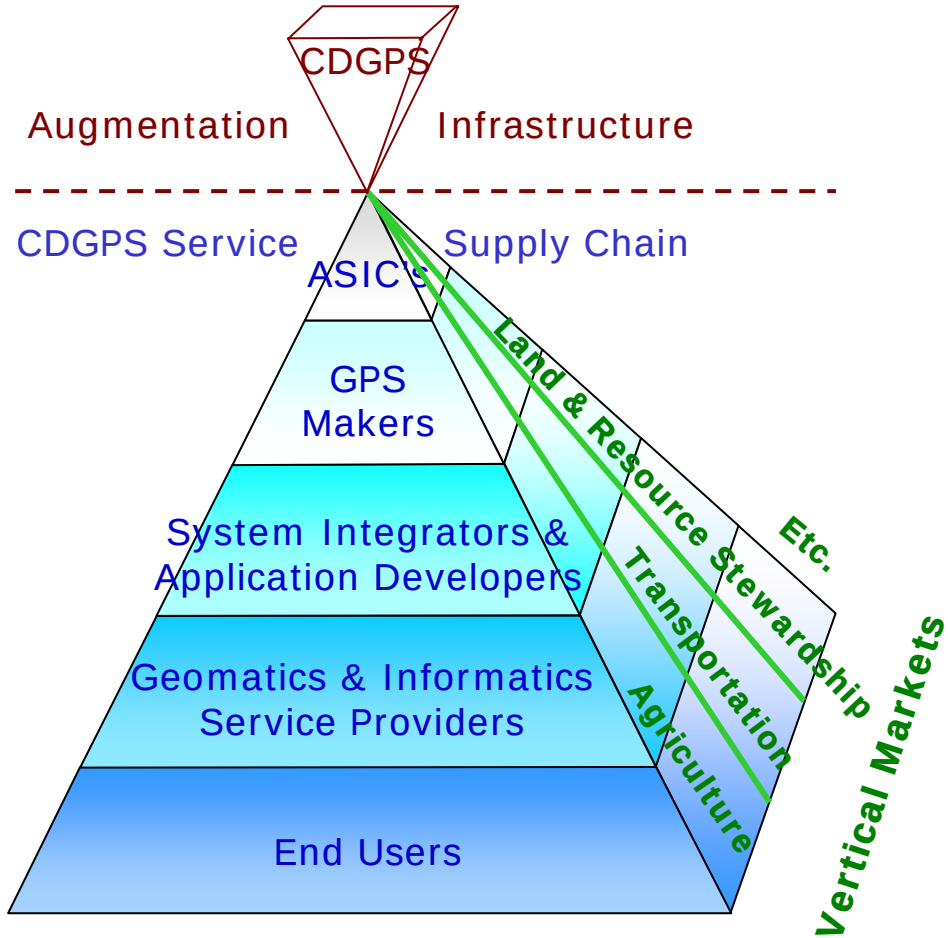
ION Alberta Chapter

Calgary, Alberta

Overview


CDGPS
THE REAL-TIME
CANADA-WIDE DGPS SERVICE
LE SERVICE DGPS
PAN-CANADIEN EN TEMPS RÉEL

National GNSS Augmentation Infrastructure



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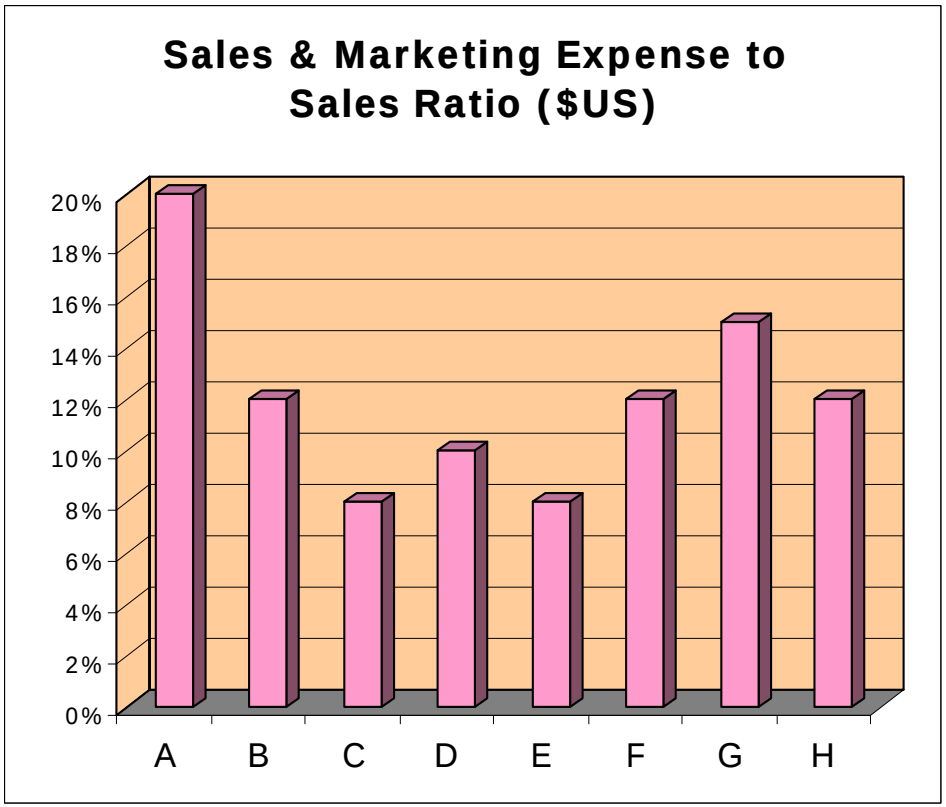
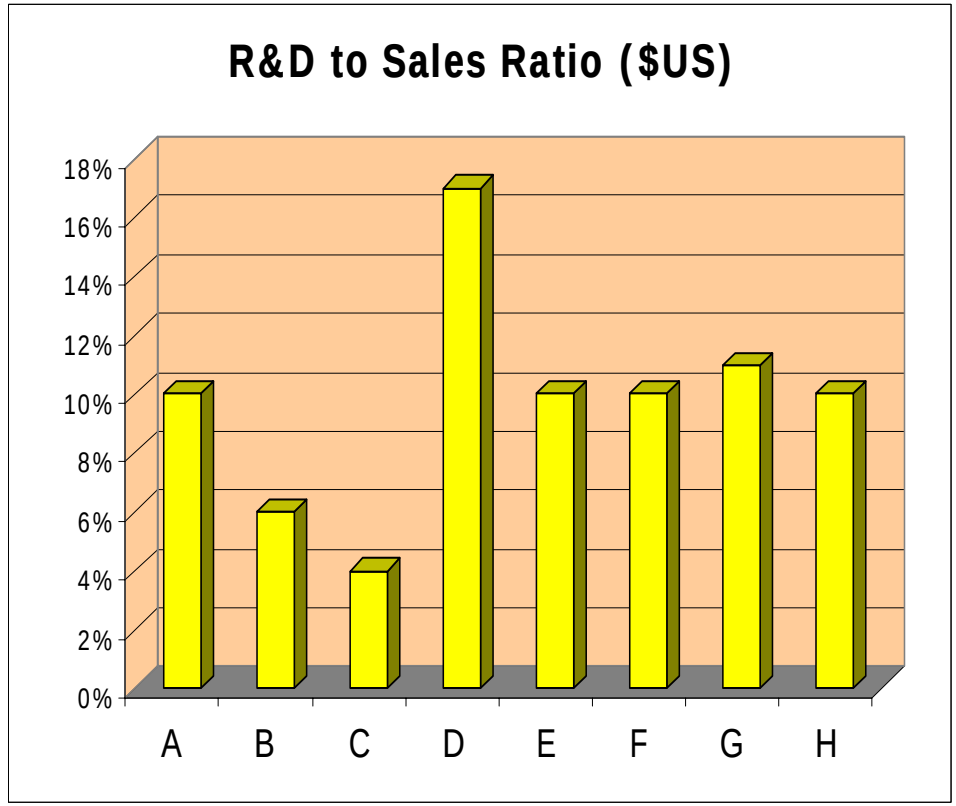
New Directions – New Opportunities

GPS Manufacturing Industry Expense:Sales Thumbnails





Sources: exchange filings & annual reports

COGPS
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Augmentation Service Comparison (2004)

