

The VITI program: *Final Report*

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Abstract

In this report we present our findings and results from the VITI program in 2000. The focus of the research work undertaken by VITI has been to provide electronic meeting environments that are easy to use and afford as natural a collaboration experience as possible. This final report is structured into three parts. Part one concerns the VITI infrastructure and consists of two sections. The first section describes the process of establishing the infrastructure, concentrating on *how* the work was done. The second section presents the actual infrastructure that is in place today, concentrating on *what* has been put in place. Part two examines the use the VITI infrastructure has been put to, giving examples of activities it has supported and discussing strengths and weaknesses that have emerged through this use. Finally part three considers the future of distributed electronic meeting environments. It is recommended that the report be read in the order in which it is presented. However, each section has been written as a standalone document and can be read independently of the others.

Keywords: Videoconferencing, electronic meeting support, ATM, meeting studios.



Executive Summary

In this report we present our findings and results from the VITI program in 2000. The focus of the research work undertaken by VITI has been to provide electronic meeting environments that are easy to use and afford as natural a collaboration experience as possible. The approach and techniques adopted are less important than the end goal – if anything our aim must be to make people forget about the technology and infrastructures and concentrate on the collaboration supported through this technology.

This final report is structured into three parts. Part one concerns the VITI infrastructure and consists of two sections. The first section describes the process of establishing the infrastructure, concentrating on *how* the work was done. The motivation for the VITI program is presented here, together with the planned structuring for the communication infrastructure. We explain why the infrastructure has evolved the way it has, giving examples and anecdotal experiences, which explain the path taken. More detail on experiences using the infrastructure is given in part two. The second section presents the actual infrastructure that is in place today, concentrating on *what* has been put in place. This is mainly a factual description followed by a discussion on possible usage scenarios for the infrastructure.

Part two examines the use the VITI infrastructure has been put to, giving examples of activities it has supported and discussing strengths and weaknesses that have emerged through this use. While there has been no real formal evaluation process, we have had regular feedback from people who have used the infrastructure. We also have the experiences of the people who have built the infrastructure, who often have been present during activities and formed their own opinions about the effectiveness of the ongoing activity. This section presents an informal evaluation of the VITI infrastructure.

Finally part three considers the future of distributed electronic meeting environments. In the first section we consider future challenges in the area of distributed electronic meeting environments, based on issues we have encountered within VITI and on general issues that need to be solved for this type of meeting infrastructure to become commonplace. In the second section we examine the possibilities for continued meeting support in the wake of the VITI program. There are many independent initiatives (e.g. VUSNET in Götaland, the KTH video network) that would benefit from some sort of national connectivity. VITI has acted as a catalyst toward this connectivity process, and in this final section we examine what possibilities exist for the future.

It is recommended that the report be read in the order in which it is presented. However, each section has been written as a standalone document and can be read independently of the others. We end by acknowledging the contribution of those people, without whom the VITI program would not have been possible.

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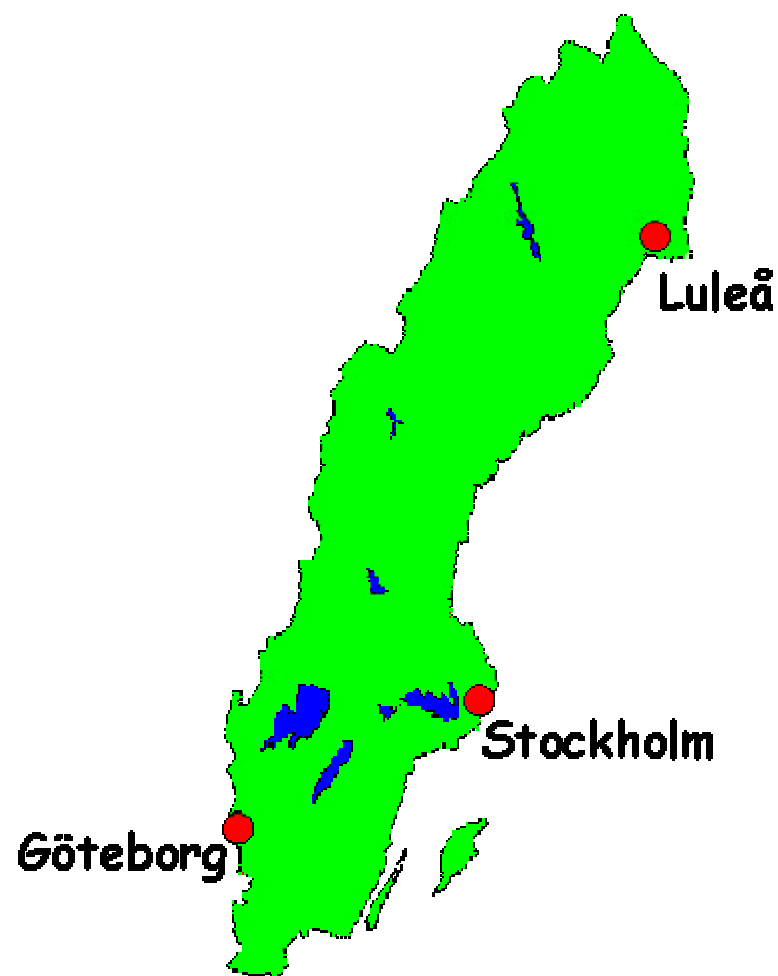
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Part One: The Infrastructure



Establishing the VITI Infrastructure

Abstract

This section discusses the process of establishing the VITI infrastructure that has been developed and refined over the past nine months. It outlines the processes we went through in order to put in place the infrastructure we have today. In this document we concentrate on describing *how* the infrastructure was arrived at, giving our experiences and lessons learnt in doing this. For a detailed description of *what* has been put in place please refer to the next section, “The VITI Infrastructure 2000”, which describes the infrastructure itself in factual detail. First, though, we begin by motivating the work undertaken and provide some background.

Introduction

The VITI program initially began in 1998, in order to establish a National Virtual Institute supporting flexible interworking between different organisations spread across Sweden. Details on the early VITI work can be found online at the following URL: <http://www.siti.se/programs/viti/archive>. There was mixed success for the initial program, highlights being the DING project (Törlind 1999) and high quality videoconference support between a limited number of sites. However, usage of the infrastructure was not as high as hoped for, possibly because of the complexity of configuring and using everything. Hence it was decided to concentrate on establishing a reduced infrastructure and to concentrate on making this easier to use, readily available and of suitably high quality.

The VITI program has been investigating the requirements of, and providing support for, effective collaboration between physically distributed electronic meeting environments. VITI's goal has been to make technological solutions, offering *appropriate* and *required* functionality, available for wide area, physically distributed multi-participant meetings. One of the themes running through the VITI work has been to support what the users want to do, rather than present a technical solution and then force people to use that.

Motivation

There already exist many possible approaches for electronic meeting support between people who are physically distributed (Bullock 2000, Meynell 1998). However these approaches in general have a number of weaknesses that make it difficult to offer high quality, easy to use, functionally adequate and flexible meeting environments for larger (i.e. more than two) numbers of people. Many desktop videoconferencing approaches are based on telephony principles (H.321, H.323), and while it is possible to have more than two participants in a meeting it is not trivially achieved, and can involve dedicated, expensive hardware, which is difficult to configure. Quality is another issue, with many systems targeted at ISDN networks and therefore using low bandwidth connections, offering lower quality video (QCIF and CIF resolutions) and audio (telephone quality at 3.5kHz with likelihood of significant delays between

participants). The consequence of this is that instead of using the available electronic tools to their best potential, people instead either travel to meet physically with others, move activities close to each other, use less competent personnel, or use lower quality meeting environments (e.g. an analogue conference telephone session).

The potential of a flexible, easily configured, heterogeneous electronic meeting environment is enormous. In spite of the tremendous advances in telecommunications and computing hardware, making it possible to connect to a host from almost anywhere in the world, the full potential of such environments has yet to be fulfilled. Things are moving in the right direction; traditional meeting room environments with dedicated connections are being augmented with connections from individuals using desktop technology (Janke 2000) and more recently mobile technology; more companies are open to the possibilities and benefits of distributed meetings; and many companies offering bespoke videoconferencing solutions exist. However better use of electronic meeting technology could be made in management, design, construction, production and project meetings where many people at different locations need to meet together (Maher 2000). Instead people still travel to meet in person or else use only a fraction of the potential that telephone and videoconference technology can offer. There is either a distrust of such meeting environments, often deriving from bad experiences or a lack of trust in the systems being used, or an ignorance of what is available and how it can be used.

Method

We focused on simple use in the first instance, initially providing the required functionality for basic communication and then extending this based on feedback from the users. Together with technological and functional inputs we were also driven by the needs and wishes of our users, making meeting technology more accessible and how we could best support social and ad hoc interactions. Our aim was to satisfy users of the environment, encouraging them to make more and more use of it, and to build from there.

We did not consider the VITI infrastructure in isolation, and it would be foolish to do so. There is a larger connected world out there and it is important that possibilities for collaboration are adequately supported. To this end part of our focus was on connections to other similar infrastructures and efforts.

A three-level approach

The overall VITI infrastructure was designed using multiple levels. These levels represented different technological configurations, different possibilities for interaction and different levels of flexibility. Initially four levels were identified: desktop, auditorium, studio and mobile. However, the studio and auditorium levels were considered together (it is the dynamics of the participants and interaction style that defines the difference, rather than different technical infrastructures. An auditorium is where one person addresses many others, while the studio is for small meeting support where groups of people communicate with each other) so we were left considering a three level approach. The depth of study and implementation for each of these levels was not equal. We concentrated on establishing the studio level

while at the same time encouraging the natural development of the desktop level through the use of a common desktop videoconferencing system (Marratech 2001). Our efforts with the mobile level were minimal at this stage as our main concerns with mobility were how a mobile user could interact with the desktop and studio levels. In order for this to be done successfully we required stable desktop and studio infrastructures to be in place. We therefore used standard telephone access to meetings to support mobility in the first instance. More information on the important role mobility plays, and what our plans were to tackle this issue, can be found in part three in the section titled “Future challenges for distributed meeting support”.

The technical infrastructural requirements of each level (desktop, studio/auditorium, mobile) were considered and established independently. Once the desktop and studio levels were sufficiently established we considered how these different infrastructures could interoperate and work together. Figures 1.1 and 1.2 show typical desktop and studio environments. The desktop environment has a standard computer, a PC in the example below, and a telephone. The computer does have video and audio capture capabilities, through the addition of a camera and a headset, but otherwise this is a standard environment with no specialised hardware or configuration. The studio environment, on the other hand, is a custom built room with large, rear-projection screens and dedicated input and output devices for both audio and video. The camera within the studio can be controlled to offer different views during a meeting. The studios established during VITI each offer a different flavour but share the same major characteristics of a generic studio.



Figure 1.1: A typical office



Figure 1.2: The SICS Studio

Below we describe how and to what level each infrastructure has been established, and describe each one's potential of use. It is important to establish stable infrastructures before widespread use is made of them. If we offer unstable solutions to our end users then we risk alienating them through glitches and hiccups. A stable successful infrastructure is vital to successful collaboration and cooperation.

Participating Organisations

Four institutions principally participated in the VITI program; the Swedish Institute of Computer Science in Kista, Stockholm, the Viktoria Institute in Göteborg, Chalmers Tekniska Högskolan in Göteborg and Luleå Tekniska Universitet in Luleå. The University of Linköping, the Interactive Institute in Stockholm and KTH in Stockholm also actively participated in parts of the VITI program. Details about these, institutions and the other organisations that were involved in the VITI program are available at the program web site, <http://www.siti.se/programs/viti/participants.html>. The studio level infrastructure, which is the most complete infrastructure, connects the four principal institutions.

Having set the scene, we now move on to discuss how we went about realising each of the different levels of the VITI program, considering each in turn.

The Desktop level

Our aim for the desktop level was to connect together a group of offices or small public locations in a persistent manner, offering possibilities for both planned, scheduled meetings as well as ad hoc spontaneous interactions. Here a conferencing application would be integrated into the standard desktop environment and it should be no more difficult to initiate communication than by using the telephone. By placing a videoconferencing application in the familiar office environment, and not forcing users to use unfamiliar equipment in unfamiliar surroundings, we hoped that usage would come naturally.

A number of possible desktop systems were considered (Bullock 2000) based on a number of approaches. Earlier systems (e.g. NetMeeting) used unicast networking, with dedicated point-to-point connections. While this is adequate for two users, once we start to have three or more people meeting together things start to become difficult with a unicast approach. It does not scale very elegantly. Instead multicast networking is used to overcome problems of scale (Marratech 2000). Once we had decided to adopt a multicast approach we had to ensure first of all that multicast traffic was supported to all participants at the desktop level and also to choose a suitable conferencing system. We concentrated on a single desktop-based system, but this is not to say that other systems would not be able to be used over the network infrastructure. We consider this more when we look at the actual Desktop infrastructure in the next section.

We decided to adopt the Marratech (2001) system as the default system, as it offered good functionality and we could get support from the company. One of the nicer features was the virtual corridor, where the user is presented with thumbnail video images of every person who is connected to the current session. Licenses were bought and suitably equipped PCs (video capture card plus camera, processor speed and memory are the main concerns, see <http://www.marratech.com/> for more details) installed at each location where required.

Concerning multicast support, this was our biggest problem to start with, as multicast was not supported everywhere. Where it was supported it was just a case of running the application and making connections to shared sessions. For multicast-

unaware sites though a proxyserver, running in Luleå, was used to bridge between unicast connections and the multicast network. This did introduce delays and impede performance a little, and where possible we tried to ensure that native multicast support was available.

