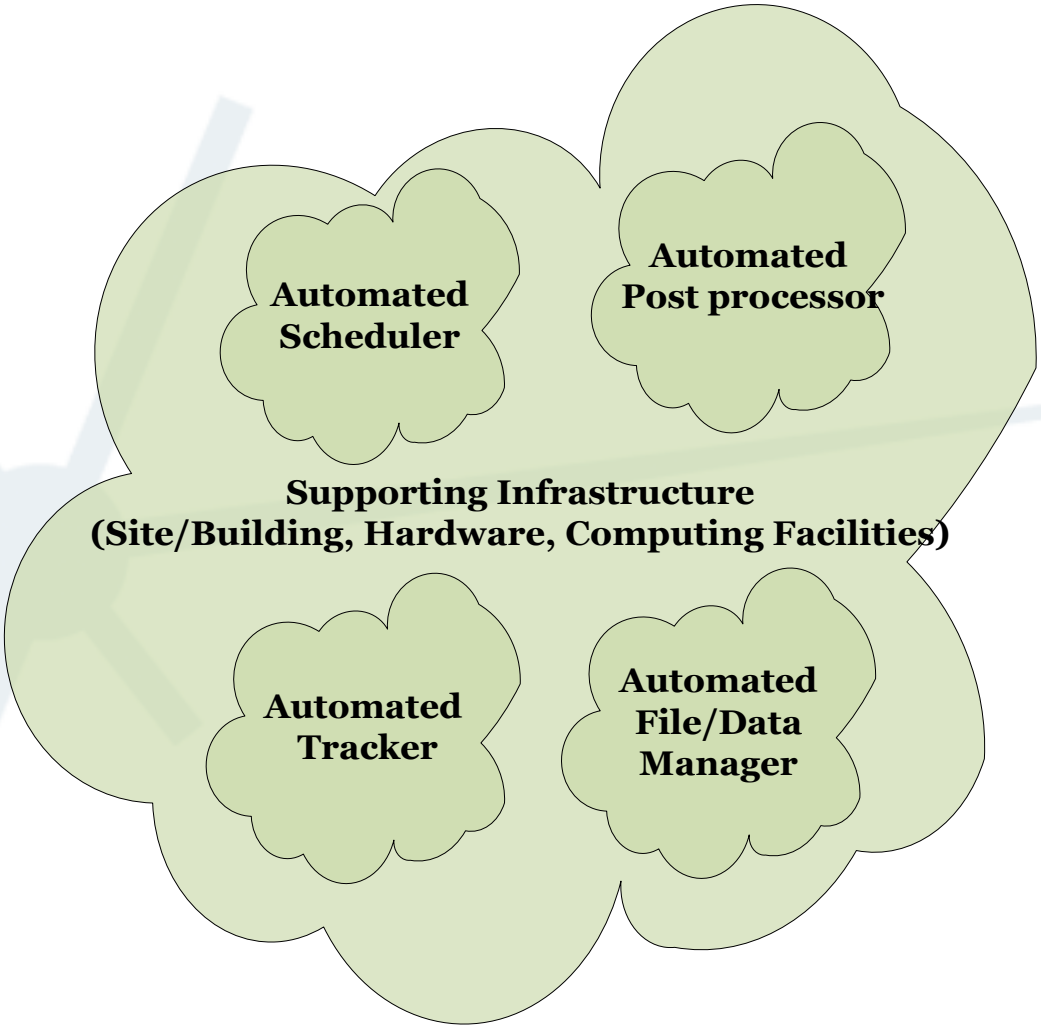
Mount Stromlo Space Research Centre

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.

