Application of remote terminal emulation in the procurement process

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ABSTRACT

The procurement of communications-oriented computer systems in the Federal Government has recently embraced a technological concept which will significantly affect the trend of such activities for many years to come. This concept, generally referred to as Remote Terminal Emulation, provides the potential customer with a means of testing and evaluating a proposed system under loading conditions that closely approximate the intended live environment but without the logistical problems that have plagued such attempts in the past. This capability takes on added significance when viewed in the context of the federal procurement process which usually involves the execution of a benchmark by all participating vendors at some point in the procurement cycle. In order to be equitable among all vendors, as well as provide meaningful results for subsequent evaluation, the benchmark must not only be representative of the anticipated workload but must also exhibit one very important characteristic—repeatability. Until recently, this latter requirement reduced most benchmarks to essentially batch-oriented exercises, with but a smattering of interactive processing that did little more than establish the functional capability. With the use of Remote Terminal Emulation, the situation has changed. Potential customers are now able to test and evaluate proposed systems with benchmarks that provide significant workload levels (benchmarks with over one hundred emulated terminals are not uncommon) such that meaningful evaluation data can be obtained. This paper documents the experience of the U. S. Geological Survey in using Remote Terminal Emulation during a recent procurement of a nationwide communications-oriented computer system.

INTRODUCTION

The recent energy-related problems of the United States have had a far-reaching impact on the scope of computer-based activities within the U. S. Geological Survey. In order to meet the myriad demands of both Government and industry concerning the management of our nation’s energy resources, the USGS has had to dramatically expand its computer resources, particularly in the area of interactive and remote processing. The planning for this expansion culminated in May of 1975 in a set of user requirements that would ultimately serve as the basis for a solicitation document (RFP) in an industry-wide competitive procurement.

BENCHMARK OBJECTIVES

The Computer Center Division within the USGS was responsible for translating the stated user requirements into a complete RFP, as well as for designing a benchmark that would best evaluate a vendor’s ability to meet those requirements. In order to accomplish the latter objective, the benchmark not only had to be truly representative of the projected user workload, but also had to provide an equitable test across all of the participating vendors. Also, the benchmark had to rigorously test all components of any proposed system, with all subsystems functioning as they would in a non-test environment.

EXISTING METHODOLOGIES

With the above objectives in mind, an investigation was begun into existing methodologies for the benchmarking of teleprocessing systems. The traditional method of employing a batch-oriented workload with a small number of live terminals was rejected because of the difficulty in equating the batch activity to a desired teleprocessing workload. Large number of live terminals were unacceptable from a repeatability standpoint, not to mention the logistical nightmare that such an approach would entail. Simulation was not considered a feasible alternative due to Federal regulations restricting the use of this technique. There was, however, one more approach to the problem that appeared to merit further investigation. Referred to as terminal emulation, this concept involved generating the required teleprocessing workload via software. However, unlike simulation which attempted to model the teleprocessing system (and was thus only as valid as the assumptions upon which the model was based), terminal emulation captured the actual teleprocessing dialog in software, with the additional capabilities of being able to control such parame-
ters as think time, line speeds, and typing delays. At the
time, two types of terminal emulators were being developed
by industry—internal and external. The internal emulators
(or measurement drivers) were typically run on the actual
system under test (SUT) but, in doing so, perturbed the
object of measurement. This factor, together with reser­
vations concerning the completeness of such a test (usually
the complete communications subsystem was not exer­
cised) resulted in the USGS insisting that any methodology
employed must generate the required teleprocessing work­
load completely external to the SUT. The external or
remote terminal emulators (RTEs) met this requirement in
that they all employed separate computers to house the
emulation software and entered the SUT via the normal
communications interface. In addition to external genera­
tion, the USGS required that no portion of the SUT could
be used in the workload generation, and that transmission
of the workload to the SUT must use the vendor’s standard
hardware and software interfaces. All of these require­
ments were intended to insure that the installed system would
need no hardware or software modifications in order to
support a live teleprocessing workload equivalent to that
emulated during the benchmark.

INDUSTRY RESPONSE

Upon release of the RFP to industry in August of 1975, it
became clear that four major mainframe manufacturers
could meet the benchmark requirements as stated, with two
others needing only additional development time to fully
comply. Unfortunately, the USGS procurement timetable
could not afford the requested delays, resulting in three
vendors (one of the four qualified vendors eventually chose
not to bid) going to benchmark.

USGS RTE WORKLOAD

The teleprocessing workload to be emulated by the
vendors was comprised of both asynchronous and syn­
chronous activity. The asynchronous portion was to reflect
a population of between 48 and 96 low speed (300 baud)
terminals, depending on the particular point in the system’s
life being tested. Each terminal was to be actively engaged
in one of four preassigned functional scenarios for the
duration of the timed benchmark. The scenarios consisted
of continuously-repeated sessions, with a session being
initiated when the emulated terminal logged into the SUT
and terminated when the emulated terminal logged out.
Each session was individually identified with an incremen­
ting two-digit field as part of the emulated dialog to aid in
tracking the activity of the emulated terminals in subse­
quent data analyses. The four functional scenarios con­
sisted of the following: (1) interactive FORTRAN compila­
tion and execution; (2) file manipulation involving media
transfer; (3) intra- and inter-file text editing; and (4) data
base query generation and execution. Each of the four
scenarios had a specified think time to be incorporated into
the dialog as a fixed delay between the last character of
the response transmitted from the SUT and the first charac­
ter of the next stimulus transmitted from the RTE.

