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Requirements Analysis for OPC UA over CoAP
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Abstract

Constrained Application Protocol (CoAP) is an application protocol proposed for constrained nodes and constrained networks. Industrial Internet of Things (IIoT) is an attractive scenario for CoAP. OPC Unified Architecture (OPC UA) defines a semantic-based information model and a service-oriented architecture for IIoT, which can satisfy the requirements of Industry 4.0. This document analyses requirements for transmitting OPC UA over CoAP.

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1. Introduction

CoAP is a web application protocol designed for resource constrained devices and constrained networks which has been widely used in machine-to-machine (M2M) communications [RFC7252].The purpose of applying CoAP to the Industrial Internet of Things (IIoT) is to provide connectivity for the devices. Whereas the communication of Industry 4.0 not only requires data value transmission, but also requires semantic information exchange. According to the definition of Industry 4.0 for communication, CoAP needs to support the exchange of semantic information, namely the semantic information model. For current protocols supporting semantic information model in the IIoT, the information model defined by OPC UA [IEC TR 62541-1] is very promising and its interactive model is similar to the

interactive model of CoAP, so it can be applied as a branch of the CoAP message payload.

2. Architecture of OPC UA over CoAP

To meet the needs of IIoT, the architecture of OPC UA over CoAP can be mainly divided into the following two patterns:

1) Figure 1 presents a logical layered structure of OPC UA Information Model over CoAP. In the transport layer, DTLS runs on top of UDP to secure transmission. Then, the middle layer utilizes the message mode defined in the CoAP protocol. Lastly, the information model of OPC UA [IEC TR 62541-5] is defined as an application of CoAP at the top. In such a hierarchical structure, the semantic-based data information in OPC UA can be transmitted in resources-constrained scenarios, so that CoAP can meet the requirements of semantic information transmission.

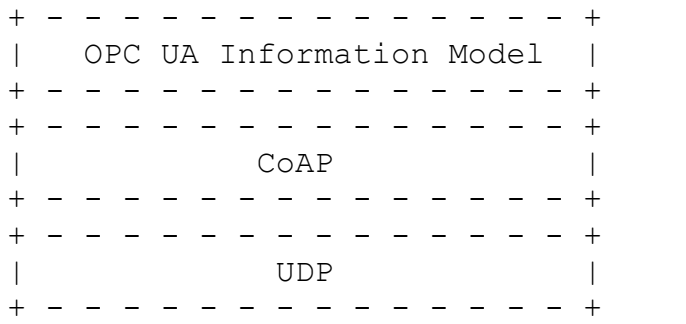

Figure 1: OPC UA Information Model over CoAP

2) In order to take full advantage of the service sets defined by OPC UA, this document proposes the other architecture for OPC UA

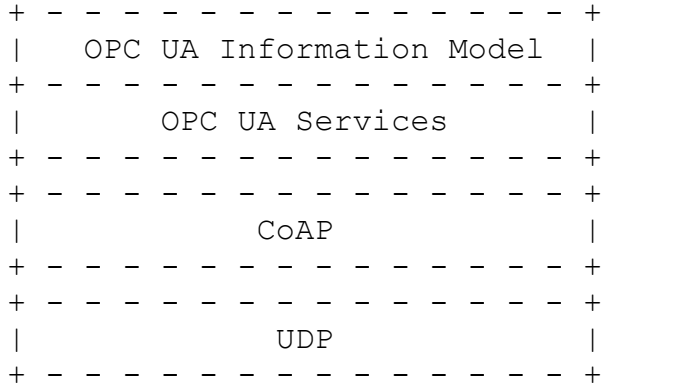

Figure 2: OPC UA Information Model and Services over CoAP

transmission over CoAP. As shown in Figure 2, the information model of OPC UA is defined as the application of CoAP, moreover, the connection establishment, creating session, publish/subscribe and other functions related to data information interaction are all implemented by the service sets defined by OPC UA. CoAP is mainly responsible for the definition of message format and runs over UDP to keep the implementation lightweight.

