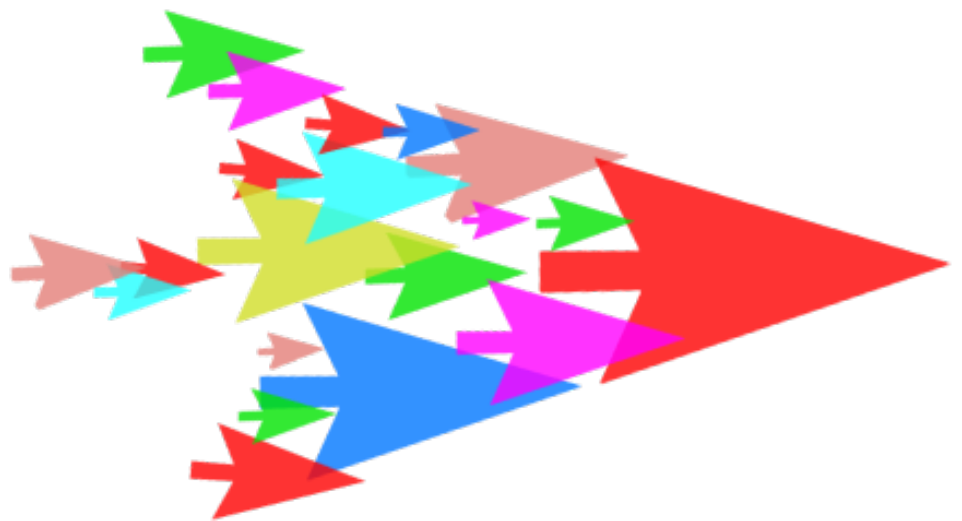# Compute Canadian

Building a successful and federated
computational research enterprise, together

A Discussion Paper For
The Compute Canada Community
by Jonathan Dursi
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www.compute-canadian.ca

Executive Summary

Computing and data, and the expertise and tools to make use of both, is now central to all fields of study. Ten years after the creation of Compute Canada in response to the National Platforms Fund call, and after the Naylor Report on science funding, it is an apt time for the Canadian community built around this national research platform to take stock. Is it doing what we need it to do for Canadian researchers? Is it working the way we want it to? What should a Canadian computation and data platform for supporting research look like in the coming years? This document aims to begin that discussion within the community.

Here we propose seven principles to guide us in this discussion — that our project should serve Canadian research in a researcher-centred, service-oriented, and truly national way; and that it should operate as a true federation of equal partners, interoperable but not identical, collaborative and up-to-date. We suggest in particular that it is vital that our national platform is adaptive and responsive to researchers, making choices driven by research needs and not technical choices, and should make full use of the diversity and specialization that a Canadian federation and its partners offer.

From those principles, we make evidence-based proposals for an renewed Canadian organization. Comparisons with successful examples of federated organizations within Canada and abroad suggest that while the basic architecture of our federation is sound, important relationships need to be clarified. While a central office must be responsible for the processes of defining priorities, strategies, and standards of interoperability, a successful federation requires those processes to set by consensus, by partners committed to the goals of the organization. The Board of the central office in a federation must have experience and training to handle the delicate task of governing a central office but being responsible to a national community. The Members need better visibility into the operations of the central office and the federation as a whole so that they can own their vital role in the organization. And that engagement needs to extend to all who are invested in the success of research in Canada: regional staff and Boards, institutional staff, researchers and funders, and other organizations that provide digital infrastructure for research in Canada. This document focusses on Compute Canada in particular, but the principles and proposals apply to any digital research infrastructure providers, or the system as a whole.

Success for this document will mean starting conversations, inspiring other documents and differing points of view, and the emerging of a consensus within the community of what a renewed national platform for the next ten years looks like. That does not mean this document is a straw-man. The authors have played roles in the national platform starting at its inception, from researcher to consortium and regional (east and west) staff and management, and within the Compute Canada central office, and hope that experience plus the benefit of some distance have produced a coherent and compelling vision of what the Compute Canada national project could be. But what matters is not this proposal; it is what the community as a whole decides it wants its national platform to be.

Specific Proposals

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Introduction

Fundamental to supporting research in Canada are a handful of questions: How do we know what services researchers need? How do we best provide them? What is the role of a central office? What is the role of provincial organizations, and institutions? How do decisions get made?

This document contains one proposed set of answers to these questions for the Compute Canada national platform; a sketch of one possible alternate future for providing computational research support in Canada. Its intention is to begin a discussion within the community, where we look forward together and ask how computing- and data-powered research should be supported.

The Compute Canada national project for supporting research through computing and data was assembled over the past ten years to drastically improve the capabilities of Canadian research. Investigators were too often limited in the scholarship they could perform because of lack of local research computing expertise, or availability of storage or computational resources. The solution to this problem was clear then, as it is now. The most scarce and valuable of our resources, the expertise of research computing staff, grows rather than being diminished by applying it to many diverse problems; economies of scale apply to the sharing of large computational and storage resources. Thus, the best way to support Canadian research is to provide and share resources nationally, rather than building small silos.

