WEB-BASED DISTRIBUTED SYSTEMS FOR COLLABORATIVE REMOTE EXPERIMENTS

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Abstract

DYNACORE, an EU funded project, will provide scientists and astronomers with a powerful tool for remote collaboration in experiments or observations requiring one or more remote facilities. One of the main objectives of DYNACORE is to develop a Tele-operation system which can be easily adapted and optimised for a particular instrument. To achieve these objectives, we are using an object-oriented, component-based approach. The user accesses DYNACORE services through a standard, web-based man machine interface. The client software is based on Java applets, which directly interact with DYNACORE servers using IIOP protocol. OMG-CORBA is used as a high-level infrastructure for component interaction, including remote Java applets. The benefits of CORBA are extended to system design: object oriented paradigms are used in the definition of a distributed environment, which allows to hide details about process location, operating systems and programming languages. The system is used for remote operation of large-physics experiments and telescopes

1 INTRODUCTION

Some scientific environments, such as Astronomy and Plasma Physics, are using increasingly sophisticated and expensive instruments, concentrated in a few selected places, sometimes driven by environmental conditions. The cost of such facilities can only be afforded by the agreement between universities, laboratories, governments and industry. In this context, experiments, observations and problem solving must be pulled together by scientists and engineers from different locations. Geographic separation becomes an essential factor for accomplishing cooperative research. The working routine and contacts are limited by the schedule constraints and cost imposed by travels. The combination of new Information and Communications Technologies can compensate the drawbacks. Collaboratory systems provide a distributed environment for people and instrument cooperation. Information of different kinds (not just data) can flow, and users can interact with instruments as easily as they do when the resources are local.

The goal of DYNAmically COnfigurable Remote Experiment monitoring & control (DYNACORE), an EU funded project, is to provide two scientific communities, Astronomy and Plasma Physics, with such an environment for the collaboration on observation and experimentation using telescopes (TNG and NOT at Roque de los Muchachos Observatory) and fusion laboratories (TEXTOR 94 at Forschungszentrum, Jülich).

A first Astro prototype has already been used by a representative and qualified group of validators (Astronomers) in realistic conditions (real NOT telescope instruments in both day and night time, TNG simulated instruments, through TNG real control system). The conclusions about the satisfaction and acceptability to the users of this new way of working are encouraging. User comments and suggestions will be taken into account in the development of a new prototype version, in order to improve the usability conditions of the system.

2 REMOTE CO-OPERATION IN MULTI-INSTRUMENT EXPERIMENTS

A collaborative system such as DYNACORE allows geographically distributed users and instruments to cooperate in an experiment, by providing a set of services for three different interaction levels (see fig. 1):

- **Human / Human Interaction:**
  - A permanent information flow allows each user to know the actions executed by other colleagues and the effects on the instruments,
  - An integrated chat server allows live discussions. Advanced tools such as video-conference can be included if supported by the communications infra-structure.

- **Instruments Interaction:**
  - Schedule co-ordination,
  - Data sharing,
  - Remote services.

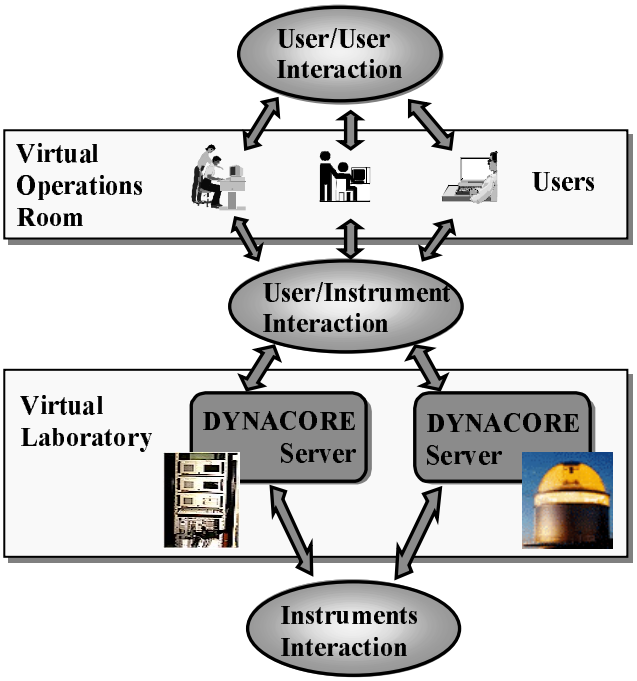

Figure 1: Instruments and experts cooperation.

DYNACORE also provides **system administration services** for:

- Users management: different roles can be defined for different users, avoiding unauthorised use of an instrument.
- System configuration,
- System Under Operation (instrument) specification: commands, events and operational rules definition,
- Schedule management, Log-book

User Category	Description	Type of Interaction
End-User	Scientific, Astronomer	Experimentation, Observation
System Engineer	Equipment specialist	Testing, Maintenance, Problem investigation, Integration
System Operator	SuO specialist	Local supervision, Operation servicing, Maintenance.
System Admin.	DYNACORE specialist	Users mngmt., System mngmt.

