SEG | WORKSHOP

Next Generation Geophysical Land & Shallow Water Acquisition Technologies

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Shaping Land Seismic Acquisition and Safety Through Persistent Satellite and Cellular Connectivity

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THE STARTING POINT

How land crews communicate today

Analog or digital radios

- Limited range
- Limited bandwidth
- Slow to collect status from the vibrators

Voice communication with the crew

- Drivers cannot take notes without pulling over
- Large crews overwhelm the radio, and some information does not get through

Journey management and personnel tracking

- Independent GPS radios, separate from the acquisition system

Proven and reliable, but every one of these limits grows with crew size and survey extent.

THE TRENDS

Where land seismic is heading

1. **Larger fleets**
   Ten or more vibrator groups on one crew is now normal.

2. **More production**
   The push for more VPs per day requires new, more demanding acquisition methods.

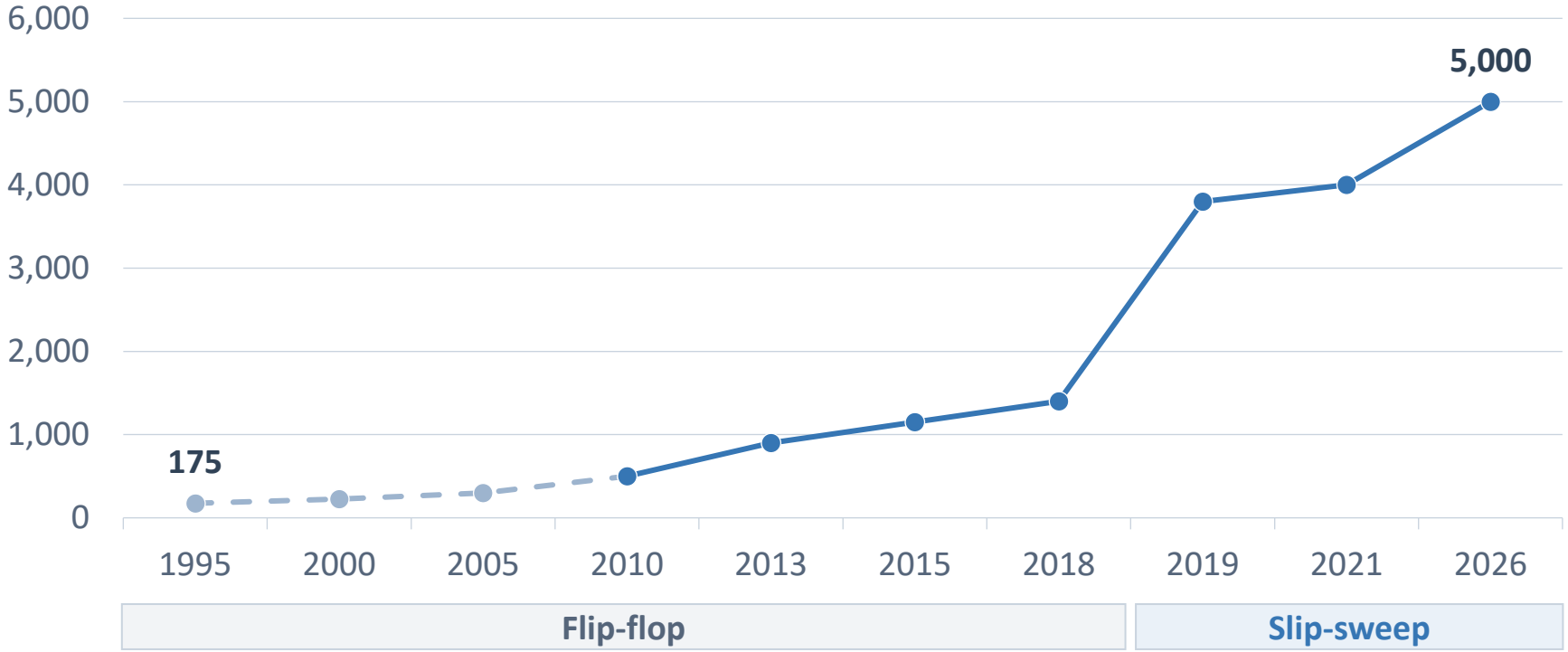
3. **Better tracking**
   No-permit and no-access zones need constant monitoring for violations.

4. **Urban work**
   More work in urban settings needs more precise force control to avoid damaging buildings and installations.

