NOAA's High Rate Information Transmission Overview

GOES DCS User Training Session

Madison, Wisconsin

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Legacy Broadcast Overview

Weather Facsimile

–WEFAX is a low data rate analog rebroadcast stream of reduced resolution NOAA Imagery data and graphic products only.

Low Rate Information Transmission

–LRIT is a digital low data rate rebroadcast of reduced resolution NOAA imagery data and graphic products. Acts as a secondary satellite rebroadcast of EMWIN and DCS data.

Emergency Managers Weather Information Network

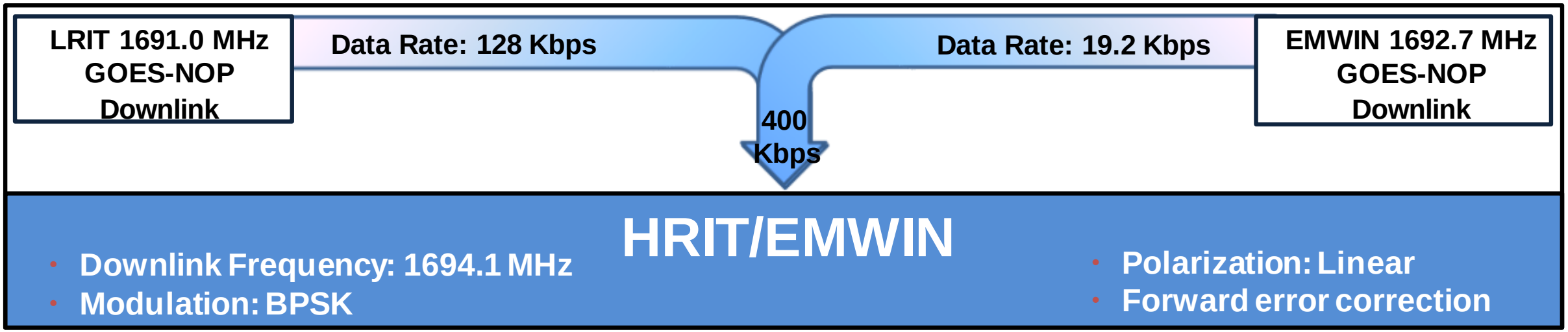
–EMWIN is a low rate dissemination broadcast used to provide timely NWS warnings, watches, graphics, and other hydro meteorological products to emergency managers with minimal equipment cost to users via the GOES-NOP satellite series.

	Weather Facsimile	Low Rate Information Transmission	Emergency Manager's Weather Information Network
Satellite	GOES I-M	GOES-NOP	GOES-NOP
Center Frequency	1691.0 MHz	1691.0 MHz	1692.7 MHz
Data Rate	30 Kbps	128 Kbps	19.2 Kbps
Modulation	BPSK	BPSK	QPSK
Polarization	Linear	Linear	Linear
Data Format		CCSDS/CGMS LRIT	EMWIN Quick Block Transfer
Availability	Anywhere within 5° of satellite footprint	Anywhere within 5° of satellite footprint	Anywhere within 5° of satellite footprint

HRIT/EMWIN Broadcast Overview

High Rate Information Transmission/Emergency Managers Weather Information Network

- HRIT/EMWIN's objective is to continue the legacy broadcast services of LRIT and EMWIN at a significantly higher data capacity. This was accomplished by combining the two services into a single service with a data relay capacity of 400 Kbps.
- HRIT/EMWIN broadcasts are currently available only on the GOES-R series satellites and is the follow up to both the LRIT and EMWIN broadcasts on the GOES-NOP series satellites.
- HRIT/EMWIN will provide more imagery channel selection with greater resolution at a more frequent rate, while reducing overall latency times than previous LRIT broadcasts .



Historical Transition Overview

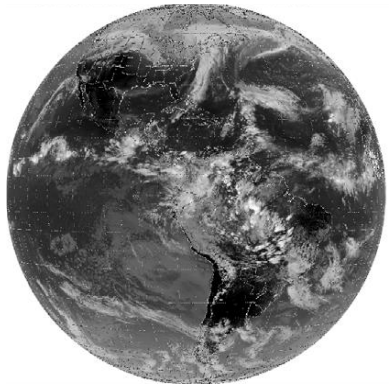
WEFAX transition to LRIT started with GOES East, GOES West still distributing a WEFAX broadcast

WEFAX transition to LRIT completed with both GOES East/West satellites carrying the 128 Kbps LRIT broadcast

LRIT Transition to HRIT began with GOES-16 (East) transmitting the HRIT broadcast, while GOES-15 transmitted an LRIT broadcast

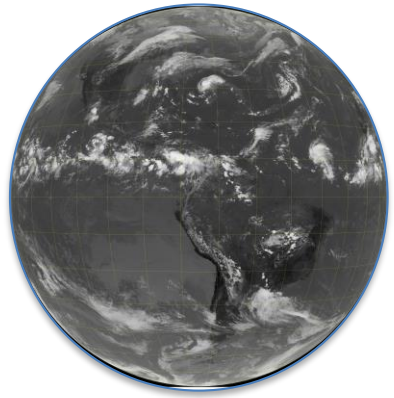
HRIT transition complete with GOES-17 declared operational as the west satellite

