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RELEVANT ADVANCED TECHNOLOGIES FOR TRADE AND SUPPLY CHAIN FINANCE

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Management Summary

The trade and, as a consequence, trade and supply chain finance business are experiencing a turning point that could not be more fundamental and challenging at the same time. The massive impact of change drivers put pressure on the transformation of business processes, the development of disruptive business models and the nature of cooperation in global supply chain networks.

The increasing volume of data represents the basis for this significant change. The combination and concentration of data generates necessary information and accelerates business processes such as decision making, risk evaluation and communication. Standardization and the new technological possibilities of accessing, storing, combining and systematically evaluating unstructured data in real time constitute one of the main change drivers.

Technologies are thus a key driver in the transformed trade ecosystems and go hand in hand with data. The term internet of things (IoT) is an omnipresent part of everyday business, supported by high data traffic infrastructures of 5G networks. The amount of artificial intelligence (AI) applications is increasing continuously. Overall, the world of trade business has become almost completely expressible via algorithms. Smart contracts ensure a large amount of automated business processes between multiple parties on secure and tamper-proof blockchain networks.

More and more new opportunities for business are appearing in the form of B2B platforms. Platform economies support boundless and automated business between supply chain partners around the globe. These platforms ensure data sovereignty and integrity. At the same time, platforms are the point where new services (such as AI-driven smart contracts etc.) are distributed.

Several other drivers influence global trade. As a matter of fact, all changes follow the urge for increasing efficiency. In addition to enhancing performance, saving costs and generating more business, KPIs for sustainability and ecological indicators are established as equally important objectives. All these drivers lead to a new trade finance ecosystem, in which data is the pulse for business. Blockchain replaces the use of paper-based trading documents by ensuring trust, security and transparency along supply chains. Through the synchronization of material, information and financial flows, logistical objects are capable of making decisions autonomously and triggering payment processes.

Commerzbank has established itself in this trade ecosystem as a trustworthy data manager and guard. By leveraging the new technologies, Commerzbank has developed innovative solutions to validate and monitor quality, manage trust, and provide new risk mitigation and financing services along the supply chain.

Pictograms used in this paper

Throughout the white paper, some pictograms have been used to draw attention to specific points.

This pictogram provides a **definition** of the respective technology

Here you can find **need to know** content

At this point, interested readers will find more **in-depth information** on the technologies

This pictogram shows **company examples**

If there are **guest contributions** to the respective technology, these can be found here

2
Heatmap / Hype-Cycle

New technologies offer financial institutions the opportunity to develop new business models. The distributed ledger technology is able to change trade significantly if it is used in combination with other technologies. An overview of the individual technologies and their areas of application in a financial institution is shown in Figure 1.

New technologies	Pre-transaction		Transaction processing			After transaction	
	Product selection	Data entry	Workflow managament	Document check	Compliance check	Problem resolution	Client mgmt. Information system
Optical character recognition (OCR)		**Text recognition** from trade documents to minimize data entry		**Checks for completeness of documents** based on transaction/ product type	**Scrape documents** for AML keyword hit		
Artificial Intelligence (AI)	**Intelligent** and **personalized marketing:** Offer new product sales or client promotions based an insights on clients´needs and behaviors	**Populate fields** with text extracted nts **(Integrate OCR with transaction process)**		**Validate/remed-iate data** with cross-references, machine learning	**Contextual filtering:** identify suspicious or unusual activity and block suspicious transaction based on predictive indicators	**Intelligentproblem resolution:** Track individual error rates and flag users in need of remediation	
Advanced Analytics (AA)		**Enhanced KYC** (e.g., web scrape)	Efficient process and productivity **monitoring, and** predictive analytics to **detect patterns**				Reports enalbe enhanced **operational and strategic decisions**
Robotic process automation (RPA)			**Bridge data flow and communication:** Integrate data from different systems into single interface				
Internet of things (IoT)			**Ease of tracking** goods and documents; **dynamic pricing and financing** triggered by shipment events; **automated payments release** based on "smart contracts"			**Track document locations:** Track goods (location, volume, quality)	
Distributed ledger technology (DLT)	Create smart letter or credit as **smart contract** on distributed ledger – auto notifications	Replace document-ation, checks, data entry, validation, with **single digital record**	Real time **verification and reconciliation;** workflow executed as per smart contract conditions; replace payment and funds transfer with **cryptocurrency**				

Figure 1: New technologies enable the digitalization of trade[1]

[1] Bain & Company

3
Trade and supply chain finance at a glance

Global economic growth depends on the efficient cross-border exchange of goods and capital along with well-performing supply chains. Trade allows individual countries to specialize in the production of goods they have a comparative advantage in. It enables technologies and innovations to spread and generates economies of scale.

The availability of trade and supply chain finance is fundamental to a functioning trading system. It closes the gap between suppliers (exporters) who need a payment guarantee before they can ship, and buyers (importers) who need to be sure that the goods they paid for are actually being delivered. Moreover, it has the power to solve conflicting financial interests between both parties. Whereas buyers prefer to extend payment terms, suppliers have the desire to accelerate the payment for sold goods or services. Trade and supply chain finance can create win-win situations by providing financing solutions designed to optimize the supply chain's overarching financial performance.

Supply chain finance (SCF)

According to the Global SCF Forum[1], SCF is defined as "the use of financing and risk mitigation practices and techniques to optimize the management of the working capital and liquidity invested in supply chain processes and transactions. SCF is typically applied to open account trade and is triggered by supply chain events. Visibility of underlying trade flows by the finance provider(s) is a necessary component of such financing arrangements which can be enabled by a technology platform. […] SCF is not a static concept but is an evolving set of practices using or combining a variety of techniques; some of these are mature and others are new or 'leading edge' techniques or variants of established techniques, and may also include the use of traditional trade finance."[2]

Trade finance

Trade finance is usually used as a generic term for a range of traditional trade finance products, such as letters of credit or document collection. In conformity with the Global SCF Forum, this paper takes a holistic view of SCF, and thus considers that traditional trade finance is included in the scope of SCF. The terms trade finance and SCF are therefore used synonymously in the following.

According to the WTO, 80-90% of world trade relies on trade finance.[3] However, the Asian Development Bank has reported a global trade finance gap of $1.5 trillion, which impedes the full potential of trade to deliver economic growth. This gap results largely from insufficiently met demand from small and medium sized enterprises (SMEs). In addition, the paper-intensive processes of traditional trade finance products, which require a number of manual activities and controls, make trade finance not only expensive for exporters and importers, but also error-prone and susceptible to fraud.[4] Many of the challenges in trade and SCF are driven by the large number of players and documents involved in a single transaction. The Boston Consulting Group estimates that a typical trade finance deal usually involves more than 20 parties. The related data field interactions are well over 5,000, with

[1] Global SCF Forum participating organizations: The International Chamber of Commerce (ICC) Banking Commission, BAFT, the Euro Banking Association (EBA), Factors Chain International (FCI), and the International Trade and Forfaiting Association (ITFA).
[2] Global SCF Forum 2016.
[3] World Trade Organization 2019.
[4] Kim et al. 2019.

“create value-adding data” accounting for only ~1% and “ignore/transmit” accounting for more than 85%.[1]

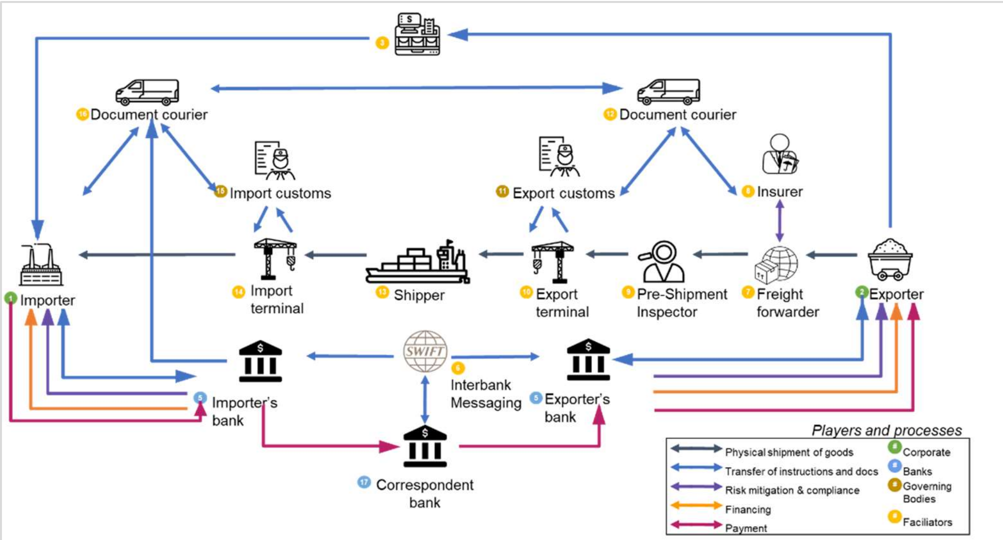

Figure 2: Traditional trade finance ecosystem[2]

One of the main reasons for financial institutions to reject trade finance proposals are the strict know-your-customer (KYC) and anti-money laundering (AML) policies as well as insufficient information flows, especially when suppliers are based in countries where credit decision is hindered by the lack of credit reports and other basic data about these trading partners.[3] In combination with Basel III regulations, which forces banks to keep higher levels of capital against trade and SCF products, transaction costs have increased. As a result, trade and SCF are often only attractive for big companies that carry out large transactions.

As it turns out, trade and SCF are faced with many challenges requiring progress towards the digitization that enables processes to be streamlined, automated or eliminated. Nowadays, after years of hype and enthusiasm, followed by modest advancements, we hold a multitude of technical opportunities in our hands to finally drive the digitization of the trade and SCF business.

