File-based Processing and Migration System

Operational Concept

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FPMS Operational Concept

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List of Tables and Figures

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1.0 Introduction

1.1 Identification of Document

This is the Operational Concept document for the File-based Processing and Migration System (FPMS) – *ASF-2002-ENG-OPS-001*

1.2 Scope of Document

This document will provide the operational concepts and description for the File-based Processing and Migration System at the Alaska Synthetic Aperture Radar (SAR) Facility (ASF). The concept for this system will include the migration of ASF's present tape library to the *StorageTek* silo, as well as fulfillment of Level Zero/Level One orders from the resultant archive.

1.3 Purpose and Objectives of Document

The purpose of this document is to explain the concept of the intended software/hardware system that will perform the migration of ASF tape library and permit processing from it (the tape library). This document will serve as the basis for a requirements document that will formally define the functional and performance specifications of the FPMS.

1.4 Document Status and Schedule

Version 1.0 of this document was released on 27 February 2002. This is version 1.7.

1.5 Documentation Organization

1. Introduction

This section identifies the physical document itself in terms of its purpose and scope. It goes on to provide its present status, schedule, and physical organization.

2. Related Documentation

The purpose of this section is to provide the references or bibliography for this document.

3. Definition of System/Software

This section describes the purpose to be served by the software that is the subject of this Concept and the scope of its applicability. It explains the primary use(s) of the software within the context of the users' environments along with its the goals and objectives. The Definition provides a top-level description of the software and its major external interfaces to provide a background to aid the reader in understanding what the software will accomplish. It will list or reference the policies and standards governing the use and applicability of this software.

4. User Definition

Lists and describes the expected users of the software, the way in which the users will be using the software, and the functional capabilities the users will require to perform their activities. Explicitly defines the users and their needs; uses terms and details that will make it possible to correlate system capabilities and characteristics to specific user needs.

5. Capabilities and Characteristics

This section describes the major operational capabilities to be provided by the software. It identifies which users' needs are supported by each capability.

6. Sample Operational Scenarios

This section describes typical operational scenarios for the software. The scenarios depict at a high level how users (including other systems) interact with the capabilities provided by the software being defined.

7. Future Considerations

The “Future Considerations” section explains the impact the FPMS will have on the ASF Distributed Active Archive Center’s (DAAC) future evolution, providing the context this concept will have in future endeavors and operations at ASF.

8. Acronyms

The “Acronyms” section contains an alphabetized list of the acronyms used in this document.

9. Glossary

The glossary contains an alphabetized list of definitions for special terms used in the document, i.e., terms used in a sense that differs from or is more specific than the common usage for such terms.

10. Notes

This section presents information that aids in understanding the information provided in previous sections, and which is not contractually binding.

11. Appendices

The appendices contain material that is too bulky, detailed, or sensitive to be placed in the main body of text. Refer to each appendix in the main body of the text where the information applies. Appendices may be bound separately, but are considered to be part of the document and shall be placed under configuration control as such.

2.0 Related Documentation

2.1 Parent Documents

None

2.2 Applicable Documents

None

2.3 Information Documents

1. Level Zero Archive Manager (L0AM) Subsystem, Software Requirements Document (SRD), Alaska SAR Facility Development Project, Version 1.2, June 23, 1999.

2. Level Zero Archive Manager (L0AM) and Information Management Subsystem (IMS)/Data Archive and Distribution Subsystem (DADS) System Interface Specification (SIS), Alaska SAR Facility Development Project, JPL - D-14324, Version 1.32, June 23, 1999.

3. Level Zero Archive Manager (L0AM) And Information Management Subsystem (IMS) / Data Archive And Distribution Subsystem (DADS) System Interface Specification (SIS), Alaska SAR Facility Development Project, JPL D-14324, Version 1.2, May 4, 1999.

4. Level Zero Archive Manager (L0AM) Software Specification Document (SSD), Alaska SAR Facility Development (AFSD), Version 1.0, April 18, 2001.

5. StorageTek T9940 Tape Drive Specifications, MT 3034E, January 2002.

3.0 Definition of Software/System

The File-based Processing and Migration System (FPMS) is conceived as a system of *existing* ASF hardware and software that will copy data from High Density Digital Recorder (HDDR) media to 9940 *StorageTek* media in the *StoragTek* silo. It is proposed as a solution to ASF's current problem of having valuable SAR data resident on aging HDDR media. The FPMS will make the "endangered" data safe in the short term and allow it to be accessed by current processing resources – effectively minimizing the need for HDDRs within the ASF SAR Processing System (SPS).

The migration system will interface with components of the existing data system: the Information Management System (IMS), Raw Data Scanner (RDS), and Level Zero Processors (LZP). Its concept does not make any assumptions about future architecture, with the exception that ASF will store its signal data in the *StorageTek* silo. Furthermore, it does not commit ASF to the procurement or development of any new hardware or software to sustain present operations.

For the FPMS concept to be considered, the following assumptions must be made:

- ASF will continue tape based production with *Raytheon* and *Vexcel* processing systems for at least a year and a half after the commencement of migration
- ASF can make relatively minor modifications to the present PDM and SPS systems
- Two *DCRSi* tape drives will be available to the FPMS for at minimum 6 months
- Two *SONY ID-1* tape drives will available to the FPMS for at minimum 12 months
- Two *Vexcel* capture systems will be available and reliable for a minimum of one and a half years
- Two dedicated Raw Data Scanner (RDS) processing resources with the capacity to scan 30 hours (combined) of satellite telemetry (105 Mbps) per 24 hour day will be available
- Three terabytes of RAID at a minimum for temporary storage will be at the disposal of the FPMS
- ASF working signal data will be stored in the *StorageTek* silo
- A dedicated Full-Time Employee (5 days per week at 8 hours per day) will be available to administer the silo for: FPMS integration, system testing, and performance optimization
- A dedicated Full-Time Employee (5 days per week at 8 hours per day) will be available to approve successful scans and investigate failed scans
- ASF Operations and Infrastructure staff will sustain a 60% operational duty cycle of the Tape Migration and Processing System

3.1 Scope

The FPMS encompasses the functionality to:

- Migrate data presently on *SONY* ID1 and *DCRSi* data tapes to "capture" files in the *StorageTek* silo (no L0 processing)
- Perform data quality checks on captured data files
- Allow L0 products to be produced from migrated data
- Allow L1 products to be produced from migrated data
- Permit Production Planners to approve or disapprove all scans of migrated datatakes

The scope of the FPMS does not extend to the migration of data from *DCRSi* tapes to *SONY ID-1* tapes. This concept precludes the need for such a migration. The FPMS will be required to migrate the taped signal data from whatever media it resides on presently. Furthermore, FPMS does not extend to L0 processing and subsequent migration to L0 data. Data presently on *DCRSi* and *SONY ID-1* in the ASF archive will simply be migrated to 9940 media in the *StorageTek* silo.

For clarity, the FPMS *will not* include the following: generation or archival of any browse products, creation of a catalog for ASF products, and/or automation of the Level Zero production queue. Although the FPMS will not be responsible for the aforementioned functionality, it will not preclude those efforts; in actuality the FPMS will be complemented by those activities (see section 7.0).

3.2 Objectives

The objectives of the FPMS, in priority order, are to:

1. Stabilize data on aging media – particularly signal data resident on approximately 3000 *DCRSi* cassettes
2. Ensure migrated data is of suitable quality to fulfill customer orders
3. Provide greater automation in ASF production with respect to manual tape processes
4. Permit L1 production from migrated data with minor modifications to present processing resources
5. Permit L0 production from migrated data with minor modifications to present processing resources
6. Facilitate the longer term objective of instituting a Level Zero data archive by storing the data as digital data files that can be accessed as if the *StorageTek* silo were a standard *UNIX* file system

3.3 General Description

The FPMS will execute the migration of entire signal data tapes from *DCRSi* and *SONY ID-1* media (presently housed in the ASF Operation Center control room at the Alaska SAR Facility) to "capture files" in *the StorageTek* silo (also present in the ASF Operations Center control room). The system will initiate and monitor each migration event wherein an archive signal tape is read into an LZP (capture board), validated, and written to 9940 tape media within the silo. Moreover, it will allow the present Production

Data Management (PDM) and SAR Processing System (SPS) to use the migrated data for the fulfillment of L0 and L1 data orders placed at the ASF Data Acquisition and Archive Center (DAAC). As can be seen in Figure 1, the FPMS will interface with a number of pre-existing ASF systems: the L0C, the LZP Capture System, and the IMS in order to migrate data. It will need additional interfaces to the silo and a "cache" in order to permit production with the migrated data (see Figure 2). Users of the FPMS will include Operators, Production Planners, and a Quality Control (QC) investigator.

