

Real-Time Telemetry Data Transfer Platform

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Abstract

Turkish Aerospace develops a wide range of indigenous platforms across fixed-wing(HURKUS, HURJET, KAAN), rotary-wing (T-625 GOKBEY,T-129 ATAK), and unmanned aerial vehicle (ANKA,AKSUNGUR) categories. The speed of operations during test and data analysis activities of indigenously developed aircraft constitutes a critical factor in overall program success. System-level and software-based enhancements that shorten the time span between the conceptual design phase and entry into service make substantial benefit to the efficiency and effectiveness of the product development lifecycle.

During the flight test phase of these platforms, data packets which transmitted from the aircraft to Flight Test Management Centers via Telemetry Systems are visualized and analyzed in real-time by using Real-Time Data Monitoring software. In the post-test data analysis phase, processed data sets are shared by telemetry responsible engineers with the relevant design teams to support detailed data analysis activities.

Through the implementation of a Real-Time Telemetry Data Transfer Platform, the data delivering process—previously conducted using legacy methods and requiring 2 hours—has been reduced to a matter of minutes. The core architectural principle of the software is based on extracting data packets not after the completion of flight activities, but from the onset of operations which are categorized according to specific test points and data set groups. Following engine shutdown, the relevant data sets are delivered to the responsible design teams within five minutes for analysis.

The shared data packages include not only time-based parameter data, but also synchronized tower and aircraft tail camera video recordings and screen captures of real-time data monitoring software screens that contain various analytical indicators and visualization tools. By accelerating the data distribution workflow, the developed software is expected to make a benefit to project schedules and overall flight test programs execution efficiency.

Key words: Real-Time Data Transfer

Introduction

Flight testing is a fundamental phase in the development and validation of aerospace systems, enabling engineers to verify system performance under real-world conditions [1]. During flight tests, telemetry systems transmit a continuous stream of data from onboard sensors to ground-based control stations. These data streams include critical parameters such as flight dynamics, system health indicators, and environmental conditions.

Flight test operations generate high-frequency, high-volume telemetry data that must be processed and distributed efficiently to support engineering analysis and decision-making. This paper presents a Real-time Data Transfer Platform developed using C# and a distributed

in-memory architecture based on Apache Ignite. Apache Ignite keeps data in memory as much as possible to minimize disk operations. Additionally, through its advanced querying capabilities, it provides access to data via the SQL API [2].The proposed system initiates data extraction at the onset of flight operations and processes telemetry streams continuously, enabling near real-time data availability. The platform also integrates synchronized video recording and automated multi-network data transfer. Experimental observations show that the system reduces data delivery latency from approximately two hours to under two minutes, significantly improving engineering workflows and accelerating post-test analysis.

Legacy Workflow

In Flight Test Management Centers, real-time data monitoring is typically performed using specialized software platforms such as IADS, which allow engineers to visualize and track system behavior during the test. However, despite the availability of real-time visualization, the extraction and distribution of structured datasets for post-flight analysis remain largely dependent on batch processing techniques.

This delay introduces inefficiencies in the test cycle, particularly in iterative testing environments where rapid feedback is essential. The growing complexity of modern aircraft systems and the increasing volume of telemetry data further exacerbate this issue.

This study proposes a real-time telemetry data transfer platform designed to eliminate post-flight delays by enabling continuous data extraction and near-instantaneous distribution.

In current data sharing method, telemetry data follows a multi-stage processing pipeline. Initially, raw telemetry streams are received and visualized in real time with real-time data monitoring software (IADS) [3]. These data are simultaneously recorded in .iadsdata format for later use.

After the test flight is completed, telemetry teams use in-house software (TADET – Turkish Aerospace Data Extraction Tool) to extract datasets from raw telemetry data. These datasets are pre-defined dataset which are

specialized before the flight according to needs of design teams.

TADET is a software tool designed to extract flight data obtained via telemetry, thereby migrating the manual workload into a virtual environment. For its data extraction operations, TADET utilizes the **iadsRead** method to retrieve data through IADS [3]. Furthermore, it employs distributed computing to distribute data processing tasks across different machines and processes. This approach significantly accelerates the process through its distributed architecture. However, the software can only initiate its operations once the flight test activity is fully completed. The necessity of transferring activity files to the server where TADET is hosted causes a delay in the data extraction timeline. This data is still in Telemetry network after extracting and should be transferred to Common Corporate Network for further analysis.

