Wireless Personal Area Network Study Group

Tutorial

Agenda

- Vision Statements
- WPAN Study Group Objective
- Methodology of Study
  - Solicited and Reviewed Study Group Member Protocol Proposals & Applications, via Calls
  - Reviewed IEEE 802.11 Standard
  - Reviewed HomeRF Specification
  - Reviewed Bluetooth Specification
- Summary
- WPAN Background

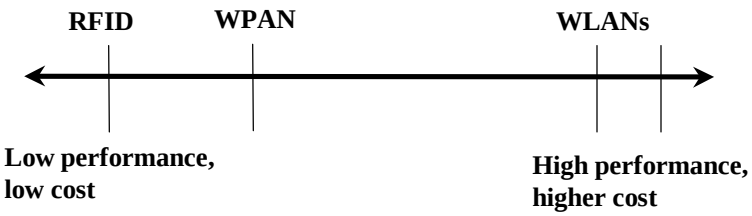
IEEE 802
Wireless Vision Statement

- 802.11 Base Standard
  - 2.4GHz Frequency Hopping Spread Spectrum (1Mbit/s)
  - 2.4GHZ Direct Sequence Spread Spectrum (2Mbit/s)
  - Infrared (1Mbit/s)
- 802.11a 5GHz Extension (>20Mbit/s)
- 802.11b 2.4GHz Extension (>8Mbit/s)
- Broadband Wireless LANs (LMDS) - ECSG
- Wireless Personal Area Networks - WGSG
- Bluetooth?
- HomeRF?

"IEEE 802 is the focal point for Wireless LAN standards." Jim Carlo

Source: Jim Carlo, 802 Chair [JC-802-Consortium.PDF] can be downloaded from the following URL: ftp://ftp.flexipc.com/wearablesgroup/802/

WPAN Vision Statement



- Continuum of needs for wireless products
- No one product which can fill all needs
- Family of complementary devices

Source: doc.: IEEE 802.11-98/97 (Pat Kinney, Intermec)

WPAN Study Group Objective

- Review WPAN/WLAN Requirements
- Determine Need for Standard
- If warranted draft a PAR for submittal
- Seek appropriate Sponsorship within 802

The IEEE 802 Local and Metropolitan Area Network Standards Committee has the basic charter to create, maintain, and encourage the use of IEEE/ANSI and equivalent IEC/ISO JTC 1 standards primarily **within layers 1 and 2** of the OSI (Open System Interconnection) Reference Model.

WPAN PAR: Purpose

- To provide a supplemental standard for low complexity, low power consumption wireless connectivity to support interoperability among devices within or entering the POS. This includes devices (see below) that are carried, worn, or located near the body. The proposed project will address Quality of Service to support a variety of traffic classes.

Examples of devices, which can be networked, include Computers, Personal Digital Assistants (PDAs)/Handheld Personal Computers (HPCs), printers, microphones, speakers, headsets, bar code readers, sensors, displays, pagers, and cellular & Personal Communications Service (PCS) phones.

WPAN PAR: Scope

- To define derivative versions of the 802.11 PHY and MAC specifications for wireless connectivity with fixed, portable and moving devices within or entering a Personal Operating Space (POS). A goal of the WPAN Group will be to achieve a level of interoperability (see -99/5) sufficient to transfer data between a WPAN device and an 802.11 device.

A Personal Operating Space (POS) is the space about a person that typically extends up to 10 meters in all directions and envelops the person whether stationary or in motion.

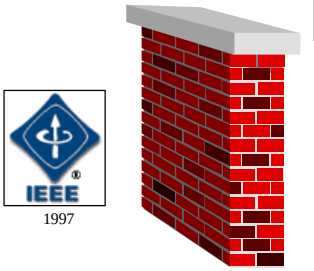
WPAN PAR: Scope (Continued)

- The 802.11 PHY and MAC have been reviewed to determine their suitability to meet the Functional Requirements of the WPAN Applications as specified in IEEE documents -98/295-298 and -98/352. Detailed suggestions on proposed changes to the IEEE 802.11 MAC & PHY Standard have been reported in documents -98/322r2, 323, 324.

