

Documentation of Site Preparation for Installation of SeaSpace Ground Stations at ECSU

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Abstract— In September 2014, a transition was made to a direct purchase and installation of Seaspace hardware and software. The installation of the Seaspace hardware included: 15 Visualization stations, 2 monitoring systems, a Teravault raw storage device, and a TeraScan Rapid Environmental X-treme (TREX) high-powered processor. The installation of the Seaspace software on the 15 Visualization stations included: an updated version of TeraScan, which includes the Graphical User Interfaces TeraVision and TeraMaster, and CentOS, which is a Linux-based Operating System. Also two 5.0m L band systems were installed on Dixon-Patterson hall in the summer of 2012. The purpose of this project was to 1) document the installation requirements and internal processes at ECSU for Seaspace Hardware and Software Equipment, with also addressing; 2) the location of engineering findings, location of installation requirements, 3) repositioning and securing current ground stations, and 4) proper training center needs.

Index Terms—SeaSpace, TREX, TeraScan, CentOS, TeraScan, Visualization stations, TeraVault, monitoring systems, GOES

I. Introduction

SeaSpace Corporation Inc. based in Poway, California is a provider of remote sensing ground stations [1]. From 1982 to the current day, SeaSpace has designed and implemented technologies such as low-cost satellite ground stations, that supply the best solutions to monitor atmospheric patterns [2]. SeaSpace has been a very fundamental provider in remote sensing technologies and related software to the Center of Excellence in Remote Sensing Education and Research (CERSER) program dating back to 2002. CERSER is a scholarship program that is lead by its principal investigator, Dr. Linda Hayden. The goal of CERSER is to help develop and implement remote sensing technologies to aid in research collaborations focused on ice sheets, coastal, oceanic and marine research and to overall expand the remote sensing capabilities at ECSU [3]. From 2002 until now, SeaSpace has provided equipment to Elizabeth City State University, in the form of an east coast training site and data center which continues to foster established research collaboration. The equipment gained from SeaSpace Corporation thus far includes two 5.0m Geostationary L_Band antennas, and a one 1.5m L_band antenna, with the associated acquisition and processing servers. In September of 2014, a new acquisition was made by Elizabeth City for new Seaspace hardware and software for Dixon-Patterson Hall on Elizabeth City State University's Campus. Dixon Patterson Hall, which houses the new

acquisition of Hardware and Software, had to be prepped and documented before Seaspace subcontractors could arrive and install new software and hardware, purchased by Elizabeth City State University. Therefore, there needed to be proper documentation of past installation of equipment in the recent years.

II. Site Preparation

A. Current Ground Station Locations and ECSU Prerequisites

Dixon-Patterson hall (located on the ECSU campus) was chosen as the ideal location for the current ground stations. ECSU had a building committee approve the installation of the ground station locations. To assure that the roof structure can hold the load of the 3.6 & 3.7 dishes an Engineering Report was generated by a local engineer to analyze the roof of Dixon-Patterson Hall. The structural engineer analyzed Dixon-Patterson Halls structure and approved the amount of weight that the building is able to support when the ground stations were attached to the roof. Geostationary Operational Environmental Satellites (GOES) East and GOES West antennas were placed on the top of Dixon-Patterson Hall in Summer 2012. The antennas were anchored by concrete bags and sat on top of concrete pads. However, currently, both antennas are anchored by bolts on the concrete pads using the implemented rail design system, so that the antennas will not move during the change of the seasons.

Dixon-Patterson Hall furthermore, met several key criteria, including: flat roof, clear sky view, and space to position the associated server. Data acquisition is established from horizon to horizon for these particular ground stations and therefore limited building and tree obstruction is essential. To provide power, the now current conduit, runs through the roof to power both stations. This conduit contains power and other AUX cords to the server room to the TeraScan Software. The L-band ground stations are in the vicinity of the ITC (Information Technology Center) building on the east side grounds. Due to the two 5.0 meter L-band ground stations being a fixed axis dish (meaning it does not rotate its focal point) that stays positioned at the Clarke belt of GOES East and GOES West, continues to point a few degrees below the equator line from the ground where the visibility is not obstructed.

