OLYMPIC COMPUTER SYSTEM
PRELIMINARY STATUS REPORT
July 1, 1999

I. Overall Condition

The Computer System utilized by the Olympic Control Center was found to be in very good working order. This system, in service for some years, was well designed and has been well maintained. A continuous effort has been made to update the software and stay current with the software vendor. The hardware is becoming somewhat dated, but updates made in early 1999 ensure reliable operations.

II. Computer System Resources

1. Hardware

Computer hardware resources consist of Primary and Secondary Computers configured to provide rapid failover to a Hot Backup.

Digital VAX 4100-300 Computers
Single processor, Q-Buss Architecture
256 Meg Memory
Three (3) Digital RF31 disk drives (384 Meg each)
TK70 Cartridge Tape Drive
TU81 Reel-to-Reel Tape Drive

2. Software

SCADA Software utilized is the Vector Supervisor Control and Data Acquisition system provided by Teledyne Control Application of Dallas, Texas and Huntsville, Alabama. The Vector system software package was upgraded in August 1998 to version 3.6.1, the latest version available for the Digital VAX hardware.

III. System Evaluation and Diagnostic Observations

At the time of inspection, all system hardware was functional and the operating system reasonably configured in accordance with best practices. No hardware was found to be intermittent, and no hardware entries were found in the VMS hardware error logs except for the common and expected errors writing to tapes. Power-up self-tests reported no memory errors. Available disk space was ample and properly distributed between applications and the operating system. Total system memory installed on the machines was more than adequate for this application. Operating system parameters pertaining to individual process execution were sufficiently large for reliable operation. Total system loading, while approaching capacity at times, was well within the threshold of maintainability over an extended period of time.

IV. Probable Causes of Recent Computer Problems

The probable cause of the recent computer slow down was the result of two issues. Diagnostics and error logs have shown that the Historic process was demanding a disproportionate amount of CPU resource during the time of the system slow downs. The last record in the Historic database was apparently corrupted and the Historic process was not able to complete the computation of the corrupted record. As programmed, the error handling routines of the Historic process require a large amount of CPU resources and all other processes must wait until the Historic process releases the CPU. Error records show that a few process queues, such as Discretes, Analogs, Scans, & some MMI Displays were overflowing repeatedly. These process queues produced hundreds of repeated errors in a short period of time. While the Computer Resources available on this system are more than adequate for normal operation, reserve resources are more limited. The CPU resource was insufficient to meet the demands of the Historic process error handling routine while maintaining all other normal operations.

V. Recommended Changes

We recommend a number of changes as a result of the computer system review. However, only three changes directly impact the specific computer issue that has been the focus of the investigation. The remaining recommendations will allow the system to run more smoothly, avoid possible future problems, and recover some computer resources. See section VI for a description of changes already completed.

1. Develop an updated version of the HISTORIC process

Commission the development of an updated version of the Historic Process to reduce the demands on CPU resources. We anticipate the recommended changes should enhance the error handling capability of the Historic process. If the record cannot be processed properly on first attempt, an appropriate entry should be logged in the error file, and normal processing continued. The end effect of this change would be to reduce the error to a nuisance level and become a maintenance issue because one trend would not work properly and need attention. There would be no performance impact to the normal operation of the system

2. Upgrade the Computer System hardware

The existing computer hardware (Digital VAX 4000-300) produces sufficient CPU resources to run the normal load of the SCADA system and pipeline operations. While the available CPU resource would allow additional RTU's or facilities to be added, there is limited excess processing power to accommodate new features or handle extraordinary processing demands. It is recommended that an upgrade of the VAX hardware be purchased and installed to provide additional CPU resource to meet extraordinary demands. The available memory and disk space provides significant expansion capability, and does not require upgrading.

3. Move the PLDS interface application to the backup computer

The PLDS system is a Line Integrity/Modeling application that runs on a completely separate computer system from the SCADA system. It does require real-time data from the SCADA system and an interface application is run every few seconds to transfer analog and discrete data from the Vector system to the PLDS system. This data transfer application utilizes 25% - 30% of the existing CPU resource. A significant recovery of CPU resources would be gained if this data transfer application were moved to the backup SCADA system. The backup system runs using a minimum of system resources. The sensitivity of this modeling application will be reduced while it is supported by the backup computer because of the slower refresh time of data sent from the prime to the secondary computer. Some changes may also be required on the PLDS system to accommodate the audible alarms that are presently transferred to the prime computer to be displayed to the Controllers. After the VAX hardware is upgraded, the PLDS interface should probably be returned to the Prime Computer for optimal operations.

