Bluetooth Security Analysis and Solution

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Abstract- Bluetooth technology has become an essential part of this modern world where it provides a short distance wireless communication between devices and other network with low cost and low power making it convenient for the users. Bluetooth utilizes the standard 2.4GHz signal range. The security issues in Bluetooth network are malicious entities may gain unauthorized access, internal attacks may be possible via ad hoc transmissions, data may be extracted without any detections, viruses or other vulnerable attacks may corrupt data on the wireless devices, etc. These vulnerabilities in the security sectors are increasing which can be possibly dangerous to the privacy of a user's personal information. To overcome these issues the network security in Bluetooth is introduced. There are many new risks created in Bluetooth network, a good security design is essential for it to be successful. This paper will be focused in what Bluetooth, the vulnerable risks associated with it, network securities related to the Bluetooth, how it works. Through this paper the solution for the above mentioned problems will be solved by giving some safety tips and the possible solutions like conducting seminars regarding the security issues and also doing some workshops for the user Majority of devices now communicates using this Bluetooth technology, the risk of the security issues are high. Due to the security issues, users will aware from Bluetooth attacks. User privacy protection methods for every new security as the device user's personal information's should be secured.

Index Terms- Bluetooth, network security, wireless network, piconet.

I. INTRODUCTION

Bluetooth was created in 1994, Bluetooth technology was considered as a wireless alternative to data cables by interchanging data using radio transmissions. The name Bluetooth arrived from a 10th century Danish King, Harald Blatand or, in English, Harold Bluetooth. Bluetooth technology was created as an open standard to gives connectivity and association between disparate products and industries. The Bluetooth Special Interest Group (SIG) is the supervisor and creator of the core specification and services. That working groups make sure the specification and services work to the highest exchangeability standards so users can identify, with confidence, their Bluetooth products simply work [1].

In this 21st century all the devices are embedded with the Bluetooth technology. Bluetooth is a wireless technology where it is connect within the short distance with the low power and low cost. Bluetooth utilizes the standard 2.4GHz signal range. Bluetooth is connected to the devices with radio waves instead of cables. This wireless network connection between the devices makes it convenient to transfer the data between devices. Bluetooth is low in cost as they are embedded with a small chip into the devices. This wireless connection need to make sure that the signals are not interrupted to secure the connection. To secure the connection, there are several security methods are available. Bluetooth can perform a trusted connection that can exchange data without asking the permissions. When the other device establishes the connection the user has to decide it to allow it. When transferring the data from one device to another devices. So the security issue arises. Security is one of the major challenges faced by this era of wireless technology. In the section II the paper discuss about the past researches done in the Bluetooth security. After discussing the literature review, Sections III talks about the solutions found to solve security issues in the Bluetooth security. And finally in section IV, V the conclusion and future work for the researches are discussed.

II. HISTORY OF BLUETOOTH

Bluetooth is a lower cost, low power, short range technologies intended to replace the cable connection between hand phones, PDA and other portable devices. It can clear up your desk considerably, making wires between your workstation, mouse, laptop, computer and many other devices. Bluetooth technology was invented by a group of scientists working for the Swedish company Ericsson in 1994. Awaiting for replacement to the cables joining their hand phones and their accessories. The Bluetooth system is named after a 10th century Danish King Harold Bluetooth who united and control Norway and Denmark. The first Bluetooth devices hit market around 1999[2].

III. OVERVIEW OF BLUETOOTH

Bluetooth is a classic for short-range radio frequency (RF) communication. Bluetooth is used mainly to establish wireless personal area network (WPAN). Bluetooth technology has been integrated into many variety of business and consumer devices consist of cell phones, laptops, automobile, printer, keyboard, mouse and headsets. This gives users to form AD hoc networks between a wide range of devices to transfer voice and data. Bluetooth is lower cost, low power technology that provides a mechanism for making small wireless networks on an AD hoc basis accepted as piconets. A piconet is collected of two or more Bluetooth devices in nearest physical proximity that operate on the same channel using the same frequency hopping sequence. Bluetooth based connection between a cell phones and headset are an example of piconet. Bluetooth piconets are often recognized on a temporary and changing basis which offers

communications flexibility and scalability between mobile devices.

