Teleworking in Co-operative Development of Industrial Software

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Abstract

*This paper addresses why and how the European ACTS project **TECODIS** (AC064) demonstrates and evaluates the use of teleworking by running an industrial software project, named the **TECODIS** Industrial Project Demonstration, using the **TECODIS** Teleworking Platform. In addition, an overview of existing standards and products in the area of video-conferencing is given.*

Keywords: *TECODIS, Teleworking, Video-conferencing, T.120, H.320, H.321, H.323, H.324.*

1. Introduction

Due to increasing competitive pressure resulting from globalisation, organisations are looking for better ways to face this challenge, even including the possibility to "re-invent" themselves. They need more flexible and effective working methods. Teleworking is now seen as one possible answer to this problem.

In this context, the main objective of the ***TECODIS*** project is to demonstrate that a more flexible and cost-effective allocation of skilled resources is possible by resorting to teleworking with the support of existing advanced communication technologies and services [TEC98].

Subsequently, with the help of telework the overall efficiency of a organisation could be improved, the lead time required for distributed industrial development software projects can be reduced, and a better quality of life perspective can be assumed for key participants.

TECODIS is an European ACTS [ACT98] project integrating results from a wide range of research disciplines in information technology and telecommunications, as well as from market analysis and methodologies for requirement capture.

2. Definition of Teleworking

The word *"Telework"* is becoming more and more important in industry. Telework covers a broad range of new ways of organisational work removing conventional conditions of space and time through telecommunications networks. It could be summarised with the expression: *in the information society, work can be done at any place and at any time.*

In this framework the traditional office environment becomes one alternative of corporate and personal work and anymore the only one.

Among various definitions and ways of telework could hardly be found consensus. The distinction after the characteristic "work place" is however by far the most common way. Hence, we will also uses it in our

approach. Telework can be divided in four different basic forms, see also Fig. 1 below:

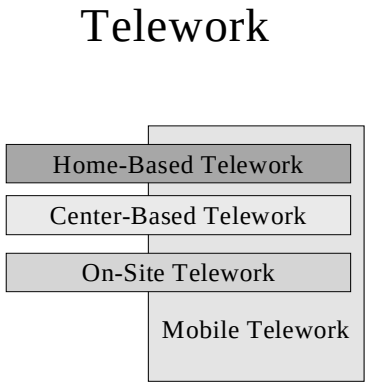

Figure 1: Telework

- **Home-based Telework** means all kinds of work from the employees living place.
- **Center-based Telework** defines all forms of bundling teleworkstations in Telecenters. For enterprises to bundle distributed work locally is the main goal.
- **On-Site Telework** defines teleworking at the site of the customer, supplier, etc.
- **Mobile Telework** stands for location independent working, i.e. 'mobile office'

These possibilities certainly do also include work across borders, and the opportunity to perform work in different time schedules. All these possible features have a major impact on cost reduction, employment flexibility, and environment responsiveness.

Assuming that teleworking is one form of work organisation, it can be stated that telework could be suitable to most of sectors of activities. Hence, telework is interesting for activities such as banking, insurance, telecommunications, computing, designing, accounting, sales by correspondence, teaching, publishing, software development, and so on.

3. Current Methods in Distributed Software Development

Due to the evolution of the markets and technology, the development and maintenance of large communication systems of high quality and very short lead times has become one of the most important issues in the current industry, almost a question of survival.

Nowadays, the large ratio of engineers and the broad spectrum of competence needed to be successful in the development of such systems. Besides historical and political reasons, this leads international companies to establish development centres in different locations and very frequently in different countries on the globe. Systems are developed in close co-operation. This co-operative way of working increases the difficulty of project co-ordination and project management with a direct impact in the quality and lead-time of the products, and increases the cost of the project, because of travel costs and the time employed.

It is worth considering the way the allocation of development responsibilities takes place when considering the development of big systems.

Big systems are generally decomposed into architectural smaller components (sub-systems) that interwork with each other to implement the desired system's functionality. This interworking takes place across well-defined interfaces, following strict protocols. The main protocols for a state of the art videoconferencing system are briefly described in the following chapter.

Of course, this decomposition process can be recursively utilised, depending on the system's level of complexity (or functional size).

4. Teleworking Platforms

In the following sections we will concentrate on existing videoconferencing systems and according standards, which both has been investigated in the framework of the evalution part of the ***TECODIS*** project.

