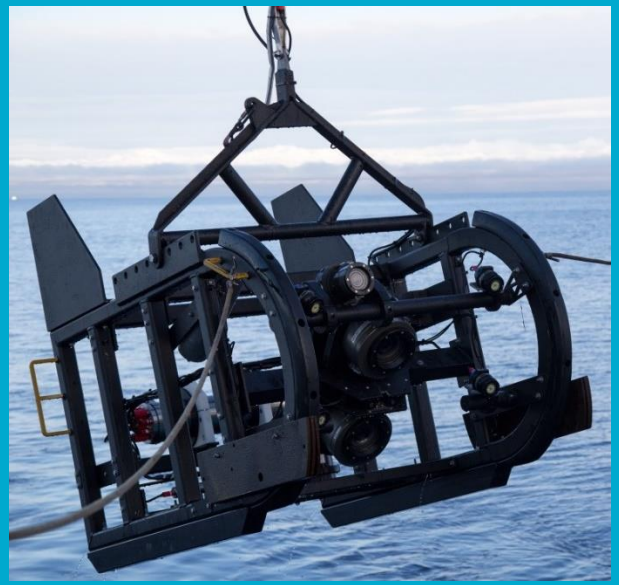



Multiple Platforms on a Fibre Optic Towed Cable

Aaron Tyndall | Seagoing Electronics Technician

16th October 2018

Content

- Platforms deployed
- RV Investigator Towed Body Cable
- Physical and operational demands of the cable
- Communication
- Terminating/Splicing
- Faults, loss and troubleshooting
- Future development

Platforms Deployed:

Triaxus

Deep Towed Camera

EZ Net

Drop Camera

Triaxus - MacArtney

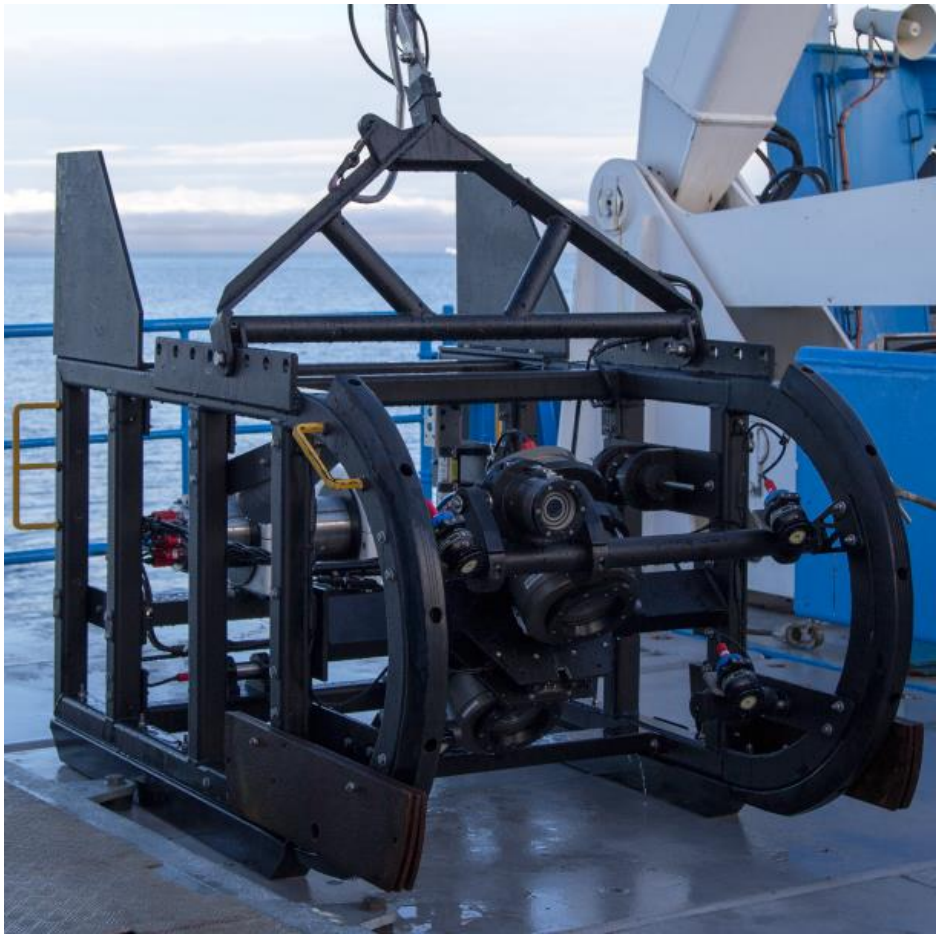
Profiling CTD

- Light weight ~ 150 kgs
- High Speed 6-8 kts
- Highly dynamic
- Gigabit Ethernet and High Speed Serial

Deep Towed Camera

HD video and stills

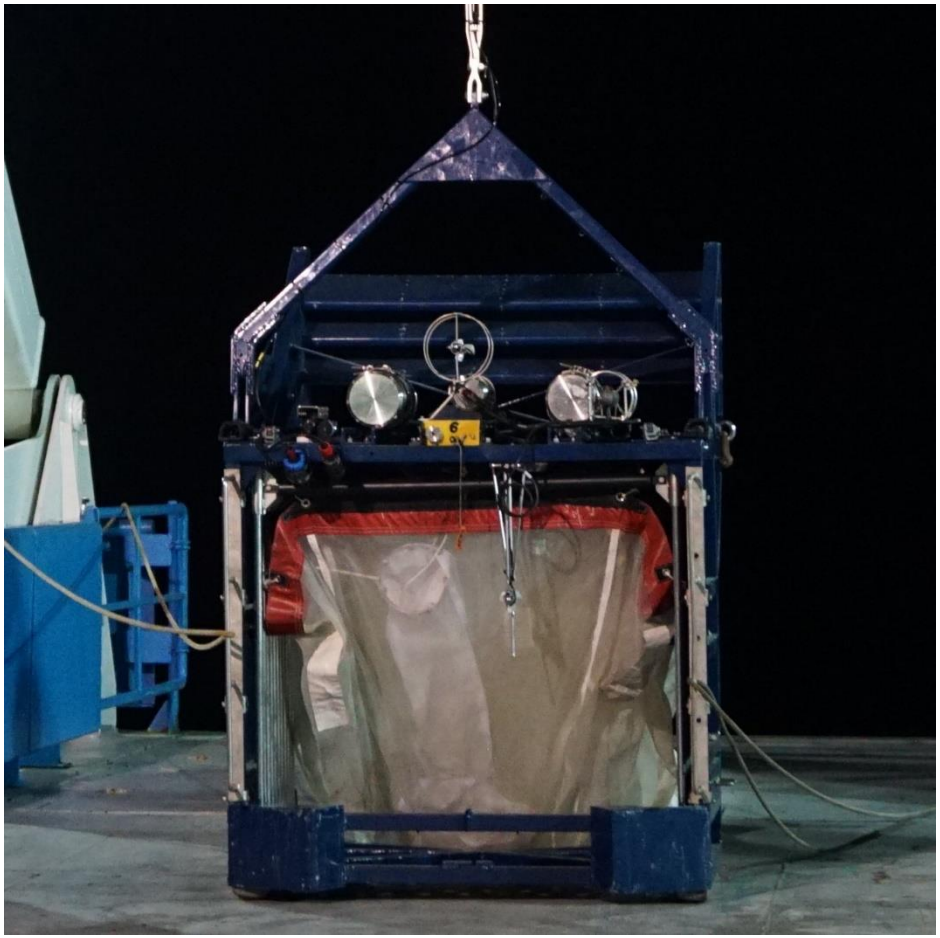
- Medium Weight: 500kgs
- Low Speed 1-2 kts
- Moderate movement in water
- Gigabit Ethernet and HDSDI Video



EZ Net

Concatenating plankton net sampler

- Heavy Weight: 900kgs
- Low Speed 2-3 kts
- Low movement in water
- Gigabit Ethernet



Drop Camera

SD video

- Light Weight: 80kgs
- Stationary deployment
- Low movement in water
- Gigabit Ethernet

Fibre Optic Cable:

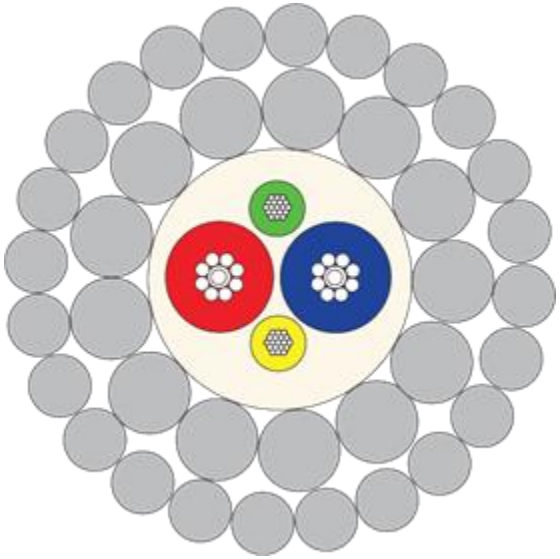
RV Investigator Towed Body Cable

MacArtney Termination

RV Investigator Towed Body Cable

Rochester A305382

- 2 x 8.8/125/245 µm SM Fibres
- 2 x 18 AWG: Power
- 2 x 24 AWG: Unused
- Working Load – 15kN
- Peak Working Load – 24kN
- Breaking Strength – 71kN



RV Investigator Towed Body Cable

MacArtney termination

- 1 x FO Bulkhead
- 1 x Power Bulkhead
- Approx. 23kg in air
- 400m max depth
- 6000m max depth with oil compensator