B. Satellite Information

The data that is transmitted to the GOES East and GOES West antennas originally come from the GOES-13 Satellite (East) and the GOES-15 Satellite (West). The main purpose of the GOES satellites are done by the Imager and Sounder instruments [17]. The Imager is a multichannel instrument used to capture radiant energy and reflected solar energy from the Earth's surface atmosphere [17]. The Sounder provides data to determine the vertical temperature and moisture profile of the atmosphere, surface, and cloud top temperatures, and ozone distribution. The GOES-13 Satellite was launched May 24, 2006 and is currently located at 135° West Longitude, and it is in its' own personal orbit above South America [19]. The GOES-15 Satellite was launched March 4, 2010 and is

currently located at 75° West Longitude, and it is in its' own personal orbit above the Pacific Ocean [18].

The one 1.5m L-band antenna provided by SeaSpace Corporation, receives the broadcast from the Polar-orbiting Operational Environmental Satellites (POES), which includes the National Oceanic and Atmospheric Administration (NOAA) 15-19 satellites [31]. The POES Satellites hover above the North and South Poles of the Earth and within each POES satellite, there includes the Advanced Very High Resolution Radiometer (AVHRR) and the Advanced TIROS Operational Vertical Sounder (ATOVS) instruments [32]. Both instruments, provides visible, infrared, and microwave data which can be used for cloud and precipitation monitoring, and other usages [32]. POES Satellites are able to receive daily global imaging.

The antennas that are on the top of the roof of Dixon-Patterson Hall, receive satellite data via the L-band frequency.

A. L-Band

The 1.5m ground station and the two 5.0m ground stations operate in L band frequency. The L-Band has a frequency range of 1-2 GHz and a throughput of ~2 Mbps [4]. A few of the telemetries that operate on the band are NOAA, the Sea-viewing Wide Field of View Sensor (SeaWiFis), and Meteorological Operational Satellites (METOP).

NOAA- provides accurate weather forecasts to protect and manage the nation's coastal and ocean resources.

METOP- is a series of three polar orbiting satellites.

SeaWiFS- to develop and operate a research data system to gather, process, archive, and distribute data received from an ocean color sensor.

1) TeraScan

TeraScan is a combination of hardware and software designed for automated reception of data from meteorological/environmental satellites and for processing the data into images and data overlays [7]. Images and overlays are of a special format called TeraScan Data Format (TDF) and can be displayed with the TeraScan viewer called TeraVision. These data files can be used to produce images in various formats. Different types of satellite data can be received from both the hardware and software that is installed on the computer. These satellite data types include: X-Band Data from Polar-Orbiting Satellites, L-/S- Band Data from Polar-Orbiting Satellites, and L-Band Data from Geostationary Satellites [7].

2) TeraVision

TeraVision is a Graphical User Interface (GUI) that is a part of TeraScan, in which the images, in the form of TDF, can be manipulated by the user to include annotations, overlays, image enhancement of different parts of the image [13].

TeraMaster

TeraMaster is a GUI that is used to define areas of Interest (AOI). In defining the Area of Interest, the user can define the area, set the resolution, and map projection information. The

main display panel can show the actual AOI size or fit to the screen [16].

3) Data Processing in TeraScan

Data processing in TeraScan is carried out according to configuration files located in \$PASSDIR/configproc. The processes to be run are set as "active" in those files [8]. Files Batch.ingest files within the configproc directory specifies for ingest function(s) to be run by run_ingest, including gvarin, which makes whole pass gvar datasets. Gvar.local specifies remapping of the whole pass datasets to the Local Master [8]. Gvarin reads GOES VARIABLE Format (GVAR) data directly from application shared memory when reception is live [9]. GVAR is the data transmission format used with the new generation of GOES meteorological satellites [10].

Information regarding the different products that can be produced with the TeraScan software from specific satellites can be located in \$DATADIR directory on the TeraScan system. For the GOES Satellites, GVAR data has different channels, which consist of the following:

- gvar_ch1: Channel 1 observes cloud cover and surface features during the day, with a transmitting wavelength of 0.5-0.7 μm [14].
- gvar_ch2: Channel 2 observes Low cloud/fog and fire detection, with a transmitting wavelength of 3.8-4.0 μm [14].
- gvar_ch3: Channel 3 observes Upper-level water vapor, with a transmitting wavelength of 6.5-7.0 μm [14].
- gvar_ch4: Channel 4 observes Surface or cloud top temperature, with a transmitting wavelength of 10.2 – 11.2 μm [14].
- gvar_ch5: Channel 5 observes Surface or cloud top temperature and low-level water vapor, with a transmitting wavelength of 11.5-12.5 μm [14].

