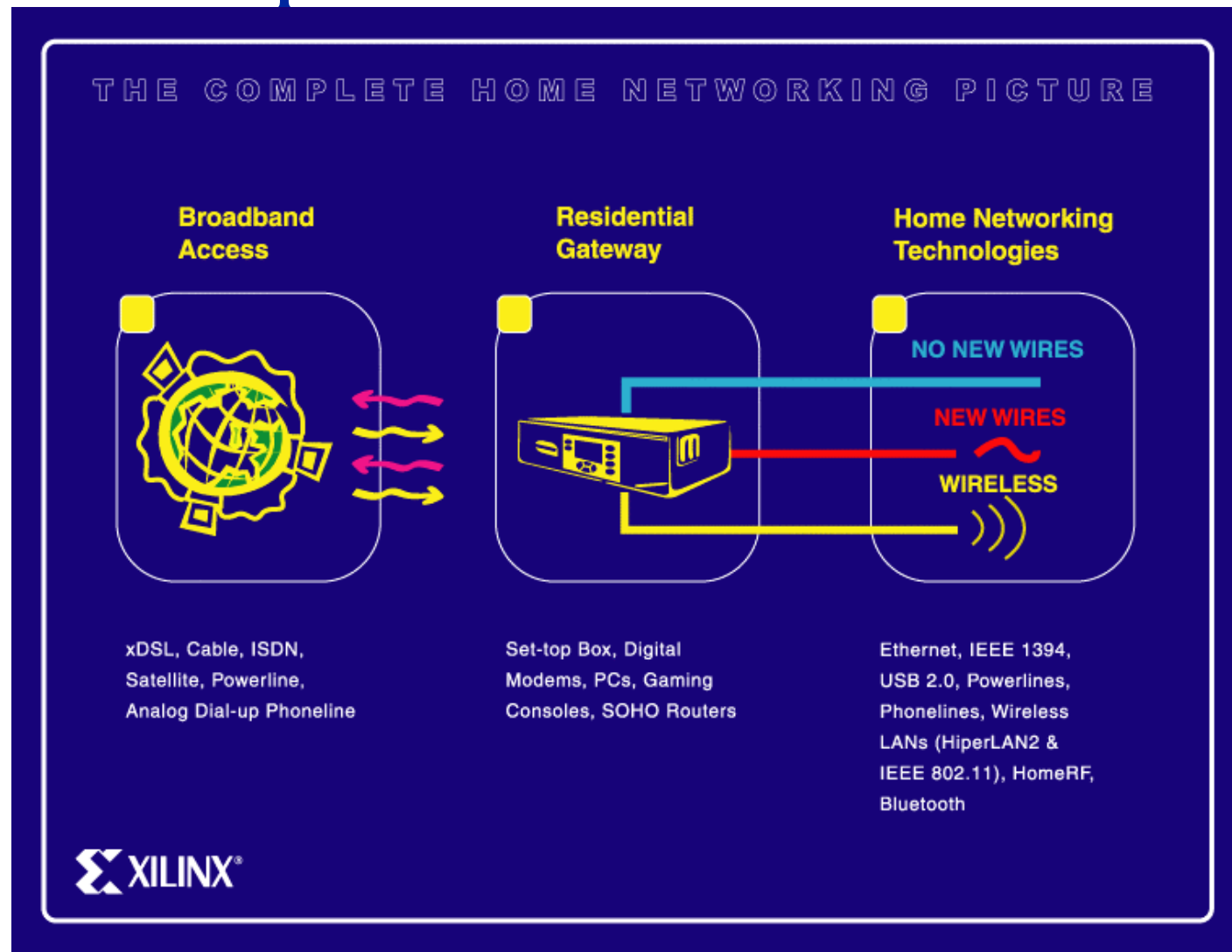
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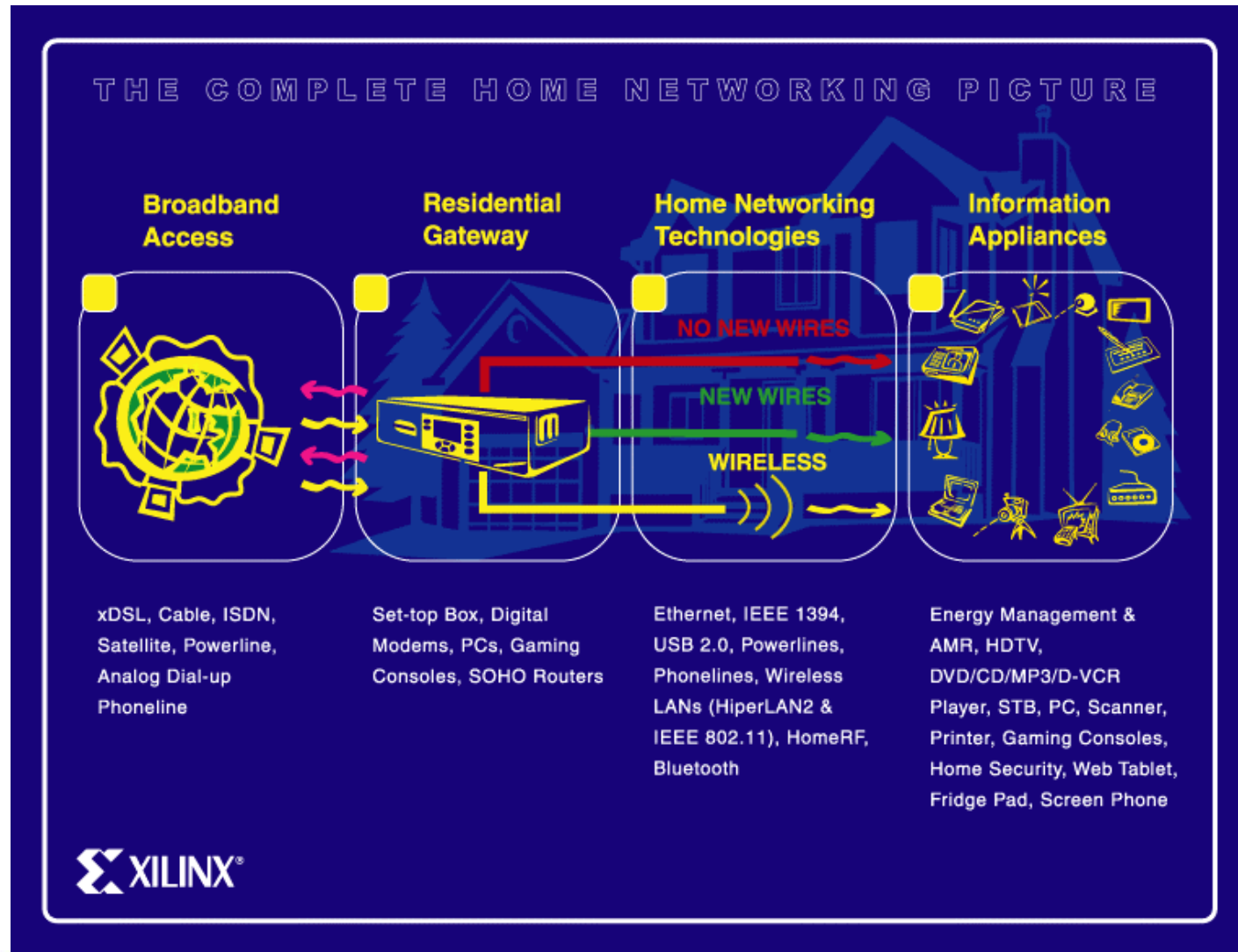
Four Aspects to Home Networking



Four Aspects to Home Networking



Four Aspects to Home Networking



Market Requirements and Solutions Available

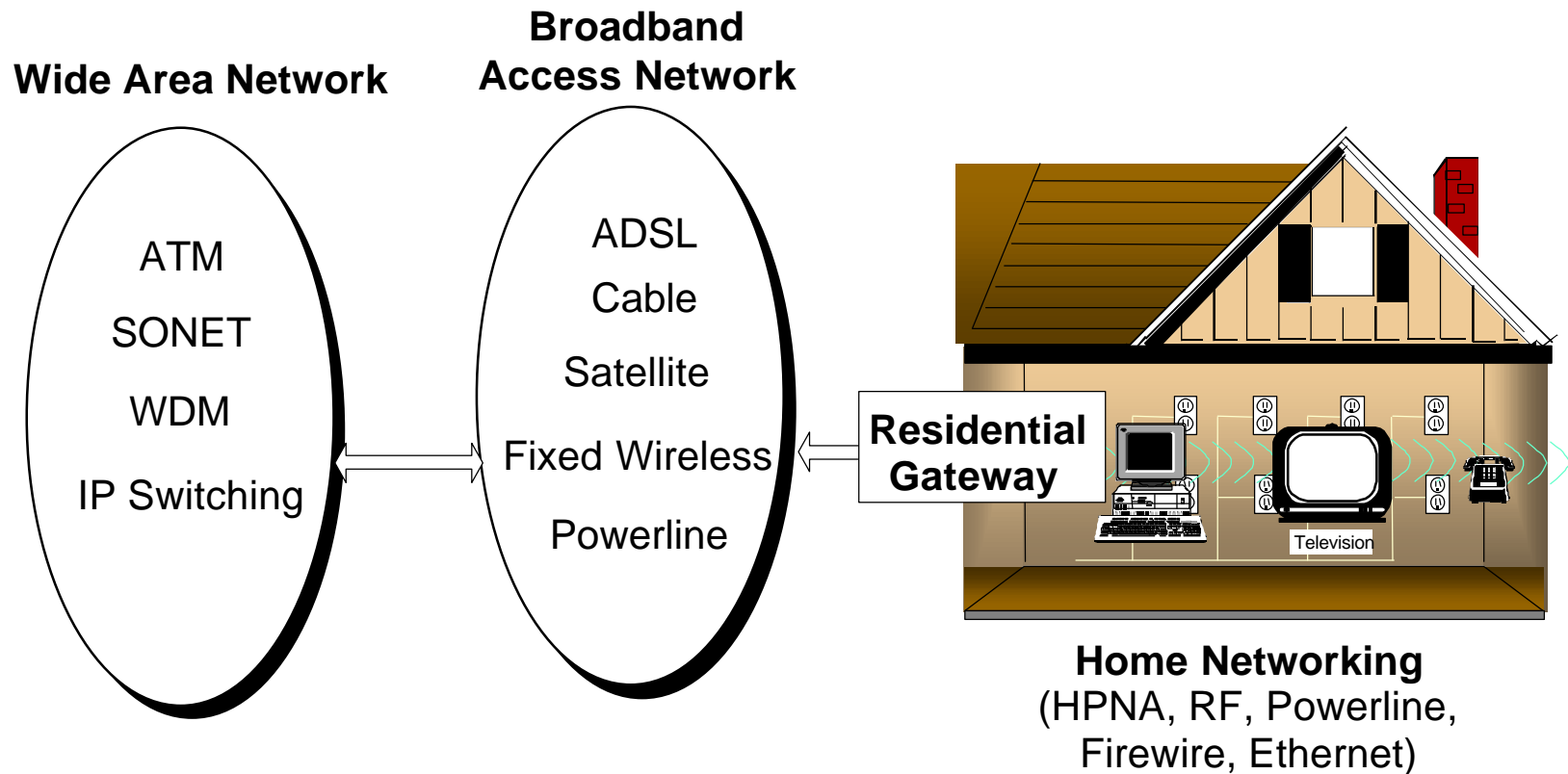
	Market Requirements	Solutions Available
Broadband Access	High Speed Access for Data, Voice and Video, Always on, Simultaneous Up-link & Down-link Communication, Support Simultaneous and Multi-User Access	xDSL, Cable, Powerline, Satellite, Mobile/Wireless
Residential Gateway	Provides Access into the Home, 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.



Broadband Access

ADSL, Cable, ISDN, Satellite,
V.90 Modem/ Phonelines

RGs - The Integral Link Between Broadband Access & Home Networking



Source: Cahners In-Stat



Broadband Access Technologies

- ◆ ADSL - Asymmetrical Digital Subscriber Line
 - Comes in several forms
 - G.Lite ADSL & G.dmt ADSL
 - Always on & phone line is not tied up
 - Downstream speeds up to 8Mbps & upstream rates up to 1.5Mbps
- ◆ Cable
 - Internet access on the same cable as regular cable TV
 - Offered by cable companies
 - Subscriber requires a cable modem
 - Potential speeds up to 10Mbps
 - Number of users on the system affects speed

Broadband Access Technologies

- ◆ ISDN - Integrated Digital Services Network
 - High-speed, fully digital telephone service
 - Can operate at speeds up to 144Kbps
 - 5 or more times faster than today's analog modems
 - Widely available
- ◆ Satellite
 - Direct broadcast satellites that transmit TV programs can also provide Internet access
 - Satellite dish can deliver download speed of up to 350Kbps
 - Upload speeds are limited to ordinary analog modem speeds

Broadband Access Technologies

- ◆ V.90 Modem - Analog Phoneline
 - Modem is designed to operate with dial-up telephone lines worldwide
 - Supports high-speed analog data, high speed fax & audio/voice operation
 - Integrated modem is host controlled
 - Reduces chip count since there is no separate microcontroller
 - Data speeds up to 56Kbps from a digitally connected central site modem - V.90 enabled
 - Data can be sent upstream at speeds up to 33.6Kbps



In-Home Local Area Networks

No New Wires: Phoneline, Powerline

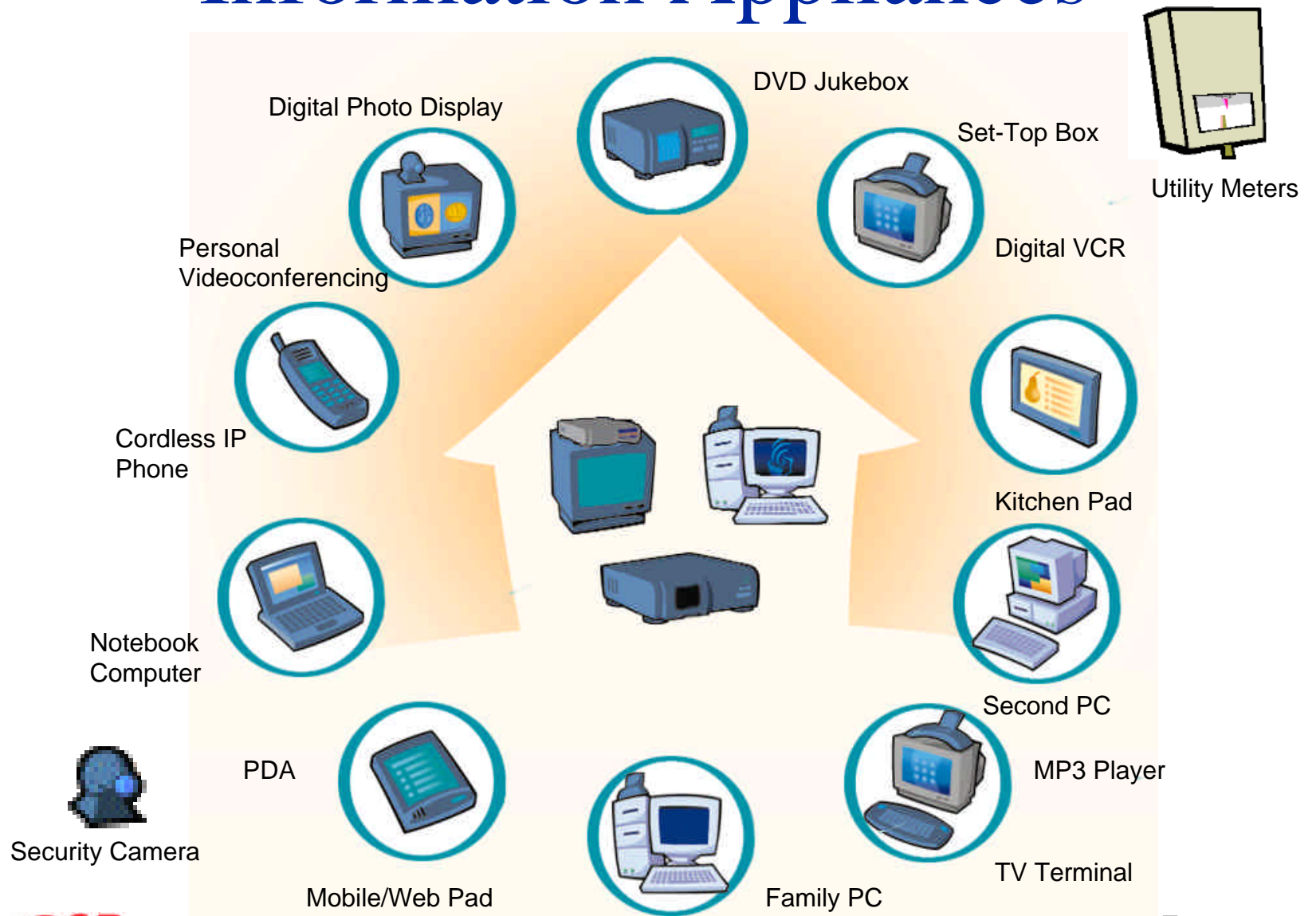
New Wires: Ethernet, IEEE-1394/Firewire

Wireless: HomeRF, Bluetooth, Wireless LANs -
IEEE-802.11 & HiperLAN2

Key Information Appliances

- ◆ Digital TV
- ◆ Set-Top box
- ◆ Internet screen phones
- ◆ Interactive DVD players, Digital VCR
- ◆ Gaming devices
- ◆ MP3 players/audio Devices
- ◆ Cordless phones
- ◆ Security systems
- ◆ Utility meters
- ◆ PCs (desktop & notebook)
- ◆ Web (kitchen) pads
- ◆ Web/Email terminals
- ◆ PDAs (personal digital assistant)
- ◆ Digital Cameras
- ◆ Emerging technologies
 - Auto PCs

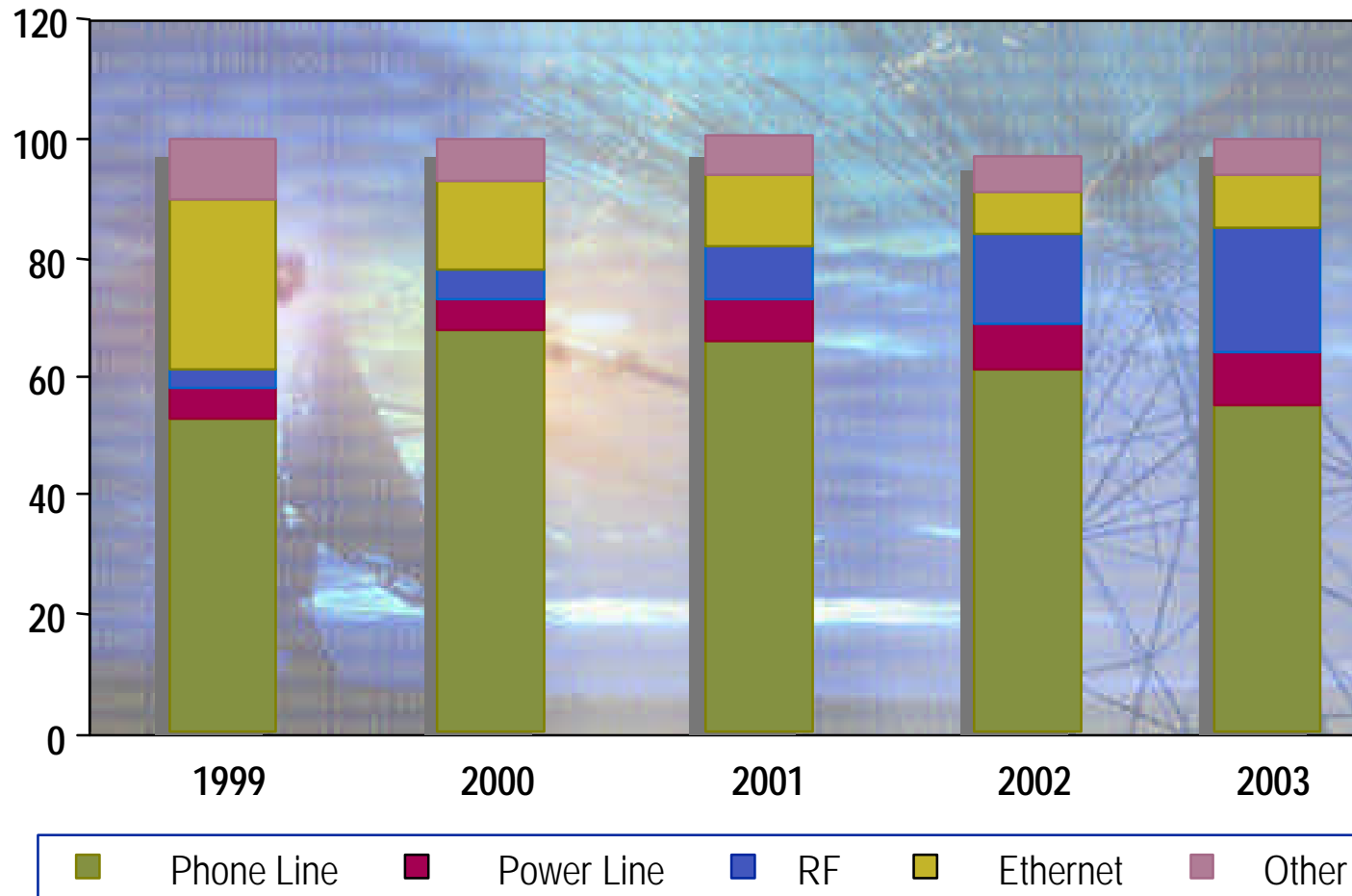
Information Appliances



Home Networking Technologies



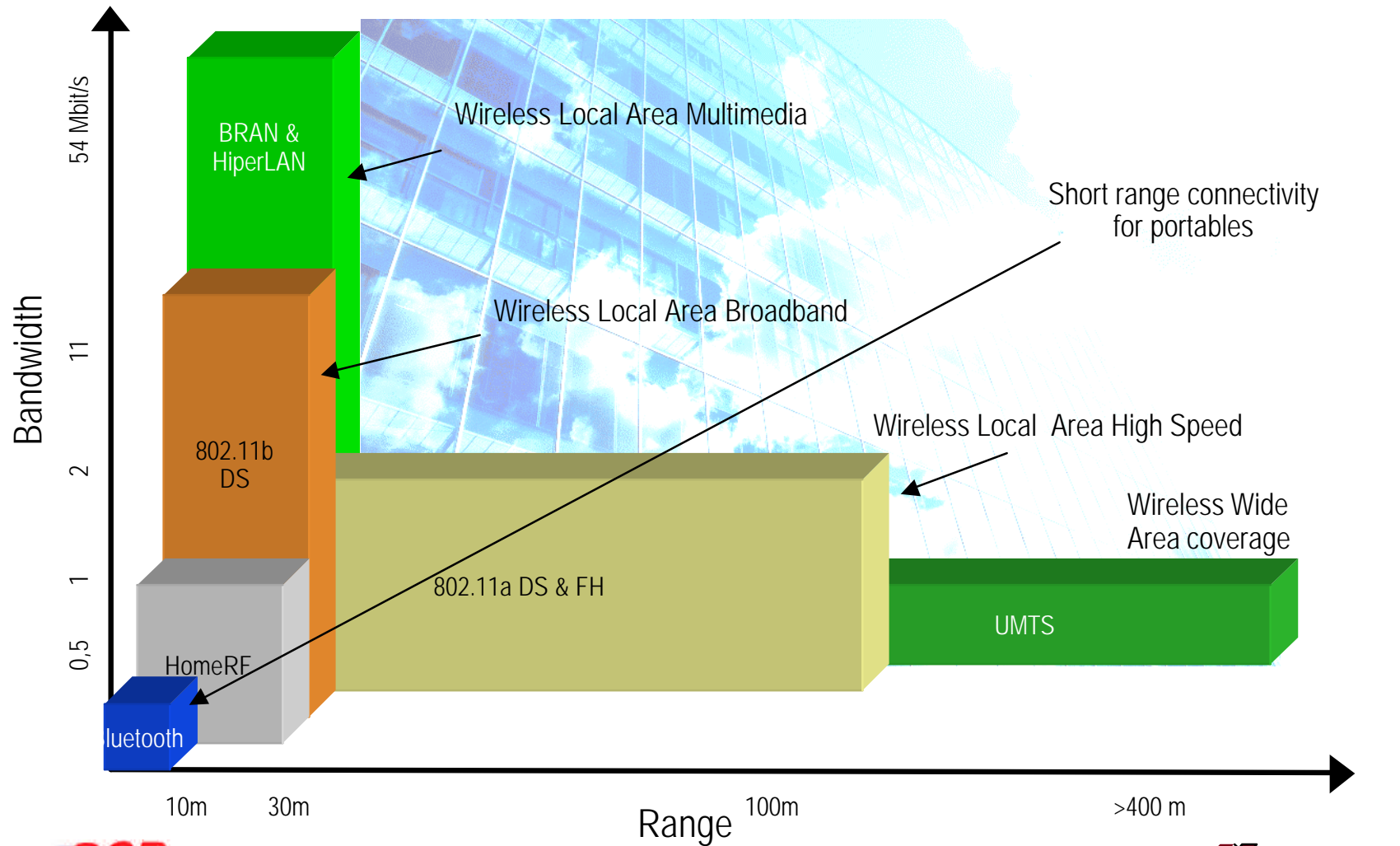
Market Acceptance



Courtesy: Dataquest



Wireless Technologies in Home Networking



Wireless In-Home Networking Technologies

- ◆ Bluetooth & IEEE 802.15
 - Personal area network for data & voice communications
- ◆ HomeRF
 - Home based data & voice transmissions
- ◆ Wireless LAN
 - High-speed wireless connectivity augmenting wired networks
 - IEEE 802.11 (a & b variations)
 - a - 5GHz standard based on OFDM
 - b - 2.4GHz standard based on Ethernet
 - HiperLAN & HiperLAN2
 - 5GHz standard based on OFDM

Bluetooth



- ◆ Short-range wireless data transmission technology - Personal Area Networks
 - Provide a simple module that will allow a wide variety of electronic devices to exchange data electronically over short ranges
- ◆ Low-cost, low power consumption methods of transmitting data without using wires
- ◆ By 2003, Bluetooth market could be worth \$5 billion (SG Cowen)
- ◆ Major industry backing of Bluetooth SIG
 - Ericsson, Nokia, IBM, Intel, Toshiba, Motorola, Lucent, 3Com
 - 2000+ members today

Key Characteristics & Capabilities of Bluetooth

- ◆ Transmits sound and data
- ◆ Used worldwide (standard technology)
- ◆ Ad hoc connection
- ◆ Open environment, but prevents external reception
- ◆ Compact, & able to be installed in a variety of devices
- ◆ Extremely low power consumption
- ◆ Open industry standard
- ◆ Low cost

HomeRF



- ◆ Enable broad range of interoperable consumer devices using RF anywhere in and around the house
- ◆ Led by HomeRF Working Group
- ◆ Technical
 - Low cost and voice support of DECT
 - TCP/IP support of 802.11 for data

HomeRF Origins

802.11
Uses CSMA/CA
Good for Data

DECT
Uses TDMA
Good for Voice

SWAP
TDMA + CSMA/CA

Good for Voice & Data
Optimized for small networks (in home)
Simplified radio & protocol to reduce cost

Wireless LAN



- ◆ Wireless Local Area Networks combines data connectivity with user mobility
 - Implemented as an extension to wired LAN
 - Minimizes the need for wired connections
- ◆ Radio or Infrared waves are used to transmit & receive data over the air
- ◆ Strong popularity in vertical markets for productivity gains
 - Health-care, retail, manufacturing, warehousing, academia
- ◆ Worldwide wireless LAN market
 - More than \$2 billion revenues by year 2000 (Business Research Group)

Phonelines-Based Home Networking



- ◆ In-home networking using existing phone lines
 - Connecting consumer devices such as PCs, TV, fridge, DVD/CD/MP3 players to each other and to the Internet
 - Rated up to 10Mbps
 - Supports up to 500 feet of phone wire between devices connected to RJ-11 jacks
- ◆ Phoneline home networking market outlook (by IDC)
 - In 2000, phoneline-based home networks will account for 34.4% of the installed base
 - By 2004, proportion will grow to 71.8% (a majority) of total home networking market's installed base

Powerlines-Based Home Networking



- ◆ Uses existing power & electric lines in the homes
 - Quite similar to phoneline networks
 - More AC/power sockets/outlets in a home than phone jacks
- ◆ Powerline realities - products run at 0.25 Mbps today
 - Data rates up to 10Mbps are possible, but
 - The greater amount of electrical noise on the line limits practical transmission speeds to much lower values
 - Widely varying transfer response - frequency & attenuation
 - Many different noise impairments at unpredictable times
 - RF jammers (particularly at night)
 - Time delay spread (multipath)
 - Usable bandwidth is not contiguous due to impairments or regulations
 - Channel Adaptation is required to achieve high data rates & reliability

Ethernet-Based Home Networking



- ◆ Known as IEEE 802.3
- ◆ High bandwidth
 - Data transmit rates between 10Mbps to 100Mbps
 - Computers & peripherals are linked using special & dedicated wiring
- ◆ Technology
 - CSMA/CD (Carrier Sense Multiple Access/Collision Detection)
- ◆ Components (such as NIC cards) are of lowest cost compared to other technologies
- ◆ But, requires new wiring!

IEEE 1394 Technology

The A/V Interface of Choice



- ◆ Hardware & software standard for transporting data
 - 100, 200, 400, or 800 Mbps
 - Ideal for audio and streaming video purposes
- ◆ Features
 - Digital interface
 - There is no need to convert digital data into analog and tolerate a loss of data integrity
 - Physically small
 - Thin serial cable can replace larger & more expensive interfaces
 - Easy to use
 - Does not require terminators, device IDs or elaborate set up
 - Non-proprietary - no licensing problem to use for products

FireWire/IEEE 1394 Technology

The A/V Interface of Choice

- Hot pluggable
 - Users can add or remove 1394 devices with the bus active
- Inexpensive
 - Priced for consumer products
- Scalable architecture - may mix 100, 200, and 400 Mbps devices on a bus
- Flexible topology
 - Support of daisy chaining and branching for true peer-to-peer communication
- But
 - Requires new wiring
 - Cable length is limited to about 15 feet between devices

Different Strokes for Different Folks

	Home Automation	Entertainment	Information	Personal Communications	Communication
Devices	<ul style="list-style-type: none"> - Home appliances - Security/safety systems - Utility meters 	<ul style="list-style-type: none"> - TV sets - Set-top boxes - DVD Players - Game consoles - VCRs - MP3 Players 	<ul style="list-style-type: none"> - PCs - Screen phones - Printers - Modems - Routers - Hubs - Scanners 	<ul style="list-style-type: none"> - Mobile phones - Smart phones - Handheld - Laptop - Pagers 	<ul style="list-style-type: none"> - Corded/Cordless telephones - Fax machines
Content	Information on home processes, house environment, remote diagnostics and technical support	Rich multimedia content, electronic programming guides, impulse purchases	Discrete information on external world, shopping for household goods	Information used on the move or requiring instant action: travel, weather, local services, stock market	Information on how to reach people in time and space
Usage Pattern	Communal	Communal	Individual Shared	Individual Personal	Communal or Individual Shared
Connection to Outside World	<ul style="list-style-type: none"> - Power line - POTS 	<ul style="list-style-type: none"> - Cable - DBS 	<ul style="list-style-type: none"> - Cable modem - ADSL - POTS, ISDN 	<ul style="list-style-type: none"> - GSM - Infrared 	<ul style="list-style-type: none"> - POTS
Practical Networking Technology	<ul style="list-style-type: none"> - CEBus - X-10 - LONWorks 	<ul style="list-style-type: none"> - IEEE 1394 (Fire Wire) 	<ul style="list-style-type: none"> - HomeRF - HomePNA - Ethernet 	<ul style="list-style-type: none"> - Infrared - Bluetooth 	<ul style="list-style-type: none"> - POTS - DECT - 900MHz, 2.4GHz

Home appliances have different content, functionality, application, and use different interconnection technologies

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Residential Gateways

Definition; Difference between PC, Set-top Box,
Digital Modems; Market Potential; Purpose &
Value; Different Types

Simple Definition

- ◆ The Residential Gateway is a device that connects or bridges an in-home network to the broadband connection
 - Enables communication & data transfer among networked device in the home & across the Internet
 - Typically combine functions of a router, hub & modem for Internet access & PC connectivity
 - Advanced models
 - Contain PBX-type functionality for advanced telephone capabilities in the home
 - Ability to bring in & route audio, video & networked games

Is it Different than a Cable Set-Top Box?

