Satellite Communications

Near term changes from

A Contractors Perspective

Remote Survey – Many Are Asking For It

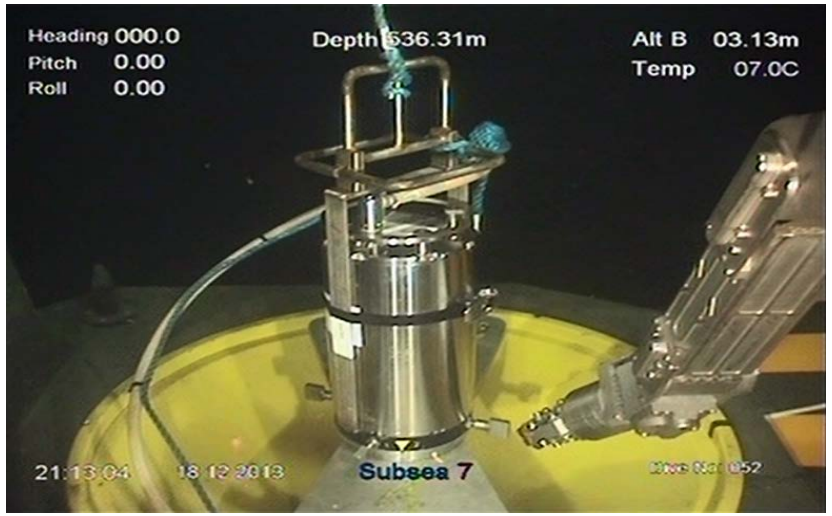
- **BP** has a stated goal that by 2025 all inspections will be performed from unmanned systems.

- **Shell** – “Within the next decade, we will see real-time, in-line, surveillance systems come to market. As a consequence, less processing personnel will be required offshore. In addition, intervention times shall be reduced, and automated annual [survey] comparisons will become commonplace. Survey platforms will become increasingly autonomous and more widely accepted."

- Obviously the COVID 19 Pandemic has focused us all a little more on remote/unmanned operations.

Where Does Zupt Fit – Remote Metrology

- >250 metrology surveys delivered in last 12 years
- Using our stand-alone inertial navigation solution – C-PINS
- Clients use us because we take apx. 50% of the vessel time consumed by acoustics. These are Total's numbers, not ours, 8 years of DPR's compared to publish these numbers.
- We work worldwide – a lot of experience in West Africa, Gulf of Mexico
- **12 Remote metrologies** (no survey personnel offshore) completed to date.
- **3 Remote buoy sets**
- **At least 3 more in the next months**.



Clients:

Total
BHP Billiton
Oceaneering
SubSea7
Oxy
Fugro
Shell
DOF Subsea
LLOG
Harkand
Marubeni
Tullow
TAQA
Acergy
Statoil
Jan de Nul
Hess, etc.

“But Bandwidth Offshore Is Unreliable”?

- Bandwidth offshore is not unreliable – **the wrong people are in control of it.**
- We have all had to upgrade our bandwidth to binge watch our favorite Netflix series. Dial up and DSL are long gone!
- If the vessel operator, or client does not pay for bandwidth – then bandwidth will be an issue – but the cost is minimal and getting cheaper.
- In many organizations satellite bandwidth is managed by IT departments and not operational departments – so the IT folks worry about network security and not about significant (huge) operational time and cost savings.

Who Is In Control?

