Autumn 2026 HPC and Cloud computing Workshop

October 21-23, 2026

High Performance Computing Team /

Alliance Support Site for Manitoba



Digital Research Alliance of Canada



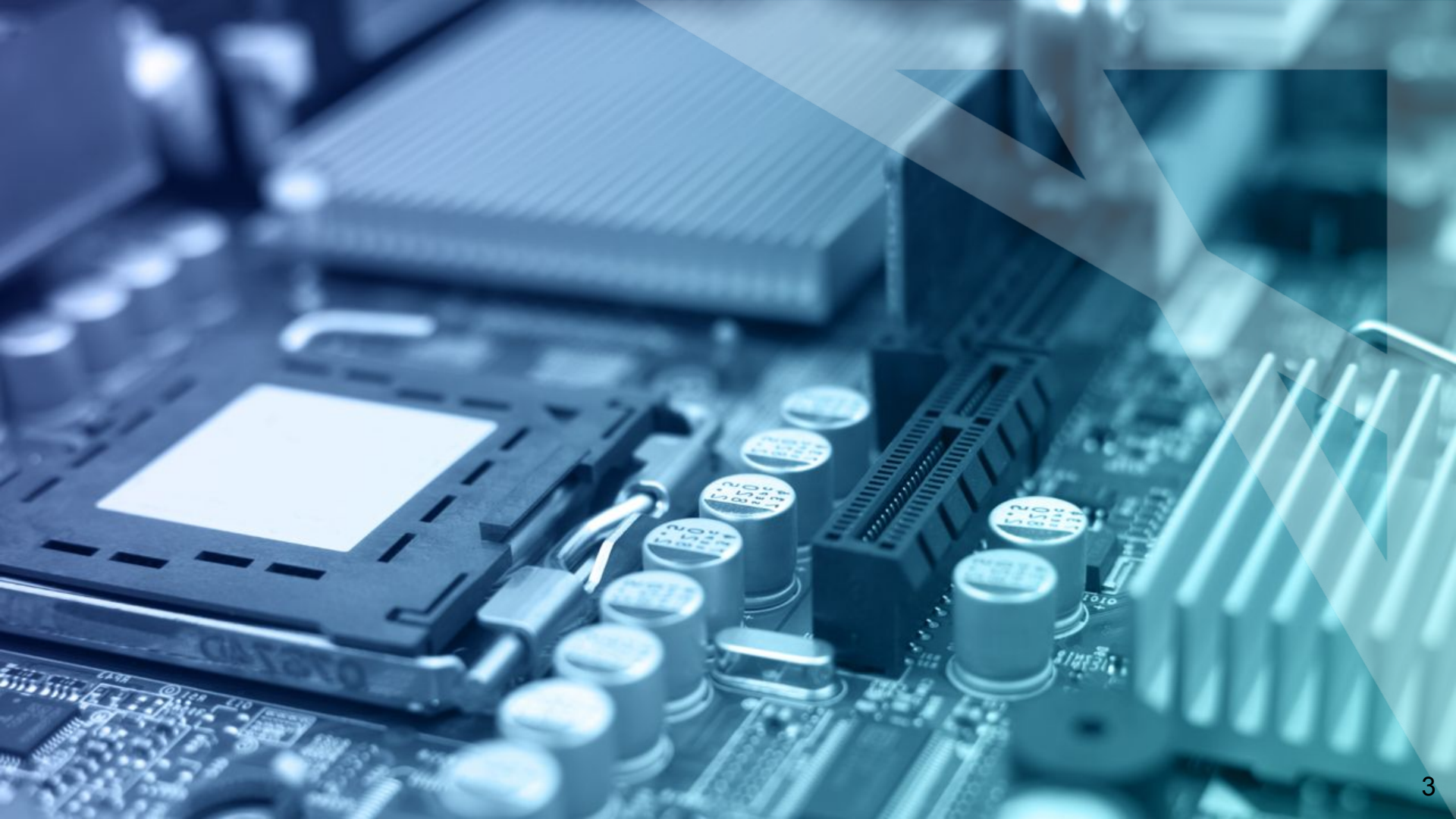
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TRADITIONAL TERRITORIES ACKNOWLEDGEMENT

University of Manitoba

The University of Manitoba campuses and research spaces are located on original lands of Anishinaabeg, Ininiwak, Anisininewuk, Dakota Oyate, Dene and Inuit, and on the National Homeland of the Red River Métis.

UM recognizes that the Treaties signed on these lands are a lifelong, enduring relationship, and we are dedicated to upholding their spirit and intent. We acknowledge the harms and mistakes of the past and the present. With this understanding, we commit to supporting Indigenous excellence through active Reconciliation, meaningful change, and the creation of an environment where everyone can thrive. Our collaboration with Indigenous communities is grounded in respect and reciprocity and this guides how we move forward as an institution.



What to expect of this Workshop?

Overview of DRI, in particular Research Computing *Resources*

- Resources available: National and Local
- How it can be useful for your research
- How to get access to these resources

Understanding of the DRI's resources capabilities

- HPC and Cloud computing, data storage and data movement
- (How do these sit with emerging AI technologies?)

Improving your skills at getting most of the resources!

- Batch computing, getting and using Software, using IaaS cloud(s)
- Getting support!

Who we are

“High Performance Computing Team”

- Running UManitoba’s own HPC system Grex

Digital Research Alliance “Support Site”

- Supporting users from all of the Province of Manitoba on National DRI
  - Training and outreach!
- Contributing to DRACs National Teams and Committees
- Grant consultations for CFI, RAC, contributed hardware

Grigory Shamov; Stefano Ansaloni; Ali Kerrache;

Program of the Workshop update

Start	End	**Oct 21: Introduction to Digital Research Infrastructure Resources, Linux Shell, Data Movement and Interactive computing**
9:30	10:10	Introduction to Alliance and Manitoba HPC, AI and Cloud Computing resources
10:10	11:10	Linux (BASH) CLI tutorial, SSH (hands-on)
11:10	12:20	Transferring data, SSH and Globus
12:30	13:00	*break*
13:00	14:20	OpenOnDemand Web Portal for HPC: Connect, File Transfer, Apps (hands-on)
14:20	15:30	OpenOnDemand Web Portal for HPC: batch jobs with OpenComposer

Start	End	Oct. 22 — Software in HPC, using Modules and Containers
9:30	11:00	Intro to HPC Software, Environment Modules (hands-on)
11:00	11:30	Containers in HPC: using Singularity/Apptaine (hands-on)
12:30	12:00	Containers in HPC: using Podman/Docker
12:00	13:00	*Short day #2*

Start	End	Oct. 23 — Advanced SLURM batch jobs, AI in HPC and OpenStack Cloud.
9:30	11:00	Running HPC batch jobs with SLURM (hands-on)
11:10	12:20	AI on HPC systems, topics
12:20	13:00	break
13:00	14:20	Using OpenStack Cloud, dashboard,deploying Web applications (hands-on)
14:30	15:00	Using OpenStack CLI and ObjectStorage
15:00	15:20	Closing Remarks

An overview of Canadian Digital Research Infrastructure ecosystem

Grigory Shamov

October 21, 2026



Digital Research Alliance of Canada



University of Manitoba

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About the Digital Research Alliance



National Scope and Mandate



Member-Based



Non-Profit



Federally-Funded

The Digital Research Alliance of Canada (the Alliance) integrates, supports and improves access to digital research infrastructure (DRI) to deliver world-class digital tools and services for Canada's researchers.

