Dynamic Positioning Committee
Marine Technology Society

DYNAMIC POSITIONING CONFERENCE

OCTOBER 9-11, 2017

SENSORS

Why choosing an acoustically aided INS is not just a tick box exercise

Mark Carter
Sonardyne

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DYNAMIC POSITIONING CONFERENCE,
SENSORS SESSION
October 10-11, 2017

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Why choosing an acoustically aided INS is not just a tick box exercise

Where is inertial navigation used?

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ACOUSTIC DP REFERENCE

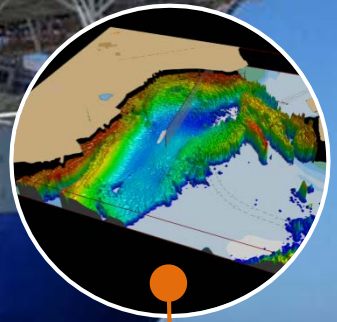
ACOUSTIC CONTROL

INERTIAL DP REFERENCE
GYRO AND MRU

SURVEY OPERATIONS

ACOUSTIC MONITORING

ROV TRACKING

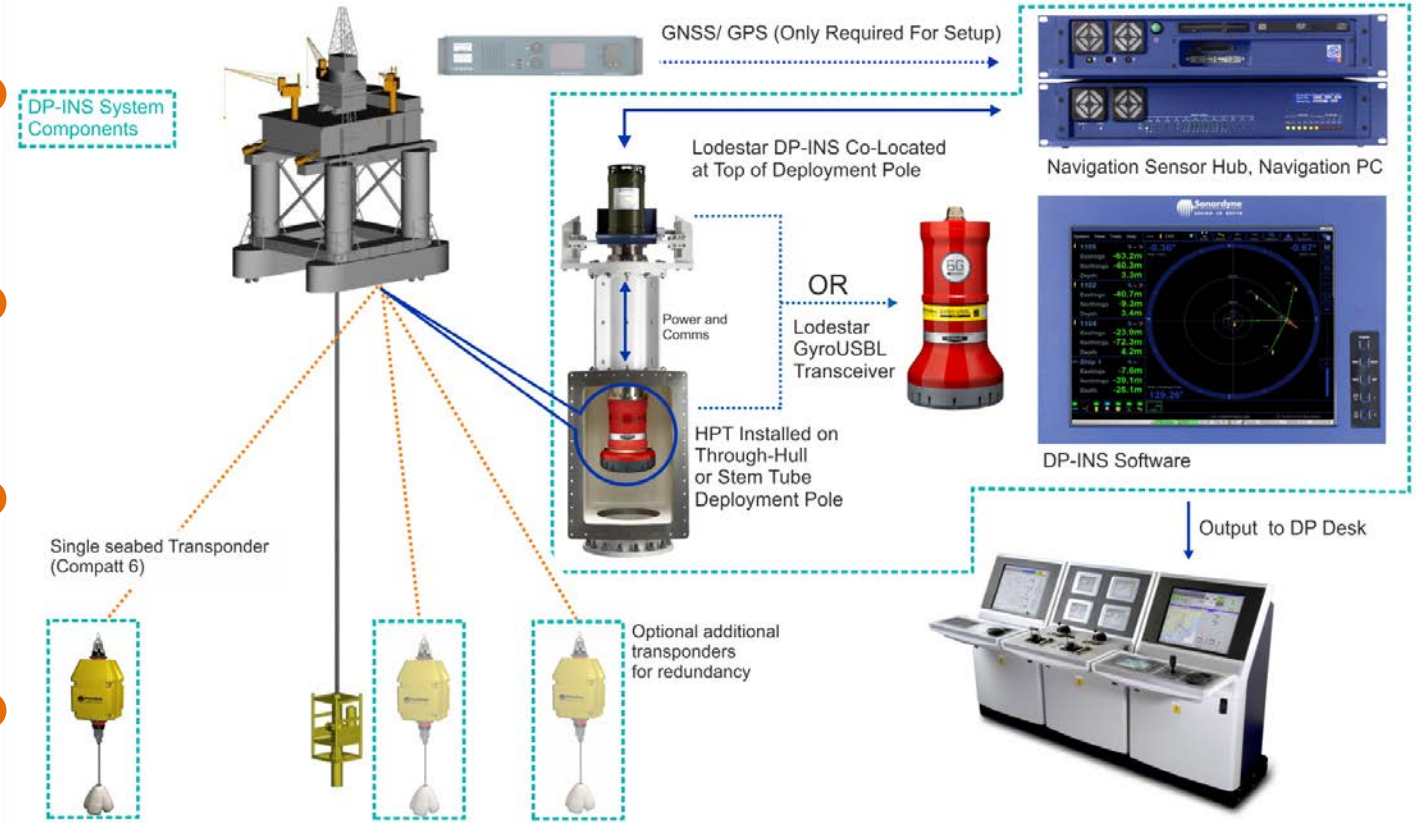


NAVIGATION OBSTACLE
AVOIDANCE SONAR

