

Microsatellite M3MSat Ground Systems – Mission Planning System and related VPN and Ground Segment Augmentation

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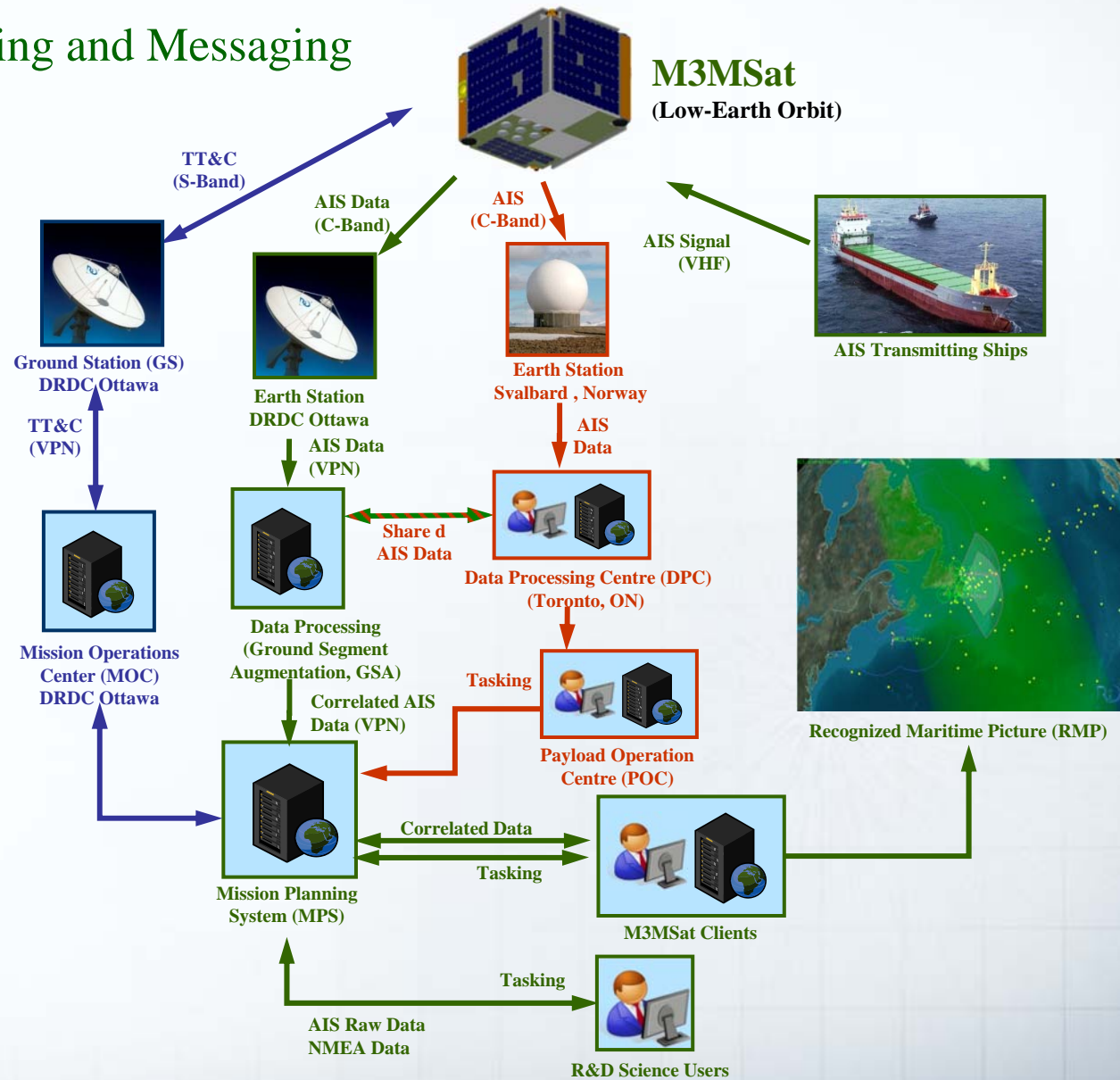
GSAW 2013

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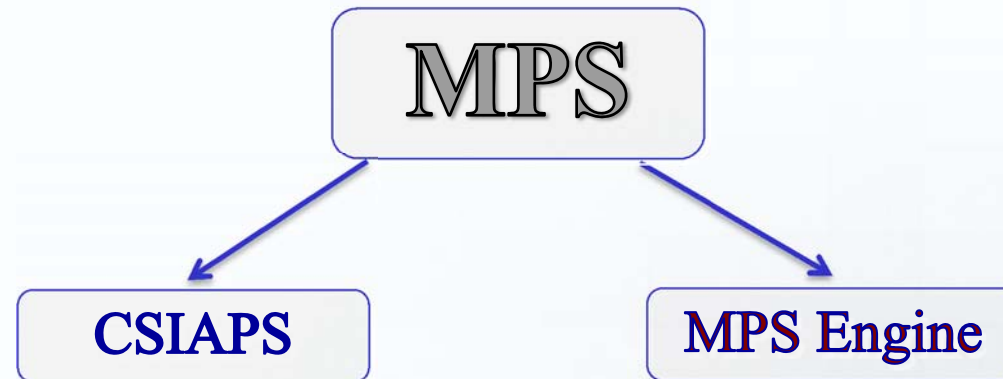


What's M3MSat?

