EUROPEAN COMMISSION – HORIZON 2020

EuroCPS
Cyber-Physical Systems

EuroCPS Platform overview

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This document provides a brief summary of the EuroCPS program and the corresponding Cyber Physical platforms offered.

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1 INTRODUCTION

To enable innovative companies to gain access to leading edge technologies, the European Union has initialized the European EuroCPS project, which offers funding for innovative ideas and products in the field of Cyber Physical Systems (CPS, hence the program's name 'EuroCPS'). There are three main constraints regarding the funding: 1) it is applicable to SMEs and new entrants – called third parties in the document, 2) the product must apply to the definition of a Cyber Physical System and 3) it is obligatory to use of one of the platforms offered. Constraints 1 and 2 will not be further described in this document. In order to provide support on the choice of platform to meet constraint 3, this document gives a brief overview of the available EuroCPS platforms and possible applications of each platform. As background information, we will start with the definition of a Cyber Physical System.

For more detailed information about each platform, please visit the EuroCPS.org website or contact your local EuroCPS networking partner (e.g. HighTech NL for the Netherlands).

1.1 Terms and definitions

BT	Bluetooth
BTLE	Bluetooth Low-Energy
CPS	Cyber Physical System
IE	Industrial Experiment, the term used in the EuroCPS project for the projects to which funding is granted.
HighTech NL	Dutch networking organization responsible for informing Dutch companies about the EuroCPS project and supporting them during the proposal and grant phase.
MEMS	MicroElectroMechanical System
SME	Small and Medium-sized Enterprises
Third party	entity (SME, start-up, new entrant, large company) interested by EuroCPS

1.2 EuroCPS partners

2 WHAT IS A CYBER PHYSICAL SYSTEM

If you Google 'what is a cyber physical system', you will find many definitions. The following two quotations clearly describe the terminology of a CPS.

From EIT Digital: '*Cyber-physical systems (CPS) enable the physical world to merge with the virtual, leading to an Internet of things, data and services. One example of CPS is an intelligent manufacturing line, where the machine can perform many work processes by communicating with the components. Using sensors, the embedded systems monitor and collect data from physical processes, like steering of a vehicle, energy consumption or human health functions. The systems are networked making the data globally available. Cyber-physical systems make it possible for software applications to directly interact with events in the physical world, for example to measure peaks in energy consumption.'*

From Wikipedia: '*A cyber-physical system (CPS) is a system of collaborating computational elements controlling physical entities. Today, a precursor generation of cyber-physical systems can be found in areas as diverse as aerospace, automotive, chemical processes, civil infrastructure, energy, healthcare, manufacturing, transportation, entertainment, and consumer appliances. This generation is often referred to as embedded systems. In embedded systems the emphasis tends to be more on the computational elements, and less on an intense link between the computational and physical elements. Unlike more traditional embedded systems, a full-fledged CPS is typically designed as a network of interacting elements with physical input and output instead of as standalone devices. Common applications of CPS typically fall under sensor-based communication-enabled autonomous systems. For example, many wireless sensor networks monitor some aspect of the environment and relay the processed information to a central node. Other types of CPS include smart grid, autonomous automotive systems, medical monitoring, process control systems, distributed robotics, and automatic pilot avionics.'*

The common CPS definitions emphasize on communication, processing and the capability to collaborate, from the physical up to cloud levels and vice versa. CPS nodes on the edge of the cloud treats sensing, actuation and external communications.

