1. SYNCHRONIZATION
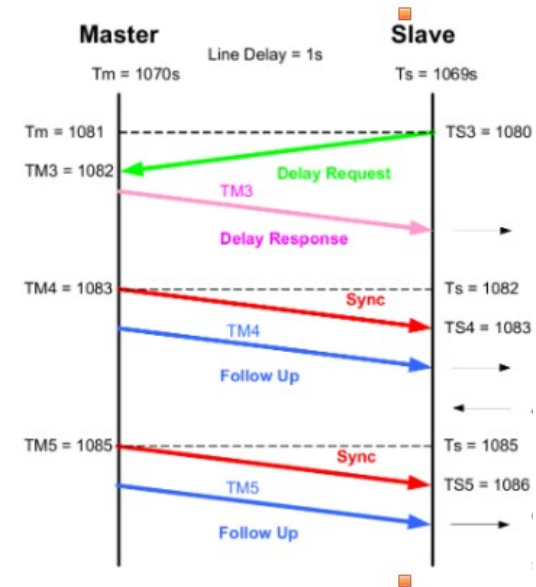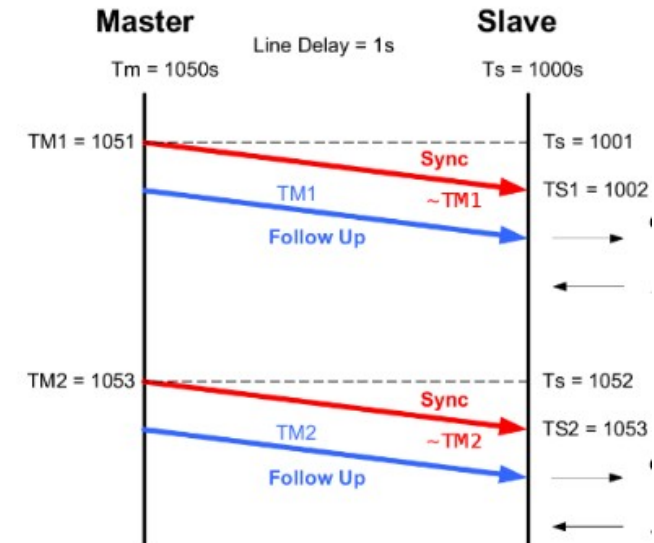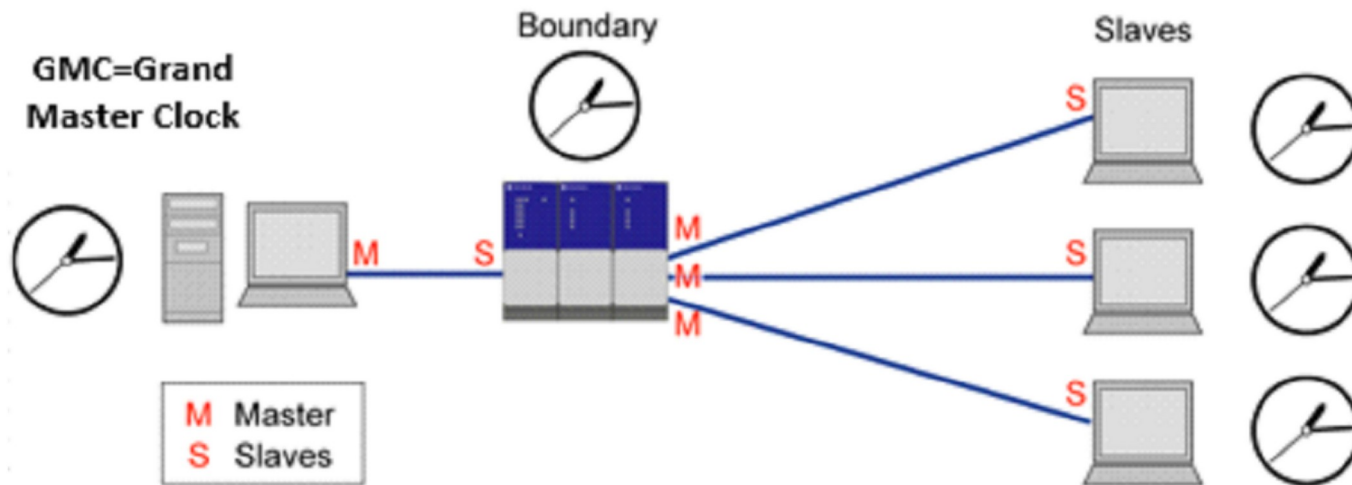
Motivation

- Distributed System challenges

- Common notion

Techniques (Real)

- Challenges
- Precision Time Protocol
  - Timestamp

Techniques (Logical)
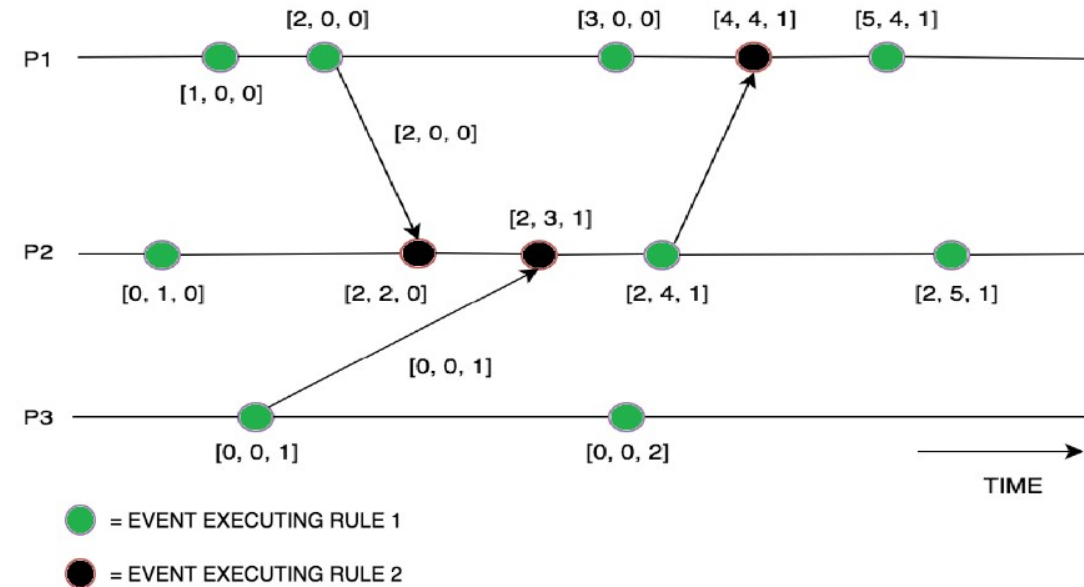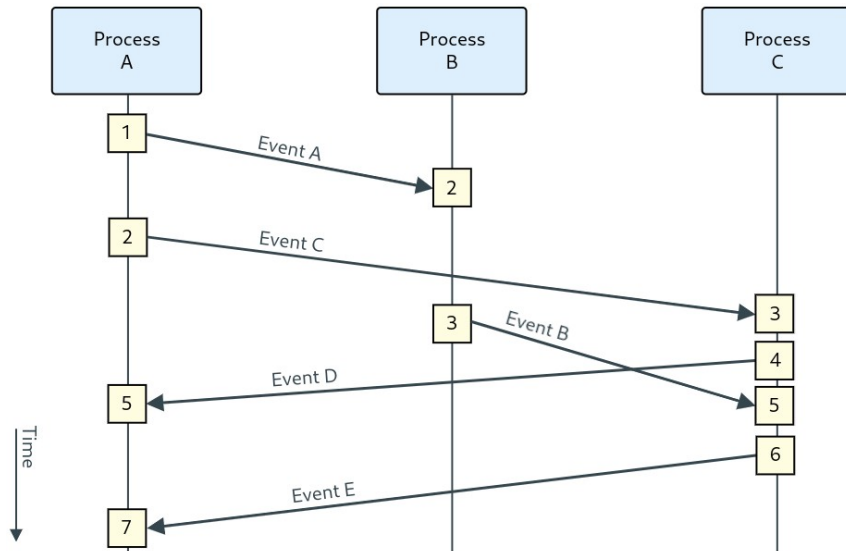
- Challenges

