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
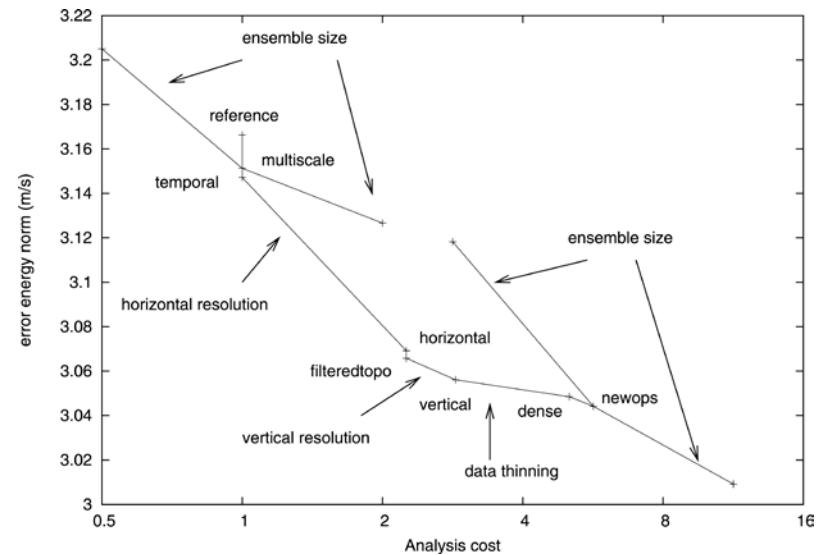
Environmental Numerical Prevision Research

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 º)
  - < 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)
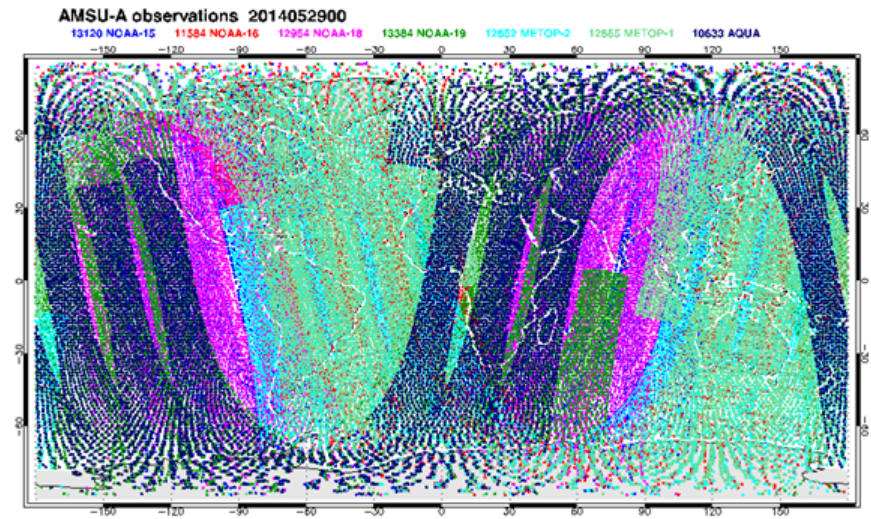
AMSU-A, 6-h period, 7 satellites, temp profiles

