



HALLIBURTON

Multilaterals on the NCS IOR & cost reducing technology

Presentation for Force

Gorm Liland

Agenda

- MLT Installations on the NCS
- Technical Solutions and Developments
- Field Development Benefits
- Risk Considerations

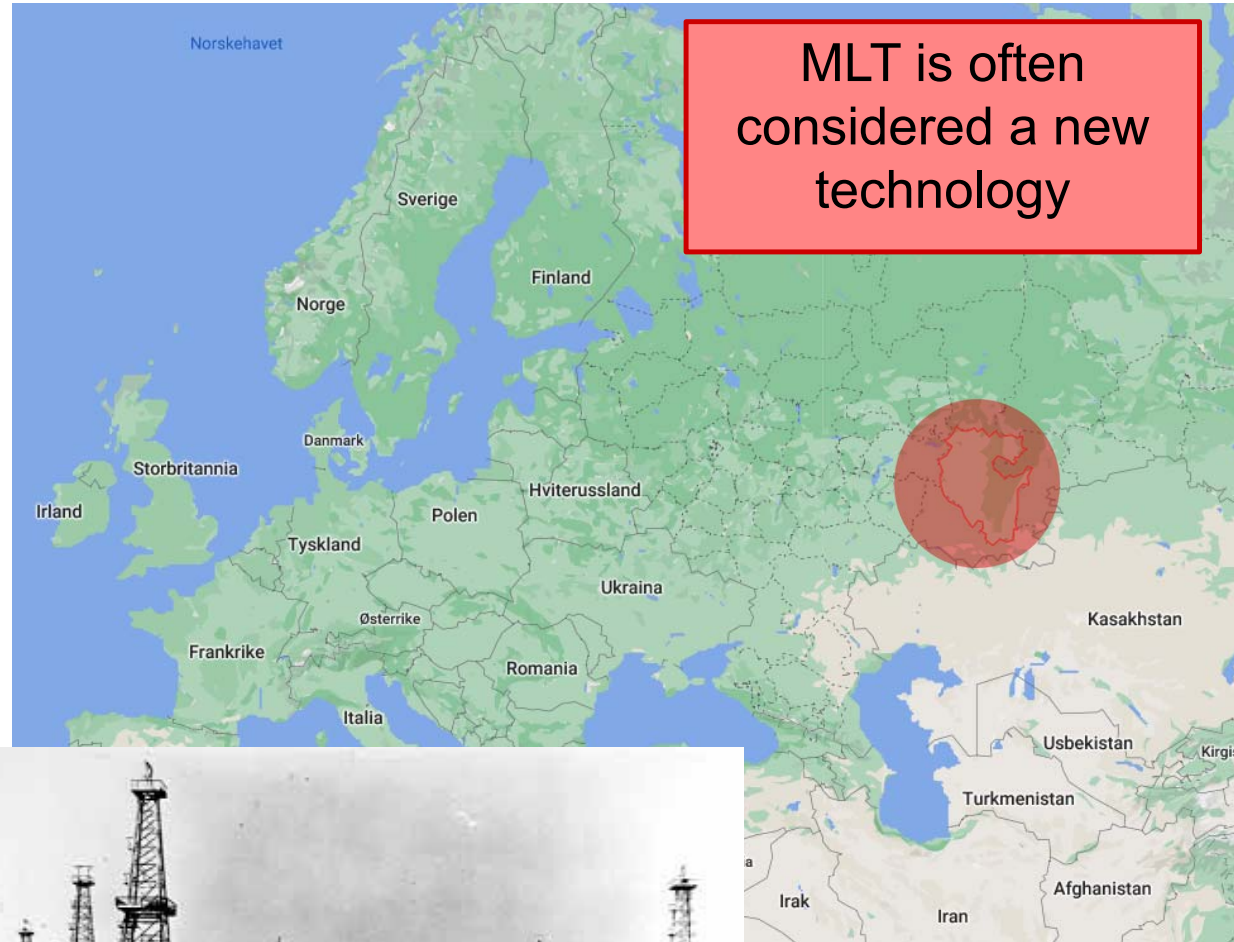
Break

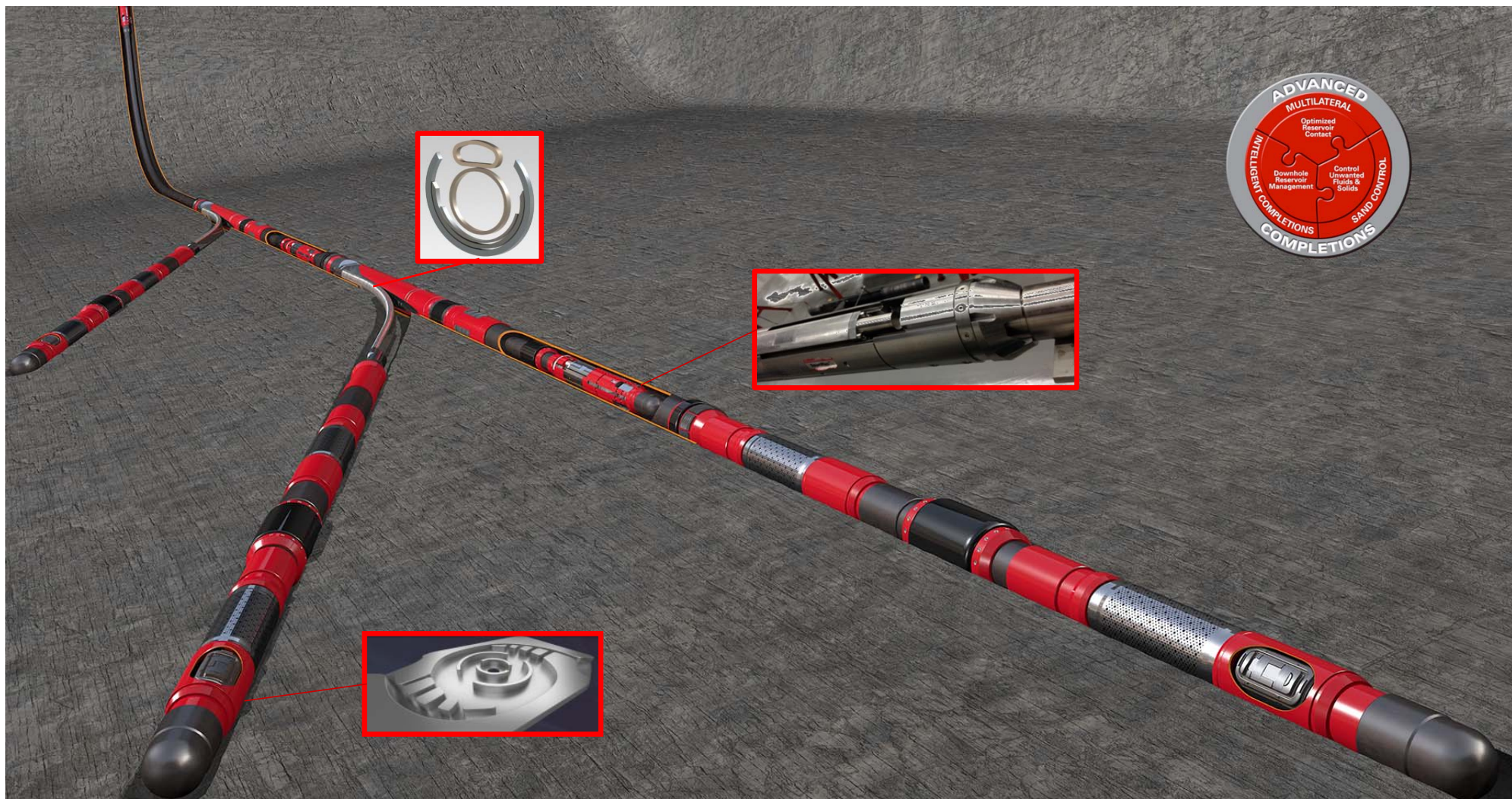
- Field Development Alternatives
- Discussion
- Q/A
- Summary



Father of Multilaterals

- Alexander Grigoryan
- Bashkiria, well 66/45
- Russia, in 1953
- 9 Laterals, 1.5 times the cost
- Produced 17 times more oil than offset wells
- 30 MLT's with Grigoryan
- ~100 additional MLTs





NCS Level-5 MLT Installations

- Ongoing MLT since 1996
- + 360 Level 5 Installations
- 84% from floaters

Success factors:

- Pre-Milled windows
- Milling Aluminium
- Standardized junctions
- Stable workforce
- Continuity