[1] Boston Consulting Group 2017.
[2] Boston Consulting Group 2017.
[3] International Chamber of Commerce 2018.

4
Big data as an indispensable basis for present and future technologies

4.1 Fundamentals / basics / definitions

Trade and, as a consequence, trade finance business are experiencing a turning point that could not be more fundamental and challenging at the same time. There are technical developments and new services on the market almost every day. The basis for these significant changes is the increasing volume of data. IDC (International Data Corporation) expects that the amount of global data will grow rapidly from 33 zettabytes in 2018 to 175 zettabytes by 2025.[1]

Big data

The term “big data” refers to the progressively growing quantity of datasets that are too large, complex, fast moving or weakly structured to be evaluated using conventional data processing tools.[2] Big data is usually characterized by the 4Vs: volume (amount of data), velocity (speed of data growth), variability (diversity in content, sources and structure), and veracity (reliability or truthfulness of data).[3] Big data management involves the use of analytical methods to extract value from this data.

Various sources are responsible for the enormous increase in the volume of data. These include data management systems (such as ERP, PLM or CRM), intelligent objects (IoT data from machines and products), sensors, mobile terminals, information from external partners, the World Wide Web and social media. The growing amount of data makes efficient and effective data management indispensable. Some years ago, the British mathematician Clive Humbly coined the particularly vivid phrase “Data is the new oil.”[4] In his formulation, data resembled oil because, just like oil needs refining before it can be used, data requires processing to obtain useful information and create business value. Like the data itself, big data analytics solutions are experiencing exponential growth. IDC predicted in their Worldwide Semiannual Big Data and Analytics Spending Guide that global sales of big data analytics solutions will grow from $130.1 billion in 2016 to more than $260 billion in 2022.[5] The banking industry is among the fastest growing market for these solutions.

Banks have huge amounts of customer data (payment data, customer profile data for KYC etc.), but due to their product-oriented organizational silos they often do not utilize these extensive data sets.[6] This is why the financial services industry has been investing heavily in big data capture and processing technologies for more than a decade. As customer expectations and competition from Fintech companies increase, banks cannot afford to leave this vast amount of data unused. Instead, they must use these data sets to maximize customer understanding and create attractive financing offers.

The goal of any business analytics solution is to provide the organization with actionable insights for smarter decisions and improved business performance. Different methods of

[1] Reinsel et al. 2018.
[2] McKinsey & Company 2011.
[3] Wachter 2018.
[4] IDC 2018.
[5] IDC 2018.
[6] Lochy 2019.

analytics, however, offer different types of insights. Therefore, it is important for managers to understand what each method delivers in order to apply its functions accordingly in practice and to adapt decision-making and business processes.

Big data as an indispensable basis for present and future technologies

Differences between four analytical methods

Analytics solutions are of four types:[1] Descriptive, diagnostic, predictive and prescriptive.[2] Descriptive analytics uses business intelligence and data mining to ask: "What has happened?" Diagnostic analytics examines data to answer the question: "Why did it happen?" It therefore presents the causes of the events identified by the descriptive analytics. Predictive analytics uses statistical models and forecasts based on the details of past events to ask: "What could happen?", whereas prescriptive analytics uses optimization and simulation to propose decision options and actions, pursuing the question: "What should we do?"

4.2 Relevance for trade and SCF

Huge amounts of data may seem impressive at first glance, but without suitable analytical methods they are useless. The collection and storage of data has never been easier and cheaper; however, according to a Veritas Global Databerg report, 84% of data held by organizations is either dark, redundant or has no known value, leaving only 16% considered as business critical.[3] In future, it is to be expected that the volume of data generated worldwide will at least double every two years. The rapid increase in the volume of data is attributable to sensor data, communication via social media channels and mobile communication, among other things. IDC expects the amount of data generated by IoT devices to grow rapidly, reaching an estimated 79.4 zettabytes by 2025. IoT will thus create a wave of new data that will lead to one of the most significant changes in trade information data sets for decades within the trade and SCF processes.[4]

Big data analytics can help financial institutions leverage the wealth of trade data stored in multiple databases across different geographies along the supply chain. By identifying data trends and flagging anomalies, banks are able to detect fraud at an early stage.

DBS

DBS, a leading bank in Asia, is partnering with **A*STAR's Institute for Infocomm Research** (I^2R), Singapore's largest ICT research institute, and **Cloudera**, the leading provider of a data management and analytics platform, to exploit big data technology to detect unusual transaction activities in the trade finance space.[5] With this new initiative for trade alerts, DBS is able to reveal fraud anomalies through transactional trends instead of relying on individual transaction checks. The program makes use of a broad range of trade data, including shipping data. It was launched in April 2016 and comprises 13 locations across DBS Group. Alerts are detected at the transaction level; however, DBS intends to extend this to a customer portfolio view in real time.

The early detection of fraud also enables improved risk management and stronger regulatory compliance, which is particularly important against the background of increasing compliance requirements in trade finance. The more comprehensive and tightly controlled regulations, such as KYC and AML policies, expose banks to a higher risk of reputational

[1] Gartner 2016.
[2] IDC 2018.
[3] Veritas Technoloies 2016.
[4] Boston Consulting Group 2017.
[5] DBS 2016.

damage and fines. From 2007 to 2014, fines on U.S. and European financial firms rose from $30 million to $58 billion.[1] The development of an effective compliance program through the use of big data analytics is therefore essential.

Big data as an indispensable basis for present and future technologies

HSBC

To combat financial crimes like money laundering, human trafficking and terrorist financing, HSBC deployed a Global Social Network Analytics (GSNA) platform in March 2018.[2] Developed with Fintech company Quantexa, the platform leverages big data, advanced analytics and automated monitoring to provide a holistic view of the bank's customers and enable investigators to analyze financial activity and detect and intercept financial crime in international trade. The bank's transaction data is enriched with additional information from external sources to identify suspicious activities across the HSBC network. By combining bank data with external data, HSBC receives stronger insights for decision-making purposes. The system automatically screens all trade finance transactions against over more than 50 potential scenarios that indicate signs of money laundering, such as associated networks and payment patterns. It is already active in the UK and Hong Kong and is being rolled out globally. In addition, HSBC has introduced an automated sanctions checking tool for its global trade and receivables finance (GTRF) business, developed in-house using machine learning technologies.[3]

Since the trade finance business is one of the most data-driven sectors in the global economy, the relevance of big data can hardly be overestimated. Substantial value lies in the underlying data on trade and shipping flows.[4] By collecting data on customers' history of payment or delivery performance and other characteristics, financial institutions owning the data can better assess transaction risks and thereby reduce the cost of financing. In addition, customer data can be used to better understand the product demand of the value chain players.[5]

Big data can support a trade finance deal in a variety of ways. But only in combination with emerging technologies such as blockchain technology, 5G (which provides the infrastructure for efficient data distribution), IoT (which further enriches data) and AI (which feeds on the data), will the potential of big data be fully exploitable. These technologies will therefore be the subject of the following chapters.

4.3 Outlook on future developments

The data world is changing. In addition to the data itself, the location and method of storage is also changing: from location-based to cloud-based data.[6] The ability to store, collect, combine and use big data for detailed analysis offers immense potential and is becoming increasingly important for companies in all industries. However, much of the data held by banks is dispersed and unstructured; in addition, the inflexibility of legacy IT architectures prevents them from realizing the full value of this data.[7] To keep up with technological developments, banks need to invest in extensible platforms and qualified employees managing big data that supply these platforms. One possibility is to cooperate with Fintechs, which can provide the data (Figure 3). The platform's data feed will enable banks to offer

[1] Dab et al. 2016.
[2] McGowan 2019.
[3] Smolaks 2019.
[4] World Economic Forum 2018b.
[5] International Chamber of Commerce 2017.
[6] PWC 2013.
[7] Dab et al. 2016.

products further down the supply chain and to more easily assess customers' credit risk based on their supply contracts and invoices.[1]

Big data as an indispensable basis for present and future technologies

Although many banks have digitized their own processes, they often operate in digital “silos” or “islands”, which makes them incapable of utilizing the extensive data sets.[2] Since the ability to connect all parties within a supply chain has been missing so far, it happens that the chain is interrupted somewhere in the process and paper is used by default. To avoid paper masses, these digital islands must be connected using common digital standards and protocols. It is also necessary to broaden the horizon to connect customs, shipping companies, control companies and banks with all actors in the supply chain in order to achieve a true digitalization of trade.

While big data offers exciting opportunities, banks also face a number of challenges in terms of data security and privacy. Particularly in the context of the IoT, robust cybersecurity will be more important than ever, as every connected device represents a new potential surface of attack.[3] The potential for misuse of this data is considerable. For this reason, banks must continue to maintain the highest levels of privacy, security and control over their customers' personal data so that consumers can be sure that their data is secure at every point along the supply chain. This trust is crucial for a well-functioning financial system and the reason why banks should continue to provide enormous resources for the protection of customer data.

Moving forward, the importance of big data, their processing and analysis will continue to evolve. Big data is no longer just a term, but is linked to many new technologies such as blockchain, IoT, smart contracts and artificial intelligence, to name just a few. If one looks for the term "big data" in the Hype Cycle of the market research company Gartner, one must go as far back as the year 2014. At the time, big data was already in the so-called "Trough of Disillusionment" phase and then disappeared completely from the radar of Gartner's trend concepts. Nevertheless, the concept itself has not disappeared. Rather, big data are the key source for the emerging technologies mentioned and have thus become part of many hype cycles. Since many reports predict that these technologies will be viral and will achieve revolutionary growth in 2025 and beyond, big data will continue to play a huge role. Figure 4 provides an overview of a B2B Trade Blockchain Ecosystem.

