INF3510 Information Security

Lecture 01:
- Course info
- Basic concepts in information security

University of Oslo, spring 2017

Course information

- Course organization
- Prerequisites
- Syllabus and text book
- Lecture plan
- Home exam
- Assessment and exams
- Security education
- AF*Security*

Course organisation

- Course activities
  - Attend 2 hours lectures per week
    - Lecture notes available at least one day prior to lecture
  - Work on the workshop questions
    - Will be discussed during the following week's workshop which follows immediately after the 2-hour lecture
  - Work on the home exam
    - Topic for the assignment can be freely chosen.
- Not just about facts, you also need to
  - understand concepts
  - apply those concepts
  - think about implications
  - understand limitations

Course Resources

- Learning material is available at:
  - http://www.uio.no/studier/emner/matnat/ifi/INF3510/v17/
  - lecture presentations, workshop questions, etc.
  - List of English security terms translated to Norwegian
- Assignment topic for home exam on:
  - https://wiki.uio.no/mn/ifi/INF3510-2017
- Various online resources
  - E.g. NIST special computer security publications http://csrc.nist.gov/publications/PubsSPs.html

Lecturer

- Prof. Audun Jøsang,
- Education
  - CISSP 2005, CISM 2010,
  - PhD Information Security, NTNU, 1998
  - MSc Information Security, Royal Holloway College, London, 1993
  - BSc Telematics, NTH 1987
  - Baccalaureat, Lycée Corneille, France, 1981
- Work
  - Professor, UiO, 2008 →
  - Associate Professor, QUT, Australia, 2005-2007
  - Research Leader, DSTC, Australia 2000-2004
  - Associate Professor, NTNU, 1998-1999
  - System design engineer, Alcatel, Belgium 1988-1992

Prerequisites

- Prerequisites
  - Basic computer and network technology
  - Basic mathematics
- Theoretic focus on a basic level
  - Discrete mathematics, number theory, modular arithmetic
  - Information theory
  - Probability calculus
  - Computer and network architecture

Syllabus and text book

- The syllabus for this course consists of the material presented during the lectures, as described in the lecture notes.
- Adequate comprehension of the material requires that you also
  - read parts of the text book and other documents
  - work out answers to the workshop questions
  - follow the lectures.
- Text book: CISSP All-in-One Exam Guide
  7th Edition, 2016
  Authors: Shon Harris (†) and
  Fernando Maymí

Fernando Maymí

- The book covers the 8 CBK domains (Common Body of Knowledge) for the CISSP Exam (Certified Information Systems Security Professional).
- Easy to order book from amazon.com, price approx: US$ 55
  https://www.amazon.com/CISSP-All-One-Guide-Seventh/dp/0071849270

How to use Harris' CISSP book (7th ed.)

- 1340 pages in total
  - But exclude
    - 50 pages of appendix, glossary and index
    - 300 pages of tips, Q&A
    - Parts of chapters
  - Around 700 pages of readable material
  - The book is very easy to read ☺
  - Sometimes long explanations and examples ☹
- Each chapter has **Main Sections** (big font) and **Subsections** (small font), but no numbering
  - The lack of numbering of subsections can be confusing

Draft Lecture Plan

Week	Date	#	Topic
W04	23.01.2017	1	Course Information. Basic Concepts in IS
W05	30.01.2017	2	IS Management, Human Factors for IS
W06	06.02.2017	3	Risk Management and Business Continuity Planning
W07	13.02.2017	4	Computer Security
W08	20.02.2017	5	Cryptography
W09	27.02.2017	6	Key Management and PKI
W10	06.03.2017	7	Incident Response and Digital Forensics
W11	13.03.2017	8	User Authentication
W12	20.03.2017	9	Identity Management and Access Control
W13	27.03.2017	10	Network Communication Security
W14	03.04.2017	11	Network Perimeter Security
W15	*Easter break*		
W16	*Easter break*		
W17	24.04.2017	12	Development and Application Security
W18	*No lecture*		
W19	*No lecture*		
W20	*No lecture*		
W21	22.05.2017		Review
W22	*No lecture*		
W23	09.06.2017	Digital exam, time: 09:00h - 13:00h (4 hours)	

