

7. Information and Communications

Introduction

Oregon's information and communication systems are especially vulnerable to damage resulting from a Cascadia subduction zone earthquake. Some of the inherent seismic vulnerabilities of the systems include the following:

- The systems are highly dependent on other resources—such as power and transportation as well as skilled staff—to remain operational and to complete needed repairs.
- The systems are financially dependent on consistent revenue streams to fund ongoing operations, maintenance, and debt service obligations.
- Essential facilities, including central offices and towers, are often located in areas that make them vulnerable to damage from liquefaction of alluvial soils and landslides.
- Many facilities were designed and constructed before the seismic design standards that reflect the current state of knowledge of regional seismicity were established.

THE EXISTING STATE

If it were to occur today, a Cascadia subduction zone earthquake would result in catastrophic impacts to the information and communications systems throughout western Oregon:

The Oregon coast would most likely experience strong ground shaking for over three minutes. Facilities within the tsunami inundation zones would be extensively damaged; in many cases, they would not be repairable. Facilities outside of the tsunami zone would be heavily damaged, disrupting current levels of service for periods measured in months. Cabling that runs through conduits supported on or in transportation bridges is likely to be damaged or severed completely when the bridges fail.

The Coast Range would experience strong to moderate ground shaking. Well-engineered structures may perform well, but older structures are likely to fail. Major impacts to the systems in the Coast Range include the high potential for landslides and the failure of bridges that support cables across geological features.

The Willamette Valley would experience moderate ground shaking. Well-engineered structures may perform well, but many older structures would likely fail, including central offices and buildings supporting antennas. One of the major impacts in the central valley, especially in the Portland Metro area, would be from liquefaction: extensive alluvial and fill deposits along rivers would lose strength, lose bearing capacity, and move towards riverbanks. Liquefaction could adversely impact buried utilities as well as antenna towers and buildings.



Figure 7.1: San Francisco – Oakland Bay Bridge after the 1989 Loma Prieta earthquake. An example of bridge failures that could impact utility conduits supported by or integrated into the bridge. Source: U.S. Department of Transportation. (Source: USGS website http://earthquake.usgs.gov/earthquakes/states/events/1989_10_18.php)

THE SYSTEM'S COMPONENTS

The Information and Communication Technology Task Group focused on wireless and wired communications and information systems that provide services to businesses, municipalities, and individuals. For the purpose of this resilience plan, system components include:

- **Central Offices.** A switching unit, installed in a telephone system serving the general public, having the necessary equipment and operating arrangements for terminating and interconnecting lines and trunks (McGraw-Hill, 2003). Central offices include the following types:
 - *Tandem office:* A telephone office that makes connections between local offices in an area where there is such a high density of local offices that it would be uneconomical to make direct connections between them (McGraw-Hill, 2003).
 - *Local office:* A telephone central office, which terminates subscriber lines and makes connections with other central offices, usually equipped to serve 10,000 main telephones of its immediate community (McGraw-Hill, 2003).
 - *End office:* A telephone central office that connects directly to the customer (Answers.com).
- **Remote Terminals.** A remote terminal is generally any type of switching or routing equipment that is located outside of the traditional telephone central office. Most are linked by fiber optic cable either directly to the central office or to a SONET (Synchronous Optical Network). Some older remote terminals are linked by T1s back to the central office over copper pairs.



Figure 7.2: The overhead lighting fixtures in a Central Office failed during an earthquake. Note the equipment in the background was supported by “jiffy poles” after the earthquake. Mexico City earthquake, 1985. (Source: Alex Tang)

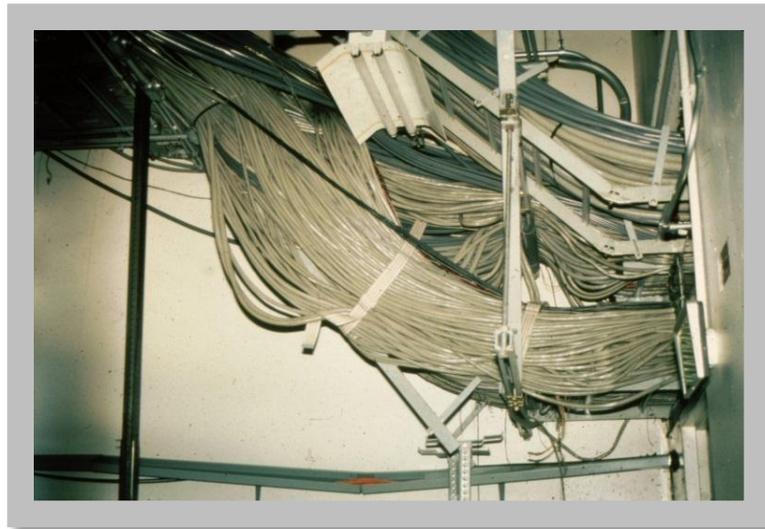


Figure 7.3: Overloaded cable rack failed in relatively minor (M=5.8), Whittier Narrows earthquake, California, 1987. (Source: Alex Tang)



