Natural Resources Canada | Ressources naturelles Canada

Canada's GNSS network expansion

SIRGAS 2022 Symposium, November 9th 2022

Sandra Bolanos, Mike Craymer, Brian Donahue

Canada

Overview

- The evolution of Canada's GNSS infrastructure
- GNSS densification in 2021-2026
- Challenges and Opportunities

From On-site Surveys to PPP

1905 - 1973

1908: first 800 km line survey Canada – US
1916 -1928: Leveling from Halifax to Vancouver, near the railway
1947: Shoran open the path for aero triangulation, 200km sides
1965 - 1973: Aerodist aircraft, 100km sides, 219 points, 25% coverage

1980

VLBI: to refine EOP, Whitehorse (YK), Yellowknife (NWT), Penticton (BC), Algonquin (ON), Saint John's (NL)

1985

CGS acquired its first GPS units. Started deploying at VLBI locations, added Schefferville, Ottawa, Churchill), then Priddis, Prince Albert, Lac du Bonnet and 4 WCDA in BC.

1990

Starting contributing Orbits and Clocks to the IGS (GPS.C)

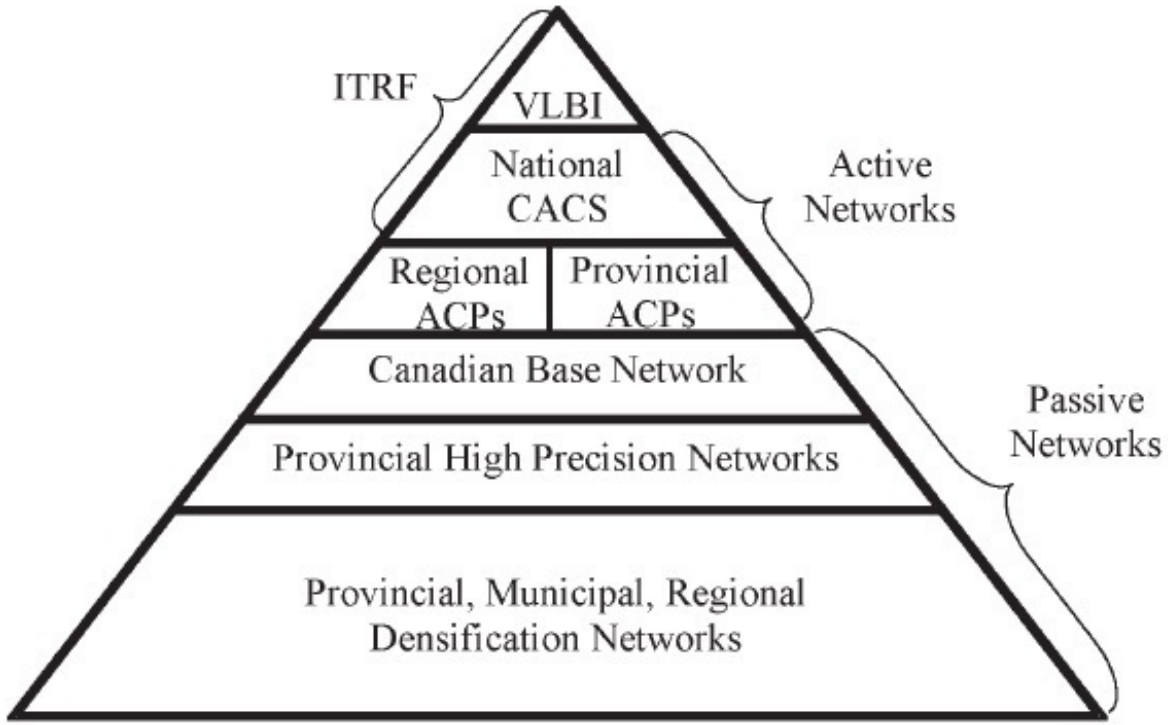
1994

CBN appears, in cooperation with provinces, spaced 200km
RACS (Regional Studies): first 6 deployed from the Atlantic to Hudson Bay, added 8 at Tide gauges in the Artic, added 5 more in the Great Lakes