Why choosing an acoustically aided INS is not just a tick box exercise

Standard configuration

- 1 second or faster update to the DP
- Accuracy and repeatability equal to GNSS
- Bridges acoustic outages
- Operationally efficient due to fewer seabed references



Why choosing an acoustically aided INS is not just a tick box exercise

Typical specification

Ride through capability?

Seabed Transponders?

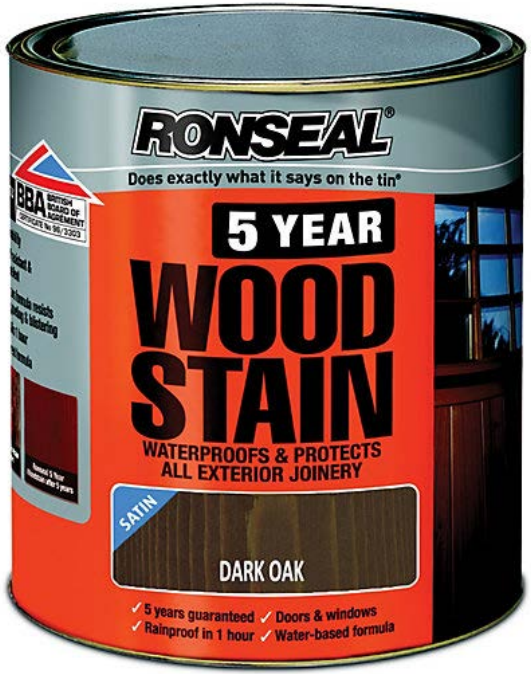
4.2.5 惯性导航系统 Acoustic Inertial Navigation system

这个系统应与 HPR 有接口，并连接至主动力定位系统 One system to be interfaced with the HPR and connected with the main DP system

Loose or tightly coupled?

Physical installation?

Typical specification



Left to chance INS does NOT do "exactly what it says on the tin"

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Is the performance you expect going to be delivered?

