# Construction of Relationship between the prominent models of distributed algorithms - the $\mathcal{LOCAL}$ and *State* model

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**LIP6 Axis** : Networks and Performance Analysis

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**Abstract** : The objective of the internship is to build bridges between two models widely used in distributed algorithms: the $\mathcal{LOCAL}$ model and the *State* model); by establishing the minimal conditions for which these two models are equivalent.

**Detailed Project Description** The community of researchers studying distributed algorithms is divided into several groups working on distinct models and issues. Even if the communities are not completely disjointed, they are sufficiently disjointed not to take advantage of the results obtained by another community. The objective of this project is to build bridges between the work of two communities: distributed algorithm and network algorithm.

At a high level, one of the communities focuses primarily on the combined impact of asynchronism and of breakdowns on distributed computing; that community uses the *State* model. While the other community deals with the impact of the structural properties of the network on distributed computing, this community uses the $\mathcal{LOCAL}$ model. These two communities address distinct various forms of computing complexities,

In distributed computing, networks are modeled by graphs $G = (V, E)$, in which messages are exchanged between processes (i.e. nodes in $V$).

The $\mathcal{LOCAL}$ [4] model assumes that the processes run in synchronous rounds, where a round allows an arbitrarily large message to be exchanged between each pair of processes linked by an edge. Therefore, in the $\mathcal{LOCAL}$ model, the main measure of interest is the maximum distance to which the processes interact. In particular, Linial [3] has proved that the coloration of the graph is not local, even in the rings (precisely, round $O(log^* n)$ are necessary). for 3-color ring size $n$).

In the model *State* [1], the processes are asynchronous. During an atomic computation step, some of the processes that can be activated change their own state according to of the state of their neighbors. Therefore, in the *State* model,

one of the main challenges is to achieve tasks by minimizing the number of calculation steps and rounds. A self-stabilizing algorithm automatically converges from any configuration to a legitimate configuration from which the system will behave correctly. But no property is guaranteed during the convergence phase. The *State* model is intensively used to design self-stabilizing algorithms. For example, a self-stabilizing reseting algorithm [2] is used to requiring $3n+3$ computation steps per process in a $n$-size network has been designed and proven in spite of the asynchrony of the system.

The objective of the internship, is to build bridges between these two models; by establishing the minimum conditions for which these two models are equivalent. Concretely, the goal is to transform the algorithms written in one model into algorithms written for the other model by optimizing the cost of the transformation.

# References


[1] Karine Altisen, Stéphane Devismes, Swan Dubois, and Franck Petit. *Introduction to Distributed Self-Stabilizing Algorithms*. Synthesis Lectures on Distributed Computing Theory. Morgan & Claypool Publishers, 2019. URL: `https://doi.org/10.2200/S00908ED1V01Y201903DCT015`.

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[3] Nathan Linial. Locality in distributed graph algorithms. *SIAM Journal on Computing*, 21(1):193–201, 1992. URL: `https://doi.org/10.1137/0221015`.

[4] David Peleg. *Distributed Computing: A Locality-Sensitive Approach*. Society for Industrial and Applied Mathematics, 2000.