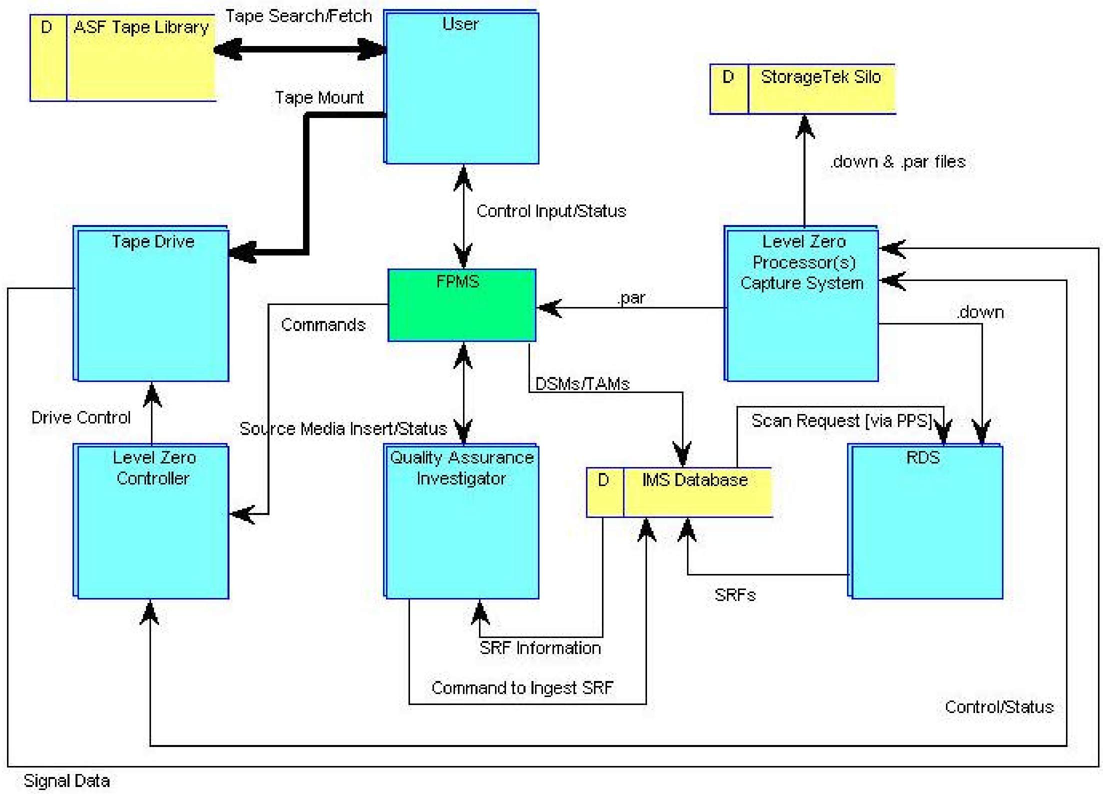

Figure 1: FPMS Migration Context Diagram

ASF operators will use the FPMS to queue the tape library for migration. Nominally, the oldest tapes – *DCRSi* – will be migrated first. The official tape queue will be generated by the Science Center. It is important to note that the ASF *archive signal* tapes will be captured to the silo – *not* the *working signal* tapes presently used for production[1]. The FPMS will use the functionality of the L0C to control tape drives and the *Vexcel* LZP capture system. A single full tape will be captured and migrated into the silo at a time[2]. The capture process takes the signal data from a High Density Digital Tape (HDDT) and produces a digital data file; this is called a "*.down*" file in the *Vexcel* system. The

[1] In some cases it may be necessary to capture a downlink from the working signal copy of a tape. The archive signal may have an exceedingly high BER or a downlink may only exist on working signal media.
[2] The capture may actually be implemented on *two or more* capture strings that function in parallel.

capture of the data will produce a Bit Error Rate (BER) map, which operations personnel can review to check the quality of the captured data. Data falling below some predefined BER threshold will be held offline, without migrating it to the silo, and be held for investigation by Quality Control personnel. The *Vexcel* LZP capture process will also produce a preliminary *.par* file[3] that the FPMS will store along with the BER map.

After data has been captured and verified, it is written to a 9940 tape in the silo. Next, the FPMS will be responsible for generating Data Sequence Messages (DSM) and Tape Availability Messages (TAM). These messages are sent to the ASF Information Management System and their content can be found in the Appendix. A DSM is generated for each downlink that is migrated and allows the IMS to ascertain its storage location. The TAM will trigger a "data scan" for each datatake in a particular *.down* file by informing the IMS that a new *.down* file is "available". The underlying concept demonstrated by the FPMS-IMS interface is that IMS will "believe" that captured files within the archive are simply "new" working signal tapes whose downlinks need to be scanned[4]. The RDS will be controlled by the Control Processor as it is now, but will receive its data from a new source – the *StorageTek* silo via the FPMS cache. The results of *all* migration scans will be kept. They will be held so that quantitative assessment may be performed *before* replacing catalog entries in the IMS database[5].

The FPMS will be responsible for allowing users to access the Scan Results Files that come out of migration, as well as additional datatake information that will aid in the evaluation of the data scanned. Users of the FPMS, specifically a QC Investigator, will use the FPMS to approve/disapprove all scans. If a scan is deemed "acceptable" the FPMS will permit the QC Investigator to populate the IMS catalog with it.

Replacement of the old archive signal tapes with newly migrated capture files, along with the ability to generate the necessary files for the IMS, are only two of the five objectives of the FPMS. The FPMS will also permit the present PDM system and SPS to use the silo as a source from which to fulfill data orders as illustrated in Figure 2. With capture files in the silo the RDS only needs a mechanism with which to retrieve the capture files for processing. Therefore, the FPMS will include a "fetching function" to provide the present system a means to get data from the silo for processing – for either L0 or L1 orders.

[3] This *.par* file *does not contain* the same information as the *.par* file resultant from *SyncPrep* L0 processing (see Appendix).
[4] The RDS will only scan for datatakes the IMS has in the "Downlink to Datatake" map
[5] Note that this differs from nominal operations. At present, Scan QC presents the results of a scan to the operator for his/her approval. Upon acceptance, the results replace the frames presently in the catalog.

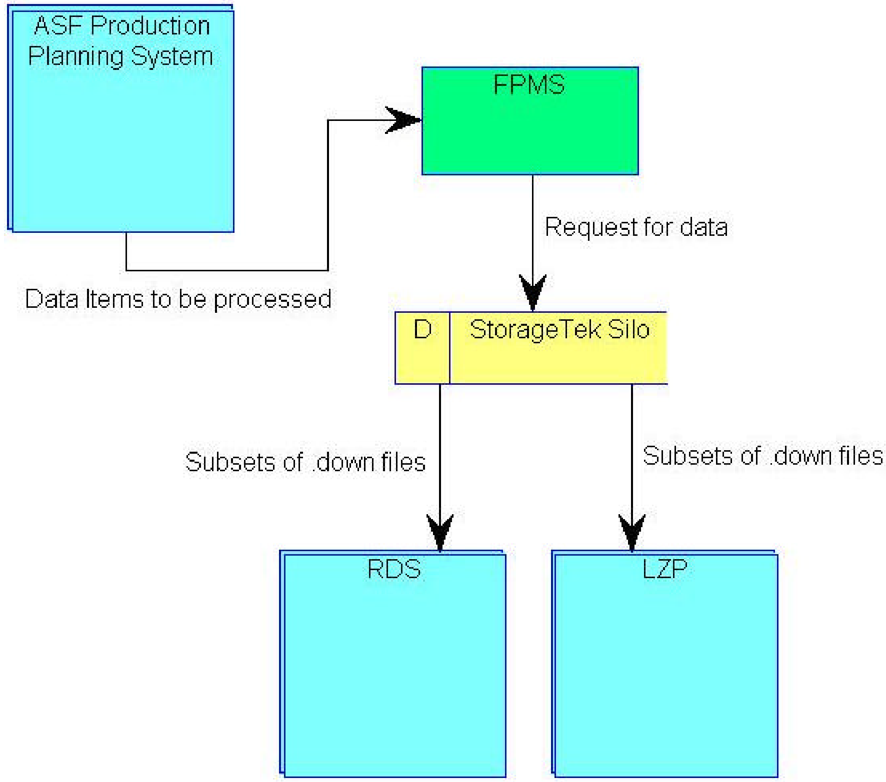

Figure 2: FPMS Processing Context Diagram

3.4 Policies

The FPMS will be supplied a tape queue or tape queue policy by the ASF Science Center. The User Services Office will be responsible for assessing the ASF tape library, documenting the tape segments to migrated by the FPMS, and establishing the priority with which they get migrated.

