Critical Infrastructure Interdependency (CII) through real-world case studies from the U.S. and Canada with a focus on financial industries and cross-border interdependencies.

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Session Description

This session explores Critical Infrastructure Interdependency (CII) through real-world case studies from the U.S. and Canada with a focus on financial industries and cross-border interdependencies.

Attendees will learn how cyber connectivity and economic indicators are correlated and can forecast cascading impacts across industries and CI sectors.

The session highlights how to improve risk management and resilience planning, including an overview of a new risk assessment taxonomy and methodology for CII from Carleton University's National Centre for Critical Infrastructure Protection, Security and Resilience. (NC-CIPSeR)

Open Science @ Carleton University, Ontario

The mission of the **National Centre for Critical Infrastructure Protection, Security and Resilience (NC-CIPSeR)** is to develop and conduct multidisciplinary research in critical infrastructure protection with the goal of enhancing the safety and security of the Canadian population.

Open Science

The research prioritizes open science by sharing methodologies, data, and results widely.

https://carleton.ca/cipser

NC-CIPSeR

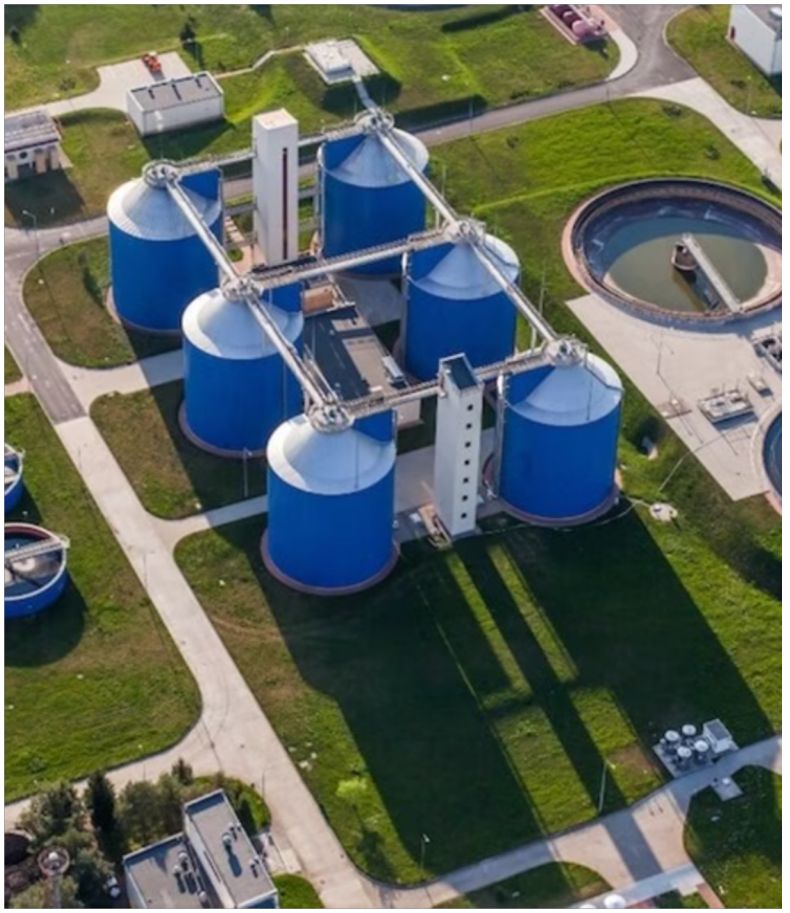
Defining Critical Infrastructure (CI)

The physical structures, facilities, networks and other assets which provide services that are essential to the social and economic functioning of a community or society.

United Nations Office for Disaster Risk Reduction (UNDRR). 2017. The Sendai Framework Terminology on Disaster Risk Reduction. "Critical infrastructure". https://www.undrr.org/terminology/critical-infrastructure.

Or,

Critical infrastructure encompasses essential goods and services that underpin the safety, security and prosperity of modern society.



What is Critical Infrastructure Interdependence?

Critical infrastructure interdependence (CCI) refers to the reliance of different infrastructures **on each other**.

When one system experiences a disruption, it can trigger cascading supply-chain effects across other sectors and industries.

“Intermediate Consumption” is the focus, but “Final Consumption” can be brought into scope.

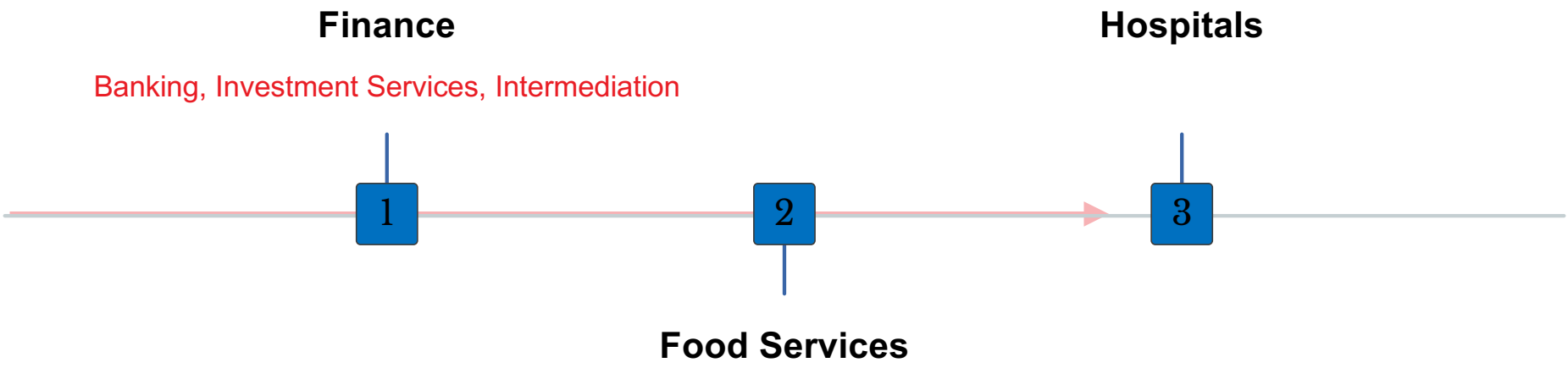
What are Critical Infrastructure Sectors?

- Energy
- Communications and IT
- Finance
- Healthcare
- Food
- Water
- Transportation
- Safety
- Government
- Manufacturing

- Energy
- Dams
- InfoTech
- Communications
- Finance
- Healthcare and Public Health
- Food and Agriculture
- Water
- Transportation
- Safety
- Government
- Chemical
- Critical Manufacturing
- Defense Industrial Base
- Nuclear
- **Commercial Facilities**

- Communications
- **Data storage or processing**
- Defense
- Energy
- Financial services and markets
- Food and grocery
- Health care and medical
- Space technology
- Transport
- Water and sewerage
- **Education and research**

Example of CII: “Finance cascade”



Why Understand CI Interdependency (CII)?

Risk Management

CII metrics can provide direct input and guidance to the “impact” dimension of risk.

Inform Policy and Regulation

Underpin decisions with metrics. Effectively governance requires more than just intuition. A data-driven approaches provides a structured and reliable framework for understanding and managing risk.

