Configure Your Research Platform: Infrastructure Needs for Embedded and Heterogeneous Computing

CMC MICROSYSTEMS

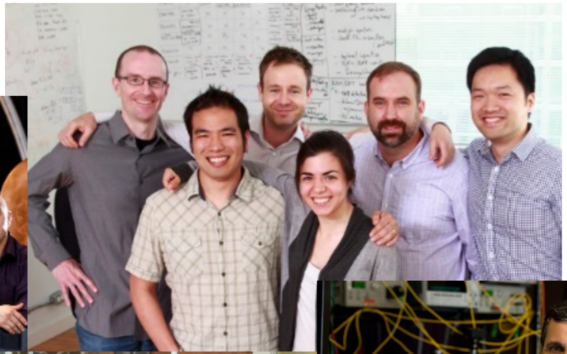
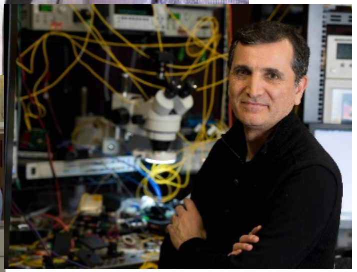
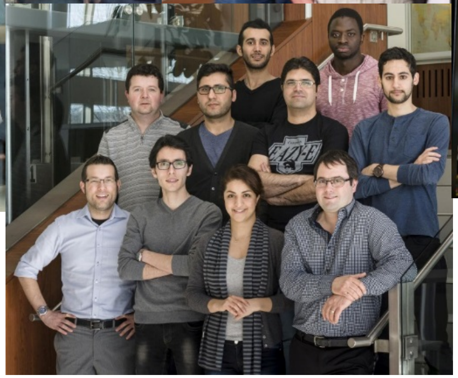
Objectives

- Obtain feedback on embedded and heterogeneous computing ***infrastructure needs*** for the Canadian research community, based on:
  - Research project needs
  - Skillsets required by industry
- Identify advisors, lead clients and early users of planned infrastructure offerings
- Identify research themes and related infrastructure that can form the basis of new funding proposals
- Gain insight on the CNDN Technology Roadmap which will influence development activities

What is CMC?

- Not for profit – federally incorporated 1984
- Creator and manager of Canada's National Design Network (CNDN)
- Delivers core micro-nano innovation capability to every region of Canada

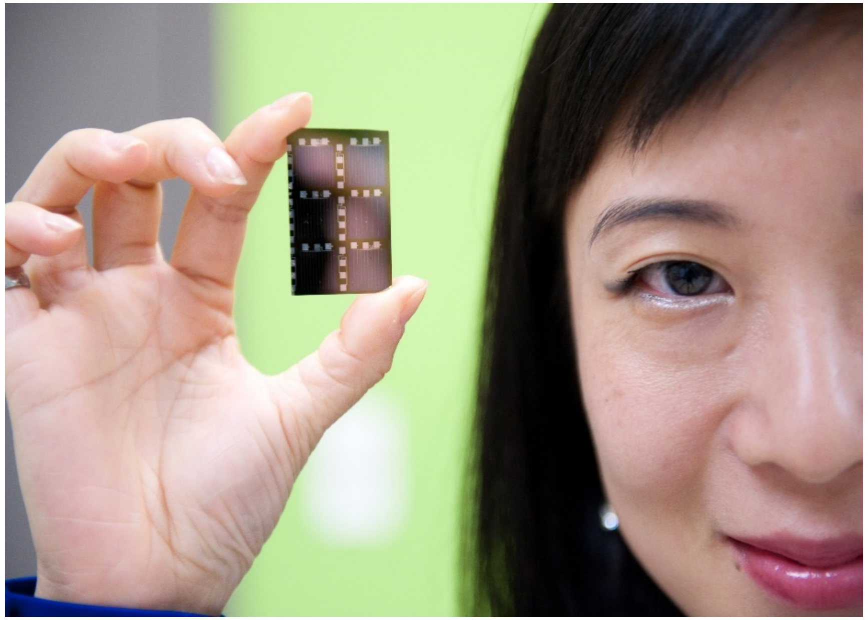


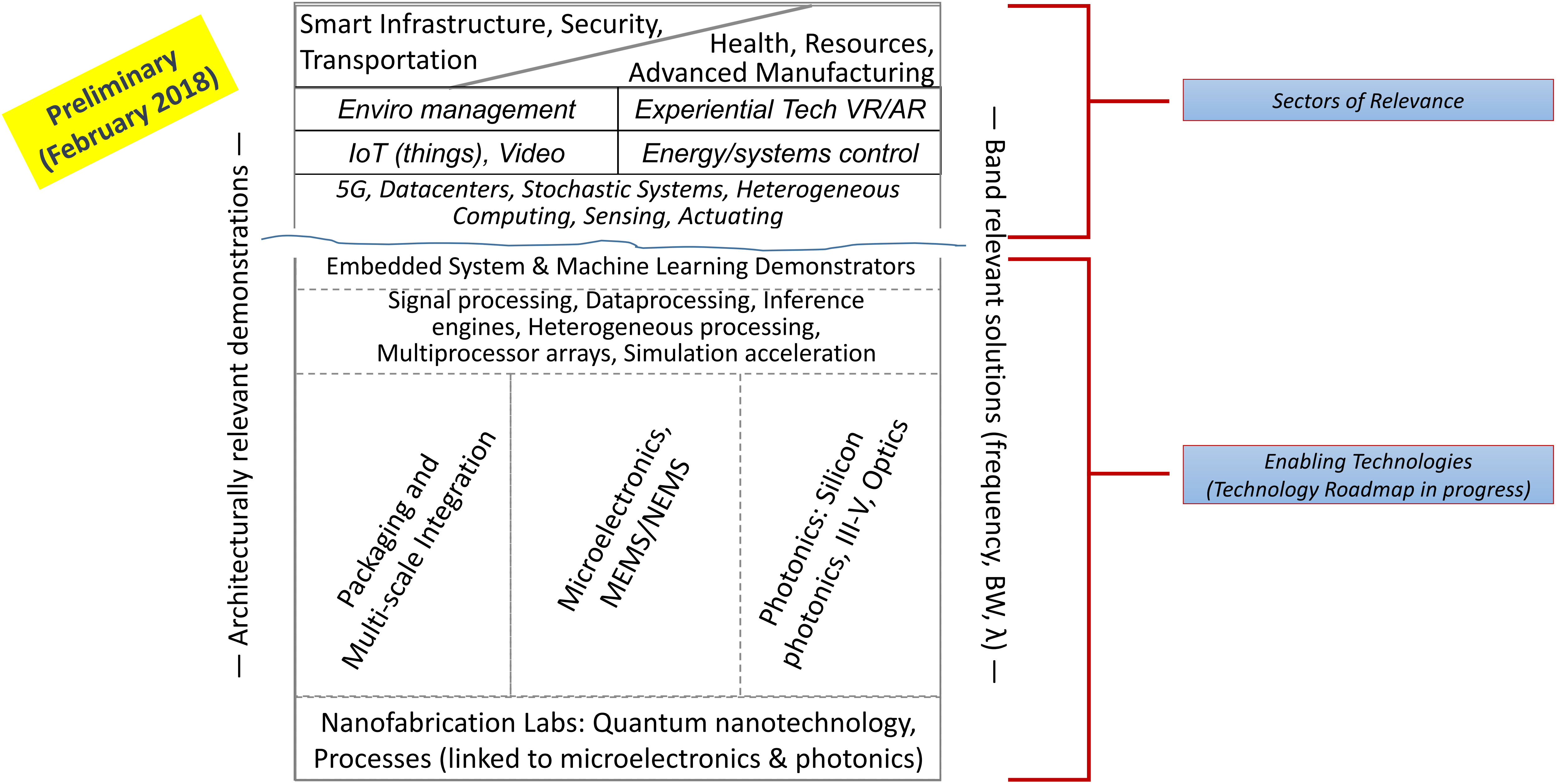
CMC Microsystems: Creator and manager of Canada's National Design Network since 1984

CMC delivers five key services to increase researchers' and companies' innovation capability in every region of Canada:

- Design tools (software)
- Fabrication services to create working prototypes
- Equipment & services for prototype testing
- Training and support
- Technology plan and roadmap



