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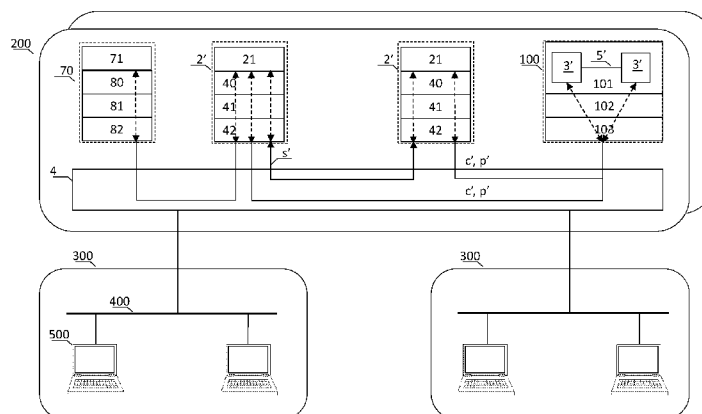


Fig. 3

(57) Abstract: A test system and method for testing the interworking of two or more control system software (21) of a marine installation or vessel (1), wherein each control system software (21) is arranged to run on a control system hardware (23), and said control system hardware (23), is arranged to be connected to an equipment under control (3). The test system comprises; - one or more computer implemented simulators (100), simulating said two or more equipment under control (3) and a connection (5) between said two or more equipment under control (3), and - two or more hardware emulators (40) emulating said control system hardware (23), wherein said control system software (21) is running on said two or more hardware emulators (40).



A TEST SYSTEM AND METHOD FOR TESTING OF THE INTERWORKING OF TWO OR MORE CONTROL SYSTEM SOFTWARE OF A MARINE INSTALLATION OR VESSEL

Field of the invention

[0001] The present invention relates to the field of testing of control systems of a marine installation or vessel. More specifically it relates to the testing of the interworking of the software of two or more control systems connected to respective equipment under control that are interconnected.

Background art

[0002] Modern offshore marine installations, such as vessels and rigs, usually have multiple computer control systems that act as an integrated system allowing control of the marine installation's operations. The physical process, in this case in the form of a marine installation or vessel, may be influenced by external events like a change in wind, waves and current, or by unexpected events like loss of motor power for one or more propellers, or failure in the function of a rudder. It is desired or expected that the control system for the marine installation can handle external influence and external events so as for the marine installation to maintain a safe state. A safe state may for example be that that the marine installation maintains the desired position or velocity, or that it avoids undesired positions (to avoid collision or grounding), that it avoids a situation of uncontrolled drift, that it maintains a desired course, etc. Moreover, it is expected that the control system in the case of loss of sensor signals or errors in sensors should not do undesired and unfortunate compensations like a sudden change in ballast pumping in response to loss of a realistic signal in a roll or pitch sensor, or sudden corrections of an apparent error in position.

[0003] The control system is to give control signals to actuators like propulsors and control devices. The propulsors may be ordinary propellers, tunnel thrusters or azimuth thrusters, or in some cases, a mooring system that is designed to pull the marine installation to the right position. Control signals can also be given to ballast pumps and associated valves to correct the roll angle or the pitch angle.

[0004] For marine installations or rigs for petroleum production and drilling, drilling control systems are influenced both by the vessel on which the drilling systems to be controlled are arranged, and also by the drilling operations to be performed. Drilling systems require large amounts of power. There is thus an interconnection between power management systems of the vessel and the drilling control systems. All said systems must correctly interact so as for allowing the proper functioning of the vessel as a whole during drilling operations. Although the individual drilling control subsystems, such as top drive, heave compensation, and mud pumps may operate

independently their control systems will often need to interact, and there may arise failures from these interactions or from the breakdown of one or more of the components or interconnections there between.

[0005] Drilling operations are in this context considered to comprise any operation performed during the preparation, drilling and completion of a well from the initial positioning of the drilling vessel until the well is ready for production. A malfunction in one of the systems may influence the entirety of systems on the vessels and may incur major failures, resulting in vessel damage or serious environmental consequences. It is advantageous to test control systems for situations that might incur potentially dangerous or hazardous situations while said systems are disconnected from the systems they are intended to control, firstly to avoid damaging the systems, secondly to be able to test for situations that rarely occur and which are highly undesirable as well as potentially destructive. The testing for control system interactions is particularly difficult when multiple control system manufacturers provide control systems to be interconnected in a top level control system. If errors arise, these may result in very costly drilling shutdowns or in the worst case equipment failure. Due to the extremely high costs associated with even minor delays in petroleum production and drilling, it is of major economic and environmental importance to detect potential problems related to the control systems before they arise and take appropriate corrective action.