By enhancing and transforming how Canadian research data is organized, managed and shared, we empower researchers to lead discovery and innovation with global impact.



What *is* Digital Research Infrastructure?

Technology, tools and services for global impact.

Digital research infrastructure (DRI) is the collection of tools and services—including AI-enabling infrastructure—that allow researchers to turn big data into new discoveries and breakthroughs.

Three Pillars of DRI:

1. **Advanced Research Computing (ARC)** | High-performance computing and storage, underpinned high-speed networks, systems software, standards and services
2. **Research Data Management (RDM)** | Services supporting the full project lifecycle including data collection, management, storage, preservation, sharing, discovery and access.
3. **Research Software (RS)** | Cutting-edge, integrated research platforms, tools and services to increase access to DRI and data.

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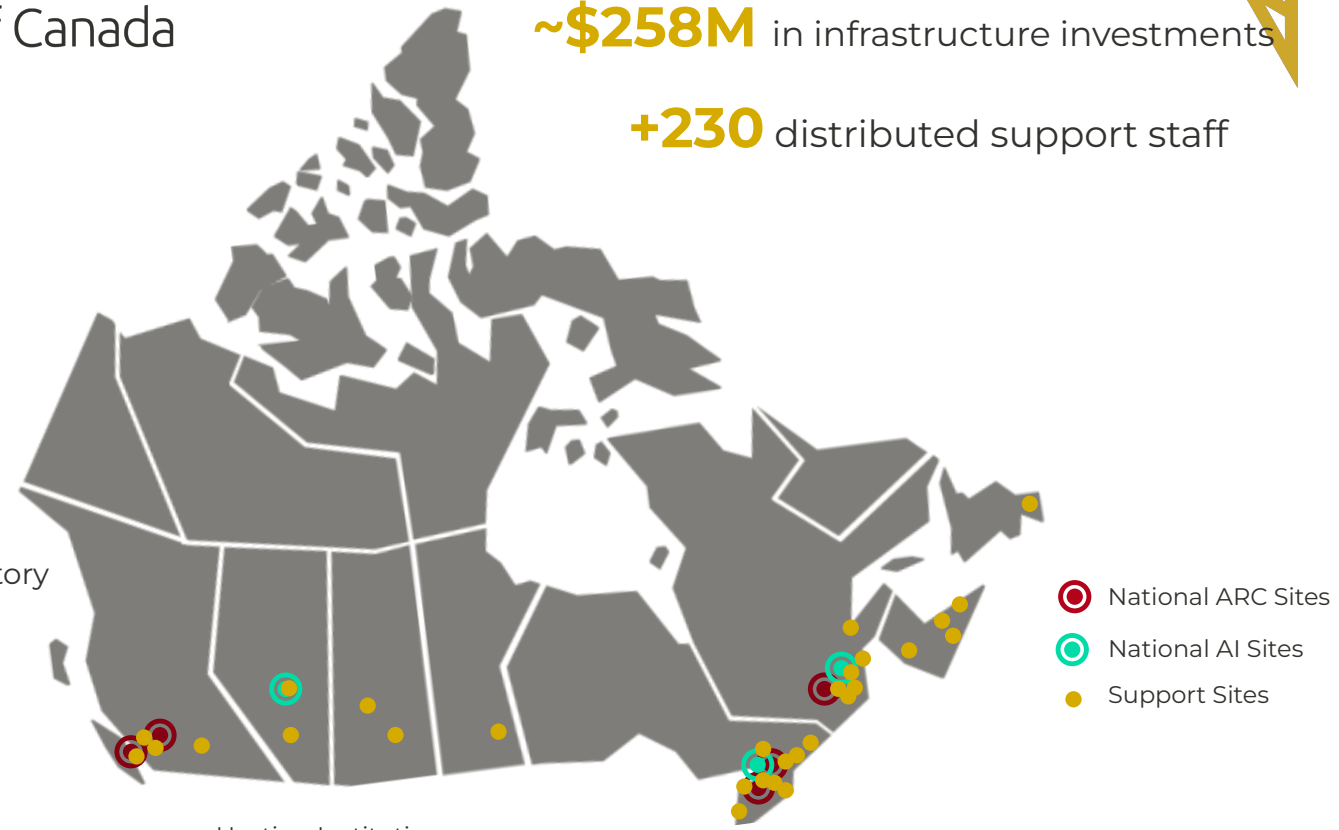
+26,000 users

~$258M in infrastructure investments

+230 distributed support staff

Alliance National Services:

- National Identity Management
- Merit-based resource allocation
- Cybersecurity Frameworks
- National Help Desk
- Explora Training Portal
- Service Catalogue
- Federated Research Data Repository
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- Lunaris Data Discovery Service



Regional service delivery partners:

Calcul Québec · Compute Ontario · ACENET accelerate discovery

Hosting Institutions:

McGill University · SFU Simon Fraser University · University of Alberta · Université Laval · University of Toronto · University of Victoria · University of Waterloo

Digital Research Alliance services “pillars”

“Advanced Research Computing” (ARC), HPC

- Focuses on enabling computational research / users
- DRAC Provides compute and storage capabilities (HPC, cloud)
- Data transfer capabilities (Globus)
- Active research phase. This Workshop is about ARC!

“Research Data Management”

- Archive data storage, Data curation, DMPs, etc.
- Libraries-focused. DRAC provides Lunaris/FRDR, Borealis
- New pilots in National Data Spaces, Canadian Research Data Platforms.

