

A review on Business-to-Business Data Sharing technical solutions

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Abstract— Interest in data sharing techniques and tools has been growing consistently over the years, given their goal is to facilitate the cross-sector collaboration of businesses. Automatic mechanisms for data exchange along the economic supply/demand chain are a necessity to ensure the proper development of Business-to-Business (B2B) processes. In this research, an overview over the data sharing techniques and applicability in the enterprise ecosystem is provided. Subsequently, a review of the most representative B2B data sharing software solutions is presented in terms of promised features and technological traits. Their analysis is concluded with a comparison in terms of technical and business requirements, characterized by relevant metrics. The aim is to clarify the advantages and disadvantages of using each alternative in the development of B2B processes and increase awareness towards their particular focuses and properties. Even if the approached tools contribute to the successful development of B2B data sharing processes, shortcomings are identified in terms of security, privacy, data modelling and data governance techniques. As a result, further research is needed to improve such systems into a generally applicable software solution.

Keywords—B2B Data Sharing, Data Confidentiality, Enterprise Tools for Data Sharing

I. IMPORTANCE OF BUSINESS-TO-BUSINESS (B2B) DATA SHARING IN THE ENTERPRISE ENVIRONMENT

Considering the intense digitalization process the nowadays society has been subjected to over the years, traditional Business-to-Business (B2B) processes [1] evolved. In theory, we can describe a traditional B2B process as a series of events and steps which occur when one business attempts to purchase and sell products from or to another business, in order to complete the product manufacture process [2]. However, in practice, the products exchanged in the B2B process slowly transitioned from physical raw goods to digital information, given its value to offer insight over a business’s end users opinions and desires [3]. Nowadays, any company engaged with Business-to-Consumer (B2C) needs to have an overview over the demand of its products reported to its supply capacity in order to survive the competition of other alternative businesses in the industry [4]. As a result, data sharing has become a key activity in the everlasting initiative of each business to improve its processes and products, with the goal

of nurturing new opportunities. In this context, the activity of exchanging data between companies can be defined as “making data available to or accessing data from other companies for business purposes” [5] either by monetizing it or by offering it for free in a mutually beneficial trade with a business partner.

The advantages of performing B2B data sharing go beyond the improvement of B2C transactions, on which most business users usually focus. Data sharing is also necessary in order to innovate current Business-to-Government [6] processes and B2B relationships, taking into consideration the complete perspective of the economic supply/demand chain which can be built using multiple aggregated data sources [7]. Companies which take part in B2B processes with their suppliers and their buyers will be able to identify difficulties in potential and existing business initiatives from multiple perspectives. Subsequently, business representatives will understand the challenges faced by their partners during their partnerships and will be able to take mutually beneficial decisions.

Most companies which want to engage in B2B data sharing processes need to estimate the effort of integrating new mechanisms and technologies, in order to assess the feasibility of the whole process. In the B2B perspectives report [5], European Commission representatives outline some categories of techniques and strategies taken into consideration by businesses for the data exchange process, as shown in Table I.

TABLE I
B2B DATA SHARING TECHNIQUES AND REVENUE GAINING STRATEGIES

Data Sharing Technique	Revenue Gaining Strategy
Data monetization	a strategy preferred by companies choosing to share part of their data in order to increase their business profit; Gartner’s report on “Magic Quadrant for Analytics and Business Intelligence Platforms” [8] shows several companies consider data sharing for revenue a significant aspect of their business plan - Microsoft and Tableau are leaders, Oracle and Salesforce are visionaries, while IBM and Alibaba Cloud fall into the Niche Players category; MicroStrategy and Looker seem to seek to make constant improvements to the existing processes, which brings the current B2B techniques gradually closer to an ideal shape;
Public data marketplaces	rely on public trusted entities that connect both data sellers and data buyers in one environment; usually, the

