

BI-DIRECTIONAL WIRELESS POWER TRANSMISSION FOR UNDERWATER ROBOTICS AND SENSING

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AGENDA FOR TODAY



Explore the **motivations** for wireless power transfer between sub-sea devices



Follow the design of an acoustic transponder with **bi-directional wireless power** capability



Study two **unique application examples of** sub-sea bi-directional wireless power transfer

AN AGE OLD PROBLEM

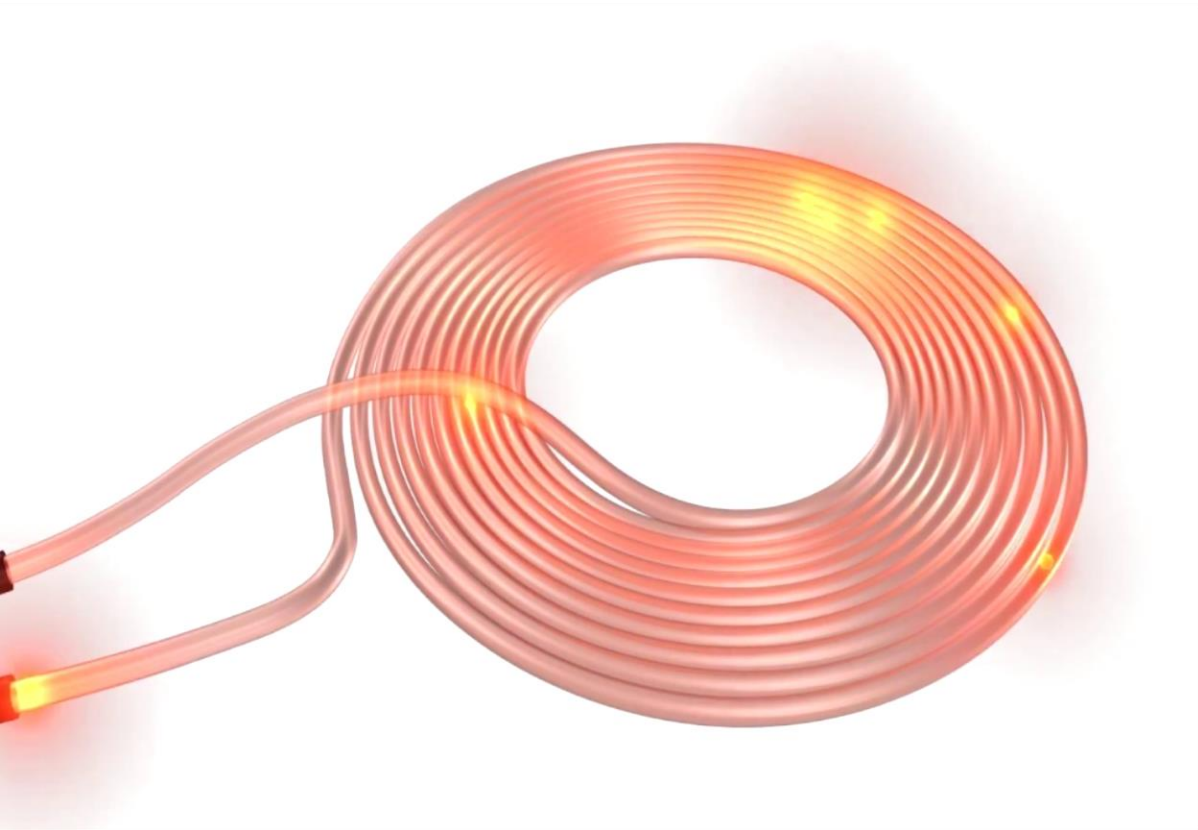
SUBSEA CONNECTORS



- Sealing surfaces can degrade and fail without **periodic lubrication**
- Dissimilar metals suffer from **corrosion**
- True underwater mating capability is **expensive** and **complex**
- Incompatibility between manufacturers leads to an **unreliable supply** chain

