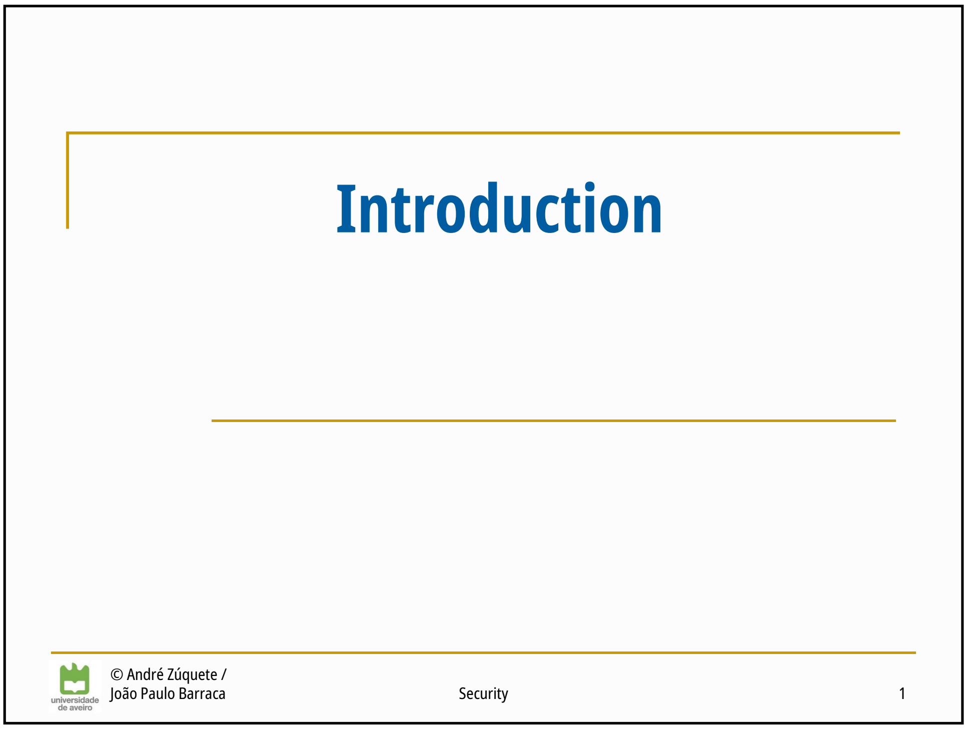
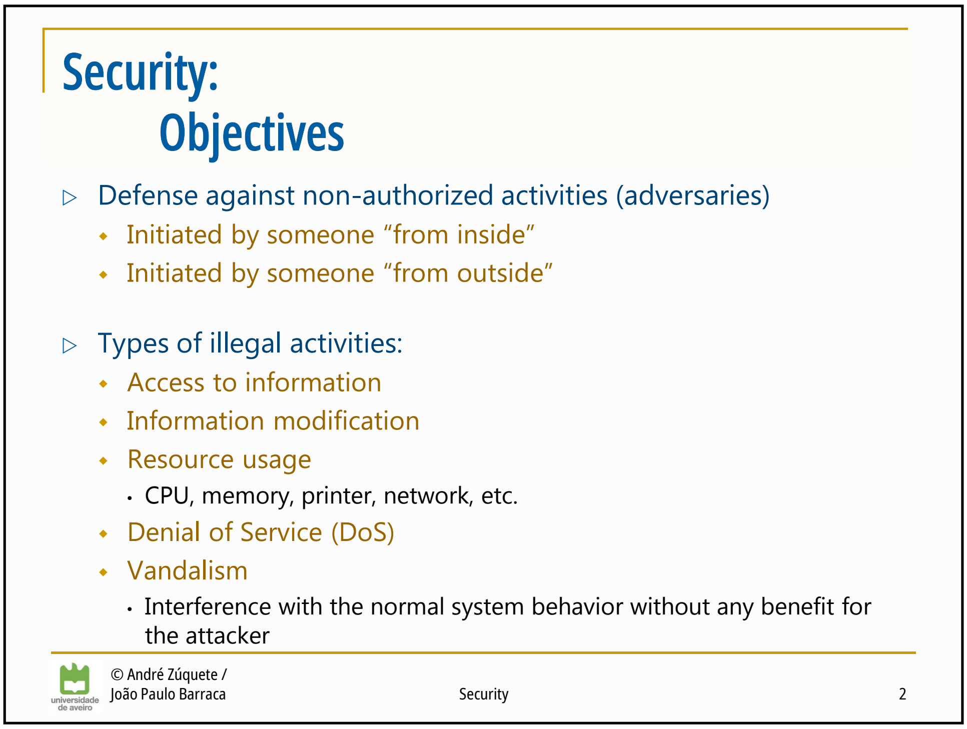