Beyond the channels of GOES satellites, the data products that come from the GOES East and GOES West antennas for the images, can be found in nexus/data1/products/tdf/whole_pass/gvar, which contains:

- .sounder – makes hourly soundings of the atmosphere over the Contiguous United States (CONUS) and adjacent oceans, providing vertical profiles of temperature and moisture, and cloud-top temperature, and wind speed and direction [14].
- gvar_sst – computes sea surface temperature from GOES GVAR imager data. The basic formulas for the algorithm are:

$$\begin{aligned} \text{DAY SST} &= A + B \cdot T_4 + C \cdot (T_4 - T_5) + D \cdot (T_4 - T_5)^2 + E \cdot \text{ANGLE} \\ \text{NIGHT SST} &= A + B \cdot T_3 + C \cdot (T_3 - T_4) + E \cdot \text{ANGLE} \end{aligned}$$

where ANGLE = (1/COS(SAT ZENITH)) - 1, and T_n are degrees Kelvin [15].

- .lowcloud – shows low cloud detection.
- .cloudprod – generates cloud image products for a variety of satellites/imaging sensors [21]. Input data must be AVHRR, GMS, GVAR, or METEOSAT [21].
- .cloudwind_ir – runs the cloudvec_script to generate images from IR brightness temperature channel data and water vapor channel data [22].
- .cloudwind_wv – runs the same cloudvec_script as cloudwind_ir [22].

For the NOAA antenna, the data products are located in /nexus/data1/products/tdf/whole_pass/hrpt. which contains:

- .sst – shows sea surface temperature [15].
- .ndvi – shows normalized difference Vegetation Index, by compiling the function ref to calculate it's index[23].
- .Lst – a script used in batch processing to create a land surface temperature product[24].
- .cloudtops – a script used in batch processing to create the following cloud products: cloud_top heights, cloud pressure, cloud temperature, and cloud levels [25]. The script uses the following TeraScan processing sequence:
 - 1) topomask – to generate a temperature mask
 - 2) cloudmask_script – to generate a cloudmask
 - 3) cloudprod – to generate the cloud image products [25].
- .avhrr – generates global coverage roughly twice daily[26].
- .avcloud – computes a cloud mask for a given AVHRR image [28].
- .fog – a script used in batch processing to map fog from HRPT data [27].
- .dcs – (including functions dcsmix, dcslst, dcsloc, and dcsin) a script that captures returned low-volume sensor data with the stationary platform from the Data Collection and Positioning System [29].
- .tobs – ran by the tovsproc script, produces temperature, moisture, and thermal wind profiles at a horizontal resolution of about 75 km from HIRS (infrared) and MSU (microwave) sounding radiance observations [30].

III. Methodology

A. Preparation:

After documentation of current systems and software were in place, a preparation of the rooms 229, 228, and 226 in Dixon-Patterson Hall had to be completed. When making contact with SeaSpace Corporation, images such as **Figure 1**, **Figure 2**, and **Figure 3** were sent to the company via email to show the blueprint of the flooring plans of the classroom in Dixon-Patterson Hall where the new hardware and software would be located and installed by SeaSpace

subcontractors. After sending these images to SeaSpace and awaiting the arrival of the SeaSpace subcontractors, the process of the getting each of the three rooms prepped began. A contractual service called B&M that is located in Elizabeth city, installed Two 220 volt connections, and a new generator, and also reinforced the concrete pads. PMV pumblng, another contractual service, drilled the holes into concrete pads. Contractual Service from ECSU mounted the 42-inch TV into the wall of room 228.

1) Room 226

In observing **Figure 1**, there had to be a written record of all the programs on the Macintosh desktop computers in room 226. It was also noted that there should be 2 visualization stations per table in room 226 with one of the visualization stations connected to the projector in the room. Furthermore, the length of each of the tables is 6ft with powerstrips beneath each of the tables. Afterwards, Linux-based programs that were equivalent to the programs found on the Macintosh computers were searched in order to supplement the 15 visualization workstations, which operate on a Linux-based Operating system.

2) Room 228

Observing **Figure 2**, the smaller box represents room 228 which houses the TeraScan hardware systems. In order to prep this room, the room needed to be removed of any unnecessary items that would potentially obstruct the SeaSpace contractors from installing the new TeraScan Equipment. The room was also consolidated in the fact that it was more accessible to maneuver in and out of the room and have more space to operate and facilitate in. Any of the excess items that were not needed anymore by CERSER or made room 228 less spacious, were discarded promptly. Room 228 would also hold one of the monitoring systems it provided by SeaSpace and it would be mounted on the wall.