WPAN Original Functional Requirements published 1/98

January 22, 1998

- Power Management: Low current consumption
- Range: 0-10 meters
- Speed: 19.2 - 100Kbps (actual)
- Small Size e.g., ~.5 cubic inches no antenna
- Low Cost: i.e., relative to target device
- Should allow overlap of multiple networks in the same area
- Networking support for a minimum of sixteen devices



1997

March 4, 1998

May 20, 1998

Source: doc.: IEEE 802.11-98/58 (Bob Heile, GTE)

Current WPAN Guidelines- "A" List

- WPANs will seek worldwide spectrum allocations for unlicensed bands e.g., 2.4GHz
- Low Cost: i.e., relative to target device
- Small Size e.g., ~.5 cubic inches(excludes antenna & battery)
- Power Management: Very Low current consumption (Average 20mW @ 10/90 or less)
- Data
- Should allow coexistence of multiple Wireless PAN's in the same area (20 within 400 square feet)
- Should allow coexistence of multiple Wireless Systems i.e. P802.11 in the same area
- WPAN Network Access Control

Source:doc.: IEEE 802.11-98/160r2 (Ian Gifford, M/A-COM)

Current WPAN Guidelines- "B" List

- Delivered Data Throughput at the MAC SAP: (19.2 - 100) kbit/s (actual 1 device to 1 device)
- All devices within a WPAN must be able to communicate with each other
- Networking support for a minimum of 16 devices
- Voice
- Range: 0-10 meters
- Attach: within one (1) second, once within range
- Bridge or Gateway connectivity to other data networks

