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A Study on INRSM Performance Improvement based on Platform Integration using Single Multi-Core System

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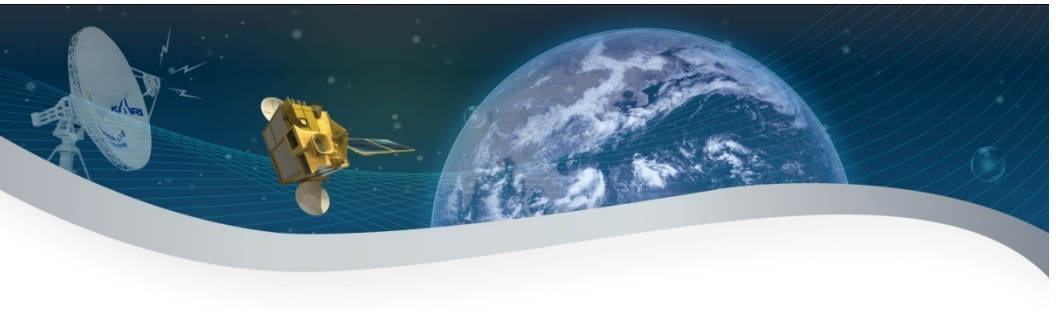
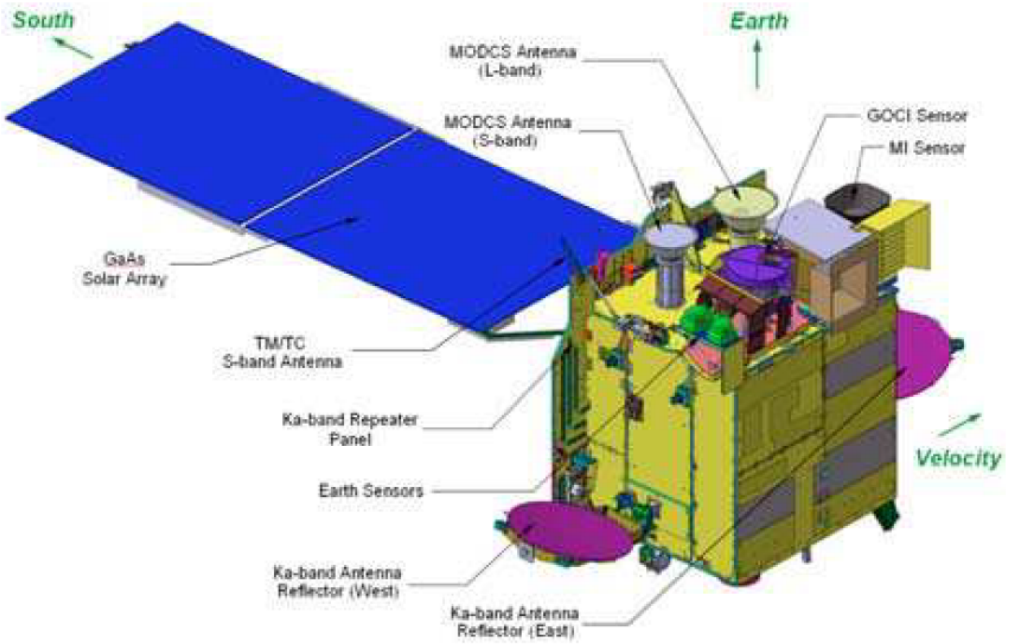


AGENDA

- COMS system overview
- COMS INR Architecture
- INR system analysis and improvement plan
- Test results
- Conclusion

