Collaborative Middleware on Symbian OS via Bluetooth MANET

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Abstract:- In this paper we explore the possibility of using Bluetooth in the development of a Mobile Ad-Hoc Network (MANET) suitable for transmitting data between Symbian OS based Smartphone's. We also analyse the problems that Bluetooth presents when considering existing MANET routing protocols. Then, we present the design of a collaborative application engine by making allowances for the restrictions associated with Bluetooth and finally we review our current progress and consider future work.

Key-Words: -Bluetooth, Wireless, Collaboration, Symbian OS, MANET

1 Motivation

The result of research activity in the field of mobile ad-hoc networks (MANET) has made short to medium range radio transceivers very popular and inexpensive. Most of the practical work and implementations focus on IEEE 802.11 Wireless LAN as an underlying physical radio network and this has been used for simulations or testing. For use in wearable devices like PDAs or cell phones, 802.11 has the disadvantage of consuming more battery power than other technologies such as Bluetooth [1][4]. Furthermore, it seems that after some initial problems, Bluetooth has become a very common feature in cell phones and PDAs. The research presented in this paper focuses on a collaborative middleware platform running on mobile devices (Smartphones) in order to enhance communication and the exchange of data via Bluetooth.

PDAs and Smartphone's can run applications such as organizers, games, and communications programs (e.g. e-mail, Web browsers etc). Here the Smartphone's goal is to combine mobile telephony and computing technologies in a synergistic way. A simple example is the ability to pull up a person's contact information or even their picture, hit a button and automatically dial that person's phone number. Other examples include viewing a pdf document, dialing an international call via VoIP, or watching live TV and listening to music. However, central to Smartphone technology is the Symbian OS. Symbian OS is a full-featured mobile operating system that resides in most of today's Smartphones [8]. Since Symbian OS is an open system, users can download, install and uninstall applications written by third-party developers (or by the users themselves). No special carrier service or device manufacturer's agreement is required to distribute new Smartphone applications since they can be downloaded by the user from a PC to the Smartphone through a link such as USB or by using a wireless network such as Bluetooth.

The initial goal of the work presented in this paper was to consider if current Smartphone technology can be easily used in combination with Bluetooth, or alternatively what modifications would be required to enable Bluetooth-based Ad-hoc networking via the Symbian OS. Initially, we tried to find a scenario where most of the characteristics and problems of MANETs running over a Bluetooth connection will appear. Within this scenario we considered connecting a large number of Bluetooth-enabled Symbian smartphones to a (multi-hop) MANET. This includes a maximum of ten nodes within the network because this number would be more likely in reality, and is also the maximum number of nodes Bluetooth has the ability to support. After the restrictions and limitations were considered in Bluetooth networks, a design was proposed which when fully developed acts like a Symbian OS application engine, and meets all the predefined requirements for a collaborative middleware.

There are a numerous applications for the middleware platform proposed in the paper. For example: given a large office complex where people move around a lot between their office desk, conference rooms, or central areas like printer-rooms, fixed-line telephones don't provide a practical method of voice communications. Therefore, people tend to call their colleagues on their cell phone in order to find out their current

location, or in order to reach them for urgent requests. Of course, the network carrier charges for these calls, however, the middleware proposed could possibly enable them to make the same calls at no cost at all. Another use of this system may be at large exhibits or fares where groups of people with Bluetooth enabled phones may assemble. Again the middleware proposed will enable them to share and relay data such as shared audio / video files or work based documents.

2 Research Aim and Some Initial Thoughts

The key aim of this research is to design, develop and test, a collaborative middleware API, running on a number of Smartphone systems with a view to improving communications and the exchange of data via a Bluetooth mobile ad-hoc network (MANET). This new collaborative middleware API will provide a set of reusable functions to higher level applications which are transparent to both application developers and users. It will also aim to provide a generic collaborative middleware API template which others may consider for further development or extension to support other hardware systems such as Ultra Wideband (UWB) communications.

