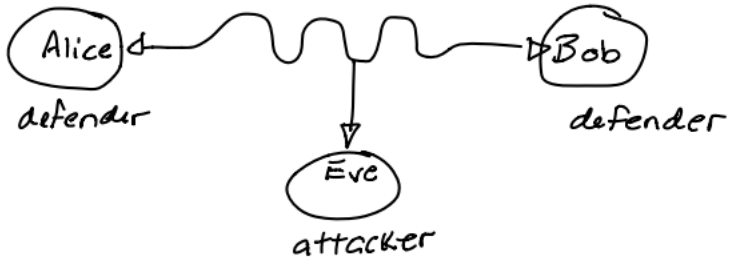
Eric Altenburg **CS-306** **September 22, 2020**

Lecture 2.1 - Basic security concepts & terms

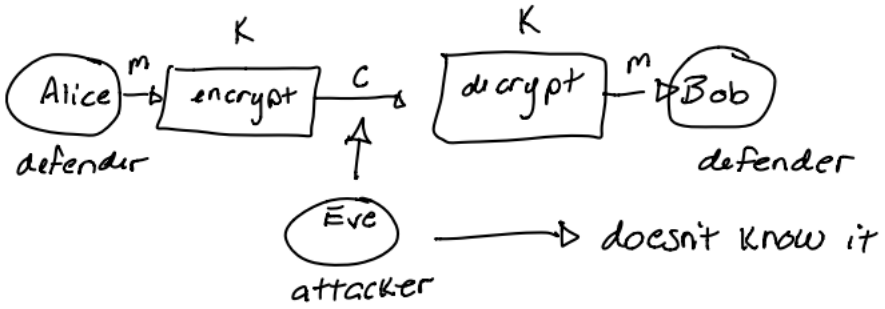
1. What is IT Security?
   - IT security is the prevention of, or protection against
     - access to info by unauthorized recipients
     - intentional but unauthorized destruction or alteration of that info
2. What's at stake?
   - Computer systems make up assets that have value to it
   - Time sensitive value:
     - At one point it means something but at anther it doesn't
   - Valuable assets deserve security protection
     - Preserve value -> expressed as a *security property*
       - Personal photos should always be accessible by their owner
     - Prevent harm -> examined as a concrete *attack*
       - Permanent destruction of irreplaceable photos
3. What are the players?
   - Defender:
     - System owners (users, admins)
   - Attackers:
     - Hackers or possibly owners
4. Security properties
   - CIA Triad: Confidentiality, Integrity, Availability
5. The CIA Triad
   - Comp security seeks to prevent unauthorized viewing (confidential) or modification (integrity) of data while preserving access (availability)
6. Confidentiality
   - An asset is viewed only by authorized parties
     - Through encryption etc.
7. Integrity
   - An asset is modified only by authorized parties
     - Beyond the normal "write" access-control rules
     - Precise, accurate, unmodified, modified in acceptable way by authorized people or processes, consistent, meaningful and usable
       - Consistency: the same file you have gets updated with every push/change, it's not an old file that didn't stage changes
8. Availability
   - An asset can be used by any authorized party
     - Timely response, fairness, concurrency
     - Tools: redundancy, fault tolerance, distributed architectures
   - DDOS attacks this specifically

Lecture 2.2 - Symmetric Key Encryption

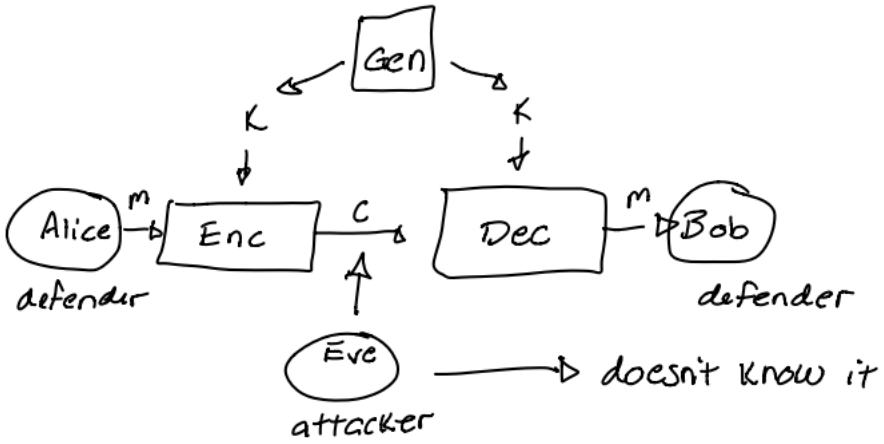
1. Recall - Confidentiality
   - Eavesdropping
     - Main thread against confidentiality of in-transit data



     - Attacker: packet sniffing over networked or wireless communications
2. Solution concept: Symmetric-key encryption
   - Main idea:
     - Secretly transform message so that it is unintelligible while in transit
     - Alice encrypts her message (m) to ciphertext (c), which is sent instead of plaintext (m)
     - Eve can intercept (c) but won't know (m)
     - Alice and Bob share secret key (k) that is used for both message transformations



   - Abstract cryptographic primitive (**cipher**) defined by:
     - A message space M and a triplet of algorithms (Gen, Enc, Dec)
     - Gen, Enc are probabilistic algorithms, whereas Dec is deterministic
       - Probabilistic employs some sort of randomness (variable output) whereas deterministic does not use any randomness (always the same output)
     - Gen outputs a uniformly random key (k) (from some key space K - all possible key values)



3. Desired Properties for Symmetric-key encryption solution
   - Should satisfy:
     - Efficiency: key generation & message transformations "are fast"
     - Correctness: For all m and k, it holds that Dec(Enc(m, k)), k) = m
     - Security: one "cannot learn" plaintext m from ciphertext c
4. Kirchoff's Principle
   - "The cipher method must not be required to be secret, and it must be able to fall into the hands of the enemy without inconvenience."
   - Reasoning:
     - Due to security & correctness, Alice and Bob must share some secret info
     - If no shared key captures this secret info, it must be captured by Enc and Dec
     - But keeping Enc, Dec secret is problematic
       - Harder to keep secret an algorithm than a short key (eg. after user revocation)
       - Harder to change an algorithm than a short key (eg. after secret info exposed)
       - Riskier to rely on custom/ad-hoc schemes than publicly scrutinized/standardized ones
5. Main Application Areas
   - Secure communication
     - Encrypt messages sent among parties
     - Assumption:
       - Alice and Bob securely generate, distribute, and store shared key k
       - Attacker does not learn key k
   - Secure storage
     - Encrypt files outsourced to the cloud
     - Assumption:
       - Alice securely generates and stores key k
       - Attacker does not learn key k
6. Brute Force Attack
   - Generic attack
     - Given a captured ciphertext c and known key space K, Dec
     - Strategy is an exhaustive search
       - For all possible keys k in K
         - Determine if Dec(c, k) is a likely plaintext m
     - Requires some knowledge on the message space M
       - ie. Structure of the plaintext (eg. PDF file or email message)
   - Countermeasure
     - Key should be a random value from a **sufficiently large** key space K to make exhaustive search attacks infeasible

Lecture 2.3 - Classical Ciphers

1. Substitution Ciphers
   - Large class of ciphers
     - Each letter is uniquely replaced by another
     - There are 26! possible substitution ciphers
2. Classical Ciphers
   - Cryptanalysis
     - No secret key issued
     - Thus the code is trivially insecure once someone knows Enc or Dec