WIRELESS POWER

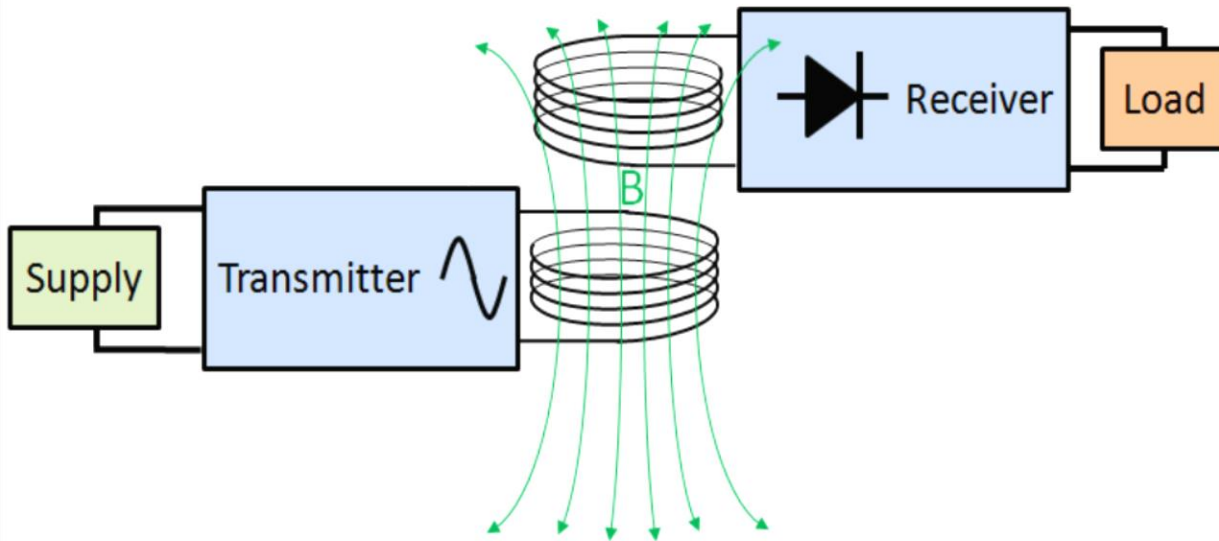
INTERCONNECT FREEDOM



- No exposed metal contacts
- All system components can be permanently sealed for life
- Low accuracy proximity mating is easily performed by robotic systems
- Internationally recognised standards ensure device interoperability

WIRELESS POWER

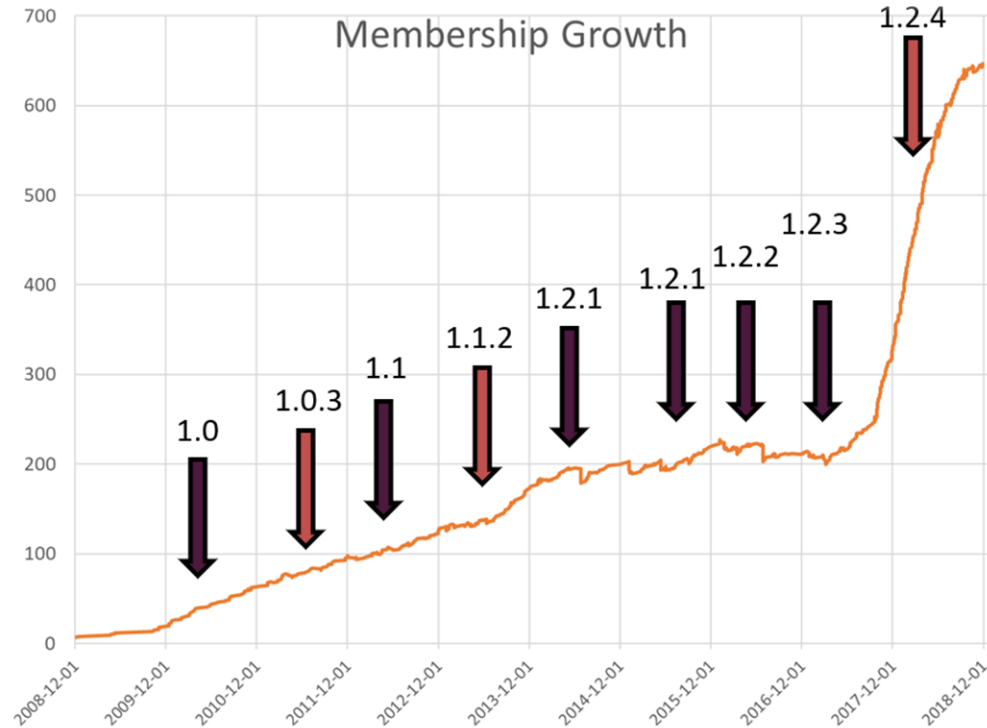
INTERCONNECT FREEDOM



- Energy transfer occurs between coils placed within <10mm **proximity**
- **Galvanic isolation** exists between the transmitting and receiving devices
- Foreign object detection and thermal **safety features** are mandated
- 5W, 15W power levels released (Qi)
200W, 2kW power levels proposed

STANDARDS GROUP

THE WIRELESS POWER CONSORTIUM



- 650+ companies have joined the group
- Periodic technical updates since 2008, **backwards compatibility** is maintained
- Prior to v1.2.4 competing standards existed (A4WP, PMA, Airfuel)
- The standards war is now over

BI-DIRECTIONAL

POWER TRANSFER



- Reverses the **direction** of power flow between two devices
- Utilises the **same physical coil** and power switching electronics
- Software control strategy **adapts** to enable power transmission

REVERSE



**WIRELESS
CHARGING**

WIRELESS POWER

UNDERWATER

Subsea electronics demand **high reliability** of interconnections between devices and **interoperability** between equipment from different suppliers

Strong growth in wirelessly charged **consumer electronics** is driving technology improvements and standardisation that can also benefit **industrial products**



DESIGN STUDY

SUBSONUS TAG

- A modern, low cost acoustic positioning **transponder**
- Can be deployed for up to **18 months** in a low-power endurance mode
- Sensor and **modem data** capability
- High reliability, **connector-less** design
- 2000m depth rating