Summarizing we could say that in the context of the EuroCPS program, a good definition of a CPS is: **a system that consists of the following elements: computational, networking/interconnecting and physical (sensor/actuator) interfacing. As such, it connects the physical and virtual worlds.**

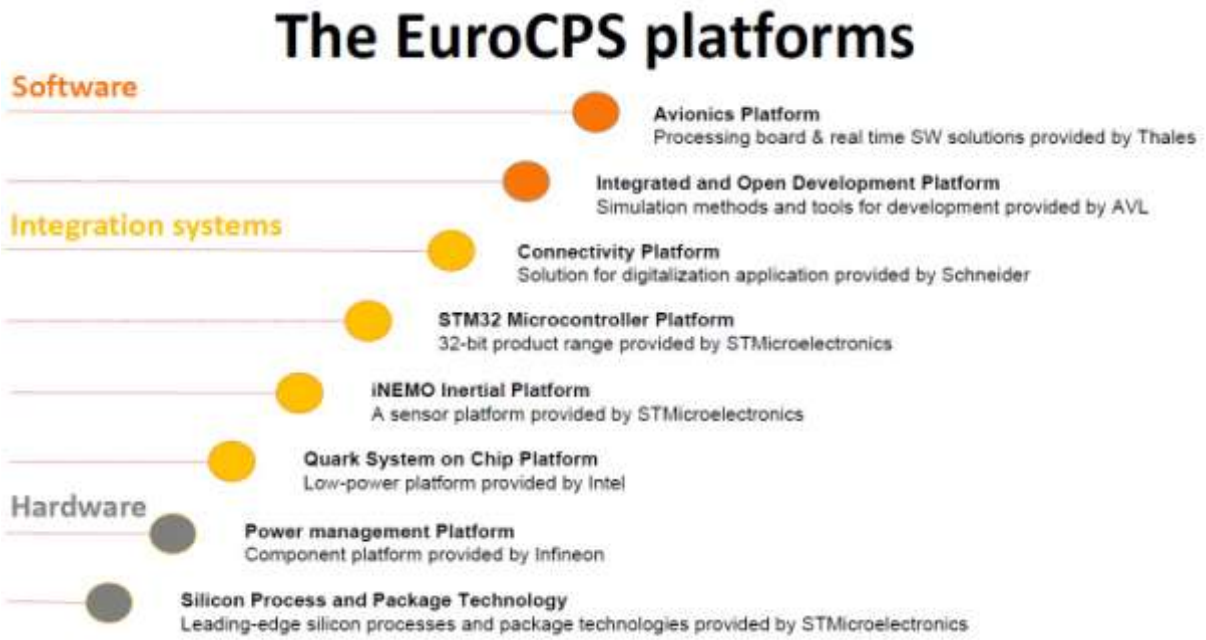
This is a broad interpretation but a positive side effect is that it is applicable to many of your product developments and ideas.

3 WHAT IS A PLATFORM?

Before discussing the eight EuroCPS platforms offered, we will briefly define the term platform and provide some examples. In the context of EuroCPS, a platform is a hardware and/or software product delivered by a 'platform provider' that helps and eases CPS product development. Platform providers will not only deliver the product from their catalog, but will actively provide support via knowledge transfer, engineering support and access to their R&D resources.

One example is the ST-Microelectronics iNEMO sensor platform. This sensor platform consists of an electronics board containing an accelerometer, gyroscope, magnetometer and ARM® Cortex™-M3 32-bit MCU. A software development kit as well as libraries to access the sensors and to perform basic calculations also form part of the platform. This platform can be used to develop products for accident detection, movement of products and indoor localization for instance.

Another example is Infineon's 'Power management platform'. This platform consists of Infineon's extensive range of power electronics and modules. This platform targets the development of (complex) power management systems, such as onboard power supplies, solar power invertors and motor drivers. The platform goal is to enable third parties to leapfrog innovation and achieve cost performance in their applications. It can be used to develop servers, telecom systems, computers, game consoles, smart phones, cellular infrastructure and lighting solutions.



4 THE EUROCPS PLATFORMS

In the table below, you will find a quick overview of the eight platforms available within the EuroCPS program. They are described in more detail in the next sections.

