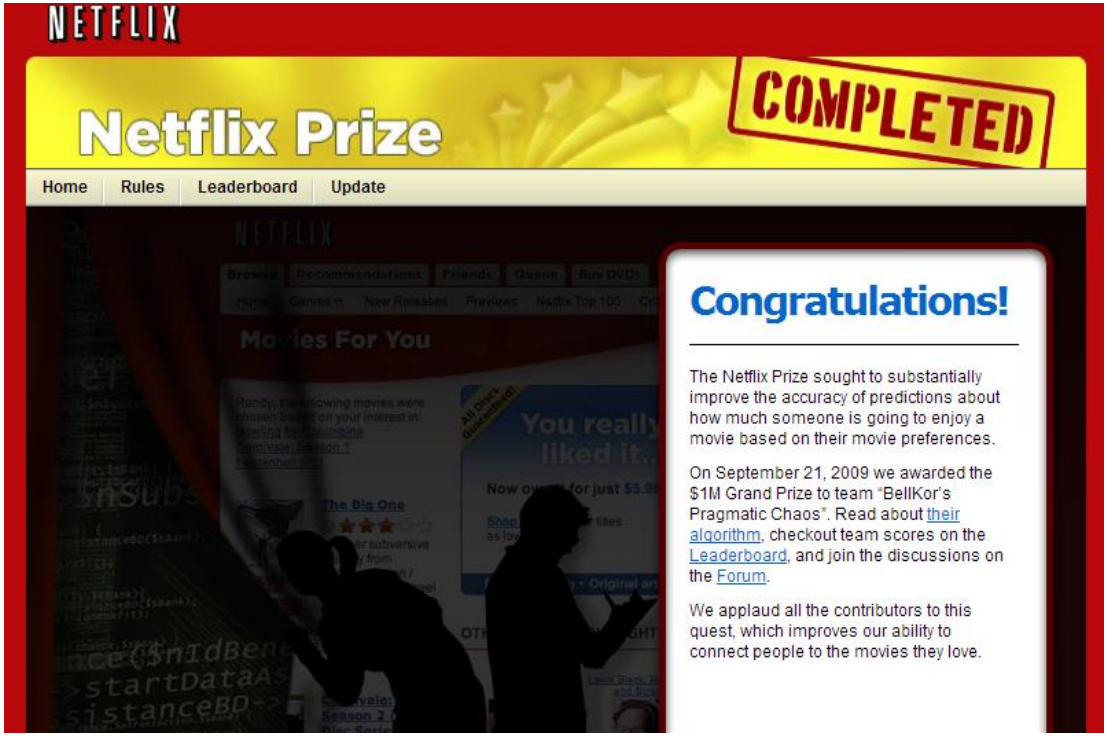
ENEE 459-C
Computer Security

Introduction
(continue from previous lecture)

UNIVERSITY OF
MARYLAND

Netflix incident



- See paper
  - http://www.cs.utexas.edu/~shmat/shmat_oak08netflix.pdf

Google chrome saving passwords

- In a previous version of Google chrome, if you saved your password so that you do not have to put it in every time you log into a website (a bad idea in general), one could retrieve the password with three clicks
- No need for the password to be displayed in plaintext
- http://www.itpro.co.uk/security/20363/google-chrome-password-access-bug-discovered

The human factor

- In 2010, Google fired an employee because he was caught snooping on user's data

Some Security Principles

Economy of mechanism

- This principle stresses **simplicity** in the **design** and **implementation** of security measures
  - Example: Avoid multiple interconnecting software modules (running in different machines) to implement a security property (e.g., input of password in one machine, checking of password in another)

Complete mediation

- The idea behind this principle is that every access to a resource must be checked for **compliance with a protection scheme**
  - As a consequence, one should be wary of performance improvement techniques that save the results of previous authorization checks, since permissions can change over time
  - For example, an online banking web site should require users to sign on again after a certain amount of time, say, 15 minutes, has elapsed

Open design

- According to this principle, the security architecture and **design** of a system should be made **publicly available**
  - Security should rely only on keeping cryptographic keys secret
  - Open design allows for a system to be scrutinized by multiple parties, which leads to the early discovery and correction of security vulnerabilities caused by design errors
  - The open design principle is the opposite of the approach known as **security by obscurity,** which tries to achieve security by keeping cryptographic algorithms secret and which has been historically used without success by several organizations

Separation of privilege

- Try to isolate software components to limit the damage that can be caused in a computer system
- E.g., when one runs a virtual machine, then an attack on some software running in the virtual machine cannot affect files in the host machine (these are different machines)

Least privilege

- Each program and user of a computer system should operate with the bare **minimum privileges necessary** to function properly
  - If this principle is enforced, abuse of privileges is restricted, and the damage caused by the compromise of a particular application or user account is minimized
  - The military concept of **need-to-know** information is an example of this principle

