

Subsea Electronic Module

This invention relates to a subsea electronic module for an underwater fluid extraction well, and a method of enabling Ethernet communication therefor.

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The control of an underwater fluid extraction well, such as a hydrocarbon extraction well, is typically managed by a subsea electronic module (SEM) housed in a subsea control module (SCM), itself mounted on a subsea “Xmas tree” located on the sea bed above the fluid extraction well. Existing SEMs contain a number of printed wiring boards or cards which perform dedicated functions, such as the operation of hydraulic directional control valves (DCVs). Communication to and from the SEM is enabled via a modem if there are copper links, or an equivalent optical modem if optical links are employed. Modern SEMs utilise Ethernet communication between the electronic cards, which requires Ethernet switches to be mounted on the circuit boards. Typically, the electronic cards are arranged in sets as a ‘bay’, with a number of bays within the SEM. Further Ethernet switches are required to enable communication between the bays. Consequently, a large number of interfaces is required between all the Ethernet components, which components typically include switch blades. These interfaces are conventionally effected by transformers. However, transformers are expensive and consume significant space on the SEM electronic cards, which limits the functions available in an SEM whose dimensions are strictly limited by well operator customers.

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It is an aim of the present invention to remove the need for transformers as SEM Ethernet component interfaces.

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This aim is achieved by replacing the Ethernet component interface transformers with capacitive couplings, e.g. capacitances such as capacitors. Although the use of capacitors instead of transformers is a known technique, it is rarely employed, as there are severe restrictions on transmission distances compared to the transformer case. Thus capacitive coupling is not generally a viable option in Ethernet systems, and so transformers are standard, including for SEMs.

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However, in accordance with the present invention, capacitive coupling is made viable through re-organisation of the cards within an SEM to ensure that transmission distances are small. This brings about major benefits in terms of cost and weight reduction, as well as allowing the functional repertoire of the SEM to be increased.

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The present invention therefore provides various advantages, including:

- a) Additional space is provided on the electronic cards for well control and monitoring functions which are the primary purposes of the SEM;
- 10 b) The cost of components is reduced in the Ethernet communication system;
- c) Power consumption is reduced compared to prior art magnetic coupling, particularly if FX PHY(s) are employed as line drivers, as these devices have low quiescent power consumption (when compared to a PHY suitable for driving a magnetically coupled interface) but have adequate capacity to drive a capacitively
- 15 coupled LAN;
- d) Reduced dissipation results in lower component temperature, which in turn leads to enhanced component longevity and reliability;
- e) Due to the reduced power consumption, it is possible to employ system umbilicals having smaller cross-section conductors, lowering costs;
- 20 f) The weight of the SEM is reduced, consequently reducing handling costs;
- g) Enhanced EMC (electromagnetic compatibility) performance (Reduced LAN emissions & susceptibility); and
- h) Enhanced speed performance (Controlled track routing).

25 In accordance with a first aspect of the present invention there is provided an electronic module for use as a subsea electronic module for an underwater fluid extraction well, wherein a local area network enables communication within the module, the local area network including a plurality of interfaces with components of the network, and wherein the interfaces comprise capacitive coupling interfaces.

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In accordance with a second aspect of the present invention there is provided an electronic module for use as a subsea electronic module for an underwater fluid extraction well, comprising a plurality of substantially planar electronics cards, wherein the cards are arranged in a stack such that the major faces of each card are substantially parallel to, and coaxial with, major faces of the other cards in the stack, and wherein the module further comprises a substantially planar switch card orientated relative to the stack such that its major faces are substantially parallel to the axis of the stack and orthogonal to the major faces of the cards within the stack and positioned such that the switch card is substantially equidistant from each card within the stack.

In accordance with a third aspect of the present invention there is provided a method of enabling Ethernet communication between Ethernet components within a subsea electronic module for an underwater fluid extraction well, comprising the step of providing Ethernet interfacing between said components, said interfacing comprising a capacitance.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 schematically shows a subsea electronic module functionality in accordance with the present invention;

Figure 2a schematically shows a physical arrangement of cards within an SEM in accordance with the present invention; and

Figure 2b schematically shows a cross-sectional view of the SEM of Fig. 2a.

