



# HomeRF: Bringing Wireless Connectivity Home

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**Wireless Systems Architect**  
**Intel Corporation**  
**Technical Committee Chair**  
**Home RF Working Group**

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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”

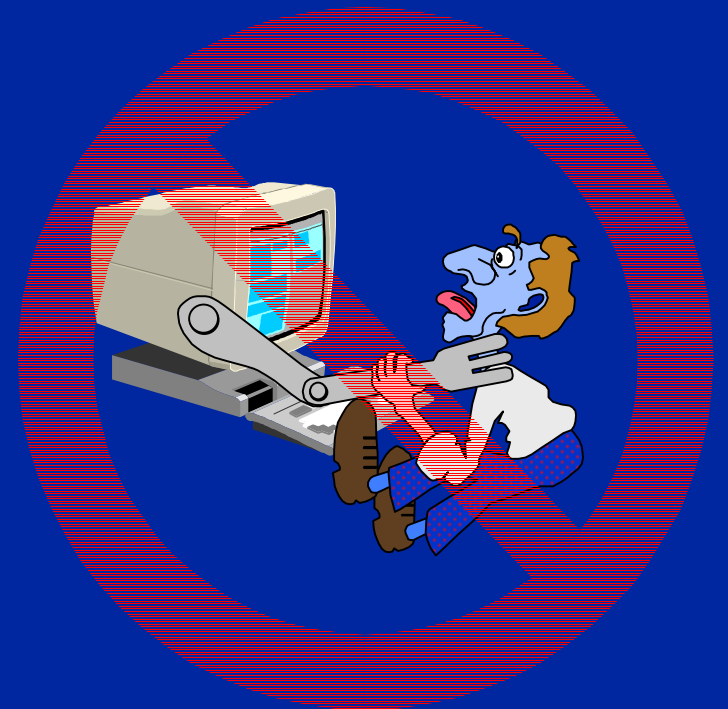
Simple to Install

Easy to Use

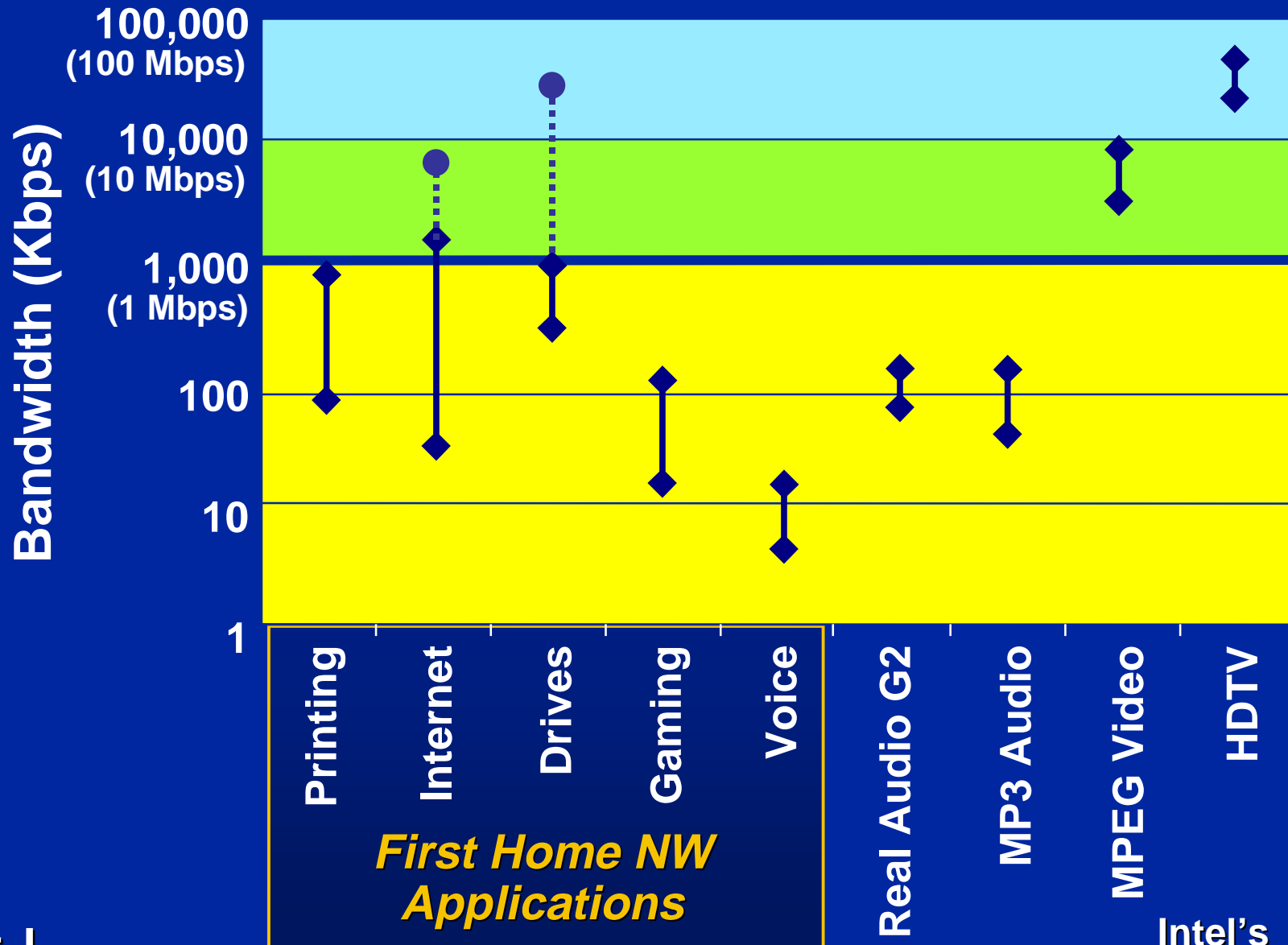
Low Cost: ~\$200 for  
2 PCs

Bandwidth To Support Common  
Home Applications

Industry Standards



