

Mount Stromlo Space Research Centre




Mt Stromlo SLR Station (7825)

- ❑ Operating since early 2004.
- ❑ Tracking automatically since mid 2006.
- ❑ Operates automatically and often unmanned for significant periods (over many days).
- ❑ Supporting staff levels are small (typically 2).
- ❑ Operates 24/7 irrespective of weather.
- ❑ One of the most productive stations in the world.
- ❑ Significant experience with automation.

A large, faint, light blue starburst graphic is centered on the page, serving as a background for the title text.

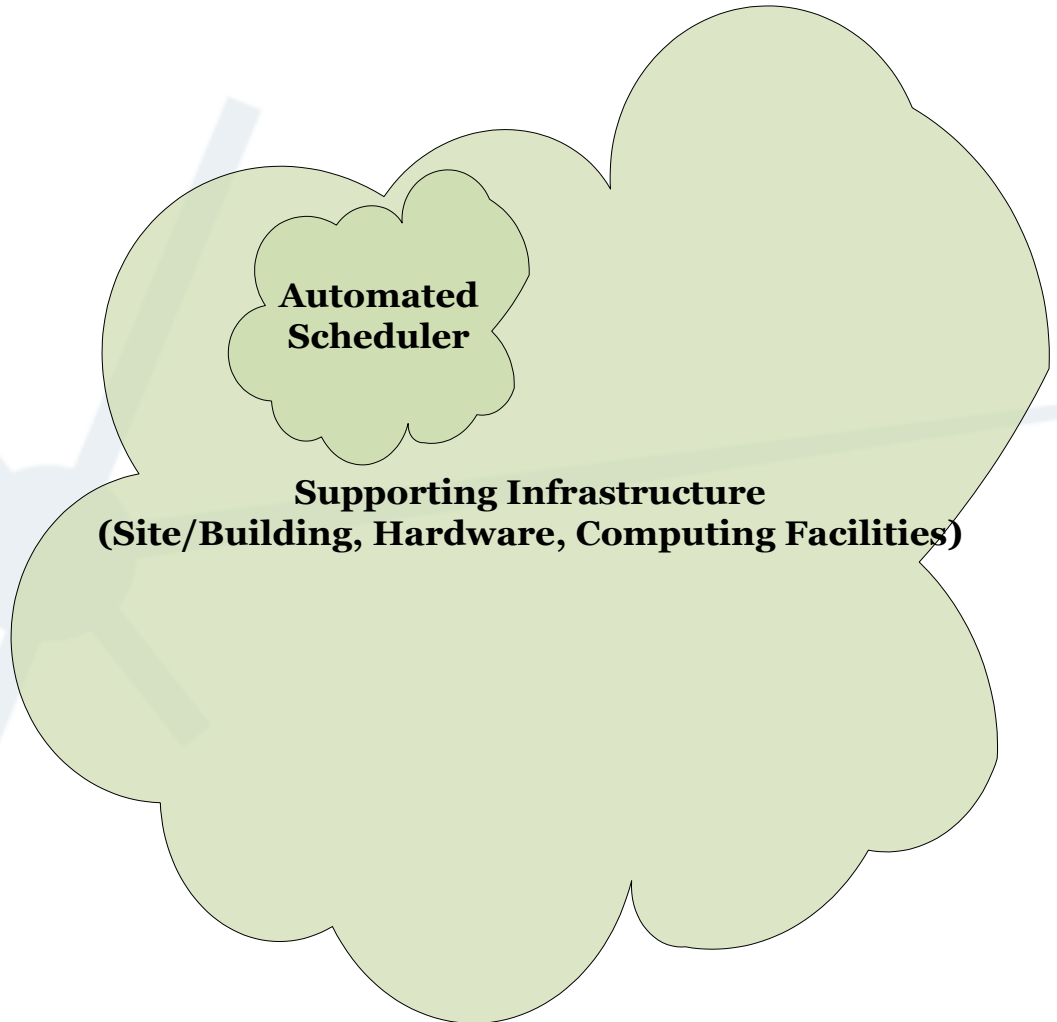
What constitutes an Automated SLR Station?

Components of a Fully Automated SLR Station

A light green, cloud-like shape with a thin black outline, centered on the page. It contains the text "Supporting Infrastructure (Site/Building, Hardware, Computing Facilities)".

**Supporting Infrastructure
(Site/Building, Hardware, Computing Facilities)**

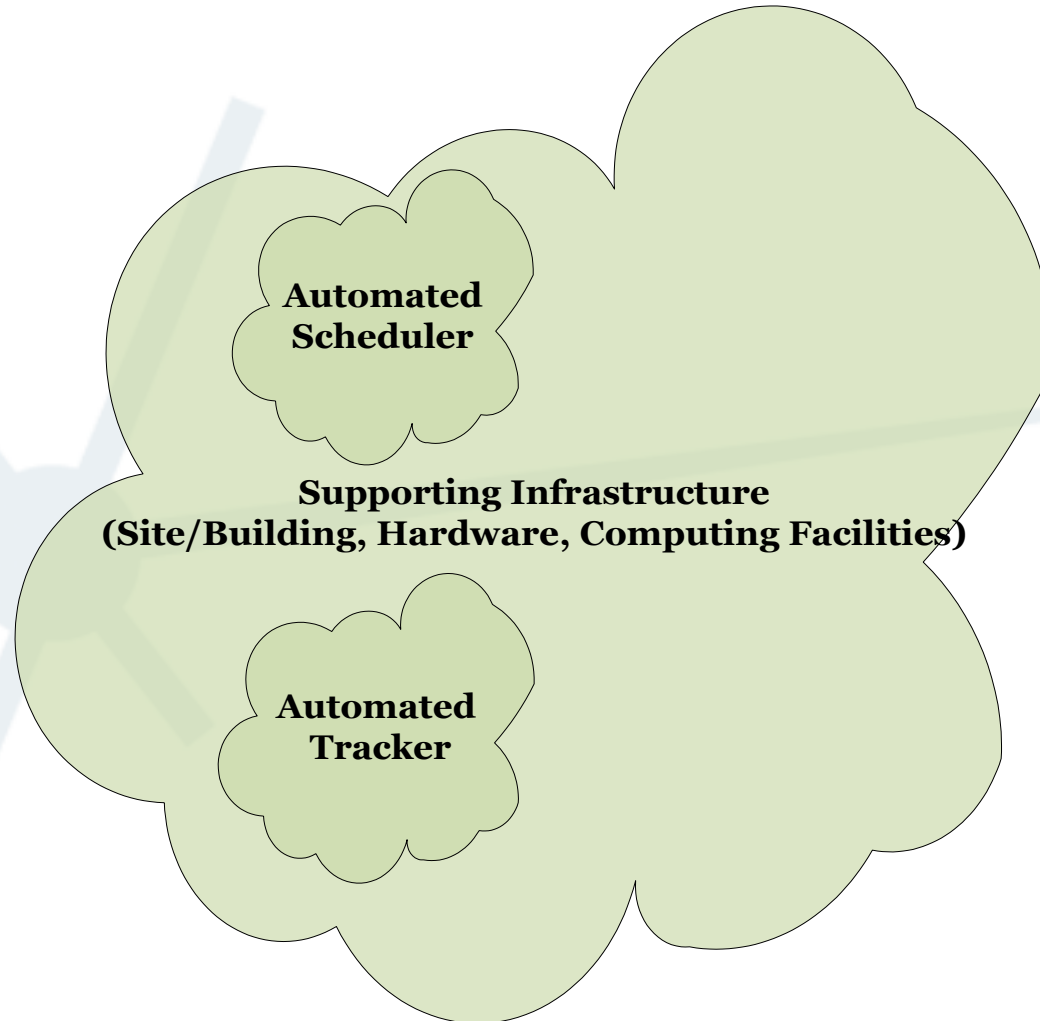
Components of a Fully Automated SLR Station

A large, light green, cloud-like shape with a black outline, containing two smaller, similar shapes. The larger shape contains the text "Supporting Infrastructure (Site/Building, Hardware, Computing Facilities)" and the smaller shape contains the text "Automated Scheduler".