COMS SYSTEM OVERVIEW

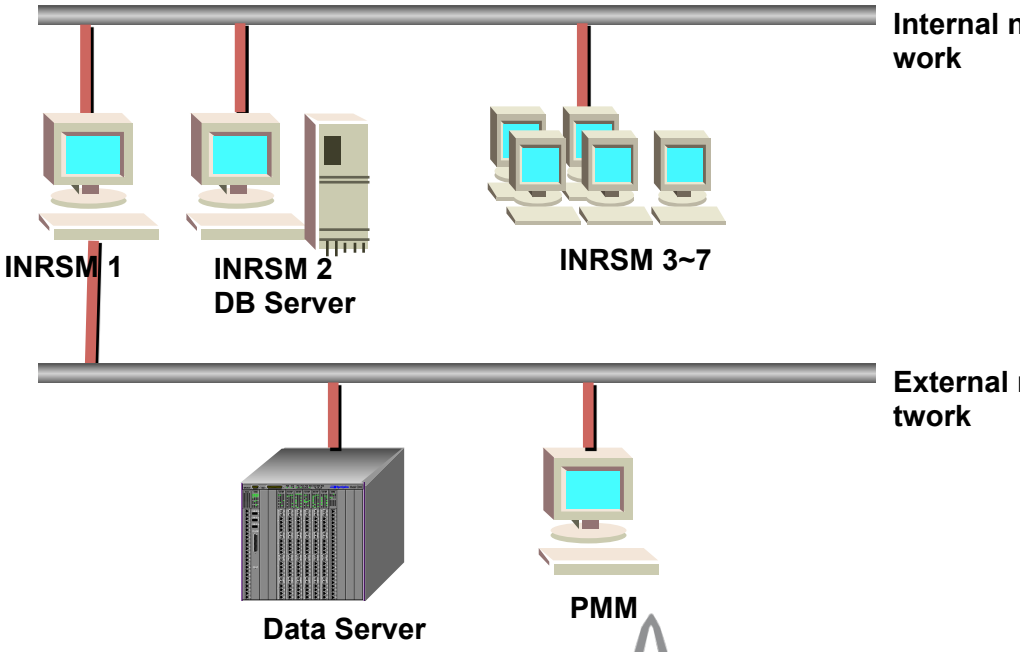
- COMS has been launched by Ariane 5 ECA on June 26 2010.
- COMS has the hybrid mission of :
  - A meteorological observation by MI
  - An ocean monitoring by GOCI
  - An experimental Ka-band telecommunication service
- COMS is the first 3-axis stabilized geostationary satellite ever built in Europe for optical remote sensing.
- Orbital location : 128.2°E.
- Life time : 7.7 years.
- S/C launch mass : 2460kg
- Size : 2.6m * 1.8m * 2.8m



INR ARCHITECTURE [1/2]

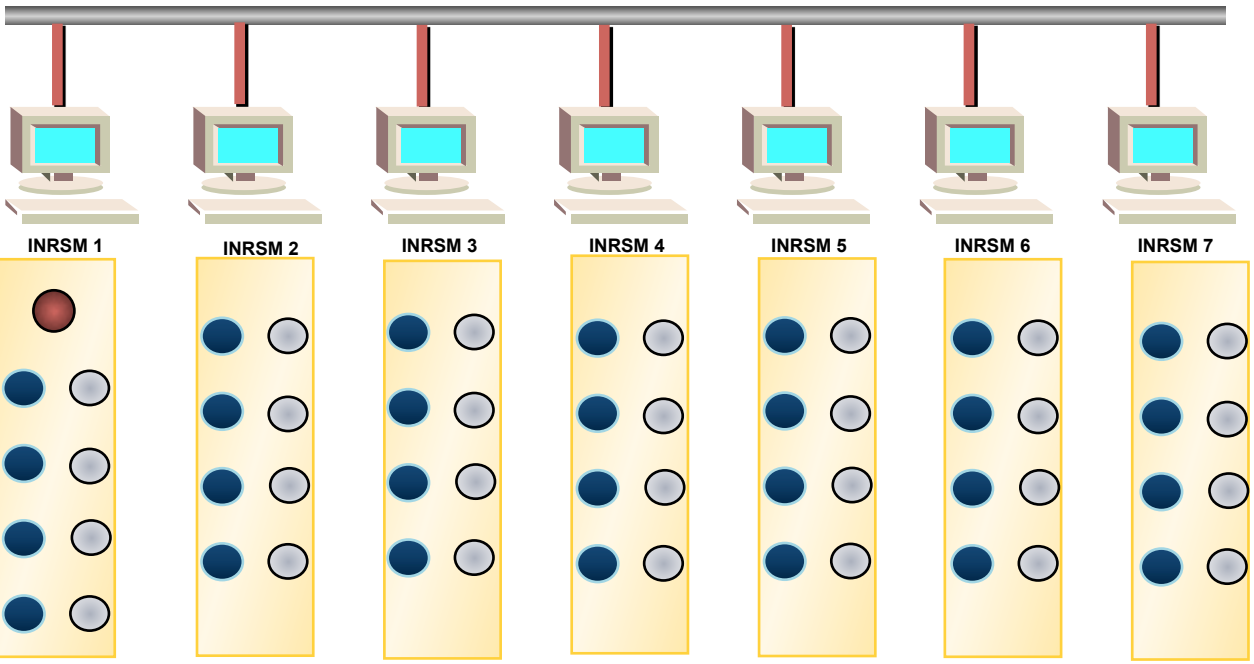
- Internal
  - 7 INR Processing Machines (include 1 DB server)
  - Each machine has 4 cores. (Total 28 cores)
  - Internal data is managed by DBMS
    - Configuration parameters / Landmarks / Tie point / etc

