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EEX 5362

**Performance Modelling**

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**Mini-project Deliverable 1**

1. **System Overview**

Airport Security Checkpoint System represents a critical queuing and processing network in air travel operations, where passengers arrive, queue, and undergo security screening before being processed to their gates. It involves multiple parallel lanes for screening, stochastic passenger arrivals, variable service times influenced by random events such as secondary checks or delays, and resource constraints like lane availability and staffing.

Airport security checkpoints must efficiently process passengers while upholding strict security protocols; however, they often encounter bottlenecks that result in long queues, increased operational costs, and reduced throughput. The primary challenge is to configure the system to minimize wait times and costs while maintaining security. This mini-project uses simulation to model these dynamics, compare scenarios, and provide data-driven insights for optimization.

Key characteristics of the system make it suitable for performance modeling,

* Stochastic Elements: Passenger arrivals follow an exponential distribution, with 20% classified as priority passengers.
* Parallel Processing: Multiple regular and priority lanes operate in parallel, with service times varying uniformly.
* Random Disruptions: Secondary random security checks occur with a 15% probability and operational delays with a 10% probability.
* Measurable Performance: The system allows analysis of bottlenecks, throughput, resource utilization, latency, and scalability.
* Real-world Relevance: It balances security requirements with operational efficiency, affecting stakeholders like passengers, airports, airlines, and security agencies.

Assumptions include independent arrivals, no group processing, uniform service distributions, and infinite queue capacity to focus on typical non-expectational conditions.

1. **Performance Objectives**

The mini-project focuses on evaluating and optimizing the airport security checkpoints system’s performance under varying configurations and conditions. The primary performance objectives are:

* Minimize Response Time: Reduce average and maximum queue wait times and total processing times to improve passenger experience and prevent flight disruptions.
* Maximizing Throughput: Increase the number of passengers processed per simulation period while maintaining security standards, to handle peak loads efficiently.
* Identifying Bottlenecks: Analyze factors like random security checks, operational delays, and uneven lane utilization that cause variability in service times and queue formation.
* Optimizing Resource Allocation: Determine the optimal number and ratio of regular vs priority lanes to balance costs with performance, avoiding over-provisioning and demonstrating diminishing returns.
* Evaluating Scalability and Trade-offs: Quantify the impact of scenarios such as increased capacity or enhanced security protocols on metrics like utilization rates, cost efficiency ratios, and overall system saturation.

These objectives will be measured through key metrics, including:

* Queue Wait Time
* Service Time
* Total Processing Time
* Lane Utilization
* System Throughput
* Queue Length