Introduction



Security: Objectives

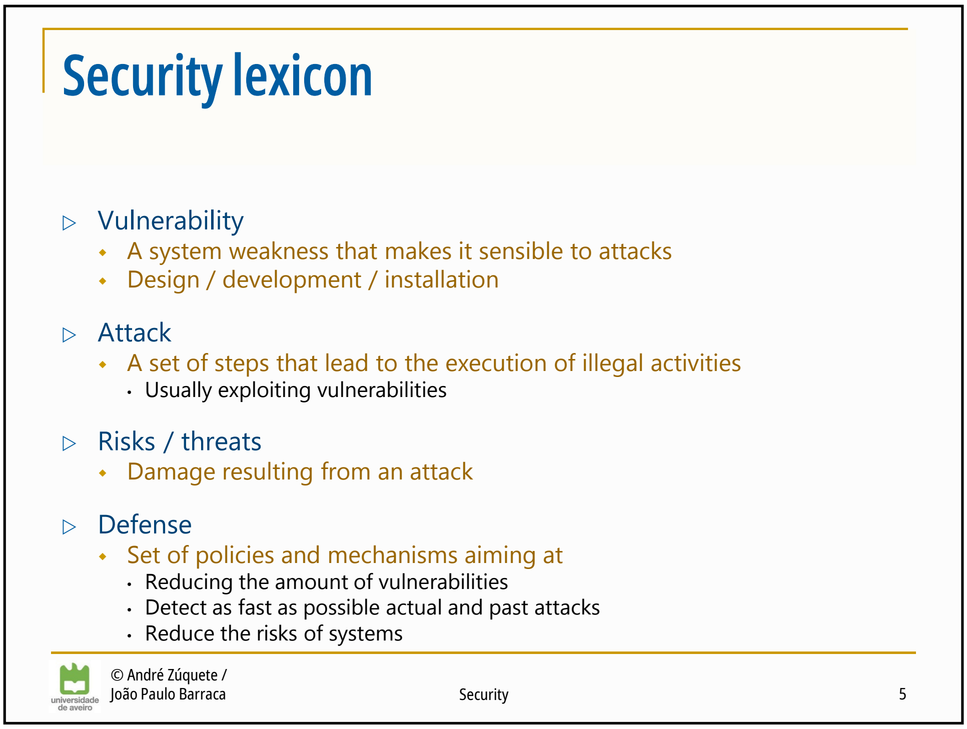
- ▷ Defense against non-authorized activities (adversaries)
  - Initiated by someone "from inside"
  - Initiated by someone "from outside"
- ▷ Types of illegal activities:
  - Access to information
  - Information modification
  - Resource usage
    - CPU, memory, printer, network, etc.
  - Denial of Service (DoS)
  - Vandalism
    - Interference with the normal system behavior without any benefit for the attacker

Security in computing systems: Complex problems

- Computers can do a lot of damage in a short time frame
  - They manage an always growing amount of data/information
  - They process and communicate very fast
- The number of weakness is always growing
  - Systems are getting more complex with time
  - Time-to-market is each time shorter
- Networks allow:
  - Anonymous (?) attacks from anywhere
  - Automatic propagation of cyberplagues
  - The existence and exploitation of hostile hosts and applications
- In general users are not careful
  - Because they are not aware of the problems and solutions
  - Because they take risks