This process exhibits several limitations:

Latency: Data availability is delayed by approximately two hours.

Manual dependency: Data extraction and transfer often require human intervention.

Scalability: Increasing data volume leads to longer processing times.

Inefficient feedback loops: Design Engineers cannot access data immediately after test execution.

These limitations highlight the need for a more efficient, real-time data processing approach

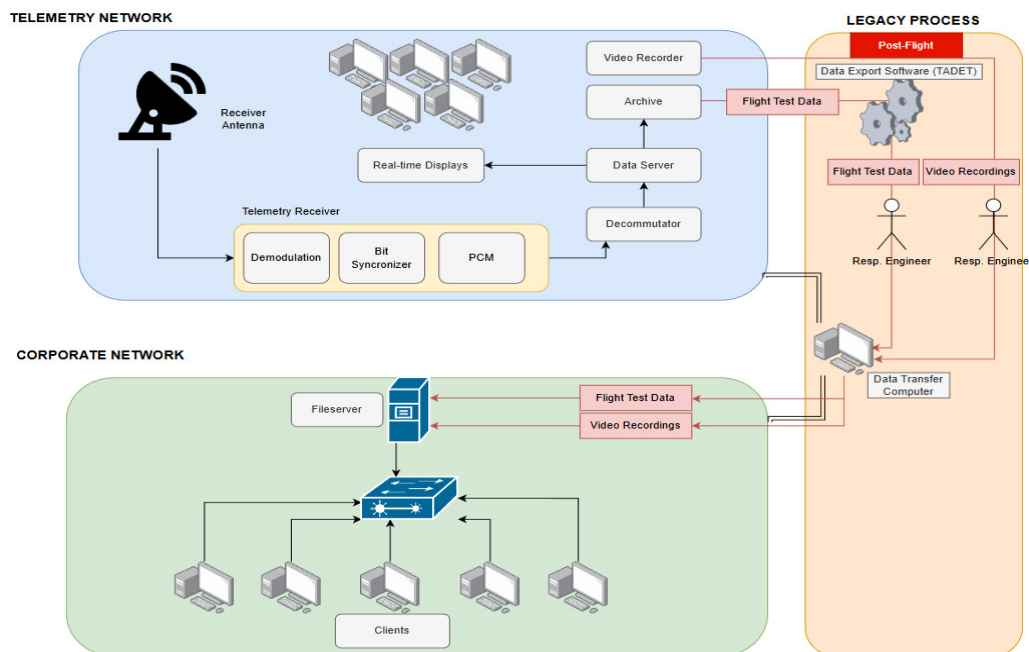


Fig.1.Current Workflow -Legacy System

New Workflow After Implementation of “Real-Time Telemetry Data Transfer Platform”

The proposed platform introduces a paradigm shift by transitioning from post-flight batch processing to continuous, real-time data processing. The system begins operation as soon as telemetry data flow is detected,

eliminating idle time between data acquisition and processing. The platform continuously processes incoming telemetry streams and organizes data into predefined datasets. Unlike legacy workflow, which operate on complete flight records, the proposed method works incrementally.

