Using geospace data for implementation of informational processes of design engineering of Gazprom's facilities: case history

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Gazprom VNIIGAZ LLC Today

Founded in 1948, Gazprom VNIIGAZ was established as a single R&D center of the gas industry. Today Gazprom VNIIGAZ is the national leader in the field of oil and gas technologies and scientific research. The Institute's experts coordinate large-scale target-oriented and engineering projects and programs covering the following areas:

- geology of oil and gas bearing territories (including shelf);
- development and operation of oil and gas fields;
- production and processing of hydrocarbon feedstock;
- gas transmission and underground storage;
- ensuring reliability, environmental and industrial safety of the Unified Gas Supply System (UGSS) facilities.

Most important recent projects include:

- The program for extended reproduction of Gazprom's commercial output: gas, gas condensate, and oil over the period 2005-2020 and up to 2030
- Master plan of the gas industry development (for the period up to 2030)
- The Program for construction of a single gas production, transmission and supply system in East Siberia and Far East, regarding options of gas export to China and Asian-Pacific countries

Engineering in Gazprom VNIIGAZ LLC

Engineering line in Gazprom VNIIGAZ is represented by highly professional specialists. There are 312 engineering experts working in Gazprom VNIIGAZ and its branch office.

Gazprom VNIIGAZ has all licenses required for successful implementation of targets related to design and survey works at oil and gas industry facilities in Russia and Kazakhstan. Moreover, some works are underway as well in China, Venezuela, Peru, Bolivia, Egypt, Uzbekistan, etc.

In Gazprom VNIIGAZ engineering is mainly associated with development of pre-design documentation, design specifications and estimates as well as surveys for hydrocarbon feedstock production, transmission and processing facilities, including:

- Linear section of trunk oil, gas and product pipelines;
- Compressor and pump stations;
- Gathering pipelines;
- Gas, gas condensate and oil processing facilities;
- Loading racks and storages for liquid hydrocarbons;
- Gas distribution, storage and refueling stations;
- Instrumentation and control systems and communication means;
- Power lines and power supply systems;
- Roads;
- Development of mineral fields;
- Heat and gas supply facilities (including boilers, heat supply and gas distribution networks);
- Water supply and water discharge facilities.

Investment Construction Engineering

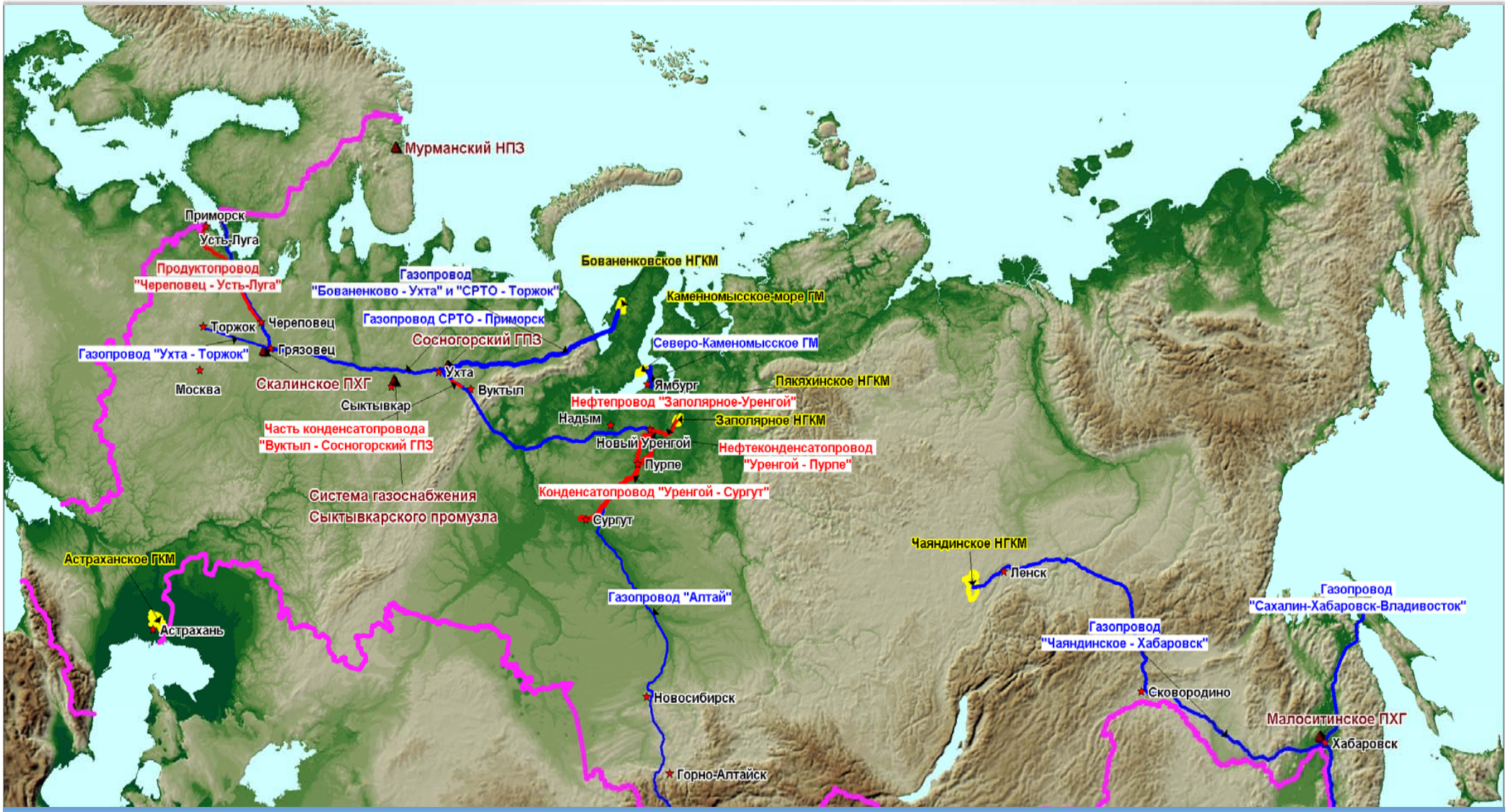
One of the main business lines of Gazprom VNIIGAZ LLC is to develop integrated investment construction engineering of Gazprom's high-tech facilities that will provide an opportunity for implementation of turn-key projects.

At present the Company handles the following types of engineering:

- pre-design engineering;
- design engineering;
- cost engineering;
- project management engineering;
- engineering of quality management systems;
- engineering of innovative activities of the Company.

Gazprom VNIIGAZ works in compliance with the Quality Management System based on ISO 9001:2000 requirements and STO Gazprom 9001-2006 standard on rendering engineering services in oil and gas industry in the field of pre-design, scientific and research activities, design management and engineering surveys, drawing up design documentation (Certificate No. 12730-2007-AQ-ROT-UKAS issued by DNV Certification B.V. (the Netherlands); Certificate No. GO00.RU.1415.K00016 issued by Certification Association "Russian register").

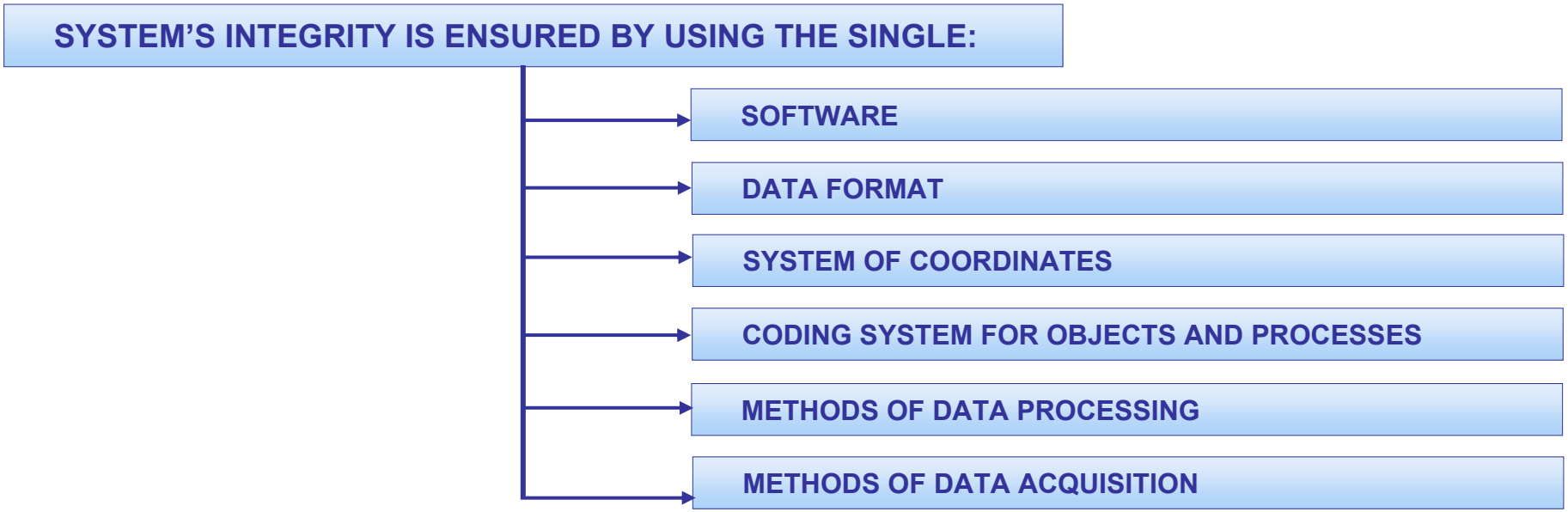
Geography of Current and Future Projects



Engineering Information System

Optimization of engineering information processes, namely data acquisition, processing, accumulation, storage, search and distribution, is implemented on the basis of engineering information system (EIS).

EIS fundamental principles – SINGLE INFORMATION DATA SPACE and GEOSPACE APPROACH.



Geospace Approach

DATA USED IN ENGINEERING INFORMATION SYSTEM SHALL HAVE GEOSPACE REFERENCE.

ALL TYPES OF DATA ARE SUBJECT TO GEOSPACE REFERENCE, INCLUDING:

- CARTOGRAPHIC MATERIALS
- DESIGN DOCUMENTATION
- SPECIFIC DESIGN SOLUTIONS
- TEXT REPORTS
- TABLES AND DATA BASES
- ECONOMIC AND STATISTICAL VALUES
- PHOTO AND VIDEO DATA
- LAND SURVEY DATA
- DIAGNOSTICS DATA
- DATA ON FACILITIES RECONSTRUCTION

GEOSPACE REFERENCE OF ALL DATA ALLOWS TO EASILY PERRFORM SPACE-TIME ANALYSIS AND IDENTIFY CAUSE-AND-EFFECT RELATIONS.

THIS ALWAYS GIVES THE TRUE PICTURE OF EVENTS.