TECHNOLOGY REQUIRED



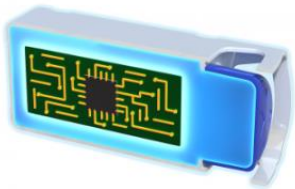
WIRELESS CHARGING

Qi standard compatible. Works with standard smartphone chargers



BLUETOOTH CONFIGURATION

Smartphone app for setup, pre-deployment checks and firmware updates



HERMETICALLY SEALED

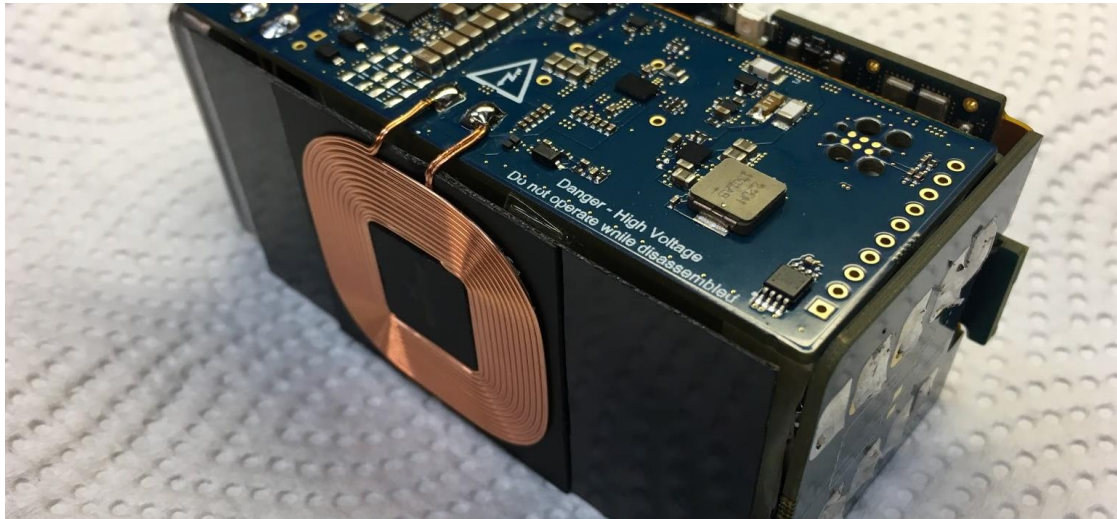
Total encapsulation of the electronics. No connectors or pressure housing required



DESIGN CHALLENGES

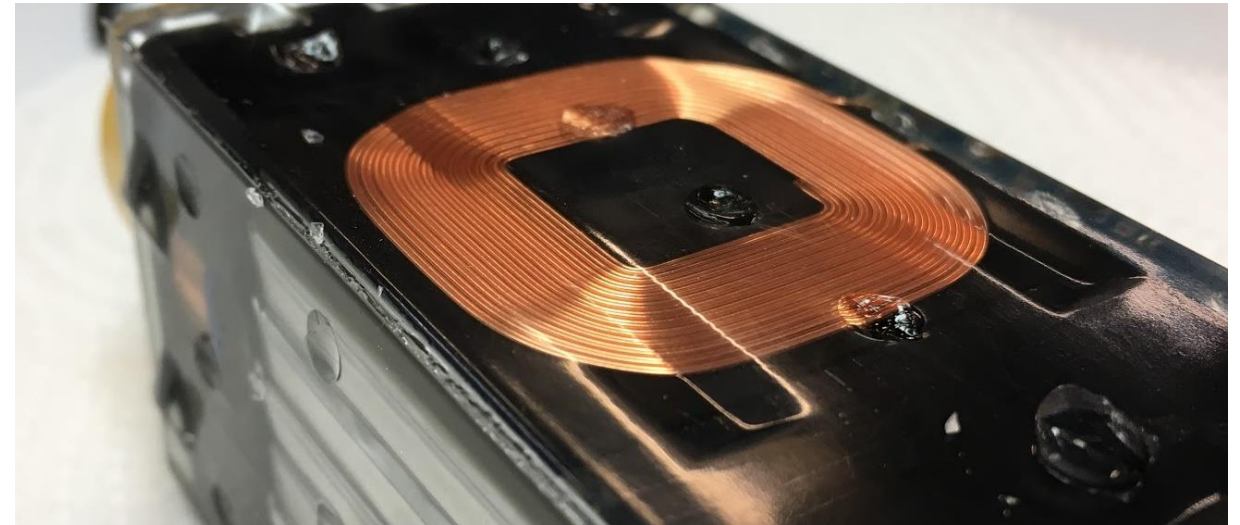
FIELD COUPLING

Ferrite shielding materials are used to ensure the coil field does not couple undesirably to components such as batteries



