CASE STUDY

# Data Acquisition System (DAS) Upgrade on an RNLAF F-16BM

CURTISS-WRIGHT


*"Only Curtiss-Wright could meet our requirements for a compact Ethernet DAU*

Johan Klijn, Principal Project Engineer, NLR

## Program

- Data acquisition system (DAS) upgrade on an RNLAF F-16BM
- Meet extended test aircraft life requirements

## System

- An Ethernet based DAS using several compact remote data acquisition units
- Simple system for adding and removing 'optional' DAUs to meet the specifics of a program

## Results

- Extended aircraft life requirements with minimal aircraft modifications
- Upgraded to a future proofed Ethernet system using existing wiring
- Deployed a flexible system capable of meeting future requirements quickly and easily

## Program

NLR (National Aerospace Laboratory) are tasked with helping the Royal Netherlands Air Force (RNLAF) instrument one of their 68 F-16's. This F-16B MLU is known as the 'Orange Jumper' and it is unique as it functions as a fully operational asset that is certified and mission ready even while fully instrumented for flight test applications. NLR have been flight testing aircraft since 1920 and have an extensive set of capabilities in accommodating applications in their dedicated aircraft, modifying aircraft, planning and executing flight test campaigns and aircraft certification. Flight test topics range from aerodynamics, flight mechanics, zero-gravity, atmosphere, airborne remote sensing and flight test methods, to system tests, air traffic management, avionics, alternative fuel, flight inspection and cold/ hot weather testing.

The RNLAF has operated the Orange Jumper since 1999, preparing and performing test operations in close cooperation with NLR. The aircraft's operational lifetime was extended in 2013 from 2015 to 2023. The flight test system installed on the F-16BM had however become obsolete as it was no longer being effectively supported by the vendor. This was leading to problems with being unable to properly maintain the system with parts no longer being available. This led NLR to select a new system, one that would meet the current and future needs of the Orange Jumper project.

There were some unique requirements for this system as it was desired that the existing data acquisition units (DAU) could be installed in the same locations as the original equipment and use the same wiring. These choices were taken in order to minimize any modification to the aircraft and simplify installation. In order to best use the space available on the aircraft and to ensure it remained fully mission capable, it was necessary to utilize several remote locations for DAU installation.

> NLR is playing an increasingly important role…they designed and maintain our flight test instrumentation and they do a lot of the data processing – our close working relationship with NLR and RNLAF is an important capability.
>
> Major Ralf, Test-Pilot, RNLAF

## Solution

Curtiss-Wright was selected to provide an on-board data acquisition system. The configuration for the Orange Jumper consists of 7 compact Acra KAM-500 chassis, 15 standard chassis and approximately 90 interchangeable data acquisition modules. A subset of the chassis was installed permanently, with the majority installable in different configurations as required by the specific flight test application. This flexibility was important as the aircraft would undergo several different tests and NLR wanted to ensure the system was expandable and adaptable so future requirements could be met.

Ethernet was chosen as the data transport protocol for two primary reasons. First, NLR believed this protocol is going to dominate flight test and thus it is more future proof. Second, since the installed wiring was to be reused, it was necessary to select a standard that could accommodate data transport, power and synchronization over the existing 14 wire looms without detecting data corruption at speeds up to 100Mbps.

A star topology network based on 100BaseT links was used for chassis interconnection and data aggregation. Data aggregation for the remote nodes was achieved using KAD/SWI/101 modules located at intermediate locations. These Ethernet switch modules acted as aggregators to connect all the DAUs to a single central switch – the NET/SWI/003.

The NET/SWI/003 is a rugged Ethernet switch specifically developed to meet the unique requirements of rugged airborne applications like flight test. The NET/SWI/003 also contains an IEEE 1588v1 Grandmaster clock which transmits Precision Time Protocol (PTP) synchronization packets to each of the bus controller modules in each DAU. This equipment meant it was possible to synchronize all the data in the network to within 200ns.

The final aggregated data was converted to IRIG-PCM stream via an Ethernet bus monitor module and a PCM encoder module. The resulting IRIG-PCM stream is suitable for recording by the previously installed recorder and for use in an onboard monitoring station. This onboard monitoring station is used by a flight test engineer to access information (the Orange Jumper has a dual seat configuration) to monitor the flight and to aid in judgments about safety such as whether the flight test should be aborted.

## Results

### Met extended aircraft life requirements with minimal aircraft modifications

Although the old system has been considerably exceeded in a number of ways by modern FTI systems, it remained very difficult for NLR to find any DAUs that could fit into the limited installation spaces typically available on any small jet aircraft. This was an important requirement for the customer as there could be a significant impact to the operational availability of the aircraft if heavy modifications were required. During the selection process, only products from Curtiss-Wright met the size and capability requirements that allowed NLR to replace the existing system without major aircraft modifications.

### Upgraded to a future proofed Ethernet system using existing wiring

Re-using the installed wiring looms considerably reduced installation time and effort. NLR felt Ethernet was the future interconnection standard and it also requires fewer wires than some other standards which use separate wires for synchronization. NLR carried out laboratory and field tests with the support of Curtiss-Wright and proved the wiring was capable of transmitting Ethernet packets without packet loss and meeting EMI/EMC requirements.

### Deployed a flexible system capable of meeting almost any future requirements quickly and easily

The Orange Jumper is required to meet different flight test applications throughout its remaining life and in order to make each test as simple and efficient as possible, NLR decided to install an adaptable system. The KAM-500 features a modular design and consistently released new modules to meet new interface or sensor requirements. By designing the system's architecture to include several optional chassis, each new test program can have its data acquisition requirements met by installing the required modules in the required number of chassis. If a new system or sensor requires analysis in the future, all that will be required is the addition of a new module to meet this need.

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