Canada's National Design Network Technology Space



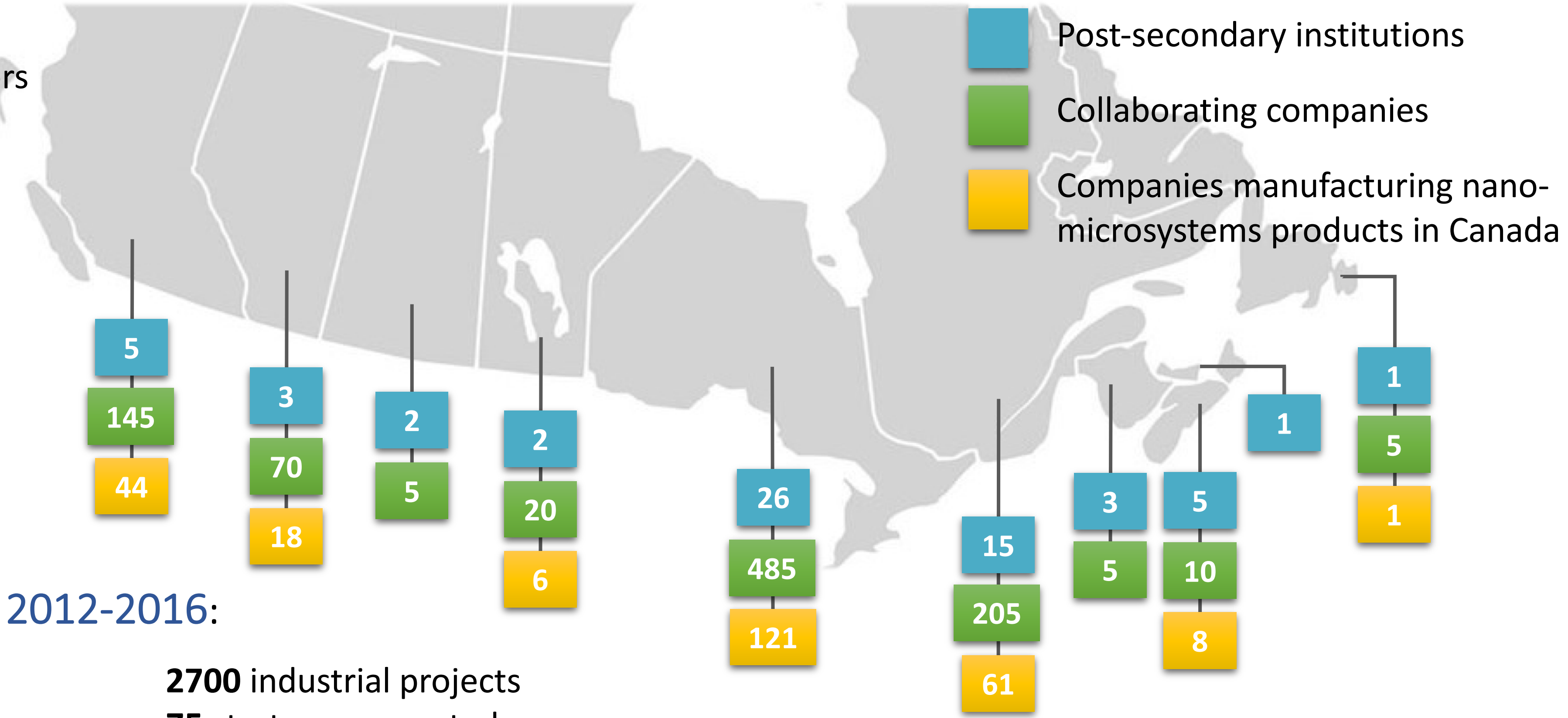
Canada's National Design Network

The National Design Network is a Canada-wide collaboration between **63** Universities/Colleges to connect **9400** academic participants with **950** companies to design, make and test microsystem prototypes

CMC Microsystems defines, develops and manages Canada's National Design Network®

Annually:

1150 connected professors
4000 researchers on professors' teams
5750 users of computer-aided design tools
350 physical prototypes
80 test equipment rental items otherwise unaffordable to users



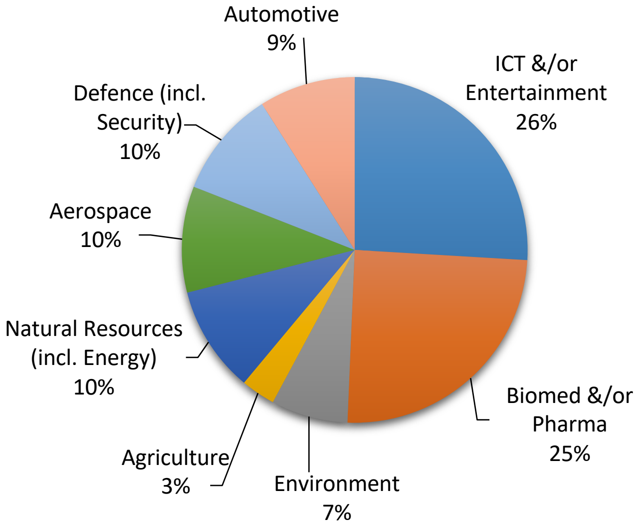
Five-Year Outcomes 2012-2016:

16000 publications
775 awards
950 patents awarded & applied

2700 industrial projects
75 startups supported
9350 researchers supported and **3050** moved to industry in Canada

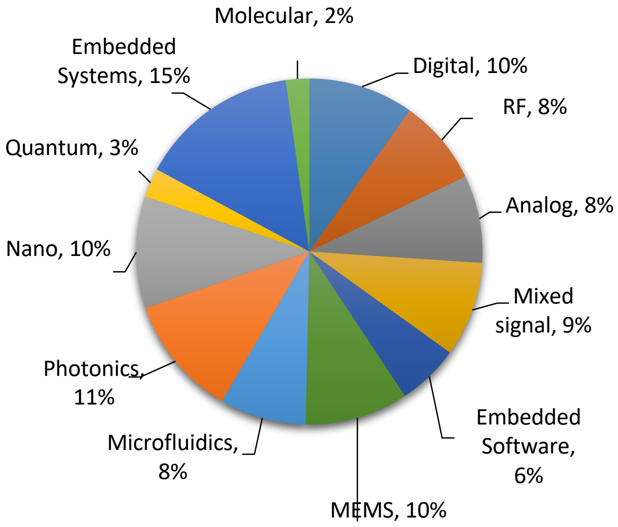
Canada's National Design Network
Academic Landscape 2016-17 (disciplines, research preferences)

Technology Application



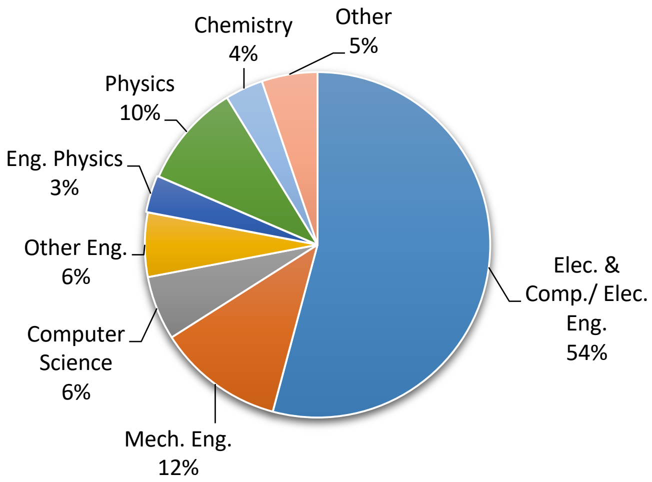
# of professors = 1060
# of interests = 2899

Design-Oriented Interests



# of professors = 1066
# of interests = 4338

Disciplines/Departments



# of professors = 1150

Global sources of essential microsystems technology to support research excellence in Canada

CMC engages strategically with selected organizations in Canada and worldwide

Save the Date!

Notez à votre calendrier !

OCTOBER
23-24, 2018
Toronto, Canada

Join us at Canada's largest gathering of micro-nano innovators!

Les 23 et 24
OCTOBRE 2018
Toronto, Canada

Venez au plus grand rassemblement d'innovateurs en nano et micro au Canada !

