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UNIC C3 RIG UPDATE FOR NEW GENERATION CONFIGURATION TESTING

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Tämä opinnäytetyö tehtiin Wärtsilä Oyj Abp :n Engine, Performance and Control – Customer Delivery osastolle. Yksi osaston tehtävistä on moottorikonfiguraatioiden tekeminen ja testaaminen. Tämän opinnäytetyön aiheena oli päivittää UNIC C3 -validointiriki uuden sukupolven konfigurointitestejä varten. Päivitys tehtiin vaihtamalla kommunikaatiokortit Smart MiniRig -moduuleihin, jotka ovat validointirikissä ja jota käytetään moottorin konfiguraatioiden testaamiseen.

Validointiriki on jatkuvassa käytössä ja siksi oli tärkeää suunnitella päivitysprosessi ennen töihin ryhtymistä. Päivitysprosessi alkoi keräämällä tarvittavat tarvikkeet, laitteet ja suunnitella tarkasti miten varsinainen työ tehdään. Varsinainen työ tehtiin vaihtamalla Smart MiniRig -moduulien kommunikaatiokortit ja konfiguroimalla kaikki muut validointilaitteessa olevat laitteet tukemaan uusia kommunikaatiokortteja. Päivitysprosessin lopussa validointiriki testattiin testaamalla moottorikonfiguraatio, joka oli jo aiemmin testattu ja sen avulla varmistamaan, että kaikki entiset ja uudet signaalit toimisivat halutulla tavalla.

Teknologiateollisuudessa Wärtsilä tunnetaan luotettavista tuotteistaan. Päivitystoiminnon avulla voidaan parantaa moottorikonfiguraatioita, koska päivitys mahdollistaa enemmän testausmahdollisuuksia ennen moottorin konfiguraation käyttöönottoa itse moottorissa. Uudet kommunikaatiokortit mahdollistavat lisää signaaleja, joita voidaan simuloida testauksessa ja tämän vuoksi konfiguraatiot voidaan testata perusteellisemmin.

Avainsanat FAST Ethernet, validointiriki, moottorikonfiguraatio

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ABSTRACT

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This thesis was done for Wärtsilä Oyj Abp at Engine, Performance and Control – Customer Delivery department. One of the department's focus is on making engine configurations and then testing them. The subject of this thesis was to update UNIC C3 validation rig for new generation configuration testing. The update was done by changing communication cards for the Smart MiniRig modules in the validation rig which is used to test the engine configurations.

The validation rig is in continuous use and therefore it was important to plan the update process before to the actual work. The update process started by gathering required equipment, devices and plan very specifically how the actual work would be done. The actual work was done by changing the communication cards on the Smart MiniRig modules and then all the other hardware on the validation rig were configured to comply with the new communication cards. At the end of the update process the validation rig was tested by testing an engine configuration which has already been tested to make sure all the former and new signals would function as wanted.

In technology business Wärtsilä is known for its reliable products. With updating the validation rig the engine configurations can be enhanced as the update allows more testing possibilities before releasing the engine configurations on the use. The new communication cards allow more signals to be simulated in testing and therefore the configurations can be tested more thoroughly.

Keywords FAST Ethernet, validation rig and engine configuration

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LIST OF ABBREVIATIONS

AIO	Analog I/O card
D	Wärtsilä engine fuel type, Diesel
D15P	15 pin D-type male connector used in various systems often in communication systems
DF	Wärtsilä engine fuel type, Dual Fuel
DIO	Digital I/O card
EM	An Electronic Module is part of the UNIC system.
EPC	Engineering, Procurement and Construction
ESD	Electrostatic Discharge
FAST Ethernet	Ethernet with speed of 100Mb/s
I/O-card	A plug-in card-type module which has hardware inputs and/or outputs.
ID	Identity of device
IDM	Integrated Document Management, database system
IP	Internet Protocol
LiYCY	Communication cable that is screened.
MB	SMR motherboard
MCU	Microcontroller unit
MIO	Multipurpose I/O card
PC	A Personal Computer

SG	Wärtsilä engine fuel type, Spark ignition
SMR	Smart MiniRig
SPG	Smart Power Generator
UNIC C3	UNIC is engine control system for Wärtsilä 4-stroke engines. C3 is 1st Generation UNIC system.
USB	Universal Serial Bus
VSE	Visual Service Engineer

1 INTRODUCTION

This thesis was done for Wärtsilä, at Engine, Performance and Control – Customer Delivery department. Wärtsilä produces power solutions for marine and energy markets. Engine, Performance and Control – Customer delivery department does engine wiring diagrams, engine configurations and validates the configurations.

The aim of the thesis was to update engine configuration validation rig for new generation testing. The rig is used for testing UNIC C3 type engine configurations. The rig can be also used to test faulty EM (Electronic Module) which can come from the test run.

The update was done by changing the communication cards on the validation rig to get more signals to monitor, control and test. The communications cards are in SMR (Smart MiniRig) modules that are installed on the validation rig. The SMR modules contain logic cards and their signals can be controlled with PC software. The SMR modules are connected to Electronic Modules that contain the configuration.

The update process started by planning the physical work because the rig is in daily use, so it would not be out of operation for too long. The physical work could not be done without powering off the validation rig. It was important to order and manufacture all the needed equipment before starting to change the communication cards. /6; 13/

2 WÄRTSILÄ OYJ ABP

Wärtsilä is a Finnish corporation established in 1834 at a little Finnish village named Värtsilä as saw and now it practises mechanical engineering industry. Over the history, Wärtsilä has managed to keep up with evolving technology and make new products to meet the requirements of present time. Nowadays, Wärtsilä has operations in over 200 locations in more than 80 countries and 18 000 employees. The biggest factories are in Vaasa, Finland and in Italy, Trieste. In Asia, markets are growing fast, and production has already been expanded in China, Korea and India.

In Finland Wärtsilä produces mainly diesel and gas engines. A specific engine type example W20V34SG can be identified as follows.

- W stands for Wärtsilä
- 20 stands for cylinder count.
- V stands for cylinders being in V formation and other possibility here is L that means that the cylinders are in a row.
- 34 stands for engine bore type which comes from the bore size, the main bore sizes in Finland are 20, 31, 32 and 34.
- Finally, there is generally three different engine types D (Diesel), DF (Dual Fuel) and SG (Spark Ignition). DF run on diesel and gas whereas D only runs with diesel and SG only runs on gas.

Engines are not the only product that Wärtsilä manufacture because Wärtsilä also designs drivetrain systems for marine use or even entire power plant solution. 45% of Wärtsilä's business is to provide service to all products.

Wärtsilä ensures that all the employees have a safe working environment and offers other activities that promote well-being at work. Employees take continuous training kept for maintaining their ability to work with the latest technology inventions. Wärtsilä encourages its employees to invent new things to make products and production better, faster and safer. Wärtsilä constantly seeks new ways to maintain high quality and cost efficiency as environmental demands increase. /1; 2/

2.1 Marine Solutions

Wärtsilä is divided in three main organizations: Marine Solutions, Energy Solutions and Services. Marine Solutions designs and produces innovative solutions for sea, mainly for ships and vessels. Marine Solutions aims to develop environmental products and services to customers by reducing emissions and waste.

Marine Solutions can deliver a single product or complete lifecycle of complex systems for powering ships. Wärtsilä introduced new engine in 2015 called W31 and it is mainly used with the Marine Solutions but also in the Energy Solutions. The W31 engine achieved a Guinness World Record title for the most efficient 4-stroke diesel engine. /1; 7/

2.2 Energy Solutions

Energy Solutions provides flexible and environmentally advanced energy solutions for engine powered plants and solar power plants. Energy Solutions is also EPC (Engineering, Procurement and Construction) contractor, EPC contractor carries out the engineering, equipment and material procurement and construction of the project for their customer.

Energy Solutions focuses to use different fuels and gases on engines to provide flexibility on continuous use. Running power plants without stopping engine needs good flexibility with fuels and that is solved with SPG (Smart Power Generation) power plants. SPG power plant engines can run on any gaseous or liquid fuels and are able to switch from one fuel to another without stopping. /1; 8/

2.3 Services

Service handles the product servicing and Wärtsilä's service is namely competitive, trusted and easy to deal with. Services offers lifecycle support for all the Marine Solutions and Energy Solutions products and installations.

Digitalising is very important in nowadays and that is where Wärtsilä is investing. Services can offer troubleshooting help by remote service concepts, such as the

VSE (Virtual Service Engineer). VSE service means that a service engineer uses specially-designed goggles that allows audio and visual communication between the service engineer and the person on site and in this way, it is possible to solve the issue in real time. /1; 9/

3 TECHNICAL INFORMATION

The rig is used to test and validate engine configurations. Engine configurations are made with PC software. The configurations consist of parameters, controls, engines safeties and maps for fuel use. The parameters can be signal measurement scaling or start values and to decide which values are measured or monitored. Values that can be measured or monitored are frequency, current or resistance. The engine safeties are for securing engine for example overheating or running too fast. The maps for fuel use are for engine to use specifically tuned amount of fuel on specific engine speed. /6/

3.1 UNIC C3 Validation Rig

The rig (see Figure 1) is used for validating engine configurations so that they can be sent to IDM (Integrated Document Management). IDM is a database system and a global platform that enables secure document sharing in companies. From the IDM the configurations can be uploaded to the production line and then downloaded to engines.

