

# *Phasor Measurement at Hydro-Québec TransÉnergie*

**NASPI ESG**

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# Presentation Outline

- ◆ **Hydro-Québec TransÉnergie system**
  - Transmission system — key data
- ◆ **Phasor Measurement System (SMDA)**
  - 25 years of development
  - Specific characteristics of SMDA 5 System
  - Examples
- ◆ **Phasor Measurement Component of HQ TransÉnergie's Defense Plan**
  - Automatic Switching of Shunt Reactors (MAIS)
  - Under Voltage Remote Load Shedding (TDST)
- ◆ **Future Development**

**Slide 2**

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**A2**

Administrateur, 2/12/2007

# HQ TransÉnergie Transmission System – Key Data

Extensive transmission and telecommunication system

- ◆ 95 % hydroelectric generation, mainly located more than 1,000 km from interconnection points and major load centers
- ◆ Transmission system:
  - 32,544 km of lines
  - 505 substations
  - 17 interconnections with New Brunswick, Ontario and United States
- ◆ 60 Hz, but not synchronized with the Eastern Interconnection
- ◆ Major concern: system stability







# ***SMDA - Phasor Measurement System*** ***25 years of development***

## **Angular displacement measurement system**

- ◆ **Late 1970s:**
  - **Experimental system tested on 2 units**
  - **Measurements taken every second**
  - **Synchronized by Loran C**
  
- ◆ **2005:**
  - **Implementation of 5th-generation SMDA 5**
  - **Increased to 8 measurement units**
  - **Processing by direct sequence**
  - **Harmonics data available**
  - **Synchronized by GPS**



# ***Specific Characteristics of SMDA 5 System***

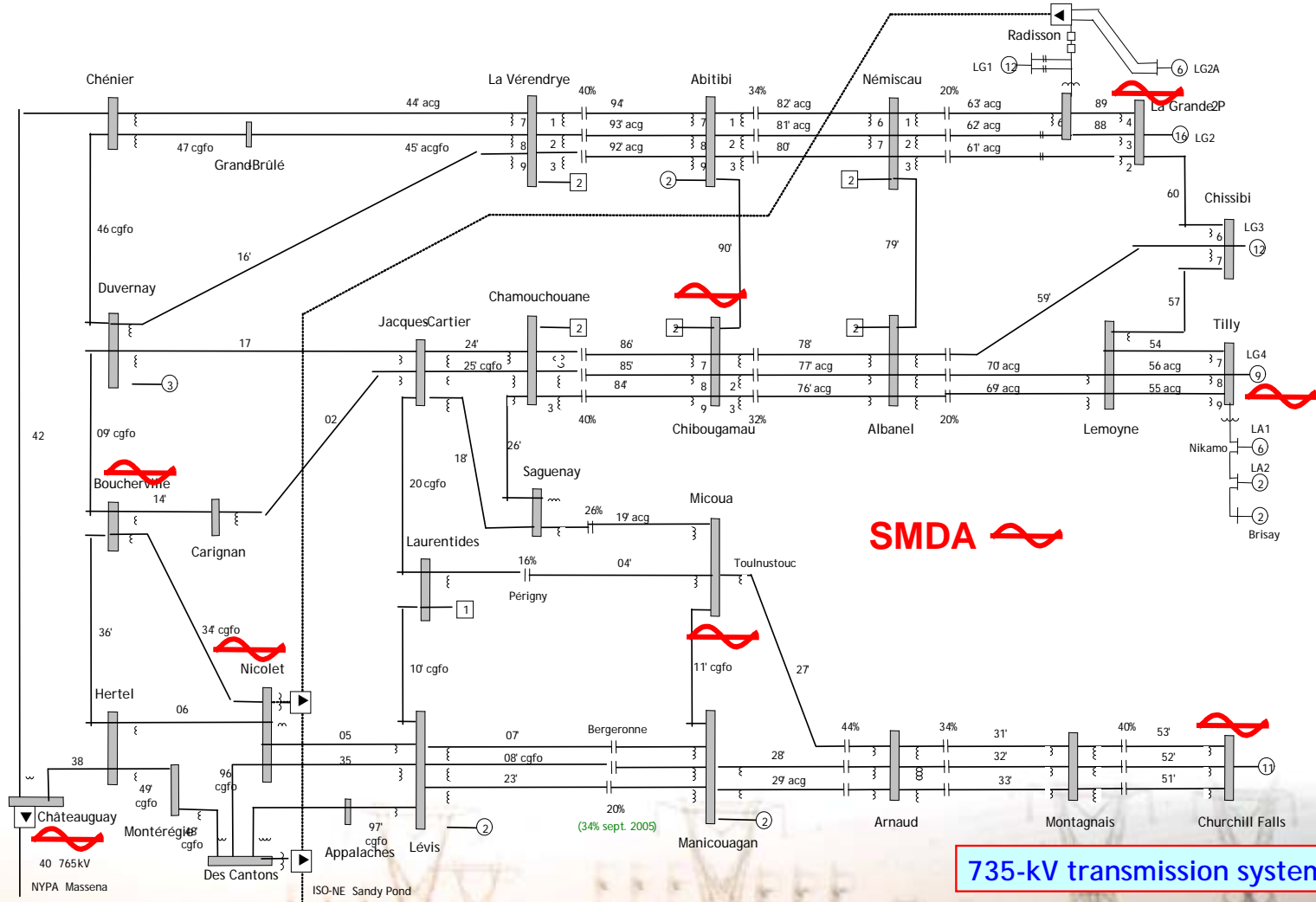
## ***Data available for real-time operation***

