

A survey on short Ad Hoc network

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Abstract –

Mobile ad hoc networks (MANETs) represent complex distributed systems that comprise wireless mobile nodes that can freely and dynamically self-organize into arbitrary and temporary, “ad-hoc” network topologies, allowing people and devices to seamlessly internetwork in areas with no pre-existing communication infrastructure, e.g., disaster recovery environments. Ad hoc networking concept is not a new one, having been around in various forms for over 20 years. Traditionally, tactical networks have been the only communication networking application that followed the Ad hoc paradigm. Recently, the introduction of new technologies such as the Bluetooth, IEEE 802.11 and Hyper LAN are helping enable eventual commercial MANET deployments outside the military domain. These recent evolutions have been generating a renewed and growing interest in the research and development of MANET. This paper attempts to provide a comprehensive overview of this dynamic field. It first explains the important role that mobile ad hoc networks play in the evolution of future wireless technologies.

Key Words :- Bluetooth, WPAN, WLAN

I. INTRODUCTION

An ad hoc network is a network with temporary plug-in connections, in which the network devices are part of the network only for the duration of a communications session or, in the case of mobile or portable devices, while in some close proximity to the rest of the network. Ad hoc network is often local area network or other small area network formed by wireless devices. In Latin, ad hoc literally means "for this," further meaning "for this purpose only," and thus usually temporary. The term has been applied to future office, home and personal area networks in which new network nodes can be quickly added and removed. The area of ad hoc networking has gathered much research interests in the past years. Many studies have concentrated on the routing issues of ad hoc networking [1].

Bluetooth is one of the technologies that can be used for ad hoc networking. Bluetooth specification is a computing and telecommunications industry specification that describes how e.g. mobile phones, computers, and personal digital assistants (PDAs) can easily interconnect and communicate with each other by using wireless transmission in a short-range. The goal of the specification is to eliminate the need for any cable connectivity and promote ad hoc networking. By using this technology, users of cellular phones, laptops, PDAs, etc. portable devices can quickly share information with each other, for example, in a conference room using ad hoc networking. [1]

II. BLUETOOTH AND WIRELESS PANS

In the past quarter century we have seen the rollout of three generations of wireless cellular systems attracting end-users by providing efficient mobile communications. On another front, wireless technology became an important component in providing networking infrastructure for localized data delivery. This later revolution was made possible by the induction of new networking technologies and paradigms, such as wireless local area networks (WLAN) and wireless personal area networks (WPAN).

Wireless personal area networks (WPANs) are short to very short-range (from a couple centimeters to a couple of meters) wireless networks that can be used to exchange information between devices in the reach of a person. WPANs can be used to replace cables between computers and their peripherals, to establish communities helping people do their every day chores making them more productive, or to establish location aware services. Wireless local area networks (WLANs) on the other hand provide with a larger transmission range. Although WLAN equipment usually carries the capability to be set up for ad hoc networking, the premier choice of deployment is yet a cellular like infrastructure mode to interface wireless users with the Internet. The best example representing WPANs is the recent industry standard: Bluetooth, other examples include Spike [Spike], and in the broad sense Home RF [Negus 2000]. For WLANs, the most well known representatives are based on the standards IEEE 802.11 [Crow 1997] and Hiper LAN [Hiper LAN 1995] with all their variations.

The IEEE 802 committee has also realized the importance of short-range wireless networking and initiated the establishment of the IEEE 802.15 WG for WPANs [WPAN] to standardize protocols and interfaces for wireless personal area networking. Altogether, the 802.15 working group is formed by four Task Groups (TG):

1) IEEE 802.15 WPAN/Bluetooth TG 1 The TG 1 was established to support applications which require medium-rate WPANs (such as Bluetooth). These WPANs will handle a variety of tasks ranging from cell phones to PDA communications and have a QoS suitable for voice applications.

2) IEEE 802.15 Coexistence TG 2 Several wireless standards, such as Bluetooth and IEEE 802.11b, and appliances, such as microwaves operate, in the unlicensed 2.4 GHz ISM (Industrial-Scientific-Medical) frequency band. The TG 2 is developing specifications on the ISM band due to the unlicensed nature and available bandwidth. Thus, the IEEE 802.15 Coexistence TG 2 (802.15.2) for Wireless Personal Area Networks is developing Recommended Practices to facilitate coexistence of Wireless Personal Area Networks (802.15) and Wireless Local Area Networks (802.11).

3) IEEE 802.15 WPAN/High Rate TG 3 The TG3 for WPANs is chartered to draft and publish a new standard for high-rate (20Mbit/s or greater) WPANs. Besides a high data rate, the new standard will provide for low power, low cost solutions addressing the needs of portable consumer digital imaging and multimedia applications.

