

# Data Communications and Networking



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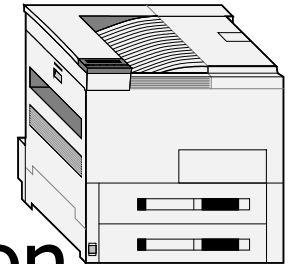
# Outline

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- Motivation
- Data Communication
- Networks
- Growth of Computer Networking
- Protocols and Standards

# 1. Motivations

- Efficient way to share resources
  - Cost – less expensive
  - Accessibility – easier
- Efficient way to exchange information
  - Time – faster
  - Size – bigger
  - Correctness – accurate





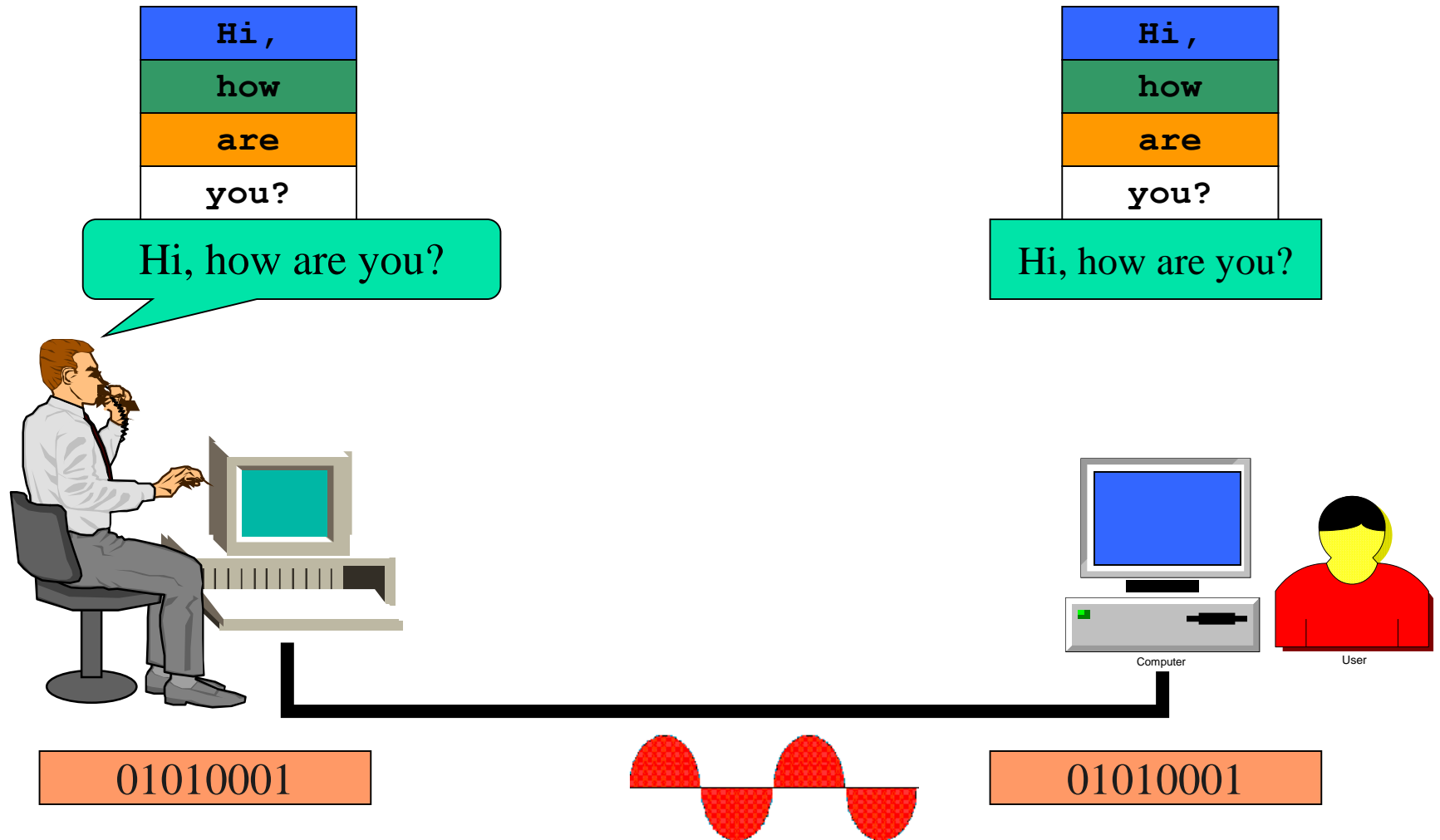
## 2.Data Communication: *Definition*

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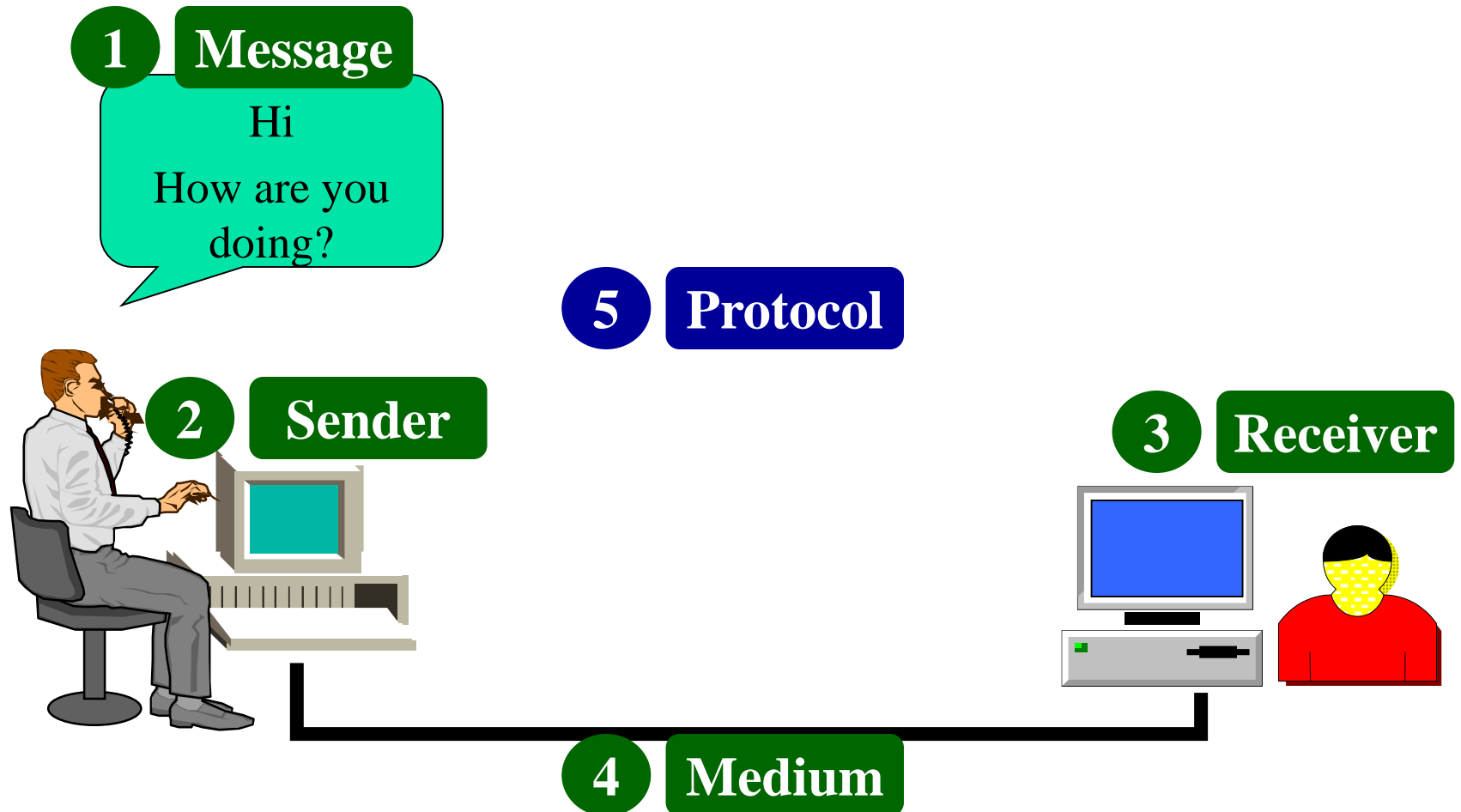
- Data Communication:

Transfer of data from one device to another via some form of transmission medium.

