

# Update of the CERSER TeraScan Cataloguing System and the TeraScan Image Processing Scripts

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## I. INTRODUCTION

In 2013, the Center of Excellence in Remote Sensing Education and Research (CERSER) added more satellite receiving hardware to its current National Oceanic and Atmospheric Administration (NOAA) satellite system [2]. The program now processes both NOAA satellite images as well as Geostationary Operational Environmental Satellite (GOES) [8] satellite images. This new imaging capability required the development of scripts on the TeraScan system to process satellite data received and produce an image file with overlay features such as latitude/longitude lines and political map outlines.

During this expansion, the image processing files had also been migrated to another server. This migration resulted in the failure of the previously developed scripts tasked with the processing of the Tagged Image File Format (TIFF) satellite images provided by the TeraScan system. This failure had not been repaired due to the mechanical failure of the previous satellite receiving system. These scripts parsed the title of the image file into database records and transformed and converted the TIFF image into various Joint Photographic Experts Group (JPEG) files. The scripting on the server side that was utilized and reviewed was the code from the 2011 research team and is written in PHP Hypertext Processor (PHP) and My Structured Query Language (MySQL) [10].

The first goal of this project was to create the scripts needed on the TeraScan system in order to process the GOES satellite data. The second objective was to reconfigure the scripts created by the 2011 team to repair and update the server processing capability to process the new GOES images into the current image database and file system on the CERSER server.

## II. SOFTWARE AND LANGUAGE

### A. 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 [1]. 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 [1].

There are several different structures of hardware for the TeraScan system in how it receives and processes data. In the system, there is an antenna, receiver, bit synchronizer, frame synchronizer, computer workstation with TeraScan software, Global Positioning System (GPS), and an uninterruptible power supply (UPS) [1]. Different antennas are used for different satellite signal interception. For high-resolution data reception from geostationary satellites, a fixed-direction antenna is used. For high-resolution data reception from polar-orbiting satellites, a tracking antenna is used. The receiver is used for tuning to the correct satellite signal frequency and separating the sensor data (the baseband) from the RF carrier. The bit synchronizer regenerates the bit stream against noise, and if necessary, extracts the clock, which is a timing pulse added to the signal on the satellite to enable synchronization of the reception system with the satellite transmitter. The frame synchronizer divides the continuous bit stream into meaningful data blocks called frames [1]. The computer workstation helps control data reception and process the data into products. Finally, the GPS supplies position and time to the system and the UPS protects the system from power surges [1].

Two of the GUIs that were used were TeraVision and TeraMaster. TeraVision was used for displaying and editing TeraScan data images and overlays. Some of the capabilities of TeraVision include the image enhancement via color palettes, convolution filters, histogram equalization, manipulation of the view area by panning and zooming, and the animation of a series of images (time/product looping) [3]. TeraMaster was used for viewing, creating, and modifying masters. A master, also known as an area of interest (AOI), a TeraScan dataset that defines an area of the earth's surface in terms of map projection (shape), extents, and pixel resolution. A master has three purposes in TeraScan: 1. Sets criteria for the schedule of satellite passes, 2. Establishes a smaller set of data from a whole pass for processing, and 3. To change a base map view to an earth-located view of the data. [3].

Data processing is carried out according to configuration files located in \$PASSDIR/configproc. The processes to be run are set as "active" in those files [6]. 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 [6]. 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].

### B. ImageMagick

ImageMagick is software that lets you create, modify, and/or convert images to different formats. ImageMagick is controlled command line inputs which may be implemented from different programming languages. [11][12]

In this project ImageMagick was used to convert the image from TIFF to JPEG format. It was also used to resize, copy, and rename the image files. The directories that it copied the images to were actual, medium, low, and thumbnail.

### C. PHP

PHP Hypertext Preprocessor (PHP) was used in this project to construct and execute MySQL commands for the database operations and to execute ImageMagick operations via a command line [13]. PHP is processed by the PHP server and generates Hypertext Markup Language (HTML) to be delivered back to the client [15] [16].

PHP was used in this project to construct and execute MySQL commands for the database operations and to execute ImageMagick operations via a command line. PHP is a cross platform language making it useful for websites that may change server operating systems.

