Receiving EMWIN and HRIT Services from GOES-16

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The GOES-East (GOES-16) satellite (GOES=Geostationary Operational Environmental Satellite) operated by NASA and the National Oceanic and Atmospheric Administration (NOAA) is exactly due south of my QTH and provides a view of Earth centered right at my longitude (75°W).

GOES-16 transmits two interesting direct services:

- The **EMWIN** (Emergency Managers Weather Information Network) service contains weather forecasts, warnings, graphics, and other information directly from the National Weather Service in near-real-time.
- The **HRIT** (High Rate Information Transmission) service broadcasts GOES satellite imagery data and other weather-related products.

I wanted to experiment with receiving these services from the GOES 16 satellite, and to do so, I added a small grid parabolic antenna to the Az/El boom that drives my 12' EME dish:



I purchased this antenna on eBay[®]. It is an Altelix WiFi 24dBi 2.4GHz parabolic dish with N-male connector that sells for \$30:

The only modification that I made is to space the secondary reflector from the dipole feed to compensate for the difference between the desired and design frequency ranges for the antenna (1.69 GHz vs 2.4 GHz). I did this by adding two 1"-long 4-40 aluminum standoffs (McMaster-Carr 93505A436 Male-Female Threaded Hex Standoff, Aluminum, 1/4" Hex Size, 1" Long, 4-40 Thread Size) with two short 4-40 stainless-steel screws:



I mounted the LNA and SAW filter chain in a weatherproof, water-tight enclosure placed right at the antenna's output:



The front-end LNA is a Mini-Circuits ZX60-P103LN+, which is followed by a Nooelec SAWbird+ GOES. A second ZX60-P103LN+ is used as the cable driver. These three modules are fed with 5V (I have +12V and +5V DC/DC converters in my mast box which are fed from 12VDC from the shack). The amplified and filtered signal is sent to my shack through 100' of LMR-400 coax cable.



In the shack, the LMR400 is connected to the input of an Airspy R2 SDR, and then to a laptop via USB.

My QTH is in New Jersey (Latitude: 39.84°, Longitude: -74.93°), so using Dishpointer.com, I found that to pick up GOES 16 at 75.2W I need to point the antenna to an Azimuth of 180.4° and an Elevation of 43.9°.

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Since GOES 16 is smack south of me, a perfectly vertical polarization on my antenna matches the satellite's vertical polarization with no skew.



GOES 16's HRIT and telemetry signals come in very strong as shown by SDR#:

To decode the EMWIN/HRIT services, I purchased a copy of the USA-Satcom XRIT software by Joe Steinmetz (K6SAT). Installing the software was very easy, since all that I needed to do was to drop the contents of the .zip file of the latest version into a directory (XRIT then creates output, archive, and temporary directories on its own):

🔆 Favorites	Name Name	Date modified	Туре	Size
Desktop	archive	7/7/2019 8:00 PM	File folder	
Downloads	le output	7/9/2019 8:17 AM	File folder	
Secent Places	li temp	7/4/2019 3:27 PM	File folder	
	🕌 tmp	7/4/2019 1:03 PM	File folder	
词 Libraries	xrit_decoder	6/18/2019 1:08 PM	Application	24,729 KB
Documents	xrit_file_manager	6/17/2019 5:17 PM	Application	31,802 KB
J Music	xview	6/18/2019 1:47 PM	Application	1,290 KB
Pictures	🚳 aec.dll	5/1/2019 11:26 AM	Application extens	23 KB
Videos	M IP2Lib32.dll	4/20/2016 11:22 AM	Application extens	2,250 KB
	IP2Lib64.dll	4/20/2016 11:22 AM	Application extens	3,114 KB
🜏 Homegroup	🚳 Magick.NET-Q8-x64.Native.dll	2/10/2019 5:00 PM	Application extens	14,205 KB
	Magick.NET-Q16-x64.Native.dll	5/21/2019 9:51 PM	Application extens	14,434 KB
🖳 Computer	🚳 szip.dll	5/1/2019 11:26 AM	Application extens	10 KB
🏭 Windows7_OS (C:)	🚳 xrit_core.dll	5/18/2019 6:38 PM	Application extens	93 KB
SB DRIVE (D:)	📋 home	7/4/2019 4:03 PM	Text Document	1 KB
😼 Lenovo_Recovery (Ç	osp_copyright	7/4/2019 3:23 PM	Text Document	1 KB
	📄 xrit_file_manager_log-1562521040	7/8/2019 8:35 PM	Text Document	130 KB
👊 Network	xrit_file_manager_log-1562672297	7/9/2019 7:38 AM	Text Document	0 KB
	int_log-1562520964	7/8/2019 8:36 PM	Text Document	828 KB
	int_log-1562672209	7/9/2019 7:36 AM	Text Document	0 KB
	TRIT Decoder	2/28/2019 7:33 AM	XML Document	21 KB
	XVIEW	3/7/2019 9:38 AM	XML Document	21 KB

Per Joe's recommendation, I set set spyserver.config file to a maximum sample rate of 2500000 to keep the USB rate as low as possible, and then ran spyserver.exe.

