CGMS XXIX USA-WP-13

Prepared by USA
Agenda Item: G.1
To be discussed in Plenary

THE CURRENT STATUS OF THE GOES LRIT SERVICE

The purpose of this document is to present the current USA assessment and plans for implementing the Low-Rate Information Transmission (LRIT) system and the new LRIT user stations. The implementation effort will begin with the testing and validation of specific LRIT system engineering issues.

THE CURRENT STATUS OF THE GOES LRIT SERVICE

1.0 Background

The National Oceanic and Atmospheric Administration (NOAA) currently uses Weather Facsimile (WEFAX), an analog meteorological broadcast service, to disseminate Geostationary Operational Environmental Satellite (GOES), Polar Orbiting Environmental Satellite (POES), and foreign satellite meteorological data to users using the GOES L band down-link frequency. In response to the Coordination Group for Meteorological Satellites (CGMS) recommendations for digital meteorological satellite broadcasts, the follow-on series, GOES NOPQ, will replace WEFAX with a new digital service called LRIT. The USA announced at CGMS XXVIII in USA-WP- 11, its plan for a transition to LRIT on the existing GOES I-M series. The transition from the (analog) WEFAX format to the digital LRIT format will require modification to the Central Environmental Satellite Computer System (CEMSCS). The CEMSCS currently ingests the retransmitted GOES variable (GVAR) data streams through a front-end processor (FEP) and provides inputs for applications that generate the WEFAX products.

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

2.0 Approach and Methodology

The major activities of the LRIT transition and implementation activities are outlined below:

- The USA conducted a study of the functionality and services of the current WEFAX generation system, especially the FEP and the CEMSCS, to assess the impact of implementing the new LRIT system
- Development and assessment of LRIT architectures
- Development and assessment of the downlink performance requirements, including transition requirements when both existing WEFAX and new LRIT services will be supported
- Identification and evaluation of industry capabilities to assess the hardware (H/W) and software (S/W) solutions for the LRIT system
- Assessment of industry capabilities to produce low-cost LRIT user stations
- Assessment of future LRIT upgrades, including higher data rates
- Development and evaluation of specific implementation and transition alternatives
- Assessment of ground segment development challenges and schedules
- Development of cost estimates for implementing the total LRIT system, including a prototype LRIT user station

The proposed architecture of the LRIT system is presented in Figure 1 and consists of six potential processing domains interconnected by various communications media. Some of the processing domains could be consolidated as determined by implementation and operational considerations.

The estimated duration of the development, acquisition and implementation effort is one year. The transition from current WEFAX to total IOC LRIT services is projected to occur over a one to two-year period for the GOES constellation (i.e., GOES East and GOES West). Parallel operations (i.e., the broadcast of both WEFAX and LRIT services from the same satellite) are recommended for a specified transition period to facilitate the ease of transition to LRIT for existing WEFAX users.

