Cryptography PKI, *and* Digital Signatures

Topics

- Cryptography
  - Services
- Digital Signature Process
- Public Key Infrastructure
  - Certificates

Cryptographic Services Review

- Confidentiality -- Encryption
  - Only authorized people –e.g., the sender and recipient of a message, not eavesdroppers – can know the message.
- Integrity – Message Digests (MAC or MIC), and Digital Signatures
  - When Bob receives a message, he can be sure that it was not modified en route after Alice sent it.
- Authentication – PKI and Digital Signatures
  - When Bob receives a message that purports to be sent by Alice, Bob can be sure that the message was really sent by Alice.
- Nonrepudiation – MAC and Digital Signatures
  - Alice cannot later deny that the message was sent.
  - Bob cannot later deny that the message was received.

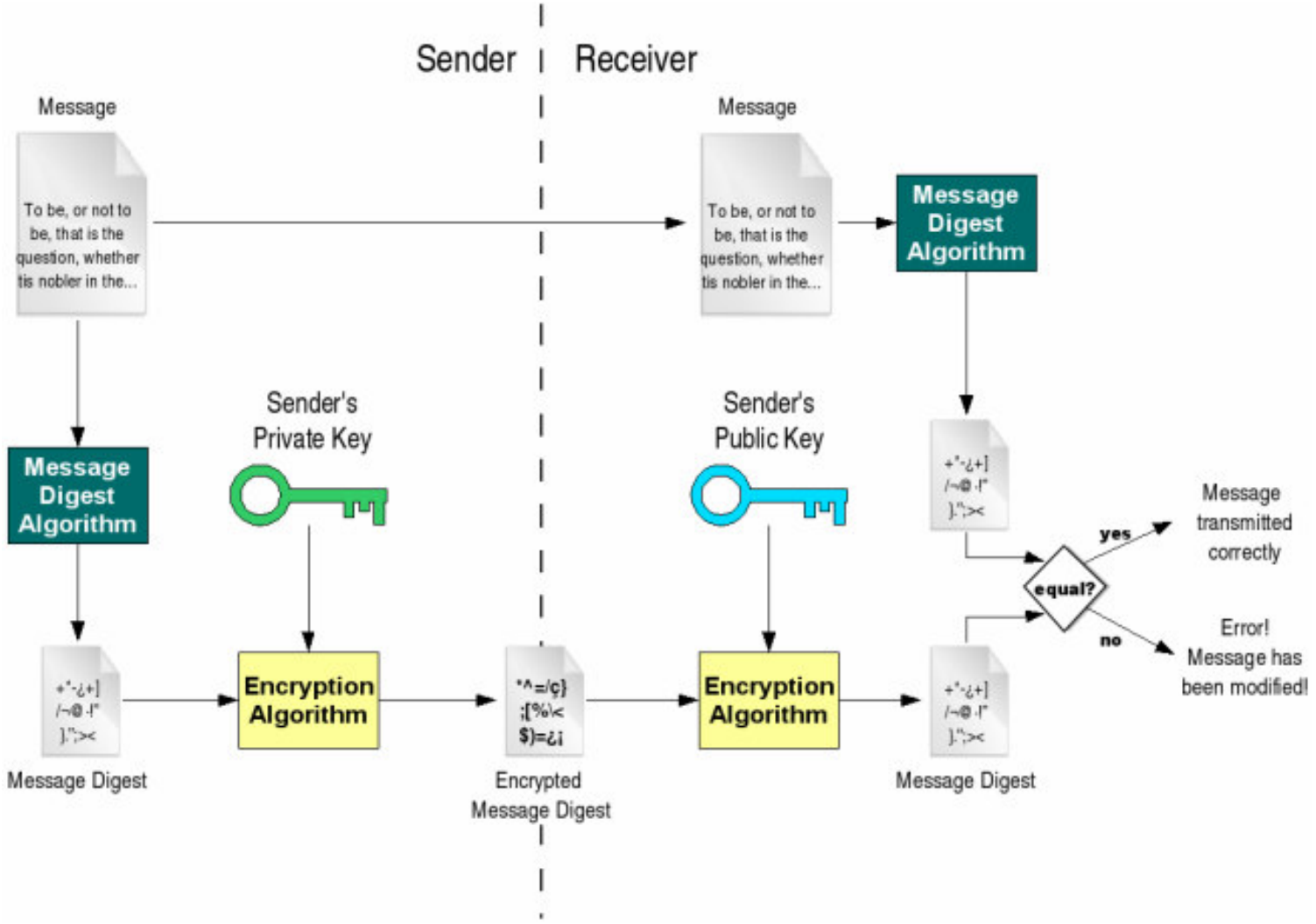
  - *Note: cryptography is not concerned with availability.*

Authentication and NonRepudiation Goals and Process

- Authentication verifies that a message came from whom it is represented to come from.
- Non repudiation provides evidence so that a message can not be disavowed at a later time.

