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**Wireless technology and protocol
for IIoT and digital twins**

Jie Tan (Co-authors: Xiubin Sha, Bo Dai,
Ting Lu)
ZTE Corporation and State Key
Laboratory of Mobile Network and Mobile
Multimedia Technology, China

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Abstract

- The industrial Internet of things (IIOT) is an important engine for manufacturing enterprises to provide intelligent products and services.
- With the development of IIOT, more and more attention has been paid to the application of URLLC in the field of IIOT.
- This paper mainly introduces the development of 3GPP for URLLC
 - Reducing delay
 - Enhancing reliability
 - Little jitter
 - High transmission efficiency
- Further analyzes the enhanced key technologies required in the IIOT, and the application of IIOT in Digital twins is analyzed according to the actual situation.

1 Introduction

- As shown in Fig. 1, the physical entity of the physical space and the digital twins of the virtual space are connected through the network.
- Among them, the miniaturization of IIoT technology makes the creation of digital twins possible and uses sensor system to realize data sharing between virtual and physical objects.
- Furthermore, 5G network can provide faster connection speed between virtual and real objects, and improves operation efficiency and reliability by reducing response time.

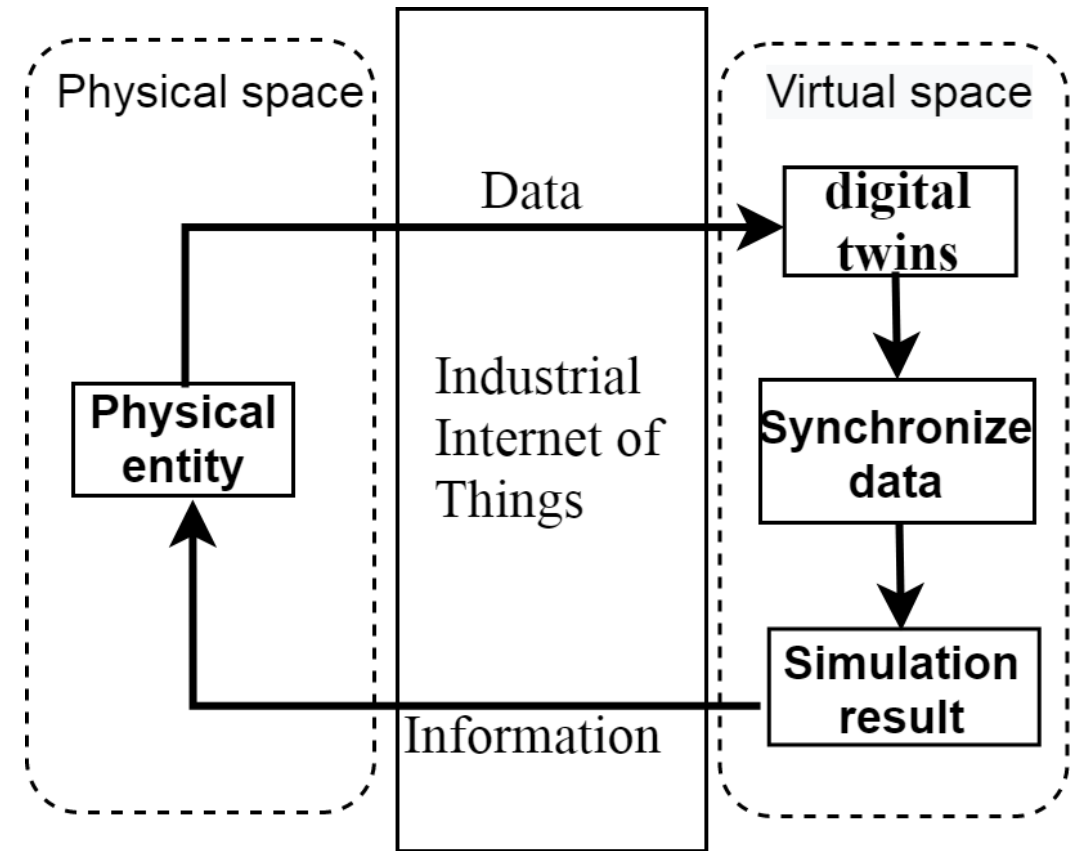


Figure 1: The relationship between digital twins and internet

2 Development and research actuality for IIoT technology

2.1 Low latency

URLLC delay research in Rel-15

- Support for more flexible frame structure
- Support for more flexible scheduling units
- Support for flexible PDCCH configuration
- Support for URLLC high-priority transmission
- Introduction of mobile edge computing(MEC)

URLLC delay research in Rel-16

- Support for grant free configuration
- Support for intra-UE priority and multiplex mechanism
- Support for TSN and 5G convergence

2 Development and research actuality for IIoT technology

2.2 High reliability

URLLC reliability research in Rel-15

- Support for PDCP (Packet Data Convergence Protocol) duplication mechanism
- Support for optimizing MCS(Modulation and Coding Scheme)\ CQI(Channel Quality Indication) tables
- Support for less load DCI (Downlink Control Information) design

URLLC reliability research in Rel-16

- Support for multi -TRP transmission mode
- Support for PDCP duplication enhancement mechanism
- Support for redundant transmission scheme

2 Development and research actuality for IIoT technology

2.3 Little jitter and 2.4 High transmission efficiency

Hold and forward

- The Hold and Forward buffering mechanism allows PDB based 5GS QoS to be used for TSC traffic since packets need only arrive at NW-TT or DS-TT egress prior to their scheduled transmission time.