- Lamport time-stamps

- Vector Clocks

$$e_1 \rightarrow e_2 \Rightarrow C(e_1) < C(e_2)$$

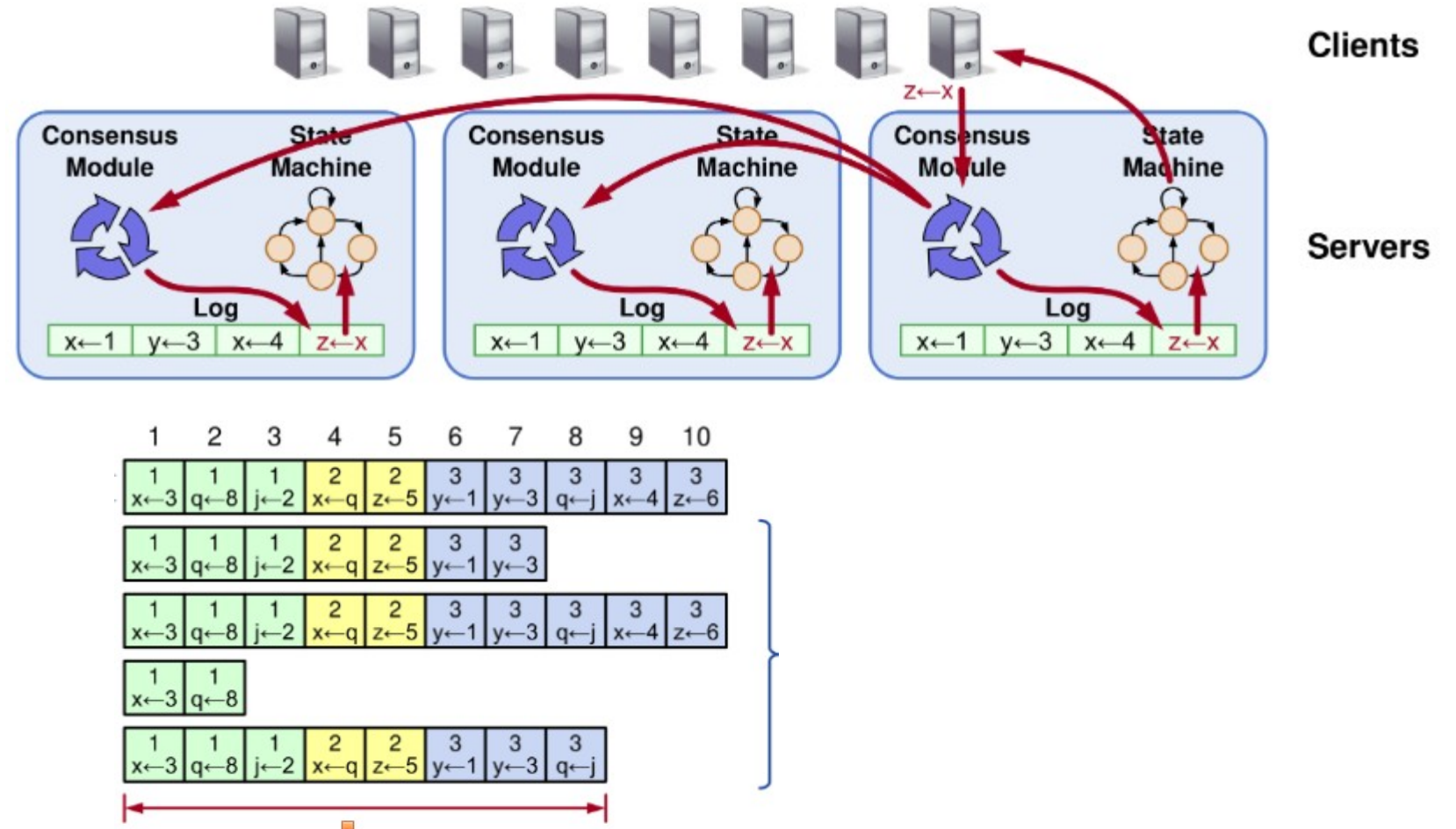thus, if $C(e_1) \not< C(e_2)$ then $e_1 \not\rightarrow e_2$

$$e_1 \rightarrow e_2 \Leftrightarrow C(e_1) < C(e_2)$$

$$C(e_1) < C(e_2) \textbf{ even if } (e_1 \not\rightarrow e_2 \wedge e_2 \not\rightarrow e_1) \text{ (concur. events)}$$
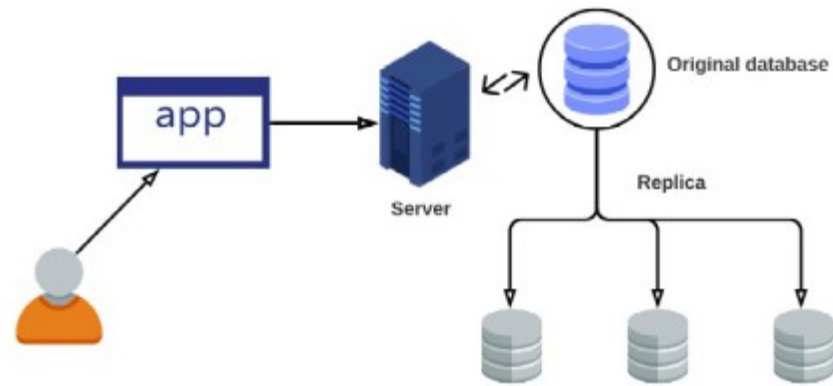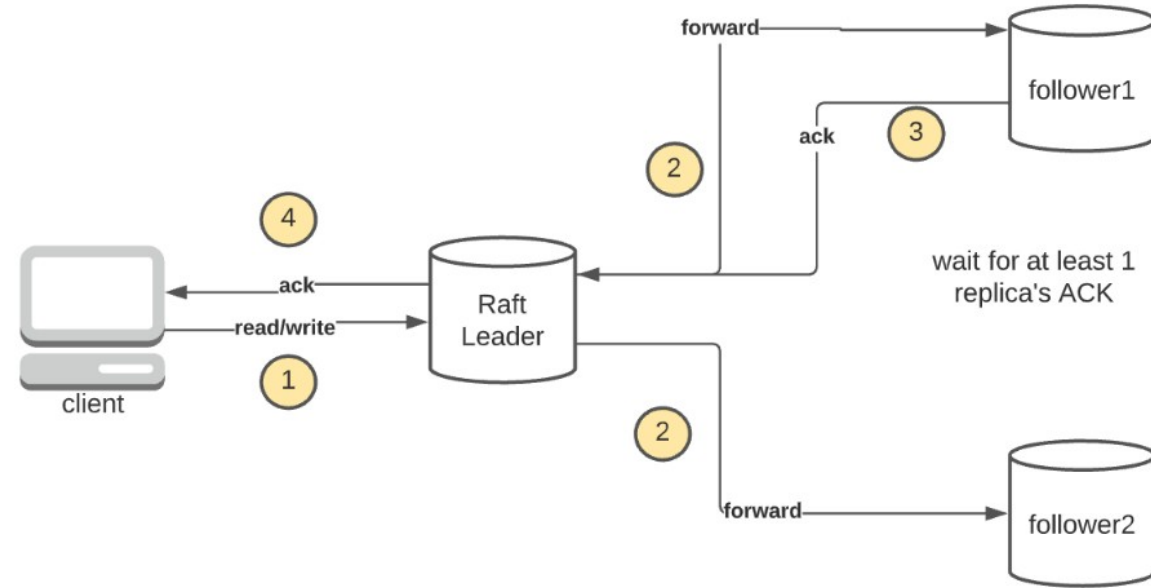
Perspectivation

- RAFT
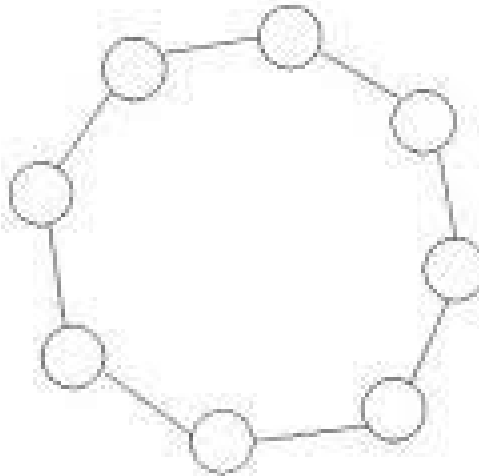
2. LEADER ELECTION AND CONSISTENCY

Motivation

- Leader Election
  - Data & Div./Conq.

