Cybersecurity
Implications for ICT and Smart Societies

S. Massoud Amin, D.Sc.
Director & Honeywell HW Sweatt Chair, Technological Leadership Institute
Professor of Electrical & Computer Engineering
University Distinguished Teaching Professor
University of Minnesota

Chairman, IEEE Smart Grid
Director, Board of Directors, Texas Reliability Entity (TRE)
Director, Board of Directors, Midwest Reliability Organization (MRO)

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Cybersecurity

Changing Risks
Cyberspace
Cyber Activism
Cyber Insurance
Cyber War
Cyberattack
Cyber-Alert
Cyber Bullying
Cyber-ethics
Cyber crime
Cyber FININT
Cyberpower
Cybersecurity
Cyber-Commerce
Cyber Espionage
Cyber Law
Cyber Communication

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Currently, there are 16 industry sectors defined as critical infrastructure

85% of critical infrastructure is in private sector *hands*[1]

Trends exposing industry to increased risk
- Interconnectedness of sectors
- Proliferation of exposure points
- Concentration of assets

Critical infrastructure sectors

- Agriculture and Food
- Banking and Financial Services
- Chemical
- Commercial Facilities
- Communications
- Dams
- Defense Industrial Base
- Emergency Services
- Energy
- Government Facilities
- Healthcare/Pub. Health
- Information Technology
- Nuclear Reactors, Materials and Waste
- Transportation Systems
- Water and Wastewater Systems
- Critical Manufacturing

1 GAO Report, Critical Infrastructure Protection: Sector Plans and Sector Councils Continue to Evolve. July 2007, http://www.gao.gov/assets/100/95010.pdf

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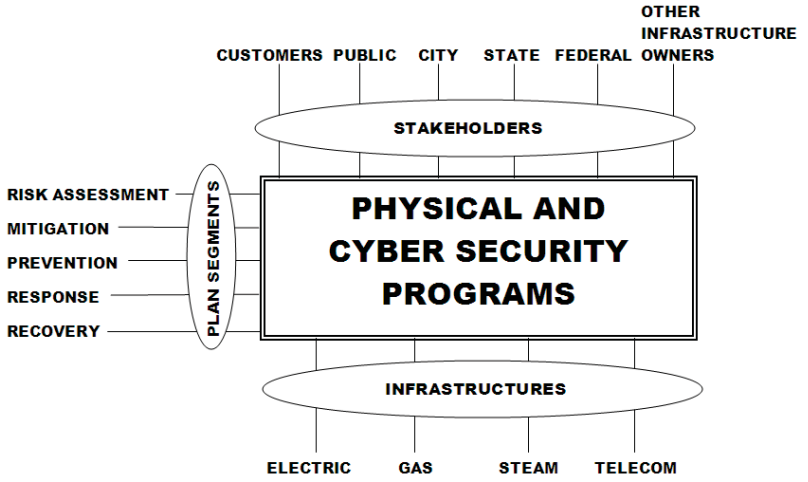
Security: What issues impede Protection

- Inability to share information
- Increased cost of security
- Widely dispersed assets
- Widely dispersed owners and operators
- Finding training and empowering security personnel
- Commercial off-the-shelf (COTS) controls and communications
- Siting constraints
- Long lead-time equipment
- Availability of restoration funds
- R&D focused on vulnerabilities

