CSCI-3403: Cyber Security
Spring 2020

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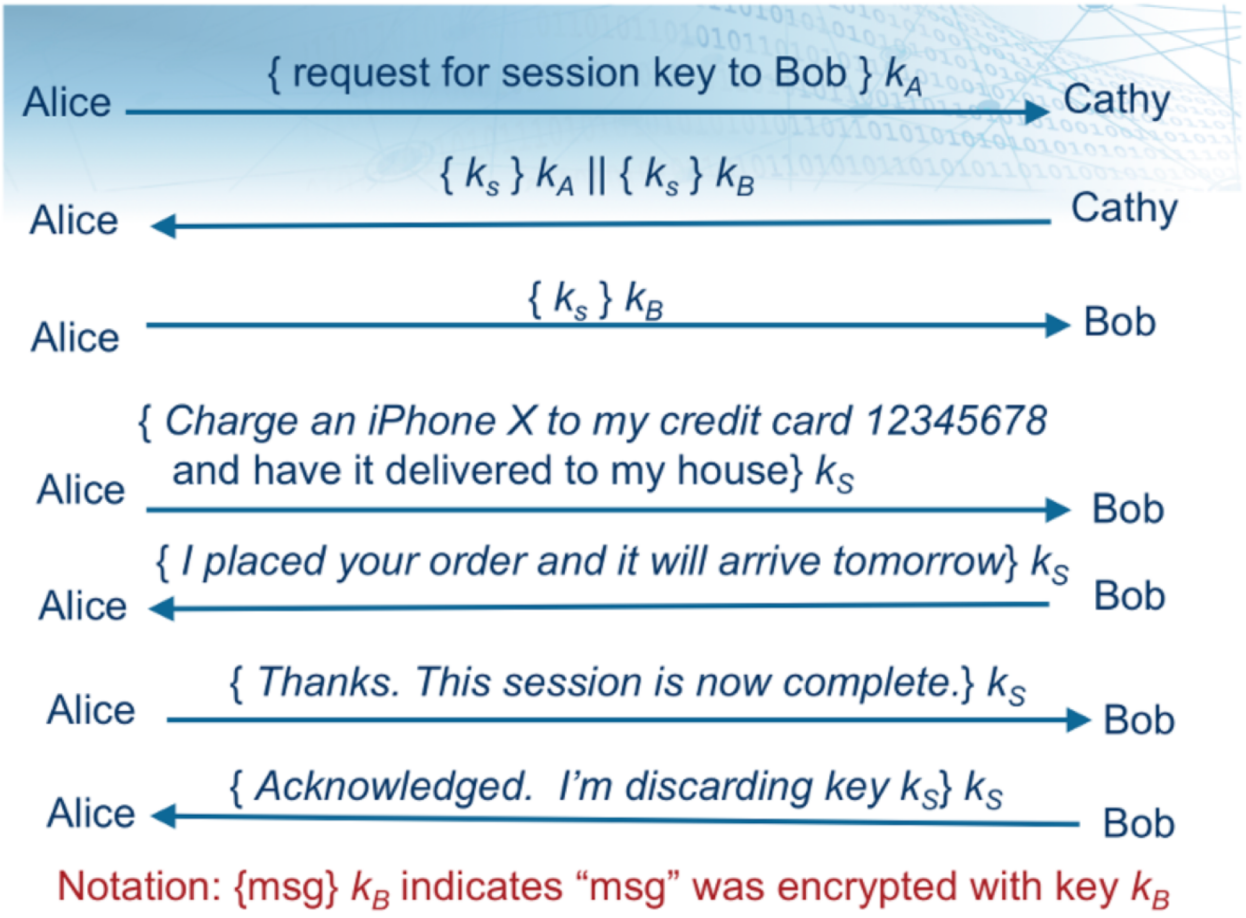
Week 5

> Replay Attacks

> Salting

> Project 2

Case 1


Alice
{ request for session key to Bob } k_A
Cathy
{ k_s } k_A || { k_s } k_B
Alice
Cathy
{ k_s } k_B
Alice
Bob
{ Charge an iPhone X to my credit card 12345678
Alice
and have it delivered to my house} k_S
Bob
{ I placed your order and it will arrive tomorrow} k_S
Alice
Bob
Alice
{ Thanks. This session is now complete.} k_S
Bob
{ Acknowledged. I'm discarding key k_S} k_S
Alice
Bob
Notation: {msg} k_B indicates "msg" was encrypted with key k_B