# Data Communication



# Data Comm. Components





# Protocols and Standards

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## ■ Protocol

- A set of rules governing data communications
  - **Syntax:** format of data block
  - **Semantics:** meaning of each section
  - **Timing:** speed and sequencing

## ■ Standards

- *De facto* (in practice) standards
  - not approved but widely adopted
- *De jure* (in law) standards
  - approved by a standard organization, e.g., ISO, IEEE



# Protocols and Standards

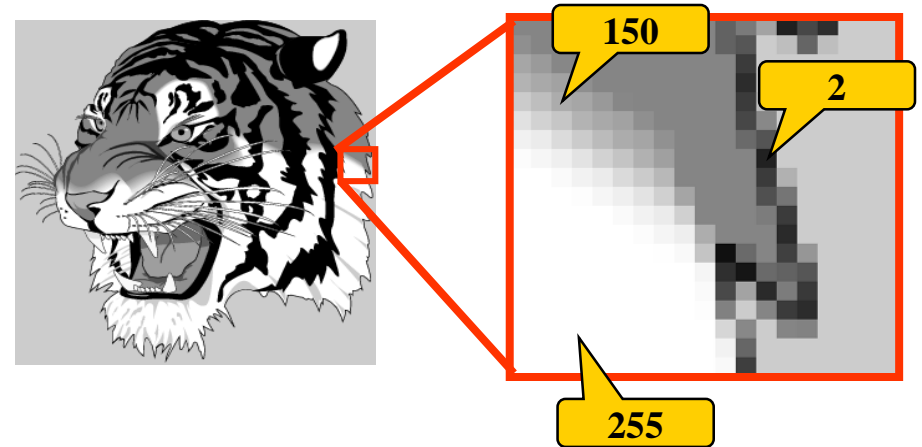
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- To communicate, two devices must follow the same set of communication protocols
- E.g., they must
  - be connected to the same medium
  - understand each other's messages
- In other words, they comply with the same **standard**



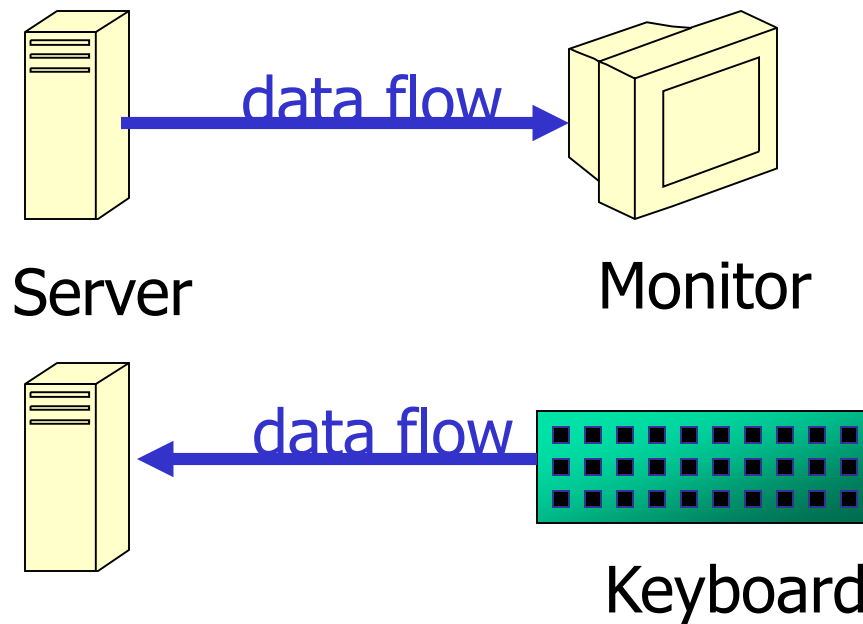
# Data Representation Standards

- Numbers
  - 8/16/32 bit integers
  - floating point
- Text
  - ASCII, Unicode
- Images
  - Bit patterns, Graphics formats JPG/GIF/etc
- Audio → Samples of continuous signal
- Video → Sequence of bitmap images



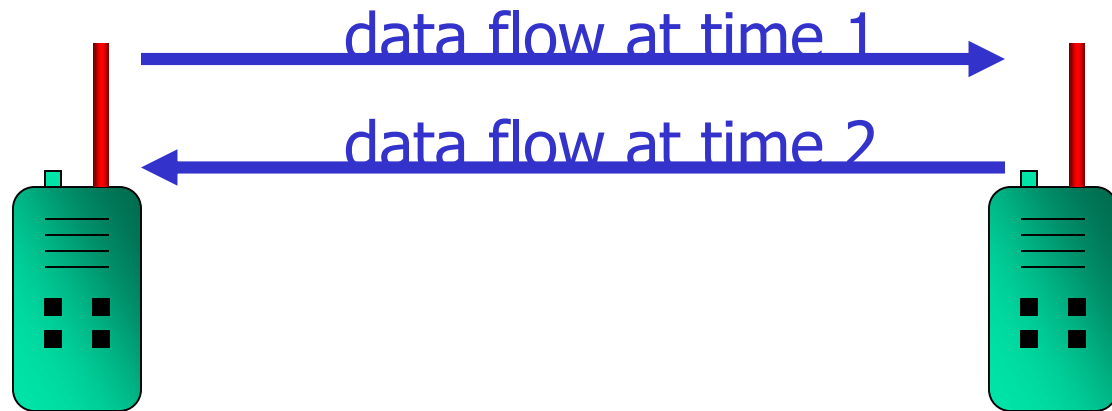
# Direction of Data Flow

- **Simplex:** One direction only

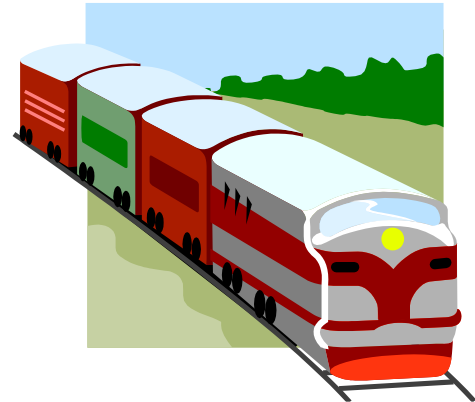


# Direction of Data Flow

- **Half Duplex:** Both directions, one at a time



- E.g., walkie-talkies



# Direction of Data Flow

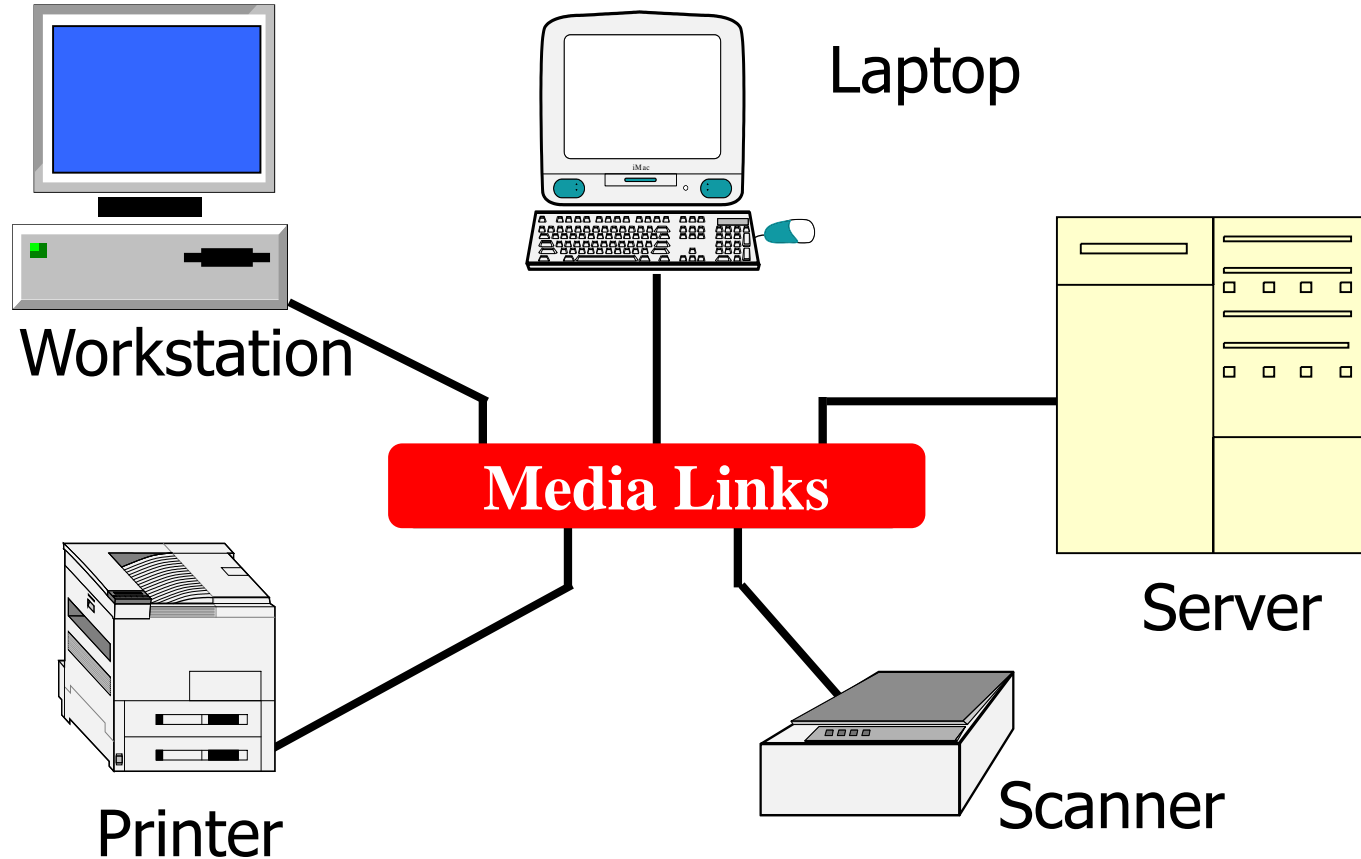
- **Full Duplex:** Both directions simultaneously



