New business models and contract strategies to improve NCS competitiveness

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Purpose & Background

Background:

- OG21's 2016 strategy revision concluded that current business models[1] and contract strategies are barriers for adoption for many promising technologies on the NCS
- During 2017, OG21 has decided to execute a project with the objective to:

  Increase the competitiveness of the NCS through more efficient implementation and adoption of value-creating technologies, resulting from changes in collaboration models, contract models, procurement strategies and work processes

The Boston Consulting Group is assisting OG21 in this project to:

- Identify the most impactful technology areas where business model changes can make an impact
- Evaluate current & new business models, and how they could be used to could stimulate technology uptake
- Discuss impact of implied changes to OG21 prioritized technologies
- Provide data based recommendations for faster & more effective use of high value technology, directed at smaller / newer suppliers, large & system suppliers, oil companies and authorities

This document summarizes BCG findings, and is based on industry analysis, studies of other industries, interviews with a range of industry executives, and a workshop with 45 industry participants

The report serves as an input for OG21's recommendations that will be published in November, 2017

1. "Business models" is used in this document as a collective term for business models, collaboration models, contract models, procurement strategies and related work processes
Source: OG21

Executives from a range of stakeholders have provided input

Note: Companies and bodies include interview participants and OG21 workshop participants
Source: BCG & OG21

Summary

Executive Summary (I/II)

Securing NCS competitiveness calls for a technology step-change to significantly reduce break-even

- Shale can set the bar for NCS competitiveness, resilience requires 'staying to the left' of Shale in the supply cost curve
- Technology focus needs to shift from breaking barriers to driving break-even down
- NCS platform is strong– legacy of innovation, collaboration, quality supply chain & workforce, instrumented fields, stable regime

Three key themes for NCS: Lean tiebacks, enhanced drilling & well performance and data driven productivity enhancement

- NCS competitiveness will be driven by tiebacks (new resources) and North Sea brownfields (cash generators)
- Technology step change in these three themes best driven through innovation by players best positioned to deliver it:
  - Smaller suppliers in hardware niches and increasingly in software
  - Global suppliers drive where they have superior scale – SPS, SURF, Well Services, Drilling
  - Operators drive innovation around new field concepts together with suppliers before concept selection
  - Industry embraces open standards & data centric innovation to drive automation & optimize asset performance
- Business Model choice is optimal combination of scope split, engagement timing, collaboration setting & compensation format

Theme I: Lean tieback solutions enabled by scope integration, earlier engagement and simplified operating models

- Superior value creation and technology uptake through integrated delivery, leveraging suppliers' expertise and scale
- Operators' operating model to adjust to modified role – focus on value, and leave interface management to key suppliers
- Link compensation to performance, with incentives for accelerated innovation and appropriate risk taking

Theme II: Enhanced drilling & well performance through supplier shared incentives, shifting focus from speed to value

- Superior well value by integrating well design & construction as one optimized activity across operators, rigs and well services
- Operators actively driving engagement, also adjusting own operating model from prescriptive to collaboration focus
- Suppliers operating model to adjust to managing higher risk / reward exposure
- Compensation linked to well value, mutual accountability through shared risk /reward linked to HSE, efficiency and well objectives

Source: BCG Analysis

Executive Summary (II/II)

Theme III: Data driven productivity enhancement through software competition enabled by open interfaces and access to field data

- Value creation by creating a highly competitive market place to deploy best in class tech. from traditional and new players
- Software procured as a service, with payments linked to value and SLAs[1]
- Elements of hardware & maintenance procured as a service, shifting from CAPEX to OPEX
- Operators take lead in creating & driving open data sharing standards, & actively curating an eco-system of innovative suppliers

Solutions identified for the three themes are also relevant for other OG21 prioritized technologies

- Majority of OG21 prioritized technologies share similar challenges, and can therefore benefit from similar solutions

Other industries have successfully used similar business models to overcome challenges

- Increased performance by increasing collaboration, introducing performance incentives while maintaining intense competition
- Innovation capture a core part of the procurement process
- Joint industry open data integration platforms lowering entry barriers & speed innovation cycle
- Use of data driven technologies to enable value based compensation models that were previously unfeasible

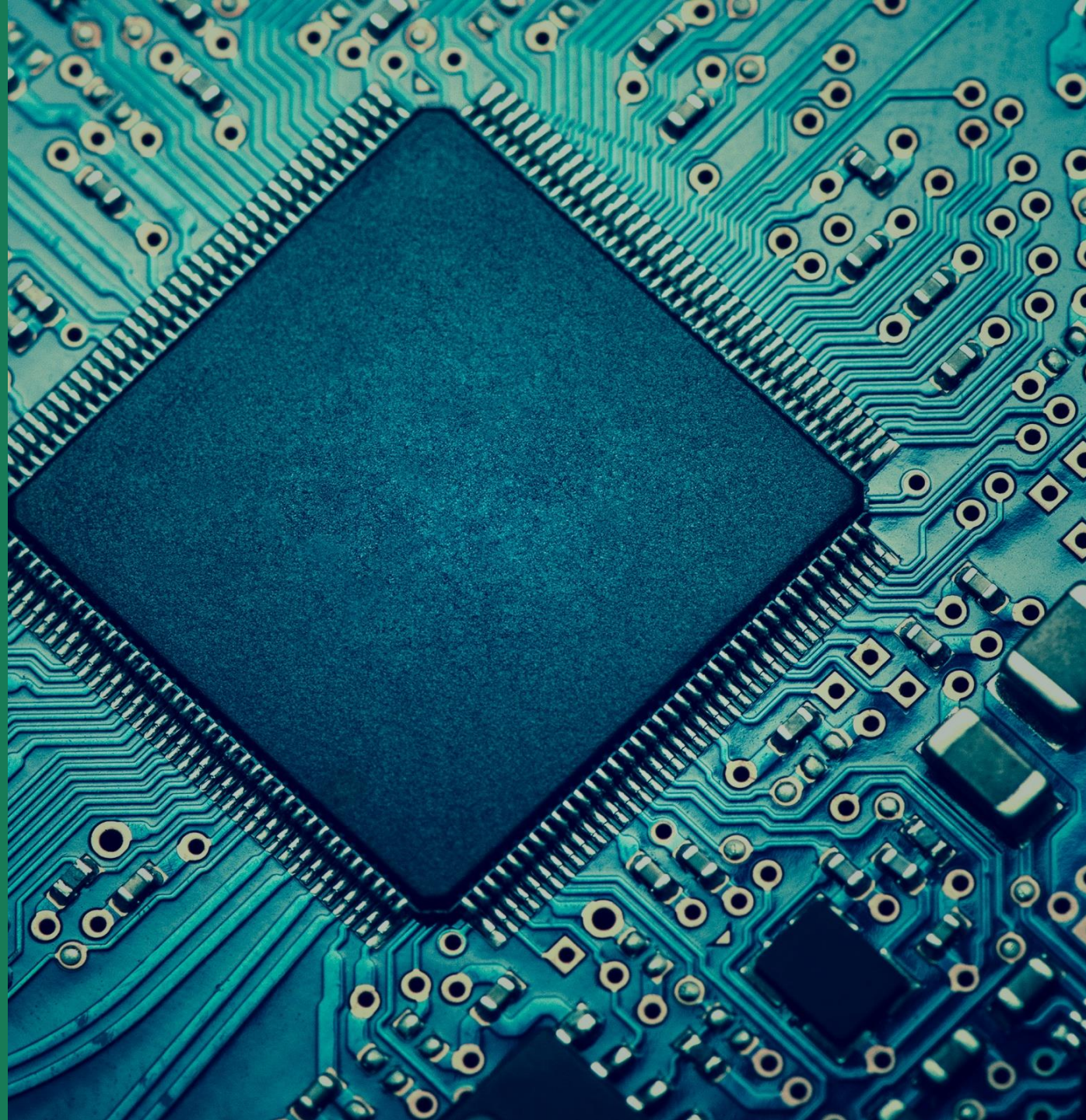
Sufficient common ground for NCS players to start embarking on a set of actions

- Large suppliers to drive cost innovation exploiting scale, strengthen integration capability, accelerate co-innovation with key sub-suppliers and prepare organization & risk mgmt for performance contracts
- Smaller suppliers to work in tighter co-innovation & co-delivery settings with larger suppliers
- Operators to adjust operating models to handle performance contracts, shift focus to functional requirements where suppliers are in lead, establish data governance principles, and drive development & adoption of open common data exchange standards
- Authorities to stimulate competition at all levels by establishing base-rules for data sharing across companies, demanding open data sharing & archival standards, and assisting entrepreneurs in the O&G space

1. Service Level Agreements
Source: BCG Analysis

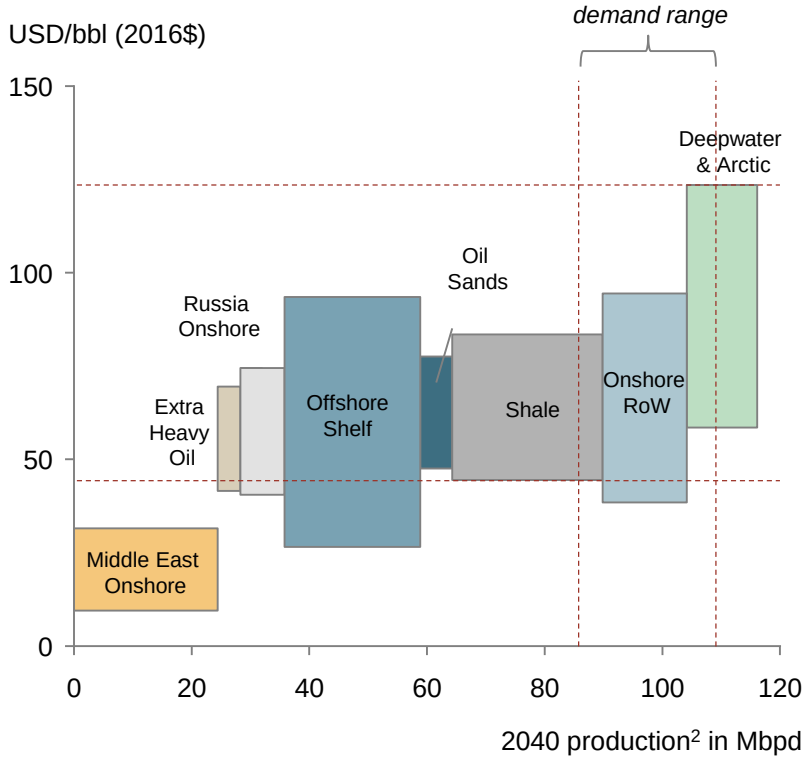
Contents

The need for a step change

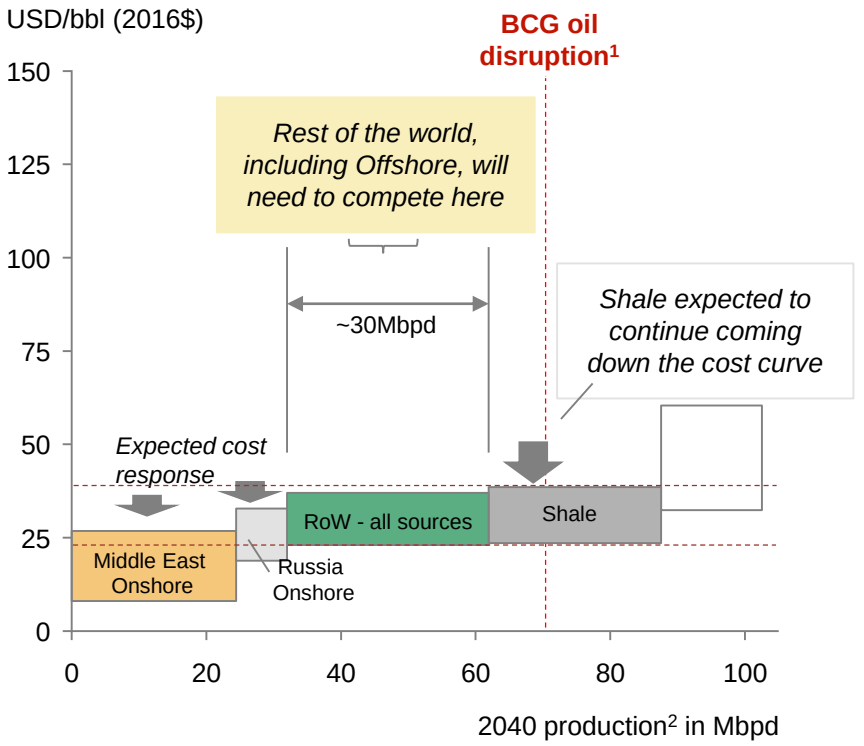


Shale can set the bar for NCS competitiveness; resilience requires 'moving to the left' of Shale

Long-term supply curve uncertain, demand range amplifies price uncertainty



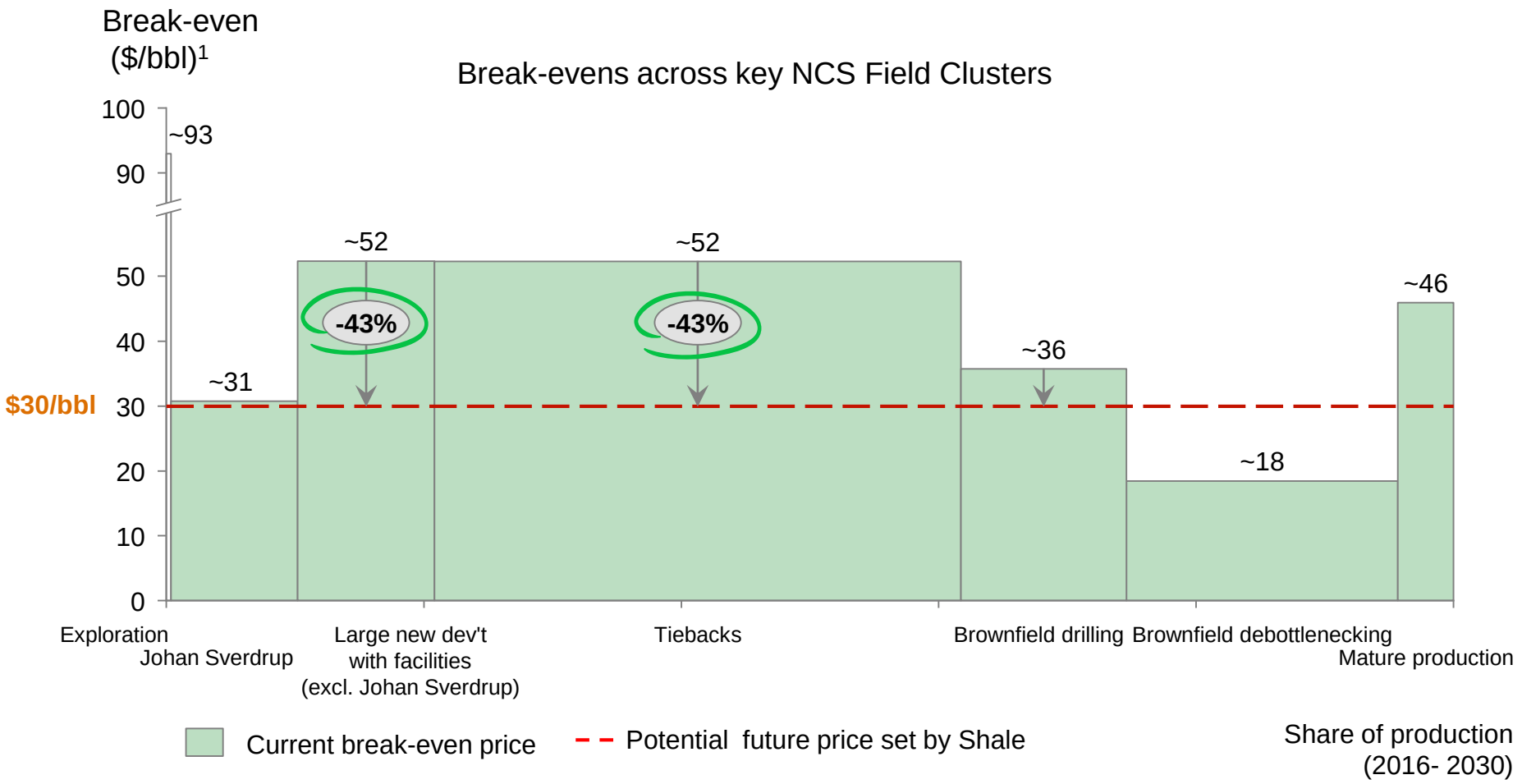
Resilience calls for NCS to outcompete Shale in a low demand scenario



1. Assumes demand reduction to 72Mbpd through substitution of oil and energy efficiency gains. 2. Includes crude oil, condensates and NGLs.
Note: Break even prices are calculated considering future cash flows as of today, with a 10% discount rate; All future production considered.
Source: Rystad UCube (Jan. 17); BCG analysis

A technology step-change is needed to reach such resilience

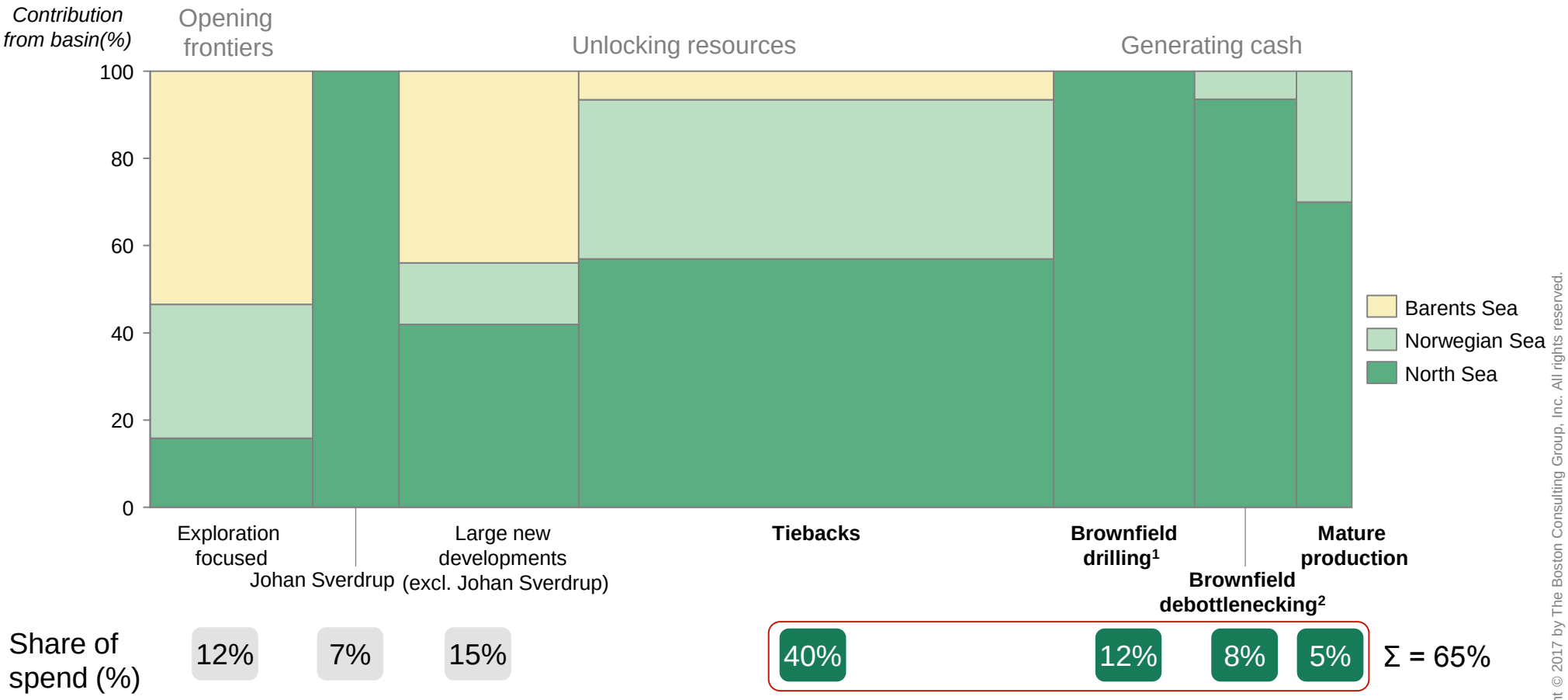
Reducing break-evens for the next generation of projects a critical bridge to frontier development



1. Break-even price for production after 2015.
Source: Rystad DCube data (Apr . 2017); BCG analysis

North Sea brownfields and Tiebacks serve as a bridge to profitably unlock NCS frontier areas

E&P spend on NCS (2016 – 2030) by basins and field cluster



1. Brownfields with significant ongoing drilling activity to manage production. 2. Brownfields with significant topside upgrades and modifications, to manage changes in produced fluids
Note: % may not add up to 100% due to rounding
Source: Rystad DCube, April 2017; BCG analysis

For NCS, 3 technology themes have emerged as most critical

These themes target the main field clusters and have the potential to close the cost gaps substantially

