Network Access Control and Wireless

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Avdelningen för informationssystem och -teknologi (IST)
Mittuniversitetet

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Overview

1. Network Access Control (NAC) and IEEE 802.1X
   - Network Access Control
   - Extensible Authentication Protocol
   - IEEE 802.1x

2. Wireless Network Security
   - Wireless Security

3. 802.11 Wireless Overview
   - 802.11 - Wireless LAN
   - Wireless LAN Security

Literature

The lecture covers chapter 5.1 - 5.3 and chapter 7 “Wireless Network Security” in [1]. To check that you have fully understood these chapters, you should solve problems 7.1, and 7.2

Network Access Control

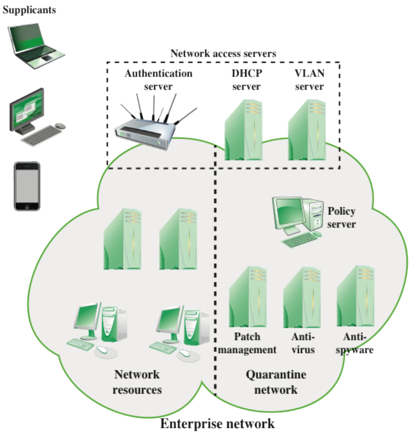

Figure 5.1 Network Access Control Context

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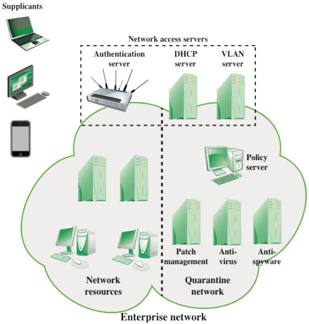

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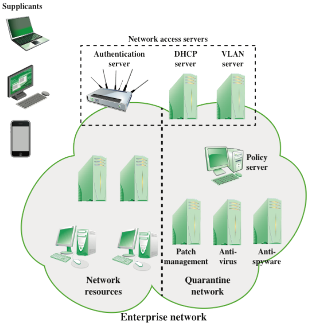
Access Requestor

- Access Requestor, Client, Supplicants, peer
- Access the network.



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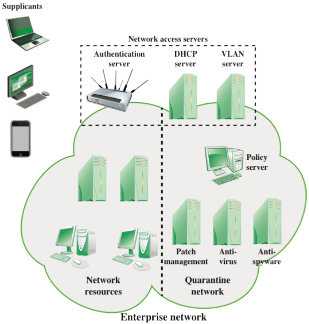
Policy Server

- Enforce access restrictions.



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Network Access Server

- Control access to Network.

- IEEE 802.1X - EAP over LAN.
- VLAN.
- Firewall.
- DHCP management.

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Network Access Enforcement Methods

Network Access Control

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Extensible Authentication Protocol

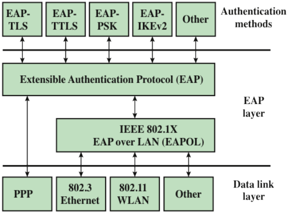

Figure 5.2 EAP Layered Context

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- *Framework* for network access and authentication protocols.
- Mostly encountered in wireless networks and PPP-connections.
- Extension to PPP

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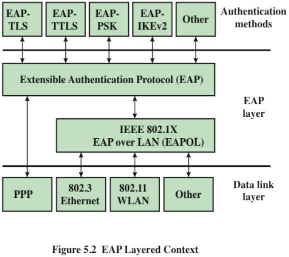

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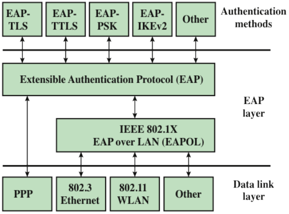

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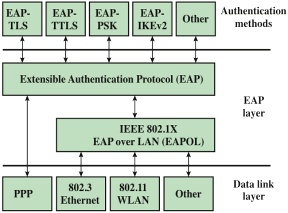

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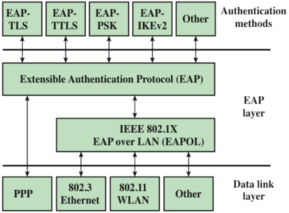

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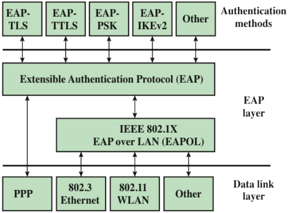

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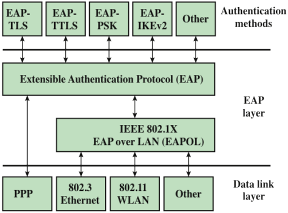

