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Remote Participation at JET Task Force work: User's experience

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The Joint European Torus (JET) fusion experiment is now operated with strong involvement of physicists from many research laboratories in and outside Europe. This paper describes needs for remote participation in JET physics experiments and summarises user's experience with the tools made available for remote collaborative work: remote computer and data access, remote meetings, shared documentation and various other communication channels. Implications for further development of remote participation infrastructure for work at JET and in an integrated European research program are discussed.

1. Introduction

Since the year 2000, the Joint European Torus (JET) nuclear fusion experiment is operated under the auspices of the European Fusion Development Agreement (EFDA) with direct involvement of researchers of all major European fusion research laboratories in JET experiments. Scientists from laboratories outside JET can participate in JET Task Force work personally by traveling to the JET site. However, this is not always possible for the entire time interval needed to prepare and execute experiments and analyze the results. For this reason a large effort has been made to facilitate Remote Participation (RP) in EFDA-JET using a number of mainly Internet-based techniques [1,2] This system is operational since the start of experimental campaigns in May 2000. The present paper gives a first summary of experience with remote participation at JET from a user's point of view.

The present paper begins with a review of requirements for remote participation at the various aspects of JET experimentation, followed by a short discussion of the scope of the existing tools. A user poll has been performed to assess the experience physicists have made so far, the results are summarised. The paper concludes with a discussion of further development of the remote participation infrastructure for JET and implications for joint collaborative work on all European fusion experiments under EFDA.

2. Requirements for remote experiment participation in physics experiments at JET

2.1. Experiment planning and preparation

Experiments in EFDA-JET are organised in campaigns of typically several weeks duration, which are outlined several months ahead. The Programme Execution Committee and topically oriented Task Forces outline the main types of experiments and scientific priorities for upcoming campaigns. Proposals for experiments are solicited from all participating institutions, which also nominate scientists to take part in the execution of the JET experimental programme. These proposals are combined to define the detailed experimental schedule. At this stage also the experiment manning is determined, a necessary step for the Task Forces to prepare the actual experiment execution. In particular, scientific coordinators and experimental session leaders are nominated who have the main responsibility for the achievement of the physics goals of the experiments.

During the planning phase, contributors are often distributed at different locations, communicate verbally and exchange mostly informal written documents which define the details of the proposed experiments. At this stage already some technical preparation work can begin, which involves remote log-in to

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[†]see annex of J. Paméla *et. al.*, "Overview on recent JET results and future perspectives", Fusion Energy, (Proc. 18th Int. Conf. Sorrento, 2000), IAEA, Vienna (2001)

JET computers for interactive creation and editing so-called "pulse schedule", a computer file which defines all major plant parameters for each plasma experiment ("pulse"). The pulse schedule for each experimental session is created by the session leader who is assisted by a set of design codes, e.g. for plasma shaping, and verified for compliance with the machine capabilities, in particular electrical current and force limitations, as defined in the operating instructions. Although this type of detailed preparation work is in most cases done on site, all tools and documentation can be accessed remotely.

2.2. On-line Participation in experiments

During a campaign, JET Experiments are usually organised in two sessions per week day, each with typically up to 10-15 pulses with up to 40 s duration each. Session leader and scientific coordinator together monitor the scientific progress during a session and make all necessary decisions to obtain the physics result aimed at. They are supported by plasma heating and diagnostics experts. The diagnostics coordinator monitors diagnostics integrity. Most important plasma parameters are logged on an overhead display in the JET control room.

Passive participation in JET experiments requires network access to logging information, such as the overhead display, diagnostics data and machine status information. Active forms of participation might include preliminary data analysis in between pulses and participation in the decision making process, which requires direct communication with the scientific coordinator and/or session leader.

In addition to raw data collected directly from the diagnostics systems (dubbed "JET pulse files", JPF), some data is analyzed in between pulses and the result stored in "processed pulse files" (PPF). For example, the magnetic equilibrium and measured temperature and density profiles are reconstructed and provided for inspection a few minutes after each pulse. It is highly desirable that a first assessment of the diagnostics results can be made quickly after and experiment to be able to to steer an experimental session for optimum overall physics output. As the amount of data collected for each JET plasma pulse is quite substantial, typically 600 MBytes at present, a high peak data rate must be sustained immediately after plasma pulses.