	companies developing and maintaining such platforms for businesses engaging in data sharing perceive a transaction fee for all exchanges
Industrial data platforms	a secure and private environment which is restricted to group of companies exchanging data for free voluntarily in order to facilitate new product and services development; companies developing this type of data sharing solution monetize it using a SaaS model [9] – the platform is deployed in a custom manner for each business partner in accordance to a licensing plan
Technical enablers	businesses which specialize in creating data sharing flows custom for companies; they do not offer a general-purpose product, but rather build custom integration and data modelling mechanisms depending on each partner's needs
Open data policy	companies choose to share some of their data in an open manner with other businesses; the value of the process is given by the resulting analytics which help businesses make long-term profitable decisions based on the needs of their consumer users and business partners

As stated in [10], achieving a performant business model requires designing reliable and cost efficient B2B data sharing processes. Reliability of a B2B data sharing process is given by technical and legal considerations a company must be compliant with in its evolutionary journey.

According to [5], the first challenges which appear in the B2B data sharing process are caused by the interoperability and standardization issues, along with the stale or insufficient quality of data. These issues result in operational barriers in the automatic data processing and analysis step.

Another important difficulty all businesses need to address is the cost associated to the storage, security and curation of the available data. Any software tool chosen by a company to fulfill its data sharing process needs to offer the option to only remove stale versions of the data, while continuing to offer metainformation about its former existence. This feature also ensures another concern of companies in regards to data sharing is avoided - denial or unforeseen termination of access to the datasets metadata by the data supplier is not possible.

However, the ability to assert ownership rights and define the legal extent to which shared data can be used, remains one of the top requirements of a company when choosing a data sharing solution. This request is ensured by designing proper data governance mechanisms [11] in the B2B data sharing platforms, while providing business customers with guidance and methodologies to follow. Furthermore, a solution offering a systemic approach to data sharing should be able to address concerns regarding potential loss of business competitiveness or exposure of trade secrets. This is possible by developing mechanisms to monitor and control the extent of usage for shared data.

Given the recent increase in user private data breaches [12], businesses are also concerned about ensuring compliance with data confidentiality regulations. As a result, B2B data sharing solutions should integrate methods to curate datasets prepared for sharing, in order to protect the privacy of users from whom the information was collected. Moreover, shared datasets should be subjected to clear license agreements. Both aspects help businesses avoid

litigation costs, which are usually implied when a business-to-consumer or business-to-business contract is breached.

Finally, costs associated to the skills development among employees within the company to analyze the available data is also an important aspect for businesses. This requirement can be ensured by the B2B data sharing software suppliers by providing an easy-to-use development environment, while ensuring all the necessary dependencies are included. It should be well-documented, offer paid support option to its business users and should be sustained by the community as well.

Given all the challenges involved, the majority of companies deciding to include data monetization as part of their business plan [13] reach the conclusion that developing and maintaining their own B2B data sharing solution is a very costly long-term investment [5]. As a result, some businesses decided to monetize the data sharing process by designing and deploying tools for companies wishing to improve their revenues by analyzing and aggregating data exchanged with their partners worldwide. In the following section, we present the features and drawbacks of each state-of-the-art B2B data sharing products. They are reviewed relative to the technical and business requirements companies engaging in data monetization have [5].

II. B2B DATA SHARING SOFTWARE ALTERNATIVES

A. B2B Data Sharing Solutions Review

Nowadays, data monetization can represent a significant source of income for businesses in any industry, given the existence of various technical solutions which facilitate B2B data sharing. In this section, the most promising public data marketplaces, technical enablers and industrial data platforms are presented, alongside with an overview of their significant features.

