
BLUETOOTH FOR EDUCATION

SUMMARY:

Bluetooth is a technology which can potentially be used across an educational organisation to help change the level of e-engagement that students have with their educational establishment. A mature implementation of the technology would have students using their mobile devices actively during their studies on campus. A mature implementation would encompass an ethos for allowing students to use their own personal technology for helping with their studies. It would provide a clear signal to people walking on to the campus that the establishment actively promotes and utilises the use of individual's technology to support their own learning. A widespread implementation would be part of a widespread and encompassing strategy to make better use of the potential of the transient technology that walks in and out of the campus everyday, but which few organisations rarely make effective use of.

Bluetooth is a technology found on all reasonably modern phones. It is integrated closely into the phone's operating systems in a way that other wireless solutions are not. For example, sending a phone a vCal file (a calendar event file), will automatically provide the option of allowing the data to be inserted directly into the phone's calendar.

Bluetooth is typically seen as a short range data transfer wireless network that broadcasts to an open group of people and its value as a tool to support learning is seen as limited.

Present day Bluetooth solutions provide opportunities for engaging students in ways which are not presently available through any other type of technology. Bluetooth can engage people at their digitally personal level by communicating directly with applications their mobile phones, the calendars, the picture galleries, the music files, the document folder, the note pad function on their phones, the SMS messaging system, the web browser on their phones and even the calendar alarm function on their phone.

For a Bluetooth implementation, there are four key components that need to be properly addressed:

1. The Bluetooth Standards & Hardware
2. Suitable content for Bluetooth devices
3. Educating the users
4. Suitable Bluetooth Software Management Tools

This short paper briefly outlines the issues for each of the above key components and provides a background for considering Bluetooth as a means of enhancing your learners experience within your own organisation.

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OUTLINE OF ALTERNATIVE SHORT RANGE COMMUNICATION STANDARDS

There are a range of short range communication standards which presently exist. They are generally characterised by limited range; high transmission speeds for the size of data packets they are designed for; specifically designed for close integration with communicating devices. The three types of close proximity protocols which are presently available are ZigBee and NFC (Near Field Communications).

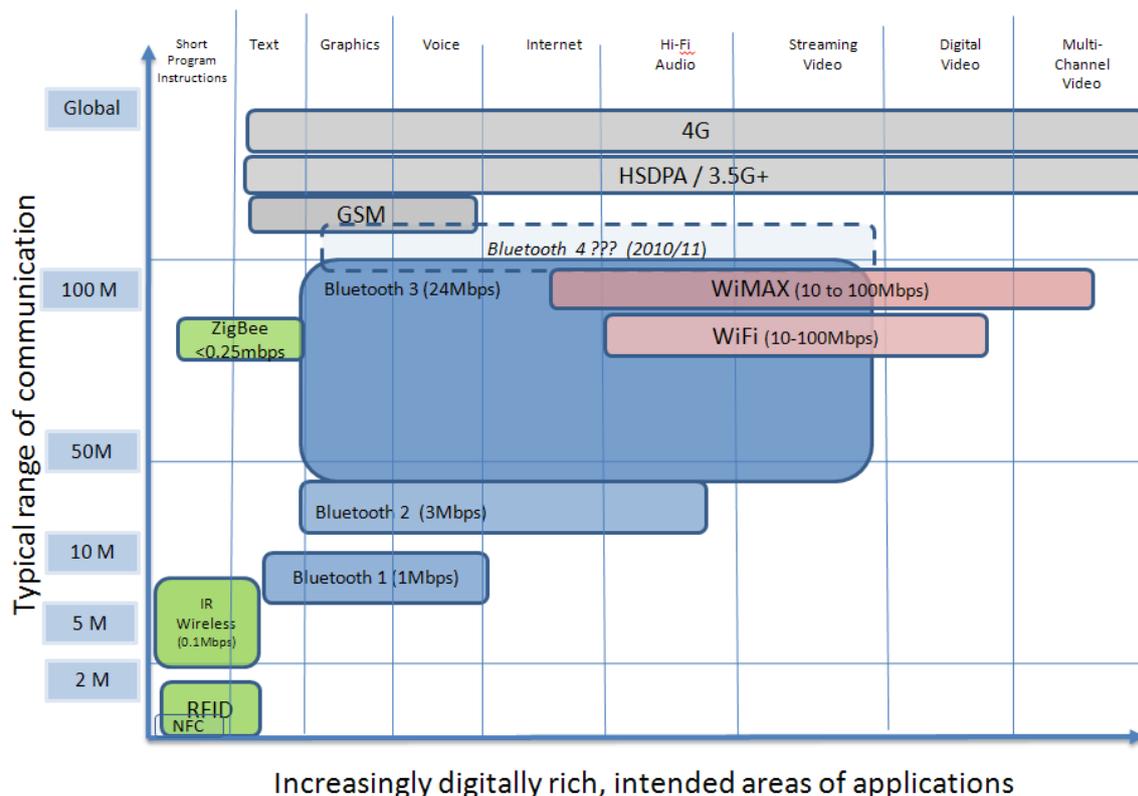
Each offers a particular flavour of choices over data transmission rates, range and potential for digitally rich content. Using them appropriately depends upon the situation and intended aims of exchanging information.

