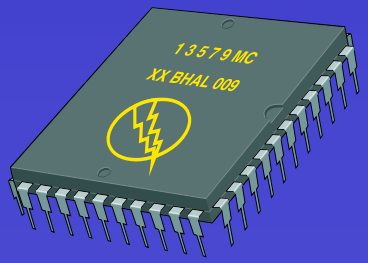
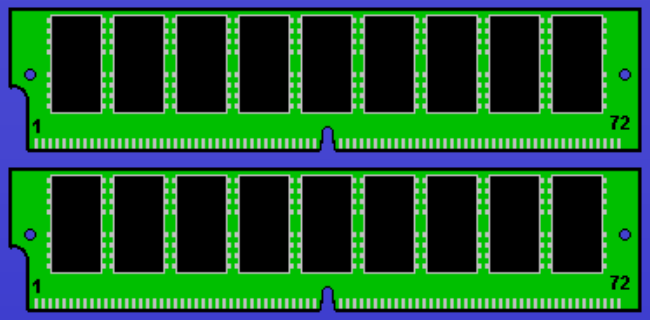
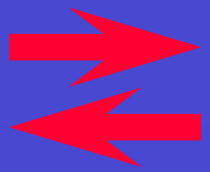
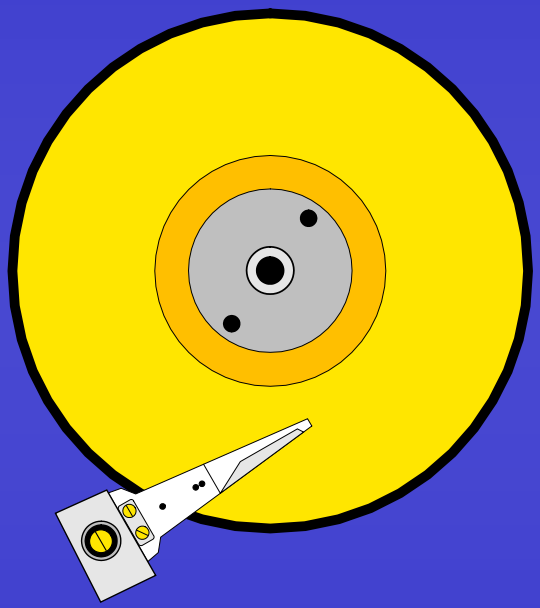
Nuts and Bolts: the Network Wire

The DANCE on your computer









The DANCE on a network

- The data from the SERVER's MAGNETIC memory is transferred to the CLIENT's ELECTRIC memory


Cross section of undersea cable.