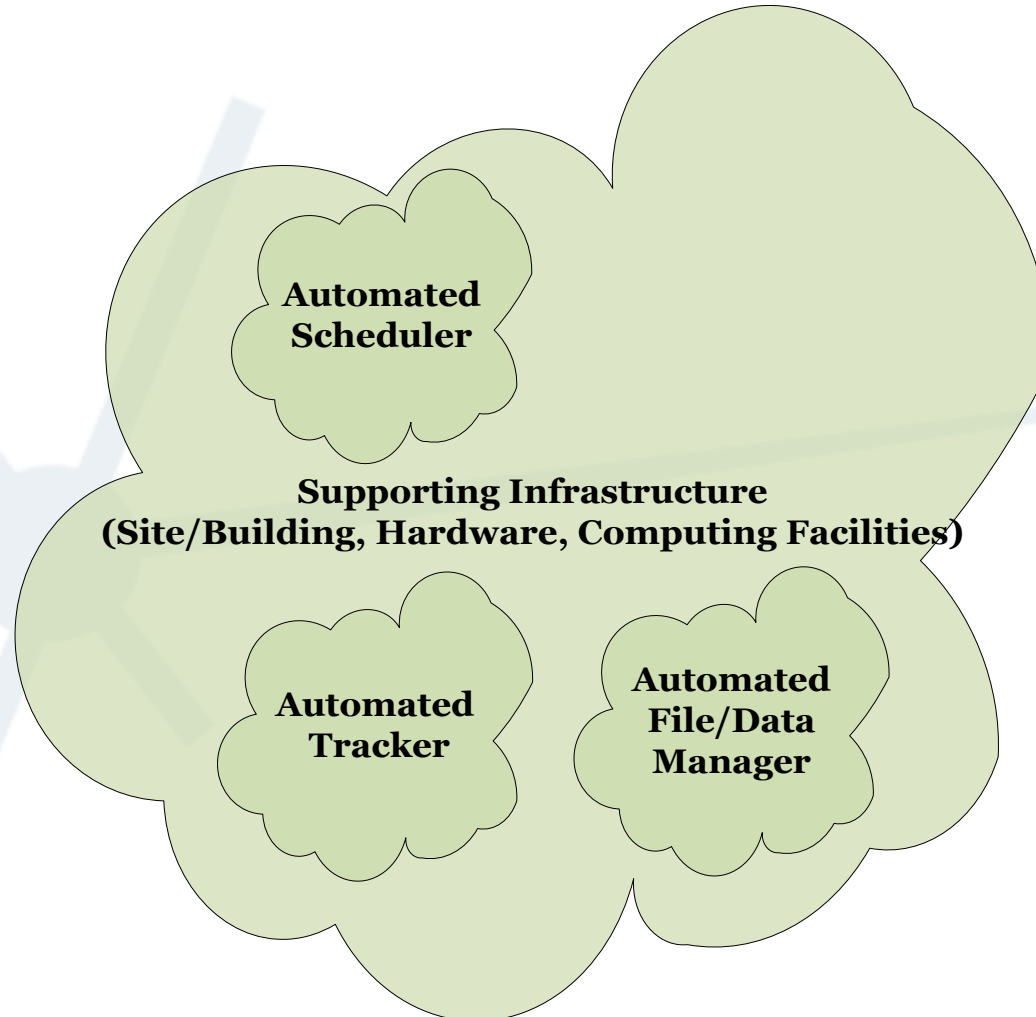
Automated Scheduler

**Supporting Infrastructure
(Site/Building, Hardware, Computing Facilities)**

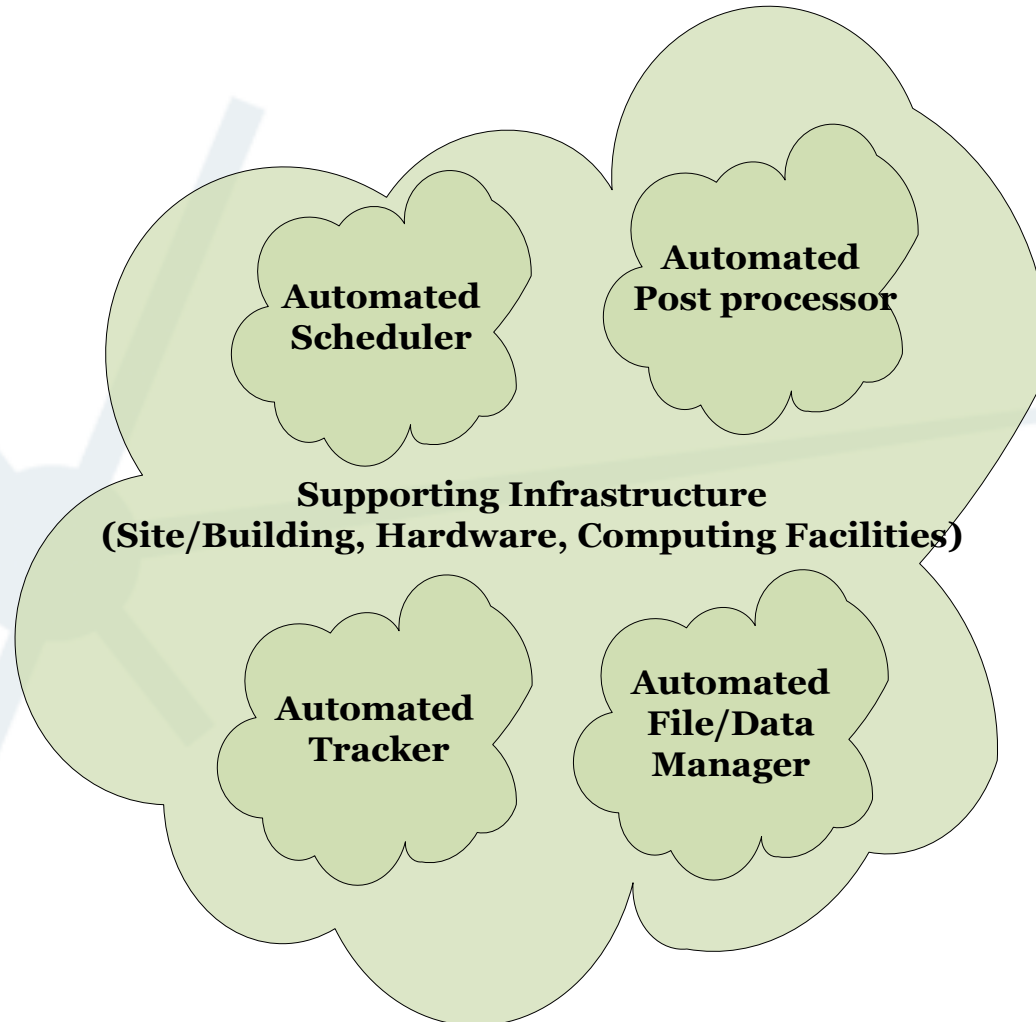
Components of a Fully Automated SLR Station



Components of a Fully Automated SLR Station



Components of a Fully Automated SLR Station



Mt Stromlo Automation Infrastructure

❑ Site & Building

- Secure building (24 hr monitoring)
- Reliable power and communications
- Aircraft safety (Lidar, ADS-B, IR Cameras)

❑ Hardware Components

- 1m Telescope and sealed enclosure
- Laser system (new, recently installed)
- Mets (new, recently installed)
- External calibration targets (cf previous workshops)
- Stable, reliable, robust designs requiring minimal maintenance and manual intervention.

