HomeRF: Bringing Wireless Connectivity Home

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Where does wireless fit?

Part of the home intranet mix

Why wireless? Portability and “No new wires”

- Core home networking capabilities, including internet, anywhere in and around the home
- Share wireless voice and data
- Review incoming messages
- Activate other home electronic systems by voice
- Needed in countries where phone lines cannot be used
Home Networking Solutions Designed for the Home User

● “No new wires”
● Simple to Install
● Easy to Use
● Low Cost: ~$200 for 2 PCs
● Bandwidth To Support Common Home Applications
● Industry Standards
Home Networking Needs 1 Mbps

Bandwidth (Kbps)

- 100,000 (100 Mbps)
- 10,000 (10 Mbps)
- 1,000 (1 Mbps)
- 100
- 10
- 1
- 1

First Home NW Applications

- Printing
- Internet
- Drives
- Gaming
- Voice
- Real Audio G2
- MP3 Audio
- MPEG Video
- HDTV

Intel’s Labs
HomeRF™ Working Group Mission Statement

To enable the existence of a broad range of interoperable consumer devices, by establishing an open industry specification for unlicensed RF digital communications for PCs and consumer devices anywhere, in and around the home.
Establishing SWAP-CA

Shared Wireless Access Protocol - Cordless Access

Standards body
e.g., ITU, IEEE, ANSI

Industry leadership and dedicated forum
e.g., IrDA, TAPI, USB

It happened one day
e.g. ISA, Soundblaster™
70+ Member Companies

Broad, cross industry support

- Communications
- Consumer Electronics
- Home Control/Home Automation
- Networking
- Peripherals
- Personal Computer
- Semiconductors/Components
- Software
Partial Membership Roster
(70+ companies are now Participants)

- 3COM
- Alps
- Advanced Micro Devices
- Aironet
- Apple
- Broadcom Corporation
- Butterfly Communications
- Casio
- Cirrus Logic
- Cisco Systems
- Compaq
- Ericsson Enterprise Networks
- Fujitsu
- Harris Semiconductor
- Hewlett-Packard
- Hosiden
- IBM
- Intel
- Intellon
- Interval Research
- Industrial Tech. Research
- iReady Systems
- Kansai Denki
- LG Electronics
- Matsushita Electronics
- Matsushita Works
- Microsoft
- Mitsubishi
- Motorola
- National Semiconductor
- NEC Corporation
- Nortel
- Oki
- Ositis Software
- Primax
- Philips Consumer Communications (PCC)
- Proxim
- Raytheon Wireless Solutions
- RF Monolithics
- RF Micro Devices
- Rockwell Semiconductor Systems
- Samsung Electronics
- Sharp
- ShareWave
- Siemens
- Siemens Microelectronics
- Silicon Wave
- Symbionics
- Symbol
- Texas Instruments
- WebGear
SWAP Product Development

The following member companies are developing SWAP products:

- Butterfly Communications
- Compaq
- Hewlett-Packard
- IBM
- Intel
- iReady
- Microsoft
- Motorola
- Proxim
- OTC Telecom
- RF Monolithics
- Samsung
- Symbionics
The SWAP Network

TCP/IP Based Network of Asynchronous Peer-Peer Devices

HomeRF Control Point

Internet

PSTN

USB

Main Home PC

Other Home Networks (HPNA, phone, AC)

Isochronous Clients

Grandma's Brownies
3 cups flour
1 cup grated chocolate
1 cup sugar
1 stick butter

3 cups flour
1 cup grated chocolate
1 cup sugar
1 stick butter
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

Both voice and data are important for home RF
Why a new protocol?

- It handles voice like DECT or PHS, but...
  - Frequency hopping
  - 20 ms frames (better for data)
  - interleaved up and down links
  - Retransmission (single)

- It handles data like 802.11, but...
  - Relaxed PHY layer specs to reduce cost
  - Beacons to manage isochronous traffic
  - Simplified protocol (no PCF)

- IP data at up to 2Mb/s and supports cordless telephony
SWAP Features

- Range: >50 meters indoors
- Speed: dual speed - supports TCP/IP traffic at over 1Mb/s
- Voice: High quality voice channels with retransmission
  - High quality cordless telephones
  - Voice recognition
Device Types

Isochronous (I node)
> minimum latency - telephones, etc.

