

Data Center Networking

Lecture 1: Introduction

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Contact Details

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Course Delivery

- Lectures - 6 Weeks
 - Slides (9 lectures + 1 revision)
- Assessment
 - Final Exam, 2 hours, 80%
 - Lab Report, 20%
- Expectations
 - To become familiar with the field of data center networking
 - Understanding key technologies in DCN and Interconnection Networks

Relationship with other courses

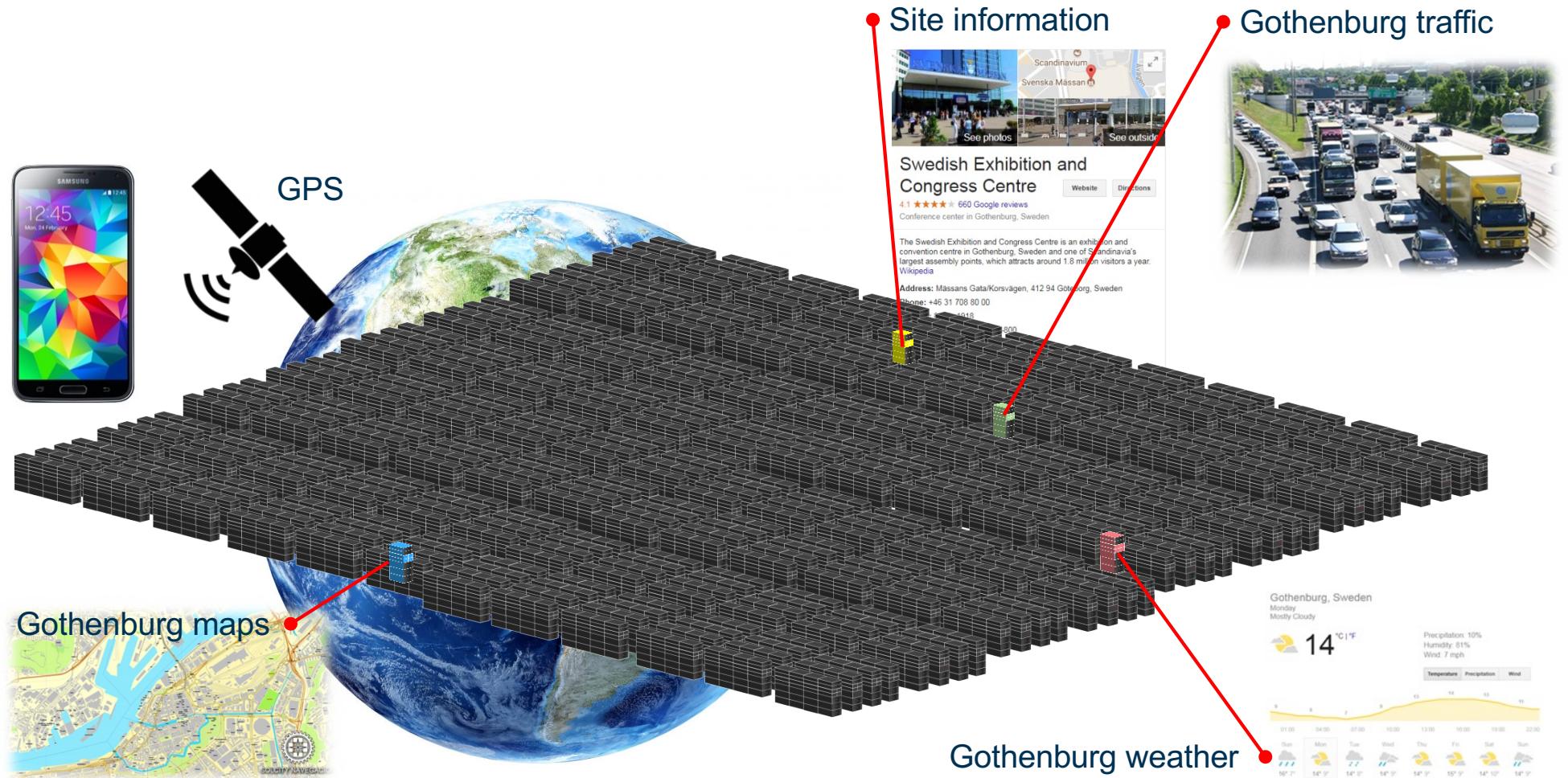
- Optical networks: Access/Metro/Core networks
- Optical communications: transmission systems, components
- Data Center Networking: Focus on networks in Data Centre & High-Performance Computing Centre
 - Large scale networks with a relatively small geographical scale
 - Complex network topologies

- Prerequisites
 - Networking Protocols and Principles
 - Optical Communication Systems and Data Networks
- Textbooks
 - Principles and practices of interconnection networks. by William James Dally & Brian Towles
 - High Performance Datacenter Networks: Architectures, Algorithms, and Opportunities, by Dennis Abts and John Kim
- Course Information
 - Blackboard

