Critical Information Infrastructure Protection: Urgent vs. Important

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Critical Information Infrastructure

- July 15th 96 American president signed Executive Order 13010
  - introduced (or popularized?) the term **critical infrastructures**
- Identifies 8 classes of critical infrastructures:
  - telecommunications, electrical power systems, gas/oil storage and transportation, banking/finance, transportation, water supply systems, emergency services, continuity of government
- Critical information infrastructures – the ICT part of these infrastructures

federal register

Part III

The President

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Power grid

- Recent past:
  - Power grid undergone significant computerization and interconnection
  - Improved operation, but became exposed to cyber-threats
- Present/future:
  - Smart grid: smart metering, distributed generation… - ICT is core
  - More computerization and interconnection, higher exposure to cyber-threats

Power grid is under siege

- 2003: Davis-Besse nuclear power plant's control systems blocked by the Slammer/Sapphire worm
- 2007: experimental DHS-sponsored cyber-attack destructs a power generator
- 2009: US electrical grid allegedly penetrated by spies from China, Russia and others
- 2010: Stuxnet damages centrifuges in Iranian nuclear enrichment center

URGENT: REDUCING RISK

Risk is high

$$\textit{risk} = \underbrace{\textit{level of threat} \times \textit{degree of vulnerability}}_{\textit{likelihood of successful attack}} \times \textit{impact}$$

- Level of threat is high – nation states, random threats, extortion
- Degree of vulnerability is high – as shown by the previous cases
- Impact is high – think of a city without power for hours/weeks

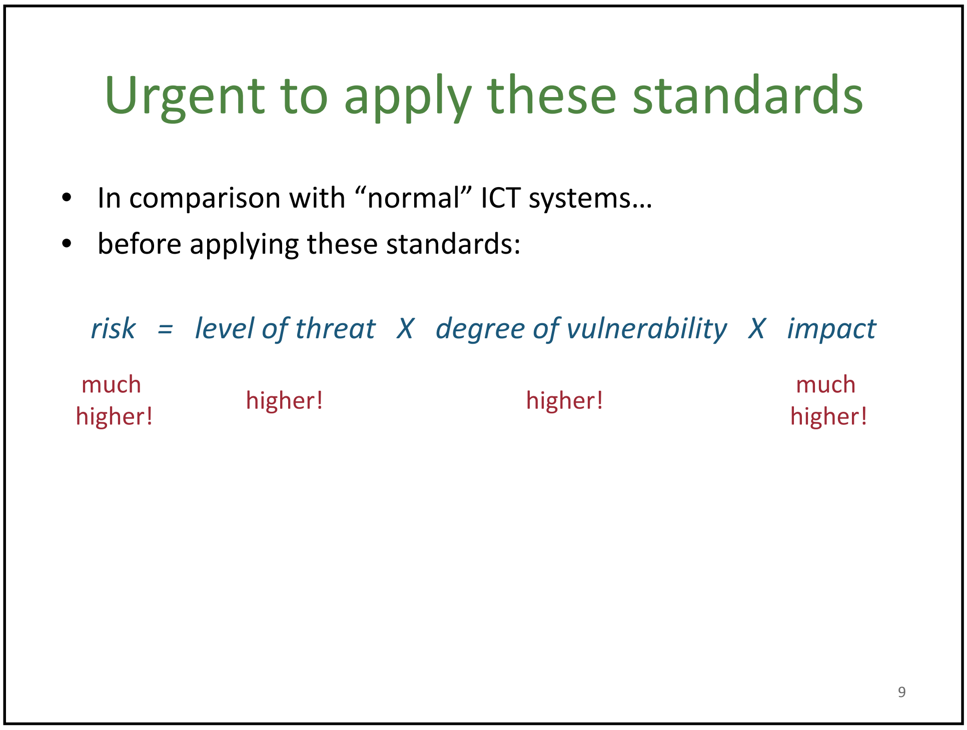
It is urgent to reduce this risk
By reducing the degree of vulnerability

NIST SP 800-82

- “Guide to Industrial Control Systems (ICS) Security”, Jun. 2011
- Recommendations about
  - Network architecture – firewall usage, network segregation,…
  - Management controls – planning, risk assessment,…
  - Operational controls – personnel security, contingency planning, configuration management,…
  - Technical controls – authentication, access control, systems and communication protection,…
- ICT security applied to CIIP

IEC 62351

- “Power systems management and associated information exchange – Data and communications security”, May 2007
- Recommendations about the security of TC57 protocols
  - protection from eavesdropping, man-in-the-middle, spoofing, and replay
- ICT security applied to CIIP



Urgent to apply these standards

- In comparison with "normal" ICT systems…
- before applying these standards:

risk	*=*	*level of threat*	*X*	*degree of vulnerability*	*X*	*impact*
much higher!		higher!		higher!		much higher!