Planning and Exercising

Exercisers can model potential vulnerabilities and develop appropriate strategies.

Common CI Risk Management Gaps

Definitions

Critical infrastructure definitions vary widely, leading to confusion and hindering effective risk management.

Missing sectors

Existing definitions are often OLD or based on intuition and may not include emerging critical industries.

Limited Sector engagement

There's limited engagement with industry sectors when defining and implementing critical infrastructure policies and regulations.

Repeatable results

A reliance on Subject Matter Expert opinions and intuitions generate different answers each time a question about risk is asked.

Indicators of Interdependency

Cyber Metrics

Scope

Data sensitivity within critical infrastructure sectors.

Normal operating conditions.

Design

Three questions.

Cyber sensitivity.

Scale: 1 (lowest) to 10.

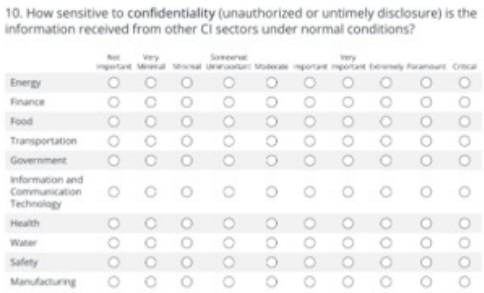
Respondents

Security Executives

IT Executives

Canadian Industries

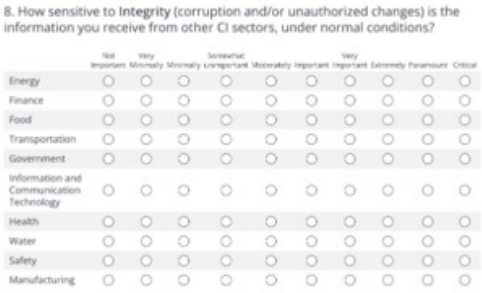
Confidentiality



10. How sensitive to **confidentiality** (unauthorized or untimely disclosure) is the information received from other CI sectors under normal conditions?

	Not Important	Very Minimal	Minimal	Somewhat Unimportant	Moderate	Important	Very Important	Extremely	Paramount	Critical
Energy	○	○	○	○	○	○	○	○	○	○
Finance	○	○	○	○	○	○	○	○	○	○
Food	○	○	○	○	○	○	○	○	○	○
Transportation	○	○	○	○	○	○	○	○	○	○
Government	○	○	○	○	○	○	○	○	○	○
Information and Communication Technology	○	○	○	○	○	○	○	○	○	○
Health	○	○	○	○	○	○	○	○	○	○
Water	○	○	○	○	○	○	○	○	○	○
Safety	○	○	○	○	○	○	○	○	○	○
Manufacturing	○	○	○	○	○	○	○	○	○	○

Integrity



8. How sensitive to **Integrity** (corruption and/or unauthorized changes) is the information you receive from other CI sectors, under normal conditions?

	Not Important	Very Minimally	Minimally	Somewhat Unimportant	Moderately	Important	Very Important	Extremely	Paramount	Critical
Energy	○	○	○	○	○	○	○	○	○	○
Finance	○	○	○	○	○	○	○	○	○	○
Food	○	○	○	○	○	○	○	○	○	○
Transportation	○	○	○	○	○	○	○	○	○	○
Government	○	○	○	○	○	○	○	○	○	○
Information and Communication Technology	○	○	○	○	○	○	○	○	○	○
Health	○	○	○	○	○	○	○	○	○	○
Water	○	○	○	○	○	○	○	○	○	○
Safety	○	○	○	○	○	○	○	○	○	○
Manufacturing	○	○	○	○	○	○	○	○	○	○

Availability

6. How important is the **availability** (timely delivery and/or unauthorized deletion) of data received from the following critical infrastructure sectors? (Sector Definitions.)

	Not Important	Very Minimal	Minimal	Somewhat unimportant	Moderately Important	Important	Very Important	Extremely Important	Paramount importance	Absolutely critical
Energy	○	○	○	○	○	○	○	○	○	○
Finance	○	○	○	○	○	○	○	○	○	○
Food	○	○	○	○	○	○	○	○	○	○
Transportation	○	○	○	○	○	○	○	○	○	○
Government	○	○	○	○	○	○	○	○	○	○
Information and Communication Technology	○	○	○	○	○	○	○	○	○	○
Health	○	○	○	○	○	○	○	○	○	○
Water	○	○	○	○	○	○	○	○	○	○
Safety	○	○	○	○	○	○	○	○	○	○
Manufacturing	○	○	○	○	○	○	○	○	○	○

3	BS111CL0	Cannabis production (licensed)	44,614	2,282	165,347	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
4	BS111CU0	Cannabis production (unlicensed)	.	.	137,128	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
5	BS112A00	Animal production (except aquaculture)	709,213	277	180	.	4,005,585	45,456	3,029	2,017	51	738	1,532	1,172	137	43	312	320	6	
6	BS112500	Aquaculture	13	3	1	.	12,955	22,299	35	3,426	3	3	316	206	51	.	69	40	1	
7	BS113000	Forestry and logging	603	1,225	24	.	282	43	231,385	75	46	109	2,426	1,656	254	77	583	323	16	
8	BS114000	Fishing, hunting and trapping	.	.	.	.	.	53,887	.	8,407	.	.	.	.	.	.	.	.	.	
9	BS115A00	Support activities for crop and animal product	1,001,687	51,243	25,327	.	718,986	19,110	.	.	.	.	.	2	.	.	2	.	.	
10	BS115300	Support activities for forestry	.	.	.	.	.	.	1,897,339	.	.	31,383	.	.	.	.	.	.	.	
11	BS211110	Oil and gas extraction (except oil sands)	129,723	169,010	56,656	.	141,607	10,130	17,255	711	6,804	3,505	1,662,320	3,019,855	48,508	181	65,658	43,747	21,85	
12	BS211140	Oil sands extraction	1,619	413	179	2,328	1,565	119	1,852	40	367	211	36,521	485,105	6,320	1,937	8,638	5,635	2,05	
13	BS212100	Coal mining	1	.	.	.	.	.	2	.	.	.	31	20	5	.	7	4	.	
14	BS212210	Iron ore mining	68	8	12	.	33	3	13	2	.	13	67	48	.	102,772	20	4	.	
15	BS212220	Gold and silver ore mining	489	61	1	6	215	72	1,293	29	246	158	26,204	17,034	4,401	21	6,323	3,403	1,49	
16	BS212230	Copper, nickel, lead and zinc ore mining	1,819	229	77	.	863	154	2,076	77	347	431	38,395	24,754	6,304	100	9,111	4,902	2,56	
17	BS212290	Other metal ore mining	103	13	.	.	45	15	278	5	52	32	5,585	3,599	1,428	1,112	27,695	10,730	8,07	
18	BS212310	Stone mining and quarrying	141	17	3	.	63	17	278	8	50	52	10,053	8,020	964	411	3,993	58,094	92	
19	BS212320	Sand, gravel, clay, and ceramic and refractor	933	119	64	.	462	43	197	36	3	222	22,864	21,950	1,171	4,004	61,109	59,806	8,58	
20	BS212392	Diamond mining	66	8	3	.	32	5	58	3	9	15	1,028	658	167	3	226	124	5	
21	BS21239A	Other non-metallic mineral mining and quarry	24	3	.	.	10	3	62	51	12	9	84,967	115,989	1,978	261	5,163	14,259	1,32	
22	BS212396	Potash mining	438,029	17	.	.	60	21	372	7	70	42	7,656	5,077	1,650	878	22,561	8,882	3,35	
23	BS21311A	Support activities for oil and gas extraction	372	46	.	.	162	55	1,002	24	188	118	6,908,749	2,797,768	3,418	.	4,563	2,508	1,11	
24	BS21311B	Support activities for mining	69	8	.	.	29	10	182	8	34	25	3,943	3,061	14,828	.	33,025	786,142	398,601	110,95

