



Tapping The Global Information Base To Build An Innovative Knowledge Society

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31 May 2005



Office of the
National Science Advisor

Bureau du
Conseiller national des sciences

Canada 



The Challenge Ahead

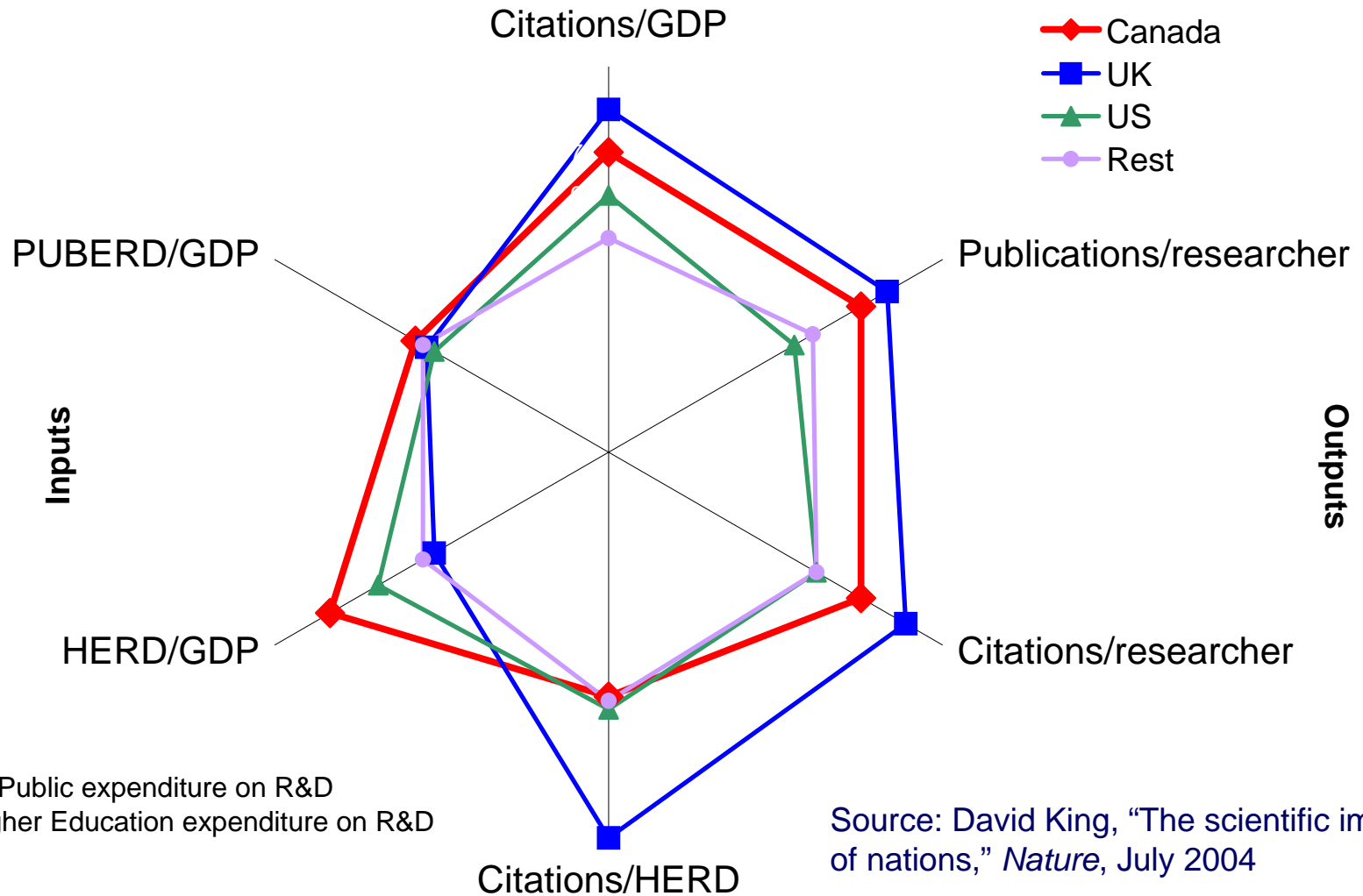
Scholarly Communications At A Crossroads

