
Cupertino Communications Risk Report

Cupertino Office of Emergency Services

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Revision

10/9/2015	Incorporated the first review feedback; Chris O; Pete C; other corrections/updates
10/14/2015	All Feedback received; first release
10/18/2015	For City Staff review
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11/05/2015	v1.3 2011 Pacific Blackout updates
11/09/2015	v1.4 handle terminology change requests
04/06/2016	v1.5 various corrections
07/18/2016	v1.6 Event additions: Ukrainian Power cyber-attack, Wireless Substitution from NHIS, 2015.
02/07/2017	V1.7 update to on-line references

Preface

This report is submitted to the City of Cupertino Office of Emergency Services, Public Affairs Department and Public Safety Commission on Cupertino Communication System Risks. Its genesis was from a heightened concern with the increasing trend in communication system outages that have occurred throughout the greater San Francisco Bay Area over the past few years.

These events begged the question: how ready is Cupertino if a communications outage occurred here? This report, and the details contained within, was created in an attempt to provide some answers. It lists the critical communication systems that exist within the city today, the different hazards that we face, and the history of problems that the Bay Area has experienced. Different communication categories and their possible failures are reviewed along with their probabilities, seriousness, and associated risks. Mitigations and contingencies are listed when known. Lastly, where mitigations and contingencies are lacking, opportunities for action are summarized in a series of recommendations.

As a final thought: because of the high level of interconnectedness with today's communication systems, if our city is impacted, then it is likely that some or all of the surrounding areas also would be impacted. As a result, some risks may be addressed with mitigations or contingencies that could be common and leveraged across the region.

Comments and feedback are welcome, and updates will be made as new information or changes to our communications environment become known.

*Jim Oberhofer
Cupertino, CA*

1 EXECUTIVE SUMMARY

1.1 OVERVIEW

The Cupertino Communications Risk Report was undertaken to assess the communication risks that the City and its residents face. This report only attempts to recommend actions that the City could take and acknowledges it has no authority to drive them. However, it hopefully presents a compelling argument for taking action to mitigate or respond to specific risks with City communications. Input to this plan came from Office of Emergency Services, Cupertino City Channel, and Department of Public Works staff members.

Communication failures can be triggered from any number of **Initiating Hazards** (Section 5.1) including Earthquakes, Power Failure, and Terrorism/WMD events to name a few. These hazards can cause a communication loss by one of three **Impacting Events** (Section 5.2): (i) Loss of Connectivity, (ii) Power Failure, or (iii) System Overloading. Because there is sufficient historical evidence, these events become one of the key drivers for assessing risk and developing the risk plan.

This assessment identified five classes of communications (Telephony, Internet, Radio, Video, and Messaging) and 15 communications 'services'. As a result, **43 Risks** were identified (Section 5.6) with the following rating:

- 0 being Acceptable
- 27 (63%) are Tolerable (cost of the risk reduction 'is not worth it')
- 9 (21%) are Undesirable (Tolerable only if the risk reduction is impracticable or the costs are grossly disproportionate to the improvement gained), and
- 7 (16%) are Unacceptable (in any circumstance).

While mitigations and contingencies were listed for each risk when known, not all Undesirable or Unacceptable Risks had both. This situation presents the opportunity for the City to determine in which areas to invest and which to further accept the risk.

1.2 OBSERVATIONS

The following observations were made from the information gathered for this plan:

1. The city appears to have sufficient primary and secondary telephone coverage to maintain business operations.
2. Recovery of the commercial communications infrastructure is not the responsibility of the City.
3. There is reasonable resiliency with City-owned communication systems both for internal use as well as for information out-reach to the community provided City Hall does not lose power.
4. The largest re-occurring risk to City communications is the loss of power.
5. On a telephone outage, the City's trunk radio system will not be able to pick up the entire internal communications load due to the limited number of frequencies available for efficient, concurrent conversations.
6. Loss of both wireline and cell phone services significantly reduces the telephone call capacity and should constitute a city emergency.
7. Loss of commercial electrical power should constitute a city emergency.
8. Amateur Radio continues to be the communications mode of last resort.

1.3 RECOMMENDATIONS FOR THE CITY

The following summarizes the recommendations that address the City's Undesirable and Unacceptable Risks.

1. Move the Travelers' Information Station (TIS) to a more secure facility, or retrofit City Hall.
2. Complete the TIS backup battery upgrade.
3. Improve the reliability of the City Hall backup generator.
4. Define the Public Information Outreach plan.
5. Define the Community Emergency Assistance Request Intake plan.
6. Complete the ARKnet build-out as the Cupertino Emergency Intranet.
7. Perform testing of specific backup communications measures.
8. Explore other emerging technologies and means for communicating with the community during an emergency.

See **Section 6.2 Recommended Actions** for details. There are several other lower priority actions that the City can take to further mitigate Tolerable Risks; see this section for details.

1.4 RECOMMENDATIONS FOR THE COMMUNITY

The following recommendations address other risks for Cupertino residents. In all cases, these are more home preparedness activities that should be emphasized with the community.

9. Public Outreach to the community:
 1. Ensure residents have a car cell-phone charger.
 2. For home wireline telephones, ensure the availability of at least one corded phone.
 3. Ensure every home has a portable AM/FM radio.

Mitigating risks for the community is limited to what each homeowner or business elects to undertake. The above 3 risk response actions, while assessed as Tolerable, are still important as part of community ownership for initial self-reliance in the event of a disaster. These items are candidates for write-ups in the Cupertino Scene's preparedness section. See **Section 6.2 Recommended Actions** for details.

1.5 SUMMARY

Stepping through this process has helped clarify specific risks that the City should further address. The ability to reduce the risk across the board, both for Communications as well as for other functional areas, ensures that the City can operate as effectively as possible in its delivery of city services to the community.

Finally, Risk Assessment is an on-going process. As mitigations and/or contingencies are defined, tested, and put in place, or as the threat levels change, risks should be re-assessed and addressed as appropriate. Reducing the risks to the community should be balanced with the other priorities that the City currently faces.

2 INTRODUCTION

At the national level, the U.S. Government's focus has been on ensuring the security and resiliency of the nation's critical infrastructure elements against terrorist attack.

In 2006, the Department of Homeland Security (DHS) produced the National Infrastructure Protection Plan (NiPP)¹ to serve as a Risk Management Framework to address pre-existing threats that may occur from natural disasters, cyber-attacks, and terrorism. To make NiPP a reality, 16 critical infrastructure and key resources² were identified and, through partnerships with State, local, and industry, *Sector Specific Plans* were developed. Communications is one such Sector.

The Communications Sector Specific Plan (CSSP)³ describes how this sector will manage risk using both public and private resources, how partners will implement programs and practices to achieve sector goals, and how the Sector will measure the effectiveness of protective activities. In the U.S., the critical communications infrastructure is owned and operated by private sector companies who are national players and, therefore, participate in the national plan.

However, the CSSP does not address what happens, or should happen, at the local level. Because there are locally-owned and managed components of communications infrastructure, these components also warrant consideration and inclusion in a local Communications Risk Plan.

This report attempts to address this for Cupertino, CA with a *Cupertino Communications Risk Report*.

2.1 BACKGROUND

Today, almost every aspect of modern life depends on the *digital infrastructure*. As a result, our nation's economic security relies heavily on the security and operations of the critical communications infrastructure. This is the case for Cupertino as well.

Past catastrophic natural disasters and terrorist attacks emphasized the need to focus attention on protecting our critical infrastructures and making them more resilient.

When we think Communications, two areas are implied:

- Communications Infrastructure – This refers to the backbone of communications systems upon which various telecommunications and broadcasting systems operate. This typically includes: wireline, wireless, satellite, cable, and broadcasting capabilities.
- Information Infrastructure – This refers to the communications networks that interconnect people with information. This includes the networks that enable the Internet and as well as other key information systems.

Vulnerabilities exist and will occur in both the Communications and Information Infrastructures. Additionally, the number of vulnerabilities will continue to increase as the businesses, government, and personal activities move toward more networked use driven by greater mobile and wireless capabilities.

¹ <http://www.dhs.gov/national-infrastructure-protection-plan>

² <http://www.dhs.gov/critical-infrastructure-sectors>

³ <https://www.dhs.gov/xlibrary/assets/nipp-ssp-communications-2010.pdf>

2.2 IMPLICATIONS TO CUPERTINO

The following must be taken into account when considering this plan for Cupertino.

1. Most critical communications infrastructure components are not owned by the City. The City approves and oversees various communications service providers that deliver services to the City, local businesses, and residents under franchise or leasing agreements. In short, the City is dependent on service providers and is a consumer of communications services.
2. The city does own and operate specific communications systems. These systems are mission-specific, and are procured, installed, managed, and operated by the City. They are used in the direct support of city government operations as part of government service delivery to residents and businesses in Cupertino.
3. The City is required by law to manage any emergency response that occurs within its jurisdiction. Times of emergencies are the most critical for having communications in place to help manage the response and speed the recovery for the community.
4. As new communications technologies for service delivery emerge, City residents may expect the City to adopt and use these technologies to provide information and assistance during times of need.

A degradation or loss of communications capabilities within Cupertino could have several adverse impacts, including, but not limited to:

1. To the City
 - a. Cannot transact government business in support of the community.
 - b. Cannot inform the community on the state of the problem, progress toward its resolution, and actions the community should take.
2. To local businesses
 - a. Cannot process financial transactions from the sale of products or delivery of services.
 - b. Cannot perform ATM and standard bank transactions.
 - c. Cannot handle cash transactions if inventory control systems are unavailable.
3. To residents
 - a. Cannot initiate calls for assistance (911).
 - b. May lose contact with family members.

2.3 PURPOSE AND SCOPE OF THIS PLAN

This plan addresses the following:

1. Identifies the City's communications assets and systems that are critical for the day to day operation of the City.
2. Assesses the risks by looking at internal and external events that can reduce or disable city communications capabilities. Lists mitigations and contingencies wherever possible.
3. Prioritizes actions that yield the largest impact in terms of mitigating or avoiding a loss of capability.
4. Develops protective actions and strategies to address prioritized risks. Develops recommendations for resources to execute the actions and strategies.

This plan characterizes and addresses all available means of communications that exist within the City in 1 of 2 ways:

- Service Provider Systems. Understand the extent of this infrastructure for the purpose of context. It is assumed that the CSSP, and not this plan, will cover the details, limitations, and

risk response plans that commercial service providers have in place. This information is not included here.

- City-managed systems. Understand the extent of the communications systems under the control of the City, their risks, mitigations, and contingencies that should be put in place.

2.4 COLLABORATION

Ensuring the completeness of the plan improves its effectiveness and chances of identifying actions that can reduce the economic loss to the City by avoiding problems in the first place, as well as reducing the impact in the event a problem does occur. To this end, the following organizations participated in the review:

1. Cupertino Government
 - a. City Channel
 - b. Department of Public Works
 - c. Office of Emergency Services
2. Community
 - a. Cupertino Amateur Radio Emergency Services

2.5 RISK ASSESSMENT APPROACH

The following process will be used to perform the Risk Assessment.

Section 4 - Identify Communications Assets and Systems

1. Identify the Risk Owners.
2. Describe the Communications Assets and Systems that are used within the City.
3. Describe the categories of communications and their content.

Section 5 - Assessing Risk

4. Define *Initiating Hazards* and *Impacting Events*.
5. Identify the initiating hazards that could trigger a communications impacting event.
6. Describe the main impacting events that could cause an interruption or failure of a communications capability. Include the history of past impacting events.
7. Assess the communications elements against the impacting events in terms of probability of occurrence and seriousness of the impact.

Section 6 - Prioritize Actions

8. For Risks exceeding a specific tolerance, develop recommendations, actions, and strategies that will further reduce or mitigate the risk.
9. Establish priorities based on the risk, and determine protection plans that provide the greatest mitigation of risk.
10. Identify and recommend appropriate actions to reduce or manage the risk identified. Include resources to address the priorities.

3 ESTABLISH GOALS AND OBJECTIVES

3.1 GOALS AND OBJECTIVES

Within the City, the usual meaning of *Communications* is in the context of dealing with the public.

3.1.1 City Communications Mission⁴

The Cupertino Public Affairs Department states its Community Communications mission as follows:

To increase public awareness, interest, understanding, and participation in city issues, programs, and services.

3.1.2 Community Communications Goals

1. Serve as a communications link between the city and residential, business, and other communities in the region.
2. Ensure all audiences have easy access to information and services via media of their choice, including print, video, internet, telephone, radio, and/or television.
3. Build community pride and positive identification with the city among our residents and employees.
4. Increase internet and participation in city services and activities.
5. Promote city council and departmental goals, initiatives, programs, and services.
6. Keep employees and elected officials well informed to assist them in service city residents and other audiences.
7. Assist in creating better internal and external communications.
8. Enhance our relationship with the news media to enable them to be two-way communicators between city government and the community.

3.2 TECHNICAL GOALS AND OBJECTIVES

Unlike the above community perspective on communications, there is also a technical side that is defined here. In the absence of any formally documented vision and objectives, the following is proposed.

3.2.1 Vision (Proposed)

The City of Cupertino has a critical reliance on communications, and strives to ensure that city-owned communications network and systems are secure, resilient, and rapidly restored in the event of a disruption.

⁴ Santa Clara County Local Hazard Mitigation Plan, Section 11, City of Cupertino Annex, 11.3.2.1 Department Responsibilities, 2010

3.2.2 Technical Communications Goals (Proposed)

The goals for the Cupertino Communications Risk Report are:

1. Ensure the overall reliability of the different communication systems.
2. Maintain an “always on / always ready” capability for City communications services.
3. Enhance the risk response and recovery abilities so that the impact of a communications loss or failure is negligible.
4. Rapidly restore City-critical communication services during a disruption while mitigating cascading effects.
5. Measure the effectiveness of the actions and strategies and make additional recommendations to adjust the response as necessary.

4 IDENTIFY COMMUNICATIONS ASSETS AND SYSTEMS

The following are the steps for identifying communications Assets and Systems.

1. Identify the Risk Owners.
2. Describe the Communications Assets and Systems that are available to the City.
3. Describe the categories of communications and their content.

Communications assets are marked as critical for Cupertino based on the role they play in the on-going operation of the core City Government functions. Identifying the critical assets is therefore an important step in the assessment process.

4.1 RISK OWNERS

This plan identifies the organizations, parties, or individuals responsible for assessing a risk. Owners fall into 2 categories:

4.1.1 Service Providers

Service Providers are either commercial service providers that own and operate their own telecommunications infrastructure, or businesses or governments that own or lease, and operate their own specific communication systems for internal or public use. All providers are responsible for managing the risks of their respective infrastructure or communications assets.

Additionally, the City of Cupertino both owns and operates specific communications systems that need to be assessed.

