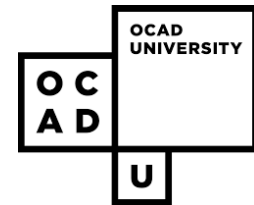# SOSCIP

SMART COMPUTING FOR INNOVATION

Elissa Strome, Ph.D.
Executive Director, SOSCIP
elissa.strome@soscip.org

February 4, 2016
University of Guelph

SOSCIP
SOUTHERN ONTARIO SMART
COMPUTING INNOVATION PLATFORM

SOSCIP's Mandate:

- To be Ontario's engine for innovation and growth around high-performance computing and big data analytics.

- SOSCIP gives SMEs access to technologies and expertise that would otherwise be out of their reach, in order to:
  - Solve business problems
  - Develop products and services
  - Improve business processes
  - Create jobs
  - Train the next generation of skilled personnel
  - Bring Canadian products and services to market more quickly and efficiently

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SOSCIP's Impact: 2012-14
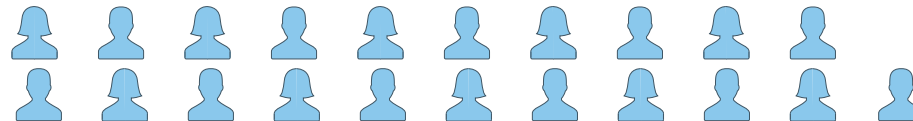
SOSCIP Governance

- Board of Directors
  - Co-chaired by UofT & Western; oversees strategic direction and vision

- Scientific Advisory Committee (SAC)
  - project approval, progress review, platform and HQP support allocation

- Project Collaboration Agreements (PCA)
  - Describes project participants, objectives and IP management

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SOSCIP Operations Team

SOSCIP Admin Staff

OCE High Performance Computing Team

IBM Canada R&D Centre

+ technical support team of 13 HPC and big data analytics experts

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SOSCIP 2.0: 2014-18 Strategic Objectives

Start 40 new projects before 2017 and:

1. Engage Medium-sized enterprises

2. Add new areas of focus: Mining, Advanced Manufacturing, Digital Media, Cyber Security

3. Expand Memberships & Partnerships

4. Focus on Commercialization

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FOCUS AREAS

Agile computing

Cities

Energy

Health

Water

Advanced Manufacturing

Cybersecurity

Digital Media

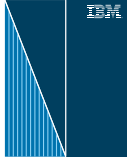**Mining**

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ADVANCED COMPUTING PLATFORMS

IBM BLUE GENE/Q

Canada's fastest supercomputer is suited for large-scale, distributed applications that require massively parallel processing power, such as molecular modelling, drug discovery, climate change forecasting, and computational fluid dynamics.

CLOUD ANALYTICS

Canada's first research-dedicated cloud environment hosts a broad array of IBM software tools for application development and data analytics. The Cloud Analytics platform is ideal for complex data analysis, streaming and managing large data volumes, and data mining applications.
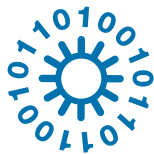
AGILE COMPUTING

Canada's first multi-platform agile research environment uses Field-Programmable Gate Array (FPGA) technology to accelerate hardware performance. FPGA cards can accomplish numerically complex tasks more efficiently and at lower cost than a traditional CPU could do alone.

LARGE MEMORY SYSTEM

The LMS platform is **a single 64-core virtual system with 4.5 TB of RAM**. Outfitted with the latest IBM analytics software, the LMS is ideal for data-intensive projects with huge active memory requirements.

What Can SOSCIP Do For You?

We can accelerate your R&D to help you solve big data, simulation, modelling and other massive computing challenges like no other platform in Canada.

We will connect you to:

➢ Project development support to help turn your idea into a viable project

➢ SOSCIP's partnership network to find the right collaborators for your project

➢ Canada's most powerful advanced computing and big data analytics platforms (incl. software)

➢ Dedicated expert technical help for your project

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SOUTHERN ONTARIO SMART
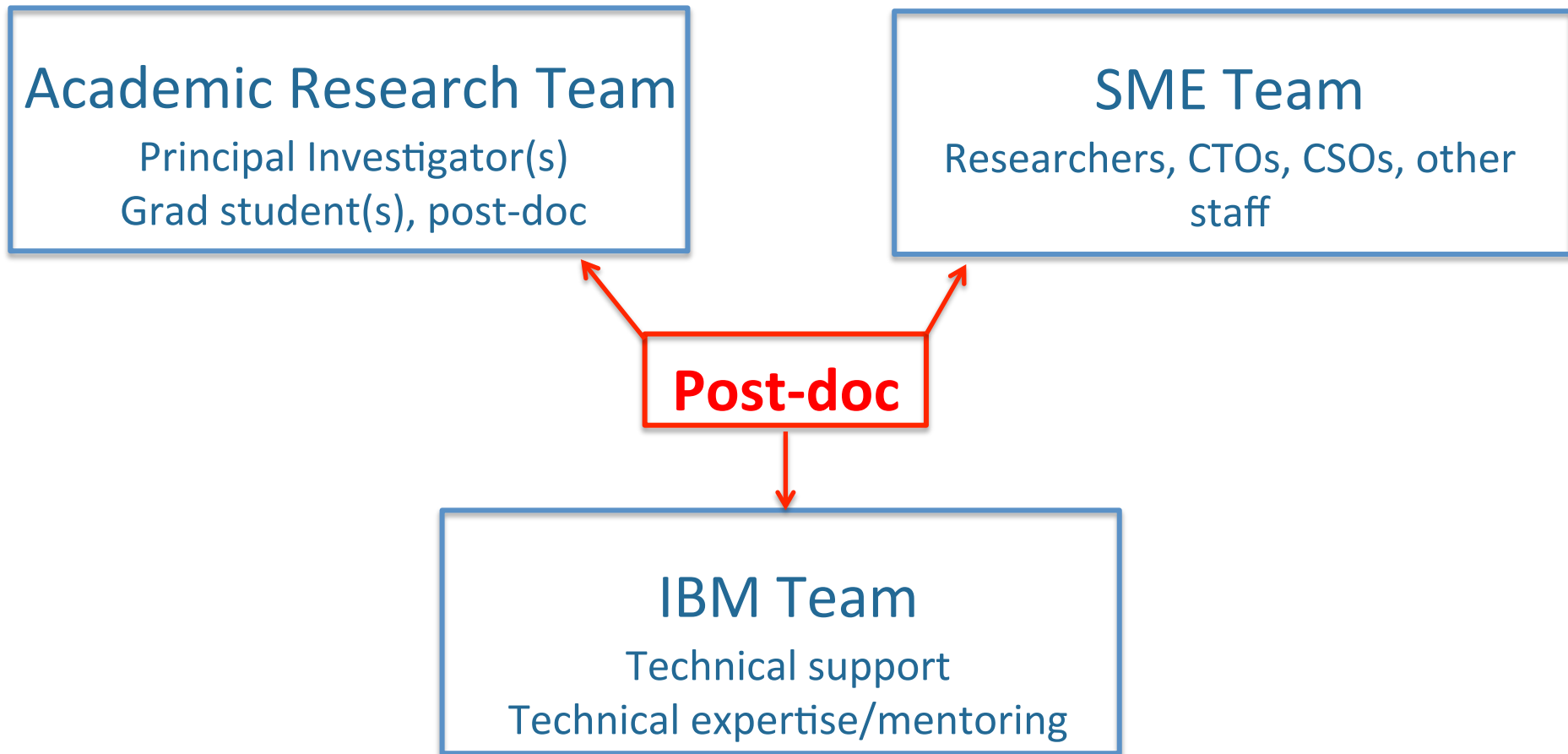COMPUTING INNOVATION PLATFORM