Figure 7.4: Telecom equipment and HVAC ducting failure. It is hard to tell which was the main cause of failure; it has several combinations, inadequate anchoring, un-braced duct supports, etc. Mexico City earthquake, 1985. (Source: Alex Tang)

- **Internet Exchange Points (IX or IXP).** A physical infrastructure through which Internet service providers (ISPs) exchange Internet traffic between their networks (autonomous systems). At these exchange points, major carriers accept traffic from each other and agree to carry one another's packets to their downstream destination points without charge. (Answers.com)
- **Submarine Cable Landings** (Answers.com)
 - *Submarine cable landing station:* This may or may not be required, depending on whether, for example, the submarine cable requires power to power submarine repeaters or amplifiers.
 - *Submarine cable termination station:* This is the point at which the submarine cable connects into the land-based infrastructure or network. A cable termination station may be the same facility as the cable landing station, or it may be many miles away.
- **Antennas.** These may be:
 - Mounted on buildings owned by the communications provider or on leased space on another building.
 - Tower mounted.
 - Satellite antennas (for system up/down links and not the satellite service of an end user).
 - Transmitter antennas for broadcast radio and TV.

- **Cables.** These may be:
 - Underground.
 - Inducted, conduit, buried plant (underground cable vaults).
 - Buried.
 - Aerial cable (overhead/above ground).
- **Outside Plants.** Examples include:
 - Splice cases.
 - Repeaters (that may require power).

Resilience Goal, Objectives, and Scope

Goal

The goal of this plan is to provide recommendations that, if implemented, would ensure that within 50 years the information and communication systems in the state of Oregon are made resilient against a magnitude 9.0 Cascadia subduction earthquake and tsunamis.

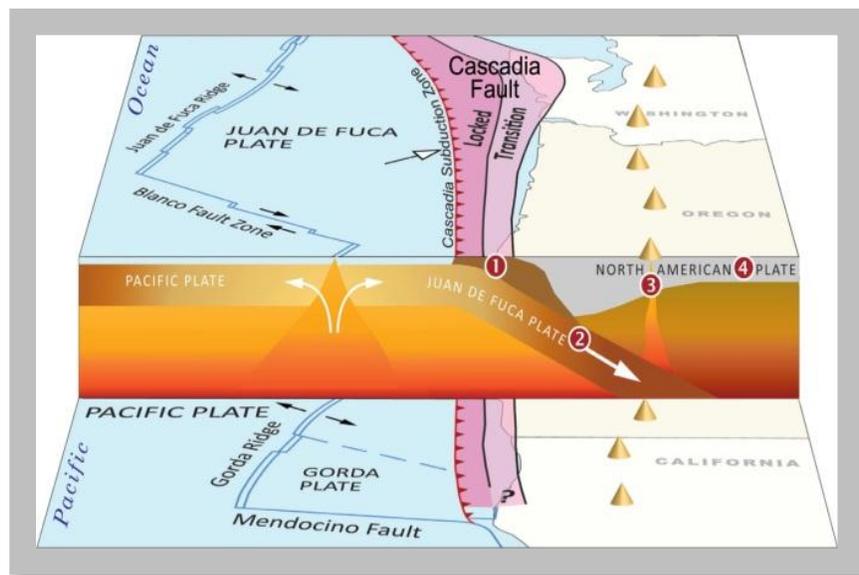


Figure 7.5: Cascadia seismic source is Oregon's most threatening fault and can produce a magnitude 9 earthquake and accompanying coastal tsunami waves.
(Source: DOGAMI)

The resilience goal for the information and communication systems is to provide for immediate emergency communications followed by phased restoration, within specified time periods, for various areas of the state. In order to establish resilience goals, the information and communication systems were assessed in four geographical areas:

- The tsunami inundation zone along the coast. This area was defined using Oregon Department of Geology and Mineral Resources (DOGAMI) maps.
- The part of the coast that is not susceptible to tsunami (from the Oregon coastline to the Coast Range summit).
- The valley (from the summit of the Coast Range to the summit of the Cascades).
- Eastern/Central Oregon.

Objectives and Targets

The task group viewed performance capability (for the purposes of recovery) across all information and telecommunications systems that support voice and data communications. The restoration objectives are based on the assumption that all other lifelines, such as roads and electricity, are functioning at a level that will support restoration of the information and communications infrastructure. In areas where the *customer* is not ready to accept service, then the service provider is not expected to meet these restoration timeframes. In the early phases of recovery, achieving these capabilities may require the use of temporary contingencies (such as mobile cellular towers) while more permanent repairs and installations are being done.

