Improved situational awareness and command efficiency for military divers

Pertti Arvonen
CEO, UWIS Oy, Kaarina, Finland
pertti.arvonen@uwis.fi

1 Abstract

This document presents how diving operations can truly be integrated into systems and command chains that are traditionally only used on the surface. We introduce how the UWIS system and the innovations developed in the CUIIS (Comprehensive Underwater Intervention Information System) project; such as the diver's sensor-equipped smart undersuit, data transmission links, and the C3S (Command Software), create a new perspective and enhance the efficiency of the Defence Forces' underwater missions.

Fig. 1. Divers communicate with the surface.

2 Introduction

Currently, underwater operations and diver activities are largely disconnected from real-time awareness on the surface. The devices used by divers do not effectively communicate with each other, there is no access to real-time data on the diver's condition, and it is seldom possible to communicate with them during the dive. Additionally, tracking their location and enabling precise navigation to meet mission requirements are limited.

In 2018, UWIS Oy introduced a new diver tracking, navigation, and communication system to the market, the UWIS System, which is widely used by scientific and rescue divers. However, the first pilot customers were military divers from the Finnish and Swedish Armed Forces. Its innovative and resilient acoustic data transmission technology enables underwater medium-range data transmission and location awareness.

CUIIS

The CUIIS project was a three-year EU-funded initiative that began in December 2021. It involved 18 organizations from seven countries (figure 2.), with the Bulgarian Defence Institute (BDI) as the coordinator. The project was supported by the ministries of five member states (Bulgaria, France, Romania, Denmark, and Italy). The project responded to the challenge of 'Enhanced defence diving solutions to detect, identify, counter, and protect against sub-surface threats' [1].

The CUIIS project scope focused on an innovative comprehensive system solution in the area of underwater technologies for physical support and recovery of divers, building C4I mission systems for underwater management, underwater monitoring, situational awareness, positioning, navigation and manned-unmanned teaming [1].

Fig. 2. CUIIS members [1].

UWIS joined the CUIIS project, with the aim of further developing the UWIS System to better meet the needs of defence forces (figure 3.). As a result, it became an essential part of the CUIIS project, providing location awareness for divers and enabling data transmission between divers and the surface (ULAN, figure 5.).

From UWIS's perspective, the biggest challenges were to develop the interface between the diver's near-field devices (diver's personal area network, DPAN (figure 4.)) and the UWIS System, as well as to establish a new connection to the new C3S software on the surface (SLAN, figure 6.). Similarly, improvements were needed in the usability and interference resistance of the surface units.

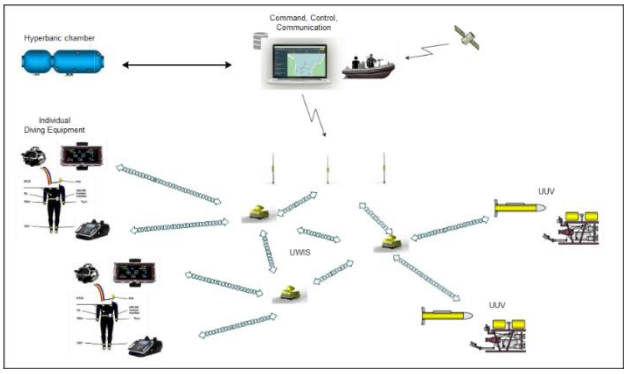

Fig. 3. CUIIS System overview [1].

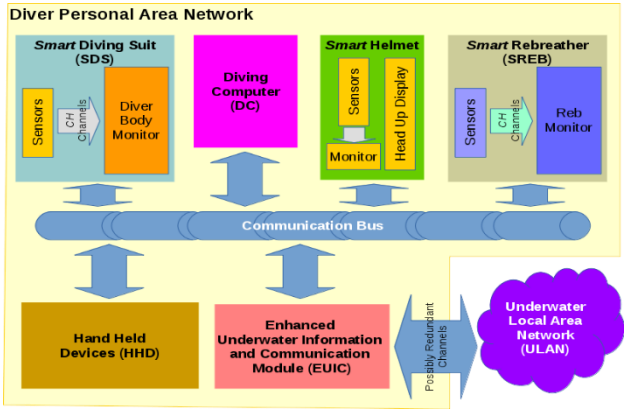

Fig. 4. Diver Personal Area Network (DPAN) [1].

