Broadening the Impact of OSI Exercises and Field Tests

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Final Verification Measure

- **OSI = Final Verification Measure**
  - Triggered by **International Monitoring System (IMS) anomalies** or other Treaty mechanisms
  - Collect factual findings to **confirm or refute a suspected nuclear test**.

Inspection Facts (as defined by CTBT Protocol)

Maximum Area: up to **1,000 km^2** (defined inspection area).

Duration: 25 days, extendable up to 130 days with EC approval.

Inspection Team: up to **40 inspectors**.

Techniques: 17 techniques permitted by Treaty

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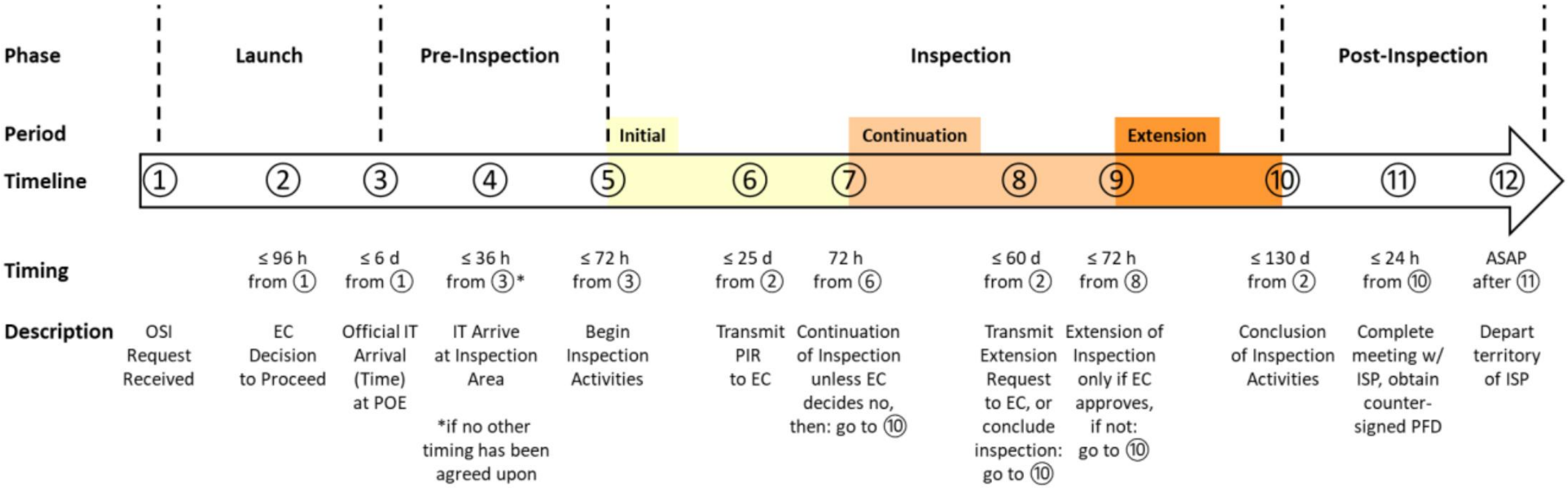
Field Operations — Operational Layers



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Inspection activities and techniques, Treaty Protocol Para.69

(a) Position finding from the air and at the surface to confirm the boundaries of the inspection area and establish coordinates of locations therein, ***in support of the inspection activities***;

(b) Visual observation, video and still photography and multi-spectral imaging, including infrared measurements, at and below the surface, and from the air, ***to search for anomalies or artifacts***;

(c) Measurement of levels of **radioactivity** above, at and below the surface, using **gamma radiation monitoring** and **energy resolution analysis** from the air, and at or under the surface, to search for and ***identify radiation anomalies***;

(d) Environmental sampling and analysis of solids, liquids and gases from above, at and below the surface ***todetect anomalies***;

(e) Passive seismological monitoring for aftershocks to localize the search area and facilitate ***determination of the nature of an event;***

(f) Resonance seismometry and **active seismic surveys** to ***search for and locate underground anomalies, including cavities and rubble zones;***

(g) Magnetic and gravitational field mapping, **ground penetrating radar and electrical conductivity** measurements at the surface and from the air, as appropriate, ***to detect anomalies or artifacts***;

(h) Drilling ***to obtain radioactive samples***.