4.0 User Definition

4.1 Operators

The ASF Control Room Operators will be the primary users of the FPMS, and as a result, the system throughput will greatly depend on their ability to use the system. They will employ the FPMS to manage the migration queue, request the migration of each tape, and initiate the capture process. They will also perform nominal data quality assurance tasks by reviewing the BER output from the capture and scanning processes.

Operators will work with a FPMS "electronic queue manager" which will store and allow for the manipulation of the various states of migration for each tape. The queue will be automated to the maximum extent possible, leaving tape mounts/dismounts as the bulk of the manual work.

Once a tape is mounted and its capture initiated, the operator need only monitor the results from a capture attempt. Upon encountering an indication of high BER, the operator will need to document the problem and perform contingency procedures. These plans may call for tape cleaning or drive maintenance. If troubleshooting succeeds, the tape should migrate as normal. For repeated failures an operator may need to mark the tape for "investigation" in the electronic queue manager. The tape will then be on "hold" until Quality Control personnel can make a final disposition on the problem.

Successful captures will result in the FPMS notifying the operator that the tape can be dismounted. An Operator will also interact with the FPMS when a capture file gets scanned. The Tape Scan Request will eventually show up at the PPS. An Operator will need to request a "Scan Job" and pull it over to the CP. Once a RDS resource is free and the scan is initiated, the data will be retrieved automatically from the cache; the Operator will not need to mount a tape. Scanning proceeds normally until the CP displays the Scan QC results. At this point, scans of migrated data will deviate from the nominal case. Instead of performing Scan QC, the Scan Results, regardless of quality will be kept in the IMS database, without hiding the present entries. These scan results will wait for review and selection by the Production Planner.

In the absence of anomalies an operator's job should be limited to; tape mounting and dismounting, migration initiation, and tape drive maintenance. The nominal concept calls for the capture of 30 hours of signal day – which subsequently translates to 30 entire tape (medium *SONY ID-1*) scans at the RDS. Operators will be required to mount, dismount, and initiate 30 capture processes each day for the duration of the migration.

4.2 Production Planners

The FPMS will permit L0 products to be produced from capture files stored in the silo. Production Planners will still need to generate a "L0 queue" (as is done presently) which will contain information for input to the Level Zero Controller – namely the platform, revolution, media ID, and byte address location of the data on the media. The only difference between this information and that gathered now is that the Scan Results File (SRF) will have the *byte* location of the data to be processed instead of tape address units. This is an artifact of how the data is stored on the 9940 media in the *StorageTek* silo. As this information is gathered through L0 tools, it will be transparent to the Production Planner. The impact of the FPMS on the Production Planning Level Zero workflow is negligible.

The FPMS will be responsible for actively tracking all scans that come from migration. The Production Planner will use the FPMS to view SRF information in order to approve scans, disapprove scans, and investigate the causes of failed scans. The FPMS will allow the Production Planner to select the “best” scan of a given datatake such that that datatake will become orderable.

Note: The Production Planner will not interact with the FPMS for L1 processing.

4.3 Quality Control Investigator

The Quality Control Investigator will need to troubleshoot tapes, or portions of a tape, that fail to capture. Tapes, or portions of a tape, that get marked by the operations staff will be held and dealt with by the QC Investigator. The resolution may call for retrying the capture with the *working signal* tape in which case the location of a particular downlink will have to be sought out. In either case the QC Investigator will need to interact with the FPMS to update the state of a tape in the electronic queue, find downlinks on working signal media, and restart captures.

5.0 Capabilities and Characteristics

The FPMS project has two main goals. The first goal is to migrate the data on the aging tapes in ASF's archive to new medium in the *StorageTek* Silo. The *StorageTek* silo allows a large volume of data, nearly 300 Terabytes, to be stored. Once the tape archive is migrated to the silo, the data becomes available "near line," with automated access to all the data archived in the silo.

The second goal of FPMS is to use the near line data in the *StorageTek* silo to replace use of tapes. This allows transparent file-based production in the existing ASF PDM and SPS system. This has the potential to greatly improve performance and reduce the operator's workload.

This section discusses the inner workings of the FPMS system, describing how the system is configured, how the pieces interact, and the tasks each piece performs.

5.1 Capabilities

FPMS provides five main capabilities. The system provides for the migration of data on HDDT to captured data in the silo. It accommodates the processing of L1 and L0 data by providing interfaces that allow the consumers of raw data to receive the data from the silo rather than the customary tape. Tracking and control of the migration is provided, allowing the users to follow the progress of data as it flows through the system. Finally, the system also includes the ability to control the staging of the captured data from the silo to cache to improve system performance.

5.1.1 Migration of Data Into Silo

The central feature of FPMS is the migration of the archive from HDDT to media in the *StorageTek* silo. FPMS provides a method by which data is taken from the HDDT and stored in an identical format in the silo. The data is read from the HDDT, captured on the LZP, then stored to the silo, and catalog information is updated.

The migration is driven by a queue. This queue contains all the tapes that will be migrated. Each tape in the queue has a number of states with each state reflecting the stage the tape is in. A Production Planner or a Database Administrator loads the queue before migration and additional tapes can be added at any point. Tapes start in the ready queue.

State	Description
Ready	Tape is ready for migration.
Capturing	The tape is currently being captured on the Migration Station.
Failed: BER	The tape was captured, but the bit error rate was too high.
Captured	The tape was captured and is waiting to be scanned.
Completed	The tape has been migrated successfully.
Failed	The tape has failed and will not be migrated.

Table 1: Tape Migration States

Tapes in the queue have several attributes. These attributes provide information about the job, including information such as the state of the tape in the queue, the number of times the tape has been captured, comments from the Production Planners, and comments from the operators. Tapes would stay in the "Failed: BER" state until the Quality Investigator inspects the failure and decides how to treat it.

Three things can be done to deal with a tape that fails due to a high bit error rate. If the tape fails just for a segment of the tape, the tape can be broken up into sections and each section added back into the queue. The area of high bit error rate data can then be recovered from a different tape. Another approach would be to override the systems bit error rate threshold and accept the noisy data. The data in the noisy area would then be migrated from a different tape. This should only be done when the noisy data cannot be retrieved from a different source. The final possibility would be to discard the tape. This should only be done if no data can be read from the tape. Data on any tape in ASF's HDDT archive can be migrated, including Working Signal, Archive Signal, and Quicklook tape series.

The steps taken for a tape failed at "Scan QC" depend on the reason it failed.
There are several reasons it could be fail. If no data was found or if noisy data is found, the data should be recovered by finding another copy of the data. If the data was not what "Scan QC" expected, then there is a problem with the catalog. The catalog should be updated with the information that "Scan QC" found. The queue interface will provide tools for the Quality Investigator to decide the cause of each failure.

Migration will be treated much like a tape "Dub" operation performed on the Dubstation, only the destination tape is actually a file stored on the silo. From the IMS's perspective, the file is just a tape, and is cataloged just like any other tape. As a tape is migrated, it is copied to a new Working Signal tape with the RECORDER_TYPE of "XXXXX" , RECORDER_MEDIA_TYPE of "XXXX", and the tape series of "XXX." During capture the addresses of the start and stop of each downlink are recorded. After the capture has finished, a Data Sequence Message (DSM) is sent to the IMS for each of the downlinks. The DSM contains the start and stop address in kilobytes of each downlink in the capture file. A Tape Availability Message (TAM) is also sent for the pseudo tape. As the tape is captured, the bit error rate is monitored. If the bit error rate exceeds XXX for more than XXX seconds, then the capture is aborted and marked as a failure. After the data has been captured the bit error rate profile obtained during capture is saved for later reference.