- Process utilizes a secret known to only one person (private key).
- Methods include digital signatures.

Digital Signature Process



Public Key Infrastructure Defined

Digital Key Signatures are part of a Public Key Infrastructure (PKI) that:

- Binds public keys to entities
- Enables other entities to verify public key bindings
- Provides the services needed for ongoing management of keys in a distributed system.

-- NIST 800-32

Provides confidence that:

- The person or process identified as sending the transaction is actually the originator.
- The person or process receiving the transaction is the intended recipient.
- Data integrity has not been compromised.

Public Key Infrastructure

- Public key infrastructure enables enterprises to protect the security of their communications and business transactions on networks.
  - An enterprise-wide network security architecture, PKI integrates:
    - Digital certificates
    - Public key cryptography
    - Certification authorities.
  - Facilitates specific security services including:
    - Public key exchange
    - User authentication
    - Nonrepudiation.

Public Key Infrastructure Issues

Specific Public Key Infrastructure (PKI) issues include:

- Key Authentication and Non-repudiation
  - Nothing about a key proves to whom it belongs
- Revoking keys
  - Nothing about a key indicates whether it has been revoked
- Policy enforcement
  - Any organization utilizing PKI needs to create and enforce a local policy.

PKI Architecture Overview

- PKI architecture consists of:
  - A Trust Model
  - Servers (Certificate, Revocation, Registration)
  - Certificates/Data format standards
    - Public key mechanism standards
- All components work together to enable trusted and secure communications.

PKI Hierarchical Trust Model

1. Hierarchical Trust
   - Sets up an independent certificate authority (CA) with authority to sign digital certificates.
   - A CA can revoke a certificate
   - Facilitates enforcement of a local policy
   - Most complex, most efficient trust model

Note

- *There are other trust models such as PGP's web of trust*

PKI Support Infrastructure

- Includes
  - Certificates
    - X.509 Standard
  - Certificate Authority
    - Trusted entity that maintains and issues digital certificates.
  - Registration Authorities
    - Performs certificate registration duties
    - Acts as a broker between users and CA
  - Certificate revocation process
    - CA maintains a Certificate Revocation List (CRL)
  - Local Policies and Procedures
  - Non-repudiation service
    - Digital Signature

Certificate Servers

- Certificate servers validate, or certify, keys.
- A certificate server holds a large number of:
  - Certificates
  - Associated data sets
  - Revocation lists
- Three data structures
  1. Certificates
  2. Certificate revocation lists
  3. Attribute certificates.
- Include:
  - Certificate Authorities
  - Registration Authorities

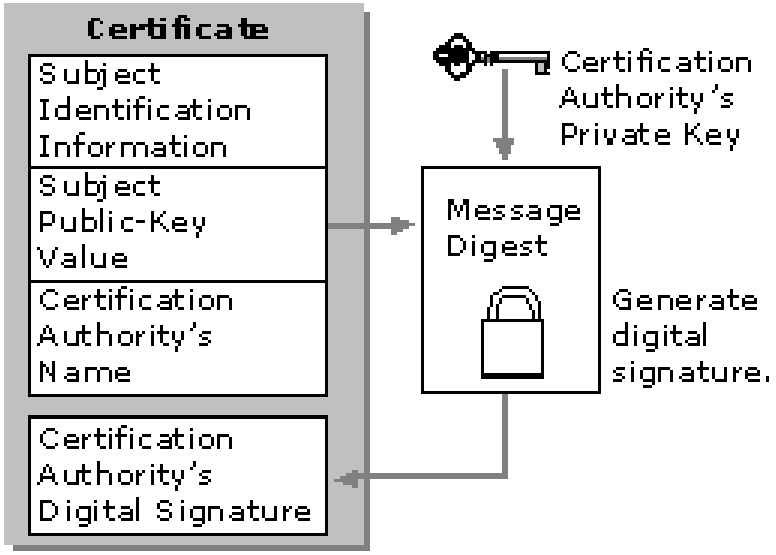
X.509 Certificate Standard

- ITU/CCITT X.509
  - X.500 component
  - Initially intended to provide X.500 authentication
    - Produced by a ISO and ITU collaboration
- Describes digital certificate format.
  - Several versions.
- PKIX – IETF working group
  - Specifies protocols for managing digital certificates as well as protocols for their use.
  - RFC 2459