Least common mechanism

- In systems with multiple users, mechanisms allowing resources to be **shared by more than one user should be minimized**

Psychological acceptability

- This principle states that user interfaces should be **well designed and intuitive**, and all security-related settings should adhere to what an ordinary user might expect

Work factor

- According to this principle, the **cost of circumventing** a security mechanism should be compared with the resources of an attacker when designing a security scheme
  - A system developed to protect student grades in a university database, which may be attacked by snoopers or students trying to change their grades, probably needs less sophisticated security measures than a system built to protect military secrets, which may be attacked by government intelligence organizations

Compromise recording

- This principle states that sometimes it is more desirable to **record the details** of an intrusion than to adopt more sophisticated measures to prevent it
  - Internet-connected surveillance cameras are a typical example of an effective compromise record system that can be deployed to protect a building in lieu of reinforcing doors and windows
  - The servers in an office network may maintain logs for all accesses to files, all emails sent and received, and all web browsing sessions

Computer Security Goals

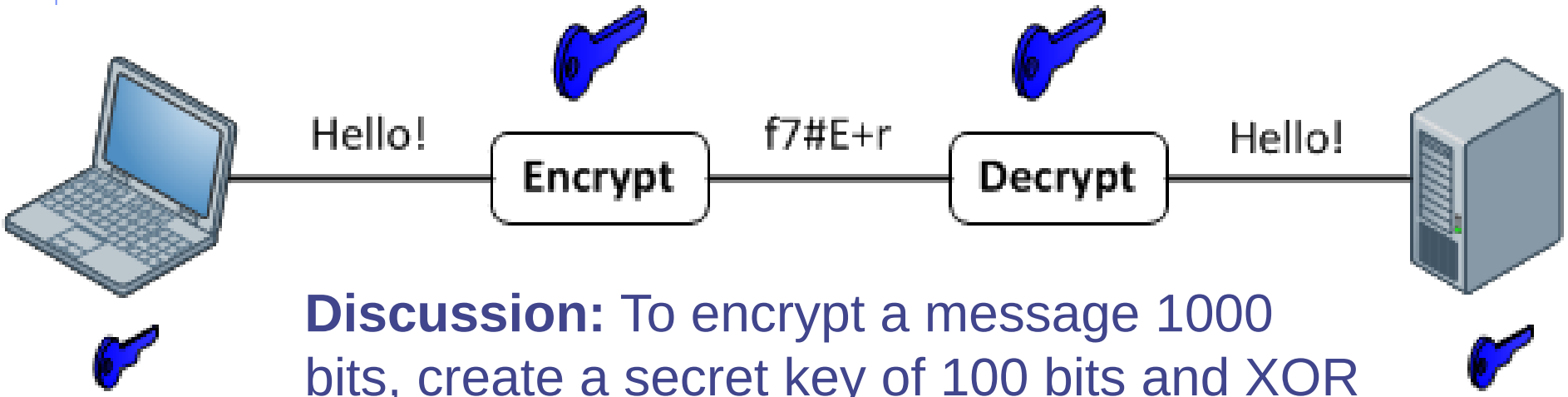
- Confidentiality
- Integrity
- Availability
- Authenticity
- Anonymity

Confidentiality

- It is the avoidance of the unauthorized disclosure of information
- It involves the protection of data, providing access for those who are allowed to see it while disallowing others from learning anything about its content
- E.g., nobody should be able to read the emails I am sending to my friends, except for my friends

Tools for confidentiality

- **Encryption:** the transformation of information using a secret, called an encryption key, so that the transformed information can only be read using another secret, called

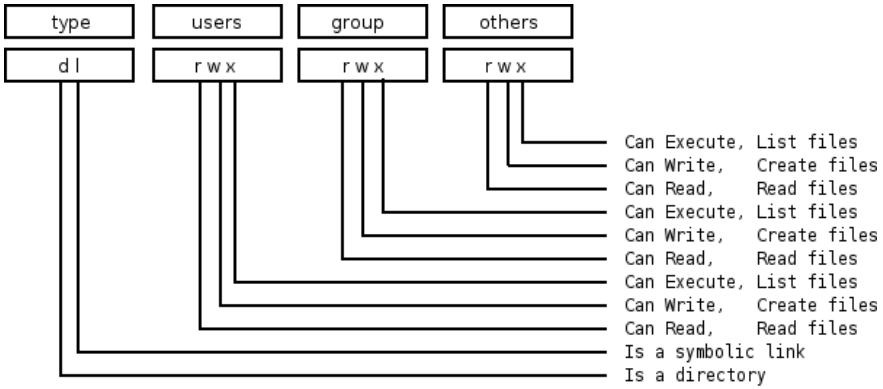


Discussion: To encrypt a message 1000 bits, create a secret key of 100 bits and XOR 100-bit blocks sequentially.

