

Web-Centric LS-DYNA - Development of a Technical Computing Portal

Dan Fraser, Youn-Seo Roh, and Henry H. Fong

Sun Microsystems, Inc.

901 San Antonio Road

Palo Alto, California 94303, USA

dan.fraser@sun.com, youn-seo.roh@sun.com, henry.fong@sun.com

ABSTRACT

The development of a Technical Computing Portal (TCP) for monitoring and managing of LS-DYNA runs is described. The Sun TCP is a new collaborative tool for High Performance and Technical Computing. It facilitates access, workload distribution, job monitoring, and management of LS-DYNA and other technical application jobs in a heterogeneous computing environment. It can be easily customized by LS-DYNA users, and by LSTC and its distributors. TCP is based on Sun's iPlanet Portal Server, Java, and Sun Grid Engine technologies.

Sun Technical Computing Portal

What is Sun TCP?

The Sun TCP has been developed to provide High Performance and Technical Computing (HPTC) users a single, Web-based point of delivery to access services, content, and complex applications. Users have the freedom to access technical applications (such as LS-DYNA) remotely through an Internet/intranet browser providing secure anytime, anywhere access using simple point-and-click interfaces. No Unix systems skills are required.

Through the Sun TCP, users can:

- ☞ Manage job submission via forms (no need to write scripts)
- ☞ Submit jobs remotely
- ☞ Dynamically check on the status of jobs
- ☞ Receive email notification when jobs are complete
- ☞ Download/visualize output files remotely
- ☞ Easily share results with collaborators
- ☞ Quickly add legacy applications for remote use and sharing
- ☞ Make TCP resources available to other users without duplicating the investment.

What is a Portal?

Portal (n): A community-based website that securely provides an aggregation of key content, applications and services: personalized based on user role/identity, user-preferences and system generated information, with centralized control of the experience.

Applications can be quickly added to the portal -- often within minutes -- either by the system administrator or by selected users. No application modification is necessary for batch applications with a command line interface. In other words, a legacy application can be transformed into an Internet-available application simply by plugging it into the TCP.

TCP builds on the commercially tested capabilities of Sun's iPlanet Portal Server (iPS) application to deliver technical applications alongside the typical portal-based applications and content (calendar, mail, ordering, tracking).

Jobs submitted by users are transparently managed by the industry-proven Sun Grid Engine (SGE) resource management software, offering an unparalleled capability for delivering application services to remote users. Resources are centrally and dynamically managed to provide maximum resource utilization according to a set of policies determined by the administrator.

TCP Value Proposition

- œ Greater return on IT and investments through improved system utilization
- œ Achieve economies of scale for increased productivity and cost savings through:
 - œ expanding application user base
 - œ addressing customers, suppliers, partners, without additional overhead
 - œ more efficient use of engineers' and administrators' time.

TCP: Remote Access to Grid Technology

Sun's vision for a standards-based software vision, architecture, platform, and expertise for building and deploying services on demand is called Sun *Open Net Environment* or "Sun ONE." Services on Demand is the ability to provide information, data and applications to anyone with permitted access, anytime they need to solve problems, anywhere in the world on any platform. The focus of HPTC enterprises is no longer just the computing environment itself but expanded applications access, data access, and availability.

To help address this need, Sun developed the TCP that links the capabilities of Sun Grid Engine (SGE) resource management software to the Internet. TCP is a services-centric, Web-based, shared-everything approach to technical computing. It offers an easy-to-use interface for job submission, job control, and access to results via Sun's iPS and SGE software. iPlanet Portal Server is a community-based server application that securely provides an aggregation of key content, application and services personalized based on user role/identity, user preferences and system determined relevancy. SGE is a distributed management software that optimizes utilization of software and hardware resources in heterogeneous networked environments.

SGE software aggregates compute power and delivers it as a network service. It provides dependable, consistent, and pervasive access to high-throughput computational capabilities, and provides the job accounting and statistics information needed to monitor and improve resource allocation. The result is a net increase in available compute resources, which leads to higher productivity, higher quality, and a reduction in time to market.

By combining the capabilities of the iPS and SGE software in the Sun ONE environment, TCP provides HPTC users with secure anytime, anywhere access to a single Web-based point of delivery for services, content, and complex applications -- through a standard Internet browser and simple point-and-click interfaces. A simple TCP hardware and software stack is shown in Figure 1. [For applications that use the Message Passing Interface (MPI) protocol, Sun HPC ClusterTools can be linked with SGE to provide this capability.]

