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#HITB2011AMS

Attacking critical infrastructures

Behind the scenes

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HITBSECCONF2011
MAY 17 - 20 @ NH GRAND KRASNAPOLSKY
http://conference.hackinthebox.org/hitbsecconf2011ams/
AMSTERDAM

FOX-IT
FOR A MORE SECURE SOCIETY

Allow me to introduce myself

Maarten Oosterink

IT security consultant at Capgemini

Expert / advisor at CPNI.NL (cybersecurity and process control security)

maarten.oosterink@capgemini.com or @m00st

Raised alongside computers, started using them in the pre-PC era and used modems when autodial was a feature. Exploring the boundaries of technology ever since..

2000: IT manager at Vuurwerk Internet (largest Dutch hosting provider at the time)

2001: BOFH and later interception specialist at Netherlands Forensic Institute

2005: Consultant at Capgemini

2008: Process Control Security at oil major

Now: Expert / Advisor for Dutch Centre for Protection of National Infrastructure

How does all this work?

PROCESS CONTROL INTRODUCTION

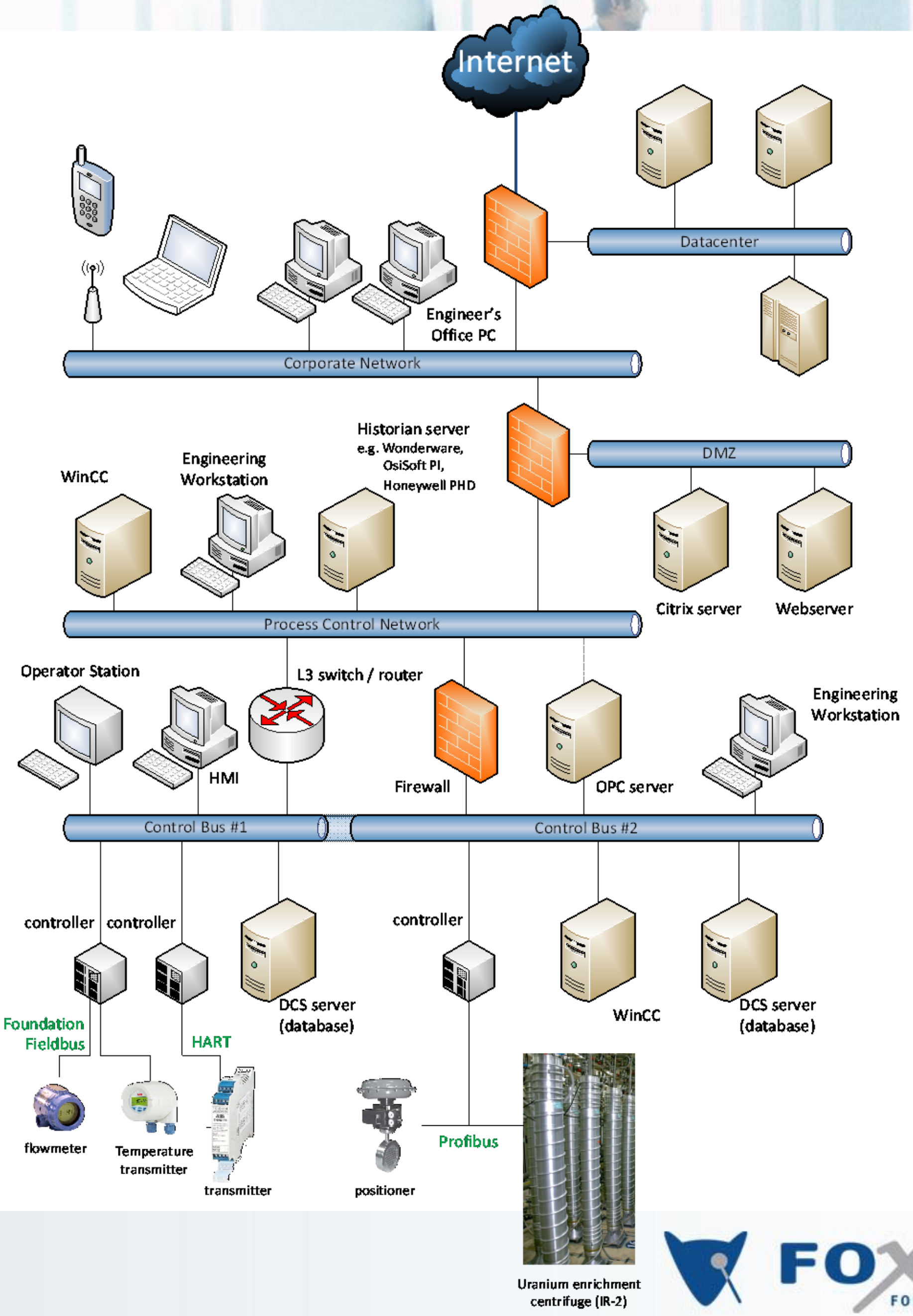
Teh interwebs

Typical office network

Factory network

Local unit network

In the field network



Level 5

Level 4

Level 3

Level 2

Level 1

How does this work?

