Fleet Monitoring System
for
Vessels

By Leung Wan Kee Shipyard Limited

Executive summary

Vessel Remote Monitoring has been a hot topic in the industry. In order enhance operational excellence, ship owners are looking for a common monitoring platform across their whole fleet of ships. There have been various companies trying to create monitoring system to achieve this function. Challenges were found particularly in terms of connectivity, signal compatibility and monitoring platform.

LWK shipyard has related experiences for retrofit and upgrade of marine equipment onboard, for instant, adding monitoring systems locally onboard, installing various types of connectivity systems, etc. LWK Shipyard believes there should be a possible way to put all these experiences together to form a Vessel Remote Monitoring System. A primary research was done on this subject. Result of the research showing it is possible to acquire and covert various type of signals originated from numerous equipment, say, machineries, tanks, electrical systems, and navigation equipment, to a common signal format regardless of the ages of ships, digital control engines versus analog control engines. This signal could be transmitted via secured internet connection back to shore. A common operating/monitoring platform will be used to interpret and display collected operation parameters.

Purpose of this project is to realize the highly confident result of the primary research and make it become a workable monitoring system. It is also expected to define limitations of the system, if any exists.

Design Basic

Preliminary systems design is based on ships using engines with digital control. Basic configuration is:

Nos. of main engine
Nos. of Diesel engine generator
Bilge Water Tanks
Fluid Tank
Fire Detection Alarm System
GPS with digital signal
Heading with digital signal
Anemometer with digital wind speed and direction signals

Vessel remote monitoring system recommended in this proposal is based on the above as references.

System Configuration

The whole Vessel Remote Monitoring is formed by 4 sub-systems named signal acquisition and conversion, onboard signal backbone, connectivity and monitoring platform.

Signal acquisition

This sub-system is mainly formed by various types of signal extraction modules and sensors. On digital control main engine(s), its operating parameters are readily available in the engine control system. Signals could be in manufacturer's proprietary format or licensed signal protocol. A data extraction bridge with conversion to backbone signal format will be used.

Generator(s) are very similar to main engine. Data acquisition will be done in the same manner as engine. In case there is no digital signal for electrical parameters, voltage and current transducers will be used for data acquisition and conversion.

Fluid tank(s) will be measured by ultrasonic sensors. These sensors use the same signal format as in the backbone, no conversion is needed.

Electrical Systems, AC and DC, will be measured by voltage and current transducers. Output signals are compatible to the signal backbone.

Alarm status modules will be used for monitoring various alarm contacts, for instant, alarms in fire detection alarm panel and bilge water level alarms. Alarm contacts status is then transformed to backbone signal format.

Most navigation equipment already has signals in various digital formats. In case signal is not compatible, conversion module will be used.

Signal Backbone

Signal backbone is made up by a data bus (data cable) running throughout the whole ship to for signal collection and transmission. There is data storage module in the backbone. Signals acquired from various equipment will be stored for record purposed. Data retention policy is terms of FIFO. A TCP/IP gateway is acting as the bridge to ethernet network.

Connectivity

Connectivity sub-system onboard a ship is for Tx and Rx signal between ship to shore control center. Data will be transmitted via 4G FDD-LTE and vSat Ku-band network. The 4G FDD-LTE secured router has **FOUR** 4G channels. Each channel can host a master SIM card and SIM card for auto-failover function. The WAN port at the secured 4G router is connected to vSat modem. Thus totally 5 communication channels could be available for communication. These 5 channels could be combined by a special VPN tunnel which gives bandwidth bonding function, load balancing and data encryption. As long as either one channel is available, connection will not be interrupted.

In shore control center a secured router with fixed IP address is needed. This is for shore side connection of the special VPN tunnel.

Monitoring Platform

Monitoring Platform is a piece of software installed on a Windows PC (either Win 7 or Win 10). Same software with same user interface will be used for monitoring all ships. Samples of typical monitoring interface is enclosed in Appendix C. Each PC could monitor one ship.

This pair of 4G FDD-LTE secured router (ship side) and secured router (shore) could be registered to either manufacturer's cloud server or a private server appliance. Once registration is done, operator could logon to the server for routers remote administration. This proposal includes this private server appliance as an option.