4. Update various VMS and Vector parameters

As a result of a complete system audit and evaluation by an outside contractual firm, we recommend additional updates to various parameters utilized by the Vector application and the VMS operating system. While these recommendations do not directly affect the primary focus of this investigation, they will help the system to run more efficiently and better utilize the available resources. See attached document titled "Olympic SCADA System Observations and Recommendations."

VI. Implementation Plans and Results

Implementation of these recommendations has already commenced. Development work has begun and equipment has been ordered to accomplish all recommendations. Performance enhancement items have been installed and are presently in service. Net result of the performance enhancement recommendations increases reserve capacity to 55% - 60%.

1. **Development has begun on an updated version of the HISTORIC process**
   A tape of the software utilized on the Olympic system has been shipped to Houston to begin the modifications. The source-code for the Historic process is being modified with the assistance of Teledyne Control Applications. In our experience, these modifications should be reasonably straightforward. The updated version of the Historic process should be delivered and installed in the Olympic system within two weeks.

2. **Upgrade the VAX hardware**
   The hardware has been located and ordered to update the existing Digital VAX 4000-300 to a Digital VAX 4000-705. This upgrade will increase the CPU rating 750% and will significantly increase the amount of excess processing power available. Memory has been purchased to match the speed of the new processor. All existing disk and tape drives will be retained and utilized. This modification will greatly enhance the capability of the system to handle extraordinary processing demands under virtually any circumstances. A 15 day delivery time has been quoted by the vendor and it is anticipated that this upgrade should be completed within three weeks.

3. **Move the PLDS interface application to the backup computer**
   The data transfer application that serves the PLDS application was moved to the backup SCADA system Thursday, June 24, 1999. Extensive testing was accomplished and the resource savings were verified to be 25% - 30%. The effects on the backup computer system were minimal. However, the update time previously obtained by attaching to the prime computer cannot be duplicated on the backup computer. The PLDS system will function with the data transfer feed attached to the backup computer, but the performance of the PLDS application has been impacted temporarily.

4. **Update various VMS and Vector parameters**
   All recommendations were implemented Sunday, June 27, 1999. The result of these changes was the recovery of approximately 5% of the CPU resource. See attached document titled "Olympic SCADA System Observations and Recommendations."

VII. Attachment

Olympic SCADA System Observations and Recommendations
Results of the system evaluations by NeoNet Inc.

Olympic SCADA System Observations and Recommendations

June 26 & 27, 1999

Diagnostics and System Observations requested by B. L. Burns of Equilon Pipeline Company and accomplished by P. K. Zimmerman, NeoNet Inc.

1. Pagefile space is overallocated. (Reservable shows 120000 blocks negative.) Recommend extending DIA2:[PAGEFILE]PAGEFILE2.SYS to 300,000 blocks from present 100,000.
   Reason: A negative "reservable" means that all processes which have been allocated pagefile space have received, in total, more than the total pagefile space available. If all processes, or a significant number of the total, were to take their allocation simultaneously, then available pagefile space would drop too low, and the entire operating system would slow down significantly.

2. Non-paged dynamic memory pool too low. This pool is used dynamically to create various memory structures and the number of bytes spare changes constantly and rapidly. It is best to maintain at least 50% of the base allocation free. Currently shows 700,000 free out of 3,150,000. Recommend increasing Sysgen parameter NPAGEDYN to 8153920 (which will provide more than 50% free since this system has considerable free memory available.) Recommend increasing NPAGEVIR to 16615680 from its present 12615680 (this is the reserve quantity that can be allocated by VMS if the base allocation is exceeded, but at the cost of some cpu time.)

