Technical Note: An Overview of the Generic Transcription System (GTS)

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Abstract

The Generic Transcription System (GTS) is an inexpensive but high performing and flexible PC-based platform designed, developed and maintained by the Canada Centre for Remote Sensing, Natural Resources Canada, for operational use at their data reception stations. GTS was designed primarily to ingest raw downlink satellite data, extract and derive all relevant data and parameters, and generate output products according to standards. The hardware is totally programmable through the use of an in-house developed custom input board. The following sensors, including SPOT 1, 2, 3 and 4, ERS-1 and 2, Landsat-4, 5 and 7, and soon Envisat ASAR, and various output formats have been implemented over the years to make GTS one of the critical systems at both satellite stations. As new requirements are agreed upon, the GTS will be upgraded to meet these new demands, and will thus continue to provide the Canadian remote sensing community with a reliable and inexpensive system to disseminate data products.

Le Système générique de transcription (SGT) a été développé et est mis à jour par le Centre Canadien de télédétection, Ressources naturelles Canada, pour utilisation de façon opérationnelle à ses stations de réception. Le SGT a été conçu principalement pour accepter les signaux satellite transmis aux stations, extraire et dériver les données pertinentes et les paramètres, et générer des produits de sortie conformes aux spécifications de format. Le SGT est peu coûteux mais très performant, adaptable et basé

sur une plateforme d'ordinateur personnel. Le matériel est complètement programmable grâce à un circuit d'entrée développé à l'interne au CCT. Plusieurs capteurs et formats de sortie ont été développés et ajoutés au fil des années, faisant du SGT l'une des pierres d'angle du processus de traitement des signaux satellite reçus aux deux stations de réception canadiennes. Le SGT accepte et formatte les données des capteurs suivants: SPOT-1, 2, 3 et 4, ERS-1 et 2, Landsat-4, 5 et 7 et bientôt Envisat ASAR. Au fur et à mesure que des nouveaux besoins seront identifiés, le SGT sera modifié pour rencontrer les demandes et continuer de desservir les stations canadiennes de réception et la communauté de télédétection en général pour la distribution des données satellite à l'aide d'outils fiables et économiques.

Introduction

In 1995, the Generic Transcription System (GTS) project started. Its key objective was the creation of a system that would acquire and process satellite data from downlink to output product. The GTS was deployed at the two satellite data reception stations operated by the Canada Centre for Remote Sensing (CCRS), Natural Resources Canada, namely the Gatineau Satellite Station (GSS) in Cantley, Quebec, and the Prince Albert Satellite Station (PASS) in Prince Albert, Saskatchewan, for daily operations involving the acquisition and formatting of ERS-1 and 2 data. Over the years, requirements changed as new sensors and formats were added, leading to numerous upgrades to the GTSs.