- Programmable Logic Controllers communicate with sensors, actuators via discrete channels or specific networks (Profibus, Fieldbus, WirelessHART)
- PLCs communicate with Human Machine Interface (HMI) and DCS servers for providing status and control
- Servers 'control' a complex process interfacing with one or more PLCs and interface (in)directly with IT systems (e.g. ERP, SAP, optimisation tools)
- Interface between IT systems and process control mostly via historian (Pi, PHD, Wonderware)

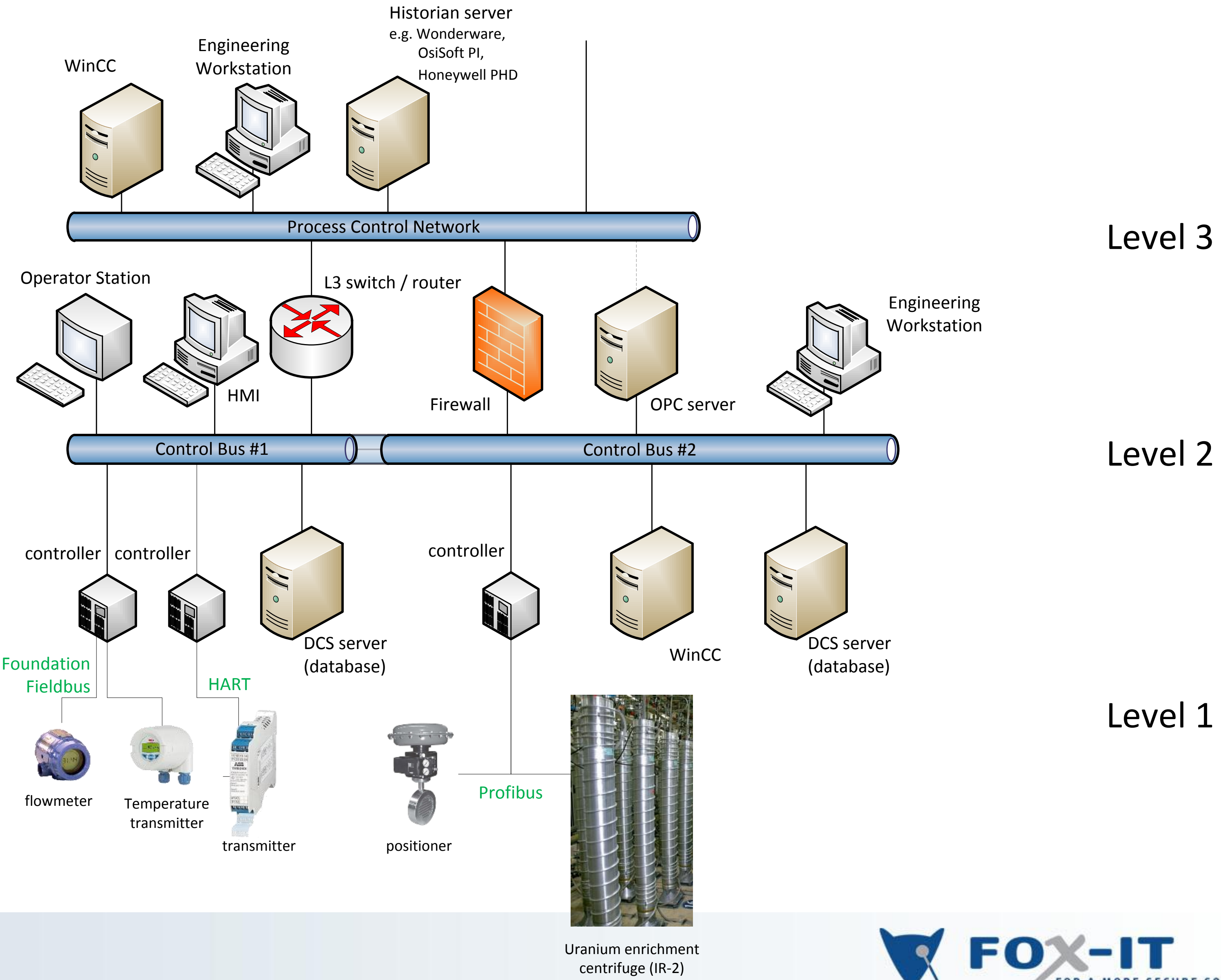
- Safety Integrity Systems operate separate from the control systems, with fixed boundaries. Engineered to bring process to a safe state (Fukishima)

