Cyber Physical Systems (CPS) and Internet of Things (IoT) have come to greater attention due to the growth of the digital part of society, with a profusion of connected objects, intelligent sensors, and microcontrollers of digital nature closely interacting with the physical reality.

The dense dissemination of sensors/actuators, and the coupling of such embedded control with communication capacities (as in the advent of smartphones and gateway computing), have drastically enhanced the heterogeneous complexity of CPS design. While various digital-only entities may communicate among themselves using dedicated protocols and synchronization standards, proper exchanges between cyber objects and their physical environment need to rely more on proper timing. The CPS/IoT system modeling then must find the proper trade-off...
between accuracy and efficiency of simulation and execution. Also, the nature of the underlying computation and communication infrastructure may have a huge impact on IoT and CPS design. For instance, always-on connected objects may be subject to drastic limitations in power consumption.

CPS and IoT have in common to be networked systems and likely to involve physical sensing and/or embedded devices: both combine aspects of the physical and digital/cyber worlds (e.g., mechanical engineering, aerospace engineering, aeronautics, industry 4.0, supply chain, etc.). It is also extensively used by computer scientists working on embedded systems and systems testing and verification.

IoT and CPS communities are widely involved in standardization activities for defining, formalizing and implementing IoT and CPS entities. In the last years, the oneM2M standard specification lead by ETSI in Sophia Antipolis (http://www.onem2m.org) took the spot.

In a nutshell, the purposes and goals of oneM2M standard are to develop technical specifications which address the need for a common M2M Service Layer that can be readily embedded within various hardware and software and relied upon to connect the myriad of devices in the field with M2M application servers worldwide. A critical objective of oneM2M standard is to attract and actively involve organizations from M2M-related business domains such as telematics and intelligent transportation, healthcare, utilities, industrial automation, smart homes, supply chain, etc; the oneM2M standard also deals with different important issues in IoT and CPS, namely:

- Reachability and discovery of applications (identification of devices and applications);
- Security and privacy aspects (authentication, encryption, integrity verification);
- Service layer aspects with high level and detailed service architecture (protocols/APIs/standard objects/interoperability);
- Information models and data management (including store and subscribe/notify functionality);
- Management aspects (including remote management of entities).

*Models and Protocols for Resource Discovery in IoT and CPS*

The candidate will focus his/her studies to design, formalize and prototype mechanisms for achieving resource discovery for IoT and CPS. Resource discovery locates and retrieves existing resources based on particular attributes across multiple administrative domains. Resource discovery is also intensively used in overlay networks applications and in IoT and CPS applications involving mobility and network features. Modeling mobility and discovery for IoT and CPS, has recently been strongly advocated by Joseph Sifakis: useful applications could be found in Intelligent Transportation Systems, smart living technologies, supply chain, etc.

Achieving mobility implies first discovering IoT and CPS entities, then synchronizing distributed sensors presents in each entities, then collecting and processing distributed inputs from connected sensors, and finally activating one (or many) actuators present in each object; since sensors and actuators have different logical time, modeling their cooperations is a research challenge.
The candidate should propose a resource discovery formal model compatible with non functional requirements in IoT and CPS like e.g. time and space. Attention will be paid on publish/subscribe protocols (topic-based and content-based), as they are recognised to be fundamental in the discovery process: previous works by the authors addresses discovery aspects in future internet applications.

In a nutshell, the candidate will first focus his research on studying, understanding and assessing the state of the art of resource discovery in IoT and CPS. To that purpose, the candidate should carry out a bibliographical study on the discovery processes as well as existing work on the consideration of mobility in the modeling of CPS. Then, the candidate will focus on designing a formal discovery model to be applied in the IoT and CPS systems: this model will integrate classical requirements of CPS, i.e. timing, mobility, security, etc. Based on the previous model, the candidate will propose ever one extension of the existing discovery feature provided by oneM2M or a new discovery mechanism to be plugged in the existing oneM2M standard. The candidate will also implement a prototype library to be compatible with oneM2M standard implementation.

URL : [http://tiny.cc/5ajg6y](http://tiny.cc/5ajg6y)

English version:

*Context*

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