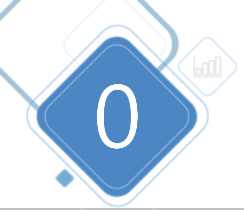


Digital twin for smart cities

30 January 2024

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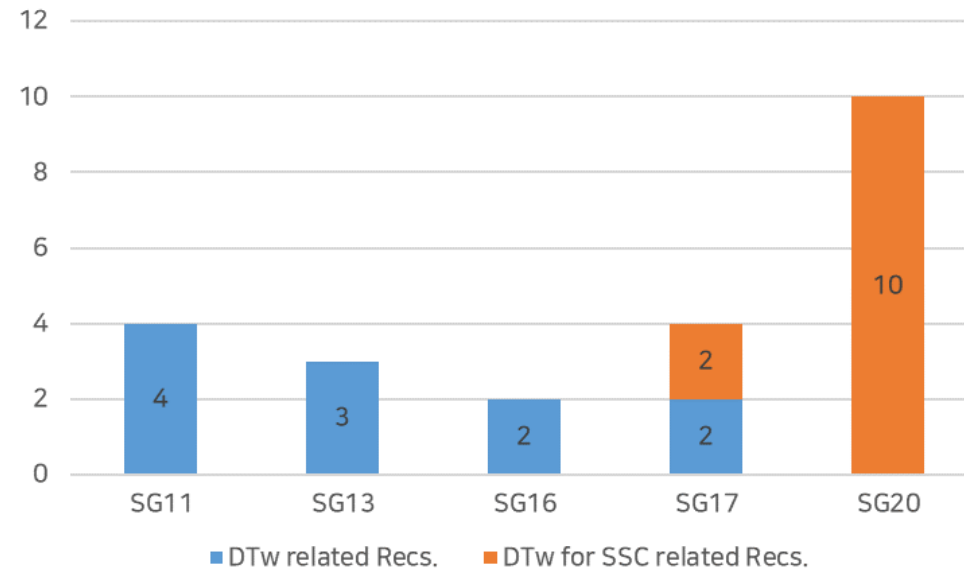
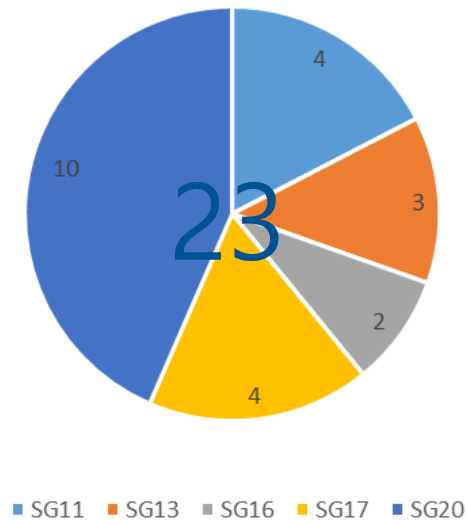
- 1. DTw and SSC in ITU-T**
- 2. ITU-T Y.4600**
- 3. ITU-T Y.4224**
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1 DTw and SSC in ITU-T



Recently, ITU-T has developed or is developing more than 23 Recommendations/Supplements related to digital twins.

Among them 12 Recommendations/Supplements are closely related to smart sustainable cities.







Current landscape of DTw for SSC in ITU-T


Federation


Y.4224, Requirements for digital twin federation in smart cities and communities
Y.4489, Reference architecture of digital twin federation in smart cities and communities
Y.4605, Information exchange model for digital twin federation in smart cities and communities

Verticals

Y.4225
 (ex Y.dt-ITS), 
 Requirements and capability framework of digital twin for intelligent transport system

Y.4601, Requirements and capability framework of a digital twin for smart firefighting 

Y.dt-IWCS, 
 Requirements and capability framework of digital twin for intelligent water conservancy system

Y.dt-SComCam, 
 Common requirements and capability framework of digital twin for smart complex and campus

Concepts

Y.4600, Requirements and capabilities of a digital twin system for smart cities
 Y.Suppl.73, ITU-T Y.4600 - Concept and use cases of a digital twin in smart sustainable cities
 YSTR.BP-DTw, Best Practices for Graphical Digital Twins of Smart Cities

X.smdtf, Security measures for digital twin federation in smart cities and communities
 X.smdtsc, Security measure for digital twin system of smart cities



Requirements and capabilities of a digital twin system for smart cities

This is the first Recommendation that defines digital twin

digital twin: A digital representation of an object of interest.

NOTE – A digital twin may require different capabilities (e.g., synchronization, real-time support) according to the specific domain of application.

smart city digital twin: A digital twin for a smart city.

