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P. Wang  
C. Pu  
H. Wang  
Y. Yang  
L. Shao  
Chongqing University of  
Posts and Telecommunications  
J. Hou  
Huawei Technologies  
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**OPC UA Message Transmission Method over CoAP**  
**draft-wang-core-opcua-transmission-01**

Abstract

OPC Unified Architecture (OPC UA) is a data exchange standard that provides interoperability in industrial automation. With the coming Industry 4.0, it is of great importance to implement the exchange of semantic information utilizing OPC UA Transmitting in CoAP. This document provides some transmission methods for message of OPC UA over CoAP.

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## [1. Introduction](#)

Internet of things is one of the attractive applications for CoAP [[RFC7252](#)]. Utilizing OPC UA [IEC TR 62541-1] Transmitting over CoAP could meet the demand for industry 4.0 based on the exchange of semantic information [[I-D.wang-core-opcua-transmission-requirements](#)]. Similar to OPC UA, CoAP message is exchanged in server/client mode. However, their transmission is not the same. Driven by this, to use OPC UA Transmitting over CoAP, the major problem to be solved is how OPC UA packets are transmitted over CoAP. For the transport layer of OPC UA, the main message transmission method is TCP or HTTP, and CoAP's design inspiration comes from HTTP, thus, there are some



connections in transmission method between them. This document provides some transmission methods for message of OPC UA over CoAP, so that a communication could be established between OPC UA client and OPC UA server.

### **1.1. Conventions and Terminology**

The keywords "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [[RFC2119](#)].

OPC: OLE for Process Control

OPC UA: OPC Unified Architecture

SOAP: Simple Object Access Protocol

## **2. Overview of OPC UA**

OPC Unified Architecture (OPC UA), standardized as IEC 62541, is a client-server communication protocol developed by OPC Foundation for safe, reliable data exchange in industrial automation. It is the evolution product of OPC (OLE for Process Control, where OLE denotes Object Linking and Embedding), the widely used standard process for automation technology, and is of great importance in realizing industry 4.0. By introducing Service-oriented architecture (SOA), OPC UA enables an open, cross-platform communication with the advantages of web services, robust security and integrated data model.

### **2.1. Protocol Stack**

OPC UA is an application layer protocol that can be built on an existing layer 5, 6 or 7 protocol such TCP/IP, TLS or HTTP. The OPC UA application layer consists of four sublayers: UA Application, Serialization Layer, Secure Channel Layer and Transport Layer (see Figure 1).

Serialization Layer includes two kinds of data encoding methods: UA Binary and UA XML. The UA XML, based on SOAP/HTTP or SOAP/HTTPS, is firewall friendly. On the other hand, the UA Binary, with least overhead and resource cost, offers an optimized speed and throughput.

The security layer varies according to the selected encoding format. For the HTTPS-based situation, security is guaranteed at TLS but Security Channel should still be presented even empty. It is



worthwhile noting that the communication based on SOAP/HTTP has been deprecated since 2015 due to the lack of industrial approbation in the WS Secure Conversation.

For the transport layer (not the layer in OSI 7 layer model), options can be UA TCP, HTTPS, SOAP/HTTPS, and SOAP/HTTP. OPC UA defines a UA TCP protocol, which differs from HTTP in two main features: the allowance of responses to be returned in any order and to be returned on a different TCP transport end-point. In addition, UA TCP defines the interaction with the upper security channel.

