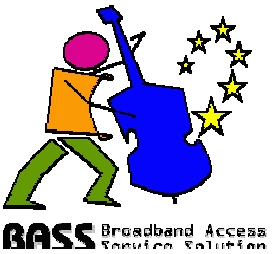

PILOT 1.2 AT TRINITY COLLEGE - THE VIRTUAL CLASSROOM APPLICATION SCENARIO

BASS - Broadband Access Services Solution

Information Society Technology

Key Action IV:
Essential technologies and infrastructures

IV.2.3:
Network Integration, interoperability and interworking

Project 11956

Deliverable D22-B WP7

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EXECUTIVE SUMMARY

Deliverable 22B (D22B) is the fulfilment of work package 7. It is the description and assessment of Pilot 1.2, the Virtual Classroom application scenario, at Trinity College, Dublin. It is included as part of D22 as the timeframe for the installation and testing was beyond the delivery date for Deliverable 16 which assesses the rest of the activities of Pilot 1.

This deliverable describes the requirements (and the resulting test objectives, techniques, and results) from two perspectives. These are the initial requirements arising from the overall design of the BASS project and a set of additional requirements that arise from the adoption of a broader pedagogical end-user context.

The results of the initial requirements are presented in section 3.4.2 and the additional requirements results are presented in section 5.5.2. The installation and implementation of the environment are described in detail along with the parallel development of the lesson structure and learning context.

The key features of Pilot 1.2 were that the test was to be in the wild, i.e. in a real learning environment, and were evaluated from an end-user perspective. The development of this pilot integrates these features closely with the use of two real teaching rooms at Trinity College and the adoption of a participant researcher approach for the end-user participants. This resulted in a new testing technique, that of questionnaire and interview. The tests were completed in accordance with the ORIONE methodology and the entries into the Requirements database are clearly stated.

The results do show an overall acceptance of such a system for distance learning where the distance students are integrated into a face-to-face class.

The nature of the installation in the wild presented some difficulty in the implementation of a stable platform. The main platform (Lucent Technologies “FRIENDS”) offered much to a Virtual Classroom application scenario though failed on some of the specific desirable interaction elements, as it was not designed specifically for a virtual classroom. FRIENDS is not a commercial product and certain test results remained inconclusive due to stability issues between the FRIENDS platform and the accompanying Meetingpoint conference server which was necessary for multicast of the audio and video.

1. INTRODUCTION

1.1 Objectives

The objective of this deliverable is to describe the Virtual Classroom application scenario at Trinity College, Dublin. This document will describe the design and installation of Pilot 1.2 from the original aims, through the design process, and on to the final results and findings.

1.2 Structure

This document begins with an analysis of the objectives (both the initial BASS objectives and expanded pedagogical objectives) in order to inform the evaluation criteria and the design and implementation of the Virtual Classroom application scenario. The elements that arise from this analysis go to form the evaluation requirements.

Chapter 2 places Pilot 1.2 in the wider context of the BASS project. The initial stated objectives are analysed to produce a table of key elements or aspects for the pilot.

The chapter also introduces a wider educational context for the pilot and explains a social constructivist approach. This also gives rise to a further set of key elements that are combined with the initial elements to inform the evaluation and design of the full Virtual Classroom application scenario pilot.

Chapter 3 introduces the BASS methodology and a further pedagogical research methodology relevant to the Virtual Classroom application scenario. The requirements arising from the initial objectives in Chapter 2 are defined, as are their test details. The results of these tests are then outlined and discussed.

Similarly the expanded requirements are defined along with their test details.

Chapter 4 addresses the design and implementation of the Virtual Classroom test bed at Trinity College. It opens with a narrative or vision of technology enabled collaborative learning with a class consisting of a mix of face-to-face and distance students.

The platform requirements and how they were fulfilled are described as well as an analysis of the FRIENDS platform, the conference server, and their related configuration. Details of the infrastructure and physical layout are also given. The chapter closes with the User Profiles resulting from the installation and a key part of the BASS methodology.

Chapter 5 describes Pilot 1.2 in detail. The users are described as are the test and lesson structure. The chapter moves on to present the results and discussion of the tests described in Chapter 3.

Chapter 6 has a concluding summary and final remarks and closes the body of the document.

2. VIRTUAL CLASSROOM SERVICE – INITIAL OBJECTIVES

2.1 Introduction

This chapter will outline the background to Pilot 1.2 in general and its role in the BASS project. The objectives and the key elements will be analysed. A broader educational context is then introduced and the resulting further objectives and key elements are defined.

By key elements we mean those factors or conditions that are necessary or highly desirable for the pilot. They will go to inform the requirements from a methodological and testing perspective as well as informing the design process as outlined in Chapter 4.

The chapter closes with the combined table of key elements from both the initial BASS perspective and also from that of broader educational context.

2.2 Background to BASS Pilot 1.2

The Virtual Classroom service was one of the services selected for inclusion in the Pilot 1 test suite in order to test delivered quality at the end-user terminal as stated in D12, section 3.3 [1]. These services are considered the "representative" applications (see D7Aa, section 1.2 [2]).

Three services were selected for Pilot 1 in order to better validate the access network. These were the Delay-TV, Tele-working, and the Virtual Classroom services. They were also chosen to test specific aspects individually, outlined in the D12, section 3.3 [1] as:

- Delay-TV: bandwidth demanding
- Virtual-classroom: interactivity
- Tele-working: inter-networking

Pilot 1.1 concerned the Teleworking and Video Server (Video on Demand) services and was conducted at the Ivrea and Hilversum sites. The pilots and the results are described in the deliverable D16 [3].

Pilot 1.2 represents the Virtual Classroom service and is assigned to Deliverable D22 as D22B. This is in accordance with the work plan as the pilot was scheduled to take place after the delivery deadline of D16.

2.3 Virtual Classroom service objectives

The Virtual Classroom service was selected specifically to demonstrate medium quality audio and video alongside other forms of data transfer such as slide shows and chat services (see D12, section 3.3.2 [1]).

Within the perspective of the Pilot 1 test suite, the Virtual Classroom service is intended to focus on interactivity, as mentioned above.

This distinction between the pilots in the Pilot 1 Test Suite is further advanced in Section 5 of D16 [3] where specific and advantageous characteristics for the Virtual Classroom service are outlined as:

1. Evaluation by actual users
2. A service type that requires several streams in a one to many scenario
3. Large scale environment
4. Real world perspective for:
    a. Infrastructure
    b. End user
    c. Pedagogy

2.3.1 Key Elements

These initial elements and objectives are matched with the relevant areas of design and laid out in Table 1 below. The design process is outlined in Chapter 4 of this document.

Element	Area of Design	Description
Interactivity	All areas	
Medium quality audio and video	Hardware and software configuration and installation	The system must be able to deliver medium quality audio and video
Several streams, one-to-many	Hardware and software configuration and installation	The system must be able to distribute several streams.
Other forms of Data transfer	Hardware and software configuration and installation	The system must be able to deliver other forms of data transfer alongside the audio and video.
Evaluation by actual users	Methodology	End user perspective, qualitative and quantitative data, and research with participant researchers.
Large scale environment (1)	Hardware installation	Should be >10 users simultaneously
Large scale environment (2)	Course design	Course should be of a group nature, not one-to-few tutoring.
Real world perspective		
Infrastructure	Hardware installation	The installation should be in a real teaching environment.
End user	Course Participants	The participants should be real students at third level.
Pedagogy	Course design	The course delivered should be a real one i.e. accredited and currently running.

Table 1: Initial Key Elements

The Virtual Classroom service can therefore be described as a large scale (in comparison with other trials in the BASS project), real pilot that utilises the ability of the BASS architecture to distribute audio/video and data transfer streams in a learning context with a high level of interactivity among the users.

2.4 Virtual Classroom service – A broader educational context

2.4.1 Introduction

The installation of the BASS architecture at Trinity College, Dublin for Pilot 1.2 afforded the opportunity to expand the pilot within a pedagogical framework. This section addresses the two main themes in this expansion and the elements and requirements that arise as a result.

The first element is that of desegregating distance students from their face-to-face counterparts. A background to distance education utilising desktop video conferencing is provided and the issue of desegregation explained.

It is essential to place the Virtual Classroom service pilot within an educational theoretical framework and this is the second theme. The theoretical approach adopted, namely social constructivism, is explained and also the resulting key elements for the design process and the requirements database.

2.4.2 The Desegregation of distance and face-to-face students

Traditionally desktop videoconferencing in education has been applied to distance education where students who are unable to travel to a specific location are enabled in their studies. This scenario traditionally has involved a tutor and one or more distance students.

This approach is fundamentally different to the traditional face-to-face classroom scenario. The face-to-face classroom has certain pedagogical advantages in that the students may interact with the tutor and their colleagues with ease. This allows for collaborative work within the lesson for example.

An ideal situation would be to enable the distance students within a face-to-face class *as if they were present* and advances in technology such as the potentialities offered by the BASS architecture, are bringing this possibility closer.

This scenario consists of a face-to-face class with the tutor utilising a desktop videoconferencing (DVC) system linking to distance students. This model blurs the distinction between these two previously disparate models of education and should present the distance students with a level of inclusion and interactivity comparable to the face-to-face students.

2.4.3 Pedagogical Framework

2.4.3.1 Constructivism and Social Constructivism

The broad educational theory adopted for the pedagogical framework of Pilot 1.2 is constructivist in nature, and more specifically social constructivist.

Constructivism is a broad church with a range of learning theories within it. It emphasizes that learners learn best when they actively construct their own knowledge within a collaborative context. It is based upon four key tenets that Peter Doolittle describes as follows,

"..constructivism acknowledges the learner's active role in the personal creation of knowledge, the importance of experience (both individual and social) in this knowledge creation process, and the realization that the knowledge created will vary in its degree of validity as an accurate representation of reality."[4]

Social constructivism accepts all of the four tenets above but places a particular emphasis on the social nature of knowledge. As a result, it believes that social interaction and communication lie at the heart of knowledge acquisition, and that this is a *shared experience*.