Each site was encouraged to run Marratech on a daily basis, and try and use it for communicating where the telephone or email would otherwise have been used. During May 2000 we peaked at around 6 instances of Marratech running concurrently, including the Interactive Institute and Linköping. Unfortunately, we encountered problems with the stability of the software, especially where different operating systems were used at different locations (Windows NT, Windows 98, Windows 2000, Solaris). We worked with Marratech AB, and solutions and upgrades were made available during the lifetime of the program, which did make positive improvements. In particular the reliability of the software was much better towards the end of the VITI, as in the beginning the client software had to be restarted on at least a daily basis. These early problems with reliability, though, dealt something of a body blow to the successful, widespread deployment of a desktop based system. We ran into the problem highlighted earlier, "If we offer unstable solutions to our end users then we risk alienating them through glitches and hiccups." We saw regular use up to the summer vacation break, but after then usage dropped off almost completely. We also ran into problems with content and usage patterns. With no driving force to use the desktop based system, other than to keep in contact with each other about program developments, its use did not take off. Project support or other natural reasons for wanting to communicate were required to ensure regular use, and it would only be through regular use that problems and issues to be addressed that would make the meeting environments better would become apparent.

In order to establish a successful desktop-based conferencing infrastructure it is important to consider not only the technical problems that need to be overcome, but also to envisage anticipated use, and to try to have natural and unforced usage scenarios for the infrastructure. We have found through experience that you cannot force people to use something, and you must most definitely make sure that what you are trying to do is stable and functionally adequate.

The potential for the desktop level is enormous. Improvements to desktop-based videoconferencing systems are happening all the time, and where sufficiently motivated the benefits to be gained can be large (in saved time, less travel, more regular meetings, etc).

The Studio Level

The aim of the studio level has been to offer high quality meeting environments in fixed locations, where a meeting experience as close as possible to meeting face to face in real life is offered. Rooms at each of the four principal VITI nodes were established with dedicated audio-visual equipment. The tasks at this level have included equipping the rooms with adequate facilities, making these facilities easily controlled, configured and initialised, and establishing the appropriate network connectivity to support the different applications within the studio environment.

The state of each of the principal nodes at the start of this phase of the VITI

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infrastructure development was extremely varied. At SICS, the grotto, a versatile room that could be used for conferencing or for large screen “immersive” applications, already existed having been developed through previous project work at SICS and previous work on the VITI program. This gave us an advanced starting point. At the other extreme a completely new studio environment was constructed at the Viktoria Institute, taking an existing office as the starting point and constructing a small, dedicated studio, replacing the Viktoria salen as the main node at Viktoria.



Figure 1.3: The SICS studio



Figure 1.4: The Viktoria Studio

At the other two locations dedicated videoconferencing rooms had been installed by Merkantildata as part of those institution’s expansion plans.



Figure 1.5: The Chalmers studio

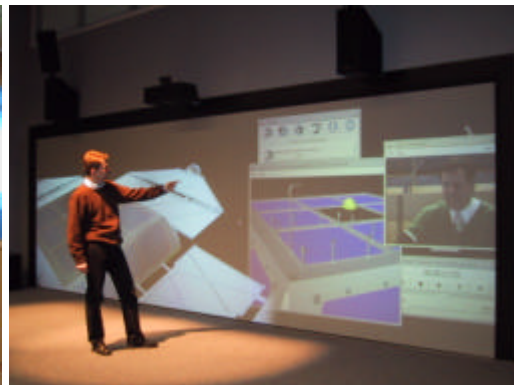


Figure 1.6: The Luleå studio

One of our first tasks was to decide on which solutions to use to support videoconferencing between these studios. Previously, dedicated hardware in the form of Streamrunner videoconferencing codecs (Streamrunner 2000), which require ATM networking support, had been use, and we decided to continue with this use. We also decided to support Smile! (Johansson 1998, Smile 2000), a software based videoconferencing application with a requirement for high bandwidth network support.

The rest of the work to establish and fine tune the studio infrastructure can be split up into three main parts, relating to networking, controlling and configuring, and refinement of the final solution. We begin by considering how the studio network infrastructure was established.

Establishing the studio network infrastructure

Previously VITI supported dedicated ATM network connections from Kista to Luleå, Viktoria, Umeå, Karlskrona–Ronneby and Linköping. When the current program commenced in April we cancelled the contracts for the connections to Umeå, Karlskrona–Ronneby and Linköping, ordered a new connection for Chalmers and renewed the contracts for the Luleå and Viktoria links. This is what we believed had taken place. Unfortunately what actually happened was that the Luleå and Viktoria connections were marked as torn down in the Telia databases as well. By chance the Viktoria connection remained up and stable, but the Luleå connection was not so fortunate. In the process of upgrading the link, Telia had removed physical parts of the connection, and in the end we were left without a high bandwidth connection to Luleå until the end of September 2000. First we had to wait until the beginning of September for the physical connection to Luleå to become operative, and then a further three weeks until this connection had been correctly configured.

Previously SICS had used a Fore ATM switch and the other sites Cisco equipment. With Umeå leaving the VITI program we took delivery of their Cisco ATM switch and installed it at SICS. We had been experiencing reliability problems with equipment attached to the Fore switch, and it was proving difficult to enable signalling in a heterogeneous environment. The arrival of the Cisco switch at SICS gave the program a homogeneous dedicated network environment that offered stable and more easily configured connections.

The Chalmers connection was originally ordered as local to Göteborg, from Chalmers to Viktoria, as it seemed logical to have these two institutions talk directly to each other. It was configured in such a way, but we then discovered that our Cisco ATM switches had the wrong hardware installed to deal with this¹. A consequence of this was that we had to have the Chalmers TCS connection modified to be between Kista and Chalmers, and this took longer to perform than expected.

Experimentation was also made to support a classical IP network over the ATM connections between the switches at the four main sites. However we were not able to put in place a stable network, due partly to the problems we experienced above, and instead chose to support IP over PVCs in the immediate future, configuring the connections statically as and when they were needed rather than dynamically.

By the end of September our ATM based network infrastructure was starting to settle down, and we could start to concentrate on using the connections, forgetting about this area of configuration as much as possible. There still remained some fine-tuning to be done concerning bandwidth allocations though. We discovered through use that at times the available bandwidth was being exhausted between sites (we had 40Mb PVPs between SICS and each site). This was noticeable by blocking and distortion in the received image. Even though we were controlling the amount of data

¹ Unfortunately all of the Cisco switches bought by VITI previously had been specified with a network feature card aimed at supporting point-to-point network connections. SICS needed to support point-to-multipoint connections being in the middle of the network topology. The Fore switch offered this functionality, so we had not run into this problem before. We therefore had to order a new feature card for the Cisco switch at SICS, one that supported multiple wide area network connections.

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being sent in each video stream, at times the instantaneous peak rates were higher than the bandwidths offered by the network connection. When this happened we had to apply traffic shaping at the local ATM switches, limiting the amount of traffic each switch allowed onto the VITI ATM backbone. This limiting had no obvious effect on the quality of the pictures received at each site, and through experimentation we were able to set levels that offered optimal image quality while not exhausting the available bandwidth. This issue is rather subtle, as the images appeared fine for long durations, and then suddenly we would experience image break-up, though nothing had changed at any of the sites involved in the meeting.

As well as the ATM network infrastructure between all the sites, SICS was additionally connected to a dedicated composite video network based around the main KTH Stockholm campus. This connection makes it possible for SICS to connect to a number of sites around Stockholm, and to act as a gateway between these sites and the rest of the VITI infrastructure. This other infrastructure is managed by KTH AMT (Advanced Media Technology Lab), who were formerly known as CITU.

Once established, the network infrastructure is something that is there in the background and just works. The next problem to solve is how to configure the rooms at the end of the network connections. So we move on to describe how we configured the studio environments and the ways in which we could support different meeting scenarios.

Controlling and configuring the studio infrastructure

In its most basic form the studio level offers interconnections between four fixed physical locations using AVA and ATV devices for communication. Once the networking issues had been worked out, we were able to start consolidating this anticipated usage, and make sure that it was straightforward to configure and control everything. SICS has been central to controlling the studio infrastructure, being in the centre of a star-shaped ATM network topology, having other external connections, and also having a sophisticated local audio-visual infrastructure already in place (<http://www.sics.se/~adrian/av>). This infrastructure made the task of switching various signals between sources possible, allowing flexible connections between sites to be made when it was not possible to use the standard studios.

We experimented with feedback destroyers in the studios at Kista and Viktoria. These are devices that connect between a microphone and a mixing desk, detect feedback frequencies and destroy them before the feedback occurs. We found that when using these devices the audio levels that resulted were far lower than at sites without these devices. Therefore it was not possible to have them in place unless every possible audio connection went through a similar device. While they undoubtedly reduced the amount of feedback, we were able to achieve comparable results with careful setting of audio input and output levels inside the studio.

The cameras used at all the studios were Sony controllable cameras. It is possible for the people within the studio to control the image they send out via a remote control. At Chalmers and Luleå a control protocol (VISCA) was enabled through wired connections that allows the camera to be controlled remotely, given access to

the PC the camera is connected to. We were unable to implement a studio wide control setup where each studio could control the other studios cameras due to the different states of completeness of the studios. A solution using VNC to allow different computers to be shared between studios is one possible way in which this problem could be solved.

At the Viktoria Institute, where a custom studio was constructed, it was possible for the occupant(s) of the room to choose between four camera angles and whether a full screen image or a composite quad image was sent to the other studios. At SICS only once camera was available within the studio. Luleå and Chalmers were equipped with many cameras, but only one of them could transmit at any given time.

Experimenting with different presentations

We had a great deal of experience connecting two locations together, especially SICS at Kista and the Viktoria Institute at Göteborg, and this was the point from which we started. Adding the video images from the extra sites posed no problems. In the first instance a single screen was used for each site. However, it soon become clear that a more flexible approach to interconnecting the studios, together with the possibility of connecting the studios to external resources, would be something worth examination. In particular making connections to and from the composite video network were examined. A composite quad image, consisting of four separate images was used. This effect was achieved through the purchase of a quad video device that took four separate inputs and gave a single composite image as output.



Figure 1.7 Quad video image

The advantage of the quad image is that sites with limited display possibilities could participate in four-way meetings. Thus the quad opened up possibilities for holding meetings away from the four main studios, making it possible to meet the requirements of meeting participants if they need to be in locations more convenient than the main studios (e.g. having a short meeting in central Stockholm, rather than travel out to Kista in the suburbs). The main disadvantage of the approach was the decreased quality levels it afforded. Only a quarter of the screen estate is being used for each image, and if displayed on a small screen (e.g. television) then it becomes difficult to see detail clearly.

Figure 1.7 above also shows how we were able to use the quad to start to examine how different infrastructures and levels could be joined together. In the image the top

left image is from a TV studio at KTH via the composite video network (a dedicated network providing 270Mb), the top right image is via the ATM network (a dedicated network providing 40Mb), while the bottom left image is via SUNET (a shared network with no guaranteed bandwidth), the Swedish Universities network (Marratech from the desktop level). Each of the sites shown in the figure were connected to SICS via the network types shown, and equipment at SICS was used to bridge between the different networks. So we have gained a lot of flexibility (any connection to SICS can be joined to any other connection with SICS, regardless of the technologies used for each individual connection) at a loss of image quality.

So far we have talked about images and made no explicit mention of audio. While video mixing is straightforward – it makes no difference that we send back the video image to its originator – when we consider audio things are more difficult. We must not send back an audio signal to its source, the effect being that you hear yourself speak. Also we have problems of feedback between speakers and microphones, again something that is not an issue with video. If microphones are too sensitive they can pick up the noise coming from the loudspeakers and send this back to its originating site. We experience these problems due to the analogue nature of audio, while video is digital.

Using separate screens and audio channels for each connection resolves this to a problem of setting the correct audio levels in each studio – the levels of the microphones have to be set according to the amplifier volume and the help of the other participants in the meeting. Microphone levels are set and then output volume levels set so that no feedback occurs. When we use the quad we had to install an audio “quad” in the form of a four-channel mixing desk, where we could remove the destination from the inputs and produce four different audio mixes to go with the four identical quad images. When different technologies are connected using the quad then the audio levels must be set accordingly at SICS, the central mixer. In particular where computer based systems are used (such as Marratech, as in Figure 1.7 bottom right quarter) then lower levels are required than for signals that go to ATVs.

We have not had as much experience with Smile over the VITI infrastructure, but Luleå and Framkom at Göteborg have undertaken extensive trials with this system, with encouraging results. In the future Smile offers to provide us with studio level connections on the desktop, as well as making the task of integrating the studio with the desktop that much easier as audio mixing is done within the software.

So, in establishing the studio level we were first driven by the need to simply connect all the studios together. Once we had done this though we explored possibilities to provide a more flexible meeting infrastructure, at the cost of lower resolution images on single displays using the quad functionality. This allowed us to support meetings that otherwise would not have been possible. However this lower quality proved unacceptable, so we reverted back to full screen imaging at selected sites. It is all a trade off between flexibility of meeting arrangement and location and quality of the meeting supported. More information on interworking between different infrastructures, the use of the established infrastructure and the problems we encountered along the way are given in the next section and in part two.

The studio level has been a great success, demonstrated by the continued and

regular use of it up to the end of the VITI program in December 2000. In some instances it is being relied upon to aid day-to-day work and is extremely effective in doing this.

The Mobile Level

More and more people are living dynamic and active lifestyles. No longer is it the case that you will be in your office everyday, with travelling and working from home become more and more prevalent. Hence there is a need to support people using electronic meetings who do not have a fixed infrastructure to operate from. Mobile telephones, laptop computers, PDAs (Palm Pilot, Psion, etc) and other such devices are now commonplace. The idea behind the mobile level is not to support communication exclusively between mobile devices, rather it is to support the interworking of mobile devices with the other two levels presented above.

Most of our effort has been expended on the studio and desktop levels, and we were not able to investigate the mobile level with the thoroughness we would have liked to. This was partly through necessity – we needed functioning and stable desktop and studio levels before we could begin examining mobile issues. We have however supported limited mobile access to the other two levels through the use of the standard telephone. A conference telephone has been used, with the audio being mixed in the studio and distributed to other sites using the microphones local to the location of the speakerphone. Marratech also supports telephone access to shared sessions, and we have had limited experience of that as well.