My background: CIP programs in the industry, government, and the academy



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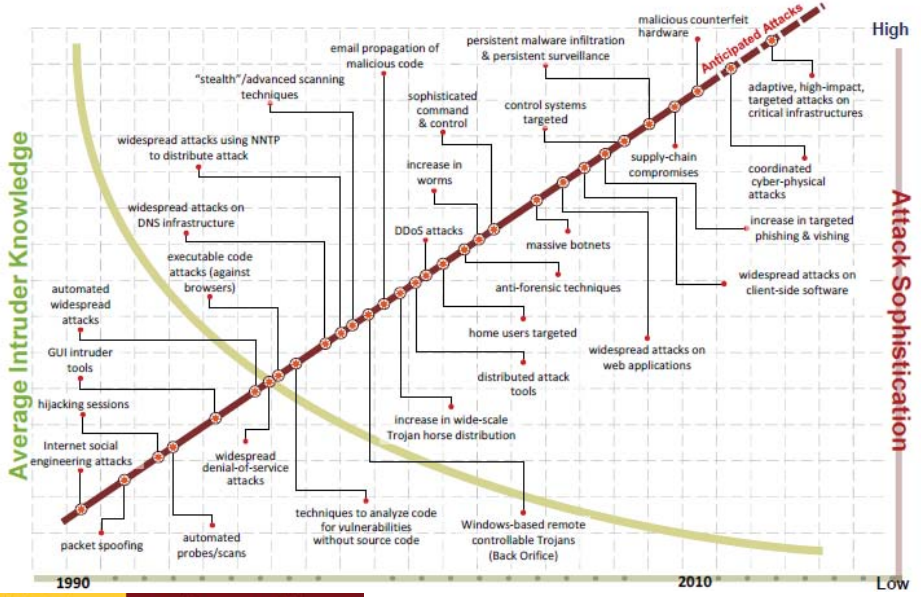
Cyberattacks – Power Grid Intruder Knowledge



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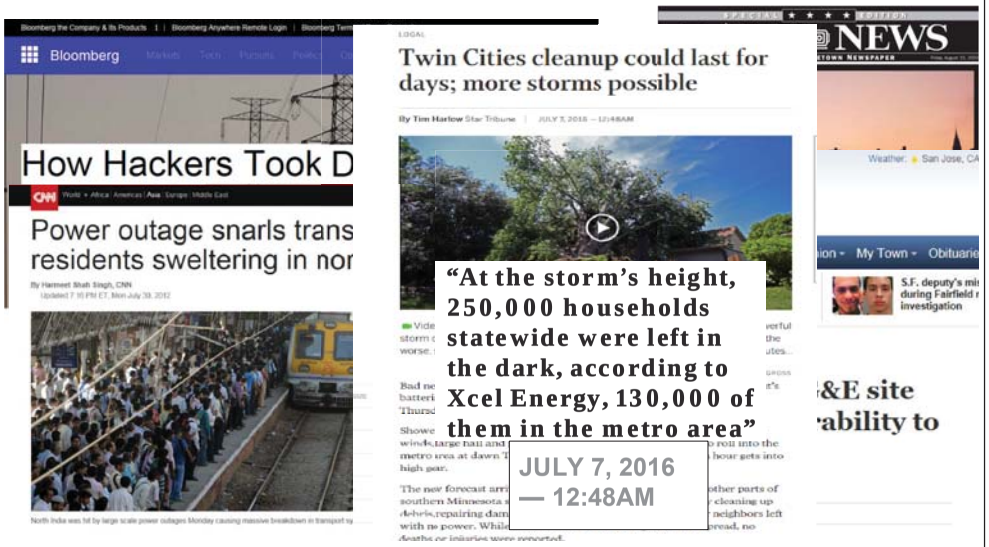

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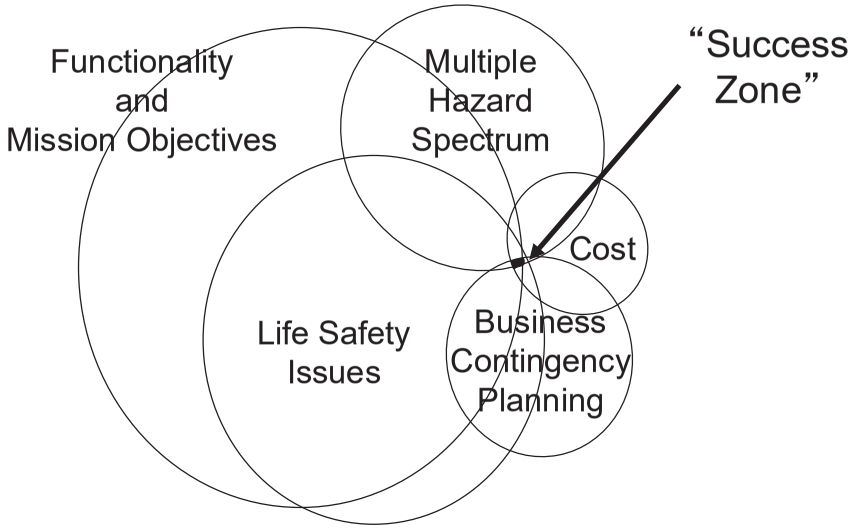
Real world solutions may be elusive