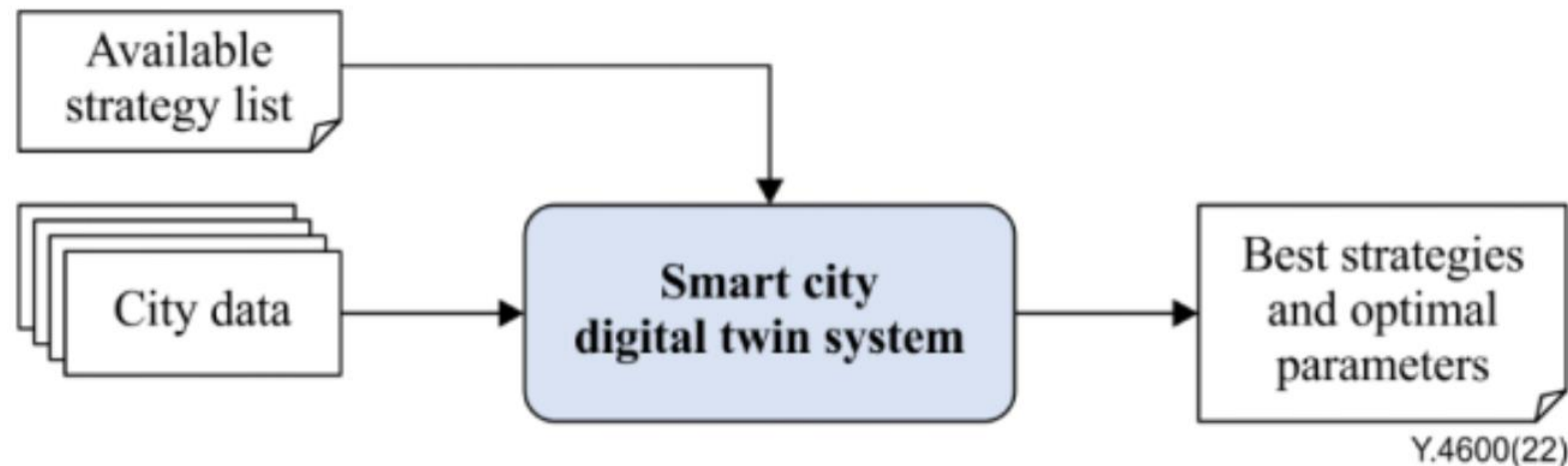
NOTE – This can be used to develop strategies to achieve specific goals of smart cities by conducting simulations before actually implementing the strategies.



Requirements and capabilities of a digital twin system for smart cities

Concept of smart city digital twin

City officers will survey available strategies based on their past experience and previous research, and this list is given to the smart city digital twin system as input. The smart city digital twin system conducts simulations on the virtual city to find the best strategy, or best combination of strategies, and optimal parameters of the chosen strategies.