Zigbee

Designed for very fast connections between automated devices normally devoid of human interaction. The connection stages between two Zigbee devices takes around 30ms compared to around 2 to 3 seconds for Bluetooth. Zigbee has lower power needs (battery life can be 2 to 3 years) but has very lower data rates. (See Figure 1). It is designed as communication medium for automatic sensors and devices such as lights, switches, thermostats etc.

NFC

Near Field Communications are a subset range of standards from the RFID technology. Where RFID technology



can use powered transmitters and has a range greater than several meters, NFC is limited to a very close proximity of around 0.1m. The standards are intended to provide a fast way of transmitting short pieces of

data between devices which are in very close proximity to each other, about 4cms. Some phones have been developed which allow the fast exchange of data as soon as they are placed near to another NFC device (eg: Nokia 6131). The proposal with including the technology within mobile phones is to help facilitate the development of electronic ticketing, personal registrations etc all from contact with your mobile phone.

Table 1: Bluetooth Version Features

Version	Release Date	Data Transfer Rate	Features
V1.0	2002	1Mbit/s	First versions, some problems with establishing links between devices
V1.1			
V1.2			Data transfer rate improved. Frequency hopping protocol introduced to help eliminate interference.
V2.0	Jan 2006	3Mbit/s	
V2.1	Jul 2007		Easier connection process with fewer steps for pairing. Include enhanced method for reducing power consumption.
V3.0	April 2009	24mbits /s	High speed data transfer rates 24mbits/s. Uses the same 802.15 but also includes the same 802.11 functionality for larger file transfers
V4.0	Dec 2009		Not presently detailed, but probably extending the range, transmission rates and integration of the standard with devices.

SUMMARY:

Where ZigBee as a standard is focussed on control and the communication of small packets of data to regulate control systems over a long period of time, Bluetooth is focussed on rich connectivity solutions such as the transmission of short video files, voice, documents, pictures, etc while enabling the appropriate activity on the receiving device. NFC is potentially a very powerful protocol for further inclusion within mobile devices but at present has not been included in phones perhaps due to the lack of suitable widespread applications. Bluetooth Version 3 was finalised in 2009 and is now appearing on mobile phones in 2010. Bluetooth Version 4 is due out as a standard in 2010 and may be seen in mobile devices in 2011/12.

BLUETOOTH – THE WORKINGS

A Bluetooth device consists of the physical transmitting and receiving circuitry and the software which controls the communication of how the devices recognise and connect to each other and then how they send and receive data. While Wireless and Bluetooth technologies can both be used to send the same types of data generally, Bluetooth interacts with the devices it connects to much more intimately than WiFi enabled devices. Data received by a device can be directed by the Bluetooth protocol stack directly to the hardware required to do something useful with it. For example, a Vcal event file can be created on a desktop and sent directly to a group of student's mobile phones and the calendar event would embed itself directly into their calendar. In this way a group of students could receive the deadline dates for their course assignment or course term dates.

Bluetooth itself, is a wireless technology operating in the 2.4Ghz ISM frequency band. The Bluetooth can be operate in different modes. The 2.4Ghz frequency range happens to also be the resonating frequency of water molecules and as such is the operating range for microwave ovens (Miller, 2003). For this reason, using a Bluetooth device near to a microwave oven may reduce the effectiveness of the device by almost 75%. Because the 2.4Ghz band range is a crowded frequency range sharing with a range of other devices Bluetooth uses a special type of 'frequency hopping' protocol to quickly switch between available channels.

