AAA

Part II

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Audio/Video recordings of this lecture are available at:

http://www.cse.wustl.edu/~jain/cse571-07/

Overview

- TACACS, TACACS+
- RADIUS, Packet Format, Accounting
- Problems with RADIUS
- Diameter Base Protocol
- AAA Transport Profile
- AAA Key Management Principles

TACAS

- Terminal Access Controller Access-Control System
- Routing nodes in ARPAnet were called IMPS.
- IMPs with dial up access were called TIPs.
- BBN developed TACACS for ARPANET
- AAA server is a process in a UNIX server - called TACACS daemon.
- Uses UDP port 49
- Username and passwords were sent in clear for authentication ⇒ No longer used
- Cisco adopted TACACS for terminal servers extended TACACS or XTACACS

TACACS+

- Terminal Access Controller Access-Control System Plus
- Cisco's further improved version of TACACS and XTACACS
- Not compatible with TACACS
- Payload is encrypted
- Described in draft-grant-tacacs-02.txt, Jan 1997.
- Uses TCP port 49

RADIUS

- RFC 2138, June 2000
- UDP port 1812
- Why UDP?
    - In case of server failure, the request must be re-sent to backup ⇒ Application level retransmission required
    - TCP takes to long to indicate failure
    - Stateless protocol

RADIUS Packet Format

Code	Identifier	Length	Authenticator	Attributes
1B	1B	2B	16B	

Codes:

1 = Access Request

2 = Access Accept

3 = Access Reject

4 = Accounting request

5 = Accounting Response

11 = Access Challenge

12 = Server Status (experimental)

13 = Client Status (Experimental)

255 = Reserved

RADIUS Packet Format (Cont)

- 16B Authenticator is used to authenticate the reply from the RADIUS server
- In Access-request packets 16B random number is send as authenticator
- Password in packet
  = MD5(Shared secret | authenticator) ⊕ password
- Response Authenticator
  = MD5(Code|ID|Length|Request Auth|Attributes| Shared secret)
- All attributes are TLV encoded.

RADIUS Accounting

- RFC 2866, June 2000
- Client sends to the server:
  - Accounting Start Packet at service beginning
  - Accounting Stop Packet at end
- All packets are acked by the server
- Packet format same as in authentication

RADIUS Server Implementations

Public domain software implementations:

- FreeRADIUS
- GNU RADIUS
- JRadius
- OpenRADIUS
- Cistron RADIUS
- BSDRadius
- TekRADIUS

Problems with RADIUS

- Does not define standard failover mechanism ⇒ varying implementations
- Original RADIUS defines integrity only for response packets
- RADIUS extensions define integrity for EAP sessions
- Does not support per-packet confidentiality
- Billing replay protection is assumed in server. Not provided by protocol.
- IPsec is optional
- Runs on UDP ⇒ Reliability varies between implementation. Billing packet loss may result in revenue loss.
- RADIUS does not define expected behavior for proxies, redirects, and relays ⇒ No standard for proxy chaining

Problems with RADIUS (Cont)

- Does not allow server initiated messages
  ⇒ No On-demand authentication and unsolicited disconnect
- Does not define data object security mechanism
  ⇒ Untrusted proxies can modify attributes
- Does not support error messages
- Does not support capability negotiation
- No mandatory/non-mandatory flag for attributes
- Servers name/address should be manually configured in clients ⇒ Administrative burden
  ⇒ Temptation to reuse shared secrets

Diameter Base Protocol

- RFC 3588, Sep 2003
- Defines standard failover algorithm
- Runs over TCP and Stream Control Transmission Protocol (SCTP)
- PDU format incompatible with RADIUS
- Can co-exist with RADIUS in the same network
- Supports:
  - Delivery of attribute-value pairs (AVPs)
  - Capability negotiation
  - Error notification
  - Ability to add new commands and AVPs
  - Discovery of servers via DNS
  - Dynamic session key derivation via TLS

Diameter Base Protocol (Cont)

- All data is delivered in the form of AVPs
- AVPs have mandatory/non-mandatory bit
- Peer-to-peer protocol ⇒ any node can initiate request.
- Documents: Base, transport profile, applications
- Applications: NAS, Mobile IP, Credit control (pre-paid, post-paid, credit-debit), 3G, EAP, SIP

AAA Transport Profile

- RFC 3539, June 2003
- Network Access Identifier (NAI) = User ID
- Application driven vs. network driven:
  Network is not the bottleneck for AAA messages
  ⇒ Application driven. No congestion issues.
- Slow Failover: TCP time outs ⇒ slow
- Use of Nagle Algorithm:
  Many AAA messages are combined in one TCP message
- Multiple Connections:
  Max 256 requests in progress between a client and a server
- Duplicate Detection: Servers and clients recognize duplicate request or responses and discard them.
  - A single request when duplicated can result in success and failure responses.

AAA Transport Profile (Cont)

- Invalidation of Transport Parameter Estimates: Timeouts should account for network congestion
- Inability to use fast re-transmit: most AAA protocols are always close to initial window set to 1 or 2
- Congestion Avoidance:
- Delayed Acks: application driven ⇒ explicit acks
- Premature failover: some implementation switch to backup server prematurely
- Head of line blocking: TCP queue may build up after a packet loss ⇒ hold up other AAA requests on the same connection
- Connection load balancing:

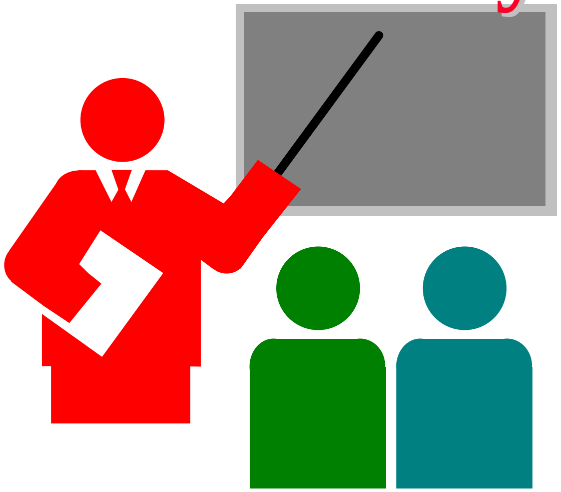
AAA Key Management Principles

- RFC 4962, July 2007 (Housley Criteria)
- Ability to negotiate crypto algorithms
  ⇒ Support multiple algorithm
- Ability to negotiate key derivation function is not required
- At least one suite of mandatory algorithms must be selected
- Use strong fresh session keys.
- Session keys must not be dependent on one another
  ⇒ Knowing a session key, Can't find another session key
  ⇒ Use nonce to ensure each session key is fresh.
- Include replay detection mechanism
- Authenticate all parties
- Lower layer identifiers used for authorization should be authenticated

AAA Key Management Principles (Cont)

- Both peer and authenticator must be authorized
  ⇒ Detect unauthorized authenticator
- Peer, Authenticator, Authentication server should have a common view of authorizations
- Cipher suite selection should be securely confirmed
  ⇒ detect roll-back attacks
- All keys should be uniquely named and key name should disclose key value
- Prevent domino effect ⇒ Compromise of a single entity must not compromise key material at other entities in other branches (may compromise children entities)
- Bind key to its context: use, who has access, life time. All entities with access to keying material should have the same context.

Summary



- TACACS and TACACS+ are legacy AAA protocols
- RADIUS provides good security but lacks sophisticated mechanisms required for failover
- Diameter is a replacement for RADIUS. Fixes most known shortcomings of RADIUS.