Compatible Brand Names of Engine and Generator with Digital Control

Caterpillar	MAN
Cummins	MTU
Detroit Diesel	Perkins
John Deere	Volvo Penta
Kohler	Yammar
Onan	

Types of Signals

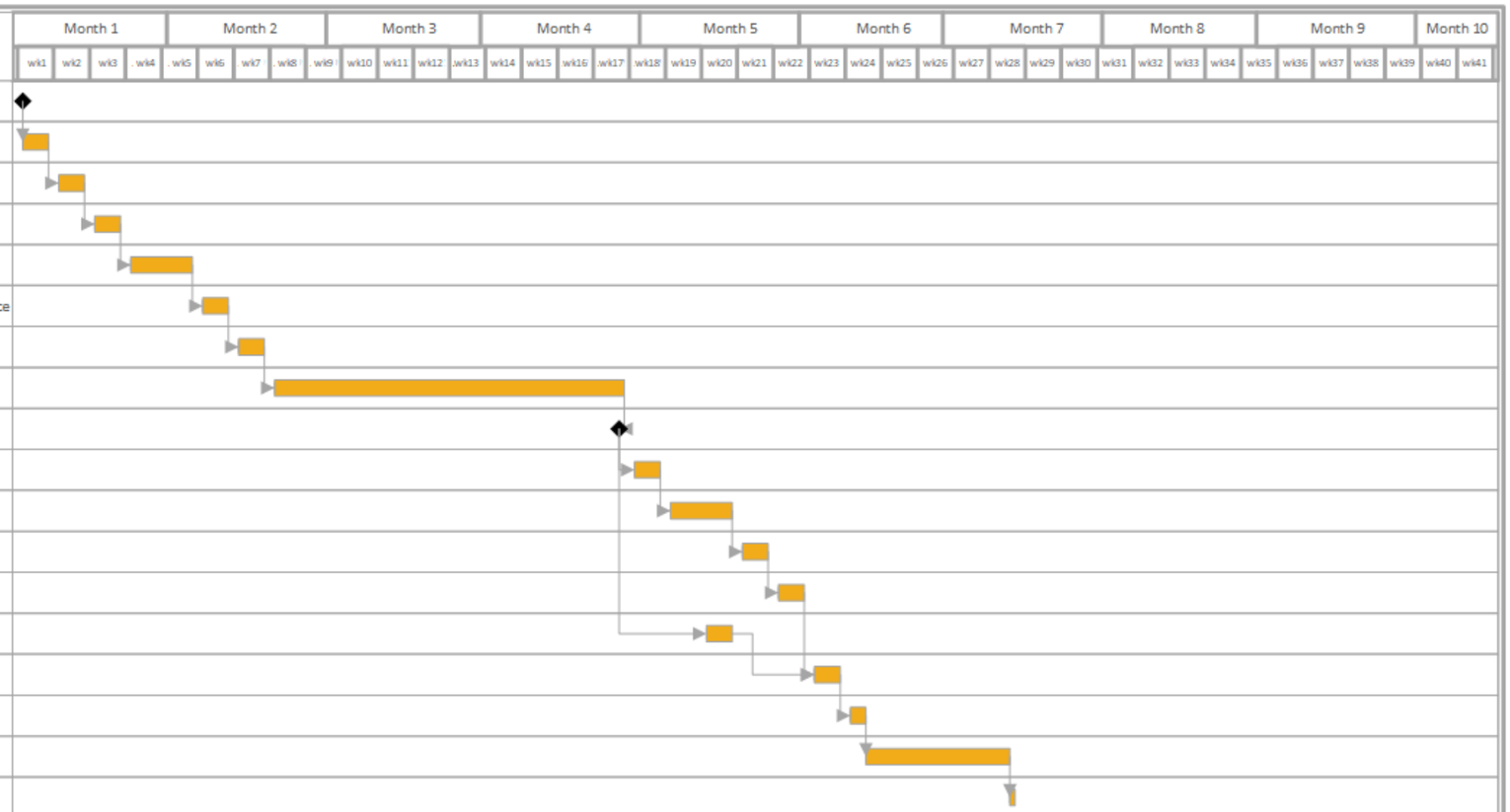
The software being used in this project is capable to interpret and display many kinds of signals. They are grouped in following table. Signals being included in this project is checked with a "√".