◆ **Data available:**

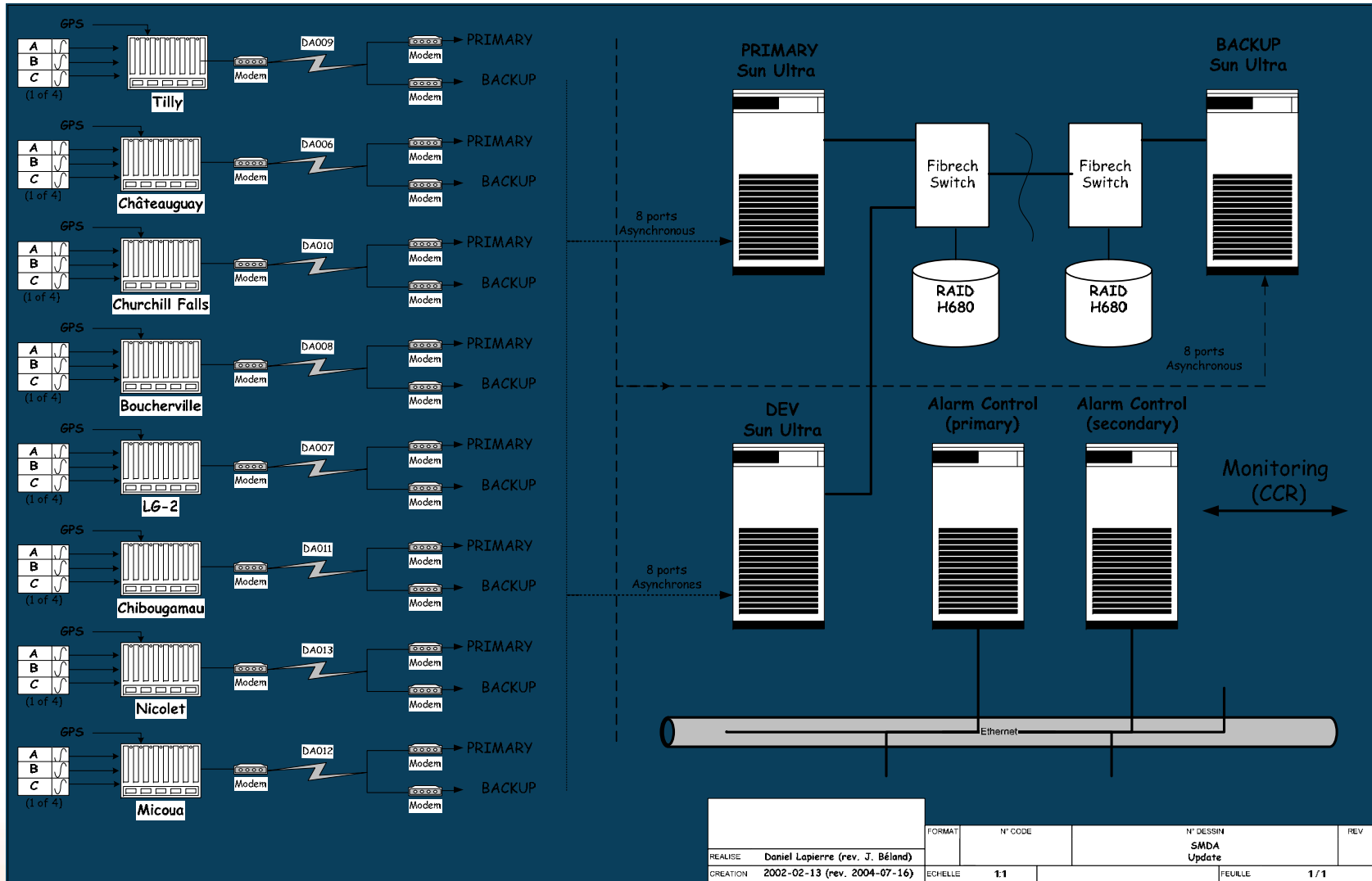
- **Harmonics distortion in each substation (direct sequence, harmonics 2 to 8 – useful for geomagnetic activity detection)**
- **Phase angle differences**
- **Frequency variation**
- **Voltage variation**
- **Time variation for Frequency Regulation System (RFP)**
- **System status**