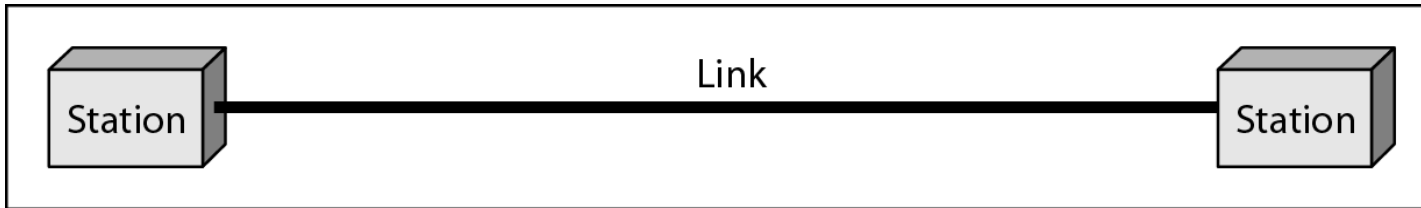
- E.g., telephone
- Can be emulated on a single communication link using various methods

# 3. Networks

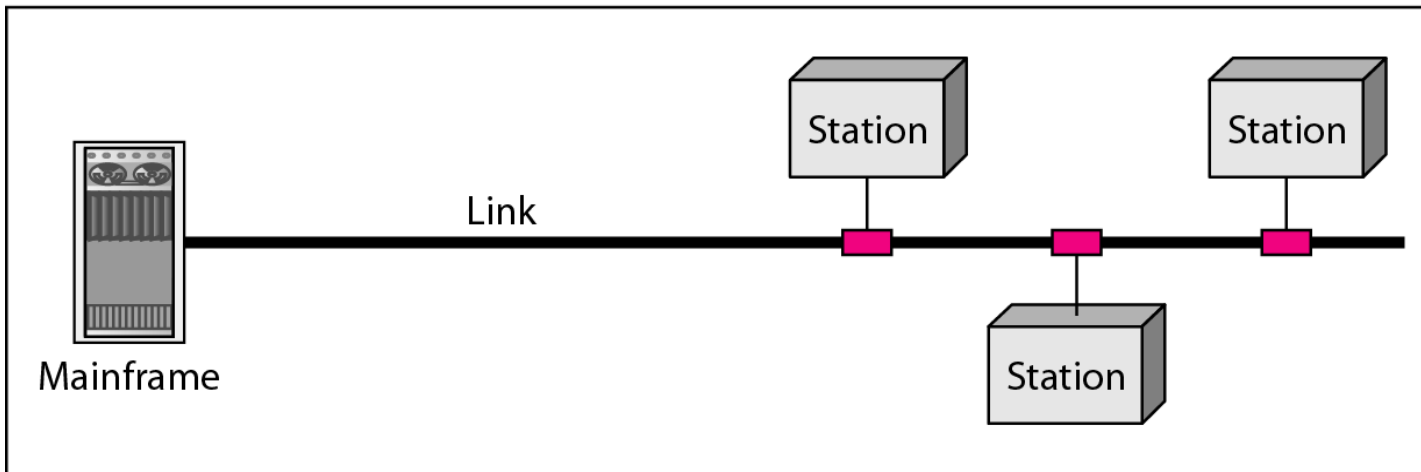
- Network: *a set of devices (often referred to as **nodes**) connected by media links*



