CS530
Authentication

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http://merlot.usc.edu/cs530-s10

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Identification vs. Authentication

- Identification
  - associating an identity (or a claimed identity) with an individual, process, or request
- Authentication
  - verifying a claimed identity
- Ex: user ID is identification, password is authentication

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Basis for Authentication

- Ideally
  - who you are
- Practically
  - something you know
    - e.g., password
  - something you have
    - e.g., smartcard, magnetic stripe card, passport, driver's license
  - something about you
    - e.g., face, hand, voice, fingerprint (i.e., biometrics)
    - sometimes mistakenly called things you are
- Note: policy determines how and what to do

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Something You Know

- Password
- Algorithm
  - e.g., encryption key derived from password
- Issues
  - someone else may learn it
    - find it, sniff it, trick you into providing it

      Ex: e-mail from eBay or Paypal asking you to validate your password
  - other party must know how to check
    - keep in table

      once this table is obtained, the attacker may use it to login to other systems
  - you must remember it (tend to use same password)
  - how stored and checked by verifier

Examples of Password Systems

- Verifier knows password
  - can one crack password one letter at a time (as often seen in movies)?
    - timing attacks (look at power consumptions, time between successive guesses)

- Encrypted Password
  - one way encryption
  - Ex: UNIX
    - login namd, UID, GID, encrypted password all stores in /etc/passwd
    - old systems make /etc/passwd globally readable
    - new systems move encrypted passwords to /etc/shadow
    - salt the password (12-bit salt) to protect against pre-computed dictionary attack

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Examples of Password Systems (Cont...)

- Third Party Validation
  - Ex: Liberty Alliance
    Microsoft Passport
    Kerberos
    Public key systems with Directory Services

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Attacks on Password

- Brute force
- Dictionary
- Pre-computed Dictionary
- Guessing
  - what's your pet's name? (favorite city, birth place, ...)
- Finding elsewhere
  - sitting in Windows' Registry
  - sitting on USB harddrive

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Something You Have

- Cards
  - mag stripe (= password?)
  - smart card, USB key
    - something your device knows!
    - verifier knows that the device is present!
  - time varying password
    - secure ID card
    - challenge/response card
    - smartcard requires special reader, this does not

      the user is the device!

      limited data length to reduce human mistakes
- Issues
  - how to validate
  - how to read (i.e. infrastructure)

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Something About You

- Biometrics
  - measures some physical attribute
    - iris scan (can’t really scan the retina)
    - fingerprint
    - picture
    - hand scan (geometry of hand)
    - voice
    - keystroke patterns?
- Issues
  - how to prevent spoofing
    - suited when biometric device is trusted/secure, not suited otherwise
  - fingerprint reading device at home, is that a good idea?
    - must be connected to a tamper-proof device

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Other Forms of Authentication

- IP address, MAC address
  - e.g., NFS, DHCP
- Caller ID (or call back)
  - also works with e-mail
- Past transaction information
  - e.g., what’s the amount of your last bill?

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"Enrollment" (for Something You Know)

- How to initially exchange the secret
  - in-person enrollment
  - information known in advance
    - e.g., what’s the amount of your last bill?
  - third party verification
    - e.g., a notary public
  - mail or email verification
    - e.g., activation code in e-mail, click here to activate

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Multi-factor Authentication

- Require at least two of the three *classes* above
  - e.g. Smart card plus PIN
  - e.g. credit card plus zip code of billing address
  - e.g. biometric and password
- Issues
  - better than one factor
  - be careful about how the second factor is validated
    E.g., on card, or on remote system
    - PIN goes to remote system (or goes through smartcard and then remote system)

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General Problems with Password

- Space from which passwords are chosen
- Too many passwords
  - and what it leads to
  - solution is "single sign on"?

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Single Sign On

- "Users should log in once and have access to everything"
- Many systems store password lists
  - which are easily stolen
- Better is encryption based credentials
  - usable with multiple verifiers
  - interoperability is complicating factor
- Liberty Alliance
  - communicating information about authentication using a markup language (Security Association Markup Language)
- Microsoft Passport
  - original version based on cookies and hotmail passwords
  - next version based on Kerberos (cross realm authentication)

