Protecting Information Assets
- Unit# 12 -

Identity Management and Access Control

Agenda

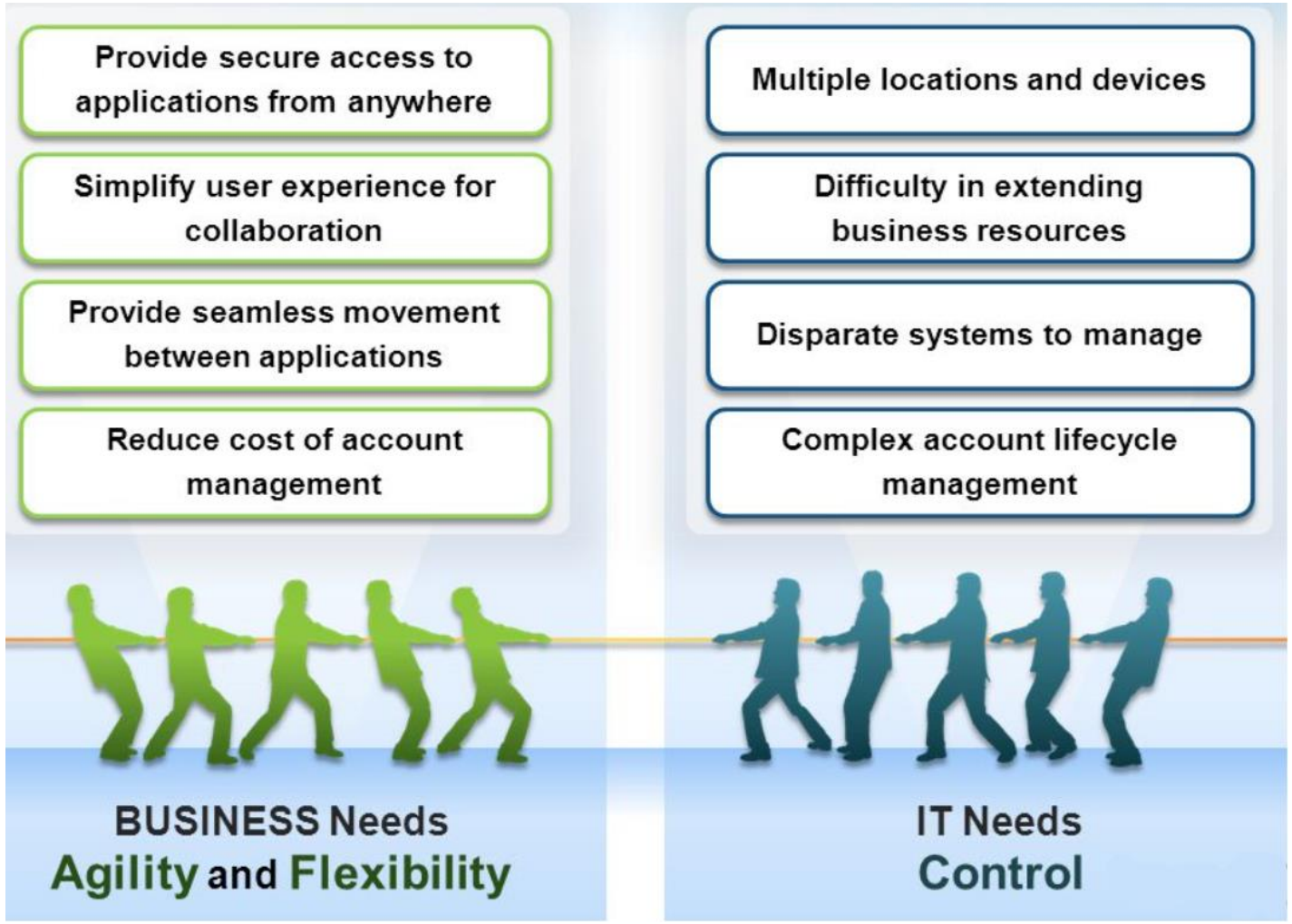
- Identity and Authentication
- Authorization
- Access control models
- Test taking tip
- Quiz

Controlling Access to IT Assets

- A central theme of information system security
- Many different security controls work together to provide access control
  - Identity, Authentication, Authorization, Auditing…
- IT Asset includes:
  - Information
  - Systems
  - Devices
  - Facilities
  - Personnel

Identity and Authentication

- First line of defense in battling unauthorized access to network resources and systems
- Broad term covering several types of mechanisms that control access to features of networks, computers and information stored and flowing within them



Authorization: Access to information…

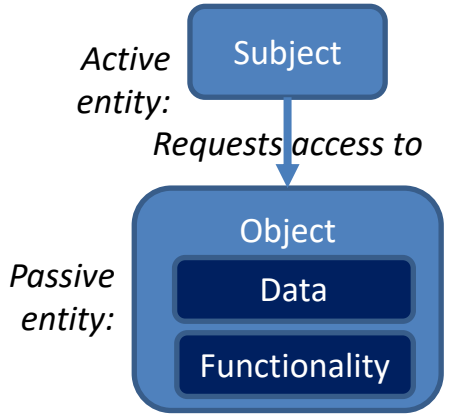
Access is the ability to create a flow of information between user and system

The flow of information between a <u>subject</u> and an <u>object</u>

- Subject
  - Always the active entity - requesting access to an object or data within the object
  - Can be users, programs, processes, services, computers…
  - When authorized, subjects can modify objects
- Object
  - Always the passive object - providing information to active subjects
  - Can be data files, databases, computers, programs, processes, services, storage media…

