ICASP Interfaces specifications for selected ROV and AUV
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Diffusion list				

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1. Introduction

The main goal of project EUROFLEETS is a stronger mutual sharing of existing national research infrastructure by European partners within the EUROFLEETS consortium. Especially the field of marine technology needs to be much more standardized to offer access and the possibility of utilization to a wider range of operators. Within the field of marine technology, payloads for AUVs and ROVs are affected by that request in particular. As a part of EUROFLEETS the development of exchangeable payload modules was decided. One of these newly developed modules will be the multi-sensor platform ICASP (In Situ Chemical Analysis and Sampling Payload), which is supposed to work in different types of AUVs that are used scientifically in Europe.

- **MARUM**, Center for Marine Environmental Sciences , Bremen, Germany

  AUV: EXPLORER 5000, International Submarine Engineering ISE Ltd.

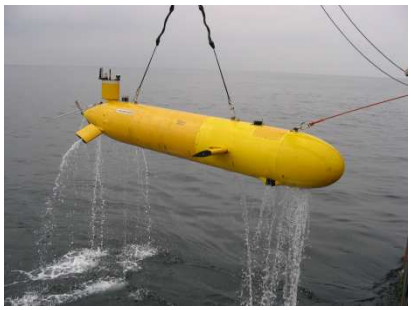


Photo © Marum

- **IFREMER**, French Research Institute for Exploitation of the Sea, Issy-les-Moulineaux, France

  AUV: EXPLORER 3000, International Submarine Engineering ISE Ltd.

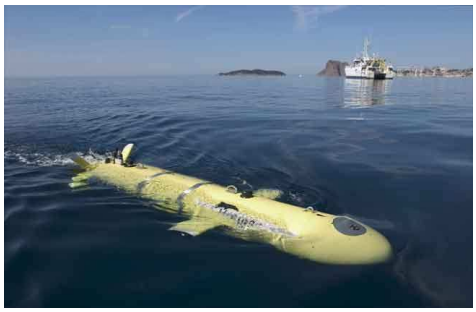


Photo © Ifremer

- **AWI**, Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany

  AUV: Bluefin 21, Bluefin Robotics Corporation

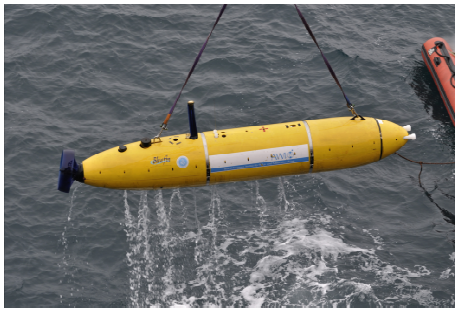


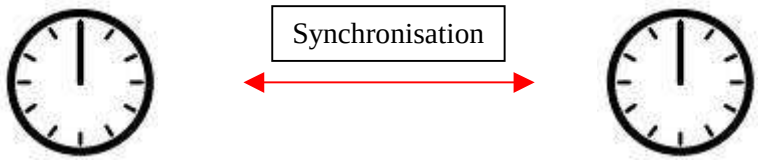
Photo © AWI

In the current version this document intends to give an overview over the conceptual design of the interfaces which are to be integrated in ICASP in order to make it work in the AUVs mentioned before.
Besides, the document describes the two stages that are currently planned during the development of ICASP and in which way these two stages affect the interface design.

2. Interfaces Specifications

In the first stage of development the ICASP module will work pre-programmed but independent from the carrier vehicle. This concept has been called “Taxi-Concept” and is preferred at the AWI since their Bluefin AUV was acquired in 2003. It represents the easiest way to guarantee high compatibility of a payload to different AUVs. At this, the payload module includes all important systems. A physical connection to the carrier vehicle, except mechanical mounting, is unnecessary.

Within the Taxi-Concept, the payload has its own control devices, which might consist of for example pressure sensors, timer, etc. In the same way, data logging is done by a data recorder that is independent from the AUV. The “interface” basically is the system clock of the AUV control computer and the clock of the payload data recorder. These two clocks have to be synchronized prior to the dive. Via the time, the measurement data can subsequently be related to the recorded positions of the vehicle.