❑ Computing Facilities

Mt Stromlo Automation Infrastructure

1m Telescope

- Excellent performance over 13 years
- Mount modelling every few months (>3)
- Original primary mirror coating
- Coude optics recoated ~3-4 years
- Good temperature stability
- No sun avoidance required
- Located in a sealed enclosure

Mt Stromlo Automation Infrastructure

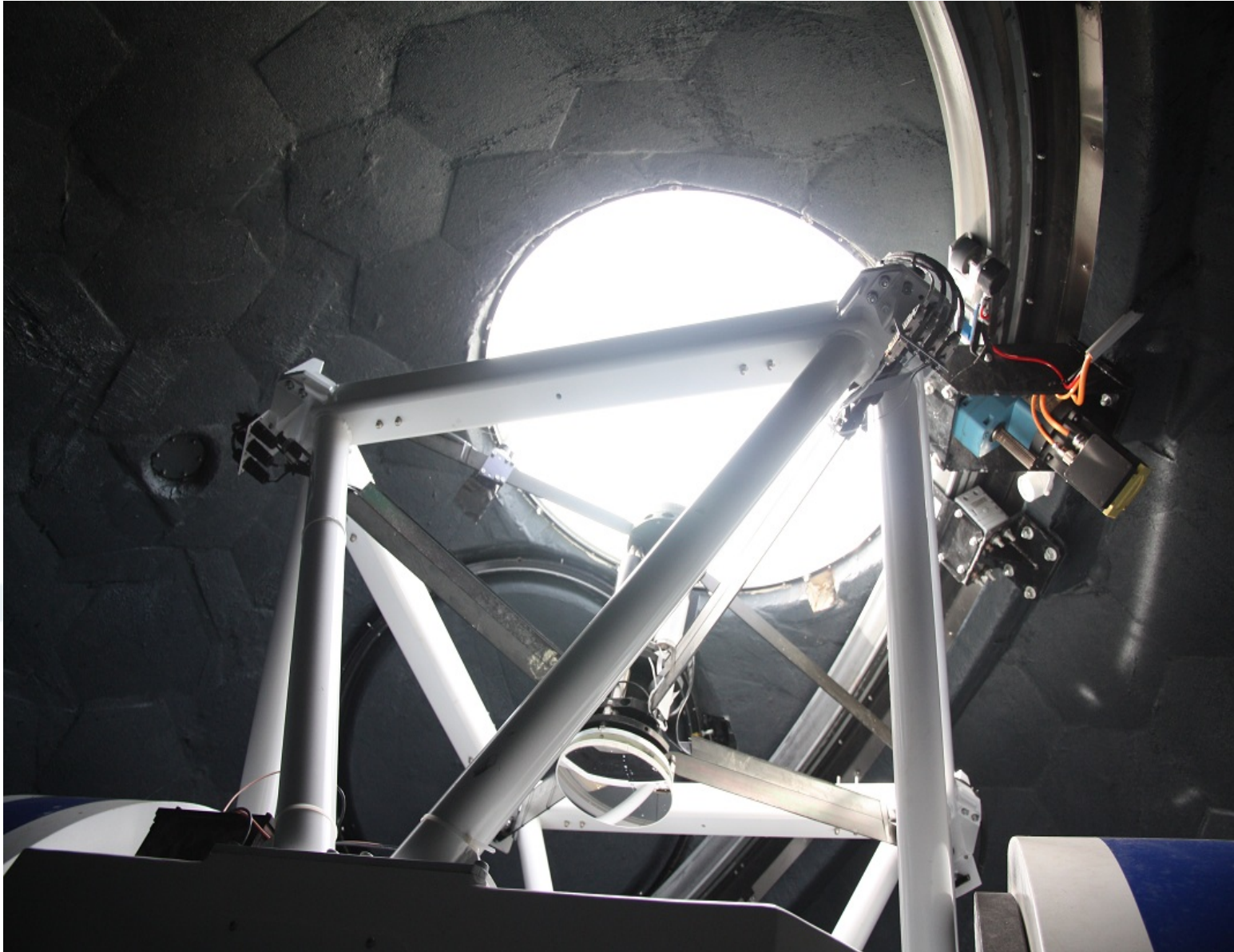
Sealed Enclosure

- ❑ Provides telescope
 - sun avoidance
 - protection from rain, hail, snow, dust & stones
 - protection from wind loading
 - clean, isothermal & low humidity environment.
- ❑ Supports automated, unmanned operations any time of day and for any weather.

EOS Typhoon Enclosure







Mt Stromlo Automation

Computing Facilities



- ❑ Distributed Dedicated Computers (Win7)
 - Local File Server to manager LAN
 - Hardware replacement ~4-5 years
- ❑ Network supports remote control
 - Via WAN to EOS staff offices
 - Via VPN clients elsewhere
- ❑ Observatory Control System (OCS)
 - Client-Server Architecture (see Canberra workshop, 2006)
 - C++ software components developed by EOSSS
- ❑ System Control and Status Monitoring
 - Client application to monitor and control servers
 - Fault identification and alerts (e-mail, SMS)

Mt Stromlo Automation Computing Facilities

Client Server Architecture.

Supports

- Incremental development
- Easy to add or remove functions & hardware.
- Minimize coupling between functions.
- Re-use.

