CNT4406/5412 Network Security

Authentication

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Fall 2014

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  ➠ e.g., user/computer authentication, message authentication...

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  - ➠ e.g., user/computer authentication, message authentication...
- Authentication mechanisms
  - ➠ password-based authentication
  - ➠ address-based authentication
  - ➠ cryptographic authentication protocols

Password-based Authentication

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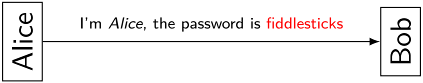
  ➠ "It's not who you know. It's what you know."



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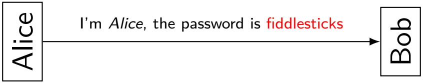

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- Threats: network address spoofing

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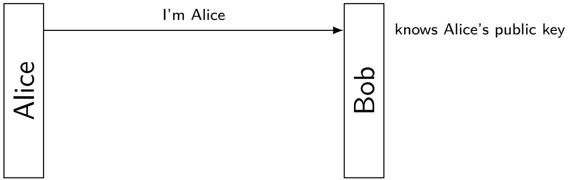

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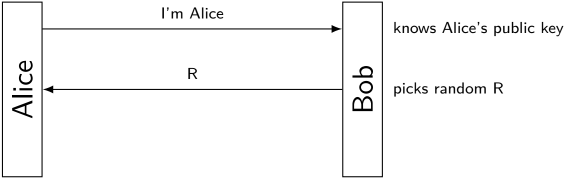

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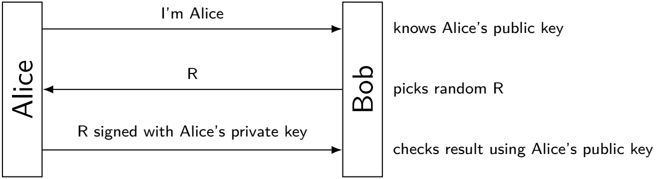

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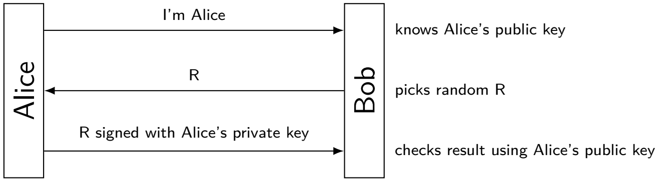

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- What the user is (inherence factor)
  - ➠ bio-metrics such as voice, fingerprint, iris pattern
  - ➠ benefits and problems?

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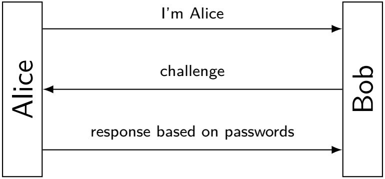

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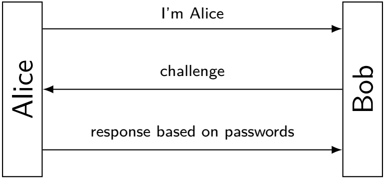

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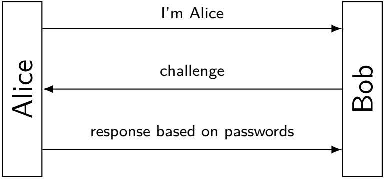
- Threats to password-based authentication?
  ➠ eavesdropping, leaking of stored passwords, online/offline password guessing, memorizing user-unfriendly passwords, password reuse



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- Passwords should be securely stored
  - ➠ always assume stored passwords can and will be leaked!!
- Passwords shall not be reused among accounts
  - ➠ bad idea for services to use email address as user name!