OG21 Prioritized Technologies		Interview feedback
G&G	• Enhanced Seismic imaging	Often cited
	• 4D Seismic systematic application	Often cited
Subsea	• Cost-efficient subsea developments	Frequently cited
	• All-electric subsea wells & systems	Infrequently cited
	• Cost efficient subsea intervention	Infrequently cited
Drilling & wells	• Drilling automation & NPT reductn. drilling techs.	Frequently cited
	• Smart well solutions	Infrequently cited
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	• High North drilling solutions	Infrequently cited
Production	• Efficient marine ops.	Often cited
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Increased recovery	• Efficient Data integration for reservoir mgmt	Frequently cited
	• EOR Techs (CO2, water diversion, new EOR)	Infrequently cited
Environment	• Carbon efficient power solutions for facilities	Often cited
	• Weather forecasting, comms. (High North)	Often cited
	• Tech. safety barriers & oil spill prep. (High North)	Often cited

Frequently cited Often cited Infrequently cited

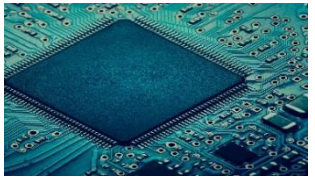
I Lean tiebacks

- Unlocking marginal fields
- Simplified solutions
- Subsea and/or UWHPs[1]

II Enhanced drilling & well performance

- More productive wells
- Faster and safer drilling
- Minimized NPT

III Data driven productivity enhancement



- Enhanced reservoir recovery
- Maximize throughput
- Minimized NPT
- Remote ops & unmanned systems

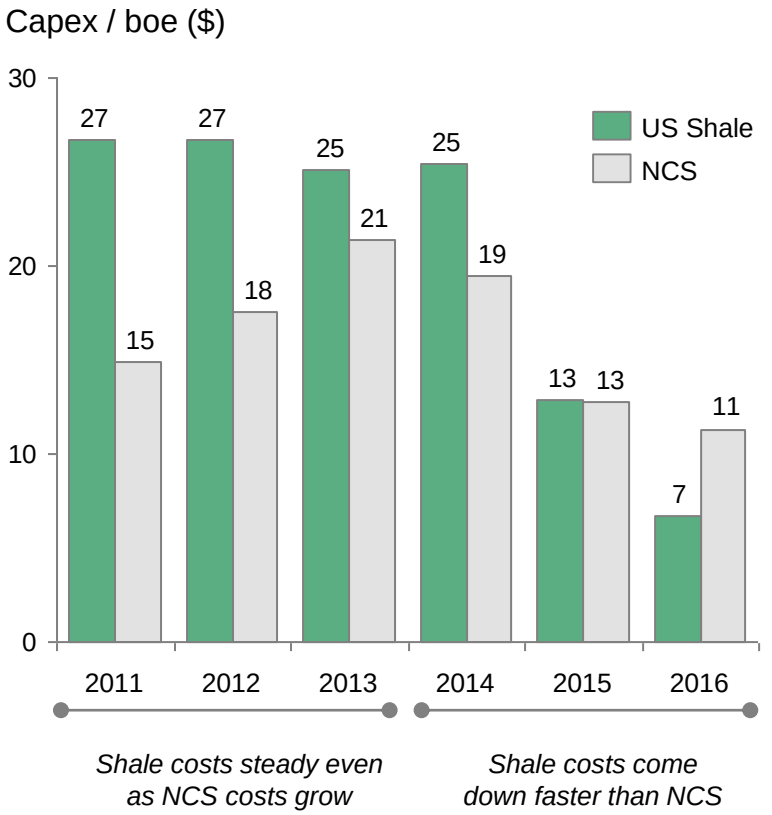
Note: List is an aggregated form of comprehensive list of OG21 prioritized technologies, grouped by technical and application area similarity. 1. Unmanned wellhead platforms.
Source: Interviews; BCG analysis

The bar is moving – technology implementation and scale effects have dramatically improved Shale economics

By applying a portfolio of technologies..

Productivity ↑	Cost ↓
Longer laterals	Pad drilling
Geosteering	High efficiency surface ops
Multi-stage fracks	Minimal casing & liner
Optimized spacing/stacking	Faster fracking ops.

.. US Shale producers continue to drive economic competitiveness



Note: Shale well productivity gains have more than offset additional costs of Productivity focused technology like longer laterals.
Note 2: While some gains in the Shale since 2014 are attributable to high grading and service price deflation, technology & efficiency gains are expected keep increasing
Source: EIA; Rystad UCube, April 2017; EIA Upstream Cost Study 2016; BCG analysis

The NCS has a strong platform to build on

Highly developed **supply chain**

Skilled and **experienced workforce**

Instrumented and **monitored fields**

Significant (>50%) **remaining resources**

Stable & **supportive regime**

Unparalleled **legacy of innovation** in offshore O&G

Source: NPD; BCG analysis

Preferred business model solutions for the key technology themes

For technology step change, we need business models that maximize innovation in the offshore E&P eco-system

Smaller suppliers drive innovation in **hardware niches** & increasingly in **software**

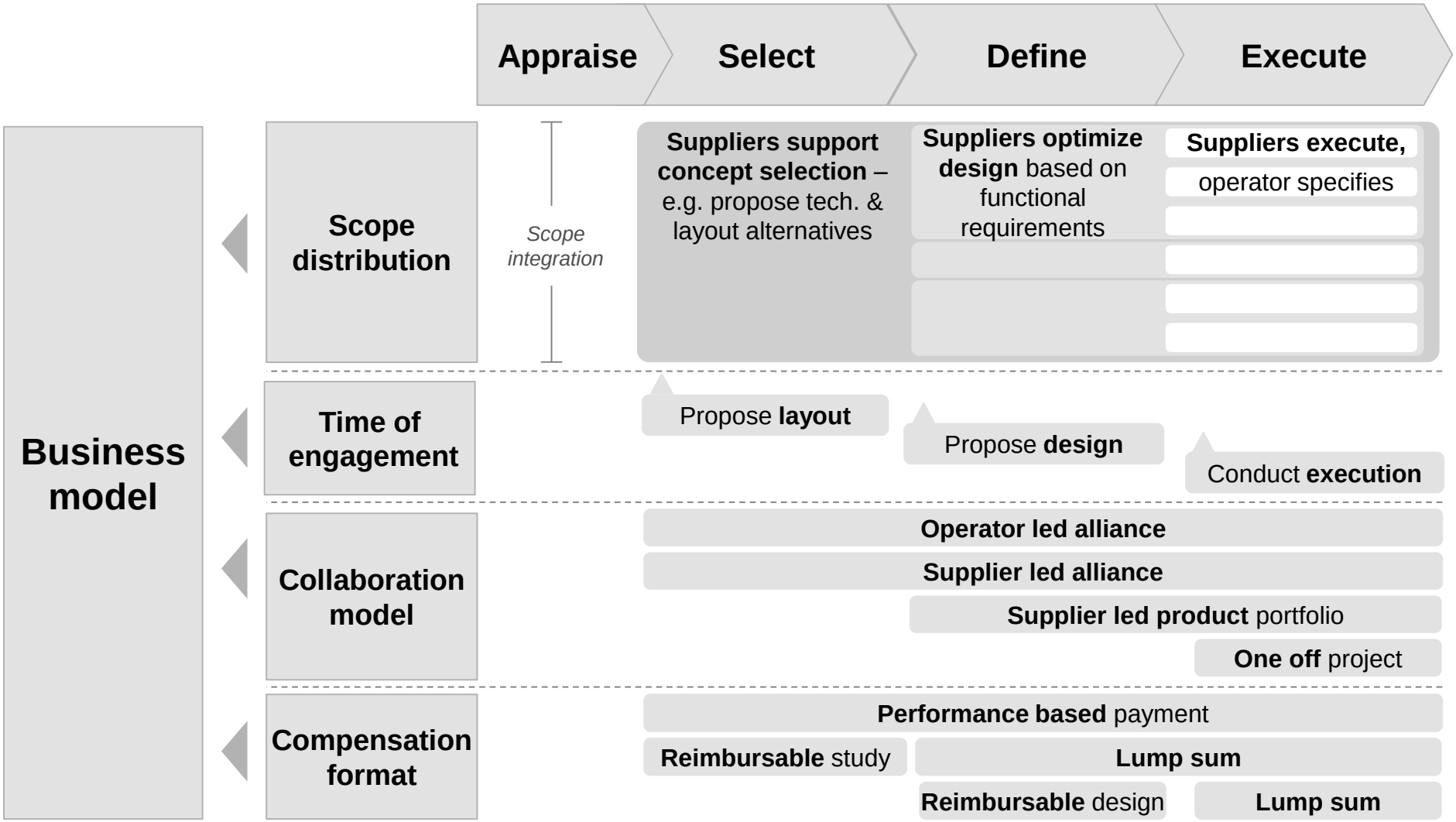
Global suppliers drive innovation where they have **large scale and integration** capability - e.g. SPS, SURF, Well Services, Drilling

Operators drive innovation on new **field & reservoir access** concepts with suppliers prior to Concept Selection

Industry embraces digital innovation through open data standards, automation & integrates data driven decision making into workflows

Source: BCG case experience

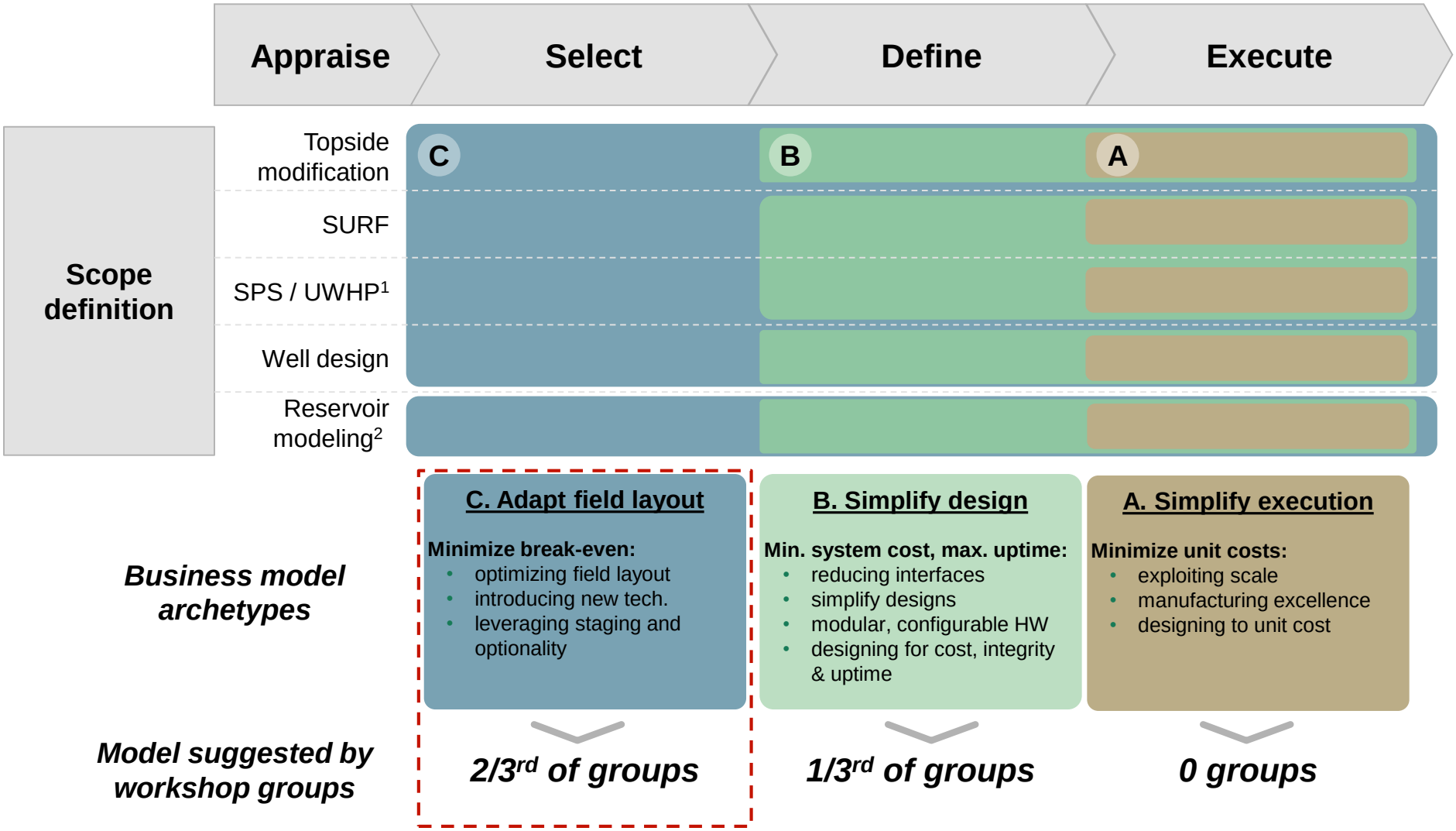
Business Models defined by choices along four dimensions



Note: Alliance as a term refers collectively to formal Combinations of suppliers – including JVs, non-incorporated alliances, and mergers, typically integrating horizontal capabilities.
Note2: Operator led alliance - where operators drive the selection of companies in a set-up. The alternative is Supplier led alliances
Source: BCG Business Model Framework, BCG Analysis

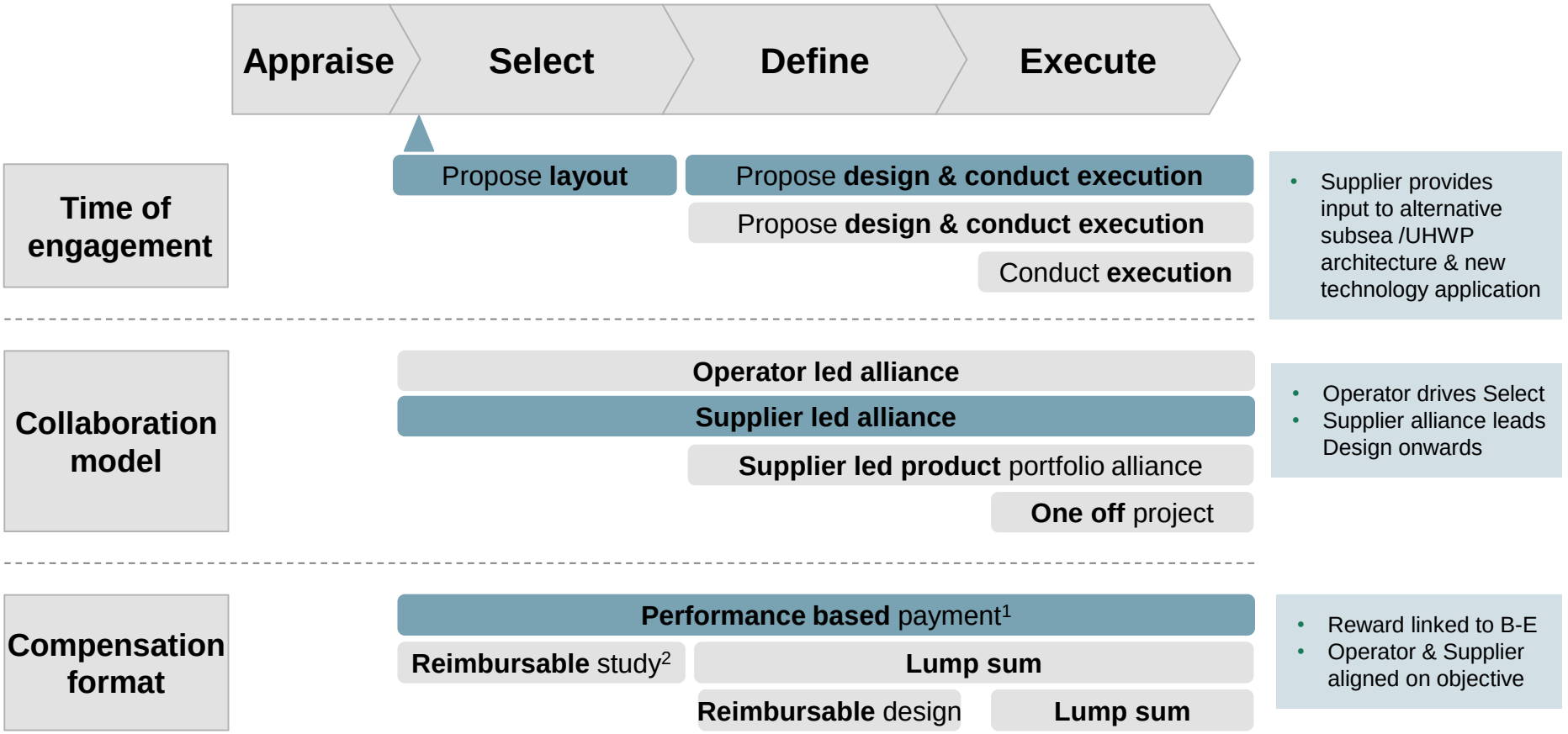
I. Lean Tiebacks

Lean tiebacks: Greater scope integration seen as creating most value for the NCS



Note: OG21 Industry workshop held on 23rd May in Oslo with ~45 participants from a broad range of O&G players on NCS
1. UWHP = Unmanned Wellhead Platform 2. Reservoir modeling & well-design strongly linked by Operator workflows
Source: BCG Analysis, OG21 industry workshop

Lean tiebacks: Integration requires early engagement, supplier led solutions & performance based incentives



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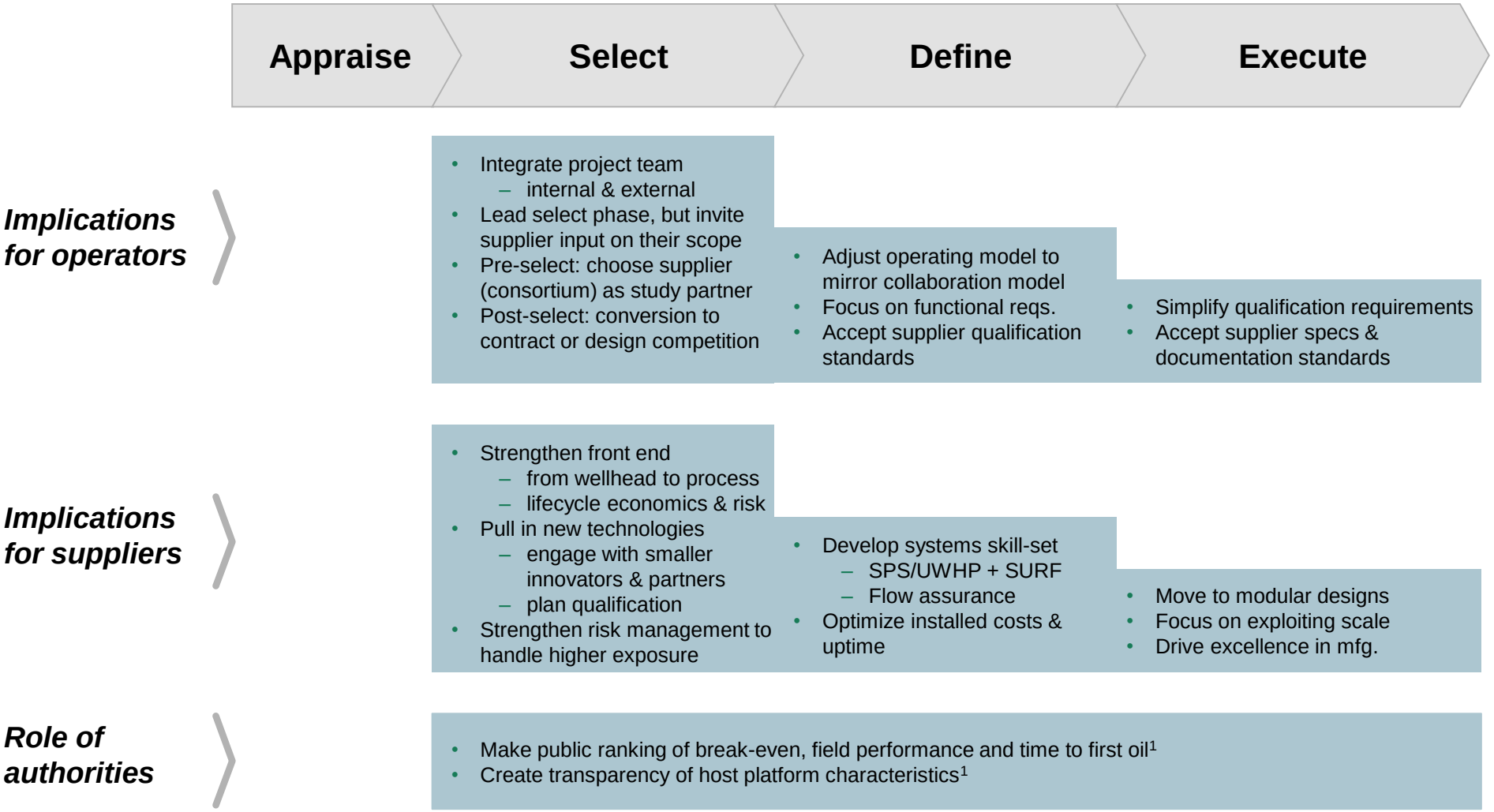
1. Performance based payments can take different forms depending on the role the supplier plays (see example on Artificial Lift contract for illustration on how to adapt contract structure to problem)
2. Reimbursable study, followed by a Lumpsum: Operator defines scope and actively manages study in early phase. Converts to Lump sum where Supplier takes over execution responsibility
Source: OG21 interviews and Industry workshop, BCG Analysis

Lean tiebacks: Earlier engagement with a greater scope calls for a significant change in operator-supplier relationship

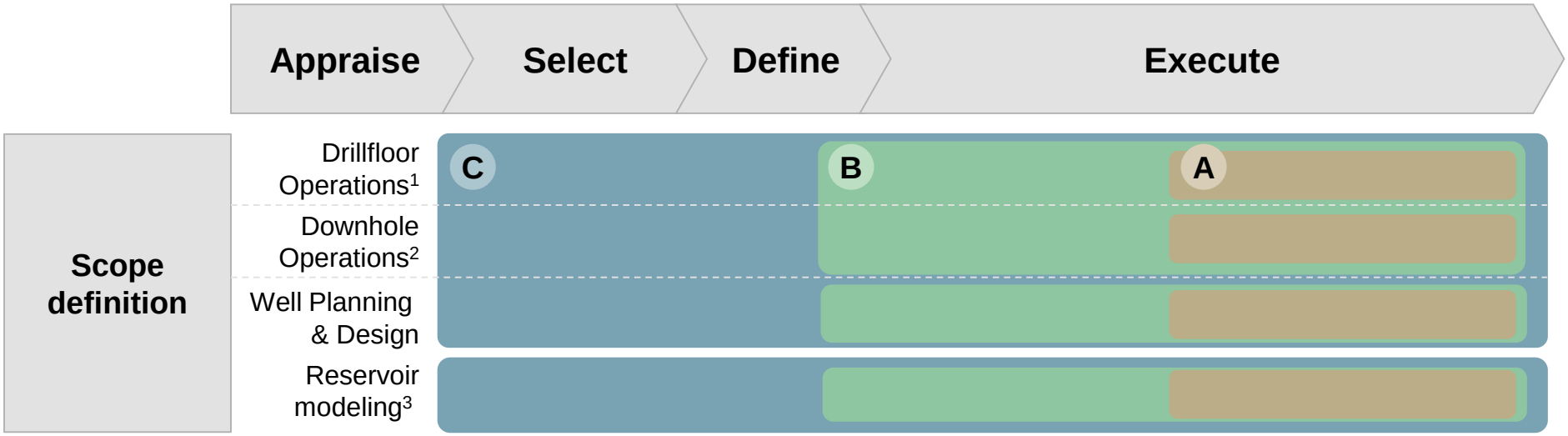


1. Extent, type and identifiability of data that can be released is likely to be subject to contractual & legal constraints – will require prior agreement amongst key stakeholders

Source: OG21 interviews and Industry workshop, BCG Analysis

II. Enhanced Drilling & Well Productivity

II Enhanced drilling & well performance: Highest value seen in performance focused integration of well design & delivery



Business model archetypes

C. Adapt well design

Maximize well value by:
- optimization of reservoir contact & completion design
- early integration of new tech.