Establishing target timeframes for the tsunami inundation zone, beyond a minimal level of capability to support response, is not practical. A large amount of planning and prioritizing will need to be undertaken to identify which areas will be rebuilt first. These will then be the areas in which the information and communications systems will be re-established first.

Resilience targets for information and communications systems were established for three levels to assist in establishing priorities for resilience and restoration activities and projects:

- **Minimal.** A minimum level of service is restored, primarily for the use of emergency responders and repair crews and in support of critical health and human services (mass care). The estimated capability at this level is 20–30 percent. In the early phases of recovery, achieving these capabilities may require the use of temporary contingencies (such as mobile cellular towers) while more permanent repairs and installations are being done.
- **Functional.** Although service is not yet restored to full pre-event capacity, it is sufficient to get the economy moving again (such as for business uses, including credit card transactions and banking). Limits may be placed on uses that take up a lot of capacity, such as streaming video. The estimated capability at this level is 50–60 percent.
- **Operational.** Restoration is up to at least 90 percent of capacity. A full level of service has been restored and is sufficient to allow people to use the system for non-essential activities, such as entertainment. The estimated capability at this level is 80–90 percent.

The attached table (see Figure 7.16) reflects the target capabilities for each zone across all information and communications systems. This approach permits greater flexibility in how the systems are

recovered, which may change with the continuous changes in technology (that is, the systems may become less dependent on large towers).

WHAT DOES BEING RESILIENT MEAN

To understand what resilience means in the context of information and communication technology, the task group referred first to the definition of resilience that was adopted for the resilience report as a whole: “Oregon citizens will not only be protected from life-threatening physical harm, but...because of risk reduction measures and pre-disaster planning, communities will recover more quickly and with less continuing vulnerability following a Cascadia subduction earthquake and tsunami.” The task group then looked at Oregon’s position on the *resilience triangle* and at the characteristics of resilient systems.

The Resilience Triangle

The basic principle of the resilience triangle is that the smaller the triangle, the higher the resilience. Higher resilience requires minimal reductions in critical lifeline services after a disaster, speedy recovery of those services, and an overall improved service level as a result of rebuilding damaged systems and implementing better systems. The resilience triangle diagram indicates that Chile and Japan have high levels of earthquake resilience—this reflects Chile’s performance after a magnitude 8.8 earthquake in 2010 (ASCE TCLEE, 2010) and Japan’s performance after a magnitude 9.0 earthquake in 2011 (Nojima, 2012) (notwithstanding Japan’s nuclear energy issues). At the current stage, Oregon’s infrastructure has low resilience and is expected to have significant loss of sector services and a slow recovery time.



Figure 7.6: Resilience Triangle (Wang, Bartlett, and Miles, 2012)

Characteristics of Resilient Systems

Based on research conducted after disasters around the world, some basic system characteristics have been identified that enable communications and information technology systems to be resilient.

Resilient systems tend to be:

- Decentralized.
- Meshed or integrated.

- Built to withstand the potential hazard, but without an expectation of 100-percent survivability.
- Capable of recovering (within two to four weeks of the event) whichever components of the system did not survive.
- Able to handle a surge in demand through system performance levels or implementation of controls.
- Upgraded by means of continuous hardening of vulnerable components within the system.

Plan Development

PLANNING CONSIDERATIONS

The task group took into consideration the following items during the development of the plan:

- Resilience planning needs to address the capacity of the system. In major events, landline and wireless telecommunications can be quickly overwhelmed by demand, even if they are 100-percent operational.
- Wireless communications technology is evolving rapidly and the technology that influences planning decisions and recommendations today may not be in existence 25 to 50 years from now.
- Hardline and wireless communication systems typically install their new technology into existing infrastructure (i.e., buildings, power poles, towers, vaults, and conduits). This means that 21st century technology may be housed in, or mounted on, a structure built in the early to mid-1900s.
- The resilience plan should consider business continuity recommendations for the companies that provide communication, information, or telecommunications services and systems, especially to customers who perform critical services and other functions related to life safety.
- Wireless communication systems include antennas installed on leased space on buildings that the communications providers do not own or control. The locations of the buildings, relative to the coverage and demand requirements, are the key factors in the placement decisions, not the resilience of the structures or their location outside of the known hazard areas.
- Restoration of aerial (overhead) telecommunication wires is secondary to the restoration of aerial (overhead) power lines.
- Lifeline interdependence is a key factor that governs the final resilience plan.



Figure 7.7: Cellular Base Station tower failure. This site is installed on the roof of an apartment building, which is not designed for critical infrastructure facility. Pisco, Peru earthquake, 2007. (Source: Alex Tang)

INTERDEPENDENCIES

Information and communications systems have several connections with other resilience planning task groups that directly impact their resilience and ability to recover:

- **Buildings**
 - Structural integrity of buildings housing system components as well as business services and call centers.
 - Structural integrity of buildings with wireless system antennas mounted on them.
- **Transportation**
 - Transportation routes typically include utility easements for overhead and underground information and communication systems.
 - Access to system facilities after an earthquake is essential for restoration as well as for maintaining emergency power systems.
 - Bridges convey utilities, as well as vehicles, over geological barriers.