[0006] Figure 1 is a schematic drawing of a prior art marine installation (1) comprising installations on rigs and vessels that may be the subject of an interworking test according to the invention. The marine installation has two or more control systems (2), where each of the control systems (2) interact with at least one equipment under control (3), where the control systems (2) are arranged to provide and send control signals (c) to the equipment under control (3), and the equipment under control (3) is arranged to receive the control signals (c) and perform an operation associated with the specific incoming control signal (c). In the other direction, the equipment under control (3) is arranged to send process data (p) from the process operated by the equipment under control (3) back to the control system (2). The process data (p) will typically be used as input feedback in a control loop of the control system (2).

[0007] A control panel (70) comprising control system hardware (73) and control system software (71) is used to operate the control system (2), and will typically provide a graphical Human Machine Interface (HMI) for an operator. Only one control panel (70) is shown in Figure 1, but usually each control system (2) has at least one control panel (70).

[0008] Figure 1 shows that a communication network (4) is used between the control systems (2) and equipment under control (3). The communication network may be of any type, such as PROFIBUS, PROFINET, Modbus, CAN-bus etc. The communication network may also typically be implemented as a redundant network e.g. with a ring topology or as two or more separate networks.

[0009] The control systems (2) may also be hardwired to the equipment under control (3), without making use of a communication network (4), or as an addition to a communication network (4).

[0010] Further, the control system (2) typically comprises a control system hardware (23), and a control system software (21), runs on the control system hardware (23). The control system hardware (23) is often PLC based but can also be implemented on embedded hardware devices or industrial PCs.

[0011] Depending on the load and reliability requirements, the control system software (21) may be designed to run on one or more control system hardware (23) devices, or computers, each with one or more processors.

[0012] Similarly, the equipment under control (3) typically comprises a control part (31), a process data part (32), and equipment (33).

[0013] The control part (31) is typically one or more actuators acting on the equipment (33) based on the incoming control signals (c), while the process data part (32), typically comprises sensors arranged for sensing parameters related to the process operated by the equipment (33), and/or sensing parameters related directly to the equipment (33) itself.

[0014] In many situations there is some kind of relationship or connection (5) between the two or more equipment under control (3). When such a connection (5) exist, the two or more interconnected equipment under control (3) are said to be interworking. Therefore, a control signal (c) acting on the equipment under control (3) to the left of Figure 1, may influence the equipment under control (3) to the right, and the sensors in the process data part (32) to the right may detect a change in a parameter value that is sent as a sensor signal value or process data (p) to the corresponding control system (2). Based on the process data (p) the control system (2) may try to maintain a stable situation for its equipment under control (3), and send a control signal (c) to its equipment under control (3). Due to the connection (5), this change may again influence the system to the left, that may take action in the same way as described for the system to the right. It is therefore evident that testing of the interworking between interconnected systems of this type is crucial to ensure that the total, integrated system is stable and reliable under different operating conditions.

[0015] As shown in Figure 1 and 2, the control systems (2) may also directly communicate by a control system interconnection signal (s). The control system interconnection signal (s) may e.g. be an incoming process data (p) signal that is forwarded to another control system (2), or a control signal from a first control system (2) to a second control system (2), that is a result of processing relevant incoming process data (p) signals in the first control system (2).

[0016] The connection (5) may be of any type, e.g. mechanical, electrical, hydraulic or any other connection that allows an equipment under control (3) to influence the operating conditions of another equipment under control (3).

[0017] In an embodiment the connection is an electric power cable from an electric power generator of a Power generating system controlled by a Power Management system (PMS) to an equipment under control (3) that is a consumer of electric power, such as drilling equipment, cranes, lifts, winches etc.

[0018] In a real-life situation, there will usually be many equipment under control with respective control systems (2) that are interconnected, making the interworking much more complex, and thorough testing is therefore necessary to detect any problems before the systems come into normal operation.

