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Article

Development of a methodological approach for processing different types of data in systems of special purpose

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DEVELOPMENT OF A METHODOLOGICAL APPROACH FOR PROCESSING DIFFERENT TYPES OF DATA IN SYSTEMS OF SPECIAL PURPOSE

The object of research is intelligent decision making support systems. Processing different types of intelligence from a variety of information sources requires significant computational operations with strict time constraints. It leads to the search for new scientific approaches to the processing of various types of geospatial information to increase the efficiency of special purpose systems. This work solves the problem of developing a methodological approach to processing different data types in decision making support systems.

During the research, the authors used the main provisions of the queuing theory, the theory of automation, the theory of complex technical systems and general scientific methods of cognition, namely analysis and synthesis. The proposed methodological approach was developed taking into account the practical experience of the authors of this work during the military conflicts of the last decade.

The results of the research will be useful in:

– development of new algorithms for processing different types of data;

– substantiation of recommendations for improving the efficiency of processing various data types;

– analysis of the operational situation during the hostilities (operations);

– creating promising technologies to increase the efficiency of processing various data types;

– assessment of the adequacy, reliability, sensitivity of the scientific and methodological apparatus of processing various data types;

– development of new and improvement of existing simulation models of various processing data types.

Areas of further research will be aimed at developing a methodology for processing various data types in intelligent decision making support systems.

Keywords: *different data types, decision making support systems, data processing, data transmission systems.*

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1. Introduction

The rapid development of geospatial data sources in the world significantly complicates the process of extracting geospatial data using technical devices, necessitates their integration and processing the geospatial data coming from various technical devices [1, 2]. The main advantage of geoinformation technologies over other information technologies is a set of tools for creating and combining databases with the ability to graphically analyze and visualize them [1, 2].

Currently, military geographic information systems (GIS) are increasingly used to solve problems of modeling processes and situations of combat troops use. It suggests the emergence of the new GIS class – intelligent geographic information systems that use artificial intelligence to collect and process information.

Processing different types of intelligence from a variety of information sources requires significant computational operations with strict time constraints. It leads to the search for new scientific approaches to the processing of various types of geospatial information to improve the efficiency of geographic information systems for special purposes.

It is necessary to solve an urgent scientific problem, which is to improve the concept of obtaining information during the monitoring of military conflict zones. It can be done by taking into account the experience gained during the development of the layout of the information-analytical system for fire fixation (IASF) in the conflict zone, for example, in the South-East of Ukraine in 2016 [3, 4].

Thus, *the research objects* are intelligent decision making support systems. *The aim of research* is to improve the concept of obtaining information in intelligent decision making support systems during the monitoring military conflict zones.

2. Methods of research

This layout was implemented on the ArcGIS platform. Expanding the functionality of the monitoring system is possible through remote collaboration with the GIS office to use a single map as a cartographic basis. The task of creating IASF model as part of the Ukrainian side of the Joint Center for Control and Coordination of Ceasefire and Stabilization of the Line of Demarcation (US JCCC) was to increase [5–7]:

– effectiveness of the duty change service of the JCCC and observer officers of the observation groups;
– efficiency in collecting, transmitting and displaying on the electronic map the recorded facts of ceasefire violation;
– the object location accuracy on the map.

To formalize the flow of information from observers to the JCCC headquarters, the current state of the information environment was taken into account. The network component of this environment, for the transmission of data on the fact of shelling by illegal armed groups, was considered in the US JCCC as open information that allows the use of information and telecommunication Internet network [8–10].

For a fuller understanding, it is possible to show the detail (logic) in the form of a description of the processes of two different ways to monitor areas of military conflict. Namely, based on email submissions of MS Office software documents, used by national staff of the UN today and improved – special software (SS) SAGE together with the conceptual layout of the IASF, which was modified for UN tasks. During the research, the authors used the main provisions of the theory of queuing, automation theory, theory of complex technical systems, information transfer theory and general scientific methods of cognition, namely analysis and synthesis.

3. Research results and discussion

Let's describe the processes of data collection and processing the existing (traditional) data collection system. *Schemes «As It Is»* monitoring of events in conflict zones by national staff of the UN Mission (for example MONUSCO) by levels of data passage:

1. The level of team sites (Team Site, TS) is presented in Fig. 1.
2. The level of headquarters of the Mission Sector (Sector HQ) is presented in Fig. 2.
3. The level of the military observer headquarters of the mission (analytical department, G2, G3) MILOB FHQ is presented in Fig. 3.
4. The level of the Joint Operation Center (JOC) is presented in Fig. 4.

