Poster #3137

A Status Report on KASI Prediction Center (KAS)

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Abstract

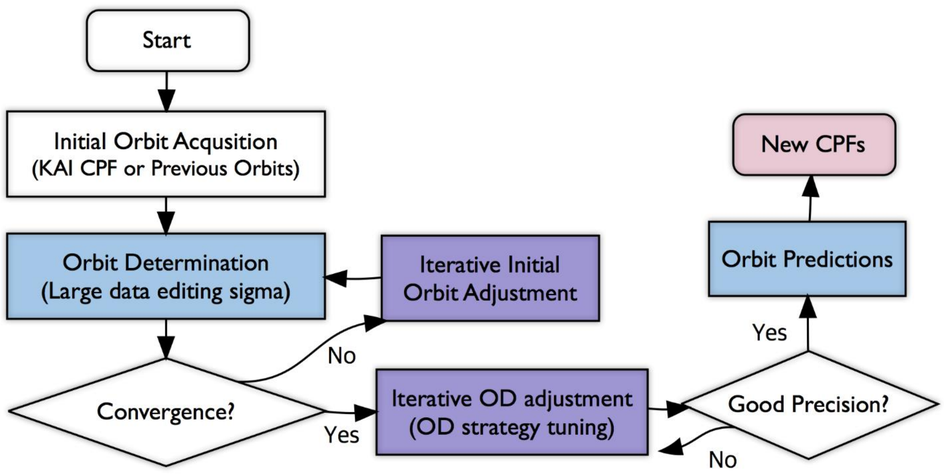
Korea Astronomy and Space Science Institute (KASI) has been providing a supplementary orbit predictions for the Science and Technology Satellite (STSAT)-2C as one of ILRS prediction centers since April 7, 2014. The satellite orbit predictions are delivered in the form of the Consolidated Prediction Format (CPF). The STSAT-2C is the first Korean satellite equipped with the laser retro-reflector array for satellite laser ranging (SLR). The abbreviation in CPFs by KASI is KAS. The main provider of CPFs for STSAT-2C is the Korea Advanced Institute of Science and Technology (KAIST, KAI). The KAI prediction center consistently provides CPFs for STSAT-2C. However, KAI CPFs based on two line element (TLE) have limits in ensuring accuracy. The only source for orbit determination (OD) for STSAT-2C is SLR observations, and therefore an attempt to make enhanced CPFs from SLR-based OD was accomplished and KASI started to operate KAS prediction center. In this study, we report an operation status and prediction procedure on KASI prediction center. For verification of CPFs generation strategy, test periods are prepared first and their results are investigated. Next, regular periods are started with CPFs generation if new SLR observations are available. The details of satellite orbit predictions procedure are described and the history of KAS CPFs for STSAT-2C generation is summarized. We will prepare better strategy for quality assessment of KAS CPFs and continuously try to generate confirmed CPFs for more SLR tracking for STSAT-2C.

Orbit Determination and Prediction System

- **Orbit Determination and Prediction Setting**
  - H/W : Workstation with Intel Xeon E5645@2.40GHz (64bit Linux OS)
  - NASA/GSFC GEODYN II system configuration

Model/Parameter	Description
Reference Frame	
Reference system	Inertial reference system
Precession/nutation	IAU2000
Polar motion	C04 IERS
Station coordinates	ITRF2008
Numerical Integration	Cowell's method
Step size	30 s
Arc length	Variable (depend on normal point acquisition condition)
Dynamic Model	
Earth geo-potential	GGM-2C (200 by 200)
Planetary ephemeris	JPL DE-403
Earth tide	IERS convention 2003
Ocean tide	GOT00.2
Dynamic polar motion	Applied
Relativistic effect	Applied
Atmospheric density	MSIS-86
Solar radiation	Box-wing macro
Earth Albedo pressure	Applied
Empirical acceleration	Radial, along and cross-track
Measurement Model	
Observations	15s SLR normal points (EDC data center)
Tropospheric delay	Mendes and Pavlis
Center of offset of the LRA	-203.54, -167.67, 928.05 (mm, X, Y, Z)
Estimation Parameters	Position and velocity of satellite

