
Integrity Monitoring Improvements for GPS Utilizing the National Geospatial-Intelligence Agency (NGA) Monitor Station Network

PAWG

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History of TAT2 and AII

- ◆ AII originally scheduled for 1999 operation as part of AEP Phase Version 3/4
 - Rescheduled to AEP Version 5.2 in 2005
- ◆ Captain Curtis Hay/CZG, NGA, and ARL:UT devised a plan to utilize AII infrastructure in the interim
 - ARL:UT deployed the prototype in 2000 under NGA funding
 - Importance elevated after PRN 22 anomaly
 - Air Force then funded ARL:UT for the operational configuration and future enhancements
 - Deployed in 2002
- ◆ Temporary Analysis Tool at 2SOPS (TAT2)
 - Provides NGA QA displays
 - Custom residual display

Current TAT2 Capabilities - 1

- ◆ Off-line means of monitoring SV performance
- ◆ Independent assessment using NGA station data
- ◆ Quick Look Display (QLD)
 - Tabular display of last 15 minute smoothed residual for NGA AII stations for PSO
 - Similar to NMRES
- ◆ Residual Analysis Tool
 - Time history residual analysis tool for 2SOPS analyst and contractors
 - 15 minute smoothed residuals for all NGA stations
- ◆ NGA monitor station status display
 - Provides PSO with station tracking and health information

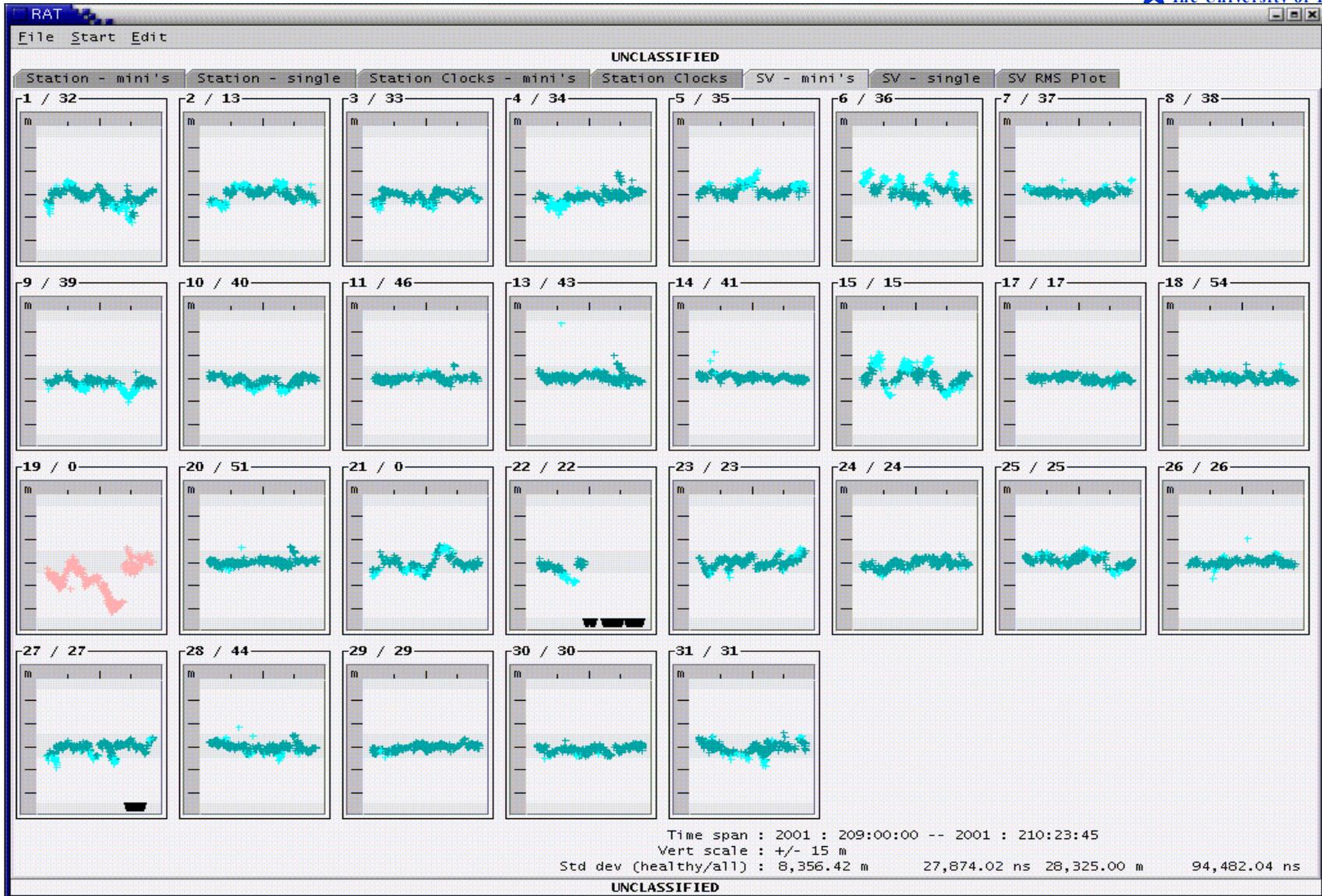
- ◆ Successfully used to
 - Monitor constellation
 - When SV are out of OCS station view
 - For validation of anomaly when there is single OCS station visibility of the SV
 - During OCS downtime
 - Perform post analysis
 - GPS Enhanced Theater Support (GETS) evaluation
 - Anomaly analysis using stored files
- ◆ Operational use is projected well into AEP transition