4.1.2 Service Consumers

Service consumers are the customer in the Provider / Consumer relationship. The commercial service is delivered to a customer through an infrastructure-to-customer interconnect.

Consumers are responsible for mitigating the risks for owned communications equipment where the end user interconnect takes place.

The City of Cupertino Government and the city's residents are consumers of communications services.

4.2 DESCRIPTION OF POTENTIALLY IMPACTED SYSTEMS

This section describes the various communications systems used in Cupertino that could be at risk of some type of failure. Systems are classified into these five categories:

- Telephony
- Internet
- Radio
- Video
- Messaging

4.2.1 Telephony

Telephony is the technology associated with the electronic transmission of voice, fax, or other information between distant parties using systems historically associated with the telephone. The following table describes the 5 telephone services that are offered in Cupertino.

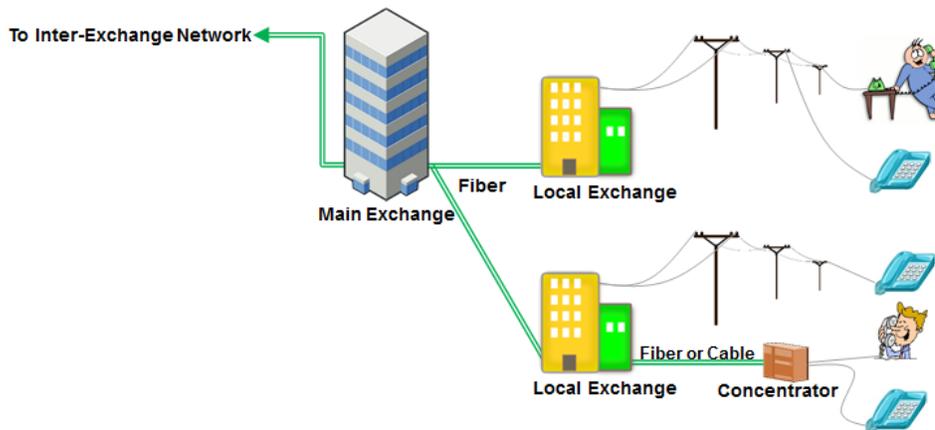
Class	Comm Service	Risk Owner	Critical Comm Elements
Telephony ⁵	Telephone Service, Wired	AT&T	Interchange Network
			International Networks
			Local Exchange Network/PSTN
			Centrex System
		Cupertino DPW	Wireline, Local Equipment
		Business	Local PBX or Centrex
			Wireline, Local Equipment
	Resident	Wireline, Local Equipment	
	Telephone, AT&T U-verse	AT&T	DSL, TV/Internet, VRAD, DSLAM
		Resident	Modem, DSL
	Telephone, Comcast Xfinity	Resident	Modem, Voice
	Telephone Service, Cellular	AT&T	Mobile Telephone Switching Office
			Access Points (Base Station)
		Verizon	Mobile Telephone Switching Office
			Access Points (Base Station)
		Business	Cellular, Mobile Stations, Hot Spots
		Cupertino DPW	Cellular, Mobile Stations, Hot Spots
		Resident	Cellular, Mobile Stations, Hot Spots
	Telephone Service, Satellite	LightSquared	Satellites, Network
			Satellite Network Gateways
Cupertino City Channel		Satellite, Phone	

⁵ These Telephone services represent the primary services used by the City. Other Cellular providers are not listed, but the problems and situation that relate to AT&T and Verizon cellular will apply to them as well.

4.2.1.1 Wireline Telephone Service

System Overview

1. Telephone service was introduced in 1876, and is expected to be obsolete by 2025.
2. Public Switched Telephone Network (PSTN), also known as Plain Old Telephone Service (POTS), is voice-grade telephone service using analog signal transmission over copper wire.
3. Copper pairs of wire run from a business or residence to a cable bundle feeding the premises.
4. The cable bundle runs to the local exchange either directly or through digital concentrators.
5. Local calls are kept on the local exchange network.
6. Out of area calls are switched to the Inter-Exchange Network.
7. The Phone Company maintains an extensive battery system with backup generators at Local Exchange offices.



Cupertino Government

The City contracts with AT&T for a **Centrex** system located in a local AT&T facility that provides all internal and external telephone functionality. The City uses this telephone system as the primary system to conduct all city government operations and business.

- **Definition:** Centrex is a voice telecommunications service that offers traditional telephone system features and functions often found in premises-based systems such as PBX. Centrex is ideal for multiple-location businesses wanting a single, easy-to-use service. Centrex allows the City to add or remove lines and features with a pay-as-you-go capacity and features model.⁶

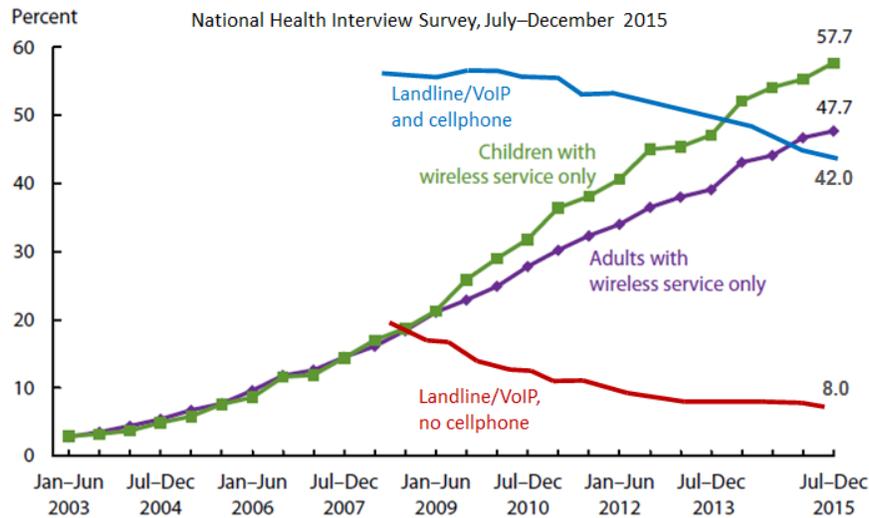
City telephone numbers are listed and published for internal and external use. Customer premises equipment (CPE) is wired from each city building directly to the Centrex system, similar to residential wiring. The City has 300 telephone numbers reserved for its use, with at least all office workers having access to a wired telephone.

⁶ <http://www.att.com/gen/general?pid=9613>

Cupertino Residents

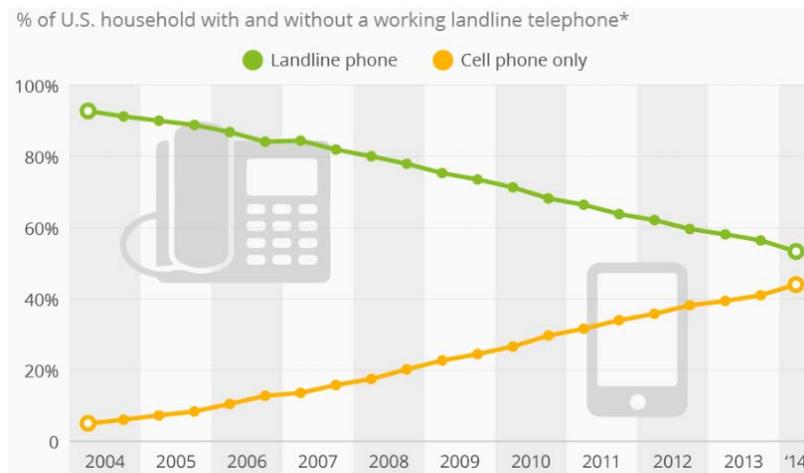
Residents and businesses have a wider range of telephone service provider choices besides POTS. As smartphones have become ubiquitous for most people in the U.S., wireline telephone service (POTS, VoIP) is rapidly losing relevance.

In 2015, the CDC/NHI (Center for Disease Control/National Health Institute)⁷ estimated that only 48% of the U.S. population uses only a wireless phone at home. Households with only a wireline service decreased from 88% to 8%. VoIP telephone service providers (AT&T, Comcast, others) are picking up market share from POTS service providers.



Wireless Substitution: NHI Survey July-December 2015

Source: CDC/NHI



Wireline Phones are a Dying Breed

Source: CDC's 2014 biannual National Health Interview Survey of 20,000 U.S. households⁸

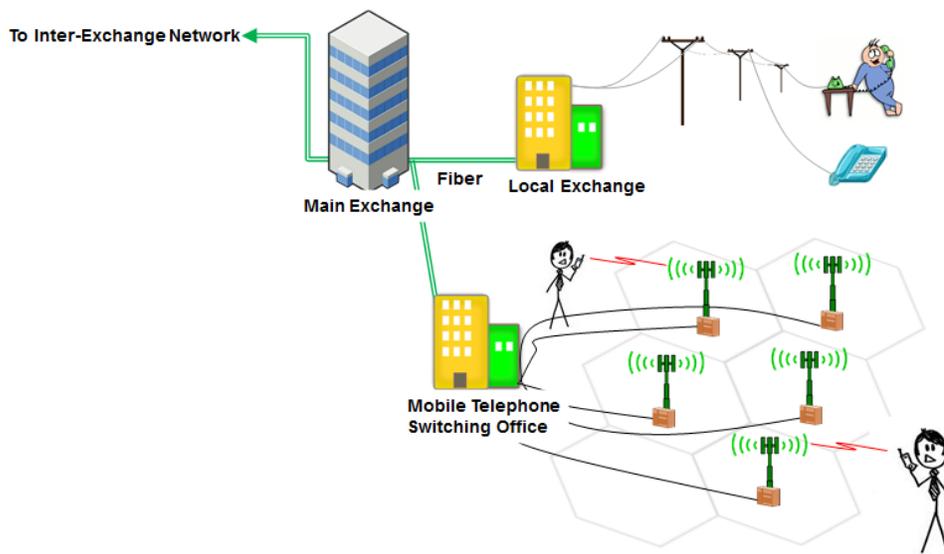
⁷ [Wireless Substitution: Early Release of Estimates](#), National Health Interview Survey, July–December 2015

⁸ <http://www.statista.com/chart/2072/landline-phones-in-the-united-states/>

4.2.1.2 Cellular Telephone Service

System Overview

1. Cellular telephone service was introduced in the U.S. in 1983.
2. A cell phone service provider receives an allocation of 832 frequencies from the FCC:
 - a. 395 frequency pairs for full duplex voice channels
 - b. 42 for control.
3. Each cell is typically sized at about 10 square miles depending on terrain and surrounding structures.
4. For 2G (TDMA), there are 168 channels per cell.
5. Cell phones and base stations use low-power transmitters, thereby allowing the same frequencies to be reused in nonadjacent cells.
6. Most cell sites are powered by commercial power, or use generators at remote locations.



Cupertino Government

The City provides cell phones to about 41 employees and mobile hot-spots to specific users under a Verizon service contract. City-owned cell phones and hot-spots are used for the execution of government operations and activities.

Personal Cell Phones may also be used for City business but at the discretion of the cell phone owner and with agreement for expense reimbursement from the employee's supervisor. Personal cell phones may be operated with any carrier with whom the employee chooses to purchase service.

There is no directory of City cell phone numbers.

Cupertino Residents

See comments on growth in the above section titled *Wireline Telephone Service*.

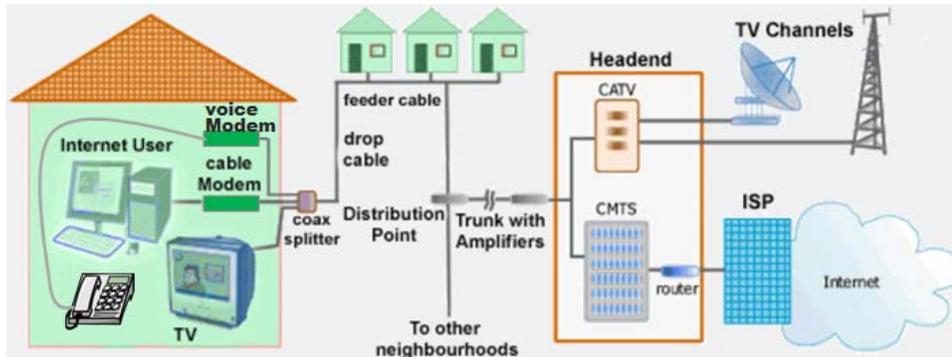
4.2.1.3 Digital Telephone Service

The following focuses on the IP telephone portion of the Comcast and AT&T service offerings.

Comcast Xfinity Critical Telephone Components

See the Internet Section for a description of the Comcast / Xfinity system.

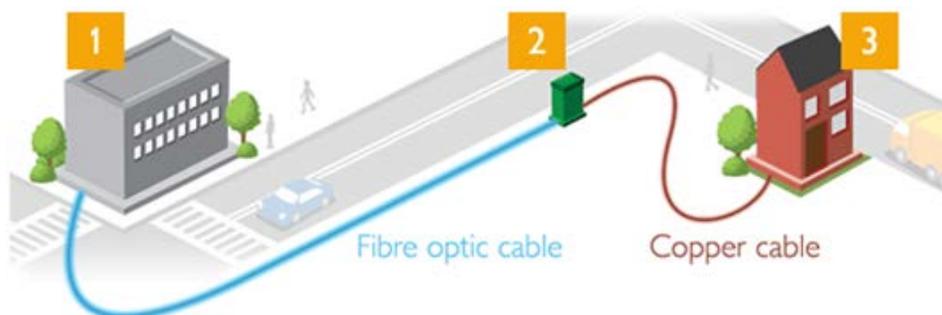
1. Central Office / Headend maintain backup generators and batteries.
2. For home installations, standard phone plugs into a voice phone modem. This modem requires a backup battery to ensure 911 access in the event of a local power outage.



AT&T U-verse Critical Telephone Components

See the Internet Section for a description of the AT&T U-verse system.

1. The Central Office maintains backup generators and batteries.
2. VRAD Neighborhood boxes include NiMH⁹ backup batteries that will continue to operate for about 2 to 4 days during a power failure.
3. For home or business installations, the Wi-Fi Resident Gateway with voice services requires a backup battery to ensure 911 access in the event of a power outage.



Cupertino Residents

See comments on growth in the above section titled *Wireline Telephone Service*.

⁹ Nickel Metal Hydride, a type of rechargeable battery.

4.2.1.4 Satellite Telephone Service

- Definition:** The MSAT-G2 Satellite two-way radio system by LightSquared allows police, firefighters, first-responders, work crews, and others to stay in touch virtually anywhere. The service covers North and Central America, northern South America, the Caribbean, Hawaii, and coastal waters. The product is available in Mobile (vehicular) and Marine (vessel) versions as well as in-building / fixed installations.

Cupertino Government

The City is under contract with LightSquared for one fixed installation satellite phone for use in an emergency.