**Figure 1.3** *Types of connections: point-to-point and multipoint*



a. Point-to-point

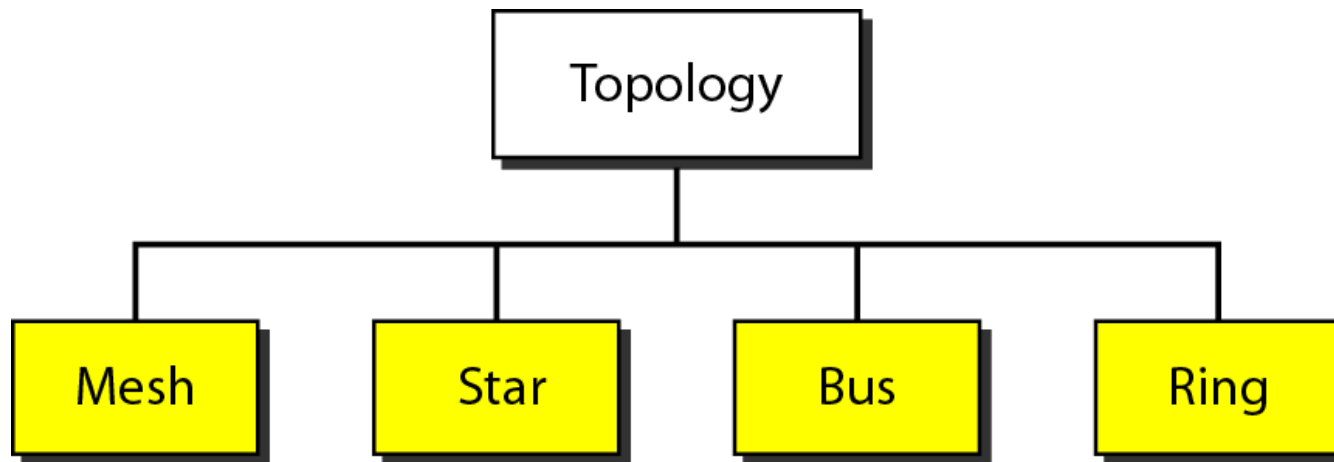


b. Multipoint

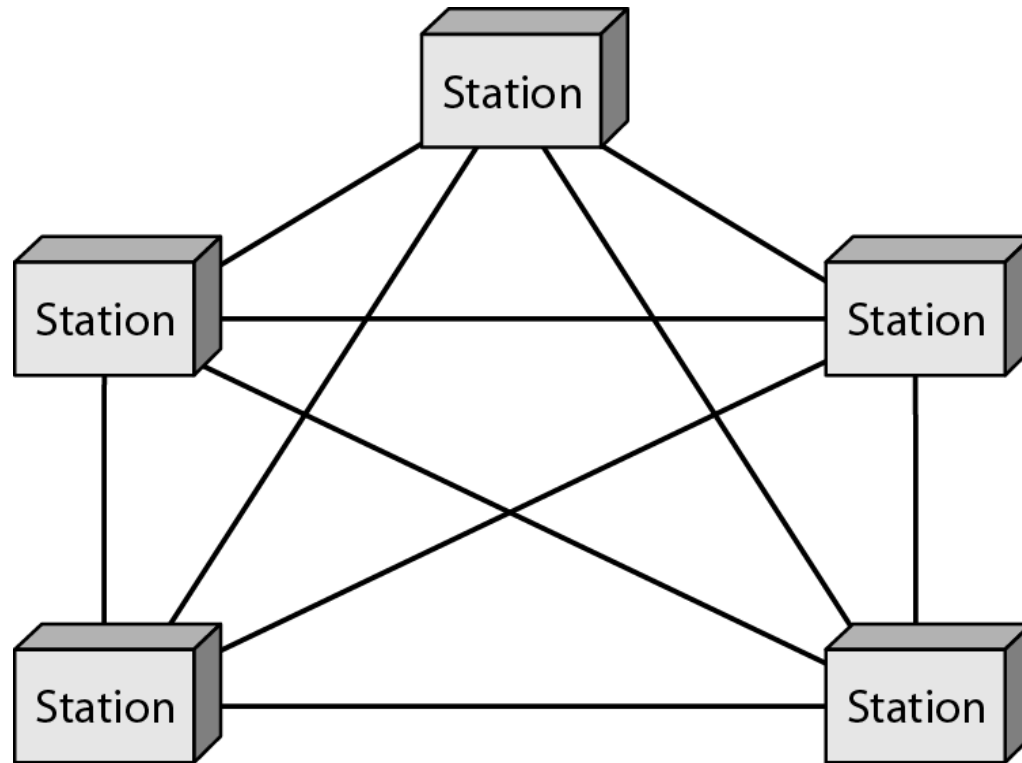


**Figure 1.4** *Categories of topology*

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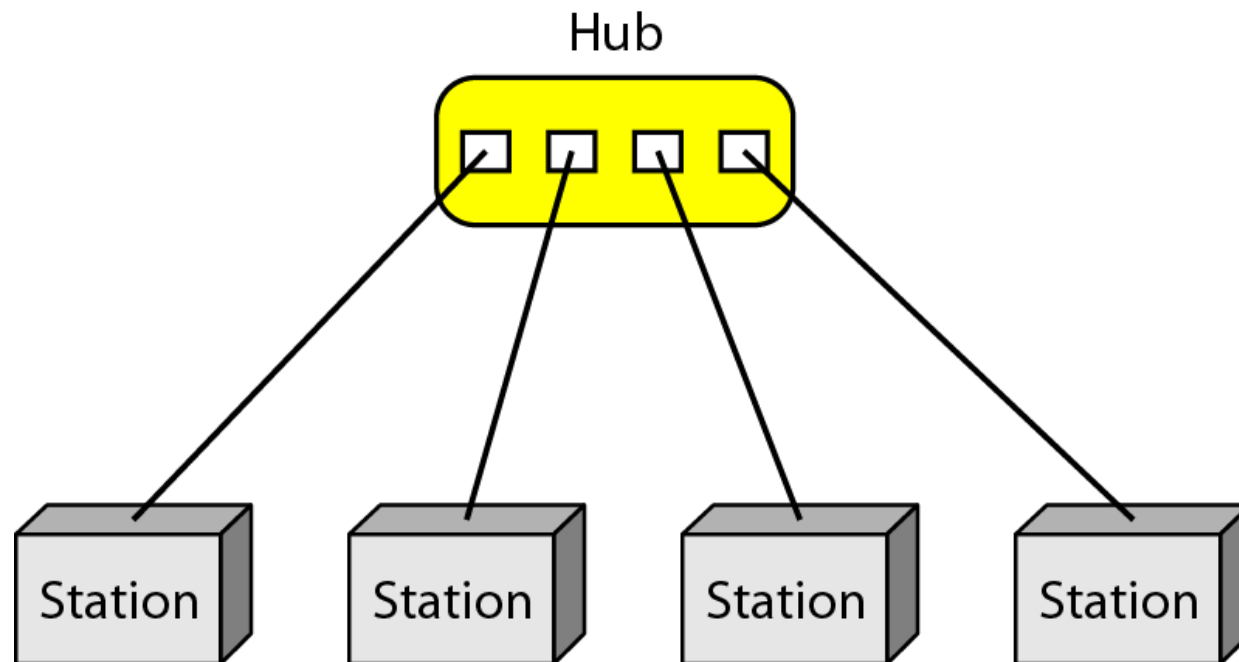


**Figure 1.5** *A fully connected mesh topology (five devices)*

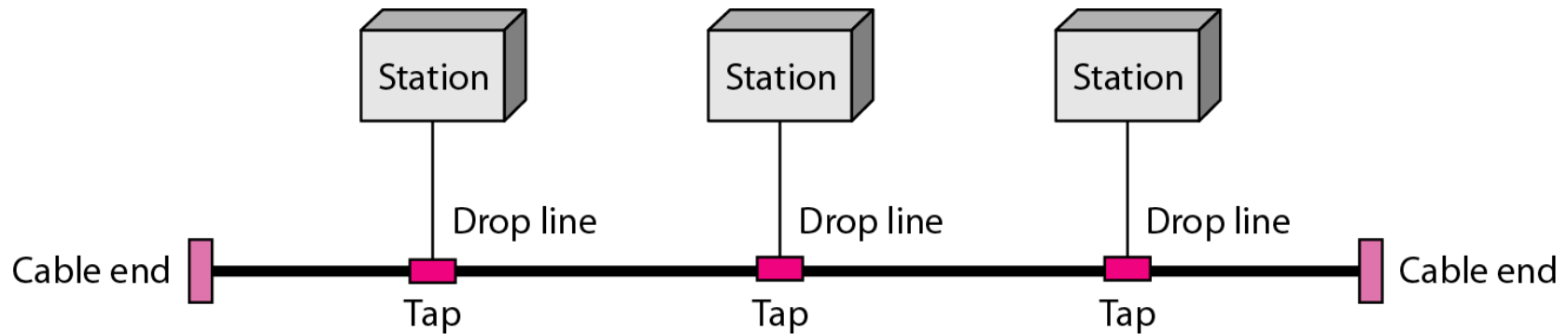




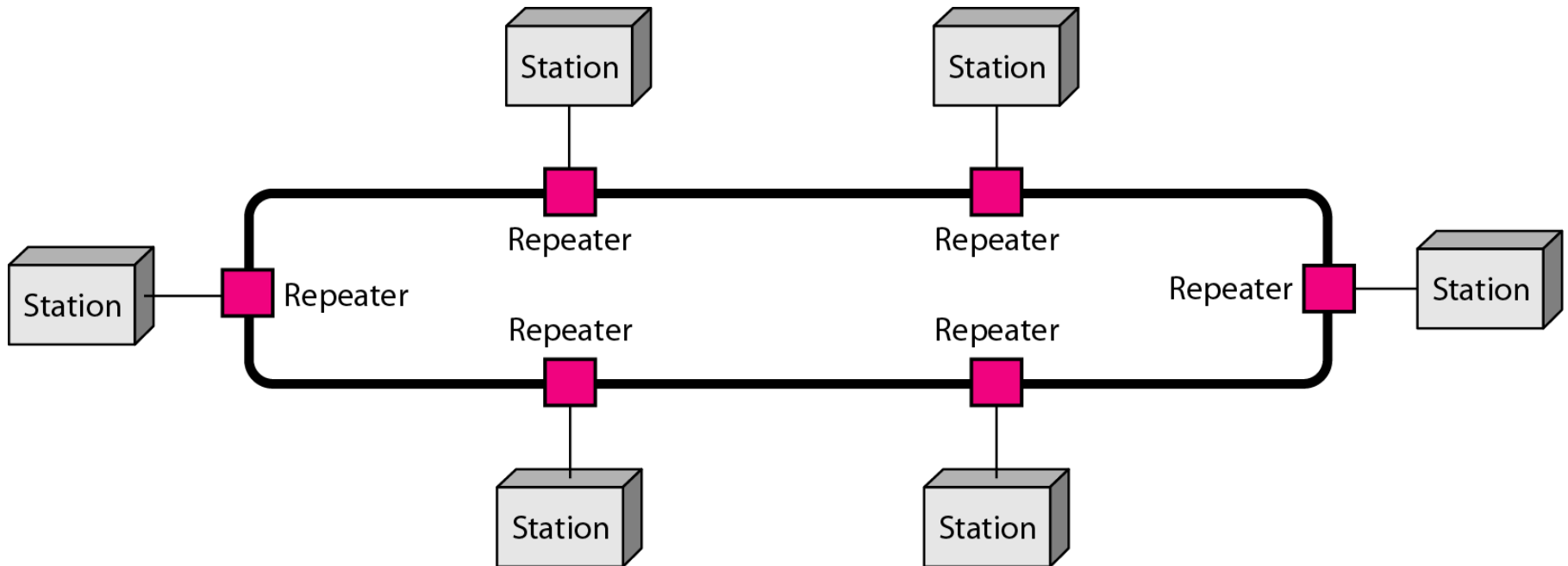
**Figure 1.6** *A star topology connecting four stations*



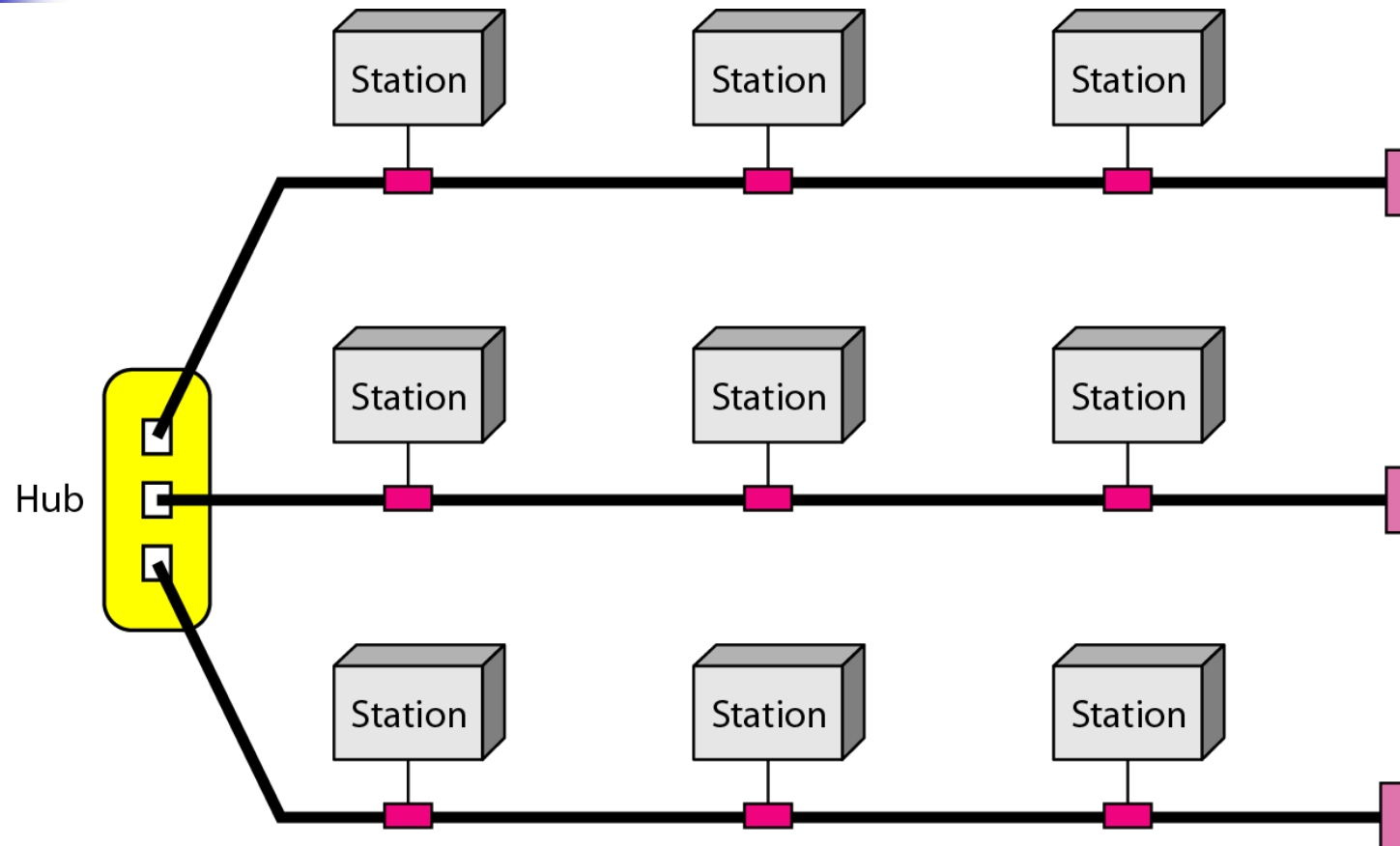
**Figure 1.7** *A bus topology connecting three stations*



