TECHNICAL PREPARATIONS FOR REMOTE PARTICIPATION AT JET

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Abstract

By 2000 the JET facilities will be exploited in a campaign orientated collaboration of the Associate Laboratories of the European Fusion Development Agreement (EFDA)[1]. This new phase will be based on both an increased presence of personnel from these Laboratories at the JET site and on Remote Participation. In contrast to High Energy Physics the operation of a large device as a "community" effort is new to the fusion research field [1]. Remote Participation will include: remote data access, remote monitoring of experiments, remote preparation of experimental sessions, remote access to JET office computing services and remote participation in meetings.

1 INTRODUCTION

1.1 Organisation of JET Operation

- Campaign Programme
  - Experiments Committee
  - Task Forces (2 or 3 per campaign)
  - Session Leaders
- Session / Pulse preparation
  - Session Leader using dedicated "Level-1" software [2]
- Operations Team
  - 24 hour permanent Control Room Staff
  - Operations-only staff
    - Session Leader (SL)
    - Physicist-in-Charge (PIC)
    - Engineer-in-Charge (EIC)
    - Duty officers for all systems
    - On-site technical support during office hours

JET is operated from a single central control room for plant and diagnostics control. During operational campaigns (~30 weeks / year) JET runs 2 shifts (sessions) between 06:30 and 22:30 with a 30 minute shift changeover period starting at 14:15. During this period the task forces usually hold ad hoc working meetings. The JET Pulse cycle consisting of parameter preparation and validation, computer controlled countdown, pulse, data collection on the control computers, data transfer to the analysis computers and data analysis lasts ~ 30 minutes. Typically 20 pulses are performed per shift.

Machine configuration is via high-level parameter setting software ("Level 1") [2] which handles more than 10 000 parameters.

1.2 Online computers

Each of the major plant subsystems (e.g Poloidal Field (PF), Vacuum (VC), Ion Cyclotron Resonance Heating (RF), Lower Hybrid Current Drive (LH), Diagnostics A (DA), Diagnostics B (DB) etc) is controlled by a dedicated SUN workstation running Solaris 7 whose size (Sparc 2, 4, 5 or 20) depends on its complexity. There are 10 control subsystems and 9 diagnostic subsystems which "load balance" 71 Physics diagnostics. Connection to the plant is via CAMAC, VME and PCs. The subsystems are gathered network-wise into autonomous clusters: safety and access, machine control, additional heating systems and diagnostics each with a dedicated file server. All subsystems are dataless (the internal disk is only used for swap space) so that they may be swapped with standby machines with a 20 minute turn around.

1.3 Man Machine Control Room Interface

A fifth online cluster houses general purpose computers (SUN ES250s, Solaris 7) to power the 58 control room X-terminals. 15 dedicated workstations (Sparc20s / Ultra5s) are used in CPU intensive locations : SL, EIC, ICRH Pilot, CODAS Duty Officer (CDO), Magnet and Power Supplies Duty Officer etc. In addition 35 IBM 3472 graphics terminals allow direct connection to the IBM mainframe.

1.4 Core Services

A further cluster holds the core services. These control traffic between the online and offline computers and provide common services: home directories, relational databases, level 1 databases, network monitoring, software license servers etc. Other services, in particular routed TCP/IP, are blocked. This functionality is referred to as the IP GAP. Services which are desirable on both sides of the Gap, but which by their very nature cannot be sourced in the "core", are made available through application proxies. Notable services include site email, JET plant monitoring, and X11 traffic.

1.5 Offline computers

There are two offline clusters : "dev" for software and hardware development and "off" for general offline computing (notably monitoring of the experiment from offices). The computers in these clusters also act as

[1] http://europa.eu.int/comm/dg12/fusion/efda.html

standby machines for the computers used in operations. It is possible to “tunnel” from offline computers to online computers via an X11 proxy. This service is only available under the close control of the EIC.