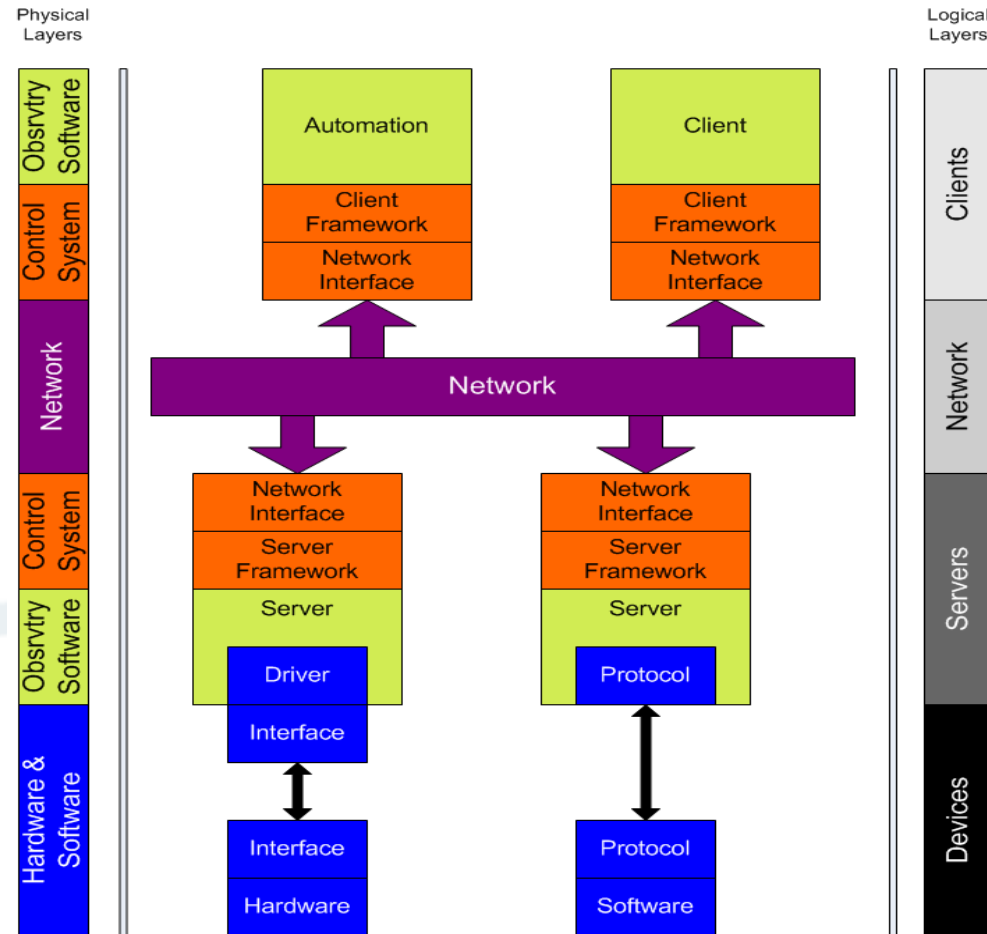
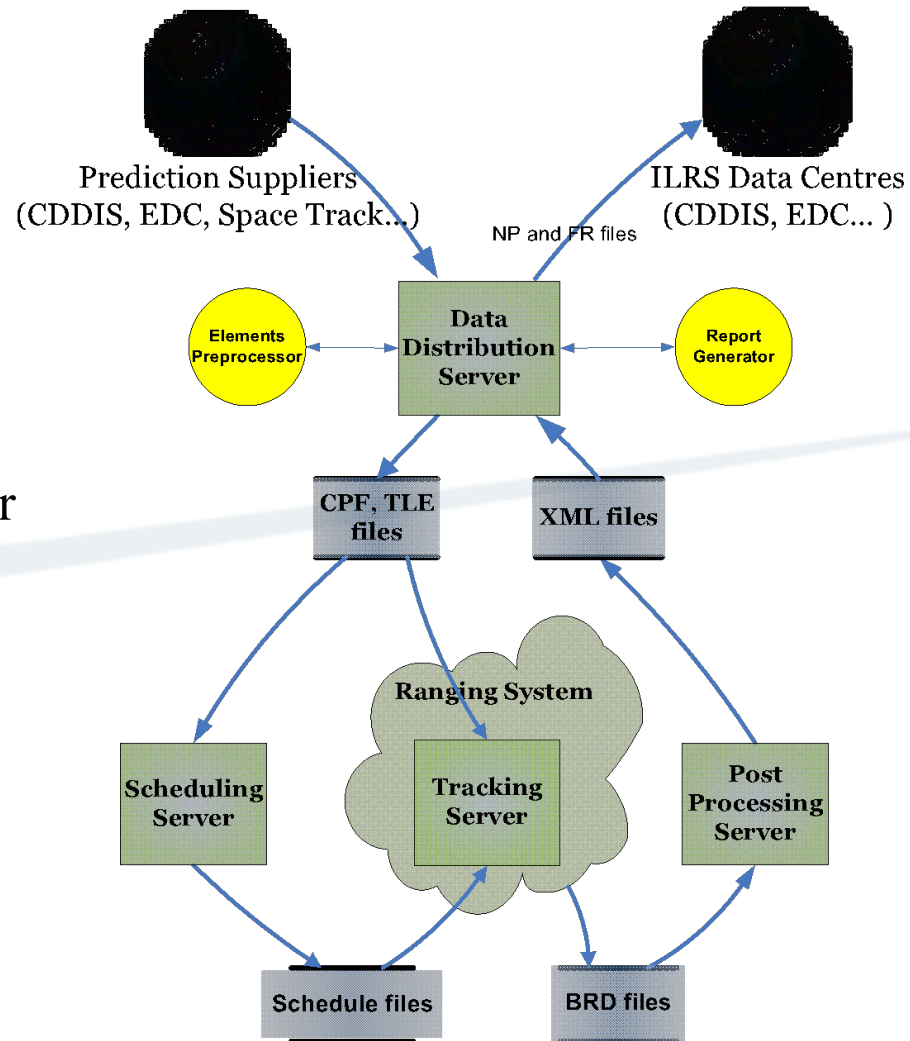


Figure 2. Software architecture employed at Mt Stromlo (from M Pearson, Proc. of 15th International Workshop on Laser ranging, 2006)

Mt Stromlo Automation Computing Facilities

Mt Stromlo SLR System Schematic of Primary Automation Servers

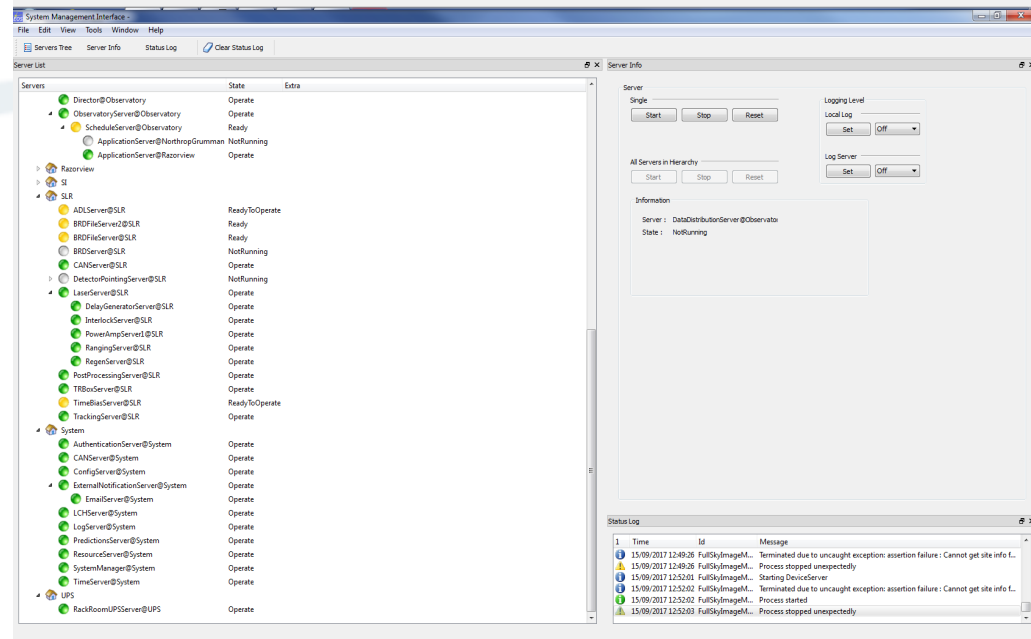
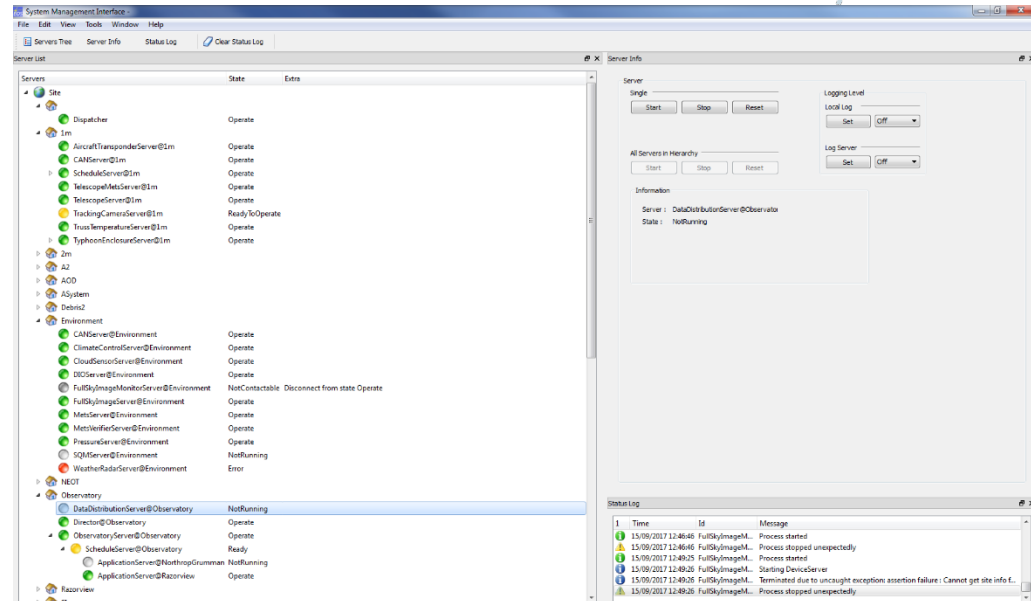