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
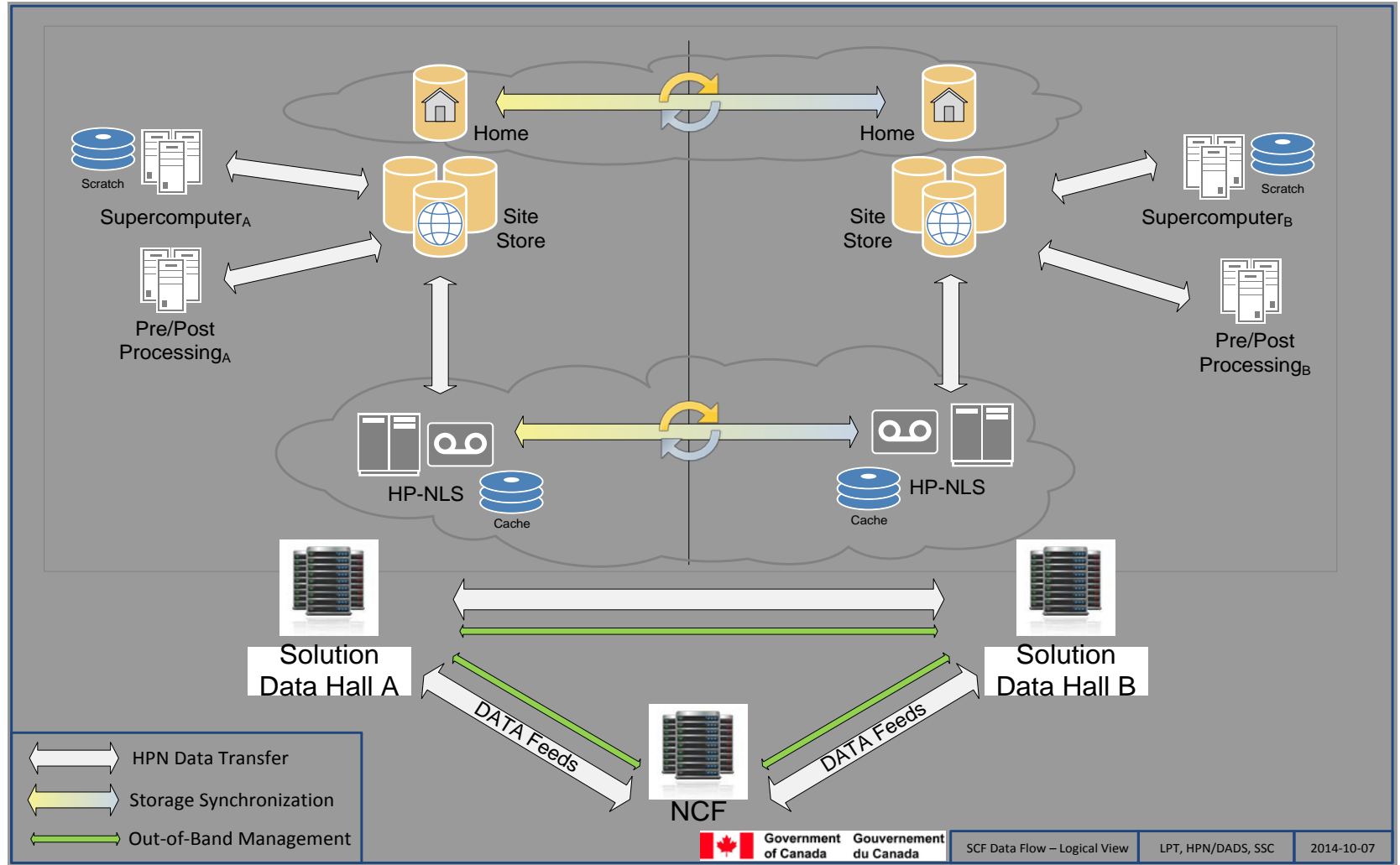
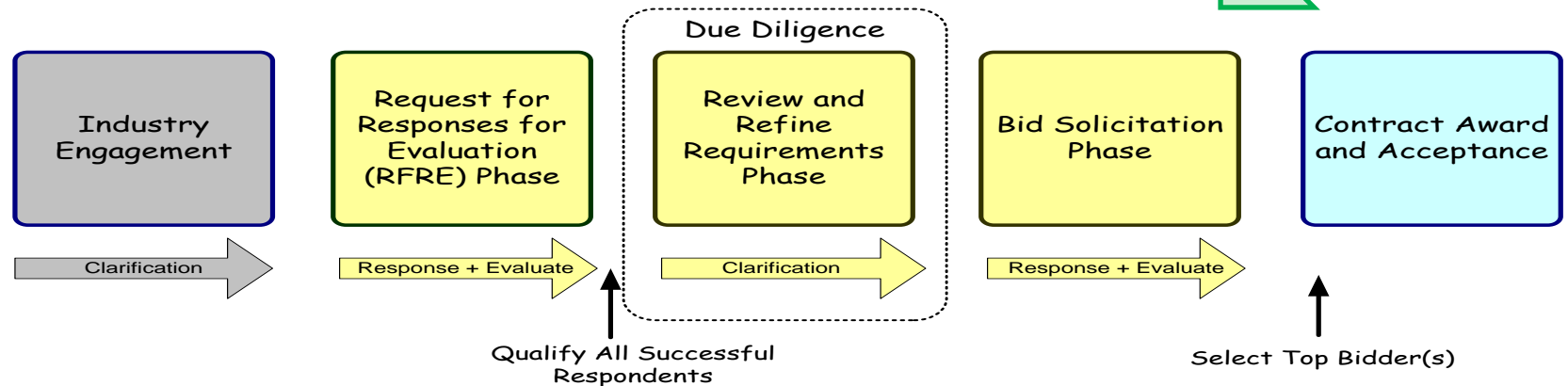- Flexible Options for additional GC needs
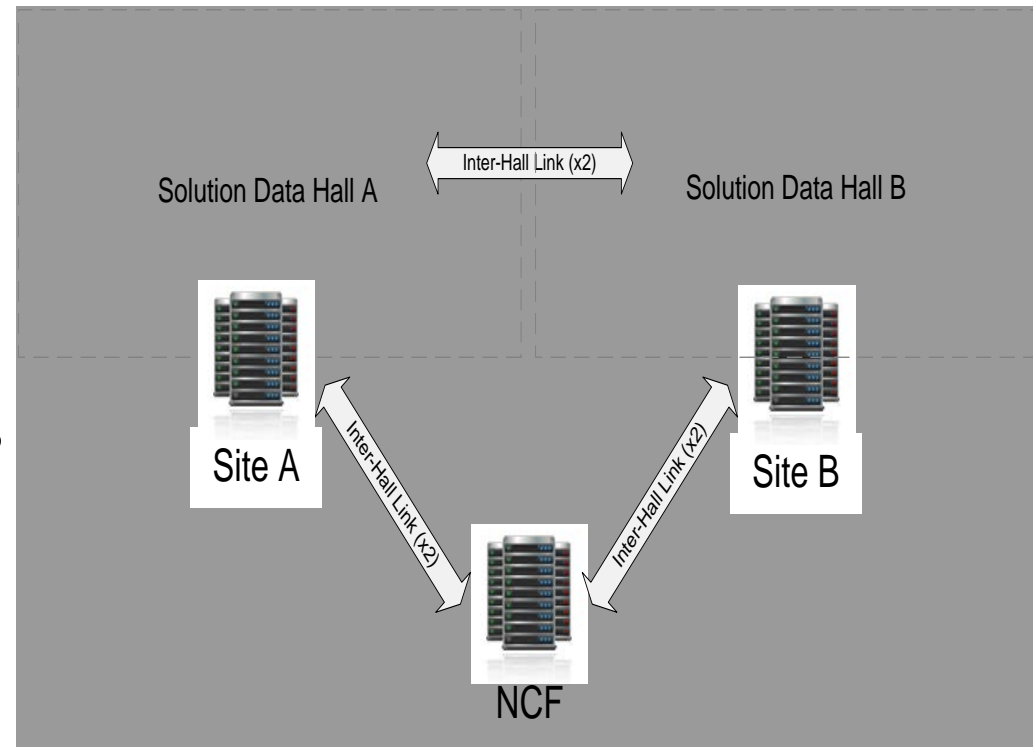
Scope