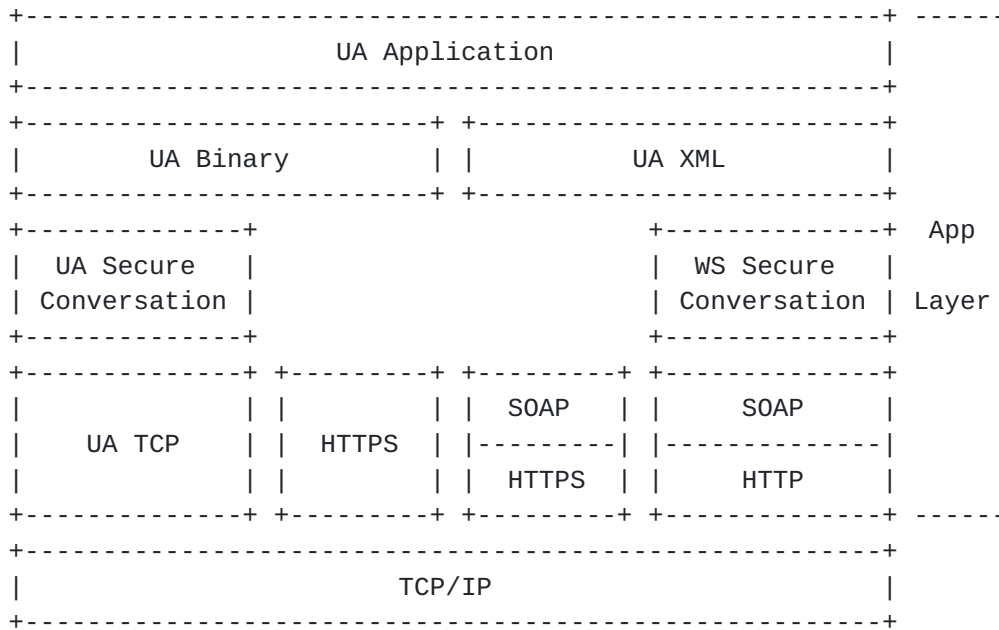


Figure 1: Layering of OPC UA over TCP/IP

## 2.2. Request/Response Model

The message exchange in UA binary mode is illustrated in Figure 2. After opening the socket, the client starts the connection with the server by using "hello" (HEL) and "acknowledge" (ACK) messages. Afterwards, a pair of messages is needed to open the security channel and define the encryption property. Then another two pairs of messages are exchanged so as to create and activate a session between the client and the server respectively. After these steps, the connection is initiated and the client can send request messages for services. When the request/response process is finished, a reverse process is required for disconnection.