An outstanding provider in the public B2B data sharing marketplace sector is DataPace [14]. The proposed solution has the goal to support data collection from IoT sensors and trading activities performed by businesses with the resulted datasets. The data acquirement transactions are executed by businesses in a secure environment, which relies on a global-scale decentralized architecture, sustained by the Hyperledger Fabric blockchain technology [15]. Following this technological approach, businesses have the ability to easily quantify the value of data – through DataPace tokens - and to build smart contracts in order to ensure the integrity of data throughout transactions. The underlying blockchain uses businesses involved in trades and validators as stakeholders. In this context, the validator has the role to validate the blocks of transactions emitted by other stakeholders through the network. The fault tolerance of the network is ensured by the PBFT algorithm [16], in case certain nodes manifest malicious behavior. Smart contracts defined in the platform by companies are the base element in the data sharing process, since they define the terms of the data exchange. As a result, businesses improve the financial and technical security of their transactions, while reducing the costs implied by a conventional legal commitment. A significant disadvantage of using DataPace is the lack of built-in privacy assuring mechanisms. Each business must define its smart

contracts responsibly, in order to ensure there is no breach of data confidentiality regulations in the on-going B2B processes. Data governance features are not included in the current version of DataPace, which may lead to data ownership doubts and lack of control over the usage of the shared data. Redundancy of the datasets and the need to build custom integrations for each of them are also notable downsides. This is caused by the absence of a comprehensive data annotation strategy, which leads to interoperability and reusability issues. The usage of the solution is limited to the data collected by the platform linked IoT sensors, which greatly reduces its applicability in various B2B contexts.

One of the most promising public data marketplace solutions so far is Omnicient [17], a platform focused on security and privacy enhancing data exchange mechanisms to connect data producers and consumers. Omnicient offers two main products: a secure AI data exchange platform, which makes B2B data exchange safe and an anonymous campaign engine (entitled ACE), whose purpose is to allow companies to reach new potential customers without actually accessing or exchanging their personal information. The data sharing platform tries to overcome the challenge of data privacy regulations compliance, which businesses need to ensure, in order to gain consumer's trust and engage in data sharing for marketing purposes. The platform integrates the ACE engine, which helps brands grow their customer base by getting in touch with data partners. From a technological point of view, the platform is delivered to the customer as a client desktop application, which anonymizes the data at source before loading it into the administration and monitoring platform to allow other companies to execute queries and perform analytics. The architecture of this platform is based on the P2P model, with producers offering data to consumers through self-hosted APIs - thus the system is scalable and extensible. Data anonymization is performed by applying tokenization techniques [18]- the link between the original data and the tokens is kept in a vault outside the production environment - and reverse engineering of tokens to gain access to personal customer information should not be possible. Based on the uniquely generated tokens, identity matching of customers across datasets of different businesses is done. This allows businesses to conduct analysis and derive trends and opportunities over all data sources available. Datasets made available by businesses in the platform are structured according to the FAIR principles [19]. This technical feature should ensure data interoperability and the proper means to build comprehensive data governance mechanisms [20], although no concluding information is presented in this direction. A major downside of the solution Omnicient offers is that it only presents an enterprise version, with no paid support for companies offered and no community support. The lack of methods to formalize legal agreements between companies is another downside encountered, therefore no legal action can be performed in case one of the data partners breaches the trust of the other in terms of data usage.

Another remarkable solution for data sharing, access and reuse is offered by Opendatasoft [21]. Its product follows the industrial data platform solution, while including traits of the open data policy [22]. The resulting system is offered as a

