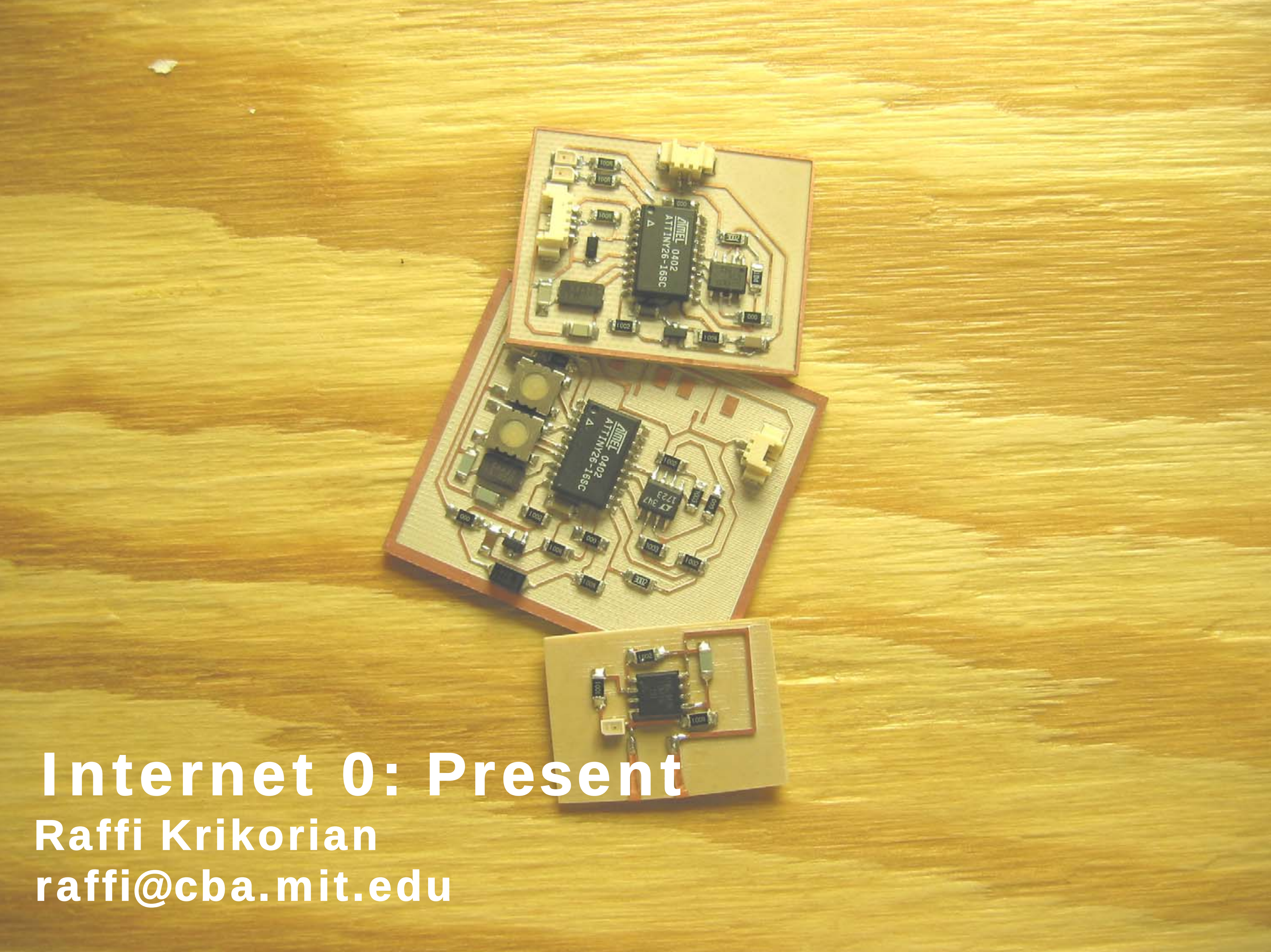

Internet 0: Present

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Romkey's Internet Toaster

What is Internet 0?