[0019] In Fig. 1b a test system for testing the interworking according to prior art is shown. In this test setup the equipment under control (3) has been replaced by a simulator (100). The simulator comprises simulated equipment under control (3') and simulated connections (5') between the simulated equipment under control (3'). This allows for testing of the real control systems without actually having to operate real generators, actuators etc. and the interworking test may be started before the actual hardware is installed in the marine installation (1). In Figure 2, it is further shown that the simulator is implemented in a simulator software (101) running on computer hardware (103) with an operating system (102).

[0020] International patent publication WO2004059411 A1 describes a system for remote testing of a control system in a marine installation where real sensor signals from sensors in the marine installation to the control system and real control signals from the control system to actuators of the marine installation are replaced with corresponding simulated sensor signals or simulated command signals that are generated in a remote test laboratory with respect to the marine installation.

International patent publication WO2005121915 A1 describes a method for testing a combined dynamic positioning and power management system of marine marine installation. The control system receives input commands from input command device, and sends control signals to actuators. The marine installation comprises sensors providing signals back to the control system. A simulator receives signals

from the marine installation, and the simulated actuator module provides simulated forces to the simulated marine installation module comprising algorithm for computing dynamic behavior of simulated marine installation. A simulated sensor module provides simulated sensor signals to the control system which continues to send control signals to real actuators.

[0021] The multiple computer control systems (2) described above act as an integrated control system for control of the marine installation's operations through the equipment under control (3). The systems are seldom produced by the same vendor and hence commissioning and integration testing of the complete integrated system is typically done onboard the vessel and typically at sea trials at the end of a new build project. At this stage the project is on a critical time line, logistics is complex and different parties are fighting for extremely expensive and limited test time. Testing and commissioning in prior art is limited not only by time but also due to restrictions concerning safety and possible damage to equipment. Problem solving and software development must be done onboard under high pressure, leading to introduction of possible other weaknesses to the system. Incidents during operation of a marine installation are also difficult, time consuming and therefore expensive to troubleshoot onboard the marine installation. It can be challenging to reveal the root cause of a problem and thereby difficult to pinpoint which vendor or vendors that must be called for action. These problems related to prior art remain to be solved.

Short summary of the invention

[0022] An object of the present invention is to disclose a test system and method that allows integration testing of the various control systems onboard the marine installation to begin at an earlier stage than prior art.

[0023] It is also an object of the invention that the test system and method allows tests to be performed faster than similar tests according to prior art, by reducing the dependency of available hardware resources.

[0024] It is also an object of the invention that control system software of marine installations or vessels in operation can be tested. For upgrade of software this is of specific importance.

[0025] According to an embodiment the invention is a test system for testing the interworking of two or more control system software (21) of a marine installation (1), wherein each control system software (21) is arranged to run on a control system hardware (23), and the control system hardware (23), is arranged to be connected to at least one equipment under control (3),
the test system comprising;

- one or more computer implemented simulators (100), simulating the two or more

equipment under control (3) and a connection (5) between the two or more equipment under control (3), and

- two or more hardware emulators (40) emulating the control system hardware (23), wherein the control system software (21) is running on the two or more hardware emulators (40).

[0026] Thus, in emulator terminology, a hardware emulator (40) is the host for the guest control system software (21).

[0027] According to an embodiment the invention is also a test method for testing the interworking of two or more control system software (21) of a marine installation or vessel (1), wherein each control system software (21) is arranged to run on a control system hardware (23), and the control system hardware (23), is arranged to be connected to at least one equipment under control (3), the test method comprising the following steps;

- simulating the equipment under control (3) and a connection (5) between the two or more equipment under control (3) in one or more computer implemented simulators (100),
- running the two or more control system software (21) on respective two or more hardware emulators (40) emulating the control system hardware (2),
- connecting the two or more hardware emulators (40) to the one or more computer implemented simulators (100),

[0028] The embodiments described above has several advantages:

- The test system and the test method according to the invention is that it is not dependent on location, hardware or the marine installation itself.
- A complete test setup can be duplicated to several instances allowing parallel testing on exact copies of the same setup leading to shorter testing calendar time, efficient usage of test teams, experts and other stakeholders in the test project.
- Verification and testing of software patches can be done on the emulated test setup before deployed into production onboard the vessel.
- Since the test setup is available and accessible at all times, it invites testers to do incremental testing as soon as new software versions are uploaded. Support and audits from vendor, class society and customer can be given on-demand.

[0029] According to an embodiment of the invention, the two or more hardware emulators (40) are running on one or more virtual machines.