Current WPAN Guidelines- "C" List

- No single element of failure
- Video
- Roaming: hand-off to another PAN

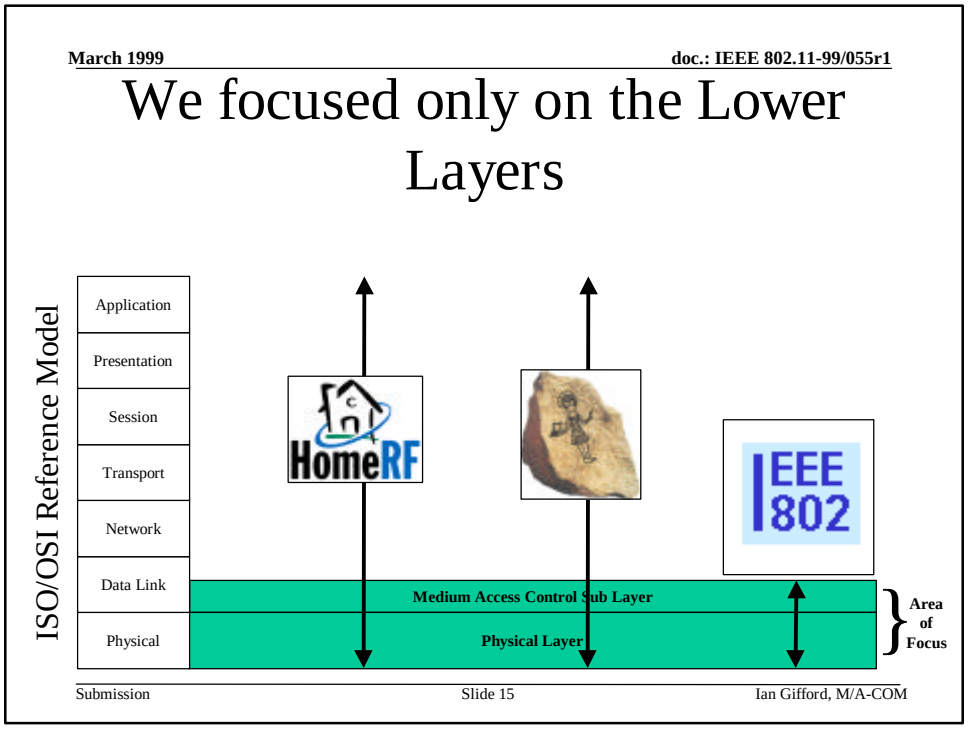
Additional Guidelines

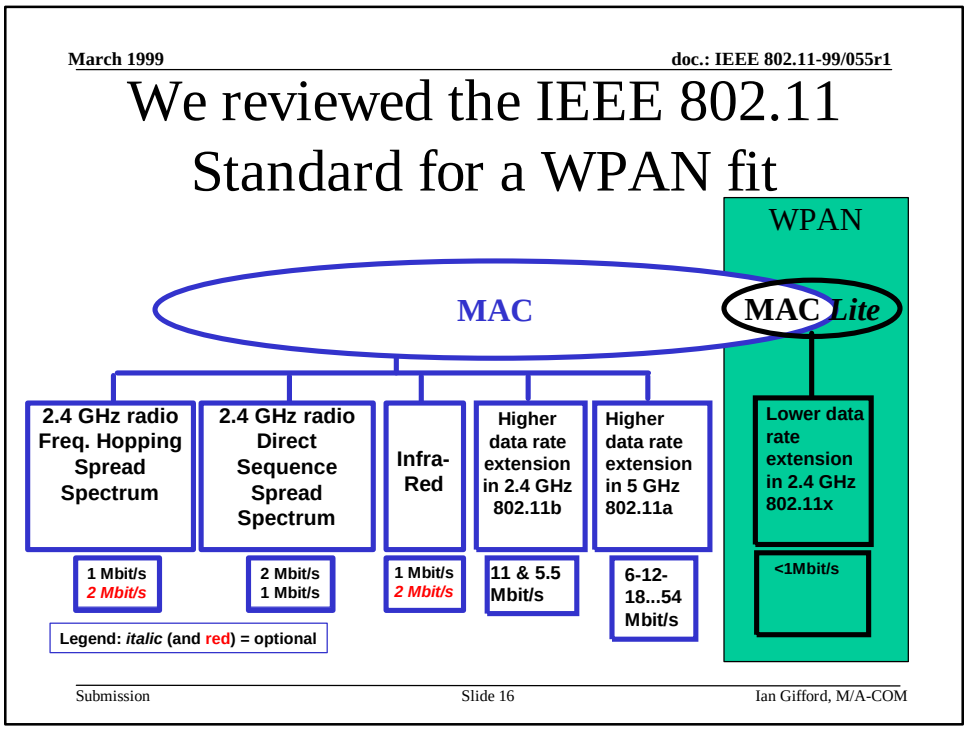
- WPAN Density: 1 WPAN in 2 square meters, average density at acceptable [TBD] performance levels
- Power Consumption: Each WPAN Device will consume <20 mW long term average [TBD] given a 10% TxRx load in the WPAN

WPAN Application Feature List

Priority

Consensus	High	Low
Strong	low cost low power small size packet data ≤ 1 Mbps range ≤ 10m active devices ≤ 10 manual auth/auto attach coexistence with 802.11	packet + isochronous encryption mobility ≤ 10 mph gateway native IP
Weak	topology active devices 10 - 128 coexisting PANs 4-30	inter-pan connectivity