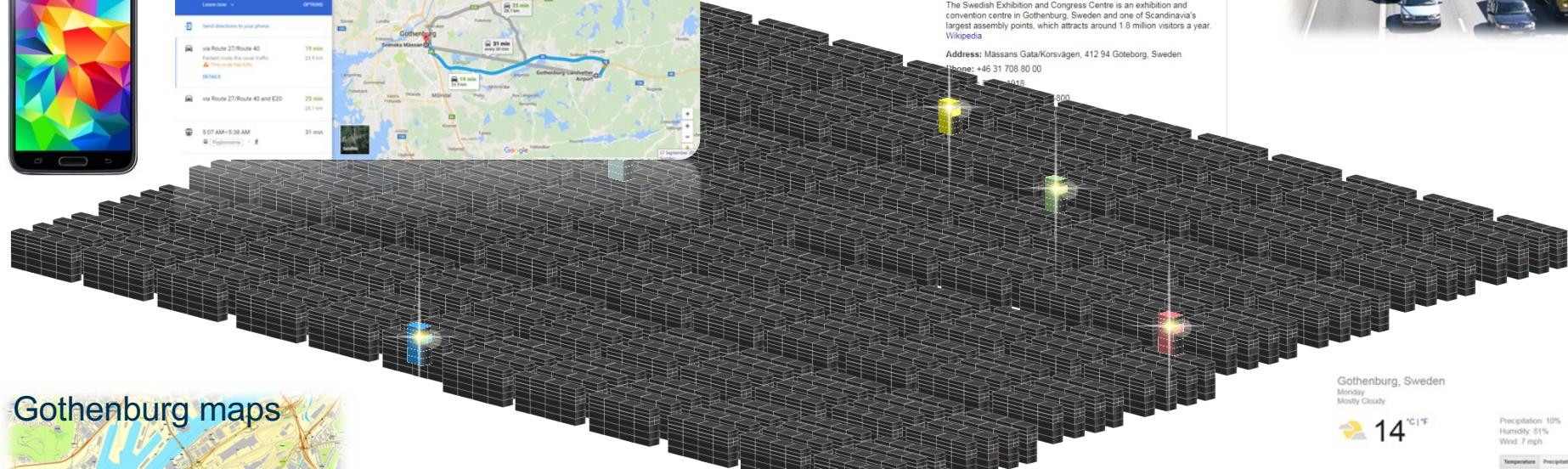
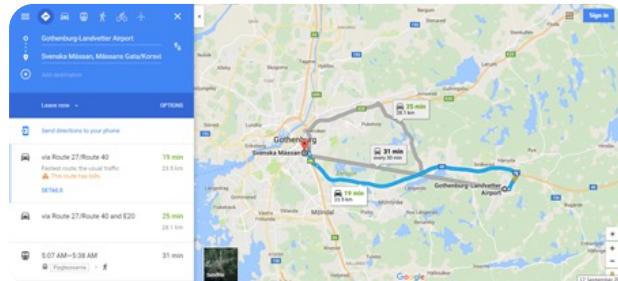
Lecture 1

INTRODUCTION TO DATA CENTER NETWORKING

A typical data-flow



A typical data-flow



Site information



Swedish Exhibition and Congress Centre

4.1 ★★★★☆ 660 Google reviews

Conference center in Gothenburg, Sweden

The Swedish Exhibition and Congress Centre is an exhibition and convention centre in Gothenburg, Sweden and one of Scandinavia's largest assembly points, which attracts around 1.8 million visitors a year.
[Wikipedia](#)

Address: Massans Gata/Korsvägen, 412 94 Göteborg, Sweden

Phone: +46 31 708 80 00

Fax: +46 31 1918

E-mail: [info@massan.se](#)

Website: [www.massan.se](#)

Directions

Gothenburg traffic



Gothenburg weather



A typical data-flow





Microsoft



facebook



NETFLIX



Dropbox



...

- An exciting time for internet
- Transforming everything
- Data centre is the key infrastructure to delivery current internet life.

What is a Data Center ?

Definition. – **Datacenter** *n.*

Computing facility with infrastructure and storage elements plugged on secured power supply

- In the early days of the world wide web, data was most likely delivered to your home computer from a room full of servers in some sort of **corporate data center**.
- Popular web service companies such as Google and Amazon needed to rapidly expand their Data Center to keep up with demand.
- Dedicated server warehouses that are today known as Cloud Data Centers start appears and open to public access.