In her study of Video conferencing in higher education, Dr. Lynne Coventry notes that,

> "Learning is a social process involving the active construction of new knowledge and understanding through individual learning and group and peer interaction. This means that a key learning skill is that of communication." [5]

This emphasis on the social construction of knowledge can be seen to be particularly well suited to the Virtual Classroom service and Pilot 1.2.

From the introduction to social constructivism above, it is possible to extract the key learning elements of such an approach and correlate them to requirements for the Pilot 1.2. These are outlined in Table 2 along with implications for the adoption of such a learning theory within the Virtual Classroom service.

Learning Element	Implication
Social Process	Telepresence
Individual learning	Access, materials
Group Learning	DVC applications which allow group configuration
Peer Interaction	DVC enabled group interaction
Communication	Adequate audio and video, chat systems

Table 2: Constructivist Learning elements and implications

As can be seen, there is considerable crossover between these elements and those identified in section 2.3.1 – Key elements of the Virtual Classroom service. Here, however, there is an emphasis on

telepresence, group configurations, and group interaction. These are expanded on below.

2.4.3.2 Telepresence

The Transparent Telepresence Research Group at the University of Strathclyde defines telepresence as: -

> "… the experience of being fully present at a live real world location remote from one's own physical location." .[6]

A sense of telepresence is more than simply adequate audio and video though they are essential elements. Telepresence is about the experience and sense of inclusion that are effected by more social aspects.

Learning in a socially constructivist framework can be seen to rely on communication. From a pedagogical viewpoint the audio and video should be of a sufficient quality to enable a real sense of involvement, or telepresence, in order not to interfere with the social construction of knowledge.

The scenario under investigation here it is not an open learning system. This means that the students will have to log onto the system at a predetermined time. In this scenario, telepresence is used in a broad sense in that it describes an experience of inclusion and presence. It does not include the current extended definitions and technologies which attempt to provide a complete sensory feedback through the system.

In this scenario it is necessary for the remote student to feel included and have the ability to interact with ease with the tutor, or with members of a group they may be working with the face-to-face group in turn should also have an adequate sense of the distance students presence.

It is possible to encourage the sense of telepresence by the tutor introducing the distant students and actively seeking interaction with them throughout the session.

2.4.3.3 Group learning

Such a collaborative view of learning as taken here demonstrates a need for a system to facilitate group learning and project work. Ideally this system would allow a defined group of users within the class to have access to all of the features of the system in their own virtual workspace.

Learning in a group setting offers advantages over the more traditional styles. Group learning teaches students about how they learn and demonstrates skills concerning interaction and collaboration.

It is perhaps ironic that the traditional models of learning consist more of the individual learner while in the real world people are expected to work in teams or groups.

2.4.3.4 Interaction

Interaction within a classroom covers a range of activities and actions from asking questions to the tutor to facilitated group discussions. There is a need for both a system to initiate interaction and also others to facilitate interaction.

Traditionally in a face-to-face class interaction is requested by the raising of a hand. This system allows the tutor to decide whether to continue until an appropriate moment to handle the request occurs, to ignore the request, or to accept the request.

An interaction request system that allows those decisions is necessary in a virtual classroom and can be enhanced if the request arrives with a brief text description. This would allow the tutor to make a more informed decision on which course of action to choose.

In a social constructivist framework peer interaction is as important as tutor-student interaction and this had implications for the Virtual Classroom service. Peer interaction is essential within group learning where a small group of students will accomplish a task collaboratively.

2.4.4 Key elements arising

Element	Area of Design	Description
Social Process	Course design	Facilitate sense of telepresence
Individual learning	Course content	Learners must have access to necessary materials and resources
Group Learning	Hardware and software configuration and installation	Learners must be able to work collaboratively either in a whole class situation, or within smaller working groups.
Peer Interaction	Hardware and software configuration and installation	There must be an adequate system for interaction between the actors in the pilot.

2.5 Combined key elements

All of the elements discussed in this chapter are presented in Table 3.

Element	Area of Design	Description
Interactivity	All areas	
Medium quality audio and video	Hardware and software configuration and installation	The system must be able to deliver medium quality audio and video
Several streams, one-to-many	Hardware and software configuration and installation	The system must be able to distribute several streams.
Other forms of Data transfer	Hardware and software configuration and installation	The system must be able to deliver other forms of data transfer alongside the audio and video.
Evaluation by actual users	Methodology	End user perspective, qualitative and quantitative data, and action research with participant researchers.
Large scale environment (1)	Hardware installation	Should be >10 users simultaneously
Large scale environment (2)	Course design	Course should be of a group nature, not one-to-few tutoring.
Real world perspective		
Infrastructure	Hardware installation	The installation should be in a real teaching environment.
End user	Course Participants	The participants should be real students at third level.
Pedagogy	Course design	The course delivered should be a real one.
Social Process	Course design	Facilitate sense of telepresence
Individual learning	Course content	Learners must have access to necessary materials and resources
Group Learning	Hardware and software configuration and installation	Learners must be able to work collaboratively either in a whole class situation, or within smaller working groups.
Peer Interaction	Hardware and software configuration and installation	There must be an adequate system for interaction between the actors in the pilot.

Table 3: Combined Elements for Pilot 1.2

3. METHODOLOGY AND EVALUATION

3.1 Introduction

This chapter has a brief outline of the BASS methodologies and the testing techniques before introducing the pedagogical research methods suited to the social constructivist framework discussed in Chapter 2. This concludes with the justification for a further testing technique, that of questionnaire and interview.

3.2 BASS Methodology

3.2.1 BASS B-model

The BASS project uses a semi-formal verification and validation methodology known as the B-model. This model is an evolution of the V-model and an analysis and development of this is outlined in Deliverable D2 Specification of Methodology Framework [7]. Within the model, the validations of the requirements are tracked as well as their verification.

The key features of this model and its implementation within the BASS project are outlined below.

3.2.2 Requirement-driven

The requirements necessary to validate the BASS architecture are contained in a database which forms part B of Deliverable D23B [8]. This is a dynamic feature of the project and the requirements are continuously tracked within it. All the requirements for the validation of the BASS network in Pilot 1.2, and outlined in this document, were entered into this database.

3.2.3 ORIONE Methodology

The ORIONE testing methodology was introduced as a measurement approach to the verification process (see D12, Chapter 2[1]). ORIONE itself is an adaptation of ISO 9646 device testing methodology to include such elements as an end-user approach and delivered quality. The basic structure is demonstrated below in Figure 3-2 from D12 [1], Chapter 2.

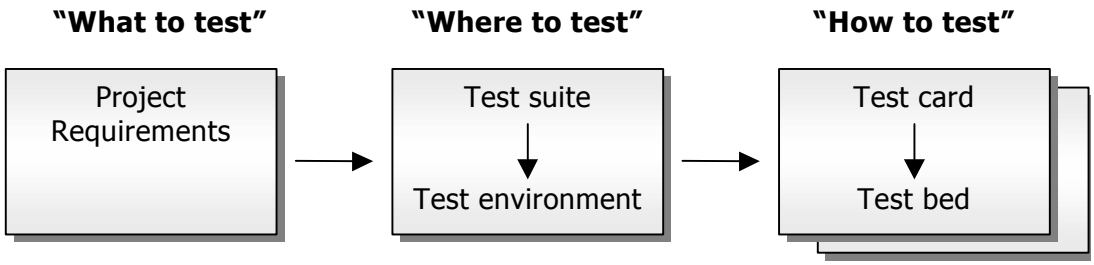

Figure 3-1: Basic ORIONE structure

In Figure 3-1, the test suite defines the objectives of the test, and in turn refers to the test environment which describes the system under test.

The testing in the ORIONE methodology is accomplished through test cards that are a cross-referenced set of cards covering the following areas:

- Test bed definition – complete description of the test environment
- User profile – detailed description of end-user terminal
- Service profile – where service functionality differs from capabilities of end-user terminal.

A combination of these cards to fully describe all aspects of the environment is collated as the *reference test bed.*

3.2.4 Testing Techniques

The test techniques are analysed in Deliverable D15A which provides the validation and verification methods along with their advantages and disadvantages.

The testing techniques are:

1. Practical testing
2. Simulation based on modeling
3. Formal proof
4. Analysis
5. Inspection

3.3 Pedagogical Research Methodology

Two of Pilot 1.2 characteristics were that it was to have a real world perspective and that it was to be evaluated by end-users (see Chapter 2). Both of these have implications for the methodology and specifically the testing techniques.

3.3.1 Evaluation of End-User Perspectives

Part of the real world perspective would be fulfilled with the use of real students on a real course and this would also achieve the aim of an end-user perspective. This raises issues as end-users evaluation are:

- Subjective – personal viewpoints
- Relative – to other experiences of similar technology and to their expectations
- Dependant on the network behaviour – the performance while the end-user is forming their opinions

Essentially end-users provide data of a more qualitative nature and the evaluation of such would require alternative testing techniques such as questionnaire, interviews, user tracking and video analysis.

3.3.2 Participant Researchers

In order to maximise the end-user evaluation the research should be as participative as possible. The use of participant researchers is a strong theme within the action research group of methodologies that attempt to take action and make change whilst conducting research and are prominent in current educational research. The use of reflective, included participant researchers in the process assists both the evaluation and the development of the project. In order to utilise this, it would be ideal for the participants to be familiar with this approach.

3.3.3 Additional Testing Technique

One characteristic of the ORIONE methodology analysed in Deliverable D15A [9] was that it was a methodology for measurements and that not all requirements in the database could be tested by this method.

From the preceding sections on end-user evaluation and the use of participant researchers, it can be seen that a relevant testing technique was needed in addition to those outlined in section 3.2.4. This was the one of questionnaire and interview.