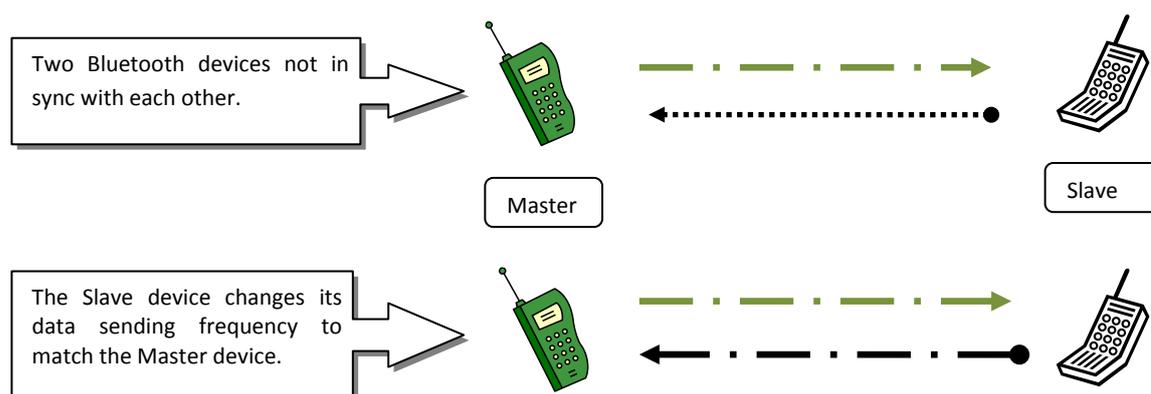


Figure 2 Diagram showing a Master Bluetooth device sending a Frequency Hopping signal for a Slave Bluetooth device to synchronise with.

The Bluetooth frequency hopping is a way for many Bluetooth devices to share the same frequency range while reducing the likelihood of conflict. The devices 'hop' between 79 frequency steps from 2.402GHz and 2.480 GHz and when connecting or 'pairing' to another device, the two devices communicate with each other to share the same frequency hopping cycle. When Bluetooth devices form a paired connection they are said to have created their own localised network or 'piconet'. A Bluetooth piconet consists of one device that has assumed Master attributes and another device or devices which have assumed Slave attributes. The 'Master' device provides the instructions for the 'Slave' device to synchronise with.

BLUETOOTH DEVICES HAVE DIFFERENT STATES

Every Bluetooth device has a different state which it resides in. The table below shows the different possible states a device may have and you will notice from examining the Bluetooth settings on a device that you effectively select which state your Bluetooth device remains in. User menu systems will use different terms from those outlined below, but essentially, they are the same selection. Depending upon the device it may

Table 2: The different states of a Bluetooth device can have

State	Description
Standby	Device enabled, power saving on. Device listens every 1.28 seconds for messages across 32 frequency steps.
Connection State - Active	Transmitting or receiving as part of a piconet
Connection State - Sniff	Listens to the piconet at a pre-defined reduced rate.
Connection State - Hold	The Master unit can sometimes put the Slave unit into a HOLD State where no data is transmitted and so reduces the power consumption for the device.
Connection State - Park	A device in a Park State remains connected to the Piconet but does not participate in it. By parking devices, a Piconet can sequentially manage up to 7 parked slaves devices at a time.

SECURITY

The Bluetooth standard offers three different levels of security for the devices which choose to allow the user to implement them. All mobile phones allow the user to select between open access to the device for all searching devices and user authorised access to devices requesting a connection.

Non-secure : a device will not initiate any security procedure. Connecting to a Bluetooth device which allows open access is not to be recommended.

Secure Level Enforced Security: Permission to access a device is dependent on the service requested. Eg: A device could allow the downloading of files on a computer but not allow access to say, the calendar application.