		CDGPS	Coast Guard	WAAS
Performance	Accuracy	0.5-2m	1-2m	1-2m
	Reference Frame	NAD83	NAD83	WGS84
Coverage	Foliage	fair	**good**	poor
	Coastal North	**good**	fair	poor
	Inland North	**good**		poor
	Coastal South	**good**	**good**	**good**
	Inland South	**good**		**good**
	Urban	fair	**good**	fair
Cost	Service	free	free	free
	DGPS Radio		**$300**	
	Generic Combo	$1,500	$1,000	**$300**
	Quality Combo	$4,000		
Backing	Resourced	modest	**significant**	**significant**
	Track Record	new	**established**	evolving

Source: CDGPS Strategic Analysis and Issues, Carter & Hardy

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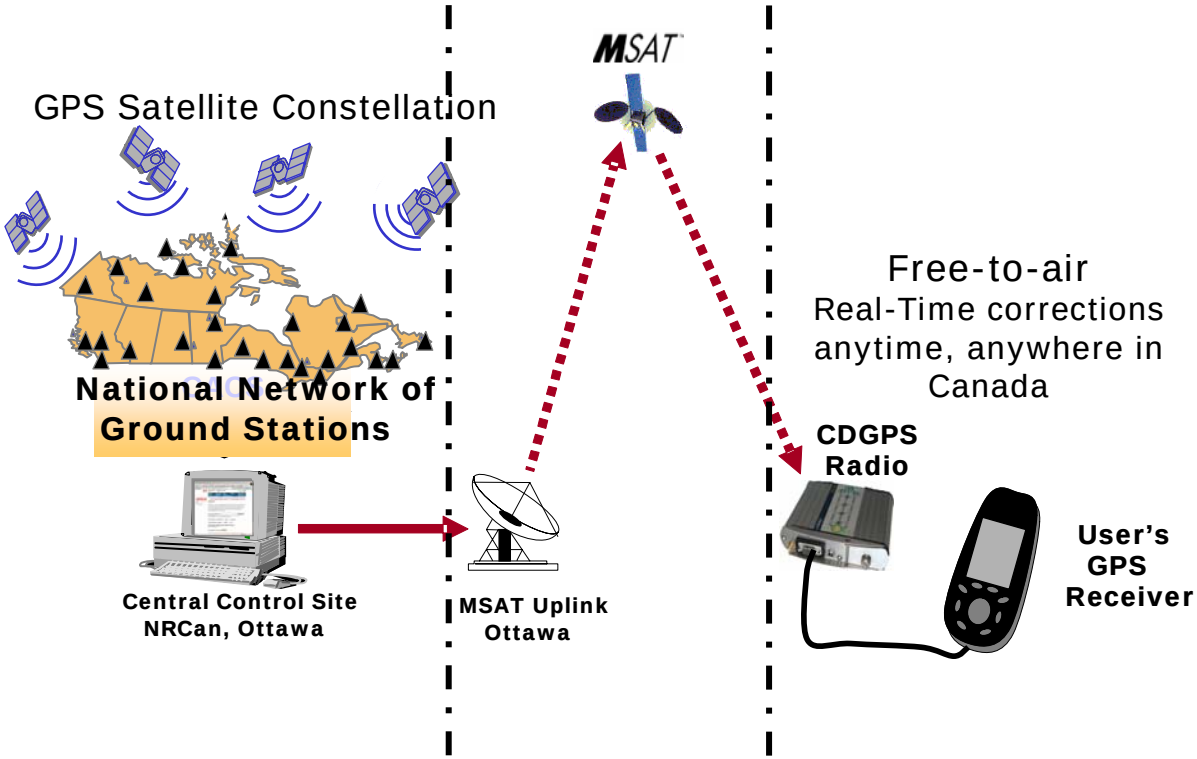
Canada-wide Differential GPS (CDGPS)

A Space-Based Augmentation System



Canadian Council on Geomatics

- Federal Govt Geomatics interests from NRCan, DND, DFO, StatsCan
- Govt Geomatics agencies of all 10 provinces and 3 territories
- $2.3M to develop 1999 to 2003
- $1.6M to operate 2003 to 2007
- $400K to operate annually until 2010

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Funding Source 2000-2007

CCOG Cash Contribution

Cost savings realized by purchasing MSAT carriage under PWGSC's discount		*$2,888,000*	
Federal Government	GeoConnections	$600,000	19%
	Canadian Hydrographic Service	$100,000	3%
Provinces and Territories		$2,525,000	78%
CCOG Total Investment		$3,225,000	100%

Development of satellite hub and 1000 MSAT radios ~$2.3M from Apr, 2000 to Oct, 2003

Annual Operation (mostly non-subsidized portion of carriage cost) ~$1.6M for 3.5 yrs of operation from Oct, 2003 to Mar, 2007

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Current Operations

CDGPS Corrections

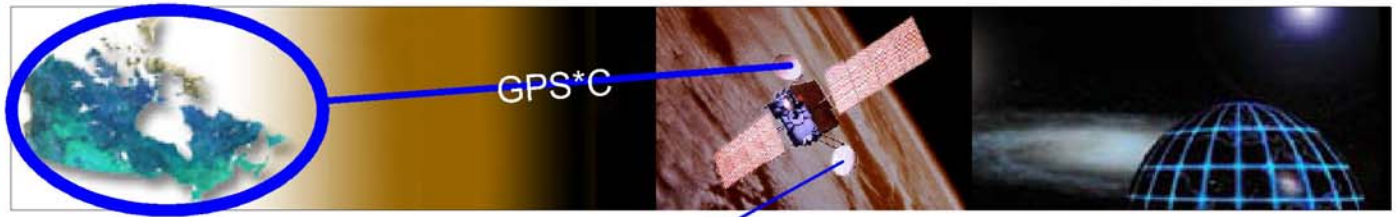
History of GPS-C Development

- The GPS-C Prototype was designed and developed in 1995-1996
- The GPS-C Prototype was further enhanced during the period 1997-2002
  - Network expansion
  - Refining the GPS-C engine
  - Architecture for high availability service finalized
  - Service management and monitoring requirements identified
  - Service agreements with service levels signed


CACS Network
Multipurpose Network
49 ACP stations
GPS·C Real-Time (15 stations)
Western Canada Deformation Array (12 Stations)
Great Lakes CORS Program (5 Stations)
Post Glacial Rebound (6 Stations)
Arctic Tide Guages (5 Stations)
Climate Change (6 Stations)
Arctic Ocean
Beaufort Sea
Baffin Bay
Davis Strait
Labrador Sea
Hudson Strait
Hudson Bay
Atlantic Ocean
Pacific Ocean
Greenland Sea
Norwegian Sea
Bering Sea
ALASKA
Fairbanks
Anchorage
Juneau
YUKON TERRITORY
Whitehorse
WHIT
CANADA
NUNAVUT
NORTHWEST TERRITORIES
Yellowknife
YELL
Taloyoak
Baker Lake
Rankin Inlet
Arviat
Nuuk
Iqaluit
BRITISH COLUMBIA
ALBERTA
Prince George
Vancouver
ALBH
Seattle
DRAO
Calgary
PRDS
SASKATCHEWAN
MANITOBA
CHUR
EUR3
SCH3
NFLD.
Happy Valley–Goose Bay
St. John's
STJO
QUÉBEC
ONTARIO
WINN
Winnipeg
Regina
Thunder Bay
Portland
WASH.
UNITED STATES
OREGON
Boise
IDAHO
Reno
NEVADA
Salt Lake City
UTAH
WYOMING
MONT.
N. DAK.
Bismarck
Sheridan
SOUTH DAKOTA
Sioux Falls
NEBR.
MINN.
Duluth
Minneapolis
WIS.
MICHIGAN
Toronto
N.Y.
Hartford
Boston
Concord
Augusta
ME
N.B.
Moncton
HLFX
Halifax
FRDN
NRC1
NRC3
Montréal
ALGO
Ottawa

NRCan / Geodetic Survey Division WAN

Data Communications Infrastructure



Aviation Parkway Data Center (APDC)

RTMACSA GPS*C Server (HP L1000)

RTMAPR PROBE (HP E-25)

RTMACSA

MacDonald Cartier Data Center (MCDC)

RTMACSB GPS*C Server (HP L1000)

RTMBPR PROBE (HP E-25)

RTMACSB

MSV (M-SAT)

