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Guideline On Telepresence Implementation

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1 Introduction

Telepresence is predominately viewed as the ability to directly interact (often via computer mediation) with a physically real, remote environment experienced from the first-person point of view; without restrictions on the location or size of the device used to carry out the user's commands at the remote location. In the context of Eurofleets+ and its fleet of research vessels we can define Telepresence as the use of technology to allow onshore personnel to interact and collaborate in real time with scientists and which can facilitate optimising the scientific output of these costly operations and logistic support where needed.

In the framework of ocean exploration, the opportunity to engage and share data and information with scientists, crew, vessel operators, and all other stakeholders such as citizen science enthusiasts offers endless possibilities for dissemination, learning and collaboration and further streamlines vessel management and logistical support while at sea.

Deliverable 3.4 Guideline for control and optimisation of hard/software outlined recommendations for improving satellite bandwidth to bolster telepresence capabilities across the Eurofleets+ Research Vessel. The benefits of this enhanced capacity has been clearly demonstrated in recent times due to restricted access and reduced capacity on vessels implemented to minimise risk during the COVID19 Pandemic. Currently, Telepresence is broadly implemented on European Vessels but to differing degrees. Increased data capacity, accessible technologies and the opportunity it presents coupled with the availability of satellite technologies its use is set to grow and expand exponentially over the next 10 years.

The following guidelines provide an overview of the different categories of telepresence, bandwidth management strategies for optimisation and guidance for scientists and vessel operates for successful implementation of ship to shore telepresence events.

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2 Telepresence Overview

Communications systems which operate on shore are not suitable for working offshore and are subject to some limitations. Fortunately, we are in an era where enhanced marine satellite communications are coming on stream rapidly in some instances which deliver expanding telepresence communication opportunities. These communications systems have become mission critical in recent years, allowing offshore connectivity on a continuous basis from research vessels for both scientists and crew.

Telepresence can be achieved with very simple technology using a computer with an internet connection fitted with a camera and a collaborative communications platform such as Microsoft Teams, Zoom or Skype which will allow sea going scientists to connect to a single shore based lab or classroom right up to a sophisticated two-way connection in real-time with voice, video and data two way streaming and can include ROV dives broadcast to multiple audiences.

Types of communications and the infrastructure required to support telepresence communications will be guided by the desired outcome and audience for the broadcast and possible onboard limitations such as bandwidth availability, hardware accommodation and restraints for large antenna.

2.1 Communication Options

Eurofleets+ Deliverable 3.4 Guidelines for control and optimisation of hard/software presents a full review of the current communication capabilities of the Eurofleets+ fleet, to establish the technology being utilized, and to make recommendations on how the fleet can manage communications in a more effective and efficient manner. The main connectivity options currently available on Eurofleets vessels are:

4G LTE Enhancement

LTE is a 4G wireless communications standard developed by the 3rd Generation Partnership Project (3GPP) that's designed to provide up to 10x the speeds of 3G networks for mobile devices such as smartphones, tablets, netbooks, notebooks and wireless hotspots. Maritime 4G systems can now reach further out to sea, and offer redundant and resilient connections, meaning a more robust overall communication gateway is available. 4g enhancement: connects to an indoor antenna, taking the cellular connection from outside the vessel and bringing it inside boosting the signal. This enhance signal will also be available to all devices onboard with sim cards such as personal mobile phones and tablets with sims.

M2M Cellular service

A cellular based solution to enhance the satellite communications onboard. The type of service being proposed is a system that utilizes multiple cellular SIM cards across multiple communication modules, and then combines the resulting connections together to offer a single connection to internet, all the while presenting the ability to use multiple SIM providers to enhance the resilience of the connection. No personal enhancement. Better speed and data throughput. Differing from 4G LTE Enhancement. **M2M (Machine to Machine) works** by bringing in the signal in the same way as above however there is a physical connection with a 4G router, meaning that there is no personal enhancement and it's just the 4g router that receives the boost. This configuration provides managed increase speeds and data throughput across the network.

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KU

Ku is one of the widely utilised VSat bands for use in the maritime environment. The services are used on many of the system in the market today, with speeds available of up to 20Mbps down to the ship and 3Mbps from the ship CIR (subject to hardware and provider considerations) it is still one of the most popular communications mediums and will be with us for some time as it covers many of the deep sea routes used by mariners today.

KA

KA is a higher frequency than Ku and put simply there is more frequency available. Due to the technical ability of the satellite operators along with the co-operation of the ITU (International Telecommunications Union) frequencies can be re-used allowing multiple spot beams. What this means to the end user is a higher throughput of data, with providers currently offering, for example up to 36Mbps down to the ship and 6Mbps up from the ship MIR using the standard iDirect X7 satellite modem.

Low Earth Orbiting Satellites (LEOS)

Low Earth Orbiting Satellites (LEOS) have not been widely adopted for Marine Communications. Challenges remain regarding data management, yet to be resolved. However, it is expected that this option will eventually come on stream as a viable solution.

Other options to be considered are:

Mobile Telepresence Unit

(Based in the USA available through Global Foundation for Ocean Exploration)

Portable, fully stabilized ocean-going satellite communications systems such as the Global Foundation for Ocean Exploration (Section 3.3) system allows for the dissemination of video, audio, and other data to be uploaded in near real time from ship to shore via the internet. This enables virtual access to ROV dives and other activities, and two-way communication between the ship and shore. This allows for an unlimited number of science participants to be engaged in an expedition, thus decreasing the resources required to send multiple people to sea. The public can also experience what it's like to be part of an oceanographic expedition. The system also allows for superior connectivity, such as internet services, during ocean-going operations. It can be configured to upload multiple high-definition video with band rates as high as 20 Mbps.

2.2 Communication Categories Requirements

Telepresence is considered a High Band Width Service. The ability to implement difference levels and categories offshore can be vessel specific as there are a number of parameters to be considered. These include the VSAT or Cellular system deployed on the vessel, the implemented bandwidth management strategy, the video streaming application in use, geographic location of the intended broadcast and atmospheric conditions on the day. The table below provides an overview of the estimated bandwidths required by commonly used activities from voice calls to High Definition Video Streaming.

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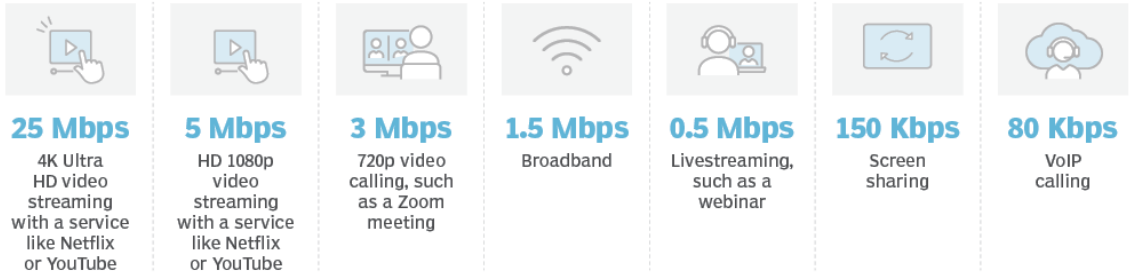

Figure 2-1 Estimated Bandwidth for communication services

Figure 2-2 below provides an indication of the bandwidth required for some of the most commonly used applications today. Some applications for video calls provide options to adjust call resolution from low to high definition providing some flexibility. However, in order to manage bandwidth onboard vessels it is recommended that Bandwidth management tools which compress data automatically to manage traffic on the network are deployed. Taking all of the variables into consideration, it is important to establish some key parameters before any telepresence event which should be planned well in advance, guidelines are outlined in see Section 3 Telepresence Implementation Guidelines.