“Research Software”

“Research Network”

- Provided by another org, **CANARIE**
- Optics cable networks for Research across Canada, 100 to 400 Gbps.

https://www.alliancecan.ca/en/services



- What is ARC, HPC and DRI, and why should you care
  - National Digital Research Infrastructure
  - Local HPC offerings

- Technology : HPC, CLoud, AI

- How to access and use these resources

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DRI names: Digital Research Infrastructure

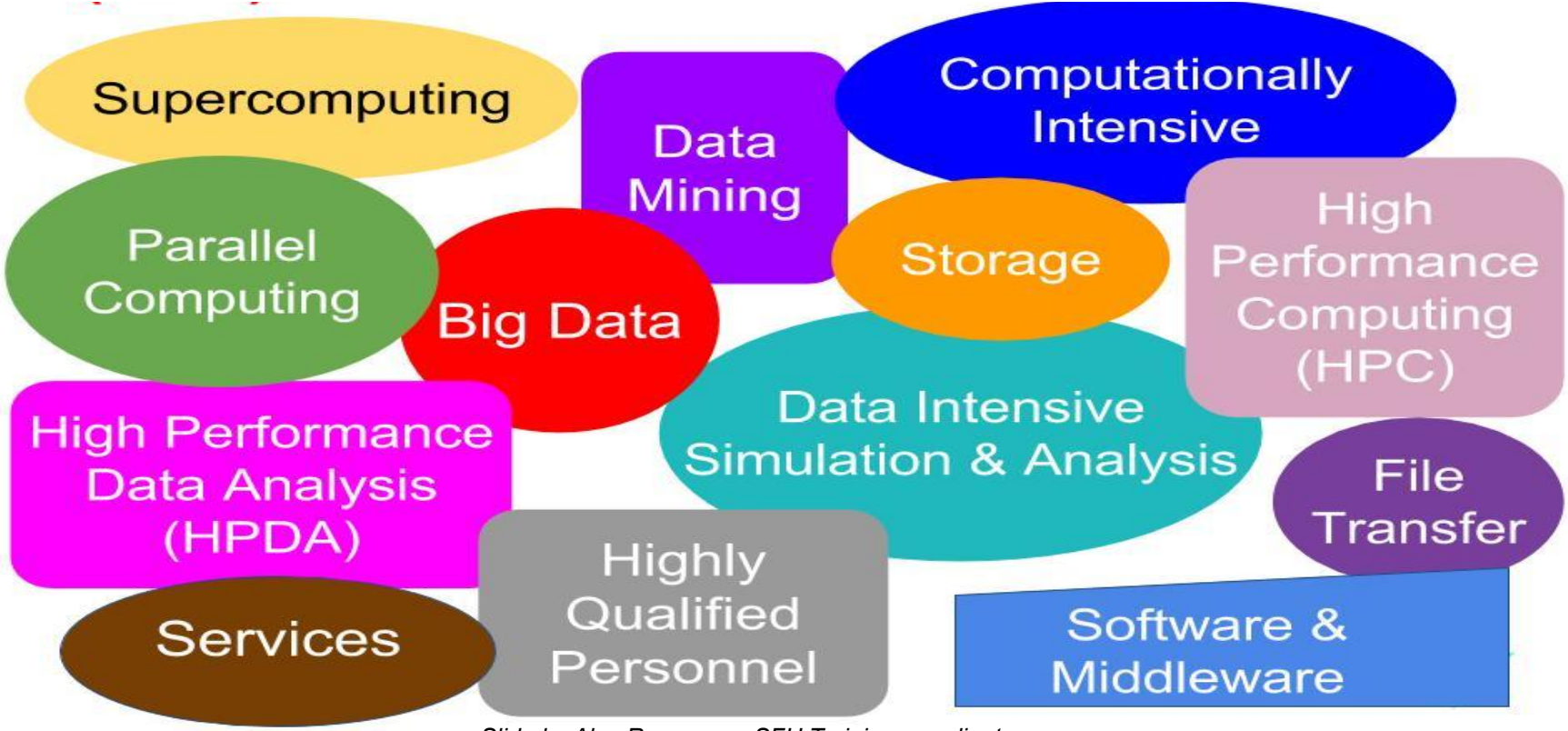
“Advanced Research Computing” (ARC), Cyber-Infrastructure, HPC, cloud

- Focuses on enabling computational research / users
- Provides capabilities that are not available with common (desktop, enterprise server) computing environment:
    - CPU time and memory, fast interconnect
    - Accelerators (GPU, TPU, FPGA)
    - Fast and scalable storage capacity
    - Network/data transfer resources optimized for research

- A specialised set of hardware and software

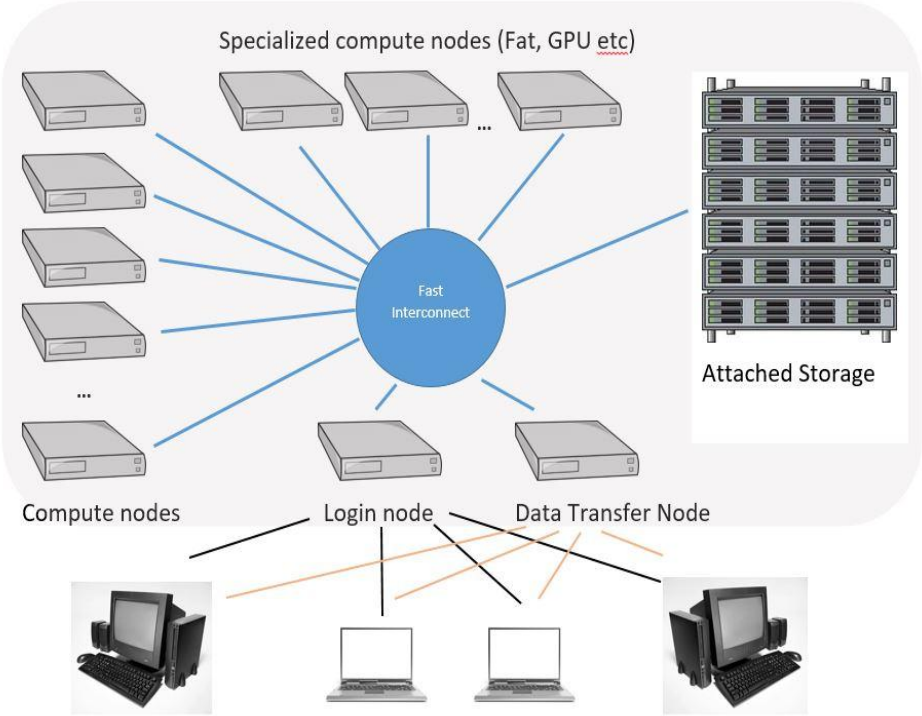
- Managed differently from Businness or Desktop support IT,
    - more research-specific
    - National organizations exist to deploy, operate and support DRI (Westgrid - > CC - > DRAC; ACESS2, EuroHPC, etc.)

