Webinar objectives

Attendees will learn about achievements related to standardization in the areas of “Internet of Things” (IoT) and “digital twin” (DTw) technologies since the creation of SC41 five years ago. Consideration will be given to emergent trends and the future work program in relation to these technologies and some of their applications.
The following material will be available after the webinar:

- Presentation material
- Recording
- Edited Q&A

Registered participants will be notified once the material is available.
Questions and answer

Please use the Zoom feature for all your questions.

The webinar program committee and presenters will try to answer your questions asynchronously during the webinar using this Zoom feature.
ISO/IEC JTC 1/SC 41

Title: Internet of Things and Digital Twin

Scope:
Standardization in the area of Internet of Things and Digital Twin, including their related technologies.
1. Serve as the focus and proponent for JTC 1's standardization programme on the Internet of Things and Digital Twin, including their related technologies.
2. Provide guidance to JTC 1, IEC, ISO and other entities developing Internet of Things and Digital Twin related applications.
Foundational standards

- Concentrate on foundational standards: vocabularies, reference architectures, interoperability, trustworthiness
# Program - day 1

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>12.00-12.15 UTC</td>
<td>Introduction: Dr. François Coallier, ISO/IEC JTC1/SC41 Chair</td>
</tr>
<tr>
<td></td>
<td>Mr. Philip Wennblom, ISO/IEC JTC1 Chair</td>
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<tr>
<td>12.15-12.35 UTC</td>
<td>IoT and Digital Twin standardization strategy in JTC 1/SC41</td>
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<tr>
<td></td>
<td>Dr. François Coallier, ISO/IEC JTC1/SC41 Chair</td>
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<tr>
<td>12.40-13.00 UTC</td>
<td>IoT Reference Architecture (RA) 2.0</td>
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<tr>
<td></td>
<td>Ms. Erin Bournival, Convener of JTC 1/SC41 WG3</td>
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<tr>
<td></td>
<td>Mr. Eric Simmon, IoT RA Lead Architect</td>
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<td></td>
<td>Mr. Östen Franberg, IoT RA co-editor</td>
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## Program - day 1

<table>
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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>13.05-13.25 UTC</td>
<td>IoT Interoperability Standardization</td>
<td>Dr. Quan Wang, Convener of JTC 1/SC41 WG4</td>
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<tr>
<td></td>
<td></td>
<td>Mr. Antonio Kung</td>
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<tr>
<td></td>
<td></td>
<td>Dr. Lan Yamashita</td>
</tr>
<tr>
<td>13.30-13.50 UTC</td>
<td>Industrial IoT Standardization</td>
<td>Mr. Detlef Tenhagen, Convener of JTC 1/SC41 AG20</td>
</tr>
<tr>
<td>13.55 -14.40 UTC</td>
<td>Panel on IoT Trustworthiness</td>
<td>Chair: Ms. Erin Bournival, Convener of JTC 1/SC41 WG3 Convener</td>
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<tr>
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<td></td>
<td>Panelists: Mr. François Coallier, Mr. Antonio Kung, Mr. Asahiko Yamada</td>
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<tr>
<td>14.40 -14.45 UTC</td>
<td>Wrap up</td>
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</table>
Cooperation with sectors

- Have an ‘incubator’ to kick-start domains or sectors applications and cover ‘dead-angles’
- Coordinate and partner as required with ISO, IEC and JTC 1 entities as well as other Standards Development Organizations (SDOs) that have the mandate and resources to develop standards for technologies used in IoT and DTw systems.
- Coordinate and partner as required with ISO and IEC entities that mandate and resources to develop standards that use IoT and DTw in specific application domains or sectors.
SC 41 Structure (November 2021)

Chair

Advisory Group
- JWG 24 with IEC/TC 57
  - IoT applications in power systems management
- JWG 3 with SyC Smart Energy
  - IEC Smart Energy Roadmap

Vocabulary Rapporteur
- ahG 26 Trustworthiness interoperability
- ahG 230 Cyber Physical systems

WG 3 IoT Foundational Standards
- AG 22 LG on IoT Trustworthiness

WG 4 IoT Interoperability
- AG 25 Use Cases

WG 5 IoT Applications
- AG 28 LG JTC 1/SC 42

WG 6 Digital Twin
- AG 29 LGC Comm and Networking

JWG 17 with IEC/TC 65
- System interface between industrial facilities and the smart grid

Committee Manager
- AG 20 SLG1 Industrial sector
- AG 21 SLG2 Utilities

Use Cases Rapporteur
- ahG 15 Communications and outreach

JTC 1/SC 41 Webinar on IoT and Digital Twin - 2022-04-26 & 28
## Program - day 2

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>12.00-12.15 UTC</td>
<td>Introduction: François Coallier (ISO/IEC JTC1/SC41 Chair)</td>
</tr>
<tr>
<td>12.15-12.35 UTC</td>
<td>Highlights from the September 2021 SC41 Digital Twin Workshop</td>
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<tr>
<td></td>
<td>Dr. Sha Wei, Convener of JTC 1/SC41 WG6</td>
</tr>
<tr>
<td>12.40-13.00 UTC</td>
<td>City Information Modelling and Urban Digital Twins</td>
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<tr>
<td></td>
<td>Dr. Chunlan Guo, IEC SyC Smart Cities expert</td>
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<tr>
<td>13.05-13.25 UTC</td>
<td>Maritime IoT and Digital Twin</td>
</tr>
<tr>
<td></td>
<td>Dr. Soo Hyun Park, Convener of JTC 1/SC41 WG7</td>
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## Program - day 2

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>13.30-13.50 UTC</td>
<td><strong>IoT and Digital Twin in the Energy Sector</strong>&lt;br&gt;Mr. Laurent Guise, IEC SyC Smart Energy and IEC/TC57 Expert, IEC SG12 MG co-convenor</td>
</tr>
</tbody>
</table>
| 13.55-14.40 UTC | **Closing Panel on IoT Applications and Domain Standards**<br>Chair: Dr. Yongjin Kim – Convener of SC41/WG5  
Panelists: Dr. Howard Choe, Dr. Kate Grant, Dr. Mingjuan Wu and Mr. Yong-Woon Kim. |
| 14.40-14.45 UTC | **Closure**                                                              |
Highlights from the September 2021 SC41 Digital Twin Workshop

Dr. Sha WEI, Convenor of WG 6
venessa724@vip.qq.com
Contents

○ About ISO/IEC JTC 1/SC 41/WG 6 Digital Twin
○ General Information of the Workshop
○ WS1: Digital Twin Use Cases
○ WS2: Digital Twin Concepts
○ WS3: Architecture of Digital Twin
○ WS4: Digital Twin System Integration
About WG 6

Until Apr. 16th, 2022, there are 174 committee members from 19 NBs in WG 6, including Australia, China, Denmark, Finland, France, Germany, India, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, Norway, Spain, Sweden, Switzerland, UK and US.

Projects:

- ISO/IEC CD 30173 Digital Twin - Concepts and terminology
- ISO/IEC CD TR 30172 Digital Twin - Use cases
- PWI JTC1-SC41-5 Digital Twin - Reference Architecture
- PWI JTC1-SC41-6 Guidance for IoT and Digital Twin use cases
- PWI JTC1-SC41-7 Digital Twin Maturity Model
Definition of Digital Twin

digital twin
digital representation of a target entity with data connections that enable convergence between the physical and digital states at an appropriate rate of synchronization

Note 1 to entry: Digital twin have some or all of the capabilities of connection, integration, analysis, simulation, visualization, optimization, etc.