Quantitative Econometric Metrics

Flow of INTERMEDIATE Goods and Services in Canada

- INTERMEDIATE vs FINAL Consumption
  - INTERMEDIATE = used to produce other goods/services
  - FINAL = Consumed as finished good/service
- Input – Output / Supply – Use tables
- Including Import / Exports = Cross-border dependencies

Open-Source Statistics

- Ex. Bureau of Economic Analysis, Stats Canada
- Most OECD (Organisation for Economic Co-operation and Development) countries publish Input – Output tables.
- Often 2 to 3 years in arrears.

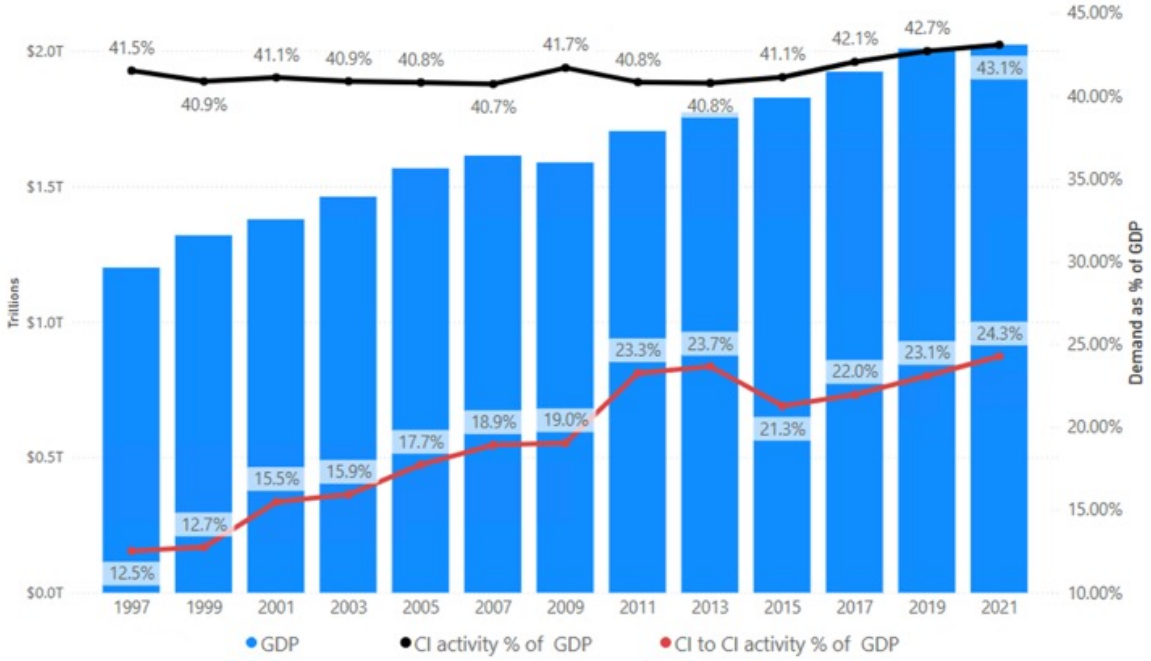
Changing CI supply chain: 1997-2021

Black line: CI sector activity as percentage of total GDP.

Red line: CI Intra-sector spending as percentage of GDP.

Observations: CI sectors are spending 80%+ more resources on each other now than 25 years ago.

<u>Conclusion</u>: CI Supply-chain interdependence has become more intense.



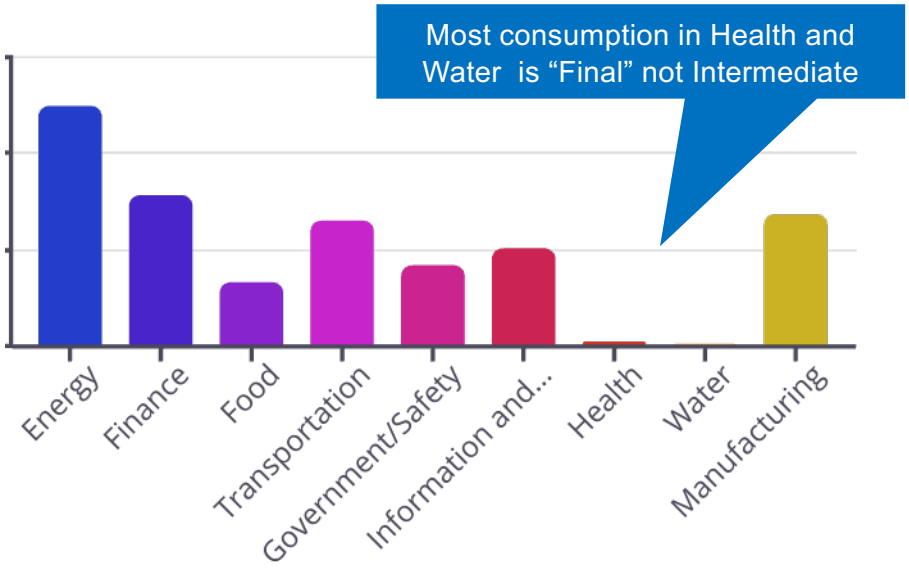
Full paper available from NC-CIPSeR – Carleton.ca/cipser

Carleton University

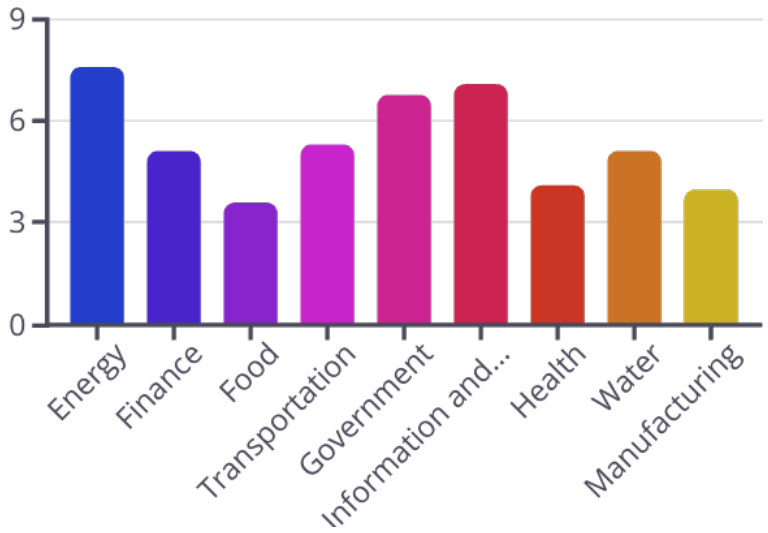
Correlation of Cyber <> Econometrics

Energy Survey 2024: Spending versus Cyber

Spending in CI Supply Chain (Log Scale)



