

Nanometrics Update

October 2018

Bruce Townsend, Chief Technology Officer

Strategic Intelligence Fueled by Science



Agenda

- Corporate introduction, and some recent changes
- New product, service and technology offerings
- Notable happenings and engagements
- Seismic Monitoring Services introduction
- Some technology directions we are pursuing

World Leading Supplier of Seismic Services and Instrumentation

- Based in Ottawa, Canada, with offices in Calgary, Houston and Beijing
- Ottawa site - 4-building campus: Corporate/Seismology, Seismic Monitoring Services, Manufacturing/Operations, R&D
- ~160 people engaged in operations, R&D, science, network installation, management and data analysis
- Dedicated Science and Technology Research staff: data processing, machine learning/AI, imaging and passive seismic monitoring
- Strong HSE practices compliant to industry standards



27,000+
Instruments sold
worldwide

100+
Countries with
active customers

Corporate Structure

Corporate + Divisional structure: Seismic Monitoring Services division, Seismology division

CEO



Neil Spriggs

CFO & VP
Corporate Services



Ian Talbot

Changes in 2018

CTO



Bruce Townsend

Vice President,
Seismology



David Shorey

Vice President,
Seismic Monitoring
Services



Dario Baturan

Vice President,
R&D



Tim Hayman

Strategic organizational changes responding to growth
in both Seismology and Seismic Monitoring Services

Manufacturing and Operations in 2018



Significant investment in plant and processes

- Scale up for growth in manufacturing – clean rooms, assembly & test
- Strengthen supply chain: multiple sources for reliability, redundancy
- Investment in automation and efficiencies

→ Continually improving

- order-to-delivery times
- ability to respond to larger orders
- reliability as a supplier
- quality and consistency of products



Centaur News

- New fourth-generation Centaur models: CTR4- series:
 - New high-precision high-output calibration signal generator
 - New 32-channel GNSS timing receiver
 - New 3- and 6-channel authenticating models for International Monitoring Station applications
- Many new features for all Centaur, TitanSMA/EA, Meridian models
- Sandia National Labs evaluation demonstrates best-in-class performance
 - report SAND2018-11442
- CTBTO confirms Centaur acceptance for IMS-wide use



New capabilities for all Centaur, TitanSMA/EA and Meridian models

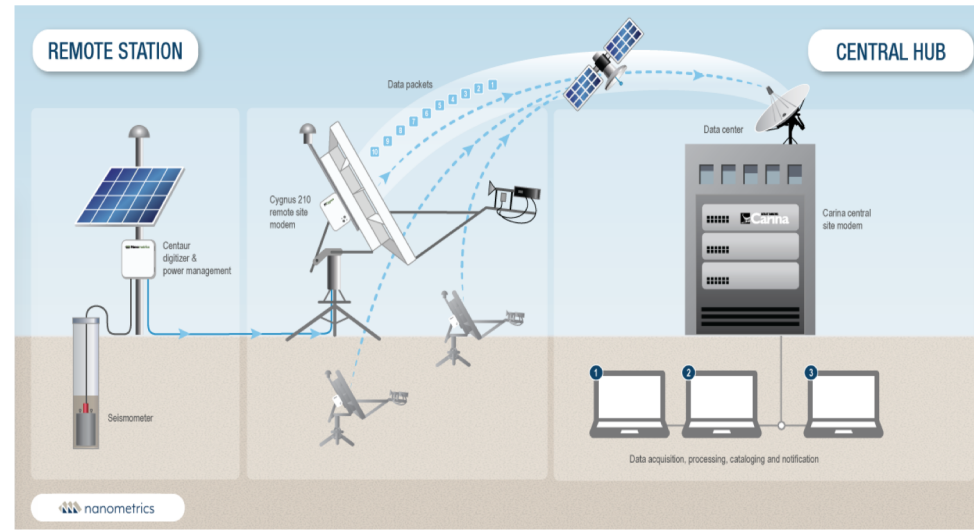
- Precision network timing (PTP or NTP) and free-run timing modes
 - Ability to source PTP or NTP timing to other units
- Rich calibration capabilities
 - Synthetic Sine and PRB waveform generation for calibration
 - Calibration playback files with adjustable gain, duration, lead-in and lead-out
 - Calibration command API
- Real-time orientation correction: 3D orthogonal data rotation to correct azimuth and tilt
- Minimum-Phase (causal) anti-aliasing filters
- Support for infrasound and weather (Centaur only):
 - Introduced units of pressure (Pa) to support use of microbarometers
 - Seismowave MB3a microbarometer added to the Sensor Library
 - Support for Gill Instruments Maximet GMX500 Digital Weather station
- Maximum sampling rate for the external SOH ports increased to 1 sps (Centaur only)



