Technical assessment of the Automated System of the State Land Cadastre (AS DZK)

EXECUTIVE SUMMARY

CONTENTS

ABBREVATIONS

AS	Automated System
CDZK	Center of the State Land Cadastre
CISS	Complex Information Security System
DB	Database
DC	Data center
EDS	Electronic digital signature
IT	Information technology (e.g. infrastructure)
OS	Operating System
QES	Qualified Electronic Signature
SGC	StateGeoGadastre
DZK/SLC	State Land Cadastre
SW	Software
VM	Virtual Machine

Acknowledgments

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Context

The National Cadastre System of Ukraine is responsible for maintaining the land and property records of the country. The automated system of management of state land resources of Ukraine is a key tool used by the National Cadastre System to manage and maintain these records.

The Automated System of Management of State Land Resources of Ukraine, known as AS DZK, is a critical tool used by the Ukrainian government to manage its land resources. The system was designed to create a unified state land cadastre and automate the management of land resources. The main goal of AS DZK is to ensure the efficient and effective use of land resources in Ukraine, to protect the rights of landowners, and to prevent illegal land use.

The AS DZK system's primary objectives are to provide a comprehensive and up-to-date database of land ownership and land use rights, to facilitate land transactions, and to monitor land use activities. The system enables the government to keep track of land use changes, identify land use violations, and take appropriate measures to address them.

The AS DZK system is used by various stakeholders, including the government, landowners, investors, and other interested parties. Government agencies use the system to manage land resources, issue permits, and enforce land use regulations. Landowners use the system to register their land, obtain information about their land, and apply for permits. Investors use the system to identify potential investment opportunities and conduct due diligence on land parcels.

The results of the AS DZK system are significant in terms of public and social impact. The system provides transparency in land transactions, reduces corruption, and protects the rights of landowners. The system also enables the government to monitor land use activities and prevent illegal land use, which is crucial for the conservation of natural resources, the protection of the environment, and the prevention of disasters.

The governance and management of the AS DZK system are critical to its success. The system is managed by the State Service of Ukraine for Geodesy, Cartography and Cadastre, which is responsible for its development, maintenance, and operation. The system's governance is also supported by

various legal and regulatory frameworks, including laws, regulations, and policies.

Overall, the AS DZK system plays a vital role in managing land resources in Ukraine. The system's goals, objectives, users, results public and social significance, governance, and management are all crucial to its success in achieving its intended outcomes.

However, the AS DZK has been facing several challenges. One of the most pressing issues is corruption opportunities, with reports of officials accepting bribes to alter land records, leading to disputes over land ownership and use.

Another challenge is the lack of transparency in the management of the National Cadastre System, which makes it difficult for landowners and the public to access information about land records and verify their accuracy. This, in turn, can cause issues with managing the records effectively.

The accuracy of the land records maintained by the AS DZK has also been called into question, with reports of errors causing disputes over land ownership and use.

Moreover, the rapid pace of urbanization and land development in Ukraine has put pressure on the National Cadastre System, which has struggled to keep up with the demand for new land records and updates of existing ones.

To overcome these challenges, reforms to the AS DZK have been proposed, including increased transparency in land record management, improved accuracy of the records, and modernization of the system to keep up with the pace of land development.

Overall, the AS DZK has an essential role in managing Ukraine's land resources, and its proper functioning is crucial for accurate and effective management of land records. However, system's drawbacks, lack of transparency, and difficulties in keeping up with the pace of land laws pose significant challenges, requiring urgent transformation to ensure the system's proper management and accuracy of land records.

I. OVERVIEW

The main objective of the Technical Assessment was to evaluate the current state of the digital environment, hardware and systems in use, IT components, and business processes of the State Land Cadastre (SLC), specifically its information System (AS DZK).

The Technical Assessment of the State Land Cadastre's automated system (AS DZK) was conducted by a team of highly skilled professionals with extensive expertise in land management systems, IT infrastructure, and software development. The team was assembled specifically for this project, and its members were carefully selected based on their relevant experience and qualifications.

The team was led by a project manager who had over 20 years of experience in managing large-scale IT projects. The project manager was responsible for overseeing all aspects of the Technical Assessment, from planning and coordination to execution and delivery of the final report.

The Technical Assessment team also included several IT experts who had extensive experience in assessing and evaluating complex IT systems. These experts were responsible for conducting technical assessments of the AS DZK's IT infrastructure, including its network infrastructure, servers, and databases.

In addition to IT experts, the project team also included land management specialists who had extensive experience in the design, development, and implementation of land management systems. These specialists were responsible for assessing the AS DZK's cadastral system software architecture, GIS part architecture, and technological processes.