Link Level Enforced Security: The most secure level requiring authentication and authorization before being granted access to any service on the device. The user is prompted for authorisation before the device allows the reception of a file or pairing with another device (Torgrude, 2003)

Table 3: Bluetooth and Mobile Phone Compatibility - 2010

Mobile Phone Operating System	Bluetooth available (2010)	Receives Files	View Picture Files	Gif Animations Work	Video	Flash Video Compatible
Symbian	Yes	Yes	Yes	Yes	Yes	Yes
Maemo	Yes	Yes	Yes	Yes	Yes	Yes
RIM (Blackberry)	Yes	Yes	Yes	Yes	Yes	Yes
Android 1.6	Yes	Limited functionality	Yes	No.	Yes	No
Android 2.1 and greater	Yes	Yes	Yes	Yes	Yes	Yes
iPhone 3	Yes	Limited Functionality	Yes	Yes	Yes	No
iPhone 4	Yes					

BLUETOOTH FOR ENHANCING EDUCATION – EXAMPLES

Bluetooth is a technology which has the potential for acting as a catalyst for culture change. If we ask suggest to students that they could use their mobile devices as an engagement tool for helping with their own learning experience in their study environment they may be likely to examine their devices more acutely for their ability to support their own learning. The use of Bluetooth to supplement other communication channels can be part of an overall strategy for making an organisation more digitally supportive. By extending the use of Bluetooth so that it is a pervasive part of digital communications inside an organisation further helps to extends the digital culture beyond 'uploads and downloads to the network', beyond classroom boards and beyond presentations and specialist technology devices in laboratories or workshops. The use of this short range closely affiliated mobile device technology means that the digital culture is extended to the pockets and palms of people's own mobile devices as they walk around and away from the infrastructure. It is a further tool for extending the reach and effect of digital communications for helping to transform the culture across an institution. Below are some descriptive examples of how where Bluetooth might be used for supporting the business of education.

EXAMPLES FOR APPLICATIONS:

IN THE CLASSROOM

- **Course / Assessment Dates:** A tutor delivers a lesson, at the end of the lesson he provides all the students in his class with the assessment and deadline date. On each other students mobile phones, they receive the Word Assessment document and in their calendar, they already have the Assessment Deadline and time recorded with an alarm function. Some of the students were not at the lesson, but when they walk into the college's reception area the next day, they automatically receive the files and calendar event on their mobile phones. All of this information is examined by the tutor at the end of the week and he can see that all the students have actively received the Word Assessment document and the deadline date.
- **Lecture Summaries:** The lecture finishes and the tutor reminds the students that the lecture summary notes are available on the network and also for their phones through the organisation's Bluetooth. As the students start to leave, those with Bluetooth enabled phones receive a simple animated gif file which outlines the main points from the lecture they were just attending. As they walk around various parts of the building, they can also receive the updates in the reception area, the refectory, the library and the various student study spaces.
- **Reflective Flash cards:** These can be created in PowerPoint with slides produced showing terms and explanations alternatively. Saved as straight pictures on a mobile phone picture gallery, this provides students with a simple reference tool and review aid for a topic.



Figure 2: Example of a series of animated gif screens of alternating information for revision purposes which could be carried on a mobile phone. A form of automated Flash Cards.

Exported as an animated GIF file, this provides an automatically changing revision aid, with pictures and answers scrolling on screen at timed intervals

- **Formative eTests:** Created using MobiPocket, standalone formative review exercises can be created for various mobile phone platforms and sent to the students at the end of a lecture. The students can use these to reflect on their understanding of topics presented in their own time at any location. Mobipocket (www.mobipocket.com) Quizzes provide customised feedback on their results.
- **A Demonstration Guide:** The pictures showing the process for dissecting and locating the otolith bone in fish to determine age are provided as a series of sequential pictures. Students can opt to receive these small pictures on their phones so they have access to the content when they need it. The tutor sends these pictures files via Bluetooth.

MARKETING DEPT

- **Open Day Dates:** The marketing department would like all the students and adults walking on and off the premises to be aware of the new open day in a few weeks time. People walking into the reception area and sitting eating and drinking at the cafeteria will receive a little animated picture indicating the marketing logo being used for the day and then the event date and time would automatically be placed into their calendar.
- **Animated Posters:** On an open day, new course titles and summary notes, pictures are broadcast as animated gif's to the people walking into the reception areas. As people walk around specific department areas, messages relating directly to the courses in those department areas are broadcast to the prospective students.
- **Community Marketing:** In the local town centre at the weekend, the marketing and student advisory services team set up a stand. As people are walking round the local market area or square, they receive short pictures inviting them to consider study opportunities at the local educational centre. The marketing department also broadcast a short 30second engaging video showing montage of what present students think of studying at the local education centre.