Current Calls for Expressions of Interest

1. SOSCIP-OCE Smart Computing R&D Challenge
   - Deadline for EOIs Feb. 23

2. Standard SOSCIP Collaborative Projects
   - Continuous intake

3. SOSCIP-CMC special call for FPGA-based projects
   - Continuous intake

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Project Eligibility Criteria

1. PI has an appointment at a member institution
2. Demonstrated need for SOSCIP's computing platforms
3. Project involves development of an idea/product/service with commercial applications
4. Industry engagement - existing partner or willing to engage new partner

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A Typical SOSCIP Project

Academic Research Team
Principal Investigator(s)
Grad student(s), post-doc

SME Team
Researchers, CTOs, CSOs, other staff

Post-doc

IBM Team
Technical support
Technical expertise/mentoring

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Project Development Process

1. Let SOSCIP know about your idea: info@soscip.org
   - We will tell your SAC member, IBM, OCE and our technical teams
2. Submit Expression of Interest (EOI) form
   - We will review a draft and help you flush out any uncertainties (technical, collaborators, funding, etc.)
3. SAC will review and likely approve

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Project Implementation

Next steps once your project has been approved by the SAC:

1. Sign PCA

2. Identify HQP

3. SOSCIP technical teams will grant access to platforms and help you get on-board

4. Start your project!

5. Let SOSCIP know whenever we can help troubleshoot; report back to SAC every 6 months

Project Resources and Costs

- SOSCIP provides:
  - Project development support
  - Connections to industry collaborators
  - Project technical support
  - Access to our computing platforms
  - Streamlined access to project and HQP funding programs

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Project Resources and Costs

- You provide:
  - One-time-only project access fee of $5k
  - Industry matching funds if you use our Mitacs or OCE personnel programs

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Summary: What Can SOSCIP Do For You?

Think big. Do you have a computationally large or complex problem?

We can accelerate your R&D to help you solve big data, simulation, modelling and other massive computing challenges like no other platform in Canada. Our team of experts will help you connect to:

- Canada's most powerful advanced computing platforms
- Dedicated expert technical help for your project
- Matching funding for postdoctoral fellows and graduate students
- SOSCIP's partnership network to find the right collaborators for your project

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Expected Outcomes

- Job Creation
- Training and skills development
  - HQP, companies, researchers
- Knowledge transfer
  - Conferences, publications
- Commercialization
  - New products and services
  - Increased productivity/efficiency/competitiveness for companies
  - New IP - protection, licensing, etc.
  - New companies

Success Stories:

Success Stories: *Atomwise*

- UofT start-up based on Abe Heifets' PhD research; developed a novel small molecule binding affinity prediction technique based on Deep Learning Neural Networks to find ways to repurpose "old" medicines for new disease treatments.

- **The Benefit:** With the BGQ, Atomwise applied their algorithm to screen thousands of known compounds to search quickly and efficiently for new applications; were able to rapidly identify two drugs that may be effective in reducing Ebola infectivity.

Atomwise
Better medicines faster.

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Success Stories:
Analytics4Life & Queen's

- A4L uses machine learning to deliver rapid, accurate, state-of-the-art images to help diagnose and pinpoint locations of cardiac tissue dysfunction to empower time-sensitive diagnosis and treatments.

- **The Benefit:** Partnered with cardiac researchers at Queen's to undertake proof of concept studies in a rat model. Will now use their algorithm to identify patients at risk for developing sudden cardiac arrhythmia or other serious cardiac dysfunction before symptoms emerge.

Providing non-invasive analytics based products and services that bring tertiary care quality to the primary care setting.

*analytics*4LIFE

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Success Stories:
Synchronicity in Motion

- UOIT start-up based on Carolyn McGregor's SOSCIP research; SiM's Artemis platform enables real-time processing of vital signs.

- **The Benefit:** In neonatal ICUs, the Artemis platform provides critical monitoring of premature babies to help detect possible serious health complications such as infections so that they can be treated as early as possible.
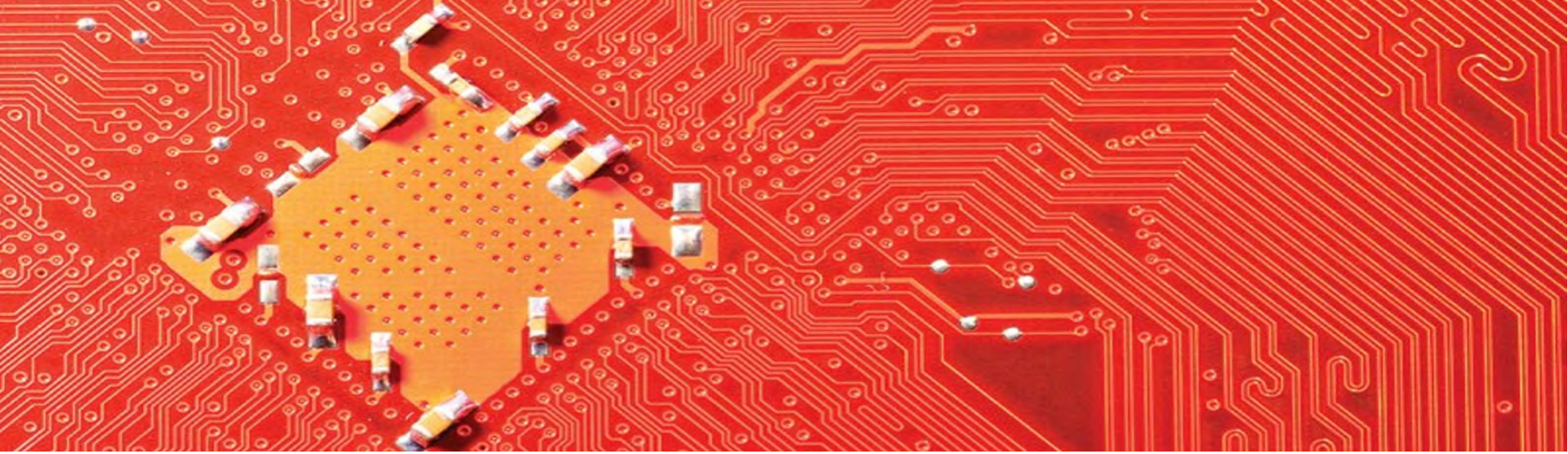
Success Stories: *Betz-IBM-Theralase*

- UofT professor Vaughn Betz and colleagues are working with IBM to take advantage of the high resolution programmability of FPGAs to design a very fast and accurate simulator of where light inserted with fibre optic probes travels within a person's body.

