Claims

1. A system for distributed acoustic sensing in a marine environment surrounding a repeater along a fibre-optic submarine communications cable, the system comprising:

at least one distributed acoustic sensing (DAS) unit, comprising:

a light source that is configured to transmit outgoing light in at least one fibre-optic sensing cable located in the marine environment; and

a receiver configured to receive reflected light of the outgoing light that has been back scattered along the at least one fibre-optic sensing cable, the reflected light including at least one optical property influenced by an acoustic disturbance in the marine environment; and

an optical multiplexer for multiplexing optical signals onto the fibre-optic submarine communications cable via the repeater, the optical signals carrying information on the at least one optical property influenced by an acoustic disturbance in the marine environment.

2. The system of claim 1, wherein the optical multiplexer is configured to multiplex the optical signals onto the fibre-optic submarine communications cable via a loop back coupler of the repeater.

3. The system of claim 1 or 2, wherein the optical multiplexer is configured to time-multiplex and/or frequency-multiplex the optical signals with other optical signals carried on the fibre-optic submarine communications cable.

4. The system of any one of claims 1 - 3 wherein the optical multiplexer includes an optical transmitter configured to generate the optical signals based on the information on the at least one optical property influenced by an acoustic disturbance in the marine environment.

5. The system of any one of claims 1 - 4 wherein the at least one DAS unit is powered by the repeater.

6. The system of any one of claims 1 - 5 wherein the at least one fibre-optic sensing cable comprises at least two fibre-optic sensing cables and wherein the at least one DAS unit comprises multiple spaced apart DAS units, wherein the DAS units are connected via a distribution hub which in turn communicates with the repeater via one or more combined or separate power and data cables.

7. The system of any one of claims 1 - 6 wherein at least one of the fibre-optic sensing cables is provided with a magneto-restrictive coating for distributed magnetic sensing in the marine environment surrounding the repeater.

8. The system of claim 7, further comprising a combination of fibre-optic acoustic and fibre-optic magneto-restrictive sensing cables to provide both distributed acoustic and distributed magnetic sensing in the same marine environment.

9. The system of any one of claims 1 - 8 wherein the at least one DAS unit further includes a housing that contains the light source and the receiver.

10. A system for distributed acoustic sensing in a marine environment surrounding a repeater along a fibre-optic submarine communications cable, the system comprising:

at least one distributed acoustic sensing (DAS) unit, comprising:

a light source that is configured to transmit outgoing light in at least one fibre-optic sensing cable located in the marine environment; and

a receiver configured to receive reflected light of the outgoing light that has been back scattered along the at least one fibre-optic sensing cable, the reflected light including at least one optical property influenced by an acoustic disturbance in the marine environment; and

an optical multiplexer for multiplexing optical signals onto the fibre-optic submarine communications cable via the repeater, the optical signals carrying information on the at least one optical property influenced by an acoustic disturbance in the marine environment;

wherein beam forming is applied to an acoustic time series to generate a scanning beam to determine one or more of a location and direction of acoustic disturbances.

11. The system of claim 10, wherein the at least one DAS unit is configured to implement beam forming along the at least one fibre-optic sensing cable such that the scanning beam yields the direction of the marine acoustic disturbance and its location relative to the fibre-optic sensing cable.

12. The system of claim 10, wherein the optical multiplexer is configured to multiplex the optical signals onto the fibre-optic submarine communications cable via a loop back coupler of the repeater.

13. The system of claim 10, wherein the optical multiplexer is configured to time-multiplex and/or frequency-multiplex the optical signals with other optical signals carried on the fibre-optic submarine communications cable.

14. A method for distributed acoustic sensing in a marine environment surrounding a repeater along a fibre-optic submarine communications cable, the method comprising:

transmitting outgoing light from a light source of at least one distributed acoustic sensing (DAS) unit in at least one fibre-optic sensing cable located in the marine environment; and

receiving reflected light of the outgoing light at a receiver of the at least one DAS unit, the reflected light being outgoing light that has been back scattered along the at least one fibre-optic sensing cable and includes at least one optical property influenced by an acoustic disturbance in the marine environment; and

multiplexing, via an optical multiplexer, optical signals onto the fibre-optic submarine communications cable via the repeater, the optical signals carrying information on the at least one optical property influenced by an acoustic disturbance in the marine environment.

15. The method of claim 14, wherein the multiplexing of the optical signals onto the fibre-optic submarine communications cable is performed via a loop back coupler of the repeater.

16. The method of claim 14 or claim 15, wherein the multiplexing occurs via time-multiplexing and/or frequency multiplexing of the optical signals onto the fibre-optic submarine communications cable.

17. The method of any one of claims 14 to 16, further comprising generating, at an optical transmitter of the optical multiplexer, the optical signals based on the information on the at least one optical property influenced by an acoustic disturbance in the marine environment.

18. The method of any one of claims 14 to 17, wherein at least one of the at least one fibre-optic sensing cable is provided with a magneto-restrictive coating for distributed magnetic sensing in the marine environment surrounding the repeater.

19. The method of any one of claims claim 14 to 18, wherein time series acoustic channels are beam formed and result in the formation of at least one scanning beam.

20. The method of claim 19, wherein the at least one DAS unit is configured to implement beam forming, such that the scanning beam yields at least one of a direction of the acoustic disturbance and its location relative to the fibre-optic sensing cable.