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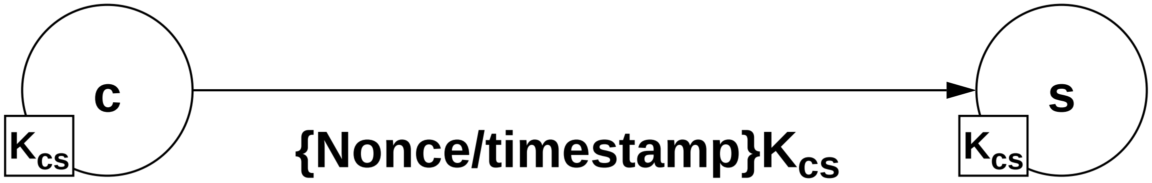
Encryption Based Authentication

- Proving knowledge of encryption key
  - nonce = non repeating value



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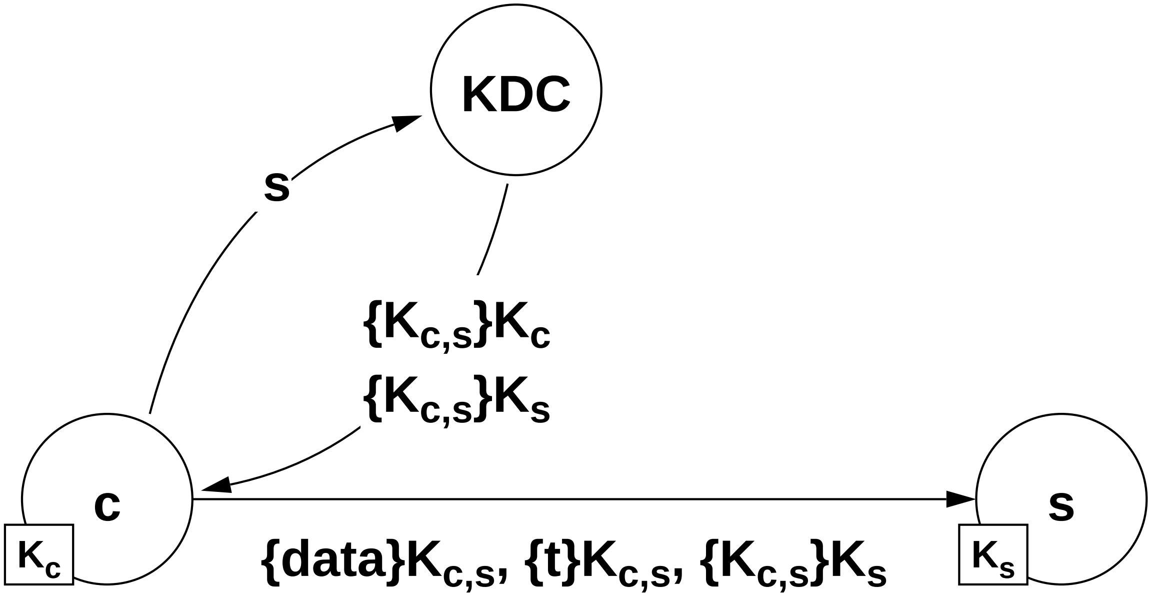
Authentication with Conventional Cryptography

- Kerberos



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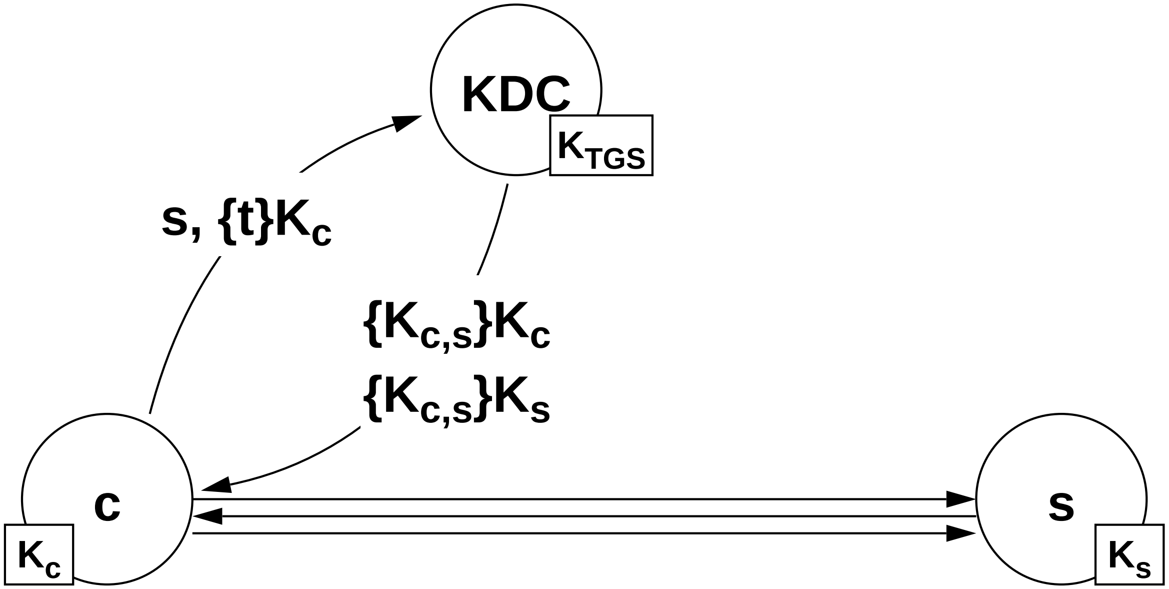
Authentication with Conventional Cryptography