4.1 Videoconferencing Systems

Room videoconferencing has been used for some time as a means for groups or individuals to meet each other and to substitute long business trips.

Advances in computer technology such as faster processors and better data compression schemes have made it possible to integrate audio and video data into the computing environment. A new type of videoconferencing, desktop video-conferencing, has become possible. Unlike room videoconferencing, which requires specially equipped rooms with expensive hardware, desktop videoconferencing can be achieved by adding software and hardware to standard desktop computers.

One benefit of desktop videoconferencing is the convenience of not having to physically move to a special location. Another benefit is the ability to incorporate data from other desktop computer applications into the conference. Desktop videoconferencing systems typically cost a few thousand dollars (high-end) or even less to set up, which is significantly less expensive than room videoconferencing systems which typically cost a minimum of $10,000 to set up.

4.2 The T.120 Recommendation

The ITU recommendation T.120 [T.120] defines a multipoint data communication service for use in multimedia conferencing environ-ments. It provides facilities to establish and manage interactive communications involving two or more participants on and between a variety of different networks, and comprehensive data communication service for the participants.

Moreover, T.120 defines an architectural model and shows the interrelationships between the constituent standards.

The T.120 standard makes provisions to ensure interoperability of commonly required functionality such as file transfer, motionless image exchange and shared whiteboard.

The T.120 protocols provide also:

- Support for conference establishment among a group of network nodes,
- Mechanisms to identify the participating nodes and a comprehensive roster and capability exchange mechanism,
- Flexible management of communication between any combination of these elements.

The T.120 protocols can handle one or more simultaneous conferences. They have the capability to organize different rates of information flow, within the constraints imposed by the type of network and connections established thereon.

4.3 The H.32x Series

Videoconferencing should be based on the ITU-T recommendations on multimedia, which are described in the following sections. A generic visual telephone system consists of terminal equipment, a network, and other system operation entities.

The videoconferencing terminal equipment consists of:

- Video I/O (camera, monitor and video processing units)
- Audio I/O (microphones, loudspeakers and audio processing units)
- Telematic equipments (electronic blackboard, still picture transceiver)
- System control unit
- Video / audio codec

- Delay compensation in the audio path to maintain lips synchronization with the sound. The video codec process requires more time as the audio codec process.
- Mux/Dmux units, which multiplexes/ demultiplexes the different bit streams
- Network interfaces

From these different elements, are resulting four different kinds of signals: audio (real time transmission), video (continuous traffic), data (may occur only occasionally as required), and control (system control signal, provided in the D-channel).

4.3.1 H.320 Narrow-band visual telephone sytems and terminal equipment

The H.320 standard [H.320] specifies technical requirements for narrow-band visual telephone systems and terminal equipment, typically for videoconferencing and videophone services. It describes a generic system configuration consisting of a number of elements which are specified by respective ITU standards, definition of communication modes and terminal types, call control arrangements, terminal aspects and inter-working requirements.

4.3.1.1 Bit rate option and infrastructure

Different communication modes of visual telephone are defined according to the channel configuration and coding. Different terminal type are also available, categorized according to the communication modes and the type of channels of the communication.

The video codec respects the H.261 recommendation. The audio codec depends on the audio quality required. The different audio quality levels are implemented according to the G.711, G.722, G.728, and H.200/AV.253 standards.

The frame structure respects H.221, the Control and indication data stream H.230, and the call control procedure H.242.

4.3.1.2 Transmission and presentation of audiovisual information at the start of visual telephone call

The audio signal should be presented to the user so that the conversation can promptly be started as soon as the initial channel is established and the audio coding law is known. The video picture may or not may visible to both users as soon as the initialisation is complete.

4.3.1.3 Intercommunication

Intercomunication with other visual telephone terminal shall be possible with:

- ISDN telephones: the operational mode of communication is G.711 speech or G.722 audio.
- PSTN telephones: the operational mode of communication for a call from a visual telephone to a PSTN telephone is G.711 audio coding. For the opposite case, the operational mode of communication is 3.1 kHz audio.
- Other audiovisual terminals: a common mode of operation is determined according to the H.200-series.