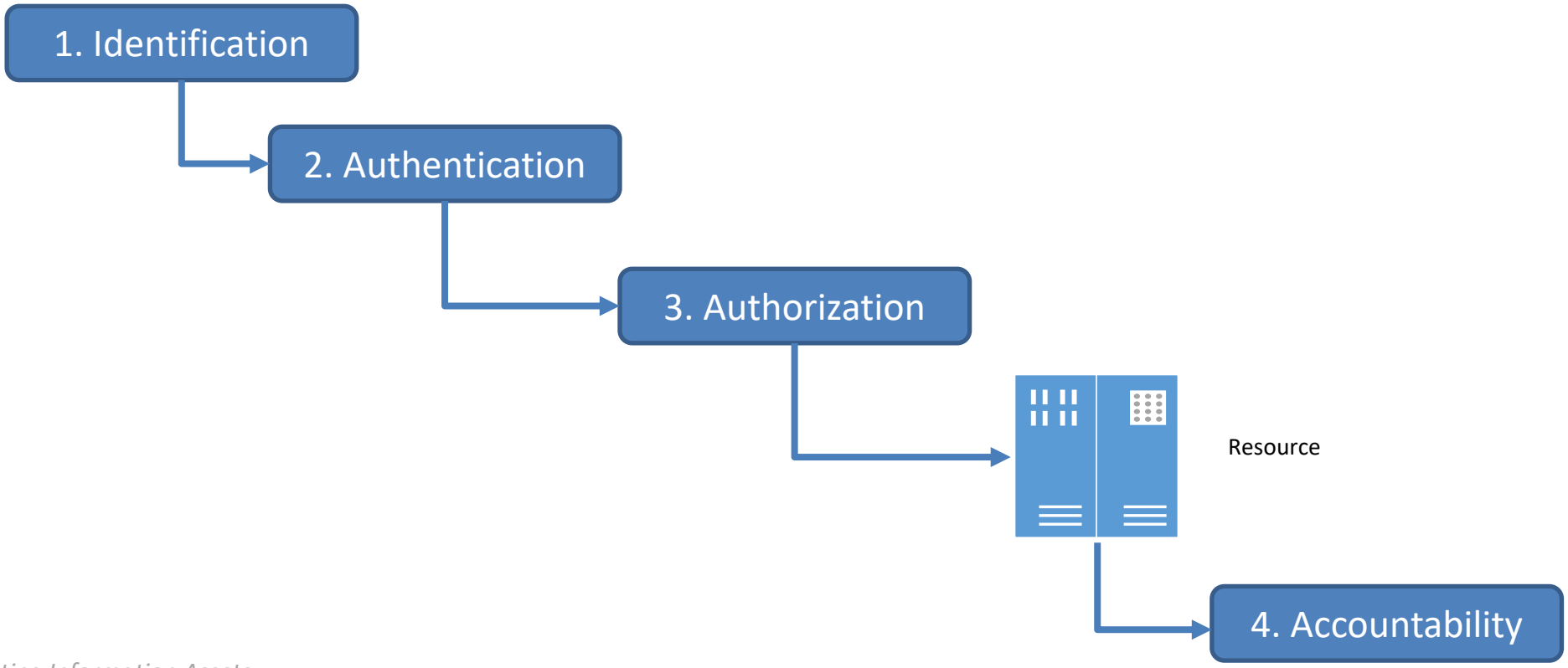
E.g. "***A user (subject) accesses an object (data file)***"

Note: *Roles of subject and object can switch during interactions – e.g. a computer program can be both a data requester and a data provider, switching back and forth*



Identification, Authentication, Authorization, and Accountability ("AAA")

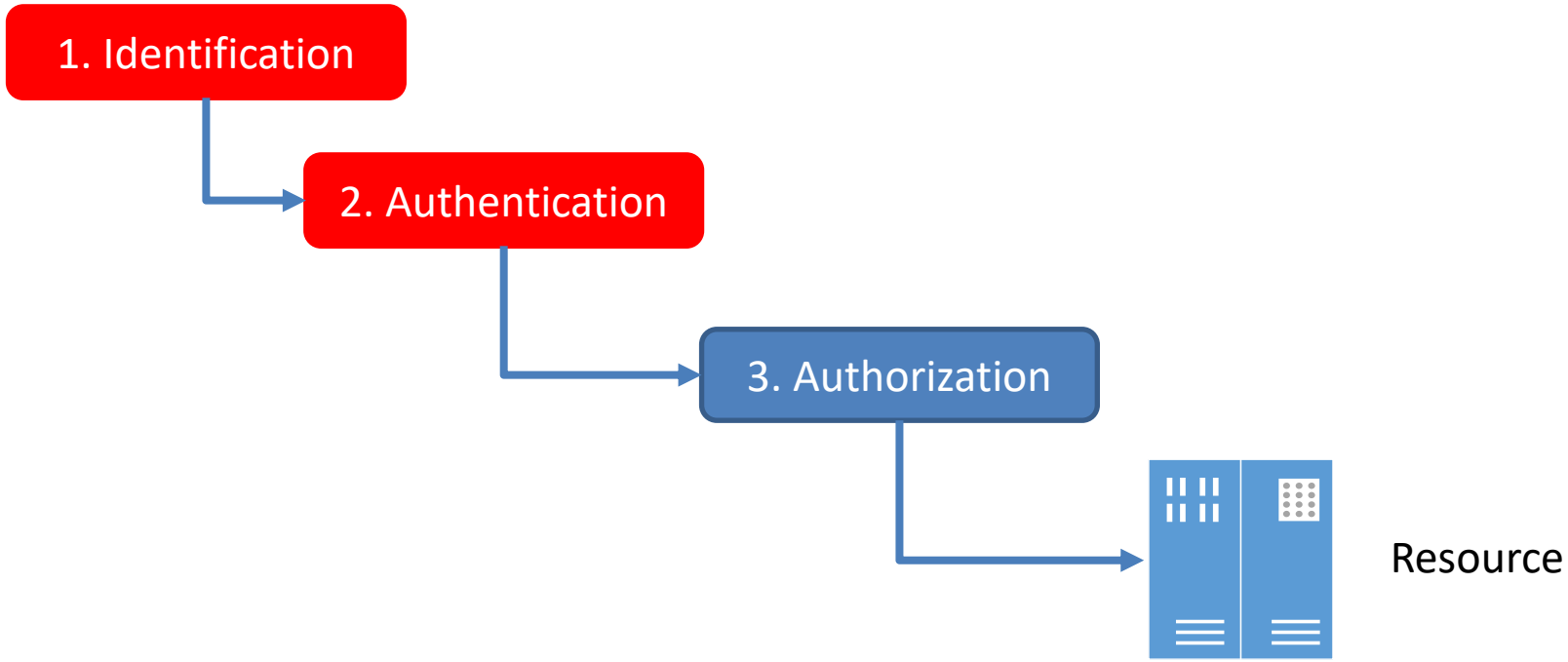
To access an information system resource, a user must pass through the following logical steps:



To access a network's resource, a user must:

Identify themself

Prove their identity (i.e. has the necessary credentials)



Identity Management

Identification and Authentication are distinct functions

Identification: Who you say you are

Authentication: Confirmation that you are who you say you are

Identification and Authentication

Usually involves a two-step process:

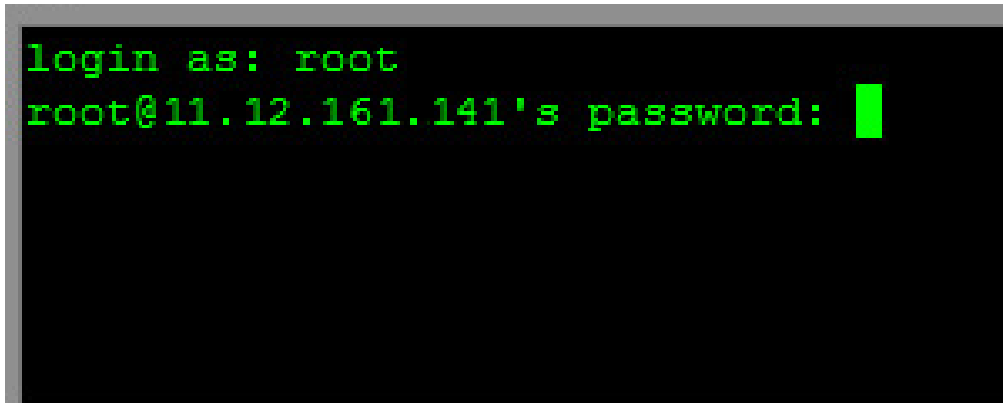
1. **Identification:** Entering public information
   - Method by which a subject (user, program or process) claims to have a specific identity
     - *Username, employee number, account number, or email address*

