Creating the Internet of Logistics

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THE LOGISTICS CHALLENGE

The logistics industry is lagging many other industries in its race to digitize due to a number of structural challenges. However, there is a huge pressure to digitize due to the benefits that each of the parties involved will reap. This article discusses these challenges and benefits and proposes that the solution to the digitization challenge lies in existing internet-based standards creating the Internet of Logistics.

Many companies involved

Historically, digitization in Logistics has largely been driven by individual enterprises digitizing their transport operations within their sphere of influence and the collaboration with other business partners on a peer-to-peer basis.

According to the Eurostat Digital Intensity Index,[1] Transport and Storage is fifth from the bottom of 24 digitization of economic sectors defined. Only Wholesale & Retail and Construction have lower scores than Transport and Storage.

The nature of the logistics industry is quite different from looking at a manufacturing site, however, since the number of enterprises involved easily ends up in 10-20 companies when all steps from shipper to consignee (see Figure 1) are added.

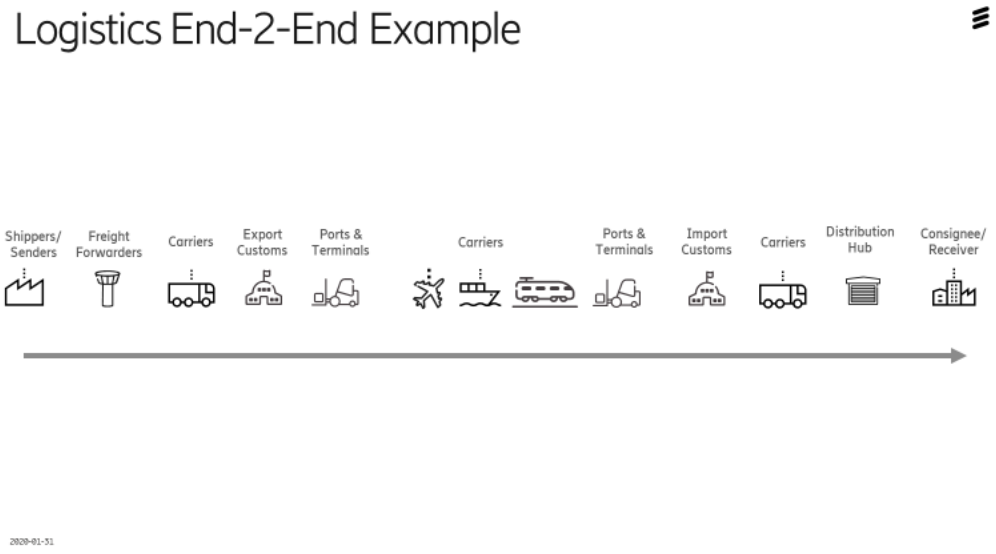

Figure 1: General point-to-point transport

[1] Eurostat, Digital Intensity Index - https://ec.europa.eu/digital-single-market/en/desi

Packages in packages - which package?

In addition, logistics have the characteristics of nested objects. As an example, consider transport where the boxes go on a pallet, pallet in a container and container on a truck. And this nesting can of course change over the transport modes and business setup between the partners in the supply chain. International Organization for Standardization (ISO) have defined a general structure[2] as shown below (see Figure 2), but the real structure could be much more complex considering several layers of product packages and returnable transport items when looking at the entire supply chain from manufacturer to consumer. In one transport leg, what is considered product package could be the Transport Unit in the next leg. As Figure 2 describes, there could also be layers omitted and phantom layers added in order to cater to specific business processes.