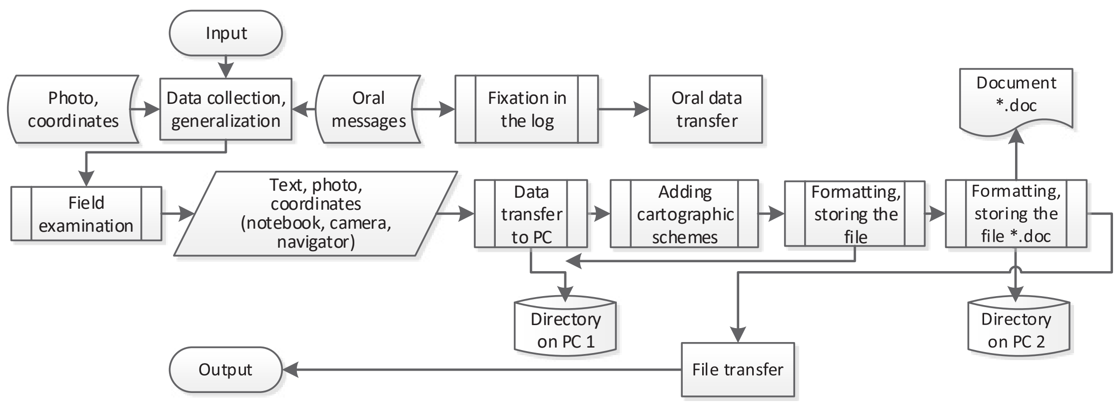

Fig. 1. Description of the data collection process at the site level (Team Site, TS) «As It Is»: PC is a personal computer (workstation on a desktop computer or laptop)

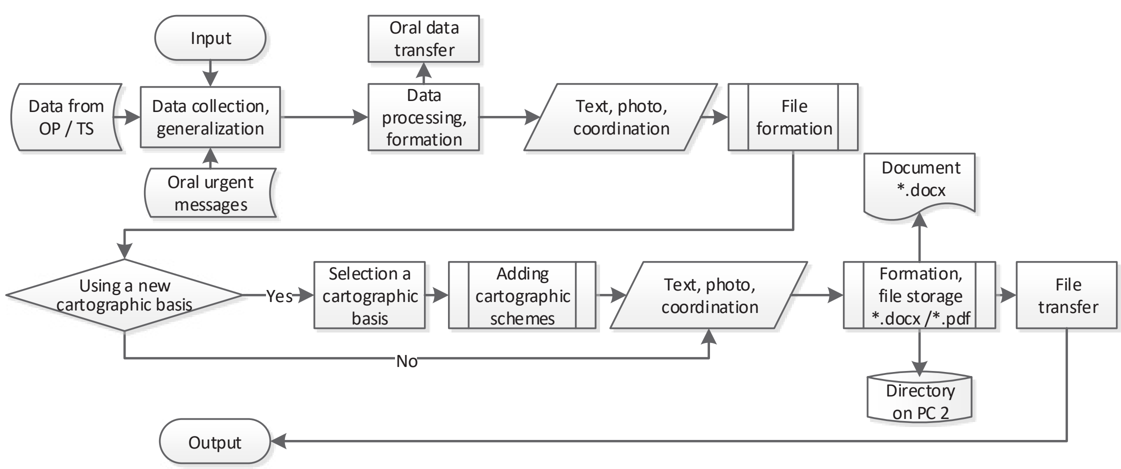

Fig. 2. Description of the data processing at the level of the Mission Headquarters (Sector HQ) «As It Is»: OP is an observation post (place of patrol); TS is the Team Site; PC is a personal computer

