

# Centre of Expertise - Models Analysis

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## Centre of Expertise - *Models Analysis*



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## 1. Introduction

This report was commissioned by Defence R&D Canada (DRDC) to support its work in establishing the Institute for Research in Defence and Security (IRDS). A planned element of IRDS envisages the development of one or more Centres of Expertise (COEs) – sometimes referred to as Centres of Excellence - which are intended to mobilize and engage strategic external research partnerships with the academic, industrial, government and non-profit sectors. A guiding principle is that an organization such as DRDC cannot afford to develop in-house all the relevant expertise it requires to fulfil its mission and that needed expertise and resources exist outside of the organization, so that it may be more efficient and effective to further develop and tap into them.

DRDC will use information from the model analysis study to determine its level of engagement with the new COEs that it establishes under IRDS. In some instances it might decide to entirely build (and operate) a new COE to meet its needs. Sometimes it will collaborate with a new COE to acquire relevant knowledge, while in other situations it will choose to access the research that one or more new COEs produce. Regardless of the approach taken, the ultimate objective is to gain access to knowledge, expertise and/or infrastructure<sup>1</sup>.

## 2. Method

In collaboration with DRDC, Research Infosource Inc. identified an initial set of existing COEs that might serve as models for the planned DRDC centres of expertise. After additional research, the initial list was revised to include a “long list” that consisted of 19 COEs including (e.g. Consortium for Aerospace Research in Canada - CARIC) or programs that gave rise to COEs (e.g. the Tri-Councils’ Networks of Centres of Excellence (NCE) program). Detailed information was collected about each organization and submitted to DRDC officials for review.

Following feedback from DRDC, Research Infosource Inc. selected 5 COEs that were sufficiently different from one another and that could form the basis for future COEs that might be best suited to the IRDS. DRDC provided a set of research issues and questions to help flesh out the nature of the candidate COEs (Appendix 1). Research Infosource Inc. refined its analysis based on the DRDC requirements. A synopsis of each short listed COE is included in Appendices 2-6. The 5 analysed “short list” model COEs are:

- Consortium for Aerospace Research and Innovation in Canada (CARIC)
- Canadian Institute for Military and Veteran Health Research (CIMVHR)
- CMC Microsystems (CMC)
- Canadian Network for Research on Terrorism, Security & Society (TSAS)
- Tutte Institute for Mathematics and Computing (TIMC)

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<sup>1</sup> Infrastructure could include facilities or equipment.

The following table summarizes the reasons for including each COE model in the short list for analysis.

COE Model	Reasons for Inclusion
Consortium for Aerospace Research and Innovation in Canada (CARIC)	<ul style="list-style-type: none"> <li>● Strong industry leadership presents a good model for DRDC leadership of a sponsored COE</li> <li>● Strong focus on technology/product outcomes</li> <li>● Industry leadership in COE priority-setting and in research collaboration encourages relevant research and improved fielding of results</li> </ul>
Canadian Institute for Military and Veteran Health Research (CIMVHR)	<ul style="list-style-type: none"> <li>● Strong multi-disciplinary approach</li> <li>● Involves multiple researchers at multiple organizations</li> </ul>
CMC Microsystems (CMC)	<ul style="list-style-type: none"> <li>● Good example of an infrastructure-oriented COE</li> <li>● Leverages infrastructure in many technology directions</li> <li>● May align with future DRDC COE model that requires unique infrastructure</li> </ul>
Canadian Network for Research on Terrorism, Security & Society (TSAS)	<ul style="list-style-type: none"> <li>● Model that uses multi-agency government-determined priorities as the basis of a research program that is largely situated outside of government but directly relevant to departmental requirements</li> <li>● Strong multi-disciplinary focus</li> </ul>
Tutte Institute for Mathematics and Computing (TIMC)	<ul style="list-style-type: none"> <li>● Example of a COE model that deals with sensitive and/or secret research</li> <li>● Model is situated within government but involves outside expertise</li> <li>● Has a strong infrastructure component</li> </ul>

### 3. Findings

The following section expand on some of the key findings of our research to date, grouped according to DRDC’s key research issues and questions, provided in Appendix 1.

#### 3.1 Purpose

A key motivating factor in the establishment of Centres of Expertise is the need to build a critical mass of expertise and knowledge in a field of research deemed important by a sponsoring organization<sup>2</sup>. In this respect, Centres of Expertise (COEs) can be broadly grouped into two categories: COEs that are intended to develop a critical mass of expertise and research where none (or little) currently exists; and, COEs that are designed to link existing expertise across organizations in order to build or enhance a critical mass of researchers and research. COEs tend to be established in an academic setting (e.g. CIMVHR and TSAS), but there are examples of COEs being created in government with links to academia (e.g. TIMC).

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<sup>2</sup> For example, the Communications Security Establishment (Cryptography - TIMS) or Industry Canada (Aerospace - CARIC).

A key consideration in establishing COEs is that they have the potential to involve many researchers working in the same or allied fields. Bringing together different disciplinary perspectives, on the same or similar research issues can improve the quality of the research.

From the standpoint of sponsoring organizations such as DRDC one key benefit of COEs relates to cost. Whereas, in most instances there are alternative approaches to COEs (e.g. the same or similar results could be achieved by a program of contracts with external researchers to deliver specific research). In those situations the sponsoring organizations would need to pay for all direct (e.g. Principle Investigator (PI) salary) and indirect (e.g. university overhead) costs. However, a key cost advantage of COEs is that PI salaries (and often all or part of overhead costs) are covered by host universities. In these situations sponsoring organizations often need only to cover incremental costs (e.g. networking, travel) and student stipends. Against this, COEs often have permanent administrative offices and staff, and sponsors need to cover these costs.

COE sponsors typically ensure the continued relevance of COEs by laying out the key research themes, issues or questions that they are willing to invest in, and inviting interested researchers to submit competitive proposals to address these themes, within the framework of the COE. By adjusting research priorities from time to time sponsors can direct or re-direct the research being undertaken.

Another approach to ensuring relevance is that sponsoring organizations (such as the Federal Networks of Centres of Excellence) often impose artificial time limits on a COE program (e.g. 14 years in the case of NCEs), after which the COEs must become self-sufficient and in fact few ever do become self-sufficient.

### 3.2 Output

COE outputs typically include the standard “codified knowledge outputs” along with “embodied knowledge outputs”. Codified knowledge outputs include such things as: Academic Journal Articles, BlogBooks, Book Chapters, Conference Paper, Databases, Digital libraries, Policy Studies, Literature Reviews, Theses, Working Papers, Videos, Workshops, Conferences, etc. Embodied knowledge outputs consist of trained (graduate) students and professors with enhanced knowledge.

COE beneficiaries include “direct beneficiaries” and “indirect beneficiaries”. Direct beneficiaries are individuals – PIs and students - and organizations who receive money from the COE for direct or indirect research costs or (student) stipends<sup>3</sup> that enhance their career prospects or defray expenses.

Organizations that sponsor COEs may be direct beneficiaries of COE research, when that research yields such concrete results as patents, licenses, algorithms, best practices, student recruits, etc. However, in many instances sponsors are indirect beneficiaries of the research.

Non-sensitive (public domain) research is typically disseminated through traditional mechanisms: scientific journals, conference presentations, blogs, newsletters, etc. For obvious reasons, sensitive (secret) research is not widely disseminated.

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<sup>3</sup> Most COEs do not pay for researcher salaries. An exception is the Tutte Institute.

Intellectual property (IP) regimes vary widely. Typically, COE research conducted in an academic setting is subject to the IP policy of the participating universities. Some require IP to be university-owned, others researcher-owned, and some specify joint ownership. In circumstances where the research is fully paid for by a government department, the Crown may hold IP rights.

### 3.3 Funding

COE funding varies widely, depending mostly on the scale and scope of the enterprise. Funding levels may range from \$500,000 annually, to cover administrative and networking costs only, to \$5 million+ to additionally cover direct research costs. In most instances COE expenses do not include PI salaries (which are paid for by host universities) but may include student stipends. COE costs may or may not include a research overhead component paid to host institutions<sup>4</sup>. Typically, government sponsors pay for the NCE's cash costs (administration, research, networking) while private sector sponsors make in-kind contributions by covering their own collaborative research costs and by paying for staff time to participate in the COE.

### 3.4 Membership

COE membership may include researchers (PIs, co-investigators, students), companies, government departments and agencies, and non-profit organizations. In the case of COEs that are legally incorporated, membership has a formal definition – individuals who are eligible to elect directors of the COE. Each organization's bylaws would specify membership conditions.

In most instances there is no *a priori* definition of membership eligibility. Eligibility depends on the circumstances of individual COEs. Some COEs may establish a membership fee for non-academic organizations which gives those organizations the right to attend meetings and interact with researchers. However, there is no standard approach to membership and membership is often dealt with on an ad-hoc basis.

Membership allows outside organizations (such as DRDC) to interact with researchers and thereby gain an early look at research activities and outputs. In circumstances where the outside organization is sponsoring (i.e. paying for the costs of) the COE membership may be automatically conferred.

Corporate members are generically motivated by a desire to advance a field of research. Sometimes they seek direct benefits from their membership (e.g. technology). Often they expect only indirect benefits, such as improved national research capacity.

Individual members – i.e. researchers – join COEs for a variety of reasons; typical reasons include:

- Increased research resources
- Funding for graduate students
- Access to unique facilities or equipment
- Opportunity to network with leaders in their field
- Opportunity to enhance their resumes

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<sup>4</sup> Universities typically set standard overhead rates, but these are often subject to negotiation.

- Prestige
- Patriotism

Members may be recruited by a Project Leader (i.e. senior researcher) who invites them to participate. Or, they might be attracted by a notice of upcoming competition, from the institution's office of research services.

### 3.5 Infrastructure

Typically, COEs do not fund research infrastructure. Instead, they rely on the infrastructure already in place in members' own laboratories or their home institutions. One exception is the Canadian Microelectronics Consortium, which purchases or licenses infrastructure (in this case microchip design software) from suppliers on behalf of members. Another example is the Tutte Institute for Mathematics and Computing, which has an elaborate in-house research infrastructure.

