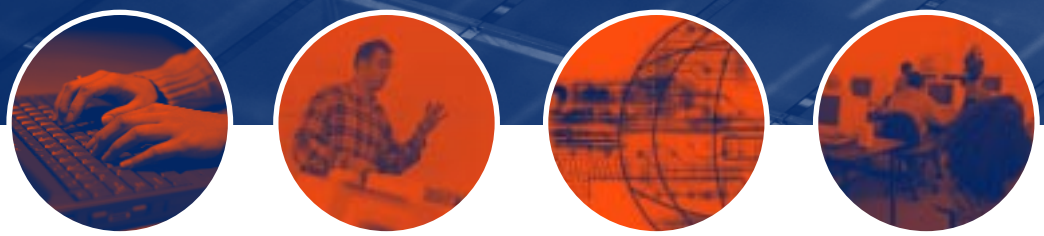
JISC

key issues series
implementation and practice

Briefing Paper

The Potential Role of Wireless LANs in Education



May 2002

New opportunities for learning and teaching

Colleges and universities are continually extending their Local Area Networks (LANs). This can be a very expensive and often disruptive process when cables are being installed. An alternative is to use wireless (radio) LANs. Not only can this be more cost effective, it is also considerably more flexible because computers can be used anywhere instead of each computer having to be placed near a network socket.

Wireless LANs are not useful universally however, and colleges and universities will continue to need wired LANs (for instance in computer laboratories). But the use of wireless LANs can present new possibilities for learning and teaching.

A wireless LAN is a method of linking computers together without using cables, but using radio signals or infrared light instead. This paper discusses the issues involved in determining whether a wireless LAN is appropriate for any institution (or part of an institution), and the issues involved in implementing a wireless LAN. It also looks at the educational opportunities that the use of wireless LANs presents for colleges and universities, and covers the pedagogical, technical and security issues that wireless LANs raise.

Pedagogy

Wireless LANs present a number of interesting new teaching possibilities because they allow computers to be used wherever required.

One user wrote in Educause Review: *"Probably the most intriguing use of wireless is not in whole building implementations but in 'wireless à la cart'. In such uses, a rolling cabinet with twenty or so portable computers and a wireless bridge [access point] are rolled into a seminar or classroom, and the bridge is plugged in to the lone Internet connection in the room. The portables are detached from the built-in chargers and are used throughout the room by students in teams of two or three."* and continued that *"productivity just went sky-high!"*.

The advantages of wireless carts are both pedagogic and economic. The computers can be used wherever it is most suitable - in a classroom, laboratory, seminar room or even outdoors! This means that computers can be incorporated into education rather than education fitting around computers.

Who this paper is for

This paper has been written for a broad audience, including those without a technical background. It is of relevance to:

- IT managers and network managers who are considering implementing a wireless LAN or extending their network infrastructure
- Learning technologists as background knowledge on wireless LANs and an introduction to some of the pedagogical opportunities that wireless LANs can offer
- Those involved in designing and building new learning spaces

By using computer carts, fewer computer laboratories will be needed, which saves space, and laptops tend to be less intrusive when teaching than desktop PCs because they are more compact and easier to move out of the way. Computers can also be used in the number needed rather than the number that has been installed in a room. Educational benefits are most likely to accrue for courses that require all students to have a laptop or personal digital assistant (PDA) such as a Palm or iPaq. Although few colleges or universities within the UK currently run courses that mandate the use of PDAs, their use is already common in the USA and is likely to increase here soon. Such ubiquitous computing with wireless connectivity opens up new educational possibilities, which are beginning to be explored. Evidence suggests that the technology enhances collaborative work and brings new methods into the classroom. All students having their own computer or PDA would allow a range of exciting potential uses in teaching, and many of these are only possible with wireless LANs, or can be greatly enhanced by their use.

Examples of the successful use of such systems in the USA include:

- Teachers using the systems to gain better feedback from students by giving quick quizzes and getting immediate responses; students can ask questions when they don't understand without "showing themselves up"
- Medical students at Wake Forest University carrying wireless-enabled PDAs on their ward rounds and thereby having access to medical information, patient notes and dosage information so they can concentrate on the patient rather than trying to remember everything
- Enhanced computer-supported collaboration and peer-to-peer working because computers can be used anywhere (there is considerable anecdotal evidence of improving the degree of collaboration between students and the amount of effort they put in)

Technology and security

Wireless LANs can be installed when it is considered economically or educationally beneficial. There are likely to be economic benefits when no good LAN exists and one is needed. This is especially true in buildings where it is difficult to lay cables, such as listed buildings or buildings containing asbestos. Wireless LANs have a role to play in creating a good network in colleges and universities, particularly where an institution wants to extend the network into additional buildings or parts of buildings or where "flood wiring" is being considered.