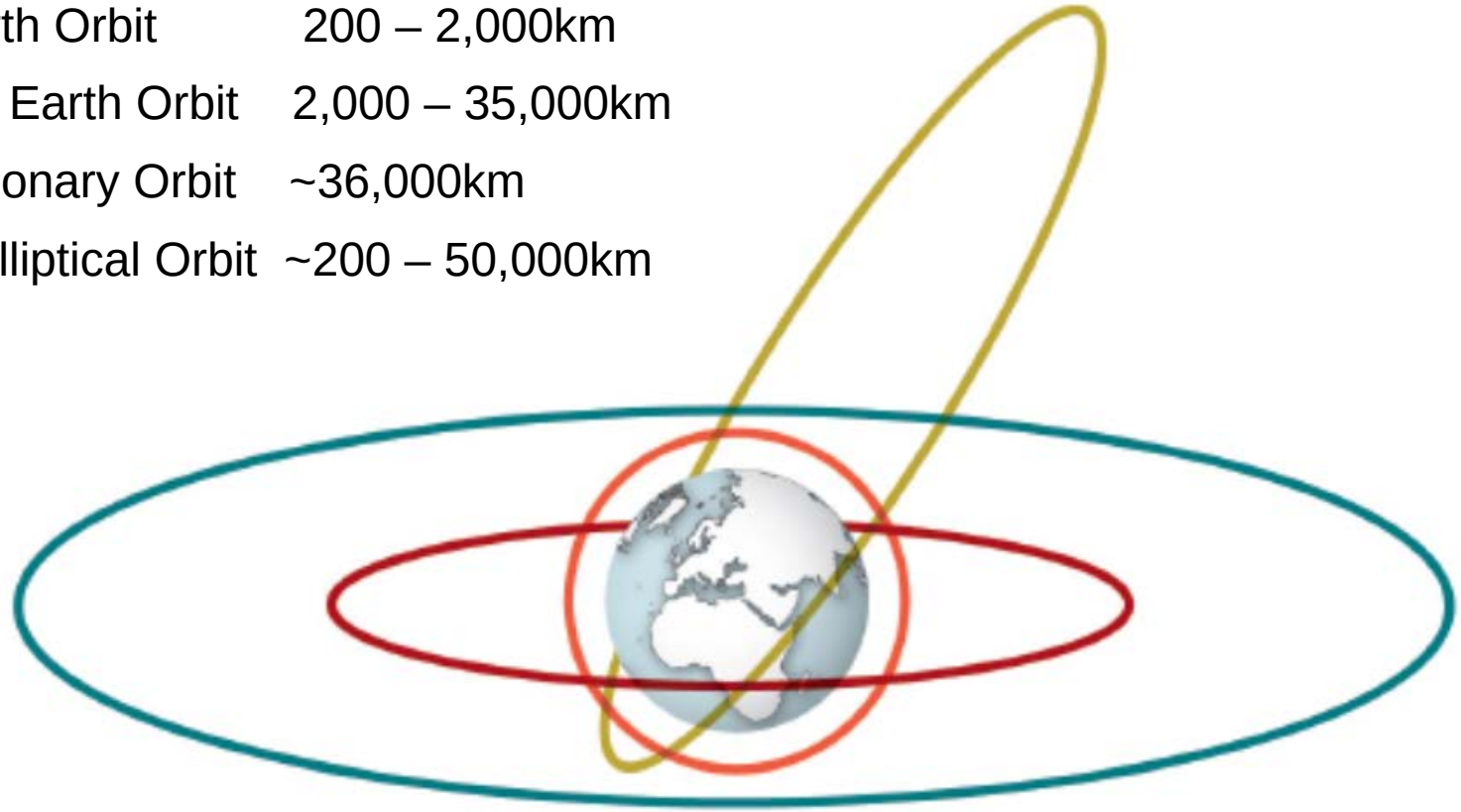
- Operations teams need to regain control of bandwidth on their vessels. It is no longer just an email/phone service provided onboard!

- For us - finding the right point of contact within the client's/vessel operators organization prior to short term deployments is not always that easy. Maybe we should turn up with our own bandwidth?