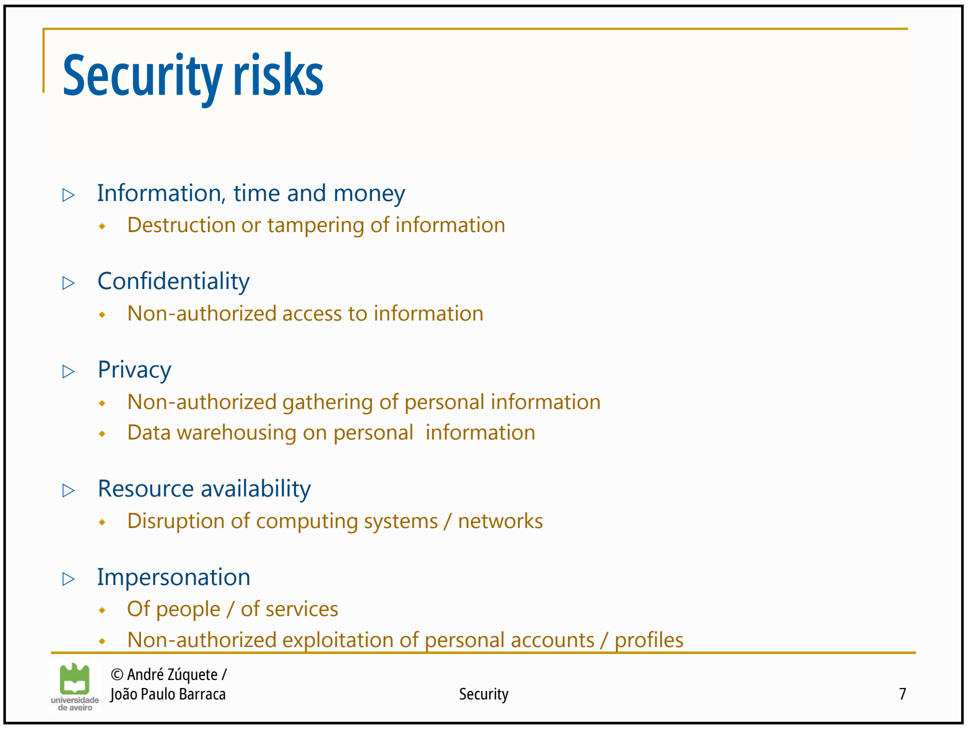
Security: Pragmatic approach

- There will never be a 100% protection
  - Cost-efficiency balance
- Security is expensive
  - Dedicated technology, skilled people
  - Use only the minimum required
- Protection, value e punishment
  - Good protection for the most frequent attacks
  - Less interference with daily work than the damage caused by attackers
  - Police and courts for tracking and prosecuting attackers
    - It is critical to avoid the notion of total impunity



Security lexicon

- ▷ Vulnerability
  - A system weakness that makes it sensible to attacks
  - Design / development / installation
- ▷ Attack
  - A set of steps that lead to the execution of illegal activities
    - Usually exploiting vulnerabilities
- ▷ Risks / threats
  - Damage resulting from an attack
- ▷ Defense
  - Set of policies and mechanisms aiming at
    - Reducing the amount of vulnerabilities
    - Detect as fast as possible actual and past attacks
    - Reduce the risks of systems



Security risks

- ▷ Information, time and money
  - Destruction or tampering of information
- ▷ Confidentiality
  - Non-authorized access to information
- ▷ Privacy
  - Non-authorized gathering of personal information
  - Data warehousing on personal information
- ▷ Resource availability
  - Disruption of computing systems / networks
- ▷ Impersonation
  - Of people / of services
  - Non-authorized exploitation of personal accounts / profiles

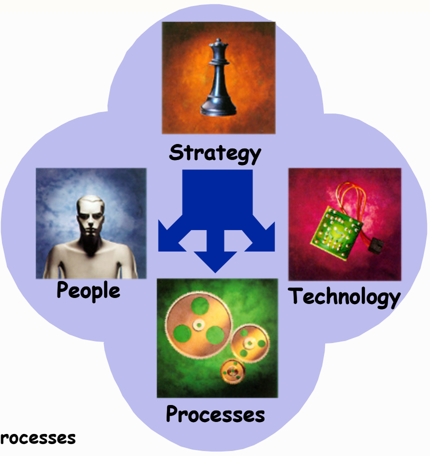
Main vulnerability sources

https://www.pinterest.pt/pin/457256168394094122/

"Tech support says the problem is located somewhere between the keyboard and my chair."

- ▷ People
  - Ignorant or careless
  - Hostile
- ▷ Applications with bugs
  - Root kits help newcomers to exploit well-known vulnerabilities
- ▷ Malware installation
  - Trojan horses, worms, virus
- ▷ Defective administration
  - Systems get more complex as they evolve
  - Security restrictions vs. flexible operation
    - Most people cannot understand security jargon in order to manage security configurations
    - Default configurations may not be the most secure ones
- ▷ Communications over uncontrolled/unknown/unsafe network links

Security: Dimensions to consider



- Training
- Awareness
- Organization of security

- Vulnerability scanning
- Firewalls
- Authentication
- Access Control
- Auditing
- Cryptography
- Digital signatures
- Certification authorities
- Certification hierarchies
- Etc.

