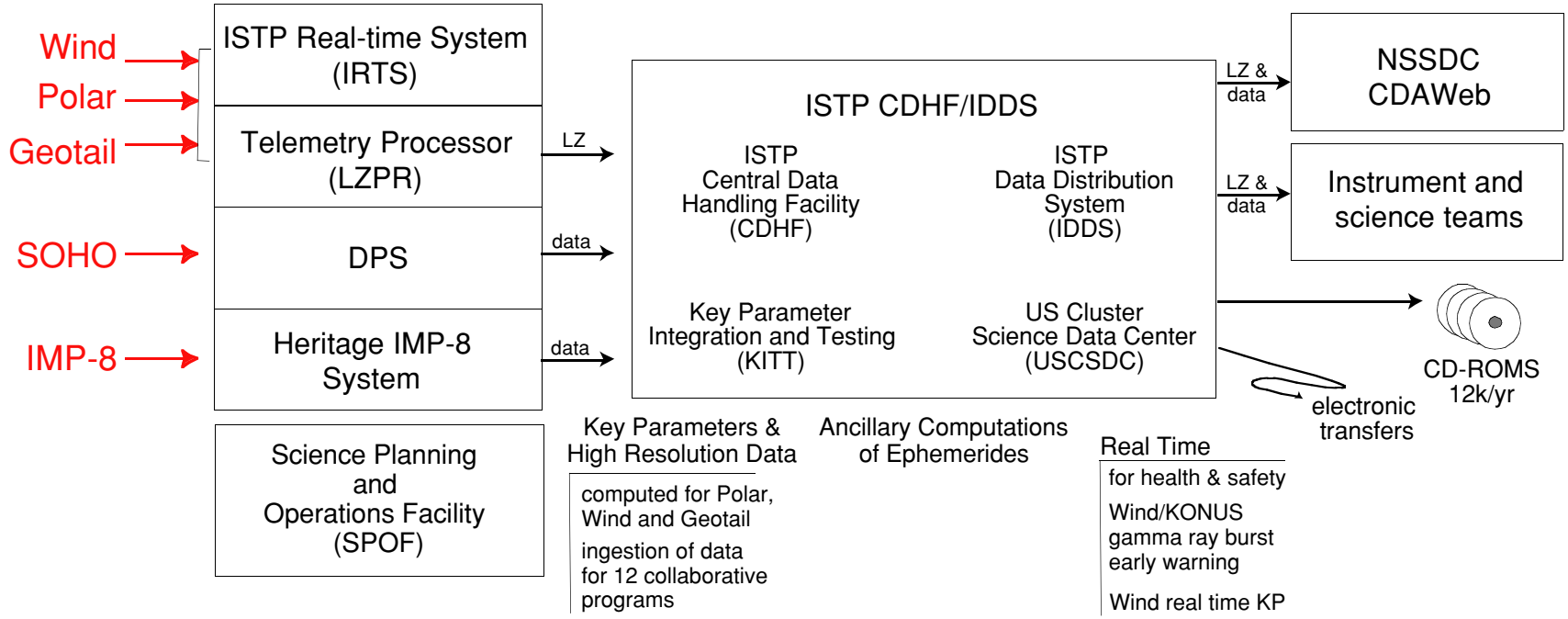
Re-engineering of flight operations and data systems for Polar, Wind and Geotail

Outline:

- Review of ISTP/CDHF
- HQ directive for FY02-FY05
- Implications of that directive
- Re-engineering the Polar, Wind and Geotail operations
- Issues and concerns

Review of the ISTP Data System

(an independent entity of ISTP to serve the worldwide SEC community)



In addition to

- data processing and distribution services for GGS (Polar, Wind, Geotail) & IMP-8,
- data distribution services for SOHO and Cluster,
- and operations and science coordination,

ISTP served as a one-stop data source by

- consolidating and distributing data for 15 additional spacecraft, observatories and T&M programs
- and by providing extensive data and media integrity and quality services.

Directive from HQ for FY02-FY05

The Senior Review 2001 evaluated separately the five elements of ISTP/GGS and recommended a substantial restructuring.

- The end of ISTP as a program.
- Continuation of Polar science activities as the apogee progresses through the equatorial regions.
- Reduction of NASA support in science participation in Geotail.
- Placement of Wind at L1 as a "hot spare" for monitoring the solar wind and limited support to science teams for special campaigns.
- Termination of the ISTP Theory and Ground Based Investigations program.
- **Termination of the ISTP/CDHF as an independently funded facility.**

Directive from HQ for FY02-FY05

HQ recommended that the continuing missions,

- Accept higher risk levels than during the prime mission phase
  - minimize operations and data processing costs in order to maximize the use of funds for instrument calibration, data analysis and science interpretation.
- Accept a lower data capture rate from 99+%
  - a 95% data capture that lessens demands on the operations and data processing staffs is acceptable.