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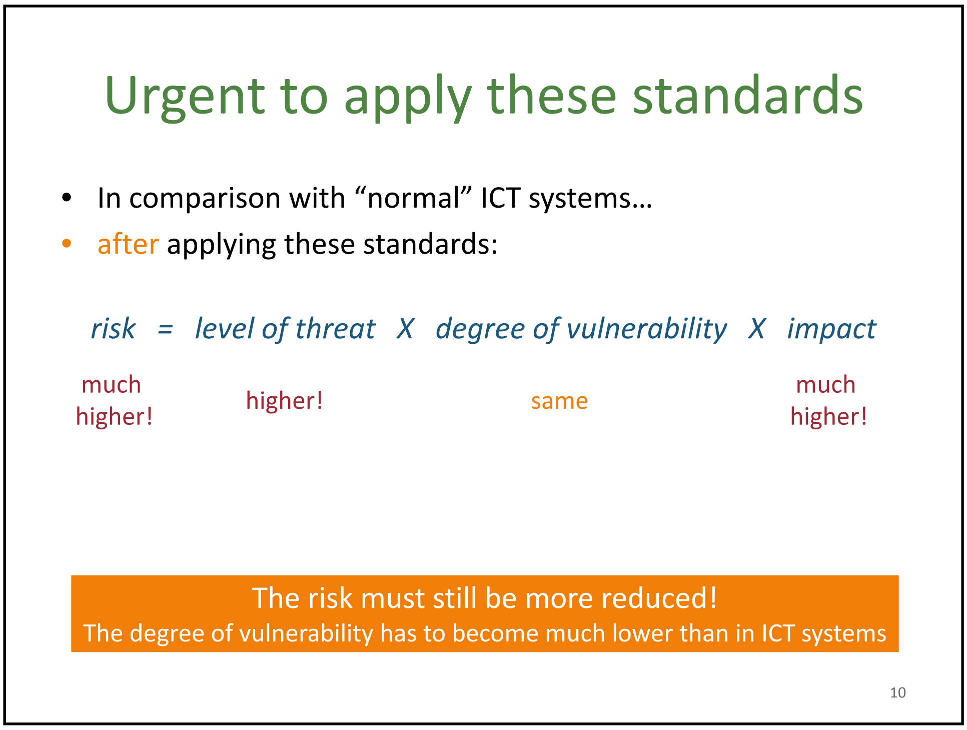

Urgent to apply these standards

- In comparison with "normal" ICT systems…
- after applying these standards:

risk	*=*	*level of threat*	*X*	*degree of vulnerability*	*X*	*impact*
much higher!		higher!		same		much higher!

The risk must still be more reduced!
The degree of vulnerability has to become much lower than in ICT systems

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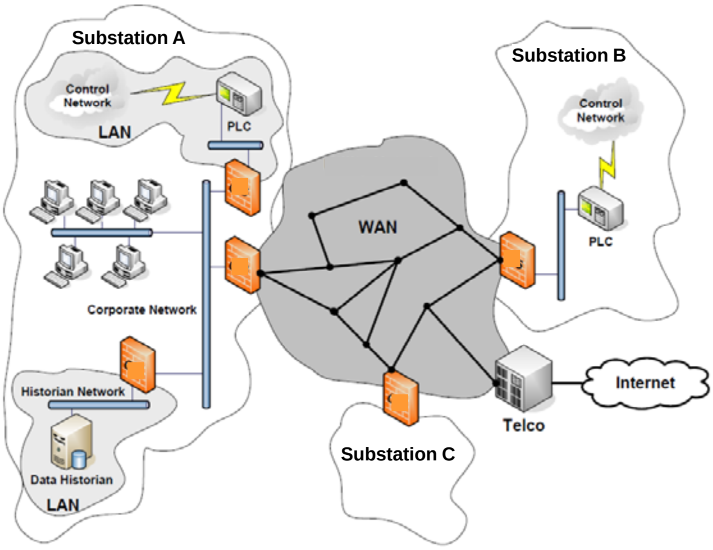
CRUTIAL
CRitical UTIlity InfrastructurAL resilience