Fig. 1 shows an example of a configuration of an Ethernet communication system within a multi-card, multi-bay SEM, in accordance with the present invention. In Fig. 1, interfaces for both an optical external interface 1 and a copper external interface 2 to the well control platform are shown. In practice, only one interface would be used, as described below. The selection of optical or copper interfaces 1, 2 is made to enable the SEM to be compatible with the form of interface required for a particular installation. In

both cases, the interface connects to a first card ("CARD 1") within the SEM, which comprises an Ethernet switch 4 capacitively coupled to a single board computer (SBC) 5.

If an optical interface 1 is used, this is connected to a small form-factor pluggable transceiver (SFP) 3, which acts as a media converter extending the topside LAN down to the SEM internal LAN(s) via an optical point to point Ethernet link, and thus provides an optical to electrical interface to the Ethernet switch 4. Modem 11 shown in Fig. 1 would not be present.

10 If however a copper interface 2 is used, this is connected via a modem 11 to the SBC 5. Here the SBC 5 supports the modem 11 and implements a bridge and interpreter / translator function for the modem communications.

SBC 5 is connected to Ethernet switch 4, and so may handle communications to and from either external interface 1 or 2. Ethernet switch 4 is a managed switch capable of implementing key level three protocol router functions including Spanning Tree Protocol (STP) to ensure that no LAN loops are created between the SEM internal LANs (A and B - see below) and traffic management including bandwidth assignment and prioritization.

20 The configuration of the SEM shown has a number of bays each with a stack of six electronic cards. In Fig. 1, only three cards (i.e. CARD 1, CARD 2 and CARD 6) are shown. In addition, only two bays of cards are shown for simplicity (i.e. Bay 1 and Bay 2), with extension of the system being provided by additional interfaces 7 and 8 for additional bays.

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The SEM shown supports two internal LANs A and B, providing redundancy. Traffic on LANs A and B are routed and managed via switch 4. The LANs A and B are segregated to assure single point failure tolerance.

30 An ESB card of each bay includes a pair of Ethernet switch blades (ESBs) 6, denoted ESB A and ESB B, controlling LAN A and B traffic respectively. Each ESB 6 is an um-

managed eight-port Ethernet switch, with six ports assigned for connection to bay-mounted cards (i.e. CARD 1 - CARD 6) and two ports assigned for bay to bay connectivity. In Fig. 1 only four ports are shown connected. The Ethernet switch blades (ESBs) 6 of each CARD 1 are arranged in a dual configuration to provide system
5 redundancy. Each ESB card is located above and orthogonal to the respective stack of six cards of the bay, as shown in Fig. 2.

Each card (i.e. CARD 1 - CARD 6) includes an SBC 10 which feeds electrical drivers to operate devices in the SEM, such as directional control valves (DCVs) and/or other
10 electrical devices and also interface with monitoring sensors on the well tree. For simplicity, these drivers, devices and interfaces are not shown in Fig. 1. Each SBC 10 interfaces to both A and B function ESBs 6, and Ethernet ports A and B are processed separately within the SBC.

15 Capacitive coupling between the ESBs 6 and the SBCs 10 and switch 4 is enabled by a multiplicity of capacitances 9 provided on the respective cards.

Figs. 2a and 2b schematically shows the physical layout of cards within an SEM housing
12. For clarity, only three cards (i.e. "CARD 1" to "CARD 3") are shown in each bay's
20 card stack.

As shown in Fig. 2a and 2b, each electronics card is substantially planar, and in each of bays 1 and 2, CARD 1 to CARD 3 are arranged in a stack such that the major faces of each card are substantially parallel to, and coaxial with, major faces of the other cards in
25 the stack. The ESB card holding the ESB switch blades 6 is orientated relative to the stack such that its major faces are substantially parallel to the axis of the stack and orthogonal to the major faces of the cards within the stack and positioned such that the ESB card is substantially equidistant from each card within the stack.