B. Accelerate construction

Faster wells, by:
- alignment between services
- optimizing service tool set-up for speed & NPT minimization
- data integration & automation

C. Simplify operations

Minimize costs, by:
- bundling similar services
- maximizing synergies in skills, equipment and logistics

Model suggested by workshop groups

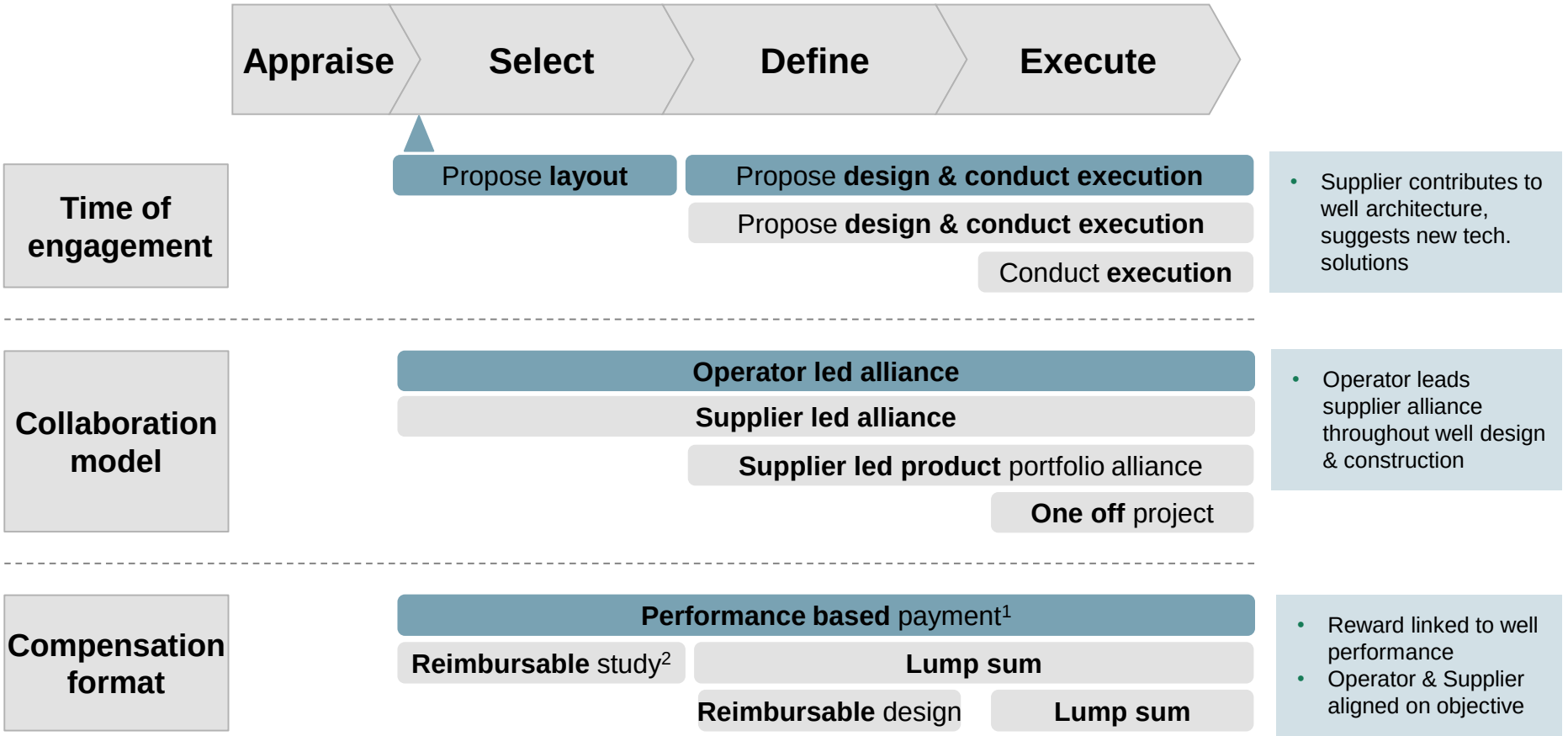
2/3rd of groups

1/3rd of groups

0 groups

1. Includes Rig contractor and drilling equipment OEM (top-drive, mud-pumps) 2. Includes all drilling services (logging, directional drilling) and well services (completions, artificial lift, etc.)
3. Reservoir Modeling and Well Planning & Design integrated through Oil Company Workflows
Note: OG21 Industry workshop held on 23rd May in Oslo with ~45 participants from a broad range of O&G players on NCS
Source: OG21 industry workshop, BCG Analysis

II Enhanced drilling & well performance: Operators lead, but actively engage suppliers earlier to contribute to well design



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Note 2: Operator led alliance - where operators drive the selection of companies in a set-up. The alternative is Supplier led alliances
1. Performance based payments can take different forms depending on the role the supplier plays (see example on Artificial Lift contract for illustration on how to adapt contract structure to problem)
2. Reimbursable study, followed by a Lumpsum: Operator defines scope and actively manages study in early phase. Converts to Lump sum where Supplier takes over execution responsibility
Source: OG21 interviews and Industry workshop, BCG Analysis

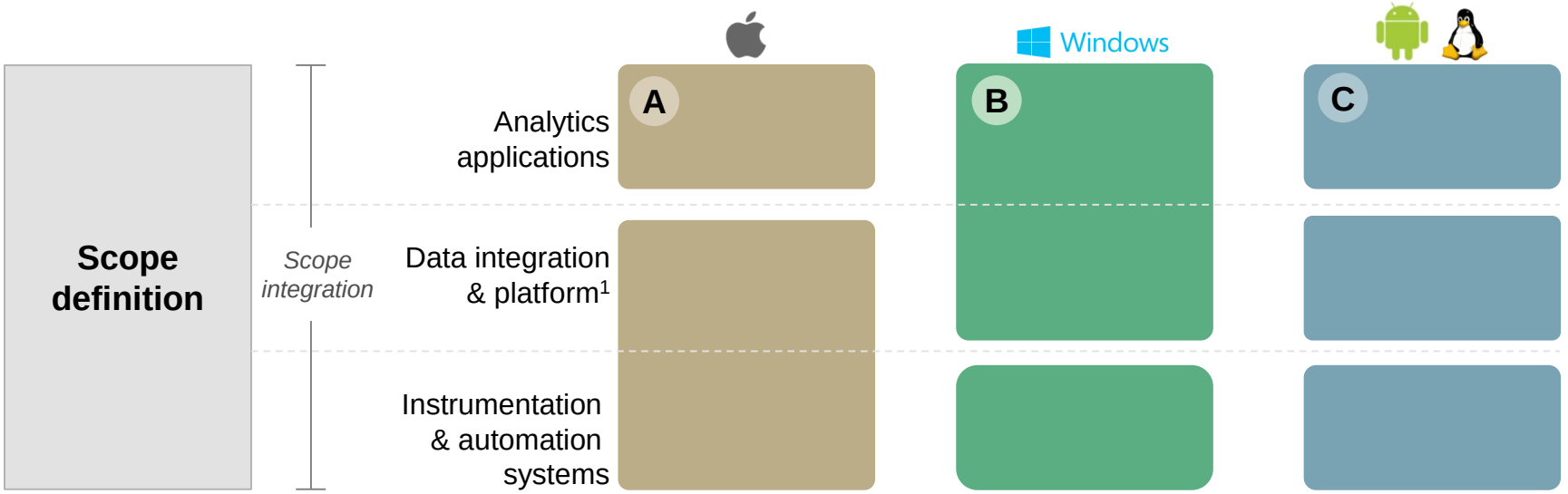
II Enhanced drilling & well performance: Operators to drive, but engage key suppliers earlier to contribute to well design

	Appraise	Select	Define	Execute
Implications for operators		• Establish one project team – internal & suppliers • Jointly assess new tech. risk • Pre-select: choose supplier (consortium) as study partner • Post-select: conversion to contract or design competition • Measure on well productivity	• Adjust operating model to mirror collaboration model • Lead collaboration process between Rig & Well services • Accept supplier integrated services if functionally sound • Measure on HSE,NPT & speed	• Simplify qualification requirements • Accept supplier specs & documentation standards
Implications for suppliers		• Integrate value chain knowhow – Reservoir to well services – well performance • Pull in new technologies – engage with smaller innovators & partners – plan qualification • Strengthen risk management to handle performance exposure	• Integrate solutions from sub-suppliers – tech & delivery • Extract synergies across new combinations of services	• Multi-skill crews • Streamline operations w.r.t crew, tools & logistic costs
Role of authorities		• Make public ranking of drilling efficiency and well performance[1]		

1. Extent, type and identifiability of data that can be released is likely to be subject to contractual & legal constraints – will require prior agreement amongst key stakeholders
Source: OG21 interviews and Industry workshop, BCG Analysis

III. Data driven productivity enhancement

Data driven productivity enhancement: most value seen in creating open eco-systems to capture maximum innovation



Business model archetypes

A. Build on plant automation platform

Simplify deployment by:
- building on existing plant data & analysis systems
- minimizing impact on plant OT[2] systems architecture

0 groups

B. Build on enterprise platform

Simplify deployment by:
- building on enterprise application software suite(s)
- minimizing impact on enterprise IT[3] architecture

0 groups

C. Build on new open platform

Maximize innovation by:
- decoupling systems with new, open middleware
- enabling true mix and match optionality

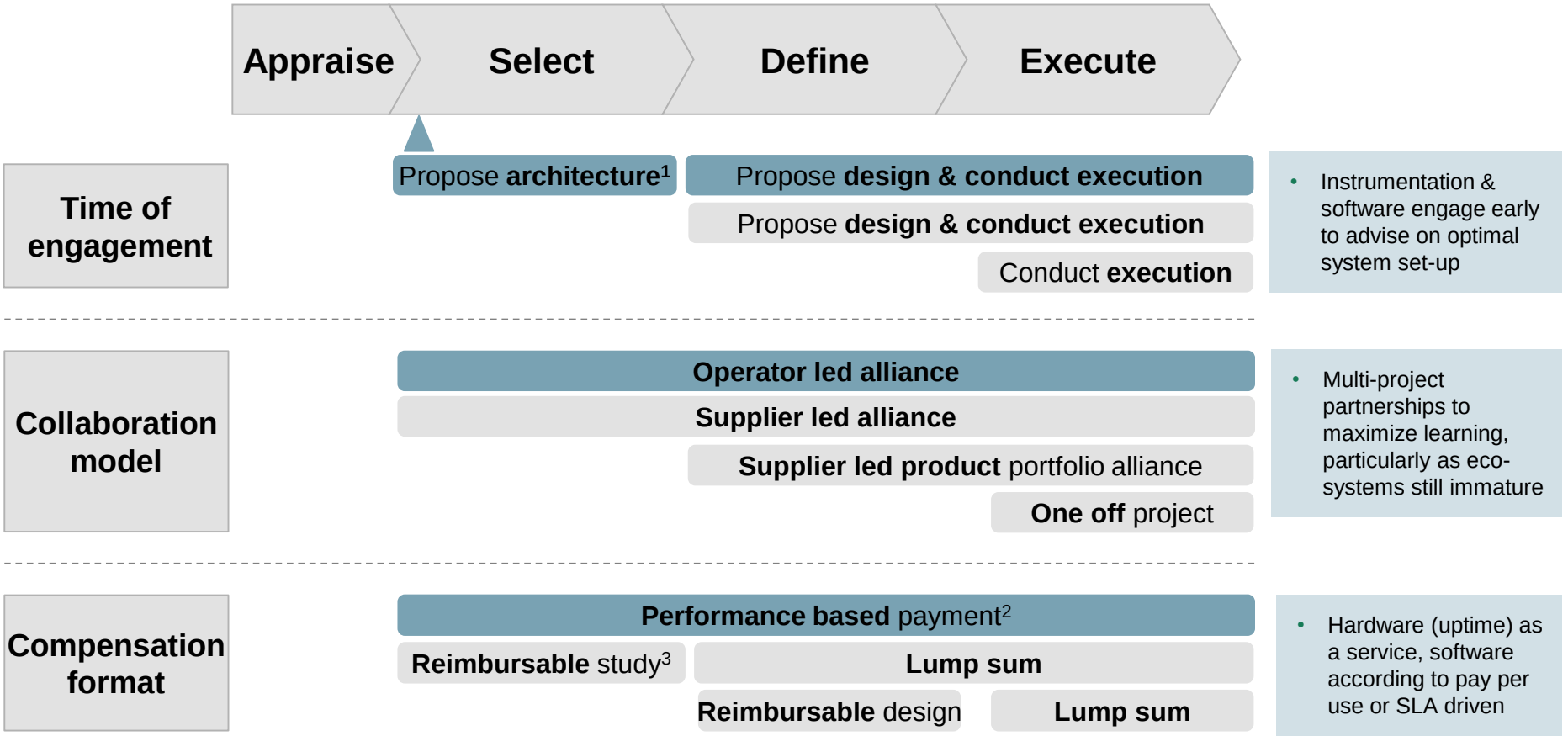
All groups

Model suggested by workshop groups

1. Data Platforms provide large scale cross-asset data harmonization & storage (including with Big Data / cloud based file systems) , access /security functions
2. OT = Operational Technology (Plant automation systems) 3. IT = Information Technology – referring to enterprise software systems like ERP and/or Petro-technical software environments

Source: OG21 interviews and Industry workshop, BCG Analysis

Data driven productivity: Early engagement, operator led alliances and performance based payments still important



Note: Alliance as a term refers collectively to formal Combinations of suppliers – including JVs, non-incorporated alliances, and mergers, typically integrating horizontal capabilities.
Note 2: Operator led alliance - where operators drive the selection of companies in a set-up. The alternative is Supplier led alliances
1. Architecture (vs layout) an appropriate term in Data and software systems context
2. Performance based payments can take different forms depending on the role the supplier plays (see example on Artificial Lift contract for illustration on how to adapt contract structure to problem)
3. Reimbursable study, followed by a Lumpsum: Operator defines scope and actively manages study in early phase. Converts to Lump sum where Supplier takes over execution responsibility
Source: OG21 interviews and Industry workshop, BCG Analysis

Data driven productivity enhancement: Success with open systems requires operators to take a central role

Implications for operators

- Drive open data exchange standard definitions with other operators
- Initiate partnerships with tech cos, key OEMs, automation cos and new entrants
- Strengthen capability across software value chain, including cybersecurity & technology scouting
- Incentivize by pay for performance:
  - hardware as a service (CAPEX to OPEX) from key OEMs and automation companies
  - software with pay per use / based on SLAs

Implications for suppliers

- Technology Platform Companies:
  - engage with Operators to define common infrastructure solutions
  - leverage experience & scale outside O&G to offer low cost, secure platforms
- Automation providers, key OEMs & major petro-tech software companies:
  - engage in standard setting to ensure interoperability of own systems
  - adapt to pay for performance models (pricing, risk, ops support)
- New entrants:
  - ensure technology is standards compliant / certified for use
  - engage with operators and key suppliers to pilot and accelerate adoption

Role of authorities

- Facilitate data governance – rules of sharing & permissible data use across players
- Define set of data to be published and shared across operators and suppliers[1]
- Publish anonymized data-sets for use by industry players and new entrants to spur innovation[1]

1. Extent, type and identifiability of data that can be released is likely to be subject to contractual & legal constraints – will require prior agreement amongst key stakeholders

Source: OG21 interviews and Industry workshop, BCG Analysis

Applicability of the preferred solutions to OG21 prioritized technologies

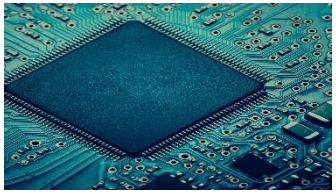
Majority of OG21 prioritized techs. share characteristics with the 3 themes, and will benefit from corresponding solutions

Themes with most similar characteristics

	OG21 Prioritized Technologies	Lean tieback solutions	Enhanced drilling & well productivity	Data driven productivity enhancement
G&G	• Enhanced Seismic imaging			✓
	• 4D Seismic systematic application	✓		
Subsea	• Cost-efficient subsea developments	✓		
	• All-electric subsea wells & systems	✓		
	• Cost efficient subsea intervention		✓	
Drilling & wells	• Drilling automation & NPT reductn. drilling techs.		✓	
	• Smart well solutions	✓		
	• Cost effective P&A of wells		✓	
	• High North drilling solutions	✓		
Production	• Efficient marine ops.		✓	
	• Condition monitoring			✓
	• Unmanned facilities/Remote operations	✓		✓
	• Production Optimization			✓
Increased recovery	• Efficient Data integration for reservoir mgmt			✓
	• EOR Techs (CO2, water diversion, new EOR)	✓	✓	
Environment	• Carbon efficient power solutions for facilities	✓		
	• Weather forecasting, comms. (High North)		✓	✓
	• Tech. safety barriers & oil spill prep. (High North)	✓		

Note: Where multiple ticks appears for a prioritized technology, the implication is that different technology sub-components match different themes
Source: OG21; Industry interviews; BCG analysis

The 3 tech themes have distinct underlying characteristics

	Implementation decision window	Scalability	Qualification hurdle	Innovation to cash cycle
 **Lean tiebacks**	Pre-DG3 (often earlier)	Low (often targeted to single fields)	High	Slow (~5+ years)
 **Enhanced drilling & well performance**	Several opportunities over life of field[1]	Medium to High (targeted across many fields)	Medium	Medium (~3-5 years)
 **Data driven productivity enhancement**	Several opportunities over life of field[2]	Very High	Low to Medium	Fast (~ 0-2 years)

1. Certain well & completions technologies require existing field support, and may not be practical to implement on a per well basis
2. Some Data driven technology may require field architecture upgrades, and can be better classified under Lean TieBack Solutions.
Note: Timeframes are indicative
Source: BCG Analysis

Example: Successful Artificial Lift performance contracts align operators & suppliers using value linked KPIs

Artificial Lift (ESP[1]) system performance contracts

Understanding the root causes of value loss in AL applications..

Artificial Lift is often mission critical
- Failed pump => no production
- Sub-optimal application => low production, NPT

Most failures emerge post installation, symptoms superficially similar – e.g. motor failures, trips

Root cause discovered after thorough analysis
- often needs a tear-down of ESP
- may take multiple events

And originates from various sources – each mitigated by different parties at different times
- design defect (OEM, service co.)
- sub-optimal application engineering (service co / operator)
- power system issues (potentially multiple parties)
- manufacturing defect (OEM, service co)
- incorrect installation (service co)
- incorrect operational settings (operator)

.. and the very nature of wells
- unexpected gas fractions, slugs, sand, etc.

