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NTT Remote Observing from Italy

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1. Introduction

Remote observing (RO) from ESO-Garching is by now a well-established service provided for the user community by ESO. So far it has been concerned with instruments located either at the CAT or at the 2.2-m telescope at La Silla, operated from Garching since 1987. The advantages of this observing mode include reduced travel times, the possibility to accommodate shorter and regular long-term monitoring observing programmes, the possibility for students to participate in the observation and the facilities (people, library and computers) normally available in a European astronomical institute [1].

In order to create a new remote observing environment for the EMMI and SUSI instruments on the NTT telescope, a collaboration with the Astronomical Observatory of Trieste, Italy, was started in 1989. The Trieste Observatory has a long experience in the field of Unix-based workstations and on distributed environments.

The project was based on the philosophy of a multi-telescope, multi-instrument system addressed by many users in parallel in a flexible scheduling environment compatible with the automatic execution of complex observing programmes.

The main goals of the collaboration were:

- The study, design and implementation of a portable kit, including hardware and software for remote observations with the ESO NTT from a European astronomical institute.
- The definition of the hardware architecture for the RO computer network and communication system.
- The implementation of a "second" generation of RO software, based on Unix and workstations hardware. An important part of this was the extension of the real-time database of the NTT to a geographically distributed

Figure 1: *Astronomers and visitors in the Trieste remote observing room – waiting during a long NTT exposure.*

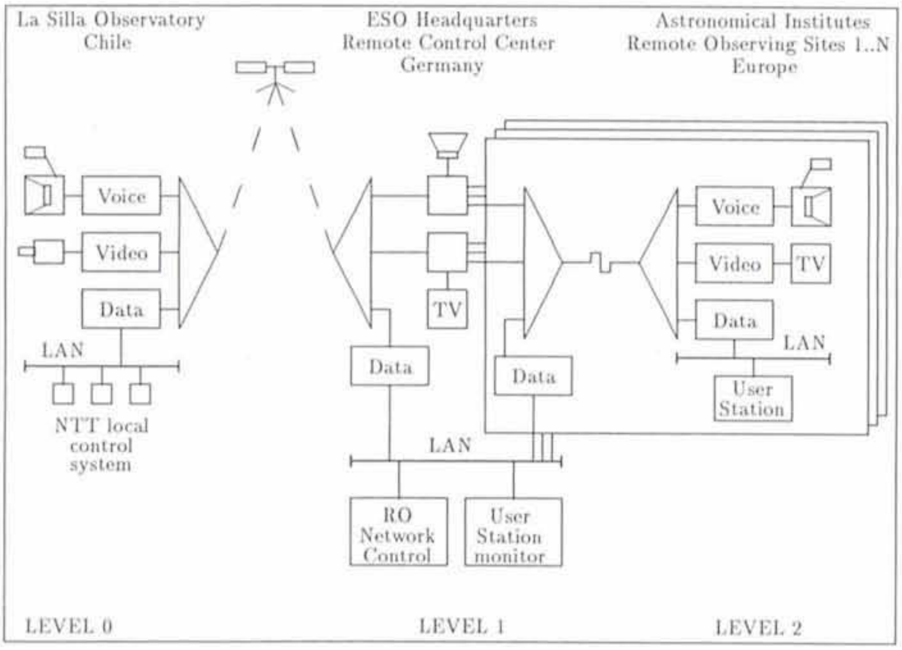

Figure 2: *Block diagram of communication system.*

telescope/instrument parameters' database (XPool).

- The availability of the same software and features for remote observing both at the first level site (ESO-Garching) and at a second level site (user's institute).

While the complete development of the project took three years, the first milestone was reached with the development and test of the remote observing system of first level in Garching. This system is now in the final test phase and the operation team is being trained. It is foreseen to offer routine remote observing from ESO-Garching on the NTT with EMMI/SUSI starting in April 1993.

Meanwhile, the relevant hardware had been procured and several tests took place, while arrangements were made for the installation of the 64 kbps link from Garching to Trieste.

The final milestone was reached when the second level remote observing run took place, from the 9th to the 11th of June 1992, at the Astronomical Observatory of Trieste, Italy, during three nights allocated for remote observation with the NTT telescope. The present article reports on the results of this run, which proved that the chosen concept and implementation were not just working but already quite reliable at the present stage. The system was in fact used for about 30 hours for real astronomical observations by a team of eight astronomers.