- 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

Home
Home

Supercomputer_A

Scratch

Site Store

Site Store

Scratch

Supercomputer_B

Pre/Post Processing_A

Pre/Post Processing_B

HP-NLS

HP-NLS

Cache

Cache

Solution Data Hall A

Solution Data Hall B

DATA Feeds

DATA Feeds

NCF

HPN Data Transfer

Storage Synchronization

Out-of-Band Management

Government of Canada   Gouvernement du Canada

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

Due Diligence

| Industry Engagement | Request for Responses for Evaluation (RFRE) Phase | Review and Refine Requirements Phase | Bid Solicitation Phase | Contract Award and Acceptance |

Clarification → Response + Evaluate → Clarification → Response + Evaluate →

Qualify All Successful Respondents

Select Top Bidder(s)

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 1st system, strong possibility on the 2nd

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
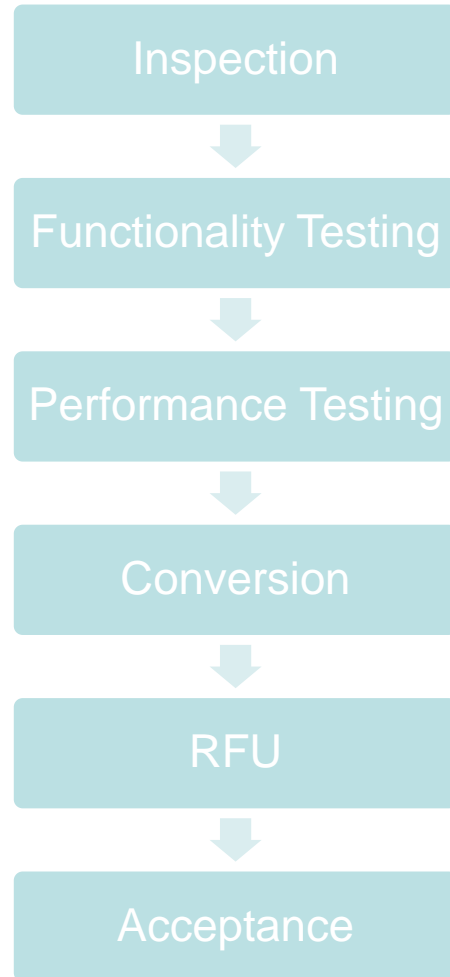 - On an exponential growth curve, the starting point matters a lot!

