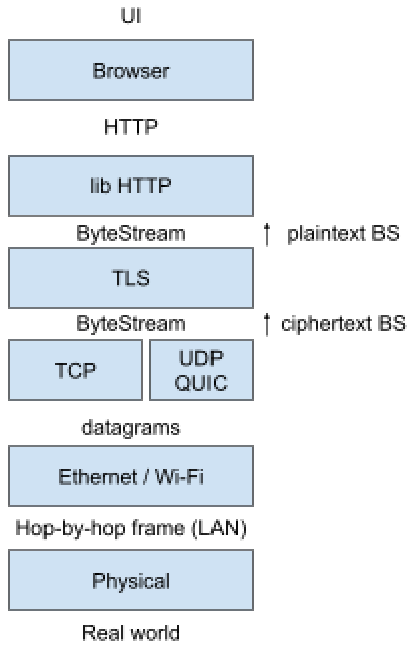
Today: Security



- Before discussing the system property, a common understanding of the thread model is necessary.

Threat Model	Mitigations / Techniques	System Property
Accidental corruption	- IP header checksum - TCP/UDP has header + payload checksum - Ethernet has header + payload FCS	**Integrity** - data received = data sent
Adversarial modification (Modify dst address / payload and modify the checksum)	- Secure hash with agreed hash value - Message Authentication Code	
Replay	Idempotence of messages	
	- AEAD - AKE	**Confidentiality** - only intended recipients can see the message
		Authenticity - parties are who the say they are

Cryptography Tools

- Secure hash algorithm: `hash:` X: arbitrary-length -> Y: 256 bits
  - `hash` is a one-way function. In other words, given `y`, it's hard to find the `x` such that `hash(x)=y`.

    - If two parties agree on the `y` before-hands, then the receiving party can verify whether the `x` is not corrupted by calculating `hash(x)`.
    - (But if someone corrupt the message for sending `y`, and change it to `y′`, which it get from `x′` such that `hash(x′) = y′`, this may still be insecure, so that the process of sending `y` needs to be done in a 100% secure way: e.g. hand a physical piece of paper in person. And this needs to happen for every `x`).
- Trust On First Use (TOFU)
- Message Authentication Code (keyed hash)
    - `mac(x, key) -> tag`
    - `verify(x, tag, key) -> bool`
    - The adversarial party cannot generate a `tag` that passes the `verify` without knowing the `key`.
    - The key still needs to be sent in a secure way, but this only needs to be done once.
- Authenticated Encryption (AE(AD))
    - `box(plain text, key) -> (cipher text, tag)`
    - `unbox(cipher text, tag, key) -> optional<plain text>`
    - It’s hard to generate a pair of `(cipher text, tag)` to pass the `unbox` function, and it’s hard to `unbox` a cipher text without knowing the `key`.
    - But still , we have the pain of how to establish a shared secret.
- Public-key Cryptography / Authenticated Key Exchange (AKE)
    - Alice: (public key_1, private key_1)   and
      Bob: (public key_2, private key_2)
    - So Alice know public_1, private_1 and public_2
    - Bob know public_2, private_2 and public_1
    - Alice sends some x_1 to Bob
    - Bob sends some x_2 to Alice
    - Adversarial parties can observe public_1, public_2, x_1, x_2
    - And, we have: AKE(x_1, x_2, private_1, public_2) = AKE(x_1, x_2, private_2, public_1) = *key* and this *key* is only known by Alice and Bob.