Integrated Approach to Drilling Operations Planning Delivers a Step-Change in Efficiency for Deepwater and Harsh Environment

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wood.

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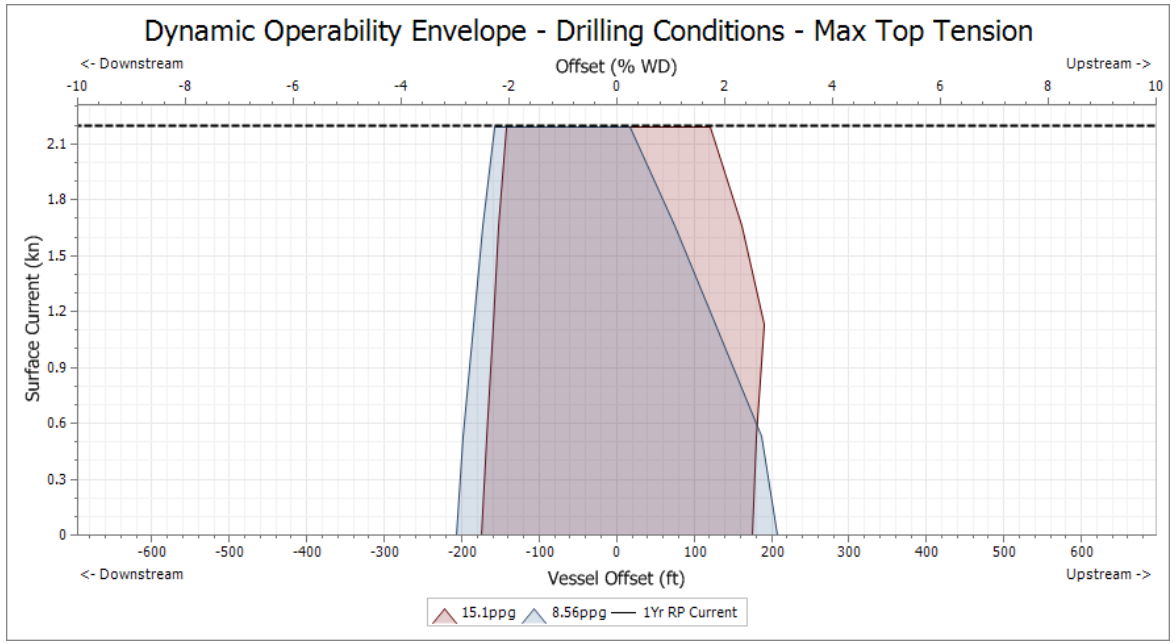
Introduction

- Deepwater / harsh environment drilling
- Commercial environment
- Integrity assurance
- Marine riser operations significant driver of weather-related downtime
- Requirement to optimize operations

The Traditional Approach: Fixed WSOG

- **W**ell **S**pecific **O**perating **G**uidelines
- Developed prior to drilling program
- Define limits for vessel and riser operations
- Verify feasibility
- Use *statistical* metocean inputs
- A necessary step, but …
- … may be too restrictive for deepwater / harsh environment
- *Wait on Weather* ⇒ *Increased Costs*



There is a better approach!

