

Update Bulletin

Connected Payments Service Report

August 4, 2008

Dealers and their customers have justifiably asked for an explanation of the two recent Connected Payments outages, and the plan to ensure they won't be repeated.

The attached letter describes what went wrong, the detailed results of the failure analysis and the plan to correct each specific factor. Please provide this letter to your Connected Payments customers.

For your own information, the faulty server hardware that failed twice has been completely replaced, Data Center Two has been upgraded with a massive new server now on-line, the software resiliency fix in 825 has been downloaded to all but two customers, and an additional layer of redundancy has been added to Data Center One.

We appreciate all your extra effort, and sincerely regret the impact on our dealers and Connected Payments subscribers.

To Your Success,



Anthony van Seveiter

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August 4, 2008

To Our Connected Payments Subscribers,

StoreNext sincerely regrets the recent pair of hardware failures that interrupted your Connected Payments service, and any effects.

Since Connected Payments is designed to maintain services through the most serious malfunctions, over the past several days we have studied every hardware, software, communications and database component to prevent future occurrences. The comprehensive investigation included a line-by-line analysis of logs from most stores, reviewing every support call, and painstaking comparisons between processor, host, store balance and settlement data to isolate and diagnose all incidents and our responses to them.

As part of this report, we are committing plans to respond positively in each area. All these plans are now in process. Several of these actions were already completed, which kept some problems from July 27 from repeating August 3. For each item, we have provided a "Summary" and "Plan" to give you the most important information, with additional details for those interested.

We present these findings and commitments to you with great appreciation to the many customer and support people who provided so much assistance — and so much patience.

Thank you very much,

A handwritten signature in blue ink, appearing to read 'Antony van Seventer', written over a horizontal line.

Antony van Seventer
vice president
StoreNext Marketing and Products

Connected Payments Service Report to Subscribers

Overview

Triggered by identical hardware failures, three simultaneous conditions combined to cause delays severe enough to stop processing. Any of these conditions in isolation would not have caused any problems, but adequate performance could not be sustained with all three acting at once.

Additional issues such as balancing difficulties were also exposed, and these are also described below together with how they have been addressed.

No transactions or data were lost by any stores according to all evidence to date. However, many stores had cases of duplicate transactions and/or reversals — including excess reversals — all of which will be corrected by StoreNext with the processors for proper settlement.

Condition #1 – Server Failure

Summary: A large data server in Data Center One suffered two sudden and severe hardware crashes one week apart, each time requiring the replacement of most electronics and storage management components.

Conclusion and Response Plan: After the second failure, the server was replaced in full with a new server. StoreNext will accelerate its plan to add another layer of redundancy by implementing server “clustering.” This architecture ensures that at least three parallel servers are simultaneously on-line and processing, and multiple simultaneous failures can be survived without stores switching data centers – or being affected in any way. While the clustering project is being implemented, Data Center One has added a standby server that supplements the replication already offered by Data Center Two.

Details: Connected Payments replicates all functions and hardware in two separate data centers to withstand any such failures with no impact on any users. The analysis project determined:

- The server manufacturer declared the cause of the failure to be a manufacturing defect. Most of the components in the server were replaced after the first failure, but the server was replaced in full after the second failure took place.
- The server design was selected due to its #1 industry rating for both performance and reliability in enterprise-class machines. This product is an industry-wide first choice for non-stop mission-critical datacenter hosting despite its cost of approximately \$120,000. There is no data leading us to question the hardware decision.
- Power quality was eliminated as a possible cause: the data center provides clean power via a filtration system, and the Connected Payments servers draw power that has been additionally cleaned by our own power cleansing and regulation components.
- Manufacturer response was excellent in both cases.
- Even with Data Center Two available for backup, additional steps will be taken to replicate hardware *within* the data center, thereby adding more layers of redundancy. This will ensure that both data centers remain available after even the most catastrophic hardware failure.
- The first step in this process has now been taken, by implementing a second standby data server in Data Center One. In case of a hardware failure, stores can process via Data Center Two, but Data Center One can also be brought back on-line in 20-30 minutes.
- As transaction volume increased, StoreNext’s plan has been to implement another layer of redundancy by replicating the main processing servers via “clustering.” The cluster of three major servers will operate in parallel, and a server failure will not affect service within the data center. The other front-end communication and back-end communication servers will also be replicated and/or clustered.
- The timetable for clustering will be brought forward.

Condition #2 — Resiliency Failures (August 3 Only)

Summary: About half the stores were running OpenEPS 824 when the July 27 failure occurred. The older software repeatedly attempted to access the failed server, and each attempt generated a series of time-outs, time-out reversals and retries. This created a processing load that was 47 times normal, which eventually overwhelmed Data Center Two's ability to keep up with transactions before Data Center One was brought back on-line.