Libra News

New capabilities:

- NTP Time Server on Cygnus remote provides timing to attached Centaurs - no second GPS antenna needed
- Carrier Initialization (CI) Change Utility - quickly change to new carrier frequency
- Promotion of backup Carina hub to master hub - automatic fail-over for improved up-time
- Many user interface and network management improvements



Libra being used in
Earthquake Early Warning networks

Sensor News

- Trillium Horizon shipping, being deployed widely
- Cascadia shipping, working well
- Sensor Tilt & Levelling Bubble GUI shipping with all Trilliums - firmware upgrade available for many existing models
- Polar certification to -50C available for most sensor products



 **Trillium**  **Titan**



BOREHOLE



POSTHOLE



HORIZON



CASCADIA



TITAN SMA/EA



COMPACT PH/
TITAN COMPACT PH

 **nanometrics**

Sensor Tilt & Levelling GUI

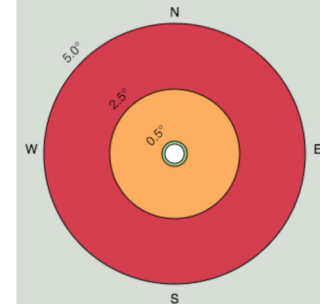
Mass Positions (Range ± 4)

Channel	Mass Position
U	-0.979
V	2.160
W	-0.589

Case tilt

X dip	Y dip	Total tilt
0°	0°	90°

Levelling Bubble

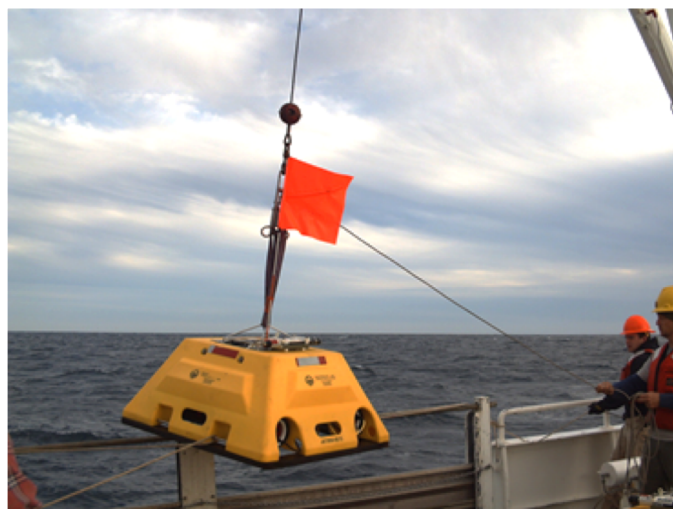
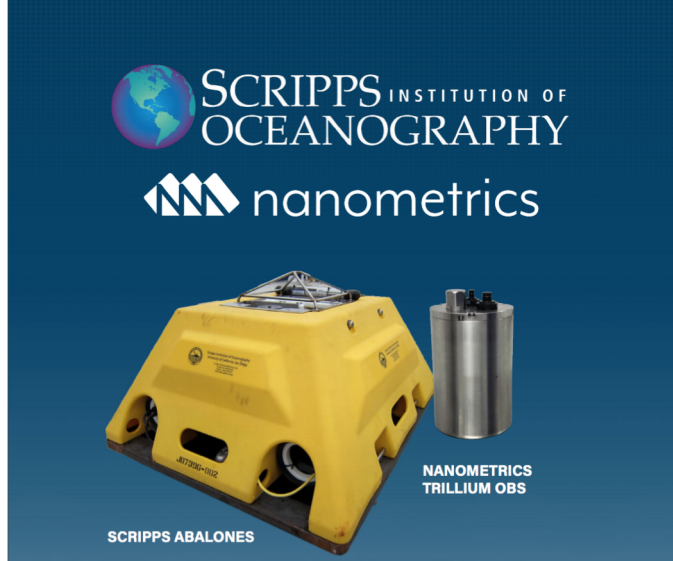