- External
  - The shared data storage(RAID) is necessary to share data between PMM and INRSM1
  - PMM and INRSM are connected to each other by LAN to share the RAID



INR ARCHITECTURE [2/2]

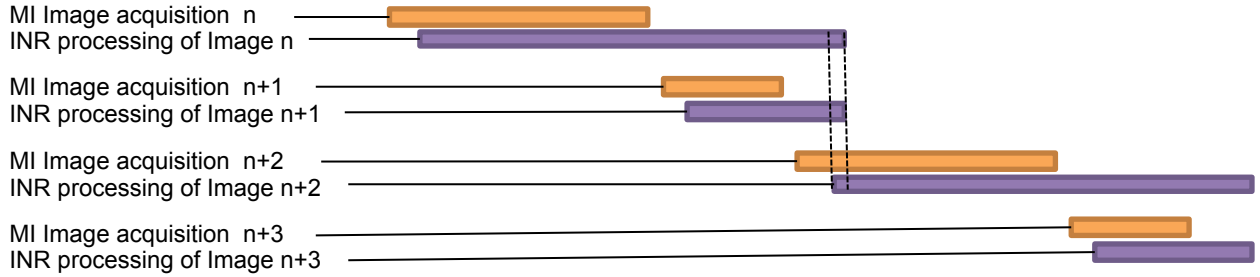
- Each process of INRSM can be executed in several machines simultaneously.
- Communications between processes are required to control the execution of each process. (INR SMexe / LDexe / IRexe)
- Parallel computing(CORBA) : use multiple processors in parallel to meet timeliness requirement.
- PMM to INRSM
  - Telemetry data
  - Ephemerides data
  - Event data
  - Image data
- INRSM to PMM
  - IMC data
  - LV1B data



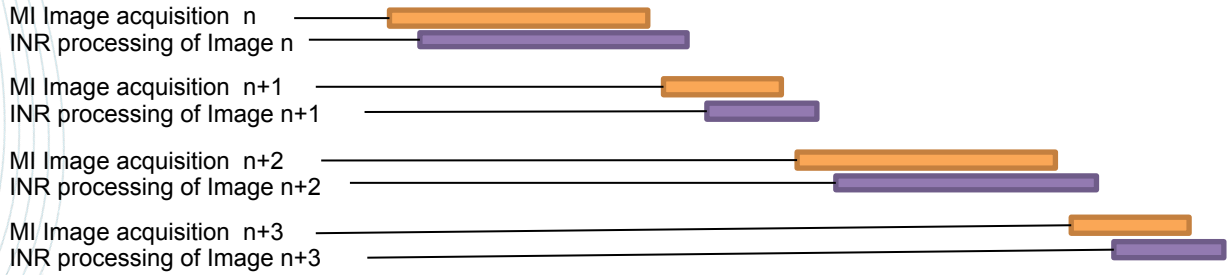
* PMM : Product Management Module

INR TIMELINESS MODE

- **TIMELINESS MODE defines for each kind of MI image**
  - **WAIT : Processing may wait for the landmarks of the first block of the following image to allow State Vector freezing and image re-sampling. (LA:592s/ENH:600s/FD :647s)**



