AnyLogic-Based Simulation: Improving Fighter Aircraft Fleet Management

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Abstract — Effective management of fighter aircraft fleets necessitates the careful consideration and harmonization of intricate variables such as maintenance, availability of parts, and the successful accomplishment of missions. Conventional approaches frequently encounter difficulties in adapting to this ever-changing environment. This study presents a simulation model created using AnyLogic software with the aim of enhancing decision-making. The model effortlessly combines with current data, offering immediate insights and interactive visual representations of daily activities. Users can conduct simulations with random variations in order to evaluate various situations and their influence on the performance of the fleet. The results indicate substantial enhancements in aircraft availability, mission success rates, and operational efficiency. The approach enables managers to effectively negotiate uncertainty and optimize fleet readiness for each circumstance.

I. INTRODUCTION

Fighter aircraft fleets are critical to air force operations but controlling them is difficult. Efficient solutions are necessary to maintain the balance between mission fulfillment, parts availability, and maintenance. Traditional approaches depend on expertise and static analysis, which might be ineffective in the dynamic environment of flight and maintenance. This study suggests a simulation model that employs AnyLogic software to improve decision-making.

The model generates a virtual environment that replicates actual operations. Flight and maintenance activities are visibly represented, such as aircraft status, hangar movements, and components inventory. This allows for more extensive examination of various scenarios as well as more accurate outcome predictions. The model offers a basis for making decisions that are both more informed and more successful by combining visualization with simulations that make use of random parameter settings.

II. PROPOSAL

This proposal presents a decision-making tool for managing a fleet of fighter aircraft, which has been developed using the AnyLogic simulation software. The model effortlessly incorporates existing data via Excel spreadsheets, enabling uninterrupted updates on aircraft and component statistics such as flight hours, failure rates, and parts inventory. The simulation can be kept accurate and relevant by receiving a continuous flow of real-time data since logistics managers are able to update the spreadsheets with fleet data anytime.

