Stingray
listening with light®

Finding Petroleum

The light bulb: A symbol of innovation and other things

A new light on reservoir monitoring

Martin Bett
7 October 2010

The light bulb

- What is Permanent Reservoir Monitoring (PRM)?
- The light bulb
- Barriers to the adoption of PRM
- Lessons learned from the light bulb

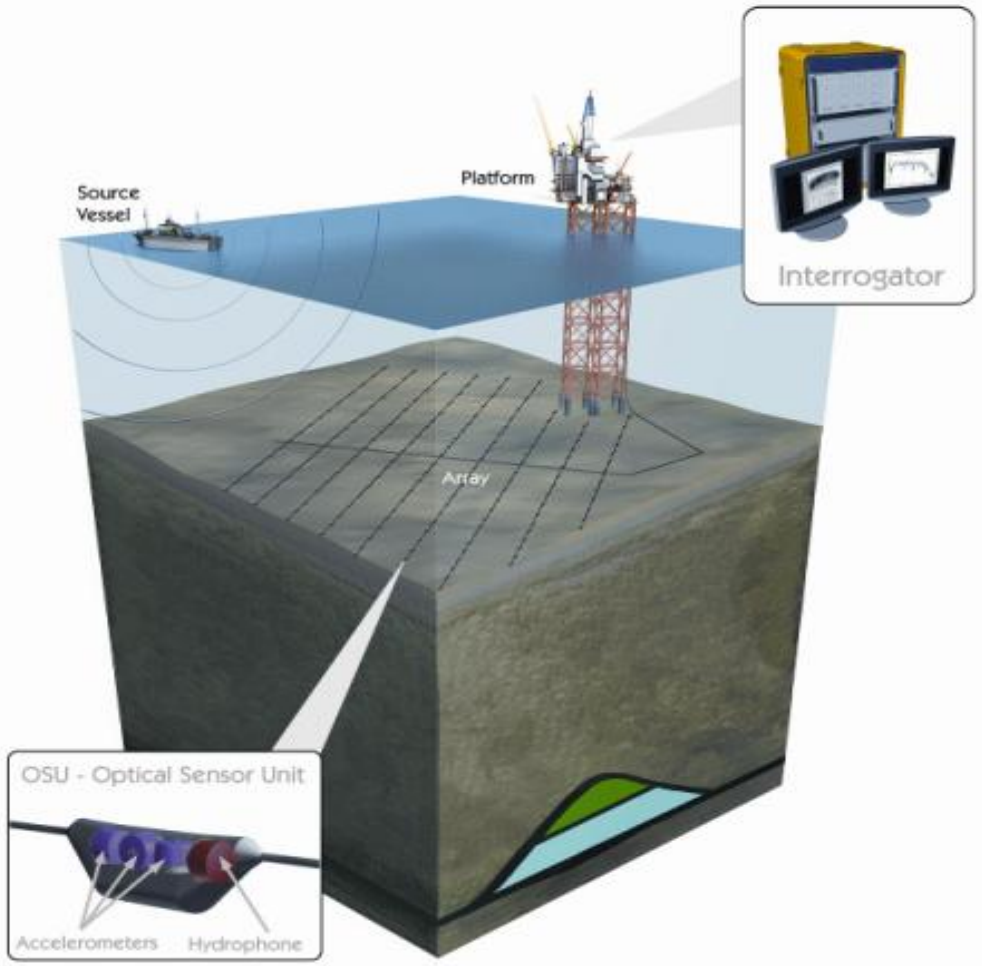
© Stingray Geophysical Limited
Company Confidential

What is Permanent Reservoir Monitoring (PRM)?

What is Permanent Reservoir Monitoring (PRM)?

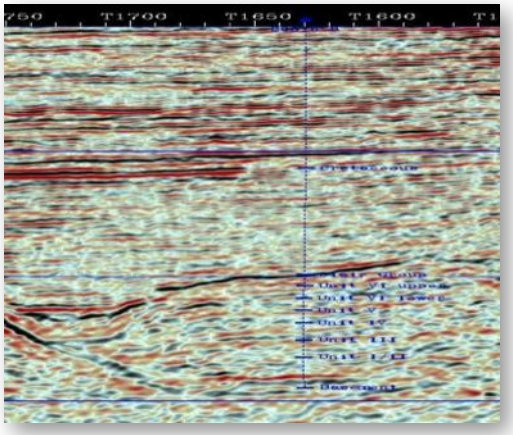
- Permanently installed array of (seismic) sensors on sea floor
- Repeat seismic surveys on 3-6 month time period
- Continuous recording of micro seismic events
- Monitoring of production and injection-induced changes in the reservoir over time
- Integrated into reservoir and production management workflow