[0030] Virtualization of the test setup has several additional advantages, such as:

- Hardware costs are eliminated and physical lab area is not needed.
- Testing and test observation can be performed at any internet-connected site.
- A virtual test environment is ideal for cross vendor integration testing.

- Version tracking of the complete integrated system can easily be done since the complete test setup is just computer files on a storage media. This opens up for quick examination of differences between different software versions.
- Incidents during operation can be investigated on the test setup and since rollback to older versions is easy it can be determined if eventual problems were introduced in a software update.
- Access and control of the virtual test setup may be done by connecting to the virtual machines using remote desktop technology. This allows multiple client terminals to monitor and share control over the different virtual machines from any location with internet access.
- Different vendors can in an embodiment only access virtual machines running their systems, e.g. a Power Management System. This allows multiple vendors to operate on the same virtual test environment without the need of sharing more information than during a normal vessel installation.
- Virtual servers may be rented on a short or long term basis. This adds flexibility to the testing, and may also be cost beneficial.

Figure captions

[0031] The attached figures illustrate some embodiments of the claimed invention.

[0032] Figure 1 illustrates in a block diagram control systems (2) acting on respective equipment under control (3) according to prior art.

[0033] Figure 2 illustrates in a block diagram the use of a simulator (100) according to prior art to test the control system software (100) of the system in Figure 1.

[0034] Figure 3 illustrates in a block diagram an embodiment of the invention.

Embodiments of the invention

[0035] The invention will in the following be described and embodiments of the invention will be explained with reference to the accompanying drawings.

[0036] In Figure 3 an embodiment of the invention is illustrated in a block diagram.

[0037] The emulated control systems (2'), each comprises computer hardware (42), an operating system (41), an emulated control system hardware (40) and the control system software (21).

[0038] The emulated control systems (2') are communicating with respective simulated equipment under control (3') over the communication network (4'). The communication network is preferably of the same type as the communication network (4) used between the real control systems (2) and the real equipment under control (3) in the marine installation (1) comprising rigs and vessels. However, adaptors between networks may also be used if different network types are involved.

[0039] For the purpose of the test according to the invention, control signals (c') from the emulated control system (2') towards the simulated equipment under control (3') should have the same format, i.e. be based on the same metamodel, as the control signals (c) from the real control system (2). Similarly, the process data (p') signals from the simulated equipment under control (3') should have the same format as the process data (p) from the real equipment under control (3).

[0040] In an embodiment at least one of said equipment under control (3) is arranged to receive command signals (c) from at least two different control system software (21). E.g. a local thruster control may receive commands both from a DP control system and a Power Management System.

[0041] In an embodiment the invention is a test system for testing the interworking of two or more control system software (21) of a marine installation or vessel (1), wherein each control system software (21) is arranged to run on a control system hardware (23), and the control system hardware (23), is arranged to be connected to at least one equipment under control (3),

the test system comprising;

- one or more computer implemented simulators (100), simulating the two or more equipment under control (3) and a connection (5) between the two or more equipment under control (3), and
- two or more hardware emulators (40) emulating the control system hardware (23), wherein the control system software (21) is running on the two or more hardware emulators (40).

[0042] The invention is also in an embodiment a test method for testing the interworking of two or more control system software (21) of a marine installation (1), wherein each control system software (21) is arranged to run on a control system hardware (23), and the control system hardware (23), is arranged to be connected to at least one equipment under control (3), the test method comprising the following steps;

- simulating the equipment under control (3) and a connection (5) between the two or more equipment under control (3) in one or more computer implemented simulators (100),
- running the two or more control system software (21) on respective two or more hardware emulators (40) emulating the control system hardware (2),
- connecting the two or more hardware emulators (40) to the one or more computer implemented simulators (100),

[0043] As can be understood from the description above, and from Figure 2, the test-setup has now been de-coupled from the physical hardware of the marine

installation, and testing is any more not limited by the hardware on-board the marine installation. The advantages of the system have been described previously.

[0044] The simulated connection (5') between the simulated equipment under control (3') simulates the real connection between such equipment as described previously. It may be a mechanical connection, an electrical connection, a hydraulic connection or any other connection that allows an equipment under control (3) to influence the operating conditions of another equipment under control (3). In an embodiment the connection is an electric power cable from an electric power generator of a Power generating system controlled by a Power Management system (PMS) to an equipment under control (3) that is a consumer of electric power, such as drilling equipment, cranes, lifts, winches etc.