After data is captured, it is transferred to the cache. The cache is large repository that holds data while it is waiting for further processing or to be written to media. The cache is sized to hold captured data from an entire day of production and a significant volume of data for feeding L1 processing. A two Terabyte, four-part RAID system, implements the cache. The cache is not in anyway related to any buffering performed by the StorageTek silo. The cache serves two purposes: it allows data to be staged from the silo to a faster medium for L1 and L0 production, and it allows the RDS to use recently captured data without re-reading the data from the silo.

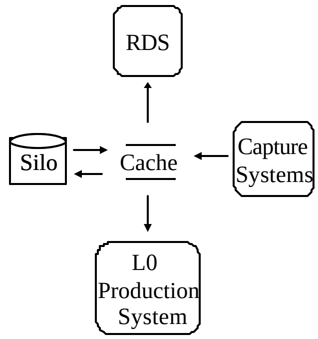

Figure 3: Cache Dataflow Diagram

The migration will nominally proceed from the oldest tapes first until all the tapes have been migrated.

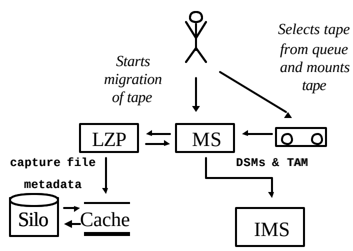

Figure 4: Dataflow Diagram for Capture

When the TAM arrives at the IMS, scan requests are generated for each of the downlinks on the pseudo tape. These scan requests make their way to the RDS. The RDS sees that the RECORDER_MEDIA_TYPE of the tape is “XXXX” and recognizes that the tape is a pseudo tape and pulls the data from the cache. Once the data has arrived at the RDS, the RDS scans the file and proceeds as it normally does for a traditional scan of a downlink recorded onto HDDT. This process includes Scan QC and the eventual submission of the SRF to the IMS. Once the SRF is archived in the IMS the frames inside it becomes orderable through the normal method. Once the captured data has been scanned and written to the silo it will be deleted from the cache.

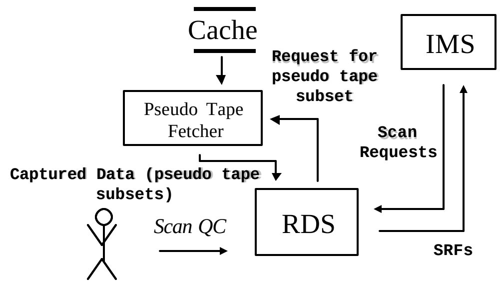

Figure 5: Dataflow Diagram for Scanning of Migrated Data

5.1.2 Processing of data on pseudo tapes into L1 images

An important feature of FPMS is the use of the pseudo tapes in the current L1 production on the SPS. The SPS and the PDM systems use the RDS to obtain data from the tape archive stored on Sony ID-1 and DCRSi tapes. The RDS provides two main functions; it examines tapes to determine what is on them, and it obtains data from the tapes (referred to as a decode operation). In FPMS, the RDS obtains information from data obtained from the silo in addition to HDDT, but the format and control mechanisms of the RDS remain the same. This allows FPMS to integrate seamlessly with the existing production system, the SPS.

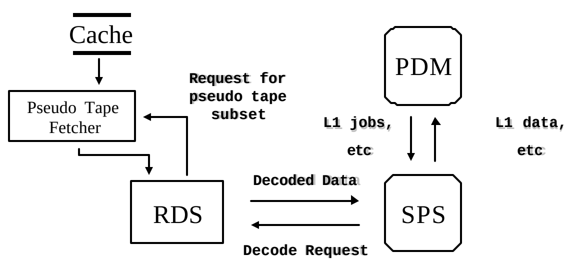

Figure 6: Dataflow Diagram of L1 Production

5.1.3 Processing of pseudo tapes into L0 data

L0 production of products is accommodated by FPMS. When given a request for L0 data that has been migrated, the system will pull the pseudo tape subset in which the data resides and generate a L0 product from it. This is a pretty straightforward process. The "Pseudo Tape Fetcher" extracts the area of interest from the pseudo tape stored in the silo, the L0C runs the Vexcel Sky processor on the data, then the resulting L0 dataset is optionally reformatted (to the RSAT CEOS format, for example), and finally written out to media.

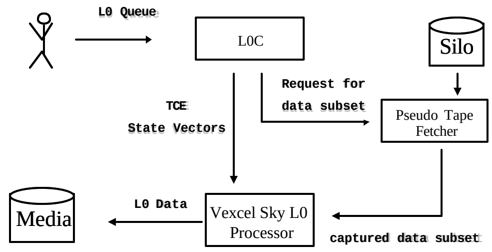

Figure 7: L0 Processing Dataflow Diagram

5.1.4 Staging of data to cache

An important part of getting the best performance from FPMS lies in the system's use of the silo. The *StorageTek* silo has fairly limited bandwidth and is slower than the Sony and DCRSi tape drives currently in use. To compensate for this, the system uses the cache to provide temporary storage for data that will be requested in the future. The Operators control the staging of the data to this cache, but this process should be completely transparent to the users of the system. Only if an error occurs will the Operators become involved in the staging of data to cache. FPMS obtains a list of the potential L1 jobs that are ready to be run from the Production Planning System, and stages the data necessary to complete these jobs to cache before the data is requested. When requests are made for data that has not been pre-staged to cache, the data will be retrieved from the silo, staged, and then made available. The Production Planners and Operations will have the ability to stage or remove data to and from the cache if for some unseen reason this becomes necessary. In the normal operational scenario, no intervention will be required.

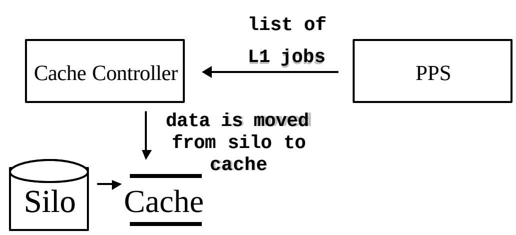

Figure 8: Cache Controller Dataflow Diagram

5.1.5 Tracking and Control of Migration

The migration of data is controlled and monitored by FPMS. Information is available to the users of the systems from FPMS about all the tapes in the migration queue. Tapes can be added to the system and the status of any tape in the system can be inspected. This allows the progress of tapes to be tracked at every step of migration.

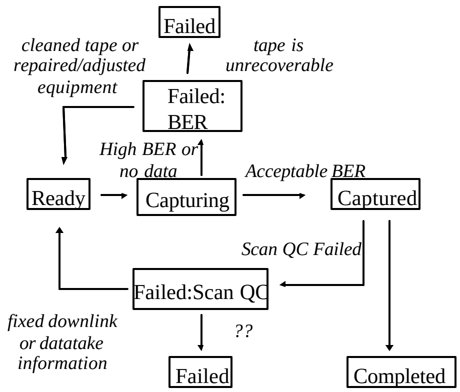

Figure 9: Migration Queue State Diagram

5.2 Hardware

5.2.1 Hardware Used by TMPS

A wide array of computer hardware is used by TMPS (see Table 2).

Device	**Number Required**	*Use of Hardware in TMPS*
AMPEX Classic HDDR	1	Used to read data from DCRSi HDDT.
AMPEX 107 HDDR	1	Used to read data from DCRSi HDDT.
DPS -II	1	Used to direct data from recorders to capture systems
Migration Control Computer	1	Used to run the L0C. Currently tanadak.
Cache	4	A large 500 Gigabyte or larger RAID system.
Sony ID-1 HDDR	2	Used to read data from ID-1 HDDT.
LZP	2	Used to capture data from HDDRs and transfer the data to cache.
DEC Server 700	1	Used to communicate with AMPEX HDDRs
RDS Systems	?	Used to scan and decode data
Fluke 6961	1	Used to generate a clock signal
Anritsu ME-520B	1	Used to generate a clock signal and for testing of capture systems
Silo Control Computer	1	Used to interface with the StorageTek Powderhorn silo and to host the cache.
StorageTek Powderhorn Silo	1	Used to store signal data

Table 2: FPMS Hardware Listing

5.2.2 Migration Station

FPMS utilizes the Migration Station, which consists of two DCRSi tape recorders; a clock source, switching equipment, the Migration Station workstation, and several Vexcel LZP capture systems. This equipment allows the Migration Station to play data from HDDR and capture the data on a LZP capture system. The switching equipment is controlled in a variety of ways. A Fluke 6061A RF Signal Generator generates a clock signal that is used to synchronize the data played from the HDDRs. An Anritsu 520B bit error analyzer converts the clock signal from the Fluke to ECL and provides a means to check the quality of the data paths through the system. The Fluke and the Anritsu are controlled via a GPIB interface. The DPSII is a large 16 by 16 crossbar switch that provides a way to route data from the recorders to the LZPs. The DPSII is controlled via a serial interface. Together these pieces allow the Migration Station to convert data stored on HDDT to data stored in the *StorageTek* tape silo.