In order to initially address this research, several issues were considered. First of all, given that the Symbian OS is the choice for the majority of Smartphone systems [4]; Symbian OS based Smartphones were chosen as the primary development platform. The Symbian OS is a full-featured mobile operating system; it is also a fast developing OS with two or three versions updates each year in its nine years history. Also, with so many changes, it is quite difficult to stay up to date with the last technology. Further details regarding this issue are discussed in section five.

Secondly, as a short range wireless network technology, Bluetooth resides in all today's Smartphones. It cost less and uses less power than IEEE 802.11 WLAN and is easy to use, but there are still some restrictions for use in an ad-hoc network. The main significance of this problem is the limited connection number. This issue and other restrictions are also discussed in section five.

Finally, it was initially anticipated that a large number of mobile devices would be required to test the collaborative middleware. However, it was found that due to the restrictions imposed by the hardware and the operating system; the maximum number of mobile devices that can be simultaneously tested is ten. In addition, although the analysis of a larger number of users may prove useful, it should be noted that this should considered as further work.

3 Research Methodology and Hypothesis

A research methodology has been adopted comprising the following stages. This is illustrated in figure 1, and explained in more detail below

Stage 1: Reviewing previous work and relevant literature.
This stage reviews existing literature and highlights the main problems. It is anticipated that the knowledge gained will prove useful during the development stage. In addition, C++ and Symbian C++ are to be studied in detail, as they are essential to the implementation.

Stage 2: Identifying related problems
The research starts by identifying the problems related to the functionality required to meet the objectives of the project. As problems are identified they are organised into specific plans of activity.

Stage 3: Design new application engine with collaborative functionality
This stage design the new application engine based on the aim of the project. All the requirements of the middleware and related problems will be covered in the designing process in order to perform the necessary network operation, i.e. to discover devices and services send data and message to each other, network maintain and collaborative download. This developed application is then implemented into a program that can be implemented on devices.

Stage 4: Software implementation / testing
A set of test metrics will be created to examine the performance of the collaborative middleware under different circumstances. The experiments should also test for extreme situations where problems may seem inevitable rather than just testing the normal operating parameters.

Stage 5: Analysis and evaluation
Results from the software implementation are recorded and analysed. These will be critically evaluated to determine if further modification is necessary. If it is necessary, go to Stage 6 to redesign the application engine, until the results

meet the object of the project.

Stage 6: Modification / improve performance
If modifications are necessary to improve the performance of the collaborative middleware, then this step will allow modification of the implementation according to the evaluation of the results.

Stage 7: Write up the report to present complete work
The final step is to complete the report, which will based on the result of Stage 5.