No one can deny that the research that has been enabled by the hardware and expertise provided over the years is and continues to be exceptional. However, like any organization it must strive to be better and challenges must be addressed with input from the entire community. Over time, the project named Compute Canada has gone from being a loose association of occasionally-cooperating independent sites to an organization with a sizeable central office where a great deal of decision making is consolidated. In this document, we argue that neither approach is sustainable; neither provides the best results for Canadian research; neither is ambitious enough in what we can do for our researchers and scholars. We instead present a vision for Compute Canada for the next ten years that is national, but not centralized; that is diverse, but interoperable; and that is focussed on supporting Canadian research with a wide range of services reflecting the breadth and depth of Canadian scholarship.

Computation and data plays a central role in all fields of study; the national project should aim for nothing less than to give Canadian researchers an unfair advantage in tackling problems that are important to Canada. Suggestions have been made by Canada's Fundamental Science Review (the Naylor report), and will be made by an upcoming Leadership Council for Digital Infrastructure report; but now is the time for we the community including researchers, staff, the members and all who support Canadian research to take a step back and have a real discussion about where to go to next. It is time for us to decide what we want computational support for Canadian research to look like, and how it should work.

Any Compute Canada, present or future, must be judged against a set of principles to

guide the research support organization. We propose seven such principles: that a Canadian computation and data research support platform should serve Canadian research in a researcher-centred, service-oriented, and national way; and it should operate as a true federation, interoperable but not identical, collaborative, and up-to-date. From those principles, and based on the experiences of other federated organizations in Canada and abroad, we suggest concrete organizational improvements that could help us move towards our goals.

For motivation and concreteness, we begin with an attempt to illustrate what such a future federation would look like, from the most important point of view — that of the researcher.

Prologue: The New Project

May 2, 2022 The paper was coming together nicely, thought Dr. Shannon Banks, a postdoc at the University of Western Manitoba. She had a meeting with her PI later in the week, and there was a pretty good chance she could have a mostly-complete first draft ready by then.

It was a little surprising how quickly the work had gone. She had joined Prof. Reeve's group bringing experimental and data-analysis expertise, but extending the work through comparison to simulations had required developing new skills, and she couldn't lean on her new colleagues for much help: as someone who had analyzed quite-large experimental datasets during grad school abroad, she *was* the local computational expert in the growing experimental group.

When she had signed up for her National Platform account, a quick process requiring just an institutional email address, a consultant analyst named Walter Payne introduced himself. He was at a nearby university, and had experience in a related field. While help desk staff had handled her inevitable login, compiler, and queue questions, as well as walking her and Prof. Reeve through the process of getting a starter allocation, Walter would be there to make sure more "science-y" questions from the Reeve group got seen by the right person.

After Shannon explained the simulations she wanted to run and sent along pointers to relevant papers, Walter ended up introducing her to Stella Gregory, another consulting analyst stationed in Nova Scotia; Stella had run very similar sorts of simulations herself, and suggested a slightly different approach which would give significantly better results. It took a couple of Vidyo calls, but afterwards Shannon had a pretty good idea how to proceed, especially with the online interactive training material Stella pointed her to.

When the simulations with varying parameters finally started producing results (quite quickly; the systems seemed much more flexible and stable than those she was used to), Shannon visualized the first few results on her laptop — but then the results kept coming! The tutorials had described how to automate the visualizations and what to do with her data. There was another cluster elsewhere in the platform (in BC? It wasn't clear, but apparently BC was big into visualization) that had GPUs and a file system

better suited for this sort of work. The same tools that helped her manage her data to ensure she met her funders data sharing requirements allowed her to move the data, so migrating the files to and from was pretty painless. In fact it went so smoothly that the one time that it hung for ten minutes, she wrote an email to the helpdesk wondering if she had done something wrong. By the time she hit Send, it had started up again. Helpdesk proudly, if somewhat cryptically, explained that a transfer server had crashed, but that they routinely tested all sorts of failures (with something or someone called a mischief monkey) and such things almost got fixed or restarted automatically within a half-hour or so.

When the visualizations were far enough along to be able to make movies, the team at the weekly group meeting was so impressed that she almost felt a little sheepish. Or, at least right up until the new grad student asked if she could now analyze the simulated data using exactly the same pipeline as the experimental data , and compare it with two other data sets she had found from researchers in Ontario and Australia; Prof. Reeves started enthusing about the idea.

Shannon nodded and mumbled something noncommittally optimistic, but left the meeting frowning — there was *much* more simulation output than experimental data and at *way* higher resolution; it wasn't at all clear that this was going to work. There had been a lot of experimental data, sure, but it was mainly about working with large numbers of small datasets. Dealing with this much higher resolution data might be an issue. When she tested the python scripts on her desktop, they crashed almost immediately.

She contacted Walter, describing her algorithm, the distributed data sets and the problem. He said that he'd look into the issue further and pointed her to to some upcoming online python parallel programming courses.

A couple of days later she was contacted by Carolyn Malone, who explained she was a performance specialist leading the team working on a prototype nonvolatile memory system in Québec. They were trying out this system to see how useful it would be for certain kinds of data analytics. Walter had raised the possibility of Shannon's project as a test case; Carolyn had gone through the research project relationship management system reading up on what Shannon had been doing (ah, so *that's* why Walter always had her contact him through the ticket manager rather than directly!) and had seen that this was a classic application for an old-is-new-again external memory algorithm. If Shannon was willing to use a small and slightly flaky test new system, Carolyn could have Andy Bell, an analyst on the team, help her with coding it up — it would be a week or so of effort, and a new use case for the pilot team, and it should (no promises) get the results she needs.

