

Collaborative Block-chain Solution for National eLogistics Systems Connectivity and Data Pipelines in the East-West Transport Corridor

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Abstract—*The innovative approach for the formation of Data Pipelines and connectivity of national eLogistics systems was proposed for the countries participating in the East-West Transport corridors. The concept of digital transport corridors (DTC) was considered and based on creation of federated network of eLogistics platforms. The main requirements to DTC Data Pipelines were analyzed and the collaborative block chain solution was developed to enable digital trust and secure data exchange between the participants of international supply chains in the East-West transport corridors. The application of the proposed solution was demonstrated for digitalization of the transport corridor between GUAM countries, namely – Azerbaijan, Georgia and Ukraine. The digital infrastructure for this corridor can be built on the base of blockchain nodes hosted in the national eLogistics platforms of GUAM countries. The core functional features and requirements were formulated for GUAM corridor Data Pipeline.*

Keywords—*data pipelines for supply chains, digital transport corridors, blockchain technologies, national eLogistics systems*

I. INTRODUCTION

In 2011 UN/CEFACT experts proposed the Data Pipeline concept as the innovative solution to provide supply chain participants with high quality data exchange for cross-border transactions. Such concept was based on results from three EU projects CASSANDRA, CORE and SELIS [1].

Data Pipeline was considered to be a web-based IT infrastructure that could enable the seamless integration of all data elements from the different sources in the supply chain. The Data Pipeline offers an innovative approach to the exchange of data throughout the international supply chain, as a prerequisite to further establishing secure and reliable supply networks, for business and government.

Data Pipeline core principles are considered to be as follows:

- Original trade data (usually supplied by the consignor) are gathered and shared and can be used by authorized parties in the logistics network to improve their operations;

- Parties participating in a supply chain provide data that can be of relevant to other supply-chain parties in a shared information space;
- Synchronization points (e.g. blockchain nodes) that determine in the integrated data pipeline how shared information can be available to parties in international transactions.

Using Data Pipeline approach in 2015 the concept of digital transport corridors (DTC) was developed by the expert community of Eastern Partnership (EaP) countries in the course of the EU initiative for Harmonization of Digital Markets (HDM initiative). DTC concept is based on the creation of federated network of platforms, which integrates information resources of the participants of international transport corridor to create Data Pipeline for multi-modal cargo transportation. DTC network can provide different services for business and government thus enabling more effective transit, control & monitoring of transcontinental cargo flows via the territories of the EU and EaP countries.

To implement such concept DTC is to be composed of national multimodal eLogistics systems built on the core integration platforms capable to serve multimodal cargo shipments via sea, railway, road and air transportation in the participating countries.

Such platforms are considered to become Building Blocks of digital infrastructure which can be developed for the effective digitalization of international supply chains and cargo transportation via main East-West transport corridors. China National Transport and Logistics Information Platform LOGINK can be taken as one of the most famous and functional example of eLogistics systems. In 2018-2019 the countries of Eurasian Economic Union (EAEU) has developed the concept of DTC ecosystem focused on integration and seamless connectivity of national eLogistics systems in the participating countries.

To provide such connectivity and the proper level of digital trust and security the main requirements to DTC Data Pipeline are considered to be as follows:

- Authorization, identification and authentication of DTC participants;
- Cross-border and interstate transmission of validated data;
- Data protection against modifications;
- Operational and long-term data storage with confidentiality.

The above requirements can be met by building DTC Data Pipeline on the base of the corporate blockchain solution which can take on the role of a mechanism for enabling digital trust between the participants of East-West transport corridors. The application of the proposed solution will be demonstrated for digitalization of the transport corridor between GUAM countries, namely – Azerbaijan, Georgia and Ukraine.

II. CORE PARTICIPANTS OF EAST-WEST TRANSPORT CORRIDORS IN GUAM COUNTRIES

The general composition of supply chain participants in the East-West countries potentially interested in the digitalization of transport corridors in the GUAM countries is presented in the following list:

- Consignor / Shipper
- Consignee
- Freight forwarder
- Stevedore / transport terminal operator
- Carrier
- Carrier agent
- Warehouse / logistics center operator
- Importer
- Exporter
- Customs agent/declarant
- Transport infrastructure operators (maritime, railway, automobile, aviation)
- Transport inspection and traffic police bodies
- Customs
- Border authorities
- Food and quarantine authorities
- Seaport / Airport Operators

In accordance with this list, the core users of the GUAM transport corridor are considered to be ports, shipping companies, forwarders, shippers, road, rail and air transport companies, as well as government agencies. Corporate information logistics systems of users of the GUAM countries can be integrated with the national eLogistics systems in their countries to automatically import/pull data, which significantly reduces the cost of information exchange. In the course of digitalization of GUAM transport corridor, the consolidating task of creating a unified information environment of digital trust between participants in business processes shall be solved, which allows remote conclusion and execution of smart contracts, the formation of electronic transportation and shipping documents, their storage and exchange by DTC users.