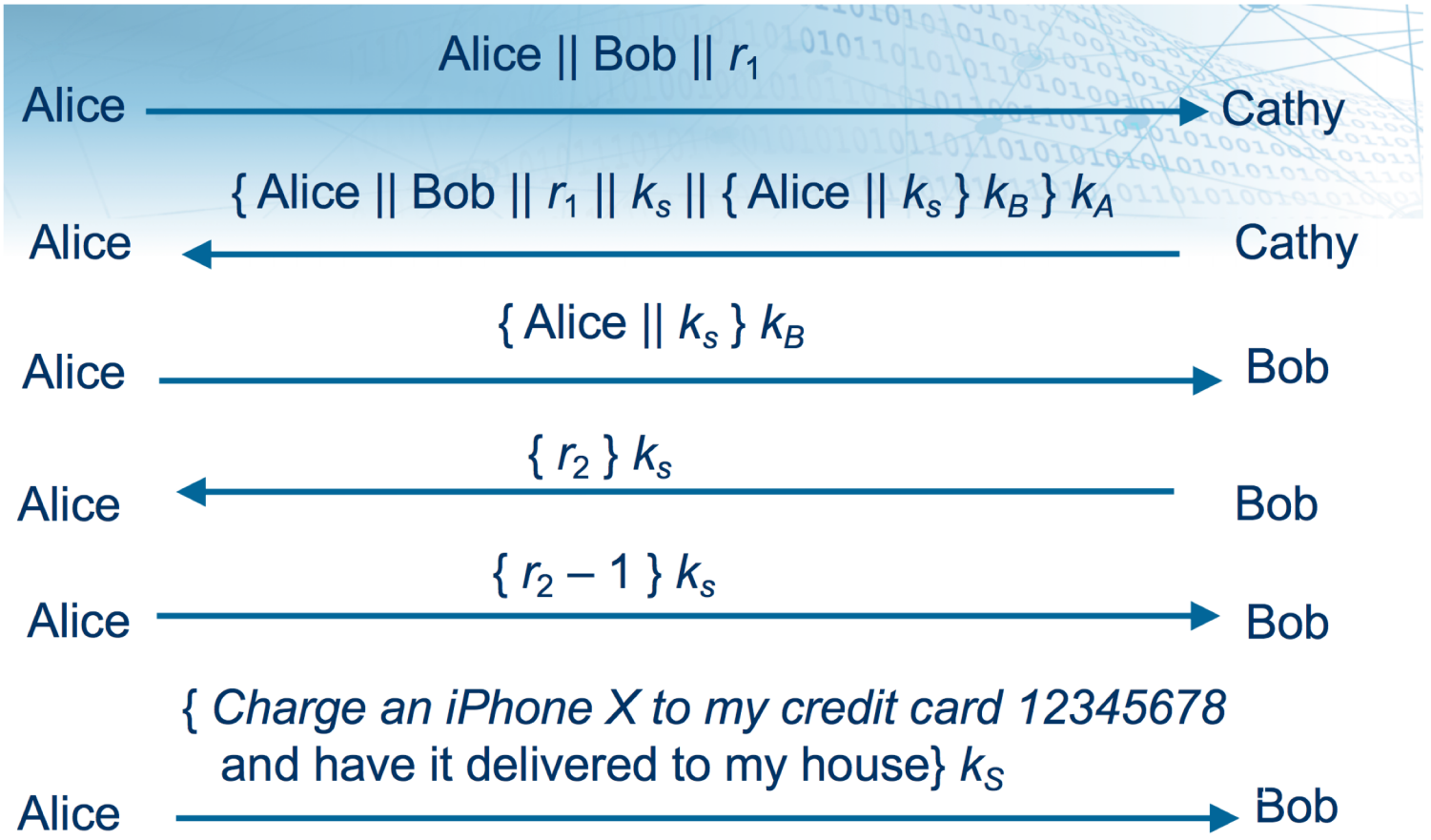
Quiz 1

In a replay attack, the adversary must necessarily know how to decrypt the message?