The Migration Station controls its devices via serial and GPIB interfaces. The Migration Station uses a DEC Server 700 terminal server to control up to 16 serial devices. GPIB devices are controlled by a National Instruments GPIBnet transceiver. Both these devices are connected to the Migration Station by Ethernet connections.

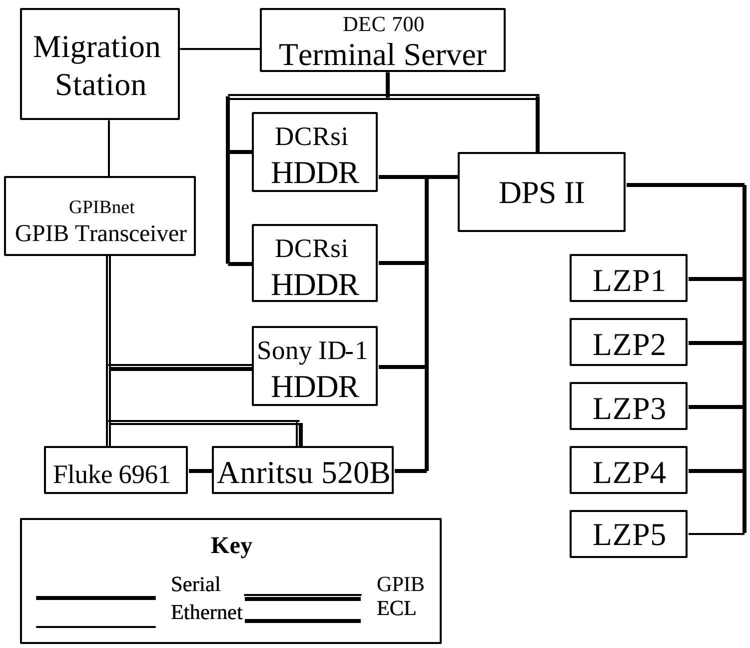

Figure 10: Migration Station Diagram

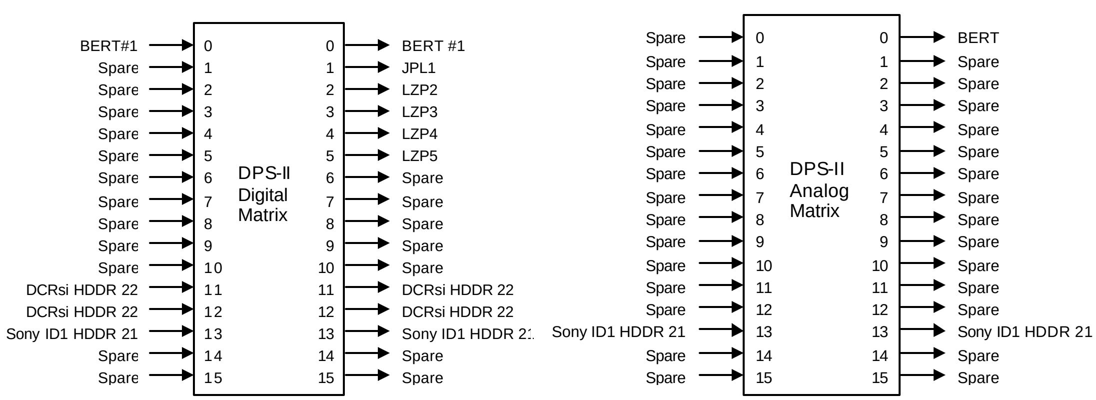

Figure 11: DPS II Configuration

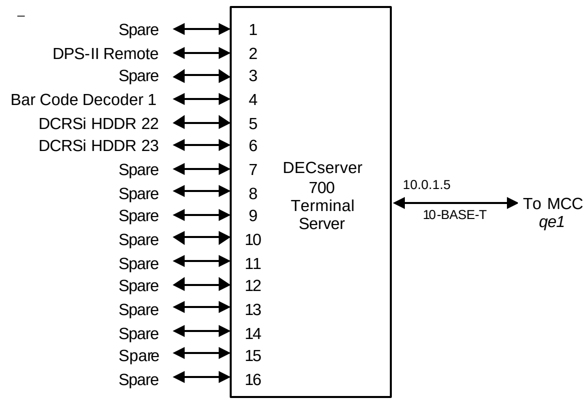

Figure 12: Terminal Server Configuration

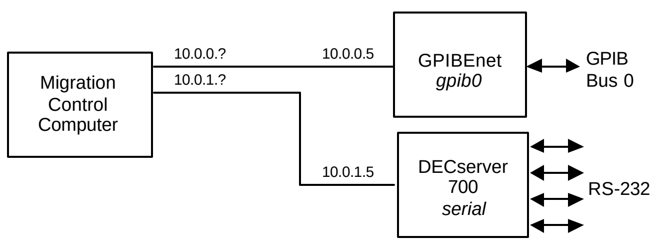

Figure 13: GPIB and Serial Connections

5.3 Network

FPMS will utilize several networks. For the transport of pseudo tapes a high performance gigabit class network is used, as these files can be quite large in size. Lower speed Ethernet networks are used to convey status and control messages throughout the system.

5.3.1 Network Communication in FPMS

System	Hostname	System	Hostname	Reason
Migration Station	Tanadak	IMS	??	Accessing and updating catalog information
Migration Station	Tanadak	LZPs	LZP1,2,3,4,5	Controlling capture and migration
LZP	LZP1,2,3,4	Silo Control Computer	seinfeld	Adding data to the silo
RDS	agate,bgate, ???	Silo Control Computer	seinfeld	Retrieving data from the silo
PP Staging Interface	XXX	Silo Control Computer	Seinfeld	Allows the Production Planner to control pre-fetching of data into cache.
Migration Control Interface	XXX	IMS	??	Accessing catalog information and tracking scans
Migration Control Interface	XXX	Silo Control Computer	Seinfeld	Accessing information about migration status

Figure 14: FPMS Network Information

5.3.2 FPMS Network Diagram

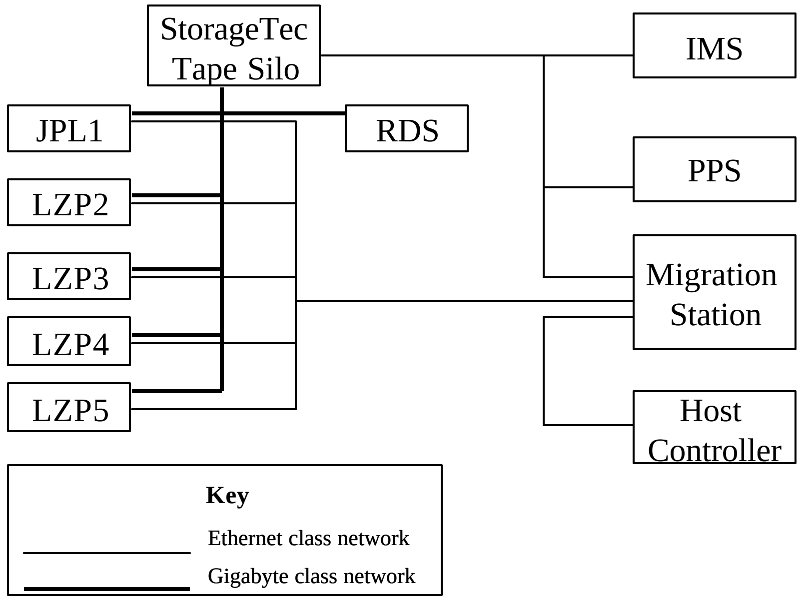

Figure 15: FPMS Network Diagram

5.4 Performance

5.4.1 Assumptions

- Gigabit class networks can sustain transfer rates of 20 Mbytes a second
    - ASF's current Gigabit Ethernet sustains greater than 40 Mbytes a second
- Operations can feed FPMS 30 tapes a day
- Operations can support scanning 30 tapes a day
- A single HDDT holds 41 Gigabytes of data
    - The vast number of tapes in the archive, DCRSi and Sony ID-1 Mediums, hold 41 Gigabytes or less.
- A HDDR can play data at 105 Mbits a second, or 12.5 Mbytes a second
- The cache has 2 Terabytes of useable space
- The cache consists of 4 RAID systems of 500 Gigabytes or larger
- Each RAID can sustain reads and writes of 60 Mbytes a second
    - The current LZP raids sustain rates higher than this.
- LZP workstations can capture and transfer data at the same time
- 6 StorageTek T9940 drives are available
- All StorageTek T9940 drives are each capable of 8 Mbytes per second sustained reads or writes simultaneously.