(Maritime Monitoring and Messaging Microsatellite)



MPS - Mission Planning System

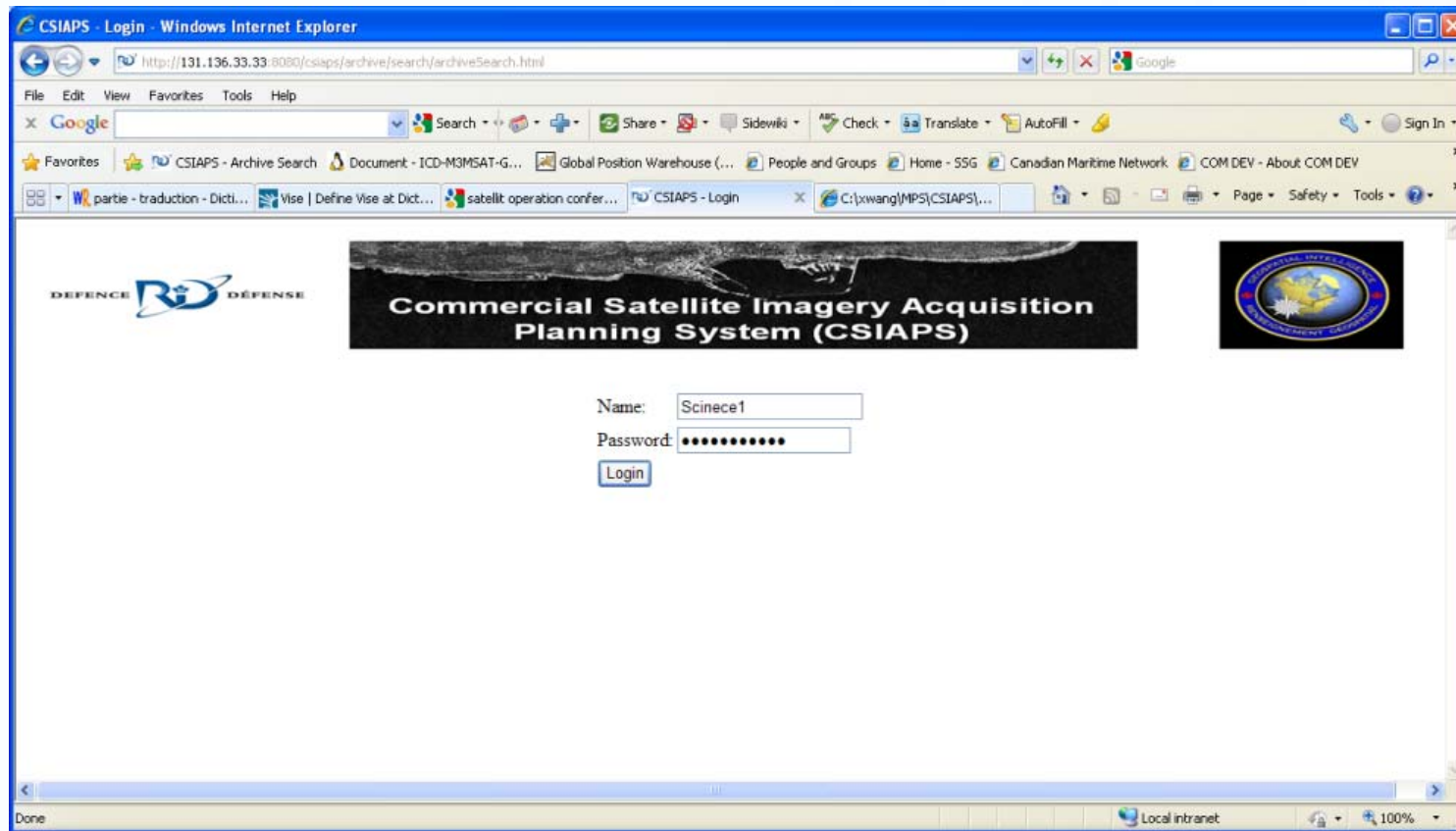


- MPS Front-end
- Web-based GUI
- DRDC existing system
- Generate user tasking reports