3. Cpu loading is high with the PLDS Server process running on the prime machine. This is the third party line/meter integrity product which runs external to Vector itself, but reads Vector databases at frequent intervals. Observing cpu loading, idle time percentage, kernal mode percentage, direct and buffered I/O, and command line response time, the system as a whole appears to be 75-80% loaded on average (over a long period of time) with the PLDS server running on the prime, and 40-50% loaded with the PLDS server running on the backup machine. At 75 to 80% loading, the system lacks reserve to handle sudden and unexpected loads (looping processes, impromptu heavy disk I/O, simultaneous change in a large number of scan data points, etc.) without a noticeable reduction in performance to the users. At 40-50% loading, most unexpected situations should be covered by the available cpu reserve. Recommend running the PLDS server on the backup machine with provision to generate alarms for the controller without direct output from the server to Vector.

4. Direct I/O rates appear nominal for the RF31 DSSI type disks in use. Peak usage averaged ~ 30 operations per second and this rate appeared only as occasional bursts. The only major user of direct disk I/O was the SYSDSKUPD process which writes copies of the databases in memory to disk at user-specified intervals. Since the disk I/O rate is within the capabilities of the disk hardware, there is no need to adjust those user-specified intervals.

5. Buffered I/O (largely network traffic) rates appear nominal, even with a three second screen refresh rate on all the mmi's. The only two heavier users of network I/O are the RDSXMT process which keeps the databases on the backup machine updated continuously, and the PLDS Server. Total network I/O does not appear to be excessive for the hardware in use, even with the PLDS Server running on the prime computer.

6. Several additional SYSGEN parameters should be adjusted to accord with best practices, although none would immediately affect system performance:

a. The memory management set by which VMS recovers pages of memory when the free list has dropped too low is presently:
FREELIM 150
FREEGOAL 12000
BORROWLIM 150
GROWLIM 150

Recommend changing to:
FREELIM 20000
FREEGOAL 42400
BORROWLIM 35600
GROWLIM 30800

This allows VMS to take action long before the size of the free list is so low that a system lockup could occur. IT SHOULD BE NOTED HOWEVER, THAT THIS SYSTEM HAS A VERY LARGE QUANTITY OF FREE MEMORY AVAILABLE (350,000 PAGES +). It is very unlikely that the free list on this system would ever become small enough to require memory recovery action.

b. QUANTUM is presently set to 20. Recommend changing to 10. This allows better sharing of available cpu time by systems having large numbers of processes and few or no large batch type jobs.

c. MPW_THRESH is presently set to 200. Recommend changing to 22520. This is the minimum value in pages on the modified page list before the memory recovery routines will attempt to satisfy the freelist shortfall by taking those pages from the modified list. If MPW_THRESH is at least the difference between FREELIM and FREEGOAL, plus the value of MPW_LOLIMIT, then memory recovery will not take place from the modified list until sufficient pages are available to resolve the freelist shortfall in one operation.

d. A global page summary command showed 21000 global pages free out of 76000 total. Recommend changing the SYSGEN parameter GBLPAGES from its present 76900 to 110000 to allow for 50% free pages. As a consequence of that increase, recommend changing the parameter GBLPAGFIL from its present 10240 to 50000. This will allow for significant additional numbers of records to be added to any of the Vector databases.

7. A review of the VMS hardware error log showed no hardware failures except for a few tape drive errors when writing backup tapes. This is normal for these tape drive models (TK70 and TU81) and is completely external to the VAX system as a whole. While it is normal to find error messages indicating automatic bad block replacement on DSSI disks, none were found on this system.

8. Free disk space was quite adequate on all three main disks. Version control of files having the same name, and purging of extraneous files in key directories appeared to be in good order.

9. Examination of the DecNet circuit and line counters showed normal network connectivity from the Vaxes. No framing errors, excess collisions, unrecognized destinations, or adjacency failures were evident.

10. All Vector processes were set to non-realtime priorities. The ET$XMTxxx processes were set to the top quantum based priority (15), the same as the RD$RCV and RD$XMT processes which maintain the dialog between primary and backup as well as updating the databases between the same. Recommend setting the ET$XMTxxx processes' base priority to 13, as a match to the other two processes which make up an mmi (the PC$KEYxxx process runs at a base priority of 12, and the PC$DYNxx process runs at 14.)