### D. MySQL

My Structured Query language (MySQL) is the most popular Open Source SQL database management system [18]. To add, access, and process data stored in a computer database, a database management system, such as MySQL Server, is needed. Since computers are very good at handling large amounts of data, database management systems play a central role in computing, as standalone utilities, or as part of other applications [17].

### E. Dreamweaver

Adobe Dreamweaver is a software package that has to be purchased; it is used to create web pages, interactive web pages and to interact with databases. Dreamweaver allows you to write in scripting languages such as PHP and JavaServer Pages. [20].

In this project Adobe Dreamweaver was used to build the TeraScan database using the PHP language and to document this project.

### F. phpMyAdmin

phpMyAdmin is a free software tool written in PHP, intended to handle the administration of MySQL over the web. phpMyAdmin supports a wide range of operations on MySQL, MariaDB and Drizzle. This graphical user interface has ability to directly execute any SQL statements [23][24].

phpMyAdmin was utilized in this project to build and maintain the TeraScan database. Fields and tables within the previously established database were created and modified utilizing this online tool. Actual data can also be modified, created, and deleted from within phpMyAdmin.

## III. GOALS

This research project had three goals for this academic year tasking:

1. Determine and repair the cause of the script failures on the CERSER server.
2. Develop TeraScan script that will process the satellite data into an image, provide overlay information, and place the completed image onto the server.
3. Rewrite the PHP processing script on the CERSER server to parse Geostationary Operational Environmental Satellite (GOES) information into a database and to execute commands to convert and resize the same image.

## IV. METHODOLOGY

### A. TeraScan Modification Script

TeraScan uses five Geostationary Operational Environmental Satellites (GOES) that are around the earth. These satellites include GOES-12 (GOES-East), GOES-10 (GOES-West), GMS-5, Meteosat-7, and Meteosat-5 [5]. GOES sends images on a fixed schedule, which includes whole passes [8]. The GOES has an imager, which can display six distinct channels or bandwidths to the user via the transmitted data from the satellite. [5]

Recently, the hardware was installed to receive data information from both the GOES and POES. CERSER is able to receive the data information from GOES using the TeraScan TAC-92 receiver, which stores and processes incoming data to a Linux-based system.

The user starts the TeraScan server through the terminal window. The user should select TeraMaster and create an area of interest (AOI) which includes increasing/decreasing the area size, pixel size, and density of the AOI. After creating a new master in TeraMaster, the user should go to "File" and "Save As" and then search for the newly created file and save it in their respective directory. Following that, the user should close TeraMaster and return to the terminal window.

In the terminal window, go to "configproc" and in the "configproc" directory change the parameters to match the AOI that was created using TeraMaster. Save the changes in the "configproc" directory. Then go to "launchpad" and click on TeraVision. In TeraVision go to "File" and "Open Data Shelf". In "Open Data Shelf" go to "Edit Data Library" and go to "New" under Shelves. In "New" find the "configproc" directory in which the images will be saved when a pass is made. Name your new Data Shelf and save it. After saving, go back to "File" and "Open Data Shelf" and click on the new Data Shelf and select images according to what time is desired. After selecting the respectable images, choose the desired channels and once the image(s) are on the TeraVision

window, you can edit the images by adding Layers, borders, Grid Overlays, etc. Then click on the Save Icon and Save the image as desired. Then exit TeraVision and exit the terminal window.

### B. CERSER Server Script Failures

The script for the database that was redesigned in 2011 [10] needed to be updated in order to process the new satellite information being received. It was found that the permissions of the directories on the CERSER server were modified to READ ONLY when the files were migrated to the new server. The directory permissions that were on the CERSER server needed to be changed from READ ONLY to READ & WRITE so the images can be processed.

### C. Serverside Script

Once it was determined that a PHP script was functional on the CERSER server the processing script could now be modified. The languages used in the script are PHP, MySQL, and HTML. [10] In 2013 TeraScan capabilities were upgraded. The ground station upgrades included a 3.7m X/L band, a 3.6m C band, and a 5.0m L band dishes, along with accompanying computing hardware [2]. The goal of this project was to update the CERSER script to process images received from the GOES imager by the TeraScan system. This script involved parsing the title into the CERSER database and then copying, converting, renaming, and resizing the original image.