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- Better idea 2: storing the cryptographic hash of the password
  ➠ less flexible than storing plaintext passwords (why?)
  ➠ capturing stored passwords allows for offline password guessing

Dictionary Attack

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- Millions of leaked passwords (plaintext) have provided both a comprehensive real-world list and patterns of password construction
  ➠ A SQL injection exposed 32M RockYou.com passwords in 2009

Example: Leaked Yahoo Passwords (Hashed)

442, 773 passwords were leaked, 342, 478 of them were unique, 100, 295 (22.65%) passwords were used by more than one person

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ninja	333	0.08%
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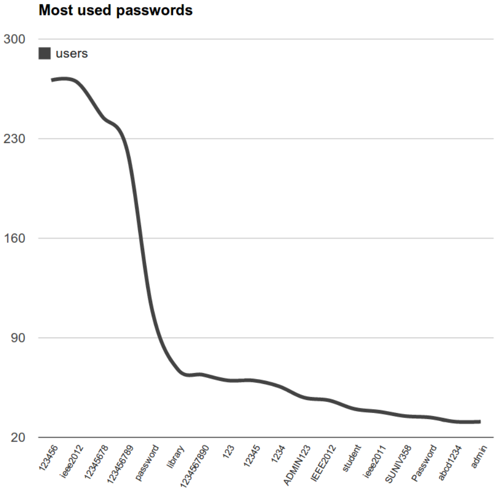
jesus	429	0.1%
love	421	0.1%
money	407	0.09%
freedom	385	0.09%
ninja	380	0.09%
writer	367	0.08%

top 10 base words

IEEE Data Leak (2012)



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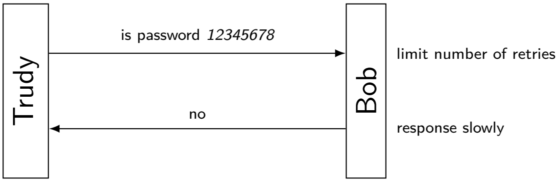
  - ➠ limit number of retries (e.g., ATM card)
  - ➠ process the password really s l o w l y



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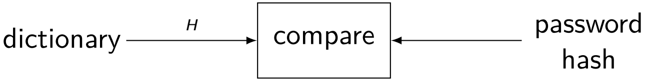
- Obtain the hash(es) of the password(s), compute the hashes of the dictionary, then look for matches



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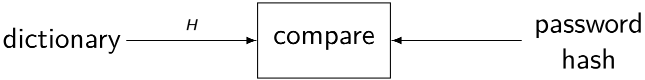

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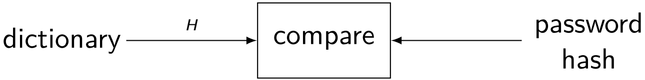
  - ➠ need efficient ways to store and search pre-computed hash
  - ➠ hash chain and rainbow table are used to reduce storage space



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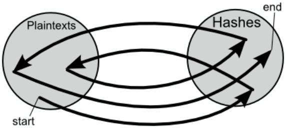

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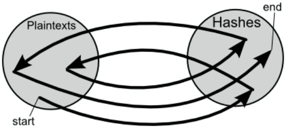

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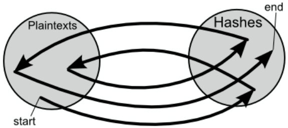

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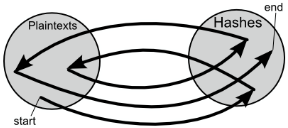

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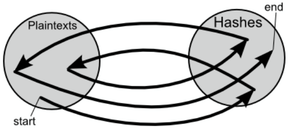

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  ➠ The last password is the answer.

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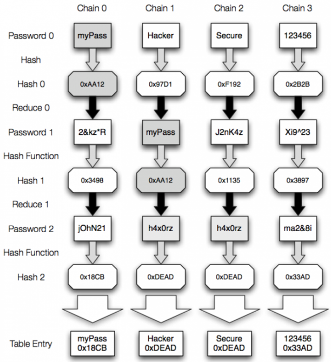

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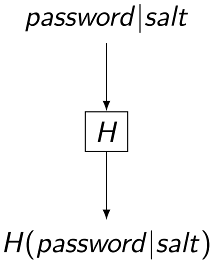

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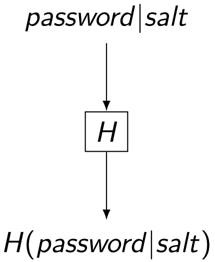

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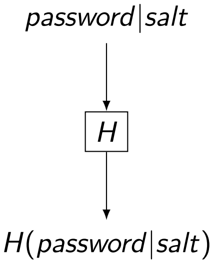
  - ➠ password file contains ($username$, $salt$, $H(password|salt)$)*
  - ➠ to verify the password, retrieve the salt from the password file



