11.10 NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) LOW RATE INFORMATION TRANSMISSION (LRIT) PRODUCT PROJECTIONS

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1. NOAA WEFAX/LRIT BACKGROUND AND OVERVIEW

NOAA's National Environmental Satellite Data Information Service (NESDIS) currently uses Weather Facsimile (WEFAX), an analog meteorological satellite broadcast service, to disseminate Geostationary Operational Environmental Satellite (GOES), Polar Orbiting Environmental Satellite (POES), and foreign satellite meteorological data to direct broadcast to users via the GOES L-band down-link frequency. In response to the World Meteorological Organization's (WMO) recommendations for digital meteorological satellite broadcasts, NOAA will replace its WEFAX service with a new digital service called Low Rate Information Transmission (LRIT).

Since the transmission formats of WEFAX and LRIT are incompatible, the current WEFAX users will need to replace or upgrade their existing WEFAX stations to receive the new LRIT products. The development of relatively inexpensive ground stations for receiving NOAA LRIT transmissions is a major goal of NOAA's WEFAX/LRIT transition plan.

The development of the LRIT standard began in the 1990's when the Coordination Group for Meteorological Satellites (CGMS) met periodically to discuss, coordinate, and develop a plan and specification (i.e., CGMS LRIT/HRIT Global Specification, Doc. No. CGMS 03) for the dissemination of digital data to LRIT user stations. This data is intended to include rasterized image data mapped to the surface of the Earth as well as other types of graphical information, alphanumeric data or binary data.

This CGMS Global Specification defines multiple levels of a specific data format that is generally consistent with both the Consultive Committee for Space Data Systems (CCSDS) and the International Standards Organization's (ISO) Open Systems Interconnect (OSI) reference model.

NOAA and other world meteorological agencies have proceeded to develop subsequent, more detailed system specifications for the purpose of designing and implementing their specific LRIT systems. NOAA is currently completing its system specifications for the LRIT ground systems (e.g., LRIT data generation and transmission) and the LRIT user stations (e.g., LRIT receive stations).

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2. COMPARISON OF WEFAX and LRIT SERVICES

WEFAX is based on 1930's technology that was actually pioneered in the mid 1800s. It uses an amplitude modulated carrier at 2400 Hz where maximum modulation, 86% of full carrier, represents black, minimum modulation, 0% of full carrier, represents white. Any value between full carrier, minimum modulation, and maximum modulated carrier represents a shade of gray. This signal is then RF modulated to 1691.0 MHz and broadcast through geostationary meteorological satellites.

The NOAA WEFAX service is a 24 hour, 7 day per week continuous operation. Product schedules repeat every 24 hours. There are different product schedules for each operational GOES spacecraft, GOES East and GOES West. WEFAX products take 4 or 5 minutes to transmit regardless of how much detailed information is contained in them. These products are "bit mapped" and transmitted one scan line (horizontal line) at a time. Tables 1a and 1b show the current number of products by product type for each spacecraft and the approximate number of data bytes per day based on the number of pixels contained in each product. For convenience we assume a pixel depth of 8 bits for all image types however; because of the bandwidth limitations, the configuration of the transmission system, and the reduced resolution of some products, end users observe pixel depths no greater than 6.5 bits. Therefore these numbers are somewhat higher than the actual figures.

GOES EAST WEFAX	
Product Type	Bytes per Day
135 GOES	154537200
44 NOAA Polar	29152640
2 TBUS/3 message	4920000
67 Meteosat	65928000
59 NWS Charts	75048000
Total Bytes per Day	329585840

Table 1a

GOES WEST WEFAX	
Product Type	Bytes per Day
132 GOES	151103040
44 NOAA Polar	29152640
2 TBUS/3 message	4920000
7 Meteosat	6888000
58 NWS Charts	73776000
40 GMS	39360000
Total Bytes per Day	305199680

Table 1b

Thus, over a 24 hour period we have approximately 330 million bytes of WEFAX data on GOES East and 305 million bytes of data on GOES West.

To transmit the equivalent bit-mapped data products on LRIT it would take approximately five to six hours for each, East and West. However, since LRIT is a digital transmission scheme, data compression can be utilized. Using non-lossy compression the transmission time could be reduced to about an hour or less without degradation of the imagery. Lossy compression could reduce the transfer time even further.

The NOAA LRIT data suite evolves from the current WEFAX product suite, but takes advantage of the new digital format to provide more data in a more timely manner (lower latency) and with greater flexibility.

GOES data is the primary product data for the LRIT Initial Operational Capability (IOC). The current LRIT dissemination plan for GOES data is to broadcast it near real-time in data segments, small chunks, that when put together cover large geographic areas (e.g., full disc, northern hemisphere) at 4 km resolution. LRIT also takes advantage of the increased digital flexibility available to the end user thus allowing users to select their own areas of interest, make images of those areas, and run enhancement processes on those areas. NOAA is relying on value added companies to develop and offer supplementary software for these enhancement processes as well as other enhancements that generate more advanced or sophisticated products and/or capabilities.

Other data to be included in the IOC are:

- Japanese Geostationary Meteorological Satellite, GMS, in the form of one infrared full disk every synoptic, and
- NWS data, though at the time of this writing a product list is not available.

Unfortunately, EUMETSAT, the agency responsible for European meteorological satellites, has denied NOAA the use of their direct reception digital data for rebroadcast on LRIT. Though EUMETSAT WEFAX data could be rebroadcast on LRIT, as it is now on GOES WEFAX, NOAA decided against including it on GOES LRIT because of poor data quality due to noisy reception. This may severely impact current users of this data.