What is Advanced Research Computing?



Slide by Alex Razoumov, SFU Training coordinator

HPC as a technology, architecture







- “Compute nodes” work together, deliver up to ExaFLOPS of performance!

“

High Performance Computing history

Quite old by now! Started in late 1990s-early 2000s.

- Beowulf clusters, 10s of PCs. – “compute nodes”

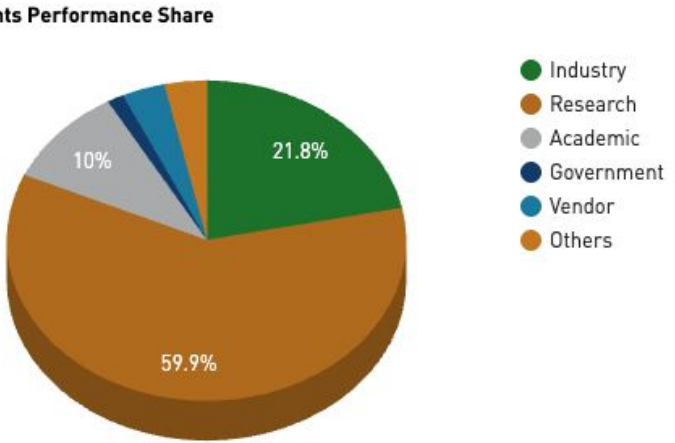
- “Single, shared supercomputer abstraction”
    - Quickly evolved into 100s and 1000s of nodes : Power and Rlectricity
    - Low-latency interconnect and parallel programming : **HPL, FLOPS**
    - Fast and scalable storage was needed to feed the compute
    - Later, accelerators like GPUs become popular

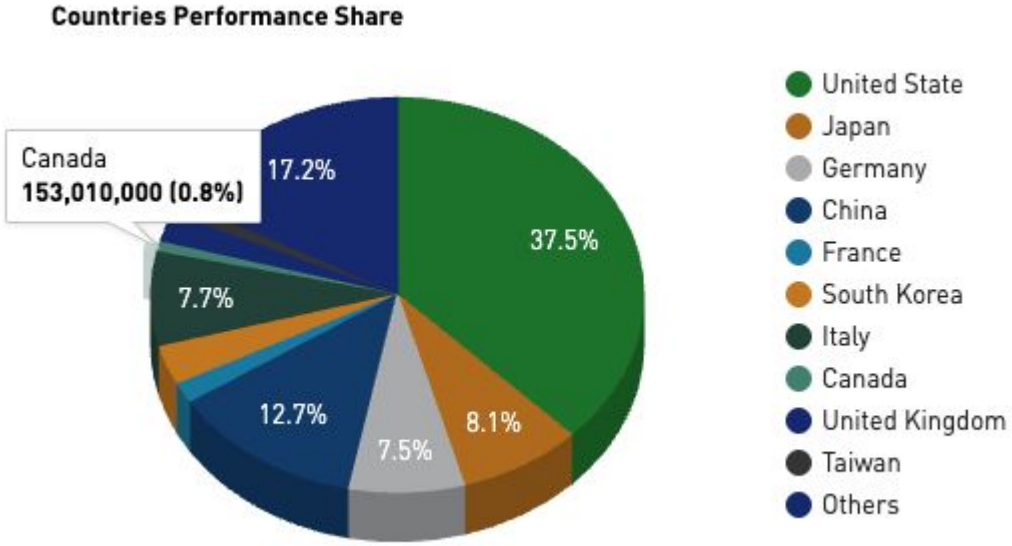
- ARC systems tend to be large and thus expensive (but efficient)
    - Triggered formation of Consortia, National HPC orgs.
    - Source of national prestige: **Top500** list https://www.top500.org

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Rank	System	Cores	Rmax (PFlop/s)	Power (MWt)
1	**LineShine** - LingKun, LX2 304C 1.55GHz, LingQi, National Supercomputing Centre in Shenzhen (NSCS) **China**	13,789,440	2,198.40	42
2	**El Capitan** - HPE Cray EX255a, AMD 4th Gen EPYC 24C 1.8GHz, AMD Instinct MI300A, DOE/NNSA/LLNL **US**	11,340,000	1,809.00	30
3	**Frontier** - HPE Cray EX235a, AMD Optimized 3rd Generation EPYC 64C 2GHz, AMD Instinct MI250X DOE/ORNL **US**	9,066,176	1,353.00	25
4	**Aurora** - HPE Cray EX - Intel Exascale Compute Blade, Xeon CPU Max 9470 2.4GHz, Intel Data Center GPU Max, DOE/ArgonneNL, **US**	9,264,128	1,012.00	39
5	**JUPITER Booster** - BullSequana XH3000, GH Superchip 72C 3GHz, NVIDIA GH200, Quad-Rail NVIDIA InfiniBand NDR200, RedHat Enterprise Linux, Bull EuroHPC/FZJ **Germany**	4,801,344	1,000.00	16
6	**HPC7** - HPE Cray EX255a, AMD 4th Gen EPYC 24C 1.8GHz, AMD Instinct MI300A, Eni S.p.A. **Italy**	3,461,472	571.50	8,7
7	**Eagle** - Microsoft NDv5, Xeon Platinum 8480C 48C 2GHz, NVIDIA H100, Microsoft Azure **US**	2,073,600	561.20	n/a
8	**HPC6** - HPE Cray EX235a, AMD Optimized 3rd Generation EPYC 64C 2GHz, AMD Instinct MI250X, Eni S.p.A. **Italy**	3,143,520	477.90	8,5
9	**Supercomputer Fugaku** - Supercomputer Fugaku, A64FX 48C 2.2GHz, Tofu interconnect D, Fujitsu RIKEN **Japan**	7,630,848	442.01	30
10	**Alps** - HPE Cray EX254n, NVIDIA Grace 72C 3.1GHz, NVIDIA GH200,Swiss National Supercomputing Centre (CSCS) **Switzerland**	2,121,600	434.90	7,1

HPC Top500 List (Jul 2026)





TOP 500
The List.

Digital Research Alliance of Canada



Digital Research Alliance of Canada

- Infrastructure renewal (**~220M**) for HPC and Cloud in 2022-2025.
  - Completed in September 2025!
  - Total: **5,175** nodes, **776,912 CPU** cores, **2,152** GPUs (A100, H100)
  - ..and counting

- PAICE systems: AMII, Vector Institute and MILA (**~40M**)
- Stop-gap **80M** AI expansion in 2025-2026
  - More B200, H200 GPUs for HPC and PAICE systems. Being deployed now!

