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ACTUAL GEOINFORMATIONAL SYSTEMS ANALYSIS FOR SOLVING AIRNAVIGATION PROBLEMS

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Abstract. *In this article modern achievements of the Geoinformatics for the aviation data maintenance have been analyzed. The survey of widespread Geoinformational Systems that are used by the modern airnavigation has been described. As a conclusion the main problem for common GIS software creation has been formulated.*

Keywords: aeronautical system, database, digital map, Geoinformational System, GIS technologies, information visualization.

Introduction

The aim of this article is to analyze modern Geoinformational Systems (GIS) and to make suggestions about improvement of GIS applications for solving airnavigation problems.

Well-developed techniques, which are used in GIS programs, allow to visualize maps and to analyze real objects and some situations around us. GIS technologies combine common operations with databases, such as queries or statistical analysis, with advantages of full visualization and geographic analysis provided by a map.

In GIS relational database structure, in which data are stored in tabular form, is used most conveniently. This simple approach is sufficiently flexible and widespread in many GIS applications.

In comparison with other fields of the human activity, such as land cadastre, geology, meteorology, ecology, municipal administration, economics [1] it can be noted that GIS programs has not got a worth place to solve navigation problems**.**

GIS applications in the aviation

Nowadays, various aviation users apply GIS technologies to solve a wide range of navigation tasks, such as both for air traffic management and for terrestrial purposes.

GIS technologies have been successfully used for the air traffic planning as well as for the real-time design of routes in the airspace [2; 3].

3D-graphics functions of the GIS allow to simulate more effectively various airspace situations on the cartographic background of the some area and take into account changes that can be occur during this time. In addition, it is possible to use a detailed visualization of the space around the airdrome and dynamic changes in airspace for:

– real-time situation analysis;

– protection an airport area;

– management of complex airport infrastructure, that is distributed over a large area;

– an air traffic planning;

– improving vehicle's arrangement on the airport area;

– solving logistics' problems;

– investigation environmental protection problems (for example, impact of the noise or environmental pollutions);

– creation of modern simulators - flight simulators.

Usage of GIS applications for aeronautical purposes

Almost all information, which is used by aviation specialists, has a geographical component, so the usage of GIS can be an inherent part of modern

airnavigation. GIS provides two important functions [2]: the creation of digital map, integrated with an expanded database, and visualization of the digital map which can be used by user. A lot of others GIS functions are based on these two ones.

Let's consider some of the most common GIS applications that are used in the airnavigation.

For instance, the information system "R.I.S.K. Air" (fig. 1) is an example of a engineered workstation in air navigation services. This program allows to simulate flight planes and airspace corridors; to plane charts in the TMA, standard instrument departure (SID) charts, standard arrival (STAR), instrument approach procedure, radar minimum altitude charts with subsequent generation of various aeronautical maps; as well as to automate the procedure of analyzing the conditions during takeoff and landing.

Usage of this program provides some services for the airnavigation. It allows:

– to give special database of tools for modeling;

– to store and edit list of the terminal area aerodrome charts;

– to identify significant parameters, to check the correctness and consistency according to legacy charts;

– to organize information on air navigation objects, corridors and routes in the one global relational database which consists of interrelated tables;

– to produce charts in standard form;

– to provide the high-speed editing of legacy charts and to create new aeronautical maps with various scales;

– to follow to the legacy standards for the cartographic information design.

GIS PANDA RNAV (fig. 2) is the GIS program to simulate common flight procedures and is designed for aeronautical information services (AIS) to create procedures for RNAV with the help of the GNSS.

This module is designed according to requirements of ICAO Doc.8168 PANS-OPS (5th edition) and provides maximum automation for procedures creation, applying the appropriate navigation criteria and specifications depending on the flight phases and transducers types.

The module has a manageable and scalable database which uses applications, contains all necessary parameters for XTT and ATT formats, takes into account the buffer zones and values of the area for all types of navigation specifications according to the PBN (Performance based navigation) and SBAS GBAS.