Note 2 to entry: Digital twin may provide an integrated view throughout the lifecycle of the target entity.
Workshop objective

- The objective of the workshop was to gather standard experts having an interest on digital twin related standards, in order to reach a common understanding on
  - Use cases
  - Concepts
  - Architecture
  - Integration.
Workshop Outcome

The expected outcome was set to

- Insight on digital twin use cases from different domains e.g., smart manufacturing, smart buildings, smart cities,
- Insight on common concepts for digital twins,
- Insight on common architecture descriptions for digital twins,
- Insight in the alignment of digital twin architecture related standards with other standards (e.g., IoT related standards), and
- Recommendations for standardization.
# Workshop Organization

**Program committee:**

<table>
<thead>
<tr>
<th>Program committee</th>
<th>Antonio Kung (Chair)</th>
</tr>
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<tbody>
<tr>
<td>Kjell Bengtsson, Jan De Meer, Masatake Sakuma, Detlef Tenhagen, Karim Tobich, Alex Samarim, Sha Wei</td>
<td></td>
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<tr>
<td>Workshop 1 (Digital twin use cases) chairs</td>
<td>Detlef Tenhagen, Sha Wei</td>
</tr>
<tr>
<td>Workshop 2 (Digital twin concepts) chairs</td>
<td>Sha Wei, Jan de Meer</td>
</tr>
<tr>
<td>Workshop 3 (Architecture of digital twins) chairs</td>
<td>Jan de Meer, Alexander Samarim</td>
</tr>
<tr>
<td>Workshop 4 (Digital twin systems integration) chairs</td>
<td>Alexander Samarim, Masakake Sakuma</td>
</tr>
<tr>
<td>Workshop Report editors</td>
<td>Antonio Kung, Karim Tobich</td>
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## Schedule

<table>
<thead>
<tr>
<th>Workshop</th>
<th>Date</th>
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<tbody>
<tr>
<td>Workshop 1 Digital twin use cases</td>
<td>16 September 2021, 13.00-16.00 UTC</td>
</tr>
<tr>
<td>Workshop 2 Digital twin concepts</td>
<td>21 September 2021, 07.00-10.00 UTC</td>
</tr>
<tr>
<td>Workshop 3 Architecture of digital twins</td>
<td>23 September 2021, 13.00-16.00 UTC</td>
</tr>
<tr>
<td>Workshop 4 Digital twin systems integration</td>
<td>28 September 2021, 07.00-10.00 UTC</td>
</tr>
</tbody>
</table>
Participants

• ISO/IEC JTC1/SC41
• Experts from ISO TC184
• Experts from ISO/IEC TC184 JWG21/TF8
• Experts from IEC TC65
• Liaison organizations (IIC, AIOTI, … )
• External alliances (Industrial Digital Twin Association, Digital twin consortium, ..)
The workshop did allow identifying:

- **Verticals**: manufacturing, energy, transportation, home, ocean, aerospace, building, robotics, etc.
- **Characteristics**: semantic, interoperability, integration, lifecycles, provenance of data, etc.
- **Problems solved by digital twins**: monitoring the status, energy saving, quality improvement, etc.
- **Challenges**: regulations, organizations, cyber securities, multi-twin interoperability, etc.
- **Actors**: People, Components, Systems, Integrated Systems, Applications and Organizations, etc.
- **KPIs**: conformity, synchronisation, verification, validation, robustness, fidelity, traceability, reconfigurability, dependability, etc.
- **Digital Infrastructures**: Computing, Sensors, Artificial Intelligence, Situation-/Context-Awareness, Localization and Tracking, Actuators, Controls, Energy Consumption, Time Synchronization, Management Functions / Risk management, Unique Identification, Database, Networking, IT Security, Data Privacy, Simulations, etc.
Highlight the need to gain from the use of DTw

- Energy/Material Savings
- higher Quality,
- economics of scale (Lot-Size 1 while large scale cost reduction),
- operation efficiency,
- better prediction,
- better planning,
- ability to simulate non-measurable values by model, scenario's, what-if,
- root-cause analysis,
- maintenance,
- advanced control,
- carbon footprint decreasing,
- disaster prevention,
- remote expertise,
- anomaly detection,
- safety intelligence,
- scalability,
- value in the ecosystem,
- willingness to cooperate.
Expectations Resulting from Use Cases

- The workshop did highlight the need to add control/actuation aspect on “Orchestration” between the real world and virtual World as a dual direction of the DTw in real-time as it is an important aspect to the ecosystem of DTws.
- A need to capture flexibility in DTw Use-Cases was raised with eventually an “actuation interface” or as Services.
- The workshop did raise the need to allow different “Views” of the same DTw. As an example, FaceBook of a person and a person are also different from each other. Public/Private views on DTw were raised by highlighting the need for that view to be considered, this could be seen as Services.
- The concept of coordination for digital twins was addressed, If more than one DTw works simultaneously a coordination is necessary on the top level!
- DTws’ services should also be discoverable to allow flexibility and interoperability.
- During the workshop different challenges were raised like identity and trust management.
- It was suggested to identify commonalities / common “values” out of all the collected DTws use cases in order to regroup the challenges and identify generic concepts.
WS2 - DIGITAL TWIN CONCEPTS

Global Concepts

Definition of Digital Twin was shared during the workshop.

Life cycle of Digital Twin was brought to the participant attention.

The notion of a semiotic triangle was introduced with its 3 components: Concept, Symbol, and Object. The relation between object and symbol to define DTw concepts was explained: the DTw is in the Symbol space, not the concept space. It was raised that an Object could be seen as a Thing and as an Asset. Experts raised the need to give special care to the idea that for one physical asset may have multiple concepts and multiple symbols.

DTw is a strategic orientation from a business transformation; this is why we should consider Modeling, Ontology, simulation and processes as key enablers.

When representing the physical entity there is a need for an engineering-based model, inspired from the NASA concept of a multi-physics model that represents the physical behavior of the physical entity, e.g. the thermodynamics, hydrodynamics, etc in the swimming pool example.
System representation and interface concepts

- entity-of-interests (EoI) and associated DTws were introduced.
- The interface (bidirectional) between the EoI and associated DTw was presented through the concept of Target Digital Integration Gateway (TDIG). It was also presented as an asset administration shell (AAS).
- Interaction between DTw and the real world can use multiple interfaces layers.
- Digital twins can be used to create the link between the cyber world and the physical world. In the case of cyber physical systems (CPS) the interface requires trustworthiness properties (to be characterized).
Discussion on approach to twins

Approach to twins:
- Twins have a decentralized ID
- Twins have semantic metadata about themselves
- Twins have dynamic data "feeds or streams"
- Metadata describes the dynamic data
- Twins "behavior" i.e. the compute part interacts with the static and dynamic data

Approach to ecosystems:
- Data owners have their own space in a network of spaces
- Interactions are brokered between twins in separate or same spaces
WS3 - ARCHITECTURE OF DIGITAL TWIN

A presentation was made on the concept of Reference Architecture (RA). A RA should define some capabilities to address common problems of a domain, however each system (compliant to the RA) may:

- implement only a subset of these capabilities (as core business);
- obtain some capabilities from business partners (remember “GE Predix”), and
- evolve at its own pace

Any RA can be viewed as a set of architecture views and architecture models, e.g., RAMI 4.0 is one of such models focusing on “service classification scheme”. In order to ensure integration, the same architecture description approach should be used, such as ISO/IEC/IEEE 42010 (architecture description).
The twin itself (level 0) VS the twinned system (level 1).