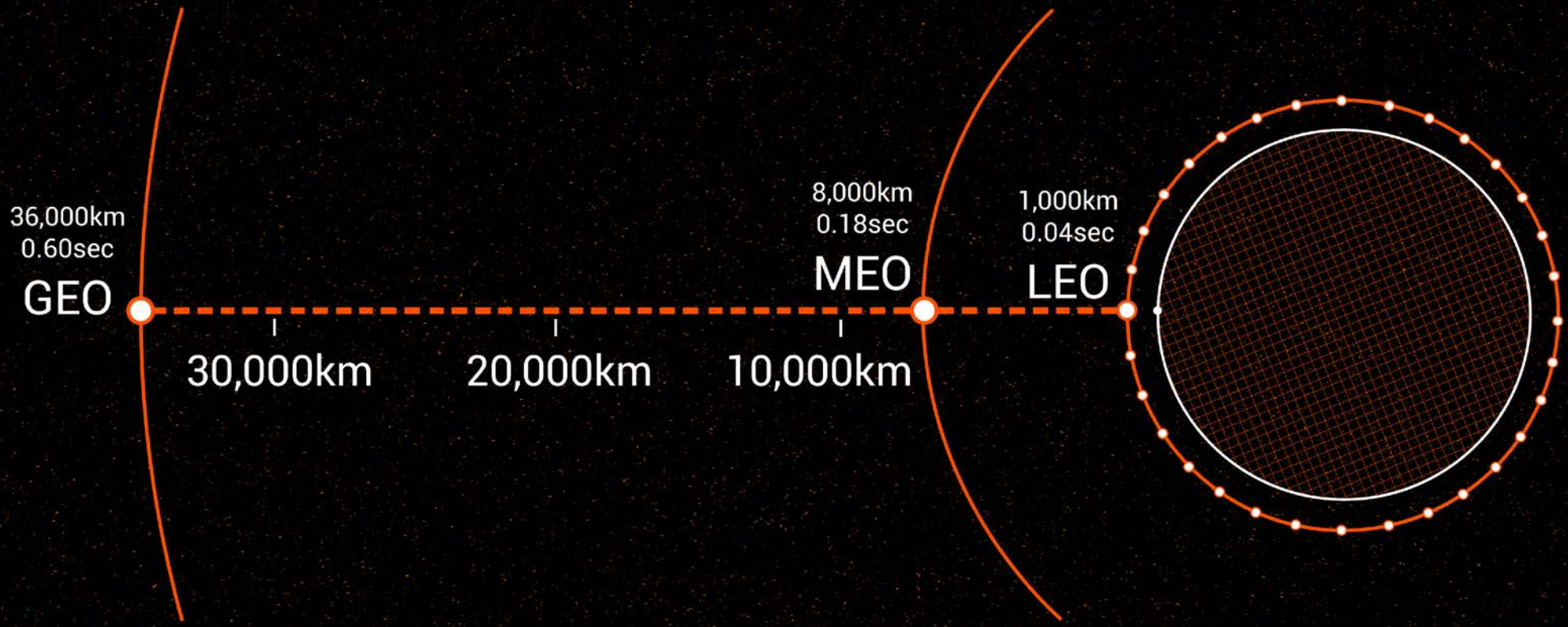
- Today - the apx. cost for a month of additional BW (+512kbps) we need added to an existing service to allow us to perform a remote metrology is less than **one day's** day rate for an offshore surveyor!

Some Simple Definitions

LEO	Low Earth Orbit	200 – 2,000km
MEO	Medium Earth Orbit	2,000 – 35,000km
GEO	Geostationary Orbit	~36,000km
HEO	Highly Elliptical Orbit	~200 – 50,000km



Latency - Why Care?