ANY DATA REPRESENTED IN GEOGRAPHICALLY DISPERSED FORM ARE PERCEIVED BETTER AND THIS REDUCES THE PROBABILITY OF A MISTAKE DURING DECISION-MAKING.

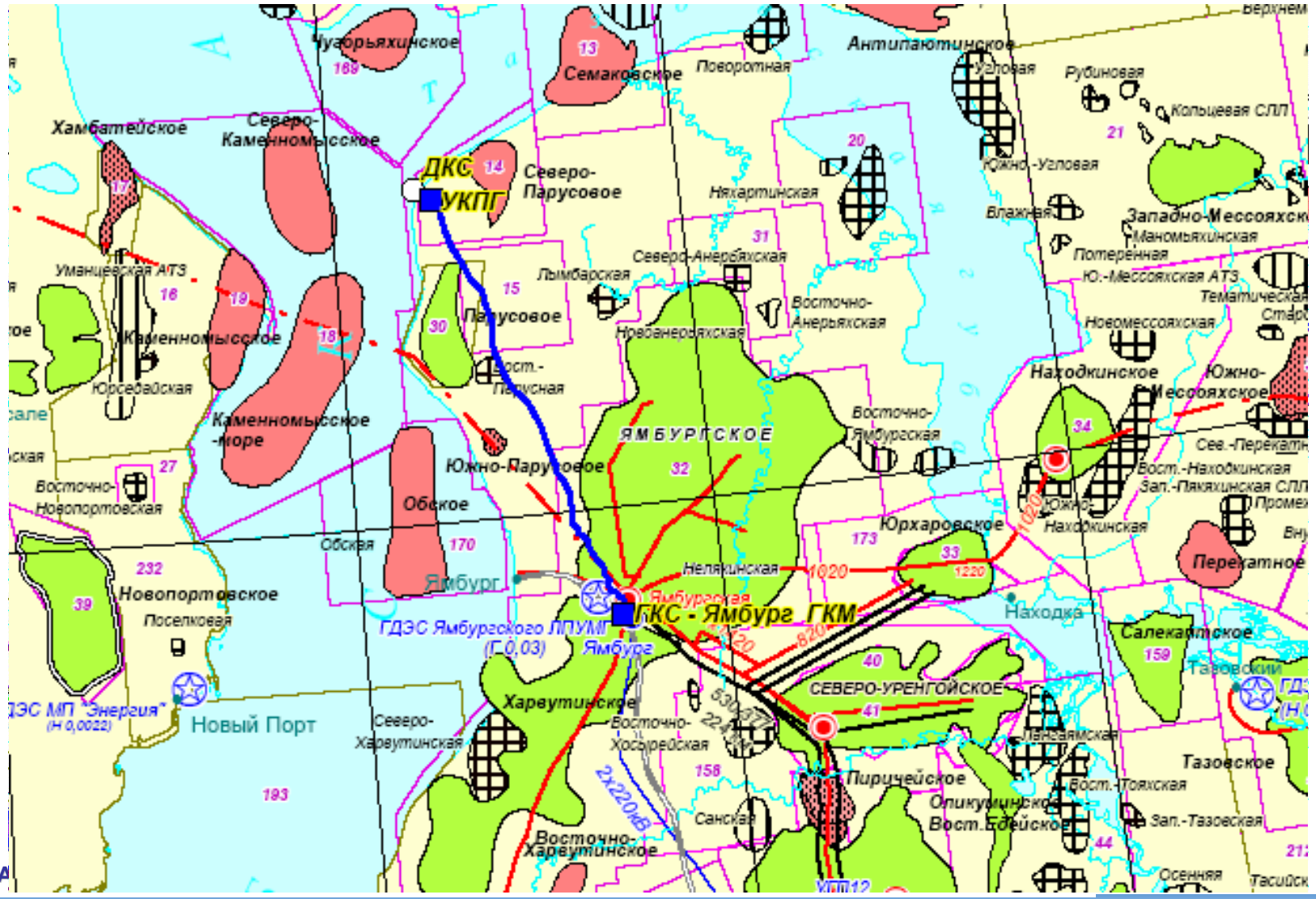
Pre-Design Engineering

- Project concept
- Concept design of the construction process
- Development of investment plan (IP)
- Drawing up Declaration of Intentions (DOI)
- Engineering survey data
- Justification of investments (JI)
- Preliminary approval of facility location site

INITIAL STAGE OF EIS DATA INSERT FOR GAZPROM'S FACILITIES

Examples of Geospace Data (Investment Plan)

- Scale of cartographic data is 1:1 000 000 and smaller
- Overview maps and charts of subject and geographical scope
- Space images on open access
- Digital elevation model (GTOPO30, SRTM, ETOPO, etc.)



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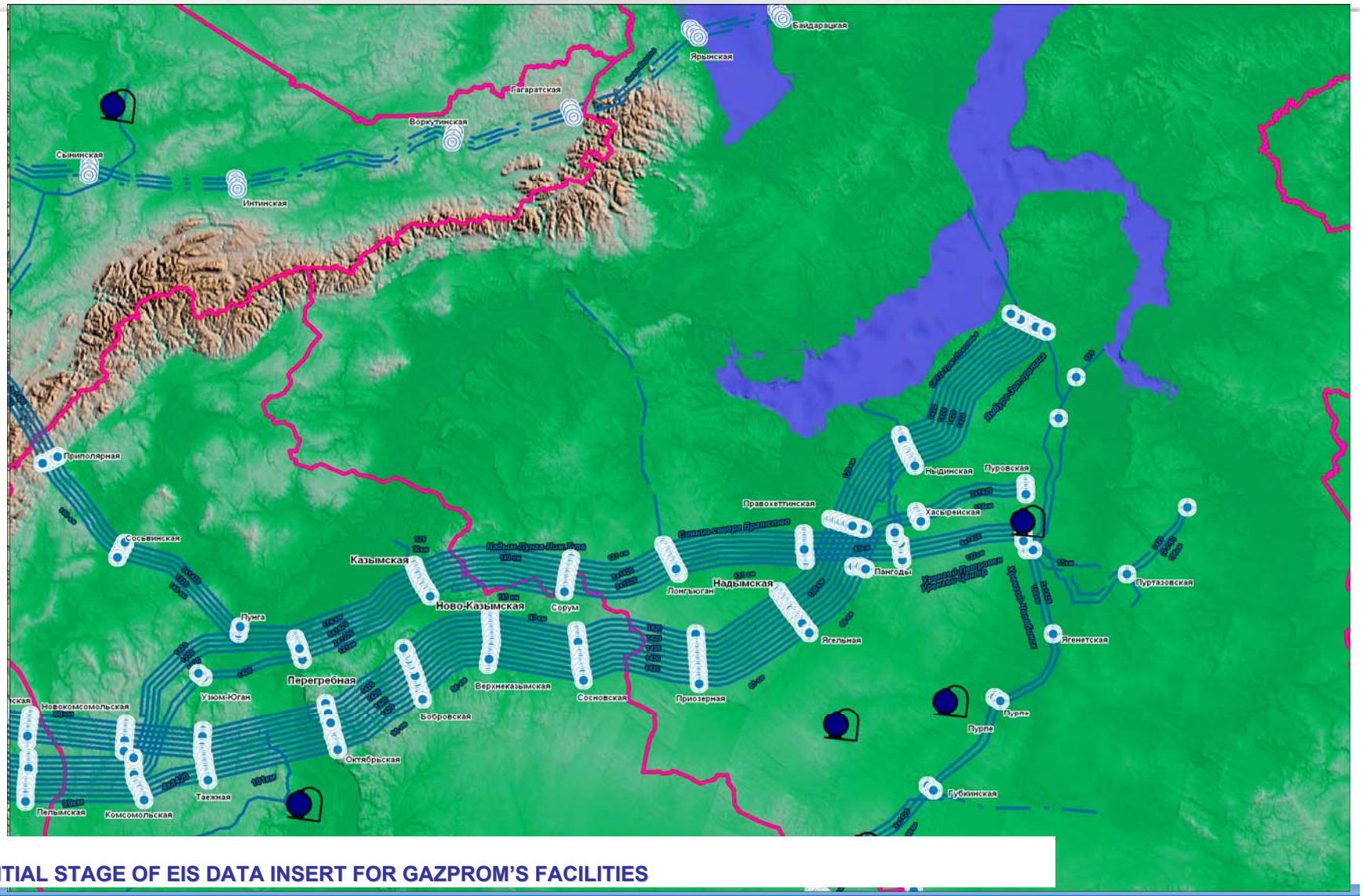
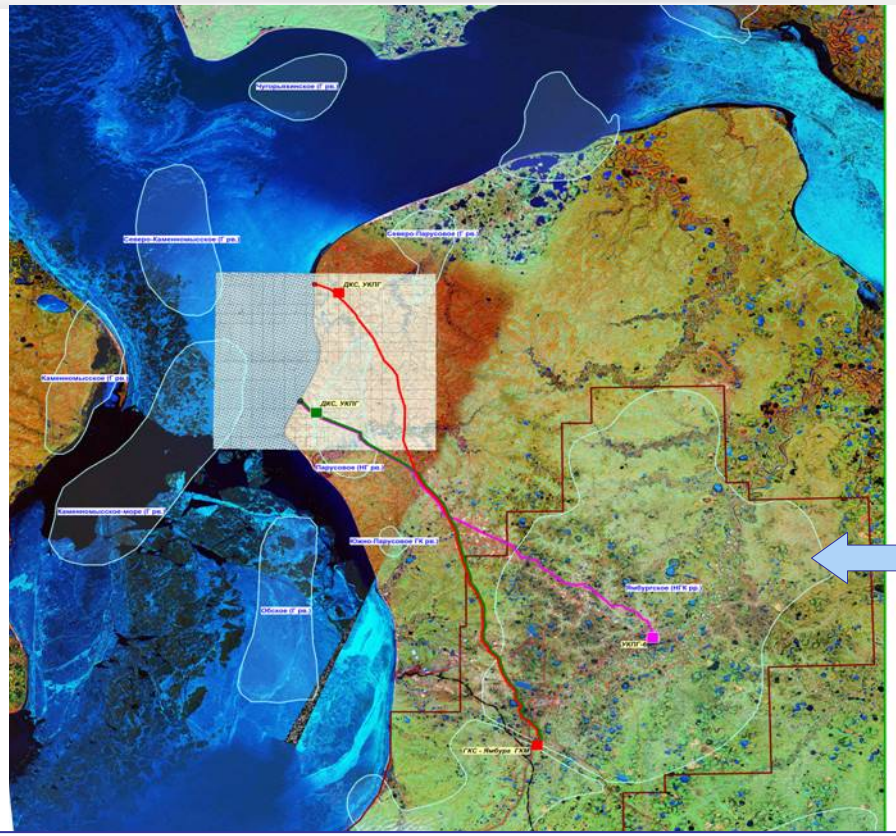


INITIAL STAGE OF EIS DATA INSERT FOR GAZPROM'S FACILITIES

Examples of Geospace Data for Drawing up Declaration of Intentions

- Scale of cartographic data is 1:100 000 – 1:1 000 000
- Topographic maps
- Set of geological maps
- Set of ecological maps
- Space images on open access
- Digital elevation model (GTOPO30, SRTM, ETOPO, etc.)
- Archive and fund materials on engineering surveys



Space survey data Landsat-7
M 1 : 200 000

Specifying preliminary conditions, planned site (region) for facilities location and generalized technical and economic indexes.