In addition, HQ reorganized the funding authority such that each spacecraft project scientist has budget responsibility for implementing the complete science, operations, data processing and data distribution program elements.

Implications of HQ Directives

- SOHO and Cluster have effectively pulled out of the CDHF.
- The ISTP flight operations and data system costs considerably exceeded funding to be provided for FY02 and beyond for PWG.
- HQ provided funding for re-engineering the PWG flight operations and data systems to the Polar project.
- SEC projects were encouraged to investigate new approaches to "find the best deal".

Polar, Wind and Geotail MO

FY01 Actual, not inc. SOMO	FY02 cost estimate, after initial reductions	FY02 budget allocation	FY03 budget allocation	FY04 budget allocation	FY05 budget allocation
$5.28M	$3.94M+	$4.12	$2.8M	$2.3	$2.3

Immediate Courses of Action

- The ISTP project office was disbanded and reduction of past ISTP activities occurred during October and November of 2001.
- ISTP ground system services immediately reduced were:
  - QuickLook data processing for special requests only,
  - key parameter CD distribution reduced from ~12,300 to 156 per year,
  - no key parameter re-processing,
  - no key parameter software updates,
  - no ground based or collaborative mission data processing or ingestion,
  - no dedicated program assistance center,
  - no system software updates excepting security patches,
  - no test or development environment, and
  - no off-hours data processing or problem response
  - services of the ISTP SPOF and Command Management System consolidated with the MOC and the project scientist's office.

Immediate Courses of Action

- Contacted instrument teams regarding their requirements for various operations and data services.
- Produced prioritized requirements document for Polar, Wind and Geotail.
- Conducted five feasibility studies for alternative approaches
  1) the present ground system management under CSOC
  2) SPDF at GSFC under the direction of Bob McGuire
  3) LASP at U Colorado under the direction of Bill Peterson
  4) UC Berkeley under the direction of Bob Lin
  5) the NSSTC under the direction of Dennis Gallagher

The University of Maryland and Johns Hopkins University Applied Physics Lab declined to conduct a study.

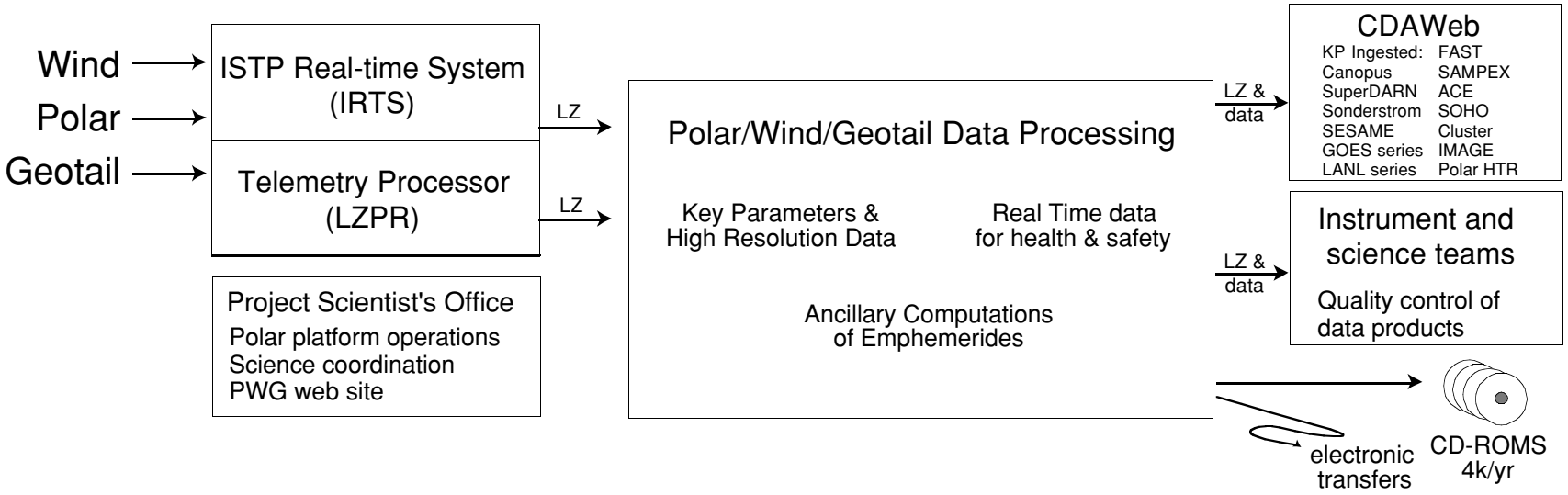
Results of Feasibility Studies

The following conclusions and actions resulted from the review of the studies:

- More software and system re-engineering needs to be pursued than provided for by the CSOC/CDHF study and CSOC estimates for flight operations.
- Seven re-engineering projects were identified that can, potentially, reduce the number of FTEs by three-quarters.
- The re-engineering work should be performed under local control.
- The UC Berkeley capabilities for hosting mission operations remain of interest.