**Figure 1.8** *A ring topology connecting six stations*



**Figure 1.9** *A hybrid topology:  
a star backbone with three bus networks*





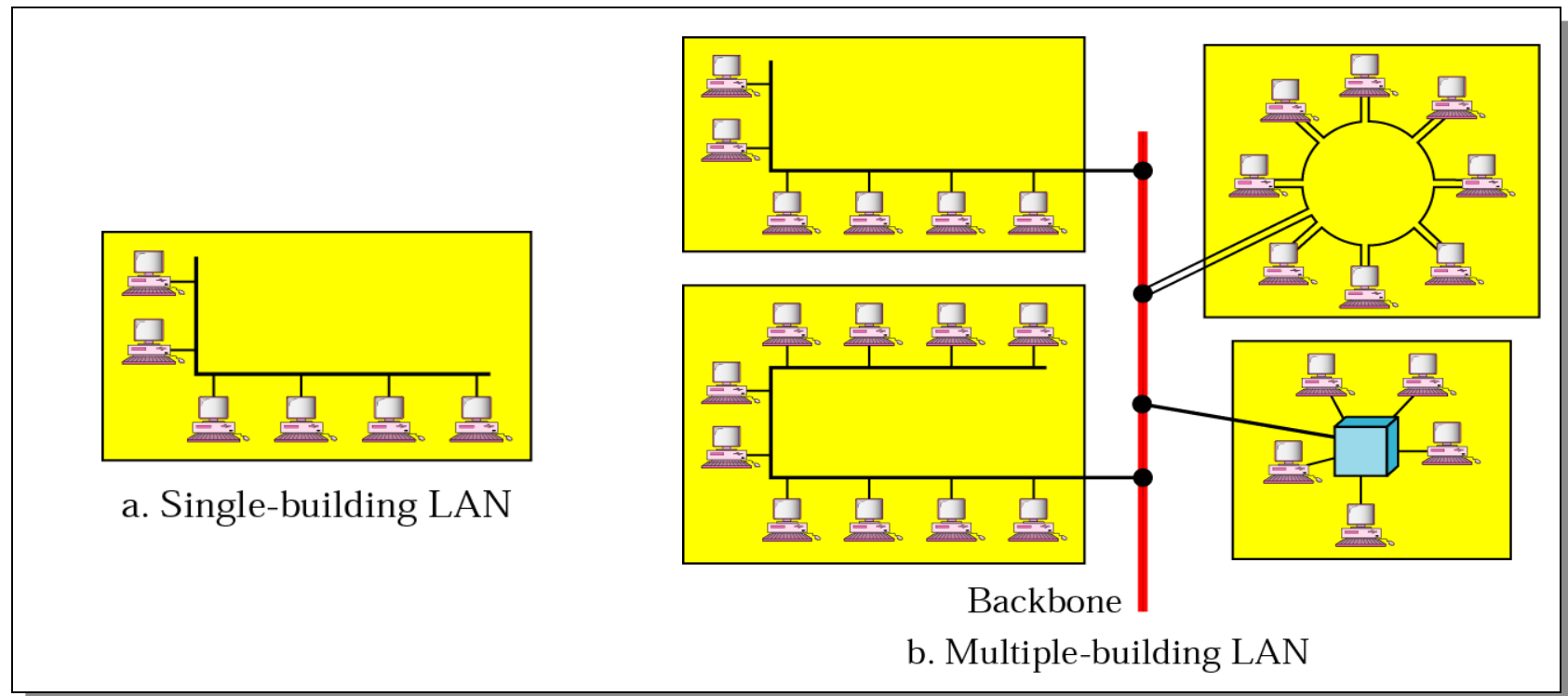
# Network Categories

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- Local Area Network (LAN)
- Wide Area Network (WAN)
- Metropolitan Area Network (MAN)

