Approaches to Global Navigation Satellite System applications in Belarus large-scale farm production

Dr. Yuri Fedulov, Eng. Sergey Reshetnik,

United Institute of Informatics Problems,

National Academy of Sciences of Belarus

Belarus in Europe (2009)

- Area – 207,6 thousands sq. km
- Population – 9, 672 million
- Average population density - 47 people per 1 sq. km
- Country people - 2,524 million or 26,1%
- Country people live in 23,9 thousands of localities
- Urban people - 7,148 million or 73,9%

Belarus agricultural sector (lands and areas)

Land categories	Total area, ha×1000	Total area, %	Reclaimed area, ha×1000	Irrigated area, ha×1000
Total lands	20760	100,0	3423,7	52,9
Agricultural lands	8944,8	43,1	2913,1	52,9
Among them: arable lands	5516,5	26,6	1256,5	41,1

Belarus possesses significant areas of agricultural lands – 43,1% of national territory – suitable for large-scale farming now and in future

Belarus agricultural sector (enterprises)

- **Large-scale and medium-scale** agricultural enterprises. Nowadays – about **1720**. In science judgment it is not optimal. Medium-scale enterprises (2-3 ha*1000) are incapable to be in progress and are loosing their competitiveness. Optimal scale enterprise should possess from 7 to 10 ha*1000. Belarus government will amalgamate agricultural enterprises with total number up to **1000**.

- **Farm enterprises**. Nowadays – **2016**. No significant increase in last years.

- **Personal subsidiary plots** – **1100 thousands**.

Belarus is going to hold large-scale agricultural enterprises hereafter with their size from 7 to 10 ha*1000

Belarus is to the left or to the right?

Belarus agricultural sector (train of machines)

Machine name	2004 (thousands of unites)	2009 (thousands of unites)
Tractors	58,8	49,5
Trucks	35,9	27,0
Combines:		
Harvester-thresher	13,3	12,9
Potato combine	2,2	1,2
Beet harvester	773 (units)	989 (units)
Ensilage harvester	5,0	2,0
Corn combine	50 (units)	39 (units)
Flax puller	1,2	1,1
Fertilizer placers:		
Organic solids	9,2	6,8
Organic liquids	3,0	2,8

Belarus is maintaining its train of machines in agriculture at a level of 104,3 (80,6%) thousands of unites (2009) as against 129,4 (2004)

Belarus agricultural sector
(exportability in billion USD)
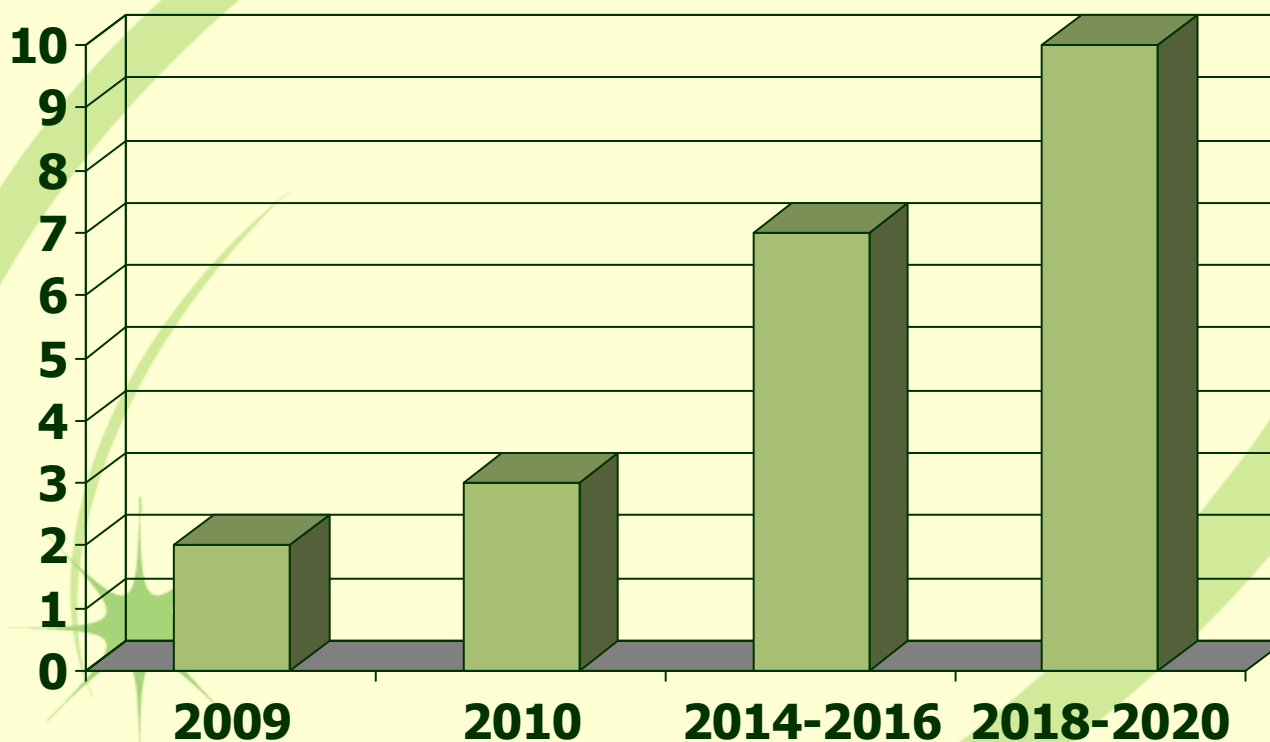
Belarus is going to increase considerably its agricultural products for export (5 times) at the expense of economical advancement