- **The Benefit:** This project will enable their partner medical technology company, Theralase, to develop minimally-invasive photodynamic therapy treatment options for harder-to treat cancers such as bladder cancer.
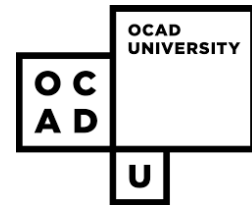
SOSCIP Platforms

SOSCIP HPC Platforms

Blue Gene/Q
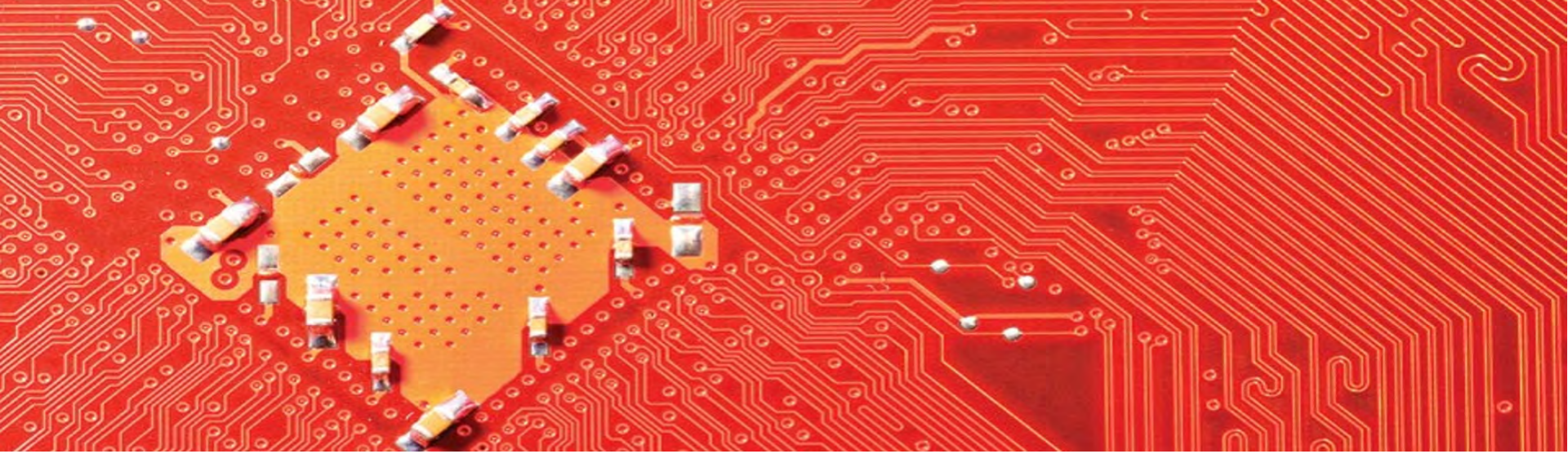
Cloud Analytics

Agile

Large Memory System

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Blue Gene/Q Platform

top500.org

Rank	Site	System	Cores	Rmax (TFlop/s)	Rpeak (TFlop/s)	Power (kW)
1	National Super Computer Center in Guangzhou, China	**Tianhe-2** (MilkyWay-2)- TH-IVB-FEP Cluster, Intel Xeon E5-2692 12C 2.200GHz, TH Express-2, Intel Xeon Phi 31S1P, NUDT	3120000	33862.7	54902.4	17808
2	DOE/SC/Oak Ridge National Laboratory, United States	**Titan**- Cray XK7 , Opteron 6274 16C 2.200GHz, Cray Gemini interconnect, NVIDIA K20x, Cray Inc.	560640	17590	27112.5	8209
3	DOE/NNSA/LLNL, United States	**Sequoia**- BlueGene/Q, Power BQC 16C 1.60 GHz, Custom, IBM	1572864	17173.2	20132.7	7890
4	RIKEN Advanced Institute for Computational Science (AICS), Japan	**K computer**, SPARC64 VIIIfx 2.0GHz, Tofu interconnect, Fujitsu	705024	10510	11280.4	12660
5	DOE/SC/Argonne National Laboratory, United States	**Mira**- BlueGene/Q, Power BQC 16C 1.60GHz, Custom, IBM	786432	8586.6	10066.3	3945
6	DOE/NNSA/LANL/SNL, United States	**Trinity**- Cray XC40, Xeon E5-2698v3 16C 2.3GHz, Aries interconnect, Cray Inc.	301056	8100.9	11078.9	
7	Swiss National Supercomputing Centre (CSCS), Switzerland	**Piz Daint**- Cray XC30, Xeon E5-2670 8C 2.600GHz, Aries interconnect , NVIDIA K20x, Cray Inc.	115984	6271	7788.9	2325
8	HLRS - Höchstleistungsrechenzentrum Stuttgart, Germany	**Hazel Hen**- Cray XC40, Xeon E5-2680v3 12C 2.5GHz, Aries interconnect, Cray Inc.	185088	5640.2	7403.5	
9	King Abdullah University of Science and Technology, Saudi Arabia	**Shaheen II**- Cray XC40, Xeon E5-2698v3 16C 2.3GHz, Aries interconnect, Cray Inc.	196608	5537	7235.2	2834
10	Texas Advanced Computing Center/Univ. of Texas, United States	**Stampede**- PowerEdge C8220, Xeon E5-2680 8C 2.700GHz, Infiniband FDR, Intel Xeon Phi SE10P, Dell	462462	5168.1	8520.1	4510

