

# FINE: IMPLEMENTATION OF A DISTRIBUTED TELEMATICS ENVIRONMENT FOR CLINICAL ENGINEERS

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## ABSTRACT

FINE (Facility for INformation Exchange) is a telematics application with objective the provision of Clinical Engineers with a central source of information and news services over computer networks. FINE provides its users with the ability to communicate with each other and with remote access to the FINE Database.

The FINE system has been designed to provide an integrated distributed communication and working environment. Thus, the FINE system integrates different services by using a sophisticated modular architecture and a flexible network protocol. Also a general and simple protocol is introduced for accessing the FINE Database. These protocols are used for communication between a UNIX workstation and a Personal Computer.

The experience, that was obtained during the design of the architecture and the network protocols of the FINE system, can be used for building efficient and user friendly telematics applications.

## INTRODUCTION

Modern methods of health care are expensive and there are conflicts between the expectations of people and

the quality of the service that can be widely provided. Telematics systems will contribute to the improvement of the health care quality, its efficiency and the cost effectiveness. Almost all of the health care sectors can benefit from the technologies of information and communications.

AIM (Advance Informatics in Medicine) was a Research and Development Programme of the European Commission, with purpose the application of information and communications technologies to Medicine and Health Care.

The programme's goal was the creation of a comprehensive, shared Health Information Environment. Its creation would be based on the development of optimised health care systems, that would also satisfy requirements such as the security and confidentiality of patients information.

BEAM (Biomedical Equipment Assessment and Management) was included in the Regulatory Tools and Quality Assessment group of AIM's projects. BEAM was focused on the development of a consistent framework for the management of all kind of information related to medical technology. This includes the availability of medical devices and equipment across Europe, cost effectiveness and quality procedures as

well as the training of technical personnel.

The usefulness of the BEAM/AIM project and its products has been recognised by the European Commission. The continuation of BEAM/AIM, which is called BEAM II, has been included in the Health Care sector of the TELEMATICS APPLICATIONS PROGRAMME.

One of the main products to emerge out of BEAM is a system for easy exchange of information related to biomedical technology among Clinical Engineers across Europe. This system is called Facility for INFORMATION Exchange (FINE) and has been developed in Patras, Greece. It is a telematics application, with objective the provision of the Technical Clinical Engineering Community with a central source of information and news services over computer networks.

Furthermore, FINE can be considered as an approach to integrated telematics environments that can support teleworking for Clinical Engineers in Europe. Teleworking tools are central points of the European Commission's policy for growth, business competitiveness and new employment. European Commission's plans aim for 2% of white collar workers to be teleworkers by 1996 and 10 million teleworking jobs by the year 2000. The potential advantages of integrated telematics environments for teleworking are of diverse and far reaching importance. Teleworking could:

- boost local employment,
- cut business costs by making better use of available skills and eliminating the need for large offices located in expensive and congested urban areas,
- provide more flexible working hours,
- save energy and reduce pollution by cutting down on commuter travel and easing traffic congestion in cities, and
- give individuals greater responsibility and flexibility.

## ARCHITECTURE OF THE FINE SYSTEM

The FINE system was designed (Institute of Biomedical Technology 1992) to use the available low-bandwidth European Networks and limited computational power. The currently available European Networks are the Public Switched Data Networks (PSDN) over X.25 and the Public Service Telephone Network (PSTN).

FINE's users are divided in two classes. The first class consists of the users who run FINE on a workstation, under UNIX, and the second one of the users who run FINE on a PC. The first class is called Full FINE Users (FFUs) (Institute of Biomedical Technology 1993a) and the second class is called Light FINE Users (LFUs) (Institute of Biomedical Technology 1993b). The services, which are provided to each class, have been defined according to the available computational power.

The FINE system offers the following services:

1. **Real time communication between two or three users.** This service includes real time exchange of messages, images and pointer coordinates. It is provided only to the Full FINE Users and is called Two and Three User Conference respectively.
2. **File Transfer.** A FINE user can transfer some files to another remote user, in batch mode. File Transfer is provided to both the LFUs and the FFUs.
3. **Electronic Mail.** After a FINE user having edited a message, he can mail it to a remote user. The FINE's Electronic Mail has a lot in common with the File Transfer. A major difference is that the Electronic Mail mechanism takes care of delivering the message later, if this is not possible at the time of the request. Electronic Mail is not available to the LFUs.
4. **Access to FINE Database (FDB).** The user can access the FDB through a user friendly interface and he can download to it or upload to his computer whatever information

he wants. FDB is accessible from both the LFUs and the FFUs.