At level 0 characteristics can be defined such as
- purpose
- encoding
- interactions
- analytical capabilities
- self-description
- others

At level 1 methods to define the twinned system should be agreed based on
- capabilities prioritization logic,
- maturity matrix
- platform pattern
- integration examples
- repository of various patterns,
- reference processes.

It was suggested to consider a viable system model (VSM) of the twin.
DTw VS CPS

The workshop raised the question of DTw vs CPS. It was pointed out that there might not be a one-to-one mapping. As an example, an autonomous robot the CPS may have several DTws for

- itself
- object to be produced as a result of the task (e.g., “bring some logs”)
- surrounding environment for navigation
- objects to be used to fulfil the task
The relationship between the **virtual entity** & the **physical entity**

- Architecture pattern # 1: Twins acting concurrently
- Architecture pattern #2: Digital Twin to provide a feedback
- Architecture pattern #3: Digital Twin to provide feed forward directives
Interoperability-by-design

The workshop raised the concept of Interoperability-by-design which led to different questions about standardization of:

- Protocols
- Data schema
- Semantics
- Capabilities
- Processes
- Policies
- Methodology
- Solutions
- Governance
- Management
- Operations
Integration issues in smart buildings are worth mentioning as they many of them were valid for other domains:

- need for global and detailed view
- need for ontology
- supporting existing systems
- hardware for deployment of system software (e.g. BOS - building operating system) in the case of an IoT (edge/cloud) environment
- multiple driver management
- data characterization
- scalability of model
- end-to-end security
- end-to-end customer path
Thank You!

Smart society

Smart healthcare

Smart transport

Smart territory improvement

Smart payments

Smart buildings

Smart energy

ANNEXES
City Information Modelling and Urban Digital Twins

Dr Chunlan Guo          28 April 2022
IEC SyC Smart Cities
Content

• Definitions
• Case study: A city level CIM platform in Nanjing, China
• Case study: New South Wales spatial digital twin
• The overlaps and differences between CIM & UDT
• The challenges to the deployment of CIM & UDT
• Standards and other developments required for CIM & UDT
city information modelling

CIM
development of digital representations and simulations of a city made up of large quantities of geospatial data, often including real time data, which enable better city planning and management

Note 1 to entry: The geospatial data is provided using an integration of building information modelling (BIM) and geographic information systems (GIS).

Note 2 to entry: The real-time data is obtained through extensive use of IoT sensors within the city.

Note 3 to entry: City information modelling involves handling large amounts of big data, which is generally brought together using cloud computing.

Note 4: Artificial intelligence is often used to generate and evaluate different scenarios using city information modelling data to help manage the city better.

[Source: IEC SRD 63273 ED1 CD]

digital twin

DT
digital representation of a target entity with data connections that enable convergence between the physical and digital states at an appropriate rate of synchronization

Note 1 to entry: Digital twins have some or all of the capabilities of connection, integration, analysis, simulation, visualization, optimization, etc.

Note 2 to entry: Digital twin may provide an integrated view throughout the lifecycle of the target entity.

[Source: ISO/IEC CD 30173]

urban digital twin

UDT
digital twin at the urban scale deployed to enable the transformation of how cities are planned, built and managed in order to deliver better services to make the urban environment more livable, inclusive, safe, resilient and sustainable

Figure: Charlton et al., 2015; Reitz & Schubiger-Banz, 2014.
The architecture of the Nanjing CIM platform
Different data in the Nanjing CIM platform
Applying CIM in the whole life cycle of construction projects
Case study: A city level CIM platform in Nanjing, China (4)

Application of “flow” data (e.g. population, mobile phone signals)

Guo Chunlan, IEC SyC Smart Cities
The framework of urban digital twins in New South Wales, Australia

Urban decision-making: focus and tools

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<th>Urban decision-making</th>
<th>Spatial analysis tools</th>
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<td>Place-based design</td>
<td>Cluster</td>
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<td>Land use</td>
<td>Proximity</td>
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<td>Planning</td>
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<td>Liveability analysis</td>
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<td>Subterranean infrastructure</td>
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<td>Resilience planning</td>
<td>Buffer zone</td>
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<td>Health</td>
<td>Geometry analysis</td>
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</table>
The structure of New South Wales spatial digital twin
Case study: New South Wales spatial digital twin (3)

The platform interface: selected key features

Website of New South Wales spatial digital twin: https://nsw.digitaltwin.terria.io/
Technology stacks and systems of the New South Wales spatial digital twin platform
The overlaps and differences between CIM & UDT

Overlaps

• Aims: To enable better urban planning and city management (maintenance, monitoring and modelling the city and urban environment) by using data and smart technologies

• Functions: comprehensibly model city infrastructure digitally, trace the physical object in the city, monitor and simulate the object in virtual spaces, progress through physical to digital transformation activities, monitor the interaction between the digital and physical worlds

• Data: Integrate multiple data from different sources and involve different formats and different levels (micro, meso, and macro)

• Technology support: Both CIM and UDT are reliant on developing technologies, such as GIS, IoT, big data, could computing and AI.
The overlaps and differences between CIM & UDT

### Differences

**City Information Modelling**
- CIM has arisen from BIM as foundational data in the modelling and development of city data management
- BIM and GIS are two critical important foundations for CIM
- CIM can be seen to show a preference for the model, tooling and technologies
- CIM employed a built environment context at an early stage of its theoretical developments
- CIM starts from the perspective of the whole city and solutions affecting the city as a whole
- Proponents of CIM see the value of the model of the city they can generate, not only to plan but also to help with the ongoing management of the city

**Urban Digital Twins**
- The concept of digital twins originated in mechanical engineering and the Finite Element Method
- Digital twins emerged from manufacturing such as those conducted by NASA and Formula One racing cars
- UDT can be seen in their composition as discrete ecosystems that can be linked, this reflecting back to the origins of technology within the product and facility twinning
- UDT focus on the transformation of the physical into the virtual world, and the reactions and simulations that occur between the virtual and physical environment
- UDT can be seen emerging from this smaller product and component viewpoint to the larger contextual environment
- UDT brings the experience from industry of using digital models not only to predict, but also to monitor and manage performance
Challenges

- Both CIM and urban digital twins are still at an early stage, and they face common challenges and questions for their future development
  - Including data silos, the usability and usefulness of applications for stakeholders, integration/interoperability, openness, regulation, and the development of the necessary skills and education
- Models, data, and software are important components for both CIM and UDT and both need to meet the challenges of data collection, data management and security sharing
- We need standards that address the following issues:
  - How can the different disciplines be aligned, and technologies be linked in CIM and UDT?
  - What are the standards for convergence of different types of data in CIM and UDT?
  - How can the public be involved in the development and usability of CIM and UDT when used for consultation and to support citizens in managing their lives in the city?
  - How can CIM and UDT support the communication between humans and virtual environments?
• An integrated reference architecture of CIM and UDT needs to be developed.
• Enabling the connection of different types of city data needed by CIM and/or UDT should be one of the focuses for standards work.
• A full set of use cases of CIM and UDT for different application areas/scenarios is needed to identify the requirement of standards for CIM and UDT.
• Standards for CIM and UDT platforms are needed.
• Collaborative standards work among the different SDOs is vital to develop effective standards for CIM and UDT.
• The above challenges/work required the researchers, front-line practitioners, standards workers, policy makers and other stakeholders to work together for a breakthrough.
Standards and other developments required for CIM and UDT