Most COEs are networked organizations. Their headquarters (HQ) is established, typically, at an individual university whereas PIs are spread across the country. In the case of incorporated COEs the HQ may be located separate from a university.

Most COEs have an administrative infrastructure that handles day-to-day operation of the COE. Administrative offices can be as small as 1-2 individuals or as large as 15+. Administrative offices manage finances, research competitions, communications, liaison with sponsors and members, networking events, etc.

Few COEs handle secret research – most engage in public domain research (TIMC is an exception.) Where secret research is carried out, researchers are subject to standard security screenings and to related laws and regulations related to secrecy.

### 3.6 Governance

CARIC exemplifies a somewhat more elaborated governance structure than most, but most COEs have a variation on this structure:

- Permanent administration
- Board of Directors (18 members + designated observers)
- Executive Committee (10 members)
- Scientific Committee (project review)
- Strategic Committee
- Research Committee (all members) (Networking and project follow-up)

Funding decisions are usually based on competitive calls for proposal, which in turn are adjudicated by a Scientific Committee (or equivalent). COEs are often required to put in place formal conflict-of-interest policies to ensure fair treatment of research proposals. Partners communicate internally using standard techniques: emails, board minutes, web portals, meetings, symposia, conferences, etc.

## 4. Model Implementation

This section provides several observations and recommendations for consideration in the development or implementation of a centre of expertise using the DRDC's current modes of interaction of build, collaborate and access.

### 4.1 Model 1 - "Build-mode CoE"

In this mode of interaction, a COE is built internally "in-house" within a strictly DRDC-controlled environment. Some of the traits and characteristics of this model include the following.

- Most appropriate for classified research
- All participants require security clearances: may complicate involvement of foreign nationals; may discourage some academic researchers
- May be best approach when specific milestones, deliverables are required
- Can be extension of current DRDC lab programs with existing reporting structure, or new programs within DRDC lab with new reporting structure
- Academic involvement more problematic - Difficult to reconcile classified research with academic objectives, academic involvement (theses, publications, promotion, tenure)
- Governance according to standard DRDC/GOC practices and procedures
- Membership primarily civil servants supplemented by selected companies and academics
- May be appropriate for involving other government departments (OGDs)
- DRDC responsible for all administrative functions and costs (using existing resources)
- Most costly option - In-house COEs require DRDC to cover all direct and indirect costs
- Can utilize contracts for PI and industrial involvement
- Can utilize existing DRDC infrastructure
- Preferred model where major new infrastructure required for COE operations (vs. university-owned infrastructure)
- Easiest to handle IP issues – de-facto IP ownership by GOC
- Minimal impact on external recruitment
- In-house COE lessens need for tools to attract academia

### 4.2 Model 2 - "Collaborate-mode CoE"

In this mode of interaction, a COE exploits the collaborative approach of the reciprocal exchange of personnel and ideas within DRDC and its CoE partners. Some of the traits and characteristics of this model include the following.

- Can handle a combination of classified and unclassified research; however, requires "Chinese wall" arrangements for classified work
- Unclassified research component can facilitate academic involvement: Can be structured to be compatible with thesis requirements, promotion and tenure
- Governance according to standard DRDC/GOC practices and procedures
- Membership primarily civil servants supplemented the selected companies and academics

- DRDC can off-load some costs to PIs' academic institutions, especially PI salaries and overhead (short term projects only)
- Requires institutional agreements for longer-term PI involvement
- Reciprocal exchange of personnel is complicated presumes physical location for COE at which (DRDC) personnel would be stationed and may require institutional agreements
- Model may be appropriate for involving OGDs
- May still require DRDC financing of student and postdoc as well as scholarships and stipends
- Moderate impact on external recruitment
- Complicated IP arrangements - IP ownership may need to be negotiated between government of Canada (GOC) and multiple institutions
- Relies on installed infrastructure at DRDC, external organizations where DRDC infrastructure can encourage external PI collaboration
- Collaboration does not necessarily require an institutional framework and can be achieved by DRDC membership in external COEs

#### 4.3 Model 3 - "Access-mode CoE"

In this mode of interaction, a COE is exclusively geared toward the access mode of interaction and it is at an arm's length of DRDC, as it is developed externally to DRDC. Some of the traits and characteristics of this model include the following.

- Most appropriate for long term capacity building
- Difficult to specify milestones and deliverables and better in specifying research themes
- Typically focus on early-mid stage technology readiness levels (TRLs)
- May be legally incorporated
- Governance provided by independent body (committees) with likely no official DRDC governance role
- Requires full-time administration resulting in added costs
- Outside organization handles administration where DRDC liaison still required
- Most cost-effective option - DRDC pays a "membership fee" and incremental sponsored research costs for specific projects
- Typically funded through grants and contributions
- Maximum potential for external human resource (HR) recruitment
- Sufficient level of research funding/activity required to offset high administrative overhead
- Relies entirely on installed infrastructure at external organizations

### 5. General Points for Consideration in COE Model Development

- COEs require long term commitment and seldom yield short term outputs or results
- Need to distinguish between COEs for results delivery vs. COEs for capacity building
- Need to determine desired outputs/outcomes in advance (e.g. capacity, recruitment, science and technology) in order to focus research programs and projects
- Research requirement will determine selection of COE model
- DRDC need for specified milestones and deliverables will influence selection of COE model

- DRDC may need dedicated liaison/knowledge translation unit/PYs to oversee relations with external COEs
- Close link between level of DRDC control, level of funding and the ability to specify milestones and deliverables
- TRLs can be used to specify desired technology outputs and COE requirement
- Academic involvement is predicated on potential to achieve academic goals and priorities – primarily need to produce theses and publications that lead to degree attainment, promotion and tenure
- Explicit HR/recruiting path should be established for each COE model
- New budget envelope required for COE program may require agreement by Privy council office (PCO), Finance, treasury board of Canada secretariat (TBS)
- Challenge of reconciling annual GOC budgeting with need for long-term commitment to COEs (advantage of external COEs)
- Respected Scientific Leader can help attract PIs
- Involvement of federal Granting Agencies (NSERC, CIHR, SSHRC) in managing COE competitions and administration can lend credibility and avoid perception of competition
- Building on existing external COEs lowers DRDC overhead costs
- Different funding mechanisms often better suited to different outputs/results: e.g. Grants (long-term/undirected), Contributions (medium-long term/semi-directed), Contracts (short-medium term/directed)
- High success rates (in research competitions) will encourage academic participation in research competitions; vice versa also applies
- New mechanism to confer academic prestige/status would aid in recruiting academic participants: e.g. “Fellow (senior, junior, associate) of the Institute for Research in Defence Science”
- COE reporting lines need to be clarified reporting to DRDC Corporate, DRDC lab directors, or separate reporting structure
- Canadian defence industry too small to assure major COE funding financial self-sufficiency of COE highly unlikely under any circumstance, thus ongoing government subsidy required
- IP issues need to be resolved prior to establishing arm’s-length, collaborative, or access COEs
- Internal COE can conform to standard DRDC/GOC reporting and evaluation requirements
- External COEs require specified reporting and evaluation milestones systems

## Appendix 1. Key Research Issues and Questions

<p><b>1. Purpose</b></p> <ul style="list-style-type: none"><li>a. Why does the CoE exist?</li><li>b. In what way the CoE is unique (is or could its function be fulfilled elsewhere)?</li><li>c. How is the continued relevance of the CoE assured?</li></ul>
<p><b>2. Output</b></p> <ul style="list-style-type: none"><li>a. What does the CoE produce (e.g. expert opinion, trainees, publications, activities...)?</li><li>b. Who benefits from the output of the CoE?</li><li>c. Is the output beneficial indirectly to others?</li><li>d. How is output disseminated externally (e.g. publications, workshops, symposia)?</li><li>e. How is IP handled/shared?</li></ul>
<p><b>3. Funding</b></p> <ul style="list-style-type: none"><li>a. What is annual budget of the CoE?</li><li>b. Where does funding come from?</li><li>c. Do members provide funding (cash or in kind)?</li><li>d. What are funds spent on?</li></ul>
<p><b>4. Membership</b></p> <ul style="list-style-type: none"><li>a. Who are the members (e.g. academics, government, ...)?</li><li>b. How is membership organized?</li><li>c. How is the membership size (critical mass of expertise) determined?</li><li>d. How are members selected (describe process)?</li><li>e. How are the members recruited (attracted)?</li><li>f. What are benefits of membership?</li><li>g. What motivates members?</li></ul>
<p><b>5. Infrastructure</b></p> <ul style="list-style-type: none"><li>a. Where is the CoE situated (physical footprint, virtual)?</li><li>b. Where are directors/administrators located relative to other partners?</li><li>c. What is central infrastructure, what is total infrastructure?</li><li>d. Is secret/sensitive work carried out, and if so where and how is secrecy maintained?</li></ul>
<p><b>6. Governance</b></p> <ul style="list-style-type: none"><li>a. Who leads the CoE?</li><li>b. What direction structures exist?</li><li>c. What administrative structures are in place?</li><li>d. How are decisions on activities made?</li><li>e. How are funding decisions made (e.g. internal/external peer review)?</li><li>f. How to partners communicate internally?</li></ul>