4.2.2 Internet

Internet delivery is covered by the following 4 service providers, not all are pervasive throughout Cupertino.

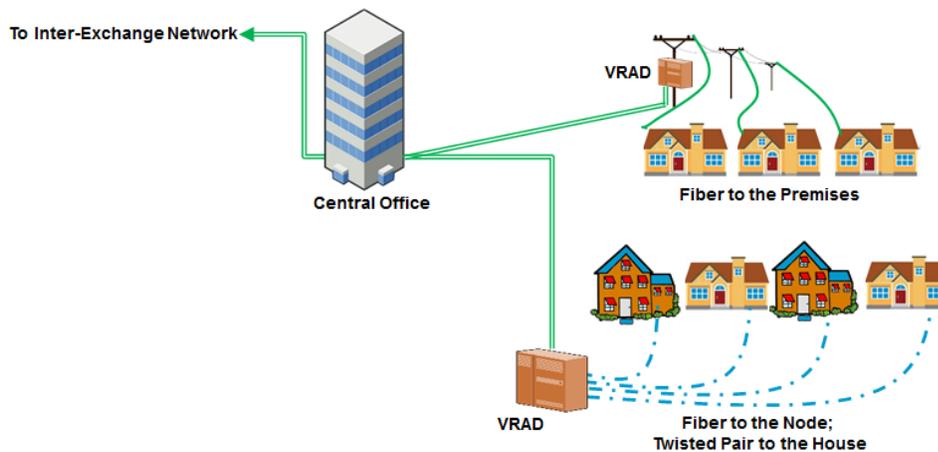
Class	Comm Service	Risk Owner	Critical Comm Elements
Internet	AT&T Digital Network	AT&T	Network (Backbone)
			IP Serving Offices
			IP Video Hub Offices
			DSL, TV/Internet, VRAD, DSLAM
		Business	Modem, DSL
			VoIP PBX
		Cupertino City Channel	Modem, DSL
		Resident	Modem, DSL
	Comcast Digital Network	Comcast	Cable, Network (Backbone)
			Cable, Central Office / Head End
		Business	Modem, Cable
			VoIP PBX
		Cupertino City Channel	Modem, Cable
		Resident	Modem, Cable
	Exede Satellite Network	Exede	Satellite, ViaSat-1
			Satellite Network Gateways
Cupertino City Channel		Modem, Antenna	
Infralink / SCEWN Network	Infralink	Wireless Network (Backbone)	
	Cupertino City Channel	Infralink Access Point	

4.2.2.1 AT&T U-verse

System Overview

U-verse is the AT&T brand of *triple-play* telecommunications services offered in 22 states; it includes broadband Internet, IP telephone, and IPTV services.

1. AT&T commercially launched the service in 2006.
2. AT&T delivers combinations of Internet, TV, and VoIP phone service.
3. The service uses the existing telephone network.
4. The implementation is either:
 - a. Fiber-to-the-Premise: a fiber optic cable runs to the home or business.
 - b. Fiber-to-the-Node; fiber optic cable runs to a VRAD, and then twisted pair wire to the home.
5. Equipment
 - a. VRAD: Video Ready Access Device; combines voice and data (DSLAM) with the TV stream to the home; uses the existing copper wiring to customers' homes.
 - b. DSLAM: Digital Subscriber Line Access Multiplexer; combines end user's voice and data traffic into one signal; installed in either the Central Office or a local VRAD.
 - c. CPE: Customer Premises Equipment, equipment to handle Internet, IPTV, and VoIP Phone.



Cupertino Government

The City uses AT&T Broadband for its general office internet access. The full bandwidth is available to City Hall, Community Center, Senior Center, Quinlan Center, and the TOC by the fiber interconnect originating from City Hall. Blackberry Farm, McClellan Ranch, and the Service Center have their own independent internet connections at a significantly lower bandwidth. There is a proposal to add the Service Center to the fiber network within the next two to three years. This will require trenching and laying conduit approximately 3,750 feet along Mary Ave.

Cupertino Residents

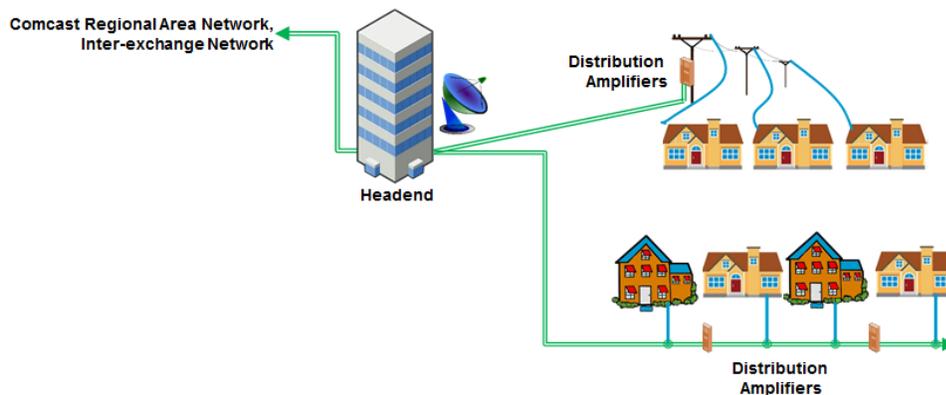
Unknown market share in Cupertino

4.2.2.2 Comcast Xfinity

System Overview

Xfinity is Comcast's trademark for *triple-play* services in Comcast's largest markets; it includes digital cable TV, cable Internet access, and cable telephone services and radio.

1. Cable TV was introduced in the U.S. in 1963.
2. Comcast broadband was launched in 1996.
3. Comcast delivers combinations of Internet, TV and VoIP phone service.
4. Broadband cable is one of the most common forms of residential Internet access in the U.S.
5. The service uses the existing cable TV system for its service delivery.
6. Equipment
 - a. Headend: the master facility for receiving television signals for processing and distribution over a cable television system.
 - b. Distribution Amplifiers: ensures a sufficient signal level further down the distribution path.
 - c. Network Termination Point: outside the customer's home, connects to the cable network.
 - d. Coax Splitter: splits the signal for TV, Internet, and the Phone.
 - e. Customer Premises Equipment: TV Set-top Box, Internet Modem, Voice Modem



Cupertino Government

The City uses Comcast Broadband for its Wi-Fi access. The Comcast cable modem for City Hall is in the video control room. Other City facilities have individual cable modems that are usually located in that facilities' MPOE/electrical rooms.

Cupertino Residents

Unknown market share in Cupertino

4.2.2.3 Excede Satellite Internet

System Overview

Excede is a satellite internet service available in all 50 states and covers 98% of the U.S. population. Similar to U-verse and Xfinity, Excede bundles TV and IP Telephone service.

1. 1999, the idea for Satellite Internet is conceived.
2. 2004, WildBlue's first satellite is launched. The next year, the company began delivering internet services to people in the rural U.S. who had no access to faster forms of internet connectivity.
3. January 2008, ViaSat Corporation begins build of the world's highest capacity communications satellite.
4. December 2009, ViaSat acquired WildBlue, its customers, satellites and operational expertise.
5. October 2011, ViaSat successfully launched ViaSat-1.
6. Plans are in place for ViaSat-2 to be launched in 2016.
7. Equipment
 - a. Ground Station: Located in Riverside, CA.
 - b. Satellite: ViaSAT-1, in a geosynchronous orbit at about 22,500 miles above the Earth.
 - c. Antenna: The residential satellite antenna, also known as a dish, is about the same size as a residential satellite TV antenna.
 - d. Modem: About the size of a large book, it is placed on your desk or next to the router.



Cupertino Government

The City has a service contract with Excede for internet service. This service is primarily used as a backup to the AT&T and Comcast internet services.

Cupertino Residents

Unknown market share in Cupertino

4.2.2.4 Infralink Internet

System Overview

Infralink provides an internet communications service for institutions that must continue to operate when problems strike. The Infralink system is a managed, comprehensive, and private wireless communications network that is independent of public communications and power infrastructure.

Cupertino Government

The City has an agreement with Infralink for internet service (currently free) at City Hall. This service is primarily used as another backup to the AT&T and Comcast internet services. Infralink-provided equipment includes an antenna, POE module, hub, and one VoIP phone.

Cupertino Residents

This service is not available to the general public.

4.2.3 Radio

Radio services break down into 2 primary classifications: Broadcast and two-way.

Class	Comm Service	Risk Owner	Critical Comm Elements
Radio	Radio, Broadcast	Commercial Stations	Commercial Broadcast
		Cupertino City Channel	AM/FM/Sat Radio Reception, Commercial
			TIS Broadcast
		Resident	AM Radio Reception, TIS
			AM/FM/Sat Radio Reception, Commercial
		Radio Comms, Two-way	Cupertino DPW
	Comms, Part 90, Simplex, Trunk Radio		
	Comms, Part 90, Simplex		
	Cupertino ARES		Comms, Part 97, Repeater
Comms, Part 97, Simplex			

4.2.3.1 Broadcast Radio, Commercial

System Overview

The Bay Area (as of October 2015) has 41 AM and 71 FM stations on the air. Many of the larger corporate stations have backup generator power and other assets to ensure they remain on the air.

There are some stations that operate as either a PEP or EAS station.

- Definition:** Primary Entry Point (PEP) stations are private or commercial radio broadcast stations that cooperatively participate with FEMA to provide emergency alert and warning information to the public before, during, and after incidents and disasters. The FEMA PEP stations also serve as the primary source of initial broadcast for a Presidential Emergency Alert Notification (EAN). PEP stations are hardened facilities, and equipped with back-up communications equipment and power generators designed to ensure they continue broadcasting information to the public during and after an event.¹⁰

The following radio station is the Bay Area PEP station for the Emergency Alert System.¹¹

Station/Facility	Description
PEP KCBS 740	

- Definition:** The Emergency Alert System (EAS) is a national warning system in the United States established in 1997 by the Federal Communications Commission (FCC) that replaced the Emergency Broadcast System (EBS). The system is designed to enable the President of the United States to speak to the country within 10 minutes. In addition, EAS is also used to alert the public of local weather emergencies such as tornadoes, flash floods, or other hazards.
- Definition:** CLERS: California Law Enforcement Radio System, the law enforcement community's mutual aid coordination radio network.

¹⁰ <http://www.fema.gov/primary-entry-point-stations>

¹¹ <http://allhazards.blogspot.com/2013/02/find-your-nearest-pep-radio-station.html>

The following stations are listed in the “EMERGENCY ALERT SYSTEM (EAS) - FCC LOCAL AREA PLAN San Francisco Bay Area Counties, California”.¹²

Station/Facility	Monitors
LP1 KCBS 740	KQED 88.5, KSJO-FM 92.3, NWS 162.400mhz, CLERS 453.875mhz and Sacramento-Sierra Local Area; 1 of the following: KFBK 1530, KSTE 650, KGBY(FM) 92.5, KEDR(FM) 88.1, KSTN(FM) 107.3, or KSTN 1420.
LP1S KSOL 98.9	KQED 88.5, KSJO-FM 92.3, NWS 162.400mhz, CLERS 453.875mhz and Sacramento-Sierra Local Area; 1 of the following: KFBK 1530, KSTE 650, KGBY(FM) 92.5, KEDR(FM) 88.1, KSTN(FM) 107.3, or KSTN 1420. (KSOL has agreed to translate all EAS messages into Spanish.)
LP2 KQED 88.5	KCBS 740, KSJO(FM) 92.3, NWS 162.400mhz, CLERS 154.710mhz and Sacramento-Sierra Local Area; 1 of the following: KFBK 1530, KSTE 650, KGBY(FM) 92.5, KEDR(FM) 88.1, KSTN(FM) 107.3, or KSTN 1420.
LP2 KSJO(FM) 92.3	KCBS 740, KQED 88.5, NWS 162.400mhz CLERS 154.710mhz and (recommended) the Monterey Bay Counties LP1, LP2.
LP2 KZST(FM) 100.1	KCBS, KQED, NWS, CLERS Sonoma County
All other LP and Cable TV firms	KCBS 740, KQED 88.5 (required) NWS 162.400mhz, CLERS 154.710mhz (recommended)

Over-air reception is from any commercially available AM or FM radio. No special equipment is required.

4.2.3.2 Broadcast Radio, TIS

- Definition:** Governmental entities, park districts and other authorities may be eligible to operate a Travelers' Information Station (TIS, also called Highway Advisory Radio) for the purpose of disseminating information by broadcast radio to travelers. A license is required before construction and operation of a Travelers' Information Station. These stations are limited to a 10 watt transmitter output power, an antenna height no greater than 15 meters (49.2 feet), and a coverage radius of 3 km (~2 miles). These stations may not transmit commercial information.

Cupertino Government

The City of Cupertino owns and operates a TIS station licensed as WQGH344, broadcasting on 1670 AM from City Hall with information about and for the residents of Cupertino.

1. Equipment

- TR6000 transmitter (30 watts max.)
- Whip style antenna (omni-directional)
- Backup Power: city hall generator, UPS system, and cabinet/rack battery system. The battery system provides approx. 4 days of backup power, in case the city hall generator fails.

NOTE: Due to battery age, a battery replacement is planned to be completed by the end of 2015.

Cupertino Residents

Over-air reception is from any commercially available AM radio. No special equipment is required.

¹² http://www.well.com/user/dmsml/eas/sf_bay_plan_2004.pdf

4.2.3.3 Two-way Radio, Cupertino Department of Public Works

System Overview

Part 90 Private Land Mobile Radio Systems are used by companies, local governments, and other organizations to meet a wide range of communication requirements, including coordination of people and materials, important safety and security needs, and quick response in times of emergency. The services included in Private Land Mobile are Public Safety, Industrial/Business, Private Land Mobile Paging, and Radiolocation.

- **Definition:** A trunked radio system is a complex type of computer-controlled two-way radio system that allows sharing of relatively few radio frequency channels among a large group of users. Instead of assigning a radio channel to one particular organization at a time, users are assigned to a logical grouping called a "talkgroup". When any user in that group wishes to converse with another user in the talkgroup, a vacant radio channel is found automatically by the system, assigned to the talkgroup, and the conversation takes place on that channel. Many unrelated conversations can occur on a channel, making use of the otherwise idle time between conversations. A control channel coordinates all the activity of the radios in the system.

Cupertino Government

The City operates a trunk radio system and is licensed under Part 90 with the call sign WQNG356.

1. Equipment
 - a. Repeater: located on Cupertino City Center roof
 - b. Base Stations: qty 2; located at City Hall and the Service Center
 - c. Mobile Stations: qty 90. Includes *HandiTalkies* and mobile radios
 - d. Four UHF frequencies are licensed for use.

4.2.3.4 Two-way Radio, Cupertino Amateur Radio Emergency Service

System Overview

Part 97 Amateur Radio (ham radio) is a popular hobby and service that brings people, electronics and communication together. Amateur Radio operators are licensed by the FCC to operate on a variety of bands depending on their class of license. Public service and emergency communications are a significant part of this service.