1. IP to the leaf node
2. Compiled standards
3. Peers don’t need servers
4. Physical identities
5. Big bits
6. End-to-end modulation
7. Open standards

IP to the leaf node

“The IP stack is hard to implement”

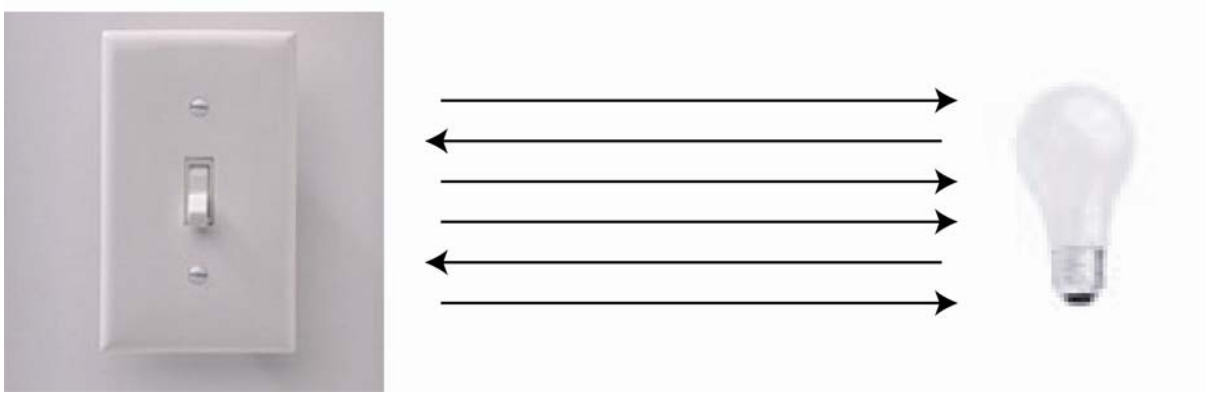
IP to the leaf node

"The IP stack is hard to implement"

- Trivial at the end-nodes
- 20 bytes prepended to data

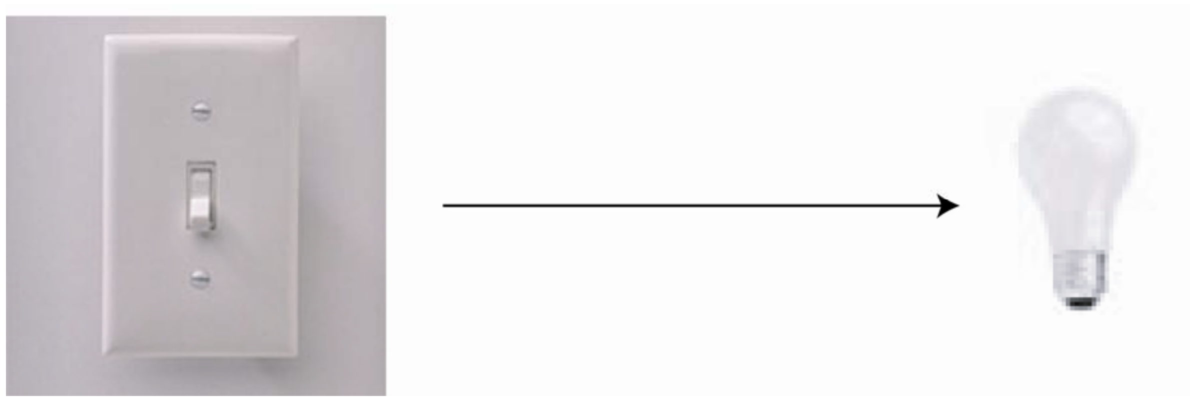
```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Version|  IHL  |Type of Service|          Total Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Identification        |Flags|      Fragment Offset    