Manufacturer recommended BW. required in .Mbps						
	Instagram		Facebook		Tik Tok	
Users	Up	Down	Up	Down	Up	Down
1	0.3	1.0	0.3	1.0	0.3	1.0
3	0.8	3.0	0.8	3.0	0.8	3.0
Total	1.0	4.0	1.0	4.0	1.0	4.0

	Twitter		Facetime		Web Browsing	
Users	Up	Down	Up	Down	Up	Down
1	0.3	1.0	0.5	0.5	0.3	0.5
3	0.8	3.0	1.5	1.5	0.9	1.5
Total	1.1	4.0	2.0	2.0	1.2	2.0

	Zoom 480P		Zoom 720P		Zoom 1080P	
Users	Up	Down	Up	Down	Up	Down
1	0.6	0.6	1.2	1.2	1.8	1.8
3	1.8	1.8	3.6	3.6	5.4	5.4
Total	2.4	2.4	4.8	4.8	7.2	7.2

Figure 2-2 Application Recommend Bandwidth Requirements

2.3 Telepresence Categories

a) Two-way video call

A video call requires the transmission of bandwidth bi-directional, or both ways. Thus, the additional bandwidth will be required to and from the shore. Even if video is only enabled in a single direction, there needs to be an allowance for a return protocol to keep the connection alive. Further to this, if only minimal additional bandwidth is being applied to facilitate the

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video call than precise traffic management is crucial to achieving a usable connection. In short, other ships communications cannot be allowed impact the connection.

b) Live stream to open audience

In the case of a live stream to an open audience the level of bandwidth will increase for the broadcast, a large increase on the uplink from the vessel will be necessary and prudent traffic management will need to be enforced onboard.

c) Classroom, Outreach and Public Relations Events

Taking account of the VSAT hardware onboard is important, particularly when looking at the link from the ship to the shore. Again, onboard Bandwidth is of the utmost importance during such events. large increase on the uplink from the vessel is likely required, unless prudent traffic management is in place. Download speeds are of equal important in these cases to ensure smooth interactions.

d) Telepresence Enable Service HD

To achieve HD in both directions an addition of more than 512kbps from shore to ship would be required. “High Definition (HD) resolution is rated at 720p and 1080i (interlaced scan)/1080p. The superiority of this resolution over standard definition is dramatic, and it requires at least 5 Mbps of bandwidth to play smoothly and without interruption”.

Key to success is Bandwidth Management Strategy

All of the above categories are possible with the correct bandwidth management in place.

The key to implementing any telepresence activity is the management of the available bandwidth on-board.

It is essential the vessel operator and its service provider know and understand the needs of the on-board science team in relation to demand for bandwidth throughout each expedition and to manage it correctly. Well managed IT strategy’s sets out how on-board bandwidth is consumed, the correct network configurations to operate it.

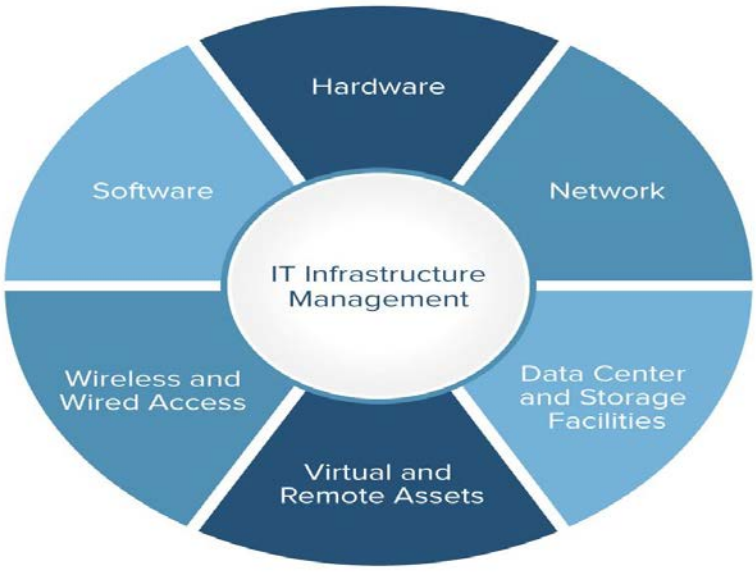

Figure 2-3 Bandwidth Management Considerations

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List of hardware/software recommended to vessels to implement telepresence.
To successfully implement telepresence on vessels the following set up is recommended.

WAN 1 – Flexible and reliable VSAT link using Sailor 900 with iDirect X7 modem (industry standard)
WAN 2 – Multi module 4G cellular router with enhanced signal reception up to 40km from the cellular tower.
Management – Enterprise level Firewall and Security/Antivirus based management solution that controls not only the various WAN connections, but also the internal connectivity out including WiFi.

2.3.1 Video Conferencing Application Management

General guidelines for successful Video Conferencing

- If your Internet router has an option for a wired connection, join with a wired option versus a wireless connection.
- Bring your laptop or device closer to your router or hot spot connection.
- Check Bandwidth. Do you have sufficient bandwidth for the call you want to make.
- Stop Camera Feed: A camera feed from a webcam (showing the video of you speaking) takes more bandwidth and may affect the quality of your call if you have a slower connection. If your Internet is unstable stop your video feed. Another option is to show your video during introductions or if you have a question, but stop your video feed during other parts of the meeting.
- Disable HD Video in Zoom: You can disable the HD video option by selecting video settings in a meeting - select the up arrow to the right of the video icon and check or uncheck the HD video option.
- Mute Microphone When Not Talking: When you aren't talking mute your audio (click on the microphone icon to mute or unmute).
- Close other Applications: closing applications you do not need will improve your call
- If there are multiple devices (from other individuals) joined to your router, ensure that they are disconnected during the call. The vessel operator may offer the option of isolating the connection for the call to avoid this issue.

Guidelines for the most common video conference applications.

Zoom

Internet bandwidth requirements for different kinds of Zoom calls.

For 1:1 video calling:

- 600kbps (up/down) for high quality video
- 1.2 Mbps (up/down) for 720p HD video
- Receiving 1080p HD video requires 1.8 Mbps (up/down)
- Sending 1080p HD video requires 1.8 Mbps (up/down)

For group video calling:

- 800kbps/1.0Mbps (up/down) for high quality video
- For gallery view and/or 720p HD video: 1.5Mbps/1.5Mbps (up/down)

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- Receiving 1080p HD video requires 2.5mbps (up/down)
- Sending 1080p HD video requires 3.0 Mbps (up/down)

Skype

The following table provides the minimum download and upload speeds required, as well as the recommended speeds for best performance.

Call type	Minimum download/ upload speed	Recommended download/ upload speed
Video calling /Screen sharing	128kbps / 128kbps	300kbps / 300kbps
Video calling(high-quality)	400kbps / 400kbps	500kbps / 500kbps
Video calling(HD)	1.2Mbps / 1.2Mbps	1.5Mbps / 1.5Mbps
Group video(3 people)	512kbps / 128kbps	2Mbps / 512kbps
Group video(5 people)	2Mbps / 128kbps	4Mbps / 512kbps
Group video(7+ people)	4Mbps / 128kbps	8Mbps / 512kbps

Microsoft Teams

Minimum, **Recommended**, and **Best performance** bandwidth requirements are based on per-endpoint usage. Typically, there's one endpoint per user, such as a computer or mobile device.

Minimum Bandwidth requirements for video calls are up to 240p resolution, screen sharing content frame rates adaptive 1.875 to 7.5fps, and Together Mode/Large Gallery video up to 540p resolution.

Recommended Bandwidth requirements for video calls are up to 1080p resolution, screen sharing content frame rates adaptive 7.5 to 30fps, and Together Mode/Large Gallery video up to 1080p resolution.

Remote Access Software

Remote Access Software such as TeamViewer allows remote access to computers or mobile devices located anywhere in the world and use them as though you were there. These applications can remotely connect to servers, and other devices to provide training, shore staff to Technicians and scientists and for the remote operation of equipment.