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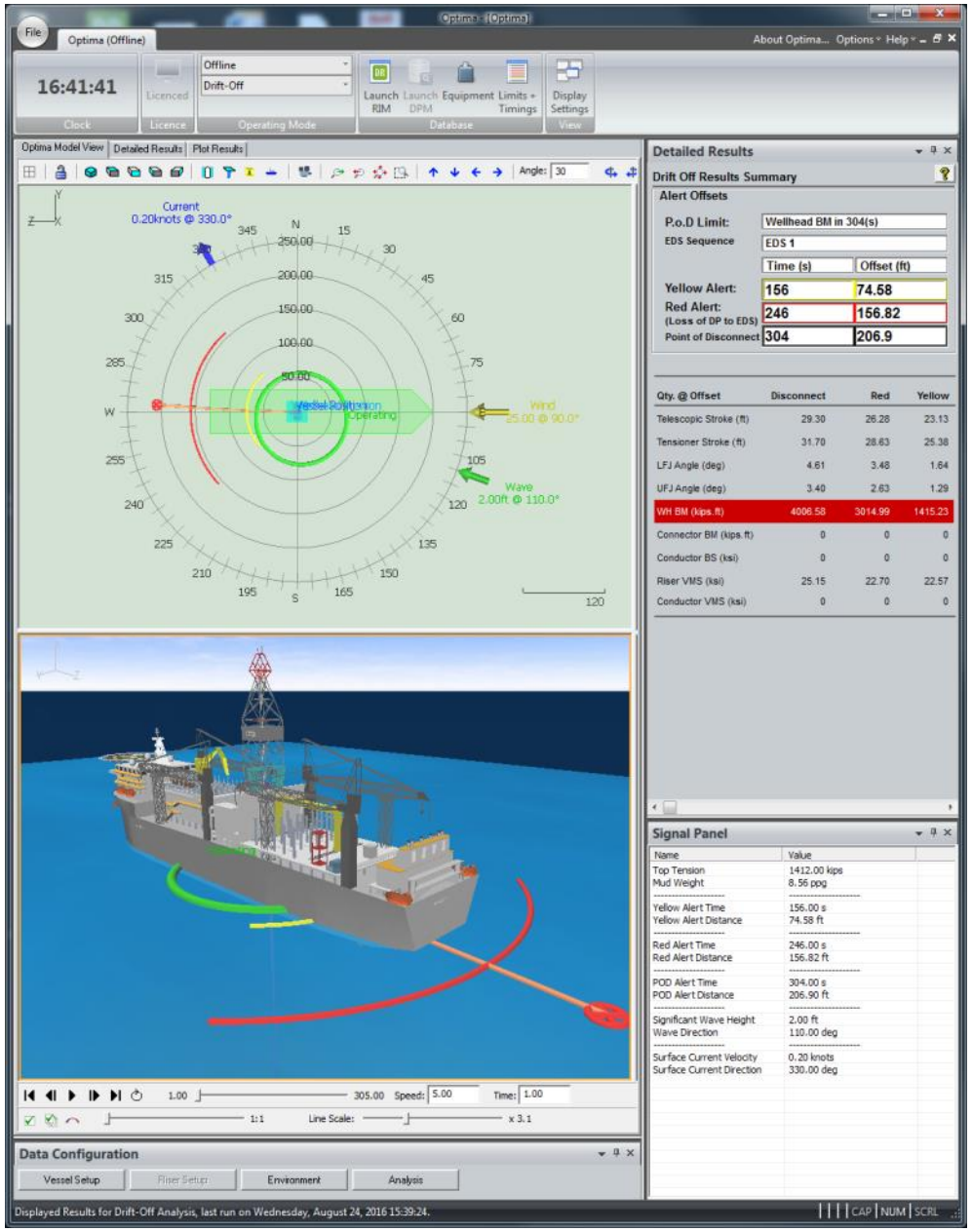
Forecast Analysis: "Live WSOG"

- Operational phase
- Combine metocean forecasts with riser simulation
- Confirm feasibility of planned operations
- Eliminates conservatism of fixed WSOG
- Continuous process – 24/7
- 12-hr, 24-hr, 2-day, 3-day, 1-week look ahead
- Informs critical decision-making
- "What if" scenario planning



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Forecast Analysis: Conductor Deployment

36" Conductor hang at Slips

Date (from)	Expected Duration to Complete (h)	Expected Time to Start (ID)	17/3/16 9:00	17/3/16 12:00	17/3/16 15:00	17/3/16 18:00	17/3/16 21:00	18/3/16 0:00	18/3/16 3:00	18/3/16 6:00	18/3/16 9:00	18/3/16 12:00	18/3/16 15:00	18/3/16 18:00	18/3/16 21:00	19/3/16 0:00	19/3/16 3:00
Hs (m)			1.7	1.7	1.7	1.7	1.8	2.0	2.1	2.2	2.1	1.9	1.8	2.0	2.5	3.1	3.5
Tp (s)			6	7	7	7	6	6	5	5	5	6	7	7	6	6	6
Current (m/s) from Full Current Profile Matrix.																	
P/U 36" CP shoe and pass throught rotatry table	3	**0**															
P/U & M/U 36" CP and RIW to 48m	3	3															
P/U & M/U 36" CP and RIW to 90m	3	6															
Rig down DP elevators, rig up slings and shackles, P/U & M/U LPWHH	3	9															
Land on padeyes, rig up DP elevators, P/U CP, cut and grind pad eyes, install deep swallow bucket, set LPWHH in RT	4	12															
Rig up 5" DP running (change inserts of elevators), run 5" cement stinger	2	16															
M/U LPWHHRT, P/U string, remove support bucket	2	18															
Pass LPWHH assy thrgh Rotary Table, Lock Mudmat to LPWHH, install 4x4" ball valves, splash LPWWHH	5	20															
RIW to 500m on 6"5/8 34#	2	25															
RIW to 1000m	2	27															
RIW to 1500m	2	29															
RIW to 2000m	2	31															