4) IEEE 802.15 WPAN/Low Rate TG 4 The goal of the TG 4 is to provide a standard having ultra-low complexity, cost, and power for a low-data-rate (200Kb/s or less) wireless connectivity among inexpensive fixed, portable, and moving devices. Location awareness is being considered as a unique capability of the standard. The scope of the TG 4 is to define the physical and media access control (MAC) layer specifications. Potential applications are sensors, interactive toys, smart badges, remote controls, and home automation.

One key issue in the feasibility of WPANs is the inter-working of wireless technologies to create heterogeneous wireless networks. For instance, WPANs and WLANs will enable an extension of the third generation (3G) cellular networks (i.e., UMTS and cdma2000) into devices without direct cellular access. Moreover, devices interconnected in a WPAN may be able to utilize a combination of 3G access and WLAN access by selecting the access that is best for the moment. In such networks 3G, WLAN and WPAN technologies do not compete against each other but enable the user to select the best connectivity for his/her purposes Figure clearly shows the operating space of the various 802 wireless standards and activities still in progress.

Given the importance within the WPAN operating space, intensive research activities, and availability of devices, we will now devote a little time in, first, giving a brief introduction on Bluetooth and then provide an overview of the Bluetooth standard as defined by the Bluetooth SIG (Special Interest Group) [Bluetooth]

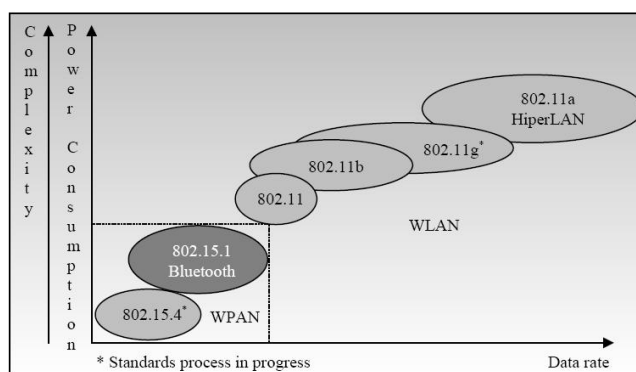


Fig1. The scope of the various WLAN and WPAN standards

III. BRIEF HISTORY AND APPLICATIONS OF BLUETOOTH

In the context of ad hoc wireless networks, the Bluetooth technology came to light in May 1998, and since then the Bluetooth SIG has steered the development of the technology through the development of an open industry specification, including both protocols and applications scenarios. It is predicted that in 2006 Bluetooth will be present in 73 percent of phones and 44 percent of PDAs. It will provide device-to-device communication, enabling seamless communication between phones, printers, PDAs and scanners in the office and between phones, smart home control units, TVs and VCRs in the home. The Bluetooth specification comprises of an end-to-end description for both protocols and application profiles that guarantee value-added to its users right out-of-the-box. As per the current specification (version 1.1), it consists of the following two parts:

- 1) The core specification defining the radio characteristics and the communication protocols for exchanging data between devices and Bluetooth radio links.
- 2) The profile specification that defines how the Bluetooth protocols are to be used to realize a number of selected applications.

Bluetooth has a tremendous potential in moving and synchronizing information in a localized setting. Potential for Bluetooth applications is huge, because we do business transactions and communicate more frequently with the people who are close by as compared to those who are far away - a natural phenomenon of human interaction.

3.1 Ad hoc connectivity

Most wireless communication systems like the public cellular phone networks- GSM, DAMPS, IS-95 or other private networks like Hiper LAN-II, DECT or Personal Handy phony system, use a network architecture in which the radio units: base stations and mobile terminals are strictly distinct. This is advantage in design as channel access, channel allocation, traffic control, interference minimization etc. can be taken care by the base stations, making the design of

mobile terminals simpler. In ad hoc networks, there is no difference between radio units. Communication is peer to peer with no central controller. Conventionally in ad hoc wireless networks, all devices sharing a common space will share the same channel, and will mutually coordinate in its sharing. In Bluetooth usage models however, even this is not sufficient as the number of Bluetooth devices in a given region of space may be very large and only a few of them may need to communicate among themselves, making mutual coordination among them very difficult and unlikely. This has led to the concept of scatter nets: a group of networks in the same space but communicating over different channels, with some overlapping devices. There need not be any coordination among devices belonging to different networks within the scatter net.