5.4.2 Migration Performance

FPMS has three pieces that limit the performance: capturing, processing by the RDS, and writing to media in the silo. In the analysis of the system, it is assumed that each step is independent. Restating the architecture, capturing places data into a large cache, while the RDS and the silo pull data out of the cache. The performance of the system is scaled such that the RDS and the silo can process at a rate greater than the data is coming through the capturing of tapes. The cache can hold an entire day (24 hour period) of data, so the analysis assumes that the cache will never fill up. This is a perfectly valid assumption, as data will be removed from the cache faster than it is filling up.

Note additionally, that performance of the FPMS is greatly dependent on human resource availability. Operator usage and QC efficiency can limit the overall performance of the FPMS.

5.4.2.1 Performance of cache

The cache consists of 4 RAID systems of 500 Gigabytes each. Each RAID system can support 60 Mbytes per second reads or writes, sustained. This results in a combined throughput of 240 Mbytes per second.
Using 6 T9940 drives, two LZP workstations, three RDS workstations, and one L0 production system:

= bandwidth consumed by T9940 drives
+ bandwidth consumed by LZP workstations
+ bandwidth consumed by RDS workstations
+ bandwidth consumed by L0 production
= 6 * 10 Mbytes/second + 2 * 20 Mbytes/second
+ 3 * 20 Mbytes/second +20 Mbytes/second
=180 Mbytes/second

This is less than the performance of the cache, so it is not a limiting factor.

5.4.2.2 Performance of capturing data from tape

FPMS is scaled for capturing from 2 HDDRs at 60% duty cycle. This works out to be about 30 tapes a day using a approximation of 60 minutes of data per tape. 30 tapes a day is 30 hours of data, or 1800 minutes of data captured during a 24-hour period.

The gigabyte class network connecting the LZP workstations will transfer data at least 20 Mbytes per second, so captured data can be sent to the cache while the following tape is being captured.

5.4.2.3 Performance of RDS

The assumption is that the RDS and SPS systems will have the capability to scan at least 30 tapes a day, including transfer of data from the cache.

To be updated with more detailed information pending discussion with Raytheon.

5.4.2.4 Performance of writing to media in the silo

The specifications of the 9940 drive published by StorageTek list a time to mount a new formatted tape, including time to rewind and un-mount the existing tape as 2 minutes, 4 seconds. This assumes that the unloaded tape needs to be completely rewound, and is a worst-case estimate.

The silo can write a single copy of a 41Gbyte file to media in around 90 minutes, which assumes a transfer rate of around 8 Mbytes/second and a tape change time of 3 minutes.

In a 24-hour period a single silo drive can write 16 copies to media. Using 4 drives the silo can write 64 copies. To support 30 tapes a day, the silo would only need to write about 60 tapes a day.

<u>*This ignores contention for the robotic tape mounting arm inside the silo. The arm is only used for 4 seconds for each tape mount and dismount, so this is a reasonable assumption and is used throughout the silo performance analysis.*</u>

5.4.3 L1 Production Performance

FPMS is designed to support the current L1 production. To do this properly, it needs to be capable of feeding the SPS fast enough to support the current level of production at a minimum.

<u>*These estimates are based on a 90 seconds of data per frame approximation. This is larger than either a standard beam frame or a ScanSAR frame.*</u>

5.4.3.1 Estimate of the time required to read a frame of data from the silo

Assuming it is possible to read pieces of data directly from tape:
The time required readying a silo tape for reading (assumes tape needed in never mounted):

= time to find correct tape + time to unload current tape
+ time to rewind current tape + time to load tape
+ time to seek to location on tape
= 2s + 18s + 45s + 18s + 41s
= 124 seconds
= 2 minutes, 4 seconds

A single frame consists of less than 90 seconds (17 seconds for a standard frame, 80 for a ScanSAR frame) of data so the amount of data required for a single frame is:

= size of a frame
= length of frame in time * data rate
= (90 seconds / frame) * 12.5 Mbytes/seconds
= 1125 Mbytes / frame

So a single frame of data requires about 1125 Mbytes of data.
Assuming that the Silo has a transfer rate of about 8 Mbytes/second, then the time required to read a frame from the silo is:

= size of a frame / read speed of the silo + time to change tapes
=(1125 Mbytes/frame) / (8Mbytes/second) + 180 seconds
= 320 seconds/frame
= 5 minute, 20 seconds a frame

In order for the performance of the silo to limit the throughput of the system, a frame must be generated by the processing element every minute. The current system can produce a L1 image every 5 minutes maximum, so this will keep the L1 system fed.

Using one drive, this system could stage 8100 frames to cache in a month. ASF's current L1 processing needs are less than that.
As an aside, 940 frames would occupy about 1 Tb, so it will be possible to stage a large number of frames to cache.

5.4.3.2 Estimate of the time required to deliver data from cache

Assuming a high speed gigabit class network capable of 20 Mbytes per second transfers, and assuming that the cache is capable of 20 Mbytes per second reads:
The time required to transfer data from cache is:

= size of a frame / read speed of the network
= (1125 Mbytes / frame)/ (20 Mbytes/second)
< 60 seconds/frame

So a frame could be provided to the RDS in less than 60 seconds. This is roughly twice as fast as it can be read from HDDR.

5.4.4 L0 Production Performance

Assuming that the average L0 job is for 5 minutes of data:
Assuming that the Silo has a transfer rate of about 8 Mbytes/second, then the time required to read 5 minutes of data from the silo is:

= (length of data * data rate) / read speed of the silo + time to change tapes
=(300 seconds * 12.5 Mbytes/seconds) / (8Mbytes/second) + 180 seconds
= 650 seconds a job
= 10 minutes, 48 seconds a job

This is roughly twice as long as it takes to read from a HDDR. Please note that L0 processing is greater than 3 times real-time, so this would keep a single LZP totally occupied continuously, not accounting for time spent writing data out to be distributed to users.

As an aside single silo drive could support 120 L0 jobs of this sort a day, 3600 jobs a month.

5.5 Reliability

FPMS is designed to maintain a 60% duty cycle on the capturing of data. The only regular maintenance the system requires is a periodic cleaning of the tape drives, which can easily be scheduled during the system's idle time. On a similar system, the Dubstation, the only failures that occur with any regularity involve the HDDRs. The effect of this on the system's reliability should be minimal due to the number of spare recorders available. Some of the components of the system, such as the *StorageTek* silo, have not been used extensively so the reliability is unknown. The mean time between failures for the 9940 drives is greater than 20 years at 70% duty cycle, according to the specifications published by StorageTek, with a head life of 8.5 years. This implies that the 9940 drives are very reliable.

5.6 Risk criticality

FPMS is composed of a number of pieces. Some of these pieces, like the Migration Station, have a proven track record for stability and reliability. Other pieces like the *StorageTek* silo have not been used extensively at ASF, so the risks involved are not well understood. All the migrated data is stored on the silo and only on the silo, so it is a critical item. Other items of high risk include the gigabit class networks and the RAIDs used for cache. To mitigate these risks, ASF needs to examine each of these and determine what can be done to maximize their performance and minimize the chance of failure.

5.7 Flexibility and expansion

FPMS is designed to provide maximum flexibility and room for expansion. Minimal coupling between the system's parts allows subsystems to be replaced without major changes to other pieces of the system.

5.8 Quality Control

FPMS provides a means to track the quality of the data as it is migrated. Information about the quality of any of the pseudo tapes that have been captured or scanned is readily available to the users of the system. The quality of the data is monitored and controlled using two methods. During capture, the bit error rate is monitored to verify that good data is captured. The bit error rate is saved and archived for later use or viewing by the users of the system. Once the data has been migrated successfully, the pseudo tape will be scanned at the RDS. FPMS will keep track of outstanding scan requests for each pseudo tape. Once all the downlinks on the pseudo tape have been scanned, FPMS will update the pseudo tape's status and the SRFs will become available to the users to view for quality control purposes.