[1] International Chamber of Commerce 2017.

[2] International Chamber of Commerce 2017.

[3] American Bankers Association 2019.

Figure 3: Tradetech 40 - Fintech in Global Trade

Big data as an indispensable basis for present and future technologies
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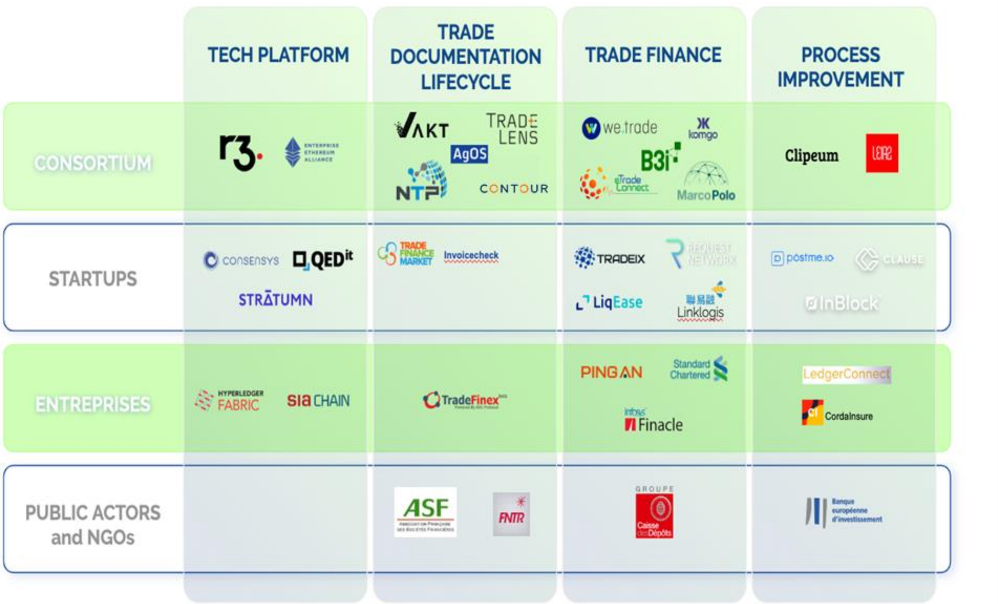

Figure 4: B2B Trade Blockchain Ecosystem

5 Distributed ledger technology (DLT) as technological basic

5.1 Fundamentals / basics / definitions

Blockchain technology

The blockchain technology represents a subcategory of the DLT and is probably the most famous of its kind.[1] Since Satoshi Nakamoto published his white paper[2] in 2008 and the first bitcoins were created in early 2009, both cryptocurrencies as well as the underlying technology of the blockchain have received a tremendous amount of attention.[3]

Definition and operating principle

In its simplest form, a blockchain may be considered as a continuously growing list of chronological data records stored in a data memory that is replicated, distributed and synchronized across a network of computers (known as "nodes").[4] These records are collected for a defined period of time and then grouped in blocks which are linked by a cryptographic reference (called "hash") to the respective previous block, thus forming a chain of blocks.[5] Unlike traditional databases, which are administered by a central entity, blockchains are not controlled by a single authority. In order to create a new block, network members use a consensus mechanism to ensure that every node agrees on the new block. Once a valid block is generated, the entered data cannot be modified or removed afterwards. The distributed data memory updates itself and saves the latest version on each node.

Originally, the blockchain was designed to perform and record bitcoin transactions. However, since people have realized that they can make use of the core concept of blockchain as a distributed transaction ledger for any type of transaction or information, more and more areas of applications are being discovered.[6] The basis for this interest is composed of the following six key functions derived from the technical aspects of the blockchain concept:

Key functions

- Witnessing function and disintermediation: Holden and Malani compare the core function of blockchain with a witnessing statement.[7] Analogous to a witness, the nodes of blockchain can observe an event (e.g. A transfers money to B) and then testify that they witnessed the event, e.g. by solving complex mathematical puzzles (proof-of-work method). The ability of blockchain to verify the authenticity of transactions reduces the need for trusted intermediaries (e.g. a notary).[8]
- Economies of scale: The distributed ledger concept utilizes economies of scale from observing multiple transactions[9], analogous to the rating system on eBay. For example, buyer A purchases an item from seller B, who delivers a high-

[1] DLT is a database technology that includes blockchain technology but not every blockchain is a distributed ledger.
[2] Nakamoto 2008.
[3] Prinz and Schulte 2018.
[4] Swan 2015.
[5] Swan 2017.
[6] Treiblmaier 2018.
[7] Holden and Malani 2017.
[8] Hackius and Petersen 2017.
[9] Holden and Malani 2017.

Distributed ledger technology (DLT) as technological basic

quality product within a short delivery time. Assume C wants to buy an item from B as well. If C is able to witness the transaction between A and B, C is more confident that B is a trustworthy and reliable seller. To demonstrate the economies of scale, suppose D wants to buy from B as well. In this case, D benefits not only from observing C's successful transaction with B, but also from A's transaction with B. The more transactions are carried out and the more positive reviews are made, the more credible the information will be.

- Secure, real-time and easy information distribution: Blockchain allows information of all types to be shared at greater speed and more securely compared to existing systems.[1] Each participant in the blockchain network has access to the same information at the same time, since the shared data is updated across the network near real-time. Before distributing information to the network, network members have to digitally sign their transaction data using their own private key.[2] If the data is modified, the signature will become invalid and the network will detect any changes immediately.[3] Another specialty that makes the technology more secure stems from the distributed character of a blockchain. Due to the fact that the ledger is replicated and shared across a network of participants, there is no single point of failure and it cannot be hacked from a single server.[4] An enormous amount of computing power is required to hack the majority of the nodes simultaneously, which, though theoretically possible with large-scale quantum computers, goes far beyond the capabilities of today's binary computers. In addition, blockchain enables a simplified digital communication. In contrast to conventional EDI, the distributed ledger concept does not require a unique implementation for each network member.[5] As blockchain is a single system, only one access point has to be implemented for each network member. The easy implementation of the blockchain allows short-term business partnerships without the investment barriers for complex EDI adoption.
- Immutable information storage and registry: In contrast to a classical ledger whereby a previous record is overwritten, each new block is timestamped and added to the chain in linear and chronological order.[6] Hence, the blockchain provides transparency into its entire transaction history and allows for registering, tracking and tracing of ownership of a wide range of assets, such as inventory or receivables.[7] Any retroactive modification made to information in one of the blocks would change a block's hash value.[8] Since blocks are linked together by hash values, altering a single block requires the changing of all following blocks, which is computationally hard and can be easily detected.[9] Besides asset registration, any kind of information can be stored on and validated by the blockchain, even activities or identities.
- Anonymity and privacy preservation: Blockchains promote the preservation of anonymity and privacy by two means.[10] The first is by providing asymmetric cryptography. Each user receives a public and a private key, which does not

[1] Euroclear and Oliver Wyman 2016; Pawczuk et al. 2018; Agrawal et al. 2018.
[2] Badev and Chen 2014.
[3] Miles 2017.
[4] Hackius and Petersen 2017.
[5] Accenture 2018.
[6] Yermack 2017; Lafarre and van der Elst 2018.
[7] Hofmann et al. 2018.
[8] Agrawal et al. 2018.
[9] Sultan et al. 2018.
[10] Holden and Malani 2017.

Distributed ledger technology (DLT) as technological basic

disclose the real identity.[1] A second means to ensure privacy is by constructing a private or hybrid blockchain. In contrast to a public blockchain like bitcoin, which everyone can access, private blockchains are usually owned by an organization, analogous to a corporate intranet.[2] In order to access, read or submit data to the private blockchain, each user needs permission.[3] In a hybrid blockchain, also known as consortium, the right to read the blockchain may be public or restricted to certain participants, while the verification process is controlled only by pre-selected parties, e.g. by a consortium of financial institutions.[4]

- Trusted automation of transactions and processes: Another function of blockchains is to provide the necessary infrastructure to realize the vision of the internet of things (IoT) and enable the efficient employment of smart contracts. Since IoT and smart contracts have a special relevance for the future of trade finance, a separate chapter is dedicated to these technologies in the following.

Alternative DLT

Alternatives to traditional blockchain technologies exist. Hoping to accomplish the same goals via different methods of increasing productivity and security. For example, a Tangle is an alternative to blockchain. It has the same characteristics, but operates differently. Defined in the "Tangle Whitepaper" by IOTA, it uses a "Directed acyclic Graph" (DAG) as the base of its data structure instead of a traditional blockchain. Vertices and edges represent approvals. According to IOTA it scales better and faster than conventional blockchain technologies, while maintaining all the positives. The focus of IOTA’s use cases lies in the Internet of Things.

The majority of current practical blockchain applications are situated in the financial industry as well as the logistics sector.[5] Supply chains are a fertile ground for blockchain implementation, since they consist of independent suppliers, manufacturers, retailers, logistics and financial service providers, who are bound together by contractual agreements and require technologies that could connect all actors along the supply chain. The ability of blockchain to provide a secure infrastructure for distributing immutable information and recording an unchangeable history of transactions holds the promise to facilitate business among anonymous supply chain parties. Blockchain, therefore, will profoundly alter the way in which trade and trade finance business is done worldwide.