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Field Operations — Operational Layers

- Health, Safety & Security HSS: protocols and risk management
- Logistics: mobility, transportation, field operations, equipment provisioning
- Privileges and Rights: Inspector privileges and State rights (ISP context) — legal & diplomatic dimensions
- Treaty and Protocol Text, Operational Manual, Standard Operating Procedures (SOPs)

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The Mandate

The Resolution establishing the CTBT Preparatory Commission

The Commission shall make all necessary preparations in fulfilling the requirements of the treaty and its protocol, for the support of on-site inspections from the entry into force of the Treaty. It shall, inter alia:

(a) Develop and prepare for the approval of the initial session of the Conference of the States Parties:

I. An operational manual containing all appropriate legal, technical and administrative procedures;

II. A list of equipment for use during on-site inspections

(b) Develop a programme for the training of inspectors

(c) Acquire or otherwise make provision for the availability of relevant inspection equipment, including communications equipment, and conduct technical tests of such equipment as necessary.

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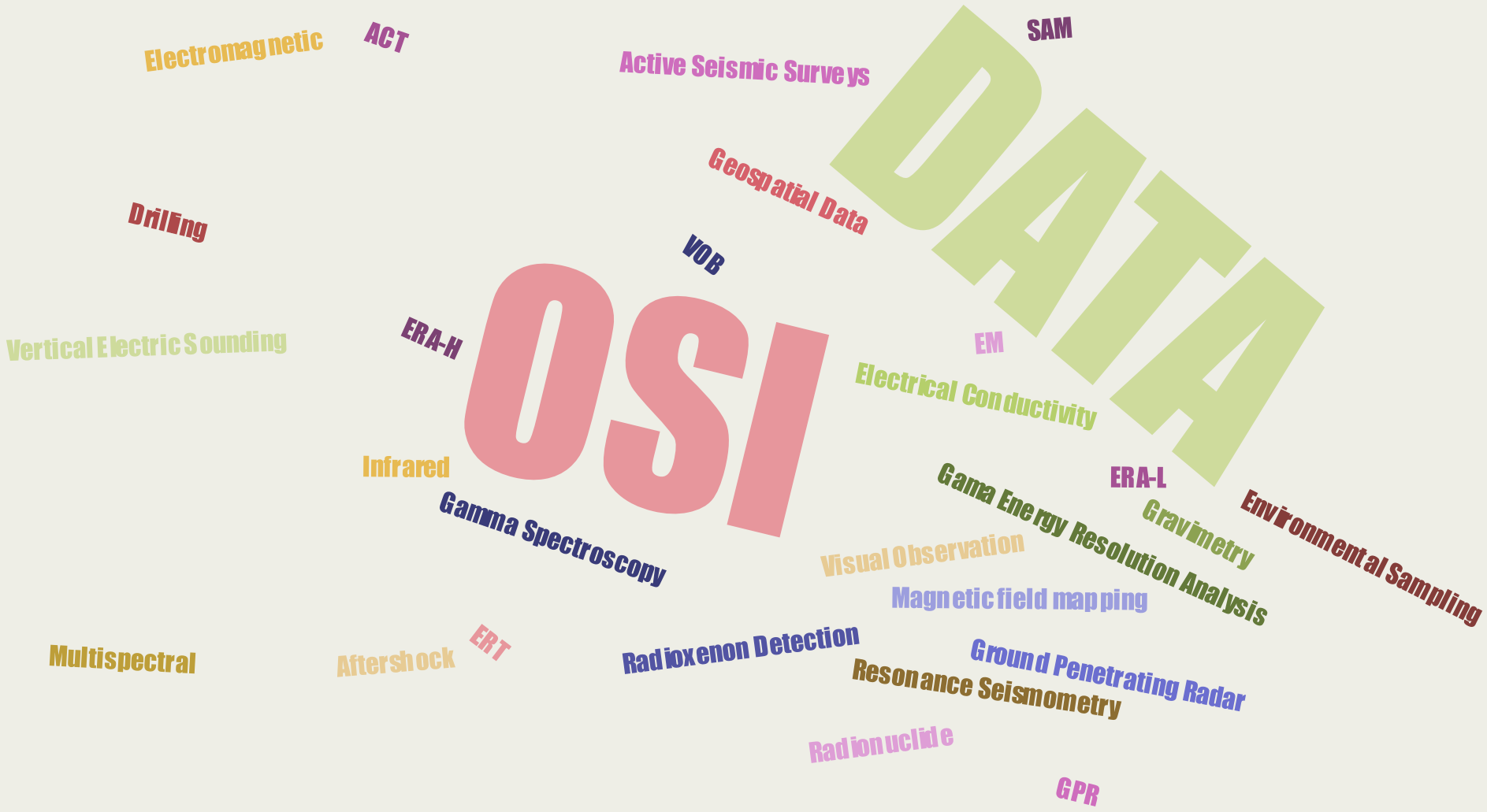
Exercises and Field Tests