CMC MICROSYSTEMS

Innovation 360 and NanoCanada's 2nd National Conference
Innovation 360 et 2e conférence nationale de NanoCanada

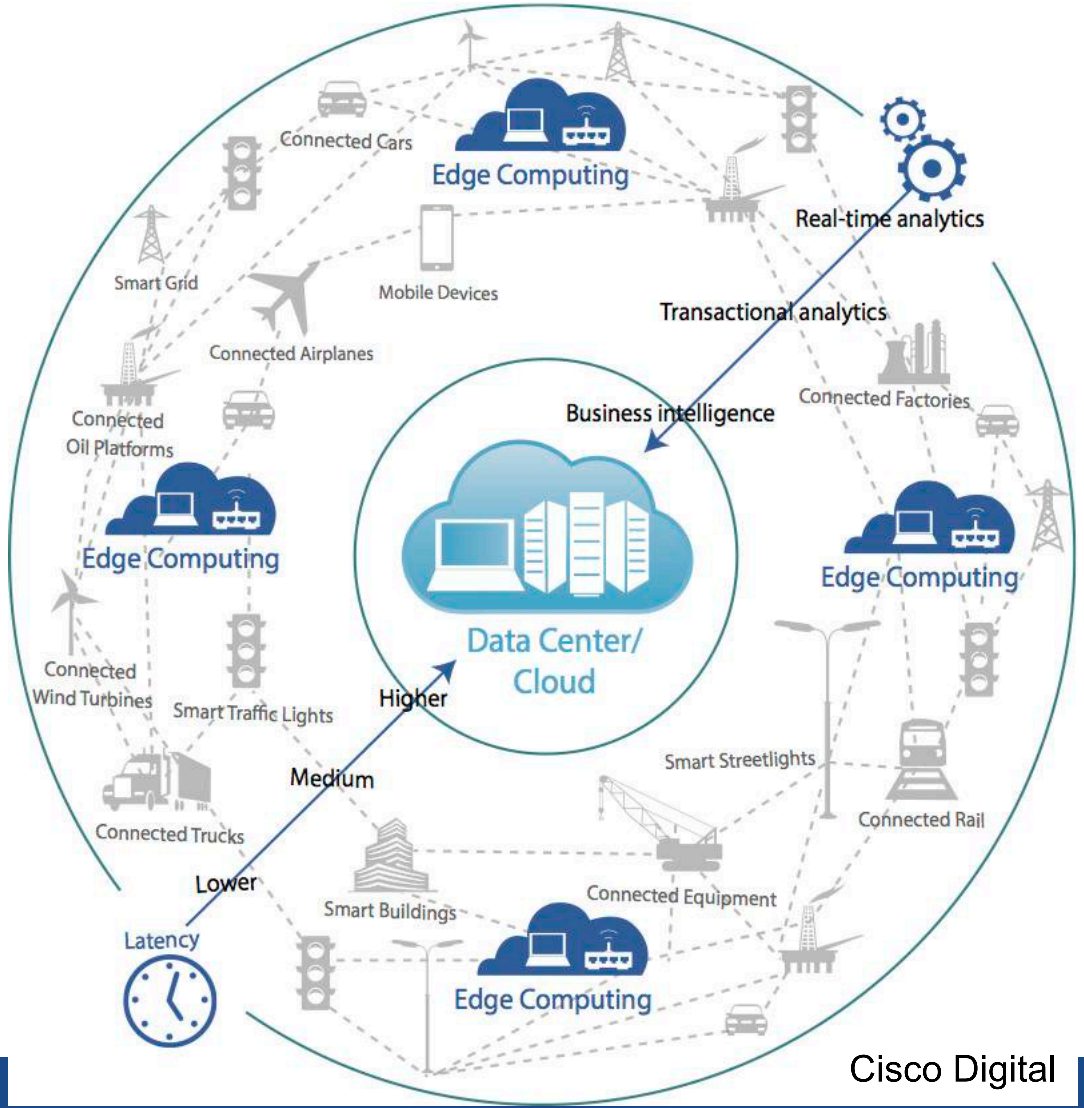
Innovation360.ca

NanoCanada

Embedded Systems Prototypes

CMC MICROSYSTEMS

Objective: Support Microsystems Research from Sensors, to the Edge, to the Cloud… and back



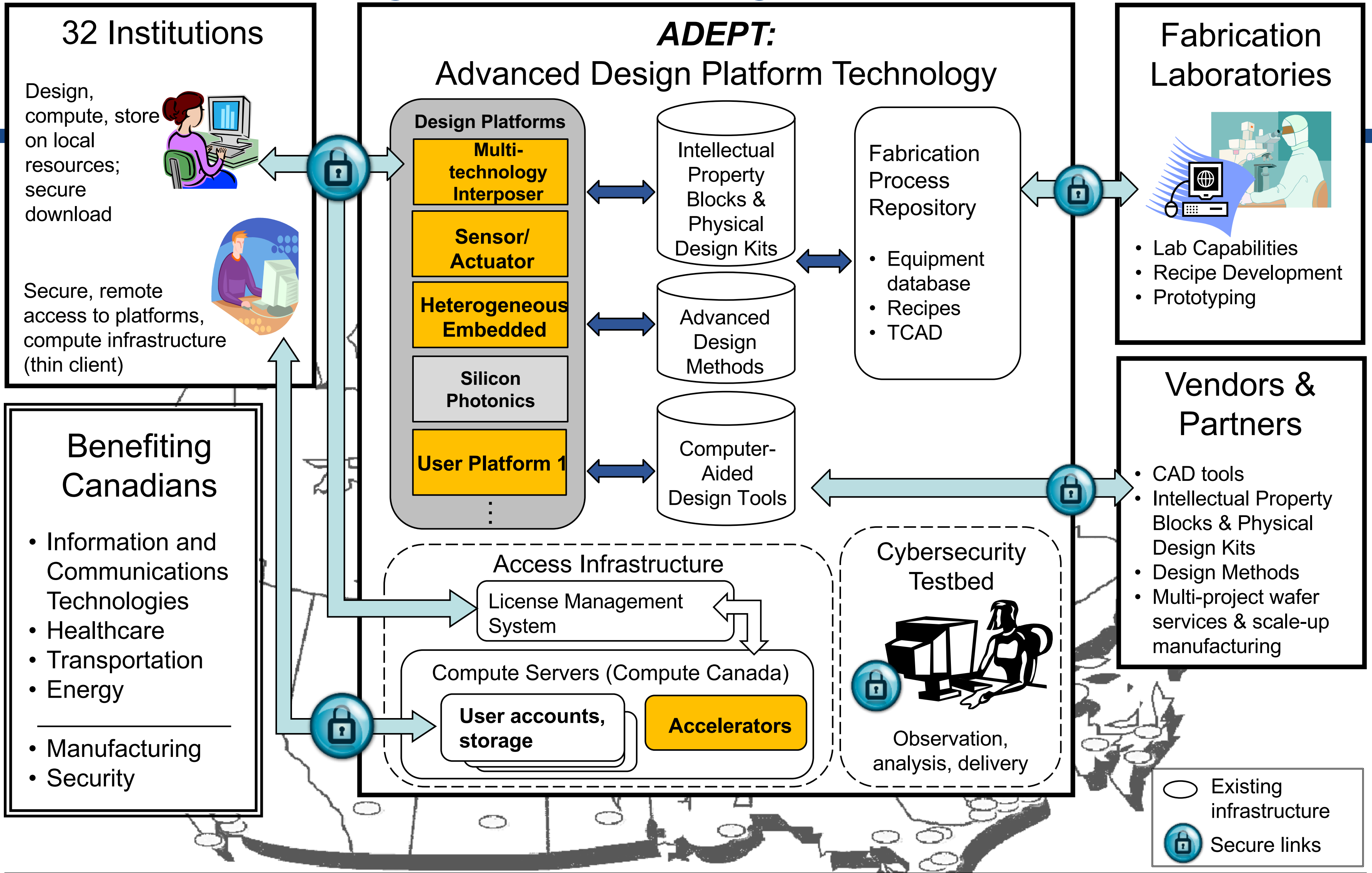
Cisco Digital

Sensor and Actuator Systems:
- Novel sensors/actuators
- Low power, energy harvesting
- Small form-factor, harsh environment
- Communications and WSN

Edge/Fog Computing:
- Machine learning
- Power-constrained processing:
  - Heterogeneous architectures
  - ASIPs and hardware accelerators
- Wireless/wired communications and networking

Cloud Computing:
- Machine learning
- High-performance computing:
  - Heterogeneous architectures
  - ASIPs and hardware accelerators
- Networking

