A Study of Networked Video Facilities in Welsh HEIs and FECs and Proposals for a Welsh Video Network

DECEMBER 1999

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Reference: RT/VIDEO/WELSHVC/001

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0 EXECUTIVE SUMMARY

Objectives and Terms of Reference

0.1 This study was commissioned by the Welsh Funding Councils (WFCs) to provide technically satisfactory and costed proposals for establishing and equipping a good quality, value for money video network encompassing all Higher Education Institutions (HEIs) and Further Education Colleges (FECs) in Wales, together with the WFCs' offices.

0.2 The terms of reference of the study were:

- to consider a range of technically satisfactory options, including those involving satellite links, for providing the video services network, and to make costed proposals for a solution or solutions, which represent best value for money;
- to ensure appropriate connectivity with other video networks;
- to take stock of existing video services facilities – studio and equipment – at each institution and assess the extent to which they can form the basis, or be used as part of, the proposed video services network;
- to specify the requirement, additional or initial basic, for establishing video services facilities at each institution and to supply associated estimates of cost;
- to examine options and prepare costed proposals for establishing links and facilities to support video services within institutions which operate on sites dispersed over a wide geographic area;
- to produce costed options for the management of the video network.

0.3 The term *video services network* is used to describe a network supporting a range of video-related applications. Videoconferencing is currently the most frequently used application and that for which present demand is greatest. Consequently, while other applications receive attention, the emphasis of this report falls very much on videoconferencing.

Method

0.4 The methodology employed for this study had three elements:

- evaluation of current academic network provision in Wales;
- site surveys to gather detailed technical information on current video facilities and equipment in FECs and HEIs in Wales;
- questionnaires to all sites to gather information on both current and anticipated usage of video applications.

0.5 The evaluation of current academic network provision in Wales was undertaken by reviewing network topology and the bandwidth of connections to sites. Technical information - which included details of videoconferencing facilities; studio environment; equipment in use; network infrastructure; and video and network expertise - was collected via site survey forms complemented by site survey visits. The information on usage was collected by questionnaire.

0.6 Network provision as currently made in HE, and anticipated in FE in the next year, was found to represent an adequate base from which to launch a Welsh video network. However, network usage is increasing rapidly, particularly in FE, and use of video applications will place bandwidth under heavy pressure. Given this, it would be reasonable to expect calls from a number of FECs within a year or two for bandwidth above the 2 Mbit/s recently agreed.

Findings

0.7 The site surveys show that videoconferencing equipment is widely deployed in both the FE and HE sectors. Individual organisations view videoconferencing as strategic and are investing in the technology. It is clear that there is a strong forward looking culture in both the FE and HE sectors in relation to the adoption of new technology and a desire to use it effectively to support institutional objectives.

0.8 Just under half of all FECs in Wales have some form of videoconferencing equipment. Most of this has been purchased in order to gain a better understanding of the issues surrounding the use of videoconferencing or for specific projects. It is, however, mainly desktop based and therefore not suitable for redeployment in a high quality video network. None of the FECs currently has a dedicated studio environment for their videoconferencing equipment although almost all have identified suitable space.

0.9 In the HE sector, five institutions are part of the C5C, or WelshNET, video network: Aberystwyth, Bangor, Cardiff, Lampeter and Swansea. Almost all other HEIs have made their own investment in videoconferencing equipment, although none has a dedicated studio. The C5C facilities are reaching the end of their maintenance life and the studios are in need of substantial refurbishment. Leading edge when commissioned in 1990, the C5C network is now substantially obsolete.

0.10 C5C member institutions have used the network extensively for administration, teaching, research, and conferences and it has also been used by other HEIs in the sector. Figures for 1998/1999 show the network to be in use for up to 15 hours a week.

0.11 Institutions in both sectors, FE and HE, are keen to develop and/or extend their use of videoconferencing, particularly for teaching and learning purposes. They see opportunities in this area in a number of directions: in-house for teaching between sites and for distance learning; and within and across sectors for collaborative work, including research collaboration.

0.12 Those HEIs for which franchising or outreaching provision forms a major element in their strategy for widening access are concerned to have good quality video links to their franchise partner or collaborating institutions. They see such links as material in strengthening teaching relationships between staff and increasing the commonality of the learning experience among students. Institutions in both sectors are alive to the opportunity video affords for maintaining or extending provision efficiently and economically in small but significant areas of the curriculum. Welsh and Welsh medium teaching were frequently cited examples in this context where, in relation to the former, a requirement for simultaneous translation facilities was also identified. These are also considered to be important from the point of view of facilitating bilingual meetings.

0.13 Three concerns in particular run alongside the general interest and enthusiasm for video development: that the facilities should be reliable and easy to use; that there should be an efficient and effective booking system, again easy to use; and last, but not least, that usage costs should be affordable. In this last context, the costs of calls for digital telephone based (ISDN) services was a matter of general concern.

Proposals

0.14 Proposals for the network have been developed taking account of the fieldwork findings and a range of further considerations of a strategic, technical and financial nature. They address the key elements of underlying technology; technology support equipment; studio environment and equipment; and management and support arrangements.

Technology and Technology Support

0.15 A range of technology options was considered with one emerging as the clear leader, readily accommodating strategic, technical and financial considerations. It is a hybrid option, using both digital telephone - ISDN - and Internet - IP - technology. ISDN is established videoconferencing technology in widespread use; IP is leading edge videoconferencing technology in limited use. IP is, however, being developed rapidly both by the HE community and the commercial market. It is, in effect, the next technology. Beyond this, it offers another major advantage: cost savings. Unlike ISDN, IP carries no call charges.

0.16 Experienced users of videoconferencing in Wales will wish to take early advantage of the cost savings associated with an IP service as well as of the opportunity, once again, to explore and exploit the potential of a leading edge network. Those will little or no experience may use the tried and tested ISDN technology and switch readily to IP when it is more firmly established in a year or two. The equipment used with both is substantially the same.

0.17 Good quality can be achieved with ISDN making concurrent use of six channels or lines, that is, by using ISDN6. This, coincidentally, is also the most effective way of using ISDN technology. It is recommended that ISDN6 is used.

0.18 Concerns about the costs associated with ISDN are likely to impede the take up of the service in the FE sector which, in general, lacks the culture and tradition of videoconferencing apparent in HE. Recognising this, and taking account of experience with recent videoconferencing projects elsewhere, it is recommended that a central call charge budget is established for FECs with a budget quota allocated to each college.

0.19 For reasons of cost efficiency and effectiveness, it is recommended that equipment already in place at the JANET Videoconferencing Service (JVCS) is used to manage conferencing using the ISDN based service. The IP service will require distinct supporting equipment, sited locally on the Welsh video network. It is recommended that this is managed locally through a Welsh Videoconferencing Management Centre. A distinct support centre is likely to be required only until such time as IP becomes the established videoconferencing technology, in around, say, two years. The need for a dedicated Welsh centre should be reviewed at that time.

0.20 Provision will need to be made to link the IP and ISDN service networks. The most cost effective way of doing this will be through gateways co-located with the ISDN service support equipment.

Studios and Studio Equipment

0.21 Studio environment will have a material effect on conference quality. Regular quality testing on the existing JVCS services has helped to bring about significant improvements in quality and it is recommended that studios on the Welsh videoconferencing network successfully complete quality assurance tests when commissioned and at regular intervals after.

0.22 A basic package of equipment can be specified depending on the size of the studio and the activities it is to support. Bearing in mind the condition and nature of existing equipment in the sectors, it is recommended that each studio is provided with the appropriate package. Substantial discounts can be obtained through bulk purchase so that it is also recommended that studio equipment is purchased in this way using EU public procurement procedures.

Management and Support

0.23 To help secure its success, the video service will require management and support at three levels: overall; central; and local. This support will need to include an efficient conferencing booking service.

0.24 Overall management will be required, inter alia, to manage the equipment procurement and take responsibility for deploying the network within a given timescale. It is recommended that a project manager be appointed for two years to deliver the network.

0.25 Central management functions will include connecting participants in conferences and controlling traffic to avoid congestion. The recommendation here is that the JVCS provides central management for the ISDN based service and a Welsh Videoconferencing Management Centre performs the same function for the IP based service, at least until such time as IP becomes the UK standard service.

0.26 Locally, sites will need support to configure studio equipment and to train staff in its use. For institutions with minimal technician staff, support of this kind will be critical. The FE Support Centres established to assist the roll out of the academic network in FE would be ideally placed to take on the video network support function for both the FE and the HE communities. It is recommended that they take on this role, the establishment of each of the two Centres being increased by one member of staff in consequence. The staffing need should be reviewed within two years of the start of the start of service operation.

0.27 The JVCS has developed an on-line booking service that has operated successfully for some time. For reasons of cost efficiency and effectiveness, it is recommended that the Welsh Videoconferencing Network joins this service.

0.28 The study recommendations are set out below and are followed by a summary of indicative costs. Costs can only be indicative at this stage: prices are subject to rapid change and the extent of cost savings through procurement cannot be established in advance of tender. Costs are shown for three years with zero costs in year three on the assumption that, by this time, IP will have been established at the standard UK video technology and operating costs will, in consequence, be covered at UK level.

RECOMMENDATIONS

TECHNOLOGY AND SUPPORTING EQUIPMENT

1 The video network established is a hybrid, using both ISDN and IP technologies.

2 In relation to ISDN, facilities are provided to support ISDN6.

3 Equipment support (Multipoint Control Units) for the ISDN service is provided from the JANET Videoconferencing Service; and parallel support for the IP service is provided from a Welsh Videoconferencing Centre.

4 Gateways to link the two service networks are co-located with the ISDN support equipment at the JANET Videoconferencing Service.

STUDIO ENVIRONMENT AND EQUIPMENT

5 Studios on the Welsh Video Service Network should successfully complete quality assurance tests when commissioned and at regular intervals afterwards.

6 Equipment for each studio is provided in the form of a standard basic package according to the size of the studio and its intended use.

7 Equipment is centrally purchased in accordance with standard EU procedures for public procurement.

MANAGEMENT AND SUPPORT

8 A Welsh Videoconferencing Management Centre is established to manage the IP based video service; and the continuing requirement for the Centre is assessed 18 months from the start of service operation.

9 The JANET Videoconferencing Service provides management support for the ISDN service.

10 An additional member of staff is appointed at each of the two existing FE Support Centres for up to two years in the first instance to serve the deployment and operation of the video network in both the FE and HE communities; and the continuing requirement for both posts is reviewed 18 months from the start of service operation.

11 An overall Project Manager is appointed on a fixed term basis for approximately two years at the outset of the project.

12 The Welsh Videoconferencing Network should use the JANET Web based videoconferencing booking service.

OTHER

13 A central call charge budget is established for FECs with a budget quota allocation for each college.

Summary of indicative costs

Capital costs for studio equipment include VAT and assume a 15% EU procurement discount.

Capital costs for central equipment and routers include VAT.

Capital Costs	**£m**
Total capital costs of equipment for all studios: 38 large studios 5 small studios	1.42
Contribution to other studio costs	0.43
Router upgrades	0.19
Central equipment	0.31
Total Capital Costs	**2.35**
Recurrent Annual Costs	
Overall project management	0.04
Dedicated personnel for FE Support Centres	0.08
Welsh Management Centre	0.06
Maintenance of central equipment	0.03
FE Central call charge budget	0.15
Total Recurrent Annual Costs	**0.36**
Total Capital Cost Year One	**2.35**
Total Capital Cost Year Two	**0**
Total Capital Cost Year Three	**0**
Total Recurrent Cost Year One	**0.36**
Total Recurrent Cost Year Two	**0.36**
Total Recurrent Cost Year Three	**0**
Total Costs Year One	**2.71**
Total Costs Year Two	**0.36**
Total Costs Year Three	**0**

Year three costs are shown as zero on the assumption that IP videoconferencing will become the UK standard by this time and that operating costs will be included at this level.

1 INTRODUCTION

Objective, Terms of Reference and Background

1.1 This study was commissioned by the Welsh Funding Councils (WFCs) from the United Kingdom Education and Research Network Association (UKERNA) in order to provide technically satisfactory and costed proposals for establishing and equipping a good quality, value for money video network encompassing all Higher Education Institutions (HEIs) and Further Education Colleges (FECs) in Wales, together with the WFCs' offices.

1.2 The terms of reference of study were to:

- consider a range of technically satisfactory options, including those involving satellite links, for providing the video services network and to make costed proposals for a solution or solutions, which represent best value for money;
- ensure appropriate connectivity with other video networks;
- take stock of existing video services facilities – studio and equipment – at each institution and assess the extent to which they can form the basis, or be used as part, of the proposed video services network;
- specify the requirement, additional or initial basic, for establishing video services facilities at each institution and to supply associated estimates of cost;
- examine options and prepare costed proposals for establishing links and facilities to support video services within institutions which operate on sites dispersed over a wide geographic area;
- produce costed options for the management of the video network.

1.3 The term *video network* is used to describe a network supporting a range of video related applications. Currently, the most commonly used application of a video network is videoconferencing. Other video applications are developing quickly, and a number of these are outlined in Section 5. For the time being, however, the principal area of general interest in the Welsh FE and HE sectors is videoconferencing with the result that the focus of this report is very much on that area.

1.4 The study has been undertaken against a background of videoconferencing activities in Wales. In the late 1980s and early 1990s the University of Wales Videoconferencing Network, C5C or WelshNET, was established with capital funds from the then Universities Funding Council (UFC). At the time this put Wales at the leading edge of videoconferencing networks. Since then there have been considerable developments, both in videoconferencing and in the capacity and capabilities of the Joint Academic Network (JANET). The HEFCW has invested funds independently as well as through the Joint Information Systems Committee (JISC) to help secure improvements to JANET in Wales. For example, the South Wales Metropolitan Area Network (SWMAN) was established with funding support from the Council. The FEFCW has also invested funds to provide all FECs in Wales with a connection to JANET and to develop expertise in, and applications for, the use of the network in FE. FECs have, in turn, invested their own funds in Communications and Information Technology (C&IT). Both Councils have recently agreed to the FEFCW becoming a funding partner in the JISC. The Welsh FE sector JANET connections will be upgraded in the near future and the sector stands to benefit from the full range of services supported by the JISC.