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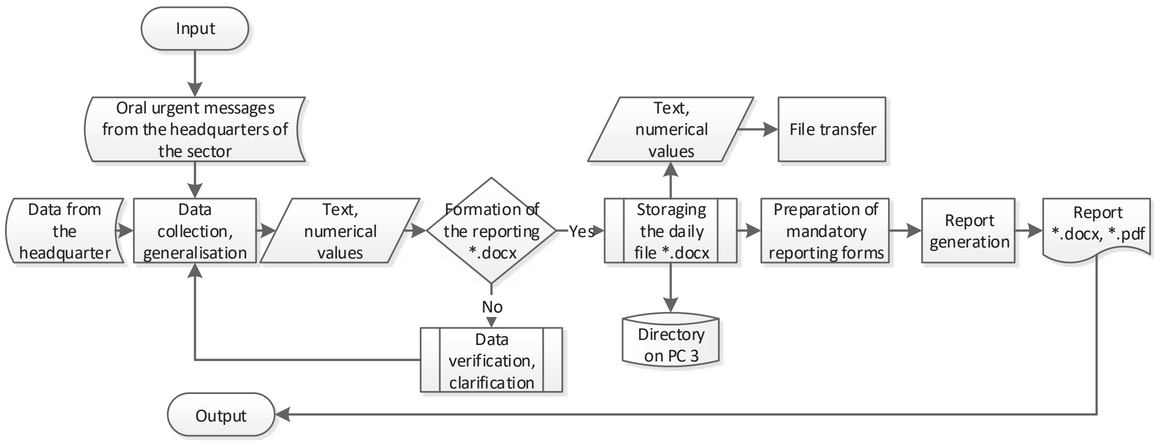

Fig. 3. Description of the data processing at the Mission headquarters level (MILOB FHQ) «As It Is»: PC is a personal computer

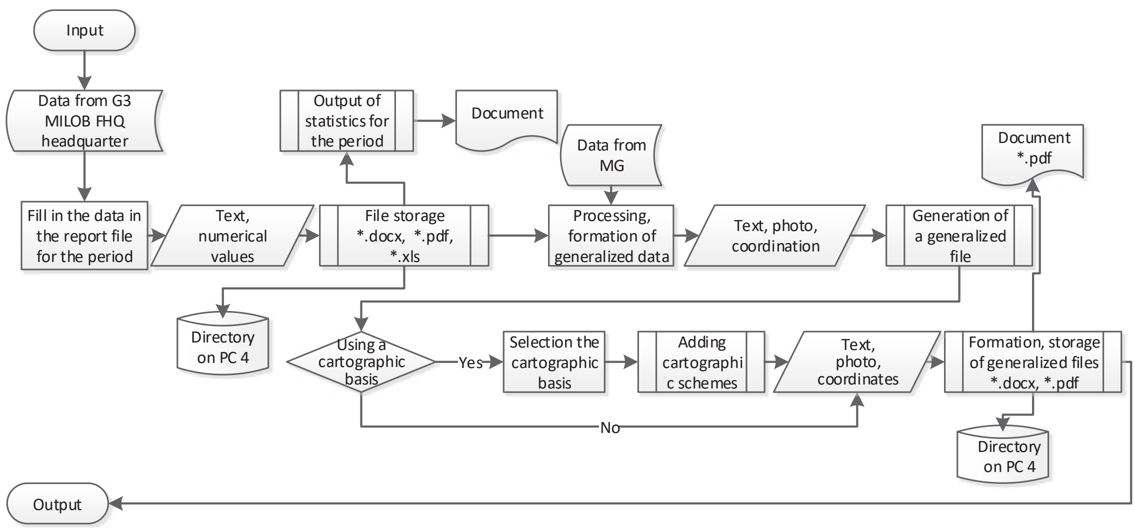

Fig. 4. Description of the data processing at the level of the Joint Operations Center of the Mission (JOC) «As It Is»: MG is the monitoring group; PC is a personal computer

For a systematic approach for improving the traditional way of monitoring military conflict zones, it is recommended to take into account the following factors:

1. Time spent on recording and reporting the event.
2. Staff number.
3. The equipment cost.
4. Error risks.

Let's evaluate the efficiency of the monitoring system for the tactical level. Evaluate the effectiveness of the office of the site and the headquarters of the UN model mission sector using an automated system implemented in the UN SAGE Mission and a traditional (manual) model based on sending text reports via email (Email UN Schema). It was based on the experience gained during the practical operation of two different models for the formation of a technical file SITREP and its sending via email or publication on a web resource. It is elementary determined that saving time on the task is significant (from 13 minutes to 91 minutes depending on the frequency of the solution).

