Introduction to Network Security

Segurança em Redes de Comunicações

Mestrado em Cibersegurança

Mestrado em Engenharia de Computadores e Telemática

DETI-UA

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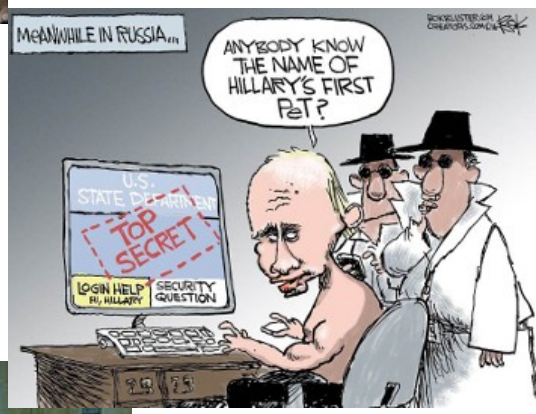
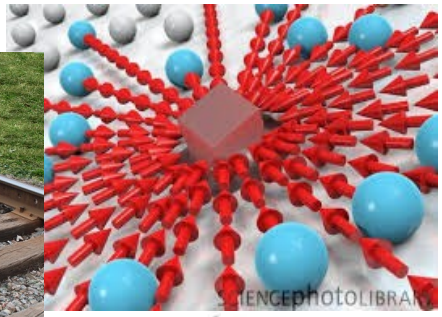
Type of Attacks (1)

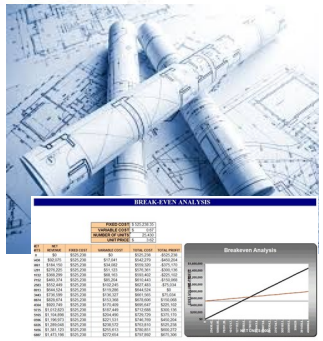
- Objectives:
  - Fun and/or hacking reputation
  - Political purposes
  - Military purposes
  - Economical purposes
  - Other?
- Technical objectives:
  - Operation disruption
  - For data interception
  - Both
    - Disruption to intercept!
    - Intercept to disrupt!



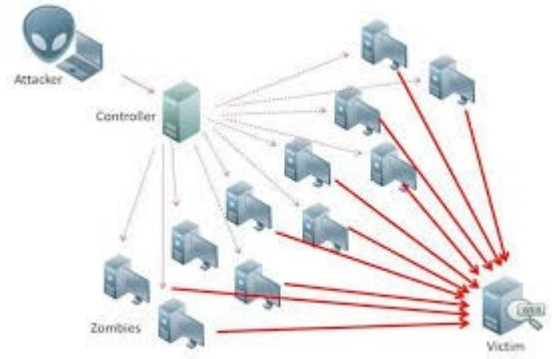
Type of Attacks (2)

- Technical objectives:
  - Operation disruption.
    - (Distributed) Denial-of-Service.
  - Resources hijack.
    - Spam,
    - Crypt-currency mining/masternodes,
    - Platform to other attacks!
  - Data interception/stealing.
    - Personal data
      - As final goal,
      - Or as tool to achieve more value information!
    - Technical data,
      - Usually used to achieve more value information!
    - Commercial data
      - Digital objects, financial and/or engineering plans, ...
- Disruption may be used to achieve interception!
- Interception may me used to achieve disruption (operational or commercial)!





Disruption Attacks



- Distributed DoS
  - Multiple slow/small devices generating traffic to a target
    - TCP vs. UDP
  - Purpose of disruption
    - By political/economical/"reputation"
    - Redirection to other service/location?
  - Solution at target
    - Load-balancers
    - For TCP, maybe its possible to survive making active (with licit client validation) session resets (server/firewalls)
      - White list solution, for completed session negotiation
    - For UDP/DNS, block requests for known external relay/redirection DNS servers (blocks attack amplification, IP target spoofing)
      - Doesn't work with large botnets and direct requests to target
  - Solution at source
    - Anomalous behaviors detection
      - Low traffic variations hard to detect
      - Time and periodicity changes are easier to detect
      - Destinations of traffic changes
      - With "really low" data rates is impossible to detect
- Denial o service by physical signal jamming
  - Pure disruption, or
  - Disruption to activate secondary channels (more easily compromised).
  - Solution
    - Detect, localized source and physically neutralize.