2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020



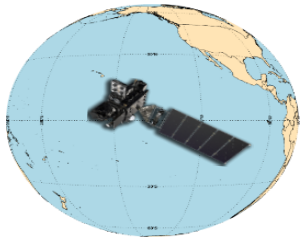
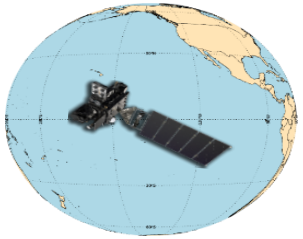
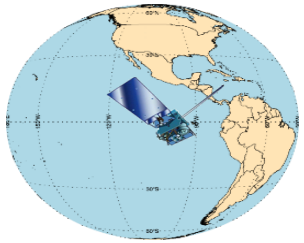
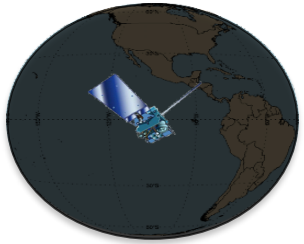
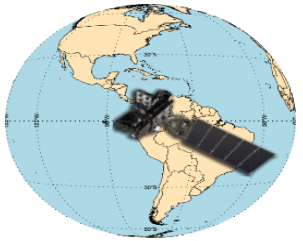
16km resolution IR Image off of WEFAX every 3 hours with end-to-end latency of 90 minutes

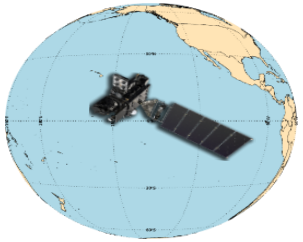
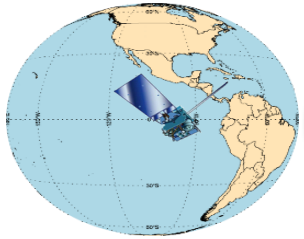
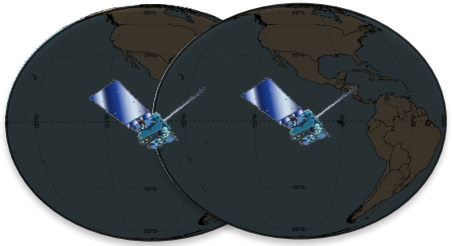
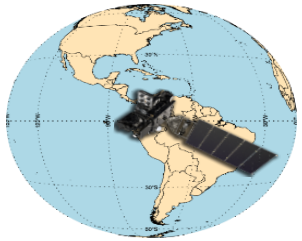
4km resolution IR Image off of LRIT every 3 hours with end-to-end latency of 31 minutes



2km resolution IR Image off of HRIT every 30 minutes with a latency of 3 minutes

GOES Constellation Status

	GOES-West	Checkout	Suppl. Ops.	Standby	GOES-East
Current Aug 2022	GOES-17 137.3° West	GOES-18 137.0° West	GOES-15 128° West	GOES-14 105° West	GOES-16 75.2° West
					
	HRIT/EMWIN Active				**HRIT/EMWIN Active**

	GOES-West	Storage	Standby	Storage	GOES-East
Plan for Jan 2023	GOES-18 137.0° West	GOES-15 128° West	GOES-17 105° West	GOES-14 105° West	GOES-16 75.2° West
					
	HRIT/EMWIN Active				**HRIT/EMWIN Active**

GOES-West Interleave

GRB: (netCDF file orbital slot will be "GOES-West")
- G18 ABI L1b
- G17 GLM L2+
- G17 Space Wx L1b

PDA: ("GOES-West" for products below)
- G18 ABI L1b, CMI (no L2+)
- G17 ABI L1b, CMI, L2+
- G17 GLM L1b, L2+
- G17 Space Wx L1b
- Note PDA cal/val subscriptions have additional G18 data access

CLASS:
- G17 ABI L1b, CMI, L2+
- G17 GLM L1b, L2+
- G17 Space Wx L1b
- Note CLASS cal/val subscriptions have additional G18 data access

NODD (formerly BDP) via AWS:
- G18 ABI Rad, CMI
- G17 ABI Rad, CMI, L2+
- G17 GLM L2+
- G17 Space Wx L1b

HRIT/EMWIN:
- G18 ABI CMI
- G17 ABI L2+

GNC-A:
- G18 ABI CMI

AWIPS:
- G18 ABI SCMI
- G17 GLM L2+

During the June 14th test, GOES-18 ABI data will still be at a "Beta" level of maturity, minimally validated, and may contain significant errors. Nonetheless, GOES-18 ABI data obtained during this test will be advised for operational use, and may be shared without restriction.