ACPs

NRCan - Geodetic Frame Relay GSDRT-WAN

ISDN

INTERNET

ACP & OTHER PROJECTS

Anik F2

Telesat Teleport Toronto, ON

NRCan Geodetic Survey Division

RTMACSD

RTMACST

RTOPSDATA1

RTOPSDATA2

RTOPSDEV1

IGPSOR1 IGPSOR2

GALILEO

KEPLER

GPSCPMS

RTPMS

NEWBURN1

NEWBURN

NRCan-WAN

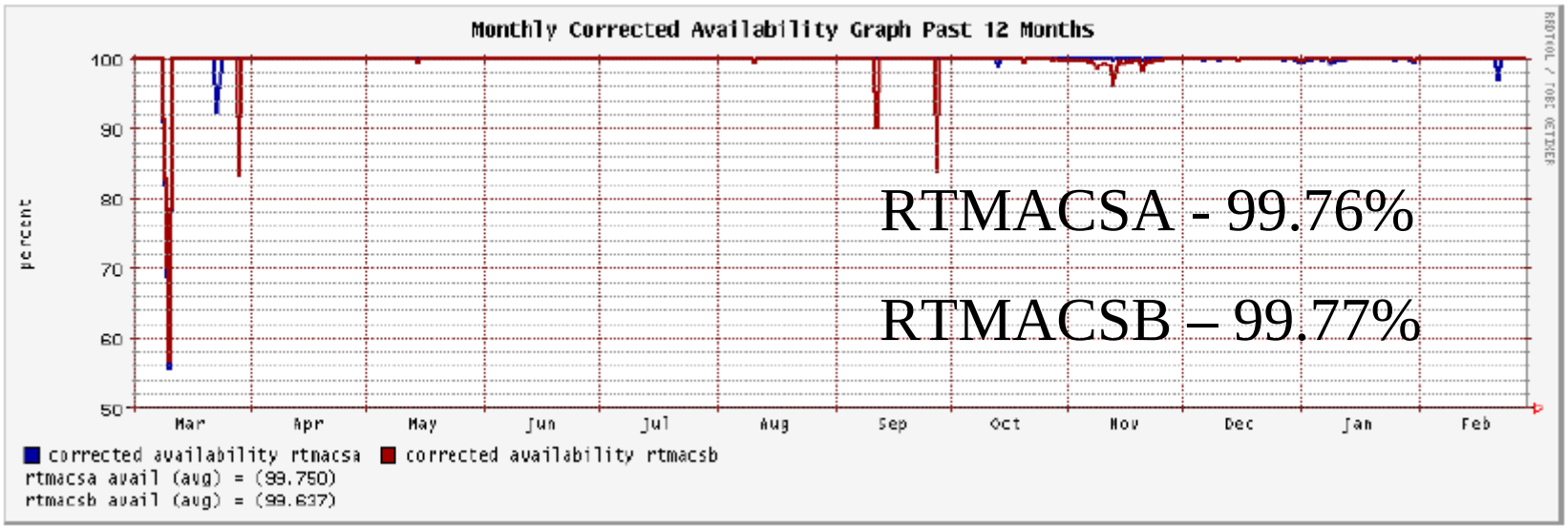
ACP & OTHER PROJECTS

ACPs (VSat)

Tasks in Delivering GPS-C

- Daily operations at NRCan
  - Performance monitoring (availability and accuracy)
  - Helpdesk 8x5
  - 24/7 application support
  - Change management
- Engineering support at NRCan
  - Performance feedback to operations
  - Bug fixes
  - Inputs to post mortems
- Monthly Reporting
  - To CDGPS – since October 2002

Availability of the GPS-C Service Mar 06 – Feb 07



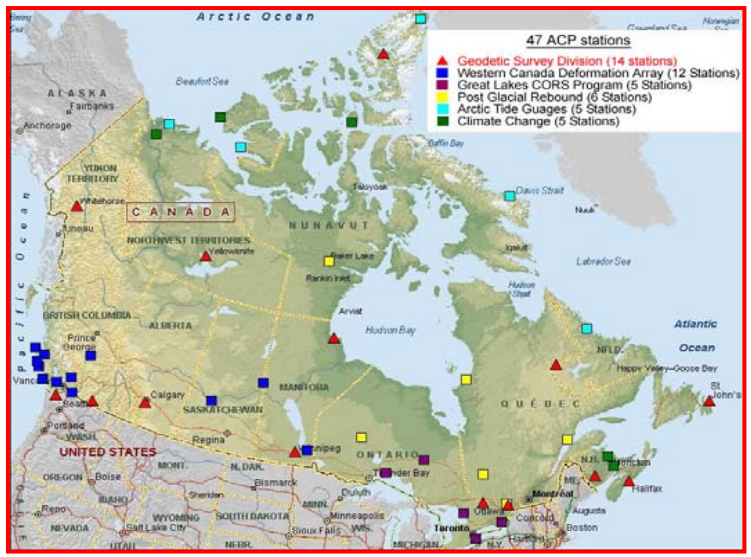
- March 2006 – first and only service outage since service began in 2002
- Service outage == both production servers down at the same time

The GPS Correction Model (GPS·C)

NRCan's Ultra Rapid Predictions (hourly)

+

Real-Time GPS Tracking
(RT-Canadian Active Control System)



GPS·C Application

RT-MACS A/B

MRTCA Messages

ORB	CLK	ION	...

See ICD for details

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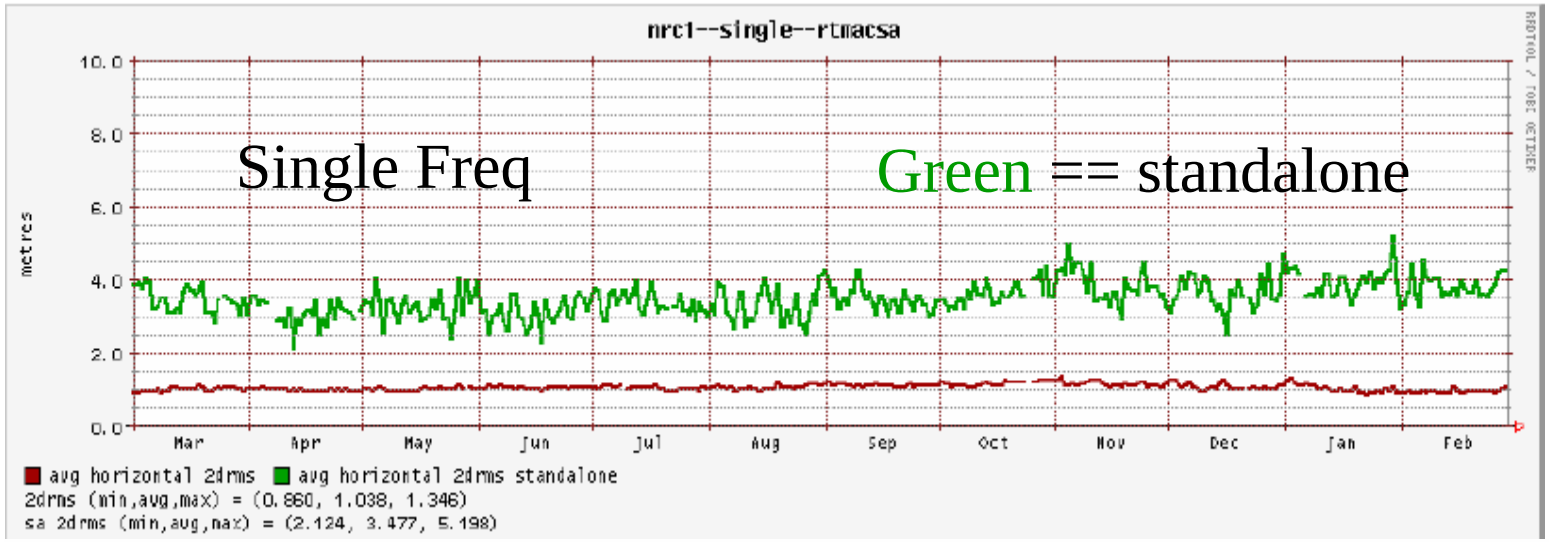
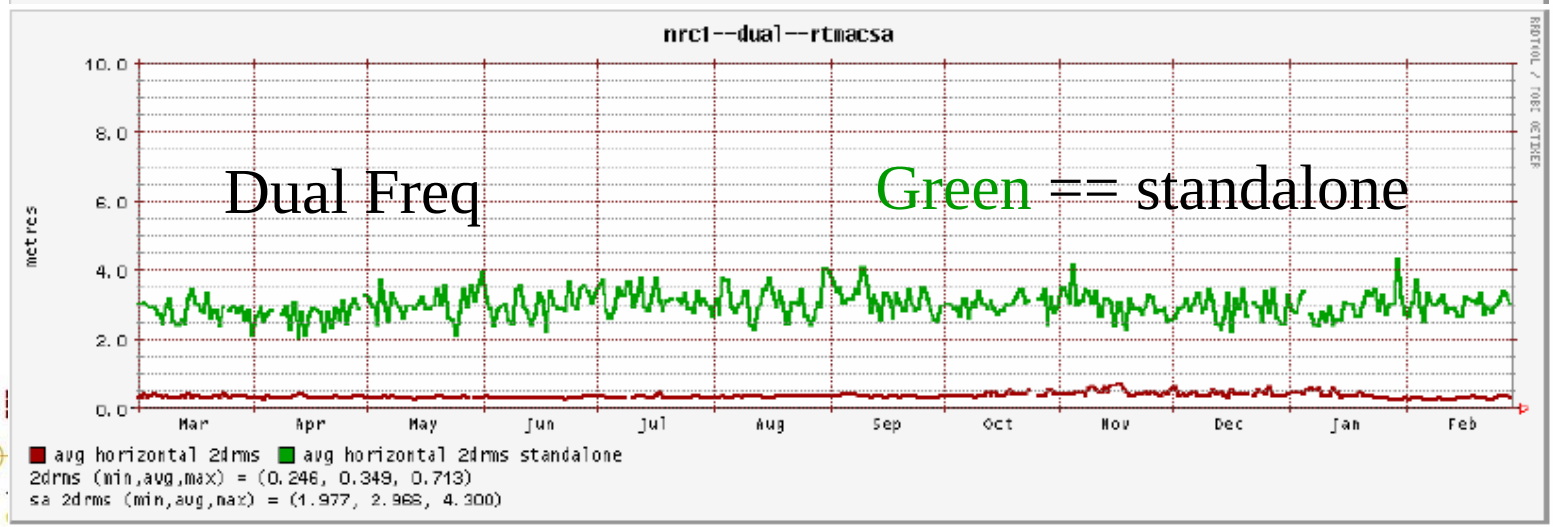
2drms Service Performance in Red
NRC1 Mar 06 - Feb 07