LIBRARY

- **Reading Lists:** The library Bluetooth software is scheduled to send out a Reading List for Assignment 1 two weeks into the new term to the class of 1st year biology students. The staff have all the relevant reading lists scheduled for each department's assessments to be automatically broadcast on the library Bluetooth transmitter at the appropriate week.
- **News bites** of new services provided by the library are broadcast directly to students phones using a simple slide from PowerPoint and Bluetooth
- A short **reminder video guide** to using the library search facility is broadcast to students phones for them to have immediate access to when they need it.
- A **summary animated gif guide** is sent to specific groups of students for using the library abstracts for particular subject areas.
- The **summary lecture** notes for particular courses are broadcast at particular times during the day for students. These summary ebook guides are created by lecturers and made available to students to quickly refer back to on their mobile phones.
- **Library Guides at Induction:** Induction guides can additionally be offered to students to carry on their mobile phones. These may include maps, short reference documents, guides for the library services or for specific for curriculum areas. The induction guides might include short video introductions to the library services created by past students.

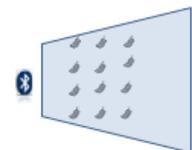
- **Calendar Events for Special Library Dates:** Details of planned library closures, special event days and maybe course deadlines can be scheduled to be broadcast at certain parts of the day or week.
- **Reading Lists:** Readings lists could be provided for students to carry on their mobile devices for use at any time on their mobile phone. This scheduled for repeated sending during the first week of courses or during induction sessions with students. Different curriculum induction sessions could be sent the reading lists appropriate to their needs.
- **eBooks:** eBooks can be sent to student mobile devices for them to use directly on their devices. MobiPocket creator provides a free tool for turning existing Microsoft documents / lecture notes / reference lists into eBook formats for viewing on mobile smartphone platforms.
- **'How to' Video Guides:** Short video guides can be created and sent to students. This type of resource could be useful early in course programmes.
- **Assignment Resources Notifications:** Linked to a knowledge of specific course assignment schedules, notifications about resources relating to a particular assignment and course could be scheduled for sending out. Using white list features in a Bluetooth management software tool would enable librarians to determine what files to send to what groups of students.

IMPLEMENTATION SOLUTIONS.

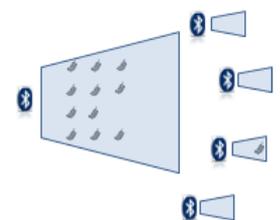
Bluetooth solutions can be implemented very easily for isolated instances such as a workshop, specific classroom or the foyer of a building. Simply purchase a cheap Bluetooth dongle and connect to a computer. This will provide a computer with a Bluetooth wireless capability and the operating will enable drivers to allow you to 'Send' files via Bluetooth to connected devices. The price of a simple Bluetooth dongle is rarely little more than a £1. Other hardware technology solutions and their potential applications are shown in Table 4.

Figure 4: Different topologies for implementing Bluetooth communications

A) A simple solution allows a tutor or administrator to broadcast to a group nearby. Using the 'whitelist' feature of some Bluetooth software solutions it is possible to only broadcast to a known group of students.



B) A network solutions using a number of Bluetooth broadcasting stations allows files to be sent to different locations across a building or campus. A tutor may then send his assignment resources to students who are both attending the class and to those who may only appear in the foyer or refectory later in the week



C) Marketing departments may be interested in the potential for completely autonomous units to be taken into the community and used to broadcast news and information directly to the community. For tutors on field work, or visting work based learners, Bluetooth broadcast schedules can be pre-programmed at the start of the course and activated as needed using a standalone unit