Cupertino Government

The City has made investments in amateur radio equipment to support the mission of CARES.

Cupertino Residents

The Cupertino Amateur Radio Emergency Service (CARES) is made up of trained amateur radio operator volunteers organized to assist in public service and emergency communications. They bring their own equipment and expertise and respond as volunteers when asked to do so.

1. Equipment
 - a. Voice radio: Transceivers (transmitters/receivers), allows an operator to send and receive voice messages.
 - b. Voice Repeater: CARES operates a high level repeater under the license W6TDM.
 - c. CARES operates on the 2 m and 70 cm band on frequencies that are either coordinated or agreed to.

4.2.4 Messaging

Class	Comm Service	Risk Owner	Critical Comm Elements
Messaging	Digital Messaging	Cupertino City Channel	Fiber interconnect network
		Cupertino IT	City Intranet equipment
			Enterprise Exchange Servers
			Virtual Desktop Interface
		SCC RACES	AX25 Packet Network
Cupertino ARES	AX25 Packet Access		

4.2.4.1 City Fiber Optic Network

System Overview

The City owns and uses a fiber optic network to support its traffic control systems as managed by the City's Traffic Division. The system has been expanded to include high-speed/high bandwidth drops to several City sites including: City Hall, Senior Center, Sports Center, Community Hall, and Quinlan Center. The connection to the Service Center is pending.

4.2.4.2 Amateur Radio Packet

System Overview

Packet radio is a digital mode of Amateur Radio communications that corresponds to computer telecommunications.¹³ A computer interfaces with a radio modem (terminal node controller, TNC) that connects to a radio. Packet radio takes any data stream sent from a computer and sends it by radio to another amateur radio station similarly equipped.

Santa Clara County RACES has adopted an application called *Outpost Packet Message Manager* that looks and behaves like an email client. County RACES also uses *JNOS* as its Bulletin Board System (BBS, essentially a mail drop). Other tools and procedures have been developed to enhance the message passing process resulting in a smooth integration of digital messaging into the emergency response. Measured digital message throughput is about 20 times faster than passing messages by voice.

Cupertino Residents

Both CARES members and the City have purchased personal equipment to operate packet radio.

1. Equipment
 - a. Personal Bulletin Board System (PBBS). Back up to the Santa Clara County RACES networked BBS system.
 - b. Packet Radio. Supports email-like digital message handling, ideal for lists, instructions, or any complex listing where you can't afford to get the message wrong.

¹³ https://www.tapr.org/pr_intro.html

4.2.5 Video

Class	Comm Service	Risk Owner	Critical Comm Elements
Video	Television, Broadcast	Commercial Stations	Commercial Broadcast
		Cupertino City Channel	Public Broadcast, City
			TV, Reception
		PBS Stations	Public Broadcast
		Resident	Cable, Reception
			DSL, Reception
			TV, Reception
		Television, Satellite	Dish Network
	DirectTV		Satellite, Uplink Stations
	Cupertino City Channel		Satellite, DirectTV, Reception
			Satellite, Dish Network, Reception
	Resident		Satellite, DirectTV, Reception
			Satellite, Dish Network, Reception
	Video, Distribution	Cupertino City Channel	Conf Room Distribution equipment
			Digital Signage

4.2.5.1 City Channel

System Overview

The City originates video content from City Hall for distribution to the community.

1. For U-verse, the video content is streamed over two dedicated T1 lines from the City's video control room to AT&T using leased encoding equipment supplied by AT&T.
2. For Comcast, the video content is streamed over a fiber connection running from the City's video control room to the Comcast Imperial Avenue hub that is then forwarded to the Santa Clara master headend where it is inserted into main channel stream.

The City receives television content from Comcast using a cable modem located in the City Hall video control room. Other City facilities also have individual cable modems that are usually located in those facilities' MPOE/electrical rooms.

4.3 MAPPING COMMUNICATIONS CATEGORIES TO ASSETS & SYSTEMS

4.3.1 Communications Categories

Communications Categories describe the methods by which information is fundamentally shared. For this risk assessment, communications technologies are mapped into categories thereby allowing us to evaluate the available communications technologies used in the City that support a category, independent of the underlying technology.

Communications can be grouped into the following categories:¹⁴

1. Verbal / Two-way: Verbal or oral communication that uses spoken words in an exchange between two or more parties for the purpose of sharing information. For this assessment, only

¹⁴ <https://www.google.com/search?q=types+of+communication&ie=&oe=#q=types+of+communications>

telephone and two-way radio services will be evaluated.

2. **Verbal / One-way:** Verbal or oral communication that uses spoken words in a one-way or broadcast fashion to communicate a message. For this assessment, only the broadcast radio and City Channel communications services will be evaluated.
3. **Non-Verbal:** Non-verbal communication includes body language, gestures, facial expressions, and even posture. 55% of in-person communication comes from nonverbal cues like facial expressions, body stance, and tone of voice. Non-verbal communication is not in scope for this evaluation.
4. **Written:** Written communication is used to communicate complicated information (such as statistics, directions, instructions, or other tabular data) that could not be easily communicated through speech alone. Written communication allows information to be recorded so that it can be referred to at a later date. Examples of written communications include memos, proposals, e-mails, letters, spreadsheets, training manuals, and operating policies. For this assessment, only the Internet and messaging communications services will be evaluated.

The approach to evaluating operational risks will start with communication categories that include a variety of communication services.

Communication Types	Communication Services
Verbal / Two-way	Telephone Service, Wired
	Telephone Service, Cellular
	Telephone, AT&T U-Verse
	Telephone, Comcast Xfinity
	Telephone Service, Satellite
	Radio, Two-way
Verbal / One-way	Radio, Broadcast, Commercial
	Radio, Broadcast, TIS
	Television, Broadcast, Commercial
	Television, Broadcast, City
	Television, Satellite
Written	Internet
	Messaging

5 ASSESSING RISK

The following process will be used to perform the Risk Assessment.

1. Differentiate between Initiating Hazards and Impacting Events.
2. Identify the *initiating hazards* that could trigger a communications impacting event.
3. Describe the 3 main *impacting events* that could cause an interruption or failure of a communications capability.
4. Assess the Communications elements against the impacting events in terms of probability of occurrence and seriousness of the impact.
5. For Risks exceeding a specific tolerance, develop recommendations, actions, and strategies that will reduce or mitigate the risk.

5.1 INITIATING HAZARDS

Hazards (or disasters) are combinations of events and circumstances that have an adverse impact on an organization or community. Natural hazards are typically considered "Acts of God" in which there is no one to blame. In contrast, man-made hazards are those in which one or more individuals may be held accountable for contributing to the cause of the disaster. These hazards could be by accident, neglect, or deliberate intent.¹⁵

Hazards are things to be avoided. When this is not possible, preparations should be made to deal with a hazard prior to (mitigations) as well as after it occurs (contingencies).

The City has listed the following as hazards of concern:¹⁶

1. Civil Disturbance
2. Dam Failure
3. Earthquake
4. Power system disruption(Power Failure)
5. Water system disruption (no potable water)
6. Floods
7. Hazardous Materials
8. Landslides
9. Transportation Accidents
10. Terrorism/Weapons of Mass Destruction
11. Wildland/Urban Interface Fires

5.2 IMPACTING EVENTS

When an initiating hazard causes a loss of communications, that loss can be traced back to a limited number of root causes. Regardless of the initiating hazard, and for the purpose of this analysis, the root cause contributing to a loss of communications is characterized as one of the following three impacting events:

¹⁵ [IT Risk Assessment Template](#)

¹⁶ Cupertino Emergency Operations Plan, 2005

1. Loss of connectivity
2. Power Failures
3. System capacity overloading

5.2.1 Loss of Connectivity

Connectivity is linking people, equipment, or automated systems together for the purpose of exchanging information. From a communications perspective, connectivity is characterized by the medium on which the information is carried, and will be described here as either wired (using any kind of cable) or wireless (using any kind of radio). Depending on where the connectivity loss occurs will dictate the extent of the loss of communications.

Fiber Optic cable cuts

Over the past few years, *Fiber Optic* cable cuts have constituted the most common type of connectivity loss. Communications companies have been deploying more than 10 million miles of fiber annually in the U.S., increasing the risk of damage from backhoes, trench-diggers and shovels. Additionally, as far back as 1995, the U.S. Commerce Department's National Institute of Standards and Technology warned that the "power of optical fiber technology is diminishing the number of geographic transmission routes," thereby concentrating the flow of information into fewer paths and "resulting in an increase in network vulnerability."¹⁷

Regardless of the cause, the end result is a loss of communications between those served by the impacted service. More importantly, it usually results in the loss of 911 or e911 calling capability.

- **Definition:** Enhanced 911, E-911 or E911 is a system used in North America that links emergency callers with the appropriate public resources. The system tries to automatically associate a location with the origin of the call for both wireline and wireless callers. This location may be a physical address or other geographic reference information such as X/Y map coordinates. An incoming 911 call is typically answered at the Public Safety Answering Point (PSAP) operated by the governmental agency that has jurisdiction over the caller's location.¹⁸

As reported by CNN, fiber optic internet cables in the San Francisco Bay area have been cut so often over the last few years that the FBI has joined the investigation.¹⁹ Security experts speculate that the attacks could be the work of a disgruntled employee or of terrorists probing the nation's infrastructure to see how long repairs take.

Natural Disasters

Natural disasters have a broader impact on the population, usually with an extended duration of communications outage. Several earthquakes and hurricanes are listed here.

The following tables are a compilation of cable cuts from public media sites and government reports. While this list is neither comprehensive nor complete, it intends to give the reader a sense of the pervasiveness of this particular risk and the history behind this Impacting Event.

¹⁷ [*Growing Vulnerability of the Public Switched Networks: Implications for National Security Emergency Preparedness*](#), Committee on Review of Switching, Synchronization, and Network Control in National Security Telecommunications, 1989

¹⁸ https://en.wikipedia.org/wiki/Enhanced_9-1-1

¹⁹ <http://www.cnn.com/2015/07/01/tech/california-fiber-optic-cable-cuts/>

Sample of Loss of Connectivity Events

Type	Date	Location	Description / Report	Recovery	User Impact	Source
Accidental Cable Cuts	2013	San Juan Islands, WA	Underwater fiber-optic cable became wrapped around a large rock and broke; some residents of Washington state's San Juan Islands were without Internet and telephone service for 10 days.	10 days	1000's	Press
	Mar-2015	Arizona	Several thousand people lost Internet and phone service for 12 hours when an electric company crew accidentally cut a fiber-optic line in northern New Mexico.	12 hours	1000's	Press

Type	Date	Location	Description / Report	Recovery	User Impact	Source
Intentional Cable Cuts	Apr-2009	San Jose, CA	Underground fiber-optic cables in California were cut at four sites, knocking out Wirelines, cell phones and Internet service for tens of thousands in Santa Clara, Santa Cruz and San Benito counties. 911 was unavailable.	unknown	10,000s	Press
	7/6/2014	Berkley	9:44pm, Near 7th St. and Grayson St.	unknown	unknown	FBI
	7/6/2014	Fremont	11:39pm, Near Niles Canyon Blvd. and Mission Blvd.	unknown	unknown	FBI
	7/7/2014	Walnut Creek	12:24am, Near Jones Road and Iron Horse Trail.	unknown	unknown	FBI
	7/7/2014	Fremont	12:51am, Near Niles Canyon Blvd. and Alameda Creek.	unknown	unknown	FBI
	7/7/2014	San Jose, CA	2:13am, Near Stockton Ave. and University Ave.	unknown	unknown	FBI
	Feb-2015	Arizona	Tens of thousands of residents were without Internet service after vandals cut through an underground bundle of fiber-optic cables owned by CenturyLink. ATMs went down, stores couldn't process credit cards, and 911 emergency service was unavailable. ~15 hour outage.	15 hours	10,000s	Press
	2/24/2015	Fremont	11:30pm, Near Niles Canyon Blvd. and Mission Blvd.	unknown	unknown	FBI
	2/24/2015	Fremont	11:30pm, Near Niles Canyon Blvd. and Alameda Creek	unknown	unknown	FBI
	6/8/2015	Alamo	11:00pm, Near Danville Blvd. and Rudgear Road.	unknown	unknown	FBI
	6/8/2015	Fremont	11:40pm, Near Overacker Ave. and Mowry Ave.	unknown	unknown	FBI
6/9/2015	Walnut Creek	1:38am, Near Jones Road and Parkside Dr.	unknown	unknown	FBI	

Type	Date	Location	Description / Report	Recovery	User Impact	Source
Intentional Cable Cuts	6/30/2015	Sacramento	Bay Area vandalism disrupts service to Sacramento, Rocklin Wave Broadband customers; three major fiber cables connecting the region were cut; ~15 hour outage	15 hours	10,000s	Press
	7/1/2015	San Jose, CA	Unknown persons broke into an underground vault and cut three fiber-optic cables belonging to service providers Level 3 and Zayo.	unknown	unknown	Press
	7/15/2015	San Joaquin Cty	Fiber optic line intentionally cut causes 911 outages; impacted Verizon Wireless and AT&T customers in the region. 10 hour outage	10 hours	unknown	Press
	9/14/2015	Livermore, CA	Unknown persons deliberately severed two AT&T fiber optic cables in the Livermore, CA. Monday night.	unknown	unknown	Press

Type	Date	Location	Description / Report	Recovery	User Impact	Source
Natural Disasters	10/17/1989	Bay Area	Loma Prieta Earthquake. 6.9m Earthquake approximately 10 mi (16 km) northeast of Santa Cruz on a section of the San Andreas Fault System. Many San Francisco radio and television stations were temporarily knocked off the air. 911 was overloaded, particularly in heavily damaged areas.	1 hour	unknown	Various
	1/17/1994	Southern CA	Northridge Earthquake. 6.0m Earthquake struck Southern California at 4:31 a.m. Communication immediately after the Northridge earthquake was very difficult for both emergency workers and residents. Power was out for most of the area, which affected the operation of the central phone system. There were numerous fires at electrical stations and telephone switching stations. One reason for phone service failure after the earthquake was that the system itself was overwhelmed. There were many phones off the hook, either knocked off by the earthquake or off with people placing calls. The system will automatically turn itself off when a certain percentage of phones are off the hook, to limit the amount of damage done to switching stations and allow for faster service restoration.	unknown	unknown	Report

Type	Date	Location	Description / Report	Recovery	User Impact	Source
Natural Disasters	Sep-2005	Louisiana coast	Hurricane Katrina ; one of the deadliest hurricanes to hit the United States. Virtually all of the critical infrastructure sectors in the region were put out of commission at the same time. Per DHS, "the magnitude of the storm was such that the local communications system wasn't simply degraded; it was, at least for a period of time, destroyed." Over 180 central office locations were running on generators as commercial power sources failed. 100 commercial radio stations were forced off the air. Up to 2,000 cell towers were also knocked out and responder Land Mobile Radio communications were significantly degraded. Emergency 911 service was severely damaged, and surviving stations were soon overwhelmed by spiking call volumes as desperate people tried to get help or check on those at risk.	weeks	millions	NDU
	Dec-2012	East Coast	Hurricane Sandy . The deadliest storm of the 2012 Atlantic Hurricane Season. The outages affected people in 17 states, as far west as Michigan. Key Manhattan Central Office facilities were disrupted when flooding damaged power backup equipment including onsite diesel generators and fuel pumps in their basements or first floor. 25% of the cell phone base stations in the affected area lost service. Other problems not listed here.	weeks	8,100,000	various

5.2.2 Power Failures

All communications systems require electrical power to operate. Power is supplied from commercial mains, backup generators, and Uninterruptible Power Supplies (UPS) to name a few.