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EAP Exchanges

Extensible Authentication Protocol

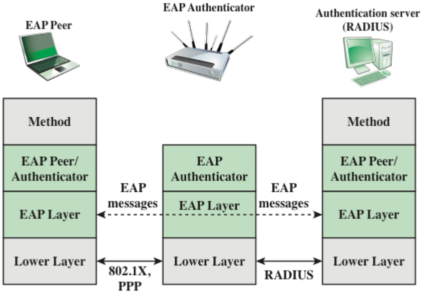

Figure: EAP Protocol Exchange [1]

EAP Messages
Extensible Authentication Protocol

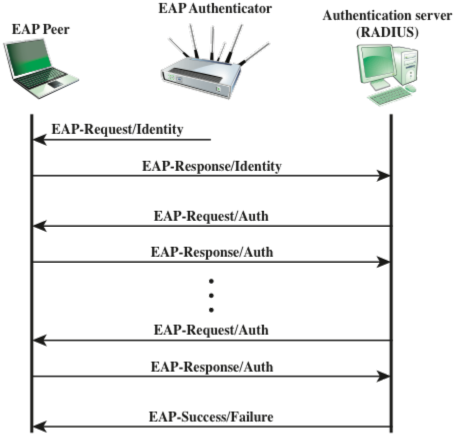

Figure: EAP Message Flow [1]

IEEE 802.1x

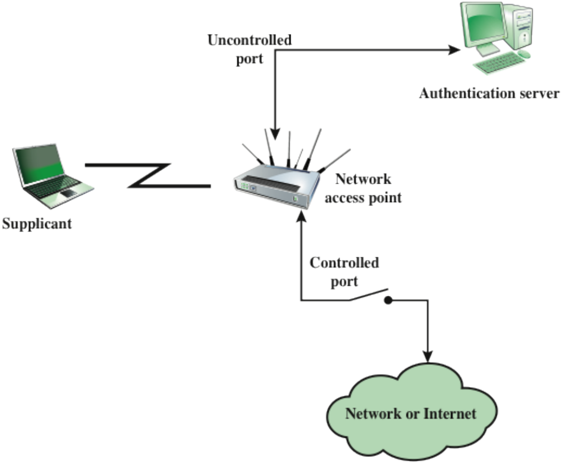

Figure: IEEE 802.1x operation [1]

IEEE 802.1x EAPOL Message types

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Wireless Network Security

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- Broadcast communication allows eavesdropping.
- Jamming traffic
- Mobile devices
- Implemented on a variety of devices with limited memory and computational resources.
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IEEE 802.11 protocol stack

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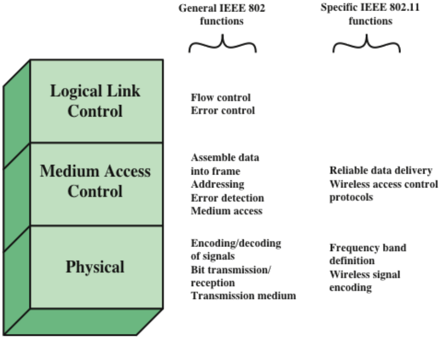

General IEEE 802 functions

Specific IEEE 802.11 functions

Logical Link Control

Flow control
Error control

Medium Access Control

Assemble data into frame
Addressing
Error detection
Medium access

Reliable data delivery
Wireless access control protocols

Physical

Encoding/decoding of signals
Bit transmission/ reception
Transmission medium

Frequency band definition
Wireless signal encoding

Figure: 802.11 protocol stack [1]

IEEE 802.11 Architectural Model

802.11 - Wireless LAN

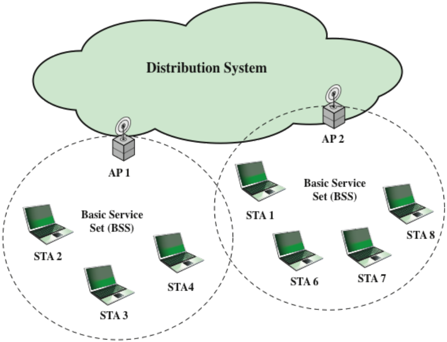

Figure: 802.11 Architectural Model [1]

Table: IEEE 802.11 Services [1]

Service	Provider	Used to support
Association	Distribution system	MSDU delivery
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Authentication	Station	LAN access and Security
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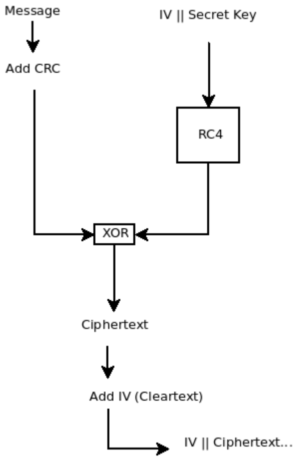

