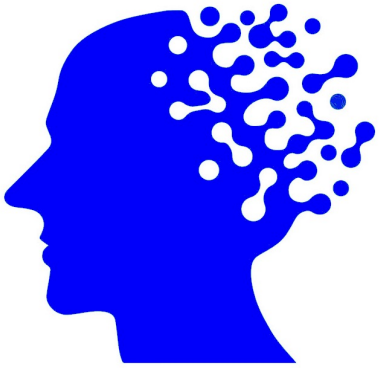

Spring 2023

Distributed Computing
- The Fundamental Aspects

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05th January 2023 (http://rajendra.2power3.com)

> About this Lecture

What do we learn today?

- This Lecture covers the essential aspects (of Distributed Algorithms / Systems) that every serious programmer needs to know about
  - **The Fundamentals of Distributed Algorithms**
  - **Design principles** and **Analysis**

with an emphasis on certain properties of

- **The Scalable Application Development**

Let us explore these topics ➔ ➔ ➔

Today's Focus

> Distributed Computing?

- How will you design a Distributed Algorithm?

- Learn to Solve using Distributed Algorithms

Recap: What do we learn?

Distributed Computing (DC)

- ➔ Core Theoretical Concepts
- ➔ Design Principles of DC
- ➔ Discrete Events Simulations
- ➔ Experimental Evaluations
- ➔ Designing Efficient Solution(s) ??
  - ➔ To Solve Some Interesting Problems !!

➔ An Overview of Distributed Computing

➔ ➔ Simple to advanced?

Recap: Distributed Systems

A Distributed System:

- A collection of independent systems that appears to its users as a single coherent system
- A system in which hardware and software components of networked computers communicate and coordinate their activity only by passing messages
- A computing platform built with many computers that:
  - Operate concurrently
  - Are physically distributed (have their own failure modes)
  - Are linked by a network
  - Have independent clocks

Recap: Characteristics

- Concurrent execution of processes:
  - Non-determinism, Race Conditions, Synchronization, Deadlocks, and so on
- No global clock
  - Coordination is done by message exchange
  - No Single Global notion of the correct time
- No global state
  - No Process has a knowledge of the current global state of the system
- Units may fail independently
  - Network Faults may isolate computers that are still running
  - System Failures may not be immediately known

What do we learn?

- Some Important aspects of DC:
  - Reliable network
  - Zero Latency
  - Infinite Bandwidth
  - Secure network
  - Fixed Topology
  - Only one administrator
  - Zero Transport cost
  - Homogeneous Network
- Remember these points while developing scalable applications

Reliable Network

- Hardware may fail! Power failures; Switches have a mean time between failures

Implications:

- Hardware: weight the risks of failure versus the required investment to build redundancy
- Software: we need reliable messaging: be prepared to retry messages, acknowledge messages, reorder messages (do not depend on message order), verify message integrity, and so on.

Zero Latency

Latency (not bandwidth):

How much time do the data take to move from one place to another? → measured by time

- ➔ The minimum round-trip time between two points on earth is determined by the maximum speed of information transmission: the speed of light.
- ➔ At 300,000 km/sec, it will take at least 30msec to send a ping from Europe to the USA and back

Implications:

- ➔ Strive to make as few calls over the network (other than LANs) as possible

Infinite Bandwidth

Bandwidth: how much data you can transfer over a period of time (may be measured in bits/second)

- ➔ It constantly grows
- ➔ Bandwidth may be lowered by packet loss: we may want to use larger packet sizes

Implications:

- ➔ Compression: simulate the environment to get an estimate for your needs

Secure Network

How to secure the underlying network?

Implications:

- ➔ You may need to build security into your applications from the beginning
- ➔ As a result of security considerations, you might not be able to access networked resources, different user accounts may have different privileges, and so on
- ➔ How to solve these issues efficiently?

Fixed Topology

Topologies do not change as long as you are in a closed environment

- ➔ In reality, servers may be added and removed often, clients (laptops, wireless ad hoc networks) are coming and going: the topology is changing constantly

Implications:

- ➔ Do not rely on specific endpoints or routes
- ➔ Abstract the physical structure of the network: the most obvious example is DNS names as opposed to IP addresses

Who is the Administrator?

Different Administrators may be associated with the network with different degrees of expertise

- ➔ Might make it difficult to locate problems
- ➔ Coordination of upgrades: will the new version of MySQL work as before with Ruby on Rails?
- ➔ Never underestimate the 'human' factor!

Zero Transport Cost

- Going from the application layer to the transport layer (2nd highest in the five layer TCP/IP reference model) is not free:
- Information needs to be serialized (marshalling) to get data onto the wire
- The cost (in terms of money) from setting and running the network is not zero.
- Have we leased the necessary bandwidth

Everything costs "Money" !!

Homogeneous Network

Homogeneous = of the same kind; uniform

- Even a home network may connect a Linux PC and a Windows PC. A homogeneous network today is the exception, not the rule!

Implications:

- Interoperability will be needed
- Use standard technologies such as XML

Summary

Focused on exploring the following:

- Fundamental aspects while building distributed applications
- Necessary Properties of a DS
- Desirable properties of a DS
- Networks and Message Passing Architectures of a DS
- Many more to come up … stay tuned in …

Penalties

- Every Student is expected to strictly follow a fair Academic Code of Conduct to avoid penalties

- Penalties is heavy for those who involve in:
  - Copy and Pasting the code
  - Plagiarism (copied from your neighbor or friend – in this case, both will get "0" marks for that specific take home assignments)
  - If the candidate is unable to explain his own solution, it would be considered as a "copied case"!!
  - Any other unfair means of completing the assignments

Help among Yourselves?

- **Perspective Students** (having CGPA above 8.5 and above)
- **Promising Students** (having CGPA above 6.5 and less than 8.5)

- **Needy Students** (having CGPA less than 6.5)
  - Can the above group help these students? (Your work will also be rewarded)

- You may grow a culture of **collaborative learning** by helping the needy students

How to reach me?

➔ Please leave me an email:

rajendra [DOT] prasath [AT] iiits [DOT] in

➔ Visit my homepage @

➔ https://www.iiits.ac.in/people/regular-faculty/dr-rajendra-prasath/

(OR)

➔ http://rajendra.2power3.com

Assistance

- You may post your questions to me at any time
- You may meet me in person on available time or with an appointment
- You may ask for one-to-one meeting

Best Approach

- You may leave me an email any time
  (email is the best way to reach me faster)

Questions
It's Your Time

Contact Information

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