The project team was further complemented by a team of software developers who had extensive experience in software support and maintenance. These developers were responsible for assessing the AS DZK's software support and maintenance processes and making recommendations for improvement.

The Technical Assessment team's qualifications and expertise were essential to the success of the project. Their comprehensive evaluation of the AS DZK's automated system identified areas that required improvement and provided

recommendations for future development and enhancement. The team's findings and recommendations will serve as a guide for the future development and improvement of the AS DZK, ultimately contributing to the goal of supporting transparent land governance in Ukraine.

The Scope of Work for the Assessment of the Automated System of Management of State Land Resources of Ukraine

The Technical Assessment was a comprehensive evaluation that covered all key software and hardware subsystems:

- IT Security technical assessment;
- Assessment of Existing network infrastructure;
- Existing servers' infrastructure technical assessment;
- Data Centers facilities assessment;
- Assessment of Oracle database;
- Assessment of PostgreSQL database;
- Assessment of cadastral system software architecture;
- GIS part architecture assessment;
- Assessment of resistance of software and equipment to loads;
- Assessment of technological processes (software development);
- Assessment of software support and maintenance;
- Gap-analysis of legislation.

The automated system of management of state land resources of Ukraine (AS DZK) plays a critical role in managing and monitoring the country's land resources. In order to ensure that the AS DZK is functioning efficiently and effectively, an assessment of its current state was conducted. This assessment was aimed at evaluating the overall performance of the system, identifying its strengths and weaknesses, and providing recommendations for improvement.

The scope of work for the assessment was comprehensive and involved several stages. The first stage was the review of the existing documentation and reports related to the AS DZK. This stage provided a good understanding of the system's objectives, design, and functionalities. The second stage involved interviews with key stakeholders involved in the management and use of the AS DZK. This stage provided valuable insights into the system's actual usage and its strengths and weaknesses.

The third stage was the IT-system components assessment and actual testing of

the system's functionalities. This involved testing the system's performance in managing land resources, including land registration, land valuation, land allocation, land use monitoring, and land disputes resolution. This stage helped to identify the system's weaknesses, including slow processing times, unreliable data, and difficulty in integrating with other systems.

The fourth stage involved benchmarking the AS DZK against other similar systems in use globally. This stage helped to identify best practices in land management systems that could be adopted by the AS DZK to enhance its performance and effectiveness.

The fifth stage was the analysis of the data collected in the previous stages. This stage involved evaluating the system's overall performance, identifying its strengths and weaknesses, and providing recommendations for improvement. The analysis revealed that the AS DZK was functioning below its potential, with several weaknesses that needed to be addressed.

The final stage was the development of a report summarizing the findings of the assessment and providing recommendations for improvement. The report recommended several interventions, including improving the system's database, enhancing its functionality, and enhancing the system's ability to integrate with other systems. The report also recommended that the AS DZK be strengthened through increased funding, capacity building, and stakeholder engagement.

In conclusion, the scope of work for the assessment of the AS DZK was comprehensive and involved several stages. The assessment revealed several weaknesses in the system, which could be addressed through a range of interventions. The recommendations provided in the report should be implemented to enhance the performance and effectiveness of the AS DZK in managing and monitoring the country's land resources.

The data control and protection scope of work involved a thorough analysis of the system's data storage and processing procedures to ensure that sensitive information is adequately protected from unauthorized access, modification, or disclosure. The scope of work included the following stages:

- *Data classification:* The first step in the data control and protection process was to classify the data according to its level of sensitivity. This involved identifying the main types of data that were collected and

processed by the system, such as personal information, geo-data, and other sensitive data. Once the data had been classified, appropriate security measures could be implemented to protect each category of data based on its level of sensitivity.

- *Data access control:* The second stage of the data control and protection scope of work involved reviewing the system's access control mechanisms to ensure that only authorized personnel had access to sensitive data. This included verifying that user accounts were properly authenticated and authorized to access specific data based on their roles and responsibilities within the organization.

- *Data transmission protection:* The next stage of the scope of work involved assessing the system's transmission mechanisms to ensure that data was securely transmitted between different components of the system. This included reviewing the use of encryption and other security protocols to protect data in transit.

- *Data storage protection:* The fourth stage involved reviewing the system's data storage mechanisms to ensure that sensitive data was securely stored and protected from unauthorized access. This included reviewing the use of encryption, access controls, and other security measures to protect data at rest.

- *Incident management:* The final stage of the data control and protection scope of work involved assessing the system's incident management procedures to ensure that the system was adequately prepared to respond to security incidents, such as data breaches or other security threats. This involved reviewing the system's incident response plans, incident reporting procedures, and other measures to ensure that security incidents were identified and resolved in a timely and effective manner.

