The Residential Gateway
Agenda

• What is a Residential gateway (RG)?
• Phased deployment of RGs
• Types of RGs and their evolution
• Middleware
• Summary
Home Networking - Four Aspects

Distribution of information (audio, video, data) around the home and the Internet between information appliances
Residential Gateway

The Essential Ingredient For Home Networking

- Single device connects all information appliances to each other and the Internet
- Bridges
  - Broadband access technologies
    - Satellite, ISDN, xDSL, cable modems
  - Home networking technologies
    - No new wires: phonelines, powerlines
    - New wires: IEEE 1394, USB 2.0, Optic Fiber
    - Wireless: Bluetooth, HomeRF, Wireless LANs
- RG Market - US $8.9 billion (by 2003) (Cahners In-Stat Group)
The Residential Gateway

Integrating Broadband Access and Home Networking Functions into One Device

- Set-top Box
- PC
- Gaming Console

- DSL
- Cable
- Satellite
- Wireless

- Home RF
- IEEE 1394
- Home PNA
- HiperLAN2
- 802.11a,b
- Bluetooth
- USB / USB2.0
- Power Lines
- Ethernet

- POTS
- 900 MHz Cordless Phones
Purpose

• Unified platform
  – Central gateway for communications, information & entertainment
  – Access point between the home & outside world
• Primary interface between Internet and Home Network
  – Bridges the different broadband WAN & in-home LAN technologies
  – Bridge between home networking technologies
  – Provides 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
- Provides efficient delivery of new services to the home
  - Streaming video, multimedia messaging, home management, security, and on-line purchasing
RG Requirements

- Broadband access
- Security & privacy firewall
  - Supports secure e-commerce transactions, remote home control, & access from authorized service providers
- QoS for multiple intelligent devices
  - Compete asynchronously for various bandwidth capabilities
- Multi-layer network bridging
  - Protocol translation for multiple home networks
- Upgradeable platform
RG Deployment -
The Incremental Change

- Phase 1: Broadband Access
  - High speed Internet access

- Phase 2: The Residential Gateway
  - Information distribution to multiple devices

- Phase 3: The Networked Home
  - Data, voice and video delivery around the home
First & Second Generation RGs

• Bridge single WAN and LAN connections
• Types
  – Set-top box RGs
  – Digital modem based RGs
  – PC-based RGs
  – Gaming consoles
  – Screen phones/Web phones/Internet enabled phones
  – Digital TV
  – Utility centric RGs or service gateways
  – Next generation RGs
Digital Set-Top Box

- Set-top box - today
  - Deliver signals to a single device like cable TV or PC
  - Advanced models support HDD storage and web browsing
  - Needs to reside near cable / antenna connection
- Evolution into a RG
  - Distributes broadband to multiple devices within the home
  - Expands upon the capabilities of advanced set-top boxes
  - Can be located wherever convenient
  - Supports new services including automated meter reading and home automation
Set-top Box

- NTSC PAL Encoder
- Audio-Video DACs
- QAM Decoder and FEC
- OFDM Decoder and FEC
- I/O Control, Glue Logic, Memory Controller, System Controller, Microcontroller
- On Screen Display & Graphics Generator
- HDD Interface
- Clock Generator & DLLs
- Conditional Access
- Conditional Access
- USB Device Controller
- USB Transceiver
- 10/100 Base-TX Ethernet MAC
- MII
- Terrestrial
- Cable
- HDD
- Smart Card
- To T.V.
Set-top Box / Residential Gateway

- QPSK Decoder and FEC
- OFDM Decoder and FEC
- QAM Decoder and FEC
- Cable
- Terrestrial
- xDSL
- DSL Driver/Receiver, Transceiver and FEC
- Clock Generator & DLLs
- HDD Interface
- Conditional Access
- Hard Disk Drive
- Smart Card
- I/O Control, Glue Logic, Memory Controller, System Controller, Microcontroller
- On Screen Display & Graphics Generator
- MPEG Decoder
- HDD Interface
- Conditional Access
- NTSC PAL Encoder
- Audio-Video DACs
- To T.V.
- 10/100 Base-TX Ethernet MAC
- IEEE 802.11 MAC
- IEEE 802.11 Radio
- USB 2.0 Device Controller
- USB 2.0 Transceiver
- IEEE 1394 Link Controller
- IEEE 1394 PHY
- HomePNA
Broadband Access Technologies