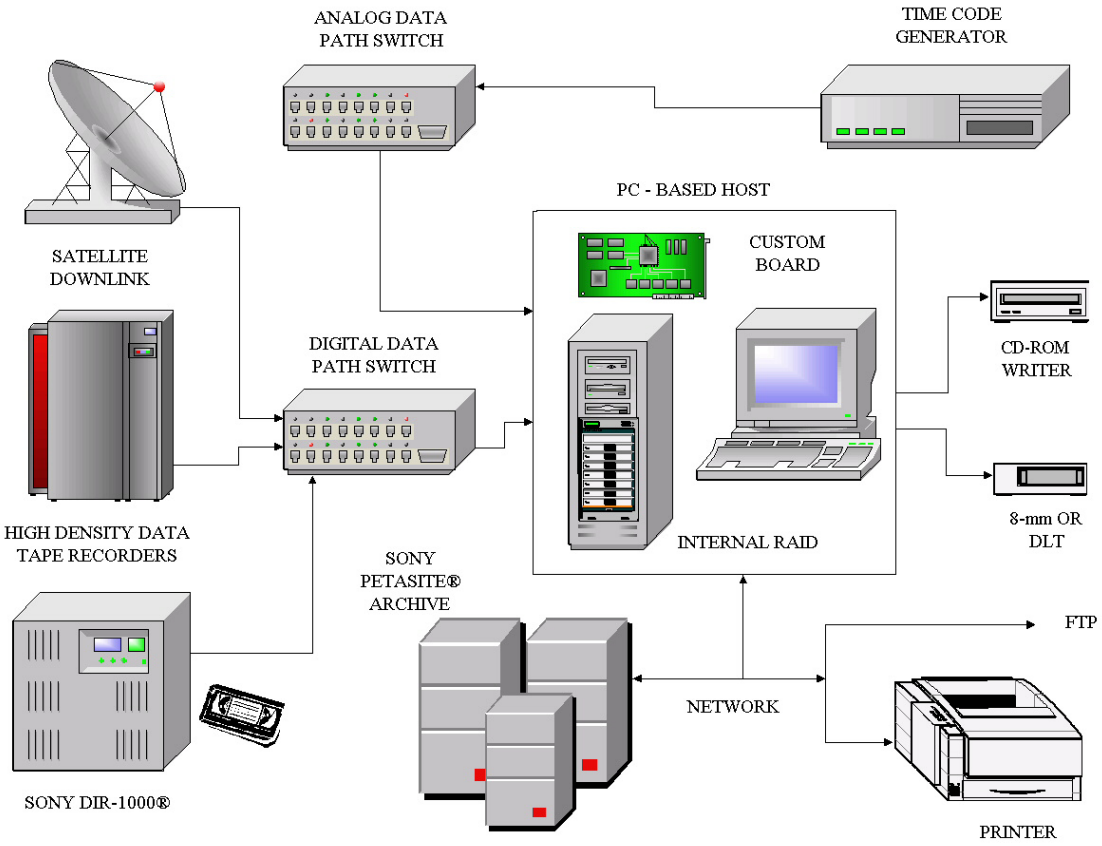

Figure 1 Generic Transcription System Block Diagram

System Design

CCRS has been able to maintain participation in international distribution programmes and meet the demands of its distributors by providing fast reception, processing, and delivery turn-around of satellite data. As such, GTS was originally designed to meet the following objectives:

- to be inexpensive and high performing (GTS uses a high end personal computer);
- to be capable of interacting with the Satellite Acquisition Services (SAS) and other systems via computer network (GTS currently uses the Windows NT operating system);
- to be flexible and programmable (GTS uses in-house developed custom input boards and object-oriented software such as Visual C++);
- to be simple to use (GTS uses Windows graphical user interfaces (GUI) with Visual C++);
- to acquire data from direct real-time downlink or playback data from high density data tapes;
- to output the products onto 8-mm tape, CD-ROM, or over a network (other media capabilities have also been added).

A complete GTS system is quite inexpensive, costing around Can$26,000 in 2001. The main components of the system consist of a PC server, 108 Gbytes of SCSI hard disks, a time code reader interface, custom GTS modules, 8-mm and digital linear tape (DLT) drives, as well as a CDROM writer, and a network connection. **Figure 1** details the present system components as a block diagram.

GTS can ingest data in real-time at bit rates, sensor dependent, varying from 500 kbps to 105 Mbps, directly from the satellite downlink or from high density digital tape (HDDT). Recently, the stations started archiving their acquired satellite data as pseudo-random noise (PN)-decoded files on a SONY PetaSite® (a robotic storage device) instead of on HDDTs. Archived PN-decoded files are computer-readable files that are as close to the original data as possible. In the case of Landsat-7 data (Lockheed Martin Missiles & Space, 1998): “The use of the pseudo-randomiser is necessary to guarantee the bit transition density required to maintain bit synchronisation with the received signal. The method for ensuring sufficient transition is to exclusive-OR each bit of the VCDU (does not include the SYNC field) with a standard pseudo-random sequence. On the receiving end, the same sequence is exclusive-Ored with the received VCDU to remove the randomized pattern and restore the original data.”.

