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
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

Data Link  Network  Transport  Session  Presentation  Application

750K

Data Link  Network  Application

3.5K
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/O 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/O Barcodes

• Each vertical line is a “click”
• A photoreflector can read those lines, condition the signal, and then insert it into the I/O network
• Signal gets routed and decoded at the endpoint
**IPID**

- RFID technology
- Transmit back I/O 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 endpoint