Level 1

Level 2

Level 3

Level 4


Historian server
e.g. Wonderware,
OsiSoft PI,
Honeywell PHD
WinCC
Engineering
Workstation
Process Control Network
Level 3
Operator Station
L3 switch / router
HMI
Firewall
OPC server
Engineering
Workstation
Control Bus #1
Control Bus #2
Level 2
controller
controller
controller
DCS server
(database)
WinCC
DCS server
(database)
Foundation
Fieldbus
HART
Level 1
flowmeter
Temperature
transmitter
transmitter
positioner
Profibus
Uranium enrichment
centrifuge (IR-2)

What does it do?

What does it do?

Image credit: Stefan Esser

What does it do?

What does it do?

What’s the situation

TIME FOR A QUIZ..

So what’s the situation?

System lifecycle is:

A. 25 years

B. 10 years

C. 5 years

D. All of the above

So what’s the situation?

We use Windows systems because:

A. They are cheap

B. They have open standards

C. We know them from home

D. All of the above

So what’s the situation?

Our systems run:

A. Windows 2000 workstation

B. Windows XP

C. Windows Vista Home Premium

D. All of the above

So what's the situation?

Systems are patched:

A. During install, FAT, SAT and commissioning

B. Following plant maintenance cycles
(every 1, 2 or 4 years)

C. Every 2nd Tuesday of the month

D. Never

So what’s the situation?

Applications are patched:

A. As soon as vendor notification is received

B. Following plant maintenance cycles (every 1, 2 or 4 years)

C. Never

D. When the sales guy calls about upgrades

So what’s the situation?

IT Systems are maintained by:

A. The IT department

B. Your local engineer/operator

C. The vendor

D. None of the above

The process control landscape

(UN)COMMON TECHNOLOGY

(Un)common technology

Citrix

RDP

800 Mhz wireless backhaul

802.11 wireless

Windows

RS-232 / RS-422

X11

VNC

Wireless HART

HART

Solaris

Juniper firewalls

Tofino firewalls

Cisco switches

Routers with ACLs

Token passing

Remote KVMs

Fiber optical networks

Redundant networks (L2)

HUBs

10Base-T

VLANs

Telnet

Deterministic networks

VSAT

(Un)common mitigations

No CD-Rom drive

Hardening

Limit physical access

Application whitelisting

Only essential OS parts

Malware Protection

Choose correct PC model

Disable USB ports

Anti-virus

Host based firewall / IDS

MBSA tool

Microsoft WSUS

Awareness

Patching

Incident Detection & Response

Security training

Purdue model

Vendor maintenance contracts

Follow local permit to work system

Centralised security team

SIEM

Staging (Citrix)