We examine the role of mobile access to meeting environments in part three, where we present ideas and possibilities to integrate this class of user into the overall infrastructure.

Summary

In this section we have introduced the VITI program and motivated the direction the work has taken during 2000. We have presented our experiences with and reasons for establishing the infrastructure that we see in place today. While we have touched on various practical details concerning the infrastructure, it was not the purpose of this section to describe it in detail. That comes in the next section. Rather we hope to have shown the thinking that went behind the development of the infrastructure, and provide pointers and guidance for anyone who wishes to undertake similar infrastructure establishment work.

The VITI Infrastructure 2000

Abstract

This section presents the VITI infrastructure that has been established during the course of 2000. It considers each of the levels, as described in the previous section, in turn, and then gives details on how interworking between the different levels has been supported. It presents *what* the VITI program has achieved, in terms of the final infrastructure. The majority of this section concerns the studio level, and information on each of the four principal VITI institutions is presented.

Introduction

In this section we describe the infrastructures that have been put in place by December 2000. This infrastructure is stable – we do not experience problems with the infrastructure itself. However, expertise is still required to configure each local studio and the peripheral devices within. The “man in the white coat” has not been eliminated from the equation – there is still some set-up that requires expert knowledge. What we have achieved is to minimise inconsistencies and enable local configurations to be made quickly and efficiently based on the changing requirements of the users of the infrastructure. If the infrastructure was used in the same way each time then we would be able to automate some of the configuration, but experience has shown us that users want to do subtly different things, which on the surface appear superficial to configure but that can be difficult in practice to achieve. The majority of this description concerns the studio level and the interworking between the other two levels and this one. In effect this section provides an inventory of the equipment and potential available across the principal VITI nodes. In order to fulfil the potential of each of the nodes there must be sufficient network connectivity between them.

The VITI Desktop infrastructure



At the desktop level VITI makes use of the SUNET network infrastructure (see Figure 2.1). SUNET offers a high degree of connectivity throughout Sweden, but no guarantees of available bandwidth as the network’s capacity is shared. On the whole SUNET is over provisioned, i.e. there is normally spare capacity, however in spite of this it is not appropriate, at this time, to run bandwidth intensive applications over this network. Rather we look to use tools that offer good collaboration possibilities using only limited resources. Desktop conferencing tools such as NetMeeting (2000), Marratech (2001), VCON (2000), Vic and Vat (Mice 2000) are all suited to this network environment, and form the basis for the desktop level of VITI. These tools allow people easy and regular communication from their desktop environment,

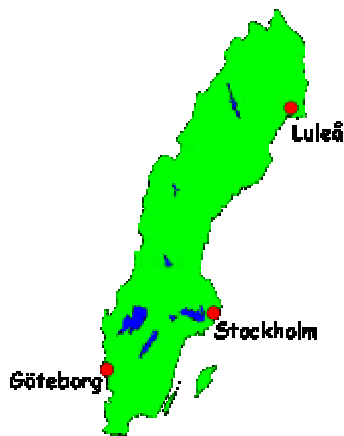
Figure 2.1: SUNET

to other users around Sweden. The aim is that there should be little or no overhead involved in using this solution – it is just there and you use it! The default equipment is a multimedia desktop PC, while it will also be able to interact at the desktop level using the facilities of a studio.

Two flavours of networking are required at the desktop level. First we need support for plain IP traffic between nodes, enabling an application such as NetMeeting to be used. Secondly we need support for IP multicast, enabling us to use applications such as Marratech, Vic and Vat. Unfortunately native multicast support is not guaranteed at each site. Currently for Marratech we use a multicast proxy server that runs at Luleå to provide non-multicast sites access to the Marratech session. A direct multicast connection at the site is the preferred solution.

The majority of sites ran Marratech on a standard PC, the exception being Linköping where Sun workstations were used. For Marratech a SITI-VITI session has been created, and this has been used for VITI activity.

The VITI Studio infrastructure



At the studio level VITI makes use of dedicated network connections to form the studio network infrastructure. SICS is at the centre of this infrastructure, with connections to Luleå, Viktoria and Chalmers. The network is realised using Telia's TCS ATM network service, each site having a Cisco LS1010 ATM switch that is the point of presence on the network. Standard SUNET connections are also available between the studios. We are using StreamRunner (2000) codecs for high quality videoconferencing over the studio infrastructure, with full screen PAL resolution video and CD quality sound. These devices have ATM interfaces and connect directly to the native ATM network.

Figure 2.2: Studio locations

As well as the default AVA-ATV approach, VITI has also used Smile!, a software based videoconferencing system developed at Framkom. Smile offers high quality videoconferencing between workstations, and represents a step towards bringing the studio quality level to the desktop. Smile needs IP connections in order to run, and we statically configured classical IP over PVCs to support this whenever it was used. As we had been unable to implement a generic IP network over the VITI ATM backbone it was necessary for each workstation that was to run Smile to have an ATM interface. Hence the use of Smile was limited to the studio environment, where such an equipped workstation could be found.

Before we describe each studio, we briefly present the equipment that was common to all the studios, that is the ATM switches, video and audio inputs, workstations and ATM-based video codec devices (the Streamrunners), as seen in Figure 2.3.



Figure 2.3: Equipment common to the studios

The top left shows the old Fore ATM switch that was used at SICS, to be replaced by the Cisco LS1010 Lightstream switch, providing a homogeneous ATM networking environment. On the left side we see a typical microphone (a Sennheiser in this instance) and the camera that was used at all the studios, a Sony EVI-D31 controllable video camera. A workstation, either a Silicon Graphics or a PC (or both) was located in each studio, and at the bottom of Figure 2.3 we see the AVA and ATV video codecs.

We now move on to describe each of the studios.

SICS

The SICS grotto is a configurable, multipurpose conference room (see Figure 2.4). It contains three large rear projection screens and access to the meeting environments is through a standard PC, an SGI O2 workstation or the StreamRunner videoconferencing hardware. The studio is also connected to a local audio-visual infrastructure (<http://www.sics.se/~adrian/av> - see Figure 2.5 for details on control), providing a flexible source of inputs and outputs beyond just the studio itself. The grotto is usually organised to support small meetings, but can be easily reconfigured as a small auditorium with space for up to fifteen physical audience members.



Figure 2.4: The SICS studio

A touch panel is used to control what appears on each of the screen within the grotto. This is the control device for a 16x16 video matrix (see Figure 2.6) that is

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located in the computer room at SICS: Any of the sixteen possible inputs can be connected any of the sixteen possible outputs. Three of these outputs are in the grotto.

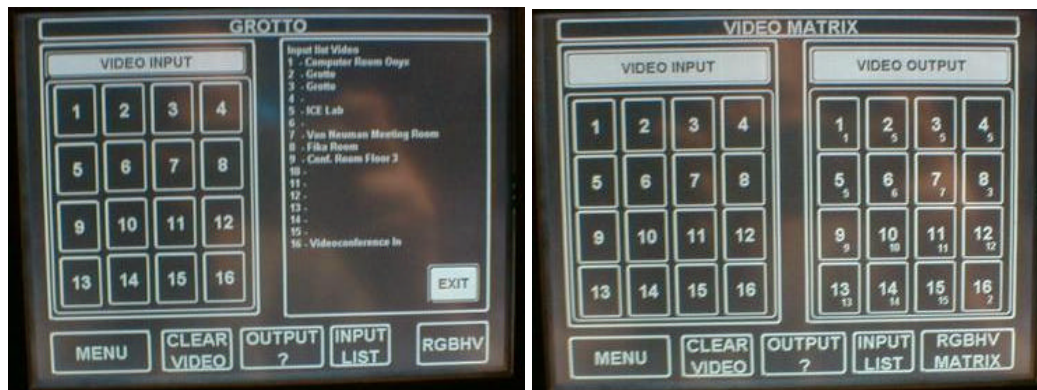


Figure 2.5: Local SICS AV control via AMX touchpanel

A consequence of this is that a second studio-like environment, such as Von Neuman meeting room (see Figure 5.1 in the final section) can be used in addition to the grotto. Hence it is possible to support multiple, simultaneous yet different meetings at SICS. An example of this was where Viktoria was connected via the AVA-ATV infrastructure to the new SICS conference room for a meeting of the Internet 3 program, while at the same time Smile was used to connect the grotto to the studio at Luleå for a meeting concerning possibilities for a distributed engineering company. Basically each source is connected to the video matrix and powerful configuration can be done by simple selection at the touch panel. Possibilities for extending this configurability, so that participants external to SICS could configure meetings, are covered in part three in future challenges. This is particularly important for scenarios where SICS acts as a bridge between participants, but is not actually involved in the meeting that is taking place. E.g. Viktoria and KTH might wish to hold a meeting. Viktoria has a connection to SICS, as does KTH, but there is no direct connection between Viktoria and KTH, so SICS acts as the gateway.



Figure 2.6: Supporting the SICS studio

Figure 2.6 shows the behind the scenes equipment that goes into supporting meetings in the SICS studio. The first image (far left) shows the control cabinet in the rear of the grotto. This contains the connections to the projectors, audio mixing desks to control input and output levels, networking connection points, workstations and a VCR. This is where the grotto is configured and controlled. The other three images show equipment in the computer room. First we see the ATM switch, video and data

switching matrices, and AMX control centre. The quad video device, capable of taking four separate inputs and giving a single composite image including all the inputs, is also located here. The output from the quad goes into a video distribution amplifier, giving five identical copies of the image. Four of these go into the video matrix. Behind the rack there is an audio mixing desk, which is used to provide the separate audio mixes to go with each of the quad outputs. The mixing desk is used to remove the destination's audio input from the mix that is sent back to it. That is, the audio mix that is sent to Viktoria, for example, does not include the audio that originates from Viktoria in the first place. We are performing analogue audio mixing here; neater and more controllable solutions mix audio digitally. The audio mixes go into the corresponding video matrix inputs. Finally we have the AVA and ATV devices, which are connected to the video matrix. Two AVAs are also located in a different location at SICS (the ICE lab). All the equipment is permanently connected, and it is just a case of changing the matrix configuration using the touch panels, as discussed above and shown in Figure 2.5, to make different connections.

It is possible to configure a telephone line within the grotto, and this has been used together with a Konftel conference telephone to enable remote access to meetings from standard home and hotel environments, where there are no fixed network facilities to make use of.

Previously much of the videoconferencing equipment was located within the grotto, all connections and configurations being made there. This involved a lot of wiring changes and matters got complex and confusing very quickly. Hence the set-up evolved into the one we have today, where there are minimal requirements for physical changes to the infrastructure, rather configurations are made at a higher level through control devices (e.g. touch panel). However, sometimes changes are necessary, e.g. incorporating the desktop level into the studio level where audio signals have to be routed to and from a PC rather than to microphones and speakers.

Standard condenser microphones were used for audio input, being connected to a Mackie mixing desk. Setting appropriate audio levels was always prone to problems. For only two sites it is fairly straightforward to ensure that both sites can hear the other well, without their own voice looping back, from the speakers into the microphone, at the other end. For three or more sites, not using the quad solution (which we tried not to use due to the poorer quality it offered), it is a long drawn out task ensuring each site hears the other well, with much minor tweaking necessary. This problem of analogue audio mixing is a known area. However, we were able to offer more than adequate quality levels after correct configuration.

For video we initially had the camera located above the centre screen in the grotto. However, this resulted in a lack of eye contact, something that is important to meaningful collaboration. The camera was therefore brought down to be in the centre of the screen. At first this appears a little distracting, but it does mean that you look directly at the person you are talking to, and after a while you forget there is a camera in the way.

We have briefly described the SICS grotto, and we now move on to examine the facilities that were available at Viktoria.

Viktoriasalen

Previously the Viktoria institute used one of its main meeting rooms as its studio for VITI. This was the Viktoriasalen and can be seen in figure 2.7 below.



Figure 2.7: The Viktoriasalen

This was a standard conference room, but with three large rear projected screens at one end of the room. For this phase of the VITI program a completely new studio was constructed, using an empty office at the Viktoria Institute, to support small meetings (Figure 2.8). A fuller description of the construction of this studio can be found in an appendix at the end of this report (in Swedish).



Figure 2.8: The Viktoria studio

The approach adopted at Viktoria was to use large screen television sets as the main displays in the studio. These offered a relatively inexpensive display with the advantage that audio output capabilities were also built into each display. This removes the need to mix separate audio signals within the room, as video and audio

are implicitly tied together. A scan converter was used to display standard PC signals on the TV sets.

The people within the studio could chose between five different images to send out, either from each of the four cameras that were located in the studio, or a composite quad image of all four images. The main camera was located in front of the middle TV (see top left picture in Figure 2.8). The second camera was on top of the middle display. A third camera gave a birds eye overview and the camera can be seen in the bottom left picture, and the view it provides on the right hand TV set in the pictures. The final camera acted as a document camera pointing down towards the desktop. The choice of view sent is controlled using the switching box, shown in the bottom right picture above. Here the quad was just used for local purposes, rather than sending one image to all other participants in a meeting.

Heavy curtains were placed around all sides of the studio dampen audio reflections and a dedicated lighting setup was installed (bottom left picture in Figure 2.8). This allowed the participants to vary the lighting conditions with dimmer switches and individual control over different lights.

As with SICS, much of the dedicated hardware was located outside the studio, and was reached through composite video and audio patch cables.

Chalmers

Chalmers is equipped with an advanced videoconference and distance learning facility. A wide variety of videoconferencing solutions are available, with dedicated H.323 switches and gateways available for use if necessary. The room is naturally more auditorium-like in nature, and of the VITI studios is the least configurable, but it is also the most technologically advanced.



Figure 2.9: The Chalmers studio

Figure 2.9 shows the Chalmers studio and Figure 2.10 the control point for configuring the set-up of the studio, at the front left in Figure 2.9. Two rear projection screens are available. From the control point it is possible to choose between different cameras, and to decide whether the studio-wide audio facilities are to be used, or just individual radio microphones. This studio is equipped with a sophisticated echo-cancellation audio system, with microphones available from each desk in the studio.

