Interworking between heterogeneous underwater networks based on underwater delay and disruption tolerant network (U-DTN)

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Scope

❑ Scope

This document describes interworking between heterogenous underwater networks based on U-DTN.

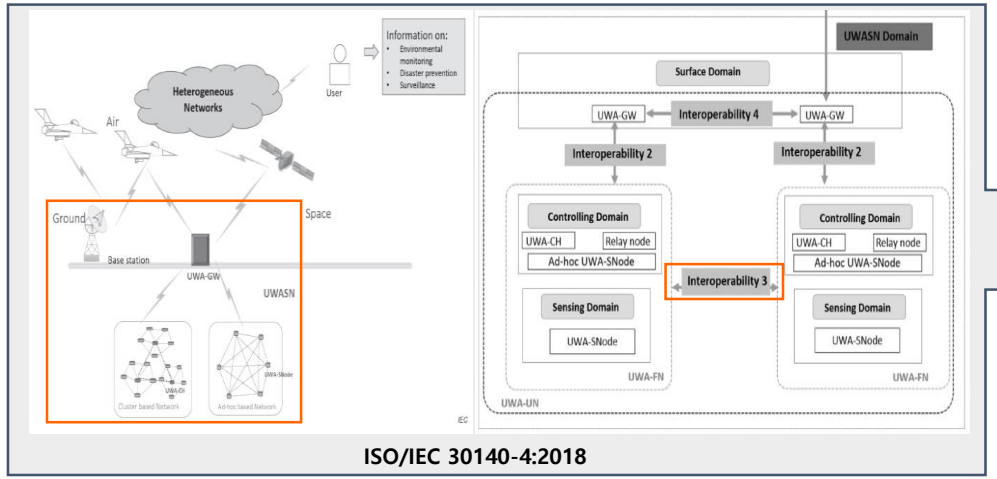
It specifies the followings:

- How to integrate heterogeneous underwater networks based on U-DTN?
- Interworking functional entities in heterogeneous underwater networks
  - Surface UWA-DTN-GW and Mobile UWA-DTN-GW
  - U-FFD and advanced UWA-DTN-GW
- U-DTN functions for heterogeneous underwater network interworking

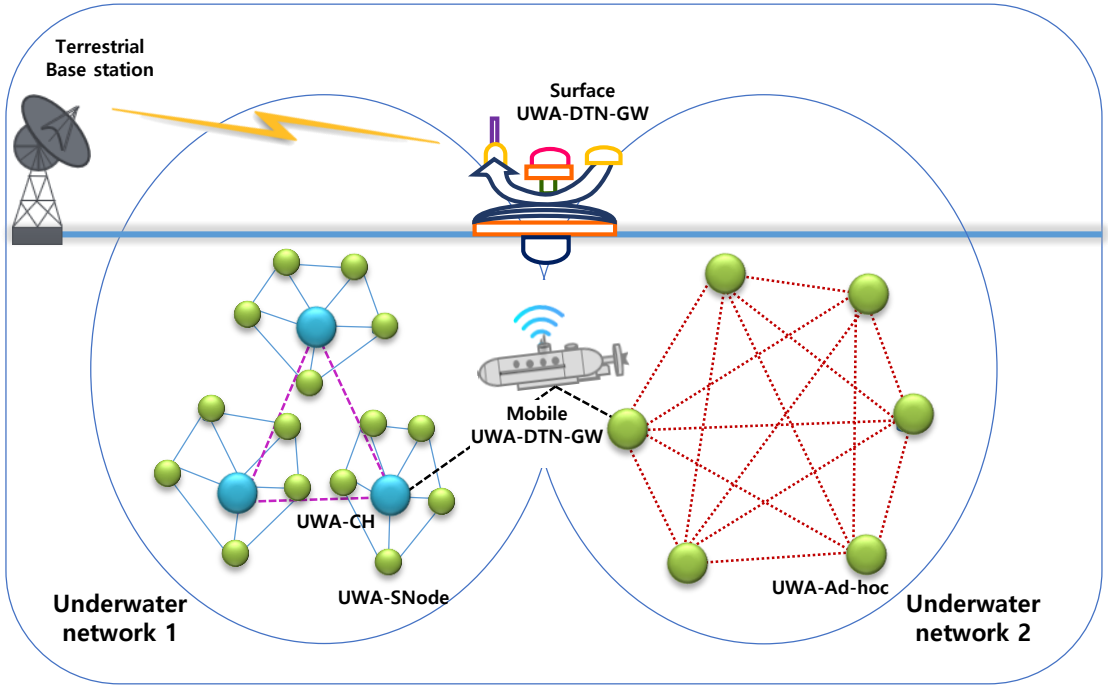
Background (1/2)