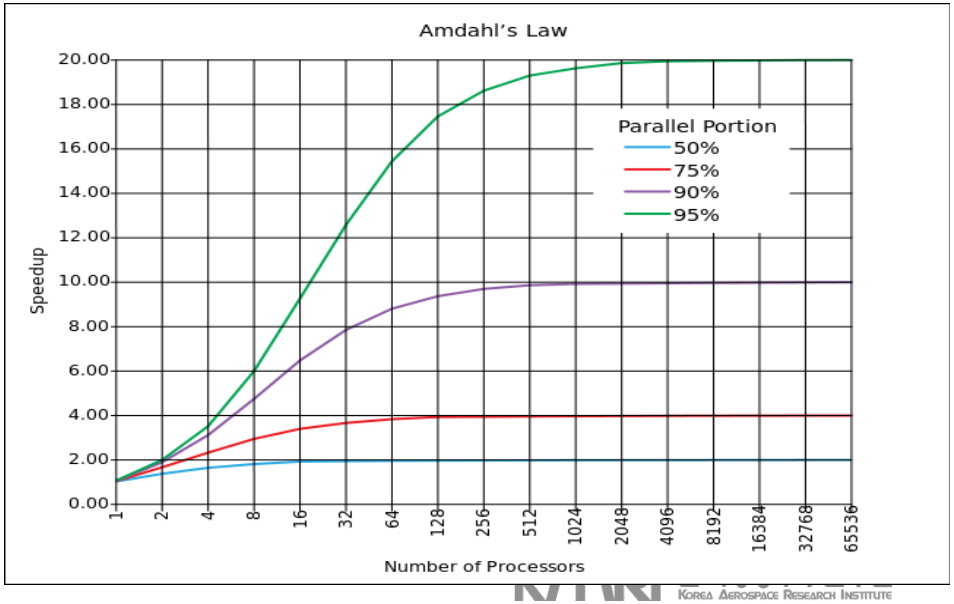
  - **NO-WAIT : Image freezing (re-sampling start) is decided as soon as last image pixel is received. (LA:159s/ENH:182s/FD :124s)**



INR SYSTEM ANALYSIS

- Parallel processing performance analysis
  - Parallel portion : 75%
  - Speed-up : 371% when comparing between 1core and 28cores. (ref. Amdahl's Law : 361%)
    - COMS INR system has a pretty good performance in parallel under the Amdahl's Law.
    - If INR system uses 32 cores, we could expect a speed-up is 365% under the Amdahl's Law.

- But, INR system has Load imbalance that results in decreasing the speed-up.
- Overall network traffic level is always high.
  - Synchronizing among processes.
  - Communicate & share process status.
  - Delivering input/output data.



IMPROVEMENT PLAN

- The distributed systems are modified to a single multi-core system.
  - To reduce network traffic volume.
  - Replace existing INR systems with new systems that have 32cores.
  - All programs for INR system, such as OS, Compiler, DBMS, Samba, are upgraded. and over all sources are modified properly to all programs upgraded.

- The distributed processing method is replaced by multi-processing and multi-threading methods suitable for the integrated system.

- The scheduling method is modified to have perfect load balancing.