Mainstreams: wasteful expenditure decrease is one of economical advancement mainstreams

Precision agriculture or precision farming is a base element of wasteful expenditure decrease in agriculture, its resource saving technology.

Precision farming is a crops productivity management with a glance of intrafield variability of plants habitat. Conditionally speaking it is an optimization control for every square meter of a field.

3 principal milestones of precision farming:

- Acquisition of information about regions, enterprises, fields and crops;
- Information analysis and decision making;
- Decision implementing in agrotechnical operations conducting

Precision farming submissions:

- Control and monitoring of costly techniques usage (GPS/GLONASS/Galileo/ Compass/etc.);
- Agricultural vehicles steering automation (autopiloting) in production steps;
- Crop yield self-monitoring and mapping of crop capacity fields;
- Enterprise soil mapping assisted by soil samplers;
- Apply feature of strongly defined quality of fertilizers and seeds into different plots of the same field;
- Data accumulation and storage in agriculture making possible tracking of in production steps dynamics and their visualization;
- Tracking of fields and crops status on different plots leading to their rational treatment;
- Multivariate analysis and visualization of collected data;
- Decision making support and execution.

What is necessary for precision farming technology?

- Modern agricultural vehicles with onboard computers capable to differentiate agrotechnical operations;
- Vehicle high accuracy positioning tools (GPS- receivers);
- Fields heterogeneity detection systems (automatic soil samplers, different sensors and inspection centers, harvesters with automatic yields accounting, remote sensing of crops, etc.).
- The core element of precision farming (next phase) is software providing automated space-attributive tracking of agricultural fields card-register and generation, optimization and execution of agrotechnical decisions with a glance of characteristics variability within cultivated fields.