5.9 Security

FPMS conforms to all applicable NASA security guidelines and policies.

5.10 L0 Migration

FPMS facilitates migration by taking the data from HDDT and transcribing it to a medium that can be more easily read by a computer. This allows migration from pseudo tapes to L0 to be largely automated. Pseudo tapes could be processed to L0 by using an automated process, which could process all the data, without operator intervention of any sort, except cases where errors occur. This has the potential to result in a terrific savings in the terms of time and operator effort. FPMS does not accomplish L0 migration, but rather sets the stage for it, allowing L0 migration to occur in a much cleaner fashion.

5.11 Phased implementation

FPMS is logically broken up into two phases. The first phase includes migration to the silo and production using the migrated data. In the first phase, FPMS would have the ability to do production with migrated data. This would allow FPMS to meet the current production needs without the use of the older tapes. In the second phase L0 production from the silo would be added, allowing automated file-based L0 on demand production.

6.0 Operational Scenarios

6.1 Migration of a single tape

Migration will start with a electronic queue of *archive signal* tapes. The priority of this queue is to be determined, but will nominally be ordered with the oldest tapes first. The process will begin with a single tape being chosen for migration from the top of the queue. The operator will mount the tape – either *SONY ID-1* or *DCRSi* – to the respective tape drive and use the L0C to play the tape into the LZP capture system (see Figure 16). While the capture is occurring, a BER map will be generated and outputted for the operator to view. The operator can make a decision about the success or failure of the capture based on this information. If the capture is deemed successful, the resultant *.down* file will be moved to the silo via the cache. Otherwise, the operator will attempt to remedy the problem. The tape drive may be cleaned and another attempt made. If after some number of attempts, the tape or portions of the tape still fail to capture, the tape, or portion of the tape will be marked for investigation.

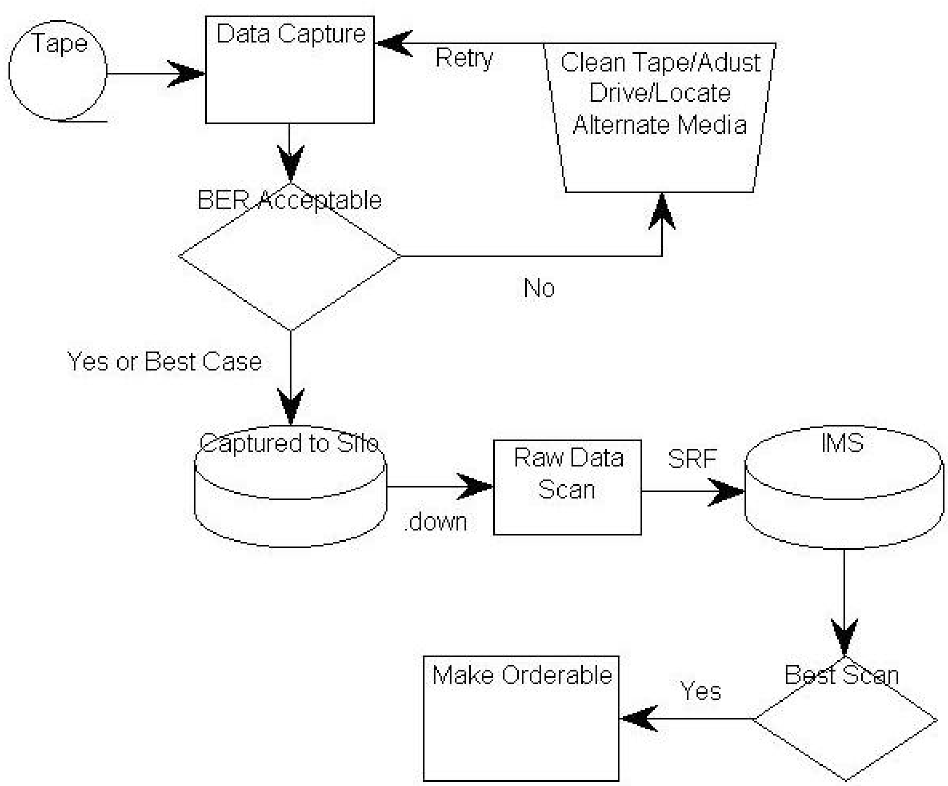

Figure 16: Migration Flow Chart

Quality Control personnel will handle all failed captures and attempt to recover the data from *working signal* media. QC will modify the electronic queue to insert an "alternate media" and retry the capture. A tape that cannot be completely captured will be decomposed into tape segments; the portions that had an acceptable BER are recaptured and proceed through the nominal migration process. Downlinks on a tape that are identified to have a high BER, will be re-inserted into the queue with an alternate source media. The QC investigator will need to find this media and modify the queue.

Once the capture is successful, the *.down* file will be moved to the FPMS cache where it will be written to the silo and also await an RDS scan. Upon the creation of the *.down* file the FPMS will automatically generate messages informing the IMS that a new "pseudo tape" has been created and needs to be scanned. A Tape Scan Request (TSR), for each downlink, will be issued by the IMS and cause a scan job to be created at the PPS – which can then be immediately processed by the RDS. No manual intervention would be needed to this point because scans that come as a result of migration could be readily "auto-validated"; the scan requests would pass through to the PPS "Planned" queue. Furthermore, dedicated RDS resources in Operations would limit the impact on Operations of 450 TSRs a day.

When the Raw Data Scanner is free and the operator permits the scanning to commence, the RDS will retrieve a portion of the capture file, corresponding to a downlink, from the FPMS cache and scan it. The repetition of this step can be avoided by loading the CP queue with migration scan requests. After a scan has completed, regardless of the result, its SRF will populate the IMS catalog[6]. The FPMS will have a user interface that will permit someone to individually approve scans, thus permitting full control over what data comprises the orderable catalog. This interface will nominally consist of the information necessary to judge the success of a scan and the tools to populate the IMS catalog with orderable frames. Approval of a scan will trigger the CP-IMS function that makes the new frames orderable.

It is emphasized that only datatakes present in the current IMS catalog will become orderable as a result of the scan. Data that is found during the scan but not part of the scan request will not become orderable. Dealing with this catalog inconsistency is not within the scope of this effort.

6.2 L0 product generation (from migrated data)

Level Zero orders will enter the system through the web-based Level Zero request form as they do now. Unless additional modifications are made to the system, Production Planning personnel will need to generate a "Level Zero Queue" with the platform, data byte range, and revolution of the datatake to be processed. The "byte range" values will be the only difference from the information gathered now. The byte range will be obtained as tape addresses are now – from the Scan Results File.

Once the Level Zero Queue information is given to the Operator it will be entered into the L0C. Instead of spooling the tape drive for the correct location of the data on tape, the L0C will acquire the data from the FPMS cache. The "Pseudo Tape Fetcher" will be

[6] This does not mean it will be orderable, only that the SRFs will be stored in the system.

employed to stage data to the cache location accessible by the LZP. Once obtained by the LZP, the subset of data can be processed, and delivered to the customer.

6.3 L1 product generation (from migrated data)

The ordering and production planning of L1 orders will not change as a result of the implementation of the FPMS. Once an item is "planned" the operator will "pull" it over to the processing queue at the Control Processor. When a RDS becomes available, it will look for a file of data in the cache instead of spooling a tape as it does now. The item's source data will have been automatically "fetched" by the same mechanism discussed in section 5.2. Since the item to be processed has been in planning for some period of time, knowledge of its impending arrival could be used to stage it beforehand.

Once the RDS is able to decode the data file, production proceeds normally. The transcription and distribution steps in L1 production stay the same.

6.4 L0 product generation (from HDDR media)

The production of L0 products from data not already migrated will not change as a result of the FPMS.

6.5 L1 product generation (from HDDR media)

The production of L1 products from data not already migrated will not change as a result of the FPMS.

7.0 Future Considerations

1. FPMS is the first step towards incorporating "Direct Capture" at the ASF Receiving Ground Station (RGS). The FPMS permits production without tapes - even though the ASF RGS may still create tapes for redundancy purposes when Direct Capture is implemented. Direct Capture technology will complement the FPMS because it creates *.down* files directly from downlinks received at the RGS, without a tape intermediary.