What constitutes an 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

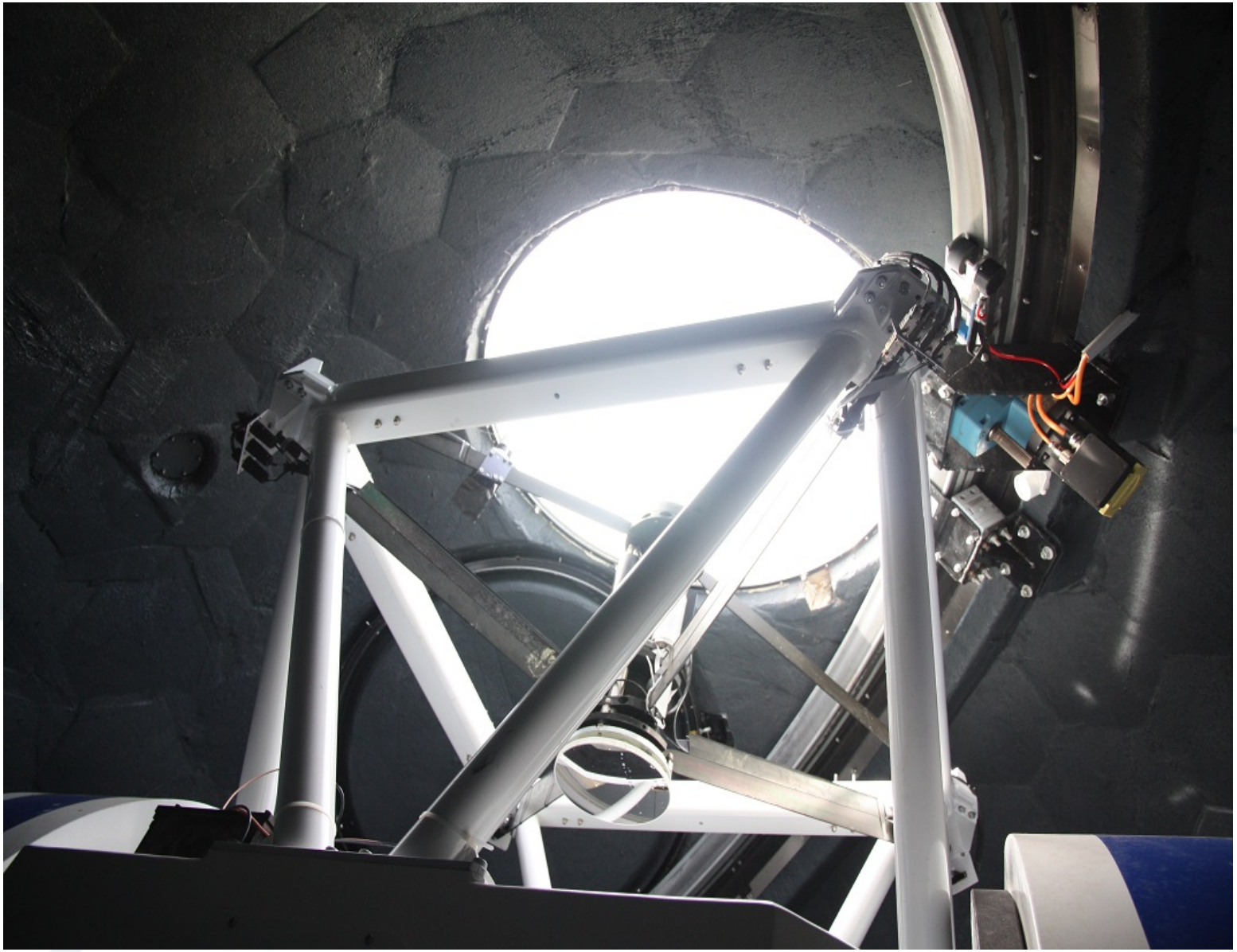
- Excellent performance over 13 years
- Mount modelling every few months (>3)
- Original primary mirror coating
- Coude optics recoated ~3-4 years
- Good temperature stability
- No sun avoidance required
- Located in a sealed enclosure

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.