3.5 m

1.0 m



3.0 m

0.35 m

Current Operations

Broadcast Service

CDGPS Broadcast Service Overview

- How we arrived at where we are
- Present status:
  - RT-CACS Infrastructure
  - CDGPS Hub Infrastructure
  - CDGPS radios – localization
  - Developer tools – engineering support
  - End user support – help desk

Service Principles

- Free public infrastructure of real-time GPS corrections (GPS•C) via MSAT
- develop an initial portable user radio/receiver to ‘seed’ market
  - manufacturing, distribution and inventory management are outside of core competency
- create enabling environment for private sector adoption of the infrastructure

CDGPS Timeline

- Service proposed in 1999 Canadian Council on Geomatics resolution → MoA

- Participants: all provinces, Nunavut and the federal governments

- The *Long & Winding Road* …
  - Start-up – January 2000
  - CDGPS Service contractor hired – October 2000
  - Marketing strategy (Hardy Report) – January 2002
  - Pre-Alpha testing – August 2002
  - Alpha testing – October 2002 – April 2003
  - Beta testing – June-November 2003
  - Launched October 14, 2004
  - MOA Extension for an additional two years
    - Operational to March 31, 2007
  - MOA Extension for an additional three years
    - Operational to March 31, 2010

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Challenges

- Leading Edge Technical Solution
- USA announcement on SA
- Initial trouble attracting contractor/builder
- Over-optimistic prime contractor
- MSAT-1 failure
- Extended schedules
- Limited budget
- Commercial service standards
- Distribution channel, marketing
- Initial inventory of CDGPS receivers sold out within 15 months
  - leaving only 1 supplier of equipment capable of accessing CDGPS

CDGPS Deliverables

- NRCan's RT-CACS Infrastructure
- CDGPS Infrastructure
- CDGPS radio
- Documentation
- Distribution and marketing
- Developers Tool Kit
- Business studies and documentation

RT-CACS Infrastructure

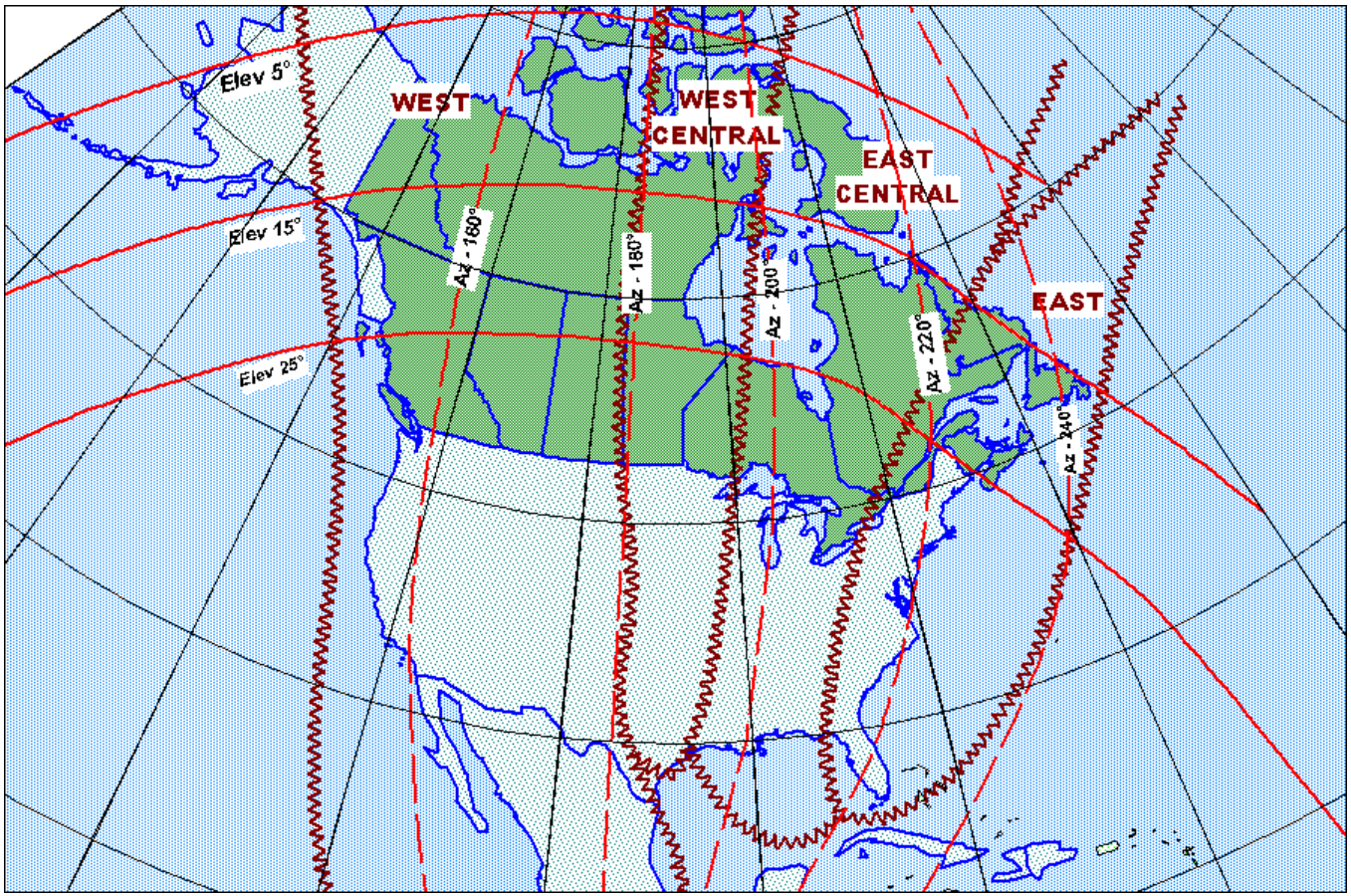
- **NRCan RT-CACS Network → GPS*C data source**
- **General Information …**
  - GPS*C operational and in production mode as of Nov. 4, 2002
  - GPS*C operations are under Service Level Agreement (SLA) with PWGSC/GTIS
  - The RT-MACS facilities are fully redundant
  - Full Integrity Monitoring available online
  - Monthly reporting to CDGPS office
- **Performance**
  - Accuracy: Typically meeting 1.5m @ 95%*
  - Availability: Redundant Hub has covered any large outages
    - No major problems/issues

** with suitable hardware & operating condition*

CDGPS Hub Infrastructure

- Main components:
  - CDGPS Hub + MSAT + CDGPS radio + RMS
  - CDGPS Service Center / Provider (BMGS)
- Key Performances
  - Fully redundant system that accepts separate data feeds from the NRCan RT-MAC's
  - Manned 24/7 and is powered by generator backed UPS systems
  - Monthly reporting & detailed system logs
- Operation & Maintenance Contract → MSV
- Performance
  - No major problems/issues
  - Redundant hub has covered any outages