❑ Interoperability

- (ISO/IEC 30140-4:2018) **Interoperability** refers to the ability of two or more components, applications, devices, systems, or networks to exchange information.
  - UWASN interoperability in a hierarchical architecture
    1) Interoperability 1: between the user and gateway
    2) Interoperability 2: between gateway and underwater fundamental network
    3) **Interoperability 3: between underwater fundamental networks**
    4) Interoperability 4: between gateways



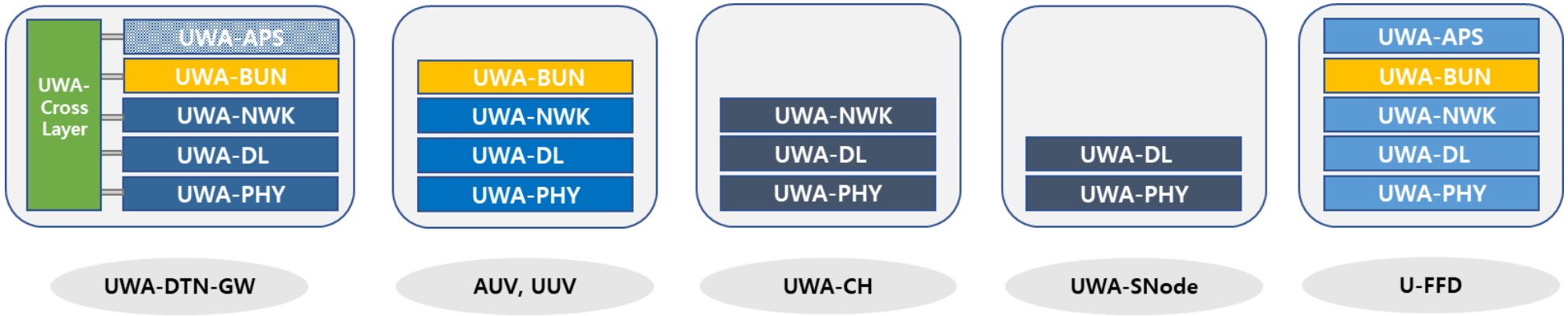
ISO/IEC 30140-4:2018



Background (2/2)