Video Streaming Software

There are many options for video steaming currently available, some such as Facebook live, YouTube and VIMEO are quick and easy to use but with that comes some limitations. They can be used in conjunction with applications such as Zoom to include multiple participants, for pre-recorded footage etc. and are generally managed via a desktop application. However, there are restrictions on the number of cameras, microphones and participants that can participate. Streaming services such as OBS project and other specialist solutions such as those developed for sea floor survey activities bring added functionality to enhance telepresence broadcasts.

Utilising Open source applications such as OBS allow for the addition of multiple cameras and video streams, play pre-recorded videos and connect multiple microphones. This configuration would facilitate live ROV footage streaming, with multiple speakers both aboard and ashore to discuss footage and interact with an audience.

When using any video streaming service whether it be Facebook Live on or using dedicated broadcasting applications there are some key considerations to be taken into account. As with video

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calls it is important to balance the available bandwidth with the resolution and bitrate that will be uploaded from the vessel with the download bandwidth and the likely resolution the audience will connect with the streaming.

3 Telepresence Implementation Guidelines

Key to successful implementation of all ship to shore communications is planning by all parties including the Research Vessel operator, crew, scientific party and communications service provider. All telepresence needs to be planned on a case by case basis for each expedition as each vessel, geographic area, operating conditions and service provision is unique. It is important to establish all party's expectations from the outset so that these can be managed throughout the process.

The following section outlines guidelines on best practice telepresence implementation aimed at vessel operators, on board scientific party and onshore support teams to ensure successful implementation at sea. As demand for ship to shore communications increased and demand it is advised that each vessel operator develop specific guidelines based on the hardware, software, area of operation and communication system available on individual vessels.

3.1 Proposal Proposition and Pre Cruise Planning

3.1.1 Science Party

1. Contact vessel operator in order to scope requirements dependant on planned communication activity before proposal writing. This is to better inform what is achievable and allow for plans to be adjusted accordingly.
2. Integrate all intended telepresence into the funding proposal including any additional days necessary for filming, required equipment, additional bandwidth (additional cost) and technical support necessary. If possible it is advised to factor in additional budget for support from dedicated communication individuals to manage activities both at sea and on land. If additional bandwidth is required most communications service providers do not facilitate commissioning of additional bandwidth for short periods (daily). This may result in additional costs to ensure available bandwidth throughout the cruise and not just on the day of broadcast. If this is the case, consider a series of broadcasts over the duration of the cruise to justify the additional cost.
3. Identify specific roles early in the process, both onshore and onboard support teams. Roles include telepresence session host, scientific panel, Q&A moderator, bandwidth management, sound etc.
4. Plan for the type of interaction, audience, length, equipment required, streaming service (Important to mange this for auidence expectations and so that host can mange any technical issues etc)
5. Ensure that all onboard scientis are aware that filiming will be taking place during the cruise and that is there is the possiblity that they may be filimed that they formally agree to this. A waiver may be necessary in some instances.

3.1.2 Research Vessel Operator

1. Check with the communications provider if the existing bandwidth onboard is sufficient to accommodate the activities in the proposal. Consider what is required for vessel operations

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and expectations of crew for access to bandwidth at the scheduled transmission time the geographic location, dates requested, duration and level of estimated bandwidth required.

2. If additional bandwidth is required establish the additional cost and revert to PI.
3. Review the proposed timeline to determine if additional time will be required to carry the broadcast to allow scope for filming, weather delays and additional time and equipment to be included in the survey scheduled. This will allow dedicated time within the cruise plan to effectively implement a successful event.
4. Confirm where the vessel is likely to be at the scheduled time, what shift will be in operation (making sure the right people were available for the stream) and to confirm equipment such as ROV will be on station and in the water on the agreed date.
5. Although not always possible it is advisable that events such as ship to shore broadcast events such as ROV live streams are outlined in ship time applications to allow scope for filming, weather delays and additional time and equipment to be included in the survey scheduled. This will allow dedicated time within the cruise plan to effectively implement a successful event.
6. Ensure that all onbard crew are aware that filiming will be taking place during the cruise and that is there is the possiblity that they may be filimed that they formally agree to this. A waiver may be necessary in some instances.

Feedback from Eurofleets+ pilots outlined in section 4, has strongly recommended that if funding for ship to shore activities are successful that planning is commenced immediately and is a key element in all discussions with the scientific party, vessel operator and the onshore support team to ensure a successful broadcast, especially if a live, interactive event is scheduled. This will allow sufficient time to build communications partnerships with onshore stakeholder's, establish communications teams and ensure that all hardware and software required as available, validated and familiar to all parties.

3.2 Implementation at Sea

If the Proposal Proposition and Pre Cruise Planning guidelines outlined above have been followed implementation at sea should be straight forward. However, there are still a number of considerations for both the Science party, crew and communications service provider to take into consideration when putting telepresence into practice at sea. Working at sea presents many challenges and ship to shore communications are not exempt from these.

3.2.1 General

Communication between all parties is key to the success of the ship to shore communication activity. Revisit all agreed pre cruise arrangements and protocols once embarked on the vessel. Connect all relevant personnel including technicians and science party. The category of communication planned will dictate the level of involvement, effort and bandwidth required for success from all parties and should be proportionate.

Offshore

- Checklist for all items agreed at planning stage in relation to available bandwidth, equipment (operational), broadcast location etc.
- Carry out a test broadcast if possible, to ensure all equipment is working, science party are ready, and that the receiving onshore hardware, software and personnel are equipped to receive the rate and size of data being sent. This is critical to ensure quality of the video stream being received.

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- If streaming footage from an ROV, prerecord some footage if possible as backup which can be used in the event of technical issues with the stream, or ROV camera on the day.
- A dedicated broadcast channel is preferred, but if not available agree with vessel operator to prioritise bandwidth during broadcast
- If the event is a live broadcast to a large audience, ensure that clear roles are assigned to all involved personnel and agree assignments for the broadcast with each to eliminate any ambiguity for the event.
- Draft a list of provisional questions for the PI and scientific party and circulate. If there is an issue with the broadcast on the day, prepared topics will ensure that discussion continue and the broadcast goes smoothly.
- Set a time limit on the broadcast to manage expectations of both vessel and onshore teams.

3.2.2 Onshore Team

- Close out as many items ahead of the science party departing on the cruise to avoid any last minute changes (although the need for some changes may be inevitable before the science party depart
- Ensure that all roles are Cleary defined ahead of the event such as Host, Support team and technical support are in place.
- Test the receiving connection ahead of the event ideally a test run day before.
- Ensure that a Backup plan has been identified in the event that the live stream is not possible or the connection goes down during the event. For example, a shore based expert panel to speak to audience if there are technical difficulties
- Ensure that the broadcast is recorded and saved for future dissemination.
- If the session is interactive via a streaming service that allows comments, ensure that these are monitored for any negative or offensive comments and was removed from the feed.
- Agree a time limit for the broadcast with the onshore team.

3.2.3 Guidance for the Research Vessel Operator and Technicians

- Review planned telepresence activities included with the ship time application to allow scope for filming, weather delays etc.
- Liaise with communications service provider to ensure any additional bandwidth requirements that have been arranged are in place.
- Identify a lead technical person to liaise with science party and ROV ops etc. If possible, provide dedicated technical support on the day
- Estimate additional bandwidth required and ensure that the necessary bandwidth management strategy is in place. Isolate (or prioritise) bandwidth during broadcast if possible and monitor throughout the broadcast.
- During the test run confirm that all equipment necessary is working
- Schedule dates and promotion of event if applicable
- If the broadcast is planned for a specific geographic location monitor cruise progress against expected location.

