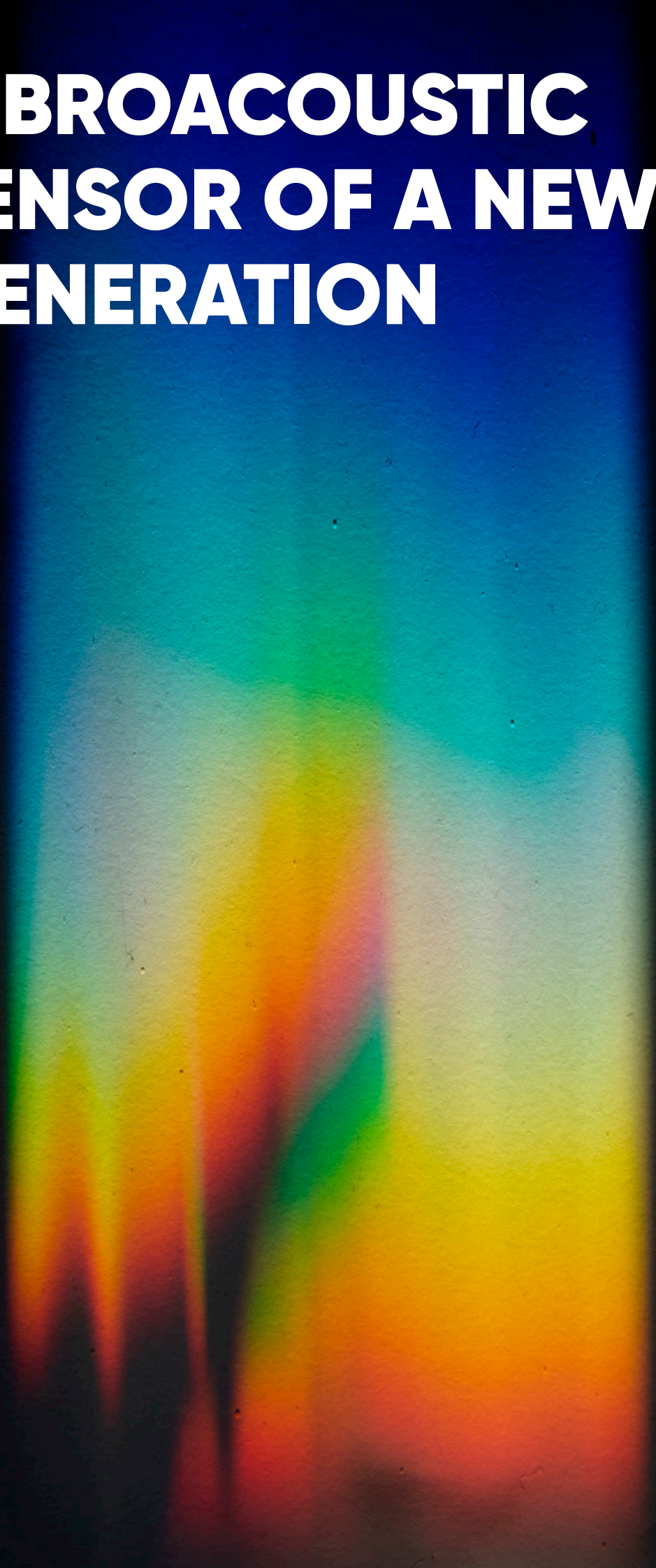
SVIAZNOY ALLIANCE

DAS SYSTEM ALMAZ

VIBROACOUSTIC SENSOR OF A NEW GENERATION



ALMAZ

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up to ±10 m

Accuracy of determination

up to 100 km

One direction distance

1 sec ±0.5 °C

Thermal or strain changes

up to 300m

Events detection around fiber

GEOGRAPHY

APPLICATION AREAS:

Perimetral protection

Oil and gas pipelines

Vertical profile

Telecom

Energy

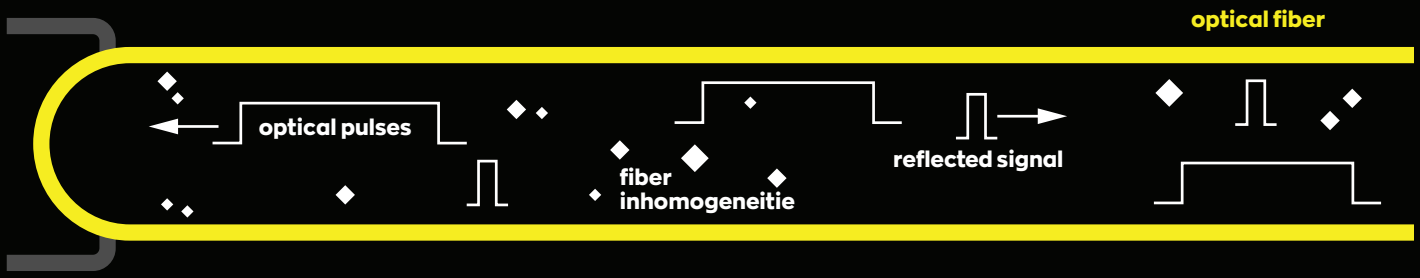
Railways and subway

DISTRUBUTED ACOUSTIC SENSOR ALMAZ

Distrubuted Acoustic Sensor ALMAZ allows detecting ground vibration (acoustic vibrations) at a distance of several tens of kilometers along an optical cable. A cable with standard telecommunication single-mode fiber (G.652, G.655, G.657) is used as a sensitive element. A vibroacoustic sensor is connected to the fiber, which continuously monitors the security zone for vibroacoustic events and changes in the temperature's gradient along the fiber-optic cable.
DAS ALMAZ allows simultaneously record many events along the entire length of the line with an accuracy of 10 meters, approaching the protected area moving along the line or crossing the border of the controlled area. By organizing several parallel lines the detection accuracy of the system repeatedly increases. When a person or car approache or when work is carried out near the border information about the location of the event is sent to the operator's computer of the DAS ALMAZ in real time. The system detects any activity that causes water or soil vibrations. When installing the system at the customer's site, the specialists carry out an individual configuration of the system, depended on the characteristics of each object.

Physical principle of operation

The system is based on the principle of coherent reflectometry. In a coherent reflectometer, in contrast to a conventional reflectometer, a narrower and more stable radiation source is used. Optical pulses are periodically introduced into the fiber which reflect part of the light back during propagation. Reflection occurs both from fiber defects and from refractive index irregularities (scattering centers) uniformly distributed over the fiber. The reflected signals are added coherently: the difference between their phases relative to each other is constant in time. Parameters of the scattered (reflected) signal change in event of microdeformations of the fiber caused by vibroacoustic and temperature influences. The simplest processing of the data obtained is to calculate the maximum difference between several sequential reflectogrammes for each fiber point. By analyzing the changes in the interference pattern of the backscattered signal, it is possible to determine the location and nature of the impact on the fiber.