It has been determined that a consolidation of all systems under the PWG Mission Operations Center (MOC), as suggested by the SPDF study, offers the most cost effective solution with the least disruption and the least risk to spacecraft health and safety.

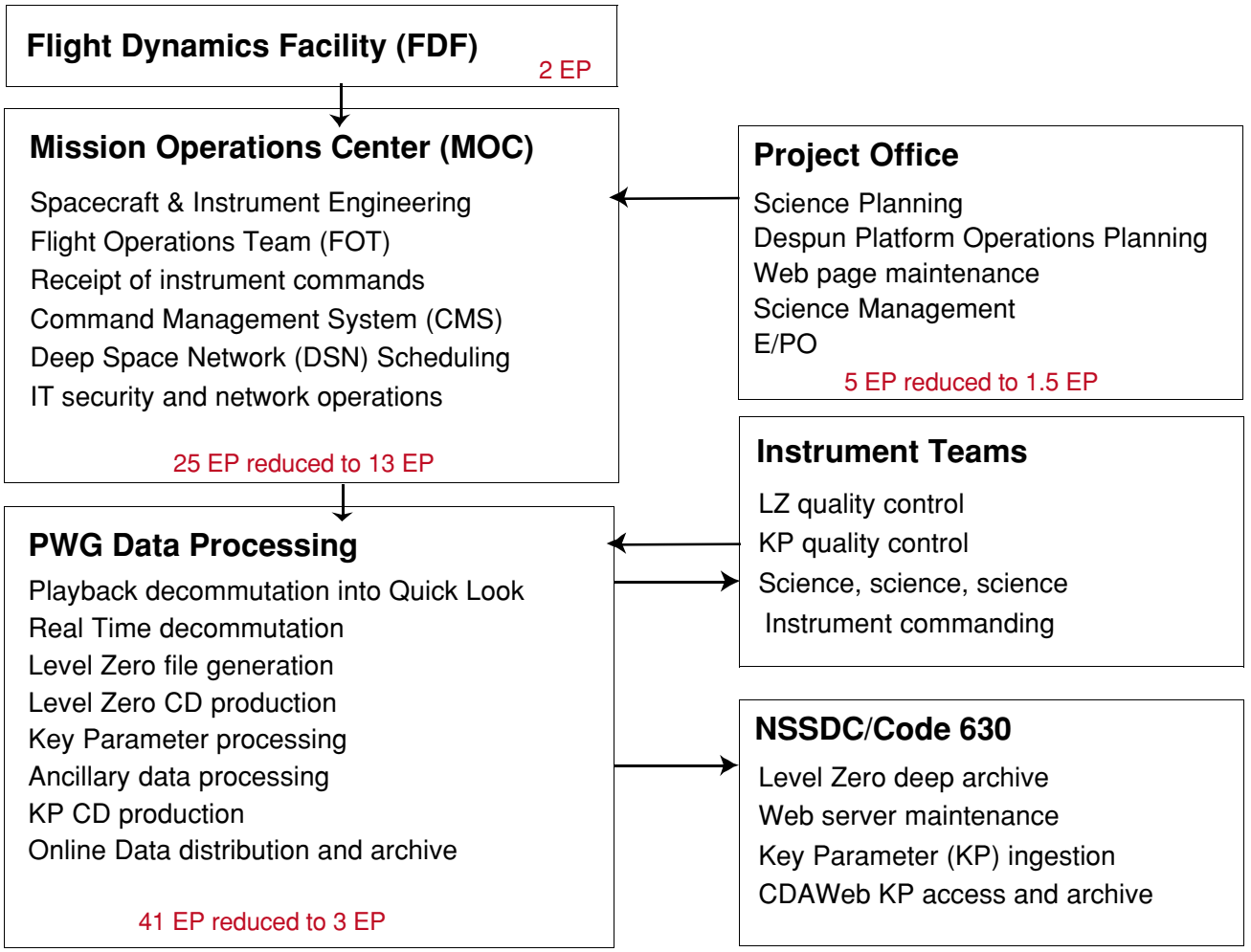
New Data System Overview



The following Polar, Wind and Geotail services provided by ISTP are to be retained:

- Near Real Time (NRT) data, open line access
- Quicklook (spacecraft playback) data, online access
- Level Zero data processing, online and CD distribution
- Geotail Sirius data processing, online access
- Key Parameter data processing, online and limited CD distribution
- Ancillary data processing, online access

Plan for Re-engineering



Plan for Re-engineering

A mission operations and data processing re-engineering team has been formed:

- Polar, Wind and Geotail project scientists, sys admin & programmer (code 690)
- Space Physics Data Facility computer scientists (code 630)
- Information Systems Center computer scientists (codes 586 and 587)

	Re-engineering task	**Responsible person**
1.	unattended spacecraft contacts for data playbacks	Steve Odendahl, Polar Mission Director
2.	cross-training of flight operations personnel	Steve Odendahl, Polar Mission Director
3.	re-hosting the CMS for security and obsolescence issues	Rick Burley, Code 630
4.	automation of KP processing	Jim Byrnes, Code 587
5.	simplifying online distribution of LZ and ancillary data	Bobby Candey, Code 630
6.	automation of CD production	Bobby Candey, Code 630
7.	streamlining LZ processing to include NRT and QL	TBD

Unattended Spacecraft Contacts for Data Playbacks

Current	After
7-9 console operators, covering 24x7, typically 4 shifts of two operators, Wind: 1 contact/day, Polar: 4 contacts/day, All attended contacts	4 console operators, covering 16x5, Wind: 3 contacts/week, Polar: 3-4 contacts/day, TBD number of unattended contacts

Notes for instrument teams:

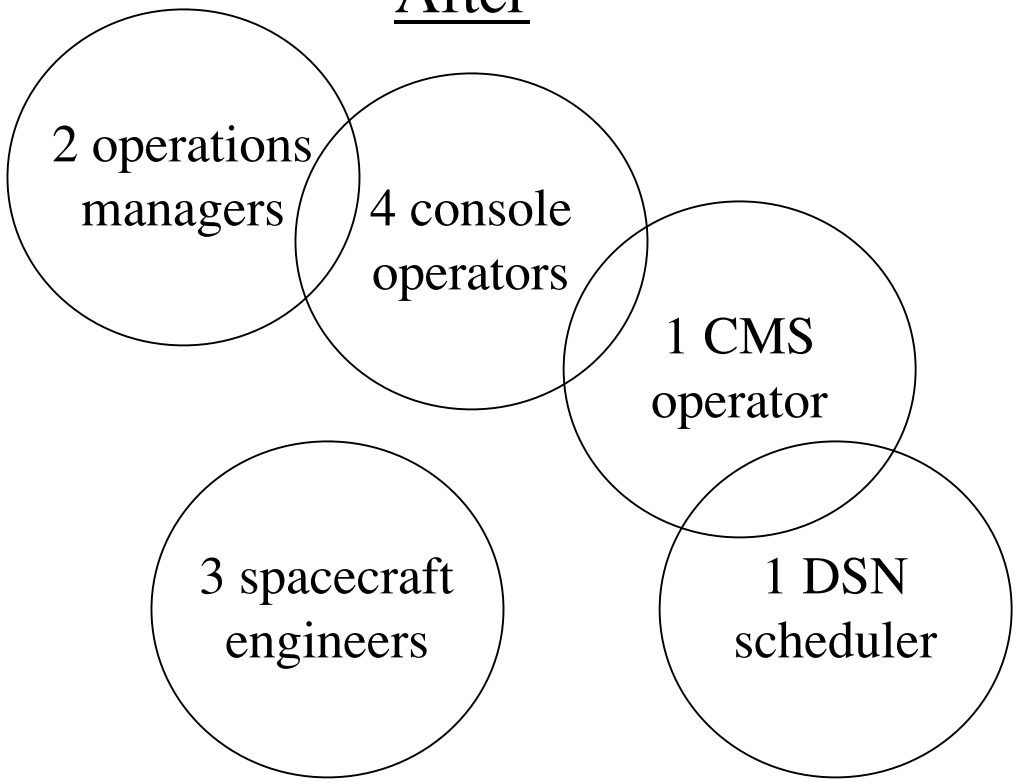
- Fewer attended contacts/fewer "double" attended contacts may mean less convenient or delayed command scheduling.
- There may be a request to the instrument teams to scrub their list of monitored parameters.