4.3.2 H.321 Adaptation of H.320 visual telephone terminals to B-ISDN environments

The H.321 standard [H.321] describes the technical specifications for adapting H.320 terminals to broadband ISDN environments. The terminal conforming to this recommendation interworks with the same type of terminals (i.e. other H.321 terminals) accommodated in B-ISDN as well as existing H.320 terminals accommodated in N-ISDN.

Interworking between H.320 and H.321 terminals is achieved, because the different H.321 terminal types, defined in this recommendation, have the same functions supported by the corresponding H.320 terminal types. Interworking between H.320/H.321 and H.310 terminals is

achieved through a common set of H.320/H.321 functions (defined in the H.310 standard). In H.321 terminals, the adaptation of H.320 functions over B-ISDN is achieved through ATM Adaptation Layer 1. Both Segmentation and Reassembly and Convergence Sublayer functions are considered in this recommendation.

The terminal can be used for various applications such as conversational services, distributive services, retrieval services, messaging services as the existing H.320 terminal can.

The H.321 terminal is mapped onto the B-ISDN reference configuration, which is described in recommendation I.413.

4.3.2.1 Terminal type

Several H.321 terminal types are defined according to the channel access capability, bit rate classes, and audio coding schemes. Each H.321 terminal type has a corresponding terminal defined in H.320.

The number of ATM Virtual Circuits that must be supported by a given H.321 terminal is the same as the number of N-ISDN channels supported by that terminal type (or the corresponding H.320 terminal).

An H.321 terminal can participate with other H.320 or H.321 terminals to a multipoint communication through a Multipoint Control Unit (MCU, see section 4.3.4.5) installed on a B-ISDN or an N-ISDN.

4.3.2.2 Intercommunication

The intercommunication shall be possible with H.321 and H.320 terminals through gateways, as much as with telephony (interwork with accommodated in N-ISDN and PSTN using G.711 audio) and audiovisual terminals connected to other networks (a common mode of operation among H.322/H.323 and H.321 terminals shall be determinated).

4.3.3 H.322 Visual telephone systems and terminal equipment for LAN, which provide a guaranteed quality of service

The H.322 standard [H.322] covers technical requirement for narrow-band visual telephone services defined in H.200/ AV.120-series. In those situations where the transmission path includes one or more LANs, each of which is configured and managed to provide a guaranteed QOS equivalent to N-ISDN such that no additional protection or recovery mechanisms beyond those mandated by the H.320 standard need be provided in the terminals. Pertinent parameters are the data error and loss properties and variation of transit delay this standard also requires that the ISDN clock is available at the terminals.

Systems and terminal equipment complying with this recommendation are able to interwork with each other and with those complying with H.320, H.321 and H.323. The H.322 gateway unit provides an interconnection between the LAN and the WAN which may be N-ISDN or B-ISDN or both. An H.322 terminal communicates with another H.322 terminal on the same LAN directly. The gateway may be connected via N-ISDN or B-ISDN to other gateways and LANs to provide communication between H.322 or H.323 terminals which are not on the same LAN.

An H.322 gateway may also contain the functionality of a MCU and the functionality to simultaneously broadcast to a number of terminals. Although this recommendation specifically addresses visual telephone systems, the methods used do not depend on the content of the signals carried. Consequently this standard has more general applicability to connecting terminals, originally designed for N-ISDN, over LAN or hybrid LAN and ISDN networks.

4.3.4 H.323 Visual telephone systems and equipment for LAN which

provide a non-guaranteed quality of service

The H.323 standard [H.323] also covers technical requirements for narrowband visual telephone services defined in H.200/ AV.120-Series. In particular those situations where the transmission path includes one or more LAN, which may not provide a guaranteed QoS equivalent to that of N-ISDN need to be supported by the terminals. Pertinent parameters are the data error, loss properties, and variation of transit delay.

H.323 terminals may be used in multipoint configurations. This means they may interwork with H.310 terminals on B-ISDN, H.320 terminals on N-ISDN, H.321 terminals on B-ISDN, H.322 terminals on Guaranteed QOS LANs, H.324 terminals on PSTN and wireless networks, and V.70 terminals on PSTN.

4.3.4.1 Gateway

The gateway provides the appropriate translation between transmission formats and the communications procedures. It also provides the necessary conversion between the different terminal types.

It performs call set-up and clearing on both the LAN side and the SCN side. It also makes the translation between video, audio, and data formats, reflect the characteristics of a LAN endpoint to an SCN endpoint, and the reverse, in a transparent fashion.