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Time to Live |    Protocol   |         Header Checksum       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Source Address                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Destination Address                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Options                    |    Padding    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

TCP (RFC 793) to the leaf node



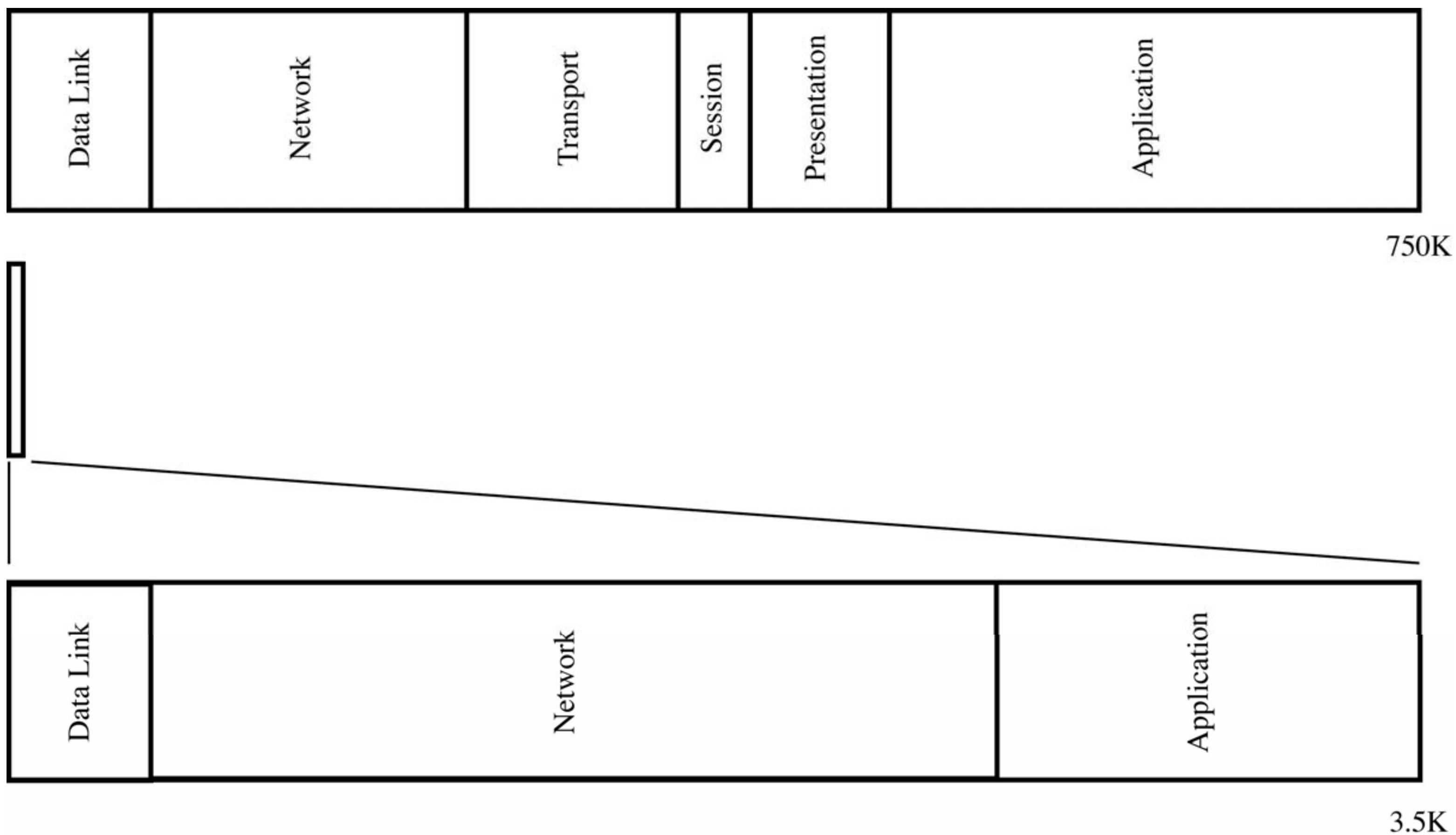
- Reliable but really complicated
- 5 – 6 packets to turn the light on
- State needed on both sides
- Can use TCP sockets, HTTP, web services, etc.