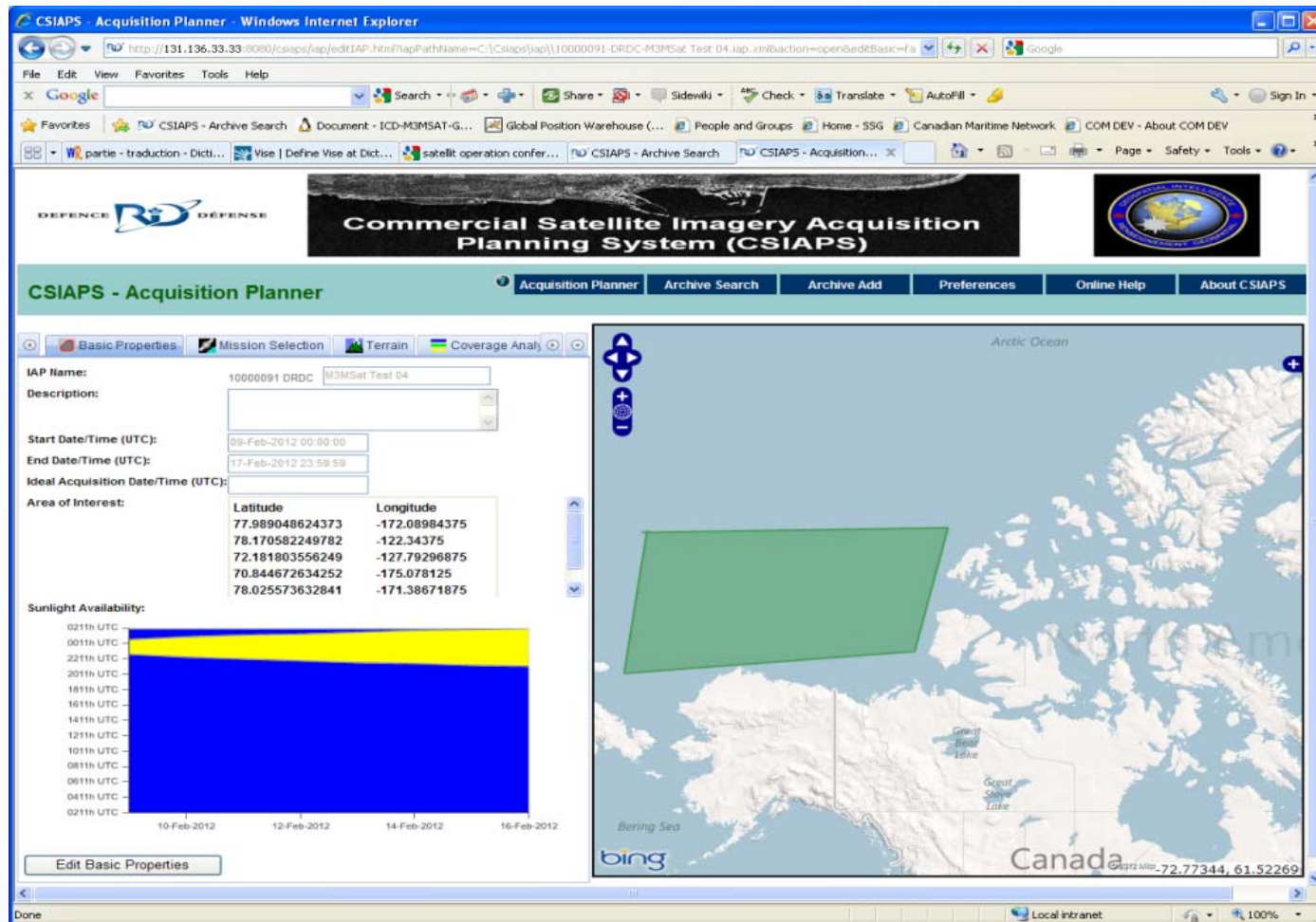
- MPS work engine
- AIS database
- Specially developed
- Generate spacecraft macro commands

CSIAPS: Commercial Satellite Imagery Acquisition Planning System

CSIAPS FrontEnd - User Tasking



CSIAPS FrontEnd - User Tasking (Cont'd)



Commercial Satellite Imagery Acquisition Planning System (CSIAPS)

CSIAPS - Acquisition Planner

Acquisition Planner | Archive Search | Archive Add | Preferences | Online Help | About CSIAPS

Basic Properties | Mission Selection | Terrain | Coverage Analy

IAP Name: 10000091 DRDC M3MSat Test 04

Description: [Empty field]

Start Date/Time (UTC): 09-Feb-2012 00:00:00


End Date/Time (UTC): 17-Feb-2012 23:59:59

Ideal Acquisition Date/Time (UTC): [Empty field]

Area of Interest:

Latitude	Longitude
77.989048624373	-172.08984375
78.170582249782	-122.34375
72.181803556249	-127.79296875
70.844672634252	-175.078125
78.025573632841	-171.38671875

Sunlight Availability:



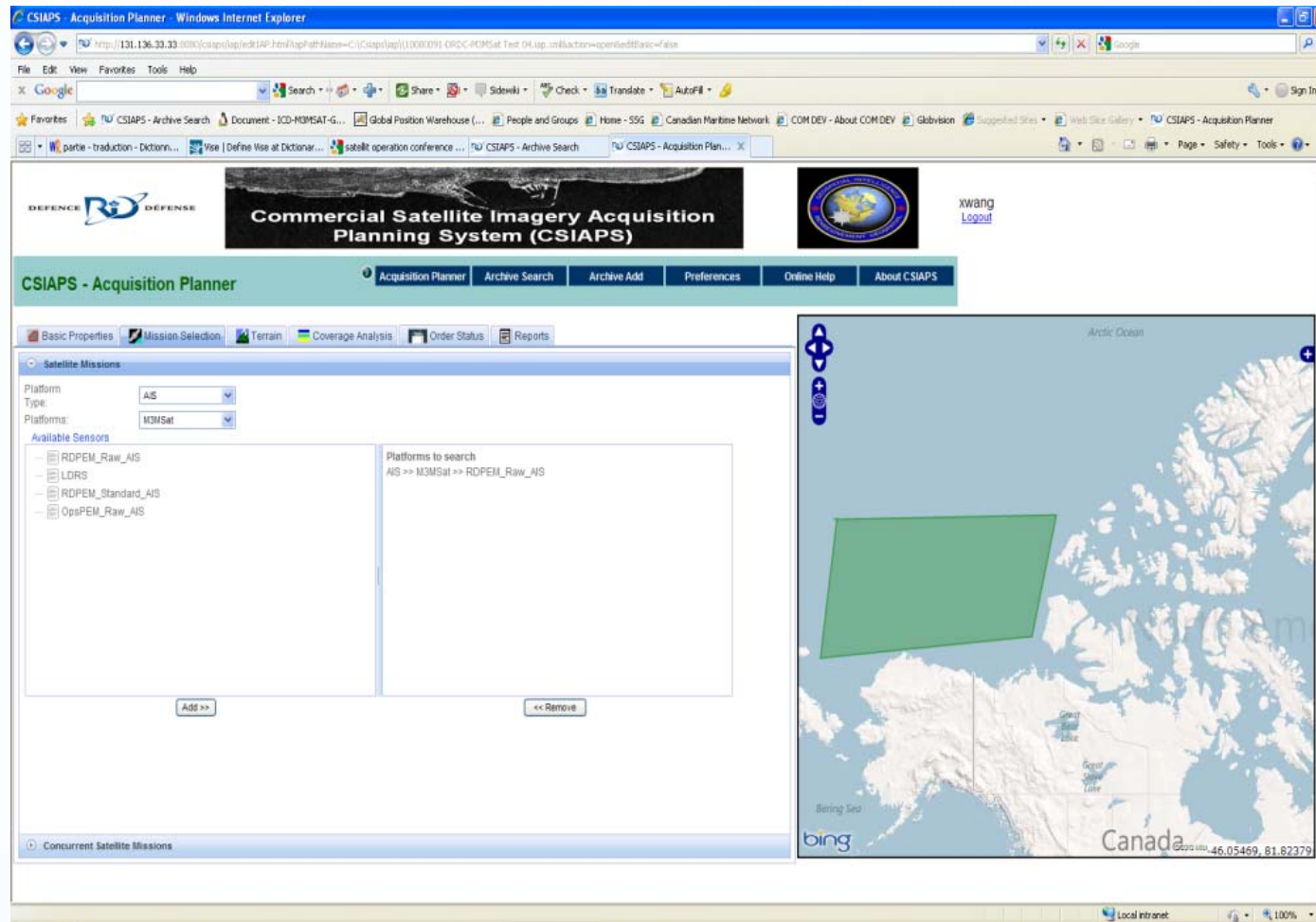
0211h UTC
0011h UTC
2211h UTC
2011h UTC
1811h UTC
1611h UTC
1411h UTC
1211h UTC
1011h UTC
0811h UTC
0611h UTC
0411h UTC
0211h UTC