Google Data Center

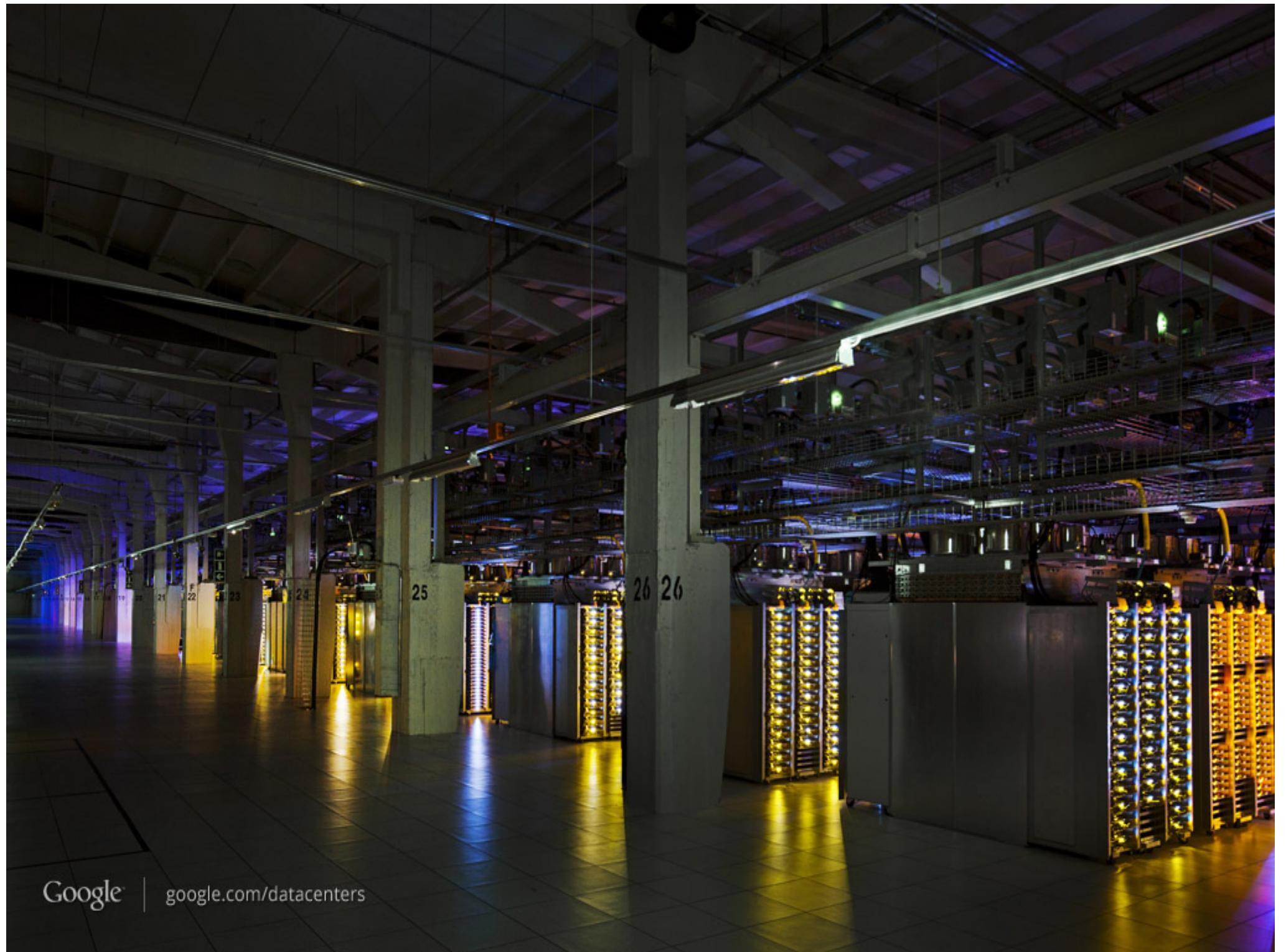


Street view in google DCN

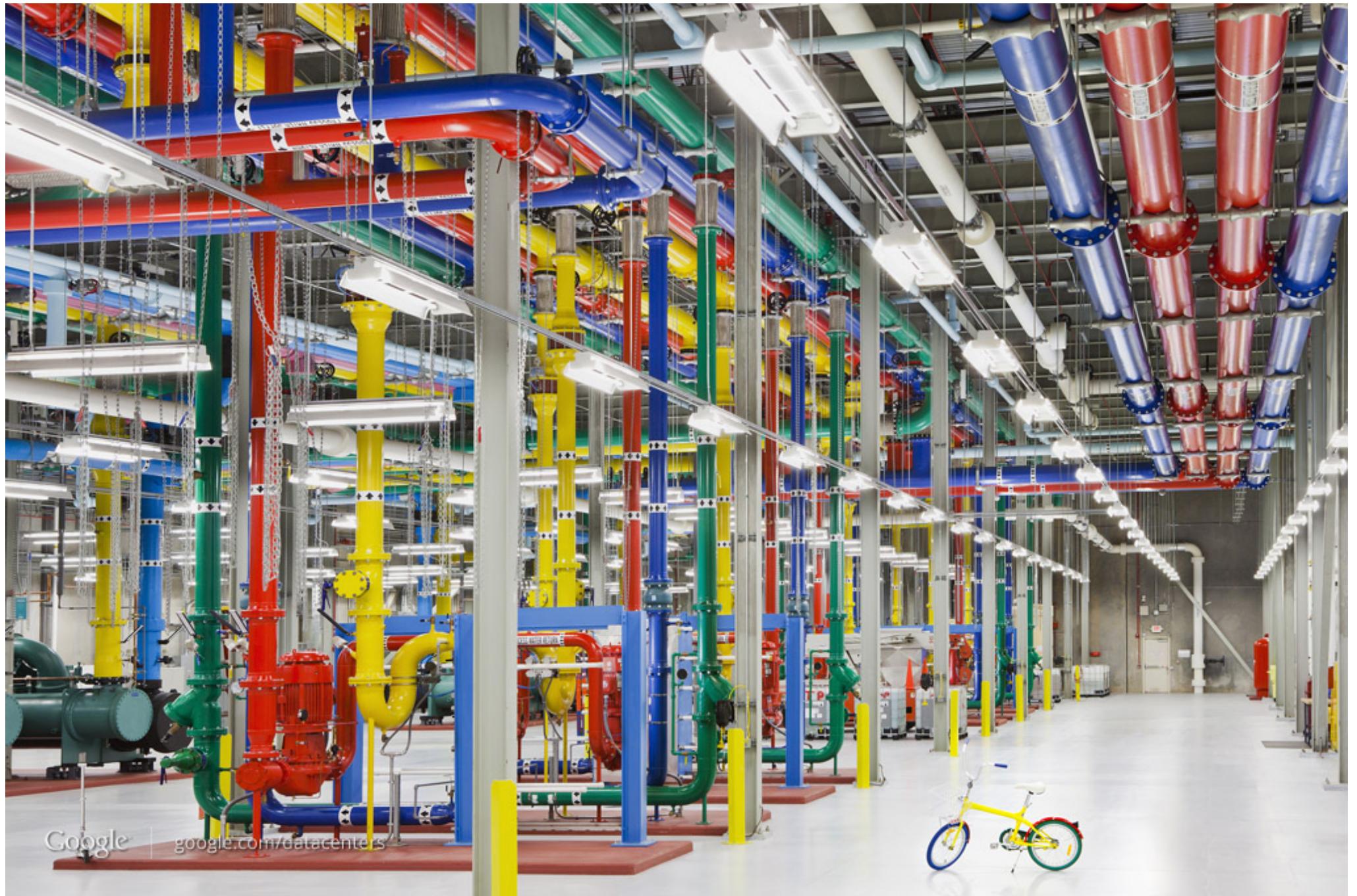
[https://www.google.co.uk/
about/datacenters/inside/
streetview/](https://www.google.co.uk/about/datacenters/inside/streetview/)