Equipment Group	Signal	Digital Control Engine
Engine / Gear Box	Engine RPM	√
	Engine Hours	√
	Coolant Temperature	√
	Engine Oil Pressure	√
	Percentage Engine Load	√
	Percentage Engine Torque	√
	Transmission Oil Temperature	√
	Transmission Oil Pressure	√
Generator	Engine RPM	√
	Running Hours	√
	AC Generator Current	√
	AC Generator Frequency	√
	AC Generator Voltage	√
	Charging Voltage	√
	Coolant Temperature	√
	Engine Oil Pressure	√
Tank	Fuel, Water, Oil Tank Level	√
AC Power	AC Voltage	√
	AC Current	√
	Frequency	√
	Real Power	√
	Reactive Power	√
	Power Factor	√
DC/Battery Power	Voltage	√
	Current	√
	Ripple Voltage	√
Alarm contact	Alarm contact closure (heat, smoke, motion, vibration, door, fluid level, etc.)	√
Navigation	Heading (signal from Compass)	√
	GPS Location (signal from GPS)	√
	Wind Speed (signal from Anemometer)	√
	Wind Direction (signal from Anemometer)	√
	Depth (signal from Echo Sounder)	√
	Speedlog (signal from Speedlog)	√
	Accumulated Travel Distance (signal from Speedlog)	√

Preliminary Project Schedule

Vessel Remote Monitoring System

ID	Task Name	Duration	Resource Names	Location
1	Project Award	0d	EMSD	
2	Project Acknowledgement	5d	LWK	
3	Collect ship drawings	5d	LWK	EMSD Office
4	Site visits and inspection	5d	LWK & EMSD	Ship
5	Preliminary design for cable routes and modules/sensors locations	10d	LWK	LWK Office
6	Finalize monitoring scope	5d	EMSD & LWK	EMSD or LWK Office
7	Material ordering	5d	LWK	LWK Office
8	Material delivery leadtime	50d		
9	Material available	0d	LWK	LWK Shipyard
10	Preparation of installation	5d	LWK	LWK Office
11	Install Monitoring Modules	10d	LWK	LWK Shipyard
12	Install Data Backbone	5d	LWK	LWK Shipyard
13	Install Connectivity Equipment	5d	LWK	LWK Shipyard
14	Shore Office Install Monitoring Station	5d	LWK	Control Center
15	Commissioning	5d	LWK	Ship / Control Center
16	Sea Trial	3d	EMSD & LWK	Sea
17	Project Report Preparation	20d	LWK	LWK Office
18	Completion Report Submission	1d		



Equipment List

Item	Description	Qty	Unit	
Shore Control Center				
1.	Secured Router	1	pc	
2.	8-Port Ethernet Switch	1	pc	
3.	19" Rack 12U with ventilation Fan and PDU	1	pc	
4.	Workstation PC with Windows 10 License	1	set	
5.	LCD Monitor 24"	1	set	
6.	Network Cable Cat5e	100	m	
7.	Monitoring Software License	1	pc	
Ship (fitted with Digital Engine) to be identified by EMSD				
8.	Signal Backbone Cable (100m roll)	1	roll	
9.	Cable Joins and terminators	1	lot	
10.	Signal Backbone section bridge	4	pcs	
11.	Power Supply Unit	4	pcs	
12.	Signal Collection Cable (100m roll)	1	roll	
13.	Data Storage Module	1	pc	
14.	TCP/IP Gateway	1	pc	
15.	4 Channels 4G FDD-LTE Secured Router	1	pc	
16.	4G FDD-LTE Outdoor Antenna	8	pcs	
17.	vSat Ku-Band Antenna 600mm dia	1	pc	
18.	vSat Antenna Control Unit	1	pc	
19.	Satellite Modem	1	pc	
20.	Engine Data Extraction Module	2	pcs	
21.	vSat Ku-band Airtime 768kbps/256kbps 1yr Unlimited Data	1	pcs	
22.	Generator Data Extraction Module	2	pcs	
23.	Fluid Level Transducer	4	pcs	
24.	Fluid Level Data Module	4	pcs	
25.	AC Power Monitoring Module	2	pcs	
26.	DC Power Monitoring Module	1	pc	
27.	Battery Monitoring Module	2	pcs	
28.	Serial Data Conversion Module	1	pc	
29.	Serial Data Multiplexer	2	pcs	
30.	Alarm Contacts Monitoring Module	2	pcs	
31.	Alarm Indication Module	1	pc	
32.	Network Cable Cat5e	50	m	
33.	Optional Server Appliance for router remote administration	1	pc	

Remarks:

The actual quantity to be subject to the vessel size

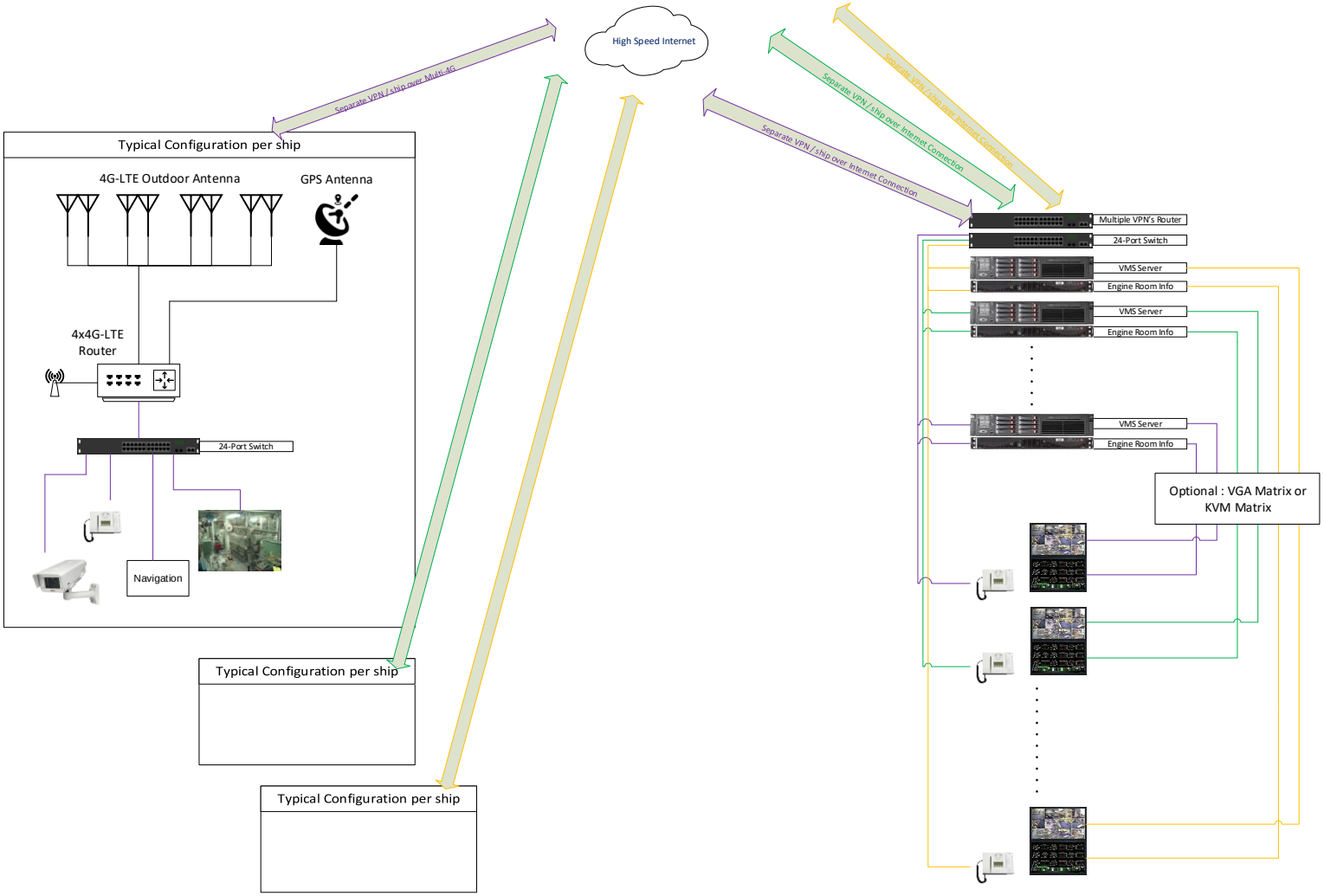
Project Outcome

After completion of the project, shore control center with monitoring PC shall be able to make secure connection to ship and monitor the selected operational parameters in a real-time manner. Meantime, it is expected to conclude:

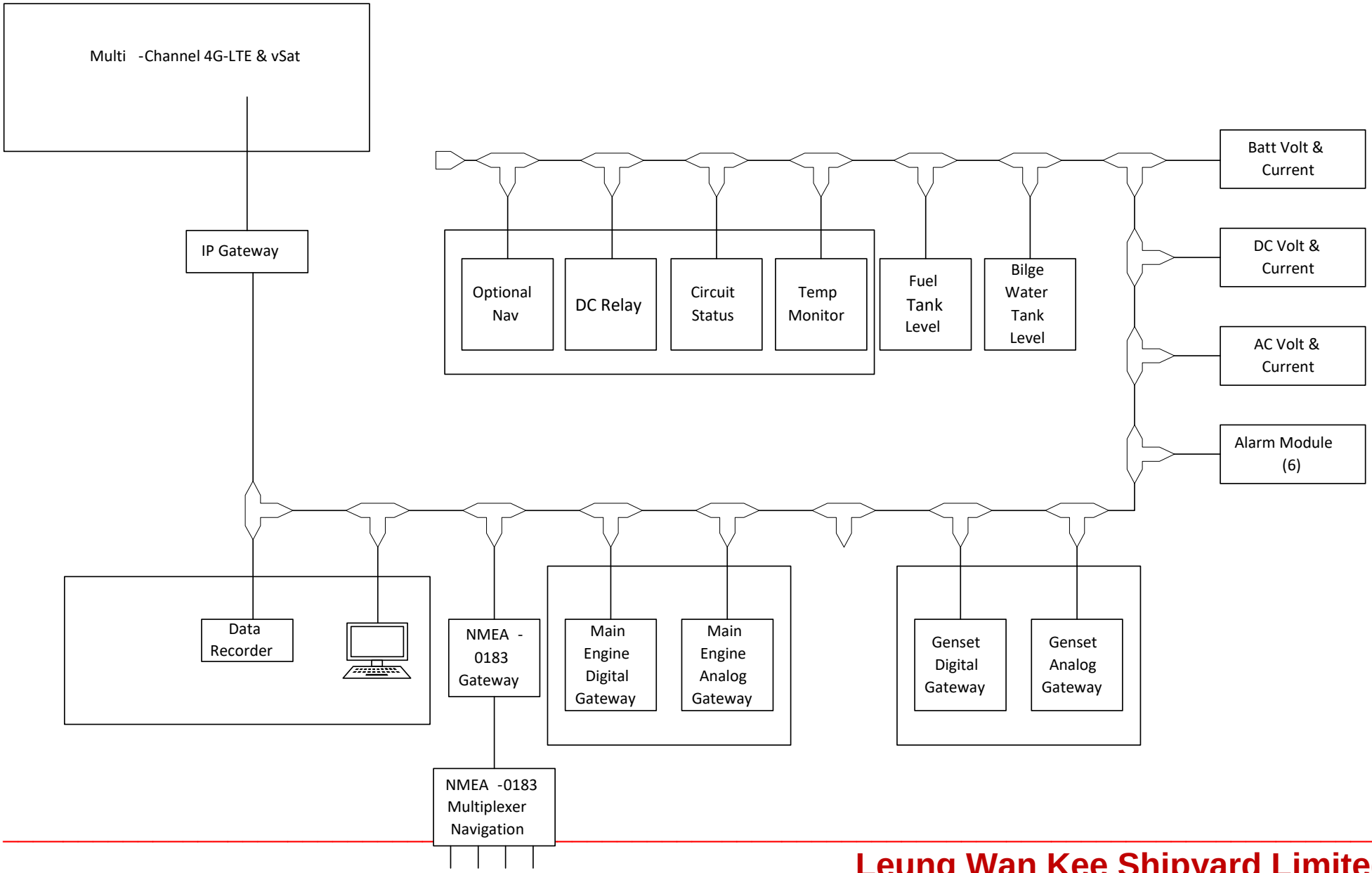
1. Limitations for monitoring ships using digital control engine in this proposal.
2. Effect for data latency for remote monitoring via a secured VPN tunnel over 4G-LTE and vSat connections.
3. 4G-LTE coverage against ships' operation regions.
4. Bandwidth requirement for 4G-LTE and vSat connections.
5. Data usage for vessel remote monitoring.
6. Possibility of using one PC to monitor multiple ships.

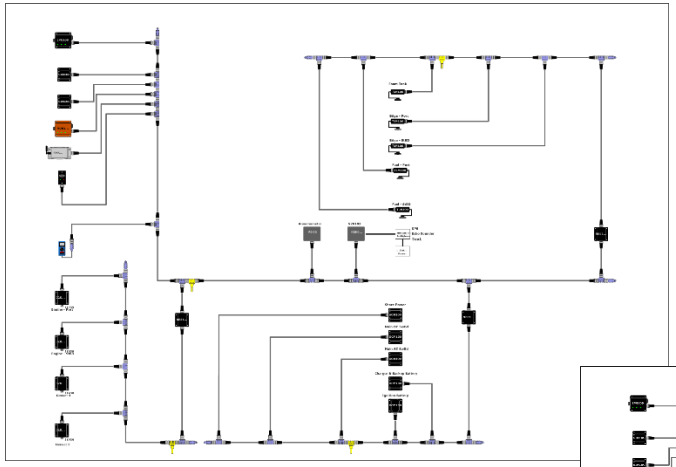
This information is very useful for an organization to plan for its remote monitoring system over multiple fleets of ships in a sense of separation and integration.

