



1 Introduction - February 19, 2020

1.1 Defining Dependable Systems

QUOTES:

A distributed system is a system where a computer of which you did not know it exists can prevent you from getting your job done. - Leslie LAMPORT

There is perhaps a market for maybe five computers in the world. - TJ WATSON

FAULT → ERROR → FAILURE

- Train delayed because of tree has fallen on the tracks
- Travelers reach destination too late
- Alice misses her exam

	<u>FAULT</u>	<u>ERROR</u>	<u>FAILURE</u>
Train:	Tree fallen	no train	delay for passengers
Journey:	Train delay	delay	reached destination 2h after intention
Exam:	arrival 2h late	missed time-slot	repeat exam

FAULT: cause of failure

ERROR: internal state of system, not according to specification

FAILURE: observable deviation of specification

FAULT examples:

- timing
- cables
- power supply
- messages lost
- data loss (solved with RAIDs)

1.1.1 How to make systems tolerate faults

- PREVENTION
- TOLERANCE
 - Replication/Redundancy
 - Recovery
- REMOVAL
- FORECASTING/PREDICTION

SAFETY ≠ SECURITY

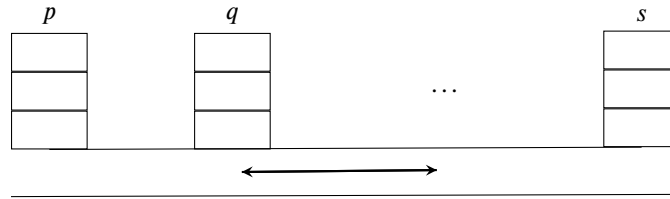
SAFETY is connected to loss of live/material due to accidents

SECURITY is connected to malicious intent

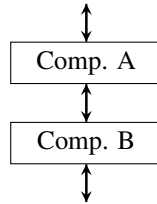
1.1.2 Defining distributed computation

Processes $\Pi = \{p, q, r, s \dots\}$

$|\Pi| = N$



COMPONENTS



EVENTS for Component c :

$\langle c, event \mid param_1, param_2 \dots \rangle$

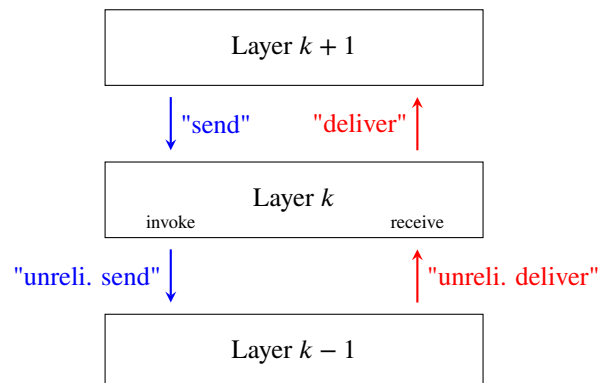
upon $\langle c, ev_1 \mid param_1 \rangle$ do

do something

trigger $\langle b, domore \mid p \rangle$

upon $\langle b, domore \mid p \rangle$ do

1.1.3 Layered modules



Events either travel:

- upwards (red): indication
- downwards (blue): request

Events on a given layer may be:

- input events (IN)
- output events (OUT)



1.1.4 Module Jobhandler

Events:

Request: $\langle jh, handle \mid job \rangle$

Indication: $\langle jh, confirm \mid job \rangle$

Properties:

Every job submitted for handling is eventually confirmed.

Implementation (synchronized) JOBHANDLER

State

...

upon $\langle jh, handle \mid job \rangle$ do

"process job"

trigger $\langle jh, confirm \mid job \rangle$

upon ...

upon ...

Implementation (asynchronized) JOBHANDLER

State

$buf \leftarrow \emptyset$

upon $\langle jh, handle \mid job \rangle$ do

$buf \leftarrow buf \cup \{job\}$

trigger $\langle jh, confirm \mid job \rangle$

upon $buf \neq \emptyset$ do

$job \leftarrow \text{some element of } buf$

"process job"

$buf \leftarrow buf \setminus \{job\}$

1.2 Concurrency and Replication in Distributed Systems



2 2nd Lecture - February 20, 2020