GIS PANDA takes into account:

– minimum distance between consecutive points of the path;

– maximum roll angle depending on the flight phase;

– maximum crossing angle of two consecutive segments;

– allowable range of air velocities, depending on the flight phase;

– obstacles clearance height.

This GIS is a flexible and powerful tool that allows creation of any types of flight paths within the limits of navigation aids or according to ability of certain devices, or their combinations. Also it includes a coding tool for procedures that were established during the design according to the standard aviation industry: ARINC 424 "Navigation System Database Specification ".

PANDA RNAV is based on a service-oriented architecture that provides the flexibility of the whole system and its expansion to new services without any changes of existing applications.

Pegasus system (fig. 3), whose kernel are ArcView GIS with Spatial Analyst additional module and ArcInfo, allows to integrate together digital map, information about obstacles, airport data and navigation data that are used for analysis of takeoff and landing corridors according to current aviation requirements.

Modules for analysis and visualization allow choosing or creating a sequence of necessary recommendations about pilots' action according to a given spatial position of the aircraft. Their visual representation helps to direct aircraft on the optimal path taking into account the terrain and land-based obstacles.

GIS Meteo program solves problems associated with the work of Aeronautical Meteorological Center. Usage of the GIS technology to create maps of hazards allows creation of maps in BUFR for any area of the globe.

