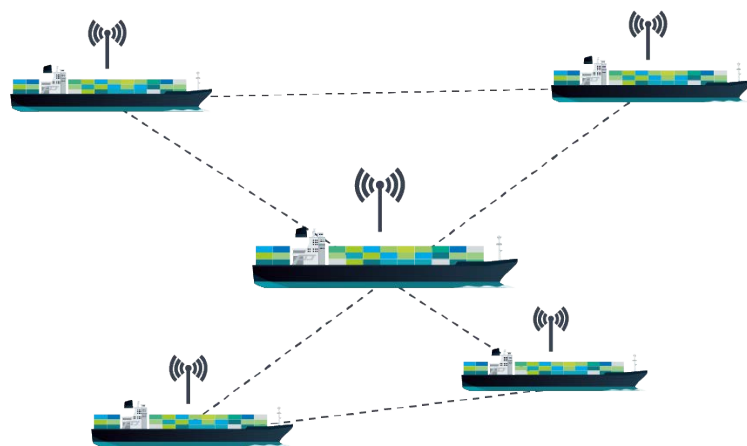


DELIVERING BUSINESS VALUE WITH KNL HYBRID COMMUNICATION

KNL NETWORKS WHITE PAPER

KNL

NETWORKS



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Teemu Vanninen
Chief Technology Innovation
Officer

PROLOGUE: PREPARING MARITIME COMMUNICA- TIONS FOR THE FUTURE

KNL Networks has developed an alternative method for the maritime industry to be connected from the high seas to the shore, and from ports and ready areas to Internet. Our method is completely satellite independent and is based on KNL's proprietary innovations and own IPR. Today, KNL's hybrid network consists of a HF global data network connected to terrestrial cellular networks all over the world.

As a complementary solution or alternative to satellite, we are able to push down communication costs. However, it's not just about price. Even though technology-wise KNL Global network is distinguished from satellite networks, the hybrid networking approach will eventually merge KNL service offering (Global & terrestrial cellular networks) with existing satellite systems. We at KNL are structuring our business on the Hybrid approach thanks to the natural benefits to each communication channel, much like how the modern cellphone has multiple cellular, Wi-Fi, and Bluetooth technologies, each adapted to specific uses and situations.

KNL's proprietary global segment of the hybrid connectivity scheme has certain advantages over satellite systems—namely security and truly global coverage— with arctic areas included. Adding to it situational awareness, online communication, energy efficiency tracking with the fleet intelligence will be the total concept benefiting from KNL's service. Our goal is to make the shipping industry sustainable for future business needs.

This white paper gives insight of the benefits of KNL as a hybrid connectivity solution. The paper has divided the discussion on four main business strategies, namely: Reducing the non-productive time of the vessels, Reducing operational costs, Adding security and the Service's Global Presence.

STRATEGY 1:

INCREASE EFFICIENCY THROUGH VESSEL TRACKING INDEPENDENT OF AIS

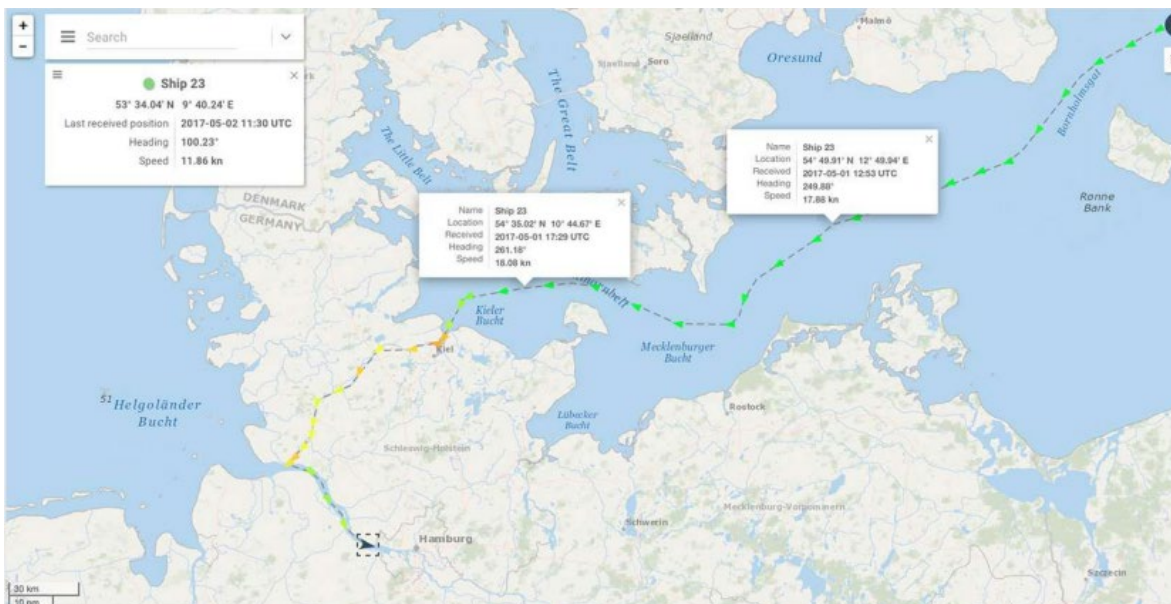
A major operational cost to shipping companies comes when vessels spend significant times in non-productive positions, like waiting access to ports after steaming faster than absolute necessary to get to the destination port. This kind of operational inefficiency could be alleviated by accurate ETAs (Estimated Time of Arrival) and global tracking capabilities.

Today, the ship tracking system AIS (Automatic Identification System) has become the standard way to see where vessels are located. But these tracking systems are restricted, in practice, to situations where vessels are close to shore. Additionally, AIS can be turned off by the crew in sea areas with increased risks of piracy. In this case, operational security has overruled vessel optimization, but it doesn't have to be a tradeoff.

As an included solution with every KNL Radio, KNL offers an independent Fleet Tracking portal, providing real-time data on vessel speed, heading, and location, powered by GNSS data. This allows KNL Fleet tracking builds data independent of AIS.

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KNL Fleet tracking is included with each KNL Radio, and does not add to vessel data usage.

In practice, KNL's independent Fleet Tracking solution and KNL's hybrid communication service can significantly reduce the non-productive times of the ships. Using KNL services in tandem with standard AIS allows KNL users to optimize connectivity by inputting real-time fleet tracking data—without gaps—into their tracking and optimization operations. Used



» A screenshot of KNL Fleet Tracking focused on a single ship.

with KNL's always-on and truly global communications, it's possible to relieve training requirements placed on the crew and centralize route and fuel management in the home office.

Global real-time tracking and always-online connectivity can add value to the maritime industry also in many other ways. For example, ship maintenance requires not only investments in servicing and spare parts, but also can mean large breaks to ship operations. The proactive maintenance enabled by the KNL connectivity can reduce the negative effect of the maintenance breaks to the ship's operations by introducing better planning and predictability of these necessary functions over the ship's lifetime.

STRATEGY 2:

REDUCE OPERATIONAL COSTS

Satellite can provide fast internet access at sea, but it comes at a price.

In a typical satellite subscription, a vessel will pay a fixed rate for data unless they go over their allotted data plan. As a consequence, it's easy for shipping companies to blow through their communication budget by thousands of dollars either through necessary communications or crew error.

KNL Networks reverses this pricing scheme by providing data with more cost-efficient pricing as more data is used.

With this model, shipping companies need only to pay for what they use. The pricing model is built upon a principle that all the hardware is offered as a service included with the same monthly fee, so that connectivity costs are predictable for the customers. See more on our pricing page on our website.