Some main benefits of Bluetooth technology

Cable replacement. Bluetooth technology recover a variety of cables, such as those commonly used for peripheral devices (e.g., mouse, keyboard, printers, wireless headsets and ear buds that interface with desktops, laptops, cell phones, etc.

Ease of file distribution. A Bluetooth-enabled device can form a piconet to support file distributing capabilities with other Bluetooth devices, such as laptops, phones.

Wireless synchronization. Bluetooth can provide automatic synchronization between Bluetooth-enabled devices. For example, Bluetooth allows synchronization of contact information consist of computerized address books and calendars.

Internet connectivity. A Bluetooth device using Internet connectivity can share that connection with other Bluetooth devices. For example, a laptop will use a Bluetooth connection to direct a cell phone to establish a dial-up connection so that the laptop can access the Internet through the phone[3][4].

IV. How does Bluetooth Work

Reported by Bluetooth website, the technology "works in the unlicensed industrial, scientific and medical (ISM) band at 2.4 to 2.485GHz, using an advance spectrum, frequency hopping, full-duplex signal at a simple rate of 1600 hops/sec". If you dropped asleep part way through that, let's break it down to find out absolutely how your headset knows to choice a calls from your phone. Bluetooth chips produce wavelengths that are constraint to frequencies operating within a range specifically set aside for this sort of short-range communication. Other devices you may catch that use this frequency include cordless telephones and baby monitors. However, there is a problem with always using the same frequency. Other devices operating at the same, or nearest, frequencies will cause interruptions in the signal.

To prevent this from being an issue, the signal is expand over a wider range of frequencies. In order to manage this, the signal hops around the frequency, and in the case of Bluetooth that come into 1600 times per second. The frequent change in wavelength means that even a consistent signal will not interrupt, and will not be interrupted, for longer than 1/1600th of a second. Bluetooth headsets can identify in two different styles, using a full or part duplex connection. A full-duplex signal means that all connected devices are capable to send and receive signals – in this case a two-way conversation – simultaneously, as opposed to a half-duplex signal, alike a walkie-talkie, where each side can still talk and listen, just not both at the same time and Table I explain about Bluetooth device classes[5][6].

Source: (http://file.scirp.org/Html/1-9701762_33221.htm)

Table I
Bluetooth Device Classes

Class	Power (mW)	Power (dbM)	Distance (m)	Sample Devices
1	100	20	~100	BT Access Point, dongles
2	2.5	4	~10	Keyboards, mice
3	1	0	~1	Mobile phone headset

Table I explain about Bluetooth device classes

Bluetooth Security Methods

There are several methods of security to secure the Bluetooth. These securities are divided into service level security and device level security. These both together secure the devices from the unauthorized access / data transmission. Bluetooth secure methods briefly explained below

• Authorization

Authorization in Bluetooth is the way that describes access control the information in general .For example, data in a device normally authorized to access other devices information is usually formalized as access control rules in a device system. During operation, the system uses the access control rules to choose whether access requests from authenticated the device user shall be approved or rejected. Resources include individual files and the personal data, provided by applications or device. In simple term it allows only the granted devices.

• Authentication

Authentication is the process of deciding the identity of the other user. For that authentication it uses the key that already in the devices so it is no need to generate new key for every new connection with the same device connected already.

• Key management

In the key management they have different types of key management they are link key, Pin, encrypted key. In the link key are sometimes permanent or temporary. This permanent key may store in a non-volatile memory, this can be used in the present situation and it will be terminated, but the temporary key is limited by lifetime in the present situation. In the pin key it is selected by the use of a fixed number. Encrypted key will be get from the present link key in that encryption is activated.

These Bluetooth securities are divided into 3 modes [7].

Mode 1:

A Bluetooth device will not initiate any security. This is a non-secure mode. In essence the authentication and encryption security procedures to allow any Bluetooth device to connect to it.

