

Wireless telemetry system for oil exploration and monitoring

Oil exploration, energy
(hydrocarbon, gas...)

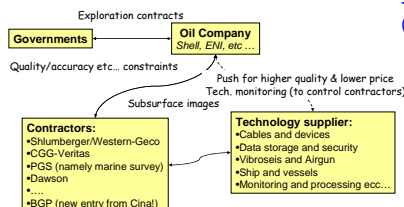


Key-innovation:
Improving exploration efficiency

Logistic costs (-20/30%)
Imaging quality (-30% exploration risks)
Number of measurements (+100/1000% fold QLand)
Monitoring efficiency (+50/80%)

Clients

- Oil contractors:
(Schlumberger/Western-Geco, CGG-Veritas)

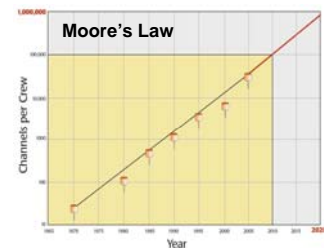


2012: the Wireless Revolution....

Cable-based exploration (2006)



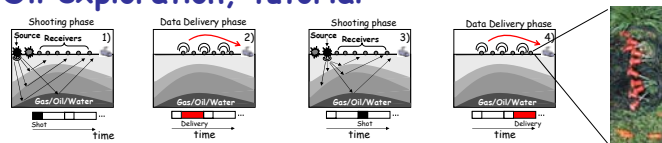
3000-10.000 man hours/sqkm
typ. >25sqkm



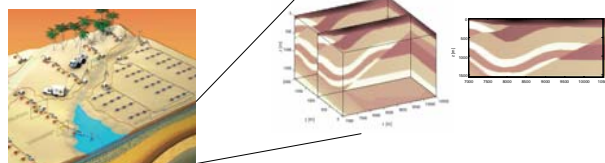
2010 - "half of all channels sold will be cable-free"
2018 - "there may be no cable operations in the world"
1,000,000 channels on a crew by 2020?

...the wireless way in oil exploration

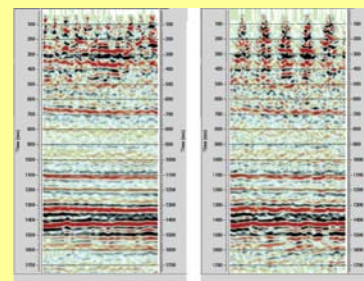
Oil exploration, tutorial



- >10.000 sensors over large monitoring areas (>25sqkm)
- Reflected seismic waves from sub-surface are registered by the geophones
- Objective is to create an image of the sub-surface



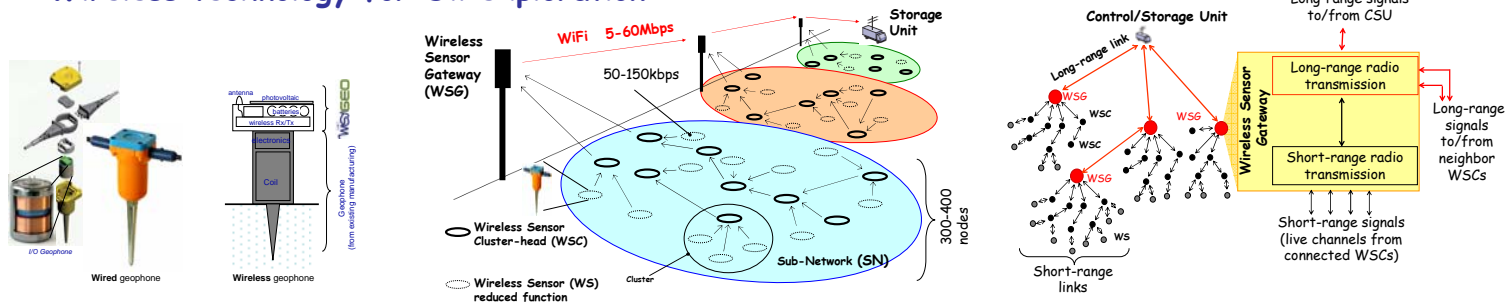
Push for high density (high number of channels and receivers)



To be able to further develop the field, a new seismic dataset was required that would provide significant improvements in resolution over the conventional seismic data recorded in 1996. To this end, a single-sensor survey covering 225 km² over the South Furusis field was designed. A single sensor was placed nominally every 12.5 m inline and 6.25 m crossline with a 6.25-m stagger to form a 25-m wide receiver line. The wide receiver line was used to ensure that adequate noise attenuation could be achieved on scattered ground roll.

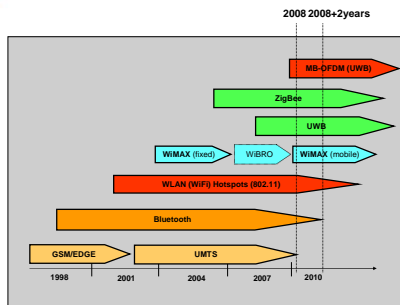
At the end of the survey, the seismic crew had completed more than 300,000 man hours without a single safety incident on this particular project, bringing their running total to in excess of 3,000,000 hours.