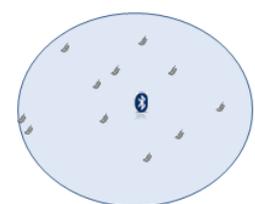


Table 4 : Bluetooth Hardware Solutions and their possible applications

Purpose	Possible Solution		Benefits	Potential Issues
Bluetooth from a single machine to a very localised area.	 <p>Individual Computer Unit</p>		<ul style="list-style-type: none"> • Cheap • Easy to run from a single computer 	<ul style="list-style-type: none"> • May take time to send files to all people in a large group. • Works from a single computer
Send files to a larger area	 <p>Individual Computer Unit</p>		<ul style="list-style-type: none"> • Cheap • Easy to run from a single computer • Long range 	<ul style="list-style-type: none"> • May take time to send files to all people in a large group. • Works from a single computer
Send files to several locations at once in a building	 <p>Broadcast Unit</p>		<ul style="list-style-type: none"> • Transmits to several people simultaneously. • Network compatible, file can be sent via remote computers for broadcasting at different building locations. 	<ul style="list-style-type: none"> • Cost
Send files in a remote location without links to any computer or network.	 <p>Stand alone unit</p>		<ul style="list-style-type: none"> • Broadcasts to 'field' based group, in town, at events or on field trips. • Broadcasts to a large groups of people simultaneously. • Requires no technical knowledge for actual broadcasting • Easily transportable. 	<ul style="list-style-type: none"> • Requires some training in managing the software for programming the stand alone Bluetooth box. • Will require charging for prolonged periods of remote use. • Files cannot be edited in the field.
Send files from a picture, poster or wall feature directly to the adjacent mobile device.	 <p>Touch Panel Unit</p>		<ul style="list-style-type: none"> • Can be used to provide authenticated evidence that an individual has received a file if appropriately located. • Provides user requested content. 	<ul style="list-style-type: none"> • Relatively complex technical implementation • Needs to be appropriately secured for remote locations. • Cost

BLUETOOTH MANAGEMENT SOFTWARE – FEATURES FOR EDUCATION

The usefulness of Bluetooth in education depends very largely on the Bluetooth Management software used to implement the solutions. Bluetooth for broadcasting information has primarily been developed for the commercial and retail world where the intention is to reach as many people as possible. In education, we are very interested in really being able to reach discrete groups and tailor the information to their needs. In an examination of Bluetooth Software Management solutions in 2009, I found no companies which provided 'White List' solutions for limiting the broadcast of a message to say, a Class Group. Since that time, one company, TextBlue, has developed their solution to include White Lists for students and have further plans to tailor their solutions further to educational needs.

This means that a Library or a tutor could potentially broadcast specific useful information to particular groups of students making the communications very valuable for the people receiving them. This is a key feature for any useful Bluetooth Management Software.

The TextBlue solution further provides automatic scheduling for times of a day, week or month, so that marketing messages, calendar events etc can be prepared in advance of events and left. A full log of all the messages sent, when they were received or rejected by each device is kept so a tutor could always know what students did not receive the communications.