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3.2.4 Post Cruise

Ensure that the telepresence operations are included on the Post Cruise meeting agenda. This will ensure that lessons learned can be documented to better guide future activity. The Eurofleets+ Telepresence Implementation Report Template (Annex II) provides a structured reporting tool which can be completed by the both the research vessel technicians and the PI to capture feedback.

3.3 Specific Guidelines for Stand Alone Telepresence Equipment

Portable solutions such as the Global Foundation for Ocean Exploration are specific to the equipment offered, the vessel and the planned expedition. An overview of the Global Foundation Ocean Exploration Telepresence Unit Implementation Recommendations can be found

4 Telepresence and Data Transfer Pilots

A number of pilot schemes were undertaken to gain further insights for possible telepresence solutions currently available, the outcomes of which have informed the guidelines outlined above. Pilots ship to shore broadcasts took place onboard two Eurofleets+ SEA Progarmme funded cruises, and a cruise funded under the EUMarine Robots project, funded by the Horizon 2020 research and innovation programme under grant agreement No 731103. Additionally, a number of operational activities were supported via realtime data exchange leading to an increase in delivery of shore based support and efficiencies in day to day vessel operations.

4.1 Ship to Shore Broadcast

i. **BENCHMARK GO SARS/ROV AEIGR, Additional Bandwidth, Streamed Via OBS to Facebook**
Summary of the cruise:
The objective for this cruise was to increase knowledge on benthic habitats on the Denmark Strait and the Greenland-Iceland Rise (GIR), focusing on Vulnerable Marine Ecosystems (VMEs). the primary objective is to collect underwater video and photographs to characterise the composition and distribution of epibenthic fauna in the Denmark Strait, with a particular focus on taxa considered indicators of Vulnerable Marine Ecosystems. This will be done via dives using an ROV (Remotely Operated Vehicle) in 20 stations located along three transects running in a NW-SE direction across the Denmark Strait.
Overview of activity:
Live stream event to Zoological Society Facebook from the ROV on the 06/08/2021. One way (ship to shore) audio and video, interactive with Facebook audience using the comments section.
Date:
Cruise Dates August 1 – August 10, 2021
Broadcast Date:

Type: 2 activities:

1x Live stream to open audience. 06/08/2021

1 X LIVE steam no audience interaction. 09/08/2021

Interactive: Yes, Q&A via Facebook Live and moderated onshore

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Acknowledgments: IMR, GOSARS Crew, ROV Aegir Technicians, BENCHMARK PI and Party ZSL outreach and communication departments.

Special Acknowledgment to Emmeline Broad for coordination the broadcast, pre cruise, moderating the live session and post cruise feedback.

Bandwidth Increased: Yes, existing capacity had bandwidth of 2.5 Mbps to the ship, and 600 kbps from the ship

Additional cost: €250 per day for the duration of the cruise.
Bandwidth Used: 4.0 Mbps the maximum measured was 3.7Mbps and we streamed at an average of 2.5Mbps
Shore support: Shore support and publicity from internal ZSL departments

Technical details
Equipment:

VSAT delivered by Telenor Maritime over Ka-band installed on "G.O. Sars.

ROV ÆGIR 6000 with standard HD caner and 4k zoom camera.

Hardware:

Blackmagic Intensity Shuttle for USB 3: (to mirror ROV cameras HDMI/Composite Video into a computer with OBS installed)

Computer

A USB conference microphone

Software:

OBS open source streaming service

Broadcasting software: https://obsproject.com/

Lessons Learned and Recommendations

It was recommended that future streams have the capability for science panel to use wireless headsets mixed into a single audio input which is then added to the stream via OBS.

Funding is required for good quality and dedicated outreach. Where possible, this should include funding for roles pre, during and post cruise and factor in dedicated individuals to conduct these roles both at sea and on shore.

Funding and support should be made available for publicising telepresence events.

Extra ship time may be required for interactive streaming events at sea, this should be discussed at the cruise planning stage with PI's.

The technology and microphones used for streaming activities should be standardised.

Ensure where possible that a recording of the event is saved.

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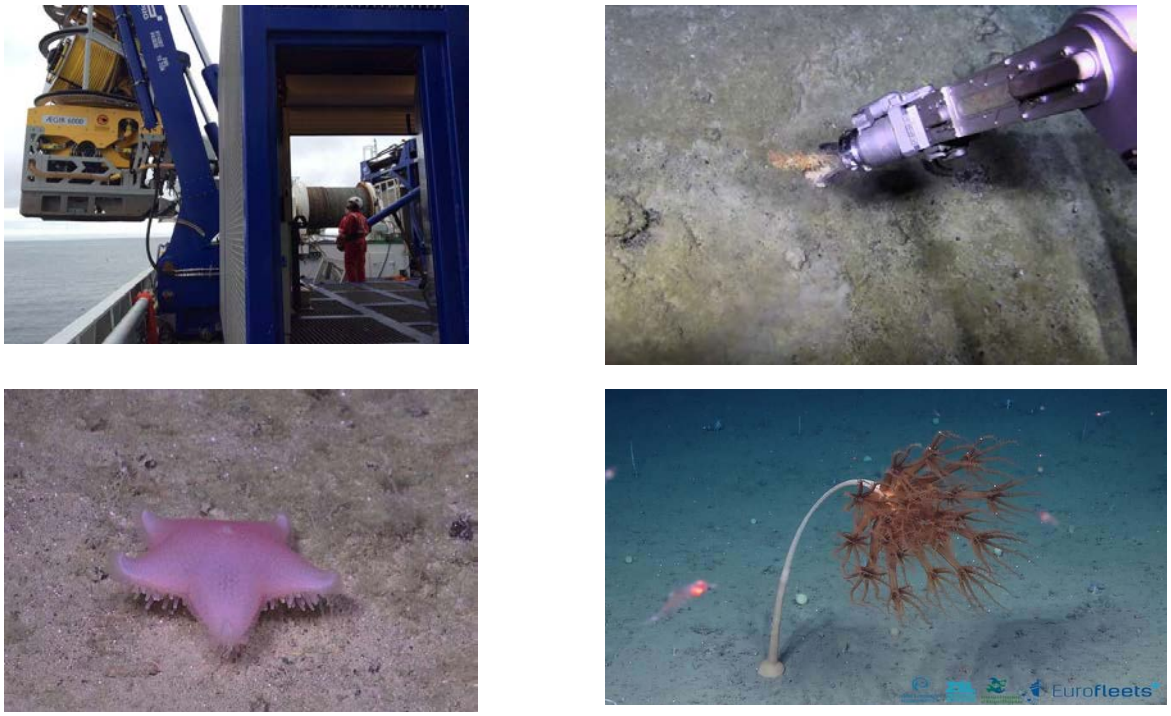

Figure 4-1 Stills form BENCHMARK Cruise Telepresence Broadcast

ii. GRASSMAP RV SOCIB, 4G, Interactive Live Broadcast Via Zoom to Facebook Live

Summary of the cruise:

Experiments with different autonomous systems: an Autonomous Underwater Vehicle, an Autonomous Surface Vehicle and a Lagrangian Drifter. These different platforms will be deployed to demonstrate in situ capabilities for marine data collection and seabed exploration, targeting endemic seagrass mapping using artificial intelligence

Overview of activity:

Live stream event to Eurofleets+ Facebook page from the RV SOCIB during the launch and recovery of Underwater Vehicles in Mediterranean Sea. Ship to shore audio and video, interactive with Facebook audience using the comments section.

Date:

Cruise Dates: 14th - 20th September 2021

Broadcast Date:

1x Live stream to open audience. 19/09/2021

Interactive: Yes, Q&A via Facebook Live and moderated onshore

Acknowledgments: Cruise PI: Miguel Massot Campos, GRASSMAP scientific party, RV Socib crew and all SOCIB operations and communications team.