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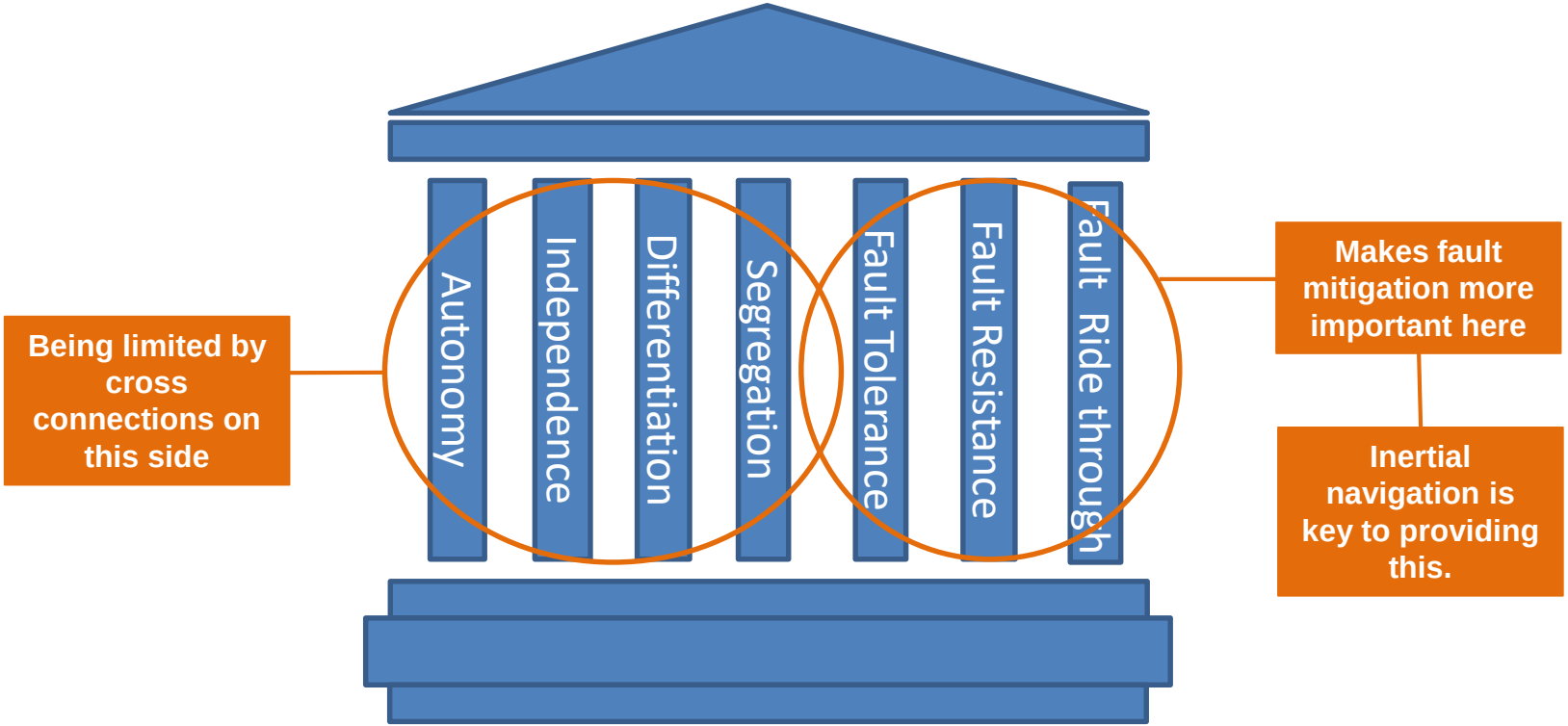
7 pillars of DP applied to an acoustic PME



Technical And Operational Guidance (Techop) Techop_ODP_14_(D) (PRS And DPCS Handling Of PRS), September 2017

Definitions used in the PRS TECHOP

Loose coupling:

- The “Position” output from the GNSS or Acoustic system is used to aid, or couple with the INS. A loosely coupled system will reduce noise (USBL smoothing), increase update rate (LBL-INS) and bridge brief gaps in positioning. The performance depends on the GNSS or Acoustic system’s ability to compute both a position and reliable quality metrics for use in weighting within the combined solution.

Tight coupling

- Tight coupling is a term used to describe systems where the raw GNSS or raw Acoustic observations are used to aid, or couple with the INS. With this level of coupling the integrated solution has full access to the associated low level quality metrics from the specific PRS in their native format and with effectively perfect timing. Tightly coupled solutions are less impacted by the degradation of GNSS or Acoustic systems as the combined solution is not dependent on a standalone position.

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"tightly coupled" integration is key

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Lodestar Acoustically Aided INS – AAINS

IMU:
Inertial Measurement Unit

IMU Data
100-200Hz
Δv, Δθ

AINS: Aided INS

INS: Inertial Navigation System

Δv → Velocity → Position

Δθ → Orientation

Acoustic INS Position

Correction

Kalman Filter (error state)

Tight Integration ✓

Loose Integration ✗

Raw USBL Measurements: Phase (Bearing), Travel time (Range), SNR,...

Acoustic Positioning System

Acoustic Position

Dynamic Positioning System

Measurement types

Sensor type	Loosely Coupled	Tightly Coupled
GNSS	GNSS geographical position	Ephemeris and Pseudo range data
Acoustic	Cartesian (X,Y,Z) Polar (r,φ,λ)	Raw range, direction, quality data
Velocity log	Velocity X,Y,Z	Individual beam level velocity

What vessel acceptance tests can be done?