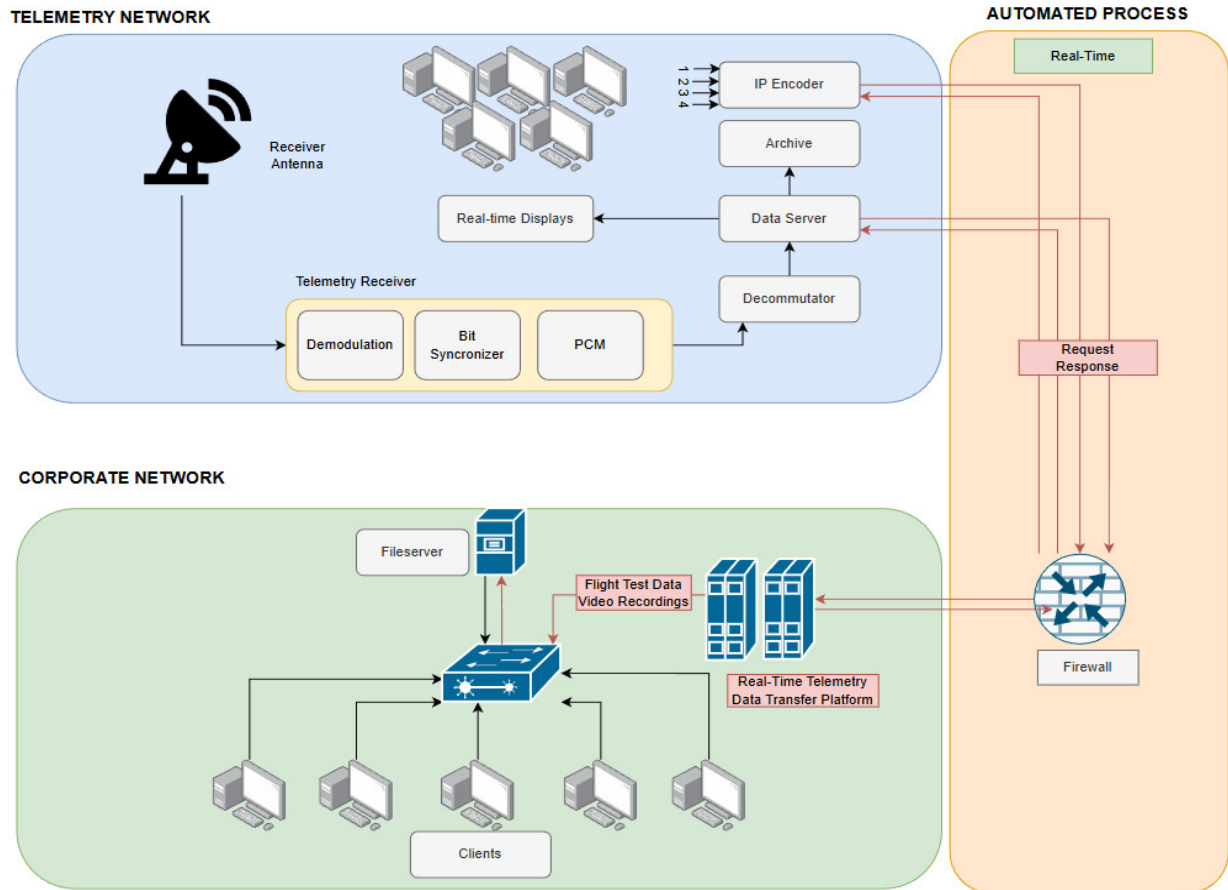


Fig.2. New Workflow – Real-Time Telemetry Data Transfer Platform

System Design

The platform is implemented in C# and follows a modular, scalable architecture. It continuously send TCP requests to data source(Cache Data Server) to detect the initiation of flight test activities. Once telemetry flow is detected, the system automatically initiates data recording and processing operations.

System use “IADSDatInterfaces.dll” to retrieve data during the flight test. This dll is an API which provided by IADS software to retrieve data in real time or post flight. The system creates as many processes as there are distinct datagroup records, and each process retrieves data using its own instance of `iadsdatainterfaces`.

The software operates on the Common Enterprise Network and sends requests to retrieve data by connecting to the Telemetry network through a firewall. The incoming data is

written into CSV files on a datagroup basis. Additionally, for each test point, the data corresponding to that test point’s time interval is extracted on a datagroup basis, and a separate CSV data file is generated for each test point.

After dataflow is finished, system saves recorded data and video files to shared file system and sends e-mail to recipients.

Parallel Processing Model

To handle high data throughput, the system employs a parallel processing model:

- Each data group is assigned a dedicated subprocess
- Subprocesses operate independently and concurrently
- Each subprocess processes a specific set of parameters

Within each subprocess:

- A data processing thread handles relevant datagroup's all time data extraction
- A test point monitoring thread tracks new test points and handles test point time interval data extraction

This architecture ensures efficient resource utilization and minimizes processing latency.

Configuration-Driven Flexibility

Each aircraft platform is associated with a configuration file containing:

- Data group definitions
- Parameter lists
- Sampling frequencies

Data Transfer Across 2 Networks

As mentioned earlier, flight test data is initially collected and monitored on the Telemetry network during the flight test activity. After the flight test is finished, responsible telemetry engineers extract this data on a datagroup and test point basis, transfer it to the Common Corporate Network, and share it with design teams for further analysis. Data transfer between different networks prolongs the data sharing process.

As a solution, the software reads data by using a specific port through a firewall that bridges the two networks and shares the generated data

files on the Common Corporate Network, where engineers perform data analysis

The proposed system enables secure and efficient data transfer between these networks

- Firewall-based communication
- Dedicated port configurations
- Automated transfer mechanism

This eliminates the need for manual data transfer methods (e.g., physical media), reducing both time loss and operational risk.