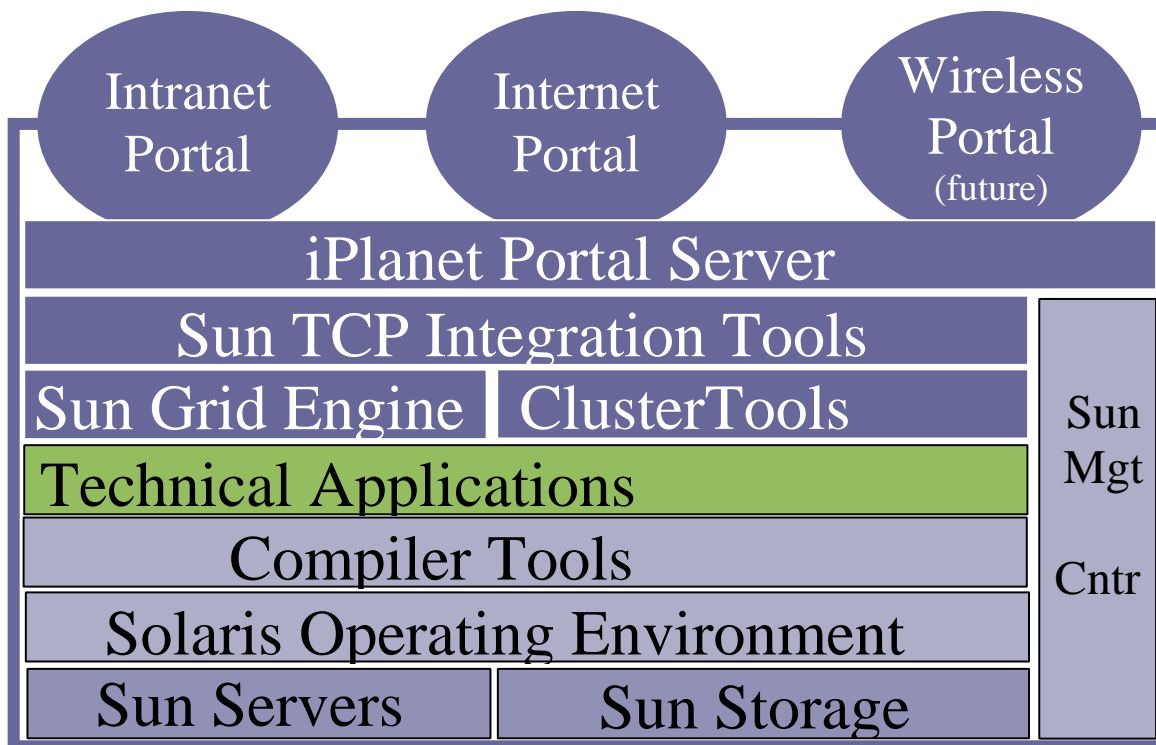


Figure 1. Sun TCP Hardware and Software Stack

TCP System Architecture Description

Sun TCP is built on open standards offering the flexibility to incorporate alternative and additional products and capabilities as desired to provide additional applications and features. A high-level architecture diagram is shown in Figure 2.