❑ Interworking functional entities

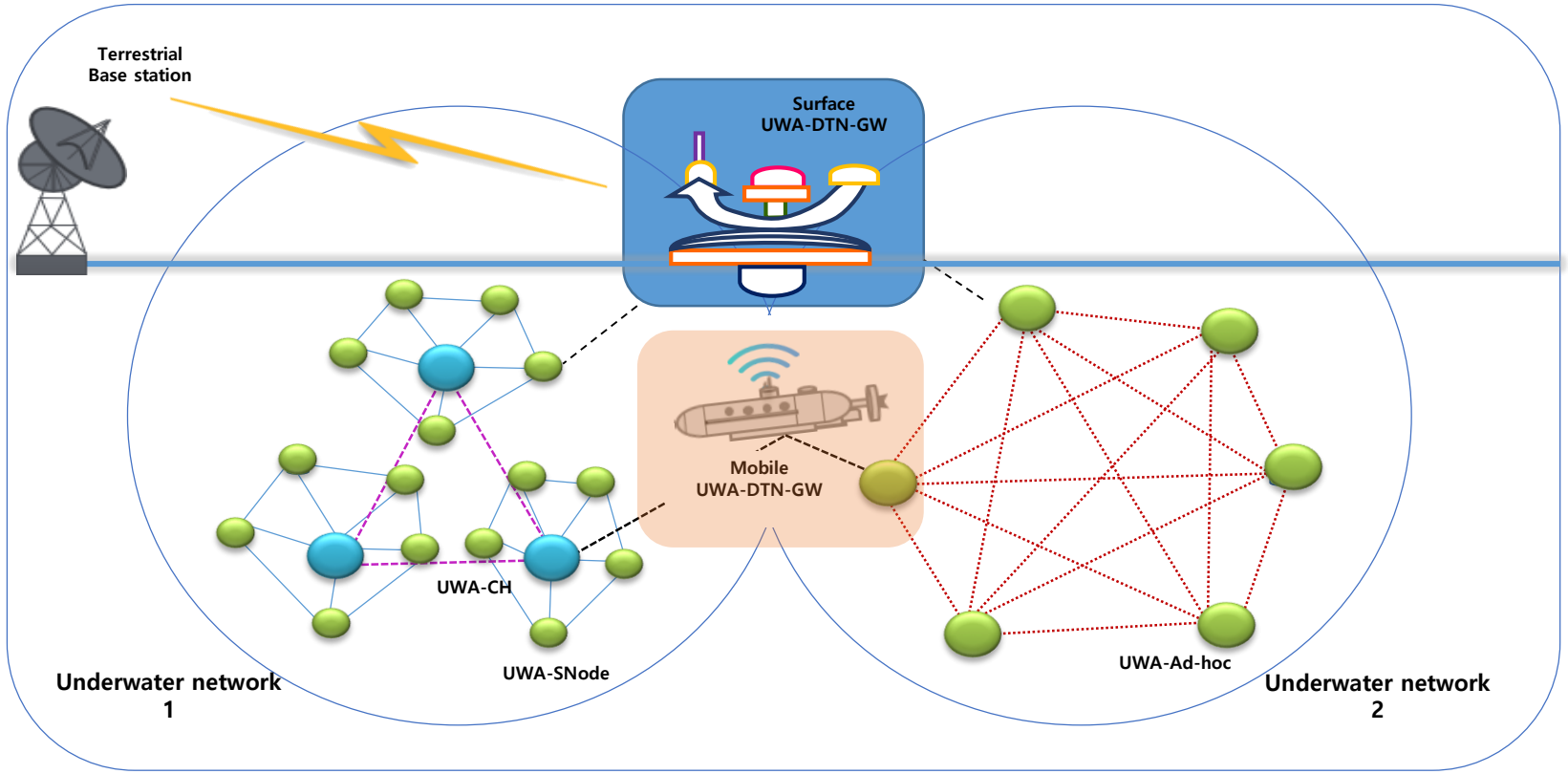
- Different functional entities behavior depending on layered architecture
- Underwater devices(entities) can receive, store and forward information to other nodes
- Each entity requires a different type of interworking functions depending on the classification
  - UWA-DTN-GW
    - Surface UWA-DTN-GW : connections between terrestrial and underwater networks
    - Mobile underwater UWA-DTN-GW (AUV and UUV) : connections between heterogeneous underwater networks
  - UWA-CH, UWA-SNode without UWA-BUN layer and U-DTN functions
  - U-FFD (Underwater – Full Function Device) with UWA-BUN layer and U-DTN functions (Optional)



Definition of Interworking between Heterogeneous Underwater Networks

❑ Definition

- **Heterogeneous underwater networks interworking** refers to a cooperative network to provide connectivity between different types of underwater networks (such as underwater sensor network, underwater ad-hoc network and underwater cellular network, etc.).