The aim of this project was not simply to build a remote observing environment for the NTT, but right from the beginning it was conceived by ESO to serve as a pilot project for the VLT. In particular new computer technologies, software (user interface, on-line databases) and operational procedures should be tested, which are of importance for the VLT control system in general and not only for remote observations.

It is foreseen to repeat the second level remote observing run from other institutes in Europe, porting to them the set-up, which has been produced as a result of the ESO-AOT collaboration and leasing jointly a link to Garching.

2. System Architecture

2.1 First Level Remote Observing

ESO-Garching is permanently linked to La Silla via a 64 kbps leased satellite link [2]. During remote observing the bandwidth is subdivided, using time division multiplexing, into three parallel channels. A voice channel implements a point-to-point voice link between the night assistant at the NTT and the remote observer at ESO-Garching. A video image channel allows the remote observer to select one video source (e.g. field acquisition, slit viewer) for transfer in slow-scan-television mode. Due to the fact that video images obtained by the acquisition cameras are normally very simple, consisting of only a few sources on a black background, the compression algorithm works very well. Using a bandwidth of 12 kbps the normal frame repetition rate is one frame every 3 seconds. This makes it possible to use the video image system as feedback for interactive control, e.g. offsetting the telescope, even when the video image system is using only one fifth of the available bandwidth. Thirdly, a data channel connects the local area networks of ESO-Garching and La Silla via routers. A dedicated local area network (LAN) has been created at ESO-Garching for remote observing. This network uses a separate interface on the router, while all other nodes connected to the general LAN use another interface. Any disturbances on the general LAN are thereby isolated from the remote observing network.

A dedicated room at ESO-Garching has been allocated as the NTT remote control room. It houses the remote control station and care has been taken to create an ergonomic installation. The remote control computer is a Unix workstation supported by two additional X terminals. Normally one of these X stations is allocated to telescope control, one to instrument control and one to quick look and image processing using MIDAS. A large video monitor displaying video images is installed above the X terminals. At both ends of the control station is a PC, which the user normally does not interact with very often. One is for video control and the other for receiving meteo data from the GOES satellite. Lastly a movable voice unit containing a microphone and a loudspeaker implements access to the voice system.

The NTT local control system is based on two main computers running the RTE-A operating system. In addition a Unix workstation is used for scientific data acquisition. The main characteristics of the software architecture are a decoupling of the control tasks from the user interface by means of a database and a command handler. The database and command handler, together with the TCP/IP protocol suit, provides the software bridge between the local and remote sites.

The remote control software architecture is discussed in detail in [3] and only a brief overview is given here. The distributed database (Xpool), implemented according to the client server model and using TCP sockets, allows remote read and write access. It is responsible for providing status information to the remote control computer and to allow definition of set-up parameters from the remote control computer. The command handler, implemented in a similar way, is responsible for routing commands, replies and asynchronous status and alarm messages between processes residing on different hosts. These two mechanisms allow a fully interactive remote control, providing the remote user with the same functionality available locally at La Silla.

Scientific data handling makes use of

Figure 3: *The ESO-Garching remote control room.*

Tentative Time-table of Council Sessions and Committee Meetings

November 12–13	Scientific Technical Committee
November 16–17	Finance Committee
November 26–27	Observing Programmes Committee
December 1–2	Council

All meetings will take place in Garching.

standard network facilities, remote shell, ftp and the X protocol to transfer and/or display scientific data. It takes about one minute to display an image, independent of detector size, in a standard MIDAS display window using the X protocol. Actual transfer of the raw data takes between 3 and 7 minutes for a 1k×1k frame, depending on a user selectable compression algorithm.

The User Interface [6] based on the Pegasus package developed at CFHT, interfaces to these other packages. It runs on top of OSF/Motif and uses standard widgets for data presentation and user interactions. It is completely configurable in the sense that everything that appears on the screen and associated control actions are described in simple ASCII files.

2.2 Second Level Remote Observing

The second level hardware and software configuration has been developed with the aim of implementing a system able to manage remote observations on a multi-telescope, multi-instrument system from European astronomical institutes, and allowing the main control centre of ESO-Garching the full control of the remote operations [4]. The basic three-channel hardware configuration is also maintained for second level remote observing. Full compatibility with the first level and userfriendliness are, of course, provided. Since more than one instrument could be active in the general architecture, multiple secondary levels are foreseen in the overall configuration in order to allow flexible scheduling. The possibility of managing remote observations from more secondary levels on more telescopes is therefore a natural extension of the system.