- ○ True
- ○ False

Can Eve launch a successful replay attack? As part of the replay attack, will Eve learn Alice's credit card number

Case 2: Needham Schroeder Protocol



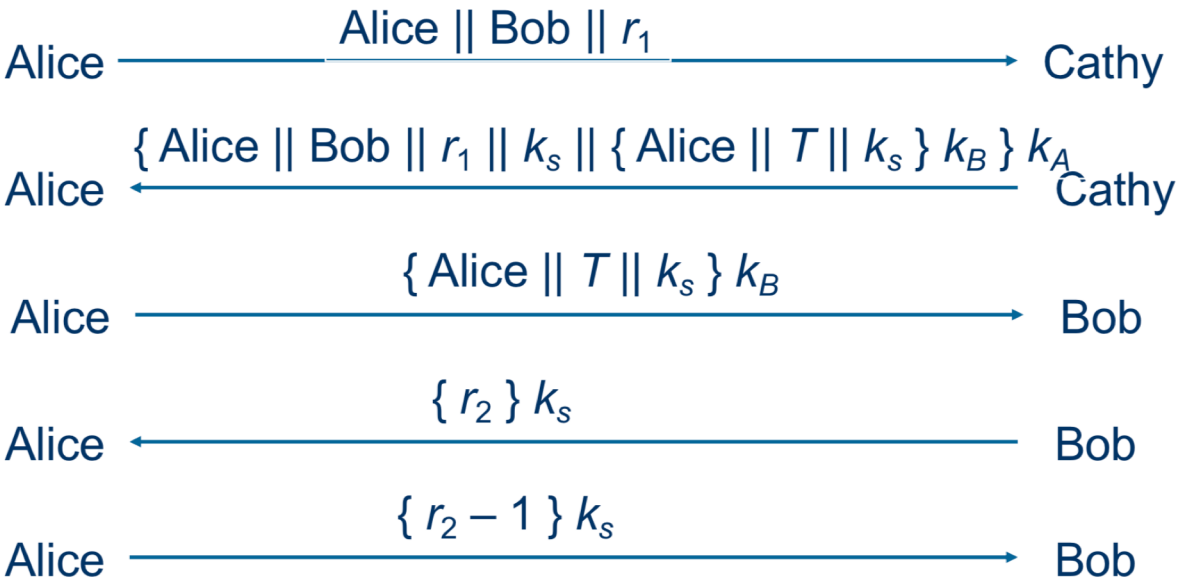
Quiz 2

Alice instead uses the key exchange shown prior, can Eve launch a successful replay attack?

If Alice uses the key exchange shown in Slide 2 and Eve has obtained session key Ks, can Eve launch a successful replay attack?

Case 3

Needham-Schroeder with Denning-Sacco Modification



Quiz 2

If Alice uses the key exchange shown in Slide 3 and Eve has obtained session key Ks, can Eve launch a successful replay attack?

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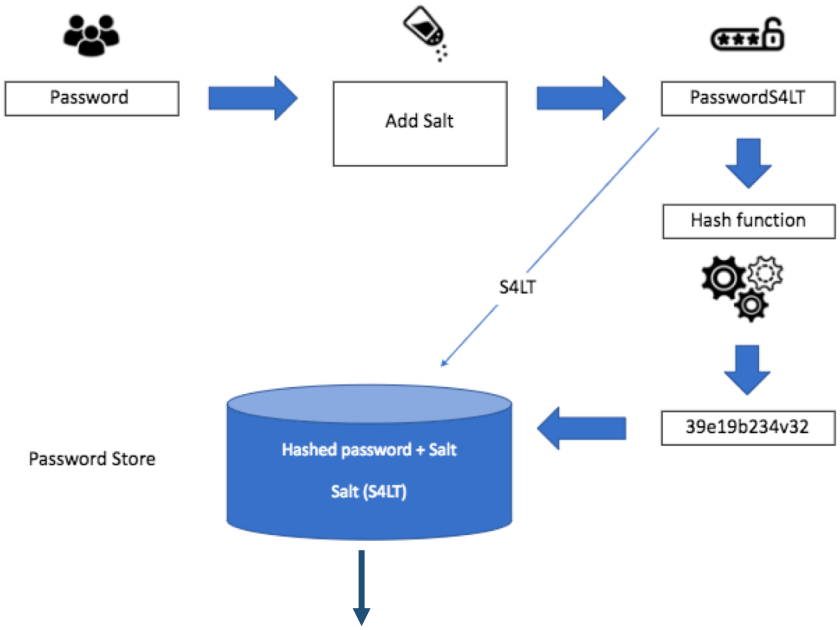
Salted Password Scheme



