BARBADOS USE OF 802.x¹x²y DEVICES AND WIRELESS NETWORKING POLICY

Policy in accordance with sections 4 (b) and 4 (f) of the Telecommunications Act 2001-36.

This document outlines the technical principles, limitations and correct use of wireless technology standards defined by the Institute of Electrical and Electronic Engineers (IEEE) $802.x^1x^2y$ (where x^1 represents the number one (1), x^2 represents any digit from 1-9, and y represents any letter from a to z).

INTRODUCTION

The term Wireless networking refers to technology that enables two or more computers to communicate using standard network protocols, but without network cabling. This technology fuelled by the emergence of cross-vendor industry standards such as IEEE 802.11, has produced a number of affordable wireless solutions to problems experienced when using a cable linked network, which are subsequently growing in popularity with business and schools as well as sophisticated applications where network wiring is impossible, such as point-of-sale handheld equipment. Among these revolutionary technologies are Bluetooth and Wi-Fi which will be further discussed in this document. The first part of the policy outlines current technologies available for wireless networking. The list is non-exhaustive as the Technology rapidly changes.

The second part of the paper outlines wireless networking in Barbados, and the use of Spectrum follows the dictates as set by the United States of America in the Federal Communications Commission (FCC), Code of Federal Regulations 15.247 which is appended, the Radio Standards Specification RSS -210 of Canada is also adhered to and the document meets all relevant international standards including the European Telecommunication Standardisation Institute (ETSI.

BLUETOOTH

This wireless technology may be simply described as the term used to explain the protocol of a short range frequency hopping radio link between devices in the 2.4GHz range. One of the ways that Bluetooth devices avoid interference with other systems, is by emitting at a very low power (1 milliwatt). This Low power emission limits the devices to a range of approximately 10meters (10m). Bluetooth technology was designed to operate in noisy radio frequency

environment and is intended to alleviate the problems that accompany infrared and cable synchronised systems.

In essence, Bluetooth is a short-range radio link intended to replace the cable(s) connecting portable and/or fixed electronic terminals. Key features are robustness, low complexity, low power and low cost. Bluetooth operates in the unlicensed ISM band at 2.4 GHz. The range of this frequency band is 2400 – 2483.5 MHz. Lower Guard Band shall be 2 MHz and Upper Guard Band shall be 3.5 MHz. Channel spacing will be 1 MHz.

There are several terms that must be used when discussing the topology of a Bluetooth network, they are piconet, scatter net, master units, slave units, MAC Address, parked units and ad hoc network. Since Frequency Hopping technology is employed by Bluetooth, multiple channels are defined for communication, where each channel is accessed by a different Frequency hopping sequence. A group of devices sharing a common channel is known as a Piconet or Personal Area Network (PAN). The devices within a piconet play two roles: Master unit or Slave unit. The master unit is the device in the piconet whose clock and hopping sequence are used to synchronise all other devices on the piconet. The slave units are the devices within a piconet that are synchronized to the master unit via its clocks and hopping sequence. The maximum number of slave units that can simultaneously be active in a piconet is seven (7).

It is clarified that one Bluetooth unit acts as a master of the piconet, whereas the other unit(s) act as slave(s). Multiple piconets with overlapping coverage areas form a scatternet. Each piconet can only have a single master. However, slaves can participate in different piconet on a time division multiplex basis. In addition, a master in one piconet can be slave in another piconet.

Since Bluetooth supports both point-to- point and point-to-multipoint connections, several piconets can be established and liked to form scatternets. Each device in a piconet must be able to be individually identified, thus three (3)-bit Media Access Control Addresses (MAC Addresses) are used to distinguished between the members of the piconet. Parked units are members of the piconet, but don't have MAC Addresses. **See Figure 1**.