Network Architecture

Intrusion Detection System

Two-factor authentication

Firewalls

Network segregation

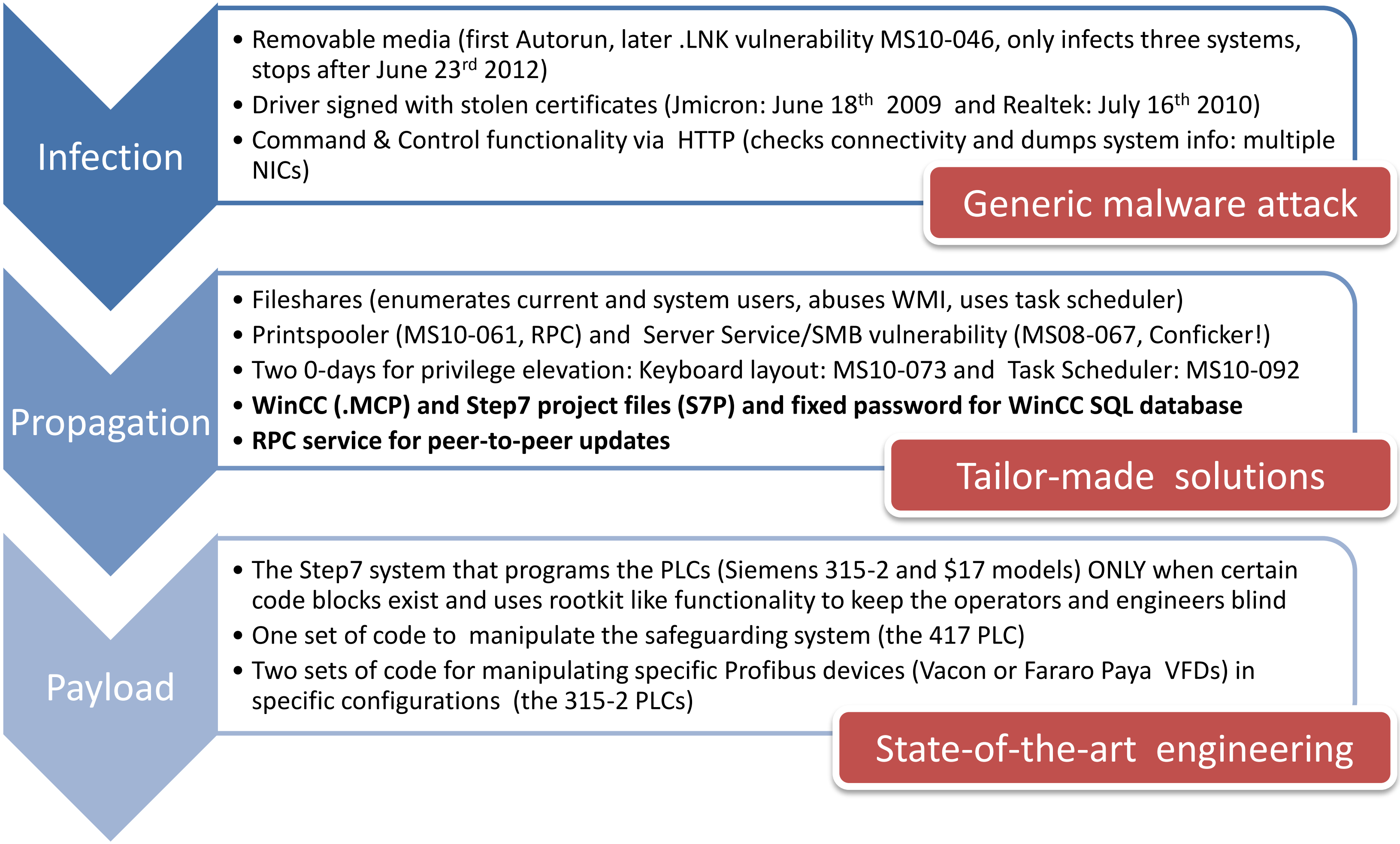
Security Operations Centre

Application aware firewalls

Peeling the layers

DISMANTLING STUXNET

Stuxnet’s journey to success



Infection

- Removable media (first Autorun, later .LNK vulnerability MS10-046, only infects three systems, stops after June 23rd 2012)
- Driver signed with stolen certificates (Jmicron: June 18th 2009 and Realtek: July 16th 2010)
- Command & Control functionality via HTTP (checks connectivity and dumps system info: multiple NICs)

Generic malware attack

Propagation

- Fileshares (enumerates current and system users, abuses WMI, uses task scheduler)
- Printspooler (MS10-061, RPC) and Server Service/SMB vulnerability (MS08-067, Conficker!)
- Two 0-days for privilege elevation: Keyboard layout: MS10-073 and Task Scheduler: MS10-092
- **WinCC (.MCP) and Step7 project files (S7P) and fixed password for WinCC SQL database**
- **RPC service for peer-to-peer updates**