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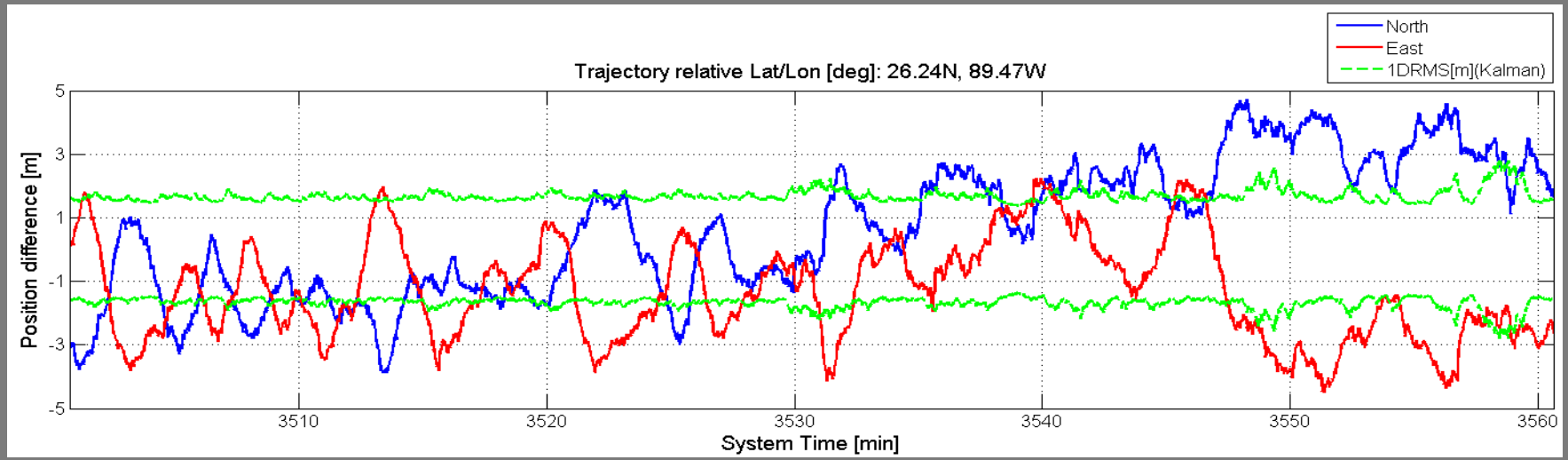
Test 1 : Good acoustic aiding



- Standalone USBL data likely to be rejected by DP if a single transponder used in deep water
- A correctly configured INS will improve the precision of the acoustic data in deep water
- Accuracy of <2m (<0.08% water depth) achieved using one transponder in 3,070m water
- “Smoothing” effect of INS adds Fault Resistance

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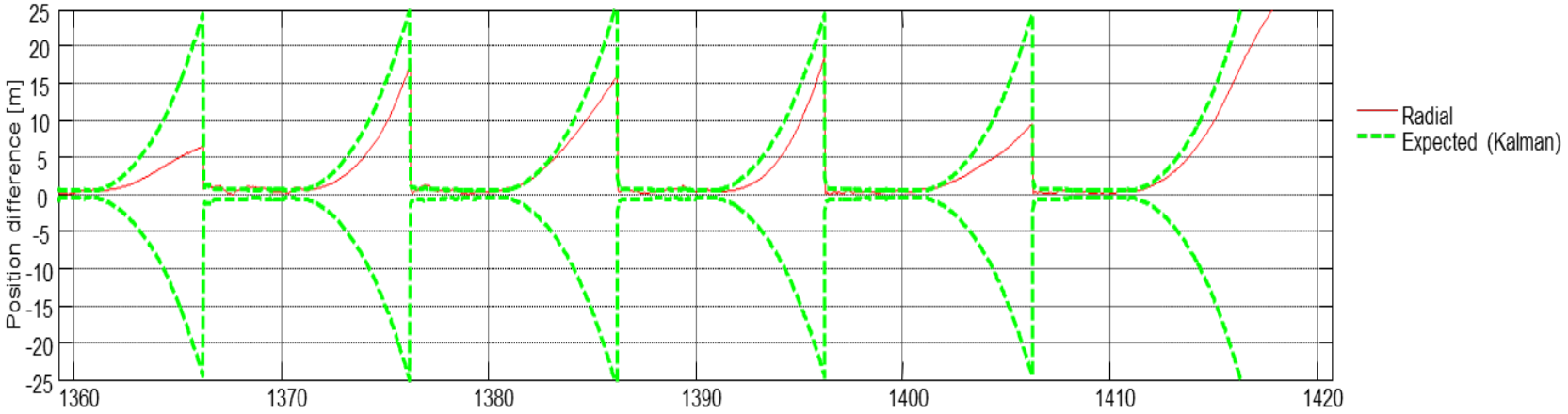
Test 2 : Free Inertial tests