Accurate reference timing

- In Rel-16, RAN1 only provides transmission delay compensation for base station and UE in the TDD and FDD scenarios according to half of the timing advance, that is, $NTA \times T_c / 2$.

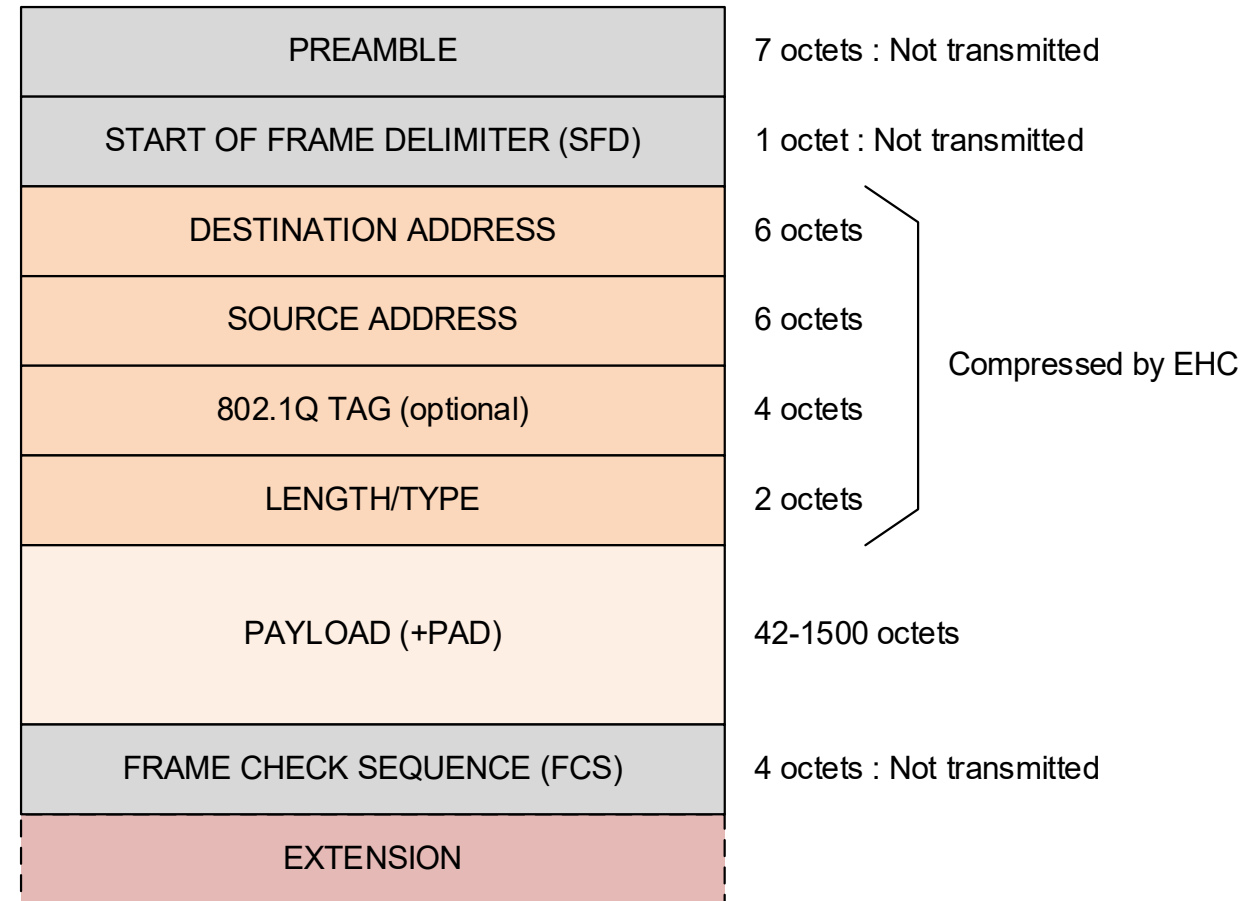


Figure 2: Ethernet packet format

3 Future research IIoT technology

- On the basis of multi-carrier deployment, the reliability is further improved by introducing PDCP layer and higher-level data replication transmission technology.
- The feedback scheme for the physical layer will be further enhanced.
- The UE service priority and uplink UCI will be enhanced.
- Licensed, shared and license-free spectrum: With the NR-U, the 5G NR will support the licensed frequency, shared frequency domain and license-free spectrum.
- URLLC: low latency, high reliability, and multi-TRP cooperation.
- Enhanced mobility.
- Wireless replacement of wired bus.
- Positioning: based on network and equipment requirements, IIoT requirements, and intelligent factory/V2X (Vehicle to everything) centimeter positioning requirements.