- Technical library community facing challenges & opportunities
 - Internationalization of S&T
 - Unprecedented flow of data and knowledge
 - Transformative information & communications technologies
 - Complex linkages between R&D, innovation, economic growth and social well-being
- Access to data and information critical to development of an innovative knowledge society
 - Researchers need rapid, unfettered access to data, information & knowledge to perform cutting edge science





Canada's Research Input-output Footprint in the G8



PUBERD = Public expenditure on R&D
 HERD = Higher Education expenditure on R&D

Source: David King, "The scientific impact of nations," *Nature*, July 2004



Canadian Scientific Productivity and Impact

- Canada's scientific productivity in geosciences rates 4th in the world (96 countries)
- Canada has outstanding citation per paper ratings in space sciences as well as clinical medicine, pharmacology, ecology environmental sciences and chemistry.

Field	% of papers from Canada	Relative impact
Geosciences	7.54	6
Ecology/Environmental	7.2	19
Plant & Animal Sciences	6.39	8
Molecular Biology	5.36	3
Computer Science	5.21	8
Biology & Biochemistry	5.05	4
Mathematics	4.69	4
Space Sciences	4.5	55
Engineering	4.48	5
Clinical Medicine	4.41	38
Immunology	4.36	4
Agricultural Sciences	4.3	10
Pharmacology	4.08	20
Chemistry	2.99	18
Physics	2.59	38

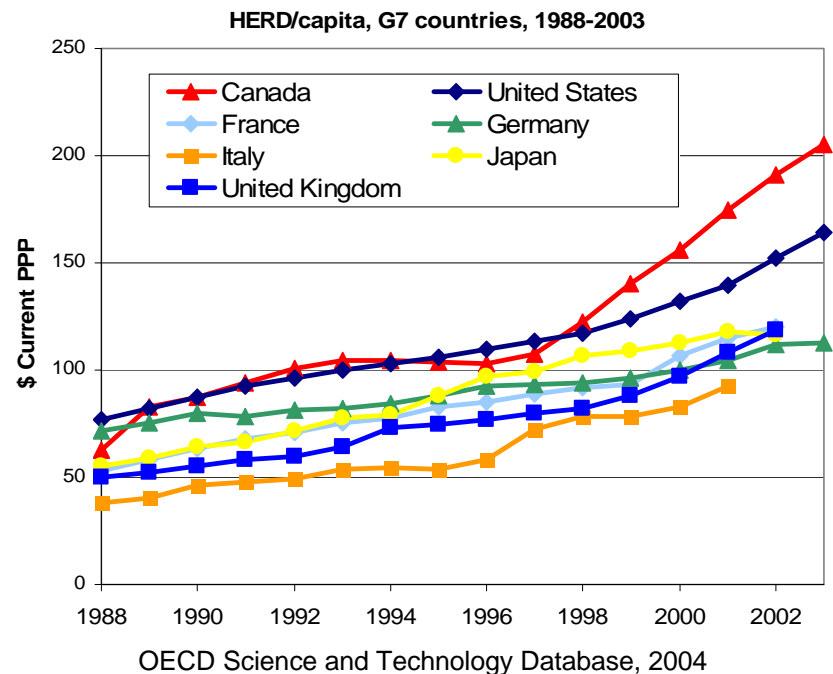
Source: ISI Essential Science Indicators





Canada In International Science

- In 2002-2003, Canada's R&D spending per capita in the higher education sector was highest in G8
- \$13 billion in new Federal S&T funding has been committed to the Higher Education R&D system in Canada from 1997/98 to 2003/04
 - Almost 70% of this has been allocated in the last 4 years
 - Research environment has improved significantly in the academic sector

