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Introduction

GOES DCS (Geostationary Orbiting Environmental Satellites Data Collection System) Satellite telemetry has revolutionized the collection and integration of environmental data delivering 7.5 million observations per day and growing rapidly. Relied on by dozens of government agencies for relaying vital environmental data, GOES-based telemetry avoids many of the vulnerabilities attributable to terrestrial media (line-of-site radios, telephone lines, cellular towers, etc.) for public weather warnings and alerts, operational decision support, emergency response and management and other critical uses. As wireless technology (e.g. cellular/smart phones) has become a viable and pervasive means of communication its continued expansion without proper safeguards threatens to disrupt, impede and halt the reception of valuable environmental data by earth ground stations.

As all wireless devices utilize an allocation of spectrum, the separation of devices and moderation of output levels allow the many wireless devices we use today to coexist in the same space. Proposed commercial high output infrastructure to support the nation’s growing number of advanced wireless devices is seeking to utilize the same or adjacent radio frequencies as the systems receiving telemetered environmental data. By not implementing appropriate safeguards for the GOES DCS frequencies the protection of life, safety and property is compromised. The continued protection of the GOES DCS spectrum is essential for ensuring public safety, protection of property, a robust economy and effective management of natural resources.

STIWG DCS History and Evolution

The Satellite Telemetry Interagency Working Group (STIWG) is a consortium of government agencies advising the GOES Data Collection System (DCS) manager on user requirements as pertinent to hydrologic, meteorologic, oceanic and other environmental data; reporting to the Subcommittee on Hydrology (SOH) of the Advisory Committee on Water Information (ACWI). The STIWG was formed in 1976 after NOAA’s and NASA’s successful launch and deployment of the GOES satellite. The STIWG is an active participant in the GOES DCS Technical Working Group (TWG) working with private industry to continue the development and ensure the viability of DCS and technologies that use it. Since the inception and expansion of the GOES DCS, the STIWG has championed the system as it is the most reliable and timely mechanism to relay sensor measurements to distributed ground stations.
Between 1980 and 1985, various federal agencies adopted the GOES DCS as the primary mechanism of relaying hydrometeorological information from field sites directly to local ground stations using the GOES DCS; in many cases migrating from earth based infrastructure. This capability has expanded from 7,000 platforms within the contiguous United States to tens of thousands of permanent and episodic data collection platforms (DCP’s) sponsored by local, state, federal, Canadian, Mexican, Central and South American agencies measuring and transmitting over 7.5 million mission critical observations per day. These data include surface water (ocean, river, lake, and stream) and ground water (wells and aquifers) levels, as well as water quality and meteorological information such as inflow, discharge, dissolved oxygen, precipitation, wind vector, air temperature, water temperature, turbidity, salinity, solar radiation, relative humidity, barometric pressure and fire weather. The majority of these data are purposed to protect life, property and safety and provide the necessary information for early warning systems, emergency management, operational hydrologic models, regression analysis, computing exceedance probabilities, power generation, transportation, inland navigation, GIS integration, dissemination, and scores of other uses that reach far beyond the government agencies - news stations, colleges and universities, and private industry utilize the transmitted information directly or via data services, web pages, and other dissemination methods to support a wealth of public, commercial and non-government applications and services.

Permanent DCS ground receiving stations are located in various settings across the United States - from rural areas to bustling city centers. These locations were strategically identified and chosen for operational and management reasons to support and maintain a robust DCS system. Terrestrial interference was tested and the sites deemed appropriate for ground reception systems. In recent years the number of wireless communication devices that rely on a terrestrial radio infrastructure that functions spectrally immediately adjacent to the GOES DCS frequency allocation has exploded. Today, there is an effort to expand the commercial frequency allocation for advanced wireless devices to include the 1675 – 1695 MHz allocation utilized exclusively by the DCS. The expansion includes the construction of commercial infrastructure consisting of large high powered radio towers to expand the capabilities of advanced wireless devices. This effort poses a direct threat to the existing and future effectiveness of the GOES DCS data receive systems.

