# Simulation Model

In this chapter, we present a detailed explanation of four simulation scenarios, each corresponding to a different configuration of blockchain queueing behavior. These scenarios are designed to reflect the structural and behavioral differences introduced by customer priority and impatience. All simulation models incorporate both First-Come-First-Served (FCFS) and non-preemptive priority disciplines, as appropriate to each case.

The first simulation model represents a single-class customer system without impatience. In this case, customers arrive and are served strictly in arrival order, and no abandonment occurs even if the waiting time is long. The second simulation model introduces two customer classes, high-priority and low-priority, handled with non-preemptive scheduling but without impatience. High-priority customers are always placed ahead in the queue, but service-in-progress cannot be interrupted.

The third simulation model considers a single-class system with impatience, where customers may abandon the queue if they wait too long. This adds a stochastic abandonment dynamic based on patience thresholds. The final simulation model incorporates both customer priority and impatience. High-priority and low-priority customers are managed with non-preemptive priority, and both classes have their own impatience rates. This complex setting allows us to examine how prioritization and abandonment interact in a congested blockchain environment.

In all cases, the simulation captures system dynamics under partial batch service, and models ON/OFF channel behavior, where the service is suspended during OFF periods. These scenarios are simulated independently to compare their performance metrics, including throughput, queue lengths, waiting time, blocking probability, and, where applicable, abandonment probability.

### Scenario 1

In this simulation model, we consider a blockchain system that handles a single class of users, where customers arrive according to a Poisson process and are served under the First-Come-First-Served (FCFS) discipline. The goal of this scenario is to evaluate the system’s performance under ideal stability, where no customer abandons the queue due to impatience.

The system consists of two queues: the customer queue, where users wait for block generation, and the consensus queue, where users participate in the consensus process after being grouped into a block. Block generation follows a partial batch service policy, allowing 1 to users to form a block. Once a block is formed, it is transferred to the consensus queue. Upon completion of the consensus process, all users in the block exit the system.

A key characteristic of this scenario is the system's ON/OFF behavior. During the OFF state, caused by interruptions such as attacks or connectivity issues, both block generation and consensus processes are suspended, although new users may still arrive. During the ON state, all services resume normally. To preserve system integrity, a constraint is imposed on the maximum number of customers allowed in the customer queue: when the consensus queue is empty, up to users may wait; otherwise, the limit is reduced to .

Since customer impatience is not considered in this model, all customers remain in the queue until they are served. This makes the first scenario a baseline case for performance comparison, focusing on metrics such as throughput, average queue length, and system utilization under a stable environment with uninterrupted user participation.