CGMS XXX USA-WP-11
Prepared by USA
Agenda Item: I.4.1
To be discussed in WG1

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 meteorological satellite 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 modifications to the NOAA 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.

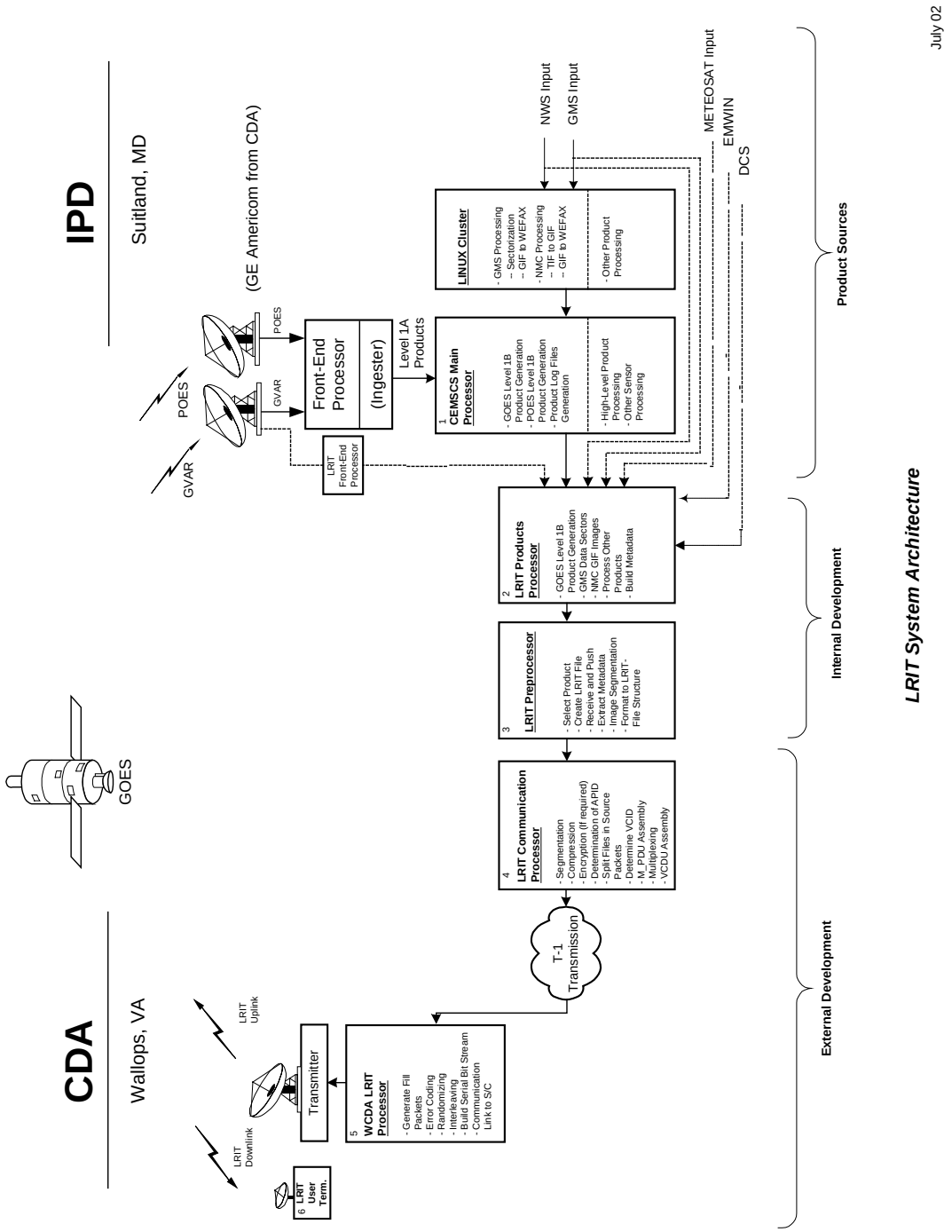
2.0 Approach and Methodology

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 the total LRIT system, including a prototype LRIT user station
- Integration, testing and evaluation

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

The development, acquisition and implementation of the LRIT system lasted eleven months. LRIT broadcast from the GOES-East spacecraft will begin January 1, 2003. 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) will be performed for a specified transition period to facilitate the ease of transition to LRIT for existing WEFAX users.