- Consistency
  - Replication → Troubles

Leader Election
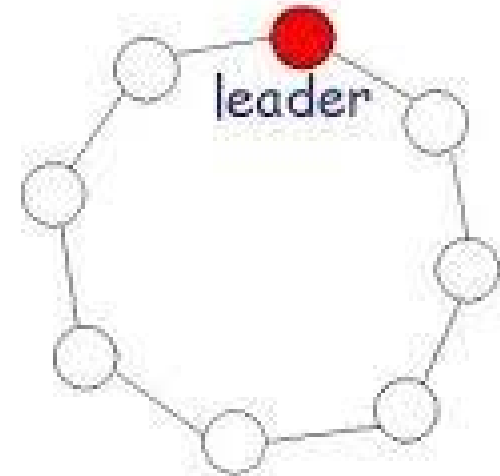
- Prerequisites
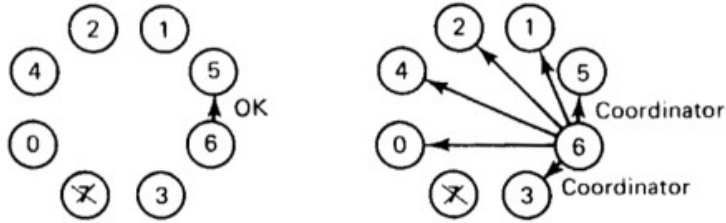- General Approach
- When?
- Technique Comparison

Techniques

- Bully
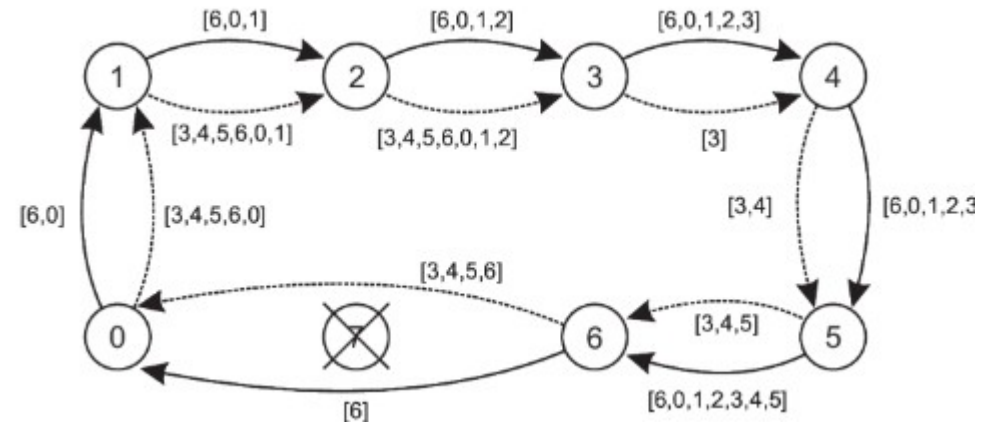- Ring-based: Chang and Roberts
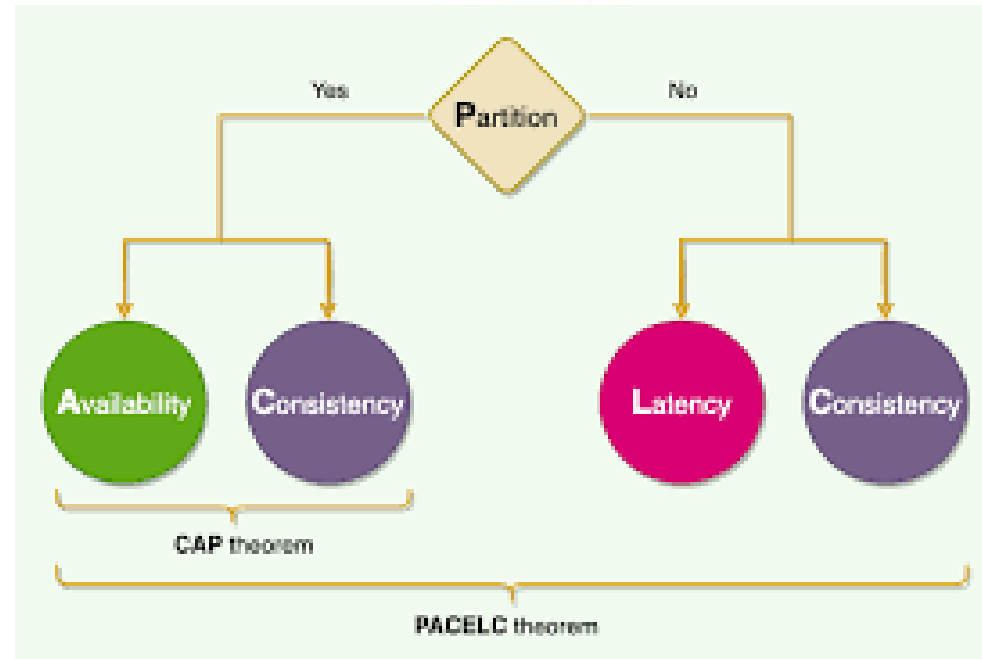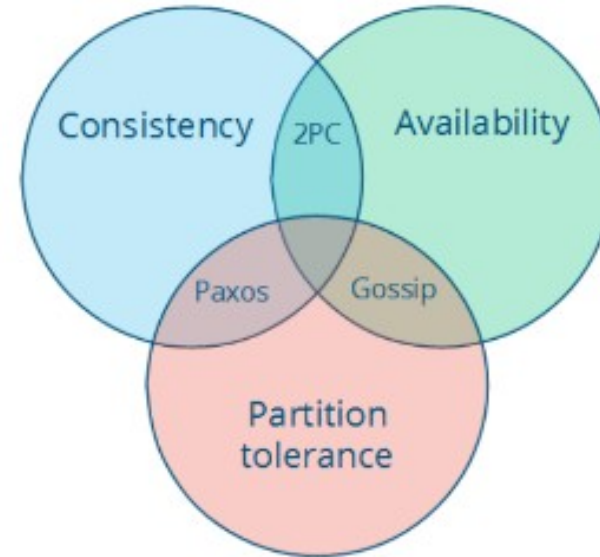- Message Complexicity

$$N\text{-}1 + N\text{-}2 + \ldots + 1 = (N\text{-}1)\cdot N/2 = O(N^2)$$
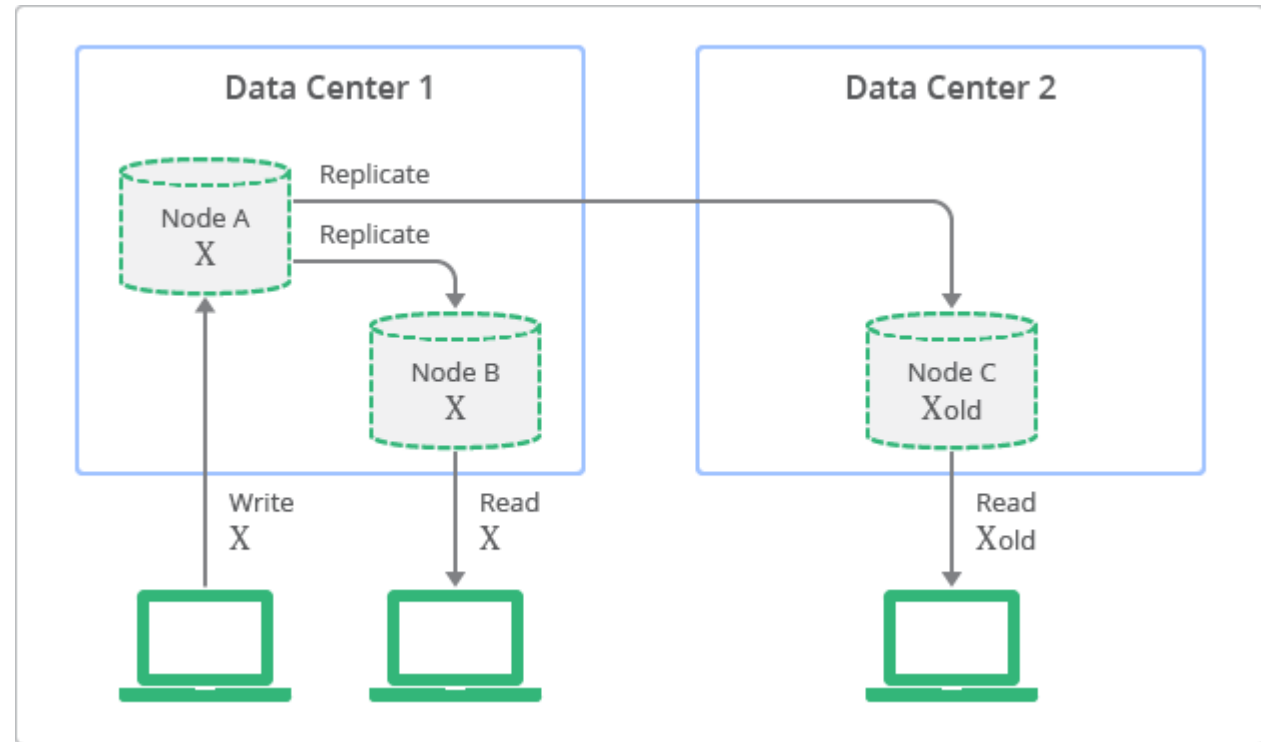
Consistency !
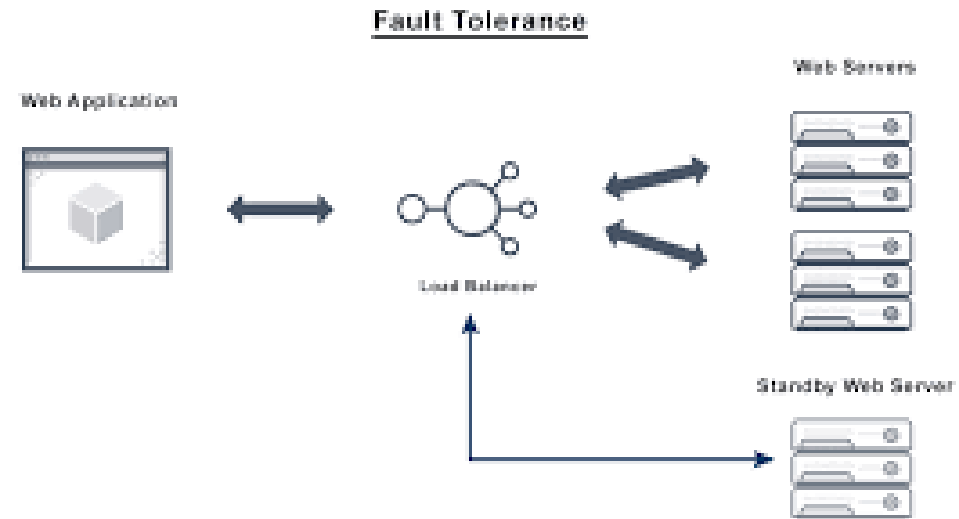
—

- CAP

- PACELC

Consistency models

- Strong Consistency

- Weak Consistency

- Eventual Consistency

- ....