Remote participation in JET experiments requires giving users access to the wealth of data produced over wide-area-network connections. Communications between remote participants and the session leader must be easy and may not introduce much overhead because the session leader is typically loaded with several parallel tasks. So far session leaders and scientific coordinators of experiments have worked locally in the JET control room and only additional experts have participated remotely.

2.3. Data analysis and modeling

After experimental sessions the acquired diagnostics data is further processed and validated. This includes, for example, detection of possible diagnostics errors which can occur under certain plasma conditions. Often, transport analysis is done based on measured parameters which serves to cross-check the mutual consistency of the results of various diagnostics.

Further analysis work done after an experimental session largely depends on the nature and goals of the individual plasma experiments. For example, analysis of magneto-hydrodynamic (MHD) instabilities, or plasma edge data can be further studied, which often requires very sophisticated procedures which are performed by specialists in the fields involved. As a means of data reduction and summary, databases are maintained which contain scalar data of representative time intervals in plasma discharges.

In principle, all of the above mentioned analysis tasks can be performed remotely. Remote access to JET raw and processed data in particular allows off-site specialists to lend their expertise for data analysis without having to travel. Again, mutual communication is vital for coherence of the joint work on JET results.

2.4. Specific issues for remote participation

Ease of use

Off-site participation in a teamwork environment implies lack of direct verbal and non-verbal personal interaction. Remote participation tools should as much as possible compensate for this, and therefore be easy to use in order not to create an additional unnecessary burden. Usage of remote computers, for example, should be possible with a simple log-in procedure, and graphical interfaces similar to those locally used should be available. Remote participation tools should be easy to install and as much as possible platform independent, owing to the widely different computer and network infrastructure installed at the participating institutions.

Performance

For remote participation, much of the functionality of a local area network has to be performed over wide area network (WAN) links which can often not be influenced by local network administrators. Remote participation tools therefore must have a significant degree of resilience against network outages or slow connections and should be efficiently using network resources. On the other hand, interactive work requires reasonably short response times to be feasible, which, particularly for graphical user interfaces, presents a challenge.

System security

Special security requirements at JET arise from the fact that radioactive material, in particular tritium, is handled on site and many systems use high electrical currents and voltages. Intentional or unintentional interference from on-site or remote locations with the plant settings must not compromise personnel and machine safety under any conceivable circumstances. The required very high degree of security is achieved at JET with a hierarchical firewall structure, which blocks access from outside the critical systems.

Data servers and most network and computing facilities are situated outside this inner militarised zone, and are protected by a separate firewall to protect data and systems integrity. All remotely accessible services are grouped in this area. Secure protocols are chosen which use encrypted authentification and data transfer.

An additional fully demilitarised zone outside the firewall structure has been set-up to support services which do not conform to stringent security requirements. This includes particularly servers for insecure communications with remote computers and to a large extent the infrastructure for video-conference meetings.

3. Remote participation infrastructure at JET

This section contains a short summary of tools provided at JET to support remote participation at JET experiments. The description is done from a user's point of view; more technical descriptions are given in Refs. [1] and [2].

3.1. Remote Computer Access

Remote Computer Access (RCA) is used to access JET computers from outside JET. Several computer systems exist at JET for various tasks associated with JET experimentation [3]. Pulse schedule development, machine monitoring and logging tools are implemented on a UNIX workstation cluster. Data archiving and analysis has been performed previously on an IBM mainframe computer which has been removed from service in June 2001. Most data analysis tasks have been moved to a cluster of Linux personal computers, termed the "JET Analysis Cluster" (JAC). The JAC is also used for sophisticated modeling tasks. Office applications such as e-mail, word processing, and graphics editing, are supported on personal computers running Microsoft Windows NT. These servers also offer file sharing, access to printing and e-mail services.

Remote computer access is possible via CITRIX ICA[3] servers which are installed at JET and specifically configured for the various services described above. Authentification is done with a one-time passcode "SecureId[4]" token cards. A total of 355 cards have been issued so far and 266 cards have been used during 2001. 215 users have connected remotely to the JAC cluster, 100 users to the office network. Typically 5 . . . 15 users are logged in simultaneously. Finally, one CITRIX ICA server is provided in the demilitarised zone outside the firewall to provide secure connections from inside JET to outside destinations using insecure protocols. This service has been used by about 50 different users.