It was then required that GTS be modified to generate an output product from archived PN files. The capability to process such files is now in place for Landsat-7 catalogue and Framed Raw Expanded Data (FRED) products, and will be extended in the near future to include all acquired sensor data. The logical steps from request to output product are described in **Figure 2**.

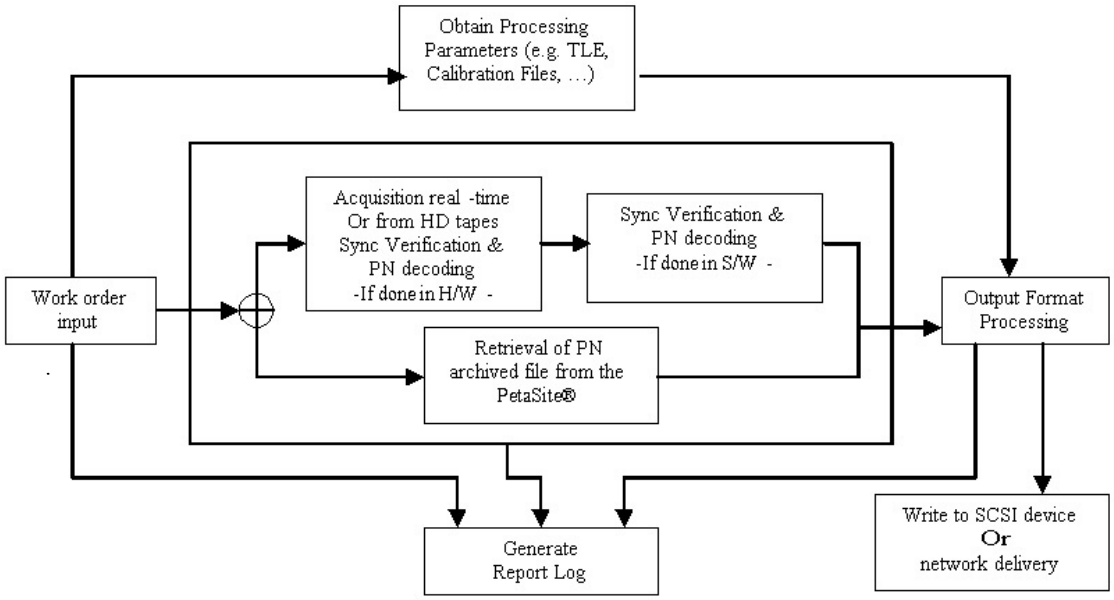

Figure 2 Block Diagram Showing Basic Data Processing Steps

The programmable hardware on the input boards is one of the big advantages of the GTS because it simplifies the addition of new sensors to the overall system. The implementation of sensors and formats is based on signed agreements with satellite operating agencies for the reception, archiving, and distribution of their data, and from distributor requests for certain formats as input to their processors.

When a requirement for SPOT capability was added to the existing ERS capability, the following updates were implemented:

- input boards were re-programmed to allow ERS and SPOT data ingest (with SYNC codes matching each sensor)[1];
- software was updated (in C++) to format SPOT raw data into standard output files;
- GUIs were modified to provide the appropriate selection of sensor/output format.

Over the years, the need to add new sensors to the system has increased. The flexibility of the programmable hardware and the object-oriented software allows new sensors or output formats to be developed as individual modules that can be plugged into the main GTS architecture. This design methodology has led to successful installation of numerous sensor capabilities including: ERS-1 and 2 CEOS Level-0; SPOT 1 to 4 CAP Level-0; Landsat-7 FRED; Landsat-7 catalogue and browse; Landsat-7 Level-0Rp HDF; SPOT 1-4 FRED and Landsat-TM 4 and 5 FRED. **Figure 3** summarizes the existing input sensors and various output products. The GTS will be upgraded to generate ENVISAT Level-0 ASAR products.

