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Big Data Empowered Logistics Services Platform

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Big Data Empowered Logistics Services Platform

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Abstract: Logistics section is one of the most important industrial sections to contribute to European economy. To improving efficiency and energy efficient of logistics, European Commission call new research theme 'smart, green and integrated transport' in its H2020 program. The paper presents a version on providing a cloud based platform for supporting big data empowered logistics services to respond this call. The research is supported by inter-disciplinary approaches, which brings experts from telecommunication, cloud computing, sensor networking, service-oriented computing, data analysis, transportation, and logistics areas to work together to provide real-world solutions for future logistics. The research questions and challenges of the platform are highlighted. Overall architecture and data collection are presented.

1. Introduction

Logistics has been identified as one of the most important and visible contributors to European competitiveness and sustainability targets. Logistics and supply chain management in Europe need to improve in efficiency, be more energy efficient, and have less negative impact on the environment. To improve overall efficiency, a number of major steps within the logistics can be taken to improve the technology for sharing logistics information for interconnected supply chain planning and execution. New data mining capabilities need to be developed to deal with data flood for logistics decision making. A European logistics information sharing architecture, combined with open systems would speed up forming of single logistics information space in pan-European logistics applications.

From a logistics perspective, a significant challenge is how to optimise supply chain processes and decisions as well as transportation processes and decisions. Effective supply chain management uses data from different information systems beyond supply chain management systems and transportation systems. In systems supporting this management, there are different user requirements which vary from long term, strategic performance indicators; to highly dynamic operational transport characteristics; to different environmental performance indicators; to different business models; and to different deployment trajectories.

In the context of transportation, all models of transport, land based, sea and air, domestic and international are need to be considered. Particular attention should be paid on intercontinental standards, to protect and enhance Europe's gateways. The performance measurement from different transportation systems should eventually influence long term transport policy and reflect users' needs.

Within different supply chain networks, international supply chains may need to be optimised and integrated with transportation management systems. For example, logistics service providers may not only take care of delivery and collection, but also take a role such as for stocking parts for suppliers/manufacturers for establishing in real time the best supply chain and/or transport network that mitigate the effect of a given situation (such as a given disruption).

Currently, fierce competition among logistics service providers limits the desire and opportunity to share and communicate data among different stakeholders. The trends of (mainly vertical) coordination, collaboration, competition and data sharing within the logistics service sector require a new services platform. Acquiring targeted, consistent and homogeneous data and information enables proper assessment of existing problems and can improve efficiency, sustainability, and resiliency of logistics services. Understanding the demand of logistics services and even more being able to anticipate or influence would help to create more efficient new logistics business models.

The proposed project (big Data Empowered Logistics Services Platform: DELOS) focuses on developing and implementing ICT infrastructure for exchanging data/information among different stakeholders for supporting decision making and planning, increasing load factor for all transport modes, collaborating and cooperating supply chains, realising horizontal collaboration in logistics networks and supply chains among different stakeholders. The design principles of the proposed platform are based on service oriented architecture, cloud automation, big data empowered analysis, and systems-of-systems engineering focussing on the following research questions:

- How to make logistic process more efficient in terms of using existing computing, spatial, and planning technologies as well as organisation strategies?
- How to make transportation more efficient and environmental friendly using nascent technologies?

The structure of the paper is as follows: issues related to communication addressed by logistics theme are present in Section 2. Our vision on DELOS project is address in Section 3. Overall architecture of the DELOS platform is described in Section 4. An example how the architecture is used in specific situation is also provided. Related work is discussed in Section 5. The paper is ended with the conclusion.

2. Issues Related to Communication Addressed by the Logistics Theme

There are two types of issues related to telecommunication in the logistic theme. *One issue* is mobile communications for secured information exchange among actors (users, service providers, operators, communities) paying particular attention to the role of the driver and the vehicle as part of the vehicle to infrastructure architecture. *Another issue* is relate to provision of position and spatial information

regarding goods on the move through European GNSS applications, RFID and 3G/4G (and future network development) services.