1.5 An evaluation of network development initiatives in HE in Wales was carried out by the Technical Advisory Unit (TAU) at the University of Kent at Canterbury and published by HEFCW in December 1997. This highlighted videoconferencing as an area in which the Council might usefully make a further investment in due course. A working party set up jointly by the Heads of Higher Education in Wales (HHEW) and the University of Wales Vice-Chancellors' Board (UWVCB) in the wake of that evaluation, drew up a set of proposals for a videoconferencing network covering all HEIs in Wales [1]; and a fund established by HEFCW during 1999 to promote partnership between the FE and HE sectors elicited a number of bids for support for the establishment of videoconferencing links between FE and HE institutions.

1.6 The 1999-2000 grant settlements for both the HE and FE Funding Councils contained capital funds earmarked for investment in C&IT. The accompanying letters of guidance directed the attention of both Councils specifically to securing improvements in access to networks, including working in partnership to improve network links between HE and FE to help to support the dissemination of high quality teaching materials.

1.7 This study can be seen as a follow up to the TAU's 1997 evaluation and a response to subsequent developments involving both the FE and HE sectors. Details of the UKERNA study team responsible for the work are set out in Appendix 1.

1.8 Throughout the report the term 'video' is used in a generic sense and encompasses videoconferencing and other video applications; the term 'site' refers to a single geographic location; and the term 'institution' refers to a single site or collection of sites, possibly spread over a wide geographic area, that are part of the same institution. A glossary of other terms and acronyms can be found at the end of the report.

2 TECHNICAL BACKGROUND NOTES ON THE ACADEMIC NETWORK AND NETWORK VIDEO

UKERNA, JANET and SuperJANET

2.1 UKERNA is responsible for providing wide area network facilities and services to HEIs, FECs and research institutions in England, Scotland, Wales and Northern Ireland. Institutions are interconnected using a variety of network technologies. The network forms one of the largest and busiest in Europe and is referred to as JANET. The core of the JANET network is sometimes referred to as SuperJANET.

The JANET Video Strategy

2.2 UKERNA's position on the development of wide area video services is represented in the JANET Video Strategy [2]. This has been developed through extensive consultation with the JANET community.

2.3 In considering video services, the Strategy adopts a classification model based mainly on levels of video resolution, or picture quality, a parameter which closely determines the bandwidth requirements of particular systems as well as other cost-related factors. The model is described below.

Level 1:	The minimum quality for videoconferencing:	one sixteenth of the resolution of Standard Definition Broadcast Television (SDTV).
Level 2:	Basic videoconferencing quality:	one quarter of the resolution of SDTV.
Level 3:	Equivalent to the resolution of SDTV.	

Levels 1 and 2 operate over narrowband networks; Level 3 requires a broadband network.

Narrowband operation may be defined as services operating at up to 2 Mbit/s, although it most commonly involves operation at up to 400 kbit/s. Broadband operation covers operation at higher bit rates, typically from 3 Mbit/s to 50 Mbit/s.

2.4 As no single technology can be prescribed to support the required range of video applications and services to be supported, the Strategy emphasises the need to adopt technologies based as far as practicable on independent standards published by recognised international bodies. Other key requirements include the provision of interoperability facilities between different standards and technologies; external connectivity to other networks; management systems for quality assurance (QA); and a network-wide booking system.

2.5 A key long term objective of the Strategy is the integration of videoconferencing and other video services over the JANET national infrastructure.

Current Status of Networked Video in the UK

2.6 Since September 1997, the primary multipoint videoconferencing service for the JANET community has been operated over the public digital telephone network, the Integrated Services Digital Network (ISDN). ISDN2 refers to using two channels, or digital telephone lines, concurrently for operation and ISDN6 to using six channels, or digital telephone lines, concurrently for operation. The JANET service uses the internationally recognised ITU-T Recommendation H.320 for narrowband videoconferencing services over ISDN. This supports operation at levels 1 and 2 of the model described in (2.3) above.

2.7 The only current example of a broadband video service operating in the UK academic community is the Scottish Metropolitan Area Networks Videoconferencing Service (SMVCN). This uses a proprietary Motion-JPEG technology operating over Asynchronous Transfer Mode (ATM) networks. A detailed review of the SMVCN service was commissioned by UKERNA in early 1999 [3] and further details of the service and its usage may be found in the review report.

2.8 In Wales, five institutions of the University of Wales are connected to the C5C videoconferencing network. This connects videoconferencing studios at the universities in Cardiff, Swansea, Lampeter, Aberystwyth and Bangor over 384 kbit/s leased lines. A gateway for external ISDN connectivity is provided at 128 kbit/s.

2.9 In addition to the circuit-based technologies described above, there has been significant development of narrowband videoconferencing over Internet Protocol (IP) networks. A project to demonstrate small scale usage of videoconferencing using IP multicast, Piloting of IP Videoconferencing (PIPVIC), was completed during 1998. A further project, PIPVIC-2, extended pilot activities to cover a larger number of sites using both IP multicast and IP videoconferencing using the ITU-T Recommendation H.323.

2.10 Further details on the network aspects of video service provision and videoconferencing technology are in Appendices 2 and 3 respectively.

3 REVIEW OF NETWORK PROVISION, CURRENT FACILITIES AND USAGE

Review Methodology

3.1 The methodology employed for the review had three elements:

- evaluation of the current academic network provision in Wales;
- site surveys undertaken to gather detailed technical information on the current provision of video-conferencing facilities and equipment in FECs and HEIs in Wales;
- questionnaires to all sites to gather information on both current and anticipated usage.

3.2 The evaluation of current network provision in Wales was undertaken by reviewing network topology and the bandwidth of connections to sites. Technical information - which included details of videoconferencing facilities, studio environment, equipment in use, network infrastructure, and video and network expertise within the institution - was collected via site survey forms and backed up by site survey visits. The information on usage was collected by questionnaire. The questionnaire and site survey form are reproduced in Appendix 4.

3.3 The FE Support Centres based at Swansea and Aberystwyth Universities conducted the site visits. They are located geographically close to the FE sites and had good working relationships with them. The individuals involved at both Aberystwyth and Swansea also had good relationships with the other HEIs in their geographic area. To ensure objectivity, Swansea was responsible for surveying Aberystwyth and vice-versa.

3.4 From the information in the questionnaires and site surveys, an analysis was undertaken of the current level of equipment and expertise in institutions to assess to what extent current facilities could be used to provide a video network; what additional equipment would be needed; and the extent to which extra support and advice would be required to make effective use of any new facilities.

3.5 With all the information collected, the study team addressed the technical issues of providing a video network. The team then came to a consensus on the best solution to recommend and drew up a costed proposal, both for the network and its management.

Current Status of the Academic Network Provision in Wales

3.6 There are currently two major JANET network entry points into Wales from the core of the JANET network. The first of these is a connection from Manchester to the North East Wales Institute (NEWI). In turn, NEWI has a number of connections that radiate out in a star topology. The second major network entry point into Wales is a connection in Cardiff between the JANET Backbone Edge Node (BEN) at Cardiff and the SWMAN. A diagram showing the location of all institutions within the FE and HE sectors in Wales and site connections can be found in Appendix 5.

3.7 Connections in North Wales provide an IP service to all sites. In South Wales, sites that are connected to the SWMAN are interconnected with an ATM network infrastructure. These sites have access to the same IP service as North Wales but have the advantage of potential access to services running over the ATM network infrastructure, e.g. the SuperJANET Managed Bandwidth Service. This offers the possibility of receiving services that offer a guaranteed quality of service (QoS).

3.8 Network provision as currently made in HE and anticipated in FE in the next year, represents an adequate base from which to launch a Welsh video network. However, network traffic is increasing, and particularly rapidly in FE. Network traffic statistics for the Welsh FE sector are detailed in Appendix 6. Comparing the increase in traffic for October, the start of the academic year, total traffic increased by 97.5% between 1997 and 1998, and by 112.2% between 1998 and 1999. Increasing use of the network for video applications will place bandwidth under heavy pressure and it would be reasonable to expect calls for higher bandwidth from a number of FECs in particular in a year or two's time.

Site Survey Findings

3.9 The site surveys showed that videoconferencing equipment is widely deployed in both the FE and HE sectors. Individual organisations view videoconferencing as strategic and are investing in the technology. There is a strong forward looking culture within both the FE and HE sectors in relation to the adoption of new technology and a desire to use it effectively to support institutional objectives.

3.10 The results of the site surveys are shown in Tables 3.1 and 3.2. Just under half of the FECs in Wales have some form of videoconferencing equipment. The majority is based upon two channel ISDN2 operation and, as ISDN6 or equivalent is a minimum requirement for high quality videoconferencing, there is little that can be used to form part of such a network. None of the FECs has a properly equipped, dedicated studio environment for videoconferencing equipment although all of the colleges except one have identified suitable space for future videoconferencing. A number were, however, concerned about space requirements for any new facilities and expressed the wish that rooms housing facilities should be regarded as multi-purpose rather than dedicated videoconferencing studios.

3.11 Five HEIs are members of the University of Wales C5C videoconferencing network consortium: Aberystwyth, Bangor, Cardiff, Lampeter, and Swansea. The C5C systems are, however, coming to the end of their maintenance life and the studios are in need of refurbishment. Leading edge when commissioned in 1990, the C5C network is now substantially obsolete. With the exception of Trinity College Carmarthen and the Welsh College of Music and Drama, all the remaining HE institutions have invested independently in videoconferencing technology. Across the sector as a whole, the University of Wales Institute Cardiff (UWIC), the University of Wales College of Medicine (UWCM), and the University of Glamorgan have each invested substantially in combined ISDN6/IP systems, all from the same manufacturer; and three universities - Aberystwyth, Glamorgan and Swansea - have also invested in other forms of networked video activities, notably audio and video streaming.

3.12 Apart from the C5C members, none of the HEIs has dedicated videoconferencing studio environments, although all have identified suitable rooms.

3.13 The WFCs have no videoconferencing equipment but possible rooms have been identified in their premises.

3.14 It was clear from the site surveys that C5C member institutions' studios and equipment were in need of substantial upgrade and refurbishment and that there would benefit in establishing at least one high quality videoconferencing studio at every other institution. The terms of reference required specific consideration of institutions which operated on sites dispersed over a wide geographic area. Taking advice from the WFCs, the study team has assumed this to be sites 25 miles or more than one hour's travelling time apart. On this basis, three FECs would warrant more than one studio. The numbers are shown in Table 3.1 and 3.2. The total requirement would be 43 studios: 29 in FE; 13 in HE; and 1 in the WFCs' offices.

Results from the Site Surveys
TABLE 3.1: FE

	Student Numbers		Site Information		Equipment in use			Support		Other	Network Information			
FE Colleges	No. of FT Students* FE & HE	No. of PT Students* FE & HE	No. of Sites	No. of Studios Proposed	C5C	ISDN	IP	A/V Service	Media Studies	Streaming	PCs	% Net	JANET (kbit/s)	MAN
Aberdare	422	2124	1	1		Y					350	60	64	
Barry	1392	5025	2	1							1000	80	384	
Bridgend	1661	6839	1	1				Y	Y		650	100	256	
CCTA	2501	11856	4	1			Y	Y	Y		1000	100	64	
Ceredigion	669	1745	2	1							150	99	384	
Deeside	1230	6990	4	1			Y	Y			600	100	384	
Glan Hafren	3012	7977	2	1				Y	Y		750	100	64	
Gorseinon	1625	1696	4	1				Y	Y		350	100	64	
Gwent	6186	22768	6	3				Y	Y		2000	90	2Mbit/s	
Harlech	129	15	1	1				Y	Y		70	99	64	
Llanrillo	2308	13281	6	1		Y	Y	Y	Y		1100	100	384	
Llysfasi	227	1698	1	1							150	90	64	
Meirion Dwyfor	1015	1843	3	2		Y					300	99	384	
Menai	2076	6983	2	1		Y					700	90	2Mbit/s	
Merthyr Tydfil	783	2148	2	1		Y			Y		300	80	256	
Neath Port Talbot	2934	12483	4	1				Y	Y		650	95	256	

	Student Numbers		Site Information		Equipment in use			Support		Other	Network Information			
FE Colleges	No. of FT Students*	No. of PT Students*	No. of Sites	No. of Studios	C5C	ISDN	IP	A/V Service	Media Studies	Streaming	PCs	% Net	JANET (kbit/s)	MAN
Pembrokeshire	1693	6171	3	1		Y		Y	Y		700	100	2Mbit/s	
Pencoed	418	392	1	1							80	90	64	
Pontypridd	2507	7347	4	1				Y	Y	Y	1000	100	64	
Powys	976	3652	3	2		Y			Y		350	99	384	
St David's	1028	53	1	1					Y		200	95	64	
Swansea	2367	12642	6	1		Y		Y	Y		1500	100	2Mbit/s	
WCOH	312	1635	1	1		Y	Y				122	90	64	
Yale	2815	6697	2	1		Y	Y	Y	Y		700	100	2Mbit/s	
Ystrad Mynach	1293	4683	5	1							500	98	384	

* Sources: HE Early Funding Statistics 1998/99 - Table A5
FE Early Student Enrolments 1998/99 - Table 1

Results from the Site Surveys
TABLE 3.2: HE

	Student Numbers		Site Information		Equipment in use			Support		Other	Network Information			
H E Institutions	No. of FT Students* FE & HE	No. of PT Students* FE & HE	No. of Sites	No. of Studios Proposed	C5C	ISDN	IP	A/V Service	Media Studies	Streaming	PCs	% Net	JANET (Mbit/s)	MAN
NEWI	2435	2362	1	1		Y		Y	Y		800	100	4	
SIHE	2873	1580	2	1		Y	Y		Y		900	90	155	Y
Trinity	1479	427	1	1					Y		350	100	2	
U Glamorgan	9785	6375	2	1		Y	Y	Y	Y	Y	3000	100	155	Y
UW Aberystwyth	6423	1730	3	1	Y		Y	Y	Y	Y	1700	100	8	
Bangor	6182	2265	3	1	Y			Y	Y		3000	97	4	
Cardiff University	13646	1938	2	1	Y	Y	Y		Y		6000	100	155	Y
UWC Medicine	2246	767	2	1		Y	Y	Y	Y		1400	80	155	Y
UWC Newport	2914	4941	2	1		Y	Y	Y	Y		1000	100	155	Y
UW Institute Cardiff	5624	1918	4	1		Y	Y	Y			1500	100	155	Y
UW Lampeter	1357	713	1	1	Y			Y	Y		350	100	2	
UW Swansea	8122	2067	2	1	Y	Y	Y	Y	Y	Y	3500	99	155	Y
WCMD	497	35	1	1							100	100	10	Y
WFC	-		1	1							100	100	64 kbit/s	

* Sources: HE Early Funding Statistics 1998/99 - Table A5
FE Early Student Enrolments 1998/99 - Table 1

Usage Questionnaire Findings

3.15 Most of the equipment in FECs has been acquired to gain an understanding of issues in videoconferencing or to take forward specific projects. Use to date has been primarily in these contexts but the experience is such as to have generated interest and enthusiasm. Three colleges in particular stand out in this respect, having gone on to translate enthusiasm into active commitment: Pembrokeshire; Pontypridd, and CCTA. All are making regular use of videoconferencing. One of the main concerns of all colleges in relation to further development is, however, the cost of call charges associated with an ISDN based service.