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Example (crack it!):

```
test:$6$Rtp8odu0$/wklQb4fmKvRQVPbAOx2UHJrjfQSxeBF8f
yLqMhxgmqZTGFQNiBG5LqyRDJ9MNoqRC0Vq3gIHIGUHkTIPhVCb.
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- Periodically change the passwords
- Never reuse the same passwords on multiple sites
  ➠ accounts have different importance, news $<$ email $<$ bank
- Reject passwords vulnerable to dictionary attacks
  ➠ remember the top 10 leaked Yahoo passwords?
- What else?

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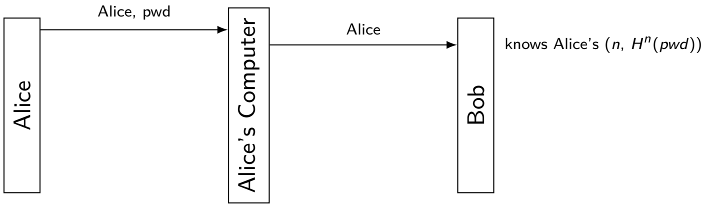

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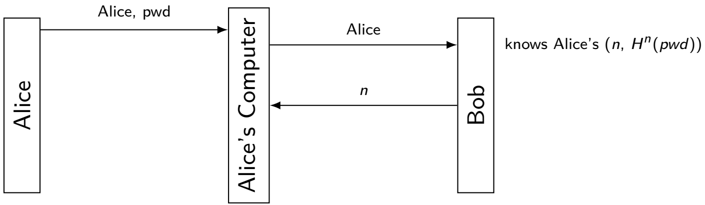

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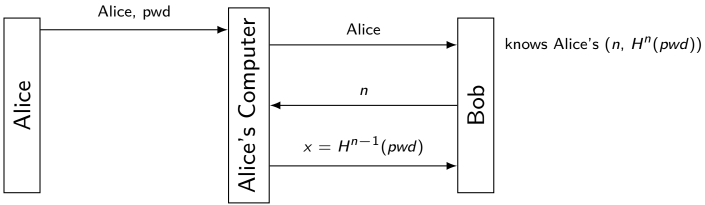

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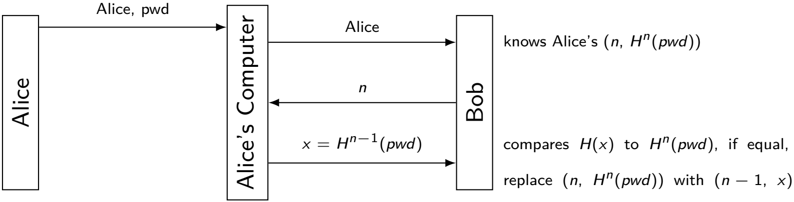

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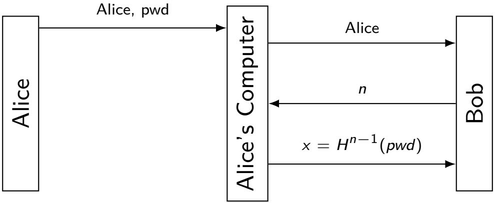

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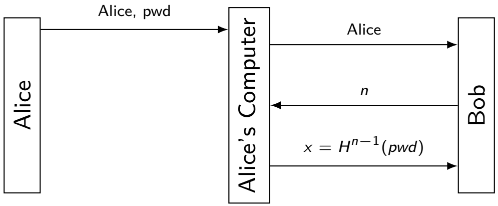

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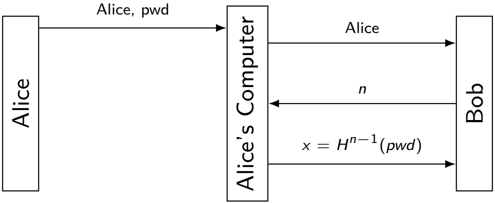

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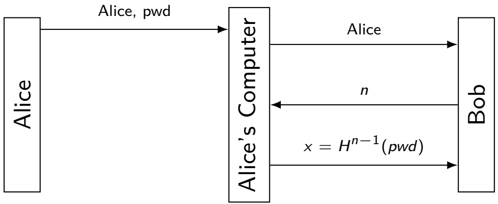
- Lamport's hash does not authenticate the server!
  - ➠ man-in-the-middle attack



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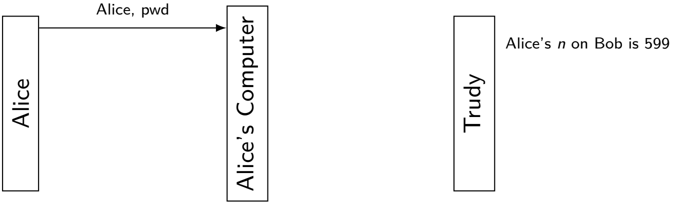

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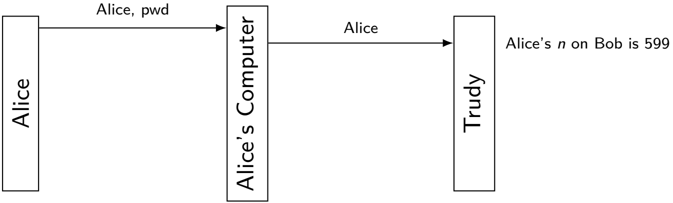