A power outage – also referred to as a power cut, power failure or a blackout – is a short- or long-term loss of the electric power to an area.

Power failures are particularly critical at sites where the environment and public safety are at risk. Institutions such as hospitals, sewage treatment plants, PSAPs, and EOCs (to name a few) will usually have backup power sources that will automatically engage when primary electrical power is lost. Other critical systems, such as telecommunication systems, also may have emergency power sources.

Natural Causes

The primary initiating event for power failures is usually some type of natural disaster. In the Bay Area, while the earthquake is the event for which most jurisdictions are preparing, our area has had its share of blackouts for a variety of reasons, including storms. When this happens, electrical system faults could occur as damage to power stations, electric transmission lines, substations or other parts of the distribution system, a short circuit, or the overloading of electricity mains.

Deliberate Attacks

A more disturbing initiating event is the attack on the power infrastructure as was the case in San Jose CA in 2013. Additionally, USA Today reported²⁰ that about once every four days, part of the nation's power grid is struck by a cyber or physical attack. As a result, the Department of Energy has directed new rules be written and implemented to protect power system assets.

1. From 2011 to 2014, the U.S. Department of Energy received 362 reports from electric utilities of physical or cyber-attacks that interrupted power services.
2. The Department of Homeland Security was alerted to 151 energy-related “cyber incidents” in 2013, up from 31 in 2011 and 111 in 2012.

The concern: If it were widely replicated across the country, an attack could take down the U.S. electric grid and black out much of the country. Loss of communications would follow.

The following tables are a sample of the power failure events. This listing does not include every power outage in the U.S. and does not include details on the hundreds of cyber-attacks that have been reported to the government.

²⁰ <http://www.usatoday.com/story/news/2015/03/24/power-grid-physical-and-cyber-attacks-concern-security-experts/24892471/>

Sample of Power Failure Events

Type	Date	Location	Description / Report	Recovery	User Impact	Source
Accidental	11/9/1965	Northeastern U.S. and Canada	The Northeast blackout of 1965 was a significant disruption in the supply of electricity affecting parts of Ontario in Canada and 8 states in the United States. The blackout was caused by the tripping of a 230-kilovolt transmission line near Ontario, Canada, which caused several other heavily loaded lines to also fail. The cause was human error that happened days before when maintenance personnel incorrectly set a protective relay on one of the transmission lines in Queenston, Ontario.	13 hours	30,000,000	Press
	8/14/2003	Northeastern U.S. and Canada	The Northeast blackout of 2003 was a widespread power outage that occurred throughout parts of the Northeastern and Midwestern United States, and the Canadian province of Ontario. The cause was a software bug in the alarm system at a control room located in Ohio. 256 power plants were ultimately affected and brought off-line. Impact: loss of water supply (boil water notices issued), sewage discharge into rivers, loss of transportation and traffic control, loss of internet, loss of cell sites when generators ran out of fuel.	1-2 days	55,000,000	Wiki
	9/8/2011	Pacific Southwest	Pacific Southwest power outage struck about 7 million customers of six electric utilities in Arizona, southern California, and northwestern Mexico. The outage was the result of 23 distinct events that occurred on 5 separate power grids in a span of 11 minutes. Human error caused an inter-substation 400KV switch to open with a substantial ripple affect across the region. A federal investigation reported problems in operations planning and situational awareness. San Diego Gas & Electric had a business continuity plan and procedures for power restoration. ²¹	12 hours	7,000,000	Report
	1/20/2015	Berkley	Traffic lights went dark Tuesday afternoon in the East Bay as a massive power outage affected the area and caused the Downtown Berkeley BART Station to close at one point.	hours	38,000	Press
	4/13/2015	San Francisco	PG&E crews restored power to more than 30,000 customers in San Francisco affected by an outage that started late Sunday	1 hour	35,000	Press

²¹ <http://www.uschamberfoundation.org/blog/post/how-handle-earthquake-power-outage-challenges-and-business-resumption/31260>

Type	Date	Location	Description / Report	Recovery	User Impact	Source
Accidental	5/18/2015	San Francisco	A helium balloon was to blame for thousands of residents and businesses losing power in San Francisco's Fisherman's Wharf and North Beach neighborhoods.	2.5 hours	7,600	Press
	6/8/2015	Berkley	A squirrel caused a massive outage that left more than 45,000 East Bay PG&E customers in the dark. The squirrel did not survive.	2 hours	45,000	Press

Type	Date	Location	Description / Report	Recovery	User Impact	Source
Intentional	4/16/2013	San Jose, CA	Sniper Attack knocked out substation. Perpetrators cut telephone cables, and then spent 20 minutes shooting at the power station. Seventeen (17) giant transformers that deliver power to the Bay Area were knocked out. PG&E rerouted power to the Bay Area through other substations. Service restoration took 27 days to make repairs and bring the substation back on line.	27 days	unknown	Press
	12/23/2015	Ukraine	Cyber Attack caused power outages at three regional electric power distribution companies. The cyber-attack was synchronized and coordinated following extensive reconnaissance of the victim networks, with the cyber-attacks occurring at each company within 30 minutes of each other. Malicious remote operation of regional circuit breakers was conducted by multiple external individuals using either existing remote administration tools at the operating system level or remote industrial control system (ICS) client software via virtual private network (VPN) connections. The companies believe that the actors acquired legitimate credentials prior to the cyber-attack to facilitate remote access. Additionally, the actors wiped some systems by executing the KillDisk malware at the conclusion of the cyber-attack. The KillDisk malware erases selected files on target systems and corrupts the master boot record, rendering systems inoperable. While power was restored relatively quickly, it took several more months for control centers to return to normal. ^{22, 23}	6 hours	225,000	DHS, Press

²² <https://ics-cert.us-cert.gov/alerts/IR-ALERT-H-16-056-01>

²³ <https://www.wired.com/2016/03/inside-cunning-unprecedented-hack-ukraines-power-grid/>

Type	Date	Location	Description / Report	Recovery	User Impact	Source
Natural	Sep-1859	Global	Solar Storm (Carrington Event) hit the earth causing Northern lights as far south as Cuba and Hawaii and global telegraph lines to spark, setting fire to some telegraph offices. ²⁴	Unknown	Unknown	NASA
	8/4/1972	Illinois	Solar Flare knocked out long-distance telephone communication across Illinois. This event caused AT&T to redesign its power system for transatlantic cables.	Unknown	Unknown	NASA
	3/13/1989	Quebec	Solar Flare caused geomagnetic storms that disrupted electric power transmission from the Hydro Québec generating station in Canada, blacking out most of the province and plunging 6 million people into darkness for 9 hours; aurora-induced power surges even melted power transformers in New Jersey.	9 hours	6,000,000	NASA
	Oct-1989	Bay Area	Loma Prieta Earthquake. 6.9m Earthquake approximately 10 mi (16 km) northeast of Santa Cruz on a section of the San Andreas Fault System. Estimated 1.4 million people lost power following the quake, mainly due to damaged electrical substations. Power was restored to most of San Francisco by midnight, and all but 12,000 customers had their power restored within 2-3 days.	2-3 days	~1,400,000	Wiki
	1/17/1994	Southern CA	Northridge Earthquake. 6.0m Earthquake struck Southern California at 4:31 a.m. 82,000 residential and commercial units and 5,400 mobile homes were damaged or destroyed. Many apartment complexes with “soft story” ground floor parking suffered significant damage. About 125,000 people were made temporarily homeless. Massive power outages were reported across LA, total impact was about 1,400,000, with 300,000 residents without power for 1 week.	1 week	300,000	Press
	Sep-2005	Louisiana coast	Hurricane Katrina; one of the deadliest hurricanes ever to hit the United States. Virtually all of the critical infrastructure sectors in the region were put out of commission at the same time. Combination of rains and winds downed trees and power lines, leaving 3.9 million people without power across the gulf states.	weeks	3,900,000	Wiki

²⁴ http://science.nasa.gov/science-news/science-at-nasa/2008/06may_carringtonflare/

Type	Date	Location	Description / Report	Recovery	User Impact	Source
Natural	Dec-2012	East Coast	Hurricane Sandy. The deadliest storm of the 2012 Atlantic Hurricane Season. The outages affected people in 17 states, as far west as Michigan.	weeks	8,100,000	various
	12/11/2014	SF Bay Area	A major storm moved across Northern California causing power outages affecting nearly 100,000 customers.	hours	100,000	Press
	8/24/2014	Napa	Magnitude 6.0 earthquake struck South Napa at 3:20 a.m., about three miles northwest of American Canyon. The local hospital treated 211 patients. 100 homes were red-tagged (labeled unfit to enter).	2.5 hours	69,000	Press
	2/6/2015	San Francisco	Storm. Nearly 55,000 Bay Area customers lost power during this storm. As of 4 p.m. that day, around 14,800 remained without power in the area.	hours	55,000	Press
	6/8/2015	South Bay	Heat wave leads to power outages for thousands in the South Bay. PG&E reported significant power outages throughout the Bay Area, and confirmed that the majority of outages impacting the area were due to temperature-related equipment failures.	18 hours	12,000	Press
	7/20/2015	New York City	Heat Wave. 18,500 lost power in NYC during an intense heat wave. Con Ed also reduced power to 138,000 homes and businesses in several Brooklyn and Queens neighborhoods. Both above-ground and underground cables had gone out of commission on Staten Island, and crews deployed generators to restore service while repair people sorted out the problems.	Hours	18,500	Press
	9/10/2015	Los Angeles	Heat Wave. Thousands of residents across Southern California were without power after a brutal heat wave led to near record-high demand on power grids. This triggered blackouts in some areas of Los Angeles, Riverside and Orange counties. A wide swath of Southern California's inland valleys were affected by the outage, where temperatures climbed into the upper 90s and triple digits for a third straight day.	Hours	15,000	Press

5.2.3 System Capacity Overloading

A number of capacity issues can hamper emergency communications traffic during a disaster response.

- **Definition:** Capacity is a communications systems' ability to handle demand, provide coverage, and send different types of information (voice and data). Some communications systems may lack the capacity to prevent system crashes due to spikes in demand that can follow disasters.²⁵

Telecommunications companies state that their systems are not designed to handle everyone in a region attempting to make a call simultaneously. Past disasters, such as 9/11 and Hurricane Katrina, created excessive demand; this caused communications systems to fail.

Additionally, for unusual occurrences like minor earthquakes, there is a natural human tendency to pick up the phone, call family or friends, and engage in a "did you feel that?" conversation. This was evident during the two earthquake examples listed below, leading to a loss of system access by subsequent callers.

The following tables are a sample of the system capacity overload events.

²⁵ *Emergency Communications: Vulnerabilities Remain and Limited Collaboration and Monitoring Hamper Federal Efforts*, David Wise

Sample of System Capacity Overload Events

Type	Date	Location	Description / Report	Recovery	User Impact	Source
Intentional	9/11/2001	New York	World Trade Center. During the 9/11 attack, traditional telecommunications were stretched and overloaded. Phone networks along the entire East Coast were congested into uselessness. 911 operators were overwhelmed with calls and could do little more than offer encouragement.	unknown	Unknown	Wiki
	7/7/2005	London	Underground bombing. On the day of the 7 July 2005 London bombings, mobile phone networks, including Vodafone, reached full capacity and were overloaded by 10:00 a.m., only an hour after the bombs went off.	unknown	Unknown	Wiki

Type	Date	Location	Description / Report	Recovery	User Impact	Source
Natural	7/30/2008	Los Angeles	Earthquake, 5.4M. Centered near Chino Hills in San Bernardino County. Cell phone lines were jammed throughout the region as people frantically made calls immediately after the jolt. Some mobile providers reported up to an 800% jump in calls, overwhelming the networks. CA OES urged Californians to free up the lines for emergency use. No damage was reported to the telephone network infrastructure.	unknown	Unknown	Press
	8/23/2011	Washington DC	Earthquake, 5.8M. Struck central Virginia at 1:53 pm EST. Cell phone networks were jammed in Manhattan, Washington D.C., and other areas. SMS text messages could get through. Major carriers reported no major problems with their telephone network infrastructure.	unknown	Unknown	Press

5.3 GENERAL PROBABILITY OF IMPACTING EVENTS

Hazard assessment will be performed within the context of the City of Cupertino and the surrounding areas.

If this hazard occurs ↓, then it could result in that impacting event ⇨	Probability of Impacting Events		
	Loss of Connectivity	Power Failure	System Overload
Civil Disturbance	Low	Low	Medium
Dam Failure	Low	Low	Low
Earthquake	High	High	High
Power system disruption(Power Failure)	Low	High	Medium
Water system disruption (no potable water)	Low	Low	Low
Floods	Medium	Medium	Medium
Hazardous Materials	Low	Low	Low
Landslides	Low	Low	Low
Transportation Accidents	Low	Low	Low
Terrorism/Weapons of Mass Destruction	High	High	High
Wildland/Urban Interface Fires	Low	Low	Low

5.4 DESCRIBING RISK

Each of the Communications Categories listed in Section 4.3.1 – Verbal/Two-way, Verbal/One-Way, and Written – will be assessed using the 3 impacting events described above. The assessment includes an evaluation of the probability of an initiating hazard occurring (and its impacting event) and the severity if it does occur (magnitude of the loss). Existing mitigations and backup measures will be called out when known. The following definitions (IEC 61508 standard ²⁶) will be used for this evaluation.

Probability: the likelihood of an initiating hazard and impacting event to occur that has an impact on the City.

1. Incredible - Cannot believe that it could occur.
2. Improbable - So unlikely, it can be assumed the occurrence may not be experienced.
3. Remote - Unlikely, but possible to occur in the life of an item; has never occurred.
4. Occasional - Likely to occur sometime in the life of an item; has occurred at least once before.
5. Probable - Will occur in the life of an item; has occurred more than once before.
6. Frequent - Expected to occur frequently; has occurred frequently.