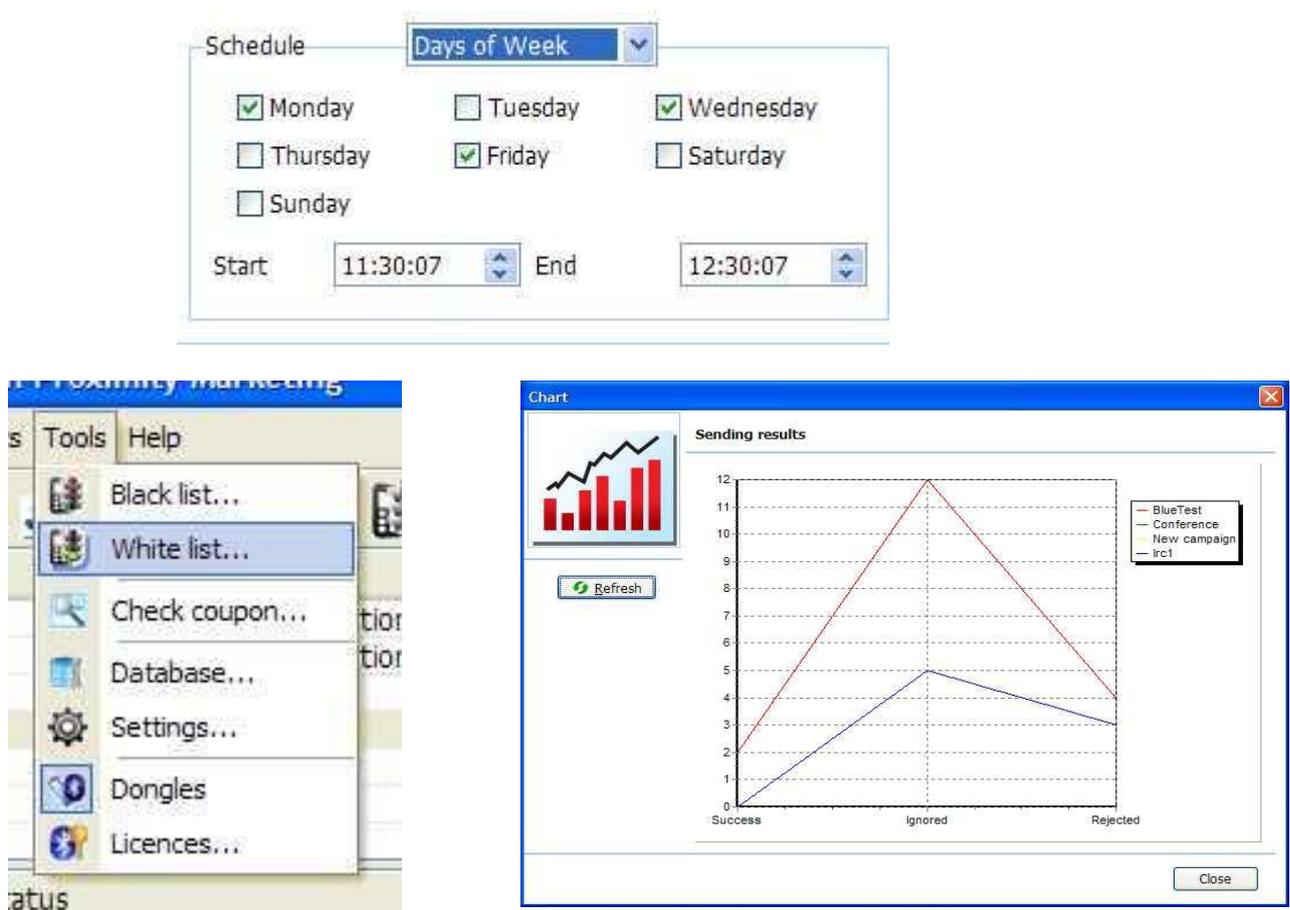


Figure 5 Screen shots from TextBlue's Bluetooth Management Software showing options for White List, Automatic Scheduling and Full User Access / Message Rejection Statistics and Reports.

CREATING CONTENT FOR BROADCASTING TO MOBILE DEVICES

There is a range of content which can be created and usefully sent to mobile devices. Bearing in mind that 'Pictures' do not just have to be pictures of scenes, objects people etc. Pictures can more usefully be pictures of text and these can be very easily created in PowerPoint which allows slides to be saved as JPEGs or Pictures. Transforming a series of these JPEG images to a GIF animation means that in a single file you may have an automated summary or other reading resource, viewable on any phone capable of viewing photographs.

There are several types of content which could be created for broadcasting to mobile devices.

- Pictures. (Including pictures of textual information)
- Animated Gifs. (For producing automated guides, texts, revision flash cards etc).
- MS Office files (For reference on smartphones).
- E-Book Publications. (As quick portable reference guides, formative assessments.
- Audio (Guides, Lecture Summaries)
- Video (Possible Uses: Introduction Guides, How to Guides, Topic Summaries.)
- Calendar events (which embed themselves directly into the student's phone calendar)
- SMS Messages for Texting
- FLASH Files (While not readily accessible by most mobile devices in 2010, this will change over time.

SUGGESTIONS AND QUICK TIPS FOR EACH OF THE ABOVE:

Pictures: Consider taking pictures that help students remember a process or topic. Import pictures into PowerPoint and label them with large headings before exporting the entire slide as a JPEG which can then be viewed on the mobile phone.

Animated GIFs: These can be created using a free program such as PhotoScape (www.photoscape.org). Combining this with picture slides exported from PowerPoint allows you to create some very useful animated gif publications with very little extra skills.

Create short summary videos with a tool such as Animoto (www.animoto.com). This website allows you to produce very engaging video summaries using just pictures very easily. With a very simple learning curve most tutors can create interesting video content ideal for export as a short summary or introductory guide for a mobile device.

