US 20080217022A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2008/0217022 A1

(43) Pub. Date: Sep. 11, 2008

Deans

(54) SUBSEA COMMUNICATIONS MULTIPLEXER

(75) Inventor: **Gregor Deans**, Paris (FR)

Correspondence Address:
SCHLUMBERGER RESERVOIR COMPLETIONS
14910 AIRLINE ROAD
ROSHARON, TX 77583 (US)

(73) Assignee: **SCHLUMBERGER TECHNOLOGY CORPORATION**, Sugar Land, TX (US)

(21) Appl. No.: **11/682,694**

(22) Filed: **Mar. 6, 2007**

Publication Classification

(51) **Int. Cl.**
E21B 7/00 (2006.01)

(52) **U.S. Cl.** **166/338**

(57) **ABSTRACT**

A system for communicating between a surface facility and a subsea production control system includes a communications device proximate the water surface. The water surface communications device has at least one communication interface. A communications device is functionally associated with a wellhead or subsea structure proximate the water bottom. The water bottom communications device has at least one communication interface. A communication channel extends between the surface communication device and the water bottom communication device. A multiplexer is functionally coupled to the communication interface on each of the surface and water bottom communication devices. At least two remote devices are functionally coupled to the water bottom multiplexer. The remote devices comprise at least one of a sensor and a control. At least two corresponding devices are coupled to the surface multiplexer. The corresponding devices include at least one of a signal acquisition device and a control signal generating device.