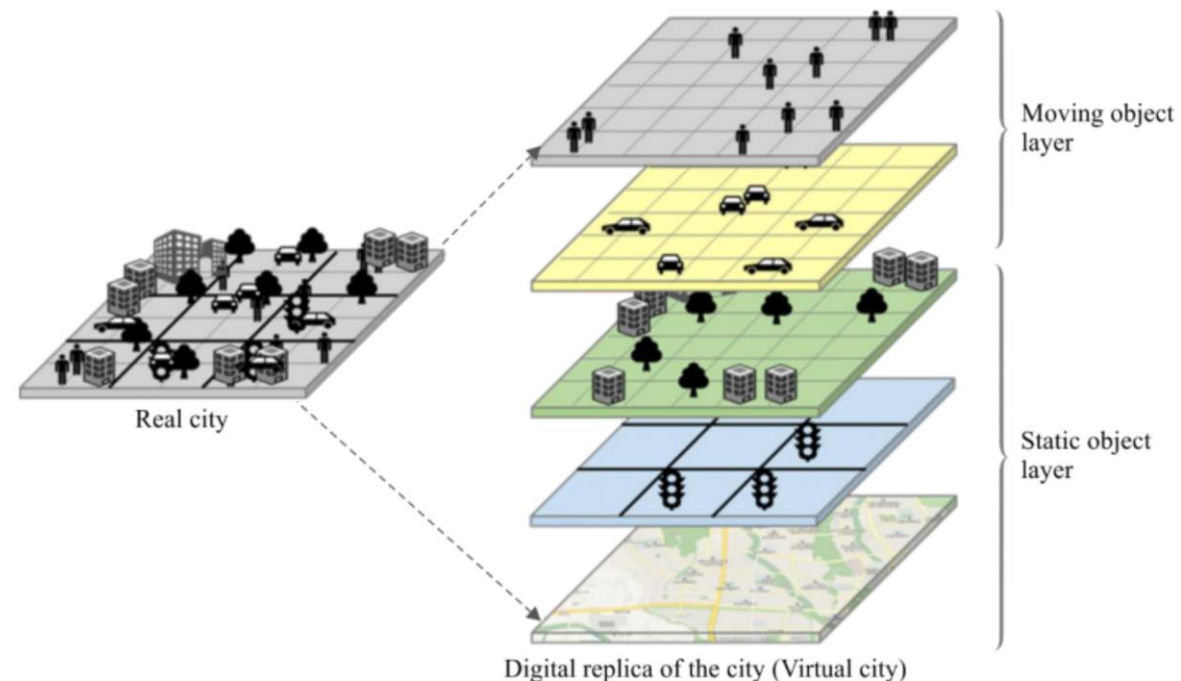




Requirements and capabilities of a digital twin system for smart cities

Digital representation of a city

For the simulations on virtual cities, the smart city digital twin needs to accurately represent not only static (or passive) objects of the city, such as land, geographical area, streets, buildings and public spaces, but also moving (or active) objects, such as citizens, buses and bicycles.





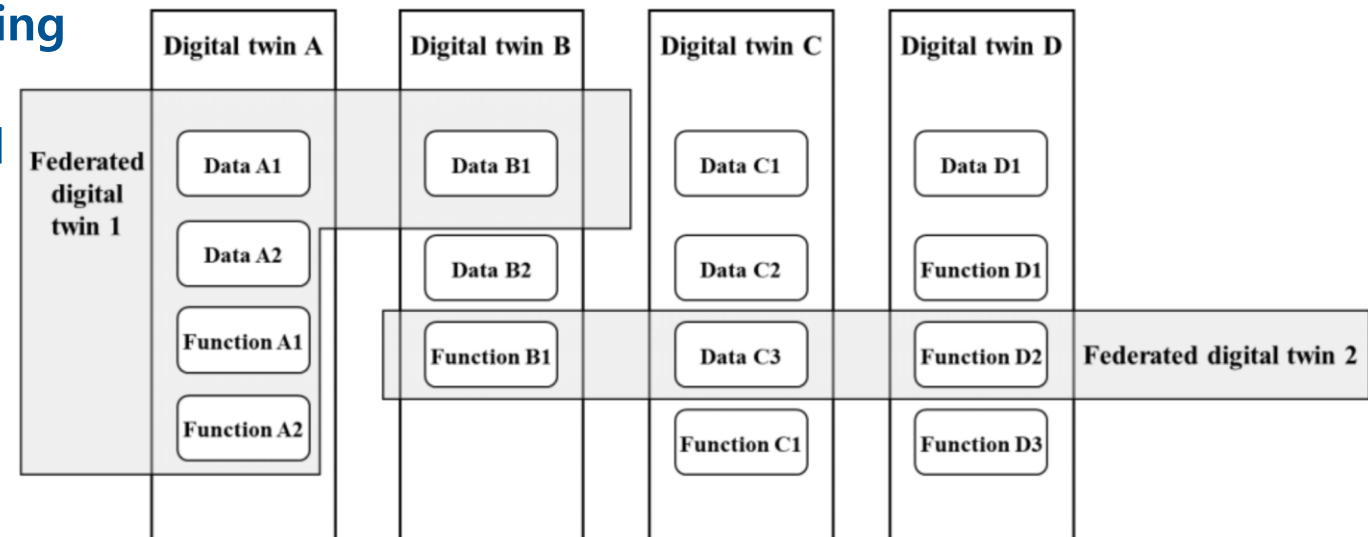
Requirements for digital twin federation in smart cities and communities

Concept of digital twin federation

digital twin federation: Sharing data and functions for collaboration across different digital twin.