3.16 Members of the C5C HE video network have been making extensive use of studio based videoconferencing for teaching, research and administration for the past 10 years and it is this facility that has helped to establish the strong culture of videoconferencing in HE in Wales. The facility is in use up to 15 hours a week. Figures by category of use for 1998/99 are shown in the table below.

C5C Network: Usage 1998/99

Category of usage	Videoconferencing hours	Number of Videoconferences
Administration	1,344.5	674
Teaching	1,246.5	651
Other	257.5	168
Totals	**2,848.5**	**1,493**

Examples of usage by category

Administration: Meetings between different departments or groups in different institutions.
Teaching: Teaching/seminars between institutions.
Others: Demonstrations or testing.

3.17 Institutions in both sectors, FE and HE, were keen to develop or extend their use of videoconferencing, particularly for teaching and learning purposes. They saw opportunities in this area in a number of directions: in-house for teaching between sites and for distance learning; and within and across sectors for collaborative work, including research collaborations.

3.18 Those HEIs for which franchising or outreaching provision formed a major element in their strategy for widening access are concerned to have good quality video links to their franchise partner or collaborating institutions. They viewed such links as material in strengthening teaching relationships between staff and increasing the commonality of the learning experience among students. Institutions in both sectors were alive to the opportunity video affords for maintaining or extending provision efficiently and economically in small but significant areas of the curriculum. Welsh and Welsh medium teaching were frequently cited examples in this context where, in relation to the former, a requirement for simultaneous translation facilities was also identified. These were also considered to be important for facilitating bilingual meetings.

3.19 From the WFCs' perspective, videoconferencing facilities on the premises and connected to the network will greatly facilitate meetings inside and outside the sectors and offer the opportunity for both improved communications and significant cost savings.

3.20 Three concerns in particular ran alongside the general interest and enthusiasm for video development: that the facilities should be reliable and easy to use; that there should be an efficient and effective booking system, again easy to use; and last, but not least, that usage costs should be affordable. In this last context, the costs of calls for dial up based (ISDN) services was a matter of general concern.

4 THE PROPOSED VIDEO NETWORK

4.1 It is apparent from the usage survey data in Section 3 that the principal immediate and general requirement is for high quality videoconferencing facilities suitable for meetings and learning and teaching applications. In seeking to meet this requirement, however, it will be important to be mindful of, and make provision for, other needs. Examples of such needs are data and applications sharing. Needs in these areas exist at present and are likely to grow in proportion to the collaborations facilitated by the network.

4.2 The key elements in meeting the videoconferencing requirement are: the underlying technology; the technology support equipment; the studio environment and equipment; and the management and support arrangements. The proposals put forward address all these elements against the background set out in Section 3 and taking account of further considerations of a strategic, technical and financial nature. The proposals are set out below by element, preceded by a summary of the factors which bore on them.

The Underlying Technology

4.3 The factors here were:

- consonance with the JANET Video Strategy - the technology selected should be consistent with the strategic objective ultimately to provide video services over the network.
- consistency - the same technology should be deployed in both FE and HE to facilitate linkages and operation.
- stability - the technology should be sufficiently well established to operate reliably.
- long term currency - the technology should have sufficient longevity to provide continuity of service in a rapidly changing environment.
- scalability - the technology should be readily capable of supporting expansion of services.
- economy - the technology should secure an affordable, value for money service.

4.4 A range of technical options was considered in relation to the factors set out in 4.3 above. They were ISDN; ISDN/IP hybrid; ATM; leased lines; and satellite. One emerged as the clear and obvious choice: ISDN/IP hybrid. The issues posed by the options which did not involve ISDN were technical and financial in nature and are explored in detail in Appendix 7.

4.5 The ISDN/IP hybrid is Level 1/2 in terms of the JANET Video Strategy model outlined in Section 2, paragraph 2.3. As such, it can be classified as a narrowband solution. ISDN is well established, proven technology in relation to videoconferencing while IP is developing rapidly to the point where, in 12 or so months, it, too, may be viewed in similar terms. The equipment used with both technologies is substantially the same.

4.6 While IP lacks the maturity of ISDN, it is leading edge technology, network based and readily scalable. The network base means that it is consistent both with the objective of the JANET Video Strategy and with the focus of development effort in the commercial market. It also means very significant cost savings: unlike ISDN, IP carries no call charges.

4.7 Experienced users of videoconferencing will wish to take early advantage of the cost savings and of the opportunity, once again, to explore and exploit the potential of a leading edge network. Under this proposal they may do so confident in the knowledge that they will continue to have ISDN as a fall back as well as for use for conferences outside the JANET community. Those with little or no experience may use the tried and tested IDSN technology and switch readily to IP when it is more firmly established in a year or so. From this point of view, the proposal is one which has long term currency.

4.8 Quality using both technologies will be comparable, particularly if ISDN is deployed using six rather than two channels, i.e. if ISDN6 rather than ISDN2 is used. ISDN6 is, coincidentally, the most effective way of deploying ISDN.

It is recommended that:

- **the video network established is a hybrid, using both ISDN and IP technologies;**
- **in relation to ISDN, facilities are provided to support ISDN6.**

4.9 Section 3, paragraph 3.20, draws attention to the fact that the cost of calls associated with ISDN is a matter of general concern. For those institutions using IP, substantially HE, the concern will largely disappear: they will only need to have recourse to ISDN for conferences with groups outside the JANET community. For others, substantially in FE, which lacks the tradition and culture of videoconferencing apparent in HE, the concern will remain and be likely to prove a major impediment to use. In these circumstances, to encourage initial take up of the service, it is recommended that a central call charge budget be established for users in FE, with a budget quota allocated to each FE college.

It is recommended that a central call charge budget be established for FE with a budget quota allocation to each college.

The Technology Support Equipment

4.10 The salient factors here were economic provision and rapid deployment.

4.11 Conferences between more than two sites - multipoint conferences - are facilitated by specific pieces of equipment: multipoint control units (MCUs). Such equipment for ISDN based conferences is in place and use at the JANET Videoconferencing Service (JVCS). To avoid the high capital and recurrent costs of making dedicated MCU provision in Wales, it is recommended that the JVCS equipment is used to support multipoint conferences over the Welsh network. This approach would also serve rapid deployment in that there would be no need to install and commission new equipment or to train staff in its operation and management.

4.12 IP based conferencing calls for a distinct type of MCU and these units require strategic placement on the network in order to control traffic to avoid congestion. IP MCUs will need to be installed as will gateways to allow interaction between the IP and ISDN networks. While the IP MCUs will have to be placed on the Welsh network, the gateways can be located with the ISDN MCUs. There would be savings in the recurrent charges associated with ISDN usage in doing this.

It is recommended that:

- **equipment (MCU) support for the ISDN service is provided from the JANET Videoconferencing Service;**
- **gateways to link the IP and ISDN networks are co-located with the ISDN support equipment at the JANET Videoconferencing Service.**

The Studio Environment Equipment

4.13 The factors here were:

- quality - a studio environment established and maintained at standards conducive to effective communication
- standardisation - standard equipment to assist inter-working and well informed support
- value for money - high quality equipment at lowest cost

4.14 The nature of the studio environment will vary from site to site depending on the requirements of local users and local environmental conditions, e.g. room location. However, there are a number of important requirements that all studios will need to satisfy in order to provide a successful videoconferencing environment. Detailed guidance on the videoconferencing room environment is provided in Appendix 8.

4.15 The studio environment has a significant effect on the success of video conferences: small problems that local participants in a video conference may not notice can have a detrimental effect at remote sites. Quality assurance (QA) testing on the JVCS has proved very successful in improving the quality of conferences and acceptance of regular testing of this type should be expected.

It is recommended that studios on the Welsh Video Service Network successfully complete quality assurance tests at commissioning stage and at regular intervals after.

4.16 Certain items of equipment can be specified as a basic functional starting point for a quality videoconferencing environment depending on the size of the studio and the uses to which it is it be put. The items include:

- CODEC to encode the outgoing signals and to decode the incoming signals;
- camera;
- microphones;
- two large monitors, to show both received and transmitted pictures;
- document camera, to enable documents or transparencies to be displayed both locally and over the network;
- high resolution projector and screen to enable the use of electronic documents, application sharing, graphic presentations and WWW based materials;
- PC to drive the projector and to facilitate other forms of video applications;
- VCR to enable the play out of video recordings or the recording of conferences;
- components for interconnection;
- amplifier and loudspeakers;
- audio mixer;
- appropriate network connections.

4.17 Paragraph 4.1 above indicates the importance of making provision for needs other than videoconferencing that exist at present and are likely to become more significant as collaborations develop. Examples of such needs are data and application sharing and video streaming. The projector, screen and PC included in the package of basic items listed are intended specifically to address these needs.

4.18 There are a number of advantages in equipment being of the same type throughout the network: guaranteed inter-working between site systems; simplification of central support; sharing of experience and through it, the creation of a pool of knowledge; and, not least, the prospect of substantial discounts from bulk procurement.

It is recommended that:

- **equipment for each studio is provided in the form of a standard basic package according to studio size and intended use;**
- **equipment is centrally purchased in accordance with standard EU procedures for public procurement.**

4.19 There is one other issue relating to studio equipment. Paragraph 3.18 in Section 3 indicates the interest in an English/Welsh dimension to video services provision. There are specific technical reasons that make such a dimension particularly problematic; these are explained in detail in Appendix 9. A detailed technical and operational specification could be undertaken separately if English/Welsh support were thought to be essential.

The Management and Support Arrangements

4.20 The factors here were practised management; well informed, easily accessible support for the roll out and day to day operation of the service; and efficient, easy to use booking facilities.

4.21 The central management requirements for the proposed video network can be broken down into three distinct areas:

- day to day operation of the video network;
- support for sites in constructing suitable studio environments; installing, configuring and operating the equipment; training local managers and trainers in videoconferencing and passing on best practice;
- overall project management.

Day to Day Operation

4.22 Day to day operation of the video network falls into two sub categories: management of the ISDN videoconferencing service and management of the IP videoconferencing service. Paragraph 4.11 recommends that, for ISDN based videoconferencing, sites make use of the current JVCS. Management of the IP videoconferencing service needs, initially, to be undertaken from a point on the Welsh video network. From this point of view, it would be advisable to establish a Welsh Videoconferencing Management Centre.

4.23 Management centres are required to undertake a large number of tasks. These are outlined below and it would fall to the Welsh Videoconferencing Management Centre to fulfil them in relation to the IP based service.

- configuring, operating and maintaining the MCUs that provide multipoint videoconferencing;
- interfacing with a booking system so that conferences can be configured as required;
- configuring, operating and maintaining gateways between different videoconferencing technologies, for example between IP and ISDN based videoconferencing;
- running regular quality assurance tests to ensure that registered sites meet a minimum acceptable standard of operation;
- monitoring the network to ensure that capacity is not exceeded and that when faults occur, that they are dealt with effectively and efficiently;
- providing support to sites experiencing problems with videoconferences;
- liaising with other agencies and manufacturers of equipment to resolve operational issues.

4.24 Paragraph 4.5 above indicates that IP is developing rapidly as a technology to the extent that it is likely to become firmly established as the standard in a year or so. This being the case, there may not be a long term need for a service dedicated to supporting the Welsh network. Initially, however, such a service would be critically important.

Site Support

4.25 Successive videoconferencing installation projects have demonstrated the need for support for sites in constructing suitable environments, configuring and operating equipment and training. Support of this type is important in both FE and HE but is perhaps critical in FE where, generally, experience is more limited and, in many cases, there is only one person to provide all the technical support needs of the institution.

4.26 The existing FE Support Centres in Wales have established very good working relationships with the FE colleges to which they provide technical support. The operational model has proved to be very successful and is one that might usefully be built on in the context of the videoconferencing network. An additional member of staff at each of the two existing Centres would serve to facilitate the deployment and operation of the video network in both the FE and HE communities.