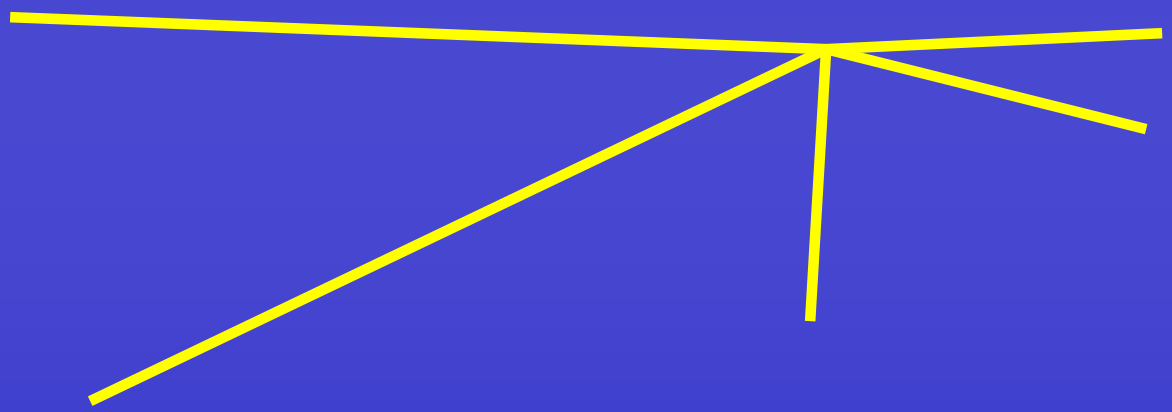
How Networks Work

- The wiring of the Internet
- Network addressing
- The way data gets delivered

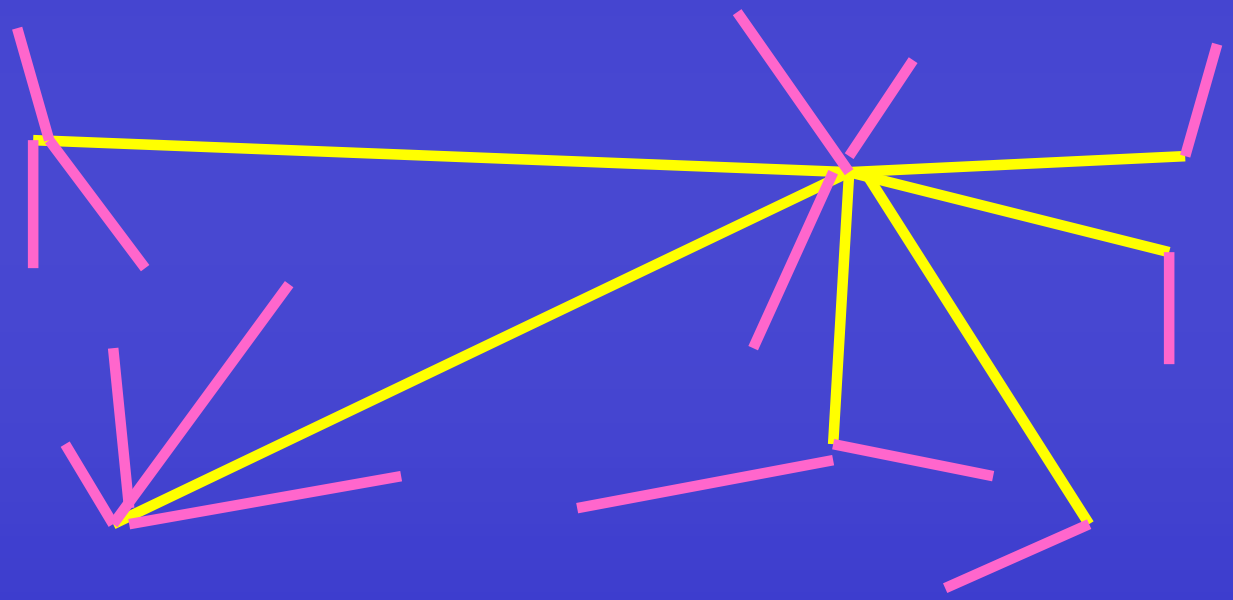
The Wiring of the Internet

- Originally nuclear fallout: a legacy of the Cold War
- Driven by desire to **share large computing resources and communicate**
- Started small but grew like wildfire

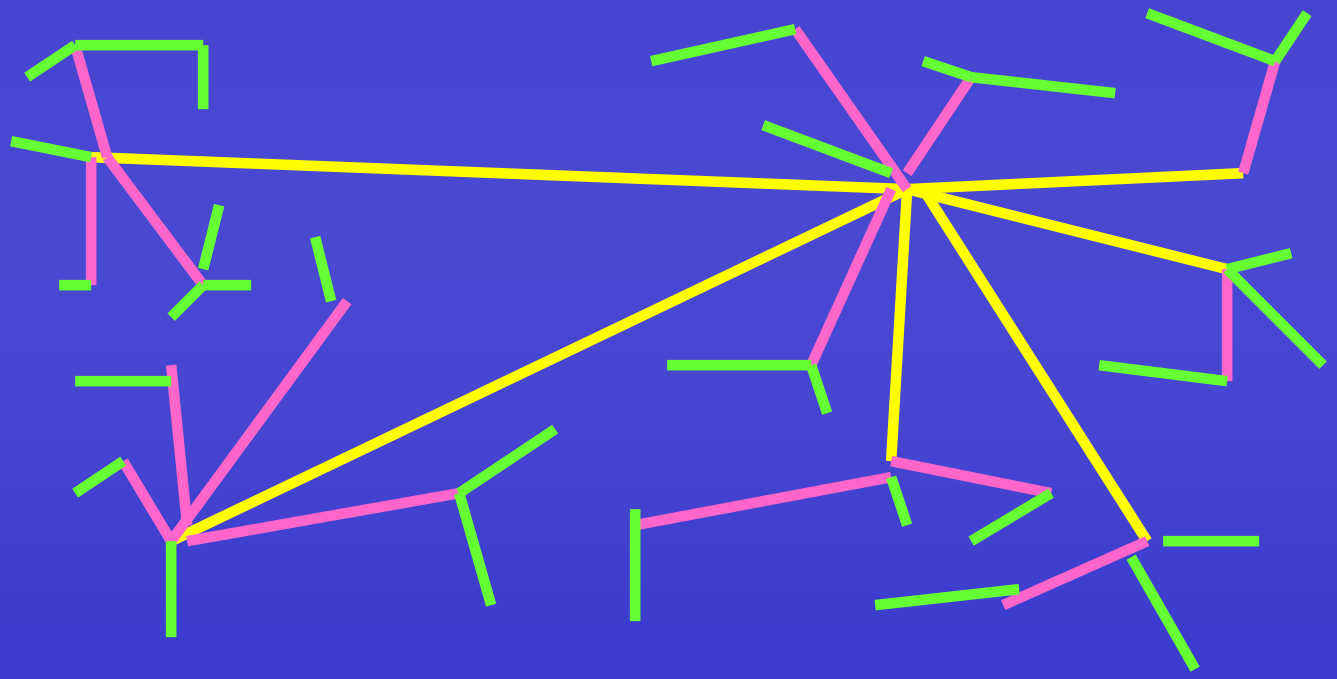
Originally hooked up major research institutions in U.S.



Other research institutions were added quickly



Within time (less than ten years) most universities and government agencies on board