Seriousness: the severity of the initiating hazard and impacting event on the City (government, businesses, and residences).

1. Negligible – no measurable system impact; no impact to the city; minor injuries at worst.
2. Marginal – minor system impact; minor city impact; major injuries to one or more persons.
3. Critical –systems are damaged or destroyed; all city operations are disrupted; loss of a single life.
4. Catastrophic – uncontrolled environmental impact; multiple loss of life.

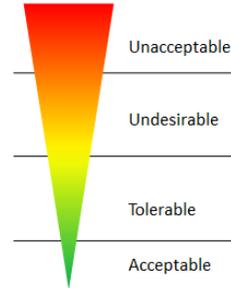
²⁶ International standard titled “[Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems](#)”, International Electrotechnical Commission

Risk is the potential loss of something of value or the intentional interaction with uncertainty. Uncertainty is a potential, unpredictable, unmeasurable and uncontrollable outcome; risk is a consequence of action taken in spite of uncertainty.²⁷

Risk increases if either probability or severity increases provided the other component does not decrease proportionally.

Risk Classifications provide a means for applying thresholds for taking action to address risk. For this report, the following thresholds are used.²⁸

- **Class 1: Unacceptable** in any circumstance.
- **Class 2: Undesirable:** Tolerable only if risk reduction is impracticable or if the costs are grossly disproportionate to the improvement gained.
- **Class 3: Tolerable** if the cost of risk reduction would exceed the improvement.
- **Class 4: Acceptable** as it stands, though it may need to be monitored.



Risk Class Space is a two-dimensional picture that helps quantify risk as best possible. The numbers in the boxes are the Risk Classification numbers listed above.

The risk space is intended to provide insight into whether a considered risk should be further mitigated or it could be tolerated without unduly compromising the integrity of government or business operations.²⁹

		Seriousness			
		Negligible	Marginal	Critical	Catastrophic
Probability	Frequent	2	1	1	1
	Probable	3	2	1	1
	Occasional	3	3	2	1
	Remote	4	3	3	2
	Improbable	4	4	3	3
	Incredible	4	4	4	4

Mitigations are the actions taken that reduce the probability of risk.

Contingencies are the actions taken to minimize further loss or impact once a risk has occurred.

5.5 INFRASTRUCTURE PROTECTION GOALS

To develop an optimal set of response plans and strategies, the following goals will be used as a means for evaluating the resiliency of the City’s communications assets.

5.5.1.1 Redundancy

If a critical system fails, another should always be there to do its work.³⁰ Redundant systems are designed using multiple copies of the same type of resource to increase system dependability.

While redundant systems improve service availability, they must guard against *common cause failures*.

- **Definition:** a common cause failure is a single failure or condition that affects the operation of multiple devices or systems that would otherwise would have been considered independent.

²⁷ <https://en.wikipedia.org/wiki/Risk>

²⁸ https://en.wikipedia.org/wiki/IEC_61508

²⁹ <http://www.mddionline.com/article/risk-analysis-beyond-probability-and-severity>

³⁰ <http://eprints.lse.ac.uk/36537/1/Disspaper53.pdf>

Goal: The City uses multiple communications capabilities to sustain operations and eliminate single points of failure that could disrupt primary services.

5.5.1.2 Diversity

Diversity is used to protect redundant systems from common cause failures. Diversity relies on independent use of different solution implementations to accomplish the same results.

One type of diversity in communications is route diversity. This is generally defined as the communications routing between two points over more than one geographic or physical path with no common points.

To provide diversity, connections between two points should be by separate and distinct methods with no common points of connection along the way.³¹ Diverse redundancy uses a different technology, design, manufacture, software, etc. to reduce the influence of common cause failures.³²

Goal: The City has diverse primary and backup communications capabilities that do not share common points of failure.

NOTE: Redundancy and diversity are effective when failures are random. They are less effective when failures are due to wear, are systemic, or intentionally introduced.

5.5.1.3 Recoverability

Recoverability refers to the ability to restore services back to the point at which a failure occurred. The ability to recover quickly from a system failure or disaster depends not only on the integrity of operational data (when data needs to be restored), but also on having a predefined plan for recovering that data and restarting operational processes.

Goal: Plans and processes are in place to restore communications operations quickly if an interruption or failure does occur.

5.5.1.4 Resiliency

Resiliency is the ability to provide and maintain an acceptable level of service in the face of faults and challenges to normal operation. It is the capacity that ensures adverse stressors and shocks do not have long-lasting adverse consequences.

Goal: Critical Infrastructure and their communications capabilities should be able to withstand natural and man-made hazards with minimum interruption or failure.

While resiliency is easy to define, it continues to be difficult to quantitatively measure. For the time being, no resiliency measure will be assigned to any communications system covered in this report.

5.6 RISK ANALYSIS

The following communication categories are reviewed as part of this assessment:

1. Verbal / Two-way – Cupertino Government
2. Verbal / Two-way – Cupertino Resident
3. Verbal / One-way (broadcast)
4. Written (Data / Internet)

³¹ <http://www2.fcc.gov/pshs/techttopics/techttopics14.html>

³² http://www.processoperations.com/SafeInstrSy/SS_Ch03i.htm

5.6.1 Verbal / Two-way – Cupertino Government

5.6.1.1 Redundancy

1. Loss of Wireline telephone only. This is the City’s primary telephone service as provided by AT&T. Also implies a loss of FAX capability.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R1. Cable break between City offices and the AT&T Central Office.	Accidental: excavation cuts the cable.	Remote (3) Unlikely, but possible	Marginal (2)	Tolerable	Develop City-internal cell phone telephone directory.	City Staff moves to city-funded or personal cell phones (1 st backup) to continue to transact City business.

a. **Impact of the Loss:**

- i. Some reduction in staff productivity may occur.
- ii. Two-way telephone communications volume is reduced by about 50% because no public directory of cell phone numbers exists. Inbound calling is limited to the public having specific knowledge of a City Staff cell phone number.

2. Loss of Cellular only. Verizon, as with all cellular service providers, provides multiple cellular network access points (cell towers).

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R2. Cell Phone battery runs out of charge (smartphone: <24 hours).	User inattentiveness or inaction to the state of the charge.	Occasional (4) Likely to occur	Negligible (1)	Tolerable		
R3. Cell Towers loses power, backup batteries are exhausted (8 to 48 hours).	An extended regional power failure caused by natural or intentional events.	Occasional (4) Likely to occur	Marginal (2)	Tolerable		

a. **Impact of the Loss:**

- i. Some reduction in staff productivity may occur.
- ii. Little or no impact if only cell phone service is lost.

3. Loss of Wireline and Cellular. This is no longer business as usual and the cause can be assumed to be some regional impacting event.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R4. Cable break between City offices and the Telco Central Office and loss of Cell Phone.	See above risks.	Remote (3) Unlikely, but possible	Critical (3)	Tolerable		<ol style="list-style-type: none"> 1. Satellite Phone is used as needed. 2. Cupertino Alert System updates are made by Satellite Phone. 3. CARES is activated for passing messages with County EOC.

a. **Impact of the Loss:**

- i. Significant impact on City Government’s ability to deliver services to the community.
- ii. City Hall EOC is activated and begins managing the incident for the city.
- iii. City Staff is directing its efforts on stabilizing the situation and drives the recovery.
- iv. Two-way communications volume is constrained by the one available satellite phone handset. This phone would be managed by a single user and likely dedicated to EOC use.

4. Loss of Wireline, Cellular, and Satellite: The Satellite telephone is the first emergency backup communications system to be invoked. Currently, there is one Satellite phone in the City that is managed by City Channel for use by the EOC.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R5. Loss of Satellite and/or ground station with other losses.	Satellite system assets are damaged or left inoperable.	Remote (3) Unlikely, but possible	Critical (3)	Tolerable		All communications shifts to terrestrial radio.
R6. Loss of backup power at City Hall.	Loss of Commercial power; backup generator fails	Probable (5) Will and has occurred	Critical (3)	Unacceptable		All communications shifts to terrestrial radio.

a. **Impact of Loss:**

- i. A loss of all three modes constitutes an *unacceptable* Risk; no city staff has access to any telephone service.
- ii. City loses the ability to update the Cupertino Alert System.

5. Loss of Radio, two-way. A loss of wireline and cellular telephone service would also trigger the use of all two-way radio services in the City.

a. Covered services:

- i. City Trunk Radio (Part 90). This system is for City internal use only and would have already been in use supporting the city’s existing radio-based operations.
- ii. Amateur Radio (Part 97). The Cupertino Amateur Radio Emergency Service (CARES) would be the first emergency radio backup communications system called into service. CARES focus would be on supporting the emergency response as directed by the EOC with EOC-to-Field and EOC-to-County communications.
- iii. County EOC-to-EOC Radio. This radio is dedicated to direct EOC to County communications by City Staff.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R7. Loss of power.	Loss of all backup power (generators, batteries).	Remote (3) Unlikely, but possible	Critical (3)	Tolerable		Not Defined
R8. Loss of capability.	Solar Storm, Solar Flare, or Electro Magnetic Pulse.	Remote (3) Unlikely, but possible	Catastrophic (4)	Undesirable	Not Defined	Not Defined

b. Impact of Loss:

- i. With a Solar Storm, Solar Flare, or Electro Magnetic Pulse (EMP) event, all unprotected electronic equipment may be disrupted or destroyed.

Summary

There are multiple levels of redundant systems available to the city for Verbal/Two-way communications. As the City progresses from normal to emergency operations, the types of message transition from normal business operations to response and recovery. The number of city staff members that can 'make a call' is dramatically reduced.

Service	User Base	Use	Message Type
Wireline	300 employees	Normal	City business
Cell phone, City funded	41 employees	Normal	Some city business
		On loss of wireline	City business
Cell phone, personal	~260 employees	Personal	Personal message
		On loss of wireline	Some city business
Satellite	1 employee	On loss of wireline and cell phones	Event messages Limited city business
Two-Way Radio		On loss of wireline and cell phones	Event messages

In the event of an accidental wireline cable cut, it could be expected that service would be restored within a 24 hour period. For intentional cuts, the recovery time may be longer depending on the extent of the damage.

The critical impacting event is an extended power failure throughout the City and region. During a power failure, the City telephone system (wireline and Centrex) should continue to work. A multi-day extended event could cause a loss of the cellular communications.

The electrical power risk is the City Hall's backup generator and the uncertainty of its ability to run and carry the City Hall electrical load for an extended period of time.

Recommendations

1. Run an extended test of the City's various facility backup generators under load to confirm their resiliency. Correct deficiencies or replace as necessary.
2. Evaluate the number of talk-groups that the City's trunk radio system can support and the information throughput of the system. Expand the number of frequencies as necessary.

5.6.1.2 Diversity

Message Delivery

There is limited telephone system diversity. The City subscribes with AT&T as its wireline telephone service provider for all its phone needs. There is no cable route diversity from any city facility to the Central Office. All telephone cables exit city buildings at the same point for that building and tie into the existing telephone cable bundle that runs to the Central Office.

In the event of loss of the Wireline Telephone Service, the City, Businesses, and residents will likely fall back on cell phones. Cell phones do constitute an element of telephone system diversity since the point of message origination is different from the wireline, but still relies on a single routing to a Central and Main Office for final call completion. However, in the event of a regional wide problem, there is limited exclusive use by the City Staff (GETS), and risk of cellular system overload is possible.

Additionally, two-way radio uses different equipment and personal to exchange a message between two points. However, there is reduced access to the radio system by the City Staff and limited use outside the City.

In the event of wireline and wireless system failures, the City does have one Satellite Phone that is used for emergencies only.

Summary

The City could absorb an in-house loss of wireline telephone service by shifting to cell phones. Adding a Cellular telephone loss would severely limit the number of two-way telephone calls that could occur.

5.6.1.3 Recoverability

1. Wireline telephone system recovery (get the dial-tone) is the responsibility of AT&T.
2. City Centrex system recovery is the responsibility of AT&T.
3. Power for City facilities is the responsibility of the City.

AT&T and Network Disaster Recovery

AT&T has an extensive Network Disaster Recovery capability. It has made significant investments in 320 trailers and support vehicles containing network, technology, infrastructure and support elements. This capability has been exercised during the September 11, 2001 WTC attack, the March 2010 Santiago Chile Earthquake, and almost all major hurricane and tornado events striking the U.S. They have also responded to California's wild fires over the past 4 years and augmented communications for first responders when necessary.

Lastly, AT&T is certified by DHS that AT&T is able to maintain or recover its own business operations in the face of an emergency or disaster, whether natural, manmade, or cyber in nature.

5.6.2 Verbal / Two-way – Cupertino Residents

5.6.2.1 Redundancy

City residents use a mix of telephone communications solutions for personal use. The 2015 national average on use breaks down as follows³³ (this report assumes the Cupertino usage is representative):

- 41.2% Wireline POTS and VoIP Telephone, with Wireless
- 7.2% Wireline POTS and VoIP Telephone, without Wireless
- 48.3% Wireless only
- 3.1% no phone

1. Loss of Wireline telephone, Cellular is still available. Wireline is primarily a home telephone solution, either wireline or a VoIP telephone.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R9. POTS: Cable break between the home and the Central Office.	Accidental: excavation cuts the cable.	Remote (3) unlikely, but possible	Marginal (2)	Tolerable		Cell Phone service
R10. POTS: Loss of Power.	Loss of regional power.	Occasional (4) Likely to occur	Marginal (2)	Tolerable	Ensure the availability of at least one corded phone.	Cell Phone service.
R11. VoIP: Cable break between the home and the Central Office.	Accidental: excavation cuts the cable.	Occasional (4) Likely to occur	Marginal (2)	Tolerable		Cell Phone service.
R12. Loss of Power to the VRAD	Extended power outage at the VRAD followed by a depletion of the backup battery (life: up to 4 days).	Occasional (4) Likely to occur	Marginal (2)	Tolerable		Cell Phone service.
R13. Loss of Power to the Phone Modem	Extended power outage at home followed by a depletion of the modem backup battery (life: 4 to 24 hours).	Occasional (4) Likely to occur	Marginal (2)	Tolerable		Cell Phone service. <i>Proposal:</i> Community Emergency Assistance Request Intake

³³ [Wireless Substitution: Early Release of Estimates](#), National Health Interview Survey, July–December 2015

2. Loss of Wireline telephone, Cellular is **not available**. Wireline is primarily a home telephone solution, either wireline or a VoIP telephone.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R14. POTS: Cable break between the home and the Central Office.	Accidental: excavation cuts the cable.	Occasional (4) Likely to occur	Critical (3)	Undesirable		Not Defined. <i>Proposal:</i> Community Emergency Assistance Request Intake
R15. POTS: Loss of Power.	Loss of regional power.	Occasional (4) Likely to occur	Critical (3)	Undesirable	Home Generator	Not Defined. <i>Proposal:</i> Community Emergency Assistance Request Intake
R16. VoIP: Cable break between the home and the Central Office.	Accidental: excavation cuts the cable.	Occasional (4) Likely to occur	Critical (3)	Undesirable		Not Defined. <i>Proposal:</i> Community Emergency Assistance Request Intake
R17. Loss of Power to the VRAD	Extended power outage at the VRAD followed by a depletion of the backup battery (life: up to 4 days).	Occasional (4) Likely to occur	Critical (3)	Undesirable		Not Defined. <i>Proposal:</i> Community Emergency Assistance Request Intake
R18. Loss of Power to the Phone Modem	Extended power outage at home followed by a depletion of the modem backup battery (life: 4 to 24 hours).	Occasional (4) Likely to occur	Critical (3)	Undesirable	Home Generator	Not Defined. <i>Proposal:</i> Community Emergency Assistance Request Intake

a. **Impact of Loss:**

- i. Inability for residents to dial 911 to report an emergency or request help.
- ii. Inability to receive Cupertino Alert System and AlertSCC notifications.