The rig is built so that every EM (Electronic Module) has its own SMR (Smart MiniRig) module except LDU (Local Display Unit), which is connected straight to the Ethernet switch. EM and SMR modules are wired together with cable sets. The SMR modules are inserted in the racks on two opposite sides and on the other two opposite sides the EMs.

The rig uses 230V main power and the 230V is then distributed to modules with three voltage supplies. Three voltage supplies distribute power to the SMR modules and the EMs. The EMs need two power supplies as the CCM-EMs need their own. /6; 12/

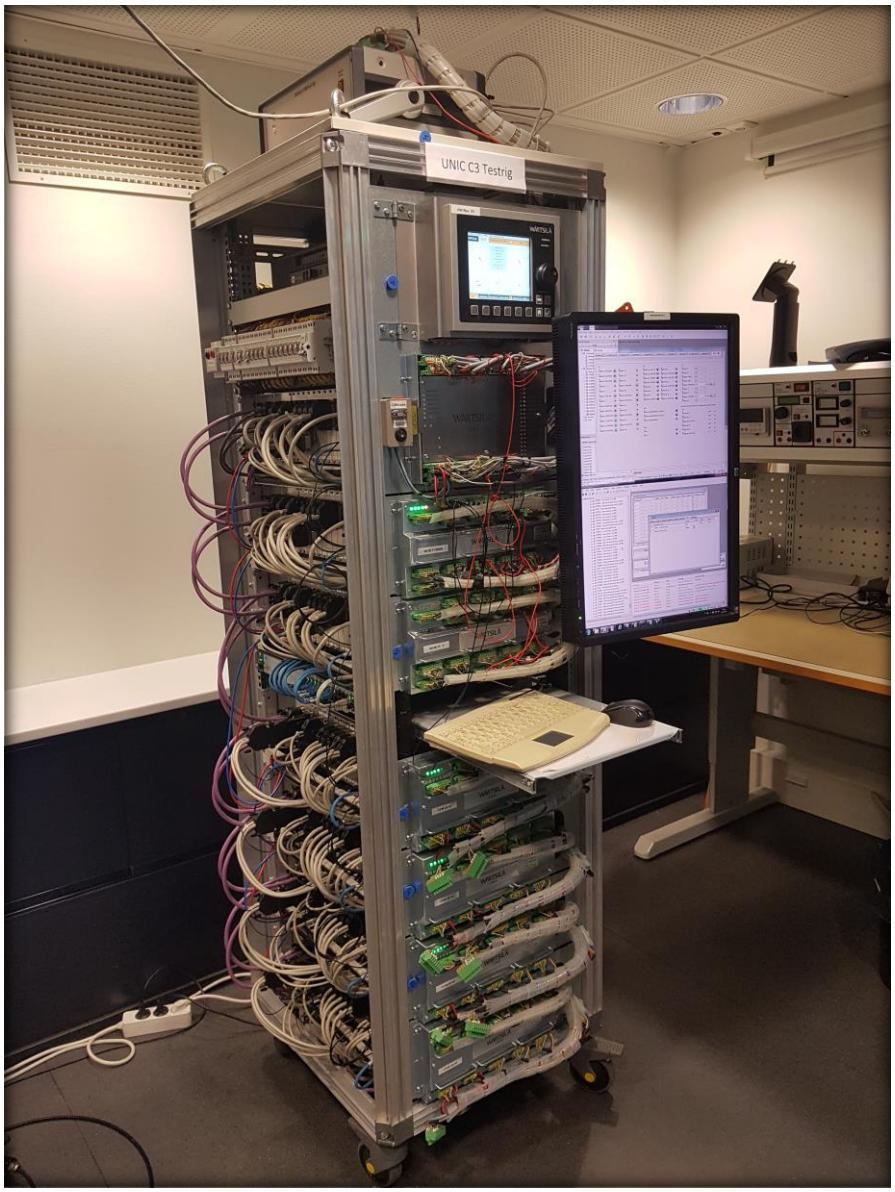

Figure 1. The UNIC C3 rig.

3.1.1 Electronic Modules

The EMs are engine modules designed by Wärtsilä. They consist small of electronics and each module has its own purpose.

Configuring the engine configuration to a specific engine is usually started from a standard engine configuration which has all the possible signals. The standard en-

gine configurations are always tested before released as standard engine configurations. Once the engine configuration is configured to a specific engine and the configuration testing is appointed to a test engineer, the engine configuration is downloaded to the EMs. EMs then act according to the engine configuration. The EM count on an engine can vary as some engines do not have all the signals in use. For example, DF engines use more signals than diesel engines, and the more cylinders engine has it uses more signals.

1st Generation UNIC EMs:

- LCP – Local Control Panel. Contains push buttons for local engine control and the LDU (Local Display Unit) shows sensor data, engine mode and possible failures.
- MCM – Main Control Module. Handles all the start/stop management and speed/load control functions of the engine.
- ESM – Engine Safety Module. Handles engine safety controls and is the major hardware signal interface to the external systems.
- CCM – Cylinder Control Module. Handles all the injection and combustion monitoring of 3 cylinders per module.
- PDM – Power Distribution Module. The engine module supply (2 x 24 VDC) and the valve drive supply (2 x 24 VDC or 2 X 110 VDC).
- IOM – Input/output Module. Handles measurements and controls. The number of modules varies according to cylinder number, engine type and application.
- WCS – The Wärtsilä CAN switch. WCS is used in Wärtsilä engines to safely connect the maintenance tool to the on-engine automation system. This module is not needed on the rig. /10/

3.1.2 Smart MiniRig Modules

The task of an SMR module is to simulate signals that would normally be generated by different sensors and solenoids in engines. The sensors on engines measure heat, pressure, engine speed and solenoids are usually controllable on/off magnetic

switches. EMs are reading those sensors by signals, which are electrical values of frequency, current and resistance. The signals can be produced with the SMR modules, so the rig will not need physical sensors. The SMR module are controlled with PC software. In the configuration test, all signals are tested and then monitored with PC software if they work as they should.

The SMR modules could be called logic modules as there are AIO, DIO and MIO logic cards in them see Figure 5. The SMR modules include three different I/O cards which all have different simulating capabilities. First there is the DIO card which is needed for EMs: MCM, IOM and CCM. The second is AIO card which is used for simulating TC(Thermocouple), PT100, current based 0-25mA and +-5V voltage sensors. The third is MIO card which used for more complex PT100 simulations and it has a current range of 0/4-20mA and voltage range of 0-5/10V. The MIO card also supports a 3-wire switch and ratiometric output signal. A ratiometric signal is an output signal, which changes proportionally as the input or supply voltage changes.

The UNIC C3 rig has two different type on of SMR modules Subrack Case which can be seen on Figure 2, and Desktop Case, which can be seen in Figures 3 & 4. Differences between these two types are that the Subrack Case is inserted in the rig and it slides on racks. The Desktop Case is installed on top of the rig as it was not originally in this rig. The Desktop Case was added in the former update in which there was a need for another IOM engine module. /10; 11; 12/

In the figure the following things can be seen:

1. Master/Slave LED indicators and SMR-ID selector switch. Master/Slave is a syncing feature, and, in this context, the optic fibre cable creates a chain from the SMR modules and the first SMR module on the chain is the master and the rest are slaves.
2. CAN1 & CAN2 connectors, fuse, power switch and power connectors.
3. RS485, HSD Input, COM/PWR. These are connected to the motherboard and it controls them.
4. 12x I/O slots and two last slots are taken by the FAST Ethernet card.

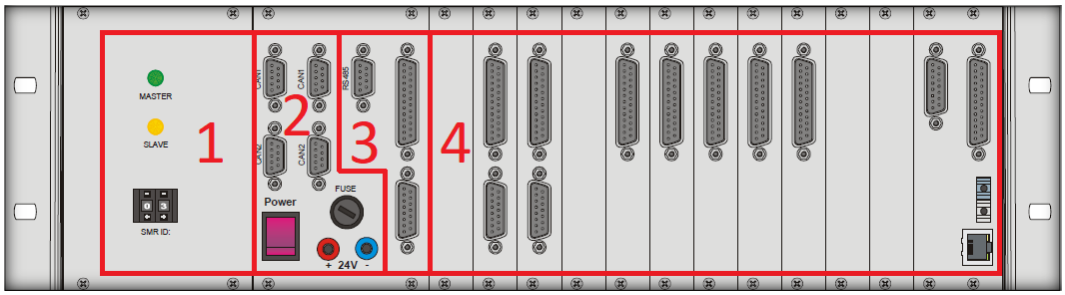

Figure 2. Subrack case SMR module.

Figure 3. Front panel of Desktop Case-type SMR module.