An H.323 endpoint may communicate with another H.323 endpoint on the same LAN directly and without involving a Gateway.

It may be possible for a terminal on one segment of the LAN to call out through one Gateway and back onto the LAN through another Gateway in order to bypass a router or a low bandwidth link.

4.3.4.2 Gatekeeper

The gatekeeper provides call control services to the H.323 endpoints. The Gatekeeper is logically separate from the endpoints. Its physical implementation may coexist with a terminal, MCU, Gateway, MC, or other non-H.323 LAN device.

It shall provide the address translation, admission control, bandwidth control, zone management, call control signalling, call authorization, bandwidth management, call management, gatekeeper management information data structure, bandwidth reservation for terminals not capable of this function, and directory services.

4.3.4.3 Multipoint Controller (MC)

The MC provides control functions to support conferences between three or more endpoints in a multipoint conference, and:

- carries out the capabilities exchange with each endpoint in a multipoint conference,
- sends a capability set to the endpoints in the conference indicating the operating modes in which they may transmit,
- may revise the capability set that it sends to the terminals as a result of terminals joining or leaving the conference, or for other reasons.

In this manner, the MC determines the Selected Communication Mode (SCM) for the conference.

4.3.4.4 Multipoint processor (MP)

The MP receives audio, video and/or data streams from the endpoints involved in a centralized or hybrid multipoint conference. The MP processes these media streams and returns them to the endpoints.

Its other functions are:

- Providing either video switching or video mixing
- Preparing N-audio outputs from M-audio inputs by switching, mixing, or a combination of these
- Providing algorithm and format conversion, allowing terminals to

participate in a conference at different selected communication modes

An MP is not callable. However, the MCU that is a part of the MP is callable. It terminates and sources the media channels.

4.3.4.5 Multipoint Control Unit (MCU)

The MCU is an endpoint that provides support for multipoint conferences. The MCU shall consist of an MC and zero or more MPs. The MCU uses H.245 messages and procedures to implement features similar to those found in H.243.

A typical MCU that supports centralized multipoint conferences consists of an MC and an audio, video and data MP. A typical MCU that supports decentralized multipoint conferences consists of an MC and a data MP supporting T.120. It relies on decentralized audio and video processing.

The LAN side of a Gateway may be an MCU. A Gatekeeper may also include an MCU. In either case they are independent functions that happen to be co-located.

4.3.4.6 Intercommunication

Interoperation with other terminals shall be accomplished through different gateways. The intercommunication is possible with speech only terminals, visual telephone terminals over ISDN, GSTN, mobile radio, ATM, guaranteed QoS LANs, T.120 terminals on the LAN.

4.3.5 H.324 Terminal for law bit rate multimedia communication

The H.324 standard [H.324] describes terminals for low bitrate multimedia communication, utilizing V.34 modems operating over the PSTN. H.324 terminals may carry real-time voice, data, and video, or any combination, including video-telephony.

H.324 terminals may be integrated into PCs or implemented in stand-alone devices such as video-telephones. Support for each media type (voice, data, video) is optional, but if supported, the ability to use a specified common mode of operation is required, so that all terminals supporting that media type can interwork. This standard allows more than one channel of each type to be in use.

This recommendation makes use of the logical channel signalling procedures of H.245, in which the content of each logical channel is described when the channel is opened. Procedures are provided for expression of receiver and transmitter capabilities, so transmissions are limited to what receivers can decode, and so that receivers may request a particular desired mode from transmitters. Since the procedures of H.245 are also planned for use by H.310 for ATM networks, and H.323 for non-guaranteed bandwidth LANs, inter-working with these systems should be straightforward.

H.324 terminals may be used in multipoint configurations through MCUs, and may interwork with H.320 terminals on the ISDN, as well as with terminals on wireless networks.

4.4 H.32x-based Commercial Tools

Already some software tools developped according to the H.32x and the T.120 standards are available. In the following sections we are describing the tools White Pine [WPi98], NetMeeting [Mic98], Intel ProShare [Int98], ShowMe [Sun98] and Paradise Simplicity [Par98].

4.4.1 White Pine

White Pine offers different conferencing software packets for enabling people to share live video, audio, and data, as well as connectivity software for enabling users of PCs and Macintosh to access data on other computers [WPi98].