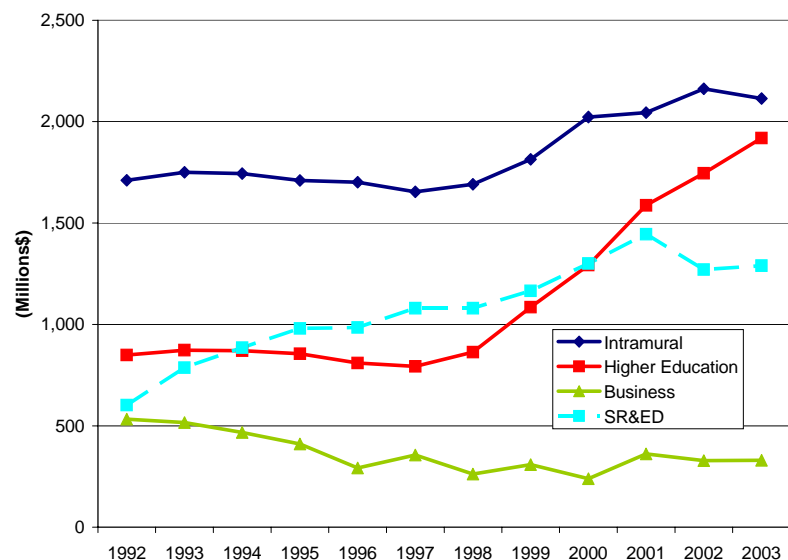




Canadian R&D Overview

- In 2004-2005, total Canadian R&D expenditures are expected to reach \$24.5B
- Total Canadian federal S&T expenditures in 2004-2005 are projected to be \$9.2B, of which 63% (\$5.8B) will be for R&D
- Budget 2005 announced \$1.2B in new direct expenditures in the research base and another \$2.4B in new initiatives with a science, technology and innovation focus particularly under the themes of Climate Change, Sustainable Development and Meeting our Global Responsibilities

Federal direct and indirect expenditures on R&D, by performing sector (1992-2003)*





Canada's 21st Century Challenges

- **Our economic future – productivity, trade and innovation**
 - Canada is a small market, highly trade-dependent nation
- **Our new partners and competitors – emergence of new economic powers – China, India**
 - Moving quickly from low-cost manufacturer to knowledge-based trade
- **Our natural resources**
 - Need to gain sustainable competitive edge through innovations in extraction and production to harness value-added benefits
- **Our environment – Global Warming: A fundamental effect on our economy, ecology and society**
 - North and coastal regions are particularly vulnerable to climate change
- **Our health and security**
 - Aging populations
 - Increasing virulence and rapidity of infectious diseases





Canada's S&T And Innovation Challenges

- Maintain leading G8 position for HERD/GDP and build on strong research base
- Harvest economic and social benefit to Canadians of R&D investments through knowledge transfer and commercialization
- Stimulate industrial R&D expansion and collaboration
- Increase international collaborations across the innovation spectrum
- Revitalize government science to respond to the priority policy challenges facing Canadians
- Develop national strategies in emerging areas – e.g. nanotechnologies, quantum information technology, biotechnology, sustainable energy, environmental technologies & northern science





Canada's S&T And Innovation Challenges

The Sleeping Giant ...

- Canada & other nations must reshape their research communications system to tap into the global information base and maintain the capacity for cutting edge science and innovation

Growing pressures:

- Digitization of data, information & knowledge
- Metadata harvesting
- Rising cost of scholarly publications
- E-publishing
- Internet/On-line searching
- Intellectual property rights
- Privacy, security





Challenge & Opportunity

“Open Access” – Science Meets The Information Commons

Transforming the way the scientific community works and shares its intellectual, analytical and investigative output

- Convergence of scientific disciplines
- Distributed knowledge networks
- Virtual collaborative environments
- New forms of communication (e.g. open publishing)
- Manipulation, archiving & sharing of vast data sets





Challenge & Opportunity

Harnessing The New Power Of Data

New capabilities to collect, analyze and share data will pave the way for scientific breakthroughs on complex issues of global concern.

- GeneBank
- European Bioinformatics Institute (EBI)
- Magnetic Resonance Imaging Data Center (MRIDC)
- Protein Data Bank (PDB)
- Global Biodiversity Information Facility (GBIF)
- International Virtual Observatory (IVO)



High Performance Computing Opportunities

	5 Tflop (2004)	20 Tflop (2006)	80 Tflop (2008)
Climate Modelling	100km atmospheric resolution; 50km ocean resolution	Include atmospheric chemistry and carbon cycle	Full coupling of atmosphere (50km) and ocean (15km);
Nanoscience: Electronic structure of materials		First principles calculation of electronic structure of a 10 000 atom system (interaction of a small cluster of nano-particles)	
Astrophysics		Galaxy formation in cosmic volumes; Supernova simulation; full analysis of cosmic microwave background radiation	
Structural Biology	Simulation of sub-cellular systems at the atomic level		Simulation of full bio-complexes for micro-seconds