Example: preliminary layout of onshore facilities of Severo-Kamennomysskoye gas field.

Methods of EIS Data Insert at the Stage of Justification of Investments

Scale of cartographic data is 1:25000 – 1:100 000

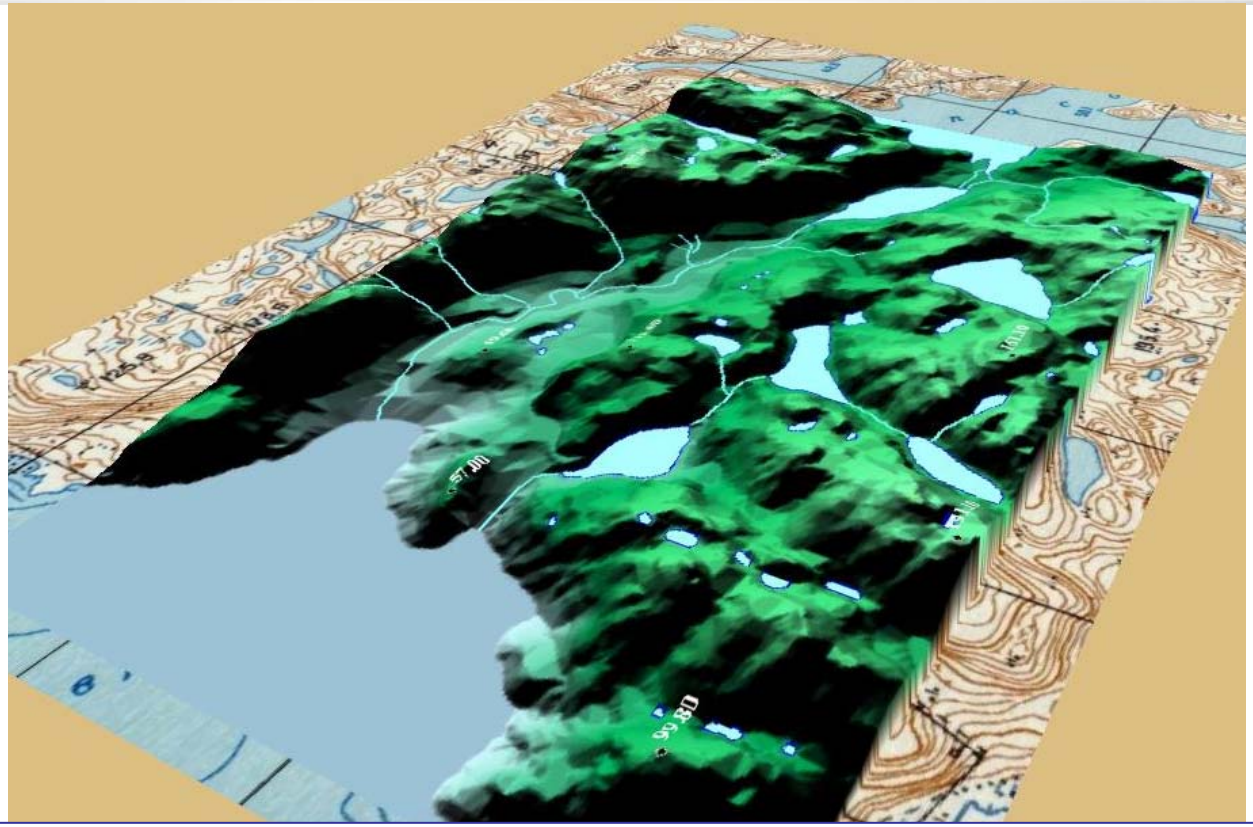
Airborne survey

Air laser scanning of linear objects. Scale 1:10000, band width 5-10 km (used under specific time or natural conditions)

Space images of high resolution

Development of digital elevation model using digital topographic maps

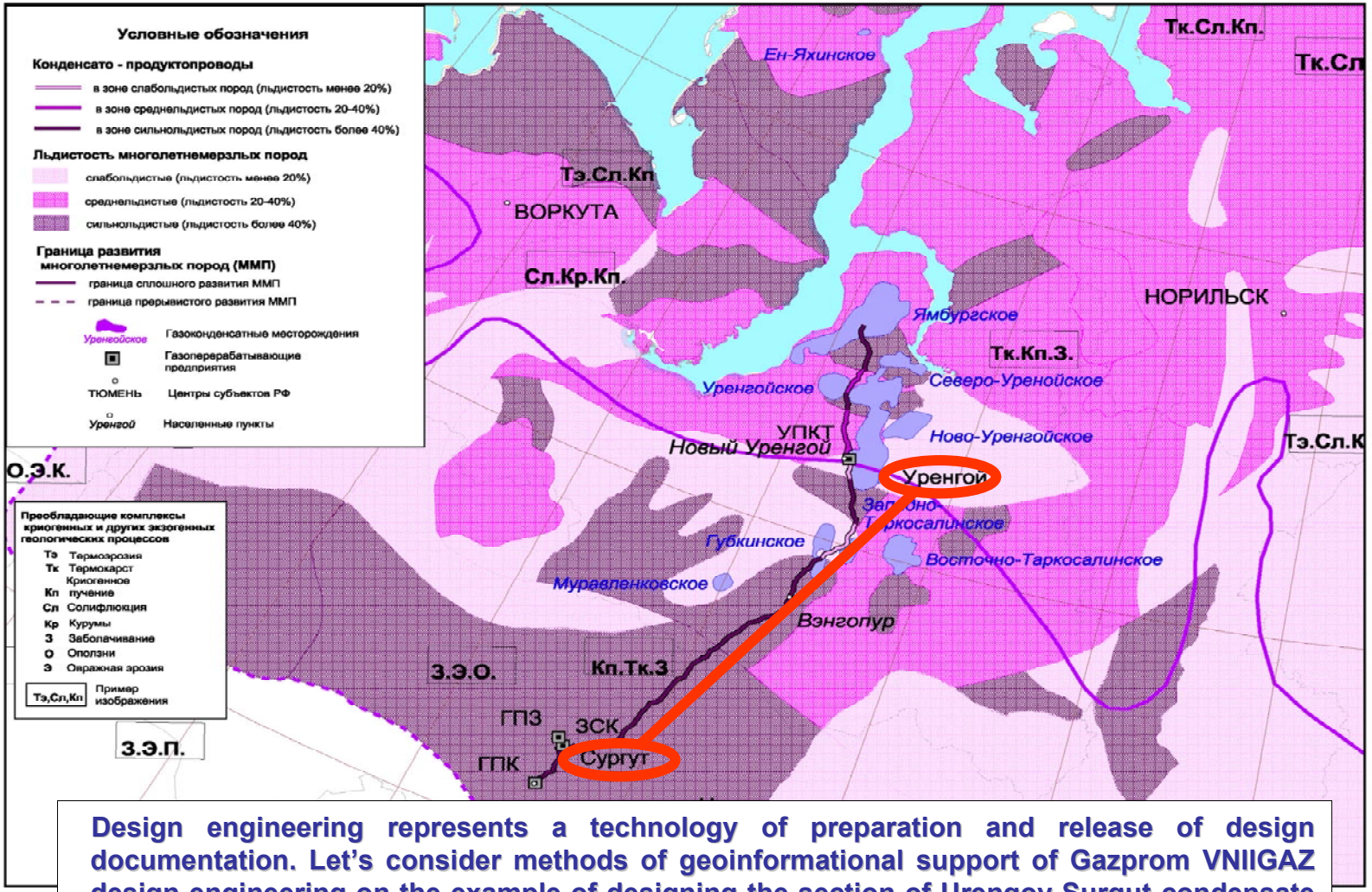
Georeference of obtained digital and analog data of engineering surveys



Integrated study of natural and industrial conditions of location sites for Gazprom's facilities, alternative study cases for all variants of facilities location.
Example: development of crucial space-planning solutions on the basis of 3D elevation modelling.

Design Engineering

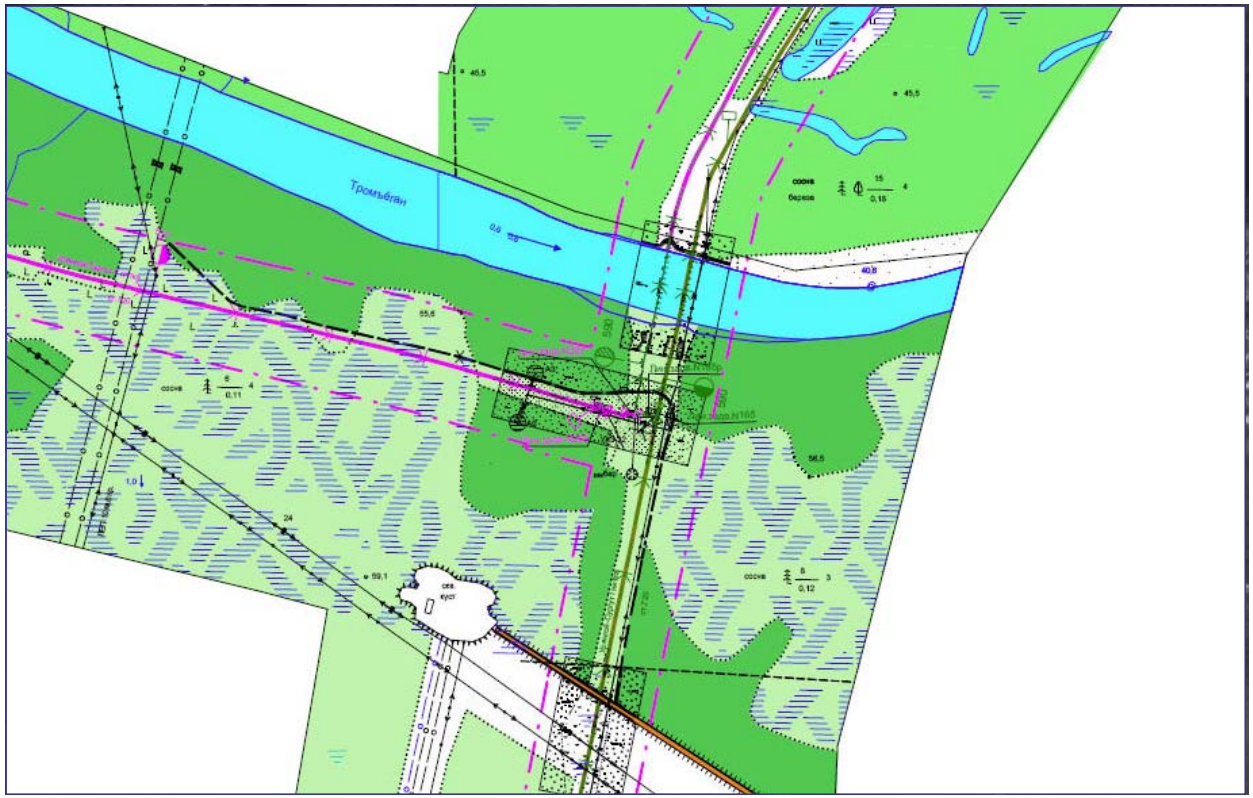
- Development of design task
- Development of specific technical regulations and requirements
- Preparing design documentation
- Integrated engineering surveys
- Preparing work documentation
- Carrying out internal and state expert review of design documentation
- Field supervision of construction



Design engineering represents a technology of preparation and release of design documentation. Let's consider methods of geoinformational support of Gazprom VNIIGAZ design engineering on the example of designing the section of Urengoy-Surgut condensate pipeline (2008-2009).