SEM housing 12 is formed as an elongate cylinder, with a substantially circular cross section. Each stack is arranged with its axis orthogonal to the axis of the SEM housing 12.

- 5 As can be seen more clearly in Fig. 2b, each ESB card occupies a segment cross-section space that exists above or below the card stack when installed in the SEM housing 12.

Since the ESB cards sit above or below the respective card stacks, the distances between the ESB cards and the cards of each stack are minimized, so that capacitive coupling can
10 be realised.

Positioning the ESB(s) above or below the card stack provides various benefits, including:

- Segregation of the capacitively-coupled LAN from the standard SEM backplane to
15 enhance EMC performance;
- Reduction of the radiated and conducted susceptibility within the SEM;
- Segregation of the SEM LAN(s) from high speed digital from AC power lines, topside communications lines, high current switching functions and sensitive analogue cables;
- Restraining and minimizing of the LAN distribution and controlled impedance of
20 printed tracks;
- Maximizing use of the volume within the SEM enclosure;
- Maximizing the SEM thermal management afforded to the ESB;
- Facilitation of the implementation of thermal provisions to effectively export heat away (via conduction) from the switches and associated power converters to the SEM chassis
25 via an ESB support ladder metalwork and cover-plate metalwork. Effective thermal provisions are critical if the mean time to failure (MTTF) of the ESB function is to be optimized.

The above-described embodiment is exemplary only, and various modifications within
30 the scope of the claims will be apparent to those skilled in the art.

For example, in an alternative configuration (not shown), the axis of the stacks may be parallel to the axis of the SEM housing 12.

CLAIMS

1. An electronic module for use as a subsea electronic module for an underwater fluid extraction well, comprising:

5 a housing;

a first and a second local area network established within the housing to enable communication within the electronic module, the first and second local area networks being segregated to provide redundancy, the first and second local area networks each including a plurality of interfaces with components of the networks;

10 a switch contained within the housing, the switch operable to manage and route traffic on the first and second local area networks; and

a plurality of bays contained within the housing, wherein:
each of the plurality of bays contains a plurality of electronic cards and first and second Ethernet switches,

15 each of the first and second Ethernet switches in each of the plurality of bays includes a first port, a second port and a plurality of additional ports;

in each of the bays, the additional ports of the first Ethernet switch contained within the respective bay are coupled with respective ones of the electronic cards also contained within the same bay to provide connectivity with the first local area network;

20 in each of the bays, the additional ports of the second Ethernet switch contained within the respective bay are coupled with respective ones of the electronic cards also contained within the same bay to provide connectivity with the second local area network;

the first port of the first Ethernet switch of a first bay of the plurality of bays is coupled with the first port of the first Ethernet switch of a second one of the plurality of bays; and

25 the second port of the second Ethernet switch of the first bay of the plurality of bays is coupled with the second port of the second Ethernet switch of the second one of the plurality of bays.

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2. An electronic module according to claim 1, wherein the first and the second
5 Ethernet switches in each of the plurality of bays are configured to provide system
redundancy.

3. An electronic module according to claim 1, wherein couplings
between the first Ethernet switch of the first bay and the first Ethernet switch of
10 the second bay associated with the respective first ports,

between such second Ethernet switch of the first bay and the second Ethernet
switch of the second bay associated with the respective second ports,

between the first Ethernet switch of the first bay and the respective ones of the
electronic cards contained therein,

15 between the second Ethernet switch of the first bay and the respective ones of the
electronic cards contained therein

between the first Ethernet switch of the second bay and the respective ones of the
electronic cards contained therein,

20 between the second Ethernet switch of the second bay and the respective ones of
the electronic cards contained therein

are capacitive couplings.

4. An electronic module according to claim 1, wherein each electronics card
comprises a single board computer, the single board computer having a capacitive
25 coupling to both the first and second local area networks.