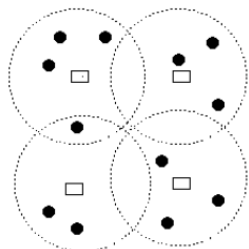


Fig2. A cellular network with squares representing stationary base stations

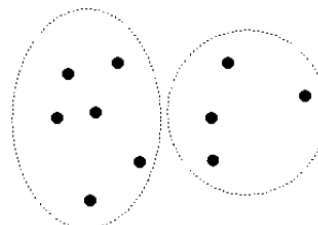


Fig3. a conventional ad hoc system

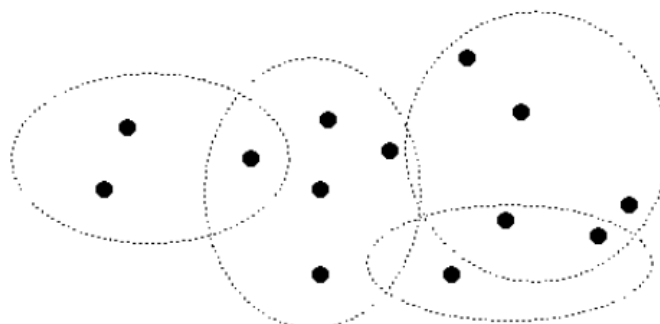


Fig4. scatter ad hoc network

3.2 Bluetooth in the nets

One of the biggest advantages, and where we can see the versatility of the design of the Bluetooth technology, is in the easy confection and arrangement of nets between different devices of Bluetooth technology. Bluetooth has been designed to operate in a multi-user environment. Presents two types of possible configurations, which can expand to a considerable number of elements to expand this way the networks and subnet works. The structure that handles this technology is composed, in the more basic form, by what it is named a Piconet and in an a bit more complex structure which it is named a Scatter net. Up to eight users or devices can form a "piconet" and even ten "piconets" can coexist in the same area of coverage. If we realize that every link is codified and protected against interference and loss of link, Bluetooth can be considered to be a wireless very sure short scope network.

The Piconet is several devices that are in the same radio of coverage where they share the same channel and that is constituted between two and eight of these units. Every device has the unique direction of 48 bits, based on the standard IEEE 802.11 for WLAN, whereas the Scatter net formed by the connection of a Piconet to other one, with a maximum of interconnections of ten Piconets. In the following figure it is possible to observe and understand with major facility these two configurations.

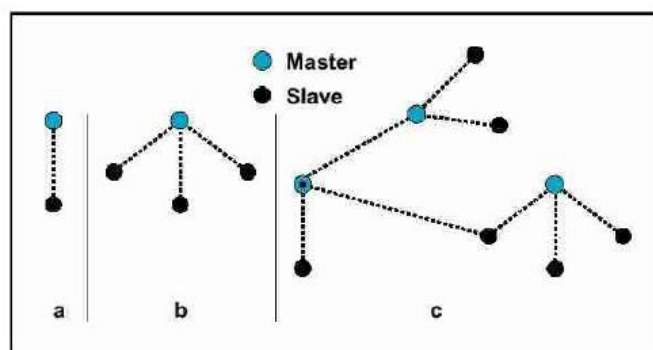


Fig 4. Piconets with single slave operation (a), multi-slave operation (b) and scatternet operation (c).

In the figure "a" we can observe the simplest Piconet which is constituted by two devices. In the "b" figure we have a Piconet constituted by four of these devices. The "c" figure is an example of a Scatter net that possesses three Piconet, one constituted for four units, the other one for two and the last one for 3 units respectively.

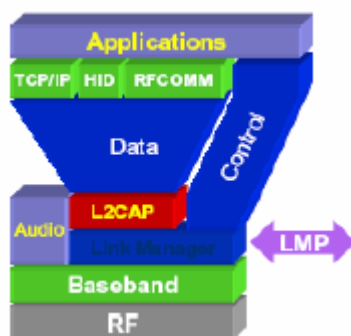
The equipments that share the same channel will divide the resources and the capacity of this one. Though the channels have a bandwidth of one 1 Mhz, as more users join to the Piconet, minor resources they will have for each user. That is the reason why the Scatter net was introduced to solve the problem of the low bandwidth that every user of a Piconet has if they find great quantity of connected units. The performance, as a whole and individually of the users of a Scatter net is major that the one that has every user when takes part in the same channel of 1 MHz

3.3 Personal Area Networks (PAN)

The final communication profile that Bluetooth focuses on is Personal Area Networks (PAN). This is similar to the peripheral interconnects profile except that it focuses on Ad hoc configurations. These are applications where devices enter and leave the network area. For example, a businessman might meet a co-worker in the airport, and using their Bluetooth enabled PDAs, they would be able to transfer a document to each other as well as synchronize their calendars and contact lists before they part ways. Numerous devices possessing PAN functionality have appeared on the market since Bluetooth's introduction, and like peripherals, they appear ready to quickly grow in number due to consumer demand.