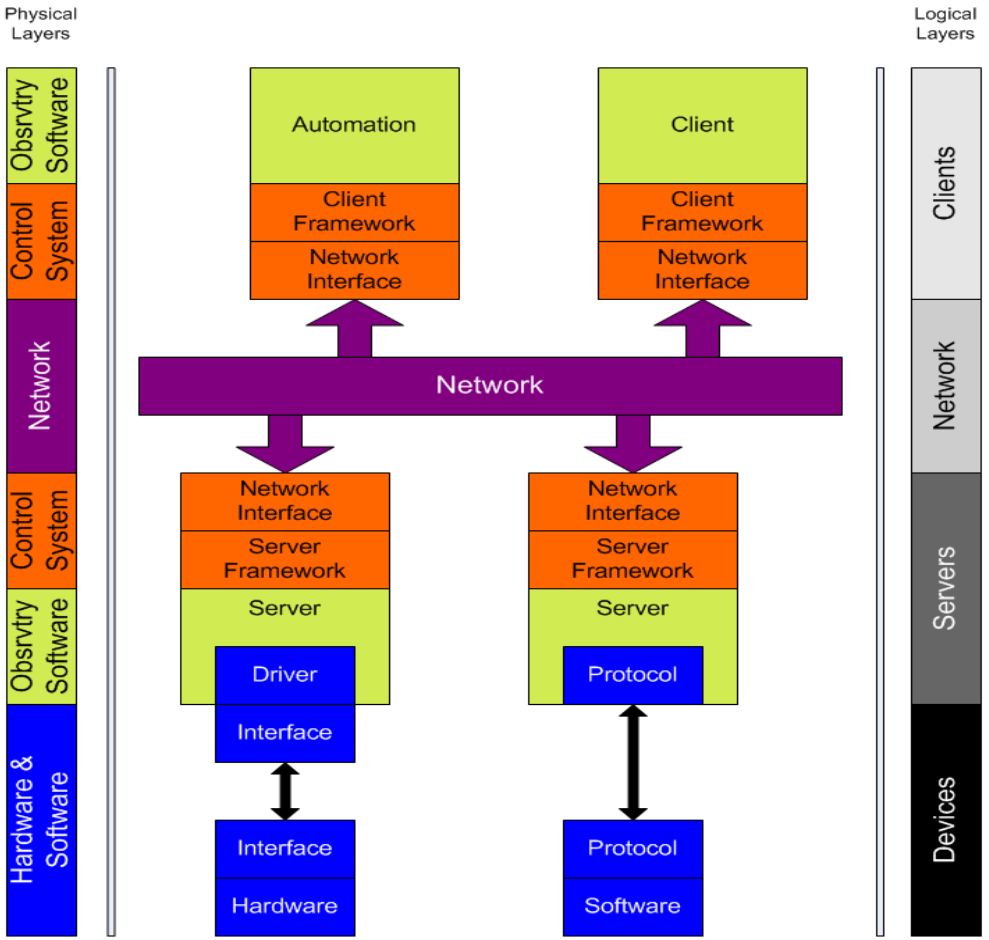
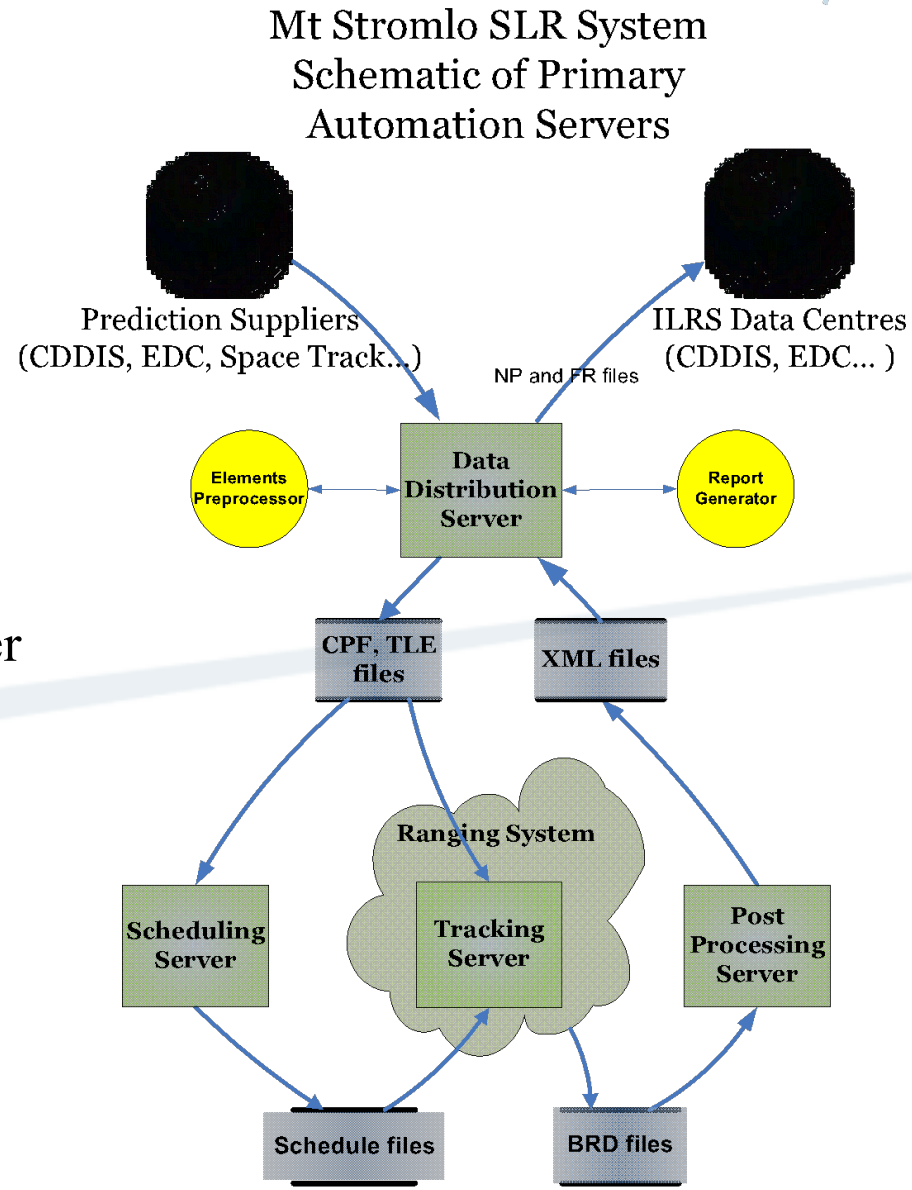


Figure 2. Software architecture employed at Mt Stromlo (from M Pearson, Proc. of 15th International Workshop on Laser ranging, 2006)