**DCS Utilization and Implemented Protection Policy**
It is acknowledged that wireless broadband communication triggers innovative businesses, provides cost effective connectivity in rural areas, increases public safety and improves productivity. The 2010 Presidential Memorandum on Unleashing the Wireless Broadband Revolution outlines the plan requiring the NTIA to collaborate with the Federal Communications Commission (FCC), to identify and auction 500 MHz of Federal and nonfederal spectrum by 2020 for fixed and mobile, licensed or unlicensed wireless broadband devices. This memo references the numerous advantages of expanding wireless capability in this country but wisely and explicitly requires that the Plan and Timetable for identifying underutilized spectrum must “ensure no loss of critical existing and planned Federal, State, local and tribal government capabilities” (section 1b).

The GOES DCS is a critical Federal system with an ever expanding user base providing users, both foreign and domestic, with timely information to protect life and property, maintain safety, make appropriate water resource management decisions, forecast and operate during flood and drought conditions, generate fire weather products to ensure the safety of the public and fire personnel, etc.

DCS owners and users collect and process transmissions from various agencies’ platforms. Users have the ability to decode and integrate data transmitted by any GOES DCS platform; allows everyone to benefit from the data without necessarily having to deploy their own platforms in certain locations or own any platforms at all. Agencies’ decoding specifications are archived in databases and made available for DCS users to import and implement on their local data collection systems to process the incoming messages.

In some instances, platform sharing is desirable; where agencies provide instrumentation for measurements they need to collect on the same DCP. This approach reduces the cost to operate a platform and illustrates the cooperative nature of the DCS community from the DCP to the ground station.

The GOES DCS has been indispensable in preventing damages and loss of life due to natural disasters by providing timely and mission critical data to United States Army Corps of Engineers (USACE) operations and emergency management personnel. USACE has achieved an 8:1 benefit-cost ratio (adjusted to using Cost Index EM 1110-2-1304) – and a critical driver of this efficiency is the abundance of historical data and temporal hydrometeorological data at their disposal through the GOES DCS.
Between FY05 and FY14, the Corps of Engineers estimates a 10-year average of over $47-billion in flood damages prevented versus a 10-year average of $3-billion suffered. Alone, $238-billion in flood damage to the Lower Mississippi River (LMR) was prevented during historic flooding in FY11. Any loss of life is a tragedy but placed in context with historic flood conditions on the LMR in 2011, casualties were minimized to 6 that year; 108 total nationwide. GOES DCP’s and DCS receive sites using the 1675 – 1695 MHz allocation represent the Corps’ primary data telemetry capability and resource. Achieved damage and casualty reductions are attributable to the integration of data received from the GOES downlinks.

Beyond damage reduction, the Corps utilizes their national telemetry network of GOES DCP’s providing data for, but not limited to, the nation’s military and civil works projects, operating over 600 Corps owned dams: navigation dams on over 12,000 miles of commercial inland waterways, 329.2 million acre-feet of lake water supply storage, generating 24% or the U.S. hydropower capacity and dam and levee safety; maintaining 926 coastal, Great Lakes and inland harbors; monitoring water quality, preserving wetlands, environmental engineering, public and internal dissemination, real estate, planning, modeling, inundation mapping, GIS integration, legislation and reports, litigation, tribal issues, archival and conducting studies.

Permanent receive stations deployed by each Corps district collect the data used in the aforementioned activities. Districts maintain individual receive stations with direct connectivity between receivers and servers to safeguard from data delivery delays or interruptions due to network outages, damaged infrastructure (e.g. severed telecommunication lines), management directed blockage of Internet traffic in response to security breaches, etc. Any disruption in the distributed acquisition of this data to individual districts jeopardizes the Corps’ federally mandated mission. Dedicated receive stations eliminate risks associated with network-only solutions and ensures robust telemetry and acquisition.