To address the first issue, The DELOS project clearly focuses on the establishment of a choreographed DELOS platform and Suite of Services that aims to access, monitor, measure, and deploy logistic related services and processes. This works by making existing databases and different communication systems interoperable through an ontological and interoperable reference architecture through related APIs. The DELOS platform enables interoperation between various supply chains, actors, communication networks, information platforms, and transport systems. In particular, the platform will expose and explore the use of V2V (vehicle to vehicle) and V2I (vehicle to infrastructure) in the improvement of freight operations.

The DELOS addresses the second issue. The DELOS project will make maximum use of existing and nascent spatial technologies to enable optimal logistical processes. The suite of services provided will include linking systems such as GALILEO to logistics, to track and trace cargo; RFID, wireless sensor nodes to monitor cargos, to improve performance of the freight transport, and to security containers; and 3G/4G networks to improve communication among logistics partners. To enable real time optimization, the DELOS project thus needs to define standard communication protocols for inter-device/system communications and standard interface specifications for rapid connections between logistics entities as well as the Cloud platform. This can take benefit of (and contribute to) the on-going efforts on future 5G communication systems where D2D (Device to Device) communications have to play an important role. Moreover, throughout the technical design of the platform and services, mobile access of service information and loosely coupled web-services logistics performance indicators reach out faster, more effective and efficiently to decision makers in industry and governmental institutions.

3. Vision of DELOS

The vision of the proposed project is to achieve a fully integrated logistics information platform with the right quality, reliable content, freight flows in pan-European operations, and activities that allow different logistics services related providers and customers to access. The proposed platform provides a single space for logistics related data, information, services, and policies. In addition it also supports the formation and execution of new supply networks for efficient and sustainable logistics in Europe. To achieve this, a number of scientific and technological challenges need to be addressed:

- Standardizing description languages for services in the logistics sector. The research also aims to design and build an ontological reference framework for supporting interoperation among different logistics and transportation related ontologies.
- A platform as the backbone for the federated cloud control, data, service and process government, and service lifecycle. Its functions thus include the initial service modelling and annotation according to the standardized description model, the engineering and deployment infrastructure, and runtime perspectives such as service discovery, provision and monitoring.
- The ease of service consumption is critical for the success of the service platform (including in its role as an overall single logistics information source). The platform provides data mining and analytic abilities for supporting logistics decision making.
- Community supports learning-by-example – For many end users, it is difficult to start to create a collaborative process model from scratch. The proposed platform is delivering living examples. The learning by examples style is common in a community environment.

Achieving a cleaner and more efficient logistics system requires a better integration of supply chain management systems and transport systems. This allows different stakeholders such as suppliers, manufacturers, logistics providers and retailers, provide their logistics services, data, information, and performance assessment frameworks. The full usage of such logistics platforms depends on the development of the capabilities of logistics services, data accuracy, assessment framework quality and qualities. As with any new platform, the platform will allow for further, novel and creative ways to combine services, data and performance indicators to be discovered.

4. Architecture of DELOS

To build DELOS, there are many high level services need to be provided for full functions of logistics services. Related to the telecommunication, the lower level, big data logistics data and resources cloud layer, is provided in Figure 1.

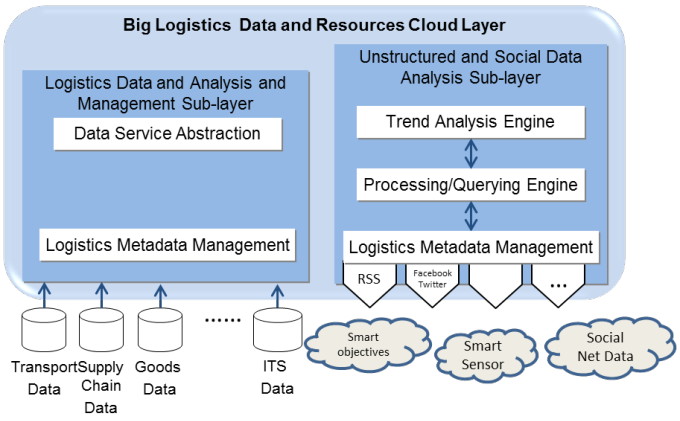

Figure 1: Big Logistics data and Resources Cloud Layer

Figure 1 shows the collections of different data, which collects from different communication devices and sensors. There are (Web) services need to be defined according to standard communication protocols for inter-device/system communications and standard interface specifications for rapid connections. Different services are included the linking between the GALILEO system to the cloud platform as well as logistics entities. The sensors which deployed in different cargos needs to connect to the data layer of the platform. Different RFID and wireless sensor deployed for monitoring cargos or other logistics processes. It is also important to support and secured 3G/4G networks existed in logistics network. The on-going efforts on future 5G communication systems between D2D (Device to Device) should also be considered. Analysing data from different resources could improve the performance of the freight transport, monitoring data could security the processes.