Schematic of automation servers –

- Data Distribution Server
- Scheduling Server
- Tracking Server
- Post Processing Server

Mt Stromlo Automation Computing Facilities

Client application
supporting local and
remote management
of server operations
and state.



Mt Stromlo Automation

Computing Facilities

Client application
supporting local and
remote monitoring of
servers and system
components.



The screenshot shows the 'Device Browser' application window. The left pane displays a tree view of servers and their status. The right pane shows the attributes of the selected 'PostProcessingServer@SLR'. The bottom pane shows a list of commands that can be executed on the server.

Server	Status
BRDFileServer@SLR	Operate
BRDFileServer2@SLR	Operate
BRDServer@SLR	Not Registered
CANServer@SLR	Operate
DetectorPointingServer@SLR	Not Registered
LaserServer@SLR	Operate
DelayGeneratorServer@SLR	Operate
InterlockServer@SLR	Operate
PowerAmpServer1@SLR	Operate
RangingServer@SLR	Operate
RegenServer@SLR	Operate
PostProcessingServer@SLR	Operate
TimeBiasServer@SLR	ReadyToOperate
TracingServer@SLR	Operate
TRBoxServer@SLR	Operate
System	
AuthenticationServer@System	Operate
CANServer@System	Operate
ConfigServer@System	Operate
ExternalNotificationServer@System	Operate
EmailServer@System	Operate
CHServer@System	Operate
LogServer@System	Operate
PredictionsServer@System	Operate
ResourceServer@System	Operate
SystemManager@System	Operate
TimeServer@System	Operate
UPS	
RackRoomUPSServer@UPS	Operate

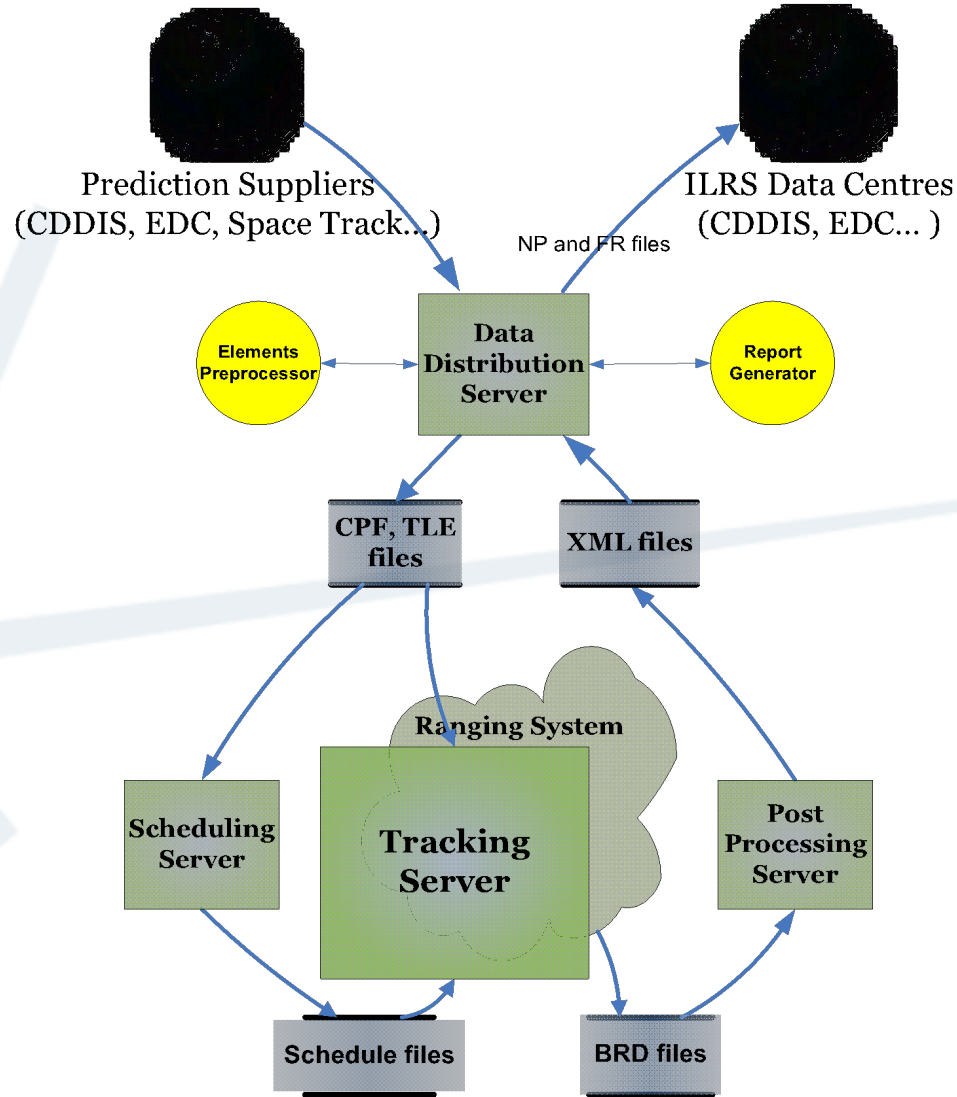
Attribute	Type	Value
PostProcessingServer@SLR		
CurrentDirectory	STRING	//172.22.50.153/operations/Networks/WPLTN/Site/Stromlo/Systems/SLR/Data/BRD/AutoTesting/Ur
CurrentFile	STRING	technosat_20170912_013541.brd
CurrentProcessTime	STRING	4.6 secs
CurrentStatus	STRING	Processing...
Enabled	BOOLEAN	true
LastFileProcessed	STRING	galileo210_20170911_212326.brd
LastFileProcessTime	STRING	3.4 secs
LastFileStatus	STRING	MetsOK. Possible signal. Segment has pre-cal method only. Require pre-cal and post-cal methods.
LastFileSummary	STRING	Unable to Complete Processing. Try later.
LastFileMLOutput	STRING	
NumberOfFilesProcessed	INTEGER	0
NumberOfFilesToProcess	INTEGER	2
Version	STRUCTURE	
Application	STRUCTURE	
buildTargetName	STRING	eosPostProcessingServer.exe
buildTime	STRING	Mon Jul 31 04:09:39 2017 UTC
platform	STRING	Win32
version	STRING	2-3-0
Astrometry	STRUCTURE	
buildTargetName	STRING	LbAstrometrySRDR.lib
buildTime	STRING	Tue Jul 25 05:41:04 2017 UTC
platform	STRING	Win32
version	STRING	2-3-1
BrdAnalysis	STRUCTURE	
buildTargetName	STRING	LbBrdAnalysisSRDR.lib
buildTime	STRING	Thu Jul 27 06:42:55 2017 UTC
platform	STRING	Win32
version	STRING	2-11-1
BrdFile	STRUCTURE	
buildTargetName	STRING	LbBrdFileSRDR.lib
buildTime	STRING	Tue Jul 25 06:21:51 2017 UTC
platform	STRING	Win32