User ID	Salt (12 Random bits)	Encrypted Password
Alice	01101000111	H(salt || password)
Bobs	01110111001	H(salt || password)

Effect of Salts

				
Password	`p4s5w3rdz`	`p4s5w3rdz`	`p4s5w3rdz`	`p4s5w3rdz`
Salt	`-`	`-`	`et52ed`	`ye5sf8`
Hash	`f4c31aa`	`f4c31aa`	`lvn49sa`	`z32i6t0`

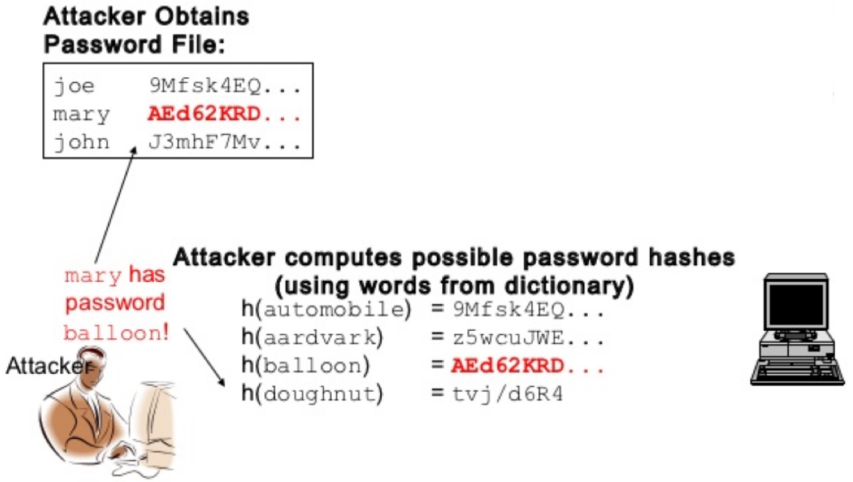
Online vs Offline Attacks

Online Attacks

- Trying a large number of password combinations on the login portal in the hope of getting the right password.
- Limited by speed of the network
- Limited by account lockouts

Offline Dictionary attacks

- A dictionary attack is based on trying all the strings in a pre-arranged listing, typically derived from a list of words such as in a dictionary



Quiz 1

How much harder does the addition of a salt make it for an attacker who compromises the password file to learn Alice's password?

Assume: salt = 12 bits long, # people $> 2^{12}$

- Not much
- Twice as hard
- 2^{12} times as hard

Quiz 1

How much harder does the addition of a salt make it for an attacker who compromises the password file to learn Alice's password?

- Not much
- Twice as hard
- 2^{12} times as hard

Quiz 2

How much harder does the addition of a salt (12 random bits) make it for an attacker to carry out an offline dictionary attack?

- Not much
- Twice as hard
- 2^{12} times as hard

Quiz 2

How much harder does the addition of a salt make it for an attacker to carry out an offline dictionary attack?

- Not much
- Twice as hard
- 2^{12} times as hard

Salting – Good News!

- Dictionary attack against an arbitrary user is harder
  - **Before salts:** Hash word and compare it with password file
  - **After salts:** Hash words and combos of possible salts
- N word dictionary, k bit salts
  - Attacker must hash $n * 2^k$ strings vs n strings (no salt)

- Offline Dictionary attack foiled!

```
h(automobile2975) = KNVXKOHBDEBKOURX
h(automobile1487) = ZNBXLPOEWNVDEJOG
h(automobile2764) = ZMCXOSJNFKOFJHKDF
h(automobile4012) = DJKOINSLOKDKOLJUS
h(automobile3912) = CNVIUDONSOUIEPQN
...Etc...
h(aardvark2975)   = DKOUOXKOUDJWOIQ
h(aardvark1487)   = PODNJUIHDJSHYEJNU
...Etc...
```

```
/etc/passwd:
john   LPINSFRABXJYWONF    2975
mary   DOIIDBQBZIDRWNKG    1487
joe    LDHNSUNELDUALKDY    2764
```

Too many combinations!!! Attack is Foiled!