The model surpasses the limitations of static data by generating a dynamic visual depiction of daily operations. Users have the ability to monitor the progress of flights, check the status of aircraft, track movements in the hangar for maintenance purposes, and view real-time information about the availability of parts in store. One important characteristic is the capability to conduct simulations with stochastic variations. Managers can use "what-if" scenario testing to evaluate how various operating conditions and investment decisions affect fleet performance. The statistical analysis derived from these simulations offers useful insights for enhancing aircraft availability and operational efficiency.
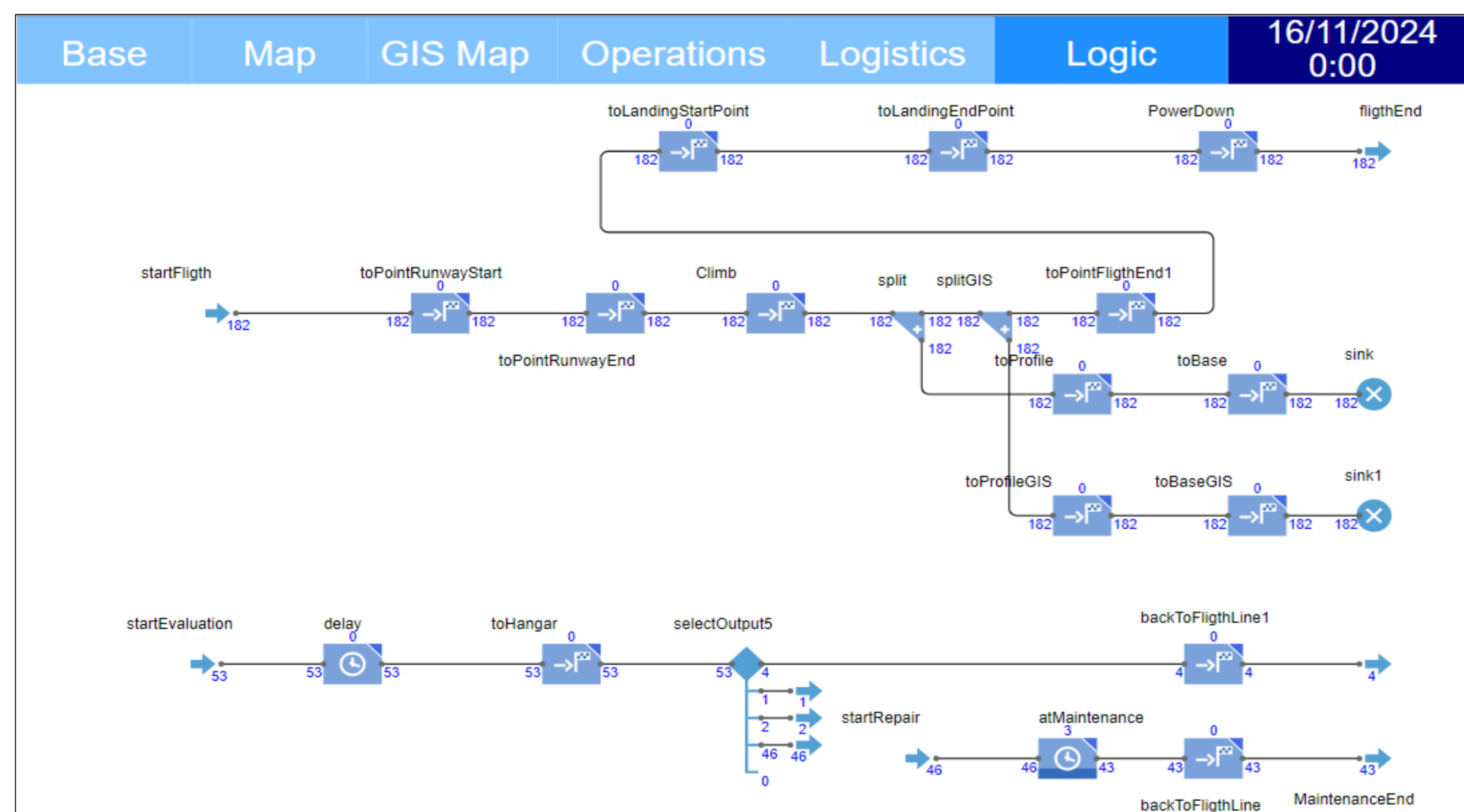

Fig. 1. Logic: Flight and Maintenance Discrete-Events Simulation Process

III. RESULTS

Simulations using the AnyLogic model confirmed its effectiveness in managing the fighter fleet. Managers gained the ability to forecast performance and assess investment scenarios, leading to operational improvements. The model allowed decision-makers to analyze historical fleet performance data, revealing trends to enhance preventive and corrective actions. This helped optimize maintenance scheduling, ensuring aircraft availability at critical times. Significant improvements were observed in key performance indicators such as aircraft availability and mission success rates, proving the model's contribution to operational readiness.

By accurately forecasting maintenance durations and controlling the inventory of spare parts, operational efficiency was enhanced. The model enabled maintenance teams to anticipate part needs better, reducing unscheduled downtime and improving fleet availability. Simulation visualizations provided clear insights into system behavior, enhancing communication between departments and supporting better decision-making. The ability to test different operational scenarios further improved preparedness by allowing managers to explore the outcomes of various fleet management strategies.