- Free inertial tests need to be repeated a number of times as the true 2d radial error varies run to run.
- Provides a measure of the Fault Ride Through performance
- Checks error thresholds are appropriately set

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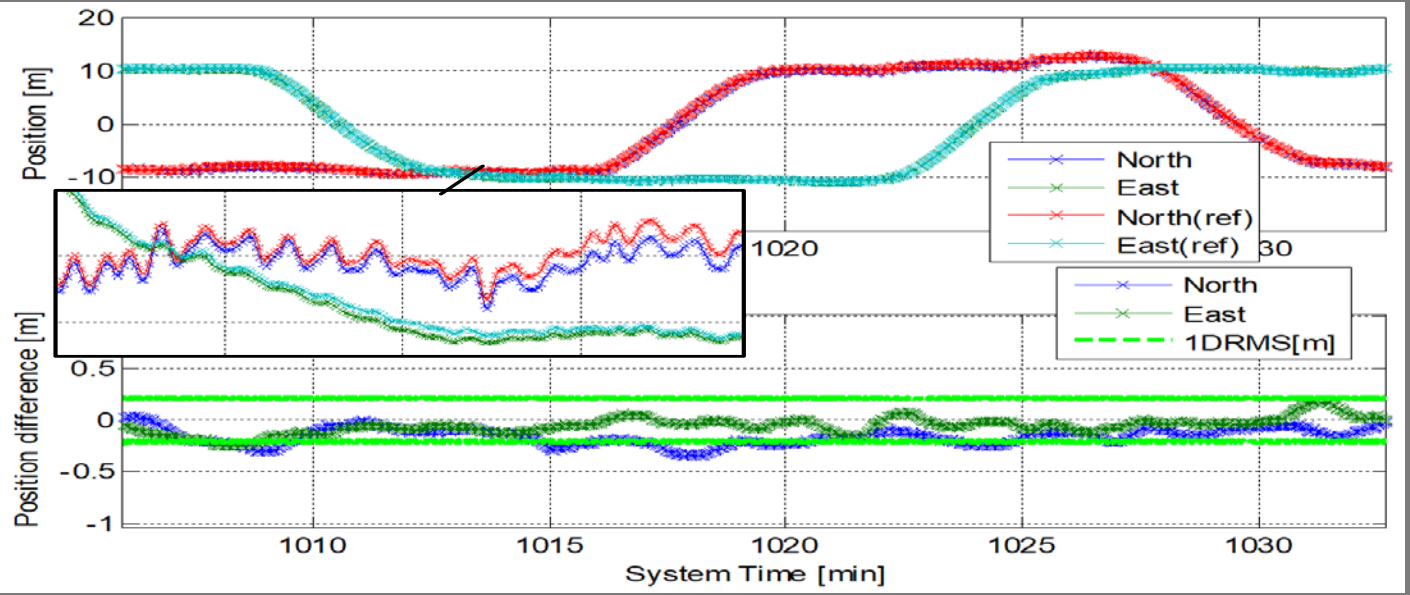
Test 3 : Degraded acoustic aiding



- Next, disable the elevation and bearing measurements using a test mode to simulate marginal acoustics
- Position should be accurate relative to GNSS with at least 2 or 3 seabed transponders - demonstrates fault resistance