10-Feb-2012 12-Feb-2012 14-Feb-2012 16-Feb-2012

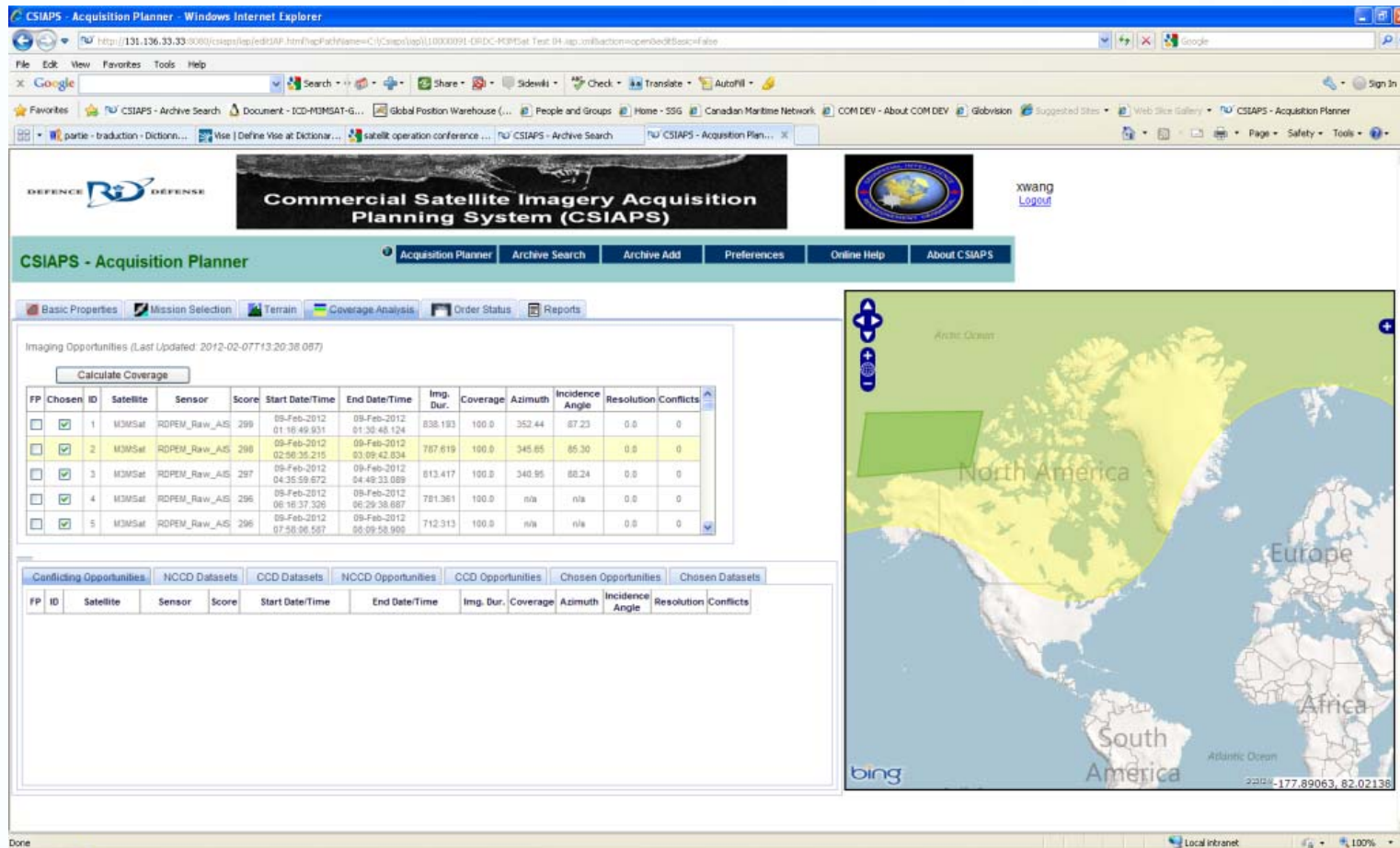
Edit Basic Properties

Arctic Ocean
Bering Sea
Great Slave Lake
Canada
bing
72,77344, 61,52269

CSIAPS FrontEnd - User Tasking (Cont'd)



CSIAPS FrontEnd - User Tasking (Cont'd)



Commercial Satellite Imagery Acquisition Planning System (CSIAPS)

CSIAPS - Acquisition Planner

Basic Properties | Mission Selection | Terrain | Coverage Analysis | Order Status | Reports

Imaging Opportunities (Last Updated: 2012-02-07T13:20:38.087)

Calculate Coverage

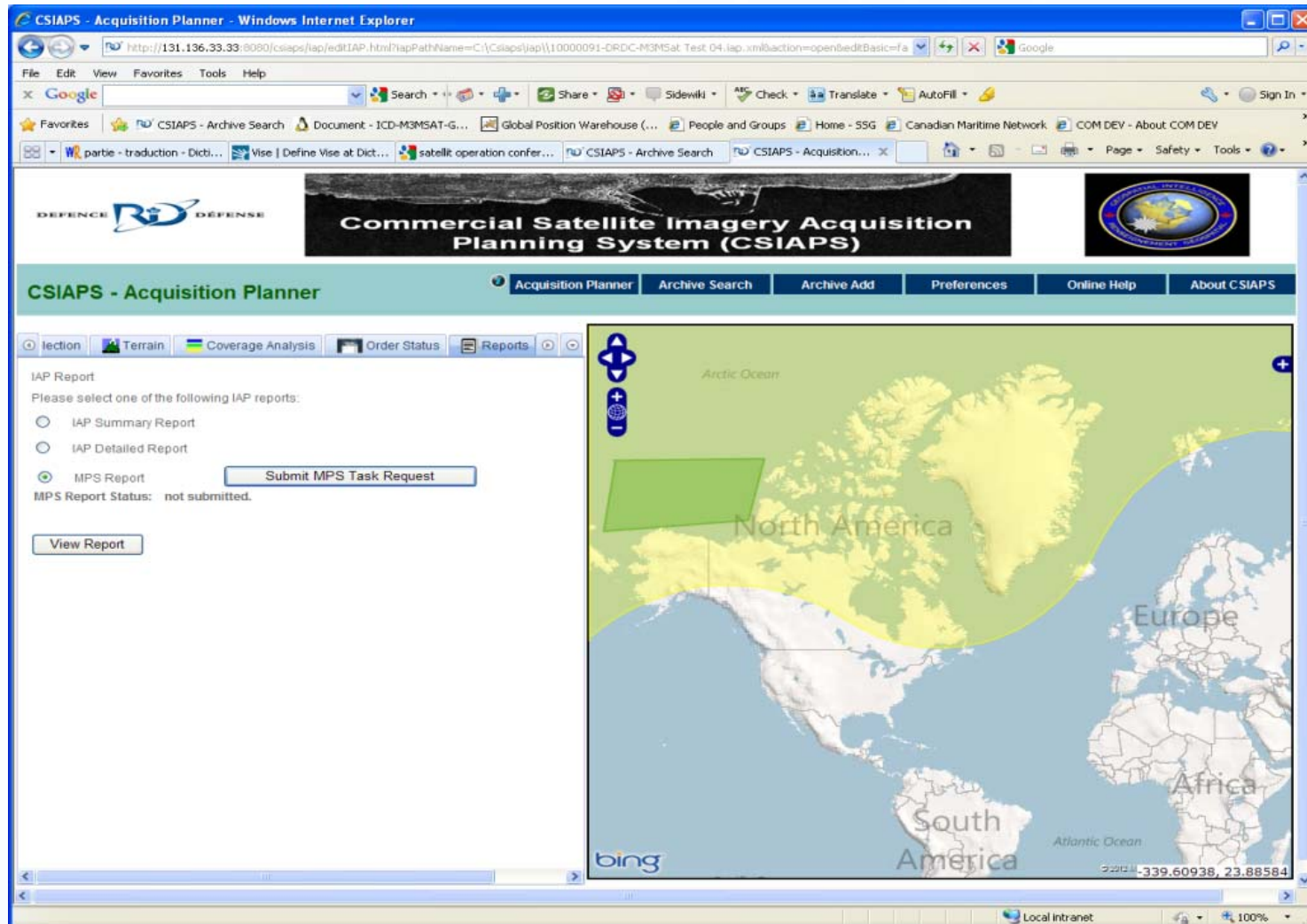
FP	Chosen	ID	Satellite	Sensor	Score	Start Date/Time	End Date/Time	Img. Dur.	Coverage	Azimuth	Incidence Angle	Resolution	Conflicts
	<input checked="" type="checkbox"/>	1	M3MSat	RDPEM_Raw_AIS	299	08-Feb-2012 01:16:49.931	09-Feb-2012 01:35:48.124	838.193	100.0	352.44	87.23	0.0	0
	<input checked="" type="checkbox"/>	2	M3MSat	RDPEM_Raw_AIS	298	09-Feb-2012 02:58:35.215	09-Feb-2012 03:09:42.834	787.619	100.0	345.65	85.30	0.0	0
	<input checked="" type="checkbox"/>	3	M3MSat	RDPEM_Raw_AIS	297	09-Feb-2012 04:35:59.672	09-Feb-2012 04:49:33.089	613.417	100.0	340.95	88.24	0.0	0
	<input checked="" type="checkbox"/>	4	M3MSat	RDPEM_Raw_AIS	295	09-Feb-2012 06:16:37.326	09-Feb-2012 06:29:38.687	781.361	100.0	n/a	n/a	0.0	0
	<input checked="" type="checkbox"/>	5	M3MSat	RDPEM_Raw_AIS	296	09-Feb-2012 07:58:56.587	09-Feb-2012 08:09:58.905	712.313	100.0	n/a	n/a	0.0	0