Mode 2:

A Bluetooth device does not initiate security procedures before connection establishment. This mode allows different and flexible policies for applications, especially running applications

with different security requirements in the same. This is a service level enforced security mode. The concept of a security manager is introduced in this mode to control access to services. The centralized security manager maintains access control policies and is responsible for interfacing with other protocols and device users. Authentication, confidentiality, and authorization are supported in this mode.

Mode 3:

A Bluetooth device initiates security procedures before the link set-up is completed. This is a link level enforced security mode and is fixed. Since this security mode is fixed it is not aware of any application layer security. Authentication and encryption are supported in this mode. Authentication and encryption are realized using a shared secret link key that is derived during the pairing process.

Bluetooth Security Related Work

1). Bluetooth Security and Vulnerabilities

Bluetooth® technology is a wireless substitute to data cables by exchanging data using radio -transmissions. Bluetooth technology was created as an open standard to authorize connectivity and collaboration between disparate products and industries. Like any wireless technology, Bluetooth also has a number of security vulnerabilities. These vulnerabilities may comprise the device or the networks that the device connects to. However if the common Bluetooth security features are used properly, it should provide adequate security.

2). Mechanism of Bluetooth Security

When devices connect to each other, Bluetooth creates a link which uses optional pre-shared key authentication and algorithms which is considered to be strong when used correctly. The strength of the Bluetooth security mainly relies on the randomness and the length of the passkey used at the time of their first connection. Discoverability and connectability settings also play an important role in determining the security strength. These settings control whether the device can searched by other Bluetooth devices and how it can be connected. Also optional user authorization for connection requests provides extra security.

3) Bluetooth Vulnerabilities

Through design, Bluetooth uses peer-to-peer technology. Bluetooth has a very complex specification and provides support for a lot of services. Some of these services include input output devices like keyboard and mouse, headphones, speakers, networking, file transfer and printing. In order for these service to work and communicate with devices, designers and programmers implements Bluetooth for a wide variety for operating systems, chipsets and devices. Settings like discoverability, connection preferences and security of the interface are not always the same and depend on the programmer. Due to this, Bluetooth is open to a lot of security vulnerabilities. Some of the known Bluetooth attacks include the following:

Identity detection;
Location tracking;
Denial of service;
Unintended control and access of data and voice channels;
Unauthorized device control and data access.

As an example, researchers have shown that Bluetooth headset use can compromise devices in several ways. This compromise is due to the headset profiles' support for powerful telephony signaling commands and the all too common use of weak established passkeys (typically “0000”) [8].

4) Types Bluetooth Attacks

Since there are billions of Bluetooth devices in use, malicious security violations are general events now and it is expected to rise in the near future. On the contrary, the rise usage of Bluetooth devices makes security worries even more disturbing. Hereafter, Bluetooth security architecture needs a constant development to avoid new unidentified threats. Like any further wireless communication system Bluetooth transmission can be deliberately jammed or block. False or modified information can be delivered to the devices by the cyber criminals. Security threats in Bluetooth can be branched into three major categories as follows:

• Disclosure threat: The information can flow from the target system to an eavesdropper that is unauthorized to access the information.

• Integrity threat: The information can be deliberately corrected to mislead the recipient.

• Denial of Service (DoS) threat: The users can be blocked to get connect to a service by making it either unavailable or severely limiting its availability to an authorized user.

Bluetooth security is presently a very active research area in both academia and industry. Security threats like disclosure and integrity attacks commonly compromise some sensitive information and therefore, can be very dangerous. On the other hand, DoS attacks commonly disturb Bluetooth network users and are considered to be fewer dangerous. Powerful directional antennas can be used to greatly increase the scanning, eavesdropping and attacking range of almost all kind of Bluetooth device. One great example of a long-distance attacking tool is the Blue Sniper Rifle. It is a rifle stock with a dominant directional antenna involved to a small Bluetooth-compatible computer. The scanning, eavesdropping and attacking can be complete over a mile missing from the target devices. Therefore, the possibility that an attacker is using range improvement tool for disclosure, integrity and DoS attacks should be taken extremely [9].