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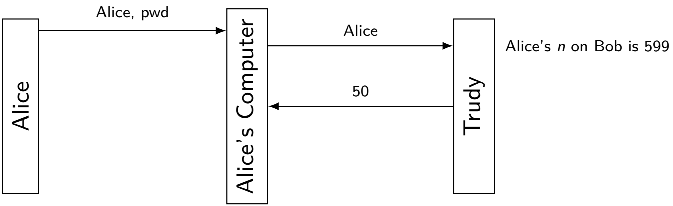

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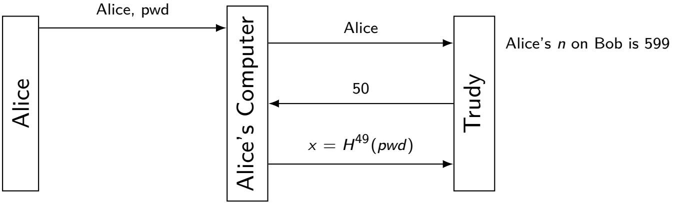

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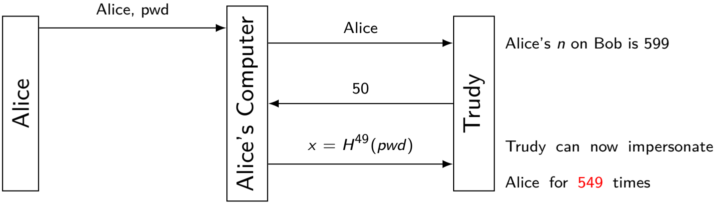

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- Is it considered a TFA if two passwords are required??

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- Example biometric devices
  - ➠ retinal scanner, fingerprint reader, face recognition, iris scanner, handprint reader, voiceprints, keystroke timing, signatures

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- Biometric information leads to privacy concerns

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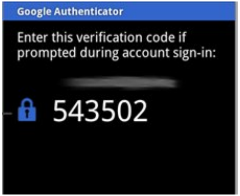

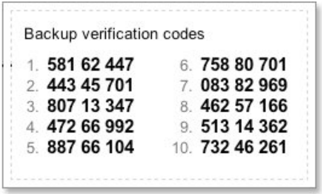

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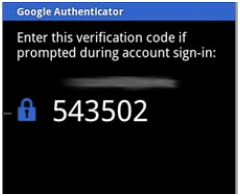

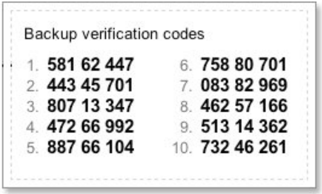

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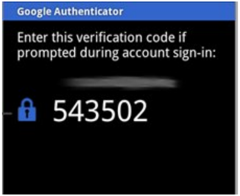

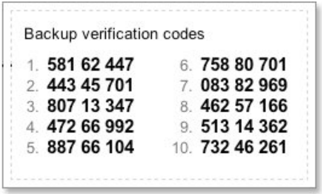

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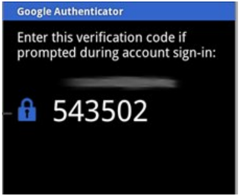

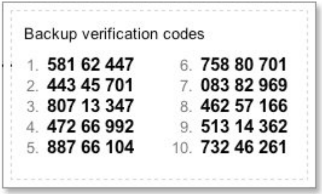

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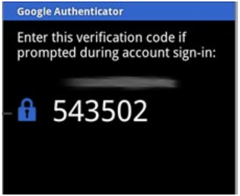

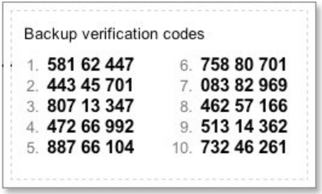

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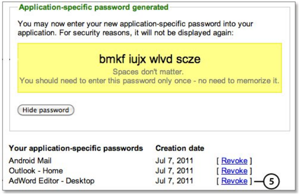

