PROJECT RESULT

Technology platform
for next-generation
core CMOS process

MEDEA+

2A701: Parasitic extraction and optimisation for efficient microelectronic system design and application (PARACHUTE)

New modelling techniques improve design of entire microelectronic subsystems

A team including chipmakers, academia, electronic design automation vendors and application builders has developed new electromagnetic reliability and radiation effects modelling and simulation methodologies to verify the design of complete microelectronics systems, rather than simply individual components. The methodologies developed within the PARACHUTE project are applicable to testing for both electromagnetic interference and particle radiation, and will help ensure Europe retains its ability to stay at the leading edge of advanced microelectronics for the automotive and avionics industries.

As microelectronics circuitry becomes ever smaller and more integrated, electromagnetic interference from internal and external sources, as well as radiation sensitivity, assumes ever greater importance. For safety-critical functions in the automotive, avionics and space sectors in particular, such problems can bring huge social and financial costs if they lead to a major crash or safety recall.

In the past, such issues were considered only as part of the design of individual components. However, as circuit integration has progressed, it has become clear that designers need to verify the electromagnetic reliability (EMR) and the radiation fault tolerance of whole systems throughout the design stage.

Reliability and robustness

The MEDEA+ 2A701 PARACHUTE project therefore set out to develop an innovative approach at systems level, including algorithms, models, test techniques, tools and measurement setups, enabling designers to optimise the reliability of microelectronics and nanoelectronics circuitry in the face of electromagnetic interference and particle radiation.

PARACHUTE brought together a team of designers, systems developers and researchers from major European chipmakers, electronic design automation (EDA) vendors, academia and applications developers in the space, avionics and automotive sectors. The team looked at how to improve electromagnetic reliability and characterise the fault tolerance of applications that use nanometre-level circuitry, microelectronic designs, microsystems technology and electronic power systems.

The project concentrated on two key areas:

1. **Electromagnetic reliability** – developing systems-level resistance to the presence of electromagnetic interference. Here the team looked at electromagnetic compatibility (EMC), power integrity, signal integrity, short electrical transients and electrostatic discharges; and
2. **Particle-radiation sensitivity** – developing tools and methodologies to assess the radiation sensitivity of complex digital components. The radiation effects are known as single-event upsets (SEUs) and single-event transients (SETs).

Work targeted electromagnetic emissions, susceptibility to internal and external electromagnetic interference, sensitivity to natural particle strikes, signal and power integrity, and close-proximity coupling effects. Electrical and electromagnetic noise in any of these areas can significantly disturb functionality, performance and reliability.

Safety-critical applications

EMR is of great interest to developers working on any kind of safety-critical application, as can be found in the space, avionics, automotive, healthcare, telecommunications and many other industry sectors. In the automotive sector for example, more and more in-vehicle electronics focus on systems such as anti-lock braking systems (ABS), electronic stability control (ESC/ESP), traction control (TCS) and collision avoidance. Loss of function due to electromagnetic interference in these areas is potentially disastrous.

PARACHUTE's key innovation in improving EMR and fault tolerance against particle radiation was the development of new modelling approaches to microelectronic-systems design, together with a range of supporting simulation tools and techniques, as well as new measurement setups.

Successes include:

- Prediction of radiation and susceptibility behaviour in time and frequency domains;
- Extended and improved modelling abilities in mixed-signal circuit design;
- A modified model-order reduction (MOR) technique which was successfully adapted to complex circuit structures, reducing simulation time;
- New models and tools to analyse pulse stress, radio-frequency (RF) and particle-excitation effects at chip level;
- Completely new signal-trace methods to analyse printed-circuit board (PCB) behaviour with respect to signal-interference issues;
- Introduction of a new power-ground analysis methodology for PCBs; and
- A new field-scan approach and equipment set-up implementation.

The new design and modelling methodology was used to invoke and test product applications for automotive subsystems, digital TV, radio-frequency identity (RFID) applications and medical systems. The project was also able to develop prediction methods for chip or systems behaviour under disturbance conditions in a virtual environment based on modelling of test setups. All the models and tools were developed to cover chip technologies from 0.18 μm to 90 nm.

These new modelling and simulation techniques have already been implemented by two of the major partners in their production environments; one for automotive systems design and the other within the avionics sector. The techniques developed have become so essential to the design process that returning to the time before they existed would be unthinkable to these partners.

Particle-radiation tools in use

PARACHUTE's particle-radiation effects research has been of great interest to the space and avionic sector, since radiation from cosmic particles may significantly disrupt the behaviour of digital electronics systems. The resulting modelling methodologies and radiation-assessment tools will be used during the development phase of complex digital systems. They were validated thanks to real time and accelerated particle experiments carried out on space and avionic applications representative of existing ones.

Space and aeronautic designers can now use these tools to assess more accurately the sensitivity of complex safety-critical systems and to select the most efficient mitigations to ensure the reliability and safety of the whole systems.

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