In almost all situations, wireless LANs will be used in conjunction with wired LANs to maximise the benefits for the college. A wireless LAN requires a "backbone" to connect the parts together, and in most cases this will be wired. Also, there will be locations where wiring makes sense. For example, in computer laboratories, the need to provide power cables means that laying data cables at the same time is comparatively inexpensive, and the density and bandwidth requirements make wired LANs the most sensible solution. With a wireless LAN the available bandwidth is shared between all uses. This can have a significant impact on performance and where there is a high density of users with high demand for bandwidth, performance is likely to be inadequate.

Great care is needed with the management of the wireless network to achieve reasonable security; that is to make sure that the wireless part of the network is not more vulnerable than the wired parts of the network to hackers. Wireless is inherently more vulnerable than the wired parts for two reasons. First, the hacker does not even need to enter the premises to be able to gain access to the network from inside any institutional firewall because radio signals pass through walls. Second, it is easier to monitor the radio signals than those in a wired LAN.

To overcome the increased vulnerability, a standard called Wired Equivalent Privacy (WEP) has been developed. Although the standard has some serious flaws, a solution to the most significant flaw has now been created and any new equipment purchased should comply with the enhanced standard. To put the security into perspective, it should be remembered that in many institutions it is not difficult for anyone to walk in and start using a computer in one of the laboratories. However, a wireless LAN should not be considered secure and where security is a concern, a virtual private network (CPN) should be considered.

Wireless LANs can use either radio frequencies or infrared light to transmit signals. Although infrared is considerably cheaper to install, as many devices already have infrared (IrDA) ports, the limitations of infrared mean that it will rarely be the system of choice. The bandwidth is more limited than for the radio frequency systems, and because infrared is dangerous (it can damage eyes) the power that can be used in a device is strictly controlled, which means that the distance the signal can travel is very limited (around 10 metres). To get a good signal, line-of-sight is needed (that is the infrared port on the computer and the access point must be able to see each other).

Radio frequency systems are considerably more flexible than infrared; they have greater bandwidth and work over greater distances than infrared LANs, and there are also no health hazards at the permitted power levels (around 1/20th of those used in mobile phones and you do not hold them to your head). Radio frequency (RF) comes with a number of restrictions as most of the available frequencies are licensed, for example for television, radio and mobile phones. There are currently two bands that can be used freely, but this means that the available space is also used by other devices.

Selecting and installing the technology

When choosing a technology for wireless it is important to consider not only the installation costs but also the upgrade possibilities of any technology. Currently there

are two families of wireless LAN technologies; the Industrial, Scientific and Medical (ISM) band and the Unlicensed National Information Infrastructure (UNII) band. They are incompatible with each other as they work in different parts of the radio frequency spectrum (2.4 GHz and 5GHz, respectively).

In most cases, colleges and universities will want to use the technologies in the ISM band as they are better established, cheaper, offer more security and require less equipment. The available bandwidth of ISM, however, is less than that of UNII (currently 34 Mb/s compared with 54 Mb/s), but is growing rapidly. Another drawback with the ISM band is that there is more likely to be interference from other devices and technologies, especially from Bluetooth, which is a low bandwidth, short range wireless communication technology suitable for connecting peripherals to computers. While Bluetooth is a concern, a number of studies have been done (mostly by manufacturers) showing that interference is not a problem. In the UNII band there are currently few applications that are likely to cause interference.

The distance that signals travel is related to their frequency, and the lower the frequency the further they will travel (for a given amount of power). This means that considerably more access points are needed (up to seven times as many) for wireless LANs that use the UNII band than for those that use the ISM band, so increasing the costs significantly.