Cross-training of FOT Personnel

Current

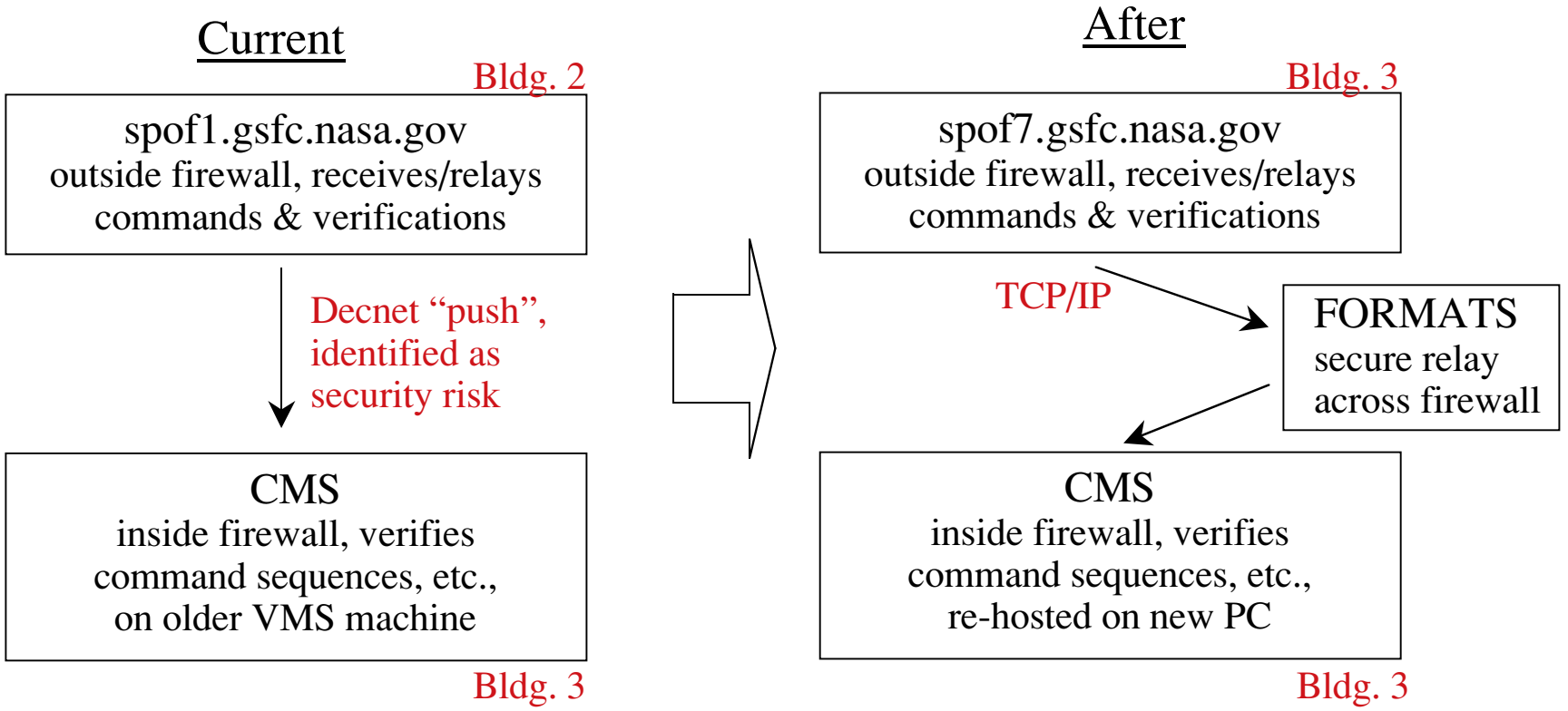
- 2 operations managers
- 7 console operators
- 3 CMS operators
- 1 DSN scheduler
- 3 spacecraft engineers

After



Notes for instrument teams:
- Cross training of FOT personnel should bring better service for day-to-day operations.

Re-hosting the CMS for Security and Obsolescence Issues



Notes for instrument teams:

- Core CMS remains the same, no changes planned for command input from instrument teams.
- Re-hosting should be transparent; possible requests to participate in parallel testing/ops period.

Automation of KP Processing

Current	After
TAE GUI interfaces on VAX to shift of operators	Automated file processing
Custom software & Oracle on Dec Alpha control processing	Consolidation to single machine with ready access to data
Frozen software library	Software library converted to collection of individual processes
Extensive quality checking	Limited quality checking

Notes for instrument teams:

- Software port process should generally be transparent to instrument teams.
- Instrument teams which retain KP software programming expertise may be asked to provide consultation services to GSFC team.
- Verification of file format and content by instrument teams will be required after porting.
- Routine quality checking of KP file production will reside with instrument teams.
- Possible data loss.

Automation of KP Processing (more details)

Current

CDHF

individually developed and installed KP & aux. data production routines	All production routines use a standard library of routines for data access	Custom software on Dec Alpha & VMS machines control automated KP production and data cataloging.

Oracle database controls file access. TAE GUI interfaces to operators for file access, production process control and quality checking

Advantages: it's working.
Disadvantages: All software and OS are frozen. Changes to any part, even security, requires knowledgable programmer. All programmers seem to be afraid of the software. Database driven, requires DBA on staff. TAE interfaces to operators reside on older VAX machines, are obsolete and expensive to maintain. Requires shift of operators.