- Go Ahead
- Go Ahead - after re analysis performed
- Go Ahead - but close to stress limit of the pipe
- Limit Reached

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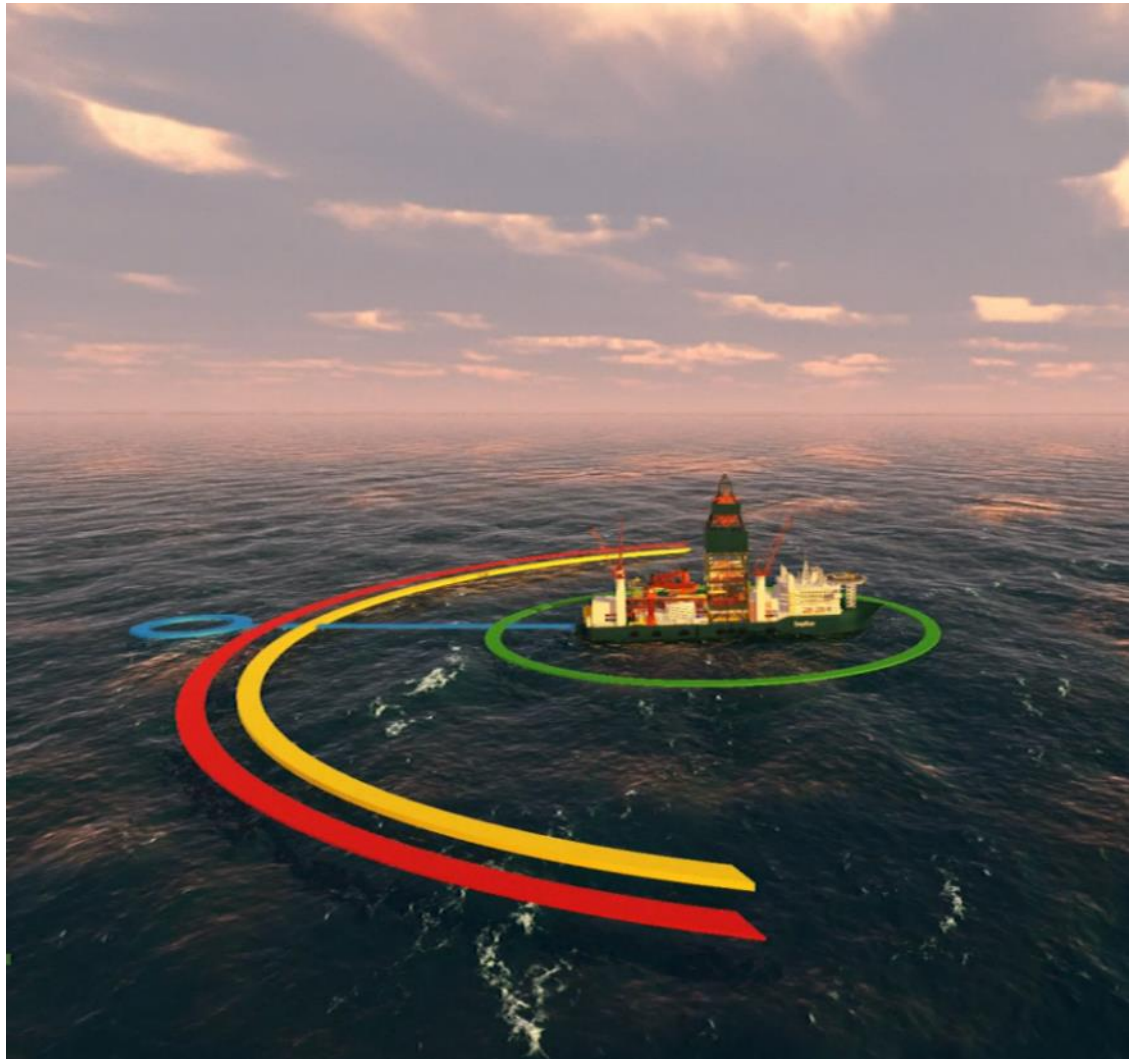
Real-Time Monitoring and Analysis