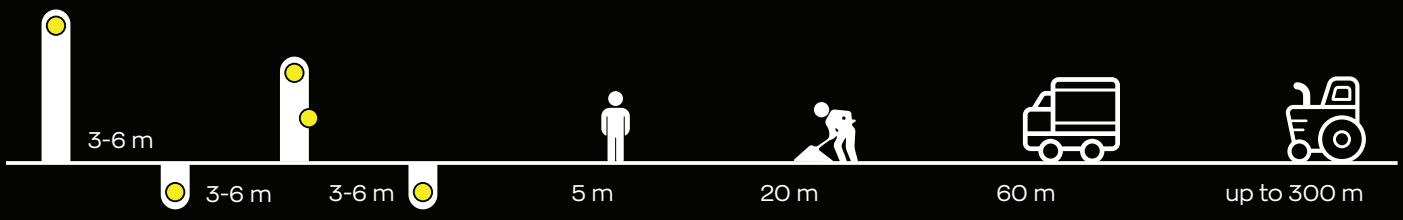
Physical principle of operation

The events of recognition

The most important element of the DAS ALMAZ is the built-in recognition system. Signal processing takes a place using a neural network. Each signal received by the optical unit from a section of the line is assigned a "vector" of probabilities which is compared with the template type of the signal. The recognition unit analyzes the information received from all sections of the line and aggregates probabilistic events into an object or sets of objects.
The final stage is the determination of each object's characteristics such as the trajectory of movement, speed, etc. Thanks to the use of a neural network and its ability to learn new types of events the range of tasks and objects for classification is significantly expanded. The neural network can work both in the built-in computer of DAS ALMAZ and on an external server. While multiple DAS ALMAZ device works its software is deployed on an external server.

Purpose of the system

One of the main applications of the DAS ALMAZ is the organization of early detection of systems for critical infrastructure facilities. The system operator receives alarm signals even before the intruder crosses the security line, since the acoustic sensor allows registering signals from sources located tens and even hundreds of meters from the cable.
DAS ALMAZ is performed as 3U shassis and can be placed in a 19" telecommunication rack. Three slots of the system are installed: 1x transceiver module (coherent reflectometer), 1x amplifier module and 1x industrial computer for processing and transmitting data to the server. DAS ALMAZ can operate as independently as part of an integrated security system. API is provided for integration with existing systems in the enterprise.



Maximum distance from fiber-optic cable
for registration and classification of vibroacoustic influences

System parametrs

Type of optical fiber	G.652, G.655 or G.657 (ITU), single-mode
Fiber length (sensing element)	75 km (100 km depending on configuration) **
Accuracy of determination	10 m

Optical parameters

Wavelength	1550 nm
Scan frequency	0,5 - 20 kHz
Deformation sensitivity	from to 0,14 nstrain
Dynamic range	30 dB
Maximum power	10 mW
Connector type	LC/APC