- **Orbit Determination and Prediction Strategy [1]**
  - Initial orbit acquisition / Iterative initial orbit adjustment / Iterative OD adjustment



< The flowchart of OD and KAS CPF generation >

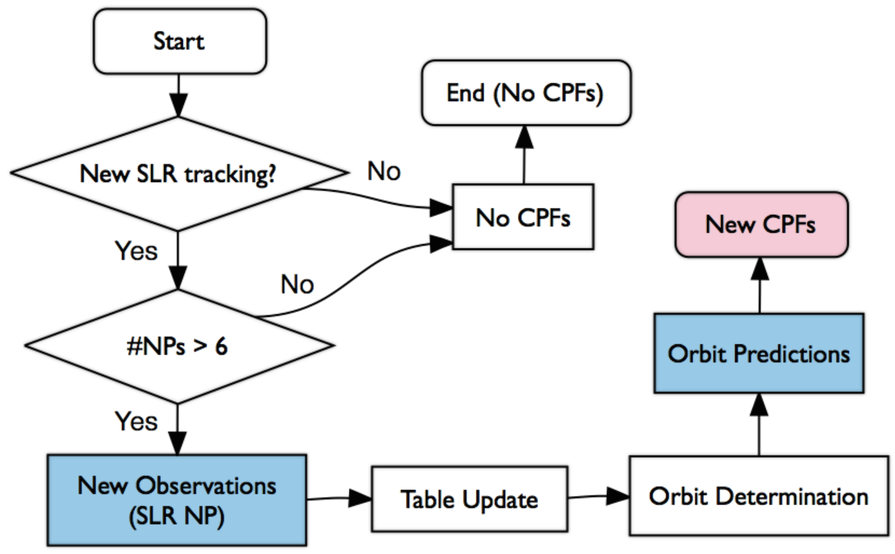
Operation Status

- **First Stage (Test Period for Effective Strategy)**
  - **Very sparse SLR tracking condition** of STSAT-2C
    - STSAT-2C : 204 passes and 2,215 normal points during one year
    - KOMPSAT-5 : 152 passes and 3,526 normal points during one month
  - **Test period** for effective orbit determination and prediction
    - Daily CPFs generation : **2014/4/7 – 2014/4/22**
    - Various estimation strategy applied (measurement bias estimation or not)
    - CPFs performance check (using precise orbit determination results)
      - **CPFs with OD using SLR observations : meaningful accuracy**
      - **CPFs with prediction only : bad accuracy**
    - Laser tracking verification (by Yarragadee station) : smaller bias than KAI CPFs (need more tracking)
  - Test conclusions
    - Only SLR-based CPFs from OD with new SLR observations
- **Second Stage (Regular Period with Stable Strategy)**
  - **Regular period** for stable orbit determination and prediction
  - CPFs generation : **2014/4/28 - now**
    - No measurement bias estimation
    - CPFs performance check
      - **SLR tracking trials** by ILRS stations using KAS CPFs
      - **SLR Residuals check** using both KAI and KAS CPFs

Test KAS Operation	Regular KAS Operation
20140407 ~ 0422 Daily CPFs generation CPFs performance check	20140428 ~ now CPFs with new SLR observations only CPFs performance check

Prediction Procedure

- **Orbit Determination Using SLR**
  - Orbit determination with new SLR observations
  - The minimum number of SLR observations = 6
  - No CPFs : no SLR observations or few (1 ~ 5 NPs) observations in pass
- **CPFs Generation from OD Results**
  - The 4 day orbit prediction based on determined orbits
  - Geocentric true body-fixed reference frame (default CPF frame)
  - Consistency check : using KAI CPFs
  - CPFs Upload : CDDIS data center