Overall, the data control and protection scope of work was designed to ensure that sensitive data was adequately protected throughout the system's lifecycle. This involved reviewing the system's data collection, storage, processing, and transmission procedures to identify potential vulnerabilities and implement appropriate security measures to mitigate those risks.

The scope of work for the user control component of the assessment of AS

DZK includes several key areas. These areas are focused on ensuring that the system is secure and accessible only to authorized users, and that the users themselves are properly trained and understand their responsibilities in using the system.

The assessment of user control includes a review of the access control mechanisms implemented within AS DZK. This review ensures that users are properly authenticated and authorized to access the system, and that appropriate levels of access are granted based on the user's role and responsibilities. The assessment also examines the mechanisms in place for managing user accounts and access rights, including password policies and user activity logs.

Another area of focus for user control is user training and awareness. This component of the assessment evaluates the extent to which users are trained on the proper use of the system, including data entry, data retrieval, and data management. It also examines the user's understanding of their responsibilities in maintaining the security and confidentiality of the data stored within AS DZK.

The assessment of user control also includes a review of the procedures in place for managing user accounts and access rights. This includes the process for granting new user accounts, modifying existing user accounts, and terminating user accounts when necessary. It also examines the mechanisms in place for managing user passwords and access rights, including password policies and user activity logs.

Finally, the assessment of user control includes an evaluation of the mechanisms in place for monitoring user activity within AS DZK. This includes the use of audit logs and other monitoring tools to track user activity and identify potential security breaches. It also includes the mechanisms in place for responding to security incidents, including incident reporting procedures and incident response plans.

The scope of work for assessing the business processes of the AS DZK. The assessment of the AS DZK's business processes involved evaluating the system's ability to manage state land resources in accordance with Ukrainian legislation and industry best practices. This included examining the system's various functions and workflows, as well as assessing the quality and efficiency of these processes. The scope of work for this assessment included:

- *Business Process Analysis:* the assessment involved analyzing the existing business processes of the AS DZK. This involved reviewing the system's documentation, interviewing system users and stakeholders, and mapping out the system's workflows.

- *Process Evaluation:* The next step involved evaluating the efficiency and effectiveness of the system's business processes. This included assessing the accuracy and completeness of the data collected by the system, as well as evaluating the efficiency of the system's workflows.

- *Business Process Improvement:* Based on the results of the evaluation, recommendations were made for improving the AS DZK's business processes. This included proposing changes to existing workflows, identifying areas where automation could improve efficiency, and suggesting best practices for managing state land resources.

- *Implementation Planning:* Finally, the assessment included developing a general plan for implementing the recommended changes. This involved identifying the necessary resources and timelines required for implementing the changes, as well as identifying potential risks and challenges associated with the implementation.

The goal of this part of the assessment was to ensure that the AS DZK's business processes were aligned with Ukrainian legislation and industry best practices, and to identify opportunities for improving the efficiency and effectiveness of the system's workflows. By conducting a thorough evaluation of the system's business processes, the assessment provided a roadmap for optimizing the AS DZK's functionality and ensuring the effective management of state land resources in Ukraine.

The study of management of system developing business processes was conducted as part of the overall assessment of the AS DZK system. The goal of this study was to evaluate the effectiveness of the management of the system's business processes and identify opportunities for improvement.

The scope of work included a review of the current business processes and procedures related to the development of the AS DZK system, as well as an analysis of the project management approach used by the system development team. The study focused on the following areas:

- *Requirements management:* This involved an assessment of the processes and procedures used to gather, document, and manage user requirements for the system. The study evaluated whether the requirements were clear, complete, and consistent, and whether they were effectively communicated to the development team.

- *Change management:* This involved an assessment of the processes and procedures used to manage changes to the system during the development process. The study evaluated whether changes were properly documented, reviewed, and approved, and whether they were effectively communicated to all stakeholders.

- *Project management:* This involved an assessment of the project management approach used by the system development team. The study evaluated whether the team followed industry-standard project management methodologies, whether project schedules were realistic and achievable, and whether project risks were effectively managed.

- *Quality assurance:* This involved an assessment of the processes and procedures used to ensure the quality of the system. The study evaluated whether the team followed industry-standard quality assurance practices, whether testing was thorough and effective, and whether defects were properly tracked and resolved.

The results of the study provided insights into the strengths and weaknesses of the current management of the system developing business processes. The study identified several areas for improvement, including the need for better requirements management, more effective change management processes, and improved project management practices.

Overall, the study of management of system developing business processes was an important part of the assessment of the AS DZK system, as it provided critical insights into the effectiveness of the system development process. By identifying areas for improvement, the study can help the development team to optimize their processes and procedures, ultimately leading to a more efficient and effective system.