.. helps design Performance Contracts around the right factors

Success ensured by structuring contracts smartly
- Engage suppliers early – optimize application design
- Expect supplier to take broader responsibility:
  - address system issues that affect lifetime, beyond ESPs
  - apply appropriate technology, beyond internal solutions
  - keep pumps operational over extended lifetime
- Structure payments to match objectives:
  - initial payment contingent on surviving early mortality
  - recurring payments over pump operational life
  - bonus for exceeding target runtime

.. and using a portfolio approach to help with grey zones
- AL performance also depends on many factors not known / understood a priori – including actual well behavior
- failure analysis outcome is not always conclusive

Performance Contracts for Artificial Lift are successful
- Lifetimes trend higher on performance contracts
- Operators gain through better performance, reduced NPT
- Suppliers rewarded for superior performance over lifetime

1: Electrical Submersible Pump – a key component in Artificial Lift Systems
Source: BCG experience & analysis

Lessons from other industries

The automotive industry transformed to a high-performing, collaborative eco-system – a model for O&G?

Not exhaustive

From a credo of "squeezing" players…

Transactional, cost-driven relationships between all players of the value chain

- ✗ OEMs forced price cuts of on average 3% annually
- ✗ Cost pressure was cascaded down the value chain to lower-tier suppliers
- ✗ OEM-supplier relationships were characterized by a culture of blame, suspicion and competing interests

"Demolition Derby"

…to a high-performing eco-system

1. **Increased performance by increased collaboration**
2. **Effective capture of innovation**
3. **Joint development of standard interfaces**
4. **Proactive use of data driven technologies and compensation models**

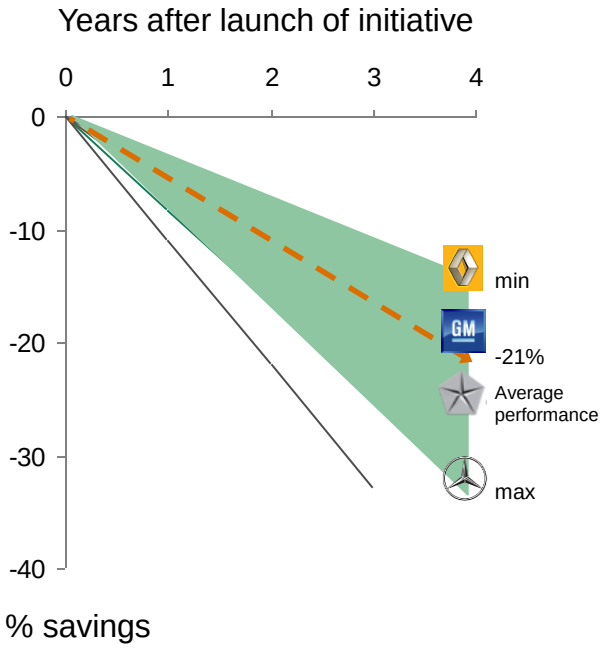
"Relay-race"

Source: BCG analysis, expert interviews

1 The reward of close collaboration with suppliers is huge – substantial results achieved in automotive

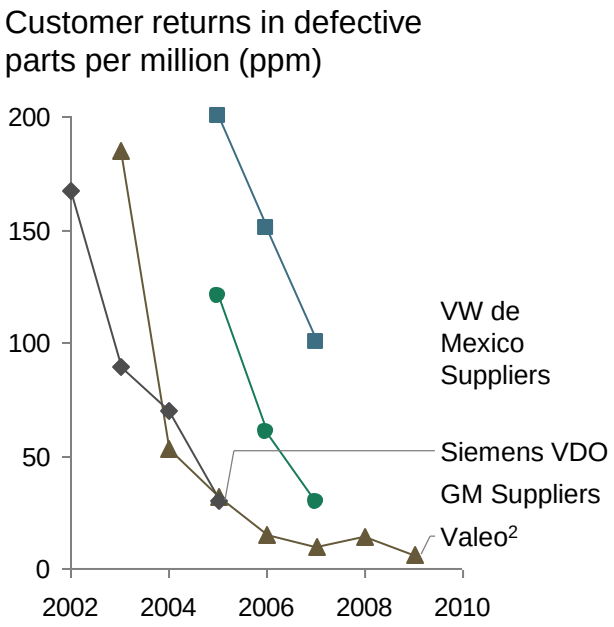
Illustrative

Drastic costs[1] reduction



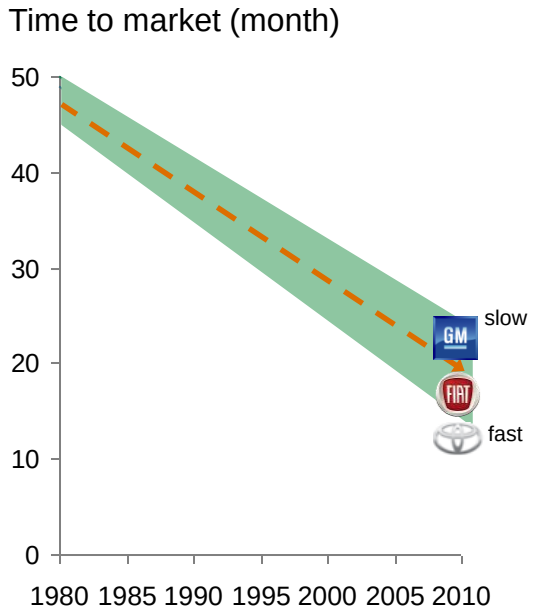
~ 21% lower overall average costs

Boost in Quality



~ 90% less defective parts

Faster development



~ 55% improvement in time to market

1. Cost reduction performance of international OEMs - figures include performance at Renault (Cntrat 2009), GM (Top 20 Suppliers), Chrysler (Suppliers of choice), Daimler Group (Core)
2. Data for 2009 as of May '09

Source: BCG Analysis; Press; Company reports

1 Close collaboration is beneficial even between competitors

O&G suppliers can benefit from joint R&D and collaboration in manufacturing to achieve scale

Benefits for BMW	*Win-Win logic*	Benefits for Toyota
• **Sharing R&D cost** with partner	***Cooperation in developing lightweight materials***	• Profiting from **BMWs carbon and light-construction expertise** • **Sharing R&D cost** with partner
• Profiting from **deep Toyota battery expertise** • **Sharing R&D cost** with partner	***Develop next generation of lithium-ion battery cells***	• **Gaining scale** for future battery platforms • **Sharing R&D cost** with partner
• Profiting from deep **Toyota fuel cell expertise** • **Sharing R&D cost** with partner	***Collaboration on developing fuel cell technology***	• **Sharing R&D cost** with partner • **Gaining scale** for fuel cell platform
• Gaining **scale for niche product**	***Collaboration on vehicle architecture (sports car)***	• Getting BMW **sports car development expertise** • Gaining **scale for niche product**
• **Increased scale** for engine platform without add. investments • Underlines **attractiveness of BMWs diesel engines for other OEMs**	***BMW supplies 1.6l & 2.0l diesel engines to Toyota***	• Gaining **competitive diesel** engine • **Avoiding investment** in sub-scale engine platform

Source: BMW investor presentations, BMW analyst conference transcripts, Press research; Expert interviews; BCG analysis

2 Operators can actively capture new tech and drive adoption

Suppliers with integration know how and open system are essential for adoption at scale

Challenge

Valuable autonomous haulage technology is available outside the industry, but low adoption in mining

Existing business models a hurdle

- Legacy suppliers offer closed systems without standard interface

Limited experience of legacy players with autonomous haulage solutions

Actions

Operator starts to take an active role in forming the ecosystem

- Seek out supplier with technology and integration competence
- Require supplier to create open system that is compatible to other systems

Enter into partnership agreement that enables both parties to protect their interests

Outcome

✓ **Operator is able to realize cost reductions through efficiency gains**

✓ **Vendor received possibility for successfully testing and integrating innovative technology into mining sector**

✓ **Legacy suppliers in mining industry are forced to adapt to new technology**

Highlights

- Vendor responsible for development, pilot-testing and **integration** of system, but can **retain IP rights** and offer solution to other operators
- Operator first player to receive access to fully integrated and **open system**, benefits from growing experience of supplier

Source: Press research; Expert interviews; BCG analysis

2 Capturing innovation can also become an essential part of the procurement process for operators and suppliers

Months before SOP[1]

~120 | ~60 | SOP[1]

Trend scouting | **Project sourcing** | **Series sourcing**

Assess innovative ideas and relevant suppliers

Example

Established interdisciplinary innovation councils to assess selected ideas presented by existing and new suppliers through Web portal and offline channels

Strategically pre-select suppliers

Example

Create trend scouting team (ten FTEs) in purchasing to
- identify and assess trends
- preselect suppliers
- maintain supplier contact

Actively integrate supplier market, product and process know-how

Example

Integrate supplier's own market surveys when developing new vehicle's interior concept

1. Start of production.
Source: Integrated interior team presentation; BCG interviews; BCG analysis

3 A joint industry effort towards an open data integration platform could also facilitate new O&G techs and services

Challenge

Availability, ownership and access to integrated, high-quality live mapping data is crucial to

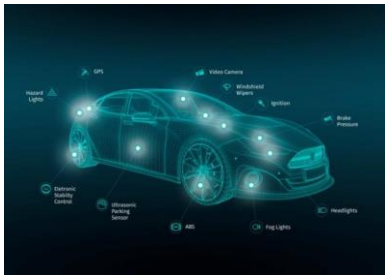
- Mature techs such as self-driving vehicles and connected mobility
- Provide new service offerings

Key to receive sufficient data is an attractive integration platform

Actions

BMW, Audi, Daimler acquire highly accurate digital mapping system "Here"

- Integrates geographical live data from vehicles
- Clear separation between roles as customers, investors and suppliers ensured through governance structure
- "Here" will remain open to other customers and investors



Outcome

OEM's have access to growing amount of anonymous data

- 2million+ connected cars provide high quality data
- Further goal is to include data from other OEMs
- Provides basis for techs such as autonomous driving
- Introduction of location-based services, potentially to other industries

You have competing brands which are putting their data together to create very unique services which were not possible before,"

Bruno Bourguet, Global Head of Sales at HERE

Competing automotive players benefit from jointly leveraging big data for new technologies and services

Source: Press research, expert interviews, BCG analysis

3 BMW in open platform collaboration to create scale and accelerate adoption of step-change technology

Automotive players ⟷ **Technology players**

Provides iNEXT model as foundation for autonomous driving

- Access to other building blocks for autonomous driving, such as "HERE"

Goal: deliver an autonomous driving system for serial production in 2021

- Aspire to define **industry standard**
- **Open platform**, available to other OEMs and industries
- **Non-exclusive** partnership

Provides computing power and connectivity

- In-vehicle and cloud **computing**
- Connectivity, safety and machine learning assets

Integrates solution into various OEM vehicle architectures

- Expertise in automated driving and electrical architecture

Offers essential capabilities for autonomous driving

- Sensing, localization and driver policy **technology** and **algorithms**

Note: Intel acquired Mobileye in March 2017
Source: Press research, BCG analysis

4 Data driven tech. enables performance based contracts– and create value for both operators and suppliers

Rolls-Royce

'Power-by-the-hour'

- ✚ Provides **predictability** in revenues
- ✚ Minimized **exposure** to seasonality
- ✚ Locks in clients via service plan
- ✚ Shows **high quality** of offering

Long-term Service Agreement

- Payments for uptime on a per engine hour basis
- Provision of add-on services for engines

SINGAPORE AIRLINES

- ✚ Gives **cost predictability**
- ✚ **Incentivizes** supplier to continuously improve products and technologies
- ✚ Gives freedom to **focus** on core business
- ✚ **Reduces** downtime

Incentivizes technology uptake

Distributed sensors

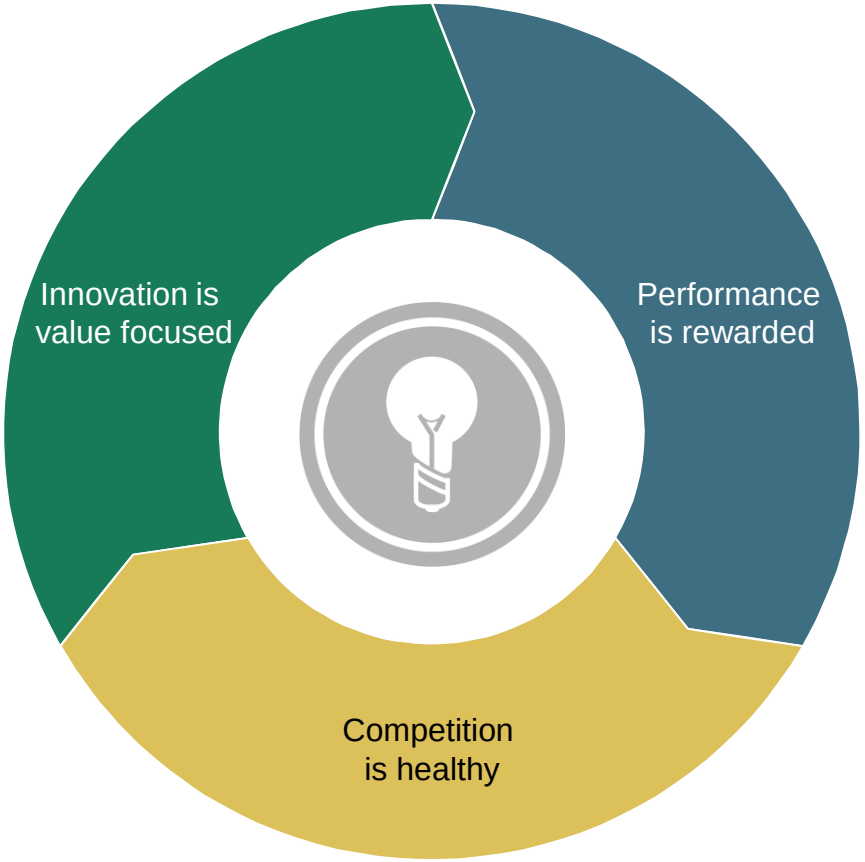
Big data and analytics

Predictive maintenance

Note: "Power-by-the-hour" is trademarked by Rolls-Royce but similar programs are offered by other suppliers
Source: Press research, expert interviews, BCG analysis

Three interlinked characteristics of innovative eco-systems

- *Innovation is focused on solving customers' problems*
- *Innovators have deep insight into what the customer values*



- *Top performing innovators enjoy superior margins*
- *Both customers and shareholders reward innovation*

- *Market continuously creates opportunities for players through evolving needs, new growth opportunities and open standards*

Source: BCG Analysis

Recommendations

Sufficient common ground to embark on a set of actions

Operators	• Seek cost innovation through **early engagement** with **supplier alliances**[1] • **Modify operating model** to mirror collaboration set-up with suppliers • Focus on **functional requirements** where suppliers in lead • Shift to **pay for value**, reward innovation through balanced risk / reward set-ups • **Lead & drive open data standards** for industry, formalize data governance
Large systems & equipment suppliers	• **Refocus innovation** to cost and effectiveness, exploiting scale • **Strengthen systems integration teams** to match changing client expectations • **Engage smaller innovation partners** to enhance R&D capability • Strengthen **risk management** to handle increased exposure to customer value
Smaller suppliers & new entrants	• Vet **technology portfolio vs. industry priorities** – rigor-test business cases • Strengthen commercial mindset - **business planning and IP strategy** • **Seek collaborations** with large system integrators, but align expectations upfront
Authorities	• Actively drive **creation of common open data standards** for storage and exchange • **Formalize governance** for data sharing & acceptable use amongst players • Make **selected data available publically** to stimulate competition & innovation[2] • Increase emphasis on **commercial training** of entrepreneurs in O&G space

1. Alliance as a term refers collectively to formal Combinations of suppliers – including JVs, non-incorporated alliances, and mergers, typically horizontal
2. Extent, type and identifiability of data that can be released is likely to be subject to contractual & legal constraints – will require prior agreement amongst key stakeholders

Source: OG21 Interviews and workshop, BCG Analysis

Appendix

Project approach: This report is based on interviews, analyses, industry research and workshop discussions

Preparation & pre-report

~25 interviews with a broad range of senior executives

- Key NCS players sharing perspectives on high impact techs and business model options

Research and interviews with experts from other industries

- Selected relevant business model innovations from other industries Leveraging BCG's global network of experts

Industry workshop

Discussion and feedback on initial report

- Testing initial findings with ~45 workshop participants
- Refining recommendations based on workshop output

Consolidated report

Synthesis

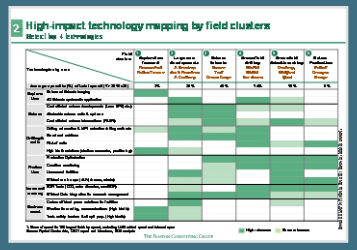
- As input to OG21's project that will be published in Nov 2017

This section zooms on interview and workshop process

We asked senior O&G executives to identify priority technology areas & convert them into high-impact themes

From list of prioritized technologies ...

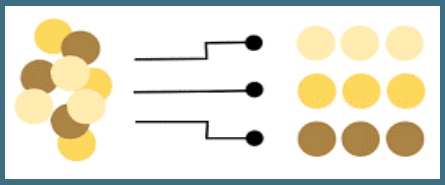
... to high-impact themes



List of OG21 prioritized technologies

Voting by interview participants

Identification of their priority technology area



Classification of inputs with 3 filters:

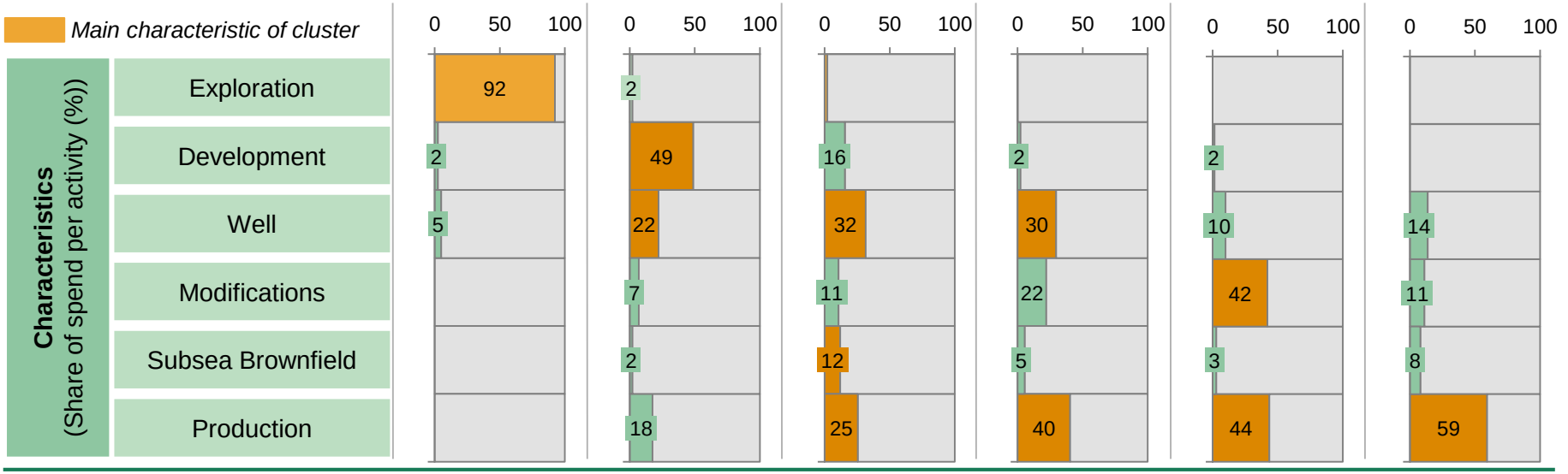
- Value and impact (weighted by NCS future activity)
- Where business models issues a significant barrier
- Clustering themes that share similar characteristics from collaboration perspective