# Approaches to precision farming implementation
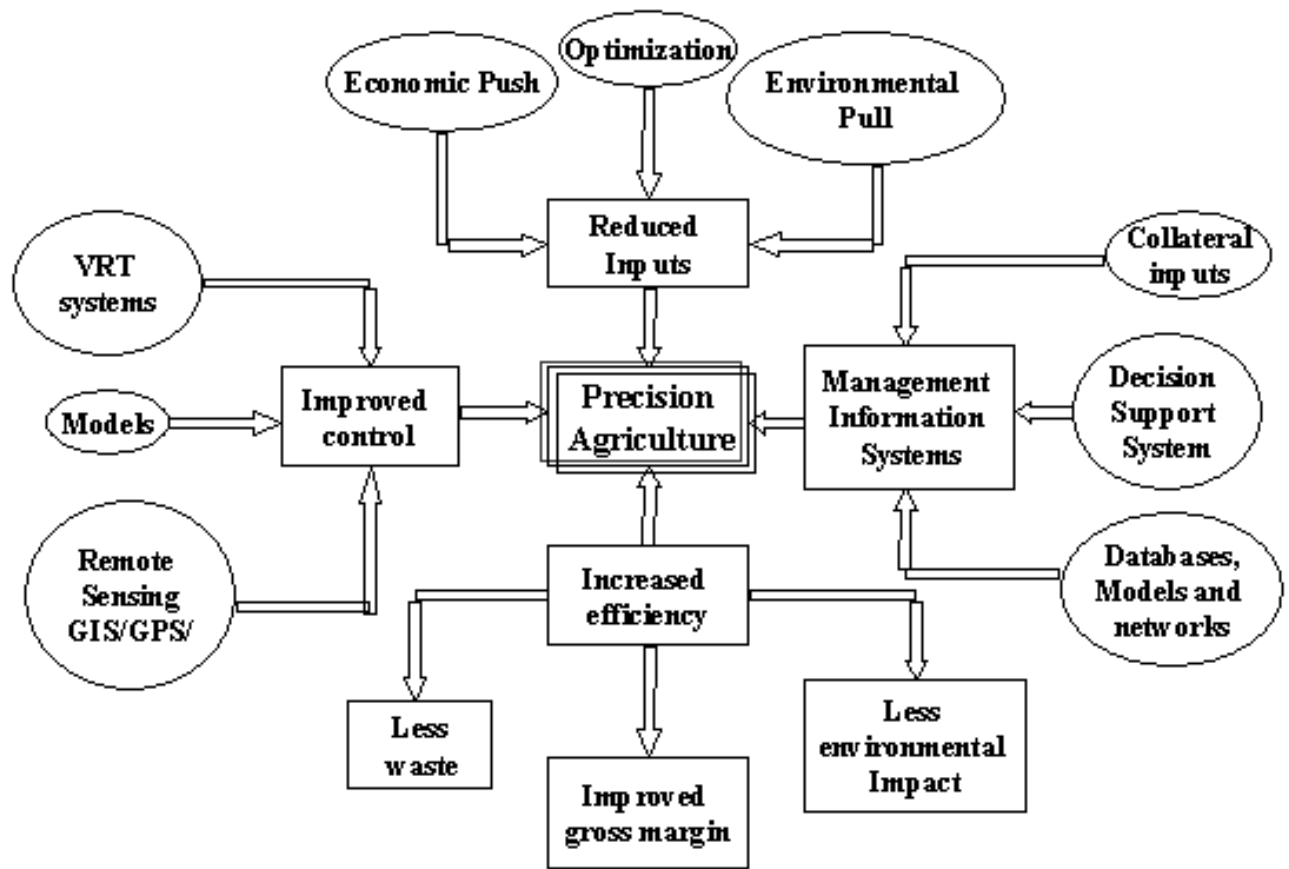
- Market research
- Requirements specification
- Designing
- Preproduction
- Production
- Realization (off-the-shelf)
- Field application

Market research

Finally completed in favour of precision farming. By the end of 2010 the state long-term program "Precision farming" should be developed in Belarus.