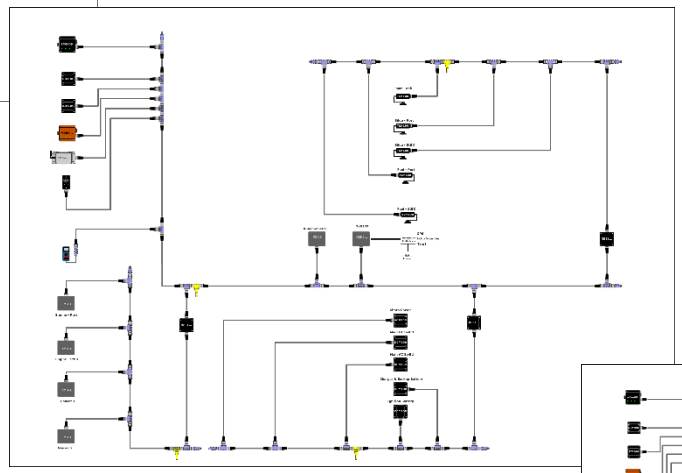
Appendix A – System Overview

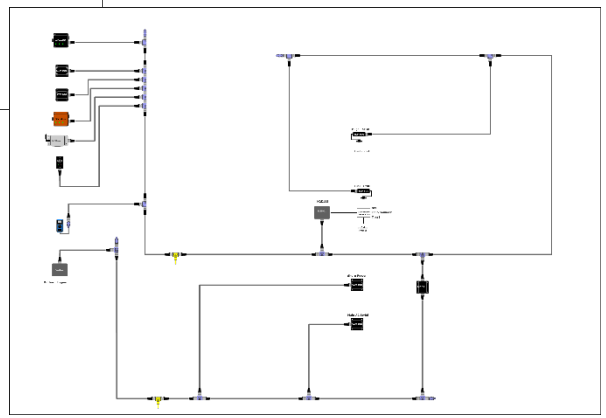


Appendix B – Typical Configuration for Digital Control Engine