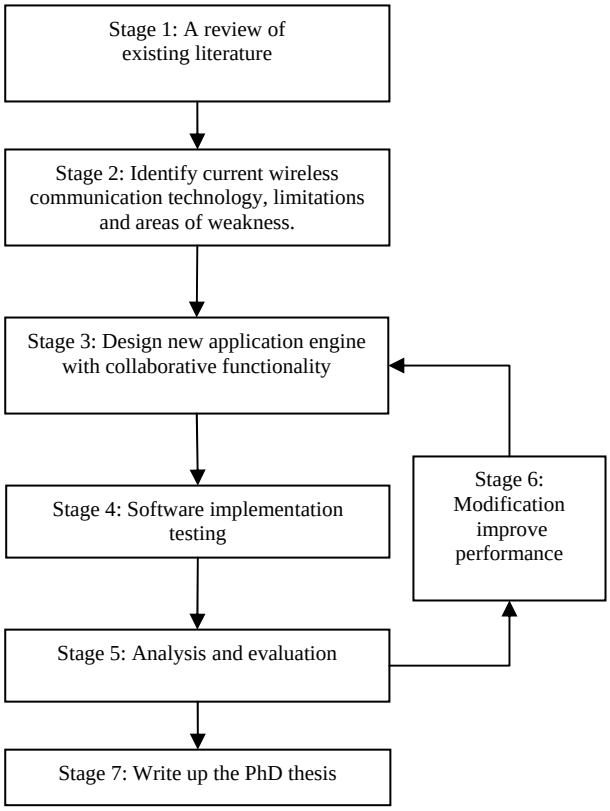

Fig 1: Research Methodology

3.1 Research Hypothesis

Based on the aim of this project, the collaborative middleware can improve the functionality and enhance the user experience of the Symbian Smartphone in several points.
First of all, the collaborative middleware will control the short range wireless connectivity, such as Bluetooth and WiFi (if applicable). The middleware can decide what wireless technology will use depend on different task. On another side, user just need select what they want to do form the user interface (UI), can ignore to choose wireless network.
Secondly, users can send message even making a phone call via the collaborative middleware instead of via the 3G network. It will save the cost for users.
Thirdly, the collaborative middle can support users to share their files to other users. The scenario could be three to ten people's meeting or presentation; chairman shared the relative files for download by others.
Fourthly, the middleware has a database to save trusted destinations and black list, which will improve the security of the connection.
Finally, to support multi-users gaming is another hypothesis of this research project. The network routing would become very complicated if the node of network more than eight. Therefore, the routing protocol of the mobile ad hoc network is the main issue for this hypothesis.

4 Bluetooth overview

In this section we provide a very brief overview of the relevant aspects of the Bluetooth standard. For detailed information please see [1][4].
When established in 1998, the original idea of Bluetooth was to create a cheap wireless replacement for the myriad of data cables that surround today's multimedia devices. Like many other communication technologies, Bluetooth is composed of a hierarchy of components [5], more commonly referred to as a stack.Bluetooth uses a protocol stack of several layers. The Radio Layer describes the physical radio system. The Baseband Layer is responsible for transmission and reception of data packets, error detection and encryption (if used). The Link Controller uses a state machine to control synchronization, connection setup and shutdown and the Host-Controller-Interface (HCI), separates the Bluetooth hardware from the part of the protocol stack that is usually implemented in software. Thanks to this standardised interface, the Bluetooth hardware and the Bluetooth stacks usually interoperate very well. The Logical Link Control and Adaption Protocol (L2CAP) layer multiplexes different data streams, manages different logical channels and controls fragmentation. Multiple higher layer modules may access the L2CAP layer in parallel. These higher layer modules may consist e.g. of RFCOMM for emulation of serial connections, OBEX for transmission of serialized data objects or SDP for service discovery.

When a device wants to connect another device it first has to carry out an inquiry for its direct neighbors. After receiving the inquiry results it can contact another device using its unique Bluetooth address. When connected, the two devices form a so-called Piconet. The initiator of the connection

becomes the Master of this Piconet; the other device becomes a Slave.

The difference between a master and a slave needs to be distinguished first in order to understand this research. A master is a device that establishes the connections to remote device, slaves. A slave can not establish any connections; it will act as a listener to incoming connections from the master device. The master discovers slave devices and their services and is capable of connecting to multiple slaves and holding these connections active simultaneously. In essence, the point-to-multipoint connectivity is a single master device (point) connecting to multiple slave devices (multiple points) and the slaves up to a maximum of seven. Using a Bluetooth connection between just two devices, it does not matter which one is Bluetooth master or slave. However, if we wish to connect more than two devices together in the same session (for example, a multiplayer game with more than two players), it is likely that we will have to consider how the Bluetooth master / slave roles impact upon the connection setup between the networked peers. Because once a master connected seven slaves, this master can not connect any more slaves; however this peer can be as slave connecting to another master peer, as show on Figure 2.The network topology will be complicated, and the requirement of routing protocol is higher as well.