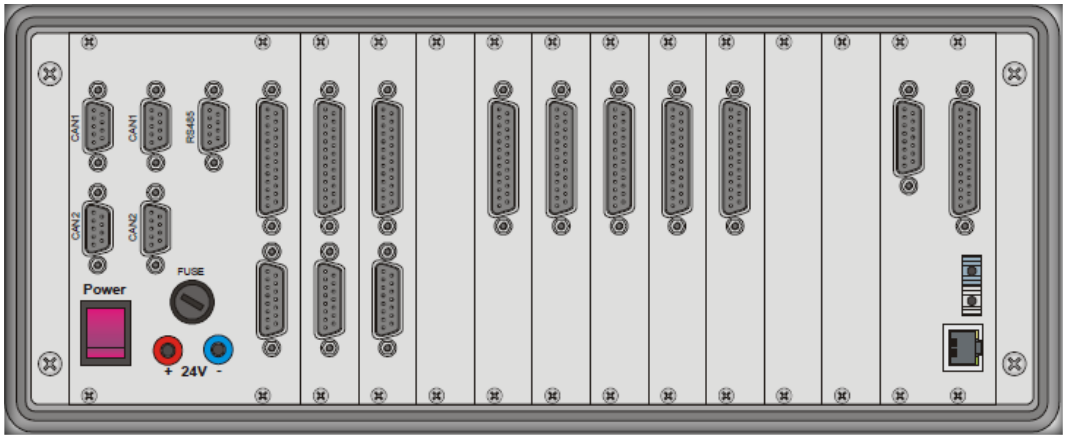

Figure 4. Back panel of Desktop Case-type SMR module.

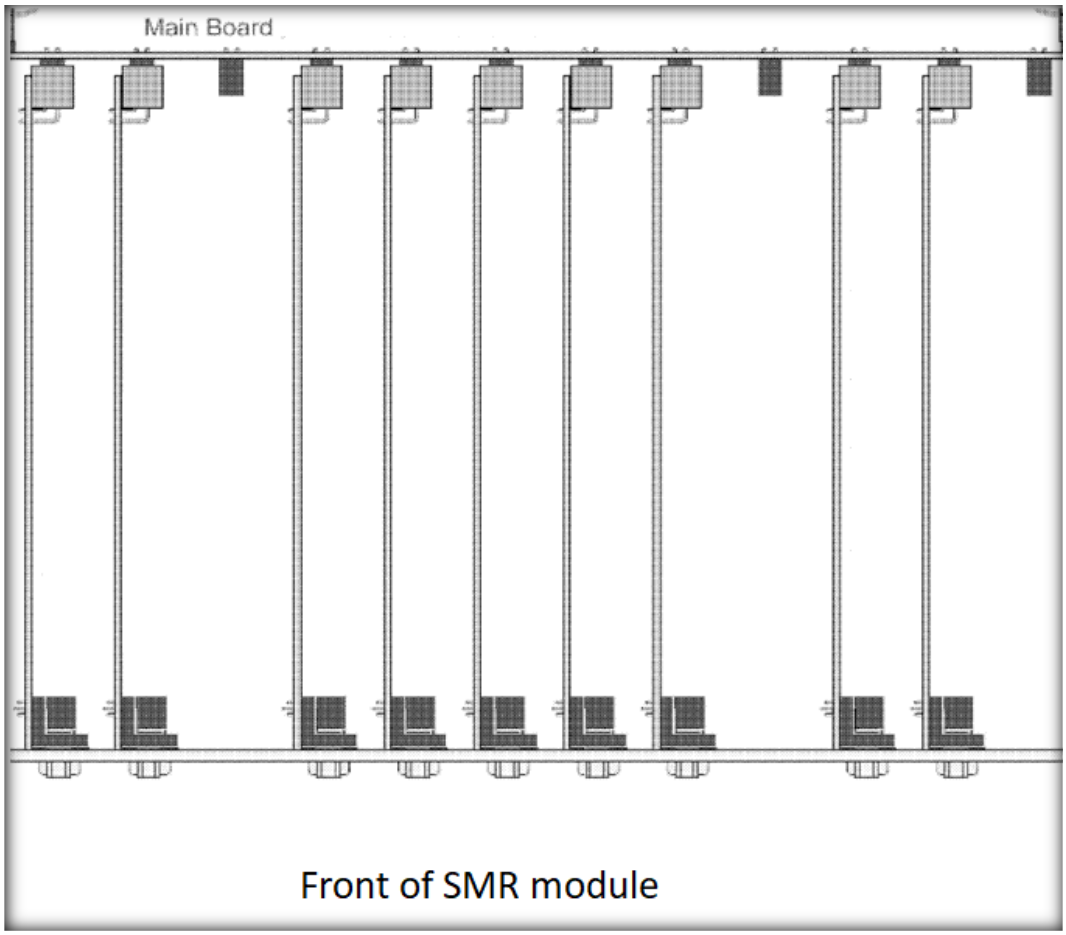

Figure 5. SMR module top view where can be seen how logic cards are inserted to motherboard

3.2 FAST Ethernet Communication Card

The Institute of Electrical and Electronics Engineers (IEEE) released a standard called IEEE 802.3u in 1995 and it defined standard for 100Base-T Ethernet which is more commonly known as FAST Ethernet. Previous standard IEEE 802.3 (1983) defined 10BASE5 was commonly known as Ethernet. FAST Ethernet was 10 times better with speed of 100Mb/s against its old standard Ethernet as it only had 10Mb/s speed. They both were the fastest communication standards of their time. /3; 4/

The FAST Ethernet card (see Figures 6 & 7) itself is a product that is designed by Tietolaite Oy and Wärtsilä. The card has 1xD15S, 1xD25S, RJ45 and input and

output fibre optic connectors. At the back there is 2xDIN 41612 standard connectors that are widely used in similar rack based electrical systems. /5/

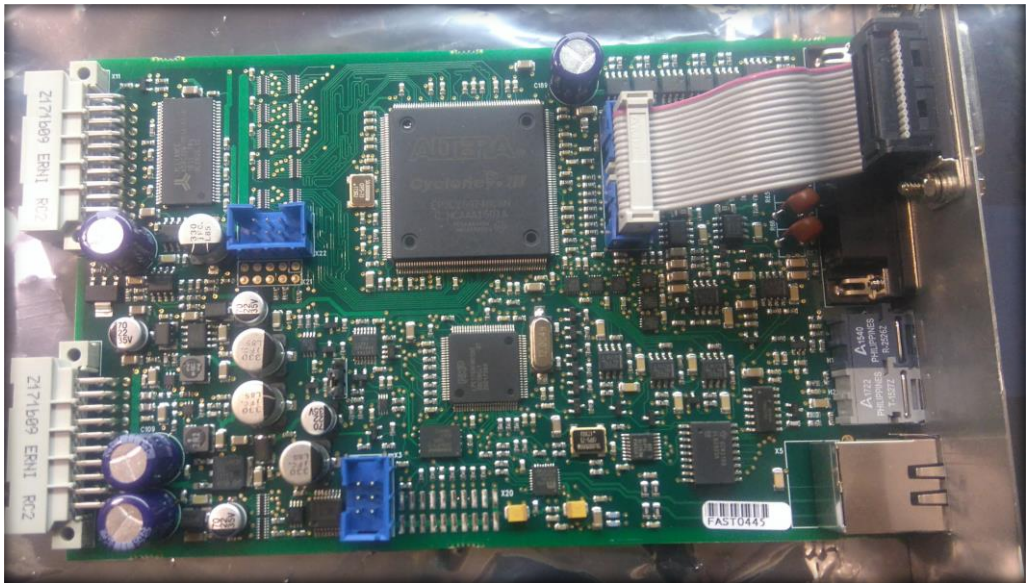

Figure 6. FAST Ethernet card pictured from the top.

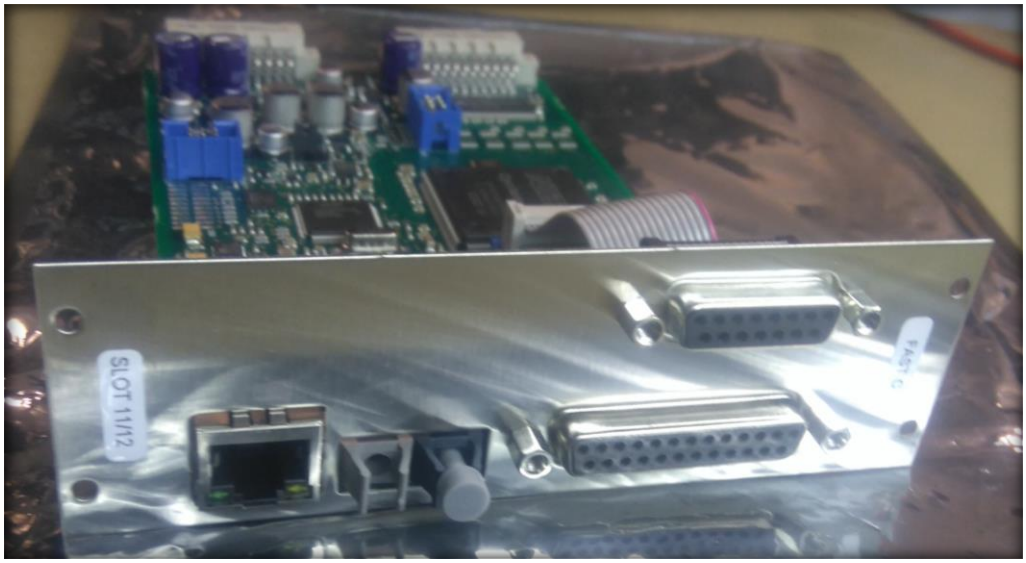

Figure 7. FAST Ethernet card pictured from the front.

4 CHANGING COMMUNICATION CARDS

It was crucial to have everything ready before starting the work as it was important to get the update work ready as soon as possible.