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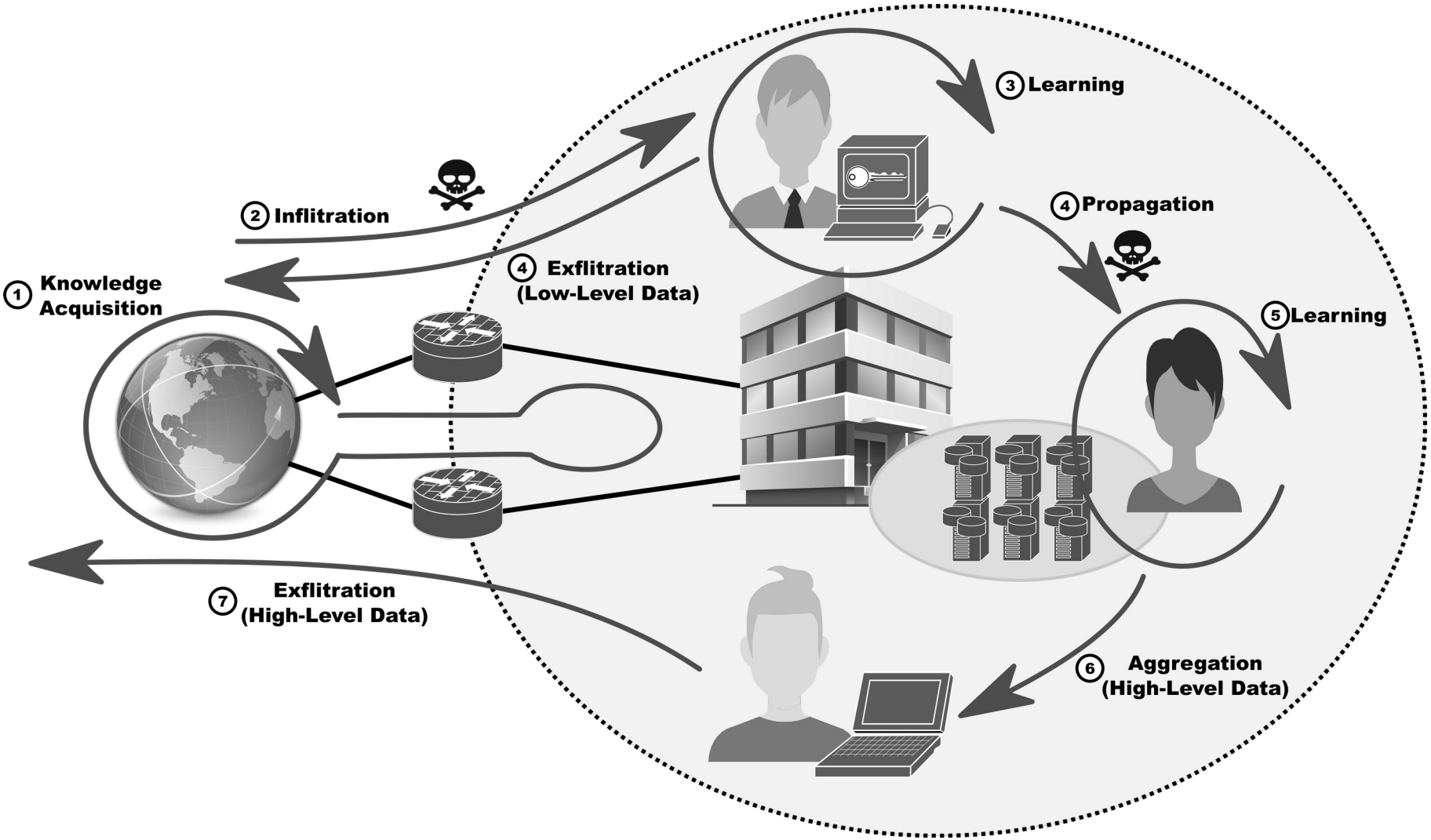
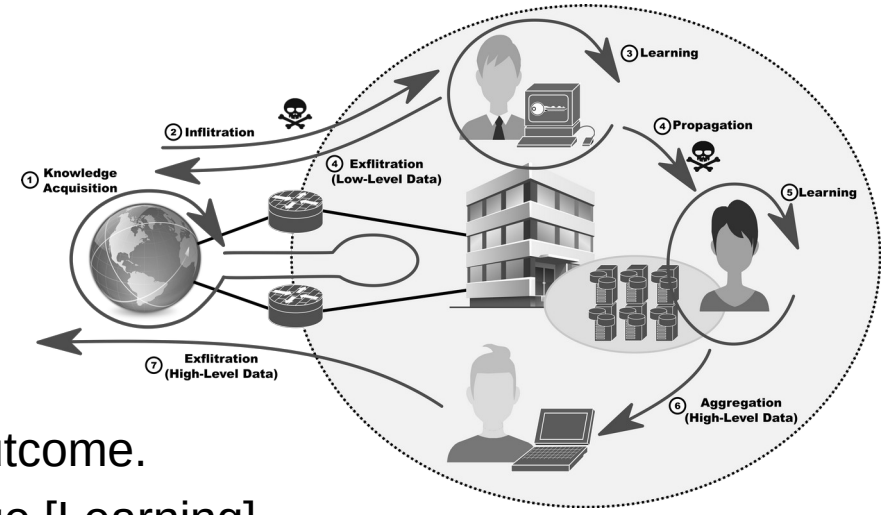
Attacks Phases