3. FAULT TOLERANCE AND CONSENSUS

Motivation

- Fault Tolerance
  - Failures?
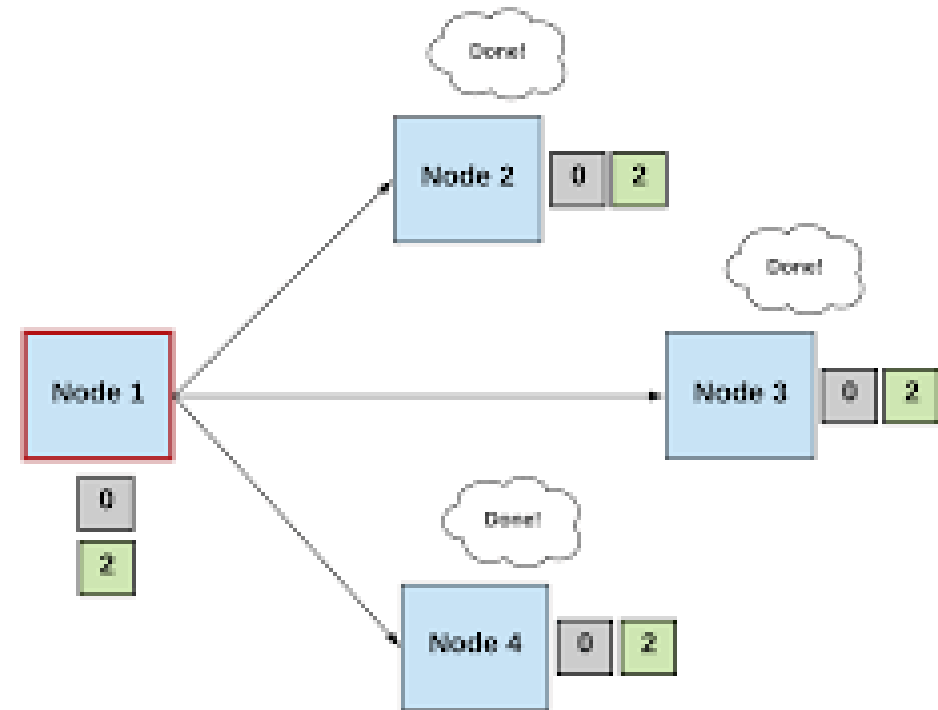
- Consensus
  - Coherent group

Terminology

- Failures:
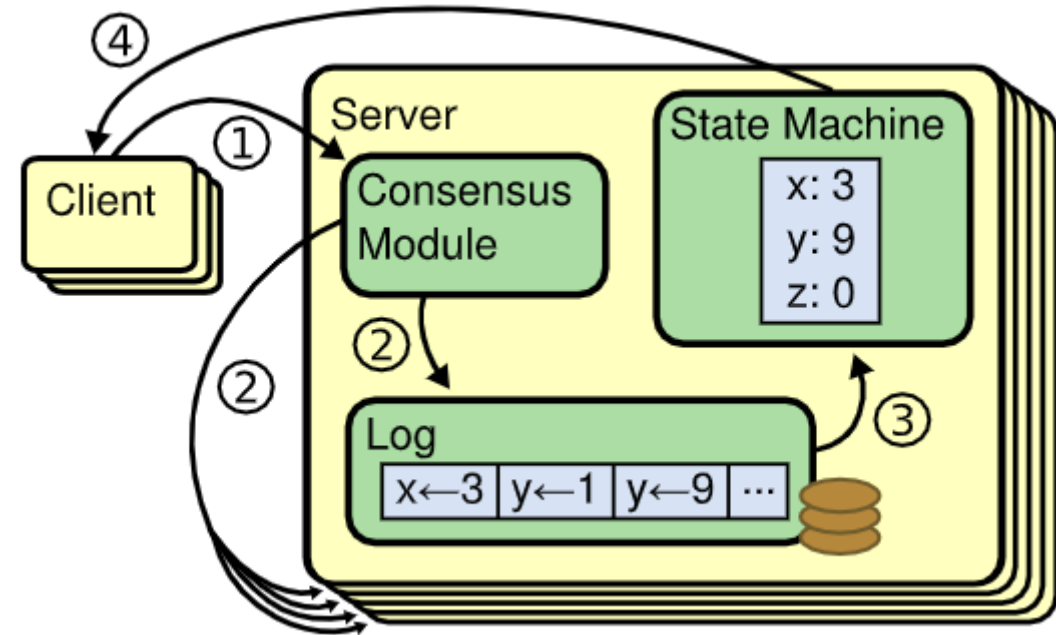 - Crash, Arbitrary...

- Fault consequences

Consensus

- What?
  - Fault consequences

- Approaches
  - State machine replication
- X Process fails

- Paxos, Zoo Keeper, RAFT

RAFT

!

- **Basics**
- Leader Election
- Log Replication
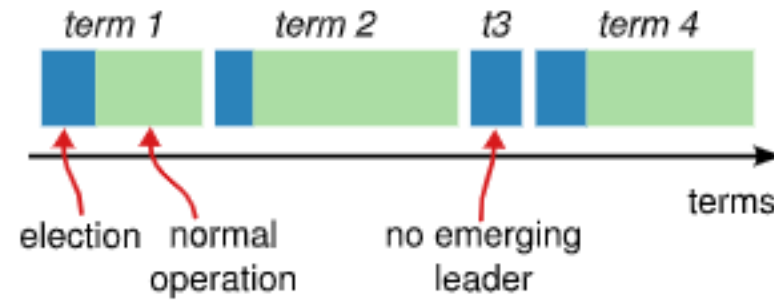- Election Restriction (Safety)
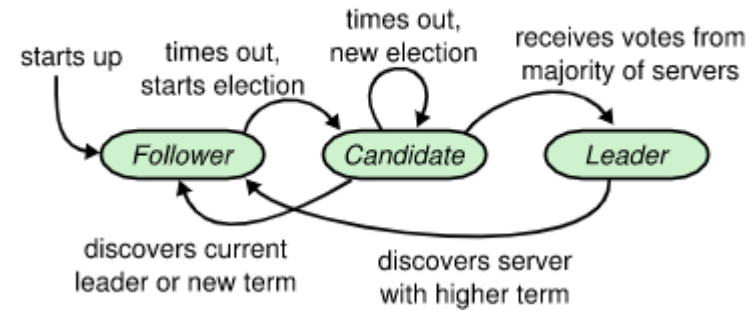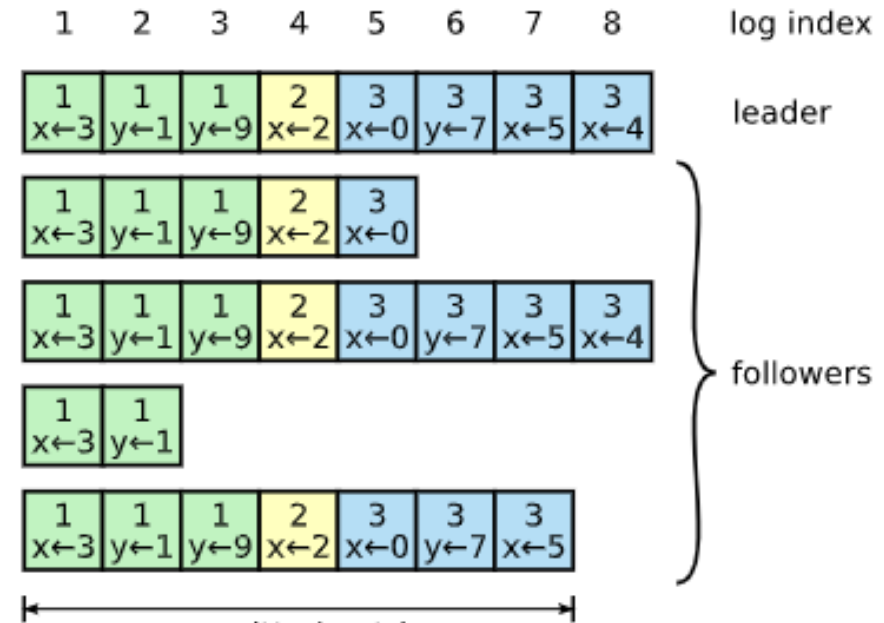
RAFT   !