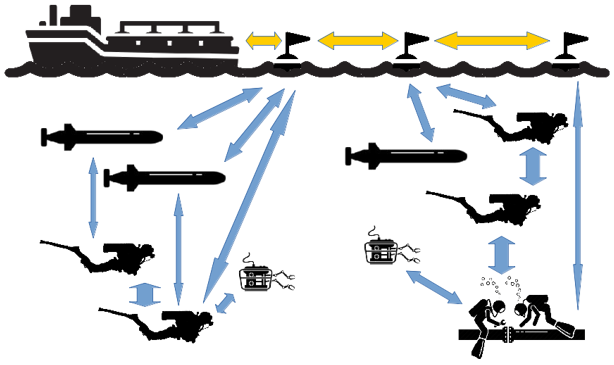

Fig. 5. Underwater Local Area Network (ULAN) [1].

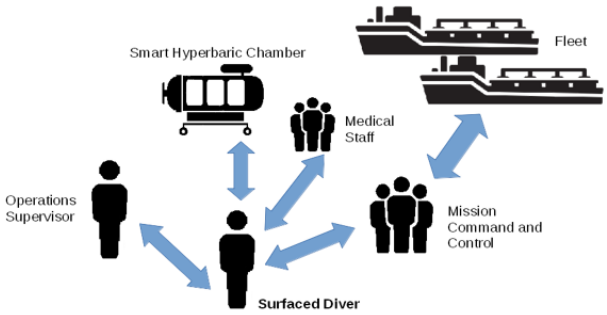

Fig. 6. Surface Local Area Network (SLAN) [1].

3 Approach and results

In the CUIIS project, the smart undersuit (figure 8.) was developed and designed with integrated sensors to monitor the diver's physiological data in real time. The suit also includes data transmission components that allow devices in the diver's personal area network (DPAN, figure 7.) and the surrounding near area to share information with each other. Such devices include the dive computer, handheld device (HHD), and connection to the UWIS system (ULAN), and from there, to the surface (SLAN).

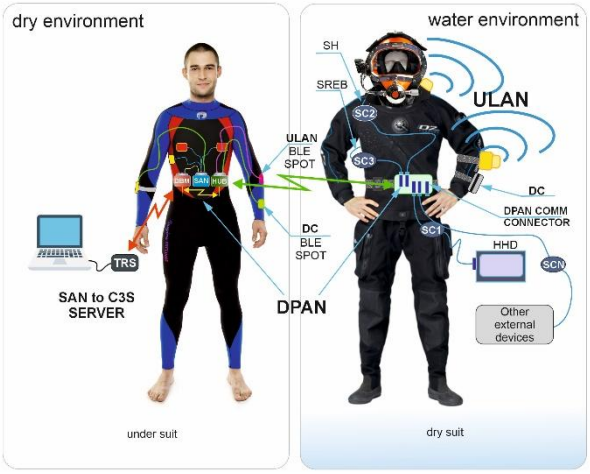

Fig. 7. Designed system in diver's personal area [1].

Fig. 8. Smart undersuit, dive computer (Ratio Computers) and UWIS Link.

One of the project's major innovations was the design and implementation of a data transmission protocol that is better suited for this kind of an environment with various data transmission technologies, data rates, and systems. This protocol was named Universal Data eXchange Protocol, UDXP [2].

During the project, it was discovered that no suitable devices existed on the market for wired or wireless data transmission in the DPAN environment. To address this, a so-called Smart Cable concept was designed, enabling fast, bidirectional data transfer between two devices. These cables can be implemented on both the dry and wet sides of a diver's equipment setup. They are autonomous, operate on independent power sources, and can be connected or disconnected to/from DPAN easily even underwater.

The main purpose of Smart Cable is to convert the devices own protocols to the UDXP protocol and vice versa (Figure 9).

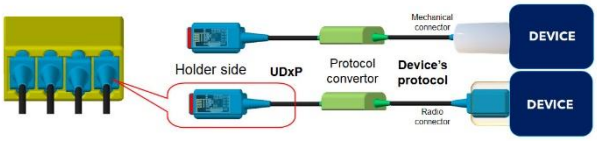

Fig. 9. Smart Cables

Divers' systems require optimal positioning for effective operation, and wireless functionality is a significant safety factor. To meet this need, the UWIS Link prototype was developed (Figure 10), enabling a data connection between Bluetooth-enabled devices underwater, where radio frequencies typically cannot penetrate beyond a distance of 5 cm.

Fig. 10. UWIS Link (Bluetooth – Inductive data transmitter).

The UWIS system was also enhanced with the introduction of so-called UWIS Cable Buoys (figure 11.), which allow the System to be used more accurately and with greater resilience to interference directly from larger vessels.

Fig. 11. UWIS Cable Buoy.

Additionally, the first C3S software for real-time military dive operation monitoring was developed during the CUIIS project (figure 12.). Its visual interface is groundbreaking, featuring underwater element icons. The software can display the near real-time positions, messages, and data from underwater units (divers, ROVs, UUVs…). The same software and devices can also be used during potential hyperbaric chamber treatments.