- Simulated 37-day OSI in Jordan (Nov–Dec 2014) over a ~1,000 km^2 area with ~40 inspectors.
- *IFE14 tested 15 of the OSI techniques prescribed by the Treaty*
- Introduced an improved in-field communications system and rapid-deployment capabilities for moving tons of equipment


DATA
OSI
Electromagnetic
ACT
SAM
Active Seismic Surveys
Geospatial Data
Drilling
VOB
ERA-H
Vertical Electric Sounding
EM
Electrical Conductivity
Infrared
ERA-L
Environmental Sampling
Gamma Spectroscopy
Gama Energy Resolution Analysis
Gravimetry
Visual Observation
Magnetic field mapping
Multispectral
Aftershock
ERT
Radioxenon Detection
Ground Penetrating Radar
Resonance Seismometry
Radionuclide
GPR

Exercises and Field Tests

- *BUE24 (June 2024) simulated the* continuation *phase of an OSI in mountainous terrain in Hungary*
- *Nearly 200 participants from 40+ countries and ~100 tonnes of equipment were deployed across a 382 km² area*
- Tested updated inspection team functionality (ITF), search logic and data workflows, including use of the Geospatial Information Management (GIMO) platform

Outcomes / Impact

Operational Readiness

ensure that once the Treaty enters into force, OSI teams are fully prepared and equipment is functional

Procedure Validation

Running realistic scenarios validates and refines inspection procedures, workflows and reporting formats (leading to updated manuals).

Technical Improvement

Data collected allow calibration of sensors and testing new equipment in situ, improving detection resolution.

Efficiency Gains

Use of integrated tools (e.g. GIMO) and refined team protocols results in faster, more effective search missions (shorter mission planning cycles, better information sharing).

Strengthened Compliance

Demonstrating these capabilities builds confidence in the CTBT regime; the exercises show that inspectors can find evidence if needed, thus reinforcing deterrence.

Challenges

Data Integration	Combining diverse datasets (seismic waveforms, radiometric counts, GIS layers, lab results) in real time is complex. Large volumes of data from varied sources require robust fusion tools
Logistical	Transporting 150+ tones of heavy, delicate equipment into remote areas under tight time pressure with Calibration requirements and personnels limitation
Time Constraints	Certain signals decay quickly – e.g. the number of aftershocks and short-lived radionuclides dissipate; Inspectors must deploy within days to capture these signals; ITF cycle(steps 1-5);
Environmental	OSI take place in environments ranging from arid deserts to the Arctic, impacting inspectors, equipment, search logic, logistics, and every component of the inspection.
Technical Limits	Instruments have finite resolution and detection capabilities; some signals can be confused with background anomalies; Keeping all equipment calibrated under field conditions is also challenging

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From Data to Improvement — Turning Field tests & Exercise Data into Value