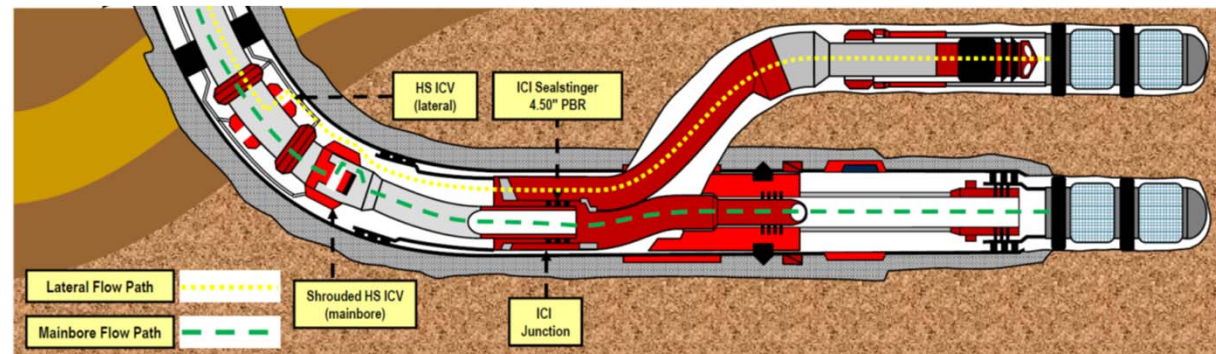
Statoil/Equinor - Norway		Installation year																			Total	Comment			
System	Field	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019			2020		
FlexRite or FlexRite ICI	Troll	9	9	13	8	8	6	7	9	8	9	12	10	11	4	1	1				0	125	234 x LDS	Steel exits	
FlexRite ICI/ MillRite						1																1			
ReFlexRite TXT ICI (RFR G3)																			2	5					7
ReFlexRite 9 5/8" ICI (RFR G4)																					1	2			3
FlexRite 10 3/4" MIC													1	7	21	29	13	19	12	17	7				126
FlexRite or FlexRite ICI	Grane						2	5	3	4	4	4	2	1	2	6	3	6	3	3	0	48	55 x LDS		
FlexRite 9 5/8" MIC																			5	1		6			
FlexRite or FlexRite ICI	Fram West			1												1						2	1 x ICI	Floater	
FlexRite	Brage				1																	1		Fixed	
FlexRite ICI	Oseberg Sør					1																2	1 x Level 3		
ReFlexRite ICI	Oseberg C									1				1								1			
FlexRite ICI	Vilje							1														1			
FlexRite LA	Fram East								1													1			
FlexRite ICI										1												3	4 x LDS		
FlexRite ICI	Gjoa										2	1										3	1 x LDS		
FlexRite ICI/ MillRite													1										1		
FlexRite ICI/ MillRite	Visund													1								1			
FlexRite ICI/ MillRite	Hyme														1							1			
FlexRite ICI/ Slim Joint	Byrding / Astero																		1			1			
FlexRite 9 5/8" MIC	Heidrun																				1	1	ACE Joint		
Yearly Total		9	9	14	9	10	8	13	14	13	16	18	14	21	28	36	17	28	20	30	10				
		Equinor Norway Junction Installation Subtotal																				336			
		Equinor Norway Steel Exits Subtotal																				16			

Marathon/Det Norske/AkerBP - Norway		Installation year																			Total	Comment			
System	Field	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019			2020		
FlexRite	Alvheim Area								2													2	28 x LDS		
FlexRite ICI									2													2			
FlexRite LA												2	3	2			2	2	1	2	1	1			16
FlexRite 10 3/4" MIC																			2						2
FlexRite ICI	Ivar Aasen																				1	1	2 x LDS		
Yearly Total		0	0	0	0	0	0	0	4	0	2	3	2	0	0	2	2	3	2	2	1	1			
		Marathon/ Det Norske/ AkerBP Junction Installation Subtotal																				23			
		Grand Total FlexRite Variant Level 5 Junction Installations in NCS																				359			

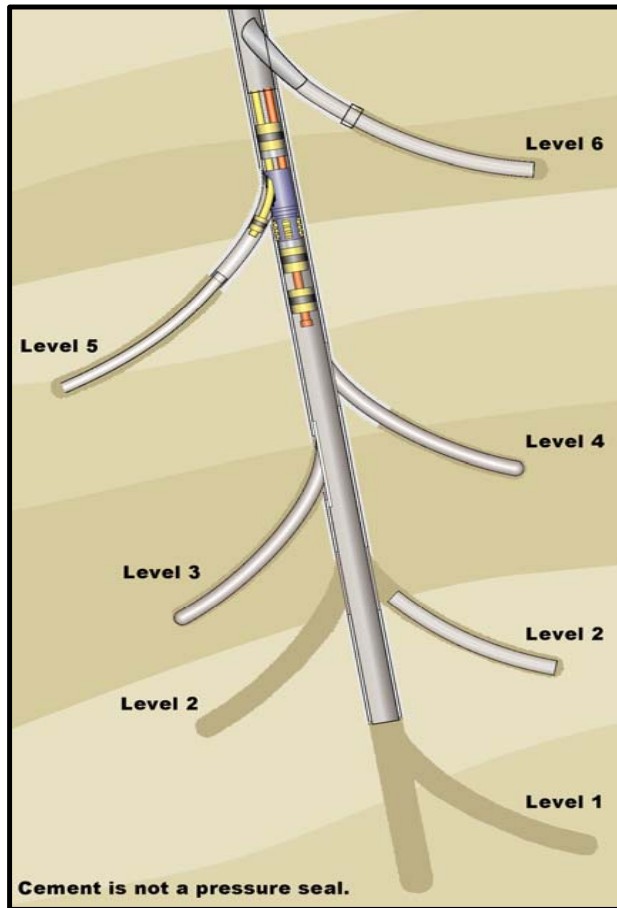
Gjøa Development - 4 Dual MLT & 3 Single Oil Producers



- Operation Period: 2010 -2011
- 9 5/8" FlexRite ICI with LDS
- SmartWell Completion ICV's and Gauges – these are all operative today (2020)
- MLT reservoir 18200m, 9340 in laterals (+50%)
- Production Benefit - as expected from reservoir penetration



TAML Classifications - Summary



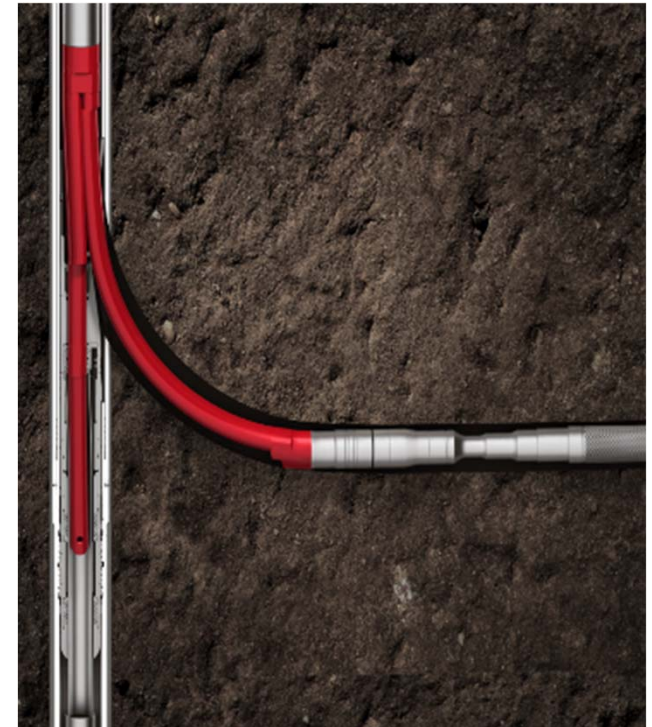
- **LEVEL 6** - Pressure integrity at the Junction. (Cement not acceptable) Achieved with the casing.
- **LEVEL 5** - Pressure integrity at the Junction. (Cement not acceptable) Achieved with the completion.
- **LEVEL 4** - Mainbore & Lateral Cased & Cemented
- **LEVEL 3** - Mainbore Cased & Cemented. Lateral Cased but not Cemented
- **LEVEL 2** - Mainbore Cased & Cemented Lateral Open
- **LEVEL 1** - Open/Unsupported Junction

Typical MLT Installation

Technical solutions

- PHASE 1: Install parent casing / liner with pre-milled window
 - Drill and complete mainbore reservoir
- PHASE 2: Install whipstock and mill window
 - Drill lateral reservoir, complete lateral reservoir
- PHASE 3A: Retrieve whipstock
 - Retrieval performed in combination with lateral completion installation
- PHASE 3B: Install Deflector and tie back mainbore completion
- PHASE 3C: Install Junction and tie back lateral completion
 - Install upper completion with ICV's

TAML Level 5 Junction



MLT from Existing Casing

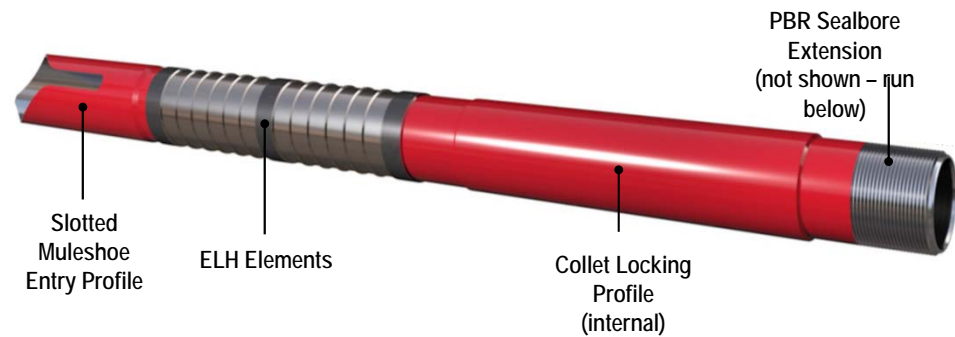
Technical solutions

Challenges:

- Condition of Casing
- Well Barrier Qualification
- Depth and azimuth control
- Window geometry
- Debris from milling operation