Cyber - Data Sensitivity (1 to 10 scale)



2024 Econometric to Cyber Correlation *0.65 (Moderate to Strong)*

2007 Correlation *0.77 (Strong)*

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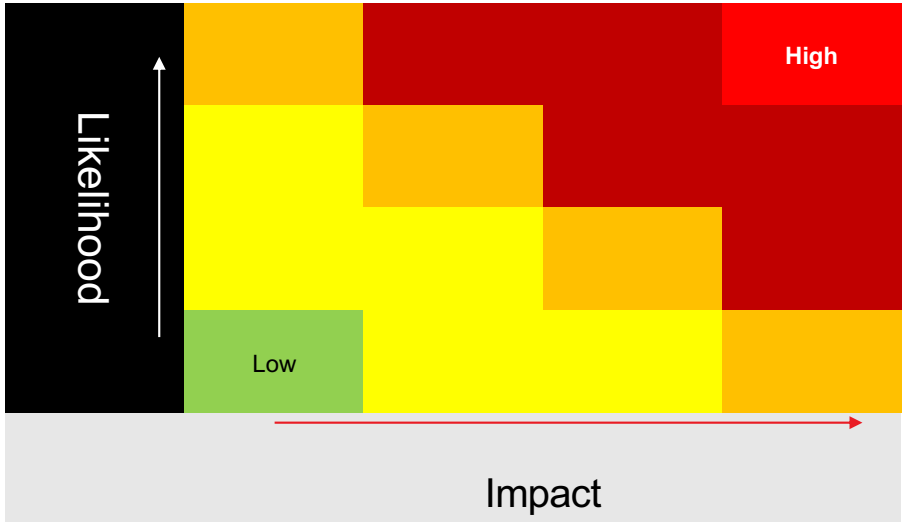
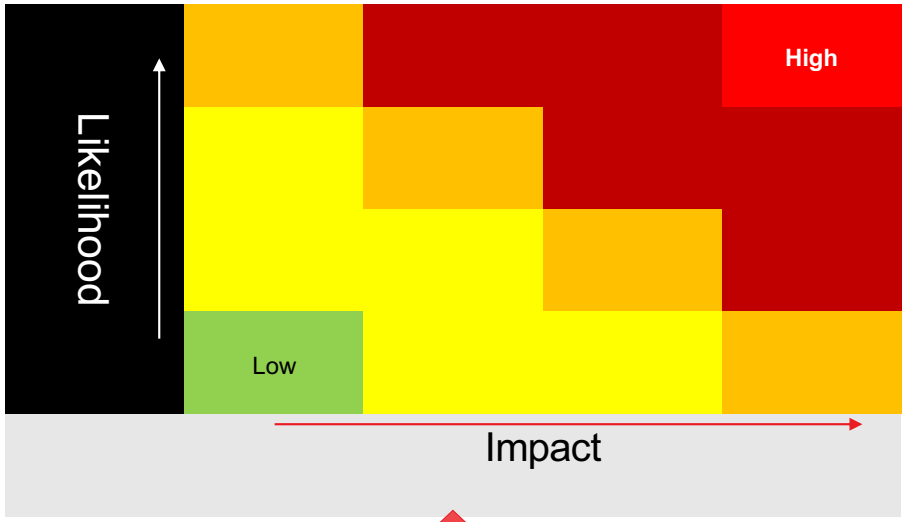
Critical Infrastructure Risk matrix



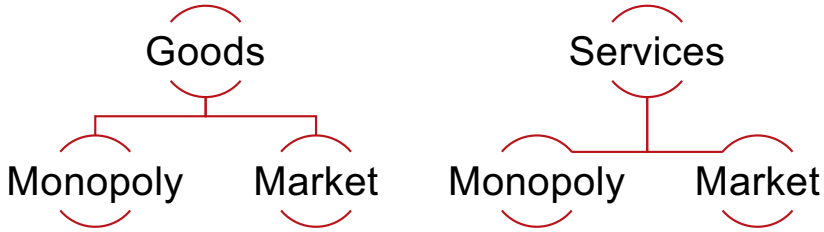
Impact: Using CII Metrics in Risk Assessment



CII metrics

Likelihood: Applying a CI Taxonomy

CI Industrial Taxonomy



Class	Sectors (Industries)
Class 1 – Monopoly Services	Energy (Electricity), Government
Class 2 – Market Services	Finance, Communications, Health, Transportation
Class 3 – Monopoly Goods	Manufacturing, Water
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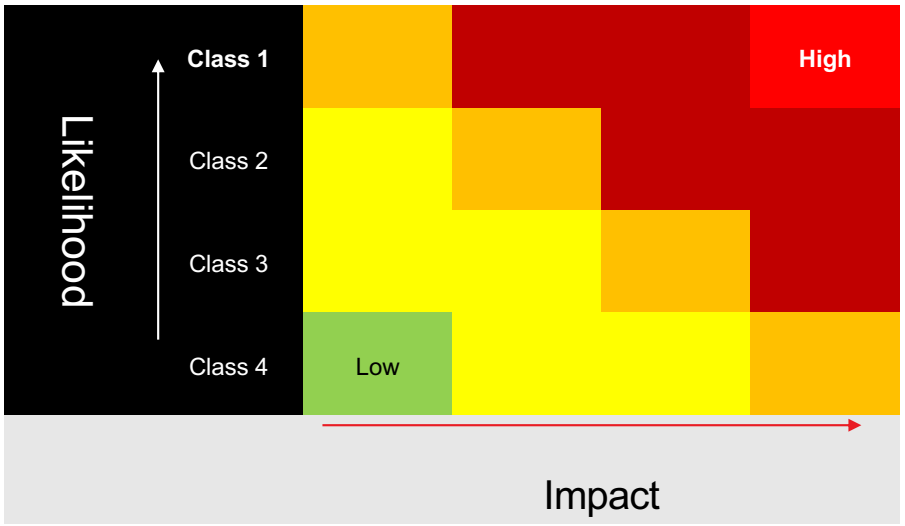

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Financial Institution (FI) vulnerabilities to cross-border trade

National and Provincial-level views

Financial Sector Defined – Components Industries

StatsCan North American Industrial Classification Scheme (NAICS) 2022

Q: Which industries are considered under existing Federal definitions?