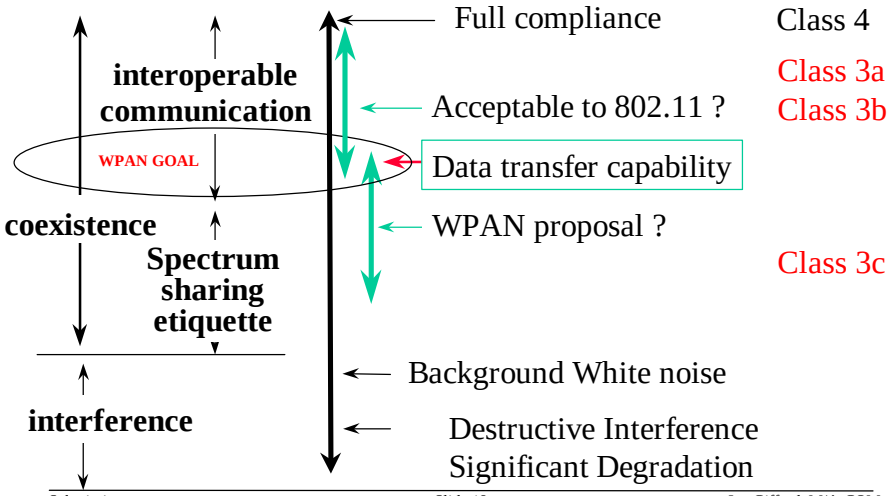

March 1999
doc.: IEEE 802.11-99/055r1
We focused only on the Lower Layers
ISO/OSI Reference Model
Application
Presentation
Session
Transport
Network
Data Link
Physical
HomeRF
IEEE 802
Medium Access Control Sub Layer
Physical Layer
Area of Focus
Submission
Slide 15
Ian Gifford, M/A-COM


March 1999
doc.: IEEE 802.11-99/055r1
We reviewed the IEEE 802.11 Standard for a WPAN fit
WPAN
MAC
MAC Lite
2.4 GHz radio Freq. Hopping Spread Spectrum
2.4 GHz radio Direct Sequence Spread Spectrum
Infra-Red
Higher data rate extension in 2.4 GHz 802.11b
Higher data rate extension in 5 GHz 802.11a
Lower data rate extension in 2.4 GHz 802.11x
1 Mbit/s
2 Mbit/s
2 Mbit/s
1 Mbit/s
1 Mbit/s
2 Mbit/s
11 & 5.5 Mbit/s
6-12-18...54 Mbit/s
<1Mbit/s
Legend: italic (and red) = optional
Submission
Slide 16
Ian Gifford, M/A-COM

WPAN Interoperability Classes

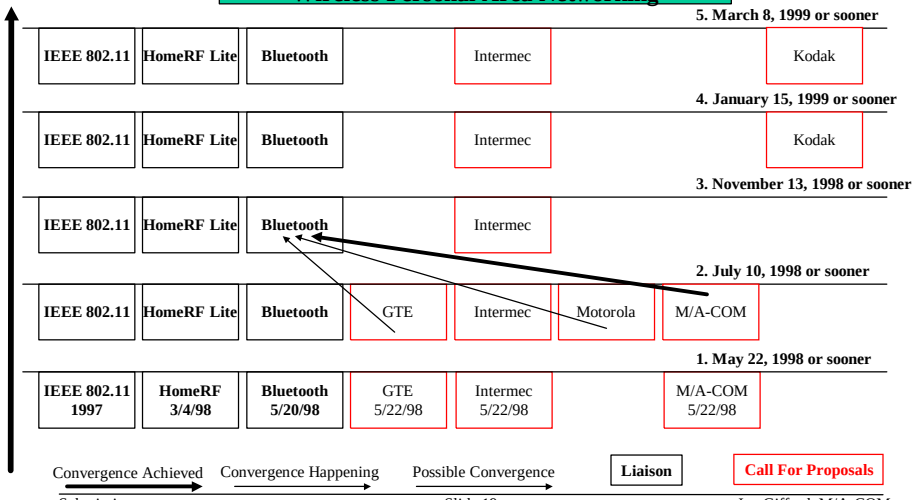
- Class 4 - Full Compliance to the 802.11 MAC & PHY PICS
- **Class 3 - Partial Interoperability: there is a way on the medium to exchange data without an intermediate device**
  - Class 3a Transmit and Receive
  - Class 3b Receive Only
  - Class 3c Detect Energy
- Class 2 - Bridge-like (1 MAC/2 PHYs)
- Class 1 - Gateway-like (> 1 MAC)
- Class 0 - Non Interoperable