- ◆ Set-top box
 - Delivers a single signal to a single device like cable TV or PC
 - Limited in its placement
- ◆ RG
 - Designed to distribute a broadband signal to multiple devices throughout the home
 - Flexibility of locating wherever convenient

Could the PC be the Gateway?

- ◆ RG functions such as routing can be performed by a PC that is correctly configured
- ◆ Advantage of using a PC as a RG
 - Existing PC can do the job
- ◆ Disadvantage of using a PC as a RG
 - Difficult to set up
 - PC will slow down when used for any other task
 - If the PC crashes the entire home network goes down

What? A Router In My House!

- ◆ Functions similarly to a router
 - Connects the home Local Area Network (LAN) to the Internet or Wide Area Network (WAN)
 - Manages the interconnections within the LAN
- ◆ Integrate a broadband modem with a router in a single box

Significant Market Potential

- ◆ Fast adoption rate for RGs
 - Because of its capability to distribute broadband access throughout the home to multiple devices
- ◆ RG marketplace
 - US\$8.9 billion by the year 2003 (Cahners In-Stat Group)
- ◆ Market demand for RGs is being fueled by
 - Low cost PCs
 - Increasing number of smart appliances
 - Abundance of online services
 - Increasing mobile lifestyles

Market Potential is Much Bigger

- ◆ Market could grow bigger by
 - Eliminating growth inhibitors
 - Standards delay and confusion
 - Lack of a clear business model
 - Focus on market accelerators
 - Broadband infrastructure is build out quickly to meet the demand for high speed services
 - Government legislation encourages or even mandates RG rollout
 - Creation of new value added services enabled through the RG is realized and demanded by the end consumer

Function

- ◆ Provides broadband connectivity to the home
 - Cable, xDSL, satellite, wireless
- ◆ Provide home networking capabilities
 - Distributes broadband access throughout the home
 - Technologies like Phoneline (HomePNA) or wireless LANs
 - Shared broadband access by multiple devices
 - Customers can use existing phone wiring to simultaneously carry telephone, fax & Internet traffic
 - Users simply plug in PCs (with HPNA adapter), fax machines & telephones to phone jacks
 - Can place phone calls, send e-mail & use Web simultaneously

Home Networking Solutions

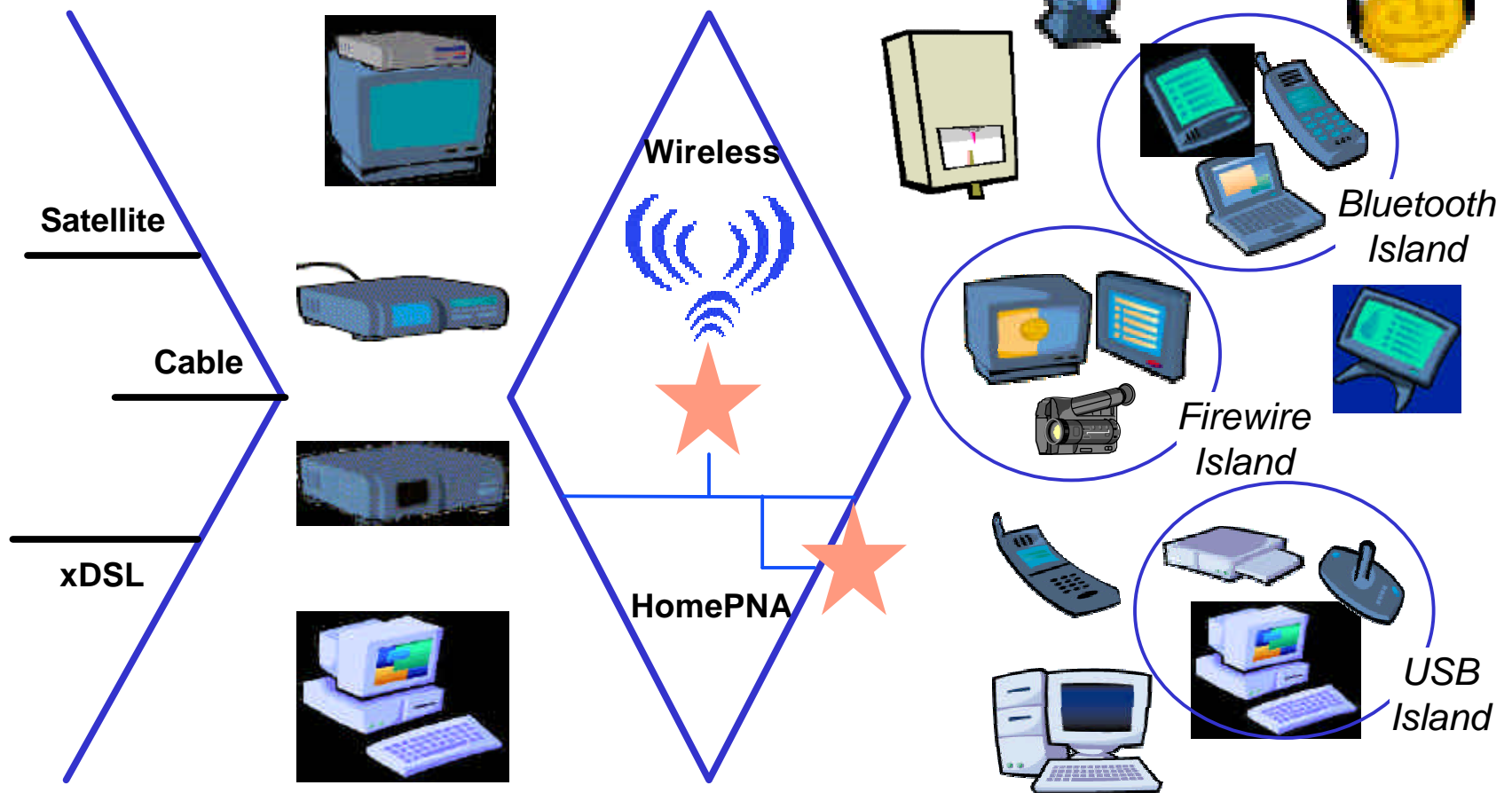
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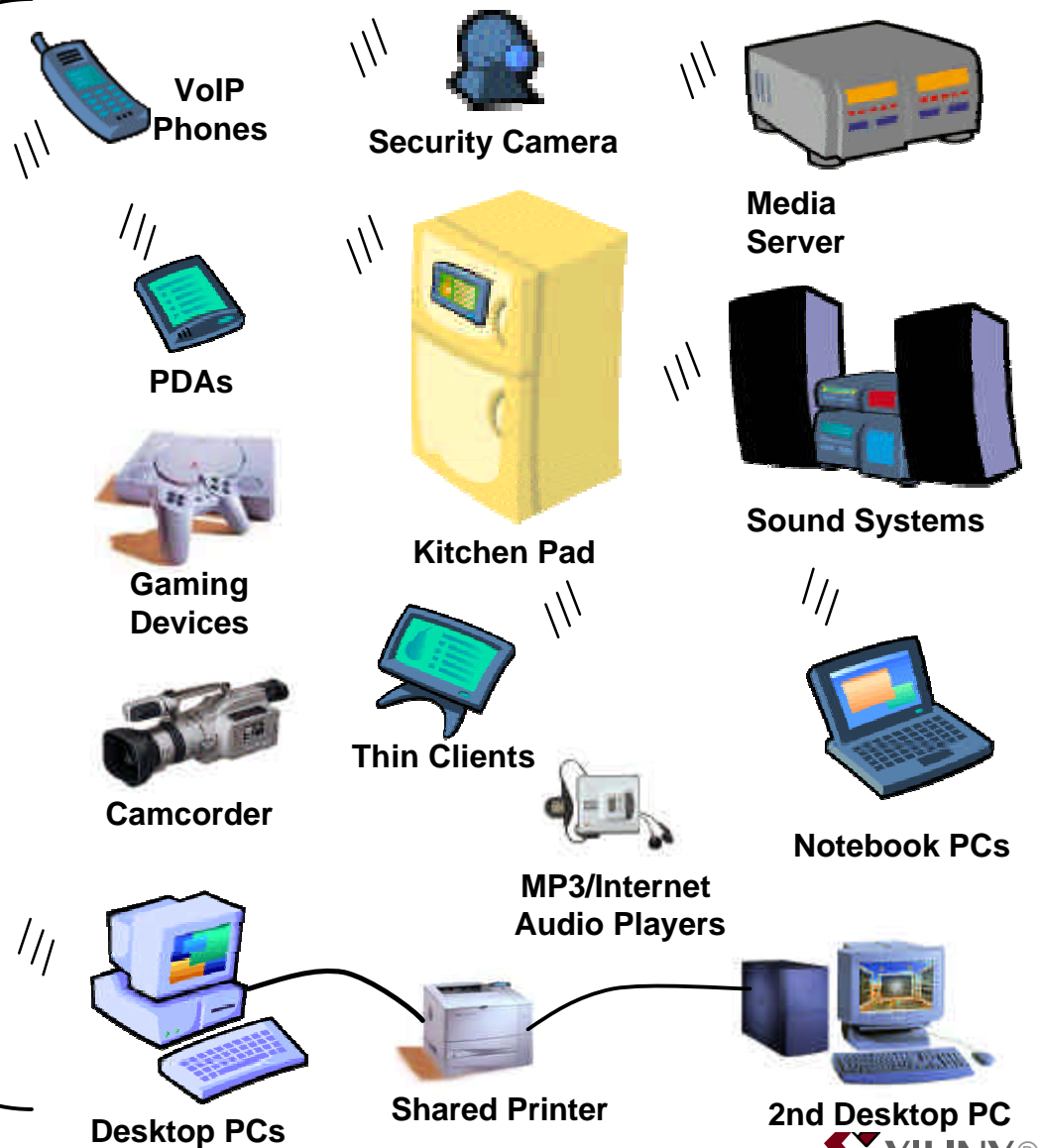
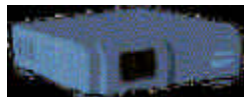
Broadband Gateways

Connected Client Devices



Broadband Residential Gateway Usage

Residential or
Broadband
Gateway



Purpose

- ◆ Provides a unified platform
 - Satisfies all of the mainstream consumer's needs for communications, information & entertainment
 - Strategic technology
 - Centralized access point between the home & outside world
- ◆ WAN-to-LAN interface device
 - Convergence point
 - Bridges the different broadband local loop WAN & in-home LAN technologies
 - Brings bi-directional communications channel to every networked device in the home

Purpose

- ◆ Serves as an access platform for service providers
 - Remote deployment of Internet services to the home
 - Control, query & network administration functions
 - Integrated firewall & security features the RG will facilitate authorized to the home by other third-party service providers such as home health care provider
- ◆ Serves as a technology bridge for integration of sub-network systems
- ◆ Provides more than just simple, basic connectivity
 - Efficient delivery of new services to the home
 - Such as streaming video, multimedia messaging, home management & security

Value Proposition for the RG

- ◆ Broadband player perspective on the RG
 - Takes the “last mile” broadband pipe & extend it to the “last inch”
 - Significantly increases the value of broadband services
 - Distribution to a multitude of intelligent devices instead of having it terminate as a single PC
- ◆ Home network player perspective on the RG
 - Enable all devices on the home network to have high-speed access to the Internet
 - Interconnecting all consumers within the home is valuable, but ability to connect all the consumer devices to the Internet is revolutionary

Basic RG Characteristics

- ◆ Not dependent on PC
 - PC with attached digital modem is the most accounted RG
 - But RGs must operate independent of a PC
 - Incorporate all the intelligence to act as an edge server & router for the home networking
- ◆ Embedded routing or hubbing
 - Will have home networking ports or RF connectivity
 - IP address management & protocol translation
- ◆ High speed (broadband) connection to the Internet for delivering integrated services

Basic RG Characteristics

- ◆ Durability & long life span
 - Reliable & robust hardware
 - Software must be reliable, not susceptible to errors and field programmable
- ◆ Ability to support multiple services throughout the home
 - Simultaneous voice, data & video capabilities
- ◆ Security
 - Secure environment for the delivery of services from a public network such as the Internet
 - May or may not mean a firewall
- ◆ Remote management through the Internet

The Must Have's

- ◆ Security & privacy firewall
 - Supports secure e-commerce transactions, remote home control, & access from authorized service providers
- ◆ QoS supporting a multiple of intelligent devices
 - Different OEMs will make devices that compete for bandwidth
- ◆ Upgrade platform
 - Remote network configuration, device queries, service deployment, software upgrades, etc.

The Must Have's

- ◆ Application server
 - Distributed computing platform for home
- ◆ Multi-layer network bridging
 - Protocol translation and physical interface for multiple home networks (backbone, control, mobility, entertainment, security, etc.)

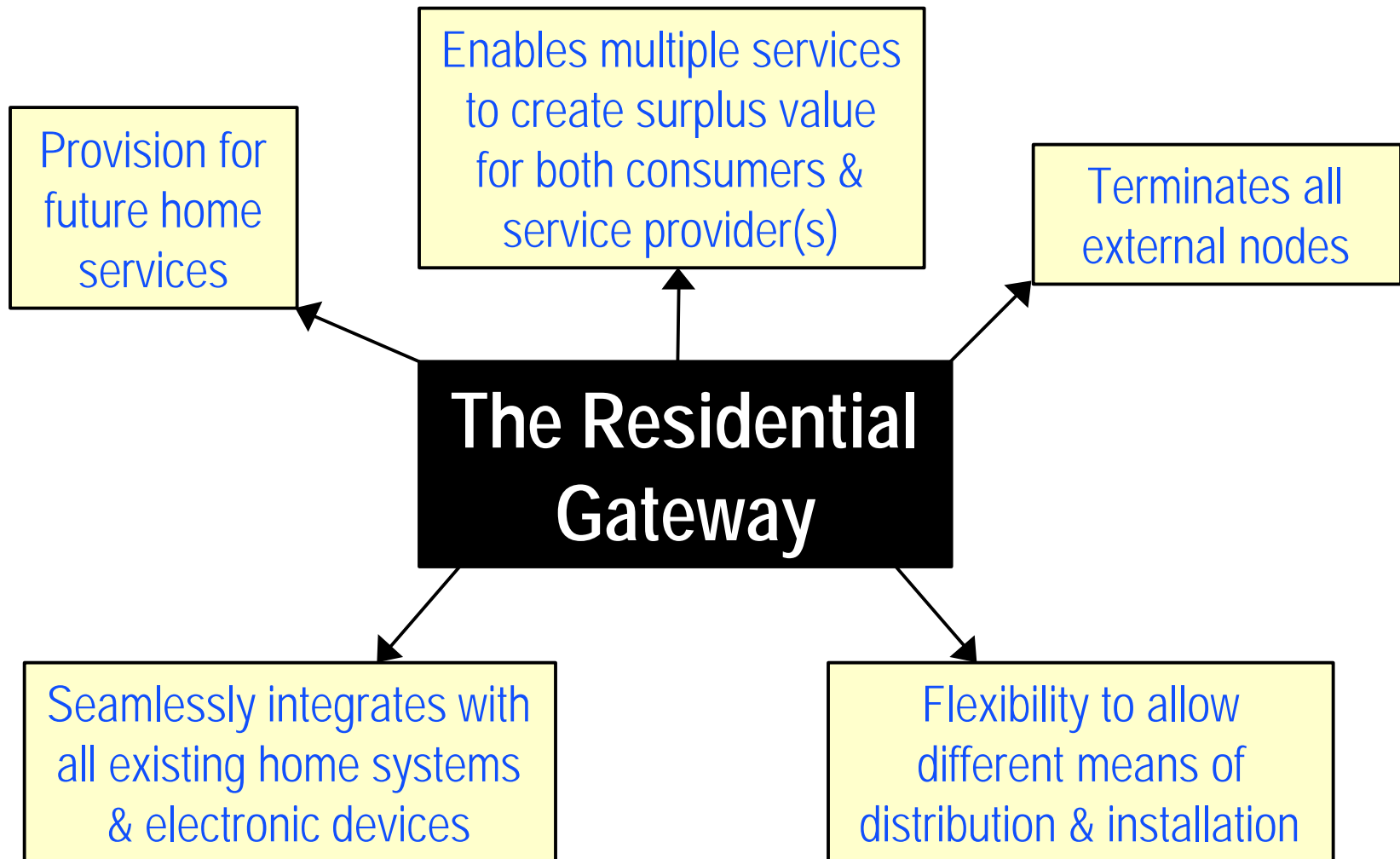


The Different Types

Evolving Product Concept

- ◆ Combine functions of a
 - Digital modem
 - Home networking chipset
 - Processor
 - Other circuitry
- ◆ Assume potential forms
 - Board level product to be inserted in a PC/PC server
 - Product integrated with a cable, xDSL or satellite modem
 - Product integrated with a set-top box
 - Services gateway
 - Stand-alone device potentially attached to the house

The “Perfect” RG



Different Models

- ◆ Broadband centric RGs or digital modem RGs
- ◆ Utility centric RGs or service gateways
- ◆ Set-top box RGs
- ◆ PC-based RGs
- ◆ Gaming consoles
- ◆ Screen phones/Web phones/Internet enabled phones
- ◆ Next generation RGs

Broadband Centric or Digital Modems RGs

- ◆ Broadband termination device that has incorporated the necessary routing functions within one device
- ◆ ADSL or cable termination device with routing capabilities
- ◆ Digital modem that has evolved to incorporate the necessary functionality to be a RG
- ◆ Gateway is sold in conjunction with DSL services
 - Can be partially or completely subsidized
 - Consumer installs the gateway
 - The service provider saves the cost of a truck roll
- ◆ Not dependent upon a PC

Broadband Centric or Digital Modems RGs

- ◆ Built to support one specific home networking technology
 - HomePNA, Ethernet, USB or wireless
 - Future technology advancements require buying another gateway & reconfiguration of the home network
- ◆ Examples
 - 2Wire Inc. - Product: HomePortal
 - Provides support for both HomePNA & HomeRF solutions
 - Platform for PC networking, communications convergence & distributed entertainment content
 - Remotely manageable
 - Cayman ADSL 3220H router/RG
 - Cisco uBR924 Cable router/RG

Utility Centric RG

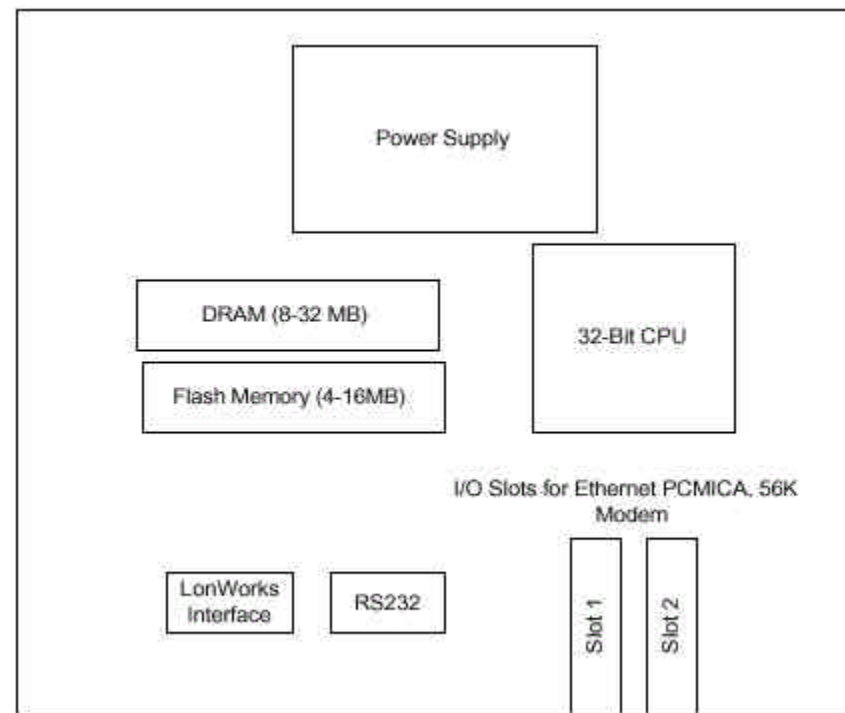
- ◆ The utility/service provider installs the gateway
 - The service provider recovers cost of hardware & installation through provision of multiple services
- ◆ Enables automated meter reading (AMR), energy optimization, management & monitoring
- ◆ e.g.: Coactive Networks - Product: Coactive Connector
 - Communications with home devices over PLC & TP
 - Strong supporter of LONWORKS & OSGi
- ◆ e.g.: Scientific Atlanta - Product: Maingate

Digital Set-Top Box

- ◆ Has home networking ports, high speed WAN connection & routing capabilities
 - Contains high speed digital modem
 - Today they broadcast TV into the home
- ◆ Example
 - Next Level Communications (product: N3 RG)
 - Pace Micro Technology
 - Scientific Atlanta (product: Explorer 2000)
 - General Instrument-Motorola (product: DCT-5000+)
 - Philips

PC-Based Architecture RG

- ◆ Products will include x86 processor & have an ISA or PCI bus
- ◆ Example:
 - Ericsson's E-box
 - IBM's RG



Ericsson PC Architecture
E-Box Block Diagram

Gaming Consoles

- ◆ Gaming platforms
 - Multi-player gaming requires the need for Internet access
- ◆ Products
 - Sega Dreamcast
 - Built in 56k modem
 - Connects to Dreamcast network to allow for online gaming
 - Giving away hardware in exchange for one-year service
 - Sony PlayStation2
 - Future broadband connections enable Sony to begin e-distribution business such as movies, Internet access
 - Nintendo Dolphin
 - Microsoft X-box

Screen Phones or Web Phones or Internet Enabled Phones

- ◆ Fully integrated, high end telephones with built-in touch LCD screens
 - Provide convergence of voice, video & data communication
 - Users can make phone calls, use email, & receive limited information from the Internet
- ◆ Companies & products
 - Cisco Systems, Sun Microsystems, Samsung, Alcatel, Nortel, Uniden, Lucent, Ericsson, IBM, Nokia (product: 9110 Communicator), Big Planet (product: iPhone 2050)



Next Generation/Multi-Service RGs

- ◆ These devices do not exist today but will evolve based on products available today
- ◆ Features
 - Modular in design
 - Multiple WAN termination of media types such as wireless, xDSL or cable supported
 - Multiple LAN/home networking technologies supported
 - Less apt to becoming obsolete with future technology changes
 - Deliver telephony/voice services
 - Easier to set up
 - Remote management is possible

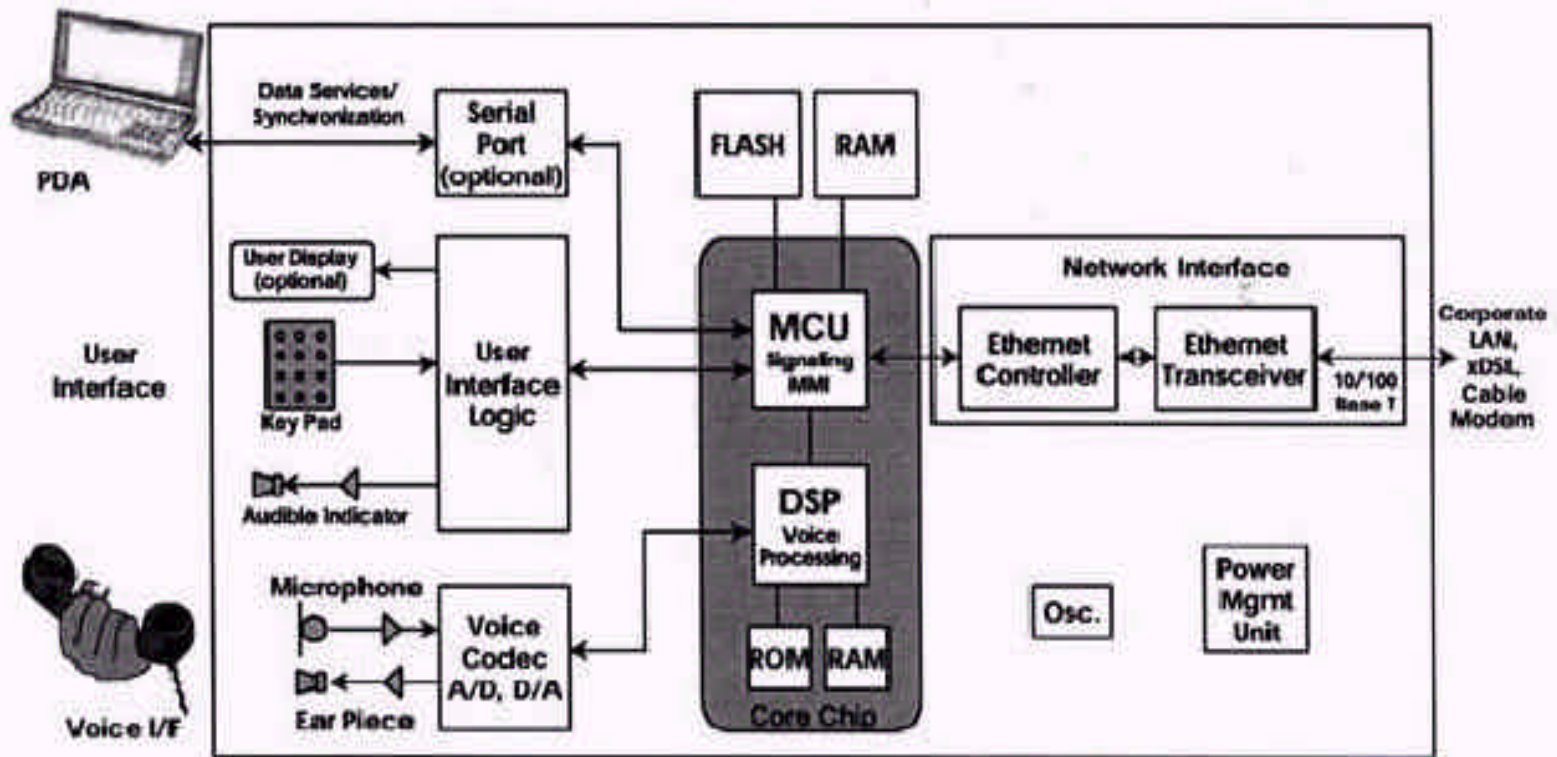


Internet Telephony Technology

What About Voice & Video?