When the thesis contract was made a meeting was held where it was discussed what the thesis work will include and there decided that Wärtsilä wanted to have the following things:

- Step by step guide for future use as Word document. The step by step guide includes instructions for executing this very same update work in future and it is shown in Appendix 1.
- Serial numbers of all FAST Ethernet, DIO, AIO, MIO and motherboard cards as they were not documented before.
- Backup data of all the cards, this includes old firmware and software. The backup data is stored in IDM as there could be reason to go back to the old setup.
- SMR module ID's and IP-addresses that were configured to the new communication cards was documented and stored in IDM.

4.1 The Plan

The objective was to change the communication cards of the UNIC C3 rig. The new communication cards use the FAST Ethernet connection as the old communication cards used USB. The very first thing was to get all needed equipment and tools to avoid any unnecessary delays when changing the communication cards. It was important that the rig was not out of service for long time as it is in daily use.

The required wirings between the new communication cards and Wärtsilä's modules can be made with a data transmission cable called LiYCY which is often used in various systems that need communication between different modules and devices. The connectors that are used with the cable LiYCY are male connectors D15P and the other end is connected to special connectors (see Figure 8), which are spe-

cially made for EMs by Phoenix Contact Oy. The D15P connectors need to be soldered to the cables but the Phoenix connectors and the cables can be connected by hands as the Phoenix connector is a push wire style connector.

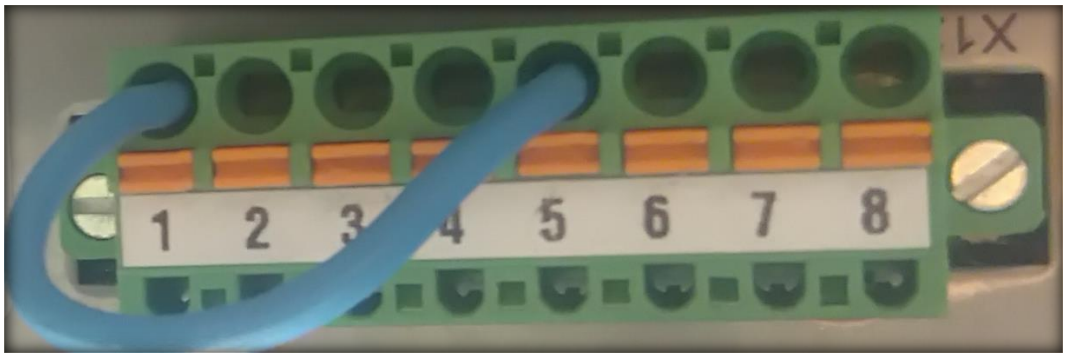

Figure 8. Phoenix connector.

Ethernet cables are also needed as the old cables are USB cables and therefore they were not suitable with the new communication cards. The old USB communication cards are wired with USB cables to a USB-hub and then to the PC on the rig, which is used for controlling the SMR modules. The USB cables and the hub were no longer needed so they were removed. The new Ethernet communication cards are wired with Ethernet cables to a switch and the switch is connected to PC. The PC will still do the same as it did with the old cards only that now the SMR modules can be controlled with new generation software because Ethernet connection allows more signals and therefore more features with the new generation software.

There is also a need for a fibre optic cable, which will keep the modules in sync, the fibre optic cables are connected in series between the communication cards. The switch needs to be installed and for that there might be need for moving the computer upwards, so the switch would fit properly. The cables need to be marked so that they are easily identified afterwards.

A programming device was needed for updating all the SMR modules to be compatible with the new communication cards and the update was made according to the Wärtsilä internal document. Next, the communication cards can be installed and then the IP-configuration was needed. IP-configuration can be made with UNITool software which the new generation software that will be used for testing engine

configuration in the rig. Next, the system needs to be calibrated. Finally, testing as a normal configuration test with W20V34DF engine as it has the most complex engine configuration with the number of signals. /6; 11/

4.2 Equipment

The planning of the physical work itself was made well in advance and equipment list was part of it. The Ethernet switch (see Figure 12) was ordered by Wärtsilä and it came from Hewlett-Packard, which mainly produces information technology products. The FAST Ethernet cards was ordered from Tietolaite Oy, which is Wärtsilä's subcontractor. Tietolaite Oy also sent a device, which could be used to update the firmware on the SMR module logic cards and motherboards. Other equipment such as cables and connectors were ordered and picked up from Starelec Oy which is electric equipment store in Vaasa. A USB3-LAN local network converter was needed as the USB-hub was replaced with an Ethernet switch. The local network converter converts an Ethernet cable to a USB cable.

Equipment that was needed:

- New FAST Ethernet based communication cards delivered by Tietolaite Oy
- Logic card programming device
- Ethernet switch
- Cable LiYCY 8x0.25 20m
- Connectors D15P 8pcs
- Connector covers DPPK15-MU 8pcs
- CAT6SSI-1M 1pcs
- CAT6SSI-1.5M 5pcs
- CAT6SSI-2M 6pcs
- CAT6SSI-3M 3pcs
- USB3-LAN local network converter

The new communication cards support more signals and therefore more cables between SMR modules and EMs are needed. The cables are made from LiYCY cable, D15P male connectors and connector covers for the D15P connectors. The cables

are wired according to document DAAF014607-rev-c. The new signals are only for CCM-EMs and in the rig, there are eight of them so eight new cables were made, and they can be seen in Figures 9,10 & 11.

Figure 9. D15P connector ready to be soldered.

Figure 10. Communication cable soldered to the connector.

Figure 11. The communication cable ready to be used.

Figure 12. The Ethernet switch placed in the rig.

4.3 Update process

The work started by powering off the rig, cables marked and unplugged. The SMR module for generator EM was the easiest to start with as it is a separate box on top of the rig. This SMR module for generator EM is a separate module installed on top the rig. Originally the rig was not designed with another Wärtsilä module but later the E1 box was needed and then the extension SMR module was added on top of the rig. As the SMR module is not installed inside the rig, it must be protected in another way and the solution here had been that it was added inside a cover. Before this update process, no fibre optic cable was attached to the E1-SMR module even though there was a connector for it because it was not working anyway. The idea of the fibre optic cable is to synchronise the speed information between the modules. With the new communication card, the fibre optic cable works, so it was added.

After the separate SMR module was updated, the update of the SMR modules installed on the rig began. These SMR modules are securely attached to the rails that

hold the SMR modules in place. The rig was originally built very tightly to save space and when doing this kind of update, a lot of access is needed. As the updating operation was time sensitive so it was clear that less work was better and so that more work could be done without taking all the SMR modules off the rig because that would have been time-consuming.

All motherboard serial numbers were at the back of the SMR modules and so most of the serial numbers could be seen from the opposite side of the rig. Two of the motherboard serial numbers were right behind some wirings but as those were exactly the SMR modules that needed to be uninstalled anyway so it made no difference as the serial numbers could be then documented. The DIO cards also had serial numbers and they did not need a local update because they could be updated via Ethernet at the end of the whole operation. So serial numbers for those were needed also and that meant that all the visible serial numbers were listed and the rest not visible needed to be taken off from the SMR modules and then documented. The serial numbers are needed to keep track on specific hardware changes and they have not been documented before. The serial numbers of the AIO and MIO cards could be documented while they were updated with new firmware.

The Ethernet switch was planned to be installed at the very beginning of the update work but as it was about to be installed information came that it could not be installed anywhere near the PC. The PC would be upgraded to a physically bigger one. The update work had been agreed to be started so the Ethernet switch installation would be done during the update process. The rig is built so that the top six SMR modules and the eight SMR modules on the bottom have a slightly bigger cap between so that could be used for the Ethernet switch.

The SMR module motherboard, AIO-, DIO- and FAST Ethernet cards firmware were updated with PC software called SMRUpdater (see Figure 13). The SMR module motherboard, AIO and MIO cards needed their flash memory to be configured before the firmware update was possible. The flash memory update was done with another PC software called FlashProgrammer (see Figure 14) but as a different

to the firmware update the programming device was needed between the flashed card and the PC.

The SMR module motherboards were updated by connecting the programming device to the motherboard and PC. Next, power was switched on, on the SMR module and then updating with PC software. AIO and DIO cards were updated in the same way but they do not need external power. There was a problem with updating two of the motherboards but eventually the reason for that turned out to be that the SMR modules needed some time after powering on before the update could be started.