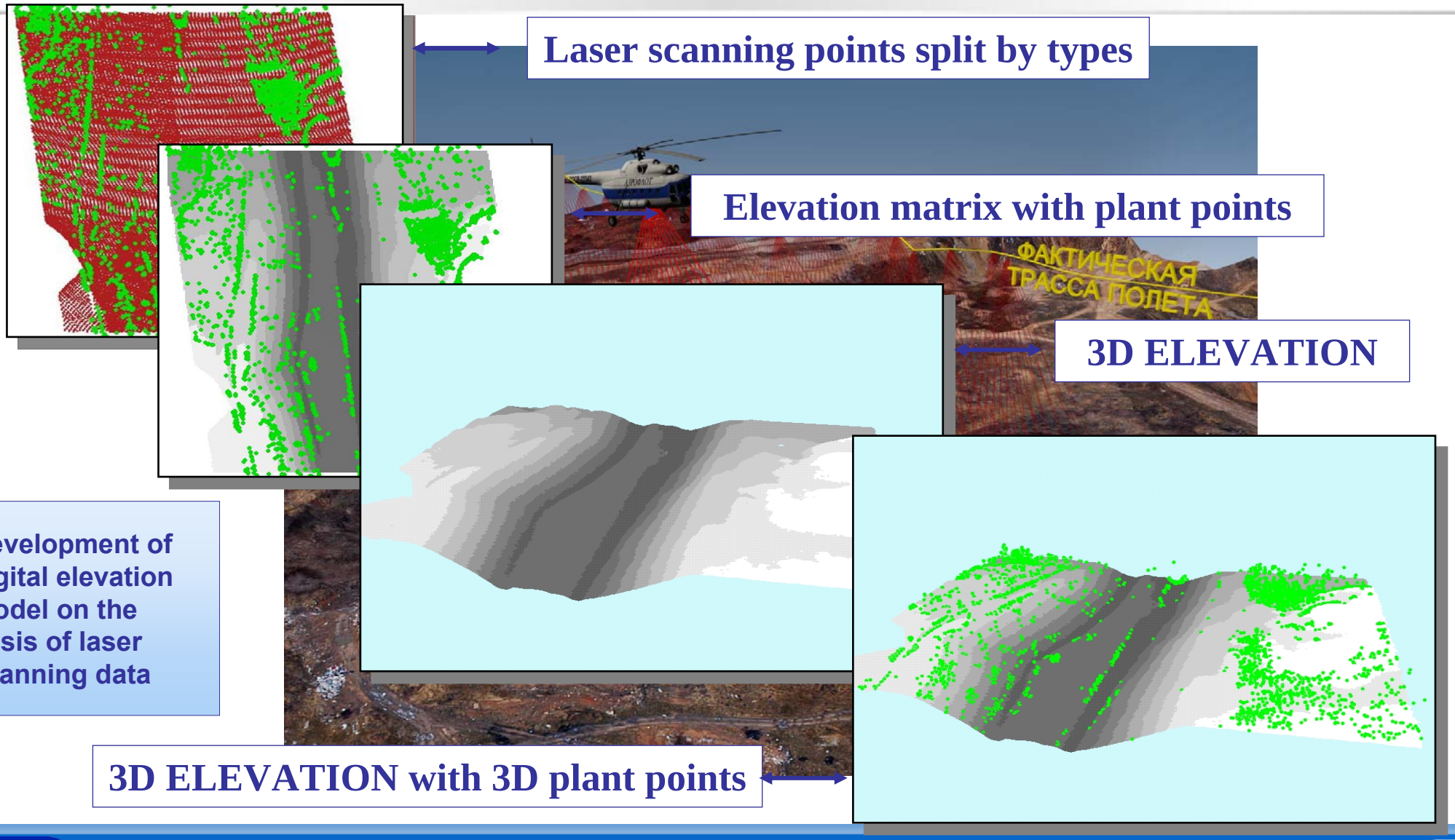
Using Geospace Data at the Stage of Design Engineering

- Development of geodetic control grid
- Geodetic positioning of condensate pipeline (length - 700 km)
- Development of orthophotomap using ALOS space images (band width – 10 km). It has become the basis for subject mapping
- Air laser scanning and air-borne survey of condensate pipeline route. Scale 1:2000, band width 1 km
- Integrated engineering surveys
- Development of specific technical regulations for designand preparing design documentation
- Development of GIS of the project



Development of the project geodetic control grid at the initial stage provided highly precise binding of laser scanning, space survey and topographic survey data of the condensate pipeline section under design. ALOS space images in 10 km band width (5 km at each side of condensate pipeline axis) allowed to detect violations in the area of minimum admissible distances from a pipeline.