The statistical methodologies applied in the simulation, including the analysis of iteration histograms, helped identify likely outcomes and associated risks. By modeling various scenarios—ranging from routine operations to high-intensity missions—managers could plan proactively, ensuring the fleet's effectiveness under different conditions. The ability to simulate future scenarios was invaluable for strategic planning, as it enabled decision-makers to allocate resources in advance to mitigate risks. The results demonstrated the AnyLogic model's value in fleet management, improving tactical and strategic readiness while enhancing fleet availability for mission success.
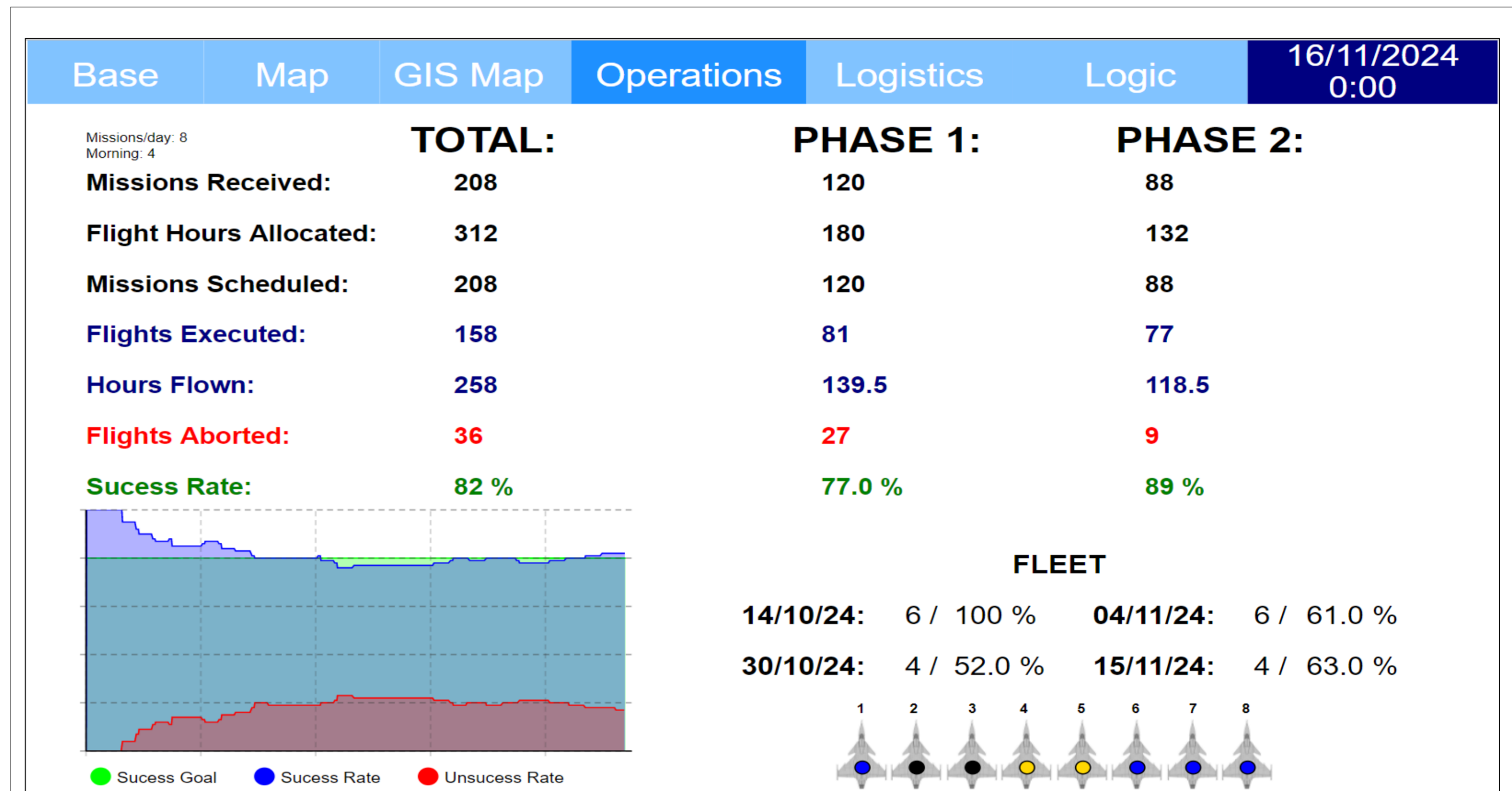