Figure: WEP encryption process

Wi-Fi Protected Access (WPA)

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- 802.11i - Robust Security Network
- RSN services
    - Authentication
    - Access Control
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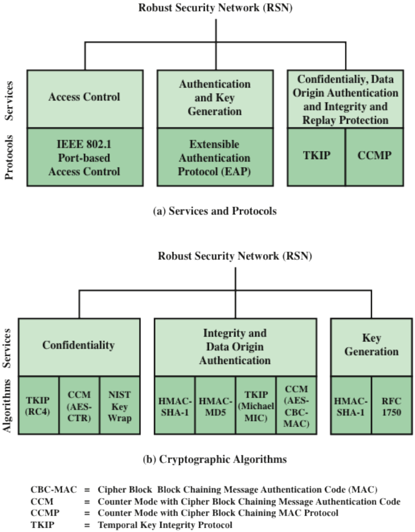

Robust Security Network (RSN)

Services: Access Control; Authentication and Key Generation; Confidentialiy, Data Origin Authentication and Integrity and Replay Protection

Protocols: IEEE 802.1 Port-based Access Control; Extensible Authentication Protocol (EAP); TKIP; CCMP

(a) Services and Protocols

Robust Security Network (RSN)

Services: Confidentiality; Integrity and Data Origin Authentication; Key Generation

Algorithms: TKIP (RC4); CCM (AES-CTR); NIST Key Wrap; HMAC-SHA-1; HMAC-MD5; TKIP (Michael MIC); CCM (AES-CBC-MAC); HMAC-SHA-1; RFC 1750

(b) Cryptographic Algorithms

CBC-MAC = Cipher Block Block Chaining Message Authentication Code (MAC)
CCM = Counter Mode with Cipher Block Chaining Message Authentication Code
CCMP = Counter Mode with Cipher Block Chaining MAC Protocol
TKIP = Temporal Key Integrity Protocol

Figure: Elements of 802.11i [1]

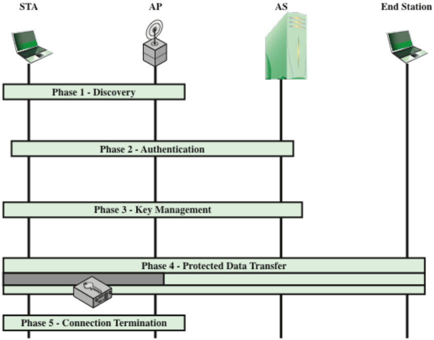

Figure: 802.11i Phases of operation [1]

802.11i - Discovery/Authentication phase
Wireless LAN Security

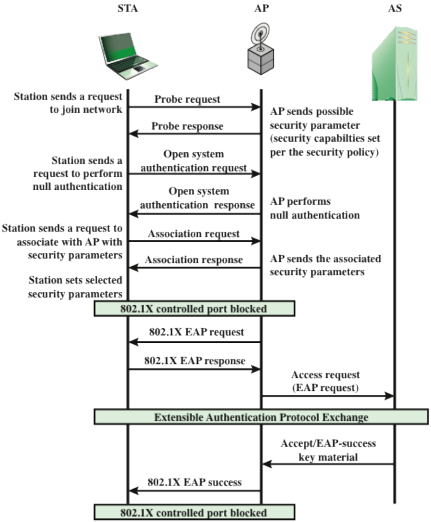
STA
AP
AS
Station sends a request to join network
Probe request
Probe response
AP sends possible security parameter (security capabilties set per the security policy)
Station sends a request to perform null authentication
Open system authentication request
Open system authentication response
AP performs null authentication
Station sends a request to associate with AP with security parameters
Association request
Association response
AP sends the associated security parameters
Station sets selected security parameters
802.1X controlled port blocked
802.1X EAP request
802.1X EAP response
Access request (EAP request)
Extensible Authentication Protocol Exchange
Accept/EAP-success key material
802.1X EAP success
802.1X controlled port blocked

Figure: Discovery, authentication and association [1]