The model for assessing the effectiveness of the elements of the reporting system during the monitoring of conflict zones at the tactical level are presented in formulaic and graphical forms. The assessment of the efficiency of the UN mission site is calculated as the difference between the time of tasks without the use of the UN SAGE system and the time of decision-making using the specified system:

$$\Delta T_{econom} = T_r - T_{avt}, \quad (1)$$

where linear models of work of that site during the formation of the report of the headquarters of the UN mission sector, which reflect the statistics obtained in the traditional way based on email sending text reports (T_r – Email UN Schema) and the method based on automation by entering data into UN SAGE (T_{avt} – UN SAGE), Fig. 5.

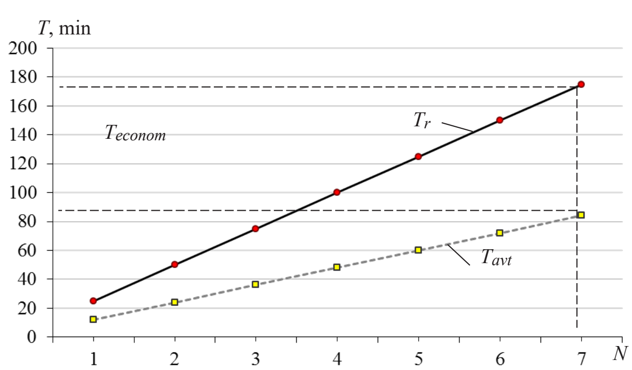

Fig. 5. Models of the site work efficiency during formation of the report of a staff of a sector of the UN mission are received in two ways

The results of determining the working time of the site during the formation of the report of the headquarters of the UN mission to perform the task of preparing seven reports (data processing as an element of the information cycle) are given in Table 1.

Table 1

Results of determining the time of preparation and sending the reports (data processing)

No.	T_r, min.	T_{avt}, min.	T_{econom}, min.
1	25	12	13
2	50	24	26
3	75	36	39
4	100	48	52
5	125	60	65
6	150	72	78
7	175	84	91

The dynamic model of decision-making based on the traditional method (Email UN Schema) T_r has the form:

$$T_r = \left(T_{pr} + T_{rr} + T_{or}\right)\cdot N, \quad (2)$$

where T_{pr} is the time to collect and prepare input data for the report itself on a PC (15 min.); T_{rr} is the time to form a cartographic basis and photos for insertion into a Microsoft Word document (5 minutes); T_{or} is the time to prepare the results of the daily SITREP report and send via email (5 minutes).

The dynamic model of decision-making based on automation using UN SAGE T_{avt} has the form:

$$T_{avt} = \left(T_{na} + T_{ra} + T_{pr}\right)\cdot N, \quad (3)$$

where T_{na} is the time to collect and enter input data for the report based on the model used in UN SAGE through a web browser on the mapping service (5 minutes); T_{ra} is the time to fill in the drop-down web forms for forming a cartographic basis and adding (inserting) photographic materials (2 minutes); T_{pr} is the time for registration of results of the daily report (5 min.); N is the frequency of solving the problem.

These results were used in assessing the operational performance of the sites and the headquarters of the mission sector. As a result, the efficiency of the models was increased, where it is obvious that while using automation, the model using the UN SAGE system predominates.

It is proposed to improve the existing system of monitoring conflict zones at the tactical level through the use of elements inherited from the IASF.

The evaluation of efficiency is also given using three models (according to Gorodnov's method) to ensure the functioning of conflict zones monitoring.

Email UN Schema is a traditional manual model based on email sending a SITREP text file from the office of the site to the sector headquarters (Traditional Email UN Schema).

UN SAGE is a model using the UN SAGE system at the levels of offices (team sites, regional headquarters SubHQ), headquarters (sector and mission), analytical departments (centers) at headquarters.

UN SAGE & IASF is a model to ensure the functioning of the inherited elements of the IASF based on SDR ArcGIS (an improved UN SAGE system).

Schemes «To Be» monitoring of events in conflict zones by national staff of the UN Mission (for example MONUSCO) by levels of data passage:

1. The level of team sites (Team Site, TS) is presented in Fig. 6.

2. The level of headquarters of the Mission Sector (Sector HQ) is presented in Fig. 7.

3. The level of the military observer headquarters of the mission (analytical department, G2, G3) MILOB FHQ is presented in Fig. 8.

4. The level of the Joint Operation Center (JOC) is presented in Fig. 9.

This model provides for the definition of efficiency as the total value of efficiency and reliability.