UDP (RFC 768) to the leaf node

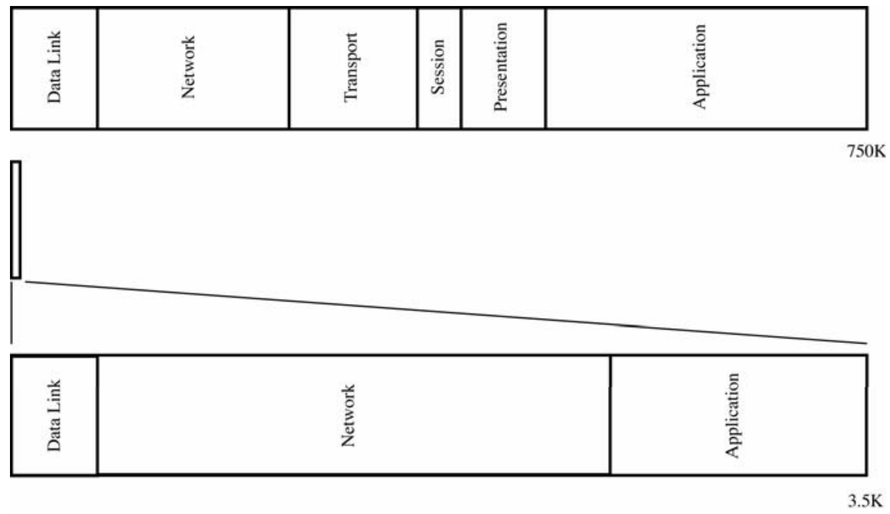


- Really really simple (8 more bytes)
- 1 packet
- Tiny Hypertext Transfer Protocol (tHTTP)
  - All the lessons of HTTP, but over UDP for very small and simple web requests

Compiled standards

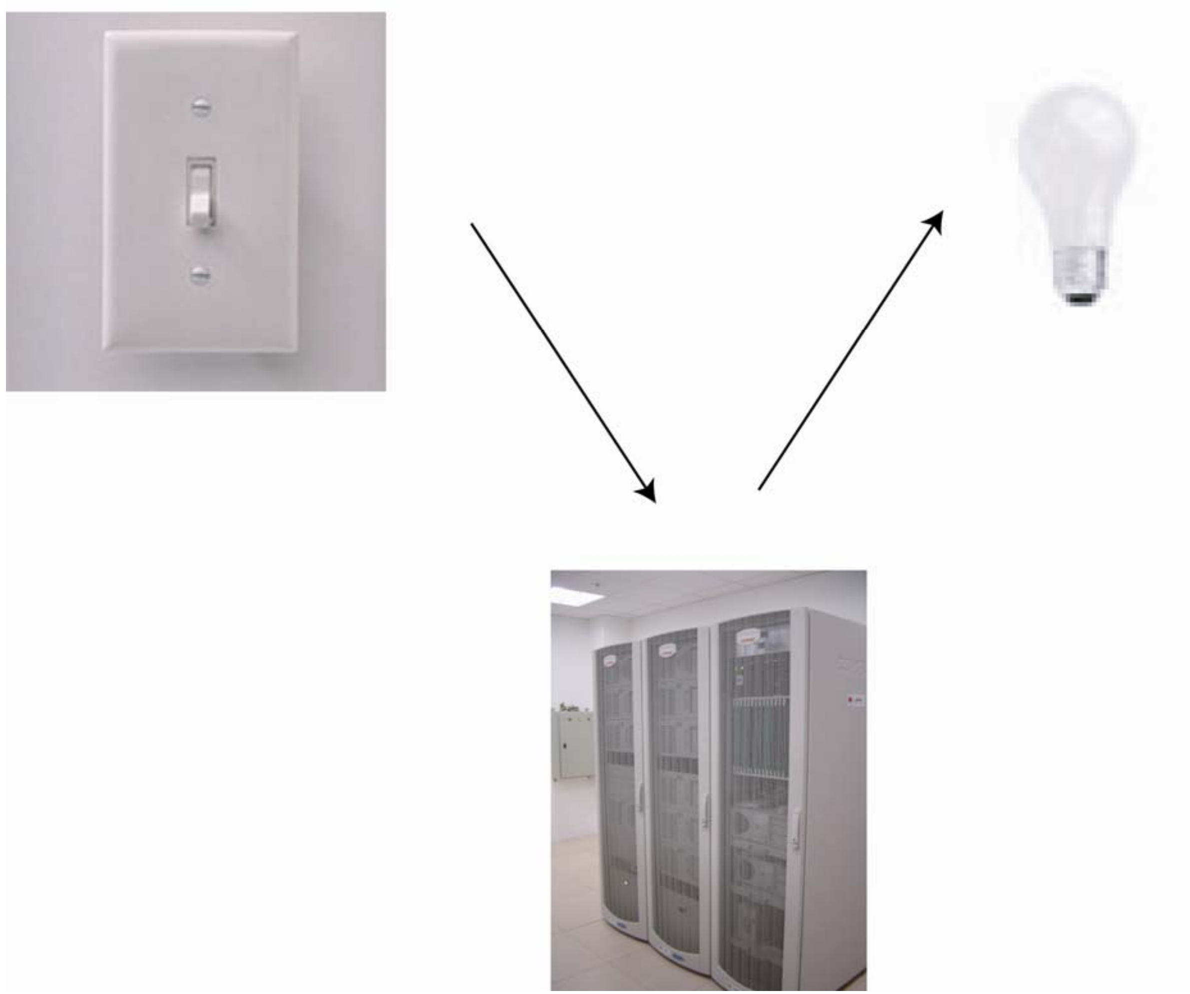


Compiled standards

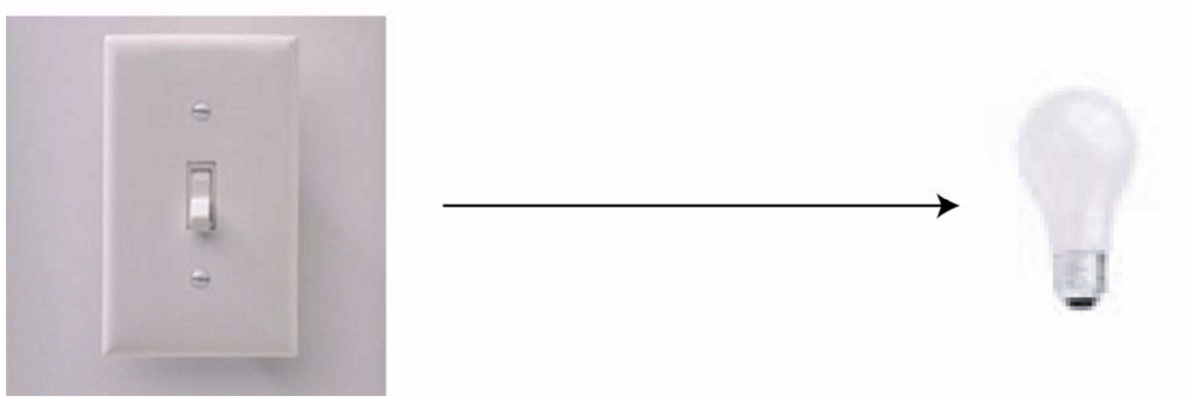


- Remove sections of the stack that are unused
- Use cross-talk to your advantage
  - “Out of layer” knowledge can help the software be more efficient

Peers don't need servers



Peers don’t need servers



- Each object owns its own data structures and threads of execution
- Failures in the network are localized
- Servers can bring higher level functionality