The United States Geological Survey (USGS) stream-gaging network provides the hydrologic information needed to aid them in defining, using, and managing our country’s invaluable surface water resources. Floods are the leading cause of natural-disaster losses in the United States comprising more than 75% of declared Federal disasters and average annual flood losses nearing $8 billion with over 90 fatalities per year. Although the number of fatalities has declined due to improved early warning systems, economic losses have continued to rise with increased urbanization in flood-hazard areas. The USGS Flood Inundation Mapping (FIM) Program benefits from GOES DCS and helps communities protect lives and property by providing tools and information that promotes understanding their local flood risks and making cost-effective mitigation decisions.
The tools necessary to conduct such studies and provide necessary services are based upon hydromet data collected by a vast network of remote sites managed by the USGS Water Mission Area (WMA) that transmit via the GOES DCS. The need for “real-time” data led the WMA to utilize the GOES DCS System as its primary method of relaying the water data from approximately 10,000 active USGS-operated surface-water (rivers, lakes, streams, etc) and groundwater (wells, aquifers, etc.) sites across the country. That number of sites is steadily growing due to an ever-expanding need for water information. The USGS considers this data to be so critical that it established the Emergency Data Distribution Network (EDDN) with its own Direct Readout Ground Station (DRGS) at the Earth Resources Observation and Science (EROS) Center near Sioux Falls, SD.

The EDDN site coordinates with and functions as a backup to NOAA’s data downlink site. The data are made available to other federal agencies such as the National Weather Service and US Army Corps of Engineers, as well as to regional, state and local entities for a variety of purposes. Some benefits of the water data from the USGS water monitoring networks include flood forecasting, water supply allocation, highway bridge design, wastewater treatment management and public recreation.

The need for increased, real-time data availability before, during and after catastrophic meteorological events has led to a USGS program to increase the network of real-time, surface-water sites along the eastern seaboard. That network utilizes the GOES DCS for transmitting the data. A direct result of Hurricane Sandy’s impact, this expanded network is augmented by a new series of GOES DCS-based Rapid Deployment Gages which transmit data more frequently (at 12 minute intervals) in order to provide a higher level of accuracy of storm-induced conditions. Rapid Deployment Gages are designed for quick deployment at any location where information is required as dictated by those conditions. By working in conjunction with the permanent gages that use standard hourly GOES transmissions, this expanded system will increase understanding and benefit public safety during future catastrophic events along the east coast.

The **2013 Presidential Memorandum on Wireless Revolution** calls for spectrum sharing between Federal and commercial entities to expand the capabilities of wireless devices beyond the 500 MHz found in the 2010 memorandum. GOES DCS ground stations have been identified and geo-referenced. The prospect of sharing the spectrum is problematic in that radio frequency interference is an inevitable and disruptive byproduct.
Furthermore, Section 4, paragraph (m)(1)(A)(vii) of the proposed Wireless Innovation Act of 2015 calls for more Federal spectrum to be made available for reallocation and sharing with the caveat that “the transfer of which [spectrum] from, or the sharing of which with, Federal Government use will not result in costs to the Federal Government, or losses of services or benefits to the public, that are excessive in relation to the benefits to the public that may be provided by non-Federal licensees”; underscores and recognizing the importance of this allocation of spectrum for Federal use.

The National Weather Service (NWS) Hydrometeorological Automated Data System (HADS) processes over 3.6 million observations from more than 16,000 GOES DCS DCP’s. The data collected feeds 122 Weather Forecast Offices (WFO), 13 River Forecast Centers (RFC), National Centers for Environmental Prediction (NCEP) The National Water Centers National Operational Hydrologic Remote Sensing Center (NWC NOHRSC) and archiving at the National Center for Environmental Information (NCEI). For many years the National Weather Service has invested in the GOES DCS by sponsoring a number of platforms owned by other agencies.

HADS provides data that allows the Weather Service to perform their congressionally mandated function of providing weather, water and climate data forecasts and warnings. DCS data is used for RADAR ground truthing, correlation and bias analysis; research, calibration and verification; model initialization and forecast validation. Weather Service products have a significant impact on inland navigation, especially on the Mississippi River which contributes billions of dollars to domestic and international economies through the transport of corn, soybeans, timber, iron, coal, grain, oil, chemicals, minerals and other commodities and supplies. The disseminated products supply vital information to citizens, stakeholders and other agencies for the protection of life and property and enhancement of the national economy.

NOAA’s NWS National Data Buoy Center relies on the GOES DCS for telemetry from its offshore weather buoy network for marine meteorological and oceanographic measurements critical to the NWS marine weather forecasts and warnings. The weather buoy network provides data for these forecasts and warnings that are not available from any other source and include data unique to the marine environment such as directional wave spectral data, surface temperature, water current profiles and salinity measurements used in marine forecasts and advisories and hurricane warnings.

