HomeRF™ Working Group

3rd Liaison Report

HomeRF™ 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.
Vision for Home Networking

Membership Roster

{Updated September 11, 1998}

3COM
Advanced Micro Devices
Aironet Wireless Communications
Alps Electric Co., Ltd.
Broadcom Corporation
Butterfly Communications
Casio Computer Corp.
Cisco Systems
Compaq Computer Corp.
Ericsson Enterprise Networks
Fujitsu Ltd.

Harris Semiconductor
Hewlett-Packard Company
Hosiden Corp.
IBM
Intel Corp.
Intellon
Kansai Electric Co., Ltd.
LG Electronics, Inc.
Matsushita Electric Industrial Co.
(Panasonic)
Microsoft
Member Roster (Cont.)

Mitsubishi Electric Corporation   Rockwell Semiconductor Systems
Motorola                     Samsung Electronics, Inc.
National Semiconductor      ShareWave, Inc.
NEC Corporation              Sharp Corporation
Nortel                        Siemens
Oki Electric Industry Co., Ltd.  Silicon Wave Inc.
Philips Consumer Communications (PCC)  Symbionics
Primax Electronics, Ltd.   Symbol Technologies
Proxim                        Texas Instruments
RF Monolithics, Inc.         WebGear

HomeRF™ Timeline

<table>
<thead>
<tr>
<th>1st Meeting</th>
<th>MRD</th>
<th>SWAP Selected</th>
<th>Launch</th>
<th>SWAP R1.0</th>
<th>1st Components</th>
<th>1st Products</th>
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<tbody>
<tr>
<td>1997</td>
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<table>
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<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
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<tr>
<td>R0.1 Launch 3/4</td>
<td>R0.5 6/24</td>
<td>R0.7 9/19</td>
<td>R0.9 10/29</td>
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<td>R0.2 3/27</td>
<td>Part. Seminars 6/19</td>
<td>Part Seminars 9/23</td>
<td>R1.0 12/17</td>
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</table>
Applications & Usage Scenarios

PC-Enhanced Cordless Telephone

- Interoperable Cordless Telephone with Digital Voice Quality
- Caller ID with PC Lookup
- Lowest Cost Call Routing (Internet Telephony)
- Voice Mail Retrieval
- Email viewing or read back as Text to Speech (TTS)
- PIM Functionality
- Speech Input to PC (Voice commands)
- Remote I/O Access to Other PC Subsystems
- Home Automation Control Center
- Endless Software-Based Applications To Be Written
Mobile Viewer Appliance

- Portable device built around inexpensive color display
- Extension of main Home PC ...
- … and/or gateway to the Internet
- Limited input functionality and local processing power
  - Relies heavily on central resources on PC or Internet
  - TCP/IP networking represents efficient link to host device/gateway
  - speech could be a primary data input method
- Known by many names - “Fridgepad”, “Infopad”, “Netviewer”, etc.

Resource Sharing

- Multi-PC homes can share files/modems/printers
- PC’s and other new devices can share an ISP connection
  - Only one PSTN line and ISP account required
  - Perfect for evolving big pipes such as UDSL or cable modem
- Peer to peer communication enables interactive entertainment and information sharing
- Multi-player games and/or toys based on PC or Internet resources
Usage Scenario - 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

Usage Scenario - ISP Sharing

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

MAC Features

- MAC provides good support for voice and data by using both TDMA and CSMA/CA access mechanisms
- Support for 6 high quality voice connections
  - ADPCM codec
  - Integration with DECT
- Excellent integration with TCP/IP networking protocols
  - Packet structure optimized for easy integration with Ethernet
  - Supports broadcast, multicast and fragmenting
- High data throughput - 1 Mb/s or 2 Mb/s
- Data security - None/Medium/High levels of encryption
  - 24-bit Network ID and optional data compression
- Extensive power management for ultra-portable devices
MAC Superframe

- Structure of the Superframe is controlled by the Beacon
- Pairs of TDMA slots are allocated by the Control Point
- Voice data transmitted in the slots in Contention Free Period 2
- Any voice data to be retransmitted is sent:
  - In CFP1, after a Hop
  - giving frequency & time diversity and low latency

SWAP MAC - Support for Data

- During the contention period the access protocol is CSMA/CA - Collision Sense Multiple Access/Carrier Avoidance
- An efficient protocol for data transfer in small networks and very tolerant of microwave oven interference
- With no voice connections the contention period occupies the whole Superframe
CSMA/CA Access Mechanism

- CSMA/CA is an efficient protocol for data traffic, like ethernet
- Listen Before Talk
- Always back-off before a transmission or retransmission
  - Designed to provide fair access to the medium

CSMA/CA Packet

Mapping of Ethernet Frame onto SWAP Packet

Sync field added here when transmitting beacon
Power Management - TDMA Nodes

- Switch on periodically to receive a Beacon if they do not have an active connection
- If they have an active connection they switch on:
  - to receive the Beacon
  - switch on for any retransmissions in CFP1
  - switch on for transmissions in CFP2
- At all other times they can be switched off