Mt Stromlo Automation Computing Facilities

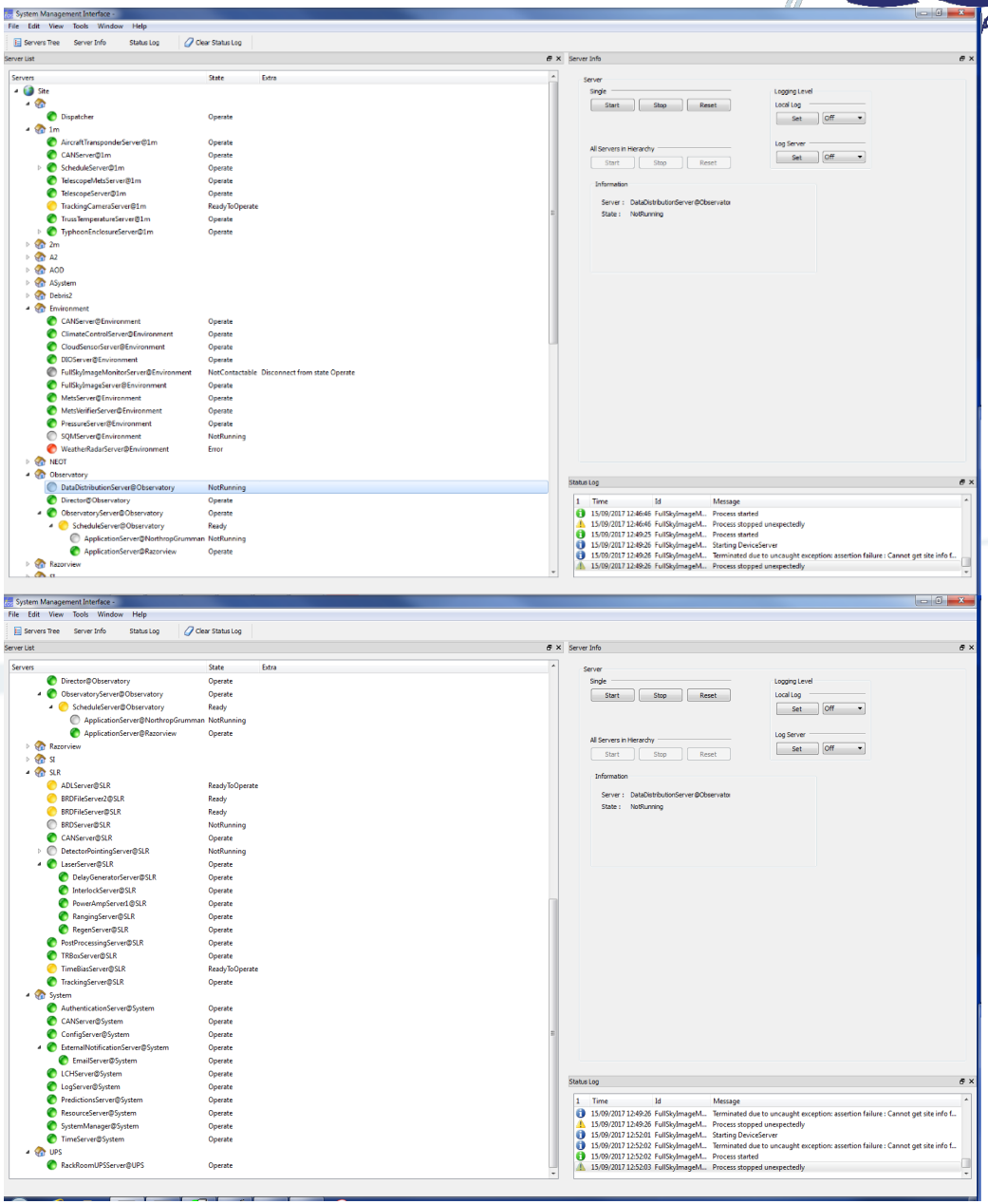
Schematic of automation servers –

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



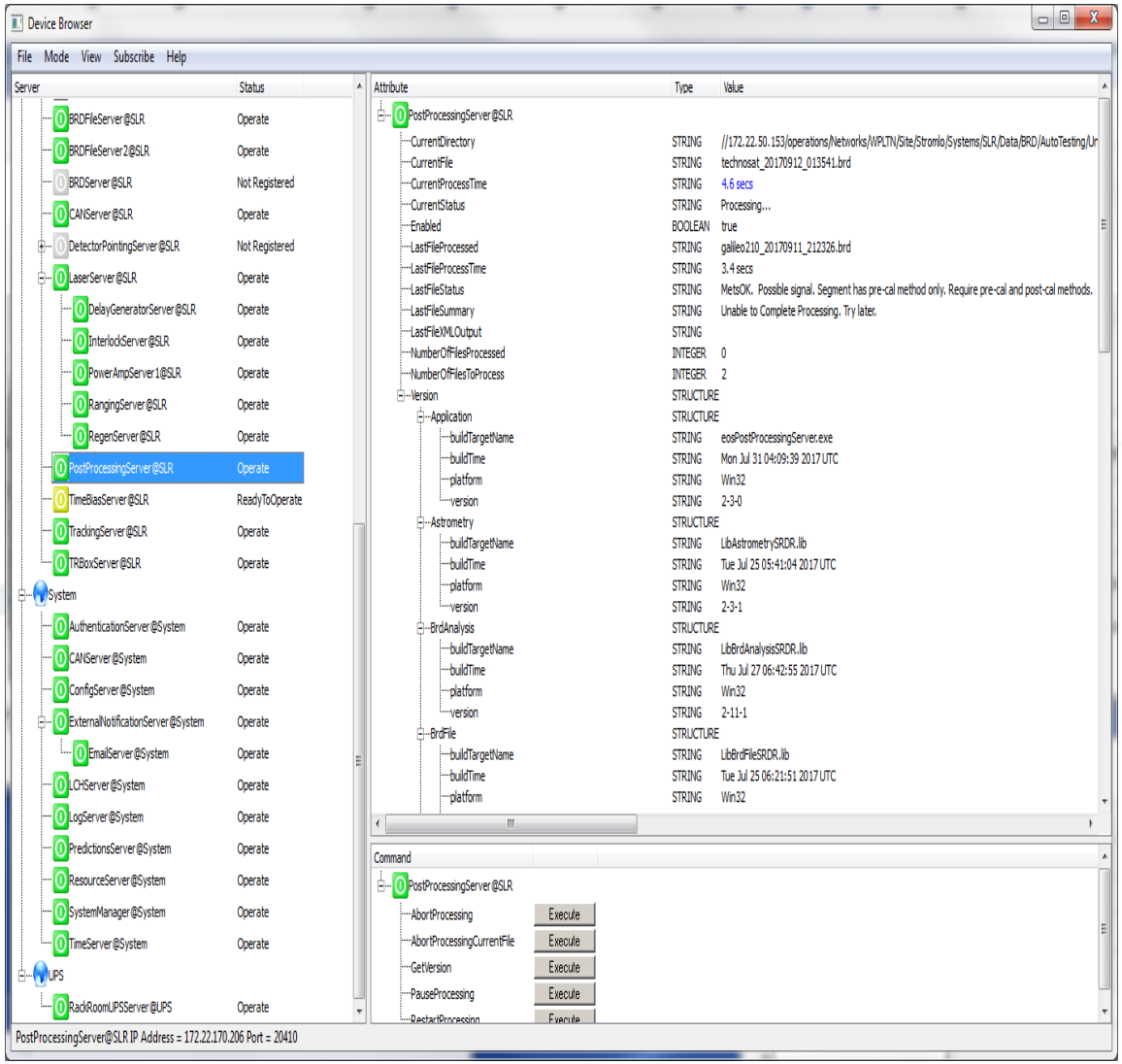
Mt Stromlo Automation Computing Facilities