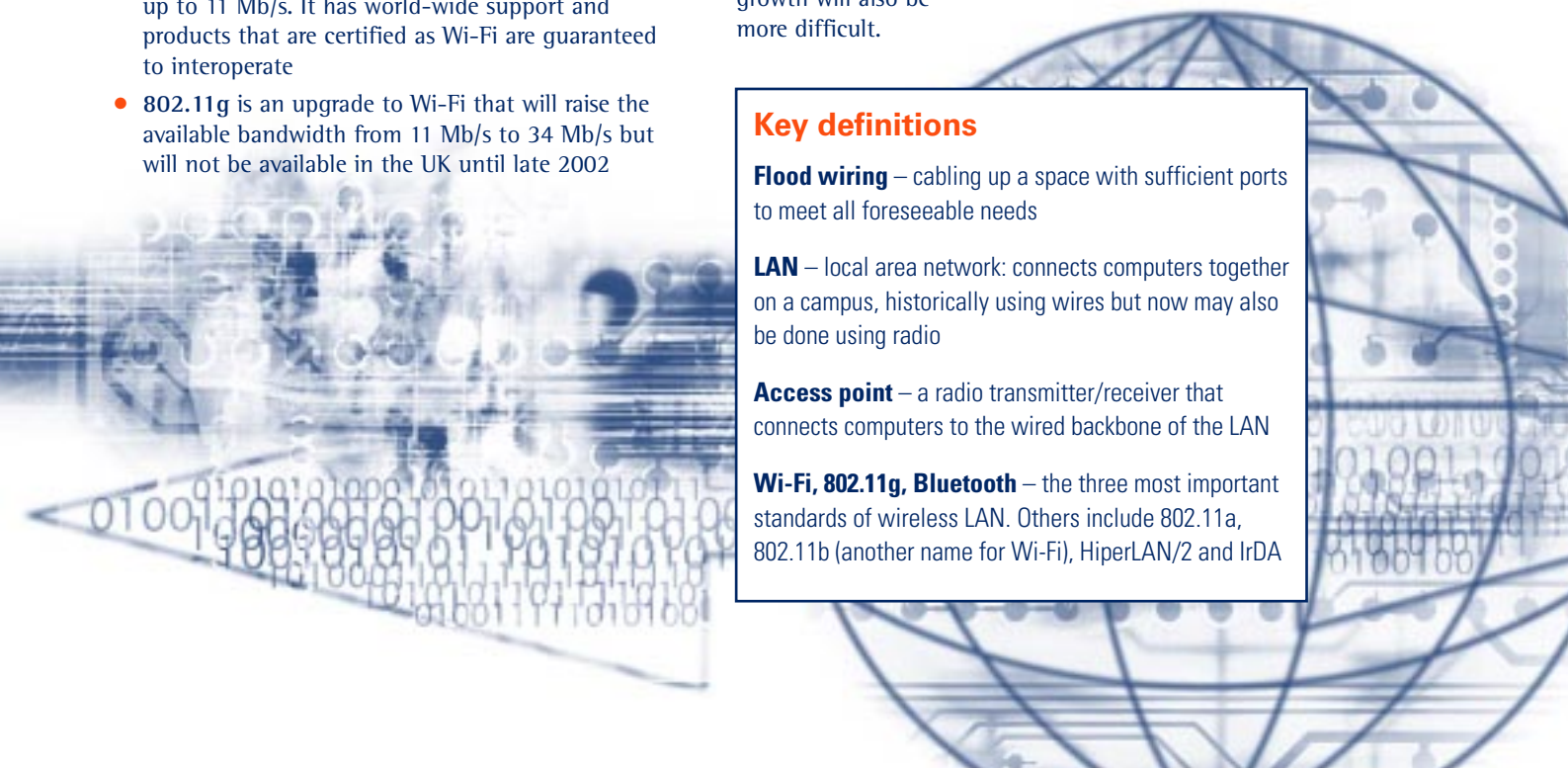
Standards

Currently, there are at least ten different standards working within the two bands that can be used to build a wireless LAN. The five main standards are outlined here:

- **Wi-Fi** (developed by the Institute of Electrical and Electronics Engineers (IEEE) as 802.11b) is the most important and most widely available standard at the moment, and will be the standard adopted by most installations. It works in the ISM band and provides up to 11 Mb/s. It has world-wide support and products that are certified as Wi-Fi are guaranteed to interoperate
- **802.11g** is an upgrade to Wi-Fi that will raise the available bandwidth from 11 Mb/s to 34 Mb/s but will not be available in the UK until late 2002
- **802.11a** and **HiperLAN/2** are two other standards that are incompatible with Wi-Fi and 802.11g, as they work in the UNII band. 802.11a was developed by the IEEE in the USA and is not currently licensed for use in the UK, whereas HiperLAN/2 is likely to disappear
- **Bluetooth** is being touted by some as a technology for building LANs, but was not designed for this and is not really suitable (it has a short range (10m) and low bandwidth (4 Mb/s) and allows only a low number of concurrent devices). Bluetooth is very likely to have a part to play in networking, but as part of a personal area network (PAN) rather than as part of a LAN