2. **Authentication:** Entering private information
   - Individual's identify must be verified during authentication process
   - Method by which subject proves it is who it says it is
     - *Static password, smart token, one-time password, or PIN*

Identification

Method of establishing the subject's identity

- *Subject can be a human user, program or process*
- **Identity** – A set of attributes that <u>uniquely</u> describe a person within a given context
- Typically a user name, email address or other public information



Identification

Entering public information

- Method by which a subject (user, program or process) supplies identifying information to claim they have a specific identity
  - *Username, employee number, account number, or email address*

- Creating secure identities involves 3 key aspects:
  1. **Uniqueness** – every user, program or process must be identified with an identifier (i.e. unique ID) that is specific to the individual for accountability
  2. **Non-descriptive** – Identifier should not indicate the purpose of the account nor the user's position nor tasks done with the account
  3. **Issuance** – provided by an authority as a formal/official means of proving identity

Authentication

The process of establishing confidence in the identity of users or information systems

Method of proving identity can be

something a person:

1. **Knows** – a secret password
2. **Has** – a token
3. **Is or does** – biometrics

Authentication – Classic 3 factor paradigm

…for authentication systems

Subject provides information to prove it is who it says it is and authentication system verifies the identification information

1. **Something the subject knows** ("authentication by knowledge") – Type 1 factor
   - Examples: password, PIN, combination to a lock…
   - Usually least expensive method to implement
   - Vulnerability: Someone else may acquire this knowledge and gain unauthorized access to a resource

2. **Something the subject has** ("authentication by ownership") – Type 2 factor
   - Examples: Key, swipe card, access card, badge…
   - Common for accessing facilities, sensitive areas, and authenticate holder
   - Vulnerability: Can be lost or stolen and result in unauthorized access

3. **Something the subject is** ("authentication by characteristic") – Type 3 factor
   - Examples: Fingerprint, palm scan, retina scan…
   - Based on biometrics – a way to identify the subject by a unique physical attribute
   - Vulnerability: Can be expensive, cumbersome/troubling to users and associated with false acceptance or rejection

Authentication – something you know

Passwords

- A secret shared between user authentication system
- User name + password most common identification, authentication scheme
  - *A weak security mechanism – requiring implementation of strong password protections*

Authentication

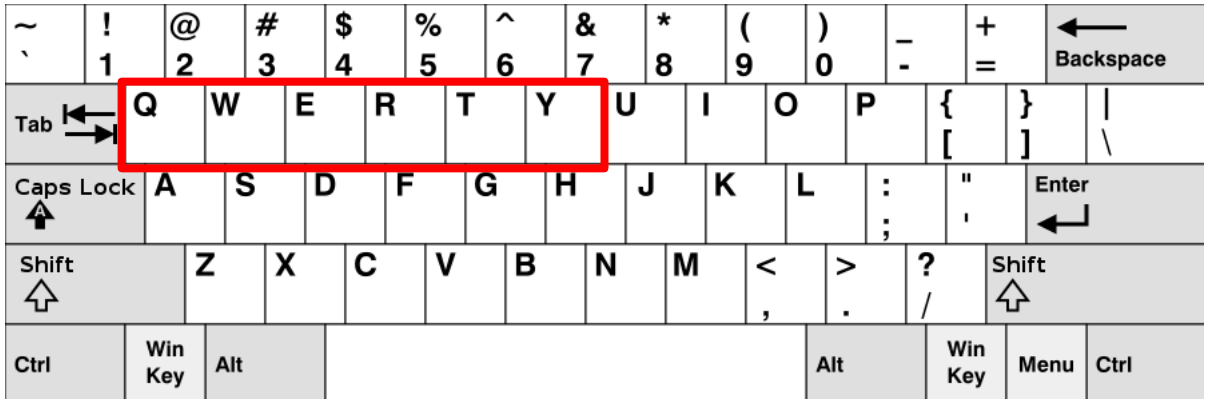
Passphrase

- Is a sequence of characters that is longer than a password
- Takes the place of a password
- Can be more secure than a password because it is more complex

Authentication - Passwords

How many unique characters can be produced by the standard QWERTY keyboard?

- *Standard US Qwerty keyboards have 101, 104 or 107 keys which can produce 96 unique characters*
  - *26 lower case letters*
  - *26 upper case letters*
  - *10 numbers*
  - *32 visible symbols*
  - *2 Windows and Menu keys*



"The name comes from the order of the first six keys on the top left letter row of the keyboard (Q W E R T Y). The QWERTY design is based on a layout created for the Sholes and Glidden typewriter and sold to E. Remington and Sons in 1873. It became popular with the success of the Remington No. 2 of 1878, and remains in widespread use."

Wikipedia

Authentication - Passwords

How to create a password that is hard to crack:

- The longer the password, the harder it is to crack
- Always use a combination of characters, numbers and special characters
- Variety in passwords on different apps and systems…

https://resources.infosecinstitute.com/10-popular-password-cracking-tools/#gref

- 1 character password: 96 tries to crack
- 2 characters: 96 *96 = 9,216
- 3 characters: 96 * 96 * 96 = 884,736
- 4 characters 96^4 = 84,934,656
- …
- 8 characters 96^8 = 7,213,895,789,838,336

Techniques to attack passwords

- Guessing
- Social engineering
- Brute force attacks
- Dictionary attacks
- Electronic monitoring
- Access the password file
- Rainbow tables

Topics / Hacking / 10 Most Popular Password Cracking Tools [Updated 2020]

Hacking

10 Most Popular Password Cracking Tools [Updated 2020]

September 25, 2020 by **Howard Poston**

Share:

https://resources.infosecinstitute.com/topic/10-popular-password-cracking-tools/

Authentication - Something you have

e.g.