IPD
Suitland, MD
(GE Americom from CDA)
POES
GVAR
Front-End Processor
(Ingester)
Level 1A Products
LRIT Front-End Processor
1 CEMSCS Main Processor
- GOES Level 1B Product Generation
- POES Level 1B Product Generation
- Product Log Files Generation
- High-Level Product Processing
- Other Sensor Processing
LINUX Cluster
- GMS Processing
-- Sectorization
-- GIF to WEFAX
- NMC Processing
-- TIF to GIF
-- GIF to WEFAX
- Other Product Processing
NWS Input
GMS Input
METEOSAT Input
EMWIN
DCS
2 LRIT Products Processor
- GOES Level 1B Product Generation
- GMS Data Sectors
- NMC GIF Images
- Process Other Products
- Build Metadata
3 LRIT Preprocessor
- Select Product
- Create LRIT File
- Receive and Push
- Extract Metadata
- Image Segmentation
- Format to LRIT-File Structure
4 LRIT Communication Processor
- Segmentation
- Compression
- Encryption (If required)
- Determination of APID
- Split Files in Source Packets
- Determine VCID
- M_PDU Assembly
- Multiplexing
- VCDU Assembly
T-1 Transmission
CDA
Wallops, VA
GOES
LRIT Uplink
LRIT Downlink
Transmitter
5 WCDA LRIT Processor
- Generate Fill Packets
- Error Coding
- Randomizing
- Interleaving
- Build Serial Bit Stream
- Communication Link to S/C
6 LRIT User Term.
Product Sources
Internal Development
External Development
LRIT System Architecture
July 02

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 services 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://noaasis.noaa.gov/WEFAX/. The Final Operating Capabilities (FOC) requirements will require additional efforts to identify and evaluate alternatives to be included on the future 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 are 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).

4.1 Summary of Domains 1 through 6.

- Domain 1 - Front-End Processor / Ingestor
  A new ingestor was obtained along with a new processor. The new ingestor is 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 are produced. Ingest and front-end processing for POES and external data are not changed. The current ingestor processing and application processing are used to provide the POES and other external WEFAX products, which are converted to the LRIT format.

- Domain 2 - LRIT Products Production
  For all data input (GOES, NWS, GMS, text, etc.) to the LRIT system, Domain 2 processing formats the data into an LRIT file and determines all the information necessary for the LRIT file headers. The header records are built. If required, segmenting and image compression are done.

- Domain 3 - Build LRIT Product for Transmission
  Processing is done to build the LRIT product in the LRIT format. The header records and image or text data are combined into an LRIT file. The transmission priority is determined and the product is made available for transmission.

- Domain 4: LRIT Communication Processor
  The Communication Processor is 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
  The WCDA LRIT Processor, Domain 5, is a Commercial Off-The-Shelf (COTS) Avtec Programmable Telemetry Processor (PTP). The Avtec PTP provides complete Domain 5 functionality without any custom development, customer-unique reconfiguration, or 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 is designed 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 consist of four main components as illustrated in Figure 2.

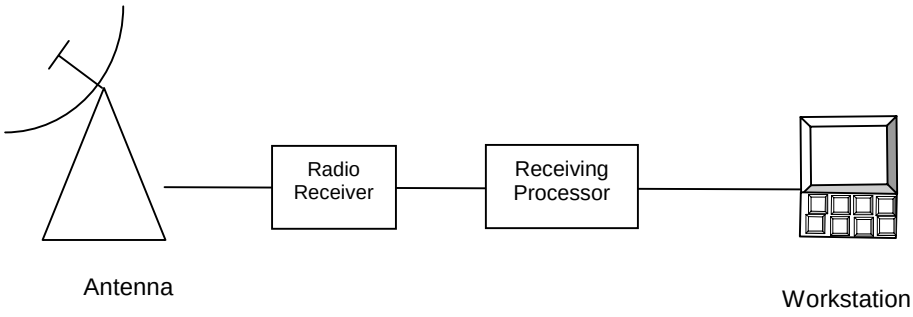


Figure 2. LRIT User Station System

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 128 kbps and use the 1-meter antenna that was used for WEFAX reception at elevations above 10^{o}. The FOC will operate at 128 kbps and use either a 1.8-meter antenna for elevations below 10^{o}.

5.0 Summary

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 was considered an interim or transition data rate and it was decided to use the 128 kbps for IOC as well as FOC. 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.

In September 2002, the development of the LRIT system was completed and system integration testing was initiated. IOC is scheduled to begin January 2003.