The scope of work for the assessment of IT-components included a comprehensive analysis of the IT infrastructure, network, servers, storage,

databases, cyber-security system, and workstations. The primary objective of this assessment was to evaluate the performance and reliability of the AS DZK system and identify any areas of concern that could impact its availability, security, or stability.

The IT-infrastructure of the AS DZK system was assessed by examining the design and architecture of the network and server environment. The evaluation included an analysis of the network topology, protocols, and bandwidth utilization to determine the capacity and scalability of the system. The assessment also analyzed the configuration and performance of servers and storage devices to ensure their reliability, availability, and fault tolerance.

The evaluation of the databases involved examining the design and architecture of the database schema and analyzing the performance of queries, transactions, and backups. The assessment also included an analysis of the data security and integrity controls to ensure that data was protected and secure.

The cyber-security system of the AS DZK was assessed to evaluate the system's ability to detect, prevent, and mitigate security breaches. The assessment included an analysis of the system's access controls, authentication mechanisms, and intrusion detection and prevention systems. The evaluation also examined the system's vulnerability management processes to identify and remediate any security risks. The evaluation included an analysis of the hardware specifications, operating systems, and software applications installed on the workstations. The assessment also analyzed the security controls, such as antivirus software and firewalls, to ensure that the operations were secure.

Overall, the assessment of IT-components was conducted to ensure the reliability, performance, and security of the AS DZK system. The assessment results provided recommendations to address any areas of concern and improve the system's overall performance and security posture.

During the assessment, special attention was paid to the state of cyber protection systems and data storage, which are critical in the operation of the system in general.

Cybersecurity component assessment scope of work involved an evaluation of the system's security architecture, policies, and procedures. The assessment aimed to identify potential security risks and vulnerabilities that could

compromise the confidentiality, integrity, and availability of system data. The cybersecurity assessment was conducted in several stages:

- Identification of system components and their potential security risks.
- Analysis of the security architecture of the system, including firewalls, intrusion detection systems, and other security measures.
- Evaluation of system policies and procedures related to security, including password policies, access controls, and incident management.
- Vulnerability scanning and analysis of security logs to detect and prevent security breaches.

Recommendations for improving the system's security posture, including implementing security patches, improving access controls, and enhancing user training.

The scope of work for the DBMS assessment included an analysis of the following areas:

- *Data structure and organization:* The assessment reviewed the organization and structure of the data stored in the database, including the data schema, tables, indexes, and constraints.
- *Data access and retrieval:* The assessment examined the methods used to retrieve and update data in the database, including SQL queries, stored procedures, and triggers.
- *Performance and scalability:* The assessment evaluated the performance of the DBMS under different load conditions and assessed its scalability to handle increasing amounts of data.
- *Security and access control:* The assessment analyzed the security measures implemented to protect the data stored in the database, including authentication, authorization, and auditing.
- *Backup and recovery:* The assessment reviewed the backup and recovery procedures in place to ensure the integrity and availability of the data in case of a system failure or disaster.

- *Maintenance and administration:* The assessment examined the tools and procedures used to manage and maintain the DBMS, including monitoring, tuning, and optimization.

- *Integration and interoperability:* The assessment evaluated the DBMS's ability to integrate with other systems and applications and its compliance with industry standards.

Overall, the assessment aimed to identify any vulnerabilities or weaknesses in the DBMS and recommend improvements to enhance its performance, security, and reliability. The results of the assessment provided valuable insights to the system developers and administrators helping make relevant improvement to current system's DBMS issues.

Storage system assessment scope of work involved an evaluation of the system's data storage architecture and practices. The assessment aimed to identify potential data loss risks and vulnerabilities that could compromise the integrity and availability of system data. The storage assessment was conducted in several stages:

- Identification of the data storage components and their potential risks, including physical and logical risks.

- Analysis of the storage architecture of the system, including the types of storage, the level of redundancy, and backup and recovery processes.

- Evaluation of system policies and procedures related to data storage, including data retention policies and data access controls.

- Testing of the system's backup and recovery procedures to ensure they were effective and up-to-date.

Recommendations for improving the system's data storage practices, including implementing data replication and increasing redundancy levels, enhancing data backup and recovery procedures, and ensuring data access controls are properly enforced.

The scope of work for the legislative gap analysis focused on evaluating the compliance of the current functionality of the AS DZK with the existing legislation. This involved a detailed review of relevant legal and regulatory

requirements, including any recent updates or changes.

During the analysis, any areas of non-compliance or potential legal risks were identified and documented. Recommendations were then made for remediation, where appropriate, to ensure that the system is fully compliant with all relevant legal and regulatory requirements.

