

Bits and Atoms

- How do send a letter? A phone call? A musical recording? An Internet Packet?
 - I want to watch Iron Man tomorrow
 - Netflix, Amazon, Pirate Bay/isohunt,...
 - Shipping bits or atoms? Differences?
- Negroponte's Being Digital
 - *"Worse, a book can go out of print. Digital books never go out of print. They are always there."*

Internet Architecture and Governance

- Break message into packets, send packets
 - Different than traditional phone/circuits
 - What happens to packets in transit?
 - What might happen?
 - Format of packet: see IPv4 v IPv6
- TCP and UDP
 - Transmission Control __ and User Datagram __
 - Reliable, handshaking protocol
 - Less reliable (packets dropped), useful?

IPv4 Header

- What is a packet? What is a packet header?
 - Who puts information into packets?
 - Who gets information out of packets?
- How many bits in source and destination address?

+	Bits 0-3	4-7	8-15	16-18	19-31
0	Version	Header length	Type of Service (now DiffServ and ECN)	Total Length	
32	Identification		Flags	Fragment Offset	
64	Time to Live	Protocol	Header Checksum		
96	Source Address				
128	Destination Address				
160	Options				
160 or 192+	Data				

Who decided on IPv4 packet format?

- IETF: who are they? How do they work?
 - Benefits of this approach? Limitations?
 - Who is really in charge?
- If format changes, what happens
 - Does hardware change?
 - Does software change?



What is IPv6?

- **What is the 6 in IPv6? Is Vint Cerf in on it?**
 - What's needed to deploy the protocol?
 - What incentives are needed to deploy?
 - What disincentives are there?
- **Difference between 32 bits and 128 bits?**
 - $2^{32} = 4,294,967,296$
 - $2^{128} = 340,282,366,920,938,463,463,374,607,431,768,211,456$

IP, CIDR, Youtube

- <http://arstechnica.com/news.ars/post/20080225-insecure-routing-redirects-youtube-to-pakistan.html>
- **Originally Duke got 65,536 IP addresses**
 - Original IP protocol, how many bits?
 - How do you figure this out?
 - Only 24 or 16 or 8 bits originally
- **CIDR (Classless Inter-Domain Routing)**
 - Any power of 2 for range of addresses
 - Youtube advertises: 208.65.152.0/22
 - Pakistan advertises: 208.65.153.0/24

Internet Governance

- **IETF: What do they "govern"?**
 - **Wikipedia rough consensus model?**
 - http://en.wikipedia.org/wiki/Wikipedia:Deletion_guidelines_for_administrators
- Consensus is not determined by counting heads, but by looking at strength of argument, and underlying policy (if any). Arguments that contradict policy, are based on opinion rather than fact, or are logically fallacious, are frequently discounted. For instance, if someone finds the entire page to be a copyright violation, a page is always deleted. If an argument for deletion is that the page lacks sources, but an editor adds the missing references, said argument is no longer relevant.

Other Players in Internet "Governance"

- **Differences between web and internet**
 - Content v Delivery?
 - HTTP: ietf standard
- **ITU and ECMA**
 - Proprietary/private
 - Differences?
- **Javascript**
 - EcmaScript
- **w3c activities**
 - Math, mobile, e-govt
- **Telecommunication**



Open or Proprietary

- **What is an open standard?**
 - Advantages of proprietary standards?
 - Open office compared to Msoft Word?
- **What about iTap compared to T9?**
 - <http://www.t9.com/us/>
- **What do we want for the Internet? Why?**
 - Effects of internationaliation (i18n)

IETF, IANA, ICANN, IGF, ITU

- **What's the I in these organization**
 - Internet or International
 - **IANA: Internet Assigned Numbers Authority**
 - Operated by ICANN
 - Root-zone management ccTLD, gTLD
 - DNS, we'll see openDNS later
 - Role of US Department of Commerce
 - Possible issues here?
- <http://www.icann.org/announcements/european-ralo-mou-en.pdf>

Rough Consensus

- **Does Wikipedia and/or IETF model work?**
 - What does "government" mean?
 - Are companies governed? Countries?
- **Why did the IETF model work originally?**
 - Similarities to Wikipedia? Differences?
- **Future of standards making**
 - Will "real" governments have a role?

Internet tags and labels

- *Multi-stakeholder governance and the IGF, by Malcolm*
- **IETF: meritocracy, technocracy**
 - Hierarchical? Not really
- **ICANN**
 - More hierarchical, nominations, elections
- **NTIA, Department of Commerce**
 - Lets ICANN run part of the Internet?

Background on Bits

- Bit is a “binary” “digit”
 - What’s binary? What’s a digit?
 - It’s all zeros and ones



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BIT: Binary Digit

- Why do humans use base-10 numbers?
- Why do computers use base-2 numbers?

0	0	Zero	
1	1	One	
10	2	two	$1 \times 2^1 + 0 \times 2^0$
11	3	Three	$1 \times 2^1 + 1 \times 2^0$
100	4	Four	$1 \times 2^2 + 0 \times 2^1 + 0 \times 2^0$
10110	22		$1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0$
111111	63		

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Scale and reasoning about bits

- Number of IPv4, 32-bit addresses?
 - How many 33-bit addresses?
- If you use a 32-bit encryption key, and computers can test one billion keys/second
 - # seconds to break with brute force?
 - If we add 1 bit, how many seconds?
 - # seconds for 128-bit encryption key?
- Skype uses 256-bit encryption key!?

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Routers, bits, and scale

- Given 152.3.250.0/24, # bits used?
 - BGP router table examines/stores prefixes
 - Look at/differentiate 2^{24} prefixes quickly?
 - How do you look things up? Computer?
- Routers process lots of packets quickly
 - 802.11n router, BGP router, ...
 - Adding one bit doubles # addresses
 - What about time to process ?

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