3.4 Virtual Classroom service Initial requirements

This section outlines the initial requirements. These were analysed, interpreted and the test bed chosen according to the principles outlined in Deliverable 15A[9]. These are outlined in Tables 3 and 4 below. The results of these tests are then provided.

3.4.1 Requirements

The initial requirements are those arising from the Virtual Classroom service's original inclusion in the test suite for Pilot 1. Table 4 outlines these initial requirements and Table 5 outlines the resulting test objectives, techniques, environments and the results as added to the Requirements database.

As mentioned in above, interactivity is a key focus of the Virtual Classroom service in the test suite and accordingly accounted for four of the seven initial requirements for the service. These are Requirement ID numbers 45, 123, 134, and 138 (see Table 4 below).

Requirement ID number 45 addresses the ability for the students to initiate various streams to the tutor. This is dependent on the features, or services, within the FRIENDS platform and as such inspection of the documentation concerning FRIENDS was chosen as the test environment and technique (see Table 5).

Requirement ID number 123 concerns the responsiveness of the system when services are started. This test was conducted with Lucent and was observation based as the test bed at Trinity College was not suited for laboratory style measurements being in the wild in a real learning environment.

Requirement ID numbers 134 and 138 concerns the prioritisation and synchronization of interaction requests within the FRIENDS platform and were to be evaluated against the FRIENDS documentation.

Requirement ID number 146 concerning inter-media synchronization was added to compare the network against the World Wide Web Consortium recommendations.

Requirement ID number 193 related to the smoothness of the audio and video under normal and stress circumstances. This is a subjective perspective and suitable for the end-user perspective adopted in Pilot 1.2. As the test bed at Trinity College was not suitable for laboratory style testing, the network could not be placed under stress conditions and as such this test was not applicable to Pilot 1.2.

Requirement ID number 225 required the end-user terminal equipment to be able to work with video MPEG and is a basic check on the end-users PC.

Deliverable D15A (section 2.6.6) analyses the test techniques and proposes selection of techniques on a basis of cost (the cheapest), and also on importance of the test, it's feasibility, and it's effectiveness. These principles guided the selection of the test techniques adopted to validate the test objectives and therefore the requirements.

Each requirement results in one or more test objectives and these are outlined, along with the technique adopted in Table 5. This table also includes the results as entered into the Requirements database. A discussion of the results follows this table.

Req ID	Requirement	Interpretation	Test bed	Test Objective
45	The students in the virtual classroom should be able to interact with the teacher in every point of the lesson, initiating new audio, video, and "cargo" streams to the teacher as appropriate	Signalling and media streams or data also in up-link direction.	Friends Documentation	31
123	Signalling and media streams or data also in up-link direction.	Interactive control must be supported Virtual classroom content presentation response time < 400ms (comparable to a remote control)	Test bed description at Lucent	46 (with LUC)
134	There should be different priorities, at least two, with a proper control in the request of interaction in the virtual classroom	Interaction requests collected in a certain period of time (continuous interruptions of the lessons must be avoided) should be served based on the relevance with the current being discussed argument of the lesson (students themselves set a priority field for the question)	Friends Documentation	51
138	There should be a method to synchronise the requests of interaction of different users in the same lesson in the virtual classroom.	Collection of prioritised interaction requests in a certain period of time (to be defined with regards to the specific lesson) to be scheduled in the end of the same period is desired	Friends Documentation	56
146	Inter-media synchronisation in the virtual classroom must be time-structured - W3C recommendation	W3C recommendation support at application level.	Friends Documentation	57
193	Audio / video content representation must be smooth.		Validation test environment at TCD	81 & 103
225	For video MPEG the user must have processor Pentium III or hardware card.		Inspection	90 (with LUC, IS)

Table 4: Initial Requirements

Req ID/TO No.	Test Objective	Test Environment	Test Technique	Result
45/31	Positive test: Inspection of the existence of the required functionality	Documentation	Inspection	Passed
123/46	Positive test: Verify the required responsiveness of 400 ms for the Virtual Classroom service	Validation test environment at Lucent Labs	Practical testing	Inconclusive
134/51	Positive test: Inspection of the level of granularity for the interaction-requests in the virtual-classroom service	Documentation	Inspection	Failed
138/56	Positive test: Inspection of the prioritisation capabilities of the interaction requests in the virtual classroom service	Documentation	Inspection	Failed
146/57	Positive test: Inspection of the inter-media synchronisation method	Documentation	Inspection	Failed
193/81	Positive test: Evaluate the smoothness of the audio / video content under normal conditions	Validation test environment at TCD	Practical testing	Inconclusive
193/103	Negative test: Evaluate the smoothness of the audio / video content under stress conditions	Validation test environment at TCD	Practical testing	n/a
225	Positive test: Inspect the processing power of the end-user systems is adequate. (Inspection of equipment)	Documentation	Inspection	Passed

[Req ID/TO No. – Requirement Identification Number/Test Objective Number]

Table 5: Test Objectives, Techniques, and Results

3.4.2 Initial requirements test results

Most of the initial requirements would be fulfilled by the inspection of documents or the inspection of the hardware. There is only one test (Evaluate the smoothness of the audio / video content under normal conditions) that relied on the BASS architecture. The results discussed below were completed at an early stage of the pilot, and are therefore discussed at this point in the document. It must be noted though that the test mentioned above concerning the audio/video quality was evaluated during the Virtual Classroom service sessions.

3.4.2.1 Positive test: Inspection of the existence of the required functionality

Requirement ID/Test Objective No. 45/31

Result: Pass

Discussion: The FRIENDS documentation was inspected to ensure that the student and tutor could initiate new audio/video sessions and other sessions (e.g. shared white board, chat etc). The functionality was found to exist and the test was passed.

3.4.2.2 Positive test: Verify the required responsiveness of 400 ms for the Virtual Classroom service.

Requirement ID/Test Objective No. 123/46

Result: Inconclusive

Discussion: The facilities did not exist at the validation test environment at TCD to measure the responsiveness of the Virtual Classroom service so estimates were gauged on the delay for starting services in the FRIENDS platform and the responsiveness of the FRIENDS GUI. As these are estimated, the result entered into the Requirements database is *Inconclusive.* The estimates are:

Starting services: estimated 3-4 seconds

GUI actions: estimated .5 second

Starting services: estimated 3-4 seconds

3.4.2.3 Positive test: Inspection of the level of granularity for the interaction-requests in the virtual-classroom service

Requirement ID/Test Objective No. 134/51

Result: Fail

Discussion: The FRIENDS platform was not designed as a Virtual Classroom application and as such specific desirable areas such as prioritised interaction requests their synchronization are not supported. The CSCW functionality does however allow its application in this scenario to support collaborative work.

3.4.2.4 Positive test: Inspection of the prioritisation capabilities of the interaction requests in the virtual classroom service

Requirement ID/Test Objective No. 138/56

Result: Fail

Discussion: See 3.4.2.3 above.

3.4.2.5 Positive test: Inspection of the inter-media synchronisation method

Requirement ID/Test Objective No. 146/57

Result: Fail

Discussion: As will be discussed in Section 4.2, FRIENDS platform and its services was supported by a conference server to multicast the audio and video. As such all FRIENDS services are

synchronised and the users control the H.323 service independently.

3.4.2.6 Positive test: Evaluate the smoothness of the audio / video content under normal conditions

Requirement ID/Test Objective No. 193/81

Result: Inconclusive

Discussion: As discussed in section 3.3.3 Additional Testing Technique, this test was evaluated using a questionnaire and interview technique with participant researchers. The participants were asked to rate the quality of the video they had experienced in during the pilot and their responses are below.

Very Poor	Poor	Average	Good	Very Good
0	2	11	2	1

They were also asked to rate the quality of the audio during the pilot and the responses to this are below.

Very Poor	Poor	Average	Good	Very Good
3	1	7	8	0

This test was conducted in the wild and therefore many factors affected the quality of the video signal as compared to the quality that would be attained in a laboratory environment. Against this though it must be noted that only one of the participants in this pilot had experience of DVC.

As a result of these responses and factors at work, the test was deemed to be *Inconclusive.*

3.4.2.7 Negative test: Evaluate the smoothness of the audio / video content under stress conditions

Requirement ID/Test Objective No. 193/103

Result: Not applicable

Discussion: As mentioned throughout this document, the validation test bed at Trinity College was in a real environment. As such it was not possible to conduct network testing under stress conditions, as this was not a laboratory situation. This test was therefore *not applicable* and entered into the Requirements database as such.

3.4.2.8 Positive test: Inspect the processing power of the end-user systems is adequate.

Requirement ID/Test Objective No. 225

Result: Pass

Discussion: The client PCs were examined to ensure they all possessed a Pentium III processor in order to manage the MPEG video. All the PCs possessed this processor and the test was therefore *Passed*.

3.5 Expanded Pedagogical Requirements

The Test Beds and their corresponding testing techniques outlined in the following table shows that it was the expanded pedagogical requirements which benefited most by the installation of the BASS network architecture at Trinity College, Dublin.

In a similar fashion to the initial requirements in the previous section, the expanded pedagogical

elements were examined to deduce certain requirements that could be validated within the ORIONE and B-model methodologies. The pedagogical constructivist elements that formed the basis of these requirements were outlined in section 2.4.4 of this document.

These elements led to four new requirements for the Virtual Classroom service.

These requirements are outlined in Table 6: Expanded Pedagogical Requirements and the resulting test objectives and techniques are described in Table 7: Expanded Test Objectives and Techniques.

3.5.1 Questionnaires

The dominant testing technique adopted was questionnaire and interview and the questions were written to specifically analyse the end-user's perspective on the requirements for the systems validation.

These questionnaires consisted of three sections.