I opened the XRIT Demodulator, and selected a remote IP of 127.0.0.1 and port 5555 (to match the spyserver's listening IP and port). Once I turned the demodulator on, and after setting the sensitivity to 15, a nice constellation was displayed in the IQ window. The signal quality meter hovered around 99% with no further adjustment:

© USA-Satcom XRIT Demodulator	And Person in Street of St	
	Rate (MSPS) Mode © 2.5 C 3.0 C GOES LRIT	GOES HRIT C COMS-1 LRIT
SDR Link	Demodulator	IQ
Device Serial # Device Name 277FBACF Airspy One Remote IP Port 127.0.0.1 5555 Network Drops 0 Connected Server ID Stream ID STREAMER1 STREAM-A STREAM-A STREAMER1 Frequency 1694.1 MHz Track	Stop Demod Locked 927,000 Symbol Rate OFF Eb/No Measure FEC 13 Viterbi 0.00171 BER +0 +0 +0 Sync Correlation	CF: +101.26 Hz NORMAL
Gain 16 Error Counters 42647415 Bad Uncoded	3 Bad Uncoded 0 Bad Coded 3 Bad Coded 15	Bad RS Clear IQ Dish Align
IQ and Packet Buffering Status-		
13 Overflows	0.0 % Capacity	Buffers Peak
Signal Quality		
		99.1 %
P Version: 2.3.0		

Then, I turned on the XRIT Ingestor, which immediately started to generate .Irit files from the received data:

onfigure Directories Ingestor Control ————————————————————————————————————	Optional Products	NOAA Product	Status		
	operonal produces	NOAA Produce	Status		
Stop Ingesting	EMWIN	BUSY	EMWIN	DCS	Products
CSDS Transport Frames	DCS	L-EMWIN	H-EMWIN	COMS-1	Other
	Weather Data				
32 VC ID	acaciter baca	GOES 13 ABI	GOES 15 ABI	GOES 16 ABI	GOES 17 ABI
12475523 VC CNT		Himawari ABI	NOAA Text	Weather Data	DCS
ecording	Mode				9
Start Replay	GOES COMS-1	Show Errors Γ	Show Debug	EMWIN Only	Mode
0 0 7:36:49 INFO Parser starting1.4.7108 7:36:51 INFO I don't have a demuxer for 7:36:52 INFO New pH-19190113622-A. 7:36:58 INFO New pH-19190113627-A. 7:37:02 INFO New pH-19190113635-A. 7:37:12 INFO New pH-19190113635-A.	or VCID 32. Creating Irit Irit Irit Irit Irit	Errors Packe		ion /108.23623	Clear
Bugs Len Errors Frame 0 0 0 7:36:49 INFO Parser starting1.4.7108 7:36:51 INFO I don't have a demuxer f 7:36:52 INFO New pH-19190113622-A. 7:36:52 INFO New pH-19190113622-A. 7:37:02 INFO New pH-19190113622-A. 7:37:02 INFO New pH-19190113632-A. 7:37:12 INFO New pH-19190113642-A. 7:37:21 INFO New pH-19190113654-A. 7:37:27 INFO New pH-19190113654-A. 7:37:30 INFO I don't have a demuxer f 7:37:31 INFO New pH-19190113701-A. 7:37:31 INFO New pH-19190113701-A. 7:37:31 INFO New pH-19190113701-A.	0 0 a.23623 or VCID 32. Creating Irit 26. Creating	0	19 1.4.7		Clear
Bugs Len Errors Frame 0 0 0 7:36:49 INFO Parser starting1.4.7108 7:36:51 INFO I don't have a demuxer fr 7:36:52 INFO New pH-19190113622-A. 7:36:52 INFO New pH-19190113622-A. 7:37:02 INFO New pH-19190113635-A. 7:37:07 INFO New pH-19190113635-A. 7:37:12 INFO New pH-19190113642-A. 7:37:21 INFO New pH-19190113645-A. 7:37:21 INFO New pH-19190113650-A. 7:37:27 INFO New pH-19190113654-A. 7:37:30 INFO I don't have a demuxer fr 7:37:31 INFO New pH-19190113701-A.	0 0 3.23623 or VCID 32. Creating Irit Irit Irit Irit Irit Irit Irit Irit Irit Irit 3.6_C_KWIN_2019070911370 3.6_C_KWIN_2019070911371 3.6_C_KWIN_2019070911361 3.6_C_KWIN_2019070911365 3.7_C_KWIN_2019070911375 3.7_C_KWIN_20190709175 3.7_C_KWIN_20190709175 3.7_C_KWIN_2007070775 3.7_	0 01_470385-1-SMWI 5_470389-2-TAFZ3 14_470364-3-ZFPLV 57_470383-2-CWFL 10_470391-2-HNWA	19 1.4.7 DXLA.lrit 1NZ.lrit 1NZ.lrit WXMD.lrit SOUS.lrit		Clear