- Security policies
- Security administration processes
- Continues evolution of auditing and follow-up processes

Security policies

http://devhumor.com/media/treat-your-passwords-like-your-underw

Maastricht University
Treat your passwords like your underwear
• Never share them with anyone
• Change them regularly
• Keep them off your desk
Be aware of the new European law on privacy and personal data, General Data Protection Regulation – effective 25 May 2018
www.maastrichtuniversity.nl/privacy

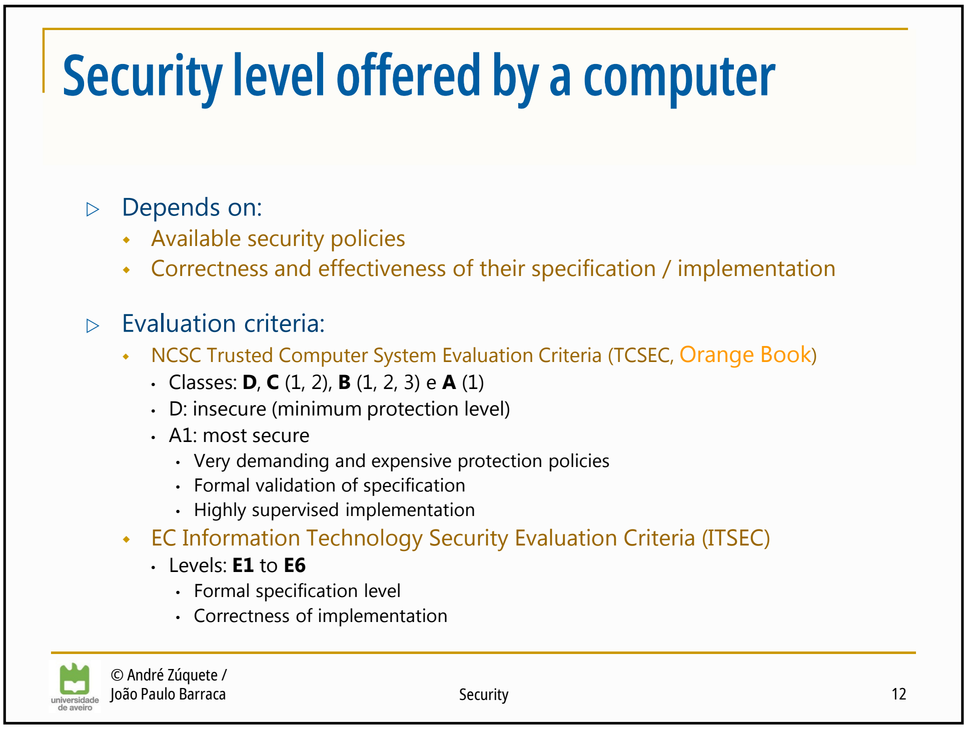
- ▷ Define the power of each and every subject
  - Least privilege principle
  - *Hardening*
- ▷ Define security procedures
  - Who does what in which circumstances
- ▷ Define the minimum security requirements of a domain
  - Security levels
  - Authentication requirements
    - And related minimum authentication requirements
    - Strong/weak, single/multi-factor, remote/face-to-face
- ▷ Define defense strategies and fight-back tactics
  - Defensive architecture
  - Monitoring of critical activities or attack signs
  - Reaction against attacks or other abnormal scenarios
- ▷ Define the universe of legal and illegal activities
  - All that is not forbidden is allowed
  - All that is not allowed is forbidden

Security mechanisms

- ▷ Mechanisms implement policies
  - Policies define, at an higher level, what needs to be done
  - Mechanisms are used to deploy policies
- ▷ Generic security mechanisms
  - Confinement (sandboxing)
  - Authentication
  - Access control
  - Privileged execution
  - Filtering
  - Logging
  - Inspection
  - Auditing
  - Crypto algorithms
  - Crypto protocols