ADEPT Project CFI Project

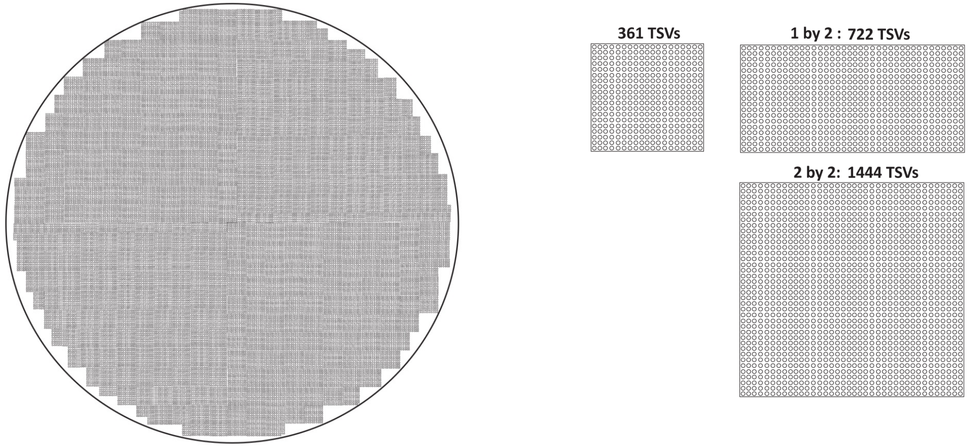


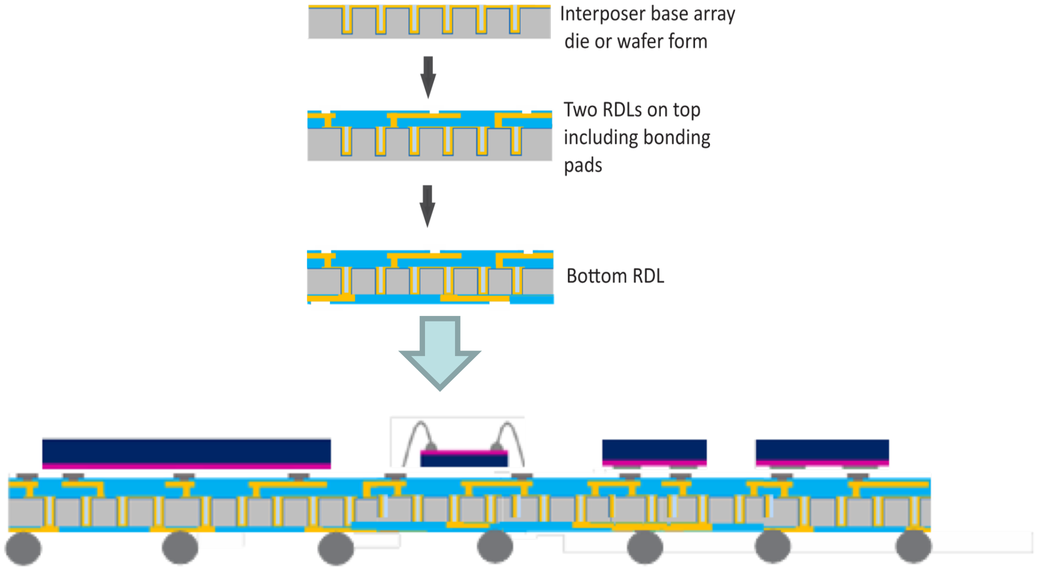
Canada's National Design Network – ADEPT Management & Operations

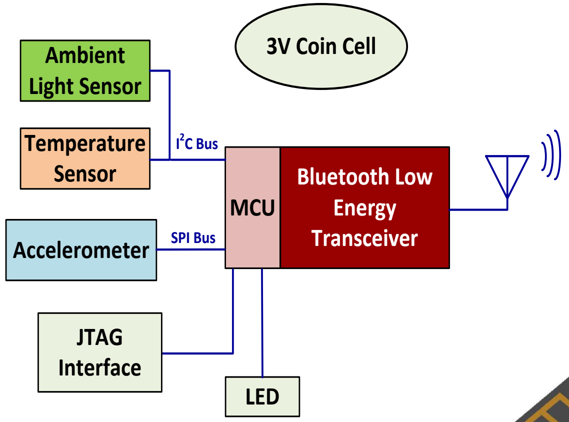
Includes software procurement, configuration, installation and delivery. Access and utilization management, engineering/technical support. Cybersecurity installations, secure testbed assistance and demonstrations. Train-the-trainer events. Advisory Group coordination. Governance, reporting, legal and financial administration.

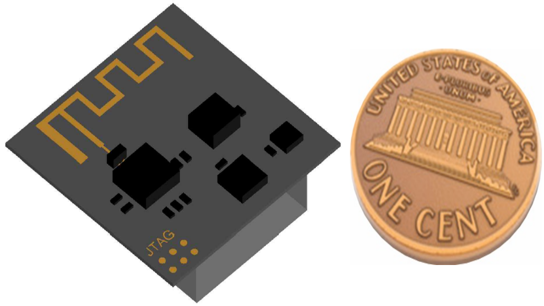
Current Tools/IP Offerings

Interposer Manufacturing Platform



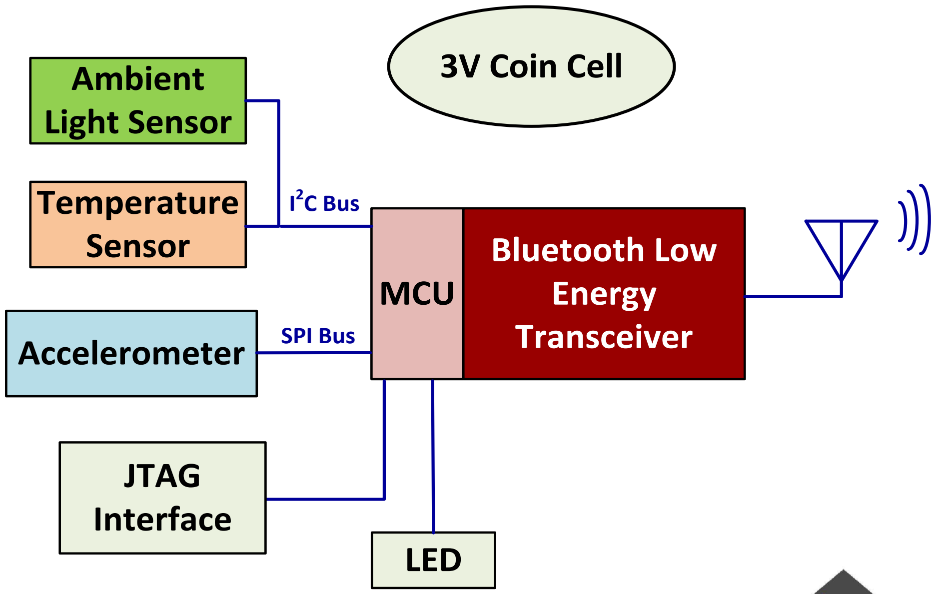


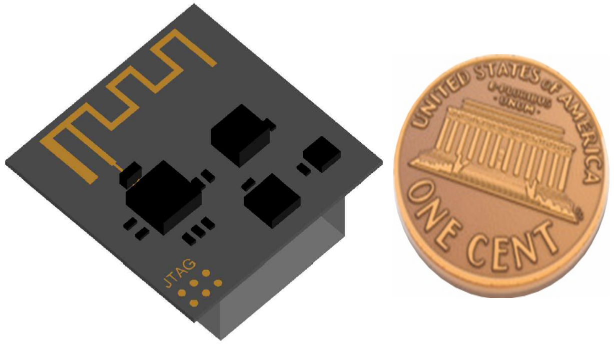


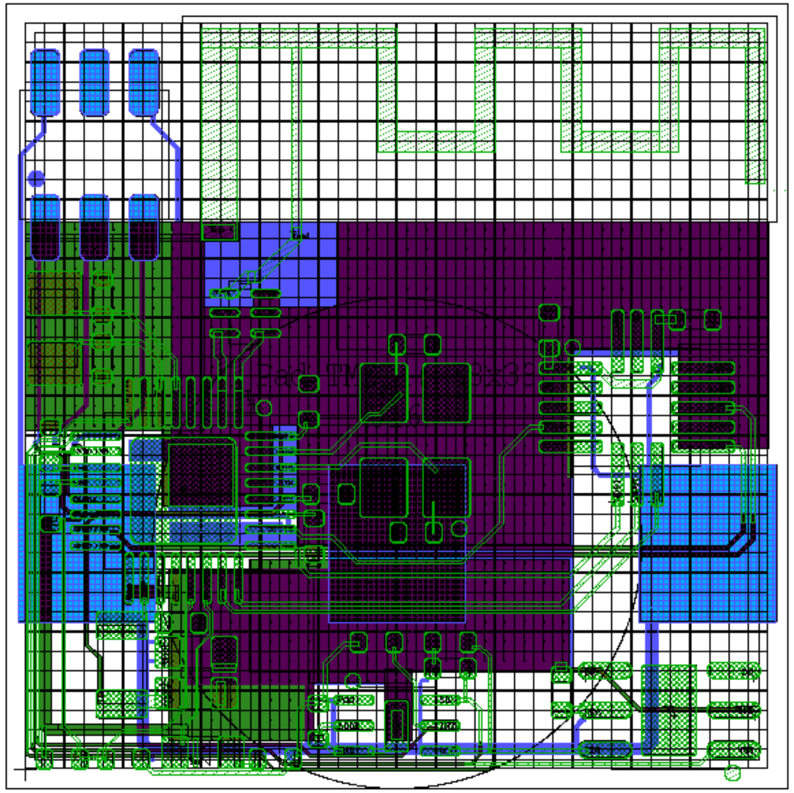


- Available:
  - PDK (Tanner L-Edit)
  - Test chip, reference designs
  - Documentation, training materials
- Expecting first prototypes April/May 2018
- Regular manufacturing service in 2018
- Contact CMC for more information