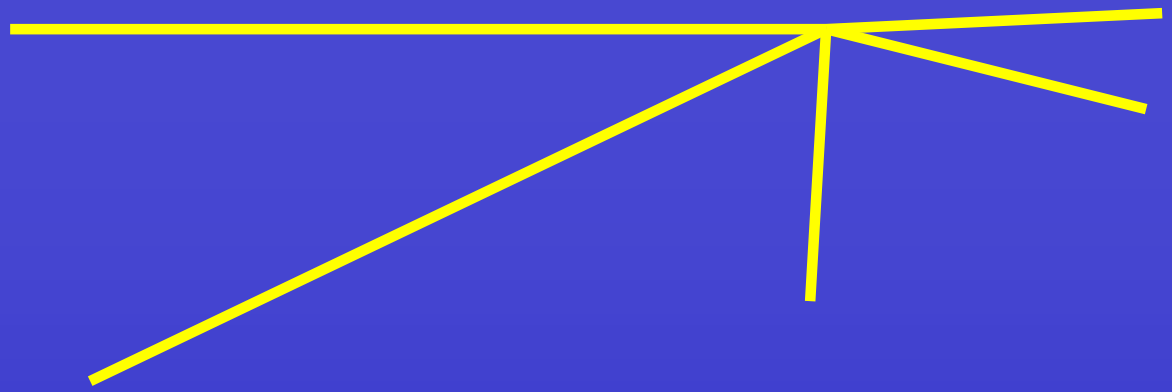


This almost biological growth process takes place on many levels

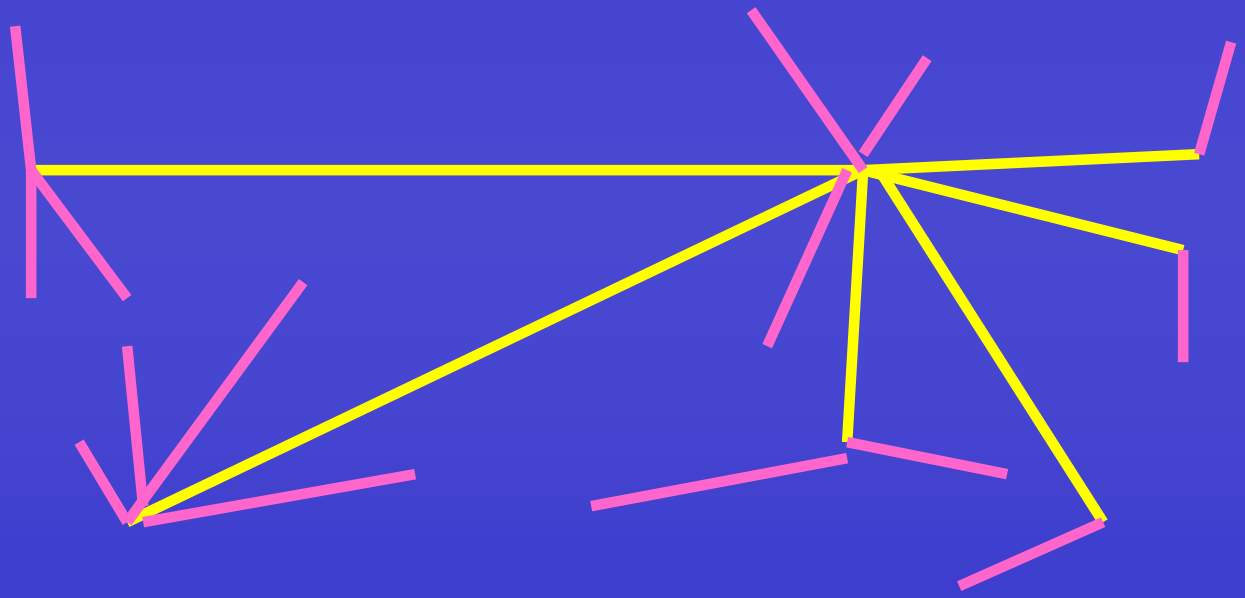
- in an office or a home
- within an organization
- within municipalities and states
- within continents
- internationally