Medium Interoperability Continuum

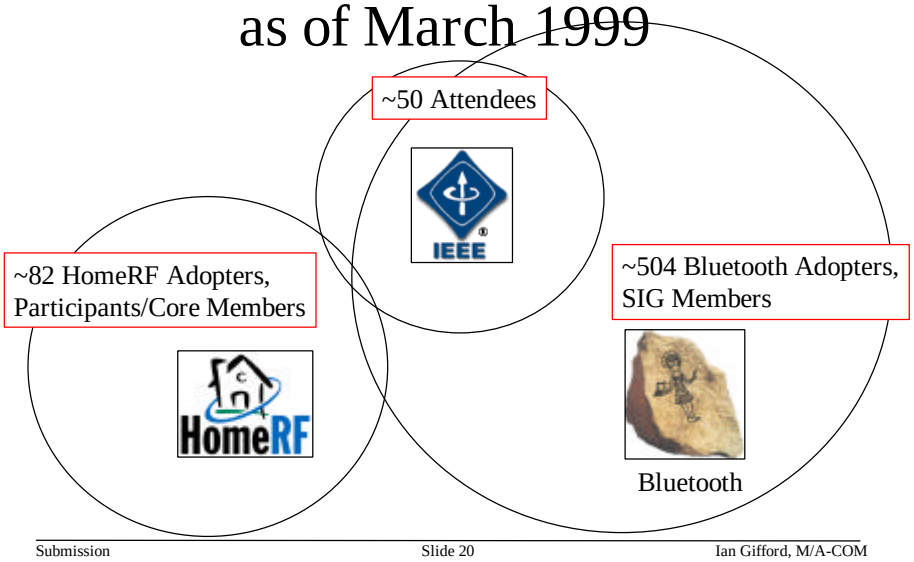


WPAN Liaison & Submissions

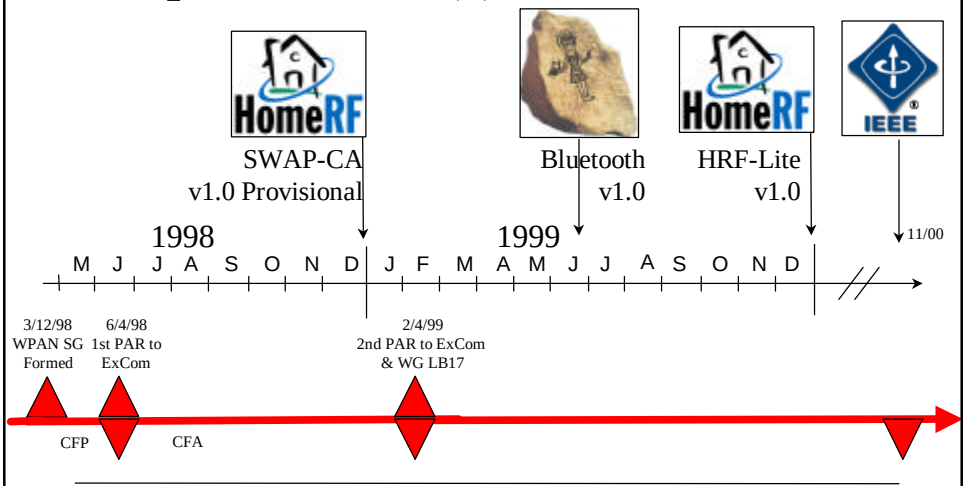
Wireless Personal Area Networking



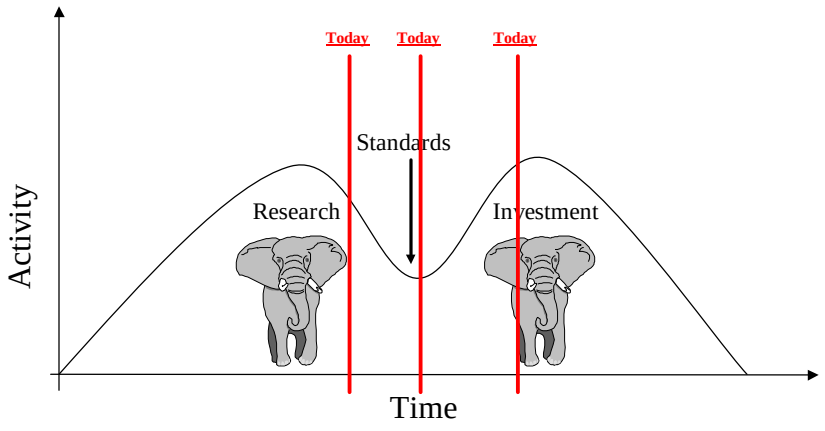
Company Participation as of March 1999



WPAN Timeline vis a vis a Specification(s) or a Standard



Standards should be written between the two elephants



Source: "*Apocalypse of the two Elephants*", David Clark, MIT

Archive, Mailing List, URLs

- WPAN Archives
  - NEW – ftp://ftp.flexipc.com/wearablesgroup/Index.htm
  - ftp://ftp.flexipc.com/wearablesgroup/
- WPAN Mailing List
  - stds-802-wpan@majordomo.ieee.org
- IEEE 802.11
  - http://grouper.ieee.org/groups/802/11/
- Bluetooth Special Interest Group
  - http://www.bluetooth.com/
- Home RF Working Group
  - http://www.homerf.org/