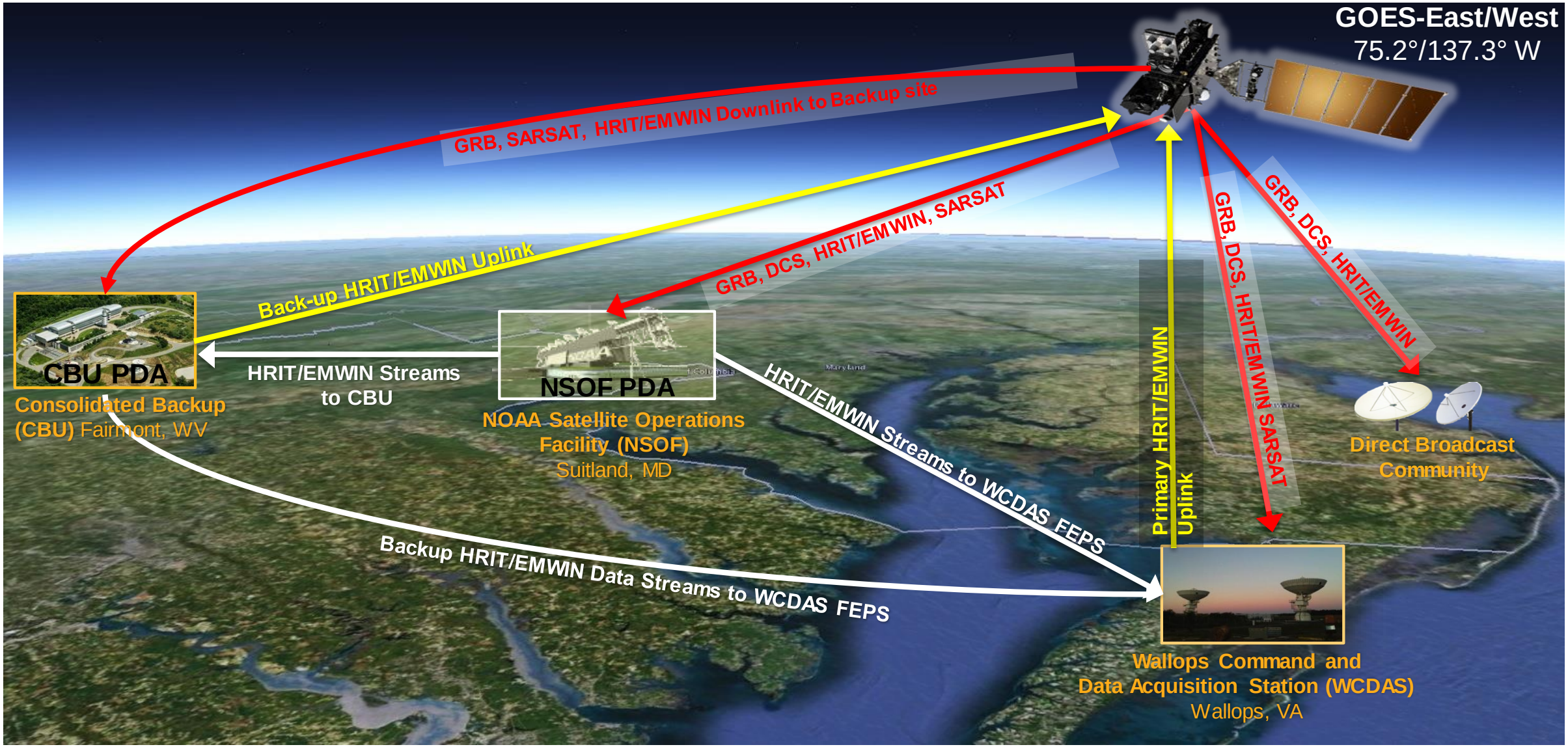
During the Aug-Sept and Oct-Nov interleave periods, GOES-18 ABI data will be at "Provisional" level of maturity, fit for operational use and may be shared without restriction.

01 August – 06 September 2022
13 October – 15 November 2022

These periods cover times of higher than usual focal plane temperatures on the GOES-17 ABI detector, impacting data quality.

During these two periods, HRIT/EMWIN will broadcast GOES-18 CMI products rather than those from GOES-17.

Ground System Architecture

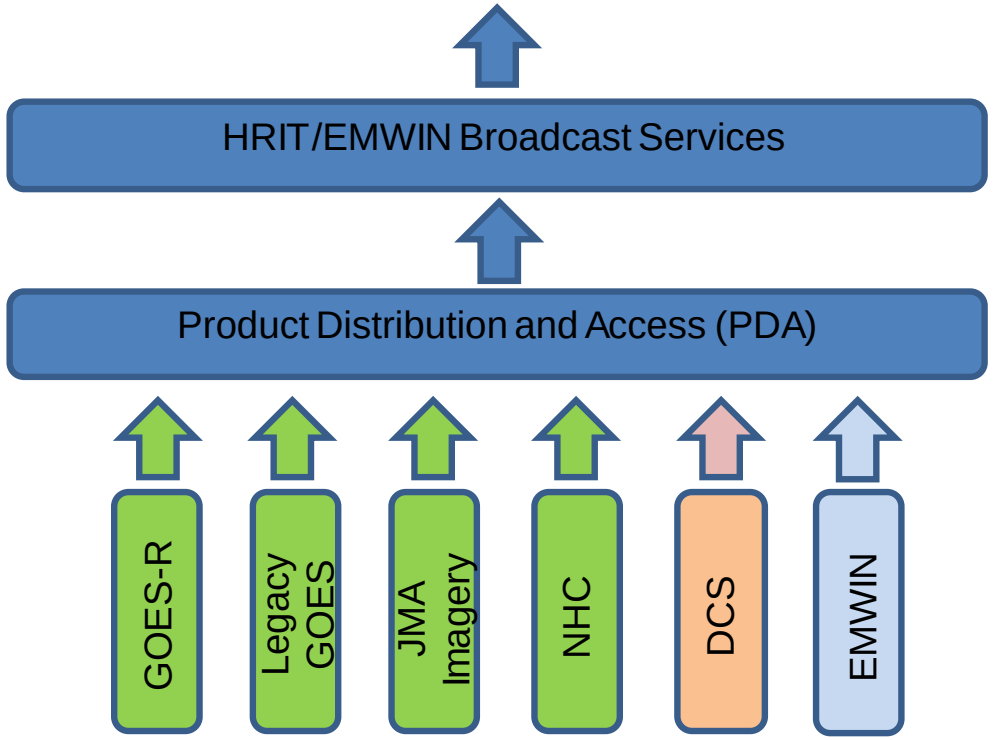


Ground Processing and Distribution Segment

HRIT Product Distribution System Capabilities

- Virtual channelization for data product assignment and filtering data by users
- Automatic retransmission of critical weather information
- Automated data quality monitoring
- Customized “region of interest” tailoring for imagery
- Time-triggered broadcasted products
- Redundant HRIT streams per satellite for contingencies
- Broadcast receipt checksum validation
- Dynamic Bandwidth allocation
  Group ranking ➡ Product Priority ➡ Bandwidth Thresholds

PDA Product Group Name	Guaranteed Bandwidth	Maximum Bandwidth	Group Order Rank
EMWIN	8%	15%	1
DCS	5%	10%	2
Imagery	87%	100%	3