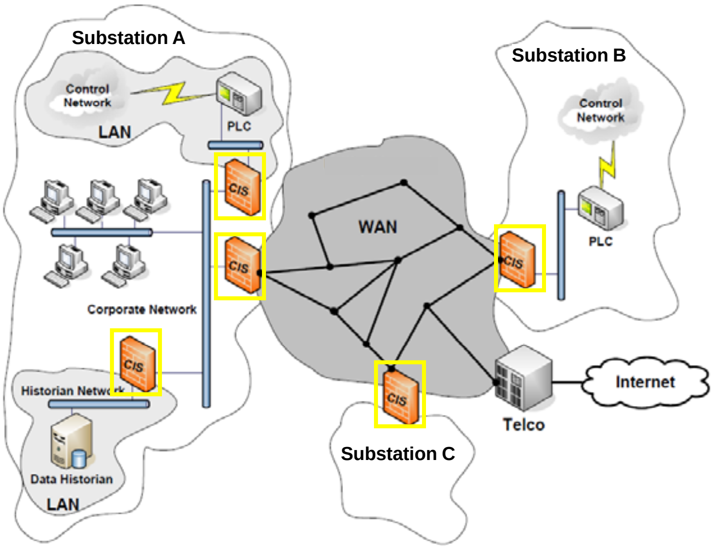
Information Society Technologies

IMPORTANT: RESEARCH ABOUT REDUCING RISK MUCH MORE

Architecture – WAN-of-LANs

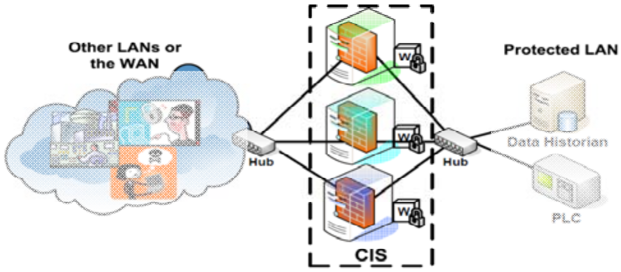


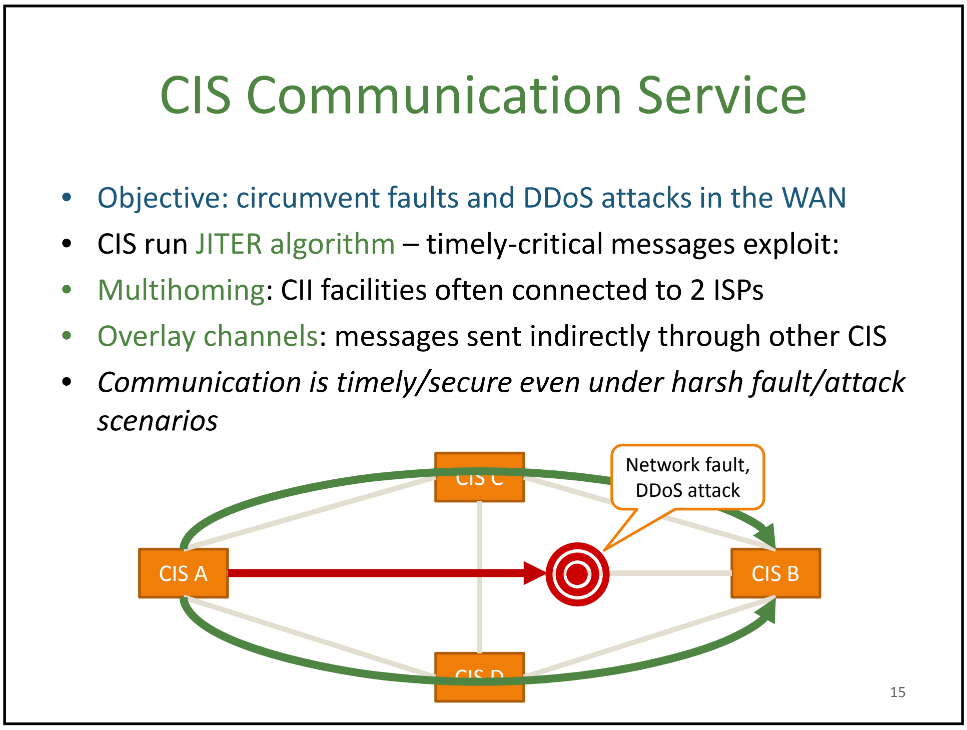
CIS - CRUTIAL Information Switch



CIS Protection Service

- Objective: effectively block incoming attacks
- CIS-PS works at application layer and is a distributed firewall
- It is intrusion-tolerant thanks to replication and diversity
- It is self-healing thanks to replica rejuvenation
- *It cannot be attacked even if there are 0-day vulnerabilities*





CIS Communication Service

- Objective: circumvent faults and DDoS attacks in the WAN
- CIS run JITER algorithm – timely-critical messages exploit:
- Multihoming: CII facilities often connected to 2 ISPs
- Overlay channels: messages sent indirectly through other CIS
- *Communication is timely/secure even under harsh fault/attack scenarios*

CIS C
Network fault,
DDoS attack
CIS A
CIS B
CIS D