1.6 IBM Mainframe

Each JET pulse yields typically 600Mbytes of raw data (Jet Pulse File (JPF) and Late Pulse File (LPF)). The JPFs are collected on each of the control and diagnostic subsystems and then immediately transferred to the IBM Mainframe (9021/821 running OS/390 2.4). The IBM manages all the raw and analysed (Processed Pulse File (PPF)) data from day one in 1983 (~ 7TB) in automated tape libraries.

1.7 Jet Analysis Cluster (JAC)

The JAC is a networked cluster of 19 RS/6000 (AIX 4.1) workstations and 37 Pentium IIs (Linux 2.2 – Slackware 4.0) used for CPU intensive analysis and simulation codes. The Linux machines, especially, are a cost effective and popular end-user and development environment. They are now the preferred platform for JET analysis.

1.8 Data Analysis

Automatic / Manual analysis tasks take place on the IBM mainframe and on the JAC. Some manual analysis is also performed from Windows NT office PCs. Initial analysis yields the Processed Pulse File (PPF). A subset of this and the JPF data is copied to the Central Physics File (CPF) which is implemented in SAS[2]

2 ENVISAGED CHANGES TO JET OPERATION

From the start of 2000 the Task Force personnel will no longer necessarily be site resident. They will be made up from the different Laboratories on a campaign by campaign basis.

The Task Force members will require the ability to monitor both the status of the experiment and the experimental results from remote locations using JET software tools. Audio and video contact with the JET Control Room and with Task Force working meetings will also be required.

The Session Leaders will require remote access to the Level 1 software to allow preparation of experimental sessions.

Experimental execution will still be exclusively from the JET Control Room **but** some diagnostics may be monitored from off-site. Under exceptional circumstances diagnostics could be actively controlled in this way.

The automatic analysis tasks will continue, at least initially, to run on JET computers but the Responsible Officers for these tasks could be at remote locations. Remote access to the analysis computers will also be required.

3 REMOTE DATA ACCESS

3.1 Requirements

Read access to the JPF and CPF and read/write access to the PPF are required from a multitude of remote computing platforms: various flavours of Unix, Windows*95, Windows*98, Windows NT, MacOS. The method chosen should be easily integrated with popular packages/languages: Matlab, IDL, Fortran, C/C++. In addition an integrated platform independent display tool should be provided.

Access should be via the Internet. The data access protocol must be able to pass through security measures in place at the participating sites.

Access rights should be independent from location of the user and should be by username and password (no SecureID).

3.2 Implementation

A three layer client-middleware-server solution has been provided. The data continues to reside on the IBM mainframe. A dedicated data server running on a Windows NT machine provides a single point of access to both the JPF and PPF data. In the future this may be extended to other data sources.

Communication is via the HTTP 1.1 protocol using the libwww[3] library.

The data is transferred using netCDF[4] formatting which provides platform-independent byte swapping, floating point formats, etc. No additional coding is required on the client or the server.

A portable client library has been written and is now available for Windows, Solaris, Linux and OpenVMS. Ports to HP-UX, AIX, DEC Unix and MacOS will follow. A display tool using the client library has been written in IDL.

Access to the CPF SAS database will be provided separately by the SAS ODBC server interface.

[2] http://www.sas.com/

[3] http://www.w3.org/Library/User/Start.html

[4] http://www.unidata.ucar.edu/packages/netcdf/

4 REMOTE COMPUTER ACCESS

4.1 Requirements

Remote login to the JET computers is required for: remote execution of interactive tasks, access to the internal JET web pages for technical documentation, log files, inventories etc, office computer access for JET staff on mission and system administration access from off-site locations. Ultimately, active remote control of equipment may also be required.

Access is required to the IBM mainframe, the JAC, the SUN machines and Windows NT.

The methods chosen must be secure and must be compatible with the security measures at all participating sites. They must also be platform independent (or at least be available on all common computing platforms).

At present we have chosen to exclude remote X traffic.

Authentication should be by SecureID.

4.2 Implementation

Dedicated NT servers have been installed running CITRIX Metaframe[5] software. Remote client machines use CITRIX ICA to communicate with these servers. The ICA client software is available on all popular platforms.