Does this reveal the content of the message?
Is this good enough?

Tools for confidentiality

- **Access control:** rules and policies that limit access to confidential information to those people and/or systems with a “need to know”
  - This need to know may be determined by identity, such as a person’s name or a computer’s serial number, or by a role that a person has, such as being a manager or a computer security specialist



Tools for confidentiality

- **Authentication:** the determination of the identity or role that someone has. This determination can be done in a number of different ways, but it is usually based on a combination of
  - **something the person has** (like a smart card or a radio key fob storing secret keys)
  - **something the person knows** (like a password)
  - **something the person is** (like a human with a fingerprint)

Integrity

- The property that information has not be altered in an unauthorized way
- **Tools:**
  - **Checksums:** the computation of a function that maps the contents of a file to a numerical value. A checksum function depends on the entire contents of a file and is designed in a way that even a small change to the input file (such as flipping a single bit) is highly likely to result in a different output value.
  - **Discussion:** Can we use the checksum f(x) = x mod M?

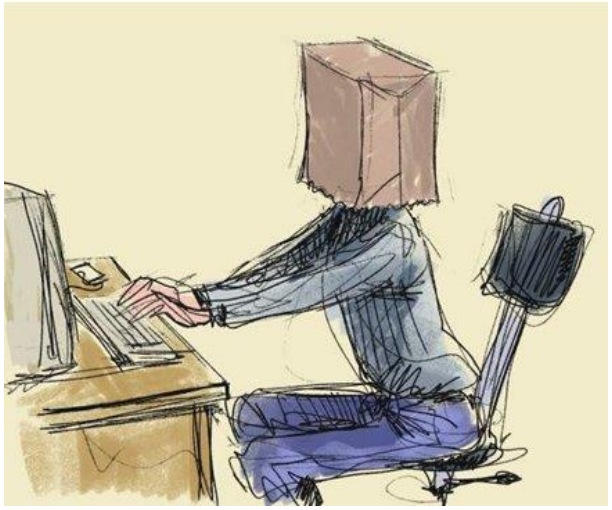
Availability

- **Availability:** the property that information is accessible and modifiable in a timely fashion by those authorized to do so
- **Tools:**
  - **Physical protections:** infrastructure meant to keep information available even in the event of physical challenges.
  - **Computational redundancies:** computers and storage devices that serve as back-ups in the case of failures
    - **E.g., error-correcting codes**

Other important Security goals

- **Authenticity**

- **Anonymity**



Authenticity

- **Authenticity** is the ability to determine that statements, policies, and permissions issued by persons or systems are genuine
- **Primary tool:**
  - **Digital signatures.** These are cryptographic computations that allow a person or system to commit to the authenticity of their documents in a unique way that achieves **nonrepudiation**, which is the property that authentic statements issued by some person or system cannot be denied

Anonymity

- **Anonymity:** the property that certain records or transactions not to be attributable to any individual
- **Tools:**
  - **Aggregation:** the combining of data from many individuals so that disclosed sums or averages cannot be tied to any individual
  - **Proxies:** trusted agents that are willing to engage in actions for an individual in a way that cannot be traced back to that person
  - **Pseudonyms:** fictional identities that can fill in for real identities in communications and transactions, but are otherwise known only to a trusted entity

Examples: HTTPS protocol

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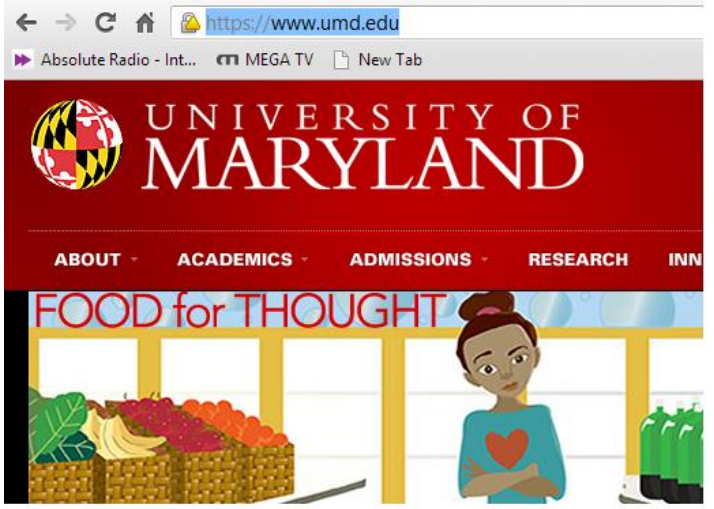