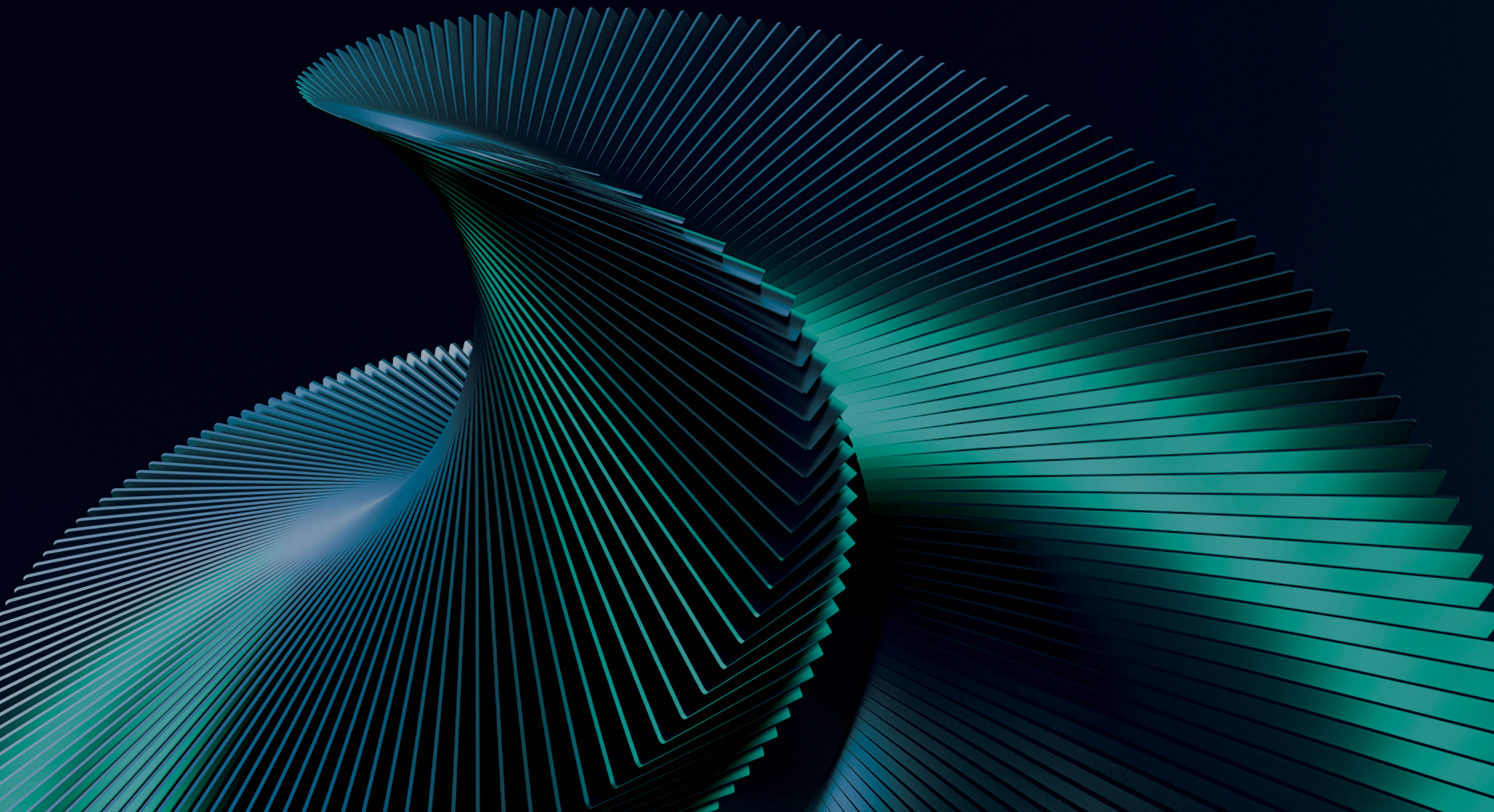
Built-in PC

CPU	Intel Core i7 *
Memory / Hard Disk	8 Gb / 2 Tb*
Protocols	TCP/IP, UDP
Interfaces	SFP, RG45, USB 2.0, DVI-D, Display Port

Options

Power supply	110-127 V / ~200–240 V, 50 – 60 Hz
Energy consumption (reflectometer / server)	300 W (100/200 W)
Dimensions	497 x 345 x 137 mm (for 3U option)
Weight	17,5 kg

Perimeter



Perimetral security system for critical objects

When building perimeter monitoring systems of a large length (tens and hundreds of kilometers), the main task of the security service is not the physical protection of the facility, but the timely detection of the intruders and the prevention of events.
In case of excavation works, a person or a car approaches near the protected object, DAS ALMAZ generates an alarm signal and transmits information about the coordinates of the event. For critical infrastructure and sensitive facilities, it is possible to build several security lines in order to determine the exact direction and speed of the offender.
An important advantage of the system is the secretive work of the DAS ALMAZ. The boundary is not visually detected and there is no electromagnetic radiation. The hidden placement of the sensing element allows solving several tasks such as a vandal resistance and the impossibility of conducting preliminary reconnaissance. The hidden work of the DAS ALMAZ does not allow a potential intruder to carry out preparatory work and practice of actions which increases the possibility of detection. Discreet placement is essential in remote areas where theft or damage to equipment is high. The preservation of the landscape makes it possible to use the system in specially protected areas of cultural heritage. DAS ALMAZ does not require power supply along the entire length of the border (supplied only at the place of installation of the device), infrastructure and terminal equipment.

The vibroacoustic sensor allows detecting digging of underground tunnels and trenches. This design allows DAS ALMAZ to be an indispensable solution for airports, large industrial and security enterprises, as well as landfills for various purposes.
The complex supports an open API (signal transmission over Ethernet) which allows it to be integrated into existing security complexes. Joint operation of the complex with a video surveillance system is possible when the camera is oriented to the corresponding section of the border on an alarm signal, and the operator sees the display of the event on his monitor. Due to instructions of the operator the system allows to mask the regular safe events, such as the passage of vehicles or people in permitted areas. Integration of the DAS ALMAZ into the complexes existing at the facilities minimizes the number of false alarms.
DAS ALMAZ has passed certification tests of functional properties in terms of ensuring transport security in accordance with the rules of mandatory certification of technical means for ensuring transport security, issued by the Government of the Russian Federation dated September 26, 2016 No. 969. Fulfillment of the Requirements for the functional properties of technical means for ensuring transport security expands the scope application of DAS ALMAZ to transport facilities and critical infrastructure.