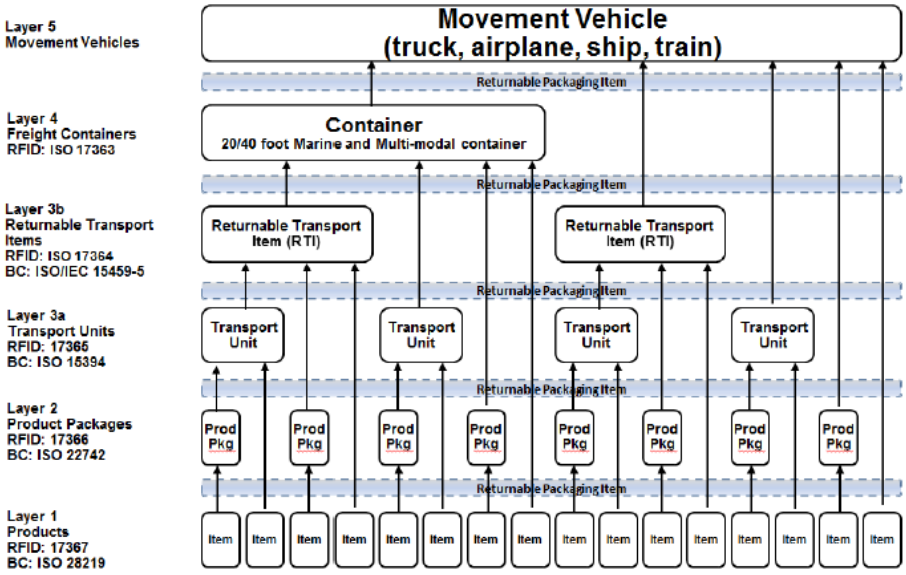

Figure 2: ISO Layers in Logistics. This is copyright protected material reproduced from part of Standard SS-ISO 17363:2013 with due permission given to Ericsson from the Swedish Institute for Standards, who holds the copyright to the Standard and sells the standard, www.sis.se. Copying and distribution is strictly forbidden.

Globalization

The increased globalization has also multiplied the digitization challenge where most companies today would have a global supply chain involving companies from many different countries and regulatory areas.

Considering that within the International Federation of Freight Forwarders Associations (FIATA) there are 40,000 forwarders—adding road transport with some 1,000,000 members in the International Road Union (IRU)—connecting

[2] ISO Layers in Logistics, Standard SS-ISO 17363:2013

all forwarders with all road carriers would result in 40 billion integrations needed, as well as another 300 airlines, shipping lines, all the 150M+ shippers, ground handlers, terminal operators, customs and customs agents, consignees and so on. It becomes quite evident that the peer-to-peer integration will not work for digitizing the logistics industry beyond very siloed application areas. In order to cope with this, different kinds of supply portals have been developed, but the increased globalization and need for agility has limited their adoption. Some of these have evolved into large industry hubs covering a specific location, mode of transport or industry.

e-Commerce rising

New challenges such as e-Commerce are driving the transformation from largely comprising enterprises ordering transport and importing/exporting to individuals being shippers and consignees.

As a result, the number of importers and exporters is increasing exponentially, putting great strain on regulatory processes. It is therefore needed to enable new services to execute transports in compliance with regulations to manage this change in the industry.

Customs and postal services have especially noticed this trend and are struggling to cope with the increase of parcels and entities that need to be managed.

IoT

Increased requirements that shippers need to understand regarding the environment through which their goods are travelling are driving the need for instance sensory devices in order to detect any cargo experiencing shocks, temperature deviations, theft, or other issues.

This places new demand for the ability to roam different logistics networks without dedicated connectivity and backend systems. For example, a cold chain container should be able to not only signal to the ground handler that an action is needed but also to alert the owner of the cargo that a deviation has occurred.

The other area to consider is the "Russian doll" of tiered connectivity and roaming inside different connectivity layers (i.e., RFID, BLT, WIFI, 5G) and physical layers (i.e., boxes, containers, cargo hull) depending on transport mode and transport service.

Standardization

Because of the volume of both physical objects and information, the logistics industry is supported extensively by systems with specific purposes and business configurations that need to be integrated. Integration between systems, even between systems running the same software, can be configured and setup quite differently, making integration an extensive business process and data mapping exercise. Figure 3 shows examples of systems involved in executing logistics.