First Bob and Julie connect their computers to share a printer

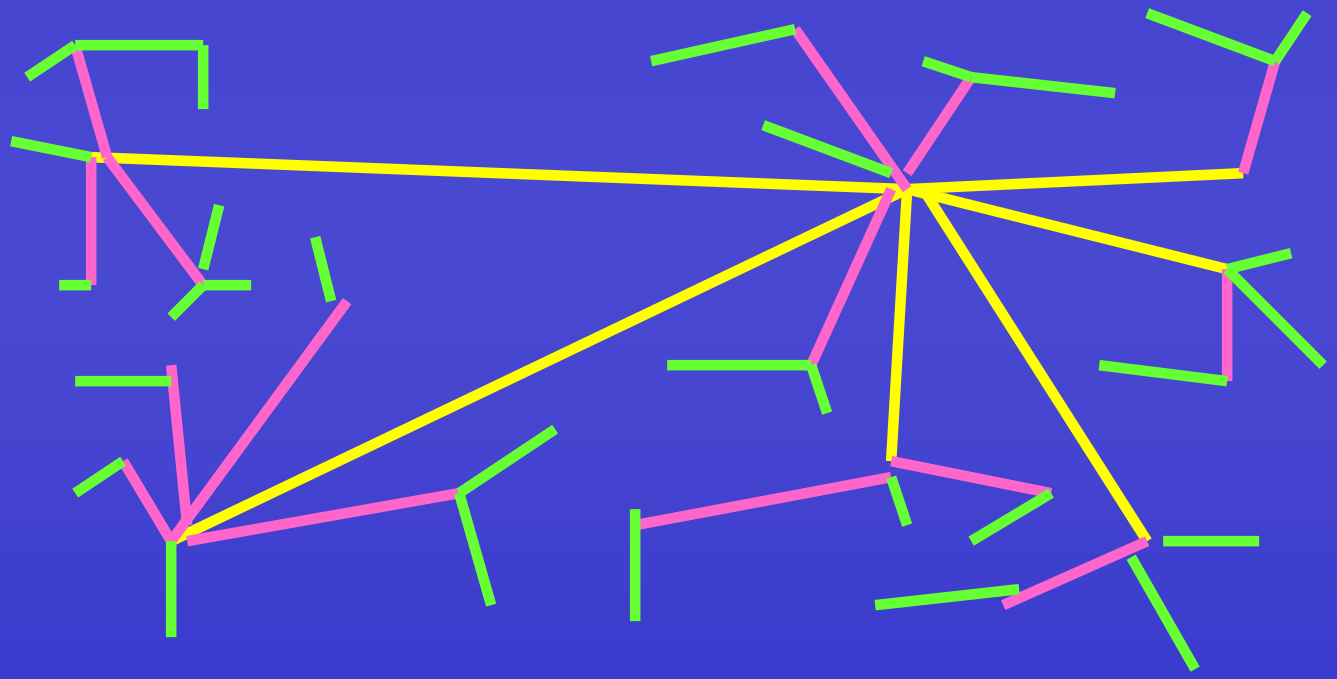
Soon others join in



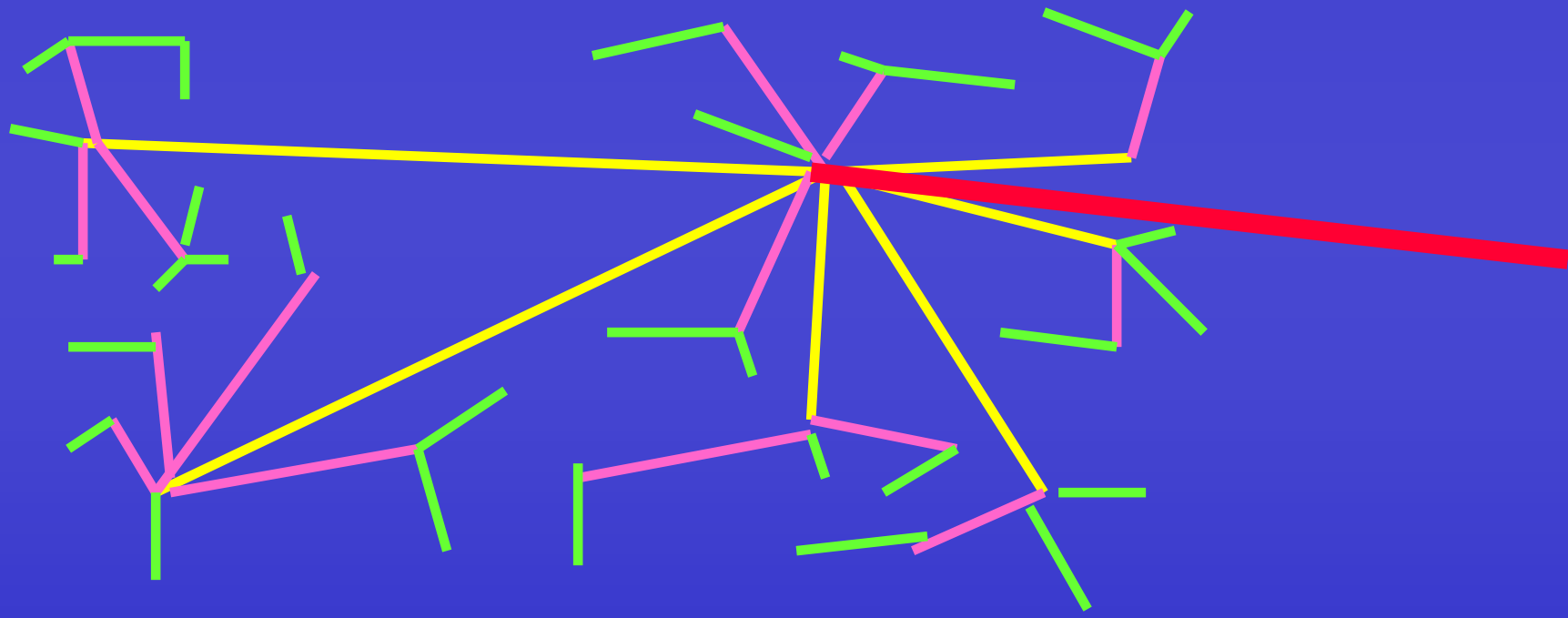
A single large hard drive is added (network server) and yet more join in