Thus There are Multiple Scenarios to Plan For…

External Threat

▪ Power failures ▪ Natural disasters ▪ Economic upheaval	▪ Malware ▪ Denial of service ▪ Sophisticated, organized attacks
▪ Unpatched systems ▪ Code vulnerability ▪ Lack of change control ▪ Human error or carelessness	▪ Developer-created back door ▪ Information theft ▪ Insider fraud

Inadvertent ***Deliberate***

Insider Threat

NIST: Enterprise-Wide Risk Management

- Multi-tiered Risk Management Approach
- Implemented by the Risk Executive Function
- Enterprise Architecture and SDLC Focus
- Flexible and Agile Implementation

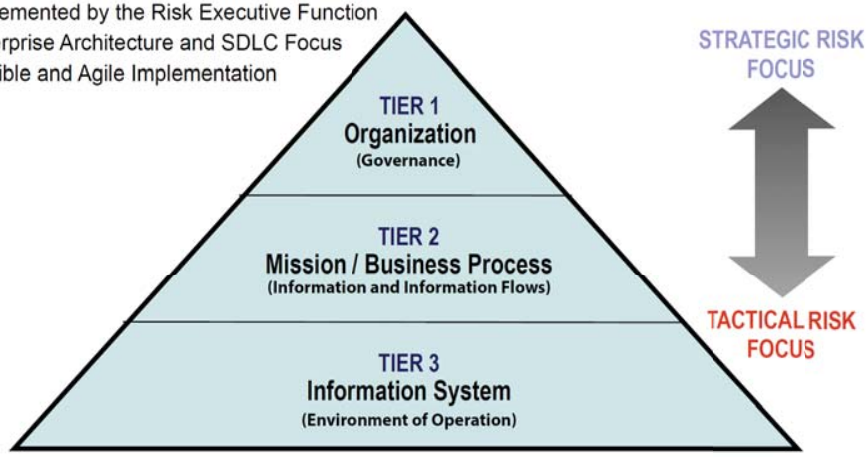


Figure 1

Enterprise risk management (conceptual model)
Source: *National Institute of Standards and Technology (NIST)*

Approach

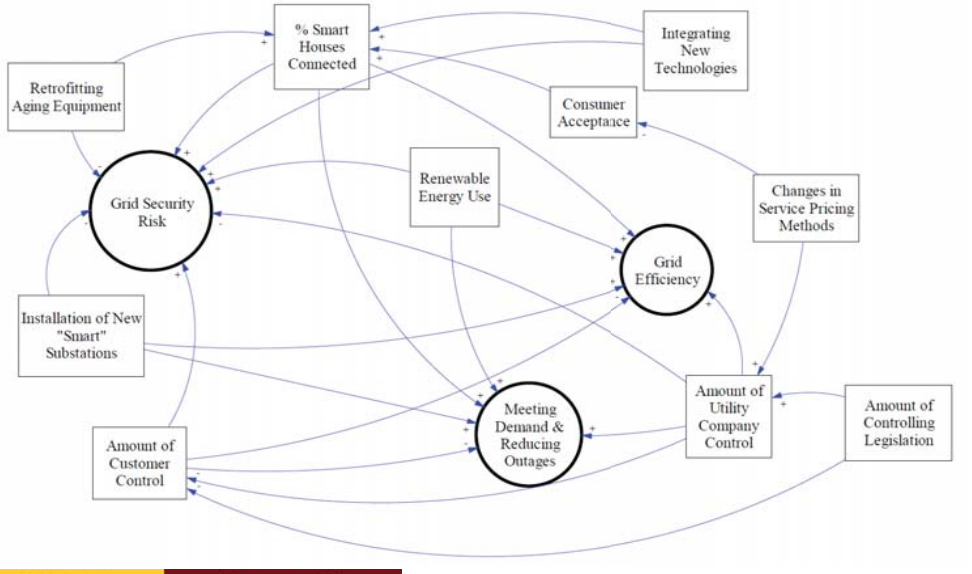
- **Vulnerability mapping**
- **Scenario analysis**
  - **The green movement**
    - Resilience requirement for new suppliers
  - **Middle East embargo**
    - New projects require improved delivery
  - **Non-renewable energy abundance**
    - Supplier and product distribution will provide snapshot of product portfolio health