SOSCIP's Blue Gene/Q
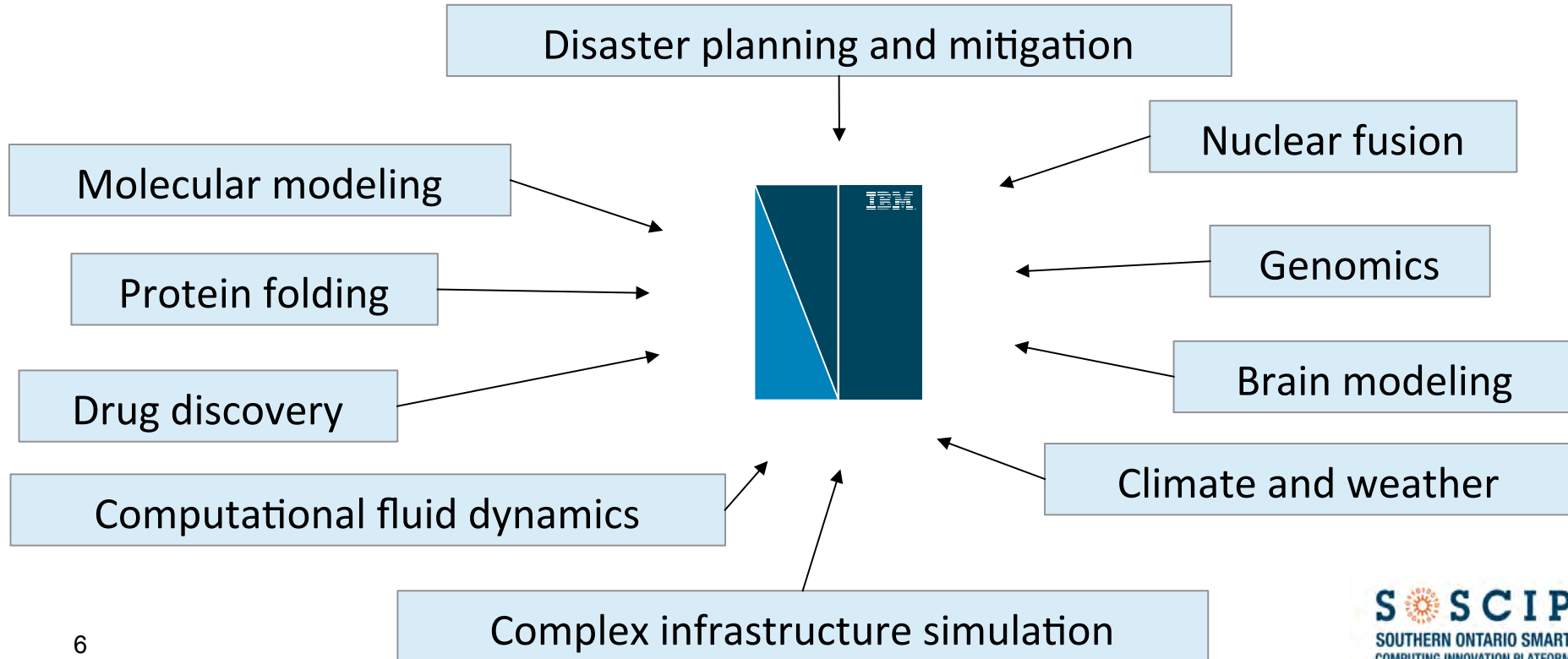

Specifications

- 64k core cluster

- 1.6 GHz cores

- 64 TB RAM

- 5-D torus interconnect

Performance

- Measured: 716 Tflops

- Efficiency: 2.1 Gflops/W

Typical Applications

Disaster planning and mitigation

Nuclear fusion

Molecular modeling

Genomics

Protein folding

Brain modeling

Drug discovery

Climate and weather

Computational fluid dynamics

Complex infrastructure simulation

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Modeling Quantum Dots

E. Sargent (University of Toronto)

- The problem: colloidal quantum dot solar efficiency is low
- The solution: model electronic properties to make better dots

MoOₓ/Au/Ag
CQD film
TiO₂/ZnO
FTO
Glass
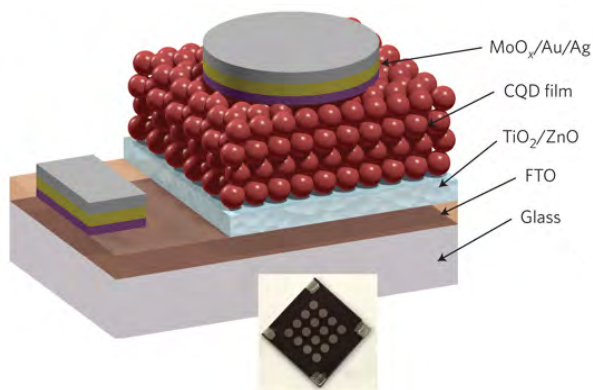
[Ip *et al*, Nature Nanotech. **2012**]

d
MPA-Pb-oleate complex
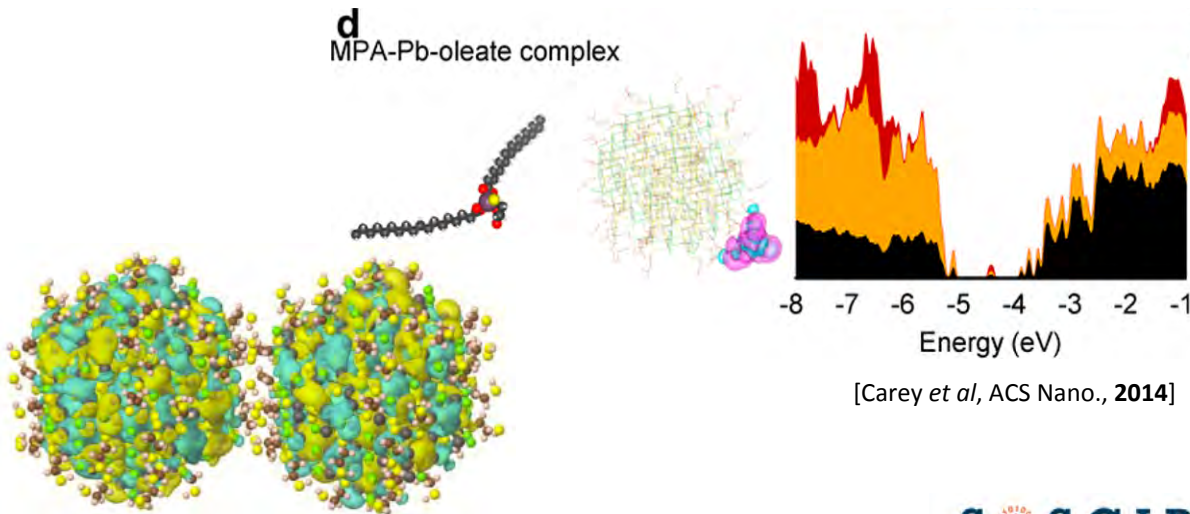
[Carey *et al*, ACS Nano., **2014**]

Energy (eV)

7

Cloud Analytics Platform

Cloud Platform Hardware

ps- & hs-series blades

POWER servers

x86 NeXtScale

x86 iDataPlex

- Powerful x86 and IBM Power Systems servers

- GPFS storage system (1 petabyte)

- Infiniband and 10 GbE networks

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Software Available

IBM InfoSphere Streams

IBM   COGNOS   IBM ILOG CPLEX

IBM InfoSphere BigInsights

IBM Rational software   IBM Platform Computing
Be the Master of Your Clusters

IBM SPSS   IBM DB2   R

Plus almost anything from the IBM Academic Initiative catalog!

