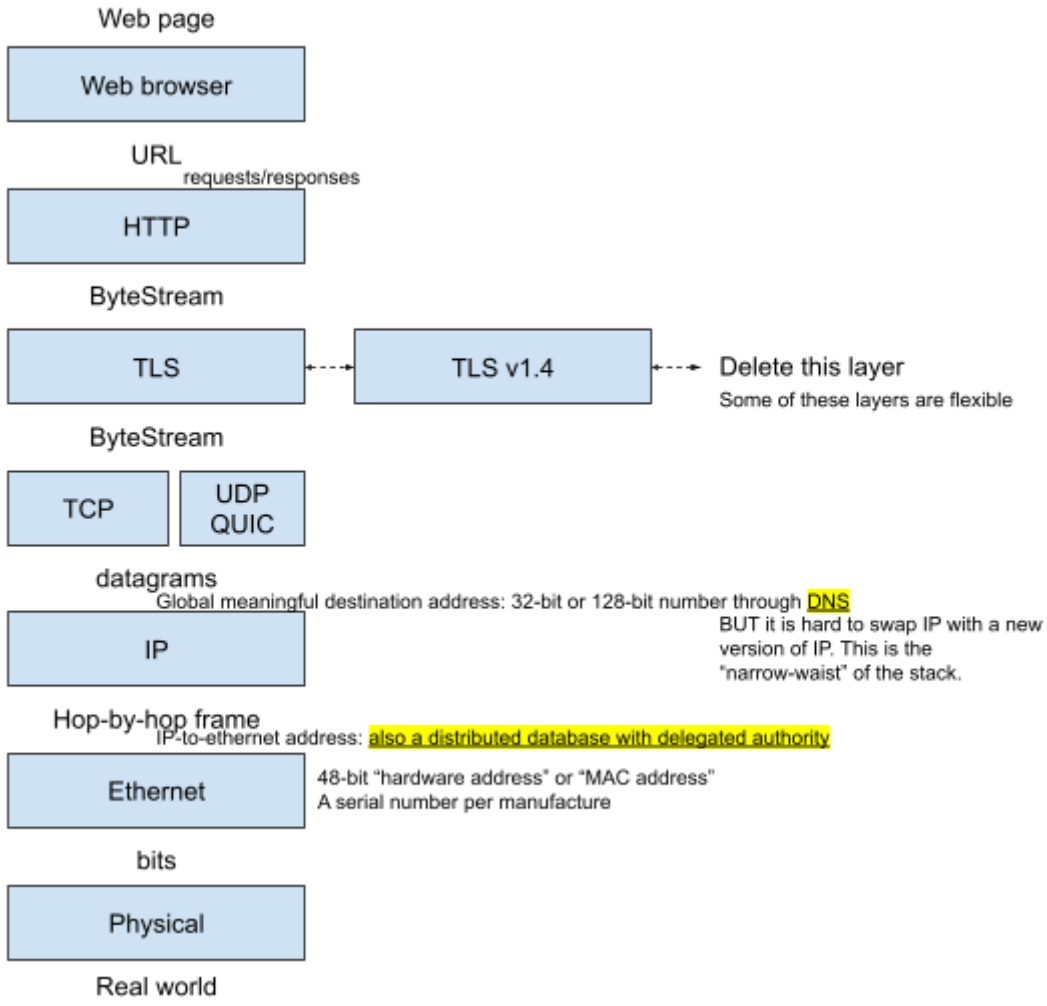
- “OSI model” (4/5/7 layers)