City information modelling and urban digital twins


Guo Chunlan, IEC SyC Smart Cities
Acknowledgement

- Michael Mulquin, IEC SyC Smart Cities
- François Coallier, École de technologie supérieure, Montréal, Canada and ISO/IEC JTC 1/SC 41
- Furong Wang, Nanjing Land & Resources Information Center, China
- Prudence Lawrence, Spatial Services, NSW Government, Australia
- Dan Rossiter, British Standards Institution, UK
- Gavin Cotterill, Professional Construction Strategies Group, Australia
- Honghui Zhang, Guangdong Guodi Planning Science Technology Ltd., China
- John Turner, Gafcon Inc, San Diego, US
- Jorge Gil, Chalmers University of Technology, Sweden
- Josh Lieberman, Open Geospatial Consortium
- Jun Zhu, AsiaInfo Technologies Ltd., China
- Richard Ferris, Independent Consultant, Australia
- Sha Wei, ISO/IEC JTC 1/SC 41
- Vi Le, BridgePoint Advisory, Australia
- Wayne Patterson, Spatial Services, NSW Government, Australia
- Yiling Jian, Guangdong Guodi Planning Science Technology Ltd., China
- Biao Liu, IEC SyC Smart Cities
Thank you

• Contact:
  • Dr. Chunlan Guo, chunlanguo@outlook.com
Maritime IoT and Digital Twin

April 28th, 2022
WG 7 Convenor: Soo-Hyun Park
Outline

- Maritime IoT
- Digital Twin Applications of the Ocean
- SC 41/WG 7 Standard Roadmap
- Conclusion
Contributors

- Howard Choe (United States of America)
- Arto Toppinen (Finland)
- Mohan Krishna Varma N (India)
- Axbjorn Hovstø (Norway)

This material is based on the presentations of the WG7 workshop held on Feb 9th, 2022.
IoT in the Ocean Environment

- The IoT is a system concept that uses many technologies that are standardized by other JTC 1 entities and standards development organizations (SDOs) ranging from networking and Digital Twin to cloud computing and AI.

- Maritime and Underwater IoT can use many technologies from networking to applications, and a variety of SDOs might standardize it.

Source: https://www.aberdeen.com/featured/darpa-ocean-things/
Maritime Definition

- Maritime is connected with the sea, especially in relation to seafaring commercial or military activity (From Oxford Languages).

- Maritime is most everything connected to the sea or waterways throughout the world, especially in relation to navigation, shipping, and marine engineering.

Source by Howard Choe's presentation material (Refer to SC41WG7N033)
Maritime Industry

- Deep-sea merchant fleet, tugs and barges, port and terminal operations, pilotage, freight forwarding, chartering, intermodal services, admiralty law, passenger and excursion services, lakes and inland waterways shipping, shipbuilding and repair, naval architecture and marine engineering, seaman training, government programs and shipping, vessel classification, marine insurance, communications, recreational boating, and much more.

- The impact of Naval Architecture, Marine and Ocean Engineering is far-reaching and greatly enhances our quality of life. For example:
  - 74% of the world’s trade is carried by ship.
  - 95% of the U.S. international trade is transported by ship.
  - 55% of the U.S. population lives within 50 miles of a coastline.
  - 60% of the U.S. energy is imported by ship.

Source by Howard Choe's presentation material (Refer to SC41WG7N033)
## Maritime IoT Applications & Possible Use Cases

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<tbody>
<tr>
<td>1. Marine equipment monitoring</td>
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<td>2. Marine equipment remote maintenance</td>
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<td>3. Hull load control system</td>
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<tr>
<td>4. Advanced weather routing</td>
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<tr>
<td>5. Cargo handling equipment monitoring and automation</td>
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<tr>
<td>6. Streamlining port operation</td>
</tr>
<tr>
<td>7. IoT utilization for ship design</td>
</tr>
</tbody>
</table>

### Maritime IoT Use Cases

1. Efficient and predictive maintenance for engine and other equipment
2. Realize remote maintenance from onshore
3. Not yet in practice, but using control system, decrease the fatigue load
4. Improve the accuracy of fuel consumption and weather condition
5. Better maintenance and operation of cargo handling equipment and remote operations
6. Improve the efficiency of port operation by logistics planning of all cargos and accuracy of port management
7. Information exchange for designing ship can be more efficient

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Source by Howard Choe’s presentation material (Refer to SC41WG7N033)
Example of Environmental Monitoring Use Case

- From the perspective of European countries
- Use case supports maritime environmental monitoring of lakes and seas. Lake condition is controlled very carefully in European Union areas. Real-time control systems are needed.
- Aim is to use a modern IoT wireless network of private NarrowBand IoT (NB-IoT) to send data to the cloud for analysis. The measurement uses ordinary sensors like temperature, salt content, poisons, oxygen content, color, cleanness, etc.

Source by Arto Toppinen’s presentation material (Refer to SC41WG7N033)
Reference Architecture Development Methodology

1. Maritime IoT

Operational Concept Level

- Use Cases
  - Standards roadmap
  - Various domain cases
  - Other use case sources

Requirement Level

- Requirements
  - System requirements
  - Functional requirements
  - Performance requirements

Architecture Level

- Reference Architecture

Design Level

- System 1 Design
- System 2 Design
- System N Design

Source by Howard Choe’s presentation material (Refer to SC41WG7N033)
1. Maritime IoT

- Target Life Cycle Phases to Collect Maritime IoT Use Cases
  - ISO/IEC CD 30172 Digital Twin — Use cases
    1. Inception phase
    2. Design and development phase
    3. Verification and validation phase
    4. Deployment phase
    5. Operation and monitoring phase
    6. Re-evaluate phase
    7. Retirement phase

Source by Mohan Krishna Varma N's presentation material (Refer to SC41WG7N033)
1. Maritime IoT

- Stakeholder Value Network (SVN) of Maritime Industry


Source by Howard Choe's presentation material (Refer to SC41WG7N033)
System Architecture of Maritime Industry Modeled by Object Process Methodology (OPM)

OPM is a conceptual modeling language and methodology for capturing knowledge and designing systems.


Source by Howard Choe's presentation material (Refer to SC41WG7N033)
Digital Twin for the Maritime Sector

- A digital twin is replicated as a unique physical object and processed by an appropriate use case. Data from various digital twins can be aggregated in real-world entities such as a port, ship, buoy, bridge, aquafarm, autonomous underwater vehicle.
- Mirroring real-world entities with digital twins is performed through synchronization.
2. Digital Twin Applications of the Ocean

Maritime Transportation Digital Twin

Maritime transportation IoT

Maritime transportation Digital Twin model of relay cooperation IoT

Benefits of the Marine Digital Twin Applications

- Optimizing fleet with the virtual transition of ship control system
- Enhancing the port and terminal operations
- Awareness of situation with regards to operational parameters
- End-to-end supply chain optimization
- Amplified security ensuring safety
2. Digital Twin Applications of the Ocean

From WG 6 Workshop on Digital Twin Use Cases

(September 16th 2021)

Source by Axbjorn Hovstø’s presentation material (Refer to SC41WG7N033)
2. Digital Twin Applications of the Ocean

https://dl.acm.org/doi/abs/10.1145/3491315.3491366
### 3. SC 41/WG 7 Standard Roadmap