Since the data channel connects computers already operating, in most cases on networks, two bridges allow an easy way to connect the LAN of the first level with the LAN of the second one. A single Remote Control LAN, comprehensive of all the three levels, is thus obtained allowing an easier use of computing facilities. Future extension of this channel to multiple second levels is straightforward.

Voice and video channel, even if devoted to different uses, can be treated in the same way, since the original signals they have to manage are intrinsically analogous. This fact, on the other hand, added a few more problems to the channel management. The electrical and communication protocols of the serial lines (these channels are generally implemented according to X.21 or V.24 standards) define a point-to-point link instead of a distributed environment. Therefore, in the simplest configuration, voice and video channels directly connect zero level with the second level observing site. However, a direct connection between the zero and first level is required to allow communications between night assistants and the ESO-Garching control centre. In order to maintain a simple hardware configuration, a software solution (SUN talk) was implemented. In the perspective of multiple second levels, a distribution board for serial lines has to be foreseen.

The link connecting first and second level sites should have a bandwidth of at least 64 kbps in order to completely manage all three channels. In a multiple-site configuration, while the first to second level lines will maintain this bandwidth, the main link between the zero level and the first one will obviously need a higher bandwidth, i.e. at least N×64 kbps where N is the number of secondary sites observing at the same time.

A 64 kbps digital ground-based link was leased jointly by ESO and OAT for this test for the duration of one month. Such a connection proved to be a novelty for the German and the Italian PTT companies. Some days at the beginning of the connection period were lost owing to tests on both sides. This kind of problem will hopefully disappear with the increasing integration of the European Community.

The control room at the secondary level site is a duplicate of the main control room at ESO-Garching in line with the resources of the institute. As a general rule, one workstation, two X-terminals and two PCs are required; if the need arises, a disk server for image storage could be used even if it is not essential. Specific equipment for voice and video channels (i.e. telephone set, monitor . . .) is also required.

The extension of the software for second level remote observing involved the implementation of a hierarchical structure. Each node must be defined as primary or secondary according to its level. The secondary node sends its requests (direct access or updating list) to the primary one. It is up to the primary node to route the request to the final target, i.e. the instrument or the telescope control computer. Thus, no direct access to zero level database is allowed from the secondary level. Even if this mechanism may induce some time delay in response, the resulting filter action obtained is very important for the control and monitoring actions of the ESO-Garching centre.

During remote observations, all the operations carried out by the second level site can be monitored by an operator in the ESO-Garching control room. Every updating action, from secondary to zero level and vice versa, is first performed by the primary level on its database. A monitoring process on the primary level control computer is thus able to check secondary level operations and, if necessary, also to filter out incorrect operations of the secondary node. The primary node can obviously perform its own operations toward zero level site, thus obtaining a complete control of the remote observing session.

All the software configuration is driven by few configuration files and environment variables, allowing the possibility of easily switching between various contexts, i.e. from simulation to reality.

3. The Final Test

The final test was carried out on the nights of 9, 10 and 11 of June [5]. The link created no specific problem, once German Bundespost and Italian SIP had solved theirs. The connection between the OAT LAN and the ESO LAN, with the creation of the extended remote observing LAN, was straightforward.

A telephone set was used as data channel terminal equipment. The only problem encountered with it was the "Donald Duck effect" on the voice due to the compression ratio of this channel. Some problems arose with the video channel due to the late and incorrect delivery of some boards on the part of the manufacturer. This channel started to work continuously as from the second night.

The OAT control room was configured in the following way. One workstation HP-425 as control computer and as display for instrument UIF. Another workstation HP-375 was configured as X-terminal for telescope UIF display. A second HP-425 was used to run a remote MIDAS session on the SUN control workstation at La Silla. A Sylicon Graphics Indigo workstation was inserted in the network to use its disk space, through NFS, for image storage. One NCD X-terminal was used to run two "talk" sessions with the ESO-Garching control room and with La Silla through remote logins on two SUN in Garching and at La Silla. These last communication sessions were used in order to have a more complete interaction with the ESO-Garching control room and the La Silla night assistant due to the test nature of the nights. Two PCs were also used for the monitoring of the data channel and for the display of the Meteosat images.