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

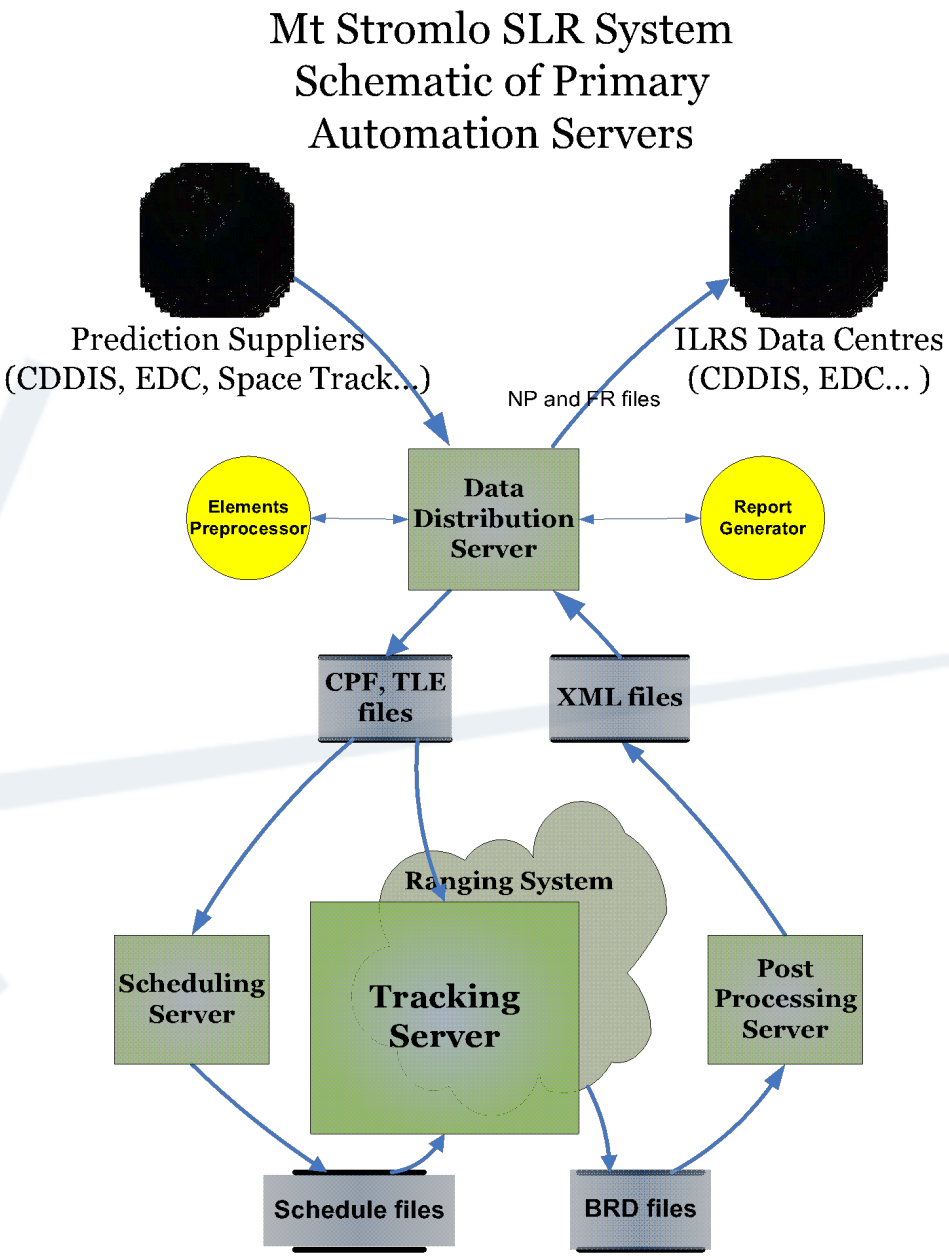


Mt Stromlo Automation Computing Facilities

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



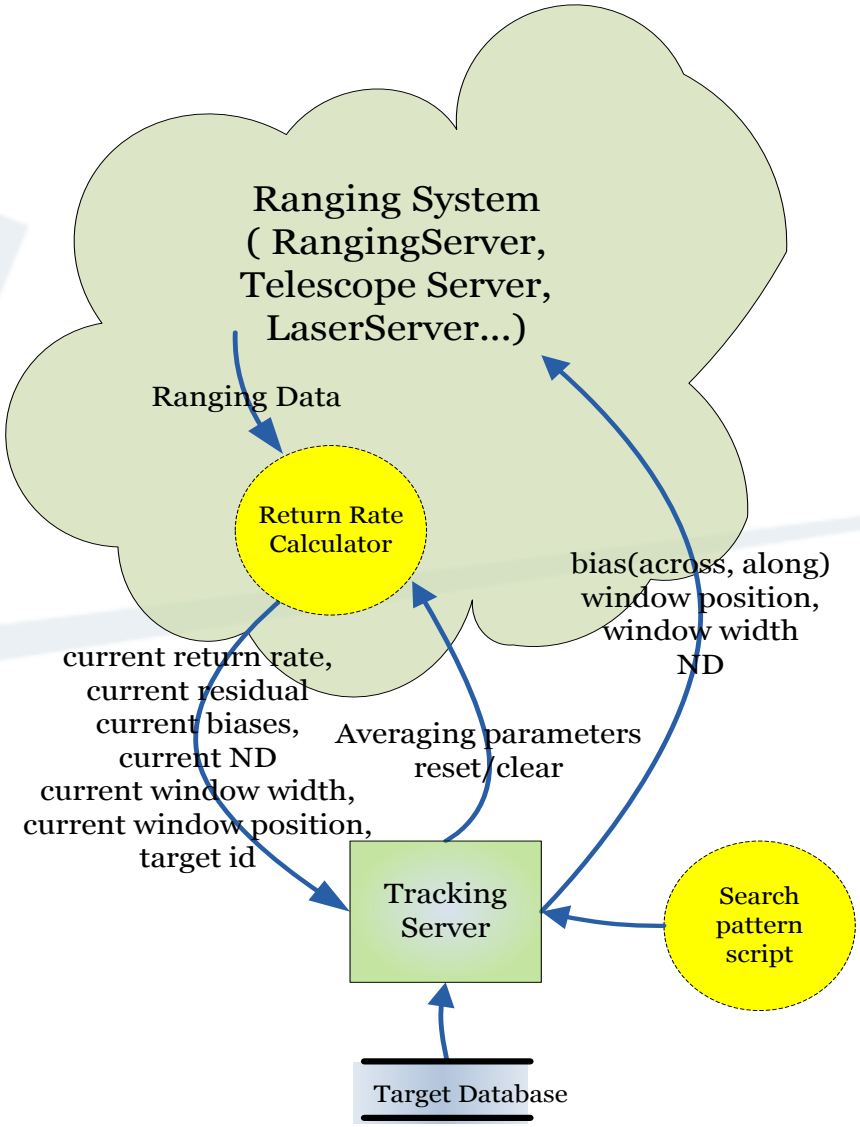
Auto Tracking