Conflicting Opportunities | NCCD Datasets | CCD Datasets | NCCD Opportunities | CCD Opportunities | Chosen Opportunities | Chosen Datasets

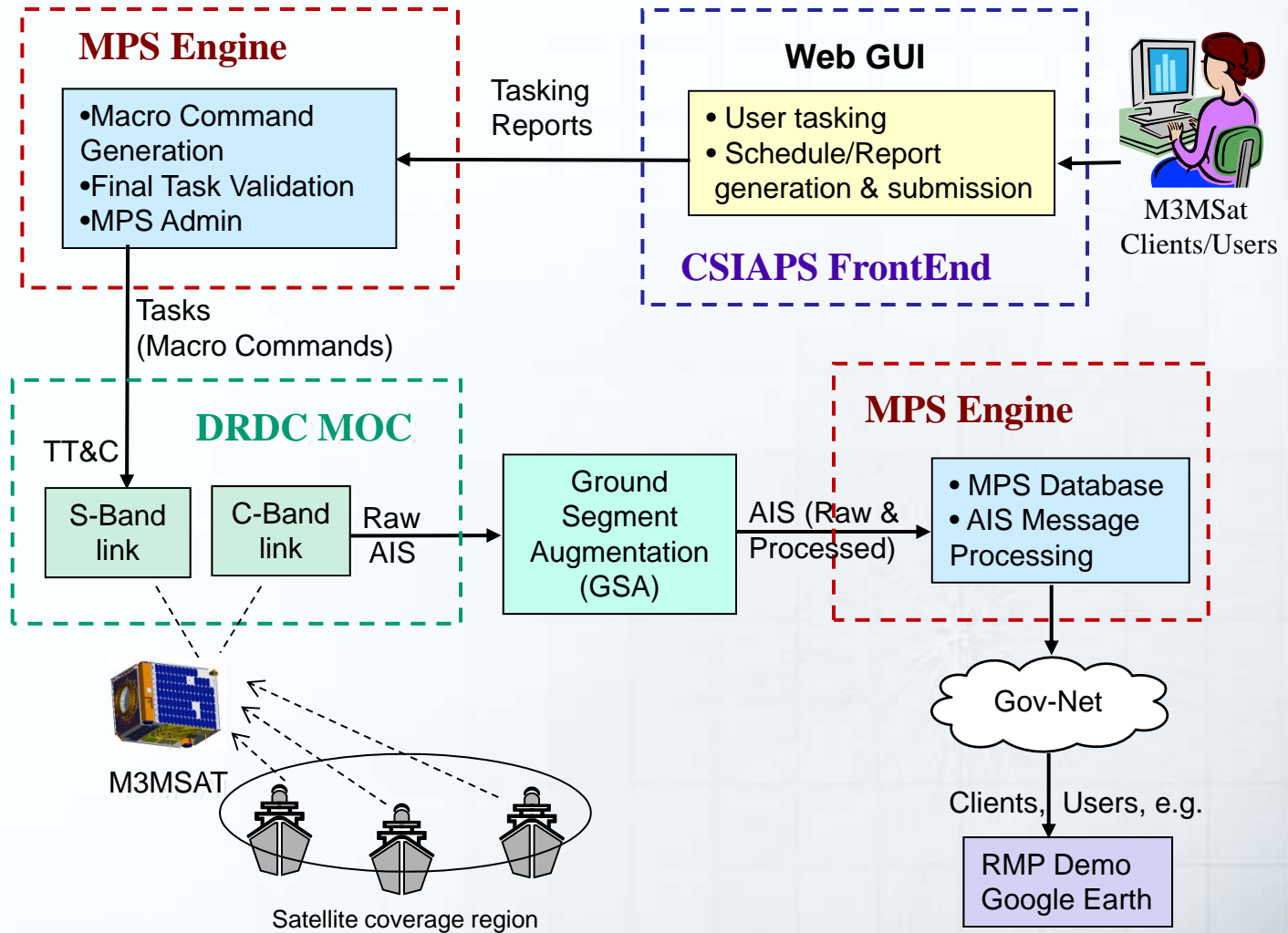
FP	ID	Satellite	Sensor	Score	Start Date/Time	End Date/Time	Img. Dur.	Coverage	Azimuth	Incidence Angle	Resolution	Conflicts

Map showing North America, Europe, Africa, and South America. Bing logo visible.

