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# ICN Wireless Sensor and Actor Network BaseLine Scenarios
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Abstract

This document presents scenarios for information centric wireless sensor and actor networks. The scenarios selected for inclusion in this first draft aim to exercise a variety of aspects in wireless sensor and actor network that an ICN solution could address.

Status of this Memo



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Table of Contents



## 1. Introduction

Wireless sensor and actor networks (WSANs) consist of resource-constrained nodes which operate in low power and lossy network environment. Therefore, resource optimization is a very important factor in design of WSANs' operations. Current TCP/IP model does not fit well in this environment, so a need of 6LoWPAN is highlighted in [RFC4919]. This draft exploits ICN approach in WSANs (ICWSANs) and illustrates the obtained benefits.

For example, Dinh and Kim [ICWSAN] consider a functional oriented naming scheme for information objects/entities and illustrate the ICN benefits through scenarios in this category, including an in-network auto-configuration, a distributed virtual information sharing model, a content-based distributed information filter, a content-based routing and data aggregation, and a semantic cooperative distributed approach for WSANs.

## 2. Naming Scheme

In comparison to the Internet, a WSAN node produces and needs a few types of information. For example, a temperature sensor may produce only temperature sensing data or a notification about an over-threshold temperature event. Types of information have a closely relationship with their producers' functions (e.g. temperature data or temperature event in a relationship with the temperature sensor). In this way, naming schemes applied for each piece of information in [CCN] and other ICN proposals are not efficient in WSANs. A functional-oriented naming scheme is proposed in ICWSANs. A name in ICWSANs includes an information category prefix and information ID. The first part expresses a real-world functional category name of a type of sensor or actor. The latter part expresses the detail information (e.g. ID, security code) which makes the name persistent and unique. The naming scheme is proposed for both information naming and node's naming, which are associated in the relationship with node's function. For example, a temperature sensor could be named as tempSen:xxx and its temperature information could be named as temp:xxx, or a temperature sink node could also be named as tempSink:xxx ("temp" is a category prefix for multiple types of sensor, actor, and sink nodes which are related to the temperature category). By this way, the scalability issue of the naming scheme in ICWSANs may not be as critical as other Internet's ICN proposals. In the other hand, by exploiting the functional category-certifying, ICWSANs could improve the network performance and reduce communication overhead in WSANs, especially in group communication. Hashing or other security functions could also apply on the name.

## 3. In-network Auto-configuration

In low power and lossy environment as WSANs, the WSAN system dynamically adapts to change in network topology due to node failures, environmental condition change, and new deployed nodes. Therefore, auto-configuration design is important for such a large scale network with limited resource nodes. Furthermore, the connectivity from a node to the sink node could not guarantee all the time because of sleep/wakeup intermediate node and low link quality. In ICWSAN, an in-network auto-configuration is proposed to reduce the configuration overhead. In particularly, when a new node is deployed, configuration information could be retrieved from the previously deployed nodes (with cached configuration information) without a need to send a configuration information request to sink node, or manually by user (e.g. a new temperature deployed node may retrieve configuration information from the nearest temperature node which is deployed previously). The new node then processes the configuration information for all the information needed to fully

join to the existing network and start its operation. The in-network auto-configuration requires only one alive neighbor node is enough to execute auto-configuration for the newly deployed node while optimizing number of forwarding requests to minimize the configuration overhead by sharing information.

## 4. Distributed Virtual Information Sharing Model

The information sharing model also could execute in a distributed virtual way; particularly, in a heterogeneous WSANs with multiple types of sensors and actors, multiple separately virtual groups could be created semantically to support inter-operate among nodes without a requirement of a complex group's member addresses management or centralized control(e.g. temperature sensors with the same name prefix "temp" in an area could form a virtual group while fired actors with the name prefix "fire-xxx" also form as another group). The sharing rules could be determined based on the category prefix of the information. The distributed virtual model is very useful in case of configuration, data collection, and inter-operation; for example, an interest request could be sent to collect only temperature sensing information or a configuration message is sent to only humidity sensors (only humidity sensors should process this message).

## 5. Distributed Information Filter

An information-based distributed information filter approach is proposed to support the distributed virtual sharing model where a node receives and processes an information object only if it is interested in this information; if not, it could forward or simply discard messages, even broadcast messages. ICWSAN could enable this technique because the network layer could understand what information is carried, what that means and distributes the information to nodes that need this information. Uninterested/error information objects are discarded from the network layer where disallow the communication/processing, hence the error is never propagated to application level. In contrast, TCP/IP network layer delivers all the indistinguishable packets equally. Therefore, the information-based distributed filer is desired to reduce failure in resource-constrained nodes like sensors.

## 6. Information-based prioritized routing and Aggregation

Routing in WSANs is tightly coupled to the requirement of sensing task as well as application. ICWSAN designs a content-based routing which is closer to the application semantics to optimize the data transport and information aggregation. The content becomes

transparently from the view point of clients, service discovery and routing, thus reduce overhead in HTTP-CoAP translation process at proxy nodes. In ICWSAN, information can be recognized in the network layer which is valuable to implement a content-based prioritized routing policy to meet different requirements of information dissemination (e.g. an emergency event type or a periodic sensing report). The content based aggregation help improve the quality of information while minimizing the communication (e.g. temperature data could be recognized and aggregate together before sending to a temperature sink node or an actor node).

## 7. Semantic Coordination and Collaboration

One of the main ideas of ICWSAN is to base sensors/actors collaboration decision on content which is to build cooperative distributed WSAN environments where autonomous objects (including information objects and network entities) can be discovered, queried, coordinated automatically without a need of a central control. ICWSAN implements a high-level abstraction for integration of sensor networks with actors (e.g. mobile robots, vehicles). Sensors could execute cooperative sensing, processing, and organizing themselves to produce and retrieve the information required by sink/actor node while minimizing the number of transmitted messages. For example, in a heterogeneous wireless sensor and actor network environment with multiple types of sensor, actor and sink nodes existing in the same space, a temperature sensor could self-coordinate to report its sensing data to a temperature sink node (not another type of sink node) without a need of sink node discovery; or a fire fighter (e.g. actors or robots) could express its interest with a key word "temp-xxx" to collect temperature data from any or all temperature in a fired area without care of specific address of each node; the actors could also self-coordinate to collaborate together to extinguish fires. In addition, cooperative caching ensures sharing sensing information among nodes to not only reduce number of communications but also support indirect query in case of sleeping node; for instant, when a node wakes up, it could retrieve configuration/notification message cached in neighbor nodes; in other hand, a node also could disseminate its sensing information to be cached in its neighbors and fall to a sleep mode; a request for the sensing data from this node could be retrieved indirectly from a cache holder or asynchronously by interest message caching.

Scenarios in this category include opened topics which are also discussed for future works.

## 8. Security Considerations

## 9. IANA Considerations

## 10. Acknowledgments

## 11. References

### 11.1. Normative References

### 11.2. Informative References

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