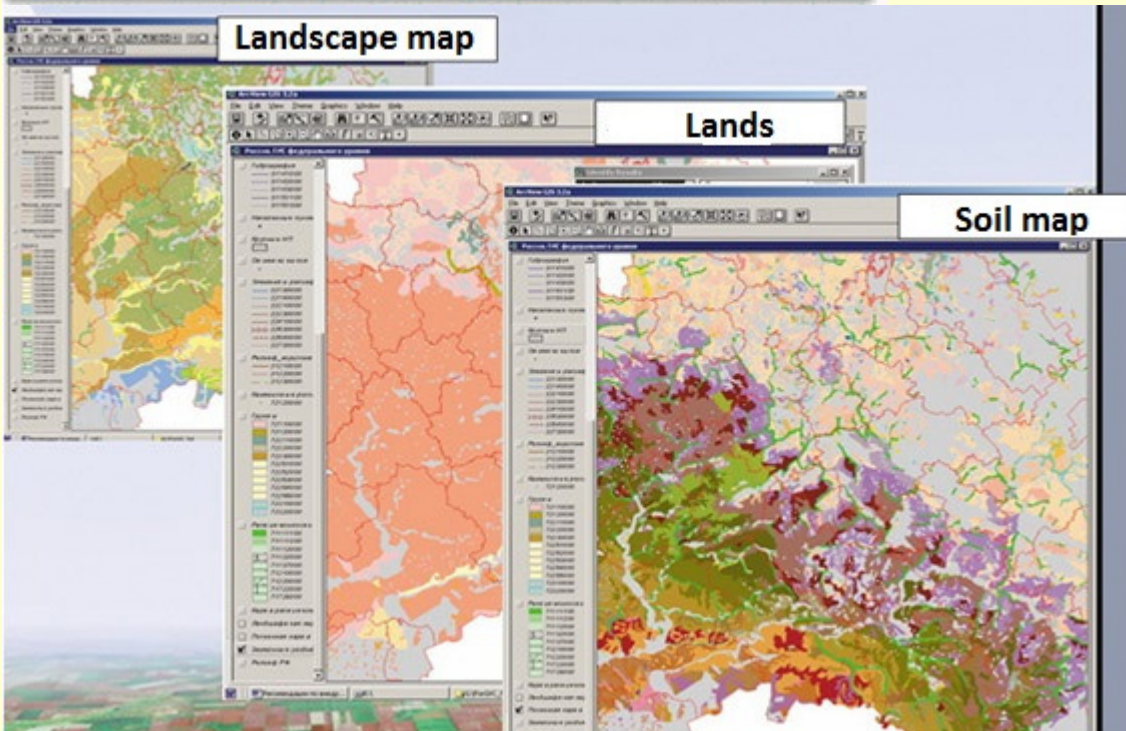# Requirements specification and designing
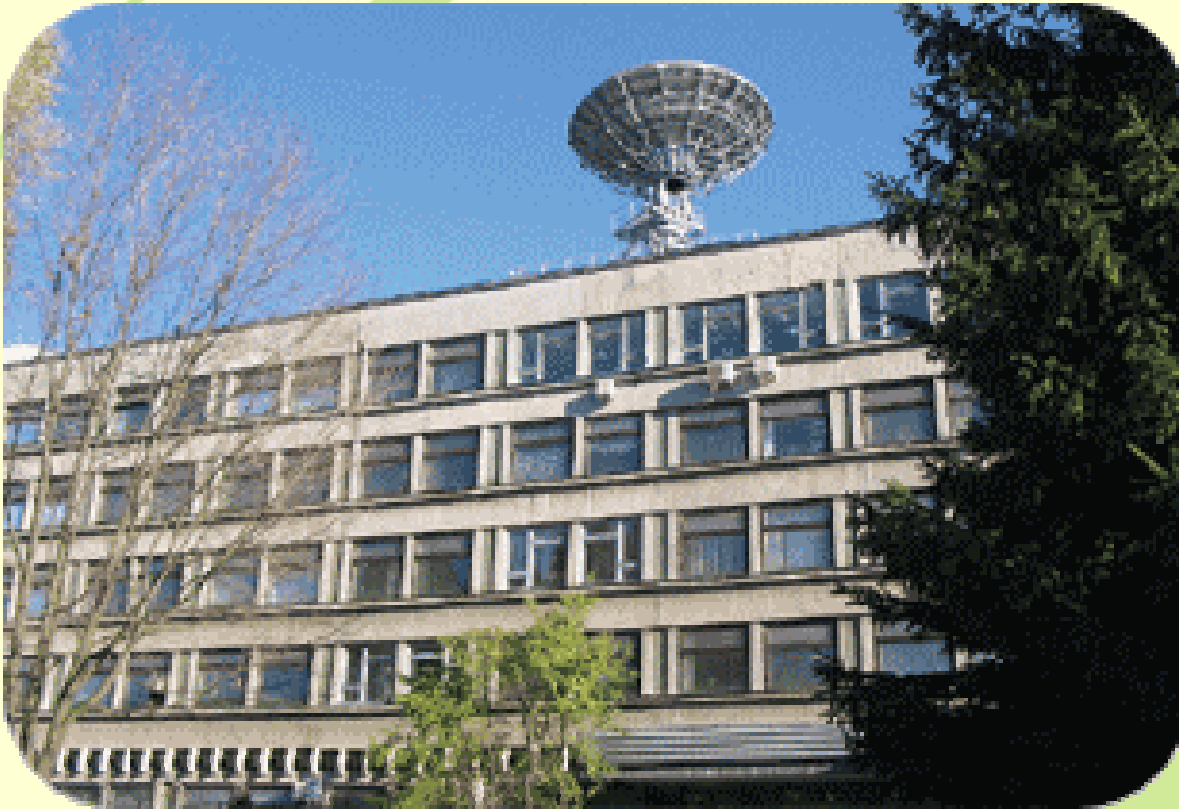
United Institute of Informatics Problems of the National Academy of