Detect smallest changes possible in reservoir performance as early as possible

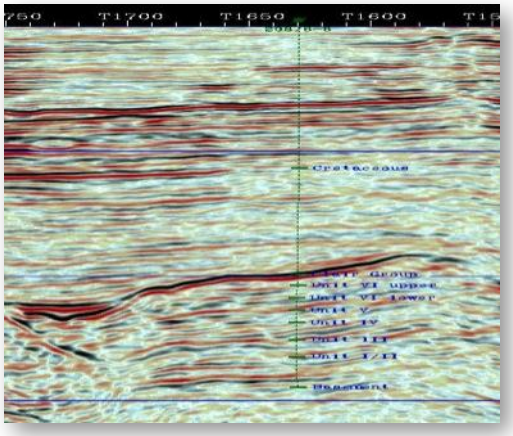


Stingray
listening with light®

© Stingray Geophysical Limited
Company Confidential

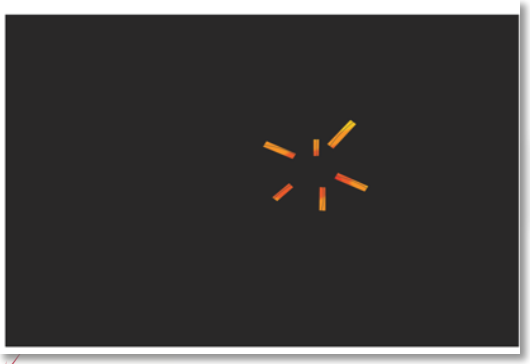


Better data

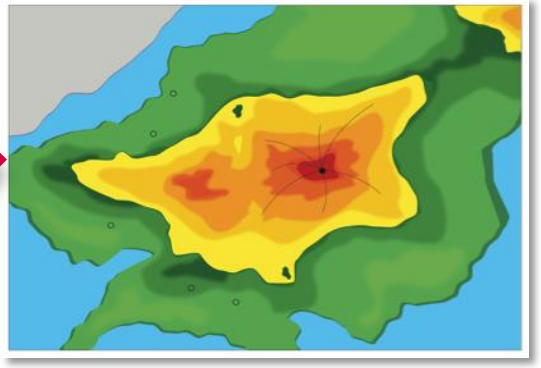


More frequently

or continuously



Over the entire reservoir



© Stingray Geophysical Limited
Company Confidential

Is the foundation of ….

3-5% increase on field with 200MMBbl reserves

$500M

Increased reserves

Reduced costs and risk

Increased production

Enterprise value

Failed well
Misplaced well
Produced water
Fractured cap-rock
Bypassed oil
Production plan assurance