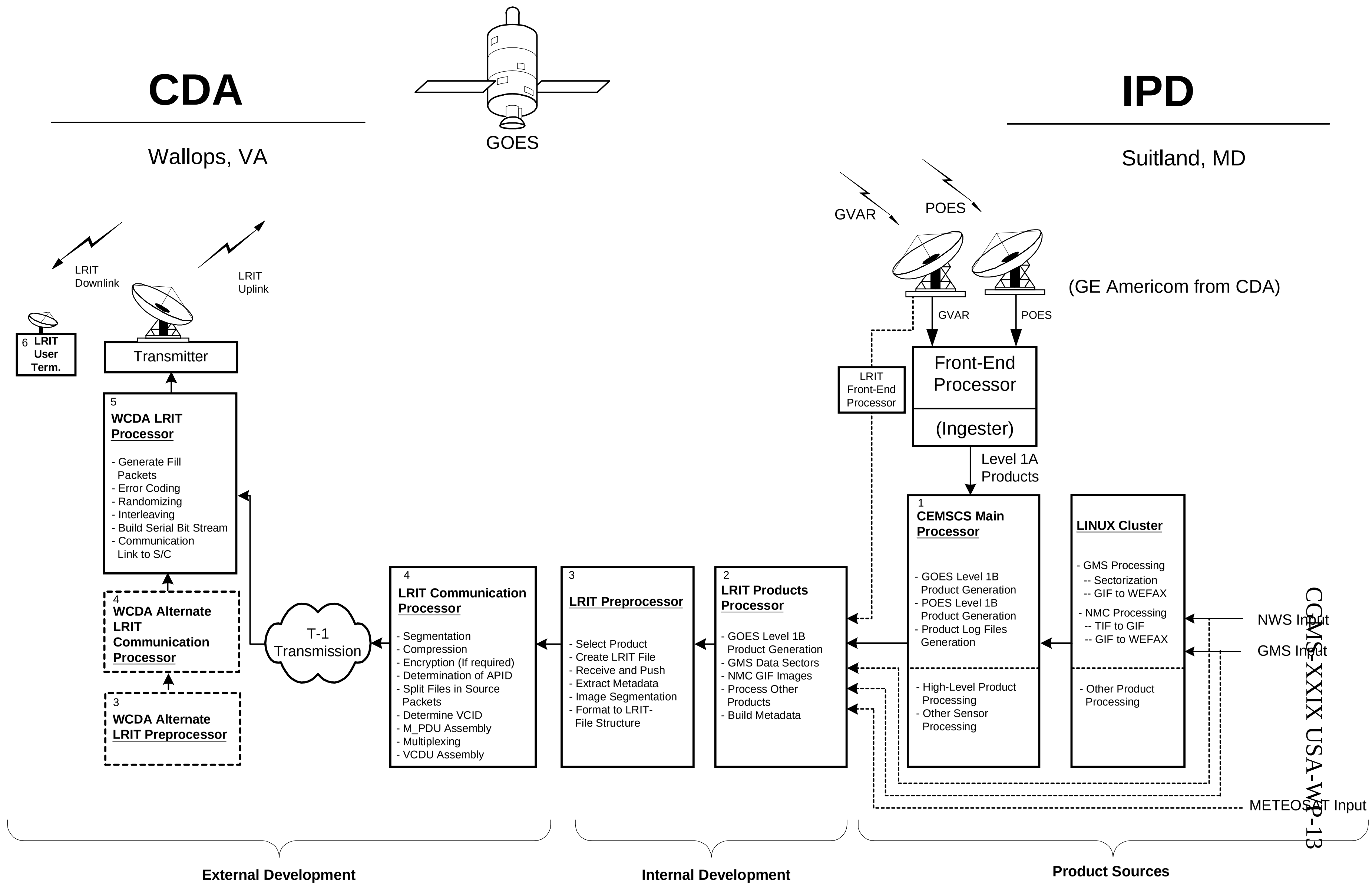

Figure 1. LRIT System Architecture

3.0 Requirements Development and Definition

The USA LRIT development and implementation are based on the LRIT global specifications endorsed by the CGMS. The detailed LRIT specifications of both the European [i.e., European Organisation for the Exploitation of Meteorological Satellite (EUMETSAT)] and Japanese meteorological regions were also reviewed and considered to maximize the interoperability between the systems.

WEFAX/LRIT user considerations as well as NOAA implementation constraints (e.g., cost and schedule) drove the USA's Initial Operating Capabilities (IOC) requirements, see http://www.noassis.noaa.gov/WEFAX/. The Final Operating Capabilities (FOC) requirements are currently constrained by the 128 kbps data rate and will require additional efforts to identify and evaluate alternatives and additional information elements to be included on the future higher capacity LRIT data stream.

4.0 System Architecture, Descriptions, Designs and Specifications

The LRIT system architecture development began with the establishment of all major LRIT processing functions and the allocation of those processing functions to specific processing domains. The six processing domains were based on the following factors: 1) geographic location, 2) existing NOAA processing domains, and 3) existing and projected industry processing products or capabilities. The LRIT architecture presented in Figure 1 begins with the existing NOAA CEMSCS processing area (domain 1) and ends with the user receive station (domain 6). Existing NOAA contractor staff is developing domains 1 through 3. Additional contractors, with Consultative Committee for Space Data Systems (CCSDS) experience, are developing or providing domains 4 through 6.

4.1 Summary of Domains 1 through 6.

- Domain 1 - Front-End Processor / Ingestor
  A new ingestor will be obtained along with a new processor. The new ingestor will be capable of acquiring GVAR data and clock from the antennae through the VIEs at the CEMSCS. Functionally on the new processor, the GVAR data will be processed a scan at a time and the GOES LRIT products produced. Ingest and Front-End processing for POES and External data will not be changed. The current ingestor processing and application processing will be used to provide the POES and other external WEFAX products, which will be converted to LRIT.

- Domain 2 - LRIT Products Production

➢ GOES

  On the new processor, develop code that will take the GVAR data, one scan at a time, from the new ingestor and produce the current suite of GOES WEFAX products for LRIT.