3.2. Remote Data Access

Facilities for Remote Data Access (RDA) have been implemented [4] which allow to retrieve data from JET pulse files (JPF and PPF) from outside JET. This is used for further processing at remote sites. JET-RDA systems supports a subset of the functionality of on-site data access, specifically writing of pulse files and access to some status information is not possible. Compared to RCA, authentification requirements are relaxed. The user applications interface supports binding to user-developed programs on various platforms. In addition, a standard application, "JETDSP", is provided which uses the JET-RDA client library to plot JET JPF and PPF data. JETDSP is now the standard display tool for JET data, both locally at JET (using local access routines or RDA) and remotely with RDA access.

An MDS+[5] server has been installed, which provides a data retrieval function to translate remote MDS+ data requests into server-side calls to JET-RDA. MDS+ is widely used in a number of fusion experiments in the U.S. and Europe and is being assessed as a possible alternative to JET-RDA. Currently, MDS+ access is enabled for a few selected institutions, mainly those which use MDS+ locally as well.

3.3. Communication and Remote Meetings

Several types of remote meetings have been used for communication between researchers on and off site. They range from point-to-point connections between individuals, informal meetings of small on- or off-site groups communicating with distributed individual participants up to large seminars and Task Force meeting broadcasts from the main seminar room at JET. In most cases teleconferences have been done using the CERN VRVS[6] system, but also simple telephone conferences using commercial services have been organised. The infrastructure installed for remote meetings is described in detail in a separate paper [5]. In the following we focus on typical uses of teleconferencing and experience with these facili-

[3] http://www.citrix.com

[4] http://www.rsasecurity.com

[5] http://www.psfc.mit.edu/mdsplus

[6] http://www.vrvs.org

ties.

Seminars and large group meetings

The most common application of teleconferencing so far has been the broadcast of large meetings and seminars with a formal agenda, individual speakers presenting prepared viewgraphs and discussion sections moderated by a meeting chairperson.

The equipment used in the seminar room at JET includes an audio system with table-top and wireless microphones, mixer and loudspeaker, a document scanner or document camera, a video projector and computers for presentation control and VRVS interface. Usually, one audio stream and one video stream is transmitted for presentations and discussions. The audio transmission is switched between the speaker's microphone and the room microphones during discussion sections. The video camera usually views the speaker and the local presentation screen to capture where the speaker is pointing at. Lip synchronised video transmission has not been found necessary for most cases.

Both electronic files (pdf[7] and Microsoft Power Point[8] formats) and digitised transparencies have been used for presentations. The possibility to use hand-written viewgraphs was maintained for several meetings, but the digitising process often introduced additional effort and time delays before and during meetings. Also, the picture quality of scanned images has been found not optimum in several cases. The presentations have been broadcast using Virtual network computing (vnc[9]) shared desktop software and followed by remote participants either with native or Java vnc clients, the latter launched from a web page. Electronic files used during meetings are usually kept for reference on a JET web site afterwards, with manually created HTML index pages. Manual collection and documentation of meeting presentations induce additional overhead for the meeting organisers.

Large meetings are conducted by a scientific chairperson in the seminar room, who organises the sequence of speakers and takes care of the microphone arrangement, and a technical supervisor, who controls the audio and video systems, viewgraph presentation hard- and software and VRVS communications. The technical supervisor also solves technical problems with remote participants, often using Internet chat tools, such as Yahoo messenger [10].

On the remote side, typically individuals participate which used their own local video-conference equipment. For single users, normally a PC with audio card and headset has been found sufficient to follow a meeting broadcast and participate in the discussion (i.e. ask questions or make comments). Several people have transmitted their own video streams, but this has not been projected for the local audience at JET. A few people have given presentations from remote laboratories for a larger audience at JET.

Broadcast meetings at JET have so far suffered from the fact that no fixed hardware installation was available for the JET seminar room. Instead, teleconference equipment had to be installed and uninstalled for each meeting, which has introduced large overhead on technical support staff and caused hardware reliability problems several times.

Informal group meetings

Teleconferencing has also been used for informal meetings of smaller groups, in particular for experiment preparation and discussion of results. This type of meeting is very common during JET experimentation and teleconferencing can create an opportunity to include also off-site scientists.

However, informal meetings are a challenge for remote participation. Quickly changing speakers and often improvised presentations make it difficult to transmit informal discussions with the usual teleconferencing tools. An additional complication arises from the fact that technical support for a large number of small meetings is very limited and often no technical supervisor can be provided.