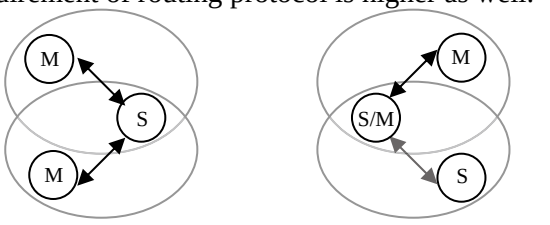

Fig 2: Bluetooth master and slave roles

5 Developing on Symbian OS S60 3rd platform

The Symbian OS is an open system; users can download, install and uninstall applications written by third-party developers (or by the users themselves). No special carrier service or device manufacturer's agreement is required to distribute new Smartphone applications since they can be downloaded by the user from a PC to the Smartphone through a link such as USB or by using a wireless network such as Bluetooth

The Symbian OS is widely used on a number of Smartphone platforms such as the Series 60, the Series 80, and the Series 90, three of the UI (User Interface), platforms from Nokia, and UIQ (the UI platform from UIQ Technology). At the time of writing, the S60 variant resides on the majority of Smartphone platforms currently available and its third edition is based on Symbian OS v9.1[7]. Software applications running on the Symbian OS can be split into a UI (also known as a View) and an Engine (also known as a Model). The UI is the part that presents the data to the user. The engine is concerned with data manipulation and other operations independent of how these are eventually presented to the user. The engine can therefore be re-used by other applications (i.e. it can be built as a shared dll). It is the application engine that takes on the role of collaborative middleware and supplies a set of classes that can re-used by other applications. Like other OSs, Symbian provides the API to developers. Its Bluetooth API provides applications with access to RFCOMM, L2CAP, SDP, OBEX, and to a limited extent, HCI[4]. With a view to the way in which the collaborative middleware establishes communications, Bluetooth sockets were chosen to provide communications between devices, and OBEX was selected to finish a single-shot operation like transferring a file. These two methods of communication are discussed in following section.

6 Bluetooth sockets and the OBEX overview

In the Symbian OS, Bluetooth sockets are used to discover other Bluetooth devices and to read and write data over the Bluetooth network. The Bluetooth Socket API supports communications over both the L2CAP and RFCOMM layers of the Bluetooth protocol suite [5]. The API is based on the sockets client side API that provides a standard API, enabling a client to make a connection to a remote device. Alternatively, it also allows a device to act as a server and have a remote device connect to it. Once connected, the devices may send and receive data before they disconnect.

The API has five key concepts: socket address, remote device inquiry, RFCOMM commands and options, L2CAP commands, and HCI commands. This research concentrates on implement a Bluetooth connection using RFCOMM. Before using the Socket API to establish a connection, a Bluetooth device must locate a suitable device with which to connect to. This means that the Bluetooth device has to finish device and service discovery, before making a connection. The Bluetooth Service Discovery Protocol (SDP) performs this task.

The SDP can be broken down into two main parts: 1. The discovery of devices and services within the local area; 2. The advertisement of services from the local device.

As previously mentioned, Bluetooth sockets are the preferred choice when communicating between two devices. However, if the transmitting task is only a single file, like an image file or MP3, OBEX is more suitable. OBEX is a transfer protocol the operates on top of a number of different transport mediums, including IrDA and Bluetooth RFCOMM. It defines data objects and a communication protocol the two devices can use to exchange those objects. It also provides a method for transferring objects or chunks of data from one device to another. These chunks are typically files or other blocks of binary data. OBEX uses a client-server model and is independent of the transport mechanism and transport API. A Bluetooth enabled device wanting to set up an OBEX communication session with another device is considered to be the client device. The OBEX protocol also defines a folder-listing object, which is used to browse the contents of folders on remote device. The main purpose of the protocol is to support the sending and receiving of objects in a simple and spontaneous manner. For example: pushing business cards or synchronizing calendars on multiple devices is handled with this protocol. In conclusion, The OBEX protocol, in its simplest form, is quite compact and requires a small amount of code to implement, but is also at the same time a reliable transmission systems over Bluetooth networks.