XtremeGrip MLT system

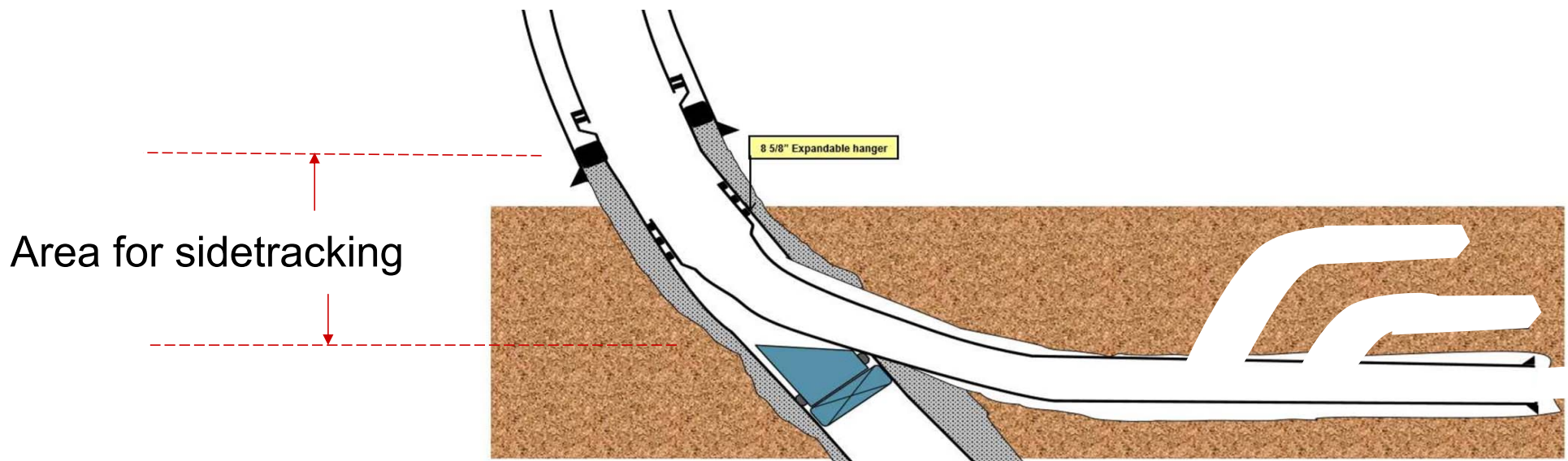
- Based on Versaflex
- Optimal setting depth
- Saves a run



Laterals from Expandable Liner

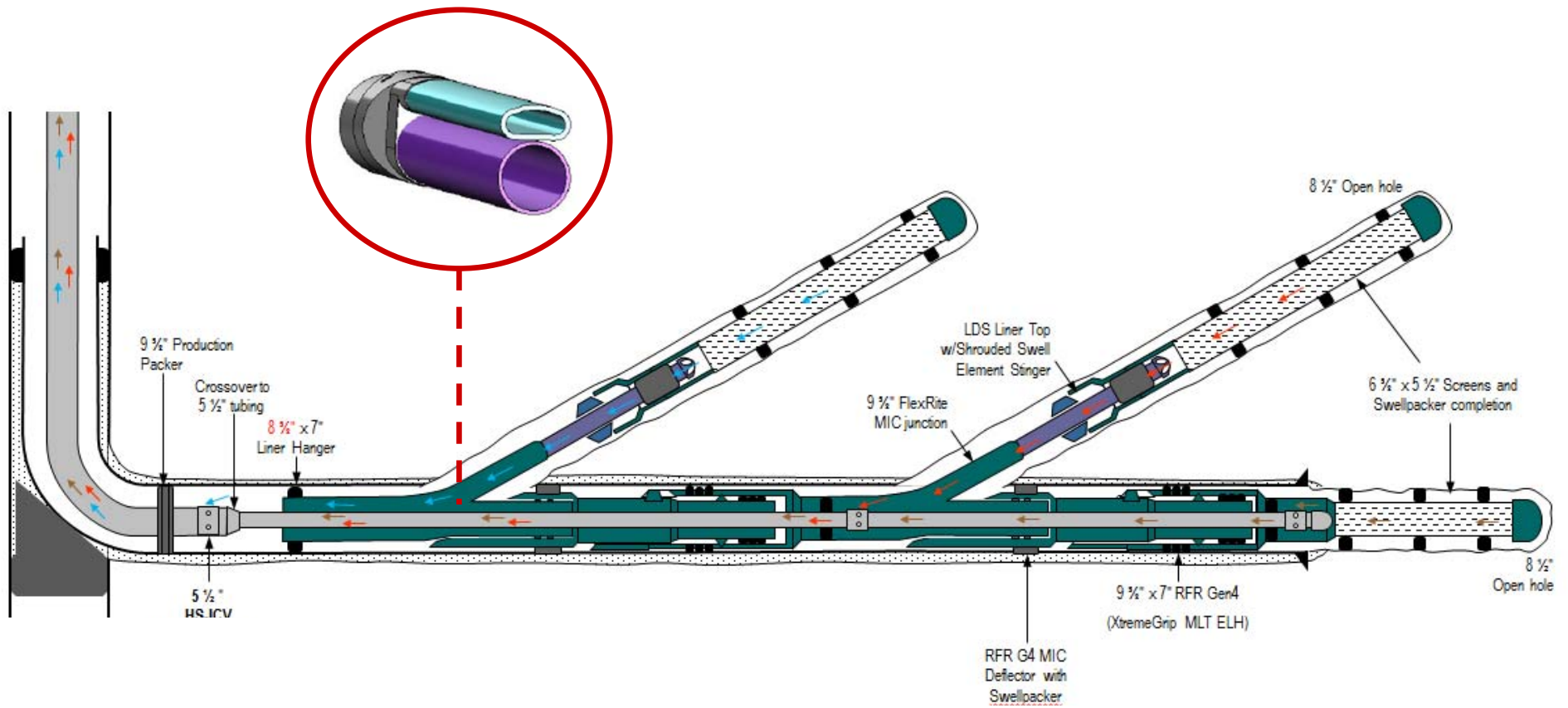
Technical Solutions

- Sidetrack in 10 3/4"
- Enventure 8 5/8" 44# Expandable Liner
- XtremeGrip MLT system
- Drill laterals from 8 5/8" (8.60" id)
- All operations done through X-mas tree



Laterals from Expandable Liner – as completed

Technical Solutions

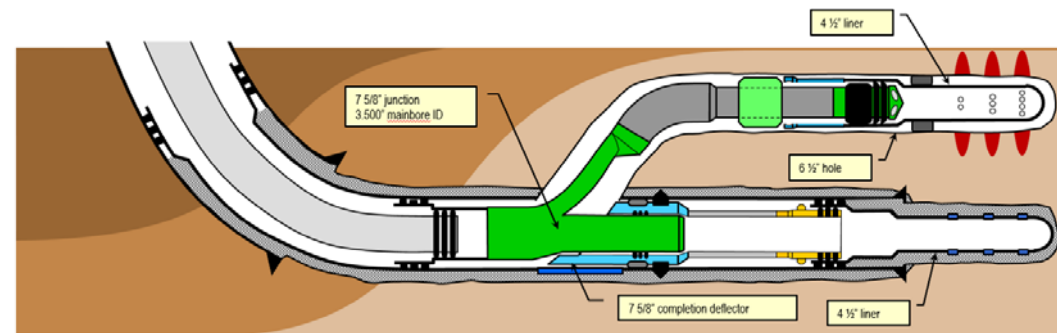
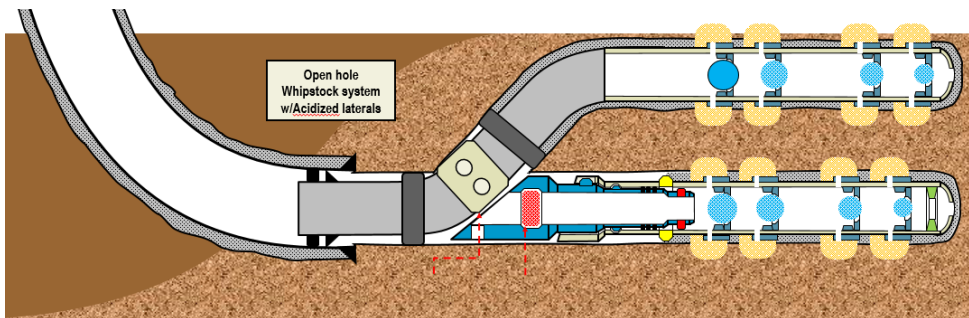