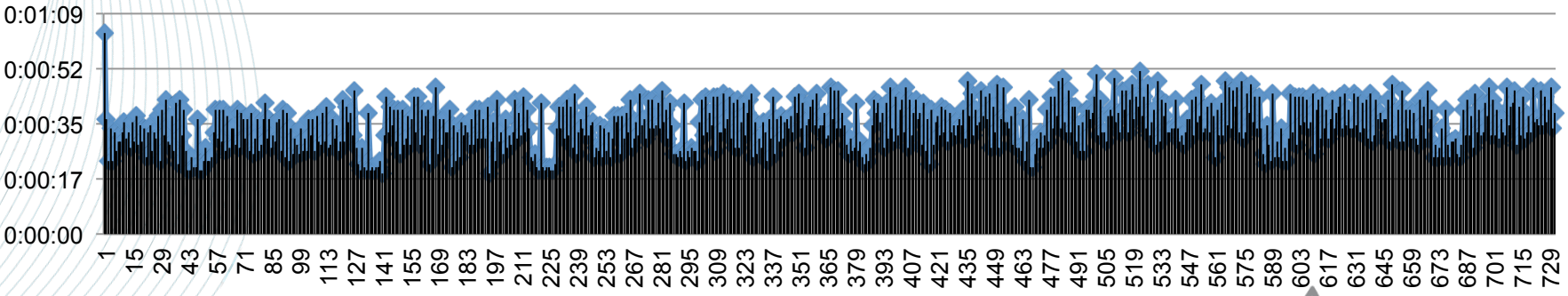
- The NO-WAIT mode is applied as Timeliness mode.

TEST RESULTS [1/4]

❖ *LA*

- **Total number of LA Image : 732**
- **Timeliness from end of the image : 0:01:22 [48.4% ↑ than before (159sec)]**

Image Scanning Time		INR Processing Time			Timing Analysis	
Start Time(1)	*End Time(2)*	*Start Time(3)*	*End Time(4)*	*Elapsed Time*	*(4) – (2)*	*(4) – (1)*
02:43:12	02:44:03	02:44:48	02:45:51	0:01:03	0:01:48	0:02:39
..	..	..	..	..	..	..
06:28:22	06:29:13	06:30:05	06:30:43	0:00:38	0:1:30	0:02:21
Statistic				**0:00:34**	**0:01:22**	**0:02:13**

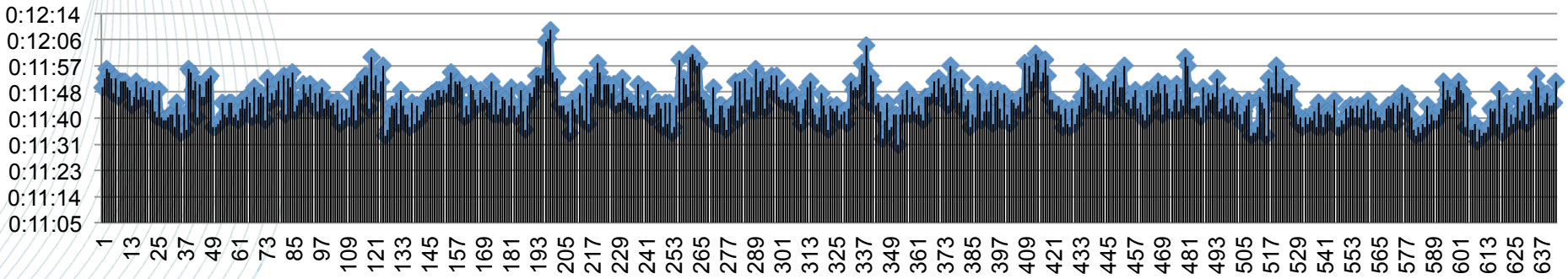


TEST RESULTS [2/4]

❖ *ENH*

- **Total number of ENH Image : 644**
- **Timeliness from end of the image : 0:02:03 [32.4 % ↑ than before (182sec)]**

Image Scanning Time		INR Processing Time			Timing Analysis	
Start Time(1)	*End Time(2)*	*Start Time(3)*	*End Time(4)*	*Elapsed Time*	*(4) – (2)*	*(4) – (1)*
02:45:21	02:57:50	02:48:12	03:00:02	0:11:50	0:02:12	0:14:41
..	..	..	..	..	..	..
06:15:23	06:27:52	06:18:12	06:30:04	0:11:52	0:2:12	0:14:41
Statistic				**0:11:42**	**0:02:03**	**0:14:32**