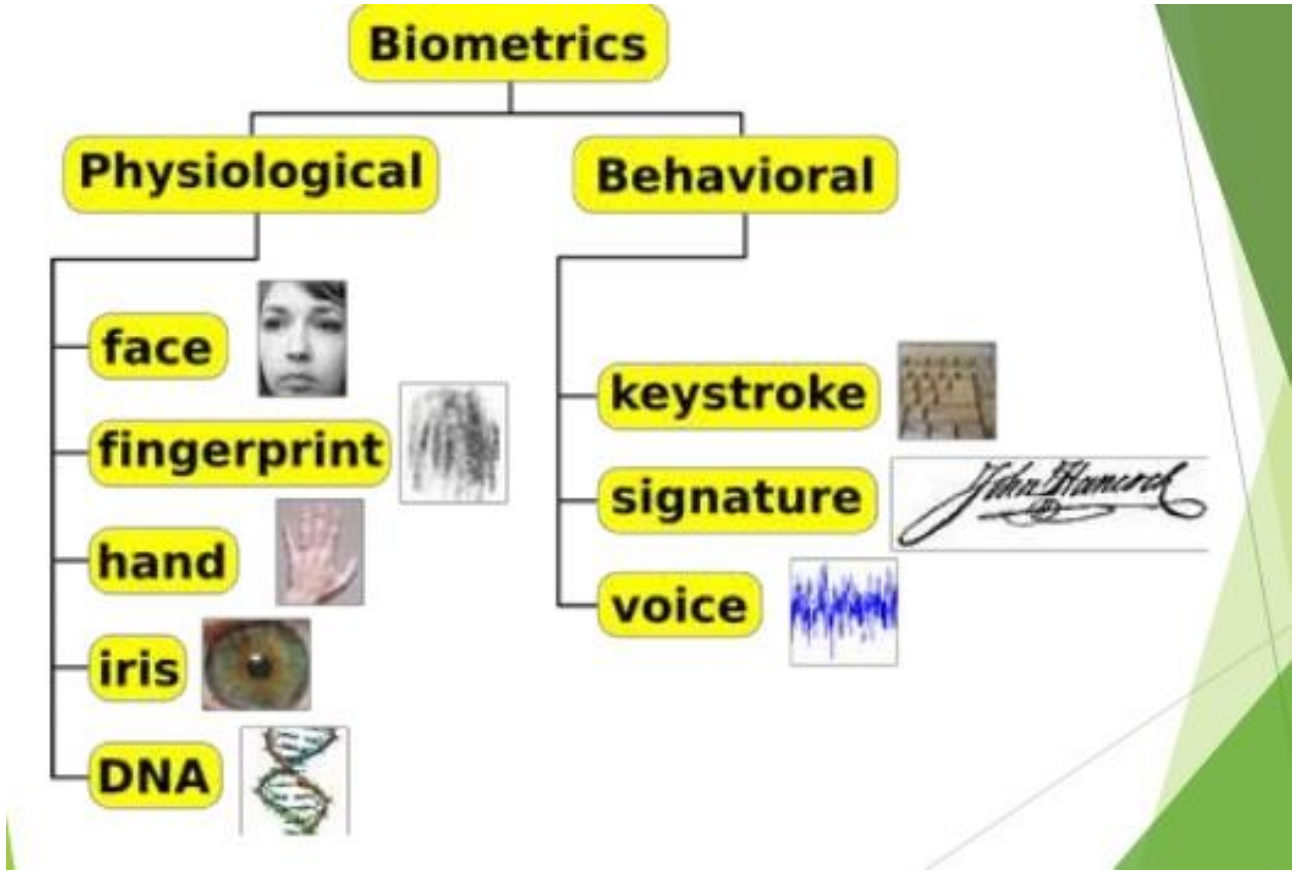
- Your phone
- Card
- Token
  - Time Based
  - Counter Synchronization

Authentication – Something you are or do (“Biometrics”)

- Verifies an identity by analyzing a unique person attribute or behavior
- Most expensive way to prove identity, also has difficulties with user acceptance
- Many different types of biometric systems

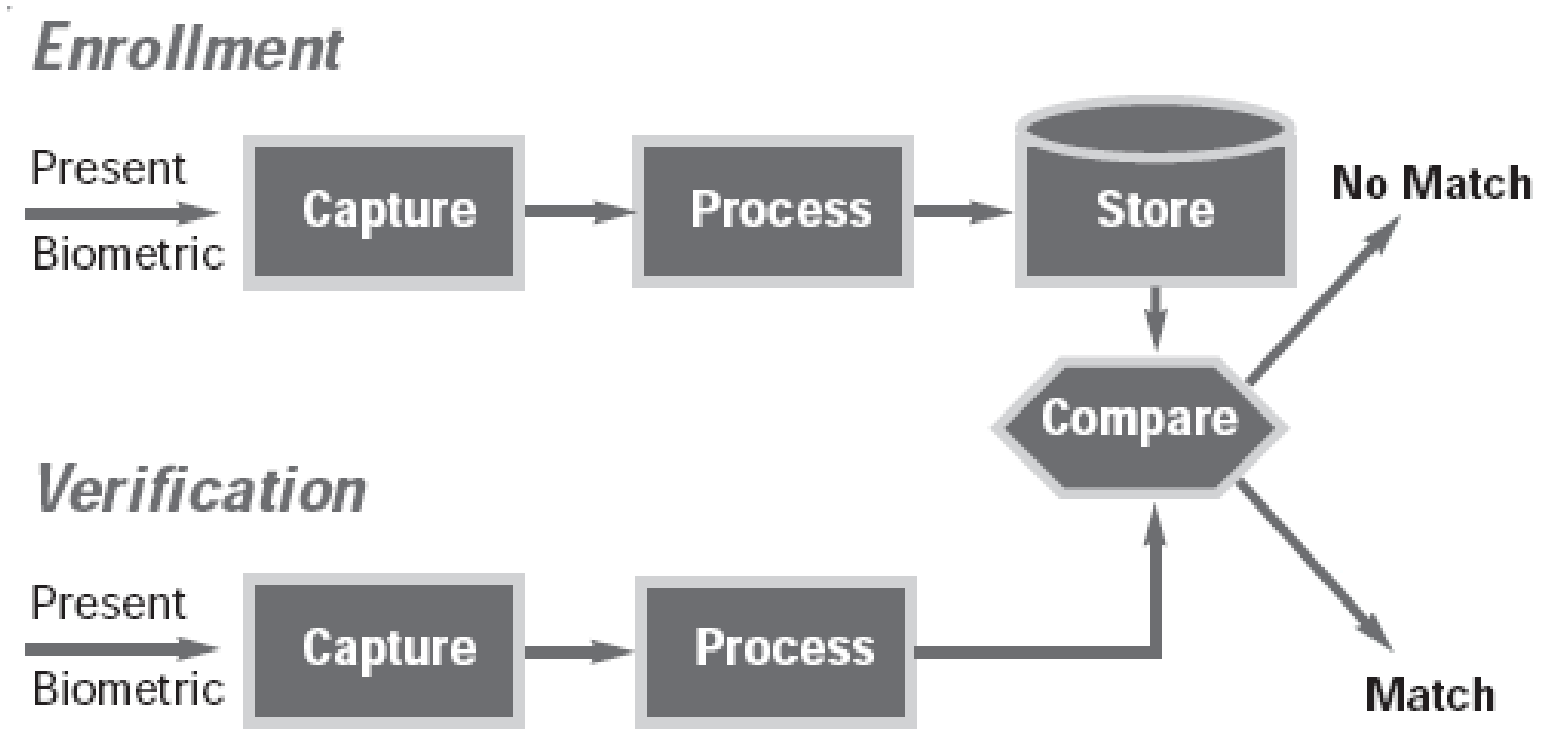
Authentication

Most common biometric systems:



Authentication – Biometric Systems

During identity verification (i.e. authentication) the biometric system scans personal's physiological attribute or behavioral trait and compares the captured data to a record created in an earlier enrollment process



Authentication – Biometric Systems

Must be capable of repeatedly taking accurate measurements of anatomical or behavioral characteristics

Error types:

- **False negative (Type I error)** – incorrect rejection of the identity of authorized individual
  - ***False Rejection Rate (FRR)*** is a measurement of the likelihood that biometric device will result in Type I errors
- **False positive (Type II error)** – incorrect match and identity acceptance of unauthorized individual ("imposter")
  - ***False Acceptance Rate (FAR)*** is a measurement of the likelihood that biometric device will result in Type II errors

Organizations' security requirements will dictate how many Type I and Type II errors are acceptable.

Extreme tradeoffs:

- Prioritizing confidentiality would accept a certain Type I error rate to achieve no Type II errors
- Prioritizing convenience would accept certain Type II error rate to achieve no Type I errors

Calibration of biometric systems would enable lowering Type II error rate by adjusting system sensitivity which will increase Type I error rate

Authentication – Biometrics

Crossover error rate (CER) also called Equal error rate (EER)

- Objective measurement of biometric system accuracy, useful for comparing different biometric system products
- Stated as a percentage (%)
- **CER** is the point at which false rejection rate equals the false acceptance rate: FRR = FAR
- ***Most important metric in determining a biometric system's accuracy!***

Authentication

Multi-factor authentication refers to use of >1 factor:

Something the subject knows ("authentication by knowledge")

+

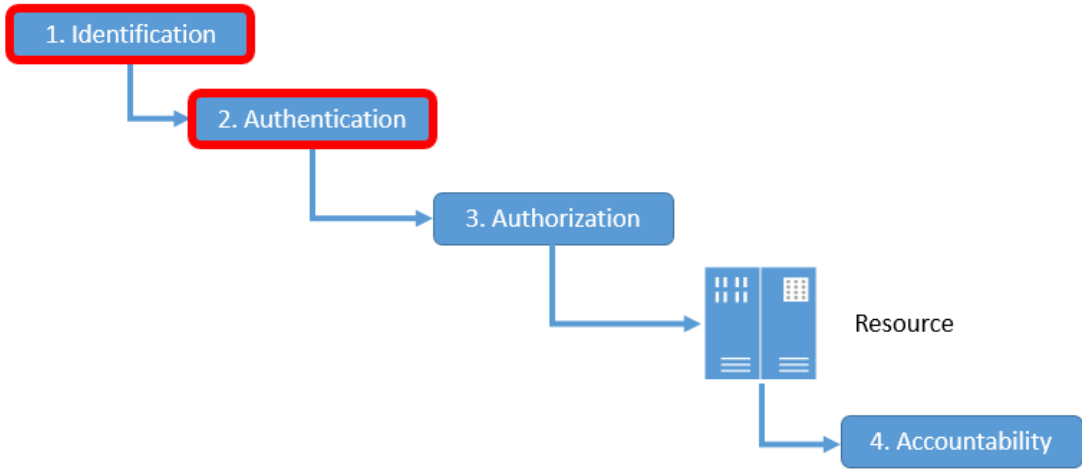
Something the subject has ("authentication by ownership")

+

Something the subject is ("authentication by characteristic")

Authentication system strength determined by the number of factors incorporated into the systems

- Implementations that use 2 factors are considered stronger than those that only use 1 factor
- Systems that incorporate all 3 factors are stronger than systems that incorporate 2 factors



Agenda

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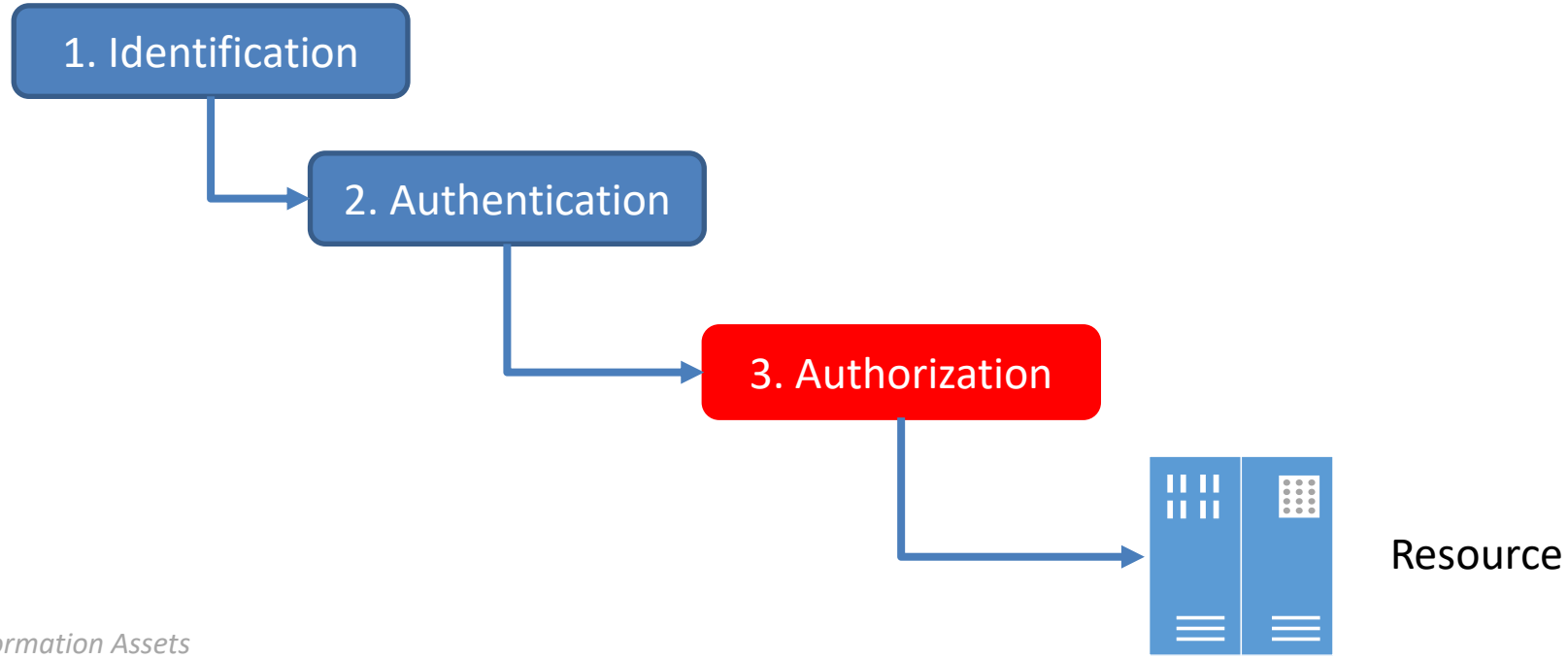
Authorization