The synchronous portion of the workload consisted of 12
to 28 emulated remote-job-entry terminals operating at line
speeds of between 1200 and 9600 baud. The scenarios of the
RJE terminals were required to function in continuous job­
submission mode, with specified delay times incorporated
between individual job submissions. Depending on the
point in the system’s life being tested, from four to seven
functionally distinct batch programs were required to be
transmitted to the SUT and accumulated into input job
queues. Once sufficient numbers of these batch jobs were
queued, one of each of the different batch jobs was set into
execution. This set of multiprogramming batch jobs formed
a continuously-replenished batch background running con­
current with the aforementioned asynchronous and syn­
chronous activity. A graphical representation of the com­
bined SUT workload over the system’s life is presented in
Figure 1.

RTE COMPARISONS

The three vendors who participated in the final bench­
mark employed functionally similar RTEs. The general
benchmark configuration is indicated in Figure 2. All ven­
dors chose to implement the synchronous emulation by
using separate physical communications cables between the
RTE and SUT for each emulated RJE terminal. However,
for the asynchronous workload, the vendors all elected to

![Figure 1—USGS benchmark workload mix](From the collection of the Computer History Museum (www.computerhistory.org))
emulate multi-dropped terminals in order to reduce cabling requirements. In the area of verification of the emulated terminal activity, several observations are in order. There existed sufficient capability common to all three vendors to provide a reasonable degree of assurance that the benchmarks were being performed properly. All vendors could display the status of any selected emulated line using the console on the SUT. All vendors could capture and time-tag all emulated terminal traffic and store it on a magnetic tape for post processing. And all vendors could display the dialog on any selected emulated asynchronous line on an output device. The vendors differed, however, in the degree to which each of these capabilities had been refined. For example, while one vendor could dynamically change the selected asynchronous line to be displayed by simply entering a command on the RTE console, other vendors had to either physically move a pair of connectors on a back panel or actually make minor modifications to the RTE software. Although all vendors could display the status of any selected emulated line (i.e., active, inactive, etc.), only one vendor could display the actual position of RTE execution within any given terminal session. While some vendors were able to automatically time-tag any displayed asynchronous terminal sessions, other vendors required manual annotation on corresponding output listings.

BENCHMARK CONSTRAINTS

The salient features of the USGS benchmark can be described as follows:

1. The vendor was allowed up to two augmentations (hardware and/or software changes) over the 60-month system's life;
2. The vendor had to benchmark the month-60 workload plus all augmentation points;
3. A live interactive terminal with a priority identical to that of the emulated asynchronous terminals was used to measure various command response times.

The resulting averages could not exceed stated maximums;
4. The transmission times associated with the emulated synchronous activity could not exceed stated maximums;
5. The elapsed times of batch jobs could not exceed stated maximums;
6. All workload types must have been concurrently executing when any timing measurements were made; and
7. For acceptance-test purposes, a “batch-only” version of the workload would be run and timed.

BENCHMARK PROCEDURES

The procedural implementation of Remote Terminal Emulation within the context of the overall USGS benchmark can be seen through the following event descriptions. At the commencement of the live benchmark run, the system configuration was verified by the USGS benchmark team. Following this, the emulated asynchronous terminals were allowed to begin logging into the SUT. At approximately 30 minutes into the benchmark, the emulated synchronous terminals were released to begin transmitting batch jobs into the SUT input queues. After approximately 50 minutes, when all of the emulated terminals had established communications and reached steady state, a record was made of the current SUT job queues. Following this, the required mix of multiprogramming jobs was set into execution. Once all portions of the benchmark workload were being processed, the first set of live-terminal timings were taken. At approximate 10-minute intervals, the remaining sets of timings were taken until six complete sets were recorded. As soon as the timings were completed and at least one copy of every type of batch job had finished execution, the benchmark was terminated. Ending job queues were recorded for subsequent quantitative analysis of the processed workload.

OBSERVATIONS

At the conclusion of the benchmark associated with the USGS procurement, the following observations were made:

1. All vendors were eventually given over six months to prepare the benchmark; nevertheless, every vendor attempted major hardware and/or software modifications during the week of the live benchmark test;
2. All vendors ultimately made some modifications to their RTEs to conform to the USGS requirements or to correct uncovered faults;
3. All vendors suffered significant SUT hardware failures during the live benchmark tests;
4. Most vendors were plagued by RTE hardware errors or unexpected communication problems associated with the RTE-SUT interface; and
5. All vendors found that traditional “on-the-fly” tuning
and reconfiguring produced somewhat unpredictable results.

CONCLUSIONS

In retrospect, the USGS feels that the efforts required to incorporate the technique of Remote Terminal Emulation into a major computer-system procurement were well justified in terms of the resulting level of confidence in the capabilities of the acquired system. It was not an inexpensive undertaking for either the Government or the participating vendors. Major competitive procurements never are. However, when one considers the overall cost-effectiveness of having obtained the lowest-priced system that has actually been tested against its ultimate projected workload, the real merits of Remote Terminal Emulation begin to become evident. And as this tool is refined and standardized through continued Government-industry cooperation, it will surely become an inseparable part of all future communications-oriented computer procurements.

REFERENCES