5. An electronic module for use as a subsea electronic module for an underwater
fluid extraction well comprising:

a housing;

30 a first and a second local area network established within the housing to enable
communication within the module, the first and second local area networks being

segregated to provide redundancy and each of the local area networks including a plurality of interfaces with components of the networks;

a switch contained within the housing, the switch operable to manage and route traffic on the first and second local area networks; and

5 a plurality of bays contained within the housing, each of the bays containing a plurality of electronics cards and first and second Ethernet switches, wherein:

each of the Ethernet switches comprises a first port, a second port and a plurality of additional ports;

10 in each of the bays, the additional ports of the first Ethernet switch are coupled with respective ones of the electronics cards to provide connectivity with the first local area network and the additional ports of the second Ethernet switch are coupled with respective ones of the electronics cards to provide connectivity with the second local area network; and

15 one of the first and second ports of the first Ethernet switch of each of the bays is coupled with one of the first and second ports of the first Ethernet switch of another one of the bays and one of the first and second ports of the second Ethernet switch of each of the bays is coupled with one of the first and second ports of the second Ethernet switch of the respective other one of the bays.

20 6. An electronic module according to claim 5, wherein couplings between the Ethernet switches and electronics cards associated therewith comprise capacitance couplings.

25 7. An electronic module according to claim 5, wherein couplings between the Ethernet switches located in separate bays comprise capacitance couplings.

8. A method of enabling Ethernet communication between Ethernet components within a subsea electronic module for an underwater fluid extraction well, the method comprising the steps of:

providing a first and a second local area network internally to a housing for the module to enable communication within the module, the first and second local area networks being segregated to provided redundancy and each of the local area networks including a plurality of interfaces with components of the networks;

5 providing a plurality of bays within the housing, each bay containing a plurality of electronic cards and a pair of Ethernet switches, each Ethernet switch of the pair of Ethernet switches within each respective one of the plurality of bays including a first port, a second port, and a plurality of additional ports;

in each of the bays:

10 coupling the additional ports of the respective first Ethernet switch with respective ones of the electronics cards in the respective bay to provide connectivity with the first local area network, and

coupling the additional ports of the respective second Ethernet switch with respective ones of the electronic cards in the respective bay to provide connectivity with
15 the second local area network;

coupling one of the first and second ports of the first Ethernet switch of first bay of the plurality of bays with one of the first and second ports of the first Ethernet switch of one of the other of the plurality of bays to provide bay-to-bay connectivity for the first local area network; and

20 coupling one of the first and second ports of the second Ethernet switch of the first bay or the plurality of bays with one of the first and second ports of the second Ethernet switch of the other of the plurality of bays to provide bay-to-bay connectivity for the second local area network.

25 9. A method according to claim 8, further comprising the steps of:
managing and routing traffic on the first and second local area networks with a switch; and

providing Ethernet interfacing between said Ethernet components within the subsea electronic module, said interfacing comprising capacitance couplings.

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10. A method according to claim 8, wherein couplings between the Ethernet switches and electronics cards associated therewith comprise capacitance couplings.

11. A method according to claim 8, wherein couplings between the Ethernet switches
5 located in separate bays comprises capacitance couplings.

12. A method according to claim 8, wherein the one of the other of the plurality of bays is a second bay of the plurality of bays, the method further comprising the steps of:

coupling one of the first and second ports of the first Ethernet switch of the first
10 bay of the plurality of bays not coupling with the first Ethernet switch of the second bay, with one of the first and second ports of the first Ethernet switch of a third bay of the plurality of bays to further provide bay-to-bay connectivity for the first local area network; and

coupling one of the first and second ports of the second Ethernet switch of the
15 first bay of the plurality of bays not coupling with the second Ethernet switch of the second bay, with one of the first and second ports of the second Ethernet switch of the third bay of the plurality of bays to provide bay-to-bay connectivity for the second local area network.