Home Exam

- Write an essay on a security topic chosen by you
- Individual, or in group of 2 or 3 students
- Select topic and specify group on wiki https://wiki.uio.no/mn/ifi/INF3510-2017/
- Length: 5000 - 10000 words (approx. 10 – 15 pages)
- Due date: 15.05.2017
- Assessment criteria:
  - Structure and presentation: weight ¼
  - Scope and depth of content: weight ¼
  - Evidence of independent research and analysis: weight ¼
  - Proper use of references: weight ¼

Assessment and Marking

- Course weight: 10 study points
- Assessment items:
  - Home exam: weight 0.4
  - Digital exam: weight 0.6
- Required to get a pass score on both assessment items
  - At least 40% on home exam and 40% on written exam
  - Relatively easy to get a high score on home exam
  - Relatively difficult to get a high score on written exam
- Academic dishonesty (including plagiarism and cheating) is actively discouraged
  - See: https://www.uio.no/english/studies/admin/examinations/cheating/
  - Should be no problem ☺

Exam statistics from previous years

Year	# students	# A (%)	# B (%)	# C (%)	# D (%)	# E (%)	# F (%)
2016	147	6 (4%)	39 (37%)	59 (40%)	9 (6%)	10 (7%)	24 (16%)
2015	121	10 (9%)	30 (25%)	45 (37%)	9 (7%)	9 (7%)	18 (15%)
2014	103	4 (4%)	8 (7.5%)	45 (44%)	14 (13.5%)	9 (4.5%)	23 (22.5%)
2013	0	For the 2013 spring semester the course was cancelled due to faculty politics.					
2012	34	2 (6%)	6 (18%)	14 (41%)	0 (0.0%)	6 (17.5%)	6 (17.5%)
2011	70	1 (2%)	10 (14%)	33 (47%)	9 (13%)	10 (14%)	7 (10%)

Other security courses at IFI

- UNIK4220: Introduction to Cryptography
  - Leif Nilsen (autumn, taught at IFI)
- UNIK4250: Security in Distributed Systems
  - Nils Nordbotten (spring)
- UNIK4270: Security in OS and Software
  - Audun Jøsang (Autumn, taught at IFI)
- UNIK4740: InfoSec in Industrial Sensor and Mobile Systems
  - Judith Rossebø (autumn)
- INF5150 - Unassailable IT-systems
  - Ketil Stølen (autumn)
- ITLED4230 Ledelse av informasjonssikkerhet
  - Audun Jøsang (autumn)
  - For professionals (fee NOK 25K)

Why study information security ?

- Being an IT expert requires knowledge about IT security
  - Analogy: Building architects must have knowledge about fire safety
- Developing IT systems without considering security will lead to vulnerable IT systems
- Global IT infrastructure is vulnerable to cyber attacks
- IT experts without security skills are part of the problem
- Learn about IT security to become part of the solution !
- Information security is a political issue
  - Often seen as a cost, but saves costs in the long term
  - Often given low priority in IT industry and IT education

Certifications for IS Professionals

- Many different types of certifications available
  - vendor neutral or vendor specific
  - from non-profit organisations or commercial for-profit organisations
- Certification gives assurance of knowledge and skills,
  - needed in job functions
  - gives credibility for consultants, applying for jobs, for promotion
- Sometimes required
  - US Government IT Security jobs
- Knowledge domains reflect current topics in IT Security
  - Generally kept up-to-date

ISACA Certifications
(Information Systems Audit and Control Association)

- ISACA provides certification for IT professionals
  - CISM - Certified Information Security Manager
  - CISA - Certified Information System Auditor
  - CGIT - Certified in the Governance of Enterprise IT
  - CRSIC - Certified in Risk and Information Systems Control
- CISM is the most popular ISACA security certification
- IT auditors and consultants commonly have ISACA certifications
- ISACA promotes IT governance framework COBIT
  (Control Objectives for Information and Related Technologies)

CISM: Certified Information Security Manager

- Focuses on 4 domains of IS management
  1. Information Security Governance
  2. Information Risk Management
  3. Information Security Program Development and Management
  4. Information Security Incident Management

- Official prep manual published by ISACA
  - https://www.isaca.org/bookstore/
    Price: US $115 ($85 for ISACA members)
  - https://www.isaca.org/bookstore/Pages/CISM-Exam-Resources.aspx