Within time every computer and sharable device is connected

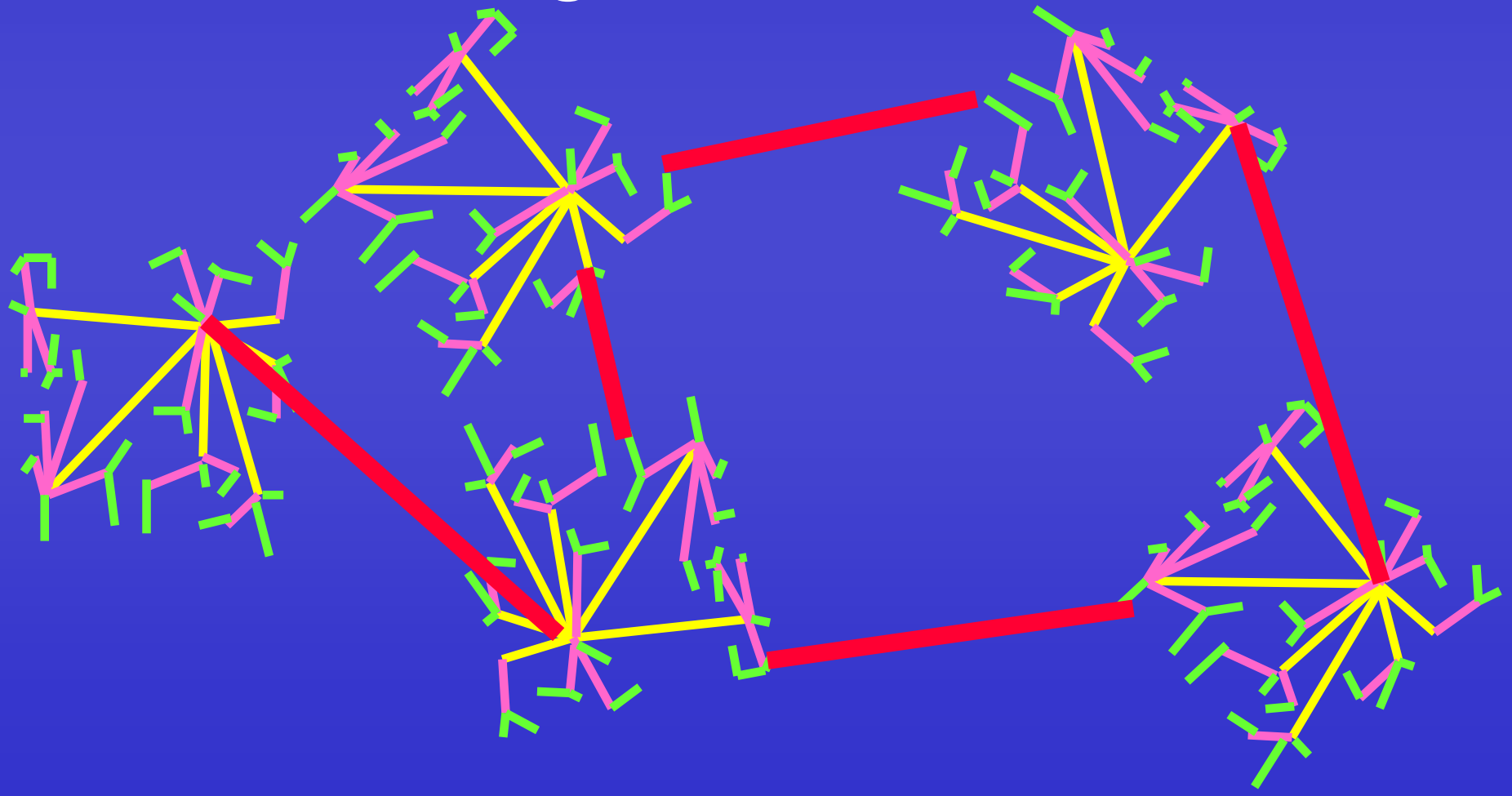


Then a connection to the Internet comes along...



This is the key: a single connection gives all on the local network access to the entire Internet

The Internet is simply a conglomeration of networks with wires running between them

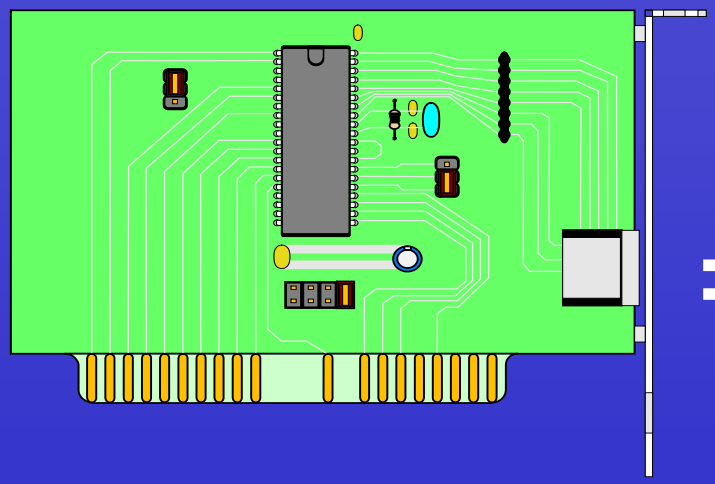


Network addressing

- Managing millions of computers that share a common set of wires could potentially be mind-boggling
- Limited network capacity means that data can’t just fly out willy-nilly
- First, each computer attached to the Internet needs a unique address
- Then we need an efficient means for finding that computer

Addressing: The computer

- In the Ethernet world, each network card is assigned a unique number by the manufacturer



Manufacturer

Serial #

= 0000456 - 000000592854

IP Address -- the domain

- Each organization registers a unique domain with a central group responsible for managing domains

ACME Widgets = 123.90

IP Address -- the network

- They can then create multiple networks under their domain and assign unique network IDs

ACME Widgets = 123.90

San Francisco = 123.90.201
Hong Kong = 123.90.202
Iowa City = 123.90.203

IP Address -- the computer

- Finally every computer on the network is assigned a unique number

ACME Widgets = 123.90

San Francisco = 123.90.201

Tom’s Laptop = 123.90.201.145
Judy’s Macintosh = 123.90.201.146
Ben’s Laser Printer = 123.90.201.147

Finding a needle in a haystack

- Taken together, like a postal mail address, the Ethernet address, domain and network provide an easy way to find a single computer

ACME Widgets = **123.90**

Iowa City = **203**

0000456-19287563092854 = **123**

IP = 123.90.203.123

The IP address

- Like a telephone number, the portions of the address narrow the options towards the destination computer