802.11i - Key Hierarchies

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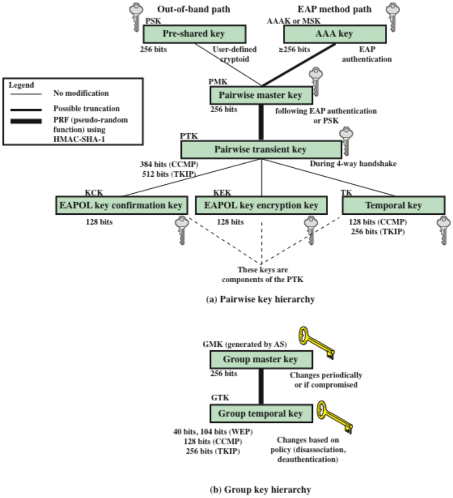


(a) Pairwise key hierarchy

(b) Group key hierarchy

Figure: Key Hierarchies [1]

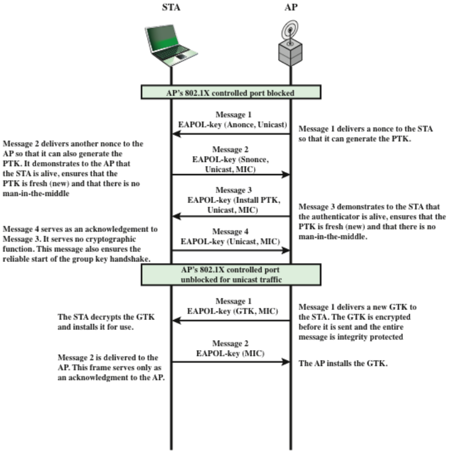
Keys used in Wi-Fi Protected Access

- Pairwise Keys
  - Used for communication between a pair of devices.
- Pre-Shared Key
  - A secret key installed outside the scope of 802.11i
- Master Session Key
  - Master key generated using IEEE 802.1x EAPOL
- Pairwise Master Key
  - Derived from MSK or PSK
- Pairwise Transient Key
  - Consists of three keys:
  - Key Confirmation Key (KCK)
  - Key Encryption Key (KEK)
  - Temporal Key (TK)

- Used for multicast communication
- Two keys are used
  - Group Master Key - Used to generate Group Temporal Key
  - Group Temporal Key - Used to encrypt the MPDUs
  - Changed every time a devices leaves the group.

IEEE 802.11i Four-way Handshake

Wireless LAN Security


STA
AP
AP's 802.1X controlled port blocked
Message 1
EAPOL-key (Anonce, Unicast)
Message 2
EAPOL-key (Snonce, Unicast, MIC)
Message 3
EAPOL-key (Install PTK, Unicast, MIC)
Message 4
EAPOL-key (Unicast, MIC)
AP's 802.1X controlled port unblocked for unicast traffic
Message 1
EAPOL-key (GTK, MIC)
Message 2
EAPOL-key (MIC)

Message 1 delivers a nonce to the STA so that it can generate the PTK.

Message 2 delivers another nonce to the AP so that it can also generate the PTK. It demonstrates to the AP that the STA is alive, ensures that the PTK is fresh (new) and that there is no man-in-the-middle

Message 3 demonstrates to the STA that the authenticator is alive, ensures that the PTK is fresh (new) and that there is no man-in-the-middle.

Message 4 serves as an acknowledgement to Message 3. It serves no cryptographic function. This message also ensures the reliable start of the group key handshake.

Message 1 delivers a new GTK to the STA. The GTK is encrypted before it is sent and the entire message is integrity protected

The STA decrypts the GTK and installs it for use.

Message 2 is delivered to the AP. This frame serves only as an acknowledgment to the AP.

The AP installs the GTK.

Figure: Four-way handshake and Group Key Handshake [1]

- TKIP (Temporal Key Integrity Protocol)
  - Software backward compatible with WEP devices
  - Message integrity using a MAC (Michael)
  - Encrypts data using RC4.
- CCMP (Counter Mode-CBC MAC Protocol)
  - Use CBC-MAC for message integrity
  - Encrypts data using AES-CTR.

IEEE 802.11i PRF

- Used for amongst other things generating nonces.
- Built on the HMAC-SHA1 hash algorithm.

IEEE 802.11i PRF

Wireless LAN Security

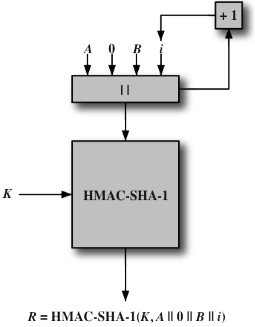


Figure 7.11 IEEE 802.11i Pseudorandom Function

Figure: IEEE 802.11i PRF [1]

Referenser

[1] William Stallings. *Network security essentials : applications and standards*. 5th ed. International Edition. Pearson Education, 2013. ISBN: 978-0-273-79336-6.