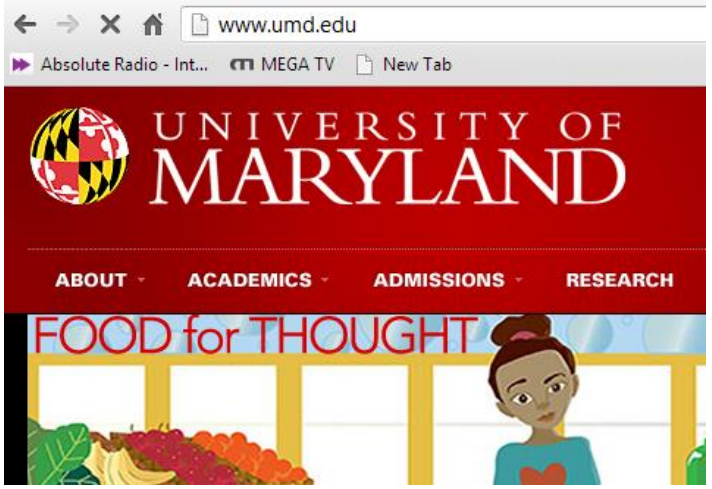

Examples: TOR protocol

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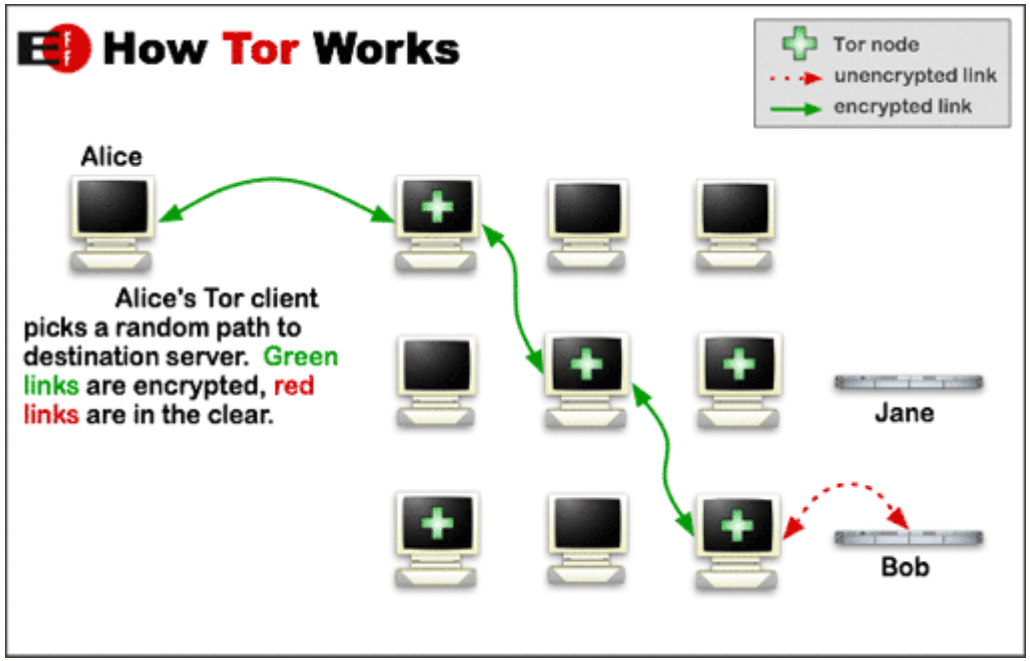

Examples: RAID technology

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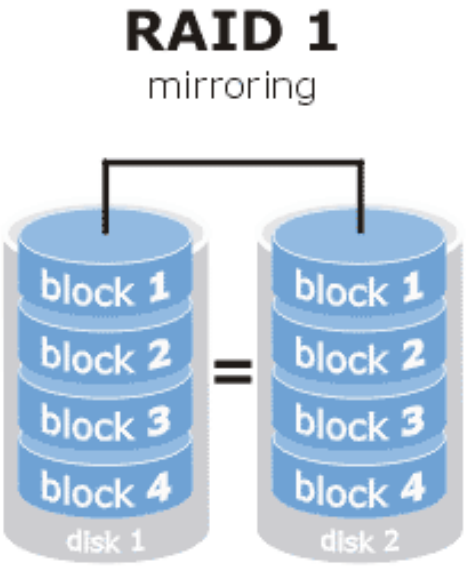

Error correcting codes

- Given blocks b1,b2,…,bn, we want to store them with redundancy
- If we just duplicate them and store copies c1,c2,…,cn, it is no good. The attacker can just delete 2 blocks (e.g., b1 and c1) and cause damage
- Alternatively, consider the polynomial p(x)=(x-b1)(x-b2)…(x-bn)
- Store b1,b2,…,bn and p(r1),p(r2),…,p(rn) for random r1,r2,…,rn
- Now even if the attacker deletes **any** n out of 2n blocks that we have stored, we can always recover our initial data
- How? Polynomial interpolation!
- As long as n out of 2n points are stored intact, we can always recover the initial data.