Digital Object Memories in the Internet of Things Workshop (DOME-IoT 2010)

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ABSTRACT
Everyday objects tagged with sensors and actuators that communicate and cooperate provide the foundation of the Internet of Things. Most applications in the Internet of Things deal with information related to such objects in the one or other way, whilst Digital Object Memories comprise hardware and software components, which together provide an open and universal platform that allows for the continuous capture and conceptual and/or physical association of digital information with physical objects. As such, they support information exchange and reuse across environments and applications, and pave the way for novel kinds of applications and services. The goal of this workshop is to unite these two perspectives on connected objects and object memory in a hybrid workshop format that combines traditional presentations and discussion with a practical experiment.

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Ubiquitous Computing, Digital Object Memories, Internet of Things, Intelligent Environments, Object-Centered Information Management.

ACM Classification Keywords
C2.4 [Computer-Communication Networks] Distributed Systems, H.3.2 [Information Storage and Retrieval] Information Storage, H.5 [Information Interfaces and Presentation], I.2.11 [Artificial Intelligence] Distributed Artificial Intelligence, J.7 [Computers in Other Systems].

General Terms
Algorithms, Design, Experimentation, Human Factors, Legal Aspects, Performance, Reliability, Security, Standardization, Theory

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INTRODUCTION
Ubiquitous computing is instigating a transformation of our environment into an information sphere spread across time and space by combining sensing and software services with physical world. This essentially creates novel design opportunities for everyday artifacts. Their behavior is determined by software and affords us to build imaginative new forms of interaction and functionalities that dramatically enhances their well-established features. Our physical space now represents an ecological synergy of networked smart artifacts tagged with awareness technologies - computational memory, sensors and actuators. This unfolds a range of imaginative possibilities to discover, manage, compose, coordinate, and control physical space to realize personalized and coordinated behavior within and across devices and provide the foundation for the Internet of Things.

Most applications in the Internet of Things (IoT) deal with information related to such networked objects in the one or other way. While there has been significant research efforts surrounding sensor and actuation technologies, yet the aspect of computational memory (Digital Object Memory) of these networked smart objects are not being addressed adequately. Digital Object Memories comprise hardware and software components, which together provide an open and universal platform that allows for the capturing and conceptual and/or physical association of digital information with physical objects. As such, they support information exchange and reuse across environments and applications, and pave the way for novel kinds of applications and services – e.g., in form of self-monitoring objects or by providing physical containers and icons for human memories and experiences.

The purpose of "DOME-IoT" is to bring together researchers from a variety of disciplines (computer scientist, electrical engineers, designers, social scientists, etc.) to discuss various aspects of Digital Object Memories and their significance with respect to IoT applications. "DOME-IoT 2010" is a merged event of two successful workshop series, e.g., DIPSO 2007-09 in conjunction with Ubicomp 2007-09 and DOMe 2009 in conjunction with IE 2009. The workshop aims to explore synergies from the overlapping of the particular objectives and topics of interest of both workshops, and to bring together their research communities. Follow the earlier workshops' goals, the workshop is an attempt to extract and extrapolate from the current state-of-the art best practices to rationalize the design and applications of Digital Object

Memories in the IoT. The major workshop activity will contain lively discussion phases structured around some concrete agendas.

TOPICS

Topics of relevance to the area of Digital Object Memories in the Internet of Things in general and "DOMe-IoT 2010" in particular include (but are not limited to):

- **Architectures**: General architectures and middleware approaches which allow for the realization of object memory functionality. This includes infrastructures for the centralized or distributed capturing, organizing, storing, and exploiting of object-related information, directly on the physical object itself or based on some remote infrastructure.
- **Memory Content Representation and Modeling**: Formats for memory content items, discussion of standards and best-practice knowledge concerning the representation of object-related knowledge.
- **Memory Creation**: Technologies and concepts for the manual, semi-automatic, or automatic creation of whole memories or single memory entries. This includes physical sensor readings, information inferred from external sources, and user-generated content.
- **Data Mining**: Information stored in a digital object memory might be analyzed in order to discover typical usage patterns or anomalies. Such information might help human users or other environments to better deal with these objects.
- **Human Memory Access**: This topic comprises technologies and concepts to make an object memory's content accessible to human users. One of the major challenges here is how to structure, relate, prepare, and explain the wide variety of diverse data that might be contained in the memory due to its open nature.
- **Applications**: Application scenarios of Digital Object Memories and existing prototypes.
- **Privacy and Legal Aspects**: Who "owns" the data stored in an object memory, who can access/delete/correct it? How long must/should memory content be stored, and can I trust the information provided in a Digital Object Memory?
- **Social Implications**: Digital Object Memories have the potential to change the way we perceive our surrounding. Not only humans now can tell their personal story, but every object potentially allows us to investigate its history and understand how our world is connected. This might fundamentally influence our relation to objects and other humans, too.