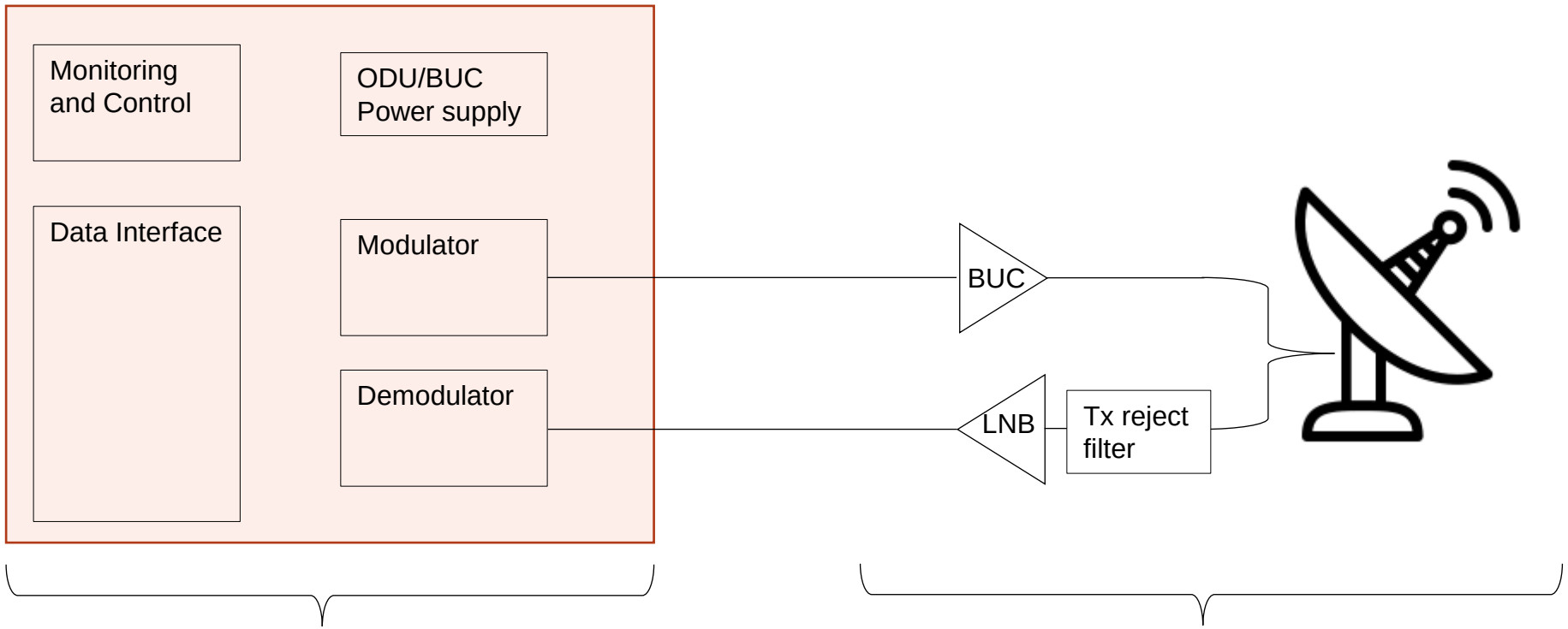


Further Into The Weeds

Abbreviation	Orbit Name	Latency	Orbital Period	Information
LEO	Low Earth Orbit	40ms	10-40 mins	Smaller and closer to earth, so easier and cheaper to launch, but many needed to cover any specific geographical area. Must have most of the constellation in place for reliable coverage. Orbit the earth many times a day. Many ground stations needed to communicate with all the satellites. Because LEO antennas can communicate with more than one satellite at a time from multiple angles, communications are more robust*. Shorter satellite life than MEO and GEO. Least signal propagation delay.
MEO	Medium Earth Orbit	180ms	2-8 hours	As with LEO, also require a constellation of satellites for global coverage. Typically, these satellites are used for positioning information (GPS, GLONASS and Galileo)
GEO	Geostationary Earth Orbit	600ms	24 hours	Bigger and more expensive to deploy. These are parked above the area of coverage and stay in place, as such network operators can gradually add to their coverage area. Larger coverage with less satellites in place. All GEO SV's are in orbit around the equator, so difficulty broadcasting in polar regions. Visible for 24hrs a day from fixed locations on earth.

Components Of An Onboard System - Terminology

Block Upconverter (BUC)
Low Noise Block downconverter (LNB)



In Door Unit – IDU or Below Deck Unit
Some call this the modem

Out Door Unit – ODU or Above Deck Unit

Most refer to all of the above as a “Terminal”

Things Are Changing - Pricing (purely our point of view)

- Conventional offshore satellite bandwidth providers [RigNet, Speedcast (Harris Caprock), Marlink, Inmarsat and ITC Global (Panasonic)] are seeing a radical change in their space.

  ViaSatellite June 2020 – Adrienne Harebottle article:

  "With the scheduled 2021 launch of Viasat-3, it is estimated that the base **cost** *(to the service provider)* will be just $5 per Mbps per month, when accounting for satellite, launch and ground segment CAPEX"

  "Given our analysis and benchmarks of CAPEX efficiency of HTS systems, we can certainly see pricing levels trending towards and below $100 per megabits per second per month over the coming decade, and this is even for smaller volumes and shorter contracts"

  Currently for low volume users this is >>$1,000/month?

Note HTS are the High Throughput (GEO) Satellites – now Very HTS are being launched.

A Few of the Existing and Planned Communication Constellations

https://www.newspace.im/ has them all!

COMPANY	LOCATION	NO. OF SATELLITES	SERVICES	NOTES
Starlink - SpaceX	Redmond, Wash.	41,493 (no typo)	Global broadband	860 launched $99/month 50Mbps to 150 Mbps
Amazon (Project Kuiper)	Seattle, Wash.	3,236	Global broadband	Kuiper constellation
Swarm Technologies	California	600	IoT - Broadband	For connected “stuff” – different BW price model
Boeing	Seattle, Wash.	2,956	Global broadband	
OneWeb (bankrupt??)	Arlington, Va.	648	Global broadband	60 launched – Bankrupt March 2020
China Aerospace Science (CASC) Honyang	Beijing, China	320	Hongyan global broadband	First satellite launched in December 2018; scheduled for completion in 2022
Russian Space Systems Company	Moscow, Russia	288	High-speed communications	Planned completion in 2025
Sky and Space Global	London, England	200	Narrow band communications	
China Aerospace Science & Industry Corporation (CASIC)	Beijing, China	156	Hongyan global broadband	First satellite launched in December 2018; planned completion in 2025
Telesat	Ottawa, Ont.	1671	Wide band and narrow band communications services	First satellite launched in January 2018
LeoSat Enterprises	Pompano Beach, Fla.	108	Broadband services	
Iridium	McLean, Va.	75	Voice and data communications	Completed Iridum-NEXT constellation in 2018
Boeing	Seattle, Wash.	60	Very high speed connectivity for end-user earth stations	
SES	Washington, DC	42	Broadband services	20 O3b satellites launched
Globalstar	Covington, La.	24	Satellite phone and low-speed data	Constellation completed in 2013
ViaSat	Carlsbad, Calif.	24	Broadband services	
Karousel LLC	Alexandria, Va.	12	Communications	