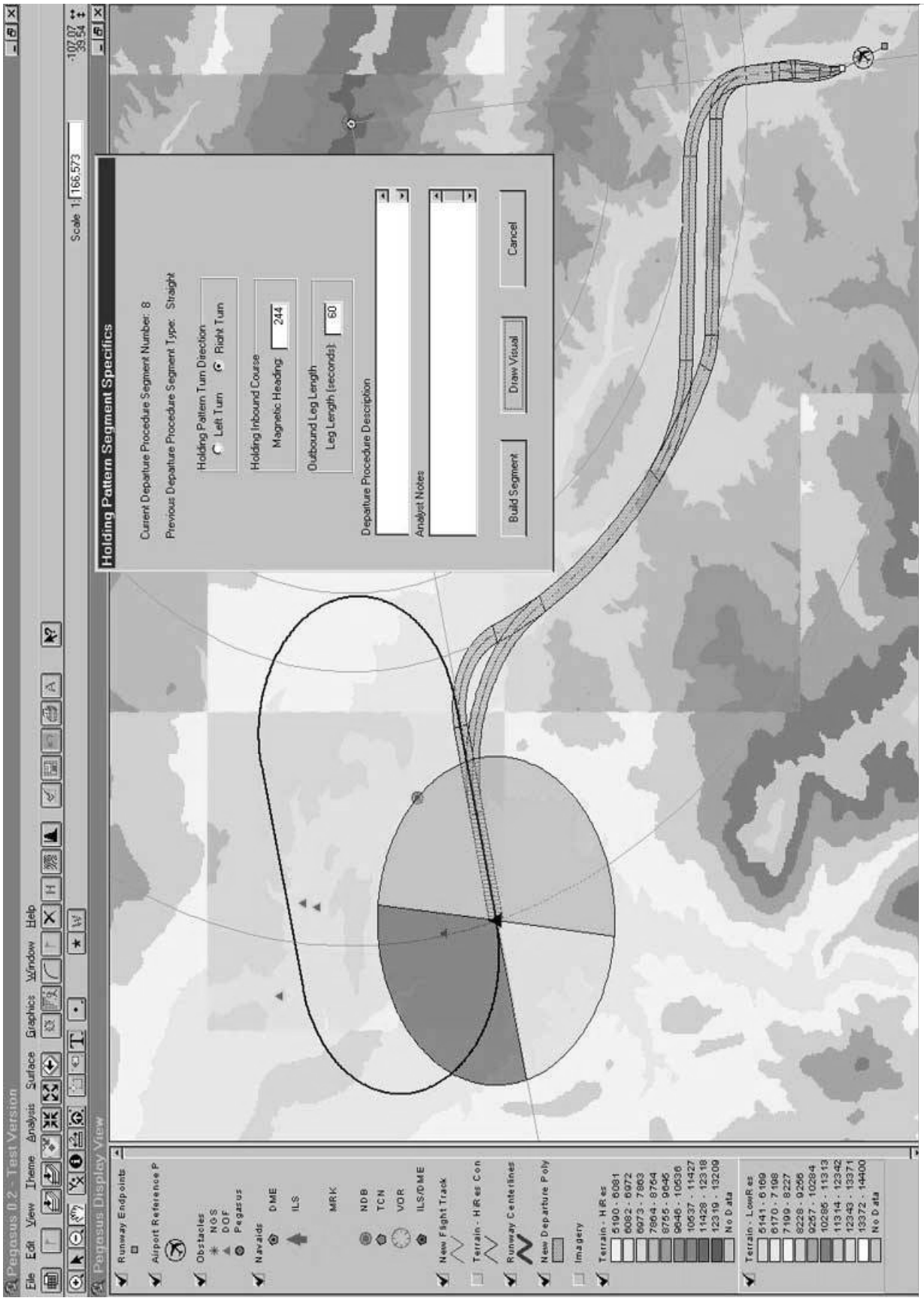

Fig. 1. Interface of the GIS R.I.S.K. Air

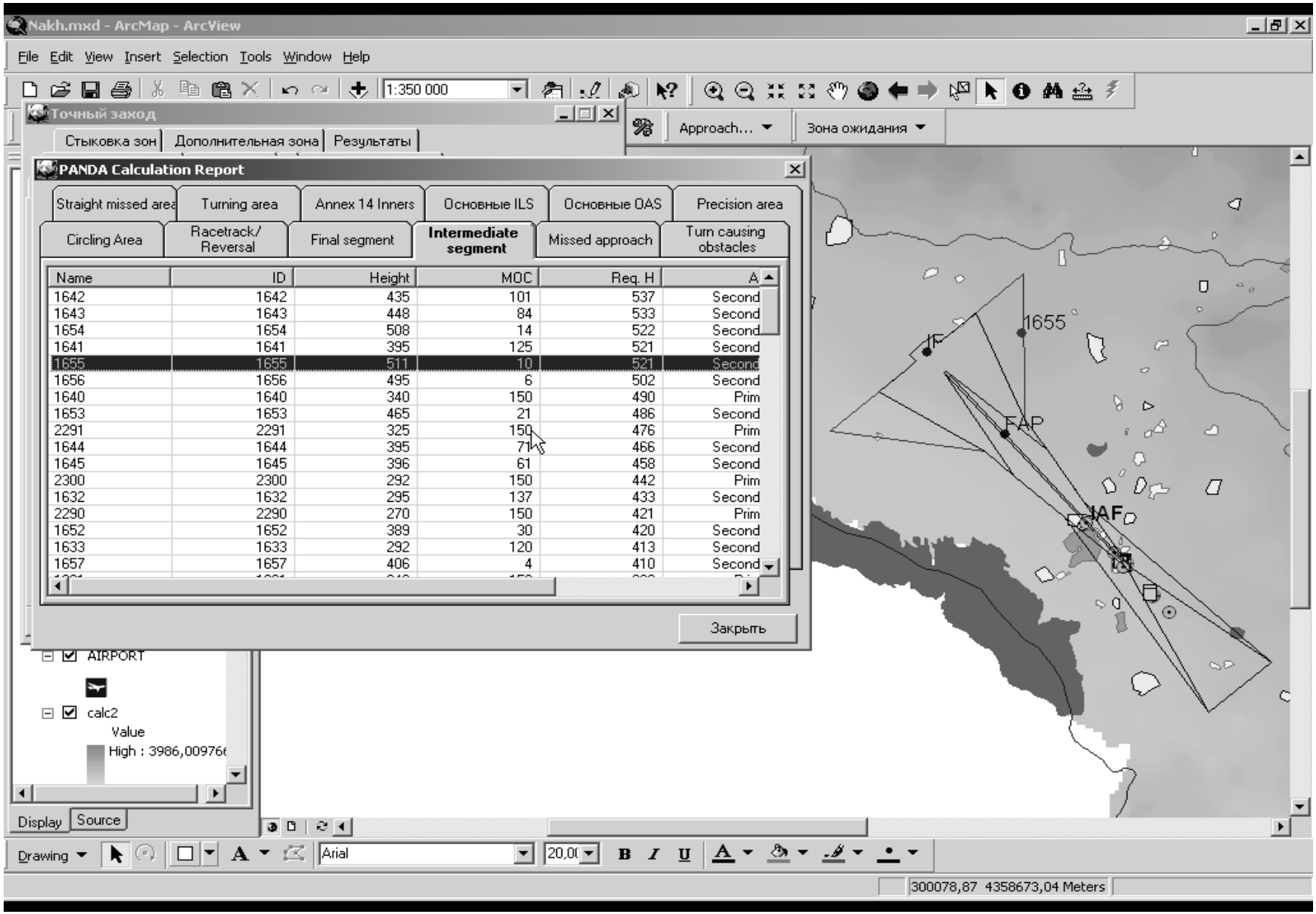

Fig. 2. Interface of the GIS PANDA RNAV

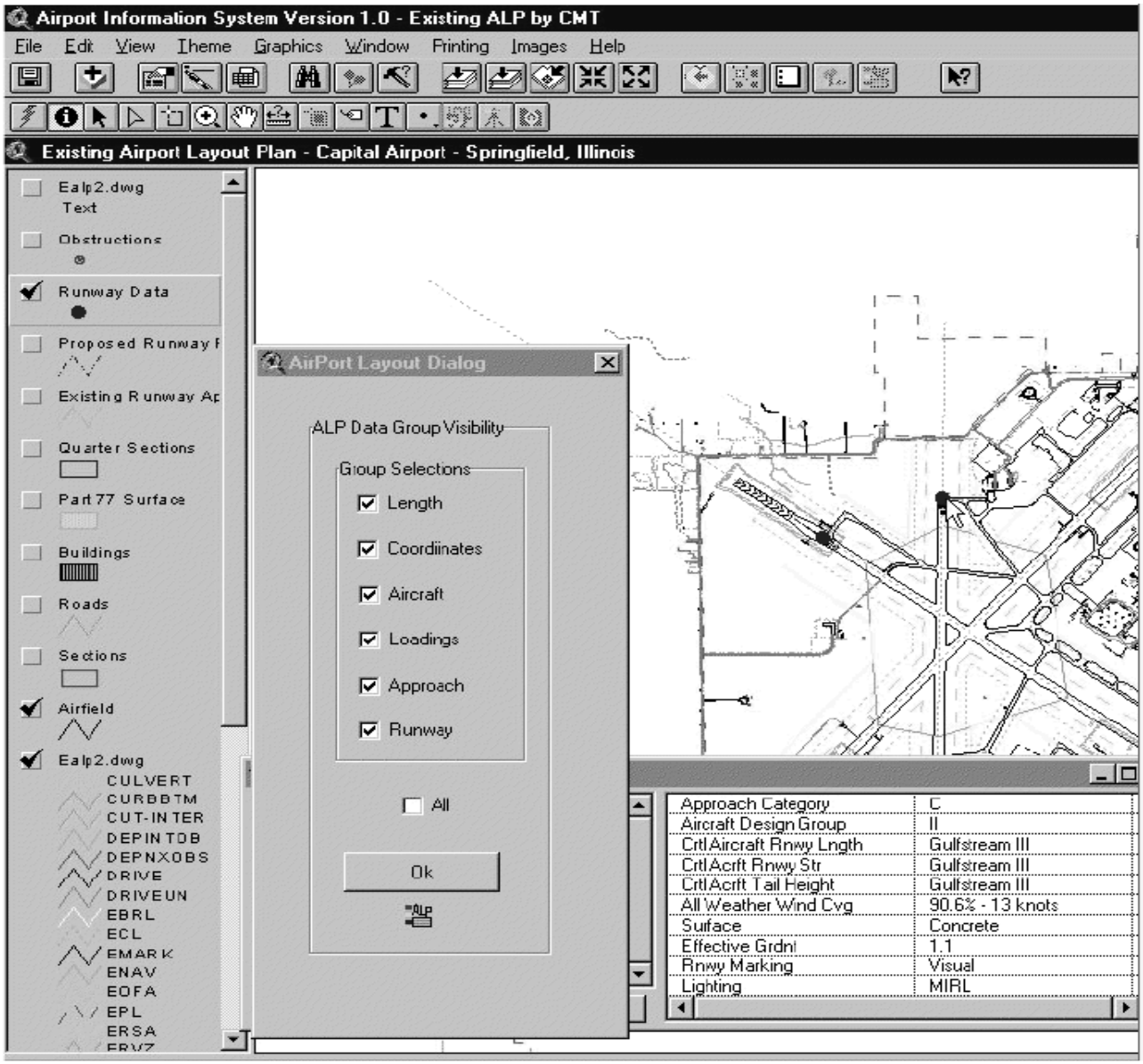

Fig. 3. Interface of the GIS Pegasus

Also with the help of it is easy to change the map scale without losing of quality and to edit maps according to local weather conditions, and even to impose on the map any other meteorological or aeronautical information.

GIS Avia Meteo, whose window is shown on the fig. 4, provides a current and predictive data on winds and temperatures, the actual and expected hazards along the route, a forecast for the flight in the form of set with METAR, TAF, SPECI codes for departure, destination and alternate aerodromes. It also allows using SIGMET, AMDAR, AIREP codes for flights at the route.

Automated flight navigator workstation (fig. 5) is designed to automate the process of preparing documents for air navigation safety and performs the following tasks:

– to create and choose optimal flight paths for internal and international routes and aerodromes, selected from a database;

– to perform pre-calculations for a route, created or loaded from a database for the definite type of aircraft both for the standard atmosphere and for any predicted climate weather conditions;