Gap Analysis

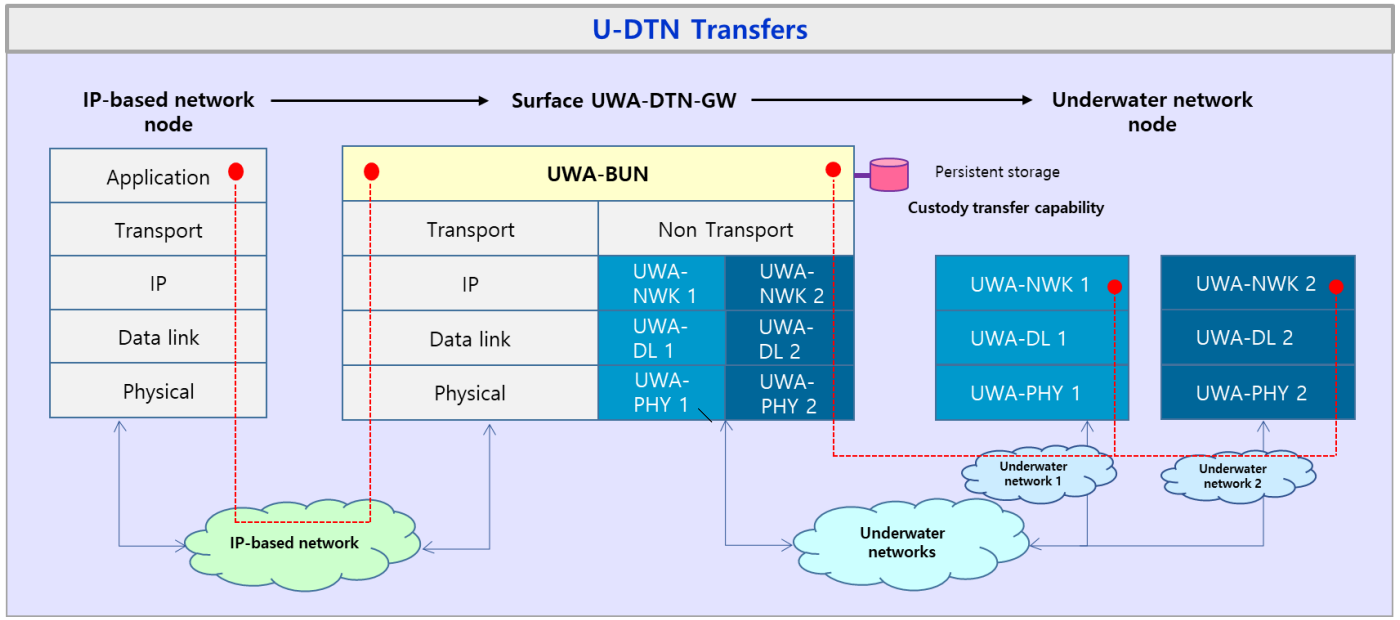
❑ Gap analysis

Gap Analysis of Interworking			
Area	**Gap**	**30140 Series (UWASN)**	**Proposed New Item**
Coverage	○	Cover overall Interoperability element in UWASN domain	Play a key role in interworking between heterogenous underwater networks
Functions	◑	Include high-abstracted main functions	Focus on underwater delay and disruption tolerant network (U-DTN) functions
Requirements	○	Describe high-abstracted networks concepts of heterogenious UWASN	Present details for heterogeneous underwater networks based on U-DTN
Underwater delay and disruption tolerant network (U-DTN)	○	Rough explanations for necessity	Dealing with interworking between heterogeneous underwater networks using UWA-DTN-GW and U-FFD
●=Few Gaps ◑=Partial Gaps ○=Significant Gaps			

Concepts of Surface UWA-DTN GW and Mobile UWA-DTN-GW (1/2)