FO Cable: Physical Demands

Agility vs Strength

Weight vs Length

Fairing

Platform Deployment Guidelines

Agility vs Strength

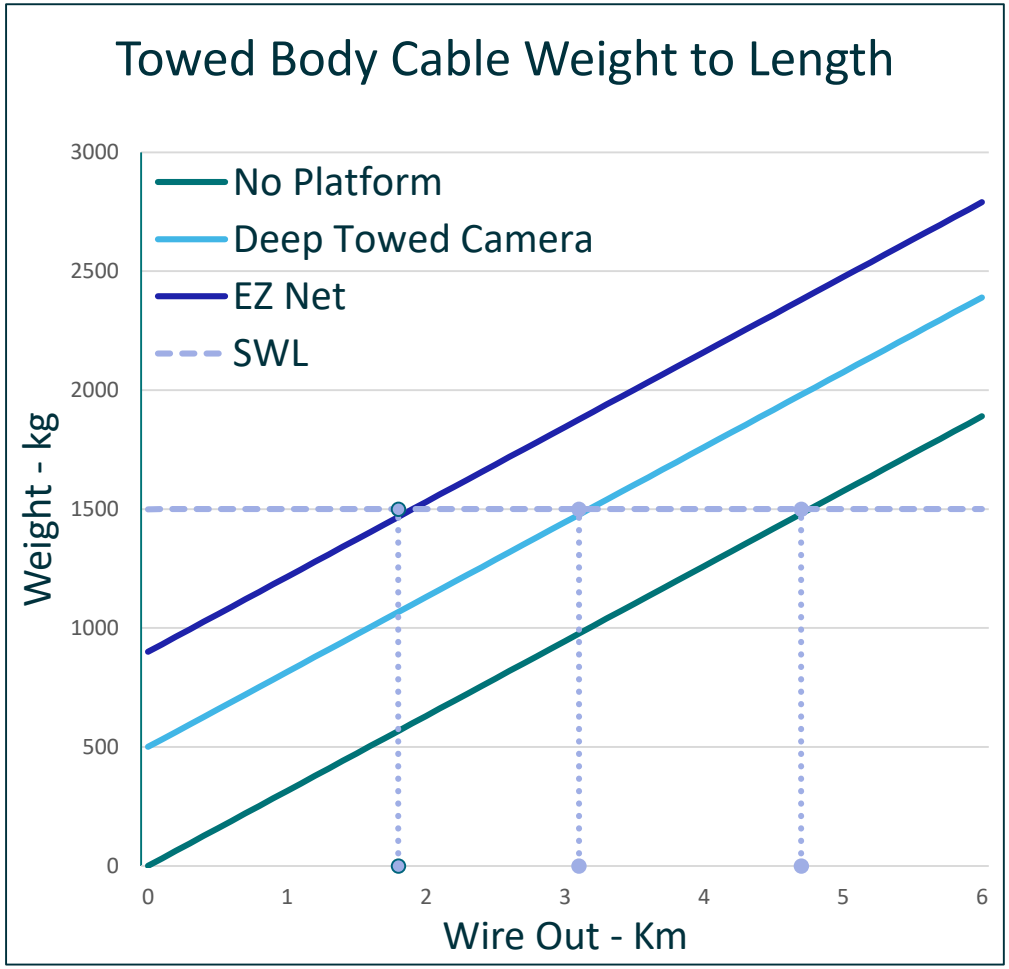
The trade-offs

- Pros:
  - Light weight enables high manoeuvrability of platforms
    - Triaxus
  - Light weight improves ease of handling on deck
- Cons:
  - Low strength limits sea state of heavy platforms
    - EZ Net
  - Low strength inhibits deployment of some platforms
    - Multicorer
    - Integrated Coring Platform

Weight to Length

Deployment limitations

- A305382: 315 kg/km
- SWL ~ 1500kg
- Total Wire length: 6000m
- Max wire out:
  - No platform – 4800m
  - Deep Towed Camera – 3200m
  - EZ Net - 1900m



Fairing

The search continues . . .

- Triaxus requires 100+m fairing to reduce strumming at speed
- Inserted
  - Rubber/poly derivative – disintegrated from use
  - Sail material – worked but accelerated cable degradation

- Wrapped
  - Rubber/poly derivative - damaged by sheaths

Platform Deployment Guidelines

A rule for each and each to their rule

- Triaxus
  - Deployable up to Sea State 4
    - Retrieval is the limiting factor
- Deep Towed Camera
  - Deployable up to Sea State 4
    - Max depth 2500m due to cable load rating
- EZ Net
  - Deployable up to Sea State 3
    - Max depth to 1000 due to cable load rating, especially with ship heave
- Drop Camera
  - Deployable up to Sea State 4
    - Minimum ship heave required to get close to sea floor.

Communication

Ethernet

Ethernet + HDSDI

Ethernet + High Speed Serial

Ethernet

10/100/1000M gigabit ethernet

- SFPEX – SFP-RJ45-GEA
  - Low Cost
  - Interchangeable SFP Modules
  - Universal Main Module
  - Single Channel
  - Limited monitoring capacity

Ethernet + HDSDI

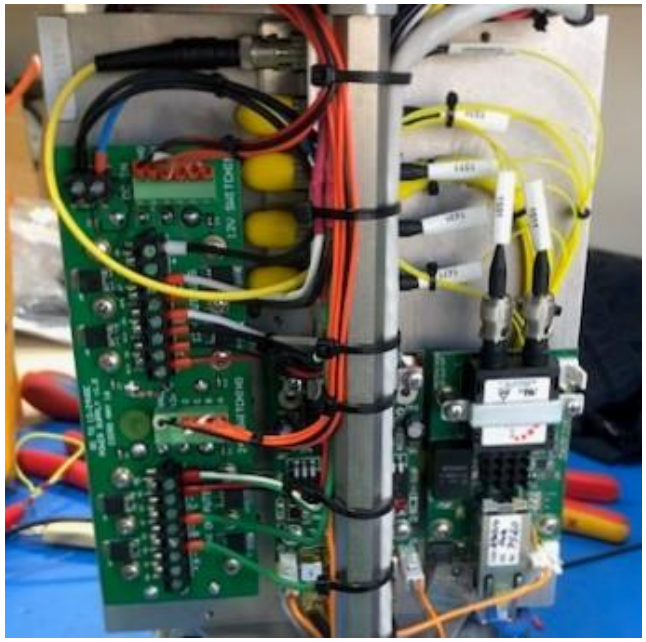
Gigabit ethernet & HDSDI video

- Moog/Focal – 907-FLEX
  - High Cost
  - Interchangeable SFP Modules
  - Dedicated console and remote boards
  - Multiple Channels
  - Limited built-in signal monitoring capacity

Ethernet + High Speed Serial

Gigabit ethernet and multi-channel RS232

- MacArtney Triaxus – Cypress 10 and Giga E2P
  - Medium Cost
  - Static functionality
  - Proprietary PCB boards and modules
  - Multiple Channel Options
  - Some built-in signal monitoring capacity



Connection

One cable to rule them all.