## Appendix 2. COE SWOT Analysis by Feature-CARIC

COE SWOT ANALYSIS BY FEATURE				
CARIC				
Feature	Strengths	Weaknesses	Opportunities	Threats
<p><b>Purpose</b></p> <ul style="list-style-type: none"> <li>• To facilitate communications and collaboration among aerospace companies, researchers and academics</li> <li>• Extension of CRIAQ model to rest of Canada.</li> <li>• To provide financial support to collaborative R&amp;D projects.</li> <li>• To launch initiatives whose primary purpose is to serve as catalysts for collaboration that can help to overcome the silo effects and promote faster, more relevant R&amp;D</li> <li>• Based on CRIAQ model; extends local model nationally</li> <li>• Continued relevance through the biennial CRIAQ Forum: Industries are invited to propose collaborative research</li> </ul>	<ul style="list-style-type: none"> <li>• Involves many companies, educational institutions</li> <li>• Builds on CRIAQ experience, reputation</li> <li>• Has national scope</li> <li>• Facilitates multiple forms of industry/university collaboration</li> <li>• Refreshes mission periodically in response to industry requirements</li> <li>• Focuses on intermediate TRLs; leaves product development to firms</li> <li>• Structured to handle industry-confidential work</li> </ul>	<ul style="list-style-type: none"> <li>• Ambitious mission requires ambitious resources and administration</li> <li>• Works for narrowly-defined industry sector with relatively few players; may not work for industry sectors with many players</li> <li>• Smaller industry players may resent domination of large firms</li> <li>• Depends on firms to translate intermediate stage TRLs to products, services</li> <li>• Not structured to handle classified research</li> </ul>	<ul style="list-style-type: none"> <li>• Potential large payoff in product competitiveness, environmental impacts, etc.</li> <li>• DRDC opportunity to leverage CARIC research, organization</li> </ul>	<ul style="list-style-type: none"> <li>• Depends on primarily addressing needs of 2 major players (Pratt &amp; Whitney, Bombardier)</li> <li>• Withdrawal of 1 major player could disrupt network</li> </ul>

**COE SWOT ANALYSIS BY FEATURE  
CARIC**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>projects based on their needs and the challenges facing the aerospace industry. Researchers are invited to take note of these needs and to form work teams.</p> <ul style="list-style-type: none"> <li>• COE model is unique in the extent of industry involvement in setting requirements and in commercializing results. Function could not be fulfilled elsewhere.</li> <li>• CARIC focuses on TRLs 4-5. (CRIAQ focuses on TRLs 1-3)</li> <li>• Secret work per se is not carried out, but industry-confidential work is.</li> </ul>				
<p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Proprietary Information will not be disclosed without having obtained the prior agreement of the disclosing party and will be treated by the receiving party with the same degree of care with which the receiving party</li> </ul>	<ul style="list-style-type: none"> <li>• Gives companies IP control</li> <li>• IP control encourages participation (foreground technology)</li> <li>• Recognizes company IP contribution (background technology)</li> <li>• Industry partners receive worldwide technology</li> </ul>	<ul style="list-style-type: none"> <li>• Difficult to validate, enforce IP rights, agreements</li> <li>• Complicated to negotiate IP model</li> <li>• Certain limitations on publishing may affect academic participants</li> </ul>	<ul style="list-style-type: none"> <li>• Use CARIC IP agreements as model(s) for corresponding DRDC COEs</li> </ul>	<ul style="list-style-type: none"> <li>• Participants may not honour licensing agreements (unlikely)</li> <li>• Rapid technological change could obviate current technology directions</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**

**CARIC**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>treats and protects its own proprietary and confidential information against public disclosure, but with no less than reasonable care.</p> <ul style="list-style-type: none"> <li>• On an on-going basis and no later than the end of the Project, each projects partner will promptly disclose to the other project partners any Intellectual Property or Inventions made or conceived in connection with the Project by or on behalf of Industry or University or jointly by Industry and University.</li> <li>• CRIAQ does not claim IP rights: a generic agreement is used in all Canadian parts of International Collaboration projects.</li> <li>○ <b>Background Intellectual Property:</b> Background IP remains the property of its original owner. A royalty free license to Background IP is granted</li> </ul>	<p>license</p> <ul style="list-style-type: none"> <li>• Use of technology roadmaps helps to organize research agenda</li> </ul>			

**COE SWOT ANALYSIS BY FEATURE**

**CARIC**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>for use during the Project and if required to exploit Foreground IP. Royalties may be payable if the Background IP is identified in a Schedule to the Project Agreement and a basis for the payment of royalties is agreed upon.</p> <ul style="list-style-type: none"> <li>○ <b>Foreground Intellectual Property:</b> Foreground IP owned by Project Partners whose researchers have had a substantive creative, inventive or intellectual contribution to its generation. Background IP remains the property of its original owner.</li> <li>○ <b>Licensing:</b> Industrial Project Partners obtain an exclusive world-wide royalty-free license for aerospace applications in their respective defined field of interest (with right to sublicense to affiliated companies) on any Project Foreground</li> </ul>				

**COE SWOT ANALYSIS BY FEATURE**

**CARIC**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>IP owned by University Partners or NRC (similar scheme applies to Joint Intellectual Property). Specific benefits sharing or financial compensation may be addressed to in a Schedule to the Project Agreement.</p> <ul style="list-style-type: none"> <li>○ <b>Publication:</b> Subject to certain limitations concerning inventions and confidential information, publication rights are guaranteed to all Project Partners (maximum delay 6 months). Use in teaching and academic research is guaranteed.</li> <li>● Has generated 250+ technology licenses</li> <li>● Creates technology roadmaps</li> </ul>				
<p><b>Funding</b></p> <ul style="list-style-type: none"> <li>● Industry Canada: \$30 million over 5 years</li> <li>● A minimum of 25% of</li> </ul>	<ul style="list-style-type: none"> <li>● Solid, long term government support for overhead, direct administration,</li> </ul>	<ul style="list-style-type: none"> <li>● Industry cash requirement may discourage smaller firms from participating</li> </ul>	<ul style="list-style-type: none"> <li>● CARIC funding model establishes precedent for DRDC in negotiations with PCO, Finance, TBS</li> </ul>	<ul style="list-style-type: none"> <li>● COE program not sufficiently ambitious: DRDC required to find money from within</li> </ul>

**COE SWOT ANALYSIS BY FEATURE  
CARIC**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>the cost of projects done at the universities is covered by industry, the remainder being covered by public funding to the universities.</p> <ul style="list-style-type: none"> <li>• <b>FUNDING SCENARIOS</b> <b>Low TRL projects:</b> Maximum 75% in public funding. Eg. Total Project Value \$125k includes \$100k cash + \$25k in-kind <b>Mid-TRL projects:</b> Total Project Value \$100k (cash + in-kind): CARIC 50%, Industry 50%</li> </ul>	<p>networking costs</p> <ul style="list-style-type: none"> <li>• Minimum financial commitment requirement for firms indicates real commitment</li> <li>• Industry financing related to degree of risk (TRLs)</li> </ul>	<ul style="list-style-type: none"> <li>• Requires substantial, long term budgetary commitment by GoC</li> <li>• Difficult to negotiate funding agreements among (DRDC), universities, companies, PCO, Finance, TBS</li> </ul>		<p>current budget</p> <ul style="list-style-type: none"> <li>• COE program too ambitious: Insufficient new funds available</li> </ul>
<p><b>Membership</b></p> <ul style="list-style-type: none"> <li>• Five regional organizations have joined the Consortium for Aerospace Research and Innovation in Canada to lead the industry, universities, research centres and colleges in collaborative research projects and develop cutting-edge technology.</li> <li>• Non-profit organization where project</li> </ul>	<ul style="list-style-type: none"> <li>• Potential for cross-Canada participation of universities, companies, researchers, students</li> </ul>	<ul style="list-style-type: none"> <li>• Broad membership base complicates administrative decision making</li> <li>• Broad membership complicates program, project formulation</li> <li>• Requires external company participation, leadership by aerospace MNEs to launch initiative</li> </ul>	<ul style="list-style-type: none"> <li>• Use CARIC membership model as the pattern for future DRDC COEs</li> </ul>	<ul style="list-style-type: none"> <li>• Withdrawal of one or more industry leaders from consortium could disrupt financing, activities</li> <li>• Future refusal of GoC to renew COE</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**  
**CARIC**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>management is equally shared between university and industrial partners.</p> <ul style="list-style-type: none"> <li>• 55+ industrial members</li> <li>• 25+ academic members (universities, colleges, research centres)</li> <li>• 1000+ academic researchers and industrial specialists</li> <li>• 900+ students</li> <li>• 30+ participating international organizations</li> <li>• SMEs = +75% of CRIAQ's industrial membership; +35 SMEs participating in CRIAQ projects, +10 acting as project leaders</li> </ul>				
<p><b>Infrastructure</b></p> <ul style="list-style-type: none"> <li>• CARIC/CRIAQ has a tool that allows virtual finding of <b>laboratories and equipment available for collaborative research</b> in Québec and, in a near future, also across Canada. The inventory of research infrastructures is</li> </ul>	<ul style="list-style-type: none"> <li>• CARIC has potential to fund infrastructure; will attract some participants</li> <li>• Research inventory facilitates infrastructure sharing ("Virtual Infrastructure"), avoidance of duplication</li> </ul>	<ul style="list-style-type: none"> <li>• Infrastructure requires additional capital funding agreements</li> <li>• Raises questions about facility, equipment ownership</li> <li>• Raises questions about additional required building space to house equipment</li> <li>• Raises questions of</li> </ul>	<ul style="list-style-type: none"> <li>• More efficient to fund common shared infrastructure</li> <li>• Potential for DRDC COEs to link to CARIC infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>• Aerospace research is infrastructure-dependent; absence of infrastructure support may hinder academic, industry participation</li> <li>• Lack of buy-in from PCO, Finance, TBS to CARIC infrastructure support</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**

**CARIC**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>accessible to CRIAQ's members who have privileged access to all features of the tool and it is also accessible to the whole aerospace community who could have an overview of the infrastructures. This tool aims to develop innovation intelligence mechanisms in order to foster a virtual infrastructure network management. The inventory could be used to identify resources and compare equipments which could lead to a GAP analysis.</p>		<p>operating, servicing, maintenance costs (and who pays)</p> <ul style="list-style-type: none"> <li>• Raises questions about technician, technologist costs</li> </ul>		<ul style="list-style-type: none"> <li>• Constrained program budget</li> </ul>
<p><b>Governance</b></p> <ul style="list-style-type: none"> <li>• A non-profit organization that unites Canadian stakeholders and promotes coast to coast collaboration. Its mission is to develop advanced technologies for the Canadian aerospace community.</li> <li>• Regional offices located</li> </ul>	<ul style="list-style-type: none"> <li>• NFP status allows for self-direction, greater stakeholder participation</li> <li>• NFP status reduces direct DRDC oversight requirements</li> <li>• NFP status insulates GoC from individual problems that may arise</li> <li>• Regional offices support nation-wide participation</li> </ul>	<ul style="list-style-type: none"> <li>• Self-direction reduces DRDC influence, control</li> <li>• Permanent administration is expensive</li> <li>• 2 plus 2 model complicates program, project planning</li> <li>• NFP status adds level of administrative burden (e.g. lawyers fees,</li> </ul>	<ul style="list-style-type: none"> <li>• Use CARIC models, templates for DRDC COE operations</li> </ul>	<ul style="list-style-type: none"> <li>• Potential for conflicts of interest in industry-dominated model</li> </ul>