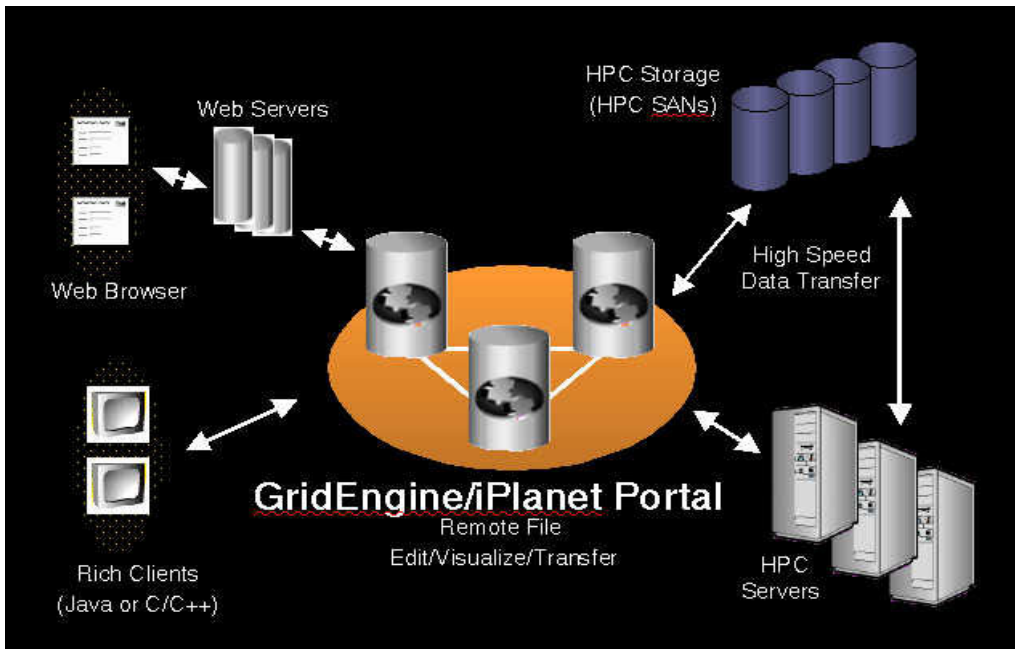


Figure 2. Sun TCP System Architecture

This is a classic 3-tier architecture except that the back-end is designed for HPTC. Back-end computational resources are managed by SGE. All three tiers can be independently configured to meet the users' existing requirements and scaled to meet future requirements. The middle tier consists of redundant servers for the iPlanet Portal Server and is also where the TCP is configured. Additionally, each iPS server is also configured as an SGE submit host. This enables the TCP to submit application jobs to SGE managed resources in the back tier. The SGE master/shadow master servers may also be installed as part of the middle tier or can be included as an additional layer that communicates between the middle and back tiers. The user interface to the computing environment via a browser window generated by the iPS. The Portal Server in turn submits the jobs to the SGE master server, whose responsibility it is to find suitable resources. This is all done transparently to the user, who does not directly interact with SGE. (The TCP also dynamically queries SGE to provide up to date job status through the portal everytime the browser window is refreshed.)

The TCP is designed for use with batch applications (including scripts) that have a command line interface, although applications that use X-windows interfaces can also be accommodated. Administrative users of the TCP can register applications with the portal server that can then be made available to the user community. This process involves editing two files and takes about five minutes, once the applications have been properly set up. At this time, specific SGE commands that specify appropriate resources can be associated with the application each time it is executed through the TCP. This will ensure that applications only run on appropriate platforms.

Additionally, the capability is provided to build HTML/JavaScript interfaces for the applications. Several templates are provided and this step may take an hour or more depending on the complexity of the application interface. By taking advantage of this administrative step however, users of the applications are no longer required to know the details of the command

line interface. Everything can be automated through a point and click interface.

In addition to managing the user interface with SGE, the iPS supports the first tier of user access by providing membership management, personalization, aggregation, security, and integration service capabilities to users via a standard web browser. The Portal Server can be deployed in a multi-domain scenario, utilizing varying authentication methods and role functions within each domain.

The Multi-Domain Environment enables organizations to provide specific content, manage multiple authentication and security structures, and create a personalized and customizable user experience with consistent look and feel within the domains. Within domains, user roles are implemented allowing varying security levels and responsibilities to be assigned to users within the portal environment. In this solution, these roles are used to differentiate between administrators, support personnel, and end users.

The administrative controls allowed within a domain provide a level of delegated administration to users of the solution. The Portal Server, its domains, the roles and users within the domain can be customized at all levels, allowing organizations to provision content and services at a certain level and have those functions "inherited" by lower level categories. For example, an application could be provisioned at the portal server level and this application could then be made available to all domains, roles and users within the portal environment.

The TCP solution therefore builds upon all the benefits of the iPS and transparently combines them with all the advantages of SGE. The net result is that the power of the Grid becomes available anywhere, anytime, on any platform. For more information, please email to: TCP@sun.com

Sun TCP for LS-DYNA

To demonstrate the concept of TCP, a pilot project has been assembled on a Sun E450 server fitted with four UltraSPARC II processors. The system was placed outside Sun's firewall and connected to the Internet directly. Any user who has an account on the machine can thus access the TCP from the user's browser window that is connected to the Internet. Connections from Netscape Navigator on a Solaris workstation, Navigator on a Windows PC, and Internet Explorer on a Windows PC have been successfully verified.

Running LS-DYNA through the Sun TCP takes these six steps:

1. User login
2. Application selection
3. Project creation/selection
4. Job submission
5. Job monitoring
6. Output inspection/download.

Figure 3 is a typical LS-DYNA Technical Computing Portal login screen. TCP login is possible

for any user who has an account on the server and is accessible from any kind of browser.