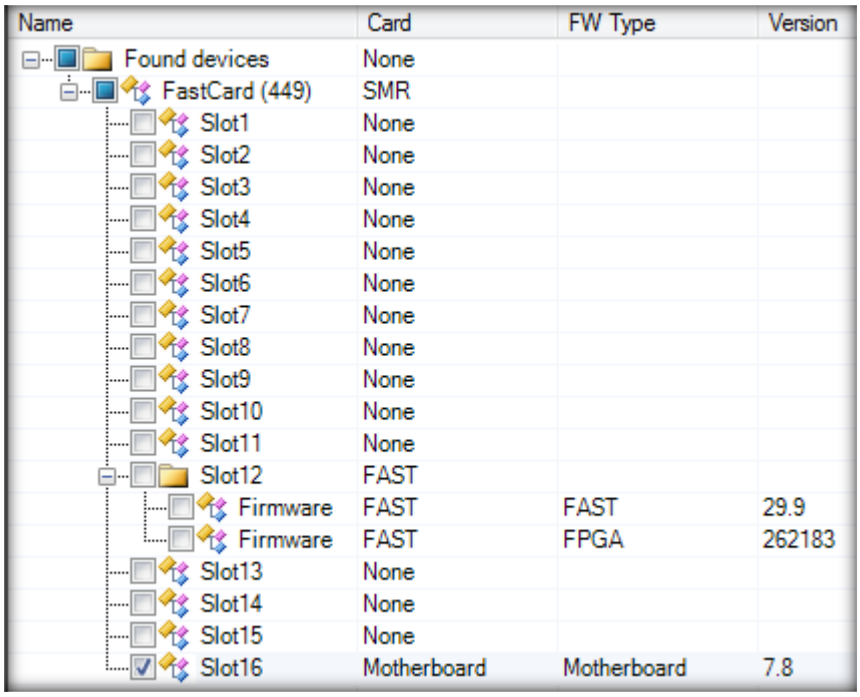

Figure 13. SMRUpdater view.

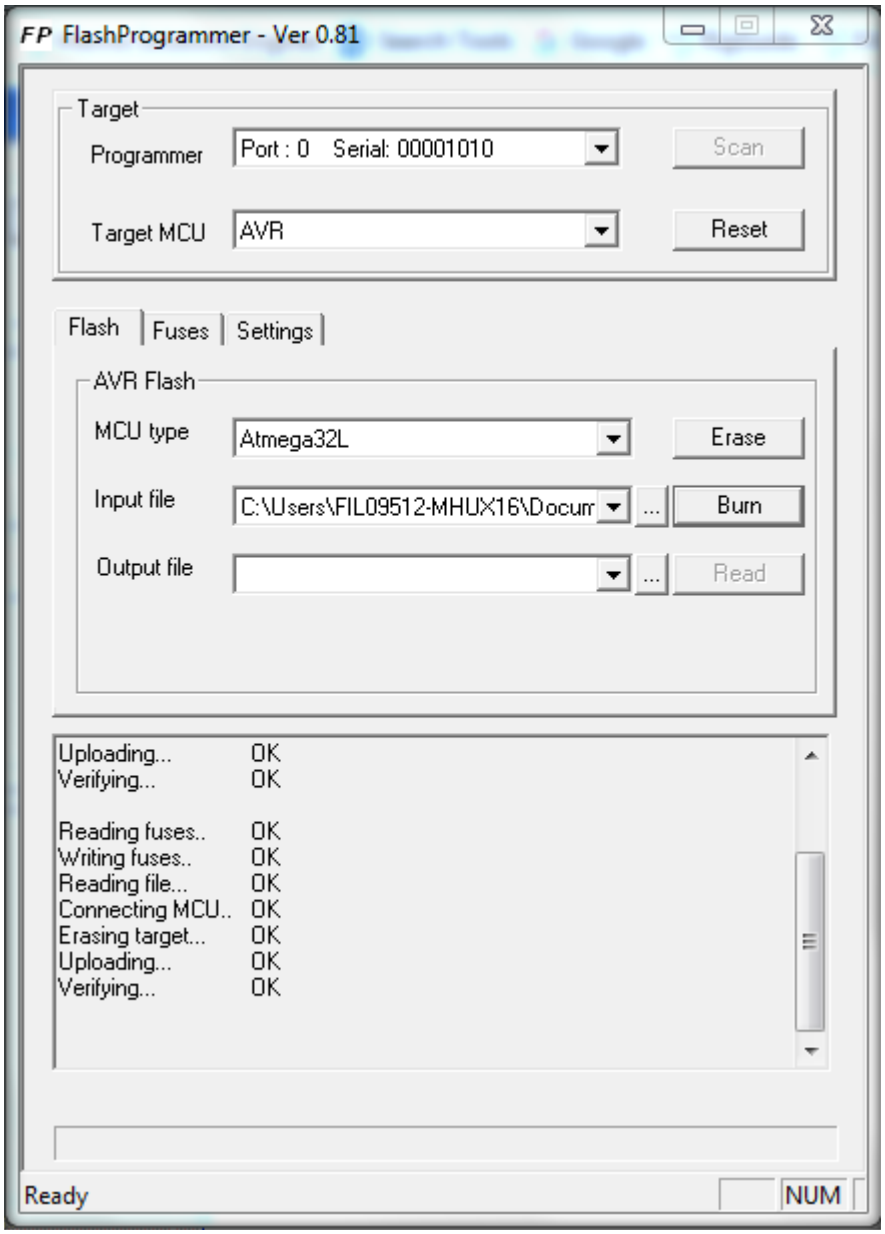

Figure 14. FlashProgrammer view.

At this point as the two SMR modules were uninstalled from the rig there was more space to pull the cables to the rig. The Ethernet cables, Ethernet switch power cable and all SMR module connectors were now connected. As the top six SMR modules were now ready, it was an apt moment to try and take connection with the PC on the rig.

Power was turned on for the SMR modules that were ready and had all cables connected. To get connection to the SMR modules with the PC on the rig, the Ethernet switch, IP-addresses and the local network converter needed to be configured. The Ethernet switch and the local network converter were configured by the instructions that came with their packages. IP-addresses were first tried to configure with the software called SMREthernet but that would not save the changes. Another software that was tried was the UNITool software which the new generation software that will be used for testing engine configuration in this rig. With the UNITool the IP-address configuration was managed successfully and the SMR modules were also named by the engine module names that they are connected to.

Now that the connection was set up, it was time to update the firmware of all needed devices. Two of the top six SMR modules were already updated while they were off the rig as a test to see that everything will go as planned. As the PC had now connection between the SMR modules, the firmware update could be done to all the SMR modules at the same time. Updating the SMR modules one at a time would take more time as the SMRUpdater software can update all the SMR modules at the same time. The SMRUpdater was not able to connect to the SMR modules if the UNITool was running.

Before this update process CCM-EMs had one signal called speed phase that did not work with the old communication card. It was implemented by chaining the signal to all the CCM-EMs with separate wiring (see Figure 15). With the new communication cards speed phase signals is fully functional and the wiring was changed (see Figure 16).

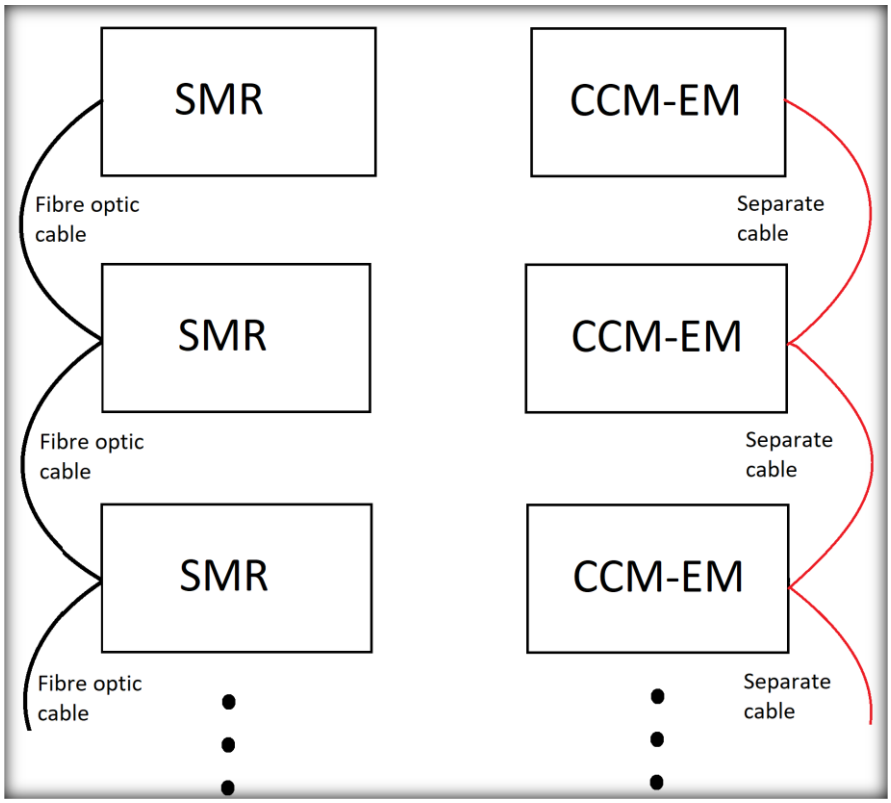

Figure 15. Illustration of Phase chaining with the old communication cards in use.

