Canadian Meteorological Centre
HPC Renewal Initiative

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Agenda

• Background information on the project
• Environmental Forecasting Requirements
• Supercomputing Procurement
• Conclusion
Background

• Contract signed in 2003 for the Scientific Computing Facility (SCF) with IBM, now soon to expire.

• Additional funding recently awarded to the Meteorological Service of Canada
  – Component 1: Monitoring Networks
  – Component 2: Supercomputing capacity
  – Component 3: Weather Warnings and Forecast System

• As a result: HPC Renewal Initiative launched
Variety of customers of SCF

- Weather forecasting
  - Research
  - Development
  - Operations
- Climate
- Air quality
- Environmental emergency response
Environmental Forecasting Requirements

• Science drives the requirements
• User Requirement Document (URD) produced
  – 10 year plan outlining the expected scientific path (EC)
  – Translated in computing needs (EC&SSC)
  – RFP (SSC lead with EC representation)
Meteorological Research Division

- RPN-A
  - Atmospheric modelling
- RPN-E
  - Environmental modelling
- RPN-SI
  - Informatics section
- ARMA
  - Data assimilation
- ARMP
  - Cloud physics and severe weather
Atmospheric Numerical Prevision Research

- HR global forecast 15 km, 4/day
  - 80 levels -> 120
- HR North America LAM 250m
- New 3D microphysics scheme
  - Turbulence
- Ensemble forecast to
  HR 50km -> 25 km -> 15 km
- Increase radiation calls
- Cloud physics renewal
Environmental Numerical Prevision Research

Ocean, ice, waves, urban, ground, vegetation, hydrology, lakes

- Global coupled Ocean/Atm forecast – 15 km
- Global ice forecast
- Global wave forecast
- Ensemble arctic ocean forecast (20 + 20 mercator)
  - 4-5 days
- HR arctic ocean deterministic forecast (1/36 °)
  - < 4 days
- Coupled HR Lake-Ice-Atm over the great lakes
Data Assimilation

• Data assimilation at same resolution as forecast
• Add aeolus, GOES-R data
• Increase ensemble # of members 256 -> 512
• Surface data assimilation -> soil moisture
  – SMAP
  – O(1000) -> O(15,000,000)

AMSU-A, 6-h period, 7 satellites, temp profiles
Shared Services Canada

- Created in 2012, to take responsibility of email, networks and data center for the whole Government of Canada.
- Supercomputing IT people working for EC transferred to SSC.
- Scope of the HPC team expanded to all science departments
- As in any reorganization, there are challenges and opportunities!
EC Supercomputing Procurement

- Contract for Hosted HPC Solution: 8.5 years + one 2.5 year option (three systems + one optional)

- Connectivity between HPC Solution, Data Halls and Dorval

- No more than 70km between Hall A, Hall B & Dorval

- Flexible Options for additional GC needs
Scope

• Supercomputer
• Pre/Post-processing
• Global Parallel Storage (high-bandwidth low latency)
• Near-line Storage
• High Performance Interconnect
• Software & tools
• Maintenance & Support
• Training & Conversion support
• On-going Availability
HPC Solution: Fully Redundant

[Diagram showing the logical flow of data transfers and synchronization between SupercomputerA, SupercomputerB, HP-NLS, Site Store, Scratch, Cache, and Home. The diagram includes arrows indicating data feeds (

- HPN Data Transfer
- Storage Synchronization
- Out-of-Band Management

Issued by Government of Canada (Gouvernement du Canada) for SCF Data Flow – Logical View, LPT, HPN/DADS, SSC, 2014-10-07]
Collaborative Procurement Process

- Use of (more) Collaborative Procurement Process
  - RFI
  - Invitation to Qualify
    - 4 Qualified Respondents (QR): Cray, Dell, HP & IBM
  - Review and Refine Requirements Phase
  - Bid Solicitation Phase
    - Contract Award

We are here
Technology

- Quite a bit of freedom on how the vendor can achieve the performance targets
- A lot of restrictions came from applications that aren’t in the benchmark suite. They need to perform as well
- No GPUs nor other accelerators on 1\textsuperscript{st} system, strong possibility on the 2\textsuperscript{nd}
Bid Evaluation

• One number that drives almost everything: Fixed Performance Level (FPL)
  – From that number, we derived floor amounts for memory, storage, benchmark performance, tape qty, etc.
  – Minimum value is 0.25 (lower bid == non compliant)
    ▪ It means ~5X performance increase (with FPL= 0.25. ~20X for FPL=1) for 1st system on the main GEM benchmark over the Power7, then 2.6X for each upgrade

• Requirements increased automatically as closing date of the RFP got pushed
  – On an exponential growth curve, the starting point matters a lot!
Reality Check

- Tender issued late November
- Supply Chain Integrity (Security Phase)
  - QR’s supply chain is vetted by GoC for security purposes
  - Took much longer than anticipated
- Market environment changes
  - Procurement risks, technology, foreign exchange rate, etc.
- And… Federal Elections
  - Longest election campaign ever in the country’s history launched in August (78 days).
  - Most main decisional processes are paralyzed until November… at the earliest
HPC Implementation Milestones: Delivery to Acceptance

- Data Hall and Hosting Site Certification
- Functionality Testing (IT infra)
- Security Accreditation
- Performance testing
- Conversion of Operational codes (Automated Environmental Analysis & Production (AEAPPS))
- Meeting the above triggers a 30 day availability test

*Scheduling Details in next slide*
Once the Ink Dries...

SSC Solution Timeline

- All dates are "no later than", unless otherwise specified.
- The term day refers to calendar day.
General Purpose Science Cluster (GPSC)

- Very similar to UK NCAS approach
- Federating users of many computing communities
- Using Linux containers (LXC, not docker)
  - Works well, but not out of the box
- Workloads extremely heterogeneous
  - Month(s)-long jobs?
  - 4TB RAM on the node?
  - 100Mio 32k files? Or one 3.2TB file? Or a 3PB database?
  - Linux and Windows?
- In dev mode. More to report in a year
Summary

- Canada is investing massively in HPC to support the Environmental Prediction program
- RFP almost completed
  - Evaluation of the bids still in progress
- It will eventually bring EC to $O(100)$ Petaflops and $O(1)$ Exabyte