Hardware Components - Changing As Well

- Conventional domes being replaced by flat panel antenna

  Flat Panel: ThinKom, Kymeta, Phasor, SatixFy, Alcan, etc.

  Low Profile: Inster, GetSat, Gilat, C-Com, ViaSat, etc.

LEO requires a much more intelligent antenna

The antenna has to track the LEO SV's as they move over and maintain seamless communications as one SV hands off to another SV. Much of the work to date has been chasing the airline sector to provide in aircraft BW for passengers. This has obviously come to a grinding halt since March.

One of the issues for the marine sector is the high rate motion that will have to be accommodated by these systems. One of the flat panel companies above is already getting bad press for lack of performance in the mega yacht market.

Many Manufacturers are producing FPA's in this sector

Current pricing from the panel manufacturers that have volumes in the market (Kymeta, TninKom, etc) are several to many $10,000's.

The next wave of developments (Isotropic, Alcan, etc) are targeting releases of sub-$1,000 antennas.

The market is estimated at 1.4 million FPA terminals for satellite broadband by 2028.

Deploy It All – Short Term Service Providers With Their Own Systems?

- Currently Zupt uses BW provided by the vessel – with additional bandwidth being added onto the service for as short a period as 4 days.

- We will soon be in a position where service contractors like Zupt will be able to turn up offshore with our own self-contained bandwidth solutions for short term operations.

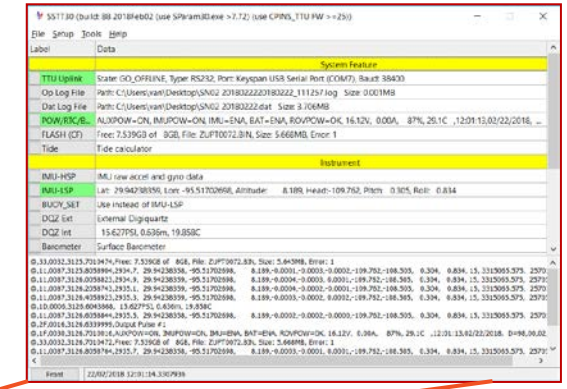
- BUT - We need to start talking today about:

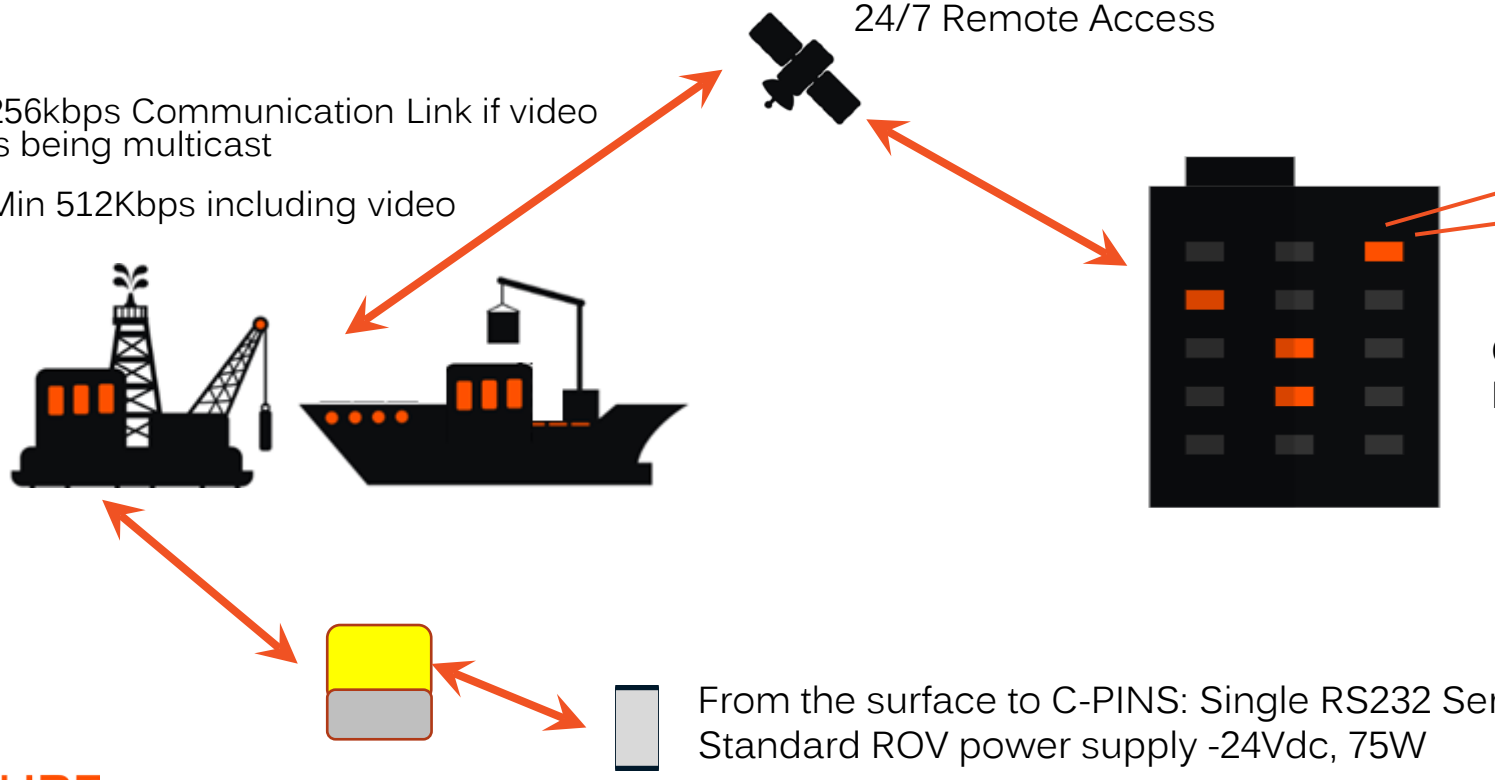
  RF spectrum management
  Mobile terminal placement
  Shadowing of antenna, etc.

- Kymeta already offer a dual redundant solution that would share multiple antennas for quick deployment of a reliable solution onto a vessel of opportunity – based around a 6’ container.

Our Example – Remote Metrology

Data collection is performed onshore, data is not sent onshore for processing.
Metrology task plan followed by the ROV team offshore, under the direction of survey team, onshore.





Remote Metrology Services vs. Manned Metrology Services

Comms configuration troubleshooting during equipment mobilization to the ROV (we regularly deal with this on manned metrology work).

The ROV team mobilizes the equipment to the ROV, and the interface test / coms test sorts out any wrong serial channel / baud rate / Tx Rx crossover issues. The physical presence of a surveyor for troubleshooting coms has not been needed.

A full compliment of spares is shipped – 2 sets of everything.

The risk associated with a remote metrology campaign is less than a standard offshore manned metrology. Remote metrology benefits from the improved HSE risk profile as no personnel are offshore (no quarantine, no visas, no vessel transfers, flight delays, POB issues)

Risk profile of remote solution is less than a manned metrology.

There has been no issues or complications faced during our remote metrology operations to date that would have benefited from a surveyor being offshore.

Benefits of Remote Metrology – Flexibility and Fixed Cost

The benefits of the remote option are more than just the possible savings from the reduction in personnel day rate.

Lump Sum Pricing – all remote metrologies have been lump sum!

Metrology "on demand"

Clients can choose when to do the metrology with no consideration of equipment or personnel logistics.
No need to mobilize an international team early with premature estimates of tree install or drilling completion.
The need to plan the exact metrology date weeks in advance is longer a factor with equipment already offshore and no personnel logistics constraints
No risk associated with early ($) or late ($$) call out of metrology team.

Equipment demobilization – no rush

Current manned contracts have clients racing to arrange a supply vessel upon completion of the metrology to get the equipment and people off day rate.
With remote project costing the offshore day rate for the equipment is factored into the lump sum, whether it gets demobilized the day after, or 5 days later when the next supply vessel is scheduled, the cost remains the same.

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