Digital twin federation can provide valuable benefits for SSC

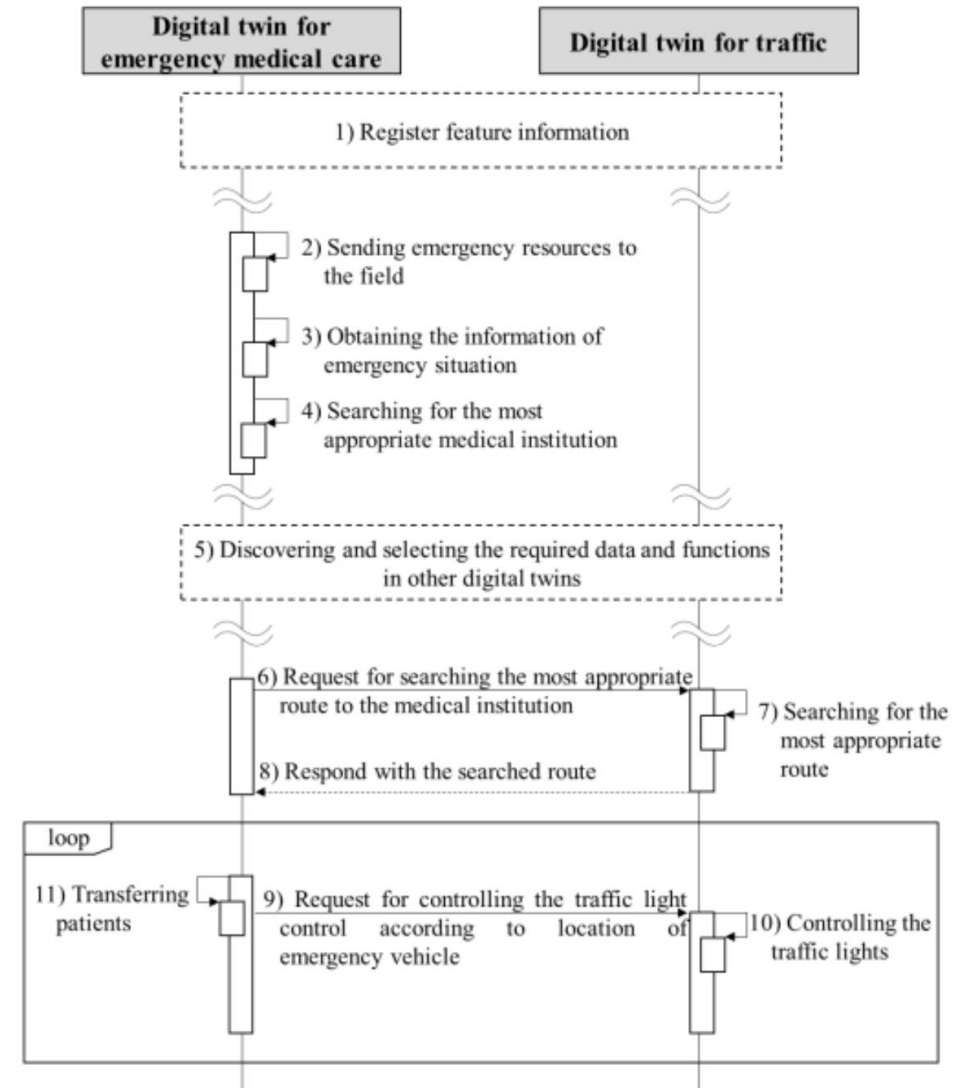
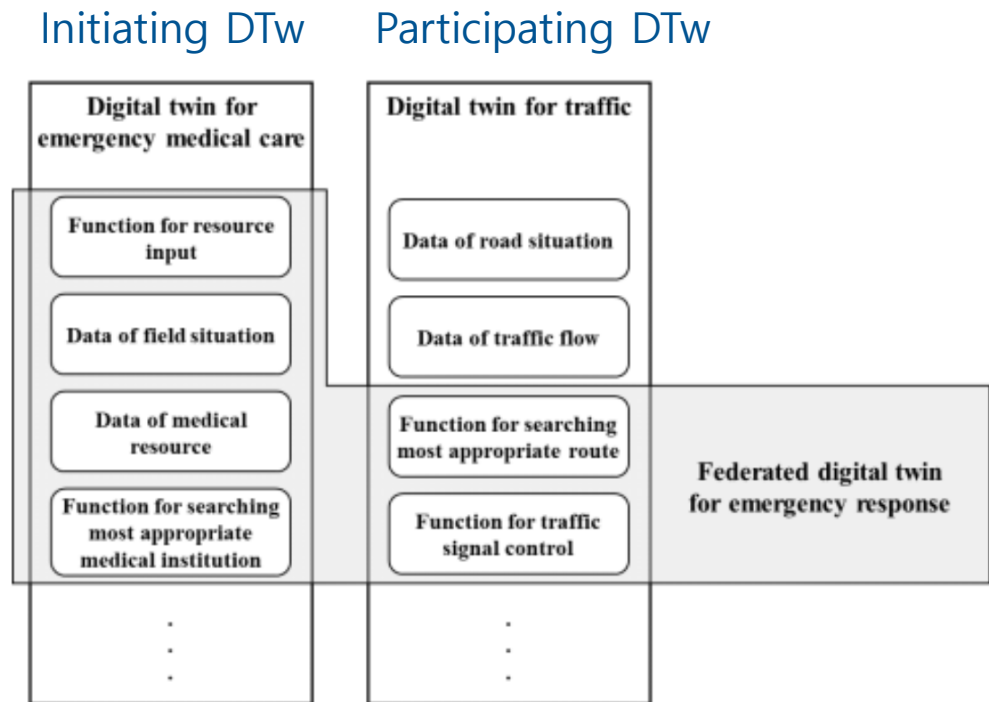
- Support identifying and responding to cross domain problems
- Support integrated simulation to provide predictive services across multiple domains
- Support multi-faceted decision making among various stakeholders
- Support identifying co-relations and mutual side-effects occurring across domains