- ◆ RG is evolving into being the central entry & control point for voice, video & data
 - Earlier RG implementations will support switched voice over regular POTS lines
- ◆ Reliable delivery of packetized voice & video requires
 - Delivery of equipment supporting standards like H.323
 - H.323 is the ITU standard for delivering voice & video content over packet oriented, non-circuit networks like the Internet
- ◆ RG should be able to handle low latency traffic through
 - Gradual adoption of H.323 standards
 - Evolvment of semiconductor & software technology

IP Telephony Within the RG



Block Diagram of Internet Telephony Device Showing The Semiconductor Content for the IP Telephony Portion of the RG

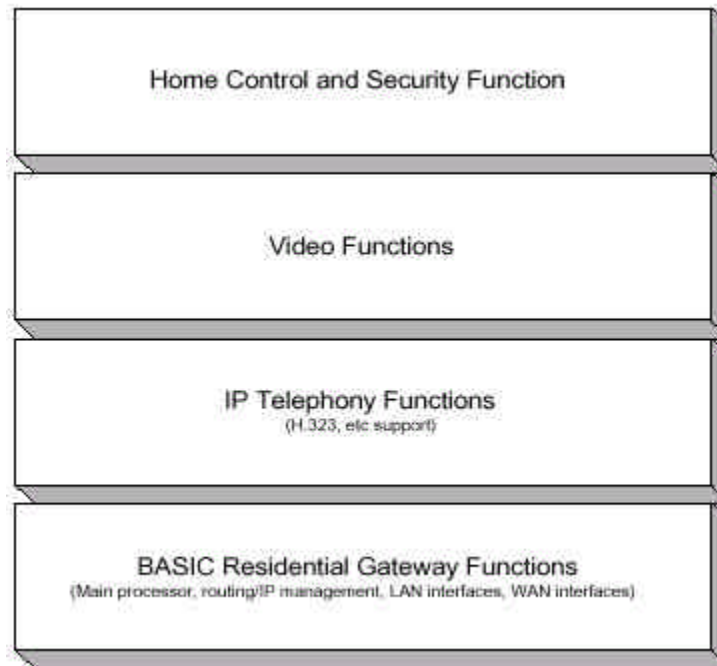
Source: Telogy

911 Support

- ◆ Delivering voice service over a RG must guarantee emergency 911 services
 - Normal POTS service over a simple telephone device derives its power from RJ-11 phone connections
 - Cable telephony providers & others not using POTS service must ensure delivery of lifeline support in times of power outages

Other

- ◆ “Stackable” type approach
 - Allows ability to add different functionality to the RG
 - Can be realized in a physical configuration
 - Each box is physically stacked in one location or logical configuration where these devices make up a RG utilizing an internal home networking data bus such as copper wiring utilizing HPNA technology



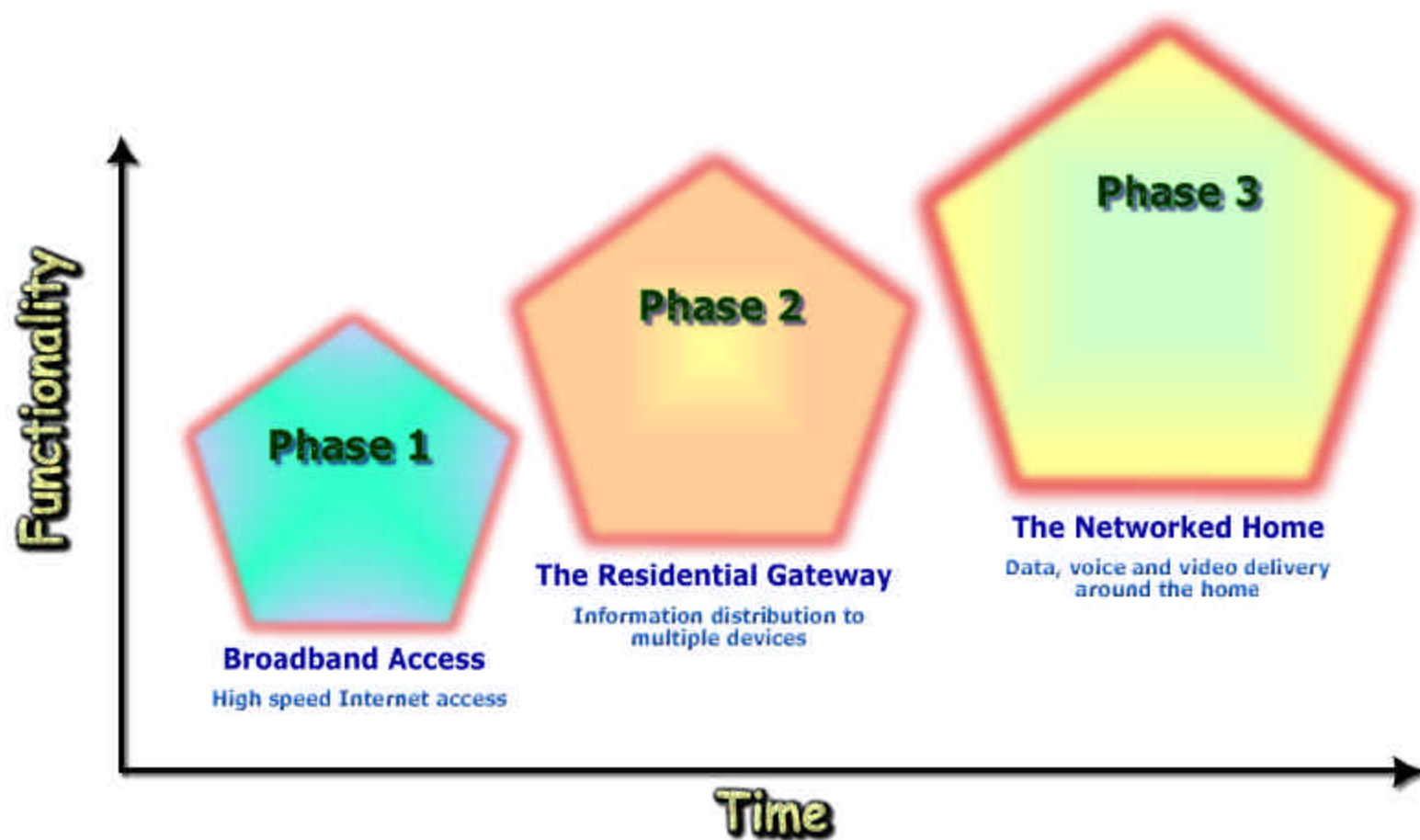
Agenda

- ◆ Introduction & state of the market
- ◆ The complete home networking solution
- ◆ Residential gateways (RGs) - definition, purpose & types
- ◆ Phased deployment of RGs
- ◆ Consortiums
- ◆ RG solutions available today
- ◆ Xilinx solutions for RGs
- ◆ Summary



Phased deployment of RGs

RG Deployment - The Incremental Change



First Generation RGs

- ◆ These are not IP based devices & have low bandwidth
- ◆ Digital set-top box RGs
 - Broadcast TV into the home
- ◆ Utility-centric RGs
 - Enable automated meter reading (AMR), energy optimization, management & monitoring
- ◆ PCs
- ◆ Gaming consoles

Second Generation RGs

- ◆ Devices that bridge one WAN pipe to one LAN connection
- ◆ Configurations are digital modems connected to a PC or stand alone devices with the intelligence to handle all of these functions without the aid of a PC
- ◆ Conduct majority of routing functions & IP address mgmt
- ◆ Broadband access termination devices with integrated LAN hubbing routing functionality
 - Example: Cayman's ADSL 3220H router/RG
 - Example: General Instruments-Motorola's DCT 5000+ Advanced Interactive Digital Consumer Terminal

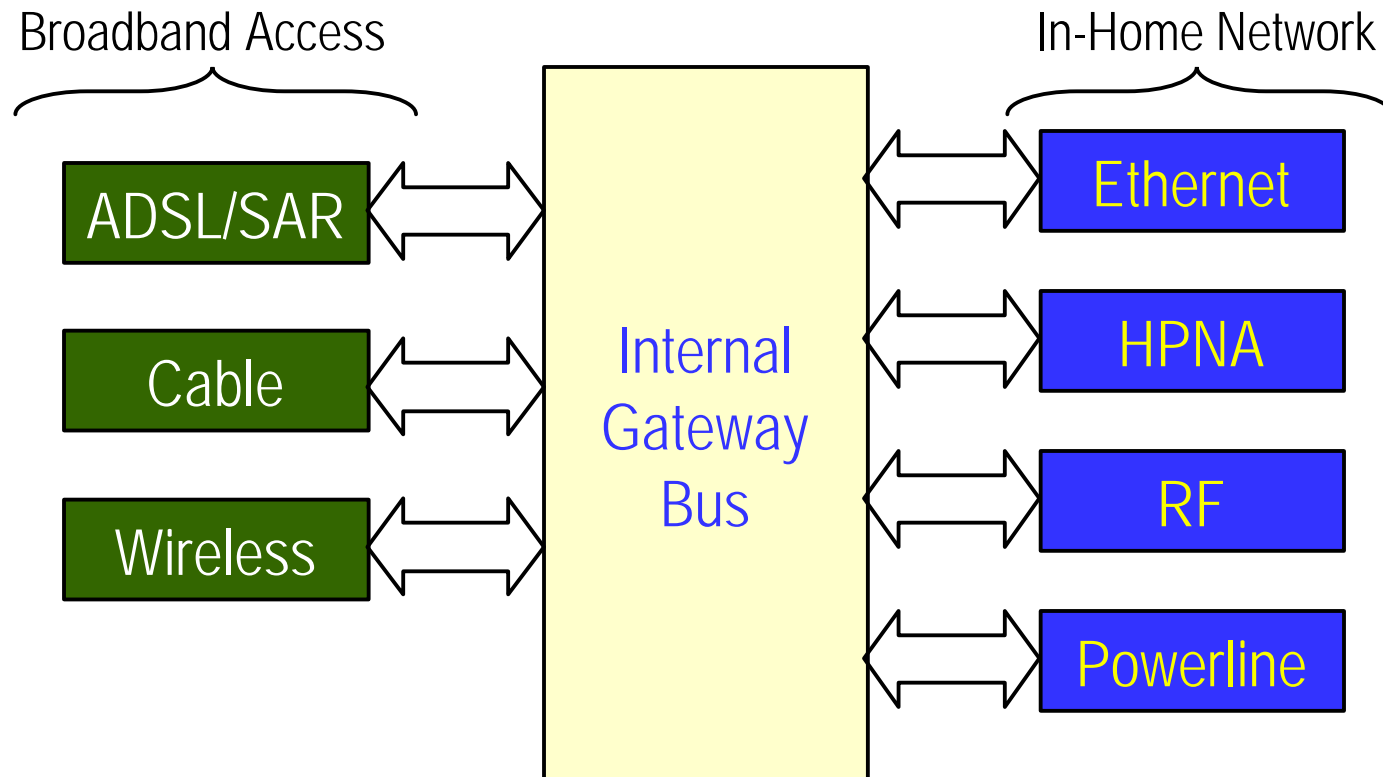
Second Generation RGs

- ◆ PC-based architecture RG
 - Example: Ericsson's E-Box
- ◆ Set-top box RG
 - Has the necessary home routing functionality
 - Example: Next level Communications N3 RG
- ◆ Smart phones
 - Example: Global Converging Technologies or Home Wireless Networks, Cisco, Alcatel, Nokia, Nortel, Ericsson
- ◆ These devices are targeted by service providers & equipment OEMs for wide scale deployment as RGs in the next 2-3 years

Third Generation RGs

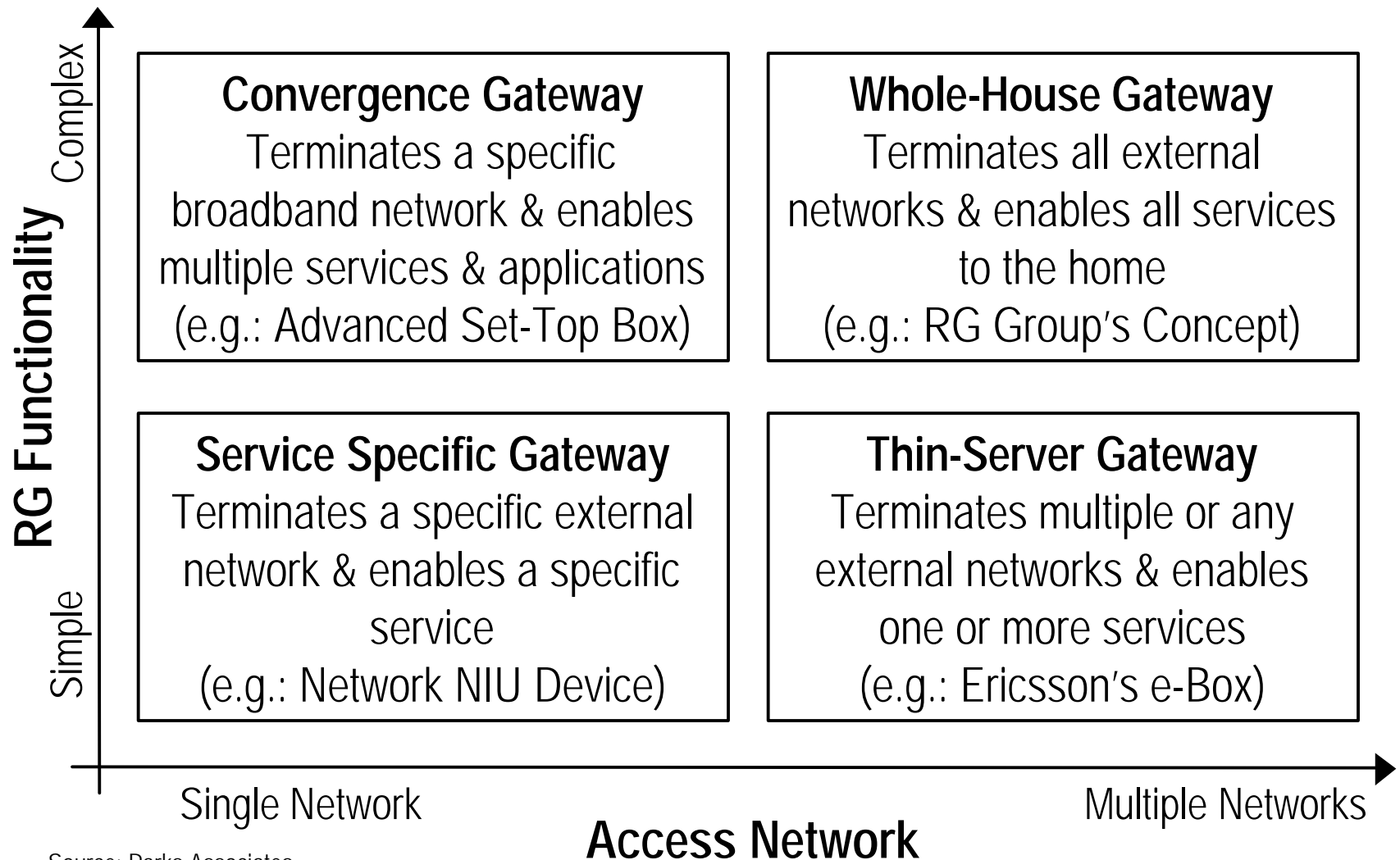
- ◆ Will have capabilities to terminate several LAN & WAN types
 - Multiple types of WAN connections (wireless, DSL, cable)
 - Multiple LAN connections (Ethernet, RF, HPNA, powerline)
- ◆ More expensive given the high degree of modularity
- ◆ Will be owned by the consumer
 - Service providers do not inherently share CPE equipment
 - Unless channel & pricing model changes this is not realistic
- ◆ Example
 - Sharegate's RG

Third Generation RGs



Conceptual 3rd Generation RG Supporting
Multiple WAN & LAN Interface

RG - Classification Model



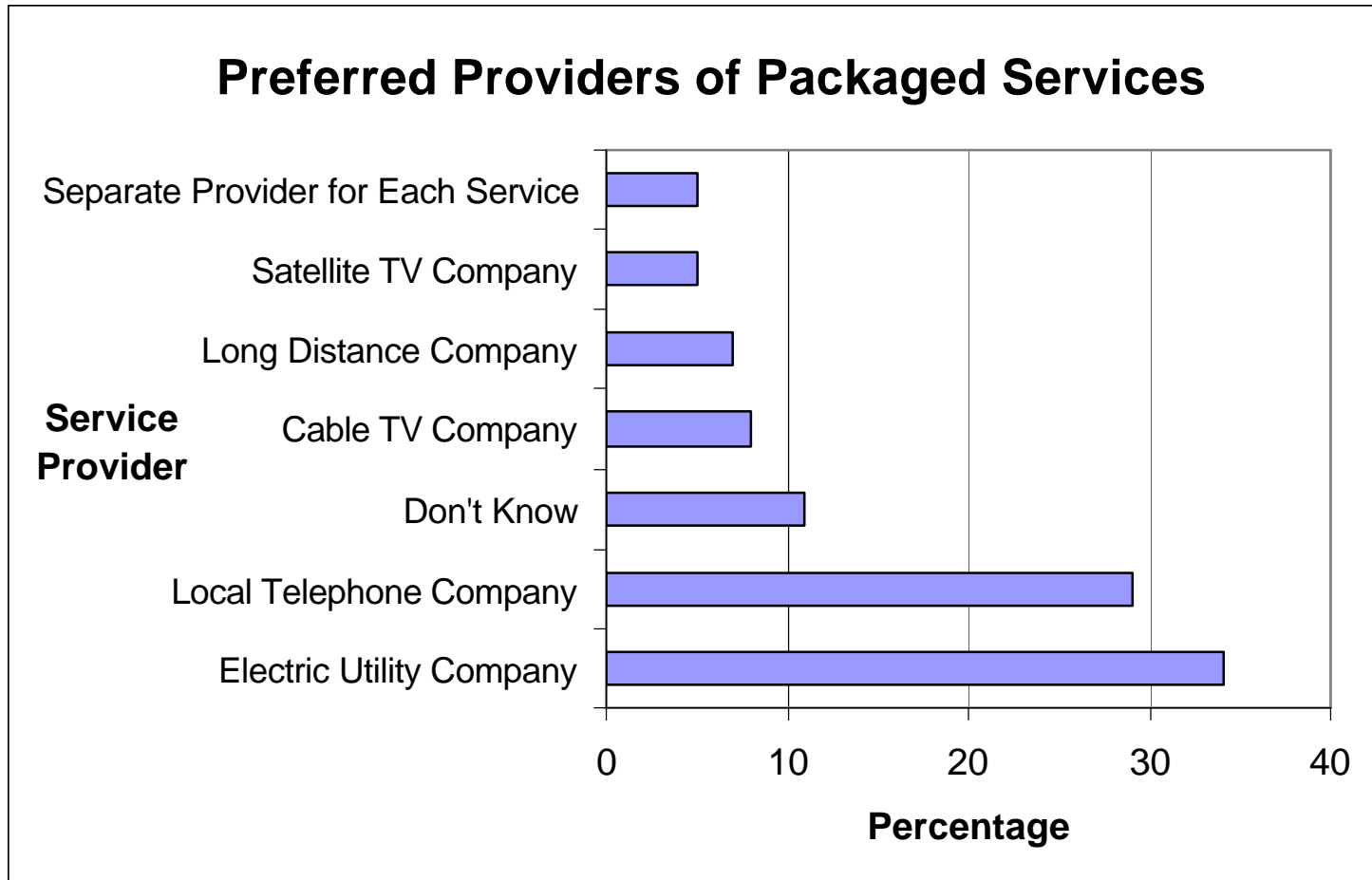
Source: Parks Associates



Early Products

- ◆ First generation products are already shipping
 - Products available from IBM, 2Wire, Panja
 - Began shipping in late 1999
 - Distribute broadband connectivity throughout the home via phoneline, RF & powerline
- ◆ Initial focus
 - Connecting & sharing high-speed Internet, phone services & networking among PCs and computer peripherals

Preferred Provider for Bundled Services



Source: Parks Associates



Drivers to RG Deployment

- ◆ Service providers expanding into integrated services
 - Voice, cable & wireless industries are moving to expand their market opportunity beyond their traditional service model
 - Providing multiple services over one broadband connection
 - RG provides the ability to enable multiple services
 - Providing non-native services through the access network
- ◆ Internet
 - Massive influence on business & consumers
 - IP bits will one day flow around the house in applications such as entertainment, home automation, security
 - RG will be the device controlling the flow of the bits between the home networking nodes & Internet

Drivers to RG Deployment

- ◆ New market opportunity for hardware equipment & silicon vendors
- ◆ Smart home construction
 - Incorporating structured wiring into the homes makes them smarter homes
 - Requires an RG that manages the network & controls the access to devices for the external network
- ◆ Low cost PCs
 - Leveraging one Internet connection for multiple PCs

Drivers to RG Deployment

- ◆ Widespread deployment of home networking
- ◆ Always-on broadband connection
 - Necessary for security & home automation services
 - Transforms the Internet into a viable broadcast advertising medium
- ◆ New entertainment options/applications
 - Interactive TV or intermingling of Internet & TV broadcasting will result in new entertainment & advertising models
 - Digital TV roll out will result in the demand for new specialized broadcasts & increase in channel capacity
- ◆ Remote monitoring

Hurdles to RG Deployment

- ◆ Unclear ownership/economic model
 - Standards
 - Cost
- ◆ Current services are reliable & cheap
 - Service providers must compete against their legacy services and brands
 - POTS, cable & satellite service is reliable & cheap
- ◆ Support issues
 - Service providers need to enable remote support & diagnosis
 - Limit the end-user interaction

Hurdles to RG Deployment

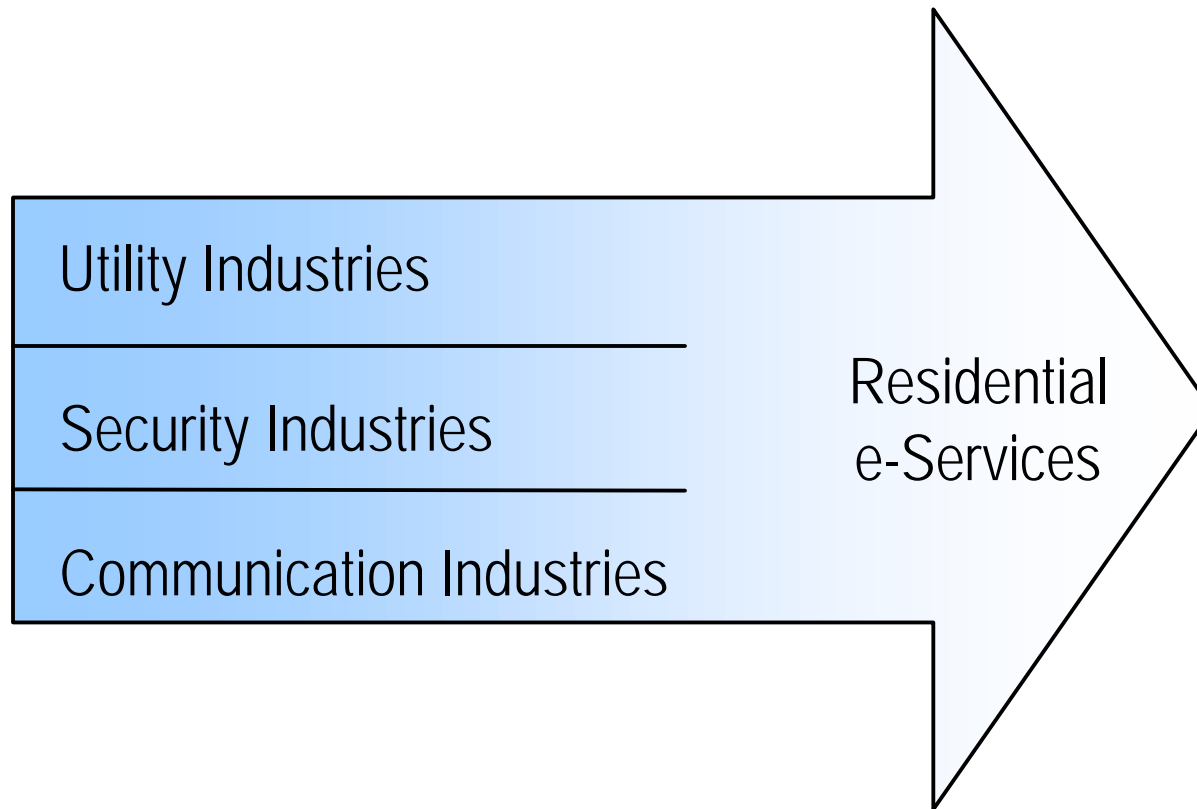
- ◆ Immature technology
 - Different home networking technologies are in different stages of maturity
 - Phoneline networking is most widespread
 - Lot of work needs to be done at the physical connection layer & above
 - Microsoft, Sun & others continue to create separate software & APIs to simplify connectivity
 - VoDSL & Voice over cable are still immature compared to the reliable switched voice



Enabling Electronic Services

Services Gateway - Concept is being enabled by network operators or service providers (SP) such as telephone operators, ISP, cable TV operators, utilities

Convergence of Residential Service Industries



Drivers of the e-Services Market

- ◆ Opportunities are being created for network operators to provide e-Services to residential users
 - The networked home allows incumbent & new players to provide a range of advanced value added services
 - Differentiate themselves from the competition
 - Managing customer relationships
 - Shift from owning & maintaining infrastructures
- ◆ Technology & industry deregulation
 - Rapidly changes the way companies addressing the residential market define & conduct their business

Emerging e-Services

Business opportunity for service providers - Bundling of the following e-Services types such as communication, entertainment, security services, energy service, home automation & home care

- ◆ Communication & entertainment
 - Shared Internet access
 - PC, TV, Web phones, gaming consoles
 - Ability to network multiple devices in the home
 - New telephony services such as IP telephony
- ◆ Security services, home automation & control
 - Facilitate new & more advanced services
 - Remote monitoring & control through standard Internet browser or mobile phone

Emerging e-Services

- ◆ Energy services
 - Key drivers - Deregulation in the energy industry
 - e-Services create new revenues as prices & margins fall
 - Secure customer loyalty on a huge new market
 - Prevent new entrants from highly competitive industries like banking & retail to develop customer relationships
 - Automatic meter reading (AMR)
 - Customers in the same local distribution network start buying energy from different suppliers
 - Need arises to measure hourly consumption by consumer
 - Benefits in network optimization, load balancing & outage detection for distribution companies

Emerging e-Services

- ◆ Home automation
 - Ease of use & penetration of network-enabled devices
- ◆ Home care
 - Key drivers
 - Aging population in developed countries around the world
 - Desire to bridge increasing geographical distances
 - Providing elderly & physically challenged persons with security & monitoring services
 - Providing communication services such as home shopping & video telephony

Requirements of an e-Services Infrastructure

- ◆ New e-service infrastructure must use existing technologies & standards
 - Complement & build upon current solutions
- ◆ Flexible, open & modular infrastructure
 - Accommodation of a range of communication protocols
 - Allow individual components rather than entire solutions to be replaced as new technologies are introduced
- ◆ Consumers should not have to administer any part of the infrastructure
 - Professional & remote system management for operation & maintenance

Requirements of an e-Services Infrastructure

- ◆ Edge servers should bridge the public & local networks
 - Run local applications, store information, control & protect devices
- ◆ Services should be implemented as distributed applications
 - Using extremely powerful & complex edge servers can be avoided by executing complex services over several infrastructure nodes
 - Increases technical life & reduces cost of edge servers

Requirements of an e-Services Infrastructure

- ◆ Consumers should be able to access services & information through different kinds of client
 - Edge server should adapt presentation of information to type of client terminal in use
 - “Fat” clients
 - Workstations & PCs
 - “Thin” clients
 - Mobile phones, PDAs, pagers

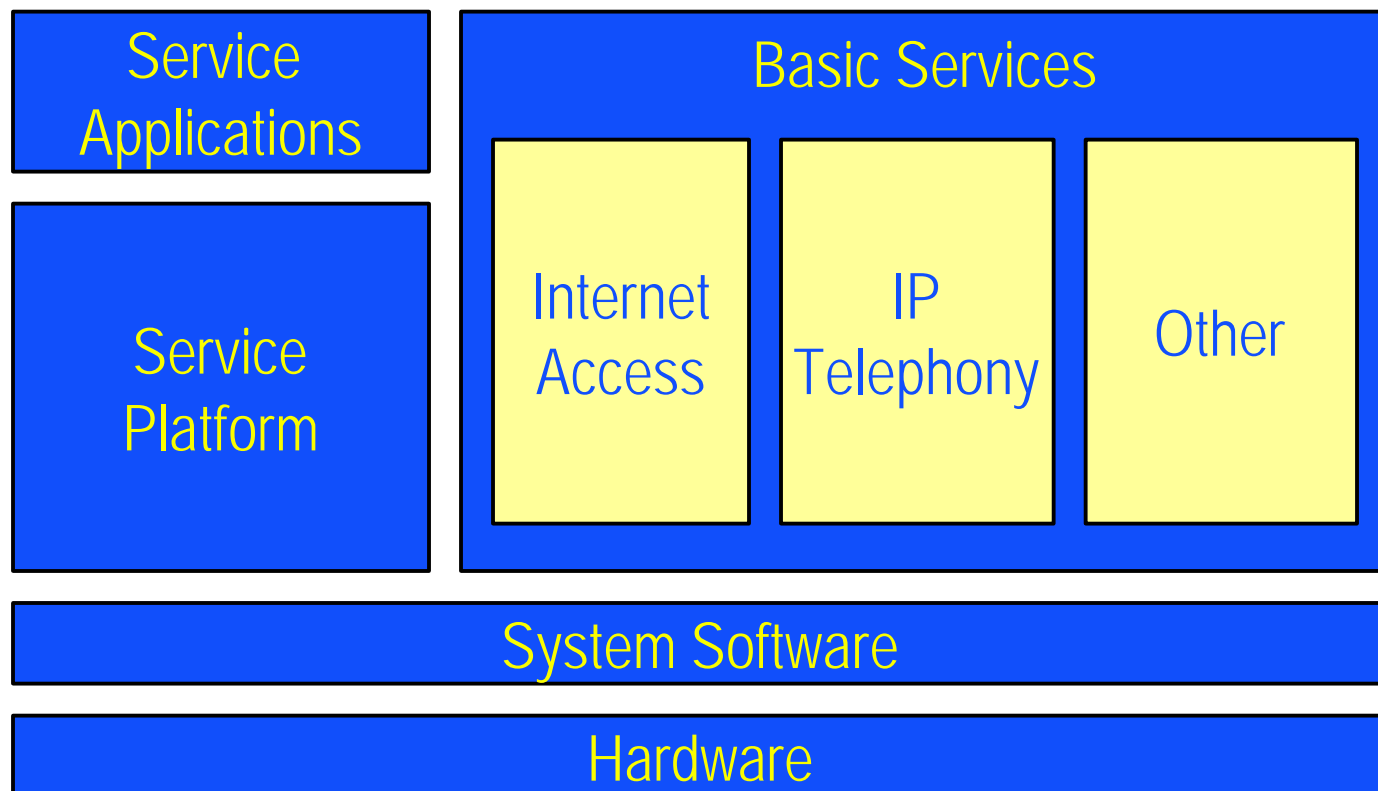
Consumer Requirements of e-Services

- ◆ Reliability
 - Mission-critical services such as security & energy management require higher reliability
 - Unlike PC crashing is tolerable by most people
- ◆ Security
 - Consumers do not tolerate invasion of privacy or hacking into mission-critical services by strangers or neighbors
- ◆ Simplicity
 - Services must be simple to install & intuitive to learn & use
- ◆ Utility
 - Home services must provide an obvious consumer value

Service Provider (SP) Requirements

- ◆ Integrity
 - Infrastructure must allow different SPs to share infrastructure without adversely affecting each others services
- ◆ SPs must have flexibility in defining their business model
 - While being able to derive cost synergies from sharing the infrastructure
- ◆ Future proof
 - Easy to modify & upgrade services on existing infrastructure & require minimal consumer involvement
- ◆ Reliability
 - Consumers expect same levels of reliability for critical services as the telephone system

Services Gateway - Architecture



Services Gateway - Architecture

- ◆ Hardware

- 32-bit CPU
- DRAM, Flash memory, SRAM
- External interfaces: RS232, IEEE 1394
- I/O card slots
 - Support to 10BaseT Ethernet, xDSL modem, 56K modem

- ◆ System software

- OS
- Drivers for external & local network access
- Server components
 - Web servers, WAP (wireless application protocol) servers, DNS (domain name servers)
- Java virtual machine (JVM)

Services Gateway - Architecture

- ◆ Basic services
 - Services that are basic in the business model & offers technical advantage both in performance & cost
 - Internet access
 - IP telephony
- ◆ Service platform
 - Applications that implement services which can be downloaded, installed or removed
 - Permits remote life-cycle management of service applications
 - Typically fulfills the role of a gateway between servers in the external network & devices in the local network

RG - A New Paradigm in Service Provision

- ◆ The world of the 'Service Provider' has traditionally ended at the edge of the house
- ◆ Service providers envision RGs to be
 - Delivering traditional & new value-added services to the home
 - Creating the desire to do more, but also bearing the burden of doing more
- ◆ New issues
 - Who owns the gateway?
 - Who pays for the gateway?
 - Who installs & maintains the gateway?

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Industry Initiatives

OSGi, UPnP, Jini, HAVi, DVI, USB 2.0,
TIA TR41.5, WG1



OSGi

www.osgi.org



OSGi

Open Services Gateway Initiative

Existence

- ◆ Founded in March 1999 by 15 companies
 - Industry group being led by over 60 companies
 - Sun, Ericsson, IBM, Nortel, Oracle, Philips, Alcatel, Motorola, Lucent, Toshiba, Cisco, Nokia, Sony, Siemens, TI
- ◆ Goal
 - Standardize efforts
 - Because a wide array of devices will be needed to connect into the RG
 - Creation of an embedded server
 - To connect the external Internet to internal clients
 - Provide a host of Internet-based services like health, energy monitoring, security, home control, information, entertainment, gaming

Technology

- ◆ Open industry standard
 - Develop specs for RGs API & physical-layer bridging features
 - APIs provide interoperability with HPNA & UPnP devices
 - OSGi is leveraging existing Java standards, such as Jini
- ◆ Enable the connectivity & management of entirely new categories of smart devices
 - Service gateways will include product categories
 - Such as set-top boxes, cable modems, routers, residential gateways, alarm systems, energy management systems, consumer electronics & PCs
- ◆ First spec released at CONNECTIONS 2000 in May 2000

Key Benefits

- ◆ Platform independent
 - OSGi APIs can be implemented on a wide range of hardware platforms & OS
 - Allows capability to tailor the services gateway to unique needs of a particular market
- ◆ Application independent
 - Defines common implementation APIs
 - Suitable for a variety of applications in different markets
 - Focussed on RG market
 - Moving into telematics applications, embedded PDAs & cell phones, PCs & other consumer devices

Key Benefits (contd.)

