X band workshop

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Data Compression and Data Relay for Transmission of ALOS Data

Korehiro MAEDA
and Kenichi TODA
Japan Aerospace Exploration Agency

Content

1. Introduction

- SFCG has studied X band data transmission for Earth Observation Satellites and produced SFCG recommendation Rec.14-3R6.
- In order to reduce band width, efficient modulation method is recommended.
- The other method is to reduce data volume by using on-board data compression.
- Moreover, by using data relay satellite, burden of the use of X band can be reduced.
- In this paper, characteristics of ALOS and its sensors, characteristic of onboard data compression and data relay transmission are presented.

2 . Outline of AlOS

- The Advanced Land Observing Satellite (ALOS) will be used for cartography, regional observation, disaster monitoring and resource surveying.
- This satellite will be launched in September, 2005.
- ALOS has been based upon development and operational results of MOS-1 (1987), MOS-1b (1990), JERS-1 (1992), and ADEOS (1996) [1]-[4].

2 . Outline of AlOS

Objectives of ALOS are as follows:

- to provide maps for Japan and other countries including those in the Asian-Pacific region (Cartography)
- to perform regional observation for “sustained development”, harmonization between Earth environment and development (Regional observation)
- to conduct disaster monitoring around the world (Disaster monitoring)
- to survey natural resources (Resources surveying)
- to develop technology necessary for future Earth observing satellites (Technology development)

2 . Outline of AlOS

ALOS has three sensors:

- the Panchromatic Remote- sensing Instrument for Stereo Mapping (PRISM) for digital elevation mapping,
- the Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2) for precise land coverage observation,
- and the Phased Array type L-band Synthetic Aperture Radar (PALSAR) for day and night and all weather land observation.

Figure 1 shows overview of ALOS.