Figure 1: simple Bluetooth Piconet
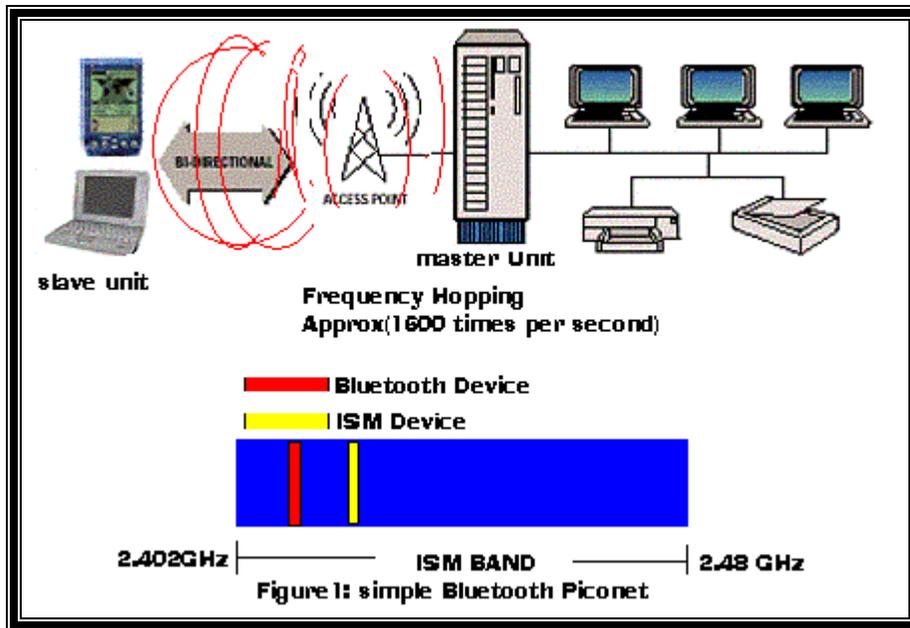
Bluetooth's main strength is its ability to simultaneously handle both data and voice transmissions. It's capable of supporting one asynchronous data channel and up to three synchronous voice channels, or one channel supporting both voice and data. This capability combined with ad hoc device connection and automatic service discovery make it a superior to other competing technologies.

There are two types of links defined for Bluetooth specification in support of voice and data applications:

♦ Asynchronous connectionless (ACL) Links- Transmissions on these links are established on a per-slot basis (in slots not reserved for SCO links). ACL links support point-to-multipoint transfers of either asynchronous or isochronous data. After an ACL transmission from the master, only the addressed slave device may respond during the next time-slot, or if no device is addressed, the packet is considered a broadcast message. ACL supports symmetrical (approximate maximum data rate is 433.9 Kbps for send and receive) or asymmetrical (approximate maximum data rate is 723.2 Kbps for one direction and 57.6 for the other), packet-switched, point-to-multipoint connections, typically used for data.

♦ Synchronous Connection-Oriented (SCO) links are typically used for voice transmission. These are circuit-switch, point-to-point symmetric connections that reserve time slots in order to guarantee timely transmission. The slave device is always allowed to respond during the time-slot immediately following a SCO transmission from the master. A master can support up to three SCO links to a single or multiple slaves, but a single slave can support only two SCO links to different masters. SCO packets are never retransmitted.

Bluetooth enabled terminal shall support either one or both types of links (SCO and ACL links) as per requirement of the application.

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The data on the piconet channel shall be conveyed in packets. Each packet shall consist of 3 entities: the access codes, the header and the payload. Before transmission both the header and payload shall be scrambled with a data whitening word and descrambled using the same word at the receivers.

SWAP

Shared Wireless Access Protocol (SWAP) was developed by the Home RF Working Group, SWAP is a specification for wireless voice and data networking in the home.

SWAP works together with the PSTN network and the Internet through existing cordless telephone and wireless LAN technologies. It supports interactive data transfer and high-speed packet transfer.

SWAP operates in the 2400 MHz band at 50 hops per second. Data travels at a rate between 1 Mbps and 2 Mbps.

On a SWAP network via cordless handheld devices, users will be able to voice activate home electronic systems; access the internet from anywhere in the home, and forward fax, voice and e-mail messages.