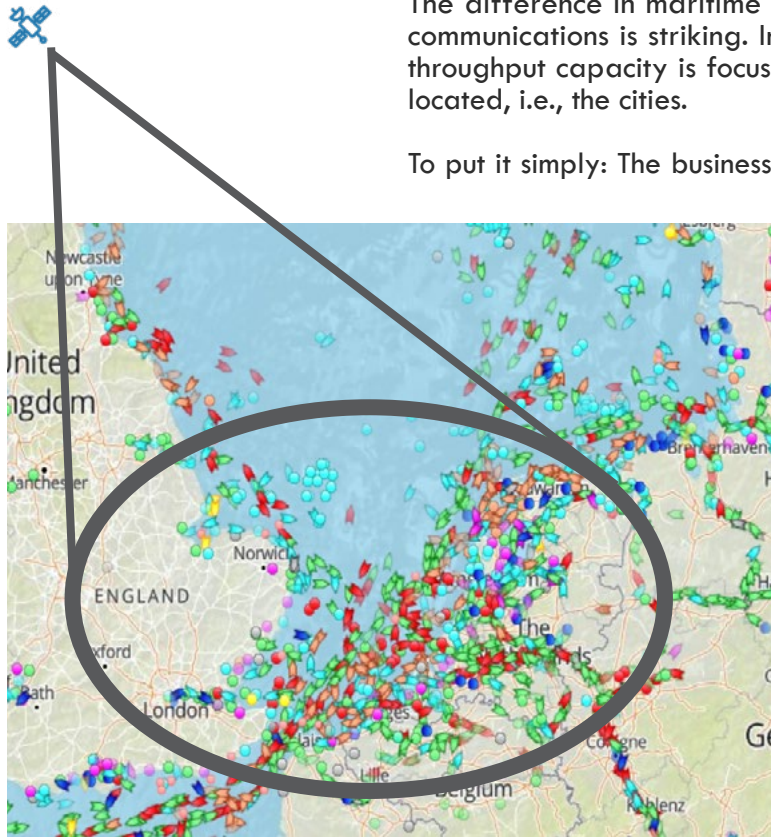
Autonomous shipping as the end goal

The maritime industry is sailing directly towards autonomous shipping. In addition to helping optimize the vessel utilization ratio, the main driver for autonomous ships is the reduction of operational costs as a whole. There are still multiple topics to address in autonomous shipping, such as business models and legislation. But before reaching any of these issues, the communication requirements placed by the autonomous shipping concept drive the maritime communication operators to develop new and more efficient methods to be connected at the seas.

The benefits of better connectivity are available even today, well before the autonomous shipping becomes a realized concept. The use of hybrid communication through KNL is one such example. One benefit of the hybrid approach with KNL and satellite is the possibility to optimize the capacity and the cost of the communication based on the ship location and the prevailing need.

The difference in maritime communications to land-based communications is striking. In more terrestrial systems, high throughput capacity is focused on areas the most users are located, i.e., the cities.

To put it simply: The business case is much better in the cities since one cellular base station serves large amount of users compared to base stations in rural areas. The way to keep up the good capacity in the cities is to minimize the cell size, and accordingly, to keep the users-per-base-station at optimal level from both the technical and business perspectives. Technically it would be well possible to build the high capacity also for the rural areas on land.



» Satellite's many-to-one model can face limitations

At the sea it's a bit different. The area of a satellite footprint zone (~analogue to the cell size on terrestrial systems) is huge compared to terrestrial base station cell sizes. There's not the same kind of possibility to balance between the amount of users and the "cell size" of the

satellite as it is on terrestrial systems, i.e., the satellite technology does not support that well a sparse and dense user densities.

Therefore, for technical reasons, satellite systems unfortunately fail on the same optimization task for example cellular networks has successfully practiced. The sea areas of high traffic suffer severe congestion of satellite network as experienced by many maritime users today.

Put simply, too many vessels share the same satellite channel in the most highly trafficked areas.

STRATEGY 3:

ADDED SECURITY FOR MARITIME DIGITALIZATION

A dedicated channel for secure operations.

Secure operations are more and more dependent on connectivity at sea, which opens the shipping industry to completely new and extremely efficient methods to cyber-attack against the shipping business. The systems connected directly to Internet require specific security measures, like firewalls, virus and malware detection, and secure user authentications.