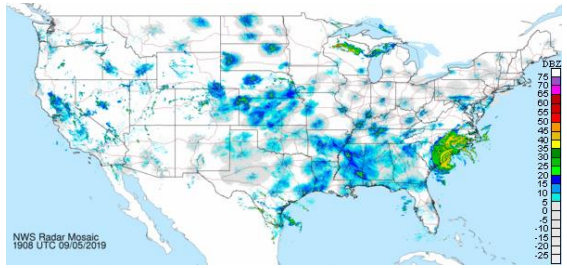


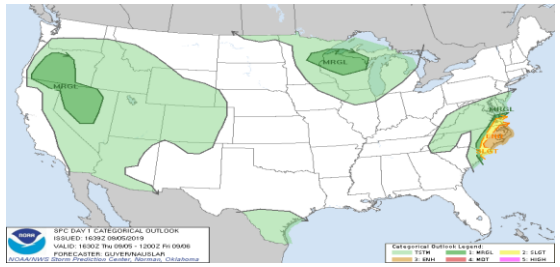
EMWIN Group Products

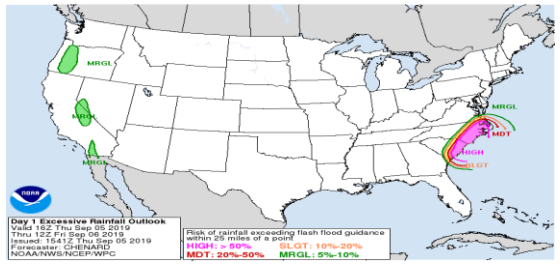
- EMWIN products are transmitted as a contiguous file on the broadcast on VCID's 20, 21 and 22. This is a departure from the Quick Block Transfer (QBT) protocol packet transmission from GOES NOP series broadcasts.
- The EMWIN file naming convention has been revised to follow the WMO format identified in WMO Pub 386.

Products Available on EMWIN Virtual Channels 20-22

- NWS WFO weather observations, warnings, watches, advisories and forecast discussions prioritized based on the severity of the message
- CONUS, Guam, Hawaii, Alaska and Puerto Rico radar mosaics
- Other NWS graphic products from Weather and Storm Prediction Centers
- NHC tropical weather forecast discussions and active TS forecast track graphics
- International Tsunami warnings/watches messaging







TORNADO WATCH OUTLINE UPDATE FOR WT 636
NWS STORM PREDICTION CENTER NORMAN OK
725 AM EDT THU SEP 5 2019

TORNADO WATCH 636 IS IN EFFECT UNTIL 700 PM EDT FOR THE FOLLOWING LOCATIONS

NCC013-031-049-051-055-061-065-079-095-101-103-107-117-127-133-137-147-163-177-187-191-195-052300-
/O.NEW.KWNS.TO.A.0636.190905T1125Z-190905T2300Z/

NC
. NORTH CAROLINA COUNTIES INCLUDED ARE

BEAUFORT	CARTERET	CRAVEN
CUMBERLAND	DARE	DUPLIN
EDGECOMBE	GREENE	HYDE
JOHNSTON	JONES	LENOIR
MARTIN	NASH	ONSLOW
PAMLICO	PITT	SAMPSON
TYRRELL	WASHINGTON	WAYNE
WILSON		

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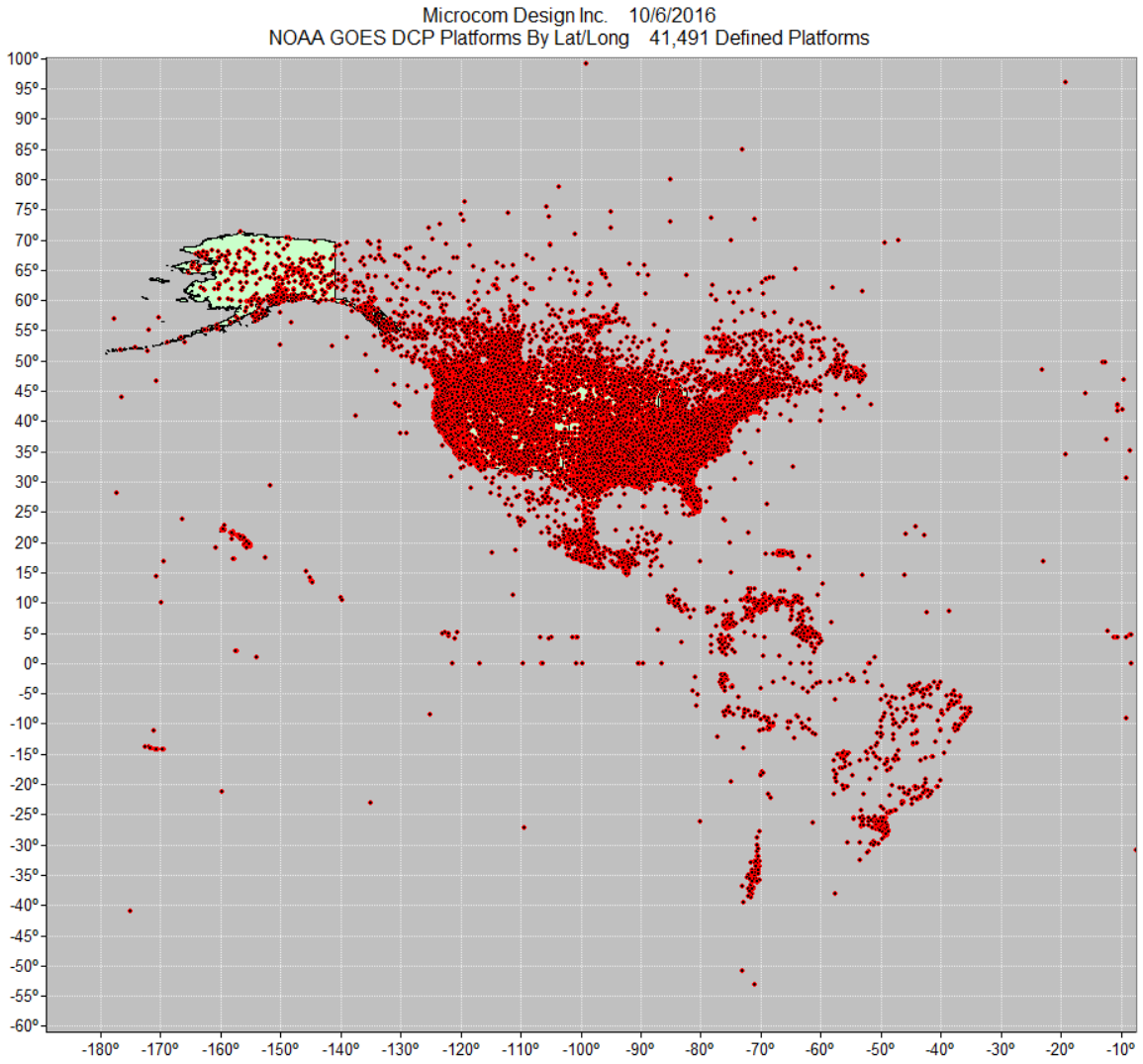
More information on the EMWIN service and products can be found at:
https://www.weather.gov/emwin/
https://www.weather.gov/iscs/