Reservoir Stimulation and Fracking

Technical Solutions

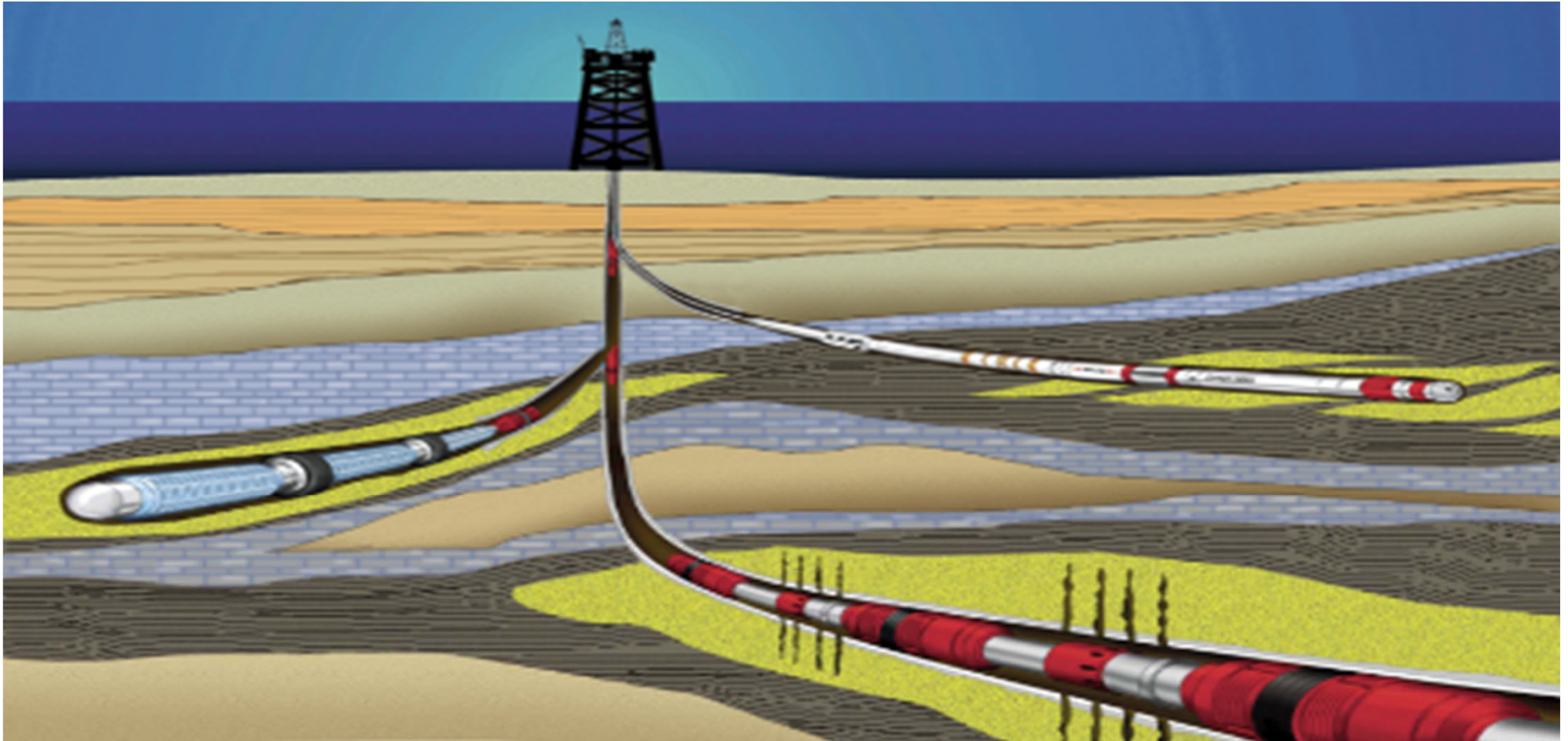
Challenges:

- Fracking pressure
- Access diameter
- Isolating during operations
- Online / Offline well treatments (Logistical issues)



Reservoir Completion Optimisation

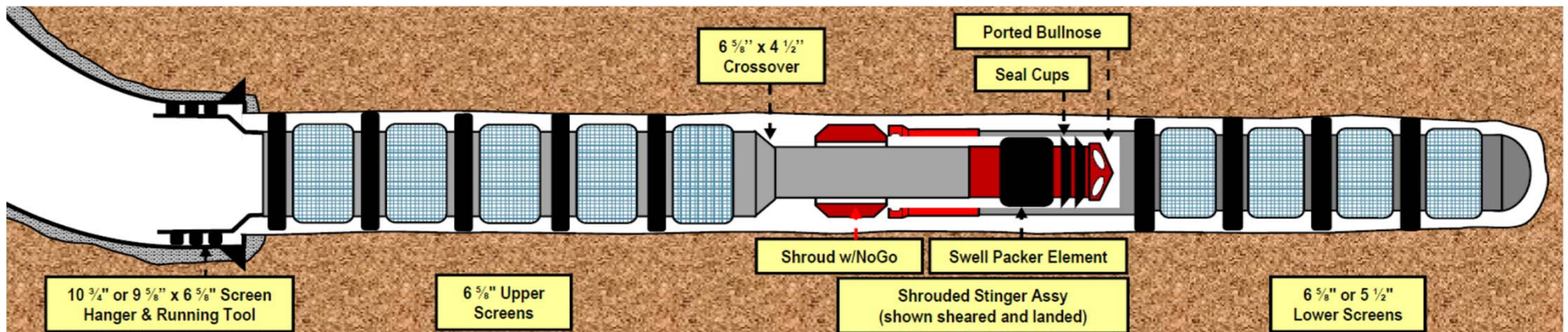
Technical Solutions



Reservoir Completion Optimisation

Technical Solutions

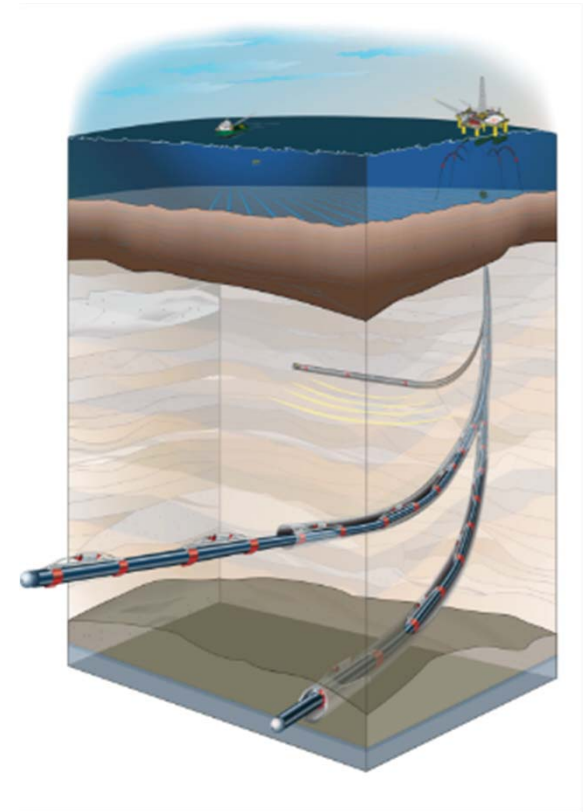
- Install screens in several sections
- Complete extended reach reservoir sections



Reservoir Completion Optimisation

Technical Solutions

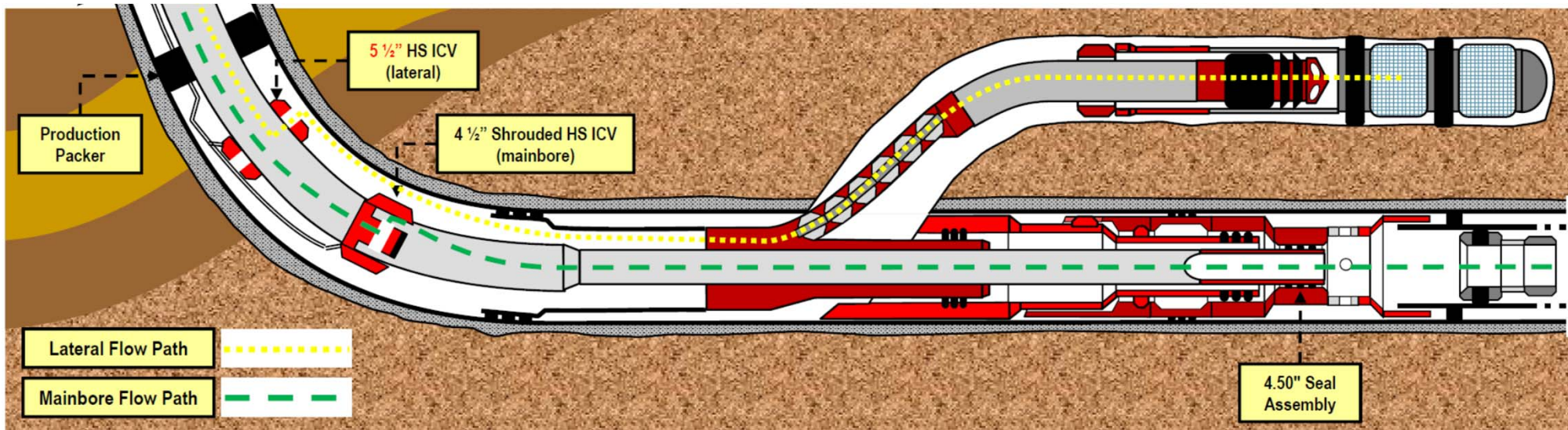
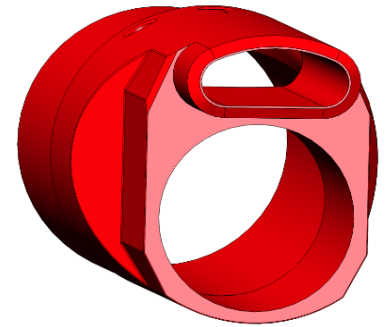
Simplified lower completion
Alternative to Gravel Pack