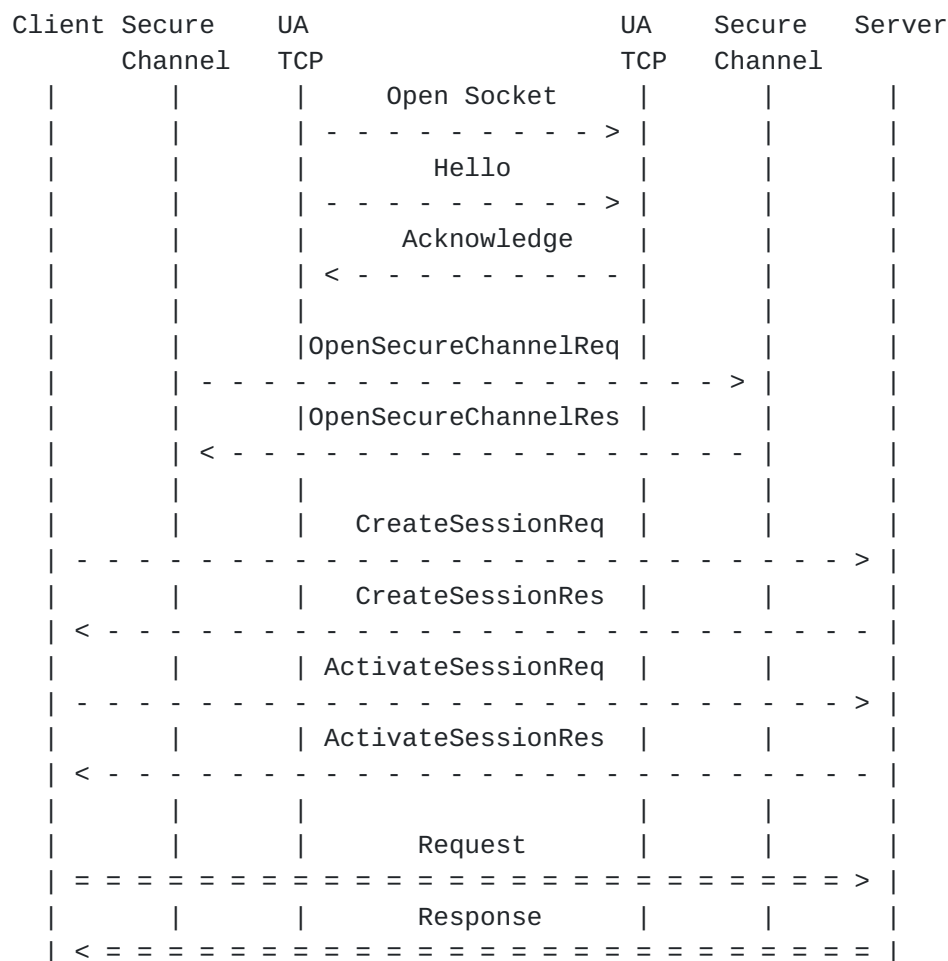


Figure 2: Request/Response Process of UA TCP

### 3. Specification of OPC UA over CoAP

As mentioned in [section 2.1](#), OPC UA communications can be processed through four options, among which two are related to HTTPS: HTTPS => UA Binary; HTTPS => SOAP => UA XML. HTTPS is a security-guaranteed protocol consisting of a HTTP layer over Transport Layer Security (TLS), thus the UA Security Channel can be left empty.

Constrained Application Protocol (CoAP) is an application layer protocol for constrained nodes and networks, which is designed to easily translate to HTTP for integration with the web. Although CoAP is built on the unreliable transport layer UDP, it offers a security mode binding to Datagram Transport Layer Security (DTLS). This document proposes a transmission scheme based on CoAPs (CoAP + DTLS) for constrained scenarios. The transmission based on CoAP over





Transport Layer Security (TLS) is also possible. Such "CoAP + TLS" transmission scheme is under development [I-D.ietf-core-coap-tcp-tls] and would be covered in the future version.

The protocol stack of the CoAP based OPC UA is illustrated in Figure 3 including two options at Serialization Layer: UA Binary and UA XML. OPC UA packets are encoded in either binary or xml format, and the option field in the CoAP header can specify parameters that support both formats. Therefore, according to the format specified by the CoAP header, the entire packet of the OPC UA can be encapsulated in the payload of the CoAP message for direct transmission.

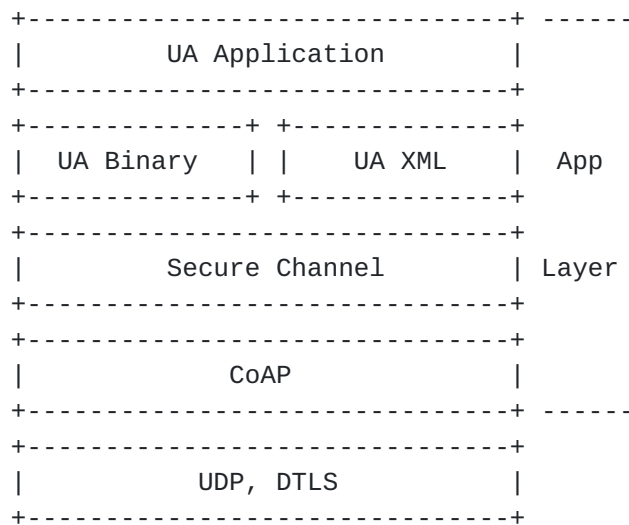


Figure 3: Layering of OPC UA over UDP

Both binary and XML encoding modes are based on the CoAP with an empty UA secure channel in between. For the XML encoding mode, since CoAP layer supports XML encoding format, the SOAP layer in the original stack is not needed.

## 4. Transmission scheme

### 4.1. Proxy for OPC UA-CoAP

OPC UA is a protocol mainly for application layer, which defines many services for the different needs of industrial applications. Message is exchanged mainly through server/client mode, utilizing TCP or HTTPS. When security is ignored, OPC UA can be considered to support HTTP transmission. CoAP's design inspiration comes mainly from HTTP, the two can be mapped between each other to meet the







transfer OPC UA messages. OPC UA packets are encoded in either binary or xml format, and the optional fields in the CoAP header specify parameters that support these two formats, and the option field in the CoAP header can specify parameters that support both formats. Therefore, according to the format specified by the CoAP header, the entire packet of the OPC UA can be encapsulated in the payload of the CoAP message for direct transmission, as shown in Figure 5. Noted that this method of transmission needs to be modified on the server side and the client side of the OPC UA according to CoAP.