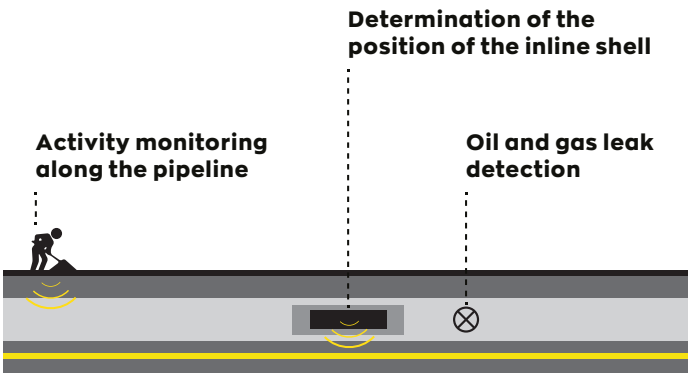
- **DAS ALMAZ operates as a part of the perimeter security complex of Domodedovo international airport (Moscow)**
- **The equipment is installed and being operate at the international airports of Omsk and Tyumen cities**
- **The system has successfully passed oil field tests of the Scientific Research and Development Institude of Radio Electronics**
- **DAS ALMAZ is installed in the transnational park Limpopo (South Africa)**

Oil and gas

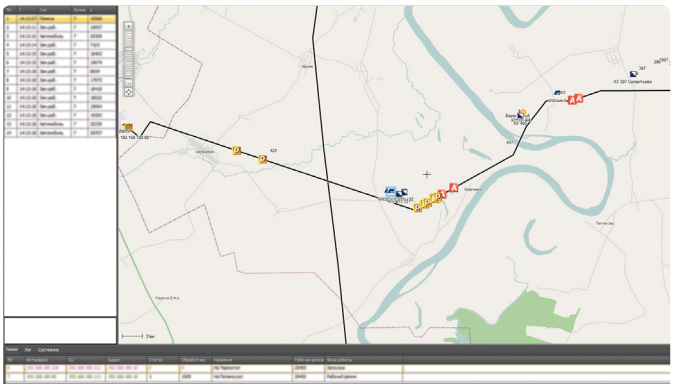
Oil and gas industry. Monitoring and diagnostics of pipelines

Monitoring of pipelines and communication lines always implies too high financial investments to the for security infrastructure. In case of classical the problem solving such a safety line contains many elements and each of them requires a periodic maintenance and monitoring of it's operation.
The sensitive element of the system is a fiber-optic cable which does not require maintenance. At the same time one fiber in a fiber-optic cable located along the pipeline is equal thousands of sensors. The average service lifetime of fiber declared by the manufacturers is more than 25 years, and DAS ALMAZ is designed to operate for more than 10 years.
DAS ALMAZ independently or as part of an integrated system informs about the approach to the protected pipeline of heavy equipment, allows operator to detect tie-ins and unauthorized work. The width of the detection zone for a person is several meters. Even before the intruder comes close to the object of protection he will be detected by the system. The sensing element of the sensor is hidden underground so the probability of accidental or deliberate damage is minimized.

DAS ALMAZ system can be easily integrated into a single video surveillance complex or any existing security system that allows the use of external APIs. The sensor provides a video image from the section of the pipeline where the alarm was triggered, and also generates an alert by various channels about an alarm event to security personnel. Full automation of the system is possible, e.g. integration with unmanned aerial vehicles. Automatic notifications of coordinates to an unmanned vehicle will allow operator to receive photo and video images quickly from the scene without the additional participation of the dispatcher. The operator can remotely monitor the operation of the system, thanks to the ability to manage it by the Ethernet channel.
The use of neural networks and modern microprocessor technology makes it possible to use the sensor for detecting oil and gas leaks, vertical seismic profiling, detecting undermines, monitoring the movement of inline shells (cleaning pigs) and flaw detectors inside the pipeline.