### D. Parse Title to Database

The title of the image holds the information needed for the database. Image date, time, type of satellite, the channel and the file extension are all found in the title. The GOES image titles have 36 characters including periods and underscores (example: 2014.0302.2001.goes-13.gvar\_ch3.tiff). The position of these characters is critical to parsing the elements into the correct database fields. The title is broken down by the following positions:

Characters	Data
1-4	Year
6-7	Month
8-9	Day
11-14	Time (Z)
16-22	Satellite Name
24-31	Product (band)
32-36	File Extension (.tiff)

The PHP script parses the title into variables utilizing the “substr” command. This command has the form “substr (string \$string , int \$start [, int \$length ])” where \$string is the input string, \$start is the integer for the starting character in the string, and \$length is the integer for the total number of characters. It must be remembered that the starting integer starts counting at “0” for the first character in the string.

The title of the file has been previously placed into the PHP variable “\$satName.” The script first tests if the image

is from the GOES imager by comparing characters 15-18 [substr(\$satName, 15, 4)] to the string “goes”. If they are equal, then the script proceeds to parse the title.

The first image element to be entered into the database is the satellite name. This is extracted from the title and placed into the variable “sat”.

The process then converts the date into the format MM/DD/YYYY utilizing the PHP concatenation “.” (period). This date is then stored in “cnvrtDate”.

The time is then placed into the variable \$cnvrtTime with the character “z” added to denote the time zone.

The final parsing element is the \$product variable. The script checks the character located at position 30 to identify which band of the imager was used to develop the satellite image.

Once the file title is parsed into the assorted variables, the variables are combined into an SQL statement and placed into the variable “\$query”. The variable is then written to the screen using the “echo” command for viewing by the developer. This step can be removed, but was left in as a feedback mechanism for the script.

The next step is to execute the SQL statement using the PHP command mysql\_query(). This will place the variables into the appropriate fields of a new database record in the “images” table. The results of this query are placed into the variable “\$result” so that any failures can be displayed to the user.

### E. Resize/Rename/Copy IMG

The next group of operations involves resizing, renaming, copying, and converting the TeraScan images from TIFF to JPEG formats. PHP is used to execute command line instructions to the graphic program ImageMagick. This section of code was not modified during this project.

## V. RESULTS

### A. TeraScan

Images are able to be processed using both TeraVision and the UNIX script. In TeraVision, the user can edit to have borders, layers, Grid Overlays, etc. In the script, each time a pass comes in and is converted into data, the batch.ingest takes the pass and cleaves it to match the parameters of the picture in the gvar.local directory, which includes the cover\_area, input files, the save directory, and other parameters.

### B. Server/ Script

After changing the permissions of the picture archives directories on the CERSER server in E.V. Wilkins Computing Center, the images can now be modify to be used in the database. The images are now able to process and to be displayed on the database. The information from parsing the title of the images is now being put into the database. The code in the script for resizing/ renaming/ copying the image is still working and larger images are able to be viewed when selected from the web page viewer.

## VI. CONCLUSIONS

Images can be successfully processed however; there are other goals that were not met. After changing the parameters in the script to modify the images to match the AOI, there needs to be a way to transfer the images to the CERSER server in order that CERSER can get the images automatically from the TeraScan server. Currently images must be processed manually and sent to the CERSER server. There needs to be a daily automated process written the script to receive processed and finalized images from the TeraScan server to send to the CERSER server. Also, there needs to be an increase of image resolution with the images being received and processed through the script in TeraScan.

Overall the database is a success and there have not been any more problems with the images transition from the satellite to E. V. Wilkins Computing Center to the database.

## VII. FUTURE WORK

A daily automated process of images from the TeraScan server to the CERSER server should be developed next. Increased resolution of the images should be explored to make the image useful for research.

The PHP script on the CERSER server will have to be updated once the POES hardware comes back on line. This should be a minor revision if the TeraScan script remains the same. Once more channels or satellites are added to the TeraScan output, the script will need to be expanded.

The TeraScan viewer capabilities on the CERSER server should be expanded to allow for searching and sorting of the information. A target audience should be identified and research should be completed to see how other ground stations are presenting and utilizing their data.

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