Determines the proven identity a set of characteristics associated with it that gives it the right to access requested resources



Authorization

Advantages of **centralized administration** and **single sign on**:

- User provisioning
- Password synchronization and reset
- Self service
- Centralized auditing and reporting
- Integrated workflow (increase in productivity)
- Regulatory compliance

Access Control Models

1. Discretionary (DAC)
2. Mandatory (MAC)
3. Role-Based (RBAC)
4. …other methods

Discretionary Access Control (DAC)

- Access control is at the discretion of the owner
- Used in Windows, Linux, Unix, OSX…

When using DAC method, the **owner decides** who has access to the resource - decisions are made directly for each user

Access Control Lists (ACL) and File system permissions are used to control access

The permissions identify the actions the subject can perform on the object

E.g. DAC method in NTFS permissions on Windows operating systems

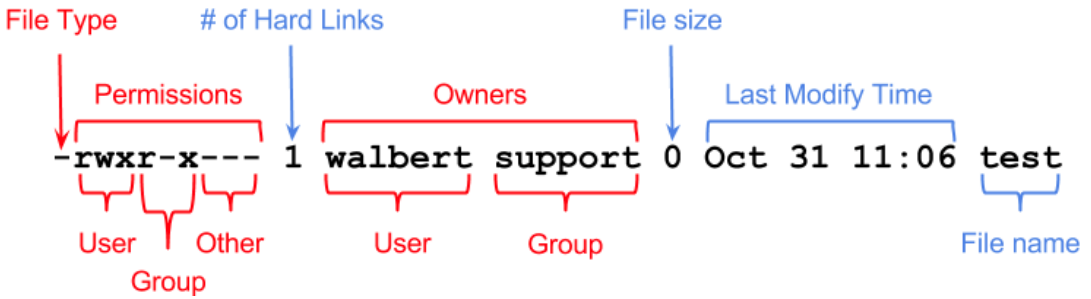
- On NTFS (New Technology File System) each file and folder has an owner
- The owner can use ACL and decide which users or group of users have access to the file or folder
- Many operating systems use DAC method to limit access to resources

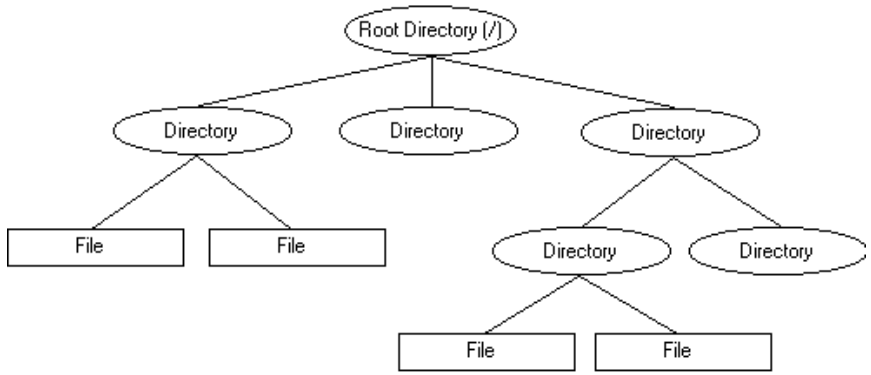
Linux/OSX/Unix file permissions – an example of discretionary access control

Typing “ls” returns a list of files in the directory
Typing “ls –l” (letter L, not number 1) returns a long listing

```
paul@debian8:~$ ls
allfiles.txt  dmesg.txt  services   stuff  summer.txt
```

```
paul@debian8:~$ ls -l
total 17296
-rw-r--r-- 1 paul paul 17584442 Sep 17 00:03 allfiles.txt
-rw-r--r-- 1 paul paul    96650 Sep 17 00:03 dmesg.txt
-rw-r--r-- 1 paul paul    19558 Sep 17 00:04 services
drwxr-xr-x 2 paul paul     4096 Sep 17 00:04 stuff
-rw-r--r-- 1 paul paul        0 Sep 17 00:04 summer.txt
```





Typing ls with –lh option shows the files sizes in a more human readable format

```
paul@debian8:~$ ls -lh
total 17M
-rw-r--r-- 1 paul paul  17M Sep 17 00:03 allfiles.txt
-rw-r--r-- 1 paul paul  95K Sep 17 00:03 dmesg.txt
-rw-r--r-- 1 paul paul  20K Sep 17 00:04 services
drwxr-xr-x 2 paul paul 4.0K Sep 17 00:04 stuff
-rw-r--r-- 1 paul paul    0 Sep 17 00:04 summer.txt
```


Cobbaut, P, 2015, Linux Fundamentals, pp. 77-78

Working with Linux Access Control List (ACL)