Sensor/Actuator Platform







Added Value

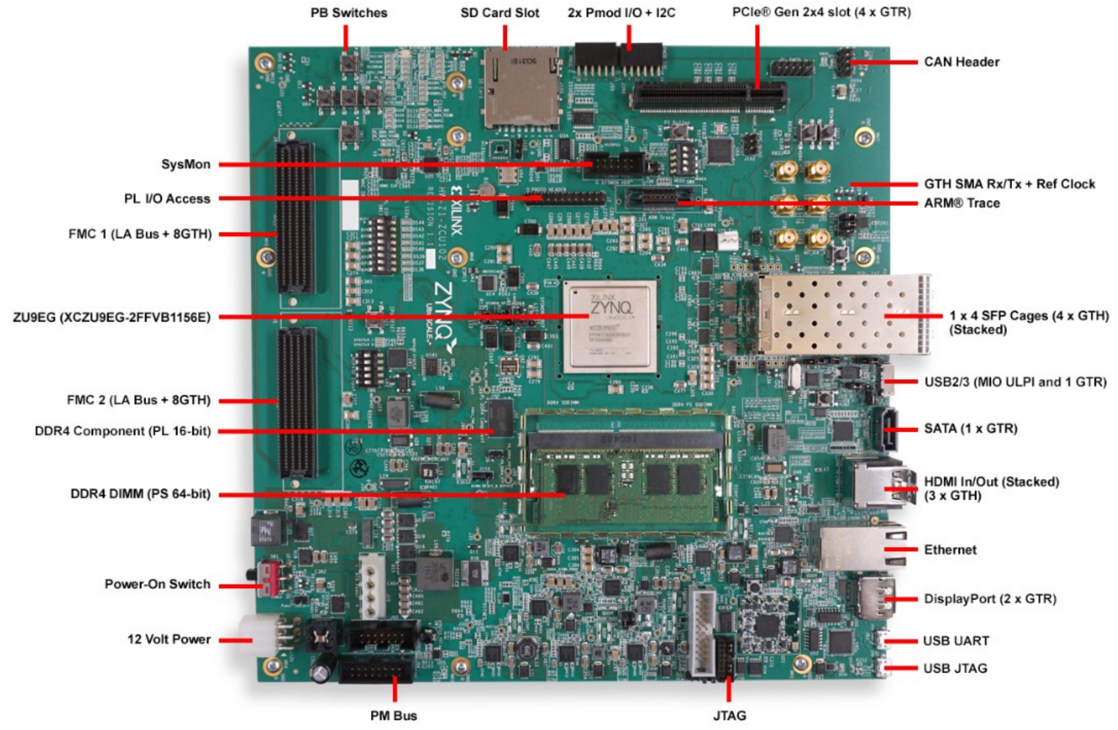
- Provide a design framework to demonstrate custom sensor/actuator in a working system
  - Validated embedded architecture, design flow, implementation & packaging service
- Software development
- Access to test and verification equipment (loan pool)
- Maintain stock of common off-the-shelf components
  - Gain access to components that an individual researcher may have difficulty sourcing (e.g., minimum quantities)
  - KGD/CSP: MCUs, FPGAs, ADC/DACs, etc.
- Training, user groups
- Demonstrate connectivity to edge/cloud computing infrastructure

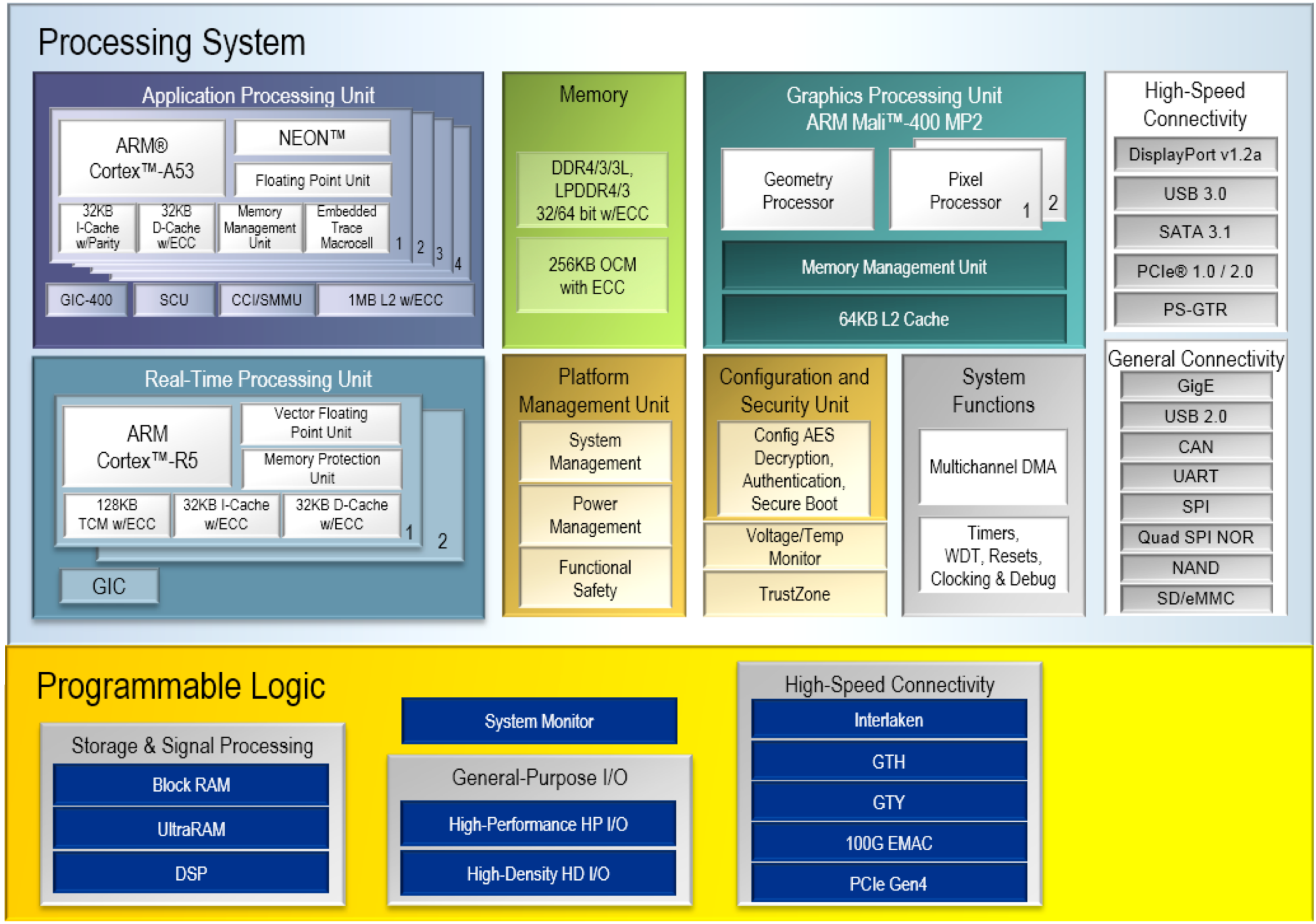
Development Systems Portfolio*

- FPGA development kits (Xilinx, Intel)
- FPGA accelerator boards (Xilinx, Intel)
- NVIDIA GPGPUs
- Intel Xeon Phi
- Heterogeneous Processing Platform
- Software-Defined Radio
- Microsystems Integration Platforms (National Instruments PXI instruments, FPGA)

* emSYSCAN development hardware available as a shared resource at institutions, for short-term loan through CMC equipment pool, or through remote access

