# WHITE PAPER

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# MultiPort Bluetooth Communication


*Bluetooth is a Radio Frequency (RF) specification for short-range, point-to-multi-point voice and data transfer. Bluetooth will enable users to connect to a wide range of computing and telecommunications devices without the need for proprietary cables that often fall short in terms of ease-of-use. The technology represents an opportunity for the industry to deliver wireless solutions that are ubiquitous across a broad range of devices. The strength and direction of the underlying Bluetooth standard will ensure that all solutions meet stringent expectations for ease-of-use and interoperability. The MultiPort design from Compaq is an innovative and revolutionary design that solves the complexities surrounding integrated wireless solutions into the notebook. RF signals, which are used for wireless communication, typically have reduced effectiveness when combined with other components inside a notebook computer. Antennae placement is a key element to an integrated wireless solution and due the rapid evolvement and change in wireless technologies, modularity is very important.*


COMPAQ

## COMPAQ'S MULTIPORT

In the Spring of 2001 Compaq will introduce notebooks enabled with the new and innovative MultiPort module. The MultiPort is an interchangeable module located on the back of the notebook display panel. A MultiPort module can be easily slid into place and thus becomes an integral part of the display assembly. MultiPort options can be selected when the notebook is purchased and installed during the CTO (Configure-to-Order) manufacturing process. If a MultiPort module is not selected at the time of purchase, a blank cover is installed to cover the slot. A variety of both wireless and non-wireless technologies will be offered in the MultiPort form factor. A user can purchase a MultiPort module at anytime in the future to wirelessly enable their unit or upgrade to a new wireless technology. The electrical interface is based on the industry standard USB (Universal Serial Bus) technology. This USB based module concept provides a great deal of flexibility in developing numerous solutions.

## MULTIPORT AND ITS ADVANTAGES

MultiPort combines the antenna and radio in a single assembly, that results in reduced signal loss and noise pick-up and eliminates the added costs associated with internal coax cables and connectors. The combined antenna/radio module is a complete solution that can receive host-independent regulatory approvals, enabling a common, easy to manage solution across the portable product line. Its location on the display improves receive-signal-strength and reduces noise pick-up from the base of the notebook. The self-shielding effects of the display greatly reduce the possibility of RF susceptibility of the various subsystems in the base of the notebook. The optimal antenna position results in omni-directional signal reception and significantly reduces human body/hands absorption affects. The resulting maximized signal strength provides the user with greater data throughput and distance performance.

Beyond the performance and technical benefits, MultiPort leaves PC Card slots and the Mini-PCI slot available for non-wireless technologies such as classic modems and NICs as well as new technologies to be offered in the future. Customers do not need to trade-off other functionality in order to get wireless enabled notebook. MultiPort's modular form-factor allows the user to easily upgrade to different wireless technologies or standards.

## CHALLENGES IN WIRELESS INTEGRATION

There are several challenges to overcome when integrating wireless capabilities into notebook computers. Due to the rapid adoption of wireless enabled devices such as cellular phones, notebook vendors have experienced a variety of issues when these RF devices are placed in close proximity to notebooks. Documented cases from end-users have shown that the interaction of the RF device and the notebook has adversely affected the performance of both devices. For this reason, notebook vendors have been fighting to keep unwanted RF sources and noise from entering or exiting the notebook. Now the industry is actually attempting to integrate these RF technologies inside the notebook.

A recent study done by Compaq revealed some of the potential issues that can arise with RF interference in notebooks. For example, audible buzzing in the Audio sub-systems, cursor deflections across the LCD panel, dimming or flickering of LCD backlights, and increased modem data error rates or dropped connections. Additional failures included CDs skipping tracks or complete failure to read, shutting down DC-to-DC power supply converters and display panel invertors, and hard driver read/write failures. In some extreme cases battery packs shut down and their protective fuses were blown.

