# IS WORLDFIP A RELIABLE RAD-HARD FIELD BUS FOR THE LONG TERM?

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*Abstract*

The WorldFIP fieldbus was chosen to cover communication needs of critical LHC systems needing determinism and radiation tolerance. WorldFIP slaves use the MicroFIP chip produced by Alstom along with the FielDrive transceiver and associated magnetics. After Alstom announced a progressive decline in support of WorldFIP technology, BE-CO decided to start a technology in-sourcing program in order to guarantee local support of this strategic technology during the lifetime of LHC. The first phase of this program consists in designing an FPGA-based alternative to MicroFIP, called NanoFIP. In addition, the last generation of MicroFIP chips was manufactured using a newer process with reduced feature sizes and there are serious concerns about its radiation tolerance. The NanoFIP development is therefore now considered a critical part in the global strategy of providing a radiation-tolerant solution to WorldFIP users. This paper presents a status of the NanoFIP project, as well as long-term plans for the overall WorldFIP technology insourcing in BE-CO.

## INTRODUCTION

The WorldFIP fieldbus is a strategic ingredient in the control and data acquisition for many critical subsystems in the LHC, including cryogenics, power converters, quench protection and beam position monitors. It was chosen as one of the three recommended fieldbusses in the LHC mainly for two reasons:

- Determinism is ensured by the fact that access to the medium is arbitrated by a master node. Slave nodes only speak when requested by the master. This guarantees that, with appropriate planning, worst-case delays in message transmission will not result in missed hard real-time deadlines.
- The first-generation slave chipset performed quite well during radiation tests. This chipset includes the MicroFIP – where all logic resides – and the FielDrive, a bus driver to interface with the magnetics that are connected to the multi-drop bus.

Radiation resistance is of critical importance in view of the latest results of the simulation for radiation conditions in LHC. Unfortunately, the latest generation of MicroFIPs coming from industry have been manufactured using a more modern process and their radiation tolerance has been diminished.

The organisation so far concerning WorldFIP-related activities at CERN includes three main actors:

- Alstom is a technology provider, selling a number of chips and complete cards, such as the PCI card used as a master for most of the WorldFIP segments.
- BE-CO-FE organises cabling, monitoring and develops software for some of the systems. In addition, they have a coordinating role and a privileged relationship with the technology providers.
- Equipment groups develop systems based on technology they buy from Alstom and rely on BE-CO-FE for installation, qualification and general coordination.

Alstom has announced they will be gradually reducing support of the WorldFIP technology in the coming years. Taken into account that this happens at a time where there are increasing concerns about the radiation hardness of the new generation of MicroFIPs, it has been decided to insource the Alstom WorldFIP technology at CERN. This insourcing effort will have two staged goals. In a first phase, a rad-hard replacement of the MicroFIP has to be designed and provided with adequate support to equipment groups. A second phase will target complete replacement of Alstom as a technology provider by BE-CO-HT. This has to include chips and cards to a degree sufficient to ensure smooth running of LHC subsystems during their lifetime.

In 2009, the test campaigns conducted in the CNGS facility have provided more evidence that the insourcing decision was right. As WorldFIP slaves always come with a combination of a MicroFIP and FielDrive chips, there were tests setup to discriminate between these two possible culprits for SEU-related problems. A Cu-Cu repeater containing just two FielDrives and a flash-based FPGA succeeded in the tests without problems, pointing at the new generation of MicroFIPs as the cause of the observed failures in previous tests. In addition, the nature of the observed failures pointed in the same direction. In particular, the scenario in which a system sends erroneous frames cannot be attributed to a problem in the FielDrive.

## THE NANOFIP PROJECT

To tackle the first of the two goals of the insourcing, the NanoFIP project [1] was launched. The goal is to provide an FPGA-based replacement for the MicroFIP as quickly as possible. The project went through a phase of requirements gathering and technical specifications writing during the first half of 2009, and is currently in the implementation phase, with results expected during 2010. The specification phase was driven by an effort to find the features users really needed from the MicroFIP, and drop the rest in the in-

terest of simplification and ultimately radiation-tolerance. The resulting feature set is in most respects a subset of MicroFIP functionality, hence the name NanoFIP, and this new solution is neither hardware nor software compatible with the MicroFIP. The results of the project will be usable in two ways:

- One can take the Wishbone-compliant NanoFIP VHDL core and instantiate it into a larger design including application-specific logic. Then radiation testing will have to be performed on the whole resulting system under the responsibility of the user.
- Another option is to use a fully radiation-tested FPGA containing the NanoFIP and nothing else. This has the advantage for the user that the radiation-tolerance of that part is guaranteed.

## OTHER OPTIONS

If strict compatibility with the MicroFIP is required, both at the functional and device packaging level, then an ASIC type of solution would be needed. While preliminary contacts with PH-ESE seem to indicate that this option is not impossible, many open questions remain, so at this point in time the NanoFIP is the agreed, endorsed and official deliverable for this phase of the insourcing project. The potential advantages of a one-to-one replacement of MicroFIP, dubbed MicroFIP3, include the possibility of leaving some of the current PCB designs and software interfaces untouched, which would be an important issue for some of the equipment groups. The possibility of a collaboration with PH-ESE for a MicroFIP3 is currently being discussed.

## CONCLUSIONS

This talk was required to answer the question of whether the WorldFIP bus can be made rad-hard during the lifetime of LHC. The answer is 'yes', provided a certain amount of effort is put in the design of a replacement for the MicroFIP chip. The NanoFIP project is well underway and will result in an FPGA-based solution that fulfils all needs of current users. Other options and strategies for other components currently supported by Alstom will be considered in the future and with a different time scale.

## REFERENCES

[1] CernFIP Project website, see `http://www.ohwr.org`.