Platform	From	Description
1) STM32 Microcontroller Platform	ST Microelectronics	The STM32 family of 32-bit Flash microcontrollers based on the ARM Cortex™-M processor is designed to offer new degrees of freedom to MCU users.
2) Inertial Platform: **a) iNEMO** **b) WESU**	ST Microelectronics	An accelerometer, gyroscope, magnetometer and ARM® Cortex™-M3 32-bit MCU are the core for two kind of inertial platforms to the user for implementing versatile inertial applications.
3) Quark System on Chip Platform	Intel	Intel Quark is a line of 32-bit x86 SoCs, designed for small size and very low power consumption, and targeted at new markets including wearable devices.
4) Power Management Platform	Infineon	Power Management electronic components for servers, telecom systems, computers, game consoles, smart phones, cellular infrastructure and lighting solutions.
5) Connectivity Platform	Schneider	This CPS platform is a new digital microprocessor concept, combining Application Processing, communication switching and Fieldbus on a single chip.
6) Silicon Process and Package Technology	ST Microelectronics	ST offers access to its leading-edge silicon processes and package technologies for customer-designed products.
7) Integrated and Open Development Platform	AVL	The IODP Platform supports the entire development process for road vehicles from office to lab to road by integrating real and virtual development methods into one framework.
8) Avionics platform	Thales	The Freescale P5040 board and Seco ARM-based Quad-core board are combined in this platform in order to provide solutions for avionics applications.

5 PLATFORMS DESCRIPTIONS AND APPLICATIONS

5.1 STM32 Microcontroller Platform

Platform information	
Company	ST Microelectronics – France
Platform	ST Microelectronics STM32-F CPU platform evaluation kits and development software
Target	Embedded systems with need for a microcontroller with or without embedded RTOS
Contact	patrick.blouet@st.com

Description
This platform is based on the STM32 processor family. The STM32 family of 32-bit Flash microcontrollers is based on the ARM Cortex™-M processor and was designed to offer new degrees of freedom to MCU users. It offers a 32-bit product range that combines high performance, real-time capabilities, digital signal processing, and low-power, low-voltage operation, while maintaining full integration and ease of development. The unparalleled and wide range of STM32 devices, based on an industry-standard core and accompanied by a vast choice of tools and software, makes this family of products the ideal choice for small projects and for entire platform decisions. To support this family of processors a large number of evaluation and development boards is available. These boards are available either from ST-F or other partners from the STM32 ecosystem.

Example applications
The STM32 platform can address the following application domains: automation (e.g. human-machine interface, programmable logic controller, power management solutions for industrial robotics or mobile robotics), building technology (e.g. control of heating ventilation and air conditioning systems, lights, shutters, gates, doors, appliances, security and surveillance systems…), communications and networking (e.g. systems assuring more efficient, faster and more secure solutions for voice, data and multimedia streams, based on IP and other protocols), health care and wellness (e.g. clinical diagnostic and therapy, medical imaging…), home appliances and power tools (e.g. motor control subsystems), and transportation (car body electronics, active and passive safety systems, steering and chassis solutions including electric steering, adaptive damper management, energy recovery in electric vehicles).

5.2 iNEMO Inertial Platform

5.2.1 iNEMO-Discovery M1

Platform information	
Company	ST Microelectronics - Italy
Platform	The iNEMO-M1 integrates MEMS sensors on a system-on-board (SoB). It integrates accelerometer, gyroscope and magnetometer in a very small size form factor (13x13x2 mm). The iNEMO-M1 is the core for the Discovery-M1, which is an eval board developed to help to discover the INEMO-M1 features.
Target	Applications that use inertial and/or compass sensors
Contact	antonio.lionetto@st.com (ST-I) and mazzotti.matteo@unibo.it (UNIBO)

Description
The iNEMO inertial platform Discovery M1 is an MEMS sensor evaluation kit, consisting of the following core components of iNEMO-M1 SoB:

- STM32F103REY6: WLCSP package, high-density performance line ARM®-based 32-bit MCU;
- LSM303DLHC: 6-axis digital e-compass module, ±2g, ±4g, ±8g, ±16g linear acceleration programmable full scale, from ±1.3 gauss to ±8.1 gauss, I2C digital output;
- L3GD20: 3-axis digital gyroscope (roll, pitch, yaw), 16-bit data output, ±250°/s, ±500°/s, ±2000°/s selectable full scale;
- in-system ceramic resonator;
- interfaces with the outside world via UART (rs232) and SPI;

In addition, the Discovery M1 board provides:

- USB Communication and powering
- Pressure sensor 260-1260mbar
- iNEMO-M1 pinout available on two double connectors
- Two push buttons (reset and user)
- Two LEDs: user and power-on

An Eclipse-based IDE with example applications can be downloaded from the ST website. Libraries to access all chips are part of the software development environment.

See the ST website for more detailed information:
iNEMO-M1: http://www.st.com/web/catalog/sense_power/FM89/SC1448/PF253162
http://www.st.com/web/en/catalog/sense_power/FM89/SC1448

INEMO-M1 Discovery board: http://www.st.com/web/en/catalog/tools/PF255175

Example applications
This 9-DoF inertial system represents a fully integrated solution that can be used in a broad variety of applications such as robotics, personal navigation, gaming and wearable sensors for healthcare, sports and fitness. Possible products might be accident detection, movement of products or persons, and indoor localization.

5.2.2 WESU

Platform information	
Company	ST Microelectronics - Italy
Platform	The iNEMO System in Package (SiP) LSM6DS3, featuring a 3D digital accelerometer and a 3D digital gyroscope, is the inertial core of the WESU evaluation board. WESU complements the iNEMO SiP with a low power ARM Cortex-M3 microcontroller, a high performance magnetometer, a barometric pressure sensor, and power management circuitry and a Bluetooth® low energy wireless network processor.
Target	Applications requiring precise motion sensing in wearable solutions
Contact	antonio.lionetto@st.com (ST-I) and mazzotti.matteo@unibo.it (UNIBO)

Description
The WESU inertial platform is an MEMS sensor evaluation kit, consisting of the following core components:

- STM32L151: low power ARM Cortex-M3 microcontroller ARM®-based 32-bit MCU;
- LSM6DS3: full-scale acceleration range of ±2/±4/±8/±16 g and an angular rate range of ±125/±245/±500/±1000/±2000 dps, with hard, soft ironing for external magnetic sensor corrections, SPI/I2C serial interface and embedded temperature sensor.
- LIS3MDL: 3-axis high performance magnetometer with 16 bit of resolution and full selectable scale of ±4/±8/±12/±16 gauss;
- LPS25HB, barometric pressure sensor;
- BlueNRG, Bluetooth® low energy wireless network processor
- Interfaces with the outside world via USB and Bluetooth® 4.0
- An Android and iOS APP, available on Google Play and Apple Store, can be used for displaying information sent by the STEVAL-WESU1 through BLE connectivity as well as for setting operative modes.

See the ST website for more detailed information:
iNEMO inertial module, iNEMO-Inertial Modules
Wireless connectivity
Analog ICs for wearable devices
Power management for handheld and portable applications

Example applications
Wearable Applications and all those application that require a precise motion sensing and very low energy consumption with wireless communication.

5.3 Quark System on Chip Platform

Platform information	
Company	Intel – Ireland
Platform	Quark System-on-Chip processor boards and software environments
Target	Wearable solutions, IoT gateways for industrial (M2M) and energy applications
Contact	finian.g.rogers@intel.com

Description
The Intel Quark processor is a low-power x86-based SoC and targets the development of IoT endpoint and gateway devices, as well as wearable devices. For the latter, power consumption is targeted at running several years on a small battery.

Intel has created a family of development boards and modules to quick start development with Quark SoCs. A rich set of software development tools and example applications is available, including fully operational IoT gateway software for IoT applications, wearable applications and mobile phone demo apps for wearable devices.