Figure 2

This illustration provides a target-and-crosshairs model for vulnerability mapping to prioritize risk factors across four sectors, including operational, hazard, financial and strategic vulnerabilities

Smart Grid Interdependencies

Security, Efficiency, and Resilience



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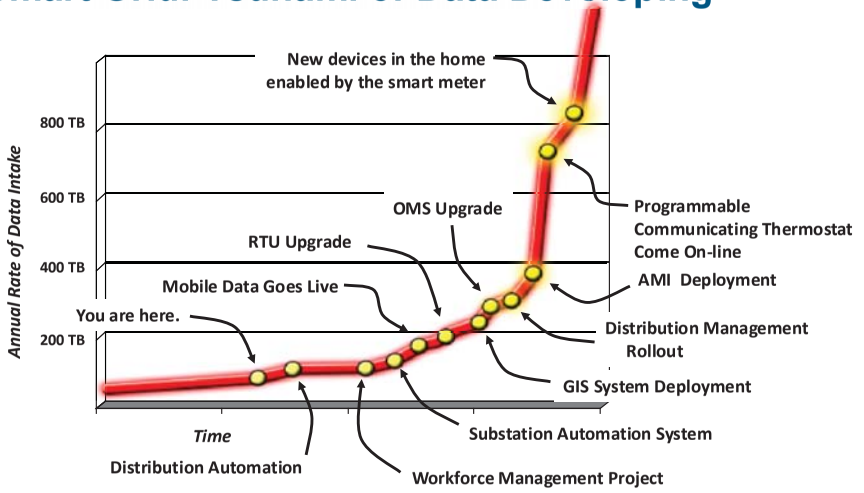
Smart Grid: Tsunami of Data Developing



Tremendous amount of data coming from the field in the near future - paradigm shift for how utilities operate and maintain the grid

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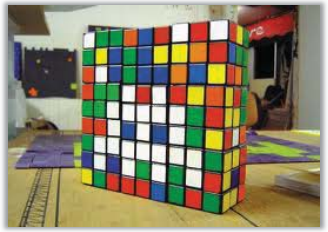
Paradigm Shift – Data at MN Valley Coop

- Before smart meters
  - –Monthly read
  - –480,000 data points per year
- After smart meters
  - –15-60 minute kWh
  - –Peak demand
  - –Voltage
  - –Power interruptions
  - –480,000,000 data points per year



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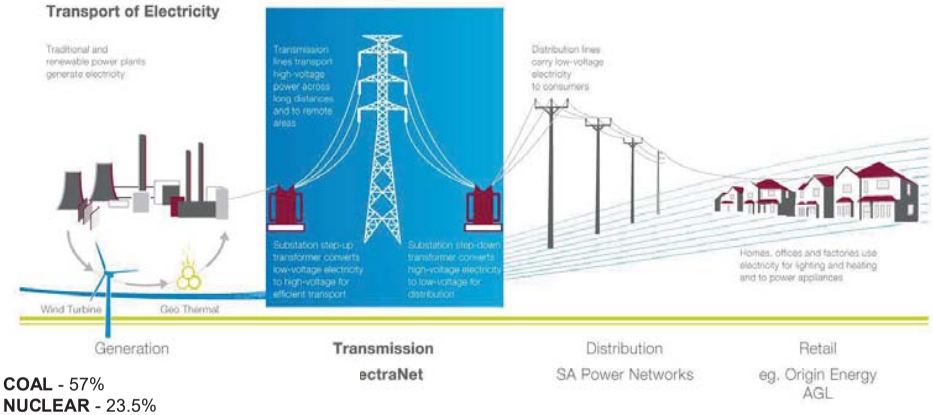
Infrastructure Interdependencies