Hummingbird eXceed[6] is used on the NT server to access X applications on the SUN and JAC computers.

Attachmate[7] on is used on the NT server to access the IBM mainframe.

User authentication is via Security Dynamics[8] SecureID (PIN plus one-time pass code).

5 WIDE AREA NETWORK CONNECTIVITY

5.1 Requirements

Network connectivity appears to be the biggest technical bottleneck in the remote collaboration of the European Fusion programme. JET's old link was only 256 kbit/s. It provided good connectivity to the US but was very poor to continental Europe.

2Mbit/s is considered a minimum workable bandwidth. A prime candidate for implementation is on the Trans European Network (TEN-34/TEN-155) to which at least 6 Associations are already connected (IPP, ENEA, CEA, FZJ, Tekes, NFR).

In the longer term the establishment of a European Fusion Intranet with reserved bandwidth and VPN features should be considered.

[5] http://www.citrix.com/
[6] http://www.hummingbird.com/
[7] http://www.attachmate.com/
[8] http://www.securitydynamics.com/

5.2 Solutions

JET has installed a new 2Mbit/s link through JANET to the European TEN-155 research network. A considerable improvement (factor of 8 to 15) of throughput for connections to European fusion Laboratories has been seen.

A further increase in bandwidth is still likely to be required.

6 LOCAL NETWORK STRUCTURES

6.1 Requirements

Security arrangements for remote participation in the JET facilities must take into account the special statutory requirements placed on JET due to its Tritium handling and operation capabilities. This has immediate repercussions on computer security measures and on the network structure.

A layered approach is required whereby the remote login process has to pass through an increasing number of security measures the closer the target computer is to the on-line systems.

6.2 Solutions

A multi-layer citadel structure is in place. At the top of the citadel are the plant interface units and the online computers. Restrictions are gradually relaxed as you move away from the online machines through the different layers towards the Internet.

A firewall machine running Checkpoint Firewall-1 software[9] on a SUN Ultra5 workstation is in place between each of the layers. The traffic through the firewalls is minimised.

Two NT servers running CITRIX Metaframe have been installed : an "outer" server for access to the IBM and the JAC, an "inner" server for access to the SUN offline computer system. Separate lists of users are defined for the two servers.

Access to the "inner" server also provides: full unrestricted access to the JET web pages - and hence to all the technical documentation – and off-site access to the JET office network.

Under exceptional circumstances a tunnel may be manually granted by the EIC to allow access to the online computers. This is only required for actions on the plant. All monitoring can be performed from the SUN offline computers.

A symmetrical use of the "outer" server and the ICA client software allows X applications at remote sites to be run from JET.

[9] http://www3.checkpoint.com/

7 REMOTE E-MAIL ACCESS

7.1 Requirements

Mobile users require location-independent access to their e-mail accounts. Both sending and receiving of email is required. The system should be secure but should not require SecureID authentication.

7.2 Solutions

MS*Echange has been adopted as the single site-wide mail server. MS*Outlook web access using https, username and password authentication allows email to be received and to be sent from the JET email account. In addition the MS*Exchange IMAP server can be used when only reading of email is required.

8 TELECONFERENCING

8.1 Requirements

Teleconferencing tools are required for four distinct uses :

8.1.1 Multi-centre "Tele"-Meetings

These are for the working meetings of the Task Forces and for management meetings. The requirements are multi-centre voice communication, multi-centre slow video (lip reading not required) and computer based shared whiteboards and other applications with overhead projection.

8.1.2 Broadcast Meetings

Transmission of presentations to a large audience, e.g. JET Science Meeting. The requirements are: remote computer screens (and projection), multi-centre voice communication, (optionally) slow video (lip reading not required) and (optionally) computer based shared white board.

8.1.3 Remote control room participation

Allow the experimental session to be followed. Remote "listening in" via computer screen is required. This should be web based and not require a login session. Control room cameras should be used to broadcast slow-speed pictures of the control room. Teleconferencing will also required similar to 8.1.1 above.

8.1.4 One-to-One Meetings

These should be desktop based. Voice is required with slow video. Shared whiteboards and other applications are essential. The solution should be platform independent – or at least multi-platform.