Sciences of Belarus is widely involved in R&D in the field of "Precision farming" on a Global Navigation Satellite Systems basis .
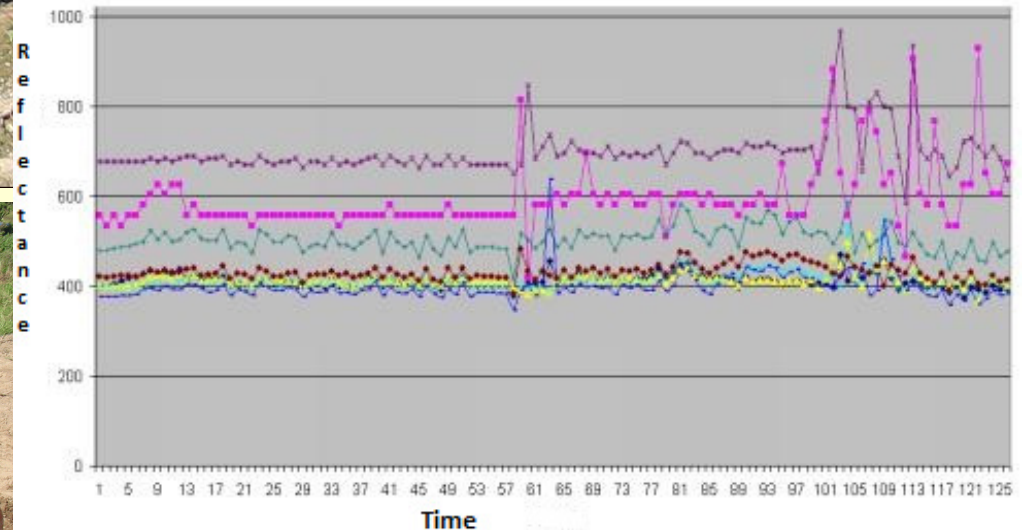
Mapping of crop capacity fields