COIL POSITIONING

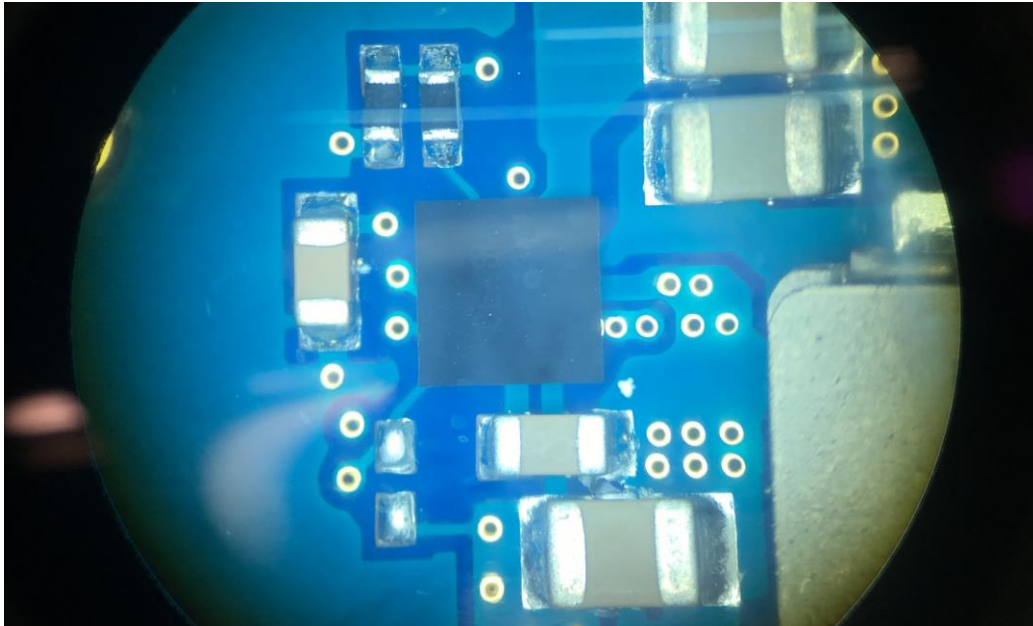
The coil must be positioned close to the external surface of the polymer composite housing to optimize the coupling gap



DESIGN CHALLENGES

PRESSURE TOLERANT ELECTRONICS DESIGN

Component selection and design is constrained by certain rules. Destructive verification testing is required



PRESSURE TESTING

Hydrostatic chamber testing for functional verification of encapsulated electronic assemblies at depth



DESIGN CHALLENGES

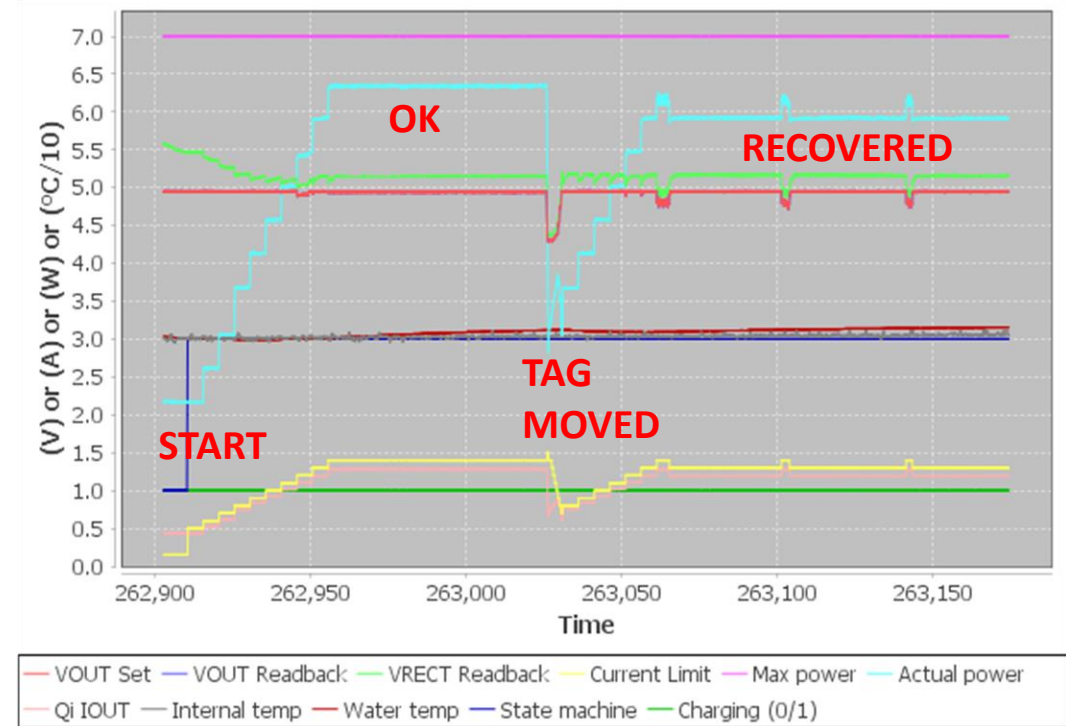
PLACEMENT ON CHARGER

Displaying the charging rate on the screen assists the user to best align Tag with the charger