Bandwidth Increased: No

Additional cost: None

Bandwidth Used: Broadcast via 4G

Shore support: Shore support from Eurofleets+ Coordination office and Dissemination and Communications Work Package leader.

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Technical details

Equipment:

Hardware:

Smartphone with 4g

Software:

Zoom Webinar broadcast to Eurofleets Facebook Live event

Lessons Learned and Recommendations

This broadcast was an example of what can be achieved with minimal equipment. Using only a mobile phone onboard and a computer onshore a live broadcast was achieved.

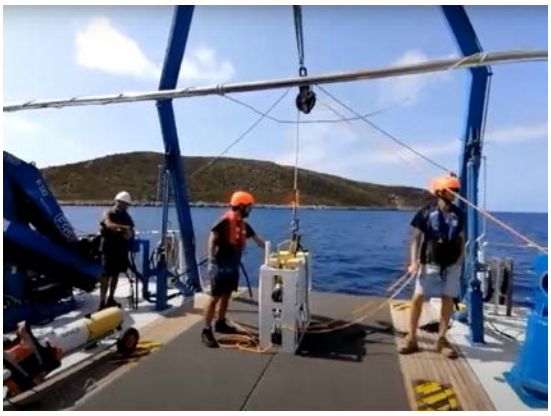
To ensure that there would be adequate bandwidth from the broadcast area, a test broadcast took place the day before. Recommended that this type of test is scheduled more in advance of the broadcast to ensure adequate time to publicise the event. This event was only published two days before due to the uncertainty around the available bandwidth.

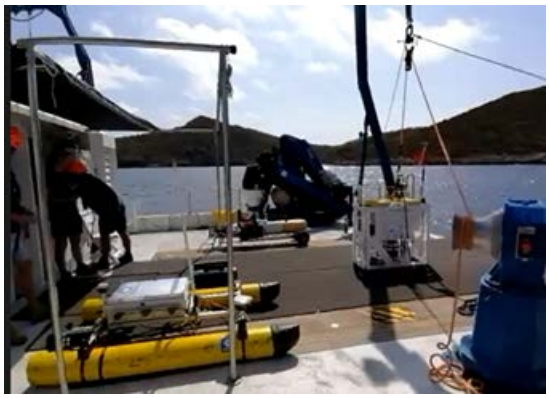
The event took place on a Sunday which led to low numbers engaging with the live broadcast. Weekdays would be more favourable as there is a better opportunity to reach a wider audience.

Zoom Webinar to Facebook live worked well and the connect did not drop at any point. However latency was poor at certain points.

Additional ship time may be required for interactive streaming events at sea, this should be discussed at the cruise planning stage with PI's.

In the event of low audience participation, a list of questions should be prepared and agreed with the broadcast moderator to ensure continuous dialogue during the broadcast.





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iii. **Advanced Mapping of Complex Marine Structures RV Celtic Explorer,**
This EUMarine Robots Transnational Access funded expedition aimed to acquire a remotely-sensed reference set of acoustic, optical and laser data for a methodological comparison of mapping fine-scale morphological and structural complexity on complex 3D structures below the surface. This allowed for development and analysis of acquisition protocols, processing workflows and other end-user applications from a range of sensors deployed on unmanned underwater vehicles (UUVs). The project aimed to ultimately inform the wider community, including both academic and industrial sectors, about the relative merits and detractions of the different methodologies in a controlled in-situ experiment

Overview of activity:
Live broadcast of the ROV operations – May 1st 2021. Live stream of wrecks of Donegal including interview from historian Thomas Balogh and deep water diver Barry McGill. Mapping of benthic habitats on shipwrecks. Transnational access project under EU Marine Robots. Accessible via URL: https://www.youtube.com/watch?v=7dlEf_diX18&t=5s

Vessel: RV Celtic Explorer
Date:
Cruise Dates: 23th April – 4th May 2021
Broadcast Date: 1x Live stream to open audience. 01/05/2021

Interactive: Yes with two onshore experts.

Acknowledgments: Dr. Gerard Dooly, Broadcast Lead, University of Limerick, Cruise PI Chris McGonigal, Ulster University, historian Thomas Balogh and deep water diver Barry McGill, Advanced Mapping of Complex Marine Structures cruise scientific party and officers and crew of the RV Celtic Explorer

Bandwidth Increased: No

Additional cost: None
Bandwidth Used: Broadcast via 4G
Shore support: None

Technical details

Equipment:

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Hardware:

Smartphone with 4g

Software:

Broadcasting software: SubC imaging in Canada https://www.subcimaging.com/real-time-streaming

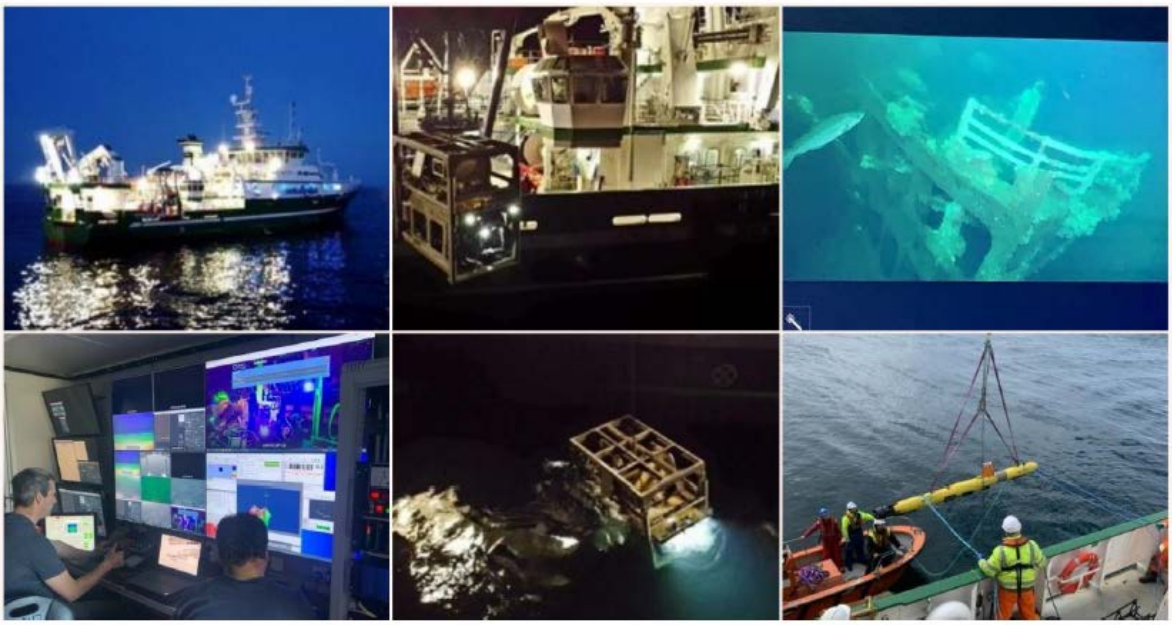
You Tube

Originally planned for to broadcast ROV dives live via an internet based social media channel such as Facebook live. However, when trialled this posed a number of difficulties such as Lag in both audio and video as well as bandwidth control of video stream to be able to provide a good quality broadcast. The communication platform onboard was through geo-stationary satellite service thought to be robust enough for completion of the live stream with a reported 2MB downlink and 1MB uplink connectivity. The media encoding and hosting was to be provided by a service from SubC imaging in Canada https://www.subcimaging.com/real-time-streaming, and would provide encoding which would match the bandwidth of the communication channel onboard. However, once tested offshore the communication link was found to be below 1MB and the streaming of a good quality video was deemed to be not possible. A secondary option was brought in the form of a mobile LTE service; however, this link was only be possible when close to shore.

Lessons Learned and Recommendations

To ensure that there would be adequate bandwidth from the broadcast area, testing took take place the day before. Recommended that this type of test is scheduled more in advance of the broadcast to ensure adequate time to publicise the event.