- ◆ Secure
 - Spec incorporates various levels of system security features
 - Digital signaling of download modules
 - Fine-grained object access control
- ◆ Hosting multiple services
 - Different providers on a single services gateway platform
 - Set of Java-based APIs provide just-in-time value added services while allowing the RG to become a service distribution, integration & management point in SOHO & residences
 - Allows flexibility for offering a wide array of services to customers

Key Benefits (contd.)

- ◆ Multiple local network technologies
 - Variety of wired & wireless, data & audio-video transport standards are emerging
 - OSGi spec is purposefully designed to complement & enhance local network & device attachment technologies
 - Bluetooth, HAVi, HomePNA, HomeRF, IEEE-1394, LonWorks, powerline communication systems, USB, VESA, Ethernet, 802.11, wireless systems, & other local network technologies
- ◆ Multiple device access technologies
 - Support for both UPnP (Universal Plug and Play) & Jini as part of device access API
 - Technologies let users control devices from many different places & diverse client devices

Key Benefits (contd.)

- ◆ Coexistence with other standards
 - Complement emerging standards in local device connectivity & in wide-area network access
 - Compatible with physical local transports
 - Bluetooth, HomePNA, HomeRF, USB
 - Compatible with several different logical device access technologies
 - Jini, UPnP
 - OSGi RGs can use narrowband Internet access as well as faster broadband (DSL & cable modem) technologies
 - Compatible with market-specific & network management schemes
 - DOCSIS & SNMP

OSGi architecture

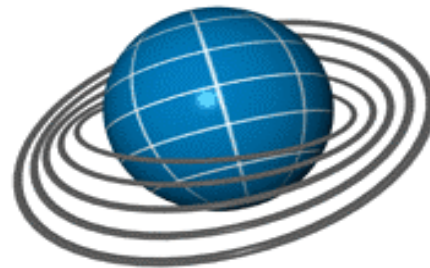
- ◆ OSGi software stack is based on Sun's Java Virtual Machine
- ◆ Design based on requirements from several new markets & businesses
- ◆ Initial primary focus: Residential Gateway
 - Concentrate on Java based APIs for the RG
- ◆ Next Steps
 - Creating reference specifications for tying in home networking protocols
 - Lead to: Defining service protocols for service gateways
 - Applications in telematics, commercial, enterprise, industrial

OSGi Requirements for Every RG

- ◆ User installable
- ◆ Remotely configurable
- ◆ Supports multiple home networking technologies
- ◆ Firewall & VPN (Virtual Private Network) capability
- ◆ Supports both versions of ADSL
 - G.lite & full rate G.dmt
- ◆ Controllable through a Web Browser
- ◆ Support multiple services like data, voice & entertainment

UPnP

Universal Plug and Play



Home API Working Group

- ◆ Primary goal of Home API
 - Simplify & reduce the cost of developing software applications
 - Enhance users' entertainment, security, comfort & convenience through the intelligent use of controllable home devices
 - Protocol-independent
 - Applications using Home API are shielded from differences in the underlying networks and protocols used to communicate with home devices
 - Provide API's above the protocol layer in a Windows (Microsoft) environment
 - Facilitate the provision of services to devices using different protocols
 - Provide services to applications running on Home API platform

Home API Working Group

- ◆ Set of software services and programming interfaces
 - Enable applications to discover and control home devices such as TVs, VCRs, cable boxes, security systems, lights and climate control systems
- ◆ Efforts primarily led by Microsoft & Intel
- ◆ Merged its efforts with those of the UPnP
 - Ensures a unified specification for development of home control software and products
 - Announced on Dec 1, 1999

UPnP Forum

- ◆ Open, industry initiative
 - Designed to enable easy and robust connectivity among stand-alone devices and PCs from many different vendors
 - More than just Plug and Play (PnP)
 - Extends PnP principles of simplicity & automation to embrace all device connections
 - Implemented using open hardware & software standards & protocols
- ◆ Working committees are set up in specific areas of domain expertise

Backed by Microsoft Corp.

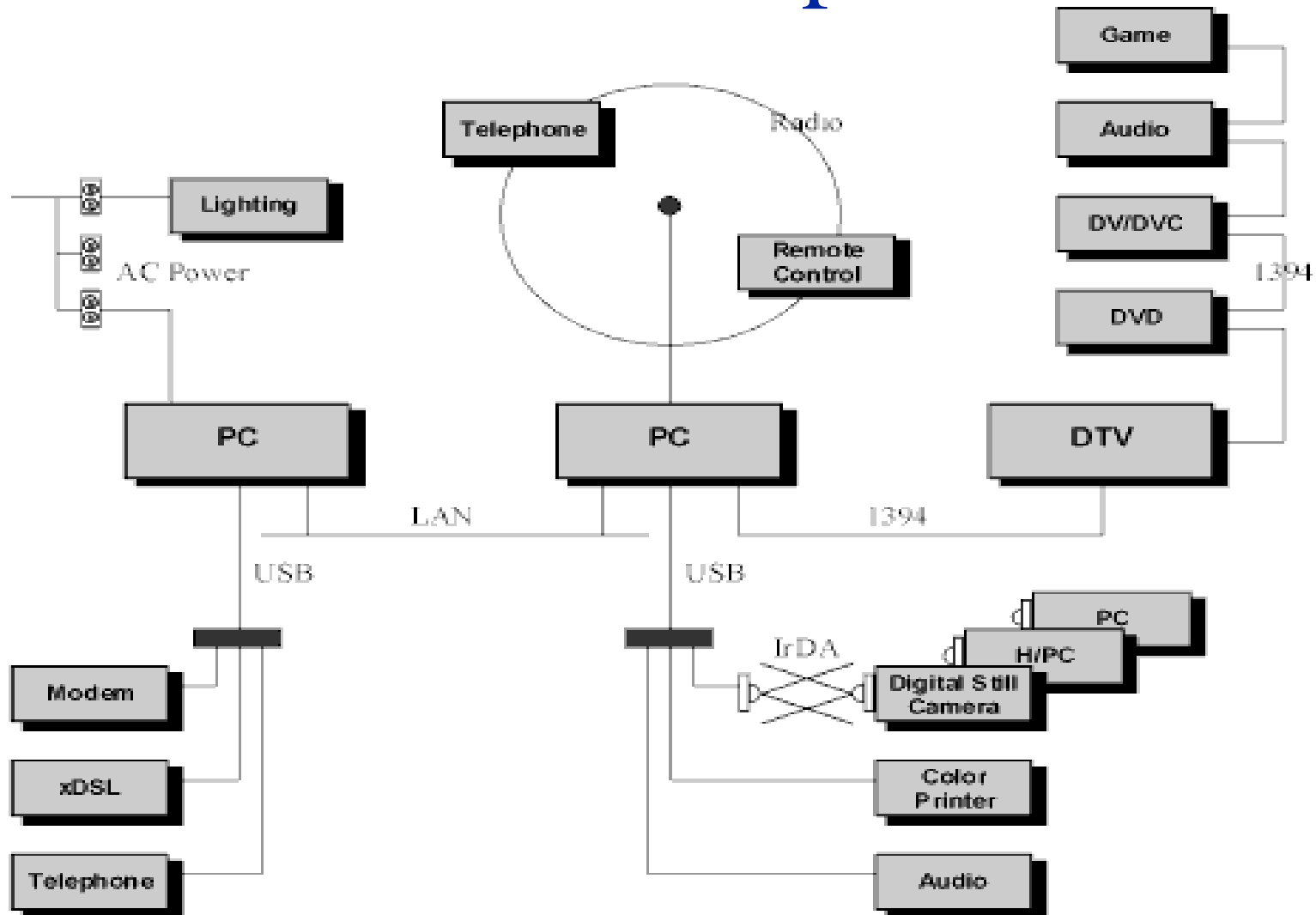
What is Universal Plug and Play?

- ◆ Distributed, open networking architecture
 - Provides pervasive & peer-to-peer network connectivity
 - PCs, intelligent appliances & wireless devices
 - Leverages Internet & Web components (like IP, TCP, UDP, HTTP & XML)
 - Enables seamless proximity networking in addition to control & data transfer among networked devices in the home, office & everywhere else
 - Like the Internet, contracts are based on wire protocols that are declarative - expressed in XML & communicated via HTTP
 - IP networking is a strong choice for UPnP
 - Because of its proven ability to span different physical media, enable multi-vendor interoperation & to achieve synergy with the Internet & many home & office intranets

What is Universal about UPnP?

- ◆ No device drivers - common protocols
 - Media and low-level (transport & below layers) independent
- ◆ UPnP devices can be implemented on any OS using any programming language
- ◆ UPnP
 - Leverages HTTP and the family of browser technologies
 - Enables vendor control over device user interface and interaction using the browser
 - Enables conventional application programmatic control
- ◆ Vendors agree on base protocol set on per-device basis
 - Vendors can unilaterally extend the base set as needed

Fundamental Principles of UPnP



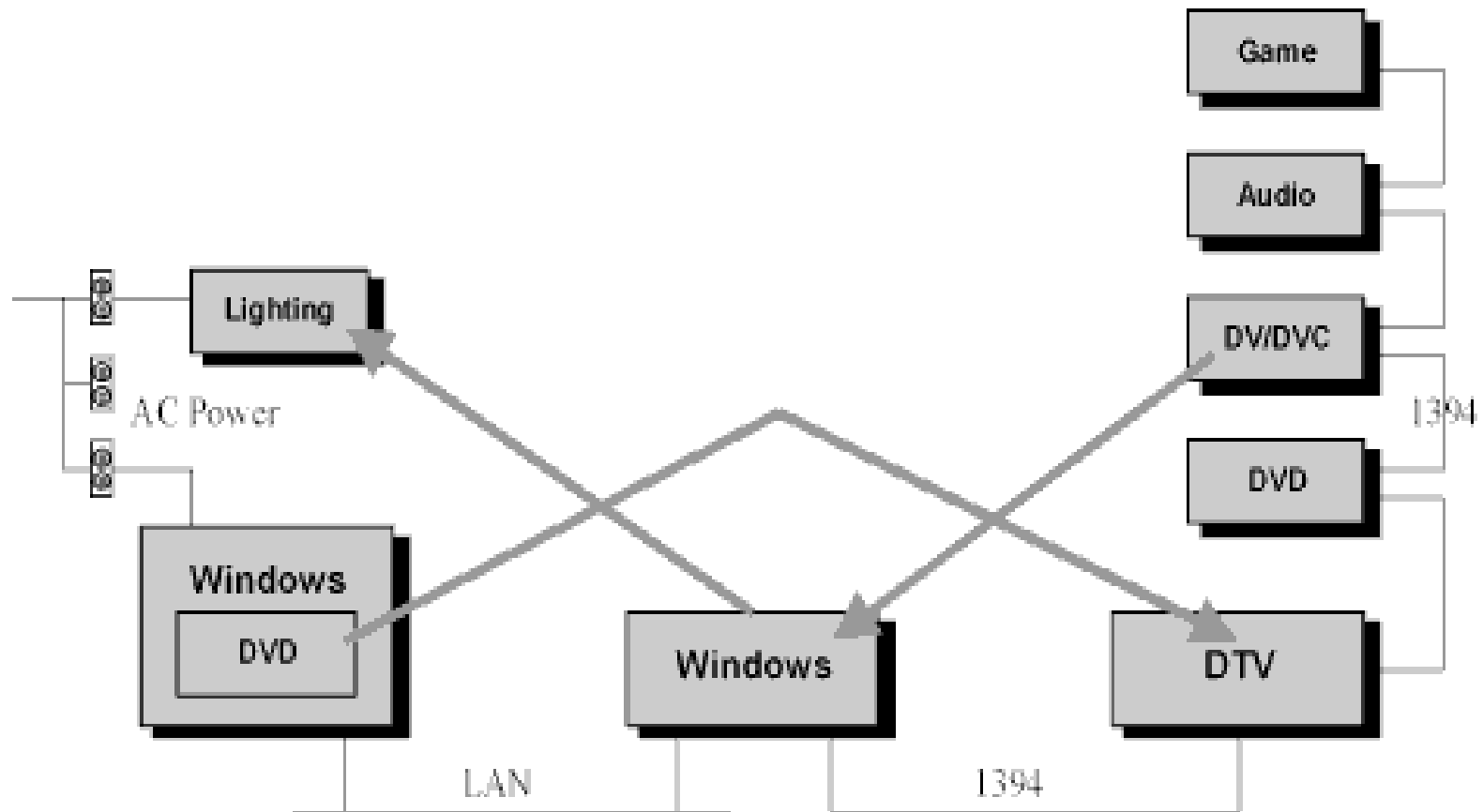
UPnP's Capabilities

- ◆ Extends the discovery and enumeration of devices to include *networked* devices and services,
 - Examples - network-attached printers, Internet gateways, & consumer electronics equipment
- ◆ Peer-to-peer model
 - Makes possible for devices to be discovered and used directly by other devices, with or without the presence of a PC
- ◆ Incorporates capabilities discovery
 - Enables enumeration of each device's unique characteristics, including communications protocols

UPnP's Capabilities

- ◆ UPnP initiatives are being developed to support key existing industry standards
 - Such as TCP/IP, HTML, XML, HTTP, DNS, LDAP, etc.
- ◆ To avoid costly rewiring in the home, UPnP supports existing network media, plus new standards such as PLC, RF & cable
- ◆ UPnP is equally adaptable to both dynamic home environments and fixed, configured corporate networks

UPnP Enables Highly Integrated Multi-Vendor Networks



Source: UPnP



Technology Trends in UPnP

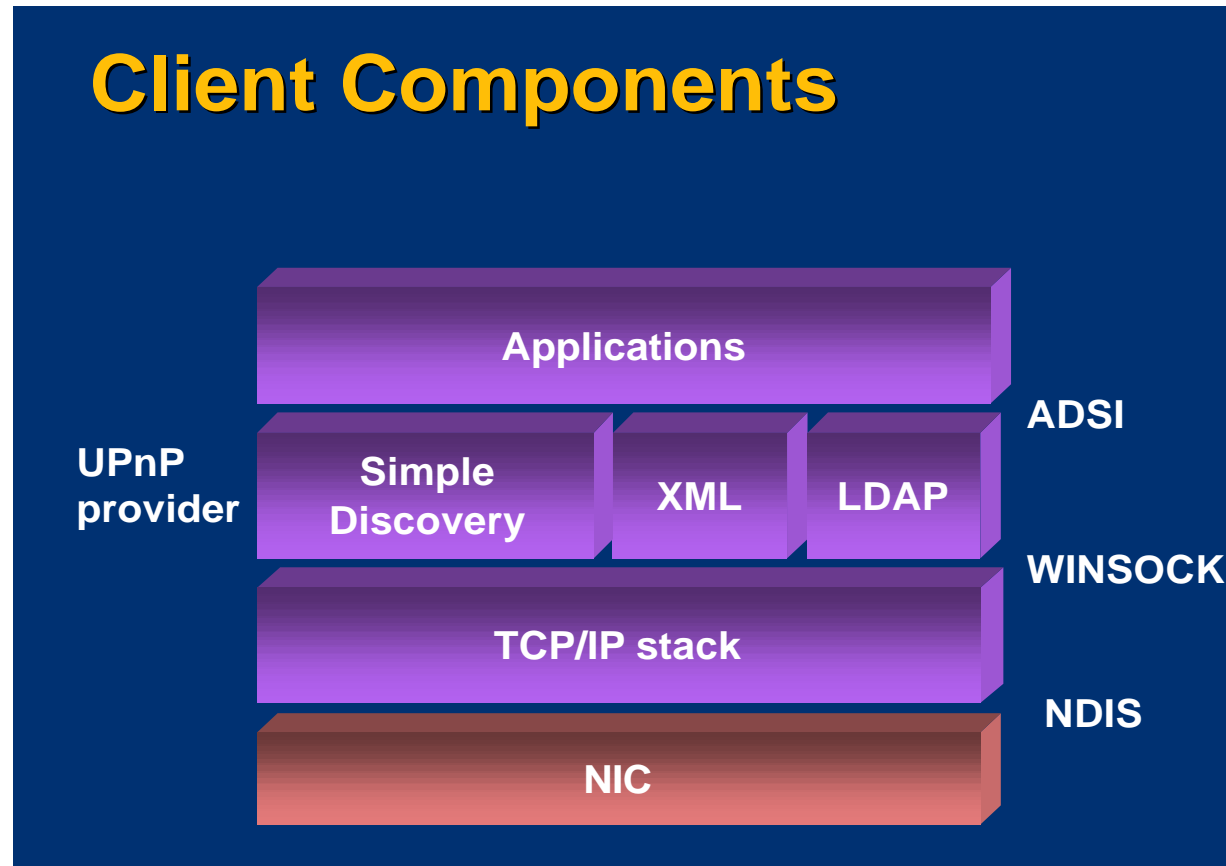
- ◆ Ubiquitous communications
 - Global communications software infrastructure has been determined - TCP/IP & the Web
 - UPnP provides high speed services & support to the home
 - HomePNA, HomeRF, powerline
- ◆ Useful bandwidth is now available to homes
 - Consumer-priced, high-speed, 24-hour data services are opening up wide bandwidth access to the Web
 - xDSL, cable, satellite
- ◆ Focus shifting from connectivity to services
 - New roles & uses for PCs & computing devices
 - Information, communications, audio, video data streams

UPnP Eases Designers Challenges

Based on standard Internet protocols, UPnP can work with a broad range of devices

- ◆ Scalability
- ◆ Robustness - "always on"
- ◆ Interoperability
- ◆ Security
- ◆ Simplicity
- ◆ Lightweight cost-effective technology
- ◆ Building network applications

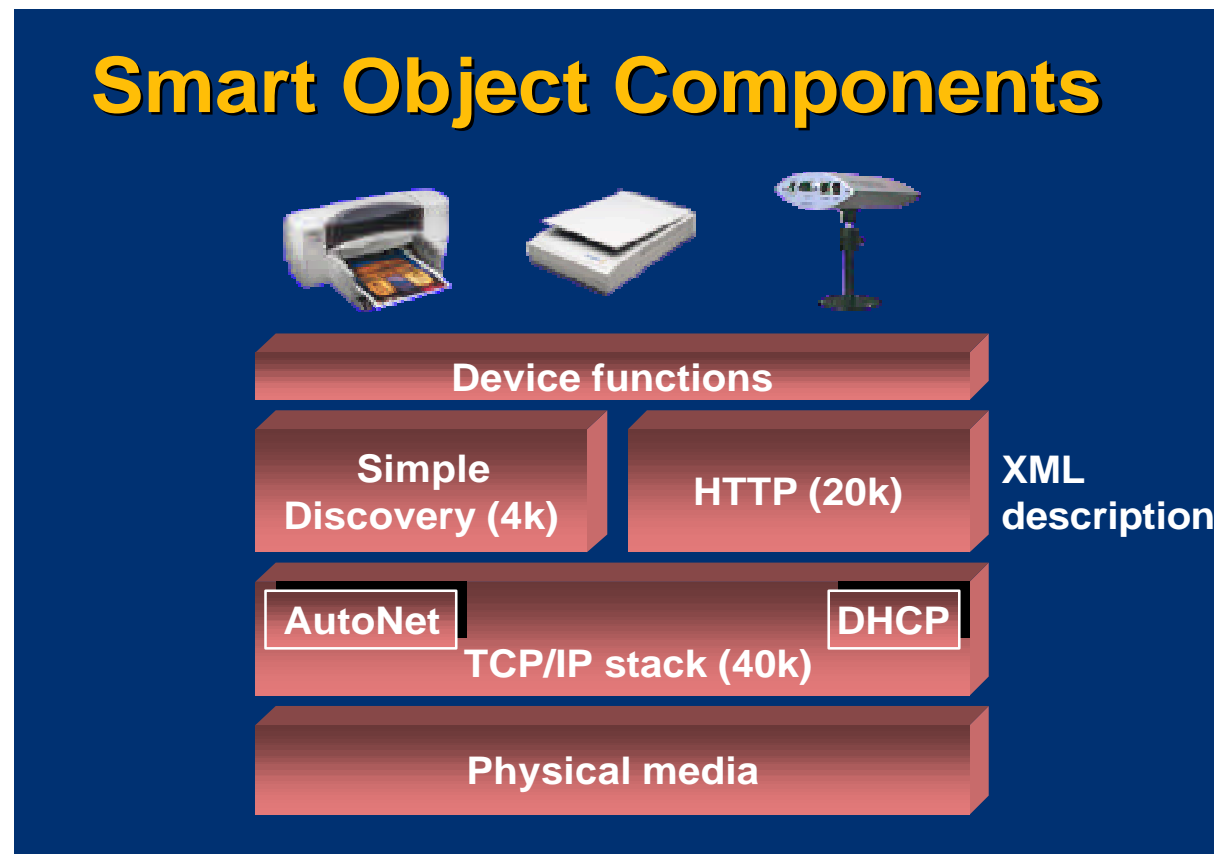
Client Elements Developed to Conform to UPnP



Source: UPnP



Smart Object Developed to Conform to UPnP

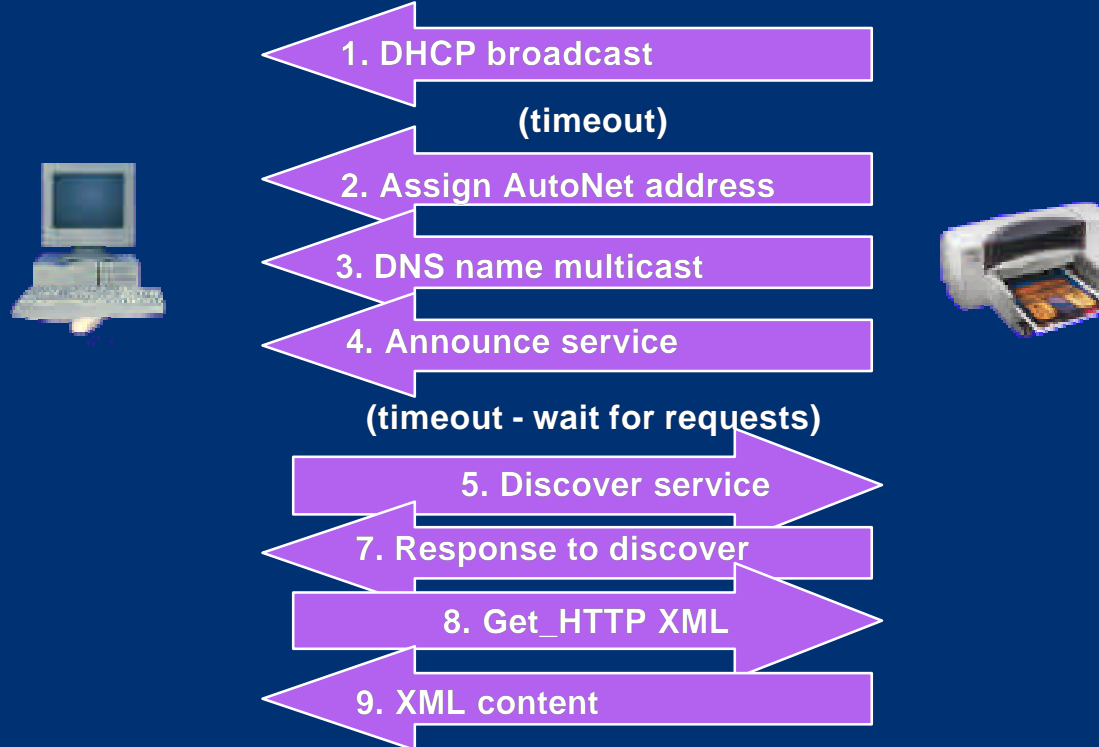


Source: UPnP



UPnP in Action - Ad Hoc Networking

UPnP in action - ad hoc

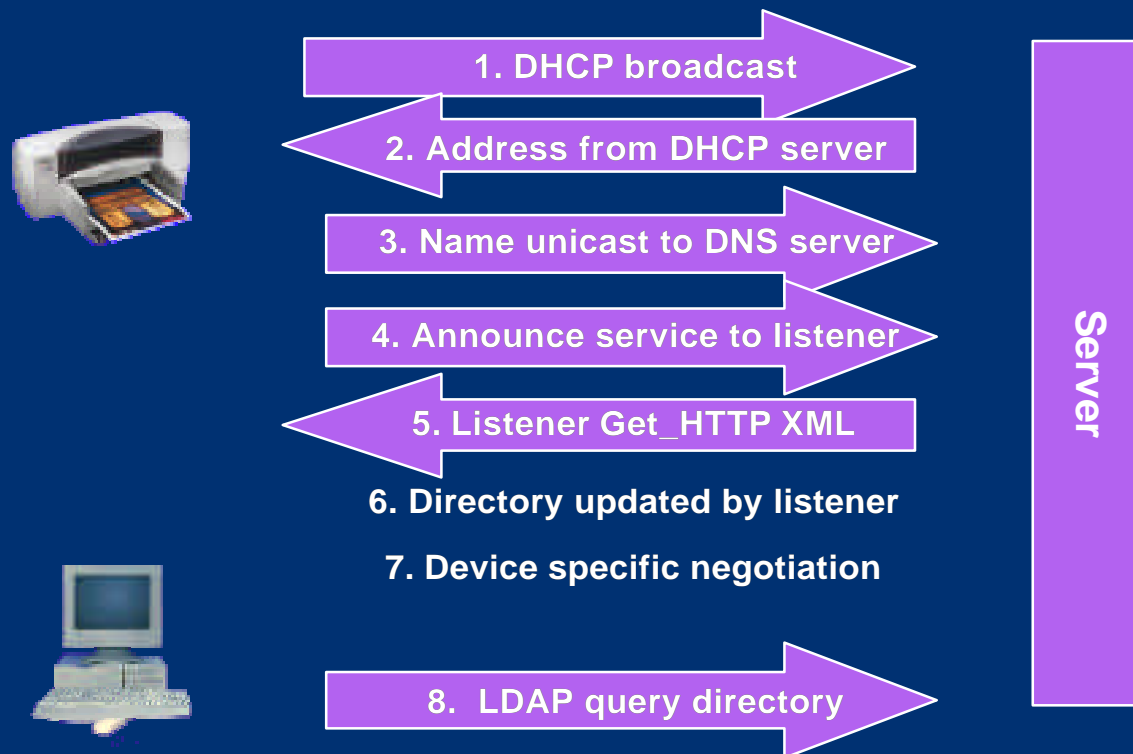


Source: UPnP



UPnP in Action - Configured Networking

UPnP in action - configured

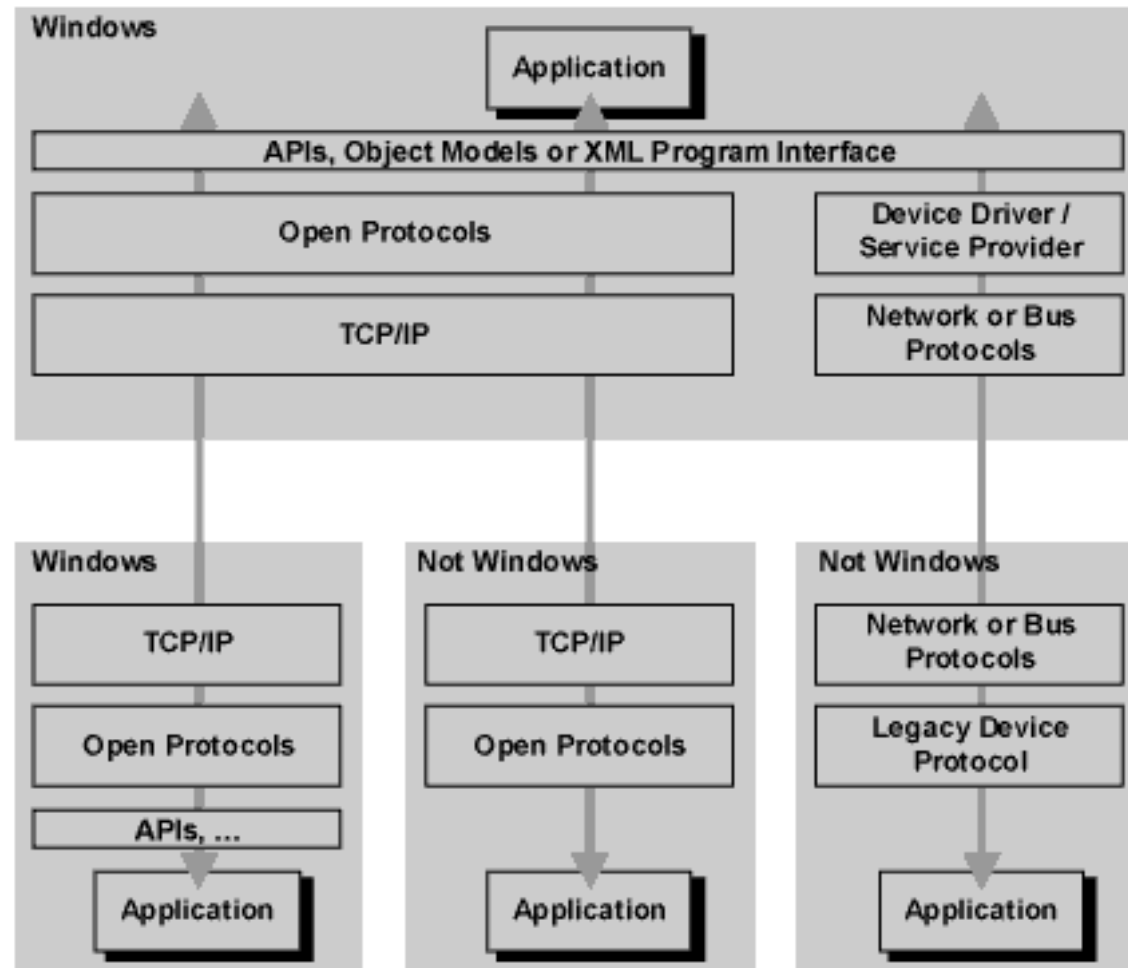


Source: UPnP



Network-Friendly Programming Model

UPnP & Legacy Integration in a Single Host

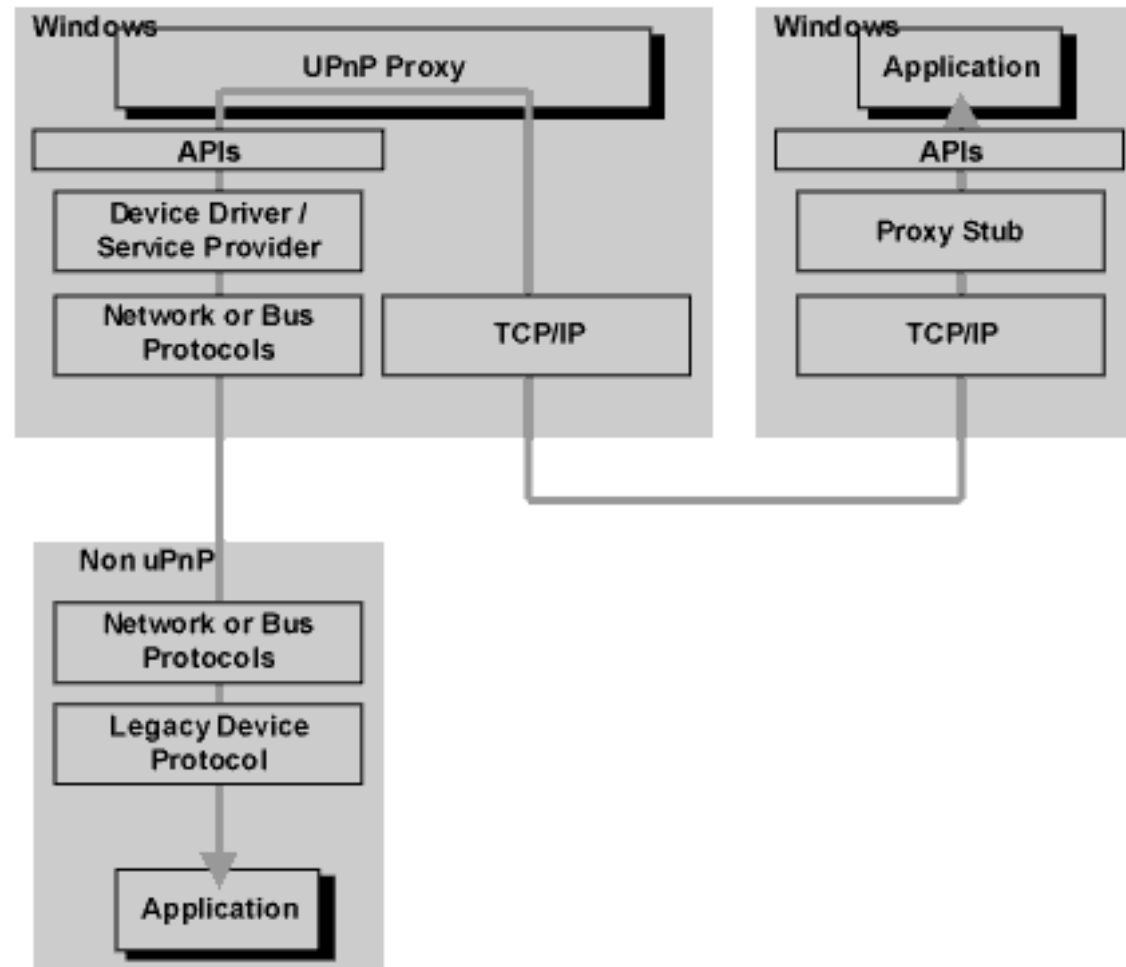


Source: UPnP



Network-Friendly Programming Model

UPnP & Legacy Integration Across the UPnP Network



Source: UPnP



Jini Connection Technology



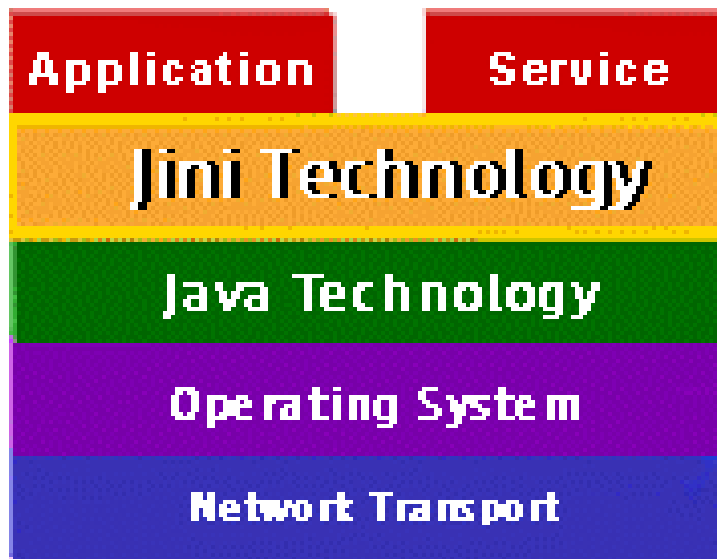
What is Jini?