.... can deliver more than 1 Petabit/sec of total bisection bandwidth. To put this in perspective, such capacity would be enough for 100,000 servers to exchange information at 10Gb/s each, enough to read the entire scanned contents of the Library of Congress in less than 1/10th of a second.

---- Google 2015



Google | google.com/datacenters



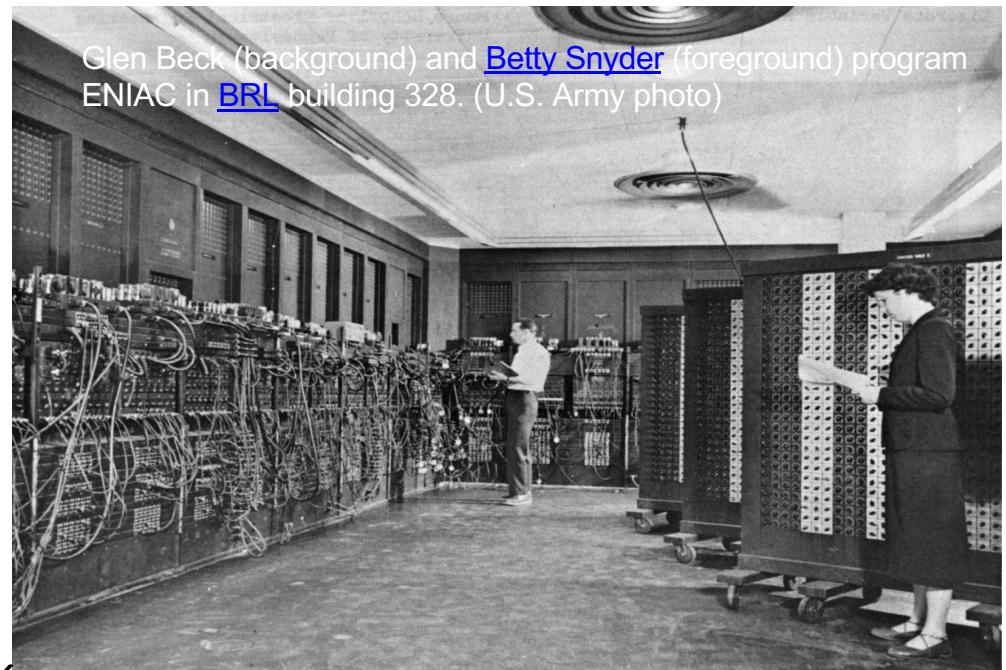
Data Center Evolution

- 1946: The Army developed a huge machine called ENIAC (Electronic Numerator, Integrator, Analyzer, and Computer)

- Weighed 30 tons
- Took up 1,800 sq ft of floor space
- Required 6 full-time technicians to keep it running
- Did 5000 operations per second

- 1965: Sabre® system

- 2 IBM 7090 computers
- located in Briarcliff Manor, New York.
- The system processed 84,000 telephone calls per day.
- Connected to 1500 terminals across the US and Canada.



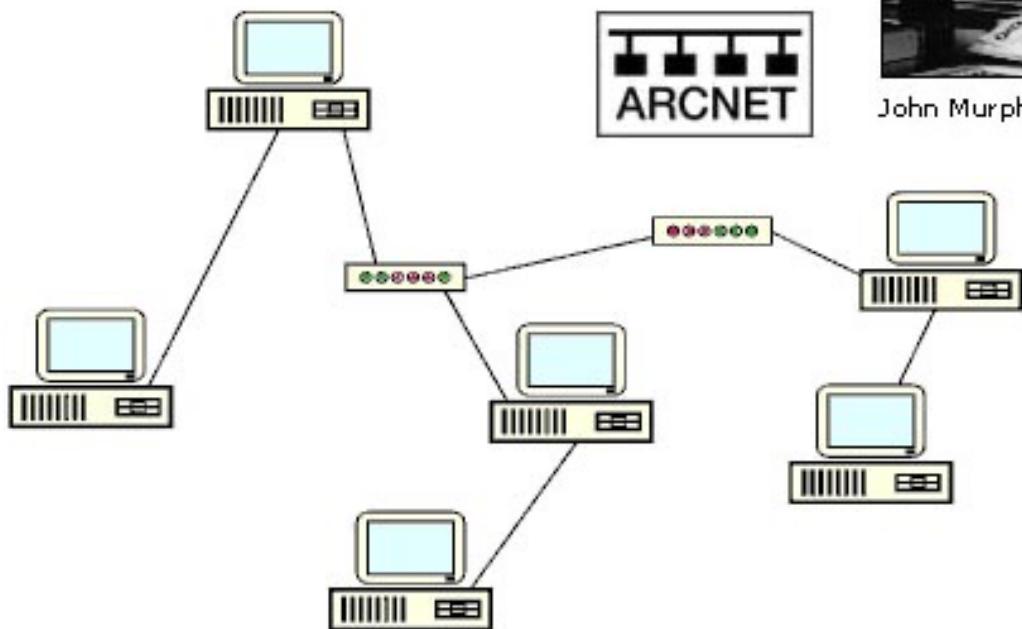
- 1971: first commercial microprocessor: the 4004 (Intel).
- 1977: ARCnet