Requirements for digital twin federation in smart cities and communities

Service scenario of digital twin federation for emergency response

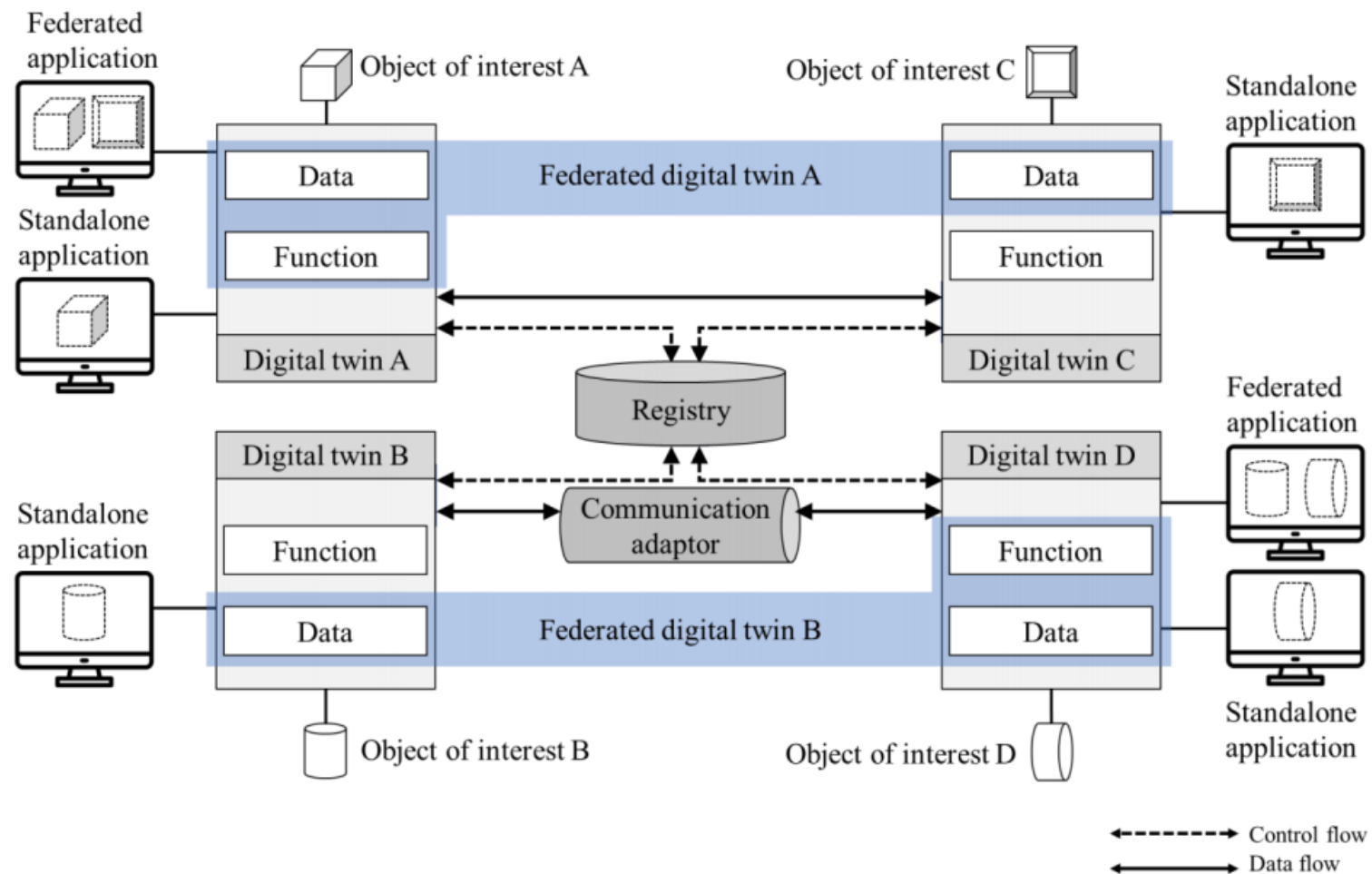




Reference architecture of digital twin federation in smart cities and communities