4.4.1.1 CU-SeeMe

CU-SeeMe started the craze for videoconferencing on the Internet for PC (Window 95/NT) and Macintosh (MAC OS system 7.6). It is a full-featured software for seeing, hearing, and sharing. It can be used over the Internet or any TCP/IP network.

By using the "reflector" software, multiple parties at differente locations can participate in a CU-SeeMe conference, each from his desktop computer.

CU-SeeMe uses video frame-differencing and compression algorithms in order to open networked videoconferencing capability to users of lower cost desktop computers and enables broader participation video-conferencing technology.

It is possible to make person-to-person calls or to join a conference room. Cu-SeeMe includes full-colour video and audio, text chat, and electronic whiteboard. It offers a choice of video and audio codecs for best performance over a various network speeds.

The development of CU-SeeMe has been inspired from tools like "nv", "ivc" or "vic" available for Unix workstations. More recent version for Mac allows the exchange of slides.

4.4.1.2 MeetingPoint

MeetingPoint Conference Server provides a virtual meeting place for networked PCs (Windows NT + Web browser) users to interact using video, audio, text chat, and data (whiteboard) in real time.

MeetingPoint allows all the H.323 standard-based software to participate in a group conference simultaneously. MeetingPoint is the server component of White Pine's videoconferencing solution. It is a multicast-capable conferencing software with intelligent optimization of network resource consumption and real time conference monitoring.

MeetingPoint is soon to be released for Sun Solaris. The White pine Reflector version 2.1 for Unix workstations is still available.

4.4.1.3 ClassPoint

ClassPoint is a distance learning software, which offer a complete distance learning solution for use over a LAN, WAN, or the Internet, for PC (Windows NT) workstations.

ClassPoint is an instructor–controlled learning environment with web-based class setup and sheduling, multipoint video and audio, instructor-led Web tours, interactive quizzes, shared whiteboard and chat.

ClassPoint has 3 components:

- ClassPoint Planning Center: server software used by the administrator
- ClassPoint Instructor: client software used by an instructor
- ClassPoint Student: client software used by each student in a class

ClassPoint is commercially available since the end of the first quarter of 1998.

4.4.2 Microsoft NetMeeting

NetMeeting is a videoconferencing software for PC (Windows 95/NT). It produces high quality, real time video images and audio even over low bandwidth connection. The data conferencing features permit to collaborate with a group of people from within any Windows application. NetMeeting video, audio, and data conferencing are all based on industry standards, so the communication is possible with people using compatible products. It includes application sharing, file transfer, a shared clipboard, a whiteboard and a chat editor.

NetMeeting allows also changing the size of the window, the video capture with existing hardware, to receive images without video hardware, to switch audio and video.

A future release is planned to support Apple Macintosh and Unix operating systems.

4.4.3 Intel ProShare

The Intel ProShare Conferencing Video System 200 is the PC (Windows 3.1x/95) desktop video conferencing solution that allows communication and exchange information worldwide over ISDN and LAN. Intel ProShare Conferencing includes compliance to H.320 and T.120, full audio/video/data multipoint capabilities.

It incluse also a video voice mail answering machine, a conference recording machine, a professional audio headset, full-screen video window, multipoint application sharing, multipoint notebook, photo exchange, high-speed and background file transfer, ISDN voice call support.

4.4.4 Sun Microsystems ShowMe

The ShowMe product family offers a complete multipoint videoconferencing solution. ShowMe is designed to run on Sun SPARC based workstations on the existing TCP/IP-based LAN or WAN over the existing medium.

ShowMe Video permits a face to face meeting through networked-based video conferencing. It includes several options like video mute, colour control, high resolution snapshot.

ShowMe Audio is the networked-based audio conferencing feature of ShowMe that comes together with all the other ShowMe capabilities. ShowMe Audio provides an uncompressed 8-bit, 8KHz audio bit stream at 64 Kbps. It allows full/half duplex, adjustable volume, and audio mute.

ShowMe Whiteboard is a dual layer whiteboard through which all conference participants can view and contribute. Each participant has a color-coded on-screen marker.

ShowMe SharedApp enables users to share their applications, by providing a common, identical view of an application and allowing users to collaboratively interact with the application.

4.4.5 Paradise Simplicity H.323

Paradise Software Inc. introduces Simplicity H.323 for Sun SPARC station and PC.

Simplicity H.323 is controlled from a Web browser as a JAVA/HTML application.