- BS521000 Monetary authorities - central bank
- BS5221A0 Banking and other depository credit intermediation
- BS522130 Local credit unions (implied)
- BS52A000 Financial investment services, funds and other financial vehicles
- BS524100 Insurance carriers

What about:

BS522200 Non-depository credit intermediation
BS522300 Activities related to credit intermediation
BS524200 Agencies, brokerages and other insurance related activities <-

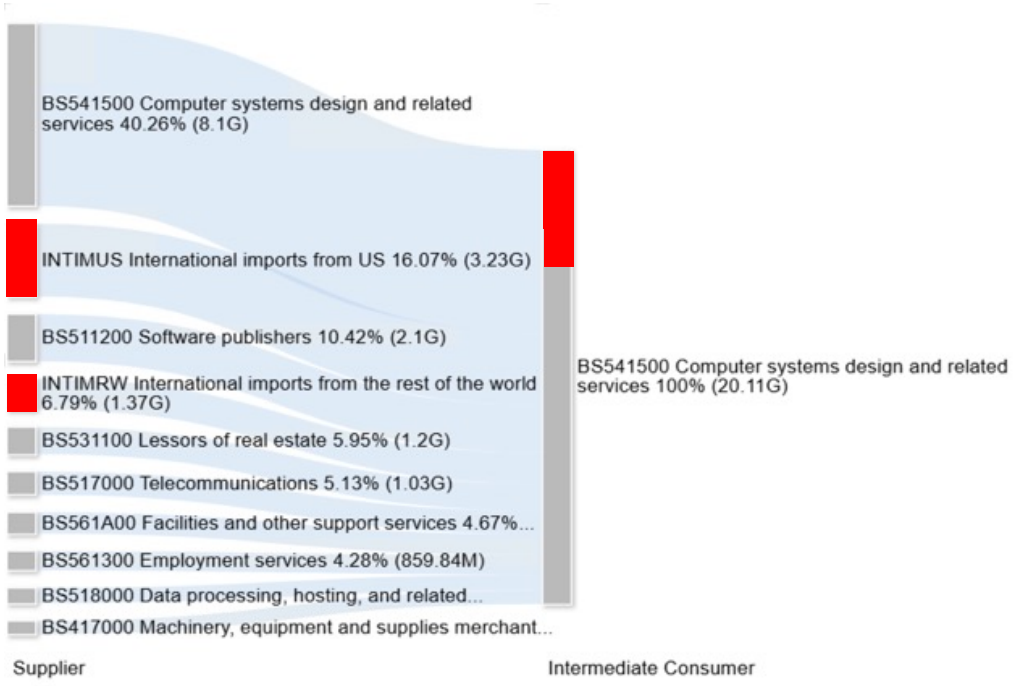
Critical Cross-border Services

What is BS5415 and why do we care?

- BS5415 - Computer systems design and related services
  - Managed software
  - Managed data centres and processing centres
  - Other professional and technical computer-related services
- $60B Domestic intermediate industry in Canada
- $5B in Imports intermediate (70% from the US)
- Imports of BS5415 accounts for ~2% total U.S. imports of ~$200B but much larger proportional impact on CI
- FI sector uniquely vulnerable

BS5415 in the Canadian Supply Chain

IMPORTS



- 25% of “domestic” BS5415 intermediate supply is imported
  - Re-selling, integrators, bundling

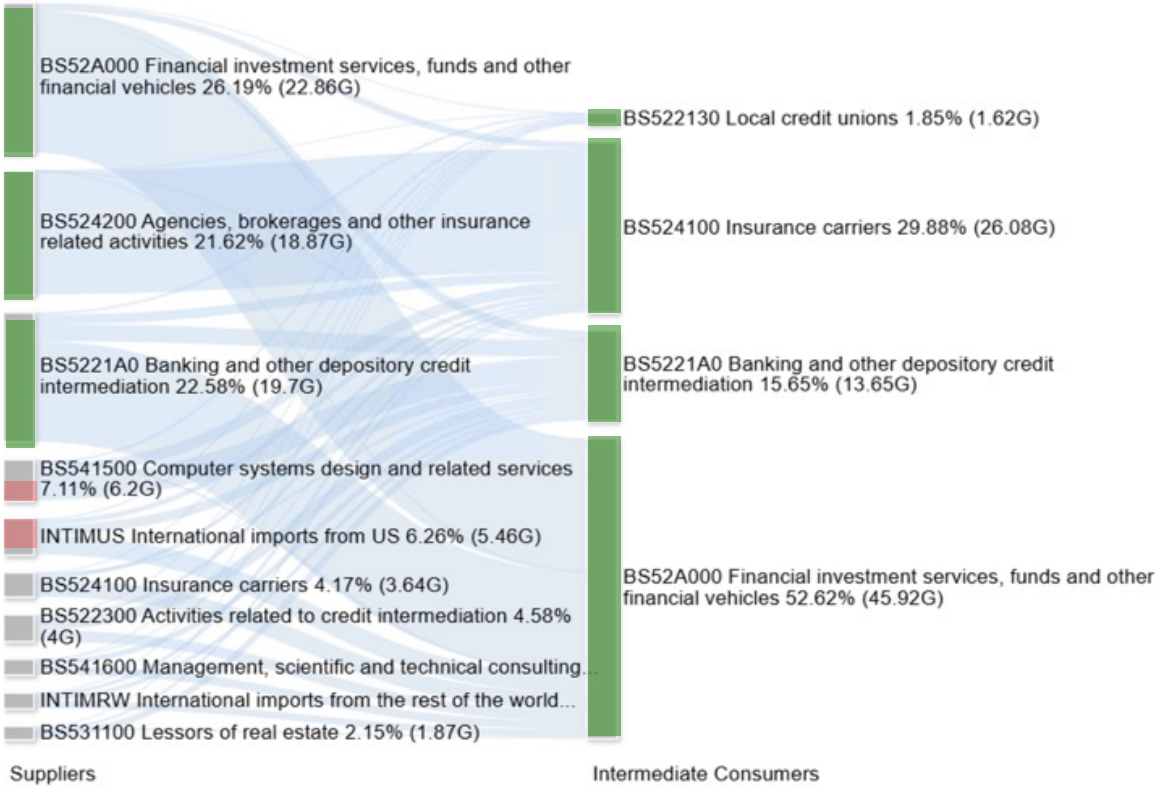
BS5415 in Canadian FI

Largest FI CI dependency is on other Canadian FIs (typical of any CI sector)

IMPORTS

25% originates in U.S.