The DELOS project solves the communication security issue from three perspectives. Firstly, it aims to develop simple to use tools as services for access and storage in security, privacy, and trust ways to high velocity, variety and volume's data, such as inflow of sensor information. The developed tools are treated as parts of the DELOS platform services and are registered in the DELOS platform logistics service repository. Secondly, to enable resilience, scalability and continuity the logistics services are distributed within cloud environments. The federated cloud control of the DELOS

platform supports scalable issues for accessing big data as well as improving data process services. Standardisation in data collection and storage approaches is necessary to allow for distributed processing. Thirdly, finding the right business models, legislative frameworks and standardized processes allows for sharing and using data among customers, authorities of international transport and trade.

Example: Forming Collaborative Production Distribution Network for Automobile Manufacturers

For end customers, it makes no difference whether products of one manufacturer are delivered together with the production of other manufacturers. Carriers today are however not capable of ensuring efficient service of logistics chains of two or more different automobile manufacturers by adapting to their unique management structures of their unique management structures. Today it is difficult to imagine a complete distribution chain of automobiles manufactured in Europe that would be used by all manufacturers. With DELOS, it is possible that finished vehicle output of different automobiles manufactures is delivered using a single production distribution network consistent of independent service providers. The complexity of designing such coordinative supply networks is dependent on the specifics of the involved, possibly distributed, production processes, i.e. distributed participated manufactures in the DELOS platform, and elements of logistics infrastructure, i.e. numbers of different types of transport, terminal, and ports involvement in DELOS platform. In forming such a production distribution network, the first step needs to identify existing problems in the distribution network, e.g. empty running, partial loading, surplus of production in warehouses, damage factors, etc.

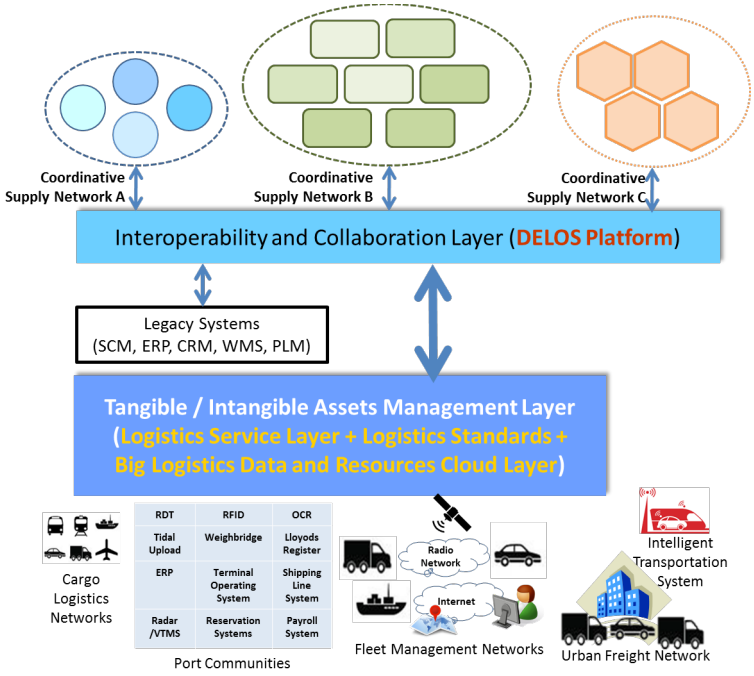

Figure 2: Forming Collaborative Supply Network for Automobile Sector

Figure 2 illustrates how the DELOS architecture (see Figure 1) can be used to form a collaborative supply network for the European automobile sector. There are two layers in the middle. The top one is the 'Interoperability and Collaboration Layer' which reflects to 'Big Data Empowered Logistics Services Platform (DELOS)' in the middle of Figure1. The low one is the 'Tangible/Intangible Assets Management Layer' which includes 'Logistics Service Layer', 'Big Logistics Data and Research Cloud Layer', and 'Logistics Standards' in Figure 1.

