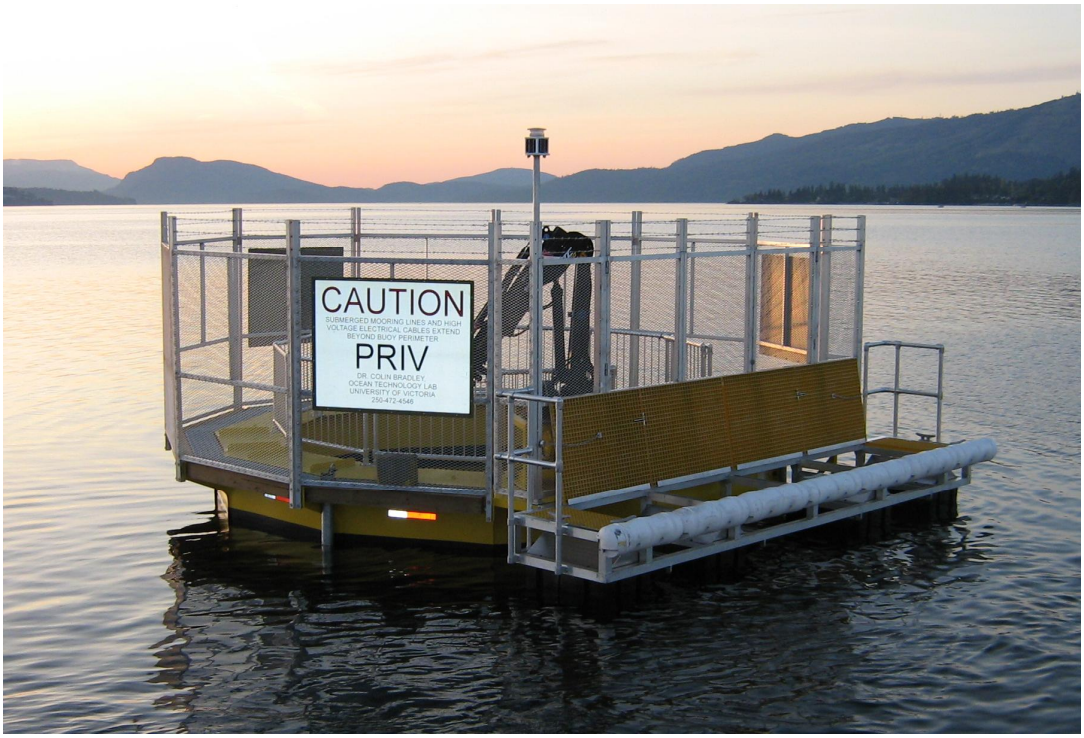
Proposal for UVic VENUS Facility

RFQ 5536A - Profiler Winch and Telemetry System



Proposal for uVic VENUS Facility
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Contents

Introduction

This document describes MacArtneys proposed solution for a Profiler Winch and Telemetry System as specified in RFQ 5536A.

The solution is based on COTS products where the design allows this. All other components are well known to MacArtney and have been tried at tested in other systems.

Surface enclosures and bulkhead connectors are produced from corrosion resistant materials such as SS316 stainless steel and coated metals.

The subsea enclosure and connectors are produced from POM and PEEK plastic materials.

Subconn Underwater Connectors are used for all cable connections exposed to sea or subsea conditions.

Both a copper and fiber optical solution has been included to allow UVic to select the most adequate solution for present and future requirements.

The proposed solution differs from the requirements regarding the available power for the Instrument Interface System, offering only 250W. A side effect of this is that profiling can be done every 30 minutes. See page 5 for further argumentation.

The following description is based on the block diagram shown on drawing V039090000-49

System Interface Controller

The System Interface Controller is the main controller of the Profiler system, which will be integrated in a separate IP67 protected cabinet on the winch. The hardware and software in the controller is based on the MacArtney NEXUS multiplexer, which is widely used in several hundred systems worldwide.

The actual controller board, the MacArtney MiniCon, is microprocessor based and equipped with serial ports plus analog and digital inputs for control, feedback and monitoring functionality. The control interface is Ethernet based. This controller is combined with modular relay boards, VICOR power modules and Ground Fault Monitoring to ensure a safe and stable system.

The MiniCon also interfaces to the motor drive, which is described in the winch section.