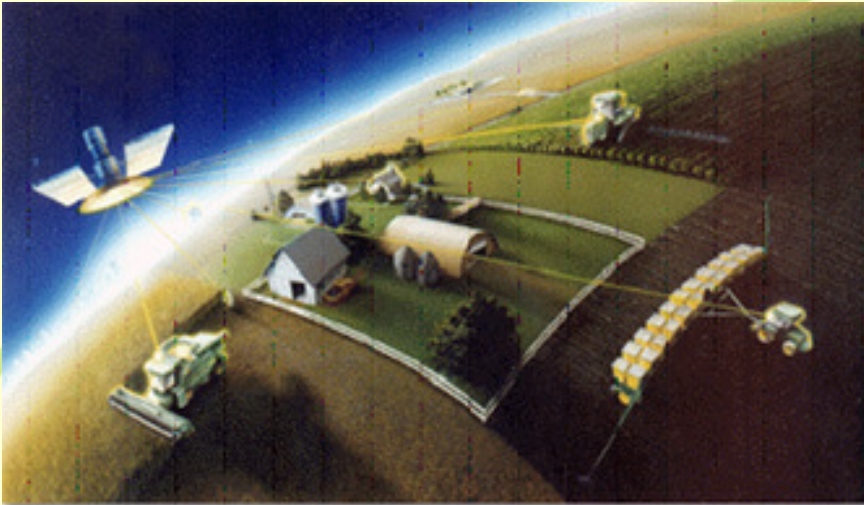
Development of soil heterogeneity measurement tools for mapping
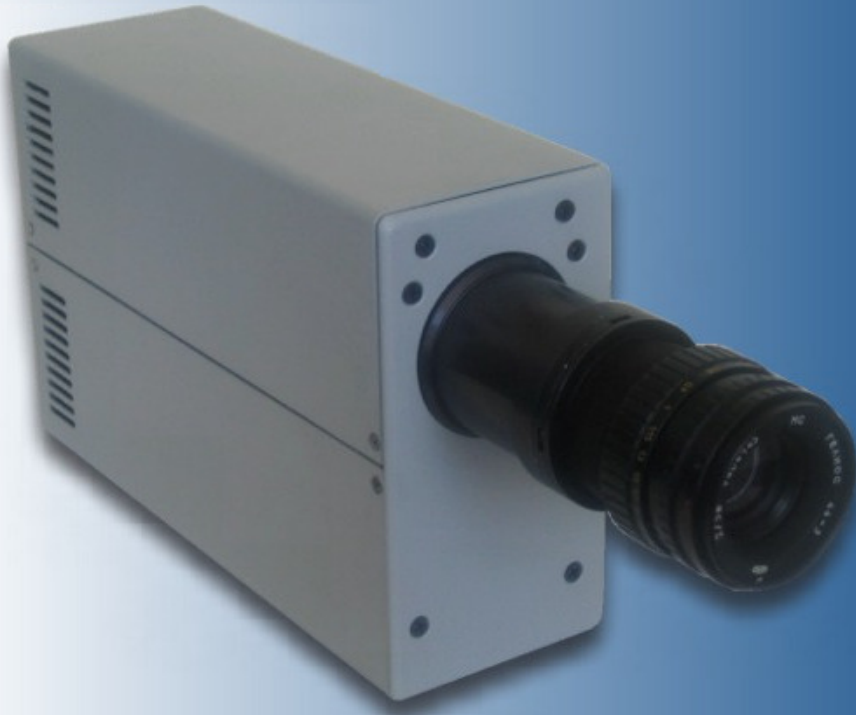
Measurement tools for mapping