- Bottom end
  - All platforms connect to MacArtney Triaxus termination
  - All power and fibre connection standardised
    - Ease of use
    - Minimise spares
    - Reliance on one supplier
- Top end
  - Independent interface unit’s in same rack
  - Fibre optic and power fly leads
  - Standardised power and fibre connections
    - Industry standards
    - Minimise spares

Terminating and Splicing

Termination

FASTConnect

Fusion splicer

MacArtney Termination

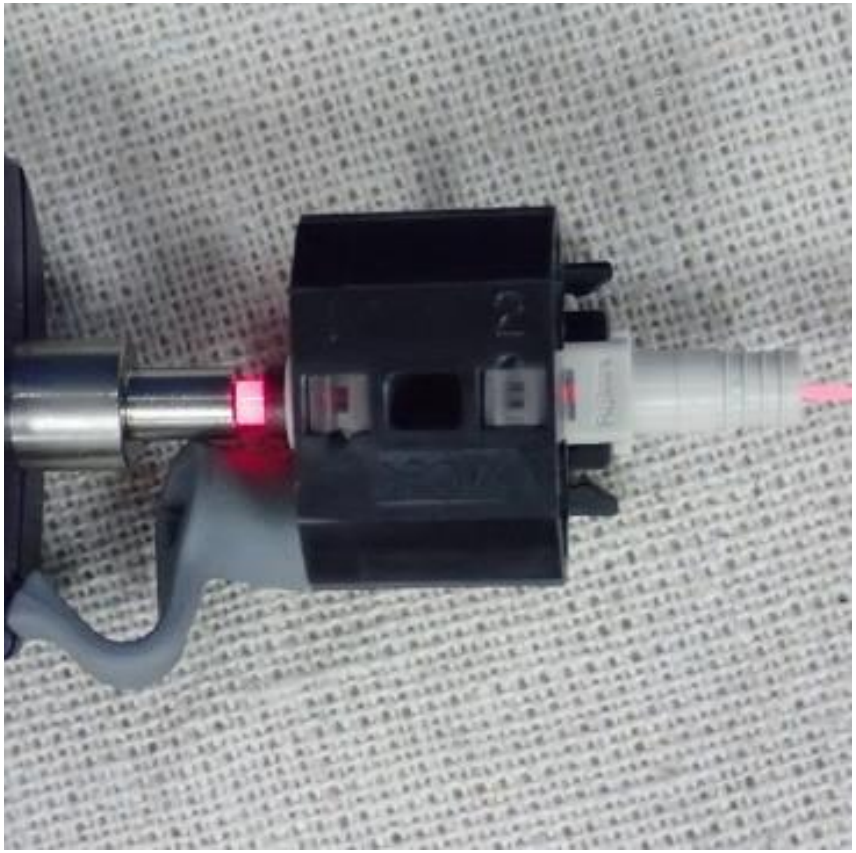
Easy to use, hard to build

- Pros:
  - Hydrodynamic
  - Easy to handle
    - No pinch points
  - Easy to change between platform
    - Plug and play (sort of)
- Cons:
  - Re-termination procedure
    - Complex
    - Time consuming
  - Unable to inspect without re-term

FASTConnect

Manual splicing

- Pros:
  - Quick, simple procedure
  - Low exposed surface area
- Cons:
  - Hard to get low loss
  - Inconsistent results



Fusion Splicer

Automatic splicing

- Pros:
  - Repeatable, low loss splice
  - Automatic with error checking
- Cons:
  - Complicated procedure
  - Large exposed surface area