Stingray
listening with light®

© Stingray Geophysical Limited
Company Confidential

The light bulb

Incandescent light bulb

CFL bulb

More efficient

More environmentally friendly

=10x less electricity

Barriers to adoption of CFL bulb

Cost 10x to buy

Economics

Ability to calculate what power (light) bulb is required and lifetime cost

Technical know-how

People

Different

~~Change~~

© Stingray Geophysical Limited
Company Confidential

CFL bulb

More environmentally friendly

Cost to buy =10x more

Lifetime cost =6x less

Barriers to the adoption of PRM

Barriers to adoption of PRM

Value

Economics

Risk management

Technical know-how

People

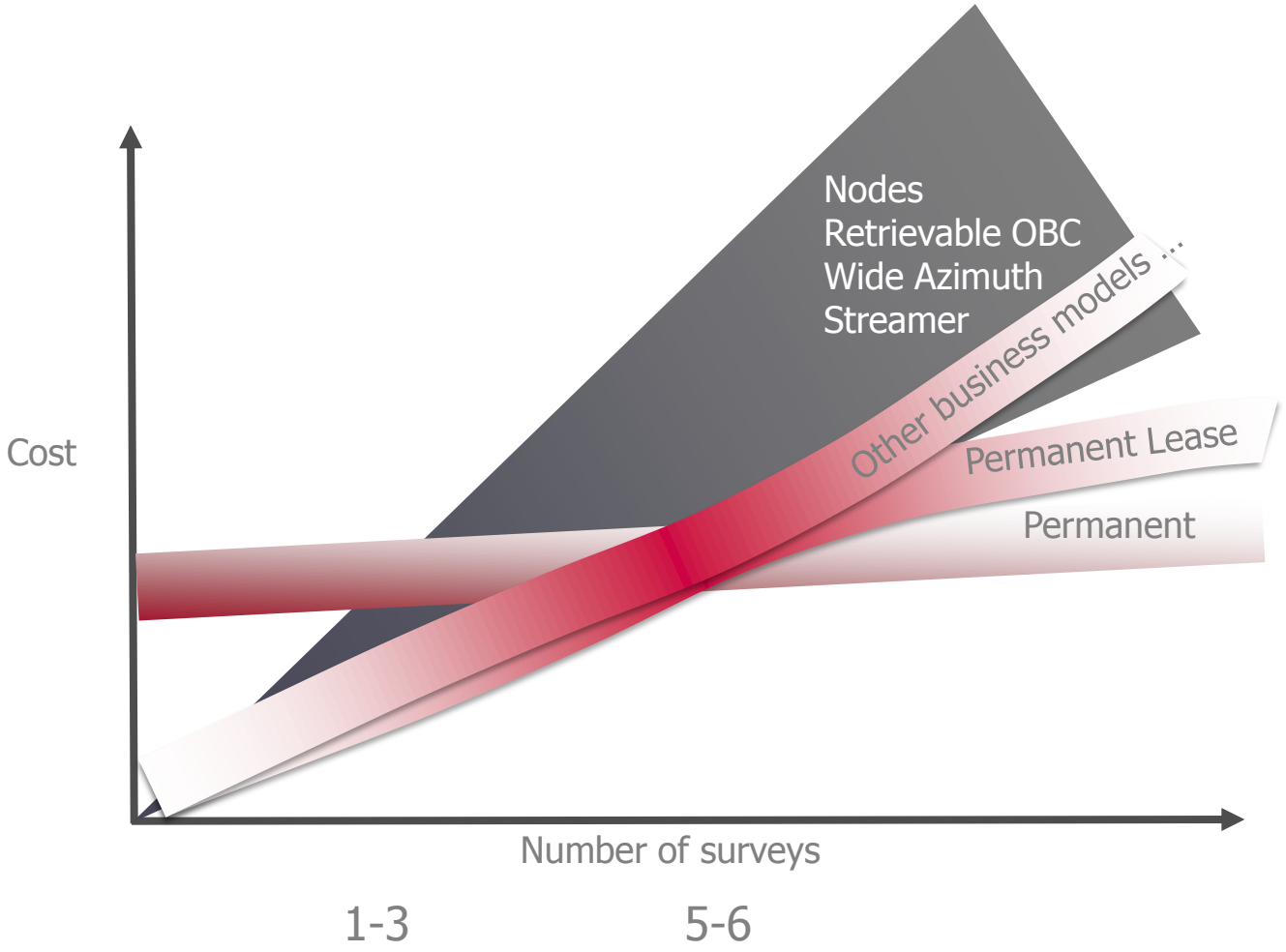
Behaviours

© Stingray Geophysical Limited
Company Confidential

Barriers to adoption of PRM

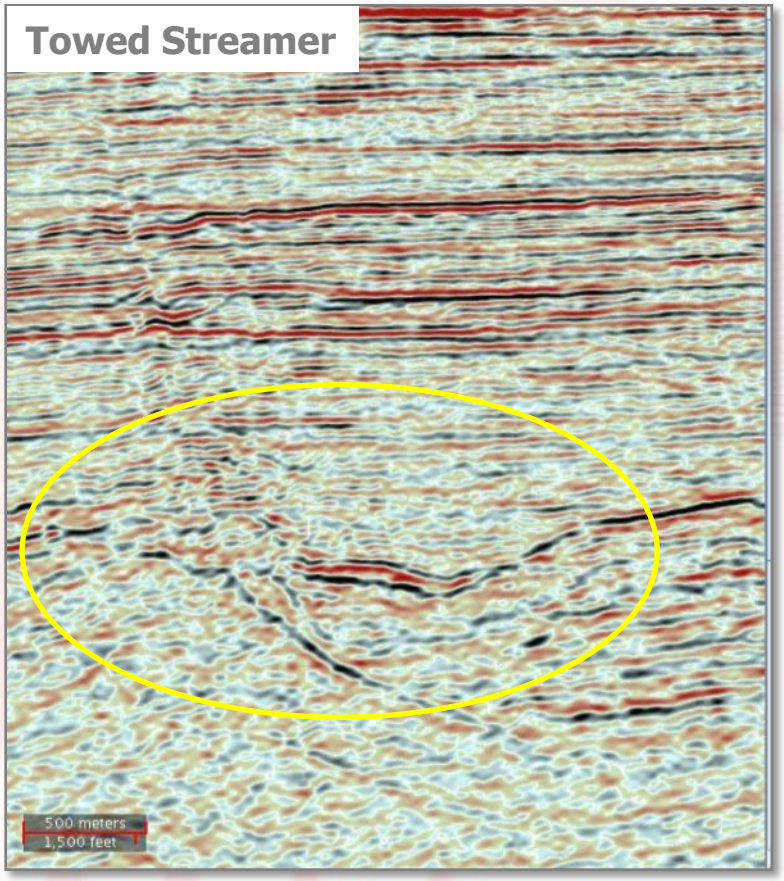
Economics
Value

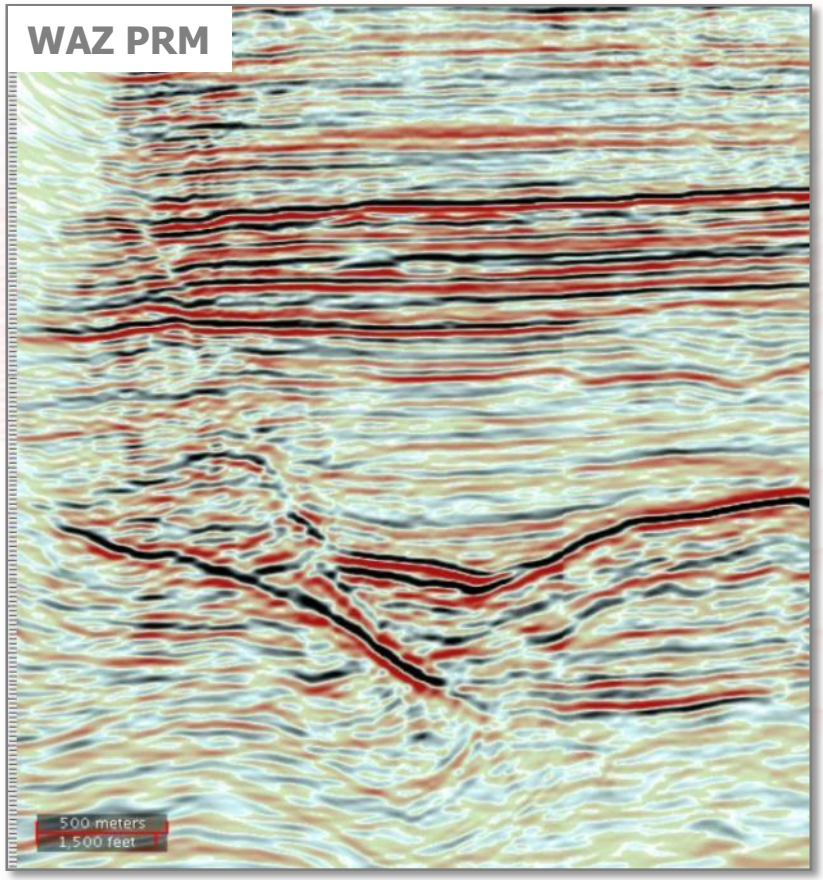
Economics – cost profile



© Stingray Geophysical Limited
Company Confidential

Value: better seismic – WAZ/MAZ revolution!





Images Courtesy BP

Towed: $5-10M per survey

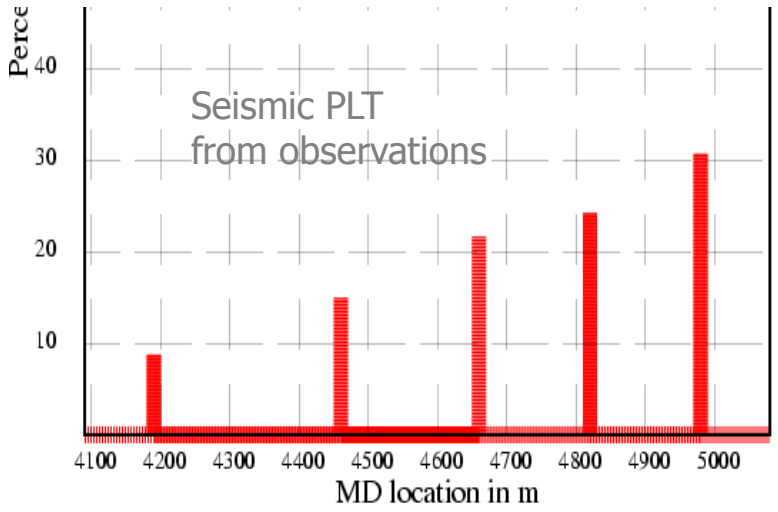
Towed: $20-40M per survey
PRM: $50 -100M + $1-2M per survey