3. Loss of Cellular when Cellular as the only home telephone service. As of 2013, 91% of surveyed adults own a cell phone. For 48% of the population, Cellular is the only phone system they have.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R19. Cell Phone battery runs out of charge (smartphone: <24 hours).	Extended power outage at home.	Occasional (4) Likely to occur	Negligible (1)	Tolerable	Ensure you have a cell phone car charger.	Not Defined
R20. Cellular is the only phone available. Cell Towers loses power; backup batteries are exhausted (8 to 48 hours).	Extended power outage caused by natural or intentional events.	Occasional (4) Likely to occur	Critical (3)	Undesirable		Not Defined. <i>Proposal:</i> Community Emergency Assistance Request Intake

a. **Impact of Loss:**

- i. Inability for residents to dial 911 to report an emergency or request help.
- ii. Inability to receive Cupertino Alert System and AlertSCC notifications.

Summary

The critical impacting scenario is an extended power outage throughout the City and region. Phone service for Wireline/POTS telephone users should continue to work. VoIP phone service will fail within 24 hours of an extended blackout as home Voice Modem backup batteries run out of charge. For both cases, there needs to be at least one wired (not cordless) telephone.

On the loss of both wireline and cellular service, the resident must deliver any requests for assistance in person.

Recommendations

1. Define the plan for receiving 911-equivalent requests for assistance and passing them to a Public Safety entity for dispatch (Community Emergency Assistance Request Intake). This plan would include:
 - a. where resident 911 messages can be delivered
 - b. when the plan will be activated
 - c. who is involved in the process (transmitting and receiving, Citizen Corps, County Fire, County Comm, others?)
 - d. how the process will work

5.6.2.2 Diversity

There is limited residential telephone system diversity. For residents with a wireline phone, it is unlikely that more than one telephone service is used. Cell Phones constitute an element of telephone system diversity since the point of message origination is different from the wireline, but it still relies on routing to a Central and Main Office for final call completion. Additionally, system overload may reduce access depending on the initiating hazard.

It is unlikely that the average resident subscribes to a satellite telephone service.

5.6.2.3 Recoverability

1. Wireline telephone system recovery (get the dial-tone) is the responsibility of AT&T or Comcast.
2. Residential power is the responsibility of the PG&E.

5.6.3 Verbal / One-Way –Broadcast

5.6.3.1 Redundancy

1. Loss of Commercial Radio Broadcast. 41 AM and 71 FM stations in the Bay Area intuitively constitute a reasonable amount of Redundancy.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R21. Loss of Power to all these stations.	Loss of Power from a natural or intentional event.	Remote (3) Unlikely, but possible	Critical (3)	Tolerable	PEP stations are hardened. EAS stations have backup power.	Commercial TV, Radio Cupertino

a. **Impact of Loss:** Residents do not have access to a PEP/EAS station for information about the problem.

2. Loss of Cupertino TIS Station. This station broadcasts information to the community 24 hours a day.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R22. Loss of Commercial power.	Loss of Power from a natural or intentional event.	Occasional (4) Likely to occur	Critical (3)	Undesirable ³⁴	City backup generator. <i>Proposal:</i> Replace City Hall backup generator	City backup generator.
R23. Loss of backup power at City Hall.	Loss of Commercial power; backup generator fails	Probable (5) Will and has occurred	Critical (3)	Unacceptable ³⁴	<i>Proposal:</i> Replace City Hall backup generator	Not Defined
R24. Loss of City Hall access where the TIS station is located.	City Hall is red-tagged due to significant damage from an earthquake event.	Occasional (4) Likely to occur	Critical (3)	Undesirable	<i>Proposals:</i> (i) Move TIS Station to a more secure facility, (ii) replace or retrofit City Hall, (iii) acquire backup AM radio transmission capabilities.	Not Defined. <i>Proposal:</i> deploy backup AM radio transmission capabilities. <i>Proposal:</i> CCC Public Information Outreach; ARKnet.

a. **Impact of Loss:** Inability to inform residents of the state of the city, how and where to get help, and other information on the event.

3. Loss of Commercial Television Broadcast. 14 network and 9 independent stations in the Bay Area constitute a reasonable amount of Redundancy.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R25. Loss of power to all these stations.	Loss of power from a natural or intentional event.	Remote (3) Unlikely, but possible	Critical (3)	Tolerable		Satellite TV, Broadcast Radio

a. **Impact of Loss:** Residents do not have a commercial television information source on the extent of the problem.

³⁴ TIS Battery Backup upgrade is funded and planned by the end of 2015. At that point, this Risk would be reclassified as Tolerable.

4. Loss of Satellite Television. The City has subscriptions with Dish Network and DirectTV.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R26. Loss of Satellite and/or ground station.	Satellite system assets are damaged or left inoperable.	Remote (3) Unlikely, but possible	Critical (3)	Tolerable		All communications shifts to commercial radio reception.
R27. Loss of backup power at City Hall.	Loss of Commercial power; backup generator fails	Probable (5) Will and has occurred	Critical (3)	Unacceptable		All communications shifts to commercial radio reception.

a. **Impact of Loss:** City loses all visibility to national TV and reports that may be relevant to the incident.

5. Loss of Cupertino Television Transmission. The City produces a cable channel that is carried on AT&T and Comcast.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R28. Loss of Commercial power.	Loss of Power from a natural or intentional event.	Occasional (4) Likely to occur	Marginal (2)	Tolerable	Ensure City Hall backup generator is operational.	Not Defined. <i>Proposal:</i> CCC Public Information Outreach; ARKnet.
R29. Loss of backup power at City Hall.	Loss of Commercial power; backup generator fails	Probable (5) Will and has occurred	Critical (3)	Unacceptable	<i>Proposal:</i> Replace City Hall backup generator	Not Defined. <i>Proposal:</i> CCC Public Information Outreach; ARKnet.
R30. Loss of City Hall access where the City Channel equipment is located.	City Hall is red-tagged due to significant damage from an earthquake event.	Occasional (4) Likely to occur	Critical (3)	Undesirable	<i>Proposal:</i> (i) Move City Channel facilities to a more secure facility, (ii) replace or retrofit City Hall.	Not Defined. <i>Proposal:</i> CCC Public Information Outreach; ARKnet.
R31. Loss of AT&T and/or Comcast digital TV to Cupertino residents.	Accidental: excavation cuts the cable.	Remote (3) unlikely, but possible	Marginal (2)	Tolerable		Not Defined

a. **Impact of Loss:** Inability to inform the residents of the city status, how to get help, and other information on the event.

Summary

The critical impacting event for the City is an extended power failure throughout the region. Public Information Outreach becomes the priority for the City to use whatever means necessary to ensure the community has the information to cope with the impacting event.

Recommendations

1. Formalize the plan and equipment for a Public Information Outreach mission to be performed by the Cupertino Citizen Corps.

5.6.3.2 Diversity

While there are a sufficiently large number of commercial stations in the Bay Area, they differ in equipment, location, content and coverage. There is 1 PEP and 4 Local Primary (LP) stations in the area. The PEP/LP diversity in studio, transmitter, and antenna locations increases the likelihood that at least one emergency commercial broadcast station will remain on the air.

5.6.3.3 Recoverability

1. Commercial radio and television broadcast recovery is the responsibility of the station owner.
2. Cupertino TIS and City Channel recovery is the responsibility of the City.
3. Regional power recovery is the responsibility of the PG&E.

5.6.4 Written / Digital Messaging

5.6.4.1 Redundancy

1. Loss of Wireline Internet. The City has two wired internet providers under contract. The Internet gives the City email, access to web applications, and search to name a few.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R32. Loss of either service provider.	Accidental: excavation cuts the cable.	Occasional (4) Likely to occur	Marginal (2)	Tolerable		Reconfigure to connect to the other internet service.
R33. Loss of both service providers.	Accidental: excavation cuts the cable.	Remote (3) unlikely, but possible	Marginal (2)	Tolerable		Reconfigure to connect to Excede Satellite Internet

- a. **ACTION ITEM:** Need to test the cross-connect of Excede to the City Internet, and all city locations connected to the city’s fiber network. Propose this test to City IT.

2. Loss of Satellite Internet. The City contracts with Excede Satellite Internet as an emergency internet service. Excede internet can be configured to cover both the main and wireless internet needs within the City via the Fiber Network.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R34. Loss of Satellite and/or ground station.	Satellite system assets are damaged or left inoperable.	Remote (3) unlikely, but possible	Critical (3)	Tolerable		This is the backup: track progress to ensure the service is again operational.
R35. Loss of Wireline and Satellite Internet.	Unknown	Remote (3) unlikely, but possible	Critical (3)	Tolerable		Reconfigure to connect to Infralink Wi-Fi Internet
R36. Loss of backup power at City Hall.	Loss of Commercial power; backup generator fails	Probable (5) Will and has occurred	Critical (3)	Unacceptable	<i>Proposal:</i> Replace City Hall backup generator	

a. **Impact of loss:**

A loss of all wireline **and** satellite internet service would constitute an emergency for the City with the Infralink as the last emergency internet backup system to be invoked.

- b. **ACTION ITEM:** Need to test the cross-connect of Infralink to the City Internet, and all city locations connected to the city’s fiber network. Propose this test to City IT.

3. Loss of Infralink Wi-Fi Internet. This is a backup internet service that is independent of commercial delivery means. Infralink provides a wireless internet path into the City Hall, but ultimately connects to a commercial internet service provider in the Bay Area.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R37. Loss of Infralink Wi-Fi access	significant damage to network equipment misaligns the access point that the City uses	Remote (3) unlikely, but possible	Critical (3)	Tolerable		This is the backup: track progress to ensure the service is again operational.
R38. Loss of Wireline, Satellite Internet, Infralink Wi-Fi access.	Unknown	Remote (3) unlikely, but possible	Critical (3)	Tolerable		
R39. Loss of backup power at City Hall.	Loss of Commercial power; backup generator fails	Probable (5) Will and has occurred	Critical (3)	Unacceptable	<i>Proposal:</i> Replace City Hall backup generator	

a. **Impact of loss:** No city staff access to any internet service. No access to Operational Area or State WebEOC.

4. Loss of City Intranet. The City’s fiber optic network connects 6 City sites within the City, and delivers High-speed Internet, high-speed WAN (wide area network), and high-definition bidirectional video between facilities.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R40. Cable break between any of the connected City sites.	Accidental: excavation cuts the cable.	Occasional (4) Likely to occur	Marginal (2)	Tolerable		None Defined. <i>Proposal:</i> ARKnet build-out.

a. **Impact of loss:** loss of high-speed Internet access at the connected city sites. We also lose the high-speed wide area network.

b. **NOTE:** City is also exploring independent high-speed access to the Cloud (including a cloud-based data center) at each of these sites, but this is at least a couple years out.

5. Loss of Amateur Radio Packet. Amateur Radio Packet can provide digital messaging between City internal locations, with City Served Agencies, with other Cities within the County, and with County OES.

Failure	Cause	Probability	Seriousness	Risk	Mitigation	Contingency
R41. Loss of all 4 County BBS (mail drop) sites.	Extended loss of power.	Remote (3) unlikely, but possible	Marginal (2)	Tolerable		CARES activates local PBBS. Voice message handling
R42. Loss of all 4 County BBS (mail drop) sites.	Significant site damage to BBS sites.	Remote (3) unlikely, but possible	Marginal (2)	Tolerable		CARES activates local PBBS. Voice message handling
R43. Loss of local client operations.	Local emergency power sources – generators or batteries – are depleted.	Remote (3) unlikely, but possible	Critical (3)	Tolerable		

a. **Impact of loss:** No digital messaging with County OES.

5.6.4.2 Diversity

There is good internet diversity between the three service providers that the City has under contract. As always, the integrity of internet access depends on power at City Hall.

5.6.4.3 Recoverability

1. Wired internet recovery is the responsibility of AT&T and Comcast.
2. Satellite internet recovery is the responsibility of Excede.
3. Infralink internet recovery is the responsibility of Infralink.
4. Power for City facilities is the responsibility of the City.

6 PRIORITIZE ACTIONS

6.1 SUMMARY OF RESULTS

Based on the above risks identified, the following observations are made:

1. The city has sufficient primary and secondary telephone coverage to maintain business operations.
2. There is reasonable resiliency with City-owned communication systems both for internal use as well as for information out-reach to the community provided City Hall does not lose power.
3. The largest re-occurring risk to City communications is the loss of power.
4. Amateur Radio continues to be the communications mode of last resort.
5. There were 43 specific risks were identified that break down into the following categories:
 - a. Tolerable: 27
 - b. Undesirable: 9
 - c. Unacceptable: 7

6.1.1 City's Unacceptable Risks

The following two risks directly impact the City's ability deliver service to its residents. While these risks listed here are specific to Communications, they also apply to all city functional areas and processes that take place in City Hall.

6.1.1.1 Loss of Access: City Hall is red-tagged; earthquake event.

In the event City Hall is damaged and subsequently red-tagged, City Staff loses access to the 2 primary communications means for reaching out to the community:

- b. City Channel
- c. Radio Cupertino (TIS) station

In support of the City's Communication Mission (*To increase public awareness, interest, understanding, and participation in city issues, programs, and services*), the key communication mechanisms that are most at risk are the City Channel and Radio Cupertino (TIS). Risks R24, R30 point to a loss of access to City Hall due to a significant damaging event resulting in the building being Red-Tagged and unsuitable for use.

6.1.1.2 Loss of Commercial power; backup generator fails

If there is a loss of commercial and backup generator power, then the City loses several communications systems that would be required to support City communications functions needed for the recovery (not to mention IT, City Operations, and EOC Operations):

- a. City Channel
- b. Infralink Internet
- c. Satellite Internet Reception
- d. Satellite TV Reception
- e. Satellite Phone

Risks R6, R23, R27, R29, R36, and R39 highlight the scenario where the City experiences a loss of commercial power and the backup generator fails. Past generator performance casts reasonable doubt

that the City Hall backup generator will operate sufficiently and reliably to satisfy the needs of the City Hall staff in the event of an emergency.