Xilinx ZCU102 Zynq Ultrascale+ MPSoC Kit

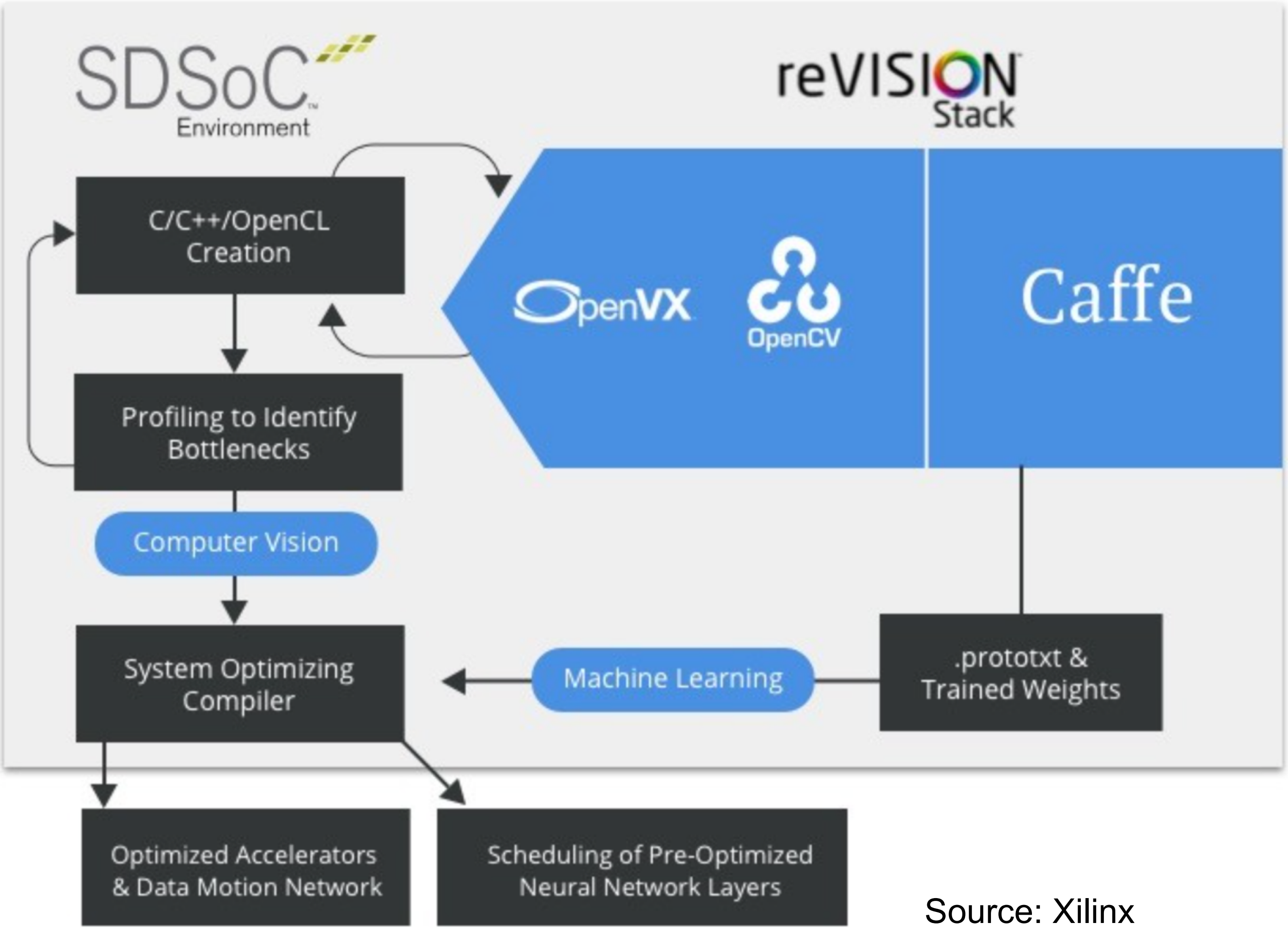




- Delivered to emSYSCAN institutions in January 2018
- Additional quantities will be available through equipment loan

Source: Xilinx

ZCU102: A platform to support machine learning demonstrations



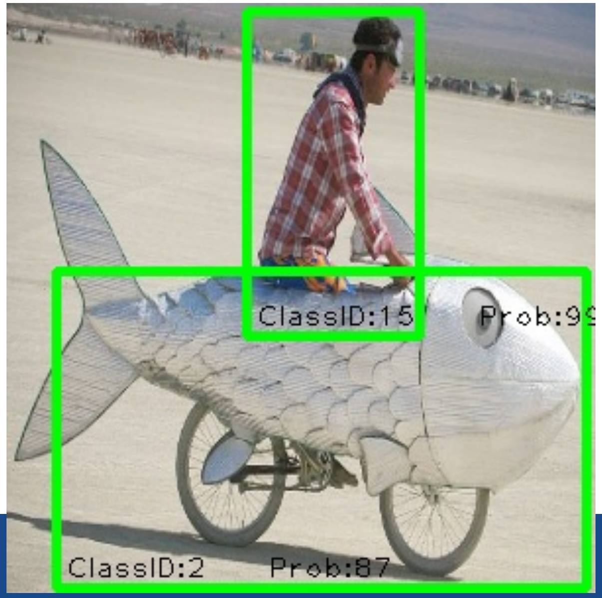
Source: Xilinx

ZCU102 (emSYSCAN)

ZCU102: CHaiDNN

- Xilinx HLS based Deep Neural Network Accelerator Library: https://github.com/Xilinx/CHaiDNN
- Source code for xfDNN lounge demos
- Example networks: AlexNet, GoogleNet, AlexNetFCN, SSD, VGG-16, Advanced ResNet50
- Build hardware/software for ZCU102 from scripts or in SDSoC 2017.4

Source: Xilinx

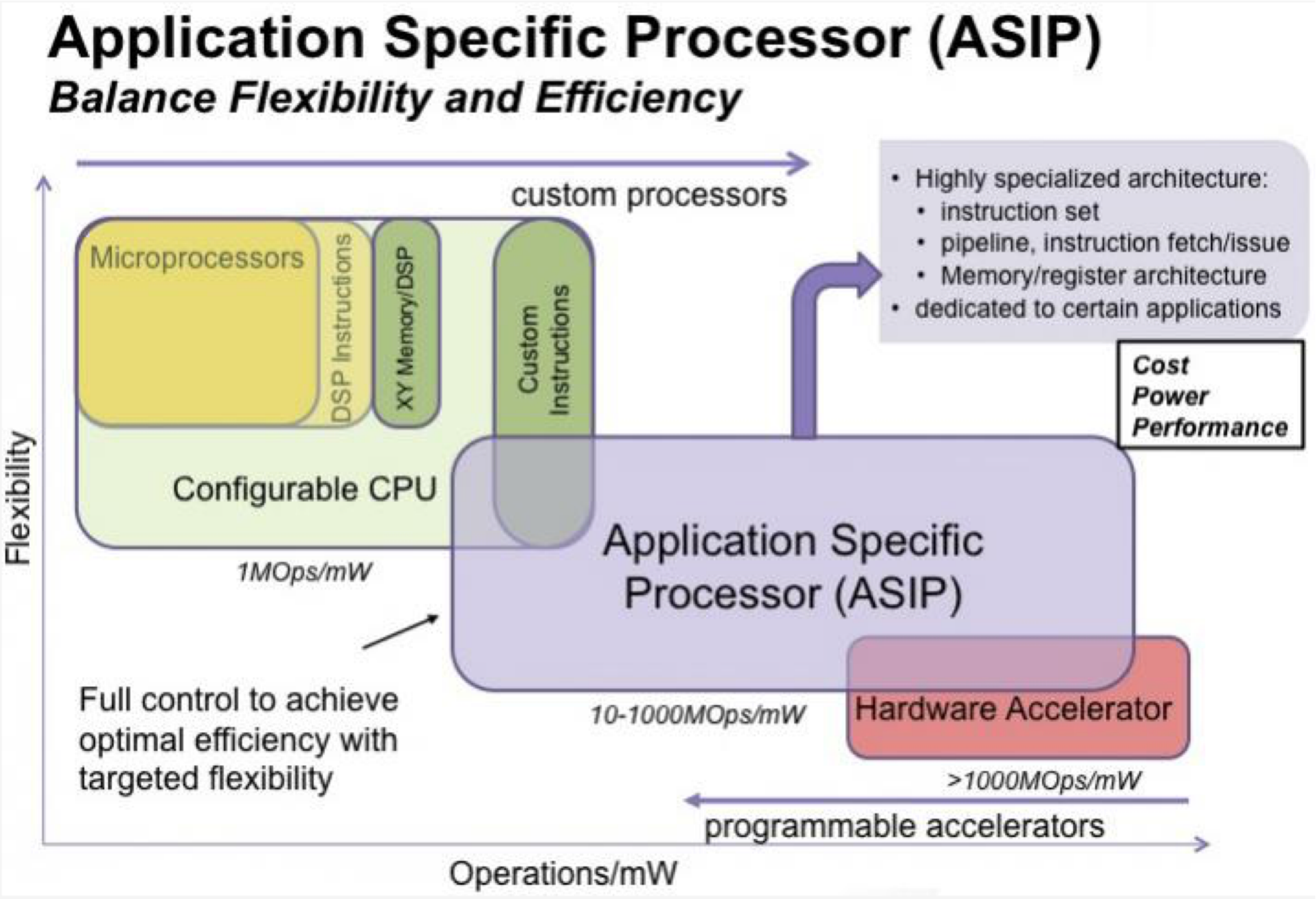


Added Value

- Common platform available on-site, through equipment loan
  - Enable collaboration, sharing results across research groups
- Maintain, support, update environment (tools, licensing, IP)
- Build, test, validate growing database of reference designs and examples
  - E.g., machine learning, interfaces & connectivity
- Training, technical support
- Demonstrate node/edge and edge/cloud connectivity and computing