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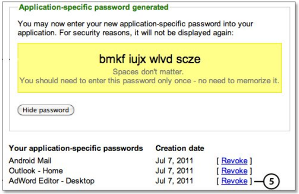
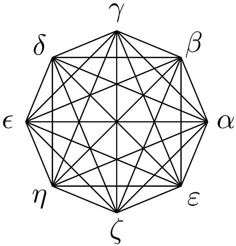


- Mark a computer/device as trusted to avoid further 2-step verification

Key Explosion

Number of keys for pair-wise authentication explodes in large networks:

- Each node needs to know $n-1$ keys



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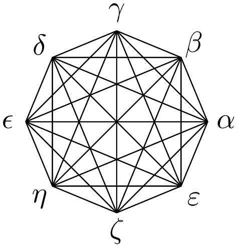

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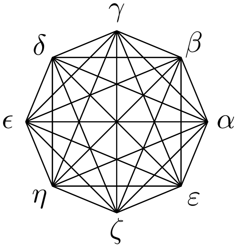

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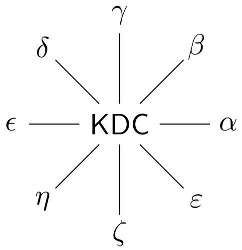

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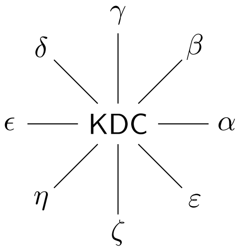

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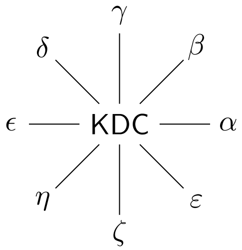
- KDC creates and distributes session keys for communications between nodes (how?)



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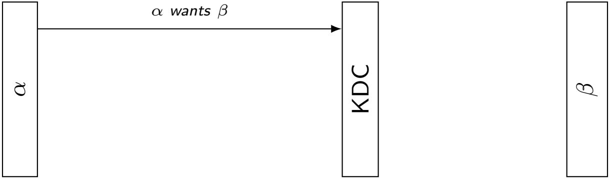

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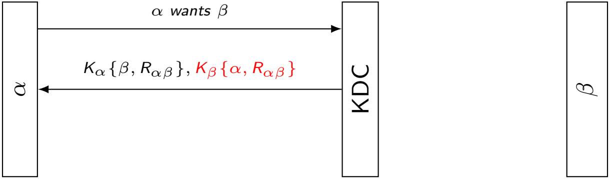

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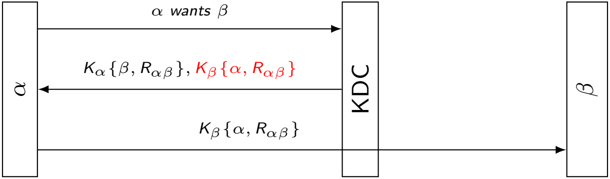

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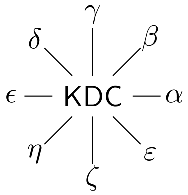

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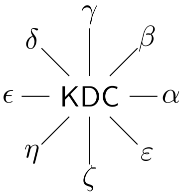
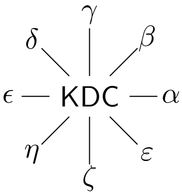


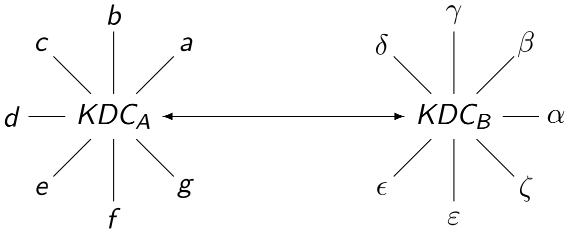
Key Distribution Center: Limitations

- KDC is security critical, it can impersonate any node to any node