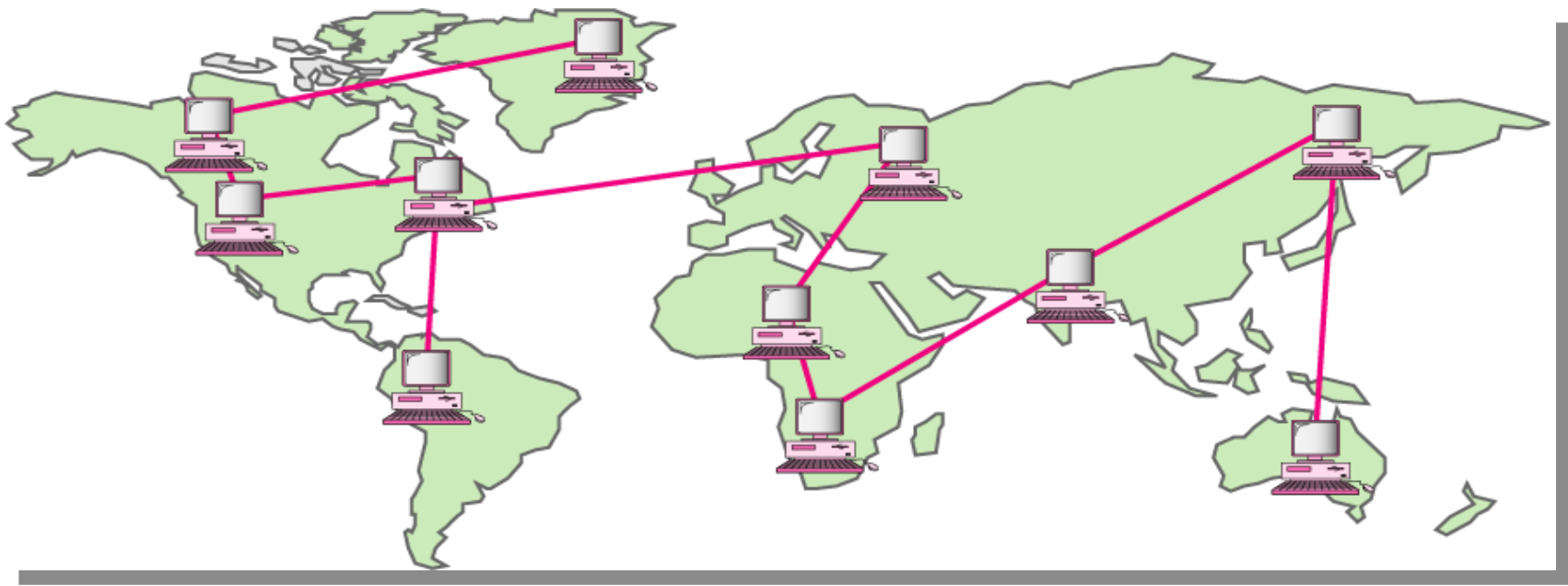
# Local Area Networks

- Network in a single office, building, or campus



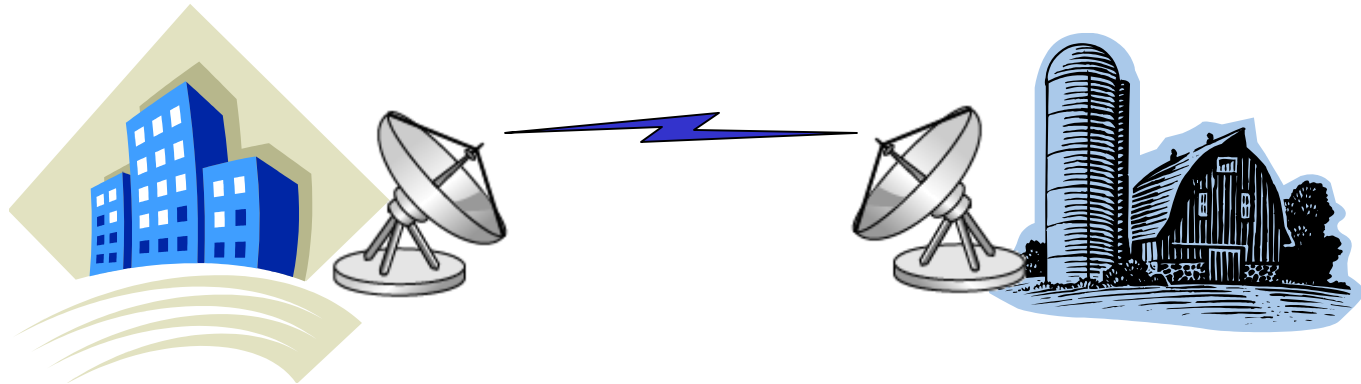
# Wide Area Networks

- Network providing long-distance communication over a country, a continent, or the whole world



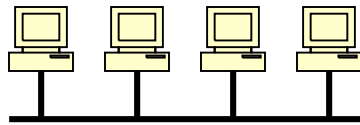
# Metropolitan Area Networks

- Network extended over an entire city





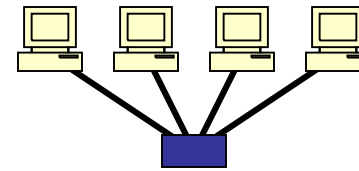
# Connection Standards



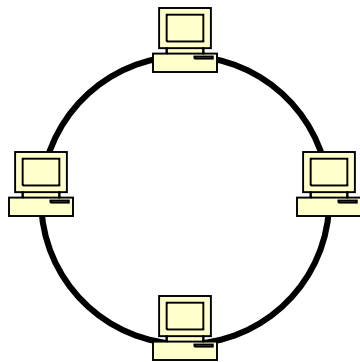
Company A



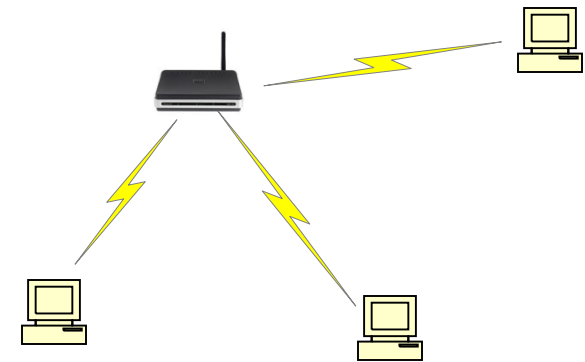
Network Interface Card (NIC)



Company B



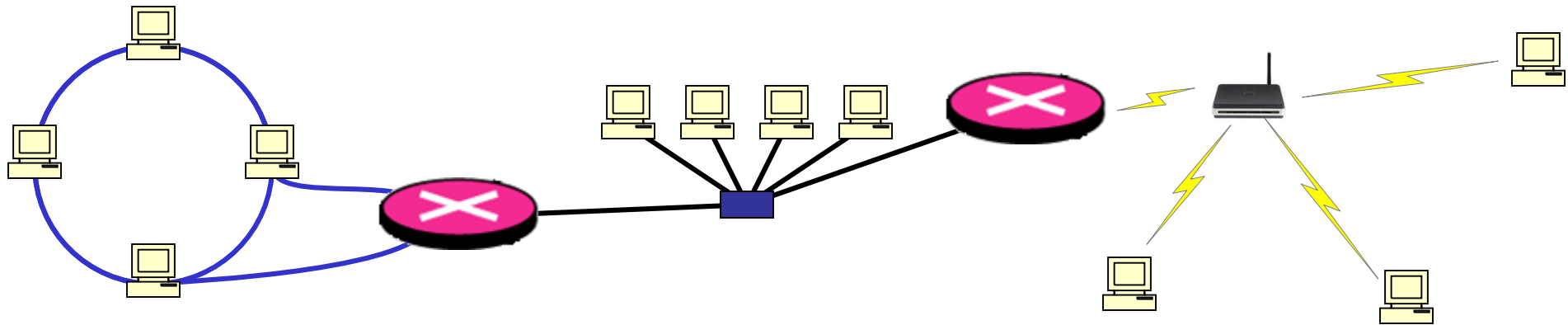
Company C



Company D

## 4. Internetworking

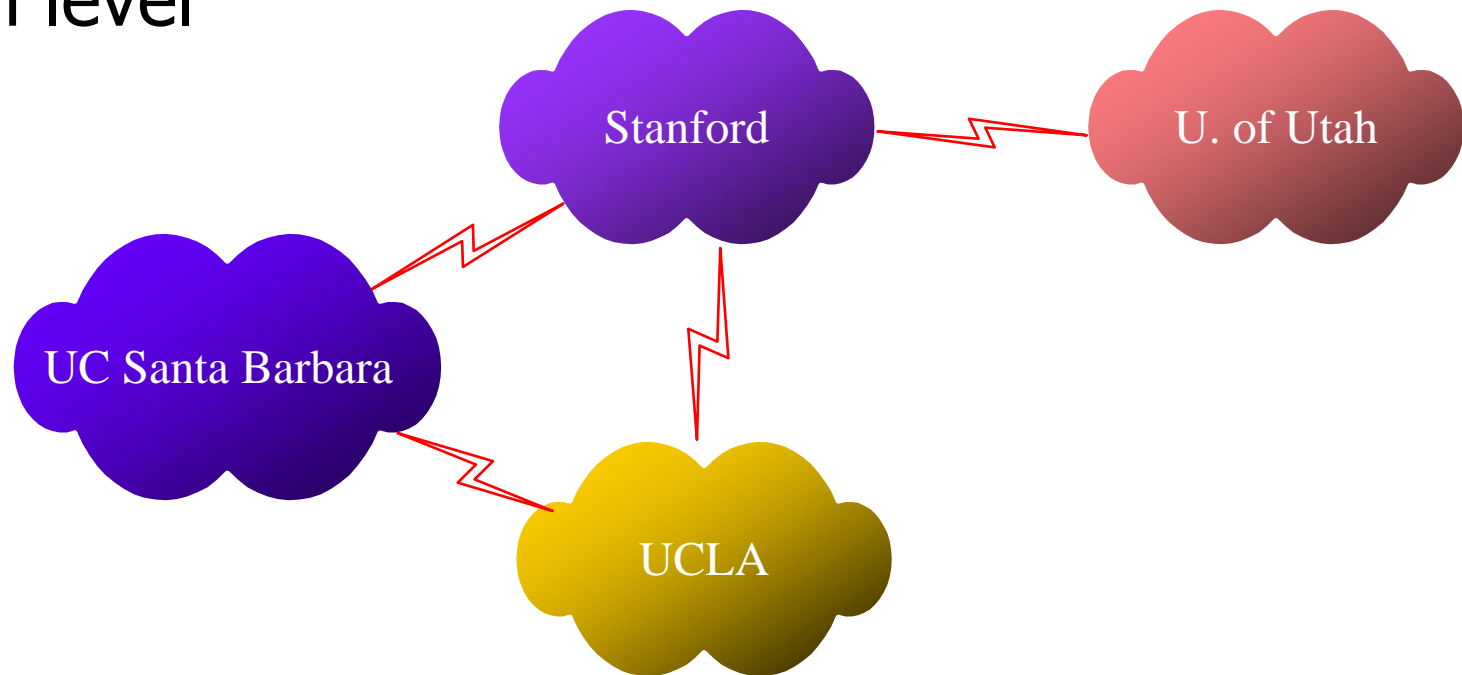
- How to allow devices from different standards to communicate
- **Gateways/routers** – devices capable of communicating in several standards



- These become "**network of networks**"