The scope of the analysis also included a review of any upcoming legislative changes that may impact the AS DZK. This involved a review of proposed legislation and consultation with legal experts to identify any potential impact on the system's functionality or operations.

Overall, the scope of the legislative gap analysis aimed to identify any areas of non-compliance or legal risks and provide recommendations for remediation to ensure the AS DZK remains fully compliant with all relevant legislation and regulations.

The Technical Assessment was completed within the prescribed timeline and produced a detailed report that presents the findings, conclusions, and recommendations. The report was presented to the leadership of the StateGeoCadastre and the Ministry of Agrarian Policy and Food of Ukraine on February 21, 2023. Full report was officially handed over to the StateGeoCadastre, and its findings and recommendations will serve as a guide for the future development and enhancement of the AS DZK.

The Technical Assessment was a critical step towards achieving the goal of supporting transparent land governance in Ukraine. It provided a comprehensive evaluation of the State Land Cadastre's automated system and identified areas that require improvement. The Technical Assessment's findings and recommendations will serve as a roadmap for future initiatives aimed at enhancing the AS DZK and improving land governance in Ukraine.

II. KEY FINDINGS

The Information and Telecommunications System "Automated State Land Cadastre System" - AS DZK, as a software and hardware complex created more than 10 years ago (and at one time became a revolutionary breakthrough in the automation of the country's land management processes and its interaction with citizens), needs urgent restoration and replacement important parts and components of software and infrastructure. The system provides a certain level of stability, but does not meet most of the controllability, safety and efficiency criteria, which in turn increases the level of risks of functioning and compliance with the goals and objectives of its existence. The study highlights the systemic weaknesses and vulnerabilities found in the IT infrastructure. The main report shows that SLC has several weaknesses in its infrastructure that make it vulnerable to attack, including:

- *Access Control and Authentication Mechanisms* – The system lacks adequate access control and authentication mechanisms, including multi-factor authentication and the principle of least privilege. This may lead to unauthorized access to confidential information;

- *Encryption* – lack of robust encryption policies for sensitive data at rest and in transit, leaving data vulnerable in the event of a security breach or data breach;

- *Software updates and patch management* – lack of a proper software update and patch management process, which could lead to vulnerabilities exploitable by attackers;

- *Monitoring and logging* — the system lacks proper monitoring and logging of system actions, which makes it difficult to identify security incidents and respond to them in a timely manner;

- *Network security* – lack of network segmentation, strong password policies and secure remote access leading to unauthorized network access and data leakage;

- *Data storage and loss prevention*. The report identified a lack of proper data storage and loss prevention mechanisms as a vulnerability. The study found that the system lacked robust data backup policies and

procedures, which could have resulted in data loss in the event of system failures or accidents. Also, there is no proper process to prevent data loss due to accidental or intentional deletion. The transformation plan recommends data validation and the implementation of data backup policies and procedures, as well as data loss prevention management processes, to ensure data availability and integrity;

- *Hardware infrastructure* – weaknesses in the hardware infrastructure are identified as vulnerabilities. The study found that the organization was using outdated equipment, which could lead to equipment failures and system downtime. In addition, there is no proper plan for equipment replacement and maintenance, which can lead to prolonged system downtime and data loss. The report recommends updating the hardware infrastructure and implementing a proper equipment replacement and maintenance plan to minimize the risks associated with equipment failure.

Based on the assessment, several deficiencies and defects may critically threaten the integrity of the SLC system. These include:

- *Data quality issues*: The data in the system is inconsistent, incomplete, and inaccurate, which hinders the effectiveness of the system in managing land resources.

- *Lack of integration*: The system lacks integration with other relevant systems, which limits its overall effectiveness.

- *Poor performance*: The system's performance is slow, especially when handling large amounts of data, which affects the user experience and overall efficiency.

- *Security vulnerabilities*: The system has security vulnerabilities that could be exploited by unauthorized users, putting confidential data at risk.

- *Lack of scalability*: The system lacks scalability, which makes it difficult to adapt to changing business needs and increased demand.

- *Compliance issues*: The system's current functionality is not fully compliant with current legislation, which poses a risk of non-compliance

and potential legal issues.

Therefore, the Assessment expert team recommends the State Service of Ukraine for Geodesy, Cartography and Cadastre to revise its management policy of the automated complex of the AS DZK, in accordance with the observations of this study, and at the strategic level to make a decision on the further direction of the development of automated land management systems as a more important tool for the implementation of state policy in the field of land relations (in accordance with the Regulation on the State Service of Ukraine on Geodesy, Cartography and Cadastre (CMU Resolution No. 15 of 14.01.15 with amendments) and to determine the strategy of system development in the long term, based on the use of the latest technologies inherent in systems of this level complexity and national importance. The involvement of external expert teams, with the support of partner organizations, increases the objectivity of state assessments and improves the quality of changes.