- Basics
- **Leader Election**
- Log Replication
- Election Restriction (Safety)
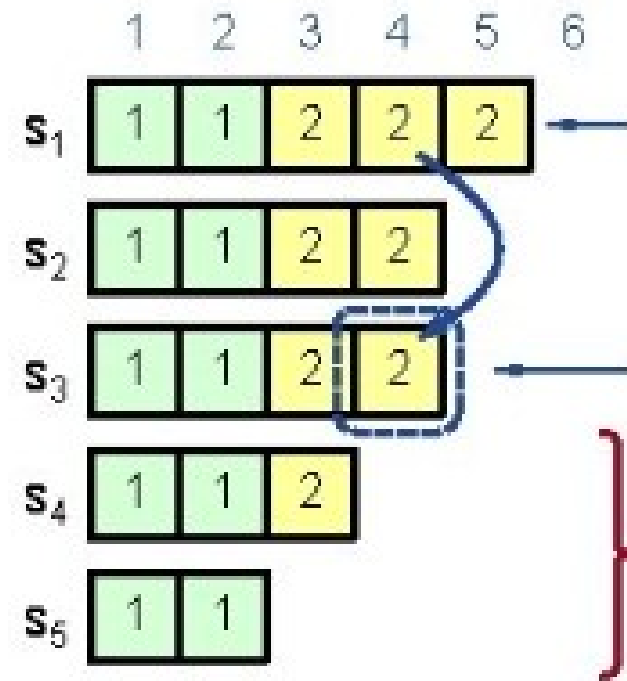
RAFT   !

- Basics
- Leader Election
- **Log Replication**
- Election Restriction (Safety)

RAFT !

- Basics
- Leader Election
- Log Replication
- **Election Restriction (Safety)**

4. POSITIONING AND LOCATION AWARENESS

Motivation

- Navigation

- Firefighters
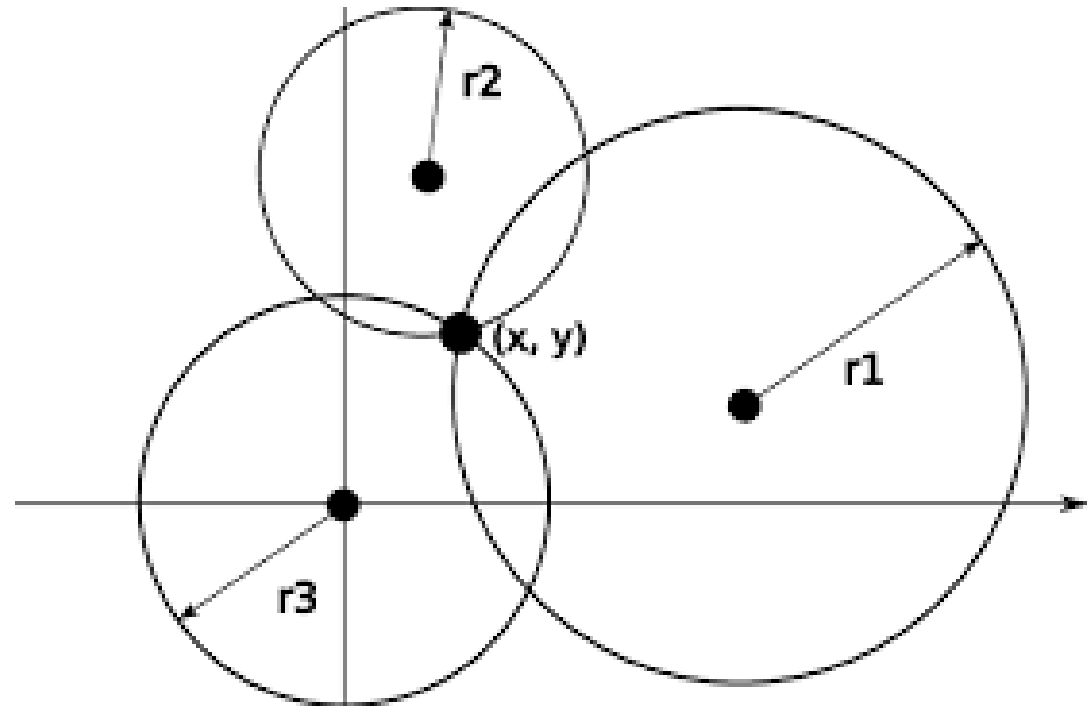
Challenges

- Level

- Privacy

Concepts

- Position
  - Absolute/Relative/Hybrid
- Location

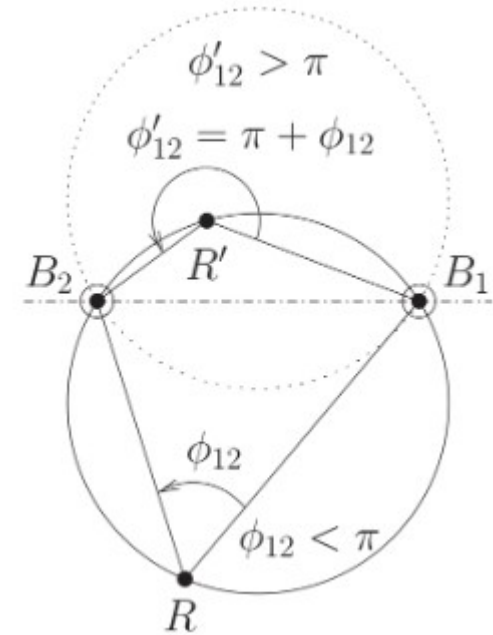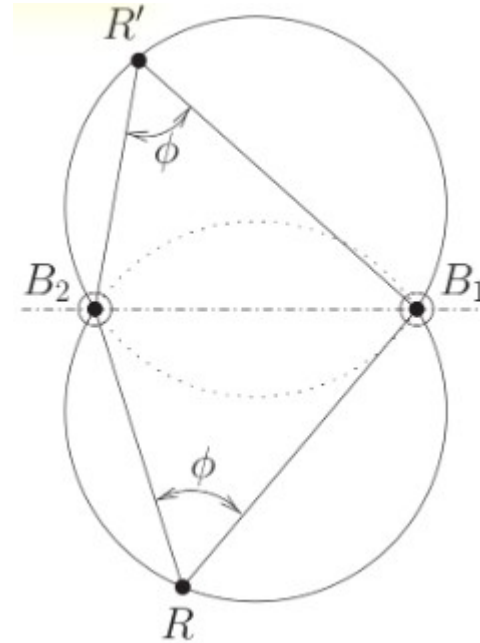- Location Service
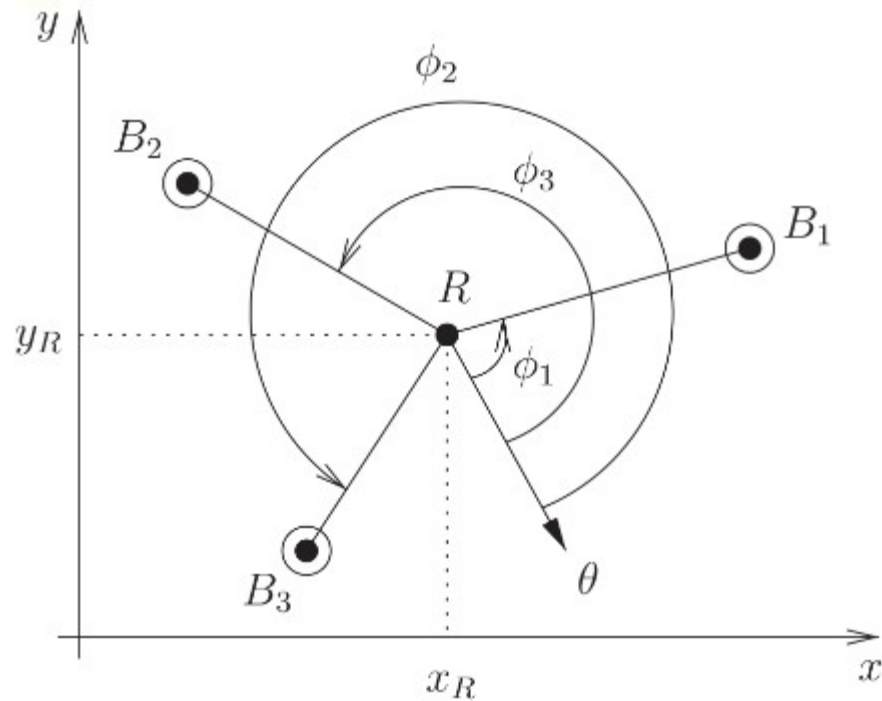
- Location Based Service