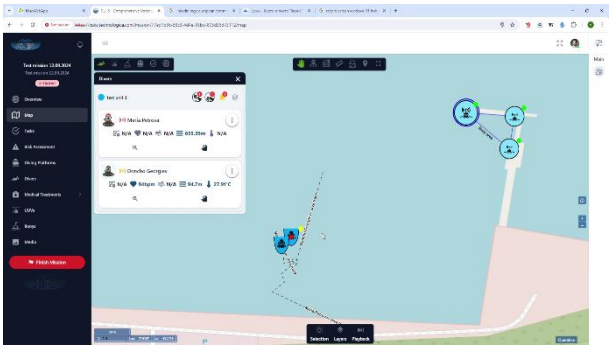

Fig. 12. C3S software with physical data [1].

One of the most significant improvements of the CUIIS project was the integration of predefined text messages into C3S, UWIS Tracker (figure 14.), and UWIS's underwater navigation application (figure 13.) for use by defence forces. This new technology now makes the use of these messages possible in addition to the traditionally standardized hand and rope signals.

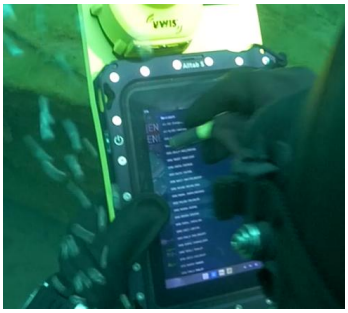

Fig. 13. Predefined text messages in underwater navigation app (Alltab underwater tablet).

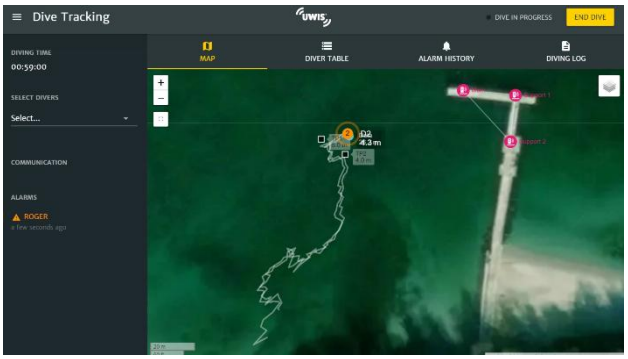

Fig. 14. Incoming "Roger" message from the diver (UWIS Tracker software).

The designs developed during the CUIIS project were realized as prototypes, and their functionality was verified during test dives under the ice in Finland (figure 15.) and two demonstrations in Varna, Bulgaria, in the fall of 2024 (figures 16. and 17.). Video recordings of these test and demo events can be found in the references [3, 4, 5] as well as additional information about the CUIIS project and the UWIS System on websites [6, 7].

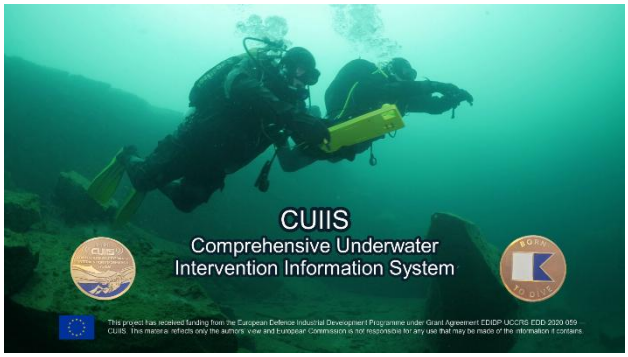

Fig. 15. Divers under the ice at the CUIIS test event in Finland [1, 3].

Fig. 16. Diver equipped with gear for data transfer [1, 5].

Fig. 17. Technical review for end users, Varna [1, 5].

4 Conclusions

We believe that this work should continue and that the system should be further developed and commercialized. We see great potential, especially in improving the efficiency and safety of various diving tasks, as well as enhancing the situational awareness and response capability within the command chain.

The current hardware and systems already support a significant portion of the targeted achievements, but there is still much work to be done, particularly in integrating different devices and ensuring their suitability for demanding tasks such as EOD (Explosive Ordnance Disposal) diving. However, we are on the right track.

5 Acknowledgement

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6 References

[1] EDIDP-UCCRS-2020-EDIDP-CUIIS, Comprehensive Underwater Intervention Information System (CUIIS).

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6 Biography

Pertti Arvonen is CEO, co-founder, one of the designers and test diver in UWIS Oy. He is Master of Science in

Electrical Engineering and he has worked in international business since 1994. Pertti served as the project leader for two tasks in the CUIIS project.