Attacks are Done Incrementally



- Escalation of goals and privileges.
  - Public knowledge opens doors to private information and access to protected domains [Infiltration].
  - The first illicit access to a protect domain may not provide a relevant outcome.
  - Attacker must acquire more knowledge [Learning].
  - The additional knowledge allows to access other secure domain zones/devices/data with increasing relevance [Propagation].
    - At any phase the attacker may require additional knowledge [Learning].
  - When a relevant outcome is acquired it must be transfered to outside of the protected domain [Exfiltration].
  - Direct exfiltration may denounce the relevant points inside of the secure domain.
    - The relevant outcome must be first transferred inside the protected domain to a less important point [Aggregation].
    - Attacker chooses a point that may be detected and lost without harm.

Technical Network Vulnerabilities

- Software
  - Applications
  - Frameworks/API
  - Protocols
  - Operating systems
    - Kernel, kernel modules, drivers, and base applications.
    - Configurations!
  - Low level code
    - CPU microcode, firmware, and BIOS/UEFI.
- Hardware
  - Physical tempering
  - Physical emissions
    - Electromagnetic emissions, sound, ...
  - Power instability, Electromagnetic Pulses (EMP), etc ...
- Known vs. unknown
  - CVE
  - IDS/IPS and antivirus databases

CVE

Common Vulnerabilities and Exposures

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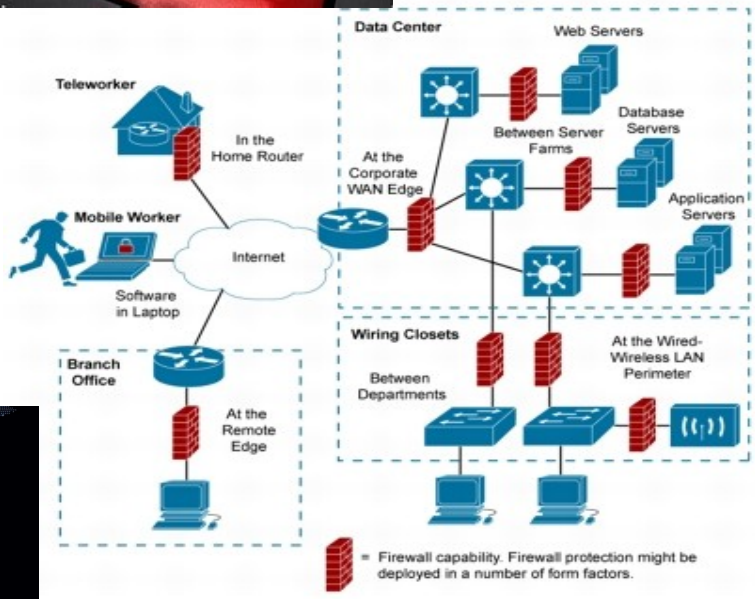
Traditional Defenses