Scripps and Nanometrics teamed-up to make Ocean Bottom Systems globally available

Scripps Institution of Oceanography (SIO) and Nanometrics Inc. announced a new partnership that will bring Ocean Bottom Seismometer (OBS) Systems to research institutes world-wide. Building the partnership on the strengths of both parties, Scripps will continue to push the boundaries of research and development for oceanographic seismology while Nanometrics advances OBS seismic instrumentation and manages manufacturing and distribution of the turnkey Ocean Bottom Systems.

Both Scripps and Nanometrics will continue to evolve OBS product offerings to facilitate the continued advancement of oceanographic research. Bringing together expertise in ocean science and seismic instrumentation provides research institutes around the world access to unparalleled seismic technologies for geophysical studies of the ocean.

SIO and Nanometrics are committed to investing in Research and Development to advance OBS System technologies and make it widely available.



Seismic Monitoring Services (SMS) - Overview

Primary mandate: to provide turnkey seismic monitoring services independent of the Application

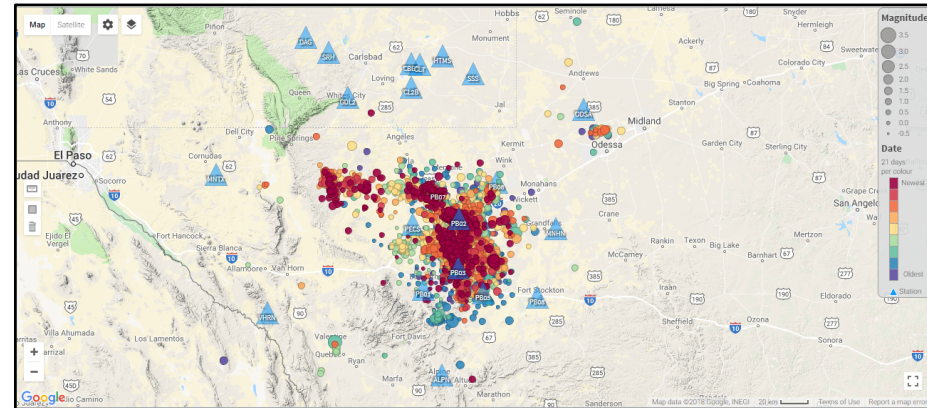
- Equipment lease
- Network deployment, maintenance, operation and decommissioning
- Cloud-based acquisition, monitoring, processing and data archiving
- Interrupt-driven automated network monitoring
- AI-enhanced automatic event processing supplemented by manual analyst review

Turnkey seismic networks in Canada, USA, South America and Europe

- 35+ networks, 300+ semi-permanent seismic stations
- 40+ clients with active monitoring projects
- 24/7 Network Operation Center (NOC)
- Next-day manual event review, 365 days/year