3.4 Core Specification

The core specification defines the internal design of Bluetooth technology. The basic interface stack can be found in Figure 1. It is important to note that the bottom three layers in the figure are generally known as the Bluetooth core. The other layers in the figure are present merely to give some reference to where the Bluetooth core sits in a system. The lowest level of Bluetooth is the Radio Frequency (RF) layer, which performs the actual sending and receiving of radio frequency data to/from the device. The typical range of a Bluetooth device is 1-10m, but with an amplified antenna, the range can reach up to 100m.



Fir5. Bluetooth core stack

Formation of the frames that are transmitted by the RF layer. The baseband layer is also responsible for creating the connection between two Bluetooth devices. This connection is known as a piconet. Many devices can connect to form a piconet, with one device being specified as the "master" and the other devices acting as "slaves". The master is then in control of the frequency hopping behaviors of the piconet. It is also possible for multiple piconets to connect to form a "scatter net". Next is the Link Manager which is responsible for the creation, modification, and release of logical links and the update and communication of altered device parameters to the physical links. The Link Manager is also responsible for handling the power management responsibilities of the Bluetooth core.

Above this are the higher level protocol layers such as TCP/IP which are located close to the application layer. These are not typically considered part of the Bluetooth architecture since they are common to many different protocols. Each device also possesses a Bluetooth PIN (sometimes called a passkey) that is used in the communication setup of two devices that have no previous connection history. This PIN or passkey can be either entered into the device at the user interface (UI) level or be hard-coded into the device at manufacture. The latter option is often used in devices with small internal memory capabilities (peripherals, etc.).

IV. AD HOC SECURITY CONCERNS

Bluetooth devices communicating in the wild form various sizes of ad hoc networks. Since it is possible for varying numbers of devices to be entering and leaving the piconets and scatter nets created by the devices, Bluetooth poses some difficult safety requirements to maintain good security in these ad hoc networks. The first aspect of the ad hoc network that is important to Bluetooth uses is availability. Users should have access to other users even if some devices are experiencing difficulties on the network. Unfortunately, this is difficult to guarantee in Bluetooth because devices are dependent on other devices for the transmission of data. This means that an attacker who is capable of interrupting a few devices in a piconet can severely degrade the performance of all devices. It is also difficult to maintain

perfect availability because of the nature of wireless communications. There is always interference to deal with in any wireless system, and an attacker who can jam the frequencies of Bluetooth transmission scan again cause problems for users.

Another aspect of the ad hoc network that is difficult to guarantee is authorization. Inherent to the nature of ad hoc networks is the lack of any structure or identifying characteristics of the devices. This creates problems with authentication. Bluetooth attempts to combat these problems by implementing a mildly complex authentication scheme.

Finally, confidentiality must be maintained in order for an ad hoc network to successfully offer security. Unfortunately, wireless communication makes this difficult since any one can sniff the airwaves for data. Bluetooth does offer encryption for transmitting data, but only certain situations present full encryption of all transmissions. Since Bluetooth is an ad hoc network protocol, creating a perfectly secure system is very difficult, and unfortunately, creating antagonists have been able to penetrate the Bluetooth specification. [4]

V. CONCLUSION

Bluetooth is a standard used in links of radio of short scope, destined to replace wired connections between electronic devices like cellular telephones, Personal Digital Assistants (PDA), computers, and many other devices. Every year we have to add new peripherals to our computers and the need to replace the wired connections is more important every year. That is why the Bluetooth technology is going continue expanding with the support of the industry of Computer science and of Telecommunications, which in some way guarantees the success. One of the biggest attractions of the implementation of this technology is the creation of networks; with the Bluetooth technology is possible to form different networks in the same geographical point, with relatively high speed of transmission. Anyway the Bluetooth technology has a limited scope, this characteristic of limited scope presents a great disadvantage if we try to implement a net in one extensive geographical area. Another positive aspect that presents this technology is the easy manipulation and configuration of networks and sub-networks inside the same space with the implementation of diverse Piconets interlaced across Scatter nets with different configurations.

REFERENCES

- [1] BLUETOOTH AND AD HOC NETWORKING Jari Välimäki Networking Laboratory Helsinki University of Technology Email: jari.valimaki@hut.fi
- [2] Bluetooth Security James Lewis ECE 578 7 March 2005
- [3] Bluetooth Primer Author: Aman Kansal
- [4] Bluetooth Author: Inigo Puy Mtknr: 230345 Course: E-Business Professor: Eduard Heindl Date: 05/05/08
- [5] <http://www.palowireless.com/INFOTOOTH/tutorial/baseband.asp>
- [6] [Haarsten 1998] J. Haarsten, "Bluetooth The Universal Radio Interface for Ad Hoc Wireless Connectivity," Ericsson Review (3), 1998
- [7] [Bluetooth] Bluetooth SIG, <http://www.bluetooth.com>