Command	Action
PostProcessingServer@SLR	
AbortProcessing	Execute
AbortProcessingCurrentFile	Execute
GetVersion	Execute
PauseProcessing	Execute
RestartProcessing	Execute

PostProcessingServer@SLR.IP Address = 172.22.170.206 Port = 20410

Auto Tracking

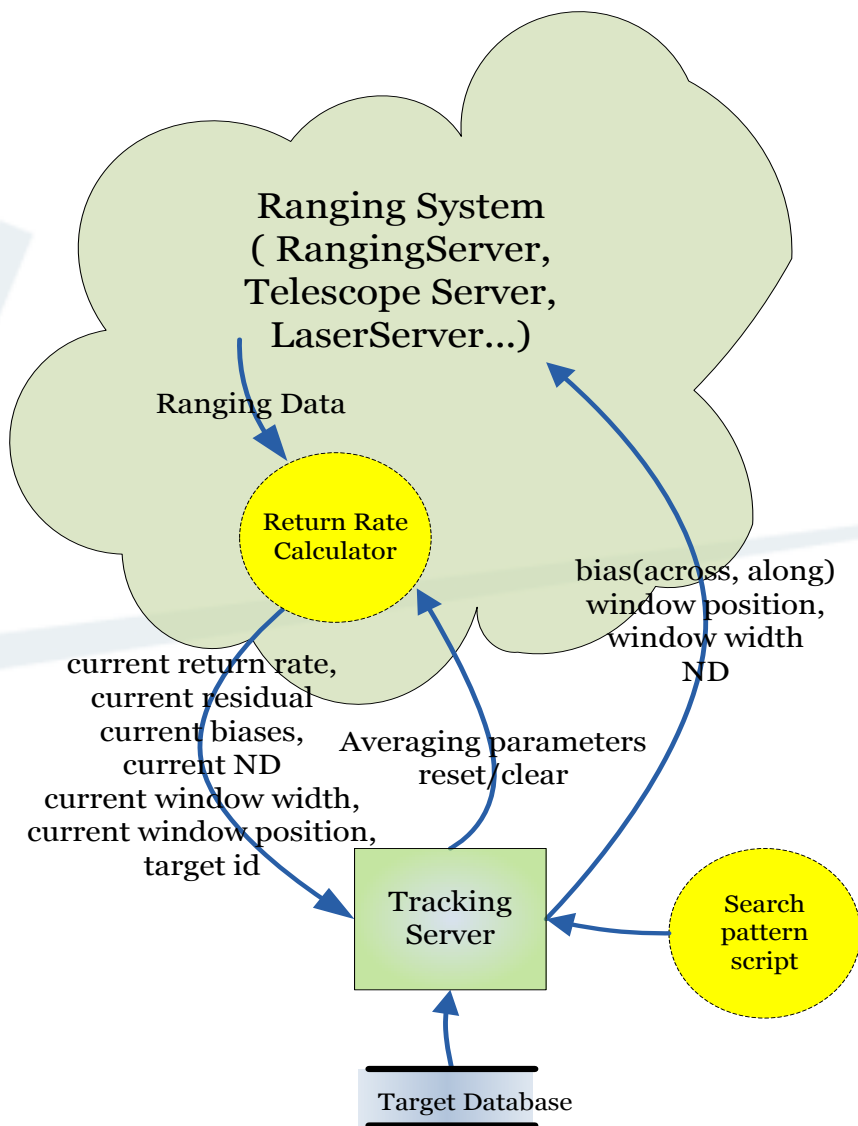
Mt Stromlo SLR System Schematic of Primary Automation Servers