Shannon agreed, and two weeks later was happy to show her group, including the "helpful" new grad student, the results. And now the manuscript was almost ready for group feedback, with Andy and Stella on the author list, and acknowledgements to Carolyn, and of course Walter.

Principles

We propose the following seven principles to guide our discussion of what our national platform could be.

Principle	Description
Researcher-Centred	The driver for every decision is researcher needs, with technology a means to an end.
Service Oriented	The organization aims to enable research in a number of well-defined ways.
National	The platform aims to support researchers as best possible, regardless of where the researchers or the resources are.
Equal Partners in Federation	Multiple funding partners, provinces, institutions, and the national office share different but equally important responsibilities.
Interoperable, not Identical	All parts of the natural platform must interoperate seamlessly, but they need not and should not be identical.
Collaborative	All parties that support the platform are coming to the table in good faith to achieve a common goal.
Modern	Tools are offered where they improve the services and support for researchers.

Researcher-Centred

Proposal 1.1: Research, and concrete researcher needs, should be the basis for all decision making.

All established organizations face the danger of losing the perspective of those it serves. It becomes a little too natural to make decisions based on what is easiest or best internally; this is especially true if decisions are made several levels removed from those working directly with the clients. Organizations that solve problems using technology are doubly prone to this, as the technology begins to seem important for its own sake, rather than simply being a way to help a client achieve success. Note that in the Prologue, everything is arranged around success for the researcher.

The difference between an organization that is focussed on its clients and one whose focus is internal is reflected in behaviour, in particular where time and money is spent. In a researcher-focussed technical organization, the first question is always "how does this help the researchers"; it casts decision making in terms of researcher needs and successes rather than technical implementation details, deferring such details until the last possible minute, and pushing such decisions as close to the researchers as possible. Significant decisions can always be justified in terms of making it easier for specific researchers to tackle concrete current or proposed projects, and the amount of resources allocated to that decision are proportional to those goals.

A researcher-centred organization must also ensure that they work closely with other partners, so that researcher needs requiring cooperation between service providers are met.

Not Researcher Centred	Researcher Centred
Users must fill out many elaborate forms	Easy sign-up, renewals, resource allocations
Technology drives decision-making	Researcher goals drive decision-making
RFPs specify technical architecture, such as interconnects, feeds and speeds	RFPs specify job mixes, researcher-facing metrics
Projects and collaborations are launched for various reasons	Projects and collaborations undertaken to meet specific, concrete, researcher needs
The researchers adapt to the way things are done	The way things are done adapt to the researchers
Researchers cobble together services across digital infrastructure providers	Digital infrastructure providers work closely together to provide seamless services researchers need

Service Oriented

Keeping the researcher central to decision-making will not automatically ensure that one is offering the most valuable services possible; researchers will not necessarily know to ask for services that have not been routinely provided in the past. One must constantly try new offerings, but in a disciplined and researcher-centred way.

Proposal 1.2: A broad range of research-support services should be offered, with new services continually piloted.

New services can be routinely and inexpensively trialled with pilot projects, whether they centre on providing expertise, hardware, software, or a combination. The training efforts, currently led by the regions, demonstrates the advantage of this approach. Enrollment provides immediate feedback on demand and content allowing for nimble program development.

Not Service Oriented	Service Oriented
New services are chosen centrally and rolled out on a full scale nationally	New services are piloted, tested, and scaled-up or phased out
Services tend to be low-level with limited value-add	Services range from hardware-provision to research partnership
Services are either devised centrally, or done "the way things have always been done"	Best practices and new services used successfully elsewhere are routinely trialled

In a technology-focussed research computing organization, the main research computing service offered tends to be helpdesk-style questions about logging in, compiler errors, or queuing jobs. Compute Canada currently has approximately 60 Ph.D.-level staff and 30 with other advanced degrees; it is critical that the federation makes as much use of this skill and expertise to provide researchers the most important added support, and retains these experts by providing meaningful opportunities to contribute to research.

Proposal 1.3: Services offered elsewhere, such as having staff participate more closely in research, should be investigated.

We can look to a variety of international organizations for examples of successful service offerings. Examples include XSEDE's extended collaborative support services[1], and the growing number of Research Software Engineers[2] in the UK. Such staff participate in the research, often to the level of authorship, and manifestly enable research that would have happened more slowly or not at all. In the 2013 Compute Canada survey of institutional and regional staff, this level of participation was mentioned often as a desire technical experts. In the Prologue, staff play several well-defined roles in Shannon's project.

SHARCNET has long offered dedicated programmer time, one type of such services, and it has been quite successful and indeed very popular with both researchers and staff. Such efforts have not yet been trialled nationally.

National

Any conversation about Compute Canada must have as a starting point that Canadian researchers merit having access to a national portfolio of resources, and that their location in the country cannot matter for the type and level of services received.