cloud-hosted on-demand product, since its target audience is represented by businesses with non-technical users. The Opendatasoft platform allows creating datasets from data resources in various locations, having different formats. The source data is restructured according to a data schema provided by the user to a generic extractor component. In order to enhance interoperability, metadata properties are extracted and structured using DCAT [23] and INSPIRE [24] vocabularies. Other transformations on data are done using processors defined in the platform by the user. The obtained data and metadata are given a unique record identifier, which is later used for indexing and the search engine integrated in the platform's APIs. Once a dataset is published, automatic data republish rules can be configured, in order to ensure data does not become stale. Another feature of the platform is its integrated marketplace, which allows businesses to browse datasets made available by others in an open manner or according to an invitation to collaborate, based on granted write access. Datasets or catalogs of datasets can be downloaded in multiple formats - such as CSV, RDF - and can be filtered and sorted based on user provided metadata. Information and content of the datasets can be either visualized and modelled in maps and charts using ElasticSearch [25] plugins or by accessing a custom API following the REST paradigm. Even though data reuse in datasets is not automatically identified, the user has the option to link its dataset to other data resources which were used in its creation. As a result, reuse of a dataset will be visible to other users in the platform and through the API returning datasets metadata in a Linked Data Format [26]. In terms of security, an access control mechanism is provided - a user can either make data available to everyone or provide write or publish access rights to individual businesses or users. To ensure datasets consistency and remediate unintended changes, a change monitoring mechanism is provided with a built-in feature to revert datasets to previous versions. Scalability of the presented SaaS platform [9] is ensured by its API driven architecture, where each main service offered by the platform is packaged in a standalone component, scaled horizontally and vertically depending on the number of users, datasets and API calls. A downside of this solution is the lack of privacy enforcing mechanisms, which should ensure shared data is shared without any infringement on current user privacy regulations, such as GDPR [27] [28] and CCPA [29]. Improvements should be made in the direction of data ownership and control of use provided to users. Access rights provided for datasets cannot be defined on time frames, which requires human intervention to ensure they are compliant with the legal agreements established between businesses.

Even if data monetization is a key focus for all data sharing solutions presented so far, Leapyear's [30] technical enabler distinguishes itself through its focus on data confidentiality, built on differential privacy techniques [31]. Their product provides tools for reporting, analytics and machine learning, which can be used by companies across a variety of datasets processed through the LeapYear's systems. LeapYear provides the technology to ensure data confidentiality, to extract its analytic value and preserve the scalability of the datasets in time. As a result, companies

engaged in B2B data sharing can stay compliant to all the data privacy regulations applied in business sectors such as retail banking, capital markets, pharmaceuticals and healthcare. However, LeapYear does not offer a complete B2B data sharing solution, since the resulting datasets are not made available in a data marketplace for the clients to manage, exchange and reuse. As a way to eliminate this downside, LeapYear provides their business clients with the option to commercialize the privacy-preserving datasets through a partner's banking platform. The platform facilitates the data distribution and marketing process. It also processes the monetary transactions performed between data buyers and producers and ensures proper data usage by the buyers. Nonetheless, businesses also have the option to create custom integrations with data markets or other companies, since datasets processed by LeapYear are available through an API gateway.

Another trending technical enabler, creating custom flows for the data sharing needs of each business, is Epimorphics [32], which includes a set of instruments to manage linked data [26]. This solution provides support for its business customers in their custom data modelling process, as well as in the engineering of applications based on the resulting linked datasets. From an architectural point of view, the data management platform is designed on three layers: a component for load balancing and routing of requests, the application containing characteristic business flows and the data storage unit. The access to the linked datasets of each business can be done through API and user interface endpoints hosted on RDF servers, while the load balancing component scales their number. At the application level, a data management service is defined. Its purpose is to ensure the successful transition of datasets from unstructured to structured. The data modelling process is different for each business, depending on their needs and data quality. As a result, Epimorphics builds custom adapters for datasets, in order to ensure their client's data becomes compliant with FAIR principles [19]. In contrast to the business models of public data marketplaces and industrial data platform, Epimorphics representatives monetize the support they offer to companies in the initiative to process their data for integration in B2B flows. However, this reduces the opportunities of businesses to form new partnerships or easily find suitable external datasets for integration. Since user privacy is an important concern for companies involved in data sharing processes, the lack of privacy centered data curation represents a major disadvantage of using Epimorphics. Data exchange activities performed without any anonymization or deidentification technique result in legal complications for both involved parties according to confidentiality laws. Even though business clients are able to provide data access to their partners through an OAuth2 [33] secured API, proper data usage and assertion of ownership cannot be guaranteed. A proper approach to solve this issue relies on developing a set of features which allow businesses to govern their data.