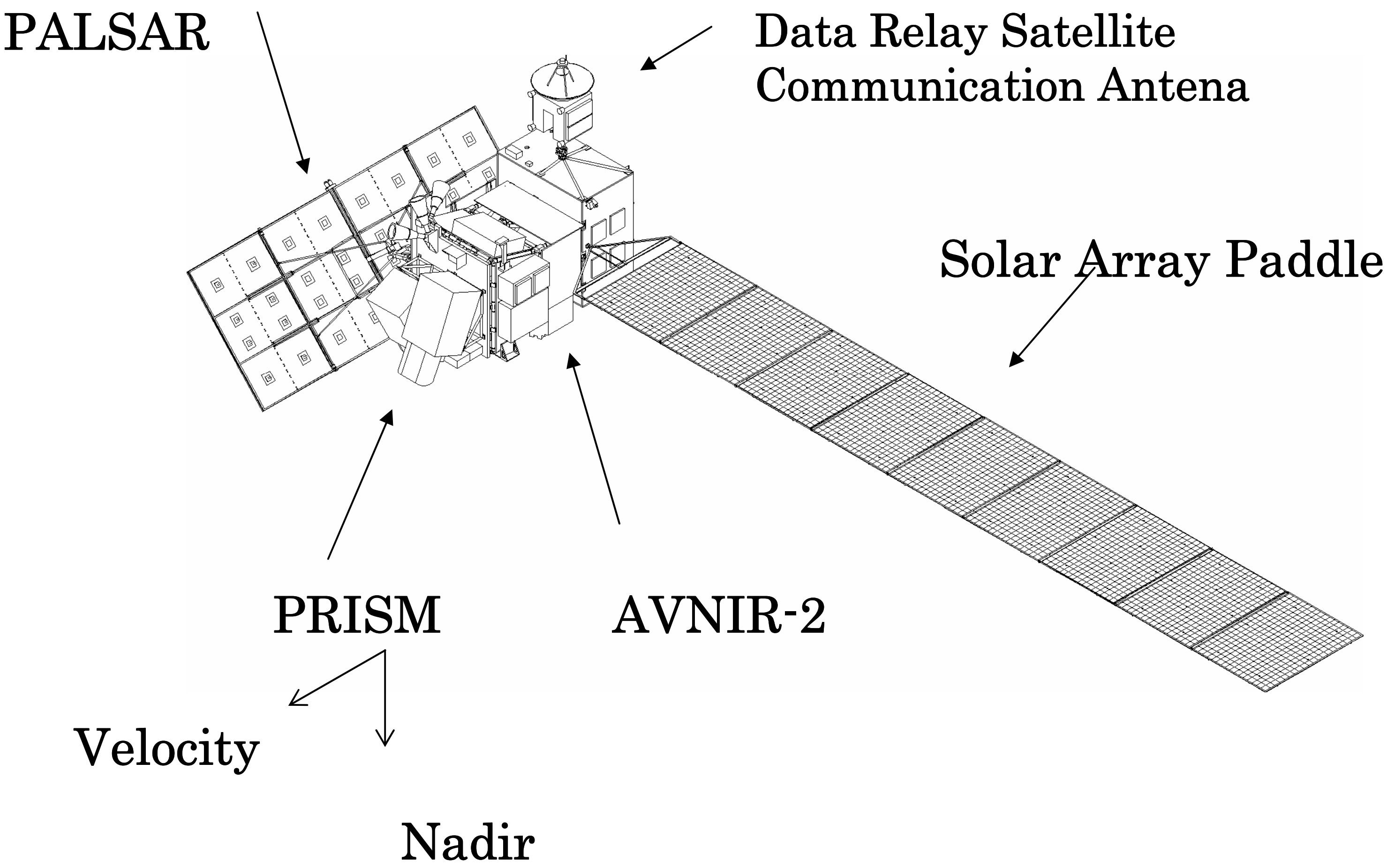

Figure 1 Overview of ALOS.

Table 1 Characteristic of ALOS

Item	Description
Launch vehicle	H-IIA
Launch site	Tanegashima Space Center
Spacecraft mass	Approx.4 ton at lift off
Generate power	Approx.7kW (EOL)
Design Life	3-5 years
Orbit	Sun Synchronous Sub-Recurrent
	Repeat cycle: 46 days Sub Cycle: 2 days
	Altitude:691.65km at Equator
	Inclination:98.16 degree

Table 2 Characteristics of PRISM

Item	Description
Observation band	0.52-0.77μm
Number of Optics	3 (Nadir, Forward, Backward)
Base/Height ratio	1.0
S/N	>70
MTF	>0.2
Spatial Resolution	2.5m
Swath width	35km (Triplet mode) 70km (Nadir Only, Wide swath mode)
Pointing Angle	±1.5 degree (Triplet mode)

Table 3 Characteristics of AVNIR-2

Item	Description
Observation band	Band 1: 0.42-0.50μm Band 2: 0.52-0.60μm Band 3: 0.61-0.69μm Band 4: 0.76-0.89μm
S/N	>200
MTF	>0.2
Spatial resolution	10m
Swath width	70km
Pointing angle	±44 degree

Table 4 Outline of PALSAR

Item	Description	
Observation mode	Fine resolution	ScanSAR
Frequency	L band (1.27GHz)	
Polarization	HH, VV, HH&HV, VV&VH	HH,VV
Spatial Resolution	10m	100m
Number of looks	2	8
Swath width	70km	250-350km
Off-nadir angle	10-51degree	
NEσ°	Approx. -23dB	

3 . Data compression

- PRISM, AVNIR and PALSAR will produce data 960Mbps, 160Mbps and 240Mbps, respectively.
- Total data rate is 1.36Gbps.
- Such large data volume can not be transmitted through limited bandwidth.
- Therefore, data compression is required.
- Data compression method is shown in Table 5. [5]-[7]

3 . Data compression

- For the data compression, one chip LSI (Large Scale Integrated Circuit) was developed which includes lossy functions based upon JPEG extension (lossy) (ISO/IEC 10918-3)
- and also includes lossless function based upon JPEG lossless specification (ISO/IEC 10918-1).
- Performance of afore-mentioned LSI (μPD55216B- E11R) is as follows:

3 . Data compression

(1)Input signal

Input signal is 8 bit (lossless) and 8-12 bit (lossy) and maximum 8192 pixel/line can be treated.

(2)Processing method

In lossy data compression, DCT, quantization and Huffman-Coder is used and in lossless data compression, DPCM and Huffman-Coder is used.

(3)Control function

Quantization matrix and table of Huffman-Coder can be changed by using specified value in PROM (programmable Read Only memory) or writing different value and it is possible to adjust output bit rate. By using this function, constant bit rate (CBR) and variable bit rate (VSR) can be specified.

(4)Output signal

Output signal is 32 bit compatibility based upon CCSDS recommendation.

3 . Data compression

- Figure 2 shows block diagram of LSI (μPD55216B-E11R).
- Processing speed of 17 Mpel/sec is the highest in the world as far as we know.

