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Hurricane Sandy

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Superstorm Sandy

Hurricane Sandy was the largest Atlantic storm in recorded history, spanning an area broader than Texas. Its hurricane-force winds extended 1,100 miles from its center and affected 24 states in the United States.

After skirting along offshore the Atlantic coast, Sandy took a sudden turn to the Northwest (as predicted) and came onshore near Atlantic City, New Jersey, on Monday, October 29. It devastated the New Jersey shore and parts of Brooklyn and lower Manhattan in New York City. In all, 253 people lost their lives to the storm. Sandy caused an estimated $66 billion of damage in the U.S., second only to Hurricane Katrina that devastated New Orleans in 2005.

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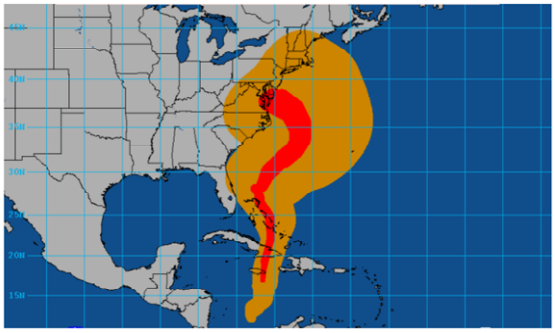
Hurricane Sandy

Sandy's storm surge moved homes off of their foundations on the New Jersey shore and filled New York City tunnels, subways, power substations, and basements with salt water. 8.5 million people in dozens of states lost power. Without power, there was no heat, elevators in high-rise buildings stopped working, and people could not charge their cell phones – often, their only means of communication.



NOAA

Sandy's Track

Pumping out tunnels, subways, and basements in New York City took days. Even more extensive was the effort to restore power. Many customers were without power for two weeks or more. Even those with generators did not always fare well as there was no fuel. Gas stations were without power and could not pump gasoline. When they did and ran out, they could not get resupplied.

A study financed by the U.S. Department of Homeland Security used Department of Energy data to determine how many days it took to restore power to 95% of the customers. New York state power companies took thirteen days. New Jersey restored power to 95% of its customers in eleven days. Interestingly, this was better performance than that experienced in several earlier hurricanes. It took 23 days to restore power in Louisiana following Katrina, sixteen days to restore

power in Texas following Hurricane Rita in 2005, and fourteen days for Florida and Texas to restore power following Hurricane Wilma (2005).

Sandy's Effect on Data Centers

There were about 150 data centers in Sandy's path as it moved through New Jersey and New York. These data centers faced devastating consequences from power outages and flooding.

As it turned out, power outages caused only minor inconveniences. Flooding caused catastrophic damage.

Preparation

Several data centers took proactive action to protect services to their customers. For instance:

- Cloud provider Nurvanix allowed customers to move data out of its NJ data center at no charge in advance of the storm.
- Equinix, Telx, and others secured hotel rooms for their critical employees and brought in cots and nonperishable foods to maintain an onsite support staff during the storm and its aftermath.
- Datagram provides multihoming for its customers via its Manhattan and Bethel, Connecticut, data centers. Multihomed customers who were primaried at the Manhattan data center were able to switch over to Datagram's Connecticut data center when the Manhattan data center went offline.
- Integrity Virtual IT maintains online replicates of its customers' data at its Reston, Virginia and Chicago data centers. It offered to move customer primary hosting to its Chicago data center at no charge.
- Telx transitioned its Clifton, NJ, data center to backup power preemptively and stayed on generator power until utility power had stabilized.

Power Outages

Most data centers that experienced a loss of utility power continued operating with their own onsite diesel generators with only minor problems. The most affected data centers were in lower Manhattan where Con Edison had to cut off power after flooding damaged a critical substation serving that area.

Equinix has data centers in New York, Washington, D.C., Philadelphia, and New Jersey. It ensured that it had 48 hours of fuel at each of its data centers with fuel vendors standing by. Except for one generator failure in New York that was repaired, its data centers continued operations through the power outages.