The transformation of AS DZK is of crucial importance for several reasons. Firstly, the current system has several shortcomings and lacks in terms of technical capabilities, data security, and compliance with current legislation. These deficiencies can lead to inefficiencies, inaccuracies, and even corruption in the management of state land resources, which can have a significant impact on the economy, environment, and society as a whole.

Secondly, the transformation of AS DZK can bring significant benefits to the government, businesses, and citizens. With an improved and modernized system, the government can better manage state land resources, increase transparency, and reduce corruption. Businesses can benefit from streamlined procedures, more accurate data, and easier access to information. Citizens can also benefit from increased transparency, better land management, and more equitable access to land resources.

Furthermore, the transformation of AS DZK can also have broader implications for the Ukrainian society. A modernized and efficient system can contribute to the country's economic development, attract foreign investment, and increase public trust in government institutions. It can also have positive environmental impacts by enabling better management of land resources, reducing illegal land use, and promoting sustainable development.

In summary, the transformation of AS DZK is essential for improving the management of state land resources, increasing transparency and reducing corruption, and promoting economic, social, and environmental development in Ukraine.

Thus, with a sufficient level of process-management and resources, the AS DZK can be completely modernized in a 2-year period without stopping the operation and maintaining the current level of service for users.

III. RISKS ANALYSIS

The general architecture of the system (hardware and software) AS DZK was created as a modern system for more than 10 years. During the entire period of operation of the system, the system was not upgraded with a revision of the architecture, components, technologies and processes, which led to the following disadvantages:

- no online backup (synchronous) copies of the system: backup is performed once every 2 weeks for equipment in another data center and once every 2 weeks for cloud storage;
- lack of a unified system architecture (there are no standardized modules for the same tasks, requirements for improvements, data storage, data access);
- use of various types of databases (Oracle, PostgreSQL, MySQL, MongoDB);
- outdated equipment not supported by the manufacturer (Hitachi storage systems, Cisco network infrastructure, Cisco cyber security systems etc.);
- outdated software for servers, virtualization systems, databases (microcode for data storage systems, servers, Windows, Linux operating systems, VMware virtualization systems, Oracle databases);
- lack of distribution of roles in setting, analysis, implementation and control in the processes of software and services development;
- lack of comprehensive threat prevention and incident tracking systems (cyber security, equipment status, a unified system for updating firmware, software versions, etc.);
- non-compliance of the functionality with the legislation of Ukraine (77 functions were not implemented as of February 17, 2022).

In addition, the assessment identified serious vulnerabilities in terms of anti-corruption legislation, namely:

- lack of a unified authentication system using digital signature for all users of the system;
- lack of encryption of the system databases;
- lack of a complete history of all changes made to the system;
- lack of control over the activities of cadastral registrars in the system.

All this leads to the potential for abuse by the personnel involved in the operation of the system, such as the introduction of deliberately incorrect data on land plots or their owners.

The possibility of making uncontrolled changes to the system, the lack of monitoring of the actions of Registrars - all this has a negative impact on the perception of services and lowers confidence in the system.

Based on the assessment of the AS DZK system, risks can be categorized into several areas:

- *Technical risks:* These risks are related to the system's technical components, such as hardware, software, and infrastructure. Some potential technical risks include system failures, data loss, cyber-attacks, and hardware malfunctions.
- *Security risks:* The AS DZK system holds sensitive information about land resources, so security risks are critical. These risks include unauthorized access to the system, hacking, data breaches, and data theft.
- *Operational risks:* These risks are related to the operation and management of the system. For example, insufficient resources to support the system, inadequate training for system users, or inefficient business processes.
- *Legal risks:* The AS DZK system must comply with legal regulations and requirements. Non-compliance with legal requirements can lead to legal actions, penalties, or fines.

The independent technical assessment team considers that in its current state the system doesn’t meet the modern criteria of manageability, security, and efficiency. If no actions are taken, the operational risks for the SGC will further

escalate, compromising compliance of the cadastral system with its legislative and policy requirements, and the growing needs of the country in the quality geo- and cartographic data.

The critical state of the system carries great risks of the data loss (which is especially a threat for the citizens of the occupied territories where paper records were lost/destroyed due to hostilities), errors in the SLC, delays in updating and potential fraud. A failing system will undermine public trust in the integrity and reliability of the State Land Cadastre. Finally, a weak cadastral system will affect also post-war reconstruction.