AUV data
Inertial Navigation System (INS) -based
Update rate: 0,1s

Payload data

Update rate: 1,0s

Time	Latitude	Longitude	Depth
[UTC]	[°]	[°]	[m]
10:46:03,8	79,009360978	4,327448700	14,475772026
10:46:03,9	79,009361146	4,327448616	14,441664579
10:46:04,0	79,009361397	4,327448532	14,598558789
10:46:04,1	79,009361649	4,327448364	14,639487692
10:46:04,2	79,009361817	4,327448113	14,823667638
10:46:04,3	79,009362068	4,327447778	14,823667639
10:46:04,4	79,009362236	4,327447359	14,810024687
10:46:04,5	79,009359218	4,327444341	14,823667640
10:46:04,6	79,009359302	4,327443838	14,994204462
10:46:04,7	79,009359386	4,327443335	15,110169411
10:46:04,8	79,009359470	4,327442748	15,021490341
10:46:04,9	79,009359470	4,327442078	15,116990877
10:46:05,0	79,009359470	4,327441407	15,273884508
10:46:05,1	79,009359386	4,327440653	15,273884509
10:46:05,2	79,009359302	4,327439815	15,273884509
10:46:05,3	79,009359302	4,327438893	15,362563459
10:46:05,4	79,009359134	4,327437887	15,417135100
10:46:05,5	79,009358967	4,327436797	15,458063819

Time	Temperature
[UTC]	[°C]
10:46:01	5,1732
10:46:02	5,1742
10:46:03	5,1758
10:46:04	5,1767
10:46:05	5,1586
10:46:06	5,1549
10:46:07	5,1603
10:46:08	5,1610
10:46:09	5,1557
10:46:10	5,1679
10:46:11	5,1772
10:46:12	5,1795
10:46:13	5,1800

Unfortunately the update rate of the payload data logger and the update rate of the vehicle can vary. For this reason computer programs are needed to connect measurement and position data subsequently. At the AWI, these kinds of programs are already approved and available.

In this early phase of the project, the Taxi-Concept has the advantage that payloads can relatively easy be integrated in any kind of AUV, since there are no real interfaces. Prior to the construction of a prototype, this concept offers the possibility to test the components of ICASP during a real mission without the hassle of connecting them to the AUV (e.g. the reaction of a sensor on vibrations caused by the AUV's thruster.)

Despite its simpleness, the Taxi Concept has some disadvantages which may influence later "operative-mode" missions. The control and supply devices of the payload increase the vehicles' weight and reduce the valuable interior volume of the AUV. Independent payload systems are obsolete because the vehicle itself is capable to provide sufficient computer capacity and power to operate a payload. Besides, the manual synchronization of different system clocks is complicate and error-prone. In the long term, it is inefficient to use independent payloads.

Thus, in a second stage of development, ICASP will gain the capability to connect to a carrier vehicle.

The integration of a payload leads to three interfaces, which are discussed in detail in the following text:

- Mechanical Mounting
- Supply
- Control / Data Management

Mechanical Mounting:

Mechanical Mounting is only discussed very briefly. To reduce the weight, all mountings, clamps, etc. will be manufactured of light Polyethylene (PE-LD). The density of this material is below the density of water, so the mountings will contribute to the buoyancy of the vehicle. If possible, structural alterations at the vehicles will be avoided as far as possible.

Supply:

One crucial item in operating a payload in different AUVs is to provide equal power supply regardless of the carrier vehicle. The most commonly used range of supply voltage for sensors is from 9 – 15 V direct current. Consequently, ICASP will run around 12 V DC power supply. The vehicles of MARUM and IFREMER both offer a supply voltage of 48 V DC, whereas the vehicle of the AWI offers 32 V DC. Therefore, ICASP needs to be equipped with either an adjustable DC-to-DC converter or two converters that fit to the particular input voltage.

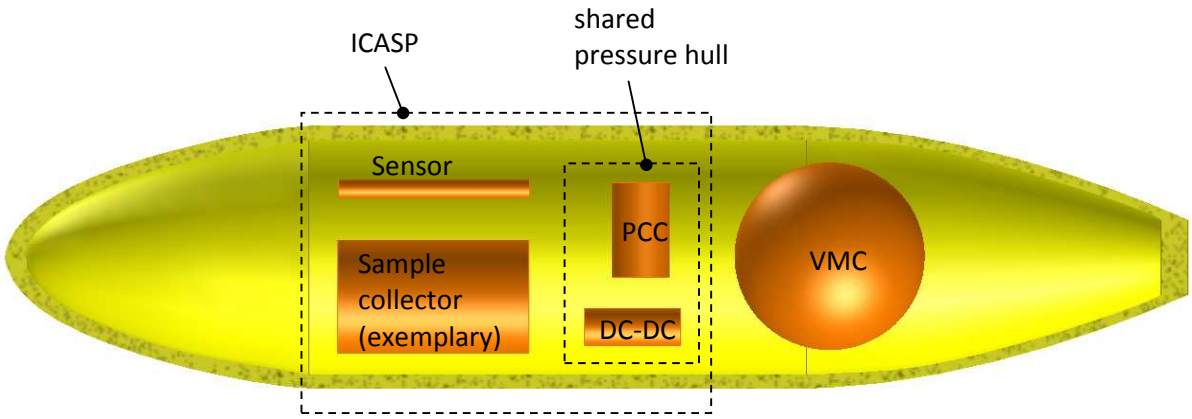
Control / Data Management:

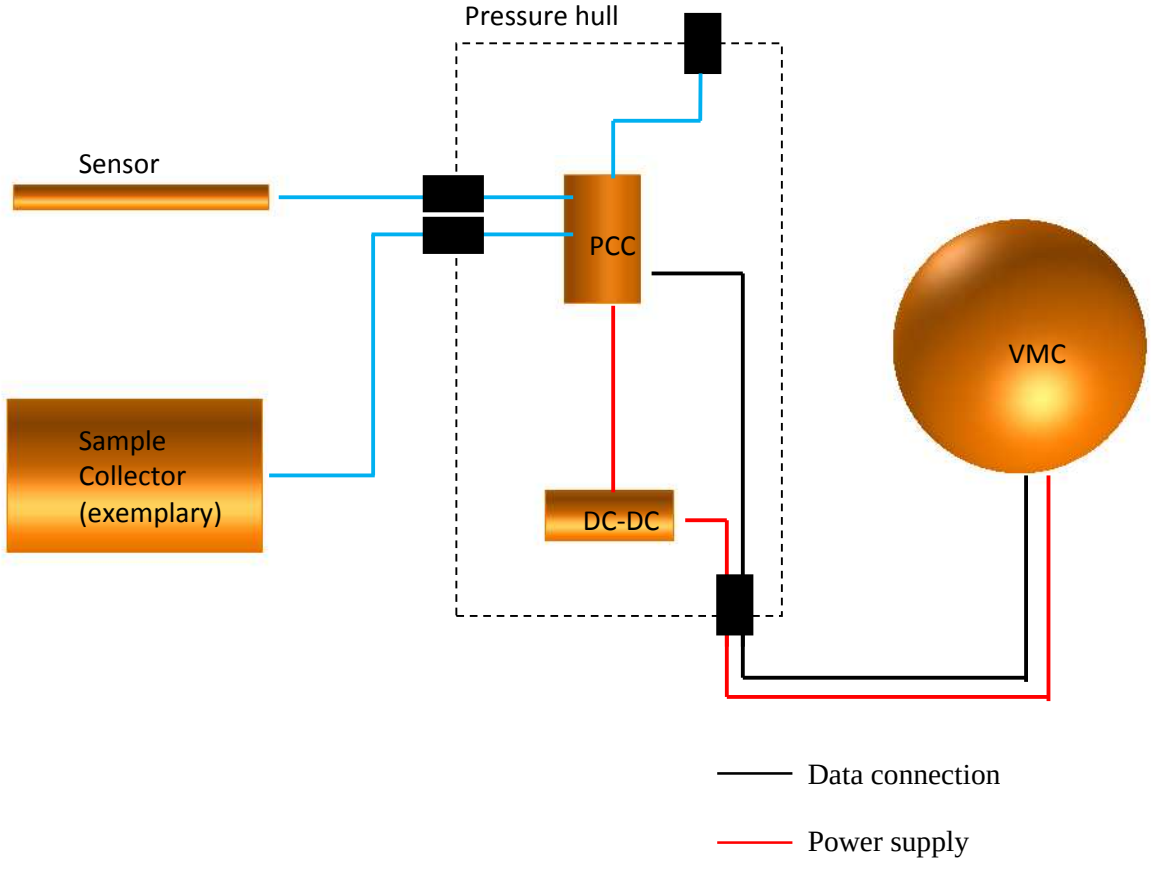
As it is not quite sure which kind of components ICASP will finally contain, it is important to cover all possible requests ICASP might have in the future. At first, a payload can consist of “active” and “passive” modules. Passive modules, like sensors, gather values and send them. They do not need any kind of control by the vehicle. The vehicle only serves as a data logger. In contrast, there might also be active modules, which need active supervision by the AUV. An example for an active payload module is a sample collector that needs to be triggered (e.g. based on time stamps, pressure, en route events, etc.).