The event took place on a Saturday, however weekdays would be more favourable as there is a better opportunity to reach a wider audience.



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4.2 Enhance Vessel Operations Examples

The following examples of telepresence use on board the RV Celtic Explorer have been carried out utilising a pooled bandwidth service across two vessels which is managed by software tuned to manage both vessels network.

- Collaborative communication platforms such as Microsoft Teams and Zoom have been used to implement outreach across multiple expeditions.
- Video communication used regularly for crew training, shore staff demo software on the vessel such as planned maintenance and HSEQ.
- Post cruise meetings completed before arrival in port via Teams. Covid won't allow these meetings to happen onboard currently which was the norm.
- Remote Desktop Software Teamviewer used to give remote support from shore staff to Technicians and scientists.
- Pre-survey refreshers of systems installed (i.e. CTD) on the vessel with scientists while they are on vessel or shore based before they start their respective surveys.
- Remote Desktop Software Teamviewer used to remotely operate more complicated equipment like EM2040 by shore based Hydrographic Surveyor where the scientific crew don't have knowledge to operate a system

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5 Eurofleets+ Communications Matrix

The table below provides an indication of vessel VSAT availibility across the Eurofleets+ fleet. Please contact the operator directly to confirm current status.

Country	Ship	VSAT Comms (Mbps)
Belgium	Belgica	Yes (512 kbps CIR)
	Simon Stevin	YES (512 kbps CIR)
Germany	Alkor	CIR download: 512kBit/s CIR upload: 128kBit/s
Denmark	Dana	Yes (1024kbps)
Faroe Islands	RV Jákup Sverri	Inmarsat C, GSM, Internet satellite connection
Finland	Aranda	Yes
France	Thalassa	CIR download: 512kBit/s CIR upload: 128kBit/s
	L'Europe	CIR download: 128kBit/s CIR upload: 128kBit/s
Germany	Alkor	Satellite Broadband system, 3072kbps/1024 Kbits, Iridium, GSM phone and VOIP system
Greece	Aegaeo	Occasionally
Greenland	Sanna	No
Iceland	Arni Fridriksson	Upload 64, download 192
Ireland	Celtic Explorer	1kbpup 2kbp down 1:1
Italy	Alliance	512 kbps CIR
	Laura Bassi	
Netherlands	Pelagia	512
Norway	G.O.Sars	0,512 Mbps
Portugal	Mar Portugal	YES
Romania	Mare Nigrum	
Spain	Ángeles Alvariño	YES (128 kbps CIR)
	Ramon Margalef	YES(128 kbps CIR)

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	Sarmiento de Gamboa	YES (256 kbps CIR)
	RVSOCIB	NO
Turkey	TÜBİTAK Marmara	NO
Canada	RV CORIOLIS II	KVH – TracPhone V7ip
New Zealand	RV TANGAROA	Yes V-SAT, Inmarsat FBB500, Iridium Openport
Bermuda	RV ATLANTIC EXPLORER	Dedicated 64/64 kbs connection INMARSAT C, Fleet Xpress, Iridium, Cellular

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Annex I

Global Foundation Ocean Exploration Telepresence Unit Implementation Recommendations

GLOBAL FOUNDATION FOR OCEAN EXPLORATION

GFOE Telepresence Guidelines

Note: The technical aspects of this document are specific to the use of the Global Foundation for Ocean Exploration's portable 2.4m telepresence system. Other systems, portable or otherwise, may need other specific considerations not covered in this document.

Vessel Requirements

Requirements for a vessel to be used in telepresence-based missions consists of many pre-use engineering questions that must be answered so the proper equipment can be provided to complete the mission. Two VSAT/telepresence engineers are required to operate the system.

- Room for 20' Container on deck
- Clear line of sight for satellite antenna system (e.g. bridge, crane, etc. cannot be in the line of sight)

Requirements needed from all vessels to be used are as follows:

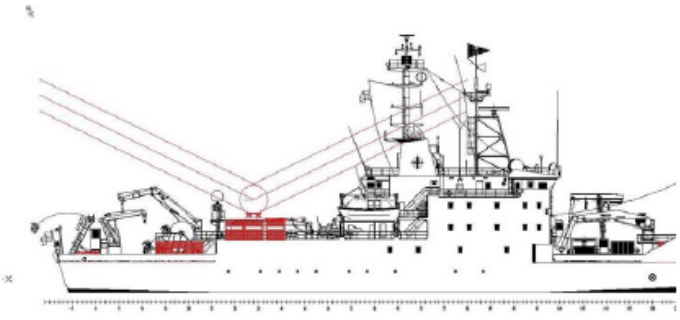
1. Ships heading information in standard NEMA format

2. 30 amp 50/60Hz. 220/110 Volts AC

3. A location to allow the most physical view with as minimal physical structural blockage as possible. The location should be as close to midship as practical.

4. An engineering tour of the vessel at least 2 weeks prior to equipment arrival.

The graphic below illustrates line-of-sight considerations that need to be addressed prior to determining whether a ship has the capacity for a portable system of this type.



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The following information for the mission is required as early as possible prior to the actual mission, to allow satellite selection and connectivity requirements.

1. Ship's length and structural information for mounting of equipment.

2. Latitude and Longitude Coordinates for the mission to include the furthest North, East, West, and South locations to be provided at a minimum of 60 days prior to the mission in order to contract with a satellite provider. In general, a user can expect to pay for 30-day minimum of satellite time even if a cruise is less than 30 days.

3. Mission start and end dates, and hours of operation. Please allow 2 weeks before the start date for equipment install, and a week after the mission for equipment removed.

Guidelines for Daily At-Sea Operations

In telepresence-based missions, the science party provides ongoing narration of the dives so that viewers understand what they are seeing and hearing. Scheduling rotations among the science party is recommended. Introductions, mission objectives, info about the vessel, etc. are helpful.

Telepresence Guidelines for Shore Based Interactions

Shore Based Interactions (SBI) are from the ship to a specific venue on shore at a specified time. They are a two-way interaction over audio or video. The following information should be collected by the scientist or outreach/education coordinator for the mission:

Name of institution and viewing group for live interaction
- Location of Live Interaction and type of room interaction will be in
- Availability Dates & Times for Interaction
- Availability Dates & Times for Interaction Test
- Contact Person for Interaction + name, email, & phone if available
- Technical Contact + name, email, & phone if available
- Estimated number of persons attending and the demographic (general public, college class, academia, etc.)
- Length of Interaction desired
- Internet connectivity (check at http://www.speedtest.net/ or by typing "speedtest" into google search) in interaction room
- Phone access in interaction room?
- Type of audio connection and audio equipment in room? If connecting via phone, what is the number? (make sure to test for feedback if a stereo system)
- Topic for desired focus of interaction
- Interaction viewing/display
- Type of interaction desired (Audio + Video, Audio only)
- Will the video interaction be streamed directly to a private destination, or through a public site such as YouTube?

A communications test should be scheduled with the venue and conducted the day before the interaction is scheduled, so that any technical issues can be worked out.