Based on the assessment of the AS DZK, several recommendations have been identified to improve the system's performance and reduce the risks associated with its operations. The recommendations cover a wide range of areas, including:

- *System architecture:* The system architecture needs to be reviewed and updated to ensure that it is scalable, flexible, and able to meet the changing needs of the users. This will require a comprehensive review of the existing infrastructure and the development of a roadmap for future upgrades and enhancements.

- *Cybersecurity:* The system's cybersecurity measures need to be improved to protect against the growing threat of cyber-attacks. This includes the implementation of advanced authentication and access control mechanisms, regular security audits, and the deployment of intrusion detection and prevention systems.

- *Data management:* The system's data management practices need to be improved to ensure the accuracy, completeness, and security of the data. This includes the implementation of data backup and recovery procedures, regular data quality checks, and the development of data retention policies.

- *User training:* The system's users need to be trained on the proper use of the system to maximize its effectiveness and minimize the risks associated with its operation. This includes providing regular training sessions, developing user manuals and guidelines, and conducting regular user surveys to identify areas for improvement.

- *Legal compliance:* The system needs to be reviewed to ensure that it is

compliant with current legislation, regulations, and standards. This includes the development of policies and procedures to ensure legal compliance, regular legal compliance reviews, and the implementation of best practices for legal compliance.

- *Governance and management*: The system's governance and management practices need to be improved to ensure that it is effectively managed and controlled. This includes the development of a comprehensive governance framework, the establishment of clear roles and responsibilities, and the implementation of effective performance monitoring and reporting mechanisms.

Addressing these recommendations will help improve the AS DZK system and ensure its effective functioning in the future.

IV. RECOMMENDATIONS

The independent Technical Assessment Team concluded that AS DZK is outdated and, requires redesign, reengineering and redeployment which can be completed within 2 years. The team recommends:

- introducing a service-oriented system architecture and functional model,
- restricting access of technical personnel to data,
- implementing an audit system,
- improving the system development and support procedures,
- introducing unified access to the system via qualified electronic signature,
- strengthening backup procedures,
- ensuring compliance with legislation.

In addition, the Assessment Team recommends modernization of the basic elements of the IT infrastructure, including the database management system, storage system, network infrastructure, logging system, network management system and virtual environment.

Minimum recommendations to keep the system up and running for the next 2 years:

- install a new storage system for the main data array,
- update VMware virtualization software,
- update the Commvault backup software,
- provide support for equipment that is not repaired or serviced by the manufacturer.

The system transformation can be done without disrupting the ongoing functioning of the State Land Cadastre while the system is reengineered, but which is conditional on immediate restoration and replacement of key SW and infrastructure parts to prevent the risks of cadastral data loss, ends procedures

and loopholes that undermine data integrity and trust in the system, significantly reduces the risks of cyber-attacks, and maintain service continuity A comprehensive disaster recovery plan should also be in place as soon as possible.

V. TRANSFORMATION PLAN

The Assessment Team suggested a Transformation Plan embracing 3 phases: (1) Planning & Immediate actions; (2) Development and Organizational Transformation; (3) Transition & Launch, preceded by SGC agreeing to and meeting a series of preconditions. The Transformation Plan includes several key recommendations, such as changing the system architecture and functional model, limiting access to technical personnel data, implementing an audit system, and changing the development and implementation procedure. Another recommendation includes unifying access to the system, strengthening backup procedures, and improving compliance with legislation. Additionally, the plan calls for modernization and updates to various elements of the IT infrastructure, including the database management system, storage system, network infrastructure, and logging system. Finally, the plan includes the creation of a disaster recovery plan and updates to the network management system and virtual environment.

PRECONDITIONS

As soon as the strategic decision towards SLC system reengineering of AS DZK, several preconditions must be met before investments with support of the EU can start. This includes data validation and creation of a reserve copy of the system to reduce the risks. These preconditions are:

1. High-level transformation roadmap approved by the SGC management.

2. Establishment of an Oversight body (Working Group - WG) in SGC to support the development and implementation of the detailed transformation plan.

3. Decision-making and approval of the data integrity check plan and their validation.

4. Development and approval of high-level terms of reference for AS DZK reengineering using the best industry standards, unified enterprise platforms, service-oriented model and cloud technologies, which will provide the necessary level of security and significantly increase the system's efficiency.

5. Approve creation of a backup copy of AS DZK at the National Centre for Reserving State Information Resources or any other 3rd party protected

government site.

6. Establishment of a project support team to manage the DZK transformation, create detailed technical documentation for system reengineering and data migration, and address in-time any emerging technical or organizational issues that could impact system functionality or result in significant delays for the system design.

