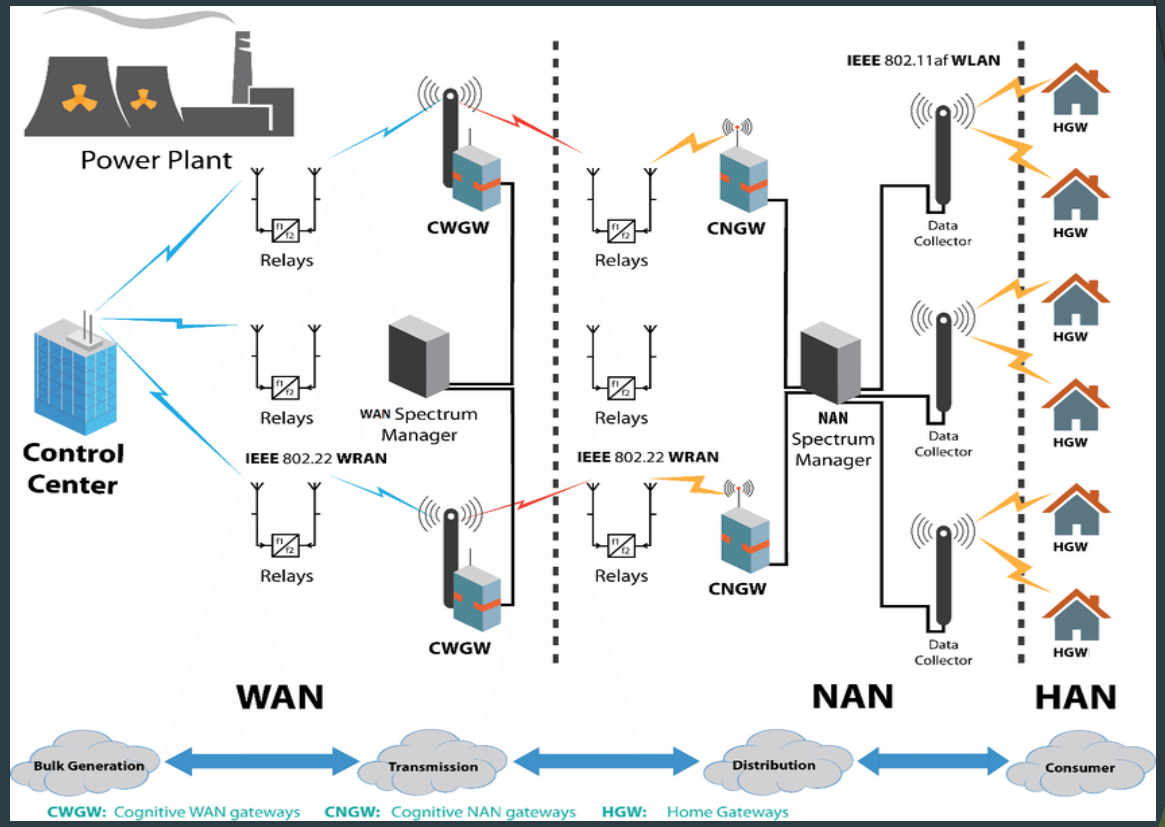
Cyber attacks on smart grid

Overview: network security in SG

- Enterprise zone
- Trasmission zone
- Distribution SCADA zone
- Distribution Non-SCADA zone
- Interconnected zone



Distribution Non-SCADA network

- AMI: network between SM and MDMS
  - NAN
  - SM
  - Collector
  - Head End

Attack a smart meter

- EPM 6100 by GE:
  - High class accuracy
  - Easy to programm and configure
  - Remote power monitoring with EnerVista

