P2: Trust-Aware Scheduling of Online Tasks in FoG Nodes

CS-528: High Performance Computing Project

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Introduction:

In the era of cloud computing, the Internet of Things (IoT), and edge computing, the scheduling of tasks on Fog nodes plays a crucial role in optimizing resource utilization and meeting reliability requirements. Fog computing extends cloud computing to the edge of the network, closer to IoT devices, to reduce latency and bandwidth usage. However, scheduling tasks in Fog nodes poses challenges due to the dynamic nature of the environment, varying reliability of nodes, and cost constraints.

Problem Statement:

Given a stream of tasks reaching the system online way where every task is associated with a userfrom a total of U users, we need to devise an approach to schedule tasks such that it minimizes the cost and maximizes the trusted reliability. Every task has an arrival time, execution time, user information, and relative deadline of task (dj=aj+K), where K is constant and K > pj for all the tasks.

The underlying system has M homogeneous FoG/processing nodes and each FoG node m is associated with shared trust (can be represented as ST[m] of ST[M], average user rating for the node/brand value of the node) and individual/direct trust from each user (DT[u][m] of DT[U][M]) for a node. Initially, all the user ratings is 0.5. Trust is rated from 0 to 1 representing the probability of successful execution.

The individual trust of a node gets updated for every successful execution (trust increase) or unsuccessful execution (trust decrease) of the task. The ST[m] is the average of direct trust which is the sum of DT[u][m]/U. The cost of unit execution time on a node is determined by the shared trust value (Brand Value) of the node and this relation is not linear, C = Base + BR*ST[m]2, where Base value is around 30% of brand constrant BR. We can associate a node with task failure probability and this failure rate changes over time. Unsuccessful execution of a task on a node depends on either (a) it missed the deadline or (b) get a failure during execution based on the failure probability of the node (this failure

probablity of task can be modeled as FP=1-exp (-f.t) where f is failure rate 0≤ f << 1 of machine and t is the execution time of the task.

Every task comes with reliability requirements and we need to schedule the task on machines such that it meets the reliability, meets the deadline constraints, and minimizes the cost.

Solution Approach:

- ## Task Generation:
  - The function iterates over each user in the system to simulate task generation for each user.
  - A random number is generated to determine if a task is generated for the current user. This randomness simulates the varying behavior of users in generating tasks.
  - Tasks are generated based on user behavior, with each task having an arrival time, execution time, user information, deadline, and reliability requirement.
  - The generated task is added to the task queue, which holds all the tasks to be scheduled for execution.

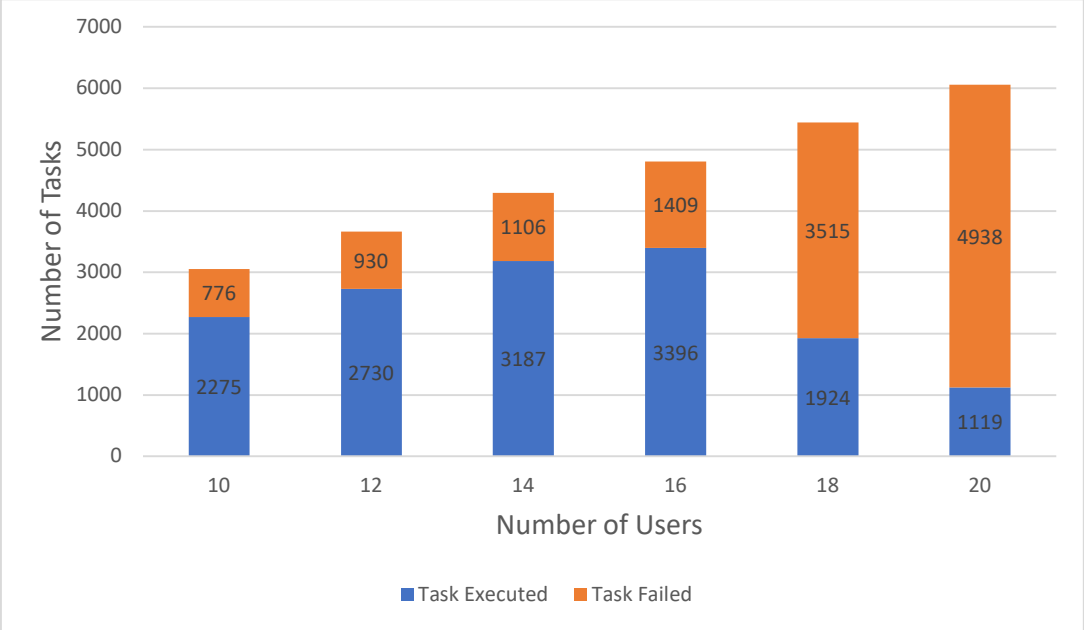
- ## Trust Calculation:
  - Trust values for nodes are calculated based on individual trust from users and shared trust of nodes.
  - Individual trust is updated for every successful or unsuccessful task execution on a node.
  - Shared trust is the average of individual trust values for a node.