**COE SWOT ANALYSIS BY FEATURE  
CARIC**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>in Halifax, Montreal, Toronto, Winnipeg and Vancouver. They are joining CARIC's Montreal headquarters, which has been in operation since April 2014.</p> <ul style="list-style-type: none"> <li>• The business-led consortium operates under a two-plus-two model, whereby a minimum of two companies and two universities collaborate on precompetitive research at the low end of the Technical Readiness Level (TRL) scale. The money goes to the universities, but the projects always come from industry companies,</li> <li>• Permanent administration</li> <li>• Board of Directors (18 members + designated observers)</li> <li>• Executive Committee (10 members)</li> <li>• Scientific Committee</li> </ul>	<ul style="list-style-type: none"> <li>• 2 plus 2 model ensures research relevance, wider participation of stakeholders</li> <li>• Puts industry in the driver's seat vis a vis priority setting</li> <li>• Permanent administration encourages professional management</li> <li>• Large BOD gives strong base of advice</li> <li>• Large Executive Committee gives strong base of advice and decision-making</li> <li>• Project Agreements formalize research arrangements</li> <li>• Removes communications responsibility from DRDC</li> </ul>	<p>regulatory filings)</p> <ul style="list-style-type: none"> <li>• Regional offices expensive to operate; add overhead costs</li> <li>• Industry priority-setting may not fulfill DRDC research objectives</li> <li>• Large BOD complicates decision making</li> <li>• Large Executive Committee complicates decision-making</li> <li>• Project Agreements may be require more time to develop (than direct funding)</li> <li>• Offers DRDC no direct control over communications</li> </ul>		

**COE SWOT ANALYSIS BY FEATURE**

**CARIC**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>(project review)</p> <ul style="list-style-type: none"> <li>• Strategic Committee</li> <li>• Research Committee (all members) (Networking and project follow-up)</li> <li>• For each Project, Industry and University will prepare a Project Agreement based on these guiding principles. Upon approval by CRIAQ the Project will be carried out and the relations of Industry and University in connection with such Project will be governed by the Agreement.</li> <li>• Internal Communications: Research Committee meetings create networking opportunities for CRIAQ's members. The Research Committee is a method of application of the CRIAQ open innovation process. All members are invited to attend these meetings</li> </ul>				

**COE SWOT ANALYSIS BY FEATURE  
CARIC**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>where new project ideas can be presented by industrial members. It is also an opportunity to follow-up on projects in preparation and to review on-going projects.</p> <ul style="list-style-type: none"> <li>• External/internal communications through website and through CRIAQ Web Community</li> </ul>				

### Appendix 3. COE SWOT Analysis by Feature- CIMVHR

COE SWOT ANALYSIS BY FEATURE				
Canadian Institute for Military and Veteran Health Research (CIMVHR)				
Feature	Strengths	Weaknesses	Opportunities	Threats
<p><b>Purpose</b></p> <ul style="list-style-type: none"> <li>• Enhance the lives of Canadian military personnel, Veterans and their families by harnessing the national capacity for research</li> <li>• Engages existing academic research resources</li> <li>• Facilitates the development of new research, research capacity and effective knowledge translation</li> <li>• Research: CIMVHR research focuses on many areas including protection, prevention, treatment, rehabilitation and technology development.</li> <li>• Databases capture current research programs, outstanding research requirement</li> <li>• Knowledge Translation: Include annual research forums, website, regular,</li> </ul>	<ul style="list-style-type: none"> <li>• “Motherhood” issue draws widespread support for military issue</li> <li>• Builds on existing academic activities; no need for “capacity building” per se; more emphasis on capacity linking, knowledge translation</li> <li>• Broad research focus potentially attracts researchers from different fields of science</li> <li>• Manages database of relevant research; useful research tool</li> <li>• Strong focus on knowledge translation, practical applications</li> <li>• Explicit focus on training of HQP</li> <li>• Offers a recognized certificate in an emerging field; certificate confers academic status</li> </ul>	<ul style="list-style-type: none"> <li>• Research program, outputs dependent on PI, student interests rather than strategic plan per se</li> <li>• Broad research focus risks lack of critical mass in one or more areas</li> <li>• HQP training goal requires aligning funding with timeframe of academic (thesis) requirements</li> </ul>	<ul style="list-style-type: none"> <li>• Link DRDC COEs to work of CIMVHR as required</li> </ul>	<ul style="list-style-type: none"> <li>• Inability to develop “killer apps” reduces confidence in research</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**  
**Canadian Institute for Military and Veteran Health Research (CIMVHR)**

Feature	Strengths	Weaknesses	Opportunities	Threats
<p>targeted communications, peer-reviewed publications, and ongoing communications with all stakeholder groups.</p> <ul style="list-style-type: none"> <li>• Education: building the next generation to conduct research relevant to military members, Veterans and their families. This is being facilitated through developing a thriving pan-Canadian graduate program, developing new sources of funding for graduate students, and in the near future offering a recognized graduate certificate.</li> </ul>				
<p><b>Output</b></p> <ul style="list-style-type: none"> <li>• CIMVHR Journal, Abstracts, Books, Conference, Webinars, Public lectures</li> <li>• Advancing methods and data sets to provide capacity for more</li> </ul>	<ul style="list-style-type: none"> <li>• Many direct beneficiaries of research (veterans, governments, etc.)</li> <li>• Broad range of knowledge outputs</li> <li>• All outputs in public domain; encourages knowledge sharing</li> </ul>	<ul style="list-style-type: none"> <li>• Open publishing not appropriate for classified research</li> </ul>	<ul style="list-style-type: none"> <li>• Use incremental research funding to address new DRDC direct needs</li> </ul>	<ul style="list-style-type: none"> <li>• None identified</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**  
**Canadian Institute for Military and Veteran Health Research (CIMVHR)**

Feature	Strengths	Weaknesses	Opportunities	Threats
<p>complex problem solving</p> <ul style="list-style-type: none"> <li>• Increasing the capacity for researchers to use existing research</li> <li>• Developing and progressing researchers through their careers</li> <li>• Building the reputations of CIMVHR and its affiliated institutions</li> <li>• Improving the relevance of research (to improve to capacity for action from research)</li> <li>• Identify areas where CIMVHR research has been used already to inform health policies.</li> <li>• Working with stakeholders to examine areas of policy to identify knowledge gaps and problems and to determine if research is required to address these problems;</li> <li>• Evaluate and integrate research findings to</li> </ul>	<ul style="list-style-type: none"> <li>• Database lessens chance that new research will “reinvent the wheel”</li> <li>• Supports researchers at different career stages</li> <li>• Strong focus on/links to practical applications</li> <li>• Strong focus on/links to policy development</li> <li>• Explicit effort to address knowledge gaps</li> </ul>			

**COE SWOT ANALYSIS BY FEATURE**  
**Canadian Institute for Military and Veteran Health Research (CIMVHR)**

Feature	Strengths	Weaknesses	Opportunities	Threats
<p>directly influence the policy decision;</p> <ul style="list-style-type: none"> <li>• Inform alternative perspectives to deal with the policy issue;</li> <li>• Persuade targeted stakeholders to support a predetermined decision.</li> <li>• Direct beneficiaries include DND, Veterans Affairs, other users of CIMVHR research, Indirect beneficiaries are veterans and other occupations where PTSD is prevalent</li> <li>• All research output to date in public domain: Annual research forums, website, regular, targeted communications, peer-reviewed publications, ongoing communications with all stakeholder groups,</li> <li>• CIMVHR Journal, Abstracts, Books, Conference, Webinars, Public lectures</li> </ul>				

**COE SWOT ANALYSIS BY FEATURE**  
**Canadian Institute for Military and Veteran Health Research (CIMVHR)**

Feature	Strengths	Weaknesses	Opportunities	Threats
<p><b>Funding</b></p> <ul style="list-style-type: none"> <li>• Office staff costs about \$650,000 per year plus materials, supplies, travel etc</li> <li>• Funders include: DND, VAC, Charities</li> <li>• Scientific Director, paid by academic salary at Queen's; Associate Scientific Director is paid by RMCC.</li> <li>• Other faculty working CIMVHR are paid by their respective institutions</li> <li>• Increasing research revenues for military and veteran's health research</li> </ul>	<ul style="list-style-type: none"> <li>• Moderate overhead costs (\$650,000+)</li> <li>• Draws financial support from different funders, sectors</li> <li>• Academic staff salaries and overheads paid by host institutions</li> </ul>	<ul style="list-style-type: none"> <li>• Fixed overhead costs of network require large research program to offset</li> <li>• University researchers essentially part-time</li> </ul>	<ul style="list-style-type: none"> <li>• Add new research at low incremental overhead cost</li> </ul>	<ul style="list-style-type: none"> <li>• Potential diminution of outside funding over time</li> </ul>
<p><b>Membership</b></p> <ul style="list-style-type: none"> <li>• A network of academic researchers from across Canada</li> <li>• Serves as a focal point for 37 Canadian member universities</li> <li>• Includes 4 sponsors: True Patriot Love, Wounded Warriors Canada, Canadian</li> </ul>	<ul style="list-style-type: none"> <li>• National membership</li> <li>• Many academic institutional members as well as individual PIs</li> <li>• Corporate, NFP support</li> <li>• Broad membership base creates critical mass</li> <li>• Interdisciplinary nature of membership, research</li> </ul>	<ul style="list-style-type: none"> <li>• No obvious involvement of private sector in research, commercialization</li> <li>• Broad base of member disciplines could make it difficult to achieve critical mass in all research areas</li> </ul>	<ul style="list-style-type: none"> <li>• Link CIMVHR activities to international research activities</li> </ul>	<ul style="list-style-type: none"> <li>• None identified</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**  
**Canadian Institute for Military and Veteran Health Research (CIMVHR)**