COAL - 57%
NUCLEAR - 23.5%
WIND - 9.4%
NATURAL GAS - 4.8%
BIOMASS - 1.5%
WOOD DERIVED FUELS - 1.4%
HYDROELECTRIC - 1.3%
(U.S. Energy Information Administration - on-line)

Xcel Energy operates 11 345Kv substations that distribute power to the Twin Cities Metro Area

Link to Infrastructure Sectors:
Communication
Healthcare and Health Services
Emergency Services
Water/Wastewater
Transportation

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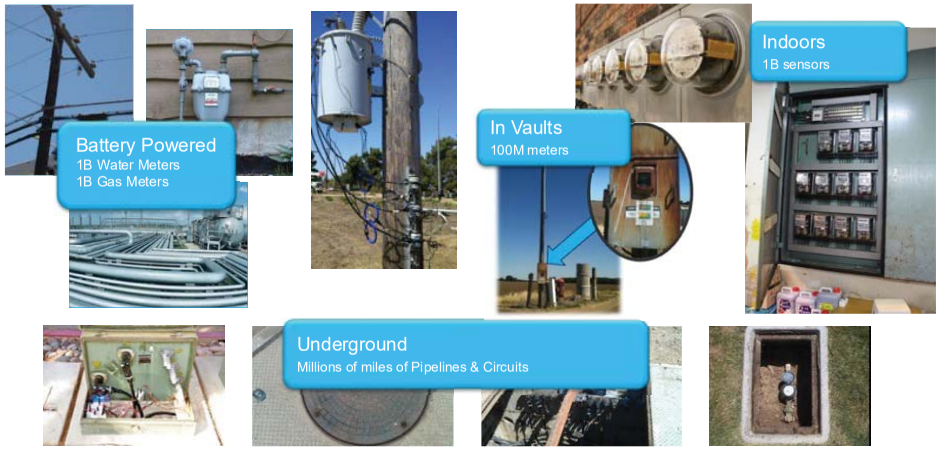
Types of Interdependencies

- Physical (e.g., material output of one infrastructure used by another)
- Cyber (e.g., electronic, informational linkages)
- Geographic (e.g., common corridor)
- Other (e.g., dependency through financial markets)

Industry Needs to Connect 50 Billion Devices by 2020

An unsolved problem costing billions per year in wasted resources requires radically improved wireless performance and lower cost



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Fast Power Systems Risk Assessment