70% is BS5415



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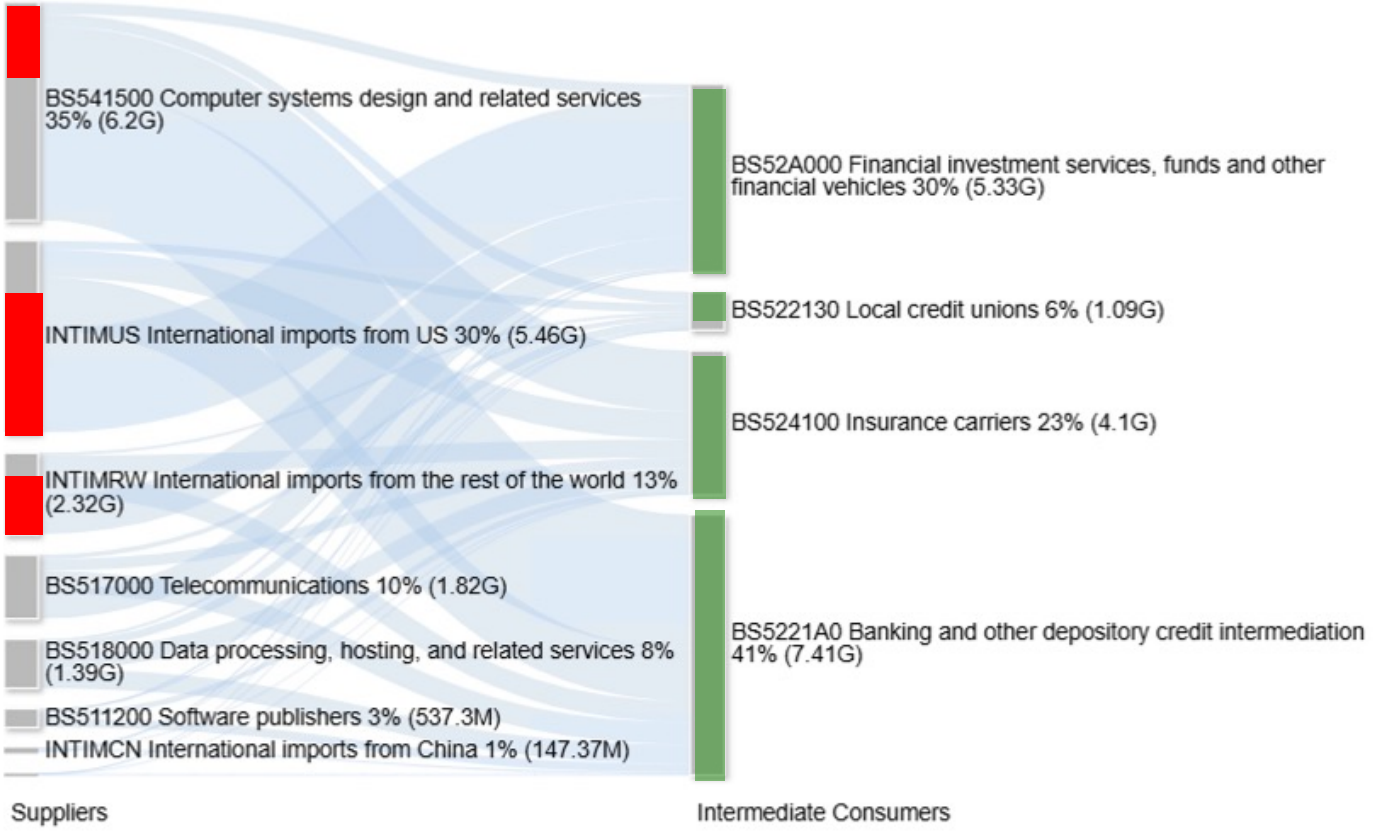
BS5415 in Canadian FI w/out Intra-FI trade

IMPORTS



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Case Study – March 2024

Manitoba CII Case Study – Spring 2024

Full paper available from NC-CIPSeR – Carleton.ca/cipser

Fuel Pipeline Shutdown

The only fuel pipeline from the US border to Manitoba experiences an emergency shutdown due to maintenance requirements.

Wastewater Main Rupture

A major wastewater main in Winnipeg ruptures, releasing 4 billion liters of untreated water into the Assiniboine River.

Cascading Effects

These disruptions have cascading effects across the province, affecting transportation, water quality, and public health.

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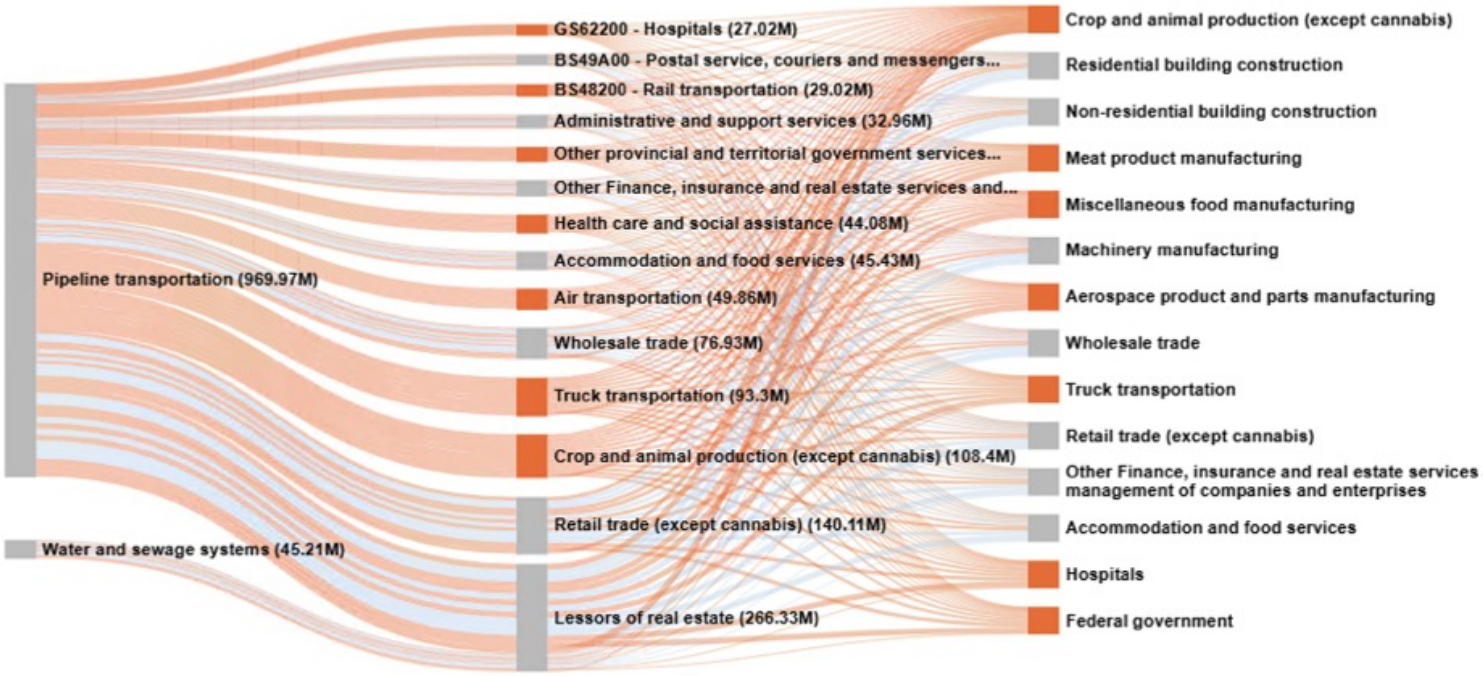
Manitoba CII Case Study – Spring 2024

Downstream cascading impacts from concurrent CI impacts: Pipeline (Energy) and Wastewater (Water)



Sector	Industrial impacts	$M
Transport	4	$173
Food	4	$108
Manuf	1	$99
Health	2	$44
Gov/Safety	2	$35

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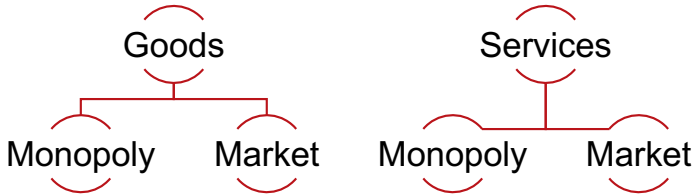
Manitoba Case Study – Modeled Risk