Country Code
Area Code
Prefix
Line #

01 - 319 - 335 - 3500

Telephone Number

Domain
Network
Computer

134 . 100 . 67 . 123

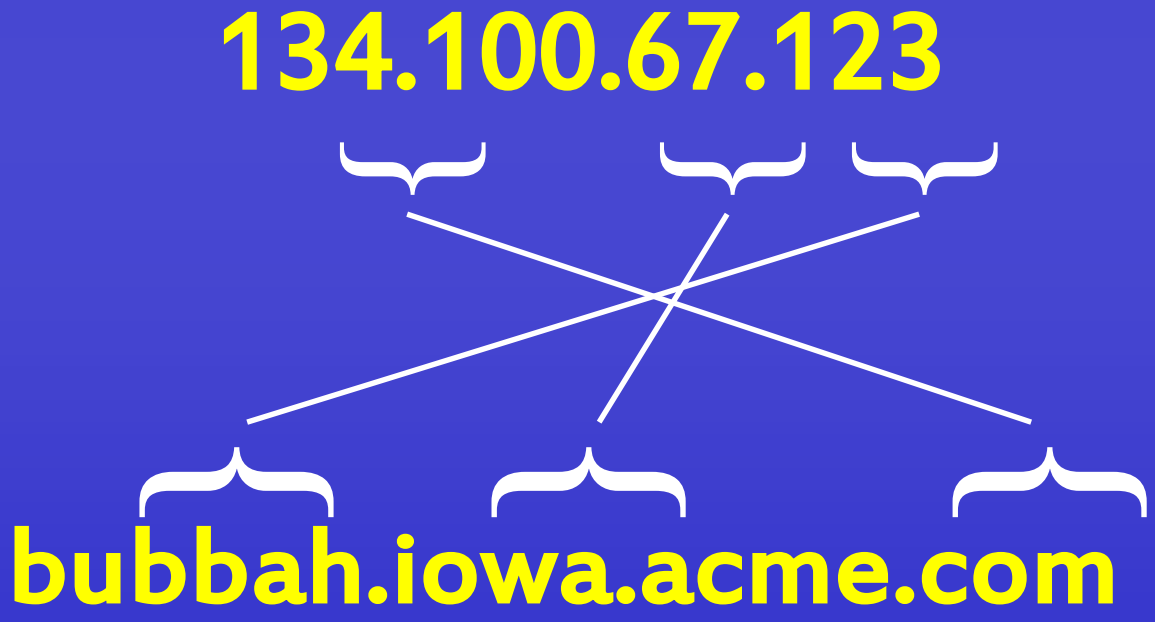
IP Number

Domain Name Service

- IP numbers being difficult to remember, Domain Name Servers gives one the option to use “common” names for computers, networks, and domains
- The DNS name for a computer is maintained in a database and is unique to the computer

Domain Name Service

- Two ways to describe the same thing



Network Data Packets

- Data is transferred from one computer to another in small bite-size pieces
- These “packets” are manufactured at the sending machine, spewed onto the wire, then collected and reassembled at the receiving machine
- The network interface can produce hundreds of thousands of packets per second

Network Data Packets

- All packets share some common elements

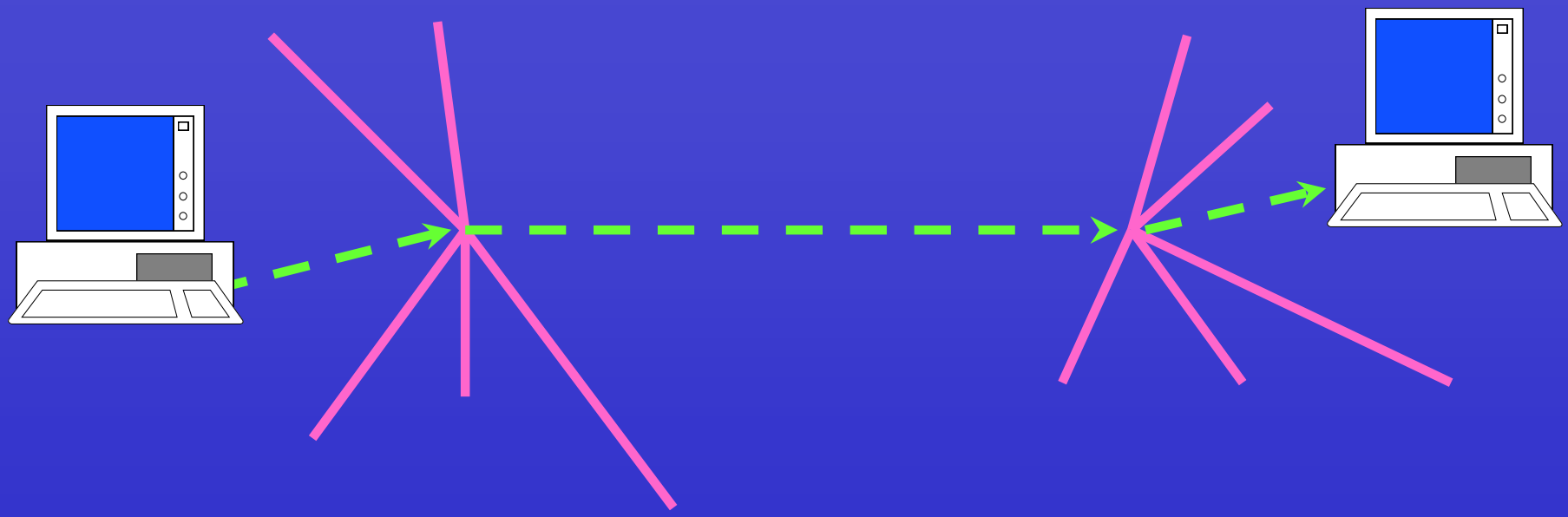
Plus time, date, expiration, etc…

Network Data Packets

- A computer ignores packet types it has not been instructed to handle
- A computer can be instructed to send and receive multiple types of packets
- Packets do not need to follow the same path from the sending to the receiving computer
- Packets are numbered so that a receiving computer can request the sender to resend missing or broken packets

