Installation of compact seafloor cabled seismic and tsunami observation system using ICT

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A seismic and tsunami observation system using seafloor optical fiber had been installed off Sanriku, northeastern Japan in 1996 to obtain exact seismic activity and to observe tsunami on seafloor. This system is based on the tele-communication technology, and observation was performed continuously in real-time. In March 2011, the Tohoku-oki earthquake occurred at the plate boundary, and the system recorded seismic waves and tsunamis by the mainshock. These data are useful to obtain accurate position of the source faults and source region of tsunami. However, the landing station of the system was damaged by huge tsunami, and the observation was suspended. Because the real-time seafloor observation by cabled system is important in this region, we decide to reconstruct a landing station and install newly developed Ocean Bottom Cabled Seismic and Tsunami (OBCST) observation system for additional observation and/or replacement of the existing system. From 2005, we have been developed the new compact Ocean Bottom Cabled Seismometer (OBCS) system using Information and Communication Technology (ICT). Our system is characterized by securement of reliability by using TCP/IP technology and down-sizing of an observation node using up-to-date electronics technology. In 2010, the first OBCS was installed in the Japan Sea. The new OBCST system is placed as the second generation of our system, and uses standard TCP/IP protocol with a speed of 1 Gbps for data transmission, system control and system monitoring. The Wavelength Division Multiplexing (WDM) is also introduced to reduce number of optical fibers. There are two types of observation nodes. Both types have accelerometers as seismic sensors. One type of observation nodes equips a crystal oscillator type pressure gauge as tsunami sensor. Another type has an external port for additional observation sensor by using Power over Ethernet technology. Clock is delivered to all observation nodes from the GPS receiver on a landing station using simple dedicated lines. In addition, clock can be synchronized through TCP/IP protocol with an accuracy of 300 ns (IEEE 1588). A simple canister for tele-communication seafloor cable is adopted for the observation node, and has diameter of 26 cm and length of about 1.3 m.
A route for the new OBCST was selected in consideration of those of the existing cable and plans for another new cable system, and results form a route survey in 2013. According to the route plan, the system has a total cable length of 105 km and 3 observation nodes with 30 or 40 km spacing. Two observation nodes have a built-in tsunami meter, and the furthest observation node has the PoE port. At the deployment of the cable system, we attached a precise pressure gauge with digital output to the PoE port.
Deployment of the OBCST system was carried out in September 2015 by using a commercial telecommunication cable ship. First, the cable ship swept the seafloor along the cable route to remove obstacles on the seafloor. An end of cable was landed to the landing station and the cable ship started deployment of the cable system offshore. In the region where the water depth is less than 1,000 meters, the submarine cable and the observation node closest to the coast were simultaneously buried with using a plough-type burial machine. Burial depth is 1 meter below the seafloor. Finally, a remote operated vehicle buried the submarine cable around the landing point. After finishing of the deployment, data recording was immediately started.
From the seismic data from the new system, it is found that the noise levels are comparable to those at the existing cabled system off Sanriku. In addition, it is confirmed that burial of the sensor package is effective noise reduction. For water pressure data, pressure gauges have a

resolution of less than 1 hPa. Data from all the sensors both the new system and the existing system are consistent.

Keywords: Cabled seafloor observation system, Ocean bottom seismometer and tsunami meter, Real-time observation