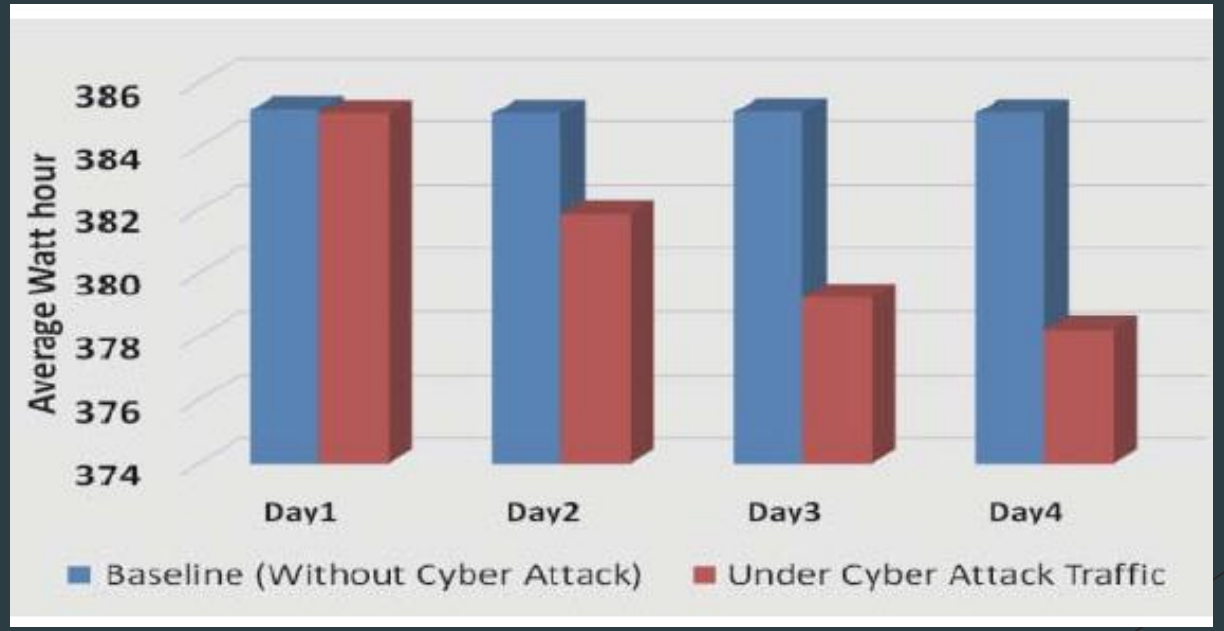
Attack on EPM 6100: Experiment A

385 W load

4.5 Mbps

4 days: final loss 1.77%

18.6 Million $ per month



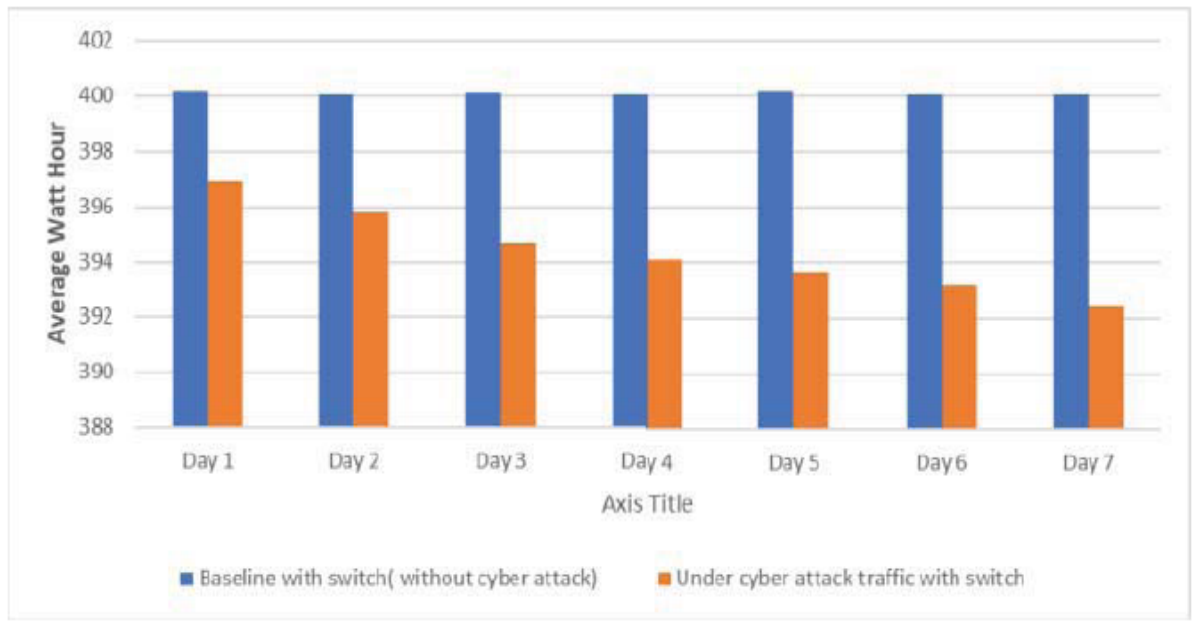
Attack on EPM 6100: Experiment B

400 W load

1000 Mbps