***Data is available every 5 seconds for real-time operation.***

# Specific Characteristics of SMDA 5 System — Location of phasor measurement units



# Specific Characteristics of SMDA 5 System – System View





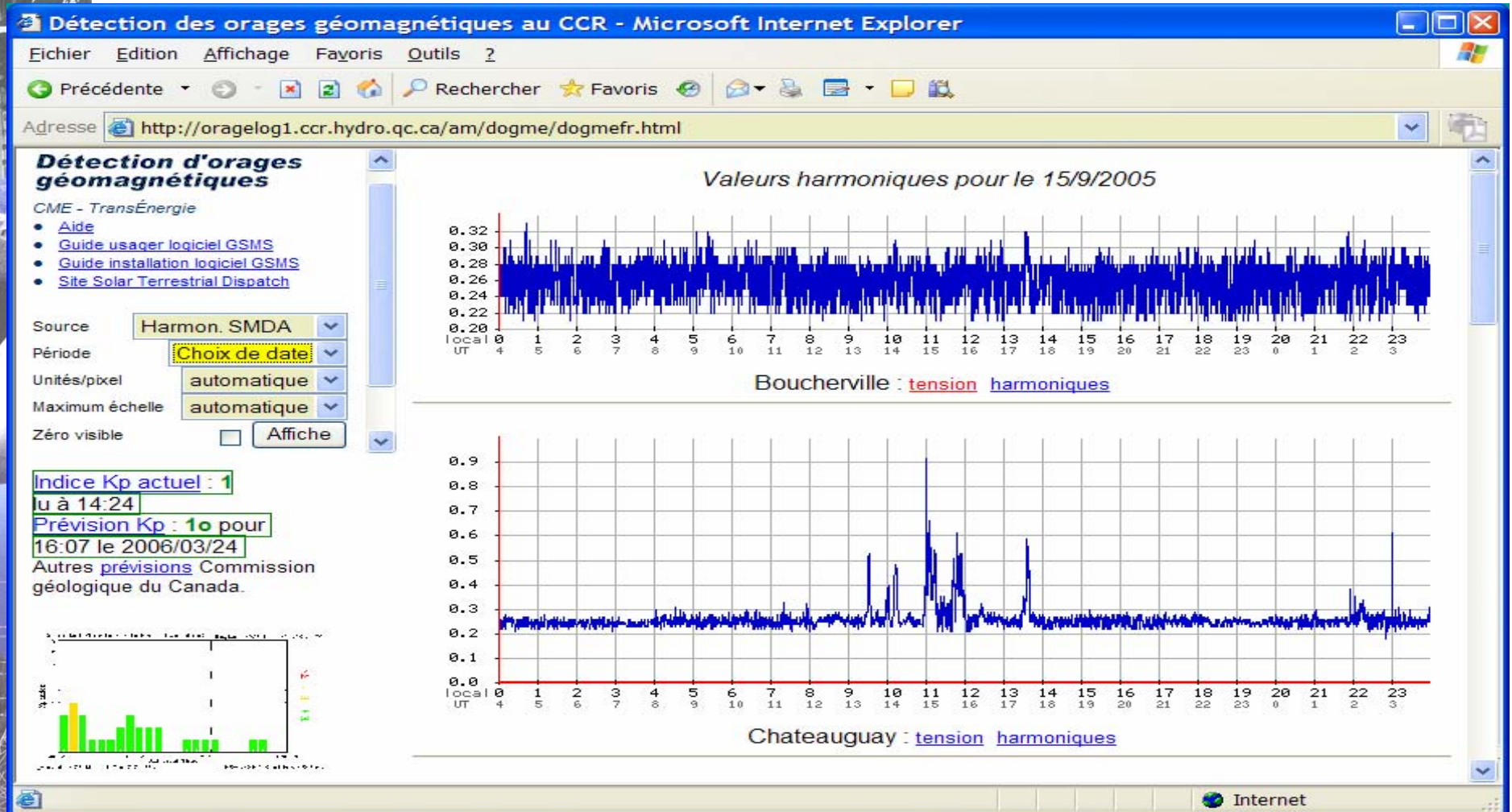


## ***Future Development***

- ◆ **Transmission system expansion and new wind farms in remote locations**
  - 2 new measurement units will be added:
    - Outaouais DC interconnection – HQ-OH
    - Gaspé Peninsula – 1500 MW of wind energy