Fig. 2. Performance Indicators to Assess the Success Rate of the Operation
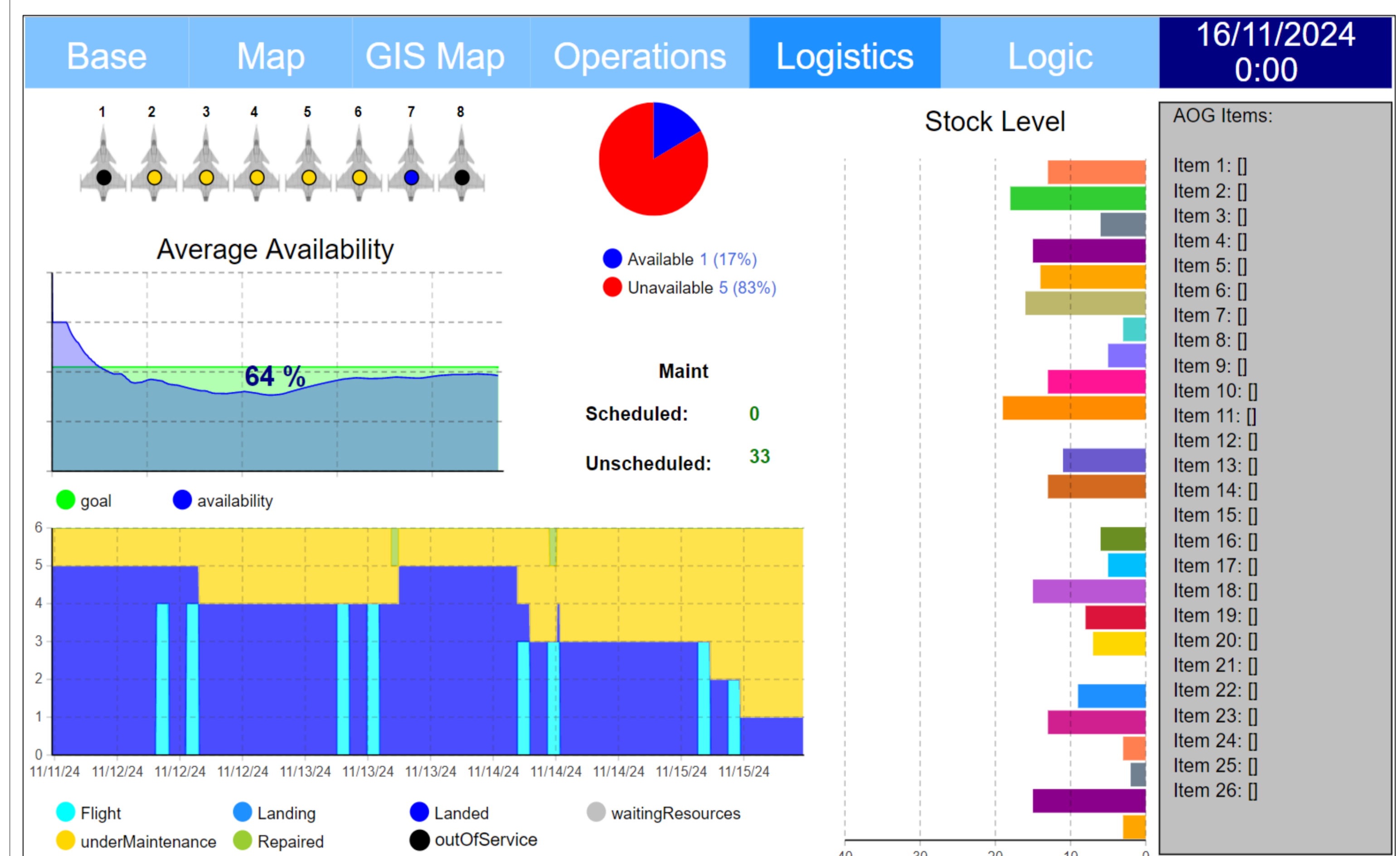