Executives from a range of stakeholders interviewed

6 distinct field clusters on NCS

tieback is most dominant, representing ~40% of spend and production

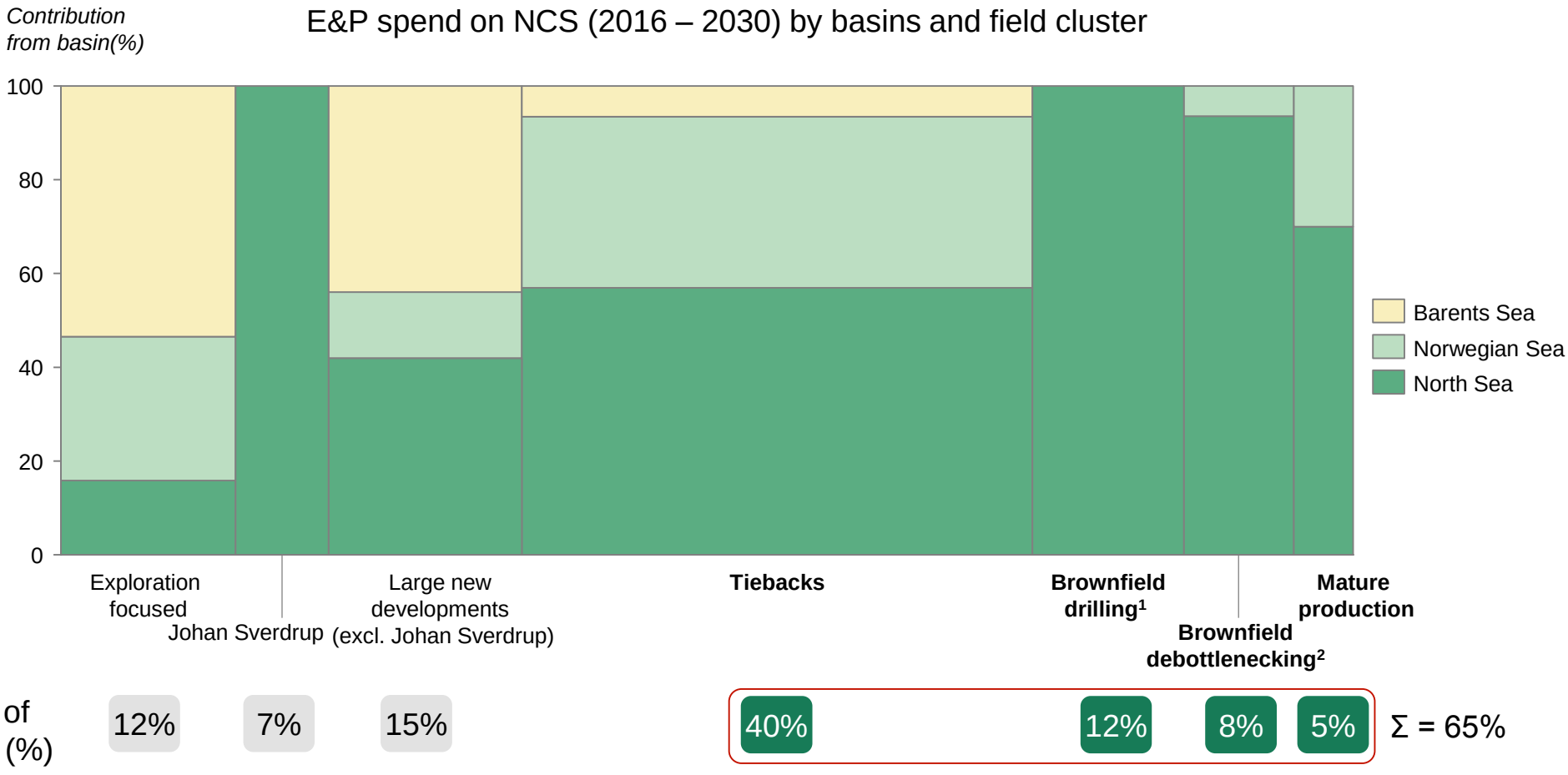
Field clusters *Example fields*	1 Exploration focused *Hammerfest* *Halten Terrace*	2 Large new developments *J. Sverdrup* *Aasta Hansteen* *J. Castberg*	3 Tiebacks *Snorre* *Troll* *Ormen Lange*	4 Brownfield drilling *Ekofisk* *Eldfisk*	5[1] Brownfield debottlenecking *Oseberg,* *Statfjord* *Njord*	6 Mature Production *Valhall* *Draugen* *Brage*
Future production (%)	**n.a.**	**20%**	**40%**	**12%**	**20%**	**4%**



Total share of spend[2]	12%	22%	40%	12%	8%	5%

1. Brownfield debottlenecking: Facility (topside) upgrades and modifications, new satellite facilities in an existing field. 2. From 2016 to 2030.
Note: Numbers may not add up to 100% perfectly due to rounding errors; Dev't includes topside and subsea costs for new developments; Well includes drilling, well completion & stimulation costs for both new and brownfield developments; subsea includes subsea capex for brownfields.
Source: Rystad DCube data (April 2017); BCG analyses

A two-pronged challenge - Tiebacks to unlock new resources while maximizing cash output from North Sea brownfields



1. Brownfields with significant ongoing drilling activity to manage production. 2. Brownfields with significant topside upgrades and modifications, to manage changes in produced fluids
Note: % may not add up to 100% due to rounding
Source: Rystad DCube, April 2017; BCG analysis

For NCS, 3 technology themes have emerged as most critical

These themes target the main field clusters and have the potential to close the cost gaps substantially

OG21 Prioritized Technologies		Interview feedback
G&G	• Enhanced Seismic imaging	Often cited
	• 4D Seismic systematic application	Often cited
Subsea	• Cost-efficient subsea developments	Frequently cited
	• All-electric subsea wells & systems	Infrequently cited
	• Cost efficient subsea intervention	Infrequently cited
Drilling & wells	• Drilling automation & NPT reductn. drilling techs.	Frequently cited
	• Smart well solutions	Infrequently cited
	• Cost effective P&A of wells	Infrequently cited
	• High North drilling solutions	Infrequently cited
Production	• Efficient marine ops.	Often cited
	• Condition monitoring	Often cited
	• Unmanned facilities/Remote operations	Frequently cited
	• Production Optimization	Frequently cited
Increased recovery	• Efficient Data integration for reservoir mgmt	Frequently cited
	• EOR Techs (CO2, water diversion, new EOR)	Infrequently cited
Environment	• Carbon efficient power solutions for facilities	Often cited
	• Weather forecasting, comms. (High North)	Infrequently cited
	• Tech. safety barriers & oil spill prep. (High North)	Infrequently cited

Frequently cited Often cited Infrequently cited

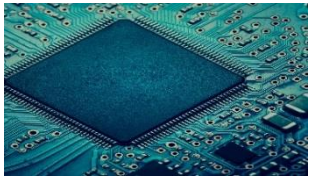
I Lean tiebacks

- Unlocking marginal fields
- Simplified solutions
- Subsea and/or UWHPs[1]

II Enhanced drilling & well performance

- More productive wells
- Faster and safer drilling
- Minimized NPT

III Data driven productivity enhancement



- Enhanced reservoir recovery
- Maximize throughput
- Minimized NPT
- Remote ops & unmanned systems

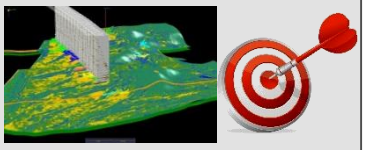
Note: List is an aggregated form of comprehensive list of OG21 prioritized technologies, grouped by technical and application area similarity. 1. Unmanned wellhead platforms.
Source: Interviews; BCG analysis

Data driven innovation valuable across the value chain

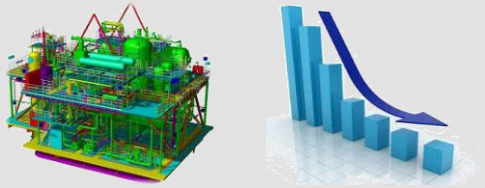
Effective data sharing & access across range of parties is a prerequisite

Explore & Appraise	Select & Define	Execute	Drilling	Operate
Accelerate interpretation with machine learning	Fully optimize field architecture with smart & integrated modeling Reduce project risk by integrating details earlier	Synchronize project build using Digital Twins & BIM[2] Eliminate duplication through systematic re-use	Faster well delivery with closed loop automation Optimize well design using data analytics	Optimize production with real time data & advanced models enabled by IIoT[3] Optimize uptime using predictive maintenance and Digital Twins

Optimize for constructability & cost



- Higher success rate
- Superior field dvpt. plans



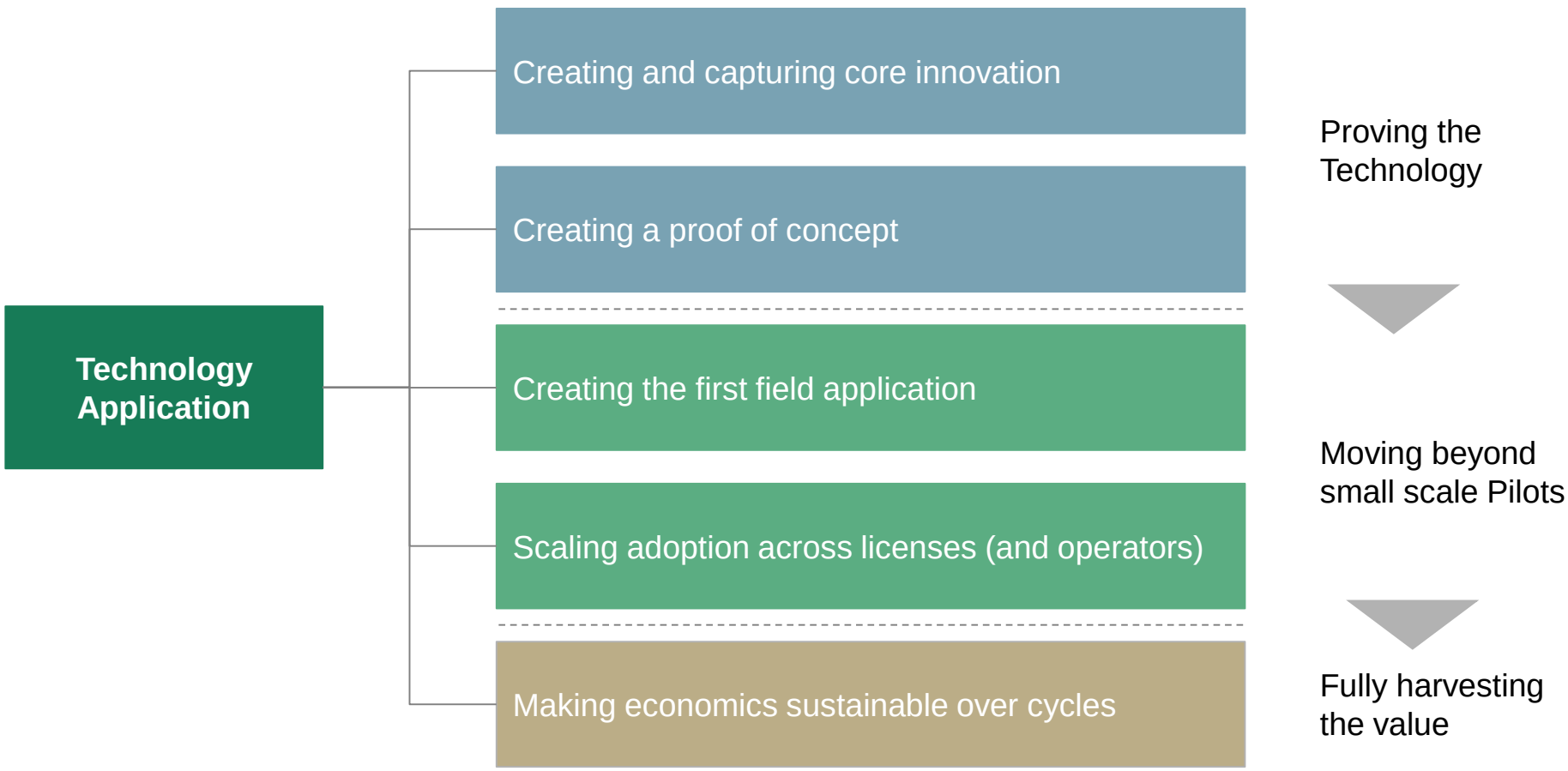
- Higher value field concepts
- Significant reduction in engineering hours
- Quicker to first oil

- More productive wells
- Faster construction
- Lower NPT

- More throughput
- Improved recovery
- Lower opex

1. Drilling covers E&A and Development / Infill drilling 2. Building Information Modeling 3. Industrial internet of things
Source: Case experience, SPE One Petro papers and JPT articles, BCG analysis

We discussed technology adoption challenges in detail with interviewees, seeking to understand underlying causes



Source: BCG

We also discussed a range of business model solutions that could help in overcoming the specific challenges raised

Not Exhaustive

Barrier	*Potential solutions*		
	Supplier led	**Operator led**	**Industry group led**
Innovation capture	Corporate Venture Funds	Corporate Venture Funds	Structured start-up incubators
	Academic partnerships	Academic partnerships	Open Challenges (X-Prizes)
	IP In-licensing from outside parties	Tech licensing to suppliers	
Proof of concept	Large suppliers creating pilot ops for smaller ones – labs/field tests	Operator (or consortia) creating and 'advertising' smaller scale pilots	Pooling corporate lab capacity for wider industry use
	Leveraging simulations to reduce hurdle for proof of concept		Established common criteria for low cost testing (e.g. simulation)
First field application	Delivering through supplier alliances[1]	Preferred vendor constellations	Creating NCS specific qualification standards
	Licensed manufacture of new IP by larger suppliers	Design competition to select best concepts	Joint creation/investment in key interface standards
Application at scale	Cross-licensed manufacturing across multiple suppliers	Long term supply agreements with select vendors	Simplifying facility sharing negotiations
	Product-as-a-service contracts	Leveraging operator-operator alliances (demand aggregation)	
Sustainable commercial model	Performance based contracting – different sharing of risk & reward	Greater sharing of demand profiles for longer term planning	
	Bridge loans to help small suppliers enter risk-reward contracts	Bridge loans to help small suppliers enter risk-reward contracts	

1. Includes full range of alliances, - both incorporated (e.g. JVs) and otherwise
Source: BCG

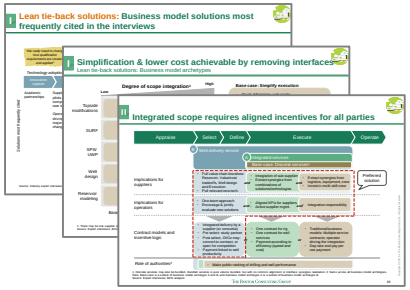
We then developed & tested potential solutions for each of the three technology themes

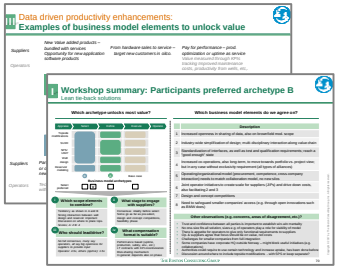
Analysis of Potential Solutions

Workshop discussions & outcome

I

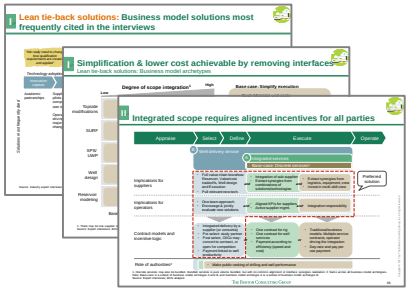
Lean tiebacks

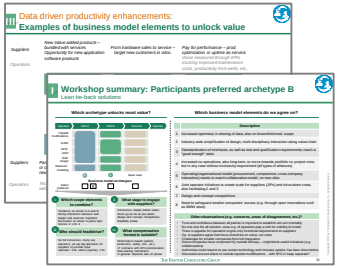




II

Enhanced drilling & well performance





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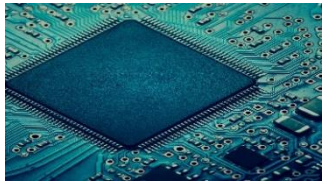
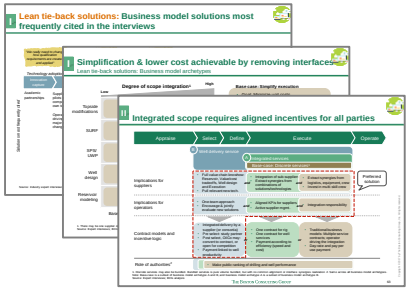
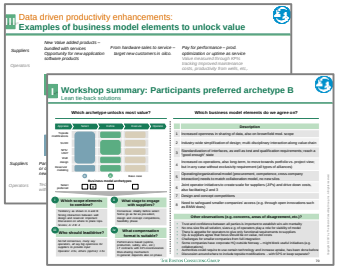


Data driven productivity enhancement

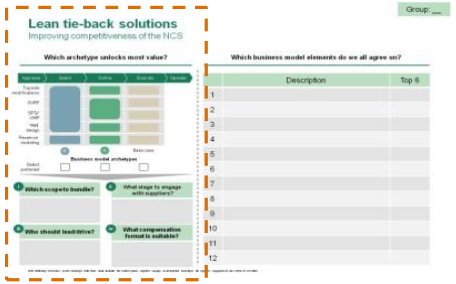


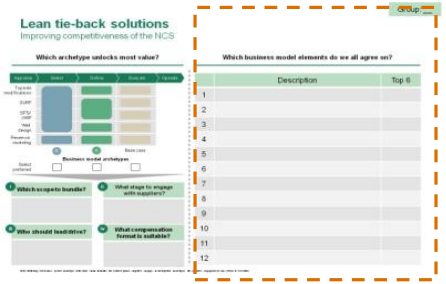


Workshop: Session with ~45 industry participants

Workshop discussions covering business model archetypes and elements for three themes[1]

Zoom on the business model archetype and elements on the three themes in following slides





	Business Model archetype	Business Model elements
Objective	• Identify which archetype unlocks most value • What this means for key questions	• Align on what actions (along the business model elements) that people agree on
Discussion format	• Discuss pro and cons and select preferred business model archetype on poster • Capture answers to key questions detailing out selected archetype on the poster	• Discuss to identify elements that participants agree on and try to prioritize the elements • Capture other observations/comments related to business model elements
Duration	**~20 minutes** (incl. 5 mins introduction to theme)	**~20 minutes** (incl. 5 mins wrap-up)

Each of the themes discussed separately – in total 6 times per theme

1. Detail on business model archetype and elements on the three themes in following slides

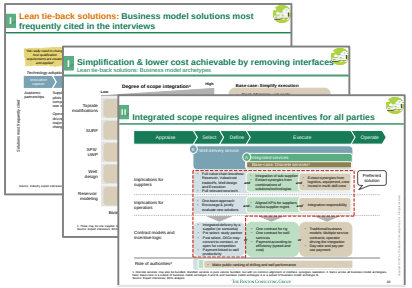
I Lean Tiebacks

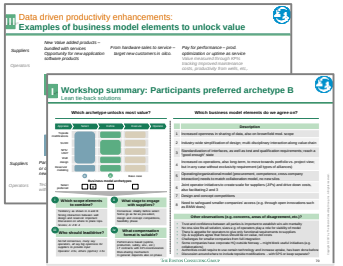
Analysis of Potential Solutions

Workshop discussions & outcome

I

Lean tiebacks





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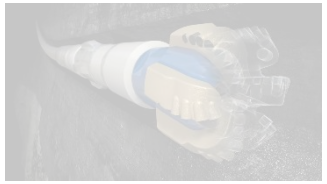
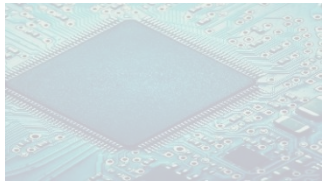


Enhanced drilling & well performance

III



Data driven productivity enhancement

Business model solution elements most frequently cited in the interviews

"We really need to change how qualification requirements are created and applied"

"Natural to integrate SURF +SPS as production system"

"If a supplier .. could license the IP, it gives the innovator royalties, and keeps the competition in the industry"

Technology adoption journey

Innovation capture	Proof of concept	First field application	Application at scale	Sustainable commercial model
Solutions most frequently cited				
Academic partnerships	Suppliers create pilots for smaller companies in own test portfolio Operators driving pilots for major new step change tech.	**Supplier led** integration / simplification Supplier alliances **simplifying integration** **Design comp.** to find the best concepts Simplified / harmonized **qualification standards**	Cross-licensed manufacturing to achieve scale Operator **alliances to aggregate demand** Simplifying **host platform** integration OilCo adjust operating model to match collaboration model	**Performance based incentives** **Subsea as a service** / leasing models