MSAT Coverage for CDGPS Broadcast



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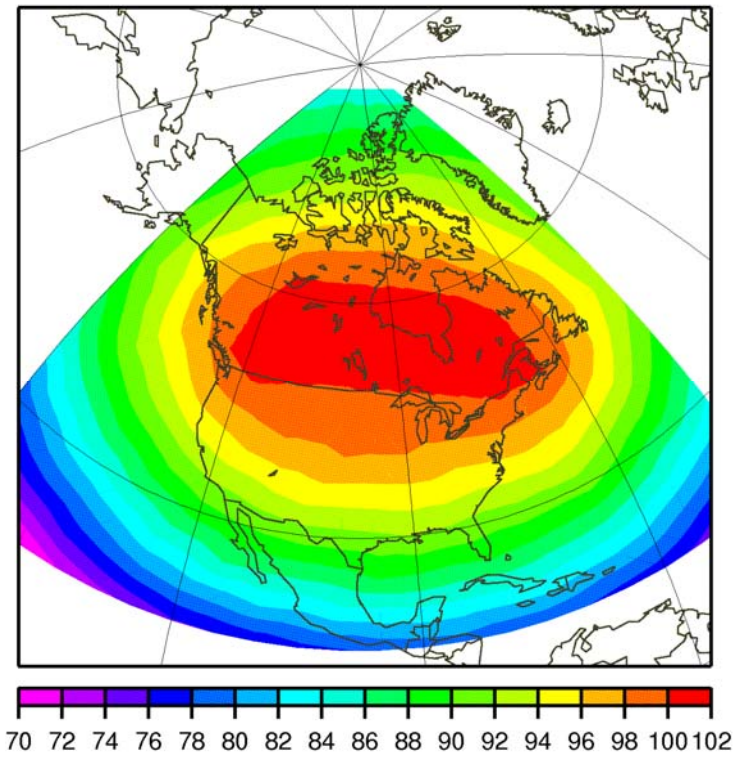
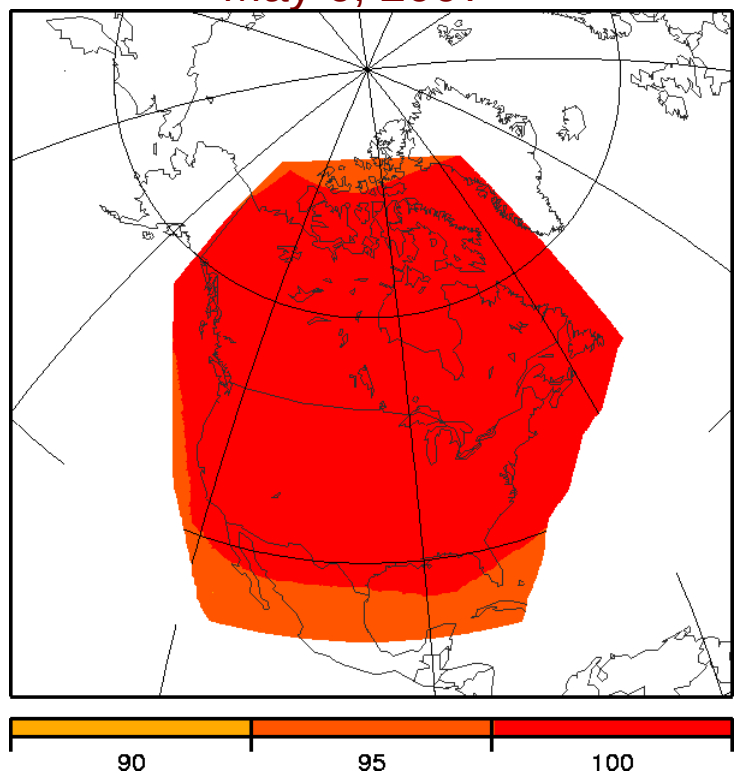
CDGPS Corrections – North American Coverage

Current



May 6, 2007



percentage of GPS satellites which will have CDGPS corrections among the total list of GPS satellites in view above 10º elevation

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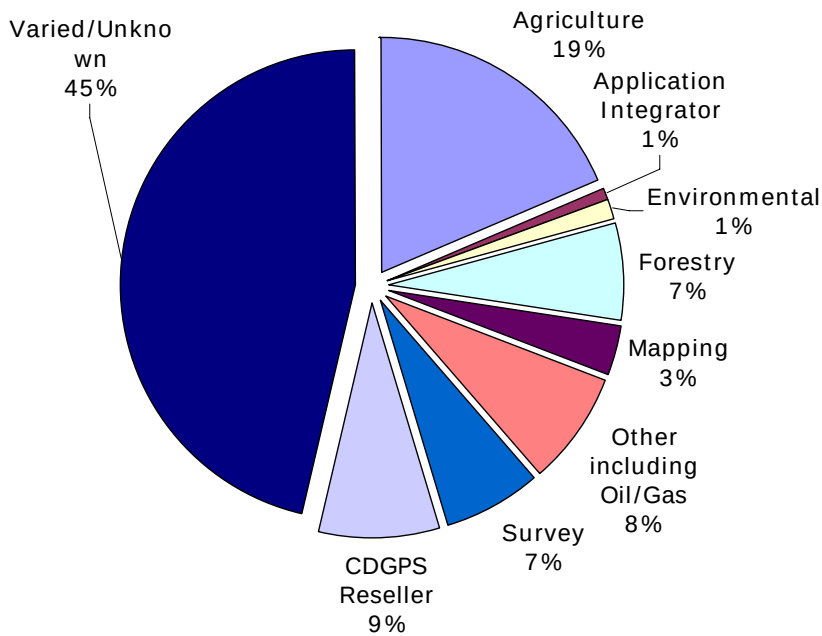
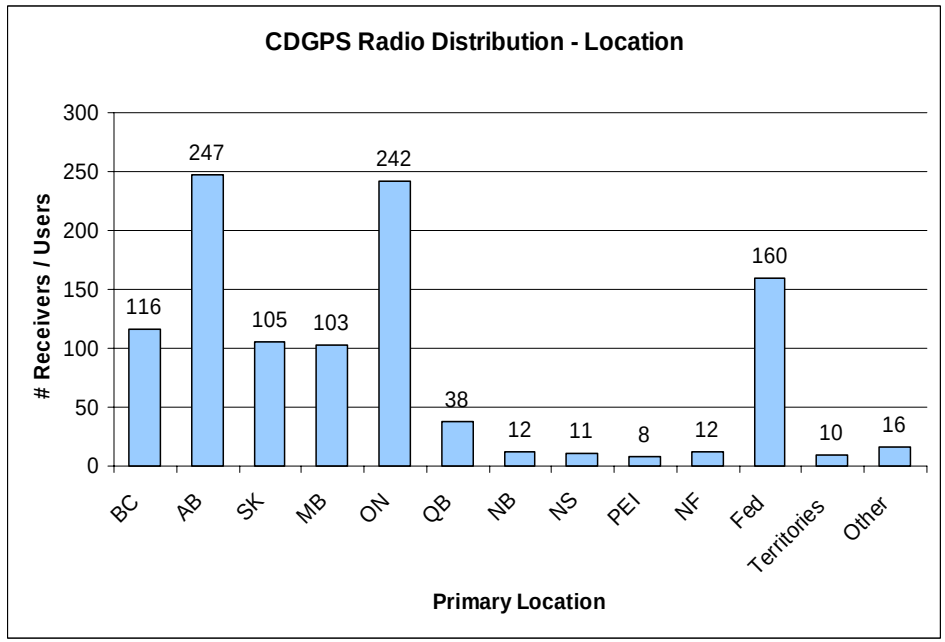
CDGPS Radio Sales

(no longer in supply)



Sales by Industrial Classification



Sales by Geographic Location

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Summary

- Commercial Operation
  - Operational for 3.5 years
  - Six (6) Resellers Established for Canada
- Industry acceptance for CDGPS radio
  - based on CDGPS radio sales
- Industry support for CDGPS Service
  - based on NovAtel commercial product; Raven; Sokkia
- Government support for CDGPS Service
  - extension of CDGPS Service funding to March 2010