# Home Networking Needs 1 Mbps



# 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™

**SWAP-CA**

# 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)

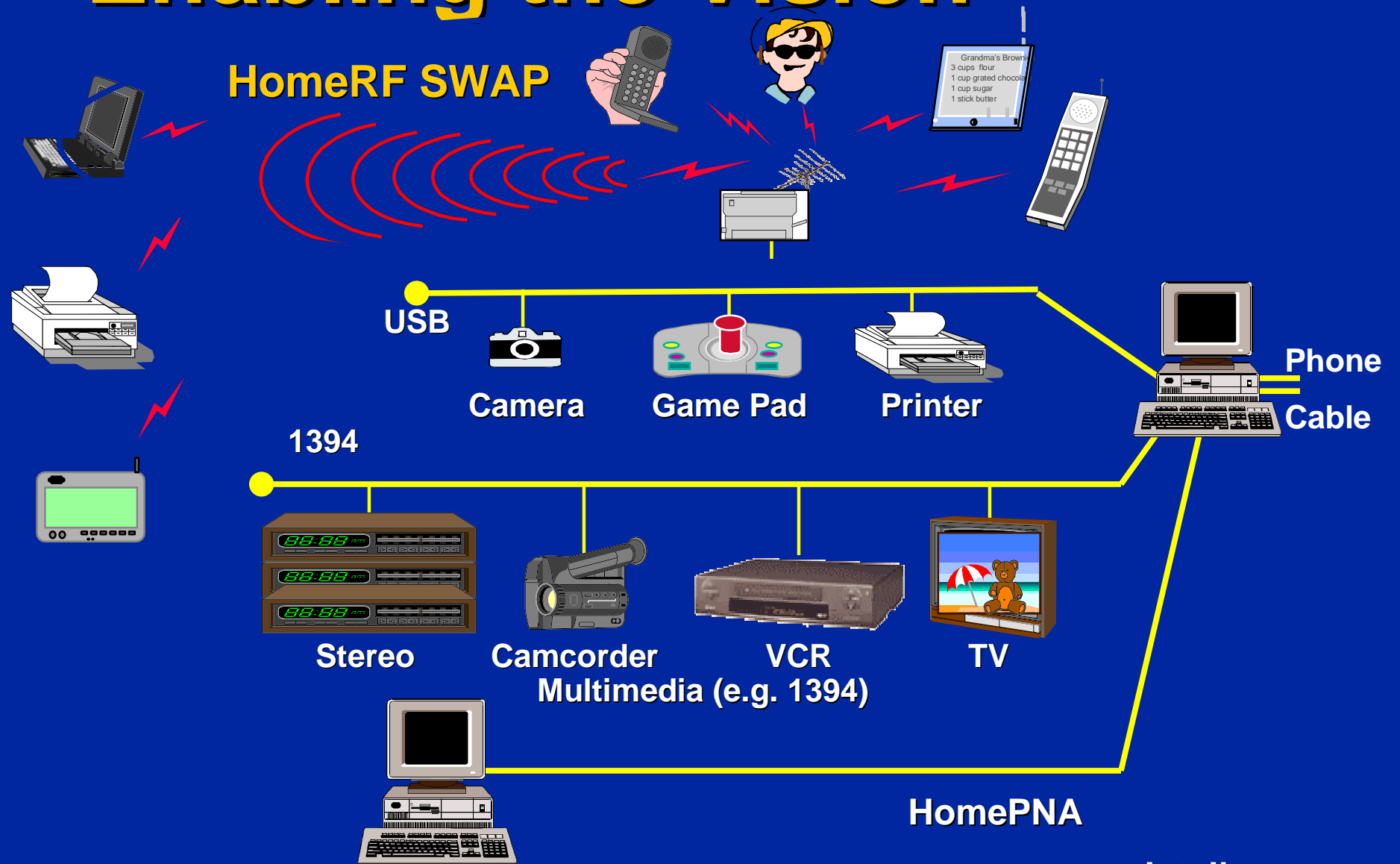
- 3COM
- Alps
- Advanced Micro Devices
- Aironet
- Apple
- Broadcom Corporation
- Butterfly Communications
- Casio
- Cirrus Logic
- Cisco Systems
- Compaq
- Ericsson Enterprise Networks
- Fujitsu
- Harris Semiconductor
- Hewlett-Packard
- Hosiden
- IBM
- Intel
- Intellon
- Interval Research
- Industrial 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:

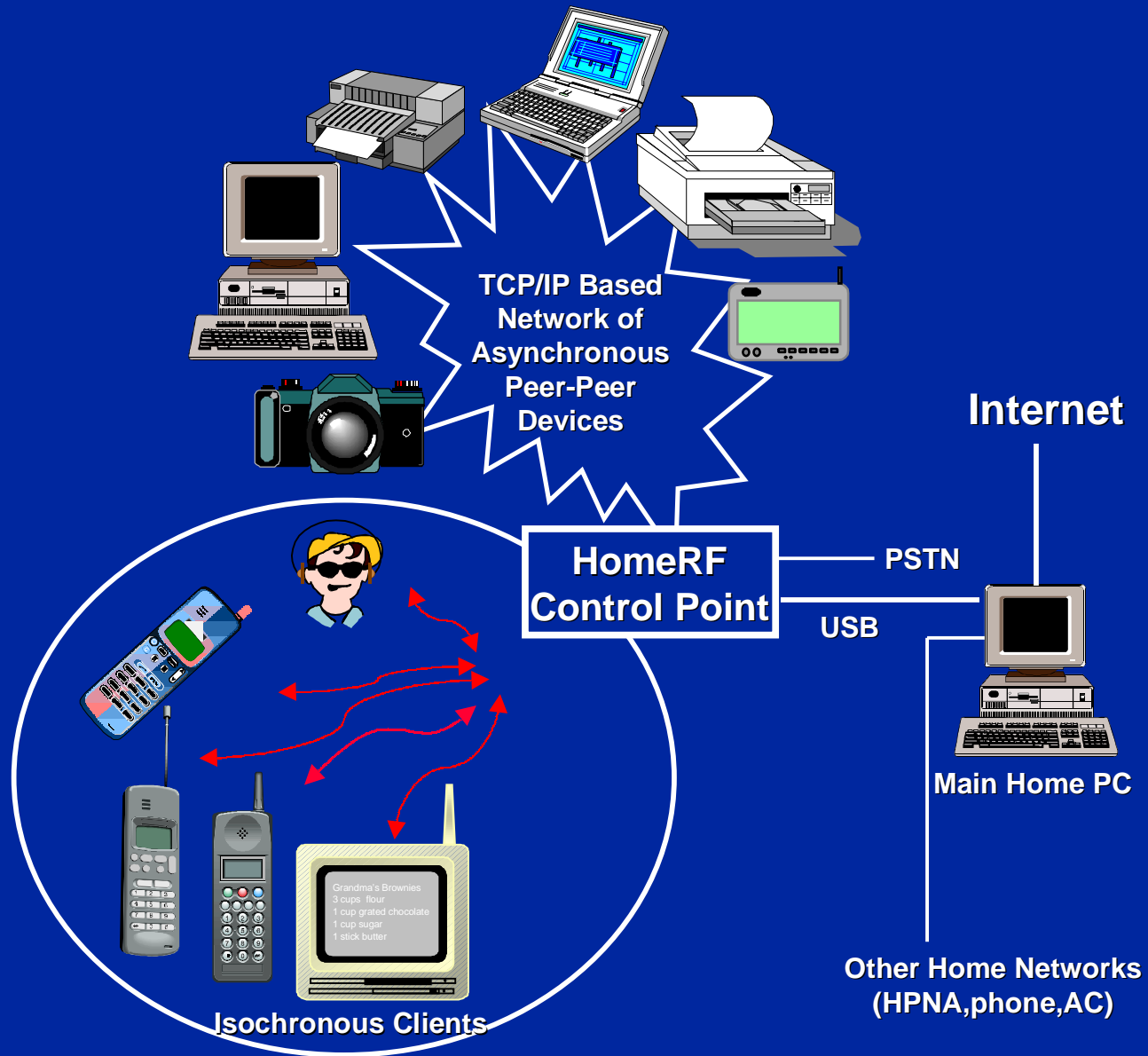
- Butterfly Communications
- Compaq
- Hewlett-Packard
- IBM
- Intel
- iReady
- Microsoft
- Motorola
- Proxim
- OTC Telecom
- RF Monolithics
- Samsung
- Symbionics

# Enabling the Vision



intel®

# The SWAP Network



# 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



Fridge pad

## Isochronous (I node)

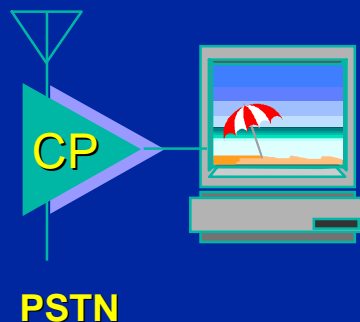
> minimum latency -  
telephones, etc.