- External (NWS, GMS, METEOSAT) and POES

  Use the current processing for generating the NWS, GMS, and METEOSAT WEFAX products. Use the current processing for generating the POES WEFAX products.

- LRIT Product Formatter for GOES

  Develop new code for formatting the GOES products into the LRIT format.

  - External (NWS, GMS, METEOSAT) and POES

    Develop new code for formatting the NWS, GMS, METEOSAT, and POES WEFAX products into the LRIT format. (These functions will run on the new processor after retrieving the WEFAX products from the system where they are generated.)

- Domain 3 - Build LRIT Product for Transmission

  Build the product in the LRIT format. Combine the header records, metadata and image data into an LRIT file; Set priority; Make the product available for transmission.

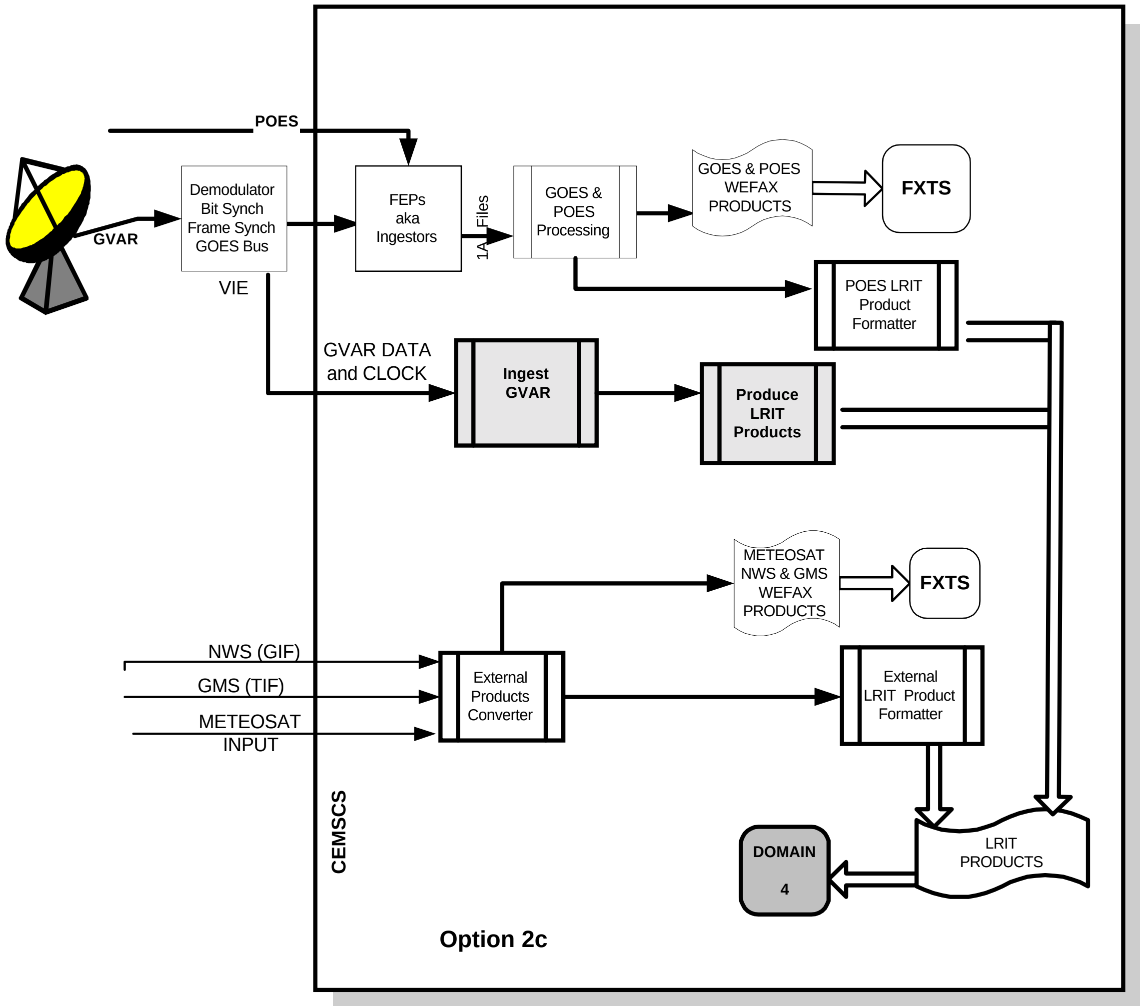

Figure 2: High-Level Functional Flow for Domains 1, 2, 3 Implementation

- Domain 4: LRIT Communication Processor
  The Communication Processor will be an Intel-based high-reliability server running Linux. The Communication Processor receives files from Domain 3, the Preprocessor, and generates VCDUs, which it sends to Domain 5, WCDA LRIT Processor. The Communication Processor receives incoming files via FTP or NFS, and delivers the VCDUS via a TCP connection using IPDU header