Each one asks more of the communication system than radio can give.

THE TRENDS

Permian Basin daily production, 1995 to 2026



Dashed: reconstructed benchmarks. Solid: documented projects. Slip-sweep replaced flip-flop from 2019.

THE CHALLENGE

More vibrators, more nodes, more exposure

More vibrators and nodes

Larger fleets and growing node counts.

More people and vehicles

More drivers, more crew laying out and picking up.

A bigger HSE challenge

More people and vehicles inherently bring more risk.

WHAT THIS MEANS IN THE FIELD

Dispersed teams

Vibrator groups and line teams spread wide, out of sight of each other.

More driving

Every added vehicle adds road exposure and more journeys to manage.

Shared awareness

A hazard found by one team matters to every other team nearby.

Conveying location, hazards, and work instructions over current radios is challenging.

THE REQUIREMENTS

What a modern land seismic crew needs

1. **Command and control at a distance**
   Communicate with, command, and control vibrators from a greater distance.
2. **Precise position and status**
   Fast, precise updates, with RTK corrections delivered over the Internet.
3. **Vehicle and personnel tracking**
   Track every support vehicle and every person on the crew.
4. **Work instructions**
   Convey work instructions to the people doing the work.
5. **Deployment progress**
   Keep the observer or coordinator updated on line deployment progress.
6. **Reliable low-force switching**
   Switch to low-force mode reliably to prevent accidental damage.

THE TECHNOLOGY

Persistent, high-speed IP connectivity

Cellular

WHERE INFRASTRUCTURE EXISTS

- Public networks already in place
- No repeaters or towers to build and move
- Best in urban, infrastructure-rich areas

Low-latency satellite

LOW EARTH ORBIT, SUCH AS STARLINK

- Coverage with no terrestrial network
- Compact terminals mounted on vehicles
- Latency low enough for real-time control

Standard IP

The same system runs unchanged over either one.

Always on

A persistent link, not a polled radio channel.

Under one second

Fleet-wide data exchange, independent of fleet size.

THE BENEFITS

What persistent connectivity delivers

1. **Control without range limits**
   Control and monitor from camp or a remote office, beyond radio range.
2. **Collision-free communication**
   Commands and status for every vibrator without delay, refreshed once per second.
3. **Live tracking**
   Vehicles, heavy equipment, and people on one map, zone violations flagged.
4. **Work orders on screen**
   Who, where, and what in writing, with start and completion notices.
5. **Live deployment progress**
   Node deployment and pickup reported live, position checked against plan.
6. **Reliable low-force switching**
   Low-force areas pushed to the source units, with PPV feedback to adjust force.

ARCHITECTURE

Communication path, actors, and observers

ACTORS IN THE FIELD

Vibrators
Commands, status, position

Support, heavy equipment
Work orders and position

Field personnel
Position, hazards, SOS

PPV stations
Measurements and alerts

COMMUNICATION PATH

Cellular

Satellite

Internet

Secure message server
Asynchronous messaging
Low-latency delivery
Distributes to every node

The path every message takes

OBSERVERS

Central recorder
Acquisition and work orders

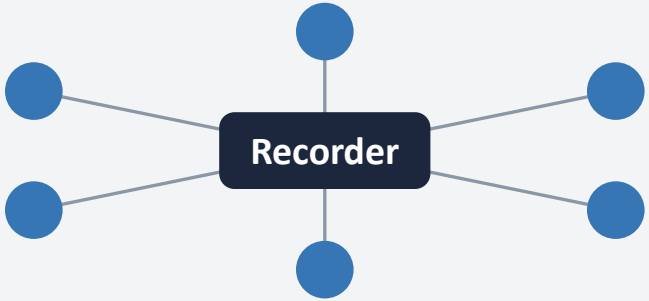
QC office
Source and deployment QC

HSE office
Tracking, journeys, hazards

Remote stakeholders
Live production updates

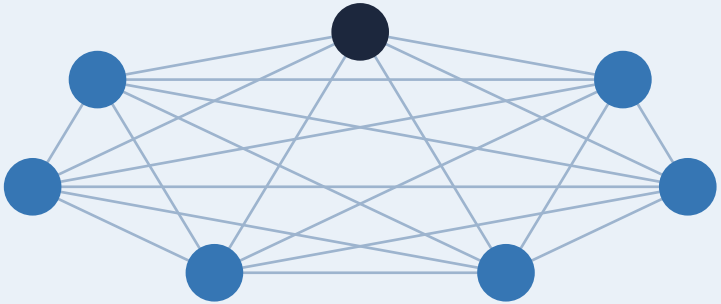
From a central hub to a connected network

Radio-centric, centralized



Every exchange goes through the central recorder, and only within its radio range.