A suitable solution for the frequently encountered problems of the B2B data sharing processes, relative to the data governance principles, is DataShareFair [10], an open source public data marketplace offering key features of an

industrial data platform model. In the design of this platform, the Privacy-By-Design principles [28] were followed in the architecture modelling. In addition, the features of the system were developed using the researcher's own blockchain solution centered on data confidentiality mechanisms. This platform is decentralized, following the P2P architectural model - each company runs its own instance of DataShareFair, which is composed of two components: a resource management module and a data sharing module. The resource management module contains a Web interface for business representatives to access data sharing and management features. Each user action performed in this data marketplace platform triggers the execution of the suitable smart contract. The available smart contracts contain the business logic to manage and exchange data between companies. They are easy to use and maintain, given the ability to version and adjust them relative to the change in business requirements. Execution of a smart contract is done on the node of the initiating business, while the generated transactions are broadcasted to all the nodes in the network. To ensure the security and integrity of the shared data and its underlying model, all transactions are validated using a consensus algorithm before their commit in the blockchain. References to each business's data and metadata is kept in the blockchain, in order to be able to administer and monitor the changes in the shared data and extracted metadata over time. Aspects regarding reusability, accessibility, findability and interoperability are approached by developing in DataShareFair a set of methodologies based on the FAIR principles [19], used to model the data shared through the platform. The data sharing module allows businesses to directly connect and exchange FAIR data and metadata, without any intermediaries to identify and locate the requested datasets. This is possible by offering a FAIR Data Point for each business, which allows assertion of ownership and control of use over the data through encryption, reversible only on validation of the defined access policies through a smart contract. As a result, formalization of legal agreements is possible in DataShareFair through direct and group data sharing based on dataset specific access policies defined in the marketplace. Data governance mechanisms included in the platform are built on top of the FAIR compliant metadata modelling, controlled through the blockchain mechanisms.

Another promising public data marketplace is iGrant.io [34], a cloud-based data exchange and consent mediation platform. Its aim is to guide businesses in their drive to monetize datasets they gather from users, while staying compliant to data confidentiality regulations [27][28]. Compared to other key players in the data sharing solutions market, iGrant.io offers mechanisms to collect data about user activity directly from products. The extent to which data is collected and used is described by the business in the enterprise management platform. Subsequently, the consumer users have to consent to the vendor's defined terms if they wish to use the product. Businesses also have the ability to control the terms under which their data can be reused and shared among other companies using a wallet. These data management features can be integrated in software products using an operator, which provides access

to an indexed metadata registry. This repository is used by businesses to discover and exchange datasets which can be aggregated as data sources in custom service improvement flows. An issue in the data governance mechanisms offered by iGrant.io is that their only focus is on consumers. They can choose which businesses associated to the product can use their data. However, businesses are not able to control access rights over their user’s data, nor can they manage which data is shared in the registry. Improvements are also needed in terms of datasets quality, since collected data is not structured to be reusable or interoperable. Considering data governance techniques included in the current solution are not designed for B2B processes, the option to define formal agreements between business directly in the platform would represent the first step to forming successful partnerships.

B. Suitability of the B2B Data Sharing tools relative to technical and business requirements

Each public data marketplace, industrial data platform and technical enabler solution described in Section 2.A offers to its business clients a set of meaningful features. Table II outlines their performance relative to a collection of relevant technical criteria, in order to perform a concluding comparison of their suitability to be integrated in the suite of technologies a company chooses to use in its data monetization plan.