5.2 Relevance for trade and SCF

Blockchain as a novel technology promises to change business processes and revolutionize financial transactions. It has the ability to a) digitize and automate trade and SCF processes, to b) reduce transaction costs, to c) mitigate trade and SCF-related risks and to d) open up new trade and supply chain financing opportunities.

a) Blockchain can digitize and automate trade and SCF processes

The processing of traditional trade finance products, in particular letters of credit, is paper-intensive and involves multiple parties along the supply chain. According to the Boston Consulting Group, more than 20 parties are usually involved in a single trade finance

[1] Zheng et al. 2017.
[2] Swan 2017.
[3] Peters and Panayi 2016.
[4] Hofmann et al. 2018.
[5] Prinz and Schulte 2018.

Distributed ledger technology (DLT) as technological basic

transaction, dealing with 10 to 20 various documents and over 5,000 data field interactions.[1] So far, many efforts have been made to digitize documents along the supply chain. One example is the introduction of electronic invoicing solutions, which are making huge steps towards the standardization of electronic business documents and procedures. However, they do not change the old paradigm of paper-based invoices, since they do not digitize the transactions themselves and mitigate the risks associated with trade.[2]

Blockchain, in the sense of a distributed digital repository, creates transparency and trust for all involved parties in a transaction by recording an unchangeable history of transaction data. After data is recorded, it is immediately shared across the supply chain, which creates an up-to-date system. Data integrity, trusted information, credit history, and verification of the authenticity of business partners facilitate the process of providing trade and SCF solutions and improve the profitability of financing. Sharing and storing documents along all processes like payment and financing in digital form enhance visibility and accelerate the traditional processes. By using the blockchain in conjunction with smart contracts, process steps that currently have a long lag time can be automated.[3]

Leading financial institutions and industry players around the world join forces to explore how blockchain could help to automate trade and SCF processes. Various use cases and proof of concepts have been developed, which will be discussed in more detail in Chapter 5.5.

b) Blockchain can reduce transaction costs

For decades, banks have been trying to eliminate inefficiencies by transforming trade and SCF. According to the World Economic Forum, the typical cost-to-income ratio in trade finance is 50-60%.[4] This means that more than half of the fees charged to clients for trade finance are operating costs before risk, liquidity and capital costs are covered. Bain & Company released a report about blockchain's disruption in transactional banking. The report estimates that the technology could reduce trade finance operating costs by 50-80% and improve turnaround times three- to fourfold, depending on the trade finance product.[5] Because blockchain technology allows information to be exchanged with all supply chain parties in real time and in a highly secure manner, and processes to be automated through the use of smart contracts, the cost of coordination and delays can be minimized. Having a single source of truth shared between involved parties reduces the cost of errors due to repeated reviews, shortening the time to financing.[6] Furthermore, information added to the blockchain can be tracked, audited and automatically verified against pre-defined terms of a smart contract, reducing verification costs to virtually zero.[7] The economy of scale function of the blockchain, as described under key function 2, additionally reduces the costs of the SCF provider when searching and obtaining SCF-relevant information of buyers and suppliers. Reputation and credit ratings of companies can be tracked through the blockchain, so that every supply chain member can access its partner's evaluation, but nobody can manipulate it. The more validated evaluations are stored on the blockchain, the lower the probability of misinformation.

c) Blockchain can mitigate trade and SCF-related risks

One of the main drivers for financial institutions to reject trade finance proposals are insufficient information flows. Where risks can be traced back to the presence of

[1] Boston Consulting Group 2017.
[2] Ganne 2018.
[3] DiCaprio and Jessel 2018.
[4] World Economic Forum 2018b.
[5] Olsen et al. 2018a.
[6] DiCaprio and Jessel 2018.
[7] Ganne 2018.

asymmetric information, the blockchain is a suitable means of overcoming information asymmetries and thus reducing risks.[1] Recording transactions on a blockchain leads to an unchangeable memory of metadata supporting the financiers' risk management. Because the blockchain network is based on the consensus mechanism, each transaction executed is verified and approved. If, for example, a supplier stores the information on the blockchain that he has produced and shipped the ordered goods, and a logistics provider confirms this information, the financier has greater certainty that the goods actually exist and are on their way to the buyer. In addition, the blockchain provides a decentralized infrastructure necessary for smart devices that are able to track the supplier's goods along the supply chain. By providing a chain of custody along the supply chain, blockchain proves authenticity and assurance against counterfeits. The witnessing function of the blockchain thereby reduces the risk of fraud.

Distributed ledger technology (DLT) as technological basic

Another concern in trade finance is about double-spending issues. Double-spending arises from fraudulent activities of a borrower who raises funds from multiple financiers using the same asset. The possibility of a distributed register of assets supported by the blockchain can protect the financier against the risk of double financing. With Corda for example, an open source blockchain platform, a notary ensures uniqueness of an invoice or payment.[2]

d) Blockchain opens up new trade and supply chain financing opportunities

Beyond efforts to exploit the benefits of blockchain to improve existing trade and SCF solutions, companies have started to explore new blockchain-based financing products to target the financial needs of SMEs. In 2016, 98% of enterprises which traded goods in the European Union (EU) were SMEs, which generated more than half of the value added.[3] Despite their importance for the EU economy, it is common knowledge that SMEs often face problems in accessing financing. To cope with these difficulties, financiers have developed innovative solutions such as SCF. The most popular SCF instruments in use are reverse factoring and dynamic discounting. Reverse factoring allows suppliers to sell their receivables to a bank at a favorable discount as soon as they are approved by the buyer. The bank relies on the credit worthiness of the buyer, thus the instrument takes advantage of the credit rating discrepancy between small suppliers and large buyers. Dynamic discounting gives buyers the flexibility to choose how and when to pay their suppliers in exchange for a lower price or discount for the goods and services purchased. Even though SCF initiatives can help SMEs to address their financing issues, many of today's instruments cannot fully meet the requirements of the SMEs. Reverse factoring and dynamic discounting are both forms of post-shipment financing. However, the liquidity needs of SMEs often arise before goods are shipped, so suitable pre-shipment financing instruments, like purchase order financing or inventory financing, are needed. Furthermore, most of the reverse factoring and dynamic discounting programs engage only big corporates and their direct, typically larger suppliers.[4] One of the main obstacles to involving SMEs or lower-tier suppliers in SCF programs is caused by complex onboarding requirements due to Know-Your-Customer (KYC) and Anti-Money Laundering (AML) policies as well as insufficient information flows, especially in case of transboundary financing activities.[5] Furthermore, financiers evaluate lending to SMEs as a costly and risky business.

As outlined under points a) and b), blockchain accelerates the financing process and reduces transaction costs, making it more profitable for banks to provide small financing volumes to SMEs. In addition, the immutable nature of blockchain makes it easier to track the transaction history and assess the creditworthiness. Apart from the storage of transaction data, companies' identities can be stored on and validated by the blockchain. To protect the

[1] DiCaprio and Jessel 2018.
[2] DiCaprio and Jessel 2018.
[3] Muller et al. 2017.
[4] Bryant and Camerinelli 2014.
[5] APEC 2014; Bal 2017.

Distributed ledger technology (DLT) as technological basic

global financial system from being used for illegal activities, banks have to perform KYC policies for every new customer in order to undertake financial business with them. Identifying the customer and collecting the relevant information is a time-consuming and costly task. The implementation of an industry-wide customer registry, based on a blockchain system that streamlines the several KYC processes across different financial institutions, could reduce onboarding wait times, eliminate the need to repeatedly provide the same information to multiple banks and allow financiers also to include the long-tail supplier base.[1]

Another potential new SCF solution results from the conjunction of the blockchain technology with further advanced technologies, such as IoT and smart contracts. As shown in chapter 6, smart contracts run on the blockchain and are called into action automatically when a “trigger event” occurs. In combination with IoT, these event-based smart contracts offer the possibility to track the physical supply chain and provide trigger points to key events for a range of SCF solutions, such as inventory finance, pre-shipment finance or receivables finance.[2]

5.3 Outlook on future developments

Blockchain is still an emerging technology, and currently a decentralized data memory by itself often does not provide a significant benefit over conventional centrally managed systems. However, with the ever-increasing complexity of IoT and autonomization of supply chains, a central coordination would probably be almost impossible and blockchain, as a decentralized peer-to-peer structure allowing far-reaching, self-determined smart objects, is necessary. Before the technology is ready for widespread use, though, some barriers have to be overcome. The World Trade Organization has identified three groups of challenges: (a) technological challenges, (b) interoperability challenges and (c) legal issues.[3]

Technical challenges exist above all in the scalability of individual blockchains. What is meant here is the possible transaction rate, which in most cases is not yet at the level of classic technologies such as visas (as a means of payment) or cloud applications (for calculations). In addition, public blockchains that use the proof-of-work mechanism generate considerable externalities due to their enormous energy consumption. However, there are already some methods and algorithms being developed to increase energy efficiency.[4] Permissioned blockchains, for example, use lighter consensus mechanisms, which are significantly less energy-intensive. IOTA or Hashgraph are alternative types of distributed ledger that are much faster than Bitcoin and need much less computational power.

A global distributed trade network still remains the vision in trade and SCF. However, in the near to distant future this thought will probably remain what it is today: a vision. According to a study conducted by Bain & HSBC in 2018, it is much more likely that a large and perhaps global network will consist of several smaller networks.[5] Each network will have its own technical standards and business rules. The development of interoperability solutions is therefore critical to realizing widespread adoption of blockchain technology.[6] There are already a few vendors that are actively working towards the goal of enabling or improving blockchain interoperability through cross-chain technology. Some examples are Pantos,

[1] Hofmann et al. 2018.
[2] Hofmann et al. 2018.
[3] Ganne 2018.
[4] Ganne 2018.
[5] Ganesh et al. 2018.
[6] Ganne 2018.