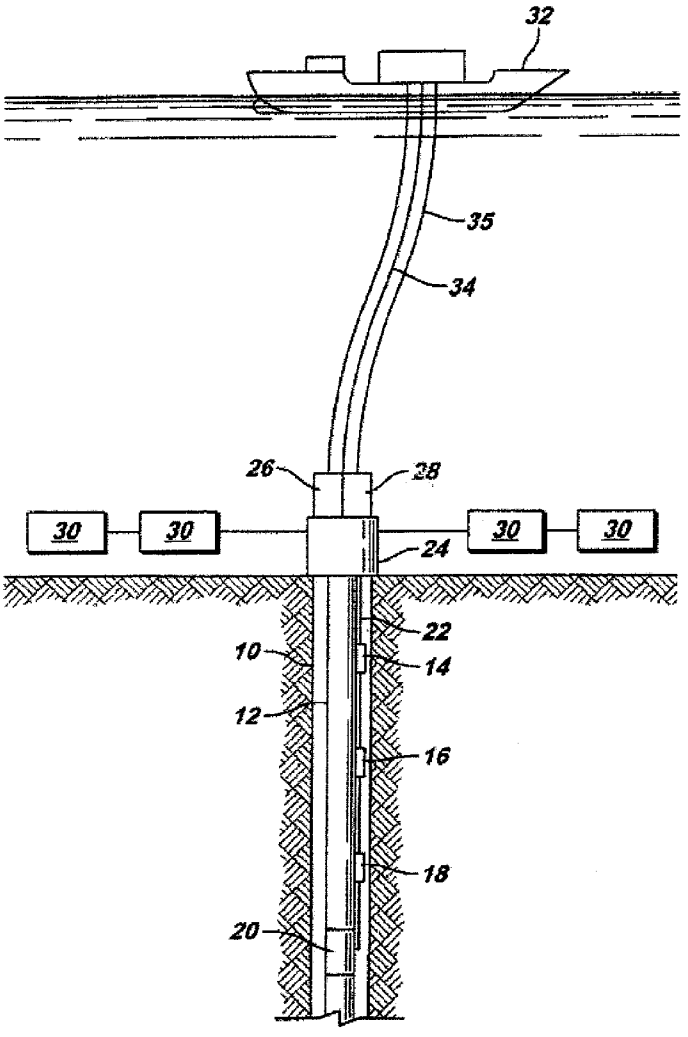
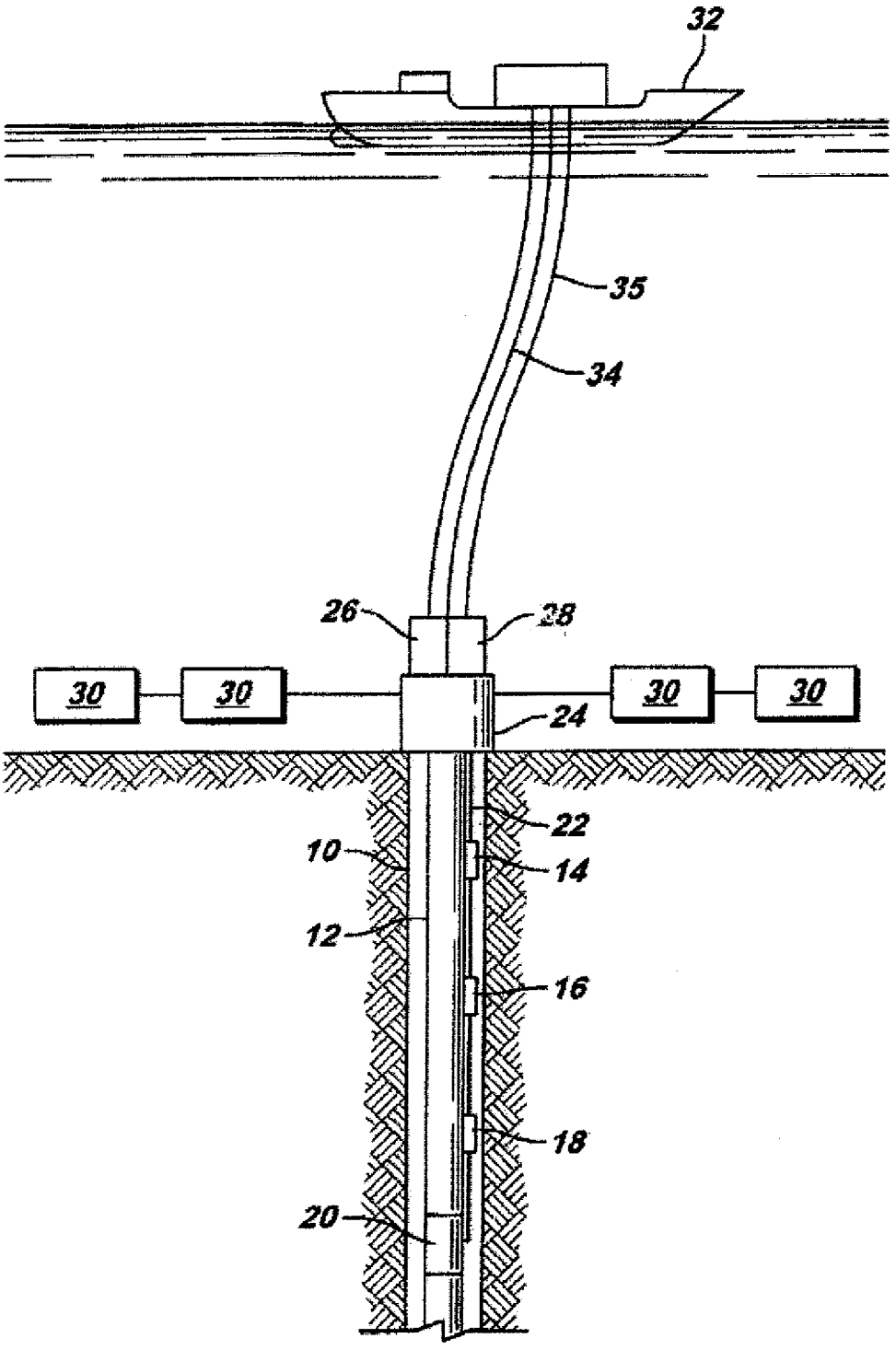