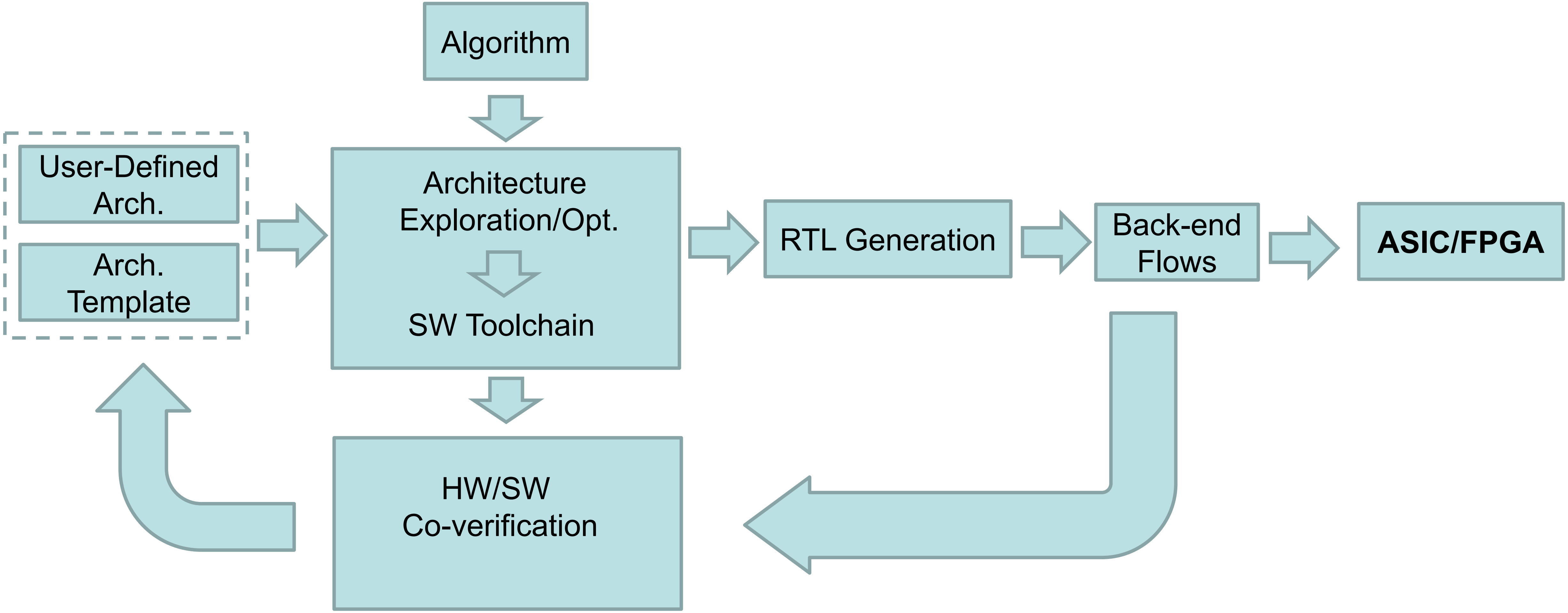
ASIPs: Application-Specific Instruction-set Processors

- Programmable microprocessor where hardware and instruction set are designed together for a specific application/function
  - Customized instruction set
  - Customized execution units/accelerators
  - Registers sized to data types of the tasks being performed
- Desired features:
  - Design processor architecture from scratch or through pre-built template
  - Architecture optimization
  - Automatic generation of SW toolchain
  - Automatic generation of synthesizable RTL (ASIC, FPGA)
  - Support for HW/SW co-verification



Source: https://www.semiwiki.com/forum/content/2767-how-design-lte-modem.html

Proposed ASIP Flow



Added Value

- Tool not part of a standard university program, difficult to access
- Larger pool of licenses available (team projects, courses)
- Develop links to implementation flows (FPGA, ASIC flow)
- Access to FPGA-based hardware for demonstration
- Technical support, design consultation
- Training

RISC-V

- Advantages in the academic (and industrial) environment
  – Free & open
  – Large, growing community
  – Low-cost development kits (e.g., Microsemi)
  – Easier path to commercialization
- What can CMC do to add value to what is already freely available? Can CMC provide a competitive advantage to CNDN researchers?
  – Support a common platform/environment; researchers get a jump-start
  – Support on CNDN tools (Cadence, Synopsys, Mentor Graphics, etc.)
    - Simulation, emulation, FPGA, ASIC
  – Acceleration of simulation, emulation (ADEPT HPC cluster)
  – Provide a path to prototyping through
    - ASIC fabrication services
    - Interposer manufacturing platform: bare-die RISC-V core

Open Discussion

Objectives

- Obtain feedback on embedded and heterogeneous computing ***infrastructure needs*** for the Canadian research community, based on:
  - Research project needs
  - Skillsets required by industry
- Identify advisors, lead clients and early users of planned infrastructure offerings
- Identify research themes and related infrastructure that can form the basis of new funding proposals
- Gain insight on the CNDN Technology Roadmap which will influence development activities

Infrastructure attributes

- Accelerates research – reduces time to publication, graduation, HQP
- Common/shared platforms
  - Useful across multiple research groups, projects, institutions
  - Develop once and replicate
- Difficult for an individual researcher to procure (cost, licensing, security, support)
- Is not (necessarily) research

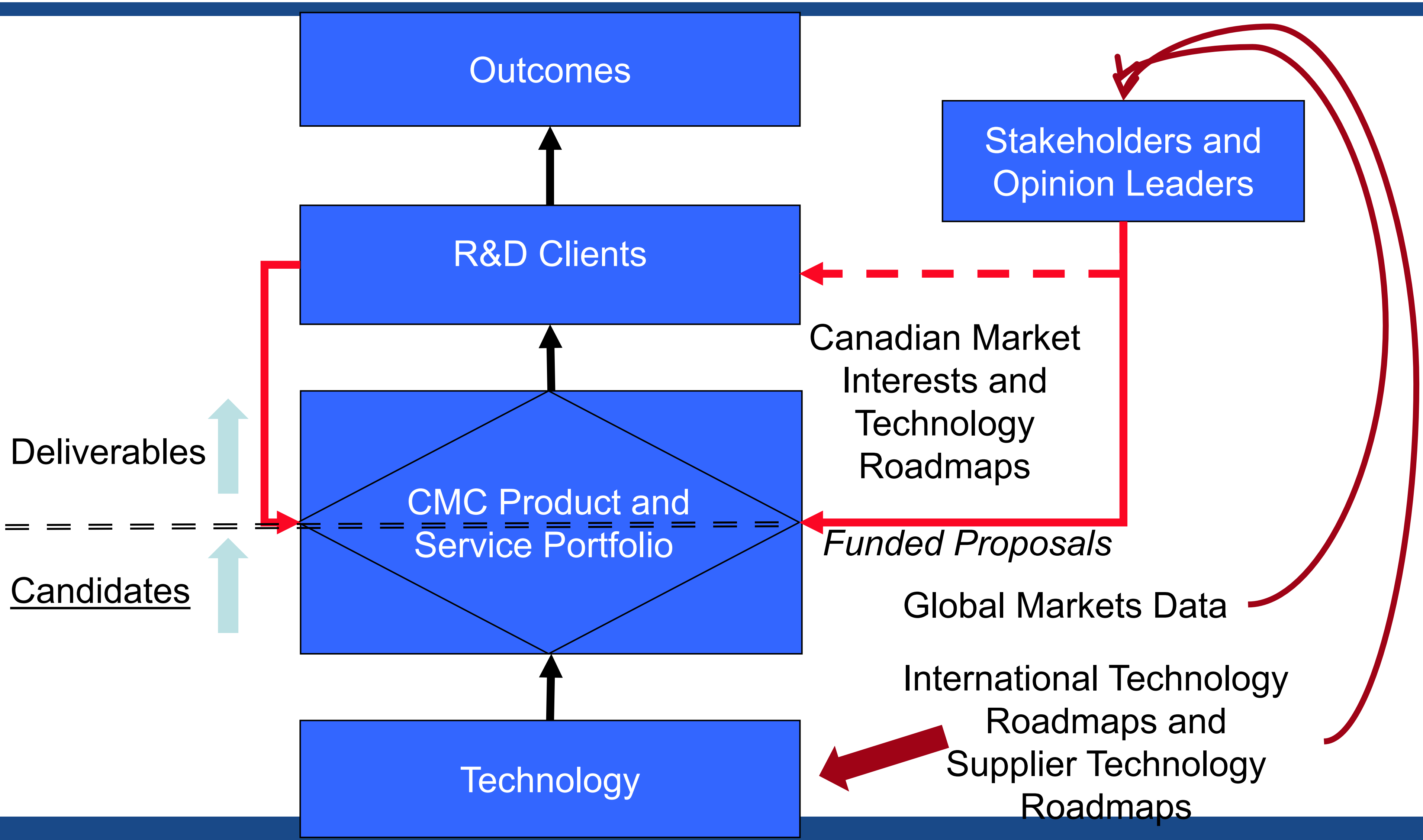
Questions

- What infrastructure is required to enable machine learning, sensor fusion at the node/edge? (Processors, ASIPs, accelerators, Tools, IP blocks, Reference designs, Datasets, Hardware platforms, Test/validation facilities)
- Is an ASIP tool relevant for your research? Do you want to be a lead client?
- What can CMC do to add value to to the RISC-V ecosystem? Can CMC provide a competitive advantage to CNDN researchers?
- What are critical training needs to use existing or proposed infrastructure?