2. Implementation of the FPMS and completion of the intended migration will result in all of ASF's signal data being accessible as if it were on a disk – a situation that can be taken advantage of by the effort to create a value added archive. The processing of signal data to L0 format and catalog synthesis could then be performed in an automated fashion. No tape mounting will be necessary, since these activities were all performed during the migration to the silo. Furthermore, data quality issues would presumably be kept to a minimum because all data in the silo would have been "screened" by the capture and data scanning processes.

8.0 Acronyms

ASF	Alaska SAR Facility
BER	Bit Error Rate
CEOS	Committee for Earth Observing Satellites
CP	Control Processor
DAAC	Distributive Active Archive Center
DCRSi	Digital Cassette Recording System - Improved
DSM	Data Sequence Message
FPMS	File-based Processing and Migration System
HDDR	High Density Digital Recorder
HDDT	High Density Digital Tape
IMS	Information Management System
L0	Level Zero
L0C	Level Zero Controller
L1	Level One
LZP	Level Zero Processor
MS	Migration Station
PDM	Production Data Management
PP	Precision Processor
PPS	Production Planning System
QC	Quality Control
RDS	Raw Data Scanner
RGS	Receiving Ground Station
RSAT	Radarsat
SAR	Synthetic Aperture Radar
SPS	SAR Processing System
SRF	Scan Results File
SSP	ScanSAR Processor
TAM	Tape Availability Message
TB	Terabyte
TSR	Tape Scan Request

9.0 Glossary

Archive Signal	A tape (either SONY ID-1 or DCRSi) that serves as the "backup" copy of data downlinked at ASF. These tapes are stored offsite at the Butrovich building.
.down file	A file that contains the data captured from HDDT.
.par file	"Parameter File", created by the LZP capture system after each capture, which contains some metadata about the data capture and the capture process.
9940	A media type for the *StorageTek* Powderhorn silo. This type holds 60 GB of data.
Auto-validate	The ability of the IMS and Production Planning Systems to automatically progress a job in the system such that it can be processed without Production Planner approval.
BER map	A file or graphical display that indicates the Bit Error Rate of a captured file as a function of byte address within the file.
Capture files	The files created from by the LZP by playing data into the LZP capture board.
Data Scan	A process where the ASF RDS ascertains the "frames" of data present for a datatake. The RDS is commanded to search for a datatake by its platform and revolution.
Data Sequence Message	A message sent from the ASF Host Controller or Dubstation that informs the IMS about the data taken from a particular downlink – specifically the datatakes from a downlink and their tape address range.
Direct Capture	The process of "capturing" signal data directly to disk without necessarily writing it to tape first.
Downlink to Datatake map	Database table whose schema maps a downlink to its associated datatake(s).
Dubstation	System at ASF used to dub working signals from data imported from foreign ground stations.
ECL	A form of high-speed serial communication.
Electronic Queue Manager	A yet to be created electronic list of a tapes that, at a minimum, holds the identity and state of each tape being migrated. As implemented it should permit the tracking of tapes with the ability to sort and modify the list.
Fetching function	A yet to be created function (software) that will permit ASF processing resources – the RDS and LZP – to get data from the *StorageTek* silo.

Level One	In general, Level One refers to signal data processed to a viewable image. For the purposes of this document it refers to products from the ASF Precision Processor.
Level Zero	Level Zero refers to data processed to the extent that it is forward ordered in time.
Level Zero Queue	The Level Zero Queue is a spreadsheet generated by Production Planning staff that serves as input to the LZPs for Level Zero production.
Nearline	Available within a short amount of time, but not instantly. Tape and disk libraries are considered nearline devices, because it takes several seconds to retrieve the appropriate cartridge before it can be read.
Planned item	A planned item is a discrete processing job that has been released from production planning such that operations is free to pull the item over to the Control Processor and process it.
Production Element	A system in that generates L1 images. Mainly the SSP and the PP.
Pseudo Tapes	Tapes within the *StorageTek* silo on which the capture files will be stored.
Scan Results File	A metadata file that reports the results of a Data Scan on the RDS. It lists al the frames of data found in any one specified datatake.
stage	To place in a location apart from the original. For the purposes of this document data will be staged on a RAID – apart from the silo – such that resources can access it more quickly that if they tried to get it directly from the silo.
Tape Availability Message	A message sent from the ASF Host Controller or Dubstation that informs the IMS about a new tape of data that is available to be scanned.
Tape Scan Request	A request by the IMS to have a media with “new” data scanned by the RDS.
Working Signal	A tape (either SONY ID-1 or DCRSi) that serves as the copy from which data products are produced. These tapes are stored in the ASF Operations Control Room.
Cache or FPMS Cache	The cache is large multi-terabyte repository that holds data while it is waiting for further processing or to be written to media.

10.0 Notes

10.1 Time Calculations

The following is meant to provide a rough order of magnitude of the time to complete a capture of all the archive signal data.

Given:

- 5500 *SONY ID-1* tapes
- 3000 *DCRSi* tapes
- 60 minutes of data per tape
- 105 Mbps data rate

Problem: How long will capture take?

(5500 + 3000) X 60 min/tape / 60min per hour / 24 hours per day = 354 days

at 60% duty cycle…

354 days / .6 = **590 days** (with a single capture string)

How much resultant data will there be?

(5500 + 3000) X 60 min/tape X 60 seconds/minute X 105E6 Mbps / 8 bits/byte / 1024 / 1024 = **383 TB**

11.0 Appendices

11.1 Vexcel LZP **.par** *File (from capture only)*

```
dcs_version: 3.03gamma
dcs_id: 3
dcs_file_creation_date: 20020202005121376
dcs_requested_start: 20020202005056983
dcs_valid_data_offset: 0
dcs_satellite: RSAT1
dcs_requested_stop: 20020202005121373
dcs_start: 20020202005057012
dcs_stop: 20020202005121376
dcs_stop_condition: stop_request
dcs_bit_error_rate: 0.000000E+00
dcs_bytes_captured: 310378496

datatake {
   satellite: UNKNOWN
   instrument: UNKNOWN
   tce_UTC: 19500101000000000
   tce_satellite: 0.000000
   tce_corr: 0.000000
   estimated_acq_start: 20200101000000000
   estimated_acq_time: 0.000000
   OrbitNr: 0
   clock_angle: 0.000000
   ellipsoid_name: UNKNOWN

   GHA {
      angle: 0.000000
      date: 19500101000000000
   }
}
js_version : 2.16.6
js_date : 20020202005054293
```

11.2 Data Sequence Message

OBJECT = DATA_SEQUENCE_MESSAGE &
common_header &
catalog_metadata &
detailed_metadata &
END_OBJECT = DATA_SEQUENCE_MESSAGE &
END

OBJECT = CATALOG_METADATA &
SYSTEM_ACTIVITY_ID &
SYSTEM_ACTIVITY_TYPE &
STATUS &
PLATFORM &
SENSOR &
REVOLUTION &
SEQUENCE &
MEDIA_ID_ALIAS &
MEDIA_ID &
MEDIA_ID_TYPE_NAME &
MEDIA_DOG_TAG &
GENERATION &
RECORDER_ID &
RECORDER_TYPE &
RECORDER_MEDIA_TYPE &
DATA_DIRECTION &
START _ADDRESS &
STOP_ADDRESS &
START_TIME &
END_TIME &
CHANNELIZATION &
BIT_RATE &
END_OBJECT = CATALOG_METADATA

OBJECT = DETAILED_METADATA &
COMMENT &
SWITCH_SETTING_ANALOG &
SWITCH_SETTING_DIGITAL &
END_OBJECT = DETAILED_METADATA

11.3 Tape Availability Message

OBJECT = TAPE_AVAILABILITY_MESSAGE &
common_header &
catalog_metadata &
detailed_metadata &
END_OBJECT = TAPE_AVAILABILITY_MESSAGE &
END

OBJECT = CATALOG_METADATA &
HC_ACTIVITY_ID &
SYSTEM_ACTIVITY_ID &
HC_ACTIVITY_TYPE &
SYSTEM_ACTIVITY_TYPE &
STATUS &
MEDIA_ID_ALIAS &
MEDIA_ID &
MEDIA_ID_TYPE_NAME &
MEDIA_DOG_TAG &
RECORDER_MEDIA_TYPE &
END_OBJECT = CATALOG_METADATA

OBJECT = DETAILED_METADATA &
null &
END_OBJECT = DETAILED_METADATA