Overall Project Management

4.27 Overall project management from the outset is required in order to

- undertake a procurement for equipment
- manage operational and support contracts
- take overall responsibility for deploying the video network within a given timescale
- liaise with suppliers to ensure equipment functions correctly
- liaise with the user community to obtain feedback and identify and resolve any problems.

It is recommended that:

- **a Welsh Videoconferencing Management Centre is established to manage the IP based video service and that the continuing requirement for the Centre is assessed 18 months from the start of service operation;**

- **an additional member of staff is appointed at each of the two existing FE Support Centres for up to two years in the first instance to serve the deployment and operation of the video network in both the FE and HE communities; and that the continuing requirement for both posts is reviewed 18 months from the start of service operation;**

- **an overall Project Manager is appointed at the outset of the project.**

Booking Facilities

4.28 The effectiveness and ease of use of the booking system will directly influence the extent of the take up of videoconferencing. It is therefore important that users of the network can book videoconferences without having to worry about the technical details.

4.29 The JVCS has developed an on-line booking system with a web based interface. This system provides one central location where all bookings for JANET videoconferencing services can be made directly and straightforwardly. There are significant advantages to having a single national booking system and development of any other booking systems would be both costly and time consuming. The system does, however, require to hold details, inter alia, of studio availability: the corollary of joining the JVCS booking service is that sites would be required to register their studios and details of their availability on a daily basis.

It is recommended that the Welsh Videoconferencing Network make use of the JANET Web based videoconferencing booking service.

5 SERVICES OTHER THAN VIDEOCONFERENCING

5.1 The proposed network will be, in essence, a narrowband videoconferencing operation. However, it will provide an enabling infrastructure to support other video applications that are becoming increasingly significant. A number of these applications are described briefly below.

Video Streaming

5.2 Video streaming is the technique of transmitting video programmes via the network in real time, rather than by file transfer methods. The programme content may be either live material or, more usually, stored content from a video archive. Strictly speaking, the term could apply to the full range of digital video resolution and bandwidth. However, in common usage, it most often applies to low resolution, low bit-rate video, usually in conjunction with Web based user interfaces. Support for this type of operation is implicit in the general network connectivity provided by an IP network, but the potentially high aggregate bandwidth may require special planning considerations, particularly in the vicinity of archive servers.

IP Multicast

5.3 IP multicast is a transmission technique for IP traffic which provides efficient transmission of IP packets to multiple receivers without replication. It has been used extensively for teleconferencing applications and for `broadcast' transmission from live events, such as conferences. IP multicast is fully supported by the JANET network although sites must opt in to this service. Sites must also provide a multicast infrastructure within their intra-organisational networks and, in some cases, this requires the deployment of specific multicast routing systems that are separate from the site's unicast routers.

Broadband Video Applications

5.4 Broadband video applications are an area of emerging interest at the national level. Applications currently under study by UKERNA in this area include:

- broadband videoconferencing, such as that in use over the Scottish MANs;
- video contribution, which supports the transfer of programme material at production quality between JANET sites, or between JANET sites and the external media;
- video distribution, including the emission of programme material originated at JANET organisations and the re-distribution of programme material originated elsewhere and received either by satellite downlink or terrestrial wired or Radio Frequencies (RF) service;
- broadband video archive applications.

5.5 As these new services are developed, it will be possible to mount pilot scale trials within broadband sections of JANET and other connected networks, e.g. MANs. Some of these potential services are of interest only to a minor subset of the organisations connected to JANET. For example, contribution services will be of value only to those organisations engaged in video production.

6 RECOMMENDATIONS

TECHNOLOGY AND SUPPORTING EQUIPMENT

1 The video network established is a hybrid, using both ISDN and IP technologies.

2 In relation to ISDN, facilities are provided to support ISDN6.

3 Equipment support (Multipoint Control Units) for the ISDN service is provided from the JANET Videoconferencing Service; and parallel support for the IP service is provided from a Welsh Videoconferencing Centre.

4 Gateways to link the two service networks are co-located with the ISDN support equipment at the JANET Videoconferencing Service.

STUDIO ENVIRONMENT AND EQUIPMENT

5 Studios on the Welsh Video Service Network should successfully complete quality assurance tests when commissioned and at regular intervals afterwards.

6 Equipment for each studio is provided in the form of a standard basic package according to the size of the studio and its intended use.

7 Equipment is centrally purchased in accordance with standard EU procedures for public procurement.

MANAGEMENT AND SUPPORT

8 A Welsh Videoconferencing Management Centre is established to manage the IP based video service; and the continuing requirement for the Centre is assessed 18 months from the start of service operation.

9 The JANET Videoconferencing Service provides management support for the ISDN service.

10 An additional member of staff is appointed at each of the two existing FE Support Centres for up to two years in the first instance to serve the deployment and operation of the video network in both the FE and HE communities; and the continuing requirement for both posts is reviewed 18 months from the start of service operation.

11 An overall Project Manager is appointed on a fixed term basis for approximately two years at the outset of the project.

12 The Welsh Videoconferencing Network should use the JANET Web based videoconferencing booking service.

OTHER

13 A central call charge budget is established for FECs with a budget quota allocation for each college.

7 INDICATIVE COSTS

7.1 It should be noted that costs can only be indicative as equipment and prices in this sector change rapidly. In addition, there could be significant cost savings through European Journal procurement for the required equipment.

7.2 While it is highly recommended that all equipment is purchased centrally under European Procurement Procedures to ensure cost effectiveness, there are other compelling reasons for central procurement of equipment. The main reason is compatibility and interworking between systems. Beyond this, purchasing all equipment centrally also reduces the costs associated with support and maintenance: given identical equipment across all studios, the Welsh Videoconferencing Management Centre and the Support Centres will be able to provide quality support and assistance directly. These measures will significantly reduce the load on sites where, potentially, one person will carry responsibility for all aspects of videoconferencing in addition to other responsibilities.

7.3 Sites with substantial experience in videoconferencing may wish to opt out of a centrally procured solution. In this case sites should be allowed to procure their own auxiliary equipment. However, it is highly recommended that CODECs are procured centrally to limit interoperability and management problems in the roll out of an IP service. Sites that opt out of the central procurement of equipment will also have to take on the support, maintenance and training requirements for their systems as it is neither practical nor economic for the Welsh Videoconferencing Management Centre to try to support equipment from a variety of manufacturers and connected in different configurations.

7.4 The costs shown in the table overleaf are divided into capital costs and recurrent annual costs. Capital costs are broken down into several sub headings detailed below.

Studio Equipment Costs

7.5 There are two sections of studio equipment costs depending on the size of the studio and the applications required. For small group meetings of up to ten people, the first set of equipment is appropriate. For larger group meetings, or teaching applications with room for up to thirty people, additional equipment is required as detailed. Total costs are shown for the projected number of each type of studio. A discount of 15% has been included for EU procurement. However, a higher level of discount may be available. It will not be possible to determine the potential level of discount in advance.

Contribution to Other Studio Costs

7.6 This section has allocated £10K to each studio to go towards the cost of providing a satisfactory high quality videoconferencing environment. This budget is allocated to provide curtains, lighting improvements, furniture, air conditioning where necessary, sound insulation and other work that may be required to bring the studio up to an acceptable standard.

Central Equipment

7.7 This section lists all the equipment necessary to provide the IP videoconferencing service. This service will provide very significant cost savings as it eliminates call charges for videoconferences.

Router Upgrades to Support Quality of Service (QoS)

7.8 In order to support an IP videoconferencing service and other new video applications, it will be necessary to upgrade current routers within the network. Current routers, particularly at FE sites, are now over four years old and do not have significant life left in them. This upgrade will allow for higher bandwidth connection to sites as well as support of QoS functionality.

Overall Project Management

7.9 Overall project management will play a key role in ensuring the success of the project. Overall project management will be required to undertake the procurement for equipment and manage the contracts for the Welsh Management Centre and Support Centres. The project management will be responsible for ensuring that the project runs within the prescribed timescales and stays within the agreed budget. They will report directly to the WFCs on a regular basis.

Project Roll Out Support Costs

7.10 These costs are to finance two dedicated members of staff to support the deployment of facilities across both the FE and HE sector, but with a particular emphasis on providing support to FE. These two staff members will provide direct support in the deployment of studios, giving help and advice with installation, configuration and operation of equipment. They will also provide help in training facilities managers and other trainers.

Welsh Management Centre

7.11 These costs are divided into two sections. The first is the cost for the operation of the Management Centre; the second is the cost of maintenance of central equipment. Operating costs are based on two full-time members of staff.

Central Call Charge Budget

7.12 This is a recommended budget for call charges for FECs. It will be centrally administered and based on a quota based system for each site.

Total Indicative Costs

7.13 Total indicative costs are shown for capital and recurrent over three years. Year three costs are shown as zero on the assumption that IP will have become the UK standard by that time and that operating costs will be included at this level. VAT has been applied only to appropriate capital components of costs.

BREAKDOWN OF INDICATIVE COSTS

Capital costs for studio equipment including VAT and assume a 15% EU procurement discount.
Capital costs for central equipment and routers include VAT.

Capital Costs	£
Studio Equipment (Small group max 10)	
H.320 (ISDN 6) / H.323 CODEC	10,750
Remote control, pan/tilt/zoom CCD camera	1,550
4 microphones	800
2 monitors for picture display	1,250
Document camera	3,600
Sound mixer	850
Projector and screen	4,100
AV fittings (wall brackets, cabinets and stands etc)	1,050
Amp and loud speakers	500
S-VHS VCR	600
PC for data and application sharing	1,550
ISDN installation	700
Total Equipment Cost (Meeting Facility)	**27,300**
Number of Small Facilities	**5**
Total Capital Costs for Small Facilities	**136,500**
Additional Studio Equipment	
(Larger Group Meeting/Teaching Facility max. 30)	
Second camera	1,550
7 extra microphones	1,450
1 tie clip microphone	500
Electronic whiteboard	850
2 confidence monitors	500
Additional sound mixer	1,550
Total Equipment Costs (Larger Group Meeting/Teaching Facility)	**33,700**
Total Number of Larger Group Meeting/Teaching Facilities	**38**
Total Capital Cost for Larger Facilities	**1,280,600**
Total Capital Costs of Equipment for all Facilities	**1,417,000**
Contribution to Other Studio Costs	
Curtains, lighting, furniture, air conditioning, sound insulation	10,000
Total number of studios	43
Total Contribution to Other Studio Costs	**430,000**
Central Equipment	
4 H.323 MCUs	117,500
2 H.320 - H.323 gateways	58,750
Gatekeeper software	47,000
Gatekeeper platforms	70,500
Network monitoring equipment	3,500
Infrastructure connectivity	11,750
Total Capital Cost of Central Equipment	**309,000**
Router Upgrades to Support QoS	**188,000**

Recurrent Annual Costs	£
Overall Project Management	
Overall project management	40,000
Project Rollout Support Costs	
2 FTEs for FE Support Centres	80,000
Welsh Management Centre	
Welsh Management Centre	60,000
Maintenance of central equipment	30,000
Central Call Charge Budget	
Central call charge budget: FE	150,000
Total Recurrent Costs	**360,000**

Summary

Total Capital Cost Year One	**2,344,000**
Total Capital Costs Year Two	**0**
Total Capital Costs Year Three	**0**
Total Recurrent Costs in Year One	**360,000**
Total Recurrent Costs in Year Two	**360,000**
Total Recurrent Costs in Year Three	**0**
Total Costs Year One	**2,704,000**
Total Costs Year Two	**360,000**
Total Costs Year Three	**0**

Year three costs are shown as zero on the assumption that IP videoconferencing will become the UK standard by this time and that operating costs will be included at this level.

8 REFERENCES

1 C & IT for Collaborative and Distance Learning in HE in Wales: HHEW/UWVCB Joint Working Party Report, August 1998.

2 The JANET Video Strategy:
http://www.ja.net/service-development/video/strategy/index.html

3 Review of the Scottish MANs Videoconferencing Network:
http://www.ja.net/video/service-development/manvc

APPENDIX 1 MEMBERS OF THE TECHNICAL STUDY TEAM

Name	Background
Robert Ash, University of Wales, Aberystwyth	Robert is the Special Projects Manager in Information Services at University of Wales, Aberystwyth. He manages the FENET support team based at Aberystwyth. He contributes to all technical planning initiatives in IT and liaises with external organisations.
Syngen Brown, UKERNA	Syngen is a member of the UKERNA Video Development Team and has recently been responsible for investigating the options of providing video services other than videoconferencing over JANET.
Paul Down, University of Newcastle	Paul is Manager of the JANET Videoconferencing Advisory Service and Director of the University of Newcastle upon Tyne Audio Visual Centre.
Henry Hughes, UKERNA	Henry is UKERNA's Video Development Manager, in his role he is responsible for the development of new video services on JANET.
Jim Leitch, University of Edinburgh	Jim is Manager of the JANET Videoconferencing Management Centre and Operations Manager within the Edinburgh University Computing Service.
Christine Lewis, Pembrokeshire College	Christine is IT Manager at Pembrokeshire College.
Tony Ollier, University of Wales, Swansea	Tony Ollier is Deputy Director of Library and Information Services responsible for all Networking, Systems and Telecommunications at the University. He is also Head of FENET support team and member of the South Wales MAN management board.
David Price, University of Wales, Aberystwyth	David is a senior member of the University of Wales, Aberystwyth Computer Science Department and has experience of developing IP Videoconferencing Solutions. He is currently a member of the UKERNA PIPVIC (Piloting of IP VideoConferencing) project.
Robert Symberlist, University of Wales, Swansea	Robert is the Network Multimedia Consultant at the University of Wales Swansea, where he is developing video streaming and videoconferencing services. He is a member of the South Wales MAN Board and Development Group.
Henry Thompson, Cardiff University	Henry has many years background in data communications. Henry is in charge of wide-area networking at Cardiff University with key emphasis on the South Wales MAN and on video-conferencing.