4 IIoT application in digital twins

- IIoT is a key link in the process of enterprise digital transformation, which accelerates the integration of various elements of information technology (IT) and operation technology (OT).
- Data is the most important binder in the integration process.
- In order to make the IT and OT integrate better, the hidden asset of data should be handled first.
- In addition, the IIoT is trying to break the boundaries of enterprises, trying to fill the gaps between IT and OT, and creating a new ecology of software definition, data-driven and mode innovation.
- The digital twin just provides the interface of data and technology for the development of integration.

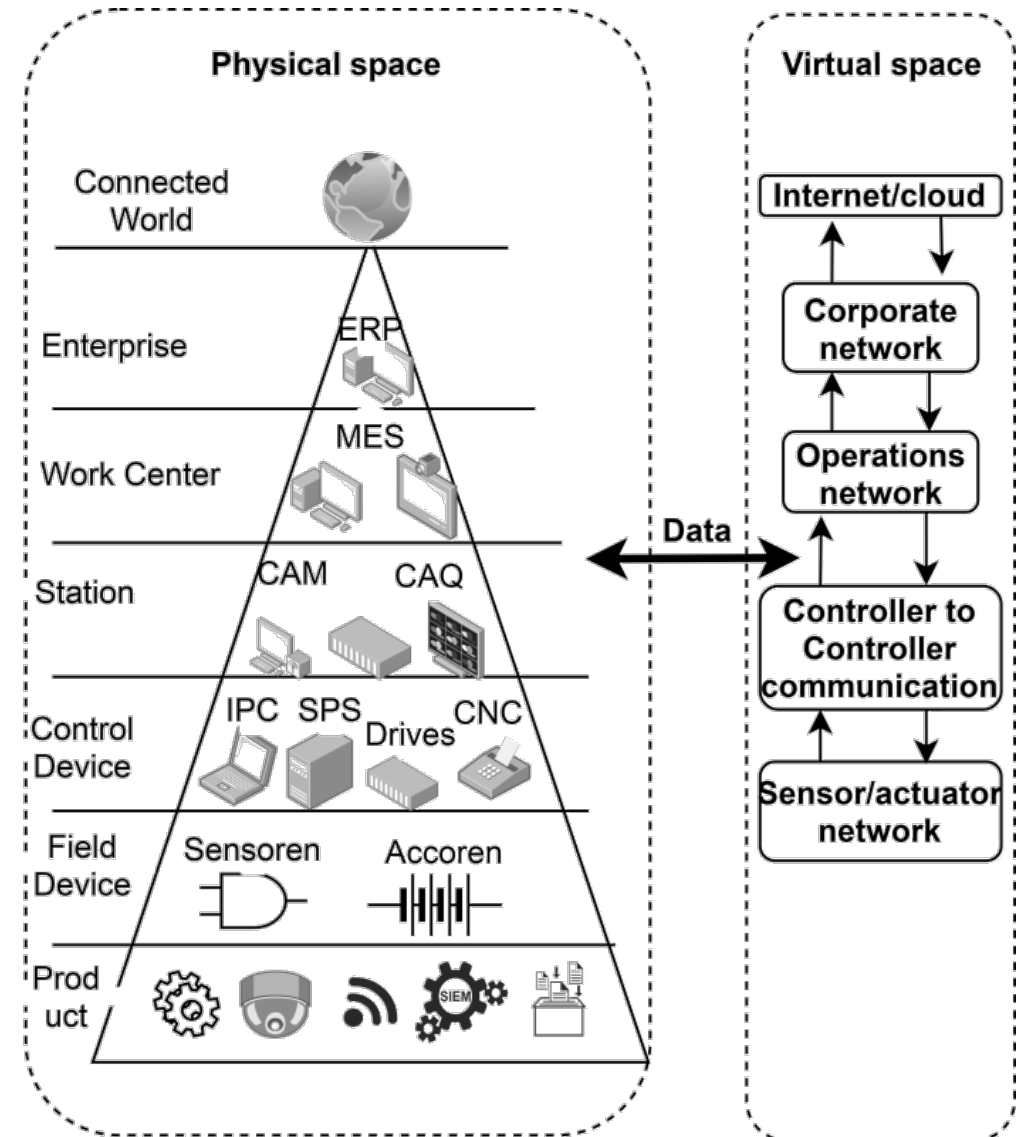


Figure 3: An example use case of Industrial IoT via Digital Twins

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Thank you!