OPTIMISING POWER TRANSFER

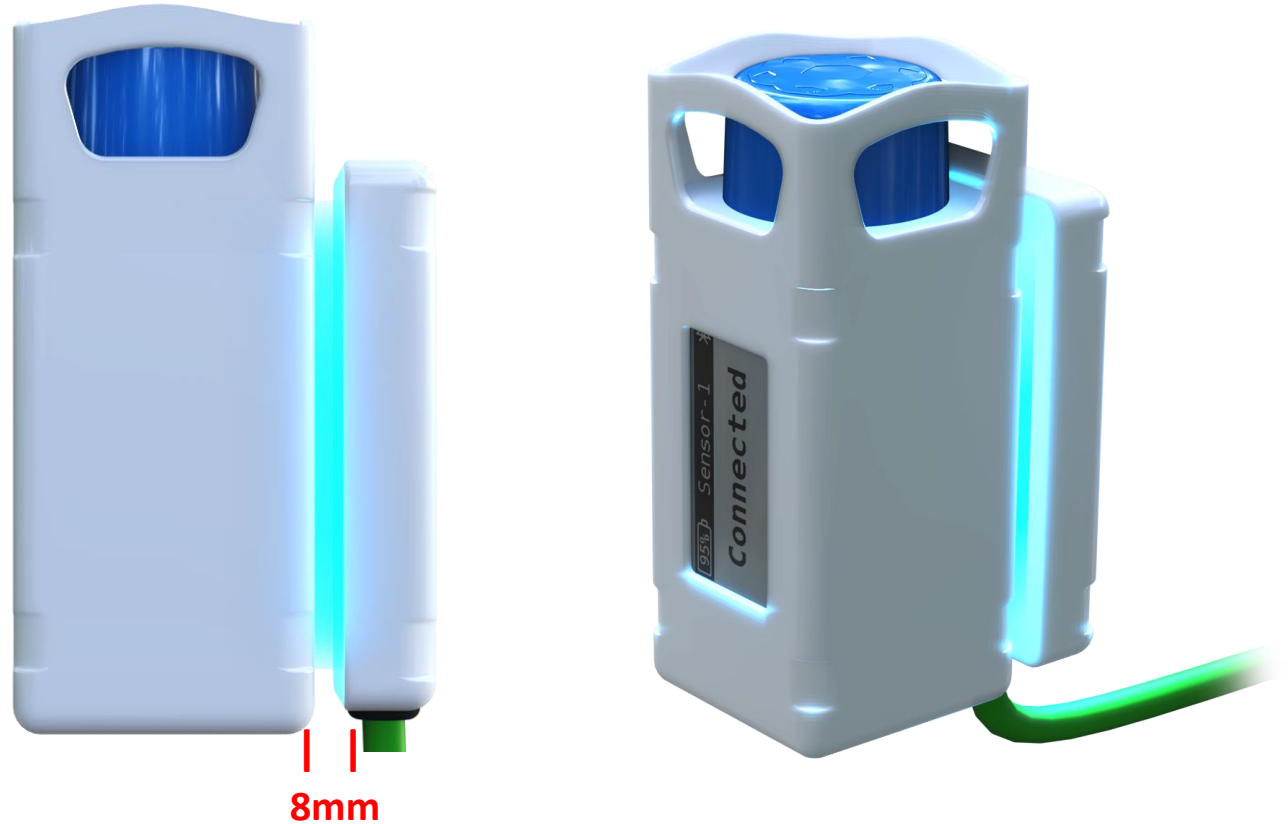
Intelligent software control of the wireless power transfer process ensures stable operation with coupling misalignment



PROXIMITY COUPLING

TO ANOTHER WIRELESS DEVICE

- Target coil separation: 8mm
- Target coil misalignment: <15mm
- Water or non-metallic materials may enter the separation gap
- Alignment method can be application specific



SIMPLE SENSORS

EASY SUB-SEA SENSING

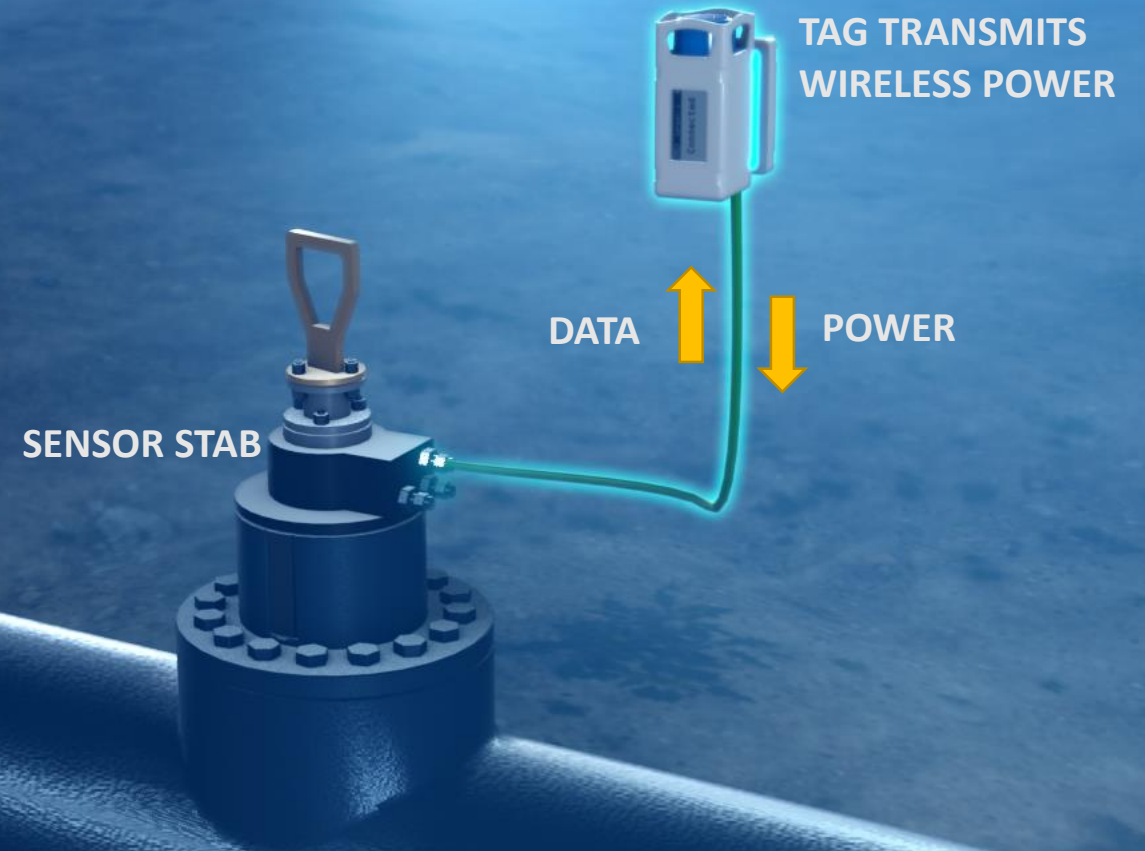
- Acoustic communication and battery are **separated** from the sensor hardware
- **Reduces cost** and manufacturing complexity of application specific sensing hardware
- Permits periodic **cleaning** of bio-foul from transducer and **recharging** of battery
- Encourages 3rd party development by providing a **standard interface** for integration