- Domain 5 – WCDA LRIT Processor
  A Commercial Off-The-Shelf (COTS) Avtec Programmable Telemetry Processor (PTP) is proposed as the Domain 5 – WCDA LRIT Processor. The Avtec PTP provides complete Domain 5 functionality without any custom development, customer-unique reconfiguration, nor customer-unique testing. Out of the box, the Avtec PTP meets all of the LRIT Domain 5 functional, operational, and flexibility requirements and goals. The PTP complies with all applicable CCSDS Uplink and Downlink specifications.

- LRIT Domain 6 -- user terminal
  The LRIT Domain 6 user terminal will be implemented using the lowest risk approach, while maintaining the NOAA low cost goal. The developed software is expected to run on both Windows NT and Windows 2000 platforms. The Domain 6 Reference User Terminal has components selected for a conservative RF gain.

The user station will consist of four main components as illustrated in Figure 3.

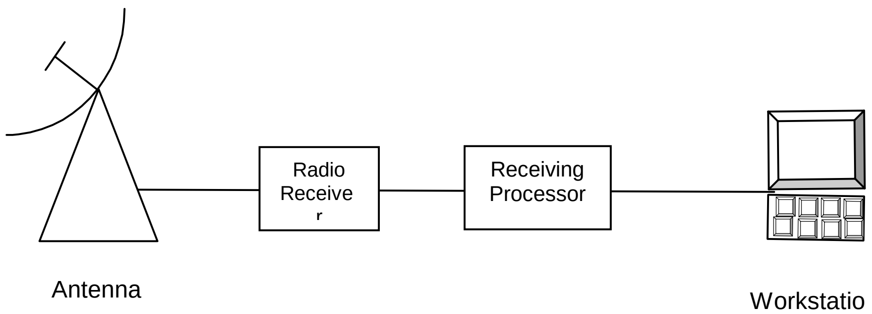

Figure 3. LRIT User Station System

The antenna is a parabolic dish antenna with no auto tracking. The downlink signal is received at 1691 megahertz (MHz). The signal may be filtered to reduce adjacent channel interference and/or amplified by a low-noise amplifier. Then it is down-converted to the receiver IF frequency. The IF amplifiers have an IF bandwidth capable of receiving a 293 kbps symbol stream. The IF signal is then demodulated in a BPSK demodulator and the baseband output to the receiving processor is a serial bit stream. The IOC will operate at 64 kbps and use the 1-meter antenna that was used for WEFAX reception. The FOC will operate at 128 kbps and use either a 1-meter or a 1.8-meter antenna.

5.0 Latency Issues

The current process of creating GOES (as well as POES) WEFAX products are to take the entire ingest before any product processing commences. This causes an initial delay of up to 27 minutes from the start of acquisition to the end of transmission, plus the product processing time. Additional delays of up to several hours are due to the limitation of the WEFAX system. For example: in a best case, a 23:45Z GOES East ingest starts at approximately 23:45Z. The ingest ends at approximately 00:12Z. Data transfers and product processing usually take no more than five minutes and there is a five-minute delay to get the products to the WEFAX transmission system. Therefore, the first 23:45Z product could be scheduled for transmission at approximately 00:22Z. Each product takes four minutes to transmit. The 23:45Z ingest is a synoptic ingest that generates 13 products requiring 52 minutes to transmit all products. Therefore, in a best best-case scenario, there could be a delay of up to 1 hour and 29 minutes. In actuality, this delay is even longer, up to several hours, because other products are often scheduled for transmission before all of these products are transmitted.

The increased transmission speeds of LRIT would allow these products to be disseminated in a fraction of the time and the delay could be further reduced if processing were to commence before the entire ingest was complete.

The USA also considered the LRIT potential for providing greater user flexibility in producing GOES image products. As previously described, the current WEFAX practice is to generate individual WEFAX products in house and disseminate them. It has generally been assumed that LRIT processing would follow the same method. However, higher resolution data with reduced latency could be achieved by not creating individual products in house, but by sending users high-resolution full disk data and allowing them (domain 6 on the main LRIT processing flow diagram) to create these products. This also gives users the flexibility to make products more specific to their individual needs, something in-house generated products cannot provide for all users. It may also be more efficient to send GOES data this way. Using this method, the data are only transmitted once instead of the current redundant method [full disk at 16-kilometer (km) resolution, full disk in quadrants at 8-km resolution, Northern Hemisphere at 8-km resolution and conus at 4-km resolution].