Absolute Positioning
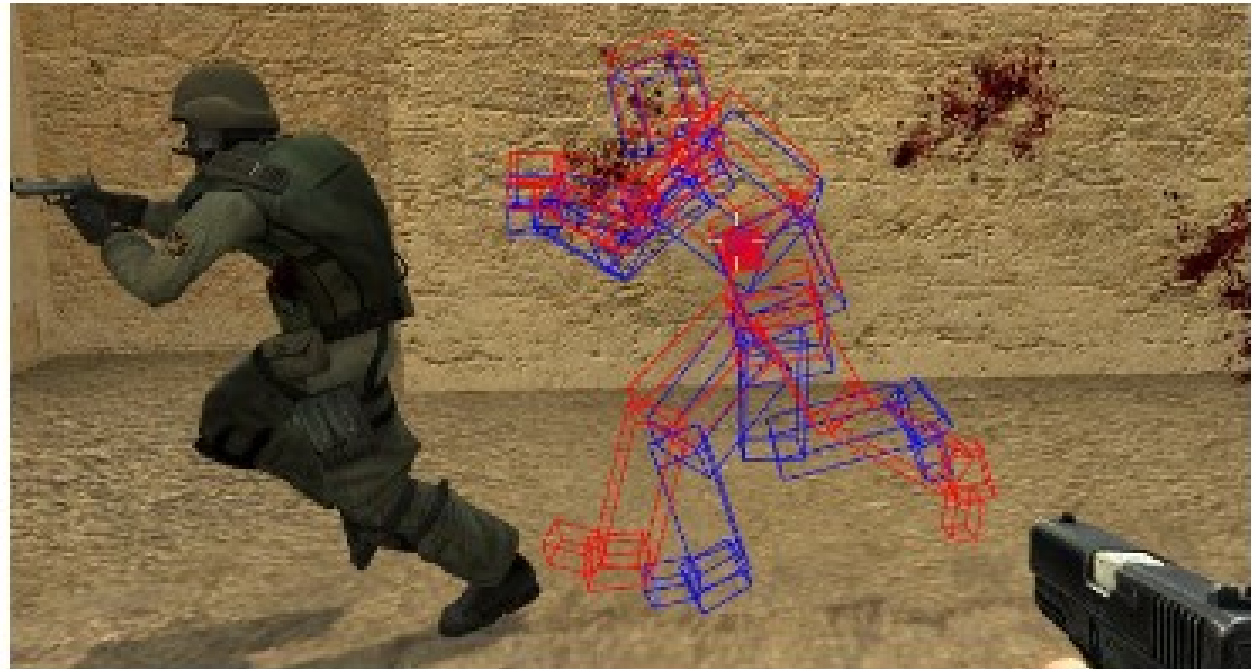
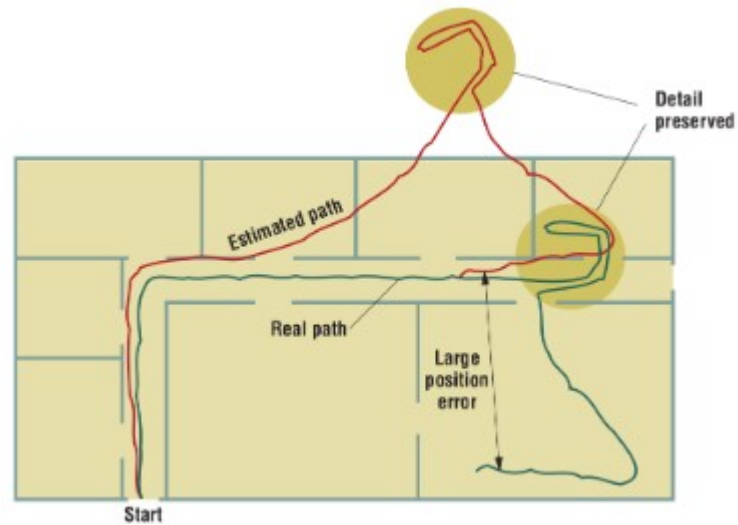- **Trilateration**

- Triangulation (ToTal)

Absolute Positioning

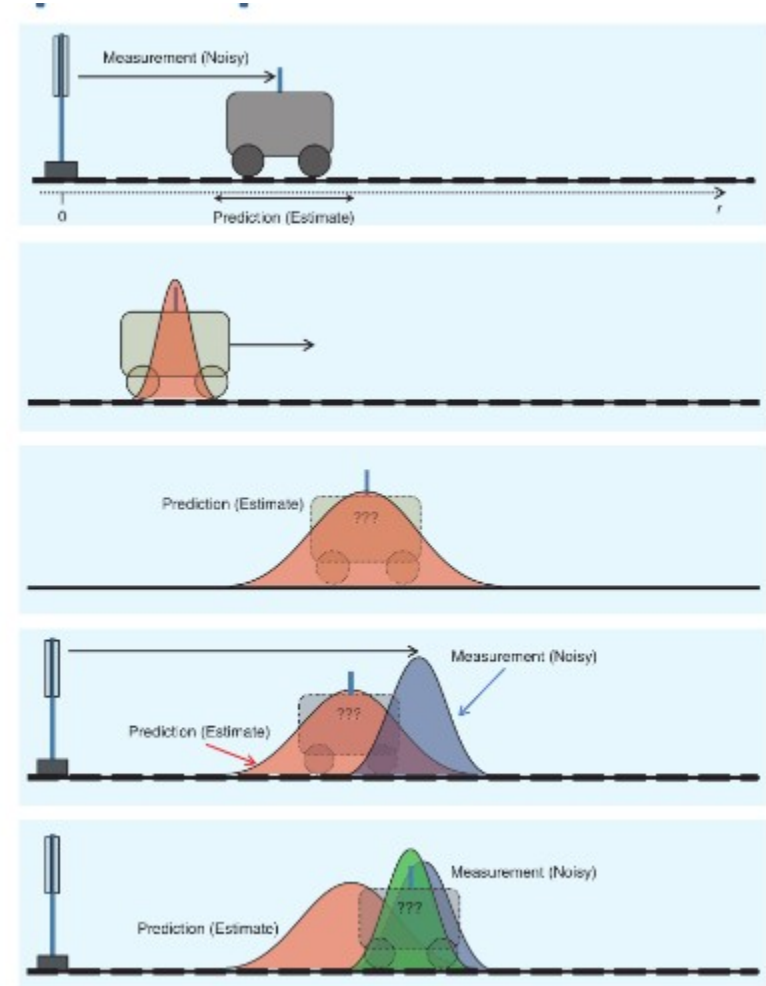- Trilateration
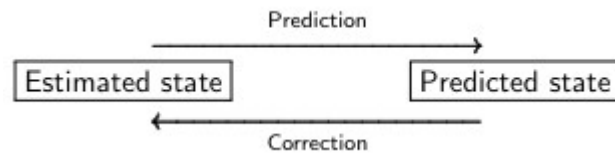
- **Triangulation (ToTal)**