• ADSL - Asymmetrical Digital Subscriber Line
  – Two standards: G.Lite ADSL & G.dmt ADSL
  – Speeds: Downstream up to 8Mbps & upstream up to 1.5Mbps

• Cable
  – Internet access using same cable used for TV transmission
  – Speeds up to 10Mbps

• ISDN - Integrated Digital Services Network
  – High-speed (up to 144Kbps), fully digital telephone service

• Satellite
  – Uses direct broadcast satellites that transmit TV programs
  – Download 350Kbps - upload limited by analog modem speeds
Digital Modems

- Enable broadband access to the home and provide
  - High-speed connection to the Internet
  - Always on
  - Simultaneous up-link and down-link communication
  - Provides > 25X the bandwidth vs. analog modems
Modem-Centric RGs

- Broadband termination device with integrated routing capabilities for Home Networking technologies
  - ADSL, Cable
- Sold in conjunction with services
  - Can be partially or completely subsidized
  - Consumer installs the gateway
    - The service provider saves the cost of a truck roll
- Configured to support only one specific HN technology
  - HomePNA, Ethernet, USB or wireless
  - Support for additional technologies requires buying a new gateway & reconfiguration of the home network
Satellite Modem

Quadrature Data from Tuner

I - Channel Input  Q - Channel Input

ADC  ADC  Clock Generator  De-Interleaver RAM

QPSK/BPSK Demodulator  Viterbi Decoder  Synch & De-Interleaver  Reed-Solomon Decoder  Descrambler

De-Interleaver  RAM

Tuner Interface

CPU

RF In

Decryption

MPEG Transport & A/V

Video Encoder

MPEG A/V

SYSTEM INTERCONNECTIVITY

RAM

Flash

VIDEO

AUDIO
Satellite Modem Gateway

Quadrature Data from Tuner

- I - Channel Input
- Q - Channel Input

ADC → QPSK/BPSK Demodulator → Viterbi Decoder → Synch & De-Interleaver → Reed-Solomon Decoder → Descrambler → HomeRF Module and Radio

- Data
- Clock

ADC → Clock Generator

Clock Generator → De-Interleaver RAM

De-Interleaver RAM → Clock Generator

Clock Generator → RAM

RAM → Flash

CPU

I/O

Tuner Interface

RF In

Decryption

MPEG Transport & A/V

Video Encoder

MPEG A/V

VIDEO

AUDIO

System Interconnectivity
xDSL Modem

- Line Driver/Receiver ASSPs provided by Broadcom, Alcatel, ITEX, Conexant, Lucent, Analog Devices

- To line & POTS splitter
- PCI Backplane Interface
- RS-232
- Ethernet
- USB
- HomePNA

- CPU / Digital Signal Processor
- System Controller
- HDLC Controller / Framer
- Line Driver, Receiver & Amplifiers
- Interface

- System Controller
Cable Modem

Connects directly to the CATV outlet & converts TV channel to a fixed lower frequency (6-40 MHz)

ASSPs available from: Sharp, Temic, Panasonic

DOCSIS Transceiver

Performs A/D, D/A, modulation, demodulation (QAM-64/256), Reed Solomon FEC and MPEG frame synchronization. ASSPs are available from Broadcom, Conexant, SGS Thomson, LSI Logic, VLSI Technologies, Philips, Fujitsu, Analog Devices

DOCSIS MAC

Cable MAC extracts data from MPEG frames, filters data, protocol execution, times transmission of upstream bursts. ASSPs are available from Texas Instruments, Broadcom, Conexant

CPU & LAN Controller

CPU is provided by ARM, MIPS, PowerPC

Interface & Memory Controller

ASSPs are available from Texas Instruments, Broadcom, Conexant, SGS Thomson, LSI Logic, VLSI Technologies, Philips, Fujitsu, Analog Devices

USB

HPNA 2.0

RAM

Flash
PC - The RG?