- Kerberos or *Needham-Schroeder*
  - includes challenge/response
  - optional pre-authenticator in original message



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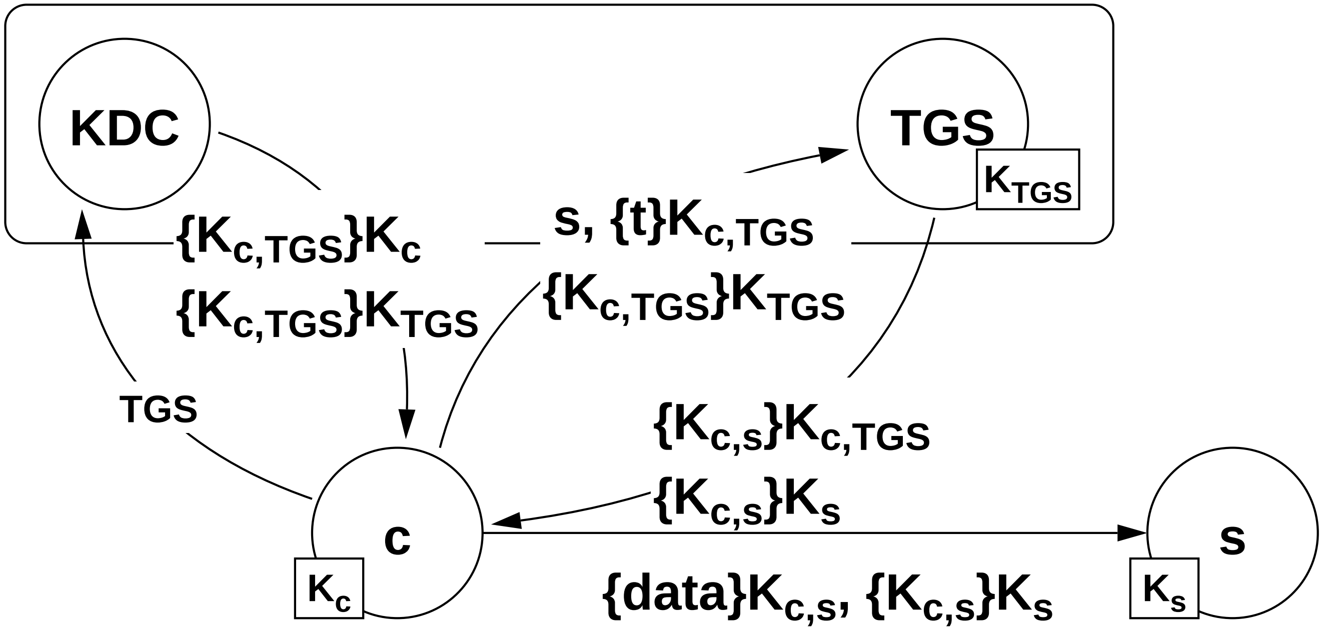
Kerberos

- Third-party authentication service
  - distributes session keys for authentication, confidentiality, and integrity
    - KDC & TGS is usually combined
    - KDC can generate cross realm TGT (pre-arranged)