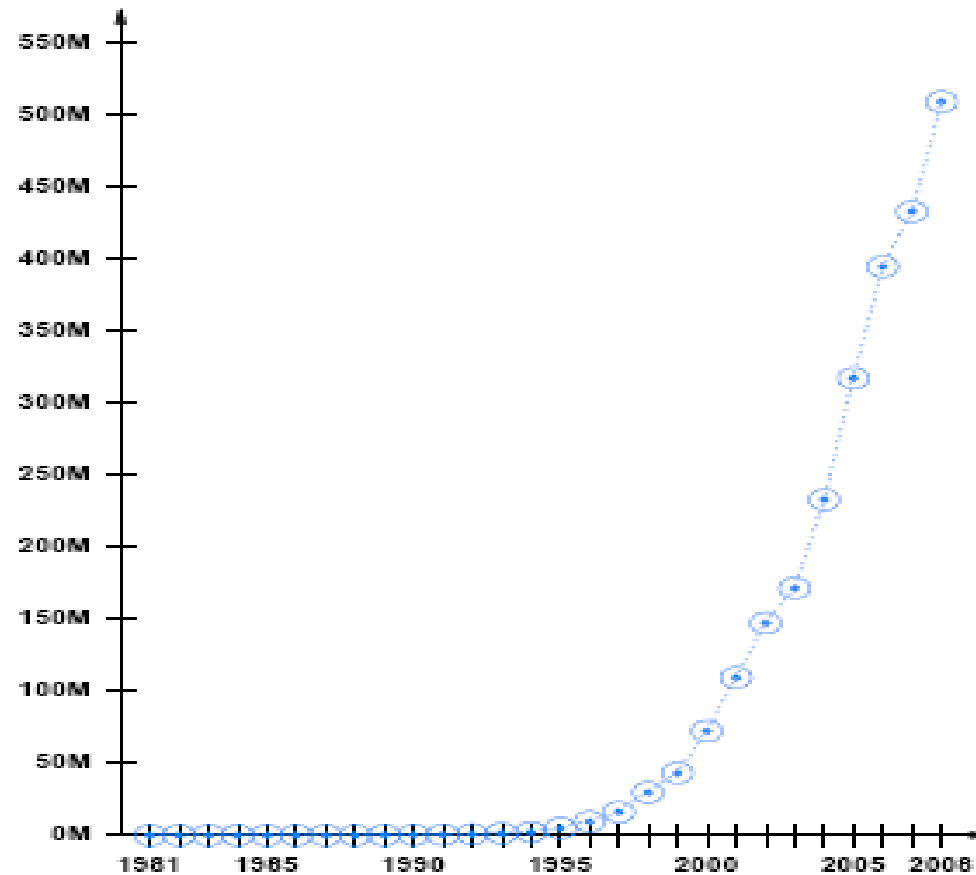
# The Internet

- The largest internetwork (network of networks) in the world
- Devices communicating with TCP/IP protocol suite at high level



# Internet Growth

#computers attached to Internet



# Recent and Future Trends

- The availability of high-quality **teleconferencing** systems
- Some **social networking** applications such as
  - *Facebook*
  - *Twitter*
  - *Google+*
  - Many others
- The Internet of Things (IoT)





# Future of the Internet

## COMPUTERWORLD



Print Article



Close Window

### Final IPv4 addresses to be issued within months, NRO warns

Martyn Williams

October 18, 2010 [\(IDG News Service\)](#)

The global body in charge of allocating Internet addresses expects to hand out the final blocks of IPv4 (Internet Protocol version 4) addresses to regional registrars early next year, it said Monday.



Those allocations would mark a depletion at the global level of IPv4 addresses -- something that has been anticipated for years -- and put further pressure on network operators to

[http://www.computerworld.com/s/article/print/9191518/Final IPv4 addresses to be issued within months NRO warns](http://www.computerworld.com/s/article/print/9191518/Final_IPv4_addresses_to_be_issued_within_months_NRO_warns)



# Future of the Internet

## COMPUTERWORLD

 Print Article  Close Window

### Update: ICANN assigns its last IPv4 addresses

Stephen Lawson

February 3, 2011 ([IDG News Service](#))

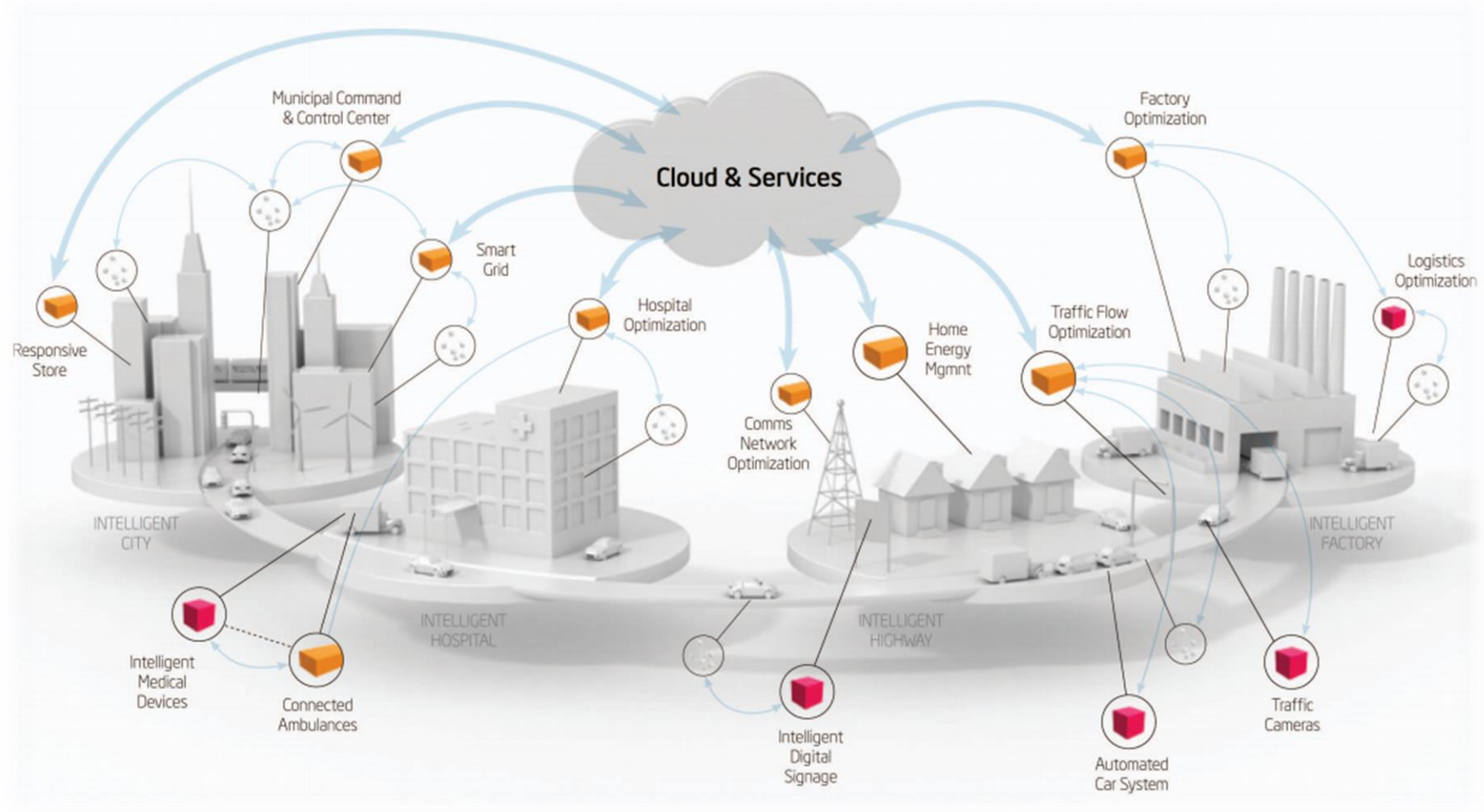
The Internet Assigned Numbers Authority (IANA) has handed out its last IPv4 addresses, leaving the remaining blocks to regional registries that in some cases may exhaust them within a few months.

The end of IPv4 (Internet Protocol version 4) addresses was announced in a ceremony in Miami on Thursday morning. Each of the five regional Internet registries (RIRs) was allocated one of the final five large blocks of about 16 million addresses.

The end of the central supply of IPv4 addresses signaled the urgency of enterprises and service