The control centre can be used for previewing sources before they are displayed on

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the main screen. If you look closely at Figure 2.10 you can see the SICS studio on the right hand screen.



Figure 2.10: The Chalmers studio control point

The dedicated hardware for the Chalmers studio is located behind the screens (you can see the door to the far left in Figure 2.9). Here there are a number of PCs, dedicated for different conferencing solutions as well as the AVA-ATV pair. The Chalmers node is very well equipped when it comes to H.323 equipment and can act as a bridge between different networks much in the same way that SICS has been used thus far for other heterogeneous network connections.

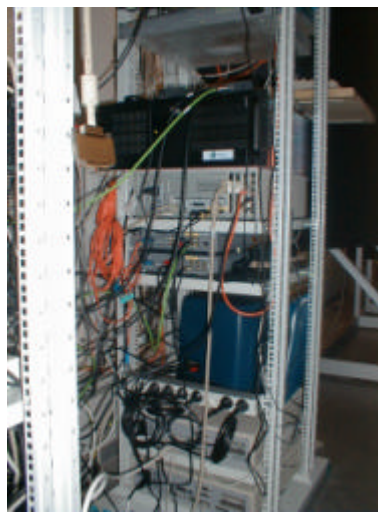


Figure 2.11: Behind the scenes at the Chalmers studio

Luleå

Luleå's studio was officially opened in December 2000 and was only available as a studio from September onwards. This studio is more like a lecture theatre than the other studios, where the traditional whiteboard at the front of the room has been replaced by a large screen display onto which multiple images can be projected (see Figures 2.12 and 1.6). The AVA-ATV pair is connected to a local video matrix. A number of Silicon Graphics workstations and personal computers are also connected to the video switch, Luleå being the site in VITI with the most experience with Smile! for videoconferencing. Smile has been used extensively between Luleå and Framkom

in Göteborg, using the VITI ATM connection between Luleå and SICS and a Framkom ATM connection between Kista and Göteborg.

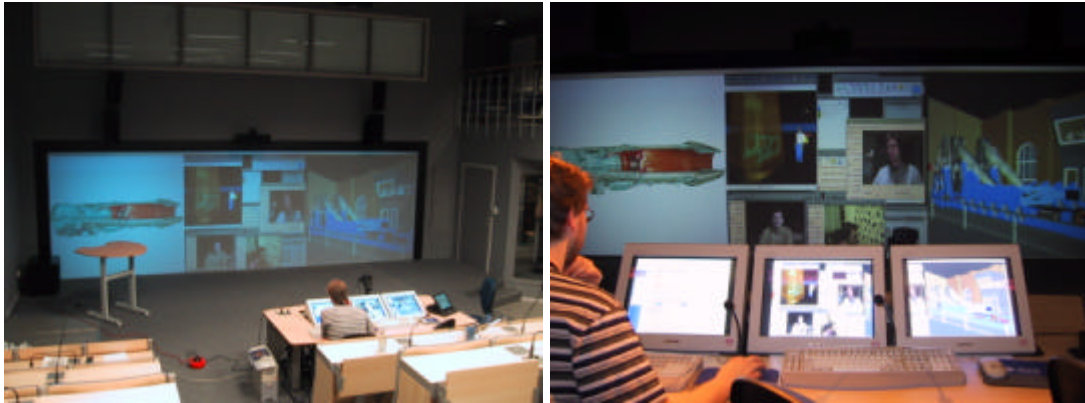


Figure 2.12: The Luleå studio

The studio is a popular shared resource, and it is advisable that any activity using it is booked well in advance.

KTH and beyond

In addition to the four VITI studios, we have also made use of alternate locations for participants in Stockholm, taking advantage of the dedicated video link that exists between KTH and SICS. This has enabled a degree of flexibility to be offered to those taking part in meetings, when it has not been convenient to travel out to Kista in the outskirts of Stockholm for a short meeting. In theory it is possible to connect to any number of locations that are on the KTH network (e.g. CID, Farsta, Interaktiva and many more), and in practice we have connected with CID, KTH and the Interactive Institute. In particular connections between Viktoria, SICS and CID have been extremely useful, support project work between people at these three institutions.

When more than one other participant is involved in a meeting with the KTH network it is necessary to use the quad functionality to distribute images. This is because the video network is only present in the VITI infrastructure at SICS, and SICS is responsible for retransmissions to the other sites. For full screen video images dedicated transmission and reception devices are required for each stream, i.e. multiple AVAs and ATVs.

The VITI Mobile infrastructure

No concrete work has been undertaken on the mobile level, rather we have concentrated our efforts on developing the desktop and studio infrastructures and incorporated mobile access to these levels in the simplest and most effective manner – through a regular telephone connection. A standard conference telephone is located in one of the meeting locations, typically SICS, and the audio output from the phone is sent to the other studios via the standard microphone in the SICS studio. Similarly the person on the telephone hears the other sites by the conference phone picking up the local conversations in the room and the output from the loudspeakers.

Marratech has been run on laptop PCs with wireless networking in test scenarios, with fair quality levels given the lack of dedicated hardware for video capture (a USB

camera was used), but no real user trials have taken place with such configurations. We discuss the potential for the Mobile level in more detail in part three in the section on future challenges.

Inter-working between the levels and with different systems

To end this section on the infrastructure that was put in place by the end of the VITI program we discuss how the different levels can be combined, and give an example of the studio and desktop levels combined in practice. In an ideal world everyone has access to facilities that offer studio level conferencing in terms of the audio and video quality. However, we do not live in an ideal world, and only a limited number of studios are supported by VITI. Where possible these studios should be used, but there will be occasions when someone wishes to participate in a meeting where they only have access to desktop or telephone facilities, while the other participants have the facilities of a studio at their disposal.

One of the main problems to overcome is the connection of different networking technologies together. The studio level is built around ATM while the desktop level assumes an IP network with support for multicast traffic. We also have the complication that when the KTH video link is used we introduce a third network type into the equation. Two solutions are possible for mixing these different technologies. Either each of the technologies must be available at all sites, thus making direct connections between everyone involved (something which could potentially involve a great deal of hardware and resources), or else we combine all the sources at a single location and send out a composite image of all participants to all sites. This second approach was the one we adopted with SICS being responsible for producing the composite signal.

SICS had connections to all the network types, and simply considered each connection as a composite video signal with accompanying audio. This removes the reliance on network technology, as we simply combine video signals digitally (using a video quad device) and audio signals with analogue technology (an audio mixing desk). The resulting signals are then sent back to the originator using the appropriate network technology. Figure 2.13 shows desktop and studio views of the same meeting. Note that SICS is not active in this meeting, merely facilitating it.

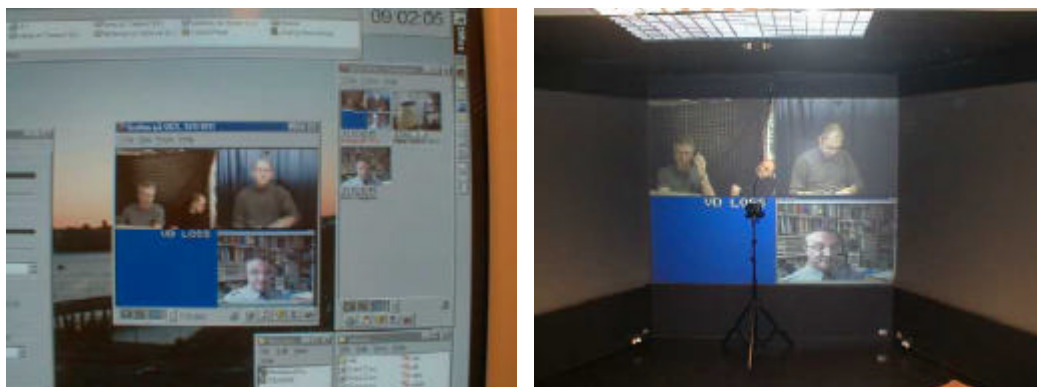


Figure 2.13: A SITI Styrelse meeting, the desktop view to the left and the studio view to the right.

Complications in this process mainly concern audio – different levels are required for the different technologies, notably lower levels are required for the PC-based desktop system otherwise there is much distortion. Also audio delay is a problem, something that we cannot easily overcome by technical means. While the studio participants have real-time audio with minimal delays, the desktop system suffers delays between half a second and a second with audio, due to both network and software delays.

To overcome this audio delay problem in later meetings we only used the video image from the desktop level and relied on a standard telephone conference call for audio. This improved matters greatly for the flow of the meeting. Although the video was often delayed it was an important component as well. In one meeting when the video image was removed but the audio connection remained it was as if that site had left the meeting. Similarly when participants attended meeting just using the telephone, or initial mobility tests, it was often easy for them to be overlooked by the rest of the meeting participants and it was harder for them to be actively involved in the meeting.

Summary

In this section we have presented a description of the VITI infrastructure that was put in place during 2000. We have concentrated on describing the studio level infrastructure, and have given examples of how the different levels can be used in conjunction with each other.

Part Two: Usage



Experiences using VITI

Abstract

This section first describes the kinds of activities that have been supported by the VITI infrastructure, and then presents qualitative experiences, remarks and feedback from this use of the VITI infrastructure. These observations are based on the experiences of both people who have used the infrastructure to support their day-to-day work, and also on the experiences of those people who developed the infrastructure. This is not a formal evaluation process. We identify particular strengths and weaknesses from our experiences. Some of the issues touched on here are discussed in more detail in part three, in the section concerning future challenges for distributed meeting environments.

Introduction

Much of the early work regarding the VITI program was simply establishing the infrastructure. Once this was in place though we could move on to support real, everyday activities, the whole reason for the existence of the VITI program in the first place. This is also the only way in which we can be sure that what we have established is indeed stable, and to tease out small issues which otherwise would not become apparent. It is only through regular use and experience that we have been able to put in place a sound baseline infrastructure and refine it accordingly. In this section we look at the different activities that have been supported through VITI and examine the feedback we have gained from people who have used VITI's facilities. When informally evaluating the use VITI has been put to we also consider the opinions of the people who built the infrastructure as they have many experiences to share.

Activities that have been supported

VITI has supported a wide range of activities based around electronic meeting environments. Videoconferencing has been the main activity. Apart from regular use of the infrastructure by the technical staff working on the VITI program, a number of leading group and project meetings have been supported at the studio level (initially involving participants at SICS and Viktoria). This has included the KidStory project (KidStory 2000), LearnITs ledningsgrupp meetings and Distansutbildningen meetings, and latterly support for the SITI program managers to meet together. Videoconferencing has also been used in conjunction with other tools, notably the use of the Smile! videoconferencing application in the area of distributed engineering (Törlind 1999).

At the desktop level we have supported communication between the VITI program technical staff using Marratech Pro, and we concentrated on establishing a stable infrastructure between all the sites using Marratech Pro. A dedicated VITI session was established and each site was encouraged to participate in this session on a daily basis. Initially there were stability problems with the software, but later releases of it improved matters greatly.

At the studio level the main activity has been to support project and board meetings. These have ranged in duration from one hour to five hours, and the feedback we have received has been very encouraging. People are impressed with the quality of video and audio, and are able to undertake their work well. We have also supported telephone access to studio meetings on a couple of occasions, at a fairly crude level, but adequate nonetheless.

We now examine and assess some of the activities that have taken place.

Project Meeting Support

A regular use of the VITI studio level has been to support project meetings, initially internal VITI program meetings, and later external project meetings and informal discussions. Figure 3.1 shows Rainer Berling and Per Gustafson in the Viktoria studio for an early program meeting. The main image is via the AVA-ATV videoconference solution, but to the left of the picture you can see a Marratech session running in parallel where five people are concurrently connected. For this meeting the main exchange was via the studio level, though some comparisons were made to the desktop level. Notably the video update rates were much slower, and the audio delayed noticeably with Marratech. Also notice that at this early stage the camera at SICS was still located above the main screen, thus making it difficult for direct eye contact, something that is very important for a “being there” experience.



Figure 3.1: Internal project meeting tests

One of our original goals was to see the natural development of the desktop level through regular day-to-day use. Unfortunately this was not to be the case, and by the end of the program the only regular use of the desktop level was in conjunction with specific meetings being incorporated into the studio level meetings. Early enthusiasm was damped by software problems. In particular the Interactive Institute were regular early users of the Marratech system, placing a PC in their kitchen for the possibility of chance encounters. By the middle of summer, just as newer versions of Marratech were being made available, enough seemed to be enough, and people stopped connecting to the VITI session and making themselves available. In addition to the technical problems, the lack of a driving force behind use, that is a specific reason to want to run the desktop system on a day-to-day basis, was felt to be very significant in the lack of take up.

Another significant user of the VITI infrastructure was the EU I3 KidStory project.

This project involves researchers at SICS and KTH, with one of the SICS researchers located at the Viktoria Institute in Göteborg. Previously much travel was involved even for the smallest of local meetings, or else the standard telephone was used. Using the VITI studio connection to Viktoria and the video connection to KTH, regular meetings could be held. Even cutting down on the necessity to travel into town from Kista for the SICS researchers was considered very beneficial. The same researcher in Göteborg has also made extensive use of the studio to stay in contact with his colleagues in Kista, helping to provide a feeling of actually working with colleagues on the other side of the country. When connecting to KTH it was very important that someone local to KTH who knew about the AV setup was around to provide assistance in case of trouble. This same person was also required to configure the connection if different local meeting venues were required.

Program and Board Meetings

A second form of activity was more formal program and board meetings. In particular the Learn IT program and the SITI styrelsegrupp have made regular use of the studio level VITI infrastructure.