Physical Identity

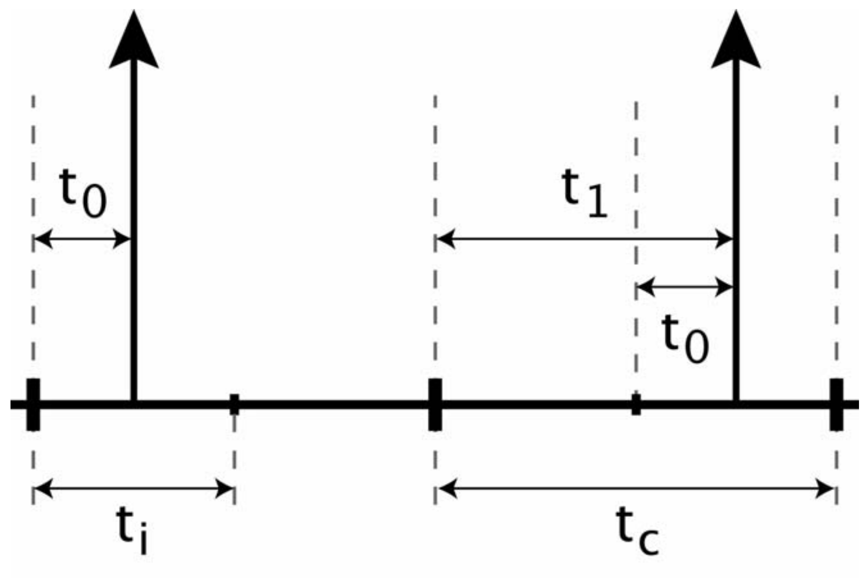
- IP addresses are not suitable for identification
  - 1 in 100,000 chance of a collision of names between NATs
- MAC addresses are unique
  - Serialized by the IEEE
  - Price cost to obtain a block of MAC addresses is prohibitively high when only creating a few devices

Physical Identity

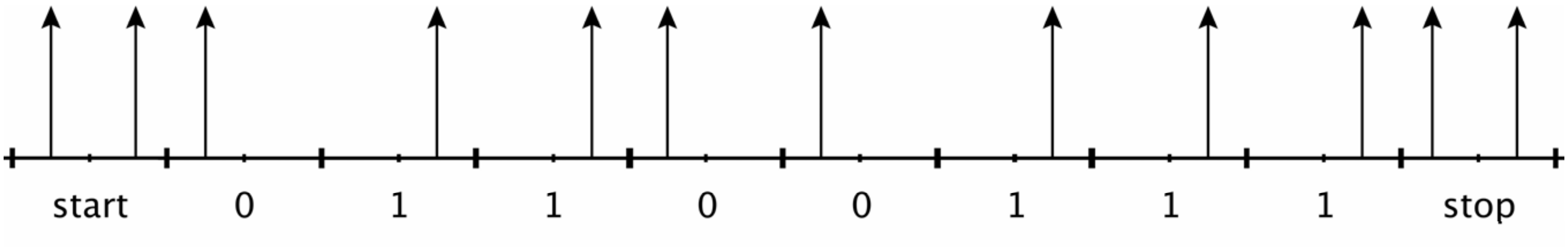
- Rely on randomness
- Zero-configuration for IP address allocation
  - Choose a random IP address from a given subnet and confirm that it is not taken
- Random 128-bit string for hardware address
  - Collision is approximately 1 in 10^{38}

End-to-end modulation (and big bits)

- Slow Manchester encoding with time-domain impulses