1. General
   This sheet gathered basic information on the age and gender of the participants, and their experience of desktop videoconferencing. This section also asked for the overall opinion of the quality of the key components such as the audio, video, conferencing and group working features.
2. Face-to-face perspective
   Users were asked questions on the effectiveness of the technology while in the face-to-face situation and whether the system interfered with their experience in that role.
3. Distance perspective
   Users were asked again the effectiveness of the system though from a distance users perspective. They were also asked questions on the level of inclusion felt.

The questionnaires are included in Appendix B.

3.5.2 Requirements.

The first requirement entered was chosen to explore the entire experience of the pilot from an end-user perspective. It attempts to do this by asking a subjective question. The participants were all part-time students and as such had a personal interest in the advantages of distance education. By asking them if they would use such a system to pursue a course of study it was hoped to reveal an overall end-user level of acceptance. This is Requirement ID number 249 (see Table 6 below).

The constructivist approach adopted requires a system that will not interfere with the group learning and social interaction of the students. An ease of use of the system is required to achieve this and resulted in Requirement ID number 250 (see Table 6 below) specifically to evaluate this point.

Group learning also lies at the heart of Requirement ID number 252 that examines the ability for all students, regardless of location, to work collaboratively with the other members of their working groups.

Requirement ID number 251 describes distance student integration and inclusion within the lesson. This is validating a sense of telepresence that is a key factor within the context of the social process at the heart of a social constructivist pedagogical approach as discussed in section 2.4.3.2 of this document.

All of these requirements were to be validated on the Trinity College test bed as described in the Chapter 5. These expanded requirements were to be tested by the questionnaire and interview techniques as described in section 3.3.3 and outline in Table 7: Expanded Test Objectives and Techniques.

The validation of these requirements needs the test bed at Trinity College and is therefore entered in section 5.5.2, after the test environment has been described.

ID	Requirement	Interpretation	Test bed	Test Objective
249	User acceptance of the BASS architecture and collaborative software for a personal learning motive.	User acceptance to extent that users would be willing to pursue a Distance Education course if one was available using the system.	Validation test environment at TCD	228
250	All students should be able to move between the whole class service configurations and the group working configurations during the session.	There should be ease of use of the system.	Validation test environment at TCD	229
251	The distance students should feel fully integrated and included into the lesson.	Distance students should have a adequate sense of telepresence.	Validation test environment at TCD	230
252	All students must be able to interact and work collaboratively with other members of their group in the working group phase of the lesson.	Distance and face-to-face students must be able to work with equal effectiveness regardless of their location.	Validation test environment at TCD	231

Table 6: Expanded Pedagogical Requirements

Req ID/TO No.	Test Objective	Test Environment	Test Technique
249/228	Verify that participant researchers in Pilot 1.2 would be willing to pursue a distance course if the BASS architecture were available.	Validation test environment at TCD	Questionnaire and Interview
250/229	Verify that there is ease of use of the group configuration system form an end-user perspective in a real setting after a minimum amount of instruction	Validation test environment at TCD	Questionnaire and Interview
251/230	To verify an adequate sense of telepresence among the distance students.	Validation test environment at TCD	Questionnaire and Interview
252/231	To verify the ability for both distance and face-to-face students to work effectively in small groups within a larger group learning session.	Validation test environment at TCD	Questionnaire and Interview

[Req ID/TO No. – Requirement Identification Number/Test Objective Number]

Table 7: Expanded Test Objectives and Techniques

4. DESIGN AND IMPLEMENTATION OF THE VIRTUAL CLASSROOM TEST BED

This chapter outlines the design and implementation of the Virtual Classroom service at Trinity College, Dublin. It approaches this in three ways. Firstly the software platform is discussed, then the network infrastructure, and finally the physical layout are described. Throughout the sections, there will be a continuous reflection of the key elements of the system as discussed in Chapter 2.

4.1 A Vision of the Virtual Classroom application scenario

The design of the Virtual Classroom application scenario at Trinity College was informed by the elements and requirements as laid out in Chapter 2. However, a description of the components and configurations to fulfil these criteria does not fully describe the intended end result. As this scenario uses end-users in a real environment there must be a vision of how the components will interact with the users, and how the users will interact with each other in this environment. The following narrative attempts to portray this.

> The tutor checks their watch and notes that it is almost time for the lesson to start. In front of the tutor, the face-to-face students are at their terminals or sitting at the tables facing the tutor. On the wall behind the tutor is a data projection driven from the tutor's PC.
>
> The tutor checks their PC to ensure that the distance students are logged on and send a message to them to confirm there are no technical problems.
>
> At the appointed time, the tutor begins. The presentation is accompanied by a slide show watched by the face-to-face students on the projection behind the tutor. The distance students watch the slide show on their own PCs and can see the tutor in a video window while listening to them through headphones.
>
> An alert sounds on the tutor's PC signifying a question received from a distance student using a messaging system. The tutor decides that the question is better left until after the presentation and sends an automated acknowledgment back to the distance student. A face-to-face student raises a hand but the tutor wishes to finish his point before discovering what the query is. After doing so, the tutor asks the face-to-face student what the query was and then assures them the query will be answered later in the presentation.
>
> A distance student asks another question and this time the tutor decides that it is important to answer this one immediately as it may represent some misunderstanding amongst the class at large.
>
> The presentation ends with the in-class assignment details. The assignment is for 30 minutes and the students, in small groups, have to prepare three slides on the topic for presentation back to the class. The tutor outlines the makeup of the groups and lets the students start.
>
> One of these groups consists of three face-to-face students and one distance student. The face-to-face students gather around one PC and together with the distance student, they all log into their group area. The students chat away together through the microphones and cameras on the PCs and after some debate decide how they will tackle the assignment. The software to create the slides is run by the distance student on their PC but control is shared through the software with the face-to-face group. Together they create the slides, first the distance student completing the first slide and then a member of the face-to-face group editing it and creating the next. The tutor drops into their workgroup and is seen on both the PCs in a video window. He asks how they are getting on, answers a question and then leaves to go to another workgroup.
>
> A message window pops up from the tutor on all the PCs alerting the students to return to the whole class group. Having checked all of the students are in the correct group, the tutor invites the distance student to present their groups presentation to the class. The tutor distributes control of the system to the distance student who is then seen and heard in the face-to-face class as well as on the screens of the other distance student. After questions

from the class and the tutor, the tutor moves onto the next group.

Having been through all of the groups, the tutor goes over the main points of the lesson and tells the class the times and details of the next session and says goodbye.

This vision contains presentation, interaction, and collaboration.

4.2 Virtual Classroom service software platform

4.2.1 Platform requirements

The platform was required to facilitate the following criteria.

4.2.1.1 Class Broadcast

The students, in a whole class setting, must be able to see and hear the tutor as well as being able to view any presentation materials (such as slides) that accompany the talk. For face-to-face students this can be achieved in a traditional manner with the presentation materials being projected onto a screen at the top of the class. The distance students must be able to see and hear the presentation and any accompanying materials. In addition to this, the distance students must have a system of interaction requests with the tutor – a virtual rising of the hand, as a face-to-face student would do.

4.2.1.2 Group Working

The students must be able to work together in real time to complete group assignments with no distinction between face-to-face and distance students. To achieve this, the students must have access and control over their own set of services within a group setting. In this way, a distance student can work with a small number of face-to-face students with audio/video, chat, shared applications and so on that will facilitate the working of the group.

4.2.2 FRIENDS

4.2.2.1 Introduction

From early in the project, FRIENDS was proposed as the main platform for the Virtual Classroom. The "FRamework for Integrated ENgineering and Deployment of Services" platform was developed by Lucent and other research organizations as part of the Dutch Internet-2 initiative called Gigaport.

FRIENDS is a distributed platform supporting a variety of services. Its impact on the BASS architecture is described in D7Aa, Section 4.2.1 [2].

In section 4.2.6 of the same deliverable [2] it is noted that that FRIENDS is a prototype and lacks the stability of a commercial product.

A software evaluation was conducted in order to ascertain how the various aspects of the platform would relate specifically to the needs of the Virtual Classroom service.

4.2.2.2 FRIENDS Services

FRIENDS operates with Service Sessions. Each Service Session is started on a single client and once the service is operating, other users may be invited to join the session. These services range from a chat messaging system to a shared application service. The available services are shown in Table 8.

The service session is selected through the services menu shown below in Figure 4-1. An exception to this is the ICQ (I seek you) service that is used to locate other users who are simultaneously logged onto the server. The ICQ service can also be activated via the Services menu.

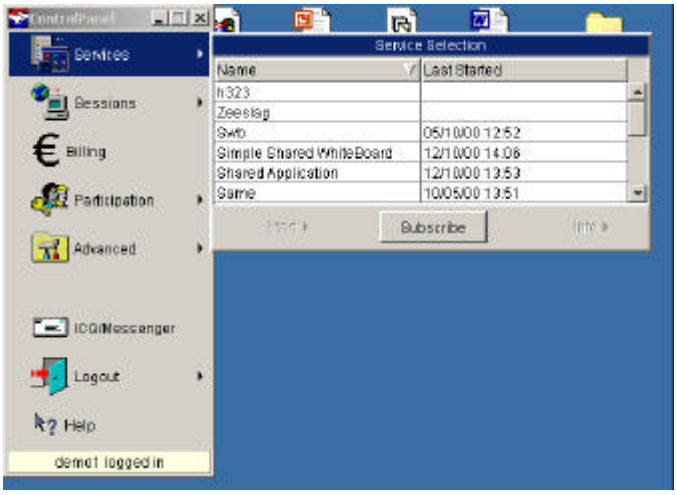

Figure 4-1: FRIENDS service selection

The table below lists the services available within FRIENDS Ver. 3.0.