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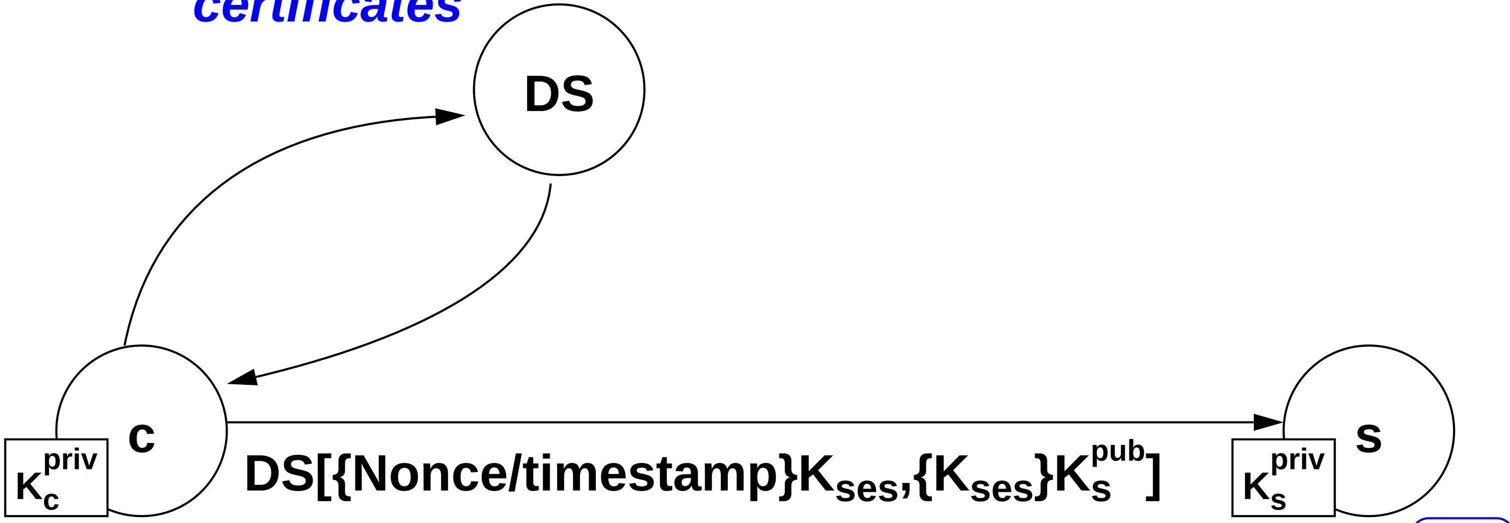
Authentication with Public Key Cryptography

- Based on public key certificates
  - DS = *Directory Server*
    - client can include public key certificate in the first message
    - contact DS mainly to check to see if the public key certificate has ben *revoked* and to *obtain other certificates*



$DS[\{Nonce/timestamp\}K_{ses},\{K_{ses}\}K_s^{pub}]$

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Public Key Cryptography Summary

- Key distribution
  - confidentiality not needed for public key
  - solves n^2 problem
- Performance
  - slower than conventional cryptography
  - implementations use for key distribution, then use conventional crypto for data encryption
- Trusted third party still needed
  - to issue public key certificates
  - to obtain other public key certificates
  - to manage revocation
  - in some cases, third party may be off-line

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Certificate-Based Authentication Summary

- Certification authorities issue signed certificates
  - banks, companies, & organizations like Verisign act as CA’s
  - certificates bind a public key to the name of a user
  - public key of CA certified by higher-level CA’s
  - root CA public keys configured in browsers & other software
  - certificates provide key distribution

- Authentication steps
  - verifier provides nonce, or a timestamp is used instead
  - principal selects session key and sends it to verifier with nonce, encrypted with principal’s private key and verifier’s public key, and possibly with principal’s certificate
  - verifier checks signature on nonce, and validates certificate

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Authentication with Hash Chains

- Based on the one-wayness of cryptographic hash functions
  - generate secret *s*, send *h(s)* to server
  - to prove identity, present *s* to server
  - but now *s* is exposed

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Authentication with Hash Chains (Cont...)

- Use ***Lamport's hash*** (or ***hash chain***)
  - $h^{100}(s) \leftarrow h^{99}(s) \leftarrow h^{98}(s) \leftarrow \ldots \leftarrow h^{2}(s) \leftarrow h(s) \leftarrow s$
  - client generate *s* (seed) and *N* and compute $h^{N}(s)$
    - sends *N* and $h^{N}(s)$ to server
    - seed can be derived from a passphrase
  - server keeps a state, start with $[N=100, h^{N}(s)]$
  - client sends name to server and server responds with *N*
    - client computes and sends $x = h^{N-1}(s)$
    - server computes *h(x)* and compare with current state
    - if succeed, new state is *[N-1, x]*
  - an attacker who has the server's state cannot login
  - this is one of the one-time password schemes

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Authentication with Hash Chains (Cont...)