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Typical Applications

Real-time Medical Data Collection and Analytics

Image Processing

Text Analytics

Machine Learning

Cybersecurity

Social Media Analytics

Document Filtering

Medical Records Analytics

Energy Systems Data Analytics
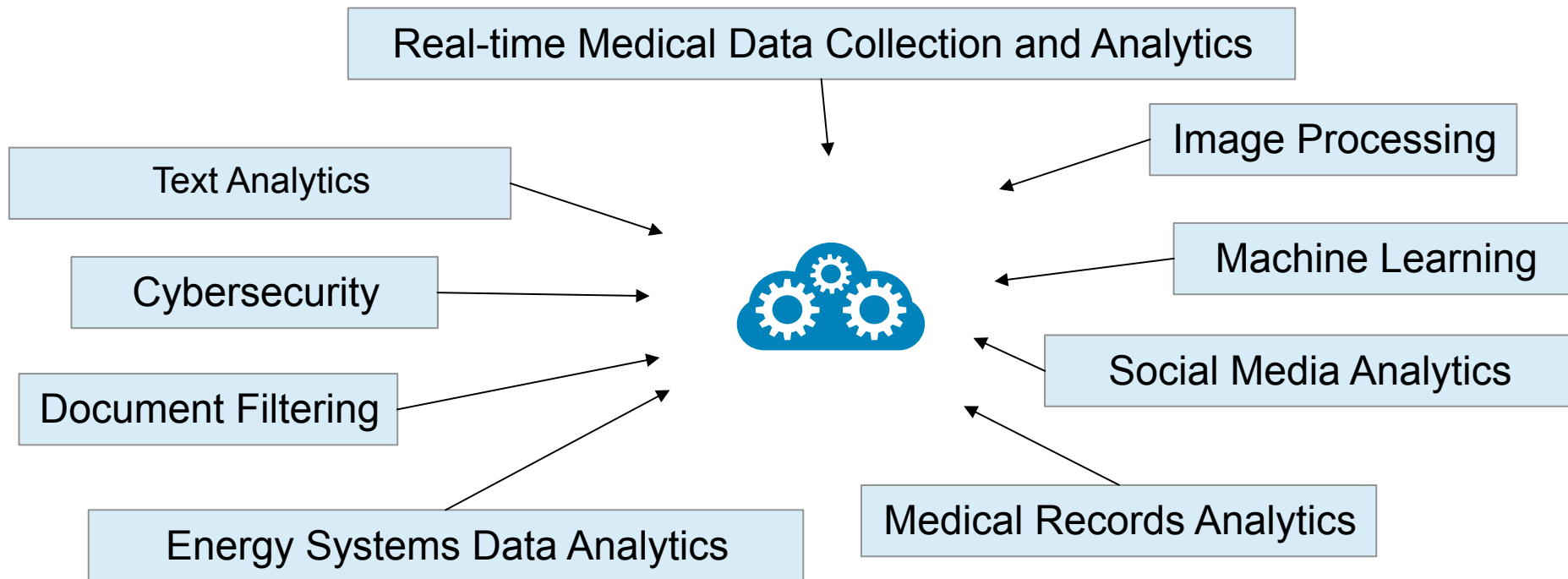
Analyzing Geospatial Patterns

Neil Banerjee (Western University)

- Multidirectional edge detection algorithm for mineral exploration and mining application

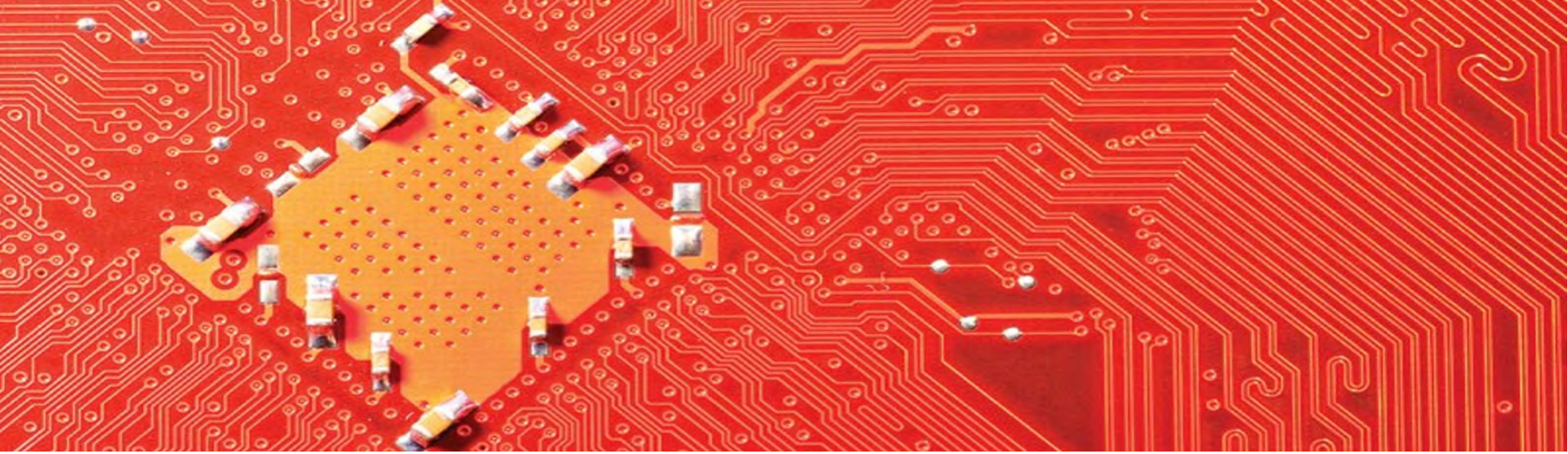- Detected edges highly correlate with known mineral deposits

- IBM BigInsights for high level of automation

SRTM-Data GeoTiff Images

Application of hill shade code using different values for azimuth and elevation

Generation of hill shade images

Apply edge detection to discover topographic details

Generation of edge detection images
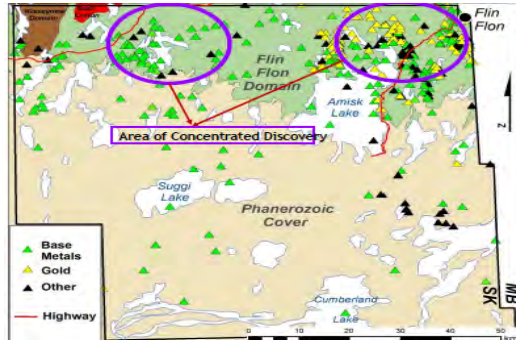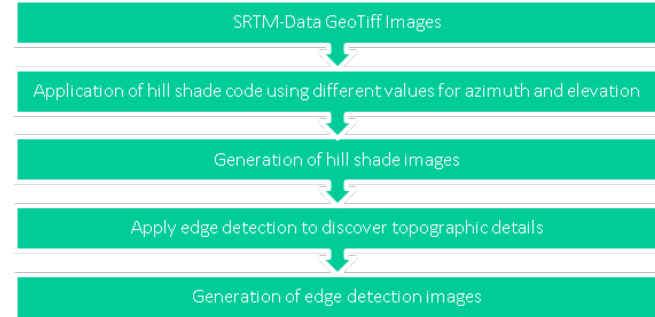
Know Mineral Locations
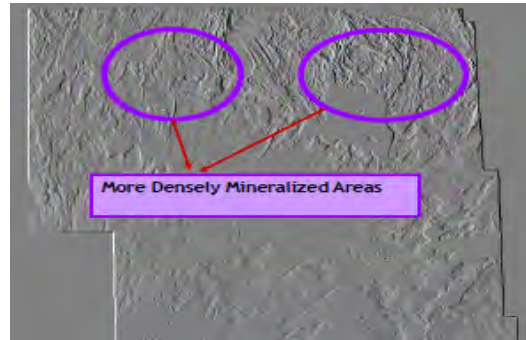
Hill shading
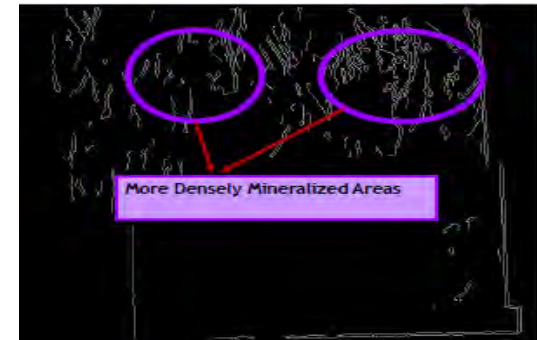
Feature detection