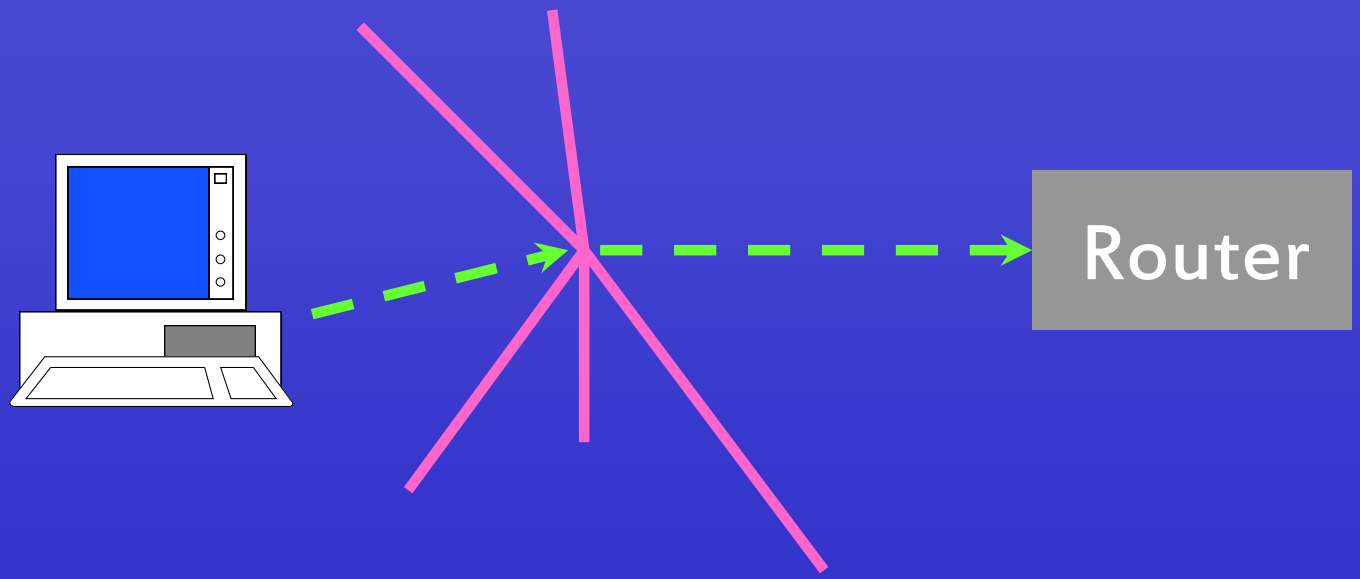
Moving Packets

- Local area networks use hubs or switches to move packets along a fixed, known path



Routing Packets

- The hubs and switches pass the packets intended for a computer outside the local network to a ROUTER