Using Laser Scanning Data at Design Engineering Stage

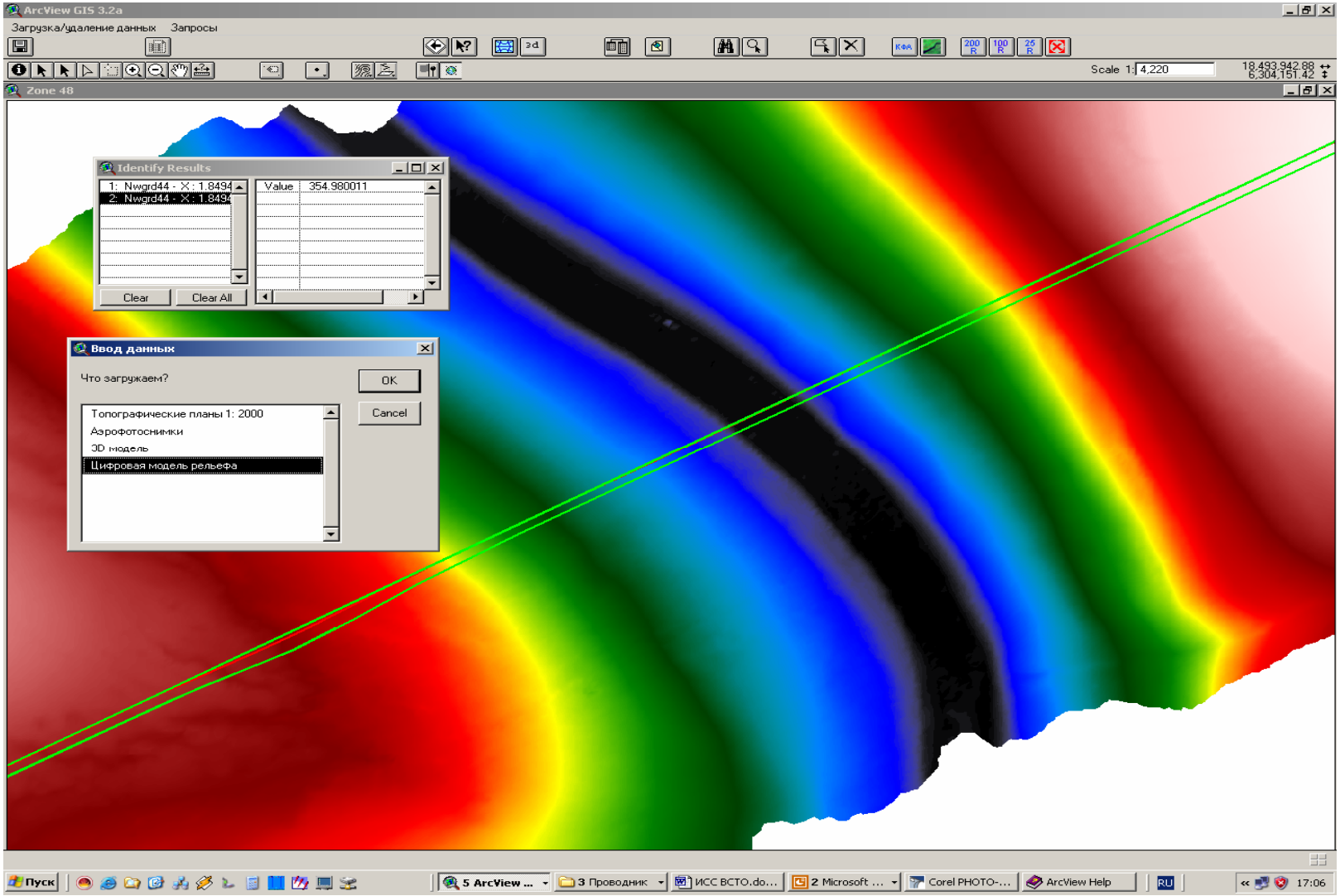


Development of digital elevation model on the basis of laser scanning data

Using Laser Scanning Data at Design Engineering Stage

Development of orthophotomap for gas pipeline route corridor

Development of digital elevation model. Scale 1:2000

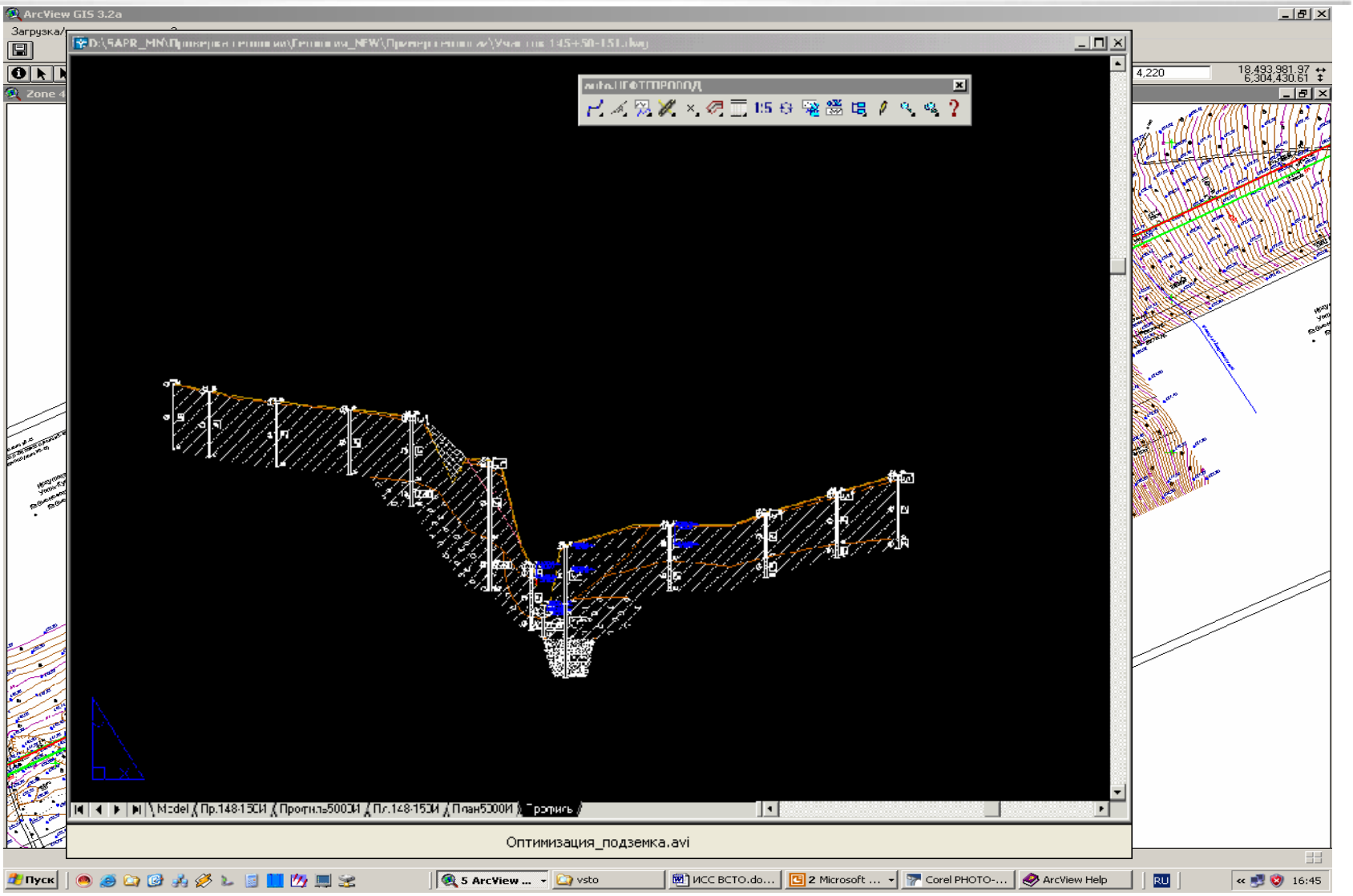


Using Laser Scanning Data at Design Engineering Stage

3D modelling on the basis of laser scanning results

Development of topographic plans

Development of longitudinal profile of designed gas pipeline on the basis of SPLIT software



3D Modelling of Technological Facilities

This technology provides:

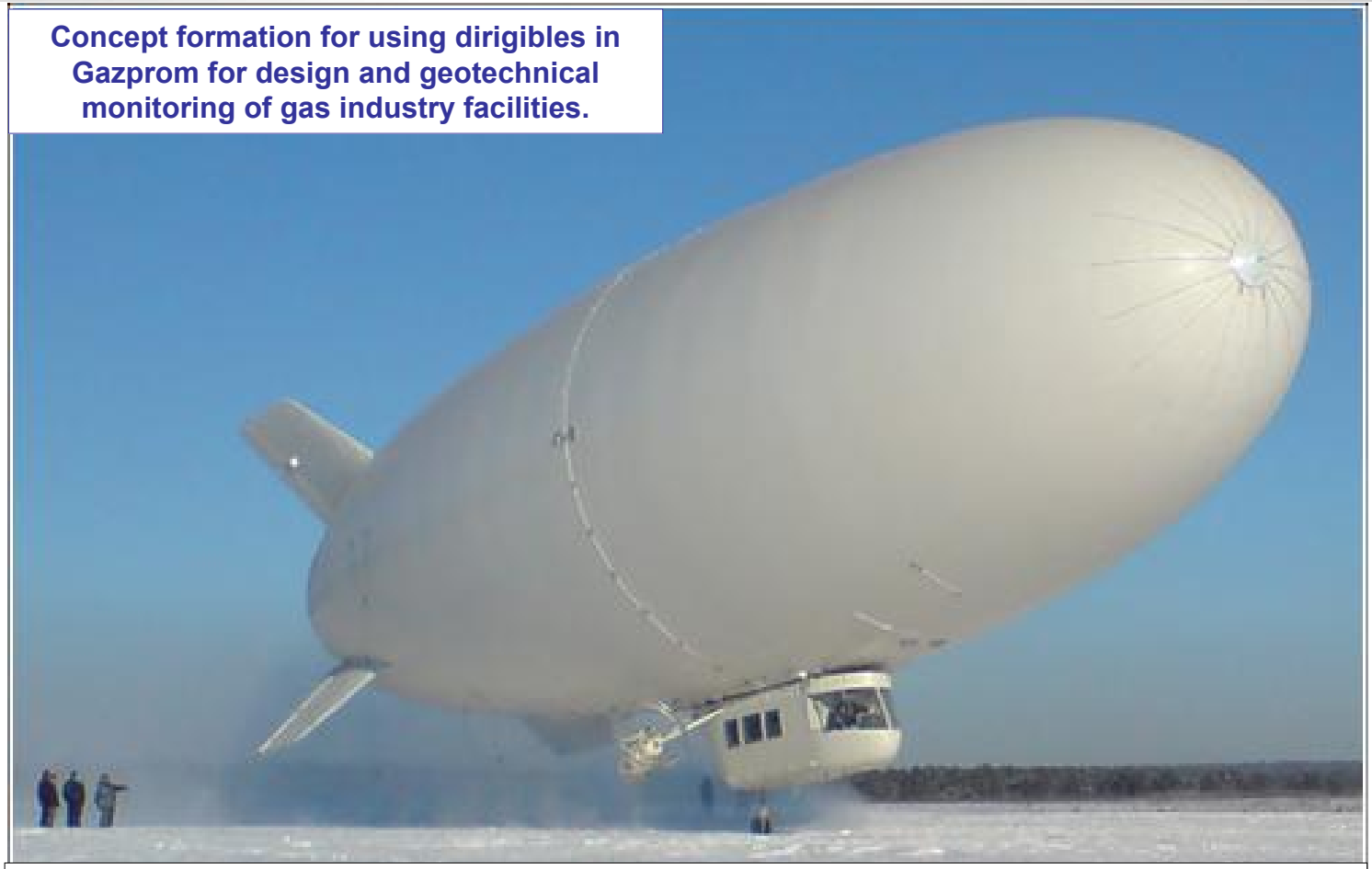
- Data integration;
- Analysis of compatibility of technological equipment;
- Quick concept formulation and project implementation;
- Flexible design based on interaction between objects. It allows to achieve accuracy and consistency of all parts of the project;
- Improved efficiency of design works due to automated drawing up of schemes, specifications and other technical documents.

Example of 3D parameter model of the unit for sulphur cement production and use, including location of technological equipment in workshops (the unit was developed by specialists of the Centre "Gas and Liquid Hydrocarbon Processing"; 3D model was developed and visualized by specialists of the Engineering Centre).

Innovative Engineering in Gazprom VNIIGAZ LLC

- R&D
- Development of the primary pool of prospective ideas
- Development of prospective ideas
- Managerial assessment of ideas
- Selection of useful ideas
- Commercialization of R&D results

Concept formation for using dirigibles in Gazprom for design and geotechnical monitoring of gas industry facilities.



Innovative engineering is intended for development of new and using previous experience (in particular technological knowledge) for commercialization purposes and to meet the needs of the Company and generate profit.

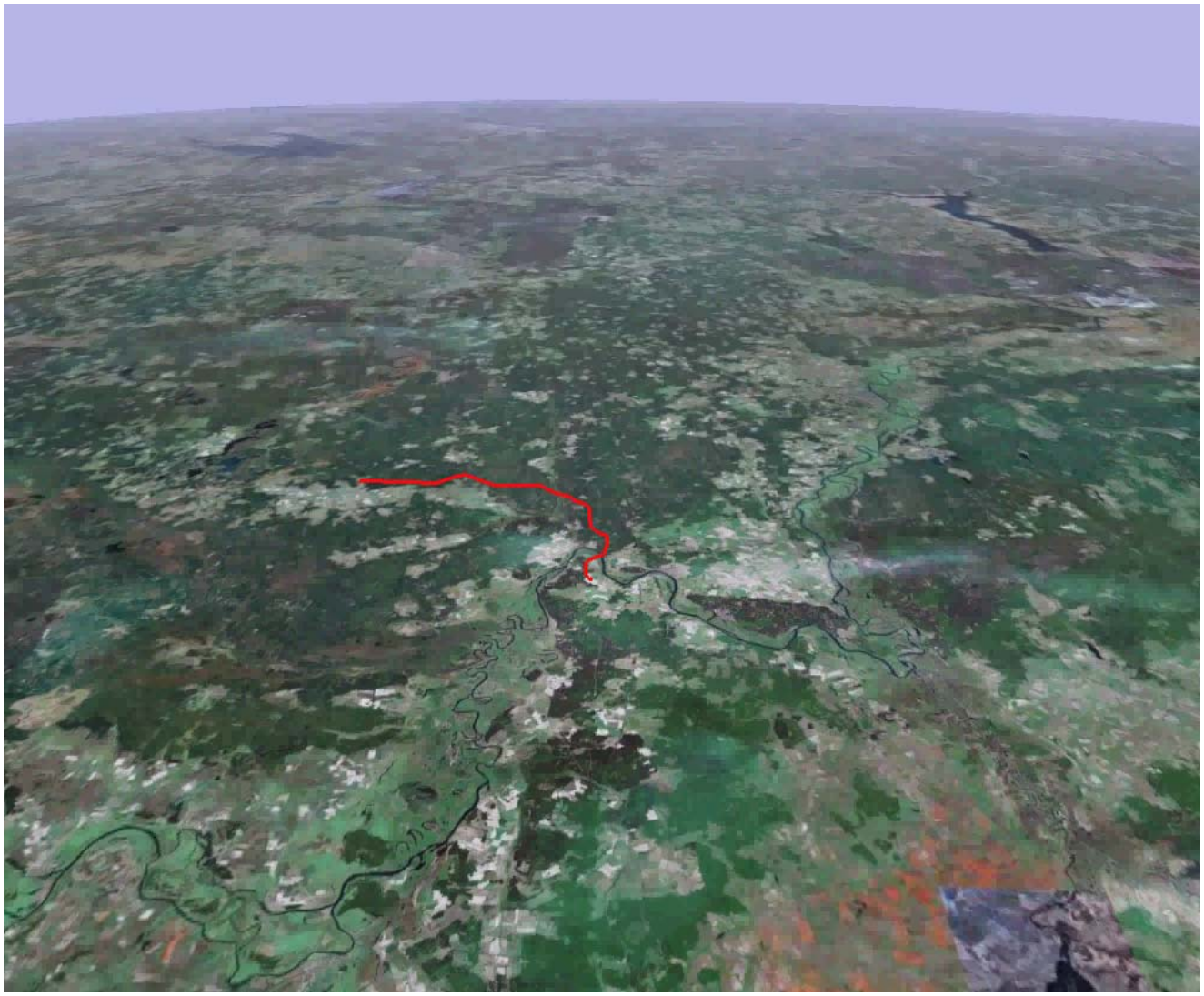
Airborne Platform: Evaluation Criteria

- distance and endurance of aircraft flight;
- disposable load;
- height and speed operating range;
- ergonomics and sizes of cargo/passenger cabin;
- capacity and voltage of vehicle-borne power systems;
- airworthiness;
- possibility of autonomous works out of the existing aviation infrastructure;
- all-weather capability;
- reliability and safety of works;
- prime cost of air works;
- cost and other expenditures for system commissioning.