Large Memory System

Big Data and Memory

~5-8 GB/s

Latency: > 1 ms

50-200 GB/s
Latency: < 100 ns
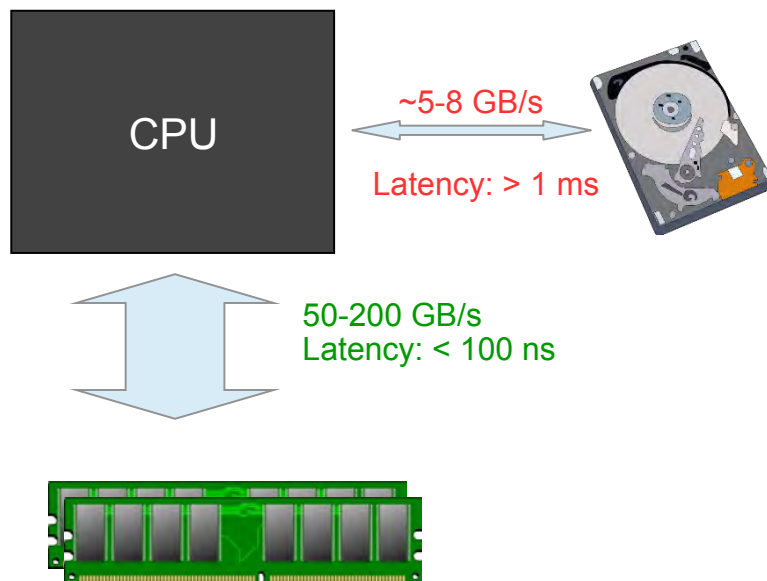
Disk Storage
Pros
- Inexpensive
- Large Capacity
Cons
-Slow!

System Memory (DRAM)
Pros
- Fast!
Cons
- Cost per GB
- Limited capacity per server

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LMS Specification

ScaleMP™
vSMP
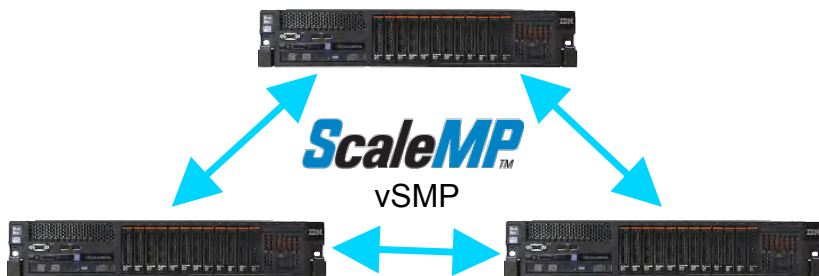
- 3-nodes acting as single system

- 64 x86 cores

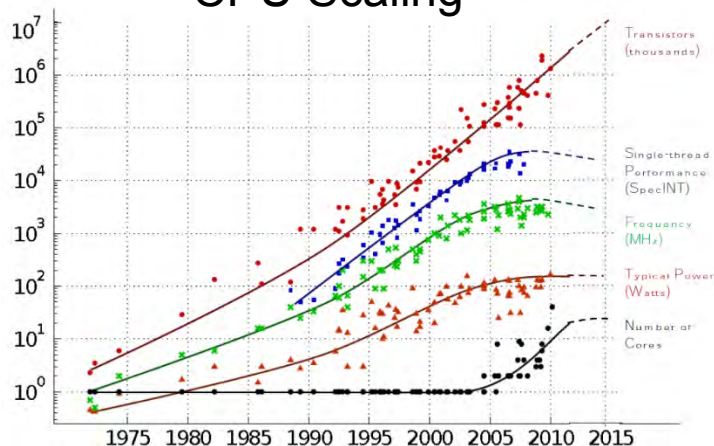- 4.5 TB RAM (1.5 TB per node)
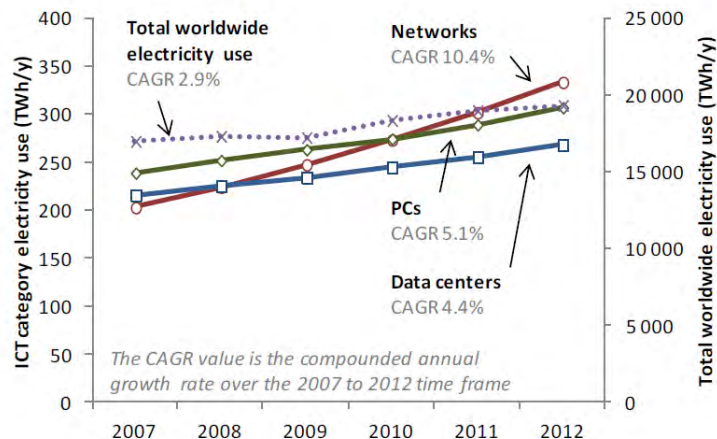
- Shared memory programming

The Case for FPGAs

CPU Scaling

ICT Power Consumption

FPGA acceleration offers:

Algorithms in re-configurable circuitry

High performance parallelism

High power efficiency

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Agile Computing Platform

Development Environment

- Fast x86 servers

- Simulate, debug, build

- Tools

Runtime Environment

- x86 and POWER8

- Stratix V FPGAs

- 10 GbE FPGA Network

- CAPI Technology on POWER8

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Typical Applications

Health/Medical systems

Image/Video Processing

Machine Learning

Signal Processing

Data Security

Big Data Analytics

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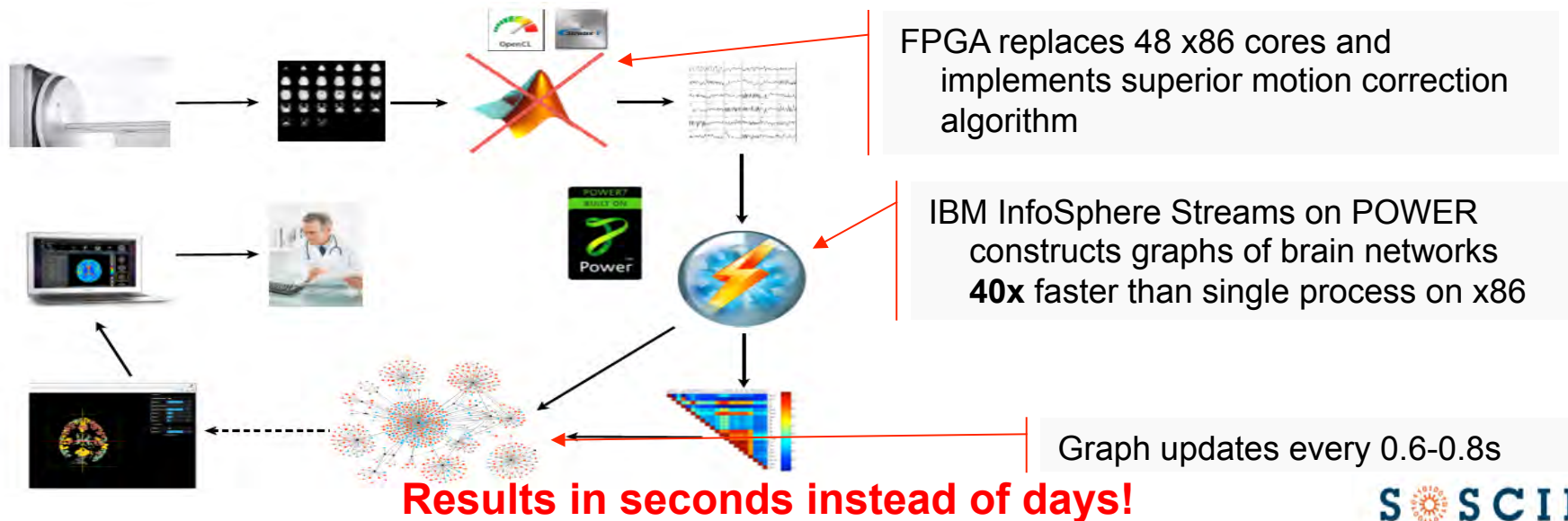COMPUTING INNOVATION PLATFORM
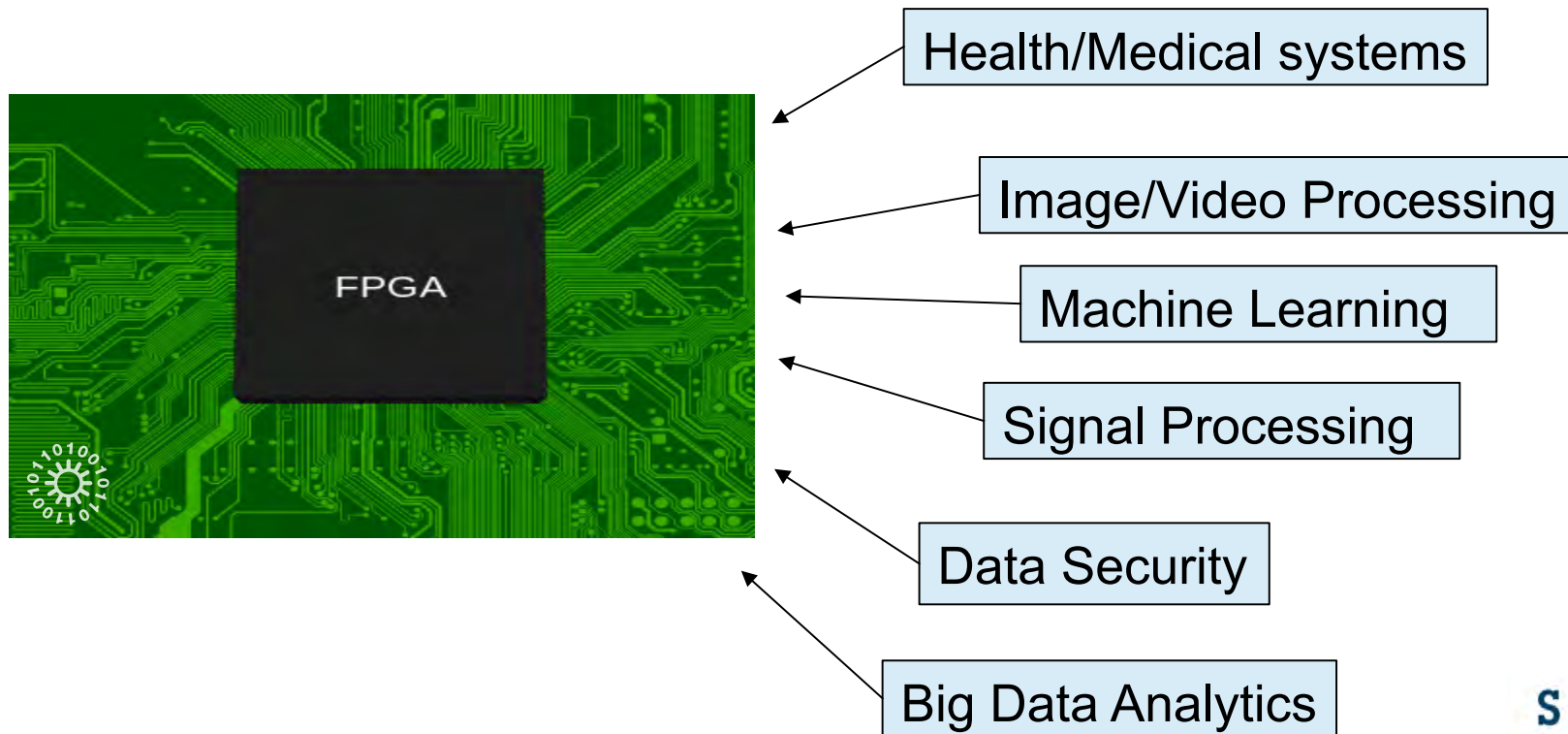
Real-time fMRI Brain Analytics

Mark Daley (Western University)

The problem: brain activity scans take days to analyze

The solution: an FPGA-accelerated real-time analytics engine

FPGA replaces 48 x86 cores and implements superior motion correction algorithm

IBM InfoSphere Streams on POWER constructs graphs of brain networks **40x** faster than single process on x86

Graph updates every 0.6-0.8s

Results in seconds instead of days!

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Platform Summary

Platform	CPU	Operating Systems	Commercial Software	Languages	Support
Blue Gene/Q	PowerPC	Linux	No	C, C++, Python, Fortran	SciNet, IBM specialist
Large Memory System	x86	Linux	Yes	All	HPCVL
Cloud Analytics	x86, POWER	Linux, Windows, AIX	Yes	All	SHARCNET, IBM specialist
Agile	x86, POWER8	Linux	Yes	All + OpenCL, Verilog/VHDL	SHARCNET, IBM specialist

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VIA – SMART COMPUTING R&D CHALLENGE
OCE FUNDING OPPORTUNITY

January 15, 2016

PROGRAM OVERVIEW

Ontario Centres of Excellence
Where Next Happens

INDUSTRY-ACADEMIC R&D COLLABORATION

- **Collaboration Voucher Program**
  - **Voucher for Industry Association R&D Challenge (VIA)**
  - **Voucher for Innovation and Productivity (VIP I & VIP II)**
  - **Voucher for E-Business (VEB)**
- **Alberta-Ontario Innovation Program**
- **Connected Vehicle/Autonomous Vehicle Research Program (CVAV) for Road Vehicles**
- **Talent*Edge***
  - **Internships**
  - **Fellowships**
- **OCE/CQDM Explore Program**

COMMERCIALIZATION

- **Market Readiness Program**
  - **Market Readiness (Customer Creation)**
  - **Market Readiness (Company Building)**
- **Advancing*Health* Program**

ENTREPRENEURSHIP

- **On-Campus Entrepreneurship Activities**
- **Campus Linked Accelerators**
- **SmartStart Seed Fund**
- **Entrepreneurship Fellowships**
  - **Martin Walmsley Award for Entrepreneurship**
  - **David McFadden Energy Entrepreneur Challenge**
- **High School Competition**
  - **Young Entrepreneurs, Make Your Pitch**

PATHS TO SOSCIP

Methods	Industry Cash Contribution ($)	Includes ($)	Who can apply
Directly though SOSCIP	5K	0	Company and/or Academic
Talent Edge	25K	32K from OCE	Company and / or Academic
VIP I	5K	20K from OCE	Company + Academic
VIP II	25K	50K from OCE	Company + Academic
VIA Smart Computing R&D Challenge	100K	100K from OCE 200K from NSERC	Company + Academic

PROJECT RESOURCES & COSTS

What do I get?