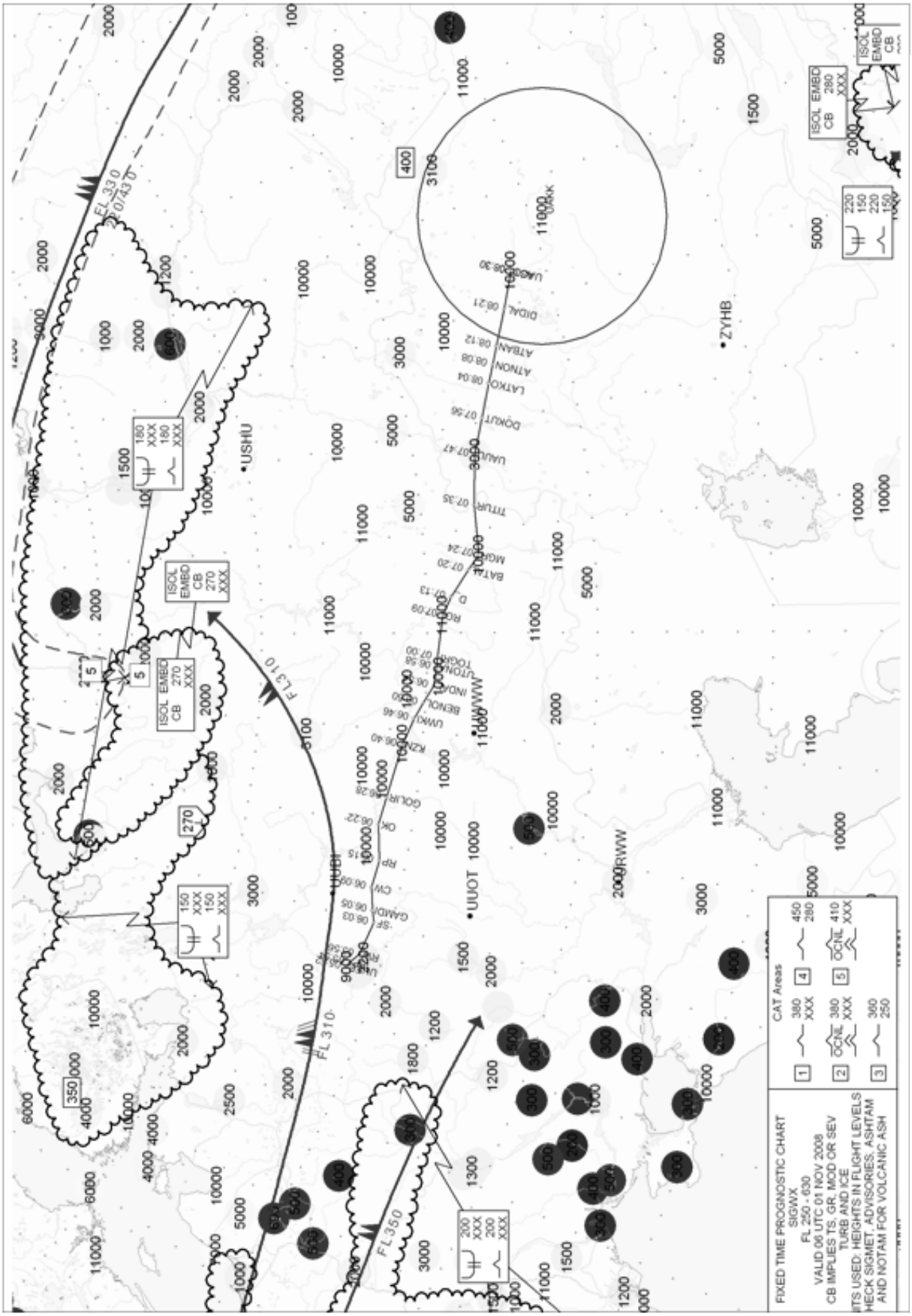

Fig. 4. Interface of the GIS Avia Meteo

– to fill in and print automatically some forms that are used for airnavigation flight services according to regulatory requirements;

– to calculate the astronomical phenomena at any given navigation point and to print it;

– to help the user (Help option).

Additional features:

– direct connection to the database «РосГидроМет» with the help of special data link channels and calculation of flight route parameters taking into consideration the short-term weather forecast ;

– direct connection to the automated workstation HOTAM created by “Monitor-Soft" or " Aeronautical consulting agency” to create a pre-flight information form for definite route automatically;

– calculation take-off - landing aircraft parameters based on actual and forecasted weather conditions at the take-off and landing aerodromes, etc.

Flightradar24 [4] (fig. 6) visualizes the real traffic for aircrafts in various regions of the world. Flight information is obtained from the ADS-B transmitters of each aircraft.

Flightradar24 has a network with about 200 ADS-B receivers throughout the world.

The system receives the plan and flight information from a aircraft ADS-B transmitter, and sends this information to the server and then visualizes this information on a electronic map.

Flightradar24 covers about 90% Europe area and some USA, Australia and Middle East countries areas.

The main disadvantage of this system is the compulsory usage of the special equipment (ADS-B transmitters) on the board of each aircraft to survey any movements of the aircraft.

GIS [5] is the basis for the aeronautical maps creation for operator workstation software of the Military Forces Aeronautical Centre of Ukraine. Operator workstation allows changing in the structure of the Ukrainian airspace according to privileges with the help of two modes.

The first mode provides to perform real-time changes according to NOTAM, reports, telegrams.

The second mode provides long-term planning based on the cycles of AIRAC (the system of advance notification about changes in an aeronautical data).

The created changes can be shown on the maps (charts) for further analysis, preparation for printing, etc.

On the prepared by this GIS cartographic framework, that have been read from an aeronautical database, is visualized the necessary information in the form of map objects (fig. 7).

If necessary, as a topographical frameworks can be used raster maps (scanned sheets of topographic maps, satellite images, etc.), connected the DEM to create digital maps with information about heights.

Also it is created the navigation GIS application that integrates a simpler version of the aeronautical database and electronic versions of the navigation maps.