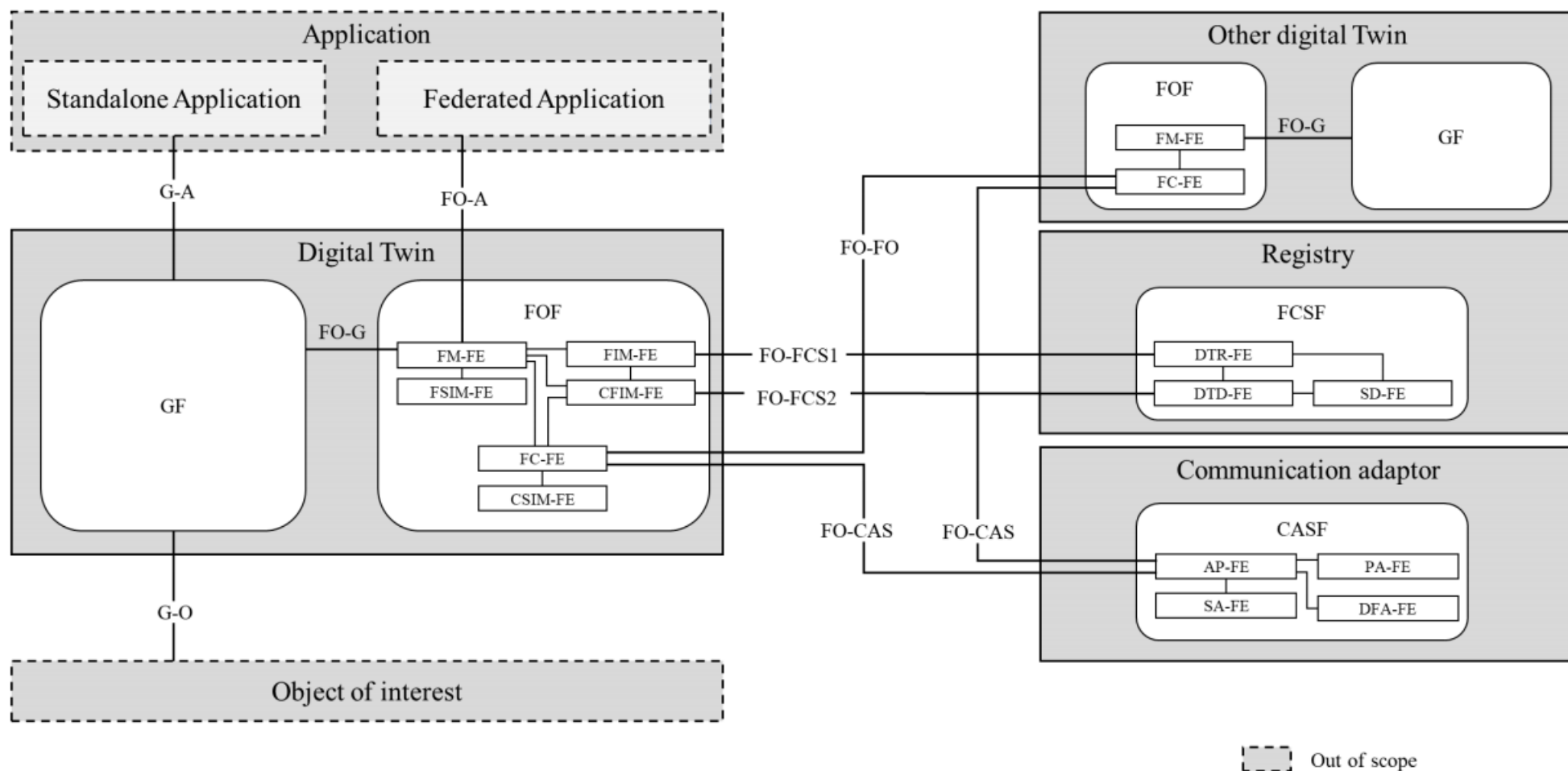
Components for digital twin federation

- Registry
- Communication adaptor
- Digital twin
- Federated digital twin
- Application
- Object of interest





Reference architecture of digital twin federation in smart cities and communities