- Real-time data acquisition from rig systems:
  - DP system
  - Marine riser tensioner
  - Upper & lower flex joint angles
  - Rig motions
  - Metocean data
- Input to live riser simulation to calculate:
  - Rig operating envelope
  - Optimum rig position & heading
  - Alert offsets for DP power-loss scenario
  - Min/max tension limits
- Continuity of riser model through all phases



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Optima - [Optima]

File | Optima (Online) | About Optima... | Options | Help

11:11:08 (Clock) | Licenced (Licence) | Online (Operating Mode) | Launch RIM, Launch DPM, Equipment, Limits + Timings (Database) | Display Settings (View) | Configure Model Signals, Configure Timetrace (Signals) | TLCM, HMS, BOP, FS10, ERA (Hardware Status) | Riser Status: Connected; Riser Condition: Not Drilling; EDS Sequence: EDS 2 (Status)

T...

TJ Stroke

8.03 m

Top ...

Tensioner Load

6557.3 kN

Riser Angle Plots

UIRJ ANGLE X (Live - UFJ)

Mean Limit (13.5) — Max Limit (13.5)

UIRJ ANGLE X : 0.8 UIRJ ANGLE Y : 230.4

BLUE LIRJ ANGLE Y (Blue Pod - LFJ)

Mean Limit (9.0) — Max Limit (9.0)

BLUE LIRJ ANGLE Y : 1.8 BLUE LIRJ ANGL

Optima Model View

Detailed Results | Plot Results | Online Results | Time Trace

Angle: 30

Current 0.50m/s @ 15.0°

Wind 14.00m/s @ 290.0°

Wave 0.31m @ 285.2°

Vessel Position

Wellhead Position

Operating

LMRP Tension 226.93kN

BOP Tension 718.00kN

Speed: 50.00 Time: 1.00

Line Scale: x 4.8

Data Configuration

Vessel Setup | Riser Setup | Environment | Analysis | Alarms and Warnings | 1 Alarm, 1 Warning

Data Panel

Name	Value
ERA HEADING	238.36 deg
VESSEL HEADING	63.84 deg
VESSEL POSITION X	-14.90 m
VESSEL POSITION Y	14.90 m
TJ STROKE	8.03 m
RISER TENSIONER LOAD	6557.33 kN
TOTAL VERT TENSION	6509.00 kN
RISER_TOP_TENSION	6315.92 kN
TENSION #1	498.35 kN
HMS WAVE	1.19 m
HMS HEAVE	2.05 m
HMS COMPENSATED WAVE	0.31 m
WAVE HEIGHT - SIGNIFICANT	4.70 m
WAVE PERIOD	21.00 s
Wave Direction OP	285.30 deg
Wave Direction DO	285.19 deg
WIND SPEED	14.00 m/s
WIND DIRECTION	290.00 deg
Wind Dir DO	285.19 deg
VESSEL PITCH	-0.58 deg
VESSEL ROLL	-0.59 deg
VESSEL HEAVE	7.38 m
STROKE #1	5.13 m
STROKE #2	8.39 m
UIRJ ANGLE X	-0.58 deg
UIRJ ANGLE Y	-0.48 deg
BLUE LIRJ ANGLE X	1.01 deg
BLUE LIRJ ANGLE Y	1.51 deg
YELLOW LIRJ ANGLE X	-1.00 deg
YELLOW LIRJ ANGLE Y	-0.49 deg
Blue Stack Pressure	31.31 MPa
Yellow Stack Pressure	32.17 MPa

Data Panel 2

Name	Value
POD Alert Distance	268.24 m
POD Alert Time	449.00 s
Red Alert Distance	228.59 m
Red Alert Time	389.00 s
Yellow Alert Distance	159.32 m
Yellow Alert Time	289.00 s
Optimum Tension	4577.26 kN
Maximum Tension	6966.69 kN
Minimum Tension	4577.26 kN

Displayed Results for Riser Operating Analysis (04/07/2017 10:53) , Drift Off Analysis (04/07/2017 10:39)

CAP | NUM | SCRL

Recent Experience

Ultra-deepwater (>3,000m), harsh environment location

3 points during drilling program where H_s exceeded trigger point for disconnect based on fixed WSOG

?