#### Maritime IoT RA
- **SC 41**
  - **2021**: IoT RA 2nd Edition
  - **2022**: Maritime IoT RA 1st Edition

#### Maritime IoT Use cases
- **SC 41**
  - **2021**: Maritime IoT Use cases
  - **2022**: Maritime and Underwater IoT Use cases

#### Maritime Terms and Definitions
- **SC 41**
  - **2021**: Maritime Terms and Definitions

#### Underwater Digital Twin Use cases
- **SC 41**
  - **2021**: Digital Twin Use cases
  - **2022**: Underwater Digital Twin Use cases

#### Maritime Digital Twin Use cases
- **SC 41**
  - **2021**: Digital Twin Use cases
  - **2022**: Maritime Digital Twin Use cases

#### Maritime and Underwater Digital Twin Use cases
- **SC 41**
  - **2021**: Digital Twin RA
  - **2022**: Maritime and Underwater Digital Twin Use cases
### 3. SC 41/WG 7 Standard Roadmap

#### UWASN RA
- ISO/IEC TR 30167-2021, Internet of Things (IoT) – Underwater communication technologies for IoT
- Multi-media Multi-band based Underwater Communication Reference Architecture

#### UWASN Interoperability
- [ACD] ISO/IEC 30177, Internet of Things (IoT) – Underwater network management system (U-NMS) interworking
- [NP] Internet of Things (IoT) – Addressing interoperability guidelines between heterogeneous underwater sensor networks (UWASN) based on underwater delay and disruption tolerant network (U-DTN)
- [NP] Internet of Things (IoT) – Addressing interoperability between IPv6-based network and UWASN
- Underwater Communication Frequency Report (TR)
- How can underwater communication systems be designed to effectively characterize and mitigate the risk of disturbing marine life? (TR)

#### UWASN Application Service
- ISO/IEC 30142:2020, Internet of Things (IoT) – Underwater acoustic sensor network (UWASN) – Network management system overview and requirements
- ISO/IEC 30143:2020, Internet of Things (IoT) – Underwater acoustic sensor network (UWASN) – Application profiles
- ISO/IEC 30171:1-2022, Internet of Things (IoT) – Base-station based underwater wireless acoustic network (B-UWAN) – Part 1: Overview and requirements
- [NP] Internet of Things (IoT) – Underwater acoustic sensor network (UWASN) – Network management system – Part 3: Underwater network element management system (U-NEMS)
- B-UWAN Architecture, Functions and Procedure
- Underwater network management system (U-NMS) Protocol

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**Underwater IoT/IoS**
- Underwater IoT RA
- Underwater IoT Use cases

**Maritime IoT**
- Maritime IoT RA
- Maritime IoT Use cases

**Maritime & Underwater IoT**
- Maritime & Underwater IoT RA
- Maritime & Underwater IoT Use cases

**Underwater Digital Twin Application**
- Underwater IoT Digital Twin RA
- Underwater IoT Digital Twin Use cases

**Maritime & Underwater Digital Twin Application**
- Maritime IoT Digital Twin RA
- Maritime IoT Digital Twin Use cases

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**Maritime IoT & Digital Twin**
ISO/IEC JTC 1/SC 41/WG 7 Activities

- Standardization for industrial and global market competitiveness is actively underway in line with the development of maritime IoT technologies.
- ISO/IEC JTC 1/SC 41/WG 7 has successfully led the development of international standards for the Internet of Things and digital twin applications.

Future Business Plan

- It is expected to improve the competitiveness of the marine industry as various international institutions actively participate in international standardization activities for maritime, underwater IoT and digital twin applications.
  - Maritime IoT applications are in the beginning, especially in supply chain and logistics, spurred by COVID-19. However, maritime industries are vast. Thus, key maritime subdomains should be selected for the WG 7 to work on.
Thank You
Digital Twins in the Energy Sector

Laurent Guise
IEC System Committee Smart Energy
Joint IEC SyC SE/ISO-IEC JTC1 SC41 JWG3
laurent.guise@energysemantic.com

JTC 1/SC41 Webinar on IoT and Digital Twin standardization
2022-04-26 & 28
Digital Twin in the Energy Sector

The role of standardization

The Energy sector has already deployed for decades quite advance approaches of its digitalization by the mean of modelling and digital communication:

- Covering most of the energy market sub-domains including transmission & distribution grid operators, generation (bulk or distributed),
- Covering (mostly) the whole life cycle – from planning to maintenance
- Covering two main macro-levels:
  - Field level
  - Remote operation level

The role of standardization consists in offering standardized communication means and semantics (including behavior) to enable twins interoperation:

- supports twins standardized interfaces, but doesn't address twins content
IoT and digital twins global framework
The Smart Grid Architecture model (SGAM)

This framework helps multiple stakeholders from different domains to depict similar "things" in a consistent way. It may apply to functional architectures, actors and use cases, physical systems, semantic domains models and ontologies, communication networks, standards …

Let's apply it to our case! Source [3]
**Example**: digital twins are already very much present in smart energy operation systems.

The SCADA hosts twins to reflect the main properties of the product/function (static - ratings, settings - and real-time), with possible advanced models to verify proper functioning.

The station interface or controller hosts twins to reflecting the main static (ratings, settings) and real-time properties of the product and associated functions.

Field device hosts twins to monitoring whether the device is running well and possibly the digital nameplate. (If a switch is too slow to open, an alert is raised)

A twin may exist in the equipment itself by hosting its digital nameplate.

Geographical info system or Asset management system store most of the static information of the product (nameplate, ratings, settings, ...) also potentially fed by condition monitoring info.

**Source [1]**
Digital twins are de facto present along the whole life cycle

- Product/function generic characteristics model (thermal, electrical, mechanical). Possibly product simulation models
- Product models and associated simulation – if any (thermal, electrical, mechanical)
- Multiple rendition digital model of product characteristics (paper, web, apps, ...) 
- Product/function requirement model, to be used at all downstream phases as a reference
- Twins comparison activity, between the manufacturer's and user’s perspectives
- Product transportation traceability model, including the change of ownership
- Digital twins in all layers and all applications of the user’s operation and maintenance systems to cover all usage facets

Note: the SGAM is missing one dimension, the life cycle

Source [1]
Digital twins benefits versus life cycle

Benefits for main stakeholders by main life phases
- Benefit(s) for users
- Benefit(s) for manufacturers

Concept
Development
Production
Use
Retirement

Source [2]
Multiple twins for a given asset ... and multiple semantic domains

Let's adapt the SGAM framework for the purpose of this exercise, and focus only on information models.

Z-axis will reflect the asset life cycle

Red bullet reflects digital twins entry

Source [1]
The standardized semantic domains used to express twins interfaces in distribution Utilities market

Mapped onto the framework

IEC CIM based data model
IEC 61850 based data model
 supplier's site
product semantic model
manufacturer's semantic model (s)
The standardized semantic domains used to express twins interfaces in Smart Grids market

Standardized semantic domains

International adoption!