- ISED AI SCIP call. Sovereign AI , waiting for Government decision
  - https://ised-isde.canada.ca/site/ised/en/ai-sovereign-compute-infrastructure-program

Rank	System	Cores	Rmax (PFlop/s)	Power (MWt)
105	**Fir (GPU)** - Lenovo, AMD EPYC 9454 48C 2.75GHz, NVIDIA H100 SFU/DRAC **Canada**	92,160	19.96	0.5
157	**Moira** - Lenovo ThinkSystem, Intel Xeon 6980P 128C 2GHz, Shared Services Canada**Canada** **— duplicates at #158 Conrad!**	232,960	12.91	
163	**Trillium** - ThinkSystem, AMD EPYC 9655 96C 2.6GHz, SciNet, UofT, DRAC **Canada**	230,400	12.55	
197	**Trillium-GPU** - ThinkSystem, AMD EPYC 9654 96C 2.4GHz, NVIDIA H100, SciNet, UofT, DRAC **Canada**	37,440	9.49	
209	**Nibi - CPU** – Hypertec Trident iC610DR-G7, Intel Xeon 6972P 96C 2.4GHz, SharcNet, **Canada**	134,400	8.62	
227	**Nibi - GPU** – Hypertec Trident iC610DR-G7, Intel Xeon 6972P 96C 2.4GHz, SharcNet, **Canada**	6,144	7.99	
247	**Rorqual (GPU)** - PowerEdge, Xeon Gold 6448Y 32C 2.1GHz, NVIDIA H100, Calcul Québec **Canada**	47,952	6.97	0.23
300	**Rorqual (CPU)** - PowerEdge, AMD EPYC 9654 96C 2.4GHz, Calcul Québec, **Canada**	131,712	5.14	

Size of PAICE systems for AI



Digital Research Alliance of Canada

System, kind (2025)	# GPU nodes	GPUs per node layout	Interconnect	Storage, PB
TamIA , HPC (Laval)	42 (H100)	**4 x** NVIDIA HGX H100 SXM	**4 x** HDR200 Infiniband, **non-blocking**	0.7 PB
Vulcan, HPC (UofA)	205 (L40s)	4 x NVIDIA L40s	1x100Gbps Ethernet	5.0 PB
Killarney, HPC (UofT)	168 (L40s) 10(H100)	4 x NVIDIA L40s, 8 x NVIDIA H100 SXM	1x HDR100, 2x HDR200	1.5 PB
HPC systems, GPU				
Fir, HPC	160	4 x NVidia H100 SXM	1x NDR200 Infiniband, blocking	51PB
Nibi, HPC	36	8 x Nvidia H100 SXM	1x Nokia 200/400G Ethernet	25PB
Trillium, HPC	60	4 x NVidia H100 SXM	1x NDR200/NDR400 Infiniband	29PB

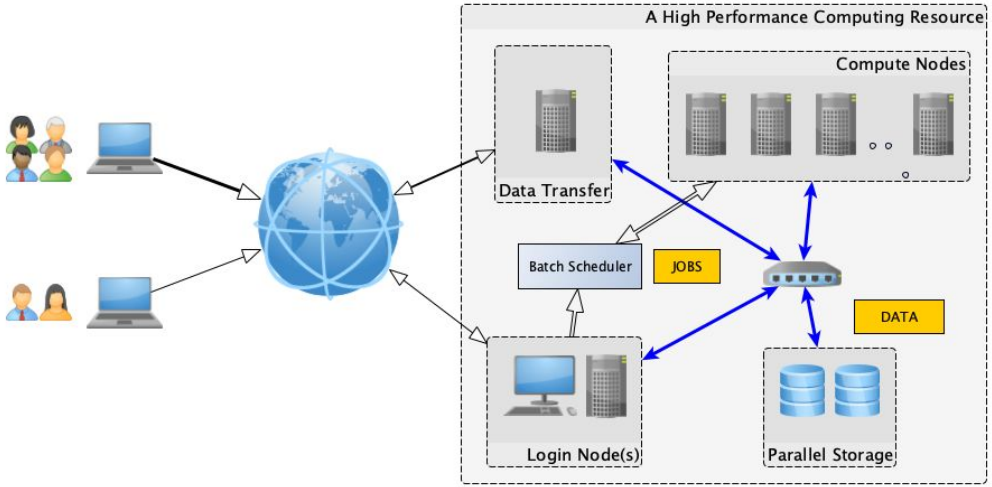
Modes of delivery, Orchestration

How to manage workload on these clusters?

1. **Traditional HPC** with a batch scheduler like **SLURM**
    a. Bare-metal performance, batch jobs; simple, best utilization
    b. Traffic control, fairness of resource usage
    c. Lovable-HPC Game by Kamil Marchiknovsky: https://hpc-cluster-scheduler.lovable.app/
2. **Cloud Computing** like AWS, Azure or GCP; **OpenStack**
    a. Started as enterprise web hosting, but found its way to compute on it
    b. Multitenancy, VMs technology ; some performance overhead
    c. Less isolation, harder to manage
3. **Container** orchestration: **Kubernetes**
    a. Low overhead, with both services and batch jobs possible
    b. Less isolation, harder to manage, harder to use (DevOps)
    c. Can be coexisting with SLURM or OpenStack on same hardware

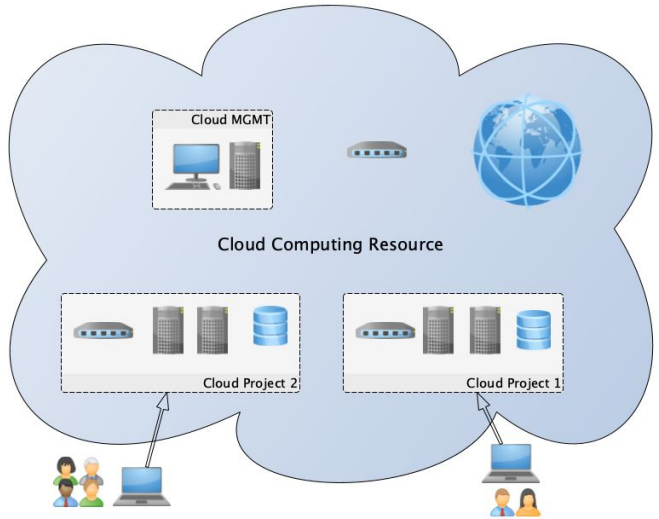
This Workshop at least touches on each of the above!