FIG. 1



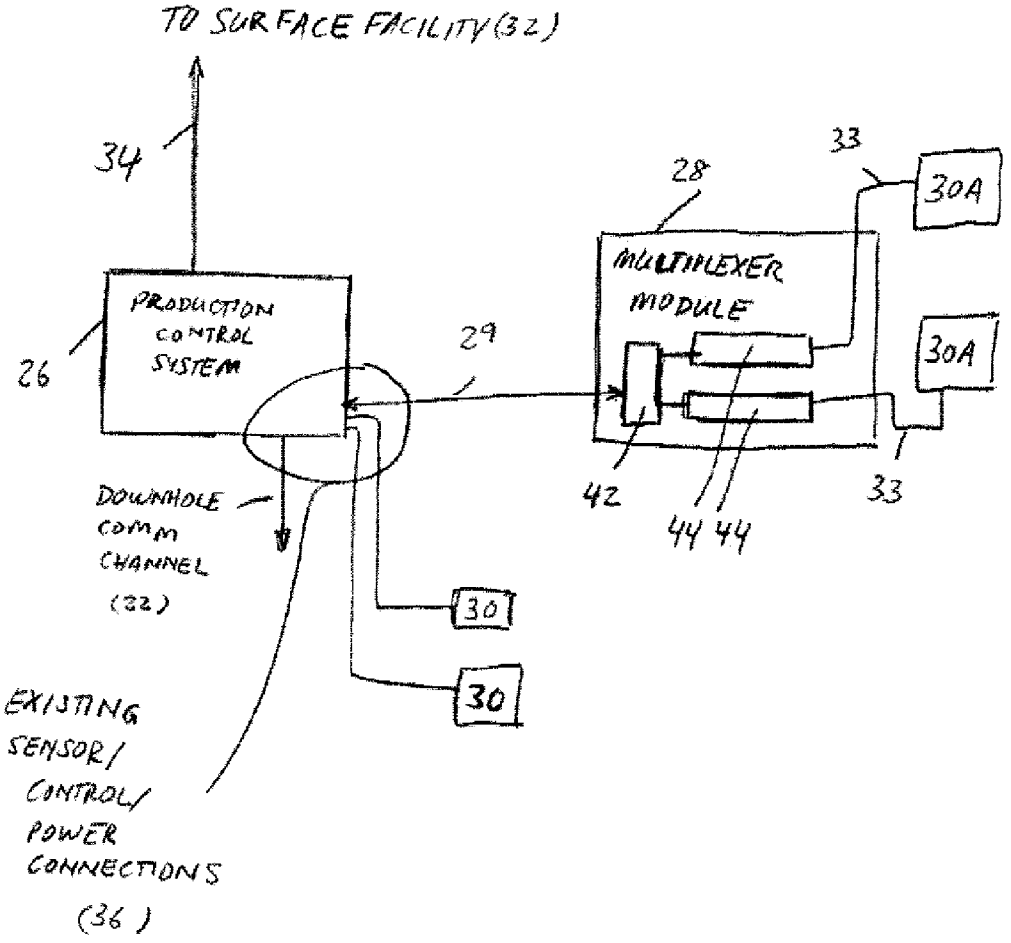

TO SURFACE FACILITY (32)
34
28
33
30A
MULTIPLEXER MODULE
PRODUCTION CONTROL SYSTEM
26
29
30A
42
44 44
33
DOWNHOLE COMM CHANNEL (22)
30
30
EXISTING SENSOR/ CONTROL/ POWER CONNECTIONS (36)