One of the early uses of the VITI infrastructure was by the LearnIT program, (<http://www.ped.gu.se/learnit>), for meetings concerning Distansutbildningen, between Göteborg, Luleå and Stockholm. In total three sessions were held, each lasting between three and four hours. We received feedback on the first two meetings and the third meeting went well but without any direct feedback. The first meeting took place at the end of August. The meeting involved participants at all three sites, in a hybrid studio/desktop environment. The participant at Luleå was present via a H.323 videoconference link to Göteborg (due to problems with the high bandwidth network connection to Luleå, discussed in part one), which was subsequently fed into the high bandwidth videoconference system that connected Göteborg with Stockholm. All mixing was undertaken at Göteborg and a composite quad image was transmitted to all participants together with mixed audio sources. The meeting started at 10am and concluded at 3pm, and there were 2 participants at Stockholm, 1 at Luleå and 5 at Göteborg. Figure 3.2 shows the configuration that was used.



Figure 3.2: The first LearnIT program meeting

Each participant filled in a questionnaire after the meeting, rating the experience they had just had (see Figure 3.3 below). Overall people were very pleased with the meeting as a whole, and felt able to participate as fully as they wished and were not held back or distracted by the technology. The environment let them undertake their normal meeting processes (see questions 8-10). The graph below the questions summarises the responses from the seven participants.

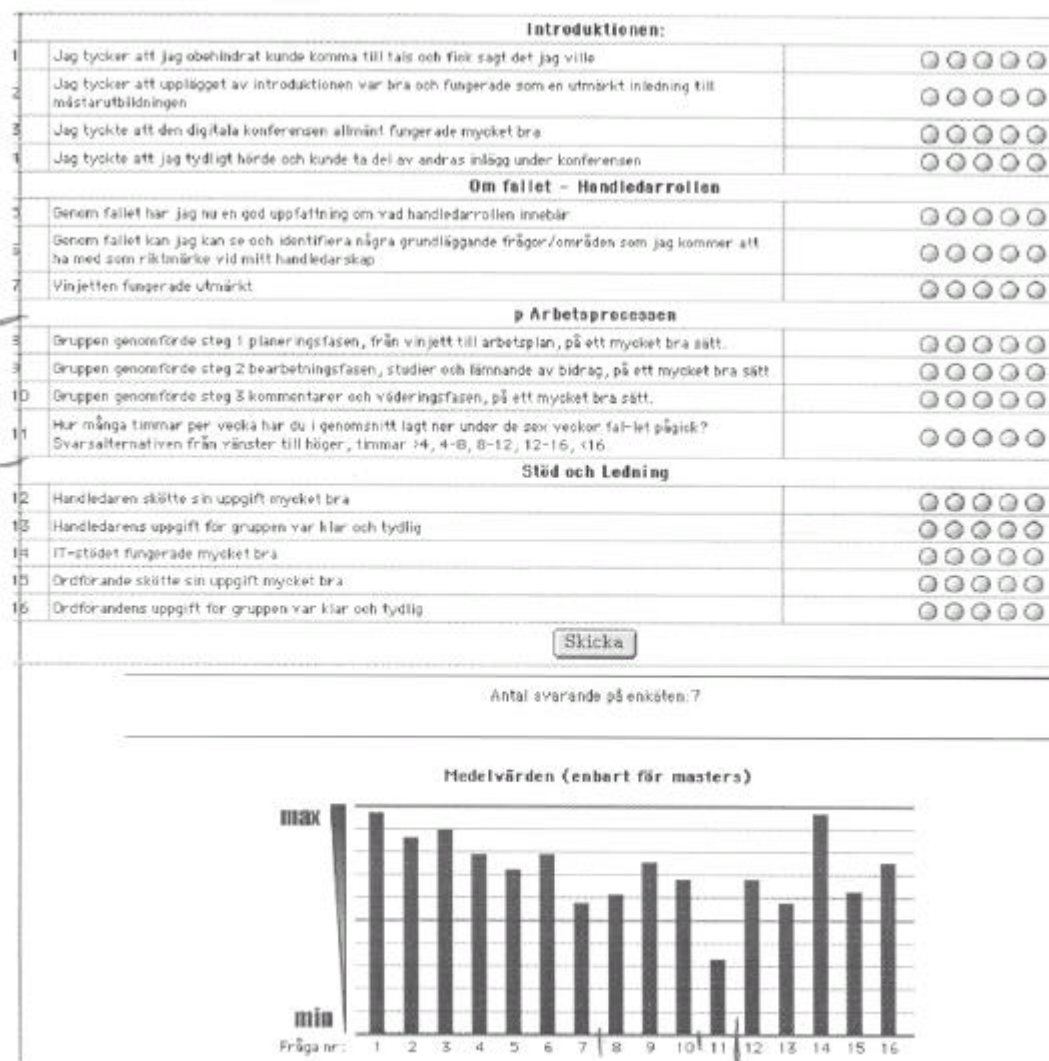


Figure 3.3: Questionnaire and results from first session

The second meeting took place in the middle of October and involved participants at Stockholm and Göteborg only (see Figure 3.4 – we were set up for a three node meeting, but at the last minute found out there would be no participation from Luleå). There were 3 people at Stockholm and 5/6 at Göteborg. The meeting began around 10.30am and concluded around 3pm. The last minute reconfiguration of the meeting environment may have contributed to the comments below, but we feel it is only one factor (and a small one at that) in the complex equation of supporting successful distance meetings well.



Figure 3.4: The second LearnIT meeting

The group was able to hold its meeting successfully once more, though this time the same overall feeling of satisfaction was not present. The video was improved for this meeting. Previously a quad image displayed on a single screen had been used, whereas this time each of the two participants was displayed on a single screen giving an image four times the size. However, this improvement was not commented upon by the participants, instead the quality of the audio turned out to be the crucial factor. The audio at Stockholm appears to have not been sufficiently tuned, and while acceptable for a short period of time it proved quite tiring for the participants to concentrate and pay attention over the extended duration of the meeting. This feeling of tiredness was not reported after the previous meeting. It could be argued that for the first meeting people didn't know what to expect and were less critical of the faults and drawbacks. However, we recognise that it is precisely the small details mentioned in the comments below that will make or break a conferencing infrastructure, and these are the things that should be carefully addressed to ensure future success.

Comments

We received the following comments after the second meeting:

Janne (i Stockholm) har gjort ett inlägg i deras grupp där han säger att: "Jag tackar även jag för en intressant föreläsning. Men efteråt var jag väldigt trött - det tror jag beror på dåligt ljud och skärpa på tekniken. Jag föredrar att träffas 'live' om det blir så här igen." Ju mer vi använder utrustningen desto mer förstår man hur sublimt och känsligt det är. Små saker betyder oerhört mycket för att det ska fungera.

Jag hoppas att det är OK att jag förmedlar era synpunkter till teknikerna och projektansvarig. Och jag hoppas att vi ska få till det ordentligt nästa gång, inte minst med ljudet.

Here one of the participants in Stockholm is commenting on how tired he felt after the meeting was over, and how he would prefer to travel to meet in person rather than use the same set-up again. This was due to the bad sound configuration in place due to the last minute changes in configuration. It is noted that the smallest of things can have enormous consequences on the quality of the final solution.

Ja ...det var lite annorlunda från första gången. Stockholm kändes inte riktigt delaktiga. Det är märkligt att så små skillnader kan få en ganska stor betydelse. Synd som sagt att inte Hans var med...men han kommer nog ingen

snart.

Here the person comments on how different it felt compared to the first meeting. A single camera position was used for this meeting, and as there were now three people at Stockholm the camera could not zoom in as close and include all three people in the image. Hence the people at Stockholm appeared smaller on the final image. This highlights the potential importance of a controllable camera view, which can zoom in and out on different people as they make their contributions. The Viktoria studio is well equipped in this instance and it is easy to switch between different views and concentrate in individuals when they talk. Obviously the lack of detail played a major part in the negative feelings.

Tack för senast. Det var intressant och givande på flera sätt. Kajsa och jag diskuterade tekniken och varför det kändes så annorlunda denna gången. Förra mötet var så jättepositivt och alla var imponerade av tekniken. Denna gången hade vi alla kanske en större förväntan på att detskulle fungera lika bra eller bättre! Jag tror att det är små detaljer som gör den stora skillnaden. Ljudet och bilden var ju inte så mycket sämre men det spelade ändå in. En annan sak var perspektivet i bilden. Det kändes mycket bättre när Janne och Bengt kom närmre kameran och på så sätt "närmre" oss.

Here again the participant wonders why it felt so different on this occasion compared to last time, where such a positive impression was felt. Perhaps it was due to expectation, as an experience at least as good, if not better than the first time was anticipated. Again the feeling that small issues have major consequences is given. In particular the fact that the camera overview perspective made it feel like the Stockholm participants were a long way off.

Jag tycker det var ett bra seminarium igår. Givande. Tråkigt att Hans inte var med. Och tråkigt att Stockholmsarna blev lite off. Det lovar dock bättre att vi till slut tog kontroll över tekniken. Det var en bra insats av Ove.

For this person the experience worked, but could have been better.

While these comments were more negative than from the first meeting, the nature of the problems the comments addressed were encouraging to us at the time, in that we had established a stable, underlying technical infrastructure and could now turn our attentions to refining and configuring the use of this infrastructure. Many of these issues were addressed in time for the third meeting, in early November, and though we had no detailed feedback we gained the overall impression that everything had gone well, and was certainly an improvement upon the previous time.

The other major use of the VITI infrastructure for structured meetings was by the SITI program managers, so that more regular meetings could take place. One problem with this was that one of the program managers was located at Linköping, where we did not have a studio level connection. Hence we had to incorporate the desktop level into the studio. As previously described in part 1 we achieved this first through the use of a quad, constructing a composite signal from four different inputs, one being from the desktop level and the others from the studio level. Typically the majority of the participants were located in Stockholm, with one or two participants at the other locations (Luleå, Göteborg and Linköping). While connectivity was possible, it was

felt by the participants that the quad image did not offer suitably high quality, and that full screen images of each participating site were preferable.

In the comment below we see the desktop connection to Linköping being singled out as poor, yet the video meeting was still felt preferable to travelling to meet in person.

... säg att jag också var nöjd. Det enda som inte var riktigt bra var förbindelsen till Sture. Han låg alltid med fördröjning och det gör faktiskt stor skillnad. Men även så var det bättre för oss alla jämfört med att resa.

We tried to minimise the problems with the desktop level, and as mentioned previously used the telephone to replace the poor native desktop audio. This improved matters, but is not really a long-term solution to the problem. Rather a better audio solution at the desktop is required, and it is not clear if the current systems can match the studio level audio quality.

On the whole we feel that we were able to support the wishes of the SITI program managers. We seldom used the same configuration twice, the Stockholm studio being represented by the SICS grotto, a TV studio in KTH and the Interactive Institute for different meetings. Here we were providing flexibility for the other plans of the meeting participants, though when away from SICS it was necessary to use the quad, so some form of compromise was necessary.

Both these uses of the VITI studio infrastructure have highlighted the importance that participants should know each other before they meet in a videoconference environment. An example that illustrates this well is when the SITI steering group met with the program managers and a group of international experts. The SITI-related participants all knew each other, but the international experts had not met most of the other participants. The majority of the participants were in the SICS grotto, and the discussions in this room were free flowing. However it was not so easy to sustain involvement from the other participants, Göteborg via ATM, Linköping and Luleå via Marratech, (and thus sharing one of the quad slots visually – we could only display one desktop image in the configuration we had), and the final participant via conference telephone from North America. On the positive side the meeting did permit an exchange of information and ideas, and did function at a technical level.

High School workshop as part of the Sonja-Kovalevsky days

The VITI infrastructure has also been used to help out in certain activities when problems have occurred with the intended infrastructure. Notably a three-way competition between high schools in Stockholm, Uppsala and Göteborg was supported using the VITI connection between Stockholm and Göteborg. Organised as part of the Sonja-Kovalevsky days (<http://www.nada.kth.se/kovalevsky>), which took place on the 10th and 11th of November 2000, this was the first time that three Swedish high schools had been connected together in this manner. The video network connections were supported by KTH-AMT (formerly CITU) and the event consisted of the three high schools being connected together in a videoconference session while they attempted to solve a number of mathematical problems. KTH-AMT have a sophisticated fibre infrastructure in the Stockholm county area, and through external

contracts are investigating and establishing a direct fibre connection to Göteborg from Stockholm. The event was meant to use such a link, but on the morning of the event it was discovered that the fibre was not correctly configured. VITI was able to step in and provide the necessary connectivity. First the high school was connected to Chalmers, then the AVA-ATV videoconference connection between Chalmers and SICS was used, and finally SICS was connected to KTH via the dedicated fibre connection between the two. Without this alternate method to connect the two sides of Sweden together the whole event would not have been able to take place. In figure 3.5 below we see some images from the high school in Göteborg. In the bottom left image the high school in Stockholm is visible on the TV set, and the bottom right picture shows the high school in Uppsala. The event was a great success.



Figure 3.5: Views from Göteborg during the problem solving

Strengths and weaknesses

One of the main strengths of the VITI program, and indeed its main goal, has been the support of meeting activities that otherwise would have entailed the participants travelling to meet together in person. By support we do not simply mean the ability to see and speak to each other, but the ability to offer an experience as close as possible to being in the same physical space as the other person. The first step towards this was basic connectivity, something that should be straightforward but as with most things proved more complicated than expected or necessary. We have then been able to address a whole host of smaller issues that have an equally profound effect on the meeting experience as just enabling basic connectivity.

A second strength of the VITI program has been its support for a wide range of

heterogeneous networking technologies in the same meeting environment. We have held meetings where three different sites meet together, each using different network and conferencing technologies, yet able to communicate sufficiently well to perform the business of work without being distracted by the technology. The infrastructure we developed has been flexible enough to cope with the wishes of the participants to be in different locations at different times, rather than forcing them to use standard environments each time. This is a weakness as well, as there is a trade-off between quality and flexibility. The four standard studios offer high quality solutions in well equipped and understood settings. If we use other locations then we lose the foundations of dedicated surroundings and have to provide common views to all participants. The infrastructure is also flexible enough to bridge between different places, as seen for the high school event.