In order to minimize the effects of RF related issues in the notebook, Compaq's MultiPort solution integrates the wireless functionality into the top of the notebook behind the display. This allows wireless functionality without integrating the device inside the base unit of the notebook where RF interference can cause problems to arise.

Another challenge to overcome is with regard to antenna placement for the wireless device. Extensive research was done jointly between Compaq and a few major antenna vendors and universities to determine optimal placement for an RF antenna within a notebook computer. The results of the study showed that the optimal placement for the antennae is at the top edge of the display. Antennas located anywhere in the base of the notebook were greatly affected by the conductive nature of the notebook itself.

Again the *Evo*™ Notebook MultiPort solution provides an optimal solution. The antenna is incorporated into the MultiPort module with the radio receiver and is at the top edge of the panel for optimal signal strength and reliability. Having both the antenna and the radio receiver built into one module has other advantages as well. In some integrated wireless solutions coaxial cable is used to connect the radio receiver to the antenna. This is more costly and results in performance loss. Signal loss of .5db can be experienced with RF coax cable connectors. Additional signal loss can be experienced in the coax cable itself. Placing the RF radio inside the base of the notebook and running coax cable up through the hinge can not only

be costly but may result in a cumulative signal strength loss of 1 to 3db. (3db signal loss can result in reducing transmit/receive distance by 50%).

## MULTIPORT VS. MINI-PCI SOLUTIONS

Mini-PCI is an industry standard technology for installing communication devices. Mini-PCI slots are generally located in the base of the notebook where the RF environment of the notebook is located. Placing a wireless communication device in the Mini-PCI area of the notebook would cause RF interference and reliability concerns. An additional concern with Mini-PCI is the higher temperatures that reside inside the notebook, which can cause wireless devices to drift out of their intended channels or bands thus losing the connection.

The MultiPort design from Compaq avoids the issues of integrating wireless communication into the Mini-PCI slots of the notebook. With the MultiPort design the communication device is far enough from the RF sources of the notebook and the internal temperatures of the notebook thus reducing interference and signal losses. This design also offers the customer added flexibility in making technology choices. By not occupying the Mini-PCI slot, the customer is free to have a modem or modem/NIC combo in the unit for alternative connection methods.

A final concern with Mini-PCI is the ease of user installation or upgradability. The average lifetime of a notebook is 3 years, far longer than most wireless standards. If a user wishes to change to a different wireless technology or upgrade to the latest standard, they will be forced to remove screws and access doors, unplug the coax cable and pop-out the Mini-PCI device. This also assumes that the antenna that is wired into the notebook is compatible with the next generation of wireless products, which is unlikely. The MultiPort design is such that as wireless technology advances and new standards are instituted, a new MultiPort module can be created for customers to install into their notebook. The flexibility offered by integrating the antenna and radio receiver into one MultiPort module allows the most flexibility as technology advances in the wireless area.

## BLUETOOTH TECHNICAL FEATURES

Bluetooth technology provides a 10 meter personal bubble that supports simultaneous transmission of both voice and data for multiple devices. Up to 8 data devices can be connected in a piconet, and up to 10 piconets can exist within the 10 meter bubble. Each piconet supports up to 3 simultaneous full duplex voice devices (CVSD).

The gross data rate is 1Mb/s, but the actual data rates are 432Kbps for full duplex transmission, 721/56Kbps for asymmetric transmission, and 384 Kbps for TMS2000 transmission. A Time-Division Duplex scheme is used for full-duplex transmission.

Bluetooth wireless technology is designed to be as secure as a wire with up to 128-bit public/private key authentication, and streaming cipher up to 64 bit based on A5 security. The encryption strength can be very robust which is good for establishing a secure link, but there may be export problems when shipping from the US. Different hardware with smaller encryption key lengths may be required to meet US export controls.