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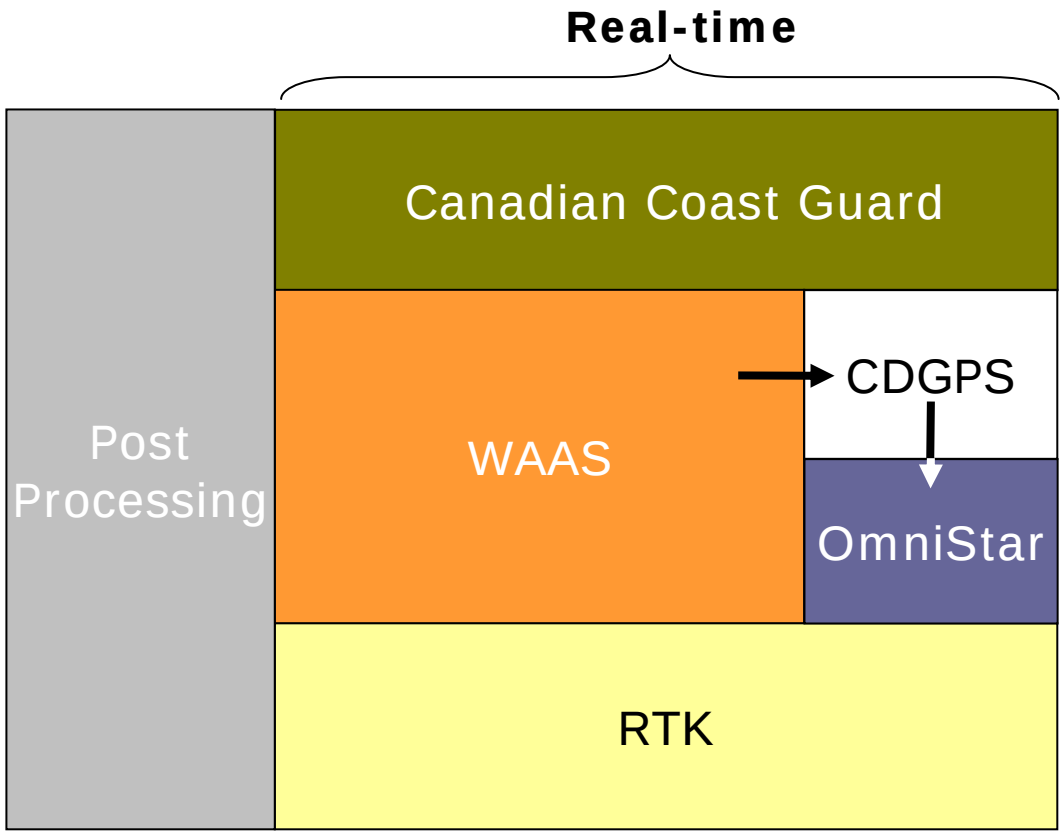
New Opportunities

CDGPS: Market Context



Source: CDGPS Strategic Analysis and Issues, Carter & Hardy

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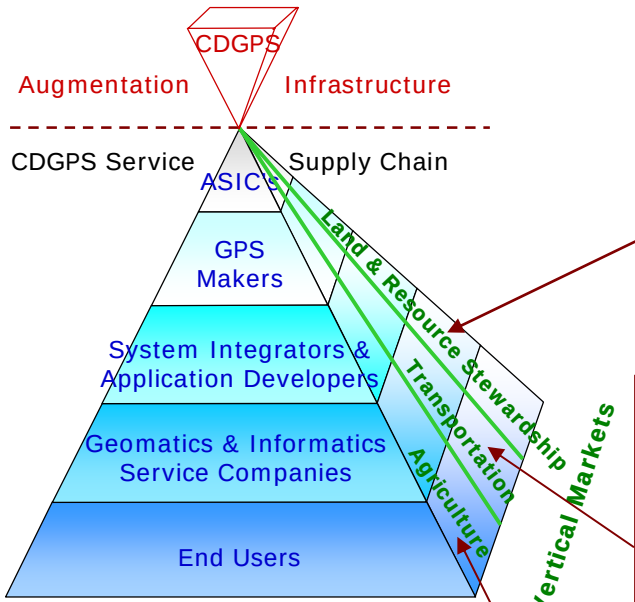
Target Areas



- **Geological Survey**
- **Fisheries & Oceans – UNLCOS & IPY**
- **AAFC - NLWIS**
- **Canadian Council of Land Surveyors**
- **Irving Pulp and Paper**
- **Canadian Assoc. Petroleum Producers**

- **Canadian Coast Guard – Maritime Svc & IT Svc**
- **Canadian Space Agency**
- **Transport Canada – Policy & TDC**
- **Public Works & Government Service -Sat Svc**
- **Railway Assoc of Canada**
- **CN – Signals**
- **SAR Secretariat**
- **North American Joint Positive Train Control Project**

- **Agricultural Policy Framework**

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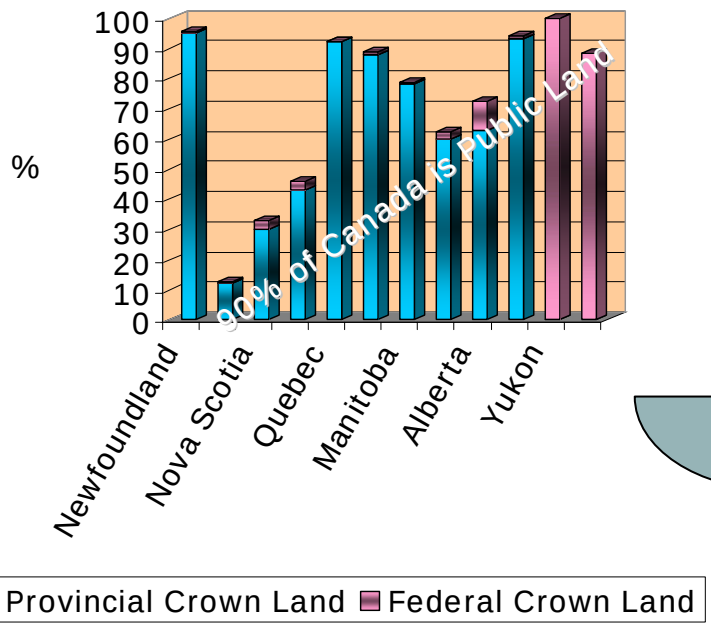
Land & Resource Stewardship on Public Lands in Canada

Proportion of Public Land
in Each Province & Territory



National Accuracy Standards
for Integrated Surveys
CCOG Resolution S05-10

Location	Accuracy (95%)
Urban Areas	5 cm
Rural Areas	20 cm
Remote Areas	1 m

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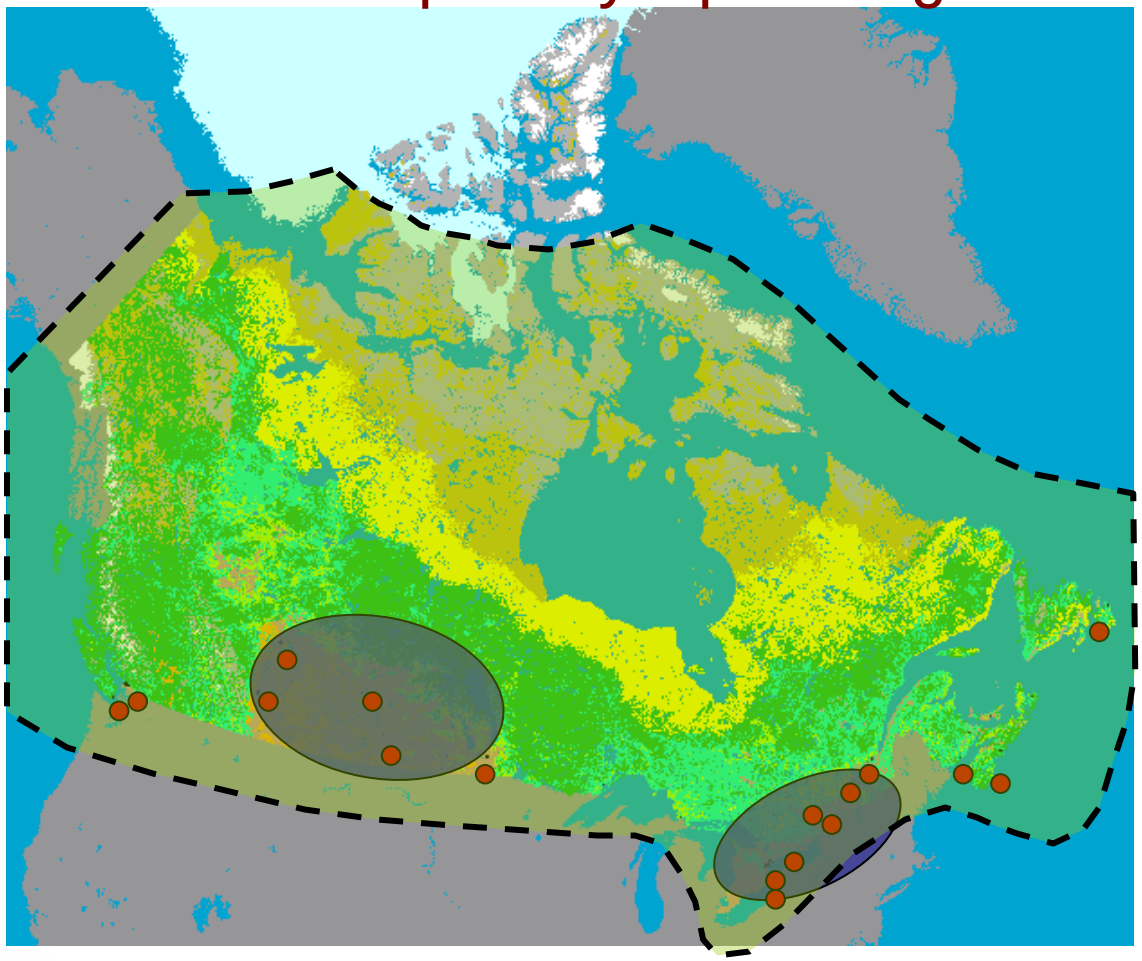
GNSS Augmentation Infrastructure