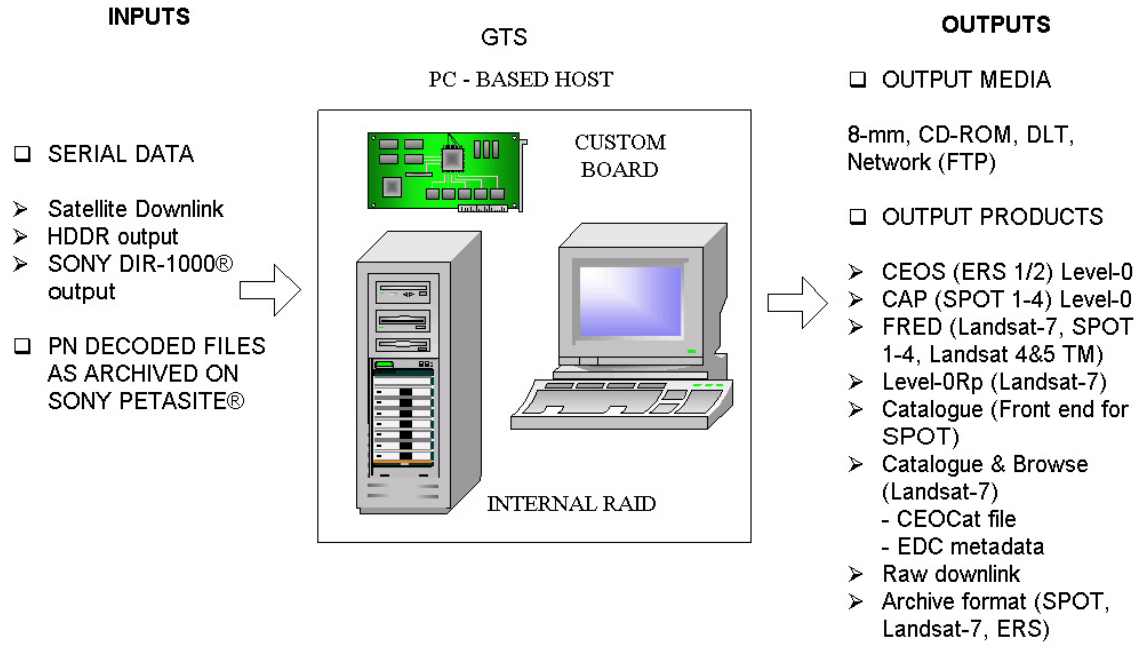

Figure 3 GTS System Inputs and Outputs

[1] Each sensor has its own dedicated binary pattern that is repeated regularly in the data stream. The hardware locks onto this synchronization pattern to store data.

Operational Context

Other standalone components exist to provide complementary information about products generated by the GTS system. For example, the Cloud Cover Assessment software for the Landsat-7 catalogue enables an operator to display and enter cloud cover values for every browse image corresponding to a given satellite pass. To ensure data quality before shipping to distributors, the Generic Transcription System Quality Control (GTSQC) module was developed. The GTSQC module displays extracted information from auxiliary data fields and allows visual inspection of SPOT FRED and Landsat-7 Level-0Rp product imagery.

The GTS has become one of the main systems at both GSS and PASS to acquire, catalogue, process, validate and store a full pass of satellite data. The GTS is only mandated to produce basic, close-to-raw output products and it is up to the remote sensing companies or agencies to process the data into value-added products to meet the needs of their clients. Many distributors and/or agencies benefit from products generated by GTS including:

- The Ground Systems Operations Section and Canadian Reception Stations where various satellite data are catalogued, archived, processed and validated. GTS produces PN-decoded files of Landsat, ERS and SPOT data, that are archived on the SONY Petasite® for easy retrieval and further processing through the GTS;
- The European Space Agency, which deals with ERS-1 and 2 CEOS Level-0 data products generated by the GTS;
- SPOT Image of France and its American subsidiary SICORP, for whom the GTS produces SPOT CAP Level-0, and front-end files for the cataloguing of SPOT;
- RADARSAT International, which orders Landsat-7 FRED, SPOT FRED and Landsat 4 and 5 FRED products from the stations;
- The CCRS Earth Observation Catalogue (CEOCat) which receives Landsat-7 catalogue and browse files;
- The EROS Data Center, which exchanges US format Metadata files (catalogue) for Landsat-7, Level-0Rp intended for data exchange products between international partners in the Landsat-7 program;

- PCI Geomatics, which uses Landsat-7 Level-0Rp data to make higher level products.