Mapped onto the framework

Source [4]

JTC 1/SC 41 Webinar on IoT and Digital Twin - 2022-04-26 & 28
The standardized semantic domains used to express twins interfaces for High Voltage equipment

<table>
<thead>
<tr>
<th>Segments vs life steps</th>
<th>Utilities</th>
<th>Oil &amp; gas</th>
<th>Buildings</th>
<th>Other ?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposal</td>
<td>IEC 61850</td>
<td>ISO 15926</td>
<td>ISO 15926</td>
<td>IEC 62474 (Substance declaration)</td>
</tr>
<tr>
<td>Operate and maintain</td>
<td>IEC 61850</td>
<td>ISO 15926</td>
<td>ISO 15926</td>
<td>IEC 61360-2 (CDD) &amp; ISO 13584-42 (ecl@ss)</td>
</tr>
<tr>
<td>Commissioning</td>
<td>ISO 15926</td>
<td>ISO 15926</td>
<td>ISO 15926</td>
<td>IEC 61850</td>
</tr>
<tr>
<td>Procurement</td>
<td>ISO 15926</td>
<td>ISO 15926</td>
<td>ISO 15926</td>
<td>ISO 15926</td>
</tr>
<tr>
<td>System design</td>
<td>ISO 15926</td>
<td>ISO 15926</td>
<td>ISO 15926</td>
<td>ISO 15926</td>
</tr>
</tbody>
</table>

Mapped onto the framework

Source [2]

JTC 1/SC 41 Webinar on IoT and Digital Twin - 2022-04-26 & 28
An innovative approach for composing twins!!

IEC 61850
Conclusion and challenges

Digital twins semantic interoperability is a must, and this shall be observed through the prisms of

- The life cycle where many data for a same given asset are shared between many steps
- The system zones (which determine the perspective to be considered for a given asset)
- The market context of usages (which determines the ecosystem in which the twins will run)

Digital twins are very much deployed and used in the Smart Energy domain, and strong foundations already support a good level of semantic interoperability, across many steps of the product/system life cycle. Innovative approaches are already addressing a specific system aspect: the composition of twins

However:

- most of the market drivers have been to address the (electrical) functional aspects of products and systems and less the physical ones (geometry, thermal, …)
- procurement is a crucial phase which is still (mostly) missing
- trustworthiness of digital twins is not addressed yet while essential. Cybersecurity with IEC 62443 and IEC 62351 offers first steps to secure the processes and data exchanges.

Supporting digital twins spreading is among the top 10 priorities of the IEC System Committee Smart Energy (the interest of having a joint JWG3 with SC41).

Future is critical, especially in the ability of international standardization bodies to manage efficiently semantic interoperability, with typically the needed level of governance. IEC SG12 (strategic group to support the digital transformation) is trying to address this issue.
Thank You!

[1] CIRED 2021 - How to overcome difficulties met in deploying digital twins of electrical assets over their whole life cycle? A data management perspective. Laurent Guise, Luc Hossenlopp, Thierry Cormenier, Anne-Françoise Cutting-Decelle, Giovanna Di Marzo Serugendo, Imran Khan


[3] IEC SRD 63200 Smart Grids architecture model

IoT Applications and Domain Standards

JTC 1/SC41 Webinar on IoT and Digital Twin standardization
2022-04-26 & 28

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Dr. Mingjuan Wu (wumingjuan@wsn.cn)
Dr. Kate Grant (kate@ninetiles.com)
Dr. Howard Choe (h_choe@yahoo.com)
Outline

1. JTC 1/SC 41/WG 5 (IoT Applications) Activity Overview

2. IoT Applications for Pandemic (with WG 5 current project)
   - Detection, Diagnosis, Contact tracking and Quarantine tracking etc.

3. IoT Applications for Environments/Climate Changes (with WG 5 current project)
   - Environment monitoring and protection etc.

4. IoT Applications for Foods (as a prospective IoT Applications area)
   - Aquaculture, Agriculture and Livestock farming etc.

5. IoT Use cases
Mission
Standardization in the area of IoT applications, Uses Cases, tools, and implementation guidance

P-Members (voting)
Australia, Austria, Belgium, Canada, China, Denmark, Finland, France, Germany, India, Ireland, Italy, Japan, Korea, Luxembourg, Malaysia, Mexico, Netherlands, Norway, Russia, Singapore, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States of America (Total: 26)

Number of Participants : 281
Wide Range of IoT Applications
Diverse and complex SDO
Approach in WG 5 - I

Cooperation & Collaboration with Domain specific SDOs

- Liaisons
  - ISO TCs/SCs, IEC TCs/SCs, JTC 1/SCs and others

- **Incubator** for (Joint) WGs
  - JWG 17 with IEC TC 65: System interface between industrial facilities and the smart grid
  - JWG 24 with IEC TC 57: IIoT and digital twin applications in power systems management
  - JWG 3 with IEC SyC SE: IEC Smart Energy Roadmap
  - SC 41/WG 7: Maritime, underwater IoT and Digital Twin applications
    (possibly to be a JWG with ISO/TC 8, IEC/TC 18, IEC/TC 80)
Approach in WG 5 - II

Cooperation & Collaboration with Domain specific SDOs

● Needs strong cooperation with SC 41/AGs:
  - AG 20: Industrial IoT
  - AG 21: Smart City and Utilities IoT
  - AG 25: Use cases
  - AG 28: LG with AI

● Every IoT Application project is recommended to describe its IoT use cases
Published standards

- **ISO/IEC TR 30166:2020** Edition 1.0 (2020-04-29) Internet of Things (IoT) - Industrial IoT
- **ISO/IEC 30162:2022** Edition 1.0 (2022-02-07) Internet of Things (IoT) - Compatibility requirements and model for devices within Industrial IoT systems
- **ISO/IEC 30163:2021** Edition 1.0 (2021-03-11) Internet of Things (IoT) - System requirements of IoT and sensor network technology-based integrated platform for chattel asset monitoring
- **ISO/IEC TR 30174:2021** Edition 1.0 (2021-11-04) Internet of Things (IoT) - Socialized IoT system resembling human social interaction dynamics
Published standards

- **ISO/IEC 30144:2020** Edition 1.0 (2020-10-29) Internet of things (IoT) - Wireless sensor network system supporting **electrical power substation**
- **ISO/IEC TR 30148:2019** Edition 1.0 (2019-10-22) Internet of things (IoT) - Application of sensor network for **wireless gas meter**
- **ISO/IEC TR 30176:2021** Edition 1.0 (2021-11-04) Internet of Things (IoT) - Integration of IoT and DLT/blockchain: Use cases
- **ISO/IEC TR 22417:2017** Edition 1.0 (2017-11-22) Internet of things (IoT) - IoT use cases (JTC 1/WG 10)

- 7 Underwater-Related Standards ....
Works in progress

- ISO/IEC FDIS 30169 : Internet of Things (IoT) – IoT Applications for Electronic Label System
- ISO/IEC CDV 30179 : Internet of Things (IoT) - Overview and general requirements of IoT system for ecological environment monitoring
- ISO/IEC WD 30180 : Internet of Things (IoT) – Functional requirements to figure out the status of self-quarantine
## Roles of IoT

<table>
<thead>
<tr>
<th>Role</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection and Diagnosis</td>
<td>Timely detection of the infection and diagnosis</td>
</tr>
<tr>
<td>Controlling the spread</td>
<td>Deterrence of and controlling the spreading of infection</td>
</tr>
<tr>
<td>Contact tracing</td>
<td>Contact tracing of infected persons</td>
</tr>
<tr>
<td>Assisting healthcare workers</td>
<td>Assisting healthcare workers</td>
</tr>
<tr>
<td>Supply chain</td>
<td>Supply of medicines and medical equipment and food items</td>
</tr>
<tr>
<td>Remote monitoring</td>
<td>Remote monitoring of patients</td>
</tr>
<tr>
<td>Quarantine tracking</td>
<td>Tracking the quarantined patients (ISO/IEC WD 30180)</td>
</tr>
</tbody>
</table>

Source: doi:10.1088/1757-899X/1055/1/012083
Detection and diagnosis

Timely detection of the infection and instant diagnosis

- Goal: Early detection reduces the possibility of the spread of infectious diseases by blocking the confirmed person’s contact with other people.