Service	Features
Phonebook	This service can be used to invite other users for service sessions. It shows all of the subscribed users and the individual user can place all or some of them into their own phonebook for ease of contact for initiating service sessions.
Chat	A standard synchronous chat system.
ICQ	A system showing all FRIENDS users currently logged in, assuming they have subscribed to the service themselves, although they do not need the service running in order to be seen.
H323	This provides a H323 audio/video window utilising Microsoft Netmeeting and offers the range of Netmeeting service components (File transfer, Chat, Shared Whiteboard and Shared Application).
Shared Application Service	This service allows for an application running on one client to be viewed and used on other clients. Full control of the application can be distributed to individual users who are then able to create and delete within that application.
Shared Whiteboard Board	This service is a FRIENDS Ver. 3.0 component and offers different functionality to the Netmeeting component and the Simple Shared Whiteboard below.
Simple Shared Whiteboard	This service is a FRIENDS Ver. 3.0 component and offers different functionality to the other Whiteboards available.
Registration	A service to register users via their terminal name.
Billing	A service that provides billing information for each service prior to, during, and after sessions. There are preset billing strategies available through the administrator login.
Project Configuration Service	This service allows the creation of a secure environment for project teams, utilising the services within FRIENDS Ver. 1.2. In this way, working groups can be configured to use all of the FRIENDS features amongst the members of the group and not to any other FRIENDS users who are not configured within the project.

Project Collaboration Service	This service allows the user to select and move between projects of which they are a member.
Chess	A shared chessboard.

Table 8: FRIENDS Services

These services, in combination, are able to satisfy the majority of the criteria outlined above. For example the Shared Application Service would be able to run a slide show across all of the end-user terminals.

FRIENDS had a point-to-point H323 service for audio and video. One problem that was discovered was that the FRIENDS platform, while supporting multicast, was not able to distribute the streams itself. For this reason, a multicast conferencing unit was sourced in order to accomplish this criterion.

4.2.2.3 Computer Supported Collaborative Work

As the FRIENDS platform developed through it's releases, the concept of Computer Supported Collaborative Working (CSCW) became a key feature. This first arose in release 1.2 of the platform and was further developed through release 2.0 and the current release, 3.0.

CSCW is a combination of the Project Collaboration Service and the Project Configuration Service and it is worth explaining these services in more detail.

The Project Configuration Service allows an authorised user to create and delete projects, select the services available to that project, insert sub group and create members for the projects and groups. It allows the project administrator complete configuration control over the projects, their members, and the services available to them.

The Project Collaboration Service is the service used by a user to navigate through the available projects. The projects available to any user are determined by the Project Configuration service and shown in a drop down menu. Once a specific project has been selected, the platform returns the structure of the project and the services available within it. The other members of the project are shown with a graphical system to demonstrate who are currently logged into the system and who are not.

An example configuration would be that when a user logs on, the only service returned initially is the Project Collaboration Service. The user then moves into a project and the services for that are returned. In a Virtual Classroom service, the tutor would also have the Project Configuration Service returned as well as the Project Collaboration Service at log on in order to facilitate any group configurations.

4.2.2.4 Observations

The FRIENDS platform, with its range of services and its focus on CSCW makes it suitable for a Virtual Classroom service. Students can be entered as users within the project structure to reflect the classes they are enrolled on. Further to this, the status of the student user is reflected in the services allowed to them.

The stability of the platform is not that of a commercial product, however, the platform is useful as a system to demonstrate the potentialities of CSCW in an educational framework, and to validate the BASS requirements.

The user interface is clear and intuitive and the ability to present only the Project Collaboration Service to the user at logon provides a simple and clear system for the user. The complexities of the Project Configuration Service are hidden from the user.

4.2.3 Meetingpoint Conference Server

The MCU that was decided upon for the Virtual Classroom service was the CUSeeMe Meetingpoint conference server. This platform was developed with the aim of supporting multimedia group interaction across IP networks.

The server allowed the administrator to create conferences and allocate permissions for user access to those conferences. There is a range of options available within each conference to configure the duration, access, protocols and so on.

The server had two specific aims. Primarily its aim was to distribute the various audio, video, and other data streams in a one to many scenario. The second was for the server to be configured in such a way as to facilitate the group working features of the Virtual Classroom service. This group-working element is described below in Section 4.2.4.

The H323 client selected for this service was Microsoft Netmeeting that is the same client as utilised by the FRIENDS platform, and commonly available.

It is important to note that the Meetingpoint server has many further capabilities than those utilised for Pilot 1.2. Its role in this pilot though was solely to overcome the absence of an audio and video facility within the FRIENDS platform. FRIENDS has a point-to-point H323 audio and video service and it would be expected that if the platform was to be developed for commercial use a multicast capability would be incorporated.

It would be correct to describe FRIENDS as the platform used for the Virtual Classroom service, and that the Meetingpoint conference server supported it.

The Meetingpoint server offered a clear perspective to the user. A user would run Microsoft Netmeeting on their PC and enter the local host name of the conference server. This would return a pop-up window with a list of available conferences by name and an identification number. The user would select the relevant conference and would then be entered into it. The users had no rights to configure, create, or delete conferences, as this right was restricted to the tutor.

4.2.4 Group working configuration

The FRIENDS Project Configuration Service allows for the full range of FRIENDS services to be made available to a predetermined group of individuals. In this way, the administrator can configure the list of services available to and seen by the user.

The users will be established so that on connecting to the FRIENDS server, they have a choice of one service, that of the Project Configuration Service. Inside this service they will have a choice of two projects, a whole class and a working group. The levels of control to the services in these projects will differ with little control for the whole class session and full control over the services in the working group project.

The Meetingpoint server will be configured to mirror the groups established in the FRIENDS Project Configuration Service. To this end, there will be a single whole group conference for the whole class elements of the session and also individual group conferences to match those created in FRIENDS. This will allow for the students when working in groups to have a dedicated group conference and a group FRIENDS project session running simultaneously

The distinction between the whole class audio/video conference and the FRIENDS whole class project and the sub groups and conferences is best illustrated by referring to where they would be used in the lesson as demonstrated in Table 9 below.

Lesson Element	FRIENDS	Meetingpoint
Lecture Presentation	Whole Class Project - Shared application service for slides	Whole Class Conference - Broadcast mode
Group work	Group work sub project - All services available	Group Conference - Using the same name as the FRIENDS sub project

Table 9: Server requirements for class and group

The overall aim is to correlate the configurations of both the FRIENDS platform and the Meetingpoint server in order to create workspaces at two levels. Workspace in this context is taken to mean a collaborative virtual environment where the specific members assigned to the workspace have access to a range of services.

Figure 4-2 demonstrates how the configurations match. Each student would be the member of the Whole Class conference and the Whole Class project within the FRIENDS platform. This workspace would be used for the presentation stage of the lesson. In addition, each student would be assigned a Group conference and corresponding FRIENDS sub-project. In this workspace, the students would be able to use the available services and audio and video to work collaboratively in the group work stage of the lesson. A complete description of the lesson is provided in section 5.3.2 of this document.

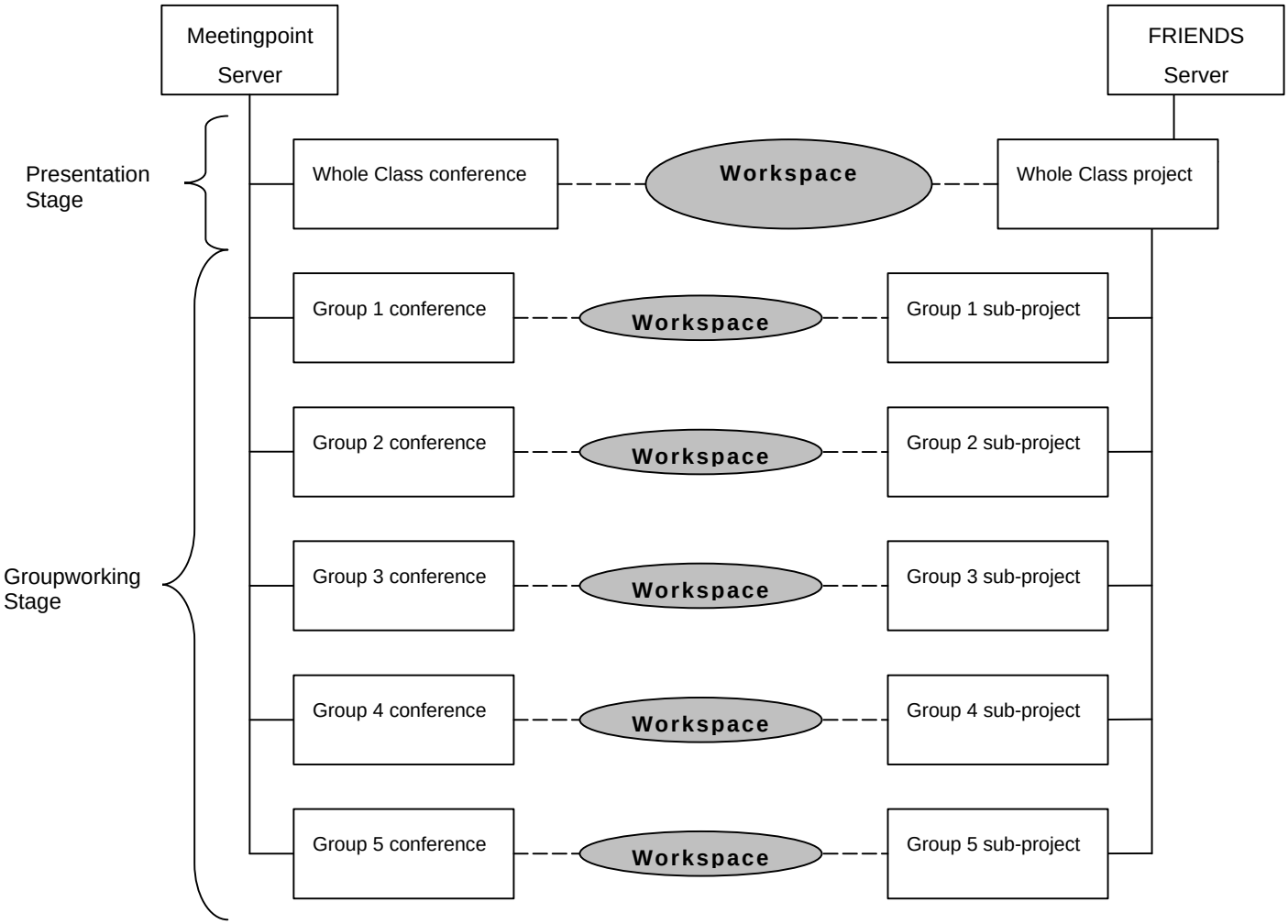

Figure 4-2: Workspace Configuration

4.3 Infrastructure

The equipment required to set up the Pilot 1.2 infrastructure on Trinity's campus is outlined in Figure 4-3.