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)
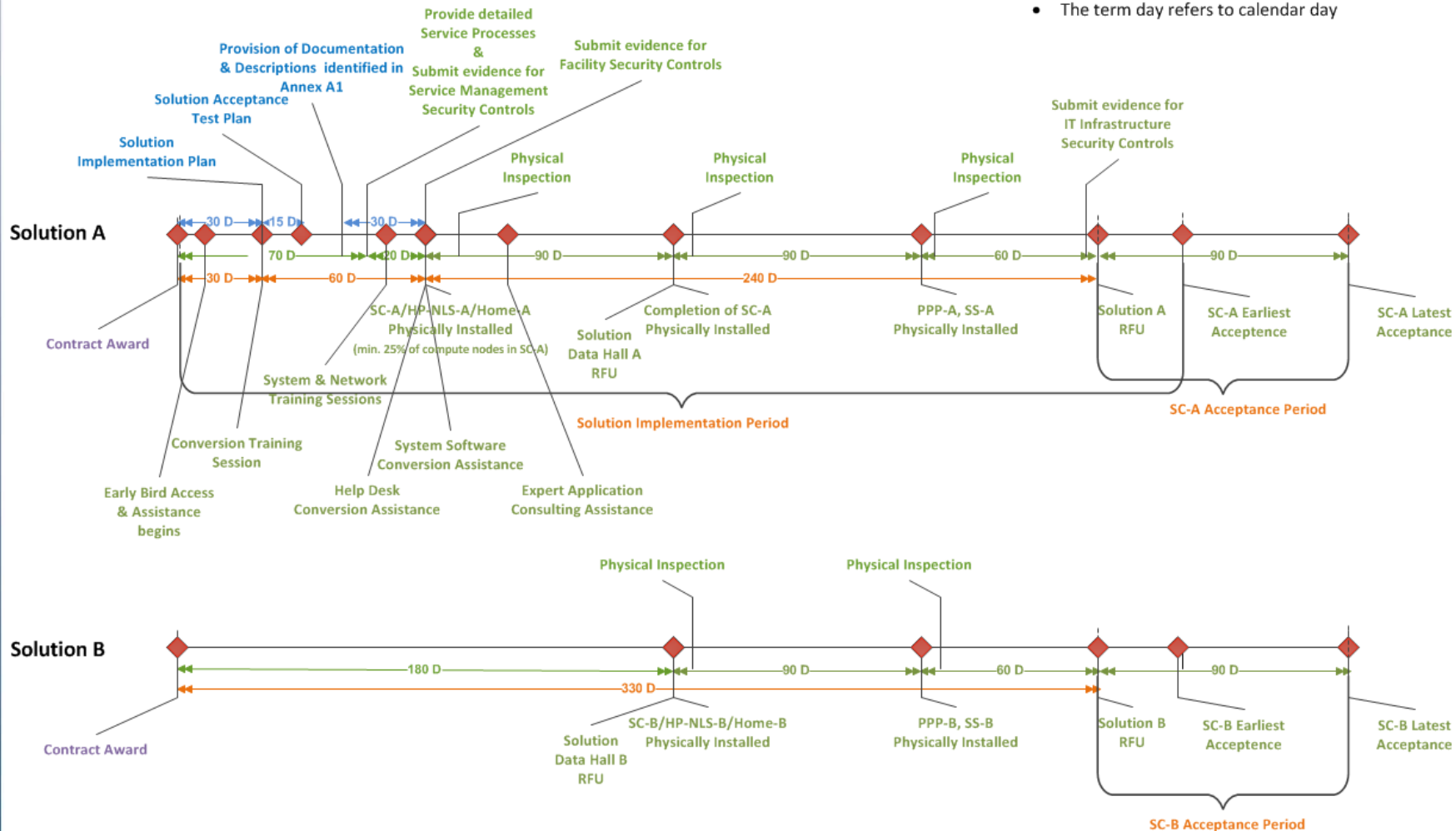
- Meeting the above triggers a 30 day availability test

*Scheduling Details in next slide

Inspection

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Functionality Testing

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Performance Testing

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Conversion

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RFU

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Acceptance

Once the Ink Dries…

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