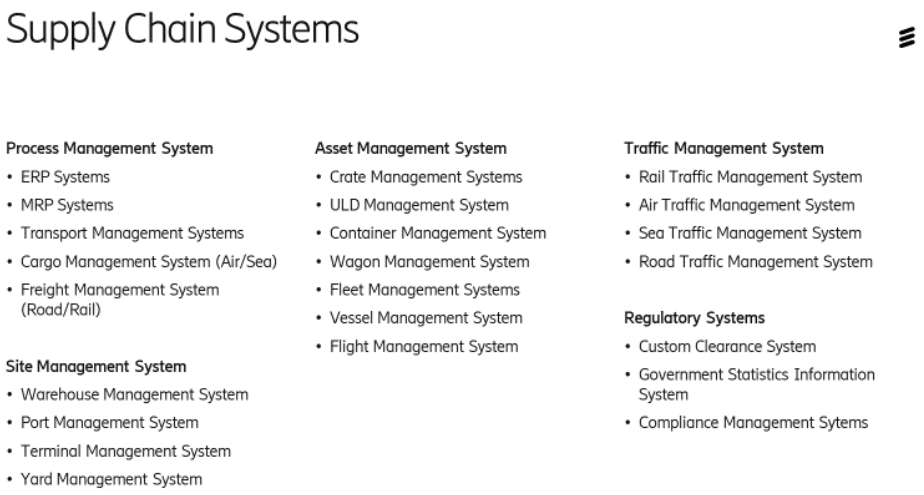

Figure 3: Examples of supply chain systems

Another area needing consideration is the number of standards that exists within the logistics domain based on industry segment, mode of transport and continent.

For example, there are UN standards such as the UN EDIFACT, the ANSI X12 standard and standards specific to mode of transport (i.e., IATA CargoXML, IRU eCMR, EUAR TAF TSI, etc.)—in addition to ISO standards that need consideration. The issue is not so much a lack of standards but rather a way of handling the interoperability between the standards. One needs to understand the different layers of interoperability for this to work.

Figure 4: Standards and Associations

Confidentiality

The information managed within the logistics industry is also highly confidential and can cause market index fluctuations and damage enterprises if disclosed. There is pricing, volume, customer and supplier information in the data, so even peer-to-peer data sharing agreements are cumbersome and difficult to achieve on a wide scale with many business partners.

Resulting in…

As a result of the previously stated challenges, the logistics industry has embraced digitization more slowly than other industries, and the main achievement appears in peer-to-peer connectivity where the Transport and Logistics sector is equal to ICT and Media sectors.[3]

Today, much of the required information flow between parties in the supply chain is still managed by paper, examples of which are shown in Figure 5.

[3] Harvard Business Review, How digitally advanced is your sector -https://hbr.org/2016/04/a-chart-that-shows-which-industries-are-the-most-digital-and-why

Figure 5: Examples of documents required in Logistics

DOES IT MATTER?

The benefits of data sharing in the logistics industry are substantial for all involved entities. Opportunities include physical benefits such as real-time information of condition, geo-position and associated automation; improved data quality; and longer-term opportunities in machine learning, artificial intelligence and new business models. Examples of possible opportunities are shown in Table 1.

Shipper benefits	• Real time track & trace and early warning • Info arrival prior to goods • Pro-active failure management towards end customer • Event management • Exception & acceptance handling • Ease to change provider/supplier • Low investment for small shippers to connect • Electronically included Letter of Credit and DG management process in total solution • Improved inbound visibility • Automatic & accurate CO2 reporting E2E
Forwarder benefits	• Shipper benefits above • Resource and capacity planning • Energy and cost spent on sales, not back office work • Increased fill rates by consolidating cargo