By August 3, almost all stores had been updated to 825 and the logs showed that all stores moved to Data Center Two as expected. (The August 3 transaction load was much higher than on July 27 due to time-of-day and day-of-month. This overran the storage I/O capability in Data Center Two, which masked 825's resiliency.)

Conclusion and Response Plan: The 825 resiliency improvement worked as designed, although its benefit was hidden on August 3 by the transaction load. Short 30-second time-out settings in some stores further increased the load and reduced successful transactions on July 27. Especially since updates execute automatically via download with no action needed in the store, StoreNext must ensure that software updates are implemented quickly. In the future, excepting predetermined unusual cases, automated software updates will be driven automatically from host — this method was proved effective immediately after the event when more than 100 stores were updated in 24 hours without incident. Also, users will be reminded of the advantages of the 45-second default time-out.

Details: The original resiliency design in 824 continued returning to Data Center One on July 27 even after failed transactions there and/or having success with Data Center Two. These unsuccessful tries generated a long series of time-outs and transaction reversals. The 825 software update instead puts an unresponsive data center "on probation" and will stay with the alternate working data center without retrying the inactive center until necessary. This further prevents impact and performance degradation in the lanes. The analysis project determined:

- The 825 software with "smarter" resiliency was installed in stores starting mid-May, but only about half the Connected Payments stores had been updated as of July 27.
- Logs from stores with 825 on July 27 and August 3 showed that they operated as designed and processed transactions successfully via Data Center Two, although the log-jam at Data Center Two eventually resulted in slow response and time-outs for 825 users too.
- On July 27, about 20% of the lanes with 825 did not correctly manage consecutive time-outs from each of the two data centers, and did not re-try until the condition was cleared at end-of-day. This problem was not a factor on August 3, but a fix for this with other minor changes will be provided automatically to the stores this week. No actions or activity at store level will be required.
- The pent-up off-line re-tries and time-out reversals — created by repeated attempts by 824 to process via Data Center One — was at fault for flooding Data Center Two on July 27. A credit sale is typically completed on a single transaction, but in this case caused up to 24 retries and reversals — each of which being far more complex and time-consuming to process. This also factored into the August 3 overload at Data Center Two.
- Several stores had reduced the recommended 45-second time-out to 30 seconds. Especially during the July 27 overload period, many transactions completed successfully but took 33-37 seconds, barely missing the shorter 30-second window and adding further the flood of time-outs, reversals and re-tries. Years of experience and processor recommendations have established the advantages of a 45-second default, which should be more strongly recommended.
- Additional host improvements were identified including better transaction prioritization that transaction duplications. Fortunately, these changes were installed prior to August 3rd and eliminated more than 90% of the duplications.

Situation #3 – Data Center Two Capacity

Summary: Before the major August 4 upgrade, Data Center Two possessed three times the CPU power needed to service the entire base of Connected Payments stores during the busiest periods. On July 27, the 47-times normal load created by the flood of pent-up off-lines and time-out reversals (due to the 824 resiliency issue) downgraded performance to unacceptable levels, timing-out transactions while that data center worked through the backlog. However, storage I/O limitations were not calculated separately from the CPU capacity, and when higher transaction volume from time-of-day and day-of-month built up to 56 times the normal load on August 3, storage requirements passed the tipping point and got further and further behind, eventually causing almost all transactions to time out.

Response Plan: Additional server hardware was delivered in May that provides 1,200 times the current performance and capacity. Staging, test and burn-in was completed last week and the new server hardware was installed and brought on-line August 4. An identical machine was brought on-line in Data Center One and it was able to process the entire backlog of off-lines, retries and time-out reversals from the August 3 outage within 10 minutes while turning around new transactions with 1-second response times.

Details: StoreNext scales the Connected Payments processing power upward so it never works at more than 1/3 capacity at typical volume. Each data center should therefore handle the complete load of both data centers with enough reserve headroom to handle a 50%-over-normal load. The analysis project determined:

- Data Center Two processed transactions successfully for the first 20 minutes after the Data Center One failure on both July 27 and August 3.
- On July 27, the flood of off-line transactions, retries and time-out reversals put Data Center Two got very far behind resulting in many time-outs. Although Data Center Two never stopped, many users thought it had failed because of very slow response. Approximately one hour was required to work through the pile-up before regaining real-time response.
- On August 3, the combination of much higher incoming transaction load from time-of-day/day-of-month — and all stores switching immediately to Data Center Two — was more responsible for stressing the system, causing time-outs that eventually built the load to 56 times normal. Although the CPU processing did not exceed 60% load, the storage I/O hit 100% after 20 minutes causing a similar avalanche of time-outs, reversals and retries as on July 27.