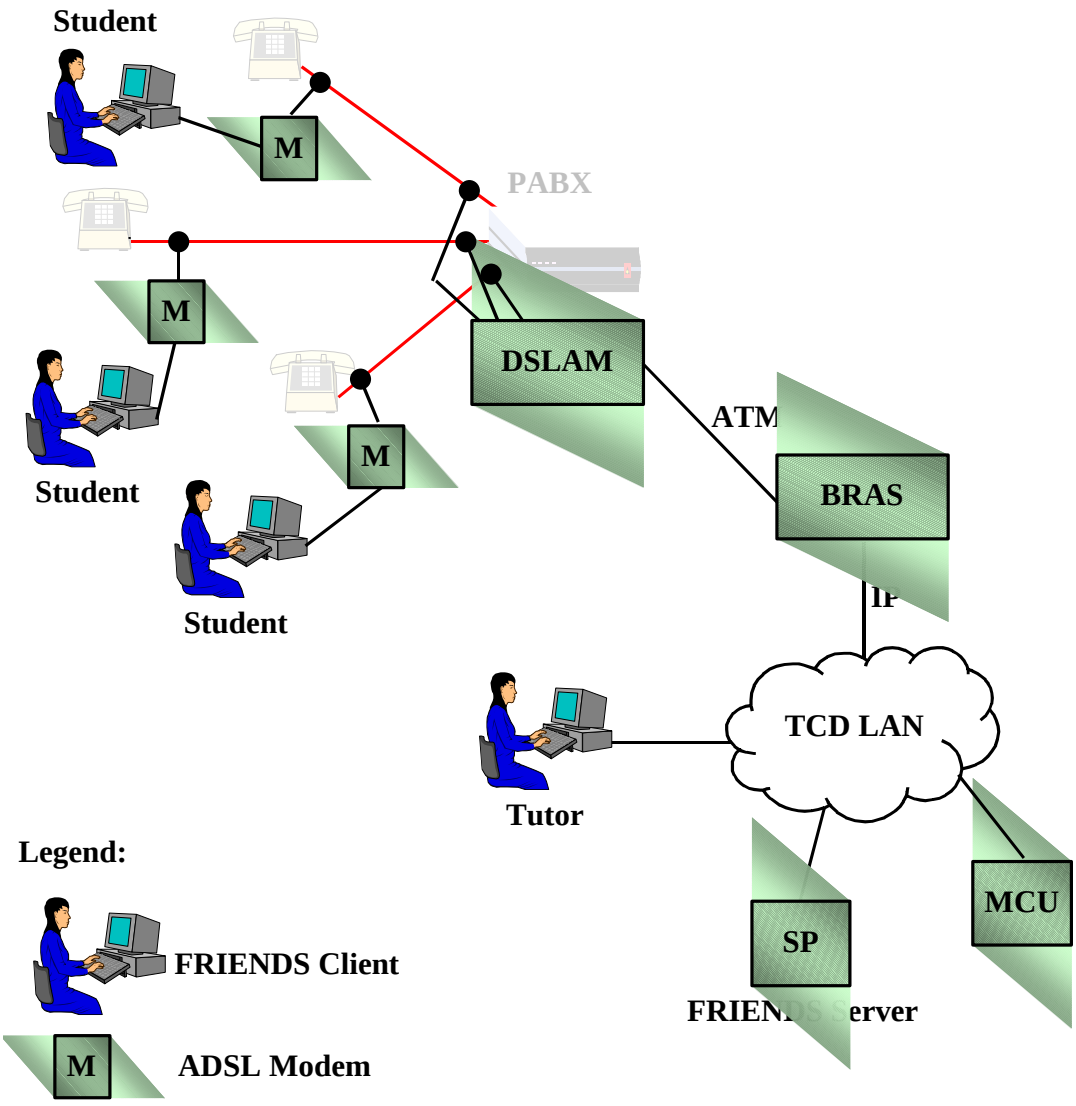

Figure 4-3: BASS Infrastructure At TCD.

The cables between the ADSL modem and the DSLAM simulate copper phone lines, i.e., no phones and PABX was connected to it. An equipment list for the installation is provided in Appendix A.

4.4 Physical layout

The plan that follows (Figure 4-4) demonstrates the environment used at TCD. The teaching laboratories are adjacent to each other with connecting doors as well as their own entrances.

For the purposes of the pilot, one laboratory will serve as the Local Classroom and the other will hold the students simulating a distance-learning environment. They are marked accordingly.

The tutor's position is also marked and they will be adjacent to a wall display for their presentation.

The BASS architecture will be placed in a room in the Distance Students laboratory and cabling will move around the laboratories as shown.

The face-to-face classroom (1.17 in Figure 4-4) is where the main class will work and the distance students will be isolated in the accompanying room (1.18).

In total, there will be 12 students, i.e., 3 distance and 9 local, connected to the BASS infrastructure. The teaching laboratories 1.18 and 1.17 in which the equipment will be set up are located on the ground floor of Oriel House on Trinity's campus.

These laboratories are used for class teaching and also project work by fourth year computer science undergraduates and as such they fulfil the requirement that they pilot be real and in the wild.

The copper cabling was laid around the edges of the rooms in order to terminate near to the PCs that would be connected as client PCs.

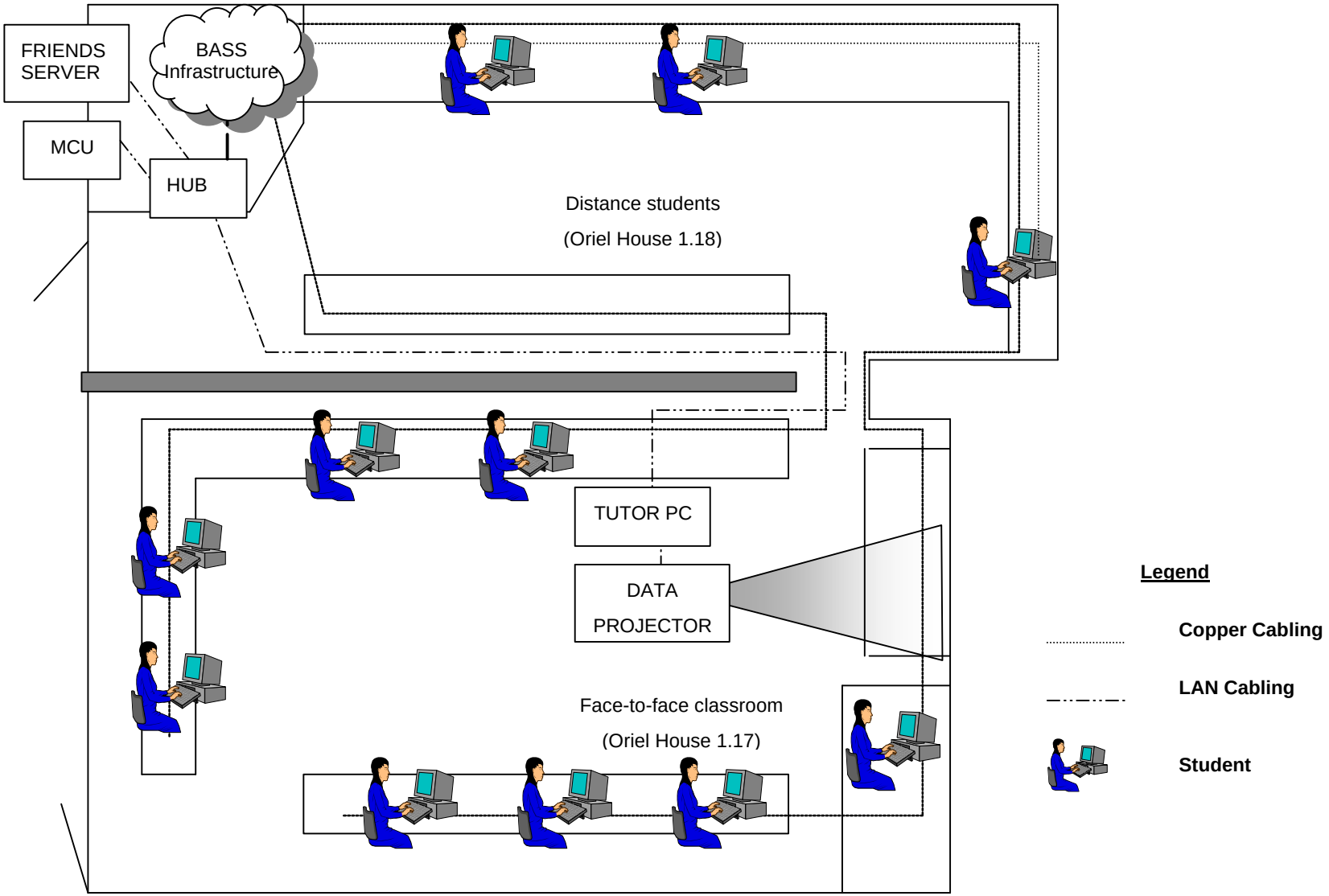

Figure 4-4: Physical Layout

4.5 Test profiles

In order to complete the testing according to the principles of the ORIONE and B-model methodologies, test cards were prepared in the following areas. These profile cards are discussed in section 3.2.3

4.5.1 User profiles

For the Virtual Classroom service there were two User Profiles namely the student user and the tutor user. These represent descriptions of the end-user terminal.