	• Impact on business model to some extent; will bring new benefits and services • Better customer service • Increased quality of events • Improved planning capacities (going beyond pulling needed info) • Reduced risk of errors (unique IDs) • Less paperwork • Document sharing (TC, export controls)
Customer benefits	• Visibility, transparency, efficiency, profitability • Risk analysis • Compliance verification and embargo fulfilment • Security and boarder management process • Trade facilitation • Faster and easier VAT & Duty collection • Pre-declaration and clearance • Supported single window lead by WCO
Authority benefits	• Harmonization between governmental bodies • Consolidated statistics availability to Eurostat (and national) • Dispatch to right authorities depending on goods • Targeted regulations based on commodity type • Police authorities' ability to scan for "risks/threats" and profiling • Medical authorities' compliance, animal decease • Communication on new regulations • Environmental and dangerous goods reporting • Easier connection to single window in other regions • Risk mitigation and evaluation
Carrier benefits	• Resource and capacity planning • Waiting/idle time and yield • Visibility and control of volumes (including track & trace) • Resource and capacity planning for optimization • Improved planning capacities (beyond pulling needed info) • Energy and cost spent on sales, not back office work • Increased fill rates by consolidating cargo • Single interface & eliminating paper • New business model (sell directly to SME)

	• Better utilization (-/-30%) • TAT time reduction • Simplified compliance checks
Terminal/Agent benefits	• Shipper, forwarder and carrier benefits above • Resource and capacity planning • Reduced dependency of individuals • Easy access to documents • Single system to interface • Reduced complexity & improved data quality • Increased planning capabilities • Reduced paper & system clutters • Increased speed in processes

Table 1: Opportunities from Digitization in Logistics

DAWN OF INTERNET OF LOGISTICS

The internet has been the most successful collaboration platform in human history. It has evolved and organically grown since its inception, from simple email communication and HTML websites to global platforms that connect billions, enabling them to communicate, collaborate and share information with each other. Technologies have advanced to provide dynamic content, security has improved and in more recent years the efforts to make the information on the internet machine-readable and learnable have increased. Much of this technology has been standardized and made open and free, enabling adoption at higher levels than any of the previous closed standards that have dominated business to business communication have experienced.

Looking at the internet as the mechanism to digitize the logistics industry is therefore elementary, and this is the direction that Ericsson together with the International Air Transport Association (IATA) have taken to specify and create the first Internet of Logistics standards and instances.

The Unique Identifier

Today, each company makes their own identifiers and labels in accordance. One fundamental in sharing and roaming information is solving how to find a universal identifier reachable for any connected device on a global basis and where entities can keep legacy systems in place.

The internet provides a good solution for a universal identifier in URIs, or more specifically, URLs[4]—an identifier that is not only globally unique but also resolvable so

[4] URL - https://www.w3.org/TR/url/

that information can be retrieved by any authorized partner in the chain.

In the Internet of Logistics, all logistics objects are represented by a URL (i.e., https://domain/entity/identifier) where logistics objects are either 1) a digital twin of a physical object such as a vehicle, container, pallet, transport unit, product package or individual item, or 2) a digital document such as an Airway Bill, Bill-of-Lading, etc..

The URL is also a Representational State Transfer (REST) endpoint, allowing authorized partners to not only retrieve information but also to update event information that occurs during the lifecycle of a logistics object.

Figure 6: Example of a Unique Identifier

It's all about semantics

With logistics objects now having a natural identifier that can roam the globe, there is a need to describe those objects. This calls for a flexible standard that will enable different industries and regions to define their data models.

The Semantic Web has been a vision of Sir Tim Berners Lee since 1999. Technologies that have been developed since then have been slowly gathering traction as machine learning and AI use cases drive the need for machine readable and learnable data. Resource Description Framework (RDF)[5] is the foundation of the Semantic Web and provides a basic model to help solve a few of the challenges in logistics.

First, there is a flexible data model that we can use to model any type of logistics object.

Second, we use RDFS and OWL to define ontologies per industry and region, and we can connect these ontologies to enable

[5] RDF - https://www.w3.org/RDF/

integration. Ontologies also have the benefit that they can organically grow. The standardization effort does not need to be a massive monolithic task—the adoption and use cases can grow, just like the internet.