Figure 3. LS-DYNA TCP login page

Once the user is logged in, the TCP desktop will pop up (shown in Figure 4). This desktop can be customized by each user to match their personal preferences. The page consists of separate boxes, called channels: including the "Application List," "Project List," and "Job List."

The Application List channel shows pre-registered applications. The SMP and MPP executables of LS-DYNA version 960 are shown.

The Project List channel enables the user to create a project (thus creating a directory space) using one of the applications that are registered on the application list channel. A browse capability is provided with the TCP to select and securely upload required input files into the directory space that has been created. Once the project is created, the user can submit a new job against this project or new runs against an existing project.

Figure 4. LS-DYNA TCP desktop page

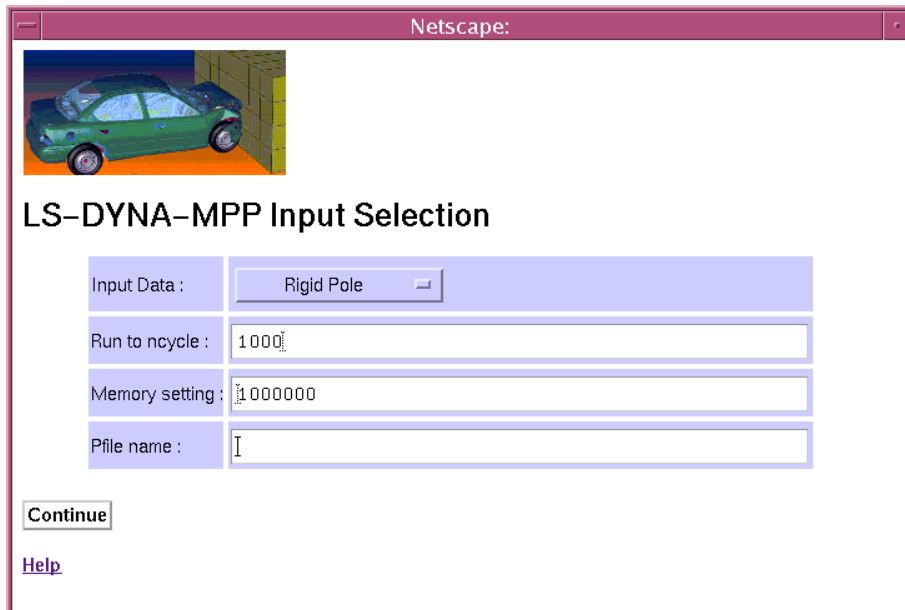
Figure 5. LS-DYNA TCP job submission form

TCP provides a user-friendly application interface. Clicking on the "Submit new job" link on the Job List channel will bring up the "New Job Form" shown in Figure 5. Within the "New Job Form," the user can select a data input from a preselected list, specify the email notification

address to get any job message from SGE, specify output and error files, and select number of processors for computation. Once a project has been selected, an input form (shown in Figure 6) can be presented to the user as a prompt for all inputs required to execute the applications. The input field on the New Job Form is then automatically filled in completely and correctly. The New Job Form allows the user to select input parameters appropriate for either MPP or SMP executables.

Once the job is submitted, the job can be monitored by clicking the job link on the Job List channel (shown in Figure 4) to check for any messages about the job. In the background, the SGE job scheduler is handling load-balancing, so the user can assign multiple jobs simultaneously.

Either during or after the run, the user can check the file status by clicking on the interested project link in the Project List channel. Figure 7 shows an example of the resulting Project Information page. The page lists the files related to the project (i.e. job) and the user can view either top (head) or bottom (tail) of the file. If desired, the files can be securely downloaded to the user's client for further investigation by clicking on the file and using the browser's "save link as" feature. Figure 8 shows an example of the File View page that was brought up by clicking the [tail](#) link on the Project Information page.



The screenshot shows a Netscape browser window with the title "Netscape:". Inside the window, there is a small image of a green car. Below the image, the text "LS-DYNA-MPP Input Selection" is displayed. The form consists of several input fields:

Input Data :	Rigid Pole
Run to ncycle :	1000
Memory setting :	1000000
Pfile name :	

Below the form, there is a "Continue" button and a "Help" link.

