

Flight Test Engineering Infrastructures Management Software

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Abstract

Effective, traceable, and sustainable management of flight test engineering infrastructures such as telemetry systems, flight test management centers, flight test data systems is of critical importance in flight test activities. Increasing operational complexity necessitates the integrated execution of inventory tracking, activity management, and data sharing processes through a digital system. This study presents the initial phase of an integrated, Software as a Service (SaaS) platform developed for the management of flight test engineering infrastructures.

Within the scope of this study, a SaaS platform has been developed to enable centralized monitoring of equipment used in telemetry infrastructures and to provide integrated management of planning, recording, and tracking of activities which are supported via flight test management centers. The system enhances the digital traceability of operational processes, ensures control of data sharing durations, and generates statistics for the Flight Test Team Members who participate to activities. In addition, a management-level structure for infrastructure and/or operation related personnel has been established to support task assignment and organizational coordination.

The proposed SaaS platform aims to enhance traceability in flight test telemetry infrastructures, reduce operational risk, and integrate institutional processes within a digital transformation perspective.

Key words: Telemetry, flight test management center, ground control, flight testing, infrastructure management, Software as a Service (SaaS) Platform, digital transformation, data traceability

Introduction

Flight test activities are critical processes where the performance, safety, and compliance of aerospace systems with design requirements are verified under real operational conditions. These processes rely on complex engineering components, including telemetry systems, flight test management centers, and data processing infrastructures. The effective and coordinated management of these infrastructures is of paramount importance for both operational efficiency and the acquisition of reliable flight data.

Serving as a cornerstone of flight test engineering, telemetry systems enable the real-time monitoring and safety assurance of Turkish Aerospace's fixed-wing, rotary-wing, and UAV platforms, such as Hürjet, KAAN, Gökbey and Anka. As system complexity and the scale of flight test programs continue to grow, managing these infrastructures becomes increasingly challenging. In environments

where multiple teams work simultaneously, processes such as inventory tracking, mission planning, activity management, and data sharing must be executed seamlessly. However, in current practices, these processes are often managed through independent systems or manual methods, leading to a lack of traceability, coordination bottlenecks, and operational inefficiencies.

In this study, an integrated software platform developed for the management of flight test engineering infrastructures is presented. The proposed system aims to establish a more effective and traceable management framework by unifying various operational processes under a single architecture.

To digitalize the management of flight test engineering infrastructures and ensure a centralized structure, this study introduces an integrated Software as a Service (SaaS) platform. The developed software is structured

around three core modules designed to meet operational requirements:

Inventory Module, Optimizes asset management by providing real-time tracking of the status and technical specifications of critical flight test equipment.

Admin Module, Facilitates authorization and accountability by enabling centralized task assignments for personnel involved in the testing processes.

Activity Management Module, Lists all flight activities supported by telemetry, manages participating personnel, tracks data-sharing durations, and allows assigned staff to submit technical evaluations and comments directly into the system.

By consolidating fragmented workflows into a single digital ecosystem, this platform aims to enhance coordination among flight test teams and ensure full traceability across all engineering processes.

System Modules

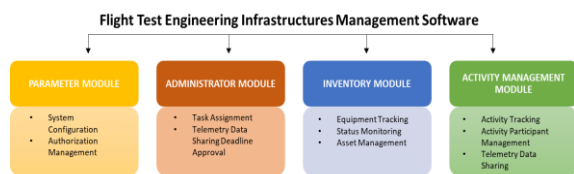


Figure 1: Flight Test Engineering Infrastructures Management Software Modules

integrated management of activities conducted by Flight Test Management Centers (FTMCs) with telemetry support. The system manages activity tracking, the management of assignment processes, operational evaluation, and post-activity telemetry data sharing processes in a coordinated manner.

The system architecture is built upon four main modules:

- 1. Parameter Module:** Forming the foundation of the system, this module manages core system configuration and authorization protocols.
- 2. Administrator Module:** Centralizing administrative oversight, this module facilitates task assignment processes and manages approval processes for telemetry data sharing.
- 3. Inventory Module:** Critical functions such as resource management, equipment tracking, real-time status monitoring, and asset management are carried out by this module.

4. Activity Management Module:

Coordinating operational execution, this module is responsible for event tracking, participant management, and ensuring the actual sharing of telemetry data.

Collectively, these modules offer a complete framework for integrated flight test operations and comprehensive data management conducted at Flight Test Management Centers.

Parameter Module

This is the central module responsible for managing the inputs that ensure a system's operational usability and constitute its foundation.

This module guarantees the system's flexibility and dynamism by rapidly adapting to new requirements that emerge in dynamic environments, particularly during operational flight test activities conducted at Flight Test Management Centers.

Through this module, various elements such as projects, aircraft, project-specific software, campuses and their associated buildings, locations, tasks, and email groups are defined in detail. The module also undertakes the management of system parameters used in implementing the aforementioned definitions.