The following IoT Gateway Series Development Kits are available. Each kit comes with a rich software environment and software building blocks, for instance Wind River Linux with connectivity (BT, WiFi, GSM 3G/4G, ZigBee), runtime (Java, LUA, OSGi) and security solutions.

- DK100 Development Kit for Industrial and Energy markets:
  - 2x Ethernet 10/100, USB 2.0 host & device, RS-232, RS-485;
  - 2x internal mini PCIe (for Wi-Fi / Bluetooth / 3G modules);
  - SPI, 12-bit 8 channel ADC.
- DK200 Development Kit for Transportation:
  - 2x Ethernet 10/100, USB 2.0 host & device, RS-232;
  - Audio line in/out, mini PCIe (for CAN, WI-Fi / Bluetooth / 3G modules);
  - 3 axis accelerometer (internal), 12-bit 8 channel ADC, ZigBee.
- DK300 Development Kit for Industrial, Energy and Transportation:
  - 2x Ethernet 10/100/1000, 1x USB 2.0, 1x Micro USB 2.0, 1X USB 3.0;
  - RS-232/RS-485 serial port, Audio, Line in/out;
  - Internal mini PCIe (for Wi-Fi / Bluetooth / cellular WAN);
  - HDMI, VGA;
  - 30 GB 2.5" SATA Solid State Drive.

The DK100, DK200 and DK300 development kits plus accompanied software, support are sold by Avnet, Arrow and Mouser and http://business.iotsolutionsalliance.intel.com/

The following development kits are available for prototyping (industrial, wearable etc) applications:

- Intel Galileo Board:
  - Development kit with support for Arduino shields;
  - See also at sparkfun.com.
- Intel Edison Board:
  - An SD card sized unit;

  - See also at sparkfun.com.
- Intel Curie module:
  - Button sized module with motion sensor and BT LE;
  - Device with Neural Net and two SDK (Time IQ will manage tasks and Identity IQ will confirm the identity of a wearer) will be released during Q4 2015.

Example applications
Industrial IoT gateways:
Gateways to sensor networks, gateways for senior citizens or remote medical care, M2M communication and smart-grid infrastructure.

Wearable applications:
Personal medical devices (heart-rate monitor, blood-pressure), care (senior citizens monitoring), and sport and fitness personal/body devices.

More info https://www.eurocps.org/eurocps-platforms/quark-intel/
http://www.intel.com/content/www/us/en/internet-of-things/overview.html

5.4 Power Management Platform

Platform information	
Company	Infineon – Austria
Platform	Component platform for power management
Target	Power supplies, power charging, solar power
Contact	herbert.pairitsch@infineon.com

Description
This component platform consists of a set of existing chips from IFAT and can be used to build power management systems. Power Management Technologies of IFAT set the benchmark for this platform in energy efficiency and power density of electronic systems. The goal is to enable third parties to leapfrog innovation and cost performance in their applications. It includes servers, telecom systems, computers, game consoles, smart phones, cellular infrastructure and lighting solutions.

Example applications
Development of solar panel inverters, PCB power supplies, battery chargers, battery operated devices, computer power supplies and complex (switching) power supplies.

5.5 Silicon Process and Package Technology

Platform information	
Company	ST Microelectronics – France
Platform	Support and access to silicon development and packaging technology
Target	Integration of electronics, and possibly MEMS sensors, into a package or small form factor module
Contact	patrick.blouet@st.com

Description
This platform is ST-France's silicon platform. ST offers access to application-specific standard and custom devices and to their leading-edge silicon processes and package technologies for customer-designed products to give added performance and value to the end product. Several technologies will be available for third parties, including advanced 65nm and 28nm CMOS. Only architecture exploration and device definition will be funded in the EuroCPS project. The R&D for designing new components will be covered by other kinds of funding (SME programs and ECSEL).