To cover the requirements of both types of payloads, a separate computer, the Payload Control Computer (PCC) will serve as the interface between all types of vehicles and ICASP. This computer will be linked to the vehicle’s main computer (VMC).
The PCC will both serve as a data logger for all kind of sensors and as a control unit for the payload. Communication with (analog-) sensors will be enabled by integrating analog-to-digital converters.
To trigger active payload modules the PCC will receive data (like time stamp, position, etc.) from the VMC. Data will be transmitted according to the NMEA-0183 protocol via Ethernet / UDP. In the opposite direction, from PCC to VMC, no data will be transmitted.

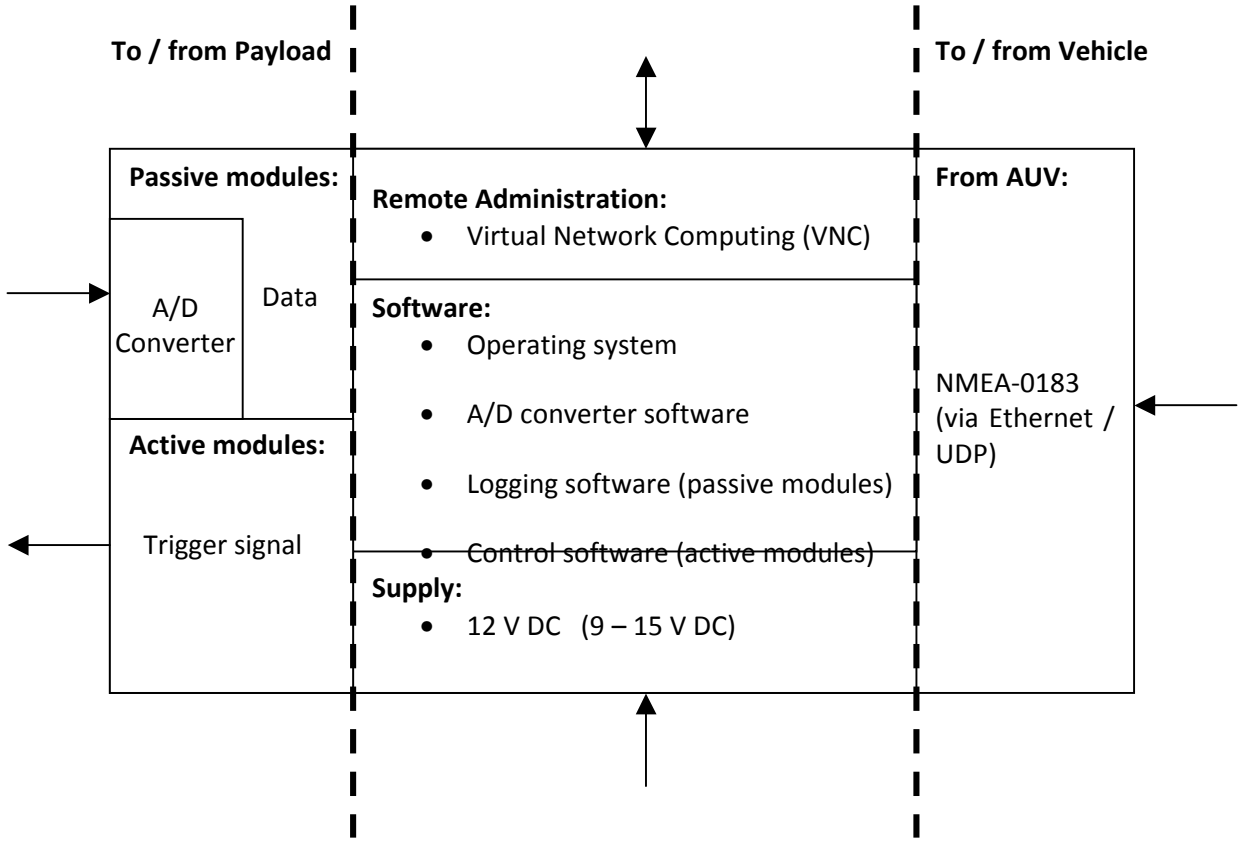
The PCC will consist of an embedded micro-PC. The programming of this computer will be carried out from an external source using remote administration. For this, Virtual Network Computing (VNC) will be used.

3. Overview and drawings





PCC:


To / from Payload
To / from Vehicle
Passive modules:
A/D Converter
Data
Active modules:
Trigger signal
Remote Administration:
Virtual Network Computing (VNC)
Software:
Operating system
A/D converter software
Logging software (passive modules)
Control software (active modules)
Supply:
12 V DC (9 – 15 V DC)
From AUV:
NMEA-0183 (via Ethernet / UDP)