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13. An electronic module for use as a subsea electronic module for an underwater fluid extraction well, comprising

a first and a second local area network (LAN) to enable communication within the subsea electronic module;

25 a housing; and

one or more bays positioned within the housing, each of the one more bays comprising:

a plurality of substantially planar electronics cards, the cards arranged in a stack such that major faces of each card are oriented substantially parallel to major faces of the
30 other cards in the stack and such that a major axis of each card is oriented substantially parallel to major axes of the other cards in the stack,

a substantially planar Ethernet switch card orientated relative to the stack such that its major faces are oriented substantially parallel to a main axis of the stack and orthogonal to the orientation of the major faces of the electronics cards within the stack and positioned such that the Ethernet switch card is substantially equidistant from a distal end of each electronics card within the stack,

a first Ethernet switch located on the planar Ethernet switch card and capacitively coupled with each of the plurality of substantially planar electronics cards, and

a second Ethernet switch located on the planar electronics card and capacitively coupled with each of the plurality of substantially planar cards.

14. A module according to claim 13,

wherein the housing includes an elongate main body in the form of an elongate cylinder with a substantially circular cross-section receiving said Ethernet switch card and said plurality of planar electronics cards

wherein said Ethernet switch card is located in a space between said electronics cards and an inner surface of an elongate main body of said housing thereby minimizing distance between the Ethernet switch card and each of the plurality of electronics cards and providing enhanced thermal management; and

wherein the main axis of the stack is configured to one of the following profiles:

the main axis of the stack is substantially parallel to a longitudinal axis of the housing of the module; or the main axis of the stack is substantially orthogonal to a longitudinal axis of the housing of the module.

15. A module according to claim 13, wherein first and the second Ethernet switches comprise a pair of Ethernet switch blades (ESBs), wherein the Ethernet switch card comprises an ESB card containing the pair of ESBs, the first of the pair of ESBs configured to control traffic on the first LAN and the second of the pair of ESBs configured to control traffic on the second LAN.

16. A module according to claim 15, wherein each electronics card includes a single board computer (SBC), wherein each SBC is configured to feed electrical drivers to

operate devices in the module, wherein each SBC interfaces with both the first LAN and the second LAN, wherein each electronics card includes a first LAN port and a second LAN port, and wherein the SBC of each electronics card is configured so that traffic received through the first LAN port is processed separately from traffic received through the second LAN port.

17. A module according to claim 13, wherein the housing has a longitudinal shape, the module further comprising:

a plurality of card stacks arranged along a length of the housing of the module;
and

a respective one of a corresponding plurality of Ethernet switch cards for each respective one of the plurality of card stacks.

18. A module according to claim 13, wherein the first and the second Ethernet switches comprise first and second ESBs, wherein the Ethernet switch card comprises an ESB card, and wherein each electronics card within the stack comprises a first Ethernet component and a first Ethernet interface for capacitively coupling with the first ESB on the ESB card, and a second Ethernet component and a second Ethernet interface for capacitively coupling with the second ESB on the ESB card.

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19. A module according to claim 6, wherein each Ethernet interface of each of the plurality of electronics cards comprises a capacitive device providing capacitive coupling to the respective first or second ESB, wherein the ESB card includes a first plurality of capacitive devices being connected with the first ESB, providing capacitive coupling to a corresponding plurality of the electronics cards in the stack, and a second plurality of capacitive devices being connected with the second ESB, providing capacitive coupling to the corresponding plurality of electronics cards in the stack.

20. A module according to claim 17, wherein each Ethernet switch card comprises an Ethernet interface capacitively coupled with a different Ethernet switch card to provide

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connectivity between associated LAN components in each other of the plurality of card stacks.

21. A module according to claim 13, wherein the first Ethernet switch located on the planar Ethernet switch card is a first ESB, wherein the second Ethernet switch located on the planar Ethernet switch card is a second ESB, the module further comprising:

a plurality of bays each containing a plurality of electronics cards and a respective Ethernet switch card including a first and a second ESB;

wherein each ESB comprises a plurality of ports configured for receiving traffic from a corresponding plurality of ports for the respective associated plurality of electronics cards, and at least one additional port configured for bay to bay connectivity.