7 MANET Overview

The research activities in mobile ad hoc networking (MANET) had a constant growth in the last ten years of the 20th century.[7] Differ from traditional scenarios of MANET such as battlefield and disaster recovery, some organizations and institutes' research results made the MANET suit for normal user in daily life. However, due to the mobility and the limited resource of MANET, routing protocol need to redefine or modify for function efficiently. Routing in the MANETs is a challenging task and has

MANET routing protocols may be divided into two categories: proactive and reactive. Proactive protocols always try to maintain up to date routing tables for all reachable destinations. All well-known Internet routing protocols like RIP or OSPF fall in this category. The reactive protocols are only activated when a node A wants to send packets to a second node B. In this case A originates a route request that searches the network for a valid path towards the destination. Once the optimal path has been discovered, B sends a route reply to A. Once A has a valid path for B it can start to send its packets. During this process the routing system needs to perform routing maintenance, i.e. it has to check if the route is still valid. If a route breaks many protocols perform a route repair.

8 Project analysis

Our research objective is to develop a collaborative middleware based on Symbian OS via Bluetooth. The following presents a discussion of some of the initial requirements and restrictions found to date.

When using Bluetooth as a physical layer for a MANET we have to consider a number of restrictions compared to the IEEE 802.11 wireless standards [9].

- Bluetooth is connection oriented. So, in order to send data to another node you have to setup and later tear down a connection.
- Bluetooth has no: 'all neighbors' broadcast capability (only point-to-multipoint within the Piconet). So, in order to flood a route request you have to first connect to all neighbors and then send a point-to multipoint packet to them. If there are more neighbors than are allowed in a Piconet [2] things get even more complicated.
- Bluetooth has very long inquiry and relatively long connection setup times.

When we want to implement a collaborative ad hoc network system using a Bluetooth, we have a number of requirements that contrast with above capabilities:

- Users want a short connection setup time similar to a normal phone dialing (a few seconds).
- We need to have relatively few hops. Otherwise, the delay will be too long, and the user will experience a significant pause and echo.
- In order to optimise the overall throughput and minimize interference we want to minimise the number of Piconets and shutdown unneeded connections.
- To avoid interrupts in data transmission we need a very efficient and fast route-maintenance-and-repair mechanism.

No current MANET routing protocols fulfill all of the above requirements. Therefore, we will design a new routing protocol with the focus on data transmission in Bluetooth Scatternets. However, the current protocols that do exist provide a number of interesting ideas which can be used as a basis for this new protocol: e.g. reactive operation and route maintenance / repair. Furthermore, there are other connection oriented networks that provide

interesting concepts. For example our data packets don't carry any destination information in the header. Instead the intermediary nodes use the incoming (L2CAP or SCO) channel identifier to decide where to forward the data. This is very similar to the circuit switching approach of ATM. We will therefore try to take these ideas and integrate them.

9 Project design

9.1 State Machine Model

In order to set up a collaborative Bluetooth network, the first thing to consider is how to establish and maintain a Bluetooth network. We then consider the design of some functional classes as an access point for the application. As previously discussed, there are three stages involved Bluetooth communications using a socket: device discovery, service discovery, and the communication itself [6]. Based on these stages a state machine model was developed as a design for the set-up of the Bluetooth network. See Figure 3. In our design, the application state starts from BTDormant, which is waiting for a user or client to request Bluetooth communications; when a user requests a connection, the application then searches for devices within range, the state is then BTDiscoveringDevices. If the application has not found any devices, the user can then restart the device discovery process; otherwise, the master is searching for the required service on each of the discovered devices. If no required services are found, the user can re-start the device discovery. After initiating a connection with a slave, and the master has established a connection with the server, the state is then BTWaitingToSend. When the master receives an enquiry message from the slave, the state then changes to BTWaitingToReceive. The Bluetooth network can then be set up following these processes.