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BlockNet, Cosmos and WanChain. Beyond the interoperability, industry participants will need to agree on standard data sets covering all data used for the exchange of information.

Regulatory challenges exist above all in unclear framework conditions. These include the tax classification of blockchain-based tokens and financing models by ICOs. Here there are still many grey areas and individual case decisions that create a high level of uncertainty among founders and investors. In addition, some basic features of the technology, such as the immutability of entries or the lack of a central information point for public blockchains, are incompatible with the basic EU data protection regulation.

McKinsey & Company estimate that the strategic short-term value of an implementation of blockchain in trade finance is primarily in reducing costs of transactions, rather than creating transformative business models.[1]

Gartner, which sees the first phase as a test phase with few high-profile successes, has a similar view. In their business value forecast the near future of blockchain is divided into 3 phases. Phase 1, which runs from 2018 to 2021, is a testing stage with a few high-profile successes, but very little actual business value. After that, in phase 2 (2022-2026), there are going to be larger focused investments and many successful models. Still, the business value won't reach 500 billions of dollars until the year 2027. This is when the third and last phase will begin. By 2030 the business value of blockchain applications will reach more than US$ 3 trillion. The BCT will have established itself on a global level and will have a large economic value-add in international trade.[2]

The World Economic Forum has not mentioned such a high amount. According to the results of its study, which was carried out in collaboration with Bain & HSBC, the removal of barriers by the BCT could lead only to more than US$ 1 trillion in new trade in the next decade.[3] Nevertheless, the removal of barriers will benefit SMEs in particular in the future. The BCT will provide them with an easy and fast way into the global market and interesting new opportunities. Especially small companies with high fixed costs and from developing countries will profit from the implementation of BCT in their financial services.[4]

[1] Carson et al. 2018.

[2] Gartner 2018a.

[3] World Economic Forum 2018b.

[4] Ganne 2018.

5.4 Relevant stakeholders and technology providers

Distributed ledger technology (DLT) as technological basic

There is a tremendous amount of activity focused on blockchain. Especially in the trade finance area, where many different stakeholders are involved, banks and regulators worldwide are teaming up in consortia to digitize trade financing processes. Since 2017 more than 30 consortia have been founded with around 10 to 15 initial founding members.[1] Each consortium is based on a specific blockchain infrastructure, offering its own unique set of features which fundamentally affect the use cases that they can be applied to (Table 1). Currently, there are three main underlying blockchain technologies in the trade finance sector: Corda, Hyperledger Fabric and Quorum.

Corda

Corda is a distributed ledger platform for recording and processing financial agreements.[2] It is developed for regulated financial institutions. What distinguishes Corda from most other DLT software solutions is that Corda does not use the blockchain technology to store data. Instead, it uses a regular SQL database technology combined with a new network design approach and a special consensus system, which makes scaling significantly easier compared to traditional DLTs.[3] While other platforms usually reach consensus at the ledger level, Corda performs the consensus on the validity of the transaction only by means of the parties involved in that transaction. Thus, data is only shared with the corresponding parties. As a result, each party sees only a subset of the data on the ledger, and no peer knows the ledger in its entirety, which ensures a higher level of privacy for all parties.

Hyperledger Fabric

Hyperledger Fabric is a blockchain infrastructure that aims to provide a wide range of industries with blockchain solutions. It is one of the Hyperledger projects hosted by the Linux Foundation and sourced by IBM.[4] Fabric ensures privacy by offering the ability to set up shared channels between parties, whereby the transaction within the channel is not accessible for external parties.[5] Each channel within a network maintains a separate ledger. As the number of required channels increases with each new participant, the complexity of the network also increases. To raise the overall performance and scalability, Fabric takes a unique system architecture. While most other blockchain systems follow an order-execute architecture, the fabric approach is based on an execute-order-validate principle. Under the order-execute architecture, the blockchain network orders transactions first and then executes them in the same order on all peers sequentially. Executing transactions prior to ordering, as in the case of Fabric, enables each peer node to process multiple transactions simultaneously.

Quorum

Developed by J.P. Morgan, Quorum is a blockchain platform that is built on top of the standard Ethereum protocol.[6] It was specifically designed to provide the financial services industry with a permissioned implementation of Ethereum that

[1] Trade Finance Global & TradeIX 2019.
[2] For a more detailed description of Corda, see Brown et al. 2016.
[3] Mathiasen et al. 2019.
[4] For a more detailed description of Hyperledger Fabric, see IBM 2018.
[5] Mathiasen et al. 2019.
[6] Ethereum differs from the other DLT infrastructure in the sense that it is a public permissioned network. For privacy and regulatory reasons, its practical use cases in trade finance are limited (Trade Finance Global & TradeIX 2019). For further information about Ethereum, see Buterin 2013 .

supports transaction and contract privacy. Quorum achieves privacy by introducing public and private transactions. Whereas in Ethereum all nodes process all transactions, in Quorum nodes process all public transactions, but only process the private transactions that they are party to. Quorum's consensus protocol is a simple majority voting protocol, following a confirmation check to ensure that each node has the same current state of public transactions. Private transactions are validated because they include the hash of the global state of public transactions of the blockchain.

At present, a total of eight major consortia and networks can be identified in the market that focus on various activities in the trade finance business.[1] These activities can be roughly categorized into the four fundamental subcategories: a) open account trade, b) commodities, c) shipping and freight and d) letters of credit and e-bills of lading.

a) Open account trade

Up to 80% of today's trade volume are open account transactions,[2] where the goods are delivered weeks or months before payment is due. That increases the risk for the supplier, who needs a higher financing of working capital, and also runs the risk of the buyer becoming insolvent and being unable to pay his invoices or failing to pay within the agreed terms and conditions. Consortia like *we.Trade* and *Marco Polo* tackle this issue by providing suppliers with a payment assurance and the possibility of additional financing.

b) Commodities

Commodity financing, a term used for funding the trade of commodities like metals and energy, has always been a challenging task, since margins in this area of trade finance are typically low and the goods are traded cross-border between different jurisdictions, resulting in a high counterparty risk. Consortia such as *Komgo* and *Vakt* have specialized in specific use cases with a focus on the oil trading industry. In these cases, the DLT technology promises cost reduction and an increased trust structure as the main benefits.

c) Shipping and freight

The consortia *CargoX and TradeLens* instead focus more on the logistics part of business. The main focus here is more on the movement of the goods. In current business this comes with a noticeable amount of overhead. This means: each entity involved in the process maintains its own tracking of actions which must be reconciled within a manual and paper-based process. The properties of DLT help to get rid of this overhead.

d) Letters of credit and e-bills of lading

Traditionally, trade finance has been largely based on letters of credit. Letters of credit are issued by the buyer's bank and guarantee that it will pay the supplier's bank once it receives proof that the supplier has shipped the goods. According to some experts, today the creation and transfer of letters of credit among the parties involved can take five to 10 days.[3] The two consortia *eTrade Connect* and *Contour* are investigating applying blockchain technology to digitalize documentary trade finance.

All of the presented consortia have in common that, due to the immensely regulated nature of trading business, the underlying DLT structure is permissioned. This means that, in contrast to a permission-less structure, access is restricted to a set of verified players.[4]

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[1] Trade Finance Global & TradeIX 2019.
[2] International Chamber of Commerce 2018.
[3] Meijer 2018.
[4] See key function "anonymity and privacy preservation" in chapter 4.1 International Chamber of Commerce 2018.

Table 1: Overview of eight major trade finance consortia

Distributed ledger technology (DLT) as technological basic

	Marco Polo	We.Trade	Contour/Voltron	KOMGO	VAKT	CargoX	TradeLens	eTrade Connect
Focus	Open account trade	Open account trade	Letters of credit and e-bills of lading	Commodities Trade Finance	Commodities Trade Finance	Shipping and freight	Shipping and freight	Letters of credit and e-bills of lading
Services	Network: Pre/post shipment financing, risk mitigation, integration of ERP/other ecosystem partners	Platform: Risk mitigation & financing: Bank Payment Undertaking (BPU)	Platform: Electronic letter of credit + integration of ecosystem partners	Document Trade (for KYC) and electronic letter of credit	Deal recap, confirmation, contract, invoicing.	Platform: Smart bill of lading solution	Platform: Information sharing and collaboration across supply chains	Platform: Pre/post shipment financing, document trade
Goal of initiative	Global digital ecosystem for trade	Platform to facilitate digital trade finance transactions for corporates	Digitize trade finance documents	Digital trading platform for all players along commodity specific supply chains	Digital trading platform for all players along commodity specific supply chains	Securing digital bills of lading for marine logistics	Connecting the logistic ecosystem, fostering collaboration and trust	Digitize trade documents, automate trade processes and connect to other trade platforms
DLT Protocol	Corda	Hyperledger Fabric	Corda	Quorum	Quorum	Ethereum	Hyperledger Fabric	Hyperledger Fabric
Govern./ Bus. Net. Owner	TradeIX and Banks	9 Banks and IBM	Banks and CryptoBLK	n/a	n/a	n/a	Maersk and IBM	Hong Kong Trade Finance Platform Company (i.e. Government of Hong Kong)