- ◆ Provides simple SOFTWARE mechanisms which enable devices to plug together to form an impromptu community
 - Community is put together without any planning, installation or human intervention
 - Each device provides services that other devices in the community may use
- ◆ Lookup service
 - Devices & services register
- ◆ Upon device plug in
 - Discovery: Goes through an add-in protocol
 - Join-in

Backed by
Sun Microsystems

Jini Technology - Architecture

- ◆ Device first locates the lookup service (discovery)
- ◆ Device then uploads an object that implements all of its services' interfaces (join)



Source: Jini.org



Using a Service

- ◆ Lookup service acts as an intermediary to connect a client looking for a service with that service
 - Person or program locates service by using the lookup service
 - Service's object is copied from the lookup service to requesting device where it will be used
- ◆ Once the connection is made
 - Lookup service is not involved in any of the resulting interactions between that client & that service
 - It does not matter where a service is implemented
 - Compatibility is ensured because each service provides everything needed to interact with it
 - There is no central repository of drivers

Jini: A Java Based Technology

- ◆ Jini is based on the Java programming language
 - Devices in a network employing Jini are tied together using Java Remote Method Invocation (RMI)
 - Java ensures a secure Jini connection
 - Discovery, join & lookup protocols depend on the ability to move Java objects (including their code) between Java virtual machines
 - Defines leasing & transaction mechanisms to provide resilience in a dynamic networked environment

Jini: Small Enough Yet Powerful

- ◆ Services architecture is powerful enough to build a fully distributed system on a network of workstations
- ◆ Jini connection infrastructure is small enough
 - Community of devices enabled by Jini connection software can be built out of the simplest devices
 - For example, it is entirely feasible to build such a device community out of home entertainment devices or a few cellular telephones with no PC in sight

HAVi

Home Audio Video interoperability

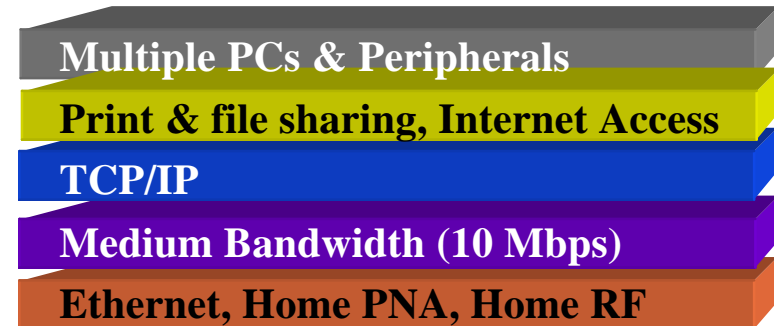


Different Home Networks

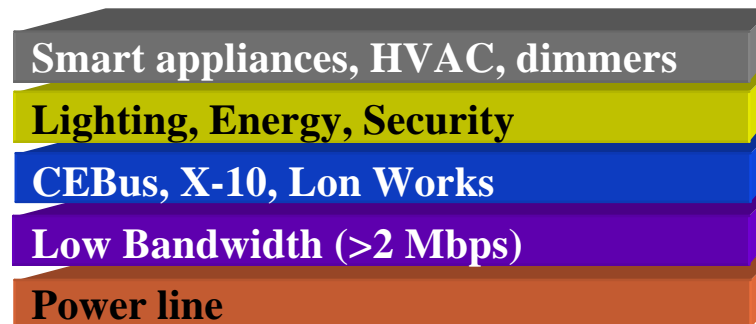
Digital Entertainment Network



Computer System Network



Home Automation Network



What is HAVi?

- ◆ Standard that allows all digital consumer electronics and home appliances to communicate with each other
- ◆ Digital Audio/Video (AV) networking initiative that provides a home networking SOFTWARE spec for seamless interoperability among home entertainment products
 - It has been designed to meet the particular demands of digital audio and video entertainment
- ◆ Functions on one or more appliances to be controlled from another appliance
 - Regardless of the network configuration and appliance manufacturer

What is HAVi?

- ◆ HAVi is a software specification
- ◆ It defines an OS-neutral software standard that adds management capability to AV devices
 - Multi-directional AV streams, event schedules, and registries,
 - Provides APIs for the creation of a new software applications
 - Utilizes chips built into modern audio and video appliances to manage a dedicated audio-video networking system
- ◆ IEEE 1394 (i.LINK® or FireWire®) has been chosen as the interconnection medium
- ◆ HAVi compliant products are expected to be available by 2H'00

Advantages of HAVi Enabled Devices

- ◆ Automatically detection of devices on the network
- ◆ Instant coordination of the functions of various devices
 - Each added appliance to the HAVi network is automatically registered so that other devices know what it is capable of
- ◆ Installation of applications and user interface software on each device, and ensuring interoperability among devices regardless of manufacturer

HAVi Gives Us

- ◆ Interoperability

- Functions on a device within the HAVi networking system may be controlled from another device within the system
 - Searching an available VCR to record a TV program with commands given via the menu selection of another TV display

- ◆ Brand independence

- Entertainment products from different manufacturers will communicate with each other when connected into a HAVi network
 - Imagine a variety of VCRs, hi-fis, MP3, CD, MD & DVD players, active loudspeakers, set-top boxes all daisy-chained together & showing up on the TV & can be controlled from one remote commander!

HAVi Gives Us

- ◆ Hot "Plug and Enjoy"
 - HAVi compliant devices automatically announce their presence & capabilities to other devices on the HAVi network
 - Simplifies installation and setup - Just plug-and-enjoy
 - No more complicated and difficult installation instructions
 - No configuration of network addresses or device drivers
- ◆ Linked to the past, upgradeable in the future
 - Today's i.LINK enabled camcorders and other devices will be able to be controlled on a HAVi network for basic functions
 - HAVi compliant devices will come with their own dynamic DCMs
 - Updating functionality can be done by downloading & uploading new capabilities via the Internet
 - Additional/replacement products can be added into the network

HAVi Device Classes

Controller
Devices



Full AV device (FAV)

- Download and execute all HAVi applications
- Download and execute DCM

Intermediate AV device (IAV)

- Ability to communicate with other HAVi device
- Ability to execute limited applications
- Offers own control service
- Ability to host other known device

Base AV device (BAV)

- Offers own information in ROM

Legacy AV device (LAV)

- Conventional devices with NO HAVi SDD data (ROM)

Who Are The Main Players?

SONY

PHILIPS

HITACHI

SHARP

Panasonic®

THOMSON MULTI MEDIA

GRUNDIG

TOSHIBA

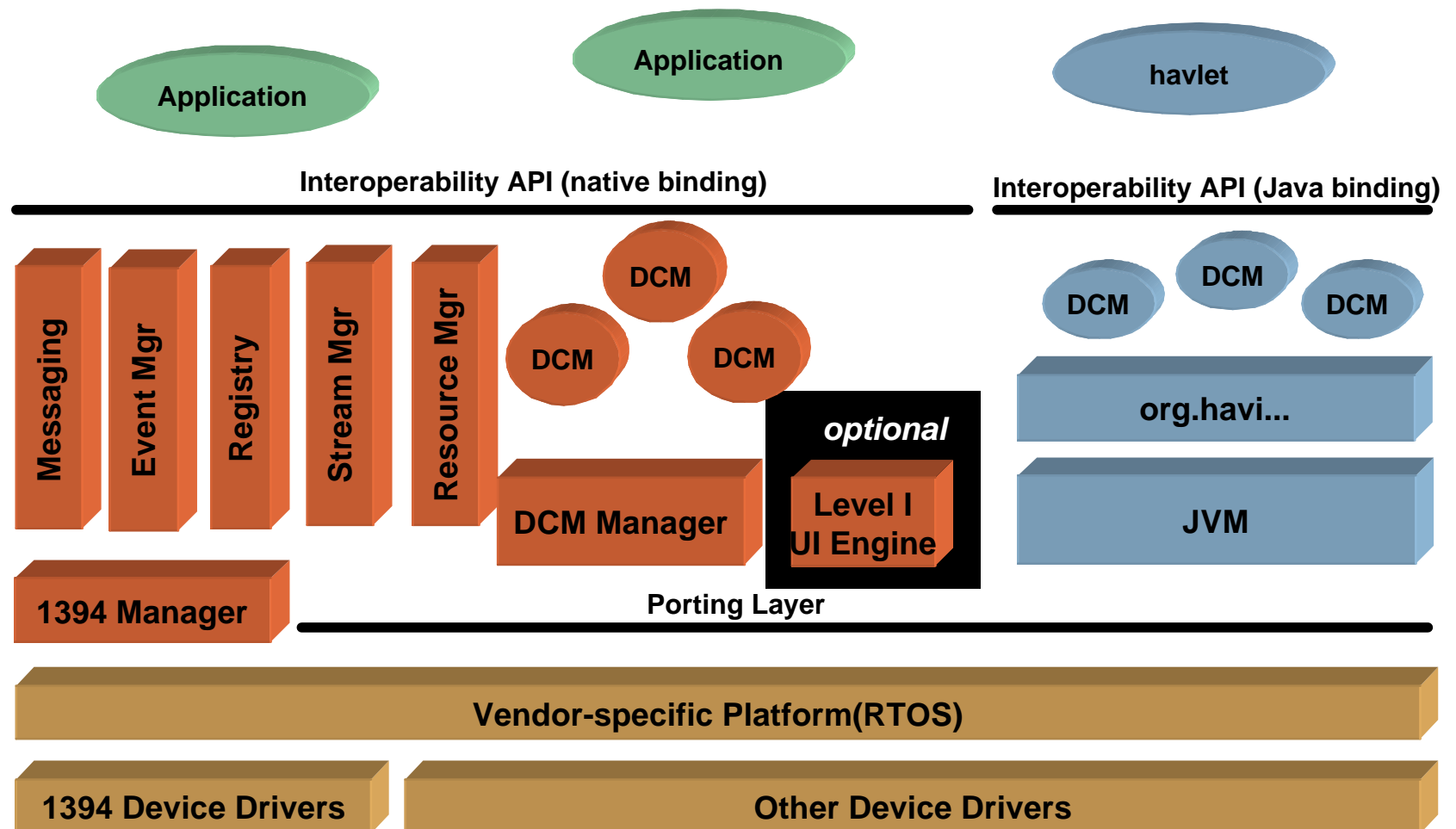
HAVi Architecture

- ◆ A set of software elements along with the protocols and APIs needed to achieve interoperability
- ◆ Device abstraction and device control models
- ◆ An addressing scheme and lookup service for devices and their resources
- ◆ An open execution environment supporting visual presentation and control of devices, and providing runtime support for third party applications

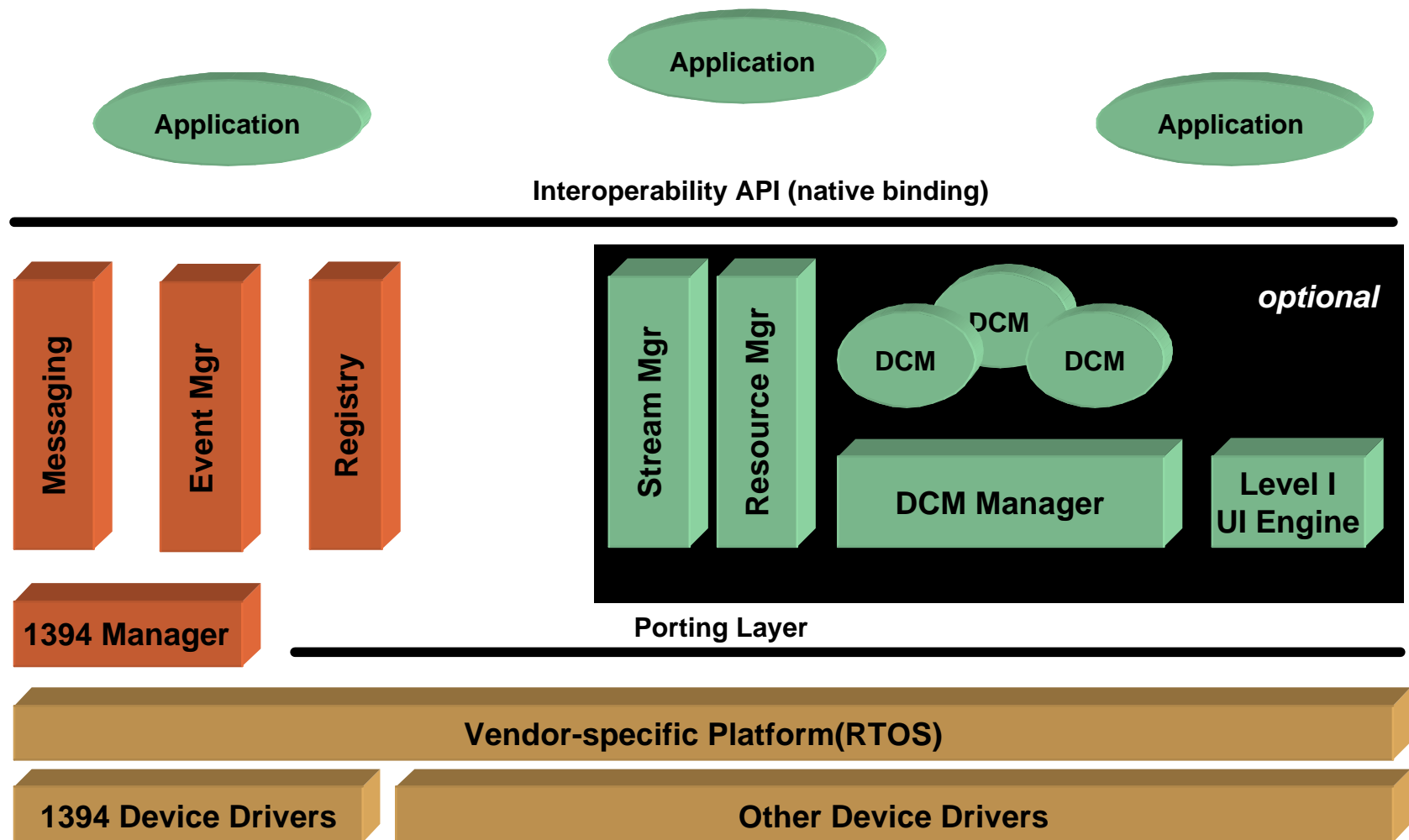
HAVi Architecture

- ◆ Communication mechanisms for extending the environment dynamically through plug-and-play capabilities
- ◆ A versioning mechanism that preserves interoperability as the architecture evolves
- ◆ Management of isochronous data streams

HAVi Architecture (FAV)



HAVi Architecture (IAV)



HAVi Architecture

- ◆ 1394 Communication Media Manager
 - Allows other software elements to perform asynchronous and isochronous communication over 1394
- ◆ Messaging System
 - Responsible for passing messages between software elements
- ◆ Registry
 - Serves as a directory service, allows any object to locate another object on the home network

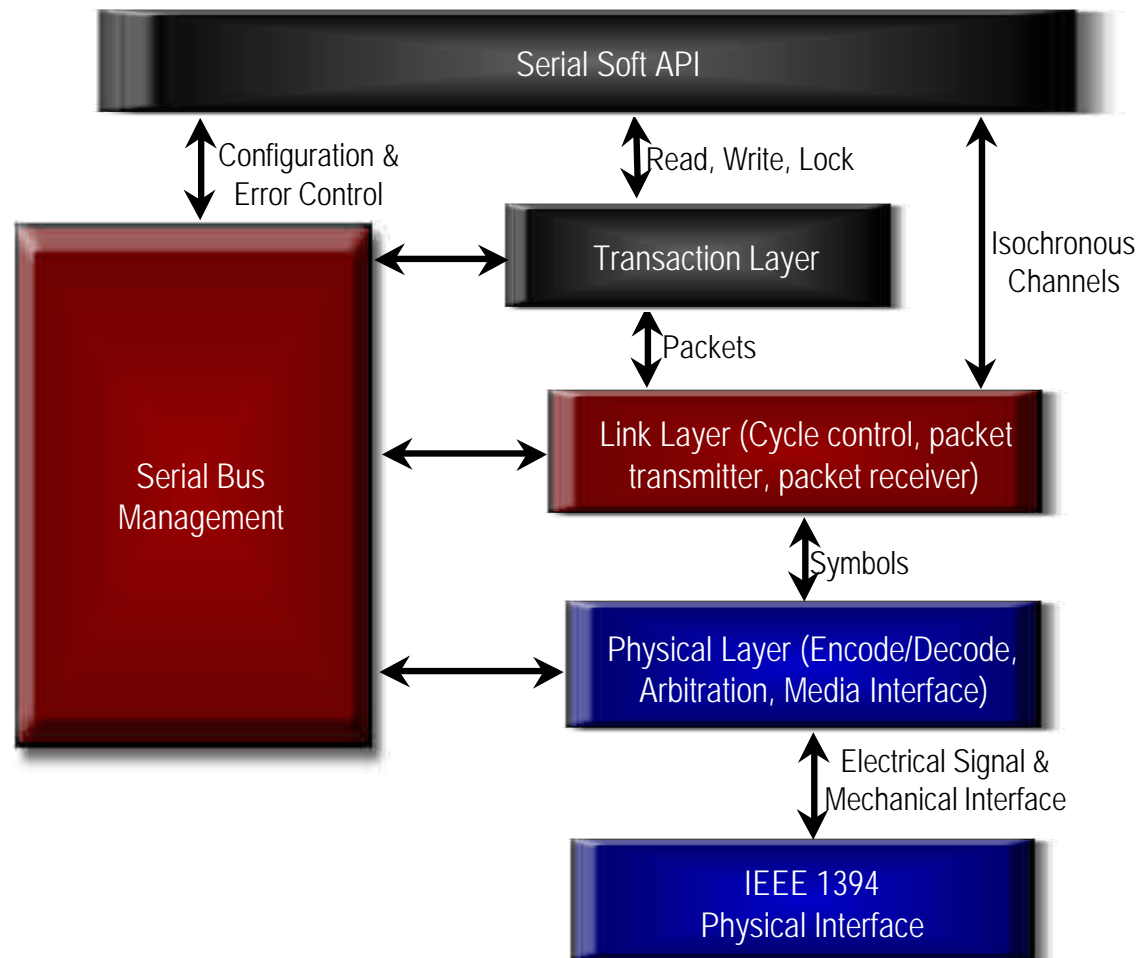
HAVi Architecture

- ◆ Event Manager
 - Serves as an event delivery service
 - An event is the change in state of an object or of the home network
- ◆ Stream Manager
 - Responsible for managing real-time transfer of AV and other media between functional components
- ◆ Resource Manager
 - Facilitates sharing of resources and scheduling of actions

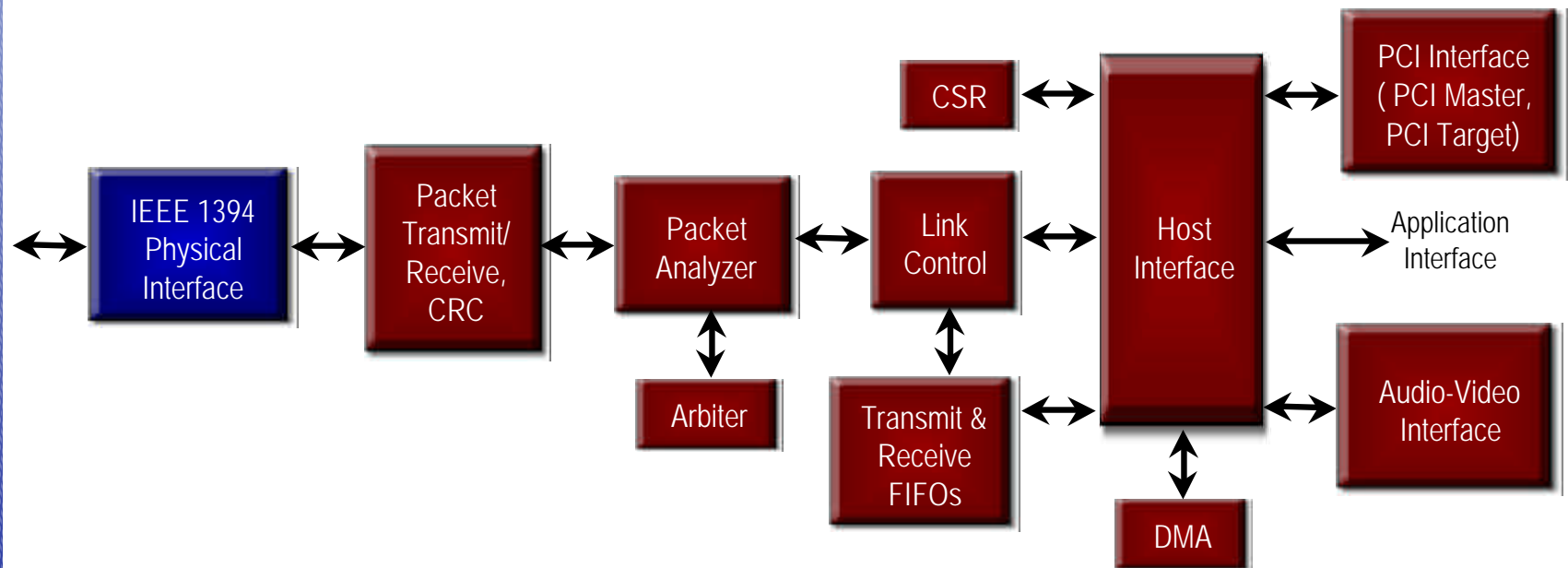
HAVi Architecture

- ◆ Device Control Module (DCM)
 - A software element used to control a device
 - DCMs are obtained from DCM code units
 - Within a DCM code unit are:
 - Code for the DCM itself
 - Code for Functional Component Modules (FCMs) for each functional component within the device
- ◆ DCM Manager
 - Responsible for installing and removing DCM code units on FAV and IAV devices

IEEE 1394 Protocol Stack



HAVi/IEEE 1394 Link Controller





USB 2.0

Universal Serial Bus 2.0

Introduction

- ◆ USB 2.0 extends the full-speed transfer rate about 40 times faster than USB 1.1 - High Performance
 - USB 1.1: ~ 12Mbps
 - USB 2.0: Up to 480Mbps = 60MBytes/sec
- ◆ USB 2.0 is based on the same architecture as USB
 - Migrating USB peripherals to USB 2.0 is much easier
 - USB 2.0 will be forward and backward compatible with current USB systems and peripherals
 - 2.0 spec uses the same cables & connectors as the 1.1 standard
 - Consumers have the benefit of using devices they already own

Facts

- ◆ USB Implementers Forum
 - Organization formed to help companies develop USB products
- ◆ First USB 2.0 enabled systems & peripherals are expected in the marketplace in 4Q'2000
 - Broad deployment is anticipated in 2001
- ◆ USB 2.0 Promoter Group consists of
 - Compaq, HP, Intel, Lucent, Microsoft, NEC, Philips

Uses

- ◆ High-bandwidth USB 2.0 spec will be used in consumer electronics products with more functionality
 - Higher-resolution videoconferencing cameras
 - Digital image creation & web publishing
 - Multiple high-speed peripherals run simultaneously
 - Next generation scanners & printers
 - Faster broadband Internet connections
 - Internet appliances will leverage USB 2.0

USB - A Must Have

- ◆ USB is the solution for any PC user
 - Instant, no-hassle way to connect a new digital joystick, a scanner, digital speakers, digital camera or a PC telephone to their PC
- ◆ Adding peripheral devices is a scary proposition without USB
 - Requires computer savvy in figuring out which port to use
 - In most cases, you had to pry open your PC to install an add-in card and set DIP switches
 - Configuring IRQ settings

Standardized Plug and Port

- ◆ USB makes adding peripheral devices trivial
 - USB replaces all the different kinds of serial and parallel port connectors with one standardized plug and port combination



- ◆ USB-compliant devices (PCs and peripherals) can be plugged in & simply turned on
 - Automatic process
 - It's like adding instant new capabilities to the PC
 - Do not need to open the PC, & do not need to worry about add-in cards, DIP switch settings or IRQs

Hot-Swapping With USB

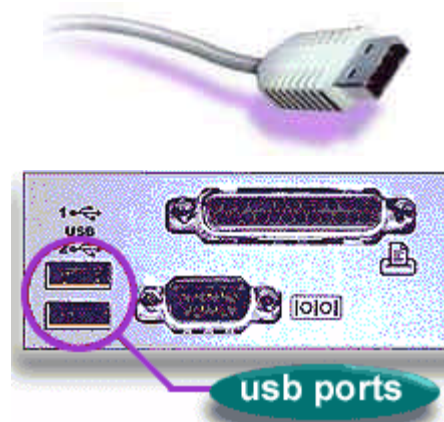
- ◆ Attaching or removing peripherals - Simple 'Plug & Go'
 - Do not need to shut down and restart the PC
 - PC automatically detects the peripheral and configures the necessary software
 - Useful feature for users of multi-player games & notebook PC users who want to share peripherals
- ◆ Connecting several peripherals at one time
 - Many USB PCs come with two USB ports
 - Special USB peripherals (called USB hubs) have additional ports that allows "daisy chaining" multiple devices together
- ◆ Eliminate those clunky power supply boxes
 - USB distributes electrical power to many peripherals
 - Lets the PC automatically sense the power required & delivers it to the device

Control Peripherals

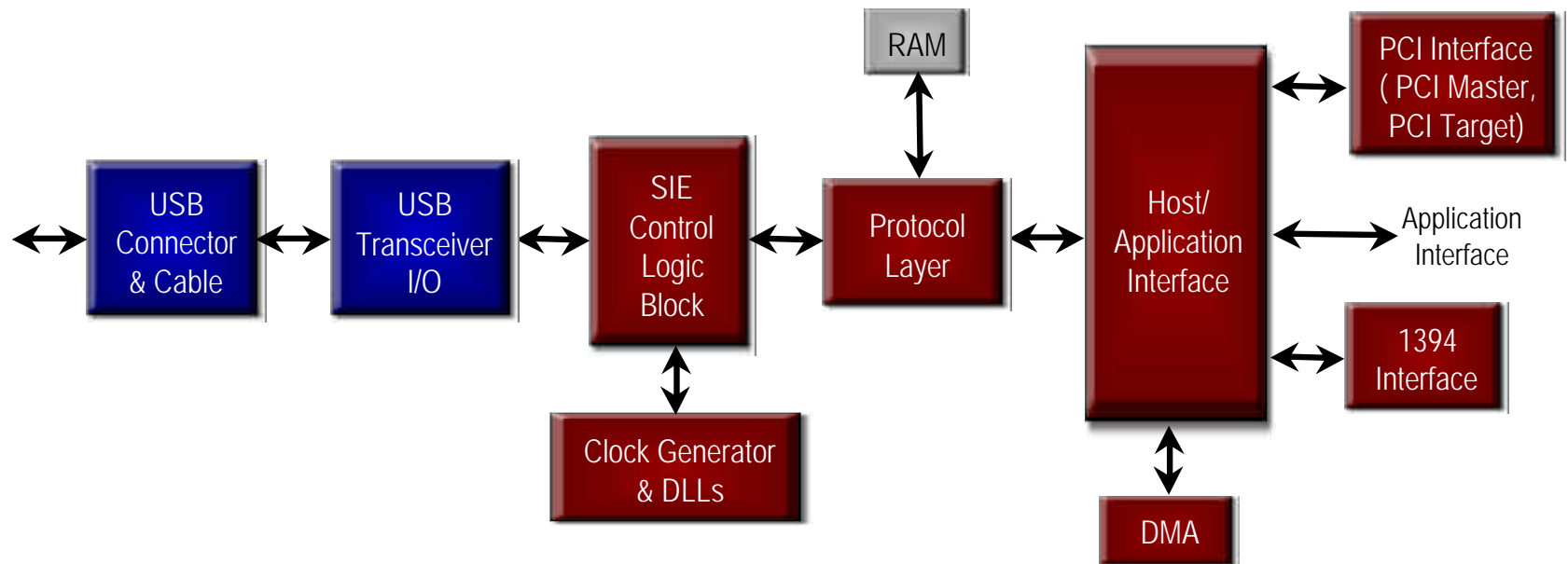
- ◆ USB connections allow data to flow both ways between the PC and peripheral
 - Allows PC to control the peripherals in new & creative ways
 - For example, the PC can be used to automatically manage a telephone call center to maintain voice, fax & data mailboxes, screen and forward your calls, and even deliver a variety of selected outgoing messages
 - Or, the PC can be used to tune a set of USB-compliant stereo speakers to match the acoustics of your listening environment

So What Do We Need?