Scientists Roles in SBI's

- Be familiar with the audience you are speaking to and guide the conversation accordingly

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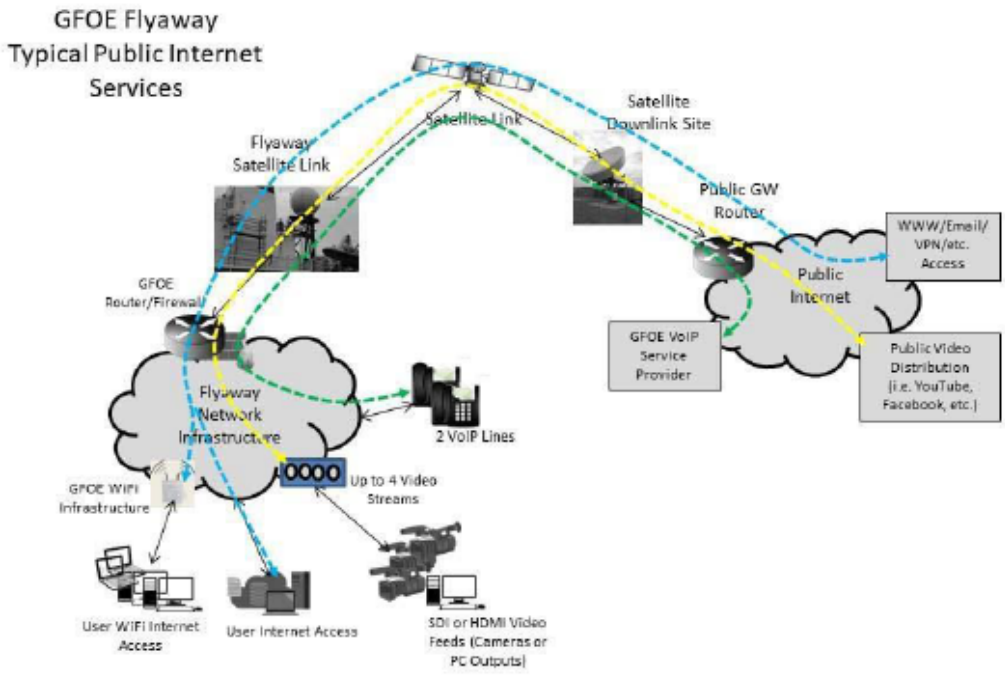
- Introduce yourselves and explain the mission
- Leave plenty of time for Q and A

Typical Telepresence Infrastructure and Services

The typical environment using the flyaway system would provide phone services, data access, and video streaming services. With the connectivity provided to access services such as email, social media, VPN and other services via the Internet. Phone services are provided by GFOE VoIP lines. Video streaming is provided via a hardware encoder onboard to any public distribution service such as YouTube, Facebook, etc.

Below is a diagram showing the typical configuration for services:



For the typical deployment of the flyaway solution these are the considerations that should be provided by the organization.

1. Bandwidth requirements for the deployment (confirm availability via the satellite link)
2. Video distribution preference; which provider would the organization like to use
3. VoIP lines required (can provide up to 4)
4. Any special protocols required for the users (this would be any special IP services)

Optional Telepresence Infrastructure Deployments

Should the organization wish to maintain control over the data or not distribute over public services optional configurations can be used. These can provide for real-time shore/ship side team collaborations without the worry of data being distributed publicly. This can provide services directly to team members located on shore side locations. Video and data can be sent via direct streaming to the team or even via encrypted protocols and therefore provide control and management of the data and

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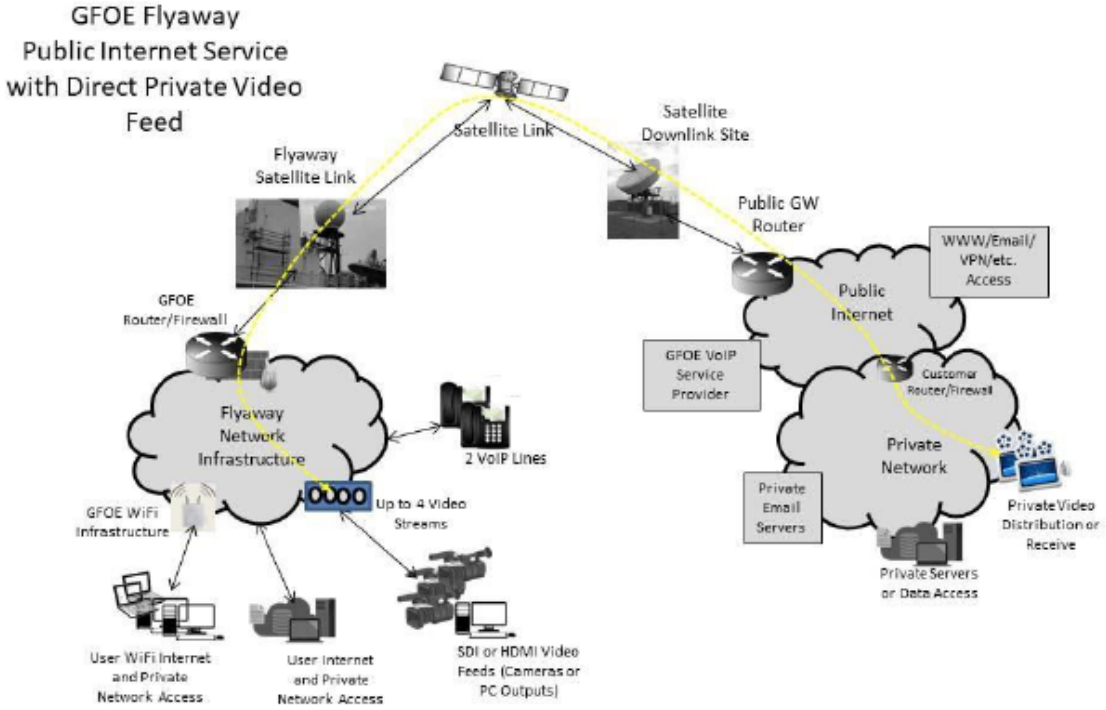
video. Voice services are via VoIP services and therefore are just like land based phone services so there is not a need to change the VoIP service paths.

This section focuses on some sample options that organizations could use to take advantage of telepresence and still maintain and manage data and video paths.

Sample Private Video Solutions

These are two example solutions for direct video feeds to collaboration shore based teams. These are just samples. The key to this solution is that the video is sent only to the location(s) provided by the organization. This will require some interaction and technical contacts within the organization where the video feed is being sent. Below is the first option where the video is sent directly to a specific location within a private network and no encryption is required:



To support the direct video distribution on the flyaway solution these are the considerations that should be provided by the organization.

1. Review the typical deployment requirements
2. How many video feeds are requested - up to 4 but will be based on video quality requirements
3. Technical contact at the organization where the video will be received to provide the IP address, ports, and firewall support
4. Software or hardware details of the receiving end for the video
5. This solution will require at least a week or two depending on the organizations current capabilities.

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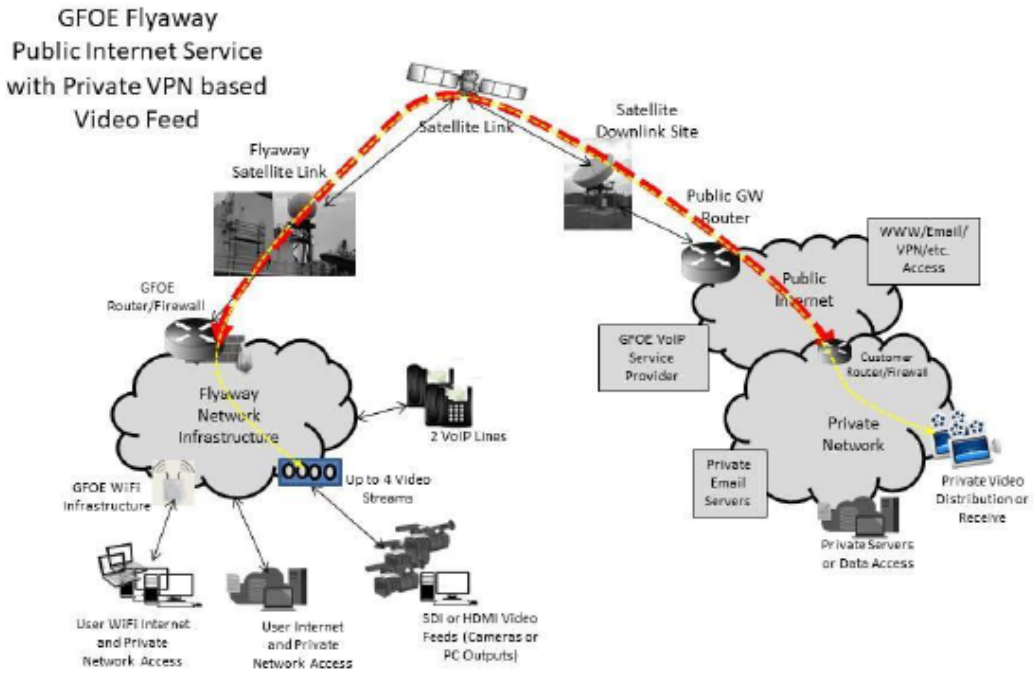
A second option is to provide an encrypted point-to-point VPN link which will require additional technical support at the organization but will provide additional protections if required. This option is shown below where the point-to-point VPN is established first and the video is sent over that link.