- **Utilities**
 - Because information and communications systems share common easements with other utilities, coordination is required to achieve restoration.
 - Overhead utilities share common infrastructure (such as poles); coordination will therefore be required to achieve restoration.
 - Information and communications systems are dependent on other utilities to provide and restore their services (such as electricity).
- **Energy**
 - Electrical power is needed to run the equipment.
 - Fuel is needed for emergency generators and to supply the vehicles used for emergency response and repair work.
- **Business Resilience.** Information and communication service providers need to be resilient so that they are able to restore service quickly to their customers.



Figure 7.8: Circuit Boards pulled out and fan to get some air cooling due to failure of the air conditioning unit. Fortunately, the site had power and they could open windows to allow cool air to come in. Izmit (Kocaeli) earthquake, Turkey, 1999. (Source: Alex Tang)

Assessment of Performance

GENERAL ASSESSMENT

A complete, detailed assessment of all the telecommunications and information systems in Oregon is not possible without detailed systems data from all the service providers. From a system-wide

perspective, however, a general assessment can be made based on information that is generally available. This information includes:

- Design standards and age of structures relative to the expected performances of buildings, towers, and other structures in the tsunami inundation zone.
- Design standards and age of structures relative to the expected performances of buildings, towers, and other structures and taking into account the relative levels of shaking expected at varying distances from the subduction zone.
- Expected performances of bridges that are an integral part of the hardwire infrastructure.
- Potential impacts that landslides and liquefaction will have on the towers, poles, buried utilities, buildings, and bridges that convey cable across rivers and ravines.
- The capabilities analyses of other sectors, particularly the electrical utilities, which have similarities with portions of the information and communications systems and are an integral part of maintaining and re-establishing information and communications capabilities.
- Capabilities and capacity—including resources (material and technical resources), mutual aid programs, spares, tools, and equipment—after a major disaster.



Figure 7.9: Inadequate anchorage and poor overhead bracing details resulted in equipment toppling. Mexico City earthquake, 1985. (Source: Alex Tang)

It should also be noted that even if a structure (building or tower) were to survive an event, damage to improperly secured equipment can result in the loss of operational capability.

Depending on the general availability of the equipment (off-the-shelf versus specifically designed and manufactured), it could take longer to replace or repair the equipment than it does to repair or replace the building.

ASSESSMENT BY ZONE

Using the general assessment criteria, the task group did an assessment of performance capabilities for each of the four geographic areas (see also the attached figure in Figure 7.16):

Zone 1: Coast—Tsunami Zone

All communications and information technology infrastructure within the tsunami inundation zone will sustain major damage or be destroyed. The ability to operate any equipment that survives both the earthquake and the tsunami will depend on the availability of electrical power and whether crews are able to access the equipment in order to perform maintenance and repairs.

- **Buildings.** All buildings in the inundation area will be destroyed or heavily damaged.
 - Few buildings are built to current seismic code and even fewer are built to the critical facility level (which is designed to increase the chances that the structure will be usable after the earthquake).
 - Those structures not destroyed by the earthquake will be inundated by the tsunami waves.
- **Equipment.** Equipment in buildings.
 - Existing standards for communications and information technology do not appear to address the protection of equipment from damage during large seismic events.
 - Improperly secured equipment can be damaged or destroyed even if the structure that houses it survives both the seismic shaking and the tsunami waves.
- **Towers.** Antenna towers in the inundation zone have the same probabilities of being damaged and destroyed as the buildings.
 - A number of the towers and antennas are located on existing buildings and will be only as reliable as the buildings they are on.
 - Even if towers are free standing and reinforced to withstand the shaking and the tsunami waves, the equipment on the towers must be positioned above the inundation height of the tsunami wave and properly secured to avoid damage from the shaking.
 - Free standing towers without properly constructed foundations could fail due to liquefaction.
- **Aerial Cables.** Overhead lines that survive the scenario earthquake will be destroyed by the tsunami wave (with the possible exception of those on the outer most edges of the inundation area).
 - Cross arms, connectors, and insulators that are designed to break away in high winds to reduce the potential damage to the utility poles could also give way during the seismic event.
 - Liquefaction can cause utility poles to lean or topple.

- Debris in the tsunami inundation waves will have significant impacts on utility poles and lines.
- **Underground Lines.** Depending on the amount of liquefaction and shearing forces, the earthquake could be just as devastating to the underground utilities as to the overhead lines. While the tsunami wave may have little direct impact on buried lines, the failure of utility vaults, salt water inundation of underground conduits, and loss of terminal posts will be just as disruptive as the physical loss of the lines.
 - Breaks in the underground lines are hard to locate unless there is some obviously related disturbance of the ground or activity in the vicinity of the break.