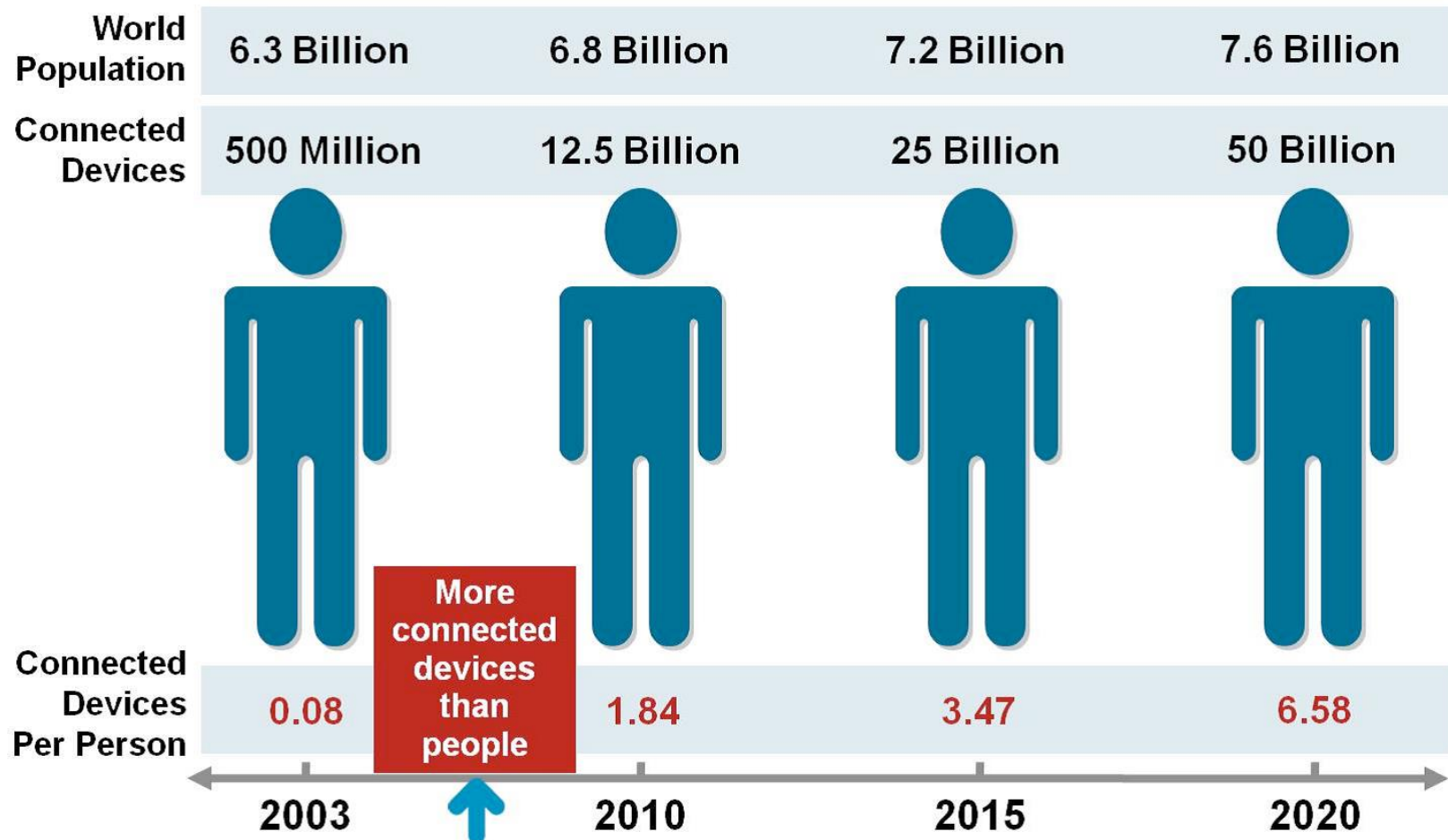
[http://www.computerworld.com/s/article/9207961/Update\\_ICANN\\_assigns\\_its\\_last\\_IPv4\\_addresses](http://www.computerworld.com/s/article/9207961/Update_ICANN_assigns_its_last_IPv4_addresses)

# Internet of Things

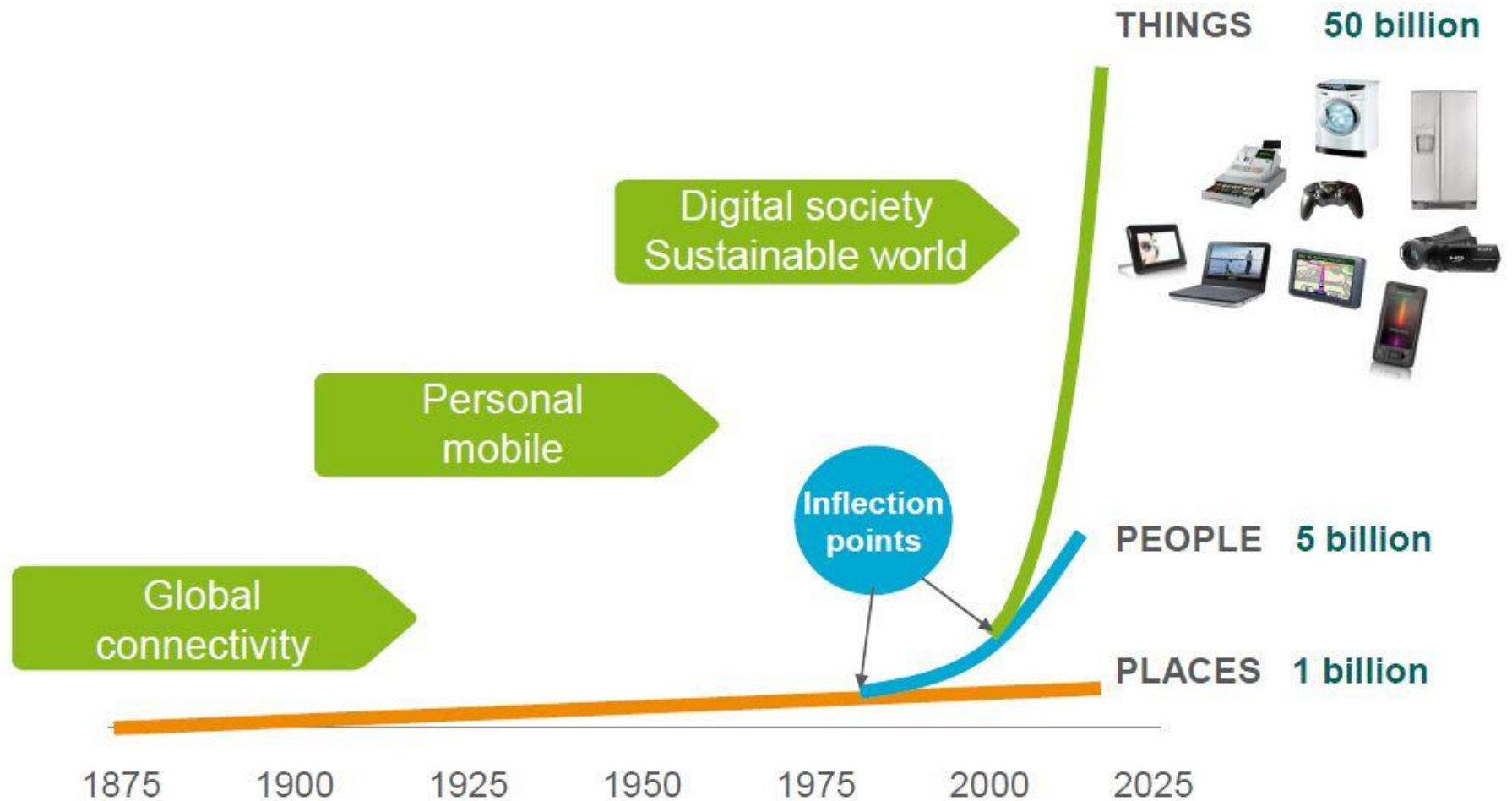




# Connected Living



# Connected Living





# Future of the Internet

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## Usenix: Google deploys IPv6 for internal network

Though the project is only halfway finished, Google's IPv6 network is already bearing fruit

By [Joab Jackson](#), IDG News Service | [Networking](#)  2 comments  Like 

**December 09, 2011, 10:05 AM** — In a project that has taken longer than company engineers anticipated, Google is rolling out IPv6 across its entire internal employee network.

Google network engineer Irena Nikolova discussed the company-wide implementation at the Usenix Large Installation System Administration (LISA) conference, being held this week in Boston. There, she shared some lessons that other organizations might benefit from as they migrate their own networks to [the next generation Internet Protocol](#).

<http://www.itworld.com/networking/231929/usenix-google-deploys-ipv6-internal-network>



# What Will We Learn in this course

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- Data communication concepts
- Computer networking devices
- Internet protocol suite (TCP/IP)
- Capture and analyze network traffic of well-known applications



# What Will We Learn in this course

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## ▣ **Description:**

- ▣ This course include: Data communication basic concepts , layered network models is studied. Digital and analogue signals, encoding and modulating, transmission media, error detection and correction, data link control, local area networks.

## ▣ **Course Objectives :**

- ▣ Introduce fundamentals of data and computer communications
- ▣ Provide the student with a conceptual foundation for the study of data communications using the open system interconnection (OSI) layered architecture model.
- ▣ Review Current fields of communications so that the student will have a sound knowledge in today's environment.



# Data Communication and Networks

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## ▣ Textbook:

- ▣ Behrouz A. Forouzan, **Data communication and networking, 4<sup>th</sup> & 5<sup>th</sup> editions** .

## ▣ References :

- ▣ · Andrews. Tanenbaum, **Computer Networks**, 4th edition . Prentice-Hall PTR 2003.
- ▣ · William Stallings, **Data and Computer Communication**, 8th edition.



# Data Communication and Networks

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## ▣ **Laboratory Works: :**

- ▣ Student required to perform at least **7** different experiments and submit reports for evaluation.

## ▣ **Grading System :**

- ▣ Continuous Assessment (**30%**)
  - Quizzes, Homeworks and Lab work **15**
  - Midterm Exam **15**
- ▣ Final examinations (**70%**)
  - Lab exam or project **25**
  - Final Exam **45**



# Summary

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- Motivations of computer networking
- Data communication
  - Protocols and standards
- Computer networks
  - LAN/MAN/WAN
- Internetworks (networks of networks)