Main Functional Advantages of Au-30 Dirigible

- The dirigible can be operated under such speed and height ranges unreachable for other vehicles; it can hover above the object for any time and even go in the back direction;
- Dirigible load capacity is 1350-1400 kg, which is comparable to ANSAT and Mi-8 helicopters. It provides enough space for *comfortable* housing of crew (2 people) and equipment operators (2 - 4 people);
- Endurance of flight can be up to 16-20 hours under significantly lower operation prime cost;
- Maximum flight distance more than 1000 km;
- Size of cargo nacelle, ergonomics of its components and dirigible load capacity allow to place all state-of-the-art equipment for remote sensing of oil and gas industry facilities;
- Dirigible demonstrates minimum vibration of cargo/passenger nacelle. This is a big advantage over light and medium helicopters;
- Flight safety in case of malfunction of one or even two cruise engines;
- Possibility to operate dirigible from unprepared grounds, high independence of dirigible and its environmental safety.

Pilot Project of Gazprom VNIIGAZ LLC and Center of Infrastructural Projects for the Section of Gorky-Center Trunk Gas Pipeline



Gazprom VNIIGAZ LLC together with Center of Infrastructural Projects organized the first test flight of AU-30 dirigible for remote sensing of the section of gas pipeline “SUGS Kasimov – CS Tuma”.
The project included digital aerial survey, laser-location survey (air laser scanning) and thermovision survey of the considered pipeline section.
The survey was carried out from 1 to 10 November, 2008.

Section length – 73 km.

Survey band width – 200 m.

Preliminary Helicopter Survey of Gas Pipeline Section

Preliminary visual inspection of Gazprom transgaz Moskva gas pipeline section was performed by KA-26 helicopter for detailed planning of remote sensing, topographic and geodetic works.

Equipment for Gas Pipeline Remote Sensing

Basic set of technical tools:

- GPS / GLONASS geo-positioning system;
- Leica ALS50 PII airborne laser scanner;
- RCD 105 digital camera with 65 mm lens.

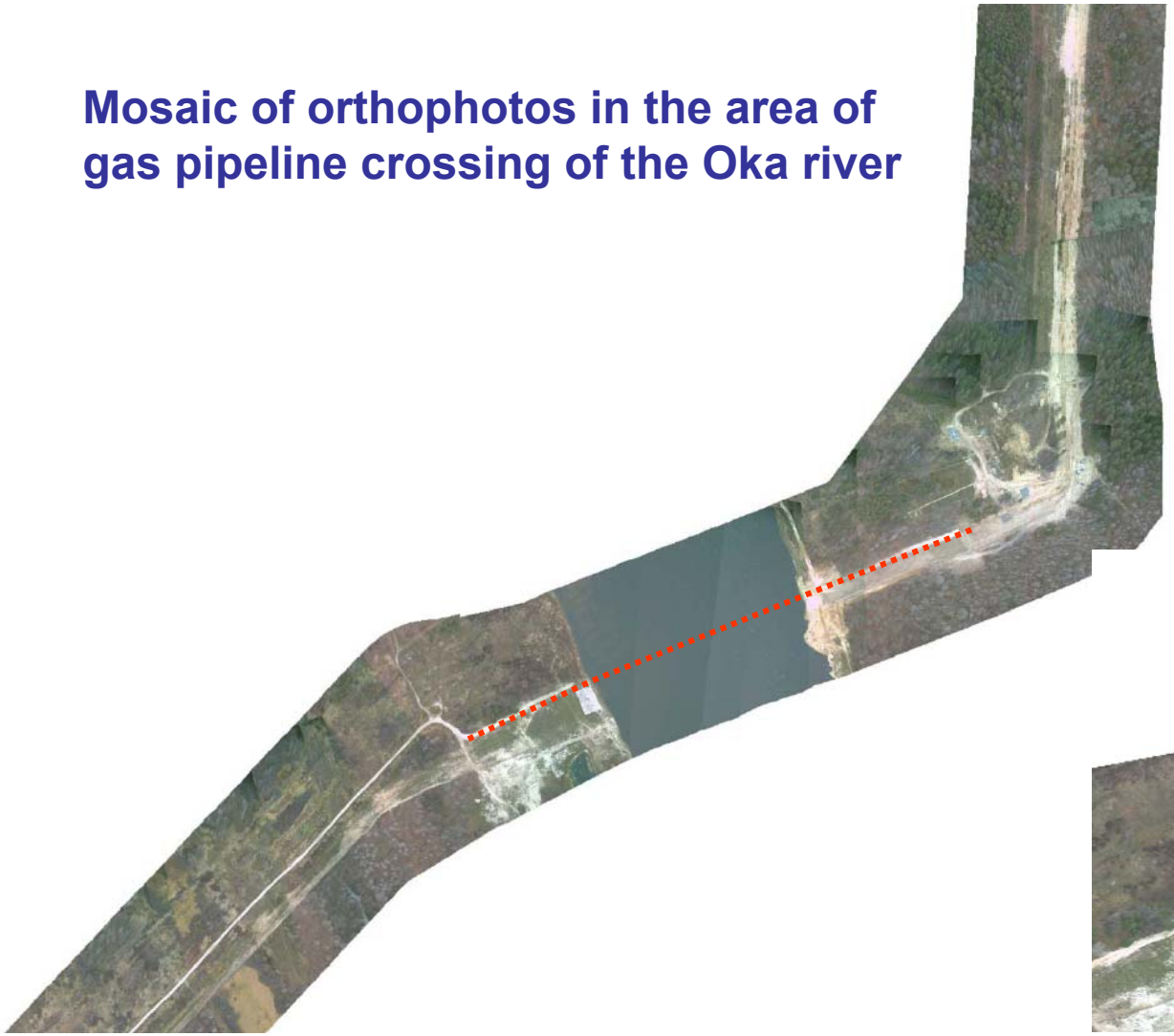
Additional sensors:

- ThermoVision 1000 Agema thermal imager

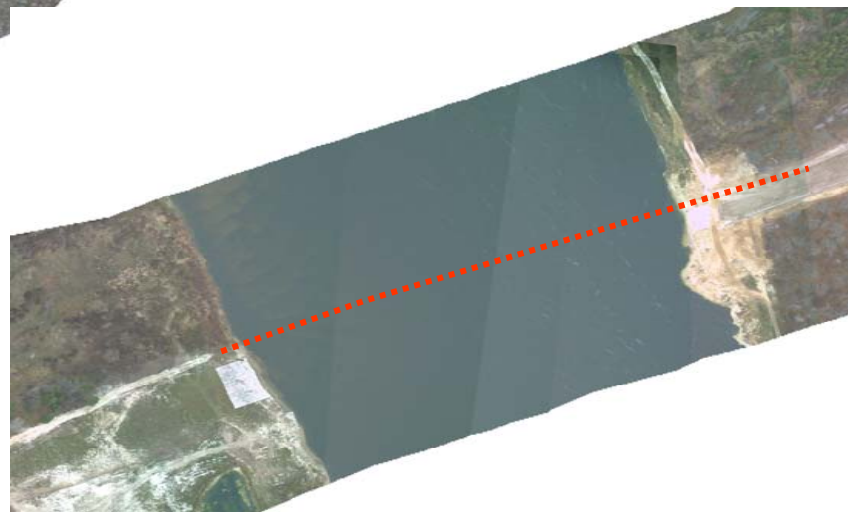
Dirigible was launched from the only one in Russia Certified Aeronautic Dirigible Site (Kirzhach town)

Examples of Obtained Geospace Remote Sensing Data from Dirigible

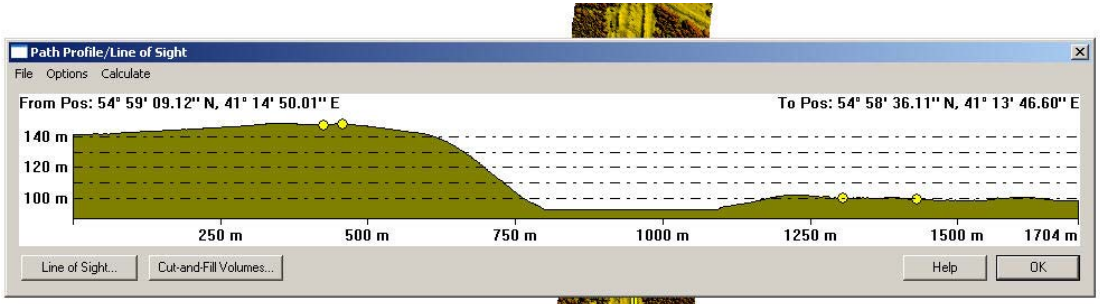
Mosaic of orthophotos in the area of gas pipeline crossing of the Oka river