Communications between individuals

A third type of remote meetings, although not used very frequently, is face-to-face communication between two or more individuals, each using their own video-conference equipment, similar to that used to participate in a seminar broadcast (see above). Since all communication is via teleconferencing channels some of the pitfalls of informal group meetings are avoided.

3.4. On-line documentation and help

The availability of up-to-date documentation is important especially for remote participation, because communication with on-site experts is often not easily possible and one has to rely to a larger extend on written documents.

For this reason, strong emphasis has been placed on web-based documentation which is located on a hierarchy of web servers, depending on the intended audience. A public server[11] contains information for a general public audience. A separate web site has been created to provide information for scientists participating in the JET programme. These web pages are password protected. Similarly, there is a web site to document RDA and RCA tools Machine details, such as operations related information, the complete

[7] http://www.adobe.com/products/acrobat/adobepdf.html
[8] http://www.microsoft.com/catalog/
[9] http://www.uk.research.att.com/vnc
[10] http://messenger.yahoo.com
[11] http://www.jet.efda.org

JET logging system (including also technical information) and a large number of other services is contained on a JET-internal server which can be accessed from outside JET only through Remote Computer Access. In addition to this large set of documentation, help is provided to users through a dedicated e-mail address by remote participation experts at JET.

3.5. Experiment participation

During experimental sessions, a potentially large number of participants outside JET need to monitor first results of the most recent plasma discharges, i.e. a fairly similar data set. Special services have been set up to facilitate the distribution of experiment and machine status information.

The contents of the control room overhead display, which contains main plasma parameters and comments on the recent plasma pulses is available on a web page, which is automatically updated.

A number of real-time displays ("JET TV", JTV) is accessible through web pages, including pulse countdown information, a post pulse summary of selected signals, real time plots of selected signals, overview of status of selected technical systems such as heating and protection systems and control room terminal views.

3.6. Publication services

Publications of scientific results are one of the main outputs from JET experimentation. Preparation of publications is aided by several services. Internal peer reviewing is an essential part of the clearance procedure for publications of JET data. All publication draft are posted on a dedicated web page ("pinboard") for all participating scientists (on- or off-site) to see and comment on. For clearance of publications an application form exists which can also be filled out and submitted from remote locations.

4. Experience with Remote Participation Tools

Three Remote Participation user polls have been carried out in November 2000, May 2001 and a recent poll in June/July 2001 in preparation for this paper. A questionnaire has been sent out to JET Task Force mailing lists and to contact persons for remote participation in each laboratory for distribution among physicists working from remote locations with JET data. The questionnaire contained eight groups of questions: general questions about individual experience and frequency of use of main remote participation techniques, questions on users experience with RCA, RDA, Teleconferencing, documentation and special services such as mailing lists, and finally the overall assessment of the techniques used, problems and suggestions. The questionnaire contained check-boxes for several basic questions and also asked for users comments (free text). A total of 52 completed forms were received within two weeks. Subsequently, we summarise the results of this most recent poll in the order of the various topics covered. All percentage numbers below are given with respect to the total number of replies.

4.1. Usage of RP tools

In the first question it was asked how frequent (daily, less than once per day, less than once per week, less than once per month, never) RP tools were used in collaboration with JET.

Remote Computer Access is used regularly by a majority: 31% of the users log in to JET daily, 64% at least once per week, 84% more than once per month. Only 16% use RCA less than once per month or never. Remote Data Access is also heavily used, daily by 21%, at least once per week by 38% and more than once per month by 55%. However, a large group (40%) is using RDA seldom or never. Teleconferences have been attended by 60% of the users, but less than once per month for most users (48%). 37% of users say they never used teleconferencing facilities.

Web pages are one of the most widely accepted information tools used by 96% (25% daily) and disregarded by only 2%. Among other communication tools, e-mail (48% daily users, 81% total users) and telephone conversations, (15% daily, 86% total users) have been named most often, the latter with a broader distribution of usage frequencies. Not often used are FAX (82% use FAX less than once per month), and Internet chat, which 63% have never tried, and 19% use less than once per month, usually only during teleconferences. Only one user mentioned ordinary mail as one of his communication tools with JET.

Are people also using RP tools for uses other than JET related work? For 19% the answer is yes, and a broad range of collaborations have been named, each by one or more users: ALCATOR C-Mod[12], ASDEX Upgrade[13], FTU[14], DIII-D[15], RFX[16], RTP[17], TEXTOR-94[18], TCV[19], and Tore Supra[20].