EXAMPLE #1

POWERING A SENSOR

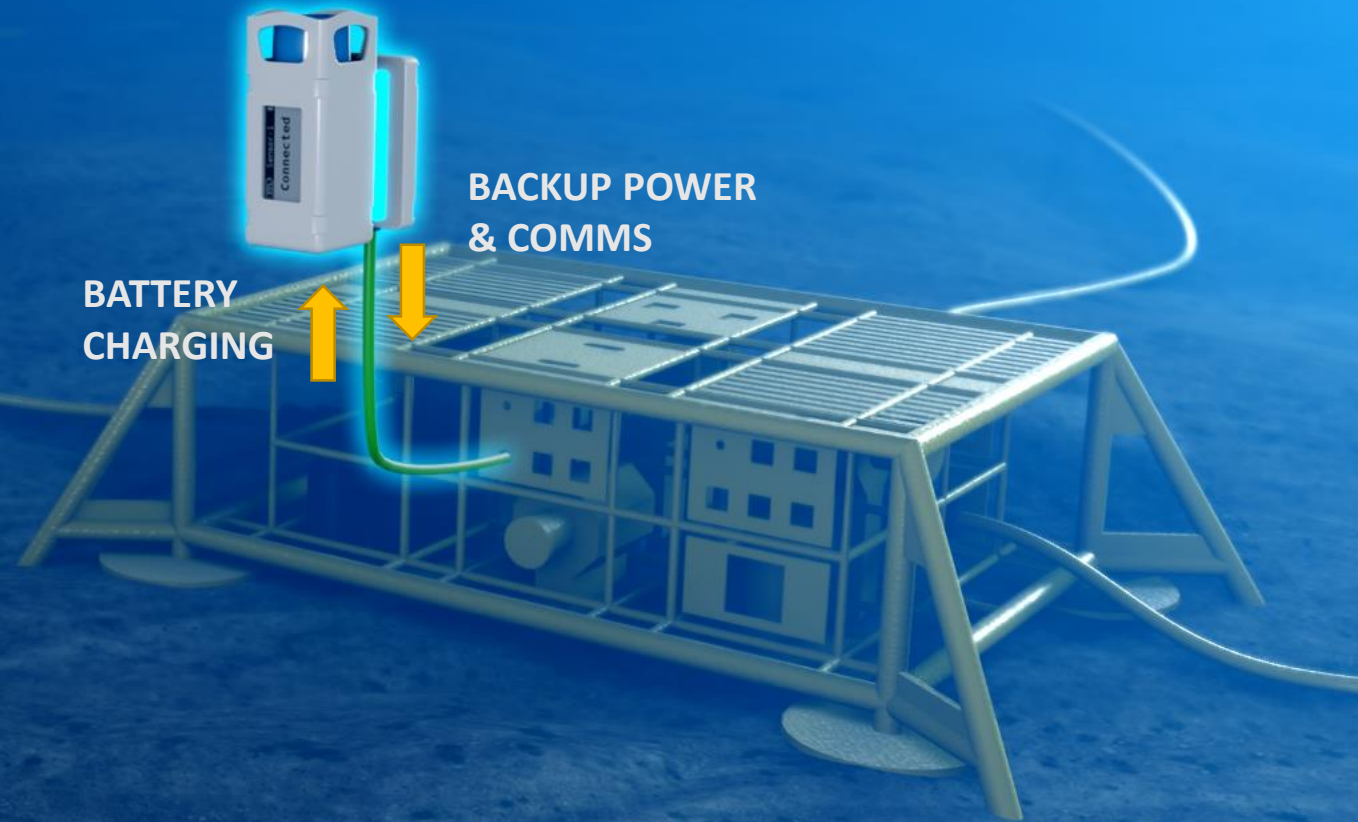
- A process monitoring sensor installed in a hot stab fitting
- Power for the sensor is drawn from the battery in Subsonus Tag via its wireless power interface
- Sensor data can be periodically polled via the Tag acoustic modem
- Tag can be exchanged without disturbing the sensor installation