Controlling and configuring the infrastructures is something of a weakness at the moment. There is a strong reliance on technical experts to configure each meeting and make sure there are no problems. Taking the SITI program managers meeting as an example, due to the interworking of desktop and studio levels it was necessary for the SICS technical person to be present during the entire meeting in a control and coordination capacity. He controlled the camera, providing different camera views, and ensured everything worked well. So a person was required to configure and then monitor the entire setup, a high overhead. Configuration can be simplified by providing simple, “push-button” interfaces that encapsulate many small actions. For example, it would be desirable to simply select the participants you wish for your meeting and then press a button labelled “Configure”, and then everything works! Using the AMX control system it is possible to take large steps in this direction, and through the use of secure web mechanisms this could also be achieved remotely. This remains an area for further work though.

A problem we encountered on more than one occasion, which had major consequences on the configuration and effectiveness of the meetings, and yet had nothing to do with the technology, was the intentions of the people involved in the meeting. Often the people using the technology to meet are very busy and wish to save time by avoiding unnecessary travel. However communication between participants and organisers is vital to a successful meeting. On more than one occasion the technical organisers thought a meeting would involve certain people at certain sites, and it would not be until 5 minutes before the start of the meeting that the organisers would be aware of major changes, for example, a participant who was thought to be in Luleå would turn up in Stockholm! In an ideal situation, where configuration is stable and easily achieved, last minute changes should pose no problems, but when considerable time has been spent preparing a particular configuration, only for it to be torn down and changed at the very last minute, this can be very frustrating from the organisers point of view. From the participant’s point of view, they are not concerned with any of the technical necessities or problems, they just want to meet as easily and effectively as possible, and this is understandable. Therefore there needs to be reciprocal understanding between both groups for successful meetings to take place, given the current state of play.

The other current weakness of the approach, not so much a weakness but a difficult

problem that must be solved, is one of appropriate audio support. This is especially problematic when sources from different technologies and levels must be mixed together. Our feedback and experience has shown that while it is possible to hold a satisfactory meeting where one or more of the participants have a good audio connection but poor or no video connection (i.e. just a conference phone, or delays of up to a couple of seconds in video frame updates from desktop systems interacting with the studio level), the opposite is definitely not true. Delays in audio break up the flow of the meeting. We have also seen above that even when video quality was increased it was the audio that had most bearing on the success of the meeting (the first and second meetings of the LearnIT group).

Summary

In this section we have described the different kinds of activities that have been undertaken using the VITI infrastructure. Problems and issues that have arisen from this use have been presented, together with comments from some of the users on their experience of meeting using videoconferencing technology. While we have been successful in establishing and using the meeting infrastructure there still remain many issues to be resolved. Some of these are touched on in the comments and experiences, but it will require further work to overcome these problems and provide suitable solutions. The next part of this report considers some such areas for future work, and possible directions for work beyond the VITI program.

Part Three: The Future

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Future Challenges for distributed meeting support

Abstract

This section considers a number of challenges that remain to be overcome in the area of distributed meeting support. Some of the issues we discuss concern problems we have encountered during the VITI program, which we have not been able to investigate fully due to constraints on time and effort. Other issues are more general in nature and are the research challenges that need to be addressed with further work. It is not our aim to present an exhaustive list of issues to be addressed, rather provide a starting point, from which other problems will no doubt become apparent.

Introduction

We have successfully established and used an infrastructure for distributed meeting support via videoconferencing during 2000. There still remain a number of problems and challenges that we need to overcome to make this infrastructure more accessible and ensure that the goals of the VITI program are met as fully as possible. Our aim has been to provide effective collaboration between physically distributed electronic meeting environments. To do this it is necessary to make technological solutions, offering *appropriate* and *required* functionality, available for wide area, physically distributed multi-participant meetings. Some of the issues for further study concern the infrastructure itself, while others concern the use of the infrastructure, which is arguably the more interesting and pertinent area, as without use an infrastructure is worthless.

Ease of Use

This is perhaps the biggest generic problem for this type of meeting support, and arguably the most crucial, encompassing a large number of issues at different levels. People's willingness to use and become comfortable with virtual meetings relies on good experiences. While expectations may not be too high the first time people use the types of infrastructures we have established, people's expectations change with experience. Therefore for continued use of virtual meetings we must ensure that the expectations of those using the technology are met at all times. We have seen this to be the case from the comments we presented in part 2, where first time use yielded positive comments, but a largely similar second use resulted in much more negative comments. You cannot force people to use virtual meetings, they must have the desire to use it, or gain tangible benefits from its use. It must be easy to configure each local node for a meeting, selecting the appropriate technology. It must also be easy to control the meeting and manage the addition and removal of participants. From a participant's point of view it must be easy to participate, and we must offer a suitably high quality experience so that they feel relaxed and comfortable with everything. We examine ease of use from two standpoints, the work that must be done just to enable the possibility of a meeting and the experience of the meeting.

Configuration and control

Presently much configuration work is necessary to support distributed electronic meetings. An expert is required at each location involved in the meeting, and generally we have found that one person is also required to take overall responsibility for the meeting. With the current set up the microphones and camera(s) need switching on and levels need to be checked. Likewise the local displays (TVs or projectors) need to be switched on and the audio output set to the correct levels. Dependent upon the meeting solution being used there can be additional technical configuration requirements at a number of sites. This is all done manually, and as a consequence a fair amount of local knowledge is required. Further work should concentrate on automating the process of configuring the meeting environment and providing simple and intuitive mechanisms for controlling everything.

The studios at Chalmers and Luleå have facilities that take a step in this direction. A central control point with a touch panel display makes it possible to quickly configure everything in the room, including lighting, audio and video. This currently requires a technician, who understands the room and is skilled in its configuration. However, the underlying connections and equipment are stable in these rooms, so once understood repeated configuration becomes easier. At Viktoria and SICS things are not quite so well developed. Viktoria has a reasonable stable set-up, with fixed audio and video connections, whereas the SICS studio is a general-purpose room which often needs to be reconfigured, from a basic wiring connections level, to support different activities. Therefore the SICS studio requires the most expertise and local knowledge of all the studios. When we take into account the second role of SICS, as a bridge between locations (e.g. the KTH network and other VITI nodes) or a redistributor of signals, then the knowledge necessary to realise these different configurations calls for a local expert.

At the present moment in time we do not see an easy alternative to having a local expert at each location, in fact we would stress that without such a person then the possibilities of successful meeting experiences will be very low. What we would propose though is that the activities of this expert be supported, automated and simplified as much as possible, making the role rather than the individual the important factor. As things stand at the moment the infrastructure we have created is dependent very much on individuals and the skills and knowledge they possess. Without these individuals it becomes difficult to support specific activities.

Taking the configuration of SICS as an example, useful as it is the node most likely to require regular reconfiguration from a distance, currently the routing of video and audio signals is controlled via an AMX control system, accessed through touch screen panels. The Streamrunner videoconferencing codecs are attached to a video matrix switcher, along with different input sources and output devices at a number of locations throughout SICS (including the grotto). Input to and output from a standard PC is also supported in the grotto through re-wiring when necessary. What this means is that from a simple control screen (see figure 2.5 previously) it is possible to configure complex meeting set ups with simple selections. The quad device is also connected to the video matrix switch so composite images can also be easily configured. Presently the interface is not very intuitive, and it is necessary to know

which sources the different numbers correspond to. It is also necessary to separately configure the incoming and outgoing connections.

An improvement would be to change the interface and underlying code at the AMX control level. Instead of presenting a 16x16 matrix to the user, they should be given a list of possible participants they can choose between. After each participant has been selected and added to the meeting, a single “configure” button should configure all the connections necessary between all the sites. There could, optionally, be an extra level specifying the type of connection to each location (e.g. studio, desktop, ...). Given a suitable understanding of the Axxess programming language and the user interface design tools that come with the AMX systems, it should be relatively straightforward to achieve these improvements.

This, however, still considers configuration just at the local level. What we need to do is provide remote access to the configuration possibilities above. This is possible through the RS-232 interface possibility offered by the AMX system. Through a web-based interface it should be possible to mimic the appearance and behaviour of the touch screen panels used locally at SICS. Then anybody with access to the web pages would be able to configure and control the overall configuration at SICS as necessary. One potential danger is that someone could disrupt a configuration that is being used, and mechanisms to safeguard and lock sessions would need to be investigated.

Controlling the camera is another issue that can and should be addressed. The VISCA protocol, supported on the Sony cameras used universally at the studios in VITI, allows the camera to be controlled through a dedicated cable connection. Therefore local camera control can be achieved either with a remote control or through a computer system. If the computer system is used then the possibility for remote camera control becomes possible, where for example the people at SICS have the possibility to control the camera at Göteborg and Luleå, and likewise at the other sites. This makes sense, as you are concerned with the view of the people you are looking at and are not the best judge the image you present of yourself.

So far the suggestions for control and configuration have been of a very practical nature. An alternate approach for configuration, using more advanced technology and sensing equipment, would be to use voice recognition and voice driven interfaces. In such a scenario you walk into the studio and announce that you would like to hold a meeting with Viktoria and Luleå. The system recognises the command, turns on the appropriate equipment e.g. projectors, microphones, cameras, etc. and makes the appropriate connections so that the other sites are visible on the screens. It should then be possible to fine-tune the environment with further vocal commands (e.g. “make Luleå louder”, “make Viktoria quieter”, “zoom in at Viktoria”, ...). A good example of the kind of ease of use this type of solution should give is in Star Trek TNG and the use of the Holodeck.

The meeting experience

In order to make the surroundings of the meeting the least possibly intrusive we need to concentrate on good quality video reproduction, but perhaps more importantly on good quality audio solutions. We have seen in usage to date that audio delays are a

crucial factor in the success of a meeting. Any delay from one participant that is not shared between the other participants is fatal and causes major communication breakdowns. This has been especially apparent when mixing the desktop and studio levels. When software solutions for audio were used at the desktop then poor results were achieved, and it was difficult for everyone in the meeting. However, when the audio was replaced by a conference telephone call between the desktop site and one of the studios, then interaction and the meeting experience went much smoother. This was in spite of a half second or so delay with the video. This delay did not interfere so much with the flow of the meeting, but was beneficial for the presence of the desktop participant. We say this because of experiences from one meeting where the video view of a desktop participant (using a conference phone for audio) was removed. This effectively removed this person from the meeting, whereas before he was an active member of it.

Even when there is no delay poor quality audio can have a significant effect on the meeting participants. Fine tuning audio is a tricky problem, however. People naturally speak at different levels, and while one person may be loud and outspoken another might naturally talk in a quieter, more reserved manner. The ideal solution is to have individual microphones, possibly radio mics, for each participant in the meeting. This way audio levels can be set for each participant. The current set up sees condenser microphones at each site, which can pick up unwanted background noise as well as the members of the meeting. An audio system with silence suppression that automatically calibrates itself according to who is speaking would be an ideal solution. We have had some experience of silence suppression systems at Chalmers and Luleå and it is not yet clear the best way in which to make use of them.

By addressing the problems raised in the previous two subsections we hope to be able to offer a room that is quickly and easily configured (albeit by someone with some previous training on how to use everything) and that supports as natural a meeting as possible, as close to being in the same room as the other participants as can be done.

Mobility

One area that VITI has been unable to address in necessary detail, an area that will play an increasingly important role in this area of study, is mobility and mobile access to meeting resources. Technological advances continue apace, and more and more standard infrastructures are being put in place (e.g. GSM -> GPRS -> UMTS) that offer high bandwidths and increased sophistication in the hands of the remote user. Future work should investigate what kind of experience can be offered to a mobile participant in a distributed meeting scenario. Below we identify a number of challenges and suggest ways in which these challenges may be understood and overcome.

Marratech already supports basic mobile access to distributed meetings through a telephone interface. However, there is poor awareness between participants and poor integration between the visually capable participants and the telephone participants. Therefore we need to look into ways of augmenting the presence of a standard telephone user in these environments, as well as investigating newer forms of mobile access to meeting environments using devices different to the standard telephone.

This gives rise to a number of challenges:

- ??What is the best representation of a mobile user? To both “regular” conference participants and other mobile participants.
- ??Do we use different representations at different levels?
- ??How do we ensure consistency between and across levels and use?
- ??What are the bandwidth limitations and how to make best use of resources?
- ??How do we represent “regular” participants to mobile users?
- ??What should a mobile user need for participation? GSM, PDA, Laptop, dedicated hardware, ...
- ??Should we use dedicated mobile hardware?

We also need to consider how we incorporate mobile users into the fixed environment and vice versa, and how a mobile user will be equipped.

Better integration between different “levels” and systems

This issue has already been touched upon in the section on ease of use above, when we looked at audio when desktop and studio environments were used together. New problems are always introduced when heterogeneous systems are used together. The approach we have adopted to date has been to reduce each different level down to a common composite video signal and an accompanying audio signal. These base components have then been combined together and redistributed back to the appropriate level. This is a solution at the analogue level, and while it offers a practical solution to the problem at hand it is not especially controllable or easily configured. It is dependent upon hardware being in place and connections between elements of the hardware being permanent. If changes are necessary then physical rewiring is sometimes required, not the best of situations to be in.

Even when we reduce things down the common video and audio components, we still face inherent problems when different levels interact – the studio level gives almost instantaneous feedback, while the desktop level has delays due to lower bandwidth, computational overhead and poorer hardware in use. Also, different audio levels are required by desktop and studio, and these must be configured to suit the mix of participants. Currently we have one corner of the matrix configured as a desktop participant, with much lower audio levels to avoid distortion. If this corner is used by a standard studio participant then the levels must be boosted, otherwise the sound is at a very low level and hardly audible.

Our approaches so far have relied on the central mixing of sources. Another way forward is to leave the mixing to the each participant. This does mean that there has to be pair wise connectivity between all meeting participants. The decision of how to display and control the outputs then becomes a local one. This is not a very neat solution, and relies heavily on local expertise to configure and control everything.

