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Loughborough College IR laser link to College cyber café

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Overview

This paper describes the implementation of a 10Mbit/s IR (Infrared) laser link to connect Loughborough College's off-site Cyber Café to its main network. It considers the motivation for the project, the planning, the equipment and its installation. Post installation issues such as the performance and benefits are also assessed. The project was carried out in the second quarter of 2000.

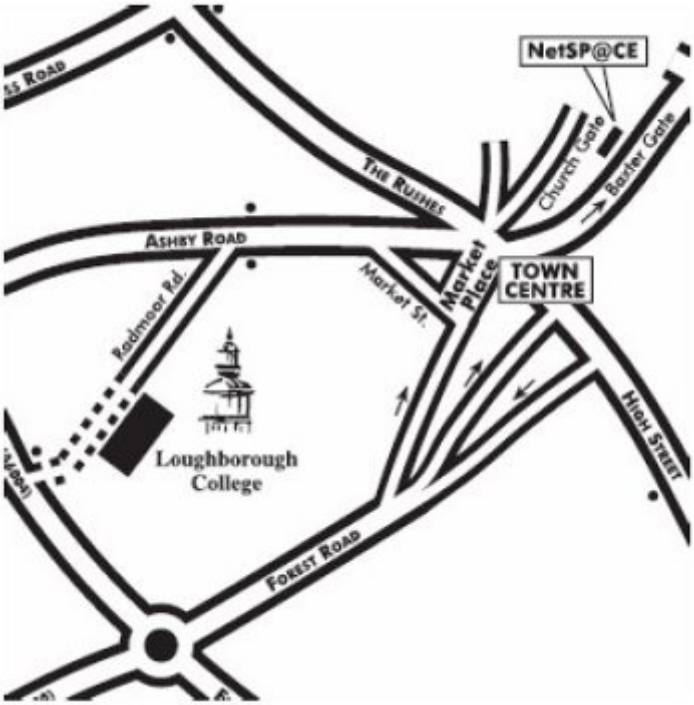
Executive Summary

Loughborough College owns an Internet Cyber Café in the town centre, approximately 1.2 km from the College campus, which it needed to connect to the Internet via the College's Janet connection. The College wanted to avoid revenue cost and fund the link through capital expenditure alone. This ruled out leased line links. There was line of sight between the buildings, but the radio based systems available in 2000 would not have worked because the close proximity of buildings would have interfered with the signals. The College selected a 10Mbit/s laser based system, which was extremely easy to install and which has proved to be very easy to manage.

Introduction

Loughborough College is a general FE establishment which shares its campus with Loughborough University and the Royal National Institute for the Blind Vocational College. The College addresses its aim to widen participation through educational provision at community outreach centres, courses in the workplace and by distance learning. In 2002/03, a total of 9,740 students were enrolled.

In 1998 the College opened NetSP@CE [1] as a commercial Cyber Café. Since it is not acceptable to run a commercial enterprise Internet connection via the Janet network, the College acquired an ISP, with the connection from NetSP@CE [1] to the ISP provided through a BT leased line. This solution ceased to be viable with the advent of ISPs such as Freeserve and Virgin. In 2000 a decision was made to scale back the commercial activity so that the Cyber Café usage would fall within the bounds of the Janet Acceptable Use Policy. This would enable the Cyber Café to be connected back to the College and thence to Janet and the



veen NetSP@CE [1] and the College [2]

Figure 1: Loughborough College in Relation to the Town Centre and NetSP@CE [1] . (This map was provided courtesy of Loughborough College.)

NetSP@CE [1] currently comprises the Cyber Café with 16 PCs, and two training suites which are used for LearnDirect courses. One has 18 PCs and the other has 12.

Service Requirements and Constraints

The College had little experience of connecting remote sites and they had to rely on outside expertise to implement a suitable system. Advice was sought from the College's main networking equipment supplier, European Electronique, a company which had experience of working with microwave and laser systems suppliers.

A key constraint was that the College wanted to use capital funding for the project and to minimise annual costs which effectively ruled out leased line solutions.