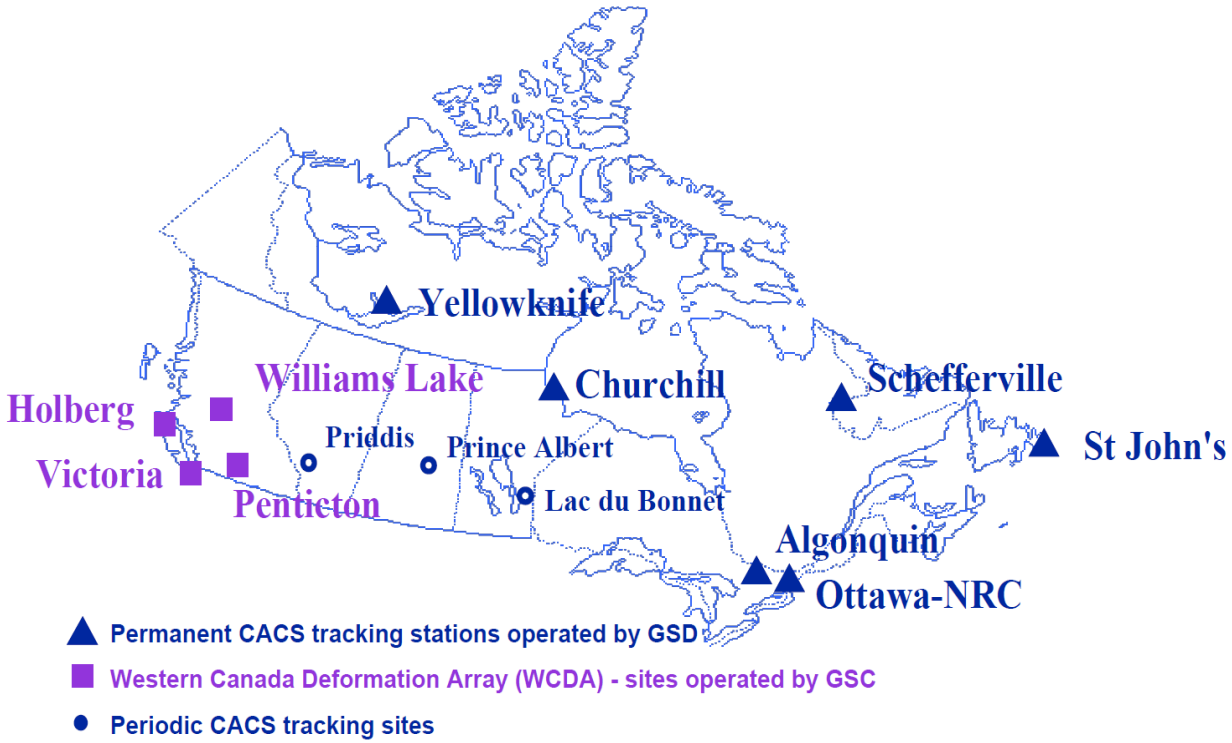
1995 - 2003

1995: RT stream using radio beacons, Wide Area DGPS. 4 CACS were upgraded and added 8 more later.
2003: CSRSC- PPP