After

Polar-Wind-Geotail KP and auxillary data production

Script monitors LZ & AD ingestion. File name and lookup table indicates processing routine. Routine and lookup table indicates associated data files. Script runs processing routine and shuttles output proper directory on PWG RAID. Notice of successful completion emailed weekly to instruments and project.	New Alpha workstation access files directly from PWG RAID?

Each data processing routine maintained as separate program. Only data access library routines rewritten to ignore database and use input file names provided by the production script. All other services, checks, cataloguing, etc in current process not retained.

- NSSDC auto downloads KP files to CDAWeb from PWG RAID or temporary directory on KP Alpha machine.
- Project may later support automated multi-instrument KP plotting routine to aid world-wide science efforts and KP validation.
- Reprocessing only requires altering the text file that contains the list of LZ (or ancillary files) that need to be processed.

Advantages: Only operator intervention needed is to monitor that software is continuing to run and occassionally to alter the input file to reprocess data. No DBA needed. New processing routines can be added. Control is by simple standard scripting that many programmers can work with if alterations are needed. Recurring maintenace costs should be less than with current equipment.
Disadvantages: Substantial upfront programming effort is required. Programmers are afraid to tackle this.

Simplifying Online Data Distribution

Current

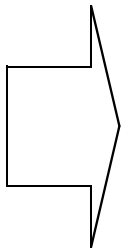
AMASS

Most Recent Data: magnetic disk ~.3TB

More Data: Magneto Optical Disks in jukebox ~2TB

More Data: Magneto Optical Disks in cabinet

workstation on open network - controlled access



After

Polar-Wind-Geotail on-line data access

SCSI RAID w/ enough magnetic disk space for 3 months uncompressed LZ and ancillary data plus older PWG LZ and ancillary data in compressed format
~2.5TB

Directory structure to mirror that of ISTP LZ CDroms

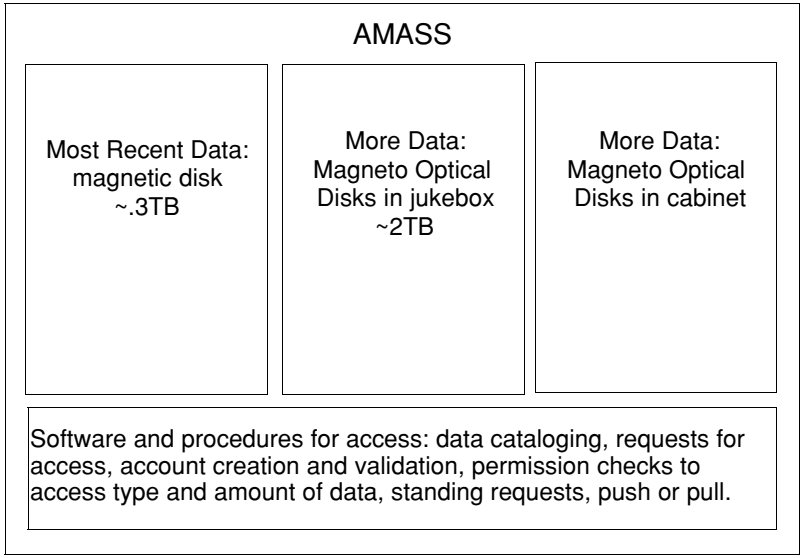
workstation on open network - open ftp access

Notes for instrument teams:

- Data by ftp pull only; data push and various user interfaces to be terminated.
- LZ data older than 2-3 months to be gzip compressed
- LZ long file names, there has been a suggestion for a different file naming convention.
- No index files or SFDUs
- All data will be public including NRT, QL, LZ, etc.

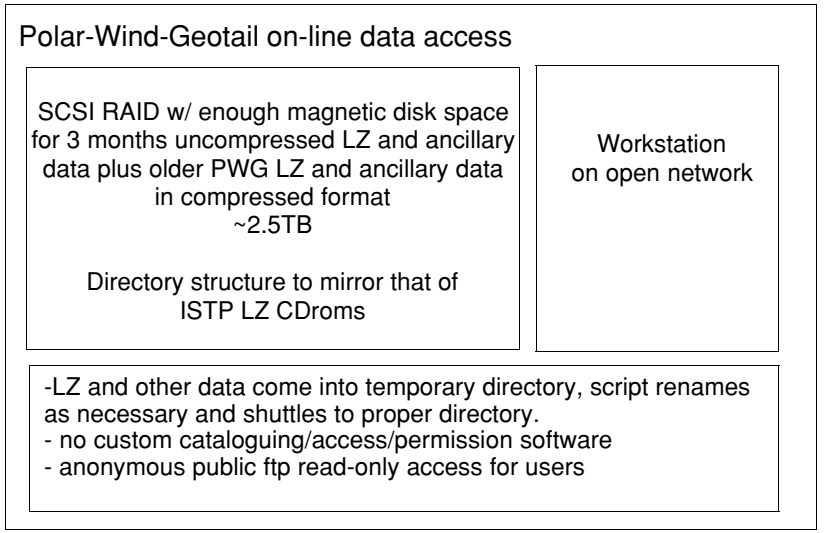
Simplifying Online Data Distribution - more details