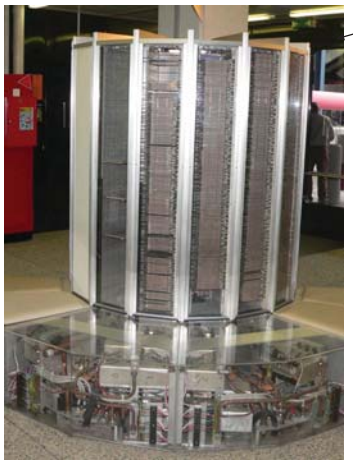
1987
Connection Machine 2

2010

$5,000,000
Only a dozen built

$350
100 million sold

Fast Power Grid Simulation

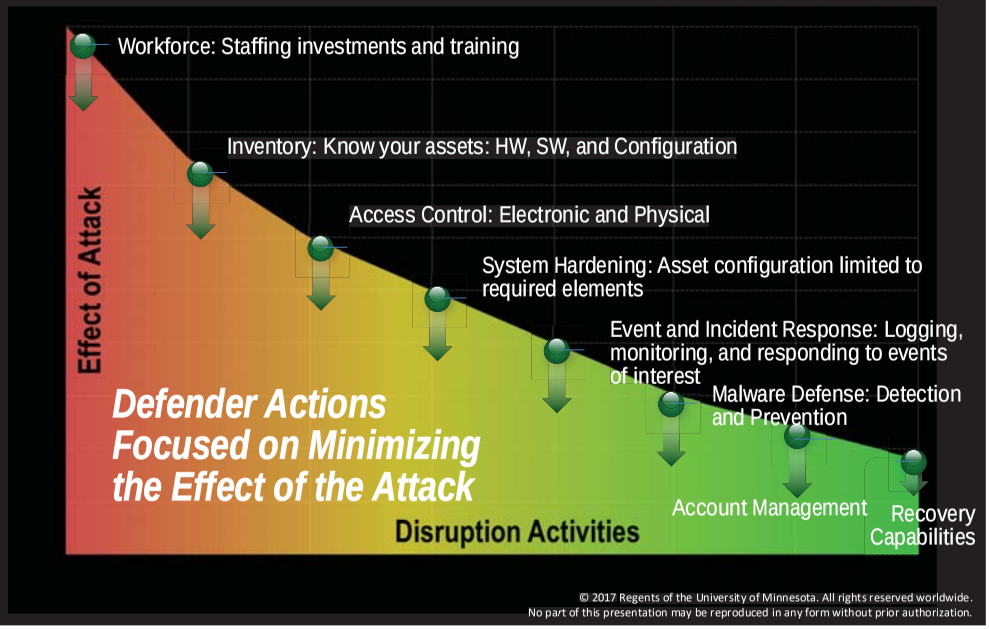


CRAY Supercomputer

Nvidia GeForce GPU card for PC

Use Nvidia GeForce GPU card to gain 15 times faster power flow calculation on PC

Take Action!



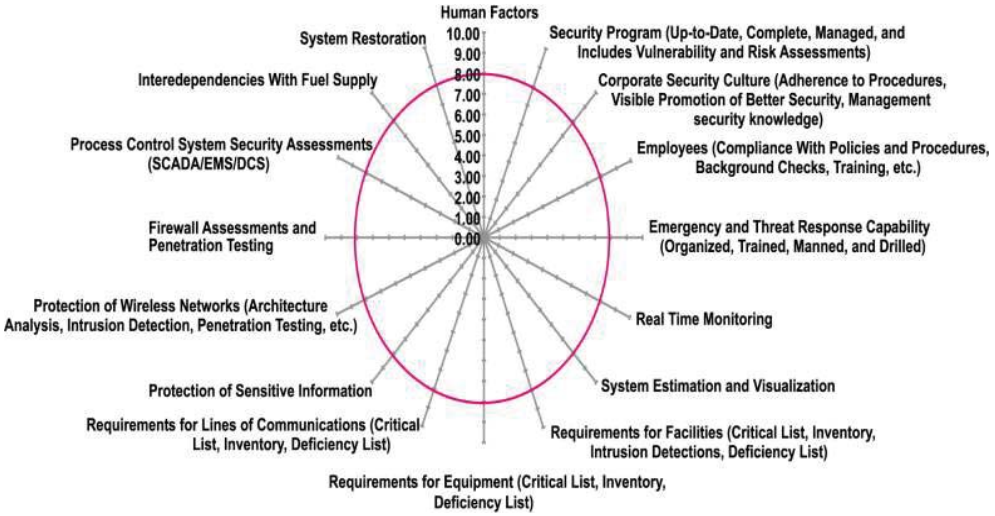
Mitigations

Prioritization: Security Index

General	Corporate culture
	Security Program
	Employees
	Emergency and threat response capability
Physical	Requirements for facilities, equipment and lines of communication
	Protection of sensitive information
Cyber and IT	Protection of wired and wireless networks
	Firewall assessments
	Process control system security assessments

Assessment & Prioritization:

A Composite Spider Diagram to Display Security Indices



Not Just Utilities … Our Role in Minnesota:
2015 MN2050 Survey

MN 2050 — Infrastructure planning, long term success

	2015 Values				
	Small City	Large City	County	State	Total
Roads	$4,174,022,424	$10,517,476,430	$27,647,815,260	$29,338,312,840	$71,677,626,954
Bridges	$1,151,894,172	$807,350,570	$1,456,009,206	$6,592,940,562	$10,008,194,510
Transit	$0	$0	$0	$0	$0
Traffic	$14,168,440	$138,820,460	$59,985,398	$0	$212,974,298
Buildings	$7,583,657,510	$13,724,959,690	$4,869,723,674	$501,696,056	$26,680,036,930
Water	$1,499,020,952	$6,279,799,230	$0	$0	$7,778,820,182
Waste Water	$1,704,463,332	$4,244,983,540	$0	$6,494,782,638	$12,444,229,510
Storm sewer	$0	$2,085,960,070	$0	$0	$2,085,960,070
Storm ponds	$150,185,464	$65,757,060	$5,453,218	$0	$221,395,742
Airports	$1,240,446,922	$1,344,366,560	$0	$0	$2,584,813,482
Ports	$0	$0	$0	$0	$0
Rail	$0	$0	$3,173,772,876	$0	$3,173,772,876
Electrical	$0	$10,564,967,640	$0	$0	$10,564,967,640
Solid Waste	$0	$94,982,420	$796,169,828	$0	$891,152,248
Natural Gas	$2,056,549,066	$2,747,183,840	$0	$0	$4,803,732,906
Total	$19.5B	$52.6B	$38.0B	$42.9B	$153B