Source: https://ko.aliexpress.com/item/1005001764349145.html


Controlling the spread

Deterrence of and controlling the spreading of infection
• Goal: Blocking opportunities for the virus to spread.

Source: https://dvdprime.com/g2/bbs/board.php?bo_tab=comm&wr_id=21272606


Source: https://www.yna.co.kr/view/AKR20210705105000004

Contact tracing

Contact tracing of infected persons

• Goal: Identifying people (contacts) who may have been infected through exposure to a confirmed case, aiming to instruct them for their self-quarantine.

Korean case: Epidemic investigation support system (EISS)

Source: ISO/IEC 5153-3 (Proposal stage: City service platform for public health emergencies — Part 1: Contact tracing)
Assisting healthcare workers

• Goal: Assisting the diagnosis and treatment through monitoring the disease status and providing proper medical care without spreading the viral infection to others

Point-of-care (POC) testing equipment

Source: https://www.pdt.com/2016-pc

Non-invasive or minimally invasive devices

Source: https://www.pdt.com/2016-pc

Internet of medical things use-case,
Source: https://www.scnsoft.com/services/iot/medical

JTC 1/SC 41 Webinar on IoT and Digital Twin - 2022-04-26 & 28
Supply chain

Supply of medicines and medical equipment and food items
- Goal: Managing public health resources to prevent the shortage of their supply

Source: ISO/IEC PWI 10311-2, i.e., 5153-2 (PWI stage: City service platform for public health emergencies — Part 2: Response resource management)

Source: https://www.scnsoft.com/blog/iot-for-inventory-management

Source: https://ejournal.lu.cp.net/index.php/ijrtbt/article/view/749/662
Remote monitoring of patients

- Goal: Monitoring the disease status to improve clinical decision making and to help patients improve self-management

Source: https://thejournalofmhealth.com/the-rise-of-remote-patient-monitoring/

Source: https://www.accessiblehomehealthcare.com/blog/reducing-costs-with-remote-patient-monitoring

Source: https://kpproud-midatlantic.kaiserpermanente.org/future-medicine-remote-patient-monitoring/

Source: https://www.sk-telemed.co.at/idis2go-rpm/
Quarantine tracking

Tracking the quarantined patients

• Goal: Checking the quarantine status to prevent disease spread by non-cooperative quarantine persons


ISO/IEC WD 30180, Internet of things (IoT) – Functional requirements to determine the status of self-quarantine through Internet of things data interfaces
Quarantine tracking

Tracking the quarantined patients
  • Goal: Checking the quarantine status to prevent disease spread by non-cooperative quarantine persons

ISO/IEC WD 30180, Internet of things (IoT) – Functional requirements to determine the status of self-quarantine through Internet of things data interfaces

● Liaison groups
  • JTC 1/WG 11 Smart cities
  • ISO/TC 268 Sustainable cities and communities
  • ISO/TC 215 Health informatics
  • ISO/TC 304 Healthcare organization management
  • IEC SyC Smart cities
IoT Application for Environments

JTC 1/SC41 Webinar on
IoT and Digital Twin standardization
2022-04-26 & 28

Dr. Mingjuan Wu
wumingjuan@wsn.cn
Environmental issues

The environmental issues are highly related with our human beings and the nature.
Regional scale eco-environment observation networks

- **GEMS (Global Environment Monitoring System)**
  - Monitors the global inland freshwater quality, measures the parameters including physics and chemistry, nutrition, major ions, metal ions, organic matter, organic pollutants, microorganisms, etc.

- **GTOS (Global Terrestrial Observing System)**
  - Monitors, simulates, and analyzes the terrestrial ecosystem.

- **ILTER (International Long Term Ecological Research)**
  - Includes some national monitoring stations, and they are: US-LTER, ECN (Britain), CERN (China), etc.

- **GEO.BON (Group on Earth Observations-Biodiversity Observation Network)**
  - Is an observation network of plant and animal Groups.
Technologies and advantages of IoT system for eco-environment

Using the IoT systems for ecological environment monitoring brings the following advantages:

- Ensuring the real-time and dynamic observation and measurements, supporting the complexity and variability of the objects under monitoring compared with the measurements made manually and/or by legacy systems;
- Transforming from single-point monitoring station to a multi-point network application through networking and sharing of data/information;
- Taking pro-active action toward ecological events in advance rather than reacting after the events took place;
- Observing the entire ecosystem rather than geographically divided areas or regions (i.e. a single point observation) in both macro and micro perspectives; and
- Analyzing the ecological entities' relationship to ensure the sustainable development.

Key Technologies of IoT

- Intelligent data processing
- Reliable data transmission and reception
- Comprehensive and accurate sensing
Use case: IoT system for eco-environment in the industrial park

- Monitoring devices and networks
- Eco-environment monitoring platform
- Eco-environment services
- Industry park

- Air
- Noise
- Water
- Soil
Use case: Eco-environment monitoring system for water quality

Example basin with climate, surface water and ground water monitoring networks by multi-agencies.
Use case: IoT system for eco-environment in the forest

A typical eco-environment monitoring system, consisting of sensor nodes, gateways, base stations, and service platform, is deployed to manage and maintain the forest environment and enhance travelism experience.
Standard project

- ISO/IEC CDV 30179 specifies the system overview and general requirements of IoT system for EEM.
  - The system overview of the IoT-based ecological environment monitoring (EEM) is described according to the Domain-based IoT Reference Model which is defined in ISO/IEC 30141.
  - The general requirements include functional requirements, security requirements, and performance requirements of the IoT system for EEM.
  - The project will bring benefits of full obtaining and utilization of observation data from eco-environment, and improving the interoperability of monitoring subsystem for unified environment management.
- Cooperation and collaboration: ISO TC 268 (sustainable cites and communities) and JTC 1/SC 35 (User interface).
- Possible future works: focusing on the enviroment monitoring subsystem on specific domains.
IoT Use cases

- IEC is now developing a use case methodology in IEC SMB SG 12 (Strategic Group 12, Digital Transformation and Systems Approach)
- More and more standardization technical entities are using Use Cases to identify standardization requirements
- IEC are encouraging the use of a standard use case template through their work on the Smart Standards Concept
- IoT Use Cases describe specific use cases and implementations to improve the general understanding of the application and context of use of IoT
- A first TR was developed in JTC 1 WG10 (the predecessor to JTC 1 SC41) and this group collected use cases from experts and encouraged the use of a common template
- JTC 1 SC41 WG5 is now developing a number of IoT application standards
IoT Use cases

- IEC SyC-AAL (Systems Committee for Active Assisted Living) developed a template based on that used in Smart Energy. However it was clear that AAL applications and use cases differed from those in Smart Energy because they involved stakeholders including end users, home networks, telehealth providers and carers and needed additional consideration of requirements for horizontal aspects such as data security, data privacy and ethical considerations.

