Towards a More Resilient and Secure EPICS

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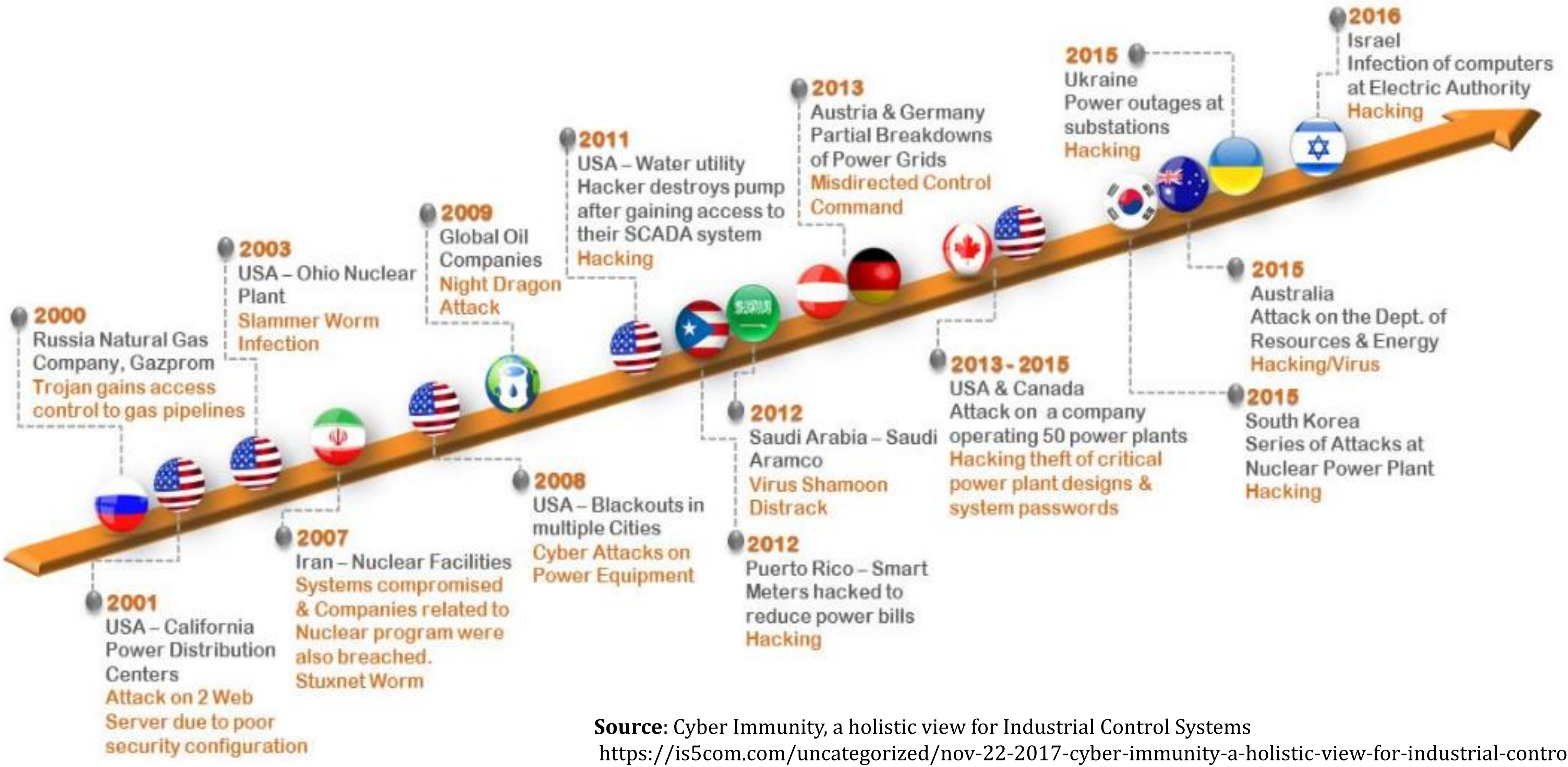
History of Cyber criminal Attacks in ICS



2000
Russia Natural Gas Company, Gazprom
Trojan gains access control to gas pipelines

2001
USA – California Power Distribution Centers
Attack on 2 Web Server due to poor security configuration

2003
USA – Ohio Nuclear Plant
Slammer Worm Infection

2007
Iran – Nuclear Facilities
Systems compromised & Companies related to Nuclear program were also breached.
Stuxnet Worm

2008
USA – Blackouts in multiple Cities
Cyber Attacks on Power Equipment

2009
Global Oil Companies
Night Dragon Attack

2011
USA – Water utility
Hacker destroys pump after gaining access to their SCADA system
Hacking

2012
Saudi Arabia – Saudi Aramco
Virus Shamoon Distrack

2012
Puerto Rico – Smart Meters hacked to reduce power bills
Hacking

2013
Austria & Germany
Partial Breakdowns of Power Grids
Misdirected Control Command

2013 - 2015
USA & Canada
Attack on a company operating 50 power plants
Hacking theft of critical power plant designs & system passwords

2015
South Korea
Series of Attacks at Nuclear Power Plant
Hacking

2015
Australia
Attack on the Dept. of Resources & Energy
Hacking/Virus

2015
Ukraine
Power outages at substations
Hacking

2016
Israel
Infection of computers at Electric Authority
Hacking

Source: Cyber Immunity, a holistic view for Industrial Control Systems
https://is5com.com/uncategorized/nov-22-2017-cyber-immunity-a-holistic-view-for-industrial-control-systems/

Motivation & Goal

How we got here

- Hyper-connectivity
- Threat to major Industrial Control Systems
- Traditional Perimeter System Protection (Gateway, Password auth.)