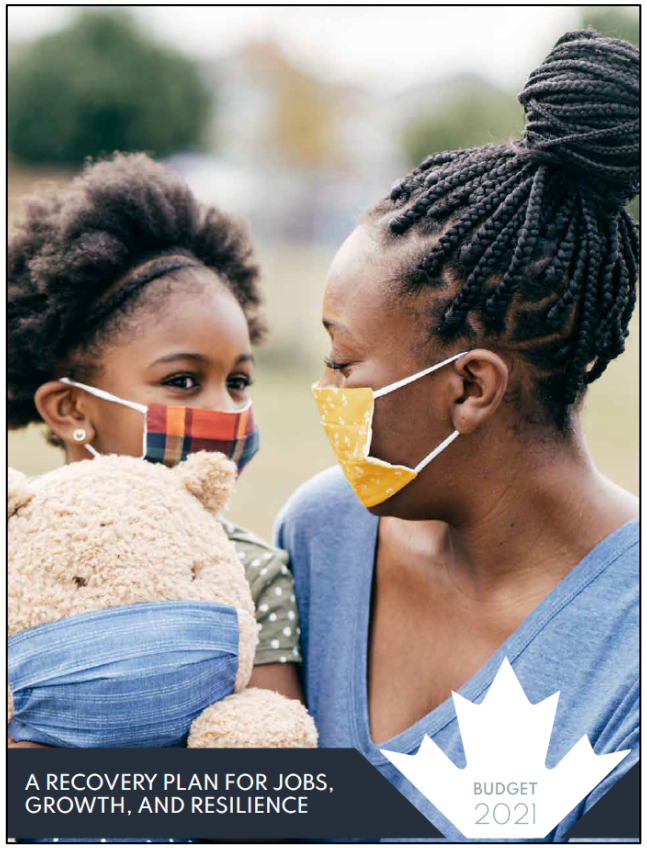
CSRS hierarchy



A Network Sparsely Distributed



Space-Based Earth Observation (SBEO) : A step towards GNSS densification



Capitalizing on Space-based Earth Observation

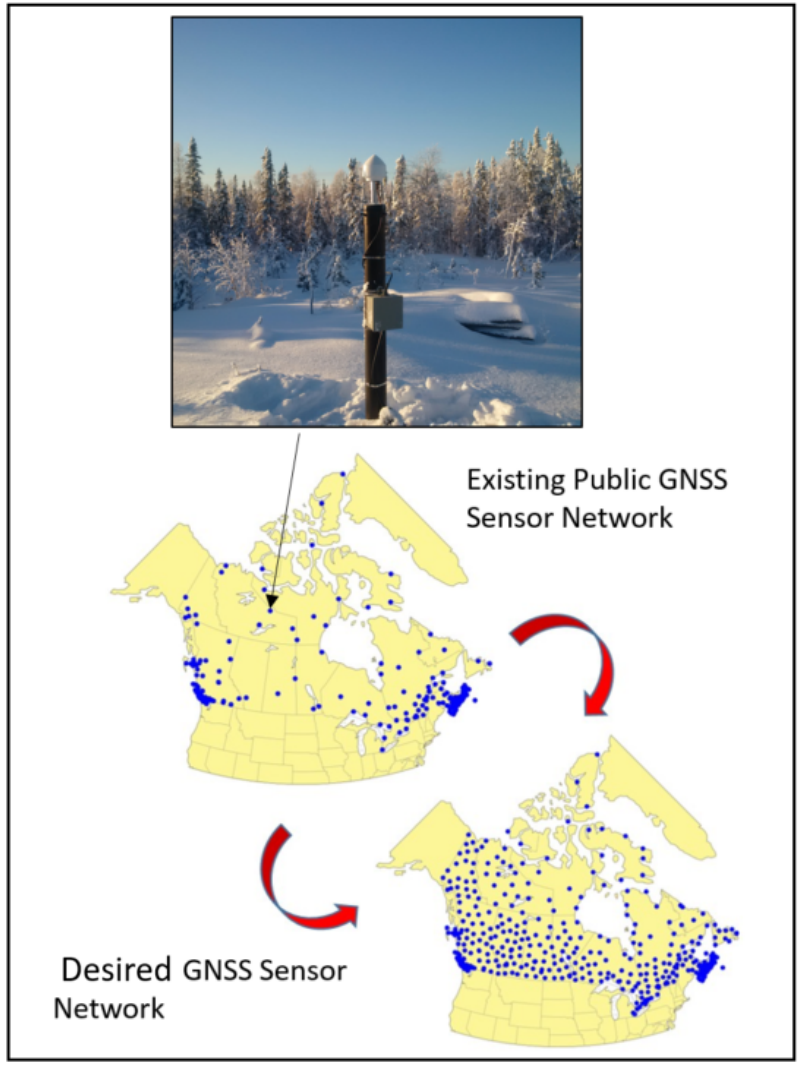
Earth observation satellites support critical services that Canadians rely on. They provide reliable weather forecasts, support military and transport logistics, help us monitor and fight climate change, and support innovation across sectors, including energy and agriculture. They also create high-quality jobs in Canada and the government will continue to explore opportunities to support Canadian capacity, innovation, and jobs in this sector. To maintain Canada's capacity to collect and use important data from these satellites, Budget 2021 proposes to provide:

- $80.2 million over eleven years, starting in 2021-22, with $14.9 million in remaining amortization and $6.2 million per year ongoing, to Natural Resources Canada and Environment and Climate Change Canada to replace and expand critical but aging ground-based infrastructure to receive satellite data.
- $9.9 million over two years, starting in 2021-22, to the Canadian Space Agency to plan for the next generation of Earth observation satellites.

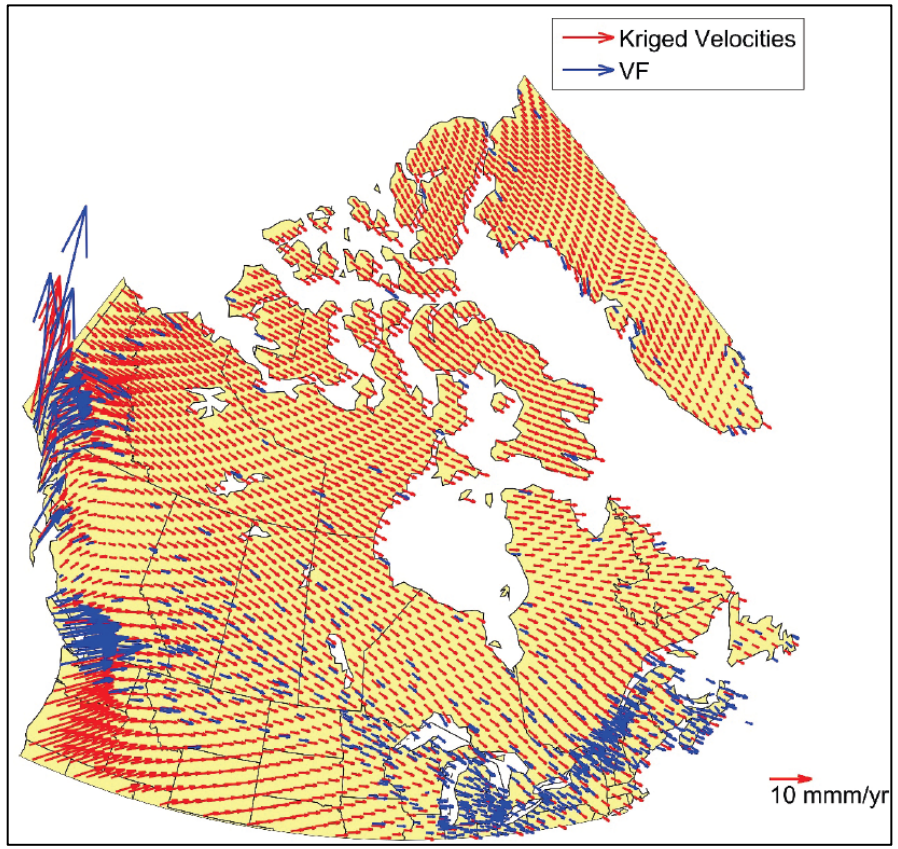
Installation of 22 new GNSS stations

Project schedule

Year 1 (2021-22)	2022-23	2023-24	2024-25	2025-26
Project Start-up: - Recruiting & Stakeholder consultation - Establish specifications for equipment and site construction - Begin procurement of goods				
New GNSS installs	2 (10%)	9 (50%)	9 (90%)	2 (100%)