Data from the NWS/NDBC Coastal-Marine Automated Network (C-MAN) are used by a number of commercial interests and services for weather forecasting and dissemination to the general public through various data sources. The C-MAN network is reliant on GOES DCS for data
telemetry of coastal meteorological and oceanographic measurements critical to NWS marine forecasts and warnings.

The United States Bureau of Reclamation (Reclamation) utilizes DCS to support their mission managing water resources in 17 western states. As the largest domestic wholesaler of water in the country providing for over 31 million people, 140,000 farmers with irrigation water, Native American Tribes and other customers, accurate and timely data DCS provides is an indispensable water resource accounting and management tool.

The Reclamation’s sound water resource protection, management and development objective is dependent upon data received from remote GOES DCP’s. Reclamations Water Operations Program utilizes hydrometeorologic data for the management of over 600 dams and reservoirs, and 53 powerplants. Reclamation collects many parameters such as: reservoir levels; staff gage readings on canals; gate opening data from which flows are computed. Reclamation also collects precipitation, air temperature and water temperature at many sites. From this data many different reports and plans are generated for the comprehensive development of water resources.

As 80 – 90% of water used in the Western United States is purposed for agriculture accounting for its use is imperative to maintain balance. Since the 1980’s, Reclamation has deployed a network of platforms dedicated to the telemetry of agricultural data to support this requirement.

Data received from AgriMet stations is used in Reclamation evapotranspiration (ET) models that allow irrigators to ascertain the water holding capacity of their soil. Irrigation scheduling that utilizes AgriMet ET data can help to reduce water utilization and operating costs, minimize erosion and protect surface and ground water from excessive fertilizer, herbicide and pesticide applications.

All of the above parameters are used in the execution of Reclamations mission to provide:

- Leadership and technical expertise in water resources development and efficient use of water through initiatives including conservation, reuse, and research.
- Providing data to municipalities, recreationist, irrigators, water managers, other governmental agencies.
- Facilitating the continued development of states water right apportionments while complying with environmental commitments.
Managing hydro facilities to fulfill water user contracts while protecting and/or enhancing conditions for fish, wildlife, land, and cultural resources.

- Protecting the public with flood control measures.
- Providing more than 40 billion kilowatt hours of hydroelectric power annually which serves more than 3.5 million homes.

NOAA’s National Ocean Service (NOS) uses GOES DCS DCPs throughout the National Water Level Observation Network (NWLON), National Currents Observation Program (NCOP), and Physical Oceanographic Real-Time System (PORTS®). In addition to serving real-time tides and currents data to the maritime navigation community, commercial fishers, and recreational boaters, the NOS network provides high resolution, 1-minute water level data to support national tsunami warning and mitigation efforts.

Tsunamis pose a significant threat to coastlines around the world. Water level observations at coastal tide stations comprise a critical component of an effective tsunami warning system. The Center for Operational Oceanographic Products and Services (CO-OPS) has been involved with tsunami detection and warning for coastal hazard mitigation since the 1940’s through the operation of a specific subset of its long-term tide stations in support of the national tsunami warning system. However, following the devastating 2004 Indian Ocean tsunami, CO-OPS began a system-wide upgrade of its instrumentation to increase the rate of data collection and transmission at all coastal National Water Level Observation Network (NWLON) stations to better support the National Tsunami Warning System’s tsunami detection and warning capabilities, as well as to provide critical inundation model input.

In addition to upgrading equipment at existing long-term NWLON stations, in 2007 CO-OPS completed a collaborative initiative with the Tsunami Warning Centers (TWCs) and the Pacific Marine Environmental Laboratory (PMEL) to establish 16 new high-priority tide stations in Alaska, the Pacific Islands, the West Coast, and the Caribbean, increasing the geographic coverage of water level observations in tsunami-vulnerable locations. At the current time, CO-OPS operates tide stations on all US coasts in support of tsunami warning. Each station collects and transmits critical tsunami warning data to regional centers using the GOES DCS.