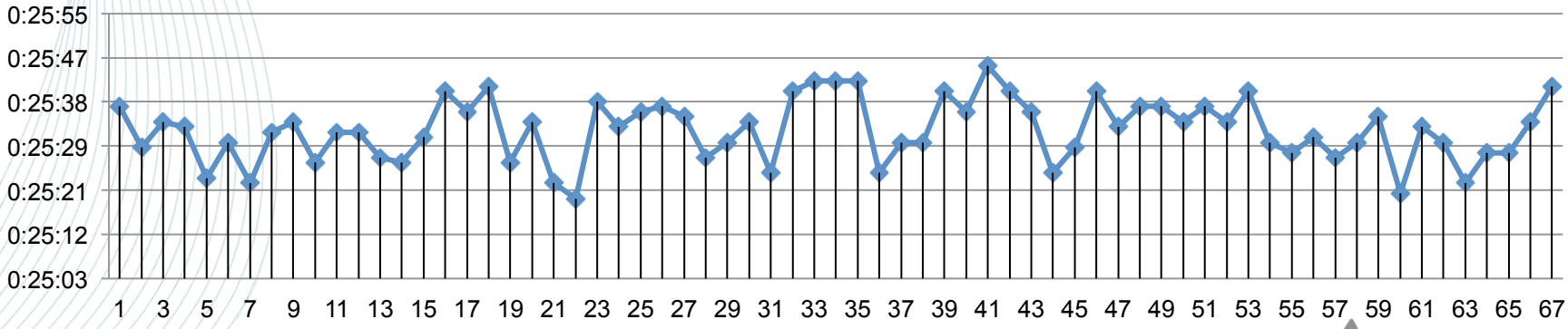


TEST RESULTS [3/4]

❖ *FD*

- **Total number of FD Image : 67**
- **Timeliness from end of the image : 0:01:49 [32.4 % ↑ than before (124 sec)]**

Image Scanning Time		INR Processing Time			Timing Analysis	
Start Time(1)	*End Time(2)*	*Start Time(3)*	*End Time(4)*	*Elapsed Time*	*(4) – (2)*	*(4) – (1)*
05:15:22	05:42:26	05:18:40	05:44:17	0:25:37	0:01:51	0:28:55
..	..	..	..	..	..	..
05:15:22	05:42:26	05:18:33	05:44:14	0:25:41	0:01:48	0:28:52
		Statistic		**0:25:32**	**0:01:49**	**0:28:53**



TEST RESULTS [4/4]

❖ **The whole processes meet image quality requirements under any weather conditions.**

ITEM	REQUIRMENT	EXISTING INRSM	TEST UNIT	RESULT
Navigation EW	65.3	47.74054559	46.95334774	OK
Navigation NS	65.3	39.24527984	38.73394339	OK
Within Frame EW	63.4	54.50161363	53.98221736	OK
Within Frame NS	63.4	52.94977142	52.57577751	OK
Registration 15m EW	55.2	27.09928853	26.81156426	OK
Registration 15m NS	55.2	23.05008163	22.79102179	OK
Registration 90m EW	63.4	30.9860367	30.71898278	OK
Registration 90m NS	63.4	26.65537953	26.55772672	OK

CONCLUSION

- To reduce INR processing time,
  - Analyzes the cause of the processing delay.
  - Suggests a new COMS INR physical design.
  - Modifies the scheduling design.

- To verify the feasibility of the suggested design, both the image processing and quality performance tests are conducted.

- From these tests,
  - The processing time decreases dramatically when applying the suggested design.
    - LA : 82 sec. (48.4% ↑)
    - ENH : 123 sec. (32.4% ↑)
    - FD : 109 sec. (12.1% ↑)
  - The image quality maintains a comparable performance to those of the existing INR system.