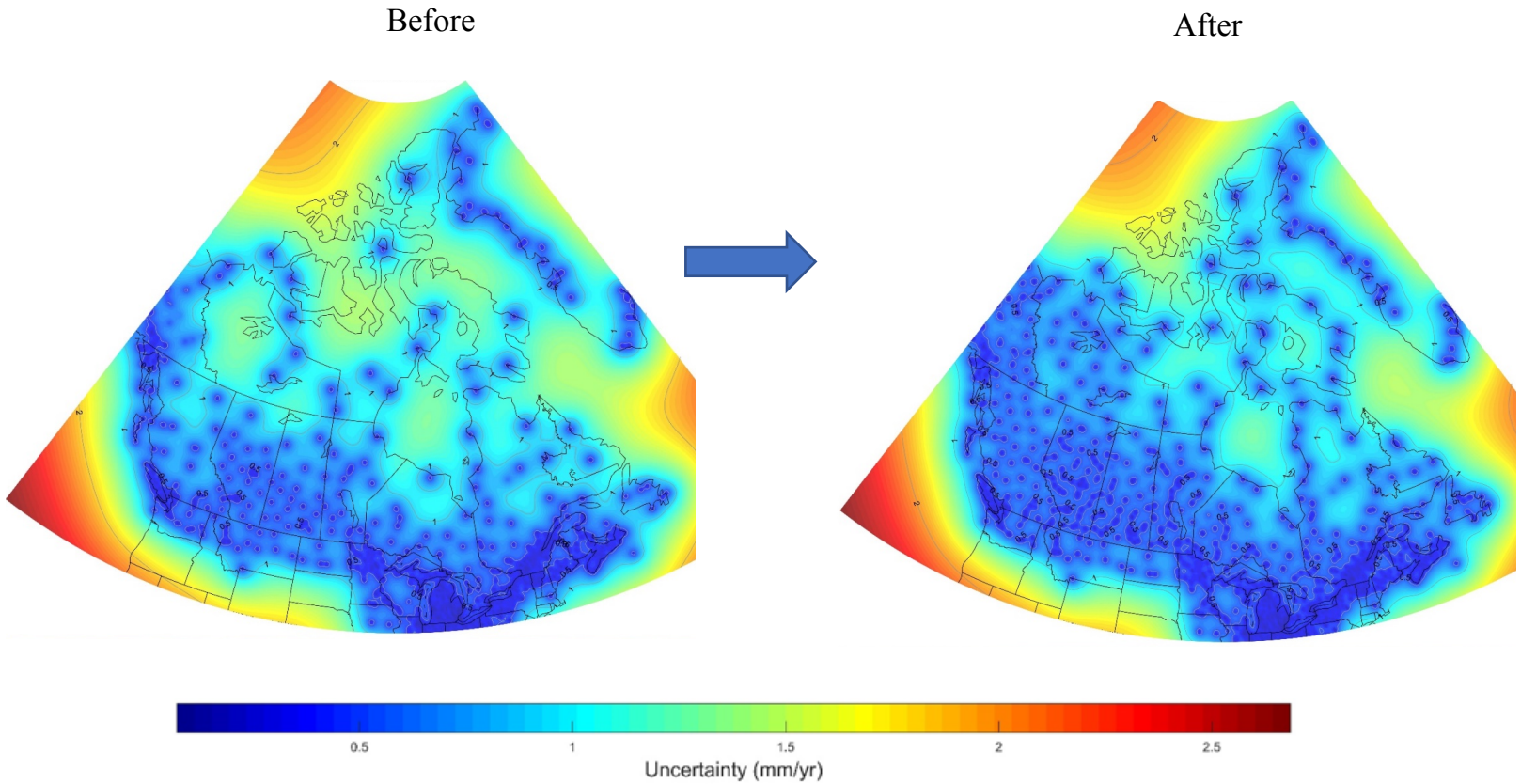


Our dynamic Canadian landmass (horizontal component)



NAD83v70VG, horizontal component, in NAD83(CSRS)