Persistent IP, any to any



Each node connects to all other nodes. The recorder is one participant among many.

No radio range to stay within

Groups coordinate directly

More nodes, no slowdown

Distributed source coordination

Shared state

Vibrator groups keep near real-time awareness of each other's operational state.

Local rules

Each group enforces time-distance and exclusion rules itself, without central arbitration.

Observer role

Quality control and exception handling instead of real-time sequencing.

Peer-based coordination reduces system overhead and improves production efficiency.

SAFETY

Safety management in real time

Unified tracking of vehicles and personnel across the whole crew, on the same backbone that runs acquisition.

Hazard notifications
Reported once, delivered to everyone immediately. Every navigation screen shows it and warns on approach.

Keep-out zones
Updated in real time as conditions change.

Low-force areas
Pushed directly to the source units.

SOS

One press, from any unit
Every connected computer, tablet, phone, and dashboard sounds the alarm, pinpoints the location, and offers navigation to it.

PPV monitoring today

Mobile monitoring team

A team follows the vibrator group and watches the values. When a value exceeds the limit, they call the driver by radio to abort the sweep.

THE PROBLEM

- Limit is exceeded before the sweep stops
- Sweep is lost, then repeated at low force

Fixed monitor at an installation

A monitor watches one installation. As the vibrator group approaches, the operator calls the observer or the driver to switch to low force.

THE PROBLEM

- Relies on a person noticing in time and a voice call getting through

In neither case are the PPV values visible to the observer or to any remote stakeholder.

INFRASTRUCTURE PROTECTION

PPV monitoring on the network

PPV monitors
Raw values published continuously

The network
Secure message server

Observer and stakeholders
Every PPV monitor, live, from anywhere

Vibrators
Receive raw values and adjust force

THE BENEFITS

PPV stays within the limit

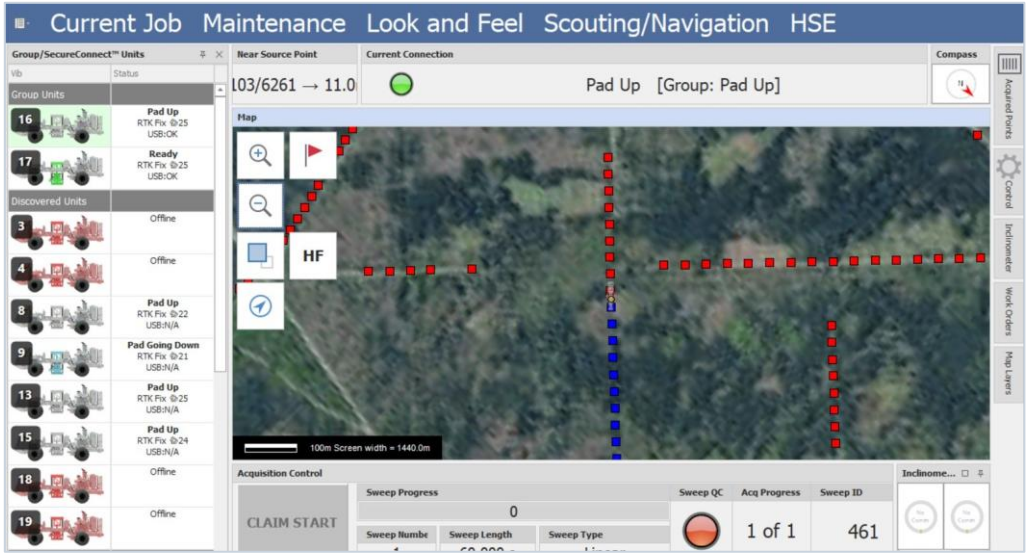
The source controller receives the PPV readings over the network and adjusts force dynamically, before the limit is reached.

The sweep is not stopped

No aborted or repeated sweeps, so production speed is not affected.

CASE STUDY 1 OF 4

Germany: the groups start themselves



Transport: bonded 5G and satellite.