Zone 2: Coast—Earthquake-Only Zone

Only structures built to withstand the expected level of shaking are likely to be usable after the earthquake. Even these structures, however, will have limited functional capability if they are without utilities and there is no way to access them.



Figure 7.10: Cell site collapsed with the commercial building collapse. Chi Chi earthquake, Taiwan, 1999. (Source: Alex Tang)

- **Buildings.**
 - Few buildings are built to current seismic code and even fewer are built to the critical facility level (which is designed to increase the chances that the structure will be usable after the earthquake).
 - The tsunami, failure of bridges, and landslides can isolate facilities that survive the shaking, further limiting their use.

- **Equipment.** Equipment that is not properly secured for the expected level of shaking or protected from cascading events (such as the sprinkler system going off) could be damaged and require an extended period of time for repair or replacement.
 - Existing standards for communications and information technology do not appear to address the protection of equipment from damage during large seismic events.
 - Improperly secured equipment can be damaged or destroyed even if the structure that houses it survives.
- **Towers.** Antenna towers are likely to be damaged both by shaking during the scenario earthquake and by liquefaction. Towers located in the Coast Range are also prone to possible impacts from landslides.
 - Even if towers are free standing and reinforced to withstand the shaking, the equipment on the towers must be properly secured to avoid damage from the shaking.
 - Surviving towers will not be usable unless power and other utilities are available.
 - Connectivity between towers or between towers and landline networks may be disrupted as microwave dishes move, underground cables are severed by landslides, and utility lines break when the bridges they span fail.
- **Aerial Cables.** Overhead lines will be prone to failure during the expected shaking of the scenario event due to the lateral forces on the lines and poles as well as liquefaction and landslides.
 - Cross arms, connectors, and insulators that are designed to break away in high winds to reduce the potential damage to the utility poles could also give way during the seismic event.
 - Liquefaction can cause utility poles to lean or topple.
 - Landslides can damage or destroy utility poles located on steep slopes.
- **Underground Lines.** Depending on the amount of liquefaction and shearing forces, the earthquake can be just as devastating to the underground utilities as to the overhead lines.
 - Breaks in the underground lines are hard to locate unless there is some obviously related disturbance of the ground or activity in the vicinity of the break.
 - Underground lines can be severed by landslides and by the failure of the bridges that support them across geological features such as rivers and ravines.

Zone 3: Valley

Only structures built to withstand the expected levels of shaking are likely to be usable after the earthquake. Even these structures, however, will have limited functional capability if they are without utilities and there is no way to access them.

- **Buildings.** While the expected shaking in the valley during this scenario earthquake will not be as great as on the coast, a significant number of buildings in the valley were built prior to current seismic code.
 - Very few buildings associated with information and communications technology have been built to the critical facility level (which is designed to increase the chances that the structure will be usable after the earthquake).
 - While the structural components of a building may survive the earthquake, failure of nonstructural components, including windows, HVAC systems, lighting, and plumbing, can render the facility unusable for an extended period of time.
- **Equipment.** Equipment that is not properly secured for the expected level of shaking or protected from cascading events (such as the sprinkler system going off) could be damaged and require an extended period of time for repair or replacement.
 - Existing standards for communications and information technology do not appear to address the protection of equipment from damage during large seismic events.
 - Improperly secured equipment can be damaged or destroyed even if the structure that houses it survives.

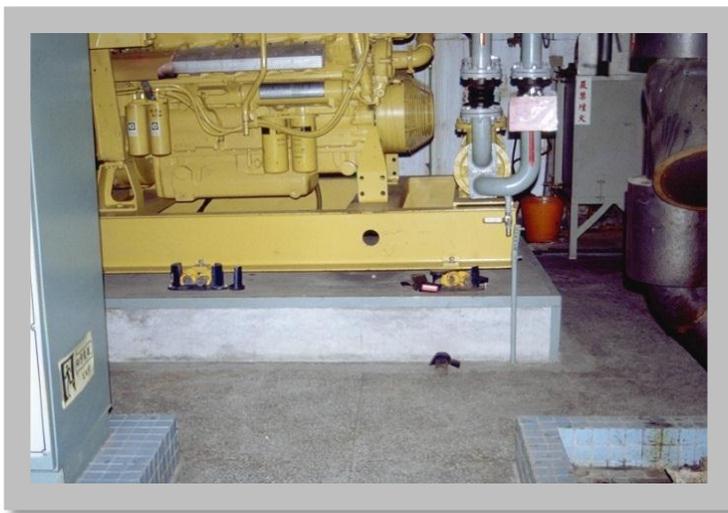


Figure 7.11a and 7.11b: Close-up of the two vibration isolation units. The cause of the failure was due to lack of details to limit the generator displacement during the strong shaking.