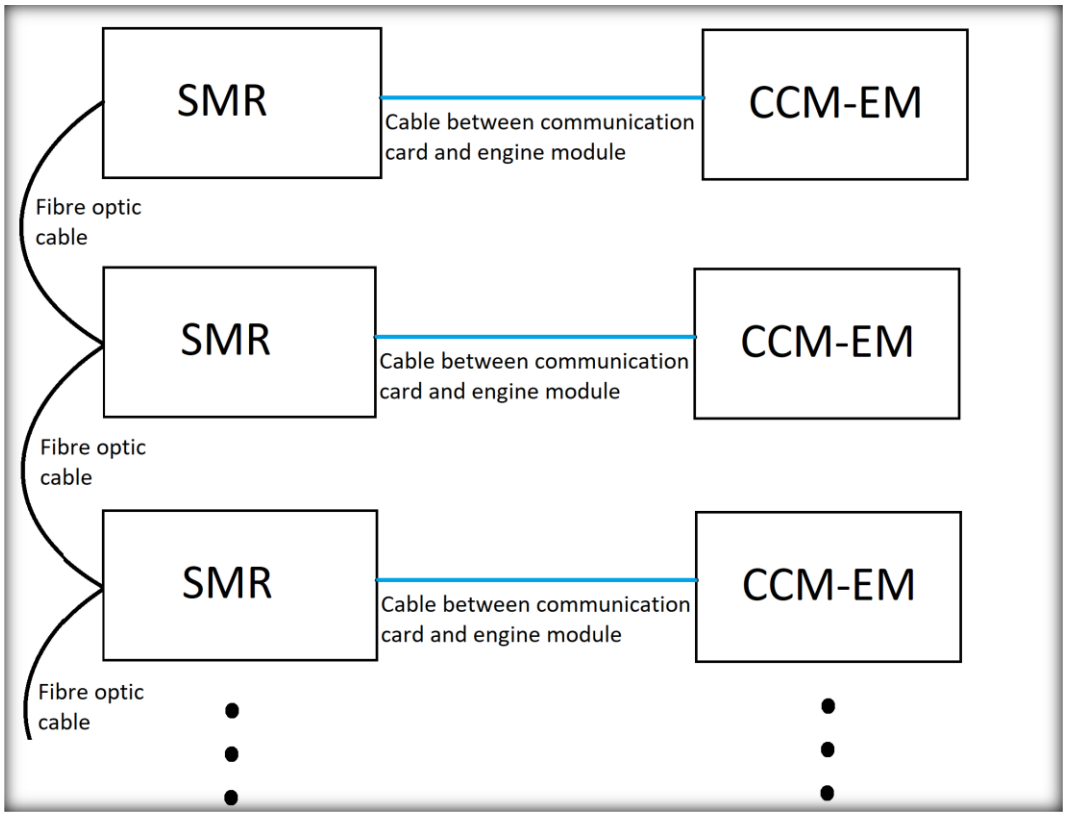

Figure 16. Illustration of Phase chaining with the new communication cards in use.

The eight bottom SMR modules were updated in the same way as the top six SMR modules, these eight bottom SMR modules control the CCM-EMs so the cables that were made earlier were added too. One problem came up as ID-1521 AIO card in ID-09 SMR module caused a confusing situation as the memory flash failed (see Figure 16). At this point no apparent reason was found for the fail as it succeeded with the second attempt.

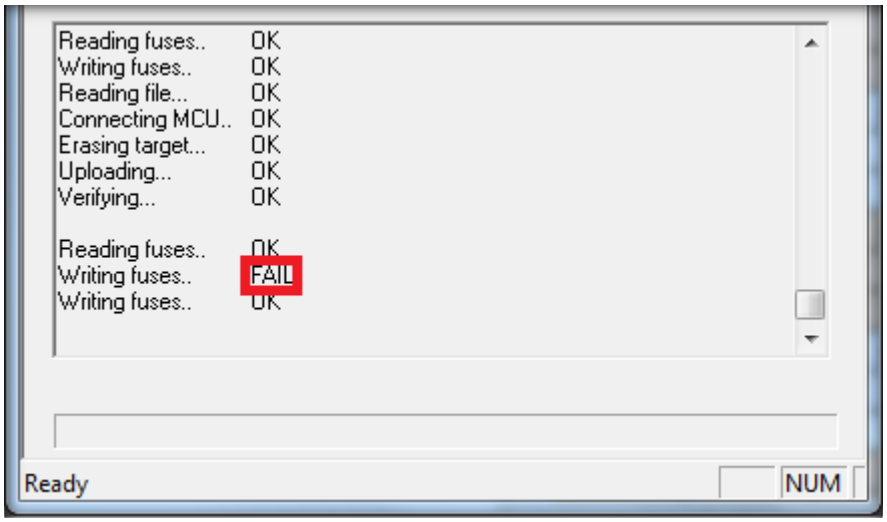

Figure 17. AIO card memory flashing failed and then succeed.

When all the SMR modules and the EMs were updated, and it was time for testing. The configuration began with a strange problem. The problem was that all the SMR modules rebooted by themselves repeatedly. The configuration test could not be done and to the troubleshooting followed. All the cables that had been unplugged were double checked and that made no difference. Then the SMR module which had the memory flash fail, was taken to investigation as it was highly potential cause for this problem. The ID-09 SMR module was uninstalled from the rig to a closer inspection. It turned out that the motherboard on the ID-09 SMR module was not attached properly. Three fastening bolts were missing (see Figure 17), and the problem could have not been noticed before. When the new communication card was inserted to the SMR module, it should have attached on the motherboard, but the motherboard gave up because the bolts were not there to hold it on place. The new communication card did not attach in place and that caused a loose connection, which was the reason for the SMR modules to repeatedly reboot themselves. Three missing bolts were attached in place (see Figure 18) and the SMR module was then reinstalled.

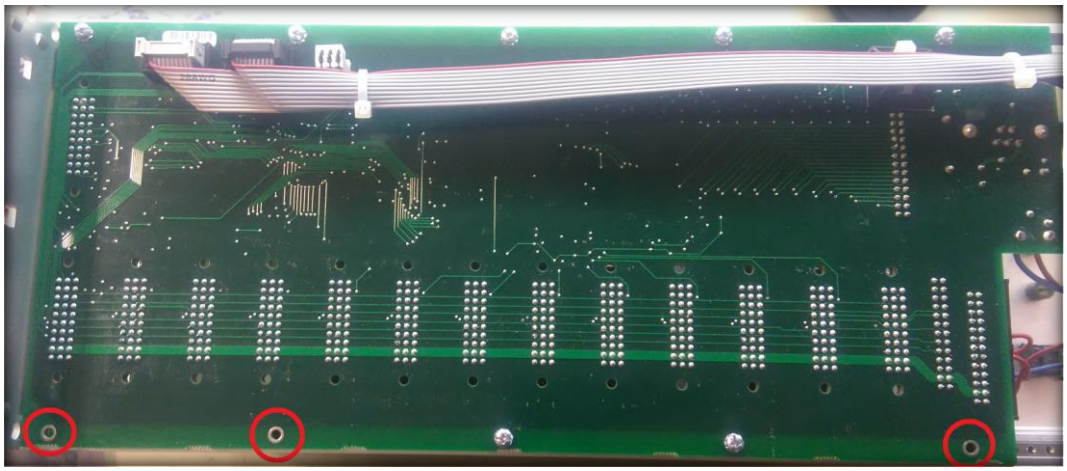

Figure 18. Subrack case ID-09 SMR module motherboard viewed from behind with three missing bolts.

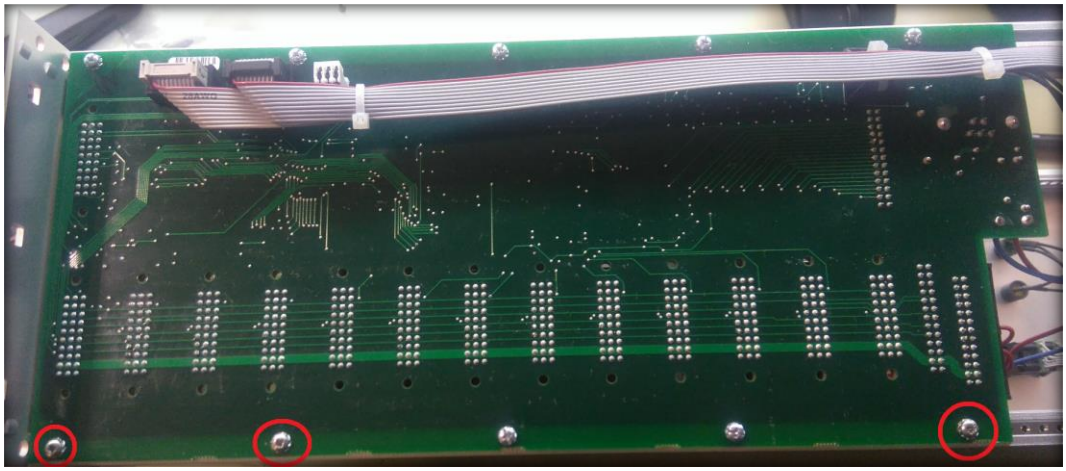

Figure 19. Subrack case ID-09 SMR module motherboard viewed from behind with three missing bolts attached.

At the last stage of the update process, all the cables were bundled with cable ties. There was also little maintenance done to the rig as there has been issue with SMR module power supply. Each power supply has a cooling fan and the power supply that powers the SMR modules have made a whining noise lately. The cooling fan was changed during the update process (see Figure 19).

Figure 20. A new cooling fan for the power supply.

5 RESULTS

When all the SMR modules were updated and reinstalled on the rig it was time for test an engine configuration on the rig to see if the results were as expected. The selected engine configuration was the W34V20DF standard release. It was selected because it had been tested before and as it is the engine configuration of 20-cylinder engine it has all the possible signals to be tested.

The most interesting result was to see if the new signals can be tested as it was one of the main reasons to start this update process. As the configuration was tested, all went as planned and the update process was done in the time given. The new signals that are now possible to simulate are engine knocks and the cylinder pressure measurements and the speed phase functions now without separate wirings.