Telx operates three data centers in metropolitan New York and one in New Jersey. It had topped off its fuel supplies before the storm hit. All of its data centers were forced onto generator power and continued proper operations. Telx experienced cooling problems in one of its New York City data centers when building management reduced the building cooling to save power. However, in anticipation of this, Telx had brought in fans for spot cooling; and it opened the windows when the rain stopped. As a result, it managed to keep its servers running.

Perhaps one of the most notable outages due to power was at Google's New York headquarters building at 111 8th Avenue. This building is one of the world's most wired buildings. It houses a major communication hub owned by Google that serves as a key hub for Internet traffic. The failure of an electrical panel while switching to backup generator power took down a major portion of Internet service for several hours.

All New Jersey data centers stayed operational during their multiday power outages.

Perhaps the biggest problem was faced by New York City data centers in their quest for additional fuel supplies. It was very difficult for fuel trucks to find a way to deliver fuel because of the closure of tunnels, bridges, and streets in the city.

Flooding

Flooding was another story. It was catastrophic for buildings and the data centers they housed in lower Manhattan near the tip of Battery Park – the southernmost part of the city. This area is one of the world's densest communication and computing hubs. Known as Zone A, it is one of the New York City areas most likely to flood. And flood it did! Some streets at times were filled with several feet of water, and this water flowed into basements destroying whatever critical infrastructure was located there.

Unfortunately, much of this infrastructure was backup power facilities – generators, fuel tanks, fuel pumps, and so forth. Without the capability of generating backup power, these data centers went dark when Con Edison dropped power to lower Manhattan.

Many of the data centers are web hosting providers. It is estimated that tens of thousands of web sites around the world were taken down as a result of the failure of these providers.

Data Center Knowledge

Manhattan's Zone A Flood District

Two flooded buildings that are particularly critical to IT infrastructure are at 75 Broad Street and 33 Whitehall Street. 75 Broad Street houses hosting providers Internap and Peer 1. They both had to shut down operations when flooding disabled their generators. They valiantly tried to recover but were hampered by an inability to get fuel delivered to them through the flooded streets.

33 Whitehall Street houses Datagram, a hosting provider that supports such popular sites and blogs as the Huffington Post, Gawker, Gizmodo, and BuzzFeed. Datagram also shut down when its basement flooded.

We relate the struggles of Internap and Datagram in more detail in the next section. A series of status reports by Pier 1 shows the frustrations that these companies faced as the situation worsened. Over a period of a few hours, Pier 1 posted the following updates:

> "Hurricane Sandy has not impeded operations"
> "Facility has made the transition over to emergency power"
> "Basement is flooded"
> "We are going to implement a controlled shutdown"

New Jersey data centers experienced no significant problems from flooding. The biggest problem was the failure of a levee that flooded part of Carlstadt. SunGard has three data centers there, but they were unaffected.

A Tale of Two Data Centers

As we mentioned above, Datagram is a hosting provider that is housed at 33 Whitehall Street in Manhattan's Zone A. Internap is a hosting provider that is housed at 75 Broad Street. They each valiantly fought to keep services up and then to restore service when they had lost the battle.

Datagram

Datagram, a Web hosting provider, was formed in 1994 and moved to 33 Whitehall Street, the former NASDAQ headquarters, in 2004. Though it had a rooftop generator, its fuel tanks and fuel pumps were located in the basement.

When water flooded the two basement levels where this equipment resided, Datagram could no longer supply power to its data center and had to close it down. It ordered six emergency generators, but only one arrived. A second one was lost in transit, victim to a better bid while enroute.

Datagram finally obtained a two-megawatt generator that was delivered on Friday, November 2; and it restarted operations the following day. The generator supplied sufficient power to also run the elevators so that the staff no longer had to walk up the twenty-five flights of stairs to the data center.