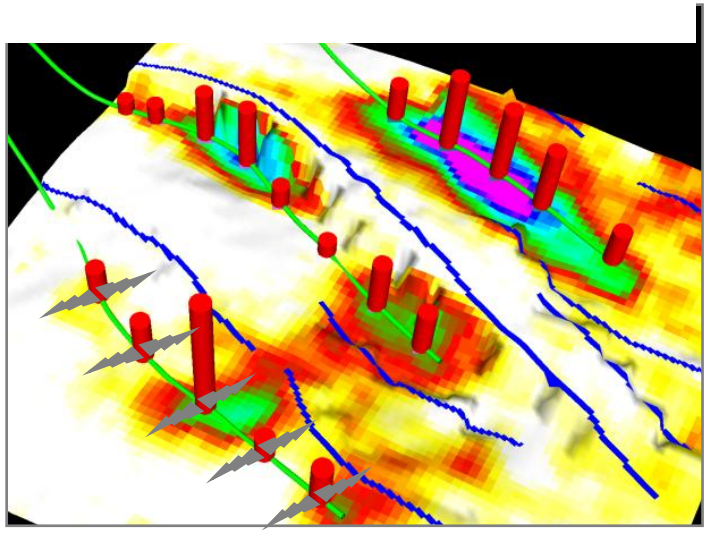
Stingray
listening with light®

© Stingray Geophysical Limited
Company Confidential

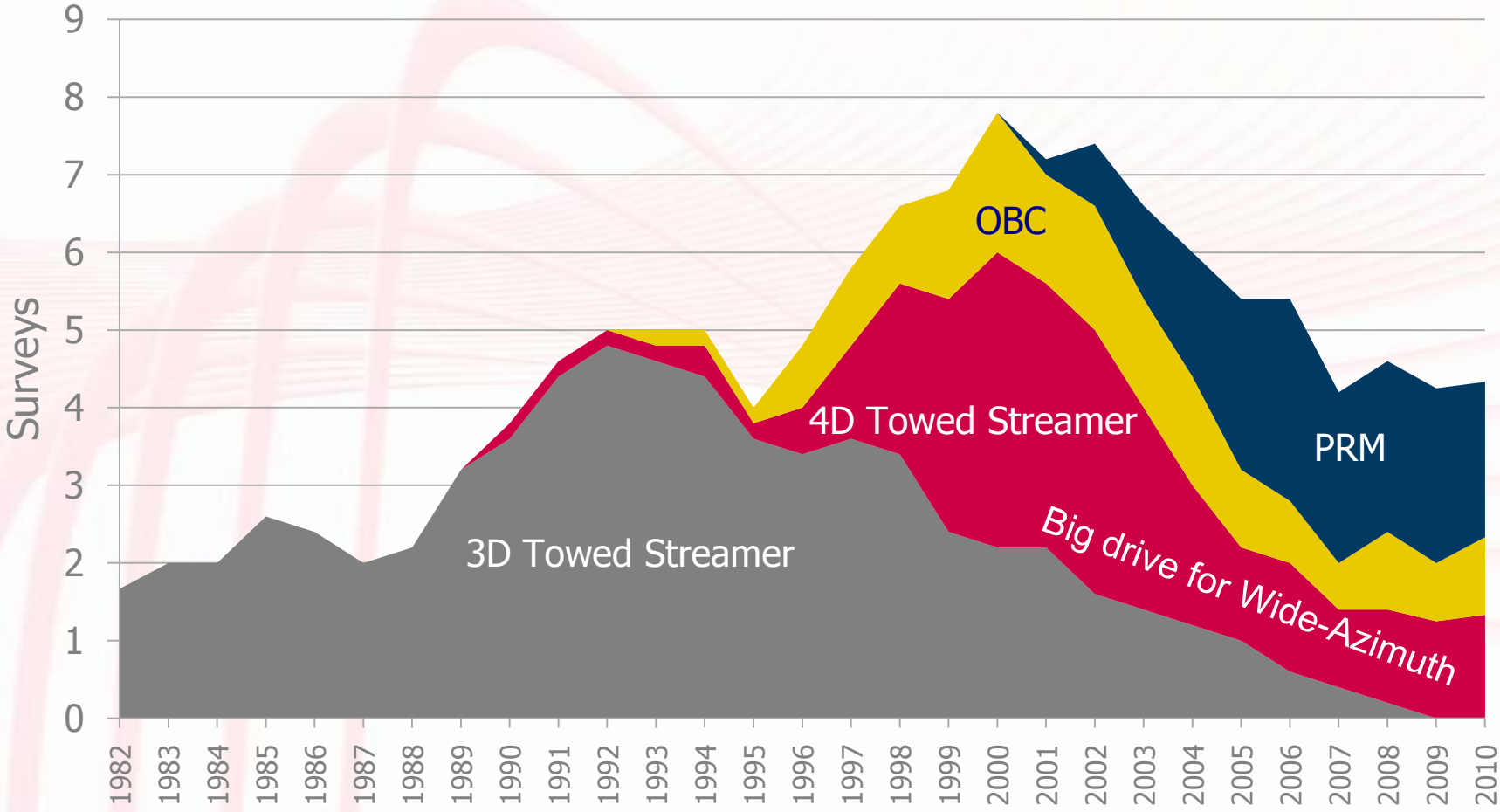
Value: seismic attributes correlated with PLT

- Production induced 4D seismic changes around individual perforations in a horizontal well are presented as a "Seismic PLT"
- Provides information on injector and production performance by zone
- Real-time reservoir-scale monitoring of water-flood
- About 60 "Seismic PLTs" are generated each year at no additional cost
- Seismic PLT has become an essential tool for integration and cross-disciplinary reservoir management