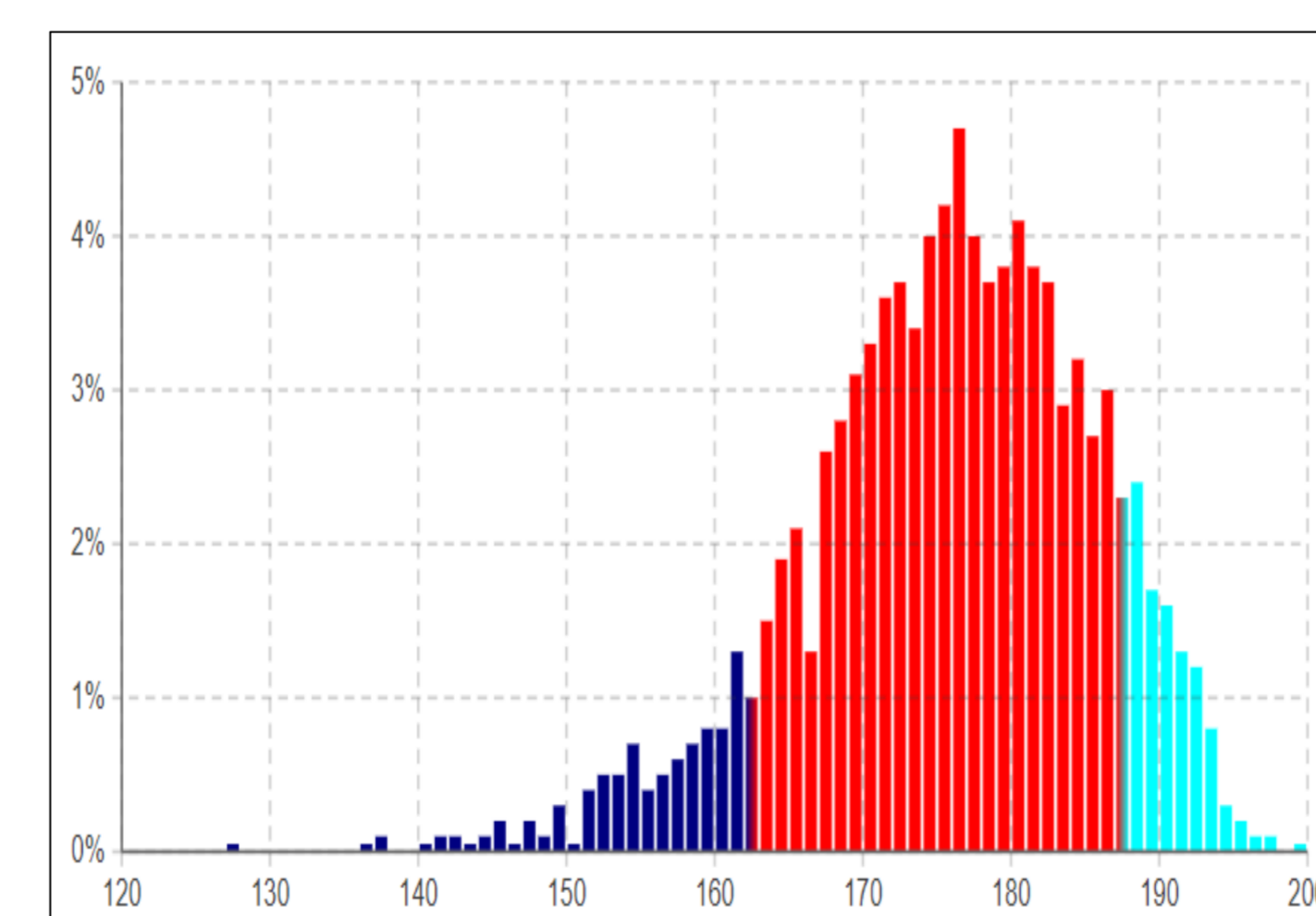Fig. 3. Performance Indicators to Assess the Logistics Performance of the Fleet

Fig. 4. Monte Carlo Simulation Histogram

IV. CONCLUSION

By providing fighter fleet managers with real-time data, dynamic visuals, and the ability to test "what-if" scenarios, the AnyLogic simulation model gives them greater flexibility. Consequently, this results in enhanced decision-making, which in turn leads to a measurably higher availability of aircraft, success in mission execution, and operational efficiency. In order to optimize fleet readiness for each scenario, the model provides managers with the tools necessary to traverse uncertainty.

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