The study team would also like to acknowledge and thank Steve Williams and Chris Price from the University of Wales, Swansea and Hefin James from the University of Wales, Aberystwyth for their enthusiasm and diligence whilst undertaking many of the site visits, and Enid O'Shea for arranging the FE visits from the University of Swansea.

Steve Williams is a network engineer with the University of Wales Swansea and is responsible for the networks connecting the South Wales FENet colleges to the Internet. He has some 7 years experience of systems and networking in both FECs and HEIs.

Chris Price is the FENET Support Officer on the Communications team at the University of Wales, Swansea. His background is in Network Management. His duties include the administration of the UNIX systems and JANET connectivity for each of the FENET member colleges in South Wales.

Hefin James is the FENET Support Officer in the Networking Team in Information Services at University of Wales, Aberystwyth. His experience includes three years working for Dyfed County Council supporting IT in schools and four years as the FENET Support Officer.

APPENDIX 2: NETWORK ASPECTS OF VIDEO SERVICE PROVISION

For the support of narrowband video applications in a wide area network setting, three network technologies may be considered.

Asynchronous Transfer Mode (ATM)

ATM is a network technology based upon the switching of small fixed length (53 byte) packets known as cells. ATM is connection oriented and provides both switched and permanent virtual circuits (SVCs and PVCs). In either case, once a connection is established between two endpoints, traffic between these points follows the same path.

ATM uses statistical multiplexing. However guaranteed QoS may be provided on a deterministic basis, in particular providing controlled latency and delay variance.

A number of ATM Adaptation Layers have been defined, each optimised for the provision of particular types of network service. For video service the most important types are AAL1 and AAL5.

AAL1 supports transmission of constant bit rate payloads with recovery of the sending clock at the receiver, emulating circuit based interfaces such as the PDH hierarchy. AAL1 is used for both narrowband and broadband video services within a broadband network environment, e.g. the ATM adaption of H.320 systems over ATM (operating at up to 2 Mbit/s) and various broadband video transport systems operating at up to 34 or 45 Mbit/s.

AAL5 supports variable bit rate transmission where there is no time correlation between sender and receiver. AAL5 is limited to single sequential cell streams and simple point-point service. It is used widely for native ATM video transmission systems operating in variable bit rate modes. Examples include M-JPEG and MPEG-2 based broadband video systems.

ATM forms the basis for the majority of current broadband network initiatives, e.g. in MANs and in SuperJANET. It readily provides the means of implementing multi-service broadband networks with provision of guaranteed QoS. ATM may be used as a carrier for IP networks. However, it is losing popularity in this application in favour of more efficient options employing native IP transmission over Wide Area links.

IP Network Transport

Internet Protocol is a connectionless protocol and provides no guarantee of end-to-end packet delivery. Employing a reliable transport layer, e.g. TCP, ensures guaranteed delivery. However, as this relies on retransmission of lost packets, it is not suited to real-time multimedia transport. Audio and video transmission over IP therefore employs a low overhead unreliable network service (e.g. UDP), and other measures are necessary to reduce the impact of congestion effects.

Congestion is an inevitable feature of IP networks, and its main effects, which contribute to impairments of audio and video quality, are packet loss and delay variation. Packet loss has effects ranging from mild distortions of audio and video to complete loss of communication. Effort on reducing the incidence and impact of congestion is currently concentrated on the application of alternative queuing strategies within IP routers. These developments include general strategies to increase the proportion of traffic delivered successfully (e.g. Random Early Detection and Weighted Random Early Detection) and mechanisms of service differentiation in which real time traffic is favoured over other traffic. These measures, applied singly or in combination, will provide some degree of QoS assurance but cannot provide absolute guarantees.

Integrated Services Digital Network (ISDN) Network Transport

The term ISDN normally refers to the narrowband ISDN service based on 64 kbit/s channels, as provided by a number of public telecommunications operators. Two ISDN presentations predominate: Basic Rate Interface (BRI) provides two 64 kbit/s bearer channels and a further 16 kbit/s channel for call signalling; Primary Rate Interface (PRI) provides up to thirty 64 kbit/s channels and a further 64 kbit/s channel for call signalling. BRI and PRI use different physical interfaces and equipment supplied for one type of interface cannot normally be used with the other type. For H.320 videoconferencing equipment, it is conventional to use three BRI circuits to provide the six channels required for operation at 384 kbit/s.
The nature of this technology is to form a star topology with central MCUs. This is cost effective in the deployment of ISDN capacity into a central location. For calls within the United Kingdom, the charging model for ISDN calls follows that of normal telephone calls, therefore, once outside the radius of local call charges, there is no additional cost incurred by locating the MCUs anywhere within the UK.

Latency

In distributed video, two sources of latency must be considered: delay in end-to-end network transmission; and delay attributable to computational processes involved in video and audio compression. Transmission delay may normally be disregarded for both ATM and ISDN - one exception being where satellite transmission is involved. In IP networks, transmission delay may be significant. However it is generally the case that the second-order effect of delay variation is of greater concern than absolute delay. Delay variation is normally eliminated by buffering in the receiver and this contributes further to the total delay involved in a communications system. Processing delay is a particular problem of video compression, both as a result of pure computation and of the intrinsic need to buffer several frames at the sender in the case of some video compression techniques. Since audio processing involves little or no compression, it is subject to a much smaller delay compared to that of video processing. It is usual to insert a further artificial delay in the audio signal path to maintain synchronisation of audio and video.

The effect of latency is essentially dependent on whether the application is interactive or non-interactive. In interactive communication, latency results in an appreciable loss of fluency characterised by the emergence of a stilted conversational style punctuated by uncertain pauses. For general two-party voice communication, ITU-T Recommendation G.114 sets an upper limit of 400ms for mean one-way propagation delay. For comfortable multi-party conversation, it is necessary to limit delay to approximately one-half of this value and ideally to a cumulative one-way delay of less than 150ms. Even if this latter figure is achieved, the delay will still result in the phenomenon known as talker echo, where a speaker hears a delayed echo of their own voice as it is picked up from a loudspeaker at a remote location and relayed over the network. This effect, known also as delayed auditory feedback, is most disconcerting and renders verbal communication impossible. It may largely be suppressed by use of acoustic echo cancellers, although it is often possible to hear occasional echo even when these are used.

APPENDIX 3: VIDEOCONFERENCING TECHNOLOGY

Overview of ITU-T Recommendations for videoconferencing and related applications

ITU-T Recommendation H.320

Recommendation H.320 provides a technical specification for videotelephony and videoconferencing systems operating at network bit rates up to 1920 kbit/s, or 30 channels. Suitable line circuits include ISDN (basic or primary rate interfaces) or private circuits. In practice, H.320 systems are most commonly operated at 384 kbit/s (six 'B' channels or three ISDN BRI circuits) and 128 kbit/s (two 'B' channels, or a single ISDN BRI circuit). The majority of installed ISDN videoconferencing systems conform to the H.320 Recommendation.

Video Encoding

All H.320 terminals are required to support Recommendation H.261 at QCIF resolution (176 x 144 pels), which corresponds to level 1 of the UKERNA model. Systems operating at a maximum network bit rate of 128 kbit/s, for example many desktop implementations, are often restricted to QCIF operation. Most room systems and rollabouts support operation at 384 kbit/s or greater, and also support H.261 at CIF resolution (352 x 288 pels). The standard provides a maximum frame rate of 30 Hz, which may be reduced by ignoring up to three frames between each frame transmitted. Most CODECs are capable of operation at a 15 Hz frame rate. Recent systems also support H.263 video encoding, which is of particular benefit for low bit rate operation.

Audio Encoding

Support of G.711, the basic audio encoding standard for digital telephony, is mandatory for all H.320 terminals. However, as the output bit rate of G.711 is 64 kbit/s, and this may account for a large proportion of the total bandwidth available at low bit rates, it is desirable that other audio encoding formats are supported by H.320 equipment. G.722 provides a 7 kHz commentary quality audio channel at a bit rate of 48 kbit/s. G.728 offers the same frequency response as G.711 (300-3400 Hz), but encodes this for transmission in a 16 kbit/s channel.

Data Transmission

Ancillary data from other applications may be transmitted according to Recommendation T.120. Examples of supported applications include graphics transmission, shared workspaces and transmission of documents.

Multiplexing and Control

H.221 defines the frame structure used for data transmission. This assumes the use of a network having guaranteed quality of service. Bandwidth may be allocated dynamically to audio, video and data, in increments of 8 kbit/s. There is an overhead of 1.6 kbit/s per 64 kbit/s channel, for frame alignment and the bit-rate allocation signal, which describes the content of the payload.
Recommendation H.230 specifies the control and indication signals that are used by H.320 systems. The communications protocol for point to point operation is specified in H.242, which also operates over the H.221 frame structure.

Multipoint Operation

H.320 terminals operate in point to point mode over peer to peer connections. Support of multipoint conferences, i.e. conferences involving three or more participants, requires terminals to connect to an MCU, as specified in Recommendation H.231. The communications protocol for MCU conferences is specified in Recommendation H.243.

ITU-T Recommendation H.321

Recommendation H321 addresses the use of H.320 equipment in an ATM network environment. Two reference configurations are outlined. Existing H.320 systems may be used in conjunction with a broadband terminal adaptor, which provides AAL, ATM and physical network interface functions. Alternatively, these functions may be integrated in a single unit along with the usual functions of a H.320 system.

The use of H.321 adopts the audio, video and multiplexing and control aspects of the H.320 Recommendation, and accordingly provides operation at equivalent levels. Since the H.221 multiplexing scheme assumes the use of a reliable constant bit rate bearer, AAL1 is used as the ATM adaptation layer. Interoperation between H.320 and H.321 terminals is provided using the general arrangements for interoperation between narrowband ISDN and ATM specified in Recommendation I.580.

A broadband terminal adaptor may also be used to connect H.231 MCUs to an ATM network. This enables H.321 systems to participate in H.320 multipoint conferences.

ITU-T Recommendation H.323

Recommendation H.323 specifies equipment and services for packet-based multimedia communication over networks which do not provide a guaranteed quality of service. Examples of Local Area Networks (LANs) of this type include Ethernet (IEEE802.3), Token Ring (IEE802.4), Fast Ethernet (IEEE802.10) and FDDI.

Video Encoding

The video CODEC is an optional feature in a H.323 system. However, it is a specific requirement for videoconferencing. Where video support is provided, support of H.261 QCIF is mandatory, whilst H.261 CIF and any of the H.263 formats may optionally be supported. If H.263 is supported at CIF or higher resolutions, then H.261 CIF and H.263 QCIF must also be supported.

Audio Encoding

All H.323 systems are required to support G.711 audio. In addition, any combination of G.722, G.723.1, G.728, G.729 and MPEG-1 (ISO/IEC 11172) audio may optionally be supported.

Data Transmission

H.323 supports user data applications using T.120 services. It is also possible to utilise the general data transmission capabilities provided by the LAN interface and associated protocol stacks.

Multiplexing and Control

Video, audio, data and control signals are multiplexed according to the stream packetisation model of Recommendation H.225.0. This makes use of Real-time Transport Protocol/Real-Time Transport Control Protocol (RTP/RTCP), although this usage is not dependent upon the use of TCP, UDP or IP as the transport layer. RTP/RTCP facilities are used to monitor QoS parameters and a number of strategies may be used to adapt dynamically to changes in network conditions, providing at least an orderly degradation of service. Although it is not possible to provide absolute guarantees of service, facilities are provided to enable the user to determine that quality problems are the result of congestion on the local LAN. H.225.0 requires that both reliable (e.g. TCP) and unreliable (e.g. UDP) services are provided by the LAN interface. The unreliable service is used for the audio and video channels. The reliable service is used for data transmission, control and call signalling.

Additional system control functions are provided according to the control protocol for multimedia communications specified in Recommendation H.245.

Gatekeepers

An optional facility in the deployment of H.323 services is the gatekeeper. This is an entity in H.323 which provides address translation, access control, bandwidth control and other management facilities on behalf of H.323 endpoints. Gatekeepers are logically separate from other H.323 entities, although their physical implementation may be co-located with a terminal, gateway, MCU or other LAN device.

Gateways

A key feature of H.323 is its intrinsic support for interworking with compatible services carried over switched communication networks. The gateway is a H.323 entity, which is connected both to the LAN and a switched communication network, and provides the necessary translation between encoding formats, transmission multiplexes and communications protocols. Not all instances of gateway operation will require translation at all these levels. The use of common encoding formats for audio and video avoids the requirement for transcoding between formats. For example, a H.320-H.323 gateway may rely upon the negotiation of mutually compatible audio and video formats, but must still translate between the H.221 and H.225.0 multiplexes, between the H.242 and H.245 control protocols, and between Q.931 and the call signalling part of H.225.0.

Multipoint Operation

H.323 provides facilities for multipoint operation in centralised, decentralised and hybrid modes. The functions enabling multipoint operation are logically separated into two units: the Multipoint Controller (MC), which oversees the control functions of a multipoint conference, and the Multipoint Processor (MP), which performs processing of media streams, for example the mixing and/or switching of audio and/or video. The MC and MP functions may be implemented, either singly or in combination, in dedicated MCUs, or co-located with gatekeepers or gateways. The MC may also be co-located with a terminal.

Support of centralised mode is required in all H.323 terminals and gateways. In this mode, point to point connections are made between terminals and the MC and MP entities. The connection between the terminal and the MC carries the control channel and that between the terminal and MP carries audio, video and data channels. With the exception of the logical distinction between the MC and MP, this mode is generally analogous with the operation of a H.320/H.231 MCU.

In decentralised operation, terminals also operate a point to point control channel to an MC. However, audio and video channels may be multicast to other endpoints in the conference. The MC has control over which terminal or terminals are actively multicasting these channels.

Hybrid multipoint configurations are possible using a combination of centralised audio with decentralised video, or vice versa.