Quick Look Display

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Epoch : 251:21:15						
SV/PRN	21 85407 USNOM MRES EL	22 85406 ECUADM MRES EL	23 85403 ARGENM MRES EL	24 85404 ENGLM MRES EL	25 85405 BAHRM MRES EL	26 85402 AUSTM MRES EL
13 / 2	-0.969 81	-1.090 34		0.043 25		
15 / 15			0.268 24	1.910 15		
17 / 17				0.410 46	0.892 61	
22 / 22						
23 / 23			3.578 31			
24 / 24						
25 / 25	-0.913 30	-1.646 20		-0.764 45		
26 / 26						-0.531 45
27 / 27						
29 / 29						0.373 39
30 / 30				-0.860 20	-0.395 69	
31 / 31	0.611 15	0.090 60	-0.273 57			
32 / 1	1.190 65	0.432 29		1.079 13		
33 / 3	1.057 41	0.520 73	0.744 43			
34 / 4						-0.723 21
35 / 5					-0.050 41	
36 / 6	-3.361 2			-1.523 57	-1.652 55	
37 / 7						1.478 73
38 / 8						0.953 25
39 / 9						0.325 29
40 / 10				0.827 15	0.920 36	
41 / 14		0.978 16	-0.187 58			
43 / 13	-0.900 37					
44 / 28						-0.397 36
45 / 21				-0.451 49	-0.400 50	
46 / 11		-0.690 17	-0.321 35			
51 / 20	-0.285 16	-0.478 39	-0.232 16			
54 / 18					-0.967 21	
56 / 16	0.209 63	0.238 20		-0.285 48		