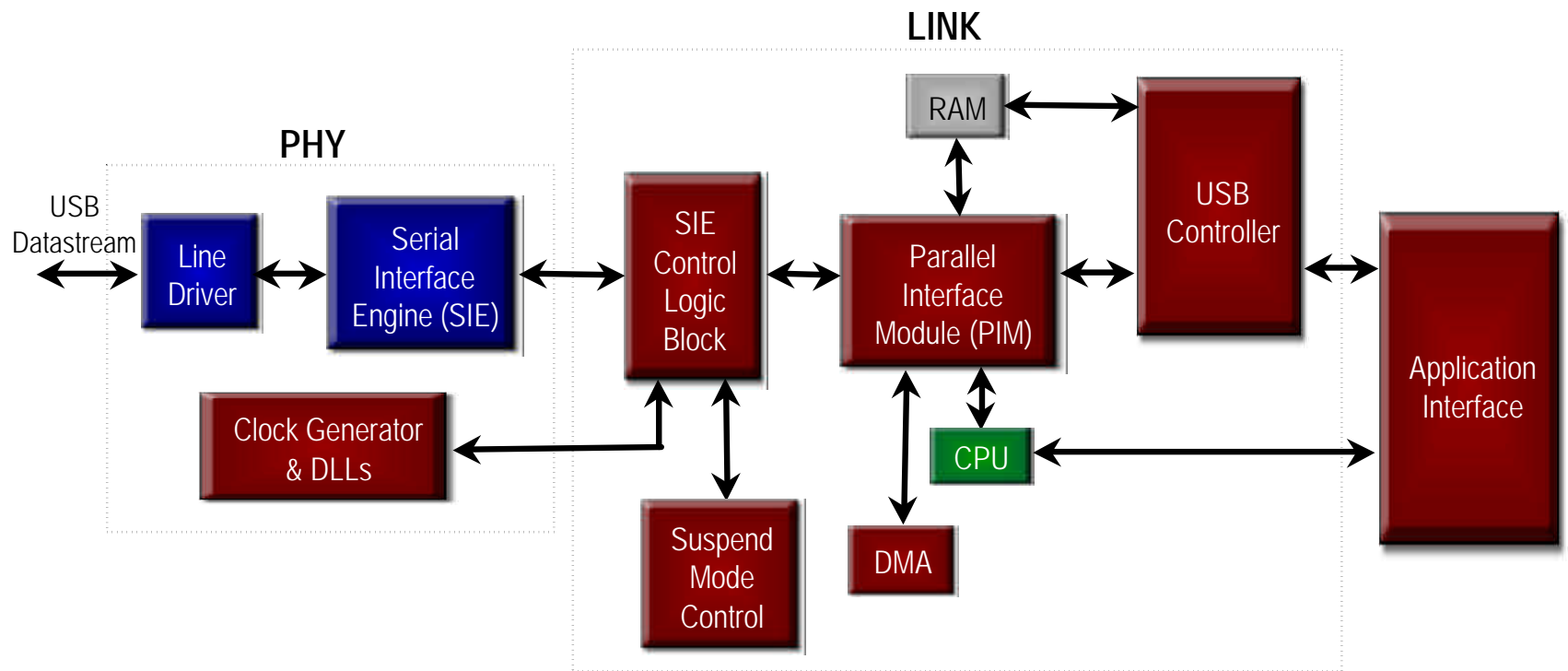
- ◆ USB-compliant devices
 - Most PCs, notebooks & PC peripherals on the market are fully USB-ready
 - Other USB-ready appliances
 - USB digital cameras, computer telephony products, digital speakers, digital gaming devices & even USB peripherals protecting your security by scanning fingerprints



USB Core



USB 2.0 Core



USB vs. IEEE-1394

- ◆ Both are serial buses intended to fulfill different bandwidth and cost needs
- ◆ 1394 has a more complex protocol & signaling rate
 - 1394 can move more data in a given amount of time, but is considerably more expensive than USB

USB vs. IEEE-1394

- ◆ Both are complimentary technologies
 - 1394 is for devices where high performance is a priority and price is not, while USB is for devices where price is a priority and high performance is not
 - 1394 applications
 - Disk drives, high quality video streams, higher end consumer devices & other high bandwidth applications
 - USB applications
 - Appropriate for middle and low bandwidth applications such as audio, scanners, printers, keyboards & mice

USB 2.0 vs. Firewire

- ◆ Even at faster speeds roles of USB & 1394/Firewire remain the same
 - USB 2.0
 - Interface for peripheral devices which operate in a PC-centric environment
 - Consumer A/V will never incorporate USB
 - USB requires a CPU to perform bus master while 1394 is peer-to-peer
 - Example: A D-VCR will not be able to talk directly to the DTV without going through a PC
 - 1394/Firewire
 - Multimedia bus enabling high-speed peripherals, convergence between PCs, peripherals, and consumer A/V products

IEEE1394 & USB 2.0 will Coexist

- ◆ High speeds of USB 2.0 will be similar to that of 1394 Firewire interface
 - 1394 Firewire: 100-400Mbps (12.5 - 50 Mbytes/sec)
 - USB 2.0: 480Mbps = 60MBytes/sec
- ◆ Coexist, even within the same PC - RG model
 - 1394 is the connector for consumer electronics like video cameras & digital TVs but will exist in the PC



DVI

Digital Video Interface

IEEE 1394 & DVI

- ◆ IEEE 1394, is a two-way high-speed interface capable of sending command and control protocols
 - It enables devices to both broadcast and record data
- ◆ DVI is a point-to-point digital interface designed to send uncompressed streams
 - It is a one-way interface with a display
- ◆ IEEE 1394 is inherently suited for recording and networking applications within the home

IEEE 1394 & DVI

- ◆ DVI is pitched as an interface between a graphics chip and various kinds of monitors
 - including plasma display panels, LCDs and even CRTs
- ◆ 1394 is suitable for distribution of compressed data (MPEG-2)
 - Most digital content received at home from DVD, satellite or cable is based on MPEG-2 streams
- ◆ DVI is suitable for distribution of uncompressed data
 - Designed to carry sustained HDTV data rate without interruption

IEEE 1394 & DVI

- ◆ IEEE 1394 distribute video data at 100, 200, or 400 Mbps, Scalable
- ◆ IEEE 1394b is being designed to deliver data at 800 Mbps to 3.2 Gbps, Scalable
- ◆ DVI's single link can distribute video data at 4.9 Gbps
- ◆ DVI's double link can distribute video data at 9.9 Gbps
 - Does not support audio/video commands

IEEE 1394 & DVI

	Stream	Bit Rate	Architecture	Command & Control	Applications
IEEE 1394	Compressed MPEG-2 Transport	1394: 100, 200, or 400 Mbps, Scalable 1394b: 800 Mbps to 3.2 Gbps, Scalable	Peer-to-peer	Support for AV command & control	Storage, networking
DVI	Uncompressed baseband	Single link DVI: 4.9 Gbps Double link DVI: 9.9 Gbps	Point-to-point	No support for AV command & control	Digital interface between a graphics chip and a monitor



TIA TR41.5

Telecommunications Industry Association (TIA)
TR41.5

Goal

- ◆ Create the physical layer spec for interfacing between different WAN & home networking technologies
 - Defines rules for signaling, pin counts, definitions
 - Defines how messages are passed between the different WAN & home networking technologies
- ◆ Focussed primarily in North America
- ◆ Intercommunication between any access & home networking technologies
 - Allow upgradability in the future
- ◆ Formed in 1995
 - Spec finalized by 2000



ISO/IEC JTC1 SC25 WG1

Goal

- ◆ Informally called HomeGate
- ◆ Operated by International Standards Organization
- ◆ Focuses on creating a set of communications protocols for RGs
- ◆ TIA 41.5 & WG1 are working together to ensure interoperability between the two standards
 - Will incorporate and ensure interoperability between such home control protocols as CEBus, BACnet & CAB (Canadian Automated Building) protocol

Agenda

- ◆ Introduction & state of the market
- ◆ The complete home networking solution
- ◆ Residential gateways (RGs) - definition, purpose & types
- ◆ Phased deployment of RGs
- ◆ Consortiums
- ◆ RG solutions available today
- ◆ Xilinx solutions for RGs
- ◆ Summary



The Industry Today

Products & Manufacturers
(Equipment OEMs & Silicon Vendors)



Silicon Vendors

Broadcom Corporation

- ◆ Home networking powerhouse through Epigram acquisition in April 1999
 - Founding member of Home Phoneline Networking Alliance
 - Provides silicon for access termination, home networking pieces of the puzzle and consumer devices
 - Technology is being licensed by Lucent and other giants
- ◆ Supplies BCM4210/BCM4100 "iLine 10" chipsets
 - Complete host bus to phone wire solution for home networking
 - Each code a packet of data so that the receiver can properly decode it

Broadcom Corporation

- ◆ BCM4210 MAC/PHY features
 - 10Mbps Ethernet controller for phoneline networks
 - Meets HPNA 2.0 proposed spec requirements
 - 16Mbps peak data rates
 - Integrated CSMA/CD Ethernet MAC with multi-level QoS
 - Integrated iLine10 digital PHY
- ◆ BCM4100 Integrated Analog Front End (IAFE) features
 - Custom IAFE for iLine10 controllers
 - Performs all required Analog Front End transmit & receive operations (PMD Function)
 - Transmit & receive filters
 - Analog to digital & digital to analog converters

Broadcom Corporation

- ◆ BCM3300 single chip cable modem features
 - Supports up to 4 lines of voice
 - Can be paired with iLine 10 chipsets for a full RG silicon solution
 - Can be paired with iLine 10 chipsets & set-top box chipsets for customers like General Instruments/Motorola & Scientific Atlanta for a RG solution

Conexant Systems

- ◆ Provides chipsets to enable broadband access and home phoneline networking
- ◆ ADSL modem
 - Uses DMT technology licensed from PairGain
 - Flexible & programmable ADSL transceiver
 - DSP based hardware
 - Supports G.Lite & full-rate ADSL

Conexant Systems

- ◆ V.90/K56flex modem
 - 33.6Kbps, 31.2Kbps, V.34, V.32 support
 - V.42 LAPM, MNP 2-4 & MNP 10 error correction
 - V.42bis & MNP5 data compression
 - Fax modem send & receive rates up to 14.4Kbps
 - Data/fax/voice call discrimination
- ◆ Home phone line networking
 - 1Mbps data rates, scalable to higher speeds
 - Ethernet: standard 802.3 MAC, CSMA/CD
 - Uses existing phonelines - no new wires required
 - Supports up to 25 nodes across 500 feet
 - Compatible with existing services

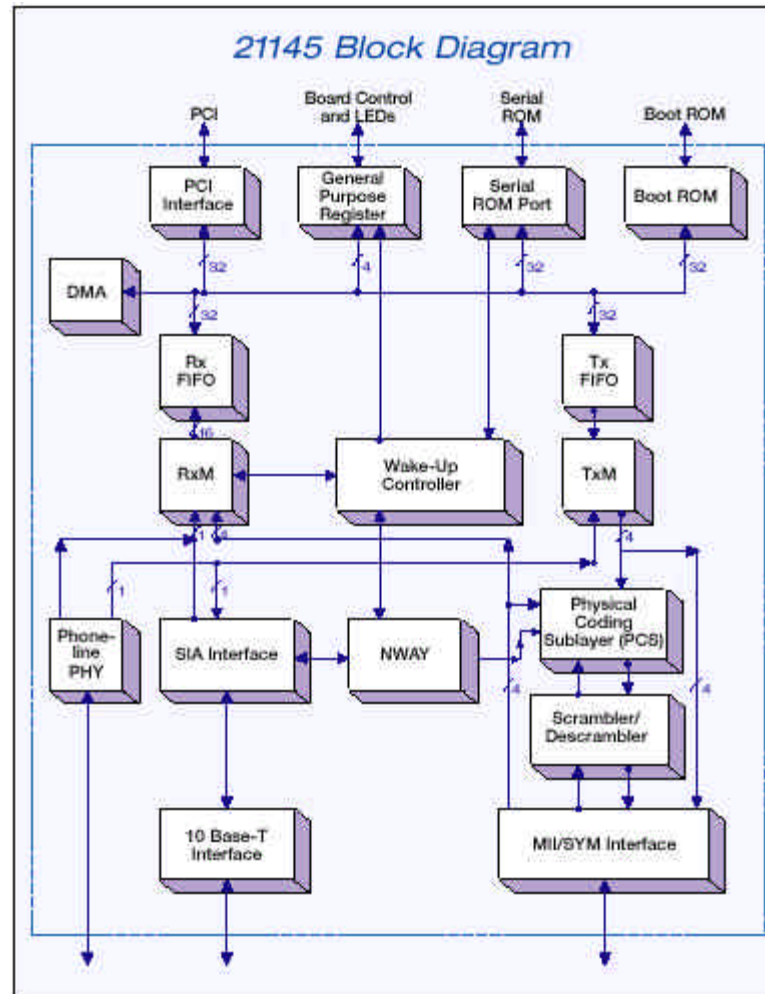
Intel Corporation

- ◆ Believes that the existing phoneline infrastructure in the home is an excellent basis for implementing home networks today
 - Founding member of HPNA
 - Develops chipsets for home phoneline networking
 - Working with industry leaders to establish open spec for phoneline-based home networking
 - Powerhouse in this area through own efforts & acquisition of Level One Communications

Intel Corporation

- ◆ Intel 21145 Phoneline/Ethernet LAN Controller
 - Integrated single-chip silicon solution for 1Mbps phoneline & 10Mbps Ethernet connectivity
 - Provides foundation for implementing fully functional home phoneline network
 - Utilizes 21x4x MAC core for 10Base-T Ethernet network
 - Fully compatible with HPNA 1.0 spec
 - Fully compliant with the IEEE 802.3 & ANSI 802-3 Ethernet standards
 - PCI interface

Intel - 21145 Phoneline/Ethernet LAN Controller



Source: Intel Corporation

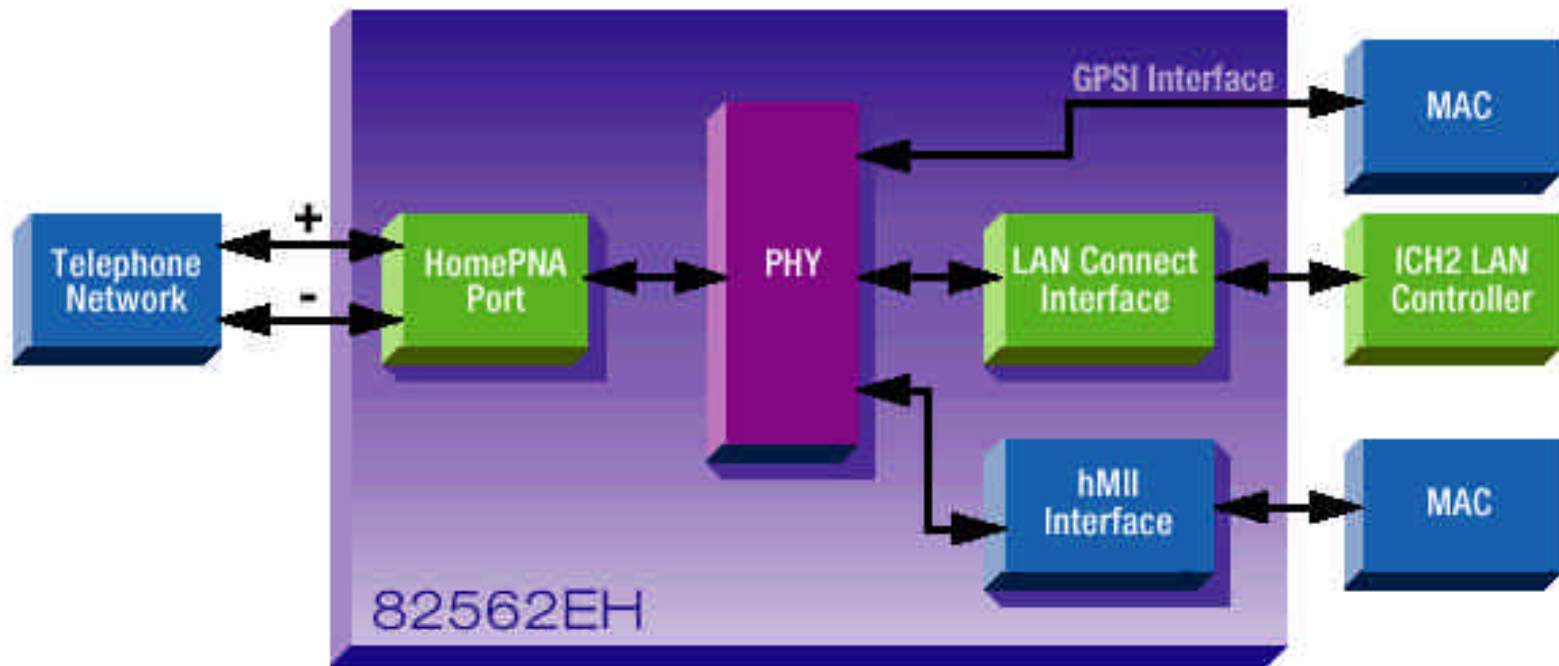


Intel

- ◆ Intel 82562EH - HomePNA LAN Connect Option
 - Highly-integrated, low cost, fully flexible network component ideal for use in a wide range of home networking designs
 - Fully compliant with HPNA 1.0 and includes a 1Mbps HomePNA port for connection to home telephone with three data interfaces
 - LAN Connect Interface for connecting Intel I/O Communications Hub2 (ICH2)
 - HomePNA Media Independent Interface (hMII)
 - General Purpose Serial Interface (GPSI)
 - Targeted for LAN-on-motherboard (LOM), Communication and Networking Riser Cards (CNR), set-top boxes, residential gateways or network information appliances
 - Supports Wake-On LAN
 - Low power consumption

Intel - 82562EH

HomePNA LAN Connect



Source: Intel Corporation



Lucent

- ◆ Home Wire chipset products
 - Create inexpensive home networks using copper phone wires
 - Provide easy interface to communication products such as DSL modems & Ethernet
 - Data transmission rates from 1Mbps to 16Mbps
 - Compliant to HPNA 2.0 10 Mbps spec, backward compliant
 - Allows
 - Fast in-home Web surfing & high bandwidth file transfer
 - Download video & graphics
 - Connect more devices to home networks
 - Multimedia & real-time applications
 - In-home video distribution, voice compression & VoIP

Lucent (contd.) - Products

- ◆ HW3000S Home Wire MSI Controller
 - Integrated 1/10 Mbps device
 - 16 bit microprocessor slave interface
 - Glueless interface to analog front end
 - Interfaces to ADSL modem chip set
 - Ideal solution for broadband residential gateways (DSL, cable modem) & other in-home networking appliances

Lucent (contd.) - Products

- ◆ HW3130 Home Wire PCI/Cardbus HPNA/LAN/Modem Controller
 - Integrated 1/10 Mbps device with a dual speed 10/100 Mbps LAN Controller
 - Interfaces to 10/100 Mbps Ethernet PHY
 - Ideal solution for triple-function PC add-in card
- ◆ HW3100 Home Wire PCI/Cardbus HPNA/Modem Controller
 - Integrated 1/10 Mbps device
 - Support for 56 Kbps modem
 - Ideal solution for dual-function PC add-in card

Lucent (contd.) - Products

- ◆ HW3000M Home Wire MII PHY
 - Integrated 1/10 Mbps HPNA PHY device
 - Media Independent Interface to an external 10/100 Mbps Ethernet MAC
 - Ideal solution for PC and Embedded motherboard applications
- ◆ HW2000 Home Wire Analog Front End
 - Fully integrated analog front end transceiver for HPNA 2.0 10 Mbps home networking



Equipment OEMs

2Wire

- ◆ Specializes in ADSL and HomePNA based RGs
- ◆ HomePortal products
 - Dubbed as the “Intelligent ADSL Residential Gateway”
 - Fully integrated ADSL & home networking platform providing high-speed data, telephony, & digital video services over standard phone lines
 - Combines DSL modem, home networking hub, router, Web server & firewall security in a single package
 - Compatible with 10/100 Ethernet, USB, HomePNA 2.0
 - Teamed up with Proxim, Inc. to offer Proxim’s HomeRF wireless technology for use with HomePortal
 - Provides wireless connectivity in the house

3Com

- ◆ 3Com RG

- Integrates DSL & cable modems and home networking functionality
 - Ethernet, HPNA &/or RF functionality

- ◆ Bridges

- Products connecting to a digital modem & through RF or phonelines to the home networking
- Bridge between Internet (PC/modem) to home networking (intermediary device) without tying all the functionality into one device

Arris/Nortel

- ◆ Arris is a joint venture between Nortel Networks & ANTEC
- ◆ Arris Cornerstone product line
 - Delivers voice & data over cable networks for cable telephony
 - Tested and deployed by AT&T/TCI
 - Voice Port
 - Includes both indoor & outdoor devices with 2 ports on up
 - Switched voice capability only
 - Packet Port products
 - Support packetized data & voice over IP on a HFC network
 - Will support life line phone & service such as 911

Cayman Systems

- ◆ DSL specialist
- ◆ ADSL 3220H products - Internet Gateway
 - Will incorporate Proxim's SWAP/Open Air add in module to its ADSL 3220 router
 - Termination of DSL service
 - HomeRF connectivity for data & voice applications
- ◆ Developed relationship with Pacific Bell to supply ADSL routers & Internet Gateways

Cisco Systems

- ◆ Wide range of consume initiatives working with a number of partners to put Cisco technology into consumers' homes
- ◆ Will NOT sell home networking equipment to end consumers and will focus on
 - Working with service providers to seed high-speed Internet access services for customers
 - Licensing Cisco technology for cable & DSL modems to consumer electronics manufacturers
 - Forming partnerships with other consumer electronics & Internet companies

Cisco Systems

- ◆ Cisco uBR924 Universal Broadband Router
 - Will provide telephony, data and video services
 - DOCSIS compliant CPE device
 - 2 voice ports, 4 data ports & a cable port for telephony, built in Ethernet hub & IPsec support for VPNs
 - Will support multiple services
- ◆ Cisco has formed
 - Partnerships with ShareWave & Echelon
 - Alliances with GTE & Sun Microsystems to test Internet-enabled home products & services

Cisco System's iHG

- ◆ iHG - Internet Home Gateway family of devices provide
 - High-speed
 - Termination for DSL service
 - Data, voice & video communication over a single, always-on broadband connection (HomePNA networking)
 - Represents the new focal point of home communications providing
 - Infrastructure control
 - Simple
 - Intelligent networking services
 - Seamless integration of data, voice & video to deliver new services to the home

Cisco - iHG

- ◆ Flexible architecture
 - Incorporates open standards to interoperate with other standards-compliant products
- ◆ Provides QoS
 - Seamless support for data voice & video without configuration requirements
- ◆ Intelligent packet filtering
 - Certain traffic is permitted or denied by addresses or application types

Cisco - iHG

- ◆ Designed to enhance the online experience
 - Enabling services to the home
 - Unlike modems which are simple access devices
 - Unlike small routers designed for business applications
 - Provides the ability to network smart appliances
 - PCs, telephones, fax machines, DVD players, digital cameras, security systems, climate controllers, lights, utility meters & kitchen appliances
 - Requires no management from the user
 - Remotely manageable by a service provider
 - Easily provisioned
 - Remotely configured, monitored & tested by a service provider with no user intervention
 - Minimizes costly truck rolls

emWare & Invensys

- ◆ Funded by AT&T
- ◆ Invensys provides embedded chips
- ◆ emWare provides communications software solutions for networking e-smart devices
 - End-to-end solutions such as emGateway, emAccess
- ◆ Together provide a product: ControlServer
 - Contains emWare's device-networking software
 - Low cost control for home systems & appliances

Emerald Gateway International

- ◆ Product: Energy Service Gateway
- ◆ Metering, load control, home security, home control functions (CEBus based)

Ericsson

- ◆ Most active in the home networking & RG market
 - Founding member of the OSGi
 - Pushing the e-services concept
 - Market where network operators use a RG such as the e-box
 - Then allow different vertical service providers use the CPE equipment to distribute their services on the network operators infrastructure
- ◆ Developed an RG called the e-box
 - Positioned as an 'Open Services Gateway'
- ◆ Also sells e-manager 901 Service & Management Center
 - Hardware & software targeted at network operators that provisions services & Internet access to end user

Ericsson e-box Architecture

- ◆ PC based architecture
- ◆ 32 bit CPU
- ◆ 8, 16 or 32 MB of DRAM memory
- ◆ 4, 8 or 16 MB of Flash memory
- ◆ 128 Kb of SRAM, battery backed
- ◆ LONWorks interface for home control functions
- ◆ Two I/O slots for PCMCIA cards
- ◆ RS232C Port



Source: Ericsson

Ericsson e-box

- ◆ PC architecture with no moving parts
- ◆ Has a Java Virtual Machine
 - Intended to allow for software downloads via the access network
- ◆ Currently supports Ethernet & LONWorks for home networking interfaces
- ◆ Will support Bluetooth, HomePNA, SWAP
- ◆ Targeted for \$400-500

General Instrument/Motorola

- ◆ Working on a 'Communications Gateway'
 - Will connect to the network via a HFC feed & then offer 4 basic lines of telephony service
 - Will be network powered
- ◆ Owns 80% stake in Next Level Communications
 - Investment into RG pie

Global Converging Technologies

- ◆ Product - Cendis

- Scaled down PBX that supports up to 4 voice lines
- Limited data support
- System consists of a RF base station plus two cordless phones
 - RF channels run over a 900 MHz spread spectrum on technology provided by Butterfly Communications
- Currently supports control protocols such as CEBus & LONWorks, but in future will support higher speed data networking protocols such as HPNA and HomeRF

- ◆ Product - Netdisplay

- Web pad

IBM

- ◆ Developed deals with system integrators such as Ameritech
- ◆ Cofounder of OSGi
- ◆ Home Director home network connection center
 - In-home hub for different types of media such as Cat 5, copper wiring, coax & POTS wiring
- ◆ Intelligent Gateway
 - PC based architecture
 - 486 processor, 4Mb of flash, 16Mb of RAM
 - Control is based on CEBus, HPNA, HomeRF

Intel

- ◆ AnyPoint brand of home networking products
 - HomePNA and HomeRF based home networking

Motorola

- ◆ Leading cable modem vendor
 - Owned 39.1% of the cable modem market share
- ◆ Bought leading set-top box - General Instrument
- ◆ Purchased 2-3% (\$10 million) stake in Proxim
 - Co-development of HomeRF based cable modem products
- ◆ Actively developing RG products - "Broadband Gateways"
 - Comes in two flavors
 - DOCSIS cable modem with HPNA based home phoneline LAN interface
 - DOCSIS cable modem with HomeRF LAN interface
 - Will deliver more intelligent services

Motorola (General Instrument)

- ◆ GI used to be the largest set-top box manufacturer
- ◆ 1998 had revenues of \$2 Billion & shipped ~5.7 million set-top boxes
- ◆ Partnered with Cisco Systems for the AT&T/TCI network
- ◆ GI is trying to focus its DCT-5000+ digital set-top box as a residential gateway incorporating
 - Cable modem technology
 - Broadband Telephony Interface (BTI)

Next Level Communications (NLC)

- ◆ Limited partnership between Spencer Trask Company & General Instrument (GI is now part of Motorola)
 - GI is a limited partner with an 80% equity stake in NLC
- ◆ Field trials are on with US West-Quest in Phoenix, AZ
 - Providing voice, video, data services over one line as part of US West's TeleChoice Digital TV and on-line services
- ◆ Partnered with Proxim to integrate Proxim's HomeRF technology into NLC's ultra high-speed RG
 - Distribution of toll-quality cordless voice & shared broadband Internet access wirelessly in and around the home

Next Level Communications (NLC)

- ◆ N3 - In-home RG
 - Access point for VDSL over twisted pair copper
 - Set-top box incorporating several MPEG decoders
 - Handles multiple concurrent MPEG streams at one time & can tune up to 3 TVs concurrently
 - Has a 10Base-T Ethernet hub & S-Video output
 - Uses a Motorola 860 RISC based processor
 - Uses VX Works from Wind River Systems as its RTOS
 - No hard drive disk currently
 - Next generation will incorporate a HDD

Nokia

- ◆ Released first Home Gateway product - Nokia MW 1122
 - Provides high-speed, wireless Internet connectivity & access to multiple device within the home & SOHO environment
 - Combines wireless LAN & ADSL
 - Simplifies access to data services by providing multi-megabit wireless connectivity for several interoperable devices
 - Precursor to a number of sophisticated Home Gateway networking solutions

Pace Micro Technology

- ◆ World's largest dedicated manufacturer of set-top boxes
- ◆ Model: Set-top Box evolves into a RG
 - Phase one: Set-top box - Broadcast TV into the home
 - Phase two: Creating the home gateway - High speed two way data access into the home
 - Phase three: The networked home - Home gateway delivering information around the home
- ◆ Believes that the TV remains fundamental to the consumer proposition
 - Interactive services offer incremental revenues

Panja

- ◆ New name for the company formerly known as AMX
- ◆ Wholly owned subsidiary of PHAST
 - Specializes in the design & manufacture of industrial & residential control & automation systems
- ◆ Internet Home "Entertainment Gateway" - Panja 1000
 - Complete entertainment system controller
- ◆ Panja 2000 - "home control and information gateway"
- ◆ Coupling hardware with suite of software & services that enable the delivery of Internet content

Panja

- ◆ “Entertainment Gateway” - Panja 1000
 - Connect the Internet directly to stereos, TVs, VCRs
 - Delivery of IP content is enabled through a cobranded Cisco cable modem
 - Uses Motorola Coldfire processor operating at 70MIPS
 - home networking interfaces include Ethernet port, HPNA & HomeRF
 - Has a DCP server to handle IP subnet allocation
 - User interface is a handheld touch panel operating at 2.4GHz spread spectrum channel
 - Price: \$1000-2495
 - Located in the entertainment closet