Figure 2: Parameter Module

These parameters encompass both immutable ones that define the system's fundamental operation and external ones that can be customized by the user. This structural design enables users to take swift action in response to evolving needs, thereby ensuring the system maintains an adaptive and dynamic structure.

Furthermore, the Parameters module also facilitates authorization on screens accessible to specific authorization profiles, by mapping system users (administrators, engineers, technicians, etc.) to these profiles.

In complex and evolving flight test environments, where multiple system components and operational definitions must be consistently maintained, the absence of a centralized parameter management structure may lead to inconsistencies in system

configurations, difficulties in maintaining standardization, and increased risk of configuration errors. Such issues can result in misalignment between system components, reduced operational efficiency, and challenges in adapting to changing requirements. By addressing these challenges, the Parameter Module ensures consistency, standardization, and controlled adaptability across the system.

Administrator Module

This module is responsible for the centralized management of user roles, task assignments, and operational approvals within the system, ensuring that flight test activities are conducted in a controlled and efficient manner. It enables task allocation to personnel based on predefined roles and responsibilities, thereby enhancing coordination and accountability across all operational units.

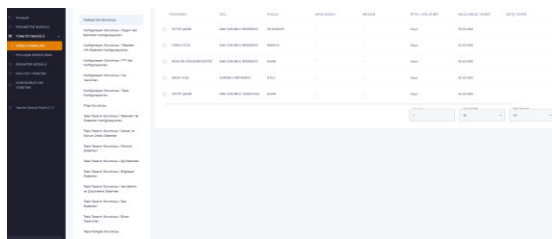


Figure 3: Administrator Module

Through this module, administrators can review and approve data sharing timeframes defined within the Activity Management Module. Furthermore, the module provides monitoring and reporting capabilities for data sharing durations, facilitating the timely and traceable management of information exchange processes.

In complex flight test environments involving multiple stakeholders and interdependent tasks, the absence of a centralized administrative structure may lead to ambiguities in role definition, inefficient task distribution, and delays in approval processes. Such limitations can negatively impact coordination, reduce operational transparency, and increase the risk of miscommunication. By addressing these challenges, the Administrator Module ensures structured and controlled operational workflow, supporting effective management and decision-making processes.

Inventory Module

The Inventory Module enables the centralized management of all materials within the system. For each item, fundamental attributes such as brand, model, and material type are recorded. In addition, the module maintains detailed information regarding procurement, current

usage status, and historical utilization of each material.

The module also tracks the allocation of materials to personnel, including the duration of use, thereby facilitating effective and transparent monitoring of material utilization. Consequently, the Inventory Module provides a centralized and controlled framework for inventory management, enhancing both operational efficiency and accountability.



Figure 4: Inventory Module

In complex flight test environments where numerous materials are utilized across different activities and teams, the absence of a centralized inventory management structure may lead to incomplete or inconsistent records, difficulties in tracking material usage, and inefficiencies in resource allocation. Such limitations can result in loss of materials, improper utilization, and challenges in identifying responsibility for assigned equipment. By addressing these issues, the Inventory Module ensures accurate tracking, improved resource planning, and enhanced operational control.

Activity Management Module

This module ensures the centralized listing and management of all flight test activities supported by telemetry. The activities conducted within the system are recorded in a structured manner together with their associated parameters, thereby ensuring traceability. Considering the increasing number of activities and operational complexity, such a centralized management structure is of critical importance for maintaining controlled and well-organized processes.



Figure 5: Activity Management Module

Technical issues encountered during the execution of activities are recorded in the system by the responsible personnel and shared with relevant units. This approach

enables systematic reporting of problems arising during operations and facilitates the creation of a data foundation for subsequent analysis processes. In the absence of such records, issues such as information loss, recurrence of similar errors, and insufficient root cause analysis may arise.

Information regarding data sharing durations is entered into the system by the responsible engineer, and these data are utilized for monitoring data flow processes and evaluating performance. Failure to systematically track this information may lead to an inability to detect delays and may negatively impact operational efficiency.

Additionally, information regarding all flight test team personnel involved in the activity is recorded in the system, enabling activity-based participation tracking. Incomplete or unstructured maintenance of this information may result in difficulties in verifying responsibilities, challenges in task tracking, and weakened operational coordination.

Future Implementations

In future implementations, several functional modules are planned to be added to the Flight Test Engineering Infrastructures Management Software in order to enhance its capabilities. These modules aim to establish a more integrated, traceable, and automated structure for flight test operations.

Within this scope, the main proposed modules include the Network Mapping Module, Activity Initiation Module, Configuration Management Module, and Jira Integration Module. The Network Mapping Module will enable comprehensive visibility of the network topology and detailed monitoring of system components. The Activity Initiation Module will allow centralized initiation and management of flight test activities. The Configuration Management Module will ensure controlled, versioned, and consistent management of all project configurations, supporting standardization across systems. The Jira Integration Module will establish an automated bridge between operational processes and issue tracking mechanisms, thereby improving fault management and task tracking efficiency.