Proposal 1.4: The platform must be available to the entire Canadian research community, with specific efforts to efficiently assemble the most appropriate resources to support new and existing communities.

Truly national provision of resources to researchers, particularly resources as diverse and important as expertise, is something which takes active effort on the part of the research support organization; it can't be neglected as something which is allowed in principle but left to the researcher to pursue on their own. Presenting researchers with a list of national staff and bullet lists of their expertise, and leaving the researcher to try contacting staff members in turn to recruit them to collaborate in their project, is a woefully inadequate approach to enabling computational research projects. In the Prologue, national and diverse resources are actively assembled to enable Shannon's research.

Not Truly National	Truly National
Researchers are given a list of national resources available for them to investigate themselves	National teams of resources are actively assembled for a project
Researchers in some fields or institution types are overlooked	Researchers are supported equally across the country, across all institution types
Services are replicated many times for provision to local users	Providers are encouraged to specialize to meet local priorities and needs while providing services to all

A truly national organization must ensure that Canadian researchers in all fields and institution types are adequately supported. Researchers in biological and life sciences (particularly human health), social sciences, and scholars in the digital humanities must be served as capably as those in physics and biochemistry; effort must be taken to reach out

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[1] https://www.xsede.org/ecss
[2] http://rse.ac.uk/

to applied research work in colleges and polytechnics (over \$200M/yr of external funding, approximately 40% of which comes from the private sector).

Currently, computing resources for the very largest users of resources are provisioned truly nationally, via the RAC process.

Equal Federated Partners

Canada has one of the most fiscally decentralized governments in the G20. This flexibility has real benefits, but it introduces complexities that are just as real, and is why there are no ready-made organizational models for research support from abroad for us to copy for our national project.

Proposal 1.5: The structure of our federation partnership must reflect the reality of several funding partners.

The majority of funding for Compute Canada is driven by the provinces and institutions with only 40% coming from national sources. The provinces will reasonably have different priorities than the national government, and their priorities and existing capabilities will differ amongst themselves. Any organizational structure or process that doesn't acknowledge and accommodate these perfectly valid and healthy tensions between equal funding partners will be too brittle to last.

Unequal Federal Partners	Equal Federal Partners
Central office makes all decisions	Central and provincial partners make decisions by consensus
Federal government gives money to provinces to spend however they want	Investments are made to build a country-wide platform that supports all researchers, with regional contributions that reflect regional priorities
Understanding of researcher needs limited to either "the researchers we've worked with" or "researchers in general"	Researcher needs local and national, supported and not-yet-supported, are considered

The crass-but-practical concern of funding is an immediately clear justification for this principle, but not the most important. Being researcher-centred means taking all perspectives on researcher needs into account, and the partners in federation have important but different perspectives.

As the front-line service-providers to researchers, the regions have immediate and hands-on experience knowing what the investigators they are working with need. The central office, communicating directly with national societies and funding agencies, and conducting needs assessments, knows what researchers collectively need, and what is currently lacking in the research ecosystem.

An effort to be researcher-centred based on only one of those perspectives cannot succeed. A project undertaken with a general intent to support researchers in the abstract can only end badly. And a project undertaken to help those researchers that are already being helped, but more so, will leave an ever-larger number of investigators behind.

Incorporating both perspectives equally is genuinely difficult. As Canadians have known for 150 years, decision-making by consensus between federal and provincial bodies can be a slow and occasionally frustrating process; but the results are robust and durable, and are better decisions for having had the multiple inputs. A platform that values the inherently federated nature of our partnership, and interoperability rather than uniformity, can build on the strengths and priorities of its participants rather than trying to paper them over.

Interoperable, not Identical

The internet is arguably the most important computational tool for enabling faster and better research made in modern times, and yet the central internet body, the IETF, does not specify brands of computer and browser, nor enforce a list of services that every website must provide each user. Instead, strict interoperability requirements, coupled with the freedom to innovate within those standards, have combined to make the internet such a powerful research tool.

Proposal 1.6: The services offered by the national platform must be interoperable, not merely identical.

The Canadian research environment can be strengthened by ensuring that each project has the potential to access the complete national portfolio of computational science resources. But to focus on implementation details rather than interoperability standards is to miss out on many of the opportunities that come from that working together and pooling resources. In the Prologue, Shannon interacts with several hardware systems and people in varying regions, so that interoperability is vital; implementation details are not. Currently some of the national teams, such as the security team, work under this model, defining standards and best practices without specifying implementation details.

Focusing on interoperability rather than implementations allows specialization, with different providers providing solutions tailored to different use-cases; it allows experimentation, testing out new implementations at one site without disrupting the platform as a whole; it allows rapid prototyping and piloting of new approaches without having to roll out homogeneous and potentially untested changes to the entire country.

Focused on Identical	Focused on Interoperable
Infrastructure is specified in terms of technical specifications	Infrastructure requirements specified in terms of SLAs and interfaces to other infrastructure
Experimentation requires lock-step changes across the country	Experimentation can be performed easily and locally
New sites cannot fully join the platform without wholesale replacement of infrastructure, procedures	New sites can easily fully join the platform by exposing services, infrastructure via interfaces
Little thought given to interaction with other digital infrastructure providers	Close collaboration and interoperation with other digital infrastructure providers

Well-defined interoperability requirements also makes bringing new providers into the

platform easier. As opposed to requiring a new site, already providing services, to completely change how they operate, clear expectations and interoperability requirements enable the site to fully participate by exposing their existing services and infrastructure through clear additional interfaces and standards. Similarly, focus on interoperability promotes collaborating with other digital research infrastructure providers.

