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Earth Station Antenna Security and Survivability

Introduction

Today's requirements for secure, interoperable communications systems, as well as rapidly deployable networks for emergency response, are driving the need for inexpensive, simple, satellite earth station antennas, ranging in size from sub-meter to 5 meters in diameter. When selecting and siting antennas, systems engineers rarely consider the earth station antenna's vulnerability to damage or destruction by the forces of nature or man.

The antenna, and in some cases antenna mounted Ground Communications Equipment, represent the most vulnerable components of any earth station installation. Mounted in plain sight and exposed to the elements, antennas are at risk of damage from high winds, or even deliberate attack. This article explores ways and means of mitigating the risk of damage or destruction of earth station antennas.

While satellite communications systems can offer a higher degree of security to users than terrestrial networks, systems engineers must be aware of the underlying security risks of an earth station and the methods of mitigating these risks. A fiber optic communications network has a "inear vulnerability profile,"meaning the fiber optic cable is vulnerable at every point along its length; this can cover many thousands of miles. Repeaters, blockhouses, telephone central offices and local loops are vulnerable, as well. Damage from natural disasters such as fire, flood or prolonged power outage, and intentional or inadvertent cable breaks, are nearly impossible to avoid. The reliability and availability of fiber networks depend upon having the ability to re-route traffic around failed sections of the network on diverse paths.

An end-to-end satellite communications system has a "point of presence"vulnerability profile. Failures can occur, and vulnerability exists, only at the points where equipment exists: the satellite, associated earth stations, and any terrestrial interconnections. The reliability and availability of a satellite network can rival that of a common terrestrial network, when proper consideration is given to system design. The satellite itself is hardened against damage by the harsh environment of outer

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space. Only a sophisticated and determined attacker can even consider a direct attack on orbital assets operating more than 22,000 miles above the equator. This leaves the earth stations, and other points of presence on the ground, which if properly designed and executed, can be made less vulnerable to attack, failure, or damage from natural phenomena than most other communications facilities.

Risks and Solutions: Environmental

When selecting the location for an earth station antenna of any size, the primary consideration is to ensure a clear view of the orbital arc, which allows the antenna to "see" the maximum number of satellites. Placing an antenna on a rooftop is often the optimal solution. However, extremely high winds can damage or destroy a parabolic dish antenna.

Most properly installed earth station antennas are designed to survive winds of at least 60 or 70 miles per hour. When located in areas prone to hurricanes, tornadoes, or seasonal periods of high winds that can exceed these speeds, special considerations should be made in selecting the location of the antenna.

Properly siting the antenna can increase the chances of surviving high wind conditions. Locating an antenna on the leeward side of buildings or hillsides, or using large roof structures, such as air conditioning units as windbreaks, while maintaining a clear view of the orbital arc, can make the difference between an antenna's survival or destruction in a storm. As every rooftop antenna installation is unique, it is important to work with the building owner or landlord in order to determine the optimum location.

Many manufacturers make antennas and antenna mounts capable of surviving higher wind conditions, than standard units. High wind antennas are more robust, and reinforced mounts should be considered in areas having an elevated risk of wind damage to outdoor structures.

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In the case of non-penetrating roof mounted antennas being installed in high wind areas, the maximum amount of ballast recommended by the manufacturer must be installed, or even exceeded, in order to ensure that the antenna does not move from its moorings during high wind conditions. The ability of the roof to bear this additional load must be considered to avoid damaging the building upon which the antenna is mounted. In general, hard mounting an antenna to a building is preferred over the use of a non-penetrating roof mount.

Having a replacement antenna available in the event of an emergency is a costly, yet highly effective means of mitigating the risk of prolonged outages in crucial networks. Installing a second, fully equipped and operational antenna on a nearby building provides full redundancy, and "pace diversity" for the system. While costly, this risk mitigating option may be appropriate in high priority, high value communications networks.

Deliberate Attack

The antenna is, by necessity, the most visible component of any earth station. In a hostile or post 9/11 domestic environment, a knowledgeable assailant can incapacitate an earth station antenna, of any size, with nothing more than a high-power hunting rifle.

A metal parabolic reflector can actually absorb a reasonable number of bullet impacts before its performance begins to degrade. The number of impacts it can withstand is roughly proportional to the size of the reflector. On the other hand, a fiberglass reflector is somewhat more vulnerable to gunfire by virtue of the fact the resin used in its construction is brittle and portions of the reflector will break away when hit. Therefore, a fiberglass antenna's performance will begin to degrade when the first bullet strikes; mechanical failure could eventually occur.

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While the main reflector of an earth station antenna presents an inviting target, it is capable of absorbing a limited amount of gunfire without immediate impact on the earth station's operation. A knowledgeable assailant will target the antenna's feed horn, or in the case of a VSAT, the RF Package, rather than the reflector. A few well-placed rounds into the feed horn or RF package could knock an antenna of any size off the air from hundreds of yards away.

While the external RF components of an antenna, as well as connecting cables and waveguide are highly vulnerable to damage from gunfire, or other projectile weapons, steps can be taken to reduce the vulnerability of these components at critical, high-risk, or high value facilities. Locating the antenna out of direct site from surrounding terrain or buildings is the best method of protecting it from all forms of projectiles. Buildings, terrain contours, plantings and screening walls can all be used to maximum effect in protecting an earth station antenna. Roof mounted antennas can be located in such a way that they are not visible from the ground. Air conditioning units and other roof mounted building elements can also be used to good effect in screening an antenna from view and eliminating sight lines that could admit dangerous gunfire.

As in the case of windstorm protection, having a replacement antenna, or spare parts available in the event of an emergency is a somewhat costly, yet highly effective, means of mitigating the risk of prolonged outages in crucial locations of high value networks. Installing a second, fully equipped and operational antenna in a secure area, provides full redundancy, and "space diversity" for the system. While costly, this last option may be viable in high priority communications networks.

Limiting access to ground mounted antennas is critical to communications system security. To limit access by the public, fencing is most commonly installed around an earth station antenna. But protection from vehicular collision should also be considered, especially for critical communications networks. Solid steel and concrete bollards, walls, high curbs, berms, swales, decorative barriers, Jersey Barriers, or sandbags may be appropriate, depending upon the situation.

Critical Communications Conclusions

Earth station antennas providing high value, critical communications links must be protected against natural, and man-made threats. While some devastating situations are unavoidable, it is incumbent upon systems engineers to design a level of security and survivability into earth station facilities, which is commensurate with the importance of the communications traffic being carried by the facility. Selecting an appropriate location for the antenna can greatly increase its chances for surviving a storm or avoiding deliberate attack. Providing sufficient spares, and or redundancy/diversity can avoid outages or greatly reduce down time in the event of an interruption caused by either weather or attack.

As a Principle Member of SES Americom's Engineering Staff, Tony Castronova designs and builds satellite communications earth stations using antennas that range in size from 1-meter to 21-meters in diameter. While serving in the U.S. Air Force, and throughout his 32 year career in the satellite communications industry, Tony has faced numerous situations where the physical security of communications antennas has been a major concern.

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