HPC vs Cloud computing



- HPC clusters are *shared* systems with r*emote access*
- Batch mode of usage
- A central Software delivery on HPC
- Dealing with Data (storage, transfer etc.)

- Public and Community Cloud computing
- Flexible, elastic, Provides isolation of tenants
- SDN, SDS, Virtualized compute
- Self-service



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Artificial Intelligence and Machine Learning revolution
https://static.googleusercontent.com/media/research.google.com/en//pubs/archive/35179.pdf
"The Unreasonable Efficiency of Data"
http://www.incompleteideas.net/IncIdeas/BitterLesson.html "The Bitter Lesson"
https://dl.acm.org/doi/10.5555/3295222.3295349 "Attention is all you need""

Infrastructure for AI is the same HPC with GPUs

***tamIA**, an AI Supercomputer of LavalU*

AI is an HPC workload :

- Clusters, managed either by SLURM or Kubernetes. Scale-out parallel storage filesystems. Fast interconnects
- *“All of it we had in HPC! We did the right thing! “*



This made old-guard HPC folks happy. Back in 2024.

What changed since?

AI workloads meant model Training and Inference

- Training shops did ok in HPC settings (either SLURM or Kubernetes)
- Early 2026, a large shift to inference!
- RAGs, Vibe Coding using public Inference services/APIs
- Agentic AI, coding and automation

The "Sovereign AI" idea, to decrease the risks of using US Big Tech

- Canada has issued 80M stop-gap funding in 2025
- AI SCIP program call, 800+M$ is open now
    - https://ised-isde.canada.ca/site/ised/en/ai-sovereign-compute-infrastructure-program

Inference is profitable: caused AI bubble with hardware costs! Canada has issued 80M stop-gap funding in 2025

- Hyperscalers ate all the hardware, exceed size of Top500 systems
- Getting electricity and cooling for data centers became an issue!



DRI requires a large capital investment

DRI requires an operation to run it:

- staff, expertise, processes
- real estate (datacentre), electricity

In Canada, there are two levels of DRI above “under your desk”:

- Institutional or “local” system.
  - Funded by Universities and / or projects (Faculties, Departments, PI grants)
- National DRI Organization / Consortium / Federation.
  - Funded by the Government of Canada with Provincial and/or Institutional matching
  - Currently, DRAC https://alliancecan.ca

Digital Research Alliance of Canada

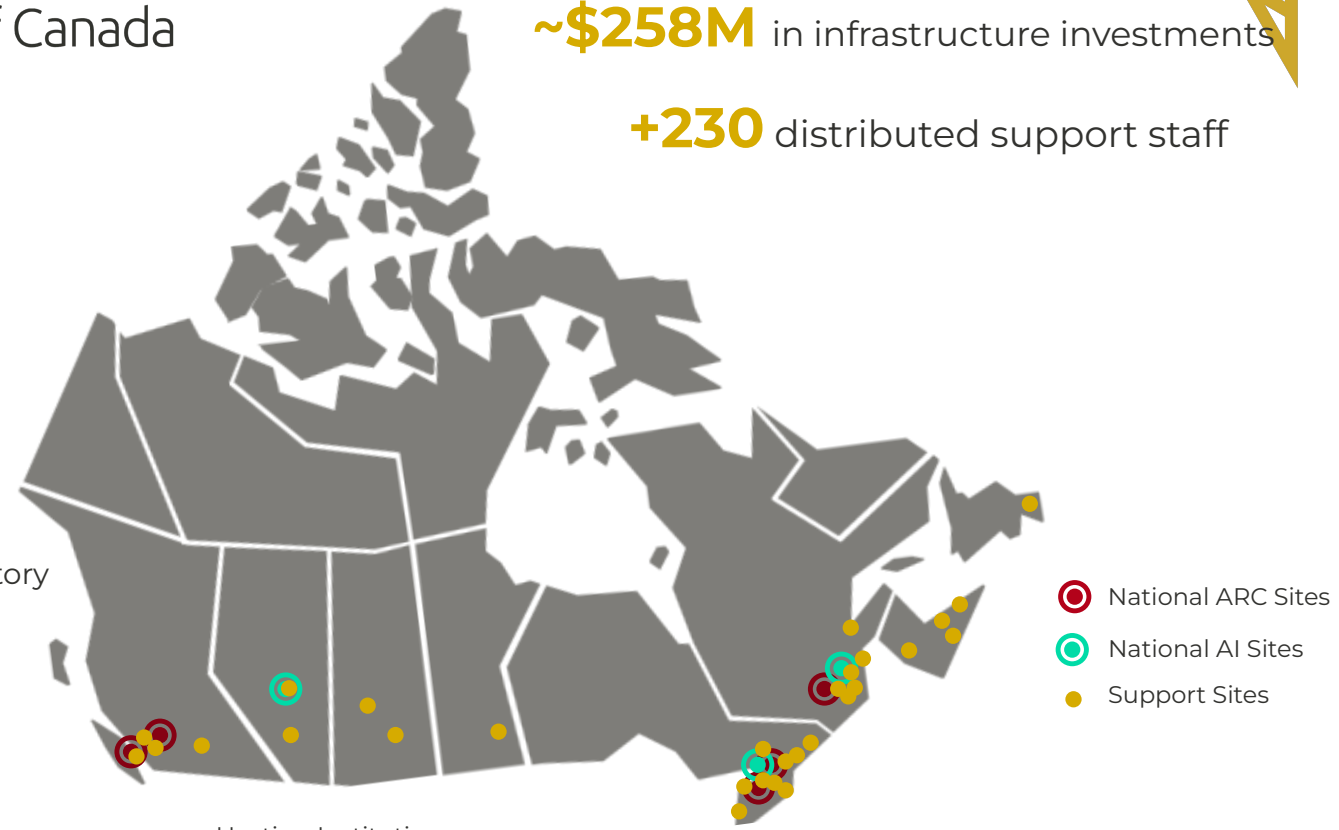
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Grex and HPCC



A step-up machine for UM users to DRAC resources

Grex used to be a Westgrid / National HPC machine kept and maintained by the University of Manitoba as a local system. **~10K** CPUs, **~2.8** PB of storage

- Authentication through DRAC CCDB systems
- Managed by the same local DRAC Federation team.
- Provides both a local and the DRAC software stacks

Renewed with help of the IST and VPRI funding 2024

System, kind (2024-2025)	**CPU cores**	**GPU devices**
Intel CascadeLake	2820	36 V100
AMD Genoa	7368	4 L40s
AMD rome	112	12 A30
	~10K	**52**