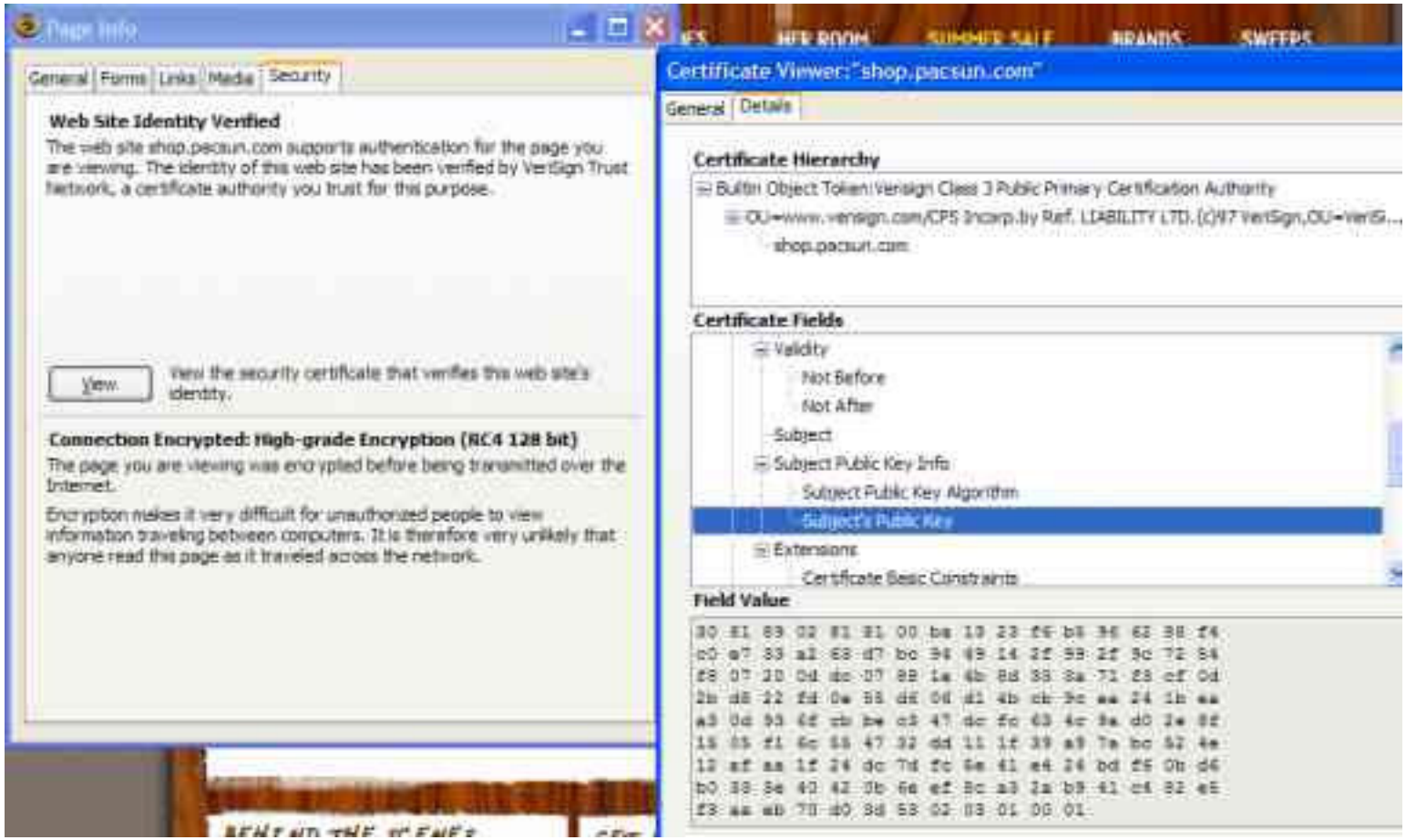
Public Key Certificates

Sample digital certificate components

1. Public key
2. Certificate attributes
   - "Identity" information about user, including name, user ID…
3. One, or more, digital signatures from the Certificate Authority.



Example Certificate



Certificate Revocation Process

- Utilizes Certificate Revocation Lists (CRLs)
  - A revocation list is a signed list (usually signed by CA) in which the serial numbers of revoked certificates are detailed.
- A revocation list is replaced by an updated version from the Trust Center at regular intervals, or as necessary.
  - Validity period determined by Trust Center
  - Usually one day

Questions?

Selected References

http://csrc.nist.gov/publications/PubsSPs.html

http://en.wikipedia.org/wiki/Digital_signature

http://www.simonsingh.net/Crypto_Corner.html

http://www.schneier.com/