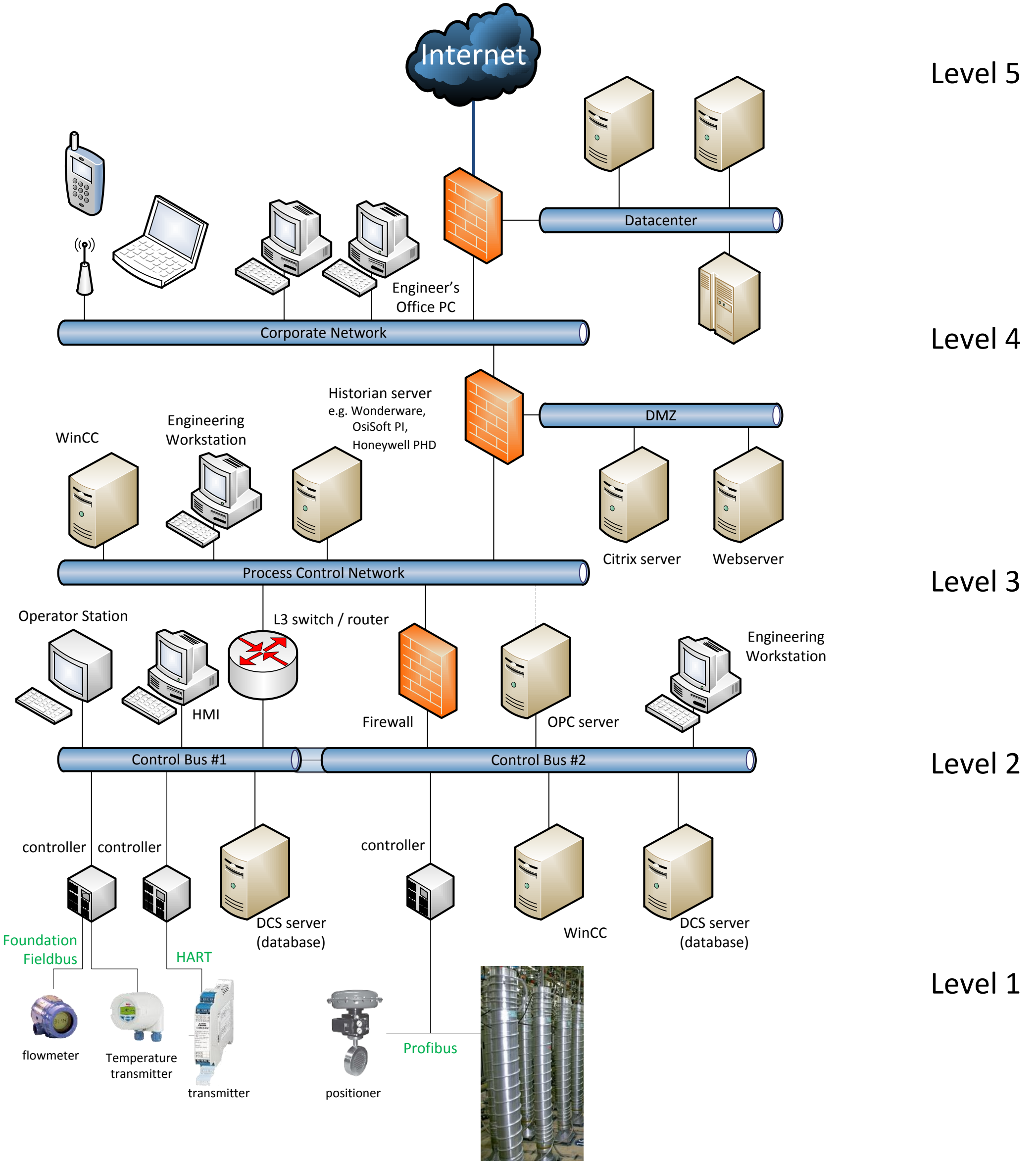
Tailor-made solutions

Payload

- The Step7 system that programs the PLCs (Siemens 315-2 and $17 models) ONLY when certain code blocks exist and uses rootkit like functionality to keep the operators and engineers blind
- One set of code to manipulate the safeguarding system (the 417 PLC)
- Two sets of code for manipulating specific Profibus devices (Vacon or Fararo Paya VFDs) in specific configurations (the 315-2 PLCs)