Literature review

D.Djenouri and N.Badache discussed about the ad hoc networks, these ad hoc networks are he collection of mobile nodes supplied with wireless communication adaptors, among that it forms a temporary network without any infrastructure. There is no permanent or centrally infrastructure network because of that the network may face many challenges. They discussed result for the essential problems, but these solutions are vulnerable to threats. Some of the security requirements are explained here. The features of mobile ad hoc network

(MANET) may lead to vulnerable attacks. The features are infrastructure less, wireless link use, multi-hop, nodes movement autonomy, amorphous, power limitation, memory and computation power limitation. The threats have been divided into two classes, they are attacks and misbehavior.in the attacks it is divided into categories; external attacks, internal attack passive attack and active attack. These attacks are explained briefly here. Then the misbehavior it define as the unauthorized of internal nodes that can result unintentionally in damage to the other nodes. Some of the proposed solutions to overcome the security issues are as follows. They have discuses about the routing security issues, data forwarding security issues, security against misbehavior and the intrusion detection system. Finally securing the ad hoc network is greater challenge [10].

This is explain background study of research paper. Wireless Network Security 802.11, Bluetooth and Handheld Devices journal which relevance to our research area. As we know wireless networks have broadcast nature so there are different security problem in the wireless communication. The security conventions intended for the wired systems can't be extrapolated to wireless systems. Hackers and intruders can modify utilization of the loopholes of the wireless communication. In this paper addresses two wireless technologies that wireless local area networks (WLAN) and ad hoc or Bluetooth networks. According to the literature survey there were many information have been discovered on Wireless Network Security 802.11, Bluetooth and Handheld Devices.

However, there are some existing method used in this journal such as Bluetooth network, Ad Hoc Networks, Wireless Standards, Wireless Security Threats and Risk Mitigation. This paper gave the solution to developers.

Our research attempts to provide an effective and efficient. Because we are especially go throw on Bluetooth security. We will give the solution to users [11].

Bluetooth have automatic and wireless connection. Bluetooth is support for over two diverse voice and data. Bluetooth is completed by designers using a variety of chip set. Bluetooth is attack to a diverse set of vulnerabilities. Some security vulnerabilities are access of data and voice channels and unauthorized device control. User can use Bluetooth headset as compromised in multiple ways. They sent the data on low power radio waves. It's one of the big disadvantage. In other word any one can easily receive your sensitive information. Need to have security features to exchange the data with the only known devices [19].

Current invention related with a network Security architecture for guiding security activities in a Mobile network platform, and directing security response Activities to a particular user access point having an important Network address.[12]A mobile network is a unique group of mobile devices (laptops, smart phones, sensors, satellites, etc.) that communicate with other wireless links and connect in a distributed manner to give the necessary network functionality in the absence of a fixed infrastructure. This type of network, operating as stand-alone network [13] .the security architecture is more operable to command a security response in conform a security policy. 12].The network is an autonomous transitory connection of mobile nodes that interact with each other over wireless links.[13]Functions and complexities of mobile ad hoc networks are Autonomous and framework less Multi-hop routing, Dynamic network topology, Device collection, Energy obligated operation Bandwidth obligated variable capacity links, Limited physical security, Network scalability, Self-establishment, self-organization and self-administration [13]. Below Table II explains about related researches.

Table II
Related Research

Wireless Network Security :	Security of Wireless LANs	Bluetooth Security	AD HOC Networks	Wireless Handheld devices
Security of 802.11 Wireless LANs[14]	V	X	X	X
Security apparatus and method during BLUETOOTH pairing[15]	X	V	X	X
Routing and mobility management protocols for ad-hoc networks [16]	X	X	X	X
Recommender system and method for generating implicit ratings based on user interactions with handheld devices	X	X	X	V
Our Research's Name [17]	V	V	V	V

The IEEE specification found numerous services to offer a secure working environment. The security services are provided mostly by the Wired Equivalent Privacy (WEP) protocol for safety of link-level data through wireless broadcast among clients and access points. WEP does not afford end-to-end security, but only for the wireless part of the connection [14].