Cordless Telephone

## Asynchronous (A node)

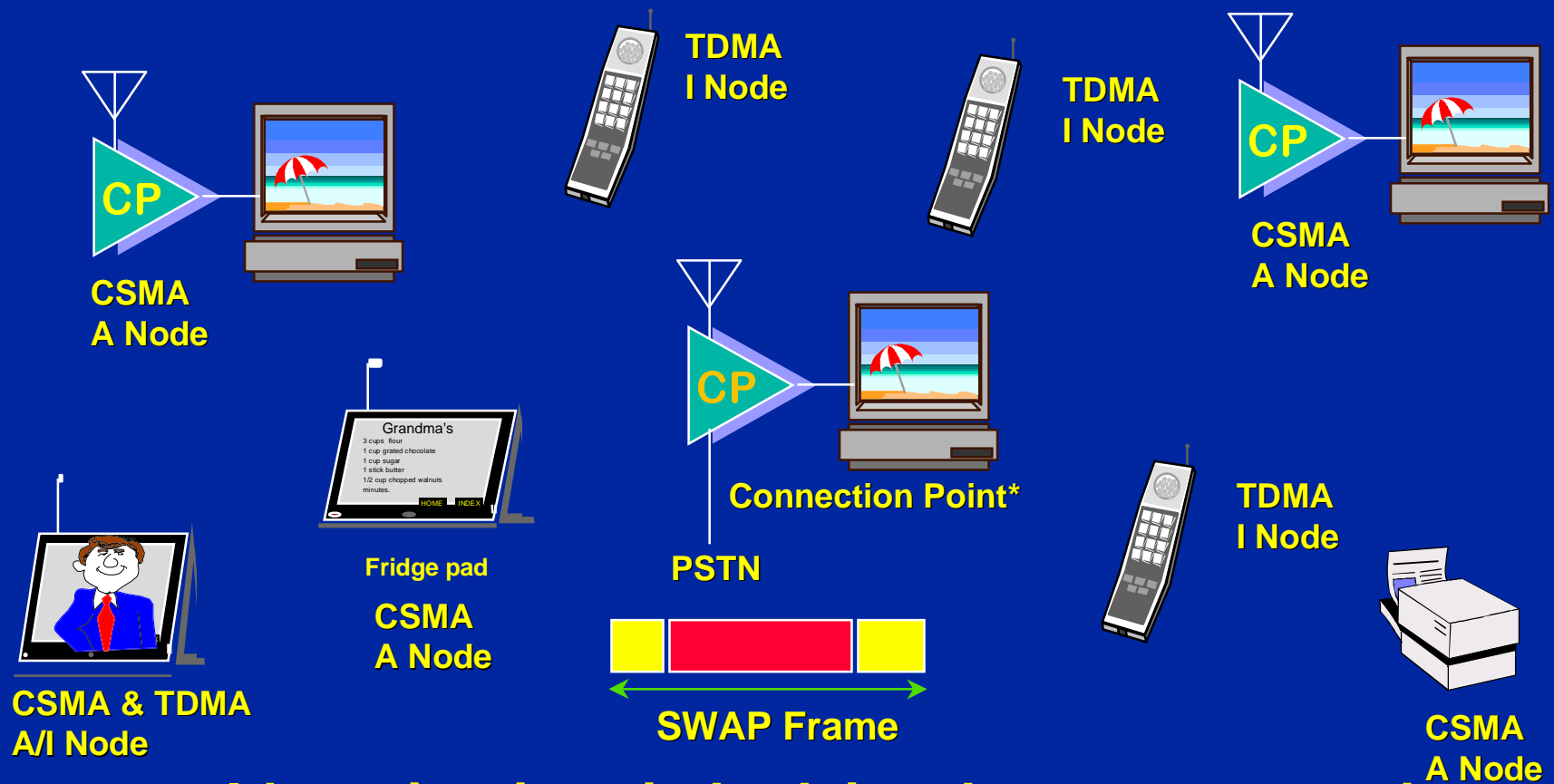
> TCP/IP traffic



- 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

# Topology



- 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

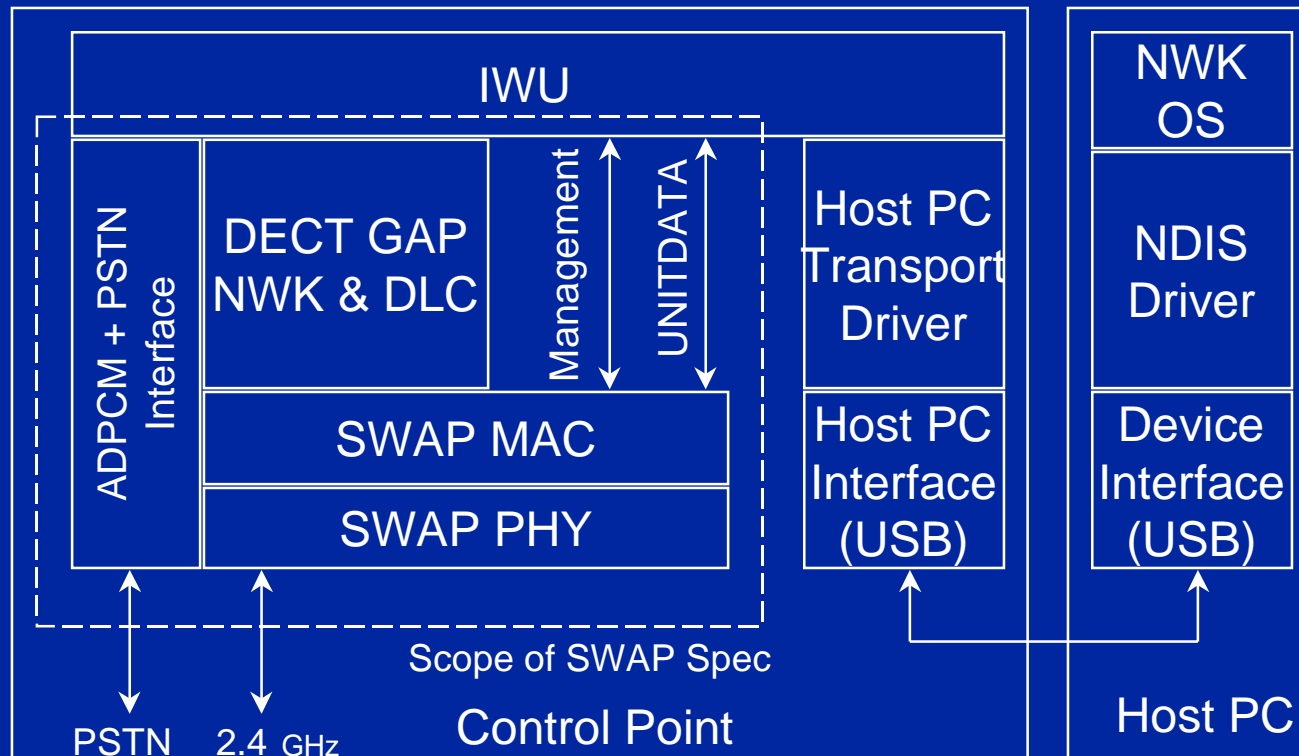
- **Nominal 100 mW transmit power**
- **Minimum receiver sensitivity of -76 dBm (2FSK)**
  - ◆ **range >50 m in typical homes/yards**
  - ◆ **-85 dBm sensitivity typical**
- **Cost effective filter requirements**
  - ◆ **Use MAC to reduce PHY cost**
  - ◆ **Makes single-chip integration simpler**

