# Bluetooth Wireless
### (File: Bluetooth wireless.doc, Update 07/10/01)

## Synopsis:

Bluetooth is an extremely low cost, wireless & seamless local area network (WLAN) technology using robust radio frequency technology.  It is designed to be built into and connect electronic appliances without adding significant cost.  Ideally Bluetooth would only add a single $5 IC chip to the device.

To date Bluetooth has seen only limited product implementation but many manufacturers have products under development.  As with many technology advances, the hype exceeded the reality and the complexities are more severe than expected. The latest estimates are that Bluetooth will not see widespread deployment until 2004.

Here is a summary of the market, Bluetooth specifications, operation of the systems, developers, and predicted products.   Current delaying issues are discussed at the end.

## Summary Facts:

Timing: Market was expected to explode in 2000.  But continual delays have pushed widespread deployment back toward 2004 2004.

Growth projection: 173% compound annual growth rate (CAGR) was originally estimated.

Market projection: 2005 production – 1.4 billion Bluetooth chips, 1 billion BT enabled devices, $5 billion in sales.  670 million devices deployed just in vehicles (update as of 10/00).

Paradigm: Bluetooth is a shift from "premise based" to "person-based" communications.  It would serve as a universal bridge between existing data networks, a peripheral interface and means of forming small private ad hoc groupings of connected devices.

Prime developers: IBM, Intel, Nokia, Toshiba = Original SIG

Promoters Group: Originators +, Microsoft, 3Com, Lucent, Motorola

SIG membership: 2,164 members (all can use standard without royalties).

Web Site: www.bluetooth.com

Standards: Bluetooth SIG – version 1.1
An upgraded version 2.0 with higher bandwidth and resolution of interoperability issues is being considered.

IEEE 802.15 (not yet adopted)

| | |
|---|---|
| Bluetooth Costs: | 2001 – Cost to implement Bluetooth node: $40.<br>2005 – projected at $13.15 (OEM) by Micrologic Research (6/01).<br>Consumer costs would be higher at 40% OEM margin<br>Concept success is pegged to $5 chip cost. |
| Range: | 10 meters (through walls & briefcases) |
| Spectrum: | 2,400 to 2,483.5 MHz in the U.S., unlicenced, ISM band |
| Technology: | fast frequency-hopping, spread-spectrum (FHSS)<br>Employs Time Division Duplexing (TDD)<br>Frequency hope rate is 1660 hops/second |
| Channels: | 79, 1 MHz wide hop channels |
| Modulation: | Frequency-Shift keying (FSK) |
| Date types: | Voice & Data supported. |
| Transmission rate: | 1 Mbit/s, raw bit rate, range 10 meters – current system<br>10-20 Mbits/s (future), range 50 meters but uncertain |
| Data rate: | 721 kbits/s (asymmetric), 432.6 kbits/s (symmetric). |
| Voice data rate: | 64 kbits/s in synchronous mode using CVSD voice coding.  Voice packets are never retransmitted.   CVSD coded voice is quite audible even with 4% bit-error rate. |
| Dual mode: | Simultaneous transmission of one synchronous data channel along with three synchronous voice audio channels is supported.  Also supported is simultaneous transmission of asynchronous data and synchronous voice audio data within a single channel. |
| I/O: | USB supported. |
| FEC | Forward Error Correction (FEC) in Bluetooth helps reduce impact of interference since noisy channels are skipped in next frequency hop sequence. |
| Antennas | The antenna for most Bluetooth devices is on the PC board. |
| Network Design: | Ad-hoc network of master & slaves called a Piconet. |

| | |
|---|---|
| Nodes: | Eight, with up to 7 active slaves per master within a Piconet. Individual Bluetooth units identify themselves within seconds using a 48-bit serial number. The first device becomes the master. Once a Piconet is established, all nodes use the same bit hopping sequence. |
| Slave Modes: | There are three power saving modes for idle devices. In order of power savings these modes are: PARK, HOLD, SNIFF. The master can command slaves to go quite and then wake them up. In park these devices need only about 2 mW to stay operational. This makes them well suited for battery operations. |
| Sniff mode: | In sniff mode, the slave listens within its Piconet at a reduced scan rate (programmable). |
| Park mode: | In park mode, the slave is still synchronized within the network, but doesn't participate in data transmission. Devices in this mode only occasionally listen to maintain synchronization and for a wake up call. This is the maximum power saving mode. |
| Hold mode: | In hold mode, only an internal timer circuit keeps on working. Slaves can request the master to allow them to go into hold mode. |
| Scatternets: | Piconets can be interconnected into larger multiple-Piconet environment known as a Scatternet. Scatternet communications takes place between the Piconet masters. This technique can extend range of the system. Scatternets are unlikely to be widely implemented in the early Bluetooth releases. There is concern about the specifications in the present 1.1 version (EET, 6-4-01). |
| Listening: | At startup, all devices within a Piconet are in standby mode. Every 1.28 seconds, they listen for any kind of signal. If a signal is detected, the device will look for a potential partner on 32 individually assigned frequencies. |
| Wake-up | Usual wake-up time needed to establish a link between master and slave is .64 seconds. The maximum time delay is 2.56 seconds. |
| Telegrams: | The master Bluetooth unit uses Inquiry telegrams to identify nearby Bluetooth devices (like printers or fax machines). |
| OS Support (MS): | Will have to wait for next version of Bluetooth specifications. |
| Service-discovery | This feature will allow auto detection of nearby devices. & available services. This will allow very easy access to pubic access devices like printers, projectors, LAN access devices. |

MS product:          Mobile Explorer Microbrowser planned

Interoperability:    In spec (v1.0), but all issues not resolved.
                     v2.0 standard is under development.  It will include auto handover
                     to next access point for voice applications.  Speed increases also
                     likely (2 - 20 Mbits/sec under discussion).