Communication to the VENUS node is done through a Moxa Ethernet Switch which is configured with fiber ports for the 4km fiber cable. All sensors on the network will be available from a shore-based terminal for monitoring and configuration.

System functions
All system functions and feedback information can be accessed through a command structure determined at a later stage according to requirements. The following functions are included:

Real-time streaming of data and eventual alarms from system monitoring
- Depth of instrument package
- Distance to seabed
- Attitude and motion of buoy
- Attitude and motion of instrument package
- Amount of cable deployed
- Identification of system faults and hazardous weather conditions

Control of profiling to 210m depth every **30 minutes**
- Profiling from near surface (1 meter) to near seabed (within 2 meters)
- Lifting of instrument package from seabed between profiles
- Transit to user-selected depth (+/- 0.5m) for generation of time-series data

Power switching and monitoring of power to all interfaces
- Ground fault monitoring of all main power rails
- Sensors can be switched on and off individually
- Thermally fused sensors with power state feedback

System Components
MacArtney MiniCon controller
MacArtney relay boards
MacArtney power boards with VICOR modules
Bender IR-125Y Ground Fault Monitors
Moxa EDS-316 Ethernet Switch
Patton 2172 Ethernet Extender

Battery System Argumentation

As the power requirements are higher than the maximum available 750W, the RFQ suggests the use of a battery system for peak power requirements. The power requirements derived from the RFQ is the following:

Profiling down at 30 cm/s		
Winch	250W	~330VDC supplied, efficiency included
Main controller	60W	
Instrument Interface	70W	
Surface Instruments	50W	
Subsea Instruments	500W	
Converter loss	100W	85%+ efficiency
Total	1030W	

Lifting at 10 cm/s		
Winch	250W	~330VDC supplied, efficiency included
Main controller	60W	
Instrument Interface	70W	
Surface Instruments	50W	
Subsea Instruments	0W	
Converter loss	30W	85%+ efficiency
Total	460W	

As seen from the calculations above, there is a power deficit of approximately 300W during profiling, which must be drawn from a battery package. During lifting there is a power surplus of the same value which can then be used for charging.

As the required power requirements cause a high power draw within 10-15 minutes and following that a very fast charging routine, the lifetime of the battery pack is limited to 1000-1500 discharge/recharge cycles. With a profiling frequency of 2 hours this equals only 3-4 months between battery replacements.

MacArtney sees this to be very inconvenient from a price and service point of view and has therefore decided to differ from the requirements on this point.

MacArtney proposed solution
Lowering the power requirements for the Sub-sea Instruments to 250W will avoid the need of such a battery package and give the following power calculation:

Profiling down at 30 cm/s		
Winch	250W	~330VDC supplied, efficiency included
Main controller	60W	
Instrument Interface	70W	
Surface Instruments	50W	
Subsea Instruments	250W	
Converter loss	70W	85%+ efficiency
Total	750W	

Lifting can now be done at 20 cm/s as no charging is taking place:

Lifting at 20 cm/s		
Winch	500W	~330VDC supplied, efficiency included
Main controller	60W	
Instrument Interface	70W	
Surface Instruments	50W	
Subsea Instruments	0W	
Converter loss	30W	85%+ efficiency
Total	710W	

This change in speed will allow the Profiling winch to run every 30 minutes if so required.

The MacArtney proposal is based on this lower power requirement.

Emergency Backup Battery
In order to be able to finish an ongoing profile in case of a power failure, an emergency Backup Battery will be integrated in the system. This battery will be kept in a charged state and will be able to deliver 750W total power for a period of 20 minutes.

The system power supply will automatically switch to this battery if the power supplied from the VENUS node should fail. In case of communication failure as well, the Instrumentation package can be lifted to a secure position with the local winch remote.

The lifetime of this battery package is estimated to 5 years.

MET & Near-Surface Instruments

The Main Controller has the following interfaces for MET and Near-Surface Instruments:

4 Analog instruments (2 connectors, 12V)
4 Serial instruments (4 connectors, 12 and 24V)
4 Ethernet instruments (4 connectors, 12 and 24V)

The available power for these instruments is limited to 50W but can be higher if needed. This will reduce the power for subsea instruments though. Power switching is provided for each individual sensor through the control system.

Analog and serial sensors will be interfaced through TCP/IP capable devices and will have an unique IP address and/or port number available to the observatory. Ethernet sensors will have a dedicated port in the Main controller switch and thus be available anywhere on the network.