Also, if the full disk data is sent in block sectors (as shown in Figure 9), any break in communications will not result in a loss of the entire full disk. Only the specific block that was interrupted will be lost.

Note: There can be any number of segments and not just six as shown in Figure 4.

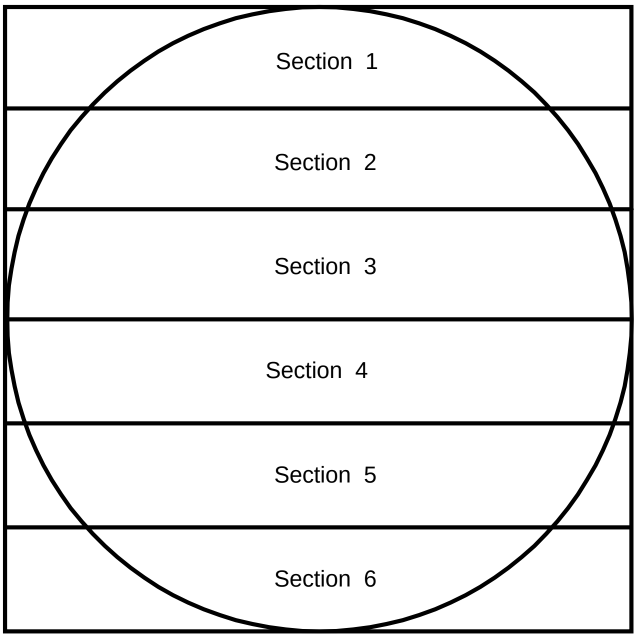

Figure 4. Image Partitioning

6.0 Development and Implementation Resources

The LRIT system development and implementation is projected to require at least one year to engineer, design, develop, acquire, implement and test, followed by a one to three-month performance evaluation period before formal and official LRIT services are offered. The major development areas for each of the six processing domains are presented in Table 1.

Table 1. LRIT Implementation Resource Estimates

Processing or Comm. Domain	Developers	Level-of-Effort Estimate	Source	Comments
0. Ingestor	Vendor	2-months	CSC (DM)	Possible non-technical implications
1. CEMCSC Processing	CSC	14-days	CSC (FE)	Minimum changes
2. LRIT Products Processing	CSC	3-months	CSC (RS, RL)	Major new S/W development and processor; Option 2 new ingestor or SSD input
3. LRIT Preprocessing	CSC & Vendor	2-months	CSC (RS, RL)	Major vendor support for gov't-owned S/W
4. LRIT Communications Processing	Vendor	2-months x 2	Industry	Vendor H/W and S/W; COTS & some upgrading and customization
5A. LRIT WCDA Processing	Vendor	2-months	Industry	Vendor H/W and S/W; (mostly COTS)
5B. LRIT WCDA Communications	Vendor NESDIS OSO	1-month x 2	OSO (RT)	Vendor H/W (mostly COTS) OSO switch development
6. LRIT User Terminal	Vendor	4-months	Industry	Vendor rcv H/W and S/W integrated with transmission system
Engineering	CSC , OSO Vendor	4-months	CSC (FE)	Rob Tye, Phil Whaley
Total		**12-months**		

7.0 Conclusions and Recommendations

The Initial Operational Capability (IOC) and Final Operational Capability (FOC) requirements were driven and constrained by the IOC data rate of 64 kilobits per second (kbps) and the FOC data rate of 128 kbps. These two data rates were determined by the CGMS LRIT standards and their planned implementation by the two other major meteorological broadcast regions, Europe and Japan. The 64 kbps IOC data rate is considered an interim or transition data rate to: 1) facilitate the ease of transition from WEFAX to LRIT services for the user community and 2) enable earlier LRIT service implementation on the existing GOES I-M series. The IOC requirements focus on four major objectives:

1) LRIT formatting of the current WEFAX service,
2) additional products and services with improvements on latency and product flexibility,

3) the inclusion of additional National Weather Service (NWS) products, information and services, possibly including all or part of the Emergency Management Weather Information Network (EMWIN) data, and
4) the inclusion of Data Collection System (DCS) information that is currently broadcast by commercial satellite to the continental U.S.

The first area has highest priority whereas support for the other improvements will depend on available data transport capacities after the highest priority LRIT needs are addressed.