Supplier to lead simplification and Integration

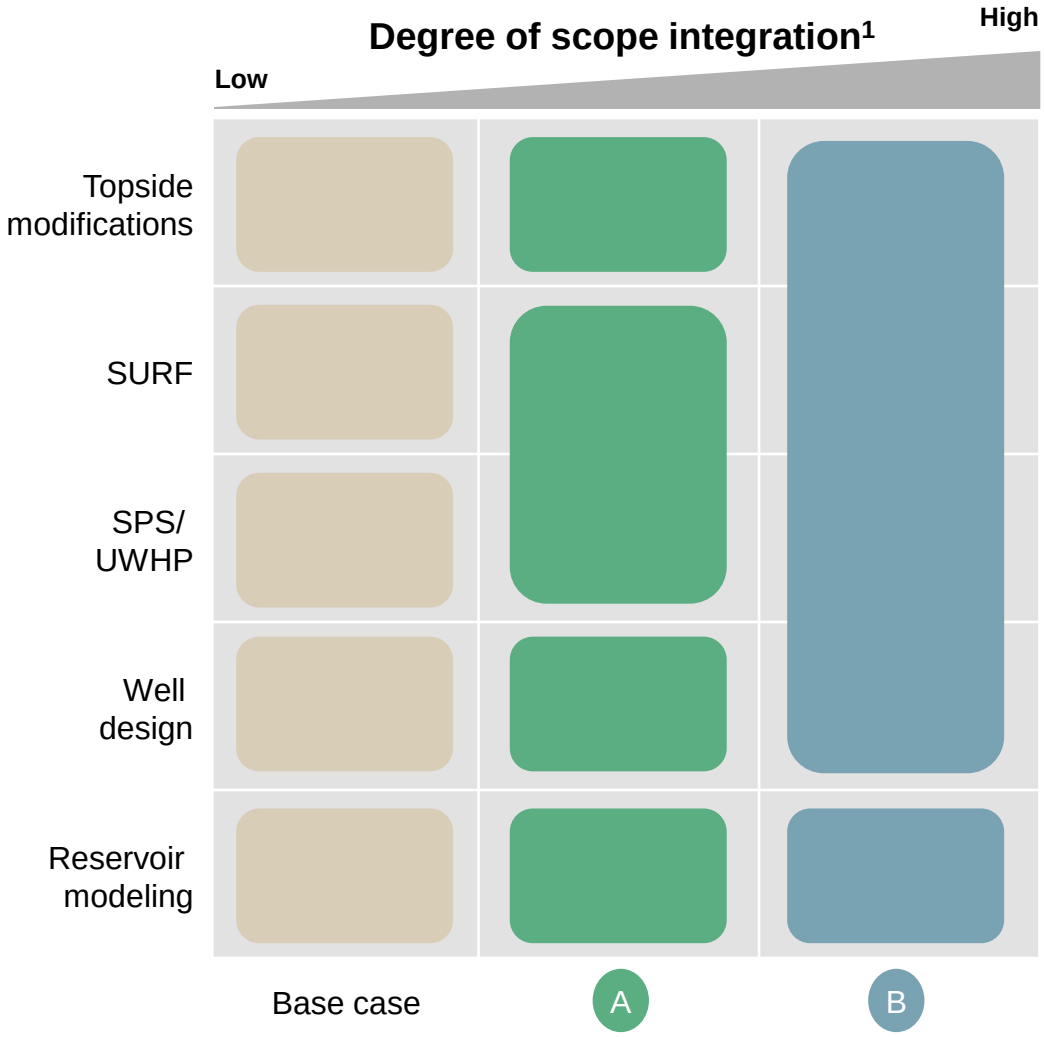
OilCos need to shift from cost to performance focus

Create opportunities to deploy innovation as a cost lever

Source: Industry expert interviews conducted week 16-20, 2017

Simplification & lower cost achievable by removing interfaces

Lean tieback solutions: Business model archetypes



Business model archetypes

Base case: Simplify execution

- Goal: Minimize unit costs
- Key levers:
  - manufacturing excellence
  - modular, re-usable designs
  - simplify requirements

A Simplify Design

- Goal: Simplify for unit cost, maximize uptime
- Key levers:
  - reduce interfaces
  - modular, configurable hardware
  - design for unit cost, integrity & uptime

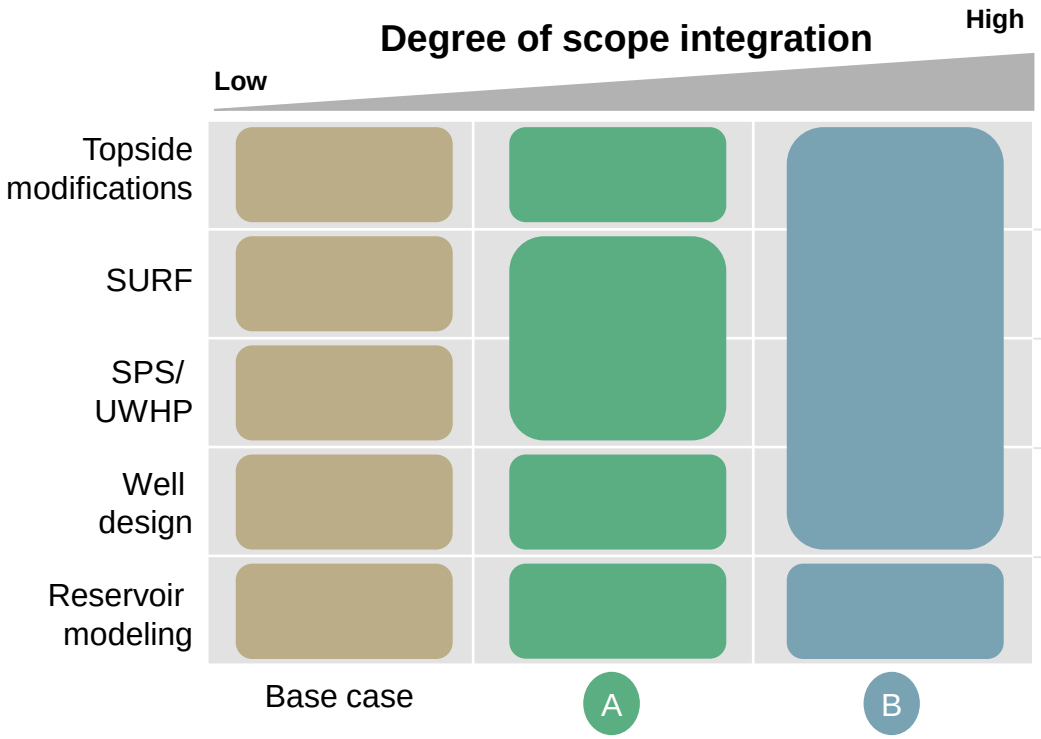
B Adapt field layout

- Goal: Minimize break-even
- Key levers:
  - introduce new technologies
  - adapt field layout
  - leverage staging and optionality

1. There may be one supplier delivering the whole scope or many suppliers delivering through alliances as one team

Source: Expert interviews; BCG analysis

Back-up: Characteristics of key dimensions



Description

- Modifications of existing topside installations on host platforms
- Umbilical, risers and flowline from production template to host platform, including installation
- Subsea production system, e.g. X-mas tree, control system
- UWHP as alternative to subsea system
- Optimal well trajectory based on targets
- Well completion designs (schematic and equipment)
- Target selection: what pay zones to hit and how many wells to drill

Additional comments

Base

In this archetype, all shown scope elements are tendered **individually**. The **operator** is responsible for **integration** and management of **interfaces.**

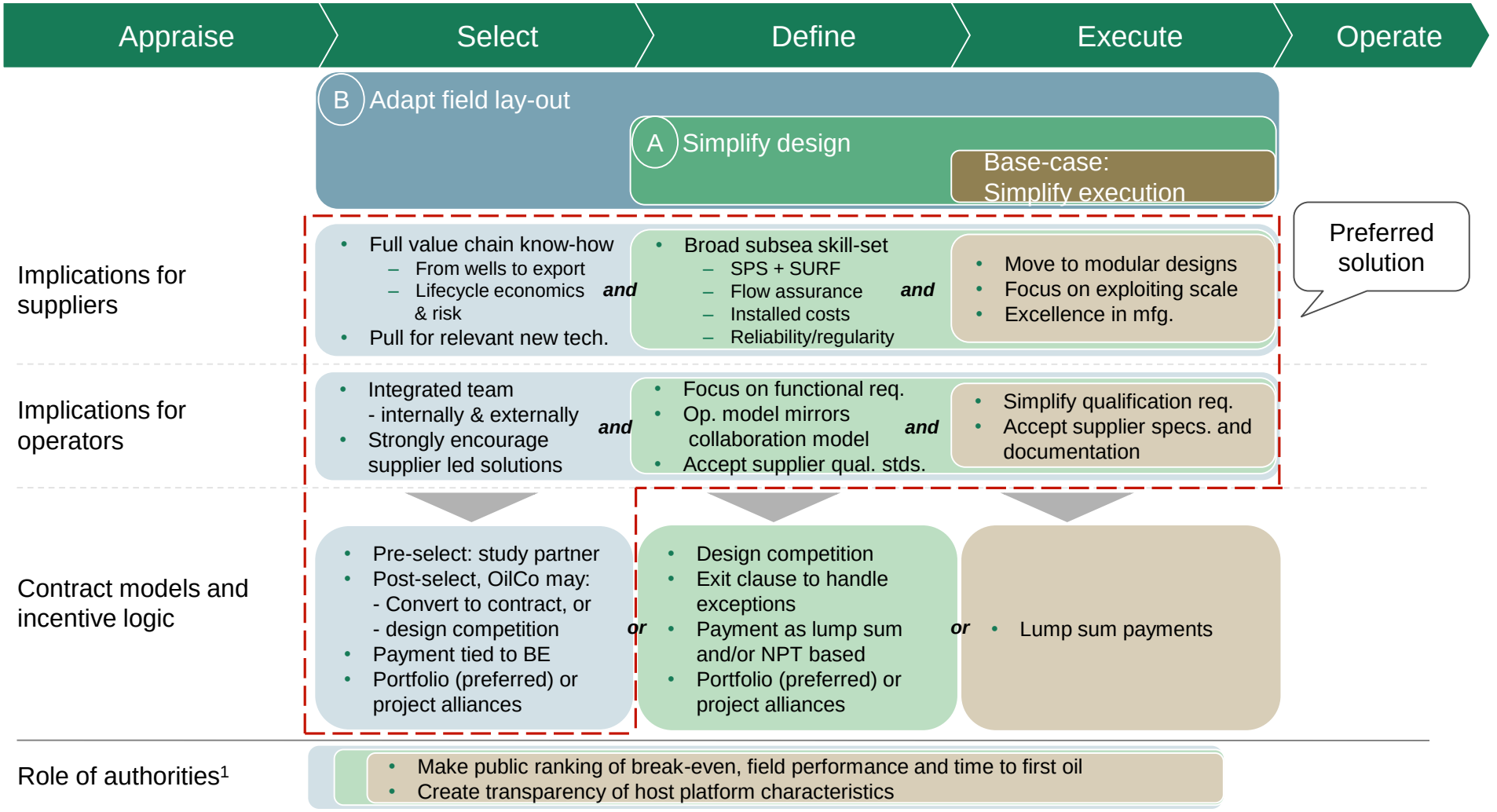
A

SURF and SPS scope are delivered by single supplier or alliance. Suppliers will **manage** the **interface**.

B

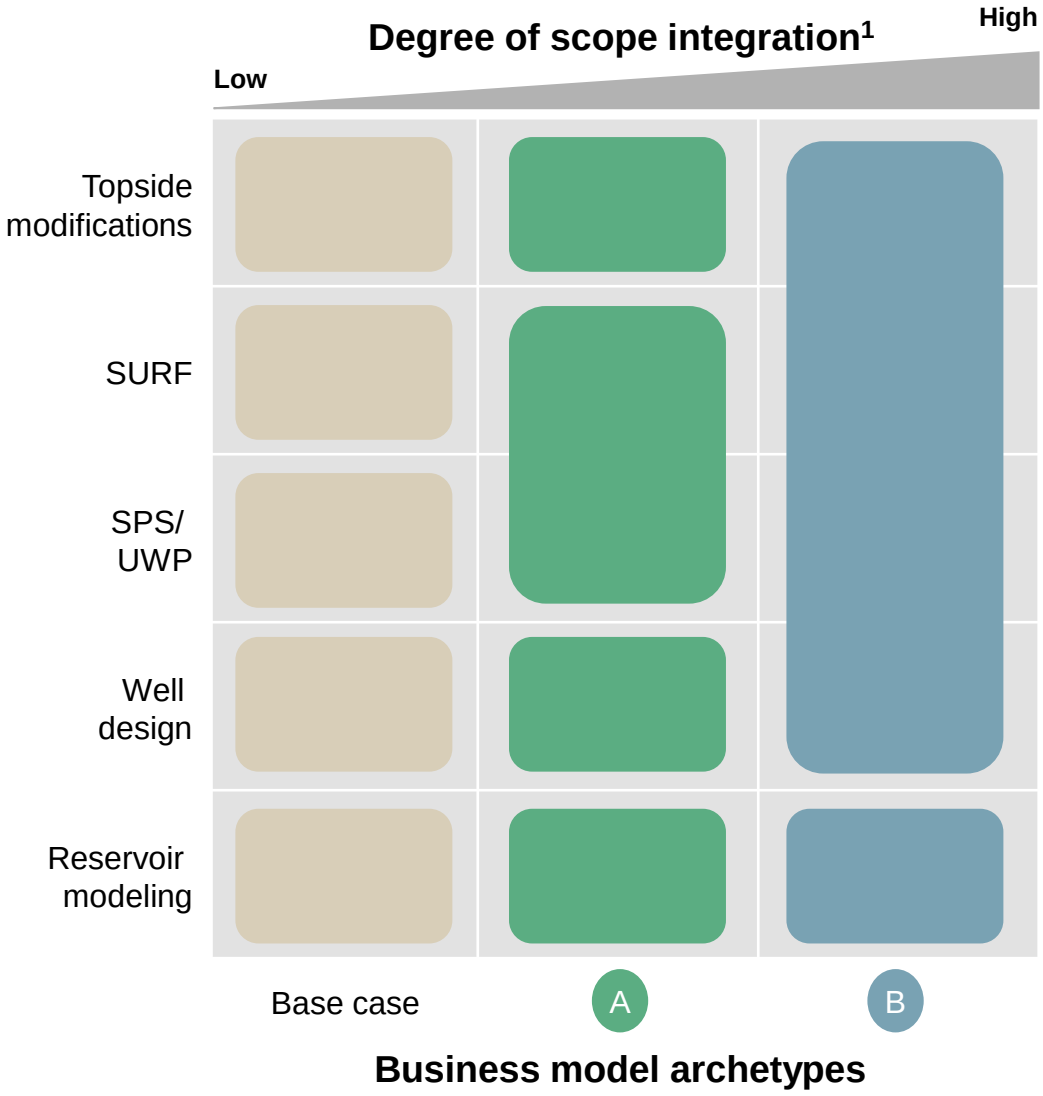
The company **manages** the **full scope** through alliances or sub-suppliers. It does not imply that one company has all services in their portfolio.

Increasing scope integration requires earlier engagement, and a significant change in operator-supplier relationship



1. Same across all business model archetypes.
Note: Base-case is a subset of business model archetype A and B, and business model archetype A is a subset of business model archetype B.
Source: Experts interviews; BCG analysis

Workshop discussion:
Business model archetype and key questions

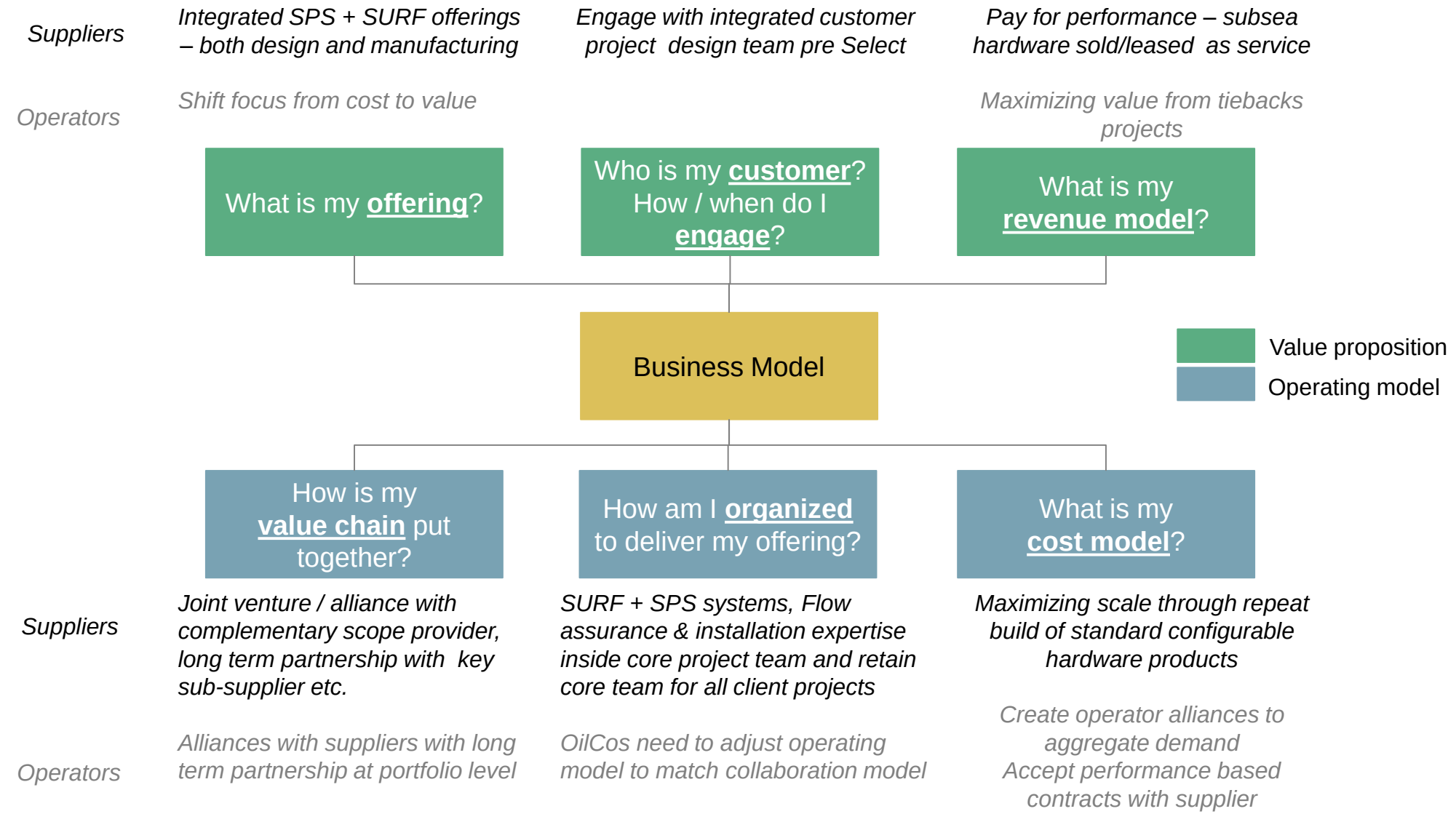


4 questions to consider:

- Which **scope elements** to combine?
- What **stage** to engage with suppliers?
- Who should **lead/drive?**
- What **compensation format** is suitable?

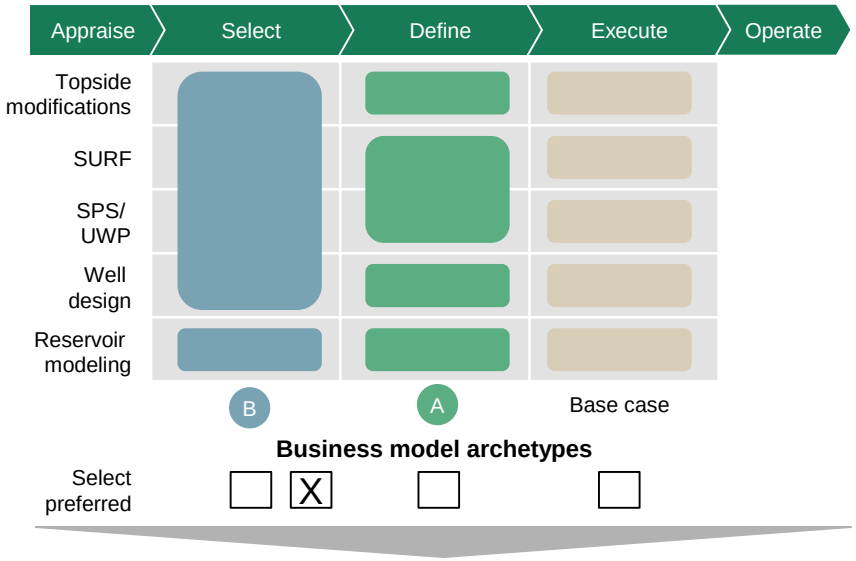
1. There may be one supplier delivering the whole scope or many suppliers delivering through alliances as one team 2. Includes drilling equipment.
Source: Expert interviews; BCG analysis

Workshop discussion:
Examples of business model elements to unlock value



Workshop output: Lean Tiebacks
Participants preferred archetype B

Which archetype unlocks most value?



i Which scope elements to combine?

Tendency as shown in A and B
Strong interaction between well design and reservoir important
Discussion on where to place tops.
Scores; A: 2 B: 4

ii What stage to engage with suppliers?

Consensus: ideally before select
Some go as far as pre-select, design and concept competitions, feasibility phase

iii Who should lead/drive?

No full consensus, many say operators, all say big openness for suppliers to provide input
Operator: 4.5x, others (op/mix): 1.5x

iv What compensation format is suitable?

Performance based (uptime, production, safety, env., etc.)
LT contracts with KPI-incentivization
Risk-sharing mechanism
In general: depends also on phase

Which business model elements do we agree on?

	Description
1	Increased openness in sharing of data, also on brownfield mod. scope
2	Industry-wide simplification of design; multi-disciplinary interaction along value chain
3	Standardization of interfaces, as well as test and qualification requirements; reach a "good enough" state
4	Increased co-operations, also long-term, to move towards portfolio vs. project view; but in any case without exclusivity requirement (all types of alliances)
5	Operating/organizational model (procurement, competence, cross-company interaction) needs to match collaboration model, no new silos
6	Joint operator initiatives to create scale for suppliers (JIPs) and drive down costs, also facilitating 2 and 3
7	Design and concept competitions
8	Need to safeguard smaller companies' access (e.g. through open innovations such as BMW does)

Other observations (e.g. concerns, areas of disagreement, etc.)?