Our goal

Hardening EPICS software to ensure security of scientific cyberinfrastructure which controls scientific instruments

Expected Outcomes

EPICS

- ✓Adopt security measures early in software development cycle
- ✓Enhance cybersecurity capabilities
- ✓Create a resilient scientific infrastructure for high energy physics research

EPICS Community

- ✓Adoption of security best practices
- ✓Creation of set of security tools
- ✓Discovery and mitigation of potential vulnerabilities

WHAT WE WILL COVER

- Threats considered
- Proposed approach
- Status of our project

Threat Models

T0 – The Unintentional Threat

- Accidental Disruption of Scientific Operations
- Modification of PV Values
- Loss of Integrity of Scientific Experiments

Threat Models

T0 – The Unintentional Threat

T1 – The Malicious Adversaries (untargeted, common)

- Destabilization of IOCs
- Modification of PV values in the IOC database
- Disruption of scientific mission of EPICS site

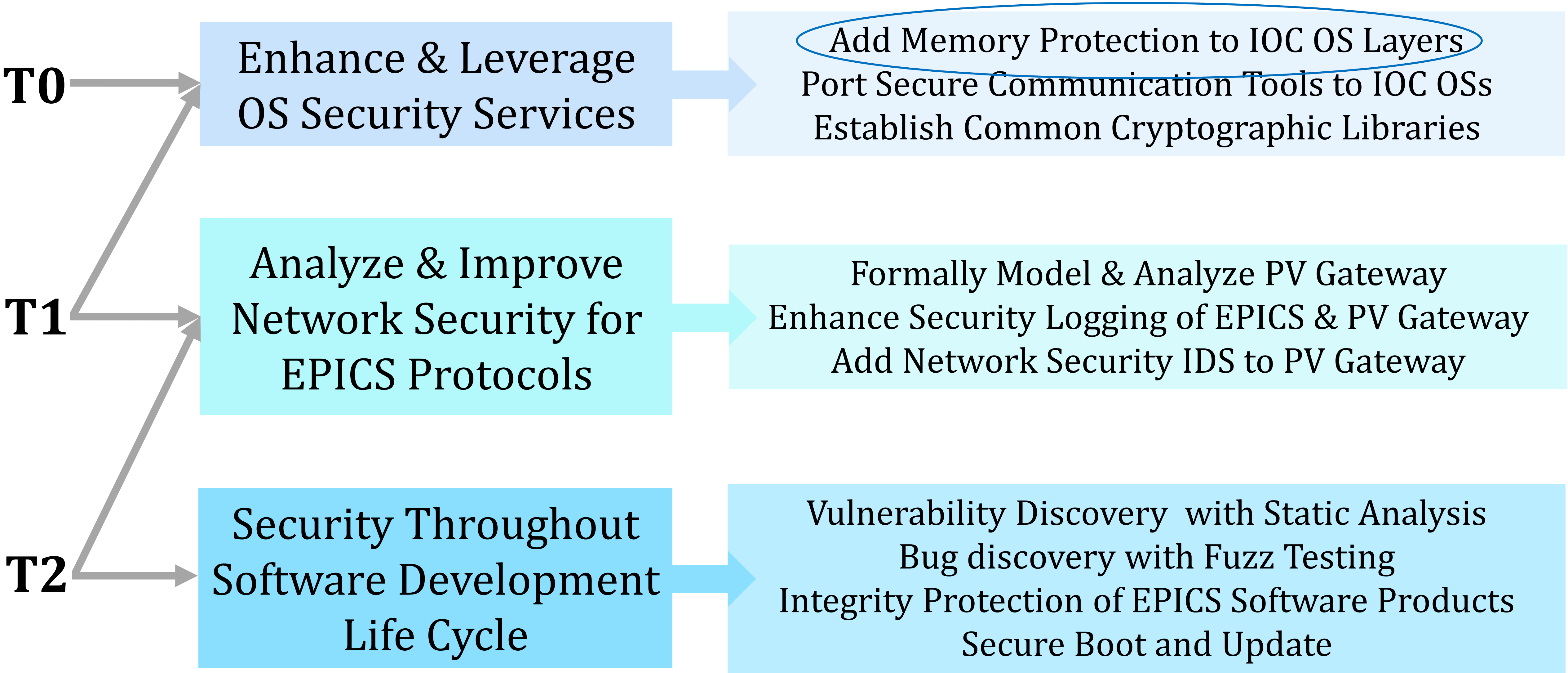
Threat Models

T0 – The Unintentional Threat

T1 – The Malicious Adversaries (untargeted, common)