Retain Production from Old Mainbore

Technical Solutions

- Perforated whipstock
or
- Access to old mainbore

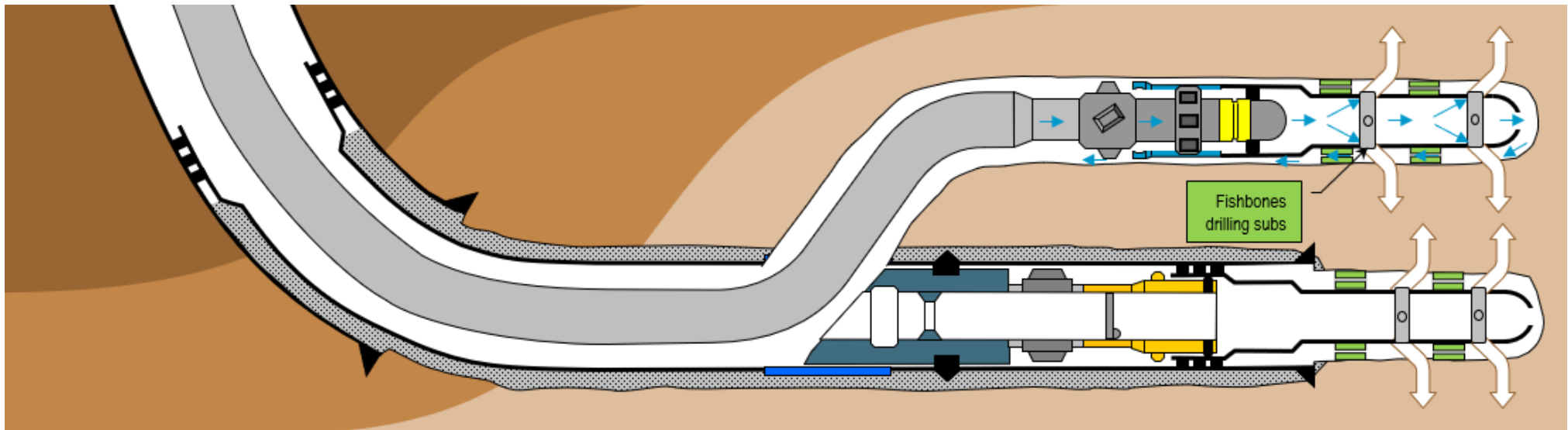
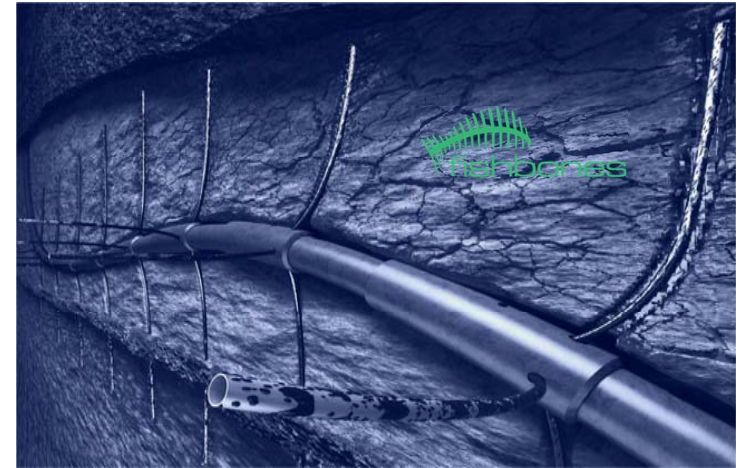


Reservoir Completion Optimisation

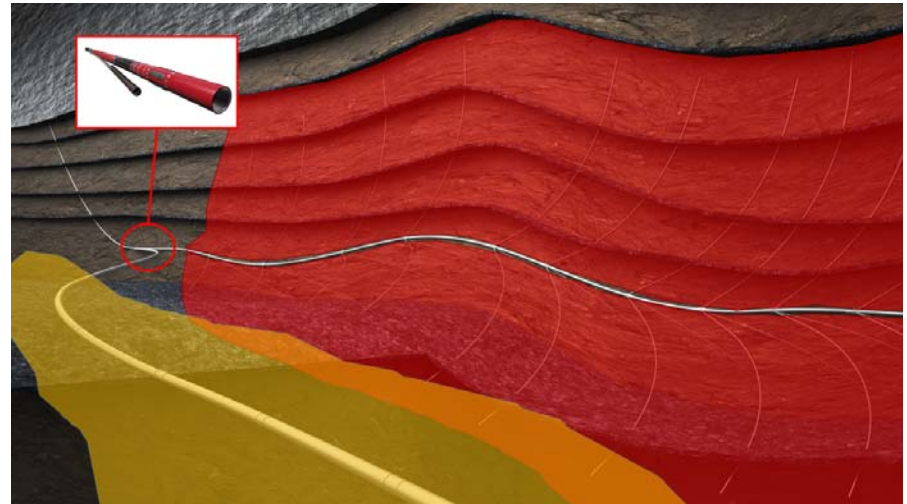
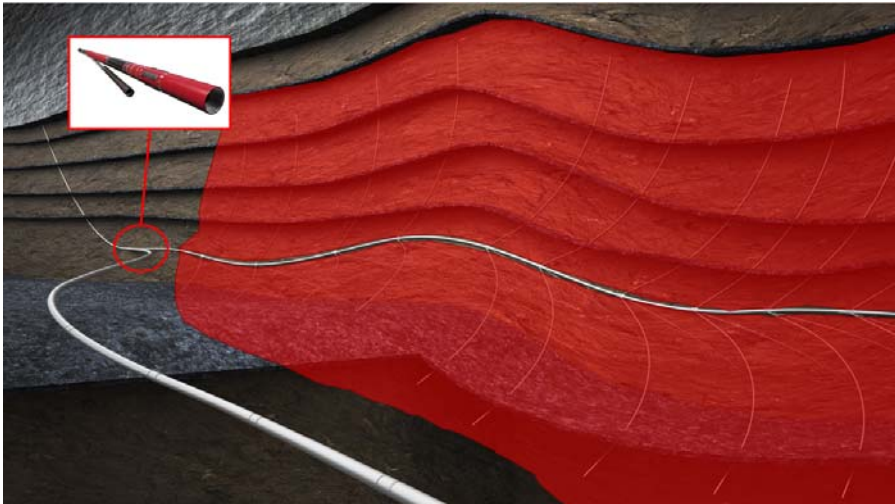
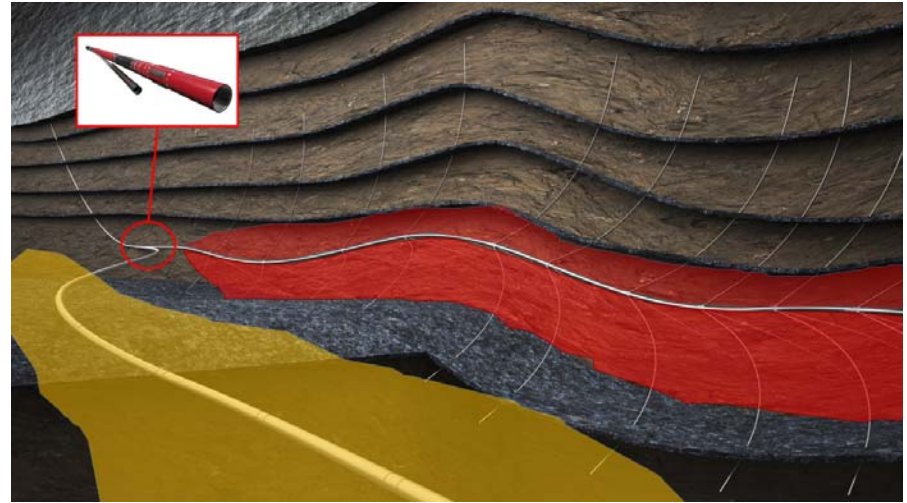
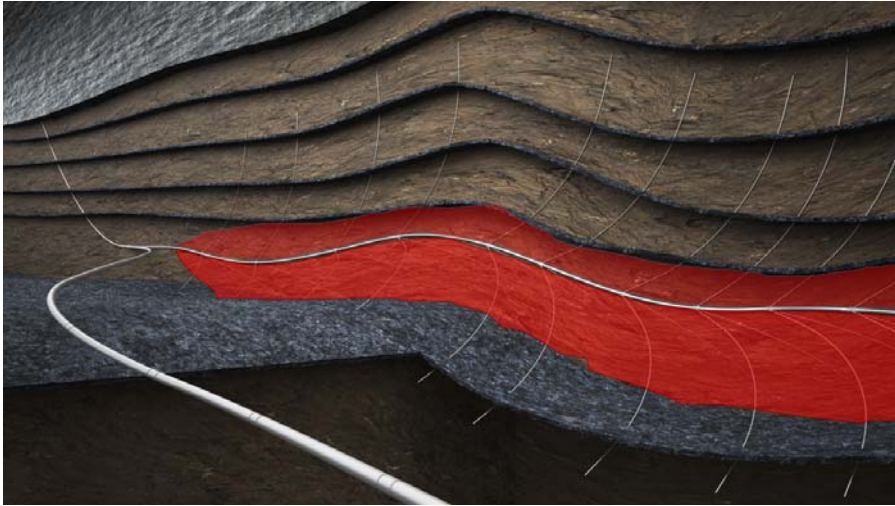
Technical Solutions

Low permeability reservoirs

- Fracking
- Stimulating
- Fishbones



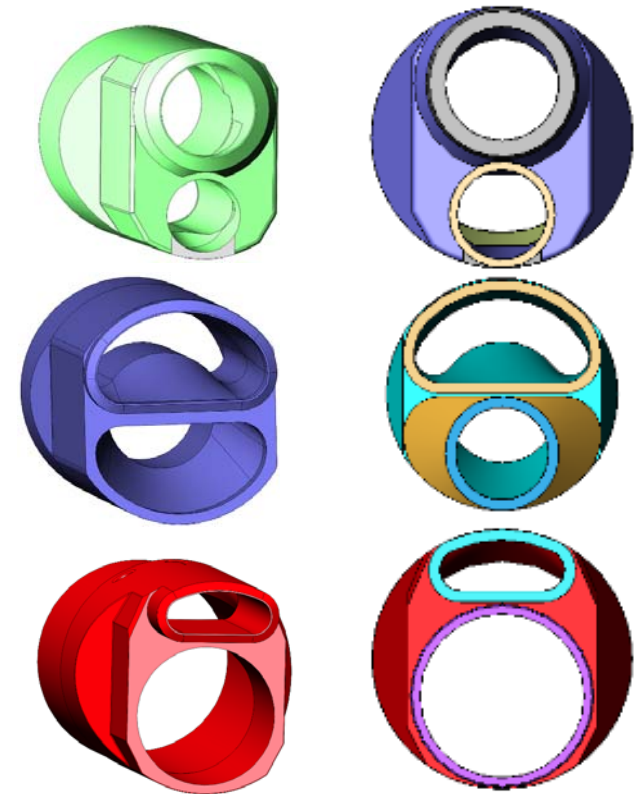
Added Reservoir penetration – Added production – Reduced drawdown – Extended well life