APPENDIX 4: USAGE QUESTIONNAIRE AND SITE SURVEY FORM

UKERNA Questionnaire

Requirements for networked video activities including videoconferencing, in FECs and HEIs in Wales: a study for the Welsh Funding Councils.

Please take the time to complete the following questionnaire. Your answers will influence the future development of networked video facilities throughout the Welsh Further and Higher Education sectors.

1	Name of College / Institution:
2	Contact Name and Position: Postal address: Telephone: E-mail:
3	Type of Organisation: FEC / HEI / Other (Please describe) General / Specialised (Please indicate specialisation) Please indicate any formal links with other institutions or federal bodies (e.g. University of Wales) How many discrete sites comprise the institution?
4	The following are examples of video communication technologies. Please indicate which are in current use and those which you anticipate will be introduced within the next eighteen months: Videoconferencing ☐ ☐ Video/Media Servers (e.g. video archives, video playout-on-demand) ☐ ☐ Video Distribution (e.g. redistribution of satellite or broadcast TV signals within an institution) ☐ ☐ Video Production ☐ ☐ Other networked video applications (please describe) ☐ ☐

Currently **Anticipated**

5 Please indicate the areas in which videoconferencing is currently used in your institution and those which you anticipate to see developing over the next 18 months.

	Currently	Anticipated
Lectures (the use of videoconferencing to address large groups of students)	☐	☐
Tutorials (the use of videoconferencing for remote tutorials)	☐	☐
Other teaching (e.g. demonstrations, alternatives to field trips or site visits etc.)	☐	☐
Pastoral care, counselling	☐	☐
Research: collaboration and project management	☐	☐
Research: dissemination of results	☐	☐
Consultancy and commercial activities	☐	☐
Administration and organisational management	☐	☐
Staff training (general)	☐	☐
Staff training in the use of videoconferencing or demonstrations of videoconferencing	☐	☐
Participation in remote events (e.g. traditional conferences held elsewhere)	☐	☐
Interviewing (e.g. candidates for employment, vivas)	☐	☐
Use of facilities by third parties	☐	☐
Others (please describe)		

6 Please indicate the forms of videoconferencing activity currently taking place in your organisation, and those that you expect to see introduced in the next eighteen months.

	Currently	Expected
Within your college or institution, including geographically dispersed locations	☐	☐
Between your college or institution and the homes of your staff or students	☐	☐
With other academic institutions within the UK	☐	☐
With commercial organisations, government agencies and other organisations within the UK	☐	☐
With organisations of any type outside the UK	☐	☐

7

For the activities described below please indicate the current level of videoconferencing usage, using the following scale.

5 More than 4 hours per day or 20 hours per week
4 2 – 4 hours per day or 5 – 20 hours per week
3 2 – 5 hours per week
2 1 – 5 hours per month
1 Less than 1 hour per month
0 None

	5	**4**	**3**	**2**	**1**	**0**
Lectures (the use of videoconferencing to address large groups of students)	☐	☐	☐	☐	☐	☐
Tutorials (the use of videoconferencing for remote tutorials)	☐	☐	☐	☐	☐	☐
Other teaching (e.g. demonstrations, alternatives to field trips or site visits etc.)	☐	☐	☐	☐	☐	☐
Pastoral care, counselling	☐	☐	☐	☐	☐	☐
Research: collaboration and project management	☐	☐	☐	☐	☐	☐
Research: dissemination of results	☐	☐	☐	☐	☐	☐
Consultancy and commercial activities	☐	☐	☐	☐	☐	☐
Administration and organisational management	☐	☐	☐	☐	☐	☐
Staff training (general)	☐	☐	☐	☐	☐	☐
Staff training in the use of videoconferencing or demonstrations of videoconferencing	☐	☐	☐	☐	☐	☐
Participation in remote events (e.g. traditional conferences held elsewhere)	☐	☐	☐	☐	☐	☐
Interviewing (e.g. candidates for employment, viva)	☐	☐	☐	☐	☐	☐
Use of facilities by third parties	☐	☐	☐	☐	☐	☐
Others (please describe)						

8

Over the next eighteen months, do you expect use of ***videoconferencing*** facilities in particular your college or institution will: (please circle)

Decrease substantially	Decrease slightly	Stay about the same	Increase slightly	Increase substantially

9	Under the following headings, please briefly describe the types of applications for which video communication technology, other than videoconferencing are used in your institution. In the absence of any current activity please outline any likely usage to be introduced in the next eighteen months to two years. Applications in teaching and learning Applications in research activities Applications for management or administration activities
10	Over the next eighteen months, do you expect that general use of ***video communication*** facilities, excluding videoconferencing facilities, in your college or institution will: (please circle) Decrease substantially / Decrease slightly / Stay about the same / Increase slightly / Increase substantially

Thank you for taking the time to complete this questionnaire

Please return to: Henry Hughes, Video Development Manager, UKERNA, Atlas Centre, Chilton, Didcot, Oxfordshire, OX11 0QS

Or

Fax for the attention of Henry Hughes to 01235 822399

Thank-you

WELSH VIDEO STUDY
SURVEY OF ALL FECs AND HEIs IN WALES

1 General Information

1.1 Date:

1.2 Institution:

1.3 *Site:

**A separate report sheet is required for each separate site.*

1.4 **Other relevant sites:

**Please list geographically separated campuses or departments.

1.5 Contact Persons (preferably one main contact per site).

1.6 Are there currently videoconferencing facilities within the institution suitable for group teaching /meetings? **YES/NO**

1.7 How many hours a week are the facilities used on average? **HOURS**

1.8 Are there sites that the institution regularly connects to on a monthly, or more frequent, basis from this facility? If yes please give details.

1.9 If the answer to question 1.6 is NO, have room(s) been identified as potential videoconferencing areas? **YES/NO**

1.10 Is the institution registered with the JANET Videoconferencing Switching Service(JVCSS) at Edinburgh? **YES/NO**

2 Videoconferencing Facilities

2.1 Room

**A separate report is required for each conference room surveyed.*

2.1.1 Building:

2.1.2 Room number or name:

2.1.3 Is the Building listed **YES/NO**

2.1.4 Category **1 or 2**

2.1.5 Location:

2.1.6 Is security adequate? **YES/NO**

2.1.7 Is access suitable for persons with a physical disability? **YES/NO**

2.1.8 Size (l x w x h, in metres):

2.1.9 maximum seating capacity:

2.1.10 Shape of room:

2.1.11 Ambient noise (identify sources of noise):

2.1.12 Windows:

2.1.13 Air Conditioning:

2.1.13.1 Is it dedicated to this room or part of the building air handling system?

2.1.14 Heating:

2.1.15 Lighting:

2.1.16 Décor (include furniture):

2.1.17 AC Power:

2.1.18 Acoustics:

2.1.19 Particular problems that would need to be addressed to bring up to recommended specification:

2.2 Equipment (C5C)

2.2.1 Is the room equipped with C5C* facilities? **YES/NO**
**See Appendix A*

2.2.2 Have the C5C facilities been modified in any way? Please describe:

2.2.3 Is the CODEC located in a separate room? **YES/NO**

2.3 Other Videoconferencing Equipment

Manufacturer Model Number

2.3.1 CODEC/Rollabout system:
2.3.1.1 Software Version:
2.3.1.2 Networks supported by CODEC: **ISDN/ATM/ IP/ VIDEO**
Other network supported:

2.3.2 Ancillary Equipment (If not supplied as part of the videoconferencing system above):
Manufacturer Model Number

2.3.2.1 Television Camera:

2.3.2.2 Microphones:

2.3.2.3 Document Camera:

2.3.2.4 Scan Converter:

2.3.2.5 Picture Monitors:
2.3.2.5.1 Screen diagonal size:

2.3.2.6 Data/Video Projector:

2.3.2.7 Audio Mixer:
2.3.2.7.1 Does the mixer offer automatic switching/mixing: **YES/NO**

2.3.2.8 Video Mixer/Switcher:

2.3.2.9 Other Equipment:

2.3.2.10 Are data and application sharing facilities available? If so please give details.

2.4 Where several rooms are connected for conferencing.

2.4.1 How far apart are the rooms?

2.4.3 If a central CODEC is in use how are the connections made to the conferencing rooms? **Optical Fibre/Category 5 Cable/Coaxial Cable.**
Other:

3 Desktop Videoconferencing Systems

3.1Does the institution have desktop videoconferencing systems? **YES/NO**

If YES, approximately how many units does the institution have?

3.2 Please assign percentages to the types of system that the institution has.

ISDN-2	%
IP-Multicast	%
H.323 (IP)	%
ATM	%
Analogue	%
Other	%

3.3 What is the manufacturer, model and software version of the majority of the systems?

3.4 Are data and application sharing facilities available? If so please give details.

3.5 How many hours a week on average are the facilities used?

Section 4 Other video activities

4.1 Are there any Audio/Video streaming products in use within the institution? If yes please give details.

4.2 Is there a central video production facility run by AV or Media Services within the institution? If yes please give details.

4.3 If the answer to 4.2 is YES, are they responsible for videoconferencing facilities? Please give details.

4.4 Does the institution have a School / Department of Media / Television studies? If yes please give details.

Section 5 Network Information

5.1 What types of network are available within the Institution?
Shared Ethernet/Switched Ethernet/10Mbit/s/100Mbit/s/ GBit/s/Token Ring/ FDDI/ Wireless systems. Please provide brief details of infrastructure.

5.2 Approximate number of PCs within the institution.

5.3 Percentage of these PC which are attached to the institutions network. **%**

5.4 Details of institutions JANET router.

5.4.1 Manufacturer:
5.4.2 Model:
5.4.3 OS Version:

5.5 Does the institution have a JANET multicast feed?

5.6 Is the Institution PBX capable of distributing digital signals to individual rooms?

5.7 What networks are accessible to a potential videoconference room?

5.8 How would ISDN-6 be installed in a potential videoconferencing room?
Service Provider direct connection e.g. BT / Connection to PBX

5.9 How far away is the nearest convenient network point from a potential videoconference room?

5.10 If ISDN is in use is there a central patching facility? **YES/NO**

APPENDIX A

C5C Basic Facilities List

Equipment Cabinet:
Single CCD television camera with zoom lens (Panasonic?)
Single CCD television tamera with fixed focus lens (Panasonic?)
BT designed core switching/control unit, 19” rack mounted
Shure M267 audio mixer
BT audio echo canceller VC3033
27” Sony Trinitron colour picture monitors, quantity 3
JVC VHS video recorder HRD 560EK

BT CODEC, model:BT2300 (Could be located outside of conference room)

BT designed overhead camera unit:
Remote control of camera zoom/focus, 35mm slide projector ON/OFF, slide change, Platen light ON/OFF.
Black and white 4” picture monitor
Kodak Carousel 35mm slide projector, SAV 1050
Sony three chip CCD television camera DXC 325P fitted with Fujinon 10:01 zoom lens, model: A10-10BMD-D8

Ancillary equipment:
Sony three chip CCD television camera DXC 325P fitted with Fujinon 10:01 zoom lens, model: A10-10BMD-D8
Shure Boundary Layer microphones, model: SM91, quantity 2
BT designed wooden conference table
White board on stand

APPENDIX 5: INSTITUTIONS' GEOGRAPHIC LOCATION AND INTERCONNECTION

FECs in Wales

Connection table for FECs in Wales

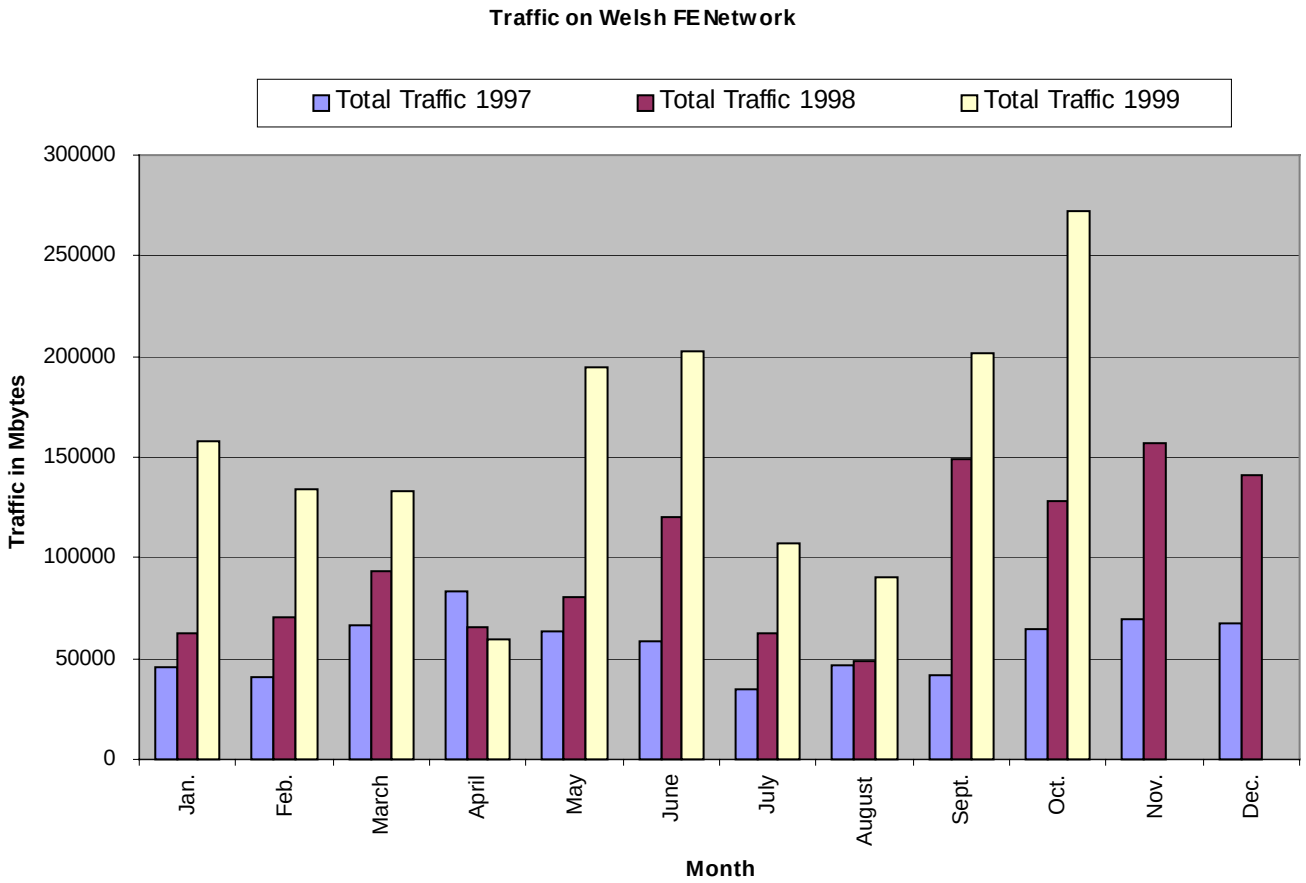
University of Wales Swansea:	Aberdare College Bridgend College Carmarthen College Gorseinon College Merthyr Tydfil College Neath Port Talbot College Pembrokeshire College Pencoed College Swansea College
Cardiff University	Barry College Glan Hafren College Gwent College Pontypridd College St Davids College Ystrad Mynach College
University of Wales Aberystwyth	Ceredigion College Harlech College Meirion Dwyfor College Powys College
North East Wales Institute	Welsh College of Horticulture Yale College Llysfasi College Deeside College
University of Wales Bangor	Menai College Llandrillo College