Third, we can represent the hierarchy of packages within packages. The linked data[6] concept is synonymous with RDF and the semantic web. We can link our package to a pallet, link the pallet to a container and link the container with the truck. This enables traceability and the ability to share context. IoT data from a container can be shared with the packages inside.

Publish and let your business partners subscribe

While demand data from a REST endpoint is valuable, there is also a need to solve the real time requirement so that business processes can be automated.

With data published on a URL, the natural solution is to allow authorized partners to subscribe to the data. Companies within the Internet of Logistics are identified themselves by URLs. Using these URLs, we can provide authorization and access subscription information. Subscribed companies provide call-back URLs, and data can be pushed to these endpoints. This data can be the logistics object, event data or simply notifications.

Using a publish and subscribe model, with companies identified by URLs and the logistics objects and events described in RDF, we have created a standard that enables a federation of vendor agnostic platforms to integrate with each other, removing the need for point-to-point integrations.

But how can we trust it?

Securing a distributed and federated global network of logistics platforms is not an easy task, yet it is critical for the success. To gain the trust of participants in the Internet of Logistics, there needs to be a holistic approach using technologies that the participants are familiar with and already trust.

Fortunately, with the rapid expansion of global platforms, this technology is maturing and becoming more widely known and accepted.

Authenticated identities are the foundation of any security model. In order to conduct business, a company needs to know who they deal with and trust that they are who they are perceived to be. Combining technologies such as OpenID connect, mutual TLS and sender bound tokens (the first two of which are widely used today) can go a long way in addressing this concern. However, how can one trust that a token or an SSL certificate is provided by a trusted party? To address this final concern, companies should use existing organizations that provide this trust mechanism. Associations such as IATA provide this role in the air industry, and using these types of organizations to provide certificates and tokens is a logical step in establishing trust between parties. Not all companies in the supply chain may register with IATA,

[6] Linked Data - https://www.w3.org/standards/semanticweb/data

however. Therefore, there is need for a federation of trusted identity providers, each of which will determine other identity providers they trust via a cryptographic mechanism—thus enabling a company registered with one identity provider to trust other companies registered with other identity providers.

Following authenticated identities, the next security challenge falls under authorization. Using JSON Web Signatures (JWS; RFC 7515), JSON Web Encryption (JWE; RFC 7516) or access tokens generated by identity and authentication providers that are bound to the sender, distributed applications are now able to check the authorization of clients or users. A key concern for data owners is the control over who is able to access their data. This control must be granular to the level that a data owner will be able to restrict access to specific logistics objects or even restrict access to specific data within an object. ACL per logistics object or blockchain ledgers are mechanisms used to attain this control. Logistic object owners can therefore specify not only who can access their objects but also importantly who can cascade authorization to objects to other companies in the logistics chain.

After restricting access to only certain authenticated identities, one must take care of the data's confidentiality so that unauthorized users cannot access it using unethical mechanisms. Perimeter technology that enforces TLS during transport and encryption at rest will be mandatory for platform providers to ensure that data cannot be easily accessed.

Even with the controls mentioned above, participants in the Internet of Logistics will need to ensure the integrity of the data for it to be trusted. The data will therefore need to be digitally signed. However, digitally signing RDF data is not a trivial task, and there is a current lack of standards in place. The main challenges with signing RDF data include the existence of blank nodes, multiple serializations and the arbitrary order of attributes. There are efforts being made in this space (including a recently published draft – Linked Data Proofs),[7] and it will require the collaboration of the logistics community to drive these efforts forward.

With security in place, the final step is to make sure the data is available. Highly available platforms and a publish-and-subscribe mechanism (so that data is available in advance of its operational needs) are the last building blocks needed to ensure one has a trusted and secure distributed platform to start consuming data from the Internet of Logistics!