***NOTE:***

*A piconet is a collection of devices connected via Bluetooth technology in an ad hoc fashion. A piconet starts with two connected devices, such as a portable PC and cellular phone, and may grow to eight connected devices. All Bluetooth devices are peer units and have identical implementations. However, when establishing a piconet, one unit will act as a master and the other(s) as slave(s) for the duration of the piconet connection.*

## BLUETOOTH TECHNOLOGY USAGE MODEL

Bluetooth technology was designed to be small and inexpensive. Bluetooth technology has no line-of-sight requirements making it a potential replacement for infrared ports. Bluetooth can operate through walls or from within your briefcase. With the MultiPort module, Compaq *Evo* Notebooks can wirelessly connect to printers, transfer data to desktop PCs or PDAs, or interface with cellular phones for wireless WAN (Wide Area Networking) access to corporate networks or the Internet. The placement of the *Evo* Notebook MultiPort module on the top rear of the panel enhances this communication by enhancing signal strength and reducing interference.

## CABLE REPLACEMENT

Bluetooth will enable users to connect a wide range of computing and telecommunications devices easily and simply, without the need to buy, carry, or connect many proprietary cables. It delivers opportunities for rapid ad hoc connections, and the possibility of automatic, unconscious, connections between devices. It will virtually eliminate the need to purchase additional or proprietary cabling to connect individual devices. Because Bluetooth can be used for a variety of purposes, it will also potentially replace multiple cable connections via a single radio link. It will allow users to think about what they are working on, rather than how to make their technology work. For instance, Bluetooth radio technology will be built into both the cellular telephone and the Evo Notebook products with the

MultiPort functionality. This communication between products would replace the cumbersome cable used today to connect a laptop to a cellular telephone.

### BLUETOOTH APPLICATIONS

Printers, PDA's, desktop computers, fax machines, keyboards, joysticks and virtually any other digital device can be part of the Bluetooth system. But beyond untethering devices by replacing the cables, Bluetooth radio technology provides a universal bridge to existing data networks, a peripheral interface, and a mechanism to form small private ad hoc groupings of connected devices away from fixed network infrastructures.

## SCENARIOS FACILITATED BY THE EVO NOTEBOOK MULTIPORT SOLUTION

### SURF THE INTERNET REGARDLESS OF THE CONNECTION

Use your laptop to surf the Internet wherever you are, and regardless if you're cordlessly connected through a mobile phone (cellular) or through a wire-bound connection (PSTN, ISDN, LAN, xDSL).

### USE E-MAIL WHILE YOUR PORTABLE PC IS STILL IN THE BRIEFCASE

When your portable PC receives e-mail, you'll get an alert on your mobile phone. You can also browse all incoming e-mails and read those you select in the mobile phone's display.

### CONNECT YOUR PORTABLE PC TO PERIPHERALS OR TO THE LAN

Bluetooth enables a cordless connection of your Portable PC to printers, scanners and to the LAN. Increase your sense of freedom in everyday work by cordless connection of your mouse and keyboard to your Portable PC.

### COMPOSE E-MAILS ON YOUR PORTABLE PC WHILE YOU'RE ON AN AIRPLANE

As soon as you've landed and switched on your mobile phone, all messages are immediately sent

### AUTOMATIC BACKGROUND SYNCHRONIZATION KEEPS YOU UP-TO-DATE

Automatic synchronization of your desktop, portable PC, notebook (PC-PDA and PC-HPC) and your mobile phone is made easier with Bluetooth. For instance, as

soon as you enter your office the address list and calendar in your notebook will automatically be updated to agree with the one in your desktop, or vice versa.

**CONNECT ALL PARTICIPANTS FOR INSTANT DATA EXCHANGE**
In meetings and conferences, you can share information instantly with all participants, and without any wired connections. You can also cordlessly run and control, for instance, a projector. This is not officially supporting in the 1.0 specification, but other companies are working on this application.

**SEND INSTANT PHOTOS AND VIDEO CLIPS FROM ANY LOCATION**
Cordlessly connect your camera to a Portable PC. Add comments and send them instantly to a receiver anywhere in the world.