PHASE 1: IMMEDIATE ACTIONS TO SECURE SYSTEM AND PLANNING OF SYSTEM REENGINEERING

Upon meeting the preconditions, firstly immediate investments will be required to (i) replace critical hardware elements to prevent SLC collapse, (ii) secure service contracts with IT providers; (iii) update SW licenses; (iv) validate and back up all the relevant data.

Secondly, development and approval of a detailed ToR for the system's re-engineering which will include requirements and other specifications for the software and hardware platform, its architecture and functional model, approaches to system development, the choice of platforms and development tools, as well as the requirements for the IT infrastructure to be deployed.

PHASE 2: DEVELOPMENT AND ORGANIZATION TRANSFORMATION

During this phase (i) the new Cadastre system will be developed based on the detailed TOR along with GIS module, mapping, SW, equipment, database, security, activity logging, online services, security services & others; (ii) the relevant IT infrastructure will be created based on the approved system requirements (on-prem/cloud/hybrid) with further deployment; (iii) SGC/DZK staff will be trained in using the new system; (iv) data migration will prepared; (v) relevant organizational, normative and/or legislative changes will be drafted and adopted.

PHASE 3: TRANSITION & LAUNCH

Activities implemented during the third stage are (i) comprehensive testing of the system; (ii) fixing gaps & shortcomings; (iii) data checked & historical data

upgraded, API integrated; (iv) final testing and checking the integrity of the system done; (v) new system launched in productive environment.

RISK MITIGATION

Changes in the system management business process, as well as the creation of a competence centre (project group / RST) within the SGC will allow managing the process of development, launch and support of the new system.

The transformation plan includes risk mitigation strategies, contingency plans, staff training and change management initiatives. In addition, it is important to ensure adequate funding, develop robust cybersecurity policies and protocols, and ensure compliance with land management legislation. In particular, during the implementation of the transformation plan, the following risks should be taken into account for its successful implementation:

- Disruption of the system during major repairs and reconstruction;
- Cyber security risks: data leakage attempts, hacker attacks and malware attacks;
- Risk of fraud, corruption and data inconsistencies during system migration and deployment;
- Delays in the implementation of legislative requirements, leading to legal problems and damage to the reputation of SGC and land reform in general;
- Budgetary restrictions leading to disruptions and project sustainability;
- Lack of qualified and well-trained personnel to support the functionality and reliability of the system;
- Resistance of system users and stakeholders to changes and processes of the new system.

System failures during the overhaul and reconstruction process are minimized by adopting a phased approach to the transformation process that ensures the system remains operational throughout. Cyber security risks are reduced by implementing modern cyber security policies and protocols, which will be built into the solution architecture itself. The risk of fraud, corruption and data

inconsistency during system transition and deployment is minimized by developing and implementing a data integrity plan that includes procedures for inventorying and verifying data to ensure its accuracy and integrity and creating necessary backups. Delays in complying with legal requirements should be minimized by developing and implementing a comprehensive compliance plan, working closely with legal experts to ensure compliance with all relevant laws and regulations. Budget constraints are minimized by involving international partners in the development and implementation of a stable financing plan, which includes the identification of potential sources of financing, the creation of a realistic budget, as well as regular monitoring and reporting of the project's financial indicators. The risk of a lack of qualified and well-trained personnel to support the functionality and reliability of the system is mitigated by the creation of an additional technical project support group. The resistance of system users and stakeholders to the changes and processes of the new system is minimized by implementing project implementation monitoring mechanisms, as well as supporting the coordination with management bodies (StateGeoCadastre, the Ministry of Agrarian Policy and Food of Ukraine on February) of the change management plan, which includes the identification of potential resistance factors, the development of communication strategies, involvement and implementation regular consultations with stakeholders throughout the transformation process.

VI. FINAL CONCLUSION

The main conclusion of the independent Technical Assessment is that reengineering the AS DZK is inevitable to address significant deficiencies in its architecture, business processes, and software that can no longer be fixed within the existing, outdated system. It is recommended to change the SLC system architecture and functional model, strengthen backup procedures, improving anti-corruption and functional compliance of the system. New architecture and functional model will improve system's manageability, process efficiency, cybersecurity and backup procedures, and legislation compliance.

Before the transformation can start, several preconditions must be fulfilled, including approval of the high-level roadmap (Transformation Plan) and TOR for system redesign; establishing a high-level oversight body for the transformation process (Working Group) and a technical project implementation team; completing validation of data & preparing of a backup; development and approval of the system continuity/ risk mitigation plan.

The transformation process can be completed within 2 years if the above preconditions (including strategic, organizational, and technical requirements) are met, and the risks are managed properly.