All TCP/IP modules are connected to the Moxa Ethernet Switch in the Main Controller.

System Components
Moxa NPort 5210 Serial Server
National Instruments ENET-9205 A/D

Winch and Cable Block

The proposed Profiling Winch is a MacArtney type MAC 250-6.5-1kN.

The winch has the following capabilities:

- Handling of minimum 100kg of submerged weight
- Profiling from surface to seabed at minimum 30 cm/s
- Lifting of instrument package from seabed to surface at minimum 10 cm/s
- Transit to user-selected depth for collection of time-series data
- Docking of instrument cage at the buoy when not profiling

See the attached winch datasheet for further details.

This winch is based on MacArtneys underwater winch series, where care is taken to make the design as mechanically simple as possible.

The winch drum operates without a level wind, instead having a grooved drum. All cable is placed as one layer, steered by a simple mechanical guide. This is done to ensure a low level of maintenance. The winch datasheet includes a drawing of this concept

All control electronics is located in a corrosion resistant, IP67 protected cabinet mounted on the winch. A Variable Frequency Drive (VFD) and a rotary encoder are used to control the winch motor. This drive is controlled from the Main Controller to adjust the speed according to the required profile. The amount of cable out is derived from the rotary encoder.

The winch can be controlled manually on the buoy by the use of a cabled remote control. This remote can be detached from the winch and connected only when needed if this is preferred.

Limit switches for safe operation are placed inside the winch for better mechanical protection.

VENUS cable termination
The cable from the VENUS node is terminated in the winch cabinet, where the 330VDC and the fibers are connected to power and communication cabling

High Voltage Lockout
A lockout system for the high voltage is placed on the winch cabinet to ensure that maintenance work can be carried out safely.

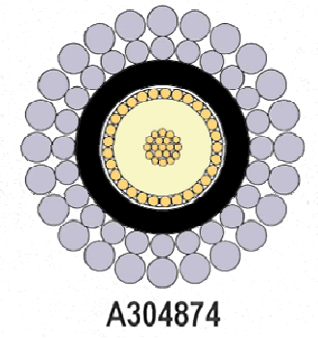
Slip Ring
The winch is equipped with a Focal 180/2 series slip ring for transfer of power and communication to the winch subsea cable.

Cable Block
As cable length and mechanical limit is monitored on the winch drum directly, the proposed cable block is a standard MacArtney Cable Sheave. Details can be seen on the attached datasheet.

System Components
MacArtney MAC 250-6.5-1kN
Focal 180-2 Slip Ring
Omron V1000 VFD

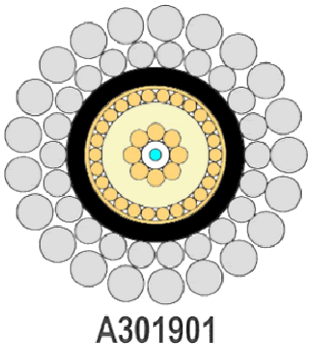
Winch Subsea Cable

The proposed Subsea Cable is a Rochester A304874 which is a 6.53mm steel armoured, single coax cable with a working load of 530 kg and a breaking load of 2300 kg.



The cable carries both power and communication on the same coax.

If a fiber solution is chosen the cable will be a Rochester A301901 which is a 6.53mm steel armoured, single coax and Multi Mode fiber cable with a working load of 630 kg and a breaking load of 2500 kg.



This cable will carry power on the coax and communication on the fiber.

See the attached cable datasheets for further details.

Reliability, Maintenance and Servicing
The two cable types above are very similar with regards to reliability. The cable construction, bending radius and flexibility is the same.

Both types should be maintained frequently by use of a corrosion inhibiting wire rope lubricant (Bio degradable type). The steel armor is zinc coated which itself acts as a corrosion inhibitor.

The major difference between the two types is the service requirements. A fiber optic cable requires specialized tools and training to re-terminate is case of cable damage, whereas a coax cable is more easily repairable. The advantage of the fiber cable is the much higher bandwidth.

Subsea Instrument Interface System

The Subsea Instrument Interface System is mounted in a Polyacetal (POM) pressure vessel rated to 250m. All connectors are Subconn PEEK types, which in combination with the pressure vessel ensure a very environmentally resistant enclosure with a design life of at least 10 years.