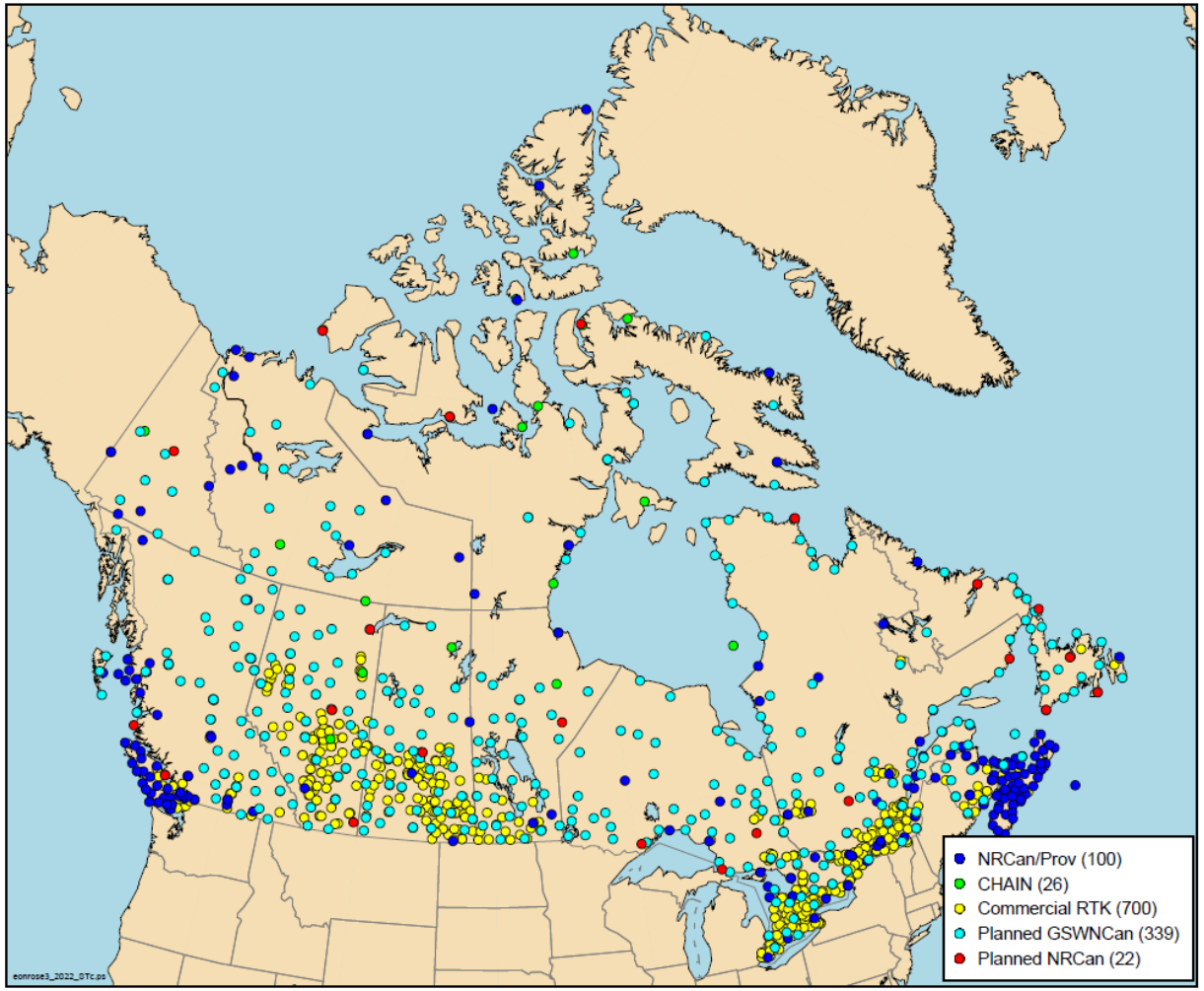
Our dynamic Canadian landmass (vertical component)



Selecting New Station Locations

Guiding principles :