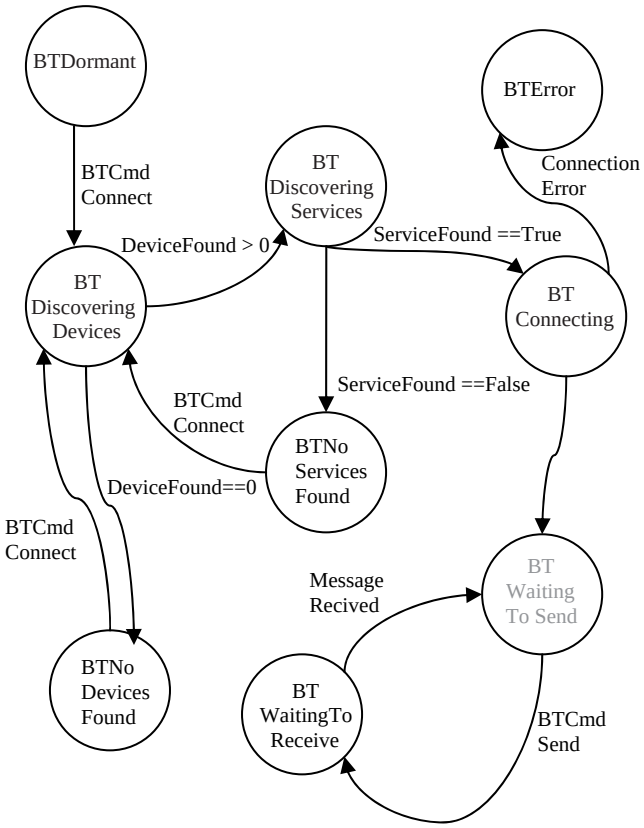

Fig.3: State machine model

According to requirement analysis, a set of classes was designed for the application Engine.[3] For details see Section 6.2 and 6.3

9.2OBEX Communications

Bluetooth OBEX protocol provides a method for transferring objects or chunks of data from one device to another. These chunks are typically files or other blocks of binary data. In this project, OBEX run on top of the Bluetooth RFCOMM protocol, but OBEX can also be used with other transport media, such as IrDA and USB.

The Send UI API is also included in the application engine. Send UI is a convenient, high-level messaging API that hides the bearer details from the developer. It can be used for sending SMS, MMS, and e-mail messages, and even for data transfer over Bluetooth.

In order to implement the OBEX communication, a few classes of Symbian OS S60 API are used for the application engine. The details of important classes and files listed below:

TObexBluetoothProtocolInfo

This class provides a way for a client application to specify the Bluetooth protocol used for OBEX.

TObexBaseObject

All data transmitted over OBEX is wrapped up in a containing object before it is sent. There are three main types of OBEX data wrapper classes.

CObexBaseObject provides the base class for all of these data wrappers.

CObexBaseObject is a virtual class that cannot be instantiated. The three concrete classes are the following:

CObexFileObject is designed to be used when sending files over OBEX.

CObexBufObject is designed to be used when sending a chunk of memory over OBEX.

CObexNullObject provides a means for sending a blank object.

MObexServerNotify is used by the operating system to inform an OBEX server of OBEX communication events.

CObexClient provides a client application with the necessary functionality to request OBEX objects from and send OBEX objects to the OBEX server.

CObexServer allows a client application to offer OBEX services to other devices.
Constant *KPowerModeSettingNotifierUid* = {0x100059E2} used for detecting whether Bluetooth is on. If not, the user is asked to switch it on.

The application engine can act as a server or client for Bluetooth communication. Since Bluetooth is used for data transmission, a Bluetooth service is needed on the server side and Bluetooth device discovery and service discovery is needed on the client side.

The application server (CObjectExchangeServer) advertises a Bluetooth service, which a client then discovers and connects to. After connecting to the service, the client can request OBEX objects from the server and send OBEX objects to the server. In this stage, only the sending part has been implemented for the server.

On server side, three main classes are designed for the application engine.

CObjectExchangeServer contains a *CObexServer* object as a member that manages the OBEX client connection. It creates the advertiser object. After the client has connected to the service, this class is also responsible for handling the received data. Its *PutCompleteIndication* function contains handle the received file

CBTServiceAdvertiser is a class for advertising the service in the Service Discovery Protocol (SDP) database for clients to connect to.

CObjectExchangeServiceAdvertiser inherits *CBTServiceAdvertiser* and adds the creation of the service description which is used in service advertisement.

On client side, there are another three classes designed.

CObjectExchangeClient is the main class for client-side functionality. It uses *CObjectExchangeServiceSearcher* to search for a service. *CObexClient* is used in client-side OBEX functionality.