To support the direct VPN solution on the flyaway solution these are the considerations that should be provided by the organization.

1. Review the typical deployment requirements
2. How many video feeds are requested - up to 4 but will be based on video quality requirements
3. Technical contact at the organization where the video will be received to provide the IP address, ports, and firewall support
4. Technical contact for the VPN termination point to provide the details of the system
5. Software or hardware details of the receiving end for the video
6. The point-to-point VPN solution could require 3 to 4 weeks of preparation time with the organization's technical contact.

Sample Private Data Solution

This solution uses the same option as the video solution where a point-to-point encrypted connection can be established. However, it should also be noted that VPN services from a user's PC to their organization is supported as an option, too. This solution will force all data to be sent over the point-to-point connection and will require technical support at the organization. Below shows the option using a point-to-point connection for data services. Note that this will require a higher level technical support contact within the organization.

With the data service provided via the public Internet an organization can utilize their standard VPN service to access their private network. This would not require any special network infrastructure

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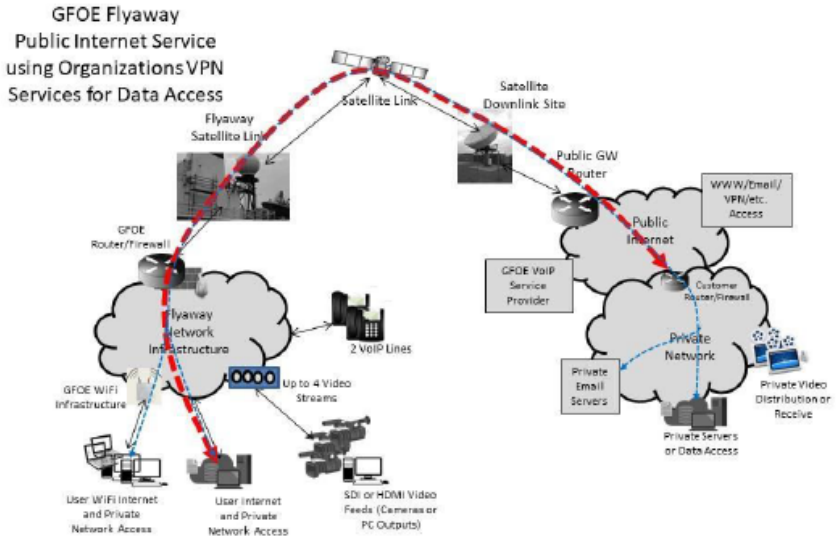
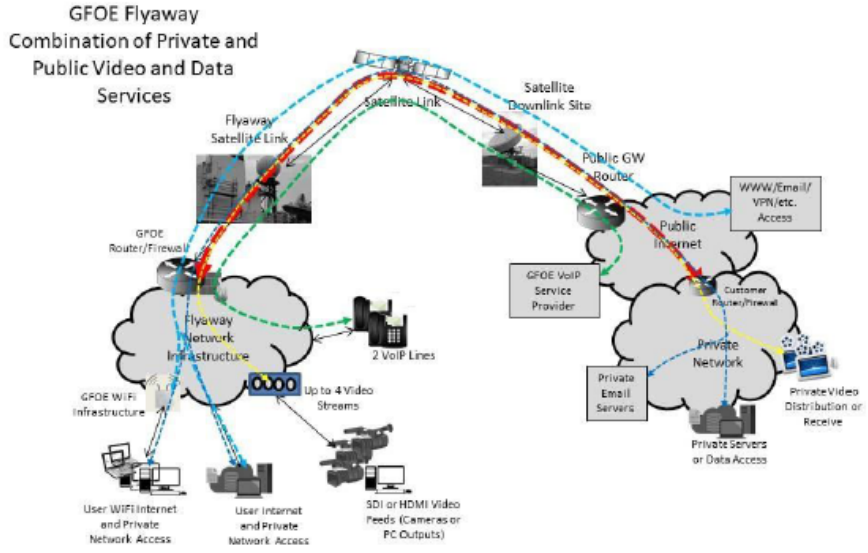
changes and therefore minor technical support if needed. Below shows that VPN connection is established from the user PC and therefore is encrypted from the user to the organization's private network.



For this option, review the typical deployment. Users will need to have their VPN service installed and in place from their organization. There is nothing special required on the GFOE network to support this configuration.

Optional Configurations Overview

Any combination of the options can also be supported. As well, there may be other options available should an organization wish to maintain the data internally but take advantage of the telepresence services to expand access to their teams onshore in real-time. The diagram below shows both public and private concepts that could be supported.



To support the direct VPN solution for all services except the VoIP services on the flyaway solution these are the considerations that should be provided by the organization.

1. Review the typical deployment requirements
2. This will be the most complicated solution and will require a significant technical contact at the organization with details on their network. This could require up to 3 to 4 weeks to work through the details.

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Annex II Eurofleets+ Telepresence Implementation Report Template

Eurofleets Telepresence Implementation Report	
Telepresence Cruise Planning	
Name of TA cruise:	
Name of Research Vessel:	
ROV/AUV Deployed:	
Expected Telepresence Level to be implemented.	
Existing VSAT Comms (Mbps) on vessel:	
Bandwidth Booster required (Y/N):	
Additional Funding Required to implement (Y/N):	
Cost of additional bandwidth:	
PI Name:	
Outreach Activity Lead:	
Activity Planned:	
Estimated Bandwidth Required:	
Implementation	
What streaming software was used	
Was it effective (please detail): • **Quality** • **Speed** • **Latency** • **Other**	
Bandwidth Available at broadcast site	
Broadcast Site Coordinates	
Shipboard Equipment Used?	

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Shipboard Personnel Involved (number, background, role played)	
Shore based equipment Used	
Shore based personnel support number, background, role played)	
Objectives Achieved Y/N	
Summary of activities:	
Audience Reached:	
Were the event(s) broadcast only or interactive with shore based participants	

Post Cruise	
Problems Encountered	
Lessons Learned	

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References

UNOLS Telepresence Guidance for Scientists and Ship Operators

https://www.unols.org/sites/default/files/UNOLS_Telepresence_Guidance_16Feb16_v3.pdf

Eurofleets2 Deliverable D3.17 Shore to ship e-access - data and metadata
https://www.epiphan.com/blog/bandwidth-for-streaming/

European Research Vessel Operators Ship Data Spreadsheet

Zoom system requirements: Windows, macOS, Linux https://support.zoom.us/hc/en-us/articles/201362023-System-Requirements-for-PC-Mac-and-Linux

Skype Bandwidth Requirements

https://support.skype.com/en/faq/FA1417/how-much-bandwidth-does-skype-need

OBS Set Up Recommend Bitrates

https://csinfos.com/how-to-set-up-streamlabs-obs-according-to-the-internet-speed/

https://teradek.com/blogs/articles/what-is-the-optimal-bitrate-for-your-resolution

https://brightspark-consulting.com/blog/facebook-live-via-obs/

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