**Root Cause Analysis**

**Event:** Registration Problem, 7/8 November, 2010.

**Summary:** Between the hours of approximately 11:45 PM November 7 and 1:20 AM November 8, 2010, the UAOnline servers were overwhelmed and many degree-seeking students had difficulty registering for classes. A number of students were either unable to login to UAOnline, experienced slow response or were kicked out of the system during the 80-minute period of very high use.

While there were reports of frustrating experiences, primarily associated with the UAA campus, students successfully registered for more than 10,000 classes during the first two hours. This represents a 3-fold improvement over registration performance experienced the previous year during the same two-hour period. Regardless, UA-wide, student body demand was not met and expectations were unfulfilled.

OIT Technical Services personnel were on-site prior to (10:30 PM) and throughout the registration peak load period (Midnight - 3:00 AM). As problems were identified, they performed numerous remediation actions such as including resetting processes and dynamically adjusting system parameters. UAOnline began to function normally at approximately 1:20 AM.

**Detail:** Due to unprecedented load, at 11:46 on Sunday October 7, 2010, an operating system process limit was reached on the UAOnline web server. This caused the Oracle Application Server (OAS) processes to abnormally terminate which resulted in all UA Online connections being dropped. Oracle memory allocation errors were also seen at this point. The Oracle System Global Area was previously increased to 7GB in preparation for the expected registration load, but was still insufficient.

Initially, there was concern that it was hardware related so Technical Services made the decision to move UAOnline to another Oracle application web server. A configuration issue on the new server resulted in UAOnline being unavailable for approximately 10 minutes, from 12:00 – 12:10 AM. The operating system process limit, which was set as recommended by Oracle, was reached on the new server as well. The limit was increased and the OAS was restarted at 12:37 AM. At 12:40 AM the maximum number of OAS client connections (2500) was reached.

At 12:40 AM another OAS issue was encountered. This issue is still under investigation and the OIT staff is working with Oracle support to attempt to identify the cause. This necessitated another restart of OAS. The affect this issue had on end-users is unknown.
At 12:50 AM memory consumption on the PROD database server increased significantly. In an effort to reach a balance between demand and available resources OIT staff dynamically altered the maximum number of OAS client connections several times between 1:00 and 1:20 AM. At 1:02 AM the maximum number of client connections and database process was again reached. This was the last time an error was logged by the OAS software (though OAS logs show warning messages until 01:17). UA Online began to function "normally" around this time.

2,734 students registered for approximately 9,000 classes between 12:10 and 1:20 AM.

**Recommendations:** Essentially, the twice a year peak load on the system (November and April) is greater than the computing resources are configured to support. There were no hardware errors/faults encountered. There were a number of configuration and software issues which OIT will continue to investigate with Oracle Technical Support.

OIT is unable to accurately simulate the load placed on the system during peak registration. Therefore, the university and vendor staffs who are tuning the system are extrapolating blind. To ensure the system will support future surges in demand, OIT should evaluate performance tuning and load testing tools which will allow real-world load simulation. This is an industry standard practice for managing transactional information systems.

If the combination of class registration policies in effect at UAA, UAF and UAS continue to drive significant portions of the student body to UAOnline at the same moment, UA should consider a fast-track ERP Peak Load project in order to scale the UAOnline system prior to when registration opens for the Fall 2011 academic term (April 2011).

Additionally, the university should explore the option of creating a more strategic registration priority system that all MAUs can support and will provide students a high quality registration experience. Informed by data from past registration openings UAA/UAF/UAS Enrollment Services can further compartmentalize registration from degree-seeking to degree-seeking graduating seniors only (during first two hours). Staggering the registration process will reduce the surge volume which is extraordinary for 90-minutes, twice a year.

Finally, OIT can improve the user experience by better managing the user’s expectations. During periods of high volume, the user interface should convey queuing and status information. Let the user know that the server is experiencing abnormally high volume and provide instruction. This could be coupled with server-side throttling in which the number of allowed connections is managed at a serviceable level. Once capacity is reached a screen could estimate the wait time or users could be queued on a first-come-first-serve basis.