John Murphy was ARCnet chief architect



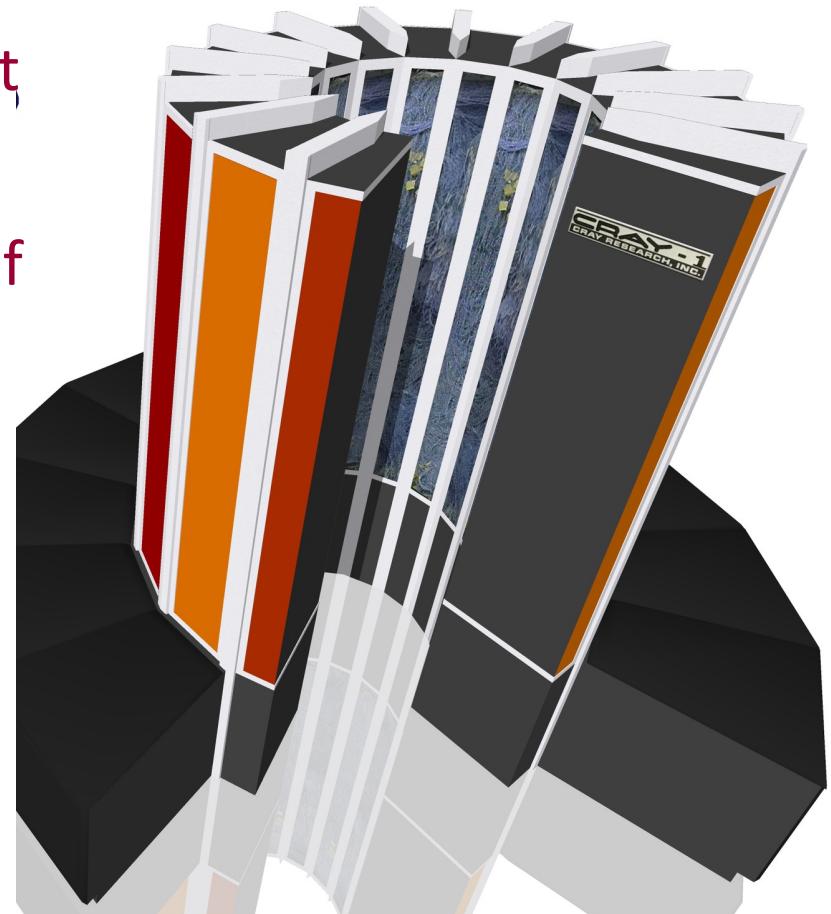
Gordon Peterson (who hates barbers) wrote ARCnet operating system



- The world's first commercially available local area network
- Top-10 most influential inventions that changed the world
- 2.5 Mbps with up to 255 computers

<http://www.old-computers.com/history/detail.asp?n=23&t=3>

- 1976 Cray-1
 - Notion of “vector” operations that allowed a single instruction to operate on an array, or “vector,” of elements simultaneously.
 - The vector parallelism approach dominated the high-performance computing landscape for the 1980s and early 1990s



- 1980s: the birth of the IBM Personal Computer (PC)
 - 1985, IBM provided more than \$30 million in products and support over the course of 5 years to a supercomputer facility established at Cornell University in Ithaca, New York.
 - In 1988, IBM introduces the IBM Application System/400 (AS/400), and quickly becomes one of the world's most popular business computing systems.
- 1990s: Companies were putting up server rooms inside their company walls with the availability of inexpensive networking equipment.
 - Rackspace Hosting opened their first datacenter to businesses in 1999.

