Asset Health Monitoring Using FDT 3.0 (FITS) & OPC PubSub

Dharmaraju B[1] Smitha Rao [2] Abhishek MR[3] Sharan Basayya[4]

[1]Utthunga KK, 3-3-5, #904, Ningyocho Nihonbashi, Chou-ku, Tokyo, Japan
(Mob: +81-03-4577-9949; E-mail: dharmaraju.b@utthunga.com)
[2] Utthunga KK, 3-3-5, #904, Ningyocho Nihonbashi, Chou-ku, Tokyo, Japan
(Mob: +81-03-4577-9949; E-mail: smitha.rao@utthunga.com)
[3] Utthunga KK, 3-3-5, #904, Ningyocho Nihonbashi, Chou-ku, Tokyo, Japan
(Mob: +81-03-4577-9949; E-mail: abhishek.mr@utthunga.com)
[4] Utthunga KK, 3-3-5, #904, Ningyocho Nihonbashi, Chou-ku, Tokyo, Japan
(Mob: +81-03-4577-9949; E-mail: sharanbasayya@utthunga.com)

Abstract: In an industrial environment, asset health monitoring is key for making informed decisions about maintenance activity, component replacement etc., to reduce the plant downtime and improve asset performance.
FDT Group's emerging FDT IIoT Server (FITS) architecture empowers a robust FDT Server solution featuring a client-server architecture scalable to suit the needs of a single manufacturing facility or an entire industrial enterprise by enabling secure mobile, cloud, on-premise, edge and enterprise-wide applications. The FDT Server natively integrates an OPC UA Server which exposes information about the devices connected to the FDT Server via the OPC UA companion specification Information Model. Any authenticated OPC UA Client can fetch the device information from the OPC UA Server via Request-Response Pull mechanism. This paper focuses on the FITS architecture by enabling the OPC UA Server with OPC PubSub mechanism, so that the remote asset health monitoring application can monitor the asset health in a different network, using various messaging protocols like AMQP, MQTT utilizing pull mechanism. This reduces the message traffic between Asset Health Monitoring Application and the FDT Server, improving the performance and scalability.

Keywords: OPC UA, FDT 3.0 - FDT IIoT Server (FITS), IIoT, FDT, DTM, FDT Server, Industrie 4.0, DTM, Pub-Sub mechanism, NAMUR, AMQP, MQTT

1. INTRODUCTION

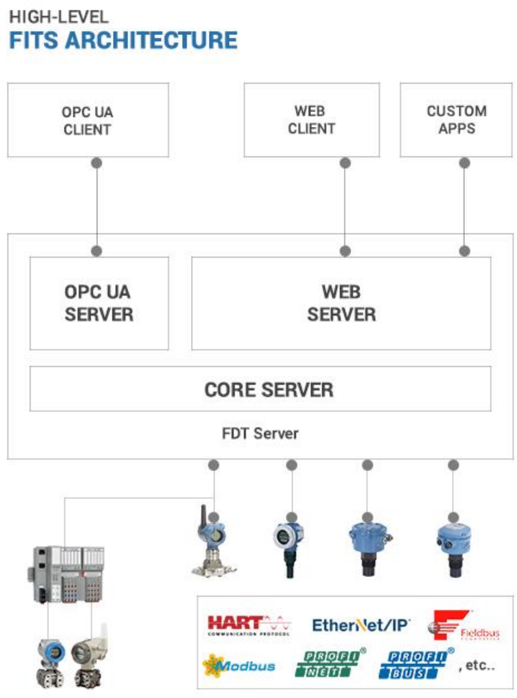
FDT is an international, IEC-62453 open standard for industrial automation integration of networks and devices, harnessing IIoT and Industrie 4.0 for enterprise-wide connectivity.

2. HIGH-LEVEL FDT IIoT SERVER - FITS ARCHITECTURE

The FITS standard employs the latest technology to allow for a server-based solution that is operating system independent. The FDT Server is a turn-key solution inclusive of a Core Server that functions as the IIoT exchange hub and manages all DTM user interfaces and business logic. Additionally, the Core Server is responsible for DTM storage, instances and execution. In addition to the Core Server, the FDT Server contains components mentioned below.