- Take a click window, subdivide it, and send the click exactly in the center of the appropriate half
  - – First half for a 0
  - – Second half for a 1
- Medium agnostic

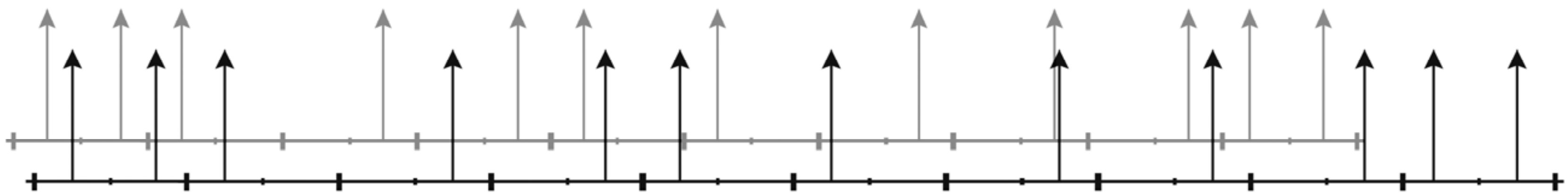


End-to-end modulation



- String bits together serially
  - 1 start bit, 8 data bits (LSB), 1 stop bit, no parity
- Sequence is self-clocking and self-consistent

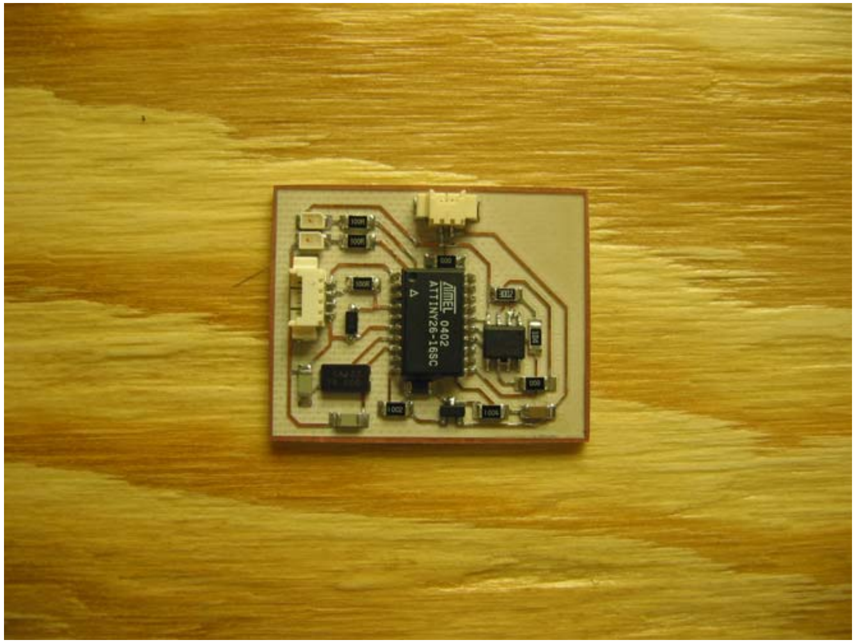
End-to-end modulation



- Multiple transmitters can share the channel
  - Blindly transmit as the receiver can separate by creating a decision tree
- For better noise rejection, transmitter can use a spreading code to carefully place the beginning of each byte

Current State

- Atmel Tiny AVR series microcontrollers
  - ATTiny26 and ATTiny15
- tHTTP stack (IP/UDP/tHTTP) + I/0 click decoding in 4.5K of compiled code
- Analog front-end for click processing



How can Internet 0 be used?

- Programmable infrastructure
- Barcodes
- IPID

I/0 Barcodes

- Each vertical line is a "click"
- A photoreflector can read those lines, condition the signal, and then insert it into the I/0 network
- Signal gets routed and decoded at the endpoint

IPID

- RFID technology
- Transmit back I/0 clicks that encode IP packets
- Stateless tag reader
  – Has to power up the tag
  – Condition the signal that is transmitted by the tag
  – Insert the clicks onto the network
  – Clicks are processed by the destination end-point