Example applications
- ASIC development for:
  - hardware-assisted algorithm implementation;
  - dedicated micro-processors: DSP, image processing;
  - security solutions.
- Development of a dedicated sensor.

5.6 Integrated and Open Development Platform

Platform information	
Company	AVL – Austria
Platform	Software platform for automotive powertrain engineering, i.e. simulation technologies, instrumentation and test systems
Target	Automotive power train and engine manufacturers
Contact	eric.armengaud@avl.com

Description
This components platform from AVL supports the entire development process for road vehicles from office to lab to road by integrating real (hardware) and virtual (simulation models) development methods into one framework: such an integrated development platform offers a seamless exchange of data from the concept phase to road testing. Thereby, the characteristic operating conditions like legislative test cycles, real world driving emissions and customer specific drive profiles or misuse tests can all be applied in a real as well as in a virtual environment during all phases of development. This also includes a cross-phase usage of tools like automatic optimization and calibration. This approach facilitates an efficient and goal-oriented development and validation of extremely complex drive configurations. Benefits for the researchers and engineers: Test cases and development tasks can be performed with a plant model of the entire vehicle, independently of the availability of hardware components in every stage of the development process. Specific features are:

- Interfaces for a wide variety of simulation tools used for vehicle development and control
- Support of FMI (Functional Mockup Interface)
- Link to PLM systems and data bases

In EuroCPS, AVL will support third parties to foster their products based on AVL tools and platforms. Within this framework, different tools can connect on and exchange product-related information over the tool boundaries by means of well-defined mechanisms. The control logics and the diagnostic procedures can be implemented and tested on dedicated SW and Hardware-in-the-loop features.

Example applications
The scope of application is very wide since it covers the entire product development lifecycle. This can include the interface to domain specific simulation solutions, as well as tool for quality management (e.g., trace management), tools for the analysis of specific system attributes (e.g. timing analysis) and test solutions (e.g., test benches). It is recommended to take contact with the networking partner or the platform partner to get more information in case of intended application.

5.7 Avionics platform

Platform information	
Company	Thales – France
Platform	Evaluation boards (QorIQ PowerPC, ARM iMX6)
Target	Mixed critically platforms
Contact	philippe.bonnot@thalesgroup.com

Description
This CPS platform consists of possibly interconnected building blocks for avionics computer systems provided by Thales. The purpose of this platform is to enable developments at real-time software level, such as real-time operating systems and/or hypervisors, and possibly software engineering tools and methods. Thus the platform consists of a processing board that can be used for multiple applications. It comes with a set of requirements that are inherent to the application domain. A representative application can be provided and implemented on the platform for the experiments that require it. For instance, a simplified complete flight management system application may be used under relevant conditions. The processing board is a PowerPC-based or ARM-based evaluation board. The processing boards are evaluation boards from the COTS boards market that are usually used in avionics or safety critical application domains. Considering the different challenges of multicore utilization in the avionics domain, processing board such as the Freescale P5040 board or Seco ARM-based Quad-core board can be combined in this platform. The evaluation boards are associated with debug tools from Thales, requirement specification for the targeted domain and support for this.

Example applications
The platform can be used to develop or improve real-time operating systems, hypervisors, performance models at different levels (application level, processor level) especially for safety critical applications (like avionics domain or others including space, railway, etc.).

5.8 Connectivity Platform

Platform information	
Company	Schneider Electric – France
Platform	Hardware + Software platform, evaluation boards
Target	Connected Devices & Controllers
Contact	kim.povlsen@schneider-electric.com

Description
The Schneider Connectivity platform provides simple, cost-efficient, yet very powerful capabilities to develop connected devices, either by Ethernet, Fieldbuses, or through external wireless technology.
In mid-2016, this cutting-edge platform will be available, including starter-kit with out-of-the box evaluation versions of operating systems and key embedded software functionality, natively embedded to help product designers focusing on their business applications, rather than basic core technology.

Example applications
TBD