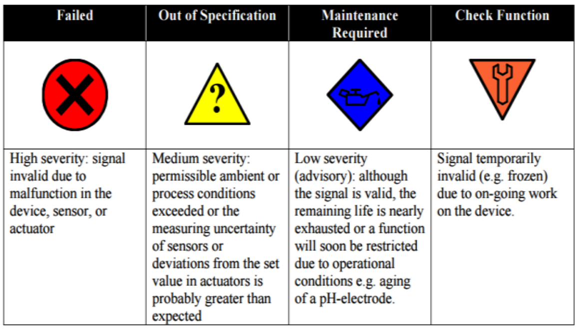
1) **OPC UA Server:** OPC UA Server exposes the FDT/OPC UA Information Model via OPC interface for any authenticated OPC UA Client. The FDT/OPC UA Server Information Model contains the internal client component which interacts with the Core Server to fetch the DTM related information to map it to the FDT/OPC UA Information Model.
2) **Web Server:** Web Server provides the web interface for authenticated remote web-enabled client applications. It is also possible to have the custom application built based on the Web Server using AppData Services.

Fig.1 FDT Server - FITS Architecture



3. ASSET HEALTH AS PER NAMUR NE107 RECOMMENDATION

NAMUR has identified that the status of the devices is important to help the plant operators run the plant better along with measured process values. This requirement is captured in their NE107 recommendation defining that detailed device-specific diagnostics are summarized as four simple status signals (Failed, Out of Specification, Maintenance Required and Check Function). These signals ensure that the plant operator is not inundated with device troubleshooting details and cryptic error codes. The NAMUR NE107 recommendation harmonizes the display of status for devices.



Failed	Out of Specification	Maintenance Required	Check Function
High severity: signal invalid due to malfunction in the device, sensor, or actuator	Medium severity: permissible ambient or process conditions exceeded or the measuring uncertainty of sensors or deviations from the set value in actuators is probably greater than expected	Low severity (advisory): although the signal is valid, the remaining life is nearly exhausted or a function will soon be restricted due to operational conditions e.g. aging of a pH-electrode.	Signal temporarily invalid (e.g. frozen) due to on-going work on the device.

Fig. 2. NAMUR NE107 Status Signal Description

4. MONITORING ASSET HEALTH USING FDT SERVER AND OPC PUBSUB MECHANISM IN FITS

This position paper focuses on the Asset Health Monitoring using the FDT Server's flexibly integrated OPC UA Server along with OPC UA PubSub mechanism. There are other possibilities of monitoring asset health using the embedded Web Server and building custom application. However, this paper does not cover these possibilities.

As shown in the above image, disparate network and devices in the plants are connected to the FDT Server and are modeled in the FDT/OPC UA Information Model as per the companion specification. DTM instances will be fetched by the Core Server while client component in the OPC UA Server Information Model will use this information to build the FDT/OPC UA Server Information Model.

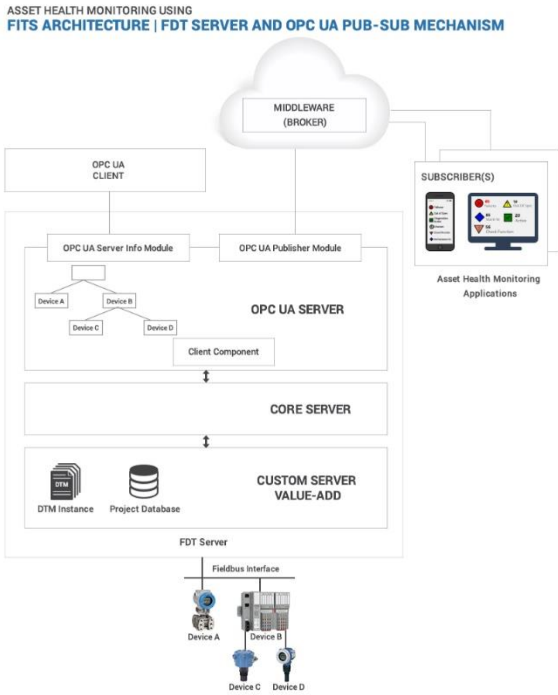


Fig.3. Asset Health Monitoring Using FDT Server and OPC PubSub mechanism in FITS architecture.

4.1 Mapping of FDT Interfaces to OPC UA DeviceHealth Status information

OPC UA Server shall support access to both offline and online information. However, DeviceHealth Status is applicable only for Online Devices. Below table maps the OPC UA Object Type for DeviceHealth information to FDT Server Interface.