‘Conceptually-speaking’



Localized High Accuracy Services

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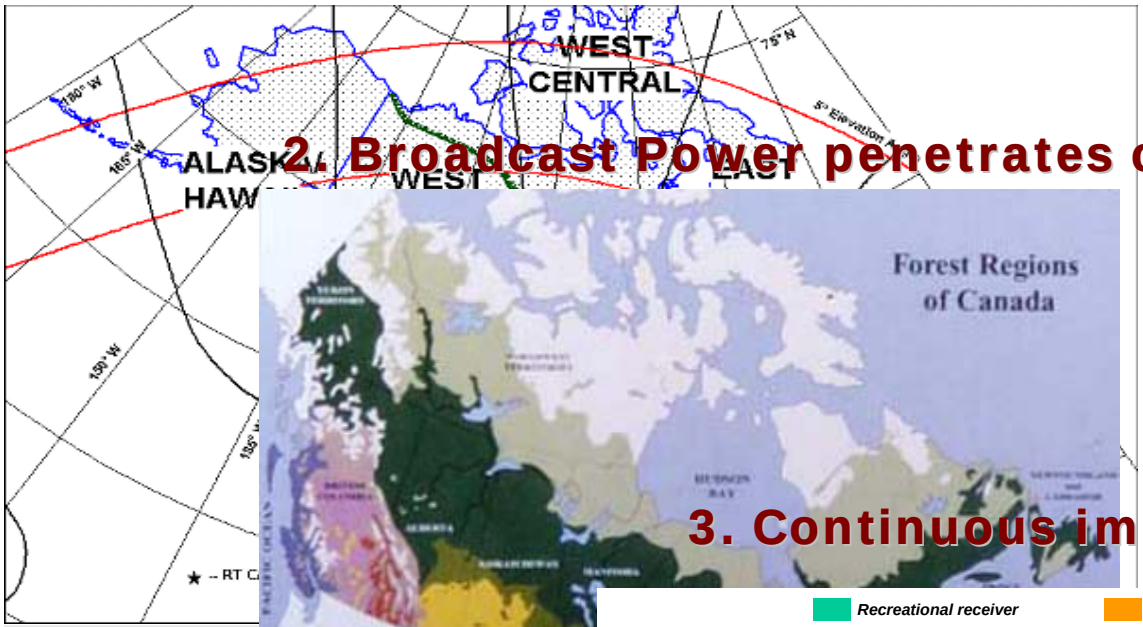
Future Opportunities

- North America-wide extension
  - greater incentive for private sector value-add
- CDGPS Service adoption
  - increased industry participation
  - possible funding opportunities
  - CDGPS Service resources for infrastructure, operation & maintenance
- Dual-Frequency users
  - directly demodulate MSAT signal
  - expect 20-30 cm (95 %) positioning
- Extend governance to include more private sector and research organizations' participation
- Internet / Alternate services (beyond MSAT)

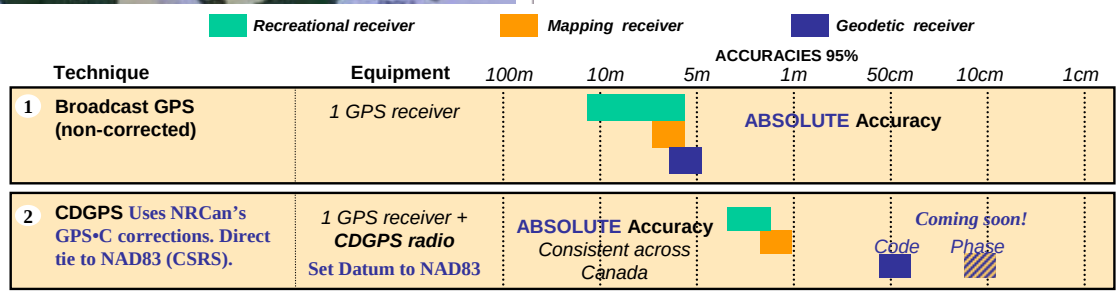
Three Defining Features of CDGPS

1. Coverage to Ellesmere Island



2. Broadcast Power penetrates canopy

3. Continuous improvement in service



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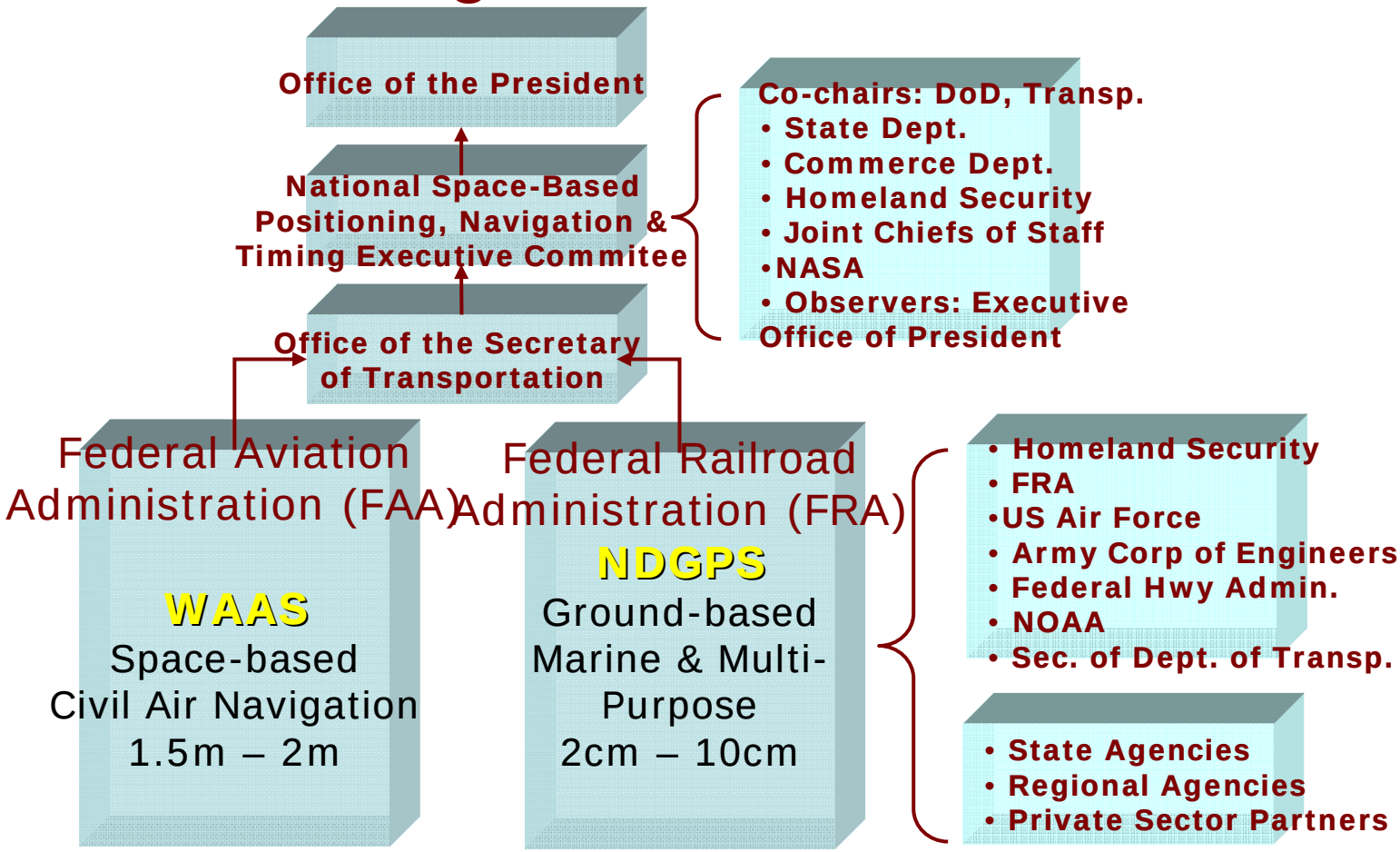
US GNSS Augmentation Infrastructure