At the beginning let's evaluate the efficiency indicator. It can be seen that at the level of efficiency $P \geq 0.9$ provision of calculations at the stage of patrolling is possible only in the presence of pre-prepared source information for the patrol after receiving information by phone from proxies (focal points).

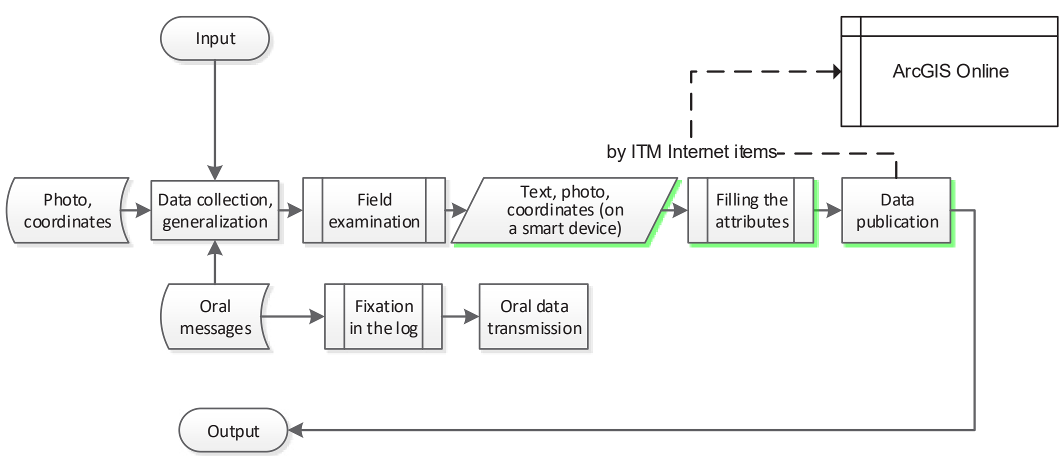

Fig. 6. Description of the data collection process at the site level (Team Site, TS) «To Be»

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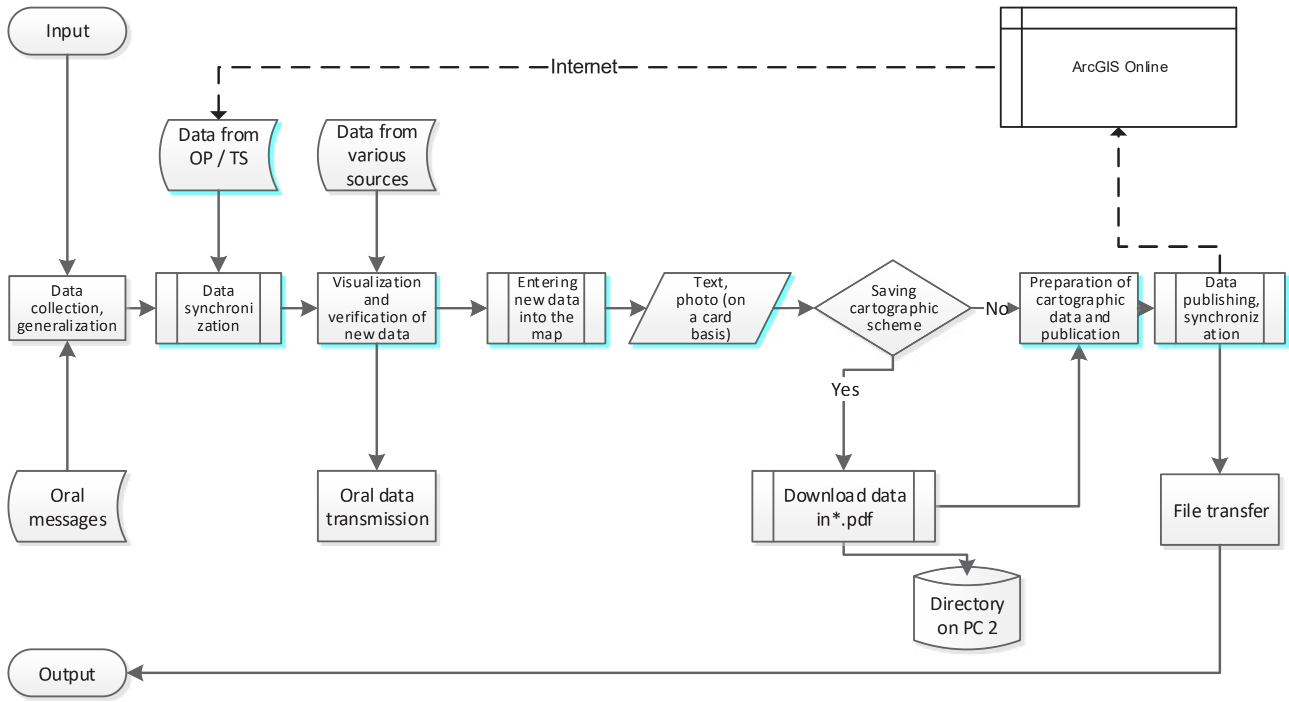