• RG functions such as routing can be performed by a PC that is correctly configured

• PC Advantages
  – Existing PC can do the job

• PC Disadvantages
  – Difficult to set up
  – PC will slow down when used for any other task
  – If the PC crashes the entire home network goes down

• Products typically based upon x86 processor & use ISA or PCI bus
PC - The RG

- Display
- Graphics
- CPU
- Memory Controller
- SDRAM
- LCD Controller
- PCI to PCI Bridge
- PCMCIA
- PCI ISA
- Audio
- USB
- ISA
- UART
- Bluetooth
- Ethernet MAC
- Ethernet PHY
- Modem
- HDD
- HDD Controller
- Speakers
Gaming Console

• Gaming platforms
  – Multi-player gaming requires Internet access
• Most new products have a built-in 56K modem
• Future
  – Broadband connections enable gaming companies to begin e-distribution business such as movies, music, etc.
  – Home networking capabilities
Gaming Console

- CPU
- Vector Unit
- Vector Unit
- Graphics Interface
- Pixel Processor
- Display Controller
- NTSC/PAL Decoder
- TV

- Memory Controller
- 10-Ch DMA
- MPEG-2 Decoder
- I/O Interface
- DRAM
- 48-Ch Sound Chip

- SDRAM
- I/O Processor
- I/O Circuit
- Audio
- Modem

- 2.4 GHz IEEE 802.11 Radio
- IEEE 802.11 MAC
- USB
- PCMCIA Interface

- DVD ROM

- IEEE 802.11 MAC
- IEEE 802.11 Radio
Screen Phones, Web Phones & Internet Enabled Phones

• Integrated telephones with built-in touch LCD screens
  – Enables convergence of voice, video & data communication
  – Users can make phone calls, answer email, & receive limited information from the Internet
Screen Phone

- Clock Generator & DLLs
- Frame Grabbing Chip (CAM DSP)
- Video Encoder
- Video Processor /CODEC
- System Processor
- User Interface Logic (LCD Controller, Keyboard Controller)
- Memory Controller
- Memory Controller
- Analog Front End
- Country specific DAA (Data Access Arrangement)
- DSP (with H.223, H.245, H.263)
- DSP (with V.34, G.723.1, AEC - Acoustic Echo Cancellation)
- Audio In/Out
- LCD
- Keyboard
- Flash
- SRAM
- Camera, VCR, TV
- To TV, VCR
- Video Encoder
- Video Encoder
- Video Encoder
Digital TV RG

- Future digital TVs will assimilate the functions of set-top box and digital VCRs
  - Video recording
  - Email services
- Provide new services
  - Video-on-demand
  - Instant replay
  - Online shopping
  - Interactive TV
Utility-Centric / Services Gateway

- Enabled by network operators or service providers (SP) such as telephone operators, ISP, cable TV operators, utilities
- The utility/SP installs the gateway
  - SP recovers cost of hardware & installation through provision of multiple services
- Provides services such as automated meter reading (AMR), energy optimization, management & monitoring
Preferred Provider for Bundled Services

Source: Parks Associates
Next Generation/Multi-Service RGs

• These devices will evolve based on today’s products
• Highly modular design supporting
  – Multiple WAN sources including wireless, xDSL or cable
  – Multiple LAN/home networking technologies
  – Telephony / voice services
  – Easy installation / set-up
  – Remote management
The “Perfect” RG

The Residential Gateway

- Terminates all external nodes
- Enables multiple services to create surplus value for both consumers & service provider(s)
- Provision for future home services
- Seamlessly integrates with all existing home systems & electronic devices
- Flexibility to allow different means of distribution & installation
An Example Roadmap

Intelligent Premises Gateway
- Remotely Upgradeable
- Firewall
- Self Installation
- User Friendly Provisioning Interface
- Derived Voice (VoDSL upgradeable to VoIP)
- Wireless Voice
- Modular System Architecture
- PBX Like Features, and available on POTS
- Supports Multiple Packet Network Protocols

Multiservice Gateway
- Supports Multiple Derived Services
- Router

Residential Gateway

Integrated Access Device
- Supports Multiple LAN Technologies

Modem
- Derived Voice
- Broadband Access

Intelligent Premises Gateway

Courtesy: Broadband Gateways
RG Market Drivers and Inhibitors

- Drivers
  - Service providers expanding into integrated services
  - Internet
  - New market opportunity for hardware & silicon vendors
  - Smart home construction
  - Low cost PCs
  - Widespread deployment of home networking
  - Always-on broadband connection
  - New entertainment options/applications
  - Remote monitoring

- Inhibitors
  - Unclear ownership/economic model
  - Current services are reliable & cheap
  - Support issues
  - Immature technology
Middleware

OSGi, UPnP, Jini, HAVi
Middleware

- Used to isolate application programs from the details of the underlying hardware and networking components
- Home networking needs to support a large number of:
  - Information appliances
  - Information appliance manufacturers
- Middleware provides interoperability between the diverse systems
  - Different appliances, manufacturers, and networking technologies
- Middleware technologies include:
  - OSGi, UPnP, Jini, HAVi
Open Services Gateway Initiative (OSGi)

