Field Terminal Segment (FTS) Update
National Polar-orbiting Operational Environmental Satellite System (NPOESS)

Raytheon Intelligence and Information Systems, Aurora CO
Gary Route, Chief Systems Engineer, Interface Data Processing Segment (IDPS/FTS)
Gary Heckmann, Chief Engineer, Command, Control and Communications Segment (C3S)

NPOESS
Northrop Grumman
Raytheon
DOC • DoD
NASA

NORTHROP GRUMMAN
Raytheon

- The Field Terminal Segment architecture (Figure 1) consists of three elements. The Field Terminal agency provides two elements: the Signal Processing Element (SPE) and the Mission Application Element (MAE). The NPOESS program makes available the NPOESS developed software for the Data Processing Element (DPE).
- Notional Field Terminal components are (1) the SPE consisting of the antenna and signal processing components and (2) hardware hosting the DPE that interfaces with the FT MAE. (Figure 2)
- The downlink parameters for the High Rate Data (HRD) and Low Rate Data (LRD) downlinks are listed in Figure 3. To fit the instrument data into the downlink bandwidth, HRD uses Rice lossless compression for the VIIRS instrument data while the LRD uses JPEG 2000 lossy compression for the VIIRS data. To fit the instrument application packets into the constrained LRD bandwidth, NPOESS is capable of selecting which application packets are broadcast in the LRD. NPOESS includes the required auxiliary data (e.g. Two-Line Element sets, processing coefficients) and ancillary data in the HRD and LRD broadcasts. These data are used to generate the LDR Environment Data Records (EDRs).
- Based on the application packet content of the HRD and LRD, a Field Terminal executing the DPE software has the capability of generating the EDRs for NPOESS sensors as illustrated in Figures 4 and 5 , respectively for HRD and LRD Field Terminals.
- The minimum hardware requirements to host the DPE software and meet the NPOESS specified latency. The processor and memory capacity requirements are based on VIIRS 18-scan (TBD) granules meeting the latency requirements of 2 minutes for imagery products and 15 minutes for all other EDRs. Figure 6.
- Storage retention capacity of 24-hours is listed for selected Field Terminal latitudes for both the SPE and DPE hardware, Figure 7. Selected latitudes are provided since the storage requirements are based on the number of satellite contacts processed by the Field Terminal with the highest and lowest latitudes requiring the most storage capacity.

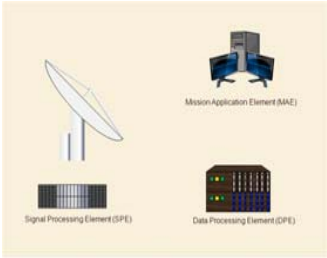

Figure 2 - Field Terminal Concept

Link Parameter	HRD	LRD
Channel Data Rate	40 Mbps	7.76 Mbps
Modulation and Filtering	SQPSK with square root raised cosine pulse shaping [alpha = 0.5]	SQPSK with square root raised cosine pulse shaping [alpha = 0.5]
Coding	(255, 223) Reed-Solomon with I=4	(255, 223) Reed-Solomon with I=4
Convolutional Coding:		
Code Rate	1/2	1/2
Constraint Length	7 bits	7 bits
Connection Vectors	G1=1111001, G2=1011011	G1=1111001, G2=1011011
Phase Relationship	G1 associated with first symbol	G1 associated with first symbol
Symbol Inversion	On output path of G2	On output path of G2
Number of Encoders	1	1
Branch Encoder	No	No
Sent to I Modulator	G1	G1
Sent to Q Modulator	Symbol inverted G2	Symbol inverted G2
Randomization	$h(x) = x^8 + x^7 + x^5 + x^3 + 1$	$h(x) = x^8 + x^7 + x^5 + x^3 + 1$
Maximum Occupied Bandwidth (99% Power)	30.8 MHZ	6.0 MHZ
BER after decoding	< 10-9	< 10-8
Carrier Frequency	7634 MHz	1707.6 MHz
Polarization	RHCP	RHCP
Minimum Elevation Angle	5.0 degrees	5.0 degrees
Orbit averaged availability	99.6%	99.9%
Data Format	NRZ-M (Prior to Convolution encoder)	NRZ-M (Prior to Convolution encoder)