Identification of Possible Solutions

There is line of sight between the main campus and NetSP@CE [1], so the recommended options were to use microwave or laser for the 1.2km link. Both options would have resulted in an initial capital expenditure with very little subsequent revenue cost. They would also have provided, in theory, a sufficiently reliable connection (not mission critical) and sufficient bandwidth – 5Mbit/s HD (Half Duplex) and 10Mbit/s HD respectively.

During the procurement other solutions were identified, including low cost, fixed line solutions such as EPS8 (Engineering Performance Specifications) or EPS9 ‘Baseband’ from BT. However, they incurred an annual running cost and the bandwidth was lower than that offered by a laser link.

Cost/Technical Comparisons

Microwave Link Option

The microwave link on offer at the time was prohibitively expensive and would have required a licence from the Home Office, since the maximum unlicensed output is 100 mW EIRP (Emitted Isotropic Radiated Power). There were also concerns that a microwave system might not work due to the proximity of surrounding buildings resulting in possible loss of signal. On further consideration and after an initial site survey, radio based systems were ruled out as there were too many buildings close to path and reflections in the Fresnel zone were thought likely to cause problems.

Fresnel zones are ellipsoidal regions surrounding the path of a signal in which reflections from obstacles can occur. Such reflections can result in out of phase signals at the receiving antenna, interfering with and either attenuating or increasing the signal. In order to reduce destructive interference, the aim is to maximise the direct signal strength so the first Fresnel zone needs to be reasonably clear of obstacles. Even so, buildings near to the line of sight can result in a wireless solution being unfeasible. This is still an issue for all microwave wireless systems, although the latest generation technology permits ‘near line of sight’ operation, using OFDM (Orthogonal Frequency Division Multiplexing). This is now the industry recognised method of reducing this interference, and goes some way towards alleviating this problem. OFDM is used in both 802.11a and 802.11g technologies.

For further information see:

http://www.zytrax.com/tech/wireless/fresnel.htm [3]

http://www.softwright.com/faq/engineering/Fresnel%20Zone%20Clearance.html [4]

IR Laser Option

PAV Data Systems Ltd offered a low cost, moderate bandwidth, IR laser link based on the SkySeries 10Mbit/s Ethernet ET2000 unit. See the following link for further details:

http://www.pavdata.com [5]

The ET2000 unit is one of a family of products offering free space optical inter-connection of Ethernet LANs over distances of 500, 2000 and 4,000 metres and at data rates of 10, 100Mbit/s and 1Gbit/s. There are also more telco-orientated versions providing E1 2Mbit/s G.703 and ATM 155 and 622Mbit/s STM-4/OC-12 connectivity.

The SkySeries ET2000 supports a data rate of 10Mbit/s at half-duplex and is well matched to 10Mbit/s Ethernet networks. Higher speed versions operate in full duplex mode. The unit behaves like a media converter and so is transparent to the devices it is connected to. No

software configuration or additional hardware is required to complete an installation.

IR laser systems work over distances up to 4km. The nominal range is determined by the power output of the laser diode, wavelength and the number of laser diode transmitters used. Weather conditions affect the operational range – laser systems are adversely affected by fog, dust, snow and other precipitation.

Where there is good line of sight, laser links can provide short - medium range, high bandwidth connections which are reliable in most weather conditions, at a reasonable one-off cost.

The cost of the particular system proposed for Loughborough College was such that the initial outlay would be recovered after two years from the rental savings made by cancelling the existing leased line. The solution also had the advantage of total ownership rather than relying on leased lines and this was more attractive to those responsible for NetSP@CE [1].