# 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**

# CP Architecture

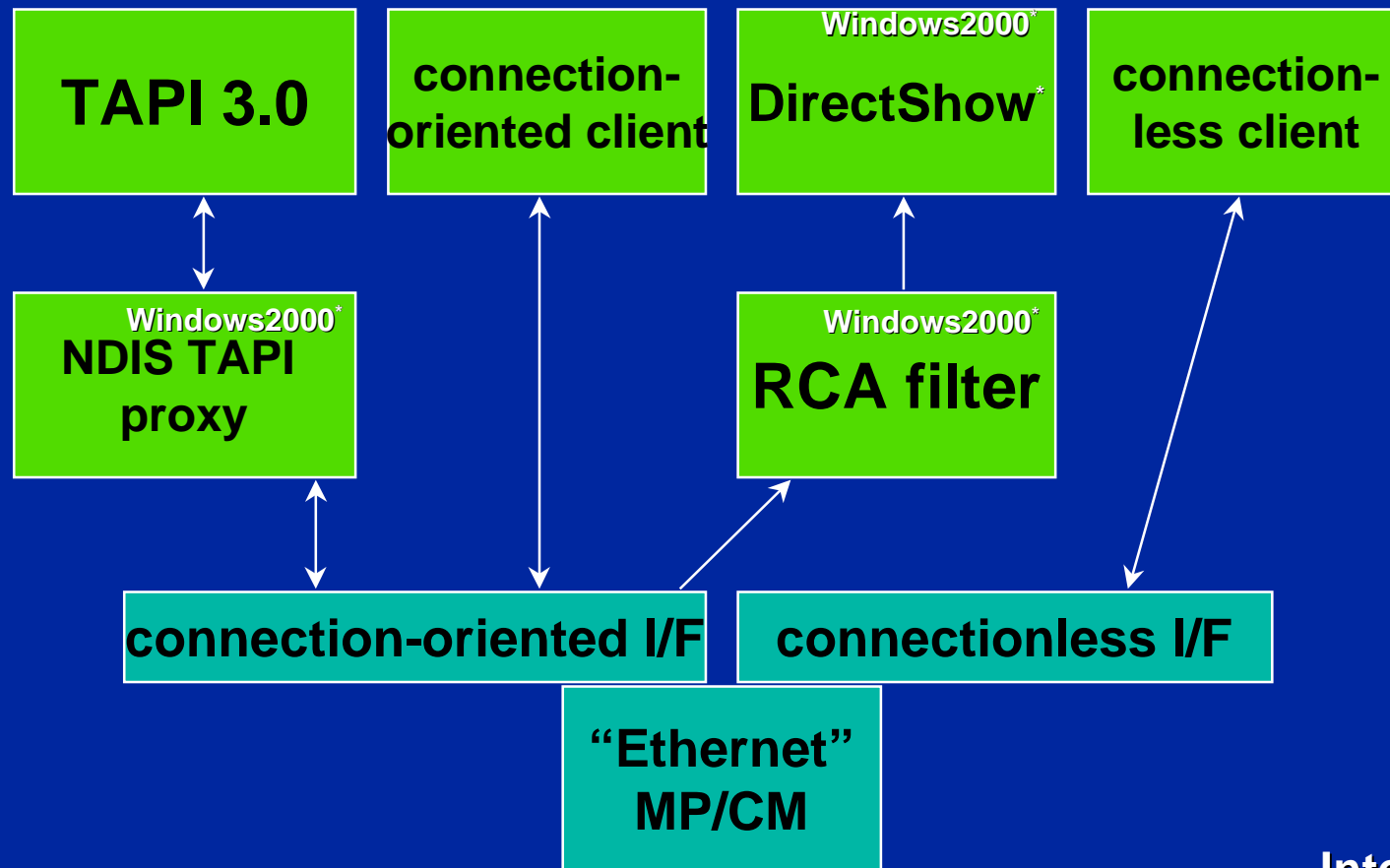


- **PSTN connection can be analog, ISDN, etc.**
- **New connections such as UDSL, CDSL, cable modem, etc can be brought into IWU for transfer to PC**
- **Interface between CP and PC can be USB, PC-Card, PCI, Device Bay, etc.**