Fig. 7. Description of the data processing at the Sector HQ level «To Be»:
OP is an observation post; TS is the Team Site; PC is a personal computer; GIS is the geographic information system

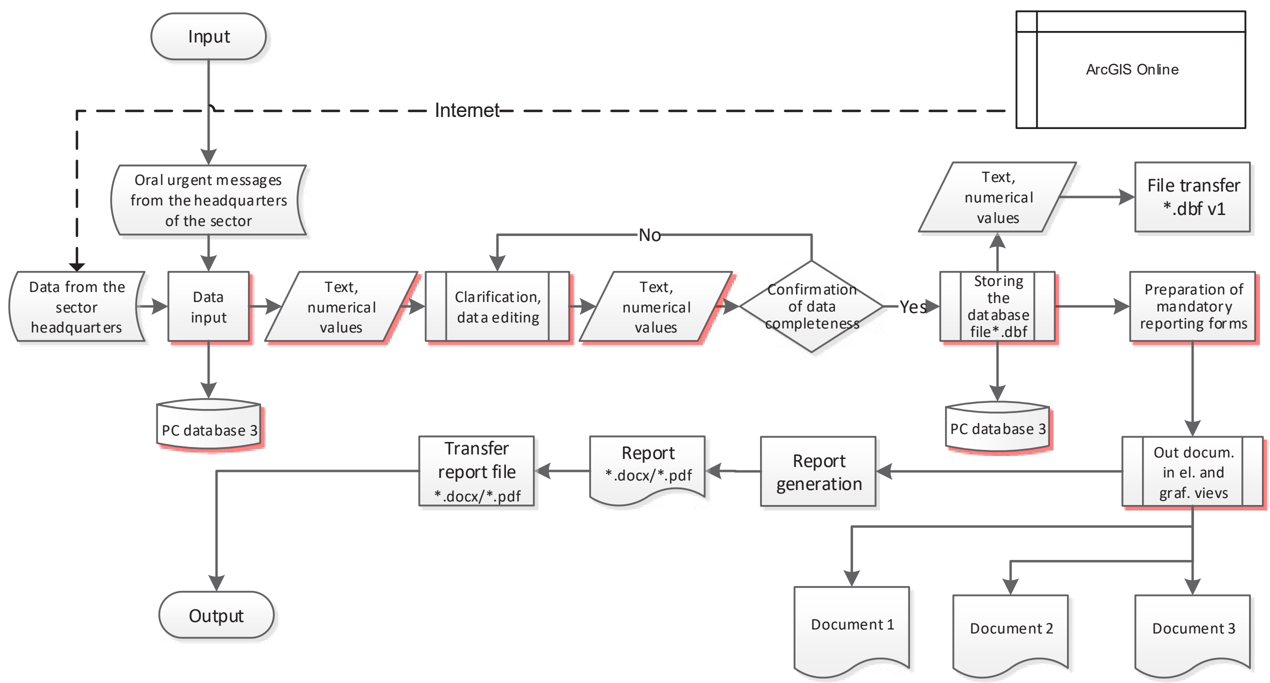

Fig. 8. Description of the data processing at mission headquarters (MILOB FHQ) «To Be»: PC is a personal computer

Efficiency assessment of the site/headquarters of the UN mission sector work (conducted in stages).

The values of time spent on the application of models and their complexes (min.) During the monitoring of conflict zones at the tactical level are given in Table 2.

The average time value for the stages of monitoring the conflict zones at the tactical level in the field (at the level of the site) for one course of action (min.) is given in Table 3.

Assessment of the situation: receiving news in the form of a mailing list in Outlook; receiving news from the Internet; receiving news from trusted items (Focal Points).