New Technology and Applications

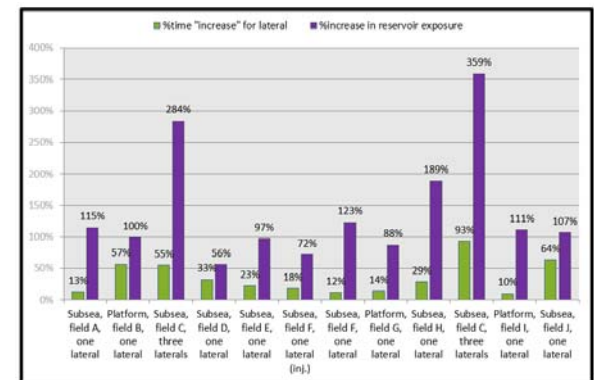
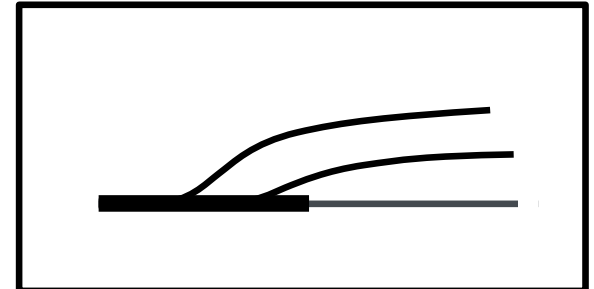
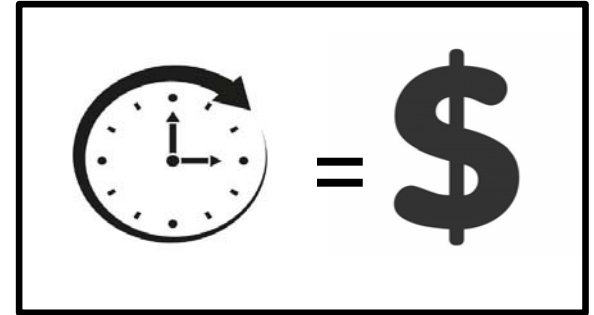
Technical Solutions

- Various upgrades to existing technology
- Open Hole Level-5 MLT junction
- Coiled tubing MLT solutions
- 7" & 7 5/8" Level-5 FlexRite installations
- MLT Use for water injectors
- MLT's as Gas producer
- Combined Injector / producer



Field Development Benefits Simplifications

- Time is the biggest cost contributor therefore time is considered the only cost contributor.
- All laterals and mainore reservoir sections have the same length. A needed simplification to apples to apples.
- Time consumption percentages are actual averages from fields using the technology today



Field Development Benefits

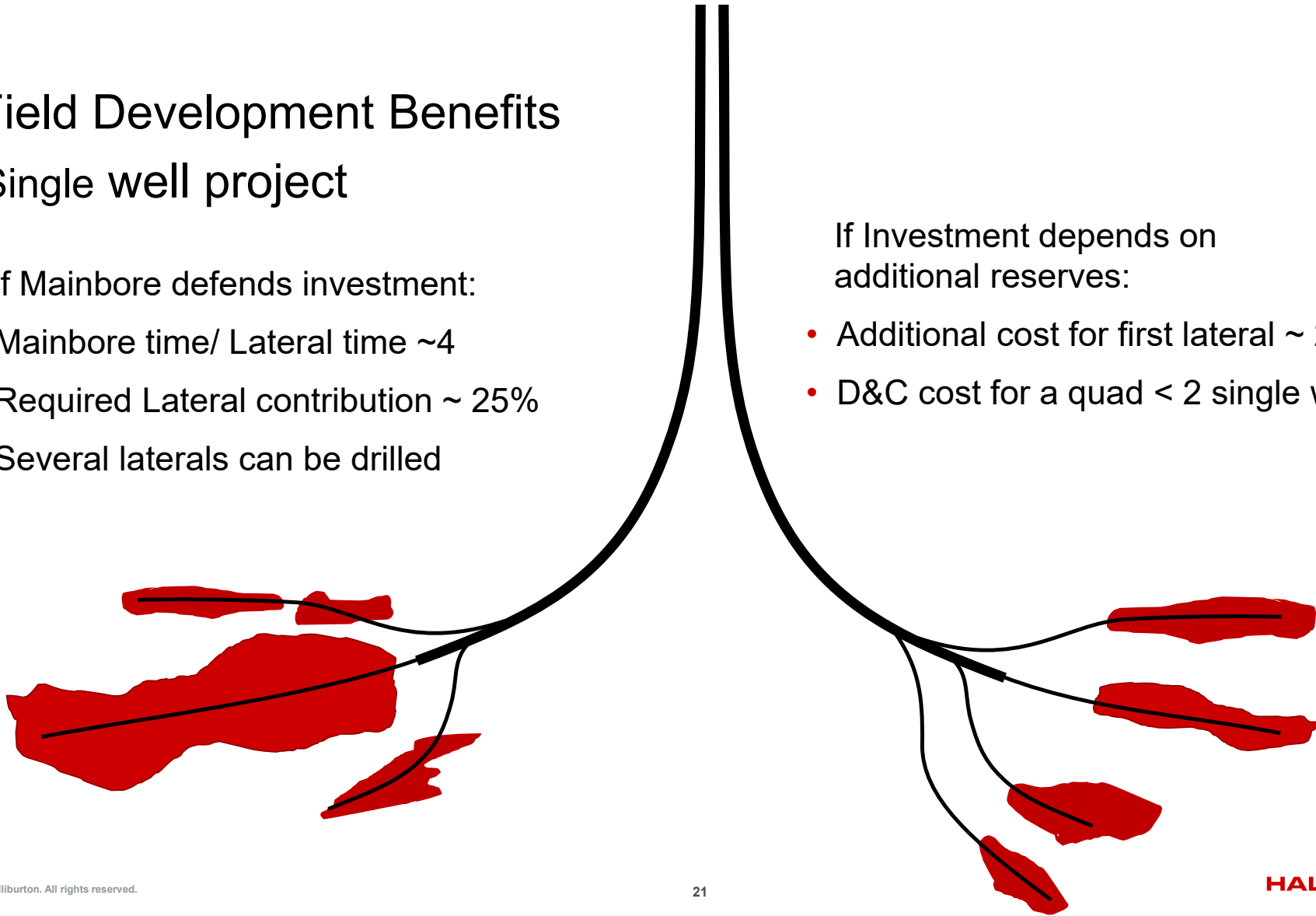
Single well project

If Mainbore defends investment:

- Mainbore time/ Lateral time ~4
- Required Lateral contribution ~ 25%
- Several laterals can be drilled

If Investment depends on additional reserves:

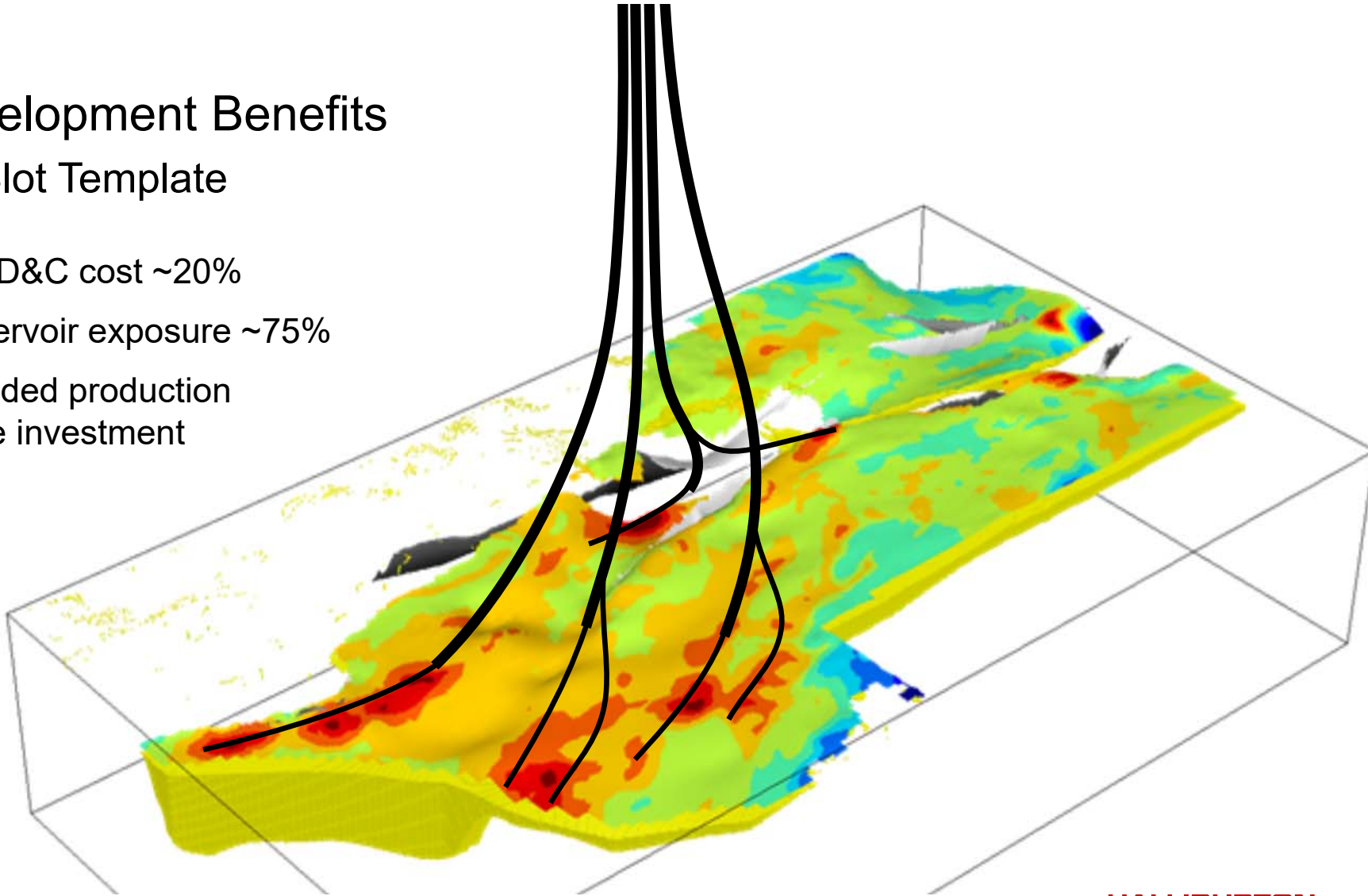
- Additional cost for first lateral ~ 25%
- D&C cost for a quad < 2 single wells