Collaborative

The foundation for any successful truly federated organization must be collaboration, not merely co-existence. A federation, which incorporates the breadth and diversity of researchers, provinces, funders and personalities can only function if all parties come to the table in good faith to discuss and negotiate. It can only be a success if the whole becomes greater than the sum of its parts.

Not Collaborative	Collaborative
The focus is only on problems and challenges	The focus is on solutions and opportunities
Parties are focused on their local organizations	Parties are focused on the shared mission of meeting researcher needs
Parties are not willing to compromise	Parties are willing to give and take to achieve the shared mission
Coexisting silos	Whole greater than sum of its parts

This document outlines principles for a successful federated Compute Canada, and one possible path to get there, but nothing is possible without all parties wanting success and wanting to collaborate.

Proposal 1.7: The federation should aim to achieve more than the partners could achieve separately.

Collaboration is not easy, and it often comes at the cost of taking more time and energy. Working together, building consensus and getting people onside requires time and compromise. And the only way this is possible is if people are truly committed to success as a federation.

Collaboration cannot end at organizational borders. As very large-scale research data and multi-institutional, multi-disciplinary consortia become more and more important, close collaboration between and not just within research support organizations will be vital. In the Prologue, Shannon makes use of tools requiring compute, research data management, and high performance networking.

Modern

A research service organization which uses technology to address researcher needs must stay on top of new tools so that they can fully meet those needs. Although researcher needs must always be the driver, solutions change quickly, so the service organization must be

building experience to evaluate the benefits of these technologies if deployed on a larger scale.

New tools can include hardware — NVMe, FPGAs, and server-class ARM CPUs are all technologies which could have significant impact on research computing in the quite-near future — but they can also be new techniques for robustly and efficiently providing technical services.

Proposal 1.8: New training should continually be available for emerging hardware and operational tools.

An organization which embraces having modern tools must ensure there is adequate staff time and training to learn and explore new hardware. Small experimental systems must be made available to staff (and interested researchers) to explore the suitability of new hardware for research systems. Canada's early but cautious and measured adoption of GPUs took this approach successfully. And such an organization ought not hesitate to make use of commercial cloud providers when appropriate to make such new technologies available.

Not Embracing Modern Tools	Embracing Modern Tools
Limited or no availability of experimental systems	Ongoing investments in new technology for staff to explore for suitability for researcher use
Little paid staff training	Provides staff with time and training in new methods and techniques
Focus on 'tried-and-true' methods from supercomputing centres for running systems and interacting with users	Focus on exploring, customizing, and using approaches from across large-scale computing for running systems, interacting with users.
Limited or no ongoing investigation of commercial service (*i.e.*, cloud): providers are the competition	Commercial service providers are one of many options for providing services to researchers

A modern organization also experiments with and trains on new operational tools. As more and more companies rely on computer infrastructure, the past decade and a half have led to improved approaches to ensuring the services they provide are reliable and effective. Techniques like Google's now-widely adopted SRE approach[3] or Netflix's 'Chaos Monkey' emphasize automation, rigorous testing, and continuous improvement, allow staff to focus on providing higher quality services.

Proposal 1.9: The federation should make use of best available tools for interacting with and supporting researchers.

Since interactions with the researcher are so important, a modern research support organization also takes advantage of new tools from elsewhere for working with clients. Customer Relationship Management (CRM) packages enable the following of researcher interactions and project progress, allowing staff anywhere in Canada to come up to speed

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[3]https://landing.google.com/sre/book.html

and assist a remote researcher. In the Prologue, Shannon benefits from up-to-date hardware, system methodologies, and interaction tools.

Governance Best Practices from Other Federations

Managing and running a complex partnership like the one that is responsible for our national platform, or any digital infrastructure platform, may seem daunting. But it is vital to realize that federated organizations are increasingly common in the nonprofit sector, especially in Canada or amongst international NGOs, and that many successful examples are available.

There is no one-size-fits-all approach to organizing a federation of partners. However, significant thought and effort, in Canada and abroad, has gone into examining governance and management models in a variety of contexts; we can learn both from models that have worked very well, and from cautionary tales. The authors have found the studies listed in the References to be particularly valuable in informing this work.

Evidence of successful federations from across Canada and abroad suggest that the choice of the basic architecture of our federation is sound. But relationships and processes matter a great deal; Widmer and Houchin (1999) report that they "...came to believe that federations were more likely to be damaged by bad processes than bad structures". Thus, we focus on how several vital relationships can benefit from being renegotiated in the light of what is done elsewhere. As a starting point for discussion, we take the evidence of federations elsewhere and propose steps for renewing the governance our federation.