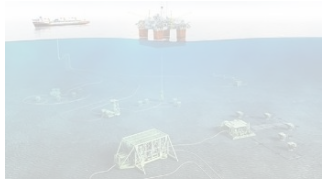
- Trust and confidence between all parties is important to establish win-win mentality
- No one-size fits all solution, sizes e.g. of operators play a role for viability of model
- There is appetite for operators to give only functional requirements to suppliers
- Op. & suppliers agree that focus should be on value, not costs
- Challenges for smaller companies from full integration
- Some companies have corporate HQ outside Norway – might block useful initiatives (e.g. collaborations)
- Authorities could require to use certain technology and increase uptake, has been done before
- Discussion around where to include topside modifications - with SPS or keep separate?

II Enhanced Drilling & Well Performance

Analysis of Potential Solutions

Workshop discussions & outcome

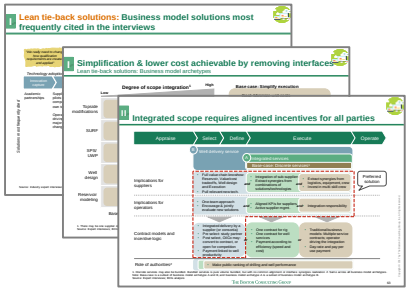
I

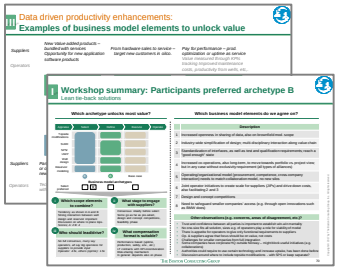


Lean tiebacks

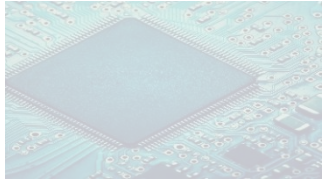
II

Enhanced drilling & well performance





III



Data driven productivity enhancement

Business model solution elements most frequently cited in the interviews

"Autonomous drilling is the end goal, it's happening in onshore right now and gradually move toward offshore"

"Bring all parties together on the table and take out a lot of interfaces waste - this is the first step"

"Key is to figure out right KPIs that align incentives for all parties and links to well productivity not just the drilling speed"

Technology adoption journey

Solutions most frequently cited

Innovation capture	Proof of concept	First field application	Application at scale	Sustainable commercial model
	Suppliers creating pilots for smaller companies Leveraging **simulations** in drilling test facilities Operators creating pilots opportunities for new suppliers	**Preferred vendor constellation** to deploy autonomous drilling **Open standard interfaces** for data integration	**Integrated contracting** for drilling & well services Operator-operator alliances to aggregate the demand Simplification of technical requirements **Common rig regulation across regions** (e.g. between UK and Norway)	**Drilling efficiency as a service** **Well delivery as a service** (linked to well productivity) KPIs elevate from **speed to value**

Untapped potential to leverage supplier technology and know-how

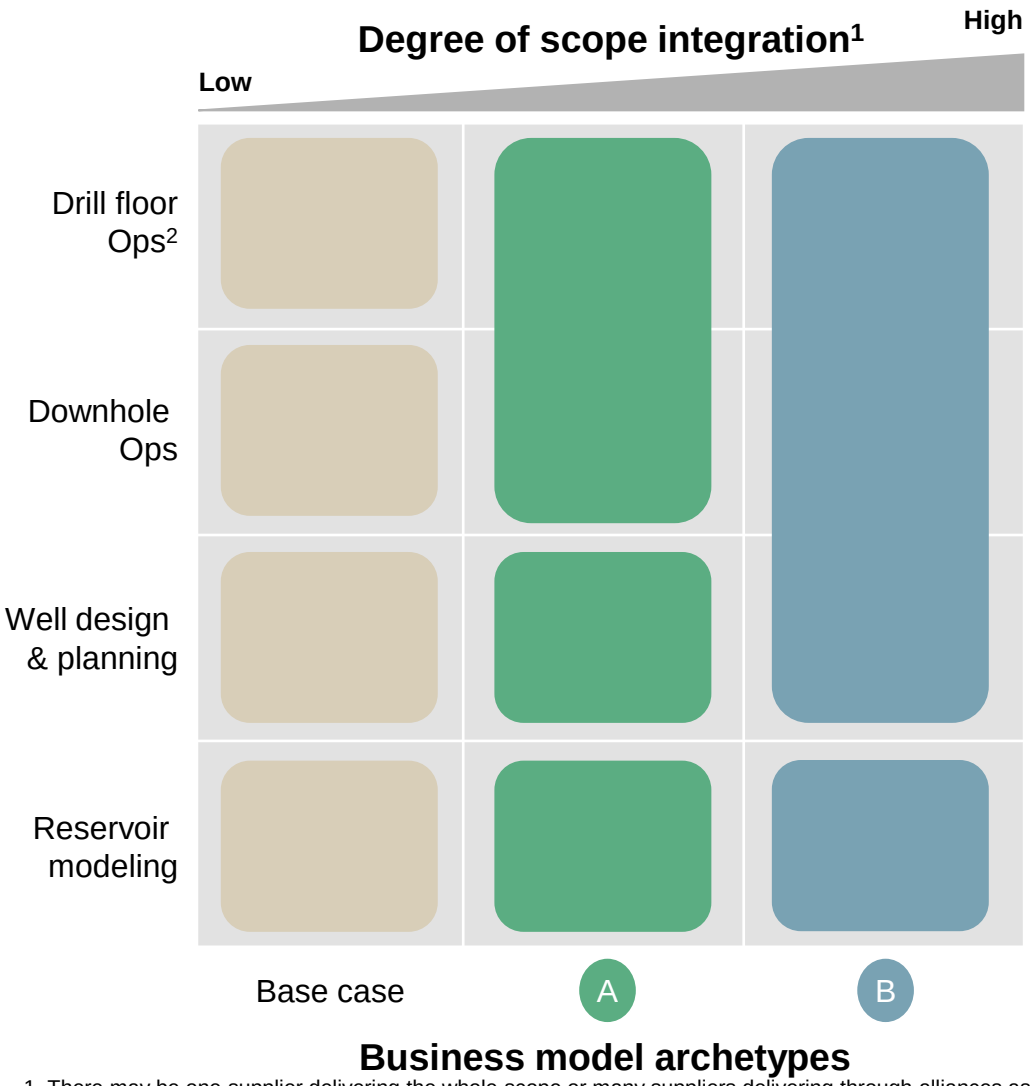
Suppliers and operators need to have shared incentives

Industry need to elevate focus from speed to value

Source: Industry expert interviews conducted week 16-20, 2017

II Increased value orientation through scope integration

Enhanced drilling and well performance: Business model archetypes



Base case: Discrete services

- Goal: Minimize costs
- Key levers:
  - Bundling of volumes
  - Maximization of synergies in skills, equipment and logistics

A Integrated services

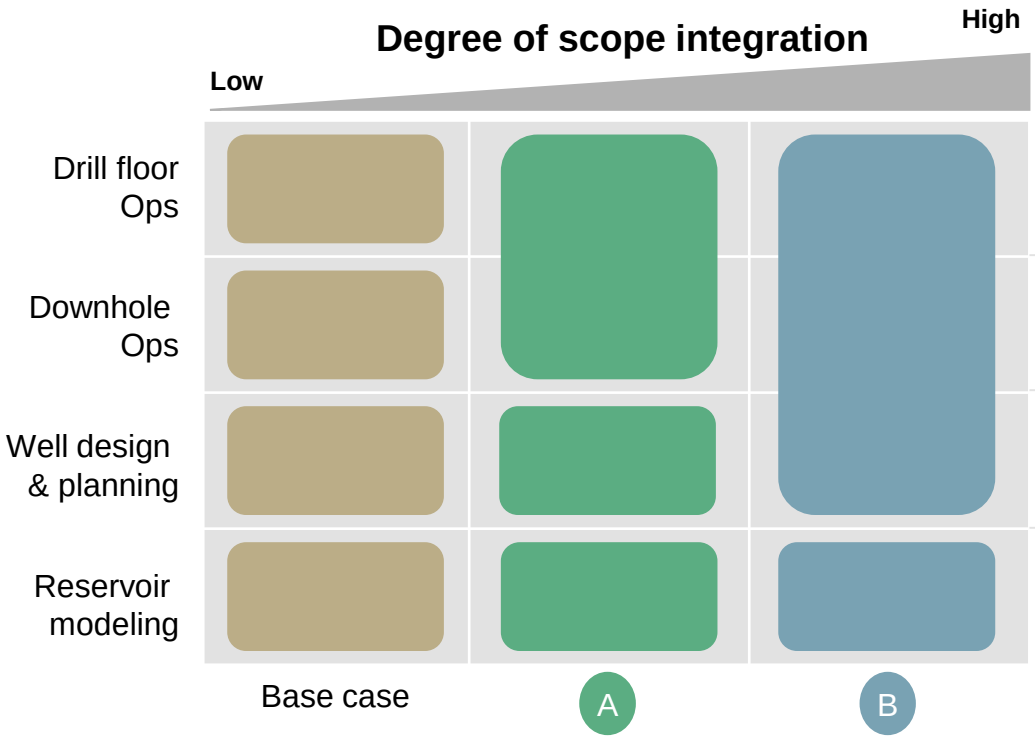
- Goal: Faster wells
- Key levers:
  - Alignment between services
  - Speed and NPT minimization
  - Data integration & automation

B Well delivery service

- Goal: Deliver max value from well
- Key levers:
  - Introduction of new technologies
  - Optimization of drainage (reservoir contact and completion design)

1. There may be one supplier delivering the whole scope or many suppliers delivering through alliances as one team 2. Includes surface equipment (top-drive, mud pumps, etc.)
Source: Expert interviews; BCG analysis

Back-up: Characteristics of key dimensions



Description of dimensions

- Rigs, drilling rig equipment (e.g. Top-drive, mud-pump) and drill floor services (e.g. platform drilling services)
- Drilling services e.g. logging, directional drilling, mud
- Well completion services e.g. cementing, fracking, artificial lifting
- Well trajectory design based on reservoir targets
- Well completion design (both schematic and equipment)
- Drilling & completion programs for the well
- Selection of reservoir targets- what pay zones to hit and how many wells to drill?

Comments on the archetypes

Base

Downhole ops scope is split between multiple well service contractors each with individual KPI. Operator picks and choose from multiple service contracts. Integration is operator's responsibility

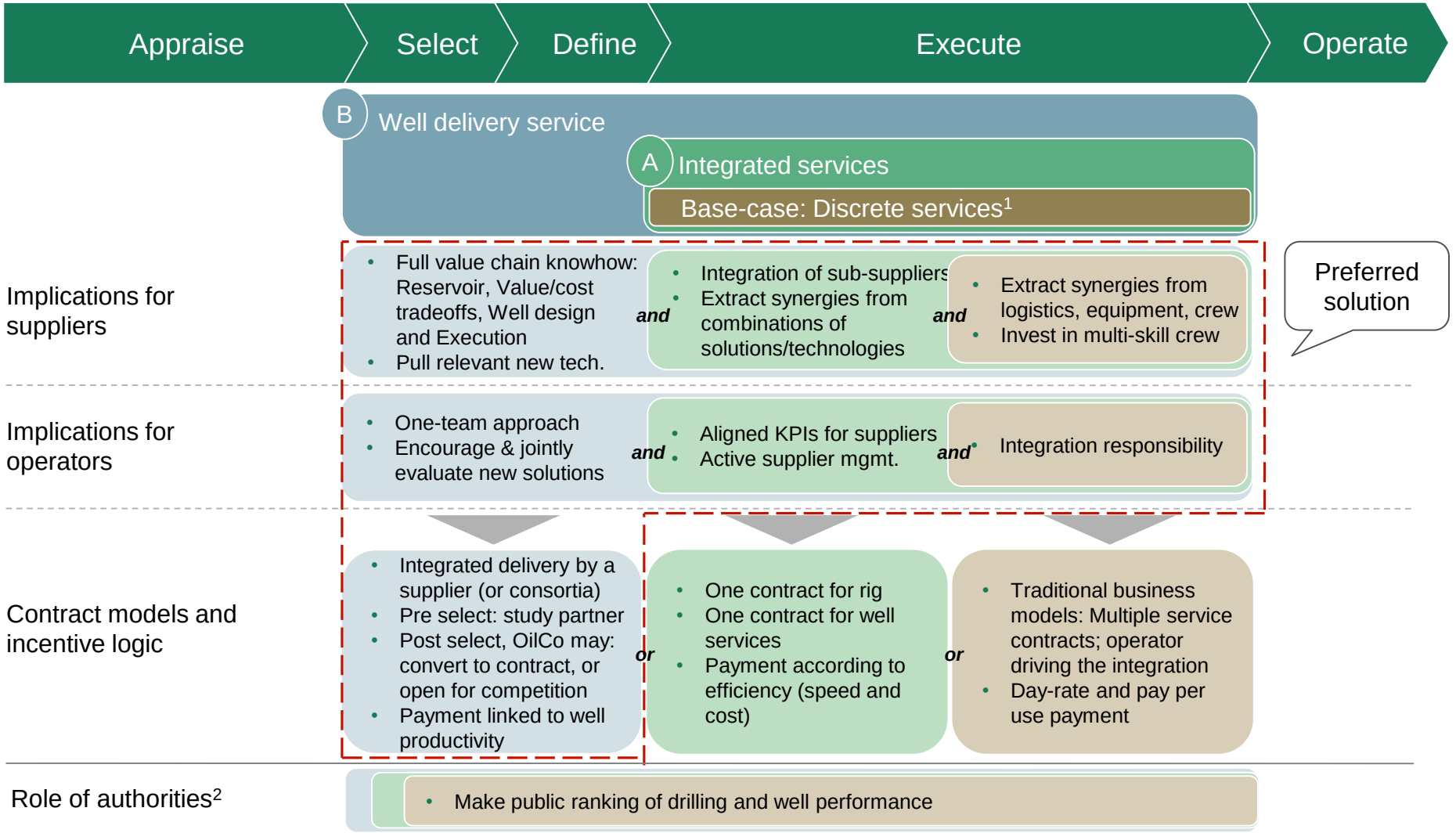
A

Usually 2 contracts 1 for for Rig and other for Well services but both behaving as one team with aligned KPIs and managing their sub-suppliers. It doesn't necessary imply that a single service company execute both drill floor & d/hole ops.

B

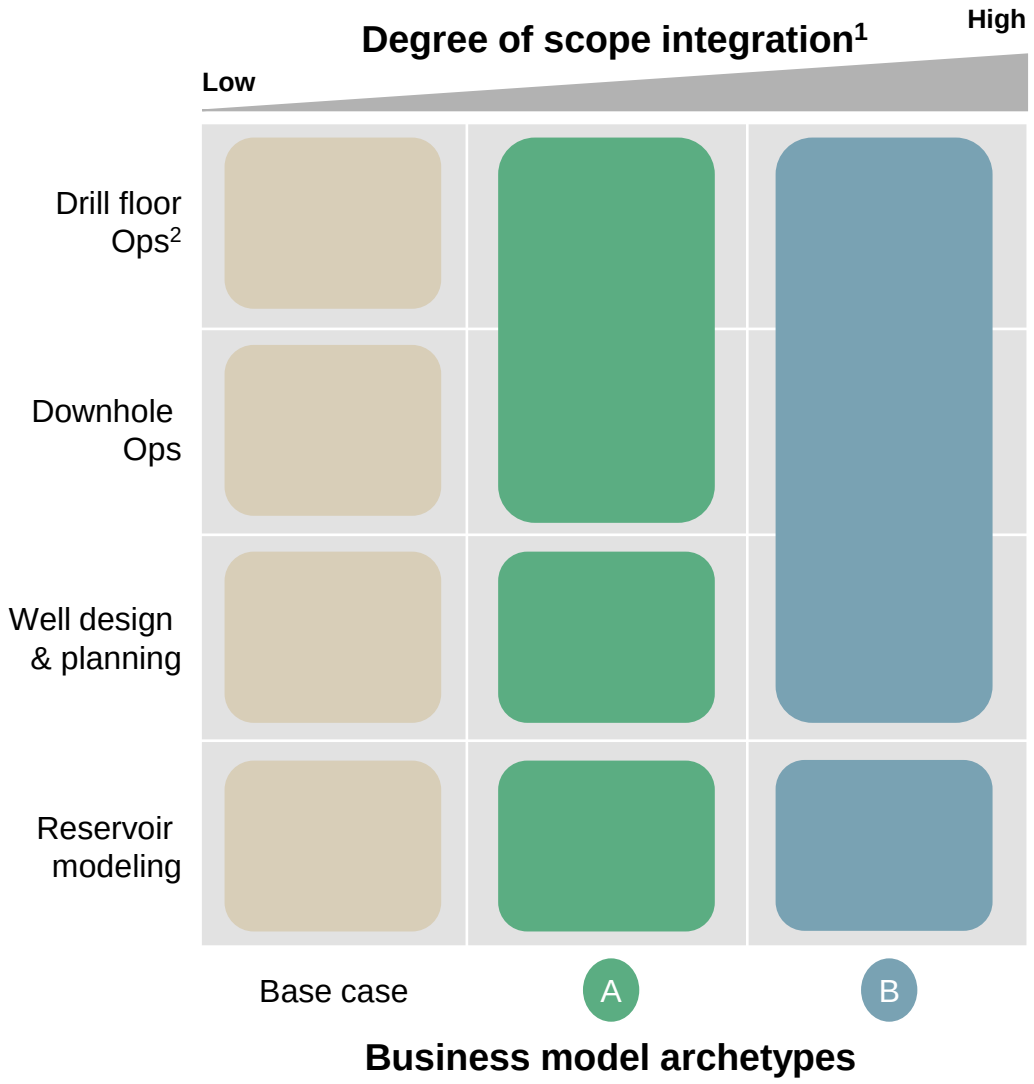
Supplier can deliver through a consortia or sub-suppliers. But need to have the full value chain know-how & manage all interfaces. This option does not imply that one service company needs to have all end to end services in its portfolio

Integrated scope requires aligned incentives for all parties



1. Discrete services may also be bundled. Bundled services is pure volume bundled, but with no common alignment or interface synergies realization 2. Same across all business model archetypes.
Note: Base-case is a subset of business model archetype A and B, and business model archetype A is a subset of business model archetype B.
Source: Expert interviews; BCG analysis

Workshop discussion:
Business model archetype and key questions



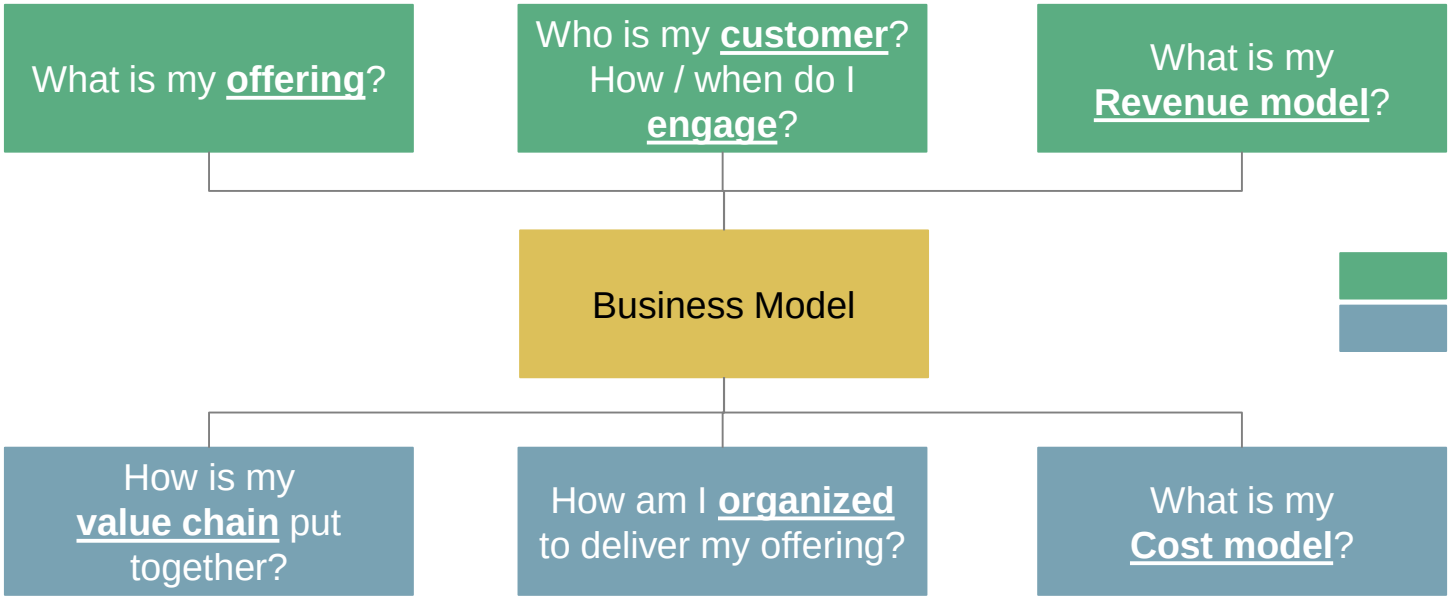
4 questions to consider:

- Which **scope** elements to combine?
- What **stage** to engage with suppliers?
- Who should **lead/drive?**
- What **compensation format** is suitable?