CBTServiceSearcher is used by clients when searching for a Bluetooth service.

CObjectExchangeServiceSearcher inherits *CBTServiceSearcher*. The service class to search for is set to: const TUint *KServiceClass* = 0x1105;
So only the services with this service class are found. This is returned by the *ServiceClass()* function of *CObjectExchangeServiceAdvertiser*.

In this stage, the OBEX communication can use in two cases:

1) The OBEX is running on two S60 devices (in client and server modes). The file is sent from the OBEX Example and received directly in the OBEX Example on a remote device.

2) The OBEX is running on a client device. The file is sent from the OBEX Example and it can be received by any other Bluetooth device supporting Object Push Profile (in S60 devices the file is received and saved by the Messaging application).

Known issues
Major:
1) There is a binary compatibility (BC) break in the OBEX implementation in S60 3rd Edition, Feature Pack 1. Thus the module compiled with S60 3rd Edition SDK Supporting Feature Pack 1 will not work with S60 3rd Edition devices. However, an application compiled with S60 3rd Edition SDK or S60 3rd Edition, Maintenance Release SDK can be run on S60 3rd Edition, Feature Pack 1 devices.

Minor:
2) Transferring a file with the same name as the temporary file does not work. It could easily be fixed by working in a different directory than the one where the files are transferred to.

3) Files cannot be received and saved by the module if they are not sent from this nodule. Instead, the file will be received by the Messaging application. This functionality could be implemented by capturing the message from the Message Type Module (MTM)
4) In the Send UI demonstration the text "Sent via Send UI" is shown even if the user cancels sending the file.

9.3 Text Chat

Text Chat is another basic function of the collaborative middleware. Users can send text via Bluetooth, which like a chatting room, Different from OBEX communication, Bluetooth Serial Port service is used in Bluetooth connection. The implementation is socket-based.

All commands are handled in *CChatAppUi::HandleCommandL()* function. The Bluetooth Chat server is starts by calling Chat's *StartL()* function. Server will advertise to other Bluetooth devices that it has Serial Port service and it is able to receive and send messages. On the screen, it will appear a series of log reports to show this starting succeeded and the device is listening for the incoming connection. Client device can connect to server by Chat's *ConnectL()* function. As connect is selected, a list of recently discovered Bluetooth devices will appear on the screen. As connection has been made, server device and client device will indicate that they are now connected.

As connection has been made successfully via Bluetooth, there are few optional commands for client device's. They are Disconnect, Send Message, Clear List and Exit. On Server side, they are Stop Chat, Send Message, Clear List and Exit.

Disconnect disconnects the connection and Stop Chat stops server and disconnects the connection. Disconnect calls *DisconnectL()* function and Stop Chat calls *StopL()* function. With Send Message command, client device can send messages to server device and vice versa.

Send Message calls first Container's *ShowDataQueryL* function. This function draws "Write Message" query. After that send message calls *SendMessageL(text)* function to deliver message from client to server or vice versa. Clear list clears the view by empting the listbox. Exit closes the application.

The Options menu commands are handled in CChatAppUi::HandleCommandL() fuction. Use Bluetooth -> Start Chat Option starts the Bluetooth Chat server by calling ChatBt's StartL() function. Server will then advertise to other Bluetooth devices that it has Serial Port service and it is able to receive and send messages. On the screen will appear a series of log reports to show this starting has succeeded and that the device is listening for the incoming connection. Client device can connect to server by selecting Use Bluetooth -> Connect from Options menu. Connect calls ChatBt's ConnectL() function. As connect is selected, a list of recently discovered Bluetooth devices will appear on the screen. Screen is implemented by listbox element. As connection has been made, server device and client device will indicate that they are now connected

As connection has been made successfully via Bluetooth, there are Disconnect, Send Message, Clear List and Exit in Options in client device's Options menu and Stop Chat, Send Message, Clear List and Exit in Server device's Options menu. Disconnect disconnects the connection and Stop Chat stops server and disconnects the connection. Disconnect calls DisconnectL() function and Stop Chat calls StopL() function. With Send Message option, client device can send messages to server device and vice versa. Send Message calls first Container's ShowDataQueryL function. This function draws "Write Message" query. After that send message calls SendMessageL(text) function to deliver message from client to server or vice versa. Clear list clears the view by empting the listbox. Exit closes the application.

