Major Topics

1. Communication
2. Activity
3. Security
4. State
5. Data

1. Communication

How do computational entities interact?
What are alternative syntaxes and semantics for interactions among computational entities?
On what basis is the communication structured?
What are example technologies?
How can communication be represented formally?

Identity-Based Communication

Examples:
- Communicating Sequential Processes (CSP)
- Common Object Request Broker Architecture (CORBA)
- Simple Object Access Protocol (SOAP)

Content-Based Communication:

Tuple Space Model

Events
Pi-Calculus
An algebra that captures the notions of communication, interaction, and synchronization among concurrently executing entities.

2. Activity
(threads, agents, processes, grids)

How can processing activity be structured on a single processor?

How can application-level information and system-level information be combined to provide efficient scheduling of processing activities?

Why is mobility of a processing activity desired and how can it be achieved?

How can processes be scheduled across a collection of machines to achieve improved performance?

How can geographically distributed individuals collaborate in using geographically distributed computing resources?

Structuring Activities

Mobile Agents

3. Security

How can rights for access control be structured for effective use and management?

How can a digital document be “signed” so as to identify authorship?

How can communicating parties be confident of each other’s identities?

How can distributed systems authenticate clients and servers to each other?
Security Overview

Certificate Authority

- private key

Server

- secure communication channel

Access Control

Identity, resources

- issues/verifies

4. State

How can events be ordered in a distributed system lacking a shared clock?

Can this ordering give rise to a form of virtual time?

How can the state of a distributed system be recorded?

Can recorded states be used to create a system that can recover from failures?

How can cooperating nodes agree to commit or abort a common action?

Event Ordering

P: P₁, P₂, P₃

Q: Q₁, Q₂, Q₃

How can the events on P be related to the events on Q?

Which events of P “happened before” which events of Q?

When does it matter how we answer these questions?

Recovery

- erroneous state

- error

- recovery

- valid state

An error is a manifestation of a fault that can lead to a failure.

Failure Recovery:

- backward recovery
- operation-based (do-undo-redo logs)
- state-based (checkpoints)
- forward recovery

5. Data

In a data-centric system, what are transactions and how are they structured?

What properties are needed to guarantee that concurrent transactions execute properly?

How can these properties be enforced automatically?

How are distributed file systems organized and managed?