Course Goals

- **Become familiar with the principles and practice of data networking.**
  - » **Routing, transport protocols, naming, ...**
- **Learn how to write applications that use the network.**
  - » **How does a web server work?**
- **Get some understanding about network internals in a hands on way.**
  - » **By building a simple network in software**

What Is a Network?

- Collection of nodes and links that connect them
- This is vague. Why? Consider different networks:
  - Internet
  - Andrew
  - Telephone
  - Your house
  - Others – sensor nets, cell phones, …
- Focus on Internet, but understand important common issues and challenges

Networks Juggle Many Goals

- **Efficiency – resource use; cost**
- **The “ilities”:**
  - **Evolvability**
  - **Managability**
  - **Security (securability, if you must)**
  - **Ease of:**
    - **Creation**
    - **Deployment**
    - **Management**
    - ***Creating useful applications***
  - **Scalability**

Challenges for Networks

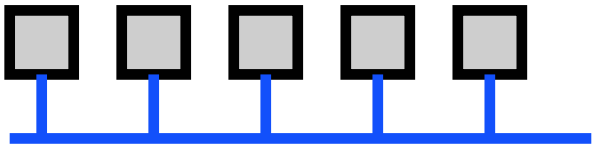
- **Geographic scope**
  - » **The Internet vs. Andrew, etc.**
- **Scale**
  - » **The Internet vs. your home network**
- **Application types**
  - » **Email vs. Videoconferencing**
- **Trust and Administration**
  - » **Corporate network – one network “provider”**
  - » **Internet – 17,000 network providers**

How to Draw a Network

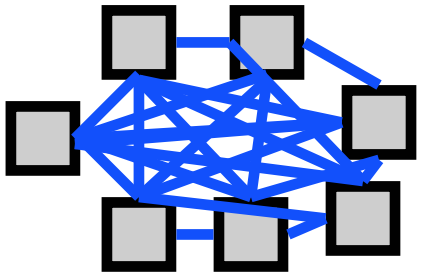
Building block: The Links

- **Electrical questions**
  - » Voltage, frequency, …
  - » Wired or wireless?
- **Link-layer issues: How to send data?**
  - » When to talk – can everyone talk at once?
  - » What to say – low-level format?
  - » Stay tuned for lecture 5
- **Okay… what about more nodes?**

- **… But what if we want more hosts?**



One wire



Wires for everybody!

- **Scalability?!**

"The Internet"

- **An inter-net: a network of networks.**
  - **A set of networks that are connected with each other**
  - **Networks are connected using routers that support communication in a hierarchical fashion**
  - **Often need other special devices at the boundaries for security, accounting, ..**
- **The Internet: the interconnected set of networks of the Internet Service Providers (ISPs) providing data communications services.**
  - **About 17,000 different networks make up the Internet**
- **In order to inter-operate, all participating networks have to follow a common set of rules.**

Challenges of the Internet

- **Scale: 100,000,000s of hosts**
- **Heterogeneity:**
  - **18,000+ administrative domains**
  - **Thousands of applications**
  - **Lots of users**
  - **Fast links, slow links, satellite links, cellular links, carrier pigeons**
- **Diversity of network technologies**
- **Adversarial environment**
- **Oh, and let's make it easy to use…**

Using Networks

- **Layering and abstraction**
  - **Protocol stacks failicate re-use**
  - **Hide underlying complexity from the programmer**
  - **(Lecture 3)**
  - **Protocol reuse *and* code/library reuse**
- **Many "human-friendly" abstractions:**
  - **Higher-level protocols (e.g., reuse the Web's HTTP instead of writing your own!).**
  - **Naming (www.google.com vs. 64.233.161.99)**
    - **The Domain Name System, or DNS**

Using Networks *Securely*

- **The Internet is an unfriendly place**
  - **Hacking, viruses, denial-of-service, etc.**
- **Cryptography to the rescue:**
  - **Secure Sockets Layer (SSL) – https://www.foo.com/**
  - **Key management, etc.**
- **Policy control to the rescue:**
  - **Firewalls / Denial of Service**
  - **Network address translation / virtual private networks (NAT, VPN)**