Distributed ledger technology (DLT) as technological basic

	Marco Polo	We.Trade	Contour/Voltron	KOMGO	VAKT	CargoX	TradeLens	eTrade Connect
Banks / Participants	Founding: BNP, Commerzbank, ING; Bayern LB, Helaba, LBBW, S-Servicepartner; AGTB, Alfa Bank, Bangkok Bank, Bradesco, Credit Agricole, Danske, DNB, INTESA, OP Financial, NatWest, Natixis, RBI, SMBC, Standard Chartered, Wells Fargo, Standard Bank, Bank of America, MUFG, National Bank of Fujairah	Deutsche Bank, HSBC, KBC, Natixis, Nordea, Rabobank, Santander, SocGen, UniCredit, Caixa, UBS, Erste Group, Eurobank[1]	BNP, HSBC, ING, Standard Chartered, Bangkok Bank, CTBC, SEB, Natwest, Scotiabank, BBVA, US Bank, Mizuho Bank	BNP, Citi, Credit Agricole, Macquarie, MUFG, Natixis, Rabobank, ABN, Guvnor, ING, Koch, Mercuria, Shell, SocGen, Consensys	bp, Chevron, equinor, Reliance, Shell, Total, ABN, Guvnor, ING, Koch, Mercuria, Shell, SocGen, Consensys	Milsped Group, MakerDAO, Fracht AG, OceanX, GCA, RoadLaunch, dexFreight, MANA, TPG Logistics, DBA Group, Actual Group, Europacific, CDM Softw. Solutions, Freightalia, Globalink, Global Value Network, Sprint, ConsolFreight	Actual Group, CDM Software Solutions, CMA CGM, ConsolFreight, DBA Group, dexFreight, Europacific, Fracht AG, Freightalia, GCA, Globalink, Global Value Network, MakerDAO, MANA, Milsped Group, OceanX, RoadLaunch, Sprint, TPG Logistics	ANZ, Bank of China HK, Bank of East Asia, DBS, Hang Seng, HSBC, Stan. Chart. + BNP, Agricultural Bank of China, Bank of Communications, ICBC, Shanghai Commercial Bank

5.5 Use cases and expert statements

Distributed ledger technology (DLT) as technological basic

Marco Polo itself is one of the fastest growing trade and working capital finance networks. It was established by ING, BNP Paribas, Standard Chartered and Commerzbank AG in 2017 and has grown to a global network consisting of over 25 members.

The core of the network is an open enterprise software platform for trade and working capital finance, developed by TradeIX and powered by R3's Corda blockchain. The platform offers a broad range of trade and SCF solutions (see Figure 5) such as receivables financing, payment commitment, payables financing or guarantees. The aim of the platform is to create better customer experience and seamless data integration, while reducing costs, time and risk.

Open Account/ SC Financing	(Traditional) Trade Finance instruments	Structured TF	Distribution	Cash	Other
Receivables Discounting	Payment Commitment	Securitization	True Sale Market Place	Payments	ERP Applications
Factoring	Trade Loans	Pre-Export Finance	Funded Risk Participation	Treasury Management	Digital Identity
ABL	Letters of Credit	Receivables Marketplace	Unfunded Risk Participation	Cash-on-Ledger	KYC Registry
Payables Financing	Forfeiting & Prom. Notes	Commodity Finance	Physical Supply Chain	Value Added Services	Government
Dynamic Discounting	Guarantees	Inventory Finance	Track-and-Trace	AI & ML	Collateral Registries
Pre-Shipment Finance	Title Registries	Warehouse Financing	Shipping and Logistics Docs	IoT	National Platforms
Deep-Tier Financing	Supply Chain Transaction Management		Warehouse Receipts	Insurance	Trans-National Networks
Distributor Finance	P2P/ OTC	Vendor Master Data	Logistics Data Aggregation	Credit Data	
				OCR	
				KYC/ TBML	

Current roadmap outlook (subject to change based on client priorities/ market conditions)

2019

2020

2021

TBD

Focus CBK

Figure 5: Marco Polo trade and SCF solutions

One of the trade finance solutions offered by Marco Polo is the Payment Commitment, which is a risk mitigation instrument to secure payments against the successful matching of trade data. More precisely, it is an irrevocable and independent undertaking of an obligor (buyer/importer) or its bank to pay or incur a deferred payment obligation and, at maturity, pay a specified amount to a recipient (seller/exporter) bank following submission of data sets required by the respective parties which result in a successful data match.

Distributed ledger technology (DLT) as technological basic

In other words, it allows companies to exchange, verify and automatically match trade data (purchase order, invoice, shipment and other trade data) to obtain digital payment obligations.

While the automatic matching process between the different data sets eliminates the need for manual reconciliation of paper-based documents, it ensures faster payments. The Payment Commitment solution also provides the opportunity to enhance the data with other trade related data feeds, which allows parties to gain visibility and reduces potential discrepancies that arise from ambiguities in payment contract terms and conditions. In addition, it offers the possibility for trade payments to be financed in favor of the supplier. This aspect is very important when it comes to providing liquidity, optimizing working capital and taking advantage of fast and optimized financing, especially for trade business which is handled on an open account basis.

Payment Commitment is similar in structure to the Bank Payment Obligation (BPO); however, it is not based on the Trade Services Utility (TSU), the SWIFT-proprietary data standard and the Transaction Matching Application (TMA). With this there is no single entity which acts as an intermediary everyone needs to trust. - However, SWIFT decided to stop offering this solution in 2020.[1]

Participants in a transaction do not have to trust each other. Once two parties have agreed to a trade, the transaction is binding and, while the network consensus mechanism of the underlying blockchain (DLT) framework ensures data integrity and the fact that there is only one single version of the truth (stored trade and finance data), smart contracts ensure compliance as well as correct and automated execution (of pre-agreed business logic) on both sides.

The Payment Commitment is based on open data standards, the distributed Marco Polo Network and R3's Corda (DLT) technology; the Marco Polo Network vision is to better connect all parties in the trade ecosystem and make trade transaction more transparent, simple and secure.

[1] Wragg 2019.

6
Smart contracts enable trusted transactions

6.1 Fundamentals / basics / definitions

By nature, a contract between two parties is made when one party agrees to the other's (business) conditions, expressed in a declaration of intent. This is commonly known as a manual process and enforces human interaction. Juristically, it is split into an obligation transaction which terminates the contract's conditions, and a fulfillment transaction which structures the contract's execution. This process can easily be illustrated by the market for rental cars: The rental firm declares its intent through a certain offer. Once the customer has decided on one, intent is declared, and the obligation transaction made. In order to execute the agreement (fulfillment transaction) the key and documents of the car are handed to the customer.

Today, in the age of digitalized factories and business processes and interconnected machines, companies fight for most efficient production and best customer experience. Therefore, it is becoming more and more important for computers to interact with each other automatically – without human interaction. This is where smart contracts come into action, with their ability to automate either the fulfillment transaction or both the obligation and fulfillment transactions. Wilkens & Falk (2019) define a smart contract as a program, working by means of an if-then-principle, which executes a predefined action, if a predefined event (so called trigger) has occurred and has been verified.[1]

Smart contracts
Smart contracts are written as small computer programs, usually running on a blockchain, that automatically carry out an operation (e.g. release payment) when certain conditions are met (e.g. invoice is approved).[2]

The term "Smart contract" was first used in 1997 by Nick Szabo, who predicted that new algorithms and public networks like the internet would make new applications of protocols possible, which "facilitate all steps of the contracting process (…) [and] formalize and secure digital relationships which are far more functional than their inanimate paper based ancestors."[3] In other words, computers can automize operations that are based on digital verifiable events through a program code. In this way, smart contracts have been exercised in many business areas for several years and, consequently, the technology is less mystic than often imagined. What makes smart contracts "smart" is the set of rules within a protocol, which determine how data is processed between parties.[4]

The reason for smart contracts' vast popularity is its application within the distributed ledger technology (DLT). With the origin of the second generation of blockchain in 2015 – Blockchain 2.0 – the playing field has been enhanced from the exclusive thought of the digital currency named bitcoin to a distributed infrastructure for software engineering.[5] As a consequence, many initiatives and companies in the blockchain community have been founded, and programs running on a blockchain network have been deployed. Technically, a smart contract builds a network participant – besides the external accounts, controlled by humans or

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[1] Wilkens and Falk 2019.
[2] Abeyratne and Monfared 2016.
[3] Szabo 1997.
[4] Mukhopadhyay 2018.
[5] Wilkens and Falk 2019.

organizations – with its own public key. Thus, transactions can be sent to/from a smart contract node.[1]

Smart contracts enable trusted transactions

By nature, a blockchain platform can only transfer information that is available on the network. Nevertheless, the inclusion of third-party information can become necessary for certain transactions. A smart contract can be extended by external data feed-ins. These so called "Oracles" work as an interface between the DLT network and external data providers like weather authorities (e.g. rain, wind, snow), news agencies or statistics offices (e.g. macroeconomic data, birth rates) in order to verify events through the analysis of these external data.[2] For instance, an oracle of flight data can be implemented to verify flight status for an insurance contract on a blockchain covering flight delays.

The blockchain technology and the design of smart contracts provide gains in efficiency:

- Automatization: Transactions are executed automatically and do not need to be monitored by intermediates. They rely on the principle "code is law": the contract's execution is not manually controlled, but self-enforced. Consequently, transaction costs and risks of incorrect fulfillment transactions can be reduced.[3]
- Mitigation of information asymmetry: The process of distributed consensus enlarges the information distribution. Cong et al. (2018) state that smart contracts mitigate informational asymmetry and increase competition, which leads to greater economic welfare.[4]
- Transparency: All transactions are stored in the network's blocks and thus can be backtracked. Due to the connection of the encrypted blocks, transactions are also tamper-proof against subsequent changes.