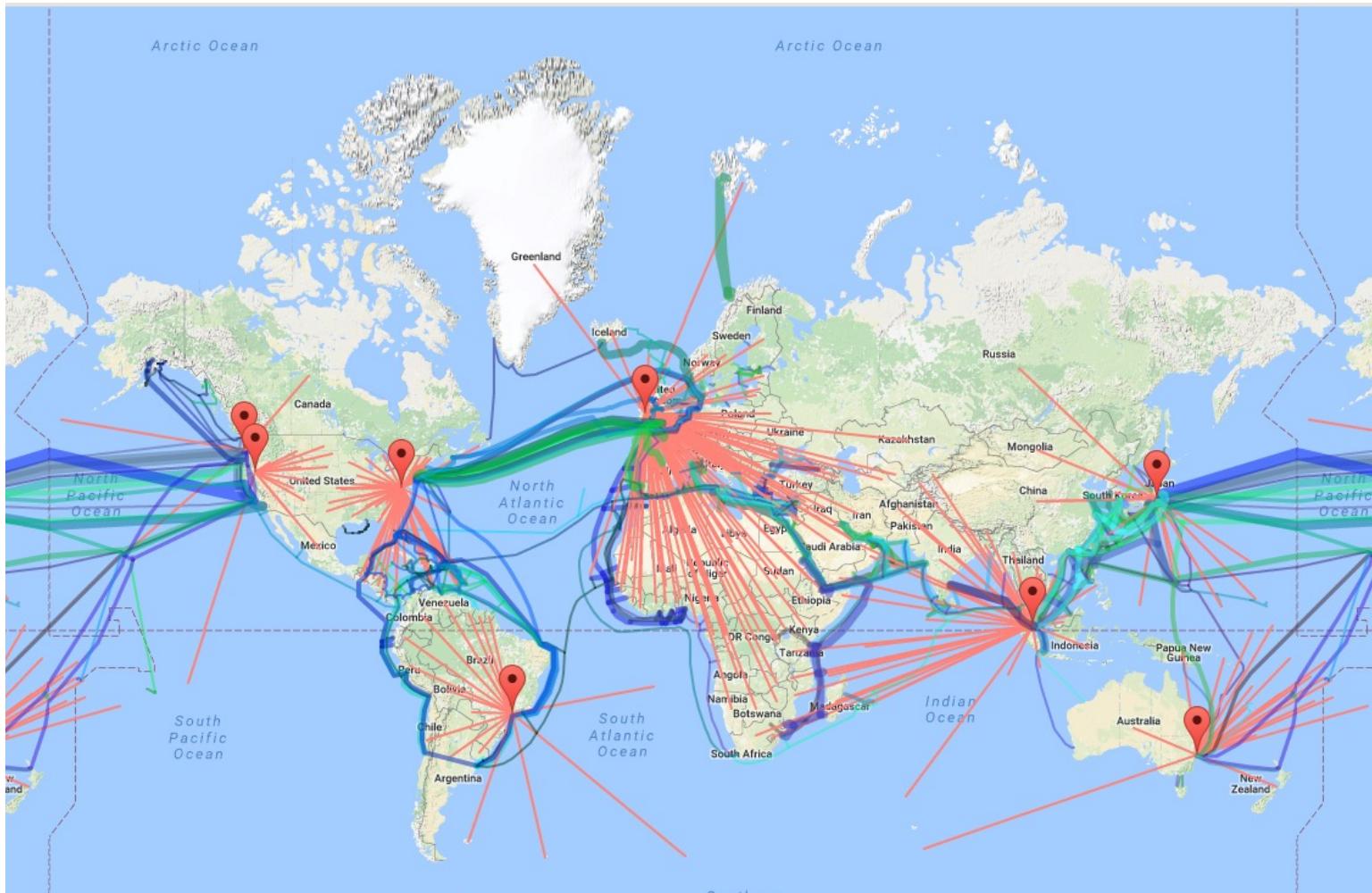
Data Center Evolution

- 2000s:
 - 2002 Amazon Web Services
 - 2007 Sun Modular Datacenter
 - 2013 Google invested \$7.35 billion in its Internet infrastructure
 - 2015 Over 5.75 million new servers are deployed every year.
 - There are an estimated 4,500+ datacenters in the U.S. alone.
 - To meet the growing demand of new applications and services, servers need to be deployed at an increasingly faster pace and larger number.

- 1 million active customers
- All 14 other cloud providers combined have 1/5th the aggregate capacity of AWS (estimate by Gartner in 2013)
- Every day, AWS adds enough new server capacity to support all of Amazon's global infrastructure.
- S3 has 132% year-over-year growth in data transfer



Amazon Web Service (AWS)



Mashup of AWS regional data centers and worldwide underwater cables

Cloud computing

- Cloud services allow individuals and businesses to use software and hardware that are managed by third parties at remote locations.
 - On demand self service
 - Ubiquitous network access
 - Resource pooling
 - Rapid elasticity
 - Flexible pricing pay per use

Cloud computing

Advantages of Cloud Computing :

- Lower Computing Cost
- Improved Performance
- Reduced Software Cost
- Instant Software Updates
- Unlimited Storage Capacity
- Increased Data Reliability
- Device Independence and the "always on, anywhere and any place"
- Free from Maintenance and the “no-need-to know”

Cloud Service Models- examples

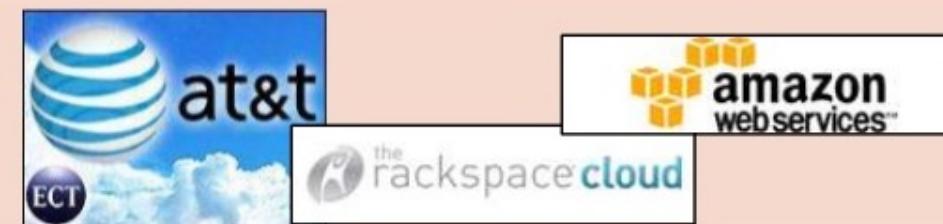
Software as a Service (SaaS)



Platform as a Service (PaaS)