With the integration of these modules, a high level of automation will be achieved in operational processes, reducing manual workload and minimizing the likelihood of human error. In addition, data consistency and traceability across systems will be improved, enabling faster and more reliable decision-making processes. Overall, these

enhancements will contribute to transforming the flight test infrastructure into a more scalable, manageable, and fully integrated ecosystem.

Centralized Configuration Management and Remote Execution for Telemetry-Supported Flight Test Operations

This module establishes a centralized structure for the management of configuration files associated with telemetry-supported flight test projects. For each project, critical configuration artifacts such as `pfconfig`, `xidml` and startup definition files are systematically uploaded, versioned and maintained within the system. This approach ensures configuration consistency across all test environments, minimizes the risk of misconfiguration, and enables rapid deployment of standardized setups. As the number of supported projects and system components increases, maintaining such a controlled repository becomes essential for ensuring traceability, reproducibility, and efficient configuration governance.

In addition to configuration management, the module is integrated with the activity initiation framework to support remote execution of software used in Flight Test Management Centers. Through secure remote connections, required applications can be deployed and executed on designated systems without the need for manual intervention. This capability enhances operational efficiency, reduces setup time, and ensures that all systems operate with the correct and validated configurations. Furthermore, centralized control of execution processes enables better monitoring, coordination, and rapid response to operational requirements during test activities.

The absence of such an integrated configuration and remote execution mechanism may lead to inconsistencies between systems, increased dependency on manual processes, and a higher probability of operational errors. Therefore, the proposed module plays a critical role in maintaining standardized, reliable, and scalable flight test operations.

Data Acquisition and Logging Module

This module is designed to enable scalable and flexible data acquisition from heterogeneous equipment operating over different communication protocols. The system supports Ethernet-based devices communicating via TCP, UDP, and SNMP, allowing seamless connectivity with a wide range of telemetry and test equipment. Upon establishing a connection with the target device, incoming data streams are collected, parsed, and transformed into a

standardized and meaningful data structure to ensure interoperability across the system.

The architecture is designed to support simultaneous data acquisition from multiple devices, enabling real-time monitoring and analysis in complex test environments. A modular and extensible design approach is adopted, allowing new devices to be integrated into the system with minimal configuration effort. This plug-and-play capability significantly reduces integration time and enhances system adaptability to evolving operational requirements.

Furthermore, the abstraction of communication protocols and data processing layers ensures that device-specific differences are isolated from higher-level applications. This improves maintainability, scalability, and system robustness. In the absence of such a unified and modular data acquisition framework, integrating heterogeneous systems becomes time-consuming, error-prone, and operationally inefficient.

Network Mapping and Asset Discovery Module

This module provides comprehensive visibility into the network topology by identifying all connected computers and their physical and logical relationships within the infrastructure. The system is capable of determining which devices are connected to specific network switches and their corresponding locations, enabling accurate network mapping and infrastructure awareness. Such visibility plays a critical role in managing complex operational environments, particularly during flight test activities where rapid identification of network components is essential.

In addition to topology mapping, the module performs automated asset discovery and collects detailed system-level information from connected computers. This includes hardware and software attributes such as RAM capacity, operating system details, and other relevant configuration parameters. The collected data is processed and presented in a structured format, allowing operators to quickly assess system capabilities and readiness.

By providing centralized and up-to-date network intelligence, the module significantly enhances operational efficiency, simplifies troubleshooting processes, and supports effective resource planning. In the absence of such a system, identifying device locations, dependencies, and system specifications becomes time-consuming and prone to errors, potentially impacting mission-critical operations.

Conclusion

This study presents an integrated Software as a Service (SaaS) platform designed to manage flight test engineering infrastructures in a centralized, traceable, and scalable manner. The proposed system consolidates key operational domains such as configuration management, activity execution, inventory tracking, network visibility, data acquisition, and issue management within a unified architecture.

The modular structure of the system, consisting of Parameter, Administrator, Inventory, Activity Management, Data Acquisition and Logging modules, as well as specialized integration components, enables standardized and controlled execution of flight test operations. These modules collectively enhance operational coordination, ensure data consistency, and improve traceability across all flight test activities. In particular, the integration with external systems such as Jira strengthens issue management workflows by enabling automated task creation and closed-loop tracking mechanisms.

The developed platform significantly reduces reliance on manual processes, minimizes configuration-related risks, and improves overall operational efficiency. Furthermore, centralized management of resources, activities, and telemetry data contributes to improved decision-making, faster response times, and more reliable test execution.

Future extensions of the system are expected to further enhance its capabilities through advanced automation, improved interoperability, and expanded system intelligence. As a result, the proposed SaaS platform represents a foundational step toward a fully digitalized, integrated, and intelligent flight test infrastructure management ecosystem.