Remote participation is used for a broad distribution of purposes: Experiment participation (including planning, preparation of pulse schedules, 54%), Task Force Meetings and dialog (44%), data analysis (94%), code development (27%), viewing or giving presentations (33%) preparation of publications (48%), day-to-day general communications (29%). Further purposes mentioned are web page mainte-

[12] http://www.psfc.mit.edu/cmod/
[13] http://www.ipp.mpg.de/eng
[14] http://www.frascati.enea.it/FTU/
[15] http://fusion.gat.com/diii-d/
[16] http://www.igi.pd.cnr.it/
[17] http://www.rijnh.nl
[18] http://www.kfa-juelich.de/ipp/
[19] http://crppwww.epfl.ch/crpp_tcv.htm
[20] http://www.cad.cea.fr/r50.htm

nance, coordination of the JET enhancement project and remote participation.

One question was asked about which tasks according to user's experience can or cannot be addressed well with remote participation. Only few users answered this question. Topics that are felt well addressed include data access and analysis, personal communication (if partners know each other well), code development and preparation of publications. In contrast, large meetings, preparation of experimental sessions, access to large or multidimensional data types were topics named unsuitable for remote participation. Experiment participation was mentioned by several users, and perceived useful by some and difficult by others.

4.2. Remote Computer Access

All remote log-in connections to JET computers are made using CITRIX ICA Windows NT servers. Most connections are used to log-in from the CITRIX servers to the JET Analysis Cluster (87%) and to the JET office network (44%). Only few users connect to the UNIX off-line cluster (8%). The experience with computer access was mostly positive, with 71% reporting successful work with the current RCA system. Several users have had RCA problems, and found network connections too slow for interactive work (27%), spontaneous disconnections (19%), login problems (6%), or installation problems (2%).

4.3. Remote Data Access

Remote Data Access is used by 69% of those who replied for data display, and 60% for numerical data analysis. Only few users mentioned other tasks: modeling and code testing. In most cases (71%) the JET-RDA system is used for access to JET data. Although at an experimental stage for JET, MDS+ is used by a couple of users (13%) mainly from laboratories which use MDS+ locally and have access to the JET MDS+ service.

For data display, mainly the JET-supported JETDSP program is used (56%), but 12% use tools developed elsewhere: SHOX[21] and the MDS+ display tools jScope[22] and ReviewPlus[23]. Only 15% of all users use entirely programs written by others while 63% use also their own programs. These are based on various platforms, most often mentioned were Matlab[24] and IDL[25].

42% of all users who participated in the poll reported positive experience with Remote Data Access and found it convenient to use. 29% of the users reported problems. The main concerns stated were slow data transfer (27%), connection stability (8%), limits to the amount of data accessible (6%) installation difficulties (4%). The data limits in place are found restrictive for some data types, in particular long traces of diagnostics with high temporal resolution, some of which cannot currently be accessed with RDA.

4.4. Remote Meetings

A majority of users have attended group meetings (54%), mostly Task Force or topical meetings and seminars; only 10% have tried user-to-user teleconferencing. According to user's replies, the various services have been used as follows: 52% watched remotely presented viewgraphs, 46% connected via phone, 44% listened to remote talks over the Internet, 29% presented their own talks, 35% watched a remote video transmission, 12% transmitted their own video image, 19% have used chat tools during remote meetings, and 12% worked on shared documents.

The experience with remote meetings was rated positive by 35% of all users in the poll, although several users commented that remote meetings cannot replace face-to-face communications at present. Negative experience has been expressed in 27% of all statements, 15% of the users complained about the sound quality, 12% found meetings not well prepared and organised and 10% considered viewgraph quality insufficient. Several users felt that local discussion groups tend to forget the presence of remote participants if the meeting is not actively moderated with remote participation in mind.

Asked in which way they would prefer to participate at a two-day meeting at JET (provided funding for the flight and accommodation was available) 62% of the users would prefer to travel to JET, 13% would participate remotely, and 29% replied they would participate remotely provided some improvement of remote meetings was made. In particular, better quality of the audio and slide presentations and generally better means of interaction between participants remote parties was desired.