Table 1: User types and roles

The web-based interface, together with the definition of a 'generic' interface model for the operation of a particular instrument, makes possible the access to the system from any computer and with no user training. DYNACORE will mainly be used by Scientifics and Astronmers for collaborative experimentation and observation, but different users can have different purposes, as shown in table1:

3 DYNACORE ARCHITECTURE

DYNACORE is an object-oriented, distributed system. **OMG CORBA** (Common Object Request Broker Architecture) is used as a high-level infrastructure for distributed computing. This allows to use object oriented paradigms in the definition of a distributed environment, hiding details about process location, operating systems and programming languages. DYNACORE objects are distributed on client (Java applets on browser environment), Web server (C++ agents) and DYNA server (C++ modules implementing application logic and basic services). Both the web server and DYNA server can be deployed in one or several computers on the same LAN.

Th system provides a **web-based** man machine interface. The user access DYNACORE services through a standard Internet browser, including a Java Virtual Machine. The client software is based on **Java** applets which directly interact with DYNACORE servers using **IIOP** (Internet Inter-ORB Protocol).

The following figure describes the main logical components of DYNACORE system, and its interactions:

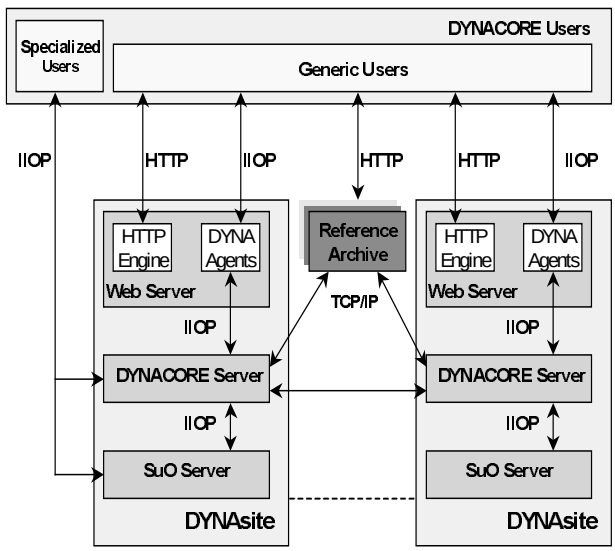

Figure 2: DYNACORE Architecture

The **user** connects the web server of a DYNACORE system using HTTP protocol. The required Java code is downloaded before starting operation. Systems with real time constraints require a

specialised interface, in order to improve performance.
- The **web server** hosts the HTTP engine and DYNACORE agents.
- **DYNACORE server** is a set of CORBA components, implementing the services provided by the system.
- **SuO Server** is a CORBA front-end to the System under Operation local control system. It allows DYNACORE to interact with the instrument.

4 DYNAMICAL CONFIGURATION

Very similar instruments, from a functional point of view, can have completely different control systems. One of the main objectives of DYNACORE project is to develop a tele-operation system which can be easily adapted and optimised for a particular instrument.

To achieve this objective, an instrument model is stored in a DYNACORE repository. An instrument is defined in terms of:

- Commands accepted by each sub-system,
- Events generated,
- Dynamical behavior (commands allowed in a particular context, transition provoked by an event, etc.), defined using a standard graphical notation (UML state diagrams) and translated into data structures.

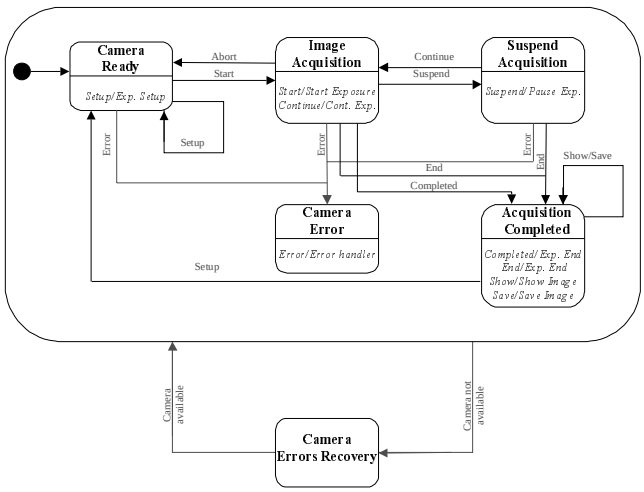

Figure 3: Operation Rules definition

5 CONCLUSSIONS

Observation sessions (with the participation of astronomers at La Palma Island, Madrid, Lund and Trieste) have been performed using both real and simulated telescopes, with fully satisfactory result. Even if the prototype is at its first stage (a second version is expected next May), it has proven to be a correct approach for collaborative, remote astronomical observation.

DYNACORE, and other similar projects, are contributing to the introduction of new concepts such as 'Virtual operations room' or 'Virtual laboratories' which are going beyond traditional remote operation or recent on-line results publication on the web. They are providing a framework for experts and instruments collaboration which makes possible a new approach to activities such as Experimentation, Integration, Maintenance or Education. Applications for this systems are not restricted to scientific environments. They can be used in other contexts such as Industry, Space or Health Care.

6 REFERENCES

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