Current



Advantages: unknown
Disadvantages: labor is involved when new user requests data, or any user needs help controlling the software. Requests for older data require operator intervention. Large older equipment with numerous components require higher level of maintenance. MO disks are ~$50 per platter. Database driven, requires DBA on staff.

After



Advantages: All data online and on modern media. Control is automated, with exception of system support. Data set would be open. Control is by simple standard scripting that many programmers can work with if alterations are needed. Recurring maintenace costs should be much less than current AMASS. At EOM can transfer control of equipment to NSSDC for continued online access. Allows termination of DBA.
Disadvantages: Cost of new system will be $25-40K. Time consuming to transfer all data from AMASS.

Automation of CD Production

Current

ISTP/IDDS

several older CD writers	several older CD duplicators	several older control machines with Oracle database

Custom and proprietary software for control , extensive cataloguing and quality control

After

Polar-Wind-Geotail DVD/CD Production

New DVD/CD writer combo auto-loader for DVD auto-loader for CD Automatic labeling of platter	New PC to control CD production equipment

Simple scripting, less quality control
DVD for archiving, CDs to instrument teams

Notes for instrument teams:

- DVDs for Polar_all, Wind_all and Geotail_all distribution
- Current (downsized) CD distribution to instrument teams to be retained
- CD directory structure to be retained
- No index files or SFDUs
- Quality control of CD product to be performed by receiver; slow replacement

Automation of CD Production - more details

Current

IDDS

several older CD writers	several older CD duplicators	several older control machines with Oracle database

Combination of custom and proprietary software for control of which data goes on which CD, to author the CDs, to catalogue all processes.

Advantages: unknown
Disadvantages: A labor intensive process conducted once per month. Not very automated. Any changes to software or distribution list require specialized programming skills. Database driven, requires DBA on staff.

After

Polar-Wind-Geotail DVD/CD Production

New DVD/CD writer combo auto-loader for DVD auto-loader for CD Automatic labeling of platter	New PC to control CD production equipment

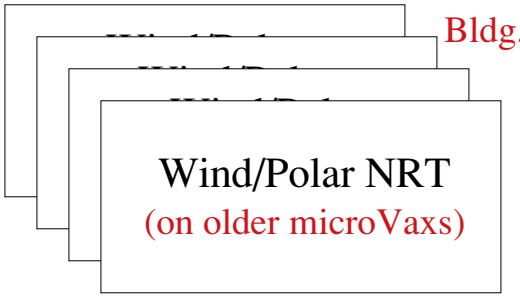
- simple script monitors LZ ingestion process, when full platter is indicated produces proper # of platters, retaining directory structure.
- content of each platter maintained in simple text file
- cursory verification of platter quality may or may not be done
- operator chooses mailing label, stuffs in sleeve and mail.
- write PO_ALL, GE_ALL and WI_ALL DVDs for NSSDC archiving and individual instrument CDs for science teams.

Advantages: Control is almost fully automated. Operator must load the auto-loader and then remove and ship completed patters. Control is by simple standard scripting. Many programmers would be able to make alterations to distribution list as needed. Recurring maintenace costs should be less than current IDSS. Allows termination of DBA.
Disadvantages: Cost of new system will be $15-30K and 2-3 man-months.