Mollenhauer (2009) pointed out that "The goal of any federation should be to get the benefits of a centralized structure, such as greater efficiency and effectiveness" — and in our case, coherence — " while retaining the benefits of local autonomy, such as community responsiveness." It is fair to say that previous attempts at organizing our federation have focused more on one or the other of those sets of advantages. But armed with working examples from elsewhere in Canada and abroad, we can aim to achieve a balance of both.

Clarity of Roles

Indeed, evidence suggests some helpful moves have already been made. Mollenhauer (2012) describes several successful Canadian organizations going through a ground-up consolidation process very similar to our history, with service providers organizing first into consortia, and then into regional organizations. In the case of both the ALS Society of Canada and the Parkinson Society of Canada, this move was made with the intent to improve both the speed of national decision-making and the coherence of local decision-making, while giving the federated organization a healthy balance between national office and regional offices.

Proposal 2.1: The federation partners should clearly delineate the roles and responsibilities of the central office and the regional organizations.

However, in the case of our federation, this move may have been incomplete. In both of those two cases part of the process involved clear partnership agreements agreed to by the new regional organizations and the central office as to the roles and responsibilities of each. Strategic Leverage Partners (2009) briefly describe a similar process with the American Cancer Society and the Girl Scouts of America — in the case of the Girl Scouts, the clarity of interactions offered by this detailed description of roles allowed, for the first time, delivering programs jointly with external partners

In a case study of the World Wildlife Fund US (Wei-Skillern and Herman, 2008), staff described these sorts of agreements very positively: "We learned that we need these kinds of network initiatives to be formal, not with bureaucracy, but with people needing to know each other's roles."

Boards

Proposal 2.2: The central office Board should be provided the training and the support necessary to play their role in the federation.

Mollenhauer (2009) offers a picture of a frequent challenge in Canadian federated organizations which speaks to the central dilemma facing their Boards:

> "A clear distinction needs to be made between the role of the national Board of Directors as it relates to the [central office] and its role in the federation. Some national Board of Directors act as if they have a greater ability to set direction and impose behaviors then is the case. As a result, they undervalue the essential role of the [central office] within the federation as convener and facilitator. … Even the language used by federations can be illustrative of the confusion about the role of the [central office]. The [central office] is a partner in the federation, but written and verbal communication often describes the [central office] as the federation."

This dilemma is particularly acute for a research support organization, where the Board has responsibilities to both a national membership needing national services, and a national funder requiring national governance, but authority only over a central office — and satisfying their responsibilities requires the participation of all partners in the federation. A Board in this situation can only be successful when their responsibilities are aligned — all federation partners are committed to their shared mission, and national membership and funders that understand the challenges but accept them for the sake of the benefits.

Even then, handling the conflicting roles of a central office board in a federation is genuinely difficult, and we have asked board members to date to take this on with little to no support on how best to proceed. Most studies recommend board training that emphasizes the challenges and possibilities of a federated system.

Proposal 2.3: The central office and regional Boards should regularly meet to ensure alignment of governance.

With the recognition that a central office Board does not operate in a vacuum, some other possibilities for support present themselves. While in our federation to date there has been much effort in establishing ongoing meetings between management and staff of the partners of our federation, several works also suggest similar interactions between members of the Boards of the partners to ensure alignment of governance, not just management.

Membership

Evidence from the study of successful international advocacy NGOs (Brown et al., 2012), suggest that membership in a federation should reflect the primary accountability of the federation. In our case, this is to the researchers, strongly suggesting that researchers or their representatives should be members; we suggest that putting the burden on researchers to govern the federation that should be working on their behalf is unreasonable, and that the existing model of membership comprising institutions in their role as representing researchers is a reasonable compromise.

Proposal 2.4: Members should be given the access and support they need to play an active role in the federation.

Shared governance in a federation — or indeed the governance of any member-owned non-profit — requires active participation of the members to be successful. A finding of Widmer and Houchin (1999) is that even in federations where "the membership may appear to have significant powers, in practice, the influence of the membership may be limited by infrequent opportunities to exercise power [...], little control over the agenda, lack of experience and cohesion among affiliate representatives, and infrequent meetings of the membership", whereas in other organizations the membership is given many more opportunities to participate in governance, from advisory roles to votes on policies. Perhaps partly because of lack of visibility members have had into the governance and management of the central office and the federation as a whole, members to date have been reticent to fully participate. If our project is to be successful, this needs to change; the federation has to make sure its members have whatever support they need so that they can take their full role within the federation.

In addition, the membership needs to be actively recruited to reflect as broad a range of Canadian institutions as possible, and barriers to membership should be reduced as much as feasible.

Federation-wide Decision Making

The role of a central office and how it interacts with with the other partners in the federation is crucial to a federation's success. Brown, Ebrahim, Batliwala (2012) identified several factors which determine whether successful international organizations function as a loosely-coupled network of allies or a more tightly-coupled federation.

In their work, they demonstrate that to the extent to which the work being undertaken is long-term and coherence is needed, that federations, being more tightly-coupled seem

to work best. If the work is more short term (as for individual short-term advocacy campaigns) or less coherence is needed (as if each group was going to lobby only within its own region), loosely-knit and perhaps even ad-hoc partnerships worked well.

We argue that Canadian research merits a long-term and coherent computational platform for supporting research, meaning that a federation, and not a loose network, is appropriate. But how should such a federation operate internally? What should the roles of the individual partners in the federation be, and how should decisions be made?