Panja

- ◆ EP3 (Entertainment Processing Level 3) - Software
 - Selects and decodes MP3, MPEG, Real Audio, Real Video & other encoding schemes
 - Offered in conjunction with its Panja 1000 & 2000 gateways
- ◆ Partnered with Infoseek/Go Network which will offer content as the basis of entertainment oriented Broadband Blast service

Panja

◆ Services

- Broadband blast
 - Multimedia service tailored for delivering MP3, MPEG video & other multimedia content to non-PC devices such as TV, stereo
- IControl
 - Internet based home control service that allows subscribers to access their homes remotely for control & security
- PanjaCast
 - Personalized information delivery service to Internet appliances such as webpads

Philips (Royal Philips Electronics)

- ◆ No. 2 position in worldwide set-top box market
- ◆ Central Gateway home server
 - Concept
 - Integrates a broadband receiver, home network system, a variety of storage systems in one box
 - Capacity to perform multiple tasks using the home networking in different rooms
 - Wireless IP telephony; watch, record & playback video programs; Bluetooth-based wireless download of MP3 files, remotely record MP3 files on a CD, simultaneous Web surfing on a web tablet

Philips

- ◆ Central gateway
 - Advanced home server system code named “Rooster”
 - Runs on 2 TriMedia processors
 - Sports 3 V tunes to watch, send & record video, 16MB of RAM, DVD player/recorder, CD recorder, 27GB HDD
 - Provides connections to the Internet, wireless IP telephony, full infrared and Bluetooth based home networking
 - Voice operated
 - Offers profile-based service
 - Fingerprint recognition system embedded in its small touch screen-based remote control unit communicates the fingerprint information to the home server, which can then identify the user
 - Sorts out user’s preferred music & video selections to make navigation easier

Proxim

- ◆ Leading supplier of
 - Spread spectrum wireless LANs (IEEE-802.11) products
 - HomeRF products for interoperable cordless consumer devices - home networking
- ◆ Harmony software products
 - Provide interoperability with both HomeRF & IEEE802.11 stds.
 - Will include PC card, USB card & a cordless design-in module for radio integration within OEM products
 - Add in module is a contributing technology for a RG
 - Enables an access termination device to then connect other connected devices that support HomeRF protocol
 - Has a radio and MAC on the module
 - 2/3rd the size of a business card

Proxim

- ◆ Motorola & Intel have each purchased minority shares to leverage Proxim's expertise in wireless networking
 - Both companies have announced RGs with Proxim card
- ◆ Teamed up with 2Wire to offer HomeRF technology for use with ADSL-HomePNA RG
 - Provides wireless connectivity in the house
- ◆ Teamed up with Next Level Communications (NLC)
 - Integration of Proxim's HomeRF wireless networking technology with NLCs Nlevel3 Unified Access Platform
- ◆ Cayman Systems will use a Proxim add in module in its ADSL RG-modem

Sage Systems

- ◆ Product: Aladn Energy Management Suite
 - Proprietary PLC technology for energy management
 - More than 1 million AMR devices sold to China

Scientific Atlanta

- ◆ Second largest manufacturer of set-top boxes behind General Instrument
 - \$1.16 Billion in revenues & ~3.3 million set-top boxes shipped in 1998
- ◆ Sold off Maingate control systems division
 - Maingate Customer Communications System is a low data rate system targeted for utilities for tasks such as AMR
- ◆ Will focus on broadband RG market
 - Expand & have its digital set-top box, the Explorer 2000 take on added RG functionality

Scientific Atlanta

- ◆ Explorer 2000
 - Currently has a TCP/IP stack & DAVIC MAC layer functionality
 - The box uses the powerful Micro Sparc 2 processor which can handle TCP/IP protocol processing
- ◆ Future developments
 - Explorer 6000 with more processing power
 - Will include features such as disk drive interface for local caching
 - Convert the box into a true entertainment 'edge server'
 - Development will be based on OSGi & H.323 standards

ShareGate

- ◆ Formerly called Utel
- ◆ RG product called 'Universal Communicator'
 - Generate ring voltages, dial tones & handle multiplexing of different simultaneous phone conversations
 - Remote software addition would turn the device into a small PBX that supports caller ID, intercom & other features
 - Support multiple LAN interfaces such as HomeRF, HPNA & CEBus
 - Will have a Java Virtual Machine for running applications & supporting OSGi software stack
 - Include a RISC processor, some RAM & flash memory
- ◆ Product: ISIS & Jupiter Gateways

ShareGate


- ◆ ShareGate DSL 2000 Residential Gateway
 - Distributes broadband services in home/small office enabling two-way, high-speed Internet, voice & video communications
 - Multiple digital phone lines
 - Provides up to 4 VoDSL lines, plus the standard existing telephone line & data line within one small box
 - Provides simultaneous operation of all lines
 - High speed Internet access using existing phone wires within the house to multiple PCs
 - Home Web Portal - Securely access home PCs from remote location via standard Web browser
 - Gateway management software for remote provisioning, service management, diagnostics, service upgrades
 - Security - Firewall protection

Sony

- ◆ PlayStation gaming platform turned into 'mobile gateway'
 - New model of Playstation - named PlayStation 2 PSone
 - Support broadband network services for mobile applications
 - 4-inch TFT display attachment
 - Can be carried from room-to-room and into the car
 - Bigger than a portable CD player
 - Not battery operated

Agenda

- ◆ Introduction & state of the market
- ◆ The complete home networking solution
- ◆ Residential gateways (RGs) - definition, purpose & types
- ◆ Phased deployment of RGs
- ◆ Consortiums
- ◆ RG solutions available today
- ◆ Xilinx solutions for RGs
- ◆ Summary

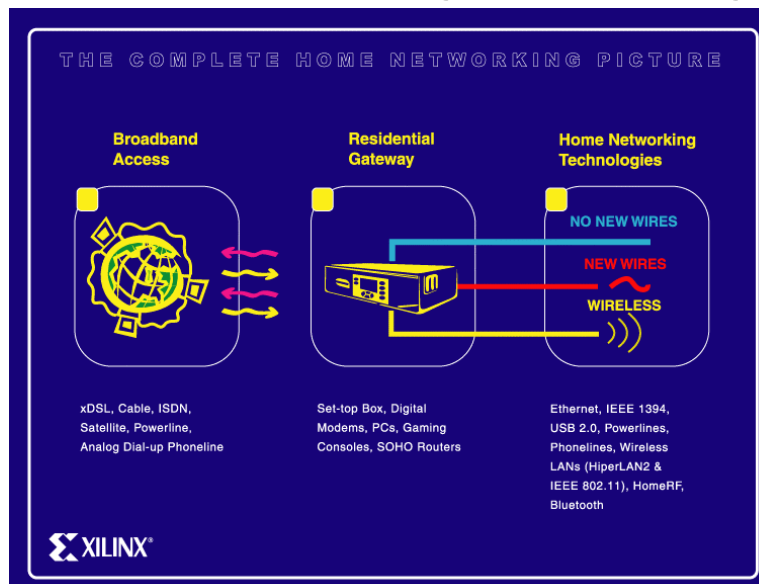


Xilinx Programmable Logic Solutions Enable Residential Gateways

Value Proposition

So What is the RG?

- ◆ Integration of a PC, digital modem, set-top box & a bridge between different broadband access & home networking technologies
 - Several variations depending on needs, geography, cost



RGs will Help Eliminate Disparate Ecosystems

Xilinx Envisioned Gateway Model

- Single “small” box
- Enable high-speed, two-way Internet, voice & video communication
 - Distribution of broadband services within the house/small office
 - Seamless connection & simultaneous operational capabilities
- Multiple digital phone (VoDSL) lines
 - Separate standard existing telephone line & separate data line
- Allow secure access from any Internet-accessible remote location via any standard Web browser
- Firewall security protection
- Extremely affordable price points
- Minimize truck rolls
 - Management software for remote provisioning, service management, diagnostics, software upgrades

Possibilities Within The Gateway

- ◆ Different combinations are available to suit different particular home networking needs
 - Depends on broadband access technologies
 - xDSL, cable, ISDN, satellite, mobile/cellular phones, analog phonelines
 - Depends on in-home network technologies
 - Phoneline, powerline, Ethernet, IEEE-1394/Firewire, HomeRF, Bluetooth, wireless LANs (IEEE-802.11 & HiperLAN2)

Evolving RG Model

◆ Phase 1

- Deployment of multiple RGs each for individual functionality
 - Multiple gateways controlling intelligent information appliances
 - Today PCs, set-top boxes, digital modems are all separate gateways into the house
 - Evolving 'digital box'
- Today, households with multiple PCs or set-top boxes or Internet access through TVs are already Home Networking

◆ Phase 2

- Integration of functionality from different RGs into a single RG or into one 'super set-top box'
 - Audio-Video-Internet Interoperability

Where does Xilinx Fit in RGs?

- ◆ Multiple responsibilities within the gateway
 - Enabling broadband local loop in digital modems
 - xDSL, cable, satellite
 - Bridges
 - Enabling different technologies to co-exist
 - Access points
 - Enabling the information appliance network
 - Within information appliances
 - Web tablets, screen phones, digital TV/HDTV

Chaos in the HN Marketplace

- ◆ Multiple broadband access & multiple home networking technologies

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

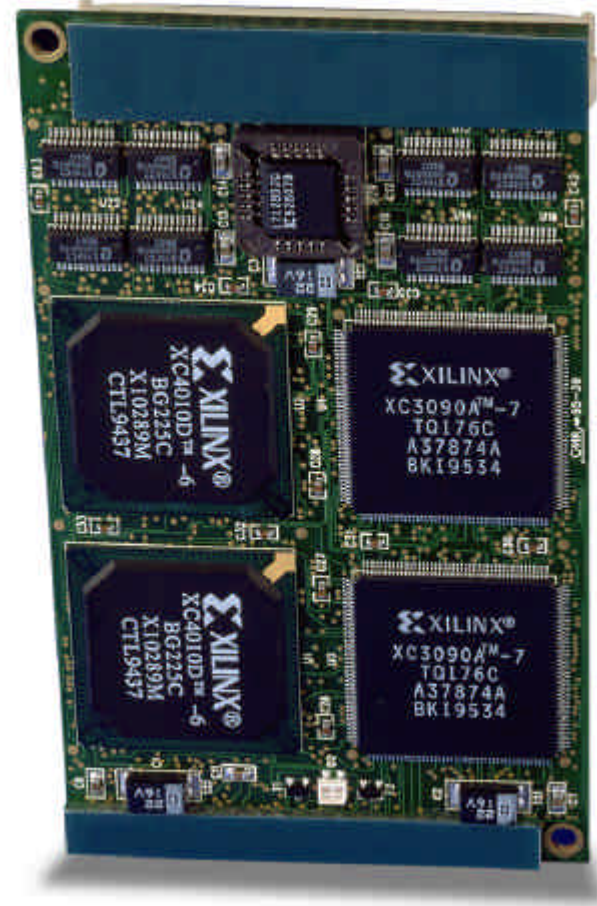
- ◆ Brings about an environment that guarantees unanticipated problems
 - Bugs
 - Incompatibilities
 - The Great Unknown about what is going to be the changes
- ◆ Translates to a steep learning curve
 - Virtually mandates a “Ready, Fire, Aim” development model
 - Plan products for the longest life cycles
 - 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 Consortia



Home
Phoneline
Network
CERTIFIED™

WLANA
The Wireless LAN 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



IP Center



Alliance
CORE



XILINX
ONLINE
UPGRADABLE SYSTEMS

Xilinx - Leader in Core Solutions

Base Level Functions	<ul style="list-style-type: none"> - 82xx, UARTs, DMA - 66MHz DRAM, SDRAM I/F - Memory blocks - 29xx - Proprietary RISC Processors 	<ul style="list-style-type: none"> - 8051 - IEEE 1284 - 200MHz SDRAM I/F - SGRAM, ZBTRAM I/F - Multi-channel DMA 	<ul style="list-style-type: none"> - JAVA - Adv 32-bit RISC Processors - 64-bit RISC - DDR/QDR RAM - 622 Mbps LVDS 	<ul style="list-style-type: none"> - 128-bit processors - Reconfigurable processors
Communication & Networking	<ul style="list-style-type: none"> - Cell assem/delin - CRC - T1 Framer - HDLC - Reed-Solomon - Viterbi - UTOPIA 	<ul style="list-style-type: none"> - 10/100 Ethernet - ATM/IP Over SONET - Cell scram/descram - SONET OC3/12 - ADPCM - IMA 	<ul style="list-style-type: none"> - Network processors - 1Gb Ethernet - SONET OC48/192 - CELP - VoIP - ADSL, HDSL, xDSL - UMTS, wCDMA 	<ul style="list-style-type: none"> - Software Radio - Modems - Neural networking - Emerging Telecom and Networking Standards
DSP Functions	<ul style="list-style-type: none"> - Basic Math - Correlators - Filters: FIR, Comb - Multipliers - FFT, DFT - Sin/Cos 	<ul style="list-style-type: none"> - DCT - Adaptive filters - Cordic - DES - DES - Divider - NCO - Satellite decoders 	<ul style="list-style-type: none"> - MP3 - QAM - JPEG - Speech Recognition - DSP Processor I/Fs - Wavelet 	<ul style="list-style-type: none"> - MPEG - DSP Functions > 200 MSPS - Programmable DSP Engines
Standard Bus Interfaces	<ul style="list-style-type: none"> - CAN - ISA PnP - I2C - PCI 32-bit - PCMCIA 	<ul style="list-style-type: none"> - CardBus - FireWire - PCI 64-bit/66MHz - Compact PCI Hot-Swap - PC104 - VME 	<ul style="list-style-type: none"> - AGP - PCI-X 133MHz 	<ul style="list-style-type: none"> - InfiniBand - Emerging High-Speed Standard Interfaces

1998

1999

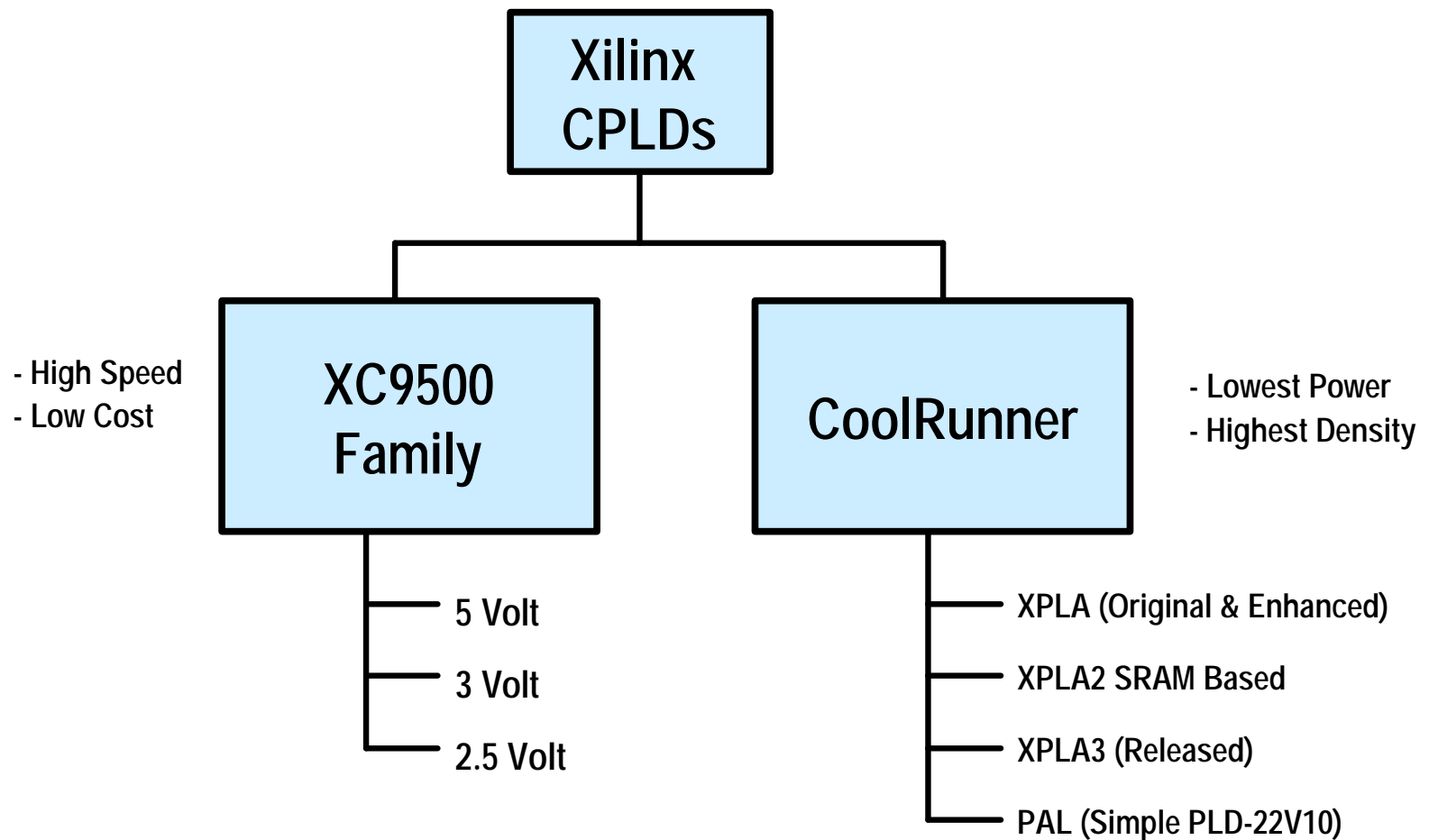
2000

2002

2004



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 $< 100\mu\text{A}$
 - 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

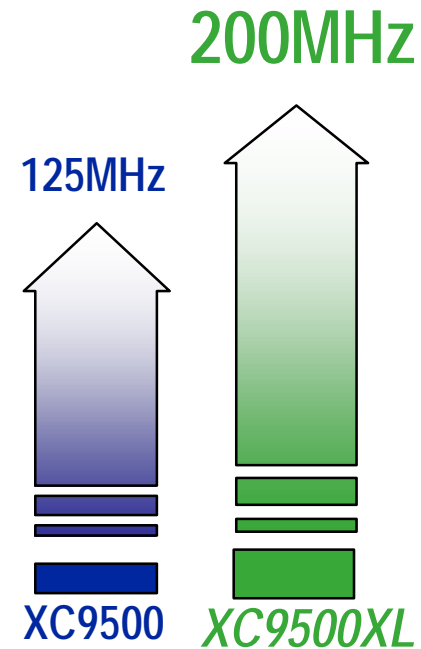


- ◆ No Speed / Power tradeoffs in scaling
 - Can build very large / very fast devices
 - 960 macrocell device @ 7.5 nsec t_{PD}



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

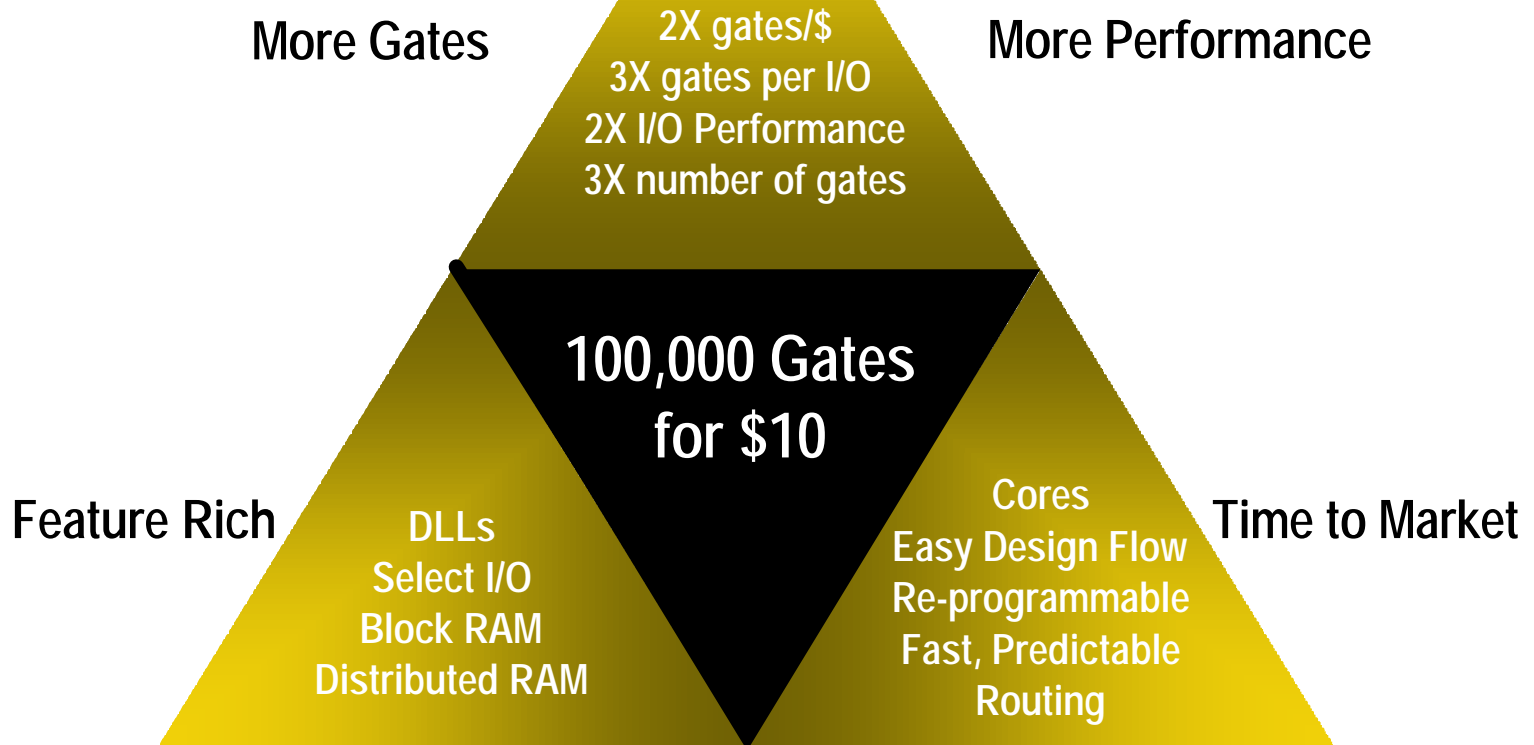
XC9500XL/XV System Features

- ◆ 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



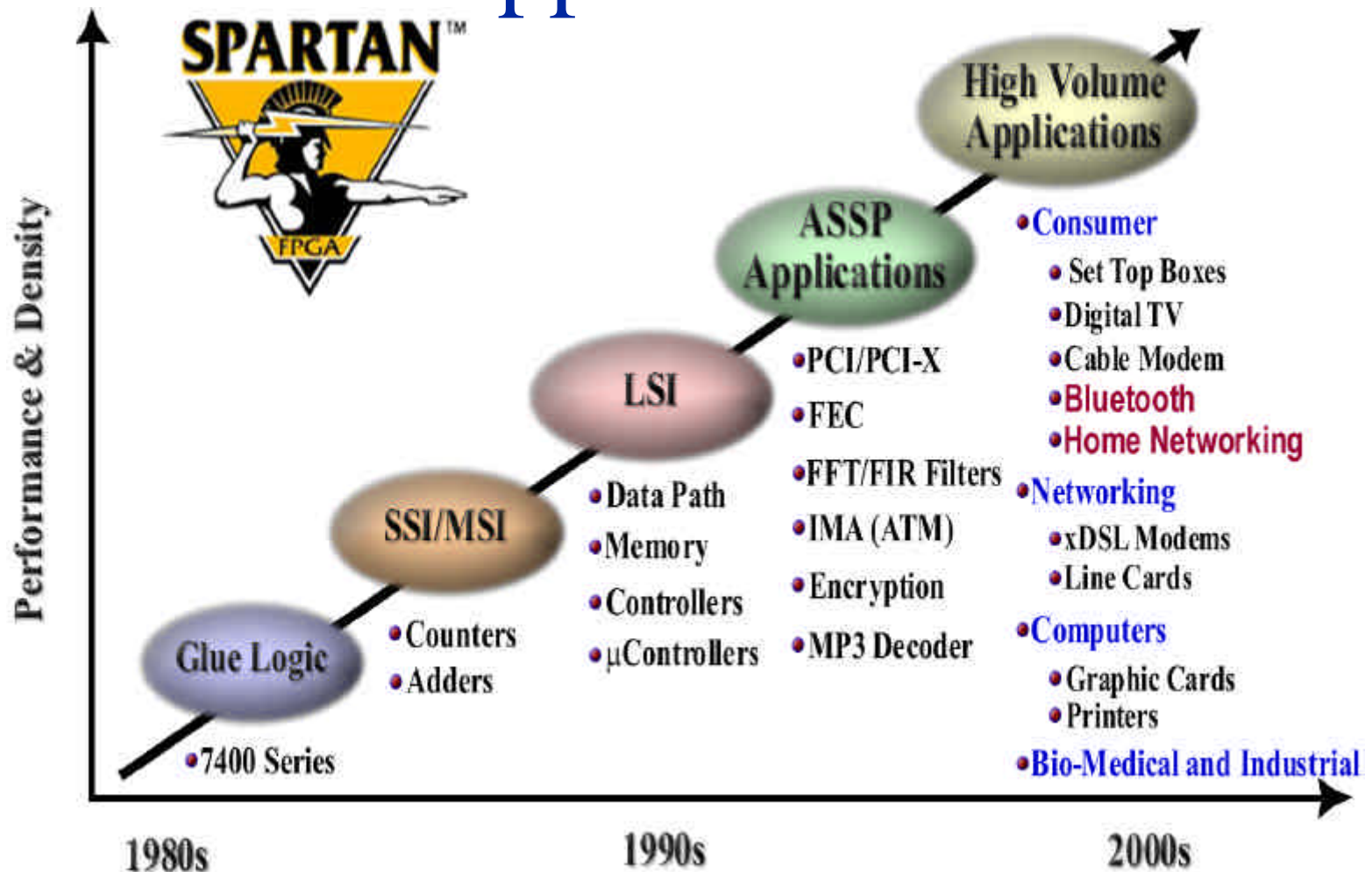
Spartan-II: Extending the Spartan Series



Programmable ASIC/ASSP Replacement!



FPGA Application Trends



Programmable ASIC/ASSP Replacement!

Spartan-II - Architecture Overview

Delay Locked Loop (DLL)

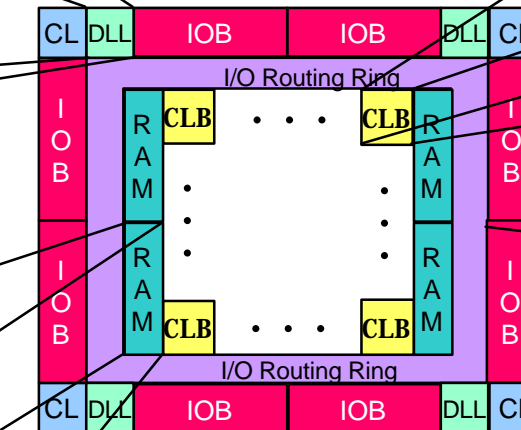
Clock Management:
Multiply clock
Divide clock
De-skew clock

Configurable Logic Blocks (CLB)