Feature	Strengths	Weaknesses	Opportunities	Threats
<p>Legion, General Dynamics Canada</p> <ul style="list-style-type: none"> <li>• Includes 150+ researchers from academe, government</li> <li>• Member benefits include: Developing critical mass of research, collaboration with leading researchers, inter-disciplinarity</li> <li>• Benefits of membership - Members motivated by: financial resources for research, networking opportunities, potential to directly impact the welfare of benefits</li> </ul>				
<p><b>Infrastructure</b></p> <ul style="list-style-type: none"> <li>• HQ at Queen’s University, researchers spread across Canada</li> <li>• Each researcher working with CIMVHR uses the research infrastructure within their own university or department</li> <li>• Secret work is not</li> </ul>	<ul style="list-style-type: none"> <li>• No need for additional research infrastructure funding; researchers bring own infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>• Not structured to carry out classified research</li> </ul>	<ul style="list-style-type: none"> <li>• Leverage individual PI equipment, facilities</li> </ul>	<ul style="list-style-type: none"> <li>• None identified</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**  
**Canadian Institute for Military and Veteran Health Research (CIMVHR)**

Feature	Strengths	Weaknesses	Opportunities	Threats
<p>carried out</p> <ul style="list-style-type: none"> <li>The highest level is Protected B; Queen's has been approved by CISD to a Protected B level. University obtains clearance for sub-contract Protected B work.</li> </ul>				
<p><b>Governance</b></p> <ul style="list-style-type: none"> <li>Has permanent administration; 11 Staff positions</li> <li>A Senate approved research center at Queen's University</li> <li>CIMVHR's hub is located in Kingston, Ontario, and managed by the founding members of CIMVHR, Queen's University and the Royal Military College of Canada.</li> <li>CIMVHR is governed by a Board of Directors; Advisory Council, Technical Advisory Committee</li> <li>CIMVHR's activities are also guided by the pan-</li> </ul>	<ul style="list-style-type: none"> <li>Arm's length network facilitates funding arrangements, reduces GOC risk</li> <li>Official recognition by Queen's U. (senate) facilitates operations</li> <li>Involvement by RMC provides link to military end-user</li> <li>Strong governance setup for administration, research, knowledge translation</li> </ul>	<ul style="list-style-type: none"> <li>Arm's length governance reduces sponsor control</li> <li>Large membership base implies more complicated governance</li> </ul>	<ul style="list-style-type: none"> <li>Potential for DRDC to participate in CIMVHR governance</li> </ul>	<ul style="list-style-type: none"> <li>Need to avoid conflict of interest, favouritism in research funding</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**  
**Canadian Institute for Military and Veteran Health Research (CIMVHR)**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
Canadian university consortium • Knowledge Translation: Include annual research forums, website, regular, targeted communications, peer-reviewed publications, and ongoing communications with all stakeholder groups.				

## Appendix 4. COE SWOT Analysis by Feature- CMC

COE SWOT ANALYSIS BY FEATURE				
CMC Microsystems				
Feature	Strengths	Weaknesses	Opportunities	Threats
<p><b>Purpose</b></p> <ul style="list-style-type: none"> <li>• CMC was established to provide a common platform for chip/nano-chip design for all Canadian universities, in order to give them state-of-the-art technology and avoid (costly) duplication. CMC services include: <ul style="list-style-type: none"> <li>• Design: Design software and CAD tools, design methodologies, intellectual property including libraries, computer systems, and manufacturing technology environments.</li> <li>• Make: Multi-project wafer services provide access to some of the best foundries in the world for the manufacture of prototypes. We offer professional services to assist clients looking for custom fabrication</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Cost-effective mechanism for providing state of the art chip design software licenses to large number of institutions; avoids duplication</li> <li>• Has resources to constantly update design tools</li> <li>• Provides expert advisory services on use of software tools; improves efficiency</li> <li>• Spans broad range of Microsystems technologies, including: MEMS, Microfluidics, Microelectronics, Nanotech, Photonics</li> <li>• Encourages multidisciplinary research</li> <li>• Encourages clear path to technology development; focus on fast</li> </ul>	<ul style="list-style-type: none"> <li>• Investigator-driven research projects do not conform to any particular research theme; each project determined by individual researcher</li> <li>• Gap between research and commercialization</li> </ul>	<ul style="list-style-type: none"> <li>• Link DRDC COEs to CMC researchers, companies at relatively low cost</li> <li>• Encourage CMC and selected CMC researchers, companies to focus on DRDC requirements</li> </ul>	<ul style="list-style-type: none"> <li>• Rapid technological change could obviate certain CMC technology platforms</li> <li>• CMC program relies on ability of offshore fabs to produce prototypes; under certain scenarios costs could become prohibitive</li> <li>• Loss of government financial support (cf. “You’ve had your chance”)</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**  
**CMC Microsystems**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>through an MNT lab. We also offer packaging and assembly services to integrate multiple technologies on a single device.</p> <ul style="list-style-type: none"> <li>• Test: Equipment, products, and services to test and verify the functionality of microsystems, components or systems, and to demonstrate proofs-of-concept.</li> <li>• CMC includes: Canada's National Design Network: Canada's National Design Network (NDN) enables excellent multi-disciplinary research and complex prototype microsystems with the potential to be rapidly commercialized, positioning Canada to be a competitive player in all economic sectors.</li> </ul> <p>emSYSCAN: Embedded Systems Canada (emSYSCAN)</p>	<p>commercialization</p> <ul style="list-style-type: none"> <li>• Can include classified and un-classified designs</li> <li>• Trains students on industry-standard software</li> </ul>			

**COE SWOT ANALYSIS BY FEATURE**  
**CMC Microsystems**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>is a 5-year project worth over \$50 million, and involves more than 250 university researchers in 37 institutions in Canada. The emSYSCAN project provides platform-based microsystems design and prototyping environments and is based at CMC. emSYSCAN infrastructure will shorten the microsystems development cycle leading to rapid commercialization, publication, and training of highly qualified personnel within a national and international multi-disciplinary research environment.</p> <p>DMT Microsystems: <b>DMT Microsystems</b> is a wholly-owned subsidiary of CMC Microsystems. Launched in June 2007, DMT Microsystems (DMT) strives to build a path between ideas and commercial products and services.</p> <ul style="list-style-type: none"> <li>• CMC is a good example of a collaborative CoE model</li> </ul>				

**COE SWOT ANALYSIS BY FEATURE**  
**CMC Microsystems**

Feature	Strengths	Weaknesses	Opportunities	Threats
<p>that is focused on infrastructure provision.</p> <ul style="list-style-type: none"> <li>• Practically speaking its function cannot effectively be provided elsewhere.</li> <li>• By continually upgrading design tool software licenses CMC stays relevant to users; it provides them with modern tools at a price that individual CMC members could not negotiate on their own.</li> </ul>				
<p><b>Outputs</b></p> <ul style="list-style-type: none"> <li>• Outputs consist of computer chip and nano-system designs, prototypes, and publications.</li> <li>• HQP is another output.</li> <li>• The direct beneficiary is undergraduate and graduate students who gain experience in chip design, often in pursuit of a degree. Graduates go on to jobs in industry, so industry is an indirect beneficiary; companies acquire graduates who are already skilled in chip</li> </ul>	<ul style="list-style-type: none"> <li>• Handles wide range of technologies</li> <li>• Spans “basic” research to more advanced TRLs</li> <li>• Outputs can be applied to many diverse industry sectors</li> <li>• Excellent vehicle for HQP training and recruitment</li> <li>• Good internal communication mechanisms; conference, newsletter, webinars</li> <li>• Successful IP</li> </ul>	<ul style="list-style-type: none"> <li>• Not clear how classified research would work in a CMC environment</li> <li>• Conflict between proprietary research, IP and academics’ need to publish could constrain activities</li> </ul>	<ul style="list-style-type: none"> <li>• Monitor CMC activities for outputs relevant to DRDC/COE</li> <li>• Encourage PIs and companies to advance TRLs</li> <li>• Become early-stage adopters of CMC technologies</li> <li>• Use CMC as a training ground for DRDC researchers, technicians</li> </ul>	<ul style="list-style-type: none"> <li>• GOC IP regulations could hinder technology adoption</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**  
**CMC Microsystems**

Feature	Strengths	Weaknesses	Opportunities	Threats
<p>design.</p> <ul style="list-style-type: none"> <li>External dissemination through: Annual conference, special events, website, monthly newsletter, webinars</li> <li>Last year: 3300+ publications and more than 150 national and international awards</li> <li>Nearly 650 HQP were recruited to industry supported by their training and experience in the NDN.</li> <li>Innovation outcomes included nearly 220 invention disclosures; 200 patents applied for or issued; and 40 technologies licensed.</li> <li>Complex IP arrangements taking into account: institutional agreements; vendor agreements, researcher rights. IP typically varies by institution.</li> </ul>	<p>arrangements in place</p> <ul style="list-style-type: none"> <li>Handles confidential industry work</li> </ul>			
<p><b>Funding</b> <b>Annual total = \$8.0 M; NSERC</b></p>	<ul style="list-style-type: none"> <li>Sufficient resources available to support</li> </ul>	<ul style="list-style-type: none"> <li>Expensive operation to fund (\$8M per</li> </ul>	<ul style="list-style-type: none"> <li>Utilize CMC tools for DRDC COE (and lab)</li> </ul>	<ul style="list-style-type: none"> <li>Termination or substantial reduction of NSERC</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**  
**CMC Microsystems**