EXAMPLE #2

EQUIPMENT POWER

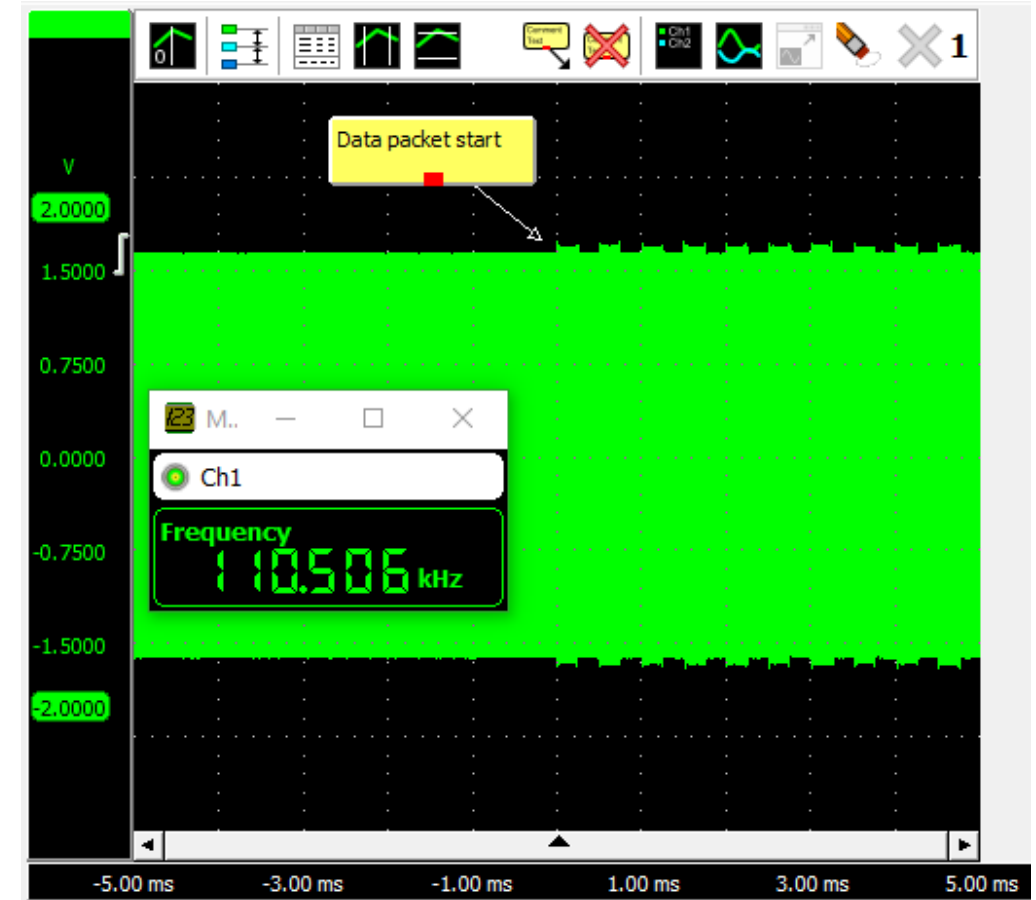
- Power is available from the sub-sea manifold under normal operation
- The Tag battery is charged using standard wireless power transfer
- If the manifold power fails, Tag begins transmitting power
- Diagnostics can be conducted acoustically using backup comms and power provided by Tag



DATA BETWEEN COILS

INSIDE THE WPC SPECIFICATION

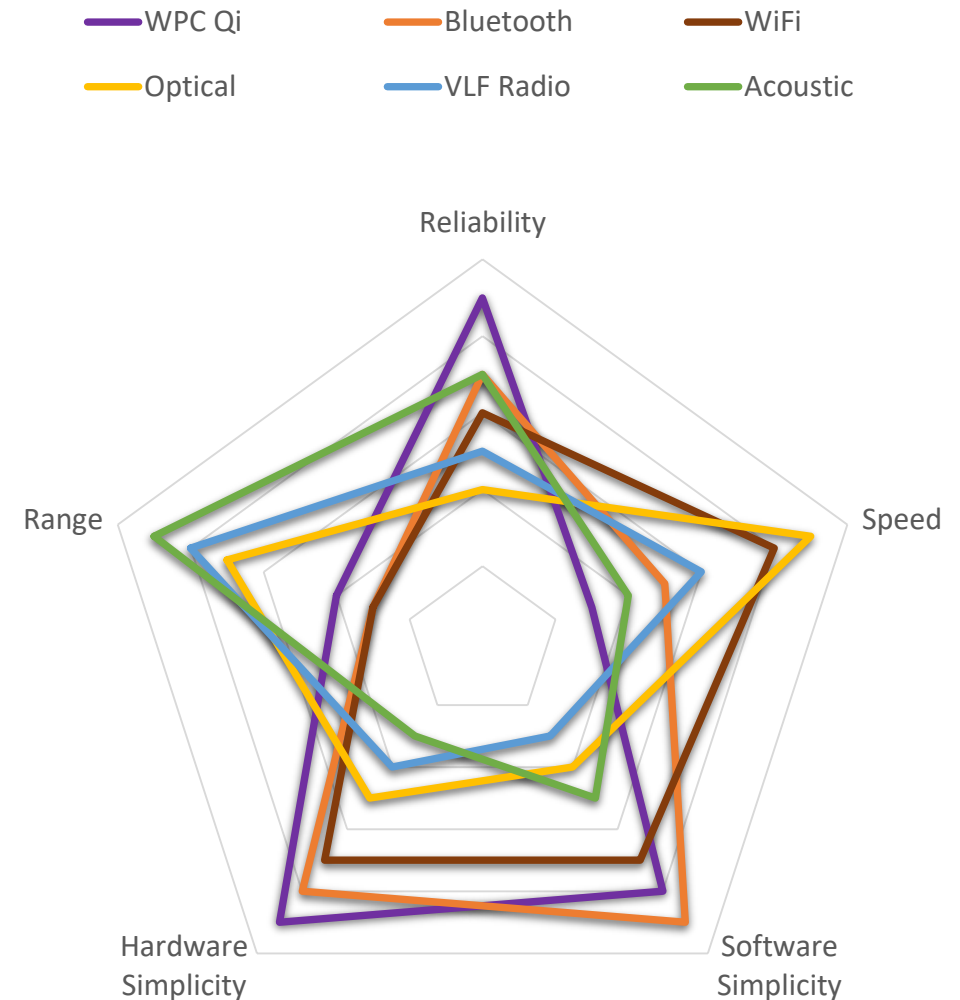
- Qi control **data packets** exist to regulate wireless power transfer
- 2 Kbps carrier, FSK modulation
- Momentarily de-tunes power frequency
- **User data** packets can be used to transmit application-specific data
- Significant certification cost and **complexity reduction** for basic sensor devices