❑ Surface UWA-DTN-GW

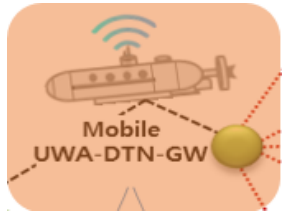
- With the help of surface gateways using DTN functions, communication between heterogeneous networks can be established.
- Located on surface, DTN functionality only exists on surface UWA-DTN-GW.
- Store and forward, Custody, Segmentation, and Persistent storage operations are provided to perform U-DTN.
- It is required for connection for terrestrial-to-underwater network and **connection for different underwater networks.**

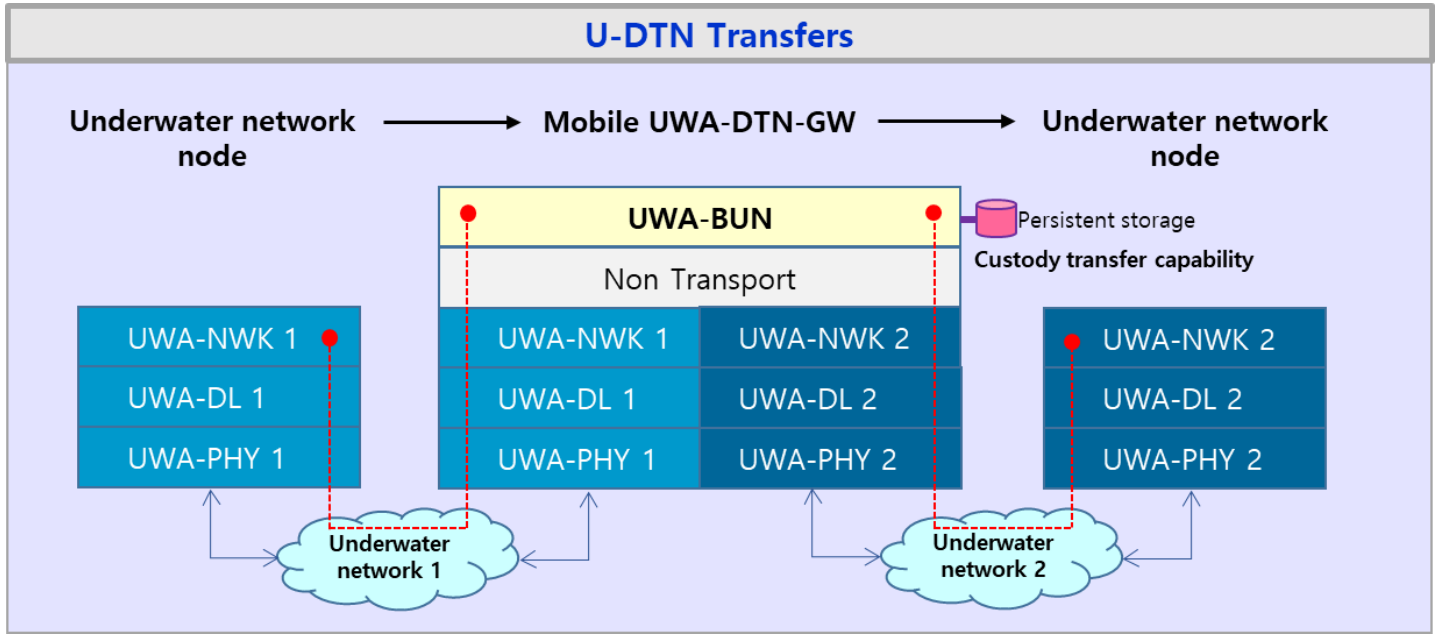


Concepts of Surface UWA-DTN GW and Mobile UWA-DTN-GW (2/2)

❑ Mobile (underwater) UWA-DTN-GW

- It connects between heterogeneous underwater networks.
- Located in underwater, DTN functionality only exists on mobile underwater UWA-DTN-GW.
- Store and forward, Custody, Segmentation, and Persistent storage operations are provided to perform U-DTN.
- It is required for connection between different underwater networks.



