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Japan's Data Centers Survive Their Big One

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In a previous issue of the Availability Digest, we published the article entitled "The Big One – Are You Ready?"[1] The article describes a catastrophic earthquake that may possibly wipe out a major portion of the Pacific Northwest coast of North America in the U.S. and Canada, destroying many data centers in its path. What is concerning is that this earthquake is overdue – it may happen at any time.

Japan recently experienced its "big one," and its data centers survived with very little damage. How did they manage to do this? We explore Japan's data-center earthquake survival techniques in this article. Are there lessons in Japan's experience that might help companies survive the American "big one" when (not if) it happens?

The American "Big One"

The earthquake that is threatening the American Pacific Northwest is caused by the Cascadia Zone running along the upper Pacific Northwest coast of North America from Oregon to Canada. The Cascadia Zone is an area where two large tectonic plates seem to be stuck and are pressing on each other. Pressure is building up on the interface, but the plates seldom move. When they do, they unleash the "big one" – a really massive earthquake.

Based on soil samples, over the last 10,000 years the Cascadia Zone has spawned 41 massive earthquakes, an average of one every 244 years. The last such earthquake occurred in 1700, over 300 years ago. We are due.

FEMA, the U.S. Federal Emergency Management Agency, predicts that everything west of Interstate 5 will be destroyed. Data centers in the area surely will be decimated.

Japan's Big One

Japan recently experienced its "big one." It occurred on Friday, March 11, 2011, and has become known as the Great East Japan Earthquake. It was a magnitude 9.0 earthquake centered 43 miles east of northeast Japan at a depth of 19 miles. It was the most powerful earthquake to ever hit Japan and was the fourth most powerful earthquake in the world since record keeping began in 1900. It moved the main island of Japan eight feet to the east.

Even worse than the earthquake was the ensuing tsunami, with waves up to

[1] The Big One – Are You Ready?, *Availability Digest*; September 2015. http://www.availabilitydigest.com/public_articles/1009/big_one.pdf

133 feet high. The tsunami caused almost 16,000 deaths and collapsed or partially destroyed over 1,000,000 buildings.

Equally destructive were the meltdowns that the tsunami caused at three nuclear reactors in the Fukushima nuclear power plant when flooding disabled their cooling facilities. Hundreds of thousands of residents had to be evacuated, and the loss of the power plants reduced the availability of electric power across Japan.

The World Bank has estimated that the economic cost of the Great East Japan Earthquake was USD $235 billion, making it the costliest natural disaster in world history.

Japan's Earthquake-Proof Data Centers

Japan is particularly vulnerable to earthquakes. It sits on top of four tectonic plates that cause frequent earthquakes, many large. Therefore, Japan has strict building codes to protect large buildings in the event of an earthquake.

Japan's building codes require a number of earthquake resiliency measures for building design. Many data centers exceeded these codes, a fact accounting for the high survivability of data centers in the face of the Great East Japan Earthquake. Smart construction and good planning allowed Japan's data centers to escape virtually unharmed. None were severely damaged or knocked offline.

The first requirement of the Japanese building codes is that data centers (in fact, all large buildings) be built on giant shock absorbers. These are isolators (called base isolators) made from metal and rubber on which buildings float while the ground underneath them shakes from side to side.

Snapshot of shake-table testing of a base-isolated (right) and a regular (left) building model

Furthermore, isolated raised-floor systems are used to further stabilize the computer-equipment rooms. The floor-level isolators further reduce shaking in the computer room.

Finally, rack-level isolators substantially remove whatever shaking is left, protecting the equipment in the rack.

All server racks, cooling equipment, and other equipment are secured firmly to the floor. Many U.S. data centers simply place their racks on the floor where they can skid around during an earthquake.

During the Great East Japan Earthquake, shock absorbers proved to be most effective at the building level. Some isolators at the rack level did not work quite as well. However, reports indicated that only five server racks in all of Japan's data centers were damaged.

Fighting for Power

Surviving the shaking of the earthquake was just the first problem faced by data centers. The failure of the three Fukushima nuclear reactors seriously reduced the amount of power available to all Japanese businesses and homes.

Where power was lost at data centers, diesel generators kicked in; and companies arranged for additional fuel supplies. Fuel was in short supply, but data centers arranged priority with the government.

However, as power was restored, data centers faced another challenge. Because of the shortage of power, the Japanese government ordered that all facilities consuming more than 500kWh of power reduce their consumption by 15%. The data centers objected to this, pointing out that they had already

reduced their power consumption as part of their energy-efficient projects and couldn't reduce their consumption further. The government agreed and changed the policy for data centers to be a reduction of 0% to 15% based on how much they had reduced energy usage the year before. However, the fines for violations were high – USD $12,500 per hour for each hour over the limit.

The Need for Water

Many of the Japanese data centers used water coolers to cool their computer equipment. After the earthquake, water was in short supply in some areas. As a result, data centers are now moving to free-air cooling that requires no water. Free-air cooling is being used to supplement or replace the data-center water coolers.[2]

The Move to Colocation and Clouds

Another mitigating factor that led to the minimal damage was that 70% of Japan's data centers are in the Tokyo region. There are no data centers in the northeastern region of the country since that is where earthquakes and tsunamis are expected. Nevertheless, many companies are moving their data centers further west, which is considered the safest.

Osaka in southern Japan is rapidly expanding as a data-center location. Data centers are being built there to back up facilities in Tokyo and elsewhere. They are served by a different power company than facilities in Tokyo.

A number of local government agencies and businesses lost all of their computer equipment and most of their records in the tsunami. Consequently, there is now a big movement to collocate their facilities in a data center. It is clear that data centers are best prepared for disasters. Nearly all companies in Japan that used data centers found that they still retained full Internet access during and after the crisis.

The move to collocation is now extending into the cloud. Japanese companies are using cloud services to manage their data processing so that they do not have to purchase and manage their own systems. A number of data centers in Japan and South Korea are offering cloud services to Japanese companies.

Other Problems

Other problems also faced the data centers. Communications were affected more than expected. Social networking tools became a temporary substitute for telephone lines.

Half of the cable capacity running across the Pacific Ocean was damaged. It took several weeks to make repairs.

Summary

Many lessons can be learned from the Japanese experience with the Great East Japan Earthquake. The first lesson is not to build data centers in earthquake-prone areas. However, there are already many data centers in these areas. They all should have a remotely located backup data center in a safe area, far from where the same earthquake could affect both data centers.

If a data center is to be built in an earthquake zone, it should be built according to earthquake building codes. This includes building, floor, and equipment isolators to reduce the effect of shaking on the IT equipment. Furthermore, all equipment should be attached firmly to the floor.

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[2] Data Center Cooling Nature's Way, *Availability* Digest; May 2010.
http://www.availabilitydigest.com/public_articles/0505/cooling.pdf
Chillerless Data Centers, *Availability Digest*; November 2009.
http://www.availabilitydigest.com/public_articles/0411/chillerless.pdf

A data center in such an area must be prepared for limited power availability for a long period of time. It would be wise to negotiate in advance with local regulators for relief from power restrictions that might be imposed following a severe earthquake.

The move to free-air chillers should be considered to survive the potential of a water shortage.

Be prepared for communication outages. Know what you are going to do if your land lines, cellular networks, or Internet service should go down. This must be part of your disaster recovery plan.

Acknowledgements

Material for this article was taken from the following sources:

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The after effect of the Japanese Earthquake, *Data Center Dynamics*; December 7, 2015.
NTT's Osaka Data Center Build Illustrates Impact of 2011 Earthquake on Industry, *Data Center Knowledge*; March 2014.