Mt Stromlo SLR System

Auto Tracking

Schematic of the Tracking Server

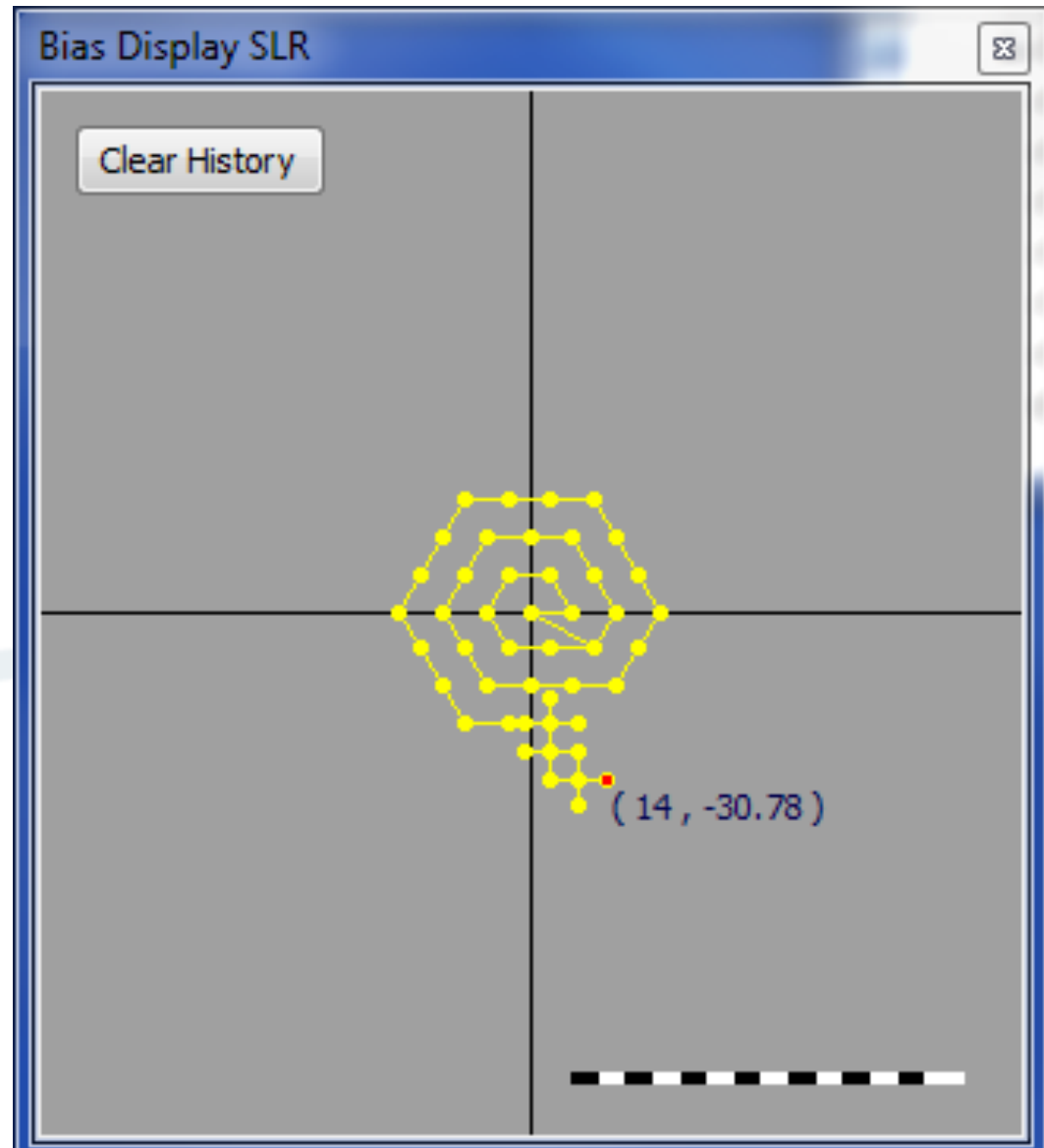


Auto Tracking

Search Pattern

Uses spiral search pattern until acquisition and then continuously looks for maximum signal using a delta azimuth/across & delta elevation/along pattern.

Example shown obtained during initial tracking of cubesat "Biarri"



Auto Tracking

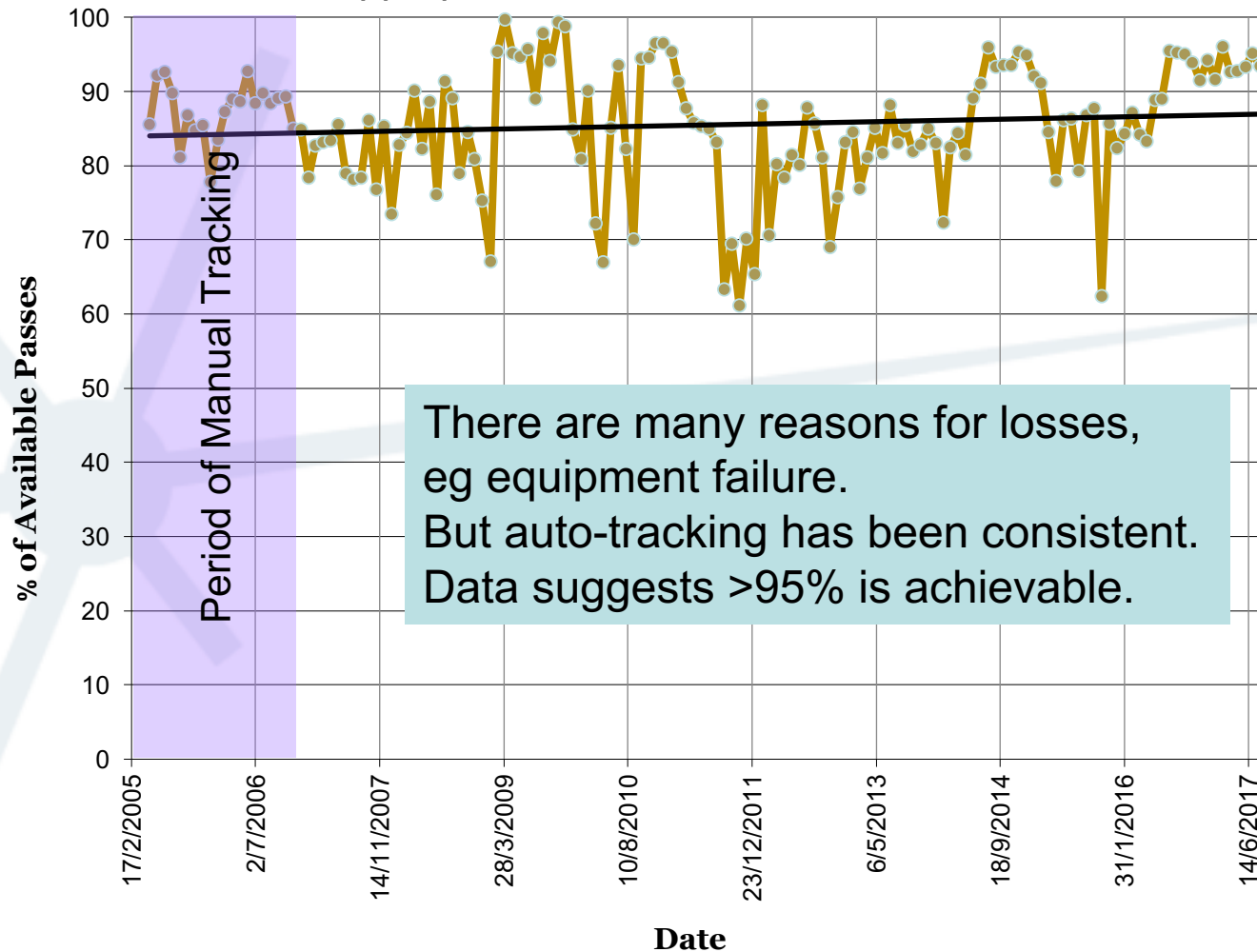


Progress

- Auto tracking functions developed and used at Mt Stromlo station (7849) in period 1998 – 2003.
- Auto tracking in continuous operation at Mt Stromlo station (7825) since 2006.
- Analysis of manual and automated tracking presented at Canberra(2006) workshop shows productivity was almost the same.
- Analysis of data from 10 years of tracking at Mt Stromlo indicates performance of auto-tracking has been maintained and is highly productive (up to 95% of possible passes tracked OK).
- More stations have adopted similar auto-tracking techniques.

Auto Tracking

Analysis of available passes successfully tracked. Includes all potentially trackable passes – ie good weather, no sun avoidance, predictions available, appropriate elevations etc.