Smarter about education, safety, energy, water, food, transp., e-gov… Innovative Cities:

- **Smarter transportation**
  Stockholm, Dublin, Singapore and Brisbane are working with IBM to develop smart systems ranging from predictive tools to smart cards to congestion charging in order to reduce traffic and pollution.
- **Smarter policing and emergency response**
  New York, Syracuse, Santa Barbara and St. Louis are using data analytics, wireless and video surveillance capabilities to strengthen crime fighting and the coordination of emergency response units.
- **Smarter power and water management**
  Local government agencies, farmers and ranchers in the Paraguay-Paraná River basin to understand the factors that can help to safeguard the quality and availability of the water system. Malta is building a smart grid that links the power and water systems, and will detect leakages, allow for variable pricing and provide more control to consumers. Ultimately, it will enable this island country to replace fossil fuels with sustainable energy sources.
- **Smarter governance**
  Albuquerque is using a business intelligence solution to automate data sharing among its 7,000 employees in more than 20 departments, so every employee gets a single version of the truth. It has realized cost savings of almost 2,000%.

Cities are perfect for promoting change and renewable energies. Cities can serve as innovation platforms, creating clusters of business around green energy."

Top 10 cities

Rank	Country	City	Rating
1	Canada	Vancouver	98.0
2	Austria	Vienna	97.9
3	Australia	Melbourne	97.5
4	Canada	Toronto	97.2
5	Canada	Calgary	96.6
6	Finland	Helsinki	96.2
7	Australia	Sydney	96.1
8=	Australia	Perth	95.9
8=	Australia	Adelaide	95.9
10	New Zealand	Auckland	95.7

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The Connected City: Trends and Developments Driving Smart City Innovation

- A "Smart City" is more than just high-tech infrastructure - it's about advancing our society.
- Improving human condition and advancing the civilization that we often take for granted … As engineers, we enable better quality of life for people
- The whole idea of a smart city is not just about power or buildings. It's about the whole ecosystem--how you educate people, how you empower people, the economic growth it can bring and what opportunities it can bring.

"The Connected City: Trends and Developments Driving Smart City Innovation," produced by MIT Technology Review and IEEE Collabratec…. vision, efficient use of technology, an environment that attracts a talented workforce, and an enabling infrastructure. Everything we do is geared towards that vision.

I-35W bridge

Just after 6:00 p.m. on Aug. 1, Prof. Massoud Amin was at work in his office on the University of Minnesota's West Bank, where he heard and watched the unthinkable happen—the collapse of the I-35W bridge about 100 yards away.

"As an individual, it was shocking and very painful to witness it from our offices here in Minneapolis," says Amin, director of the Center for the Development of Technological Leadership (CDTL) and the H.W. Sweatt Chair in Technological Leadership. Amin also viewed the tragedy from a broader perspective as a result of his ongoing work to advance the security and health of the nation's infrastructure.

In the days and weeks that followed, he responded to media inquiries from the BBC, Reuthers, and the CBC, keeping his comments focused on the critical nature of the infrastructure. He referred reporters with questions about bridge design, conditions, and inspections to several professional colleagues, including Professors Roberto Ballarini, Ted Galambos, Vaughan Voller, and John Gulliver in the Department of Civil Engineering and the National Academy of Engineering Board on Infrastructure and Constructed Environment.