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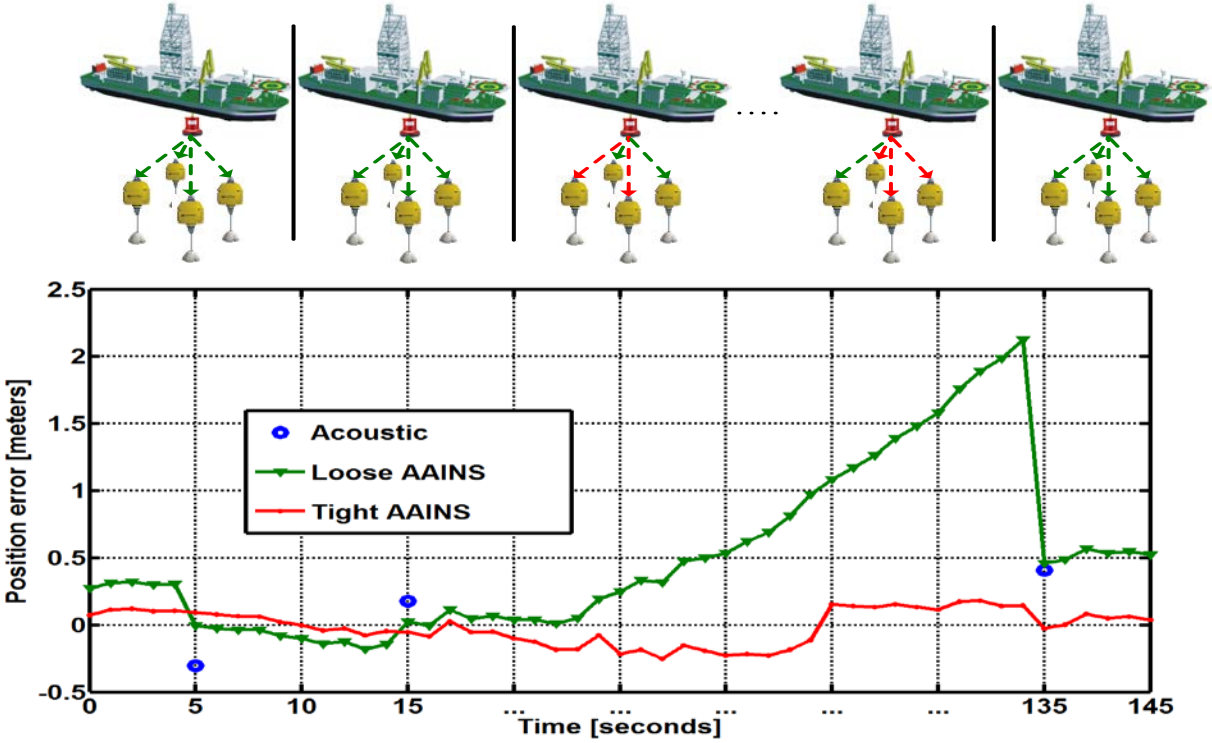
Fault Resistance of tight coupling



Red arrow in the top most illustrations indicates a failed acoustic measurement.

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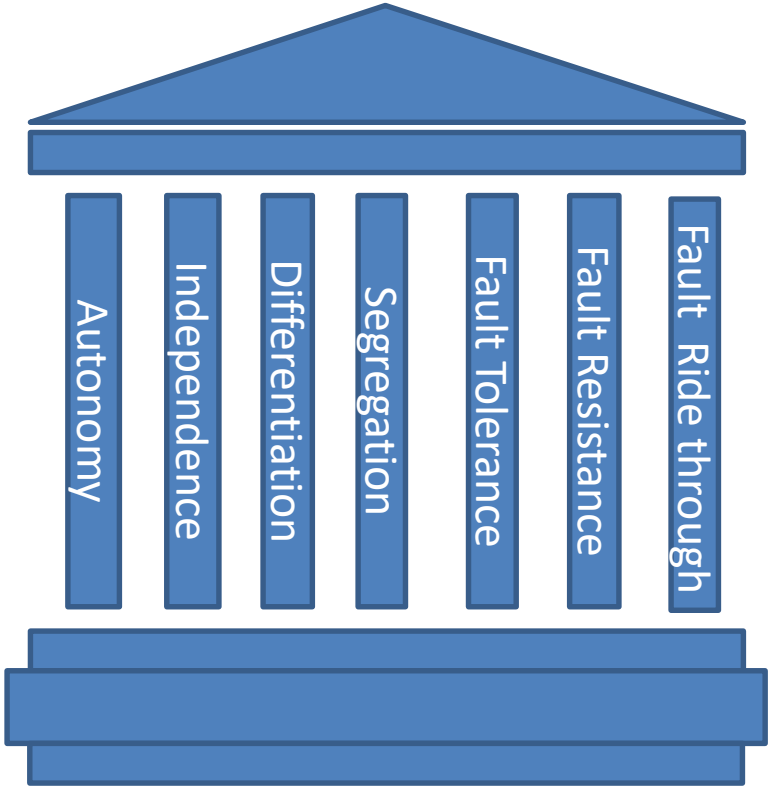
INS – enables efficiency savings