Simplicity H.323 includes the Paradise Software Motion-JPEG Extension, an optional, premium codec that delivers uncompromising video quality. Based on the Parallax Graphics XVideo JPEG codec, Simplicity H.323 support 30 fps NTSC/PAL resolution, near-broadcast quality video delivered at 4 to 12 MBits/sec. It also includes the Paradise Software Native ATM Extension. This feature allows you to switch to AAL5 Multicast for the conference to transport the critical audio and video data and to take full advantage of ATM's QOS capabilities.

It includes audio, video, and whiteboard for both PC and Sun SPARC, shared applications are only available for Sun SPARC.

4.5 H.32x-based Solutions

A videoconferencing system is a combination of hardware and software. In the following sections the videoconferencing solutions of VTEL [VTE98], Intel [Int98], Elsa [Els98], and VCON [VCO98] are described.

4.5.1 VTEL

VTEL offers a large range of videoconferencing solutions: Workgroup Systems, Personal Systems, and Rooms Systems. All of these solutions are H.320 standard compliant.

The *Workgroup Systems* products are designed for geographically dispersed

workgroups. These products are based on a PC hardware platform offering high quality video and performance data collaboration tools, standards compliance offer T.120, integrates Microsoft NetMeeting for the whiteboard and application sharing, network flexibility. This solution includes also a 27'' SVGA monitor.

The *Personal Systems (SmartStation)* converts a windows 95-based PC into a digital visual communications system compatible with VTEL systems and standards-compliant products from other manufacturers. The SmartStation offers a high qulity audio and video, a wide variety of connectivity options including ISDN and ATM, dynamic bandwidth T.120 multipoint data transmission, and integrated Microsoft NetMeeting.

The *Room System* is a scaleable product, assure a total interoperability of video/audio/ data conferencing features, is a fully integrated solution, and is manageable with existing network infrastructures. This solution includes one or two 27'' or 32'' monitors and the Intel Proshare software.

4.5.2 Intel Business Video Conferencing

Intel Business Video Conferencing with ProShare Technology is a complete desktop solution standard-based videoconferencing over ISDN and LAN. This kit for desktop PC includes all needed for audio/video/data conferencing. It provides an audio quality, a crisp video images and smooth movement.

Intel Business Video Conferencing is compliant with industry standards for ISDN (H.320), LANs (H.323) and application-sharing (T.120/Microsoft NetMeeting).

It includes an ISDN BRI I/F board, a composite colour video camera, audio headset, microphone.

4.5.3 ELSA Vision 32

The ELSAvision 32 videoconferencing system is a sophisticated 32-bit solution. It is the first ISDN videoconferencing system that fully supports Windows NT 4.0. Complete with an ISDN/video board, camera, headset, and the NetMeeting conferencing software, ELSAvision 32 is easily integrated into a PC (Windows 95/NT) workplace.

ELSA vision 32 is H.320, T.120, and H.323 compatible.

4.5.4 VCON

VCON's Escort systems is a videoconferencing solution for PC, coupled with a Router or Gateway, allow seamless communication from the LAN (H.323) based desktop to other LAN or WAN (H.320) connected systems.

The VCON software package integrates Microsoft NetMeeting for full application sharing through the T.120 protocol.

5. Technical Approach of TECODIS

TECODIS will demonstrate the use of teleworking by running an industrial software project, named the ***TECODIS*** **Industrial Project Demonstration**, using the ***TECODIS*** teleworking platform. In order to do this, requirements for the platform have to be defined, the platform components must be assembled, integrated and installed at the participating sites. A small test software design project, named the **Validation Project**, will be run using the ***TECODIS*** platform in order to validate the requirements on the platform.

The ***TECODIS*** evaluation of teleworking will be based on the ***TECODIS*** Industrial Project Demonstration. The evaluation of teleworking will include a comparison between the working methods used and results achieved in the ***TECODIS*** Industrial

Project Demonstration and a similar project which did not use teleworking.

The ***TECODIS*** Industrial Project Demonstration will be based on the co-operative development of large-scale real-time software systems by a team of people, which is distributed across several European companies based in satellite offices. It will also involve accessing the knowledge of experts not located in any of the development sites.

This type of distributed engineering scenario is one which could be used in many large industries and the evaluation of the results will take advantage of this point to show how the results can be applied to general project management and flexibly re-engineered working patterns involving, e.g. telecommuting.