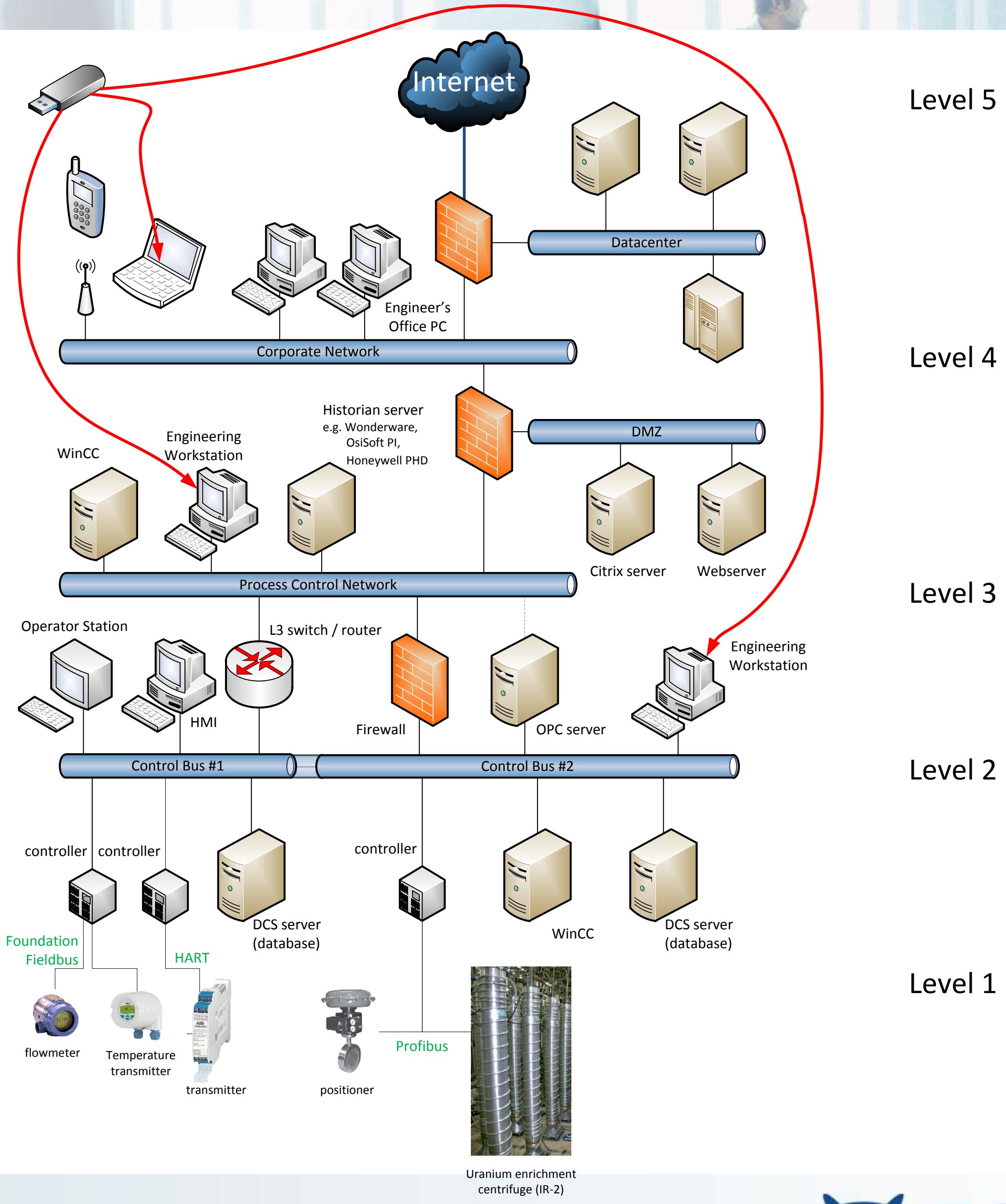
State-of-the-art engineering

Day 0



Uranium enrichment
centrifuge (IR-2)

Infection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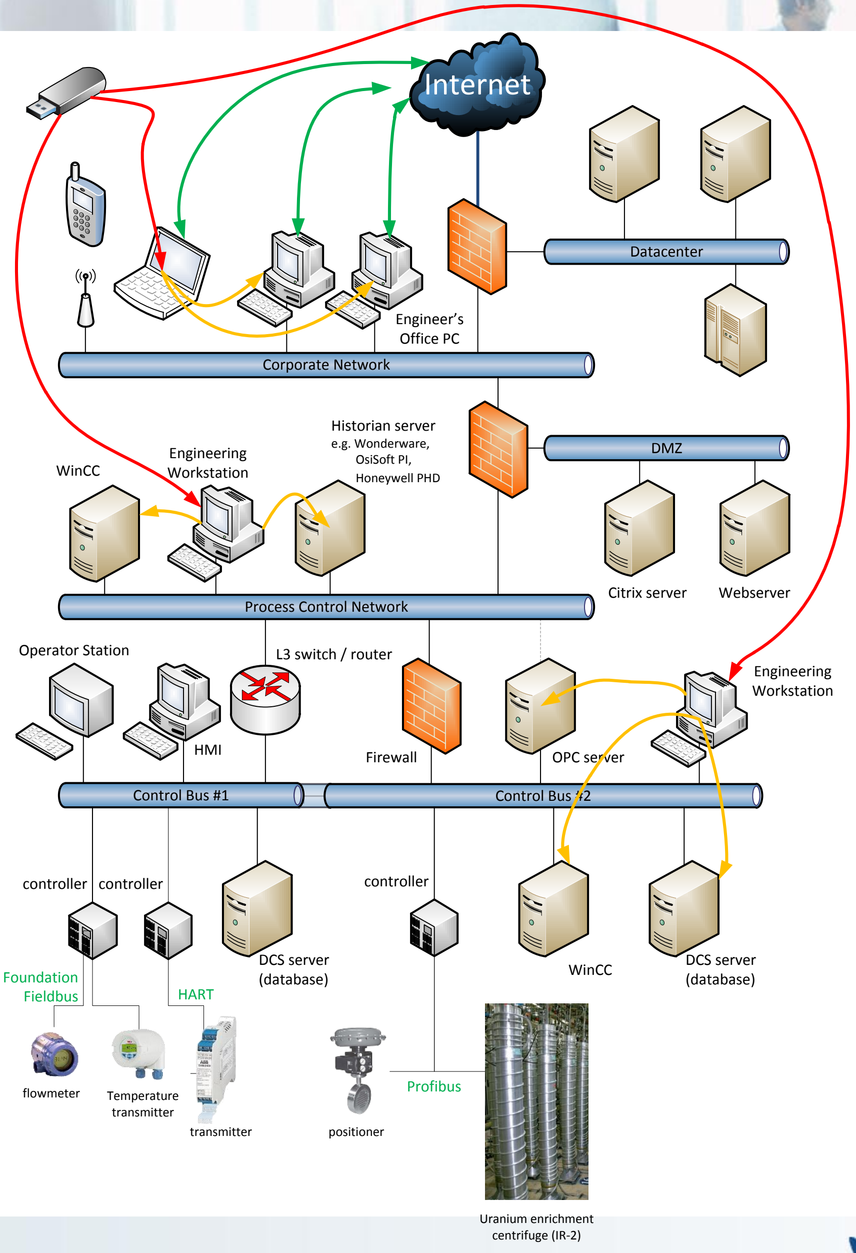
Propagation