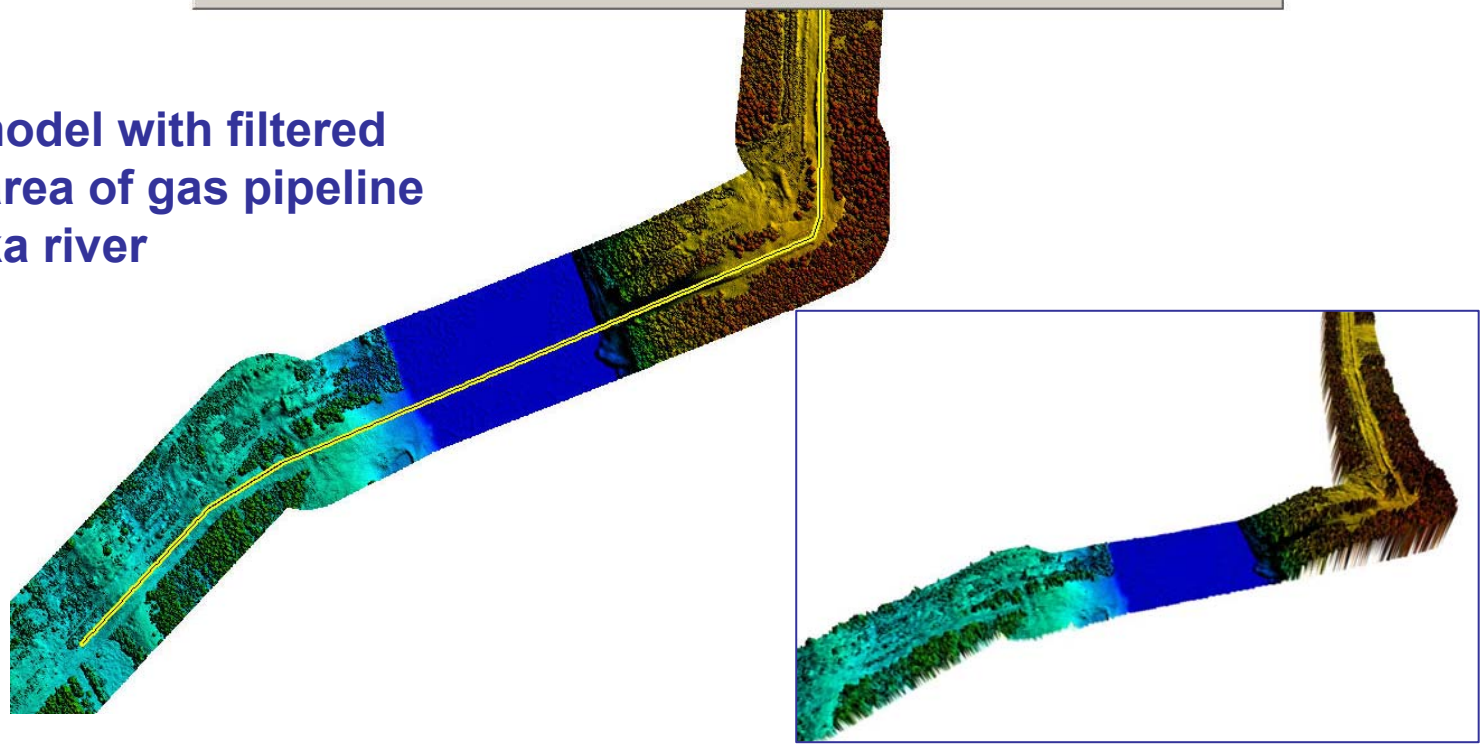
Enlarged segment of orthophoto mosaic



Examples of Obtained Remote Sensing Data

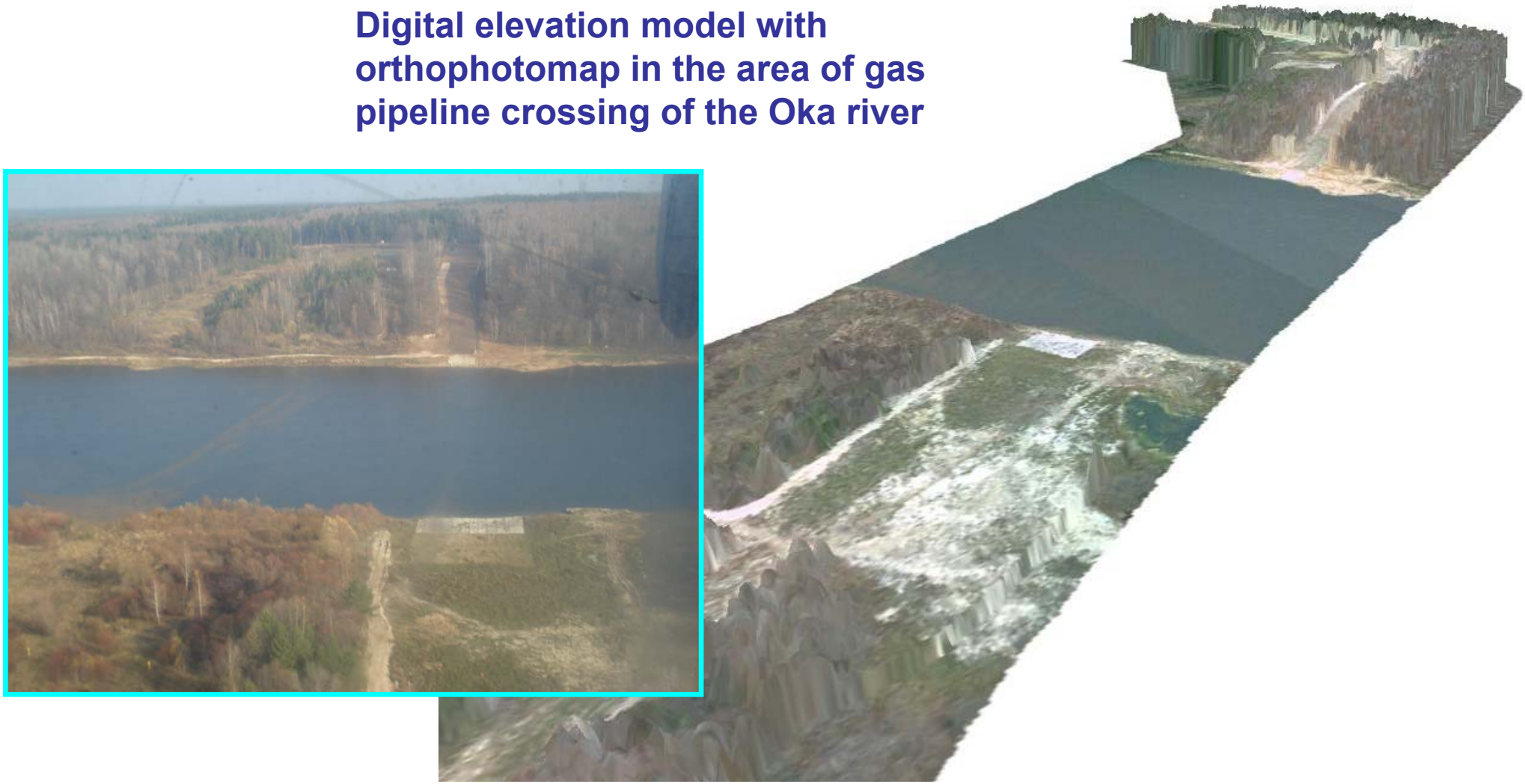


Digital elevation model with filtered plant layer in the area of gas pipeline crossing of the Oka river



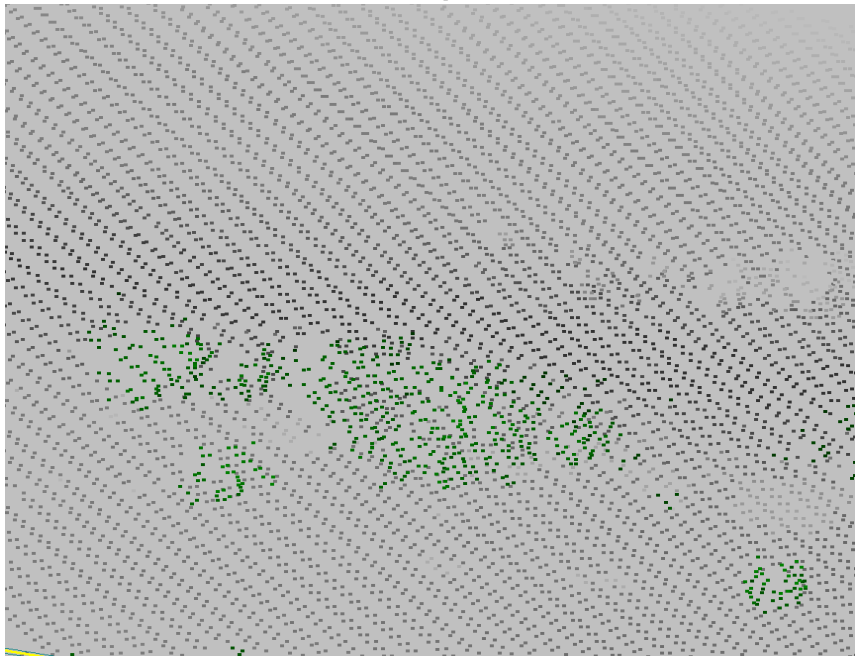
Examples of Obtained Remote Sensing Data

Digital elevation model with orthophotomap in the area of gas pipeline crossing of the Oka river



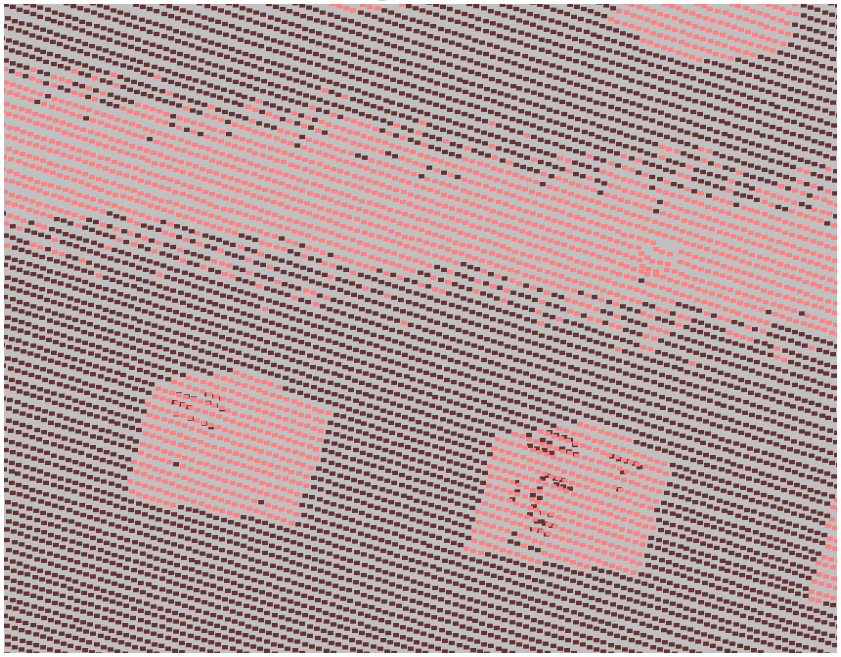
One of Dirigible Advantages is Smooth Flight

Helicopter



Laser scanning points:
unevenness, curvilinearity,
unpredictable changes of distances
between scans (neighboring point series),
low covering density