Grex and HPCC

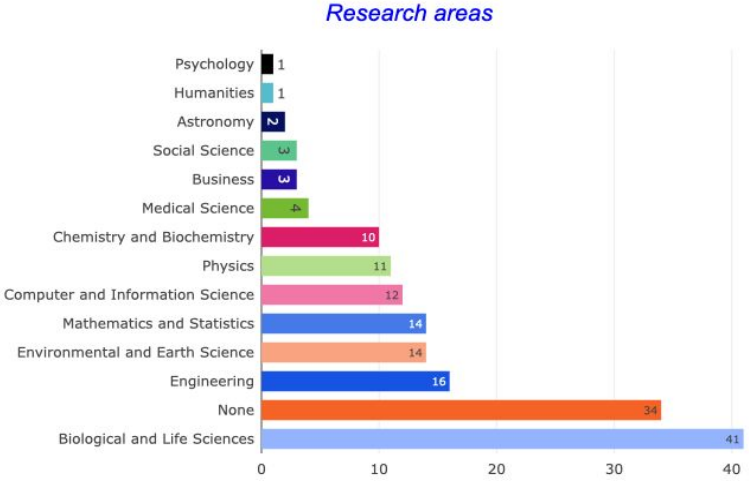
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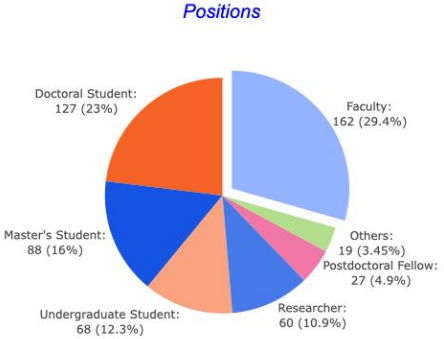
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- Governance:
  - VPRI Office
  - RCAC Faculty Working groups
  - Local Resource Allocation Calls
- *Hosts CFI and other user-contributed hardware*

Renewed with help of the IST and VPRI funding 2024

- Serves >160 research groups, >500 users





Access to and use of ARC resources



Access, Costs of Alliance Resources?



- Free for Eligible PI's : https://ccdb.alliancecan.ca
- Access through CCDB (ComputeCanada user DB)
  - The unit of resource allocation is "Research Group".
    - Not a university, not individual users
  - Thus, a Principal Investigator has to apply first, then "sponsor":
    - Undergraduate students research projects
    - External collaborators
    - Grad students, postdocs, support staff
- Eligible use: for academic research
- A user can belong to more than one research group.

What is useful for me in ARC?

Service	Limits?	Notes
CPU and GPU Compute	Default allocation 200 CPU core-years;Default allocation of ~1 year of H100. more with RAC. H100, A100, H200 and B200. More with RAC!	CPUs with fast interconnect, next to a scalable storage. Can be useful for Large Parallel or High-Throughput workloads *Note that it would not make serial code any "faster"*
Cloud Compute	80 VCPUs/year; 10TB of ObjectStorage, IPs, 10TB of local volumes, vGPUs, etc. More with RAC.	OpenStack cloud(s) for both Persistent and Ephemeral Computing workloads.
Active, Scalable HPC Storage	40TB/group ; more with RAC	Directly attached HPC storage; tape backup and "Nearline" *"Moving compute closer to the data"*
Globus Data Transfer and Data sharing	n/a	Allows for moving data in, out, and between Alliance systems. Allows for data sharing and publishing.
NextCloud	100Gb	A Dropbox-like service. Several instances exist in the ecosystem.
CVMFS Software stack	n/a; thousands of software items	A curated, central software stack distributed across Alliance and other systems (like Grex)
Visualization, interactive compute	n/a	Support for Jupyter, OpenOnDemand, and remote viz ParaView

Access, Costs of Alliance Resources?

- Free for Eligible PI's : https://ccdb.alliancecan.ca



- Default allocation (CPU, storage)
  - Immediately available for active accounts
- RAS (Rapid Access Service), on request any time of the year.
  - Mainly for Storage and Cloud resources.
- **RAC (Resource allocation call) for increased requests, annually (Nov.3 Deadline Looming!)**
  - Application process through CCDB
  - Proposal needed for CPU and GPU years, Storage TBs, cloud resources
- AI systems follow their own Tiered allocation process
  - Tier-4 for non members, needs an application.

What ARC-specific skills do I need?

- Working with Remote systems
- Working with Command Line Interfaces (CLI)
  - Automation, AI ♥ CLI
  - Managing active research data

- HPC works in batch mode
  - Interactive GUI / Jupyter /RStudio/VDI as jobs possible too

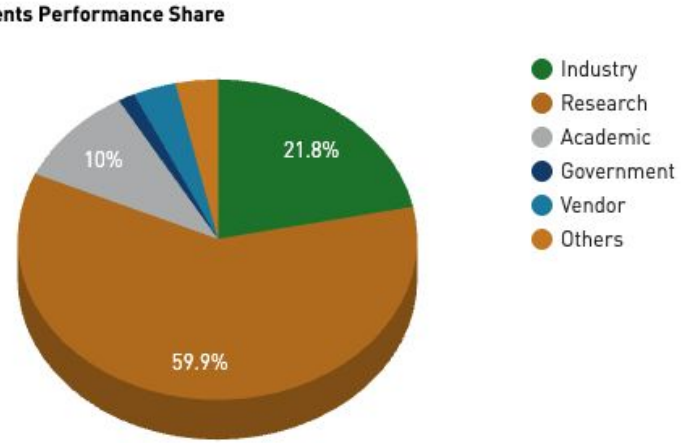
- Centralized, optimized software stacks
  - Or *bring-your-own* software via containers.

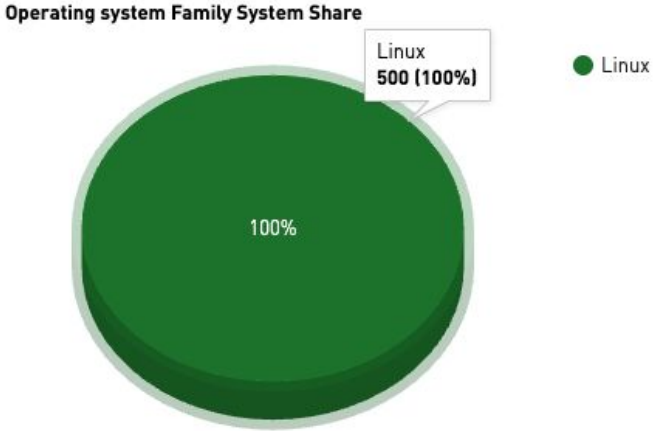
- Persistent/Server workloads can be served by OpenStack Cloud (UVic)
  - Familiarity with Infrastructure as a Service (IaaS)



HPC Top500 List (Jul 2026)







Why are we using SLURM?