CISM Exam

- Exams normally twice per year worldwide
- Next exam in Oslo (and worldwide): June 2017
  - Deadline for registering: April 2017
  - Register for exam at www.isaca.org
  - Exam fee approx. US $500
  - Multiple choice exam
  - Requires 5 years professional experience

  - Yearly CISM maintenance fee approx. US $100
  - Requires 120 hours “practice time” per 3 years

(ISC)^2 Certifications

International Information Systems Security Certification Consortium

- (ISC)^2 provides certification for information security professionals
  - CISSP - Certified Information Systems Security Professional
  - ISSAP - Information Systems Security Architecture Professional
  - ISSMP - Information Systems Security Management Professional
  - ISSEP - Information Systems Security Engineering Professional
  - CAP - Certification and Accreditation Professional
  - SSCP - Systems Security Certified Practitioner
  - CSSLP - Certified Secure Software Lifecycle Professional
- CISSP is the most common IT security certification
  - Most IT Security Consultants are CISSP

CISSP Exam: Certified Information System Security Professional

- Many different books to prepare for CISSP exam
- e.g. text book used for INF3510 course

  CISSP All-in-One Exam Guide
  7th Edition, 2016
  Author: Shon Harris and Fernando Maymí

- € 560 fee to sit CISSP exam
- Exam through http://www.pearsonvue.com/isc2/
- Test Centre in Oslo: http://www.glasspaper.no/
  Brynsveien 12, Bryn, Oslo
- Most of the of the material presented in the INF3510 course is taken from the syllabus of the CISSP CBK (Common Body of Knowledge).

CISSP CBK (Common Body of Knowledge)
8 domains

1. **Security and Risk Management** (Security, Risk, Compliance, Law, Regulations, and Business Continuity)
2. **Asset Security** (Protecting Security of Assets)
3. **Security Engineering** (Engineering and Management of Security)
4. **Communication and Network Security** (Designing and Protecting Network Security)
5. **Identity and Access Management** (Controlling Access and Managing Identity)
6. **Security Assessment and Testing** (Designing, Performing, and Analyzing Security Testing)
7. **Security Operations** (Foundational Concepts, Investigations, Incident Management, and Disaster Recovery)
8. **Software Development Security** (Understanding, Applying, and Enforcing Software Security)

Security Surveys

- Useful for knowing the trend and current state of information security threats and attacks
  - CSI Computer Crime & Security Survey (http://gocsi.com/survey)
  - Verizon Data Breach Report: http://www.verizonenterprise.com/DBIR/
  - PWC: http://www.pwc.com/gx/en/consulting-services/information-security-survey/
  - US IC3 (The Internet Crime Complaint Center): http://www.ic3.gov/media/annualreports.aspx
  - Næringslivets Sikkerhetsråd Mørketallsundersøkelsen; http://www.nsr-org.no/moerketall/

+ many others

Security Advisories

- Useful for learning about new threats and vulnerabilities
  - NorCERT: For the government sector: https://www.nsm.stat.no/
  - NorSIS: For the private sector: http://www.norsis.no/
  - KraftCERT: For the national power sector: https://www.kraftcert.no/
  - FinansCERT: For the national finance sector: http://www.finanscert.no/
  - HelseCERT: For the national health sector: https://www.nhn.no/tema/sikkerhet/HelseCERT/Sider/default.aspx
  - US CERT: http://www.cert.org/
  - Australia AusCERT: http://www.auscert.org.au/

+ many others

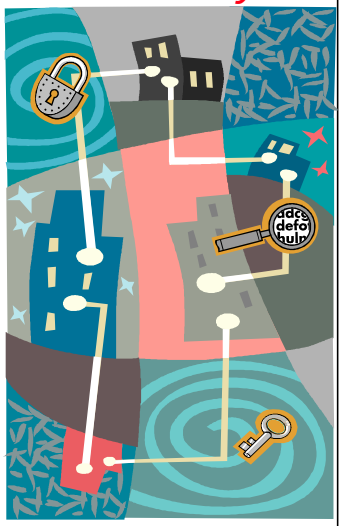
Academic Forum on Security

AF*Security*

- Monthly seminar on information security
- https://wiki.uio.no/mn/ifi/AFSecurity/
- Guest expert speakers

- Next AF*Security* seminar:
  - **Topic:** *Post-Quantum Crypto*
  - **Speaker:** *Thomas Gregersen, NSM*
  - **Time:** 28 February 2017, 14:00h
  - **Place:** Kristen Nygaards sal, 5th floor, OJD

- All interested are welcome !