Inner-city geothermal 3D

About 120,000 points. Eight groups of two vibrators.

One time/distance rule

One rule under a distance-separated method, enforced by every group.

No central recorder

Groups negotiate who starts when. The driver claims the start.

Distributed coordination holds a planned 300 VPs per group per day in a city.

CASE STUDY 2 OF 4

Australia: no-drive zones, no exceptions

Transport: satellite.

Ten single-vibrator groups

About 4,000 points in eight hours. Several time/distance rules, recorder starts.

No repeaters

The IP link reaches every vibrator across the spread. The recorder never moves.

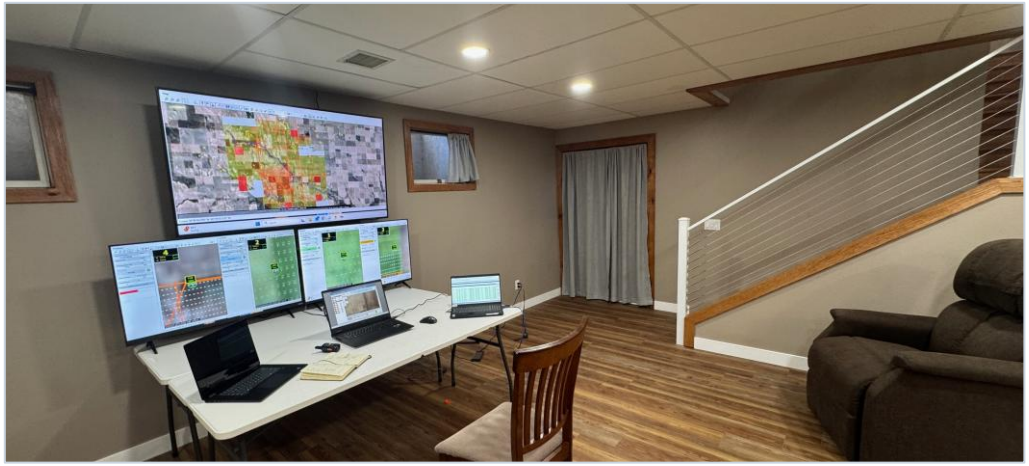
A strict client rule

One zone entry is penalized. Repeat violations can shut the crew down.

Compliance monitored and logged remotely, in real time.

CASE STUDY 3 OF 4

Midcontinent USA: the observer off the spread



Transport: satellite.

Six days, around the clock

About 30,000 points over 42 square miles in continuous 24-hour operation.

A low-risk place for the observer

No transport for shift changes at night, so less HSE exposure.

A recorder that stays put

For a smaller operation, not moving the recorder saves time, fuel, and crew hours.

Zero recordable incidents on a 24-hour crew.

CASE STUDY 4 OF 4

Alaska: node deployment QC, same network

Unit 202 deploys a node. Transport: satellite.

Deployment and pickup, live

Supervisor and observer see it at once. Sources learn when new points are ready.

Location and accuracy checked remotely

Every node's position and its offset from plan, in real time.

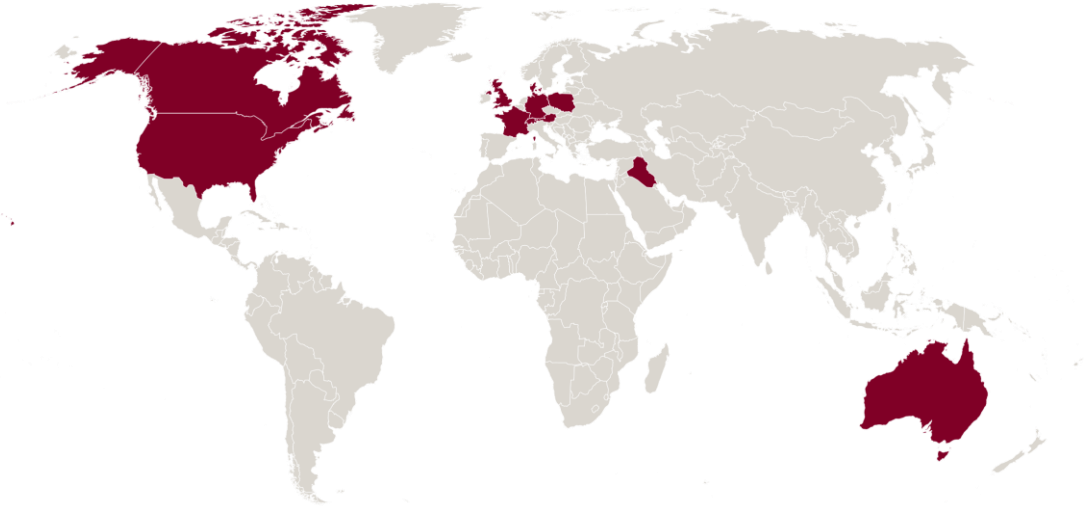
Deployment crews tracked for HSE

Every unit on the live map, speeds monitored.