Figure 7.11: Backup generator failure - the vibration isolators of this unit all failed after the earthquake. Chi Chi earthquake, Taiwan, 1999. (Source: Alex Tang)

- **Towers.** Antenna towers may be damaged by the shaking during the scenario earthquake as well as by liquefaction. Towers located in the Coast Range and West Hills could also be damaged by landslides.

- A number of the towers and antennas are located on existing buildings and will be only as reliable as the buildings they are on.
- Even if towers are free standing and reinforced to withstand the shaking, the equipment on the towers will need to be properly secured to avoid damage from the shaking.
- Surviving towers will not be usable unless power and other utilities are available.
- Connectivity between towers or between towers and landline networks may be disrupted as microwave antennas move, underground cables are severed by landslides, and utility lines break when the bridges they span fail.
- **Aerial Cables.** While the damage is expected to be less severe in this zone than on the coast, overhead lines could fail during the expected shaking of the scenario event due both to the prolonged lateral forces on the lines and poles and to liquefaction and landslides.
 - Cross arms, connectors, and insulators that are designed to break away in high winds to reduce the potential damage to the utility poles could also give way during the seismic event.
 - Liquefaction can cause utility poles to lean or topple.
 - Landslides can damage or destroy utility poles located on steep slopes.
- **Underground Lines.** Depending on the amount of liquefaction and shearing forces, the earthquake can be just as devastating to the underground utilities as to the overhead lines.
 - Breaks in the underground lines are hard to locate unless there is some obviously related disturbance of the ground or activity in the vicinity of the break.
 - Underground lines can be severed by landslides and by the failure of the bridges that support them across geological features such as rivers and ravines.

Zone 4: Eastern Oregon

In this zone, capabilities will be more dependent on the availability of power than damage or physical loss of structures and equipment.

- **Buildings.** Older and poorly built structures (for example, unreinforced brick buildings) that are located in areas identified in the scenario earthquake as likely to sustain moderate and moderate-to-heavy damage will sustain damage and could partially collapse.
 - Very few buildings associated with information and communications technology have been built to the critical facility level (which is designed to increase the chances that the structure will be usable after the earthquake).
 - While the structural components of a building may survive the earthquake, failure of nonstructural components, including windows, HVAC systems, lighting, and plumbing, can render the facility unusable for an extended period of time.

- **Equipment.** Equipment that is not properly secured for the expected level of shaking or protected from cascading events (such as the sprinkler system going off) could be damaged and require an extended period of time to repair or replace.

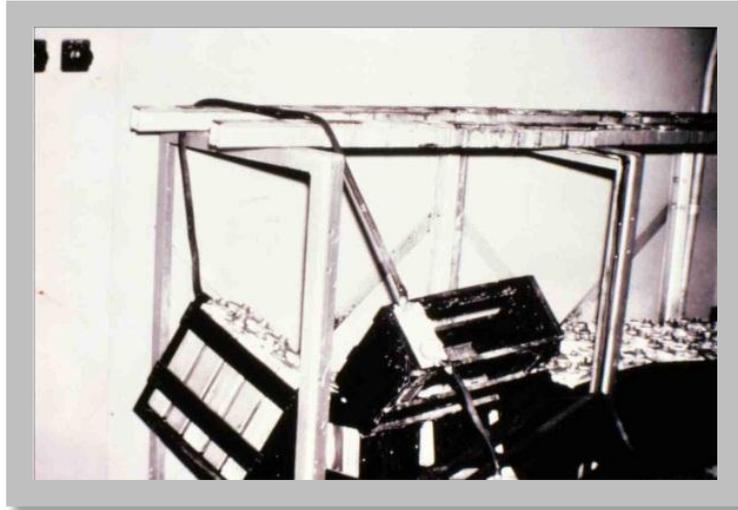


Figure 7.12: The battery rack is designed to resist lateral force with very light cross bracing. The batteries, however, were not secured on the rack and fell, resulting in reserve power failure San Fernando earthquake, California, 1971. (Source: Alex Tang)

- Existing standards for communications and information technology do not appear to address protection of equipment from damage during large seismic events.
- Improperly secured equipment can be damaged or destroyed even if the structure that houses it survives.
- **Towers.** Antenna towers may be damaged by the shaking during the scenario earthquake as well as by landslides if the towers are located on steep slopes.
 - A number of the towers and antennas are located on existing buildings and will be only as reliable as the building they are on.
 - Even if towers are free standing and reinforced to withstand the shaking, the equipment on the towers must be properly secured to avoid damage from the shaking.
 - Surviving towers will not be usable unless power and other utilities are available.
- **Aerial Cables.** Overhead lines could fail in areas that experience higher levels of shaking due both to the prolonged lateral forces on the lines and poles and to landslides that are triggered by the earthquake.
 - Cross arms, connectors, and insulators that are designed to break away in high winds to reduce the potential damage to the utility poles could also give way during the seismic event.