This last point relates to the component that's hardest managed component of the security concept –human error. This could be as simply as a weak password for some of the sub-systems onboard through which the hacker can access to a ship's vital major systems.

The best way to control the human factor on security is to restrict the access to only the necessary sub-systems. To take a step further, this means is to separate the crew network from the vendor networks so that there's no means to access from one to other. KNL service supports this, simply by adding a redundant and independent communication alternative on board.

ADDITIONALLY WE:

- ***Use private and secret keys to manage access to the public Internet via our VPN (Virtual Private Network) tunnels.***
 - ***Strongly encrypt user data stored on the flash***
 - ***Encrypt network operation data***
 - ***Run our servers on AWS to guarantee the availability and the network to withstand denial of service attacks or other types of cyber attacks.***
-

Built to the highest standard.

In addition to communication security, KNL's whole service concept is built with the strong security aspect in mind . All the transmitted data (user data, headers, control, location) are encrypted, which means it is virtually impossible to intercept or interfere with over-the-air information.

Additionally, our hardware securely boots, preventing software not authenticated by KNL Networks from loading.

STRATEGY 4:

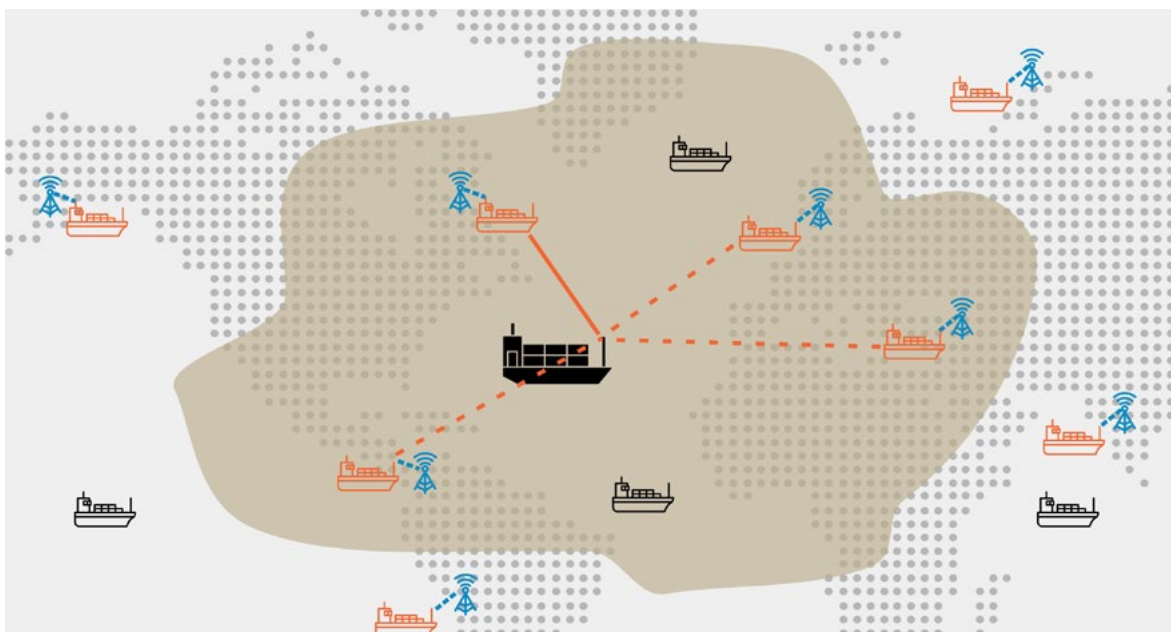
TRULY GLOBAL CONNECTIVITY

Worldwide operations requires connectivity that works anywhere on Earth. .

For KNL Networks, global service means that the network is accessible on every corner of the world where ships are sailing - including both the Arctic and Antarctic regions. The foundation of the global service is that it is offered through a single subscription; we are not restricting customers' access the network based on subscription types. Once you are in, you are in!

KNL's global service is based on two main building blocks which are assimilated to form a so called hybrid networking concept. The first one is the long range mesh network segment, which is constituted on KNL's own proprietary innovations and IPR. This part of the hybrid solution enables global presence of the network.