- Open industry standard for residential gateways
  - Supported by over 60 major companies including: Ericsson, Cisco, Nokia, Siemens, Sun Microsystems, Motorola, IBM...
  - Develop specs for API & physical-layer bridging features
  - OSGi leverages Jini and Java Virtual Machine (JVM)
- Enable connectivity & management of smart devices
  - Set-top boxes, cable modems, routers, residential gateways, energy management systems, consumer electronics & PCs
- Initial focus: Residential Gateways
OSGi Charter Focus

• Platform and application independence
• Support various levels of system security features
• Host multiple services
• Support multiple local networking technologies
• Support multiple broadband access technologies
• Coexist with other standards
UPnP - Universal Plug and Play

- Open, industry initiative - extension of ‘92 PnP initiative
  - Allows easy plug in and operation of any information appliance into any home network
  - Extends the discovery and enumeration of devices to include networked devices and services
  - Use a new information appliance without worrying about configuration settings or installing new drivers

- Distributed, open networking architecture
  - Supports peer-to-peer networking - does not require PC
  - Leverages Internet protocols (IP, TCP, UDP, HTTP, XML)
  - UPnP devices can be implemented on any OS
Jini Connection Technology

• Java based software layer
  – Based upon model that info appliances should connect and work together in communities
  – Allows info appliances to plug into home network without installing drivers or configuring OS
  – Robust error messaging - greater detail than: abort, retry, ignore
  – Supports “true” peer-to-peer plug and play (no user intervention beyond connecting a cable required)
  – Supports appliance upgrading without IT involvement
• Intended to run on anything with a “digital heartbeat”
  – Cell phones, digital cameras, PDAs, alarms, TVs, etc.
Using a Service

• Lookup service (Discovery) 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 (Join-in)
  – 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
Home Audio Video Interoperability (HAVi)

- OS-neutral middleware focusing on transfer of real-time digital AV content between AV equipment
  - Initiated by Sony & Philips, and includes: Thomson, Hitachi, Toshiba, Matsushita, Sharp, & Grundig
  - Based on IEEE 1394 as underlying networking technology
  - Provides seamless interoperability between digital consumer electronics and home appliances
    - Independent of network configuration & appliance manufacturer
  - Does not support home automation control
- Benefits
  - Automatic detection, registration, and upgrades
  - Instant coordination of various device functions
HAVi Device Classes

**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)
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 telephone & data lines
- Allow secure access
  - From any Internet-accessible remote location via any standard Web browser
- Firewall security protection
- Affordable price points
- Minimize truck rolls
  - Management software for remote provisioning, service management, diagnostics, software upgrades
- Remotely upgradeable
Residential Gateway

- Clock Generator & DLLs
- QPSK Decoder and FEC
- NTSC PAL Encoder
- Audio-Video DACs
- QAM Decoder and FEC
- Memory
- MPEG Decoder & CPU
- Glue Logic
- HDD Interface
- Conditional Access
- Smart Card
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- HDD Interface
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- Smart Card
- I/O Control
- On Screen Display & Graphics Generator

Satellite

Cable

Terrestrial

xDSL

Digital Subscriber Line (DSL) Driver/Receiver, Transceiver and FEC

Hard Disk Drive

USB Device Controller

IEEE 1394/FireWire

RS-232

USB Transceiver

UTP

IEEE 1394/FireWire

RS-232
Summary

- 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
- Xilinx solutions
  - Enabling broadband access in digital modems
  - Bridges disparate technologies
  - System interfacing
  - Encryption
Summary

• Extreme chaos in home networking
  – Multiple standards
  – Evolving standards
  – Interoperability???
• Xilinx solutions address the different needs of this evolving market
  – Reprogrammability provides - time to market & time in market
  – Xilinx enables solutions for all aspects of Home Networking
    • Broadband access
    • Residential gateways
    • Technology bridges between Home Networking technologies
    • Information appliances and Home Networking technologies
Xilinx Helps Redefine Product Development Time Line for Convergence Markets

eSP is the Industry’s First Web Portal & Comprehensive Resource

  eSP is a True System Design Resource

eSP Extends the Traditional Benefits of Programmable logic to Convergence Customers’ Market Requirements

  TTM & Design Flexibility

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