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Modular EGSE

MODULAR ELECTRICAL GROUND SUPPORT EQUIPMENT

Abstract
Final Presentation Days

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1 Introduction

Modular EGSE is intended as a replacement for existing EGSE SCOE and Hardware-in-the-loop (HiL) systems. This concept was born from the observation that many of the recurrent costs on EGSE benches could be reduced by replacing proprietary technologies, such as National Instrument's PXI, or obsolete components such as VME/PCIe bridges, with modern, high-performance Ethernet-based components. This goal was achieved while preserving a high degree of compatibility with legacy I/O modules from ADS.

2 Achieved goals

The overarching goals that have been achieved are:

- **Modularity**

  Independent modules can be easily reused or adapted, unlike in monolithic, fixed form-factor architectures.

- **Simple deployment**

  The architecture enables easy integration and configuration; it is a distributed EGSE system with non-fixed topology.

- **Autonomy**

  Each I/O module behaves as an independent network node and is able to process data and perform various actions.

- **Low-cost, short time-to-market**

  The design is based on off-the-shelf elements, thus reducing time-to-market.

- **Configurability**

  An embedded http server provides I/O module configuration or firmware update at user level.

- **Portability**

  The solution is independent from any SCOE or simulation framework and on the client side, can be used under multiple operating systems.

3 Technical overview

The Modular EGSE architecture leverages gigabit Ethernet and embedded hybrid FPGA/CPU technology to provide a flexible, cost-effective solution for real-time Hardware-in-the-Loop EGSE benches. The key features of Modular EGSE are:

- fast digital and analog I/O command and acquisition, adequate for the simulation of hardware sub-systems under the control of a real-time simulation scheduler,

- data exchange latency compatible with Simulation Front-Ends real-time constraints,
- ability to run in a distributed fashion with sub-microsecond synchronization accuracy.

Modular EGSE is based on a master-slave architecture where the master will typically be a Gigabit Ethernet-capable workstation controlling a number of nodes. The nodes, would perform electrical signal generation or acquisition, or any other type of I/O required in a HiL bench.

The master and its slaves are all synchronized with sub-microsecond accuracy via the IEEE-1588 PTP protocol. This allows synchronization to be performed through Ethernet, which considerably simplifies the deployment of a bench and provides significant simplification compared to dedicated synchronization solutions such as IRIG.

Each module is responsible for the serialization/deserialization of I/O data. In the case of fast, time-stamped data I/O, these operations demand real-time processing capability and management of the Ethernet network stack. For these reasons, the project takes advantage of the new generation of hybrid FPGA SoC.

Modular EGSE adopts a future-proof approach that relies on modern, widely-adopted COTS technology. It also responds to today's expectations in terms of platform neutrality, avoiding any vendor lock-in.

Modular EGSE's main innovation lies therefore in the definition of a flexible architecture for HiL that exploits the synergies between 3 modern technologies, namely:

- Gigabit Ethernet, for high data-rate communication,
- hybrid SoC processors, for real-time command and acquisition and serialization/deserialization of data over the network,
- the Precision Time Protocol (PTP) for sub-microsecond synchronization.