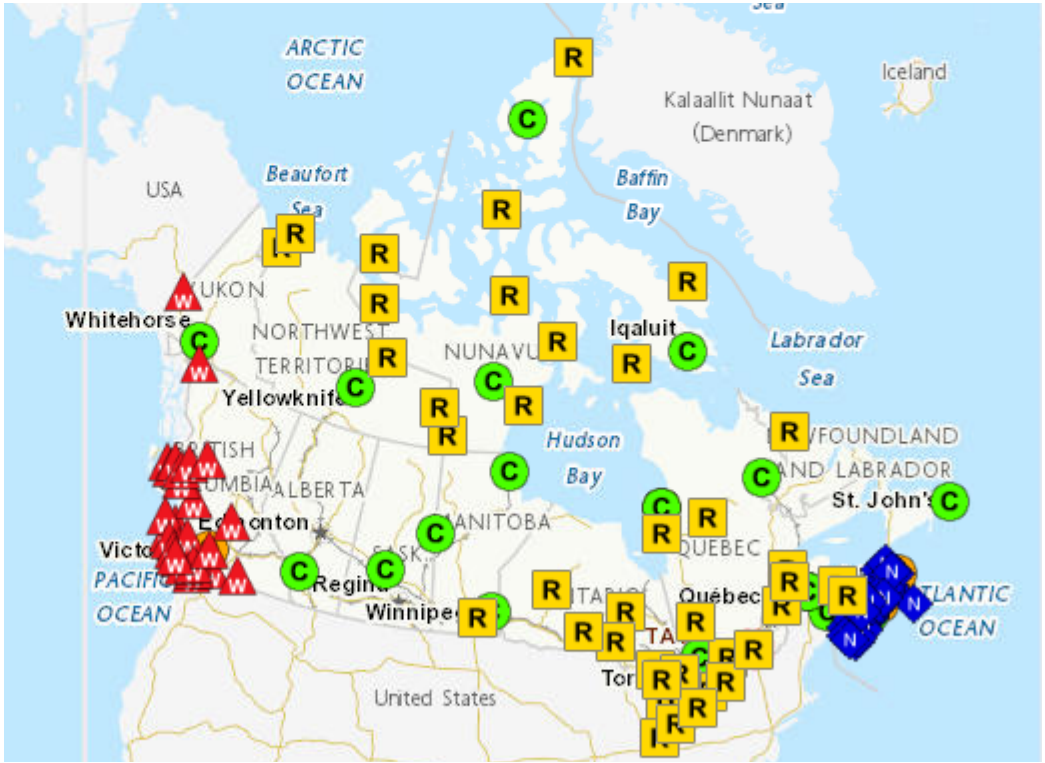
1. Fill in gaps in current coverage
   - Positioning service gaps
   - Reference frame needs
   - Scientific needs
2. Avoid overlap with commercial RTK networks
3. Maximize benefits to stakeholders



Challenge #1: Adequate Coverage

Oh Canada!:

- ❑ Surface: 9 984 670 km2
- ❑ Fresh water: 891 163 km
- ❑ Coast: 202 080 km and
- ❑ Temperature: -62 to 45 degrees
- ❑ Permafrost and many very remote regions



C Canadian Active Control (19)

R Regional Active control (40)

Western Canada deformation Array (31)

Nova Scotia Active control (41)

Challenge # 2: Adequate Equipment

- Specification for goods – procurement
- Besides GNSS antennas and receivers, battery systems need to be designed, tested, deployed and maintained
- Communication Services in the North
- Specification for services
- Drilling, building and installation of sites in the Arctic
- Balance fieldwork with multiple projects

Challenge # 3: Long Term Commitments

- Land agreements
- Trained local site contacts specially difficult in very remote regions
- Costs of maintenance and communication services
- Rapid technology changes: e.g. E6, LEO support
- Partnerships and collaborative projects

Active Control Network Expansion (summary)

- Don’t do it alone
- It won’t be perfect, but we’ll get there
- Be creative:
  - Support (not compete with) the private sector (e.g. RTK service providers)
  - Talk to your ‘clients’ and have them request a GNSS stations to you – not the other way around (e.g. Hydro)
  - Write specifications (e.g. NRCAN’s RTK compliance program)
  - Talk to your governments (e.g. CCOG, CGRSC)
- GNSS infrastructure is key for:
  - Climate Change
  - Infrastructure
  - Natural Hazards (e.g. ICAO

$

© Her Majesty the King in Right of Canada, as represented by the Minister of Natural Resources, 2022

sandra.bolanos@nrcan-rncan.gc.ca