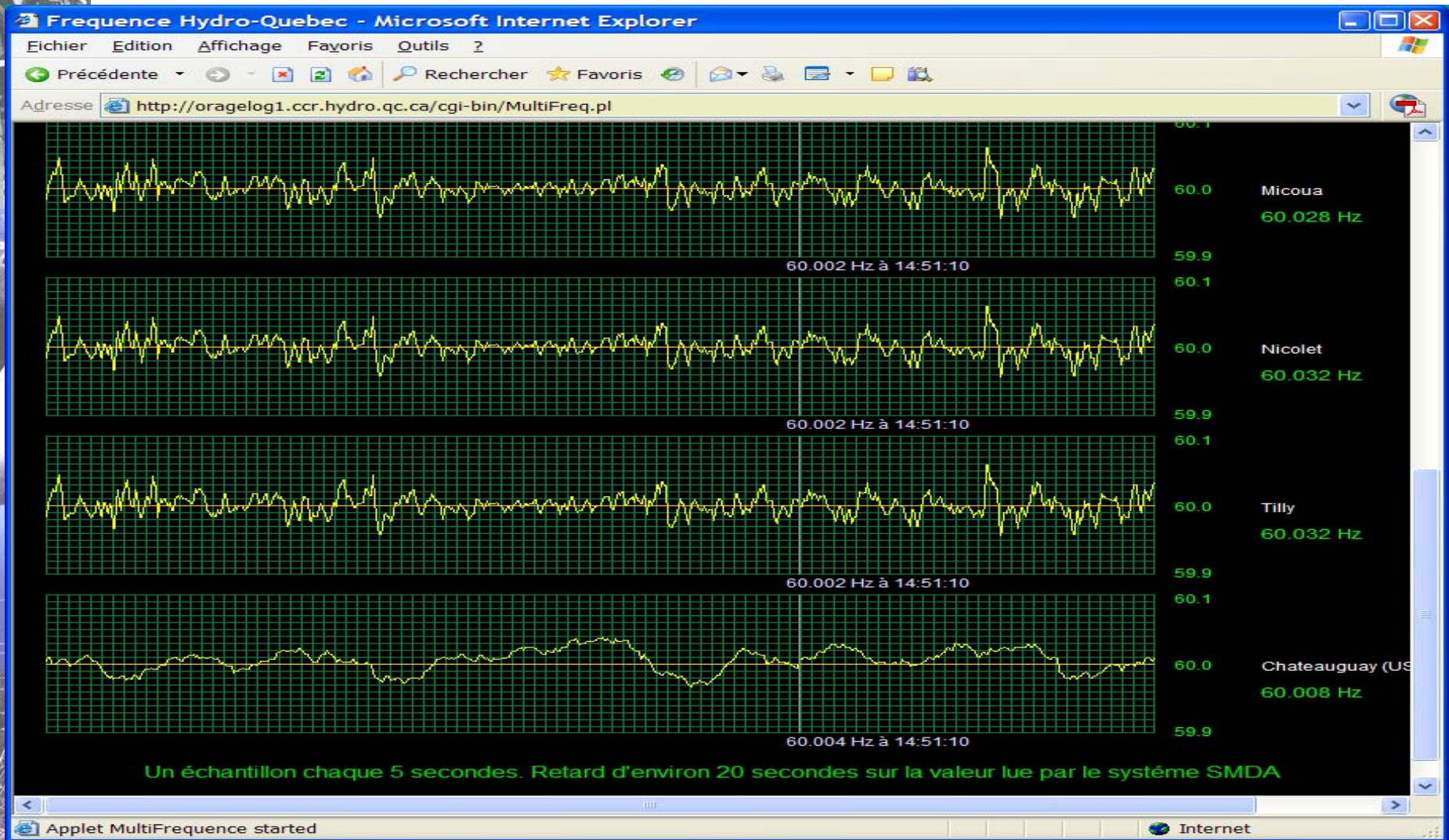
# Example – Magnetic Storm

(Dispatcher view of alert system display – Web page)