Integrated Video Data Management

In addition to telemetry data, the platform captures and processes multiple video streams:

- Cockpit camera
- Tail camera
- Tower camera
- Real-time monitoring screens

These video streams are:

- Recorded continuously
- Time-synchronized with telemetry data
- Distributed alongside telemetry datasets

This multimodal data integration enhances situational awareness and provides engineers with a comprehensive understanding of flight conditions



Fig.3. Video Recordings with Flight Data

Performance Evaluation

The implementation of the new platform results in significant performance improvements:

Tab. 1: Method Comparison

Metric	Legacy System	Real-Time Data Transfer
Data Availability	~2 hours	~2 minutes
Processing Method	Post-Test Batch	Real-time
Transfer Method	Manual	Automated

Key Improvements

- Data Sharing Duration : ~60× faster
- Operational efficiency: Reduced manual workload
- Faster decision-making: Faster data access
- Improved test cycle speed: Faster iteration capability
- Automated process: System does not need human effort for data sharing



Fig.4. Data Sharing Durations Before Implementation of "Real-Time Telemetry Data Transfer Platform"

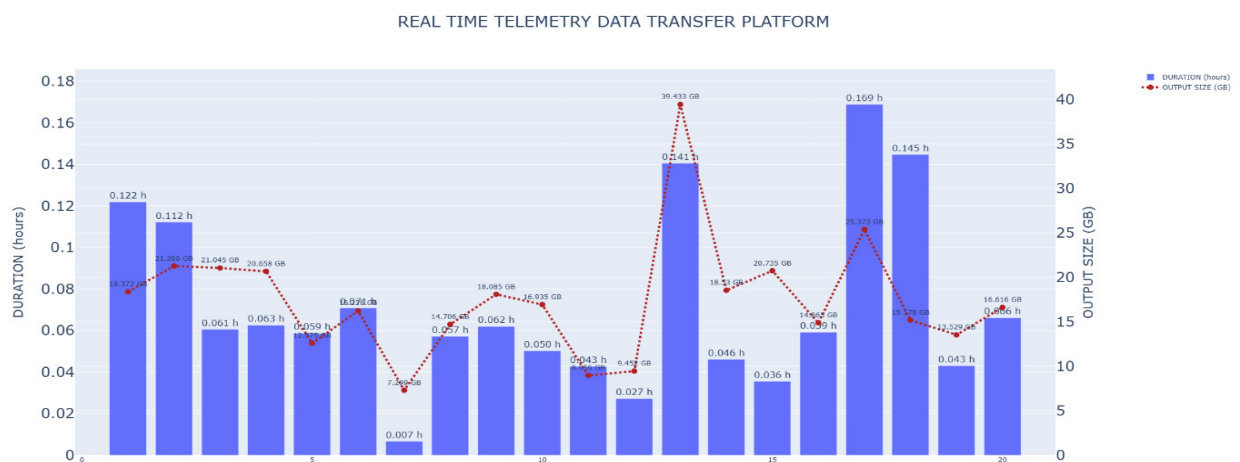


Fig.5. Data Sharing Durations After Implementation of "Real-Time Telemetry Data Transfer Platform"

Tab. 2: Data Sharing Duration in hours for Randomly Chosen Aircraft

	Mean Duration	Min Duration	Max Duration
Legacy Data Sharing Process	1.81	1.25	2.68
Real-Time Telemetry Data Transfer Platform	0.07	0.006	0.16

Conclusion

This paper presents a real-time telemetry data processing and sharing platform that improves flight test workflows. By real time data extracting the system reduces data availability latency from hours to minutes.

The integration of telemetry and video data, combined with automated multi-network transfer, provides an efficient solution for flight testing environment.

The results highlight the importance of real-time data accessibility and demonstrate the potential for further advancements in data-driven aerospace systems.

The proposed system demonstrates the advantages of real-time data processing. By eliminating post-flight delays, the platform enables continuous feedback and faster validation cycles.

It also creates a profit of 2 hours human power in average per flight test activity.

However, several considerations must be addressed:

Scalability: Managing extremely large datasets

Security: Ensuring safe cross-network communication

Synchronization: Maintaining accuracy between telemetry and video data

In future studies, in addition to recording telemetry data in real time and delivering it to users, the aim is to perform test-point-based real time analyses and compliance statuses of test points.

References

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