Upgraded tide stations are equipped with new hardware and software to enable collection and dissemination of 1-minute water level sample data. The raw water level data is made available to the regional Tsunami Warning Centers via GOES DCS satellite transmission. In addition, the GOES DCS-based real-time tide and current data provided through PORTS* represents one component of NOS’s integrated program promoting safe navigation. PORTS* data, when combined with up-to-date nautical charts and precise positioning information, can provide the mariner with a clearer picture of the potential dangers that may threaten navigation safety.
New commercial shipping systems rely on the availability of GOES DCS-based real-time tide/current and other information. One additional foot of ship draft may account for between $36,000 and $288,000 of increased profit per transit. Knowledge of the currents, water levels, winds, and density of the water can increase the amount of cargo moved through a port and harbor by enabling mariners to safely utilize every inch of dredged channel depth, and the GOES DCS is critical to ensuring the timely provision of this data. Each PORTS® installation provides information that allows mariners to maintain an adequate margin of safety for the increasingly large vessels visiting U.S. ports, while allowing port operators to maximize port throughput. This accurate, real-time water-level information allows U.S. port authorities and maritime shippers to make sound decisions regarding loading of tonnage (based on available bottom clearance), maximizing loads, and limiting passage times without compromising safety.

The aforementioned uses of DCS and interagency coordination are attributes of a well developed, balanced and managed resource. Interference within this spectrum would result in the loss of millions of records of data per day and potentially jeopardize the safety and wellbeing of millions of people and billions of dollars of infrastructure, real estate, agriculture, commerce, etc. that the GOES DCS is instrumental in helping to protect.

The International Boundary and Water Commission – United States and Mexico (Commission), as a binational commission utilizes GOES DCS in the application of several treaties between the United States and Mexico regarding boundary demarcation, the national ownership of waters, sanitation, water quality and flood control across the U.S.-Mexico border region. The Commission is comprised of a U.S. Section, which receives foreign policy guidance from the U.S. Department of State, and a Mexican Section, which is administered by the Secretariat of Foreign Relations of Mexico. As the treaties charge the Commission with keeping a record of the waters belonging to each country, insuring the accurate and timely delivery of each country’s water allocation, and maintaining the requisite gaging network for the collection of this data, the U.S. and Mexican sections have each deployed GOES DCS DCP’s throughout the U.S.-Mexico border region. This network includes platforms on the international reaches of the Rio Grande, Colorado River and Tijuana River Basins and their tributaries.

GOES DCS DCP’s serve as the primary data resource for the management of waters in these shared basins and the collected data is used to insure compliance with the provisions of the treaties and subsequent agreements that have been created over the years. These data are disseminated to the public and are used by stakeholders at the federal, state and local level for tracking irrigation deliveries, water quality monitoring and emergency management. The Commission’s and other U.S. federal agency’s usage of the DCS has also encouraged the federal agencies in Mexico to build and expand their own network of hydrometeorological GOES DCS
DCP’s in their territory thus improving the operational knowledge and data transparency between the two nations while managing the binational waters within the shared basins and the basins throughout the country of Mexico.

**Spectrum Auctions and FCC Precedence on Spectrum Protection**

Interference by terrestrial sources has been a major concern for DCS users for many years. Observing a spectrum analyzer will reveal the presence of several signals being captured by a receive antenna at any given location. These other bumps in the radio spectrum may be coming from any number of sources be them mobile or stationary. Concern is elevated when the observed frequencies are near the desired frequency and are at decibel levels high enough to cause interference. The allocation of radio spectrum directly concerns DCS. The closer radios are permitted to operate near the protected 1675 – 1695 MHz band in geographic proximity to DCS ground stations the likelihood of impeding interference increases. Without proper safeguards the 1675 – 1695 MHz allocation is exposed to activities that threaten the viability of this spectrum and the people, assets and infrastructure it protects.

