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Agenda item [[1]](#footnote-1) (from agenda) x

Workplan Task Number / Technical Domain 2 …………………………………

Working Group WG 2

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Assessment of LEO satellite constellations

# Introduction

At the ENAV 24 meeting, WG2 identified LEO satellite constellations as a potential technology to consider for e-navigation purposes. Canadian Coast Guard has volunteered to provide an initial assessment of the technology for consideration by WG2 at eNav25.

After ENAV30, October 2022, the Canadian Coast Guard provided an update to this document and recommends that the review of this technology be resumed by WG2 as it was on hold since eNav25.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Question** | **Technology Candidate Response** | | **Working Group Response** | |  |  |  | | --- | --- | --- | | **Green** | **Amber** | **Red** | |
| **Infrastructure** | **User** |  | **Status** |
|  | Where has the referral come from? | Internal, eNav WG2 | |  |  |
|  | Name of technology and product name | Low Earth Orbit (LEO) satellite constellations.  Many service providers have announced their intentions of launching a LEO satellite constellation for general purpose digital communications, in particular to provide global Internet access. CCG has identified 4 service providers with concrete high speed LEO projects:  Service Provider / Constellation  Virgin/OneWeb,  SpaceX/Starlink,  Amazon/Kuiper,  Telesat/Telesat LEO,  SpaceX / Starlink is operational in 2022 and has started to provide service to some maritime users. Coverage is currently limited to below 60 degrees latitude. Not all countries regulators have approved roaming mobile usage of the Starlink constellation at this time. | LEO satellite user terminal. Solid state user terminal under development.  Space X / Starlink has a solid state user terminal as well as a ruggedized version for maritime users. |  |  |
|  | Functional description | Constellation of Low Earth Orbit satellites that provides low-latency, high-speed broadband connectivity to unserved and underserved communities around the world. Typically, broadband LEO constellation will use Ka or Ku band. |  |  |  |
|  | Proposed user group | Mostly unserved and underserved communities around the world. Can be extended to the maritime community and commercial shipping industry.  The global maritime community would benefit immensely from such a service. In particular for digital communications, Leo constellations can be used as the backbone for carrying S-100 / 200 / 300 / 400 products as well as for supporting the Maritime Connectivity Platform. |  |  |  |
|  | What are its Key limitations | The amount of satellites required to achieve global coverage would range in the hundreds to the thousands, requiring a very large up-front investment by service providers in order to even begin commercial operations. Mass market deployment of the service is require in order to balance the initial investment cost. | End users would need a satellite terminal and antenna allowing them to join the LEO networks. Current satellite antennas are too expensive to attract mass market users. It is believed that advances in solid state user antennas/terminals would allow a significant reduction in end-user costs to join LEO satellite broadband networks.  This limitation seems to have been solved, at least by Space X who provide solid state terminals that are a factor of magnitude more affordable than a legacy maritime satellite antenna. |  |  |
|  | Where is it currently used (geographic and/or industry)? | Iridium was the first LEO satellite broadband operator with its first satellite constellation reaching 128kbps per user terminal. In 2019, Iridium deployed its second generation LEO constellation called Iridium NEXT. Still not offering broadband service, Iridium NEXT is a commercial success offering true global coverage, increased data capacity up to 768Kbps (December 2019) per terminal and a reduced latency (400ms) compared to typical GEO broadband satellite providers (800ms).  SpaceX / Starlink currently offers global coverage at latitudes lower than 60 degrees in selected countries where the regulators have approved its use. | Iridium NEXT user terminals are much smaller and cheaper than GEO satellite terminals. |  |  |
|  | How is it currently used? | Iridium NEXT is currently widely deployed across Maritime, Land and aviation sectors to provide global coverage connectivity and moderate connection speeds. Iridium NEXT uses the L-band which is typically more robust than Ka or Ku band but cannot achieve the same data transfer throughput.  SpaceX / Starlink has begun deploying its ruggedized maritime terminal to some cruise ship to provide broadband Internet access to travellers. |  |  |  |
|  | How could it be used within the maritime sector? | Any commercial service provider could be used once they become operational. | Ships will be able to subscribe to a commercial satellite broadband service to provide connectivity to their crews and also participate in e-navigation.  As mentioned above, LEO constellations are capable of supporting the Maritime Connectivity Platform requirements. |  |  |
|  | Who developed it? | Each service provider has their own implementation. |  |  |  |
|  | Is it commercial, non-commercial or military? | Commercial. | Commercial |  |  |
|  | Is there an existing technology that meets the same requirements?  If so, what make this different? | The satellite component of 5G, if it is deployed, could be considered a competitor.  For the moment, LEO constellation seem to be much further advanced than satellite 5G to the point where satellite 5G might be rolled-out using LEO constellation infrastructure. |  |  |  |
|  | Ease of implementation? | Very difficult and expensive up-front investment. | Now that solid state panels are available, implementation for users is easy and relatively cheap. |  |  |
|  | What are the constraints for implementation? | Deployment of massive satellite constellations in Low Earth Orbit. | Development and mass production of solid state panel antennas. |  |  |
|  | what is the capability of the technology? | Low-latency (<100ms), Broadband (>100Mbps), global coverage (including poles) connectivity. |  |  |  |
|  | What is the scalability of the technology? | The service providers current promise to be able to provide capacity to hundreds of millions of users. |  |  |  |
|  | Is the technology backward compatible? | N/A. |  |  |  |
|  | Is the technology dependant on another technology? | Most likely GPS. |  |  |  |
|  | Can the technology be demonstrated? | Iridium NEXT constellation is considered a first generation LEO constellation currently in-service.  In 2022, CCG has now completed many tests and has about 10 fixed sites using the technology. Maritime mobile usage (roaming) is not yet approved in Canada, but some cruise ships are already using it in the United States. |  |  |  |
| 17 | Are there any results and test bed? Please List | CCG has tested the Iridium NEXT constellation service on one of its IceBreaker in the Arctic during summer 2019.  CCG has tested StarLink / Space X constellation at their remote site on Anticosti Island.  CCG currently has 10 sites using Space X / Starlink, some as their main operational link. |  |  |  |
| 18 | Is there a compliance summary? | N/A |  |  |  |
| 19 | Are there legal issues associated with the implementation of the technology? | N/A |  |  |  |
| 20 | Are there any intellectual property rights (essential patents) associated with the technology? | N/A – commercial service |  |  |  |
| 21 | Is the technology safe to use | Yes |  |  |  |
| 22 | Does the use of the technology require extra training? | No | NO |  |  |
| 23 | Are there environmental considerations with the technology? | Detrimental impact to astronomical observations.  Increase in space debris / launch danger. |  |  |  |
| 24 | What are the financial considerations for implementation and use? | High upfront investment to deploy the satellite constellation | Users will need to purchase a terminal / antenna and subscribe to a monthly data plan. |  |  |
| 25 | Is the technology secure (i.e. protected against hacking; privacy of data)? | N/A encryption is performed at the application layer, just like any other broadband service. |  |  |  |
| 27 | Readiness (EU Technology Readiness level - TRL) (level of maturity of technology) | TRL 9 | Solid state antennas: TRL 9 |  |  |
| 28 | Can you provide independent References | <https://spacenews.com/divining-what-the-stars-hold-in-store-for-broadband-megaconstellations/> |  |  |  |

# Action requested of the Committee

The Committee is requested to assign this document as a work paper of WG2(emerging digital technology), consider the response of the working group and finally decide the further work plan for LEO satellite constellations as appropriate.

1. [↑](#footnote-ref-1)