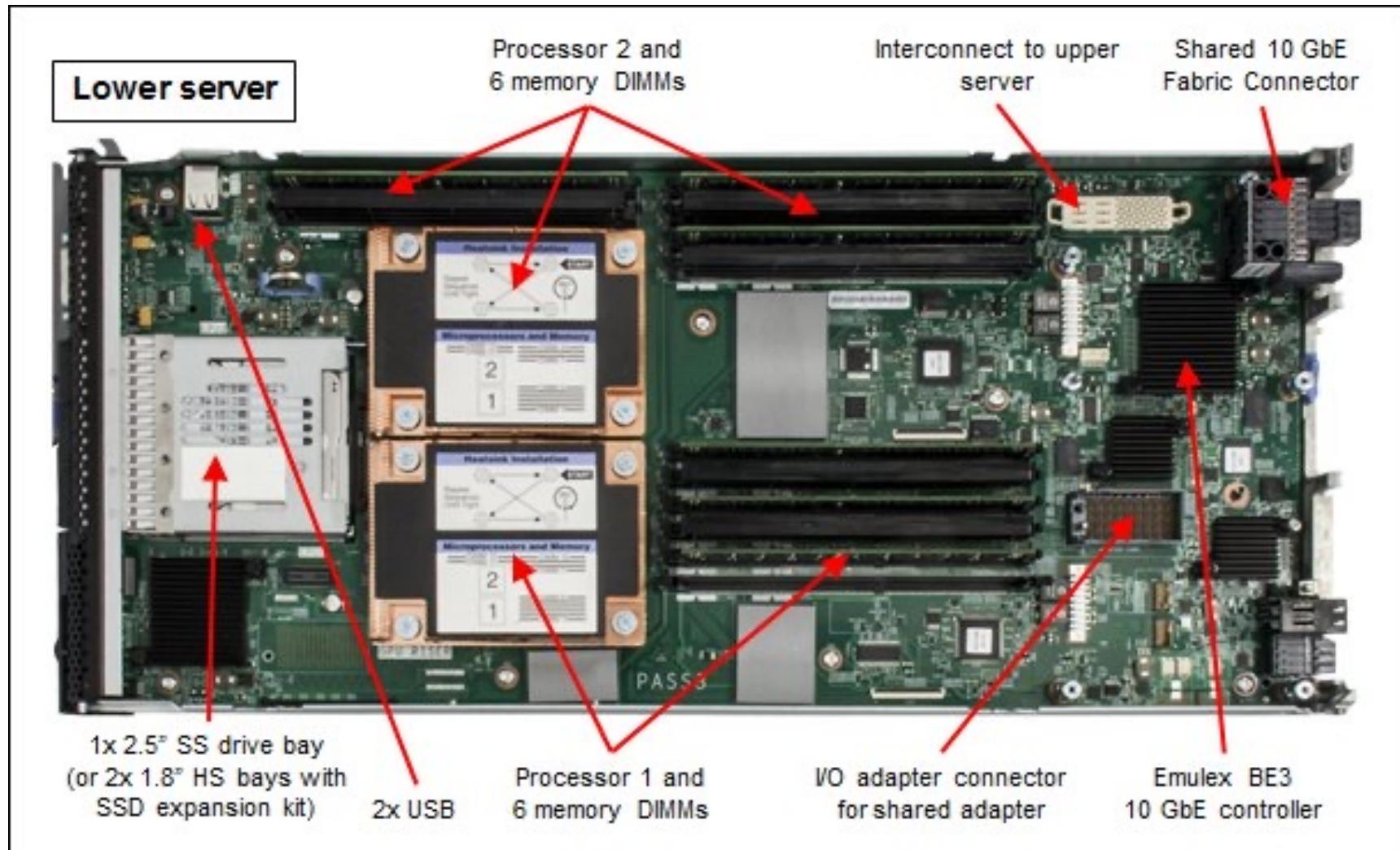
Infrastructure as a Service (IaaS)



- Massive number of servers
- Massive amount of storage
- Orchestrated together with a Data Center Network
- Virtual Machine support

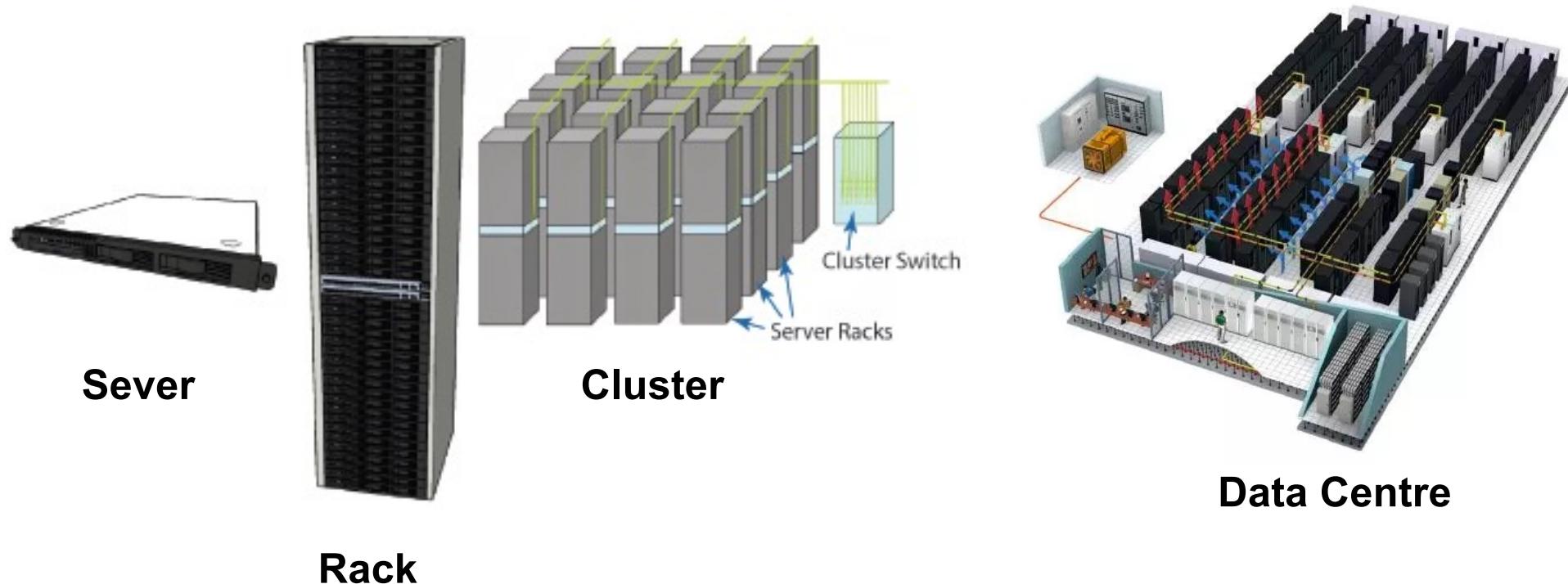
Intel: 70-80% of compute, storage, and network gear will go into scale data centers by 2025.