Challenge & Opportunity

NSF Biocomplexity Studies

- Researchers integrating international data to study relationship between human & environmental factors
- Databanks used to understand cholera outbreaks:
 - Epidemiology
 - NASA remote sensing
 - Marine biology
 - Microbiology
 - Genomic
 - Social science



NSF



MIT



Challenge & Opportunity

Further Trends

- Internet is becoming a huge database
- More computers have the capacity to interact with people
- Autonomic computing -- computers managing themselves and dealing directly with each other without human oversight
- A demanding new generation of researchers familiar with Information & Communications technologies



U of Waterloo

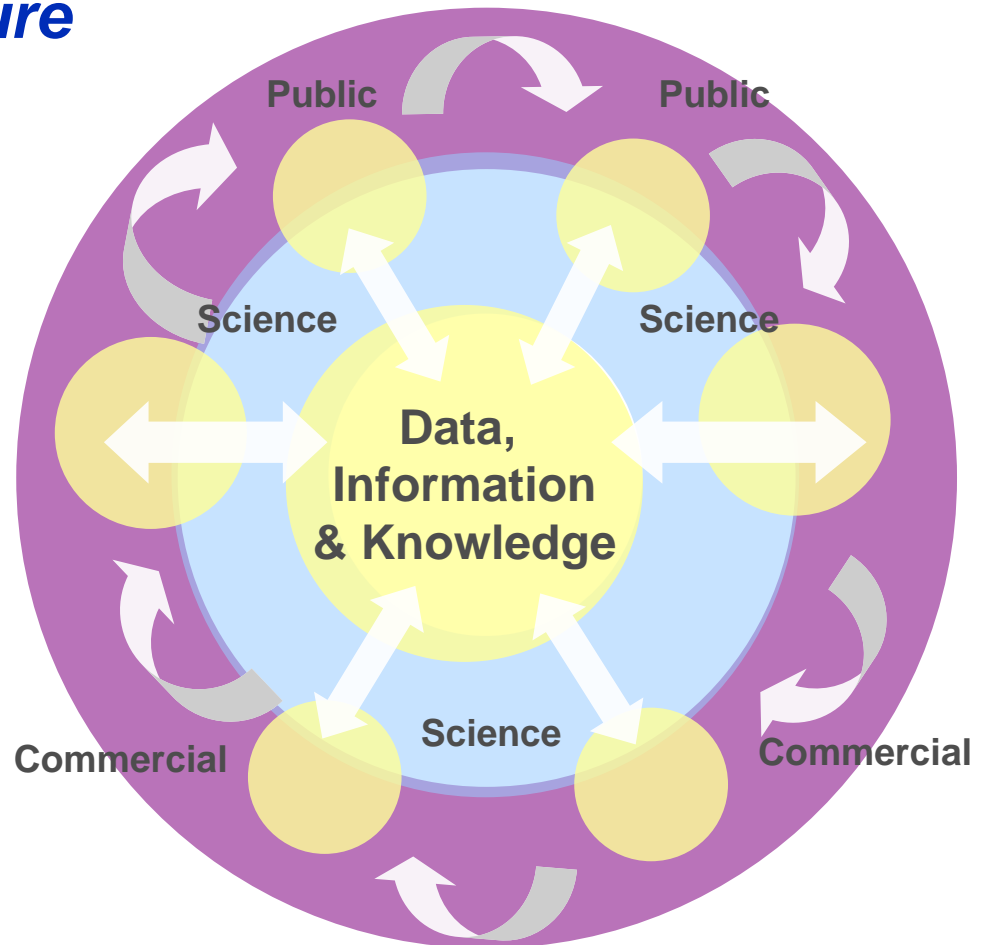


Where Are We Headed?

Looking At The Big Picture

A 21st Century Research Communications System

- Open Access journals, archives & databanks
- Internationally networked
- Wide range of users (including Government, Academia, Industry, NGOS & the Public)





Where Are We Headed?

Advantage To The Early Movers

The countries that move early to build a 21st century Research Communications System – harnessing the full power of “open access” – will be the leaders in building tomorrow’s knowledge economies and innovative societies

- **The U.S., U.K., Germany, France, Netherlands & Australia are all moving ahead**





Where Are We Headed?