4.5. Documentation

The web-based documentation available for JET was found generally useful by almost all users who replied. Many special services were explicitly mentioned, most often named as helpful are PPF and diagnostics information (52%), Task Force pages (29%), the publications pin-board (17%), codes documentation (15%), and contact information, e.g. the JET phone book (10%). Contents quality was rated good or very good (with statements ranging from "useful" to "excellent") by 75% of all users. Besides various detailed wishes to add specific contents, several users suggested to improve the navigation around the various JET web sites.

[21] http://efrw01.frascati.enea.it/JETSoftware/shox

[22] http://www.psfc.mit.edu/MDSplusDOC/javascope/ReadMe.html

[23] http://lithos.gat.com/comp/analysis/uwpc/docs/reviewplus.shtml

[24] http://www.mathworks.com/products/matlab/

[25] http://www.rsinc.com/products/idl/

4.6. Various services

In the questionnaire, it was asked how users would rate the relative importance of various services on a scale from 1 (most important) to 5 (least important). Ordered by the average user rating (in parentheses), JET web sites (1.4), e-mail help address for remote access (1.8), and the overhead display for experiment participation (2.1) were named most important. In comparison, other services like local support for remote participation (2.5), the JET logging system (2.6), JET mailing lists (2.7), remote clearance of publications (2.7) remote submission to JET graphics office (3.3) and JET TV channels (3.7) were considered less important. User's views on these topics were remarkably coherent with the standard deviation ranging from 1 to 1.4 for all topics.

4.7. Problems and Suggestions

In the last section, users have been asked to summarise their problems and make suggestions for improvement of remote participation services.

Apart from more detailed comments to the individual services many general comments have been made. It was felt by several users that remote participation creates a significant overhead compared to local work. This includes special technical problems, network bandwidth and reliability, teleconferencing quality, complicated and tedious set-up procedures for the additional hardware and software tools needed, as well as organisational aspects. The latter particularly applies to remote meetings, which require good preparation and are more successful if moderated in a more formal manner.

Many users suggested improvements of the system, most of all investments in the reliability, performance and quality of the existing services. Several users wish to make the remote participation tools simpler to use, e.g. easier authentification for remote computer access and stable, permanently installed teleconferencing equipment. Several MDS+ users suggested to continue support for MDS+ as a faster and easier-to-use alternative to JET-RDA. Further development of the JETDSP display program was encouraged by a number of users, some suggested to adopt third-party programs for general use with JET.

5. Summary and Conclusions

Remote participation has been widely used by scientists to prepare, perform and analyze experiment at JET. A large variety of services is available and has been used successfully: Remote Computer Access (RCA) to JET computers, Remote Data Access (RDA) to retrieve experimental data remotely, Teleconferencing, a large set of on-line documentation and other web services, and central support for remote participation users.

Further development of remote participation infrastructure will certainly focus on consolidation of the tools used. The user poll has shown that wide-area network limitations can impede communications directly by slow and unstable connections and also indirectly, if limitations of the remotely accessible data size are needed which users have to work around.

While computer and data access has become a work horse for collaboration with JET, other aspects of remote participation have potential for further development. Teleconferenced meetings for JET Task Force work so far have suffered from the fact that no permanent installation has been available to date at JET and at most of the participating laboratories. Further investment into good audio and presentations equipment is suggested to turn teleconferencing into a standard tool that can be easily used and ultimately reduce the overhead associated with frequent commuting between laboratories.

As collaborations between fusion laboratories are probably becoming more important and experimental facilities are more often jointly used by scientists of different laboratories, homogenisation of tools can become an important resource to increase efficiency both for users (faster learning curve) and system administrators (reduced number of platforms to maintain). Some of the decisions on further developments will certainly have to be influenced by the question on how standards can be adopted more to create a more homogeneous environment or at least provide compatible tools for the various research laboratories. An example is the MDS+ system, which is being used in several laboratories and has a built-in interface protocol for remote data access. The relatively large number of installations leads to faster development and debugging cycles than can be achieved with a system used only in one laboratory. Another resource for RP development can originate from incorporating the contributions by users themselves as a number of users have made own developments or use software developed in their own laboratories.

The integration of European Fusion experiments under EFDA [6] creates a challenge for information exchange, not only as far as network technology is concerned, but also for users to cope with a wealth of detailed information. An important task for a future "fusion intranet" is to simplify access to the resources, in order to allow users make most efficient use of the data. The collaborative work of all European fusion laboratories at JET is a valuable experience on this path.

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