Soil spectral analyzer

Specific spectral soil characteristics

Measurement tools for of soil heterogeneity mapping
(Portable spectroradiometer MC-12)

- Portable spectroradiometer MC-12
- Short-form specifications
- Spectral range   350÷1050 nm
- Spectral resolution   2 nm
- Radiation-measuring instrument
  CCD bar
- Receiving working member length
  3648
- Spectral sampling increment 0,2 nm
- Polychromator with dished multisectional diffraction grating 120 g/mm
- Gross geometry 275 x 170 x 90 mm (without lens)
- Mass not more 4,0 kg
- Power consumption – 0,5 W

Sampling instrument

Core sampler

To verify and validate spectral measurements of soil characteristics in the field by ground tools and remote sensing (GNSS based)

Local off-the-shelf products (GPS+GSM)

Все машины одним взглядом

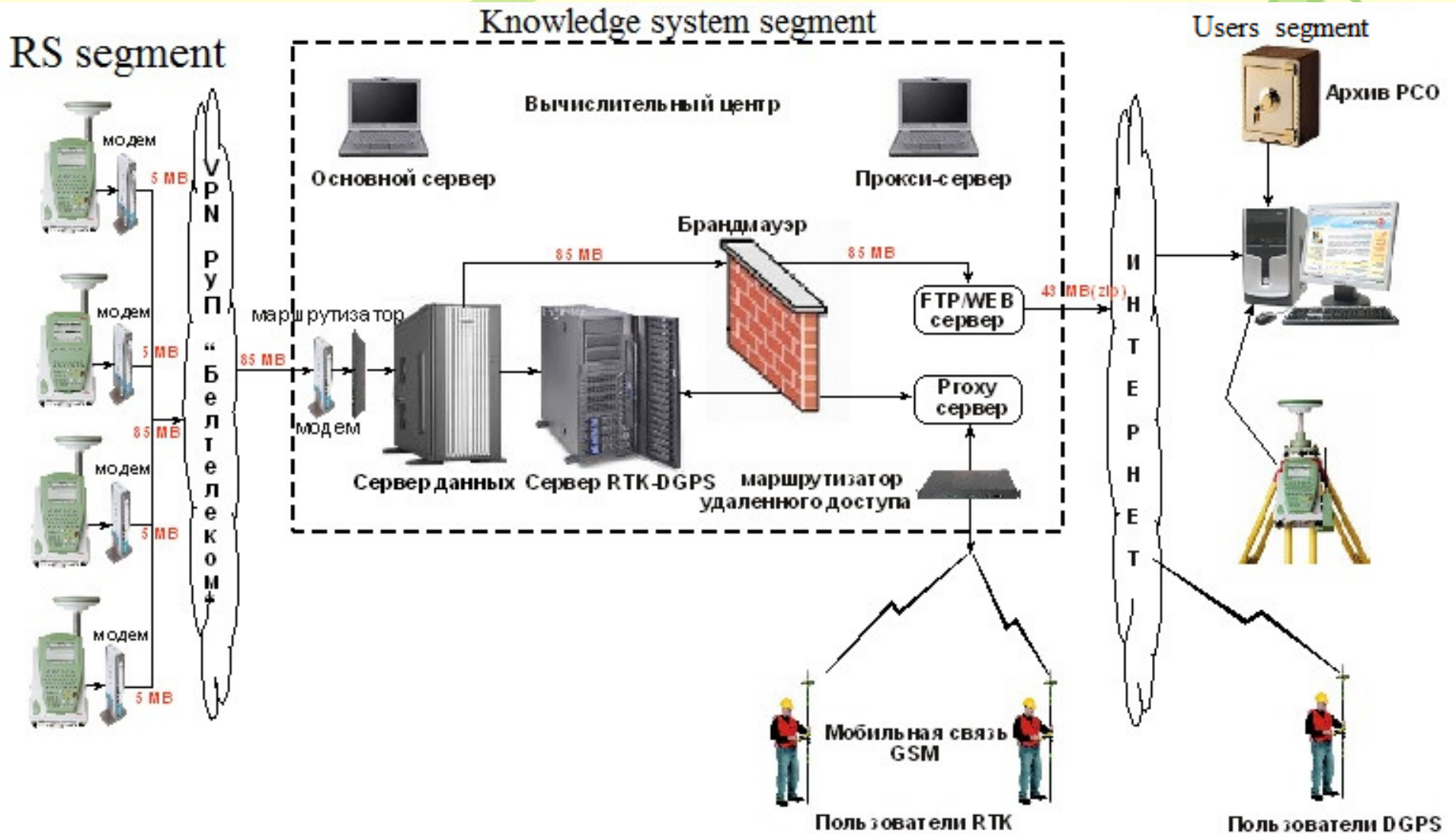**All machines at a glance**

Белтранс Спутник

Costs: 15 (GPS) +1,5 (GSM) Euro per month

Saving of business time and resources through real control:

- Only business stopovers possible;
- Unauthorized delays on route;
- Speedometer twisting;
- Accounting of real time driver employment;
- Arrival and departure time to/from shops/warehouses/offices;
- All speed driving offences;
- Real fuel consumption, etc.

Up to 60% costs cutback

Navigational support
(satellite exact positioning system composition)

Knowledge system segment

RS segment

Users segment

Архив РСО

Вычислительный центр

Основной сервер

Прокси-сервер

Брандмауэр

85 МВ

85 МВ

FTP/WEB сервер

43 МВ(zip)

маршрутизатор

модем

Серверданных   Сервер RTK-DGPS   маршрутизатор удаленного доступа

Proxy сервер

модем   5 МВ

модем   5 МВ

85 МВ

модем   85 МВ

модем   5 МВ

модем   5 МВ

VPN РУП "Белтелеком"

85 МВ

И Н Т Е Р Н Е Т

Мобильная связь GSM

Пользователи RTK

Пользователи DGPS

Satellite exact positioning system structure

- Segment of permanent operating points (POP) is a network of POP composed of hardware and software complex consisting of permanent operating satellite signals receivers with securely fix antennas.