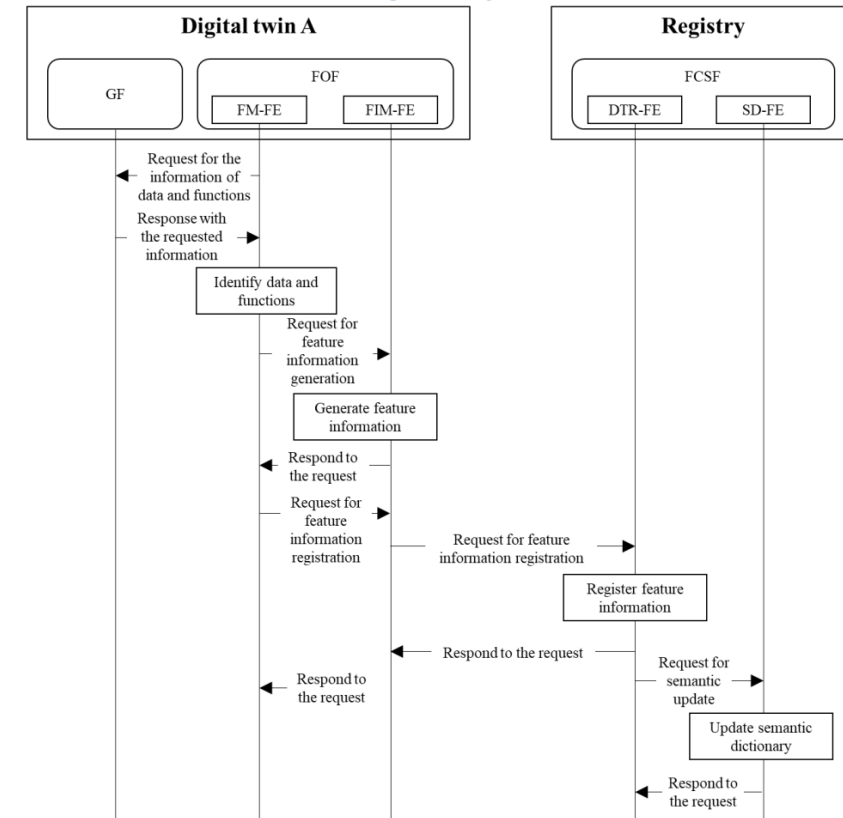




Reference architecture of digital twin federation in smart cities and communities

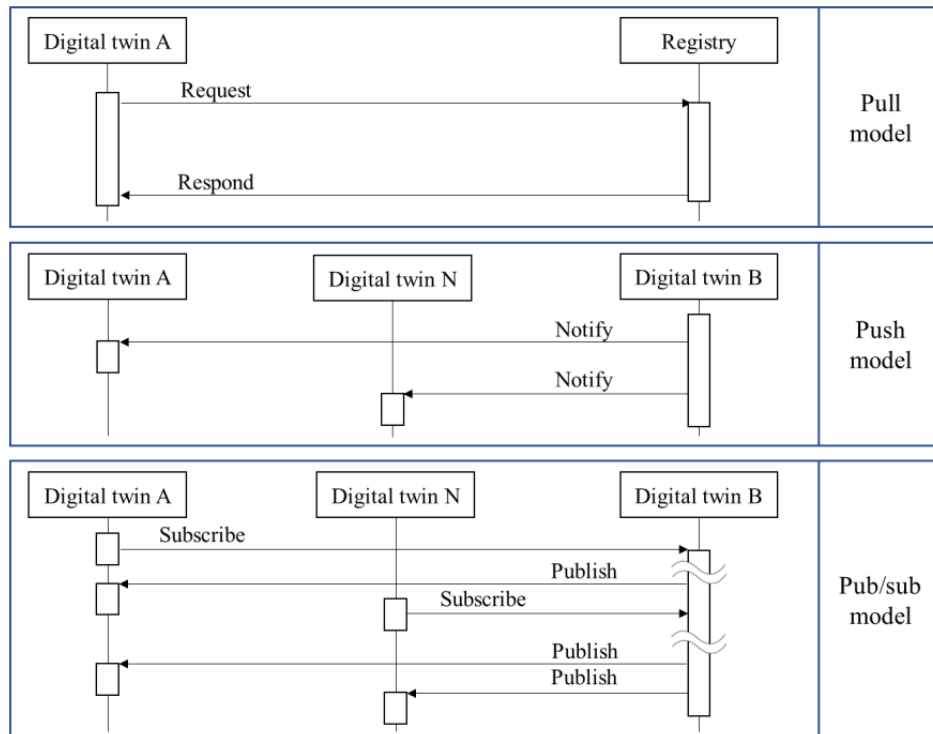
Basic operations between components

- ① Feature information registration between a digital twin and a registry
- ② Feature information registration between digital twins without registry
- ③ Candidate digital twin discovery
- ④ Direct communication establishment
- ⑤ Indirect communication establishment
- ⑥ Direct information exchange
- ⑦ Indirect information exchange





Information exchange model for digital twin federation in smart cities and communities



Pull model: The sender requests the receiver to send information, and the receiver responds by sending the requested information.

Push model: The sender notifies the new or changed information to the receivers without request or subscription.