The controller is the same as used in the Main Controller, combined with modular relay boards, VICOR power modules and Ground Fault Monitoring. The controller interface is Ethernet based

Additional sensors are used as well to monitor depth and altitude of the instrumentation cage.

A Moxa 16-port Ethernet switch is used as a central communication unit to connect controller, serial servers, analog interfaces and Ethernet sensors to the instrumentation network.

The Instrument Interface System is connected to the Main Controller network, and thus the VENUS network, through a Patton Ethernet Extender providing 50 Mbps of bandwidth. A special filter, developed for the NEXUS MK-E, is used to couple the communication with the 300VDC power on the single-coax subsea cable.

The Instrument Interface System has the following interfaces:

8 Analog instruments (4 connectors, 12V)
8 Serial instruments (8 connectors, 12 and 24V)
4 Ethernet instruments (4 connectors, 12 and 24V)

The available power for these instruments is limited to 250W.
Power switching is provided for each individual sensor through the control system.

Analog and serial sensors will be interfaced through TCP/IP capable devices and will have a unique IP address and/or port number available to the observatory. Ethernet sensors will have a dedicated port in the Ethernet switch and thus be available anywhere on the network.

System Components
MacArtney MiniCon controller
MacArtney relay boards
MacArtney power boards with VICOR modules
Bender IR-125Y Ground Fault Monitors
Benthos PSA-916 Altimeter
Druck PCDR-1830 pressure sensor
Moxa EDS-316 Ethernet Switch
Moxa NPort 5210 Serial Server
National Instruments ENET-9205 A/D
Patton 2172 Ethernet Extender

Fiber option

A fiber option is included in the quote to present a more future-proof solution. This option would give the opportunity to upgrade the network speed to Gigabit Ethernet at a later stage, if a sensor would require so. Examples of such sensors could be high resolution plankton imaging systems, High Definition cameras and similar high data rate sensors.

The following equipment is proposed for the fiber option:
Focal 180-2/197 power / single pass MultiMode fiber Slip Ring
Rochester type A301901 subsea cable
Moxa IMC-101G media converter

The communication path in this case is a set of Moxa media converters, which provides a Gigabit Ethernet connection through a single MultiMode fiber. These will replace the Patton Ethernet Extenders proposed for the copper solution.

System Components
Focal 180-2/197 slip ring
Rochester type A301901 subsea cable
Moxa IMC-101G media converter

Standards

All MacArtney product and service ranges conform to the DS/EN ISO 9001:2008 standard.

All goods provided are assembled and/or produced according to all Danish law and legislation.

1) The goods and services provided meet the following requirements:

IEC/EN60204-1 Ed. 5	Safety of machinery, Electrical equipment of machines, General requirements.
2006/95/EC	Low Voltage Legislation: Low Voltage Directive (LVD)

2) All Commercial Off-the-shelf equipment used is CE approved and conforms to the relevant standards for the specific type of equipment.

   Datasheets for major components are included in the Datasheets appendix. These lists the standards to which each of the components complies.

3) All installation and commissioning work will be undertaken under local law and legislations, in addition to relevant Danish law and legislation. Additional regulations may be added if the work conditions require this

4) CSA approval or similar approval standards is not included but will be offered as an option at 3rd party cost + 15%

In-kind Contribution

MacArtney has great interest in helping the University of Victoria to experience a problem-free installation and reliable future use of the Profiler Winch and Telemetry System.

The following describes the In-kind contributions that MacArtney will offer free of charge.

Factory Testing
One week of Factory Acceptance Test (FAT), including two days of System Integration Test (SIT). This includes:

FAT at MacArtney premises
SIT where UVic supplied sensors will be tested with the system
Access to the MacArtney test pool for 2 days

UVic personnel are welcome to attend these tests.

Training and Installation
A major part of an installation task is to deliver the necessary training to the people involved with operating and servicing the system. Therefore MacArtney will offer one week of onsite training and installation support, including site acceptance test.

The following services will be included:

Preparation of training material
Onsite and remote system familiarisation
Module level technical training
Maintenance training
Documentation walkthrough
Site Acceptance Test (SAT)

Both travel and accommodation for two MacArtney engineers to Victoria, Canada will be covered at no cost to UVic.

Harness Cables
Harness cables will be provided for 5 sensors - connectors, moulding and electrical test are included.

All FAT and SAT testing will be documented according to MacArtneys Quality System which is certified to the **DS/EN ISO 9001:2008** standard.