Feature	Strengths	Weaknesses	Opportunities	Threats
<p><b>\$6.84 M; ICP \$1.16 M</b> Natural Sciences and Engineering Research Council has committed \$40 million to CMC for 2010-2015. Canada Foundation for Innovation (CFI) - Embedded Systems Canada: Embedded Systems Canada (emSYSCAN), a project valued at over \$50 million that is managed by CMC on behalf of the lead institution, Queen's University, represents an investment of \$19.3 million by the Canada Foundation for Innovation. Additional partners funding Embedded Systems Canada include:</p> <ul style="list-style-type: none"> <li>• The Ministry of Innovation and Advanced Education – Alberta Science and Research Investments Program (\$1.5M cash)</li> <li>• British Columbia Ministry of Technology, Innovation and Citizens' Services – British Columbia Knowledge Development Fund</li> </ul>	<p>significant national program, critical mass of activity</p> <ul style="list-style-type: none"> <li>• Consistent funding since 1984</li> <li>• Strong support from 1 major funder (NSERC) plus additional funding from other funders</li> <li>• Contributions from many provincial governments, agencies</li> </ul>	<p>year)</p> <ul style="list-style-type: none"> <li>• High administrative and personnel costs (52 FTEs)</li> <li>• Difficult to negotiate, renew funding agreements with many different sponsors</li> </ul>	<p>operations</p> <ul style="list-style-type: none"> <li>• Leverage CMC activities for DRDC “collaborative” COE</li> <li>• Participate in CMC at incremental cost</li> <li>• Join CMC</li> </ul>	<p>funding would severely hinder CMC operations</p> <ul style="list-style-type: none"> <li>• Decision by one or more major software vendors to discontinue licenses or substantially raise prices</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**  
**CMC Microsystems**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>(\$2.1M cash)</p> <ul style="list-style-type: none"> <li>• Research Manitoba – Manitoba Research and Innovation Fund (\$0.5M cash)</li> <li>• New Brunswick Innovation Foundation (\$0.1M cash)</li> <li>• Department of Business New Brunswick (\$0.1M cash)</li> <li>• University of New Brunswick (\$0.02M cash)</li> <li>• Research and Development Corporation Newfoundland and Labrador – Industrial Research and Innovation Fund (\$0.3M cash)</li> <li>• Nova Scotia Research and Innovation Trust (\$0.15M cash)</li> <li>• Ontario Ministry of Research and Innovation – Ontario Research Fund: Research Infrastructure (\$9.2M cash)</li> <li>• Québec Ministère de</li> </ul>				

**COE SWOT ANALYSIS BY FEATURE**  
**CMC Microsystems**

Feature	Strengths	Weaknesses	Opportunities	Threats
<p>l'Éducation, du Loisir et du Sport (\$4.9M cash)</p> <ul style="list-style-type: none"> <li>• Saskatchewan Ministry of Advanced Education (\$0.14M cash)</li> <li>• In-kind industrial partners (\$12.5M)</li> <li>• An additional \$5.8M in infrastructure operating funds are managed by CMC for this project.</li> <li>• Funds are spent on CMC staff, overheads, licenses, equipment, etc.</li> </ul>				
<p><b>Membership</b></p> <ul style="list-style-type: none"> <li>• CMC Collaborates with organizations - both in Canada and world-wide - involved in microelectronics and micro-nanosystems R&amp;D, including: Industry, Industry Associations, Federal Research Labs, Academic Research and Training Networks, National Infrastructure and Research Support Organizations, and University Research</li> </ul>	<ul style="list-style-type: none"> <li>• Strong academic and industrial membership base</li> <li>• Facilitates industry interaction with potential new hires</li> <li>• 700+ companies involved with CMC</li> </ul>	<ul style="list-style-type: none"> <li>• Broad membership base complicates priority-setting, internal communications</li> <li>• Broad membership demands high level of internal communications</li> <li>• Constant entry of new participants demands substantial technology "hand-holding"</li> </ul>	<ul style="list-style-type: none"> <li>• Develop research, commercialization relationships with academic, industry participants; facilitate technology commercialization, adoption</li> </ul>	<ul style="list-style-type: none"> <li>• None identified</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**  
**CMC Microsystems**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>Groups and Laboratories.</p> <ul style="list-style-type: none"> <li>• CMC Microsystems' corporate members include post-secondary educational institutions from across Canada, and a wide range of companies, and in some cases individuals, who are involved in the development and application of microsystems and related technologies.</li> <li>• Membership in CMC Microsystems enables access to products and services for research and education in microsystems technologies. Through their member representatives, all these organizations are able to actively participate in setting CMC's strategic direction.</li> <li>• Over the past year, approximately 1100 academics, 3200 graduate students, 330 postdoctoral</li> </ul>				

**COE SWOT ANALYSIS BY FEATURE**  
**CMC Microsystems**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>fellows and 250 research staff at 54 institutions across Canada, and 700 connected companies, were active in Canada's National Design Network (NDN). CMC delivered a value of \$24 M to NDN researchers across Canada.</p> <ul style="list-style-type: none"> <li>• 260 companies collaborating in research projects or hiring graduates</li> <li>• CMC's Board of Directors is drawn from both the university and industrial communities, as are the various technical committees and working groups that advise CMC Microsystems on ongoing and potential initiatives.</li> <li>• Motivating factors include:               <ul style="list-style-type: none"> <li>○ Access to state-of-the-art software tools</li> <li>○ Access to expertise</li> <li>○ Lower costs to researchers</li> </ul> </li> </ul>				

**COE SWOT ANALYSIS BY FEATURE**  
**CMC Microsystems**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<ul style="list-style-type: none"> <li>○ Access to specialized training</li> </ul>				
<p><b>Infrastructure</b></p> <ul style="list-style-type: none"> <li>• Headquartered in Kingston</li> <li>• 7 senior leadership team members</li> <li>• Confidential industry work is carried out; secrecy maintained through confidentiality agreements and IP agreements</li> <li>• Provides access to products and services for R&amp;D in microelectronics, MEMS, optoelectronics/photronics, microfluidics, and embedded systems.</li> </ul>	<ul style="list-style-type: none"> <li>• Sophisticated infrastructure available to all members</li> <li>• Infrastructure accessible online</li> <li>• Provides expert advice to utilize infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>• Multiple software licenses require ongoing renewal negotiations</li> </ul>	<ul style="list-style-type: none"> <li>• Leverage CMC program for DRDC purposes; avoid duplication</li> </ul>	<ul style="list-style-type: none"> <li>• Termination/reduction in funding from a major government sponsor(s)</li> </ul>
<p><b>Governance</b></p> <ul style="list-style-type: none"> <li>• BOD members come from across Canada: academia,</li> </ul>	<ul style="list-style-type: none"> <li>• Independent from government</li> <li>• Strong governance</li> </ul>	<ul style="list-style-type: none"> <li>• Independent structure gives CMC more independence, but</li> </ul>	<ul style="list-style-type: none"> <li>• Pattern DRDC infrastructure-oriented COE on CMC model</li> </ul>	<ul style="list-style-type: none"> <li>• Potential for conflicts of interest</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**  
**CMC Microsystems**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
government, industry • 7 senior management staff • 52 FTEs in total • CMC Board of Directors • Industrial Advisory Committee • Technical Advisory Committee • Funding Agencies	involvement by academic, industrial users • Explicit governance role for industry • Provides oversight role to funders	lessens role of financial sponsors • Large number of FTEs		

## Appendix 5. COE SWOT Analysis by Feature- TSAS

COE SWOT ANALYSIS BY FEATURE				
Canadian Network for Research on Terrorism, Security & Society (TSAS)				
Feature	Strengths	Weaknesses	Opportunities	Threats
<p><b>Purpose</b></p> <ul style="list-style-type: none"> <li>Engages in policy-relevant research and dissemination in terrorism, security and society. Network is designed to foster: Communication and collaboration between academic researchers working on these topics in Canada; Communication and collaboration between academic researchers and policy officials in these subject fields; Links with research on these topics in other countries.</li> <li>Also aims to cultivate a new generation of scholars</li> <li>Function could be fulfilled otherwise (e.g. research grants, contracts, contributions to individual PIs, research teams)</li> <li>Sponsor organizations</li> </ul>	<ul style="list-style-type: none"> <li>Research themes set by sponsoring GOC departments/agencies, rather than by individual PIs</li> <li>Broad base of participation from academe, OGDs, NGOs</li> <li>Focus on development of capacity, expertise (new generation of scholars)</li> <li>Maintains relevance through periodic, competitive Calls for Proposals</li> <li>Focus on academic excellence combined with policy relevance</li> <li>COE model is not unique; mirrors structure/function of other COEs</li> </ul>	<ul style="list-style-type: none"> <li>Institutional approach (Network) is more cumbersome than direct contracts/grants to PIs</li> <li>Requires GOC partners to develop, coordinate uniform requirements</li> </ul>	<ul style="list-style-type: none"> <li>Adopt/build on TSAS model for DRDC COEs</li> </ul>	<ul style="list-style-type: none"> <li>Failure of TSAS to develop practical outputs that can be implemented by GOC leads to lack of confidence in the organization</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**  
**Canadian Network for Research on Terrorism, Security & Society (TSAS)**

Feature	Strengths	Weaknesses	Opportunities	Threats
<p>post priority research themes/topics</p> <ul style="list-style-type: none"> <li>• Relevance maintained through periodic, competitive Calls for Proposals based on sponsor priorities</li> </ul>				
<p><b>Outputs</b></p> <ul style="list-style-type: none"> <li>• Academic Journal Articles</li> <li>• BlogBook</li> <li>• Book Chapter</li> <li>• Conference Paper</li> <li>• Databases</li> <li>• Digital library</li> <li>• Government Documents</li> <li>• Literature Reviews</li> <li>• Policy Recommendation Papers</li> <li>• Summer Academy 2015</li> <li>• Theses</li> <li>• TSAS Working Papers</li> <li>• Videos</li> <li>• Primary beneficiary is GoC departments/agencies with a security mission</li> <li>• Secondary beneficiary is academic participants – PIs, students</li> <li>• Other beneficiaries include community</li> </ul>	<ul style="list-style-type: none"> <li>• Produces broad range of knowledge outputs</li> <li>• Utilizes many different knowledge formats (e.g. journal articles, databases, digital library, etc.)</li> <li>• PIs, students comfortable with producing standard academic outputs</li> <li>• Standard outputs align with academic promotion, tenure, thesis requirements</li> <li>• Network allows IP to conform with PI institution's requirements (no need for additional negotiations)</li> <li>• Annual conference, Summer Academy facilitate knowledge transfer</li> <li>• Dissemination of summary research findings to sponsors aids adoption of</li> </ul>	<ul style="list-style-type: none"> <li>• Public nature of outputs may hinder development of "politically incorrect" solutions</li> <li>• Research conforms to academic schedules; No timeline for deliverables</li> <li>• Institutional IP ownership may constrain technology development, commercialization</li> </ul>	<ul style="list-style-type: none"> <li>• Utilize TSAS model for non-classified research</li> </ul>	<ul style="list-style-type: none"> <li>• Public outputs used by adversaries to develop counter-measures</li> <li>• TSAS research overtaken by non-TSAS research</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**  
**Canadian Network for Research on Terrorism, Security & Society (TSAS)**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>groups, parents</p> <ul style="list-style-type: none"> <li>• Dissemination of a summary of research findings from each project to cooperating agency staff and, where possible, to all those who participated in the study</li> <li>• Flexible and responsive approaches to dissemination should be considered, such as community meetings to test ideas and gather feedback from research participants, agencies, and researchers</li> <li>• Process of dissemination to include representatives of community organizations as well as representatives of government, ideally at the same time.</li> <li>• Intellectual property vested in the developing institution(s) (cf. Canadian Incident Database (CIDB))</li> </ul>	<p>research</p>			