- Majority of Research systems do
- Resource congestion prevention
- Usage Fairness
- Higher utilization of systems

Everyone on top 500 uses a Linux OS


University
of Manitoba

Closing Remarks!

Grigory Shamov

October 21-23, 2026



Digital Research Alliance of Canada



University of Manitoba

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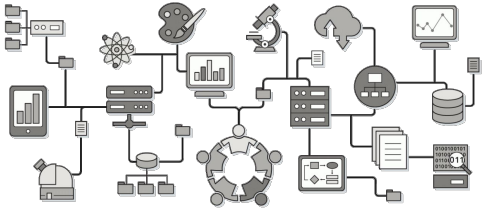
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  - Familiarity with Infrastructure as a Service (IaaS)

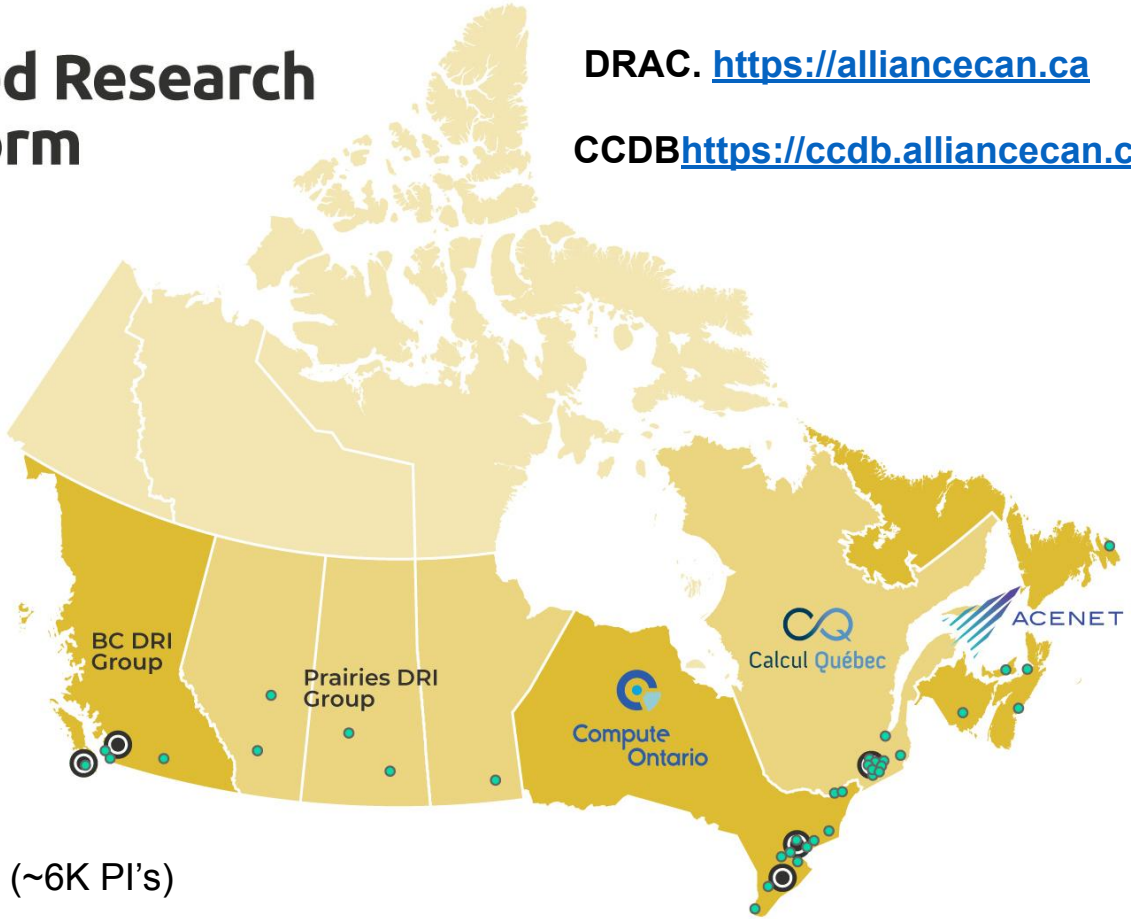
Canada's Advanced Research Computing Platform

DRAC. https://alliancecan.ca

CCDBhttps://ccdb.alliancecan.ca

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Number of "roles" in CCDB : **~24K** (~6K PI's)

Number of "roles" in Prairies: **2873** (843 PIs), of them in Manitoba **490** (**153** PIs)

Resources available with CCDB account

https://ccdb.alliancecan.ca

- Fir HPC system: https://docs.alliancecan.ca/wiki/Fir
- Nibi HPC system: https://docs.alliancecan.ca/wiki/Nibi
- Rorqual HPC system: https://docs.alliancecan.ca/wiki/Rorqual
- Trillium HPC system:

- Clouds (Arbutus, Beluga, Fir, Juno) https://docs.alliancecan.ca/wiki/Cloud

- PAICE systems : tamIA , Vulcan, Killarney (for AI research and collaborators)
- Grex HPC system: https://um-grex.github.io/docs (for UMan and collaborators)

- Storage-only (NextCloud) : https://docs.alliancecan.ca/wiki/Nextcloud
    - Etc.

Documentation



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- User Wiki at the Alliance: https://docs.alliancecan.ca/wiki/Technical_documentation
  - https://docs.alliancecan.ca/wiki/National_systems
  - https://docs.alliancecan.ca/wiki/Running_jobs
  - Alliance systems' status page Status | Alliance

- UM Grex system, technical documentation site
  - https://um-grex.github.io/docs/
  - User-extendable: github.com/um-grex/docs
  - Grex status page https://um-grex.github.io/status/

- National Helpdesk contact
  - support@tech.alliancecan.ca : general support for HPC
  - cloud@tech.alliancecan.ca : OpenStack cloud questions
  - **rac**@tech.alliancecan.ca : RAC request questions ! **Till Nov 3.**

More Training!



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- **More training!**

- Western training courses (former WestGrid)
  - SFU: https://training.researchcomputing.ca
  - UAlberta Research Computing Bootcamps | Information Services and Technology (IST)
  - Other regions (AceNet, SharcNet, SciNet, CalculQuebec)

- National Training Discovery portal at the Alliance
  - https://explora.alliancecan.ca

Thank you!!