1. There may be one supplier delivering the whole scope or many suppliers delivering through alliances as one team 2. Includes drilling equipment.
Source: Expert interviews; BCG analysis

Workshop discussion:
Examples of business model elements to unlock value

Suppliers	*Integrated contracting for drilling & well services*	*Engage with customer in earlier stages- well design and planning*	*Pay for performance – (drilling efficiency / NPT driven)*
Operators	*Focus on ultimate well value, not just on speed or NPT*	*Tighter internal integration with reservoir team to optimize well plan*	



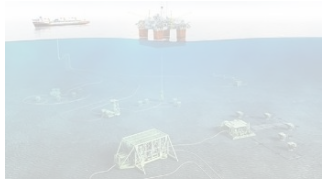
Suppliers	*Integration of multiple services and sub-suppliers to extract synergies from combinations*	*Reservoir, value/cost tradeoffs, well design and execution capabilities inside core project team and retain core team for all client projects*	*Extract synergies from logistics, equipment, crew by leveraging bundling / integration*
Operators	*Preferred vendor constellations delivering across projects in long term partnership*	*OilCo needs to adjust operating model to match collaboration model*	*Pay for outcome (through system of value driven KPIs)*

Data driven productivity enhancement

Analysis of Potential Solutions

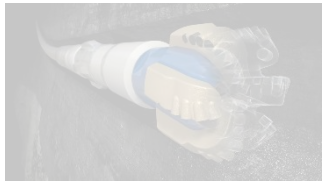
Workshop discussions & outcome

I



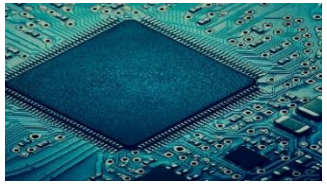
Lean tiebacks

II

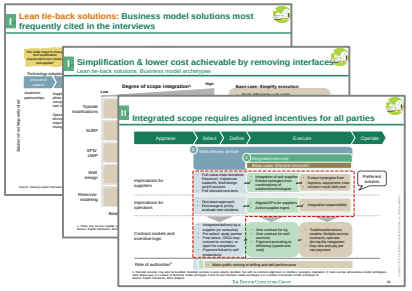


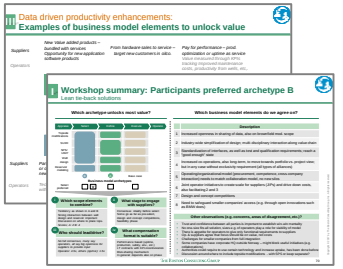
Enhanced drilling & well performance

III



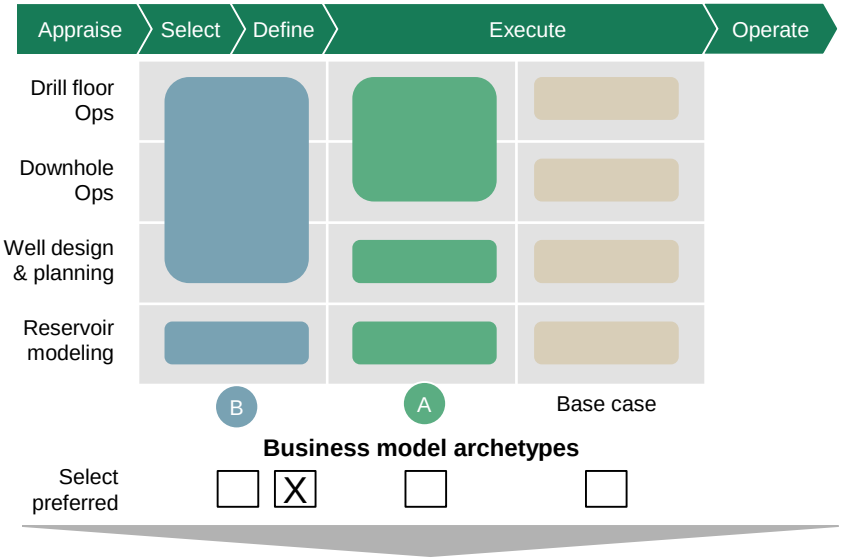
Data driven productivity enhancement





Workshop output: Enhanced Drilling & Well Performance
Participants preferred archetype B

Which archetype unlocks most value?



i Which scope elements to combine?

Execution (Rig + Downhole ops) into one & Res. modeling + Well design & planning into second. Scores- B:4, A:2

ii What stage to engage with suppliers?

Consensus: Earlier during well design and planning

iii Who should lead/drive?

Operators need to lead or act as catalysts to bring all parties together and design common aligned incentives

iv What compensation format is suitable?

Performance based contract with shared KPIs: Win-win or lose-lose

Which business model elements do we agree on?

	Description
1	Agreement on the willingness for entering win-win performance based contract. Floor on capital yield with upside linked to performance (benchmarked with market)
2	Engage suppliers early in the well design and planning stage
3	Incentivize procurement department not on the contract spend but on the value
4	Implement drilling optimization in steps; begin with full optimization till top of the reservoir. Authority needs to take more pro-active role
5	Drop company specific standards, Have TR relevant for the well, Give supplier more flexibility
6	Open interface to share data between surface & downhole
7	Closer alignment between reservoir and Well design/ planning department
8	Operator to establish long term alliances with well services companies, rig contractors and equipment manufacturers

Other observations (e.g. concerns, areas of disagreement, etc.)?

- Model B raises key issues regarding risk sharing, many supplier not in position to assume risks
- Question whether there is more value in doing reservoir modeling + well design in-house or outsourcing. It depends on the size and internal expertise of operator
- Risk of small supplier being squeezed out in model B

Business model solution elements most frequently cited in the interviews

"NCS facilities are well instrumented but bulk of data doesn't get utilized for anything"

"The industry is extremely protective of its data. Sharing sets of selected data could be a start "

"There needs to be an infrastructure in place, and then there are several applications you can put on top."

"Need to treat NCS as a company and use data for the greater good of the NCS as whole"

Technology adoption journey

Solutions most frequently cited

Innovation capture	Proof of concept	First field application	Application at scale	Sustainable commercial model
Academic **partnerships** **Partnerships** with start-ups Innovation **partnerships** with large tech cos. Spur innovation in analytics by more openly sharing data sets (e.g. certain types of operating data)	Operator (or consortia) creating smaller scale pilots **Effective leverage of use cases to convince ops people on data applications** **Cross-industrial initiative**s to build public opinion on automated remote ops	**Joint creation** and investment in key infrastructure (e.g. open source) **Common standards** to simplify sharing of data Technology partnerships / deliver through supplier alliances Simplified legislation around remote ops Agreed principles around ownership & use of data	Create right incentives in OilCos (e.g. asset managers to compete on asset performance) **Sharing of data, e.g. performance data**, to create transparency	**Product-as-a service, e.g. uptime as a service** Pay as you perform contracts –risk/reward sharing for realized gains

Unlocking 'dead data' a priority

Aggregating data amplifies value

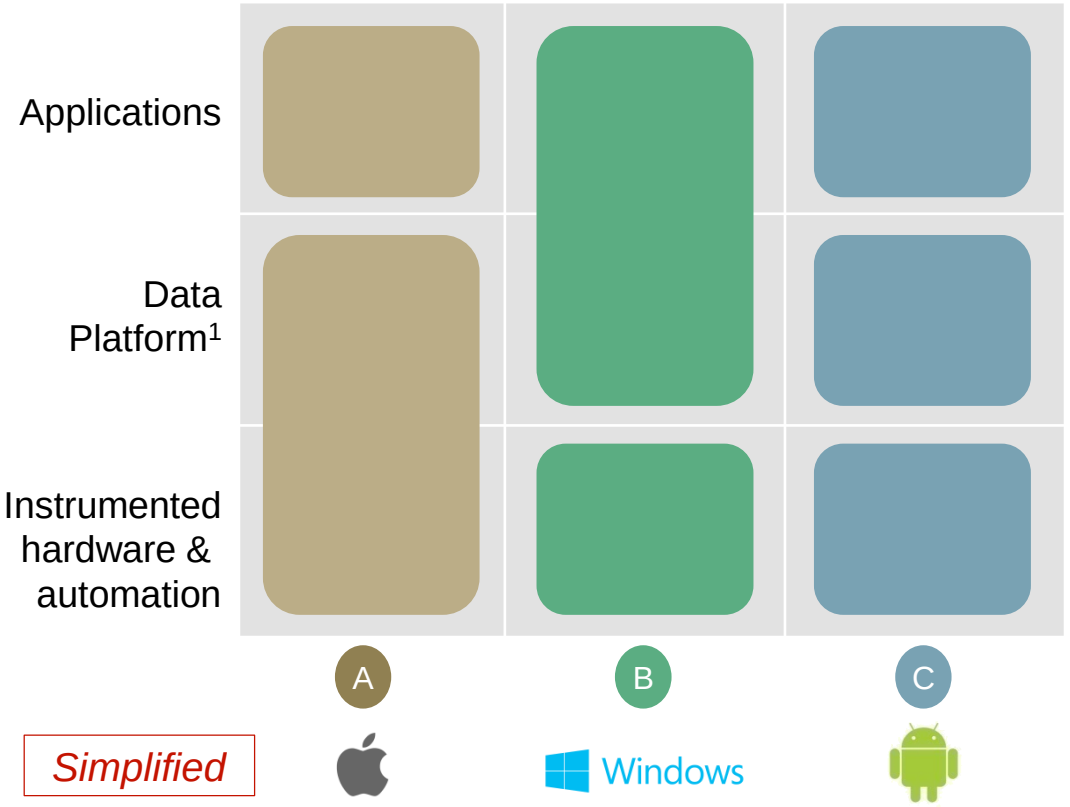
Rapid innovation from smaller companies, and often outside O&G

Governance of data management key

Source: Industry expert interviews conducted week 16-20, 2017

Multiple approaches to create a 'data to value' eco-system

Potential eco-system structure
(e.g. for a Real-time Production Optimization setting)



A

- Goal: Leverage existing industrial automation software upward
- Key levers:
  - build on OT[2] framework
  - staged introduction , reducing risk

B

- Goal: Extend existing production mgmt. software 'downward'
- Key levers:
  - build on software/IT[3] framework
  - staged introduction , reducing risk

C

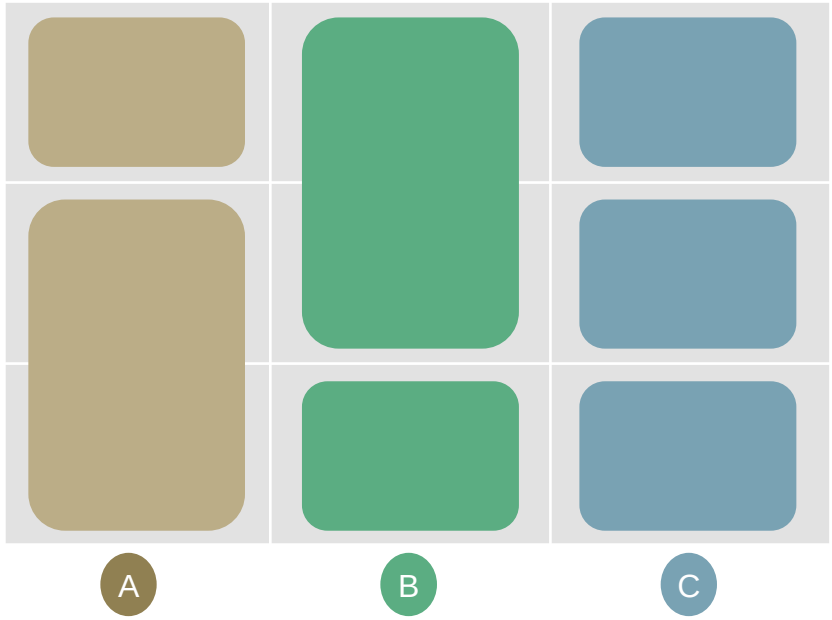
- Goal: Create interoperability
- Key levers
  - reduce need for vertical integration
  - level playing field ('mix and match')

Note: Graphics are simplified to facilitate discussion around archetypes of business models. 1. Data Platforms provide data storage (including Big Data file systems) , integration and access /security functions. 2. OT = Operational Technology (Real time factory automation systems) 3. IT = Information Technology – referring to enterprise IT systems
Source: Expert interviews; BCG analysis

Back-up: Characteristics of dimensions

Potential eco-system structure

(e.g. for a Real-time Production Optimization setting)



Description of scope elements

- Software to analyze, transform and visualize data for insight creation and decision making
- E.g.: Prod. mgmt, reservoir history matching, flow assurance, uptime mgmt. and maintenance optimization

- Primary data storage and sharing mechanism
- Data platform contains all software and hardware infrastructure to capture, store and manage data across applications and sites

- Instrumented hardware and automation systems covering all functions from wells to process and auxiliary systems
- Data types contain sensor, control and diagnostic information.

Archetype description

A **Hardware and plant automation systems grow in scope to include more advanced analytics** and cross-domain. Key strength is to re-use the existing / familiar hardware integration layer.

B A range of Petrotechnical software is used today to manage. This archetype assumes these **software systems are expanded to connect directly with historians / data interfaces** to the automation systems.

C In this archetype, there is an **IT layer between hardware systems and applications** that uses plug and play interoperability to simplify development of advanced features, using components from many companies.

Significant value opportunity, but in all cases players must embrace open interfaces to fully exploit the potential

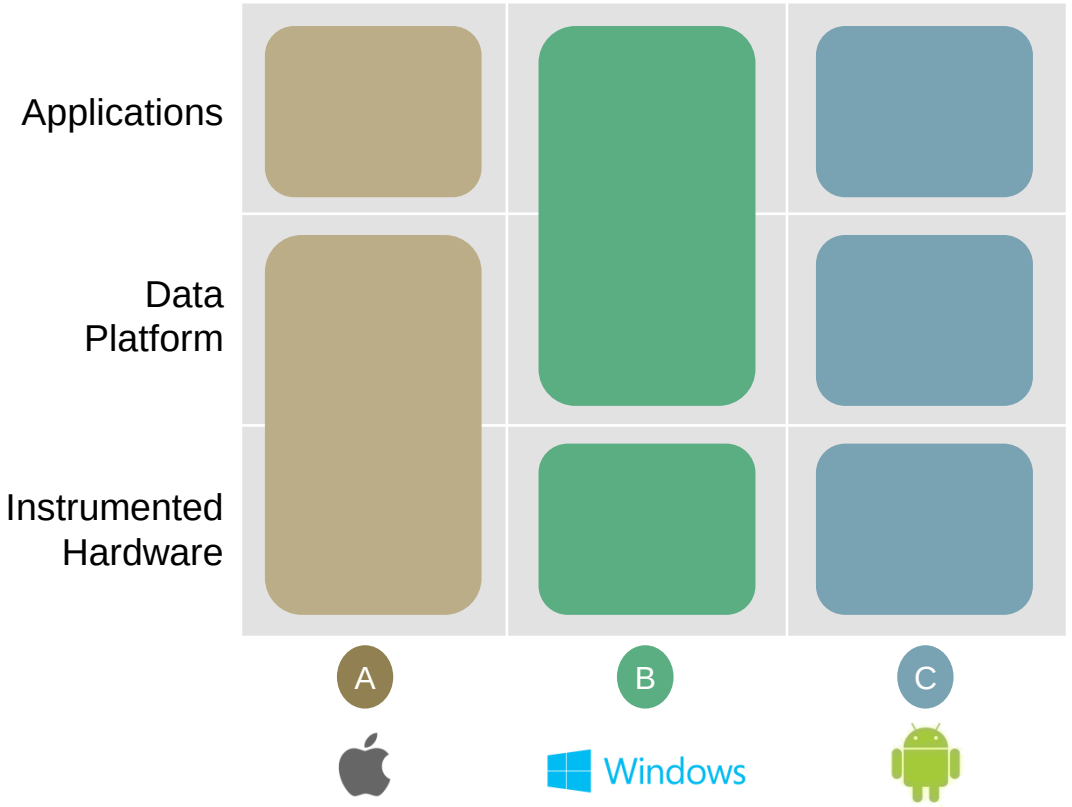
	Archetype A	Archetype B	Archetype C
Implications for suppliers	• OT companies lead systems integration • More opportunities fro smaller cos in process/systems analytics	• Petro-tech software cos lead systems integration • More opportunities for smaller cos on hardware analytics	• New tech companies with major opportunities in infrastructure offerings • Smaller cos with opportunities in both OT and IT domains
Implications for **operators**	• Demand open analytics applications interfaces • Strengthen internal capability in workflow software integration	• Demand open analytics applications interface • Strengthen internal capability in OT systems integration	• Proactive role in defining open standards • Strengthen Digital capabilities across the board - tech. scouting, development, deployment
Role of **authorities**	• Demand a predefined set of data to be published and shared across operators and suppliers • Extract value from aggregated data sets to drive further value for the NCS		
Contract Models & Incentive Logic	• OT software – portfolio procurement, linked to 'Hardware as a Service' • Analytics software – license based	• Analytics software – portfolio procurement, payments linked to SLAs	• Portfolio procurement to IT infrastructure provider (pay per use, also linked to SLA, uptime) • Range of agreements with small cos – both license fees and/ or value linked

Source: Expert interviews; BCG analysis

Workshop discussion:
Business model archetype and key questions

With focus on production optimization

Potential eco-system structure



Business model archetypes

3 questions to consider:

1. What needs to be in place to capture the value?
   - Common standards, access rules, data integration platforms, applications..
2. Where do we expect solutions to come from:
   - Oil Cos
   - Suppliers (OT or IT)
   - Small new companies
   - Large tech. companies
3. What will it take to leverage the NCS data-set as a whole for greater value?

1.OT Operational Technology (Real time factory automation systems) 2. IT Information Technology – referring to enterprise IT systems
Source: Expert interviews; BCG analysis

Workshop discussion:
Examples of business model elements to unlock value

	Offering	Customer engagement	Revenue model
Suppliers	*New Value added products – bundled with services Opportunity for new application software products*	*From hardware sales to service – target new customers in oilco.*	*Pay for performance – prod. optimization or uptime as service*
Operators			*Value measured through KPIs tracking Improved maintenance costs, productivity from wells, etc,.*

Business Model

Value proposition

Operating model

	Value chain dynamics	Organization	Cost model
Suppliers	*Partnership/ alliances from within or outside the industry to deliver new scope*	*Shift in core capability set from pure hardware to software and services*	*Co-development with other industry players & leveraging open source solution to reduce cost base*
Operators	*Technology partnership/alliance within or outside industry*	*Complementary operating model to work with software & integrated service providers*	*Shift from CAPEX to OPEX for certain equipment classes*

Workshop output: Data driven performance enhancement
Participants preferred archetype C

Which archetype unlocks most value?

i What needs to be in place to capture the value?

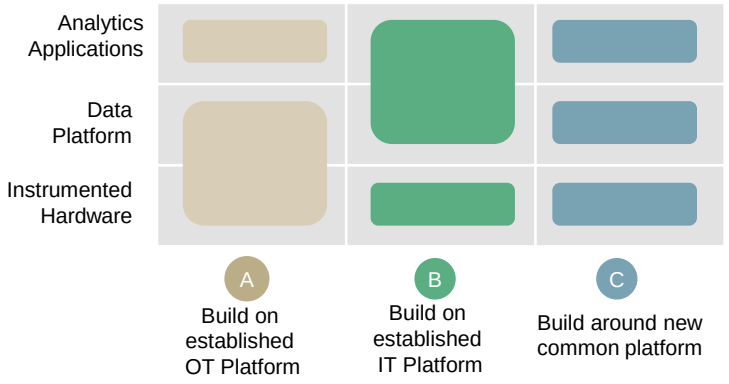
1. Common standards/open interface (removing/avoiding silos)
2. Access rules (which data can and should be shared, who can access it, what are the (if any) requirements to get access, etc.)
3. Harmonization of data (quality of data, effective taxonomy, etc.)

ii Where do we expect solutions to come from?

Oil companies to be in the driver seat and align on standards
Authorities to facilitate, and potentially develop "frames"

iii What will it take to leverage the NCS data set as a whole for greater value?

Data governance (see points above)
NPD instructing on best-practice of sharing of data



1. Amazon web service

Which business model elements to consider?

	Description
1	Product-as-a-service contracts
2	Integrated value chain through alliances (i.e. longer-term partnerships with preferred suppliers, and integrated value-chain thinking from suppliers to remove interface waste)
3	Shared incentives/pay-per-performance contracts
4	Smaller companies and companies outside of O&G to contribute to innovation (enabled by a standard interface)
5	Increased competition in application and hardware space, if data platform is standard
6	

Other observations (e.g. concerns, areas of disagreement, etc.)?

- Despite archetype: Need to have in mind that this is a continuous journey
- Need to split data platform in two distinct things (data platform element (i.e. what the oil companies need to develop) and cloud element (AWS[1], Microsoft, etc.).
- Do we need to drive to one archetype? (Tech. industry does well with multiple)
- Even though C was the preferred option for most participants, there were two diverse opinions (depending on whether you see the platform in itself as the comp. edge):
  - Some have the view that all companies should use one data platform (i.e. operators use a similar platform that may have been developed by one company or in conjunction between several)
  - Some have the view that multiple platforms will be developed (i.e. one per company), but still the platforms need to be built on standard interfaces

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