Faults, Loss and Troubleshooting

Cleaning

Source/Meter

OTDR

Case Study: Same fibre, different frequency, different loss

Cleaning

Chasing 9µm bits of dust and grease

- Over 50% of fibre losses/problems rectified by cleaning
- Handy tools
  - Fibre Optic Pen Cleaner
  - 2.5mm Fibre Optic swab
  - 1.25mm Fibre Optic swab
  - ISO wipes

Source /Meter

First step in fault identification

- The first test is an end to end continuity test
- Step through at each connection to locate loss point
- Pros
  - Quick and easy to use
  - Easy connector exchange
  - Verify splice/FASTConnet
  - Verify media card output
- Cons
  - Hard to test submersible cables
  - Need to test the tester

OTDR (Optical Time Delay Reflectometer)

Next step for complex faults

- Provides a detailed trace of entire fibre run
- The main method to identify fault in tow cable
- Pros
  - Able to identify faults inside cable
  - Able to identify hard to access faults
- Cons
  - Complicated to setup and use
  - Designed for Telecommunications Networks
  - Multiple connections inhibits consistent results
  - Difficulty testing short fibre cables

Miscellaneous

Other faults and challengers found

- Faulty/incorrect ST-ST couplers
- Broken ceramic mating sleeves in submersible bulkheads
- Fitting fibre optic connection in small pressure cases
- Fusion splicing a Towed Body Cable with minimal exposed fibre
- Keeping submersible fibre optic connections clean in a salt water environment

Case Study

Different losses for different wavelengths

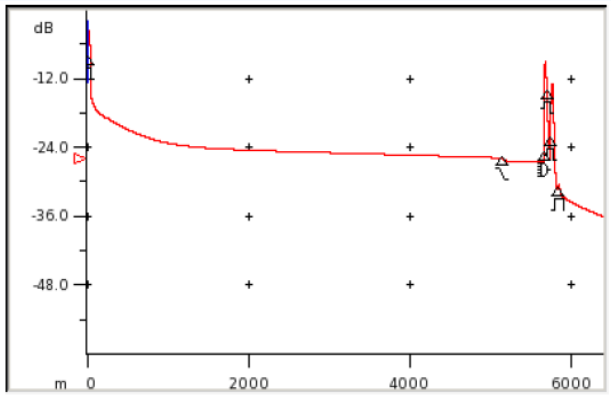
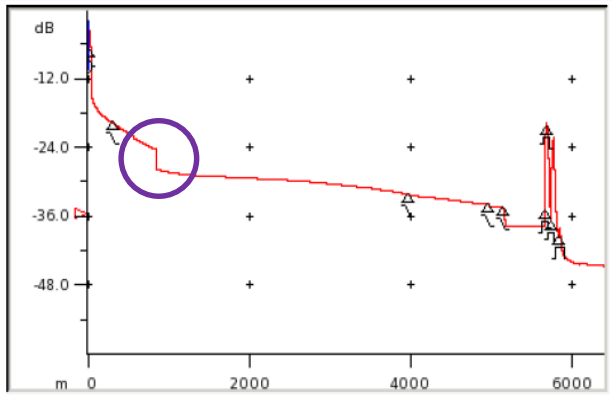
- Upgrading the Triaxus system with an ethernet connection identified fault in Towed Body wire
- Ethernet card with lower max loss would not work though original serial card still functioned normally
- Source/Meter test showed no problem though known difference between 1310 and 1550 wavelengths was evident
- Retermination, cleaning and physical inspection of fibre did not identify/rectify a fault

Case Study

Different losses for different wavelengths

- OTDR readings identified an anomaly in the fibre, 500m from the drum

OTDR Trace

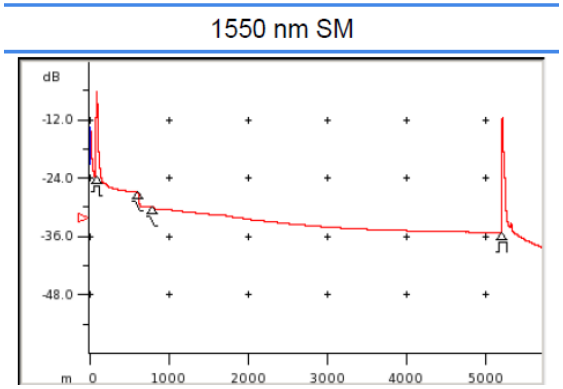
1310 nm SM	1550 nm SM
	

- Minimal experience with the OTDR decreased confidence in result
  - Was anomaly operator error or true artefact?