Auto Tracking

Mt Stromlo SLR System

Schematic of the Tracking Server

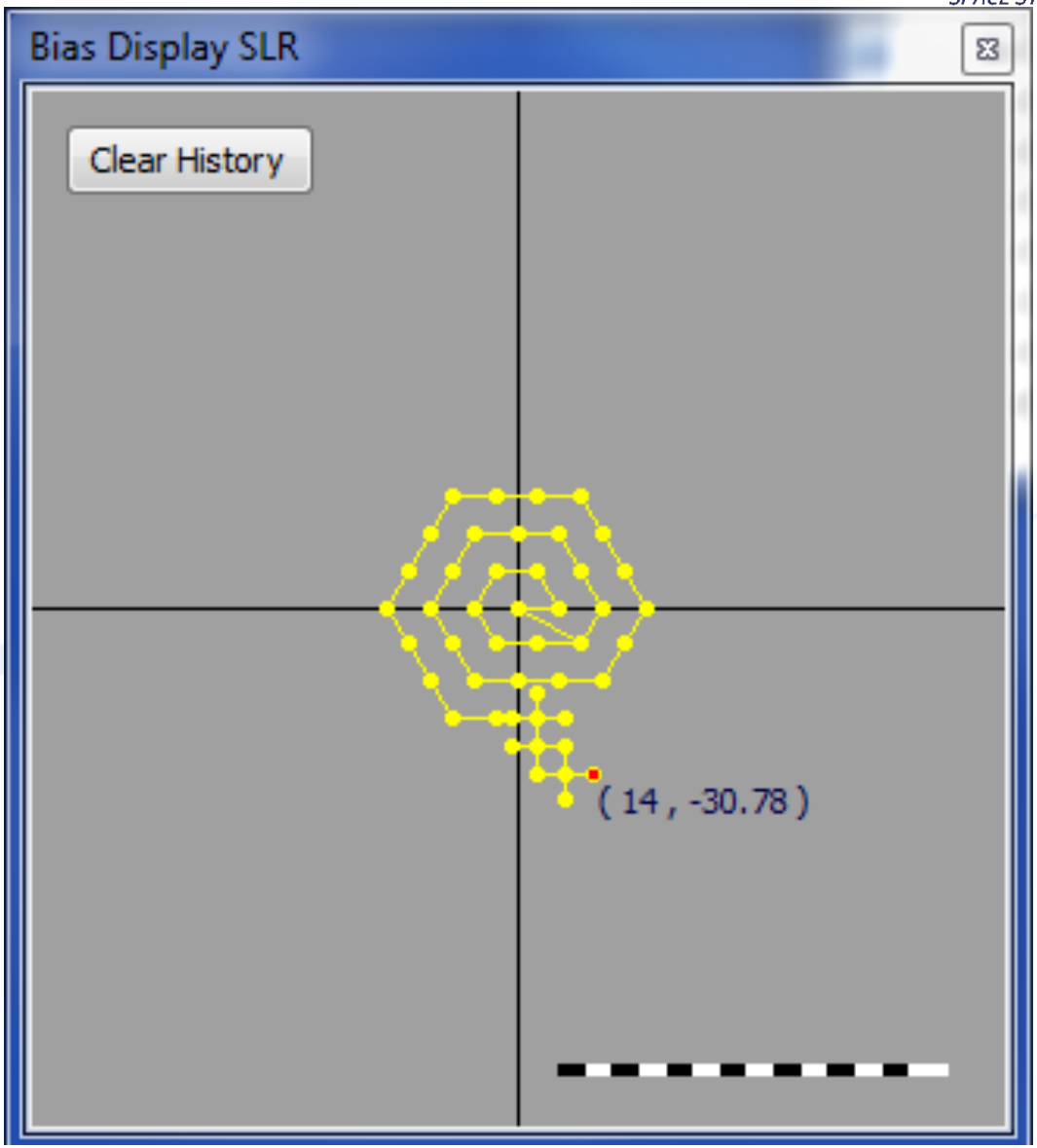


Auto Tracking

Search Pattern

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

Example shown obtained during initial tracking of cubesat “Biarri”