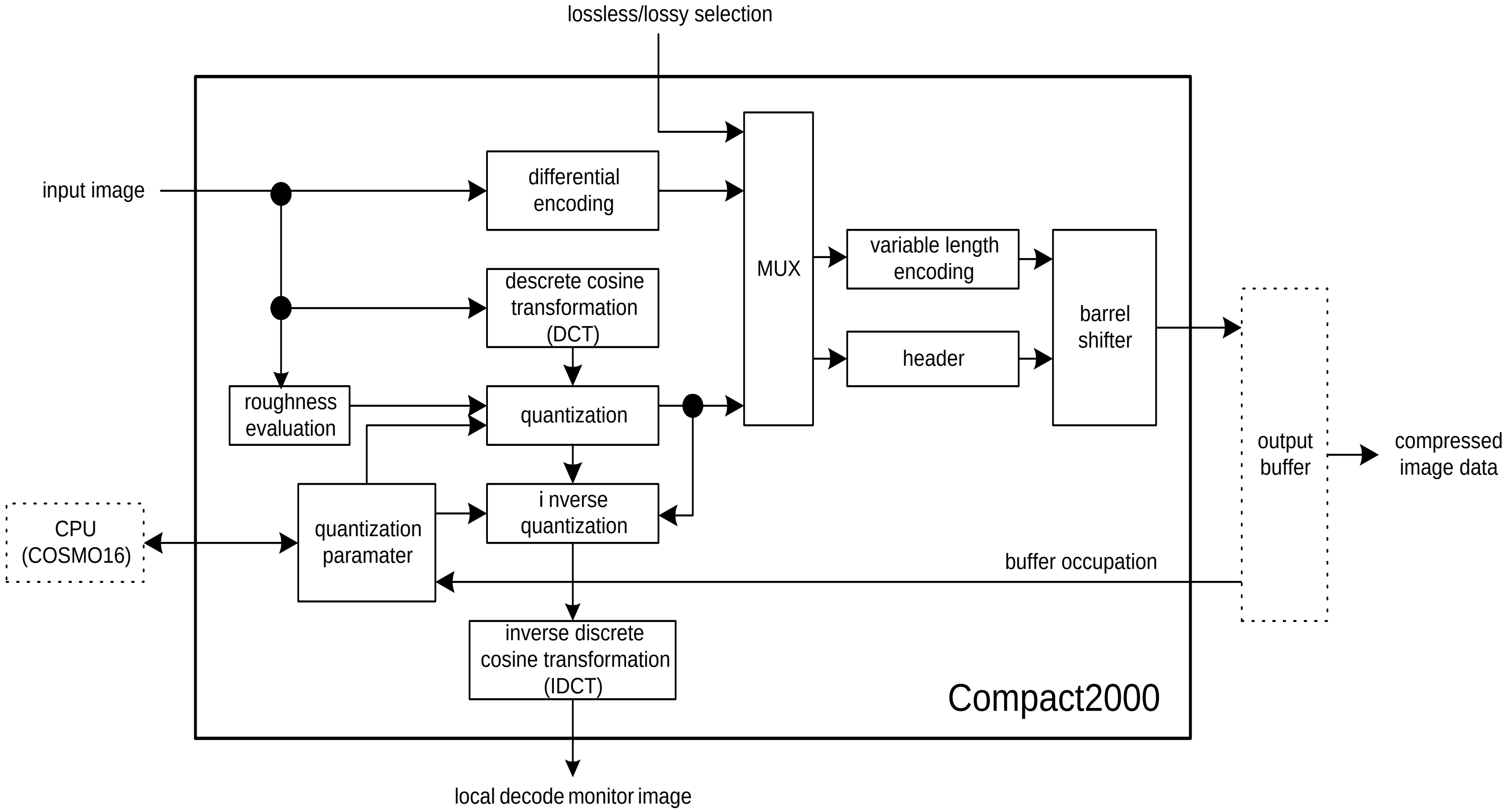

Figure 2 Block diagram of LSI (μPD55216B- E11R).

Table 5 Characteristics of mission data handling subsystem

Item	Description
Data compression	•PRISM data: Data compression method: Discrete Cosine Transformation (DCT) + Huffman-Coder Compression rate: 1/4.5,1/9 (lossy) •AVNIR data: Data compression method: Differential PCM (DPCM) + Huffman-Coder Compression rate: 3//4 (lossless) •PALSAR data: None

Data recorder	**Type:semiconductor data recorder** **Data volume:96Gbyte** **360Mbps (recording)** **240Mbps (replaying)**
Error correction	**Reed-Solomon Code** **Bit error rate: $1x10^{-16}$**
Via DRTS	**278 Msps** **26.1GHz (300MHz)**
Direct transmission	**139 Msps** **8.105 GHz (144MHz)**