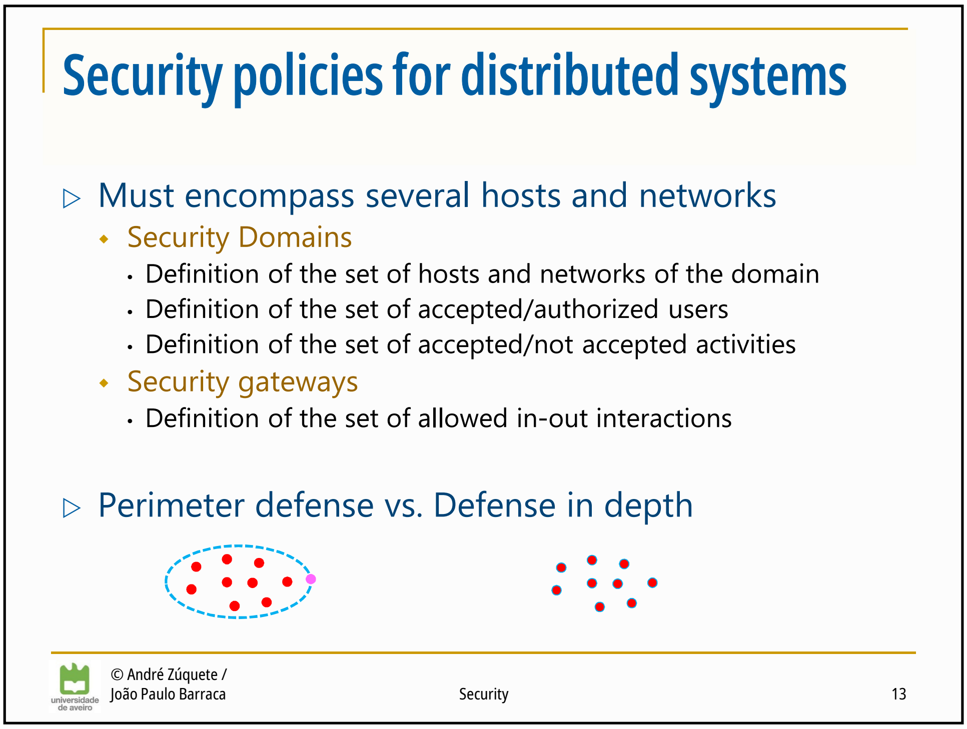
http://devhumor.com/media/human-error-dave

DATA SECURITY
IN THIS CORNER, WE HAVE FIREWALLS, ENCRYPTION, ANTIVIRUS SOFTWARE, ETC. AND IN THIS CORNER, WE HAVE DAVE!!
HUMAN ERROR
copyright 2006 John Klossner, www.jklossner.com



Security level offered by a computer

- Depends on:
  - Available security policies
  - Correctness and effectiveness of their specification / implementation
- Evaluation criteria:
  - NCSC Trusted Computer System Evaluation Criteria (TCSEC, Orange Book)
    - Classes: **D**, **C** (1, 2), **B** (1, 2, 3) e **A** (1)
    - D: insecure (minimum protection level)
    - A1: most secure
      - Very demanding and expensive protection policies
      - Formal validation of specification
      - Highly supervised implementation
  - EC Information Technology Security Evaluation Criteria (ITSEC)
    - Levels: **E1** to **E6**
      - Formal specification level
      - Correctness of implementation



Security policies for distributed systems

- Must encompass several hosts and networks
  - Security Domains
    - Definition of the set of hosts and networks of the domain
    - Definition of the set of accepted/authorized users
    - Definition of the set of accepted/not accepted activities
  - Security gateways
    - Definition of the set of allowed in-out interactions
- Perimeter defense vs. Defense in depth

Attacks to distributed systems

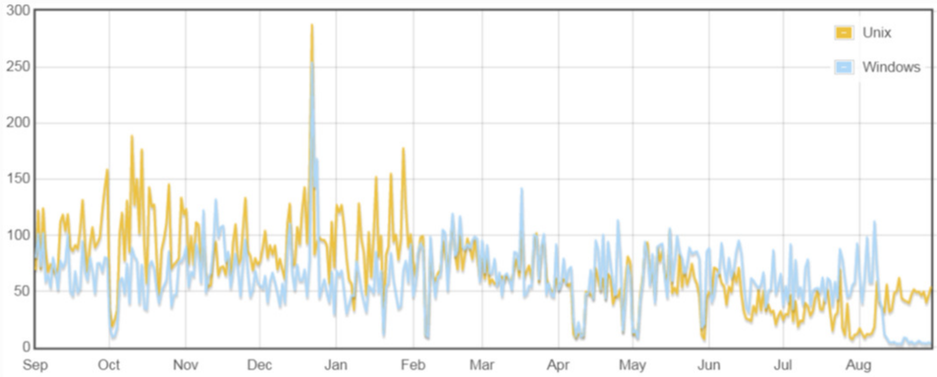
- ▷ Attacks to hosts
  - Stealing
  - Intrusion
  - Impersonation (of users)
  - Denial of service
- ▷ Attacks to networks
  - Packet inspection
  - Packet tampering / injection
  - Traffic interception
  - Traffic replaying
  - Host impersonation
  - Denial of service (jamming, flooding, deception, etc.)
- ▷ Other
  - Covert channels

"On the Internet, nobody knows you're a dog."