To add your name to IEEE mailing list please send an e-mail to Ian Gifford giffordi@amp.com

WPAN

Background

WPAN Background - PR

- During the March 1998 802 LMSC Plenary, a Study Group was formed to investigate the MAC & PHY Layers for Wireless Personal Area Networks (WPANs). This study will examine the requirements for WPAN for PCs, HPCs, peripherals, and consumer electronic devices to communicate and interoperate with one another in the home, office, etc. The WPAN Study Group has defined a WPAN with 0 to 10 metre range, data rates of less than 1 Mbit/s, low power consumption, small size less than 0.5 cubic inches and low cost relative to target device. One of the first applications anticipated is for wireless communications for Wearable computing devices.

WPAN Background - Meetings

- June, 1997. Cleveland, OH, Request to PASC
- July 16, 1997. Nashua, NH IEEE PASC Plenary Meeting
- December 2, 1997. Cleveland, OH Ad Hoc Wearables Committee Meeting
- January 14-15, 1998. Memphis, TN, Ad Hoc Wearables Committee Meeting
- January 19-23, 1998 Lynnwood, WA IEEE 802.11 Interim Meeting
- March 9-13, 1998 Irvine, CA IEEE 802 Plenary Meeting (SG formed)
- April 8-9, 1998 Cambridge, MA IEEE 802.11 WPAN SG Meeting
- May 4-8, 1998 Utrecht, NL IEEE 802.11 Interim Meeting
- May 19-21, 1998 Irving, TX IEEE 802.11 WPAN SG Meeting
- July 6-10, 1998 LaJolla, CA 802 Plenary Meeting
- September 14-18,1998 Westford, MA 802.11 Interim Meeting
- October 26, 1998 Atlanta, GA Ad Hoc WPAN SG Meeting
- November 9-13, 1998 Albuquerque, NM 802 Plenary Meeting
- January 11-15, 1999 Orlando, FL 802.11 Interim Meeting
- March 8-12, 1999 Austin, TX 802 Plenary Meeting

WPAN Background - Liaisons

Our Sponsor submitted an IEEE Liaison Letter to the following Groups:

- ATM Forum Wireless ATM (WATM) Working Group
- Bluetooth Special Interest Group
- ETSI Broadband Radio Access Networks (BRAN) Project
- Infrared Data Association (IrDA)
- Internet Engineering Task Force (IETF), MobileIP
- Home Radio Frequency Working Group (HRFWG)
- Wireless LAN Alliance (WLANA)

We reviewed the HomeRF Specification, via Liaison & Public info

- HomeRF Working Group Formed March 4, 1998
  - Liaison #1 May 5, 1998 -98/217
  - Liaison #2 July 7, 1998 -98/251r1
  - Liaison #3 September 15, 1998 -98/299
  - Liaison #4 November 26, 1998 -98/360
  - Liaison #5 January 12, 1999 -99/004r1 (Minutes only)
  - *Liaison #6 March 9, 1999 -99/054 Tutorial*

We reviewed the Bluetooth Specification, via Liaison & Public info

- Bluetooth Special Interest Group Formed May 20, 1998
  - Liaison #1 July 7, 1998 -98/253
  - Liaison #2 September 15, 1998 -98/300
  - Liaison #3 October 26, 1998 -98/350 (Minutes only)
  - Liaison #4 December 14, 1998 J. Carlo 802 Overview to Bluetooth SIG
  - *Liaison #5 March 9, 1999 -99/053 Tutorial*