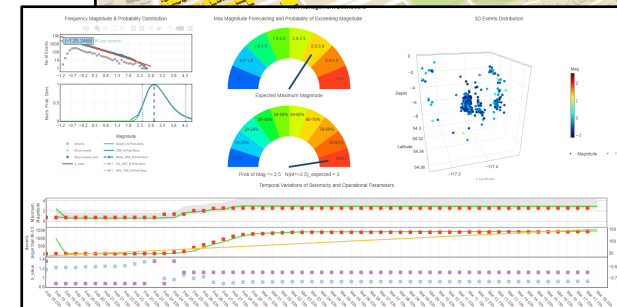
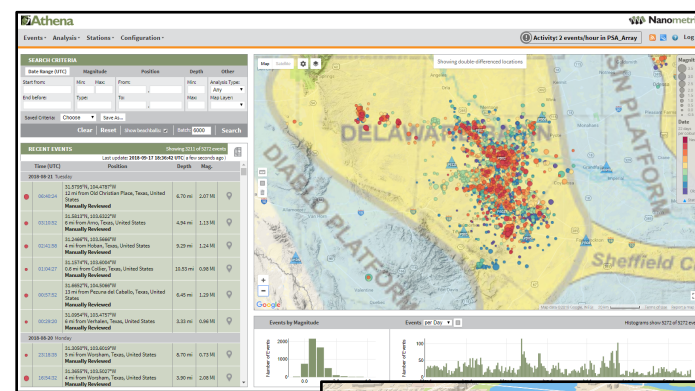
5+ years of experience

- 3 offices: Ottawa, Calgary and Houston
- Processed 300,000+ events to date



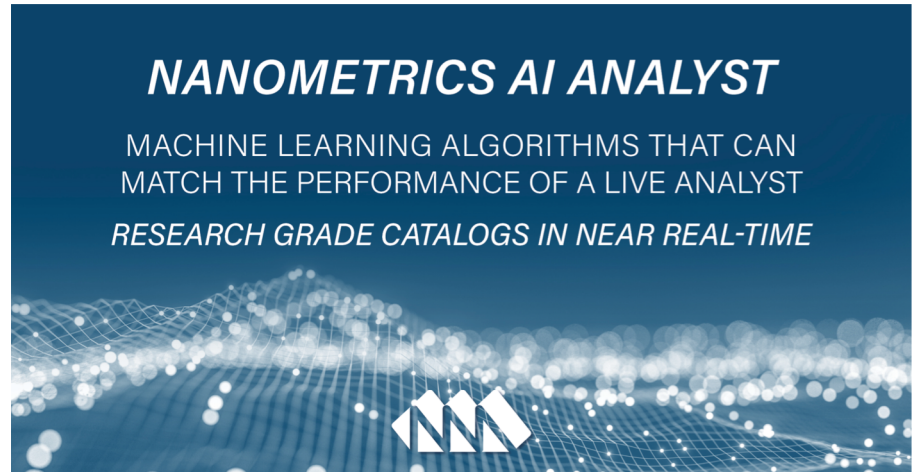
SMS Product lines

- Passive Seismic Monitoring (PSM)
 - Continuous (long-term) real-time monitoring
 - Local, regional and microseismic scale
 - **Subscriber arrays**
- Passive Frac Imaging (PFI)
 - Microseismic monitoring of HF operations
- Engineering Seismology (ES) services
 - Magnitude calibration studies
 - GMPE/site amplification map development
 - Shakemaps/seismic hazard analysis
- Applications and clients:
 - **Induced seismic monitoring** & regulatory compliance
 - **Critical infrastructure monitoring**



Machine Learning Update: New 'AI Analyst'

Nanometrics supervised Machine Learning algorithm, *AI Analyst*, can now match the accuracy of a live analyst for well-constrained events; this advanced processing is now included as a standard feature with all monitoring services. AI Analyst enables complete, accurate and consistent assessment of target region seismicity in near real-time as a critical input into operational decision making.



AI Analyst is a significant accomplishment by the Nanometrics Science and Development team

Thank You

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