The best solution sees the mixing of audio and video being done digitally and decoded to analogue only when it is about to be displayed locally. If everyone is using the same solution, e.g. Streamrunner codecs, then if suitable software is available all

mixing is hidden from the user. However, this is only for homogeneous solutions, and here we are considering how different levels can be made to integrate more easily. Therefore there is a need to produce software codecs that can take different inputs and combine and mix them as necessary. Smile is a step in this direction, providing high quality software-based videoconferencing that is equally at home on the desktop or in a studio. If we rely on hardware solutions at a particular level there will always be problems with interworking between levels. So rather than try and force different methods to interwork seamlessly together we may be better served by coming up with solutions that work across the different levels and naturally support interworking as part of their normal functionality.

Summary

In this section we have considered some of the areas where further work is required to better support distributed meetings. We have concentrated on ease of use, both from the aspect of arranging and setting up the meeting and actual participation, mobility where dynamic and fluid access to standard meeting environments is supported, and interworking between different solutions. We feel these are the areas that offer the best benefit to users of this technology, making it more appealing for people to use virtual meetings.

Beyond VITI

Abstract

The VITI funding from SITI ended at the end of 2000, leaving us with substantial installations at the studio sites but no dedicated high bandwidth network to connect these sites together (the ATM TCS links were funded directly through the VITI funding). This document discusses the possibilities for continuing the work of VITI, concentrating on but not limiting ourselves to the studio-level infrastructure that has been developed, either using alternate networks or else through alternate funding for existing network links.

Introduction

Through the work in the VITI program a great deal of experience and knowledge has been accumulated concerning numerous approaches to videoconferencing and electronic meeting support. Another tangible outcome from the VITI work has been the development and equipping of studios at the principle nodes and the supporting infrastructures that have been put in place at each of these locations. The main component of the work has relied upon dedicated high bandwidth connections in place between the studios, and particularly upon ATM technology, as substantial investments have been made in both network switches and special hardware videoconferencing codecs that use ATM. In this section we consider the different possibilities available to continue the work started by the VITI program, reviewing the facilities in place, the general requirements, and examining the potential of cooperation with other infrastructures that are in place or being established. Finally we present a brief overview of planned future activities we are aware of from our collaborations while working on VITI.

Brief review of facilities at VITI nodes

We summarise the facilities at the four studio nodes, SICS, Viktoria, Luleå and Chalmers, and additionally at Linköping and the Interactive Institute, the two locations with most experience of the desktop level of VITI outside the main four nodes. We see these six locations, or some subset, as being core participants in any future work in this area. Full details for the studio nodes are given in part 1 of this document.

SICS

Of the principal VITI nodes, SICS has the most flexibility when it comes to equipment and local infrastructure. The grotto offers a high quality multi-screen meeting environment for individuals or small groups. Thanks to a sophisticated local audio-visual infrastructure (<http://www.sics.se/~adrian/av>) a number of other rooms can also be used for meetings, with audio and video signals switched locally to and from the appropriate locations. Figure 5.1 shows two such rooms, the small Von Neuman meeting room and the Fika room near the reception.



Figure 5.1: Von Neuman meeting room and the Fika room at SICS

As well as a standard connection to SUNET, SICS is connected to the KTH video network supported by the AMT lab (see below under KTH for more details on this network), and also has the possibility to connect to Framkom via an ATM connection that organisation uses to connect its offices at Kista and Möndal. For the previous ATM network configuration SICS was the centre of a star topology and often acted as a bridge between different organisations using different networking infrastructures. Projectors are located in all the main conference and meeting rooms at SICS, and we have a number of cameras, audio mixing desks and microphones that can be easily set up to provide input and output facilities in the different rooms.

Viktoria Institute

The Viktoria Institute is equipped with a large seminar room with three large rear projected screens, and the custom built small studio with three television sets providing the displays. Viktoria has standard SUNET networking connections and limited local fibre is installed within the institute as well. It is also possible to patch audio and video using a pair of boxes that can be connected using standard UTP network cabling at distances up to 300 metres, thus allowing a third location to be added to the facilities at Viktoria, for example an office.

Chalmers

Chalmers is equipped with a dedicated, high quality videoconference room with two large rear projected screens and a sophisticated local control system for the room concerning cameras and microphones. Chalmers is also highly equipped with H.323 videoconferencing equipment, having a dedicated gateway where four individual signals can be joined together. For this type of conferencing activity (H.323 based) Chalmers is the natural place to be the centre of any topology. ISDN lines can be ordered to provide guaranteed quality levels between participants. In addition to the standard SUNET connection, Chalmers is also connected to the AMT lab in KTH, Stockholm via a dedicated fibre connection, though this connection has yet to be used extensively for prolonged periods of time. This is something we expect will change rather quickly though.

Luleå

Luleå is equipped with a large, state of the art studio/lecture theatre that contains an 8-metre by 2-metre rear projection screen. Currently Luleå only has a standard SUNET network connection. Like the Chalmers room, the Luleå studio is equipped with sophisticated control equipment and the room can be used very flexibly for a number of purposes.

KTH

KTH will play a pivotal role in the future of widespread use of electronic meeting environments throughout Sweden. The Advanced Media Technology lab (<http://www.amt.nada.kth.se>) has established a large, dedicated fibre based video network in the Stockholm county area, connecting many locations together. This infrastructure is easily controlled and configured through web based control pages and connections to SICS and the Interactive Institute in Stockholm (amongst other places) are available today. A cross-country connection to Chalmers is also available for use, though use of this currently requires a little more configuration.

Linköping

Linköping also have a videoconference room similar to that at Chalmers (see Figure 5.2 below). This is connected to the outside world via a standard SUNET connection. We have yet to have any interactions with this room, but it offers potential for the future. To date our interactions with Linköping have used the desktop conferencing system Marratech over standard network connections.



Figure 5.2: Linköping's videoconference room

Interactive Institute

We have connected with the Interactive Institute in Stockholm, first using the desktop-based Marratech system, and later using the dedicated fibre connection provided by KTH AMT. The Interactive Institute only has a 10Mb network connection to SUNET. It has cameras and television sets installed in standard locations at the offices.

Existing video and data network connections

VITI has relied on leased ATM connections for communication between the studios. With these connections no longer available we need to examine the possibilities that exist to provide continued support for interconnections.



The basic data network connecting together all the studios and other VITI locations is SUNET. The main backbone connections (shown in black to the right) offer 622Mb capacities and the other connections at least 155Mb. SUNET is constantly being updated and reconfigured, and at the time of writing some Gigabit connections are being put in place or are planned. See <http://www.sunet.se/karta> for more details on the network and planned upgrades.

With such high bandwidths available, it becomes possible to run bandwidth intensive applications, such as Smile!, over this network without consuming large percentages of the available bandwidth. However, the main drawback when using SUNET is that there is no guaranteed quality of service, and the observed results depend very heavily on how much other traffic is present at any given moment.

Figure 5.3: SUNET network

On most occasions acceptable quality should be achievable (though not at the levels of the ATM-based AVA/ATV approach given initial tests). To some extent when using SUNET we are also relying on services such as Multicast to be supported well, and sometimes there can be problems with these services on the network. So SUNET offers excellent connectivity between all locations with potentially high bandwidths, but does not guarantee any level of service. However, we can only expect SUNET's capacity to increase with time so it is worth investigating conferencing solutions based on this infrastructure.

Aside from SUNET, the other main network that offers possibilities for VITI is the fibre video network controlled by the Advanced Media Technologies lab (AMT) at KTH. This offers many connections in the Stockholm area and a connection to Chalmers, Göteborg on the west coast. The central switches at KTH can be remotely controlled via a web interface, and it is possible to use satellite and other connections that are in place at KTH as well, so KTH can act as a hub in a grander manner than SICS did for VITI. The advantage of this network is that it just relays composite video and audio, so as long as you can feed video and audio signals into the network there are no compatibility or interoperability problems. More technical information on this network is available at <http://www.amt.nada.kth.se/teknik/index.html>.

Future initiatives

Currently we are aware of two activities that have emerged in the wake of the VITI program. The first concerns VUSNET, a videoconference infrastructure in the west coast of Sweden connecting the major high schools and universities in the region together for videoconferencing based on independent systems and platforms. These connections are based around the node at Chalmers and more information on VUSNET is available from Per Gustafson (see the title page for e-mail contact details). Further plans at Chalmers are discussed below in Swedish. Again for more details on these plans contact Per Gustafson.

Den Virtuella Utbildningsplatsen - en vision om möjligheterna för IKT-samverkan

Vid Chalmers tekniska högskola har ett modernt videokonferens- och distansutbildningsrum byggts upp. Detta rum skapar den grundläggande plattformen för Chalmers i den samverkan som kan ske i västra regionen, övriga landet och resten av världen. Rummet är en resurs, vars möjligheter kan bidra till en expansion och utveckling av kommunikativ utrustning. Uppbyggnaden har följts med stort intresse, inte minst från Göteborgs universitet, som under 2001 kommer att bygga om Wallenbergssalen till ett modernt kommunikationscenter.

Tillsammans med avdelningen för media, konferens och service vid GU, kan Chalmers Videokonferens- och Distansutbildning åstadkomma kärnan i ett Västsvenskt samarbete. Detta undertrycks inte minst av den gemensamma satsning som nu görs mellan GU och Chalmers avseende IT-universitetet i Göteborg.

Genomförandet

Den Virtuella Utbildningsplatsen genomförs genom att utöka GU:s fibernät, med en komplettering mot Chalmers (Campus Gibraltar), Lindholmen (Chalmers Lindholmen, IT-universitetet), Universeum och Världskulturmuseet. Detta nät skall användas för att utveckla nya tekniker inom kommunikationsfältet, utan interferens av ordinarie trafik. Genom utveckling av så kallade "Bryggor" och "Grindar", som bildar länkar mellan system, skapas kompatibilitet mellan olika plattformar. Det är den minsta gemensamma nämnaren i systemet som utgör grundstommen för kommunikationen.

För IT-universitetets del, där avståndet mellan undervisningslokalerna på Lindholmen och de övriga centrala campus är påfallande, krävs åtgärder för en ökad flexibilitet och kostnadseffektivisering, avseende lärarnas insatser.

Som ett komplement till den traditionella undervisningen, med lärare i sal, sker föreläsningen via bild- och ljudöverföring med hög kvalitet. Just den höga kvalitén möjliggör interaktivitet och interaktion mellan lärare och studenter, då det inte förekommer någon fördröjning. Applikationer delas parallellt, på separat linje, utan avkall på kvalitet eller med visualiseringsbortfall.

Lärarna kan från sina respektive campus genomföra föreläsningar till och från såväl GU, Chalmers som IT-universitetet, utan att behöva åka som "skottspolar" mellan enheterna. Detta gäller även det utbyte som idag sker mellan Chalmers och Chalmers Lindholmen.

Ansiktet utåt...

En koppling över ett separat nätverk möjliggör en anslutning mot företag och andra institutioner i regionen. Detta ger framtida utvecklingsmöjligheter som inte kan tillgodoses idag.

Universeum och Världskulturmuseet

Universeums uppgift är att stimulera intresset för naturvetenskap och teknik bland barn och ungdomar.

Ett sätt att åstadkomma detta är att nyttja Den Virtuella Utbildningsplatsen.

Med en förbindelse till Universeum och även senare mot Världskulturmuseet skapas ett ansikte utåt, där allmänheten ges möjlighet till närmare kontakt med universitetsvärlden. Genom en daglig uppkoppling mot en aktuell forskare på någon av skolorna, kan besökare på Universeum ställa frågor i realtid och få dessa förklarade. Avstånden överbryggas och närhet med forskaren uppstår.

Tidsdokumentet

Evenemang på respektive enheter kan följas med hög kvalité på andra ställen och även kablas ut mot omvärlden. En koppling till Tidsdokumentet möjliggör visualisering i centrala Göteborg, där evenemanget kan följas i Kuben vid Stora Teatern.

TV-kanaler

Intressanta händelser, debatter, presskonferenser kan på ett enkelt och smidigt sätt förmedlas ut mot omvärlden via de TV-kanaler som är uppkopplingsbara, t.ex. SVT, Öppna Kanalen och övrig Kabel-TV. Vidare kan samarbete med Teracom möjliggöra marksändning över så gott som hela Sverige. Detta gäller även det marksända digitala TV-nätet. Up-link mot satellit sker via GU:s kommande länk.

Samarbetsnoder

Inom det Västsvenska universitets samarbetet (VUS) pågår för närvarande ett planerings-arbete avseende utveckling av flexibelt lärande och flexibel kommunikation mellan högskolorna. När man kommer till den nivå, då det är dags för ett genomförande, finns det risk för begränsningar i det vanliga datanätet mellan högskolorna.

Den Virtuella Utbildningsplatsen kan då komma att utgöra stommen för ett fortsatt arbete.

Pågående och framtida utbredning

??Sahlgrenska Universitets sjukhuset för samarbete med Medicinsk IT, Telemedicin

??KTH/AMT för forskning och utveckling inom Medieteknik

??Luleå tekniska universitet för vidare forskning inom distribuerat ingenjörarbete

Summary

In this final section we have reviewed the facilities in place at each of the organisations that have previously participated in the VITI program. We then discussed the possibilities that exist today to continue this work, given that the dedicated high bandwidth ATM connections are no longer available for use. We concluded by presenting some future plans, which have been influenced or encouraged by the work that was undertaken during the VITI program.

Closing Remarks

To conclude, the VITI program has established infrastructures for desktop and studio level conferencing; firm foundations upon which further use and research activities could be based. Unfortunately it will not be possible to continue directly on with the work, as the ATM networks which formed the backbone of the high quality meeting environments are no longer available. However, valuable lessons have been learned and experiences gained, and we can transfer this knowledge and experience into working with other network technologies. As mentioned in the last section, possibilities of using dedicated fibre connections are emerging, and the capacity of SUNET is improving such that it can support bandwidth intensive applications, such as high quality videoconferencing, better than previously.