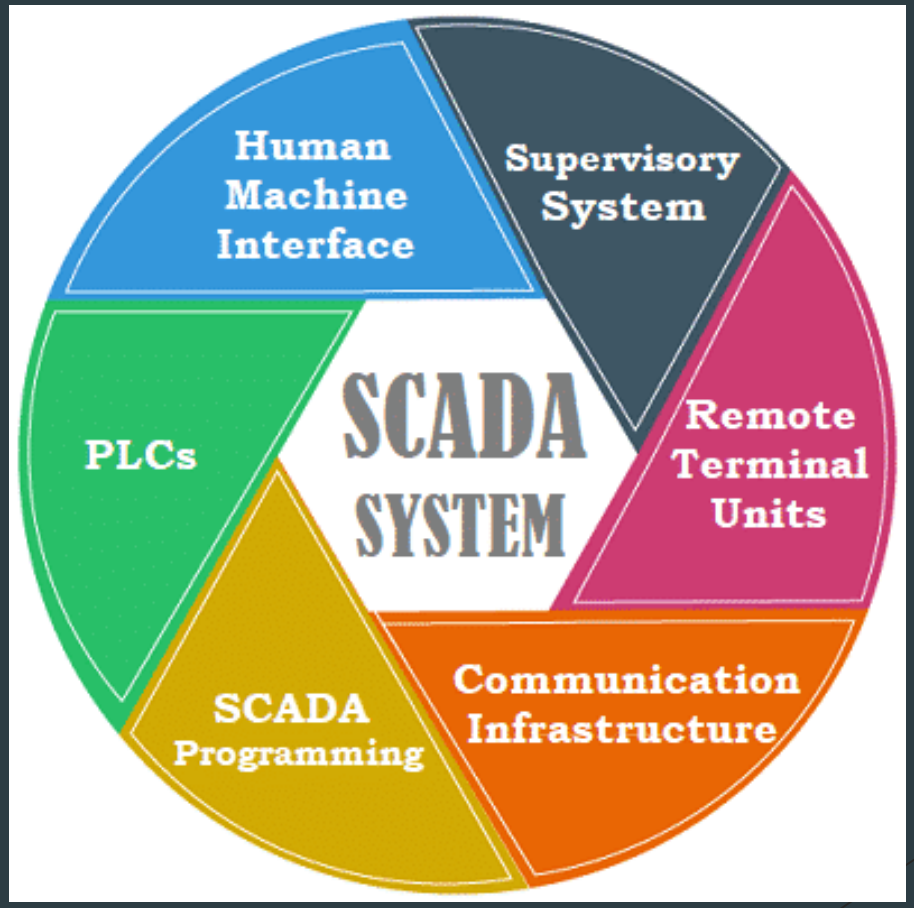
7 days: final loss 1.91%

20.9 Million USD per month



Distribution SCADA zone

- Monitoring and Control
- SCADA is made of:
  - Sensors and actuators
  - PLC or microcontrollers
  - Communication network
  - Server