6. The ISABEL Application

The heart of the ***TECODIS*** teleworking platform is the ISABEL application [ISA98]. ISABEL is a CSCW application (Computing Supported Co-operative Work) developed by the University of Madrid, especially to support big group conferences, optimising network resources and providing a flexible control flow. The aim of the ISABEL application is to take benefit of the broadband technology in order to provide a good support to new distributed multimedia services. It is allowed being used not only over LAN but also over narrowband and broadband networks. The application has been specifically designed to run synchronous distributed events, namely teleconference, telemeeting, teleworking, and teleteaching.

6.1 Network Infrastructure

The ISABEL application generates two different kinds of IP traffic: unicast and multicast traffic. Therefore, two separate networks are usually devised for each type of traffic.

- The first is used to transmit Application Protocol Data Units (e.g. control commands), and make use of TCP/IP (connection-oriented).
- The second carries most of the multimedia stream and makes use of UDP/IP (connection-less).

The multicast traffic is routed to a root site, which aggregates the different streams into a single global stream and distributes this global multimedia flow to all attached nodes. Therefore, we can differentiate the multicast traffic into two different streams:

- The Upstream: generated at each station and flows from each station to its network node toward a root node
- The Downstream: output of the root network node station travelling to all end-point stations

Each station has a low bandwidth bi-directional channel to support unicast traffic, and two unidirectional circuits for the multicast traffic (upstream and downstream).

The ISABEL application supports the following network environments:

- ATM: The configuration of ATM network comprises ATM LANs and the Pan European ATM Network, using IP/AAL5/ATM with multicast both at the IP level and at the ATM level.
- ISDN only one channel at 64 kbit/s is enough to support all the functions of ISABEL at a minimum quality. However, this quality is only satisfactory for desktop telemeetings or teleworking. The inverse multiplexing of at least 6B channels is necessary to provide a quality acceptable to support a conference service.
- Satellite network
- Internet (TCP-UDP/IP) directly through LANs and the public Internet.

6.2 The ISABEL Architecture

The ISABEL application is supported on the top of generic application architecture, which provides a general framework to build almost any distributed CSCW environment. Thus, three subsystems have been defined, which are described in the following sections.

6.2.1 Conference Co-ordinator Layer

This layer consists of a daemon activated by the originator of each particular conference. An IP port number and a host name define a conference. This information helps user to identify the conference and it is used to configure the application daemon in order to co-ordinate the conference.

6.2.2 Conference Adaptation Layer

This layer consist on a set of functions devoted to transfer different types of control information between the common conference subsystem and each component integrated in the ISABEL Co-operative Work Application.

6.2.3 Cooperative Component Layer

Application components are the real programs executed by user to perform certain type of interaction within the conference. ISABEL application has been designed using X.11 windows system because it has been selected as the industry standard user interface software system to develop and integrate graphical applications. The application component integrated within ISABEL have been selected in order to allow the highest functionality with the lowest integration effort and better performance in order to address the ISABEL objective, that is, to get a flexible tool to allow distributed parallel work.

The ISABEL consists of different components such as audio/video distribution tools, distributed slides projector, distributed pointer, distributed whiteboard, co-operative text editor, distributed display, application sharing.

7. Summary of Trials

The ***TECODIS*** trial based on running a real industrial project under a real working environment will involve **three Ericsson's design centres** in Madrid (Spain), Stockholm (Sweden) and Aachen (Germany), using the principles contained in the ***TECODIS*** teleworking model for software development and running on the ***TECODIS*** teleworking platform. The trial started in April 1998 and will finish in October 1998.

The ***TECODIS*** trial will be closely monitored and evaluated to strengthening the learning process. In a first instance this evaluation will review the feasibility of teleworking in a real environment. This will be done from both, a technical point of view, i.e. availability of the applications and networking technologies and services, and from an economical point of view, i.e. relative measurement of the economical feasibility of the solution and comparison among the different networking technologies.

Finally, the ***TECODIS*** project will asses how the bottom-line parameters associated to the business process, i.e. cost, lead-time and quality, are affected by the introduction of these new more flexible and efficient ways to use the existing resources. This will be done by studying the possible impacts on the organisational structure and the business process, i.e. the possibility of performing outsourcing for some developments due to the better communications means.

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