Figure 6. LS-DYNA TCP input selection form

SunTCP Project Information

Project name: Rigid Pole Crash Simulation: OpenMP 960
 Application: SMPDYNAFORM
 Exports:

Files: [.suntcp-project](#) [head](#) [tail](#)
 [.suntcp-su](#) [head](#) [tail](#)
 [rp200p2.out](#) [head](#) [tail](#)
 [rp200p2.err](#) [head](#) [tail](#)
 [messag](#) [head](#) [tail](#)
 [d3hsp](#) [head](#) [tail](#)
 [d3plot](#) [head](#) [tail](#)
 [d3thdt](#) [head](#) [tail](#)
 [status.out](#) [head](#) [tail](#)
 [d3dump01](#) [head](#) [tail](#)
 [d3plot01](#) [head](#) [tail](#)
 [d3thdt01](#) [head](#) [tail](#)

Copyright 2001 Sun Microsystems, Inc. All rights reserved.

Figure 7. LS-DYNA TCP project information page

SunTCP File View

```

estimated clock time to complete = 12399 sec ( 3 hrs 26 mins)
  1 t 0.0000E+00 dt 1.16E-06 flush i/o buffers
  1 t 0.0000E+00 dt 1.16E-06 write d3plot file

***** termination cycle reached *****

  200 t 2.3176E-04 dt 1.16E-06 write d3dump01 file
  200 t 2.3176E-04 dt 1.16E-06 write d3plot file

Normal termination

Storage required for explicit solution: 1067632

Timing information
-----
CPU(seconds)  %CPU  Clock(seconds)  %Clock
-----
Initialization ..... 1.7300E+00  4.26   9.0089E-01   4.42
Element processing ... 3.6780E+01  90.52  1.8315E+01  89.91
Binary databases .... 1.7000E-01  0.42   8.8151E-02  0.43
ASCII database ..... 0.0000E+00  0.00   1.4046E-03  0.01
Contact algorithm ... 1.9500E+00  4.80   1.0620E+00  5.21
  Interface ID      1 1.9200E+00  4.73   1.0542E+00  5.18
Contact entities ... 0.0000E+00  0.00   0.0000E+00  0.00
Rigid bodies ..... 0.0000E+00  0.00   3.2400E-03  0.02
Implicit Nonlinear ... 0.0000E+00  0.00   0.0000E+00  0.00
Implicit Lin. Alg. ... 0.0000E+00  0.00   0.0000E+00  0.00
-----
T o t a l s                4.0630E+01  100.00  2.0370E+01  100.00

Problem time      = 2.3176E-04
Problem cycle     = 200
Total CPU time    = 41 seconds ( 0 hours 0 minutes 41 seconds)
CPU time per zone cycle = 35635 nanoseconds
Clock time per zone cycle= 17835 nanoseconds

Number of CPU's   2
Start time        03/27/2002 10:18:48
End time          03/27/2002 10:19:10
Elapsed time      22 seconds ( 0 hours 0 minutes 22 seconds)
  
```

Copyright 2001 Sun Microsystems, Inc. All rights reserved.

Figure 8. LS-DYNA TCP project file view page

The use of the TCP described above provides first-time users with a quick-start platform to develop a working prototype. In addition, the iPS can, by design, provide a very flexible development platform for advanced users who wish to add additional functionality to the portal system. The developer can add/modify channels by programming Java servlet and/or JSP, and

the TCP provides the required application development interface.

Conclusions

A new Technical Computing Portal for LS-DYNA is described. The TCP facilitates access, workload distribution, and job monitoring. It is ideal for outsourcing or collaborative projects. Current work is being done to import LS-DYNA postprocessing graphics into a TCP window. This work will be reported in the future.

Acknowledgments

The authors would like to thank the technical contributions made by Frederic Pariente in the original development of the Sun Technical Computing Portal, and an editorial review of this paper by Douglas Norr and Stephen Perrenod.

Glossary

[Note: all Sun products/solutions are registered trademarks or trademarks of Sun Microsystems, Inc.]

HPC ClusterTools	Sun High Performance Computing clustering software, which includes a Sun-optimized MPI implementation
HPC SAN	A Sun-developed Storage Area Network solution for HPTC
HPTC	High Performance and Technical Computing, sometimes called HPC.
HTML	Hypertext Markup Language
iPS	Sun's iPlanet Portal server application
ISV	Independent Software Vendor
JSP	Java Server Pages
MPI	Message Passing Interface protocol
SGE	Sun's Grid Engine resource management software
SunMC	Sun's Management Center system management software
Sun ONE	Sun Open Net Environment -- Sun's standards-based software vision, architecture, platform, and expertise for building and deploying Services on Demand.
TCP	Technical Computing Portal, a Sun-developed portal for HPTC
T3	Sun Storage Product