Cluster for Application and Technology Research in Europe on NanoElectronics

PROJECT RESULTS

CA303 | Fault-mitigation electronics is the best defence against soft, firm and hard errors in critical applications [OPTIMISE]

Electronic systems deployed to control critical functions – such as in aerospace, avionics and automotive applications, as well as, in crypto-graphic chips, medical implants, networking and servers – need to be secured against errors in the information flow, and failures in electronic components. The OPTIMISE project developed optimised mitigations for advanced digital and power electronic systems that cope with the issue of reliability in the face of increasing soft, firm and hard errors.

Platforms, like satellites, launchers, aircrafts and cars, have electronic systems which are often subjected to harsh environments capable of inducing errors in their information flow, and failures in components. High-energy particles present in space, for example, cause errors and failures in space electronics. With the sharp increase in the use of computing, electronic systems, even on the ground, can be impacted. Both digital and power electronics are affected, and in the latter case, radiation can be destructive. For space, avionic or automotive applications, the mean requirement for safety critical functions is 1-10 failures in 109 hours. The answer is to develop optimised mitigations for these electronic systems in order to successfully improve reliability to counter the increasing problem of so-called soft, firm and hard errors.

Risks assessed and mitigation techniques optimised, validated and deployed

This project had three key aims:

1. To develop and validate mitigation techniques, from layout to application architecture levels, for three applications specified by different end users in automotive, avionics and space;

2. To acquire knowledge on new radiation threats that may impact future electronic equipment, and work in close collaboration with standardisation bodies to propose guidelines or standards to be able to perform relevant risk assessment;

3. To benefit from the synergies in the project to achieve one of the first detailed radiation risk assessments for automotive.

Validating mitigation techniques was conducted in two phases. Proof-of-concept mitigations were applied to simple test cases (such as simple test structures implemented on a test vehicle, power devices manufactured and the use of the well-known Leon soft processor) and the efficiency was then assessed based on experiments. Developed mitigations were then deployed (with some adaptation), where possible, in end-user applications, and their efficiency assessed.

Project results look promising. The proposed mitigation optimisation for the avionic system-on-chip (SoC) application passed assessment. The latest test vehicle embedding the mitigated version of the space ASIC (V53) was successfully produced in December 2013. The assembled and functionally tested parts were made available in May 2014, radiation tests and the exploitation of the results performed in June 2014, and a first assessment of the radiation risk for automotive done in 2013. In terms of product development, a new commercially available power diode (1200V SiC STPSC6H12), which offers better radiation tolerance, has been available since 2013.

In short, OPTIMISE resulted in a set of validated mitigation techniques (from layout to application-architecture levels), customised mitigations for given applications and a strong argument for standardising error assessment.

Close European working

Mitigation development was achieved through the close collaboration of some 20 Spanish and French project partners, ranging from semiconductor manufacturers and their technology developers, to academic partners and end-users.

It is worth noting OPTIMISE's close interaction with RELY, a complementary project. While both deal with improving system dependability, OPTIMISE's focus is in developing mitigations for radiation effects, whereas RELY's is in the design of reliable SoCs.

PROJECT CONTRIBUTES TO

- Communication
- Automotive and transport
- Safety and security
- Energy efficiency
- More than Moore

PARTNERS

AIRBUS
ARQUIMEA
ATG
ATMEL
CEA, DAM, DIF
CNM
Continental
D+T Microeletronic.
EADS IW
IM2NP
IMS
iRoC
Renault
STM (Rousset)
STM (Tours)
TAS-E
TIMA
UC3M
UIB
VALEO

COUNTRIES INVOLVED

France
Spain

PROJECT LEADER

Florent Miller
Airbus

KEY PROJECT DATES

July 2009 - June 2013

All partners contributed to the dissemination effort, with presentations at six events and through more than 120 publications. Standardisation was also pursued through workshops to promote tools and test methodologies and update of avionic radiation test standards. In automotive, a standardised method for assessing reliability due to radiation effects on power components was proposed.

Impacting technology, business and safety

This project helps make possible the use of advanced electronics in critical end-user applications, and ensures the reliability of consumer electronics. Let us look at some market demands, business opportunities and benefits from which OPTIMISE's deliverables and other results can profit.

Electronics – sensors and intelligence – are found everywhere in cars, increasing safety through driver assistance and drive-by-wire systems. And the all-electric car will push the use of power electronics even further. Studies show that sales of electrical vehicles have already increased by 50% since 2012. This trend is expected to continue. Now, considering reliability of electronic components is an essential element in lots of applications (including automotive domain and more particularly, power electronic applications), the number of power components is also expected to increase significantly. Similarly, SmartPower-type devices which are used in many automotive power applications, also follow the same trend. Between 2005-2014, the number of SmartPower devices in a single product has increased by factor of four, and the number of products in production by about a factor of two.

A main challenge in the avionic sector is the ability to implement high performance ICs while ensuring the required safety level. OPTIMISE now offers solutions to support these and other avionics requirements. In space, satellites and launchers are totally autonomous so their reliability has to be determined prior to launch. In recent ESA space projects, complex digital and mixed signal functionalities require their integration into a single chip, making the chip size and power consumption critical for the development of the application. This also means that radiation-induced mitigation techniques, related to chip size and power consumption, also need to be optimised. Advances from OPTIMISE will allow the implementation in space chips of some functionalities that were not implementable using classical radiation mitigation techniques. Another key outcome of OPTIMISE is the development, assessment and validation of a complete 90nm digital rad-hard standard cell library.

Finally, regarding safety, OPTIMISE will provide competitive strength in sectors of European industry that need to make use of 'fail-safe' electronics in automotive, aeronautics and space applications, as well as, in those that provide enabling technology for low-power consumer electronics. At the same it will also ensure increased human safety.

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