[0045] In Figure 2, a simulator (100) comprising simulation software (101), simulator hardware (103) and simulator operating system (102) is indicated. In this embodiment the simulation software (101) comprises the simulated equipment under control (3') and the simulated connection (5). However, the architecture of the simulator (100) may differ from this in another embodiment of the invention, e.g. each of the simulated equipment under control (3') and simulated connections (5') run on a separate simulator hardware (103) and operating systems (102).

[0046] In an embodiment each of the computer hardware (42) is a virtual machine in the Internet cloud. This means that the hardware emulators (40) are running on virtual machines, and the control system software (21) under test is running on the hardware emulators (40).

[0047] In an embodiment of the invention at least one of the one or more computer implemented simulators (100) are running on a virtual machine.

[0048] In an embodiment the test system comprises a control panel (70) with a control panel software (71) arranged to run on a control panel hardware (73) and communicate with at least one of the control system software (21), wherein the test system comprises an control panel hardware emulator (80), emulating the control panel hardware (73), and the control panel software (71) is running on the control panel hardware emulator (80).

[0049] The control panel software (71) communicates with the control system software (21) as indicated by the arrow in Figure 3. Only one control panel (70) is indicated in the illustration, but one or more operator panel software (71) may run on one or more operator panel emulators (80), again running on one or more operating systems (81) and hardware (82).

[0050] In an embodiment the test system comprises one or more control panel hardware emulators (80) running on one or more virtual machines. In this

embodiment the hardware (82) is a virtual machine in the Internet cloud.

[0051] One of the most important interworking tests to perform onboard a marine installation or a marine vessel, is the interworking between the power production system and the power consumption system, to ensure that high power consumption will not lead to critical situations, such as black-out, or costly production stops.

Power production is controlled by a Power Management System (PMS) and in an embodiment at least one of the control system software (21) is a Power Management System Software. The Power Management System Software is typically part of a power management system, i.e. control system (2) with a PMS hardware, or control system hardware (23). In this embodiment the PMS hardware is emulated.

[0052] Further, Figure 3 shows how the tested network can be accessed from one or more client locations (300), comprising one or more client terminals (500) connected to a physical network (400) connected to the network (4) between the computers in the test setup. In one embodiment the client terminal (500) operates as a thin client by providing the graphical interface of the control panel software (71), by e.g. Remote Desktop or similar technology. According to role of the operator logging into the client terminal (500), different privileges may be given for access to the system. Roles may be e.g. tester, auditor, equipment and control system vendor etc.

[0053] When the hardware (23) of the tested system is emulated, the testing is not anymore limited by the availability of the hardware on the marine installation, or to the location where the hardware is located. By installing sufficient amount of hardware in a testing location, the test can be set-up and run without other dependencies, such as control system hardware (23). It is also possible to set up parallel test environments (200) by increasing the number of hardware and software. Since the hardware can be based on standard computer based technology, duplication of the test setup in this way becomes an alternative that was not possible according to prior art testing, where limited availability of control system hardware (23) and control panel hardware (73) made such duplication difficult. Client terminals (500) in client locations (300) may connect to the appropriate or allowable control panel (70) of a test environment (200) over a private or public network, such as the Internet.

[0054] In the embodiment where some or all of the emulated hardware or even the simulator hardware runs on virtual machines in the Internet cloud, scaling and duplication of the test environment becomes even easier, since test environments can be set up without access to local hardware and test premises. Therefore, a complete test environment (200) can be set up just by ordering the required number

of virtual machines from a cloud virtual server, and remotely installing the hardware emulators (40) and the control system software (21) for each control system, the simulator software (101) for each simulator, and the control panel hardware emulator (80) and the control panel software (71) for each control panel.

Configuration and communication between the different parts of the test system should preferably be set up as it would have been set up for a real system.

[0055] Access and control of the virtual test setup may be done by connecting to the virtual machines using remote desktop technology. This will allow multiple client terminals (500) to monitor and share control over the different virtual machines from any location with internet access.

[0056] Different vendors can in an embodiment only access virtual machines running their systems, e.g. a Power Management System. This allows multiple vendors to operate on the same virtual test environment (200) without the need of sharing more information than during a normal vessel installation.