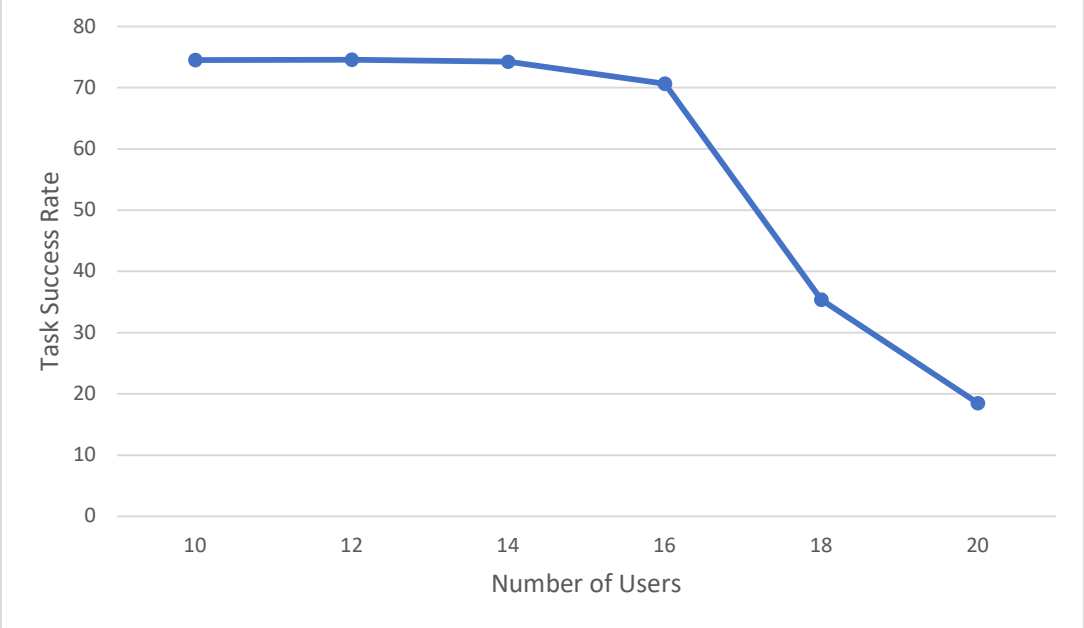
- ## Task Scheduling:
  - Nodes are sorted based on their availability and increasing trust values for efficient scheduling.
  - Tasks are scheduled based on their reliability requirements and node availability.
  - Nodes with a trust value greater than or equal to the task's reliability requirement are considered for scheduling.

- ## Task Execution:
  - Tasks are executed on scheduled nodes.
  - The execution result (success or failure) updates the trust values of nodes and users.
  - Failure can occur if a task misses its deadline or due to a failure during execution based on the failure probability of the node.

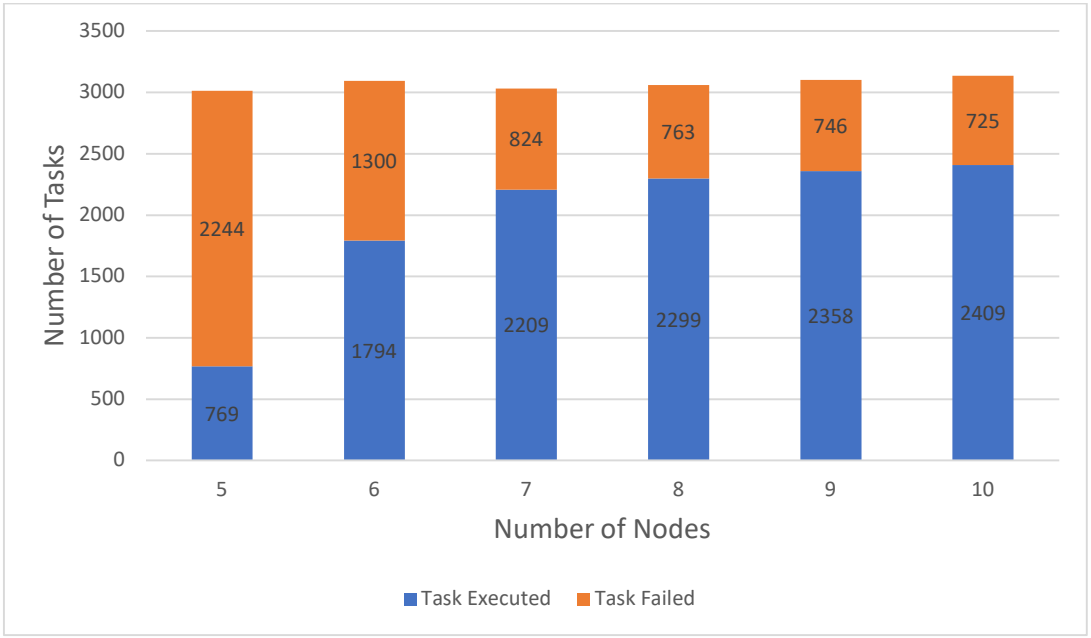
Results:

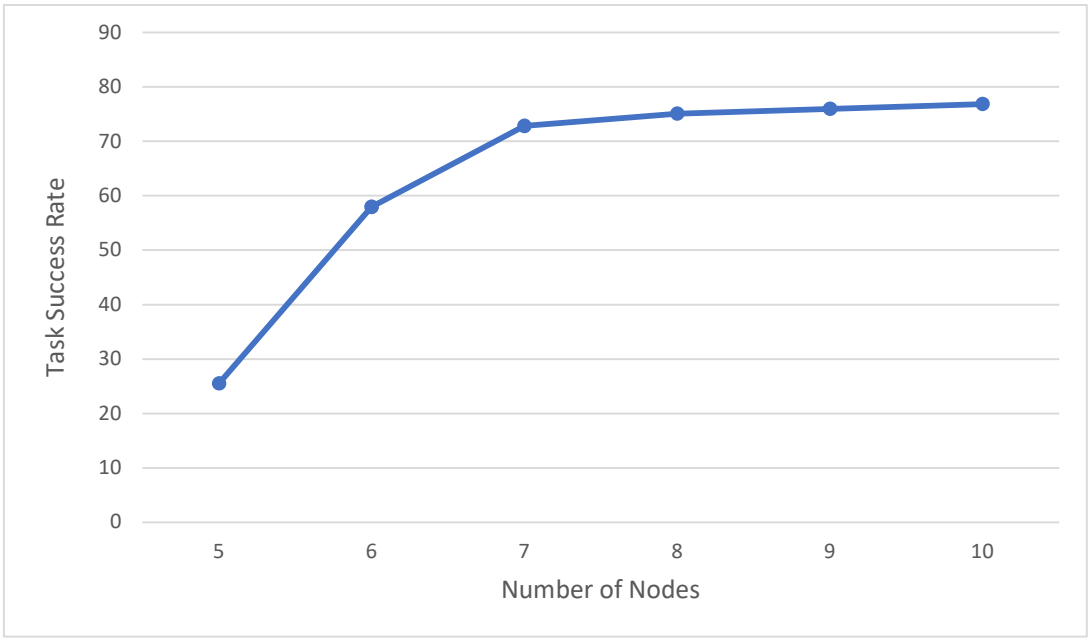
1. Varying Number of Users with Simulation Time = 1000, Total Nodes = 10, K = 10, Failure Rate = 0.0003