Optical fiber



System operator window with a map and a list of events at the turn

- **The system is deployed into operation on the gas pipline of Gazprom transgaz Ufa LLC, Gazprom transgaz Ukhta LLC, KazTransOil JSC (Kazakhstan)**
- **Equipment installed and operated at the Saratov refinery (Rosneft)**
- **Field tests successfully performed on Surgutneftegas JSC oil pipeline**

Transport

Transport infrastructure safety

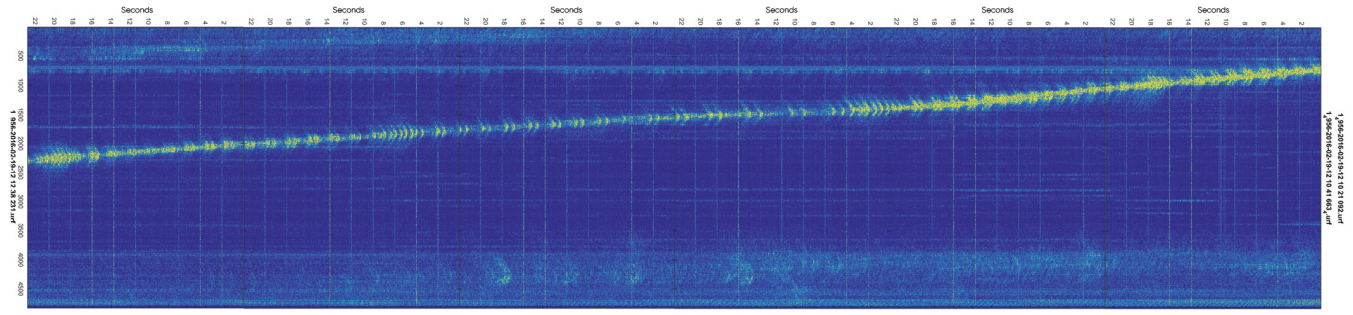
Railways are the most important transport artery of the country but like all modern transport systems it is inconceivable without control and management automation systems. The operation of the railway infrastructure requires real-time monitoring of train traffic and the condition of railway tracks.

DAS ALMAZ allows such detecting:

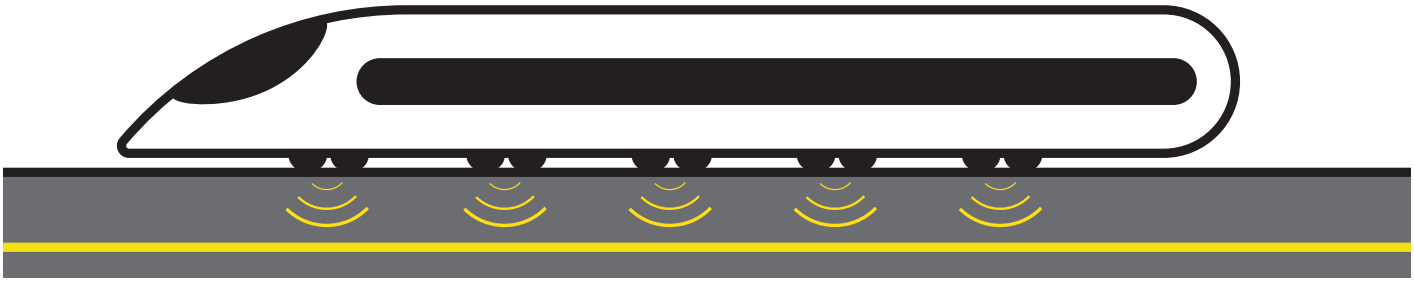
- repair work carried out along the railway tracks
- person appearing on the path or movement along the railroad track
- transport vehicle appearing on the way
- types of trains, their coordinates, length of the train and travel speed (up to 0 km/h for diesel trains)
- facts of cargo dragging in case of emergencies
- damage to the railway track
- rockfalls, avalanches and landslides

The big advantage of the system is that the sensor is insensitive to electromagnetic influences. The sensor works without failure in lightning discharges and doesn't depend on weather conditions and climate change, and allows the proximity of the sensitive element to power lines. The system can filter signals from nearby industrial facilities and highways (up to 20-25 m from the railway). DAS ALMAZ has the function of binding the location of the detected impact. Its opens up the opportunities for the integration of DAS ALMAZ with the existing information systems of the customer.