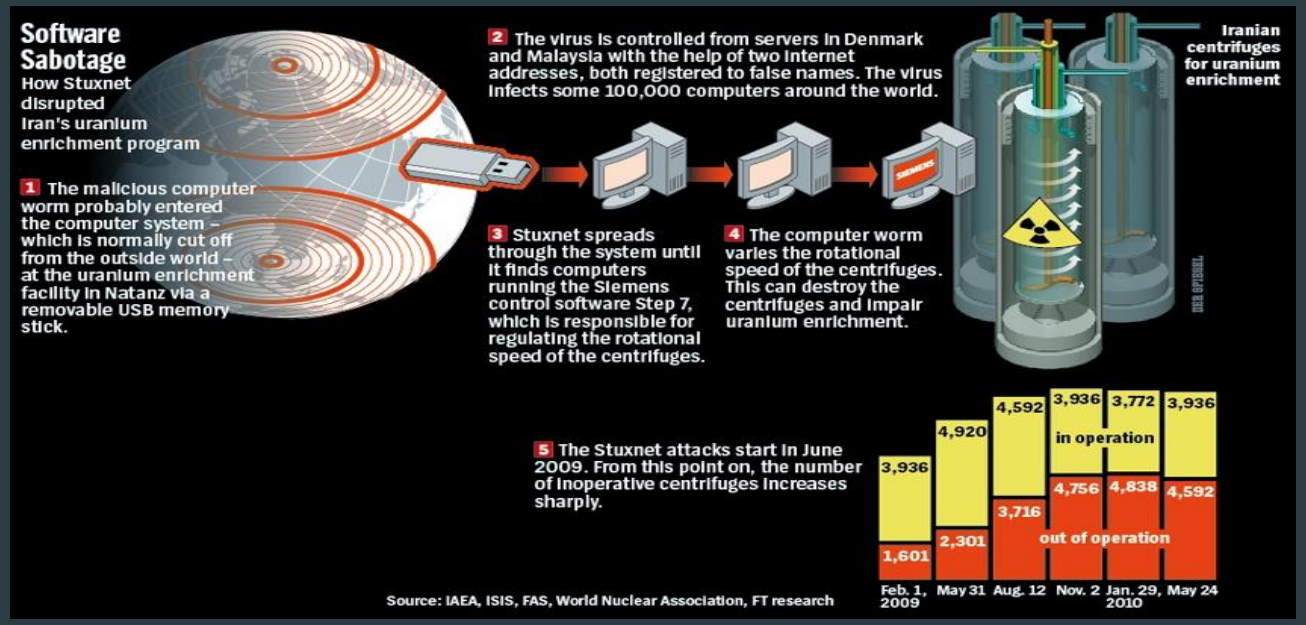


Attack a PLC

- Siemens S7-300:
  - 22 different CPU (standard, compact, failsafe, technology)
  - Different I/O technologies analog and digitals