22. A module according to claim 13, further comprising:

a plurality of bays each containing a plurality of electronics cards, a respective Ethernet switch card, and a pair of Ethernet switches contained within the respective Ethernet switch card;

wherein each Ethernet switch of the pair of Ethernet switches within each respective one of the plurality of bays comprises a first port, a second port, and a plurality of additional ports;

wherein the first port of a first Ethernet switch of the pair of Ethernet switches of a first of the plurality of bays is coupled with a first Ethernet switch of the pair of Ethernet switches of a second of the plurality of bays to provide bay-to-bay connectivity of the first LAN;

wherein the second port of the first Ethernet switch of the pair of Ethernet switches of the first of the plurality of bays is coupled with a first Ethernet switch of the pair of Ethernet switches of a third of the plurality of bays to provide connectivity with the first LAN;

wherein each separate one of the plurality of additional ports of the first Ethernet switch of the pair of Ethernet switches of the first of the plurality of bays is coupled with a separate one of the plurality of electronics cards contained in the first of the plurality of

bays to provide connectivity of the respective plurality of electronics cards with the first LAN; and

wherein each separate one of the plurality of additional ports of the second Ethernet switch of the pair of Ethernet switches of the first of the plurality of bays is
5 coupled with a separate one of the plurality of electronics cards contained in the first of the plurality of bays to provide connectivity of the respective plurality of cards with the second LAN.

23. A subsea electronic module for use as a subsea electronic module for an
10 underwater fluid extraction well, comprising:

a first and a second local area network (LAN) to enable communication within the subsea electronic module; a housing; and

one or more bays positioned within the housing, each of the one or more bays comprising:

15 a plurality of substantially planar electronics cards, the cards arranged in a stack such that major faces of each card are oriented substantially parallel to, and coaxial with major faces of the other cards in the stack, and

a substantially planar ESB card orientated relative to the stack such that its major faces are oriented substantially parallel to a main axis of the stack and orthogonal to the
20 orientation of the major faces of the electronics cards within the stack,

the ESB card comprising a first ESB configured to control traffic on the first LAN and the second ESB configured to control traffic on a second LAN,

each of the plurality of electronics cards comprising a first Ethernet component and a first Ethernet interface for capacitively coupling with the first ESB on the ESB card
25 and a second Ethernet component and a second Ethernet interface capacitively coupled with the second ESB on the ESB card, and

the first and second Ethernet interfaces each providing a capacitive coupling to the respective first and second ESBs on the ESB card.

30 24. A module according to claim 23,

wherein the housing includes an elongate main body in the form of an elongate cylinder with a substantially circular cross-section receiving said ESB card;

wherein said ESB card is located in a space between said electronics cards and an inner surface of an elongate main body of said housing, thereby minimizing distance
5 between the ESB card and each of the plurality of electronics cards; and

wherein the main axis of the stack is substantially parallel to a longitudinal axis of the housing of the module.

25. A module according to claim 23,

10 wherein the housing includes an elongate main body in the form of an elongate cylinder with a substantially circular cross-section receiving said ESB card;

wherein said ESB card is located in a space between said electronics cards and an inner surface of an elongate main body of said housing, thereby minimizing distance between the ESB card and each of the plurality of electronics cards; and

15 wherein the main axis stack is substantially orthogonal to a longitudinal axis of the housing of the module.

26. A module according to claim 23, wherein each electronics card includes a single board computer (SBC), wherein each SBC is configured to feed electrical drivers to
20 operate devices in the module, wherein each SBC interfaces with both the first LAN and the second LAN, wherein the first Ethernet interface comprises a first LAN port, wherein the second Ethernet interface comprises a second LAN port, and wherein the SBC of each electronics card is configured so that traffic received through the first LAN port is processed separately from traffic received through the second LAN port.

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27. A module according to claim 23, wherein the housing has a longitudinal shape, the module further comprising:

a plurality of card stacks arranged along a length of the housing of the module;
and

30 a respective one of a corresponding plurality of ESB cards for each respective one of the plurality of stacks.

28. A module according to claim 23, further comprising:
a plurality of bays each containing a plurality of electronics cards and a respective ESB card including a plurality of ESB;

5 wherein each ESB comprises a plurality of ports configured for receiving traffic from a corresponding plurality of ports for the respective associated plurality of electronics cards, and a plurality of additional ports configured for bay to bay connectivity.