A main feature of this application is the ability to connect GPS-navigators, whose allows to determine the location of the computer, to visualize this information in real-time on the background of navigation maps (for operational flight course corrections), to inform the crew about their approach to forbidden zones, to common control boundaries, turning points, to maintain flight path as a file with the coordinates or as an object on the map (for further control of the flight route), and other tasks.

This application has searching engine that allows an operator to obtain information about any object both from a database and from its graphical map visualization as quickly as possible.

There is an opportunity to draw a flight path (to put on the map like an object according to adopted symbols), to undertake the necessary pilot calculations, to translate the data from various coordinate systems - CK42, PZ90 (GLONASS), WGS-84 (GPS).

Conclusions

This article deals with an overview of the GIS actually used in the aviation industry. Each of the above programs can solve a specific set of tasks, has advantages over others, but at the same time can not be a universal tool in solving the full range of navigation problems.

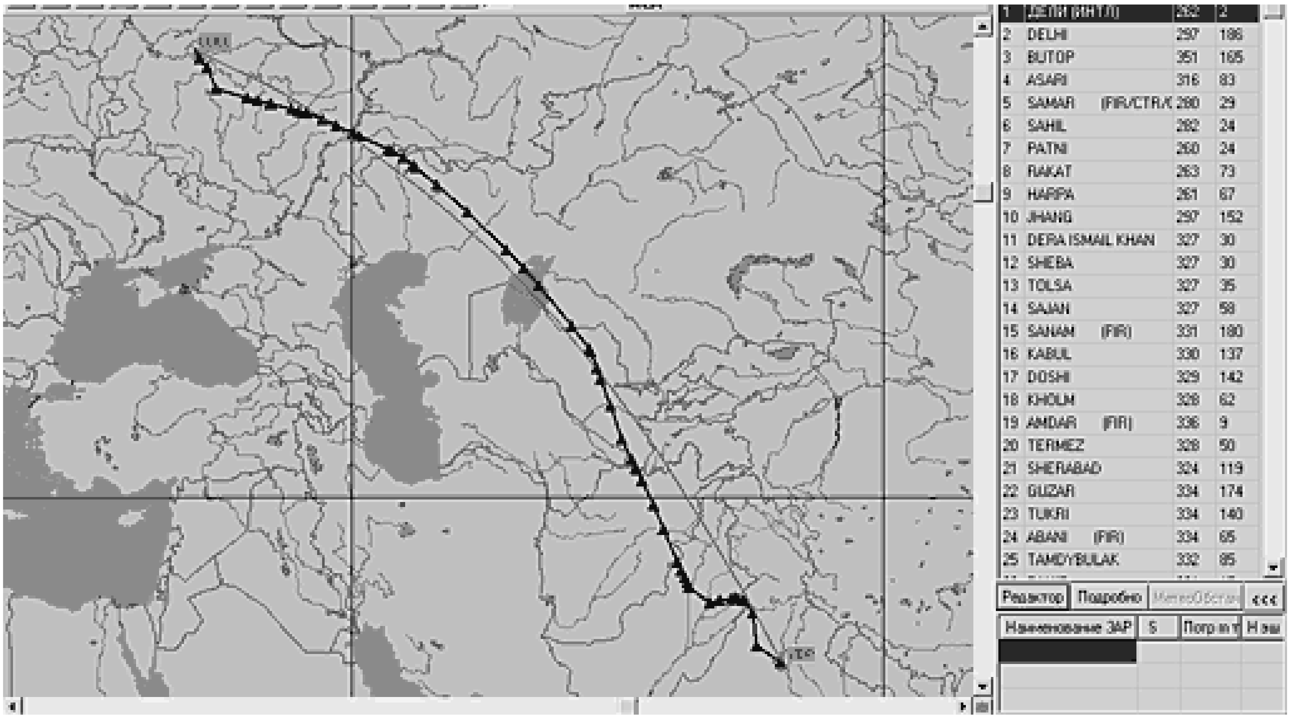

Fig. 5. Interface of the flight navigator workstation

Fig. 6. Main window of the Flightradar24 application

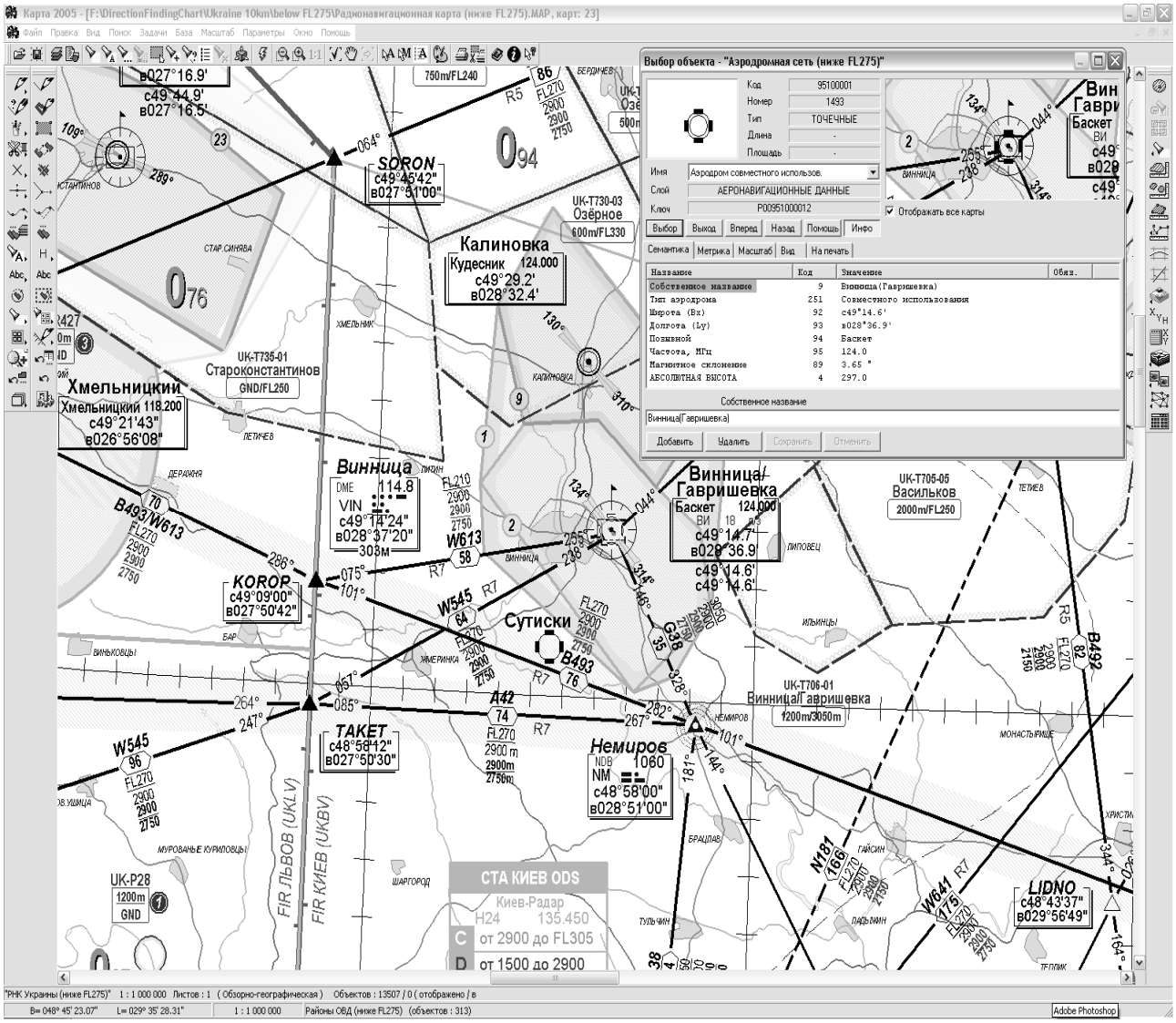

Fig. 7. Visualization of the aeronautical information from the database to the cartographic framework

Problem formulation to create a universal GIS program with the necessary applications in our opinion must be initiated by the ICAO Air Navigation Committee, moreover, that today it has developed a number sufficiently original and successful applications.

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