9.4 PMP

A number of Bluetooth APIs provide the following capabilities that are demonstrated in this module. Device discovery inquires for Bluetooth devices within range. Service discovery inquires the discovered Bluetooth devices for the services they offer, filtering the service discovery query to return only the service class required; in this way, the service discovery query will only return the service entries that match the service class of our service. Connection will then be established to all the remote Bluetooth devices found to be offering the service we require. Once the connections are established, messages can be sent from the master device to the connected slaves, and vice versa, from a slave to its master device.

The slave mode initiates the application to act as a slave. In the slave mode, the application listens to incoming connections and advertises its available service. The master device will then be able to find the service offered by the slave by performing device/service discovery and connection establishment to the slave's listening channel/port.

There are many Bluetooth protocols over which the connection can be accomplished. RFCOMM is used in this module but also OBEX and L2CAP,

among others, are suitable for third-party applications.
Important files and classes :
CBluetoothPMPEngine:
Acts as an engine and handles the connections.
CDeviceDiscoverer:
Is used in device discovery.
CServiceDiscoverer:
Is used in service discovery.
CConnector:
Wraps a socket connection. CListener sets up a listening channel (notice the different versions listener.cpp and listener_26.cpp).
Main Symbian classes used:
RSocketServ:
Socket Server
RHostResolver:
Provides an interface to host name resolution services, such as DNS, that may be provided by particular protocol modules.
CSdpAgent:
Service discovery agent.
SdpSearchPattern:
Service discovery search pattern.
RSdp iSdp:
Service discovery protocol session.
Known issues
The application is intended to be used on real devices, not on the emulator.
Problems may occur if many Bluetooth devices are in range. It will at least take a lot longer for device and service discovery to complete.
Carbide causes a build warning NewApplication__Fv @1[BtPmpEx.def], which can be ignored.

10 Current progress

The research presented in this paper has been on-going for the last year. We have completed an extensive literature survey in this field. Related work such as XMiddle and Syn have been discussed and listed by advantage and disadvantage. Learning to program the Symbian OS has taken slightly longer than anticipated and the application structure and naming conventions is quite different from traditional programming. Unfortunately, we do not have the facilities to debug code on a target device, only on the emulator, which does not support Bluetooth. Bluetooth programming in Symbian OS is far from simple, so we have found that the key is to develop the application slowly and testing as often as possible. However, the initial design work has been completed, and we are able to program two Bluetooth devices which can communicate with each other via a Bluetooth socket and OBEX. This means files and messages can be sent between two Bluetooth devices using our application Engine. A shared file list, like a shared folder in the Microsoft Windows OS, is currently under test. Users will soon know what files are shared by others from this list, and when the device gets authorisation from the files owner, the downloading can begin.

11 Future work

In our on-going work we will try to optimise our design as well as build a real-world prototype in order to fully test our application engine as soon as possible. For a more efficient application of our research there needs to be a number of changes. First of all, the connection setup times need to be reduced drastically. Secondly, a routing protocol for enhancing collaborative communication between Bluetooth nodes need to be designed based on the transmitting protocols within Bluetooth. Finally, how to design and develop a test bed to fully test the application engine needs to be considered.

12 Conclusions

With the design presented in this paper we have tried to address the question whether it is reasonable to build a Bluetooth based MANETs on Smartphone technology and thus to use it to share data. This might depend largely on the intended use and environment, however; this has yet to be addressed. A number of real-world applications for this type of system was outlined including the potential benefits possible. In addition, the implications of using Bluetooth in this way has been discussed, and a state machine model that enables the establishment and maintenance of a Bluetooth network with a view to collaborating with other users has been presented.

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