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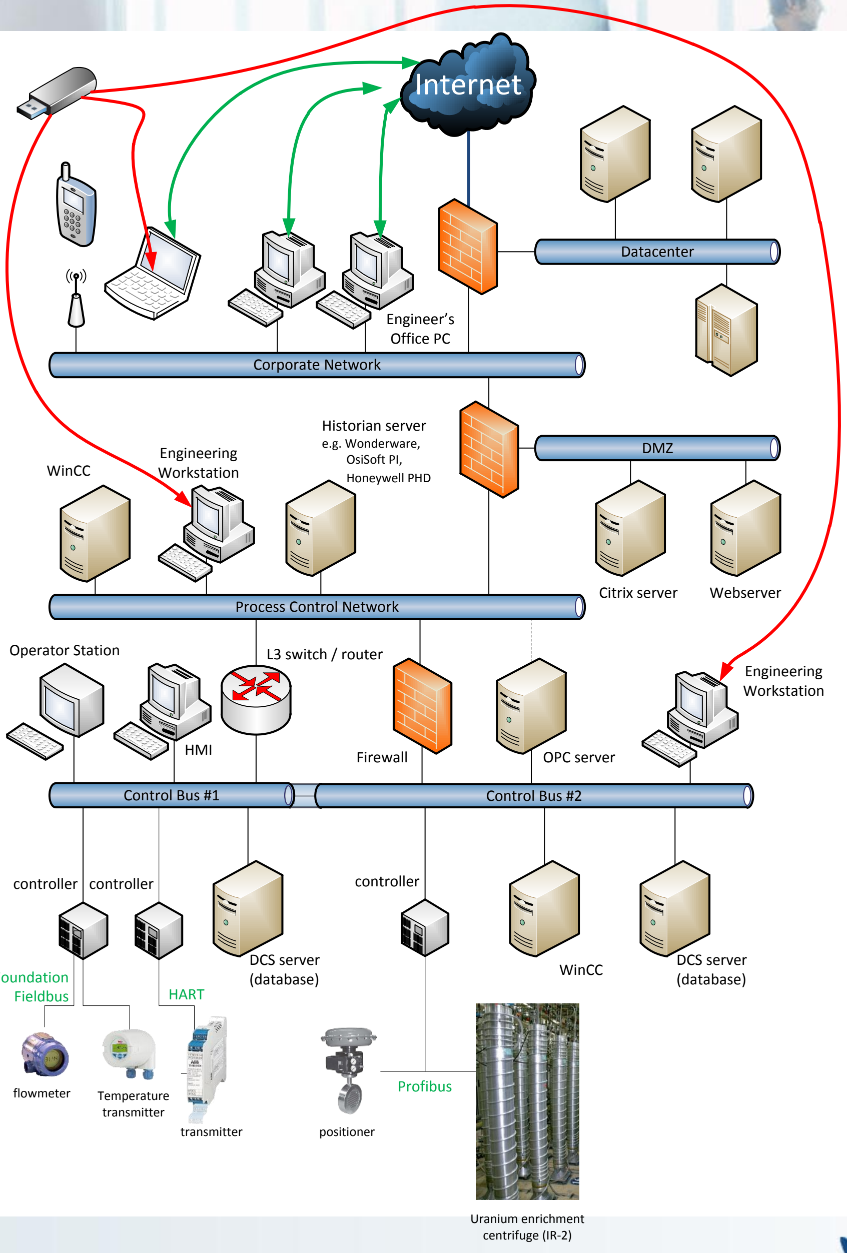
C&C Updates



