Knightmare

Background

Knight Capital Group is an American global financial services firm engaging in market making, electronic execution, and institutional sales and trading. In 2012 Knight was the largest trader in US equities with market share of around 17% on each the NYSE and NASDAQ. Knight's Electronic Trading Group (ETG) managed an average daily trading volume of more than 3.3 billion trades daily, trading over 21 billion dollars…daily. That's no joke!
On July 31, 2012 Knight had approximately $365 million in cash and equivalents.
The NYSE was planning to launch a new Retail Liquidity Program (a program meant to provide improved pricing to retail investors through retail brokers, like Knight) on August 1, 2012. In preparation for this event Knight updated their automated, high-speed, algorithmic router that send orders into the market for execution known as SMARS. One of the core functions of SMARS is to receive orders from other components of Knights trading platform ("parent" orders) and then send one or more "child" orders out for execution. In other words, SMARS would receive large orders from the trading platform and break them up into multiple smaller orders in order to find a buyer/seller match for the volume of shares. The larger the parent order, the more child orders would be generated.
The update to SMARS was intended to replace old, unused code referred to as "Power Peg" – functionality that Knight hadn't used in 8-years (why code that had been dead for 8-years was still present in the code base is a mystery, but that's not the point). The code that that was updated repurposed an old flag that was used to activate the Power Peg functionality. The code was thoroughly tested and proven to work correctly and reliably. What could possibly go wrong?

What Could Possibly Go Wrong? Indeed!

Between July 27, 2012 and July 31, 2012 Knight manually deployed the new software to a limited number of servers per day – eight (8) servers in all. This is what the SEC filing says

about the manual deployment process (BTW – if there is an SEC filing about your deployment something may have gone terribly wrong).

"During the deployment of the new code, however, one of Knight's technicians did not copy the new code to one of the eight SMARS computer servers. Knight did not have a second technician review this deployment and no one at Knight realized that the Power Peg code had not been removed from the eighth server, nor the new RLP code added. Knight had no written procedures that required such a review.

SEC Filing | Release No. 70694 | October 16, 2013

At 9:30 AM Eastern Time on August 1, 2012 the markets opened and Knight began processing orders from broker-dealers on behalf of their customers for the new Retail Liquidity Program. The seven (7) servers that had the correct SMARS deployment began processing these orders correctly. Orders sent to the eighth server triggered the supposable repurposed flag and brought back from the dead the old Power Peg code.

Attack of the Killer Code Zombies

Its important to understand what the "dead" Power Peg code was meant to do. This functionality was meant to count the shares bought/sold against a parent order as child orders were executed. Power Peg would instruct the the system to stop routing child orders once the parent order was fulfilled. Basically, Power Peg would keep track of the child orders and stop them once the parent order was completed. In 2005 Knight moved this cumulative tracking functionality to an earlier stage in the code execution (thus removing the count tracking from the Power Peg functionality).

When the Power Peg flag on the eighth server was activated the Power Peg functionality began routing child orders for execution, but wasn't tracking the amount of shares against the parent order – somewhat like an endless loop.

45 Minutes of Hell

Imagine what would happen if you had a system capable of sending automated, high-speed orders into the market without any tracking to see if enough orders had been executed. Yes, it was that bad.

When the market opened at 9:30 AM people quickly knew something was wrong. By 9:31 AM it was evident to many people on Wall Street that something serious was happening. The market was being flooded with orders out of the ordinary for regular trading volumes on certain stocks. By 9:32 AM many people on Wall Street were wondering why it hadn't stopped. This was an eternity in high-speed trading terms. Why hadn't someone hit the kill-switch on whatever system was doing this? As it turns out there was no kill switch. During the first 45-minutes of trading Knight's executions constituted more than 50% of the trading volume, driving certain stocks up over 10% of their value. As a result other stocks decreased in value in response to the erroneous trades.

To make things worse, Knight's system began sending automated email messages earlier in the day – as early as 8:01 AM (when SMARS had processed orders eligible for pre-market trading). The email messages references SMARS and identified an error as "Power Peg disabled." Between 8:01 AM and 9:30 AM there were 97 of these emails sent to Knight personnel. Of course these emails were not designed as system alerts and therefore no one looked at them right away. Oops.

During the 45-minutes of Hell that Knight experienced they attempted several counter measures to try and stop the erroneous trades. There was no kill-switch (and no documented procedures for how to react) so they were left trying to diagnose the issue in a live trading environment where 8 million shares were being traded every minute . Since they were unable to determine what was causing the erroneous orders they reacted by uninstalling the new code from the servers it was deployed to correctly. In other words, they removed the working code and left the broken code. This only amplified the issues causing additional parent orders to activate the Power Peg code on all servers, not just the one that wasn't deployed to correctly. Eventually they were able to stop the system – after 45 minutes of trading.

In the first 45-minutes the market was open the Power Peg code received and processed 212 parent orders. As a result SMARS sent millions of child orders into the market resulting in 4 million transactions against 154 stocks for more than 397 million shares. For you stock market junkies this meant the Knight assumed approximately $3.5 billion net long positions in 80 stocks and $3.15 billion net short positions in 74 stocks. In laymen's terms, Knight Capital Group realized a $460 million loss in 45-minutes. Remember, Knight only has $365 million in cash and equivalents. In 45-minutes Knight went from being the largest trader in US equities and a major market maker in the NYSE and NASDAQ to bankrupt. They had

48-hours to raise the capital necessary to cover their losses (which they managed to do with a $400 million investment from around a half-dozen investors). Knight Capital Group was eventually acquired by Getco LLC (December 2012) and the merged company is now called KCG Holdings.