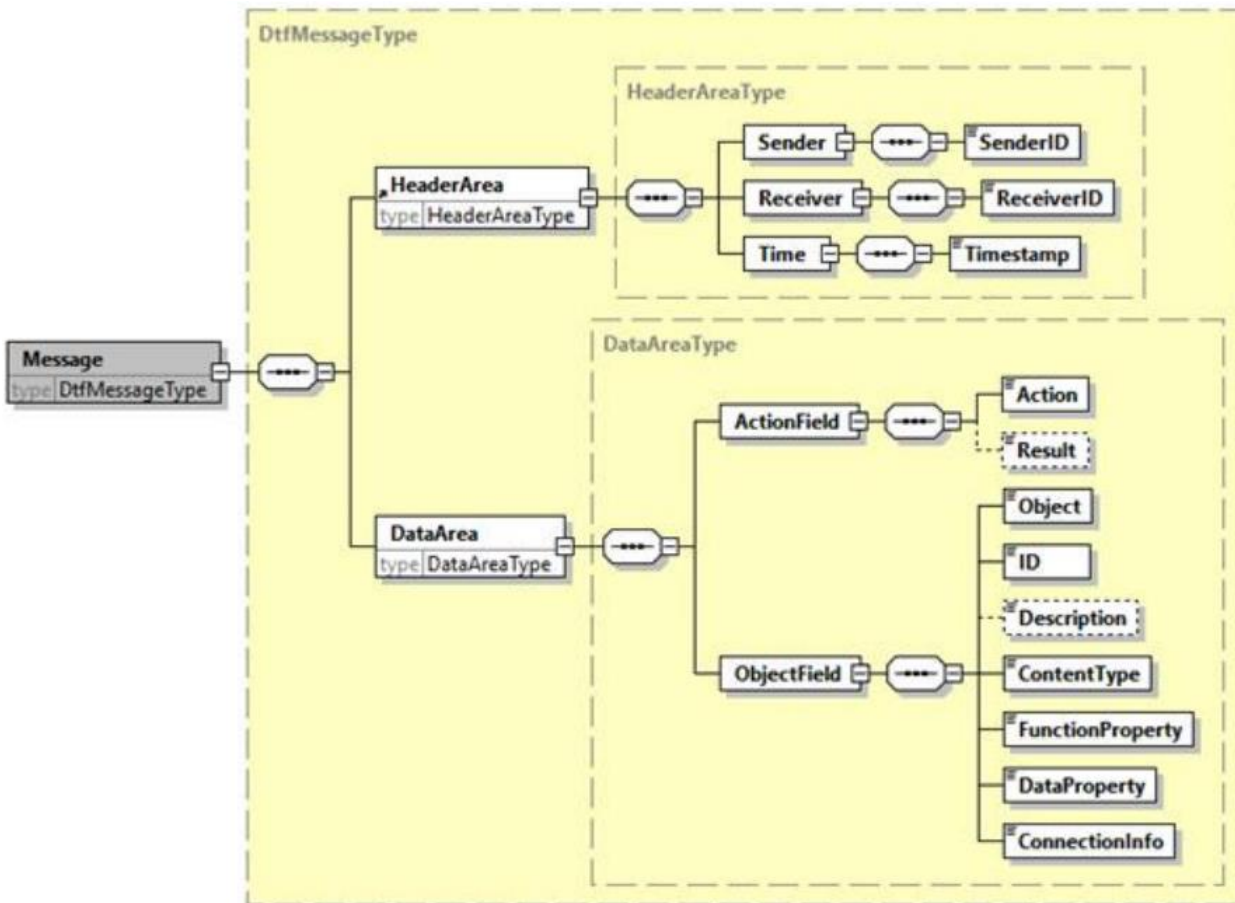
Pub/sub model: After subscription procedure, the publisher sends the subscribed information to the subscribers

The use of three models for the operation are implementation dependent.

The operations from ① to ⑤ can be implemented using the pull model. The operation ⑥ and ⑦ can be implemented using the pull, push or pub/sub model.



Information exchange model for digital twin federation in smart cities and communities



List of actions

CHANGE: Request to a receiver to change the existing data

CONNECT: Request to a receiver to connect for digital twin federation

DELETE: Request to a receiver to delete existing data

GET: Request to a receiver for sharing data

PROCESS: Request to a receiver for processing functions

REGISTER: Request to a receiver to register the data

RESPOND: Used to respond which contains the result

SYNC: Publish the new information or change in existing information by the information owners to subscribers

Q&A

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ITU-T is working on the DTw for SSC

Including concept, various verticals and federation between DTw

ITU-T Y.4600, Requirements and capabilities of a digital twin system for smart cities

The first Recommendation that defines digital twin

Provide the concept of smart city digital twin

ITU-T Y.4224, Reference architecture of digital twin federation in smart cities and communities

Provide the concept of digital twin federation

Explain service scenario of digital twin federation with the example of emergency response

ITU-T Y.4489, Reference architecture of digital twin federation in smart cities and communities

Explain the components of digital twin federation, reference architecture and basic operations

ITU-T Y.4605, Information exchange model for digital twin federation in smart cities and communities

Explain pull, push, pub/sub models for information exchange in digital twin federation

Define message structure for digital twin federation