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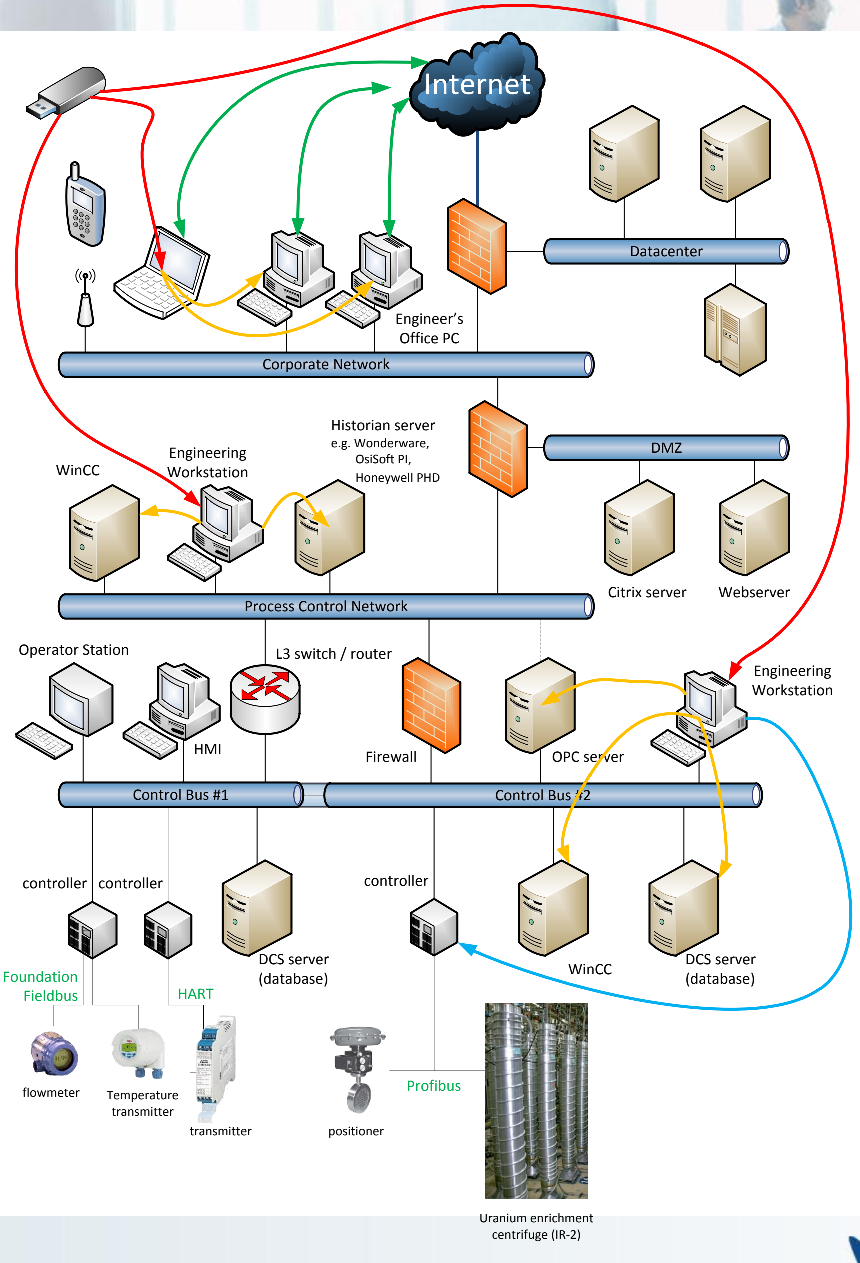
Payload



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Stuxnet Conclusions

The Good

- 4x 0-day for relevant systems (Windows XP and Vista)
- Designed for industrial environment: USB and S7P propagation to jump air-gap and RPC to jump L3 to L2
- Code is better than the code being abused

The Bad

- Initial hand-off got out of hand (AtomStroyExport)
- Did the four star general really want all this attention?

This presentation was about attacking critical infrastructure?

ATTACK VECTORS

Attack vectors

Human Factor

- Night shifts and remote locations
- Computers like home
- Cold and noisy auxiliary rooms
- Poor IT skills
- Third party engineers / vendor maintenance

Attack vectors

Procedural

- Low patch frequency
- Manual patching
- Backups on removable drives
- Company IT policy doesn’t fit

Attack vectors

Technological

- 90s networking (design and technology)
- Badly configured and maintained firewalls, ACLs
- IDS maturity (signatures), no security monitoring
- Control bus (Level 2) uses custom high-availability protocols. ‘Not so robust’ Windows driver implementation
  - Yokogawa Vnet/IP
  - Honeywell FTE
  - Invensys Nodebus
- OSI layers 5 to 7 (as researchers get better access)

Are you done?

WRAP UP

Take-aways

Pretty common technology
(together with some ancient stuff)

The industry has a hard time taking on the other chores than come with modern IT

Attacks move up the OSI stack, but proprietary network protocols are of interest..