HEIs in Wales

Connection table for HEIs in Wales

Cardiff BEN -	SWMAN			
	SWMAN	University of Glamorgan		
		University of Wales Institute Cardiff		
		University of Wales Swansea		
		University of Wales Swansea	University of Wales Lampeter	
			Trinity College Carmarthen	
Swansea Institute of Higher Education		Welsh College of Music and Drama		
		University of Wales College Newport		
		Cardiff University		
		Cardiff University	University of Wales Aberystwyth	
			University of Wales College of Medicine	
			Welsh College of Music and Drama	
			Welsh Funding Councils	
Manchester Computing Centre BEN		Manchester Computing Centre		
		Manchester Computing Centre	NEWI	
			NEWI	Bangor

APPENDIX 6: TRAFFIC STATISTICS FOR FE SECTOR 1997 - 1999



	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Total Traffic 1997	45391	41115	66217	83027	63855	58634	34344	46670	42192	65030	69263	67147
Total Traffic 1998	62820	70832	93415	65603	80802	119998	62240	48282	148928	128452	157110	141062
Total Traffic 1999	158017	134242	133109	59358	195142	202752	107554	90776	201172	272558	~	~

APPENDIX 7: TECHNICAL OPTIONS CONSIDERED

Use of Satellite Technology

The study group was specifically requested to assess the use of satellite technology for videoconferencing.

Satellite transmission is essentially an asymmetric broadcast technology. It is well suited to applications where programme output from a single station is to be delivered to a large number of receivers. It is particularly practical where the number of receivers is in the order of hundreds or thousands and the receivers are distributed over a very wide geographical area, or in regions without highly developed terrestrial telecommunications infrastructures.

Previous use of satellite technology in conferencing applications has been confined to two application scenarios. The first of these uses a single satellite uplink at an originating centre from which the primary output is broadcast. This broadcast may comprise any combination of live and recorded programme material. ISDN-based videoconferencing is then used to provide a `backchannel' for interaction, with the backchannel content redistributed to all receivers via the primary (satellite) link. In typical usage, this scenario is limited to providing support for questions or brief comments, in a manner analogous to floor contributions in a conventional single-venue event. In this type of operation, it is often the case that only a subset of the receiving sites are equipped for interaction. The second application scenario involves the use of a send/receive (uplink/downlink) terminal at the conference sites. One variation of this approach is to provide a satellite gateway to an H.320 videoconferencing network. These configurations are used as a last resort technology, for example to vessels at sea or terrestrial locations where suitable wired services cannot be provided. It is believed that almost all inhabited locations of the United Kingdom may be served through fixed terrestrial services (cable or RF) at lower cost than duplex satellite solutions.

The typical cost of a Ku-band VSAT uplink, similar to types used for Satellite News Gathering (SNG) operations, is in the region of £80K. However, a complete Ku-band receive-only terminal, including receiver and decoder, may be obtained for less than £1000. More recently there has been more interest in use of the higher frequency Ka-band for bi-directional satellite-based communication, including telephony and multimedia. However, this market is at an early stage of development.

It is concluded that the use of satellite transmission systems does not provide a cost effective option for the proposed services.

Leased Lines

The group has considered the use of leased lines for H.320 videoconferencing. This approach has been used successfully for the C5C network. There are two options involving leased lines: the first is to follow the model of the C5C network, i.e. build a separate network on dedicated leased lines; the second is to build a separate leased line network by dedicating some capacity from current network connections to each site.

Option 1

This option would require dedicated leased line connections into all sites in Wales and effectively mean building a separate network alongside the current JANET connections to each site. All of these dedicated leased line connections would need to be brought together in a number of locations in Wales, each of which would need an MCU. Each MCU would then need a leased line connection to a central MCU. A minimum of three MCUs would be required at a cost of £200k to £250k each. The option would provide a videoconferencing network but would not provide support for other emerging video applications, such as video streaming, which need IP based network infrastructures. The option would not scale up easily and resilience would be difficult to provide. All in all, it was concluded that this option would be uneconomic and, moreover, unsatisfactory in terms of its overall capability.

Option 2

This option would use part of the bandwidth available on existing or projected 2Mbit/s access circuits to sites. It would require the installation of an add/drop multiplexor (multiplexor/demultiplexor) at each terminal site. Using

the scheme described in ITU-T Recommendation G.704, only 1920kbit/s (30x 64kbit/s channels) of the 2048kbit/s is available for payload traffic. 64kbit/s is reserved for common channel signalling and the rest is lost to framing overhead. The bit rate for good quality multipoint H.320 operation is 384kbit/s. This leaves only a nominal 1.5Mbit/s available for the general Internet service. It is possible to provide dynamic allocation of bandwidth, but this would require IP routers to be equipped with multichannel line interfaces at significant additional cost.

A further difficulty arises from there being multiple points for the network-side termination of leased lines. It would be necessary to provide some 64kbit/s circuit switching capacity at each of these network service points. It would also be necessary to provide additional circuit-based transmission between these network service points and a central location housing further circuit switching capacity and an H.320 MCU. A gateway between the private network and the ISDN, would also need to be provided with the ability to dial-out to the JVCS and other external videoconferencing locations.
Taking all considerations into account, alongside the cost of the additional equipment and circuits required, it was concluded that this option would not be cost-effective.

ATM

Currently ATM services are only available to sites connected to the SWMAN. Extension of ATM services might be possible in the short to medium term if all sites were connected to MANs. However, at present, the option of providing videoconferencing via ATM to MAN connected sites would create two different types of videoconferencing infrastructure: ATM services to support MAN sites and a different form of infrastructure to support non-MAN sites. There would then be a need for gatewaying facilities between the two technologies. The approach would increase the support and operational and maintenance costs of the video service as a whole.

There are a number of products that could be used to implement videoconferencing services over and ATM network. The Cellstack product as used on the Scottish MAN Video Network is well proven but has a significant drawback in the amount of network bandwidth it uses for each conference: each conference uses 25 Mbit/s and this severely limits the extent to which the service could be scaled, given current costs of bandwidth and current levels of provision. Another product is available from FVC and this provides videoconferencing at a lower bandwidth. However, neither of these products is fully standards compliant and, in order to operate, both require signalling to be implementing on ATM networks.

The conclusion is that using ATM is not a cost effective option. Beyond this, however, the strategic direction of videoconferencing development is seen to lie in IP rather than ATM services.

APPENDIX 8: ROOM ENVIRONMENT

It is impossible to prescribe exhaustive specifications to cover all possible variations of room layout and physical characteristics and all types of meeting or teaching activity. For the purposes of the following illustration, it is assumed that a room is used in a multipoint meeting with a small group of local participants.

LIGHTING AND DÉCOR

Careful attention must be paid to lighting and interior decor, both for the optimum operation of cameras and video compression systems and for the comfort and safety of the participants. Fluorescent or other low pressure discharge lighting is usually employed, preferably using broad spectrum polyphosphate tubes possessing a high colour rendering index. The use of high frequency control gear will provide more uniform performance over the lifetime of the lamps, with some improvement of illuminating efficiency. Incandescent lamps are not favoured, for reasons of the higher power consumption and thermal emission. Backdrops should be of neutral unsaturated colour and uniform texture. Saturated colours and patterns or textures reduce the efficiency of video compression and result in poorer image quality. The impact of backgrounds and other surfaces on room acoustics should also be considered.

NOISE, SOUND INSULATION AND ROOM ACOUSTICS

Audio is usually the primary medium for communication within videoconferences and thus largely determines the overall success of a conference. In the room environment, attention must be paid to the exclusion of extraneous noise. Noise may be generated by moving parts such as fans, discs and tape transports; by AC traction coils in relays and contactors; and by the laminations of transformers or chokes, especially in lighting equipment. An ideal solution is to house equipment in a separate cubicle. Air conditioning systems are another frequent source of noise. General purpose building services are often inappropriate for the videoconferencing environment, and large volume low velocity air handling systems are preferred. Noise may also enter by conduction from adjacent rooms or structural members, or by flanking transmission through floor or ceiling voids. It should be remembered that noise will find its way through the smallest hole in a floor, wall or ceiling. Particular attention should be paid to doors, which should ideally be fitted with compression or magnetic seals. Door furniture is another source of intermittent, and therefore distracting, noise. Door catches should be avoided and door closers should be of the type with damped final closing stroke.

Room acoustics require an equal degree of attention. Rooms should be of proportions avoiding the creation of standing waves, i.e. it should not be possible to express the ratio of the room dimensions in small integers. To avoid flutter echoes, reflective surfaces such as vision panels and television monitors should not be positioned in mutually adjacent or directly opposite situations. If an extensive reflective surface is unavoidable, it should be angled so that it is not parallel to another extensive flat surface or, failing that, the opposite surface should be faced with an acoustic treatment such as sculptured acoustic tiles or modular resonators. Such cases may require the services of an acoustician or architect specialising in acoustics.

Layout and Seating Arrangements

Whilst it is possible to seat the participants along one side of a table, this arrangement does not provide the most efficient use of space and does not promote effective discussion amongst the local participants. A more satisfactory arrangement is to seat the local participants in an arc or obtuse wedge formation, providing mutual gaze between local participants. Providing multiple ranks of seating is also efficient in space usage, although it suffers from the problem of restricted face-to-face contact between participants seated one behind the other. Despite this shortcoming, this approach is popular as it permits the space to be used for larger meetings without compromising its function for smaller groups, where the participants occupy a single rank.

Cameras, Video Switching and Monitors

The room size and layout determine the requirements for cameras, display monitors, microphones and loudspeakers. Where all participants face approximately in the same direction, it will usually be possible to provide coverage with a single camera. This camera should be provided with remote control of motorised pan, tilt, zoom and focus. In some cases a second wide angle camera may be used to provide a general view. This may be provided with a fixed focal length wide angle lens and a static manually adjusted mounting. However, providing the same degree of remote control as the first camera has many advantages in flexibility. Many remote control camera systems permit presets to be stored and recalled. In more elaborate systems, microphone gating may be used to trigger the recall of particular presets: speaking into a particular microphone will cause the camera to home in on the current speaker. At least one type of system has been marketed which attempts to position the camera according to the direction of a sound source picked up by highly directional microphones. However, these systems do not perform well in practice due to interaction with room acoustics.

A document camera is an essential facility within the videoconferencing room environment. These units comprise a small camera mounted on a rostrum above a baseboard upon which a document, transparency, radiograph or small solid object may be placed. Usually a choice of reflection and transmission lighting is provided, for display of opaque documents and transparencies respectively.

Switching between different video inputs may be effected internally to the CODEC, or an external video switch may be used. If an external switch is used, all sources should be synchronised and the switch should employ vertical interval switching. This ensures that the switching transition occurs during the blanking interval of the video signal and avoids picture disturbances when switching between sources. Synchronisation of sources, or genlocking, requires that a reference signal is provided to each camera. The reference signal may be obtained either from one of the cameras, or preferably from a separate synchronising pulse generator.

Some CODECs support the transmission of stacked images, where two discrete pictures are multiplexed and displayed one above the other, in a manner reminiscent of the popular television light entertainment programme "University Challenge". This mode is advantageous when it is necessary to display a larger number of participants, or when room layout prevents all participants being covered by a single camera.

Video monitors must be provided so that all participants are able to view comfortably at all times. The most common configuration uses pairs of monitors in which one displays the incoming remote image and the second displays the outgoing picture. The size and positioning of monitors is closely related, the optimum viewing distance being between four and six times the height of the screen. Care should be taken to avoid glare from lighting. Where multiple pairs of monitors are required to provide uniform viewing conditions over the entire seating area, distribution amplifiers are used to fan-out the signal. Looping the signal through successive monitors is to be avoided, both because of signal degradation and the possibility of lines being incorrectly terminated if units are added to or removed from the chain. In some installations small preview monitors may be used to assist in lining up images before switching or to aid in the placement of materials beneath a document camera.