Relative Positioning

—

- Dead Reckoning

Hybrid Positioning

- Sensor Fusion

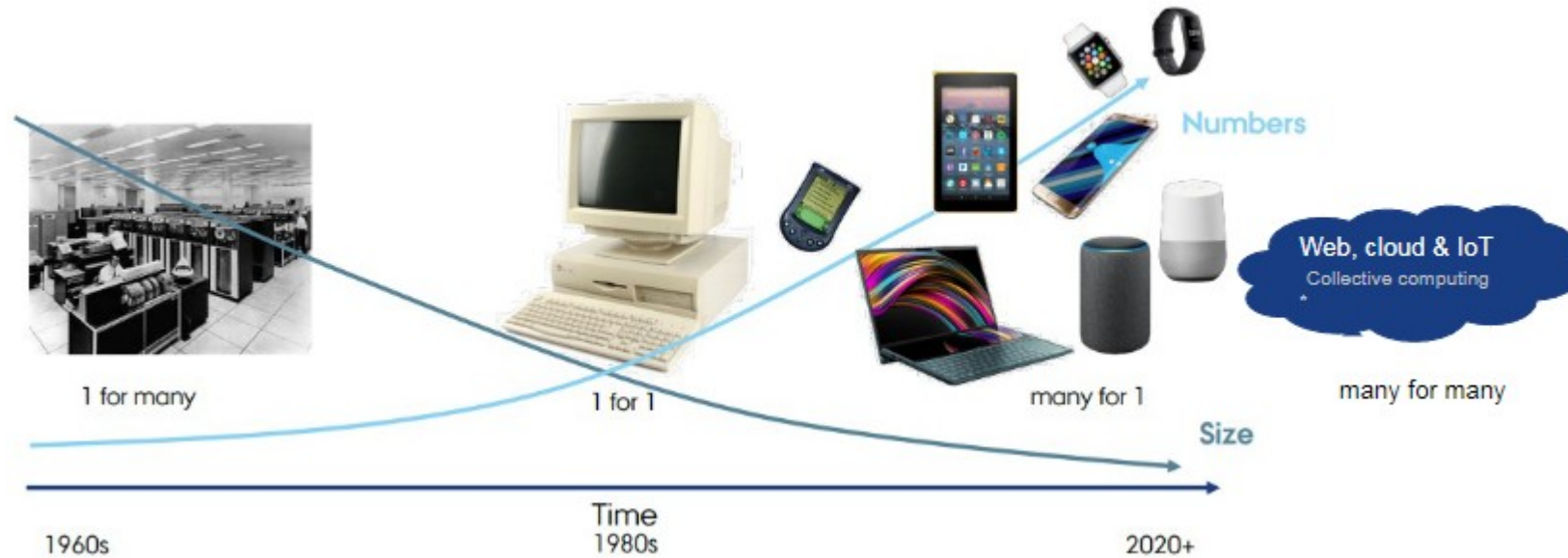- Kalman filters

Perspective

- Pervasive systems

- Article - Privacy

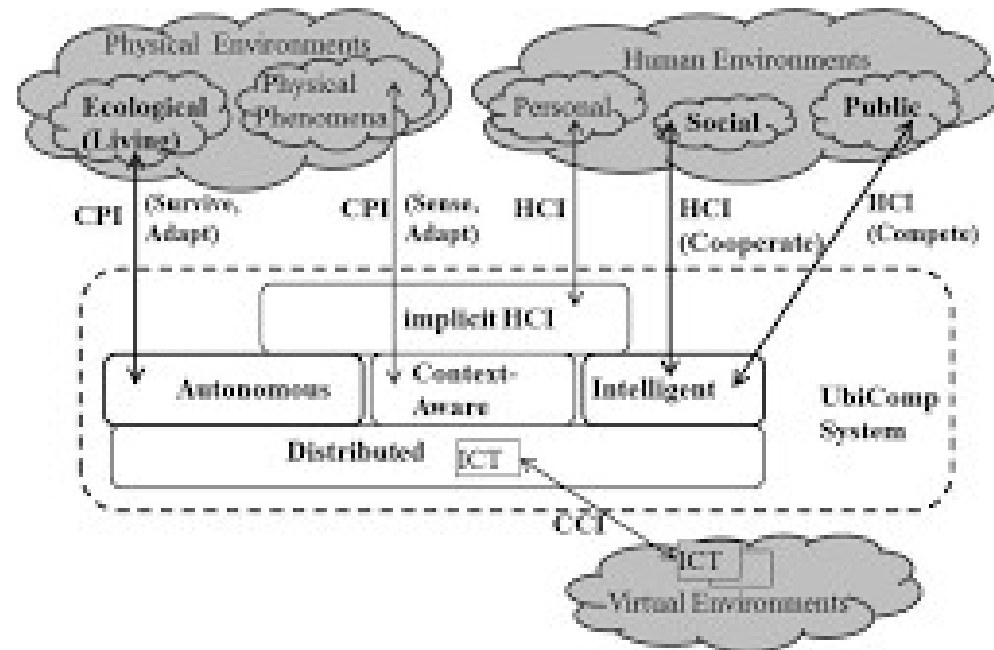# 5. PERVASIVE COMPUTING (BACKGROUND, METHODS AND ENABLING TECH.)

Background

- Weiser – XEROC PARC
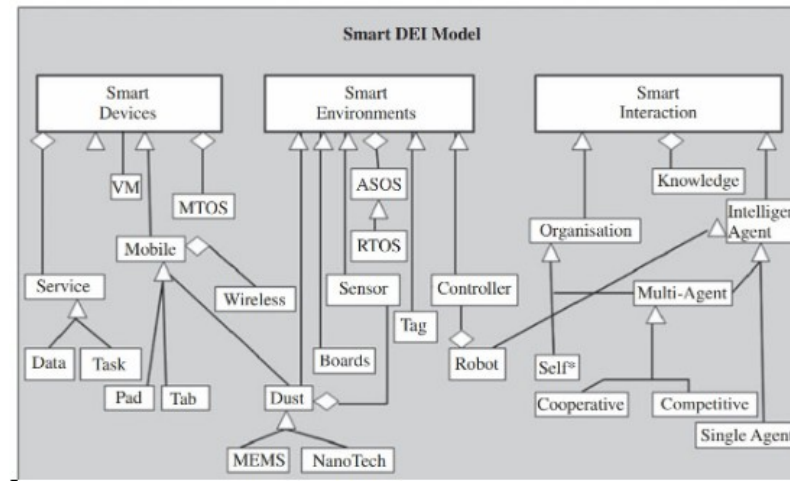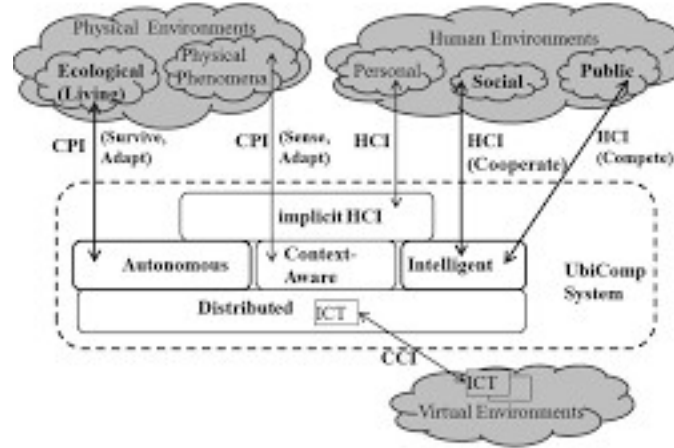- → Cloud, Crowd and Shroud

Properties

- Ubiquitous

- Transparent

- Openness

- Autonomous
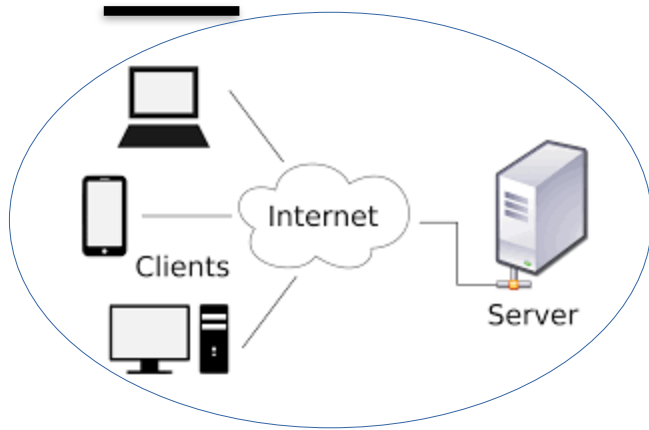
Concepts/Methods

- Awareness

- Interaction
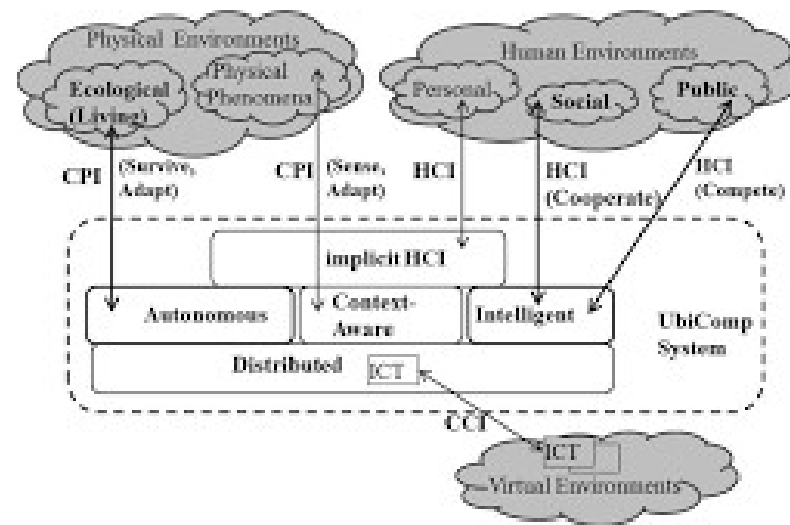
- Smart X

- Calm Tech.