- Knowledge system segment is composed of a computing center and communications network.

- Users segment includes users of coordinate and time information who owns satellite signals receivers.

Differential correction points in Stolbcy and Kletsk

Dome and antenna of
Leica AT504 receiver

Location of satellite system exact positioning elements in Minsk oblast
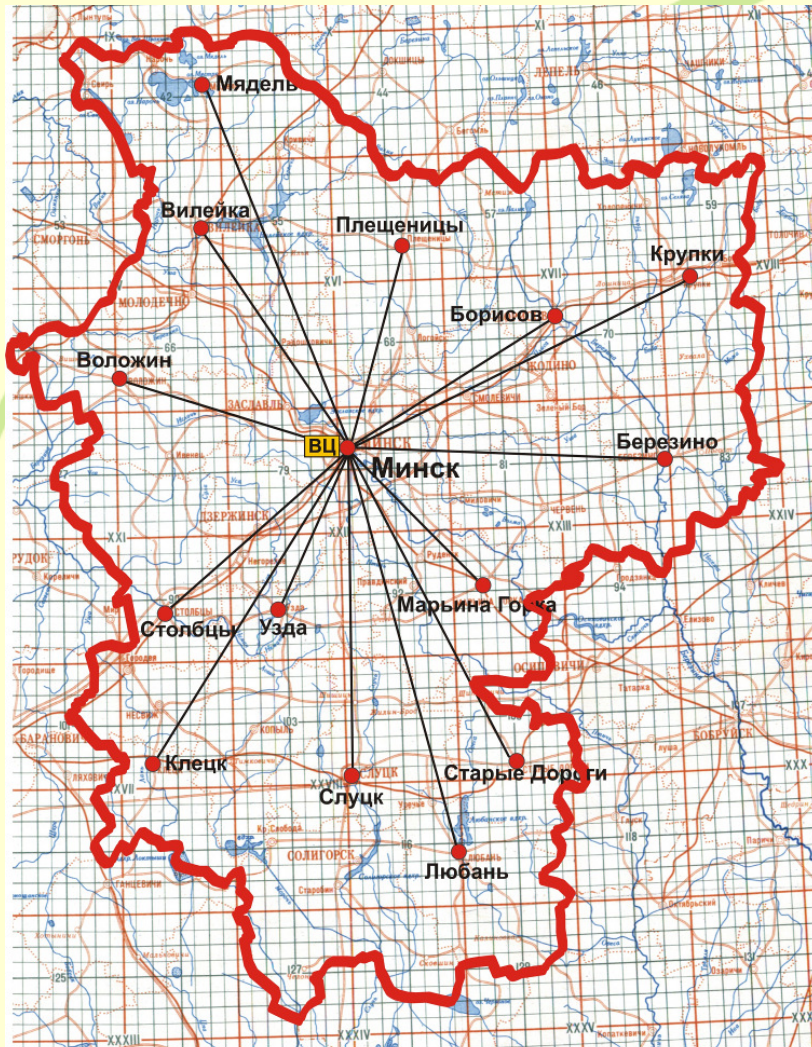
Belarus territory is fully prepared for GNSS services with accuracy required for different national economy tasks including precision farming (agriculture). Its beta test was launched in April 2010.

Accuracies achieved:

- In statics 1÷2 Cm
- In dynamics (fast statics) 2÷4 Cm
- Using only open (free of charge) corrected data – 30 Cm

Economic effect

Nowadays GNSS economic effect in Belarus is obtained in transport control using both GPS and GSM technology. Full potential of such technology implementation is about 60% against unequipped vehicles not managed in real time.

In future this effect should be increased in agricultural sector implementing GNSS-based technologies of precision farming especially in large-scale farming and livestock. As would be expected economic effect might be at a level of dozens percent.

Thank you for your attention

Any questions?

United Institute of Informatics Problems
6, Surganava St., 220012 Minsk, Belarus
Tel: 00375 17 2842171/fax: 00375 17 3318403