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National Earthquake Early Warning (EEW) System for Canada

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https://earthquakescanada.nrcan.gc.ca/eew-asp/system-en.php



Introduction

- Parts of Canada with large populations continue to be exposed to substantial earthquake risk,
- Seismic monitoring since 1898, with modern recording since 1927, but this is unsuitable for Earthquake Early Warning (EEW) purposes





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Earthquake Early Warning



Proven effective in other countries (Japan, Mexico, Taiwan, & U.S.)

- System triggered within seconds of rupture, by earthquake's P-wave; alert sent before (more damaging) S-wave arrives
- Provides valuable seconds to tens-ofseconds of warning
- Allows protective measures & reduces impact of an event



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EEW System's Network

- Dense network of sensors (~20 km in urban areas)
- High speed, redundant communications to multiple data centres
- Rapid data processing and alert dissemination (via USGS's software)
- Cyber and physical security (ITSG-33)







EEW Stations

- Equipment optimized for EEW:
 - Strong motion accelerometers with digitizer
 - Power with back-up
 - Communications with redundancy
- ~1m² space at grade or in basement (concrete floor)
- Heat <u>not</u> required (shed/garage fine)
- Sensor bolted to floor

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- 120V AC power < 20W; dedicated circuit preferred
- Antenna's outside for GPS timing and for communications
- **Communications** options:
 - Shared Internet Connection
 - Wireless Broadband (Cell modem)
 - Specialized Shared Connection
- Bandwidth: minimum <5GB/mo continuous data rate (Occasional 40kB/s for configuration)
- Consider cyber and physical security (ITSG-33) requirements







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Alert Dissemination

- Alerting in xml format to Critical Infrastructure operators and other Technical Partners
 - Trigger automated protective actions
 - Potential for technical development
- F/P/T emergency operations centres
- Public via National Public Alerting System (NPAS/AlertReady)
 - Already in use by ECCC for severe weather alerts, but entirely automated
 - Sent via radio, t.v., cellular 'phones

Appropriate alert thresholds for Canada to be determined

- Threshold too low people annoyed
- Too high is system working?
- Public Education required

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National Public Alerting System (NPAS)





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Automated Responses



- EEW connected systems can **automatically** take protective actions
- Personal safety by protective response public education through ShakeOut and others

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Mitigation: Business Resumption

- EEW sensor stations provide a record of actual shaking at the site where they are located
- Rapid delivery of this report to the site operator can assist in damage assessment and business resumption planning
- Work with end-users to determine exact content and format of the report also potentially in electronic formats

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Innued 20yy/mm/dd 99.99 UT

Shaking Report for Station VGZ

Earthquake with an estimated magnitude of x.x. Located 31 km WSW of station VGZ Epicentre 48.26N 123.66W, 31 km WSW of VGZ Origin Time 20yy/mm/dd 88:88 local time (20yy/mm/dd 77:77 UT)



Uniform Hazard Spectra - shaking levels recorded at VGZ from earthquake on 20wimm/dd at 88:88 local time





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Shaking Intensity with Distance from Earthquake

Attenuation of seismic waves with distance



Example earthquake: Vancouver Island

- M7.3 in 1946 felt throughout BC and into YT, WA & OR; caused considerable damage in central Vancouver Island
- For similar earthquake, EEW would provide:

Warning Time	Location
~40 s	Vancouver
~50 s	Victoria
0 s	Cumberland (within Late Alert Zone)



Example earthquake: Ontario

• M5.0 in 2010

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- Felt east of Quebec City, west of London, north of Sudbury, and south into the northwestern United States, as far as Kentucky
- For similar earthquake, EEW would provide:

Warning Time	Location
3-10 s	Ottawa & Gatineau



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Example earthquake: Québec

- M5.9 in 1988 felt across broad region, causing damage
- For similar earthquake, EEW would provide:

Warning Time	Location
29 s	Québec City
84 s	Montréal
>90 s	Ottawa & Fredericton

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Summary

- Earthquake Early Warning has the potential to mitigate the impact of major earthquakes in Canada
- System construction underway
- Cross-border integration with systems in the United States
- Initial operation to begin in 2024