Many of Datagram's customers are multihomed, being able to operate either out of Datagram's Manhattan data center or its Bethel, Connecticut, data center. These customers were substantially unaffected by the outage. However, Datagram's single-homed customers faced several days of downtime.

Internap

Internap provides managed servers and customer-managed servers in its data center at 75 Broad Street. Its 10,000 gallon fuel tank and the fuel pumps are located in the basement, and the generators are on the mezzanine floor. Its thousands of servers are on the fourteenth floor of the building.

The flooding filled the lobby with three feet of water and inundated the basement, taking out the fuel pumps. The fuel tank in the basement was damaged when water poured into it through an outside breather pipe.

Internap had a 1,200 gallon header tank on the mezzanine floor which provided enough fuel to run the generator and the data center for twelve hours, but the data center had to close down when this tank went dry. Internap had been able to move some workload to its data centers in Dallas and Santa Clara.

In trying to get additional fuel, Internap faced priority issues because hospitals and critical-care facilities were getting top priority for what fuel could be brought into the city. Internap finally arranged for two fuel trucks and fuel pumps to come up from Baltimore. It had to fabricate new fuel hoses to connect the replacement fuel pumps with the tanker trucks on the street and with the generators on the mezzanine floor.

Internap

A Fuel Truck Parked Outside of Internap

Internap ran for ten days like this until November 10 when power was restored. It burned 20,000 gallons of fuel during this time, and kept one full fuel truck parked outside until the basement tank and fuel pumps were repaired.

Pier 1 is also located in this building. Its employees fueled their generators by carrying five-gallon cans of fuel up eighteen flights of stairs to an auxiliary generator. Now, that is dedication!

Sandy's Effect on Communications

In addition to data center operations, Sandy had a significant effect on communication services. A study funded by the U.S. Department of Homeland Security found that twice as much of the Internet in the U.S. was down during Sandy as compared to normal times. Though the total outage was small (growing from 0.2% to 0.43%), it was all centered in New York and New Jersey. It took four days for Internet service to return to normal.

Wired and wireless communication outages were widespread for all major carriers. – Verizon, AT&T, Sprint, and T-Mobile. The FCC reported that one quarter of all cell sites in a ten-state area were out of service. People were lining up at payphones to make calls.

A small number of 911 emergency call centers were disabled. Their incoming calls were routed to other 911 centers.

The storm surge flooded several of Verizon's facilities in lower Manhattan, interrupting both utility power and backup power. These sites were rendered inoperable. Verizon teams were unable to access some sites.

Lobby of one of Verizon's primary Manhattan facilities

Lessons Learned

Hurricane Sandy put several disaster recovery plans to an ultimate test. Some companies came through unscathed. Others learned a great deal. Some of the lessons include:

- Is a one-hundred mile separation of production and backup facilities sufficient when Sandy's hurricane winds stretched 1,100 miles from its center? Cities as far away from New York as Chicago were affected.

- Provide onsite living facilities for critical staff who may not be able to travel. This includes local hotel rooms if available, cots, nonperishable food, water, and other emergency supplies. Several days (or even weeks) should be accommodated.

- Customers should be offered redundant hosting on a backup site a safe distance away (facilities such as Amazon's Availability Zones, which are in fact collocated, may not be sufficient in a disaster of great magnitude).

- Don't put critical facilities in a basement that can flood. They should be above the first floor, which can also flood. (Note: New York City does not allow fuel tanks on rooftops following 9/11 when leaking fuel from a rooftop fuel tank is suspected of contributing to the collapse of 7 World Trade Center).

- Buy backup mobile generators and store them in a safe distant location.

- Make sure that fuel tanks are topped off, generators can start, and power can be safely switched from utility power to backup power.

Who would have ever thought that New York City would be inundated with sea water and lose power for weeks? Make sure your company has a thorough and well-tested disaster-recovery plan that covers major outages regardless of the cause.

Acknowledgements

Material for this article was taken from the following sources:

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