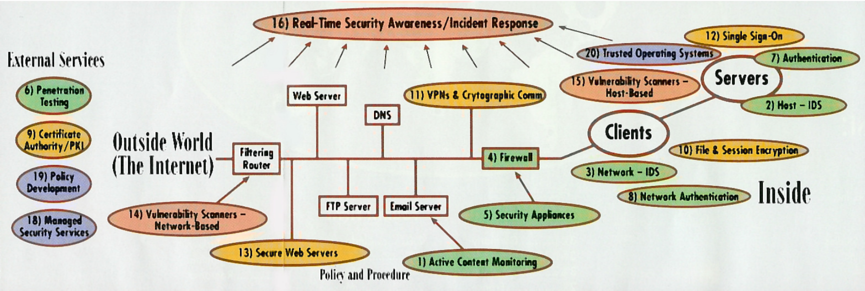
Attack models

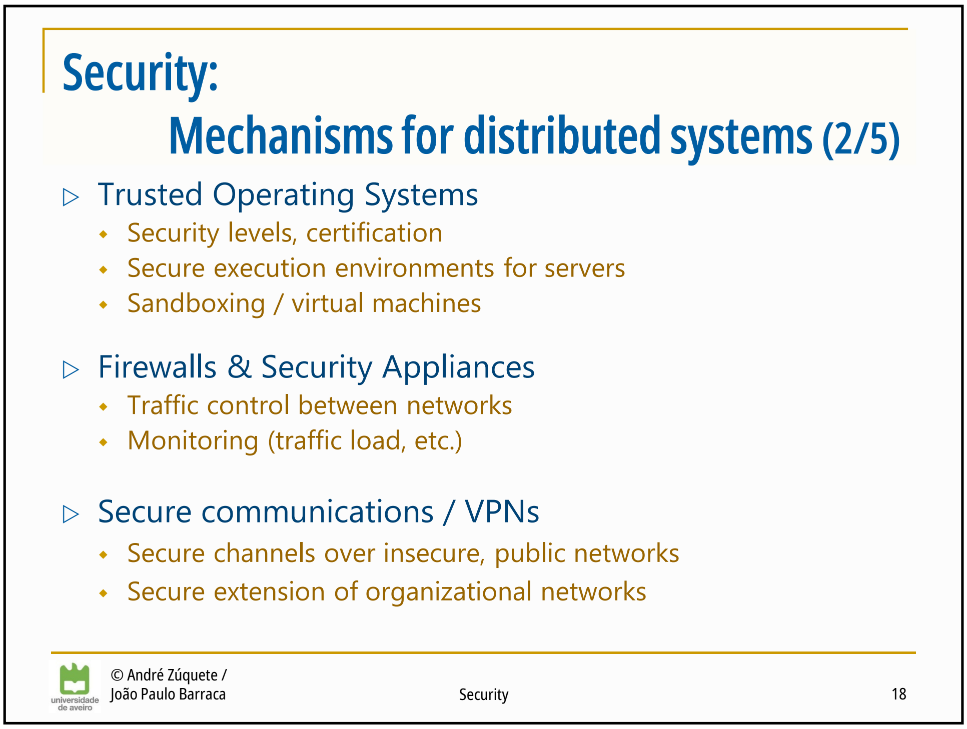
- ▷ Target-specific attacks
  - Conceived for a particular host / network
  - Idealized and conducted in real-time by specialists
- ▷ Generic, autonomous attacks
  - Conceived for exploiting well-known, common vulnerabilities
  - Coded for many scenarios and targets
  - Mean survivability time
    - Time between two consecutive automatic attacks
    - There are "network sensors" that help to compute it

Mean survival time (http://isc.sans.org/survivaltime.html)