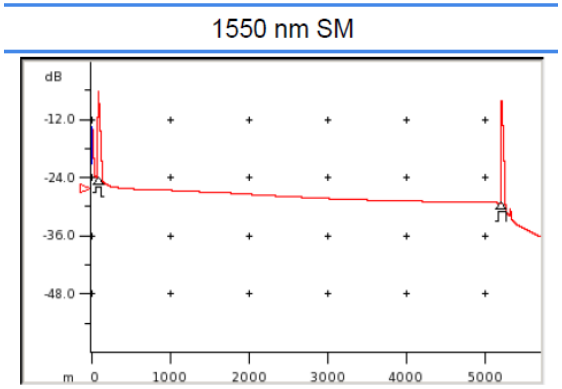
Case Study

Different losses for different wavelengths

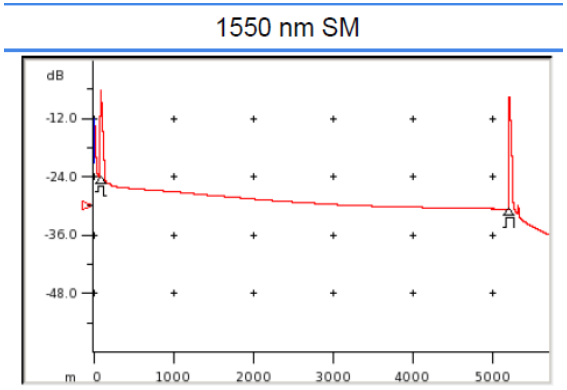
- The Towed Body wire was stream out behind the ship past the ~500m anomaly
- OTDR readings were taken before, during and after streaming



Before Streaming



During Streaming



After Streaming

Case Study

Different losses for different wavelengths

- Conclusion
  - The artefact was likely due to torque/strain in cable while on drum
    - unknown whether this has always been evident or caused during a deployment.
  - This particular fault would have been difficult to confidently identify and remedy without an OTDR
  - The technical team learnt there can be significant differences between frequencies
    - a source/meter result on one wavelength does not mean cable is problem free.
  - Further investigation and training in OTDR functionality would be beneficial

Future Developments

Heavy Duty Towed Body Wire

OTDR Integration

Other

Heavy duty Towed Body wire

Heavy weight platforms and instrumented coring

- An additional heavy duty Towed Body wire is required to increase the capability of the RV Investigator
  - Increase the depths current platforms can de deployed
    - EZNet: +1000m and larger sea states
    - Deep Towed Camera to 6000m
  - Deploy instrumented coring platforms
    - ICP and Multicorer
  - Put a camera on ‘everything’
- Currently investigating options
  - Steel/Synthetic
  - Permanent/demountable
  - Desired capacity

OTDR integration

Live fibre monitoring

- Investigating the ability to operate the OTDR on the towed body wire during a deployment:
  - The OTDR only operates on 1310nm and 1550nm
  - Investigate whether platform medium converters can use alternative frequencies
    - 1310nm and 1550nm are standard frequencies that most SFPs operate on
- Benefits:
  - Identify or exclude fibre issues as the root cause of communication problems during a deployment.
  - Monitor the fibre characteristics of the cable under load during a deployment.

Other

More changes

- In-line wire washing system
  - Reduce the degradation of the cable
- Identify and test other fairing options
  - Doesn’t intensify cable degradation
  - Robust enough to withstand constant handling
  - Slim-line enough to fit through wire management system
- Investigate alternate termination options
  - Easier to install
  - Ability to be inspected
  - Proven reliability

Thank you

Oceans and Atmosphere
Aaron Tyndall
Seagoing Electronics Technician

t +61 3 6232 5240
e aaron.tyndall@csiro.au
w www.csiro.au/en/Research/OandA

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