- Landslides can damage or destroy utility poles located on steep slopes.
- **Underground Lines.** Underground lines are likely to be the least impacted in this zone.
 - Breaks in the underground lines are hard to locate unless there is some obviously related disturbance of the ground or activity in the vicinity of the break.
 - Underground lines can be severed by landslides and by the failure of the bridges that support them across geological features such as rivers and ravines.



Figure 7.13: Super structure of cable racks failed due to lack of detailing and in many cases, overload. Whittier Narrow earthquake, California, 1987. (Source: Alex Tang)

Figure 7.14: Upgraded Central Office with bracings damaged, Northridge Earthquake, California, 1994. (Source: Alex Tang)



Target Timeframes for Recovery

Performance capability for recovery purposes is viewed across all information and telecommunications systems that support voice and data communications. The restoration objectives are based on the assumption that all other lifelines, such as roads and electricity, are functioning at a level that will support restoration of the information and communications infrastructure. In areas where the *customer* is not ready to accept service, the service provider is not expected to meet these restoration timeframes.



Figure 7.15 – Collection of damaged bracing beams removed from Central Office. Northridge earthquake, California, 1994. (Source: Alex Tang)

Establishing target timeframes for the tsunami inundation zone, beyond a minimal level of capability to support response, is not practical. A large amount of planning and prioritizing will need to be undertaken to identify which areas will be rebuilt first. These will then be the areas in which the information and communications systems will be re-established first.

KEY TO THE TABLE

Target Timeframe for recovery:

Operational: Restoration is up to 90% of capacity: A full level of service has been restored and is sufficient to allow people to use the system for non-essential activities (such as entertainment). 80%–90%

Functional: Although service is not yet restored to full pre-event capacity, it is sufficient to get the economy moving again (e.g. business uses for credit cards and banking). Limits may be placed on uses that take up a lot of capacity (such as streaming video). 50%–60%

Minimal¹: A minimum level of service is restored, primarily for the use of emergency responders, repair crews, and in support of critical health and human services (mass care). 20%–30%

Estimated time, under current conditions, for system-wide recovery to be at (or 90% of) pre-event capacity

G
Y
R
x

1. In the early phases of recovery, achieving these capabilities may require the use of temporary contingencies (such as mobile cellular towers) while more permanent repairs and installations are being done.

TARGET STATES OF RECOVERY:										
INFORMATION AND COMMUNICATIONS TECHNOLOGY SECTOR										
	 Event occurs	0–24 hours	1–3 days	3–7 days	1–2 weeks	1–3 months	3–6 months	6 months –1 year	1–3 years	3 + years
ZONE 1: COAST—TSUNAMI ZONE				R						
Buildings (includes central offices, internet exchange points, and cable landings)										
• Repair								x		
• Replace									x	
Equipment in Buildings and on Towers									x	
Towers									x	
Underground Lines									x	
Overhead Lines									x	
ZONE 2: COAST—EARTHQUAKE-ONLY ZONE			R		Y	G				

(To be continued on next page)

	Event occurs	0–24 hours	1–3 days	3–7 days	1–2 weeks	1–3 months	3–6 months	6 months –1 year	1–3 years	3+ years
Buildings										
• Repair								x		
• Replace									x	
Equipment in Buildings								x		
Towers								x		
Underground Lines							x			
Overhead Lines							x			
ZONE 3: VALLEY		R		Y	G					
Buildings										
• Repair								x		
• Replace									x	
Equipment in Buildings						x				
Towers						x				
Underground Lines						x				
Overhead Lines					x					
ZONE 4: EASTERN OREGON	R		Y	G						
Buildings										
• Repair						x				
• Replace								x		
Equipment in Buildings					x					
Towers				x						
Underground Lines				x						
Overhead Lines				x						
	Event occurs	0–24 hours	1–3 days	3–7 days	1–2 weeks	1–3 months	3–6 months	6 months–1 year	1–3 years	3+ years

Figure 7.16– Target States of Recovery: Information and Communications Technology Sector

Resilience Gap Analysis Summary

The table in Figure 7.16 shows significant difference between the current capabilities of the system and the target capabilities, especially at the coast and in the valley. As the threat of a magnitude 9.0 subduction zone earthquake is recognized and new design and building standards are adopted and implemented in response to it, new construction of information and communications infrastructure will be more likely to achieve the resilience targets. Without changes in policy and other incentives,

however, we do not foresee any significant changes in the performance capabilities of existing system components.