CSIAPS FrontEnd - User Tasking (Cont'd)



M3MSat MPS Uplink and Downlink



Mission Planning System – some thoughts

- **System function requirements** should be complete and accurate, and detailed.
- **Planning:** good plan – good system delivered on time.
- **Fund management** – very important. Fund issue could affect the system developed.
- Complicated system requires **expertise in different areas** and good handover.

GSA - Ground Segment Augmentation

AIS Raw Data

- AIS spectrum signal
- In AU (Acquisition Unit, 99 seconds AIS signal, 32MB file)

GSA

- AIS data processing system
- Management Server (Windows 2008) and AIS de-collider (Beowulf cluster) (head node & computing nodes).

AIS Messages

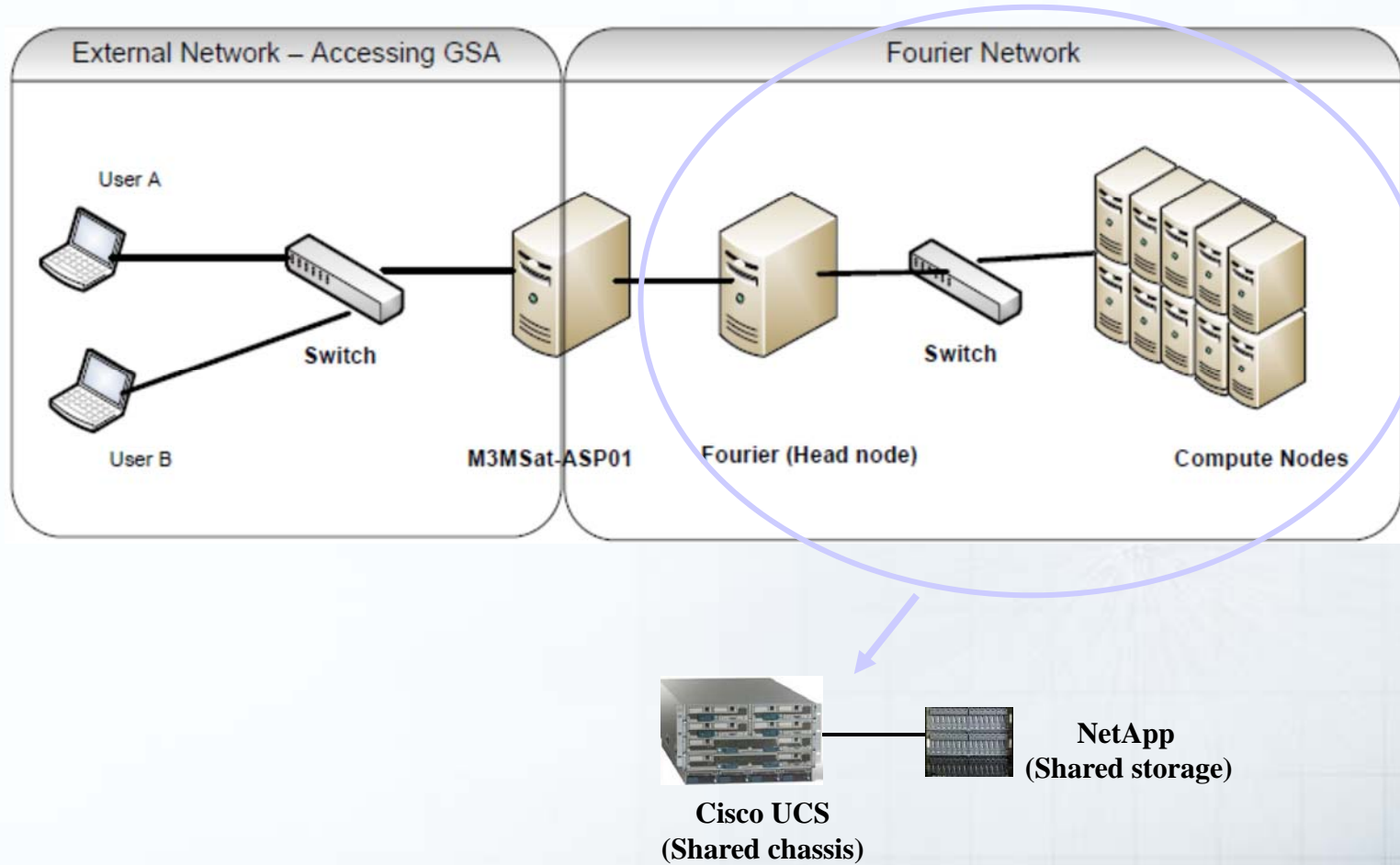
- Readable AIS messages
- in NMEA0183 format with UNIX timestamp appended).

- Initial GSA, legacy, unreliable:
 - 12 rack mounted computers,
 - limited processing capability.
 - The system O&M problematic.