Salting – Bad News!

- Ineffective against chosen victim attack
  - Attacker wants to compromise particular account
  - Just hash dictionary words with the victim's salt
- Attacker's job becomes harder, not impossible
  - Easy for attacker to compute $2^k * n$ hashes?
  - Then offline dictionary attack is still a threat

Week 5

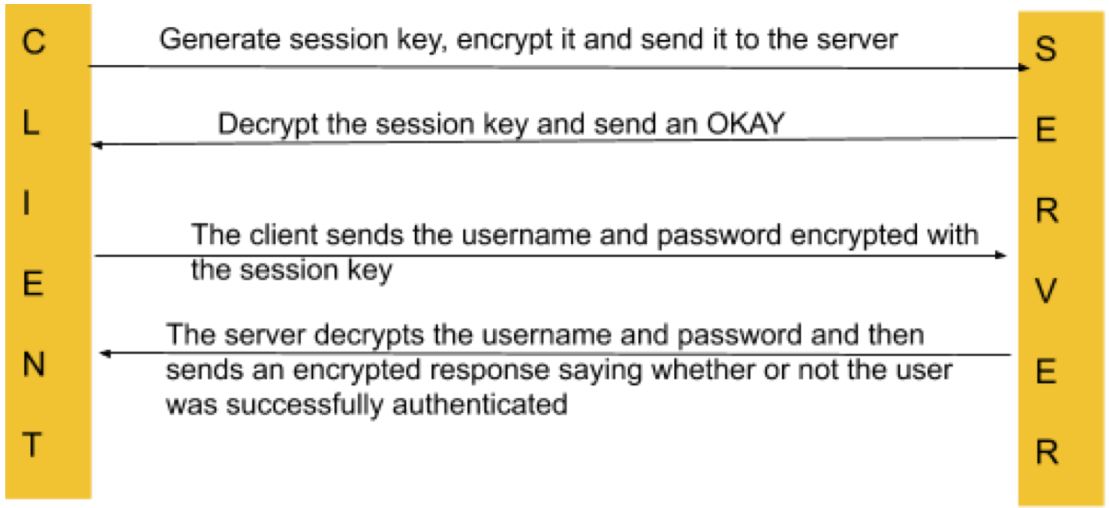
> Replay Attacks

> Salting

> **Project 2**

Project

- **Goal:** Learn how almost everything **secure** on the internet works, including HTTPS and SSH
- The communication should be guaranteed to be **confidential** and it should have complete **integrity**



Session keys

- The session key should not be guessable
- What is a good source of a "random" session key?

  `/dev/urandom`

- How do you access /dev/urandom

  Hint: See python's os module

Session Keys

Can we send this session key out in the open?

Of course not!

How can we make sure that nobody other than the server can read this session key?

Public Key Encryption!

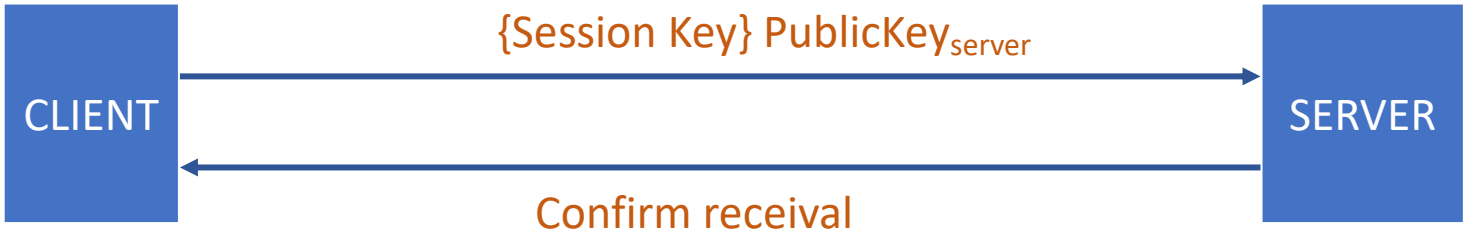
Generating Public – Private Key Pairs

Whose public key should we use to encrypt the message?