FIG 2

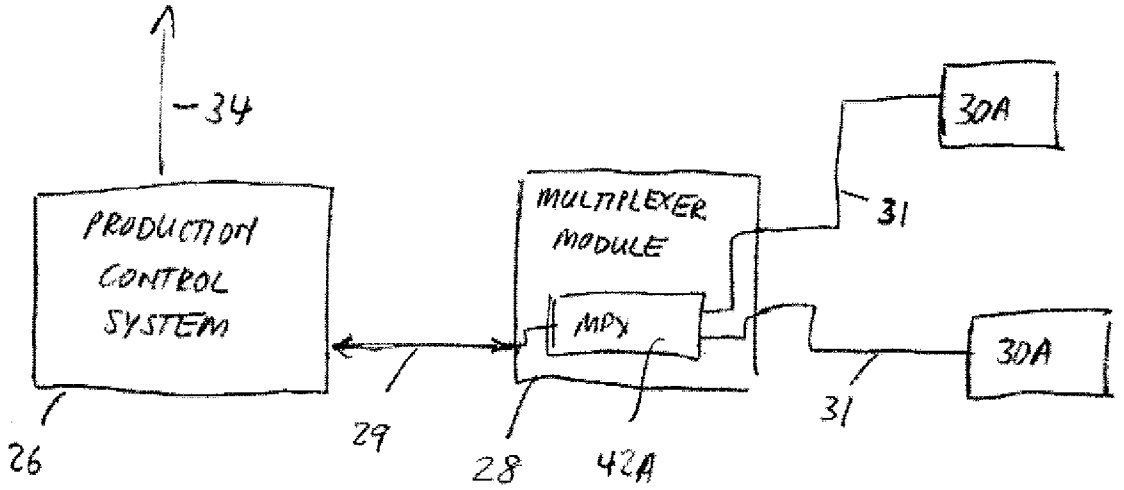

34
PRODUCTION CONTROL SYSTEM
MULTIPLEXER MODULE
MPX
30A
30A
31
31
26
29
28
42A

FIG 3

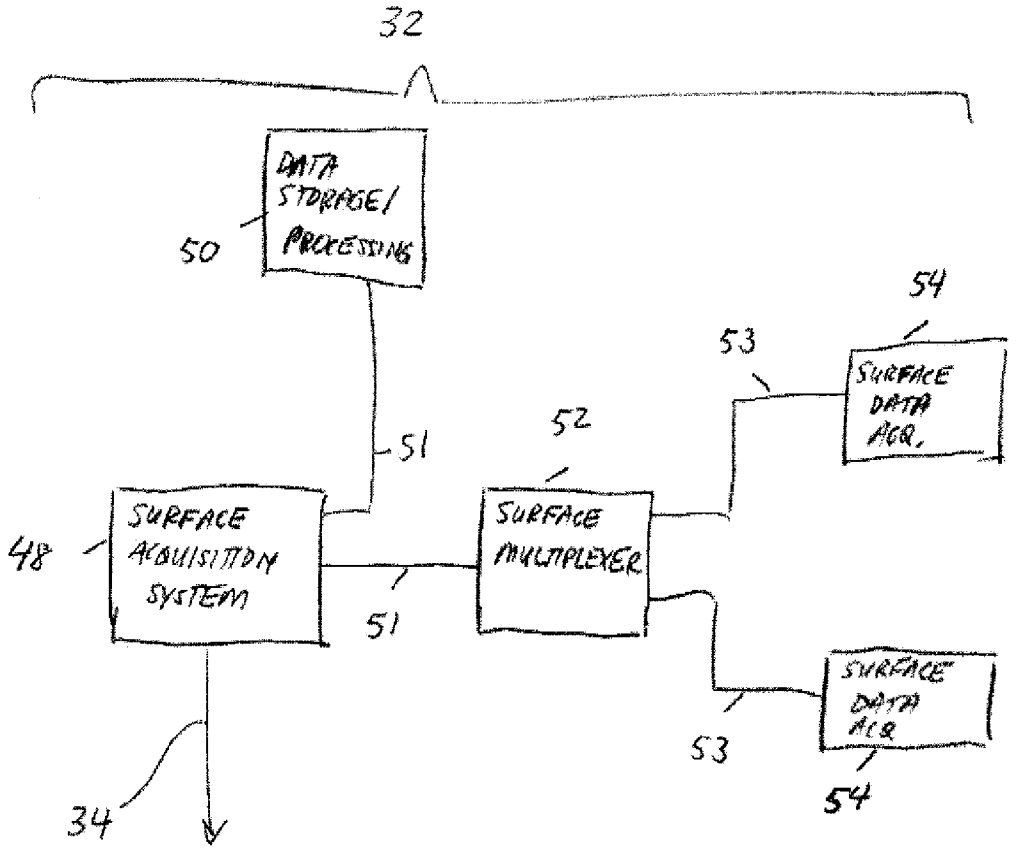

32
DATA STORAGE/ PROCESSING
50
54
53
SURFACE DATA ACQ.
52
51
48
SURFACE ACQUISITION SYSTEM
SURFACE MULTIPLEXER
51
53
SURFACE DATA ACQ
54
34

FIG 4

SUBSEA COMMUNICATIONS MULTIPLEXER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Not applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable.

BACKGROUND OF THE INVENTION

[0003] 1. Field of the Invention

[0004] The invention relates generally to the field of devices used to communicate signals between a wellbore or seafloor-based device having production control equipment at the bottom of a body of water and production facilities located at the water surface. More particularly, the invention relates to signal multiplexing devices that enable signals to and from a plurality of wellbore or seafloor-based devices to communicate to the production facilities using existing water bottom to water surface communication channels.