Claims

1. A test system for testing the interworking of two or more control system software (21) of a marine installation or vessel (1), wherein each control system software (21) is arranged to run on a control system hardware (23), and said control system hardware (23), is arranged to be connected to at least one equipment under control (3),

said test system comprising;

- one or more computer implemented simulators (100), simulating said two or more equipment under control (3) and a connection (5) between said two or more equipment under control (3), and
- two or more hardware emulators (40) emulating said control system hardware (23), wherein said control system software (21) is running on said two or more hardware emulators (40).

2. A test system according to claim 1, wherein said two or more hardware emulators (40) are running on one or more virtual machines.

3. A test system according to claim 2, wherein at least one of said one or more computer implemented simulators (100) are running on a virtual machine.

4. A test system according to any of claims 1 to 3, comprising a control panel software (71) arranged to run on a control panel hardware (73) and communicate with at least one of said control system software (21), wherein said test system comprises an control panel hardware emulator (80), emulating said control panel hardware (73), and said control panel software (71) is running on said control panel hardware emulator (80).

5. A test system according to claim 4, wherein said control panel hardware emulator (80) is running on one or more virtual machines.

6. A test system according to any of the claims above, wherein at least one of said control system software (21) is a Power Management System Software.

7. A test system according to any of the claims above, wherein at least one of said equipment under control (3) is arranged to receive command signals (c) from at least two different control system software (21).

8. A test method for testing the interworking of two or more control system software (21) of a marine installation or vessel (1), wherein each control system software (21)

is arranged to run on a control system hardware (23), and said control system hardware (23), is arranged to be connected to at least one equipment under control (3), said test method comprising the following steps;

- simulating said equipment under control (3) and a connection (5) between said two or more equipment under control (3) in one or more computer implemented simulators (100),
- running said two or more control system software (21) on respective two or more hardware emulators (40) emulating said control system hardware (2),
- connecting said two or more hardware emulators (40) to said one or more computer implemented simulators (100).

9. A test method according to claim 8, comprising running said two or more hardware emulators (40) on virtual machines.

10. A test method according to claim 9, comprising running at least one of said one or more computer implemented simulators (100) on a virtual machine.

11. A test method according to any of claims 8 to 10, comprising the step of operating said control system software (21) remotely from a control panel software (71) arranged to run on a control panel hardware (73), wherein said control panel software (71) is running on a control panel hardware emulator (80), emulating said control panel hardware (73).

12. A test method according to claim 11, comprising running said control panel hardware emulator (80) on one or more virtual machines.

13. A test method according to any of the claims 8 to 12, wherein at least one of said control system software (21) is a Power Management System Software.

14. A test method according to any of the claims 8 to 13, wherein at least one of said equipment under control (3) is arranged to receive command signals (c) from at least two different control system software (21).

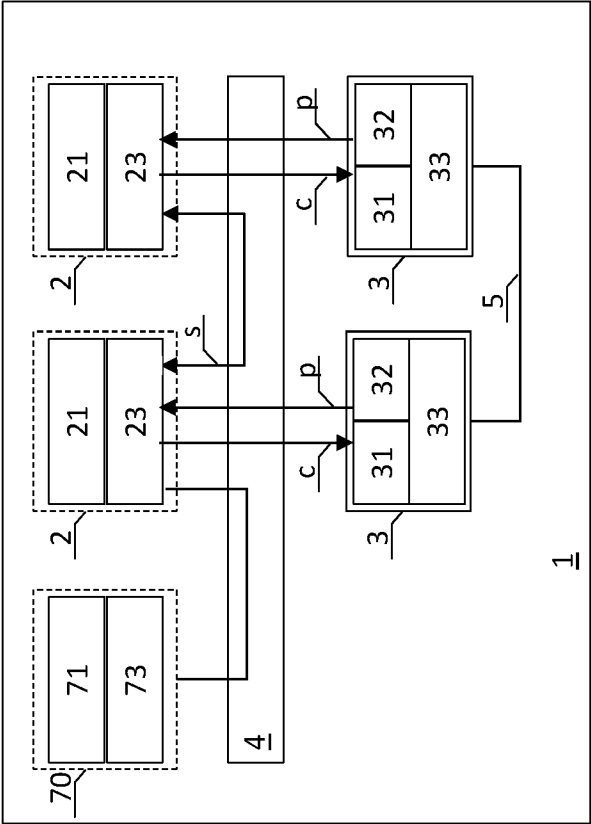


Fig. 1 (prior art)