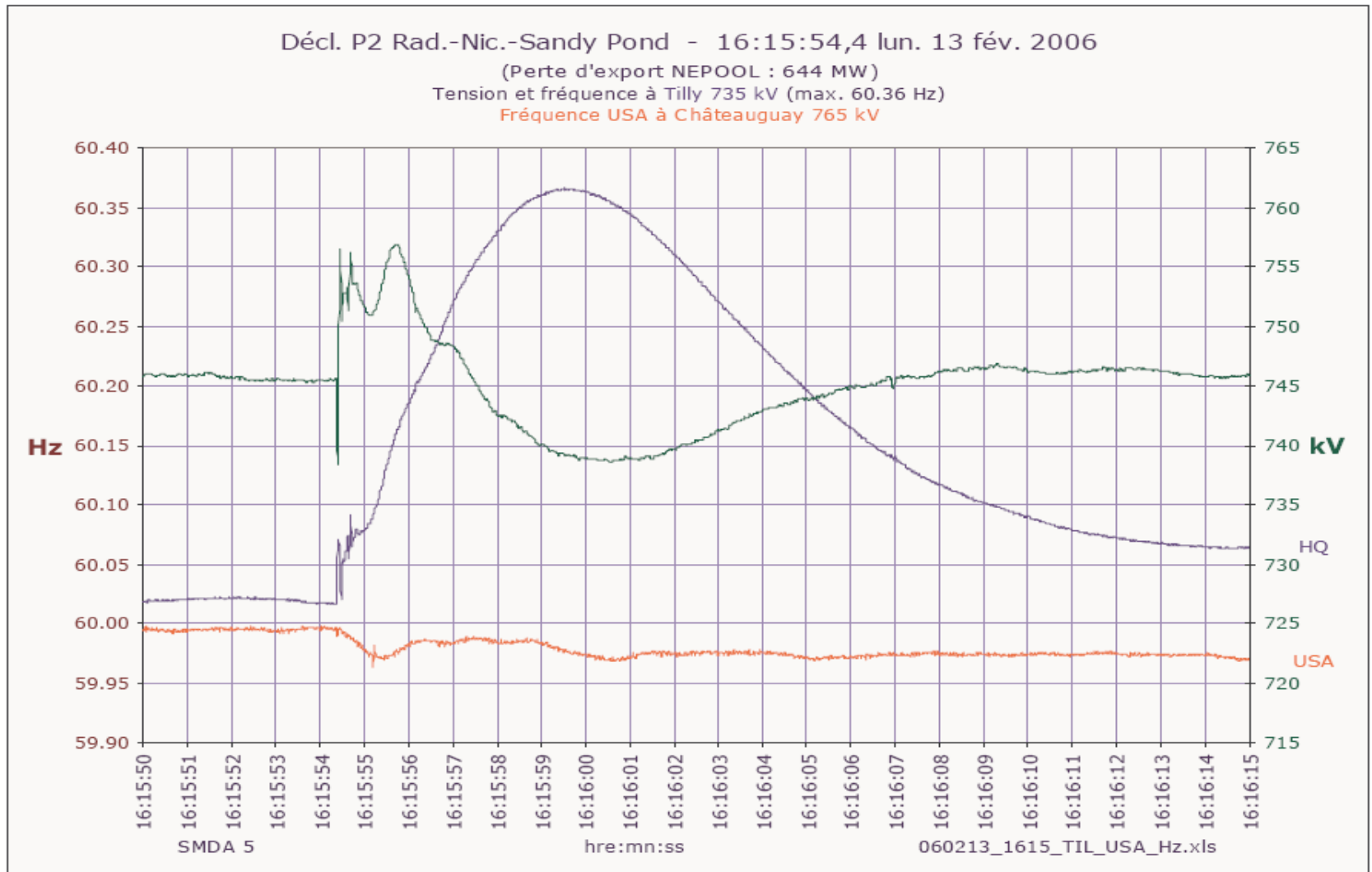




# Example – Frequency in Real Time



# Example – Frequency and Voltage in Real Time







## **Phasor Measurement Component of HQ TransÉnergie's Defense Plan**

- ◆ **Ensure system reliability and security in relation to multiple contingencies**
- ◆ **SPS are coordinated to give the best possible coverage for all events and system behaviors**
  - *Power Rejection and Remote Load Shedding (RPTC)*
  - **Automatic Switching of Shunt Reactors (MAIS)**
  - *Under Frequency Load Shedding (DSF)*
  - **Undervoltage Remote Load Shedding (TDST)**
  - *Protection against System Separation (SPSR)*