Gathering and planning: frequency of visits; security situation; provision of cartographic materials; approval of a weekly patrol plan; patrol route (safety class for roads, route length, complexity, seasonality); radiofrequency.

Thus, the use of the data collection system to monitor military conflict zones using the IASF layout model on the ArcGIS platform (including integration with the UN SAGE system) increases the efficiency by more than 30 % compared to the traditional method.

This approach is proposed to be used in the settlement of military conflicts. It will increase the efficiency of data processing and transmission.

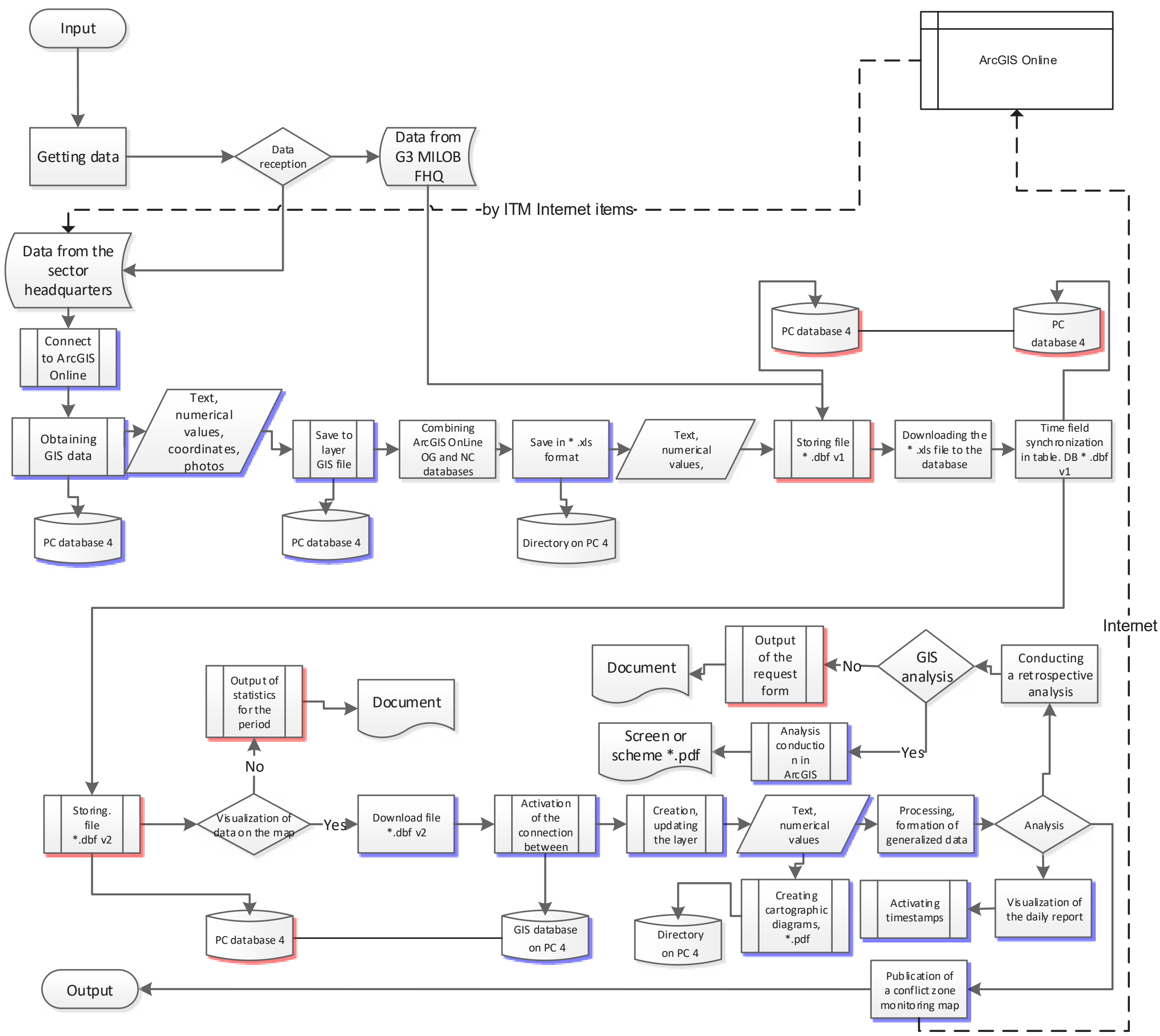

Fig. 9. Description of the process of data processing at the level of the mission joint operations center (JOC) «To Be»: GIS is the geographic information system; DB is the database; OG is the observation group; NC is the next changes