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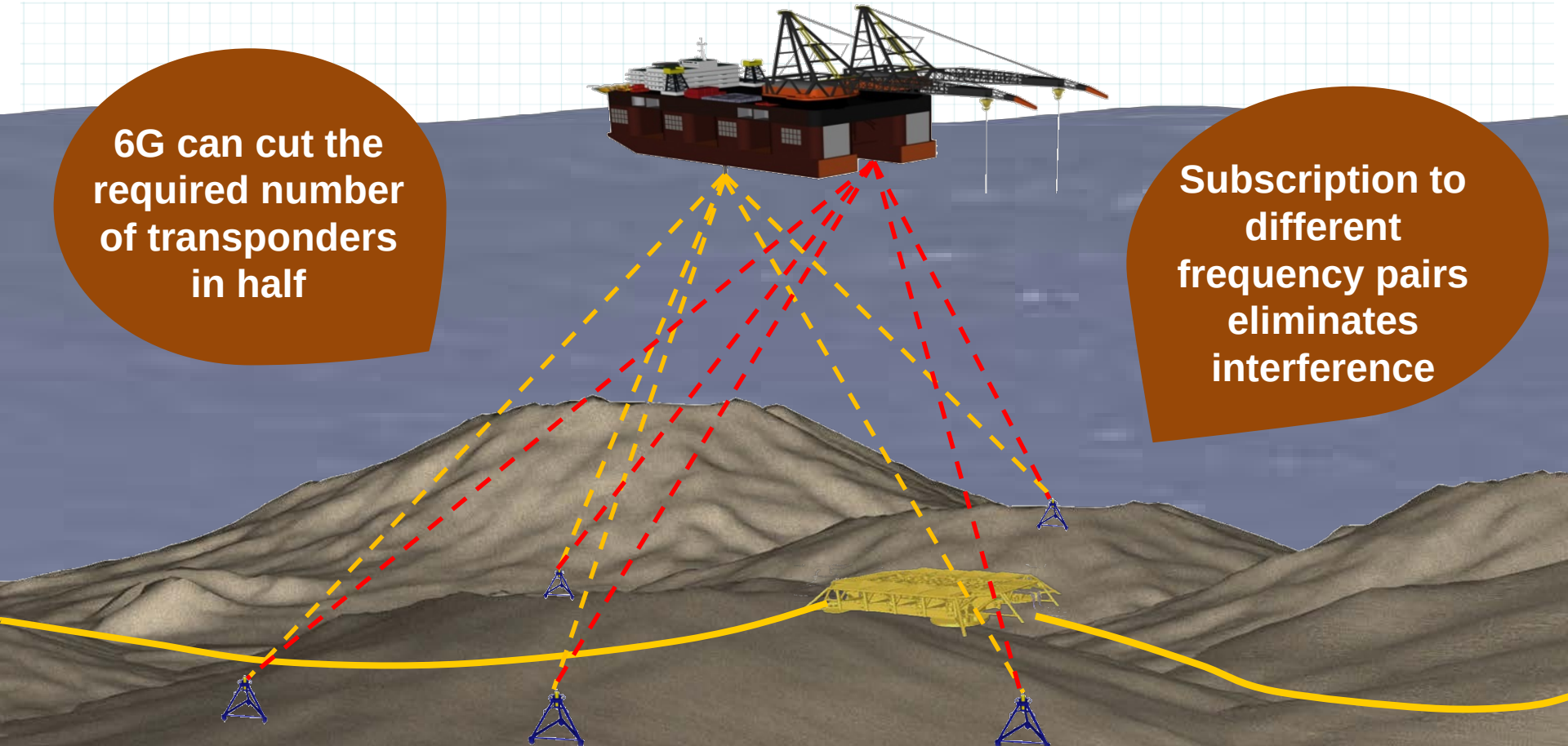
Shared 6G Arrays