The other segment is build upon the terrestrial cellular technologies, i.e. 3G networks and takes care the connections to Internet.



» This diagram shows KNL's global connectivity through our mesh network. The gold area represents the HF propagation range, and the orange ships represent ships nearshore or at port that have cellular access, and are available to act as base stations for the ships at sea. The KNL Radio automatically selects the best connection available, and switches to cellular internet once it finds signal.

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Find out more in our White Paper “Looking toward the future of HF Technology” at www.knlnetworks.com

This unique hybrid approach for the maritime connectivity offers an extremely flexible and scalable network topology. From the network operational point of view, this means, that there's no need to expressly build a network for a certain location, but the network builds itself literally everywhere. The paramount of this, like said, is the long range network segment but also the fact that the cellular segment facilitates the Internet gateways from all the vessel locations within cellular networks (like the ports and most of the ready areas) where there's a ship using KNL services.

The bottom line is, that unlike with the telecommunication satellite technology the network is already there, since KNL service users are regularly visiting ports all around the world. As an example, in arctic use case, the most probable base stations would be the ships at the ports of north Norway, Iceland or Greenland.

KNL AS A SOLUTION FOR:

MITIGATING RISKS AND LOOKING TOWARDS THE FUTURE

What would it mean if the global connectivity and the communication security could be taken granted same way it's done on shore? On the other hand, what would it mean if the satellites would not be available for some reason? Let's explore some of these thoughts:



» A KNL technician on a new installation

What if - you were always connected?

In shipping operations, what are the functions having potential to the highest savings and optimization? How many of those are independent of connectivity or are there any nowadays?

Things like fuel consumption optimization, predictive maintenance, better emission controlling, asset tracking or autonomous shipping are build on connectivity.

The other way round, think what if the connectivity would not be a restrictive factor when optimizing the operations. The introduction of any digital services would be just matter of suitability to one's operational model, not matter of cost or lack of the required connectivity.

Obviously better connectivity has a potential to change the way ships are operated.

What if – Secure practices were built into your digitalization strategy?

If a personal computer at your home is connected to Internet without a firewall and virus protection software, it is estimated that it'll take less than a second after which some malicious software tries to access your operating system. Unfortunately, along with the Internet access on the boards all the cyber threats are suddenly reaching ships.

To avoid that always online would equal to always under cyber attacks, countermeasures needs to be considered. Basically, there's nothing new here that haven't been considered already for example in onshore industry digitalization.

The most efficient way to assure that certain vital digital systems are safe from malicious accesses is to physically isolate those from the public Internet. This method is used by militaries, for example. With the commercial systems physical isolation is not always an option. In practise, the most convenient method would be to restrict the number of credentials to minimum for those systems and separate the use cases of the operational needs (IoT, Vendor) and the crew needs.

KNL's alternative, satellite independent connectivity service adds security by providing possibility to physically separate vendor, crew and bridge communication systems.



» *Cybersecurity is rightfully one of the biggest concerns to the shipping industry today*

What if - satcom is off?

Even though the satellite technology can be very reliable, there are occasions when it is wise to have other options to keep up operational connectivity. Due to the topology of the satellite constellations on geostationary orbits the link geometry prevents coverage above approximately 75° North. Even before that latitude the obstructs on the link path, like the ship's own structures (such as cranes and exhaust pipes) or even ice bergs can cause severe problems for the connectivity via satellite. The bottom line is the more north you go the less you should count on the geostationary satellite coverage. Currently, there's no adequate satellite coverage on north due to lack of business opportunities adequate to launch and maintain the required satellites.

As indicated elsewhere on this paper, the satellite systems suffer a severe congestion in certain high traffic sea areas. The root cause is that too many users are connected to the same satellite. In these cases, the consequences of the lost connectivity could have more effect on the ship operations than in the cases on up north for two main reasons: the connectivity breaks are harder to predict and the need for the communication might be more urgent due to port logistics and the required documentation, etc.