Data Collection System (DCS) Group Products

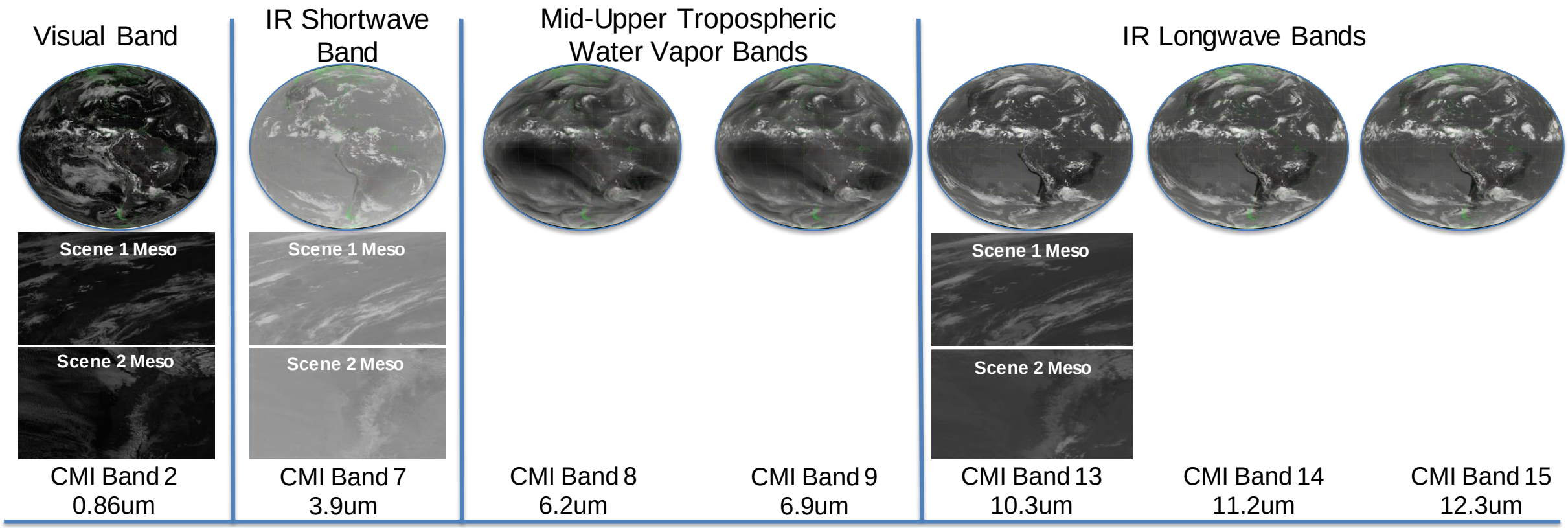


- 30,000+ active Data Collection Platform (DCP) transmitters producing an estimated 800,000 messages a day. These are then rebroadcasted on HRIT/EMWIN with a mean end-to-end latency of ~16 seconds after file generation from the initial downlink.
- April 2021 measurements:

>= 99.5% availability

9.6s avg. latency, < 20s @ 99.988%

Imagery Group Products



- All full disk imagery is in its native spatial resolution of 2 kilometers (km), except Band 2, which has been scaled from 0.5 km to 2 km for bandwidth management.
- All seven full disk bands are currently available every 30 minutes, containing the :00 - :10 and :30 - :40 scan times.
- All meso imagery is in its native spatial resolution and distributed every 15 minutes.