Field Development Benefits

New four Slot Template

- Additional D&C cost ~20%
- Added reservoir exposure ~75%
- 10-15% added production justifies the investment



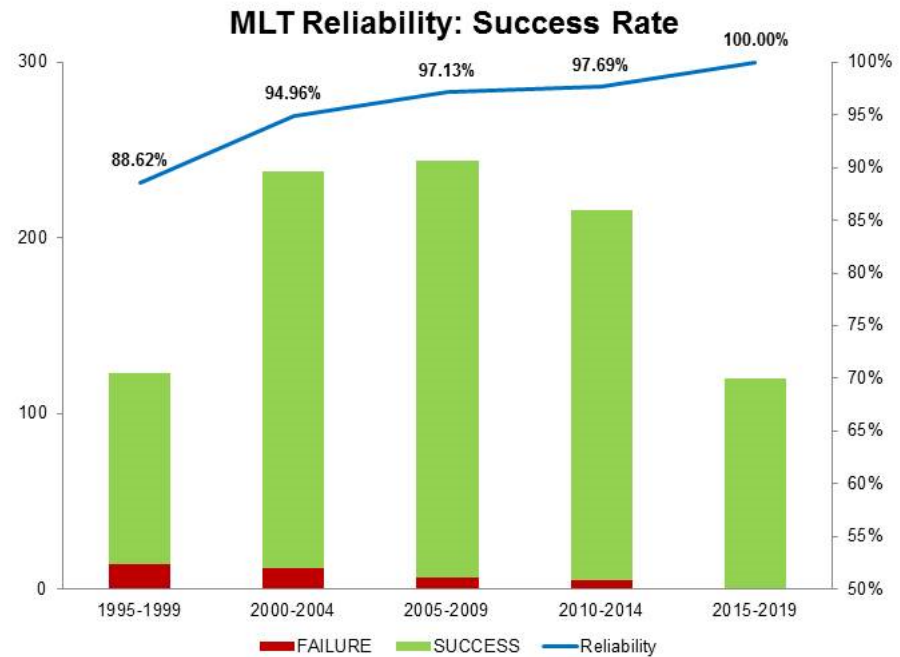
Risk Considerations

- Liner installation and window orientering
 - Add torque and Recipocate string
- Cementing of parent casing / Liner
 - Foam cementing
 - Cement diverters
 - Cement is required for barrier control not MLT construction
- MLT window milling
 - Window milling is an advanced side track
 - Time milling solves roll off and early kick off challenges
- Whipstock retrieval
- Deflector Installation
- Junction Installation
 - Thorough depth control and good deris control solves most challenges related to the three latter challenge areas

Reliability has Continued to Increase

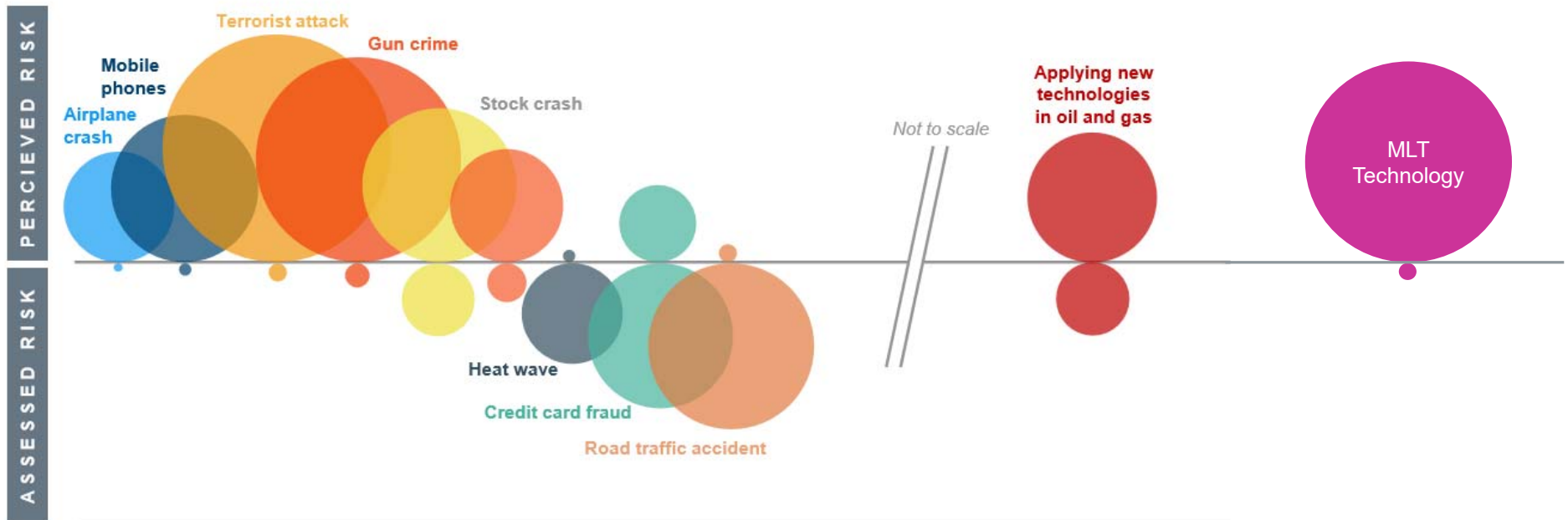
Risk Considerations

- Highest reliability in the industry
- More than 1,200 junctions installed
- 25 years of sustained reliability improvement
- Technology improvements
- More challenging wells



Perceived risk seldom align with assessed risk, oil and gas technologies are no exception