RELATED LITERATURE

Research on instrumented physical objects and the Internet of Things has been going on for more than a decade and reaches back to Mark Weiser's original vision of ubiquitous computing. Bruce Sterling recently popularized the idea of smart objects and the Internet of Things; Sterling coined the term spime [1] to describe a new category of space-time objects that are aware of their surroundings and can memorize real-world events. Julian Bleeker advocated a similar notion of blogjects (objects that blog) in his "Manifesto for Networked Objects" [2]. This more visionary work has been met by a growing body of technology- and business-focused research on RFID, smart objects, and smart products [3].

Roy Want and his colleagues augmented physical objects with passive RFID tags so that they were uniquely identifiable and information related to them could be presented to their users [4]. Michael Beigl and his colleagues defined a smart object as an everyday artifact augmented with computing and communication, enabling it to establish and exchange information about itself with other artifacts and/or computer applications" [5]. Friedemann Mattern formulated in a similar way: "Smart objects might be able to not only to communicate with people and other smart objects, but also to discover where they are, which other objects are in the vicinity, and what has happened to them in the past" [6]. Norbert Streitz and his colleagues looked at smart objects from two perspectives: one model has system-oriented, importunate smartness in which smart objects can take certain self-directed actions based on previously collected information; the other is people-oriented, empowering smartness where smart objects empower users to make decisions and take mature and responsible actions [7]. Most recent work on smart objects has focused on technical aspects (hardware platforms, software infrastructure, and so on [8,9]) and application scenarios. Application areas range from supply-chain management and enterprise applications [10] to (home and hospital) healthcare [10] and industrial workplace support [11-15]. Human-interface aspects of smart-object technology are just beginning to receive attention [16]. Yet design principles and methods for smart objects that go beyond mere hardware have yet to be explored, e.g. by exploring the smart object design space and identifying canonical smart object types (see also Fahim Kawsar's dissertation [17]).

If continuous records of object-related information are collected and linked to the physical objects, this data can be exploited for a broad range of applications. For instance, the electronic pedigree [18] aims at protecting consumers from contaminated medicine or counterfeit drugs. It establishes a link between physical item and external data sources which enables a verification of the physical item's integrity along several steps of such products' lifecycle. Furthermore, according to Decker et al. [19], the use of smart labels for object-based tracking and quality monitoring may be beneficial for the business partners along the supply chain.

Other works are related to the issue of modeling data for object memories. For instance, with the increasing distribution of smart labels in mind, Maass and Filler [20]

suggest to link physical product items with digital information in order to support customer-oriented services such as a product comparison. They rely on *facets* (e.g., "business", "security") to encode domain-dependent views on a product – which is different from the abstraction-based model we use in our system. Decker et al. [21] even propose a further application of an information link for physical items: By storing parts of the business logic in a smart label with its own sensing and processing capabilities, a physical item can be enabled to participate actively in the monitoring of the underlying business process.

Regarding the infrastructure for such applications with various business partners and user groups, Schmitt et al. [22] emphasize the value of open structures for data collection and exchange. This is also reflected by the approach of Schneider [23]. He proposes a Web-based Object Memory, which serves as an open reference to object-related information hosted and controlled by arbitrary content providers.

From the user's point of view, the idea of Digital Object Memories creates a new design space for everyday interactions. Physical objects could become sites for their owners' personal stories [24], but also afford people the opportunity to explore an object's provenance and connections to other elements of physical and digital life [25]. In this sense there is the potential for designers to augment or even transform our relationship with objects and the services that they mediate.

EXPECTED OUTCOME

We expect three types of results from the workshop:

1. Submitted position papers and a documentation of the group discussions (slides) will be provided on the workshop homepage. Furthermore, we aim at publishing a special journal issue or book series volume considering the quality and novelty of the submitted papers.
2. Design case studies have been solicited as an explicit submission category for the workshop. From our previous experience we anticipate that this category will be particularly attractive to designers and digital media artists. Contributions from creative practice disciplines have significant potential both to stimulate discussion around non-traditional notions of Digital Object Memories.
3. In a live experiment at DOME-IOT, workshop participants will use objects equipped with Digital Object Memories, and experimental participatory methods for simulating such memories. We plan to recollect the objects and/or their memories at the end of the workshop and to present a preliminary evaluation of the utilization of Digital Object memories through the Ubicomp participants at the third conference day (e.g. in form of a poster and/or a short presentation). We furthermore plan to document the live experiment on the workshop website and use this to promote a sustained interaction between the participants after Ubicomp.

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