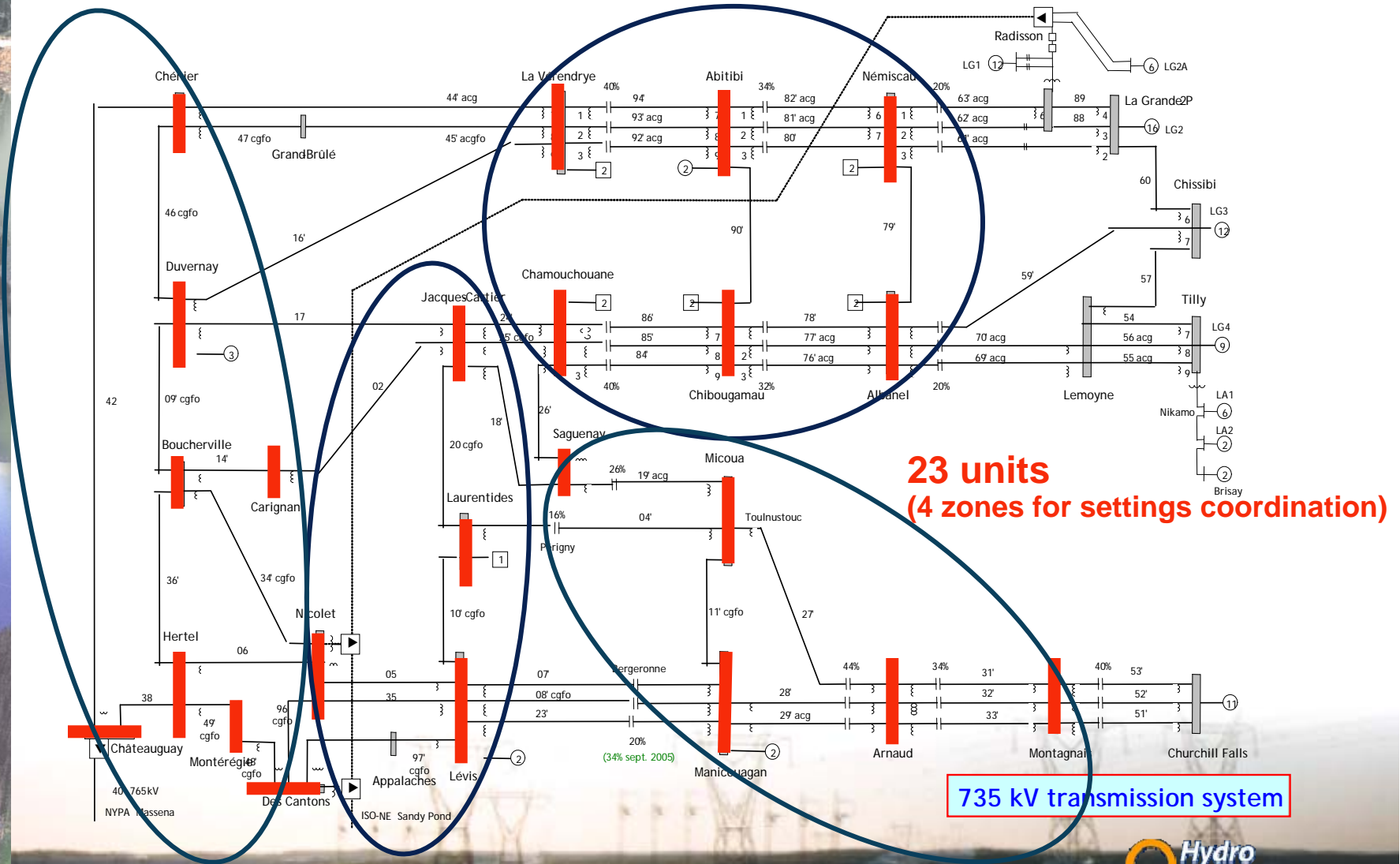


## ***Specific characteristics of MAIS***

- ◆ Relies on precise local phasor measurements
- ◆ 23 units
- ◆ Each unit is comprised of a high precision 735 kV measurement transformer, a sophisticated filtering and a command module.
- ◆ Each unit uses local voltage measurement for shunt reactors switching
- ◆ Coordination is accomplished by appropriate setting of voltage threshold and time delays

# Specific Characteristics of MAIS

## Local measurement units



**23 units**  
**(4 zones for settings coordination)**

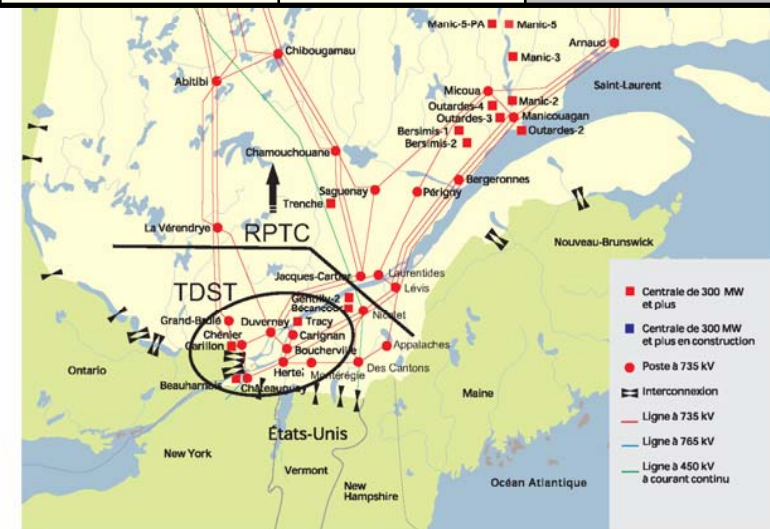
**735 kV transmission system**



# Specific Characteristics of TDST (UVLS)

- ◆ Relies on precise local phasor measurements (MAIS):
  - Monitors voltage in 5 sub-stations in the Montreal area
  - Uses an average voltage value obtained from MAIS units
- ◆ Basic action:
  - 3 fixed thresholds (voltage vs. time)
- ◆ Security
  - Identify severe disturbances
  - Detect faulty data
  - Max. load shedding of 1500 MW
- ◆ Fully redundant

<i>Threshold average voltage</i>	<i>Time delay</i>	<i>Amount of load</i>
.94 pu	11 sec.	400 MW
.92 pu	9 sec.	400 MW
.90 pu	6 sec.	700 MW







## ***Future Development R&D Projects – SPS***

- ◆ **New method to detect line opening using local measurements (new product to be installed on the grid)**
- ◆ **New method to detect loss of synchronism (replacement of an old relay)**
- ◆ **New method to detect instability of a generating station**
- ◆ **New method to detect instability of a grid (instability indices)**



# ***Future Development R&D Projects – Control***

- ◆ **New multi-band power system stabilizer**
- ◆ **New dynamic shunt compensator controls**
- ◆ **Overall control of SVCs based on synchronized phasor measurements**



*Thank you for your attention!*



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