International Developments

- Berlin Declaration on Open Access (2003)
- Funding agencies moving towards open access policies
 - Wellcome Trust
 - RCUK
 - NIH requiring researchers to address access to data
- Open publishing gradually gaining supporters
 - U.K.: Jisc providing free university access to Biomed Central
 - U.S.: PLoS rolling out open access journals
- OECD Ministerial Declaration on Access to Research Data (2004)
- Canadian consultations on scholarly communications and open access to publicly funded research data
 - SSHRC, CARL and NCASRD





A Vision Of The Future

What Would A 21st Century Research Communication System Look Like?

Goal: Maximizing the impact of research knowledge for society

Realized By: Providing pathways (through individual & institutional connections) for the rapid circulation, effective management & preservation of data, information & knowledge

Guiding Principles:

- All nations should have the capacity to access & contribute to the vitality of the system
- Open access to data, information & knowledge





A Vision Of The Future

Key Characteristics ***(a Canadian perspective)***

- Takes full advantage of enormous potential of new ICT
- Capable of handling unprecedented flow of information in wide variety of formats
- Brings Canadian research knowledge to the world and the world's research knowledge to Canada
- Does not place unwarranted additional burdens on researchers, research librarians & their institutions
- Is accessible by all Canadians – ensuring that public investment in scientific research leads to economic, social and cultural benefits





A Vision Of The Future

Any Researcher Could Access

- Full text of most journal articles & extensive back issues
- Monographs & theses
- Relevant research data supporting published outcomes
- Powerful search engines
- Research reports, conference proceedings & non-peer reviewed research materials
- Discussion forums, contact lists, directories & other basic information sources
- Electronic tools to customize channels of communication (websites, weblogs, etc.)

... From Their Desktop





From Vision To Reality

Canada's Building Blocks

- *Canada's university research libraries* are developing a network of institutional repositories (26 to date)
- *NRC's Canada Institute for Science and Technical Information (CISTI)* publishes scientific, technical & medical research literature and provides web-based document searching, order & delivery from its own & partner collections
- *National Library and Archives of Canada* is a world leader in the management of electronic materials & long-term archival preservation of digital objects





From Vision To Reality

Canada' Building Blocks (cont'd)

- *CANARIE Ca*Net4* connects every Canadian university with a high capacity optical data pipeline
- *Canada's High Performance Computer Network* gives researchers access to high performance computational power & short- and medium- term storage capacity
- *Érudit* (a non-profit electronic publication service) provides journals with a full range of manuscript preparation, file management, electronic publication & repository services
- *Research Councils & Foundations* (NSERC, SSHRC, CIHR, CFI & others) provide financial support & regulatory frameworks