Unicast - Power Saving CSMA/CA

PS-node wakes up doesn’t hear ‘wakeup’ so switches off

Sender asks CP to wake-up PS-node

Sender hears PS-node wake-up

PS-node wakes up, hears ‘wake-up’ so stays switched on

CP sets ‘wake-up’ flag and node address

Sender and PS-node transfer data

PS-node switches off after timeout

Node #1

Power-Saving Node

Sender hears PS-node wake-up
Broadcast - Power Saving CSMA/CA

**Control Point**

PS-node wakes up to check ‘dwellsto-wakeup’

- CP Buffers Broadcast
- CP re-Broadcast

PS-node wakes up to receive broadcast

- CP Buffers Broadcast
- CP re-Broadcast

**Node #1**

- Broadcast
- Dwell to Broadcast wakeup

**Node #2**

- Broadcast
- PS-node receives Broadcast

**Power-Saving Node**

**PHY Features**

- Nominal 100 mW transmit power (+16 to +20 dBm)
- Minimum receiver sensitivity of -76 dBm (2FSK)
  - 4 dB easier than IEEE 802.11 FH parameter
  - Range should exceed 50 m in typical homes & yards
  - Expect manufacturers (especially cordless telephones) to exceed specification considerably (-85 dBm) for longer range
- Optional lower power mode around 1 mW (0 to +4 dBm)
  - Range reduced to 10-20 m typically across household walls
  - Motivated for ultra-portable devices with limited peak current
- Exceptionally simple filter requirements - No Adjacent or Alternate channel specification
  - Move cost out of PHY by taking advantage of MAC
  - Makes single-chip integration more straightforward
PHY Features (Cont.)

• Hopping time is 300 $\mu$ sec
  – Should allow use of conventional synthesizers
• Transceiver turnaround time is 25 $\mu$ sec
  – The toughest SWAP specification
  – This is easier than the IEEE 802.11 FH specification

SWAP Partitioning
SWAP vs. Other Connectivity Options

<table>
<thead>
<tr>
<th></th>
<th>Peak Data Rate</th>
<th>Relative Cost</th>
<th>Data Network Support</th>
<th>Voice Network Support</th>
<th>Range in home</th>
<th>Standby &amp; Peak Currents</th>
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</thead>
<tbody>
<tr>
<td>HiperLAN</td>
<td>23.5 Mb/s</td>
<td>High</td>
<td>TCP/IP</td>
<td>Via IP</td>
<td>&gt; 30 m</td>
<td>TBD, ~2A</td>
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<tr>
<td>IEEE802.11FH</td>
<td>2 Mb/s</td>
<td>Medium/High</td>
<td>TCP/IP</td>
<td>Via IP</td>
<td>&gt; 50 m</td>
<td>~10 mA, ~400 mA</td>
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<tr>
<td>HomeRF™ (SWAP)</td>
<td>2 Mb/s</td>
<td>Medium</td>
<td>TCP/IP</td>
<td>Via IP &amp; PSTN</td>
<td>&gt; 50 m</td>
<td>&lt; 1 mA, ~300 mA</td>
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<tr>
<td>HomePNA</td>
<td>1 Mb/s</td>
<td>Medium/Low</td>
<td>TCP/IP</td>
<td>Via IP &amp; PSTN</td>
<td>All phone jacks</td>
<td>TBD</td>
</tr>
<tr>
<td>Bluetooth</td>
<td>1 Mb/s</td>
<td>Medium</td>
<td>Via PPP</td>
<td>Via IP &amp; Cellular</td>
<td>&lt; 10 m</td>
<td>&lt; 1 mA, ~60 mA</td>
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<tr>
<td>IrDA</td>
<td>16 Mb/s</td>
<td>Low</td>
<td>Via PPP</td>
<td>Via IP</td>
<td>&lt; 2 m line of sight &amp; aimed</td>
<td>&lt; 10 mA, ~300 mA</td>
</tr>
</tbody>
</table>

HomeRF vs. Bluetooth

- Optimized for Home wireless voice & data requirements
- 50m in the home & yard
- 6 near line quality voice links
- Unlimited device links/base
- 2 Mbps raw data rate (4FSK)
- 4 types: voice/Data/Both/Base
- 2.4 GHz, 50 Hops/sec radio
- Peer-to-Peer networking
- “Native” TCP/IP support
- Low power paging mode
- Lower transmit power possible
- Based on shipping 802.11 & DECT technology

- Optimized for cellular phones & mobile device requirements
- 10m in shirt pocket/briefcase
- 3 near-line quality voice links
- 7 device links/base
- 1 Mbps raw data rate (2FSK)
- One type: Voice-Data-Base
- 2.4 GHz, 1600 Hops/sec radio
- Multipoint-to-point connections
- Point-to-point TCP/IP support
- Low power standby mode
- Higher transmit power possible
- Based on working prototype radio technology