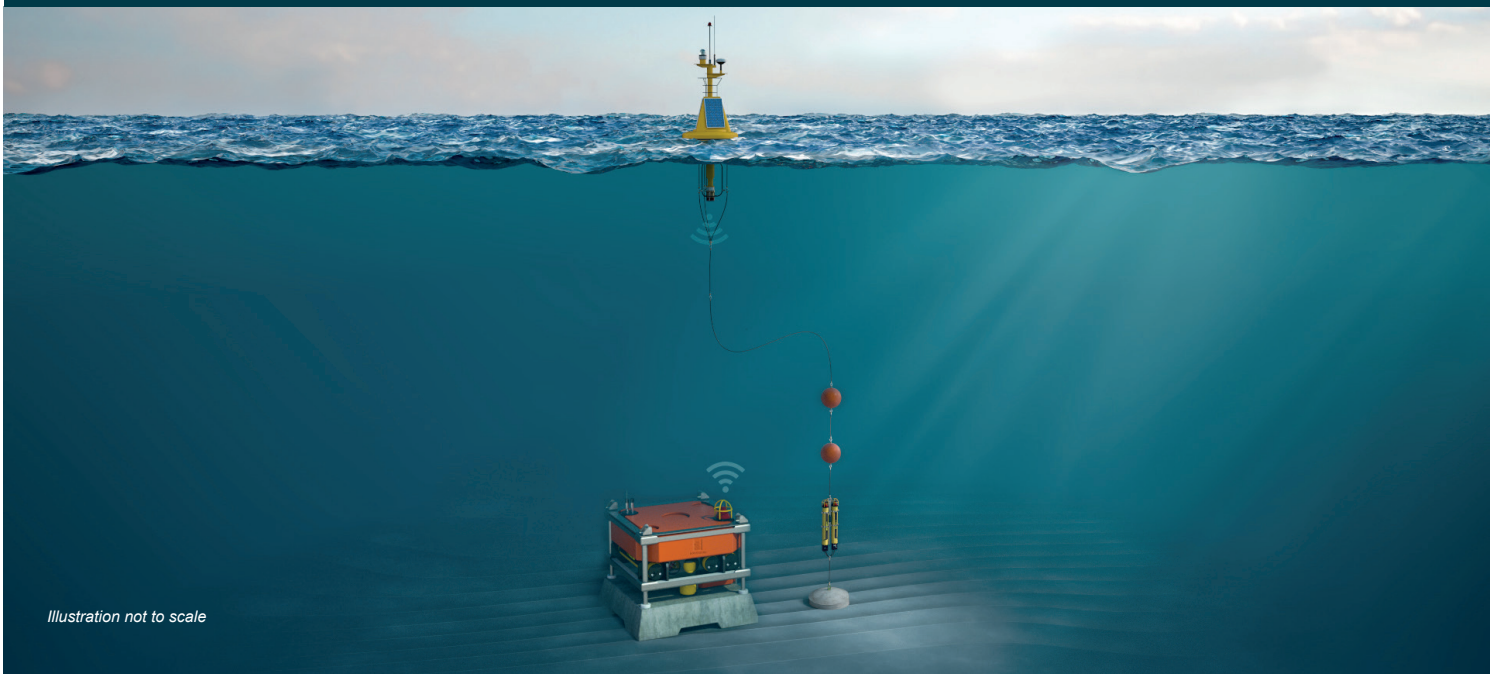
APPLICATION NOTE

KONGSBERG



07.08.2017

KONGSBERG TSUNAMI WARNING SYSYEM

Importance of GEODESY Monitoring

Tsunamis are caused by a displacement of a huge body of water that can produce waves of up to 100 meters high, which can be devastating for anybody close to shore. Tsunamis may be caused by (among others) earth quakes and submarine landslides. At sea with high water depth a tsunami wave may not be noticed, however the wave is slowed down by decreasing water depth on the way to the shore, causing the wave height to increase significantly. Tsunamis have resulted in the loss of life in several incidents. For example, the 2004 Indian Ocean earthquake occurred at 00:58:53 UTC on 26 December with the epicenter off the west coast of Sumatra, caused a devastating tsunami that resulted in the death of 230,000–280,000 people in 14 countries. People living in coastal communities were inundated with waves up to 30 metres (100 ft) high.
[U.S. Geological Survey. Retrieved 16 June 2016].

Description of the system

The Kongsberg tsunami warning system uses two acoustically linked but physically independent components. The system is comprised of a K-Lander and a buoy which form one tsunami warning system.
The key component of the system is the GEODESY module which is part of the K-Lander. The GEODESY module (or SOS module – Seismic and Oceanic Sensors) consists of a combination of highly precision pressure sensors and a high-resolution accelerometer. The pressure sensors used in this module have a depth resolution that is better than 1 mm / 5000 m and are combined in a system that effectively removes long term drift to less than 1 cm for its multi-year lifetime.

