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Subsea Ethernet-based communication

Ichthys LNG case study

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Ichthys LNG is a joint venture between INPEX group companies (the Operator), major partner TotalEnergies, and the Australian subsidiaries of CPC Corporation Taiwan, Tokyo Gas, Osaka Gas, Kansai Electric Power, JERA and Toho Gas.



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Ichthys Field introduction

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- Final Investment Decision for Ichthys LNG was reached in 2012 and production commenced in 2018.
- Ichthys LNG is expected to produce 9.3 million tonnes of LNG by 2024 and 1.65 million tonnes of LPG per annum, along with more than 100,000 barrels of condensate per day at peak.
- Operational life of around 40 years.
- Incorporates the whole chain of development and production: subsea, offshore, pipeline and onshore.



Ichthys LNG



Ichthys Subsea Control System overview



Ichthys subsea assets - six producing drill centres and two more in construction phase. More to come...

Key Subsea Control System communication concepts for Ichthys Field:

Transport	TCP/IP or UDP/IP depending on application			
Internet	• IPv4			
Network interface	 100BASE-SX / TX Ethernet – Full duplex Long-range fibre Ethernet lines / single mode "Bidi" (topside to subsea) Ethernet on copper to Subsea Control Module Ethernet backbone within Subsea Control Module 			
Topology	Point to point (topside to subsea)Star topology at the drill centre			

Limited track record existed at that time of the concept select stage. Ichthys was to be one of the first to realise an area wide Ethernet network subsea (towards the 100m range).

Ichthys Subsea Control System overview





Concept selection and Ethernet development program

A mature technology – at least for topside IT application.

Why we selected an Ethernet-based communication?

System robustness / fault Performance Increased availability / open **Availability** source products, condition Life cycle cost Ethernet-based communication

- High bandwidth / increased • amounts of data at faster rates
- Prioritisation of traffic / safety ٠ in execution
- Obsolescence / backward-• compatible replacement systems
- Future proofing / easy connection of • almost any application.

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tolerance

monitoring

Problem statement

The industry standard for Ethernet, IEEE802.3, recommends a maximum Ethernet segment length of 100m.

INPEX kicked off an Ethernet development program with key suppliers to overcome the Ethernet connectivity challenges.

Program phasing

• Phase 1: Unit level testing

Ethernet flying leads only (from multiple suppliers). Active and passive types.

Phase 2: System level testing

EFL integrated within distribution system (incl. Control Modules) with a selected OEM for multiple segment length.





Ethernet development program

Methodology - Phase 1

Evaluate the performance of the flying leads with specified arrangement/type, lengths and data rates for different suppliers. Types as below:



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Results and	conclusion -	Phase 1
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				Results		
Test number	Length, Description	Ethernet Data Rate	Supplier	Data Test @ 100Mb/s Full Duplex	Cable Test (compliance to IEE802.3)	
1	100m, Point-to-Point	10 & 100Mb/s	1 & 2	PASS / FAIL	PASS / FAIL	
2	60m, Point-to-Point	10 & 100Mb/s	1 & 2	PASS	PASS	
3	100m, Integrated	10 & 100Mb/s	1 & 2	PASS	FAIL	
4	150m, Integrated	10 & 100Mb/s	2	FAIL	FAIL	
5	150m, Media converter	1Gb/s	2	PASS	N/A	

- 1) Ethernet EFL design with high grade Ethernet Cat 5e or 6 cables are capable of supporting Ethernet communications transmitted at 100Mb/s full duplex up to a length of 100m.
- 2) Workmanship is important to ensure compliance with specified speed test.

Methodology - Phase 2

Evaluate the performance of the system (incl. SEM and Router Module) with specified lengths with different suppliers as below:





Results and conclusion - Phase 2

The following performance indicators were monitored throughout the testing:

- Cable testing (Insertion Loss / Return loss / NEXT)
- Data streaming parameters (Latency / throughput / Ethernet devices buffering capability / frame loss).

			Results	
Test number	Length	Supplier	Cable testing	Data streaming
1	88 m	1 & 2	PASS / FAIL	PASS
2	108 m	1 & 2	FAIL	PASS
3	115 m	2	FAIL	PASS
4	128 m	1	FAIL	PASS
5	148 m	1	FAIL	FAIL

Main conclusion

Ethernet devices can establish a performant and stable communication path beyond 100m using 'typical' subsea equipment.

Use of active flying leads

But what if we still need to run it further than that?

Then signal repeaters or media converters are readily available.

A flying lead with a mid-line repeater was qualified for Ichthys and currently in operation.

Advantages:

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- Completely transparent as the device is operating on OSI Layer 2
- Compact design which is fully retrievable
- Data streaming performance maintained throughout the segment.

It can be used to connect older generation systems to more advanced products.







Operate phase - benefits

Performance

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- Reliable communication Frame Loss Ratio better than API17F requirement
- Performed system wide firmware and software upgrades in a limited shutdown deployment window
- Ability to acquire fast data during transient well operations and use of automated application to control subsea assets.

Availability

- Electronics failures have not resulted in any production availability impacts due to ability of the system to reroute traffic
- Increased flexibility during interventions where segments of the network can be isolated with redundant legs still offering full duplex comms
- Condition monitoring of the system hardware health and production envelopes via fast and comprehensive data acquisition → including improvement for future.

Life cycle cost

- Obsolescence risks proactively managed without impact on production
- Extensive use of operational decision support system (ODSS) tools.



Future - evolution

Ichthys Field opportunities

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- Capitalising on the plug and play capability to support future extensions
- Support digital / IIoT solutions deployment
- Expand on condition monitoring by implementing diagnostic tools based on AI in the historian system
- Undertake further Ethernet development programs (Single Pair Ethernet / Time Sensitive Networking / Ethernet to the field and instrument / one network for everything!).

Ethernet is now a mature solution for subsea application and will be crucial to handle increased data volume, to allow increased AI usage and to provide increased productivity.



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Thank you

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