COMPARING COMMS

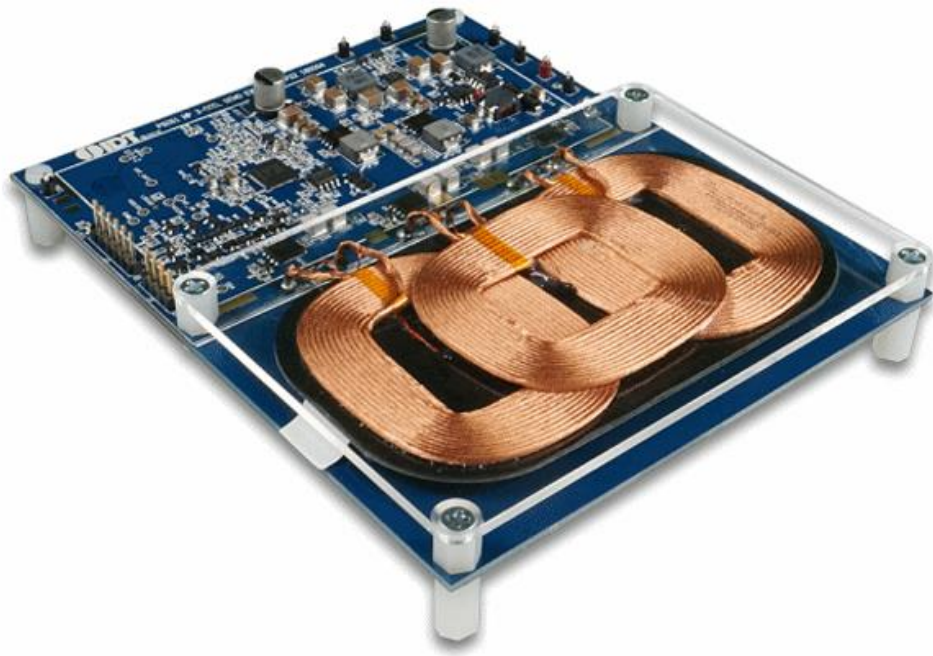
SUBSEA DATA TRANSFER

- No single **data transfer method** is suitable for all subsea communication applications
- Very short range data protocols only offer **connector replacement** functionality
- **Implementation simplicity** plays a key role in the speed of new technology adoption
- Development of **well managed standards** is required for manufacturer interoperability



FUTURE: COIL ARRAYS

WIRELESS POWER FOR ROBOTICS



- Coil arrays increase active **transfer area**
- **Multiply** the power transfer capacity
- Increased installation **flexibility**
- Drafted upcoming WPC standards specify multi-coil **reference designs**

SENSOR DEMO

USING SUBSONUS TAG

- The 'Sensor Demo' board demonstrates the wireless sensor coupling concept
- Place in proximity to the Subsonus Tag battery powered transponder to establish the wireless power connection
- The demo board contains a temperature sensor chip. The data is transmitted to Subsonus Tag and displayed on the screen



OUR PRODUCTS

INERTIAL NAVIGATION SYSTEM



SUBSEA



POST-PROCESSING



COMPASS



ACCESSORIES



OUR CUSTOMERS

AEROSPACE & DEFENCE

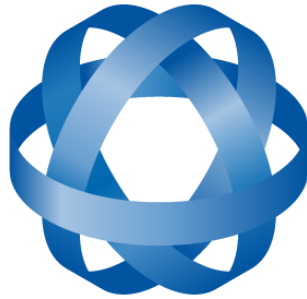


AUTOMOTIVE



TECHNOLOGY





ADVANCED NAVIGATION

POSITIONING **EVERYWHERE.**