Improving acquisition efficiency by managing and modelling seismic interference

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Motivation

- Interference: all coherent noise affecting the seismic data
  - Concurrent acquisitions
  - Supply boats
  - Activity on the field (trenching, piling)
  - Platform noise

- Cost savings
  - 8 to 10% of the acquisition time has historically been spent on timeshare on NCS

- Increase our ability to complete the acquisition programme
  - North Sea season is short and the area busy
  - Extensive acquisition programme
  - Spawning and fishery activities
Principles of SI removal

- Two critical parameters
  - Dip of the SI arrival on the shot record
  - Consistency from shot to shot

- The amplitude of the SI is not a limiting parameter anymore

- Acquisition should not be aborted because of SI
Main questions

• Q1: Given the position of a vessel receiving the SI, which are the positions of the interference source(s) that can be handled?

• Q2: Given the position of the interference source, what part of the seismic line of the receiving vessel is affected by SI and to which extent can it be handled?

• Q3: Given the acquisition layout and planning, can the processing algorithms filter the SI?

• The required functionalities for the analysis have been implemented in ArcMap in a series of 3 different scripts according to their purpose.
Tools workflow
Dip calculation

Case 1:
Wavefront *comes from ahead*
\[ t_{1+\Delta t_1} \gg t_1 \]

Case 2:
Wavefront *comes from abeam*
\[ t_{2+\Delta t_2} \approx t_2 \]

Case 3:
Wavefront *comes from astern*
\[ t_{3+\Delta t_3} \ll t_3 \]
SI modelling

• Tool1: Given the position of a vessel receiving the SI, **where the other vessels could work without interfere our acquisition?**
  
  - acquisition areas (polygon)
  - receiving streamer (polyline)

• We can acquire in B if we modify slightly the direction
SI modelling

• Tool 2: Given the lines and the interference source locations, how the interference sources influence the acquisition along the preplot line?
  - Preplot lines (polyline)
  - Interference sources (point)

• We can only acquire one line without being disturbed
SI modelling

• Tool 3: Given an acquisition layout and the relative displacements between entities, **would the filtering algorithms be able to clean all the received SI?**

Vessel A (I. Source)

V. A

Oil platform (I. Source)

Oil P.

Vessel B (Recording seismic)

V. B

Rec.
Single interference result

- Example: 8km length streamer & Recording intervals of 5s. [Direct arrival]
Interference matrix

V. A
Oil P.
V. B
Rec.

Str front-end
Str tail-end

Platform interference

Recording time

Str front-end
Str tail-end

Vessel B interference
Combining interferences [Consistency modelling]

- Example: 8km length streamer & Recording intervals of 5s.
SI modelling

• Tool 3: Given an acquisition layout and the relative displacements between entities, **would the processing algorithms be able to clean all the received SI?**
  
  - Preplot line (polyline)
  
  - Interference sources (polyline)
Tampen Area in 2014

• 10 competing surveys
  – Statoil: Statfjord, Gulfaks, Snorre PRM, Oseberg, Oseberg SWIM, Veslefrikk
  – Brage (Wintershall), Alwyn (TOTAL)
  – Multi Client: CGG Horda

• Veslefrikk 4D
  – Challenging survey as in the middle of the area
  – SI from Oseberg SWIM, Oseberg, Brage and CGG Horda
Example: Veslefrikk 2014

- Acquisition by Polarcus Asima
- Interference from Oseberg SWIM
- Shooting directions are such that the interference is difficult to remove
Veslefrikk – QC display before SI removal
Veslefrikk - Modelling

• Modeling exercise in ArcGIS
  – For each survey we need the acquisition parameters
• Model the dip and the arrival time of the SI arrival
• Estimate the consistency from shot to shot
Veslefrikk – QC display before SI removal
Veslefrikk – QC display after SI removal
Veslefrikk – shots before SI removal
Veslefrikk – shots after SI removal
Cost saving – streamer seismic on NCS

- 10% of line acquisition time used for SI prior to 2012
- Down to 2% in 2014
- Cost
  - Estimated saving in 2013: 4 MUSD
  - Estimated saving in 2014: 12 MUSD
Way forward

• Include **more geophysics** (amplitude decay, ...)

• Seismic community
  - **Communicate** to the other players (oil companies and contractors)
  - Update the regulations for **timeshare**

• Implement **realtime processing with live feed data** from vessels

• **Improve the output** of scripts using generalization (to polygon and to line).
  - Easier to handle
  - More representative

• Make the script able to work with **more complex geometries** (sections of great circles, geodetic lines, etc.)

• Develop it using **ArcObjects**
  - Event handling
  - Interactivity and easy-of-use
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