8.1.5 General Requirements

The solutions provided should be: low cost; Internet based rather than telephone based; platform independent – or at least multi-platform and suitable for non-specialist users.

8.2 Solutions

Commercial systems do not seem to address the fusion community's mix of requirements. The Caltech / CERN Virtual Room Videoconferencing System (VRVS) [10] is the most promising solution: It is suitable for all four types of teleconferencing; It is Internet based for all services; It is based on existing freeware products and it is in routine use by LHC computing collaborations.

8.3 Status

Up to now JET has adopted a very low technology approach (conventional meeting telephones, conventional overhead projection, fax and photocopier). These techniques are surprisingly suitable for small two-centre meetings, but expensive and difficult to manage for more than two centres.

JET has successfully evaluated the VRVS system via a three centre meeting between CERN, CNAF Bologna and RAL. All participants agreed that the quality of transmission for audio and slow video was acceptable and that the system can now be considered a serious candidate for a solution for the Fusion community in Europe.

The next step is now to install a system locally at JET and at a second site, possibly UKAEA Culham, to run some more trials in particular to test on the same desktops the various tools to be used for remote access, for sharing applications and for videoconferencing. In addition, a VRVS "reflector" should be set up at JET in order to gain experience also with this part of the VRVS system.

In parallel we should be able to define the installations which would be required for a first working system to connect with remote fusion Laboratories in Europe.

Virtual Network Computing (VNC)[11] is also under evaluation as a possible provider of whiteboards and shared desk tops.

9 CONCLUSION

Until recently collaborations with JET have been mainly of the visiting scientist kind. JET now has an open data policy for the European fusion community and is

[10] http://vrvs.cern.ch
[11] http://www.uk.research.att.com/

gradually opening up the site network to remote collaborators.

JET operations will resume under the EFDA agreement in the Spring of 2000. By that time the essential technical developments to allow full remote participation by the Associate Laboratories need be in place.

10 FUTURE WORK

Ongoing developments are likely to take place in the following areas:

10.1 Internet bandwidth

An increase of the Internet connection bandwidth to at least 8Mbits/s is essential, particularly with the onset of video conferencing.

A reserved bandwidth service and a VPN service for the fusion community will be investigated.

10.2 Teleconferencing

It is most likely that VRVS will be adopted by JET for teleconferencing.

10.3 Web Technology

More investigation of secure socket technology may allow us to open up the site to X traffic and to allow access to the JET Intranet without requiring SecureID and computer login.

Until now our solution for "listening in" to the JET experiment has been to provide remote login. As time permits we may look to implementing some of our standard tools in Java to allow access via the Internet.

Hummingbird web eXceed will be investigated as an alternative to the CITRIX ICA technology.

10.4 Remote Data Access

MDSPlus[12] which is a joint collaboration between MIT, LANL and IGI Padova is becoming a de facto standard for access to fusion data in the USA. It is likely that the existing remote data access server could sit beneath this system.

The possible use of mirror sites for the JET data should be investigated.

10.5 Sharing of Computer Resources

The possibility of using off-site computer resources for JET automatic and manual analysis tasks will be investigated.

[12] http://www.pfc.mit.edu/mdsplus/

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REFERENCES

[1] Villard Ad-Hoc Group

The programme committee of the European fusion program at its 52nd meeting 23/24 September 1998 in Brussels, decided to establish an Ad-Hoc Group (AHG) with the following terms of reference:

"to assess the present situation in the European fusion Laboratories (including JET) concerning policies, protocols and standards for remote access, transfer and exchange of data. The Group, under the chairmanship of L. Villard (CRPP-Lausanne) shall examine practical means to optimise accessibility and exchangeability of data among all participants, in particular in view of the enhanced participation of the Associations in the JET operation during 1999 and the campaign-oriented collaborations of Associations beyond 1999 exploiting the JET facilities. …."

[2] P.A.McCullen, J.W.Farthing "The JET Level 1 Software", SOFT 98, Marseilles, September 1998.