Using ACLs enables the user who owns the file to specify how other users can access a directory of file

```
$ ls -l report
-rw-r--r--. 1 max pubs 9537 01-12 23:17 report
```

```
$ setfacl --modify u:sam:rw- report
```

```
$ getfacl report
# file: report
# owner: max
# group: pubs
user::rw-
group::r--
other::r--
```

```
$ getfacl report
# file: report
# owner: max
# group: pubs
user::rw-
user:sam:rw-
group::r--
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```
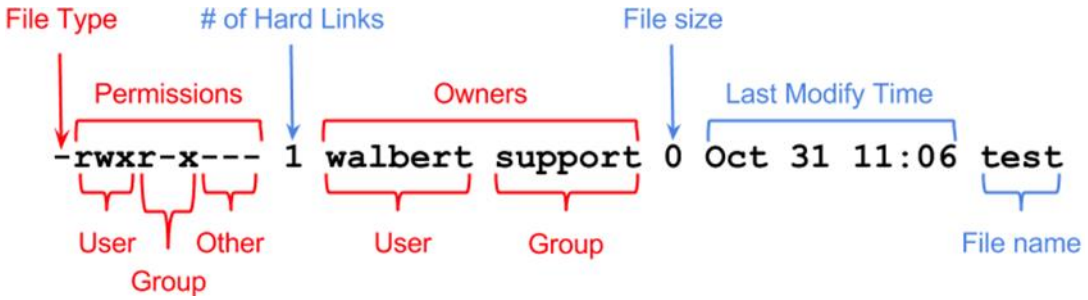



Discretionary Access Control (DAC)

Provides a huge tradeoff:

- Strengths
  - Flexibility to user
  - Less administrative overhead to IT
- Weaknesses
  - Achilles' heel (i.e. weakness) to the operating system
  - Malware can work under the identity (security context) of the user
    - If a user opens an virus infected file, code can install itself in the background without user awareness
    - Code inherits all rights and permissions of the user, can carry out all activities the user can on the system
      - » Send copies of itself to all contacts in user's email client, install a back-door, attack other systems, delete files on hard drive…
      - » If the user is a local administrator or has root accounts then once installed malware can do anything

Discretionary Access Control (DAC)

Security administrators can counter downside of DAC and protect critical assets by removing user control by implementing “nondiscretionary access control” within a DAC Operating System by:

- Setting up workstations with pre-configured and loaded user profiles specifying the level of control the user does and does not have:
  - With permissions on files (including Operating System command files) and folders set to block discretionary access control to users from:
    - Changing the system’s time
    - Altering system configuration files
    - Accessing a command prompt
    - Installing unapproved applications
    - …

Access Control Models

1. Discretionary
2. **Mandatory**
3. Role-based

Mandatory Access Control (MAC)

Used in very specialized systems by government-oriented agencies:

- To protect and maintain highly classified data
- For focused and specific purposes – and nothing more

- Users do not have discretion to determine who can access objects
- Systems are "locked down" for security purposes with
  - Reduced amount of user rights, permissions and functionality
    - *Users cannot install software, change file permissions, add new users*

DAC systems are discretionary and MAC systems are considered non-discretionary because users are unable to make access decisions based on their own choice (discretion) – Exam Tip

Mandatory Access Control (MAC)

Based on security models that implement one of a number of systems of multi-level security policies and security labels

- Subjects (e.g. users) and objects (i.e. resources) are classified and labeled with their classification:
  - ***For example: Top Secret, Secret, Confidential, Restricted, Official, Unclassified…***

- MAC OS systems decide whether or not to fulfill a request to access an object based on:
  - Its security policy (e.g. confidentiality or integrity), and
  - Clearance of the subject and classification of the object

Mandatory Access Control (MAC)

Bell-LaPadula model enforces <u>confidentiality</u> in access control

- Goal: Prevent secret information from unauthorized access
  - Provides and addresses confidentiality only
    - Who can and cannot access the data, and what operations can be carried out on the data
    - Does not address integrity of data the system maintains

- First mathematical model for multilevel security policy – based on modes of access and provides rules of access

- A system based on Bell-LaPadula model is called a “multilevel security system” because its users have different clearances and it processes data at different classification levels

Mandatory Access Control (MAC)

Bell-LaPadula model enforces confidentiality in access control

3 main rules:

1. **"No read up"**

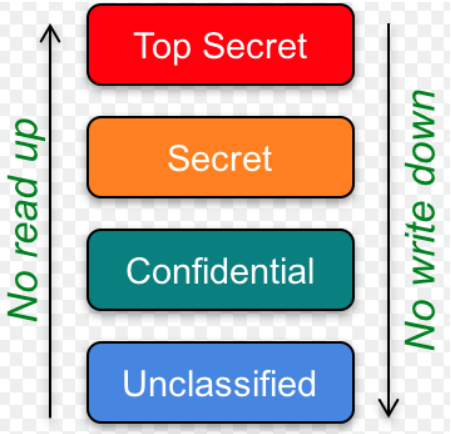
   A subject at a particular security level cannot read data that resides at a higher security level

2. **"No write down"**

   A subject in a given security level cannot write information to a lower security level

3. **Strong star (*) property rule**
   - A subject who has read and write capabilities can only perform both functions at the same security level; nothing higher and nothing lower
   - For a subject to be able to read and write to an object, the subject's clearance and the object classification must be equal

Bell-LaPadula is an information flow model!



Mandatory Access Control (MAC)

Security policy models

- **Biba** model enforces <u>integrity</u> of data within a system
  - **Goal:** Prevents data at any integrity level from flowing to a higher integrity level
  - Uses integrity levels
  - Is not concerned with security levels nor confidentiality

Mandatory Access Control (MAC)-**Security policy models**

Biba model enforces <u>integrity</u> of data within a system

3 main rules:

1. **"No write up" rule**

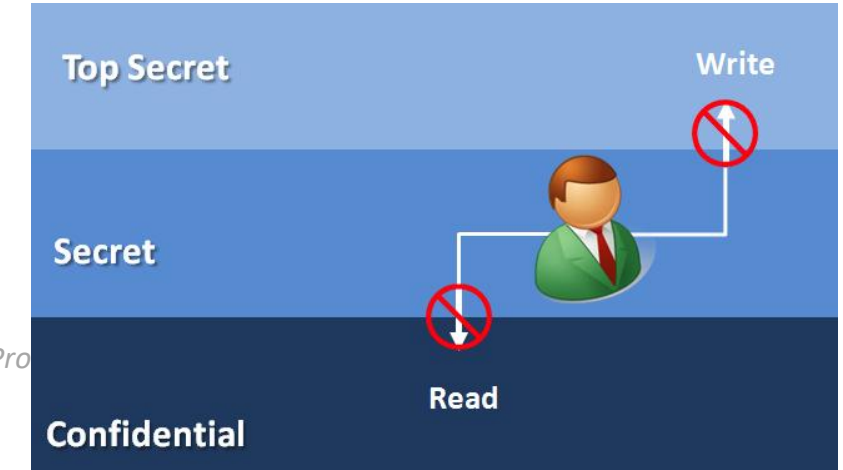
   A subject cannot write data to an object at higher integrity level

2. **"No read down" rule**

   A subject cannot <u>read</u> data from a lower integrity level

3. **Invocation property**

   A subject cannot <u>communicate</u> by calling on or initializing another subject (invoke a service) at a higher integrity. Subjects are only allowed to invoke services at a lower integrity level



Biba is an information flow model!

Mandatory Access Control (MAC)-**Security policy models**

Bell-LaPadula versus Biba

- Both information flow models concerned with data flowing from one security level to another
  - Bell-Lapdula uses security levels to provide data <u>confidentiality</u>
    - *"no read up" (simple rule)*
    - *"no write down" (* rule)*
  - Biba uses integrity levels to provide data <u>integrity</u>
    - *"no write up" (simple rule)*
    - *"no read down" (* rule)*

Both are information flow models!

Clark Wilson Model

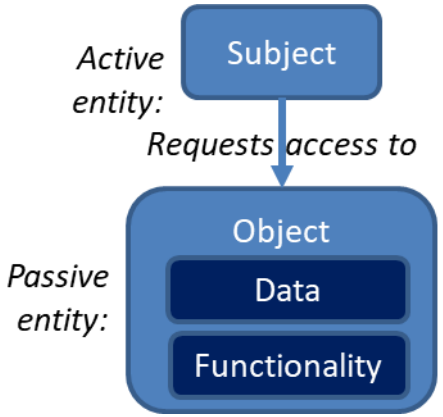
Developed after Biba, also related to integrity and not confidentiality

- Focuses on
  - **Well formed transactions**
  - **Separation of duties**
- Data objects can only be manipulated by a certain set of programs (“Transformation procedures”) which define a user’s role in the information system
  - Users have access to the programs rather than to the data
- “Integrity verification procedures” check the consistency of “constrained data items” which can only be manipulated by the “transformation procedures”

Brewer and Nash Model (“Chinese Wall”)

- A subject can write to an object “if and only if” the subject cannot read another object that is a different dataset
- Creates security domains around data that are used to block conflicts of interest
  - For example, someone working for Company A should not also be allowed access similar or relevant data from Company B if it creates a conflict of interest (e.g. the two companies compete with each other)

Lattice-based Access Control (LBAC) Model



Supports more refined security domains