Asynchronous (A node)
> TCP/IP traffic

• CP - Connection point...can manage a network or act as an A node
  • Can be USB, PCI, PC-Card, Device Bay, etc.
  • CP can place calls even when PC is down
• It’s a circuit switched, isochronous network
• It’s a packet switched, asynchronous network
• It’s both - I nodes get priority on bandwidth
PHY Features

- Nominal 100 mW transmit power
- Minimum receiver sensitivity of -76 dBm (2FSK)
  - range >50 m in typical homes/yards
  - -85 dBm sensitivity typical
- Cost effective filter requirements
  - Use MAC to reduce PHY cost
  - Makes single-chip integration simpler
MAC Features

- MAC provides good support for voice and data
- Leverages existing DECT technology for voice
- Excellent integration with TCP/IP networking protocols
  - easy integration with Ethernet
  - Supports broadcast, multicast and fragmenting
- Data security - Basic/Enhanced levels of encryption
  - Basic: 24-bit Network ID and Frequency Hopping
  - Enhanced: Basic + LFSR algorithm
- Extensive power management for ultra-portable devices

Optimizes existing technology for home use
The PC interface

● SWAP’s PC connection is designed for use under Windows 98*, Windows2000*, and beyond
  ◆ Wake on ring
  ◆ Connection Oriented NDIS (NDIS 5...for Windows2000*)
  ◆ A nodes appear as Ethernet devices
  ◆ I nodes become Connection Oriented clients

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PC Software Architecture Diagram

- TAPI 3.0
- connection-oriented client
- Windows2000® NDIS TAPI proxy
- connection-oriented I/F

- Windows2000® DirectShow®
- connectionless client
- RCA filter
- connectionless I/F

- “Ethernet” MP/CM

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Voice: Robust clarity

- Superframe structure controlled by Beacon
- TDMA slot pairs allocated by the Control Point
- Voice data transmitted in the slots in CFP #2
- Any voice data to be retransmitted is sent:
  - In CFP1, after a hop
  - frequency/time diversity & low latency
Data transmission

- CSMA/CA during the contention period
- Efficient for small networks
- Tolerant of interference
- Data for entire frame if no voice
Encryption Algorithm

- Open, royalty free - published in open literature over 30 years ago
- Low gate count
- Fast “warm up”
- Required for CP in the US market, optional for other devices and geographies
- Robust
- Similar concept to GSM A5 algorithm, but “stronger”
Usage - Voice Control

• Handset initiates voice transfer to PC
• Application accepts streaming audio from CP
• Application performs speech recognition and sends commands back down stack
• For automatic call placement, CP dials number and connects handset
• Handset - PSTN connection remains until call teardown

Data traffic can also be active

Grandma’s Fridge pad
3 cups flour
1 cup grated chocolate
1 cup sugar
1 stick butter
1/2 cup chopped walnuts

HOME IN DEX

TDMA I Node
CSMA A Node
Usage - ISP Sharing

- PC initiates ISP connection (modem, ISDN, UDSL, Cable, etc.)
- Applications on host PC can access ISP immediately
- Remote A nodes access ISP through NAT and TCP/IP
- Remote A nodes can also share files and printers
- Ad hoc peer-peer transfers between nodes do not require resources of “server” PC

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Timeline

'98 Q1  '98 Q2  '98 Q3  '98 Q4  '99 Q1  '99 Q2  '99 Q3  '99 2H

Home RF Working Group Announced
Published R0.5 (Functionally complete)
Reached 50 members
SWAP 1.0 Provisional Specification
Define Logo Usage Requirements
Sample Physical Layer radios
SWAP 1.1 Specification
First Products

www.homerf.org

Intel's Labs
HomeRF Summary

- Home RF Working group developing open, royalty free spec
- Over 80 member companies
- NOW is the time to begin implementation plans
- More info (including membership) at www.homerf.org
- $4,800 membership fee