Figure 3 - NPOESS Direct Broadcast Link Characteristics

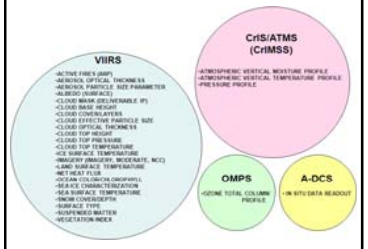

Figure 4 – High Rate Data Downlink EDRs and Sensor Mapping

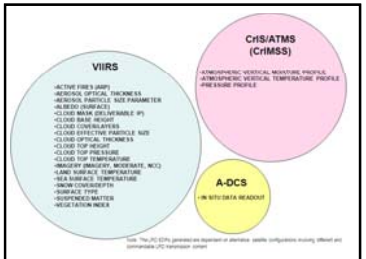

Figure 5 – Low Rate Data Downlink EDRs and Sensor Mapping

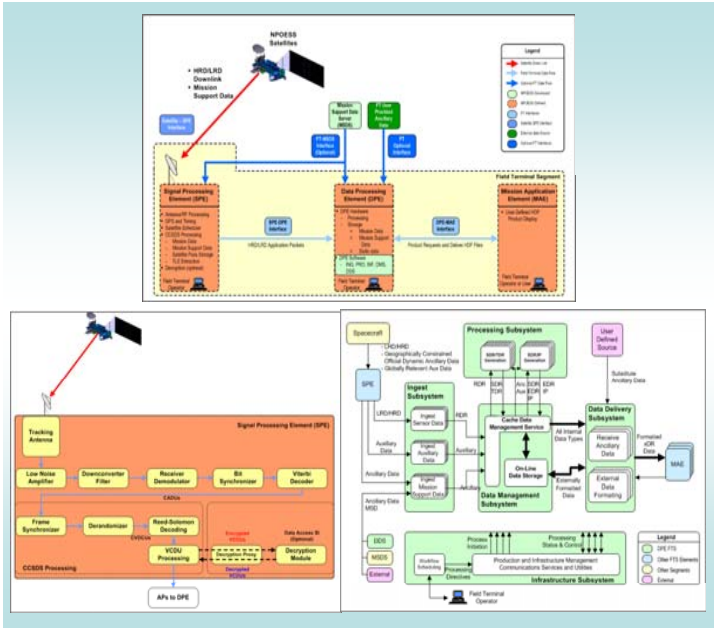

Figure 1 - Field Terminal Segment Architecture

DPE Predicted Processing Estimate

Constellation of 2 NPOESS Satellites (1330, 1730)
3.64 GHz Processing Processors, 2.1 GHz Additional Processors
18-scan (TBD) VIIRS Granules 8/19/2009 Results

Field Terminal Type	Processors No. Processing + Additional	Imagery EDR Latency (minutes)	Maximum EDR Latency (minutes)
HRD	32 + 4	1.98	4.5
LRD	32 + 4	1.98	4.5

DPE Memory Capacity and I/O Estimates

Constellation of 2 NPOESS Satellites (1330, 1730)
18-scan (TBD) VIIRS Granules, 8/19/2009 Results

Field Terminal Type	Memory (GB) Processing + Additional	Disk I/O (Mbps) data only
HRD	64 + 16	1820
LRD	64 + 16	1753

Notes: Processor estimates based on AIX Power architecture
TBD - VIIRS granule size in review

Figure 6 – Data Processing Element (DPE) Estimated Processing Needs

SPE and DPE 24-Hour Storage Estimates

Constellation of 2 NPOESS Satellites (1330, 1730)
8/19/2009 Results

Field Terminal Element		SPE		DPE	
(Latitude N/S)	Total Contacts (17 day period)	HRD (GiB)	LRD (GiB)	HRD (GiB)	LRD (GiB)
0 degrees	128	20.98	4.07	250	241
30 degrees	150	25.62	4.97	293	282
60 degrees	334	56.24	10.91	649	624
90 degrees	482	81.70	15.85	936	900

Notes:
HRD: 40 Mbps Channel Data Rate
LRD: 7.76 Mbps Channel Data Rate

Figure 7 – Field Terminal SPE and DPE Storage Needs

Assistance with Developing NPOESS Field Terminals

The NPOESS program is developing the following documents for free distribution to Field Terminal equipment vendors

1. Field Terminal Specification – details the minimum specifications for Field Terminals
2. Field Terminal Interface Control Document – documents all necessary external interfaces, satellite interfaces, interfaces between SPE and DPE, and interfaces between DPE and MAE.