We reviewed the Liaison Usage Models for applicability

Bluetooth

- Three-In-One Phone
- Interactive Conference
- Briefcase Trick
- Forbidden Message
- Automatic Synchronizer
- Instant Postcard
- Portable PC Speaker Phone
- Cordless Desktop
- Videos
- Ultimate Headset
- Internet Bridge

HomeRF

- Set up a wireless home network to share voice and data between PC's, peripherals, PC-enhanced cordless phones, and new devices such as portable, remote display pads
- Access the Internet from anywhere in and around the home from portable display devices
- Share an ISP connection between PC's and other new devices
- Share files/modems/printers in multi-PC homes
- Intelligently forward incoming telephone calls to multiple cordless handsets, FAX machines and voice mailboxes
- Review incoming voice, FAX and e-mail messages from a small PC-enhanced cordless telephone handset
- Activate other home electronic systems by simply speaking a command into a PC-enhanced cordless handset
- Multi-player games and/or toys based on PC or Internet resources

WPAN Application Summary

Submitter ← Attributes →

	# of Active devices in 1 PAN	Min. device	Attachment/Initialization	Data types	Link eff. Data throughput	Conn. to other n/w
Boeing	2 to 8	WinCE	Manual auth/auto attach	Data/VoIP	19.2 to 64 kbps	802.11/PCS
Fedex	6 to 16	Printer	Manual auth/auto attach	Data/Voice	19.2 kbps	Private and Public
Symbol/Wearable	8	Scanner	Manual	Data	19.2 kbps	802.11
TI	30-128	Graphing Calc/PDA	Manual auth/auto attach	Data	19.2 kbps	802.3/802.11
PED	8	Sensor	Manual auth/auto attach	Data	9.6 kbps	Yes
Bob O'hara	8	PDA	Manual auth/auto attach	Data/Voice	1 Mbps	Yes
Kodak	4	Camera	User invoked	Data+Isoc	10+ Mbps	Yes

	Inter PAN conn	# PANs co-exist	Power	Range	Size	Mobility Speed	Topology	Encryption within MAC	MAC level IP support
Boeing	Yes	2	WinCE for 8 hrs	10-15m	1.5"x1.5" (Compact Flash)	10 mi/hr	Don't care	Yes	Yes
Fedex	No	30	30mW avg (10hr)	10m	.5"x1.0"	10 mi/hr	Peer-to-peer like		No
Symbol/Wearabl	No	4 to 8	30 mA, 100 uA	10m	.5"x.5"	Don't Care	Don't care	No	No
TI	No	4	30 mA, 100 uA	10-15m	.5"x.5"	10 mi/hr	Master-Slave	No	No
PED	No	10	10-15 day batt	2m	.5"x.5" (4 oz. Wt)	N/A	Master-Slave	No	No
Bob O'hara	Yes (Manual)	20	WinCE for 8 hrs	10m	.5"x.5"	10 mi/hr	Don't care	Yes	Yes
Kodak	No	4	Low	60m	.5"x.5"	10 mi/hr	Don't care	No	No

Source: doc.: IEEE 802.11-98/353 (Bruce Kraemer, Harris)

WPAN Background - Companies

- **3Com**
- **Aironet**
- **Amerisys**
- **AMD**
- **AMP**
- **ARIB**
- **Boeing**
- **Bosch**
- **BreezeCOM**
- **Broadband Access Systems, Inc.**
- **Butterfly Communications, Inc.**
- **Carnegie Mellon**
- **Clarion**
- **Commcepts**
- **Compaq/DEC**
- **Conexant**
- **FedEx**
- **GTE/BBN**
- **Harris**
- **H-P**
- **Informed Technology, Inc.**
- **Intermec/Norand**
- **Kodak**
- **Kyocera**
- **Lace**
- **Lucent**
- **McDonnel Douglas**
- **Micrilor**
- **MIT Media Lab**
- **Motorola**
- **Netwave**
- **PED Inc.**
- **Philips**
- **Raytheon**
- **Sanders**
- **Sprint PCS**
- **Symbol**
- **Texas Instruments**
- **Unisys**
- **ViA**
- **Walt Disney**
- **Xetron**
- **etc.**