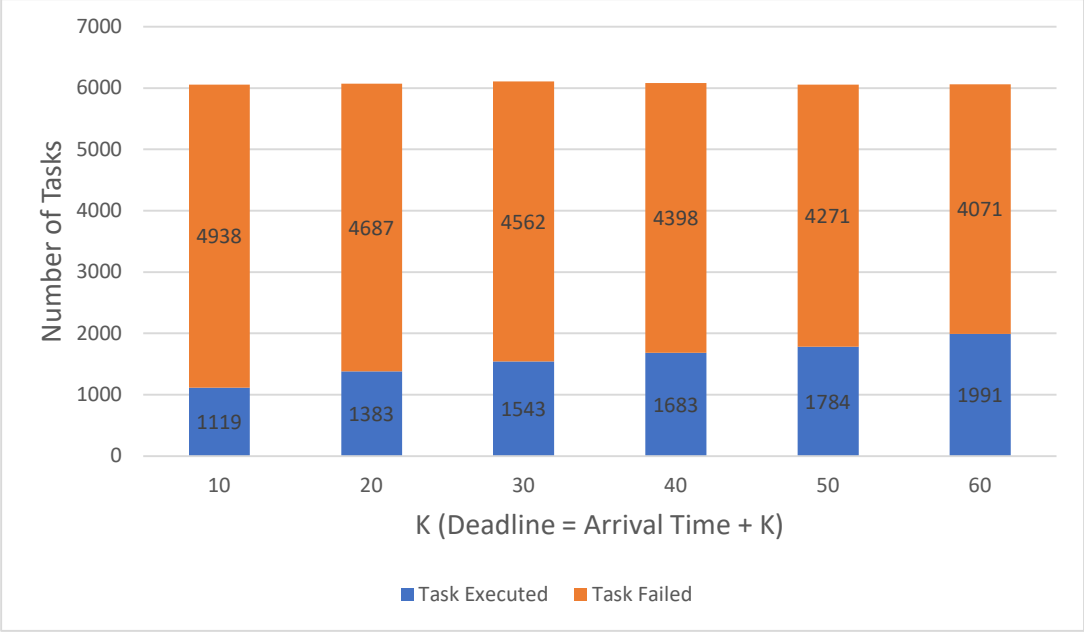


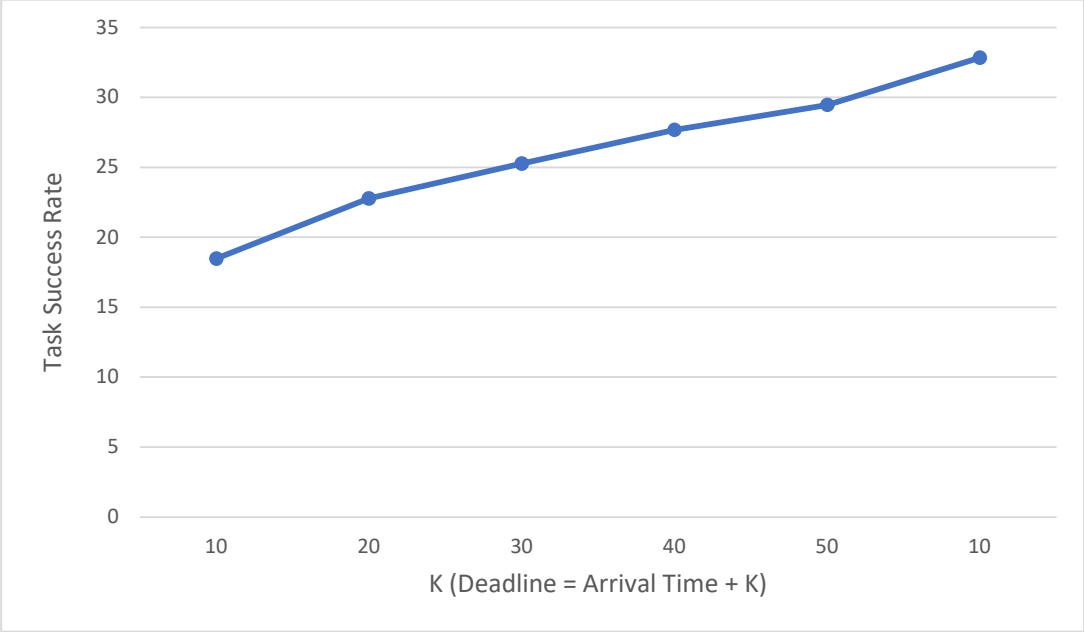
2. Varying Number of Nodes with Simulation Time = 1000, Total Users = 10, K = 10, Failure Rate = 0.0003





3. Varying K with Simulation Time = 1000, Total Users = 20, Total Nodes = 10, Failure Rate = 0.0003





Conclusion:

In conclusion, the Trust Aware Scheduling of Online Tasks in Fog Nodes project presents a comprehensive approach for scheduling tasks in Fog nodes. By considering trust values, reliability requirements, and cost constraints, the approach provides a framework for optimizing task scheduling in Fog computing environments. Further research can explore enhancements to the trust calculation and scheduling algorithms for more efficient resource utilization.

- The proposed approach aims to balance reliability, cost, and resource utilization in Fog nodes.
- By considering trust values and reliability requirements, the approach optimizes task scheduling to meet deadlines and minimize costs.
- The simulation results demonstrate the effectiveness of the approach in a dynamic Fog environment.

Future Work:

- Future research can explore enhancements to the trust calculation and scheduling algorithms for more efficient resource utilization.
- Integration with real-world Fog computing environments can provide insights into practical implementation challenges and performance improvements.