The work of the VITI program had reached a critical mass point just as the program was coming to an end. Most of the technical problems had been resolved and more and more regular usage was seen. People were satisfied with the solution provided and started to plan around using the technology in an everyday way. We must try and ensure that we can build upon this positive outlook in the near future, looking at how the results of the VITI program can be most effectively harnessed to provide some form of meeting possibility using the alternate possibilities for wide area connectivity.

Acknowledgements

The work of the VITI program has very much been a team effort, and would not have been possible without the assistance of many people. In particular we would like to thank Peter Törlind for maintaining the Luleå node, Kåre Synnes for support with Marratech and network planning, and Bernt Nilsson for providing technical support at Linköping. David Jonsson and Konrad Tollmar provided technical support at the Interactive Institute. Karl-Petter Åkesson has been a willing test subject as well as providing valuable backup support at the Viktoria Institute in Göteborg. We are very grateful for the support we have received from AMT (formerly CITU) at KTH, especially from Simon Berg and Mats Erixon. Mathias Johanson at Framkom in Göteborg assisted with network configuration. At SICS, Lars Nilsander and Peter Ehlin worked on the program for a short while before moving on to pastures new. Pär Hansson and Mikael Nehlsen have also helped with local configuration issues at SICS. Mikael Gustafson helped in the production of the appendix describing the construction of the Viktoria studio. Finally we would like to acknowledge the guidance of Rainer Berling, from the Viktoria Institute, throughout the duration of the VITI program.

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Appendix: Viktoria Digital Environment, Uppbyggnad av en studio för videokonferens

At the Viktoria Institute there is a seminar room for thirty persons used for education, graphic presentations, videoconferences and cinema evenings. As the difficulties to combine the education purpose with the need to develop high quality videoconferencing, we decided to build a studio in ordinary office. The purpose of this work was to build a conference room with a high quality and a low cost. We found out that it was possible. We could also see that the need of high quality is a field of highest priority. The future work will be to find equipment for high quality at a low cost with a low bandwidth.

Bakgrund

Viktoriasalen, seminarierum

Vid IT-forskningsinstitutet Viktoria, även kallat Viktoriainstitutet, finns ett seminarierum för trettio personer som används för undervisning, grafikpresentation, videokonferens samt biokvällar. Visualiseringsutrustningen består av tre bakprojektionsskärmar med var sin [1]ASK Impression på 400 ANSI LUMEN brutna via två ytfolierade speglar. Skärmarna är monterade med underkanten 1250 mm från golvet. Projektorerna är kopplade till en [14]SGI Onyx, som genererar den grafik som kan visas över de tre skärmarna på ett sådant sätt att upplevelsen blir till en skärm.

Ett högkvalitativt videokonferenssystem med en direktkoppling till SICS i Kista, ger rummet en yttre dimension. Detta system består av två [11] FORE Streamrunner ATV/AVA kopplade via en [4]Cisco Lightstream 1010 och anslutet till [16]Telia City Service (TCS) ATM-nät med en hastighet av 40 Mbps. Diverse annan utrustning såsom ljudmixer, kamera, A/V-router, DVD och VCR, Surround -förstärkare skapar förutsättningar för ett varierat utbud av multimedia.

Viktoriastudion

Då det visade sig vara svårt att kombinera behovet av ett stort seminarierum för undervisning med behovet av en flexibel miljö för uppbyggnad av videokonferens, beslöt vi att uppföra Viktoriastudion, Viktoriainstitutets videokonferens laboratorium. I studion skulle komponenterna för högkvalitativ videokonferens med fokus på kvalitet, anpassad funktionalitet, extremt enkelt handhavande, social kvalitet och integration provas ut under laborativa former. Inom ramen för verksamheten skulle rekommendationer för olika typer av mötesteknik och social integrationen tas fram.



Bild A.1: Viktoriastudion under uppbyggnad

Genomförande

Vi valde att nyttja ett normalt kontorsrum för studion. Genom en flexibel möblering skulle möjligheter skapas för utprovning av olika typer av "sittningar". Antalet mötesdeltagare kom att bli max sju stycken, då rummet inte rymmer för fler. Då kontorsrum oftast är ljusa och försedda med fönster, var den första åtgärden att stänga ute dagsljuset. Vid all slags videoupptagning är det viktigt för ett gott resultat att man kan kontrollera ljus och ljud. Väggarna försågs därför med draperier av en någorlunda "tung" kvalitet. Mot fönstren gjorde vi dem dubbelsidiga, med en mörkläggnings textil. Draperiernas förmåga att absorbera ljud, motverkar ett rums normala ljudreflektion, på ett sådant sätt att efterklängen upphör. Mot taket vidtogs ingen åtgärd, då detta har ett relativt gott värde.

Mot fönstersidan placerades ett bord för tre stycken TV-apparater. Dessa valdes för att erhålla en så skarp bild som möjligt, med avseende på användningen. Här skulle det röra sig om max sex personer på ett kort avstånd, varför större bild än 33" ej ansågs vara nödvändigt. Apparaterna kom att bli av [5]Grundigs fabrikat, då de hade en modell som var förberedd för "Bild i Bild" och VGA. "Bild i Bild", även kallat "PiP" (picture in picture), möjliggör användandet av flera videoingångar, så att man kan bevaka eventuella händelser på en annan kanal. VGA-modulen ger koppling mot dator med en upplösning av max 640x480. Detta kan tyckas vara litet, detta ger en större bild med bra kvalitet. En datorskärm eller en dyrare monitor för video och VGA, med en högre upplösning, ger endast en mer grovkornig bild då bilden ej innehåller tillräckligt med information för att fylla rutan.

Mot den apparat, som placerades i mitten, vinklades ett mötesbord. Detta bord gavs möjlighet att kunna vridas i en halvcirkel, med fästpunkt mot TV:n. På så sätt kan en flexibel sittning åstadkommas. På kortändan av bordet monterades en skrivkiva för tangentbord och mus. Här sattes även växelpanelen för kameraingångarna. I taket

fästes ett V-format stativ för spotlight, mikrofon och OH-kamera. Detta stativ möjliggör rörelse för utrustningen åt olika håll. Mitt i bilden på den mittersta TV:n placerades en kamera. Denna placering motiveras av att den inkommande bilden skall betraktas på ett sådant sätt att minsta möjliga vinkel erhålls till den sändande kameran. Detta för att eliminera känslan av att man tittar förbi den man talar med (genom att nyttja "eye2eye-teknik" kan man komma förbi detta problem, jmf [19]Telepromth). En översiktscamera placerades i taket mot ett hörn, för att fånga upp så många personer som möjligt. Huvudkameran, en [15]Sony EVI-31, som är fjärrstyrd med möjlighet till fasta lägen och såkallad "pan, tilt & zoom" fick sin plats ovanpå den mittersta TV:n. Här kan då en av de deltagande personerna styra kameran efter behov. En såkallad bevaknings "Quad" från [18]Philips, genererar en fyrdelad bild, som möjliggör sändning av alla kameror samtidigt. I hop med en VGA-scanner kan denna fungera som en "brygga" och "grind" mellan olika system.

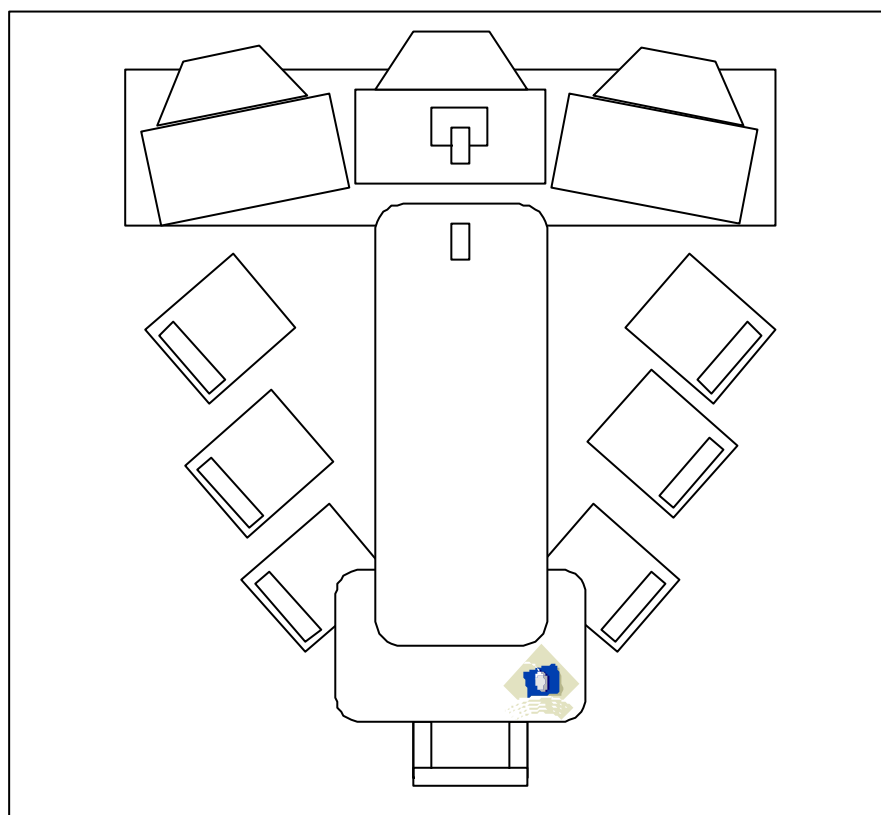


Bild A.2: Stolarnas placering

Ett mikrofonsystem bestående av mixer från [2]Behringer och mikrofon från [12]Røde med en placering i taket, gav tillräcklig upptagningsförmåga för ljudet. För återgivning av inkommande ljud användes TV-apparatens högtalare.

Med en dator från [3]Computime, av god prestanda skapades förutsättningar till traditionell videokonferens via den [13]RadVision Gateway/Gatekeeper som finns på Chalmers tekniska högskolas videokonferens- och distansutbildningsrum. Datorn försågs med ett videokonferenskort från [17]VCON, Escort 25 även det kopplat till mikrofon- och högtalarsystemen.

För att även kunna återge konferenser distribuerade via programvaran [10]Marratech, monterades ett [6]WinTV-kort. Detta kort kopplades till en

[8]KonfTel konferenstelefon, som har line in och line out. När denna inte används till datorn, kan den användas som en vanlig konferenstelefon kopplad via en digital systemtelefon.

Bordets konstruktion möjliggör sittande med en ”sned” placering in mot skärmarna och på så sätt kan man lättare följa samspelet mellan deltagarna. Under den långa bordskivan finns utrymme för utfällbara hyllor avsedda för Laptops.

Som en förlängning av studion anslöts även köket på sjätte våningen till systemet via nyttjande av befintlig UTP-kabel mellan våningarna, på så sätt slapp vi onödig kabeldragning via brandtätningar m.m. Till detta användes små sändare och mottagare från [9]KRAMER. Genom detta förfarande kunde vi utöka antalet personer i ”rummet” med ytterligare tjugo.

Användandet

Ett av delmålen var att skapa system för extremt enkelt handhavande. Genom att förbereda utrustningen för kompatibilitet mellan plattformar skulle detta åstadkommas. Ett av de första tillfällena då studion kom att användas var när förbindelsen över ATM till Luleå inte hade kommit igång. Vi fick då i uppgift att lösa problemet med att knyta samman ATM mellan Viktoria och SICS med en annan lämplig utrustning i Luleå. Genom att deltagaren fick bege sig till Kalix Folkets Hus kunde vi via Chalmers Gateway ringa upp honom över ISDN från Viktoria. Bilden från Kalix fick passera scannern och kunde på så sätt plockas ut som en videobild. Genom att agera stjärna i navet kunde vi lägga ut alla bilder via Quad:en och på så sätt åstadkomma en gemensam bild där alla ingick. All interaktion föregick via denna bild, även den i rummet, på så sätt kom ingen att känna sig utanför.

Resultat

Vi kunde visa att man med enkla medel kan bygga en högkvalitativ studio för videokonferens, utan att det kostar miljoner. Slutsumman för detta projekt kom att hamna under 150 kkr.

Vår målsättning var att bygga en plattform för visualisering med en överkomlig prisnivå. Genom att välja konsument apparater (TV) fick vi en kostnad/nytta nivå, mer intressant mot om vi hade valt en dyr utrustning också kräver dyrbara reinvesteringar för att man skall kunna följa med nödvändig utveckling i funktionalitet, prestanda och kvalitet.

I grunden till detta system finns ATM-utrustningen, som i sig självt är en hög kostnadsfaktor, både hårdvaru- och transmissionsmässigt. Det fortsatta arbetet kommer att leta lösningar för andra typer av transmissioner t.ex olika nivåer av MPEG alternativt MJPEG och då via TCP/IP.

Vi kunde konstatera att hög kvalitet är ett måste vid videokonferenser då upplevelsen skall bli bra och behållningen god. Om man åstadkommer en relativt hög funktionsökning på ett befintligt system, är det inte säkert att man ökar användarnas intryck av att tekniken är användbar.

Flertalet av de som nyttjar videokonferensanläggningar har högt ställda krav på tekniken. Den referens som anges vid dessa tillfällen är tyvärr TV-mottagning. Att

använda sig av video-konferens är inte lika med att titta på TV. Trots detta görs ständigt jämförelsen. Det krävs därför en höjning av kvalitén för att acceptera utnyttjande av tekniken.

Enligt [7] Jobrings tes om den ”exponentiellt” positivt ökande marginalupplevelsen, där vi får maximal nyttaupplevelse först vid funktionsförbättringar nära fullkomlighet i bild och ljud, måste vi sträva efter system som möjliggör detta.

Vinsten med funktionsförbättringarna görs först vid denna nivå då full acceptans hos användarna inte kan tillgodoses tidigare. Ett fortsatt arbete är att finna system för fullkomlighet i bild och ljud till ett pris av låg bandbredd.

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