Wireless LANs should currently be built using Wi-Fi with 802.11g as an upgrade route. There are a number of reasons for this assertion. First, there is already a large user base who will want to continue to use their equipment. Wi-Fi wireless cards will work with 802.11g access points and 802.11g wireless cards will work with Wi-Fi access points. Second, Wi-Fi will continue to be cheaper than 802.11a or HiperLAN for quite a while, not only because much of the research and development cost of Wi-Fi has already been recovered, but more importantly because the ISM band has a greater reach than the UNII band so that fewer access points will be required. Third, Wi-Fi is now a reasonably well understood technology by many network managers, and although there are undoubtedly problems with it (including security and performance in a noisy environment), solutions to many of the problems are known and understood.

Determining exactly how to install a wireless LAN is more complex than for a wired LAN and it is essential to undertake a site survey to determine how the LAN should be installed. If this is not carried out, there are likely to be areas where no service is offered and additional equipment will be needed to give sufficient coverage. Without a survey, planned growth will also be more difficult.



Key definitions

Flood wiring – cabling up a space with sufficient ports to meet all foreseeable needs

LAN – local area network: connects computers together on a campus, historically using wires but now may also be done using radio

Access point – a radio transmitter/receiver that connects computers to the wired backbone of the LAN

Wi-Fi, 802.11g, Bluetooth – the three most important standards of wireless LAN. Others include 802.11a, 802.11b (another name for Wi-Fi), HiperLAN/2 and IrDA

Recommendations

- When extending a LAN to a part of the campus not already covered by networking, or where networking is being upgraded, compare the costs and other benefits of using Wi-Fi for part of the network with those available from a wired network. It is likely that a wireless LAN will offer greater educational benefits through flexibility and good value for money. Wireless LANs will not always be the most suitable choice though
- It is important to consider the upgrade options for any network that you may purchase, and with this in mind it is likely that Wi-Fi will be the network of choice in most cases
- In planning for the future, include provision for student use of their own computers (laptops or PDAs), because it will become more commonplace and presents new possibilities for learning
- If you are considering the purchase of a wireless LAN it is essential to undertake a wireless survey as part of the procurement

About this paper

This paper is one of a pair, and is aimed at those responsible for implementation and practice. A corresponding briefing paper, providing an overview aimed at senior managers and those responsible for strategy and policy, is available for this issue. Copies are distributed by and available from JISC Assist, or:

http://www.jisc.ac.uk/pub/

The information in these papers is taken from a report on wireless LANs produced by TechLearn (see below) which contains a much fuller discussion of the issues and the pedagogical opportunities that wireless LANs offer as well as an extensive annotated bibliography.

http://www.techlearn.ac.uk/NewDocs/Wireless.doc

Further information

TechLearn: a JISC-funded service that acts as a major source of information and advice to the FE and HE sectors on the exploitation of new and emerging technologies for learning and teaching and how these technologies may impact on strategic and operational planning. TechLearn identifies key technologies that are at or near market and provides digestible reports, events and other activities to help inform FE and HE at both strategic and practitioner level. Wireless technology is one of the key technologies currently identified. For further information on TechLearn and Wireless technology please see:

http://www.techlearn.ac.uk/

Berger C, *Wireless: Changing Teaching and Learning "Everywhere, Everytime"*, Educause Review, Jan/Feb 2001, p58

Wireless LAN Association:
http://www.wlana.org/

To find out about the JISC

See our Web site, at: http://www.jisc.ac.uk/

Email JISC Assist, at: assist@jisc.ac.uk

Or phone JISC Assist on: 0117 954 6850

To find out about new JISC developments and major strategic issues join the mailing list JISC-Announce. Send the message

"join JISC-Announce YourFirstName YourLastName"

to:

jiscmail@jiscmail.ac.uk

JISC

The Joint Information Systems Committee