Spend a full session engaging students with the use of Bluetooth in the classroom or library and highlight the security features on their phones and the potential value they may have from accessing content via Bluetooth.

STRATEGIES FOR IMPLEMENTATION.

When considering the implementation of a Bluetooth solution it is important to consider plans that focus strongly on educating and accommodating the users needs. Bluetooth technology works, the Bluetooth on mobile phones works, but frequently, most people are not sure how to use it or why they would want to. To successfully use Bluetooth in your organisation it is important to consider various communication issues:

A) Student Awareness: A strategy for educating students on why they would want to use Bluetooth on their mobile devices. It will be important to educate students on how the technology is used in the context of their own learning experience and potential advantages it may provide them. This could be delivered as part of a course induction programme and included in course handbook materials etc.

B) Help for Students: Showing less techno-savvy students how to access and use Bluetooth on their mobile devices. It may be necessary to provide some form of support for students who find it difficult to use Bluetooth on their own devices.

C) Signage: Clearly indicating what areas of the buildings are available for Bluetooth communications. Consistent signs on walls, on floor spaces, using digital signage etc to highlight and raise the profile of Bluetooth opportunities. It would be particularly important to make the use of Bluetooth overt for people entering the building. On open days and events there will be short opportunity to suggest and inform people that they could use their Bluetooth to receive and takeaway extra information on courses and the organisation.



Figure 6. Bluetooth awareness raising at Lisbon Railway Station.

D) Staff Training: The other key factor in the success of technology is the commitment given to training and informing staff of the developments. Adopting an appropriate staff development strategy is essential. It would be important to show staff how they could choose to use the technology, the benefits it could bring to students, how it may change some teaching practice. A key part of a lot of training will be showing people how to access and use the various Bluetooth options on their phones.

E) Changing Behaviour: The use of a technology which invades directly into the personal devices of students wherever they happen to be on a campus comes with changing the expectation about the use and access to resources from their institution. A goal is to have students who readily know that they can receive updates, information, news, lesson summaries, resources guides, ebooks, course deadlines, all directly to their mobile devices for access when they need the information. The technology culture needs to be one of almost transparent use. No student thinks of any difficult for accessing texting features on their phones. In a Bluetooth enabled system, no student should be thinking it problematic to access information from the organisation via their Bluetooth. It should just be a 'normal', expected feature of studying at this establishment in the same way that access to the network is expected and understood.

BLUETOOTH – TAKING THE NEXT STEPS.

If you have an interest in examining the use of Bluetooth within your own organisation, I would suggest looking at the following checklist.:

- ☑ **Purchase and play** with a Bluetooth Dongle on your own computer and linking to a mobile phone. Understand the problems a student may have in being able to navigate and change their settings to get Bluetooth to work. Learn how to send files between devices.
- ☑ **Download** some Bluetooth Management software
- ☑ **Develop** some easy content and examine how it may appear and usefully be used on a mobile device.
- ☑ **Develop and Run** an Experimental Group or an event where you use the technology, software and content in earnest to meet a specific need and conduct a user survey for feedback on the issues people may have.

WORKS CITED

Miller, M. 2003. *Discovering Bluetooth*. s.l. : Sybex, 2003. ISBN 0-7821-2972-2.

Torg rude, M. 2003. Bluetooth Technology. [Online] 2003.

Keen, I. 2009 (April) NFC Technology Overview Innovision R & T.

USEFUL LINKS

Example of a short Video Summary: www.tiny.cc/videosummary
(Links to Animoto.com)

Text Blue <http://ww.textblue.co.uk>

How to Video for Creating Animated GIFs for mobile devices.: <http://tiny.cc/gifguide>
(Links to Screentoaster.com)

JISC RSC South East <http://www.rsc-southeast.ac.uk>

Mobipocket <http://www.mobipocket.com/en/HomePage/default.asp?Language=EN>

NFC Updates – <http://www.nfc-forum.org/specs/>

NFC Forum: www.nfc-forum.org

NFC News <http://www.nfcnews.com>

Zigbee : <http://www.differencebetween.net/technology/difference-between-zigbee-and-bluetooth/>

ZigBee <http://homepage.uab.edu/cdiamond/index.htm> - Last visited June 2010.