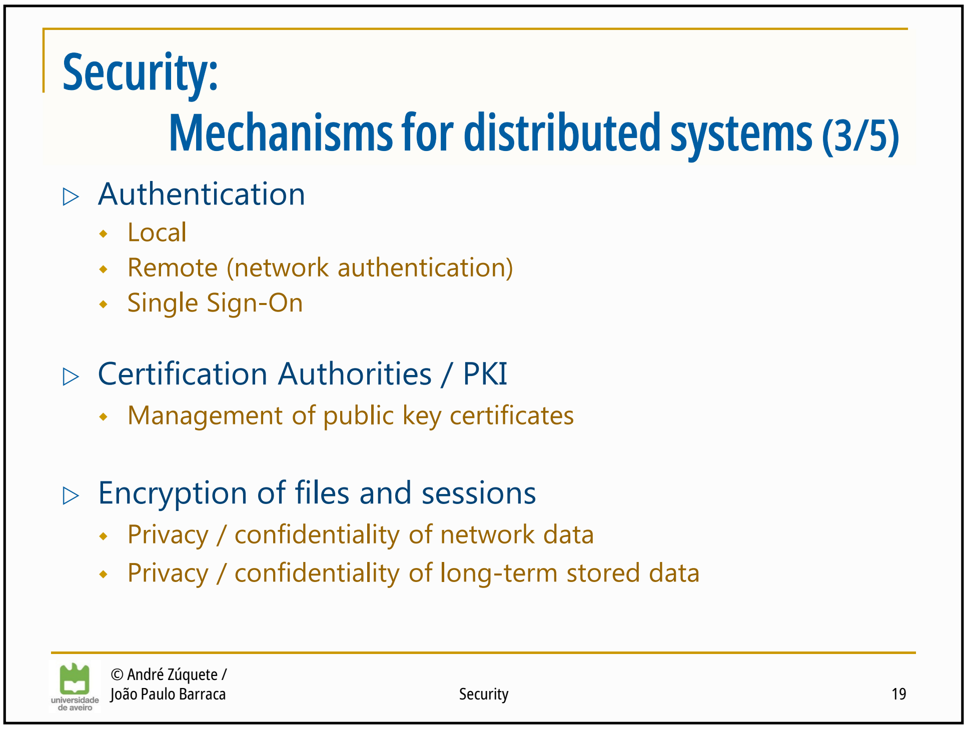
Security: Mechanisms for distributed systems (1/5)


16) Real-Time Security Awareness/Incident Response
External Services
6) Penetration Testing
9) Certificate Authority/PKI
19) Policy Development
18) Managed Security Services
Outside World (The Internet)
Filtering Router
Web Server
DNS
11) VPNs & Crytographic Comm
4) Firewall
FTP Server
Email Server
14) Vulnerability Scanners – Network-Based
13) Secure Web Servers
1) Active Content Monitoring
5) Security Appliances
Policy and Procedure
20) Trusted Operating Systems
12) Single Sign-On
7) Authentication
15) Vulnerability Scanners – Host-Based
Servers
2) Host – IDS
Clients
10) File & Session Encryption
3) Network – IDS
8) Network Authentication
Inside



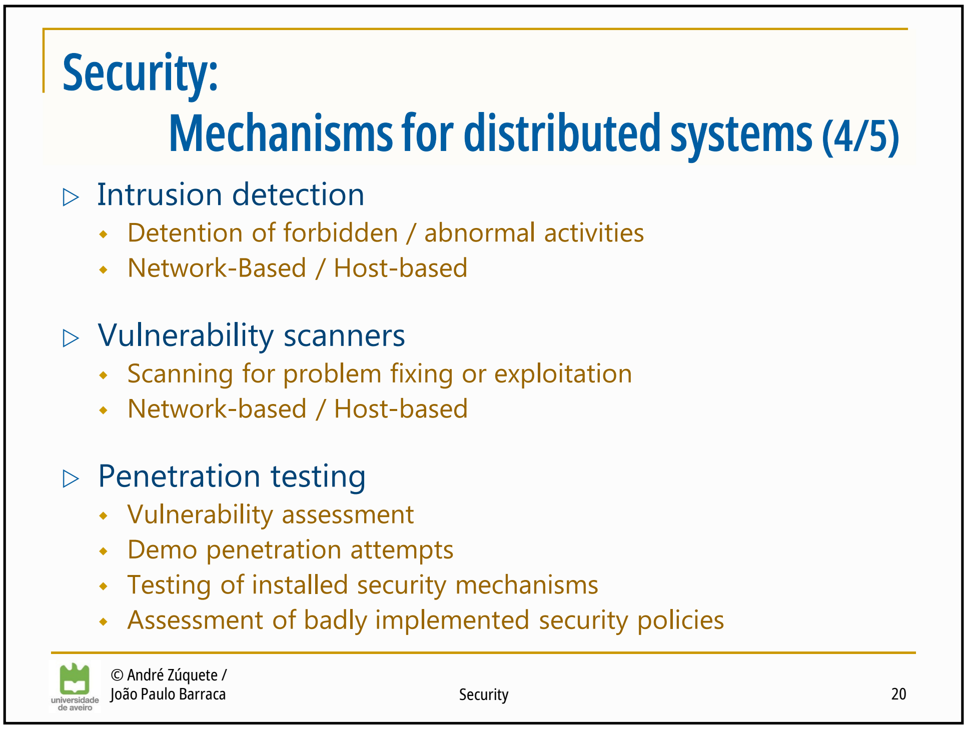
Security: Mechanisms for distributed systems (2/5)