Information Security Basic Concepts

Good and bad translation

English

- Security
- Safety
- Certainty

Norwegian

- Sikkerhet
- Trygghet
- Visshet

Good

- Security
- Safety
- Certainty

- Sikkerhet

Bad

What is security in general

- Security is about protecting assets from damage or harm
- Focuses on all types of assets
  - Example: your body, possessions, the environment, the nation
- Security and related concepts
  - National security (political stability)
  - Safety (health)
  - Environmental security (clean environment)
  - Information security
  - etc.

What is *Information* Security

- *Information* Security focuses on protecting *information assets* from damage or harm
- What are the assets to be protected?
  - Example: data files, software, IT equipment and infrastructure
- Covers both intentional and accidental events
  - Threat agents can be people or acts of nature
  - People can cause harm by accident or by intent
- Information Security defined:
  - The preservation of confidentiality, integrity and availability of information; in addition, other properties such as authenticity, accountability, non-repudiation and reliability can also be involved. (ISO27000 Information Security Management Systems - Overview and Vocabulary)

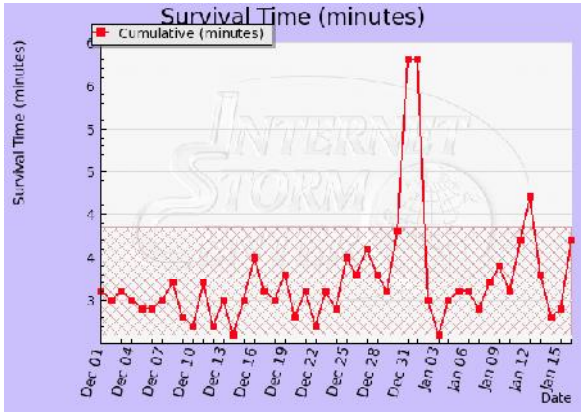
Scope of information security

- IS management has as goal to avoid damage and to control risk of damage to information assets
- IS management focuses on:
  - Understanding threats and vulnerabilities
  - Managing threats by reducing vulnerabilities or threat exposures
  - Detection of attacks and recovery from attacks
  - Investigate and collect evidence about incidents (forensics)

The Need for Information Security

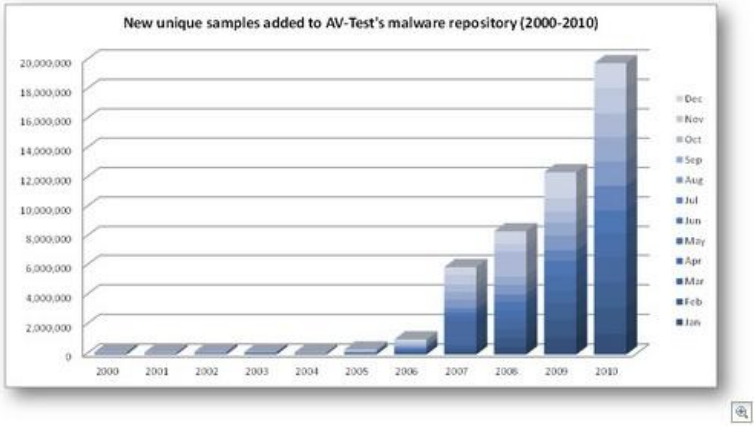
- Why not simply solve all security problems once for all?
- Reasons why that's impossible:
  - Rapid innovation constantly generates new technology with new vulnerabilities
  - More activities go online
  - Crime follows the money
  - Information security is a second thought when developing IT
  - New and changing threats
  - More effective and efficient attack technique and tools are being developed
- Conclusion: Information security doesn't have a final goal, it's a continuing process