3) Room 229

Looking at **Figure 2**, the bigger box represents room 229. Room 229 would house the other monitoring system provided SeaSpace. This monitoring system would be mounted and displayed on a cart.

When the equipment from SeaSpace arrived to Dixon-

Patterson Hall at ECSU, all of the hardware equipment had to be unpacked and stored in room 228 until the SeaSpace subcontractors came. The SeaSpace subcontractors came the week of March 23 and the research group aided them in the installation process with the 15 Visualization Stations and the monitoring systems.

Figure 1, room 226

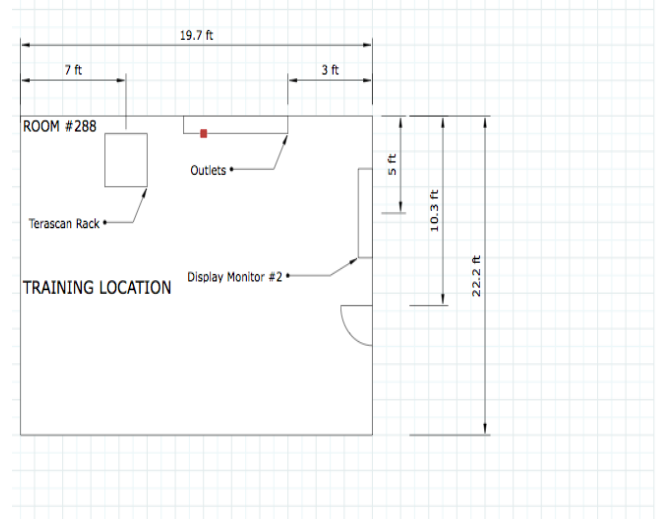


Figure 2, room 228

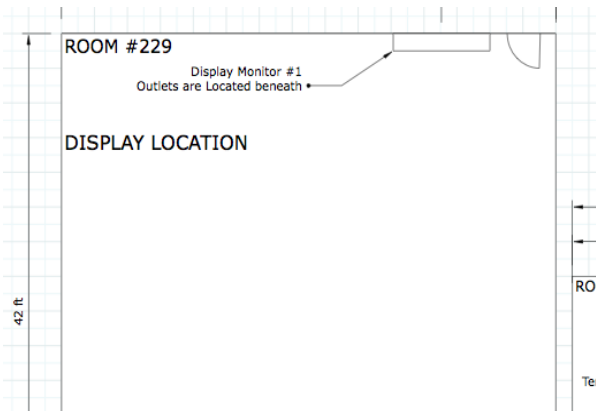
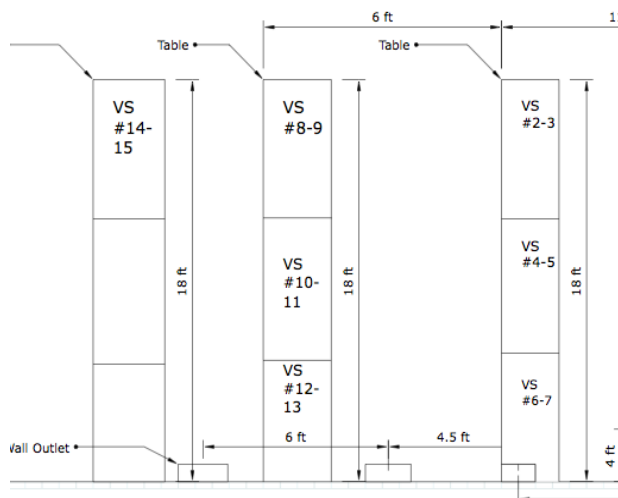


Figure 3, room 229



B. New Hardware Provided by SeaSpace:

1) Visualization Station

The Visualization Station provided by SeaSpace is a Dell T1700n Computer, with an intel core i7-4770 processor, 3.4 gHZ 4 core, and 8 GB of RAM. This hardware specification is for all of the Visualization stations in room 226 [6]. The visualization stations will be able to access whole pass datasets from the TeraScan systems and will also be able to manipulate the datasets as well.