User Profile	Terminal
Student User	Pentium III Processor – 700 MHz 128 MB RAM Windows 2000 Operating System
Tutor User	Pentium III Processor – 650 MHz 128 MB Ram Win 2000 Server Operating System

Table 10: User Profiles

5. DESCRIPTION OF PILOT 1.2

5.1 Introduction

This chapter describes the actual Pilot 1.2 tests at Trinity College, Dublin. The participants and the lesson structure are described as well as observations from the tests. The data is presented as well as some of the participants' comments from the follow up interviews.

Due to delays in the installation of the necessary network equipment for the pilot, the timing of the tests was delayed. This had implications for the participants as new dates for the testing fell outside of term time and ordinary timetabling. As a result, the participants came to Trinity in their own time and this resulted in fewer participants than if the testing had gone ahead in a timetabled course slot.

5.2 End-Users

As mentioned throughout this document, it was necessary for the participants to be real students and also desirable for them to have some experience or knowledge of participant research.

We were fortunate to obtain two student bodies, both of which were on real postgraduate courses in the area of information and communication technology in education.

Both of the participant groups were on part-time courses as they were employed in the education sector in the day. They were all also mature students. These factors show a level of motivation and commitment that could only improve the evaluation of the system.

5.2.1 Masters in Information Technology in Education

The Department of Computer Science at Trinity College, Dublin offers a two-year part time Masters level course in Information Technology in Education (MSc ITEDU). The characteristics of these students are:

- Mature
- Actively engaged in the education field
- Motivated
- Familiar with current educational theory
- Computer literate

In addition to the above, the students were familiar with the concept of participant research and as such fulfilled the criteria listed as desirable in section 3.3.2 of this document.

5.2.2 In-service – Computer Based Training

The Department of Education at Trinity College, Dublin offers in-service courses to practising teachers. This course is modular and a group studying the Computer Based Training module agreed to participate. This course is not as intensive as the Masters course described above but is it important to note that students on this course would commonly take over one hour to travel to Trinity for their classes. This meant they were interested in such a system for their own personal motives.

5.3 Test Structure

The tests consisted of the delivery of authentic content through the BASS architecture, which in combination with the FRIENDS platform and the conference server configurations facilitated the desegregation of distance and face-to-face students.

The students were rotated throughout the test in order that each individual participant would experience both the face-to-face and the distance student perspective.

The testing consisted of three phases.

1. Introduction
2. Lesson
3. User Evaluation

5.3.1 Introduction Phase

The introduction phase consisted of an introduction to the network and the software as well as the distribution of logon details and instructions.

A brief demonstration was given using the data projector with all of the students in the face-to-face classroom/laboratory. This was to illustrate how to navigate through the group configuration within the FRIENDS platform and the Conference list on the Meetingpoint server. In addition, there was also a brief introduction to the service selection feature within FRIENDS.

Further to this, the objectives of the test were outlined as well as the participants role as researchers.

This introduction phase was kept to a minimum in order to better validate certain requirements. For example, the ease of use of a system should not be dependant on the familiarity with it. To an extent, ease of use and the intuitivism of a system are related in this aspect. The validation of the systems ease of use was improved by only supplying the most basic of operating instructions.

5.3.2 Lesson Phase

The lesson to be delivered as part of Pilot 1.2 includes various elements to explore the scenarios and the desired features and is outlined below.

Lecture Presentation	H323 multicast to distance students and projected in face-to-face class. Slide presentation multicast to distance students and projected in face-to-face class.
Group Work	A group assignment to be completed in class, in small groups. These groups will be configured prior to the session and each group will have access to a project within FRIENDS and a dedicated group conference within the Conference Server.
Assignment Presentation	A group member, preferably the distance student, will present the assignment.
Closing Presentation	A H323 session from the instructor.

Table 11: Lesson Structure

The lesson content was a presentation on the use of desktop videoconferencing in education and the system under test. The group working assignment required the groups to prepare a short slide show on the benefits of such a system in education.

5.3.3 Evaluation Phase

Even though we have specified a particular phase for the evaluation, in effect it was continuous. While the questionnaire completion and discussion were conducted subsequent to the lesson delivery, other evaluation techniques were ongoing.

The tests were video taped through the use of an unobtrusive digital video camera and this commenced with the introduction phase.

The discussion of the testing was conducted in an informal manner after the questionnaires had been completed, and notes were taken of pertinent points. A further opportunity was then given to the participants to add any further comments to their questionnaires.

5.4 Test Details

5.4.1 Pre-testing

It was decided that each of the end-user groups would have two sessions. The first would be a pre-test session the aim of which was two-fold.

Firstly, the pre-test aimed to highlight any issues that had not been foreseen during the design and installation phases. It provided an opportunity to have a trial run of the architecture to ensure that the fully evaluated test would have less chance of technical problems.

Secondly, the pre-test aimed to introduce the system to the participant researchers most of whom had never used DVC or group collaboration software before. The pre-test was intended as an orientation session, rather than a training session. This would minimise the time lost in the actual pilot testing answering users queries on the platform and allow the participant researchers to concentrate on the pedagogical implications of the Virtual Classroom service.

5.4.2 Test Timetable and participant numbers

The tests were conducted over a two-week period with two groups of researchers as well as individual explorations of the system by two academics. The details are laid out below.

Date	Group	Participants
12th April 2001	In-service (Pre-test)	7
19th April 2001	MSc ITEDU (Pre-test)	12
24th April 2001	MSc ITEDU	12
26th April 2001	In-service	7

Table 12: Test Dates and Groups

5.4.3 Test Set-up

As stated, one of the key elements of the Virtual Classroom application scenario in Pilot 1.2 was that it was to be real and “in the wild”. The use of real teaching computer laboratories, as outlined in section 4.3 of this document, had implications for the set-up of the test bed *prior to each test.*

As would be expected in a modern third level educational institution there was a high level of demand on the teaching laboratories and the integrity of the PCs in them had to be maintained. During the configuration phase of the test bed, all installations and configuration changes to the PCs in these teaching laboratories had to be first checked by the computer science technical support department.

Further to this, the setting up of the tests had to be completed with a minimum of disruption to the student body around. It was also necessary for the teaching laboratories to be returned to their original state and configuration immediately after the tests.

To set up each test, the following steps were taken:

1. Power the BASS architecture and start the FRIENDS and Meetingpoint servers.
2. Connect the tutor laptop PC to the BASS LAN (see Figure 4-3).
3. Remove all client PCs from the Trinity local area network.
4. Connect and power ADSL modems to all client PCs and the twisted copper pair cabling.
5. Connect the cameras and microphones to the PCs.

After each test the teaching laboratories had to be returned to the pre-test condition. This process took approximately 1hour 15 minutes to set-up the teaching laboratories and 45 minutes to return them to their previous condition.

5.4.4 Test Duration

All of the tests, including the pre-testing, were of the same duration. This was as it was necessary to book the teaching laboratories beforehand.

The time taken for the various phases is illustrated in Table 13 below.

Test Phase	Duration
Test bed set-up	1 hr 15 mins
Introduction	15 mins
Lesson	1 hr
Evaluation	45 mins
Breaking down of the test bed and restoring teaching laboratories	45 mins
Total	**4 hrs**

Table 13 - Test Duration Analysis

5.5 Analysis of testing in Pilot 1.2

5.5.1 Pre-tests

Both of the pre-tests were problematic for a variety of reasons. They did however serve their function of familiarising the participants with the interfaces, configurations, and capabilities of the platforms. The key issues are discussed below.

5.5.1.1 FRIENDS Platform Issues

FRIENDS is not intended for commercial use and the developers, Lucent Technologies, concede that while it has been under development for many years, the stability is not that required for a commercial product (see D7A, section 4.2.6)[2].

This analysis was borne out by the experience of the pre-tests. The platform was stable with a small number of users (<5) running multiple services and switching between, or a larger number of users (>10) running a few services.

When problems occurred, they were with the users machines running the FRIENDS client and not with the FRIENDS server. A typical problem would be that the users interface would freeze, normally when closing services. When this occurred, the FRIENDS client program would have to be terminated and restarted. This has implications for the flow of a lesson for example and also reduced the confidence of the users in the platform at large.

A subjective observation suggests that when the platform was running stably, it would continue to do so. However, when one user experienced a problem it was common for other users to also experience the same problems a short time later.

It must be stressed that the platform, when stable, did perform its function of facilitating CSCW and has much to offer any Virtual Classroom application scenario.

5.5.1.2 Meetingpoint Conference Server Issues

The Meetingpoint Conference Server had issues concerning the switching between conferences in order for users to access the correct group working spaces, and the quality of the audio and video.

At times the user would select a conference from the list returned form the Meetingpoint server but would not be able to see or hear anything. To clear this problem, the user would have to close the

client software (Microsoft Netmeeting) and attempt to join the conference again. On certain occasion this would not fix the problem and it was necessary at times to either close and restart the Meetingpoint server PC or even create a new conference “on the fly”.

The quality of the audio and video was erratic and ranged from poor to good. There was some pixelation of the video image, especially from a client PC that lay downstream of the ADSL network. As would be expected, the video signal would degrade if there were much movement. The audio signal would occasionally suffer from low volume.

5.5.1.3 Other Observations

The physical layout and configuration were confirmed as suitable for the Virtual Classroom application scenario and despite the problems with the platform, the users gained a familiarity with both the platform and the aims of the pilot.

5.5.2 Evaluated tests

The results of the questionnaires were broken down according to the test objectives and are presented below, along with an interpretation and the result entered into the database.