All the backup data from FAST Ethernet, DIO, AIO, MIO and motherboard cards, SMR module ID's and IP-addresses, serial numbers of all FAST Ethernet, DIO, AIO, MIO and motherboard were uploaded to Wärtsilä's database system IDM. The step by step guide was also uploaded to Wärtsilä's database system IDM and attached as an appendix to this report (see Appendix 1).

6 CONCLUSIONS

The update process was executed in the time given and had the results that were expected so all in all it went as planned.

The validation rig is in continuous use and therefore it was important to plan the update process before to the actual work. The planning before starting the update process was very helpful as it speeded up all the work. There was not a moment where the next step would not have been known.

In the early stage when the SMR modules needed to be updated and the cables were pulled on the rig, four of the SMR modules were uninstalled from the rig and there was only little room for pulling the cables in. Pulling the cables with very little room for hands was a bit tricky but if more of the SMR modules would have been taken of, it might have been more time consuming. If this kind of update process would have no time limit, the best way to do it is to take all or at least more of the SMR modules off from the rig.

When the configuration test was started, and the motherboard problem came up there was a thought that if the SMR module would have been taken off from the rig in the first place, the missing bolts might have been noticed. On the other hand, that was not an expected problem because the rig had worked before and there was no need for inspecting the SMR modules as they were off. There was also a thought that some device could have been broken during the update as these kinds of electronic devices and equipment that were used are very sensitive for breaking for example due to ESD (Electrostatic Discharge) or connection errors. The conclusion for that problem was that it was an unavoidable issue as the bolts had to be forgotten already at the time that the rig was made.

This thesis work helped to understand the functionality of the engine configurations and how the validation rig works and how it is used to test the engine configurations. As a last conclusion, well planned is half done.

REFERENCES

/1/ This is Wärtsilä. Fast facts. Our businesses. Accessed 18.04.2018 https://www.wartsila.com/about

/2/ History. Accessed 18.04.2018 https://www.wartsila.com/about/history

/3/ 100 Mbps Ethernet / IEEE 802.3u including 100 Base-T. Accessed 12.04.2018 https://www.electronics-notes.com/articles/connectivity/ethernet-ieee-802-3/100-base-t-802-3u.php

/4/ IEEE Standard for Ethernet. Accessed 14.04.2018 http://www.trincoll.edu/Academics/MajorsAndMinors/Engineering/Documents/IEEE%20Standard%20for%20Ethernet.pdf

/5/ Eurocard Connectors per DIN 41612 and IEC 60603-2. Accessed 14.04.2018 https://www.digikey.com/Web%20Export/Supplier%20Content/Tyco_8004/PDF/te-connectivity-eurocard-connectors.pdf?redirected=1

/6/ Wärtsilä internal document. RigGuide. Accessed 30.01.2018 DBAD548710 rev: c2

/7/ New Wärtsilä 31 engine achieves Guinness World Records title. Accessed 19.04.2018. https://www.wartsila.com/media/news/02-06-2015-new-wartsila-31-engine-achieves-guinness-world-records-title

/8/ Energy Solutions. Accessed 20.04.2018. https://www.wartsila.com/energy

/9/ Virtual engineering for enhanced services. Accessed 20.04.2018. https://www.wartsila.com/resources/article/virtual-engineering-for-enhanced-services

/10/ Wärtsilä internal document. Unic C3 system description W34DF ver a7. Accessed 25.04.2018. DBAC740106 rev: 5

/11/ Wärtsilä internal document. RigGuide_ym2009. Accessed 25.04.2018. DBAA194634 rev: c

/12/ Wärtsilä internal document. SysDescr. Accessed 25.04.2018. DBAA194634 rev: c

/13/ Wärtsilä internal document. SMR-UserGuide. Accessed 25.04.2018. DBAA194634 rev: c

APPENDIX 1

Step by Step Guide for changing FAST Ethernet cards to a UNIC test rig

Equipment

- New FAST Ethernet based communication cards delivered by Tietolaite Oy
- Logic card firmware programming device
- Ethernet switch
- Cable LiYCY 8x0.25 20m
- Connectors D15P 8pcs
- Connector covers DPPK15-MU 8pcs
- Ethernet cables CAT6SSI 15pcs (measure before ordering)
- Tools
- Laptop with needed software introduced in document: DBAD514583
- USB3-LAN local network converter

Guide

Step 1. Make communication cables ready. Required items for that are: basic tools, cable LiYCY 4x0.25mm and LiYCY 8x0.25mm, D15P connectors, D15P connector shields, soldering iron, soldering tin, wire end sleeves, heat-shrink tube and a workbench.

Making the cables: The grounding of the cable needs to be rounded together and then protected with a heat-shrink tube. The end of the stripped part of cable should also be protected to avoid unnecessary contact which could cause short-circuits. The cables are wired according to document DAAF014607-rev-c.

Figure 21. D15P connector ready to be soldered.

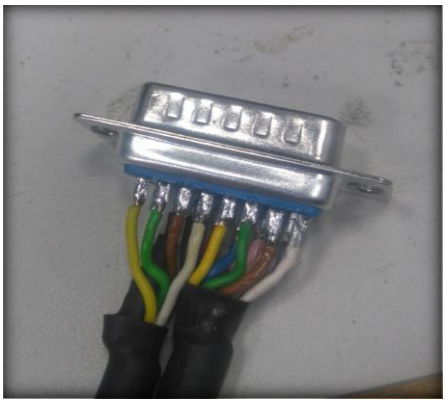

Figure 22. Communication cable soldered to the connector.

Figure 23. The communication cable ready to be used.

Step 2. Prepare the following equipment: Cables that were made in Step 1, access to basic tools, the new communication cards, Ethernet cables and Ethernet switch.

Figure 24. HP Ethernet Switch.

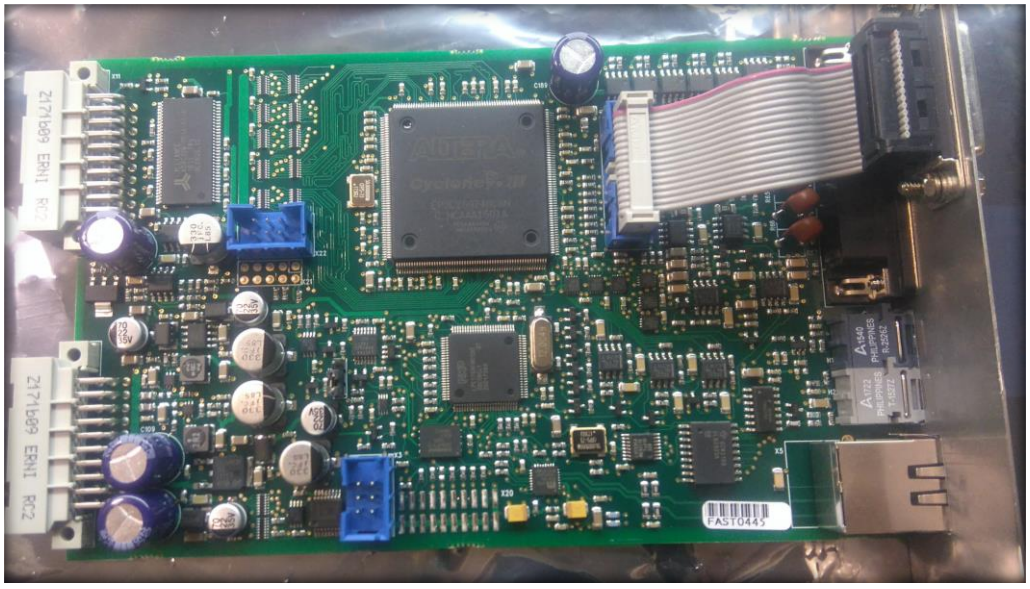

Figure 25. FAST Ethernet card.

Step 3. Unplug power from the rig.

Figure 26. Push main fuse down.

Step 4. Install Ethernet switch to the rig. Install the USB/LAN converter and connect it to the PC.

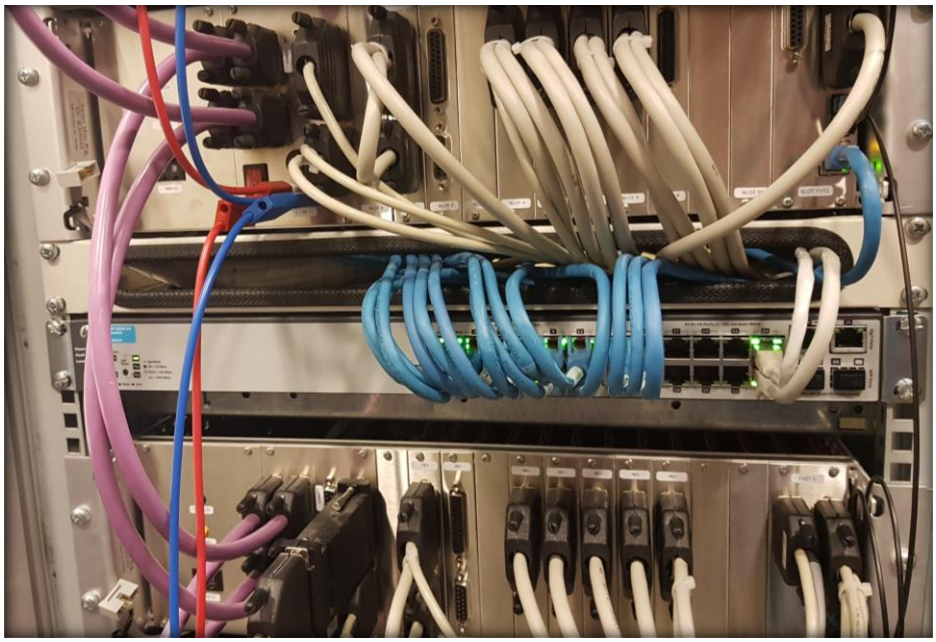

Figure 27. Ethernet switch installed on the rig.