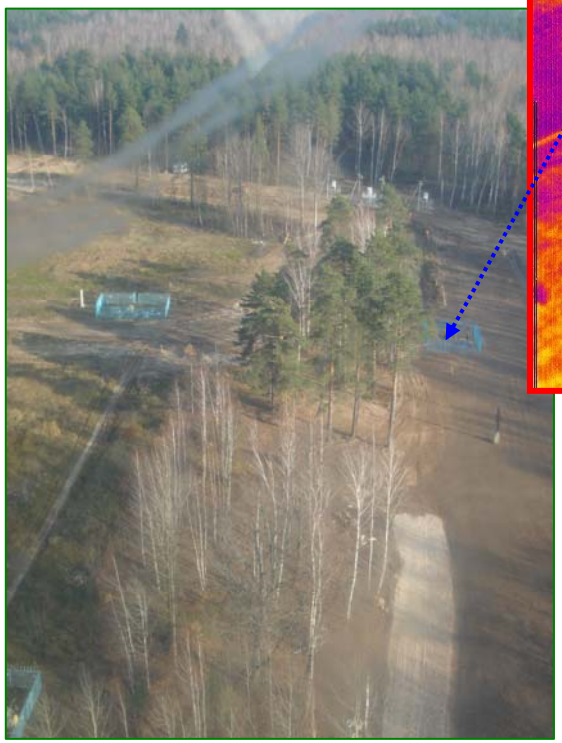
Dirigible

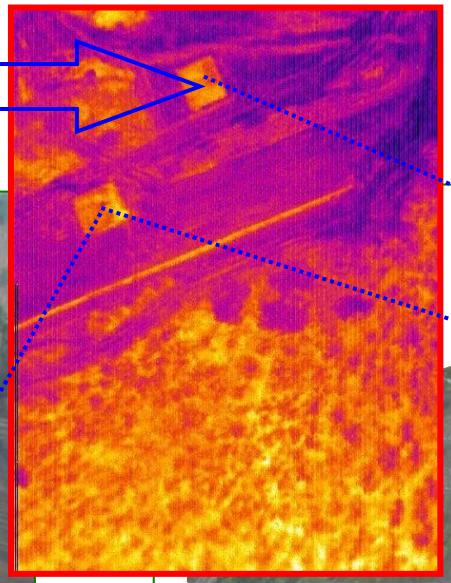


Laser scanning points:
smoothness, linearity,
equal distances between scans,
high covering density

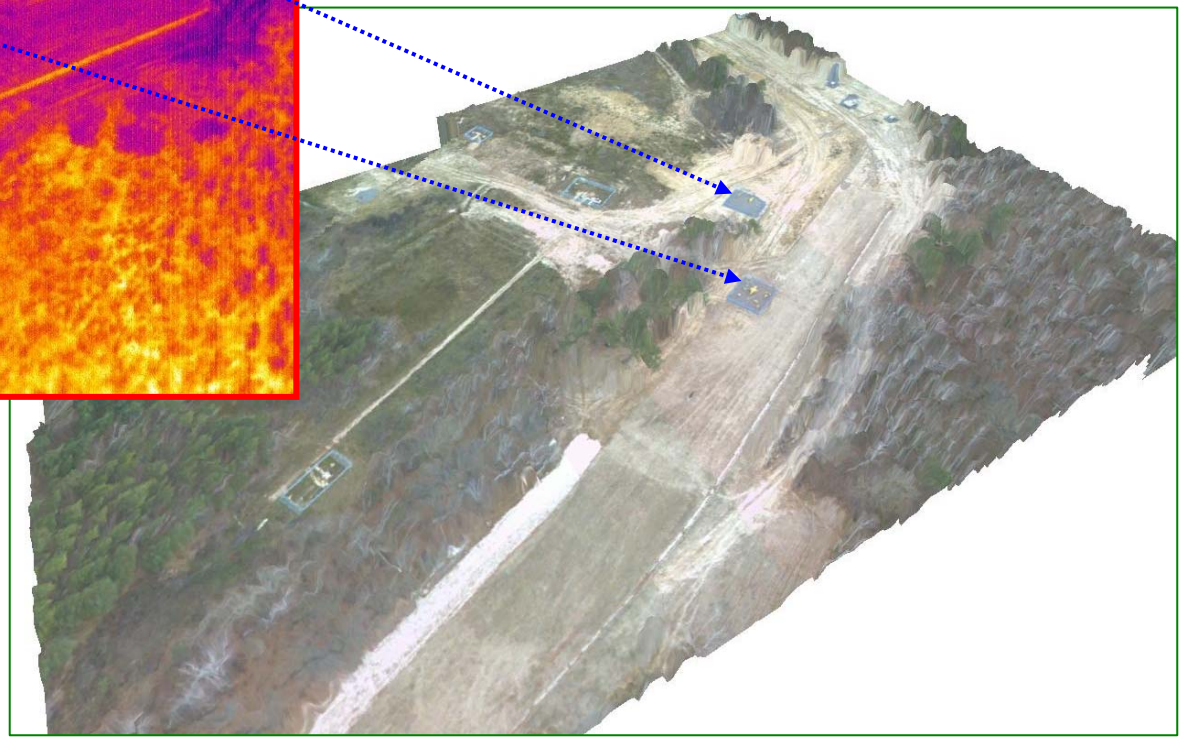
Examples of Obtained Remote Sensing Data

Thermovision image with clearly recognized sites of block valve stations





Digital elevation model with orthophotomap in the area of location of stop valves

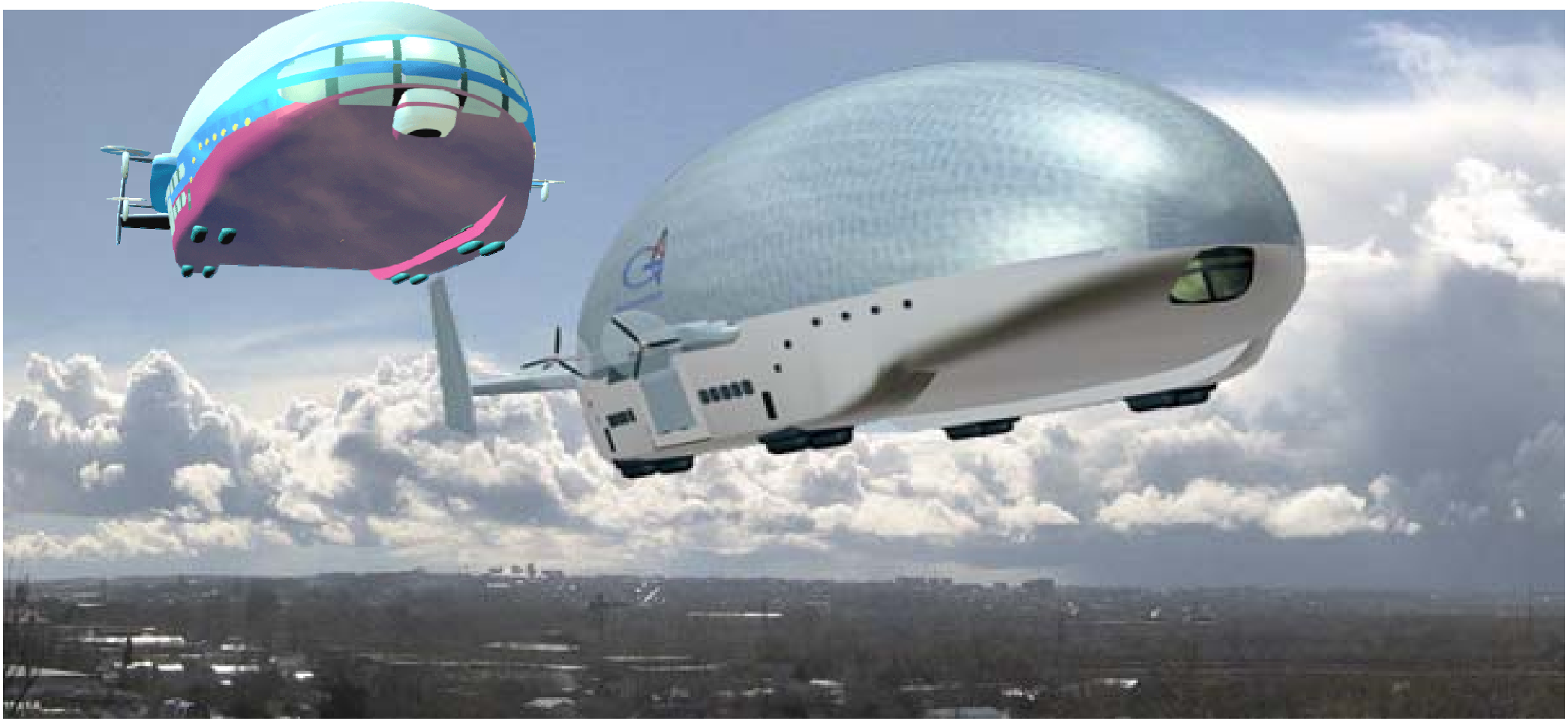


It is planned to use AU-30 dirigible for remote sensing of Sobinskoye OGCF

Development of Industry Standards

Development of industry standard and procedural base aimed at regulating technology of laser-location, thermovision and airborne surveys by dirigibles to carry out pre-design works, design and geotechnical monitoring of existing gas industry facilities.

Concept of using transport hybrid aerostatic crafts /GALA/ - ATLANT during Construction Engineering of Oil and Gas Fields located in East Siberia, Far East and Far North



Russian State-of-the-art Developments in Dirigible Building

Hybrid, rigid-framed crafts designed by RosAeroSystems for passenger/cargo transport are considered to be the most interesting and prospective developments in the field of dirigible building industry.

Designed dirigibles will demonstrate the larger flight distance and capacity to carry 14, 52 and 182 tons (depending on the model). Due to specific structure windage of such crafts will be lower and thus it will be more stable in air and on the surface. There will be no feathering under wind speed up to 10 m/sec. Such dirigibles will do without hangar and mooring mast, they will be able to take off and land from/to any unprepared ground (site) of small size.

From theoretical point of view, such crafts can partially replace cargo carriers. Use of such equipment is especially relevant for development of new fields in remote regions of Siberia and Far East with poor transport infrastructure.

Designed Aerostatic Transport Craft /ATLANT-30/ for remote sensing of territories and cargo/passenger transport

ATLANT-30 transport craft - load capacity 16 t

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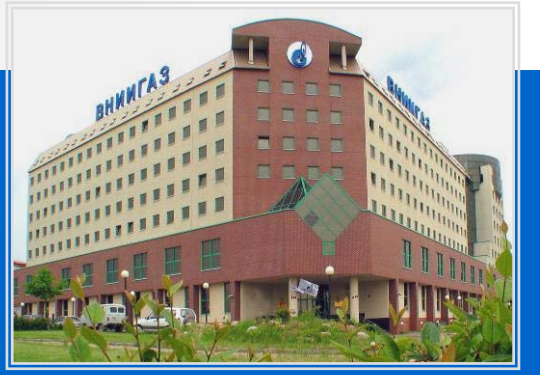

THANK YOU

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