Specification for Sky Series 10 Mbit/s

Product Code		ET2000
Outdoor unit		
Performance	Effective Data Rate	10 Mbit/s
	Range (metres)	2000
	Bit Error Rate	>10E^-10
	MTBF (hours)	105,000
Transmitter	Number of Transmitters	1
	Light Source	Laser Diode
	Laser Class	1M
	Wavelength (nm – nanometer)	910

	Output Power (mW – milliWatt))	100
	Nominal Ocular Hazard Distance (m)	0
	Beam Divergence (mrad – milliradians)	11
Receiver	Detector Type	Pin Diode
	Field of View	15°
	Sensitivity (dBm – decibel milliWatt)	-35 to +20
Interface	Presentation	AUI Transceiver
	Connectors	RJ45/BNC/SC
	Cable	Shielded twisted pair/Coa mode fibre
Power Supply	Input Voltage	19.5 - 72 V DC
	Power Consumption (Watts)	40
Environmental Information	Operating Temperature (°C)	-40 to +65
	Operating Humidity	95% (non condensing)
	Enclosure	IP66

Mechanical Design	Link Head Dimensions W x L x H (mm)	350 x 550 x 198
	Mounting bracket	200 x 200 x 76
	Height including mounting bracket	274
	Weight (kg)	8.5

Table 1: Technical specification of PAV ET 2000 system

[6]

Figure 2: Images of the PAVData 10Mbit/s IR Laser System

Feasibility

PAVData conducted a site survey, establishing line of sight by visiting NetSP@CE [1] and visually identifying the main College building from there. The distance of 1.2km was not a concern and PAVData confirmed that their system would work and could be installed at the quoted price.

Implementation

Four weeks after the order was placed, the equipment was installed without any problems by a contractor in one day.

Since the SkySeries ET2000 behaves like a simple media converter, no software configuration of the unit was required at all. IP configuration changes on the NetSP@CE [1] LAN were of course required to set the default gateway and DNS server configuration to that of the main College network.

The system went live on 13th June 2000.

Operational Performance and Reliability

At first the system was extremely reliable with no problems during the first year (with the exception of wet snow adhering to the glass on the front of the unit on one occasion – the problem only occurs with wet snow).

However, during the second year the link kept failing during foggy weather. As the result of a service callout by PAVData following a protracted outage, one component was found to have degraded. There may also have been a slight movement in the alignment of the laser units. These two issues were resolved and there have been no significant outages on the link since. The replacement of the faulty part cost £1,000 as the College had decided not to take out a maintenance contract.

Recently (early 2005) there was a need to power off one end of the link for electrical maintenance and, on rebooting the system, it was found necessary to reboot the far end as well. This was simply accomplished at the NetSP@CE [1] end by switching the unit off and back on again at the wall power socket.

From a network management viewpoint the link is invisible and is treated like just another copper cable.

Benefits of Project

The link has enabled the Cyber Café to be connected to the College in a cost effective manner, with sufficient capacity for all current needs.

Lessons Learned

The system has worked reliably, apart from occasional problems with snow and fog. The lesson learned from these experiences is that it is useful to have reasonable access to the units so that they can be cleaned if there is a build-up of snow on the glass fronts of the units. Other weather conditions, such as strong winds, can also cause a slight movement in the alignment of the laser units which may also affect performance.

The College chose not to take out a maintenance contract for the system and so far have only had to call the engineers out on the single occasion when one component failed. In the light of experience, this has proved to be a cost effective decision. (It is worth noting that for the three wireless links which the College has since deployed, they have similarly eschewed maintenance contracts, preferring to purchase a spare system for swap-out to cover any equipment failures.)

Future Plans

There are no future plans for the IR laser link at present, but the College would be very happy to use the same system should they have a need for another short hop, moderate bandwidth, line of sight, remote link.

Summary

The project has provided a simple and cost effective solution to linking the NetSP@CE [1] Cyber Café to the College and has been remarkably trouble free and easy to manage.

Source URL: https://community.jisc.ac.uk/library/advisory-services/loughborough-college-ir-laser-link-

college-cyber-caf%C3%A9

Links
[1] mailto:NetSP@CE
[2] http://community.ja.net/system/files/images/loughborough-laser-01.jpg
[3] http://www.zytrax.com/tech/wireless/fresnel.htm
[4] http://www.softwright.com/faq/engineering/Fresnel%20Zone%20Clearance.html
[5] http://www.pavdata.com/
[6] http://community.ja.net/system/files/images/loughborough-laser-02.jpg