< The flowchart of KAS CPF generation >

Status of KAS CPFs Generation

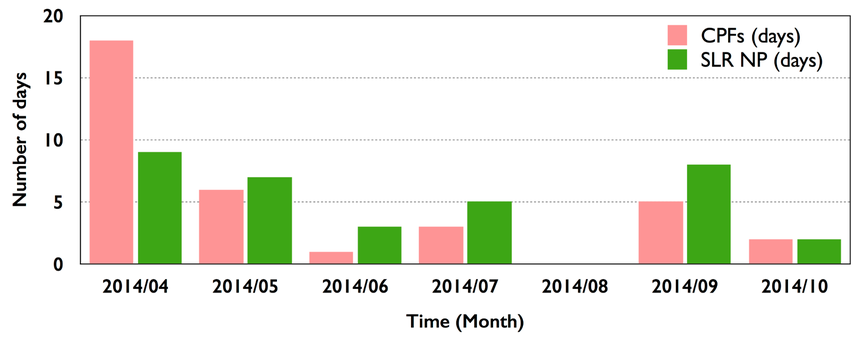
- **The Statistics of KAS CPFs**
  - Total number of KAS CPFs (2014) : 35 CPFs

#	File name (.kas)	#	File name (.kas)	#	File name (.kas)	#	File name (.kas)
1	stsat2c_cpf_140404_5941	11	stsat2c_cpf_140416_6061	21	stsat2c_cpf_140508_6281	31	stsat2c_cpf_140912_7551
2	stsat2c_cpf_140407_5971	12	stsat2c_cpf_140417_6071	22	stsat2c_cpf_140517_6371	32	stsat2c_cpf_140929_7721
3	stsat2c_cpf_140408_5981	13	stsat2c_cpf_140418_6081	23	stsat2c_cpf_140521_6411	33	stsat2c_cpf_140930_7731
4	stsat2c_cpf_140409_5991	14	stsat2c_cpf_140419_6091	24	stsat2c_cpf_140529_6491	34	stsat2c_cpf_141001_7741
5	stsat2c_cpf_140410_6001	15	stsat2c_cpf_140420_6101	25	stsat2c_cpf_140622_6731	35	stsat2c_cpf_141002_7751
6	stsat2c_cpf_140411_6011	16	stsat2c_cpf_140421_6111	26	stsat2c_cpf_140712_6931		
7	stsat2c_cpf_140412_6021	17	stsat2c_cpf_140422_6121	27	stsat2c_cpf_140714_6951		
8	stsat2c_cpf_140413_6031	18	stsat2c_cpf_140428_6181	28	stsat2c_cpf_140716_6971		
9	stsat2c_cpf_140414_6041	19	stsat2c_cpf_140506_6261	29	stsat2c_cpf_140905_7481		
10	stsat2c_cpf_140415_6051	20	stsat2c_cpf_140507_6271	30	stsat2c_cpf_140910_7531		

- **SLR observations and KAS CPFs Follow-up** SLR tracking KAS CPFs

2014/04	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
CPFs																															
2014/05	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
CPFs																															
2014/06	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
CPFs																															
2014/07	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
CPFs																															
2014/08	No observations																														
CPFs	No CPFs																														
2014/09	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
CPFs																															
2014/10	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Month	CPFs/SLR NPs (days)
2014/04	18/9
2014/05	6/7
2014/06	1/3
2014/07	3/5
2014/08	-
2014/09	5/8
2014/10	2/2



Conclusions and Future Works

- **Conclusions**
  - KASI prediction center (KAS): SLR-based STSAT-2C CPFs generation
  - KAS CPFs test period: 2014/04/04 - 2014/04/22
  - KAS CPFs regular period: 2014/04/28 – now
  - SLR-based KAS CPFs: better quality if only SLR NPs exist
- **Future Works**
  - Continuous operation of CPFs generation
  - KAS CPFs quality check by ILRS tracking supports (not easy works)
  - Alternative strategy for quality assessment of KAS CPFs

References

[1] Kim, Y.-R., Park, E., and Lim, H.-Y. (2013) Orbit determination and analysis for STSAT-2C, 18th International Workshop on Laser Ranging.

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