- IEC SyC-AAL are progressing an amendment to TS 63134 which provides an amended use case template and covers Use Case Categories:
  - (Self-)management of daily life activities at home
  - Health & wellness
  - Mobility
  - Social interaction
  - Prevention and management of chronic long-term conditions
IoT Use Case Methodology

- General study of IoT applications
- Identify sub-systems
- Identify basic stakeholder needs
- Fill out template

User Stories

- From user stories break down stakeholder needs based on analysis of sub-systems and application areas
- Develop detailed use cases using the IEC Smart use case template

Use Case analysis

- Analyse use cases to identify sets of common requirements, actors and interactions etc.
- Use the common features to scope out a family of IoT application standards

Application Systems study

User Stories

- Analyse use cases to identify sets of common requirements, actors and interactions etc.
- Use the common features to scope out a family of IoT application standards
IoT Use cases

- WG2 of IEC SyC Smart Cities are identifying the key aspects of a Smart City, collecting and analysing use cases, electrotechnical aspect of smart cities simulation, road test standards in real cities. These all involve IoT applications. They have a number of SRDs where Part 1 is the high level analysis and Part 2 is the use case analysis; eg
  - **IEC SRD 63301-1 ED1** and **IEC SRD 63301-2 ED1** Water systems in Smart Cities

![Water Cycle Diagram](image-url)
Stakeholders in the application scenario can be identified and the high level use case can be broken down into specialised use cases such as water quality monitoring, data acquisition, processing and application.
Prospective New Application Areas for SC 41 / WG 5

Smart Fish Farming and Recommended Areas

JTC 1/SC41 Webinar on IoT and Digital Twin Standardization
2022-04-26 & 28

Dr. Howard CHOE
h_choe@yahoo.com
IoT & DT Application Areas (Vertical Examples)
Global Fish Farming Market

• Global Fish Farming Market Size
  ▶ 2019 – $285.36 Billion
  ▶ 2027 – Expected to reach $378 Billion
  ▶ CAGR = 5.8% (2021 to 2027)

• Asia-Pacific held a leading position in the global market in 2019
  ▶ Expected to maintain its dominance in the future.

• Fish Farming Market Segments (environment types)
  ▶ Marine Water
  ▶ Fresh Water
  ▶ Brackish Water

• Fresh water segment has been the fastest growing industry.
Aquaculture: Smart Fish Farming

• Aquaculture
  ▶ Breeding, rearing, and harvesting of animal and plants in both fresh and saltwater environments [1].

• The Needs:
  ▶ The fish farming industry needs instruments that can monitor in real-time fish health and welfare objectively, without harming the fish or interfering with the daily management [2].

• IoT Technologies in Aquaculture of Fish Farming [2] → Smart Fish Farming
  ▶ Revolutionize fish farming process using sensor networks to measure the status such as:
    ▪ pH, temperature, oxygen level, salinity, pressure, contaminants, and other parameters.
    ▶ Develop sustainable and resilient aquaculture systems.
    ▶ Maintain healthy aquatic ecosystems.
    ▶ Strengthen capacity for adaptation to surrounding climate change, especially outdoor farming.

• Automated Fish Farm Management
  ▶ Monitor and control fish farm’s status in real-time, 24/7, easily and remotely;
  ▶ Save time and operational costs; and
  ▶ Ensure profitability.
Aquaculture Legislation and Regulation

• Aquaculture, especially fish farming, is rapidly growing, which causes regulatory challenges, resulting in:
  ▷ Increased risk of the industry becoming unregulated;
  ▷ Falling short of stakeholder expectations due to lack of aquaculture legislation and regulations; and
  ▷ Negative impacts on the environment and societies do occur.

• Well-designed legislation and proper regulation:
  ▷ Comes with investment costs;
  ▷ Benefits aquaculture industries; and
  ▷ Creates a level playing field between business actors.

Proper and beneficial regulations must be based on well-established and industry-accepted standards.

Ref. [4]
Status of Standardization in Fish Farming

• ISO/TC 234 – Fisheries and aquaculture [5]
  ▶ Ten (10) published standards and one (1) under development:
    ▪ Traceability of finfish, crustacean, molluscan products;
    ▪ Environmental monitoring of the impacts from marine finfish farms; and
    ▪ Marine finfish farm; Carbon footprint, etc.
  ▶ Already liaised with ISO/IEC JTC 1 / SC 41

• Aquaculture Stewardship Council [6]
  ▶ Certifies aquaculture products.
  ▶ Develops and manages standards – The requirements covering the potential impact of aquaculture including:
    ▪ Water quality, feed, disease prevention, animal welfare, fair treatment and pay of workers, etc.
  ▶ Has its regional presence in:
    ▪ Australia, Belgium, Brazil, China, France, Germany, Austria, Switzerland, Japan, Netherlands, north America, Spain, and Sweden; and international chapter covering other regions.

No Smart Fish Farming International or Regional Standard Seems to Exist.
Smart Fish Farming
High-Level System Architecture

Data/Information Flow & Network Connectivity

Physical Entity Domain
- Fish Farm
- Fish Farm Environmental Weather Sensors
- Fish Farm Maintenance Sensors

Sensing & Controlling Domain
- In-Aqua Sensors
- Actuators
- End-point Devices

Operations & Management Domain
- Technology Insertion
  - Advanced Analytics
  - Digital Twin
  - Edge Computing
  - Cloud Storage
  - Blockchain
  - Automation, etc.

Applications & Service Domain
- Consumers & End-Customers
- Logistics & Supply Chain

Resource Access & Interchange Domain
- Contract Sales
- On-line Fish Sales Platform

User Domain
- User Equipment
- User Interface

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Smart Fish Farming
Potential Standardization Areas

- General requirements and specifications.
- Reference architecture.
- Fish farm monitoring – fish health, water condition, maintenance, environment, etc.
- Fish farm automation – Intelligent feeding, biomass determination, etc.
- Fish farm sensing requirements and technologies.
- Fish farm surrounding development.
- Different types of applications and services with data analytics.
- Logistics and supply chain associated with fish farming.
- Fish farming business model.
Smart Fish Farming
Standard Development in JTC 1 / SC 41 / WG 5

• Dr. Jie SHEN of CeleFish, LLC. (QingYuTang) in collaboration with Dr. Howard CHOE plans to submit a New Work Item Proposal (NWIP) on Smart Fish Farming.
  ▶ The NWIP topic area(s) will be selected from the “Potential Standardization Areas” in Chart #8.
  ▶ The fish farming-related standards are expected to be multi-part international standards.
  ▶ Informative presentation is planned in SC 41 / WG 5 Meeting during May 30 - June 10, 2022 (with NWIP in NWIP in September 2022 with project starting in December 2022).
Standardization in SC 41 / WG 5

Recommended Application Areas

• SC 41 / WG 5 seeks International Standard (IS) NWIPs in food production areas with IoT technologies:
  ▶ Agriculture: Arable farming (crops – grains, fruits, vegetables, etc.) → Crop cultivation & production
  ▶ Agriculture: Pastoral farming or livestock farming (animals) → Livestock rearing & production
  ▶ Aquaculture

• SC 41 / WG 5 also seeks NWIPs in the IoT application areas not yet introduced topics in SC 41.

SC 41 / WG 5 Seeks NWIPs in Food Cultivation and Production Standardization Areas; and Application Topics Not Yet Introduced in SC 41.
References

5. https://www.iso.org/committee/541071.html
7. The clipart icons used in Charts #2 and #7 in this presentation are from Google image search, free download, free trial, etc., from various clipart websites or other websites and from Dr. Jie Shen’s “Study on the Integration IoT & Blockchain,” May 2018.
Discussion

Smart society
Smart healthcare
Smart transport
Smart territory improvement
Smart payments
Smart buildings
Smart energy

https://www.iotnow.com/2017/09/25/67259-everything-can-smart-key-
 traits-newest-smart-cities-part-1/