Inside of a server

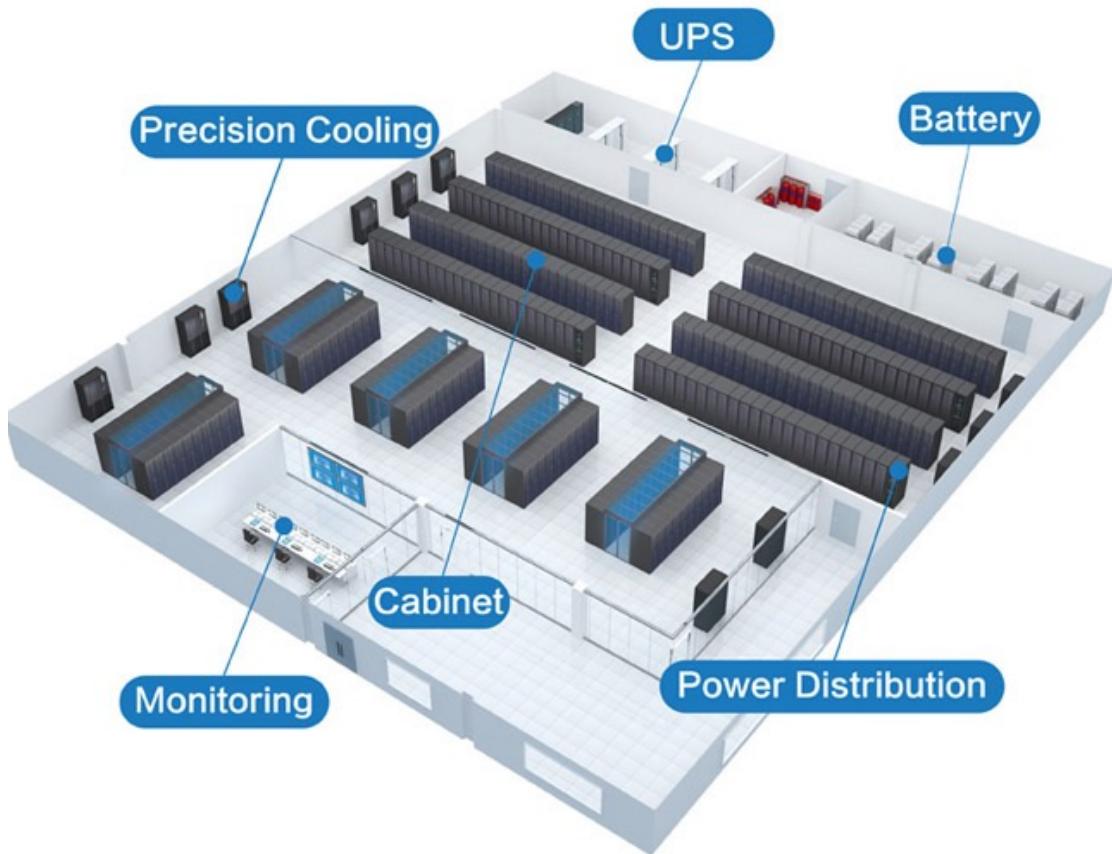


<https://lenovopress.com/tips1036-flex-system-x222-compute-node>

Data Center Networks



Data Centre



Data Centre



Racks of Data Centre

Objective of this course

- Introducing the relevant technologies for datacenter
 - Data center architecture
 - Interconnection networks
 - Protocols for data center networks
 - Advanced technologies for data center networking

Outline of the course

- Chapter 1: Introduction of data center networking
- Chapter 2: Architectures of data center networks
- Chapter 3: Traffic characteristic of DCN
- Chapter 4: Interconnection networks
 - Part 1: Network topologies
 - Part 2: No-blocking networks
- Chapter 5: Routing
- Chapter 6: Network Protocols for data center networks
- Chapter 7: InfiniBand protocol architecture
- Chapter 8: Advanced technologies for data center networking

Book Chapter:

Evolving Requirements and Trends in Datacenter Networks

- https://www.ole.bris.ac.uk/bbcswebdav/pid-4577670-content-rid-19049739_2/courses/EENGM0008_2020_TB-2/Liu2020_Chapter_EvolvingRequirementsAndTrendsO.pdf