Wi-Fi

Wireless Fidelity (Wi-Fi) is the term for a high frequency Wireless Local Area Network (WLAN). Wi- Fi allows users to connect wirelessly to the internet via a computer or some other device at broadband speeds. Wi-Fi is an open standard set by the Institute of Electrical and Electronic Engineers (IEEE). Wi-Fi products may be manufactured by any manufacturer. All products that are tested and approved by the 'Wi-Fi Alliance' and are subsequently given the recognition of being 'Wi-Fi Certified' are interoperable with each other, even if they are not manufactured by the same company.

The radio equipment shall comply with radio requirements specified in clause 15.4.6 of IEEE 802.11 (1) and clause 18.4.6 of IEEE 802.11 b (2) standards.

The maximum peak output power shall not exceed 1watt effective isotropic radiated power (e.i.r.p.).

It shall support access control, authentication, encryption and privacy as per IEEE 802.11 standard. Encryption key length can be 40 bits, 128 bits or 256 bits.

Wi-Fi technology may be categorized into two main types:

♦The 802.11b Wi-Fi technology, which operates in the 2.4GHz range, offering data speeds of up to 11 Mega bits per second (Mbps). The modulation method selected for the 802.11b is known as Complementary Code Keying

(CCK), which is responsible for high data speed and lessens the susceptibility to multipath- propagation interference. Since the 802.11b and 802.11g standards of Wi-Fi use the 2.4GHz spectrum, which is in use by other devices such as Bluetooth and microwave ovens, this may cause degradation in performance.

♦ The 802.11a Wi-Fi technology which operates in the 5GHz range, offering data speeds of up to 54 Mbps.
Some companies manufacture products which operate as 'dual-band' systems which can interoperate with the 802.11a and 802.11b standards.

Basic Wi-Fi systems are most commonly deployed in homes, and small offices. These systems consist of a small transceiver or 'base station' that is wired to the internet via a cable modem or a broadband telephone connection. Using very little power, the base station broadcasts Internet access in a 30-meter radius indoors, or a 100-meter radius outdoors. The area in which access in available is called the 'hot spot'. A small wireless card is inserted into the device in which the internet would be accessed through, the connection is made seamlessly when the card and the base station begin to communicate. Base stations may communicate with several devices equipped with wireless cards simultaneously. **See Figure 2**.

Figure 2: Simple Wi-Fi Network
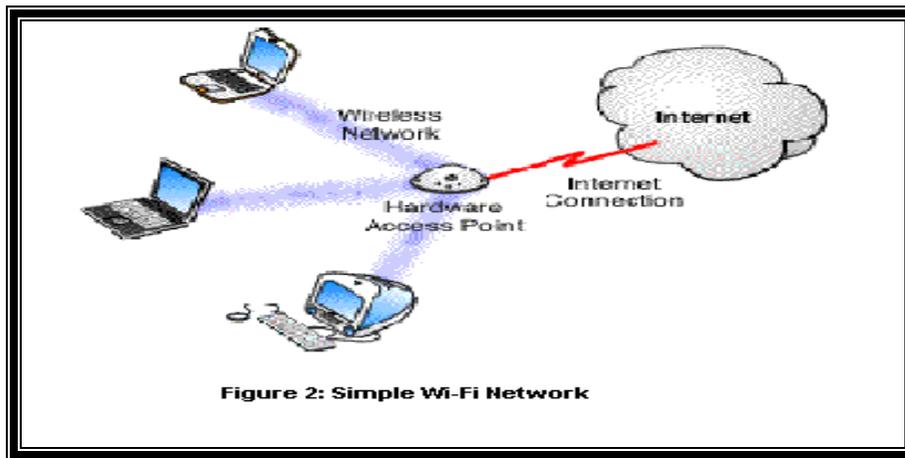
Wi-Fi can be used securely but like most network technologies its not invulnerable. A security protocol known as Wired Equivalent Privacy (WEP) also is provided with most Wi-Fi systems and can effectively guard against most unwanted intruders.