Microphones, Loudspeakers and Echo Cancellation

The microphones most often used are of the boundary layer type. These are typically low profile units placed directly on the table before the participants, although they may be affixed to any convenient adjacent flat surface. These microphones are particularly unobtrusive and do not require the user to be trained in microphone technique. Since the microphone capsule is positioned very close to the plane of the table or other surface, the problem of interference between the direct sound wave and its reflection from the table surface is eliminated. In normal microphone placement, this interference results in an irregular frequency response, an effect known as comb filtering. One disadvantage of boundary layer microphones is their susceptibility to picking up extraneous noise caused by behaviours such as table tapping or by the use of cups and saucers. Boundary layer microphones used for videoconferencing should be of the hemispheric polar response type, in which the sensitivity is reduced for sounds originating to the rear of the microphone.

Loudspeakers are normally used for output of the received audio signal. It will be necessary to employ an acoustic echo canceller to reduce talker echo. Most contemporary CODECs include integral echo cancellers. However, these may prove inadequate for complex acoustic environments or configurations where a large number of microphones are in use. In these cases the use of external echo cancellers will be necessary. Echo

is avoided entirely by using headphones or headsets for audio but most users find this solution unacceptable. If facilities are to be provided for people with hearing impairments, induction loop systems may be used. These systems are used in conjunction with hearing aids set to the `T' position.

Data and Application Sharing

There is an increasing requirement for data and application sharing in the videoconference studio environment. There are a number of possible solutions to this requirement: data transmission may be supported either using a multiplexed media component in-band to the conference circuit or stream, as in the case of ITU-T Recommendation T.120, or by using general IP facilities provided by the network infrastructure. It is also possible to display computer graphics output within the video component, either by using a scan converter or computer graphics adaptor having an output suitable for presentation to the CODEC. However, the low resolution of narrowband videoconferencing restricts the level of detail that may be effectively communicated in this way. There will also be a requirement to display computer graphics output for the benefit of the participants assembled in the local studio. This may be achieved using strategically placed multiple high resolution monitors, or by using a high resolution projector. Projectors suffer from the disadvantage that the ambient light levels required for optimum contrast conflict with the lighting requirements of video cameras, and careful planning and positioning will be required to avoid mutual detriment.

Miscellaneous Requirements

It is essential that a telephone be provided in the conference studio, and also in any separate equipment room. Telephone instruments should have their internal ring facilities turned off and a ring detection relay and illuminated sign should be used to signal an incoming telephone call.

Some conference audio systems provide a facility whereby a telephone call may be added to a conference, or a group audio teleconference may be conducted to remote locations over the PSTN. In facilities provided with high quality audio and acoustics, the installation of a separate ISDN audio CODEC will enable the studio to be used for remote contribution to public radio broadcasters.

It is extremely useful to have an illuminated "mic live" warning sign. This alerts all participants to the current status of microphone muting.

In the case of some large theatre installations where there is a significant requirement for the co-ordination and direction of staff, a technical intercom system may be required.

Requirements for Teaching and Larger Groups

Requirements for teaching use are largely determined by the teaching scenario. For teaching with small groups, the requirements are largely similar to those for meetings described above. However, there will usually be local students within the same studio as the lecturer, and it usual to arrange for the lecturer to be facing this local audience. This will probably require the use of an additional camera and an additional pair of (smaller) monitors that may be seen from the lecturer's position or lectern.

Other video origination facilities may be required in the teaching environment. 35mm transparencies may be displayed using a slide visualiser. This often takes the form of a slide magazine transport similar to that of the Kodak Carousel or Ektapro projectors, but having a video camera instead of a lens system. Some document cameras also offer the facility of displaying a 35mm transparency, but such facilities are generally suited only to the display of one or two slides. Fuji offer a compact imaging device for positive or negative film of up to 6x9 cm format. This is unique in that composite and YC video interfaces are provided as well as the digital interface which is normally used for digitising still images on film. Videotape players may be used to replay material from recordings. Machines with integral time base correction are recommended as these may be genlocked and produce stable video output which is less susceptible to perturbations arising in the video coding process. There is some interest in using whiteboard capture systems which image a drawing on a whiteboard surface.

Microphone coverage of large audiences is particularly difficult. One possibility is to employ a multiple microphone system, with each audience position provided with individual microphone and floor request button. These systems are often installed in council chambers or conference centres but may be prohibitively expensive for many educational organisations. The traditional lecture scenario involves a much lower level of participant

interaction than most meetings and in practice the occasional requirement for floor participation may be served by a small number of handheld microphones.

For teaching or other presentation activities, lavalier microphones are useful. These comprise small electret capsules mounted on a clip attached to the user's clothing, or suspended on a lanyard worn around the neck. Wireless versions of lavalier microphones may be of value in cases where restriction of movement is to be avoided. Handheld wireless microphones also find application in lecture theatres where blanket microphone coverage is impractical and a microphone must be passed around for floor questions or contributions. In large theatres where there is considerable movement, fading and distortion caused by multipath effects may occur. These may largely be avoided by using diversity reception, in which more than one aerial and receiver system is employed.

In large theatres the simple dual monitor model described above may be inappropriate. There will be a requirement for the lecturer to monitor student reaction at remote sites, perhaps using the chairman control mode of the MCU to manually select a remote site. The lecturer will also need to see the transmitted video at all times on a confidence monitor. However, there may be little benefit in displaying both of these images on the main monitors at all times, and there is probably a requirement for the independent selection of the video signal to be displayed on these monitors. In many larger theatres, the video display system will be combined with general facilities for the display of video tape or other programme sources and it is therefore desirable that all video requirements are integrated in a single system, possibly under the control of one of the proprietary AV control systems (e.g. AMX or Crestron).

APPENDIX 9: SUPPORT FOR BILINGUAL AUDIO

The normal audio channel carries either English or Welsh, depending on the language currently being used within the conference. In addition to the normal audio media component of the videoconference, two additional audio channels are required: one channel for English language translation and one for Welsh language translation.

Currently available videoconferencing systems of the type recommended for the proposed service do not offer multiple audio channels and the ISDN H.320 standard does not provide any option for this capability. While the IP H.323 standard may be implemented with multiple audio channel support, it is believed that such a facility will not be offered in hybrid ISDN H.320/ IP H.323 systems. It would therefore be necessary to deploy additional dual mono audio CODECs.

Commercially available audio CODECs for ISDN networks are available for a number of audio formats, the most popular being G.722, MPEG-1 Layer II and the proprietary apt-X 100 standard. These systems do not support the H.221 transmission multiplex and therefore will not interoperate directly with remote videoconferencing systems and MCUs. It would therefore be necessary to provide a separate audio CODEC and additional ISDN line at all locations where dual language support is required. Multipoint operation is not supported and it would be necessary to provide multiple CODECs if support of multi-site bilingual conferences were required.

In addition to the cost of audio CODECs, there are a number of further costs associated with this option. Firstly it would be necessary to equip rooms with headphones and headphone distribution systems. It would also be necessary to provide acoustically isolated cubicles for interpreters to work in. Interpreters would be provided with headsets, and additional video monitors might be required in the translation cubicles. The additional hardware costs are estimated at approximately £2500 per site, plus approximately £100 per headphone listening position. The cost of building works and additional furniture would also be significant.

There are a number of further technical and practical considerations for further study. The preparation of a detailed technical and operational specification would be undertaken in the event of any specific requirement for this option.

GLOSSARY

AAL	ATM Adaption Layer.
ATM	Asynchronous Transfer Mode.
BEN	Backbone Edge Node.
BRI	Basic Rate Interface (of ISDN).
C&IT	Communication and Information Technology.
C5C	University of Wales Videoconferencing Network.
CIF	Common Interchange Format. A H.261 frame format having a resolution of 352 x 288 picture elements.
CODEC	COder/DECoder. A hardware or software processor converting between analogue audio or video and the digital format used for transmission, in both directions. The term is also used to describe the major hardware component of a videoconferencing system.
Echo Canceller	A device inserted into the signal path between the CODEC and the conference room audio system. Its purpose is to reduce, as far as possible, the delayed retransmission of incoming audio which would otherwise cause a disruptive echo effect at remote sites.
Ethernet	A high speed local area network using CSMA/CD. It was developed jointly by Xerox, Intel and Digital Equipment Corporations.
FDDI	Fibre Distributed Data Interface. A 100 Mbit/s American National Standards Institute standard for LAN architecture.
FE	Further Education.
FECs	Further Education Colleges.
FEFCW	Further Education Funding Council for Wales. http://www.niss.ac.uk/education/fefcw/
G.114	ITU-T Recommendation for one way transmission time.
G.711	ITU-T Recommendation for 8 bit 8 kHz mu-law or A-law PCM, for voice grade transmission, (300-3400 Hz), encoded in 56 or 64 kbit/s. The principal encoding for digital telephony.
G.722	ITU-T Recommendation for a commentary quality (7 kHz) audio channel carried in 48, 56 or 64 kbit/s.
G.723.1	ITU-T Recommendation for a dual rate speech coder for multimedia communications transmitting at 5.3 and 6.3 kbit/s.
G.728	ITU-T Recommendation for speech coding at 16 kbit/s using low-delay code excited linear prediction (LD-CELP).
G.729	ITU-T Recommendation for speech coding at 8 kbit/s using conjugate-structure algebraic-code-excited linear prediction (CS-ACELP).
Gateway	A system providing interoperability services between two or more networks.
H.221	ITU-T Recommendation for the frame structure used by H.320 systems.
H.225.0	ITU-T Recommendation for a packet multiplex over LANs which provide a non-guaranteed quality of service.
H.230	ITU-T Recommendation for the signalling used by H.320 systems.
H.231	ITU-T Recommendation specifying multipoint control units for multipoint conference involving H.320 systems.
H.242	ITU-T Recommendation describing the control protocol used by H.320 systems.

H.243	ITU-T Recommendation for a control protocol for multipoint conferences.
H.245	ITU-T Recommendation for a control protocol for multimedia communications. This is used in H.323 and H.310.
H.261	ITU-T Recommendation for video encoding in narrowband audiovisual systems.
H.263	ITU-T Recommendation for video coding optimised for use at bit rates lower than those typically used with H.261.
H.320	ITU-T Recommendation for narrowband videoconferencing systems (operating at up to 2 Mbit/s).
H.321	ITU-T Recommendation for adapting H.320 systems to operation over ATM networks.
H.323	ITU-T Recommendation for packet-based multimedia communication services, including videoconferencing.
HE	Higher Education.
HEFCW	Higher Education Funding Council for Wales.
HEIs	Higher Education Institutions.
HHEW	Heads of Higher Education in Wales.
I.580	ITU Recommendation for interworking between narrowband ISDN and ATM.
IP	Internet Protocol.
ISDN	Integrated Services Digital Network; a set of communications standards allowing a single wire or optical fibre to carry voice, digital network services and video.
ISDN2	Integrated Services Digital Network operating using 2 ‘B’ channels (128 kbit/s).
ISDN6	Integrated Services Digital Network operating using 6 ‘B’ channels (384 kbit/s)
ITU	International Telecommunications Union.
ITU-T	The ITU branch concerned with international standardization of telecommunications.
JANET	The UK’s Academic and Research Network; the computer communications infrastructure linking UK Higher Education, Further Education and Research organisations. JANET is the trademark of the Higher Education Funding Councils for England, Scotland, and Wales. http://www.ja.net
JISC	Joint Information Systems Committee of the Higher Education Funding Councils for England, Scotland and Wales, and the Department of Education for Northern Ireland.
JVCS	JANET Videoconferencing Service.
LAN	Local Area Network.
MAN	Metropolitan Area Network.
MC	Multipoint Controller (In H.323 and H.247).
MCU	Multipoint Control Unit. A central switching and control device for videoconferences involving more than two participating terminals.
Motion-JPEG	The application of JPEG picture encoding to video, where each successive frame is encoded as a discrete picture.
MP	Multipoint Processor. A functional component of multipoint support in H.323 and H.247. It is responsible for the processing of media streams, typically the mixing or switching of audio or video.
MPEG-1	ISO/IEC 11172. ``Coding of Moving Pictures and Associated Audio for Digital Storage Media at up to about 1.5 Mbit/s.''
MPEG-2	ISO/IEC 13818. ``Generic Coding of Moving Pictures and Associated Audio Information.''

PDH	Pleisochronous Digital Hierarchy.
PIPVIC	Piloting of IP Videoconferencing (UKERNA project).
PIPVIC-2	Piloting of IP Videoconferencing two a follow on project.
PRI	Primary Rate Interface (of ISDN).
PVC	Permanent Virtual Circuit.
Q.931	ITU-T Recommendation for ISDN user-network signalling.
QA	Quality Assurance.
QCIF	Quarter Common Interchange Format. A H.261 frame format having a resolution of 176 x 144 pels.
QoS	Quality of Service.
Resolution	This refers generally to the ability of an imaging system to faithfully reproduce detail in the original subject. In a digital video or graphics system it may be expressed simply as the number of discrete horizontal and vertical picture elements (or pixels) in the digitized image. It may also be expressed as the maximum resolvable spatial frequency in either cycles per linear unit, or MHz. For a video system, it may be expressed in terms of TV lines, or more correctly, the number of TV lines per picture height. It should be noted that for video systems, horizontal and vertical resolution are generally not equivalent.
RF	Radio Frequency.
RTCP	Real Time Control Protocol.
RTP	Real Time Protocol.
SDTV	Standard Definition Television.
SMVCN	Scottish MANs Videoconferencing Network.
SuperJANET	The core or backbone of the JANET network.
SVC	Switched Virtual Circuits.
SWMAN	South Wales MAN.
T.120	ITU-T Recommendation specifying protocols for data transmission in multimedia systems.
TAU	Technical Advisory Unit.
TCP	Transmission Control Protocol.
Token Ring	A type of local area network based on a ring topology. Token passing is used to control transmission onto the ring.
UDP	User Datagram Protocol.
UKERNA	United Kingdom Education and Research Networking Association.
VCAS	Videoconferencing Advisory Service.
VCR	Video Cassette Recorder.
WAN	Wide Area Network.
WelshNET	University of Wales Videoconferencing Network.
WFCs	Welsh Funding Councils.
WWW	World Wide Web.