III. COLLABORATIVE BLOCKCHAIN SOLUTION FOR GUAM CORRIDOR DATA PIPELINE

When developing an appropriate solution, it is necessary to take into account the position of the GUAM member states on the protection of critical trade and transport information and digital sovereignty. The state bodies of the EU and Eastern Partnership countries are not ready yet to recognize the operation of cryptographic facilities of other states on their territories, or to export their own cryptography. At the same time, the GUAM member states have not yet developed well-developed mechanisms for resolving the problems of litigation on transport and logistics transactions based on electronic documents from various jurisdictions. As a standard approach to solve the above problems, developers of eLogistics platforms can use services of a Trusted Third Party, which is capable of providing cross-border information interaction between the parties. But this solution is not exhaustive for the requirements imposed by Data Pipeline principles and latest EU regulations for electronic freight transport (eFTI) data exchange [2].

In addition, in the process of transportation activities in the international transport corridors the large flow of technological level information can be generated from IoT devices - electronic seals, smart containers, IoT and RFID sensors accompanying cargo units. The transactions of this data will also require online validation, not only at the technological and national levels, but also when transferred to a unified trust environment of the GUAM digital transport corridor for monitoring and managing international supply chains. As a result, when creating a regional DTC, it seems appropriate to ensure the provision of legally significant electronic documents and data transactions from both legal entities and individuals, and from IoT "inanimate devices".

Modern views on the creation of the unified digital trust environment for GUAM DTC participants primarily involve the exchange of validated data, and only in a number of necessary cases it is required to provide information in the form of electronic legally significant documents. In this respect it is important to identify and authenticate GUAM DTC users, in order to exclude their anonymity and to give them the appropriate authority to carry out specific actions. In this regard, when developing a conceptual solution, approaches were considered for organizing cross-border information interaction and creating an environment of trust in the GUAM corridor data pipeline based on modern blockchain technologies. In of the above analysis, it was concluded that the solution for authorization, identification and authentication of GUAM users as well as for the cross-border transmission of validated data and protection against their modification can be effectively achieved using a GUAM DTC corporate key infrastructure (Public Key Infrastructure - PKI). Such infrastructure can be built on the base of blockchain nodes hosted in the national eLogistics platforms of GUAM countries, hereinafter referred to as Logistics Block Nodes (LBN). The schematic structure of building a GUAM corridor data pipeline based on typical LBN network located in the participating countries is shown in Fig. 1.

It is advisable to build such an infrastructure using blockchain technologies based on the well-known Hyperledger Fabric platform [3]. This specialized PKI infrastructure is able to create the trust environment for participants of international transport information exchange, as well as to implement on this basis a service infrastructure

compatible with the European Blockchain Services Infrastructure (EBSI), which is actively developed in the EU countries. This decision is also in good compliance with the requirements of the new EU eFTI regulations in the field of electronic freight transport information.

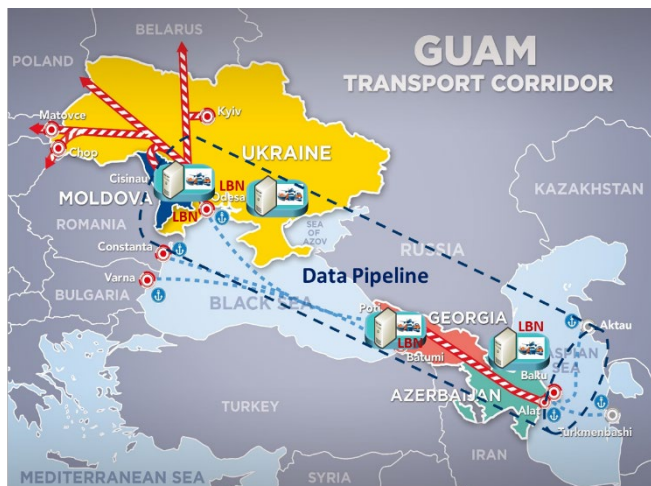


Fig.1 Data pipeline for GUAM transport corridor

IV. CORE FUNCTIONAL FEATURES AND REQUIREMENTS FOR GUAM CORRIDOR DATA PIPELINE

When developing functional requirements for the GUAM corridor data pipeline, the best practices of building information logistics systems in the countries of the Asia-Pacific region (China, Japan, South Korea, Singapore, etc.) was taken into account, as well as the results of relevant projects of the EU countries to create information systems for the European network of transport corridors TEN-T [4]. As a result of such analysis, the following main functions of the regional GUAM corridor data pipeline were formulated:

- data capture and analysis in GUAM transport corridor for their subsequent collective use and exchange in order to increase the efficiency of interaction of all participants in logistics processes and making management decisions;
- ensuring the interoperability of processes and systems used by various modes of transport (multimodality);
- unification of standards for the exchange of logistics data based on the exchange of standardized electronic documents and structured data.

In this case, the list of functional requirements for the GUAM DTC may include the following bullet points:

- 1) ensuring the digital sovereignty, quality and integrity of data;
- 2) ensuring information security and digital trust;
- 3) collection, storage and processing of initial data received from participants of multimodal transport and logistics processes for the subsequent exchange of structured data packages and exchange of standardized electronic documents;
- 4) providing visibility of supply chains, including monitoring of national transport infrastructure, logistics processes and cargo tracking;
- 5) communication and interaction with technological information systems used by various modes of transport;
- 6) interaction with cross-border platforms and international networks such as FENIX [5] in the EU and NEAL-NET[6] in the countries of North-East Asia;
- 7) authorization and user management with an appropriate set of client services;
- 8) supply chain management and information processes with an appropriate set of analytical services;
- 9) information support of transport, logistics and import-export processes with an appropriate range of services for the public and private sectors.

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