Layout progress and placement accuracy, visible in real time, from anywhere.

DEPLOYMENT

Where it has been used

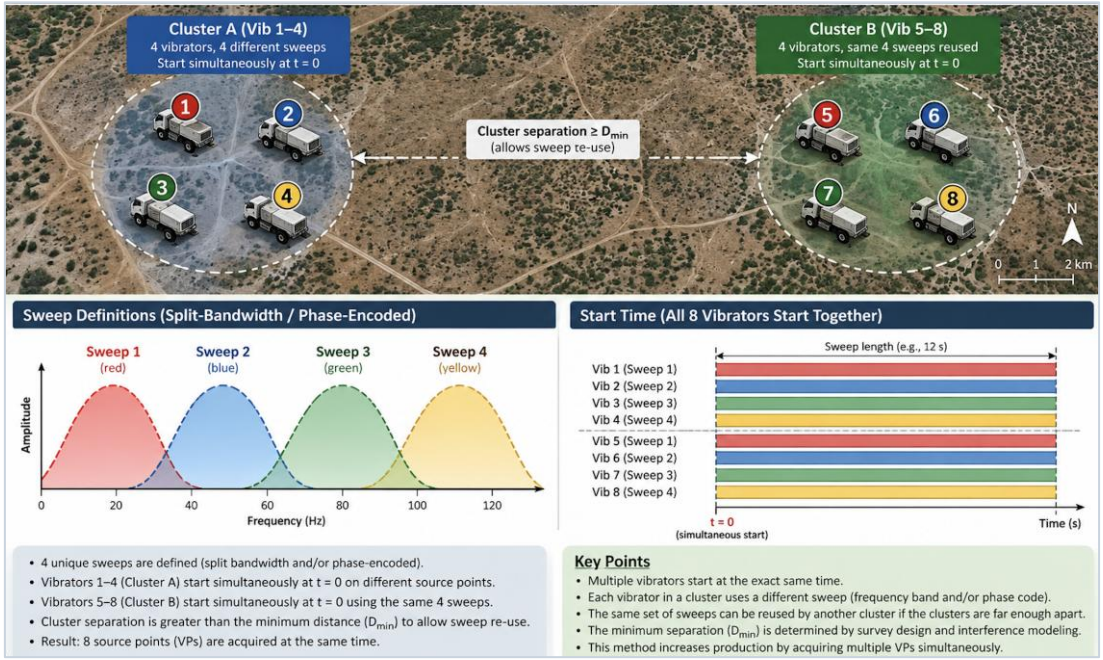


EUROPE DETAIL

Eleven countries on four continents, across a range of geographic and regulatory environments.

A method the radio could not keep up with

WesternGeco/Schlumberger simultaneous-activation method using split-bandwidth, phase-encoded sweeps, combined with distance-separated concurrent groups



LOOKING AHEAD

The same method over radio and over IP

OVER ONE ANALOG RADIO CHANNEL

12 groups of 2 vibrators, West Texas

- Poll 12 groups for status: over 12 seconds
- Collect QC, send the start, poll again
- Decision made far from the end of the previous sweep
- Groups ready at the start had been polled while driving, so they sat it out

OVER PERSISTENT IP

Every group reports in under a second

- The recorder knows who is ready at the moment of the decision
- Start decided at the end of the previous sweep, not seconds before
- More groups in every simultaneous start
- Current methods run faster with less overhead; new ones can be invented

CONCLUSIONS

Persistent connectivity as the foundation

Productivity

Sub-second fleet telemetry and distributed coordination remove polling delays.

Safety

Live tracking, shared hazards, and PPV-driven force control.

Visibility

Observers, QC, HSE, and remote stakeholders follow the same operation in real time.

Transport abstracted from operational logic, over cellular or satellite: a scalable, resilient base for land and transition-zone acquisition.