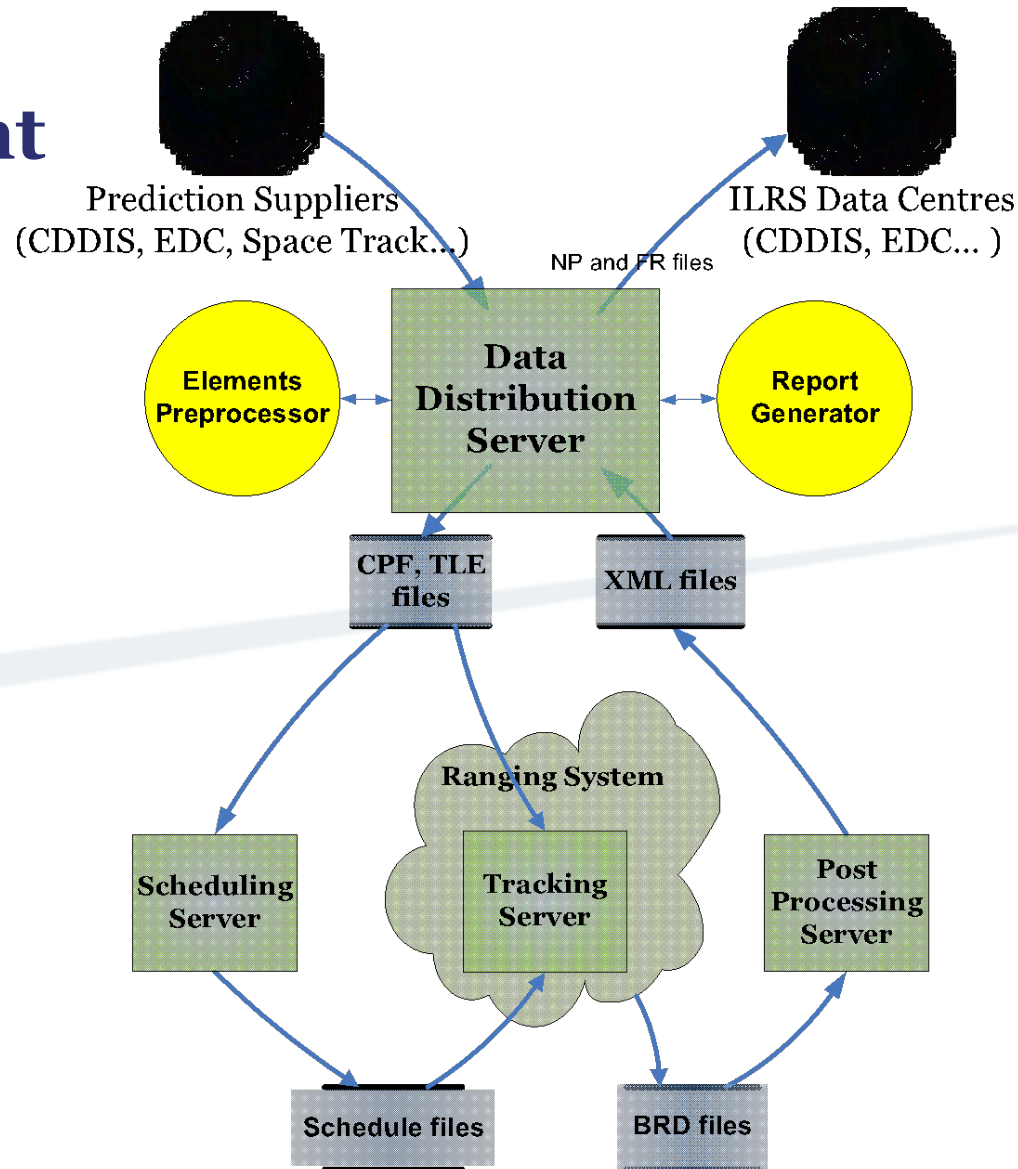


Summary

- ❑ Autonomous tracking has been successful over many years, but...
- Consider additional search patterns.
- Integrate script with tracking server to improve language capability.
- Improve ND control responsiveness to keep return rates at single photon levels.
- Simplify parameterization and integrate with target database.

Autonomous Data Management

Mt Stromlo SLR System Schematic of Primary Automation Servers



Autonomous Data Management



- ❑ Download of prediction data, including
 - CPF files from CDDIS...
 - TLE file from Space Track...
 - EOP files from USNO...

- ❑ Upload of reports, including
 - Normal point, full rate data to EDC...
 - Operational report to clients...

- ❑ Intermediate processing including
 - Selecting the best CPFs
 - Extract TLE data and create files for each target
 - Creating reports from local data.

- ❑ Management of local files, including
 - Relocation of published files
 - Backup and archival of critical data.

Autonomous Data Management

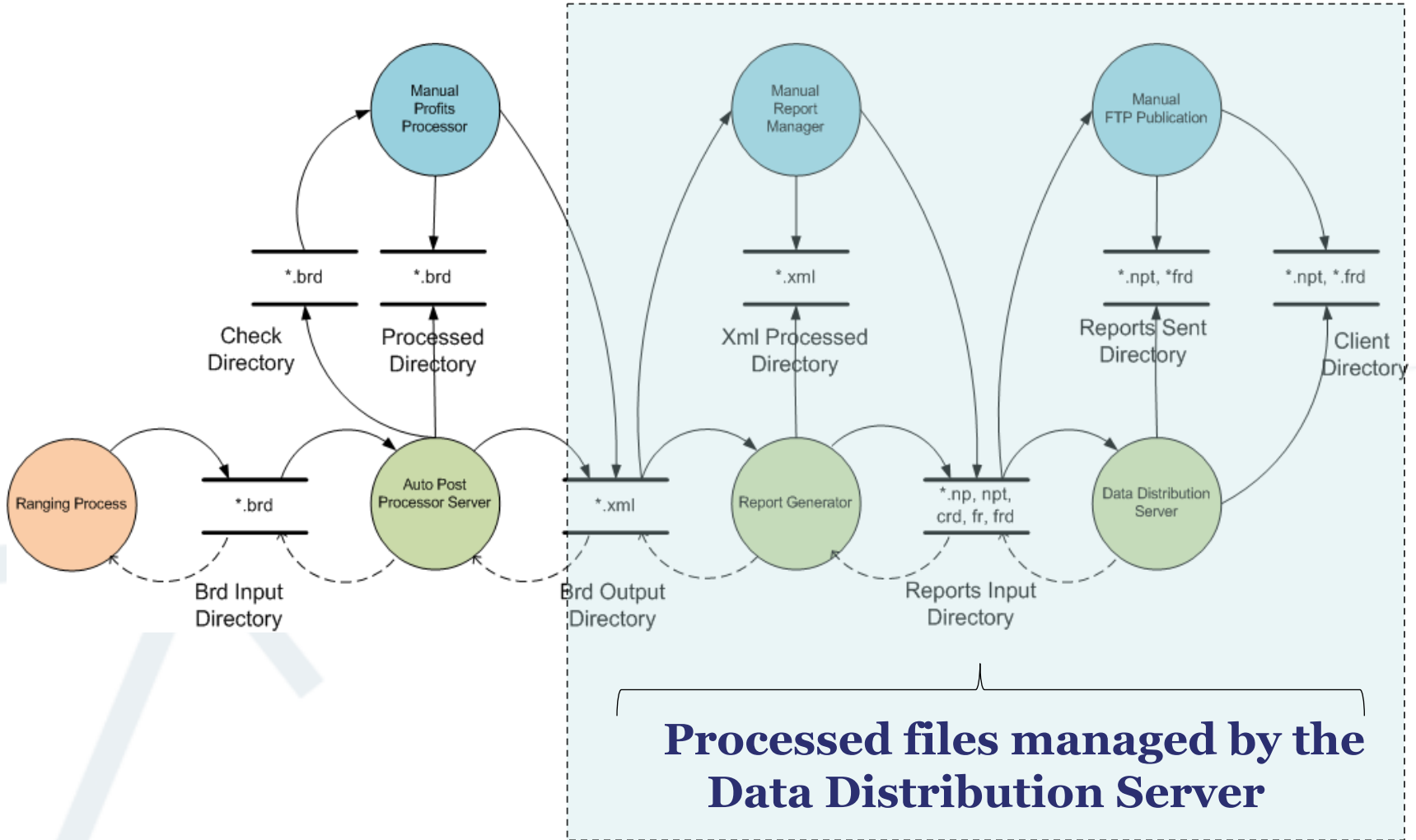
❑ Autonomous Data Distribution Server

- Define a script then set and forget.
- Supports ftp, file and http(s) schemes.
- Supports compression (libzip).
- Proven robust to network problems, but...
- Built on Qt4 networking library.

❑ Script of Transactions

- Runs one transaction at a time.
- Supports linked transactions (ie completing a transaction can start a new transaction).
- Frequency of transactions is defined.

Autonomous Data Management



Autonomous Data Management

Summary

- ❑ Currently in operation, replacing manual processes.
- ❑ Performs tedious/complex file management tasks.
- ❑ Supports timeliness of data transfers.
- ❑ Provides a log of all transactions.
- ❑ Provides alerts(eg email, SMS) of file transfer problems or failures.