

Q1 Networking: New Phone Who This (6 points)

EvanBot joins a new **broadcast** local network with many users. CodaBot is on the local network, but EvanBot doesn't know CodaBot's phone number. EvanBot wants to learn CodaBot's phone number, using the following protocol:

1. EvanBot broadcasts a request asking what CodaBot's phone number is.
2. CodaBot sends a response to EvanBot with their phone number.
3. EvanBot caches the phone number.

Q1.1 (1 point) Which networking protocol is this most similar to?

- ARP WPA2 BGP TCP

Q1.2 (2 points) Eve is an on-path attacker in the local network. Select all attacks that Eve can carry out.

- Perform an online brute-force attack to learn CodaBot's phone number, by sending back every possible phone number to EvanBot.
- Learn CodaBot's phone number by reading message(s) Eve was not supposed to read.
- Learn CodaBot's phone number without reading message(s) Eve was not supposed to read.
- Convince EvanBot that CodaBot's phone number is some malicious value chosen by Eve.
- None of the above

In the next three subparts, consider this modification to the protocol: Instead of sending just the phone number, CodaBot sends their public key, and a signature on their phone number.

When EvanBot receives this data, EvanBot uses the public key to verify the signature on the phone number.

Eve wants to trick EvanBot into thinking CodaBot's phone number is a malicious value chosen by Eve. What values does Eve include in the packet she sends to EvanBot?

Q1.3 (1 point) For the public key, Eve sends:

- Eve's public key EvanBot's public key
- CodaBot's public key The router's public key

Q1.4 (1 point) For the signature over the phone number, Eve signs using:

- Eve's private key EvanBot's private key
- CodaBot's private key The router's private key

Q1.5 (1 point) How often will this attack succeed?

- 100% of the time Only when CodaBot's packet arrives first
- Only when Eve's packet arrives first Never

Q2.2 (5 points) The client and AP perform the WPA 4-way handshake with the following modifications:

- $PTK = F(\text{ANonce}, \text{SNonce}, \text{AMAC}, \text{SMAC})$, where F is a secure key derivation function
- $MIC = \text{HMAC}(PTK, \text{Dialogue})$
- An on-path attacker that observes a successful handshake can decrypt subsequent WPA messages without learning the value of the PSK.
- An on-path attacker that observes a successful handshake can trick the AP into completing a new handshake without learning the value of the PSK.
- An on-path attacker that observes a successful handshake can learn the PSK without brute force.
- A rogue AP attacker can learn the PSK without brute force.
- A rogue AP attacker can only learn the PSK if they use brute force.
- None of the above

Q2.3 (5 points) The client and AP perform the WPA 4-way handshake with the following modifications:

- Authentication: Client sends $H(\text{PSK})$ to AP, where H is a secure cryptographic hash.
- Verification: AP compares $H(\text{PSK})$ and to the value it received.
- AP sends: $\text{Enc}(\text{PSK}, \text{PTK})$ to client, where Enc is an IND-CPA secure encryption algorithm.
- An on-path attacker that observes a successful handshake can decrypt subsequent WPA messages without learning the value of the PSK.
- An on-path attacker that observes a successful handshake can trick the AP into completing a new handshake without learning the value of the PSK.
- An on-path attacker that observes a successful handshake can learn the PSK without brute force.
- A rogue AP attacker can learn the PSK without brute force.
- A rogue AP attacker can only learn the PSK if they use brute force.
- None of the above

Q2.4 (5 points) The client and AP perform the WPA 4-way handshake with the following modifications:

- Authentication: Client conducts a Diffie-Hellman exchange with the AP to derive a shared key K .
 - Client sends: $\text{Enc}(K, \text{PSK})$ to the AP.
 - Verification: Check if $\text{Dec}(K, \text{Ciphertext})$ equals the PSK
 - Upon verification, AP sends: $\text{Enc}(K, \text{PTK})$, where PTK is a random value, and sends it to the client.
 - Assume that Enc is an IND-CPA secure encryption algorithm.
- An on-path attacker that observes a successful handshake can decrypt subsequent WPA messages without learning the value of the PSK.
 - An on-path attacker that observes a successful handshake can trick the AP into completing a new handshake without learning the value of the PSK.
 - An on-path attacker that observes a successful handshake can learn the PSK without brute force.
 - A rogue AP attacker can learn the PSK without brute force.
 - A rogue AP attacker can only learn the PSK if they use offline brute force.
 - None of the above