3. Requirements for OPC UA over CoAP

3.1. Encoding

CoAP messages are encoded in a simple binary format that starts with a fixed-size 4-byte header. The header is followed by a variable-length Token value, which can be between 0 and 8 bytes long. Following the Token value comes a sequence of zero or more CoAP Options in Type-Length-Value (TLV) format, optionally followed by a payload that takes up the rest of the datagram. In addition, the OPC UA protocol coding mainly includes two ways that are binary and XML. Therefore, in order to transmit the information model of OPC UA over CoAP, specific frame formats of CoAP need to be designed to support two kinds of coding modes of OPC UA.

3.2. Application Sublayer Optimization

For information exchange, the document [I-D.ietf-core-coap-pubsub] defines the corresponding application sublayer, OPC UA also defines a number of specific communication patterns. For example, in the new specification defined by OPC UA, there are two publish/subscribe modes.one is the Broker-less mode, another is Broker-based mode. Correspondingly, in the publish/subscribe specification of CoAP, it introduces broker mechanism in which the client sends the state information to the Broker and the Broker provides storage and forwarding function to implement the publish/subscribe function. Comparing above two protocols, they are achieved the publish/subscribe function by the Broker. But it is still necessary to optimize the application sublayer of CoAP to support some particular communication modes of OPC UA.

3.3. Consistency

The interactive model of CoAP is the client/server model. However, in M2M scenarios, CoAP entities often act as both servers and clients. Compared to OPC UA, though the interactive model is also the client/server model, there is a set of supported services in the OPC UA server. Consequently, for the great difference of the server definition of these two protocols, we need to tackle with the

consistency and integration issues between the CoAP server and the OPC UA server.

3.4. Reliability

One of the main design goals of CoAP is to satisfy some special requirements such as communication in the constrained scenarios that address power consumption. Hence, in order to reduce network overhead and avoid network congestion, CoAP is designed to run over UDP, which is a good choice to achieve inter-network data exchange in use of the IP architecture. However, UDP is a connectionless transport layer protocol that provides unreliable information transmission services. In the field of IIoT, we need to ensure the reliability of data transmission to avoid losing some important data information. Moreover, CoAP addresses transmission reliability by defining a message as requiring acknowledgment, obviously this is not enough to meet the high reliability requirements in the field of IIoT, so the reliability of COAP remains to be optimized.

3.5. Transmission Methods

For OPC UA over CoAP, one of the important issues that needs to be addressed is how to transmit messages. The connection between OPC UA client and server is stateful, the connection status need to be maintained in the process of message interaction, while CoAP is a stateless connection, so that the message transmission of the two protocols is different. Fortunately, the transport layer protocol of OPC UA supports TCP and HTTP, in addition, the CoAP protocol can be considered that it is improved for constrained scenarios based on HTTP. Therefore, a solution can be found for the messages transmission by using the similarity of two protocols in HTTP.

3.6. Cache

In order to reduce response time and network bandwidth consumption, CoAP provides caching responses in the endpoints. When the endpoint gets the request, it may use the old message to reply the request. It is meaningful for the resource-constrained devices to save resource. However, the information model of OPC UA does not support the mechanism that should be solved by proposing some ways.

3.7. Usability

For OPC UA over CoAP,it contain the key technologies of two different protocols. It is difficult for application developers to master the two protocols at the same time. Moreover, application developers usually focus on the implementation of the function, and do not care about the specific implementation process of the

underlying protocol. So,OPC UA over CoAP need to remain independent from the application. On the other hand, it should maintain the flexibility of configuration so that application developers can set it to satisfy different needs.

4. Security Considerations

The security of CoAP includes four modes in which three modes implemented based on the Datagram Transport Layer Security (DTLS) except the non-security mode. However, the security architecture of OPC UA is built on the application layer and the communication layer above the transport layer. Specifically, the application layer adopts the authentication and authorization, and the communication layer achieves the security of OPC UA [IEC TR 62541-2] through secure channel encryption. Though OPC UA has four modes, the security model of OPC UA is realized based on Transport Layer Security (TLS). Actually, DTLS is an addition to TLS to solve the unreliable transmission feature of UDP. Currently, some documents show that CoAP needs to support TLS. Therefore, the security of the two protocols can be implemented jointly.

5. IANA Considerations

This memo includes no request to IANA.

6. References

6.1. Normative References

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6.2. Informative References

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