1. Publishable Summary

Project Name:	**Increasing EU citizen security by utilising innovative intelligent signal processing systems for euro-coin validation and metal quality testing**
Project Acronym:	**SAFEMETAL**
Project Promo Images:	
Project's Official Website:	http://www.safemetal.eu/
Project Type and Reference:	**FP7-SME-2010-262568**
Project Duration:	**24 months** (start date: 01 December 2010)
Total Budget:	**€ 1,252,482**
Project Co-ordinator:	Douglas Reid Ardoran OÜ Heltermaa, Pühalepa vald, Hiiuma 92312, Estonia *douglas.reid@ardoran.ee*
Project Technical Co-ordinator:	Ioannis Papaefstathiou Telecommunication Systems Institute Technical University of Crete, Kounoupidiana, Chania, Crete, Greece *ygp@mhl.tuc.gr*

SAFEMETAL Consortium

Project partners	Country
Ardoran OÜ	EE
Edis	SK
Dunvegan Systems Ltd	UK
Algosystems	GR
Tallinn University of Technology	EE
AS Metrosert	EE
Electronics Design Ltd	EE
Riga Technical University	LV
Telecommunication Systems Institute	GR
University of Cyprus	CY

SAFEMETAL Positioning

Euro coinage has been steadily subject to increasing outlawed counterfeiting activities. The most recent figures bring to 17 the number of illegal mints discovered to date, accompanied with a significant cumulative total of counterfeit coins detected or confiscated. Around 140 classes of counterfeit coins and corresponding tooling and working methods are identified, which by European Technical and Scientific Centre directives lead undoubtedly to the conclusion that the vast majority of counterfeit manufacturing facilities remain in operation. At the same time conductivity measurements are widely used for characterisation of heat treatment of aluminium alloys and other non-destructive testing, especially for safety-critical applications in aerospace industry, nuclear reactors etc.

Prior art in the field has led to technologies made to reduce at manufacturing time the spread of electrical parameters and at validation time the measurement of electrical conductivity of the metal respectively. Due to the large number of coins produced by European mints, material for coin blanks is sourced from different suppliers. Recent European standards to increase the security of the coinage by reducing the spread of parameter values result in significant challenges for manufacturers of coin validators used in vending machines and bank coin sorting machines.

The Project

The participating SME's have identified these challenges and consider they represent major product opportunities. The developed metal validation technology will be required to distinguish between increasingly sophisticated counterfeit and the tightly specified genuine coins and to characterise the metal quality. This will be accomplished by developing advanced signal processing and data fusion techniques, and by also developing planar electromagnetic sensors and pulse eddy-current measurement techniques with increased field sensitivity. The market being addressed includes coin validators and aerospace and nuclear industries.

Project Objectives

The key scientific and technical objectives of the project are:

- Development of techniques for measurement of electrical conductivity of coinised copper-alloy specimens. Targeted uncertainty within +/-1% from DC to 1MHz and +/-4% from DC to 10MHz with measurements traceable to international standards.
- Development of mathematical models and numerical techniques to define the interaction of broad-band electromagnetic fields with objects of finite size, such as coins and bi-metallic/layered construction.
- Detailed characterization of the electromagnetic properties for euro coins of all denominations and selection of other coins.
- Investigation of Eddy current signal interaction with bi-metallic/ layered construction of euro coins at a range of frequencies form DC to 10MHz.
- Investigation of the effect of surface finish, plating, tarnishing/oxidation and embossing patterns (for both the common and country-specific sides of a coin) on conductivity across the range frequencies.
- Development of theory to model electro-magnetic planar sensors, enabling use as improved alternative to conventional coil sensors.
- Development of the theory for pulse-based/ broad-band eddy-current conductivity measurements.
- Development and application of novel signal processing techniques to extract useful information from the complex electromagnetic signals using low-cost and low-power hardware.
- Development and optimisation of sensors to measure other parameters of coins — diameter, thickness, weight, etc.
- Development and application of novel data fusion methodologies to combine information from the electromagnetic and other sensors.

- Design, realisation and evaluation of validator prototypes based on the innovations applicable to vending, service automation and amusement machines. The requirement of these high volume market sectors is for high security and reliability coin validation combined with low cost.
- Design, realisation and evaluation of validator prototype based on the innovations applicable to high speed coin sorting and counting machines used by banks. In addition to high speed operation (targeted at up to 3,500 coins per minute), high discrimination between genuine, counterfeit and foreign coins is necessary with accurate, traceable calibration of the machines.
- Design, realisation and evaluation of prototype conductivity measurement and calibration system based on the innovations applicable to the needs of mints, coin blank suppliers and banks.

Project Contributions

The project is expected to make an important contribution in support of implementation of recent European Commission Recommendations. In particular, *Recommendation 2005/504/EC on the authentication of euro coins and handling of euro coins unfit for circulation*.
The project results also have relevance to implementation of *Council Regulation 2182/ 2004 on medals and tokens similar to euro coins*. This regulation recognises that similarity of tokens with euro coins needs to be forbidden in terms of visual and machine-readable characteristics, the objective being to minimise euro-coin related fraud and confusion for the public. The measurement techniques and new instrumentation resulting from the project will assist in checking conformity with this regulation in respect of the metal properties.
The project will make a contribution in further ways to assist in protection of euro coinage. Introduction of improved measurement techniques will enable coin blank suppliers and mints to reduce the variation in parameters of coins. Additionally, new security features such as characterisation of junction resistance between bi-metallic materials will be proposed. Introduction of additional security features in coin construction together with reduced variability in manufacturing tolerances and the associated proposed improvements in coin validator technology makes it more difficult for counterfeiters to replicate and use fake coins.