Configurable Logic Block Array and Distributed RAM

Block Memory

True Dual-Port™
4K bit RAM
4Kx1
2Kx2
1Kx4
512x8
256x16

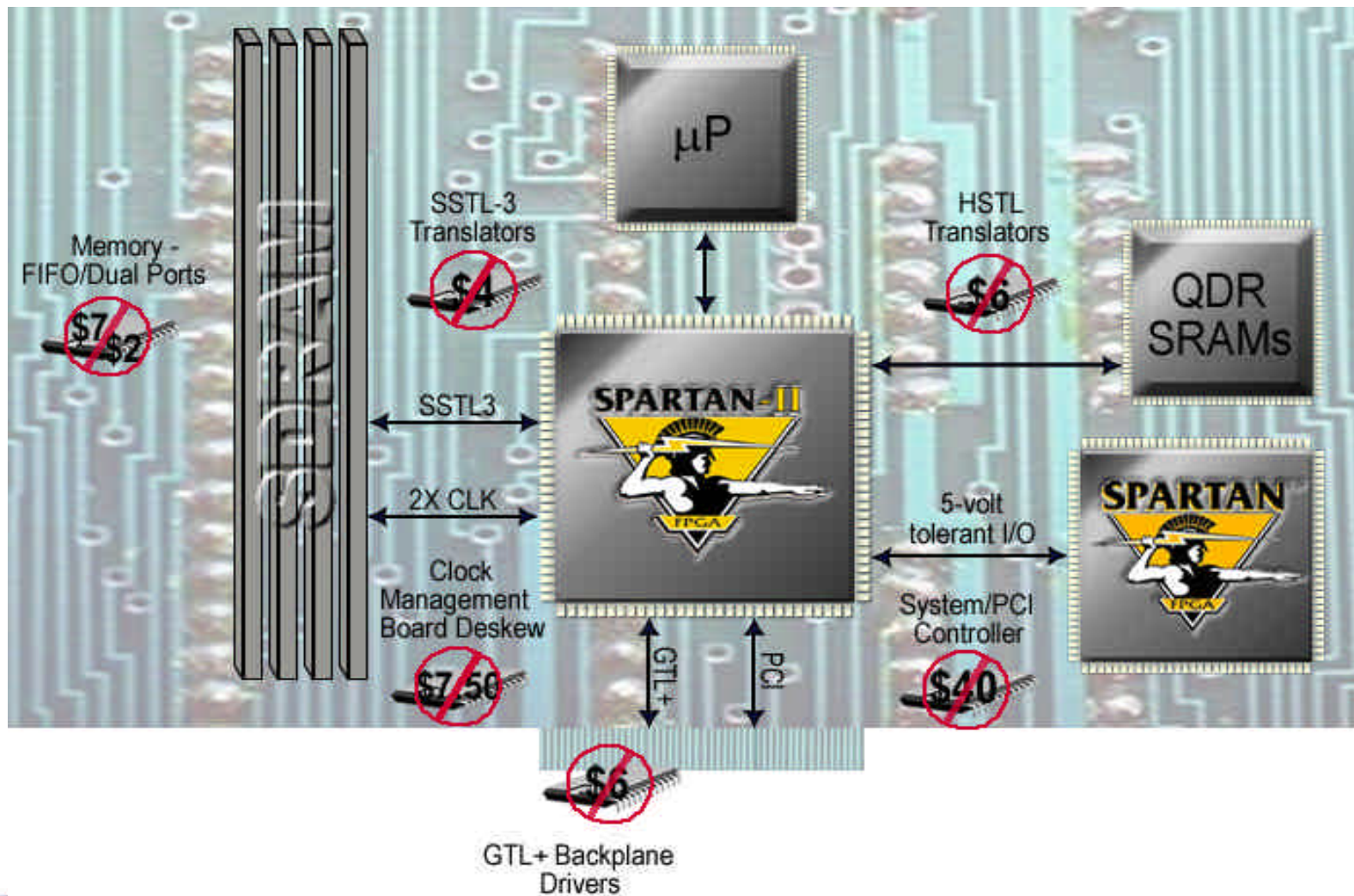


Select I/O™ Technology

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

"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



System Block Diagrams for Residential Gateways

Set-Top Box Based Residential Gateway

Satellite Modem Residential Gateway

Cable Modem Residential Gateway

DSL Modem Residential Gateway

Block Diagram Template / Index



Xilinx Solution



Or



Non-Xilinx Components



Memory



Mixed Signal / RF



CPU

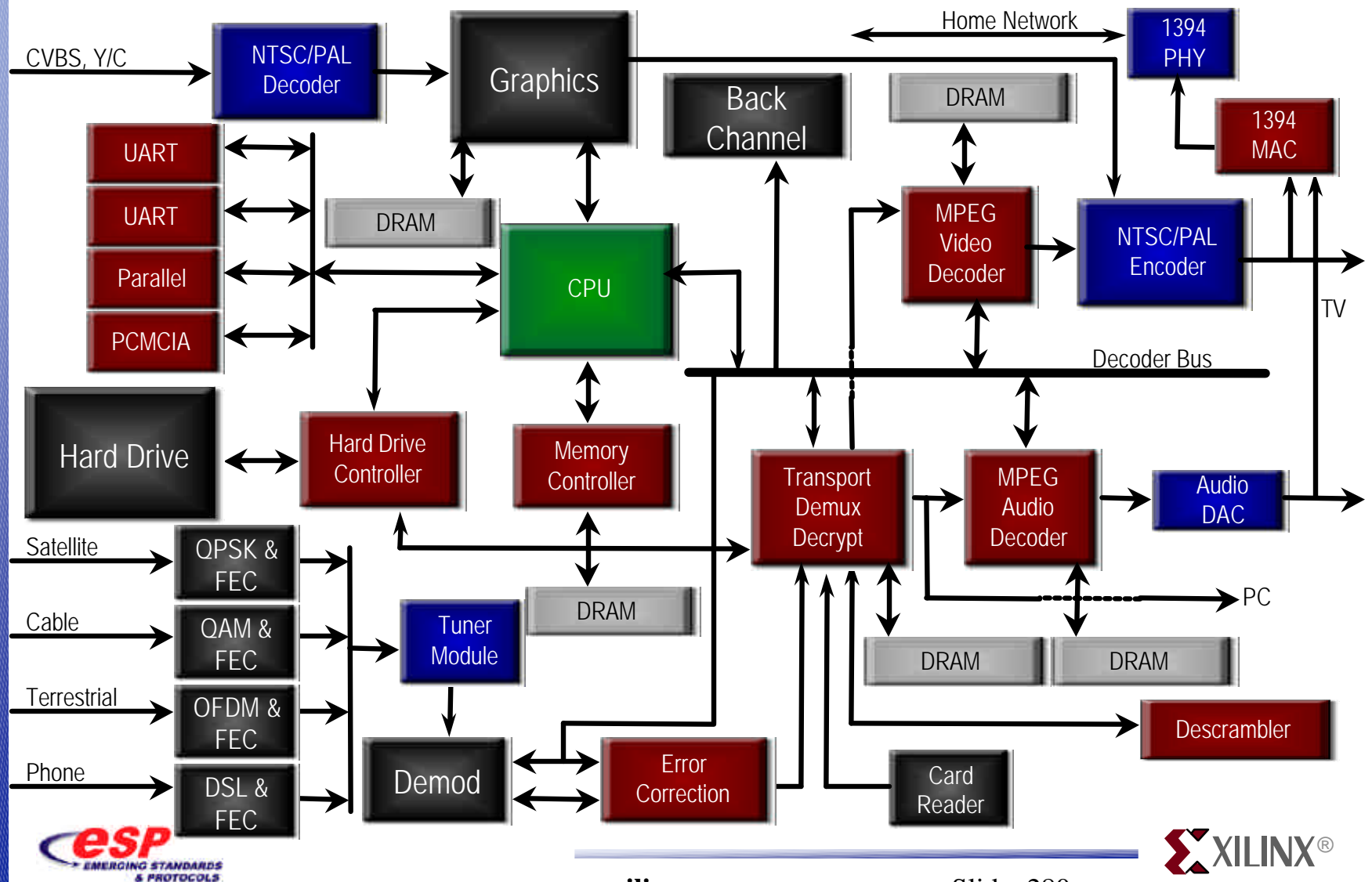


Embedded Chip

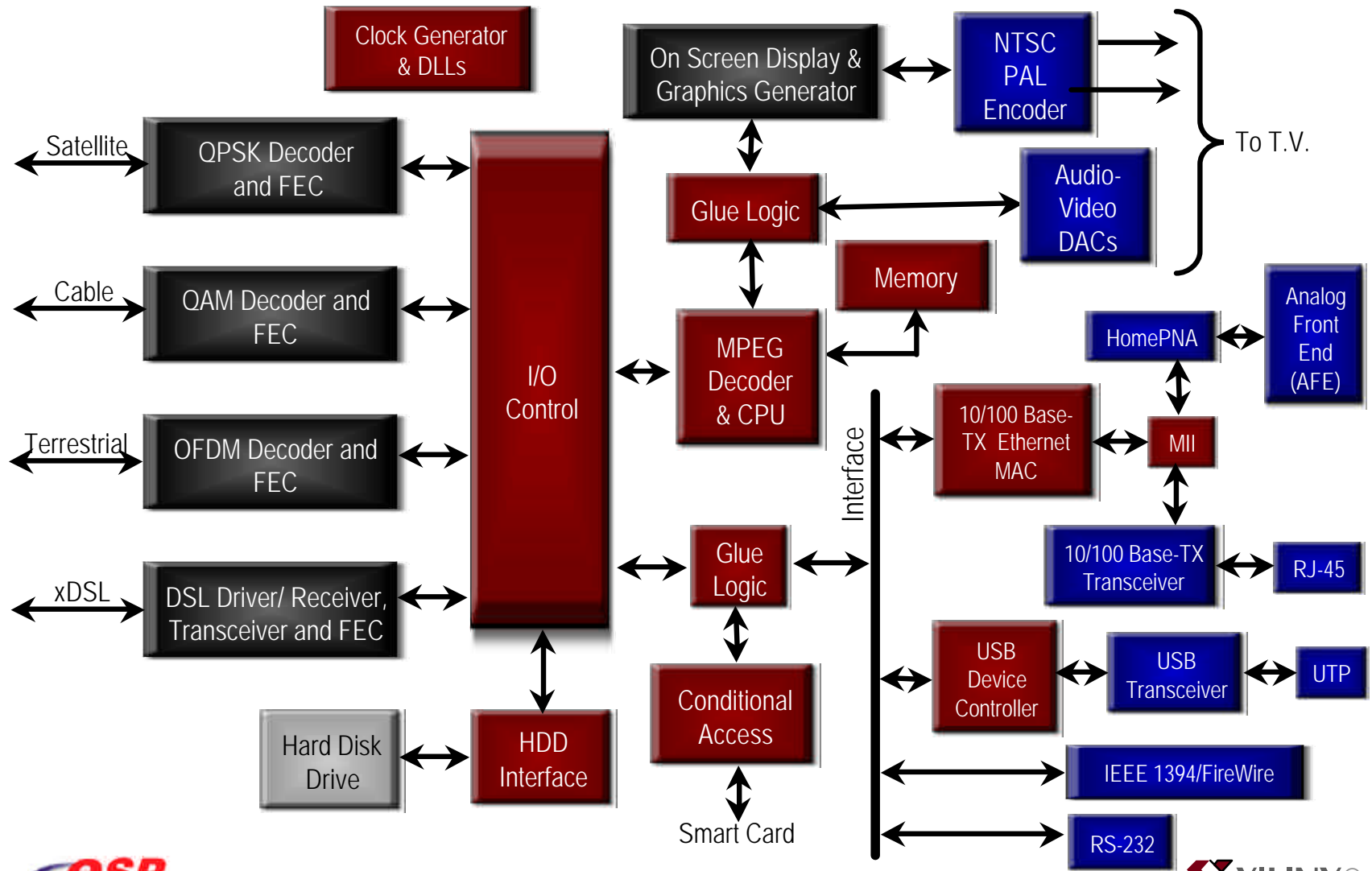
Response	Percentage
Yes	65%
No	30%
Don't know	5%



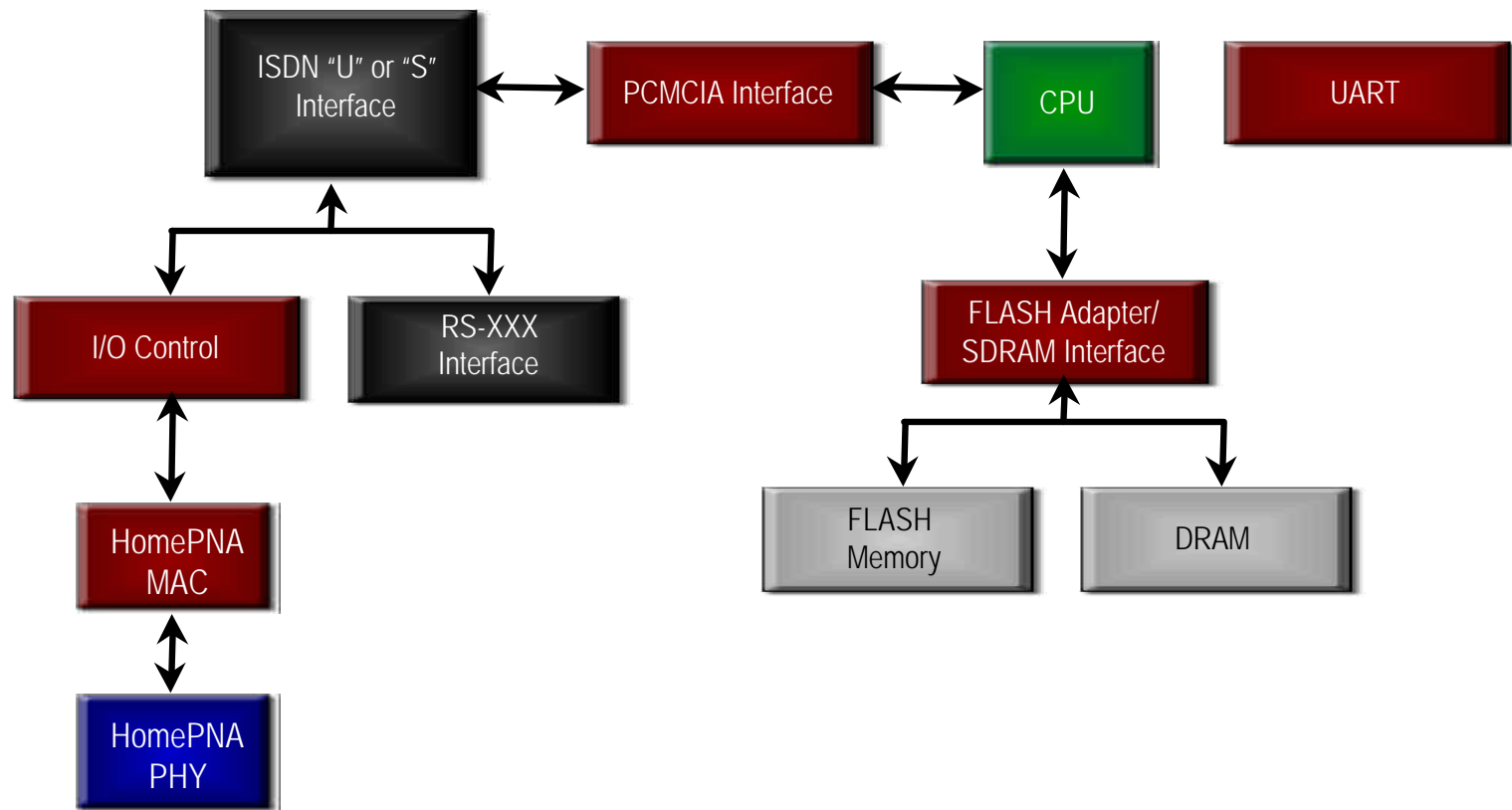
“Super” Set Top Box



Super Set-Top Box: Residential Gateway

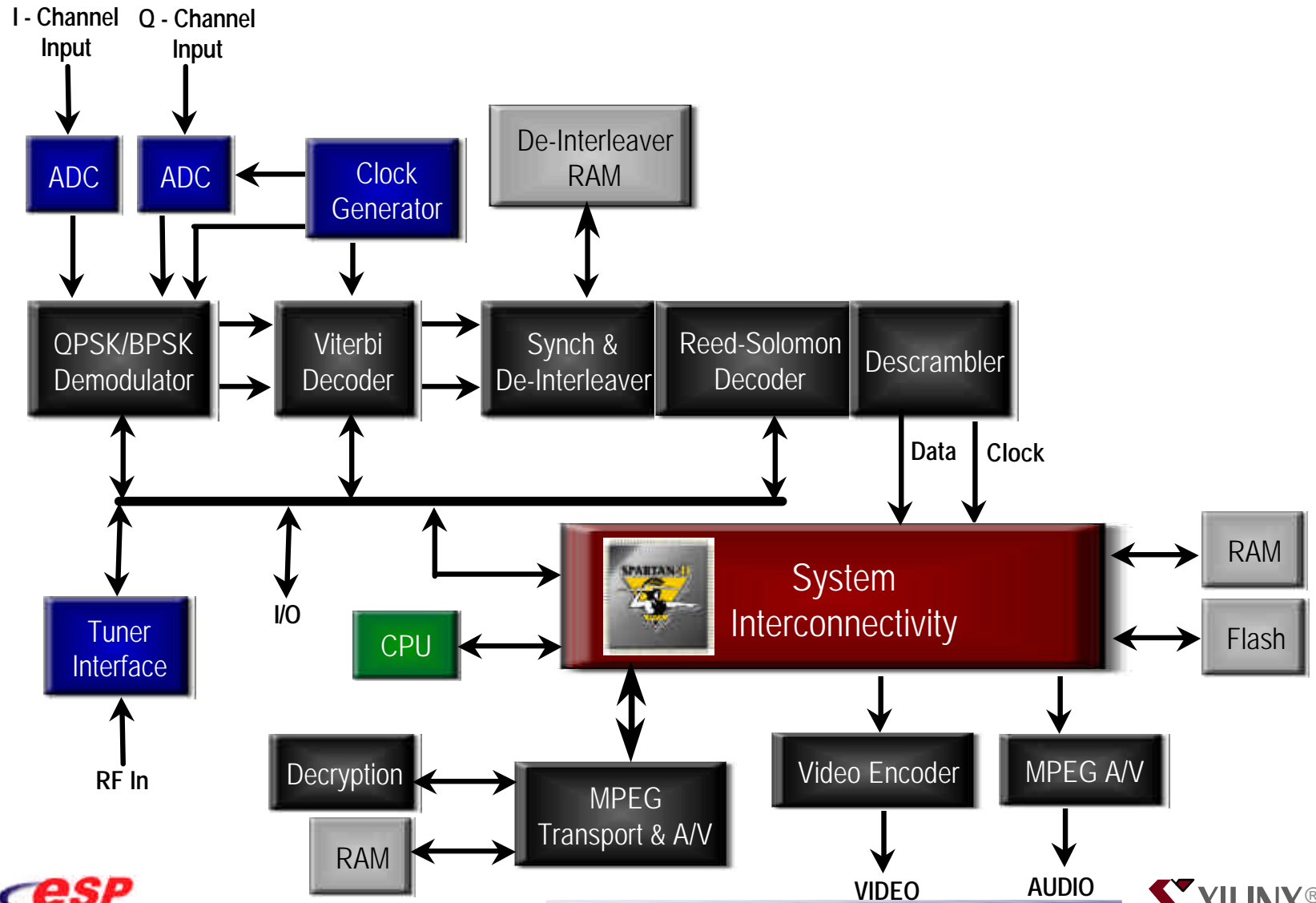


ISDN Modems

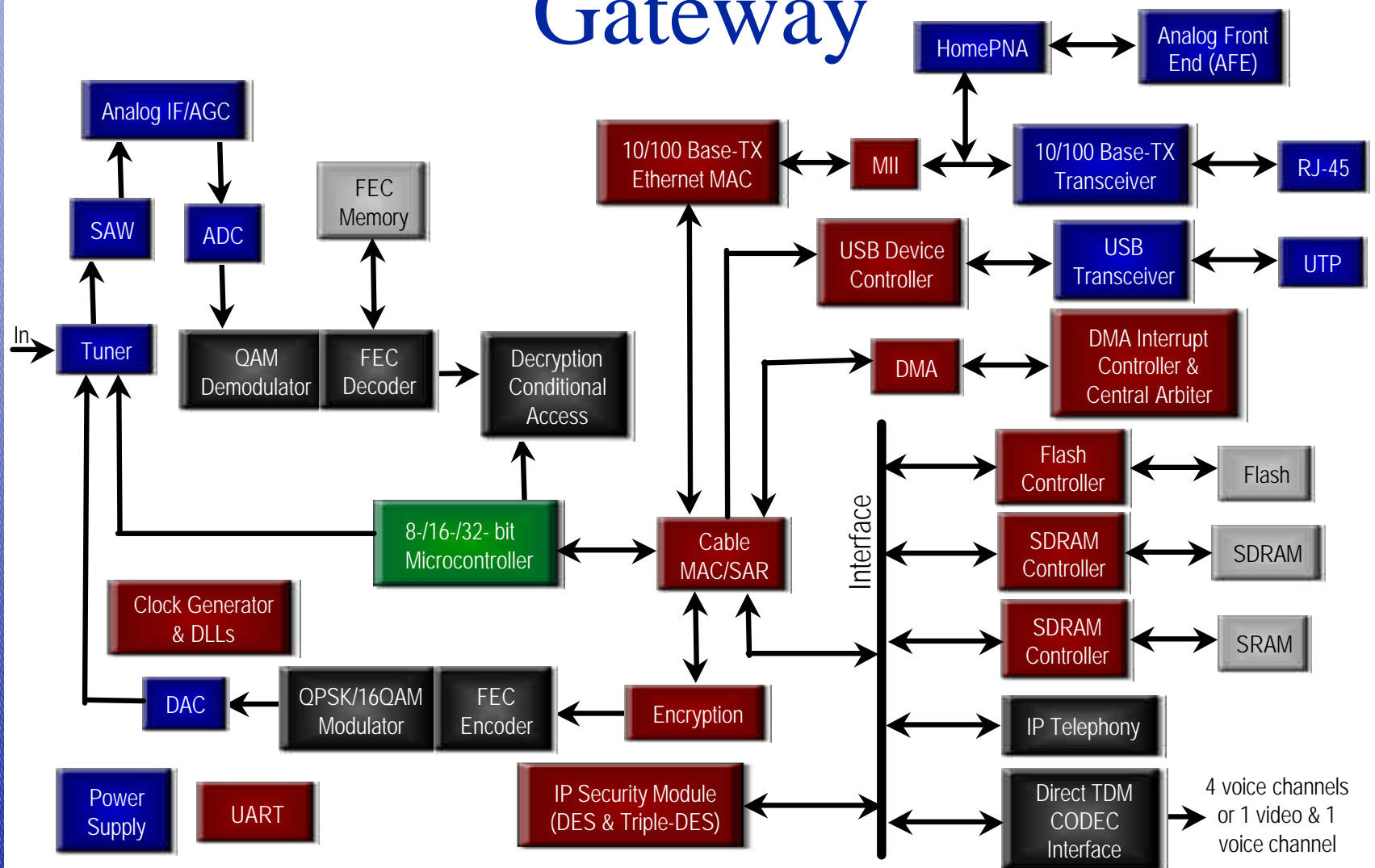


Satellite Modems

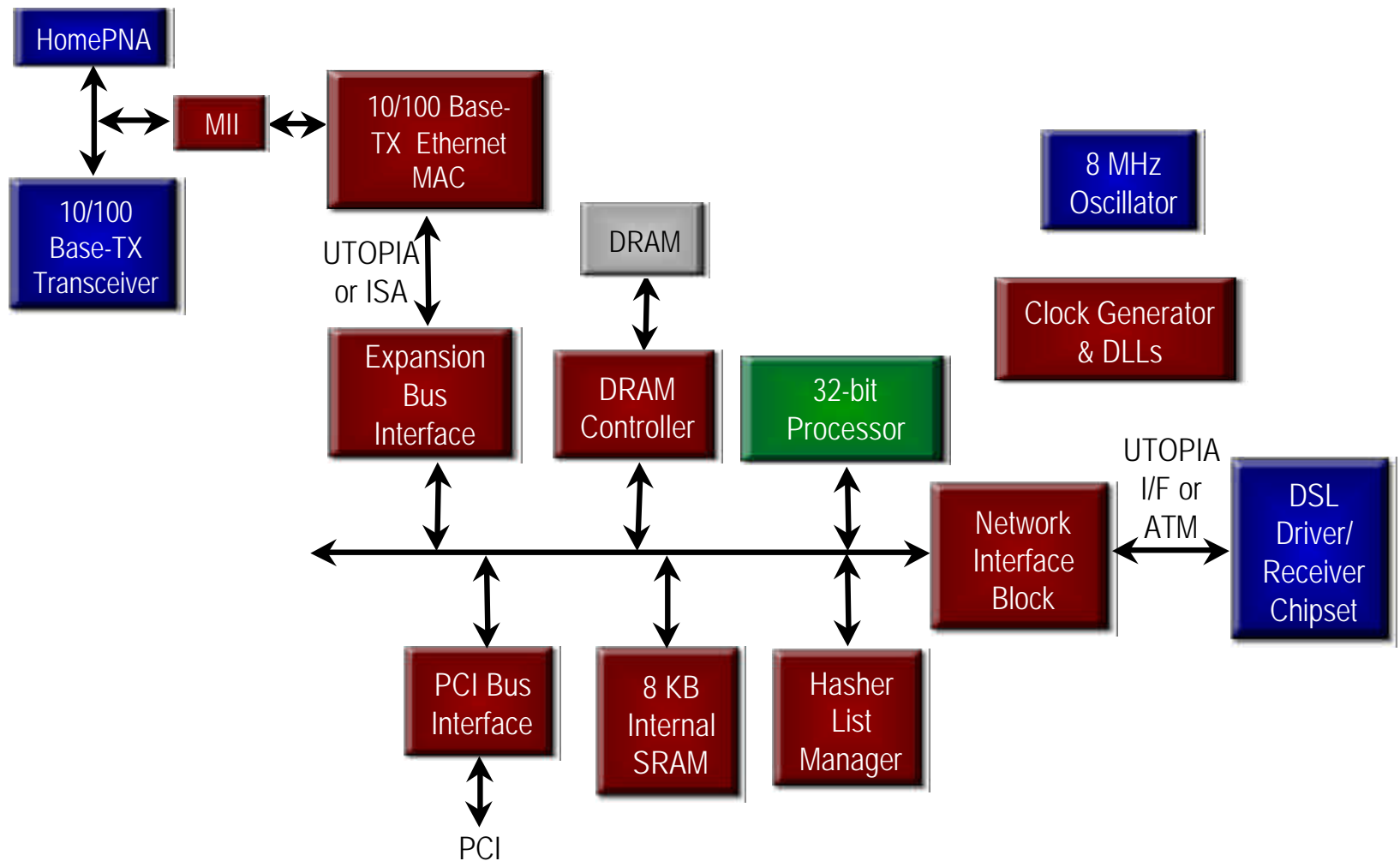
Quadrature Data from Tuner



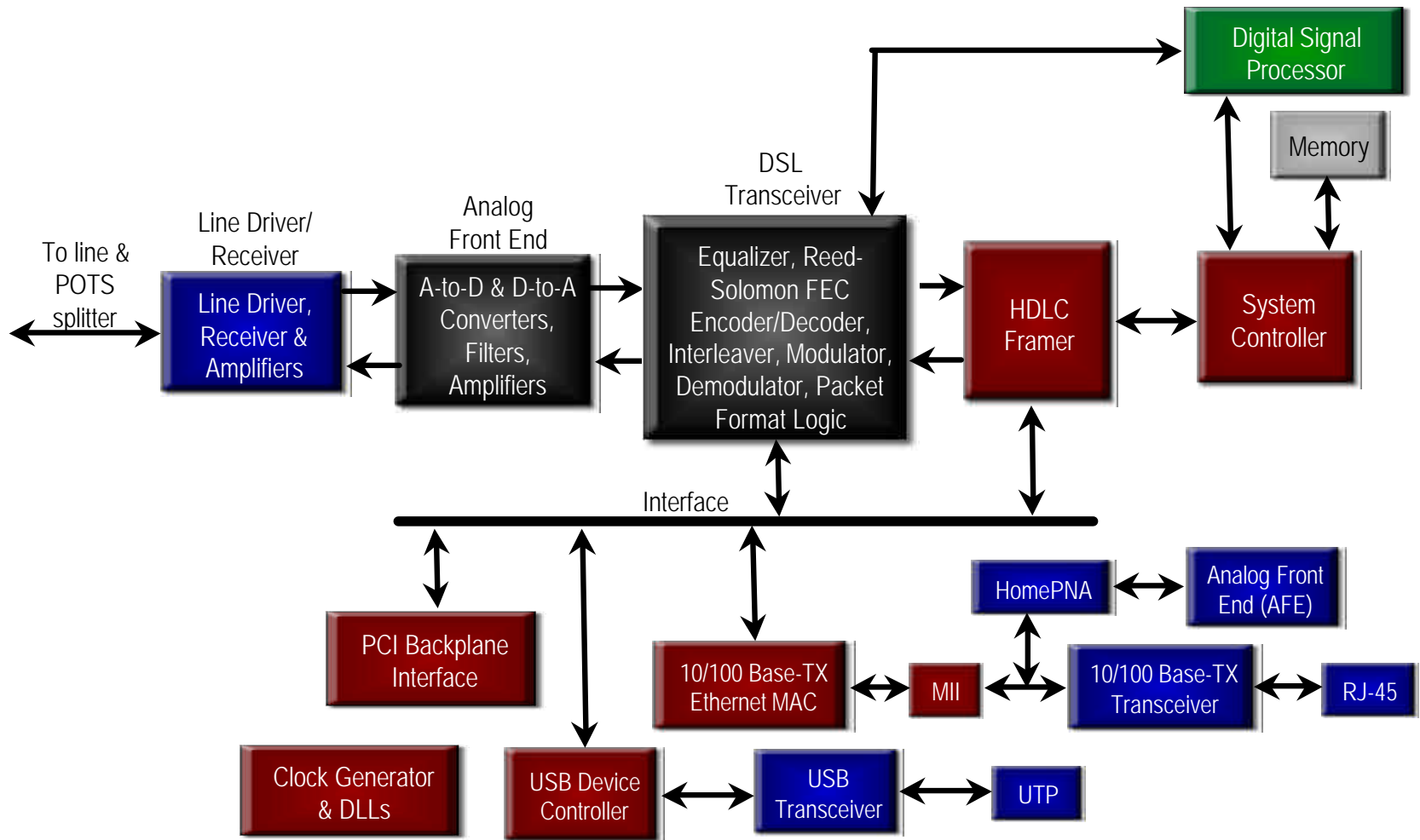
Cable Modem Residential Gateway



DSL Modem Home Gateway



DSL CPE (Customer Premise Equipment)



Spartan-II Solutions for Residential Gateways

- ◆ 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

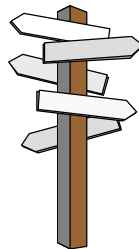
Specification Changes

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

OEM/ Vendor



Market



U.S. Networks Select Digital Broadcasting Format

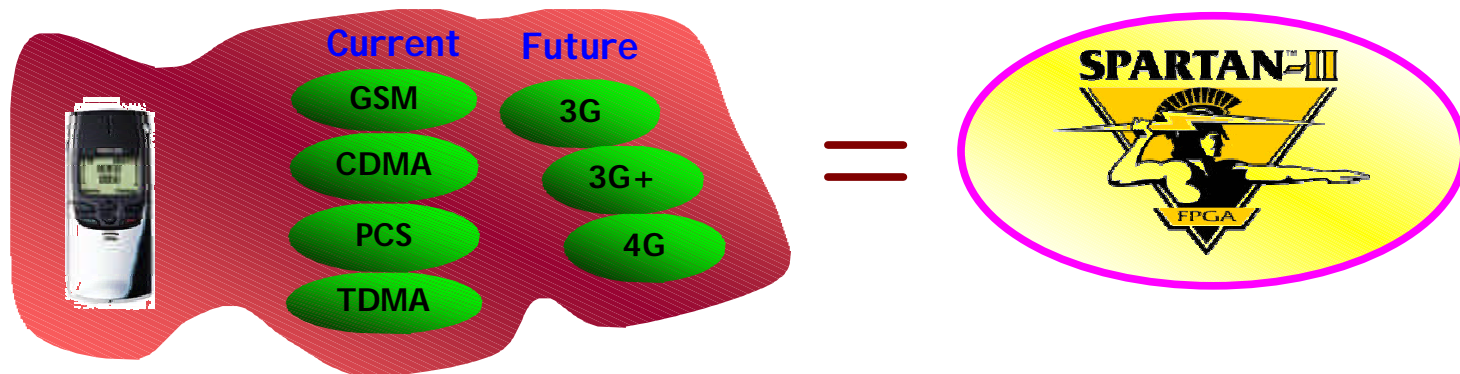
ABC	720-Progressive. For non-HDTV broadcasts, ABC will use 480-line progressive format.
CBS	1,080-Interlaced. Wants to be compatible with HDTV sets as well as normal quality formats on regular analog television sets. Digital broadcasting will begin at select CBS-owned stations in the fall of 1998. By 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

A Programmable Solution Future Proof's Success

New Flexibility from FPGAs

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



Enabling a whole new breed of consumer products



Xilinx & Replay TV
- Revolutionizing consumer TV



Reprogrammable nature allows

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



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 & state of the market
- ◆ The complete home networking solution
- ◆ Residential gateways (RGs) - definition, purpose & types
- ◆ Phased deployment of RGs
- ◆ Consortiums
- ◆ RG solutions available today
- ◆ Xilinx solutions for RGs
- ◆ Summary

Summary

- ◆ The digital consumer revolution & the Internet are forcing broadband into the home
 - Residential gateways provide broadband access to the home and network the information appliances in the home
 - Broadband access technologies
 - Satellite, ISDN, xDSL & cable modems
 - Home networking technologies
 - HomePNA, HomePlug, Ethernet, 1394, HomeRF, wireless LANs
- ◆ OEMs will develop several variations of gateways
 - Broadband access (front) end
 - DSL modem, cable modem, satellite modem based
 - Home networking (back) end
 - HomePNA based, Ethernet based, wireless LAN based

Summary

- ◆ Spartan-II FPGAs, CoolRunner & 9500 CPLDs enable RGs
 - IP cores + Spartan-II FPGAs provide solutions like ASSPs
 - Embedded solutions : FPGA logic not used from IP can be programmed with other IP cores
 - Example: DCT/IDCT and DES/TDES soft IP in a Spartan-II FPGA can be used in multimedia and imaging applications
 - Increases the value proposition and reduces solution cost
 - Features within the Spartan-II provide system integration
 - Reprogrammability enables time-to-market & flexibility
 - Home networking market is rapidly growing and products need to be rolled out
 - Internet Reconfigurable Logic allows time-in-market as specs in emerging technologies keep evolving
 - Cost effective