A BLUETOOTH device is provided wherein the output RF transmission power level during pairing is purposefully minimized from otherwise conventional or usual communication levels to a low power level, greatly reducing the series of possible interception. Security can be enhanced more and more by further reducing the transmit power even below that clear for a class 2 radio to a really low power level. After the link keys have been passed and/or other pairing processes, the BLUETOOTH devices may return to normal power levels safely to last communications [15].

There are two network communication protocols, one for routing and one for mobility management, are introduced that are

mainly compatible for use with ad-hoc networks. The routing protocol is a proactive-reactive hybrid routing protocol that limits the possibility of the positive procedure to the node's local neighborhood. Routing areas are described for each node that contain nodes whose distance from the subject node in hops is at greatest some predefined number, stated to as the zone radius. Every single node is need to know the topology of the network within its routing zone well [16].

An expert system employs implicit evaluations created from showing user interaction with an item, such as while listening to a music path on a MP3 player or reading an electronic book. A method for generating item suggestions include: offering an item to a device having an application for appealing a repetitive activity with the provided item, wherein the repetitive action happens mainly during separate operation of the device; creating a history of user interaction with the provided item, where user interaction contains engaging in the repetitive activity with the provided item; altering the past of user interactions into an implied ranking of the provided item; and using the complete rating of the provided item to cause recommendations of other items [17].

Solution

Establish that Bluetooth users are made aware of their security-related responsibilities Regarding Bluetooth use.

A security awareness program benefit users to follow security practices that help prevent security loopholes. Participate seminars about Bluetooth security

Set your device's visibility to "Off." This will stop other devices from seeing your Bluetooth name.

Change the default name of the Bluetooth device to something unidentified and without meaning. By default, we mean the name of the device which usually identifies the model and type of device (e.g. Samsung S4), which could make it a target of attack.

After use turn off your Bluetooth. If your Bluetooth is off, nobody can connect with you.

Use a PIN code whenever pairing with another Bluetooth device. If the other device doesn't know the PIN code, it will not gain access to your device.

Remove all pairings for devices that have been lost or stolen and frequently checkup to ensure devices are only paired with current and recognized devices.

This will prevent attackers from using a lost or stolen device to connect the other Bluetooth devices that it was paired with. It will also ensure your device pairings stay ongoing and you will be made aware of any illegal pairings.

Select PIN codes that are comfortable and long. Avoid static and weak PINs, such as PINs consist of all 0's or 1's.

PIN codes should be random so that they cannot be simply guessed by attackers. Lengthy PIN codes are resistant to brute force attacks. The use of a fixed PIN is not.

Ensure that portable devices with Bluetooth interfaces are configured with a password.

This helps prevent unauthorized access if the device is lost or stolen.

Install mobile security software on your Bluetooth device like as antivirus, firewall. This is in order to prevent, or reduce the Bluetooth attacks [18].

V. Conclusion

This paper gives an overview of some of the big attacks that Bluetooth has challenged over the years along with some possible solutions. Some security tips for the users have also been gave to instantly create awareness among them to be more careful about their important personal information. Although all majority of devices now communicate using this technology, the risks are deep greater if the security threats are neglected by our peers in this industry. Bluetooth security specialists will have to provide automatic updates to its security protocols and user privacy protection methods for every new security open up so that protection of the device user's personal information becomes the primary objective. Due to limitations in time and resources, only an overall literature survey has been presented in this paper. Emerging devices all have Bluetooth as a essential feature and its potential applications are increasing, so its future vulnerabilities needs to be analyzed through further research in this field. The bottom line is, we need technology to survive and technology needs us to evolve ensuring our safety first.

VI. Future Work

As the future work, we have given some solutions for the users to secure their Bluetooth network. But for the developers we didn't give any suggestions, if the developers can increase the rate of security in the Bluetooth network the users will be benefited by it. And also the developers can increase the encryption of the password it will be better and they should secure the Bluetooth network with new protected network layers.

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