CI Industrial Taxonomy



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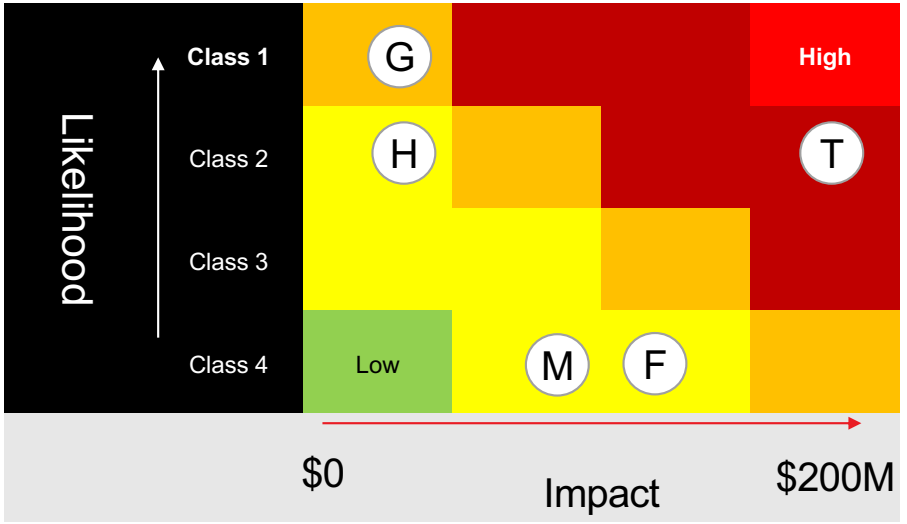

T Transport
M Manuf
G Gov / Safety
F Food
H Health

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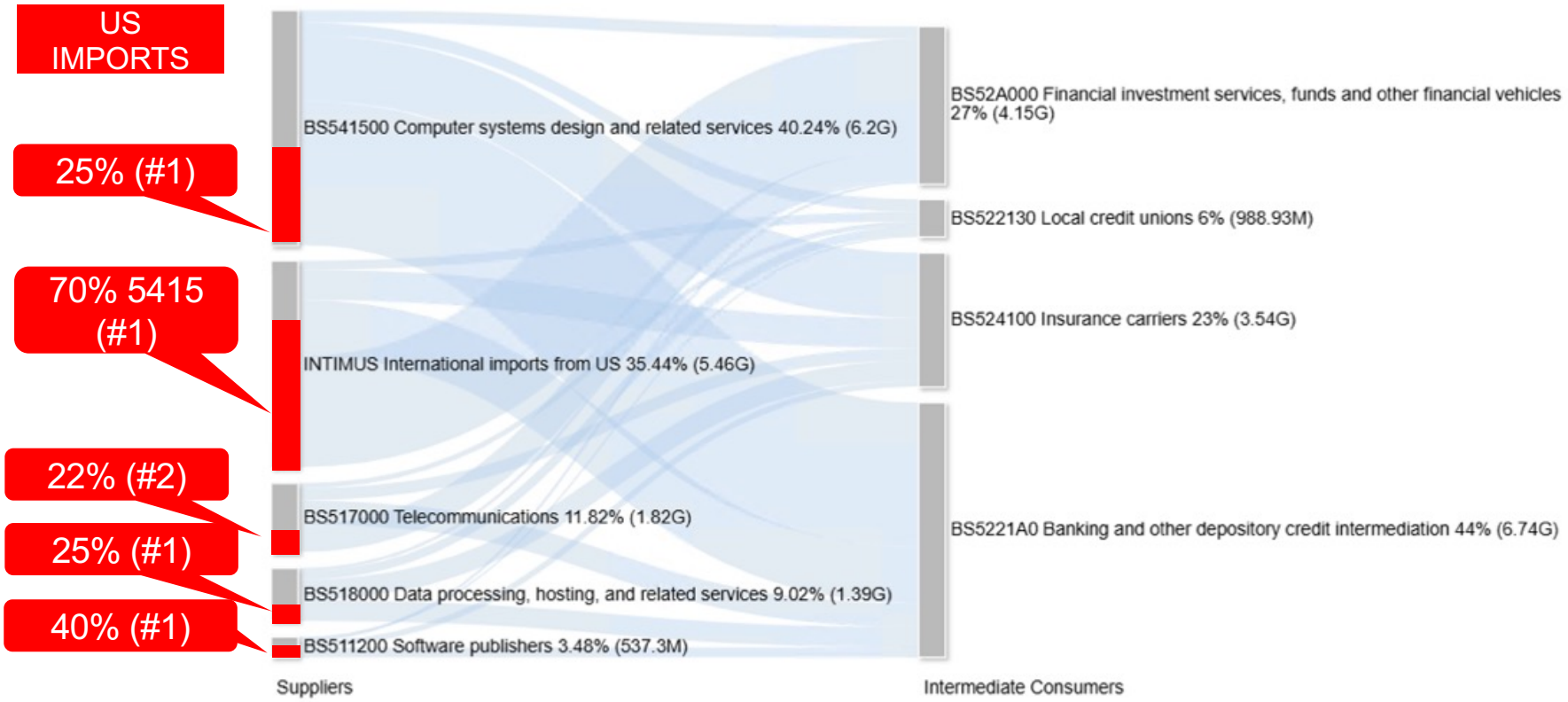
Telecom <> FI Case Study (National level)



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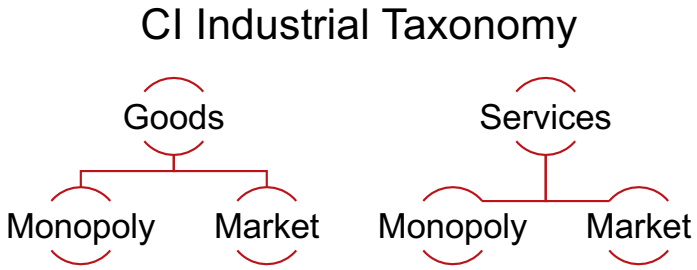
Telecom <> FI Case Study – Modeled Risk



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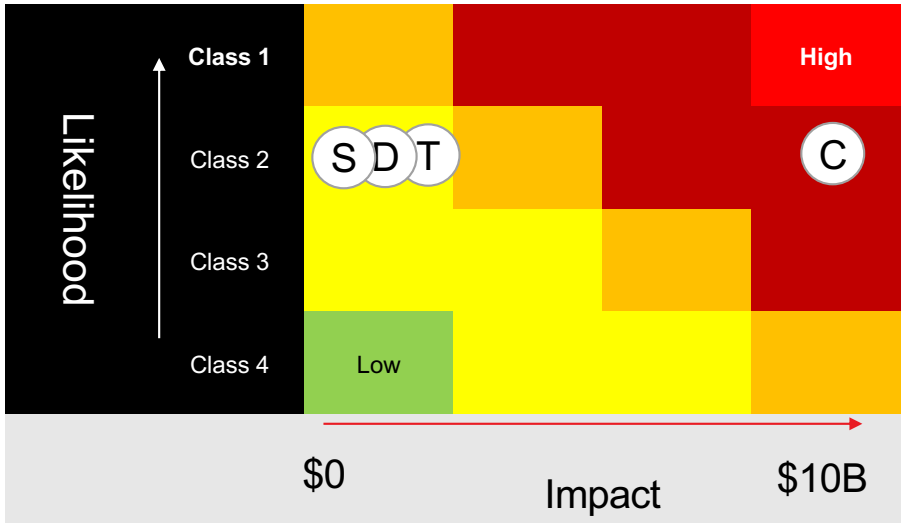