TABLE II
B2B DATA SHARING SOLUTIONS TECHNICAL COMPARISON

Technical criterium	B2B Data Sharing Solutions						
	DataPace	Omnisient	Opendatasoft	LeapYear	Epinorphics	DataShareFair	iGrant
System Scalability	+	+	+	+	-	+	+
Security Mechanisms	+	+	+	+	+	+	+
System Extensibility	+	+	+	+	+	+	-
Methods to protect Data Confidentiality	-	+	-	+	-	+	+
Data Governance Mechanisms	-	-	+	-	-	+	-
Data Modelling to a Structured Format	-	+	+	-	+	+	-
Data Interoperability	-	+	+	-	+	+	-
Data Accessibility	-	+	+	-	+	+	+
Data Findability	-	+	+	-	+	+	+
Formalization of legal agreements	+	-	-	+	-	+	-
Easy-to-use environment	-	+	+	+	-	+	+
Dedicated components/modules for	+	+	+	+	+	+	+

features							
Includes the necessary dependencies	-	+	+	-	+	+	-
Administrative and monitoring tools	+	+	+	-	+	+	+
Well-Documented Solution	+	-	+	+	+	+	+
Paid Support 24/7	-	-	+	+	+	-	-
Trial version	-	-	+	-	-	-	-
Community support	-	-	+	-	-	-	+

Based on the analysis in Table II, we can conclude that Opendatasoft offers one of the most promising data sharing tools, given that it allows companies to exchange data in a secure and structured way, while providing the necessary support and documentation to build successful B2B processes. However, the lack of integrated data confidentiality mechanisms brings a great risk for businesses willing to share raw data, since they may be open to legal repercussions in case sensitive consumer data is exposed in the data sharing process.

The second data sharing solution in terms of fulfilled evaluation criteria is DataShareFair, which addresses the data confidentiality concerns businesses may encounter when using Opendatasoft. A strong advantage of this platform is that it manages to overcome technical impediments such as interoperability, scalability and accessibility issues, while taking into consideration the potential legal issues which arise in the data sharing process. Anyhow, some improvements in terms of support and community visibility should be made, considering the lack of an automatic way to sign up for trial and evaluate the solution.

Ranking third in the presented overview, Omnisent promises to deliver to its business users a complete set of features required to easily integrate and take advantage of the valuable insight data can provide. Nonetheless, the lack of built in data governance mechanisms and support, as well as the scarce documentation can become an obstacle in the way of acquiring new business clients for their truly remarkable product.

To sum up our technical analysis, we can state that the data sharing tools approached in this paper bring a significant contribution to the proper development of B2B integrations. Anyway, as we have seen in Table II, there are still aspects to improve to the existing solutions until businesses can engage in data sharing without having any concerns about the potential financial impact of a technical oversight.

III. CONCLUSIONS

Early B2B processes merely focused on the exchange of physical products to obtain the final product to be delivered in B2C transactions. However, the constant change in society’s needs forces businesses to continuously adjust their production processes in order to match their end-user’s expectations. Considering the need to optimize this initiative cost-wise, companies aim to obtain data in an efficient and reliable manner from all their suppliers and buyers. As a result, having a market for B2B data sharing platforms

which meet the legal, technical and economical requirements becomes an important prerequisite for companies concerned with building successful business plans.

In this paper, seven key solutions in the B2B data sharing industry are reviewed and evaluated in terms of their capacity to offer a scalable, secure and extensible system. Furthermore, their ability to offer data governance mechanisms and methods to protect data confidentiality is assessed, given the legal implications that may be generated by the lack of such features. Usability of the analyzed systems is quantified in terms of included dependencies, offered support and effort required to take advantage of all the advertised features.

In summary, presented tools serve their goal to facilitate the development of B2B processes by giving businesses powerful tools to share their data. However, concerns are identified in terms of usability, security, privacy, data modelling and data governance techniques for each of the approached solutions. Further research is needed to improve the current data sharing products, in order to obtain an efficient and reliable software solution to conduct all B2B data sharing processes.

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