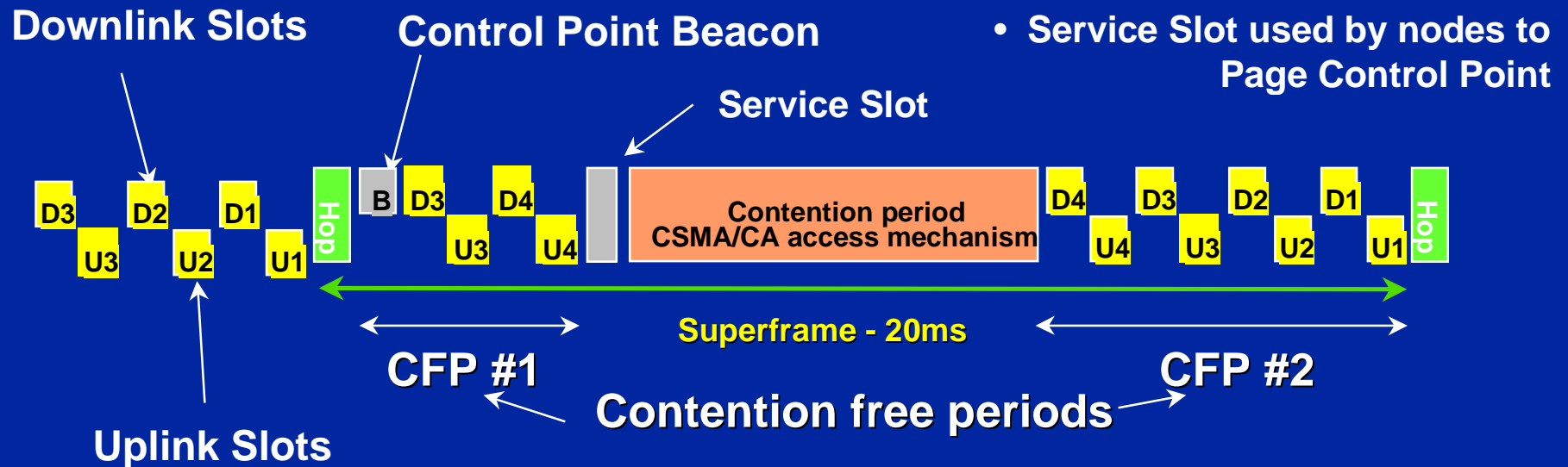
# The PC interface

- 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

# PC Software Architecture Diagram

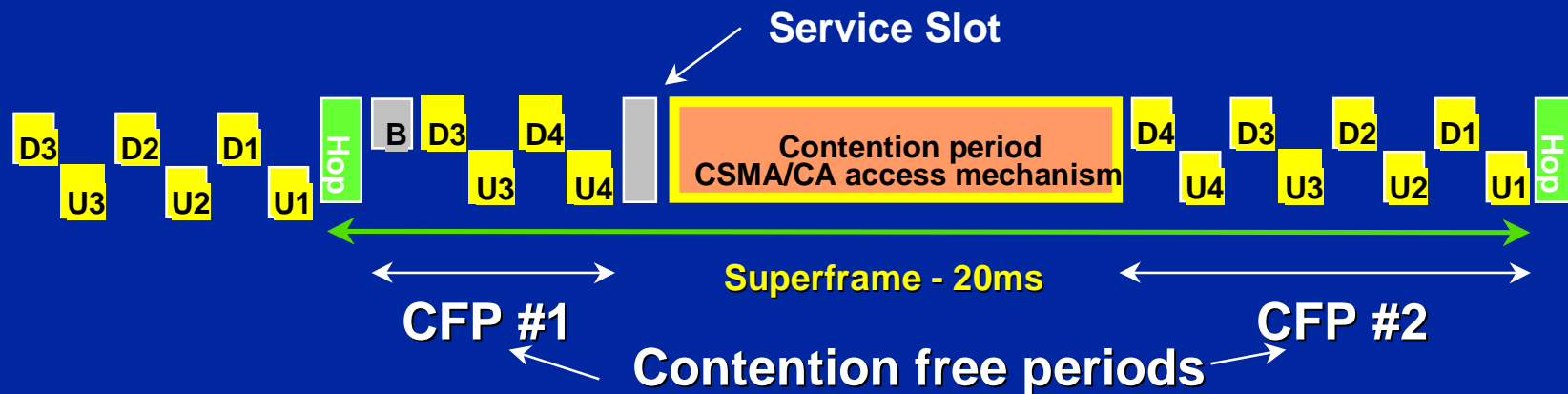


# Voice: Robust clarity



- 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

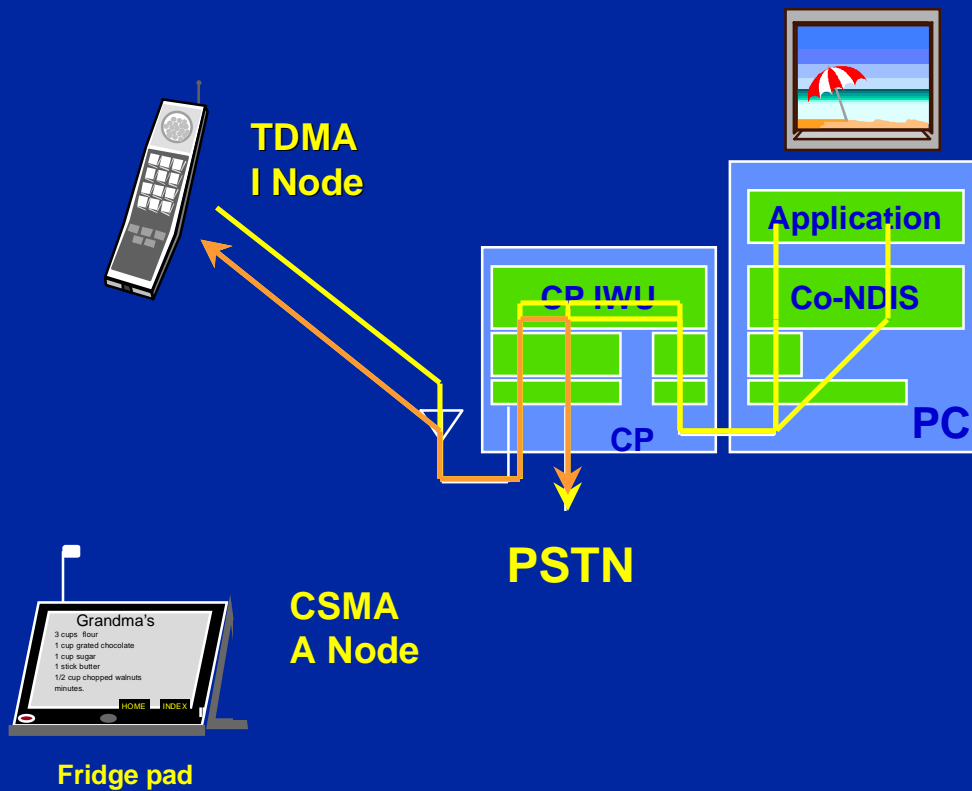


- CSMA/CA during the contention period
- Efficient for small networks
- Tolerant of interference
- Data for entire frame if no voice