I then ran xrit_file_manager:

😜 © USA-Satcom GOES XRIT File Manager	_	
Configure Directories Standard Products Custom Products Overlays Misc Logging		
CPU 0.00% Current Memory 633.3 MB Peak Memory 2,627.0 MB	Stop Processing	Idle
111111111111111111111111111111111111111		
Drive C:\ Space Used 98.3 GB Capacity 942.9 GB Storage OK		
1000000		
07-49-26 INFO New Band 2 Image: G16-Full Disk-VIS(0.64)-201907091130.png 07-49-28 INFO Resizing Infrared (524, 524, 542) to match Visible (524, 5424) 07-49-30 INFO Generating (MessCONUS VIS for G16-CMessCONUS-F5CIR-30.840000N-87.674320W-201907091130.png 07-57:30 INFO New Band 3 Enhancement Image: G16-Hesoscale-IR(10.3)-41.402560H-99.33003W-201907091153.png 07:57:30 INFO New Band 3 Enhancement Image: G16-Hesoscale-IR(10.3)-44.482540H-99.33003W-201907091153.png 07:57:31 INFO New Band 3 Enhancement Image: G16-Hesoscale-IR(10.3)-44.482540H-99.330203W-201907091153.png 07:57:31 INFO New Band 2 Image: G16-Hesoscale-VIS(0.64)-41.108250H-105.685800W-201907091153.png 07:57:31 INFO New Band 2 Image: G16-Hesoscale-VIS(0.64)-41.108250H-105.685800W-201907091153.png 07:57:55 INFO New Band 2 Image: G16-Hesoscale-VIS(0.64)-44.482070H-99.324260W-201907091153.png 07:57:55 INFO New Band 2 Image: G16-Hesoscale-FSCIR-44.482070H-99.324260W-201907091154.png 07:57:55 INFO New False Colour Image: G16-Hesoscale-FSCIR-44.482070H-99.324260W-201907091154.png 07:57:55 INFO New False Colour Image: G16-Hesoscale-IR(10.3)-30.865800W-201907091154.png 08:10:11 INFO New Band 3 Enhancement Image: G16-Hesoscale-IR(10.3)-56.892980H-85.07210W-201907091208.png 08:10:11 INFO New Band 3 Enhancement Image: G16-Hesoscale-FSCIR-44.482070H-99.324260W-201907091208.png 08:10:11 INFO New Band 3 Enhancement Image: G16-Hesoscale-IR(10.3)-38.92950H-85.553820W-201907091208.png 08:10:11 INFO New Band 3 Enhancement Image: G16-Hesoscale-IR(10.3)-38.392950H-75.00000W-201907091208.png 08:10:11 INFO New Band 3 Enhancement Image: G16-Hesoscale-FSCIR-84.47200N-89.494030W-201907091208.png 08:10:11 INFO New Band 3 Enhancement Image: G16-Hesoscale-IR(10.3)-38.392950H-75.000000W-201907091209.png 08:11:16 INFO New Band 3 Enhancement Image: G16-Hesoscale-IR(10.3)-38.392950H-75.000000W-201907091209.png 08:11:16 INFO New Band 3 Enhancement Image: G16-Hesoscale-IR(10.3)-30.840000H-87.674320W-201907091209.png 08:11:16 INFO New Band 3 Imhancement Image: G16-Hesoscale-IR(10.3)-30.		
Custom Mesoscale A Custom Mesoscale B Custom Mesoscale C	Custom Mesoscale D-	
GPS undefined GPS undefined GPS undefined	GPS undef	ined
Crop undefined Crop undefined Crop Undefined	Crop undefined	
LRIT: C:\Users\X220 Spec Analyzer\Desktop\GOES\XRIT [1.4.7093 1.0.7095 1.0.7094 2.3.0 190605]\output		



The file manager soon started generating .png image files, including beautiful high-resolution pictures such as the following full-disk image:

The USA-Satcom XRIT software is magnificently written and well maintained with frequent updates, so it runs flawlessly. It is very easy to understand, and I soon discovered the many interesting products that are transmitted over the EMWIN/HRIT channel, including weather maps, discussions, advisories, detailed images of storms, etc.



30.840000 -87.674320

I also purchased the optional XVIEW module, which makes it a snap to generate animations from a succession of HRIT images.

Although all of these images and products can be downloaded for free from the Internet (from <u>www.noaa.gov</u>), having the possibility of receiving them directly from the satellite gives me the ability to use real-time information during emergencies that may completely disrupt Internet availability.