- Man-in-the-middle *small N attack*
  - man-in-the-middle attack intercepts *N* from server and forward *N-10* to client
  - client sends $h^{N-11}(s)$ which the attacker will intercept
    - use this to compute $h^{N-1}(s)$
  - attacker can login 10 times without knowing *s*

- Mitigating the small N attack
  - the client needs to remember the last *N* received from this server

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Authentication with Hash Chains (Cont...)

- Other weakness in Lamport’s hash
  - short lifetime of key
    - when N reaches 1, must generate new seed
    - can use a *salt* so that the seed can stay the same
      - client generate s (seed) and t (salt) and N and compute $h^N(s+t)$
      - sends N and t and $h^N(s+t)$ to server
      - client can discard the salt
      - on client login, server responds with N and t
  - problem with multiple servers
    - need different seeds
    - 3rd party authentication may not be desirable
    - *salt* also helps with loging to multiple servers with the same seed or passphrase
      - use a different salt per server

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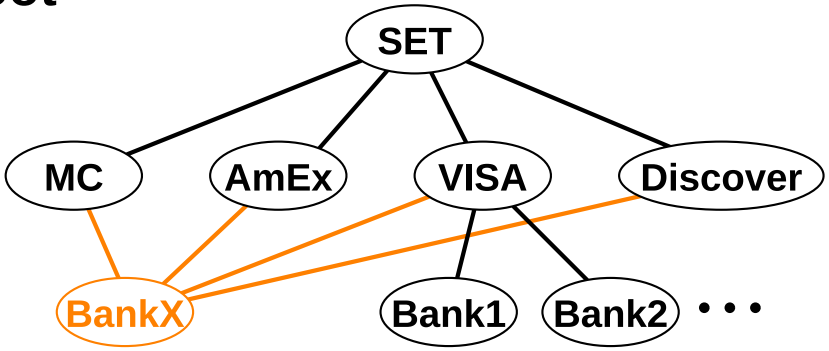
Trust Models for Certification

- X.509 hierarchical
  - OSI model:
    - X.400 - e-mail
    - X.500 - naming (DNS equivalent)
      - X.509 - authentication standard
  - single root (original plan) - UN is the root CA
  - multi-root (better accepted)
  - SET (Secured Electronic Transaction) has banks as CA's and common SET root
    - private key of the SET root CA is split and spread among child CA's



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Trust Models for Certification (Cont...)

- PGP Model
  - "Friends and Family approach" - S. Kent
    - put more trust on more paranoid people
      as a result, look like a hierarchy!
- Other representations for certifications
  - X.509 (popular)
- No certificates at all
  - out of band key distribution
  - SSH
    - ~/.ssh/authorized_keys

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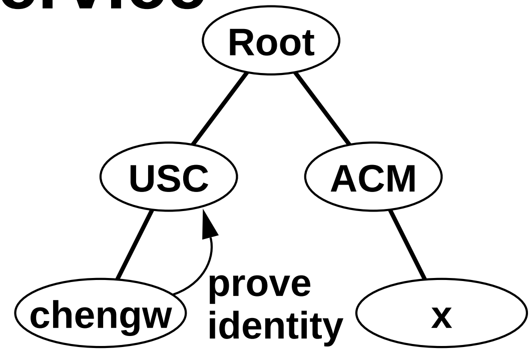
Global Authentication Service



- From DEC
- Pair-wise trust in hierarchy
  - name is derived from path followed
  - shortcuts allowed, but changes name
  - exposure of path is important for security
- Compared to Kerberos
  - transited field in Kerberos - doesn’t change name
- Compared with X.509
  - X.509 has single path from root
  - X.509 is for public key systems
- Compared with PGP
  - PGP evaluates path at end, but may have name conflicts

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Generic Security Services API (GSS-API)

- Standard interface for choosing among authentication methods
  - once an application uses GSS-API, it can be changed to use a different authentication method easily
    - difficulty lies in the fact that different methods of authentication use different models of interaction
      - e.g., one way vs. challenge/response (requires, at a minimum, 2 messages), with zero knowledge proof, can have hundreds of messages
  - API calls
    - acquire and release credentials
    - manage security context
      - init, accept (on server side), and process tokens
    - wrap (confidentiality and/or integrity) and unwrap

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