6.1.2 City's Undesirable Risks

The City's largest residential risk is the loss of residents' ability to dial 911 for help. Several causes will contribute to this situation:

1. Accidental: excavation cuts the cable to some or all of residential telephones (Risks R14, R16).
2. Extended power outage at home followed by a depletion of the VoIP modem backup battery (Risks R13, R18).
3. Extended power outage at the VRAD followed by a depletion of the backup battery (Risk R17).
4. Extended power outage caused by natural or intentional events (Risk R20).
5. Loss of regional power (Risk R15).

6.2 RECOMMENDED ACTIONS

There are several risks that are outside the City's span of control involving commercial infrastructure owners. However, there are specific actions that the City can take. The following actions are proposed to address the Undesirable and Unacceptable risks identified above.

1. **Move TIS Station to a more secure facility, or retrofit City Hall.**

TIS is the ultimate communications lifeline between the city and the community in the event of an emergency, and this system needs to be protected. Mitigation of Risks R24, R30 (**Undesirable**) address losing access to City Hall by City Staff caused by *Red-Tagging* the building as a result of a sufficient City Hall-damaging event. In this case, City Hall is deemed unsafe to occupy until corrective actions are taken to make the structure safe again for use.

2. **Complete the TIS backup battery upgrade.**

TIS is the ultimate communications lifeline between the city and the community in the event of an emergency, and this system needs to be protected. Completing the mitigation for Risk R22, R23 (**Undesirable**) would reclassify this risk to **Tolerable**. Once complete, Radio Cupertino would be able to stay on the air during a prolonged loss of City Hall power. Also, this is a backup mitigation in the event of a City Hall power generator failure.

3. **Improve the reliability of the City Hall backup generator.**

Power was the most common re-occurring risk that was identified, with a quarter of risk causes linked to the failure of the City Hall Generator. The ultimate mitigation for Risks R6, R23, R27, R29, R36, R39 (**Unacceptable**) is a generator replacement. As an interim measure, it is recommended to frequently test the generator to (i) find and correct faults with the generator system, (ii) build staff confidence that the generator will reliably run when required to do so, (iii) or build the case for a generator replacement.

4. **Define the Public Information Outreach plan.**

A significant event will require all means to public information outreach. The Contingency for Risk R29, R30 (**Unacceptable**) is a mechanism to publish city information out to the community using the Cupertino Citizen Corps infrastructure for posting the information in the field. This action include both hardware (printers) and procedures to be finalized.

5. Define the Community Emergency Assistance Request Intake plan.

The loss of home telephone capability will result in the inability to place a 911 emergency call from an impacted home. The Contingency for Risks R14, R15, R16, R17, R18, R20 (**Undesirable**) is to define the procedure and policies for taking 911 information in the field and relaying it to a PSAP, either County Comm, a Fire Station, or some other entity tasked with initiating an emergency dispatch.

6. Complete ARKnet build out as the Cupertino Emergency Intranet.

Coordinating among City response facilities will be critical. The Contingency for Risks R29, R30 (**Unacceptable**) is building out the Cupertino Emergency Intranet that enables high speed, broadband data to field response sites and City facilities when commercial means are lost. The delivered capability includes an ARKnet-based VoIP telephone service for critical sites. ARKnet also enables other network services from which the City will benefit. See the ARKnet Project Data Sheet for details.

7. Perform testing of specific backup communications measures.

There are several contingencies that are assumed to work but have never been tested. Perform tests on the following:

- a. Develop a test to cross connect Excede Satellite Internet to the City fiber network and confirm internet access at all networked city sites.
- b. Develop a test to cross connect Infralink Internet to the City fiber network and confirm internet access at all networked city sites.
- c. Develop a test to exercise the Satellite Telephone.

8. Explore other emerging technologies and means for communicating with the community during an emergency.

City Channel is beta testing several new technologies and platforms for broadcasting live content on the internet and social media that can distribute useful information to the public. This information could be also used by Public Safety and anyone with internet access. Examples of these platforms include (not limited to):

1. Periscope (live streaming)
2. MeerKat (live streaming)
3. Hang (live streaming)
4. StringWire (live streaming)
5. Instagram (image submittal and posting)

9. Public outreach to the community.

There are specific actions that should be taken to further prepare the residents for communications events over which they have some element of control. These items are candidates for the Cupertino Scene's preparedness section.

1. Ensure residents have a car cell-phone charger (mitigation for Risk R19, Tolerable).
2. For home wireline telephones, ensure the availability of at least one corded phone (mitigation for Risk R10, Tolerable).
3. Ensure every home has a portable AM/FM radio (best practice)

6.3 UNMITIGATED RISKS

There are contingencies or proposals for all Undesirable and Unacceptable risks. However, there are 10 of these risks without mitigations. These break down as follows:

1. 50% are loss of Commercial Power impacting service provider or home assets
2. 20% are loss of Commercial Power and City Generator Power
3. 20% are loss of connectivity to the home
4. 10% are loss of access to City Hall due to significant damage from an earthquake event

The mitigations should be identified (if possible) and evaluated to determine if they should be pursued, if no action is warranted, or if the Risk is properly assessed.

A. REFERENCES

A.1 SUMMARY OF COMMUNICATIONS ASSETS AND SYSTEMS

The following tables list the communications systems in Cupertino.

A.1.1 Telephony

Class	Comm Service	Risk Owner	Owner Type	Critical Comm Elements	Description
Telephony	Telephone Service, Wired ^{35 36}	AT&T	Provider	Interchange Network	Digital switching nodes that provide the connection between Local Exchange networks.
				International Networks	Digital switching nodes, that are located in each country and act as international gateways to destinations outside of their respective countries.
				Local Exchange Network/PSTN	Digital switching nodes (EOs) that provide network access to the subscriber.
				Centrex	An AT&T product; a managed PBX for a contracting customer that supports their enterprise telephone system that switches calls between enterprise users on local lines while allowing all users to share a certain number of external phone lines.
		Business	Consumer	Wireline, Local Equipment	Personal Equipment
		Business	Provider	Local PBX	An in-house telephone system within an enterprise that switches calls between enterprise users on local lines while allowing all users to share a certain number of external phone lines.
				Consumer	Wireline, Local Equipment
		Resident	Consumer	Wireline, Local Equipment	Personal Equipment
		Telephone Service, Cellular	AT&T	Provider	Mobile Telephone Switching Office
	Access Points (Base Station)				Radio transmitter, receivers, and antennas that communicate directly with the mobile stations. The base station transceiver are the defining element for each cell.
	Business		Consumer	Cellular, Mobile Station	Mobile equipment; cell or mobile phones are the section of a cellular network that the user sees and operates.
	Cupertino IT		Consumer	Cellular, Mobile Station	Mobile equipment; cell or mobile phones are the section of a cellular network that the user sees and operates.
	Resident		Consumer	Cellular, Mobile Station	Mobile equipment; cell or mobile phones are the section of a cellular network that the user sees and operates.
	Verizon ³⁷		Provider	Mobile Telephone Switching Office	Main control and interfacing for the whole mobile network. Provides access to PSTN or the internet.
				Access Points (Base Station)	Radio transmitter, receivers, and antennas that communicate directly with the mobile stations. The base station transceiver are the defining element for each cell.
Telephone Service, Satellite	LightSquared		Provider	Satellites, in orbit	One or more satellites in orbit providing telephone by satellite coverage.
		Satellite Network Gateways		Satellite up and downlink stations that connect satphone users to the PSTN	
	Cupertino City Channel	Consumer	Satellite, Phone	Satellite phone to access the satellite phone network	

³⁵ https://www.informit.com/library/content.aspx?b=Signaling_System_No_7&seqNum=31

³⁶ <http://searchunifiedcommunications.techtarget.com/definition/private-branch-exchange>

³⁷ There are other carriers that include Cupertino in their service area that are not listed here.

A.1.2 Internet

Class	Comm Service	Risk Owner	Owner Type	Critical Comm Elements	Description
Internet	AT&T Digital Network	AT&T	Provider	Network (Backbone)	National digital network that interconnects data services with users
				IP Serving Offices	Distribute programming to homes via neighborhood VRAD equipment.
				IP Video Hub Offices	Receives national programming from Super Hub offices, add local programming; store Video-on-Demand programming
				DSL, TV/Internet, VRAD, DSLAM ³⁸	Video Ready Access Device; provides digital subscriber line access and high-definition television programming to customers subscribed to IPTV services.
		Business	Consumer	Modem, DSL	Personal Equipment
				VoIP PBX	IP Telephone system within an enterprise that switches calls between enterprise users on local lines while allowing all users to share a certain number of external phone lines.
				Cupertino City Channel	Personal Equipment
				Resident	Personal Equipment
	Comcast Digital Network	Comcast	Provider	Cable, Network (Backbone)	National network for interconnecting Central Offices / Head-End locations.
				Cable, Central Office / Head End	Local cable TV office that originates and transmits cable TV services and cable modem services to subscribers.
		Business	Consumer	Modem, Cable	TV Set Top Box, router, voice.
				VoIP PBX	IP Telephone system within an enterprise that switches calls between enterprise users on local lines while allowing all users to share a certain number of external phone lines.
		Cupertino City Channel	Consumer	Modem, Cable	TV Set Top Box, router, voice.
		Resident	Consumer	Modem, Cable	TV Set Top Box, router, voice.
	Exede Satellite Network	Exede	Provider	Satellite, ViaSat-1	Satellite in a geosynchronous Orbit, 115.1° west
				Satellite Network Gateways	Riverside, CA. connects service to the internet.
		Cupertino City Channel	Consumer	Modem, Antenna	Average broadband speed is about 12 Mbps download and 3 Mbps upload.
	Infralink / SCEWN Network	Infralink	Provider	Wireless Network (Backbone)	A managed, comprehensive, and private wireless communications network that is independent of public communications and power infrastructure.
		Cupertino City Channel	Consumer	Infralink Access Point	Rooftop access point.

³⁸ Video Ready Access Device; Provides AT&T digital subscriber line access and hi-Def television programming; Fiber to VRAD, copper from VRAD to your home

A.1.3 Radio

Class	Comm Service	Risk Owner	Owner Type	Critical Comm Elements	Description
Radio	Radio Comms, Two-way	Cupertino DPW	Provider	Comms, Part 90, Repeater, Trunk Radio	Radio system that supports Public Works and other city functions, Repeater
				Comms, Part 90, Simplex, Trunk Radio	Radio system that supports Public Works and other city functions, Simplex
				Comms, Part 90, Simplex	Radio system can operate in a simplex mode between Public Works users independent of the trunking system.
		Cupertino ARES	Consumer	Comms, Part 97, Repeater	UHF Amateur Radio repeater, battery backup, accessible to site emergency generator.
	Comms, Part 97, Simplex	VHF, UHF on Amateur Radio bands. Shared use of 2m simplex voice frequencies.			
	Radio, Broadcast, Reception	Commercial	Provider	Commercial Broadcast	Over Air broadcast commercial radio stations located throughout the Bay Area
			Cupertino City Channel	Provider	TIS Broadcast
		Consumer	AM/FM/Sat Radio Reception	Over Air broadcast commercial radio stations located throughout the Bay Area	
		Resident	Consumer	AM Radio Reception, TIS	Over Air broadcast TIS
				AM/FM/Sat Radio Reception	Over Air broadcast commercial radio stations located throughout the Bay Area

A.1.4 Messaging

Class	Comm Service	Risk Owner	Owner Type	Critical Comm Elements	Description
Messaging	Digital Messaging	Cupertino IT	Provider	City Intranet equipment	Wiring, switches, routers, and internet access points for internal city use.
				Enterprise Exchange Servers	Central database for Microsoft email.
				Virtual Desktop Interface	Virtual Desktop
		Cupertino City Channel	Provider	Fiber optic interconnect network	Connects City Hall, Quinlan Center, Sports Center, Senior Center, and the Traffic Operation Center for possible use for video, voice, and data in an emergency. Backbone is already in place and functioning (July 2015)
		SCC RACES	Provider	AX25 Packet Network	Digital message network based on JNOS that was developed, deployed, and supported by and for the Santa Clara County ARES/RACES team. Multiple BBSs are lined by an RF and Wi-Fi backbone. Includes access and network Redundancy.
		Cupertino ARES	Consumer	AX25 Packet Access	Client AX.25 packet system that can exchange messages with the County BBS and other BBS/PBBS nodes in the surrounding area.

A.1.5 Video

Class	Comm Service	Risk Owner	Owner Type	Critical Comm Elements	Description	
Video	Television, Broadcast	Commercial Stations	Provider	Commercial Broadcast	Over Air broadcast commercial television stations located throughout the Bay Area.	
		Cupertino City Channel	Provider	Public Broadcast, City	City specific programming	
			Consumer	TV, Reception	For monitoring of local and national television broadcasts.	
		PBS Stations	Provider	Public Broadcast	Over Air broadcast public television stations located throughout the Bay Area.	
		Resident	Consumer	Cable, Reception	For monitoring of local and national television broadcasts.	
				DSL, Reception	For monitoring of local and national television broadcasts.	
				TV, Reception	For monitoring of local and national television broadcasts. Over Air antenna on the roof	
		Television, Satellite	Cupertino City Channel	Consumer	Satellite, DirectTV, Reception	For monitoring of local and national television broadcasts. Satellite antenna on the roof.
					Satellite, Dish Network, Reception	For monitoring of local and national television broadcasts. Satellite antenna on the roof.
	DirectTV		Provider	Satellite, Uplink Stations	Transmits local and national television content.	
	Dish Network		Provider	Satellite, Uplink Stations	Transmits local and national television content.	
	Resident		Consumer	Satellite, DirectTV, Reception	For monitoring of local and national television broadcasts. Satellite antenna on the roof.	
				Satellite, Dish Network, Reception	For monitoring of local and national television broadcasts. Satellite antenna on the roof.	
	Video, Distribution	Cupertino City Channel	Provider	Conf Room Distribution equipment	Each conference room and the EOC is capable of receiving specific video feeds, which can be assigned and selected in the city channel control room area. These feeds may include live reports from camcorders/crews in the field that use wireless LTE networks for streaming live video, satellite broadcast channels, live traffic camera feeds from the traffic operations center (still being developed), near real-time video that is brought back from the field and played back from the control room. Live and pre-recorded footage taken by drones (future)	
				Digital Signage	Digital network feeds public displays at City Hall, the Sports Center, Quinlan Center, the Senior Center (library pending). These digital signs also receive automatic feeds from the city's Twitter page which display at the bottom of the screen.	