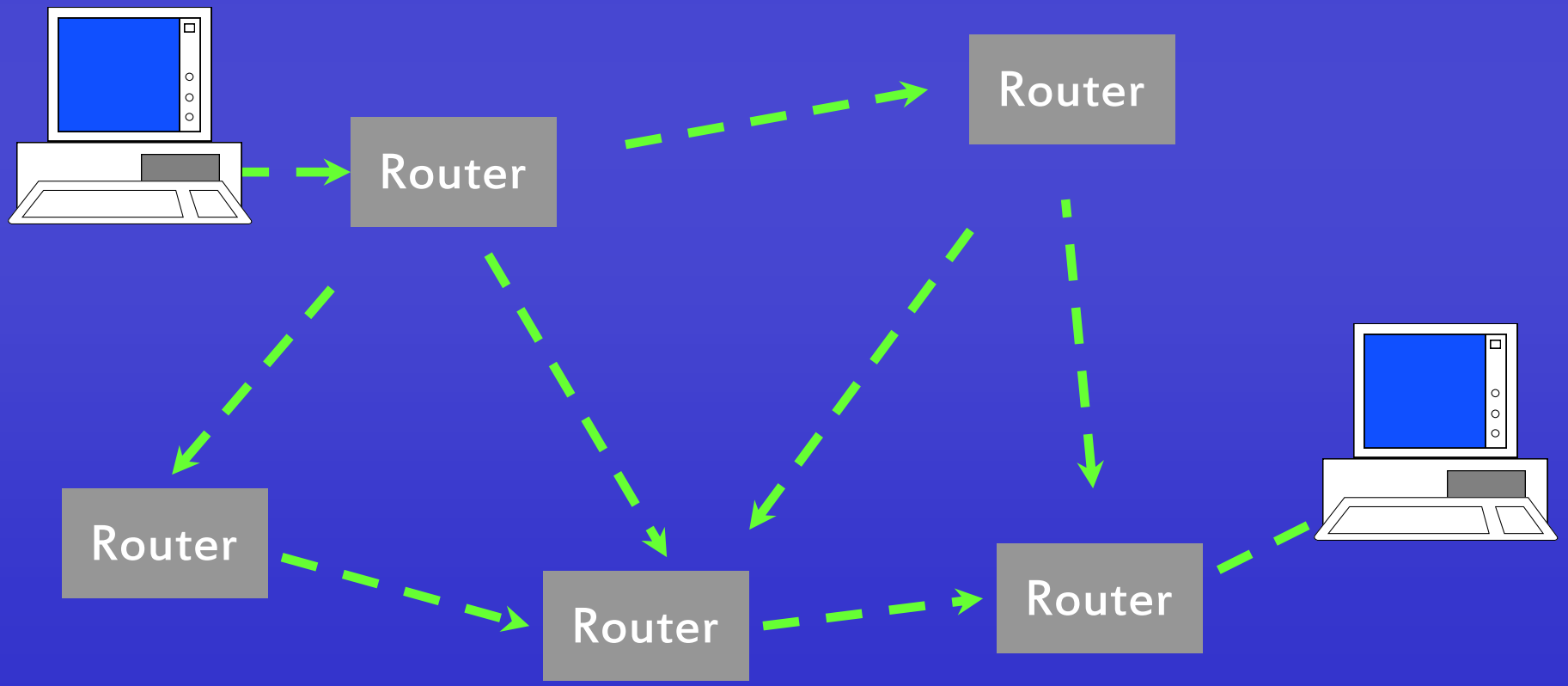


The Router

- Directs packets from one network to another
- Keeps track of other routers
- Tests to find the most efficient route(s) for packets
- Can handle multiple types of packets

Routing Packets

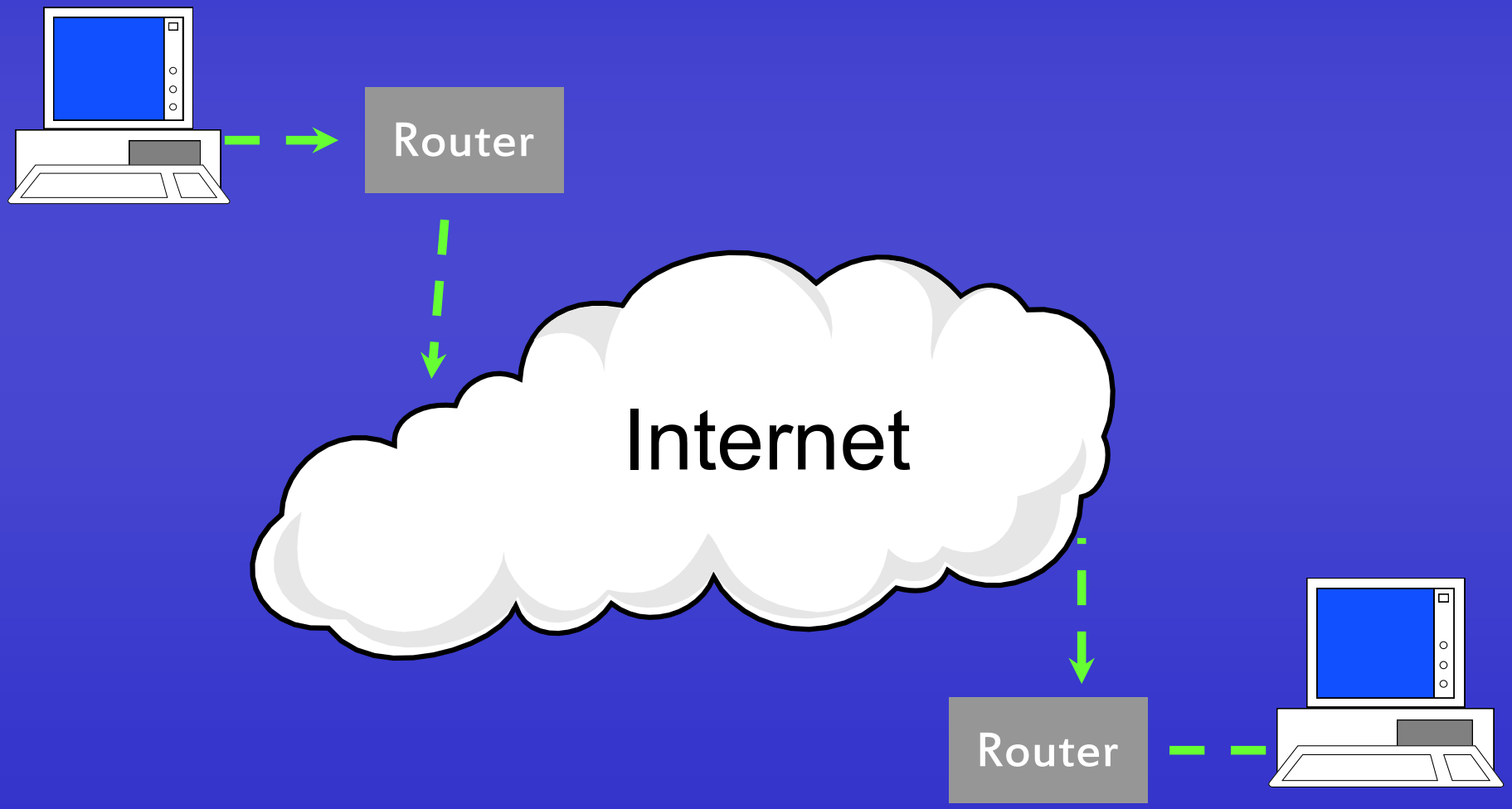
- Depending on the traffic load, the packets may travel multiple routes



Routing Packets

- Given that one cannot know the actual route the packets are taking, the Internet is usually represented by a cloud in network drawings

Routing Packets



The TCP/IP protocol

- A widely understood set of rules for inter-computer communication
- Sets the standard
- Adds an element of trust and reliability
- Not entirely bullet-proof

The End