From Vision To Reality

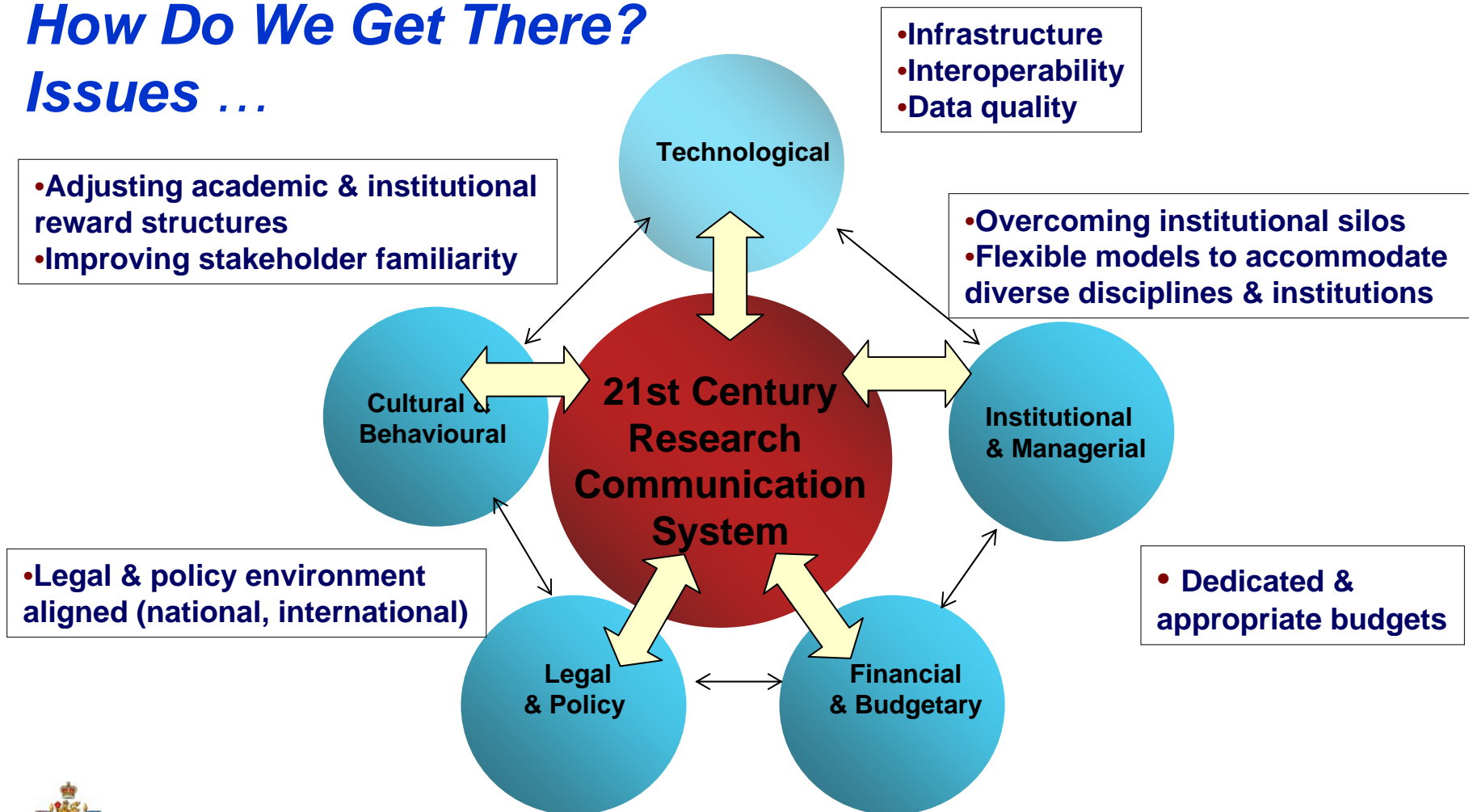
Three Proposals

- *Federal eLibrary (FSeL)* – The Strategic Alliance of Federal Science and Technology Libraries is proposing the creation of a virtual library for use by all Government of Canada scientists, S&T researchers & policy analysts
- *SSHRC and Canada Foundation for Innovation* – are supporting development of a SYNERGIES PROJECT
- *National Data Infrastructure* – the National Consultation on Access to Scientific Research Data (NCASRD) has recommended the creation of a national data infrastructure to ensure open and secure access to key databases of scientific & historical importance to Canada



Building A 21st Century System

How Do We Get There? Issues ...



Building A 21st Century System

Scientific Progress & Social Justice

- A 21st Century Research Communications System must effectively engage the developing world
- Uneven distribution of OA Archives (2005)
 - United States: 114
 - United Kingdom: 51
 - Germany: 28
 - Canada: 26
 - India: 6
 - China: 4



IDRC

(Source: Stevan Harnad, Southampton OA Conference & SSHRC)



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Building A 21st Century System

What Can You Contribute?

- IATUL & Technical Library Community can bring a unique perspective to the policy process
 - Knowledge of technical & managerial challenges
 - Position to facilitate discussion & collaboration across disciplines
 - International awareness & linkages





Building A 21st Century System

Key Points To Remember

As a global community, we must maximize the impact of scientific, technological and medical research for the benefit of society as a whole.

- Data, information & knowledge are fundamental to innovation, economic growth and social-well being around the globe
- Building a 21st Century Research Communication System is a national and international challenge: all nations must have the capacity to tap into the global information base
- We can build on existing strengths. Leveraging national, international & multidisciplinary partnerships will be essential to making the transition
- We must act now or the system will become unmanageable: highly valuable information & data will be lost





Building A 21st Century System

Leadership: Vision and Practicalities

“The world needs uninhibited thinkers, not afraid of far out speculation; it also needs hard-headed conservative engineers who can make their dreams come true.”

Arthur C. Clarke





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