Major Oil Company – seismic surveys in the North Seas



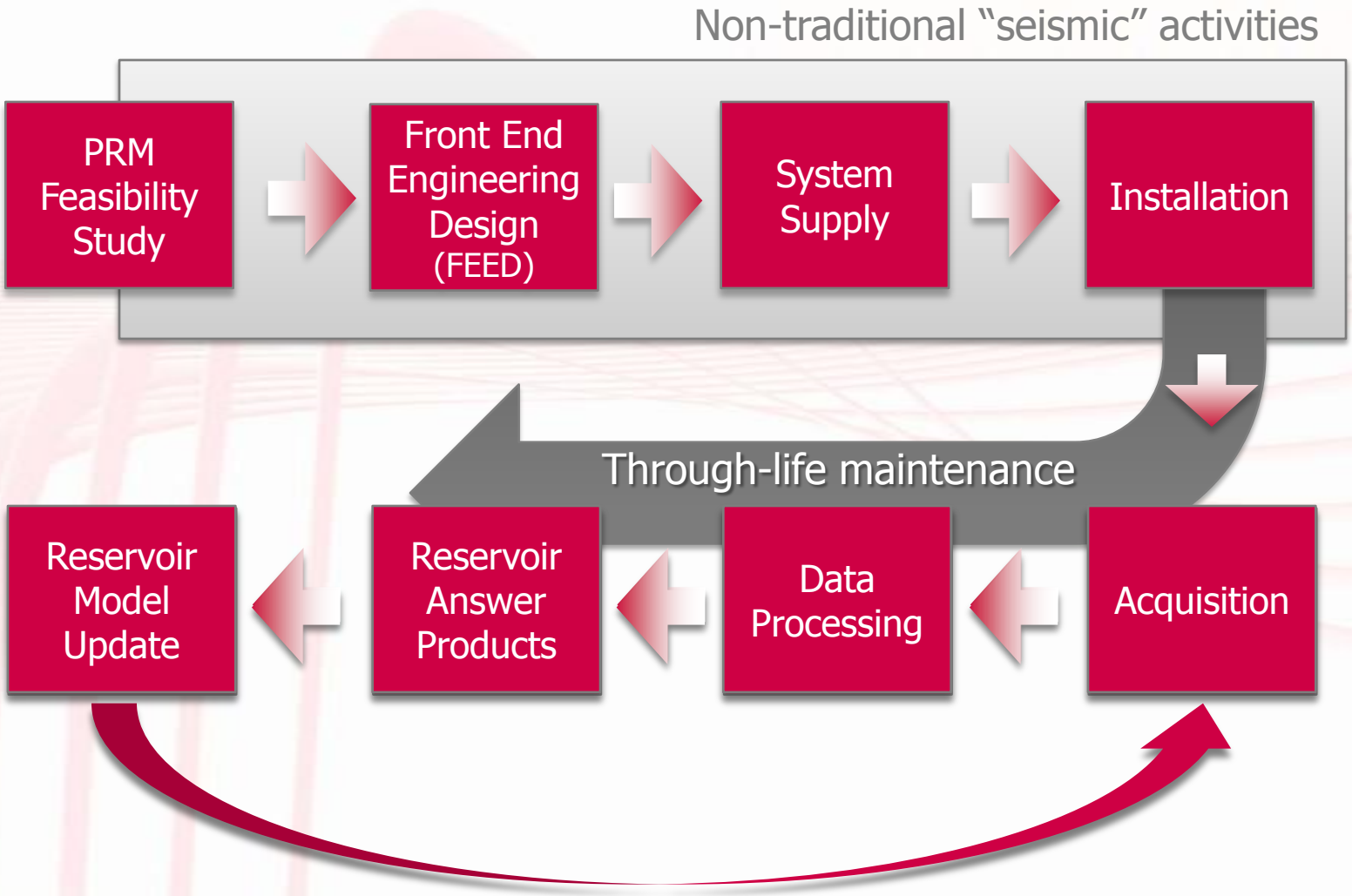
Source: Giles Watts

© Stingray Geophysical Limited
Company Confidential

Barriers to adoption of PRM

Technical know-how
Risk management

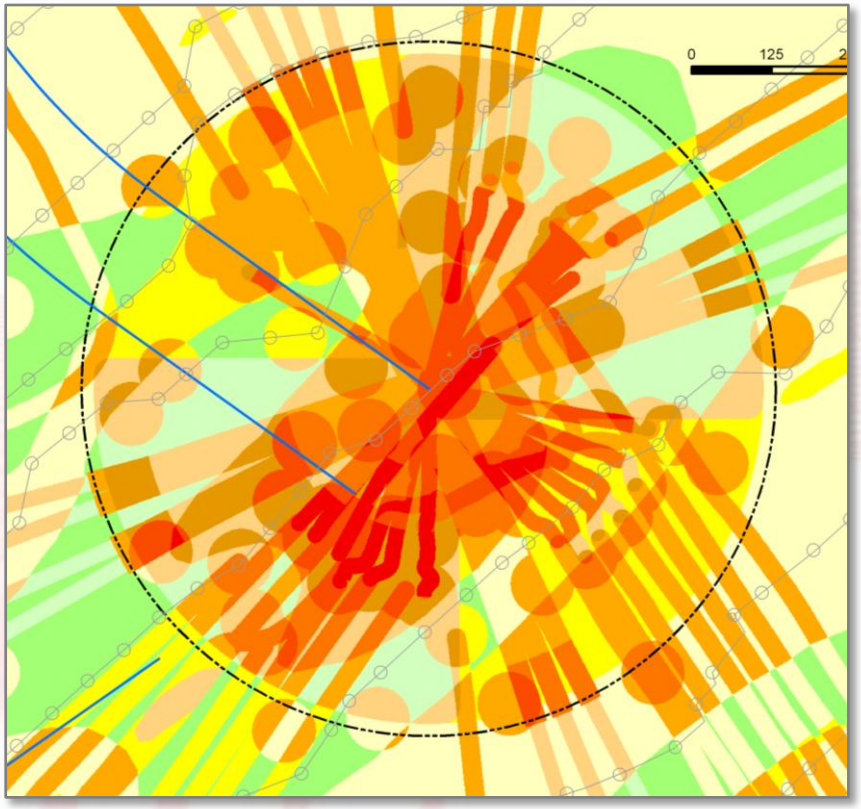
A different process
Involves new disciplines and timescales