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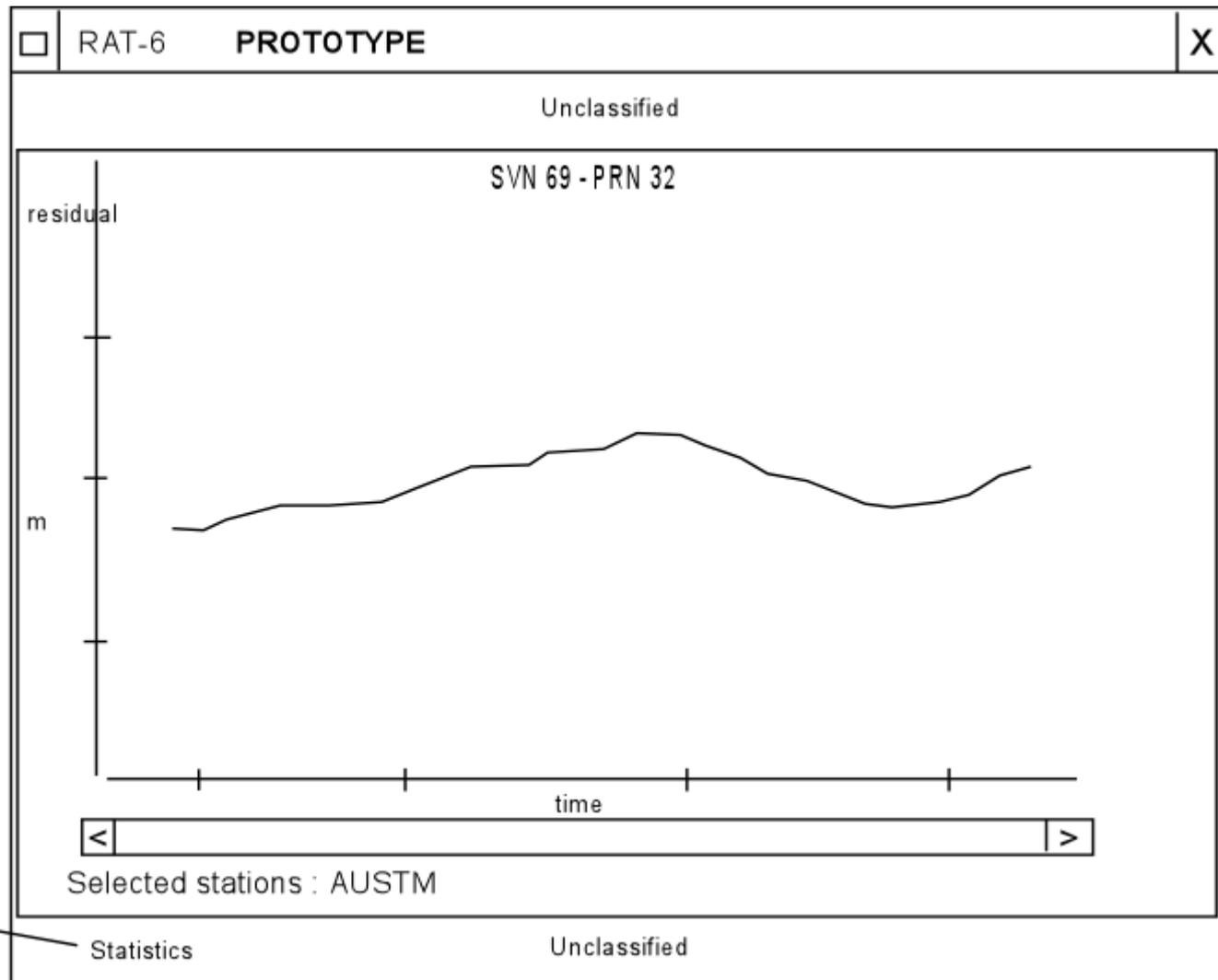
Residual Analysis Tool



CY04 TAT2 Enhancements

- ◆ Enhancements are currently in development
- ◆ C/A code monitoring
 - NGA stations track C/A code throughout pass in addition to P/Y-code tracking
 - Tabular residual display
 - Updated in real-time off 1.5s data
 - Similar to NMRES/QLD
- ◆ 1.5s SV P/Y-code residual display
 - Graphical display of single SV per plot
 - Updated in real-time off 1.5s data
 - Similar to NRDSUM
- ◆ Deployment planned in spring/summer 2004

Prototype 1.5s Plot



show average residual and standard deviation (m/ns)

TAT2's Future

- ◆ Continued use of functionality after AEP 5.2
- ◆ Possible additional independent GPS monitoring tools
 - Use of EPOCHAs – NGA's future near real-time orbit production
 - EPOCHAs derived ERDs
 - EPOCHAs vs OCS Kalman filter comparisons
 - L2C monitoring
 - SA corrected vs SA uncorrected displays
 - PVT accuracy at a station
 - IGS real-time stations as additional monitor stations

- ◆ Near real-time NGA ephemeris generation
- ◆ Could provide OCS real-time quality control of GPS filter
 - Similar to the way the NGA Precise Ephemeris provides post quality assurance
- ◆ Possible tools/screens
 - Real-time comparison of OCS and EPOCHCHA filter states
 - ERD displays based on EPOCHCHA filter

L2C Monitoring

- ◆ Next NGA receiver will provide L2C tracking
 - Expected deployment in spring 2006
 - Display could be available to OCS in same year
- ◆ OCS L2C data currently not planned to flow into AEP until V6 at the earliest
- ◆ Provide additional screens to display L2C data
 - Similar to C/A QLD display

- ◆ Provide display of PVT accuracy at a monitor station
- ◆ Generate accuracy statistics using SPS, PPS, single or dual frequency to determine actual PVT performance at a station
- ◆ Could be used to evaluate GETS improvements in real-time

Summary

- ◆ TAT2 functionality provides valuable capabilities to OCS mission with additional monitoring capabilities and redundancy
- ◆ Independent verification from a trusted source
- ◆ ARL:UT will provide 1.5s and C/A residual displays in CY04
- ◆ ARL:UT could provide additional capabilities to improve monitoring of GPS by 2SOPS