[0005] 2. Background Art

[0006] U.S. Patent Application Publication No. 2004/0262008 A1 filed by Deans et al. and incorporated herein by reference describes a system for communicating signals from a production facility located at the surface of a body of water, such as a floating production, storage and offloading facility ("FPSO") or a floating production platform, for example, to and from a wellbore drilled through subsurface formations below the bottom of the body of water or to and from sensors and equipment located on the seafloor. The wellbore includes various sensors and control devices connected to a communication linking device disposed in a "wellhead" system disposed near the water bottom. The seafloor equipment can include various sensors mounted on seabed production equipment disposed on the water bottom.

[0007] In some instances, it may be desirable to add sensors and/or control devices to an existing wellbore or seafloor equipment, or to be able to couple sensors and/or control devices from additional wellbores or seafloor equipment to an existing communication link. Such need could be addressed by adding an additional communication channel. Such need could also be addressed by providing additional interfacing devices between such additional sensors/controls and an existing communication channel. The latter option has been made less desirable by adoption of certain industry standard communication configuration and protocol. The configuration and protocol are described in, *Intelligent Well Interface Standardisation* ("*IWIS*") *Panel,* published by OTM Consulting Ltd., 44 Quarry Street, Guildford, Surrey GU1 3XQ, United Kingdom. The adopted standards limit the number of device interfaces that may be used in association with a communication channel. Other communications standards include the subsea instrumentation interface standardization ("SIIS") interface standard, also published by OTM Consulting Ltd. and the subsea fibre optic montoring group ("SeaFOM") standard for fiber optic subsea equipment, also published by OTM Consulting Ltd.

[0008] It is desirable to provide additional control device and/or sensor communication capacity to an existing water bottom to water surface communication channel without increasing the number of device interfaces.

SUMMARY OF THE INVENTION

[0009] A system for communicating between a surface facility and a subsea production control system includes a communications device proximate the water surface. The water surface communications device has at least one communication interface. A communications device is functionally associated with a wellhead or other production control structure such as a production manifold proximate the water bottom. The water bottom communications device has at least one communication interface. A communication channel extends between the surface communication device and the water bottom communication device. A multiplexer is functionally coupled to the communication interface on each of the surface and water bottom communication devices. At least two remote devices are functionally coupled to the water bottom multiplexer. The remote devices are at least one of a sensor and a control. At least two corresponding devices are coupled to the surface multiplexer. The two corresponding devices include at least one of a signal acquisition device and a control signal generating device.

[0010] Other aspects and advantages of the invention will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** shows an example arrangement of a subsea monitoring and control (SMC) system that includes a multiplexing unit coupled thereto.

[0012] FIG. **2** shows one example of a multiplexer coupled to a subsea production control system.

[0013] FIG. **3** shows another example of a multiplexer coupled to a subsea production control system.

[0014] FIG. **4** shows one example of equipment in a surface facility that can send commands to an accept signals from multiplexer-connected devices such as shown in FIGS. **2** and **3**.

DETAILED DESCRIPTION

[0015] FIG. **1** shows an example arrangement of a subsea production system, which includes a subsea well **10** in which certain types of completion equipment is installed. The completion equipment includes a production conduit **12**, such as production tubing. Various sensors **14**, **16**, **18** and control devices **20** are positioned within the subsea well **10**. Examples of sensors **14**, **16**, **18** include pressure sensors, temperature sensors, flow rate sensors, shock detectors (e.g., accelerometers), among other types of sensors. Examples of control devices **20** include a flow control device (e.g., a valve) and a pump, among others. The sensors **14**, **16**, **18**, and the control device **20** can be coupled by a downhole communications link **22**. The downhole communications link **22** can be an electrical cable, a fiber optic line or a wireless communications link such as acoustic or electromagnetic. The downhole communications link **22** extends to subsea wellhead equipment **24**, such as a subsea well control system or "tree." Part of the subsea wellhead equipment **24** can include a subsea production control system **26**. Note that sometimes the production control system may be mounted on a structure such as a production manifold rather than on the tree and

perform valve control and monitoring on the seabed equipment rather than in the wellbore ("downhole").