Table 2

Spending time on the application of models and their complexes during the monitoring of conflict zones at the tactical level

No.	Model numbering	Modeling cycle time that takes into account preparation, data entry and calculation time	
		With full information entry	While adjusting the entered data
1	Email UN Schema	60	40
2	UN SAGE	15	3–5
3	UN SAGE & IACF*	15*	3–5*

Table 3

The average value of time by stages of monitoring the conflict zones

Stages of monitoring conflict zones (at the site level)		
Immediate training		Patrolling
Assessment of the situation	Gathering and planning	
40	240	10

The limitations of the research are:
– taking into account time constraints on the transmission of a specific type of message (formalized report);
– restrictions on the quality of data channels.

4. Conclusions

In this research, a methodological approach to the processing of various data types in special purpose systems. The results of the research will be useful in:
– development of new algorithms for processing different types of data;
– substantiation of recommendations for improving the efficiency of processing various data types;
– analysis of the operational situation in the course of hostilities (operations);
– while creating promising technologies to increase the efficiency of processing various data types;
– assessment of the adequacy, reliability, sensitivity of the scientific and methodological apparatus of processing various data types;

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– development of new and improvement of existing simulation models of various types of data processing.

Areas of further research will be aimed at developing a methodology for processing various data types in intelligent decision making support systems.

References

1. Makridenko, L. A., Volkov, S. N., Khodnenko, V. P. (2010). Kontseptualnye voprosy sozdaniya i primeneniya malykh kosmicheskikh apparatov. *Voprosy elektromekhaniki, 114,* 15–26.
2. Shyshatskyi, A. V., Bashkyrov, O. M., Kostyna, O. M. (2015). Rozvytok intehrovanykh system zviazku ta peredachi danykh dlia potreb Zbroinykh Syl. *Naukovo-tekhnichnyi zhurnal «Ozbroiennia ta viiskova tekhnika», 1 (5),* 35–40.
3. Trotsenko, R. V., Bolotov, M. V. (2014). Data extraction process for heterogeneous sources. *Privolzhskii nauchnyi vestnik, 12-1 (40),* 52–54.
4. Bodianskyi, E. V., Strukov, V. M., Uzlov, D. Yu. (2017). Generalized metrics in the problem of analysis of multidimensional data with different scales. *Zbirnyk naukovykh prats Kharkivskoho natsionalnoho universytetu Povitrianykh Syl, 3 (52),* 98–101.
5. Petras, V., Petrasova, A., Jeziorska, J., Mitasova, H. (2016). Processing UAV and lidar point clouds in grass GIS. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XLI-B7,* 945–952. doi: http://doi.org/10.5194/isprs-archives-xli-b7-945-2016
6. Polovina, S., Radic, B., Ristic, R., Milcanovic, V. (2016). Spatial and temporal analysis of natural resources degradation in the Likodra River watershed. *Glasnik Sumarskog Fakulteta, 114,* 169–188. doi: http://doi.org/10.2298/gsf1614169p
7. Poryadin, I., Smirnova, E. (2017). Binary Classification Method of Social Network Users. *Science and Education of the Bauman MSTU, 17 (2),* 121–137. doi: http://doi.org/10.7463/0217.0000915
8. Tymchuk, S. (2017). Methods of Complex Data Processing from Technical Means of Monitoring. *Path of Science, 3 (3),* 4.1–4.9. doi: http://doi.org/10.22178/pos.20-4
9. Semenov, V. V., Lebedev, I. S. (2019). Processing of signal information in problems of monitoring information security of unmanned autonomous objects. *Scientific and Technical Journal of Information Technologies, Mechanics and Optics, 19 (3),* 492–498. doi: http://doi.org/10.17586/2226-1494-2019-19-3-492-498
10. Zhou, S., Yin, Z., Wu, Z., Chen, Y., Zhao, N., Yang, Z. (2019). A robust modulation classification method using convolutional neural networks. *EURASIP Journal on Advances in Signal Processing, 2019 (1).* doi: http://doi.org/10.1186/s13634-019-0616-6

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