Imagery Group Products (continued)

Ancillary Level II ABI Products

- Cloud Top Height Full Disk
- Cloud Top Temperature Full Disk
- Derived Stability Indices (CAPE and LI) Full Disk
- Land Surface Temperature (Skin) Full Disk
- Rainfall Rate / QPE Full Disk
- Sea Surface Temperature (Skin) Full Disk
- Total Precipitable Water Full Disk

NHC Maritime Graphics

- Atlantic & Pacific significant wave height and swell direction
- Atlantic & Pacific 24/48/72 hour forecasted wind, significant wave height, direction and period
- Atlantic & Pacific 24/48/72 hour surface weather chart forecasts
- Americas, Caribbean & Gulf surface analysis charts
- Atlantic/Pacific high wind/weather danger graphics

GOES-15 Imagery (Supplemental Operations)

- Full disk Infrared
- Full disk Water Vapor
- N. Hemisphere Infrared
- N. Hemisphere Water Vapor
- S. Hemisphere Infrared
- S. Hemisphere Water Vapor

Himawari-8 Imagery

- Full disk Infrared
- Full disk Water Vapor
- Full disk Visual

Virtual Channel Listing (as of 2022-Aug-01)

VCID #	Product Name	GOES-E(16) Availability	GOES-W(17) Availability	Frequency (Minutes)	Priority on Broadcast	Guaranteed Bandwidth	Format	Resolution	Product Status
0	Admin Text	X	X	60	1	87%	Text Messages	N/A	Active and available
1	Mesoscale Imagery	X	X	15	12	87%	HRIT/LRIT	0.5km Band 2, 2km for bands 7 and 13	Both Meso scenes active and available
2	CMI Band 2	X	X	30	7	87%	HRIT/LRIT	2 km	Active and available
5	GOES-15 WV Imagery		X	30 - 180	13	87%	LRIT	4 km	Only during Suppl Ops
6	GOES-15 IR Imagery		X	30 - 180	13	87%	LRIT	4 km	Only during Suppl Ops
7	CMI Band 7	X	X	30	6	87%	HRIT/LRIT	2 km	Active and available
8	CMI Band 8	X	X	30	8	87%	HRIT/LRIT	2 km	Active and available
9	CMI Band 9	X	X	30	9	87%	HRIT/LRIT	2 km	Active and available
13	CMI Band 13	X	X	30	5	87%	HRIT/LRIT	2 km	Active and available
14	CMI Band 14	X	X	30	10	87%	HRIT/LRIT	2 km	Active and available
15	CMI Band 15	X	X	30	11	87%	HRIT/LRIT	2 km	Active and available
16	G16 CMI Band 13		X	60	17	87%	HRIT/LRIT	4 km	Active and available
17	G17 CMI Band 13	X		60	17	87%	HRIT/LRIT	4 km	Active and available
20	EMWIN – High Priority	X	X	Continuous	1	8%	Text	N/A	Active and available
21	EMWIN - Graphics	X	X	15 - 60	3	8%	Graphic (e.g. GIF, JPEG)	N/A	Active and available
22	EMWIN – Low Priority	X	X	Continuous	2	8%	Text	N/A	Active and available
24	NHC Maritime Graphics	X	X	Variable	14	87%	Graphic (e.g. GIF, JPEG)	N/A	Active and available
25	GOES-E/W Level II Ancillary Products	X	X	Variable	15	87%	HRIT/LRIT	2 - 10 km	Active and available
32	DCS Data	X	X	Continuous	4	5%	DCS Formatted Text	N/A	Active and available
60	Himawari-8		X	60	16	87%	HRIT/LRIT	4 km	Active and available

Future HRIT/EMWIN Broadcast Changes

- Himawari-9 will replace Himawari-8 in December 2022
- GOES-18 will become operational GOES-West in January 2023, replacing GOES-17.

Contact the HRIT/EMWIN program manager at hrit.manager@noaa.gov to be placed on the HRIT/EMWIN User roster mailing list in order to:

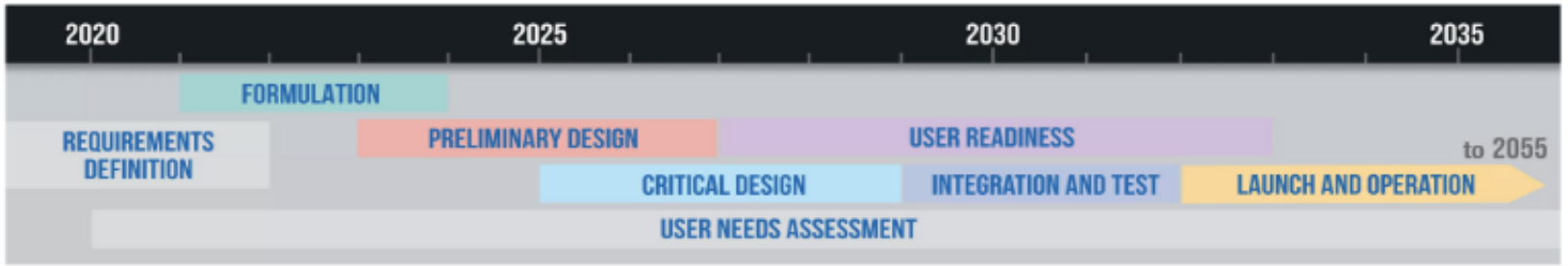
- receive notification of broadcast content or format changes
- receive notification of issues affecting broadcast data products
- receive notification of upcoming meetings or training opportunities
- offer feedback or suggest broadcast changes