5. **FDB broadcasting information.** Periodically (i.e. once a month) FDB broadcasts information, which the users are interested in, during low traffic hours.
6. **FDB to FDB communication.** FDB consists of several Databases, which are organised to a homogeneous distributed database. When a database is changed, the other databases must be updated. This happens through communication from FDB to FDB, which takes place during low traffic hours.
7. **Access to Y-Net.** This service is provided to all FINE users, and it permits them to communicate with other non-FINE users to other European or world-wide networks, such as INTERNET, COSINE, EUNET etc.

These services can be categorised to batch and interactive ones. Interactive services needs the user's attention throughout their duration. Batch services have modules that can be executed without the user's attention. Services 1, 4 and 7 are highly interactive processes, while services 2, 3, 5 and 6 have batch character.

Every LFU accesses the FINE Network through the PSTN. The PSTN can offer the bandwidth which is necessary for the services provided to the LFU, with a reasonable cost. In contrast to the LFUs, every FFU must have a permanent connection with a PSDN, which is based on the X.25 recommendation of CCITT. Eventually a gateway (Tanenbaum 1989) has been developed to permit the LFUs to communicate with the FFUs and vice versa. This gateway is called FINE Gateway (FGTW). It must be able to carry the traffic directed from PSTN to PSDN or the traffic directed from PSDN to PSTN. Since the access to Y-Net is provided through the PSDN, the FGTW permits the LFUs to access it.

The FDB consists of several national FDBs, which are organised as a homogeneous distributed database. A FINE user (either LFU or FFU) can access his national FINE database for obtaining whatever information he wants. If this database does not have the appropriate information, it is responsible for establishing a connection with another national FDB in order to satisfy the user's request. Of course the user can consider that this scheme acts as one database.

The higher communication layers of the FINE Network are implemented with the use of the widely adopted TCP/IP (Transmission Control Protocol/Internet Protocol) (Comer, Daglas, Steven, and David 1993) family of protocols. Actually TCP/IP provides the communication layers 5 (Session), 4 (Transport), and 3 (Network), according to the ISO/OSI reference model (Tanenbaum 1989). Since TCP/IP provides both routing and end-to-end reliable transfer, the underlying X.25 network with its protocols is treated basically like a hardware delivery system.

The FINE application modules are implemented over the TCP/IP protocol stack (Stevens 1990). A user friendly interface has been developed to provide the user with access to the network through the FINE application modules. Figure 1 demonstrates the architecture of the FINE system.

## THE SOFTWARE MODULES OF THE FINE SYSTEM

The FINE system offers a number of user services. The implementation of the corresponding communication services is based on the client-server model (Stevens 1990). For each communication service there is a software module that acts as a client and another module that acts as a server. We call the FINE system that initiates the services (client) *Initiator FINE System* and the remote one (server) *Responder FINE System*.