<u>OTHER</u>

This is intended to cover any future developments of the $802.x^1x^2y$ devices to which this policy will still apply, any required modifications to the Policy will be implemented by the Telecommunications Unit.

WIRELESS NETWORKING IN BARBADOS

Barbados is in the ITU Region 2 as it relates to the electromagnetic spectrum allocations. This region also includes the USA, Canada and all Caricom countries, as well as the entire South and Central America. For the purpose of wireless networks in Barbados the Telecommunications Unit chooses to use the same principles as laid down in the Federal Communications Commission (FCC) Code of Federal Regulations (CFR) Part 15.247 attached for reference.

Section (83) of the Telecommunications Act 2001-36 deals with the manner in which interference is investigated and solved in Barbados.

Bluetooth and SWAP systems are basically used indoors and operate in the ISM band 2.400- 2.4835 GHz. Wi-Fi operates in both the 2.400-2.4835 GHz ISM band and also 5.725-5.850GHz ISM band. At the last World Administrative Radio Conference (WARC-03) held in Geneva in 2003 the ITU allocated the band 5.15-5.35 GHz on a secondary basis for the use of Radio Local Area Network (R-LAN) and Hyper Local Area Networks (Hyper- LANs) (which is a subset of R-LANs). In this band non-line of sight and Orthogonal Frequency Divisional Multiplexing (OFDM) is utilised.

All the above mentioned bands are unlicensed for the use of $802.x^1x^2y$ devices. Although no licence is required to operate Wi-Fi devices in Barbados these systems are not unregulated. For example, Wi-Fi devices have to be used in the radio frequency spectrum bands that have been set aside for the use by unlicensed technologies like Wi-Fi by the Telecommunications Unit. Wi-Fi type devices that operate outside the bands set aside for them (i.e , the 2.4 GHz and the 5GHz bands) without a licence would be illegal. Wi-Fi devices also have to operate within certain technical limits spelled out in 'Part 15' of the FCC rules that help ensure they do not create harmful interference to licensed devices that may use the same bands. The restrictions include requirements that the power of the devices' antennas do not exceed certain limits (250 milliwatts). Wi-Fi devices that cause interference to a licence system- even where the Wi-Fi system is observing the specified power limits, must shut down. Wi-Fi systems also must 'accept' interference from licensed devices (i.e. there is no legal protection for Wi-Fi systems from interference caused by licensed devices). Wi-Fi equipment used in Barbados once certified by the 'Wi-Fi Alliance' need no individual type approval certification from the Telecommunications Unit.

Persons wishing to set up Wi-Fi 'hot spots' in Barbados must submit details of their antenna sites to the Telecommunications Unit after having obtained the approval from the Town and Country Planning Department, they must also submit the details of the Radio Frequency (RF) Transmitting antenna as laid down in the Telecommunications Radio Frequency (RF) Transmitting Antenna Inspection Policy. The band(s) to be used must also be submitted to the Telecommunications Unit. No spectrum licence fees are charged for the use of the $802.x^1x^2y$ or RLAN in Barbados.

Persons providing Wide Area Networks (WAN), Metropolitan Area Networks (MANs) or Local Area Networks (LANs) must obtain a Private or Public (LAN/WAN) as the case may be from the Telecommunications Unit. In cases where service is being provided to the public, a service provider licence is also required. A free Spectrum Licence will be issued.

APPENDIX 1

DEFINITIONS

802.11 **refers to a family of specifications developed by the IEEE for wireless LAN technology. 802.11 specifies an over-the-air interface between a wireless client and a base station or between two wireless clients. The IEEE accepted the specification in 1997.**

There are several specifications in the 802.11 family:

- **802.11** -- applies to wireless LANs and provides 1 or 2 Mbps transmission in the 2.4 GHz band using either frequency hopping spread spectrum (FHSS) or direct sequence spread spectrum (DSSS).
- **802.11a** -- an extension to 802.11 that applies to wireless LANs and provides up to 54 Mbps in the 5GHz band. 802.11a uses an orthogonal frequency division multiplexing encoding scheme rather than FHSS or DSSS.
- **802.11b** (also referred to as *802.11 High Rate* or *Wi-Fi*) -- an extension to 802.11 that applies to wireless LANS and provides 11 Mbps transmission (with a fallback to 5.5, 2 and 1 Mbps) in the 2.4 GHz band. 802.11b uses only DSSS. 802.11b was a 1999 ratification to the original 802.11 standard, allowing wireless functionality comparable to Ethernet.
- **802.11g** -- applies to wireless LANs and provides 20+ Mbps in the 2.4 GHz band.
- **802.16** - - applies to non line of sight links.

IEEE: Abbreviation of *Institute of Electrical and Electronics Engineers*, pronounced *I-triple-E*, is a non-profit, technical professional association of more than 360,000 individual members in approximately 175 countries. Through its members, the IEEE is a leading authority in technical areas ranging from computer engineering, biomedical technology and telecommunications, to electric power, aerospace and consumer electronics, among others.

LAN: Acronym for **L**ocal **A**rea **N**etwork. A system of connecting PCs and other devices within the same physical proximity for sharing resources such as an Internet connections, printers, files and drives.

WLAN: Acronym for **W**ireless **L**ocal **A**rea **N**etwork. A type of **L**ocal **A**rea **N**etwork that uses high frequency radio waves rather than wires to communicate between nodes.

WEP: Acronym for **W**ired **E**quivalent **P**rivacy**,** part of the IEEE 802.11 standard, is a system to secure WiFi networks.
It comes in three main levels of security: 64 bit, 128 bit, and 256 bit encryption. Each level is more secure than the previous -- 128 bit encryption is much stronger than 64 bit.

APPENDIX 2

FEDERAL COMMUNICATIONS COMMISSION

CODE OF FEDERAL REGULATIONS (CFR) 15.247

OPERATION WITHIN THE BANDS 902-928 MHZ, 2400-2483.5 MHz AND 5725-5850 MHz

(a) Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 KHz or the 20 dB bandwidth of the hopping channel, whichever is greater. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

    (i)   For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

    (ii)   Frequency hopping systems operating in the 5725-5850 MHz band shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

(iii)   Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 non-overlapping channels.   The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems which use fewer than 75 hopping frequencies may employ intelligent hopping techniques to avoid interference to other transmissions. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 non-overlapping channels are used.

(2)   Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

(b)   The maximum peak output power of the intentional radiator shall not exceed the following:-

(1)   For frequency hopping systems in the 2400-2483.5 MHz band employing at least 75 hopping channels and all frequencies hopping systems in the 5725-5850 MHz band: 1 Watt. For all other frequency hopping systems in the 2400-2483.5 band: 0.125 Watt.

(2)   For frequency hopping systems operating in the 902-928 MHz band: 1 Watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a) (1) (i) of this section.

(3)   For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

(4)   Except as shown in paragraphs (b) (3) (i) (iii) of this section, if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in paragraphs (b) (1) or (b) (2) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(i)   Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

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(ii) Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi without any corresponding reduction in transmitter peak output power.

(iii) Fixed, point-to-point operation, as used in paragraphs (b)(3)(i) and (b)(3)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(5) Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See §1.1307(b)(1) of this chapter.

(c) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15,209(a) (see §15.205(c).

(d) For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

(e) (Reserved)

(f) For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a

time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall comply with the power density requirements of paragraph (d) of this section.

(g)   Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmissions bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

(h)   The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognise other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

Note: Spread spectrum systems are sharing these bands on a noninterference basis with systems supporting critical Government requirements that have been allocated the usage of these bands, secondary only to ISM equipment operated under the provisions of part 18 of this chapter. Many of these Government systems are airborne radiolocation systems that emit a high EIRP which can cause interference to other users. Also, investigations of the effect of spread spectrum interference to U.S. Government operations in the 902-928 MHz band may require a future decrease in the power limits allowed for spread spectrum operation.