Management of a federation of co-equal partners can only be derived from conensus. Again from Mollenhauer (2009), a success factor in federations is that

> "There is a clear understanding that leadership is shared across the federation and there is acknowledgement of the role of consensus, not authority, as key to decision-making. The CEO/Executive Director of the national organization has strong skills in communication and facilitation and puts high value on process as well as on delivering results."

Proposal 2.5: Federation-wide decision making should be be supported by consensus.

This doesn't mean that consensus must be achieved for every single agenda item in a meeting — that brings paralysis — but on decision-making processes themselves there must be explicit, formal agreement, with clear distinctions between "between decisions that need unanimous or consensus agreement because they are critical (e.g. those tied to risk management) versus those that need a majority (e.g. those related to activities)." And while a central office must be responsible for those processes as the facilitator, that is a different role from being the decision-maker.

The central office has played different roles over the years. As the national arm of the platform, it will always be primarily responsible for directly working with national funders, national research organizations and societies, and international partners. Working with those organizations gives the central office a different, birds-eye view of the national research community.

These different perspectives matter; our federation's mandate is not just to assist individual researchers already working with us but Canadian researchers collectively. It is far too easy to focus too much on either the forest or the trees, and the combination of hands-on and birds-eye perspectives is vital in setting priorities, and consensus decision making is required to bring these two perspectives together.

The Value of a Federation

Grossman and Rangan (2001) take an overview of five international federations and look at what determines the relationship between the partners. They point out that local autonomy and affiliation to a central coherent framework aren't opposed; one can have partner organizations with high autonomy and low (Outward Bound) or high (The Nature Conservancy) affiliation and coherence. The determining factor in the authors' view was the

value of affiliation into a federation for the partners; if there was high value in a federation, one would persist and be stable, even in the presence of disagreements about operations or strategy.

Proposal 2.6: The federation should make it clear internally, to the research community, and to funders, the value of providing services as a federation.

In the case of our federation, there are several important ways a federation can be valuable to the partners, although these have not yet been fully realized. A federation can enable specialization, allowing individual providers to focus their efforts on the services they are best at providing, instead of trying to be all things to all researchers in their jurisdiction; and it can allow the researchers in the jurisdiction to access a wider range of services and expertise than would otherwise be possible. However, those value propositions are greatly diminished if the national platform focuses on uniformity rather than interoperability.

The WWF-US case study mentioned earlier illustrates the importance of need for value from working together for a federation. In the early 2000s, after years of WWF national offices being largely independent with only certain aspects being set centrally, there was disagreement about mission and priorities. This grew to tension between the central office (WWF International, in Switzerland), and several national offices, including WWF-US, the largest, which had seriously considered leaving the network.

But in the mid 2000s a major international victory surrounding conservation preservation in Tesso Nilo, Indonesia, had required coordinated pressure from several national organizations and expertise ranging from finance and marketing and the ecosystem science to the local governance and land management practices; this collaboration, which had grown organically and almost accidentally, convinced the member organizations to restructure the federation around such projects of global impact requiring global effort. Decisions are now largely made through a "network executive team" involving the central office and representatives for national and program offices, and local office commitments to various programmes are spelled out in detailed documents agreed to by both sides. While the national offices retain autonomy, the network now acts in a much more coherent, integrated way; that increased coherence has brought *reduced* tension between central and local offices due to the clarity of the mission.

On the other hand, if the value of federation isn't made clear, partners may stop engaging with the federation or even depart, such as with the recent situation with the Alzheimer's Association in the US (McCambridge, 2016).

Turning Principles into Operations

Implementing governance best practices in our federation can greatly improve how our federation functions, but we must make sure that the federation operates in a way that lives up to the principles we choose for our organization.

Proposal 3.1: Key Performance Indicators (KPIs) should reflect our Principles.

We must ensure that the metrics we set ourselves to measure success are measuring the right things, rather than being easy to count. This is genuinely difficult; it is easier to

measure interactions with researchers than the number of interactions that no longer have to take place because a task has been made simpler. However, we must ensure that our stated goals and our measurements of success coincide.

Services

In the document we argue the best model for our federated organization is services based. All partners in the federation provide services to each other to build the national platform, and collectively to the researchers. The Central Office is accountable to the researchers (through the Members) and so the Central Office is responsible for ensuring the Regions are accountable for meeting their agreed upon services.

We propose that the priorities for the national platform will be set through collaboration with the regions and the central office. These priorities will be defined by a service or more appropriately a set of services with the associated Service Level Agreements (SLAs) and interfaces. The SLAs must have clearly defined metrics for evaluating the effectiveness of the services provided.

Proposal 3.2: Services provided should come with agreed-upon SLAs ensuring quality and interoperability.

A federation colleague (ie: a region or the central office) will propose taking on the responsibility for providing some or all of the necessary service or services: allowing regions to build on existing strengths or meet regional priorities. Ideally these services will be assigned based on consensus, but for big ticket items where this is unlikely to be possible by some pre-agreed upon process led by the central office.

Once the agreement is made, the provider is free to implement the service in any way they see fit, but are held accountable for meeting the agreed-upon standards and metrics.