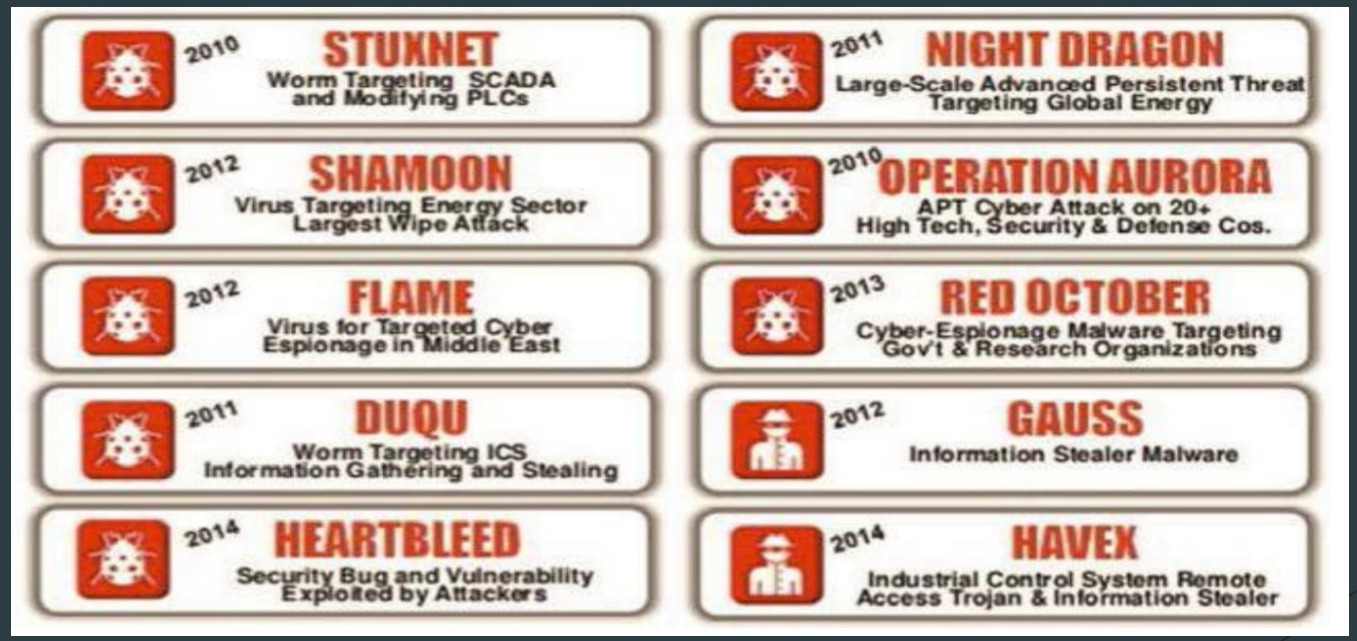
Stuxnet attack

- Advanced Persistent Threat Attack
- Made by US and Israelian Government to attack Iran
- Works on 2 update: learn and control
- 3 infections: Windows, s7otbxdx.dll, Siemens S7-300