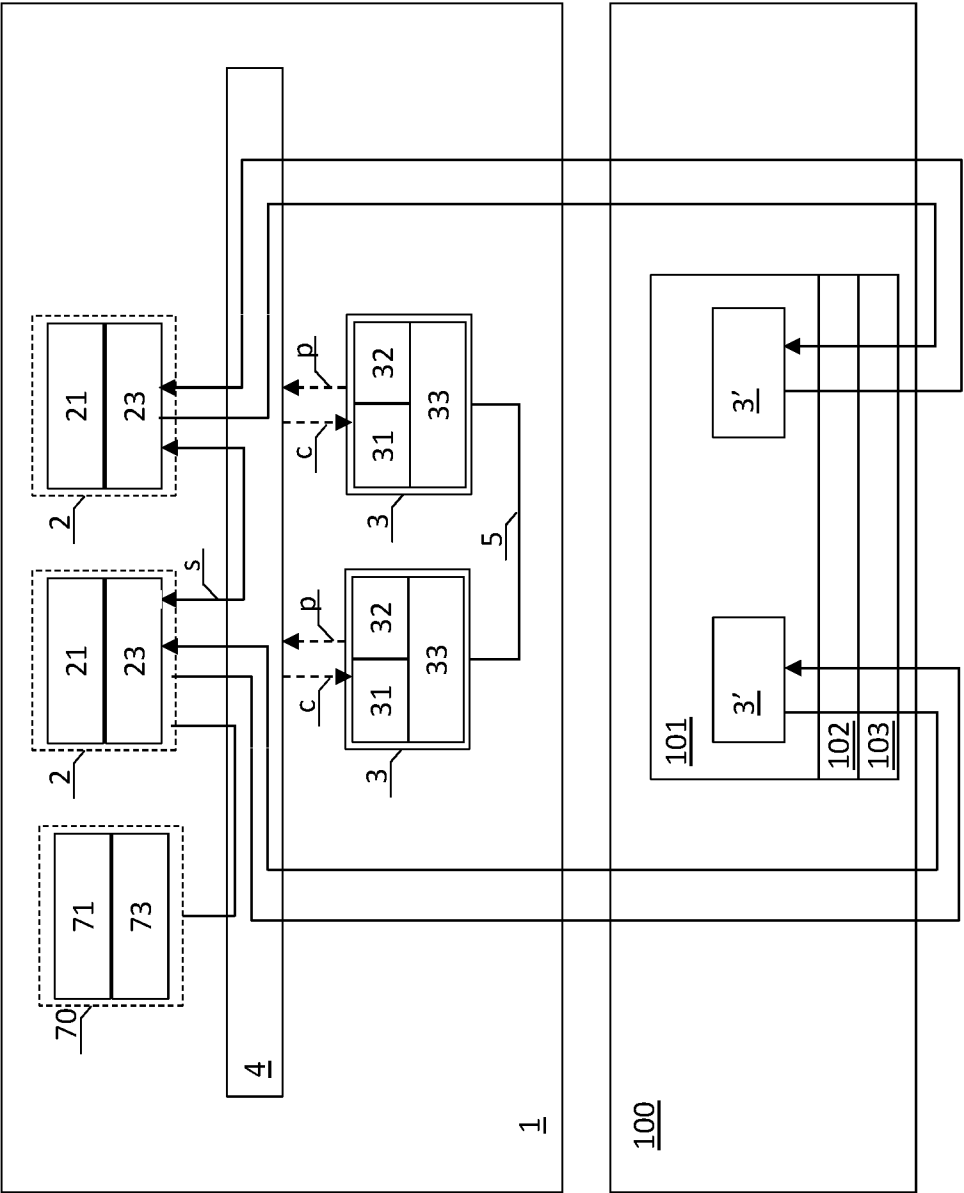


Fig. 2 (prior art)

