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Geoscience & Positioning, Navigation and Timing Services for Canadians

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International Comparison

Nations (G8)	GNSS Constellation	Augmentation System
United States	GPS	WAAS (38 ground stations, 3 satellites,
Germany	Galileo	EGNOS (40 ground stations, 3 satellites)
UK	Galileo	EGNOS
France	Galileo	EGNOS
Italy	Galileo	EGNOS
Russia	GLONASS	SDCM
Japan	QZSS	QZSS, MSAS
Canada	(NONE)	(NONE)

India (IRNSS/GAGAN), China (Beidou)

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Investment in GNSS ground stations and other infrastructure

- Canada has approximately 75 GNSS stations operated by the federal government, supplemented by provincial, scientific (e.g. CHAIN) and private networks.
- Ground-based GNSS is not used in Canada for meteorological forecasts at this time (unlike E.U., U.S., ...).
- Canada has a geoid-based system for height standards (height above sea-level), unlike most nations, dramatically reducing infrastructure and associated costs.
- The U.S. National Geodetic Survey has over 2000 CORS stations in their network (with partners). The Earthscope Plate Boundary Observatory has 1200 continuous GPS instruments.
- In August 2017 the U.S. government approved the establishment of an eLORAN system (GPS backup), and \$200M in “Capital Spending for PNT systems”. \$10M was approved for a “GPS backup technology demonstration” in 2018.

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Canada's investment is likely less than 1% of that of the U.S.

... Why is Canada different?

- The Canadian Geodetic Survey's direction for many years minimizes ground infrastructure and relies on "wide area" solutions, such as PPP.
- Federal government (including military) and funding agencies have not regarded geodesy as an investment priority (although requests have been rare).

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Is this a good thing?

- Yes and No.
- Canadian tax payers benefit by taking advantage of huge investments by other nations (GNSS constellations, WAAS, etc.).
 - *In 2012 the annual operating cost of GPS was estimated to be \$750M (Time magazine). The initial cost of WAAS was approximately \$1B (Aviation Week). The cost to “provide the WAAS signal” is ~ \$50M/year (Wikipedia).*

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Is this a good thing?

- Canada has been lagging other nations due to a lack of investment.
 - Meteorology (troposphere content)
 - Geoscience (major gaps in north, coastal areas)
 - Surveying efficiency (PPP less efficient than RTK)
 - GNSS timing system security issues
- Canada may be more dependent on international cooperation in Geodesy than any other nation.
- Opportunities exist to improve competitiveness and spur innovation across the national economy. Also to support autonomous vehicle revolution, advance precision agriculture, location-based services, Earthquake Early Warning, etc.

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Where could Canada invest?

Canada can take better advantage of global positioning through relatively very small investments:

- Expanded GNSS ground networks (20? 100?) for geoscience, PNT services, constellation health monitoring, operational space weather monitoring.
- Broadcast real-time correction streams (5-10 cm, global, real-time) for Earthquake/Tsunami Early Warning, precision agriculture, autonomous vehicles, augmented reality, etc.
- Provide improved reliability information to users via real-time GNSS health monitoring and secure timing systems.
- Support meteorological use of GNSS troposphere information at Environment and Climate Change Canada.
- Give something back to the global community through providing geodetic data and perhaps other services (PPP?).

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We propose that Canada make these investments.

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