TELECOMMUNICATION SYSTEM – HAZARD MITIGATION STRATEGIC PLANNING

A.K. Tang[1]

[1] *President, L&T Engineering and Project Management Consultant, Mississauga. Canada*

Email: alexktang@mac.com

ABSTRACT:

Telecommunication is the most vital service for the manufacturing industry, the financial industry, education institutes, Government functions, national security, emergency response and recovery. The convergence of telecommunication networks, such as voice, cellular, data, video, Internet, satellite, etc. has created a huge interdependent nodes and links to deliver the services of each of these networks. The failure of any nodes or links of a particular network in a disaster, whether it is a natural or an intentional event, will impair or disrupt services of all associated networks. As a telecommunication service provider, in addition to hardening the buildings and equipment within the buildings, a strategic plan is required to handle the low probability and high impact events. The paper will discuss various approaches to prioritize the tasks to mitigate service disruption and to enhance the network survivability. The financial loss of equipment and building damage is far less than the financial loss of a financial institute without telecommunication service during business hours. The large global companies that have their own networks must evaluate their network integrity from a service provider's point of view. In this paper the services and equipment that are required to maintain a functioning network will also be discussed. Specific example of telecommunication network disruption on industry will be provided.

KEYWORDS:

security, emergency, recovery, economics, interdependency, redundancy

1. INTRODUCTION

Telecommunication networks are designed to forecast demand of the regions they serve. That means for commercial cities the number of circuits will be more than those rural residential areas. It is not economical to provide a one to one connection between all customers. Therefore the switching equipment is sized to the expected volume and duration of calls of the customer base that it serves. However, the design is based on normal operating situations.

Invariably the demand on the telecommunication network spikes right after major disasters, resulting in many incomplete calls. The callers will interpret this phenomenon as the telecommunication network malfunction, even when nothing happens to any parts of the network.

In a major earthquake, some level of damage will occur in the network that is composed of many components and that the interconnections are spatial. Any damage to the components and connections will cause the network response to be worse. In addition, the network convergence (landlines, cellular, internet networks) puts more fuel in the fire. Today the Internet usage is ranked the highest in the telecommunication network. This data service network is evolving at an alarming pace as demand for bandwidth and speed increase. This leads to concentration that any damage caused by earthquakes to the components will result in a large service disruption. The capacity of an optical fiber cable is a few thousand times higher than a copper cable.

Lifeline interdependence is critical to the performance of telecommunication networks.

One of the most important service provided by telecommunication service providers is emergency call system, in North America is the 911 system. After an earthquake this system will be the key element in the overall emergency services. The next high priority service will be for the large corporations such as banks, manufacturing facilities, and government services.

2. PREPAREDNESS STRATEGY

In general the telecommunication networks have performed well in major earthquakes when compared to the other utilities such electric power, water supply, and transportations since the 1971 San Fernando, California earthquake. The damage to equipment of a central office shut down the emergency service in the area for days. The awareness of hardening both equipment design and installation spread throughout the industry. Standard was established by Bell CORE and implemented by the telecommunication service providers. The result shows in the subsequent earthquakes in North America. Equipment catastrophic damage is not observed. It is not perfect and there are still a lot of improvement opportunities.

The key lifelines that are needed to sustain telecommunication service provider activities are electric power and water supply. The probability of disruption of these lifelines in earthquake is key to one of the components of addressing the potential performance of telecommunication service. The second component to address is the customer's business continuity.

2.1 Electric Power

Electric power among all the lifelines usually experience most damage, particularly in substations. The usual outage is from hours to days. In many occasions, electric power outage impacts other lifeline performance in a post earthquake situation. It is a common practice for telecommunication facilities to have reserve power (battery banks) for short duration outage. These battery banks have power form three hours to eight hours in North America. It is essential for key telecommunication facilities to have backup power generator for prolonged power outage. There were numerous incidents that the back power generators were not functioning properly or not starting at all after an earthquake. The problem ranges from rotted diesel fuel to transfer switch contact corroded. There were also cases that the power generators were shaken off their base, ran out fuel, etc. Although these problems seem to be small, the impact in an emergency situation is high.

2.2 Environmental Control System

Electronic equipment requires cooling from an environmental control system to maintain a constant operating temperature to reduce the chance of failure. Some of these cooling systems need water to chill radiators. Without water supply, these units will not operate, that means the equipment does not get the cooling it requires. Prolonged heat build up will cause the components to burn out; the equipment will not function when that happens. Underground water tank providing water to the radiator and also acts a heat sink can be considered as one of the solutions. It must be cautioned that the pump for pumping the water to the radiator must be connected to the back up power generator.

2.3 Redundancy

From a network perspective, there are multiple means to maintain a reasonable level of service in an adverse situation. Establishing a dispersed redundant route will avoid a total disconnect from another facility. The reason for the word 'dispersed' is that two cables in the same conduit connecting to another facility are not truly redundant. This is not to suggest that all routing has a dispersed redundant route. The network owner can easily determine the important routes that shall have dispersed redundancy. For example, a route that connects from the telecommunication facility to an emergency service call center is an important connection. The redundancy routing can be physical connections using cables, copper or optical fiber cables, or wireless connections using microwave, radio or satellite. This is the redundancy using technology. A loop configuration network with bi-directional signaling capability is also a good method to reduce isolating facility due to severed connection. This is commonly configured when optical fiber cable and equipment are used.

Facility redundancy is also important in providing an uninterrupted service after a major earthquake. This is particularly important to have redundant network control center. When a network control center is affected by an earthquake, the employees who work at the center may have to attend to their own problems at home, or getting to work may be problem, etc. Even without any damage, the network control center may be functioning as normal and it is particularly critical in a post earthquake situation. Transferring the control functions to another network control center designed to handle the additional capacity is going to resolve call volume problems.