5.5.2.1 Observations

The evaluated sessions themselves were delivered in a more formal format than the pre-tests. An attempt was made to deliver the lesson as if it was a normal everyday event. The pre-tests enabled the users to follow this perception as well.

There were still problems with the platform though of a reduced number and frequency. The pre-tests also allowed known problems to be identified earlier and the working solution to be adopted sooner than if the pre-tests had not been undertaken.

That problems still occurred had implications for the evaluation. For example one user may have encountered particular problems with the audio and video and evaluated that service accordingly. Another user in the same session may have encountered no such problems and this disparity in recorded quality is not necessarily a reflection of the BASS architecture.

5.5.2.2 Verify that participant researchers in Pilot 1.2 would be willing to pursue a distance course if the BASS architecture were available.

Requirement ID/Test Objective No249/228

Question: Having used this technology, would you consider a course of distance study that used a similar set-up?

Responses

Yes	No
16	3

Result: Pass

Discussion: This test is probably the most subjective of all the tests undertaken. It attempts to evaluate the whole Virtual Classroom application scenario, and not just elements of it, from the viewpoint of an individual’s personal motives. The overwhelming positive response indicates that, despite the problems, there is an understanding of the benefits that such a system could bring to an individuals learning goals. This implies that in an era of lifelong and life wide learning, the alternative to a traditional face-to-face learning environment are no longer a second rate choice or compromise.

5.5.2.3 Verify that there is ease of use of the group configuration system from an end-user perspective in a real setting after a minimum amount of instruction

Requirement ID/Test Objective No250/229

Question: What is your overall opinion on the ease of use of the group working technology?

Responses

Very Poor	Poor	Average	Good	Very Good
0	2	4	13	0

Result: Pass

Discussion: The users experience of the group working features was limited to approximately two hours. The overwhelming positive responses to this question after such a short duration indicate that the group configuration was easy and intuitive to use. It had been a point of concern that the users would understand the relationships between the FRIENDS project configurations and the associated Meetingpoint conferences as outlined in Figure 4-2. The clarity of the interfaces of both the component parts of the software platform assisted in this aim.

5.5.2.4 To verify an adequate sense of telepresence among the distance students.

Requirement ID/Test Objective No251/230

Question: How included did you feel with the face-to-face class during the presentation?

Responses

Very Excluded	Slightly Excluded	Included	Very Included
5	10	4	0

Result: Inconclusive

Discussion: As demonstrated by the responses above, the majority of the respondents stated a feeling of slight exclusion during their participation as distance students. As discussed in section 2.4.3.2, telepresence relies more than just adequate audio and video. Possible reasons for this include:

- Inadequate audio and video
- Lack of understanding of inclusion techniques by the tutor
- Unease of the distance students as a result of not being physically proximate to the other students. This is the culturally normal environment and the one that would have formed the expectations of the students.

Certain implementation issues also affected this test. For example there was no room microphone and comments or questions form the face-to-face students would have to be repeated by the tutor for the distance students to hear.

These factors resulted in the inconclusive result.

5.5.2.5 To verify the ability for both distance and face-to-face students to work effectively in small groups within a larger group learning session.

Requirement ID/Test Objective No252/231

Question: How effective was the technology in enabling you to work with the group you were assigned to for the in-class assignment?

Responses

Distance Students perspective working with face-to-face students

Not Very Effective	Slightly Effective	Effective	Very Effective
2	7	10	0

Face-to-face Students perspective working with distance students

Not Very Effective	Slightly Effective	Effective	Very Effective
5	9	5	0

Result: Inconclusive

Discussion: There is a marked difference in the responses from the distance student perspective and the face-to-face student perspective. The majority of the distance students found the Virtual Classroom service to be within the effective range of response while the face-to-face students were not as positive in their analysis.

The distance students relied on the system for all of their interaction and information. As a result there was no fundamental difference between the lesson presentation and the group-working phase of the test. The face-to-face students would have received the lesson presentation in an environment where they were actually seeing the information projected onto a screen and seeing and hearing the tutor face-to-face. When the face-to-face students then moved onto the system for the group-working phase they would have been evaluating it from a different comparative perspective.

This phase of the lesson also relies more upon the interaction between the members of the group than any other phase. Human interaction is a complex area and within small groups the non-verbal communication techniques are of greater importance. For example while facial expressions would still be available to the distance students at a somewhat reduced clarity, hand gestures might not be apparent at all. In this way the face-to-face students would be noticing the difference between their immediate colleagues and the distance students more as they had a comparison available to them.

As a result of these points, the test was deemed inconclusive.

5.5.3 Participants Observations

The participants overall spoke positively of the experience and showed understanding and patience with the problems which arose during the tests.

An interesting perspective that was common was that the potential of such a system had been demonstrated and that such technology, if working optimally, would allow distance students to engage with a face-to-face class with good interaction and group working capabilities.

As students who were on part-time courses and who would travel considerable distance to achieve that interaction and social learning, they were approving of the further possibilities over a traditional distance course.

Suggestions were made to improve the audio streams in that room microphones were necessary and better techniques needed for the distance students to be heard by the whole class. These elements were in respect of the implementation and not the network itself.

6. CONCLUDING SUMMARY AND FINAL REMARKS

The installation of the Virtual Classroom application scenario in the wild at Trinity College, Dublin presented many issues. For example, delays in the provision of the hardware had implications for the timing and participation of users in the trials. It was also necessary for the FRIENDS platform to be supported by a multicast conference server to accomplish the requirements of Pilot 1.2. The test bed itself was located in two teaching computer rooms and as such did not have the access or exclusivity of a computer research laboratory.

The initial requirements were tested using the most applicable techniques and the results entered into the requirements database. A further set of requirements and accompanying tests were devised to expand the pilot within a pedagogical end-user framework. These further tests explored the experience of both the system, the group learning potential, and the desegregation of distance and face-to-face students from an end-user perspective.

The results demonstrate that there was a high level of user acceptance, and even enthusiasm for the system and it's potential. The end-user perspective naturally produced subjective data though the use of participant researchers allowed for a deeper level of analysis and understanding than would have been possible with ordinary end-users. Certain results were deemed inconclusive due to the combination of the differing user perspectives and expectations, and technical problems during the trials.

The use of a developmental platform (FRIENDS) on a novel architecture (BASS) would be expected to present technical issues, however, the overwhelming positive responses from the end-users when asked if they would themselves consider a distance course utilising the system indicates a level of success for both the Virtual Classroom application scenario and Pilot 1.2.

The Virtual Classroom application scenario demonstrated the potential for technology to integrate learners in different locations and provided a working collaborative learning environment. The installation generated much interest around the College as this area is of increasing interest to all third level educational institutions.

This concludes Pilot 1.2 at Trinity College, Dublin.

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GLOSSARY

ADSL	Asymmetric Digital Subscribe Line
CSCW	Computer Supported Collaborative Working
DVC	Desktop Videoconferencing
MSc ITEDU	Master of Science in Information Technology in Education

APPENDIX A – EQUIPMENT LIST FOR PILOT 1.2

Number	Component & Description	Provided by
12	CPE, ADSL modem including cable for connecting to PC's Ethernet socket	LUC
300 m	Copper cable connecting	TCD
12 sets	Connectors to copper cable connecting	LUC & TCD
1	DSLAM (AMAS), consisting of shelf, modem and AFM	LUC
1	ATM Cable connecting	LUC
1	BRAS SMS500	LUC
1	LAN, consisting of several coax cables and a switch	TCD
1	MCU-PC, multicast control unit used to facilitate one to many audio/video streams	TCD
1	MCU server software (Meetingpoint)	LUC
1	SP-PC, specification according to FRIENDS requirements, hosting the FRIENDS server	TCD
1	Tutor PC, specification according to FRIENDS requirements	TCD
12	Student PC, specification according to FRIENDS requirements	TCD
	Know-how, i.e. installation and support of BASS equipment	LUC
2	Computer laboratories	TCD
1	FRIENDS software, R3	LUC
1	VC application and course material	TCD
13	DVC cameras	TCD
1	Data projector	TCD

APPENDIX B – QUESTIONNAIRES

BASS Pilot Student Evaluation Form

1. **General Information**

Gender

Male ☐

Female ☐

Age ☐

2. **Experience**

Have you had any experience of videoconferencing before? ☐

If yes, please briefly outline your experience.

3. **What is your overall opinion on**:

	Very Poor	Poor	Average	Good	Very Good
the quality of the images					
the quality of the sound					
the ease of use of the conferencing technology					
the ease of use of the group working technology					

4. **Do you see a use for this kind of technology in your learning environment, and if so in what areas, and to what ends?**

BASS Pilot Face-to-face Student Evaluation Form

1. Did the use of this technology interfere with your experience in the face-to-face class?

Yes ☐ No ☐

If Yes, please tell us how.

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2. How effective was the technology in enabling you to work with the distance student you were assigned to for the in-class assignment?

Not Very Effective	Slightly Effective	Effective	Very Effective

3. Having used this technology, would you consider a course of distance study that used a similar set-up?

Yes ☐ No ☐

4. Please note any comments you have about the use of this system to include and desegregate distance students from their face-to-face peers.

BASS Pilot Distance Student Evaluation Form

1. How included did you feel with the face-to-face class during the presentation?

Very Excluded	Slightly Excluded	Included	Very Included

2. How would you rate the use of the videoconferencing technology for the presentation of the lecture?

Very Poor	Poor	Average	Good	Very Good

3. How effective was the technology in enabling you to work with the group you were assigned to for the in-class assignment?

Not Very Effective	Slightly Effective	Effective	Very Effective

4. How effective did you find the system to interact with the tutor?

Not Very Effective	Slightly Effective	Effective	Very Effective

5. Having used this technology, would you consider a course of distance study that used a similar set-up?

Yes ☐ No ☐

6. Please note any comments you have about the use of this system to include and desegregate distance students from their face-to-face peers.