- KDC is a single point of failure
- KDC might be a performance bottleneck ➠ replicate KDCs?



Multiple KDC Domains

- No single KDC will be trusted by all principles in the world
  - ➠ e.g., KGB and CIA, Apple and Google



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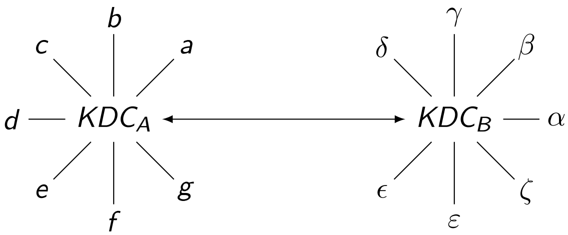

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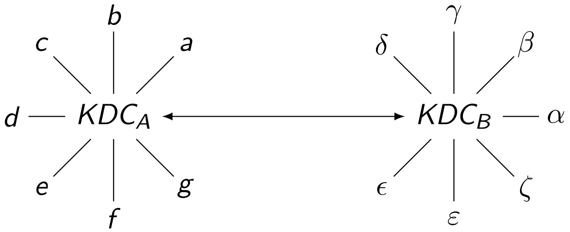
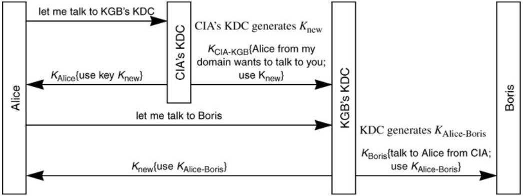
  - ➠ each KDC has a shared key with KDCs it's willing to talk to
  - ➠ communication cross domains require KDC's involvement



Multiple KDC Domains: Cross-domain Key Distribution

For node a in KDC_1 to communicate with β in KDC_2:



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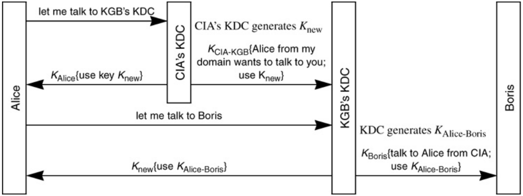

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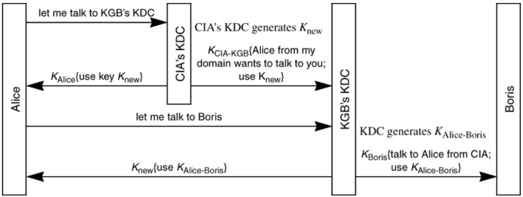

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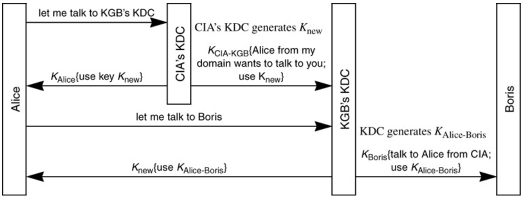
For node a in KDC_1 to communicate with β in KDC_2:

- a requests KDC_1 to create a session key with KDC_2
- a requests KDC_2 to create a session key with β
- a can now securely talk to β



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  - ➡ a compromised CA cannot decrypt conversations (why?)

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Summary

- Authentication
- Passwords: storage, dictionary attack, rainbow table, salt
- Lamport's hash
- Two factor authentication
- Biometrics
- Trusted intermediaries: KDC and CA

- Next lecture: Security Handshake