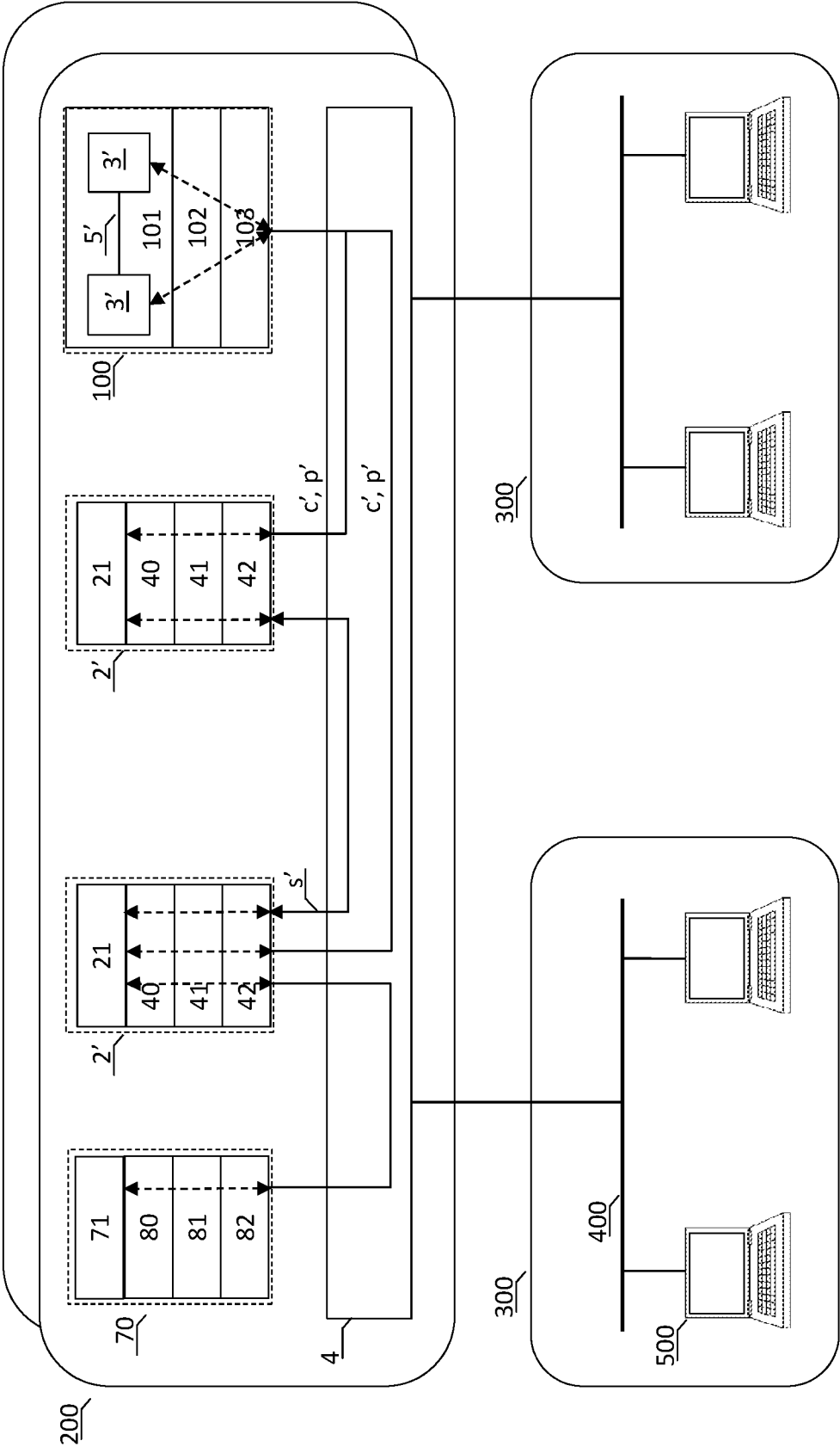


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/N02014/050018

A. CLASSIFICATION OF SUBJECT MATTER INV. B63B39/00 G05B17/02 G05D1/02 G06F9/455 G05B23/02 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) B63B G05B G05D G06F		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	page 4, line 11 - line 12	2-4,9-11
A	page 13, line 18; figure 4a page 17, line 20 - line 26; figure 4b	5,6,12, 13
Y	----- US 2008/208374 A1 (GRGIC RICHARD J [US] ET AL) 28 August 2008 (2008-08-28) sentence 14, paragraph 42 - sentence 30; figure 4	2,3,9,10
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 10 July 2014		Date of mailing of the international search report 16/07/2014
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Bernard, Eddy

INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	EP 2 508 954 A1 (ABB TECHNOLOGY AG [CH]) 10 October 2012 (2012-10-10) figures 1-3 -----	2,3,5,9, 10,12

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