There are also indicated occasions when the satellite connection is blocked by either intentional or unintentional interference or jamming. These cases are hard to predict, but it can be stated that the means to interfere a satellite signal are there and the consequences can be severe.

The shipping operations relying exclusively on the connectivity via a satellite technology are in danger of jeopardize the benefits of the "being online" – especially on the three cases indicated above. The more the shipping operations are build on the constant data flows and the capability to communicate at a will the more dependent the whole business will be on the connectivity; and more justified it's to lean on hybrid communication than just one communication technology.

Epilogue

Where do we go from here?

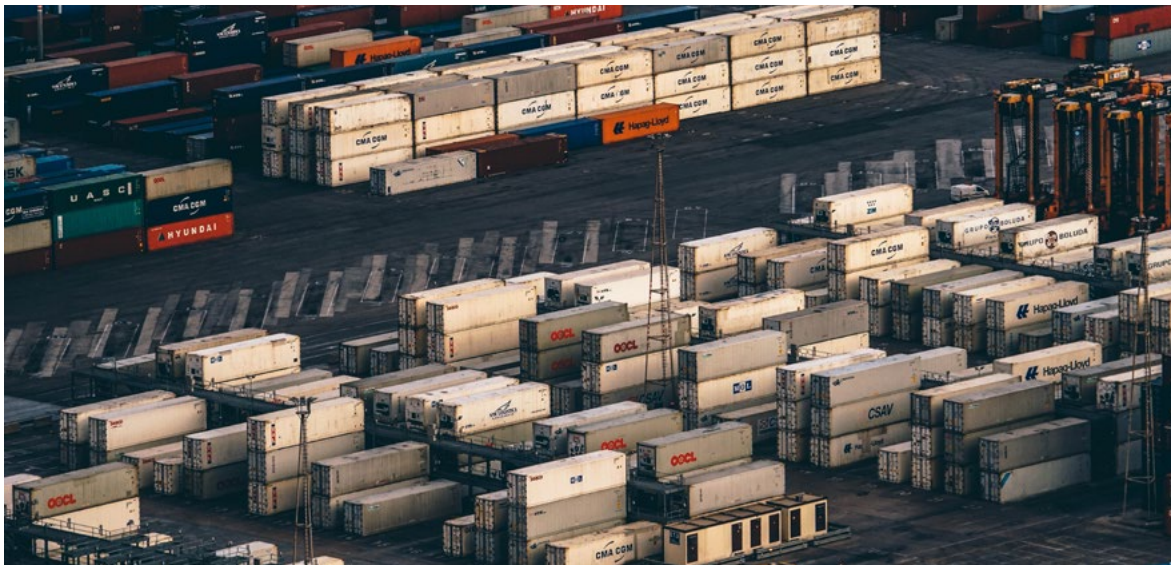
The worldwide logistics business is worth of multiple trillion dollars. General approximation is that more than 90 % of global trade is carried by the sea. The shipping is evidently having a major role on that logistics business. More optimal, more efficient and more productive shipping operations could

therefore enable not only better margins for the shipping but huge saving for all the rings of that logistics chain.

The connectivity offered by most of the currently available solutions has three major flaws. The first one is the lack of global presence. There are huge areas on the globe not covered by these systems, like the polar areas. The second one considers the network capacity distribution. Not the user need nor the offered capacity are distributed evenly. However, the problem is that where need is most urgent there's the most lack of capacity, like the high traffic sea areas. The third one is the system's security against the cyber attacks and the attack against the over the air signal.

KNL Networks take on the maritime connectivity provides the possibility to optimize the communication costs and secure the global connectivity. The service covers the whole world, Arctic and Antarctic areas included and the system is virtually impossible to block by a hostile 3rd party. Therefore, KNL's hybrid connectivity solution can answer to all the "flaws" indicated above.

KNL hybrid communication system is designed for our customers to stay connected with reliable and secure way.



FOR MORE INFORMATION CONTACT
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OR VISIT KNLNETWORKS.COM