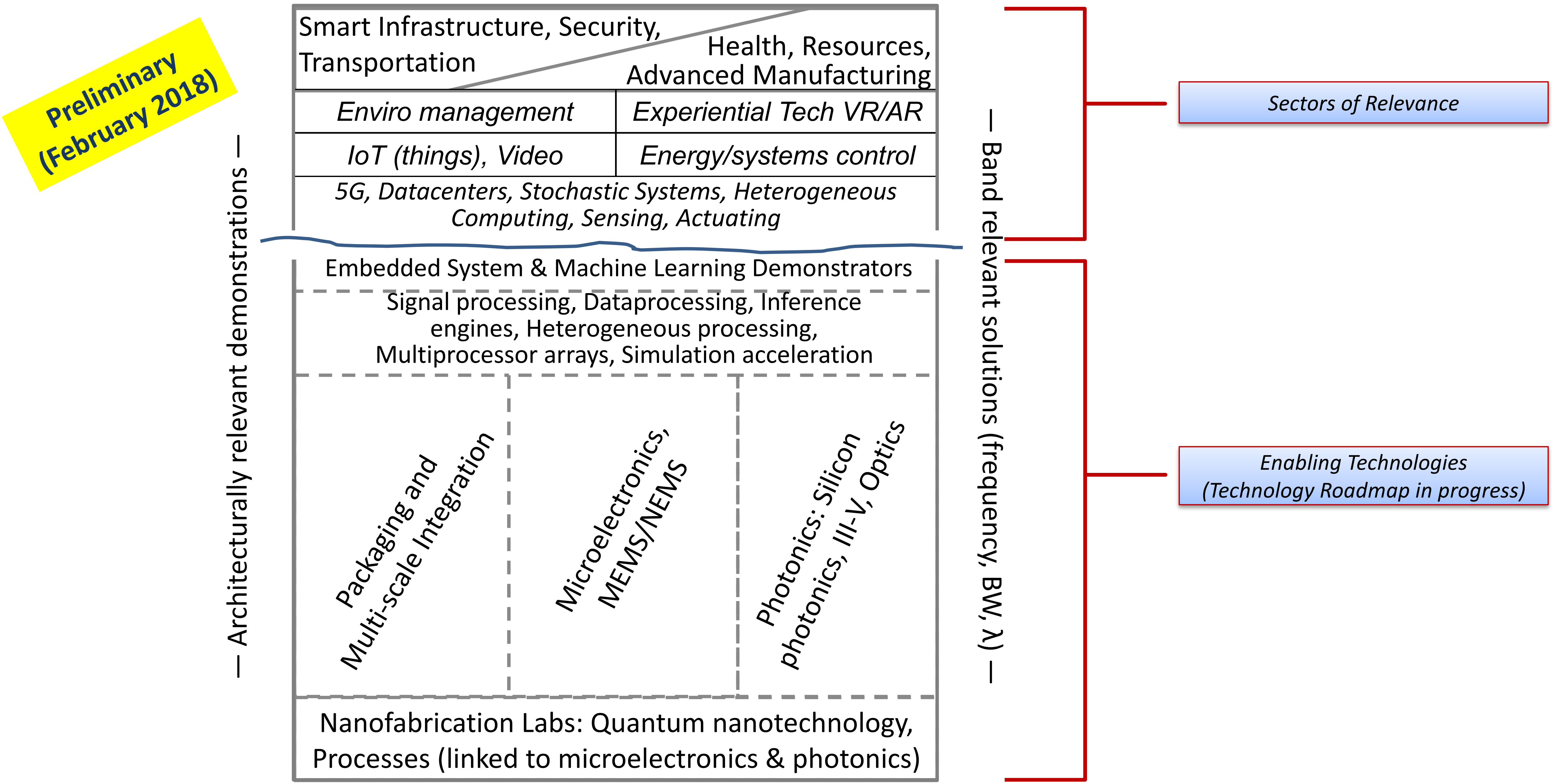
The Technology Roadmap of the CNDN

CMC MICROSYSTEMS

Add Value to Research, Technology Development and Demonstration



Canada's National Design Network Technology Space



Canada's National Design Network:

Indicative Drivers and Enabling Technologies

Drivers/Industry sector ⇦

- Advanced Manufacturing
- Mining, Oil & Gas
- Personalized Healthcare
- Security
- Smart Infrastructure
- Transportation

Drivers/Intermediate in value chain ⇦

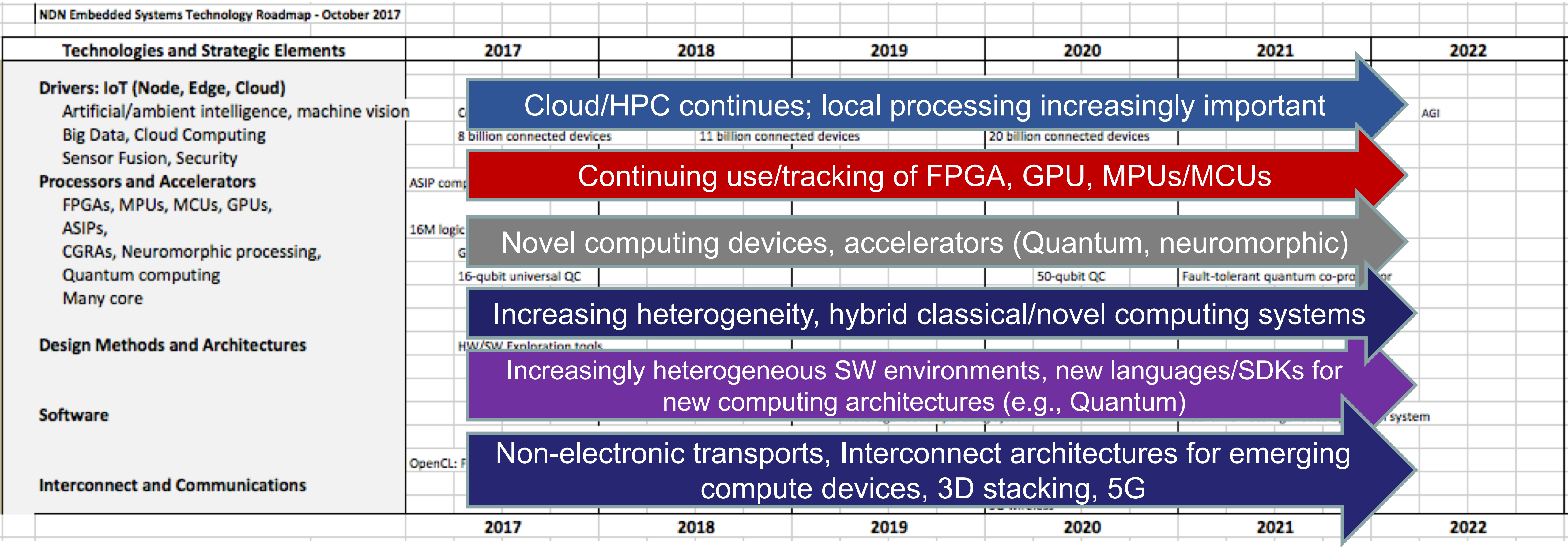
- AI
- Computing
- Embedded Systems
- Energy management
- Environmental management (Green)
- Experiential technology
- 5G and Data Centres
- Sensors & actuators

†Enabling Technologies

- Embedded Systems
- Microelectronics
- Photonics
- Quantum Nanotechnology
- MEMS/NEMS
- Packaging and multi-scale integration

† These are categories of enabling technologies: detailed advice about specific technologies within the categories was the focus of the workshop. Compiling the advice is a work in progress. The advice will assist in flavouring the CNDN platform.

Roadmap Trends



Questions

- Looking at 2018-2023, what are key technology trends for computing (node, edge, cloud)?
- What are the key applications/drivers?
- What new materials, architectures should CMC investigate/support (from a systems perspective)?
- How can CMC support quantum computing beyond the materials/physics community?
- What sources of roadmapping information do you recommend?

Thanks!

Contact:

Hugh Pollitt-Smith, CMC (Pollitt-smith@cmc.ca)
Yassine Hariri, CMC (Hariri@cmc.ca)