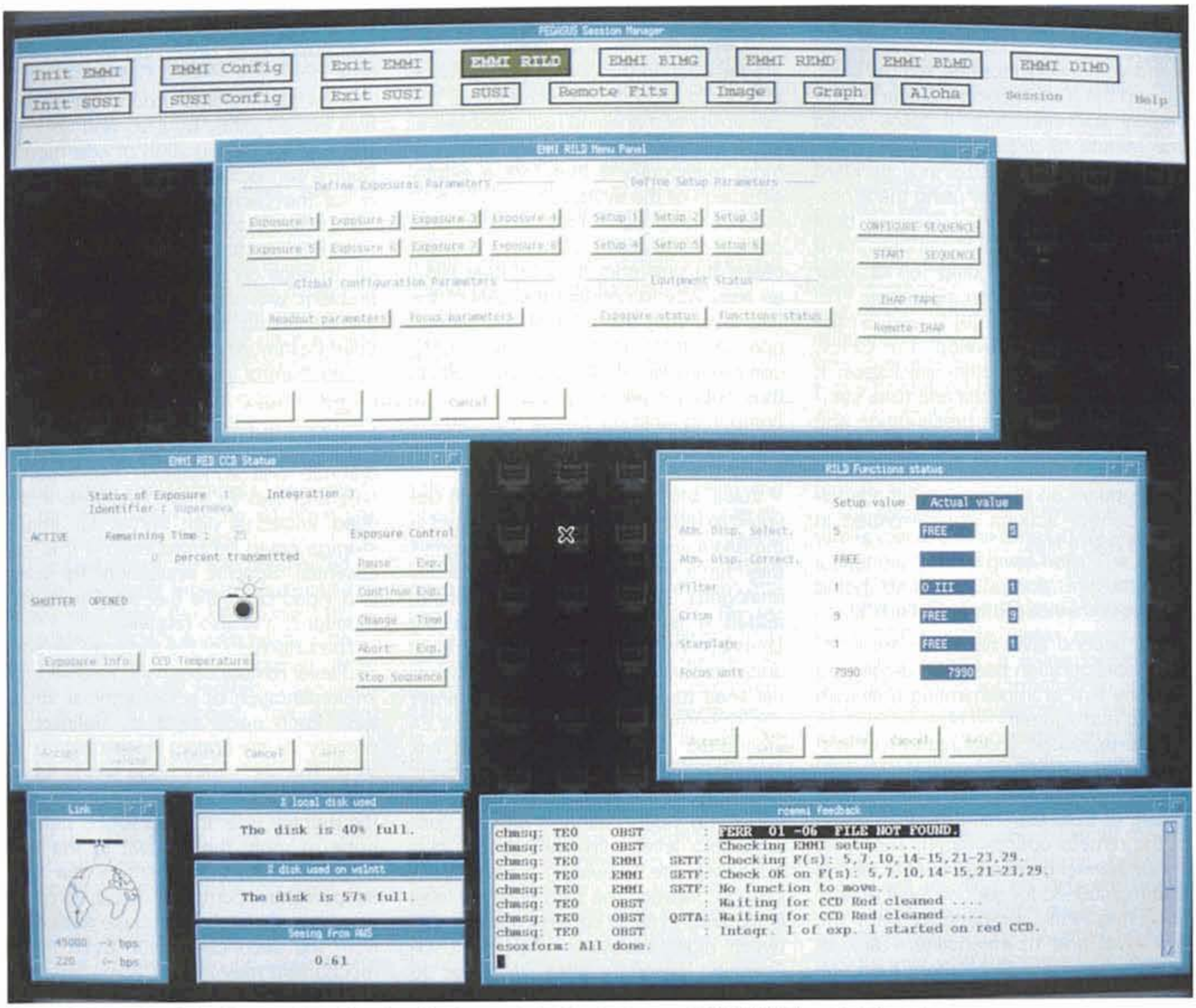

Figure 4: *Example of the Pegasus User Interface for the control of the instrument (EMMI/SUSI) and of the telescope.*

The software had to be ported from the remote control computer in ESO (an HP-720) to the OAT HP-425. No problem at all was encountered during this procedure. A porting of Xpool package on SUN and Sylicon Graphics was also put into effect, for test purposes, in the months preceding the final test.