Recently, the 1695 – 1710 MHz was auctioned for the purpose of sharing between government and commercial wireless. This segment is less than 1 MHz from the top end of the DCS allocation (LTE broadband wireless signal comes within ~300 kHz) occupied by the GOES High-Rate Information Transmission (HRIT) downlink at 1694.1 MHz. The higher transmission rate HRIT signal will replace the current Low-Rate Information Transmission (LRIT) downlink (at 1691 MHz) to provide GOES space and Earth imagery, emergency management information (EMWIN) and other hydrometeorological products used by public and private groups in various industry sectors including but not limited to public safety, aviation, energy, communication, agriculture, insurance and media and broadcast. Many of these users have deployed their own ground stations that collect and process the products included in the L/HRIT stream.

A typical terrestrial LTE signal is an order of billions of times stronger than the signal received from the GOES spacecrafts and at such close proximity would annihilate the DCS signal and render it unintelligible causing GOES DCS-based data collection to cease. Such a powerful signal can impede reception in several ways by: creating excessive errors, overloading amplifiers, creating additional signals within the receiver front end and loss of link margin to where reception is impacted. Filter implementation on in-spectrum DCS receivers is not possible as it would reduce both the desired and interference signals.
Private wireless companies are vying for spectrum allocations to build multi-billion dollar nationwide infrastructures. In 2012 the FCC blocked a planned wholesale national wireless network over concerns of the wireless infrastructure impeding the global positioning system (GPS) transmitting in the 1559 - 1610 MHz band. GPS devices utilize mechanisms designed to prevent interference above and below 1575.42 MHz but the signal strength of the base stations operating in the proposed 1525 – 1559 MHz band at 15kW output power exceeded their filtering capacity approaching the GPS spectrum. Additional filtering near the GPS frequency would minimize both the offending and desired signal but will not improve reception of the desired GPS frequency.

After a series of tests conducted by the National Telecommunications and Information Administration (NTIA) the proposed wireless network utilizing terrestrial and satellite transmitters operating on spectrum near 1575 MHz was found to overpower GPS transmissions with no practical way to mitigate the potential interference. As a result, the FCC also ended earlier orders giving authority to build some parts of the proposed network.

Intrusion-induced cessation of data collection has also been demonstrated by injecting white-noise interference (e.g. a typical LTE signal) into a stream containing GOES imagery (see “FCC Precedence on Spectrum Protection” section). This condition can be further exacerbated by meteorological conditions and proximity to large bodies of water. If the entire 1675 – 1695 band were to be auctioned for frequency sharing, all DCS related data transmissions would be jeopardized where LTE and other wireless radio interference would cohabitate within the spectrum. One look at a major cellular carrier’s LTE coverage map should be enough cause for concern.

The interference found during the NTIA intrusion substantiates what was found during recent bench tests conducted by The Aerospace Corporation. The test involved injecting a 5 MHz wide LTE-shaped signal into the LRIT stream transmitting at 1694.1 MHz [mixed down to intermediate frequencies (IF) 144.0 and 140.6 MHz respectively]. As the LTE interference signal level increased the much lower decibel LRIT signal became less distinguishable. The LRIT receiver was able to tolerate an interference/signal ratio (I/S) of less than 24 decibels (dB). When the tolerance threshold was exceeded the LRIT receiver was unable to process the incoming data stream. The LRIT/HRIT downlink would likely be less tolerant of interference because the guard band separating it from the recently auctioned spectrum above 1695 MHz is much smaller at just roughly 300 Hz versus the ~3.6 MHz guard band used during the test.
A typical wireless terminal would operate at +30 dBm which is in this case 154 dBm above the HRIT Earth signal power and 130 dB above the tolerance threshold. Assuming a center frequency of 1697.5 MHz, an LRIT/HRIT Earth Signal Power of -124 dBm, an I/S threshold of 24dB, LTE transmit power of 30 dBm it may require a line of site distance of up to 26 miles to achieve and maintain an I/S of less than 24 dB from an LTE transmitter emitting +30 dB of signal using the Okimura-Hata Free Space Fading Model. The O-H Urban Area Signal Propagation Model estimates a required distance of at least 1,000 feet from an LRIT/HRIT receive station is required to reduce interference to levels below the 24 dB threshold.