These benefits come at a price in terms of technological challenges that must be faced:

- Irrevocability: After a smart contract has been deployed it becomes irrevocable and typically cannot be stopped from performing. Since the code can consist of faults, Mukhopadhyay (2018) recommends smart contract auditing in advance of any deployment.[5]
- Irreducible distribution: Due to a smart contract's automated execution, its distribution cannot be manually controlled. This means an increase in efficiency, but also contains a higher risk of collusion.[6]
- Restriction of technology: Smart contracts are restricted to use cases that are implementable on a blockchain.
- Restriction of events: The events' verification is based on a true/false consideration. Decisions that require elements exceeding this binary structure, cannot be made.[7]
- Inefficient development: Since smart contracts run on networks like Ethereum, each transaction is accompanied by a certain fee (in case of Ethereum, gas) that must be paid to the network's owner. Inefficient smart contracts demand higher amounts of gas than necessary. Blockchain researchers have identified

[1] Wilkens and Falk 2019.
[2] Bashir 2018.
[3] Wilkens and Falk 2019.
[4] Cong et al. 2017.
[5] Mukhopadhyay 2018.
[6] Cong et al. 2017.
[7] Wilkens and Falk 2019.

several inefficient programming patterns, which Mukhopadhyay (2018) summarizes as useless code and under-optimized loop patterns.[1]

- Legal issues: Smart contracts are designed with the aim of a global application. Nevertheless, they must be in line with the law of all countries of the network's participants. For now, German civil law attributes automated declarations of intent by smart contracts to their users, if they act independently only to a minor extent. Even so, the extension of the law in favor of an e-person has already started.[2]

Smart contracts enable trusted transactions

6.2 Relevance for trade and SCF

The need for efficient financial supply chain management is high: There is a bigger demand than supply for trade finance as reported by 61% of participants in a representative survey among banks from the Asian Development Bank.[3] At the same time, the global volume of SCF has been increasing about 20% annually, and its processes are becoming more and more digital. The sustainability consultancy BSR sees smart contract implementation in financial supply chains as one of three major performance enforcing mechanisms.[4] The estimated increase in efficiency mainly results from cost savings and quality gains through ongoing digitalization and automation of the paper intensive trade finance transactions. The Boston Consulting Group estimates that new digital technologies such as smart contracts, intelligent automation and collaborative digitization represent USD 2.5-6 billion savings opportunities (equal to 20-35% of total) in global trade operations cost, based over three to five years.[5]

As stated in the previous chapter, the multifaceted and leveraging application of smart contracts is strongly related to the implementation within a DLT network (chapter 5). The resulting combination of reduced information asymmetry and process automation increases the probability of proposals' acceptance, enhances the correct proof of documents and thus reduces compliance risks. The latter can already be identified faster and more accurately by optical character recognition (OCR) than by humans. Rule based decisions for subsequent processing can be represented by smart contracts. Consequently, they enable a better verification of trade finance data due to their objective and automated nature of processing information. This is especially important since banks mainly reject trade finance transactions because of KYC concerns and low quality of applications; 74% of rejections come from SMEs. According to a global survey of the International Chamber of Commerce, banks see major opportunities in financial technology facilitating KYC checks and enhancing ability to assess risk of small clients.[6]

Various scandals in the automotive and food industries are proof of the increasing need for transparent value chains.[7] Smart contracts and DLT make transactions traceable, transparent and irreversible. These are elementary features of a sustainable supply chain and enable trusted transactions among anonymous parties without the need for a central authority.[8]

A smart contract could prove the observance of production and distribution conditions and automatically react to any violation with a follow-up process, e.g. refusal of goods acceptance or payment. That would require a shared database which recorded any business

[1] Mukhopadhyay 2018.
[2] Wilkens and Falk 2019.
[3] International Chamber of Commerce 2017.
[4] Bancilhon et al. 2018.
[5] International Chamber of Commerce 2017.
[6] International Chamber of Commerce 2017.
[7] Deloitte 2017.
[8] Bancilhon et al. 2018.

transactions, as well as the implementation of IoT devices (which provided location specific measurements like temperature, coordinates or air pressure) on tools of production and distribution. For instance, the temperature of a container with pharmaceutical products that must be constantly cooled could be measured and the data directly integrated into a smart contract by an oracle. The program – which included lines of code for the prewritten temperature to be held as a condition – would automatically reject the goods acceptance if the measured temperature differed resp. the cooling chain were interrupted.

Smart contracts enable trusted transactions

Furthermore, smart contracts could considerably facilitate the billing of services between two trading partners, especially in conjunction with the use of IoT. By equipping the means of transport with radio transmitters and using pre-programmed smart contracts, automatic payments could be made. On arrival of the goods at the destination, the recipient could automatically activate the transactions held until the final delivery via the transmitter, if he were satisfied.[1]

The consulting company Deloitte states that the application of smart contracts is most worthwhile when frequent transactions with manual and repetitive tasks are performed: "The blockchain acts as a shared database to provide a secure, single source of truth, and smart contracts automate approvals, calculations, and other transacting activities that are prone to lag and error."[2] The use of smart contracts in financial matters makes transactions more transparent, traceable and tamper-proof. This ensures sustainable and more efficient supply chain management for all participants in the network.[3] In addition, the use could increase speed and real-time updates, the accuracy of transactions and create new business and operational models like peer-to-peer trading and automated access to vehicles and storage units.[4]

6.3 Outlook on future developments

The positive effect of smart contract implementation on sustainable economic growth has been shown by several use cases in the previous chapter. However, the technology's further development and scalability strongly depend on the distribution of DLT based networks, since smart contracts alone cannot generate their effectiveness without shared and secure databases. According to Gartner (2019), blockchain will be one of the most scalable technologies from 2023 onwards.[5] Consequently, a smart contract's full performance can be fetched from this time on.

Smart contracts can contribute to more sustainable business processes in terms of higher ecological or social standards. Suppliers could provide production and distribution data within a business network through the combination of smart contracts and IoT sensors. In return for exemplary conduct, e.g. lower CO2 emissions or fair-trade primary materials, suppliers could achieve preferential discount rates.[6] The idea of incentivizing sustainable performance is based on an increase in transparency and traceability through smart contract automatization.

Especially small companies will profit from an implementation of smart contracts within trade finance: The reduced transaction costs due to a higher quality of document

[1] UBS 2016.
[2] Deloitte 2016b.
[3] Bancilhon et al. 2018.
[4] Deloitte 2016b.
[5] Gartner.
[6] Bancilhon et al. 2018.

verification, fewer errors and a lower risk of compliance faults will facilitate SMEs' access to SCF products.[1]

Smart contracts enable trusted transactions

[1] International Chamber of Commerce 2017.

7
The role of internet of things (IoT) and sensoric

7.1 Fundamentals / basics / definitions

The concept of the internet of things (IoT) appeared for the first time within the supply chain area, with the idea already developing at the beginning of 1990.[1] IoT stems from the IT sector and refers to a vision of the future where everything – people, objects and machines – is interconnected. It aims at improving the quality of the interaction between man and machine or even between machines.[2] Since a central coordination of IoT would probably be almost impossible, a far-reaching autonomy of the intelligent objects is necessary. Blockchain as the underlying infrastructure has the capability to support this autonomy.[3]

Internet of things

IoT can be described as a network consisting of numerous smart objects, which unite physical objects with the information network. Every day physical objects receive a unique identity in the network, they are equipped with electronic intelligence (e.g. smart sensors, RFID) and enable data to be exchanged between objects throughout the network. That is why they are called "smart".[4] These smart objects are connected to the internet; the objects are thereby able to act independently, adapt to situations and react to specific scenarios.[5]

Nowadays, around 1.5 billion people are using the internet. It is estimated that this number will continue to increase in future, since devices are becoming smaller and, at the same time, the processing power is increasing, whereas the energy consumption is decreasing.[6] In 10 years' time, the number of connected objects will reach more than 125 billion, according to the preliminary forecast by the American Bank Association.[7]

The internet of things can be divided into a private and industrial area of application.[8] In the private environment, it is mainly about common objects that are linked with each other for more comfortable and intelligent usage. The industrial sector aims at connecting machines and plants with each other in such a way that entire industrial processes can be automated. This makes production processes more efficient and favorable. With IoT, the self-organization of industrial processes becomes possible through the direct communication of machines, plants, goods and people. It is no longer only possible to automate individual production steps, but also entire value chains, and make them much more efficient.[9] This new technology will also enable financial institutions to offer new products to their customers. Chapter 7.2 deals with specific application areas in trade and SCF.

[1] Ben-Daya et al. 2019.
[2] Prinz and Schulte 2018.
[3] Gartner 2015.
[4] Xu et al. 2014.
[5] Ben-Daya et al. 2019.
[6] Mayer 2009.
[7] American Bankers Association 2019.
[8] Atzori et al. 2010.
[9] Ploennigs et al. 2018.

The role of internet of things (IoT) and sensoric

According to Xu et al. the IoT has four different layers, namely the *sensing layer (1), networking layer (2), service layer (3) and interface layer (4)*:[1]

The (1) **sensing layer** with the link of sensors and RFID tags forms the interface to the physical world. This is where data acquisition takes place. Nevertheless, this is also where the influence on the physical world is located. As the number of objects that are equipped with RFID tags or sensors is continuously increasing, it has become easier to connect things with each other. The exchange and collection of information from individual objects therefore take place in the sensing layer and form an important basis for a smooth process in the IoT. The sensing layer is followed by the (2) **networking layer** in which all things are connected with each other and the information is exchanged via a wireless or wired network. In addition, the networking layer is suitable for combining different information from different systems. It is important to assign individual roles to each object in order to be able to control the objects at any time and change the assigned roles if necessary. The (3) **service layer** is based on a middleware technology, which guarantees the smooth integration of virtual services and applications that are created and managed on service platforms, such as search engines for physical things. These services serve to fulfill specific tasks, such as maintenance support over the entire lifecycle. Topics such as data management, communication and information exchange are also dealt with at this level. The (4) **interface layer** allows the interaction of humans and IoT.[2] With the help of an interface profile, which describes the specifications between applications and services, the interface layer ensures that different programs and objects with different standards can interact with each other without any disturbances.