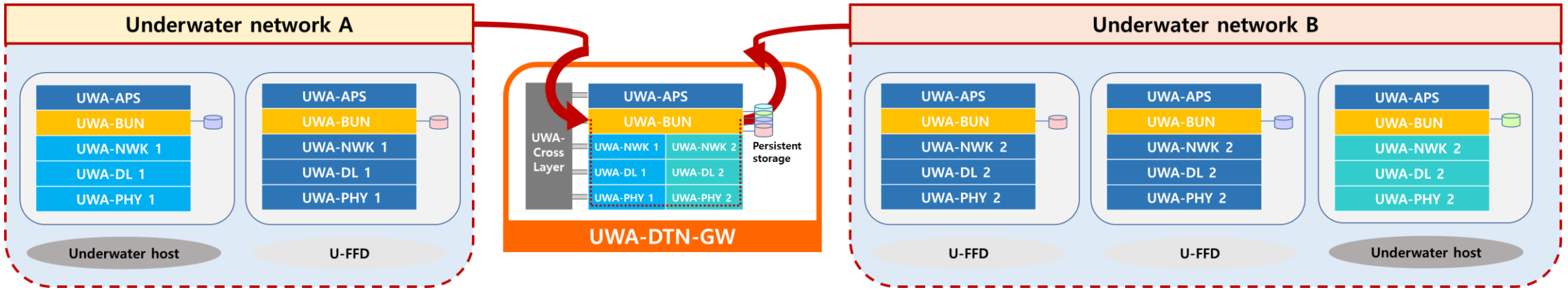


Concepts of U-FFD and UWA-DTN-GW (advanced)

❑ U-FFD and UWA-DTN-GW (advanced)

- When we have frequent interruption and long delays in communication between nodes, U-DTN guarantees end-to-end reliability through UWA-Bundle transfer mechanism.

  : hop-by-hop & custody transfer
- U-FFD uses persistent storage to keep UWA-Bundles (custody) in UWA-BUN when the link is unstable. After the link is available, UWA-Bundles is forwarded to next hop.
- UWA-DTN-GW has persistence storage for heterogeneous underwater networks.
- Interworking between heterogeneous underwater networks based on U-DTN is through UWA-DTN-GW and U-FFD with UWA-BUN as relay DTN node.



Interworking Functional Entities in Heterogeneous Underwater Networks

❑ Entities

- Surface UWA-DTN-GW / Mobile UWA-DTN-GW
- U-FFD
- UWA-CH / UWA-SNode

❑ Functions of entities for interworking

- Store and forward
- Persistent storage in UWA-BUN
- Custody mechanism
- Segmentation