Internet Storm Survival Time Measure

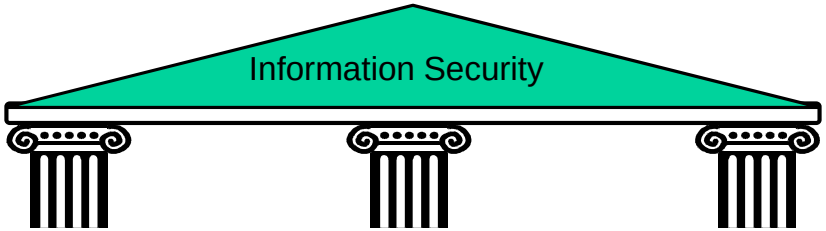


The survival time is calculated as the average time between attacks against average target IP address.
http://isc.sans.org/survivaltime.html

Malware Trend



Security control categories



Physical controls
- Facility protection
- Security guards
- Locks
- Monitoring
- Environmental controls
- Intrusion detection

Technical controls
- Logical access control
- Cryptographic controls
- Security devices
- User authentication
- Intrusion detection
- Forensics

Administrative controls
- Policies & standards
- Procedures & practice
- Personnel screening
- Awareness training
- Secure System Dev.
- Incident Response

Security control functional types

- Preventive controls:
  - prevent attempts to exploit vulnerabilities
    - Example: encryption of files

- Detective controls:
  - warn of attempts to exploit vulnerabilities
    - Example: Intrusion detection systems (IDS)
- Corrective controls:
  - correct errors or irregularities that have been detected.
    - Example: Restoring all applications from the last known good image to bring a corrupted system back online

- Use a combination of controls to help ensure that the organisational processes, people, and technology operate within prescribed bounds.

Controls by Information States

- Information security involves protecting information assets from harm or damage.
- Information is considered in one of three possible states:
  - During storage
    - Information storage containers
    - Electronic, physical, human

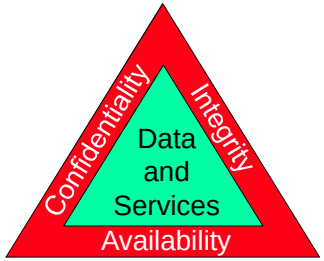
  - During transmission
    - Physical or electronic

  - During processing (use)
    - Physical or electronic

- Security controls for all information states are needed

Security Services and Properties

- A security service is a high level security property
- The traditional definition of information security is to preserve the three CIA properties for data and services:
  - **Confidentiality**:
  - **Integrity**
  - **Availability**:



- The CIA properties are the three main security services

Security services and controls

- Security services (aka. goals or properties)
  - implementation independent
  - supported by specific controls
- Security controls (aka. mechanisms)
  - Practical mechanisms, actions, tools or procedures that are used to provide security services

Security services:

e.g. Confidentiality – Integrity – Availability

support

Security controls:

e.g. Encryption – Firewalls – Awareness

Confidentiality

- The property that information is not made available or disclosed to unauthorized individuals, entities, or processes. (ISO 27000)
- Can be divided into:
  - Secrecy: Protecting business data
  - Privacy: Protecting personal data
  - Anonymity: Hide who is engaging in what actions
- Main threat: Information theft, unintentional disclosure
- Controls: *Encryption, Access Control, Perimeter defence*

As general controls, also include:

Secure System Development, Incident Response

Integrity

- **Data Integrity:** The property that data has not been altered or destroyed in an unauthorized manner.

  (X.800: Security Architecture for Open Systems Interconnection (OSI))
- **System Integrity:** The property of accuracy and completeness (ISO 27000)
- Main threat: Data and system corruption
- Controls:
  - *Cryptographic integrity check and encryption,*
  - *Access Control*
  - *Perimeter defence*
  - *Audit and verification of systems and applications*

As general controls, also include:

Secure System Development, Incident Response

Availability

- The property of being accessible and usable upon demand by an authorized entity. (ISO 27000)
- Main threat: Denial of Service (DoS)
  - The prevention of authorized access to resources or the delaying of time critical operations
- Controls: *Redundancy of resources, traffic filtering, incident recovery, international collaboration and policing*

As general controls, also include:

Secure System Development

Incident Response

Authenticity (Security Service)

The CIA properties are quite general security services.
Other security services are often mentioned.
Authentication is very important, with various types:

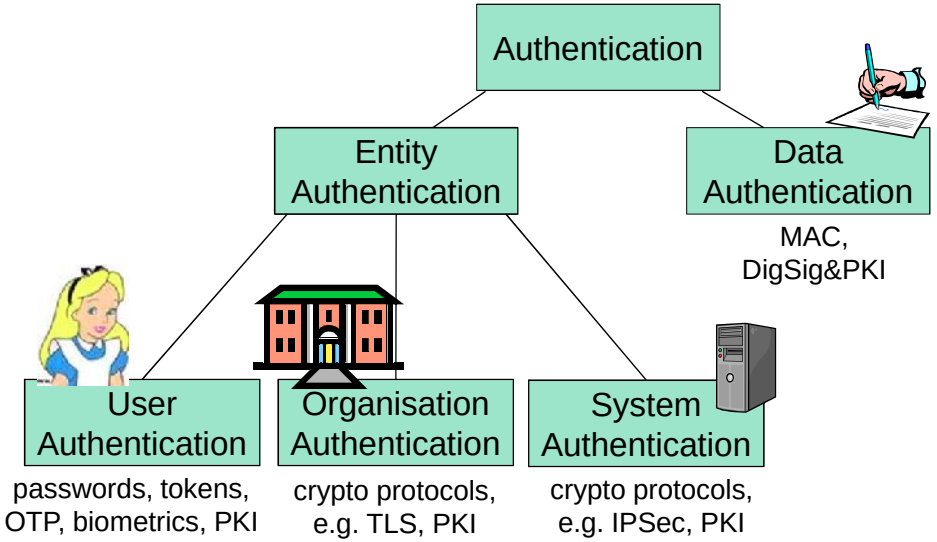
- User authentication:
  - The process of verifying a claimed identity of a (legal) user when accessing a system or an application.

- Organisation authentication:
  - The process of verifying a claimed identity of a (legal) organisation in an online interaction/session

- System authentication (peer entity authentication):
  - The corroboration (verification) that a peer entity (system) in an association (connection, session) is the one claimed (X.800).

- Data origin authentication (message authentication):
  - The corroboration (verification) that the source of data received is as claimed (X.800).

Taxonomy of Authentication

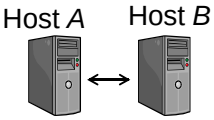


User Identification and Authentication

- Identification
  - Who you claim to be
  - Method: (user)name, biometrics
- User authentication
  - Prove that you are the one you claim to be
- Main threat: Unauthorized access
- Controls:
  - *Passwords,*
  - *Personal cryptographic tokens*,
    - OTP generators, etc.
  - *Biometrics*
    - Id cards
  - *Cryptographic security/authentication protocols*

Authentication token

System Authentication



- Goal
  - Establish the correct identity of remote hosts
- Main threat:
  - Network intrusion
  - Masquerading attacks,
  - Replay attacks
  - (D)DOS attacks
- Controls:
  - *Cryptographic authentication protocols based on hashing and encryption algorithms*
  - *Examples: TLS, VPN, IPSEC*

Data Origin Authentication (Message authentication)

- Goal: Recipient of a message (i.e. data) can verify the correctness of claimed sender identity
  - But 3rd party may not be able to verify it
- Main threats:
  - False transactions
  - False messages and data
- Controls:
  - *Encryption with shared secret key*
  - *MAC (Message Authentication Code)*
  - *Security protocols*
  - *Digital signature with private key*
  - *Electronic signature,*
    - i.e. any digital evidence

Non-Repudiation (Security Service)

- Goal: Making sending and receiving messages undeniable through unforgible evidence.
  - Non-repudiation of origin: proof that data was sent.
  - Non-repudiation of delivery: proof that data was received.
  - NB: imprecise interpretation: Has a message been received and read just because it has been delivered to your mailbox?
- Main threats:
  - Sender falsely denying having sent message
  - Recipient falsely denying having received message
- Control: *digital signature*
  - Cryptographic evidence that can be confirmed by a third party
- Data origin authentication and non-repudiation are similar
  - Data origin authentication only provides proof to recipient party
  - Non-repudiation also provides proof to third parties

Accountability (Security Service)