For further information please visit http://www.osdpd.noaa.gov/IPD/IPD.html and http://noaasis.noaa.gov/DSD/

3. LRIT IOC USER TERMINAL

The NOAA LRIT user terminal is planned to be economically viable with respect to both users and industry. As such, it has been planned to minimize the cost increases associated with the modernization of the WEFAX service and its long overdue transition to the digital communications world.

Most of the RF components of the LRIT user station will be relatively unchanged from its predecessor WEFAX station. In particular, the major front-end components such as the antenna and down converter should be very similar to the existing WEFAX stations in function, performance and cost. The WEFAX 1 or 2 meter dish requirement will remain the same. The operational band will still be L-band with the similar requirement to down convert the RF signal. The demodulation requirement will now be a BPSK demodulator, producing a binary data stream that is bit-synched. The resultant CCSDS signal must then be decoded and processed in “basic software” or firmware to produce the basic LRIT image and message data for viewing, display, or storage. This “basic software” will be relatively low cost since it has been developed by NOAA and will be freely available to both industry and users.

The primary parameters of the LRIT user stations are as follows:

1) L-Band operation
2) Binary Phase Shift Keying (BPSK) modulation
3) Data rate of 128 kbps
4) Gain over Temperature (G/T) of -0.3 dBi/K with a 1 to 2 meter antenna
5) ReedSolomon/1/2 rate Convolutional Forward Error Correction (FEC)

The cost of an LRIT user station has always been a primary concern for NOAA. The cost is currently projected to be under $5,000.00 and could even be considerably less than $5,000.00. Development of prototype stations, including the basic required software package, has already been completed.

The NOAA LRIT User Terminal includes software for handling data after it has been received and reassembled into LRIT files:

- Imagery data, which includes GOES, POES and foreign spacecraft, will have the LRIT header stripped

off and saved as a metadata file. This metadata file and its associated imagery are saved in the default directory or in a directory assigned by the user. The User Terminal also includes some rudimentary viewer capability. The viewer software allows users view images stored on disk, to pan and zoom on the viewed image, and to save the viewed area of the image to a separate file. The display also overlays lines of latitude and longitude for basic navigation on an image. These navigation lines are recalculated when zooming on an image and change size relative to the area view. Simply put, the navigation lines are reduced in size when zooming in on an image to give the user more useful data to look at instead of larger navigation lines.

- National Weather Service product data will have the LRIT headers stripped off and discarded leaving the NWS product data which is in the Global Telecommunication System (GTS) format. This product data can either be saved, again in the default directory or one assigned by the user; discarded; or sent to a socket for use by another program or another system outside the LRIT User Terminal. The NWS has public domain source code that can be used for processing this data. However, this code is provided "as is" with no support. There are third party vendors that have products and support for processing this data. For more information, please visit http://www.nws.noaa.gov

- GOES Data Collection Service data will also have the LRIT headers stripped off and discarded. At the time of this writing there is uncertainty as to the format of this data and how it will be processed. It appears that the user software currently used for GOES DCS Data will not be compatible with the GOES DCS Data on LRIT. For more information and updates please visit http://noaasis.noaa.gov/DCS/

4. LRIT SERVICE IMPROVMENTS

LRIT will provide a considerably improved product set over WEFAX, its predecessor, especially after the time sharing transition phase is completed. Some of the candidate data set improvements being considered for future inclusion are:

1) Higher resolution GOES data (e.g., 1 km resolution)
2) More frequent updates (i.e., lower latency)
3) Additional ocean data (e.g., winds, currents, sea state, sea surface temperature)
4) Polar data from both US and foreign sources
5) GOES Rapid Scan
6) GOES Data Collection Service data
7) NWS data
8) The inclusion of EUMATSAT Geostationary data or frequent polar products for this area of coverage.

The specific determination of what is eventually included will be based on what is learned during the transition phase and from user feedback.

5. LRIT TRANSITION AND IMPLEMENTATION PLANS

During the planned WEFAX/LRIT transition phase (approximately 6 to 18 months), the GOES I-M transponder will probably be time shared with both the existing WEFAX service and the new LRIT service. During this time sharing transition phase a somewhat reduced suite of products will be offered by both services. GOES data, being the primary product of WEFAX, will generally be given first priority. Polar WEFAX products, currently considered the less useful due to its severe latency, will generally be given lower priority. NWS charts, GMS and Meteosat data will be scheduled as time permits. NOAA will continue to consider specific user needs during this transition period.

NOAA is currently planning to begin its new LRIT broadcast by early 2003, with LRIT test broadcasts scheduled to begin about 3 months earlier. Regular LRIT broadcasts will actually begin before the new GOES NOPQ series of satellites becomes operational in 2004 or later. This will be achieved by using the current series of satellites, GOES I-M, for LRIT broadcasts. The actual recommended design and specification of the LRIT user station, however, is based on the lower Effective Isotropic Radiated Power (EIRP) of the GOES NOPQ series. The L-Band frequency for LRIT is close to the current WEFAX L-band frequency and it is expected that most existing L-band WEFAX receivers can be retuned to the LRIT L-band frequency.

The GOES East satellite is planned to be the first GOES satellite to transition to LRIT beginning in early 2003. The GOES West satellite is planned to begin it's LRIT transition 6 to 12 months after the GOES East satellite transition begins. The GOES West transition period is planned to be somewhat shorter than the GOES East transition period.

6. CONCLUSION

The NOAA GOES system will begin its new LRIT broadcasts in early 2003. As the successor to WEFAX, the general content of this digital LRIT broadcast will include most of the current WEFAX product set. It will also include additional products that expand, improve and/or supplement the current WEFAX product set. The flexibility of the system will allow end users to customize the data to suit their needs. Additionally, NOAA is committed to keeping the LRIT User Stations economically viable for users, developers, and industry. To support that endeavor, NOAA will provide basic receiver software and rudimentary viewer software to the public domain.