- Improved GSA, virtualized, reliable:
 - Cluster: Cisco Unified Computing System (UCS) with VMware virtual machines and NetApp RAID 5 storage
 - Increased GSA processing capability
 - Simplified system O&M (e.g. hardware)

GSA - Initial and Improved System



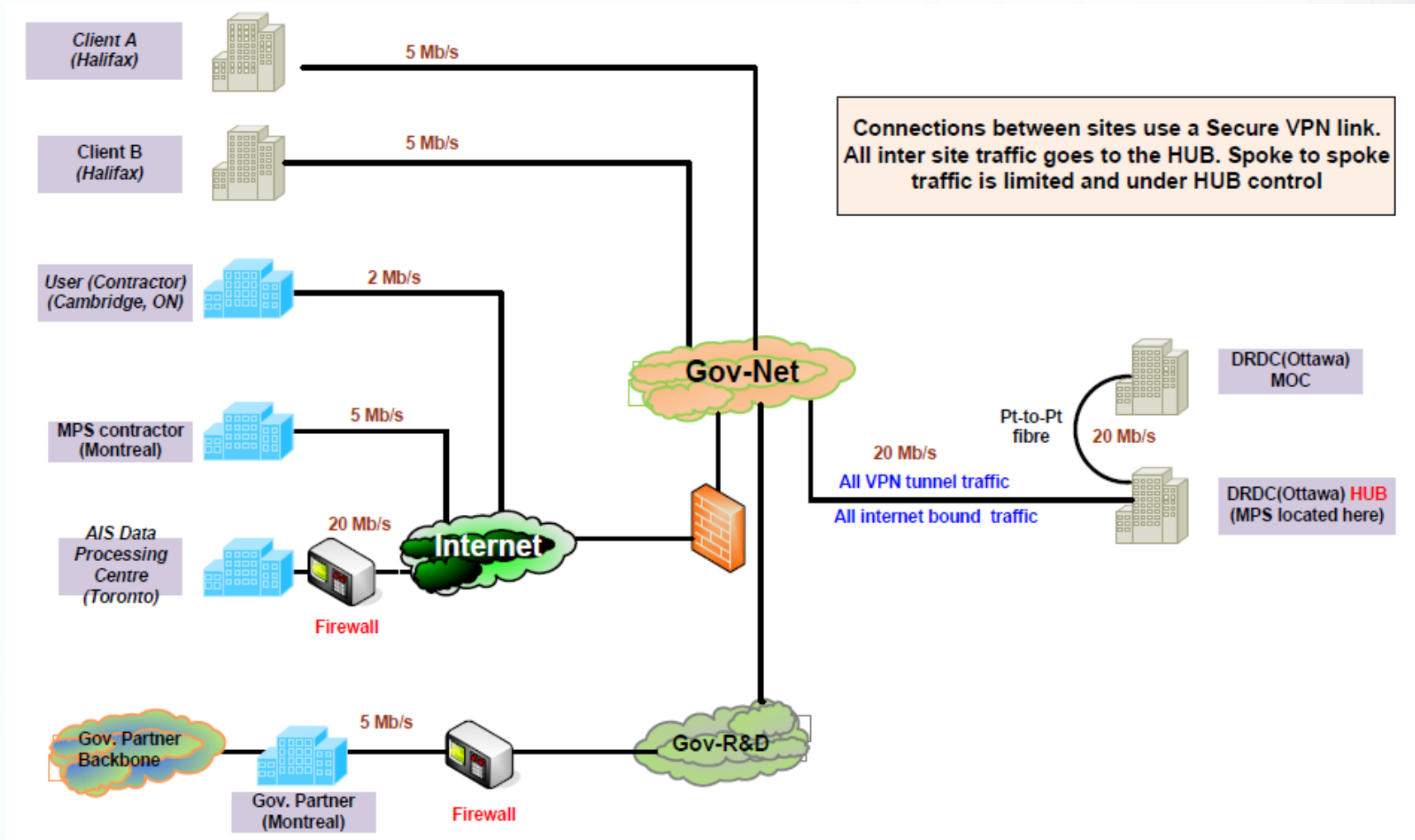
GSA Lessons Learned and Next Step

- Lessons learned:
 - **Virtualization**: reduce cost, reduce implementation and O&M efforts.
- Next Step:
 - **Improve system control and management**: migrate the cluster system to physically independent hardware (not shared)
 - **Increase GSA processing capability** (the bottleneck) through cluster expansion - add new UCS blades for more virtual machines – compute nodes.

M3MSat VPN Network

- **Goal (M3MSat and MPS):** Automation, for users and services.
- **Challenges:** multiple sites, complicated networks, security concerns.
- **Solution:** VPN network. Secure transfer data, e.g. user tasking, macro commands, telemetry and operation data, AIS data.
- **VPN design:**
 - Architecture: Hub (DRDC lab) and Spokes (other sites).
 - IPSec VPN using Cisco routers.
- **Two VPN links implemented:**
 - DRDC lab to Ground Station (MOC, Ottawa)
 - DRDC lab to AIS Data Processing Centre (DPC, Toronto).

M3MSat MPS VPN Architecture



M3MSat VPN Implementation Lessons Learned

- Good network design, mature technique, compliant with security and performance requirements. **But expensive.**
- **Implementation: lots of effort**, e.g., site survey, design, follow rules and policies, obtain various approvals. Installation and testing.
- **VPN network C&A** (Certification and Accreditation) took long time (> 1year) and cost much, should plan well and in advance.
- **Technical knowledge sharing, backup** of people (expertise).

Summary and Conclusion

- **M3MSat: microsatellite, space-based AIS**, interesting, and challenging.
- **Mission Planning System**: automation, key software system in ground segment. **Good requirement specification and design**. System completion is underway.
- **Ground Segment Augmentation (GSA)**: key for readable AIS message. **Virtualization - excellent** implementation, O&M and expansion, and better performance.
- **M3MSat VPN**: good architecture and design, expensive, implementation - lots of work.
- **Lessons learned**: good planning and management, new technologies, people backup and knowledge sharing.