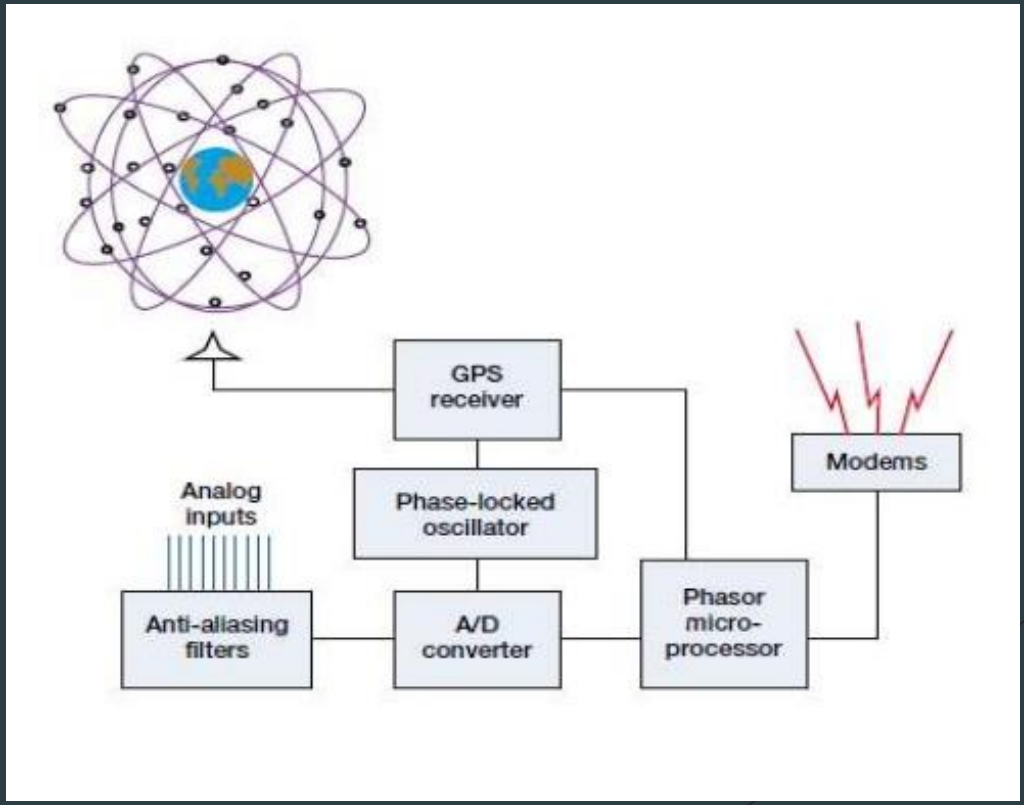
Stuxnet variances

- 09/2011 Duqu: steal information to attack the industry (key logger)
- 05/2012 Flame: cyber espionage on Middle Eastern countries
- 08/2012 Shamoon: attack energy and oil sector of Middle East countries
- 12/2017 Triton: not even known



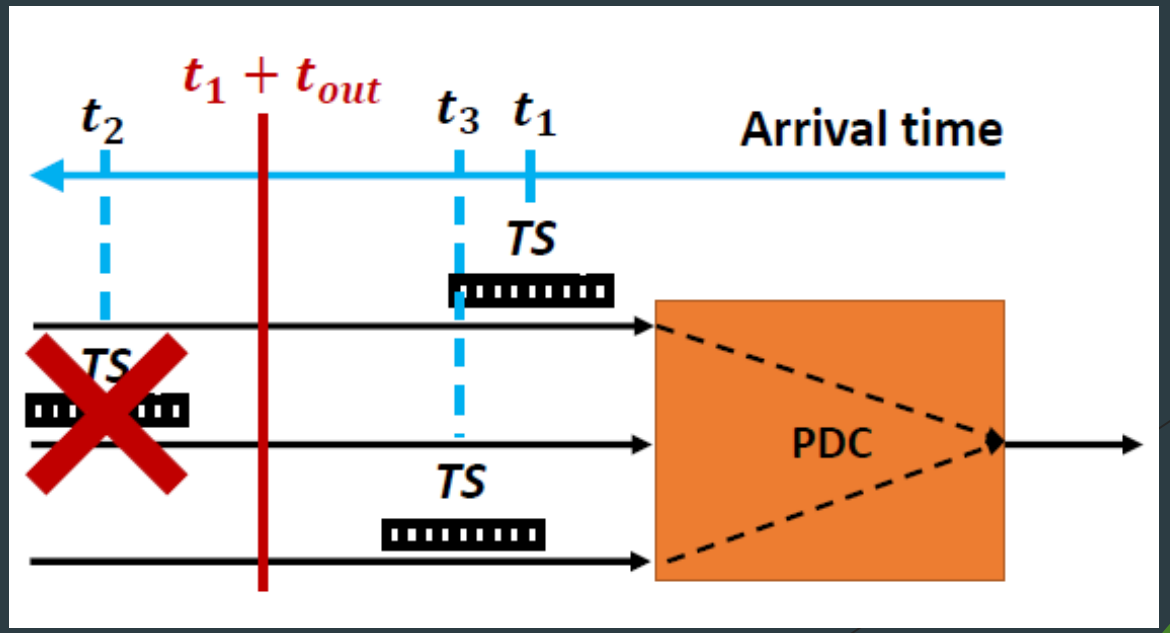
Transmission network

- PMU:
  - Replace SCADA measurements
  - Phasor measurement
  - Time Synchronized



Attack a PMU

- Jammer GPS
- Act as a PMU
- Delay: hop, modify timestamp
- Steal data from PDC storage



Storage electrical system

- The importance on smart grid:
  - Demand and response
  - Renewable sources
  - Store for blackout

Attack a storage system

- Electrical damage on a single cell to break the accumulator
- Change environmental temperature: break charge-discharge cycle

How to know if the grid is under attack?

- State estimation or STAMP

- Traffic matrix

	Server 1	Server2
Router 1	X1 Mbps	X2 Mbps
Router 2	X3 Mbps	X4 Mbps

- FMEA: Risk Assessment

f(Threat, Vulnerability)	Level of Risk < Threshold risk

How to protect the grid?

- Firewall (DMZ)
- Encryption
- Logical isolation
- DBMS protection
- Constantly update software
- Biometric authentication
- Hierarchical authority