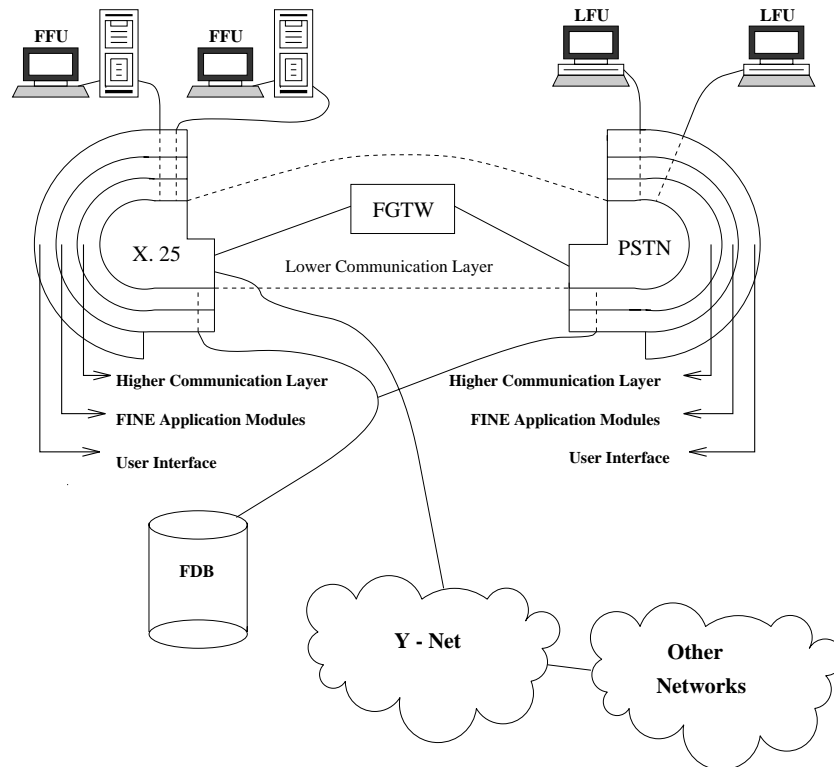


Figure 1. The architecture of the FINE system.

Although the FINE System is implemented in two completely different platforms, UNIX and MS-Windows, the software architecture is the same in both implementations, meaning that the software modules are similarly defined, and interact each other in a similar manner in both implementations. Of course, the implementations are adjusted to the features of each platform. The software modules of the FINE architecture are distinguished in the following ones:

- The *User Interface Module (UIM)* offers to a FINE user the ability to select the desired user service and to communicate with a remote FINE user in a friendly manner.
- The *FINE Service Control Module (FSCM)*, which acts as the server, is listening for connection requests to a specific, for the FINE application, TCP port. After the connection establishment, FSCM receives the Service Request from the Initiator FINE System, and after interaction with the user, accepts or rejects the Service Request. Depending on the requested service, FSCM invokes the appropriate Service Process

Module in order to process the communication service.

- The *Service Process Module (SPM)* processes and completes the communication service after the request acceptance.

#### MAJOR GUIDELINES OF THE USER INTERFACE

All services and facilities of the FINE system are provided through a user friendly Graphical User Interface (GUI). The interface for Full FINE Users has been developed under OSF/Motif, and the interface for Light FINE Users under MS-Windows. It must be noted that although two versions of the same interface have been implemented, there are only a few differences between them, a result of the different window managers.

The user interacts with FINE through buttons, scrolled lists and text fields. All possible actions can be performed by pressing buttons and all selections can be made by clicking on scrolled lists. Also check boxes and radio buttons are used where items, that can be divided into classes, are listed or

where the user must make a decision and there is only a limited number of possible choices. The user can enter or read text through text fields, wherever is necessary.

The user interface of the FINE system has the following advantages:

- It uses visible controls (buttons, lists), with meaningful labels, for getting the users input. This is much better than using pulldown menus, because it is difficult for the user to remember the actions which are hidden under a menu.
- All FINE windows construct a multilayered tree structure. The use of every window corresponds to its position in this tree. So, the results of the user's actions can be predicted.
- On line, context sensitive help is provided wherever is needed.

## CONCLUSIONS

The FINE system provides the Technical Clinical Engineering Community with an infrastructure for communication. The main results of the design, development and use of FINE are summarised below.

- FINE can be used either by an LFU which is connected to PSTN or by an FFU which is connected to PSDN. So, the decision for the class of the FINE users, one wants to belong to, can be made by considering the required services and the corresponding cost. This feature is expected to increase the popularity of the FINE System.
- The Light FINE System may be considered as the "home version" of FINE. It can be used for establishing a community, whose members will be all the Clinical Engineers in Europe. The use of FINE will permit them to cooperate and to access the FINE Database for obtaining whatever information they need. The majority of the Full FINE Systems are expected to be installed in Hospitals, Laboratories, Institutes, Universities etc. So, the

LFUs will be able to contact organisations of this kind for getting information about special topics.

- The user friendly interface is expected to help the wide adoption of the FINE System. The majority of network applications are accessible through command line user interfaces. This fact prevents a lot of users from using them. FINE provides its users with access to network services through a windows-oriented user interface. The user is informed only about the results of the complicated operations but not about the operations themselves. So, even an inexperienced user can access the services offered by FINE.
- Some ideas that are introduced by the FINE system will be used by a new generation of user friendly distributed applications. We believe that FINE will guide the design and the development of many applications in the sectors of teleworking and computer supported cooperative work.

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