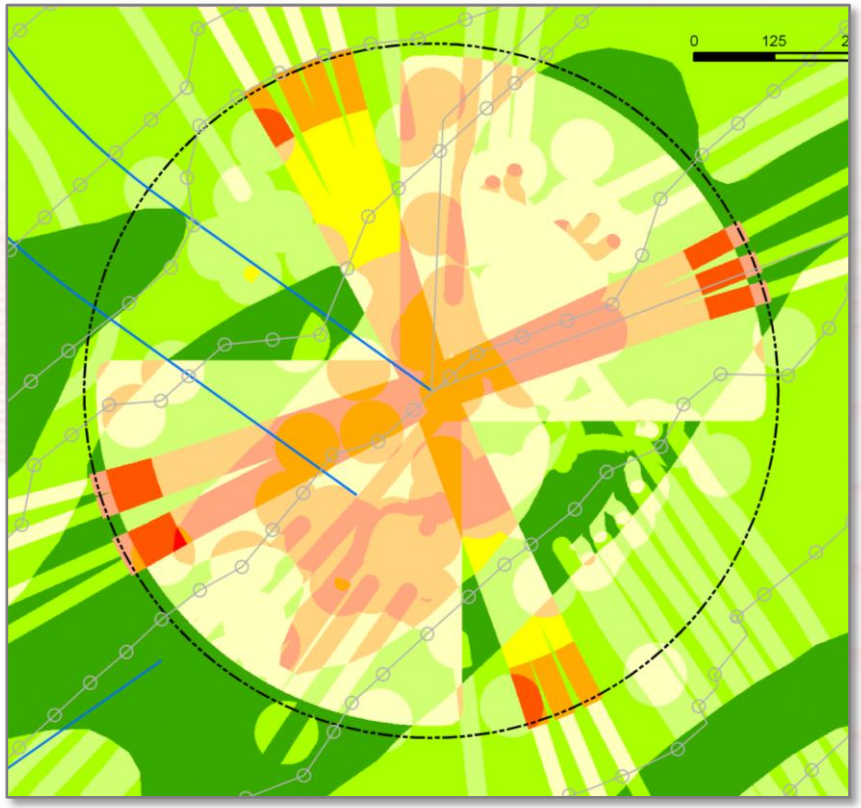
Stingray
listening with light®

© Stingray Geophysical Limited
Company Confidential

Risk Management



Installation risk



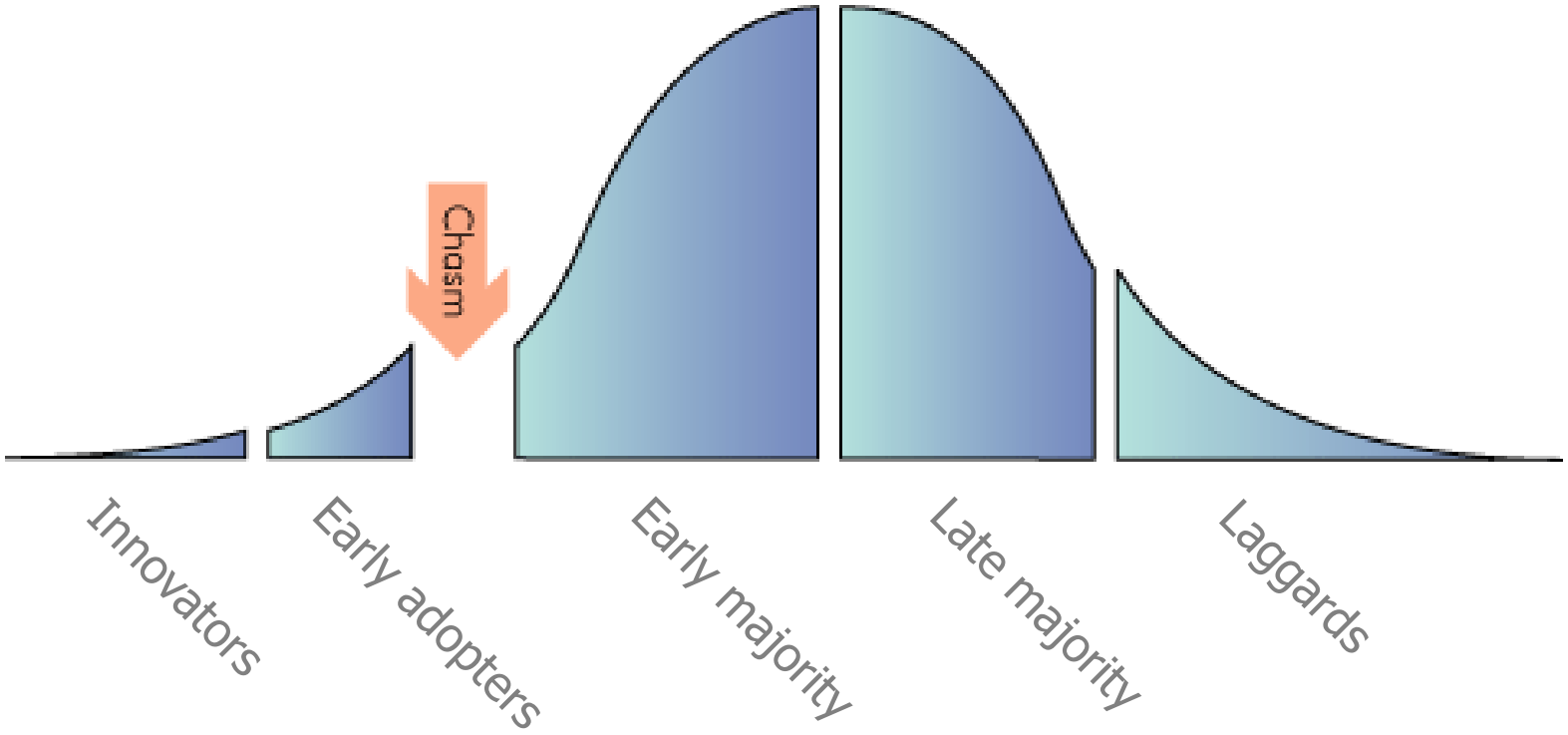
Post-installation risk

© Stingray Geophysical Limited
Company Confidential

Barriers to adoption of PRM

People
Behaviours

People
Behaviours: technology adoption cycle



© Geoffrey A. Moore

© Stingray Geophysical Limited
Company Confidential

People Behaviours

- Technology adoption cycle
  - Very slow
  - Needs appropriate risk management
  - Risks usually don't just go away!
  - Will our current performance suffice in the post-Macondo and financial crisis world?
- Alignment of objectives
  - Timescales: reservoir life vs financial markets expectations
  - Governments and licence operators
  - Through-life costs vs minimising costs in the immediate future
- Market expectations
  - Oil companies are expected to generate cash now (this quarter)
  - Focus should be on maximising long-term value
  - The winning next-generation oil companies will focus on this and communicate it successfully to the market

© Stingray Geophysical Limited
Company Confidential

Lessons learned

Lessons learned from the light bulb!

- Volume changes everything!
  - Product and service refinement
  - Price
  - Experience/capability and risk
  - Peer pressure
- Different budgets and timescales
  - Through-life costs are most relevant
  - Operating vs capital costs
- We are looking at the wrong thing:
  - WAZ/MAZ vs traditional streamer
  - Value, not cost
  - Reasons to change rather than the barriers
- How should we apply these observations to oil and gas to create more value from oil we already have?
- Responsible stewardship of finite resources is the key role the industry and regulators have to address to respond to the environment agenda

© Stingray Geophysical Limited
Company Confidential

PRM: the three "Rs" and two "I s"

Reducing risks

Reducing costs

Reducing time

Reducing risks

Reducing costs

Increasing production time

Increasing value

Improving our "green" credentials

Stingray
listening with light®

© Stingray Geophysical Limited
Company Confidential


THIS AREA
IS UNDER
SURVEILLANCE


listening with light®