T2 – The State Actors (targeted attacks, costliest)

- Undermine IOCs
- Cause long-term damage to physical infrastructure
- Inject malicious code in open-source software development supply chain
- Tamper with release software products to instrument malware into downloadable binary images



T0

Enhance & Leverage OS Security Services

- Add Memory Protection to IOC OS Layers
- Port Secure Communication Tools to IOC OSs
- Establish Common Cryptographic Libraries

T1

Analyze & Improve Network Security for EPICS Protocols

- Formally Model & Analyze PV Gateway
- Enhance Security Logging of EPICS & PV Gateway
- Add Network Security IDS to PV Gateway

T2

Security Throughout Software Development Life Cycle

- Vulnerability Discovery with Static Analysis
- Bug discovery with Fuzz Testing
- Integrity Protection of EPICS Software Products
- Secure Boot and Update

Project Status: Memory Protection

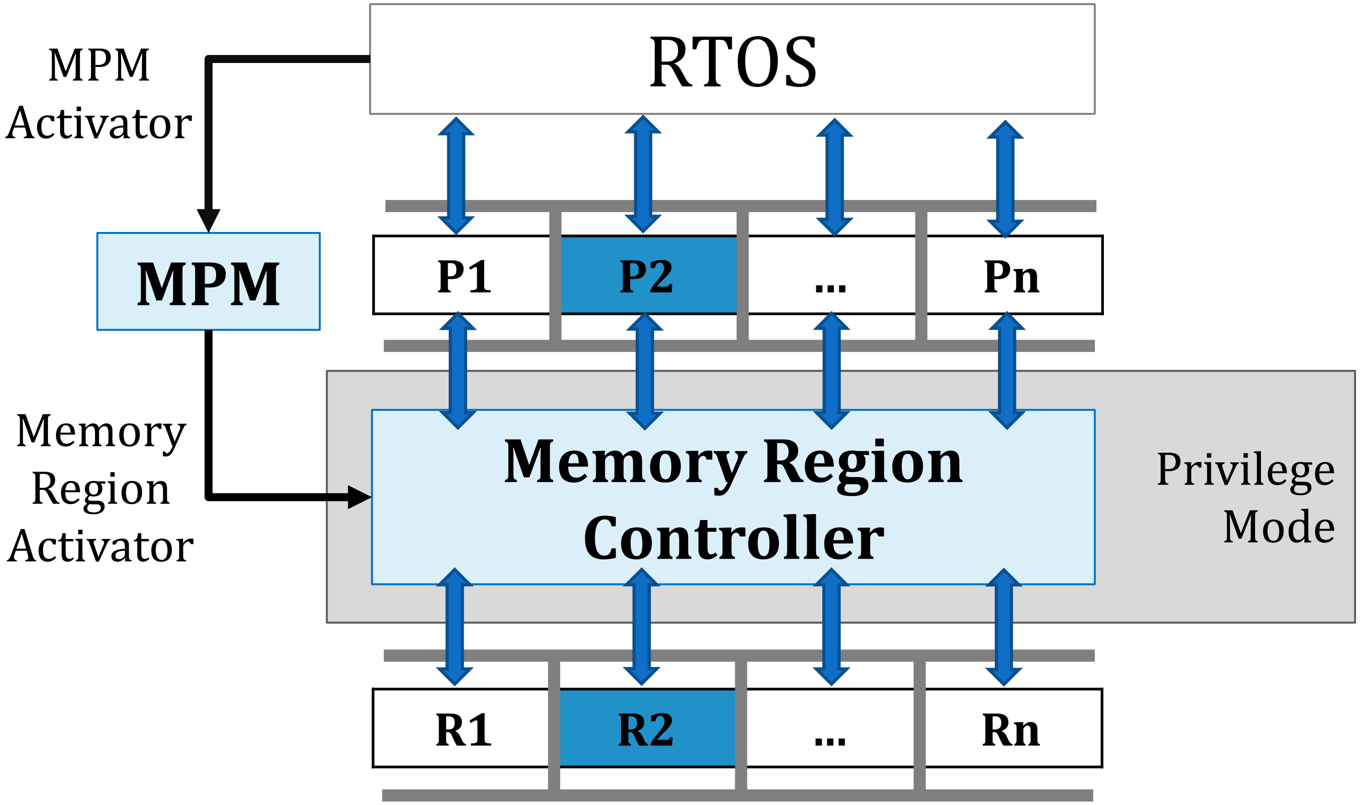
Current Memory Protection in EPICS

- Memory management in GPOSs
- Available protection for VxWorks
- Non-existent in RTEMS

Desired Features

- Flexible (can be used with different OSs)
- Optional (for OSs with memory management unit)
- Low overhead
- Low performance degradation

Memory Protection Module (MPM) Design



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