Step 5. Unplug all connectors.

Step 6. Uninstall the old communication cards.

Figure 28. Old communication card installed, remove it.

Step 7. Install the new communication cards.

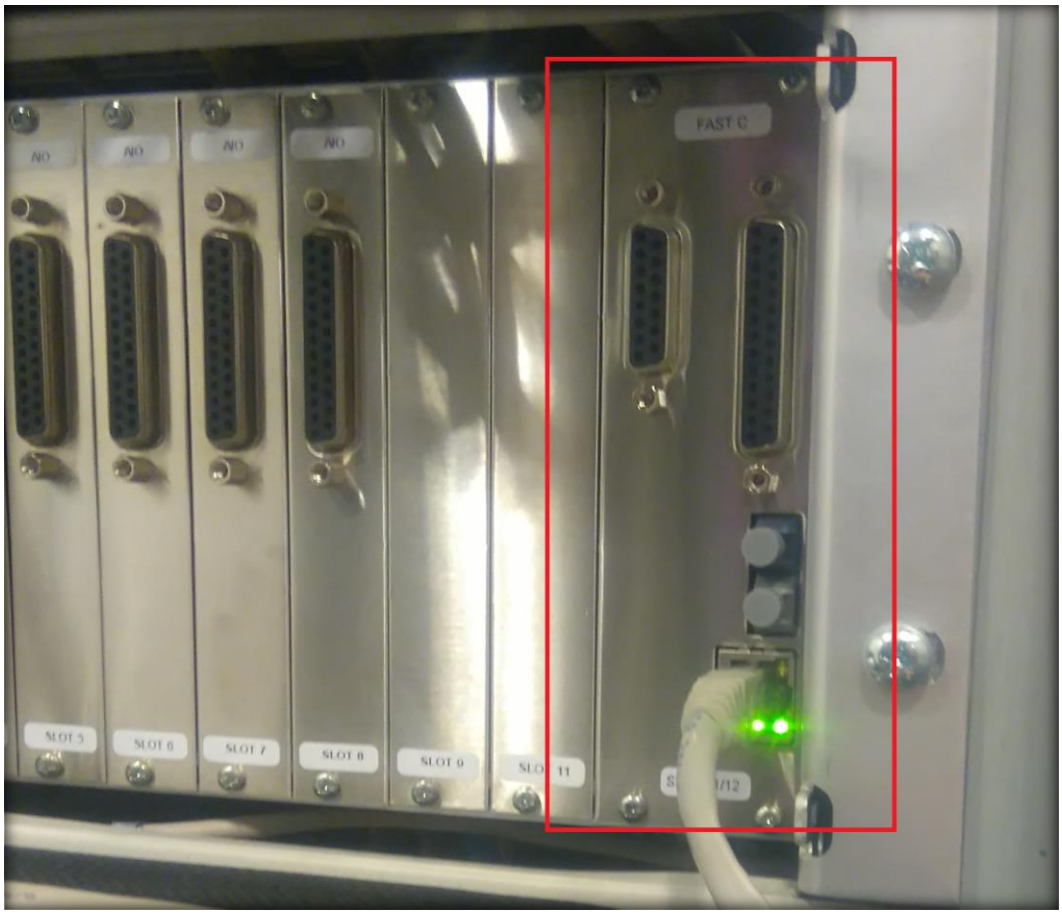

Figure 29. New FAST Ethernet card installed.

Step 8. Uninstall SMR modules that are marked in Figure 10 to get access to the update firmware of the SMR modules. By uninstalling every third SMR module you can access the one on top of the one being uninstalled and also the one under it.

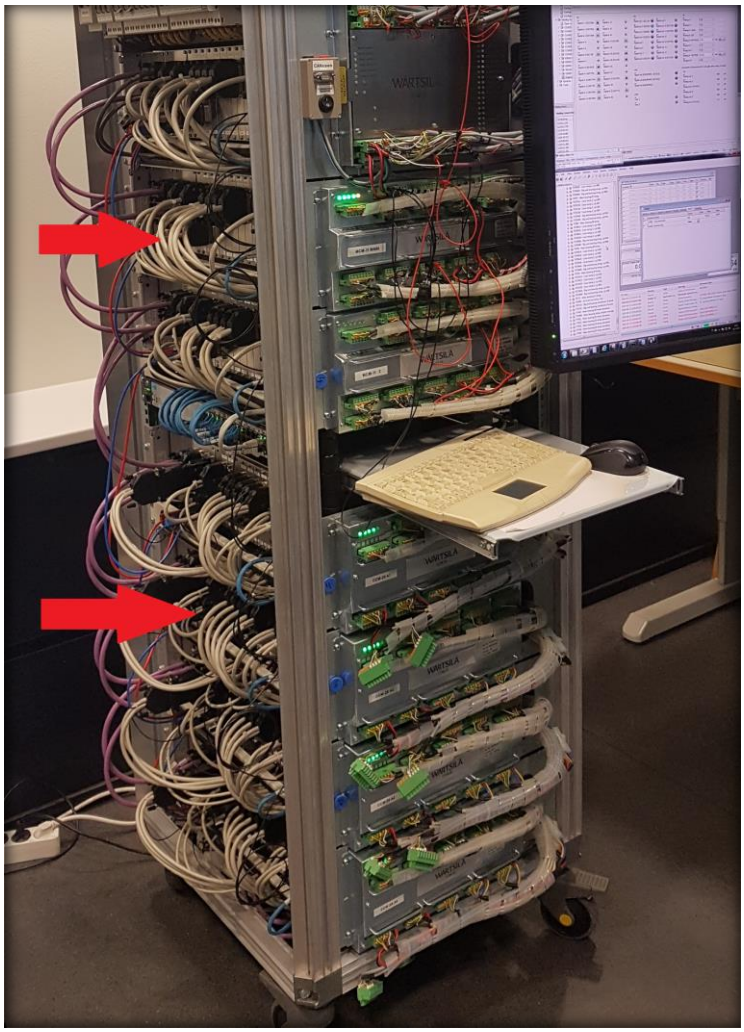

Figure 30. Remove every third SMR module.

Step 9. Update the firmware as instructed in following document DBAD514583

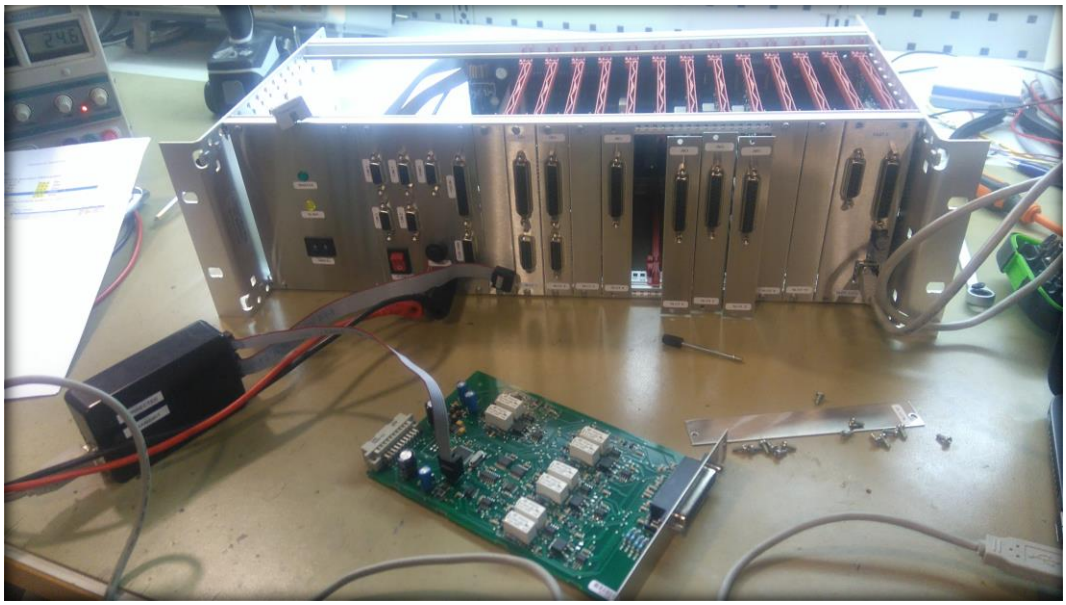

Figure 31. Update on process.

Step 10. Install the SMR modules back to the rig when updated.

Step 11. Replug the connectors back as they were.

Step 12. Make sure all connectors are connected properly and plug power to the rig.

Step 13. Test the rig by completing the normal test procedure with the UNIC C3 WMAP4 W20V34DF package. Use the test guide in document DBAD372126