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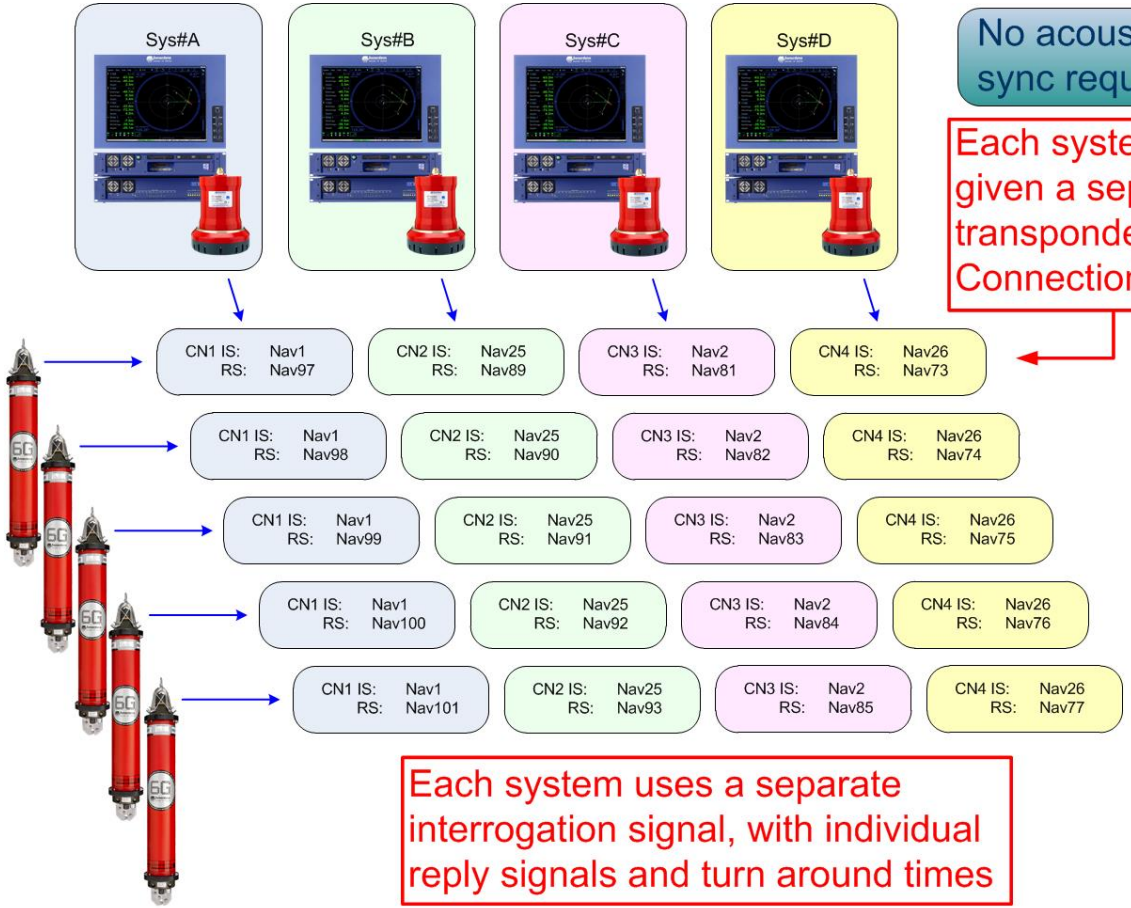
Multi-user operations



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Example Rig using a shared array

Acoustic Reference System	Original	L/USBL	DP-INS
Set-up	Dual Independent		
Generation	5G	6G	6G
Transponder type	Standard	Long life Multi User	
Acoustic Update rate	6	6	12
Deployment and calibration			
Number of transponders	10	5	4
ROV payload (tpdrs)	4	4	4
ROV trips	3	2	1
Average array set-up time (hours)	18	9	9
Number of wells per year	5	5	5
Annual deployment and calibration time (hours)	90	45	45
Time saved (hours)		45	45

Fault mitigation maintained

Fewer Seabed transponders

Save nearly 2 days rig time per year

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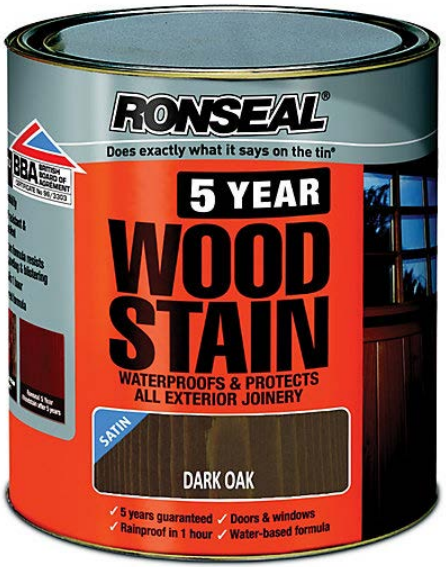
Key Points

SPECIFY and TEST

"it does exactly what it says on the tin"



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SUBSEA TECHNOLOGY

Thank you
Any questions?

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