the Availability Digest

www.availabilitydigest.com

Wells Fargo's Pioneering Active/Active ATM Network

Phil Kloot
Manager, Tandem Systems Support
Park Nicollet Health Services
September 2010

Wells Fargo (www.wellsfargo.com) has always been a pioneer. Remember the Pony Express that delivered mail by horseback to the Wild West in the mid- to late 1800s? That service was run by Wells Fargo, a company formed in 1852 to provide banking and express services to California. In 1905, Wells Fargo separated its banking and express operations; and in 1918, as a wartime measure, the U.S. Government nationalized the express operation, which became the Railway Express Agency and which has since been privatized.

Wells Fargo is now one of the Big Four banks in the United States, joining Bank of America, Citigroup, and JP Morgan Chase. Wells Fargo operates more than 6,600 branches and 12,000 ATMs for its 43 million customers.

The Early ATM Days

As in the stagecoach days, Wells Fargo has been a pioneer in bringing banking convenience to its customers. It was an early adopter of ATM technology and worked tirelessly to make ATM services highly available to its customers. To ensure availability, the bank implemented its ATM network with a fault-tolerant Tandem system, located in its San Francisco data center.

But an ATM is not in itself a reliable component. The bank's initial thrust was to make its ATM machines as reliable as possible. However, in the late 1980s, it realized that there was a diminishing return in improving the availability of the individual machines themselves. There were just too many things that could go wrong, such as cash depletion, jammed cash drawers, and network failures.

Consequently, Wells Fargo changed its focus from machine availability to location availability. Machines were going to fail – this was a fact that had to be accepted. But if another operating machine was right next to it, the customer could easily use it instead and not be inconvenienced. This is location availability.

Active/Active ATM Availability

At every location that Wells Fargo had an ATM, the bank installed a second one. It provided two ATM networks, with each ATM at a location being connected to a different network. One network connected its ATMs to the Tandem system in the existing data center in San Francisco; and the

other network connected its ATMs to an identical Tandem system in a new data center built by the bank in El Monte, near Los Angeles in Southern California.

The ATM application, called Retail Delivery System (RDS), was custom-built by the bank – the popular third-party application, Base24, was not used.

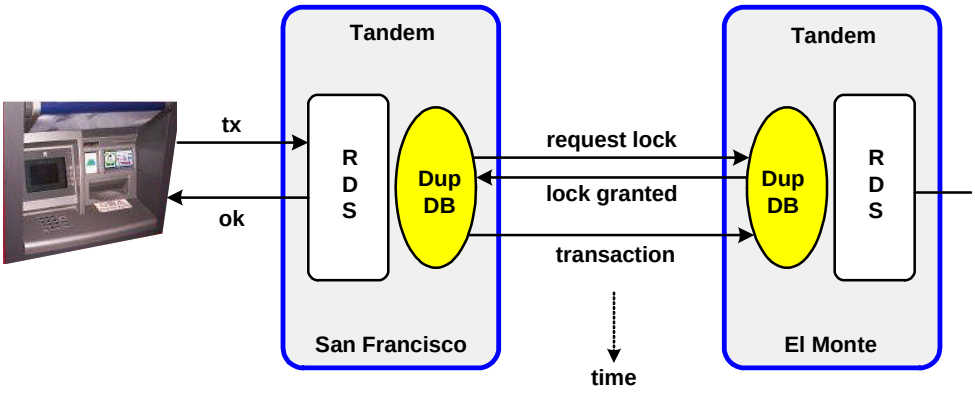
Synchronizing the Databases

Each data center had a full copy of the customer database. The bank's IT staff implemented its own replication facility called "Duplicate DB," abbreviated "Dup DB." (this was well before the days of commercial data-replication engines). Dup DB replicated each transaction to the other data center with an SLA of twenty seconds. The intent was that if a customer made a transaction at ATM-a, by the time his card was returned and could be inserted into ATM-b just three feet away, the transaction was already recorded in both systems.

Dupe DB was initially single-threaded, but a multithreaded version followed less than a year later to improve performance.

Eliminating Data Collisions

Dup DB used asynchronous replication with lock coordination. During the transaction, the account was locked in both systems. The system servicing the ATM being used locked its copy of the account and authorized the transaction only if the Dup DB replicator succeeded in obtaining a lock on the account in the alternate system. In this way, data collisions were eliminated. In later years, when online ordering became popular, this strategy eliminated data collisions even when a husband and wife made legitimate, simultanous transactions over the Internet.



Wells Fargo's Active/Active ATM Network

There was no ability to switch ATM machines individually from one network to another. However, an entire network could be switched from its home data center to the alternate data center should there be a data-center failure. This was called the "Big One" option - after all, the data centers were in California, an area prone to devastating earthquakes.

The system was thoroughly stress-tested in the Tandem Benchmark Center in Cupertino before it was successfully deployed in the early 1990s.

The Active/Active Architecture

The original active/active ATM architecture reflected the technology of the late 1980s. In each data center were a pair of Tandem VLX systems connected via a FOX ring.

The replication network connecting the two systems comprised six 56-KB Expand lines (Expand is the proprietary protocol used by Tandem, now HP NonStop, to interconnect systems). The ATMs were connected to their respective data centers via 9600-baud modems.

By focusing on location availability through the use of dual systems kept synchronized by data replication, ATM availability from the customer's viewpoint was significantly increased. Furthermore, with the capability to switch networks from a downed data center to an operating data center, efficient and effective disaster recovery was achieved.

Summary

This solution is reminiscent of the bank's survival of the disastrous 1906 San Francisco earthquake. Bank president I. W. Hellman telegraphed, "Building Destroyed, Vault Intact, Credit Unaffected."

Wells Fargo's active/active ATM system lets it continue in this tradition. Let's hope that sometime in the future, Wells Fargo does not have to email the message, "Building Destroyed, Network Intact, ATMs Unaffected."

The material for this article was provided by many members of the original development team. The team believes that this model is still in use today to control Wells Fargo's ATM network.

Acknowledgements

To the best of my recollection, the people who were involved in the ATM system and their roles are as follows:

Scott Alexander - Systems Programmer/Architect
Angel Cenizal - Systems Programmer (built the systems in the south)
Stan Chapman – Lead Programmer
Nick Courtney - Systems Programmer
Bill Grossman - Systems Programmer/Data Communications
Phil Kloot - Project Manager
Joyce Lai – Senior Programmer
Ralf Myer - Senior Project Manager
Jim Murphy - Systems Programmer
Mark Pleticha - Performance & Tuning
John Quinn - Systems Programmer
Joel Sandberg - Wrote the stress test driver
Scott Sitler - Tandem employee - stress test performance and measure
Mark Stockton - Application Programmer/ Architect
Bobby Tranilla – Systems Programmer

My sincere apologies to the many I may have missed and a big thanks to those who helped out by jogging my memory and filling in details. - Phil Kloot

[Editor's Note: None of this material came from Wells Fargo directly, nor has Wells Fargo commented on this article. It represents only the collective memories of the development team.]