[0016] Other, various types of sensors and/or control devices **30** may be placed at or near the water bottom (sea bed), either in the subsea wellhead equipment **24**, at or within flow conduits arranged on the seabed, on a hydrocarbon-gathering manifold, a water-injection manifold, or elsewhere above or on the water bottom but below the sea surface. The sensors and/or control devices **30** (collectively "water bottom devices") can include, as non-limiting examples, a corrosion monitor, a sand monitor, a subsea flow meter, a pump, a flow line measurement sensor, a seabed acoustic sensor, a deposition sensor, a seabed seismic sensor. The various subsea sensors and/or control devices **30** are also coupled to the subsea production control system **26**. Such sensors and/or control devices can be coupled to the control system **26** using fiber optic monitoring and control lines. For purposes of defining the sensors can be interrogated or what control devices can be operated, the term "remote device" is used herein to mean any device that generates a signal either as indication of a change in status (such as a control device being switched on or off) or in response to detection of a physical parameter (a sensor), or any device that changes its operation in response to a control signal (i.e., a control device such as a valve being opened or closed or a pump being switched on or off).

[0017] The subsea production control system **26** provides control signals to the various subsea sensors and/or control devices and to the various downhole sensors and/or control devices. The subsea production control system **26** may also provide control signals to wellhead equipment **24** components, such as valves. The subsea production control system **26** may include a local processor (not shown) that can generate such control signals in response to parameters detected by one or more sensors (e.g., **14**, **16**, **18** and **30** in FIG. **1**). The subsea production control system **26** may also accept command signals generated by equipment (FIG. **4**) on board the surface facility and distribute such command signals to the various control devices (e.g. **20** and **30** in FIG. **1**).

[0018] In the present description a "subsea" device (such as a subsea sensor or a subsea control device) refers to a device located generally at or above the water bottom but below the sea surface. A "downhole" device refers to a device placed in the well **10** or in another well drilled through the subsurface. More generally, a "device" (such as a sensor or a control device) associated with a subsea well refers to either a subsea device or a downhole device.

[0019] In one example implementation, the subsea production control system **26** is able to receive measurement signals from one or more of the sensors associated with a subsea well for communication to a surface facility **32** over a communications link **34**. The communications link **34** can be provided through a flexible power/signal and/or produced fluid conduit called an "umbilical" **35** extending from the subsea wellhead equipment **24** to the surface facility **32**. Usually, hydraulic, electrical power and other control lines are also provided through the umbilical **35**. The subsea production control system **26**, as previously stated, may also accept control signals from equipment (FIG. **4**) disposed in the surface facility **32** to control operation the various devices and to communicate such control signals to the respective devices. The surface facility **32** may be a production platform or a floating production storage and offloading unit ("FPSO") or similar device above the water surface that includes production monitoring and control systems as well as equipment (not shown separately) to process and direct the flow of fluids from one or more wells below the water surface.

[0020] The communications link **34** can be implemented using electrical cable, fiber optic lines, or, other types of communications links such as acoustic telemetry through the water. The subsea production control system **26** typically has a communications interface that uses a proprietary communications protocol for communicating signals between the subsea production control system **26** and the equipment (FIG. **4**) on the surface facility **32**. The proprietary protocol is typically specific to a wellhead equipment manufacturer, and often differs between various wellhead equipment manufacturers. In the present example, the associated systems disposed in the wellhead equipment **24** and the surface facility **32** can conform to a configuration and protocol standard that is described in, *Intelligent Well Interface Standardisation* ("*IWIS*") *Panel,* published by OTM Consulting Ltd., 44 Quarry Street, Guildford, Surrey GU1 3XQ, United Kingdom, cited in the Background section herein. The IWIS standard is set forth in, *ISO* 13628 part 6:2006, published by the International Organization for Standardization, ISO Central Secretariat, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211 Geneva 20, Switzerland.

[0021] In the example arrangement shown in FIG. **1**, the subsea production control system **26** may only include a limited number of interfaces for connection to various sensors and control devices (shown at **14**, **16**, **18**, **20** and **30** in FIG. **1**), or may even include only one such interface. In order to add additional sensors and/or controls operable through the production control system **26** while remaining in conformity with the above adopted industry standard, a system according to the invention can include a communications multiplexer **28** module (explained in more detail below with reference to FIG. **2**) to enable sharing the same communication channel **34** for communication between additional subsea and/or downhole sensors and/or controls with the surface facility **32**. The multiplexer module **28** may be disposed in the same housing as the subsea production control system **26**, or may be disposed in a different housing.