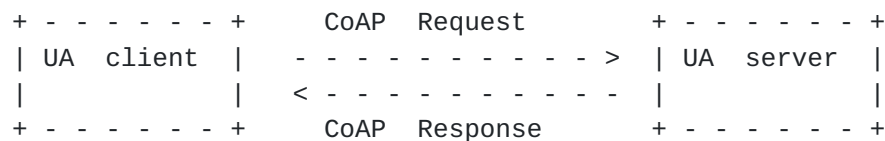


Figure 5: Direct transmission OPC UA based on CoAP

#### **4.3. REST transmission for OPC UA**

OPC UA is a set of data exchange specifications for industrial communication, the core of the OPC UA protocol is information modeling and transmission, which marks each node in the address space with a unique identifier. A series of state interactions are needed before performing normal reading and writing, including message handshaking, opening a secure channel, creating a session, activating a session, etc. Besides, some states also need to be maintained during read and write operations.

In OPC UA, each node has an independent identifier in the address space, and different types of nodes can establish contact with each other by reference. OPC UA defines a variety of services, and these services are fixed, the user cannot arbitrarily modify, each service is invoked through a single message, without relying on the previous message, the service response is also completed by a separate message and do not rely on other messages. The above features are in line with the REST architecture, due to CoAP is based on the REST architecture. Therefore, it is possible to simplify the interaction before the OPC UA performs the normal communication, and carry the OPC UA message by using the communication mode of the CoAP. Communication process is shown in Figure 6.

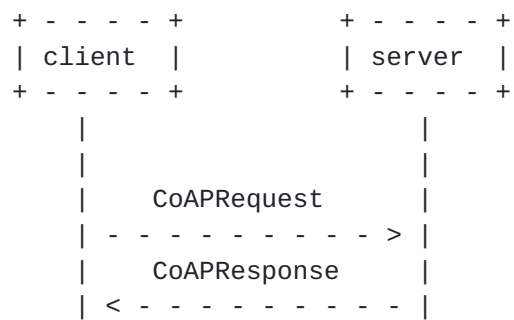


Figure 6: REST architecture communication of OPC UA

In Figure 2, the traditional OPC UA requires a series of interactions between normal read and write operations. Figure 6 shows that when using CoAP to carry OPC UA message, the interaction process is significantly reduced, which is conducive to the application of OPC UA in the restricted scene. The cost of simplifying the interaction process is that the secure channel number is set to 0 by default, how to conduct secure data interaction needs further discussion.

## 5. Publish subscription for OPC UA and CoAP

As an application sublayer, CoAP provides publish-subscribe functionality, primarily for resource or network-constrained scenarios. Introducing broker into the network [I-D.ietf-core-coap-pubsub], when a node needs to sleep, the node information is sent to the broker agent, when a node requests to obtain information of this node, the broker release function can provide information. OPC UA defines the publish-and-subscribe function as a service in the service set. The client initiates the subscription request directly to the server, and the server periodically sends the information to the client. Comparing the characteristics of the two protocols, it is found that each of them has its own advantages. Joint design can be conducted for constrained applications.

TODO.

## 6. Security Considerations

## 7. IANA Considerations

This memo includes no request to IANA.





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## Authors' Addresses

Ping Wang  
Chongqing University of Posts and Telecommunications  
2 Chongwen Road  
Chongqing, 400065  
China

Phone: (86)-23-6246-1061  
Email: wangping@cqupt.edu.cn

Chenggen Pu  
Chongqing University of Posts and Telecommunications  
2 Chongwen Road  
Chongqing, 400065  
China

Phone: (86)-23-6246-1061  
Email: mentospcg@163.com

Heng Wang  
Chongqing University of Posts and Telecommunications  
2 Chongwen Road  
Chongqing, 400065  
China

Phone: (86)-23-6248-7845  
Email: wangheng@cqupt.edu.cn

Yi Yang  
Chongqing University of Posts and Telecommunications  
2 Chongwen Road  
Chongqing, 400065  
China

Phone: (86)-23-6248-7845  
Email: 382991208@qq.com

Lun Shao  
Chongqing University of Posts and Telecommunications  
2 Chongwen Road  
Chongqing, 400065  
China



Phone: (86)-23-6246-1061  
Email: yjsslcqupt@163.com

Jianqiang Hou  
Huawei Technologies CO., LTD  
101 Software Avenue,  
Nanjing 210012  
China

Phone: (86)-15852944235  
Email: houjianqiang@huawei.com