Table 1 provides a summary of GTS products at both GSS and PASS in 2000-2001. Production is driven by requests from distributors and clients, except for the cataloguing of Landsat-7, which is executed daily.

As a result of improvements to PC technology during the last five years, the GTS development team is presently looking at the next generation of GTS. The data acquisition procedure is one area that may need improvement. In the original design, the use of the RAW partition on the RAID storage system was used to acquire real-time data. Only the RAW partition was fast enough to allow the acquisition of high-speed satellite data; the NTFS partition throughput was too slow. A second step was requested to copy the data from the RAW partition to the NTFS partition before any output formatting was performed. With newer technology, the real-time downlink data could be written directly to the NTFS partition, thus reducing processing time by one-third.

Product Type	GTS products
ERS-1 CEOS Level-0	62
ERS-2 CEOS Level-0	290
SPOT 1-4 CAP Level-0	71
SPOT 1-4 FRED	9
Landsat-7 FRED on DLT	863
Landsat-7 FRED via FTP	415
GTS products delivered to distributors	1710
Landsat-7 catalogued scenes	26797 (1254 orbits)

Table 1 GSS/PASS GTS Product Generation for fiscal year 2000-2001[2]

[2] Statistics taken from the Station Report of the Ground Systems Operations Section, Data Acquisition Division, and from CEOCat project office, GeoAccess Division, CCRS.

Conclusions

As the Ground Systems Operations Section at GSS and PASS modify their reception schemes by including the reception of new or additional sensors, upgrading archiving storage technology, and/or signing new distribution contracts or international programme agreements, the GTS will be upgraded to meet these new demands. The flexibility of the programmable design will demonstrate its usefulness by providing a low-cost, reliable data reception and transcription system. Development work continues in parallel to ensure a long life to the system by providing timely hardware and software upgrades, as well as integrating new technology to make the system more efficient and easy to maintain. As the GTS offers a broad range of functionality, continued effort will be made to automate data processing, thus minimizing operator involvement and overhead cost.

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List of Acronyms

ASAR	Advanced Synthetic Aperture Radar
CAP	Centre d'Archivage et de Prétraitement
CCRS	Canada Centre for Remote Sensing
CD-ROM	Compact Disk Read Only Memory
CEOCat	CCRS Earth Observation Catalogue
CEOS	Committee for Earth Observation Satellites
DAD	Data Acquisition Division
DLT	Digital Linear Tape
EDC	EROS Data Center
EROS	Earth Resources Observation Satellite
ERS	Earth Resources Satellite (ESA)
ESA	European Space Agency
FRED	Framed Raw Expanded Data
FTP	File Transfer Protocol
GBytes	GigaBytes
GSS	Gatineau Satellite Station
GTS	Generic Transcription System
GTSQC	Generic Transcription System Quality Control
GUI	Graphical User Interface
HDDT	High Density Digital Tape
H/W	Hardware
Mbps	Megabits per second
NT	Microsoft Windows Operating System
NTFS	Microsoft Windows NT File System
PASS	Prince Albert Satellite Station
PC	Personal Computer
PN	Pseudo-random Noise
RAID	Redundant Array of Independent Disks
SAS	Satellite Acquisition Services
SCSI	Small Computer System Interface
SICORP	SPOT Image Corporation
SPOT	Satellite Pour Observation de la Terre
S/W	Software
SYNC	Synchronization
TM	Thematic Mapper
US	United States
VCDU	Virtual Channel Data Unit