Wireless technology for Oil exploration



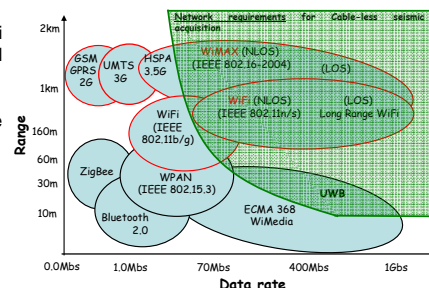
Expected device radio range: R	10-30 (max range 50 meters - AWGN channel)
Estimated Node density: d	larger than 2000 nodes/sqkm
Estimated network size: S	5-15 sqkm
Max Number of devices (WS+WSC) per SN: SN_dev	400 (SN size 0.2sqkm).
Max Number of WSGs: WSG_dev	75 (S=15sqkm, SN_dev=400)
Expected Number of WSCs per SN: WSC_dev	50 up to 96 (depending on the device density)
Max. number of neighbors per WSC (i.e., within one Beacon Group): WS_neighbors	16 (assuming WSC range of 50 meters)

Max Throughput per WS: WS_throughput	150kbps
Max Throughput per WSC: WSC_throughput	2.55Mbps (WS_neighbors=16) up to 60Mbps close to the Gateway (aggregated throughput)
Max Throughput per WSG (Aggregated throughput for each SN): SN_throughput	60Mbps
Relaying capability	WSCs should be capable of relaying data from neighboring sensors (WSs and other WSCs)
Power consumption	Sensors are expected to work continuously for days (2-3) without recharging.
Device synchronization	Frame alignment max error: 1µs. Devices should adjust their beacon period to maintain synchron. with the slowest device in the Beacon Group (the last one to finish its super frame).
Synchronized acquisition	Sensing operations need to be synchronized with max timing skew of 1/100 msec.



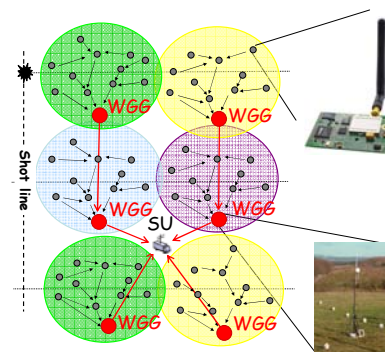
In 1998 – 2000 prototypes based on WiFi technology have been proposed for field trial.

Failure cases motivated the use of more advanced radio technologies:



Multi-Band OFDM represents one of the most promising Ultra Wide Band technology innovations for cable-replacing applications supporting high data-rates (wireless high definition video-transmission, wireless USB)

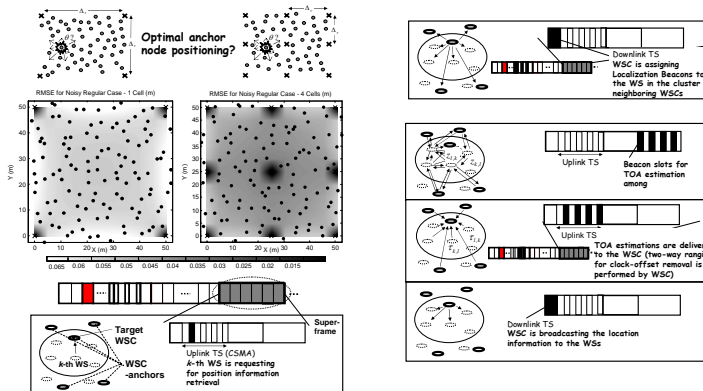
ZigBee technology for "shoot-blind" systems



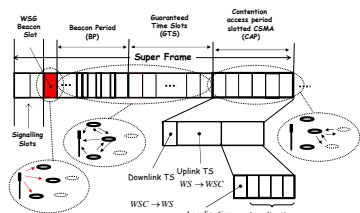
ZigBee for Quality Control

- SU: Storage Unit
- Short range communication Quality Control (QC) from Zigbee-compliant devices (IEEE 802.15.4)
- Long range communication (WiFi)
- WG: Wireless Geophone
- WGG: Wireless Geophone Gateway

UWB for geophone self-localization



Multi-Band OFDM technology for real-time telemetry (Wireless Geophone Network - WGN)



- Cluster-mesh hierarchical structure to support high-density networks and to combine both TDMA and RA channel accesses to offer more flexibility
- the WSG and the WSC devices have the right to access the beacon period (BP) and to issue a beacon frame; the WSG serves as sink node and occupies by default the first beacon slot after the so called signalling slots;
- WS geophones inside clusters communicate with the cluster-head without sending beacons but using RA in a reserved part of the super-frame

This proposed structure offers the advantage of scaling down the network size, hence relieving the collision problem and limiting the energy expenditure (reducing the number of devices that are occupying the BP)