10 29. A module according to claim 23,
wherein the one or more bays comprises a plurality of bays each containing a separate plurality of electronics cards, a respective ESB card, and a pair of ESBs contained within the respective ESB card;

15 wherein each ESB of the pair of ESBs within each respective one of the plurality of bays comprises a first port, a second port, and a plurality of additional ports;

wherein the first port of a first ESB of the pair of ESBs of a first of the plurality of bays is coupled with a first ESB of the pair of ESBs of a second of the plurality of bays to provide bay-to-bay connectivity of the first LAN;

20 wherein the second port of the first ESB of the pair of ESBs of the first of the plurality of bays is coupled with a first ESB of the pair of ESBs of a third of the plurality of bays to provide connectivity with the first LAN;

25 wherein each separate one of the plurality of additional ports of the first ESB of the pair of ESBs of the first of the plurality of bays is coupled with a separate one of the plurality of electronics cards contained in the first of the plurality of bays to provide connectivity of the respective plurality of electronics cards with the first LAN; and

wherein each separate one of the plurality of additional ports of the second ESB of the pair of ESBs of the first of the plurality of bays is coupled with a separate one of the plurality of electronics cards contained in the first of the plurality of bays to provide connectivity of the respective plurality of cards with the second LAN.

30. A method of providing communication between components within a subsea electronic module for an underwater fluid extraction well, comprising the steps of:

providing a housing of a subsea electronics module, the housing including an elongate main body in the form of an elongate cylinder with a substantially circular cross-section;

providing a plurality of substantially planar electronics cards adapted to control or operate devices in the subsea electronics module;

arranging the plurality of electronics cards in a stack within the housing such that major faces of each card are oriented substantially parallel to, and coaxial with, major faces of the other cards in the stack, each the plurality of electronics cards including a first Ethernet component and a first Ethernet interface for coupling with a first ESB on a substantially planar Ethernet switchblade (ESB) card and including a second Ethernet component and a second Ethernet interface for coupling with a second ESB on the ESB card;

establishing a first and a second local area network (LAN) to enable communication within the subsea electronic module, the step of establishing including the step of providing the ESB card, the ESB card comprising the first ESB configured to provide for control of traffic on the first LAN and the second ESB configured to provide for control of traffic on the second LAN;

positioning the ESB card in a space between said stack of electronics card and an inner surface of the elongate main body of said housing, ESB card being oriented relative to the stack such that its major faces are oriented substantially parallel to a main axis of the stack and orthogonal to the orientation of the major faces of the electronics cards within the stack, thereby minimizing distance between the ESB card and each of the plurality of electronics cards and providing enhanced thermal management;

capacitively coupling the first Ethernet component on each respective one of the plurality of electronics cards with the first ESB;

capacitively coupling the second Ethernet component on each respective one of the plurality of electronics cards with the second ESB;

managing and routing traffic on the first LAN using the first ESB; and

managing and routing traffic on the second LAN using the second ESB.

31. A method as defined in claim 30, wherein each electronics card includes a single board computer (SBC), wherein each SBC interfaces with both the first LAN and the second LAN, wherein each electronics card includes a first LAN port associated with a first capacitor device, providing capacitive coupling to the first ESB, and includes a second LAN port associated with a second capacitive device, providing capacitive coupling to the second ESB, the method further comprising the step of:

processing traffic received through the first LAN port of each respective electronics card separately from traffic received through the second LAN port.

32. A method as defined in claim 31, wherein the ESB card includes a first plurality of capacitive devices being connected with the first ESB, providing capacitive coupling to a corresponding plurality of the electronics cards in the stack, and a second plurality of capacitive devices being connected with the second ESB, providing capacitive coupling to the corresponding plurality of electronics cards in the stack.

33. A method as defined in claim 30, wherein the ESB card includes a first plurality of capacitive devices being connected with the first ESB, providing capacitive coupling to a corresponding plurality of the electronics cards in the stack, and a second plurality of capacitive devices being connected with the second ESB, providing capacitive coupling to the corresponding plurality of electronics cards in the stack.