- Trusted Operating Systems
  - Security levels, certification
  - Secure execution environments for servers
  - Sandboxing / virtual machines
- Firewalls & Security Appliances
  - Traffic control between networks
  - Monitoring (traffic load, etc.)
- Secure communications / VPNs
  - Secure channels over insecure, public networks
  - Secure extension of organizational networks



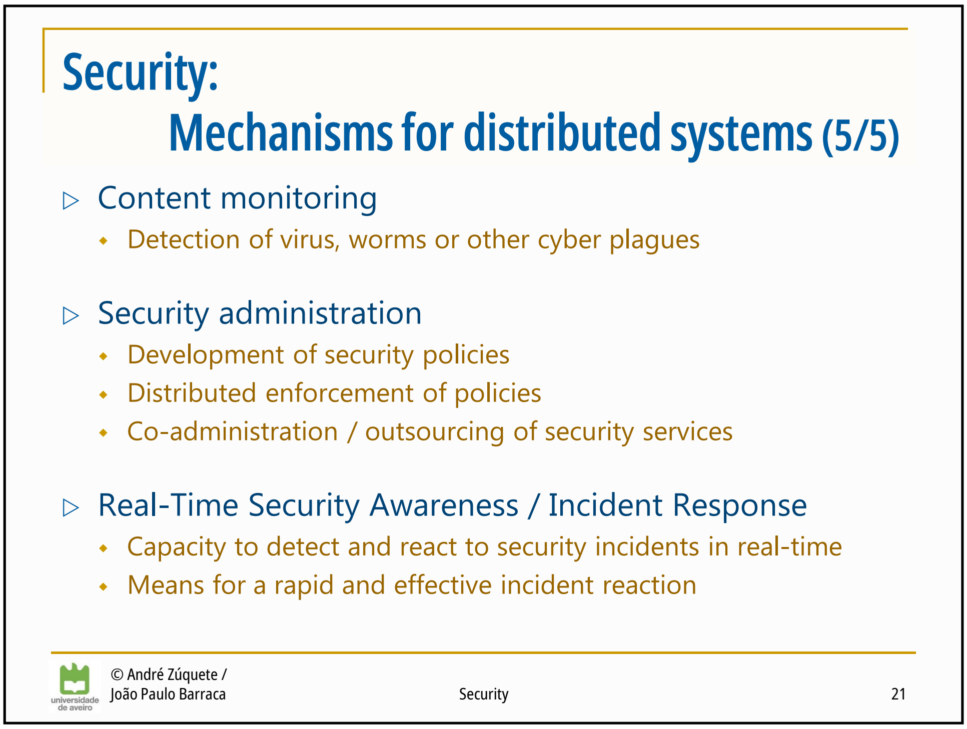
Security: Mechanisms for distributed systems (3/5)

- Authentication
  - Local
  - Remote (network authentication)
  - Single Sign-On
- Certification Authorities / PKI
  - Management of public key certificates
- Encryption of files and sessions
  - Privacy / confidentiality of network data
  - Privacy / confidentiality of long-term stored data



Security: Mechanisms for distributed systems (4/5)

- Intrusion detection
  - Detention of forbidden / abnormal activities
  - Network-Based / Host-based
- Vulnerability scanners
  - Scanning for problem fixing or exploitation
  - Network-based / Host-based
- Penetration testing
  - Vulnerability assessment
  - Demo penetration attempts
  - Testing of installed security mechanisms
  - Assessment of badly implemented security policies



Security: Mechanisms for distributed systems (5/5)

- Content monitoring
  - Detection of virus, worms or other cyber plagues
- Security administration
  - Development of security policies
  - Distributed enforcement of policies
  - Co-administration / outsourcing of security services
- Real-Time Security Awareness / Incident Response
  - Capacity to detect and react to security incidents in real-time
  - Means for a rapid and effective incident reaction