Access is based on <u>combinations of labels</u> being matched by both subjects and objects

- For example,
  - There are 4 separate confidential security compartments that have an added layer of security, these are Lentil, Foil, Crimson, and Horn
    - To access data in Foil (e.g. Create, Read, Update, Delete) a subject would need to have both a Confidential label and a Foil Label
  - There are 4 separate private security compartments that have an added layer of security, these are Apple, Pear, Grape, and Sleuth
    - To access data in Pear a subject would need to have a Confidential or Private security label and a Pear security label

Lentil	Foil	Crimson	Horn	Confidential
Apple	Pear	Grape	Sleuth	Private
				Sensitive
				Public

To access Sensitive data a subject would need to have a Confidential, Private, or Sensitive label

Mandatory Access Control (MAC) Models

- *Bell LaPadula*
  - *Protects confidentiality of data*
- *Biba*
  - *Protects integrity of data*
- *Clark-Wilson*
  - *Another way to protect integrity of data*
- *Brewer and Nash (Chinese Wall)*
  - *Protects against conflicts of interest of a subject*
- *Lattice-based*
  - Access is based on combinations of labels being matched by both subjects and objects
  - *Provides additional compartmentalization of access protecting confidentiality*

DAC versus MAC Systems

Administrators cannot simply switch on MAC and switch off DAC in an operating system

- DAC systems
  - System access decisions by comparing subject's identity to the ACL on the object (i.e. resource)
  - Very flexible and dynamic
  - Malware usually targets
  - Viruses, worms, and rootkits can be installed and run as applications on DAC systems

- MAC systems
  - System access decisions by comparing subject's clearance to the object's security label
  - Are very constrained and have very limited functionality
  - OS does block users from installing software including malware
  - Special types of Unix systems are developed based on the MAC model
    - SE Linux is a publicly released MAC system developed by NSA and Secure Computing
    - Trusted Solaris is a product based on the MAC model

Access Control Models

1. Discretionary
2. Mandatory
3. **Role-based**

Role-Based Access Control (RBAC)

Developed to address the following issues with access control administration based on Discretionary Access Control (DAC) model:

- Access control specified explicitly to subjects at the object level with ACLs
- Complexity
  - As administrators translate organizational policy into ACL configuration permissions
  - As number of objects and users grow, and users change responsibilities, users tend to be granted or retain unnecessary access to some objects (“authorization creep”
    - Violating least-privilege rule, increasing organizational risk

These can be addressed by **Role-Based Access Model**…

Role-Based Access Control (RBAC)

Uses a centrally administered set of controls to determine how subjects and objects interact

- Roles defined in terms of operations and tasks the role will carry out
- Access to resources is implicitly assigned (inherited) based on the role the user holds within the organization
- Best system for organizations with high employee turnover
  - Assignment of users to roles is changed by administrators
  - Administrators do not need to continually change the ACLs on individual objects

Authorization concepts

- Authorization Creep
- Least Privilege: Default to Zero – start with no access
- Principle of “Need to Know”
- Access Control List (ACL)

Agenda

- ✓ Identity and Authentication
- ✓ Authorization
- ✓ Access control models
- Test taking tip
- Quiz

Test Taking Tip

Look at the facts and ask yourself, so what?

- The issue that jumps out is likely to be the issue that the correct response addresses
- Non-relevant answers can be eliminated more readily
- Especially useful in questions that ask for the “Best” answer

Quiz

Quiz

1. A network administrator must grant the appropriate network permissions to a new employee. Which of the following is the best strategy?
    a. Give the new employee user account the necessary rights and permissions.
    b. Add the new employee user account to a group. Ensure the group has the necessary rights and permissions.
    c. Give the new employee administrative rights to the network.
    d. Ask the new employee what network rights they would like.

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Quiz

3. To quickly give a contractor network access, a network administrator adds the contractor account the Windows Administrative group. Which security principle does this violate?
    a. Separation of duties
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4. A secure computing environment labels data with various security classifications. Authenticated users must have clearance to read this classified data. What type of access control model is this?
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5. To ease giving access to network resources for employees, you decide there must be an easier way than granting users individual access to files, printers, computers, and applications. What security model should you consider using?
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6. Linda creates a folder called Budget Projections in her home account and shares it with colleagues in her department. Which of the following best describes this type of access control system?
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Quiz

7. You require that users not be logged on to the network after 6 PM while you analyze network traffic during nonbusiness hours. What should you do?
    a. Unplug their stations from the network
    b. Tell users to press CTRL-ALT-DEL to lock their stations
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    d. Disable user accounts at 6 PM

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Quiz

8. One of your users, Matthias, is taking a 3-month leave of absence because of a medical condition, after which he will return to work. What should you do with Matthias' user account?
    a. Delete the account and re-create it when he returns
    b. Disable the account and enable it when he returns
    c. Export his account properties to a text file for later import and then delete it
    d. Ensure you have a backup of his account details and delete his account

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Quiz

9. During an IT security meeting, the topic of account lockout surfaces. When you suggest all users accounts be locked for 30 minutes after three incorrect logon attempts, your colleague Phil states this is a serious problem when applied to administrative accounts. What types of issues might Phil be referring to?
    a. Dictionary attacks could break into administrative accounts
    b. Administrative accounts are much sought after by attackers
    c. Administrative accounts are placed into administrative groups
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Agenda

- ✓ Identity and Authentication
- ✓ Authorization
- ✓ Access control models
- ✓ Test taking tip
- ✓ Quiz

Protecting Information Assets
- Unit# 12 -

Identity Management and Access Control