Disconnect and retrieve riser as per fixed WSOG

Wait on Weather (WoW) typically 6-7 days per event

Approx. 20 days WoW at a spread cost of **>$1M/day**

Metocean forecast

Perform riser simulations using actual forecast metocean conditions

Based on forecast results, operator and drilling contractor agree appropriate course of action

Outcome: all 3 potential disconnect events avoided, significantly reducing WoW

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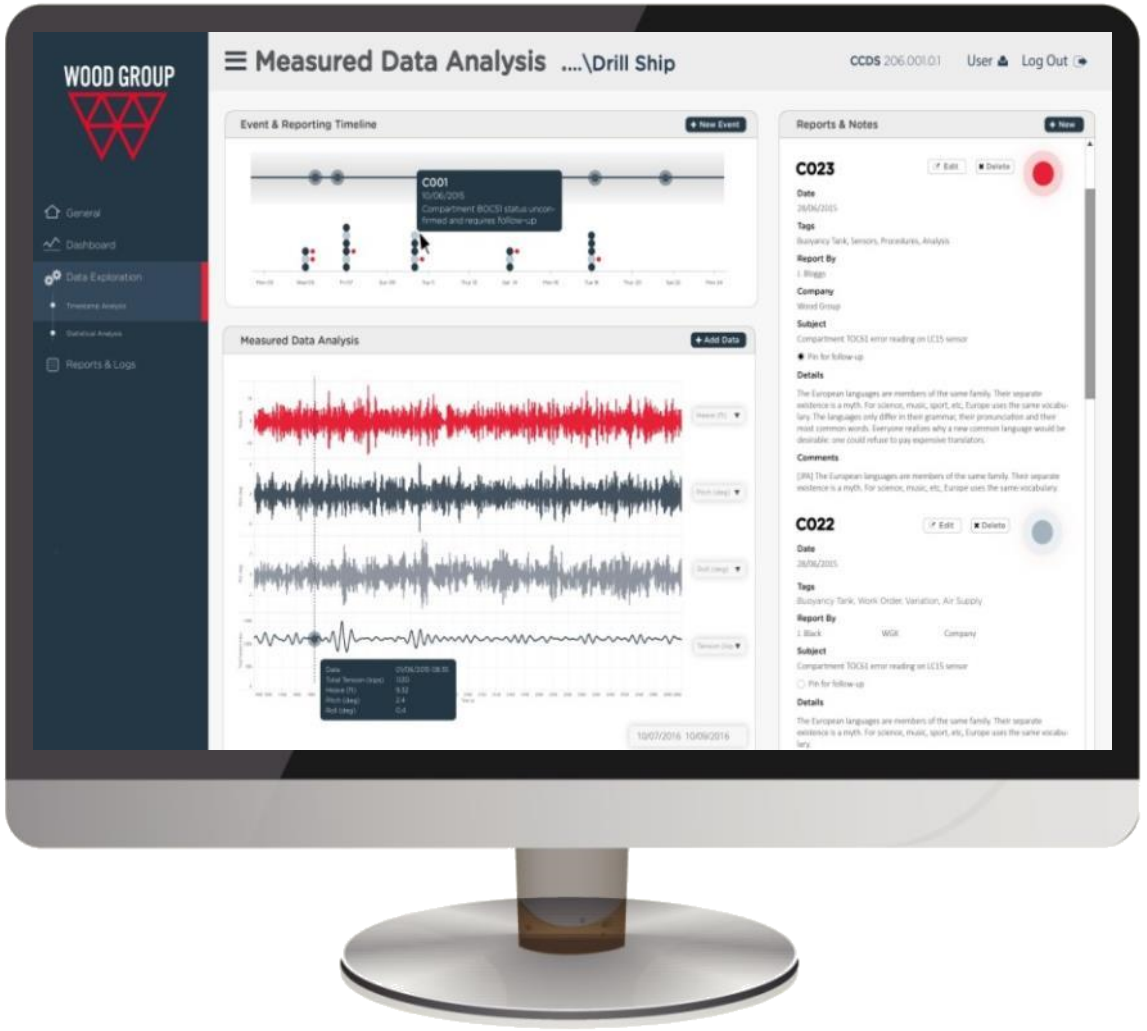
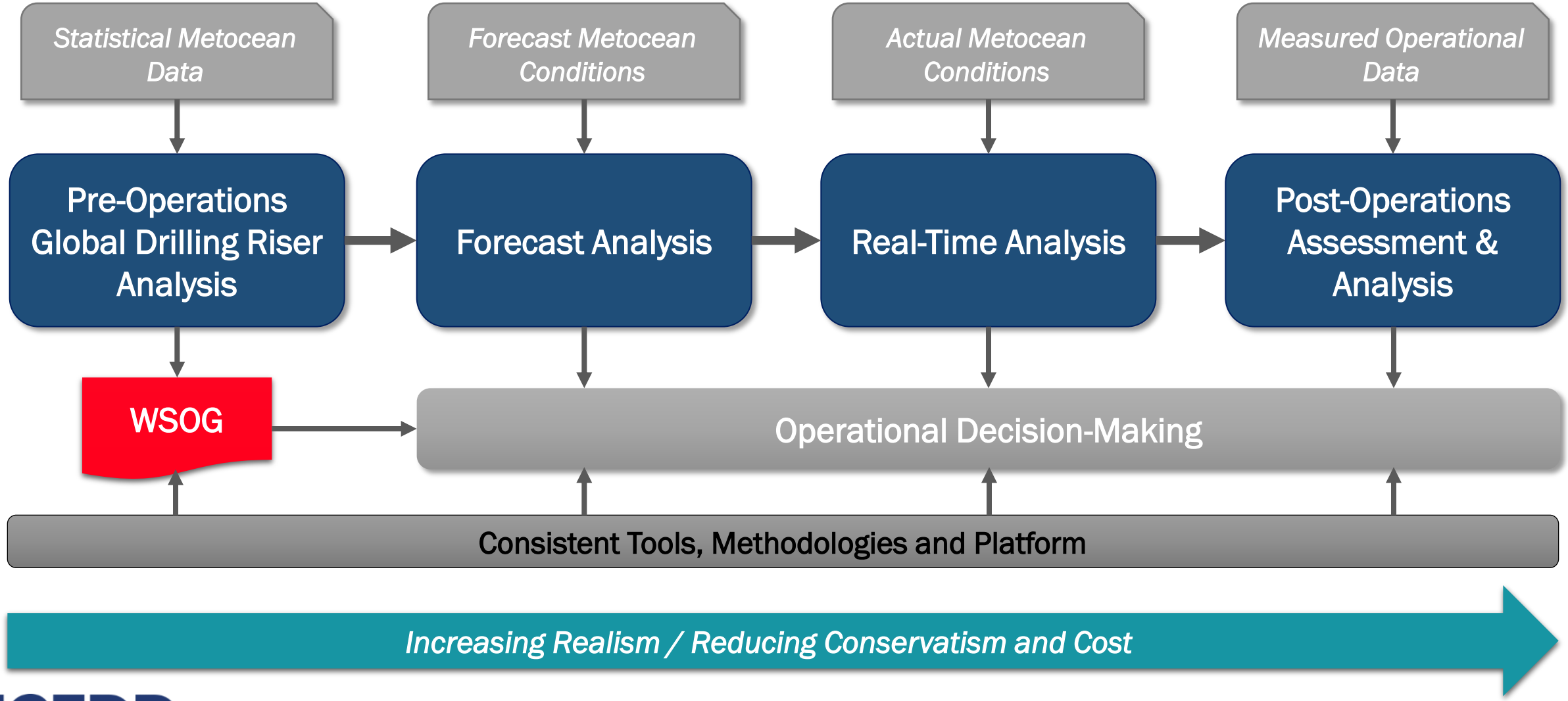
The Next Step: Post-Operations Analytics

- Wealth of measured operational data
- Post-operations analytics enables:
  - Review / assessment of operational strategy
  - Example: heading strategy
  - Feedback to operational procedures
  - Riser equipment usage tracking
  - Condition-based maintenance
  - Wellhead fatigue tracking
  - Incident investigation



Summary



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Conclusions

- Legacy approach of using fixed WSOGs for marine riser operations potentially restrictive for deepwater / harsh environment
- Continuous planning using forecast metocean conditions offers potential for significant reduction in Wait on Weather and associated costs
- Real-time analysis permits optimisation of operations in progress
- The approach has been demonstrated on an ultra-deepwater harsh environment well and resulted in a significant reduction in Wait on Weather

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Thank you!