Table 1. Mapping of FDT Interfaces to OPC UA DeviceHealth Status Information

OPC UA			**FDT Server Mapping**			
Object Type	**BrowseName/ TypeDefinition**	**DeviceHealth Value**	**FDT Interface**	**DTMService (IEC62453-2)**	**FDT 3.0 Method**	**DeviceStatus.StatusFlag**
FDT DeviceType	DeviceHealth/ BaseDataVariable Type	NORMAL_0 FAILURE_1 CHECK_FUNCTION_2 OFF_SPEC_3 MAINTENANCE_REQUIRED_4	IOnlineOperation	DeviceStatus	Request: IOnlineOperation.BeginReadDeviceStatus Response: IOnlineOperation.EndReadDeviceStatus	Ok Invalid Check Function Outof Specification Maintenance -Required

As per FDT 3.0 (FITS) specification, ReadDevice Status method available in the IOnlineOperation interface is an asynchronous operation. FDT also provides StaticFunction GetDeviceStatus to return the DeviceHealth values which can also be mapped to OPC UA DeviceHealth attribute.

Along with DeviceHealth Status, it is also possible to include Device Diagnostic Information and map it to the OPC UA Information Model. However, this has not been discussed in this position paper.

4.2 OPC UA Publisher Module for OPC UA Server in the FITS Architecture

This position paper proposes the OPC UA PubSub model on top of the OPC UA Server to support pushing the DeviceHealth Status in the event of status change instead of OPC UA Client polling the DeviceHealth information on time-based interval. OPC UA PubSub Communication Model is based on a well-known Publisher-Subscriber design pattern where publisher and subscriber are loosely coupled. With PubSub Communication Model, OPC UA application does not exchange the information directly using the request-response mechanism, instead, OPC UA publisher module sends the message/topic to the Message Oriented Middleware (Broker). Message Oriented Middleware could be software or hardware infrastructure which supports sharing the information between publishers and subscribers. OPC UA PubSub Communication mechanism supports both broker-less and broker-based middleware.