- Project Development Support

- Computing Platforms

- Technical Expertise

- Project Funding

EXAMPLE CONTRIBUTIONS

Sample calculation:

	Gross Contribution ($)	Institutions Overhead ($) (35% example)	Net Contribution ($)	*NSERC CRD leverage ($)
Industry Cash	100,000	26,000	74,000	74,000
Industry In-kind	100,000	0,000	100,000	74,000
Total Industry	200,000	26,000	174,000	148,000

OCE: $100K
Company: $74K cash + $100K in-kind
NSERC: $148K cash

NOTE: The funding goes to the academic institutions to work on the company-define project

SMART COMPUTING R&D CHALLENGE

ACADEMIC & PARTNER ELIGIBILITY

Academic partner eligibility (Applicant):

- Full-time faculty member

- SOSCIP member academic institution

Industry partner eligibility (Project Partner):

- Ontario based company

- Large companies, as well as small-to-medium-sized enterprises (SMEs)

- Provide a 2:1 cash and in-kind match

PROJECT OBJECTIVES

- **Idea**: commercial applications

- **PI**: Appointed at one of SOSCIP member institutions

- **Company**: SME with R&D operations in Ontario

- **SOSCIP**: need for SOSCIP computing platforms

- **Training Opportunity**: support post-docs and graduate students

SMART COMPUTING R&D CHALLENGE

APPLICATION PROCESS

Stage 1: Submit an EOI to OCE

- OCE Business Development Manager will provide support

Stage 2: Submit a NSERC CRD or ARD application

- OCE Business Development Manager will provide support

- NSERC will provide feedback on 1st draft

SMART COMPUTING R&D CHALLENGE

TIMELINE

- Smart Computing Partnering Forum: 20th January

- EOI Deadline: 23rd February

- NSERC 1st Draft Deadline: 9th May

- NSERC Final Application Deadline: 6th June

- Project Start: October 2016

PLEASE CONTACT

OCE's HPC team:

Saira Meese-Tamuri, Business Development Manager
Saira.Meese-Tamuri@oce-ontario.org
416.861.1092 x 1052

Lenny Freilich, Business Development Manager
Lenny.Freilich@oce-ontario.org
416-861-1092 x1007

Ron Van Holst, Director, Research Development
Ron.vanHolst@oce-ontario.org
416-861-1092, x1021

IBM's Role in SOSCIP
SOSCIP Contractual Requirements and IP
SOSCIP Project Delivery Framework

Stephen Timms
Business and Operations Executive
IBM Canada Research and Development Centre (CRDC)
stimms@ca.ibm.com
(905) 316-4095

IBM Canada Innovation Ecosystem:
Timing is right to take advantage of opportunity

IBM Canada R&D Centre (CRDC) as a true innovation collaboration partner:

- Academia, Government and Industry Partners with IBM as model collaboration partners

- Researchers are indicating the infrastructure is speeding up research by years

- Discussion moved from 'procurement' to 'partnership'

- Developing special collaborative relationships and leveraging to incubators and other government sponsored initiatives

- Initiates a strong platform for growth

- Leverages our R&D investments for competitive advantage

IBM CANADA RESEARCH & DEVELOPMENT CENTRE

Working Together to Apply Big Data to Industry Challenges for 21st Century Competitiveness

What's Next?
- Continually Assess Approach
- Commit and Engage
- Focus on Outcomes

IBM

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SOUTHERN ONTARIO SMART COMPUTING INNOVATION PLATFORM

IBM's Role in the SOSCIP Innovation Ecosystem

Dedicated state of the art High Performance Computing and Big Data

- IBM BGQ Canada's #1 Supercomputer
- IBM Advanced Analytics Cloud
- IBM Agile Computing Site
- Large Memory System

IBM provided and supports globally-leading and unique HPC platforms:
- Simulate Real World
- Complex system modeling
- Fast design and prototyping
- Real time analysis/response

True Collaboration with Focus on Research Outcomes

- Academic Leaders
- Research and Innovation Outcomes
- IBM
- Research Framework on Economic Priorities
- Small-Medium Enterprises

IBM's role:
- Platform Specialists
- Project Mgmt Expertise
- Mentors
- Collaborators/Funding
- Research Assets and IP

High-value cross disciplinary analytics skills

- Analytics Curriculum Assets
- Campus Ontario
- Job Related Training Opps

IBM's role:
- Curriculum & Training
- Internships
- Job creation
- Mentors
- Academic Programs

Governance and Cross Team Support

Board of Directors
Scientific Advisory Committee
Agreements and Frameworks
Cross-Team Collaboration

SOSCIP
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COMPUTING INNOVATION PLATFORM

SOSCIP Research Projects - How We Document
Project Collaboration Agreement (PCA)

> **Standard PCA template used for all SOSCIP-sponsored research projects**

1. **General Terms and Conditions**
   - Start and end dates, Principal Investigator, publications, termination ….

2. **Statement of Work**
   - Project scope, goals, timelines, key milestones, co-collaborators, industry partners …..

3. **Participant Terms**
   - Confidentiality and non-disclosure, publications, IP (Academic Institutions may use their own templates, and have them signed if required)

4. **Intellectual Property (IP) Agreement**
   - Policy Statement
   - Background IP
   - Foreground IP

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SOSCIP Intellectual Property (IP) Policies

- **Background IP**
  - IP that was conceived, created or developed prior to the research project
  - Ownership is always retained by contributing party, and documented in PCA
  - Critical to SMEs and industry partners

- **Foreground IP**
  - IP that was conceived, created or developed during the research project
  - SOSCIP's mandate is to foster collaborative R&D projects, and to promote commercialization and knowledge creation
  - IP created **jointly by all Parties** during the project will be jointly-owned by all Parties
  - IP created **solely by one Party** during the project will be solely-owned by that Party
  - All of those Parties will be entitled to secure patents, design rights, copyrights, etc.
  - IBM participation:

Direct contribution by IBM (eg. IBM PostDoc allocated to project)	Joint-ownership of IP (same as all Parties)
No direct contribution by IBM	Non-exclusive license grant to use IP • <u>not</u> applicable on "Improvements" to Background IP • IBM may consent to terminate license after 1-year

  - **Note** - exceptions will apply in rare circumstances (eg. VIA Smart Computing Challenge program, and to comply with Contribution Agreement with Gov't of Canada)

- **Guidelines and Recommendations**
  1. PCA must be signed before access is extended to SOSCIP computing platforms
  2. Secure agreement on IP terms in advance from Co-collaborators and SMEs