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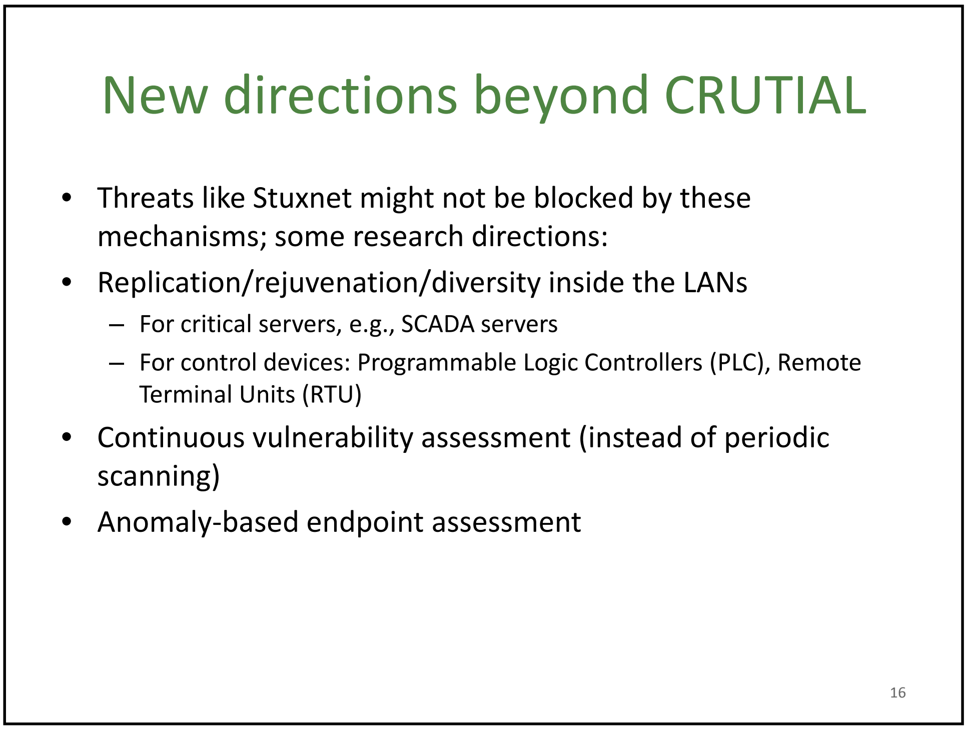

New directions beyond CRUTIAL

- Threats like Stuxnet might not be blocked by these mechanisms; some research directions:
- Replication/rejuvenation/diversity inside the LANs
  - For critical servers, e.g., SCADA servers
  - For control devices: Programmable Logic Controllers (PLC), Remote Terminal Units (RTU)
- Continuous vulnerability assessment (instead of periodic scanning)
- Anomaly-based endpoint assessment

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Conclusions

- The power grid and other critical information infrastructures are vulnerable to cyber-attacks
- It is urgent to do the urgent: apply standards and recommendations
- But ICT-like security mechanisms are not enough: the threat level and impact of CII failure is high, so risk remains high
- So it is important to do what is important: to investigate novel protection mechanisms that greatly reduce the degree of vulnerability

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