The tangible/intangible asset management layer in Figure 2 normally concerns transport assets, supply chain assets, utilization assets, and management assets. Some examples of different transportation and logistics related networks are shown in the lowest part of Figure 2.

Different legacy systems related to supply chains, such as SCM, ERP, CRM, WMS and PLM systems are accessed through the 'Interoperability and Collaboration Layer' in Figure 2. Using the tools provided in 'Big Data Empowered Logistics Services Platform (DELOS)', logistics and transport plans are updated across different modes and actors, i.e. manufacturers, retailers, logistics services providers, carriers, terminal operators, etc. The collaborative supply network designers take into account the typology and characteristics of logistics flows for the collaboration to identify collaboration opportunities and lead to network designs that maximise the resource utilization. The collaboration of supply networks should take multiple criteria into account, weighting several aspects (i.e. cost, service and sustainability) and offer different viewpoints to the different involved stakeholders. The shared supply network should be finally executable, manageable, monitorable, and flexible as well as meet expected security standards.

5. Related Work

A number of national and international research and innovation activities will be linked to this project based on the active participation and involvement from the DELOS consortium. The DELOS partnership has proven track records in EU and national funded projects that have investigated integrated logistics approaches. Previous research of Bournemouth University team performed in SOA4All (Service Oriented Architectures for All, EU FP7), FAST (Fast and Advanced Storyboard Tools, EU FP7), and VIDE (Visualize all moDel drivEn programming, EU FP6) will largely benefit to build the capabilities on services/assets describing, clustering, and discovery as well as interoperability on data/information, services, and process levels.

Other projects, the consortium has been involved in are: SAIL project - Hybrid Freight Sailing: Sustainable Approaches and Innovative Liaisons (EU INTERREG), MoVe IT! Project - Modernisation of Vessels for Inland logistics way freight Transport (EU FP7), S-Cube project - Using On-line Role Play to Promote Soft Skills Development for Social Enterprises (EU Leonardo TOI), GIFT project – Green Intermodal Freight Transport in the South East Europe (EU SEE), ENCOMAR-TRNSPORT – Enhanced Co-operation between EU Member States and Associated Candidates States in Maritime Transport Research'' (EU FP6), EUROMAR BRIDGES – ''Building bridges between EU Member and Candidate States in maritime research on transport within the frames of European research area'' (EU FP6), EUROMIND – ''Creating an innovative European Open Maritime Industry through facilitating the integration of standards into new business practices and services'' (EU FP6), EcoRefitex – ''Eco Innovative refitting technologies and processes for shipbuilding industry promoted by European Repair Shipyards'' (EU FP7), REMCAP – ''Resource Efficiency Maritime Capacity Project'' (EU FP7), LATLIT INTERREG – ''Development of Join Research and Training Centre in High Technology area'', EU structural funds national project ''Lithuanian Maritime Sector's Technologies and Environment Research Development'', national priority project ''Mobility ICT technology'' (MOBAS), EU Social funds project development and application of innovative research methods and solutions for traffic structure, vehicles and their flows'', CAM4Home –Semantic and distributed storage for heterogeneous data management (EU IETA2), MAGNET Beyond – context management and routing for network clusters (EU FP7), WONDERVILLE – optimizing M2M communication over heterogeneous network (National Project), SEAMLESS – Mobility Management and Multi-homing over heterogeneous wireless access networks (National Project).

6. Conclusions

The paper presents a specific view on the challenges related to communication to build a big data empowered logistics services platform. In the context of logistics, mobile communications for secured information among logistic entities, building secure, resilient and trusted communication, and provision of position and spatial information regarding goods on the move through European GNSS applications, RFID, and 3G/4G services are identified as the big challenges. The proposed architecture will facilitate to above mentioned challenges. The project is still in it initiative stage, the further detailed research questions need to be identified based on the real-world cases.

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