# 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

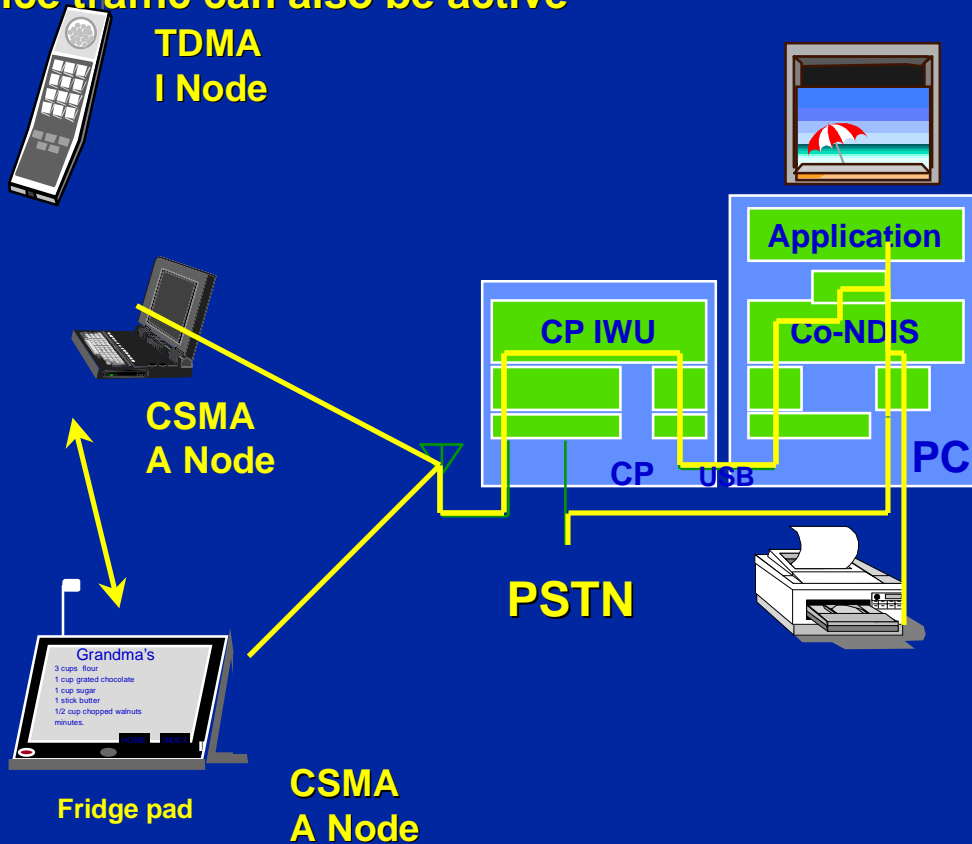


Data traffic can also be active

- 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

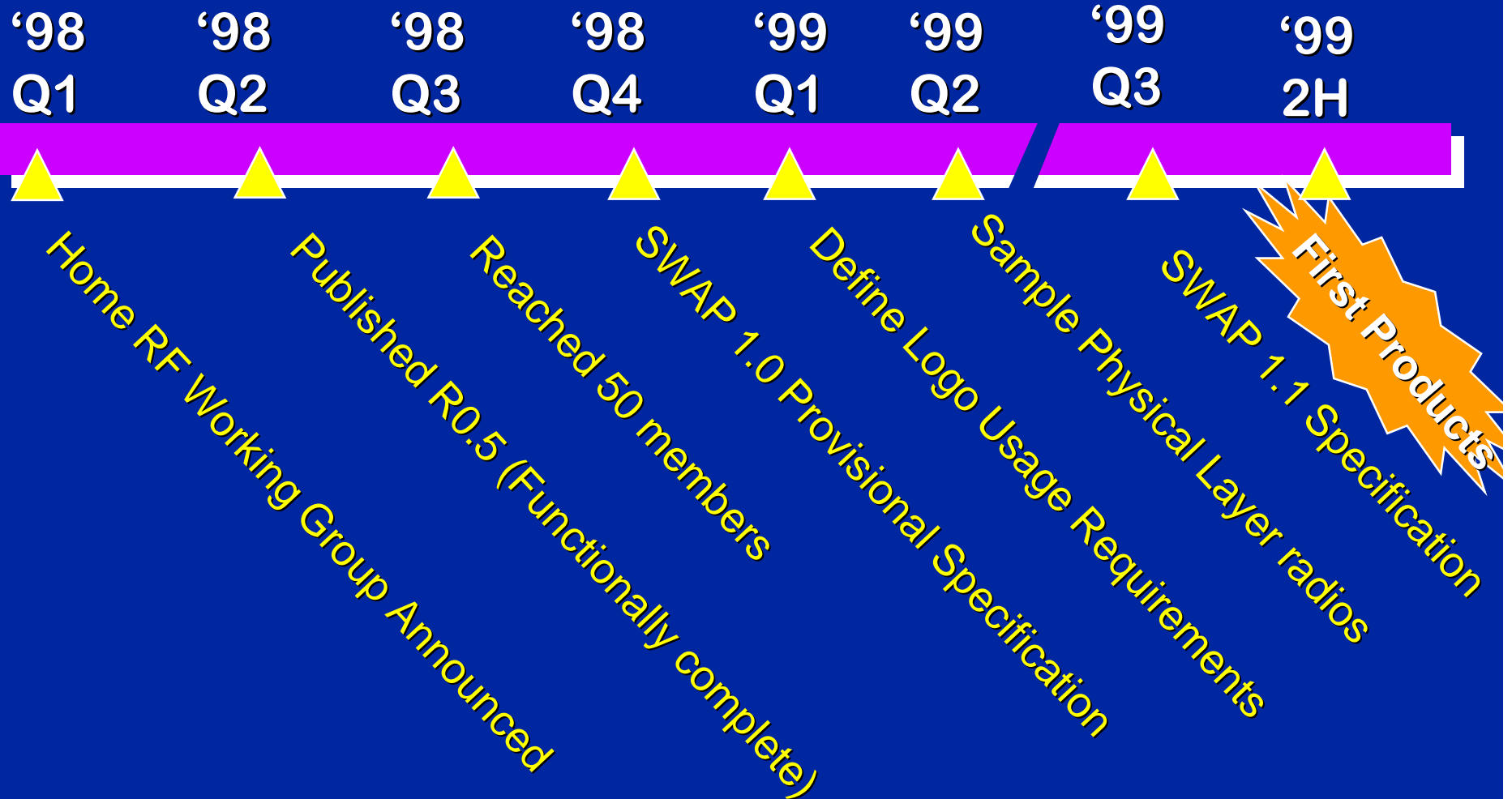
# Usage - ISP Sharing

Voice traffic can also be active



- 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

# Timeline



# Futures

- **Firefly - study group for embeddable radio**
  - ◆ Ultra low cost
  - ◆ Oriented toward toys, peripherals, control devices
  - ◆ Possibly at 900MHz
- **HomeRF - Multimedia (Mercury)**
  - ◆ QoS guarantees
  - ◆ Multiple MPEG stream support
  - ◆ Possibly at 5GHz

# 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](http://www.homerf.org)