- Vulnerability patching.
- Firewalls
  - Centralized.
  - Distributed.
- Intrusion Prevention and Detection Systems (IDS/IPS).
- Antivirus.



- **All rely on previous knowledge of the threat and/or problem!**

“Intelligent” Defenses

- Detection of unknown threats and/or problems.
  - In time to deploy counter-measures.
- Application of Big Data and Data Science techniques to network ans systems monitoring data.
- Some traditional solutions start to incorporate AI into their equipment
  - E.g., Palo Alto Network Firewalls, Cisco Appliances, …
- Still limited to manufacturer based solutions and localized data.
- Still limited in scope.
  - Obvious threats vs. Stealth threats.
- Optimal deployment requires an overall network and systems knowledge.
  - Network and Systems (Cyber) Situational Awareness.

Infiltration Phase

- Licit machines must be compromised to implement the different attacks phases.
  - Ideally in a privileged “zone” of the network, and/or
  - With access credentials, and/or
    - User credentials, address(es), hardware key, etc…
  - With “special” software, and/or
  - Target data.
- May include the installation of software or usage of licit vulnerable software.
- May be remotely controlled (constantly or not).
  - Command and control (C&C).
- May have autonomous (AI) bots installed to perform illicit actions.
  - When remote C&C is not possible or subject to easy detection.

Propagation Phase

- Done using a mixture of methodologies:
  - Credentials exploitation.
    - Direct usage or by using allowed applications.
  - Impersonating users and systems.
    - Similar to credential exploitation but more advanced based on acquired knowledge (licit behavior).
    - Requires time to learn and mimic licit behavior.
      - Time patterns, traffic patterns, application patterns, etc...
  - Vulnerability exploitation.
    - Inside a protected domain systems are many times considered in a secure zone.
    - Less maintained and legacy OS/applications may be required to run (no patching).
    - Broader range of vulnerabilities

Aggregation and Exfiltration Phase

- Data transferred from machine to machine.
- Internally [Aggregation] it can be done using existing channels.
- Externally [Exfiltration]
  - It can be done directly using existing channels.
    - File copy, email, file sharing, etc…
    - Can be detected.
  - It can be done hiding information within existing/allowed channels and licit communications.
    - Slower data transfer, harder (impossible?) to detect.
    - Examples:
      - Usage of steganography in photos (via social networking).
      - Usage of embed data in text and voice messages.
      - ...

Security Metrics/KPI

- Access management
  - How many users have administrative access, and how often is used.
  - Shared passwords between staff.
- Preparedness
  - Percentage of devices fully patched and up to date.
- Days to patch
  - Average time between patch availability and deployment.
- Unidentified devices
  - Illicitly deployed devices.
  - BYoD policy, legacy devices, unlisted devices, IoT devices, etc...
- Security devices average/maximum load per time period.
- Intrusion attempts
  - Amount of detected and undetected attempts (in real time or after off-line auditing).
- Cost per incident
  - Includes staff overtime, external support, investigation costs, employee productivity loss, loss of communication, service failure, etc…
- Mean Time Between Failures (MTBF)
  - Average time between failures (hardware and/or software).
  - General or per device/service.
- Mean Time to Recovery (MTTR)
  - Average time between failure and recovery (hardware and/or software).
- Mean Time to Detect (MTTD)
  - Average time between intrusion and detection.
- Mean Time to Acknowledge (MTTA)
  - Average time between detection and start of countermeasures deployment.
- Mean Time to Contain (MTTC)
  - Average time between start of countermeasures deployment and complete mitigation.
- Mean Time to Resolve (MTTR)
  - MTTA+MTTR