Proposal 3.3: Services should be piloted, with definitions of success decided upon before the pilot.

Most services should normally go through a pilot phase before being provided more widely. Deciding what success means for a pilot will necessarily differ from service to service, and consensus should be reached before the launching of a pilot what would merit a more permanent, larger-scale roll-out.

It's worth noting that it may be perfectly reasonable for some regions or institutions to provide services locally that are not part of the national platform; there are some services which are not possible to provide nationally, or there might not be sufficient demand for outside of a given region, but one jurisdiction may be willing to fund nonetheless. Not every type of research support necessarily has to be shoehorned into a national platform framework.

Relationship between Federation Partners

While federations of equal partners must have a basis in consensus, each partner has specific roles to play.

Proposal 3.4: The central office should be responsible for nation-wide needs assessments and researcher satisfaction.

The central office must be the convenor of the "birds-eye view" of the Canadian research community, working closely with national funding agencies, national scholarly communities, and other research service providers who can identify gaps in the research ecosystem, or underserved communities. In that role, the central office should be responsible for performing nation-wide needs assessments, measuring researcher satisfaction, and ensuring the input of national researcher communities into the federation's discussions.

Proposal 3.5: The agenda should be managed by the central office, and consensus should be found or built around priorities.

As a convener and facilitator, and as the organization developing nation-wide assessments, the central office will always be the setter of the federation's agenda. It will need to be the body that drives the push for evidence-based consensus around national priorities, planning next steps, and where necessarily, building partnerships outside of the federation to accomplish the federation's agreed-upon goals.

Proposal 3.6: The central office should be responsible for monitoring and enforce interoperability and other SLAs on the platform.

Coherence of the national platform, and adherence to interoperability and other agreed-upon standards, will necessarily be the responsibility of the central office. It is this body that will perform monitoring of these service levels, and testing interoperability. It is also the central office's responsibility to ensure that there are accountability measures in place for service providers not meeting their SLAs. However, since failure to provide interoperability or service levels is a failure felt by the entire platform, not just the central office, other federation partners must also play a role in enforcing these standards.

The needs assessment and SLA or interoperability monitoring roles are vital, and generally will be the primary technical roles of the central office, as researcher-facing technical services and operations will generally be best managed by the regional organizations and sites.

Proposal 3.7: Responsibility for operations of researcher-facing services should generally belong to the regional organizations.

Being nimble, and being able to quickly tell if a researcher-facing service is successful or if it should be changed, will normally require researcher-facing services to be provided organizationally close to the researchers. This will generally mean that such services will be housed in one or more regional organization.

Proposal 3.8: Internal federation services can be provided by any partner, or externally.

On the other hand, internal services necessary for the administration and operation of the federation itself — CRMs, email, dashboards and monitoring, finance services — might reasonably be housed in any of a number of places; any federation partner might propose hosting such a service. As with a researcher-facing service, such a service would come with an SLA. Externally-provided services would still require one federation partner to be responsible for the SLA and interacting with the vendor.

Relationship with Other Partners

As the uses of computation and data broaden, and become more integrated into all areas of scholarship, investigators will increasingly need services that require coordination of remote and institutional computation and storage, networking, data management, and other research services. It won't — and shouldn't — matter to those researchers this coordination happens; either across multiple organizational boundaries or within a single organization so long as the access to resources is seamless.

Proposal 3.9: The federation must work closely with other digital infrastructure providers and research services organizations in service design, service delivery, and future planning.

Several models for how this close collaboration could work have been proposed, and should be discussed by the community at large. As suggested above, however, structures matter less in and of themselves than they do for their effect on processes; and it is the process that is crucial here. Just as it is unacceptable for researchers to have to routinely cobble together resources to support their project within a researcher-centred organization, it is unacceptable for researchers to have to manage for themselves the more complex task of coordinating resources across research support organizations.

In research, collaboration means much more than participants announcing to each other what they have done or what they intend to do; just so with research service organizations. A meaningful collaboration, one that can make the best use of each other's strengths and resources, means frequent discussions through planning, implementation, and execution phases of a project.

Conclusion and Next Steps

The purpose of this document is not to advocate in particular for the proposals contained within (although the proposals made here reflect genuinely-held convictions, rather than being straw-man arguments). The purpose is to start in earnest a conversation that is overdue, allowing the community to come to a consensus about what the internal organizational structure of Compute Canada should be, how it should make decisions, and how it should offer services to Canadian researchers and scholars.

The most important next step, then, is for you to have this discussion with colleagues locally and across the country, disagreeing vehemently initially on some points, and coming to agreement on others. Our document focuses on the organization that is Compute

Canada. However, as mentioned the principles and proposals presented can be applied to any digital infrastructure organization. Furthermore, the ultimate organization or governance structure that supports the delivery of research computing support could be any number of a wide range of models. Open discussions about that model, or various options could be a valuable step forward. However, we advocate that regardless of the model it is critical that researcher needs be the first and most important consideration.

The members and regions can build a successful and coherent national platform that works the way the community wants it to, but they cannot do so before the community tells them what destination they should aim for. The Canadian research and research computing communities can do great things together. Let's get started.

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