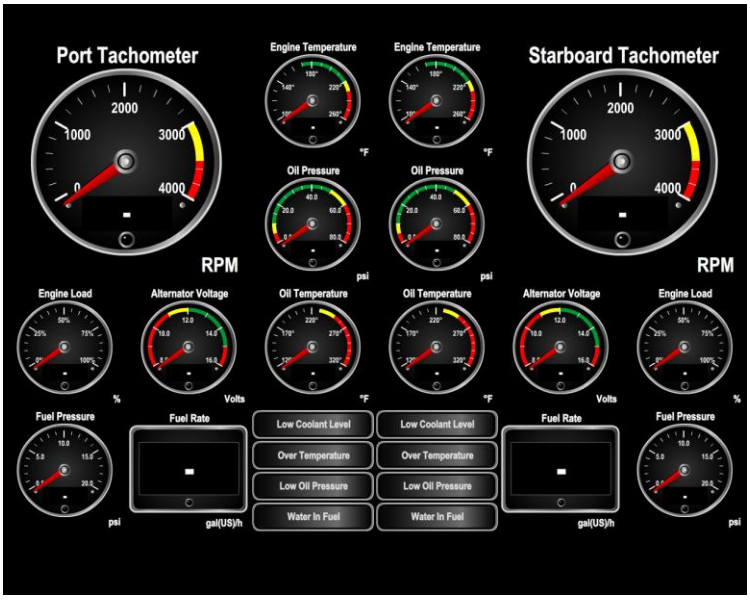




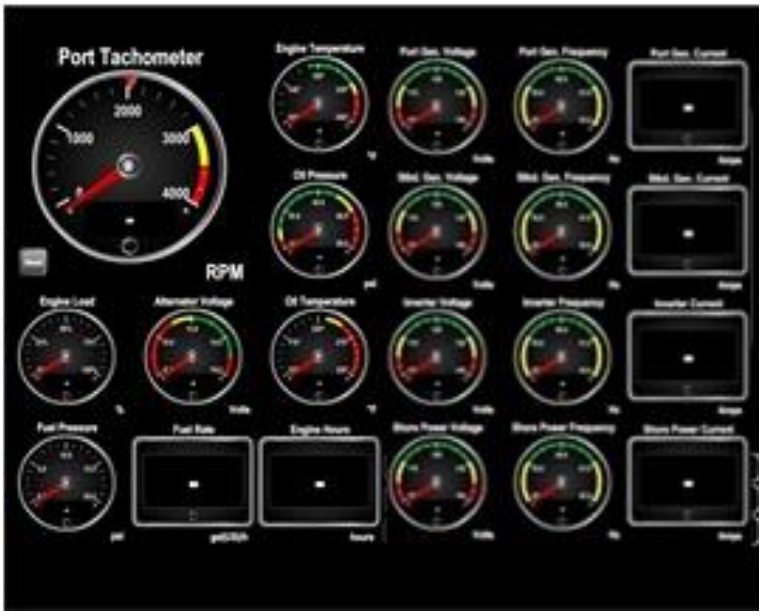




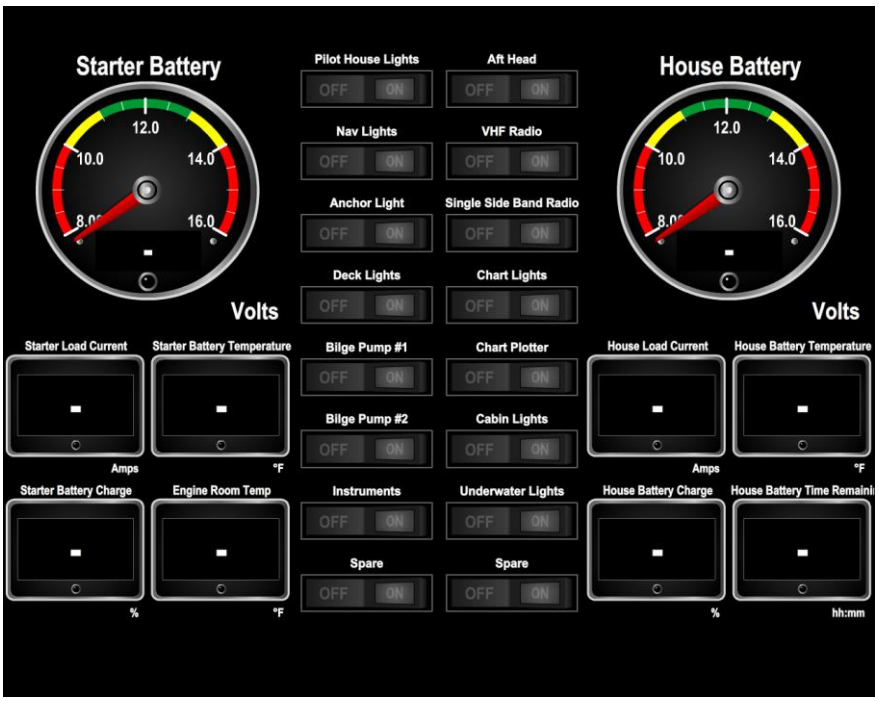
Appendix C – Screen Capture for typical monitoring screens