- High-volume, multi-modal datasets enable recalibration and QA/QC
- Refine analytical algorithms and develop better acquisition SOPs
- Procurement insights: inform future equipment acquisition, lifecycle planning, and upgrades.
- Document lessons learned for operational manuals and training.
- Knowledge transfer: lessons learned feed directly into operational manuals, training, and inspector preparation.
- Innovation driver: exercise-derived data supports R&D, fostering continuous improvement of OSI capabilities

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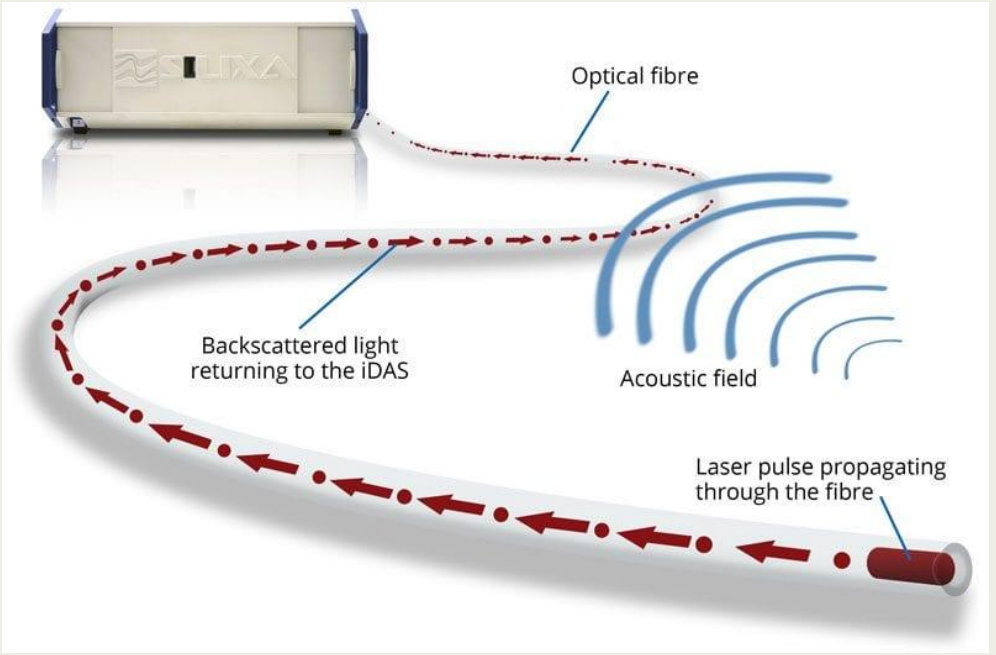
Optical fibre
Backscattered light
returning to the iDAS
Acoustic field
Laser pulse propagating
through the fibre

Data Fusion Tools

Autonomous Systems

Logistics Prep

Sensor Advances

Novel Processing methods

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Broadening Engagement — Who to Involve

- Academic researchers and university labs
- Technical experts from member states
- Industry partners
- Students and early-career professionals

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Broadening Engagement - Impact

- Stronger feedback loops for procedures, software and equipment design
- Innovation pipelines from academia and industry
- Expanded capacity across member states — localized expertise
- Greater transparency, trust-building and improved readiness

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Vision Forward

- Keep OSI techniques robust, treaty-compliant and future-ready
- Institutionalize data-sharing mechanisms and collaborative Research and Development
- Codify lessons into living manuals that evolve with technology
- Leverage exercise-derived data to strengthen scientific foundations and preparedness
- Broaden engagement to harness innovation, build capacity, and reinforce trust

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Conclusions

- **OSI exercises** prove that the CTBT's verification system is robust, operational, and future-ready.
- **Exercise-derived data** fuels improvements in equipment, methods, and data integration.
- **Community engagement** broadens the impact — linking experts, policymakers, and students.
- **Shared goal:** Strengthen trust, enhance readiness, and ensure effective treaty compliance.

👉 *By operationalizing technological advances and broadening participation, OSI remains a cornerstone of global nuclear disarmament and security.*