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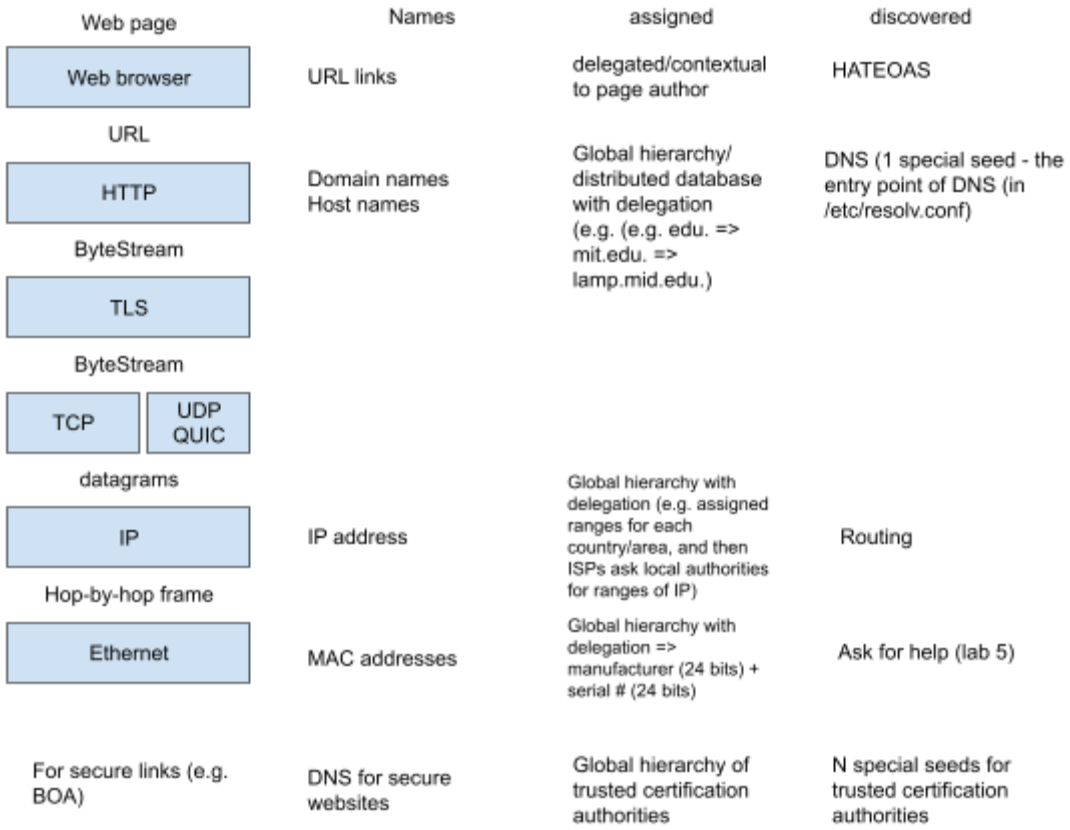
- Last Time: How naming works? (How names are assigned and discovered?)



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- Q: Why can't we use MAC address as our IP address?
  A: we need a structured way to delegate the responsibility of "looking for the next hop given the IP address". Using IP addresses make this easier, since each hop can only care about the prefix of IP addresses in the local routing table. However, if we are using unstructured addresses such as hardware addresses, the routing table would each of size the number of total hardware addresses.
- From "bits" to real world:
  - Bits are 0s and 1s: 10110110. How to translate that to analog.
  - One proposal: "1" -> high voltage/signal; "0" -> low voltage/signal
    - The signal may be: low, high for a while, low for a while
    - Then it's hard to tell from the signal how many 0s and 1s there are without knowing how long each 0 and 1 lasts.
  - Another proposal: preamble - a special sequence before the actual stream to give the clock speed.
    - preamble : 10101010 - high low high low …
    - And then the receiver knows how long each "tick" is
  - But preamble is not enough for clock synchronization. "0" -> downward transition, "1" -> upward transition.
    - For each "clock tick", there must be a transition.
    - Therefore, the clock rate can be calculated by looking at the time interval between two transitions, whether each of them is downward or upward.
- How did we tell what the link rate is?

- Limits:
    - Sender's average power ("loudness"): more power probably means more bits per second
    - Receiver's average noise power: the larger the noise the less bits per second (assumes normal distribution)
    - The band width - the range of frequencies allowed to use: the larger this range is the more can be transmitted
- In the old days: people "believed" there were a tradeoff between link rate and error rate, and this can't be precisely described in a mathematical way:
    - Intuitively, the slower you send, the more power you put into each bits and then the message would be "clearer"
- BUT, there is an equation:
    - $C = W\,log(1 + \frac{P}{N})$
    - (P - average power, N - average noise, W - band width)
    - Single-flow from a sender to a receiver. If you send lower than the capacity C, for whatever error rate, it can be done period.
    - Information theory (1948)