On the first night ten hours were devoted to preliminary tests and to identify and fix some software bugs. From 4.00 UT astronomical observations could begin and continued until 11.00 UT. The second night started with some minutes of delay due to some minor software problems and lasted till 11.00 UT. The last night was entirely devoted to astronomical observations. On the whole, more than thirty hours were entirely devoted to astronomical observations. Eight OAT astronomers used this time to carry out various scientific observations. It should be stressed that while an observation was going on, the astronomers were able in remote MIDAS sessions to have a quick look at the previously acquired images in order to evaluate the validity of their data. Accordingly, if necessary, the transfer of the images from La Silla to Trieste could then be carried out.

4. Conclusions

This project was successful in proving the feasibility and reliability of second level remote observing already at this stage.

During the three nights of the final test over 30 hours were devoted to astronomical observations and, as can be inferred by the users' comments, the system proved to be very easy and flexible to operate, considering also that most of the observers had no experience in the use of EMMI.

In view of the success of the experiment it has been decided not to stop here but to proceed along two lines:

- To study and implement a special hardware/software system for on-line data compression technique, in order to reduce the quick-look time (at present of the order of minutes) and obtain an almost completely interactive environment.
- To identify other interested institutes in Europe to repeat a second level remote observing run from there, in order to test portability and reliability of the present set-up. This can also be useful to test operationally the feasibility of remote access during flexible scheduling, where more than one observing team can be active during the same night from different institutes.

The modalities are currently under definition. The candidate institute should have a network of Unix workstations, and provide the possibility of dedicating part of the LAN to the remote observings tasks in addition to the astronomical interest in participating in such an experiment. The communication equipment could be provided by ESO for the purpose of a first test.

The joint procurement of the leased link to Garching is another condition to be fulfilled, and further preliminary daytime tests and remote test nights will be necessary.

As an independent parallel activity the first level remote observing system is now getting its final touch. The operation team is being trained and user guides are being produced. It is planned to start offering remote observing with EMMI/SUSI to the user community in April next year.

5. Acknowledgements

Many people have participated in the development of the described system. The NTT (local) control system was developed within the Electronics Department at ESO-Garching. Major contributions to the implementation of the remote control system were made by B. Gilli and J. Brynnel.

At the Astronomical Observatory of Trieste M. Pucillo was one of the designers of the second level hardware and software architecture and participated in the software developoment, and C. Vuerli implemented most of the software utilities. The help of P. Marcucci and R. Smareglia is also acknowledged. C. Corte gave his precious support during the set-up of the second level observing room.

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References

[1] D. Baade, "Three Years' Experience with Routine Remote Observing at the European Southern Observatory", in Proceedings of Workshop on Remote Observing, Tucson, USA, April 1992.

[2] A. Wallander, "New Communication Link between Garching and La Silla", in *The Messenger* No. **60**, June 1990.

[3] A. Wallander, "Remote Control of the ESO New Technology Telescope", in Proceedings of Workshop on Remote Observing, Tucson, USA, April 1992.

[4] A. Balestra et al., "Remote Observing Activities at the Trieste Astronomical Observatory: The ESO/NTT Second Level Remote Observing and the Galileo Telescope Project", in Proceedings of Workshop on Remote Observing, Tucson, USA, April 1992.

[5] A. Balestra et al., "The ESO/OAT Second Level Remote Observing Project. Final Test on ESO/NTT: 9–11 June 1992", Technical Report *OAT Publication* No. 1443, June 1992.

[6] M. Comin, J. Kerr, "A Prototype for the VLT user Interface", in Proceedings of Conference on Progress in Telescope and Instrumentation Technology, ESO-Garching, April 1992.

A Fourth VLT Instrument Science Team

At its May, 1992 meeting the ESO Scientific and Technical Committee approved the two Ultraviolet-Visible Echelle Spectrographs (UVES1 and UVES2) for the Nasmyth foci of the second and third VLT telescopes. The ESO staff responsible for building these instruments is now proceeding with the design studies of this major facility which will do high-resolution spectroscopy (resolution-slit width product = 40,000) in the 300 to 1100 nm wavelength range. At the same time an Instrument Science Team has been formed for this facility. Its members are:

B. Gustafsson (Uppsala)
H. Hensberge (Brussels)
P. Molaro (Trieste)
P. Nissen (Aarhus)

The team will select its chairman at its first meeting on December 9. As is the case for the other VLT instruments (see *The Messenger* **68**, page 8), the IST members and myself welcome your input on scientific matters relating to these instruments.

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