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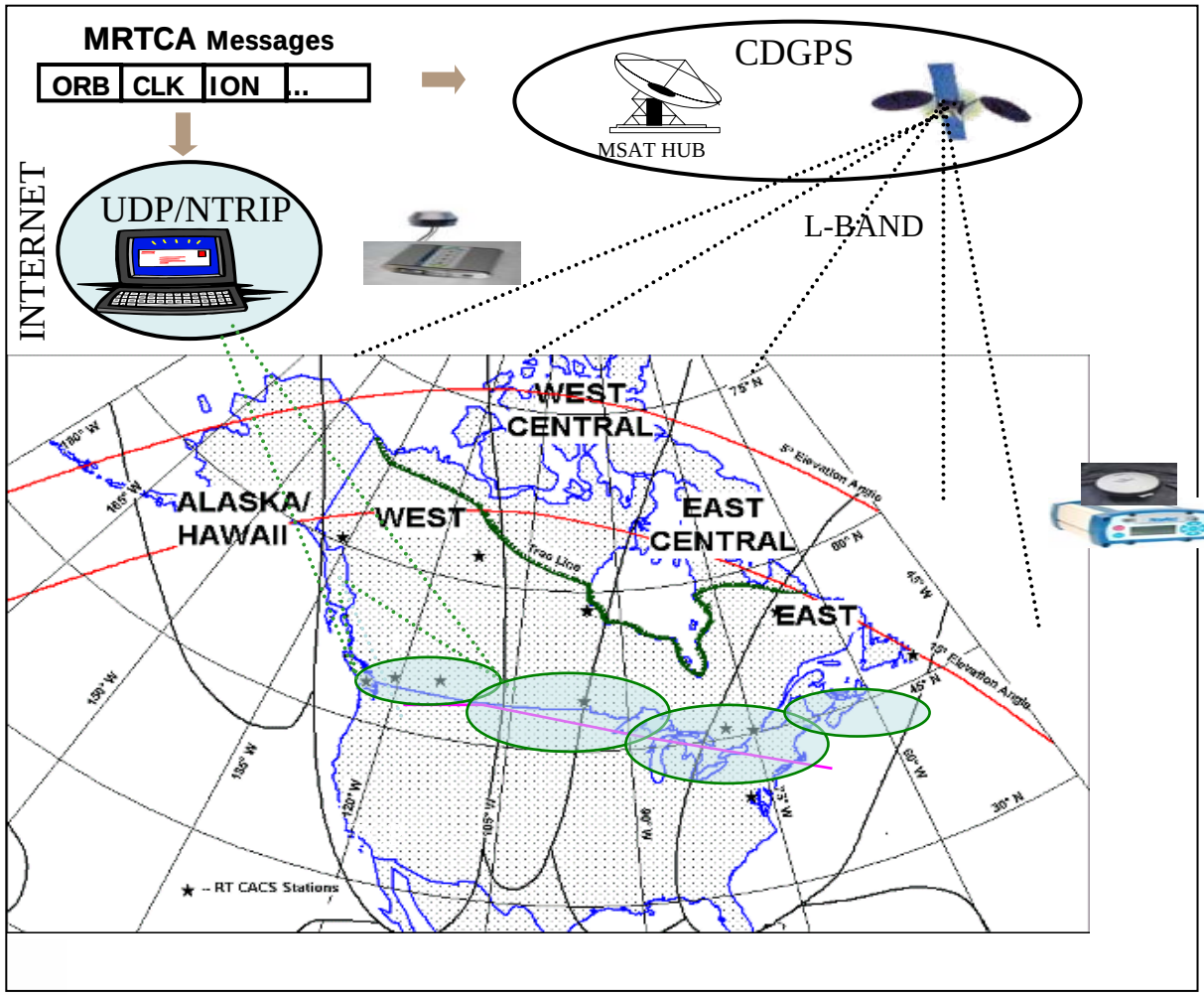
GPS·C Distribution Channels



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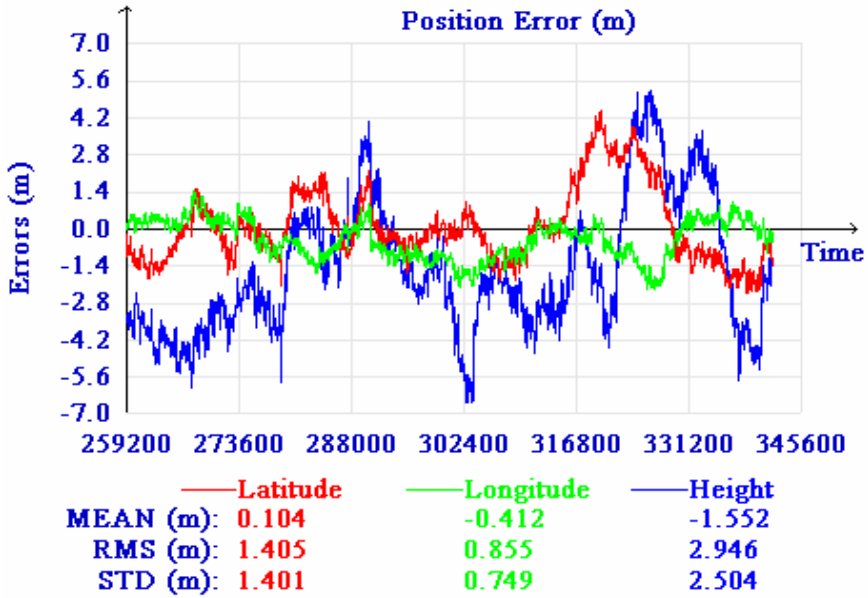
GPS·C NTRIP Server Features

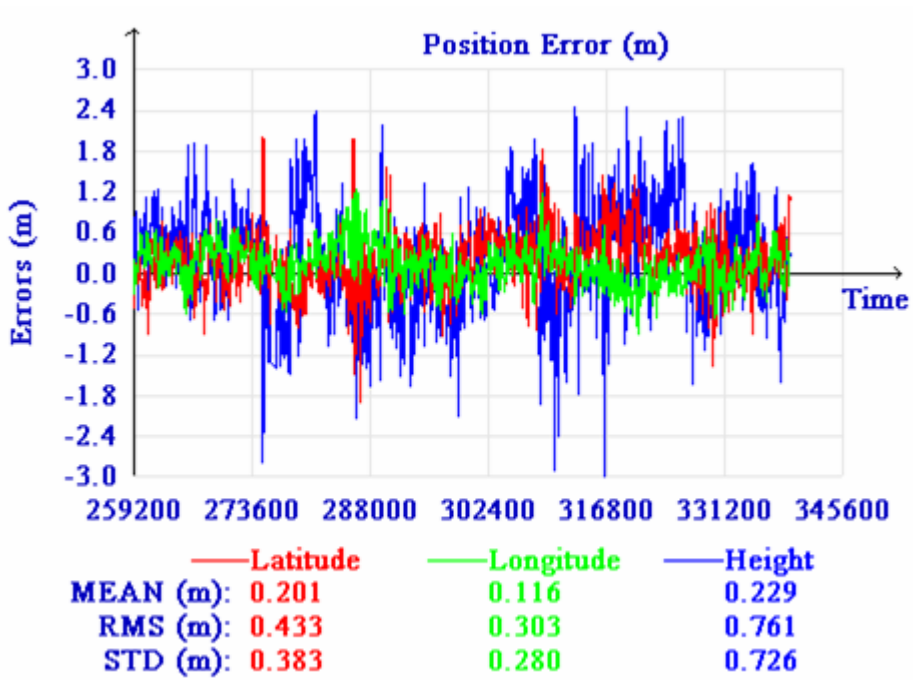
- A Java application that runs under Linux/Windows
- Developed and tested under contract by Golden Sun Inc. in cooperation with the University of Calgary.
- Acquires MRTCA messages from a GPS·C UDP Server or a CDGPS radio serial port.
- Forwards a single MRTCA and/or multiple RTCM correction sources (computed by localizing the wide-area corrections for user-defined locations) to an NTRIP Caster.
- Is administered using a Web-based interface.

GPS·C NTRIP DGPS Performance

SPS



iRelay DGPS



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From NRCan-04-0629 Contract Report by Golden Sun Inc