C BS5415 - Comp Sys

D BS5180 - Data Pro

T BS5170 - Telecom

S BS5112 - Software

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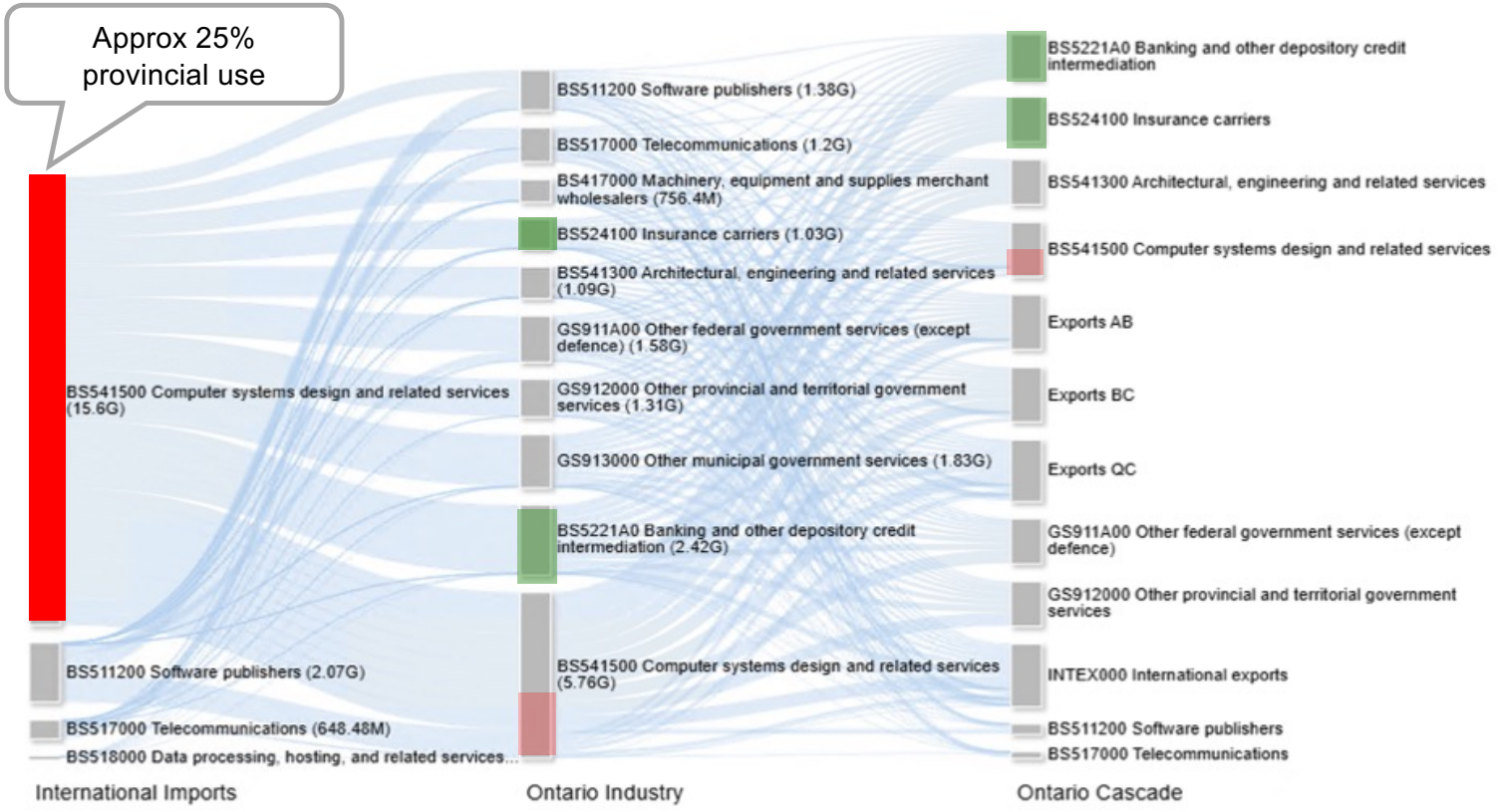
BS5415 Cascading Dependency

Ontario Provincial level



- FIs in Ontario 2x more exposed to cross-border BS5415 risks due to cascading impacts
- Government is next most exposed
- Inter-provincial trade by FIs exposes other CIs to interdependence risk

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Review of Cross-border Physical Dependencies

Laws in the U.S. and EU allow for lawful access to data “no matter where it is located”.

The Register

Microsoft admits it 'cannot guarantee' data sovereignty

Under oath in French Senate, exec says it would be compelled – however unlikely – to pass local customer info to US admin

Paul Kunert Fri 25 Jul 2025 // 13:00 UTC

Council of the EU

PRESS
EN

PRESS RELEASE
48/23
25/01/2023

Electronic evidence: Council confirms agreement with the European Parliament on new rules to improve cross-border access to e-evidence

EU member states' ambassadors today confirmed the agreement reached between the Council presidency and the European Parliament on the draft regulation and the draft directive on cross-border access to e-evidence. The agreed texts will make it possible for the relevant authorities to address judicial orders for electronic evidence directly to service providers in another member state.

Cross Border IXPs

- 23 IXPs supporting Canada (Source: Internet Society)
- 12 are in Canada – most of the rest are US-based
- 407,000 routes identified as Canadian in total
- ~260,000 routes sourced from Canada (63%)
  - Most Canadian hosting is inside Canada
  - 52,000 (13%) of these “boomerang” through the US and Europe
- ~147,000 (37%) are not logically inside Canada

50% of Canada-to-Canada routes pass outside Canada – mostly through the US.

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Content Management

- 60% of DC capacity is US-owned
- 98% of Office software is US-owned
- 100% Content Delivery Networks (CDNs) are foreign owned

CDN	POPs	Cities	Origin
AdvancedHosting	0	Toronto (planned)	Netherlands
Akamai (600+ CA customers)	1(?)	Montreal?	United States
BelugaCDN	2	Quebec, Toronto	United States
Bunny CDN	3	Montreal, Toronto, Vancouver	Slovenia
BytePlus	2	Toronto (planned), Montreal	Singapore – Owned BY TIKOTOK BYTE DANCE
CacheFly	3	Calgary, Toronto, Montreal	United States
CDN77	1	Toronto	United Kingdom
CDNetworks	2	Montreal, Toronto	Singapore
CDNvideo	2	Montreal, Toronto	Russia

CDN	POPs	Cities	Origin
Cloudflare (500+ CA customers)	8	Calgary, Halifax, Montreal, Ottawa, Saskatoon, Toronto, Vancouver, Winnipeg	United States
CloudFront	3	Montreal, Toronto, Vancouver	United States
Edge Next	4	Halifax, Montreal, Toronto, Vancouver	Singapore
Fastly	4	Calgary, Montreal, Toronto, Vancouver	United States
Imperva	2	Toronto, Vancouver	United States
Lumen	1	Toronto	United States
Mediannova	1	Toronto	Turkey
StackPath	1	Toronto	United States
Tencent Cloud	1	Toronto	China

Call to Action

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