For Amin, Voller, and many others, the bridge collapse puts into focus the importance of two key issues—the tremendous value of infrastructure and infrastructure systems that help make possible indispensable activities such as transportation, waste disposal, water, telecommunications, and electricity and power, among many others, and the search for positive and innovative ways to strengthen the infrastructure.

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To improve the future and avoid a repetition of the past:

Sensors built in to the I-35W bridge at less than 0.5% total cost by TLI alumni



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BASIS OF FUTURE COMPETITION

The speed at which an Enterprise can

- Gather
- Collate
- Analyze
- Apply information

MN and Regional Partnerships: Means to Identify/Validate Needs/Foster Preparedness

- **Major benefits from encouraging and supporting creation of MN and regional cyber security partnerships**
  - Help identify Cyber ICT/CIP requirements
  - Expedite cross-sector and cross jurisdiction coord. and collaborative implementation of solutions
  - Assist in mission assurance
  - Facilitate information sharing on threats and disruptions
  - Facilitate coordination among regions, thereby fostering interoperability
  - Serve as test-beds for pilot projects
  - Support and assist smaller local entities

Looking Beyond Interdependencies: Other Pressing Infrastructure Security Issues

Current focus on technical, practitioner-related challenges—Tyranny of the In-Box

Not Being Adequately Addressed:

- Building the necessary policy foundation that addresses legal, ethical, and defense in depth issues in assuring Local/State/National/Global infrastructures

- Long-term analysis of what technology, political and economic developments will have far-reaching repercussions for securing infrastructures and keeping them secure (with Economic Growth opportunities)

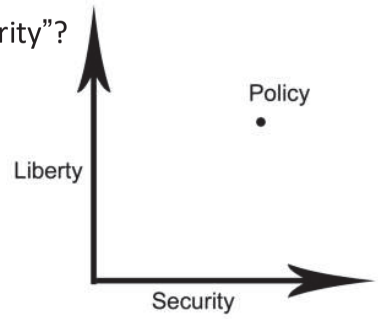
Discussion Questions

- What level of threat is the industry responsible for, and what does government need to address?
- Will market-based priorities support a strategically secure cyber-physical critical systems?
- What system architecture is most conducive to maintaining security?

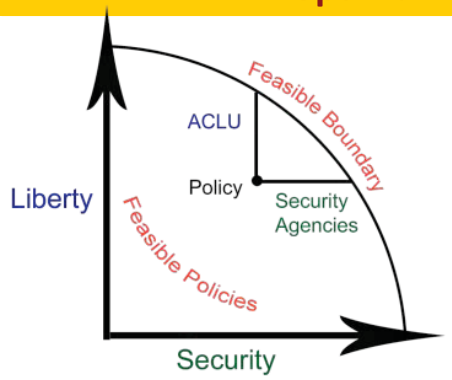
Can we build non-intrusive yet high confidence tools, systems, processes that increase our security AND preserve/extend our civil rights?

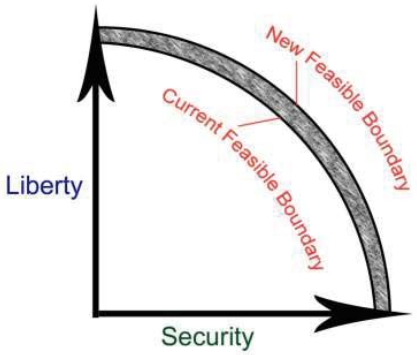
Synergy Between Security Technologies & Policy

- Incorporate security and privacy early as "design criteria"
- Provide policy impact statement
  - E.g. tradeoffs between "liberty & security"?
  - Non/low-intrusive but high confidence technologies analogous to "MRI"
  - Plot the space



Where is a given policy w.r.t. -a theoretically optimal frontier?





Implications for new technologies -some offer more "L" or more "S"

-What if we offer both?
-Can this be a design criteria?

E.g. remote monitoring; anomaly detection; wide-area tamper detection

Unresolved Issues Cloud Planning for the Future

The Land and The People

- **First animal life:** 500 Million years ago in the fossil record (MN was under water)
- **First humans:** Ancestors of today's American Indians arrived about 12,000-15,000 years ago at the end of the last ice age
- **Dakota language:** ***Mni Sota Makoce***
  "land where the waters are so clear they reflect the clouds"