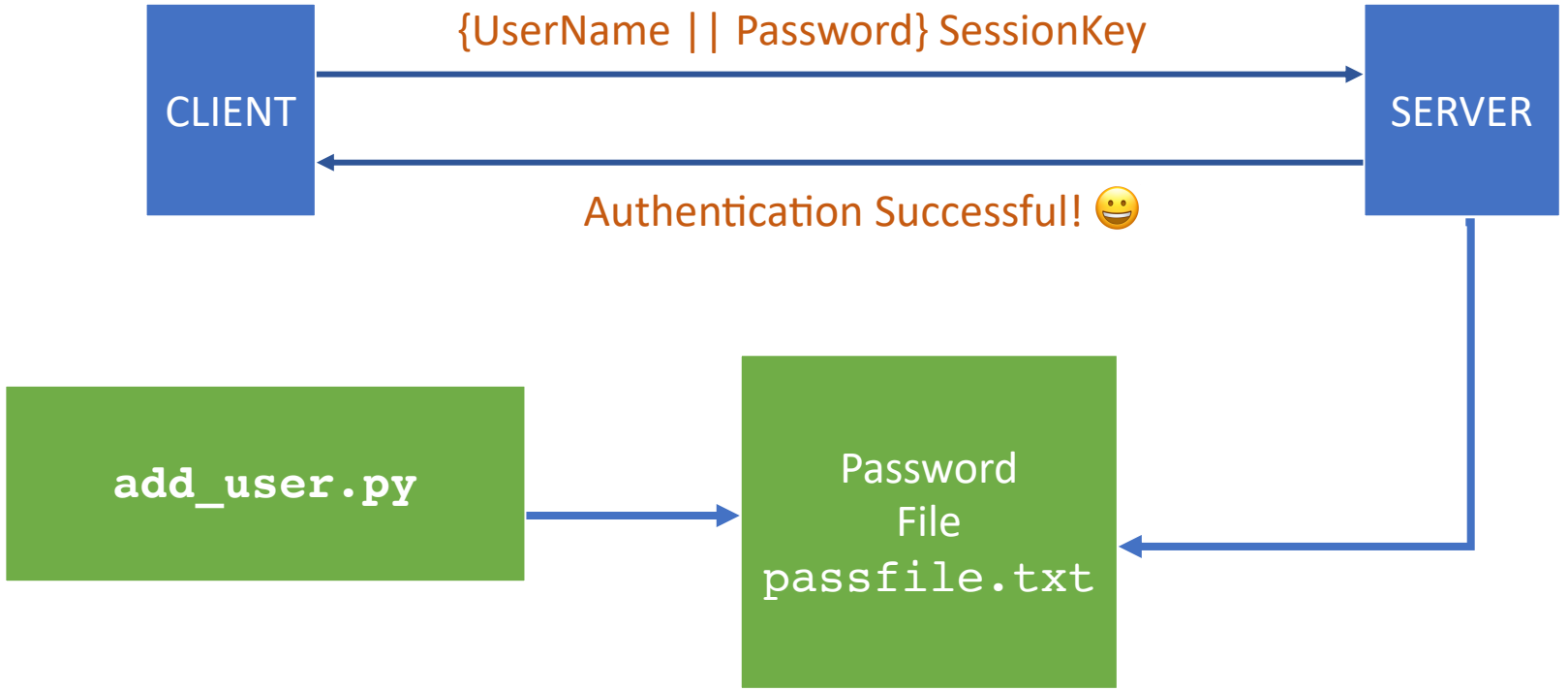
- **Server's!**

How to generate public key private key pairs?

- **`ssh-keygen`**

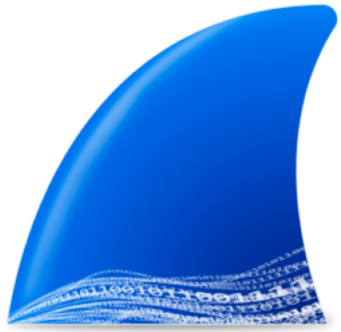


Send Username Password



Verify your message is encrypted

WIRESHARK



Mid Term FCQs

Your feedback is important!!!

Please and Thank you!