Interval regulation	Technological disasters	Rail defects	Activity monitoring (human/vehicle)



An example of fixing a trolley passage: time is on a horizontal axis, distance is on a vertical axis.
The picture showes the sound of wheelsets at the rail joints.



Optical fiber

Cable

Control of access to cable infrastructure

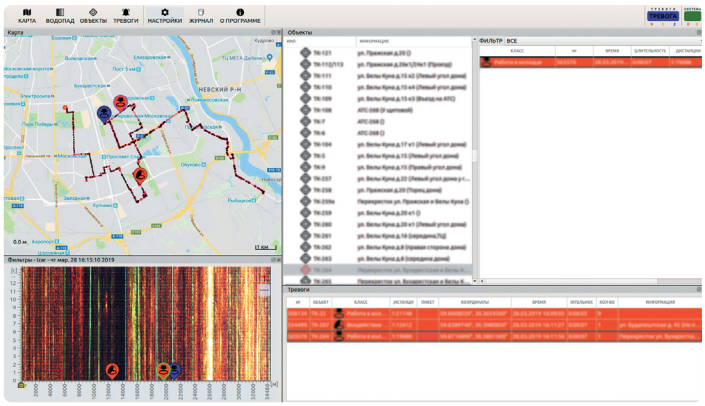
Line and cable infrastructure

Monitoring and security the cable sewerage in populated areas are a laborious and costly tasks. Theft of copper cables, vandalism, accidents and road accidents due to open hatches - all this requires the telecom operator to ensure continuous monitoring of the state of line-cable structures, including well hatches. Commercial losses due to unauthorized laying of trunk cables should be especially noted.

There are not so many control devices for underground utilities and hatches of wells on the market and DAS ALMAZ compares favorably with similar devices. Operation of the system does not require the installation of sensors on each hatch and the length of the linear infrastructure per unit can be up to 75 km or more.
DAS ALMAZ allows not only to detect penetrations into the wells but also informs the operator about the stage of exposure: an attempt to open / open the hatch cover, work in the well pulling a cable. The system software is adapted to the operator's tasks, a control mode for routine maintenance in the well is implemented.

Communications lines

During the operation of the cable infrastructure, the tasks arise such as tying the place of the cable break to the terrain, clarifying the route and the security zone of the communication line on the terrain. Tying the break point to the terrain along the optical length reduces the troubleshooting time.
It is often not possible to clarify the route by standard means based on the detection of metal parts. DAS ALMAZ allows operator to determine the route of laying an optical cable with an accuracy of 1 m.
To clarify the map of laying on an infrastructure's object, team of engineers literally tap the soil. The operator reports the readings of the device in real time and remotely corrects the work of the team.
It's possible to connect remote access to the readings of the device for performing an independent fiber search by a team of engineers.
The specialized DAS ALMAZ software provides advanced capabilities for linking monitoring objects to geographic coordinates. The software application for mobile devices allows not only to determine the coordinates at the time of the binding of the monitoring object on the ground but also automatically generates a database of coordinates.
One of the most common causes of fiber optic communication line failure is cable breakage which can be caused by vandalism or accidental damage when working near the cable line.
DAS ALMAZ makes it possible to prevent an accident by informing the system operator about unauthorized work near the communication line.



Examples of the operator's graphical interface for the access control system for cable duct wells based on DAS ALMAZ sensor. Events of different alarm categories are displayed by pictograms of different colors on the map with the marked route of the optical fiber cable.

• The equipment is installed and operated in St. Petersburg at the underground infrastructure of the largest telecom operator in Russia

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