2.4 Compliance

For critical service facility, buildings that are used to house equipment shall meet code with the proper importance factor applied. The cost of exceeding code is a less costly insurance against earthquake damage to the equipment inside the building.

In addition to building, the towers for mounting microwave dishes, cellular antenna, and radio antenna must be included in this category.

2.5 Network Elements

Nodes and links are the high-level network elements. In each node there are different equipment installed to perform a specific function of the node. The major components of a node are switching equipment, transport equipment, data processing and storage equipment, signal control equipment, and power equipment. The links between nodes are copper cables, optical fiber cable and microwave.

2.5.1 Node equipment

Equipment should be anchored to the expected seismic load of the region where the node is located. This is the minimum requirement. The cable conveyance system within the node should be designed and installed to avoid both cable and cable conveyance components damage. Power cable routing should be separated from the signal cables. This is to prevent fire spreading from power cable to signal cable.

There are many small pieces of equipment that are loosely placed on trays in equipment cabinets. These should be secured using tie-wraps or screwed down with brackets.

Spares cabinet doors should be locked to prevent the spare parts from falling off when the doors were shaken loose. Tools for repairs, whether they are electronic tools or mechanical tools, should be secured to prevent from being damaged.

2.5.2 Links

Links are spatial, that means they cover all geographical terrains connecting one node with another. Within a city, the connection can either be aerial using poles, or underground using conduits. Cable splices for underground cables are in manholes while for aerial cables the splices are inside a cylindrical housing close to a pole. Co-locating and collateral damage often happens to these cables (Reference #2). It was observed that cables damage occurred in earthquakes in regions with poor soil conditions.

Although the incident reported in reference #1 is not a result of earthquake, the impact of this incident underlines the importance links. In this incident, the optical fiber was erroneously cut that took Northwest Airlines operations to a halt. This link carried all the operations data such as flight schedules, baggage routing, aircraft fuel requirement, passenger bookings, flight attends and pilots schedules between the data center and all operation locations the Northwest Airlines serves. A dispersed redundant routing is a better means for link survivability to keep the customers in business in the event of link damage.

3. DISASTER RESPONSE PLANNING

Most of the service providers in North America have emergency response plans. It is not clear whether they have emergency response plans that can deal with disasters such as a large earthquake impacting a large area. It is reasonable in the competitive world to assume that such plans that deal with low probability incidents but extremely high impact do not exist in all service providers. But in fact it does not take a lot more effort to develop an understanding the impact of a devastating disaster when an emergency response plan exists. This understanding will play a key part in the strategic planning of overall network earthquake mitigation plan. It may turn out to be a good strategy to deal with other hazards that the network may experience.

3.1 Resource Capacity

The telecommunication network is populated with many specialized equipment that requires special tools and highly skilled people to perform repairs and to determine the correct procedures of bringing the equipment back to normal. After a large earthquake, if the number of damaged locations is high and are located in a wide spread area, the availability of tools and people to handle the recovery will not be able to meet all the demanded repairs at one time. Therefore knowing what can be handled right after a devastating earthquake will help to execute recovery efficiently and effectively.

This information is key to making decisions on prioritizing damaged sites for repair, and time to full recovery. When a fixed duration of outage is promised, then this information can be used to calculate the skill resources needed to meet the target interval.

The other factors that must be considered in evaluating the available resources are:

1. Locations of this resource; the available resource may be affected by the earthquake. In many cases, the skill persons and the equipment are located in the disaster area; therefore the total number of available resource will be less than that before the earthquake. This must be taken into consideration when planning the recovery effort. A reduced resource for recovery will result in a longer recovery interval. That is the service performance will be affected.
2. The available resource within the organization will be the deciding factor of recovery interval. Large earthquakes generally damage more facilities with various degrees of severity. That means the resources will face a large volume of work.
3. Mobilizing resources from other locations should be evaluated and a plan should be established when this action is required. It is easy to mobilize people, but moving equipment can be a task by itself.

3.2 Duration of Recovery

In general all service providers will try their best to shorten the interval of interruption. The customers will prefer no interruption in any situation, but when an interruption does occur then the demand will be speedy recovery to normal. So far in North America, the longest telecommunications outage after an earthquake is not more than one to three days. However, in the recent North West Pacific coast windstorm in 2007, some communities experienced longer than three days of telecommunication outage. Even 911 emergency call service was out as long as three days in some community.

Establishing a recovery interval is difficult and inaccurate without the system vulnerability information. The other factor is available resources as mentioned above. Duration of recovery is a key performance factor of the telecommunication system.

3.3 Mutual Aid

Establishing strategic agreement with competitors to help one another after a devastating earthquake will improve the interval of recovery. For example, equipment that requires a long delivery time from a supplier is damaged and there is no stock available. A mutual agreement will reduce the interval when a competitor has ordered the equipment is expecting a delivery.

Being able to have additional resources, both skilled persons and tools will reduce outage interval.

3.4 Government Support

In many cases right after a devastating earthquake, access to remote facilities will be hazardous and will require special equipment to reach the facilities. An agreement with the emergency response agencies within the government will render speedy access to special resources to bring the damaged facilities back to service.

The recent Wenchuan earthquake in China is a very good example of how the government support with military personnel can bring telecommunication service in the hardest hit areas.

4. CONCLUSION

In addition to preparedness against earthquake damage, a continuous process of vulnerability assessment of the network will improve the survivability of the network. Identifying the critical circuits for emergency services, and high economic impact customers will keep loss to a minimum.

When vulnerable components are realized, upgrading with the most current seismic requirements and knowledge will enhance the overall performance of the network.

Periodically reviewing and performing simulation exercise with the written emergency plan will help to improve and identify inadequate process within the plan.

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