Interop Specs:       Called Profiles

Power requirements Two levels in spec.  (EIRP = effective Isotropic radiant power)
                     1 milliwatt EIRP for 10 meter range
                     100 milliwatt EIRP for 100 meter range

Receiver             Input sensitivity of -70 dBm working with an IF of 1 MHz.

UnPlugFest           Developer strategy to test Bluetooth products and improve product
                     design and remove specification ambiguities.


# Alternate Technologies:

- 802.11b wireless Ethernet (11 mbps) – Designed for business market but
  becoming the dominant wireless technology as Bluetooth delays continue.
  802.11b speed advantage may obsolete Bluetooth on some applications.

- 802.11a wireless Ethernet – This is the next generation wireless Ethernet which
  moves to 5 GHz spectrum and has even higher bandwidth.

- HomeRF –    Home LAN,  May become compatible with Bluetooth
                        Low end version of 802.11
- HomePNA – Home LAN

- HomePlug 1.0 – A LAN system operating through within buildings through the
  powerline wiring.   Rollout expected in 2002 at  5 to 8.8 Mbits/sec.

- CEA R7.3 – Another powerline wiring LAN system for intra-building use.   The
  CEA system also is expected to launch in 2002 and will compete with HomePlug.

- DECT - Digital European Cordless Telecommunications

- Non-RF magnetic-induction systems

- Infrared (IR)

# Current Products:

- Bluetooth PC Card for laptops **(3Com)**

- USB – Bluetooth adapter **(Motorola, IBM, Sony)**

- Bluetooth Clip-on adapter for Palm Vx  **(Red-M)**

- Cable Replacement (**Blue2Space AB**)

- Wireless Remote Speaker & Microphone for 2-way radios (**Motorola**)

- Bluetooth adapter for 2-way radios (**Motorola**)

- Inkjet Printer with Bluetooth connectivity (**HP** – Deskjet 995c)

- LAN Access Point (**Pico Communications** – PicoBlue)

- Bluetooth Stack (drivers) for Windows (**Toshiba, etc**.)

# Delaying Issues:

- **No Windows XP Support** -- In May 2001, Microsoft announced that the upcoming Windows XP would not support Bluetooth.   This came after a number of disastrous connectivity demos.

- **RFI Issues**  -- Bluetooth & 802.11 wireless LANS use the same 2.4 GHz spectrum.  Interference may disrupt 802.11 communications more than Bluetooth because fast hop rate of Bluetooth.  The effect is dramatic reduction in throughput.  Work is progressing to reduce RFI on both systems.

- There are also "jamming" problems related to using Bluetooth devices next to higher power 900 - 1800 MHz transceiver inside a cellular handset.

  The FAA is also concerned over Bluetooth transmissions on airline navigation channels and France has banned Bluetooth due to RFI on defense channels.

- **Interoperability** – The specification is complex enough to create interoperability issues as developers work to create competing devices.  To date this has been a significant problem that is delaying production.  In theory these problems should eventually go away as the market weeds out non-interoperable solutions.

- **Costs** – The driving idea behind Bluetooth as a "cable replacement" was based on the idea that adoption would only occur if overall price addition is between $5 and $10.  So far, just the Bluetooth chip sets are $30.  Predictions are that costs will not hit the $5 range until 2004 or 2005.

- **Feature Creep** – As more developers entered the effort, the demand for more "features" increased.  Considerable complexity was added by networking functionality and yet not all applications require sophisticated networking. Development and testing of these complex features have added considerable more development time than expected.

- **Version Envy** – The proposed version 2, which greatly increases throughput, eliminates RFI and adds other features may be delaying version 1.1, since there is a tendency to wait for the more robust solution.

## Possible Future Products:

- Portable phones
- Wireless PDA (Palm, Handspring) as control center
- Laptop computer to printer & ad hoc LAN link
- PCMCIA Bluetooth modem
- Cell phone wireless headset
- Cell phone to laptop wireless connection
- GSM phone

- In-Car communication & information Systems
- In-Car device actuation & control
- Car to service equipment link in service shop
- Digital camera downloads (Kodak pushing for 10 Mbps)
- Video cameras
- PDA to cell phone phone # transfer

- eBook content refresh
- TV remote & web TV remote
- Smart security badge
- eCash (wireless credit card)
- Electronic lock entry (house & car)
- Breath tester for police use
- Signature capture device
- Entertainment robots
- Toys (RF controlled vehicles)

## Sources:

- Electronic Engineering Times
- Electronic Design
- Wireless Systems Design, etc.
- InfoWorld
- Wireless Systems Design
- EWeek
- Network World
- www.bluetooth.com

_____

**LAST UPDATE:     July 2001**
**MWB**