2) Monitoring Systems

The monitoring systems provided by SeaSpace is a visualization station with a 24 and 42 inch widescreen monitor attached to each of the visualization stations. This hardware specification is also for all of the Visualization stations in room 228 and room 229 [6]. The monitoring systems will be able to do what the Visualizations stations do, but will be able to display the information on a 24 and 42 inch screen.

3) T-Rex Processing Computer

The TeraScan Rapid Environmental X-treme (T-REX) processing computer is provided by SeaSpace. The T-REX processing computer is a Dell R720E, 16-core E5-2667 3.30 GHz, with 128 GB RAM, a 12x1.2 TB 10K SAS HDD, with a Dual PS [6]. The TREX is will consistently collect the whole pass data sets that are made with the GOES East, GOES West, and NOAA antennas on top of Dixon-Patterson Hall.

4) TeraVault

The TeraVault is provided by SeaSpace Corporation. The TeraVault is a 60 TB (Raw) with a certain number of extra TB which is effective. Accompanying the TeraVault specifications includes: a 4U, 2 controllers each with X4 1 Gigabit NIC+ 1 mgmt ctiler, 60 Drive Bays, X20 3 TB disks, C20 connector, Dual PS, and a Rapid controller [6]. The TeraVault will hold the raw data incoming from the TREX which is collecting the whole pass data sets [6].

5) UPS Assy

The Uninterruptible Power Source (UPS) Assy is provided by SeaSpace Corporation. The UPS Assy houses a 1500 VA, 220VAC, and 2U Rackmount. There is a total of two UPS machines, with four possible racks/outlets. One of the racks will be for the GOES East connection, and one for the GOES West connection. The TREX and the TeraVault already have a UPS [6].

C. New Software Provided by SeaSpace:

After setting up the 15 Visualization stations, each of the computers had to go through a Site Acceptance Test to see if the computer is working correctly and the software on the computer is updated to the newest versions. This software includes the previously listed TeraScan and CentOS, which is a Linux-based Operating System.

1) CentOS

CentOS is a Linux-based Operating System that is a free and open source computing platform [11].

D. Flow of Information

The combination of the new hardware and software from SeaSpace Corporation has constructed a new flow of information from the satellites to the new visualization stations in Dixon-Patterson Hall. The receiving data from the NOAA Geostationary Satellite transmits to the GOES East and West antennas on top of Dixon-Patterson Hall. The transmission of

data will then be processed into the subsequent GOES East and GOES West CPU's. This same data is then further transferred into two different locations: the TREX Processor and the TeraVault. The TREX will process the data into respective TDF. The same data will be saved to the TeraVault.

IV. Future Work

To expand this project, the server room needs to be set up completely in the coming months, in order for the room to be used to its optimal level. Being that the room has TeraScan Hardware functioning all of the time, it is important that instead of having carpet floor, to have tile floor, meaning that room 228 will have to be completely cleared out in order for the carpet to be removed and the tile floor to be placed. This is important because having a tile floor, will be able to manage air-flow to sensitive SeaSpace Equipment. Furthermore, a Ground Lightning arrestor is need for each of the Ground Stations on the top of Dixon-Patterson Hall, in order to keep the stations protected throughout the different seasons of the year, when lightning is present. The arrestor will act as protection from the lightning so that the antennas will not be damaged during the duration of the antennas' usage. To further expand this project, there will be usage of the actual TeraScan system itself, such as developing Data Archives Batch Operations (scripts) and a web application to share the images that are edited in TeraVision done with now its new hardware and software to accompany it.

Currently, the TeraScan system has scripts that the run based on the current data products on the system. In developing the scripts for the TeraScan system, the scripts will run an automated process, as indicated by the user, to capture specific images made by TeraMaster. These scripts will have parameters that would need to be changed for the desired outcome by the user. After developing the scripts, a web application will then be developed in order to connect the TeraScan System to the CERSER Web Server. The web application will be attached to the images on the TeraScan system in Dixon-Patterson Hall, and then at a specified time each day, the images from the most recent whole pass, will be adjusted to fit certain parameters that were personalized so that images can be produced on the CERSER main webpage.

V. Conclusion:

In conclusion, rooms 226, 229, 228 have been prepped for new hardware and software that is currently in each of the rooms. The rooms still have more additional material that need to be added to them to make them efficient for the server room in Dixon-Patterson Hall. As CERSER continues to advance in research collaborations and projects, CERSER will have the most up to date technologies for its students and trainees of the CERSER program, that will be able to expand their knowledge of the TeraScan Hardware and Software System.

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