Enabling Technologies

6. CONTEXT AWARENESS USING SMART X (TOWARDS INTELLIGENT ENVIRONMENTS)

Context Aware System

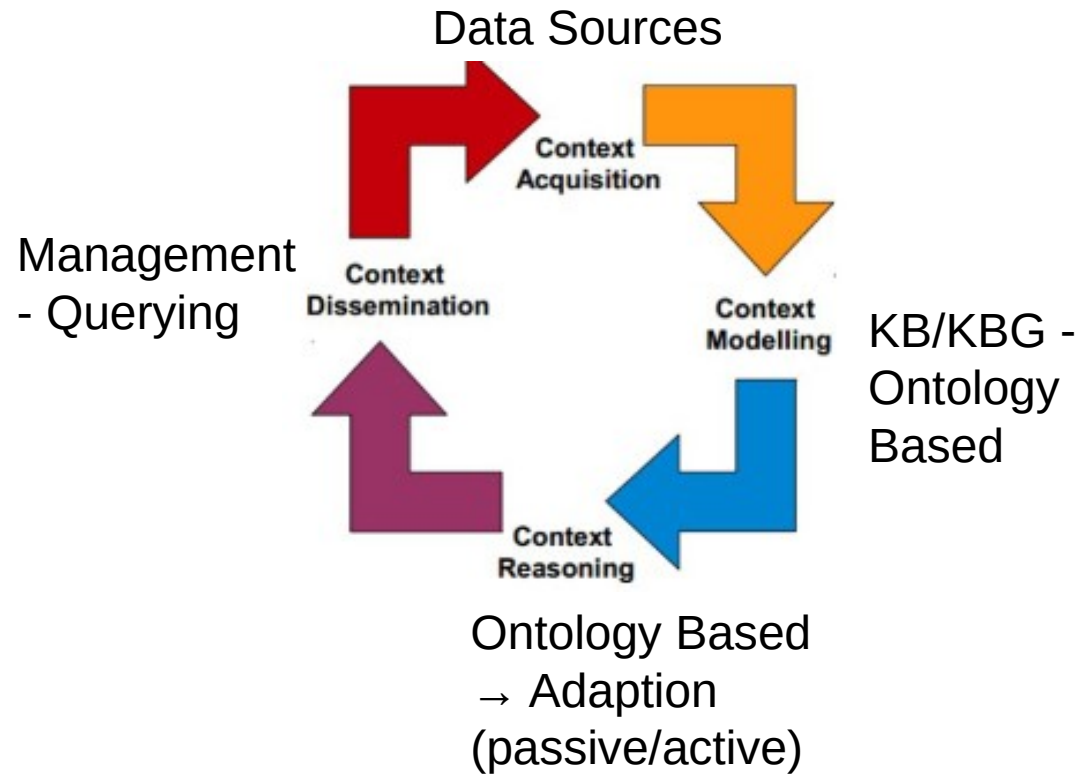- Situation

- What, Where, When,

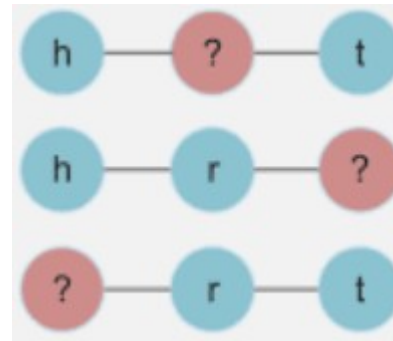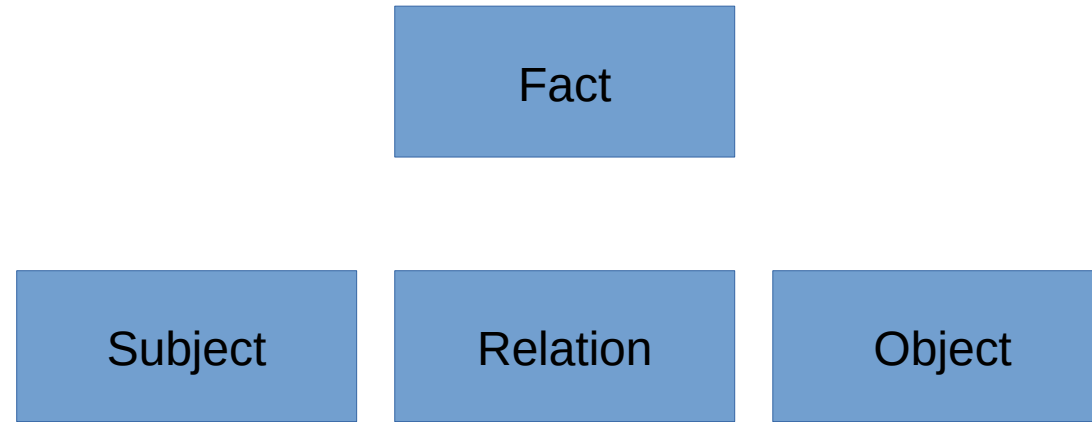- How

- and Why

- Sensor Fusion

Challenges

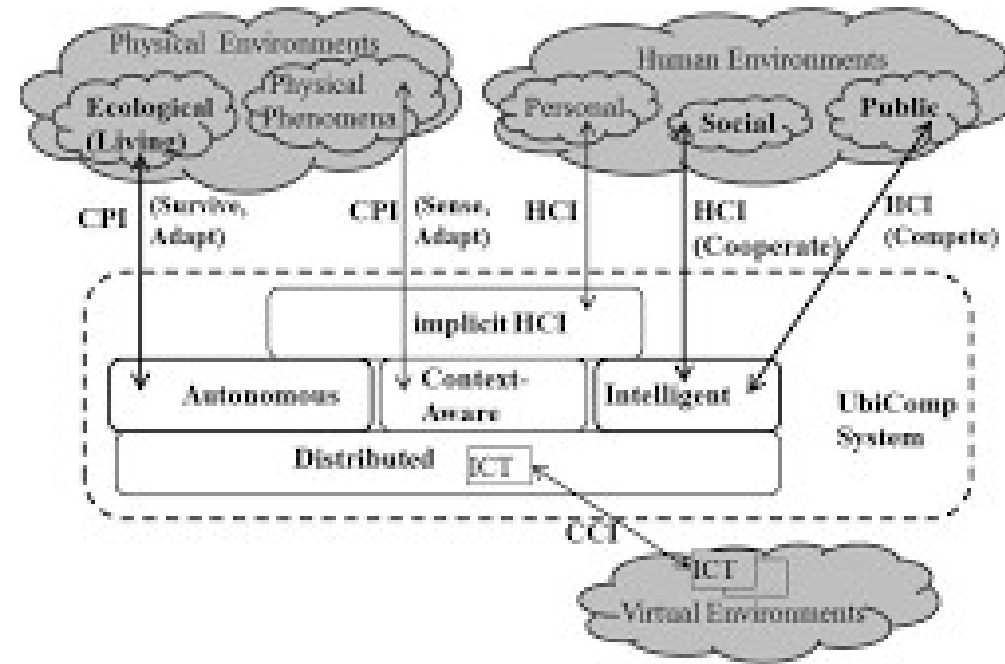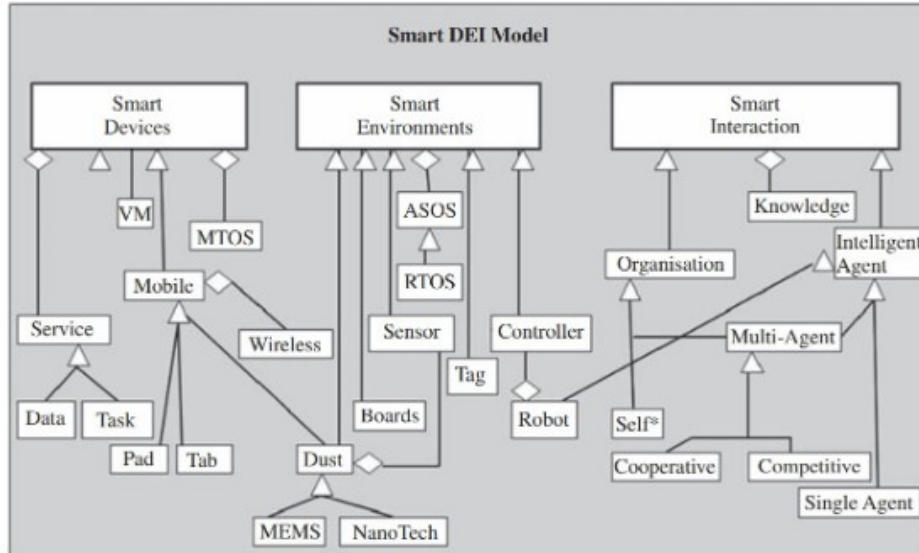- User Context

- Environment Context

- Privacy

Lifecycle

Data Sources

Management - Querying

KB/KBG - Ontology Based

Ontology Based → Adaption (passive/active)

Example

Fact

Subject   Relation   Object

Smart X

- Combination → Intelligent Environment

Smart DEI Model

Intelligent System

- Distributed

- Environment

- Interaction

- Context

- Zero Conf.