Issue: Duplicate Transactions

Summary and Plan: Duplicate credit transactions were created July 27 when processing delays caused approvals and re-tries to “cross in the mail.” Host software has since been implemented that prevented all but nine total instances on August 3, and a patch will be downloaded to stores the week of August 4 that eliminates all additional known causes. All duplicates have been identified and all are being corrected with the processors by StoreNext. We would like to thank First Data, Chase Paymentech and Shazam for their outstanding cooperation and responsiveness.

The analysis project determined:

- On July 27, once the data center got behind, approvals might come from the processor, but so late that a time-out reversal for that transaction had already been created and was in-queue – and then submitted and processed. The new host software successfully eliminated this issue by August 3.
- A hole still existed whereby a duplicate could be created under special stress conditions in the store software. This was identified but the fix was still in test on August 3, leading to one duplicate in each of nine stores total. The patch is being downloaded automatically the week of August 4.
- Transactions are normally approved by the processor within one second, and time-outs from processing delays are never a factor. But with multiple time-outs in effect for one transaction, multiple retries, and multiple time-out reversals, almost any combination of timing errors could occur depending in the order these items are submitted, including reversing transactions that had already been approved — or even already reversed.
- Depending upon the processor, the duplicate transactions were resolved by a combination of StoreNext using Connected Payments data and analysis with the processor on behalf of the merchant, use of the processor’s duplicate-trapping software, and manual processes by StoreNext and/or the processor. In all but a few of the July 27 cases, this process is now complete.
- Of course this does not count the additional work by merchants and dealer support personnel to manually balance these transactions, which we sincerely regret.

Issue: Dual End-of-Day Batches

Summary: On July 27 when Data Center One returned to service, it automatically commenced a duplicate end-of-day process adding to the one already completed by Data Center Two. Most reports had zero transactions due to the short window, but two end-of-day batches were created instead of the usual single batch.

Response Plan: Data center personnel revised their re-start processes to prevent this inconvenience and the new process successfully prevented the dual batches successfully August 3.

Issue: Off-Line Stand-In (Store-and-Forward)

Summary: When a lane is unable to get a credit transaction processed or it times out, off-line stand-in can complete the transaction and solicit the approvals later once the system is back on-line. The OpenEPS software in the lanes followed the normal convention of sending all pending transactions immediately upon restoration of service. This sudden flood caused processing delays and further multiple time-outs, reversals etc.

Response Plan: An update to the store software will now send the pending off-line transactions one-by-one at intervals instead of all at once. Also, it will not send another pending transaction until the previous transaction has been successfully completed. This will increase performance by smoothing the transaction flow and preventing bottlenecks. This software update will undergo further testing before being downloaded later the week of August 4.

Issue: Proactive Crisis Prevention

Summary: While it's important to learn from history, we cannot wait for real life to teach required changes. The "what-ifs" of unlikely events in unusual combinations must be foreseen with strategies developed in advance.

Response Plan:

- A "Crisis Team" has been formed to head off problems in advance and coordinate reactions when necessary.
- Connected Payments Data center and support staff personnel meet monthly to discuss potential weaknesses and brainstorm new problem scenarios. The best solutions are agreed in advance and RoadMapped into the software release schedule, together with matching new processes and training for data center and the support staff.
- Once per week, the data center staff conducts "crisis simulation" exercises. This develops diagnostic skills under fire while providing experience that prevents mistakes under pressure.

Issue: Communications

Summary: On July 27 users and support personnel flooded the support desk and e-mail with questions and calls. Depending on timing and personnel, they did not receive adequate, timely, accurate or consistent information, and the ability to provide mass communications and updates was insufficient. A plan addressing all of these problems was developed but not in place yet on August 3, although some information bulletins were issued during and after the outage. Every user or supporting person that called the Connected Payments support desk August 3 received a personal telephone call as soon as the system was returned to service.

Conclusion: Being "in the dark" can be more frustrating than the problem itself. Users most often need to know (1) what to do, (2) the ETA for the return and (3) notification when the full service is returned. Sources and methods must be developed to distribute immediate, clear, consistent and accurate information — this will decrease concerns, provide good direction, reduce wasted effort and increase confidence.

Response Plan:

- The "Crisis Team" has added communications to its responsibilities, and will ensure that accurate and timely information is available whenever users may be affected by an event.
- User contact information is requested on the Connected Payments Site Information sheet, but many e-mail addresses and/or cell-phone numbers were not supplied. StoreNext will go back and collect all missing information so that e-mails and/or text messages can be sent to users and others with a need-to-know. These messages will include critical information and "all-clear" notifications.
- In September, the Connected Payments user home screen will add real-time advisories to provide the most reliable up-to-the-minute information, status and recommendations. The same information will also be available from a backup location on the StoreNext.com Web site.
- When useful, StoreNext will post support advisories and critical information for StoreNext dealers on the StoreNext Dealer Support Web site.