4.Data relay

- Data relay test satellite (DRTS) was successfully launched on September 10, 2002 and DRTS was injected into geostationary orbit where DRTS is stationed on the equator over the Indian Ocean (Altitude: about 36,000 km, East longitude: 90.75 degrees) on October 11, 2002 and has completed its initial function verification test and moved to the operation phase on January 10, 2003.
- Ka band data transmission experiment using ADEOS-II and DRTS was successfully conducted in February 20, 2003 for the first time in the world.
- In the same way, ALOS will use DRTS where data transmission of 278 sps is available by using 26.1 GHz (bandwidth 300MHz).
- Figure 3 shows data flow of ALOS data using DRTS and Earth stations.

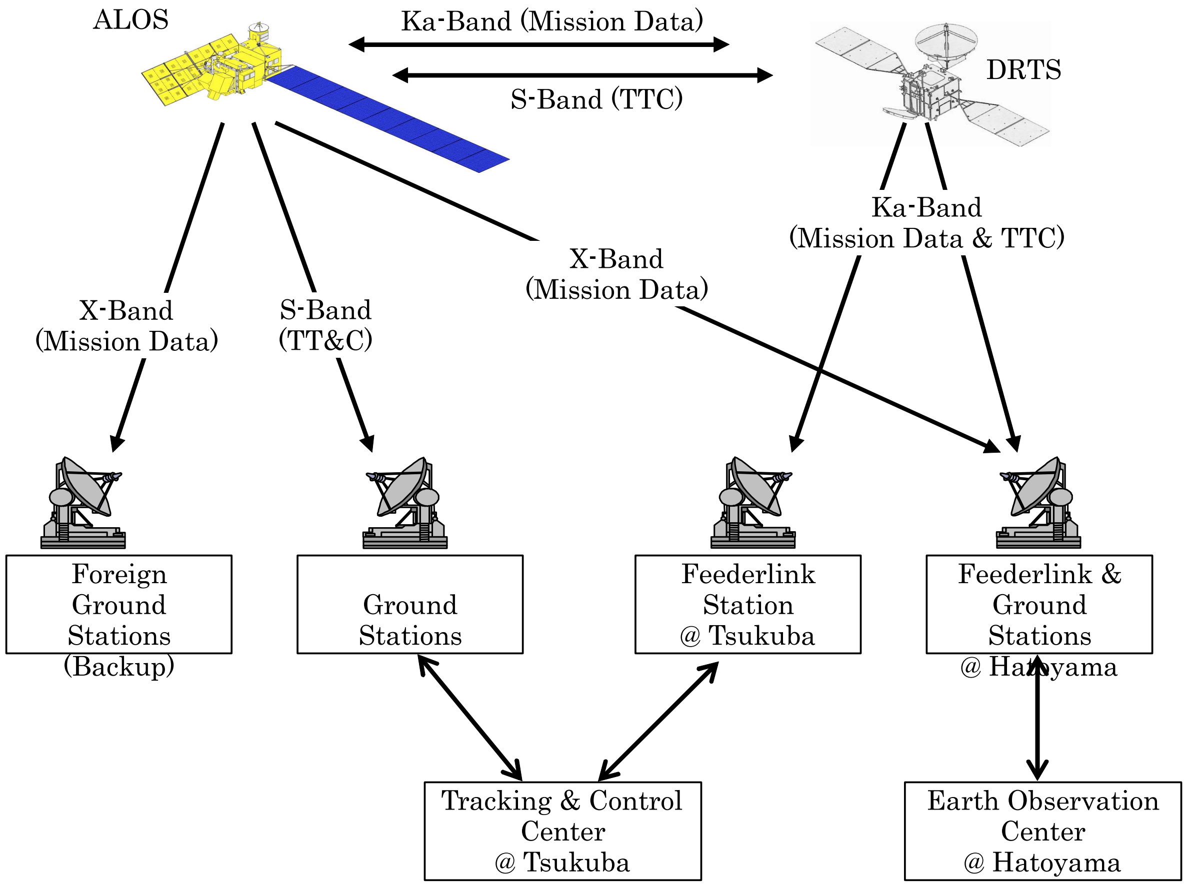

Figure 3 Data flow of ALOS data.

5 . Conclusion

- By applying data compression method, substantial data reduction is achieved which leads to smaller bandwidth.
- Moreover, the use of data relay satellite enables reduction of burden of X band transmission and reduction of interference of X band.

6 . References

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