- Companies in this sector should institutionalize long-term seismic mitigation programs and should work with the appropriate agencies and stakeholders to achieve timely and effective mitigation to ensure that their facilities are resilient and their operations reliable.
 - Require that central offices, Internet exchanges, remote terminals, and submarine cable landings be built or retrofitted to meet the *critical facility* standard.
 - Include within site development and zoning codes the requirement that information and communications technology structures be built to withstand the potential impacts of a scenario earthquake and tsunami. This should include:
 - Limitations on building in tsunami inundation areas.
 - Limitations on construction of antenna towers on buildings that do not meet the critical facility standard.
 - Accounting for potential liquefaction and slope instability when constructing towers, buildings, underground utilities, and overhead lines.
 - Adopt clear, statewide uniform standards, like the NEBS (Network Equipment-Building System), for the adequate performance and bracing of information and telecommunications equipment that must withstand the scenario event, and establish a mechanism for reliable enforcement.
 - Establish a hardened backbone for information and telecommunications systems in conjunction with the ODOT's hardening of primary transportation routes.
- Companies in this sector should work with the state of Oregon to build Oregon's seismic resilience to a Cascadia earthquake.
 - Adopt pro-active practices and a risk management approach to help achieve seismic resilience.
 - Encourage a culture of awareness and preparedness in relation to the seismic vulnerability of the energy sector, and stress the need to conduct long-range energy planning.
- Create an ongoing marketing and education program for Oregon to craft the resilience message for the public. This is to bring about a cultural shift toward preparing for the catastrophic Cascadia subduction zone earthquake and to learn the cost of becoming prepared.
 - Create a public information officer position (for the state) and assign to it responsibility for this marketing and education program.
 - Involve all types of media in promoting this new culture of preparedness.
- Recommend the state and municipalities should include system resilience criteria in their requests for proposals when contracting for telecommunications and information services.



Recommendations

As demonstrated in Chile (ASCE TCLEE, 2010), resilience can be achieved within a 50-year period without unrealistic amounts of new investment. Companies in this sector should be encouraged to institutionalize long-term seismic mitigation programs and to work with the appropriate agencies and stakeholders to achieve timely and effective mitigation to ensure that their facilities are resilient and their operations reliable. Towards that end, the task group proposed the following recommendations for consideration:

- ▶ **Information and communications companies should conduct seismic vulnerability assessments (SVA) on all of their infrastructure facilities, and they should work with the appropriate agencies and stakeholders to achieve timely completion of the assessments to understand existing vulnerabilities.**
 - The Public Utility Commission of Oregon (OPUC) is the proper oversight authority for all telecommunications utilities that are subject to the OPUC’s Oregon Administrative Rules.
 - The OPUC may need to define the criteria for seismic vulnerability assessments.
 - The OPUC should review the results of the seismic vulnerability assessments and the systems’ resilience to other natural disasters (within the scope of their mission).
 - The implementation of this recommendation could also involve the participation of the Oregon Department of Geology and Mineral Industries (DOGAMI), the Building Codes Division, and the Oregon Seismic Safety Policy Advisory Commission (OSSPAC).
- ▶ **Provide liability waiver language in statute for vulnerabilities identified in the seismic vulnerability assessments that are above operators’ current normal operations.**
- ▶ **Companies in this sector should institutionalize long-term seismic mitigation programs.**
- ▶ **Utilize the Oregon Office of Emergency Management’s public-private sector position to help ensure coordinated planning, information sharing, and interoperability among critical organizations and agencies. The position will also ensure that work being performed by this entity and its partners helps provide public education and outreach to local, county, and state agencies and organizations.**
- ▶ **The state of Oregon should provide statutory authority for a prescriptive waiver of routine permitting requirements and processes for the design, construction, and restoration of communication and information infrastructure, if it is determined that the waiver is in the public interest and is necessary to address an actual or impending emergency (and subsequent actions) caused by a natural or manmade disaster.**

References

1. McGraw-Hill (2003). *McGraw-Hill Dictionary of Scientific and Technical Terms*, 6th edition. New York/Chicago/San Francisco: McGraw-Hill Companies.
2. Nojima, N. (2012). "Restorations and System Interactions of Lifelines in the Great East Japan Earthquake Disaster, 2011," *Proceedings of the International Symposium on Engineering Lessons Learned from the 2011 Great East Japan Earthquake*, March 1-4, Tokyo, Japan.
3. ASCE TCLEE (2011). *Preliminary Report on the 27 February 2010 Mw 8.8 Offshore Maule, Chile Earthquake*. Technical Council on Lifeline Earthquake Engineering (TCLEE), American Society of Civil Engineers.
4. Wang, Y., Bartlett, S.F., and Miles, S.B. (2012). *Earthquake Risk Study for Oregon's Critical Energy Infrastructure Hub*. Final Report to Oregon Department of Energy & Oregon Public Utility Commission. Oregon Department of Geology and Mineral Industries, August. The full EAP report is accessible at <http://www.oregon.gov/puc/docs/DOGAMICEIHubreport-8-1-12-R1.pdf>.