**COE SWOT ANALYSIS BY FEATURE**  
**Canadian Network for Research on Terrorism, Security & Society (TSAS)**

Feature	Strengths	Weaknesses	Opportunities	Threats
<p><b>Funding</b></p> <ul style="list-style-type: none"> <li>• Main funding through GOC Kanishka Project</li> <li>• Kanishka is a 5 year \$10M initiative</li> <li>• SSHRC Partnership Development Grant; \$2.15</li> <li>• Public Safety Canada will provide funding in the amount of \$460,000 over two years</li> <li>• Members provide cash or in-kind funding</li> <li>• Funds spent on research, networking and administrative costs</li> <li>• All applicants are eligible to apply for a standard grant (\$15,000).</li> </ul>	<ul style="list-style-type: none"> <li>• Long term GOC funding commitment provides stability, confidence in academic participation</li> <li>• Funding involvement by SSHRC assures strong social sciences and humanities focus</li> <li>• Standard (\$15,000) grant provides all researchers with an assured minimum of resources</li> <li>• Allowance for in-kind contributions encourages partners without cash to participate</li> </ul>	<ul style="list-style-type: none"> <li>• Funding of \$10M over 5 years (\$2M per year) is not substantial</li> <li>• Total funding level may not ensure critical mass of research, researchers</li> <li>• Requires new funding envelope (Kanishka)</li> <li>• Standard grants sufficient to hire students as RAs, but insufficient to support graduate students for the duration of their thesis program</li> <li>• Difficult to assess the value of in-kind contributions</li> </ul>	<ul style="list-style-type: none"> <li>• Potential to use TSAS funding model in DRDC COEs</li> <li>• Potential for new DRDC cash contribution to leverage TSAS research strengths</li> </ul>	<ul style="list-style-type: none"> <li>• Termination of Kanishka Project or shift in GOC priorities could lead to abandonment of TSAS project</li> <li>• Inability to develop “killer apps”</li> </ul>
<p><b>Membership</b></p> <ul style="list-style-type: none"> <li>• Includes fourteen Canadian universities, nine departments in the Canadian federal government, and six non-governmental organizations. Government: Social Sciences and Humanities</li> </ul>	<ul style="list-style-type: none"> <li>• Very broad participation by academic, government, international organizations</li> <li>• Formal designations (Senior Research Affiliate; Post-doctoral – Junior Affiliate; PhD – Junior Affiliate; Masters – Junior Affiliate; Non-Academic Affiliate) confer a degree of</li> </ul>	<ul style="list-style-type: none"> <li>• Large membership complicates research coordination, administration</li> </ul>	<ul style="list-style-type: none"> <li>• Recruit current TSAS researchers for new DRDC COEs (depending on subject area)</li> </ul>	<ul style="list-style-type: none"> <li>• None apparent</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**

**Canadian Network for Research on Terrorism, Security & Society (TSAS)**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>Research Council; Public Safety Canada; FINTRAC; RCMP; Department of Justice Canada; Citizenship and Immigration Canada; DFATD; Canadian Security Intelligence Service; Correctional Service Canada</p> <ul style="list-style-type: none"> <li>• DRDC is an in-kind contributor</li> <li>• Universities: University of British Columbia; Simon Fraser University; Université Laval; Carleton University, The Norman Paterson School of International Affairs; University of Waterloo; Ryerson University; Université de Montréal</li> <li>• Other: International Centre for Counter Terrorism; National Consortium for the Study of Terrorism and Responses to Terrorism; Chatham House; Mosaic Institute; LIU Institute for Global Issues; Institute</li> </ul>	<p>status to PIs, students</p> <ul style="list-style-type: none"> <li>• Involves groups of researchers (e.g. Norman Patterson School) in addition to individual PIs</li> <li>• Potential for companies, OGDs to join with cash or in-kind contribution</li> <li>• Researchers selected through competitive calls for proposal encourages high quality participation</li> <li>• Allows for co-researchers from outside of Canada to participate</li> </ul>			

**COE SWOT ANALYSIS BY FEATURE**

**Canadian Network for Research on Terrorism, Security & Society (TSAS)**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>for Strategic Dialogue; The Royal United Services Institute</p> <ul style="list-style-type: none"> <li>• Companies or departments wishing to join: would look at each on a case-by-case basis; If the entity was willing to contribute (cash or in-kind) to TSAS, could explore making them a formal partner under SSHRC, or if the department simply wants to stay informed of activities, the relevant person(s) can join their mailing list or become affiliated as non-academic.</li> <li>• Membership categories include: Senior Research Affiliate, Post-doctoral Research Affiliate, PhD-Junior Research Affiliate, Junior (Masters) Research Affiliate), Non-Academic Affiliate</li> <li>• Researchers selected through competitive Calls for Proposals</li> </ul>				

**COE SWOT ANALYSIS BY FEATURE**

**Canadian Network for Research on Terrorism, Security & Society (TSAS)**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<ul style="list-style-type: none"> <li>• Researchers currently number 60+</li> <li>• Principal Investigators (PIs) must hold a continuing position at a University, in Canada or elsewhere, (under normal circumstances this means a tenured or tenure-track appointment), and be recognized as an affiliate of TSAS as a Senior Researcher.</li> <li>• Co-Investigators must also be affiliated with TSAS, as Senior Researcher, and may be from outside of Canada.</li> <li>• Typically, PIs of TSAS projects hire graduate students under their supervision as research assistants.</li> <li>• Research Assistants are typically graduate students (Junior Researchers), or they can be anyone relevant to the research project.</li> <li>• Research Partners are</li> </ul>				

**COE SWOT ANALYSIS BY FEATURE**  
**Canadian Network for Research on Terrorism, Security & Society (TSAS)**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>institutions that are relevant to a research project. They may be compensated (at an institutional level... i.e., through an invoice) for services rendered for a research project (e.g., recruitment of research subjects).</p>				
<p><b>Infrastructure</b></p> <ul style="list-style-type: none"> <li>• Administrative HQ at University of British Columbia; Co-director HQ'd at University of Waterloo</li> <li>• No physical infrastructure; distributed network</li> <li>• Work is in the public domain</li> <li>• Sensitive work is carried out, but all research in the public domain</li> </ul>	<ul style="list-style-type: none"> <li>• As a largely social sciences-based research network, there is a minimal requirement for physical infrastructure</li> <li>• Ability to publish research results encourages PI, graduate student participation</li> </ul>	<ul style="list-style-type: none"> <li>• Network not structured to handle classified research</li> </ul>	<ul style="list-style-type: none"> <li>• NA</li> </ul>	<ul style="list-style-type: none"> <li>• NA</li> </ul>
<p><b>Governance</b></p> <ul style="list-style-type: none"> <li>• TSAS is an independent organization built on the principle of academic</li> </ul>	<ul style="list-style-type: none"> <li>• Independence from government provides some administrative flexibility</li> <li>• Standard COE governance</li> </ul>	<ul style="list-style-type: none"> <li>• Independent structure diminishes GOC control over specific research projects undertaken</li> </ul>	<ul style="list-style-type: none"> <li>• Adopt TSAS governance model for DRDC COEs (as appropriate)</li> </ul>	<ul style="list-style-type: none"> <li>• Poor governance decisions and perception of conflict of interest could sow</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**  
**Canadian Network for Research on Terrorism, Security & Society (TSAS)**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>independence</p> <ul style="list-style-type: none"> <li>• Funding decisions based on peer review; applications reviewed by a committee including academic researchers and government officials across several departments</li> <li>• Internal communications through newsletters, databases</li> <li>• Executive Committee is currently comprised of 2 Co-directors; 3 Associate Directors, 5 Members, 1 Ex-officio (non-voting) Member</li> </ul>	<p>model</p> <ul style="list-style-type: none"> <li>• Provides online resources that help people to connect, network and collaborate</li> </ul>	<ul style="list-style-type: none"> <li>• Self-governance by academic members receiving financial support could be subject to conflicts of interest</li> </ul>		<p>dissent among PIs, others</p>