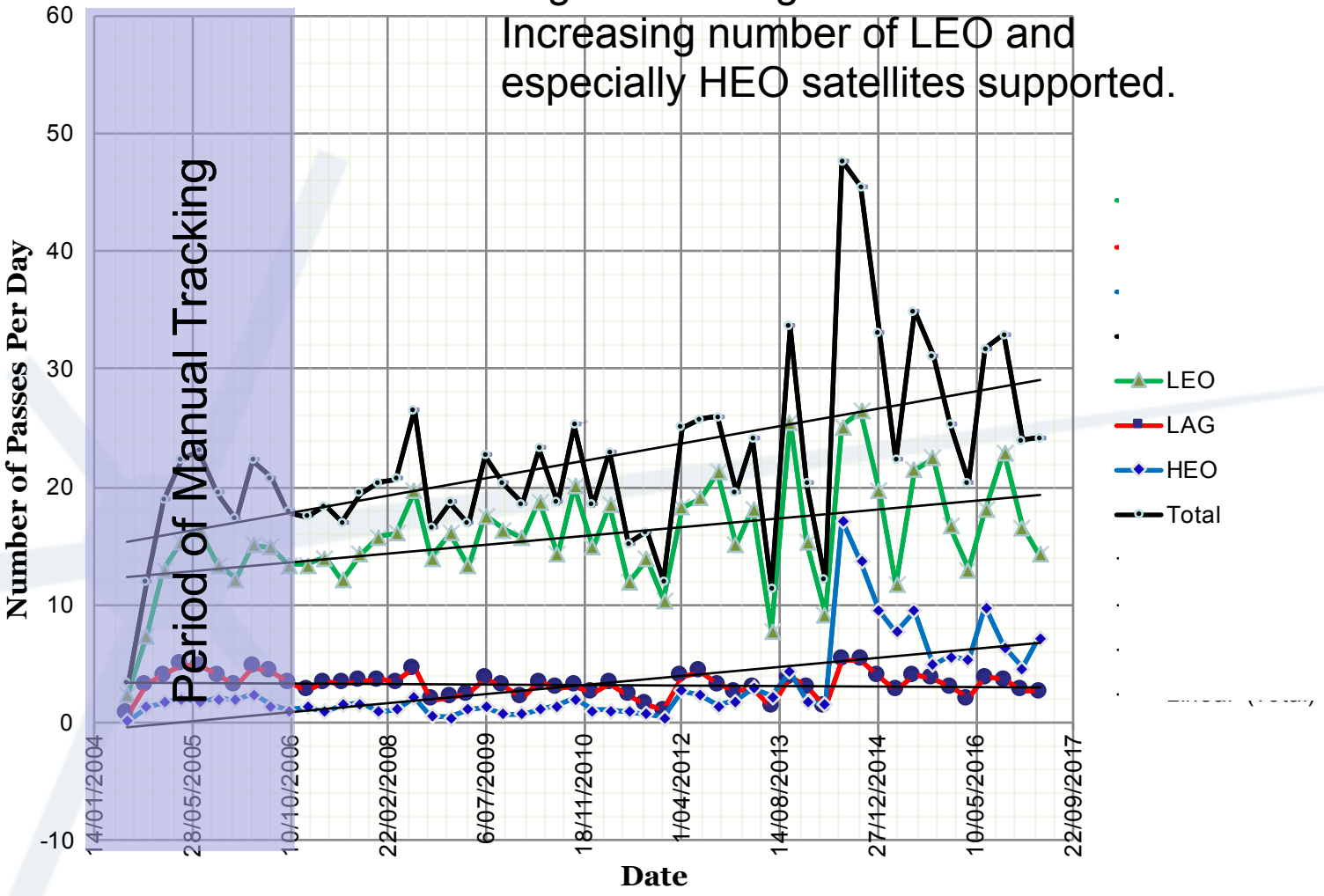
Auto Tracking

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.

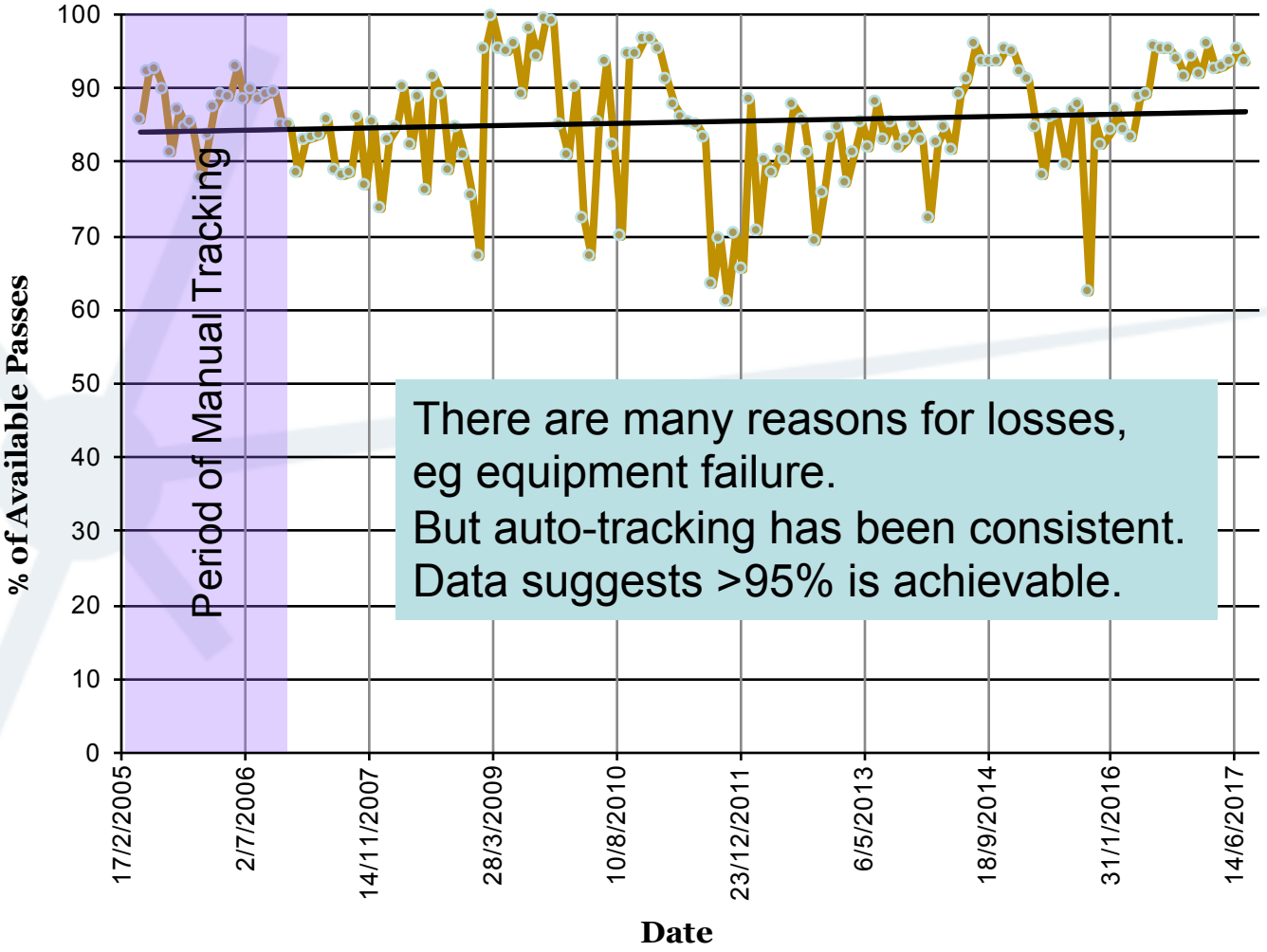
Auto Tracking

Over 10 years;
Lageos tracking has been maintained.
Increasing number of LEO and especially HEO satellites supported.



Auto Tracking

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



There are many reasons for losses, eg equipment failure.
But auto-tracking has been consistent.
Data suggests >95% is achievable.

Auto Tracking

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.