The adverse effect of radio frequency intrusion on terrestrial systems has been proven, documented and appropriately blocked by the FCC on other parts of the radio spectrum utilized by vital infrastructure. Bench testing applied to the DCS spectrum has yielded results corroborating the findings of the NTIA intrusion study. Coordination zones, spectrum sharing and insufficient guard bands all threaten the capability of DCS and the agencies that rely on the data it provides. The operation of terrestrial radios in the recent auctioned spectrum adjacent to 1695 MHz poses the same threat as the GPS signal interference study. To propose coordination zones would present an even greater threat as there would be no guard band between the DCS spectrum and broadband signals.

**GOES DCS Alternatives and Policy Perspective**

Alternatives to the current DCS data feed are often a logical progression within any discourse on spectrum preservation. Commercialization or Internet-based options are perceived as viable replacements. Cost, reliability, terrestrial risk elimination and timeliness are key features of the existing GOES telemetry system. Both commercial and Internet solutions pose a significant threat, require sizable funding and/or violate prescribed protections of Federal systems not unlike the GOES DCS.

Internet based solutions have been proven to lack the reliability, timeliness and risk protections to be on par with the current telemetry system. There are many recent cases where Internet connectivity to government agencies has been interrupted for one reason or another ranging from a few hours of lost data to years of limited Internet connectivity. A common occurrence involves a network appliance hardware failure that isolates users from the Internet. Another cause is accidental severance of telecommunication lines during construction or maintenance work which can disrupt service for several days. Administrative termination of Internet connectivity due to security concerns have been known to last months or years at a time. All of the mentioned scenarios are real and have a probabilistic risk of occurring again in the not too
distant future. Internet reliance for all mission critical information is a high risk probability and impact proposal.

Timeliness of the data is imperative. The availability of internet bandwidth is not guaranteed. As packets can be prioritized it is not a certainty that hydrometeorological data will receive the proper treatment in the context of all the other data sharing the same pipelines. Direct collection from the GOES spacecraft eliminates any data latency due to prioritization, firewall issues, network collisions or other impediments. The internet and any terrestrial vehicle simply will not provide necessary protection, reliability and efficiency comparable to the GOES DCS.

GOES DCS users have utilized the system with the expectation of future support, development and coordination outlined in 15 CFR 911.6 and 911.7. Transferring the DCS functionality to commercial third-party satellites incurs subscription costs as well as additional operational and management outlays to DCP owners who would be required to purchase, install, and configure new transmitters and other hardware for every deployed GOES DCP. This option does not satisfy the user requirements relative to cost due to the size and scope of the GOES DCP network. The recurring expense to commercially transmit data exceeds what already exists and will conceivably result in the removal of DCP’s due to funding constraints, therefore diminishing the capacity for water resource management and accounting and life-safety-property protection.

The Corps of Engineers has converted more than half of its direct readout DOMSAT ground stations (Domestic Satellite – commercial GOES DCS rebroadcast) to L/HRIT systems in order to move away from commercial relay systems; estimated completion by FY17. Agencies using the GOES DCS have already invested millions of dollars in certified GOES compatible DCP’s and transmitters to utilize this resource in accordance with 15 CFR 911.5. Moreover, 51 U.S. Code § 60161 prohibits the Government from making any effort to lease, sell or transfer to the private sector or commercialize any portion of the weather satellite systems operated by the Department of Commerce or any successor agency; This includes the GOES spacecrafts and DCS.

Transference also impacts the network of GOES Direct Readout Ground Stations (DRGS) that receive the initial DCP transmission relay from the East and West GOES spacecrafts versus the L/HRIT consolidated rebroadcast. DRGS systems receive and process data from each GOES satellite separately and require dual dish antennas and multiple receive systems. These systems represent an even greater financial investment than the rebroadcast L/HRIT primarily due to the hardware and infrastructure requirements. Modifying these systems would require
purchasing new antenna components, replacing receivers and demodulator cards and software/firmware modifications to the DRGS servers and the Open DCS server software that decode, archive and disseminate the incoming data.

As DCS has matured and utilization continues to increase, making changes to this aspect of data collection is an ever increasingly expensive proposal and places an undue and unnecessary hardship on agencies that have invested resources in the current system.

**STIWG Consensus**

Protection of the 1675 – 1695 MHz band and GOES DCS in general is critical to the continued use and effectiveness of the well established distribution of GOES DCP’s. The importance of this spectrum allocation is captured and iterated in various policies designed to either protect and/or define the parameters and thresholds for spectrum sharing within coordination zones. The lives and assets this system protects and the data it provides for government agencies and private industry on a daily basis make the GOES DCS and its associated rebroadcasts indispensable.