IMPLEMENTATIONS

Ericsson, together with IATA, has developed the first initial version of the Internet of Logistics under the IATA initiative ONE Record,[8] a data sharing architecture based on the concept network of platforms using a single web Application Programming

[7] Linked Data Proofs - https://w3c-ccg.github.io/ld-proofs/

[8] IATA ONE Record - https://www.iata.org/en/programs/cargo/e/one-record

Interface (API), linked data, ontologies and a data security framework.

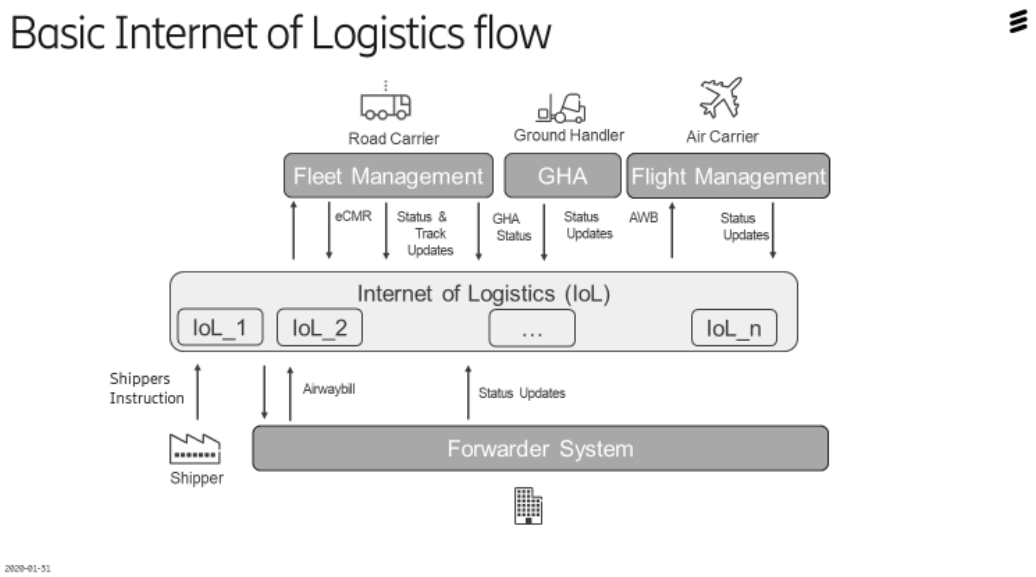

Figure 7: Basic Internet of Logistics flow

Logistics and transport data are accessed through a network of linked data (through URLs) in RDF format based on W3C standards. This enables shared data on a distributed network of platforms. Direct access to the logistics and transport data creates visibility in the supply chain. Logistics and transport companies such as shippers, forwarders, airlines and other partners are developing implementations. The semantics of logistics data for air cargo is being developed by IATA together with logistics and transport partners and other associations, with the first release in December 2018 and a new revision planned for March 2020.

Another ongoing initiative with similar purpose and vision is the EU DTLF (Digital Transport and Logistics Forum), a group of experts that brings together stakeholders from different transport and logistics communities (from both the private and the public sector) with a goal to build a common vision and road map for digital transport and logistics. The DTLF also contributes to identifying needs for measures at the EU level and supports their development and implementation where relevant. Two projects, FENIX [9] and FEDeRATED, [10] have been initiated to start the move from thought to action.

[9] FENIX - https://fenix-network.eu/

[10] FEDeRATED - http://www.federatedplatforms.eu/

CONCLUSION

The challenges global supply chains are facing from major trends in society, as outlined above, will require digitization transformations in most enterprises to stay successful. Known technologies such as URIs, RDF, OpenID and TLS enable a federated network of platforms supporting digitization in the supply chain. It is also the foundation needed to pivot into more advanced concepts such as wide scale automation, machine learning and artificial intelligence. We believe that with the ongoing initiatives occurring within IATA and the EU, we could be seeing the dawn of the Internet of Logistics.

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