GeoXO and HRIT/EMWIN

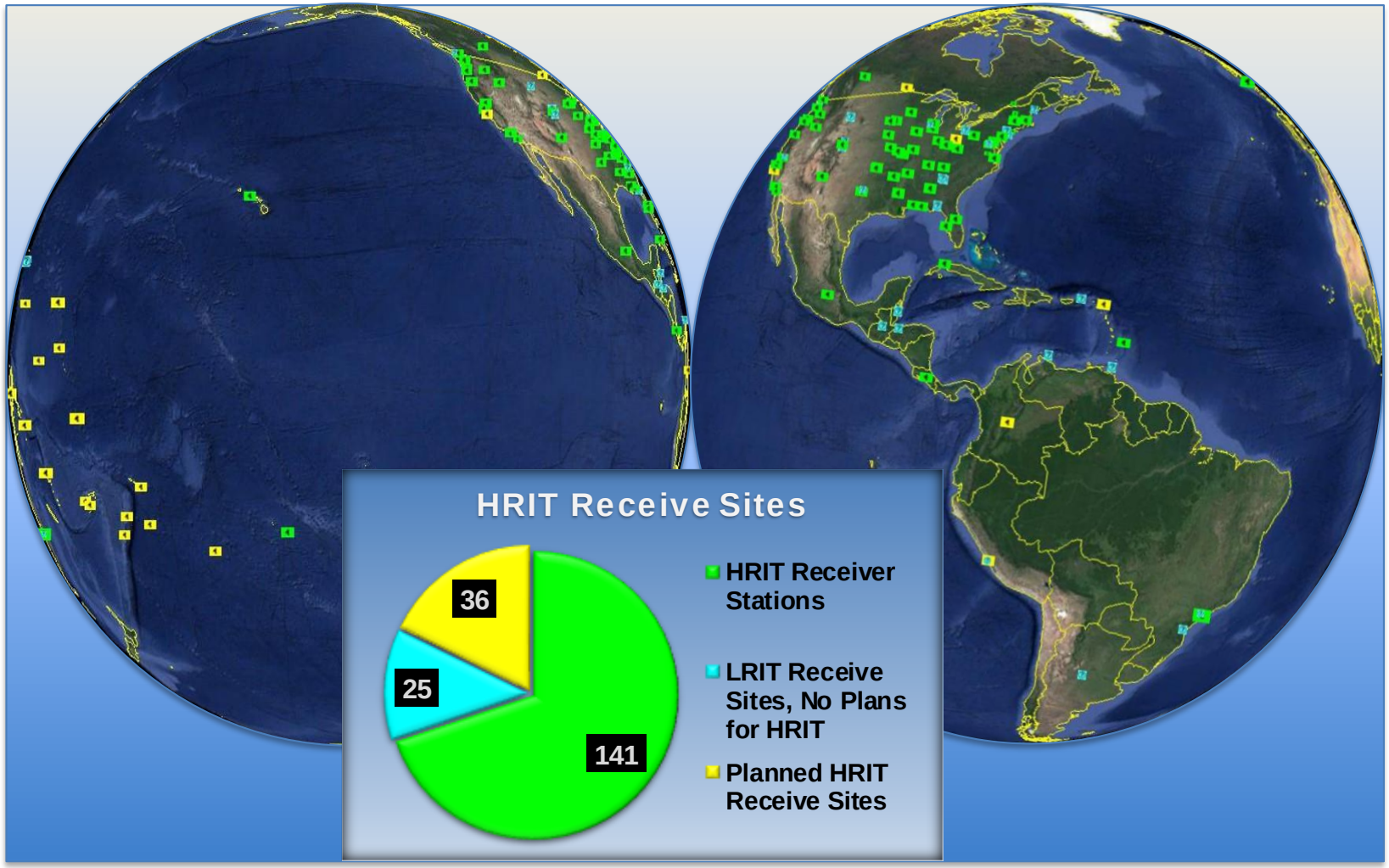
- **NOAA's Geostationary Extended Observations (GeoXO)** satellite system is the next generation mission that will advance Earth observations from geostationary orbit.
- GeoXO requirements definition and pilot studies underway will lead to the preliminary design of the spacecraft and instruments

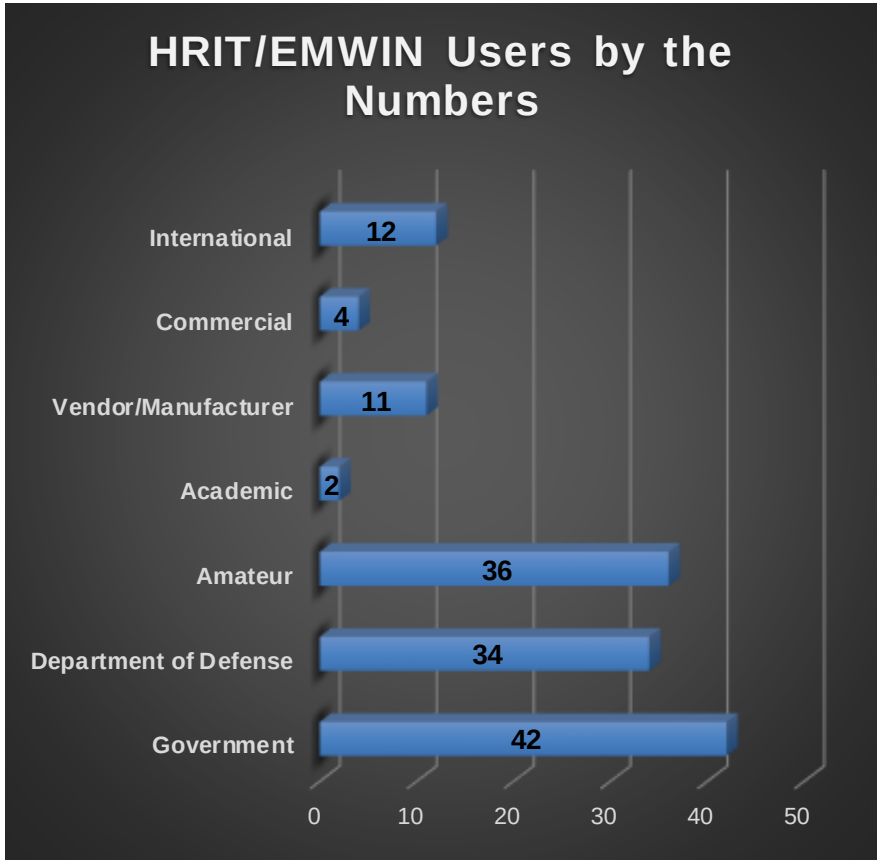
GeoXO and HRIT/EMWIN

- Continuity of service and meeting user needs for HRIT/EMWIN are key objectives
- It is likely that GeoXO will not carry an HRIT/EMWIN transponder; commercial satellite broadcasts are considered an effective replacement. Broadcast study example specifications:
  - Nearly-global location coverage
  - 1 Mbps data rate (compare to current 400 kbps)
  - 24/7 distribution of data
  - > 99.9% availability
  - <2-3 seconds latency
- We are continuing to take input from the user community about their future needs and the impact of these changes on their use of the service.
- To offer feedback, and to be informed of future meetings, please contact hrit.manager@noaa.gov