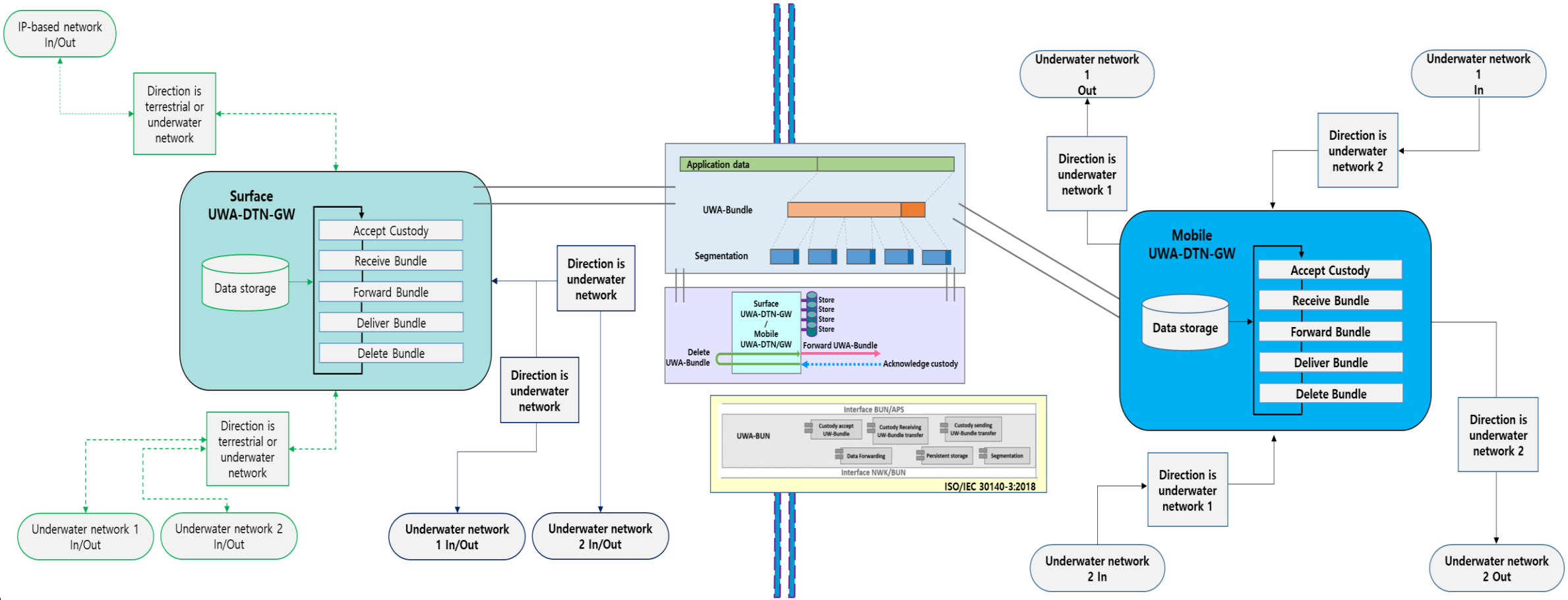
❑ UWA-BUN layer

- Provides an appropriate service interface between the UWA-NWK layer and UWA-APS
- Performing legacy transport protocol functions partially and U-DTN functions

U-DTN Functions on Heterogeneous Underwater Networks Interworking

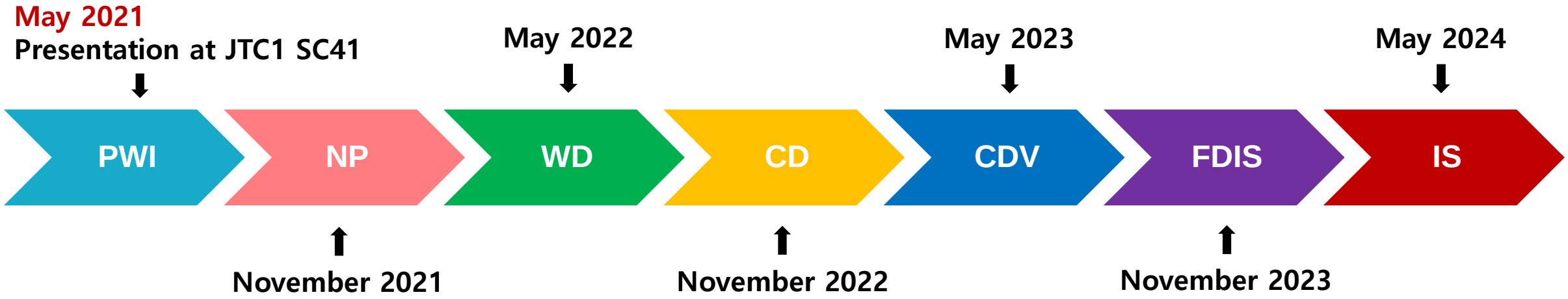
❑ U-DTN based interworking between heterogeneous underwater networks

- **UWA-BUN provides functions such as persistent storage, custody transfer, etc. (Refer to ISO/IEC 30140-2).**



Timeline

❑ Standard Development Roadmap



* PWI (New work item Proposal)
* NP (New work item Proposal)
* WD (Working Draft)
* CD (Committee Draft)
* CDV (Committee Draft for Vote)
* FDIS (Final Draft International Standard)
* IS (International Standard) publication)

Thank You