[0022] One example of a multiplexer module **28** used with a subsea production control system **26** is shown schematically in FIG. **2**. The subsea production control system **26** is shown as including a number of existing power/sensor/control connections **36**, each of which can be used to supply operating power to, to supply control signals to and to accept signals from a respectively coupled device such as subsea sensors/controls **30**, or the downhole devices the downhole communications link **22**. The existing connections **36** may be serial (e.g., RS232, RS 422, RS485), Ethernet, or other industry standard such as Profibus and Foundation Fieldbus, for example, or may be proprietary. Because the number of such existing connections **36** is limited, additional sensors and/or control devices (collectively "devices") shown at **30**A and which may include subsea devices and/or downhole devices may be coupled over a communication line **29** to only one of the existing connections **36** through the multiplexer module **28**. In the example shown in FIG. **2**, the multiplexer module **28** may include a multiplexer card **42** disposed in a separate housing and may include individual interface devices **44** for converting proprietary communication protocol from each of the devices **30**A sent thereto over a communication line **33**. The communication lines **33** may include both electrical power and signal communication channels. The interface devices **44** are in signal communication with the multiplexer

card **42**. Output of the multiplexer card **42** is coupled to one of the existing connections **36** on the subsea production control system **26**.

[0023] In a different example shown in FIG. **3**, the multiplexer module **28** may only include the multiplexer card **42**A, and may be coupled to devices **30**A that have open or industry standard communication protocol (e.g., serial, Ethernet, Profibus, Foundation Fieldbus, etc.) and/or interface devices directly associated with each device, and thus do not require separate interface devices in the module **28** such as shown in FIG. **2**. The devices **30**A are coupled to the multiplexer **42**A over communication lines **31**. The communication lines **31** may include both electrical power and signal communication channels.

[0024] FIG. **4** shows one example of equipment located in the surface facility **32** that can be used in connection with the multiplexer-connected devices (**30**A) shown in FIGS. **2** and **3**. A surface acquisition system **48** is in signal communication with the subsea production control system (**26** in FIG. **1**) over the communication link or network **34**. Signals communicated from the various subsea and downhole devices are routed to the appropriate destination device by the surface acquisition system **48** over communication lines **51**. Absent the multiplexer system of the invention, the number of possible communication channels may be limited by the particular configuration of surface acquisition system and its corresponding communication connections in the subsea production control system (**26** in FIG. **1**). Signals associated with the various subsea and downhole devices (e.g., **14**, **16**, **18** and **30** in FIG. **1**) are routed to their ordinary destination in data storage and processing systems, shown generally at **50**. Such systems **50** may include any and all surface facility devices associated with processing measurements from subsea and/or downhole sensors, and devices to send suitable control signals to operate such sensors and/or control devices, as explained with reference to FIG. **1**.

[0025] In the present example, multiplexed signals, originating from the multiplexer (**42** in FIG. **2** and **42**A in FIG. **3**), that occupy a particular portion of the communication protocol used between the surface acquisition system **48** and the production control system (**26** in FIG. **1**) are routed to a surface multiplexer **52**. The surface multiplexer **52** may be embodied as software running on personal computer ("PC") hardware, or may be embodied, for example, as a application specific integrated circuits (ASICs) on a dedicated or other circuit board associated with the surface acquisition system **48**. Signals corresponding to each of the multiplexed devices (**30**A in FIGS. **2** and **3**) are then demultiplexed and are routed to a corresponding surface data acquisition or control operating device **54** over a communication line **53**. In some implementations, one or more of the surface devices **54** may communicate data and signals directly to the data storage and processing system **50**. The surface data acquisition or control device **54** may be embodied as software running on a separate PC or possibly the same PC as the surface multiplexer **52**. The communication protocol sent over the communication lines **53** may be proprietary to the particular device (**30**A in FIGS. **2** and **3**), or may be a standard communication protocol, e.g. serial, Ethernet, etc. The device **54** may be either or both of a data acquisition device. Where the subsea or downhole device (**30**A in FIG. **2**) is a sensor, the surface device **54** would typically include data acquisition elements. Where the subsea or downhole device is a control device, such as a valve or pump, the surface device **54** would typically include control signal generating elements. The surface device **54** may include both acquisition and control signal elements for combination devices subsea or downhole.