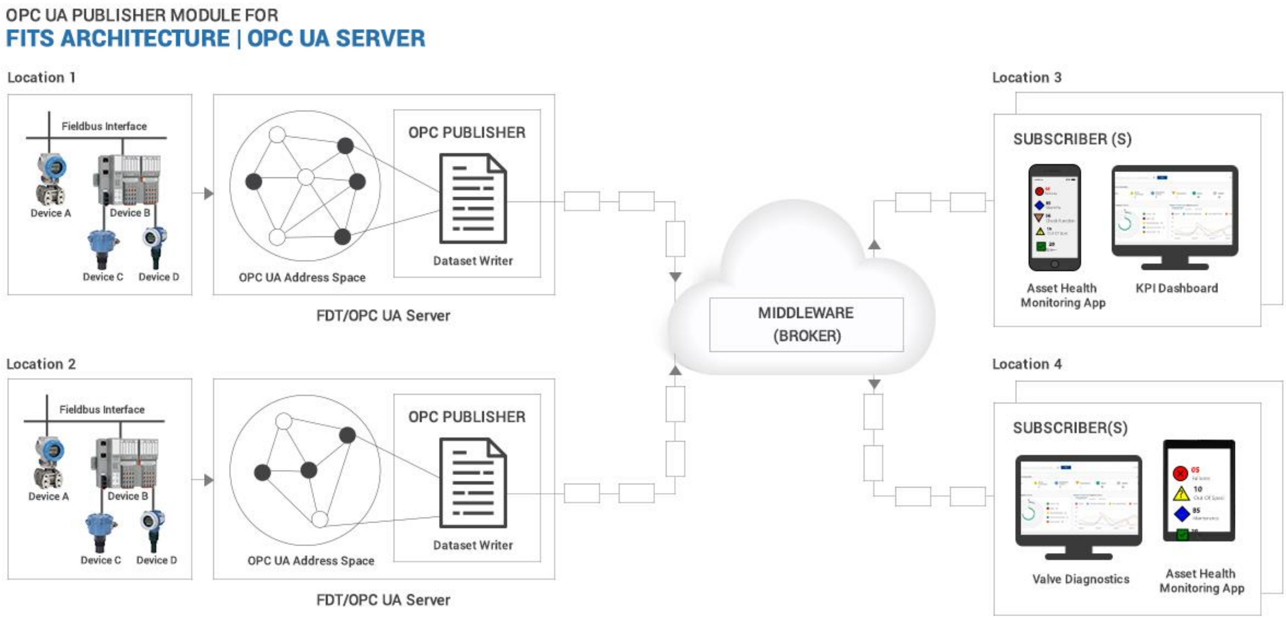


Fig.4. OPC UA Publisher Module for OPC UA Server in the FITS Architecture

The broker-less mechanism uses the UDP multicast whereas in broker-based mechanism uses the standard messaging protocols like AMQP or MQTT to communicate with broker.
OPC UA PubSub Communication Model supports two types of DataSet Messages - Key Frame and Delta Frame messages. A key frame DataSetMessage includes all fields of the DataSet whereas Delta Frame message includes only subset of fields that changed since the previous DataSetMessage.

5. BENEFITS

OPC UA PubSub Model enables the Asset Health Monitoring Applications (Subscriber) to pull the interesting data i.e. topics from the cloud platform without any knowledge about the FDT Server (Publisher) of the data. However, these messages will be associated with its metadata information which enables the subscriber to interpret this information correctly.

FDT Server (Publisher) and Asset Health Monitoring Application (Subscriber) do not have to be directly addressable. They can be anywhere in their own networks as long as they have access to the broker.
Fan out can be handled against a very large list of subscribers, multiple networks or even chained or scalable brokers. Publisher and subscriber lifetimes do not have to overlap. The publisher can push data to the broker and terminate. The data will be available in the subscriber application which can be accessed later.

OPC UA PubSub Model is independent of the cloud platform and messaging protocols like AMQP or MQTT.

This enables the existing application to easily adopt this technology with less investment.

6. STUDY POINT

This position paper covers the study point of comparing the existing FDT/OPC UA Information Model for FDT Server with FDT/OPC UA Information Model enabled with the OPC UA PubSub module for Asset Health Monitoring.

Key Features	Asset Health Monitoring using OPC UA Server with OPC UA Client/Server communication model	Asset Health Monitoring using OPC UA Server with OPC UA PubSub communication model
Information exchange mechanism between OPC UA Server and Asset Health Monitoring application	Pull Model using Request/Response mechanism: Asset Health Monitoring application needs to pull the information from OPC UA Server at regular interval irrespective of Asset health status change	Push Model using Publisher-Subscriber mechanism: OPC UA Publisher module in the OPC UA Server pushes the Asset Health status only when Asset health status change is detected. This brings huge benefit in reducing message exchange between Asset Health Monitoring Application and the FDT Server
Connection between OPC UA Server and Asset Health Monitoring application	Tightly coupled: OPC UA Session must exist between OPC UA Server and Asset Health Monitoring application.	Loosely coupled: There is no direct connection between OPC UA Server and Asset Health Monitoring application. This allows both of these applications to be in different network.

7. CONCLUSION

FDT Server (Publisher) can push the data to the broker only on change of status which brings huge benefit in reducing message exchange between the Asset Health Monitoring Application and the FDT Server.

OPC UA Server supports Client-Server based Request-Response Communication mechanism between the OPC UA client application and generic client application. Combining the OPC UA PubSub communication mechanism with OPC UA Server brings huge benefit in reducing the communication traffic between the Asset Health Monitoring Application and OPC UA Server application, making it scalable to IIoT requirement.

Apart from Asset Health Monitoring, this position paper can also be extended to support Loop & Control Valve Diagnostics, Equipment Diagnostic, KPI Monitoring and Dashboard Application etc.

Utthunga is niche Industrial Software and Solution provider. Utthunga is specialized in Industrial standards, specifications, communication protocols like OPC UA, FDT/DTM, FDI, HART, EtherNet/IP, BACNet, CC-Link, PROFINET etc.

8. REFERENCES

[1] OPC UA Part 14 PubSub Specification
[2] OPC UA for Devices Companion Specification
[3] FDT OPC UA Information Model Specification
[4] FDT 2.x Specification
[5]https://instrumentationtools.com/namur-ne107-standard/
[6] https://fdtgroup.org/

9. COPYRIGHT