## Appendix 6. COE SWOT Analysis by Feature- Tutte

COE SWOT ANALYSIS BY FEATURE Tutte Institute for Mathematics and Computing (TIMC)				
Feature	Strengths	Weaknesses	Opportunities	Threats
<p><b>Purpose</b></p> <ul style="list-style-type: none"> <li>TIMC is a program within Communications Security Establishment (CSE)</li> <li>Exists to harness Canadian cryptology capabilities inside and outside of government and to build a critical mass of expertise (and applications).</li> <li>Conducts classified research in cryptology and knowledge discovery with a mission to support the Canadian Cryptologic Program and its international partners by providing leading-edge solutions to emerging complex problems. Has four objectives:</li> <li><b>Objective 1:</b> Research: Provide leading edge solutions to mathematical and computational challenges facing the Canadian Cryptologic Program and</li> </ul>	<ul style="list-style-type: none"> <li>Under direct CSE control; no need for external intermediaries</li> <li>CSE determines research directions, specific research projects</li> <li>Structured to handle classified research</li> <li>Flexible employment terms for research associates (short, medium, long term)</li> <li>Can hand-pick researchers from outside of government</li> <li>Has ongoing partnerships with similar government bodies abroad; useful for information sharing, etc.</li> <li>Aims high: to establish “world leading research, knowledge centre”</li> <li>Has mechanisms to involve academic</li> </ul>	<ul style="list-style-type: none"> <li>Subject to usual GoC constraints (recruitment, salary scales, etc.)</li> <li>Potential for “tunnel vision” as all priority setting is internally-driven</li> <li>Security requirement complicates recruitment, hiring timelines</li> <li>Foreign governments may impose additional constraints on hiring (e.g. limitations on foreign-born researchers)</li> <li>Costly to build and sustain “world leading research, knowledge centre”; may fail to live up to promises</li> <li>Reduced potential for open source publishing reduces attractiveness to junior faculty, postdocs</li> <li>Secret operations make program evaluation difficult</li> </ul>	<ul style="list-style-type: none"> <li>Build on (already-approved) Tutte model to facilitate establishment of comparable DRDC COEs</li> </ul>	<ul style="list-style-type: none"> <li>Competition with the private sector for human resources</li> <li>GoC salary scales may not be competitive</li> <li>Security breaches would severely disrupt operations, government confidence</li> <li>Insufficient funding to achieve promised leadership position</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**

**Tutte Institute for Mathematics and Computing (TIMC)**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>partners.</p> <ul style="list-style-type: none"> <li>• <b>Objective 2:</b> Recruitment: Attract and engage Canada's top researchers to work in support of Communications Security Establishment (CSE).</li> <li>• <b>Objective 3:</b> Partnership Development</li> <li>• <b>Objective 4:</b> Create and maintain a world leading communications research knowledge centre.</li> <li>• Unique (in Canada) in involving the academic community in top secret work.</li> <li>• Could, in principle, be out-sourced to a RAND-type organization (if such existed in Canada).</li> <li>• Relevance maintained through response to priorities determined by Communications Security Establishment (CSE).</li> </ul>	<p>community in classified research</p>			
<p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Threat and Vulnerability Analysis</li> <li>• Prediction, Prevention and Response to Cyber-</li> </ul>	<ul style="list-style-type: none"> <li>• Outputs are both theoretical and applied</li> <li>• Industry Program for Information</li> </ul>	<ul style="list-style-type: none"> <li>• Outputs are largely classified; publication restrictions do not help junior faculty with promotion and tenure</li> <li>• Classified outputs hinder</li> </ul>	<ul style="list-style-type: none"> <li>• Opportunity to leverage Tutte research in DRDC-specific directions</li> <li>• Opportunity to build</li> </ul>	<ul style="list-style-type: none"> <li>• Classified outputs, security requirements may hinder academic participation</li> <li>• Major security breach</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**

**Tutte Institute for Mathematics and Computing (TIMC)**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
security incidents • IT Security Services Architecture and Engineering • Certification and Accreditation • Industry Program for Information Technology Security Assurance • Training and Awareness Program • Support for IT Security Policy and Standards Development • Joint Distinguished Speaker Series • Visiting Scholar Program • Provide funding to select academic conferences, workshops • Direct benefit to CSE and partners; indirect benefits to other stakeholders • IP is secret; management according to GoC rules/regulations	Technology Security Assurance of direct use to end users • Formal Visiting Scholar program provides engagement mechanism for professors • Funding of academic conferences, workshops provides low-cost engagement mechanism with academe • Has mechanism(s) in place for conducting classified research, involving outsiders • Has mechanism(s) in place for managing IP	involvement of grad. students, postdocs who need to publish theses, studies • Level of industry engagement not clear; low level hinders technology commercialization/adoption • Potential loss of external review due to secret nature of work • Potential for “tunnel vision” in research planning, implementation	on Tutte experience in establishing DRDC COEs • Opportunity to engage with end-users	in Canada could threaten entire program
<b>Funding</b> • Fully funded by government • Funding through annual	• Insufficient information for complete analysis • Full funding by CSE	• CSE and Tutte subject to annual parliamentary allocations; reduced possibility of long-term	• Use Tutte model as basis for COE planning, budgeting • Replicate Tutte	• Entirely reliant on federal government funding • Competition from

**COE SWOT ANALYSIS BY FEATURE**

**Tutte Institute for Mathematics and Computing (TIMC)**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>parliamentary appropriation</p> <ul style="list-style-type: none"> <li>• Funding information not publicly available</li> <li>• Research Infosource estimate of \$4-5 million, based on 15 full-time staff; 30 contract researchers</li> <li>• Funds spent on salaries, contracts, stipends</li> <li>• Researchers often begin with short-term contacts (7-10 days); a number of flexible work options are available to researchers. Contracts range from short term (one week) to multiple years. While on contract, researchers may elect to work on a flexible part-time or full-time basis.</li> </ul>	<p>means no reliance on external (e.g. industry) funding</p> <ul style="list-style-type: none"> <li>• Flexible funding mechanisms for short, medium, long term external researcher involvement</li> <li>• Pays “competitive” wages/fees</li> </ul>	<p>funding</p> <ul style="list-style-type: none"> <li>• Difficulty of accepting non-government, international government funds</li> <li>• Contracting and recruitment flexibility hindered by GoC regulations, practices</li> <li>• Available funding may not be sufficient to match external salary scales</li> </ul>	<p>contracting arrangements to elicit PCO, Finance, TBS support for DRDC COE</p>	<p>other CSE elements for budgets</p>
<p><b>Membership</b></p> <ul style="list-style-type: none"> <li>• International security and intelligence agencies: Institutes for Defence Analysis; CCR Princeton; CCR La Jolla; CCS Bowie; The Heilbronn Institute for Mathematical</li> </ul>	<ul style="list-style-type: none"> <li>• International collaboration broadens knowledge base, makes TIMC more attractive work location</li> <li>• Appears to be developing</li> </ul>	<ul style="list-style-type: none"> <li>• Defence, military connotations may put off some academic researchers</li> <li>• Challenge of negotiating multiple institutional membership arrangements</li> <li>• Classified research may constrain external research</li> </ul>	<ul style="list-style-type: none"> <li>• Adopt Tutte membership model for DRDC COEs</li> </ul>	<ul style="list-style-type: none"> <li>• Security breach could lead to restrictions on membership</li> </ul>

**COE SWOT ANALYSIS BY FEATURE**

**Tutte Institute for Mathematics and Computing (TIMC)**

<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<p>Research</p> <ul style="list-style-type: none"> <li>• Carleton University</li> <li>• The University of Calgary</li> </ul> <p>Additionally, the TIMC is working to develop partnerships with:</p> <ul style="list-style-type: none"> <li>• Canadian research institutes</li> <li>• Canadian governmental agencies</li> <li>• Canadian universities</li> <li>• The TIMC recruits employees and contractors through academic outreach as well as by direct networking. Individuals who are interested in working for the institute are encouraged to submit their CV. Selected applicants are contacted for an interview. <p>Rationale/benefits for academic involvement:</p> <ul style="list-style-type: none"> <li>○ Solve problems in a challenging and meaningful field</li> <li>○ Work that makes a difference</li> <li>○ Access to state-of-the-</li> </ul> </li></ul>	<p>institutional relationships within Canada (vs. working only with individual PIs)</p> <ul style="list-style-type: none"> <li>• Interchange program facilitates movement of personnel between institutions and CSE</li> <li>• Appears to have formal outreach program to academe</li> <li>• Utilizes networking (targeting?) to recruit researchers</li> <li>• Provides “competitive compensation”</li> <li>• Intellectually challenging mission attracts top researchers</li> <li>• State of the art infrastructure attracts top researchers</li> </ul>	<p>planning, oversight</p> <ul style="list-style-type: none"> <li>• Security clearance requirements will stall recruitment</li> </ul>		

**COE SWOT ANALYSIS BY FEATURE**  
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Feature	Strengths	Weaknesses	Opportunities	Threats
<p>art technology</p> <ul style="list-style-type: none"> <li>○ Participation in world class Knowledge Centre</li> <li>○ Advanced collaborative working environment</li> <li>○ Competitive compensation</li> <li>○ Interchange program allows for long-term secondment from universities</li> </ul>				
<p><b>Infrastructure</b></p> <ul style="list-style-type: none"> <li>• Detailed information on infrastructure not available</li> <li>• Co-located with Communications Security Establishment's new building on Ogilvie Road in Ottawa</li> <li>• Housed in a state-of-the-art facility operating on an advanced collaborative work model</li> </ul>	<ul style="list-style-type: none"> <li>• Access to leading-edge infrastructure attractive to external researchers</li> <li>• Infrastructure costs (probably) shared with other parts of CSE</li> </ul>	<ul style="list-style-type: none"> <li>• Remote locate in NCR makes it difficult for many researchers to get to work/home; could dissuade some from participating</li> </ul>	<ul style="list-style-type: none"> <li>• Partnership between DRDC COEs and Tutte on relevant projects</li> </ul>	<ul style="list-style-type: none"> <li>• None apparent</li> </ul>
<p><b>Governance</b></p> <ul style="list-style-type: none"> <li>• No information on governance in the public domain</li> </ul>	<ul style="list-style-type: none"> <li>• Administrative structure in place; assume standard GoC mechanisms</li> </ul>	<ul style="list-style-type: none"> <li>• In-house governance potentially facilitates, accelerates decision making</li> <li>• Tutte governance subsumed</li> </ul>	<ul style="list-style-type: none"> <li>• Adopt Tutte governance model for a classified DRDC COE</li> </ul>	<ul style="list-style-type: none"> <li>• Political call for external program oversight</li> </ul>

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<b>Feature</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Opportunities</b>	<b>Threats</b>
<ul style="list-style-type: none"> <li>Presume standard public sector administrative structure</li> </ul>	<ul style="list-style-type: none"> <li>No need to duplicate “back-office” functions</li> <li>Can leverage CSE administrative structure in order to reduce overhead costs</li> <li>Assume traditional line-reporting structure</li> </ul>	in CSE governance structure; reduces autonomy		