[0026] A system according to the invention also relates to the control, supply and monitoring of the electrical power to each device interface card (**44** in FIG. **2**) and/or device (**30**A in FIGS. **2** and **3**). The subsea production and control system **26** can provide electrical power to the subsea multiplexer (**42** in FIG. **2**) over the same subsea cable or jumper which contains the communication channel (**29** in FIG. **2**). The subsea multiplexer module **28** can then route power to each connected internal device interface card (**44** in FIG. **2**) or to each external device (**30**A in FIGS. **2** and **3**). The subsea multiplexer **42** can switch the power on or off to each device and provides monitoring of the individual power supplies to each device. If the existing subsea production control system **26** cannot provide sufficient power for the subsea multiplexer module and sensors, power can be provided directly from surface to the subsea multiplexer module **28** over the existing subsea infrastructure and umbilical (**35** in FIG. **1**) or through a new umbilical and power supply in the surface facility (**32** in FIG. **1**).

[0027] The surface multiplexer **52** packages the communications message with a unique device identifier or address and sends it to the surface acquisition system **48** for communication to the subsea production control system (**26** in FIG. I) over the communication channel **34**. The message is then delivered to the multiplexer module (**28** in FIGS. **2** and **3**) over a local communication connection (**29** in FIGS. **2** and **3**). The multiplexer (**42** in FIG. **2** or **42**A in FIG. **3**) retrieves the original communications message and sends it to the appropriate interface card (**44** in FIG. **2**) over a communication link using the device identifier in the message as a reference, or as explained with reference to FIG. **3**, directly to the respective device. The response from the device or interface card is sent to the surface by the reverse operation through the multiplexer (**42** in FIG. **2** or **42**A in FIG. **3**).

[0028] A multiplexing system according to the various aspects of the invention may provide the capability of adding multiple additional subsea and/or downhole devices to an existing subsea production monitoring and control system without the need to modify such system and without the need to add additional communication channels between the wellhead equipment and the surface facility.

[0029] While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.

What is claimed is:

1. A system for communicating between a surface facility and a subsea production control system, comprising:

a communications device proximate the water surface, the water surface communications device having at least one communication interface;

a communications device functionally associated with the subsea production control system proximate the water bottom, the water bottom communications device having at least one communication interface;

a communication channel extending between the surface communication device and the water bottom communication device;

a multiplexer functionally coupled to the communication interface of each of the water bottom and water surface communication devices;

at least two remote devices functionally coupled to the water bottom multiplexer, the devices comprising at least one of a sensor and a control; and

at least two corresponding devices coupled to the surface multiplexer, the at least two corresponding devices comprising at least one of a signal acquisition device and a control signal generating device.

2. The system of claim **1** wherein at least one remote device is disposed proximate the water bottom.

3. The system of claim **1** wherein at least one remote device is disposed within a wellbore.

4. The system of claim **1** wherein at least one remote device comprises a pressure sensor.

5. The system of claim **1** wherein at least one remote device comprises a temperature sensor.

6. The system of claim **1** wherein at least one remote device comprises a pump.

7. The system of claim **1** wherein at least one remote device comprises a valve.

8. The system of claim **1** wherein the communication channel comprises electrical cable.

9. The system of claim **1** wherein the communication channel comprises a fiber optic communication line.

10. The system of claim **1** wherein the subsea production control system comprises at least one of a, fibre optic monitoring line, a sand detection sensor, a flowrate sensor, a corrosion sensor, a deposition sensor, a micro-seismic sensor, a strain sensor, a vibration sensor, and a position sensor.

11. The system of claim **1** wherein the water bottom multiplexer is disposed within a housing with a subsea production control system.

12. The system of claim **1** wherein the water bottom multiplexer includes a communication interface coupled between the multiplexer and at least one of the remote devices.

13. The system of claim **1** wherein the water bottom communication device comprises only one communication interface.

14. The system of claim **1** wherein the water bottom communication device and the water surface communication device are configured to operate with a proprietary communication protocol.

15. The system of claim **1** further comprising at least one of a data acquisition system and a device control system in signal communication with the water surface communication device, at least one of a data acquisition system and a device control system configured to selectively switch on and switch off operation of at least one of the remote devices by generating a control signal therefore.

16. The system of claim **1** wherein the subsea multiplexer is configured to control the operating power of each individual multiplexed device or sensor.

17. The system of claim **1** further comprising a stand-alone communications device mounted proximate the seafloor and external to the subsea production control system.

* * * * *