Streamlining LZ Processing to Include NRT and QL

under study for possible implementation

Current



Bldg. 23

Wind/Geotail QL & LZ

Bldg. 3

Polar QL & LZ

Unix using LabView & Oracle

After

NRT for Wind & Polar
rehosted to Dec Alpha

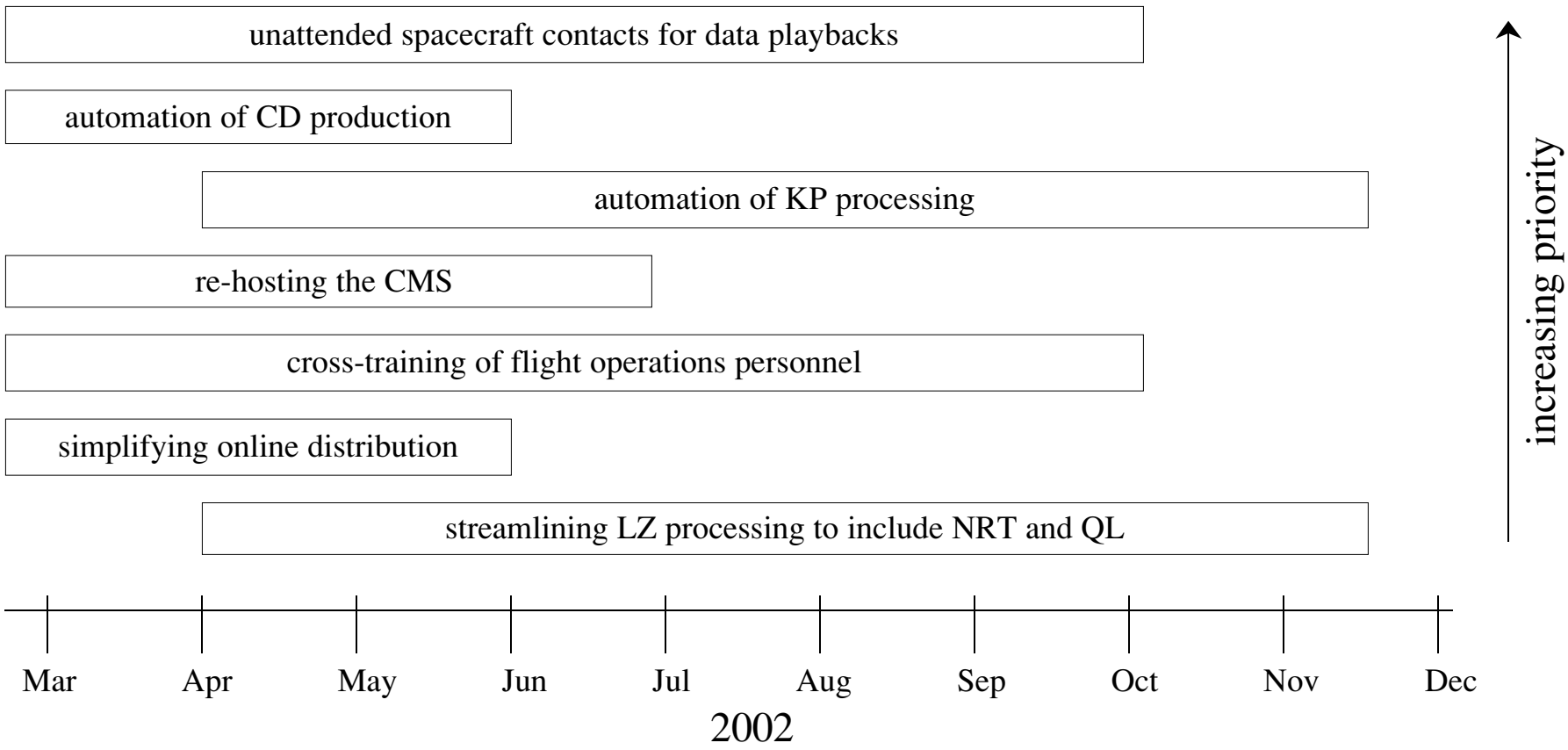
LZ for Wind & Polar
rehosted to Dec Alpha

Geotail QL & LZ

Notes for instrument teams:

- Software port process should be transparent to instrument teams.
- File types and formats would remain identical.
- Verification of file format and content, by instrument teams, will be required after porting.
- Routine quality checking of LZ data files will reside with instrument teams.
- Reprocessing/replacement of LZ data may be limited to 1-2 months after receipt of files.
- There will be some data loss.

Approximate Schedule for Re-engineering Activities



Summary

- Process of re-defining the Polar, Wind and Geotail flight operations and data systems requirements is complete.
- Feasibility studies were conducted to explore fresh approaches.
- Identified areas, responsible parties and funding for re-engineering tasks.
- Initiated re-engineering tasks.
- The re-engineered flight operations and data system should retain most, if not all, Polar, Wind and Geotail specific processing functions previously provided by ISTP.
- The re-engineered system is expected to properly support the PI teams and be affordable.

Concerns on the Project Side

- Unintended impacts to instrument teams.
- If any re-engineering tasks are not successful, either technically or fiscally, can the impact be afforded?
- Can we find a contractual environment for operations that is affordable and legal?
- Can the re-engineered system collapse to an affordable Wind-only environment after Polar and Geotail end of missions.
- Where should the separation be between project data processing and NSSDC data distribution?
- What is the minimum data recovery percentage acceptable in light of fiscal constraints imposed on extended mission programs.