Risk perception vs. assessed risk



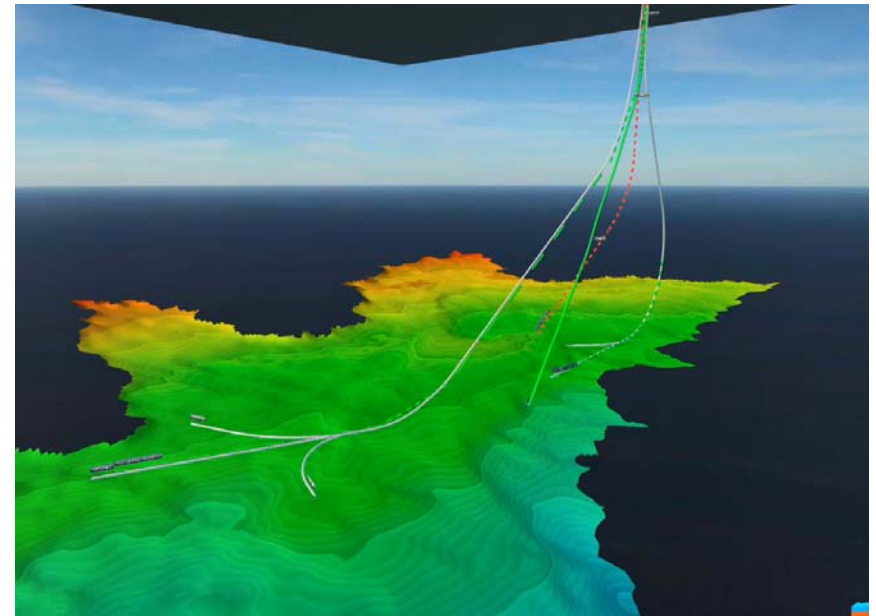
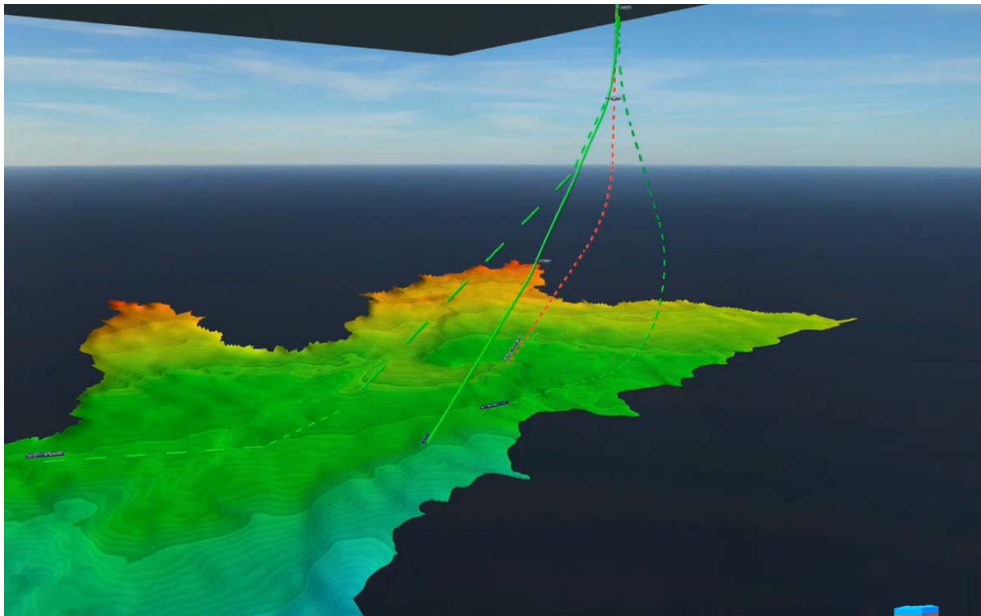
- Studies reveal that there is a large discrepancy between the scenarios that the population fears and those that are actually harmful (see chart above). I.e., the public's perceived risk of flying is far larger than that of driving a car. Assessed risk of flying is actually very low, and driving a car is objectively one of the more dangerous things to undertake
- In the OG21 strategy, **perceived risk is identified as one of the barriers of technology adoption**. That is, an additional premium on the assessed risk, explaining the conservatism and risk aversion that characterizes the industry in adopting new technologies.
- For the purpose of this study, we always assume that the perceived risk is higher than the assessed risk, driven by the detailed procedures on HSE and qualification underlying risk assessment procedures.

Source: Susanna Hertrich, 2008: «Reality Checking Device»; OG21 2016 strategy; Rystad Energy research and analysis

WORKING DRAFT

Field Development Alternatives

- The Duva field
- Brainstorming new developments



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Field Development Alternatives

Brainstorming to Evaluate targets and understand possible benefits as early as possible in the evaluation process. Teams meeting is ok.

Suggested kickoff:

Information

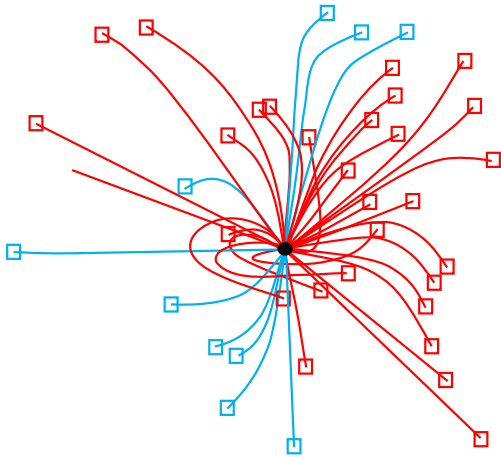
Timeline
Field overview
Original Wellplan
Reservoirs
Faults
Special Challenges
Casing program
Lower completion needs
Depletion
Pressure requirement

Team

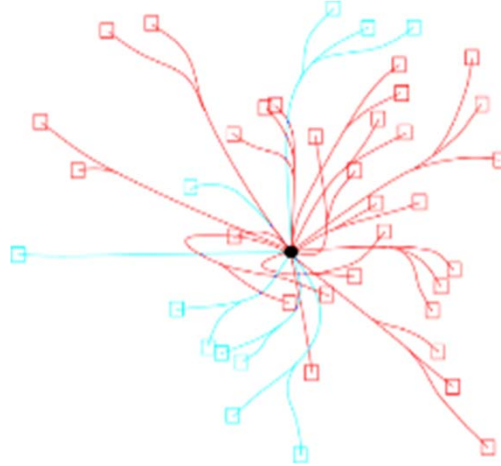
Reservoir Engineer
Drilling Engineer
Well Planner
Informatiq
Completion Engineer
Asset Management
Production Engineer
MLT representative
Other Service Co rep



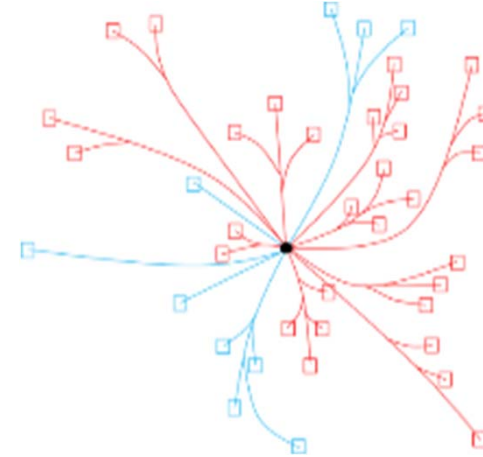
Field Development Approach



Conservative
Single wells only.



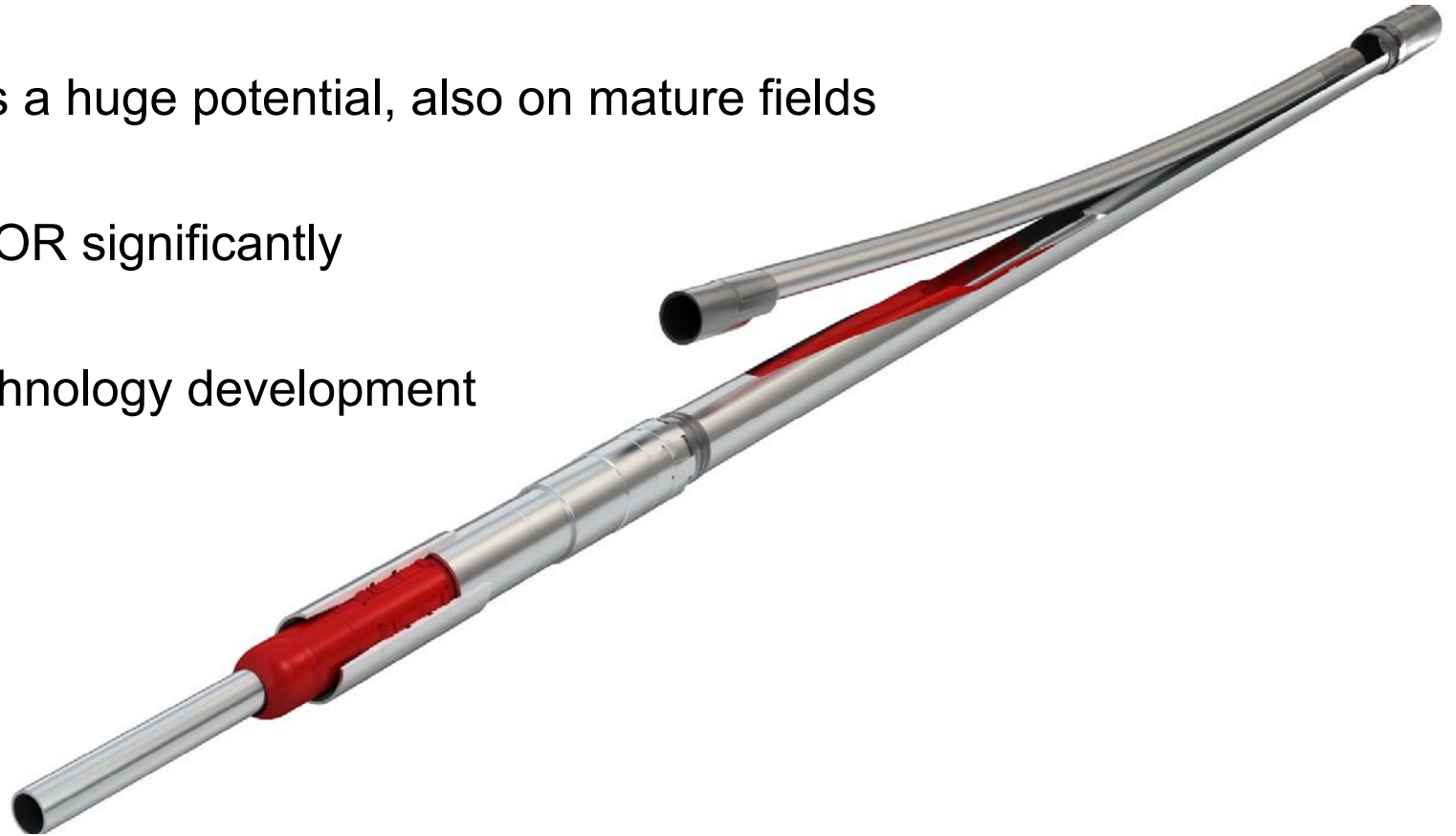
Adaptive
Average well is a dual MLT.
Saves about 35% on
D&W budget



Integrated MLT
Used where applicable.
45-50% saved on D&W
budget

Conclusion

- MLT Drilling has a huge potential, also on mature fields
- MLT improves IOR significantly
- An ongoing Technology development



THANK YOU

"If you **always** do what you
always did, you will **always** get
what you **always** got"

-ALBERT EINSTEIN

