Real-time, Fault-Tolerance and Consistency in Distributed Systems

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In this report, I show how to deal with (i) **Real-Time constraints** (e.g. termination deadlines of tasks, delivery deadlines of messages), (ii) constraints related to **Fault-Tolerance** (e.g. type and number of process/network failure to tolerate during a given time interval), and (iii) **Consistency** constraints (e.g. invariants binding persistent objects) in distributed systems.

At the communication level, I have actively contributed to standardization with: (i) the French military standards **GAM-T-103 and GAM-T-111 for real-time transport** services and protocols, and (ii) the **ETSI HIPERLAN** standard for radio LAN. The originality of **routing in this ad-hoc network** is brought by the multipoint relay concept that allows an efficient management of mobility and broadcasts. Moreover, I have been the co-advertiser of two PhD theses dealing with **atomic multicast** in the bounded and known delays model. An atomic multicast is a reliable multicast with the same message delivery order for any correct process in the group. The tolerated failures, in bounded number, are crash for the processes and omissions for the network. The ABP protocol uses the group view and the fault-tolerance is achieved by **detection/recovery**. A family of protocols is proposed, it offers a total global order preserving locally/globally the **FIFO/causal/chronological order.** Fault-tolerance is obtained by **masking**.

In distributed systems, consistency can be destroyed by conflicting executions and by failures. I have shown that the **conflict avoidance** approach is based on a total global order within each equivalence class of the task set. With the graph task model, establishing necessary and sufficient feasibility conditions is faced with a high complexity. Formalizing this problem is the object of a PhD thesis. TI have applied the **conflict detection/resolution** approach to tasks **admission control**. An accepted task has the **guarantee** to access consistent values and to meet its deadline.

Keywords: real-time constraints, real-time scheduling, distributed systems, consistency, persistent objects, serializability, conflict, admission control, fault tolerance, routing in mobile ad-hoc networks, reliable multicast, atomic multicast, deterministic guarantee, feasibility condition, FIFO order, total order, global order.