This pressure sensor setup exceeds all quality requirements for a tsunami warning system. The GEODESY module also incorporates a high resolution triaxial accelerometer that is used to distinguish between pressure events originating from sea level changes and ground movement. The integrated datalogger uses the accelerometer data to remove seafloor movement events from the pressure measurements.

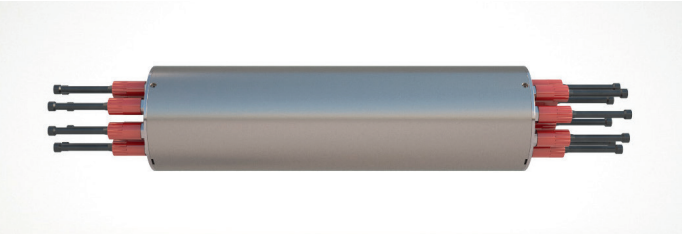
The triaxial accelerometer can also be used as a seismometer to get more detailed information about the earthquake that caused the tsunami. The GEODESY module is calibration free and requires very low maintenance.

The KONGSBERG K-Lander 1S1H. The modular design, coupled with a self-floating buoyancy based recovery system, allows for easy integration and recovery of various sensors suited for diverse long-term subsea monitoring applications.

KONGSBERG TSUNAMI WARNING SYSYEM

Intelligent Logger
The DPU (Data Processing Unit) is the nerve center of each K-Lander system, managing and controlling sensor operations as well as logging sensors data. Intelligent algorithms allow for event-based changes in scheduling and switching between sampling scenarios.

The standard measurement interval is 15 s for all sensors on the system. If the logger detects a water depth change of 3 cm or more in a specific timeframe then a tsunami warning is sent to a tsunami warning center.



The Kongsberg DPU can be interfaced with analog, RS232, RS485 and Ethernet sensors. The DPU is capable of processing the sensor values into key data, min / mean / max, or events for example that can be efficiently transmitted via the cNODE® acoustic link, either to a vessel or via a subsea transponder network.

As a precaution, every 6 h the system collects pressure data for every 15 minutes from the logs and sends the collected data to the buoy. The information collected by the buoy can be forwarded to the tsunami warning system. These regular transmissions can be used to gather statistical data for the specific site of the warning system and to make sure that the system is online.

Industry standard Lithium cNODE batteries are used to power the lander. Typical deployments of the lander system are in the range from one to 3 years.

cNODE® Communication
Communication topside is conducted by a buoy outfitted with modem technology. The lander includes one to two cNODE transponders that are acoustically connected to the cNODE modem in the buoy. This cNODE technology has proven to work reliably in many industrial applications all over the world.

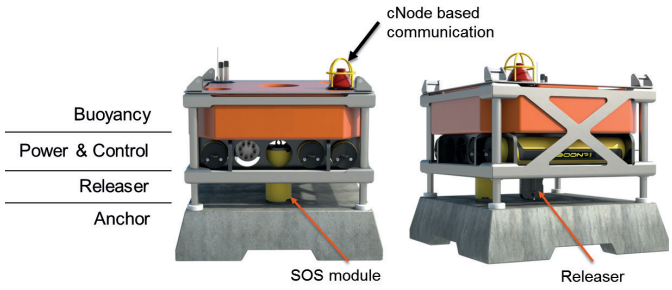
cNODE® is a family of transponders for underwater acoustic positioning and data link. cNODE® operates with both HiPAP®, HPR and cPAP® transceivers.

Buoy
The buoy in the system acts as a relay station between the lander system on the seafloor and a satellite link to the tsunami warning system. Messages can be sent in either direction, for example to activate a higher data resolution mode on the lander.

The buoy is controlled by a low power data processing unit that contacts the tsunami warning center in regular intervals with status information about the quality of the contact to the lander and the status of the overall system. The Kongsberg bottom-side lander can also be easy integrated in other Tsunami buoy systems that are a proved technology for tsunami monitoring.

Patapsco River smart buoy of the Captain John Smith Chesapeake National Historic Trail buoy system. Image courtesy of NOAA

Release Mechanism
On the lander, the GEODESY module is fixed on a concrete block that forms the foundation of the lander. The lander itself resides on a concrete block which is connected to a release mechanism. That mechanism can be triggered to disconnect the lander and the GEODESY module from the concrete block. From there, the system floats to the surface where it can be easily recovered.



K-Lander 1S1H Geodesy Package, highlighting cNODE data link, SOS module and acoustic releaser.

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