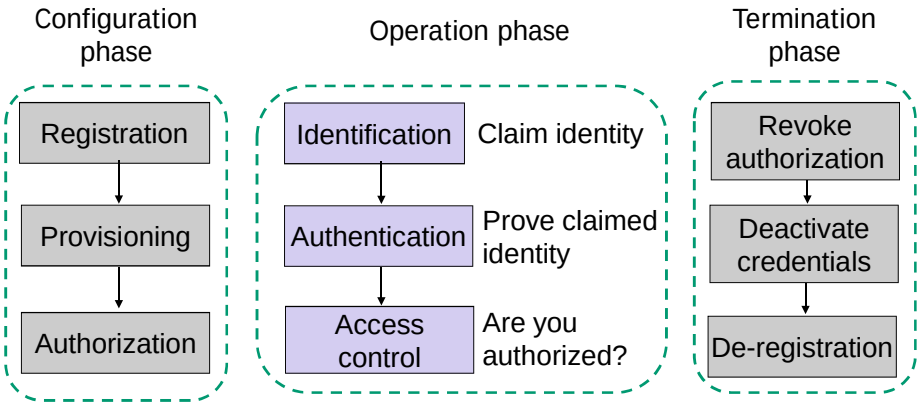
- Goal: Trace action to a specific user and hold them responsible
  - *Audit information must be selectively kept and protected so that actions affecting security can be traced to the responsible party*

    (TCSEC/Orange Book)
- Main threats:
  - Inability to identify source of incident
  - Inability to make attacker responsible
- Controls:
  - *Identify and authenticate users*
  - *Log all system events (audit)*
  - *Electronic signature*
  - *Non-repudiation based on digital signature*
  - *Forensics*

Authorization

- Authorization is to specify access and usage permissions for entities, roles or processes
  - Authorization policy normally defined by humans
  - Issued by an authority within the domain/organisation
- Authorities authorize, systems don't
- Authority can be delegated
  - Management → Sys.Admin
  - Implemented in IT systems as configuration/policy

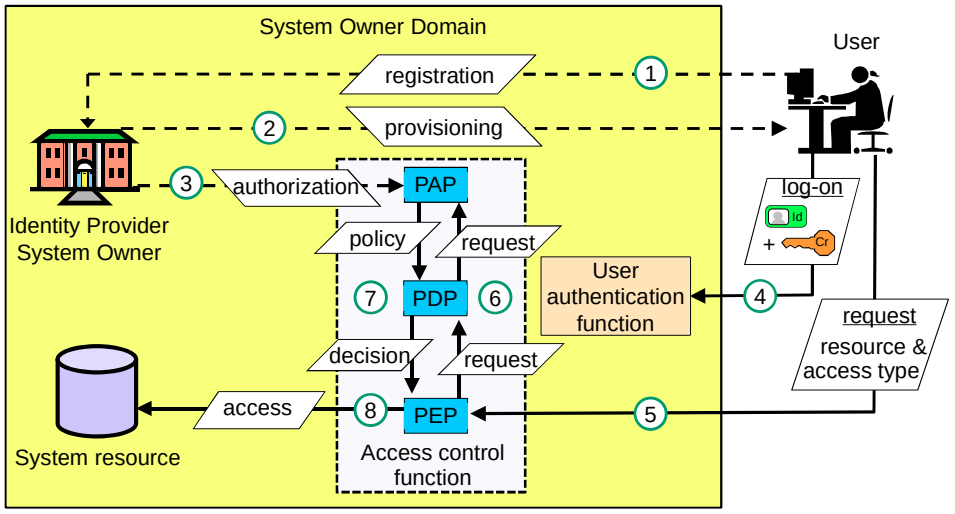
Identity and Access Management (IAM) Phases



Confusion about Authorization

- The term “authorization” is often wrongly used in the sense of “access control”
  - e.g. misleading figure on p.725 in Harris 7th ed.
  - Common in text books and technical specifications (RFC 2196 …)
  - Cisco AAA Server (Authentication, Authorization and Accounting)
- Wrong usage of “authorization” leads to absurd scenario:
  1. You get somebody’s password, and uses it to access account.
  2. Login screen gives warning: *“Only authorized users may access this system”.*
  3. You get caught and taken to the police
  4. You argue: *“Text books in security state that a system authorizes the user when typing the right password, hence I was authorized because I typed the right password”.*
  5. Case dismissed, you go free.

Identity and Access Management Concepts



End of lecture