Project profile

Cluster for Application and Technology Research in Europe on NanoElectronics

CA303 | Optimisation of mitigations for soft, firm and hard errors (OPTIMISE)

PROJECT CONTRIBUTES TO

Communication	✔
Automotive and transport	✔
Health and aging society	
Safety and security	✔
Energy efficiency	✔
Digital lifestyle	
Design technology	
Sensors and actuators	
Process development	
Manufacturing science	
More than Moore	✔
More Moore	
Technology node	

ELECTRONICS IN TRANSPORTATION FOR SAFETY AND SECURITY, ENVIRONMENTAL PROTECTION AND COMMUNICATIONS

Partners:

Airbus Industrie
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CONTINENTAL Automotive
D+T Microelectrónica
EADS IW
IM2NP
iRoC
Renault
STMicroelectronics
Uni Balearic Islands
Uni Carlos III Madrid
Uni ENSEIRB
Uni INP-TIMA
VALEO

Project leader:

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Key project dates:

Start: July 2009
End: June 2013

Countries involved:

France
Spain

The aim of this CATRENE project is to optimise the mitigation of soft, firm and hard errors in advanced digital and power electronic systems to resolve reliability issues. To reach this goal, OPTIMISE combines the strengths of European semiconductor manufacturers, technology developers, academic partners and end-users. The project will result in a set of validated mitigation techniques from layout to application-architecture levels, customised mitigations for given applications and a strong argument for standardisation of error assessment. The expected benefits will be the ability to use advanced electronics in critical end-user applications and ensure the reliability of consumer electronics.

Electronic reliability is essential in the many application domains where safety and security are major concerns. This includes electronics systems used to control critical functions – such as in aerospace, avionics and automotive fields, cryptographic chips, medical implants, networking and servers.

The CATRENE CA303 OPTIMISE project focuses on safety-critical applications. The key is to ensure that, in case of an error or a failure, there is no critical consequence to the safety and the integrity of the system. To reach such a goal, the environment in which the electronic systems are used has to be taken into account and studied to evaluate the probability of failures.

OPTIMISE will particularly address the mitigations necessary to tackle the natural radiation environment. This is a major concern for aerospace and avionics but often has also to be taken into account at ground level. Particles coming from space are able to provoke non-permanent soft errors, firm errors which require reset or reconfiguration to recover or hard errors that lead to definitive failures inside electronics systems if not mitigated.

Power and digital electronics

The project is strongly end-user driven. All players in the value chain will contribute, whether platform integrators, developers or semiconductor technology providers. Complete electronic boards performing a function will also be considered.

Two types of electronics of particular importance for aerospace, aeronautics and automotive applications will be studied:

1. **Power electronics:** the use of high power electronics inside transportation platforms is a major challenge to overcome in designing fully-electric vehicles – for example the replacement of hydraulics and air circuits in aircraft or electric cars. Commercial power modules may be sensitive to radiation effects in some cases and therefore it is necessary to study sensitivity conditions and failure probability; and
2. **Digital electronics:** automation or driving assistance for vehicles – satellites, aircraft and fly-by-wire – requires the use of flight computers exploiting advanced digital electronics. As these mainly use CMOS technologies, such applications have to cope with the decreasing reliability of CMOS as dimensions shrink and operating voltages decrease. Soft, firm or hard errors may occur and it is necessary to evaluate conditions for which mitigations have to be implemented.

Impact on performance

Some mitigations are already used even in consumer electronics but with major drawbacks. Firstly, there can be a large impact on the performance of the application. Secondly the need for

higher computing power increases power consumption and induces associated thermal effects. Thirdly, new effects appear for which the usual mitigation approach is no longer effective.

Consequently, the scientific aims of OPTIMISE are to:

- Characterise the sensitivity ranges of various component technologies and at system level, with respect to radiation effects, and to obtain orders of magnitude of expected failures for the identified sensitivity ranges;
- Develop optimised mitigations at transistor, layout, component, architecture and board level that are also able to deal with new effects appearing in advanced technologies – beyond 90 nm – and which are applicable to all applications; and
- Propose benchmarking standards for the design of optimised and customised mitigations in a given application by comparing the efficiency delivered by the various levels of performance, power consumption, cost and reliability.

For digital applications, OPTIMISE will consider complete electronics boards with various types of individual components. Mitigations of various memory types will be studied. Most of the developments – some 90% – will take place at higher design level to be as generic as possible. It is the specificity of each type of component that needs to be considered.

Since the main breakthroughs in power electronics come from technology change, this segment will be addressed but mitigations will also be studied at module level, where some improvements can also be expected.

Test vehicles will be developed for both digital and power electronics, but commercial off-the-shelf technologies will also be investigated.

Areas of vulnerability

Inside platforms such as satellites, launchers, aircraft and cars, electronics systems are subjected to especially harsh environments liable to induce errors in information flow as well as component failures. In particular, high energy particles such as protons and heavy ions from stars – for example the sun – are present in the space environment and are well known to provoke errors and failures in space electronics. It is even the main cause of space electronics failure – some 80% of errors result from this.

Even though the Earth is partially protected by its magnetic field, the interaction of cosmic particles with atoms in the atmosphere produces 'particle showers'. The resulting flux of particles – mainly neutrons and protons – increases with altitude. This is why civil aircraft flying at a cruising altitude of 12 km began to be affected in 1990, when on-board electronics systems were introduced.

With the rapidly growing use of computers, even ground-level electronics systems can be affected. This is taken into account by network operators and large computing system providers; major manufacturers are very active in this domain and in all fields where 100% service reliability has to be guaranteed.

Extensive scope

In space, satellites and launchers are totally autonomous so their reliability has to be determined prior to launch. Flight computers are mandatory for the functionality of the latest generations of aircraft and, in the future, this could be the case also for power electronics in electric vehicles.

A third of the overall value of aircraft already lies in electric, hydraulic and air systems, while electricity will replace hydraulics in the future generations. Electronics – sensors and intelligence – are applied everywhere in cars, increasing safety through driver assistance and drive-by-wire systems. The all-electric car will push the use of power electronics even further.

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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CATRENE focuses on delivering nano-/microelectronic solutions that respond to the needs of society at large, improving the economic prosperity of Europe and reinforcing the ability of its industry to be at the forefront of the global competition.