Known HRIT/EMWIN User Community





Users are defined as a having a complete receiving station capable of obtaining the HRIT/EMWIN broadcast downlink

HRIT/EMWIN User Group

- NESDIS holds Quarterly HRIT User Group Meetings aimed at the following:
  - Providing the latest news and status on the HRIT/EMWIN broadcasts
  - Providing the latest status of upcoming GOES schedules
  - Information exchange, user feedback on broadcast content
  - User/Manufacturer Readiness for new product content or change.
  - Other topics as they arise
  - Please contact hrit.manager@noaa.gov to be added to the HRIT User Group roster

How to Receive HRIT/EMWIN

- There is no fee, registration or license requirement required by NOAA to receive the products on HRIT/EMWIN
- The NOAASIS Web Site provides program and technical information at: https://www.noaasis.noaa.gov/GOES/HRIT/hrit.html
- To receive HRIT/EMWIN, a user can purchase the necessary equipment (antenna, cabling, receiver, computer, and software) from commercial companies for unlimited access. A manufacturer's list is available at: https://www.noaasis.noaa.gov/GOES/HRIT/manu_list.html
- A free software-based solution is described at the HRIT/EMWIN prototype receiver links and specifications webpage: https://www.goes-r.gov/users/hrit-links.html
- There is an active amateur & hobbyist community with helpful information on hardware and software resources; a good starting place is: https://usradioguy.com/

- The transmission format; "The Coordination Group for Meteorological Satellites LRIT/HRIT Global Specification" can be downloaded from: https://www.cgms-info.org/documents/cgms-lrit-hrit-global-specification-(v2-8-of-30-oct-2013).pdf

Contact Information

HRIT/EMWIN Broadcasts	EMWIN Product Information
Ian Avruch HRIT/EMWIN Program Manager Direct Services Branch Satellite Products and Services Division Office of Satellite and Product Operations NOAA NESDIS NOAA Satellite Operations Facility (NSOF) Suitland, MD Cubicle #1652 Email: hrit.manager@noaa.gov Tel: 301-817-4543	Robert Gillespie EMWIN Program Manager National Weather Service Office of Dissemination NOAA NWS 1325 East West Highway Silver Spring, MD 20910 Email: Robert.Gillespie@noaa.gov Tel: 301-427-9693

HRIT/EMWIN Broadcast Receive Information

Component	HRIT/EMWIN Broadcast Specifications	Additional Information
Platform	Operational East and West GOES-R Series Satellites	• GOES-16 at 75.2° West • GOES-17 at 137.0° West
Broadcast	Operating Downlink Frequency Range	L-band
	Center Frequency	1694.1 MHz
	Data Rate	400 Kbps
	Symbol Rate	927,000 symbols per second (sps)
	Modulation - BPSK	• Convolutional rate ½ code with constraint length 7 concatenated with Reed Solomon (255,223) with Interleave = 4 • Square Root Raised Cosine filtering w/ Alpha factor of 0.3 • The resulting "Necessary Bandwidth" for this signal will be 1.205 MHz
	Polarization - Linear	Vertical Offset
Antenna System	VSAT	• At 5 degree elevation, the minimum antenna is 1.2 meter. • At 10 degrees or more elevation the minimum size is 1.0 meter
Low-Noise Block-Down Converter	L-band	Example: • Input 1691 MHz • Output 137.5 Mhz
Satellite Receiver	L-band	• BPSK 1691 MHz to 137.5 MHz

Software	N/A	• De-encapsulates HRIT/LRIT files
		• Visualization and Manipulation of Files
		• Optional Applications (examples)
		  ○ EMWIN visualization application
		  ○ GOES-DCS database software or application

Acronyms

ABI	Advanced Baseline Imager
AWIPS	Advanced Weather Interactive Processing System
BPSK	Binary Phase Shift Keying
CBU	Consolidated Backup
CCSDS	Consultative Committee for Space Data Systems
CMI	Cloud Moisture Imagery
CFDP	CCSDS File Delivery Protocol
DCP	Data Collection Platform
DCPR	Data Collection Platform Report
DCS	Data Collection System
DoD	Department of Defense
DRGS	Direct Readout Ground Station
DRO	Direct Readout
ESPC	Environmental Satellite Processing Center
ESPDS	Environmental Satellite Processing and Distribution System
FEP	Front End Processor
GOES	Geostationary Operational Environmental Satellites

Acronyms

GOES	Geostationary Operational Environmental Satellites
HRIT/EMWIN	High Rate Information Transmission/ Emergency Managers Weather Information Network
LNA	Low Noise Amplifier
LNB	Low Noise Block
LRIT	Low Rate Information Transmission
NESDIS	National Environmental Satellite, Data, and Information Service
NHC	National Hurricane Center
NOAA	National Oceanic and Atmospheric Administration
NSOF	NOAA Satellite Operations Facility
NWS WFO	National Weather Service Weather Forecast Offices
OSPO	Office of Satellite and Product Operations
PDA	Production Distribution and Access
QPSK	Quadrature Phase Shift Keying
VSAT	Very Small Aperture Terminal
WCDAS	Wallops Command and Data Acquisition Station
WEFAX	Weather Facsimile