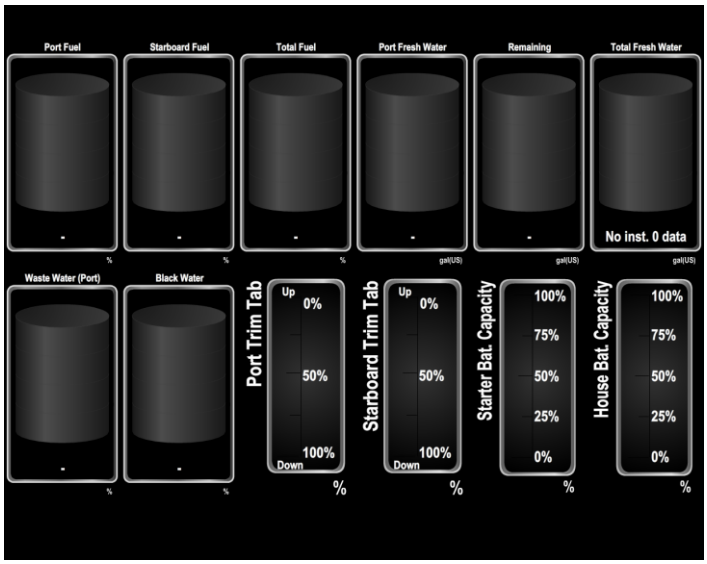
Engine



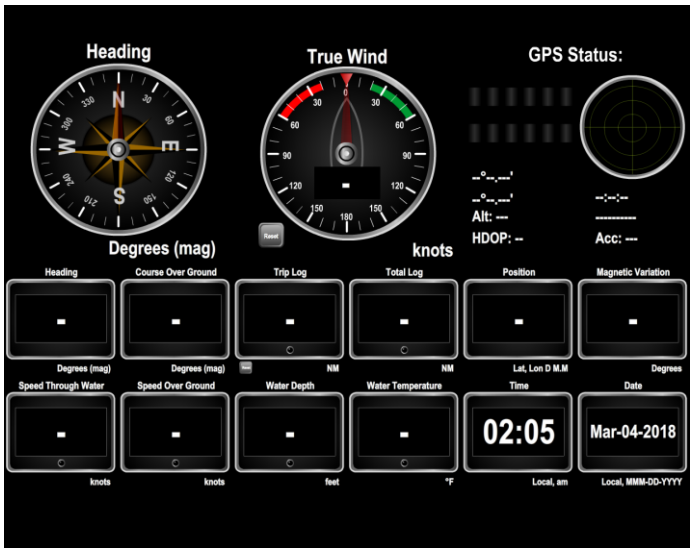
AC System



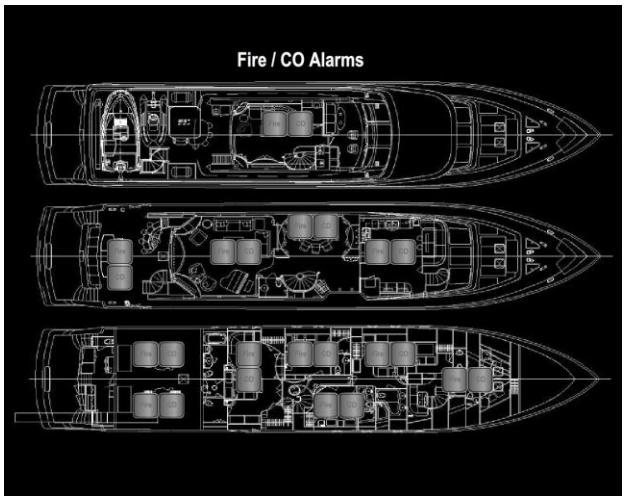
DC System



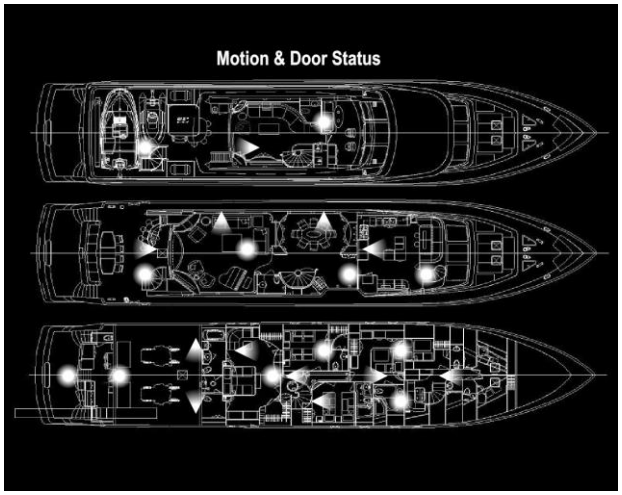
Tanks



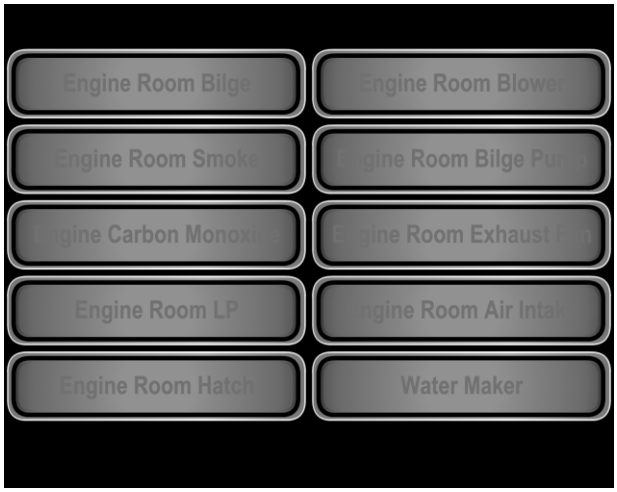
Navigation



Fire / CO Alarm



Motion & Door Status



Indicators