Transferring the DCS function from GOES spacecrafts for tens of thousands of platforms to a commercial satellite, migrating the entire GOES DCP network to a terrestrial medium, relying on the Internet or any combination thereof presents a number of concerns currently not attributable to the current DCS relay system. Training, labor, software modifications, hardware procurement and long term operating expenses outweigh the immediate cost benefit of transferring the capability. Relying on ground relay systems relegates the network by becoming susceptible to outages due to natural and manmade disasters, vandalism, internetwork outages, accidents, power outages and various types of interference. The robust, timely, cost effective, highly organized, widely used and STIWG community supported GOES DCS has provided exceptional service and reliability.

Additionally, the sharing of this allocation jeopardizes the critical capabilities of DCS and the missions of users that have relied on it for almost 40 years; dozens of federal military and civilian agencies, numerous state agencies, colleges and universities and private entities across many industry sectors. The magnitude and importance of the relayed hydrometeorological information and implemented protection policies against intrusion and third-party commercialization are clear indications this allocation should not be classified as underutilized, expendable or transferrable. Unless it can be demonstrated that frequency sharing within
coordination zones while incorporating appropriate guard bands will not cause interference we are in agreement that the 1675 – 1695 allocation should be deemed inherently governmental and elevated to a protected status with a specified interference standard that will ensure the continued function and evolution of the GOES DCS and ground stations into the future.
## STIWG Voting Members

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<th>Name</th>
<th>Organization and Agency</th>
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<tr>
<td>LySanias Broyles</td>
<td>United States Army Corps of Engineers, Department of Defense</td>
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<tr>
<td>Jim Heil</td>
<td>National Weather Service, National Oceanic and Atmospheric Administration</td>
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<tr>
<td>Bonnie Wyatt</td>
<td>Forest Service, Department of Agriculture</td>
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<td>Robbie Swofford</td>
<td>National Interagency Fire Center, Bureau of Land Management</td>
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<td>Howard Diamond</td>
<td>National Centers for Environmental Information, National Oceanic and Atmospheric Administration</td>
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<td>Charles Allen</td>
<td>United States Bureau of Reclamation, Department of Interior</td>
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<td>Mark Fitch</td>
<td>National Park Service, Department of Interior</td>
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Annex
GOES Footprint

Figure 1 An illustration of the concentric elliptical camera and communication footprints of the GOES East and West satellites over the Americas.
Figure 2 Depiction of the GOES communication spectrum. The downlink graph (top) shows the 1675 – 1695 MHz band used by satellites to relay data to Earth receive ground stations and the close proximity of the recently auctioned spectrum for wireless broadband (1695 – 1710 MHz) to the HRIT/EMWIN frequency at 1694.1 MHz.
Figure 3 A basic illustration of the filter response curve for GPS receivers. The bottom picture includes the LightSquared proposed wireless broadband infrastructure that was found to interfere with GPS receivers. The interference detected during intrusion tests prompted the FCC to block the effort. The signal overpowers filters approaching 1575 MHz.
Figure 4 Shows a typical GOES DCS DRGS (Direct Readout Ground Station) dish antenna (red circle) deployed on a roof top in a typical downtown metropolitan area. Sites such as these are especially susceptible to interference. DRGS systems are the most timely and reliable methods to acquire GOES DCS data as they collect the first relay from the DCP; operate within the 1675 – 1695 MHz spectrum.
Figure 5 Graph illustrating the billions of dollars in flood damages prevented by the Corps of Engineers from 2005 - 2014. GOES DCS is the primary data source for operational and emergency water resource management.
Figure 6 Graph illustrating the adjusted flood damage reduction benefit to cost relationship for the Corps of Engineers from 1927 - 2014. GOES DCS has been instrumental in providing data to maximize benefits since the early 1980's.
Figure 7 Tsunami Water Level Monitoring Station at Christiansted Harbor, St. Croix, United States Virgin Islands. The GOES DCS antenna is the round can atop the left-most post.