7.2 Relevance for trade and SCF

In the future, it will not be enough for banks simply to develop mobile applications of existing products and services to keep pace with digitization. Rather, financial institutions must position themselves at the heart of the new networked systems and offer their customers more than just payment transactions. Financial institutions have to make use of the new data information by proactively supporting their customers in their decision-making processes. It is necessary to find new starting points for the development of innovative business models in order to capitalize on the opportunities of digitization and IoT to provide customers with an innovative banking experience.[3]

The networking of each object opens up new revenue opportunities. This results in new demands on payment flows. The financial industry is therefore able to offer new attractive services, especially for transaction processes, cash flow and risk management. The supporting technologies are already in place and should therefore be used by the financial sector.[4]

Starting point for new financial services:

[1] Xu et al. 2014.
[2] Heidrich 2015.
[3] Albayrak 2017.
[4] Pähler et al. 2017.

Pay-per-use

With pay-per-use, the monthly financial burden on the borrower depends on the output and utilization of the financed object. In this case, billing can be agreed according to the number of units, operating hours or other output. With IoT technology, the object independently informs the bank about the parameters required to settle the loan.[1]

One application scenario in the area of SCF could arise through the pay-per-use business model: companies that currently finance one or more of their machines with pay-per-use supply important data via the underlying IoT technology. Based on this data, the banks are now in a position to inspect the utilization of a machine and to offer new suitable financial products accordingly.[2] A large amount of this data is of great value to the banks and provides them with the opportunity to contact the customer proactively in future without having received a request at all.[3]

New prospects in foreign trade financing

Potential can also be seen in foreign trade financing, represented by the following example of a food maker.

Rio Mints and Sweeteners

The Dutch enterprise Rio Mints & Sweeteners usually had to wait about 6 months for its incoming payments from foreign transactions. As this period was too long and there were hardly any lenders willing to finance the receivables from goods in transit, the company turned to the Swiss start-up Arviem. Arviem equips the goods with an automated locating and sensing technology, and thus offers companies and banks the opportunity to track their goods in real time. Besides that, the sensors can also be used to view information on humidity and temperature. The new cargo tracking and monitoring system offers banks an independent verifier, represented by Arviem, that provides transparency and security for foreign trade financing. Using this new system enabled Rio Mints & Sweeteners to find a bank to finance their foreign businesses.[4]

Skuchain

Just as with the help of IoT, enormous improvements can be achieved as well with regards to the opening of a letter of credit. So far, most administrative tasks have been carried out on paper and require the physical presence of an employee. This results in high costs, and possible errors. The instalment of goods with sensors can offer an improvement in the current process. Like Arviem, the US company Skuchain also relies on IoT technology. In an initial test run, a letter of credit could be approved within a few minutes compared to several days in the past. The GPS sensor in the container allowed the banks to track the shipment in real time. With the designated blockchain technology, the required documents could be uploaded and stored electronically.[5]

With IoT technology, many barriers in the area of trade and SCF can be reduced. Access to real-time documents will eliminate manual supervision and paperwork. Letters of credit can

[1] Rabolt 2019.
[2] Belinky et al. 2015.
[3] Pähler et al. 2017.
[4] Spong 2019.
[5] Castellani 2018.

be created more efficiently with the help of real-time data and smart contracts. Foreign trade financing with IoT provides information about the condition of goods and offers the possibility of tracking them. In sum, customer confidence will increase.[1]

The role of internet of things (IoT) and sensoric

7.3 Outlook on future developments

The IoT has the potential to significantly improve both the company's productivity and the user's quality of life, while at the same time enabling us to conserve our resources. In order to use this potential, the IoT must be widely accepted, the existing challenges must be eliminated and topics such as security and data protection must be clarified.[2]

Challenges of IoT

- **a)** Architecture Challenge: Through the IoT, individual devices will communicate in a wireless and autonomous manner with each other, anywhere and anytime. Modular interoperable components support the difficult data integration across different environments. Hence, systems that combine the data volumes of different sources, interpret and compare these data to derive decisions, are needed. The architectures should therefore be open and flexible, as a single reference architecture will not be the solution for all applications.[3]
- **b)** Technical Challenges: The design of service-oriented architecture (SOA) poses a major problem. The SOA is a principle of the IT architecture according to which different programs exchange each other by means of individual functions and modules (services), thus optimizing and accelerating work processes. With the increasing number of physical objects, there are scalability problems that affect, amongst other things, data transfer as well as data processing. Performance and cost restrictions can also result.[4]
- **c)** Hardware Challenge: The Internet of Things will create billions of IoT terminals. The various hardware requirements present an associated challenge. Low-cost systems with low energy consumption are therefore needed. However, a suitable solution is not yet in sight. At the moment, higher performance indeed still implies lower energy consumption, but at a higher price. Researchers are therefore developing a functional wireless system on a low-cost and small-scale basis.[5]
- **d)** Standardization: To be able to operate smoothly at any time, a standard is required for the IoT. Today, global standards are more important than local agreements. For the development of an efficient IoT architecture, it is important that standards are set and made freely accessible to all participants.[6] Examples of such are security, identification and communication standards.[7]
- **e)** Business Challenge: Since every company has different requirements, there are also different business models and use cases, which create many opportunities and uncertainties. This is not efficient for the alignment of the business technology, which is why several solutions have to be developed to minimize the error rate.[8]
- **f)** Privacy and Security Challenges: Especially in the context of IoT, a big issue with regard to personal data is developing, as intelligent systems automatically collect

[1] Pähler et al. 2017.
[2] Xu et al. 2014.
[3] Chen et al. 2014.
[4] Xu et al. 2014.
[5] Chen et al. 2014.
[6] Chen et al. 2014.
[7] Heidrich 2015.
[8] Chen et al. 2014.

countless data about the user behavior of customers. The currently used security network in combination with IoT will not be suitable; on the contrary, the network will block the IoT technology. It will therefore be of great importance that cost-effective and machine-to-machine oriented technical solutions are developed to ensure security.[1] To gain acceptance among the population, it is essential that individuals have control over the collection of their personal data. In addition, the data should only be collected for specific purposes by authorized bodies and only be kept for as long as is strictly necessary to fulfil these purposes.[2]

Future prospects of IoT

The internet of things will provide us with new opportunities to improve our business processes as well as our personal lives. We will be able to observe things or processes from a distance and act accordingly at the same time. If the above mentioned challenges are overcome and brought into line with the conceptual further development of IoT, measuring things will become easier and cheaper. This will increase the amount of collected data and gives us the chance to derive insights that are more accurate. Especially companies will benefit from this technology, since the production will become more efficient and customer specific.[3] Companies that are already involved with IoT technology today are increasing their chances of being at the forefront in the upcoming decades.[4]

[1] Chen et al. 2014.
[2] Heidrich 2015.
[3] Ploennigs et al. 2018.
[4] Heidrich 2015.

8
Artificial intelligence (AI) to provide added values

8.1 Fundamentals / basics / definitions

In times of digital change, we encounter artificial intelligence (AI) in our everyday lives: when looking at our smartphone, as a parking assistant while driving a car or when talking to Amazon Alexa. However, the development of AI already began more than 50 years ago. John McCarthy first coined the term AI in 1955 when he invited a group of researchers to a workshop at Dartmouth College to discuss the concepts around AI.[1]

Artificial intelligence
When defining AI, it is important to distinguish between **strong** and **weak AI**:[2] **Strong AI** describes generally all the approaches that try to imitate human-like intelligence, including characteristics such as empathy or self-awareness, and perform any intellectual task that a human being can. However, such a super intelligence is not to be feared in the next decades.[3] In contrast, solutions that are now technically feasible and implemented in software solutions today, as well as all applications described in this paper, are examples of **weak AI**. In this case, it is not a question of imitating human thought processes, considerations and creativity, but of developing specific algorithms for specific problems.

It was not until the beginning of commercialization that artificial intelligence finally left the research laboratories and made its way into our everyday lives.[4] The main reasons for this are improved AI procedures and more powerful systems. Another reason is the large amount of digital data which can now be collected and stored anywhere and used to train algorithms successfully. The availability of Big Data and the increased computing power have made methods such as machine learning possible at all.[5] AI operates in a changing and increasingly complex environment in which a multitude of data is generated through sources such as external data sources, microphones, cameras, sensors, chips and data management systems. The systems observe and understand the situation in which they are located through targeted interpretation, combination, planning and evaluation with the help of their knowledge. The knowledge that the systems obtain from the various data sources is used to decide, speak, move and control. By storing the actions they can learn to select their next activities, expressions and comments to fulfill their tasks and goals.

The tasks and objectives of AI can be divided into the three aspects Automation, Speed and Collaboration. Each pillar enables the company to be more agile and flexible in terms of digital transformation - be it the elimination of manual labor, accelerating processes or data exchange for real-time visibility.[6]

[1] McCarthy et al. 1955.
[2] Buxmann and Schmidt 2019.
[3] National Science and Technology Council 2016.
[4] Fraunhofer-Allianz Big Data 2017.
[5] Wischmann and Rohde 2019.
[6] Oracle Financial Services 2018.

Due to the heavy implementation of technology solutions, in particular Artificial Intelligence, revenues from AI business applications worldwide will increase from $2,867.54 million in 2019 to $31,236.92 million in 2025.[1]

Artificial intelligence (AI) to provide added values

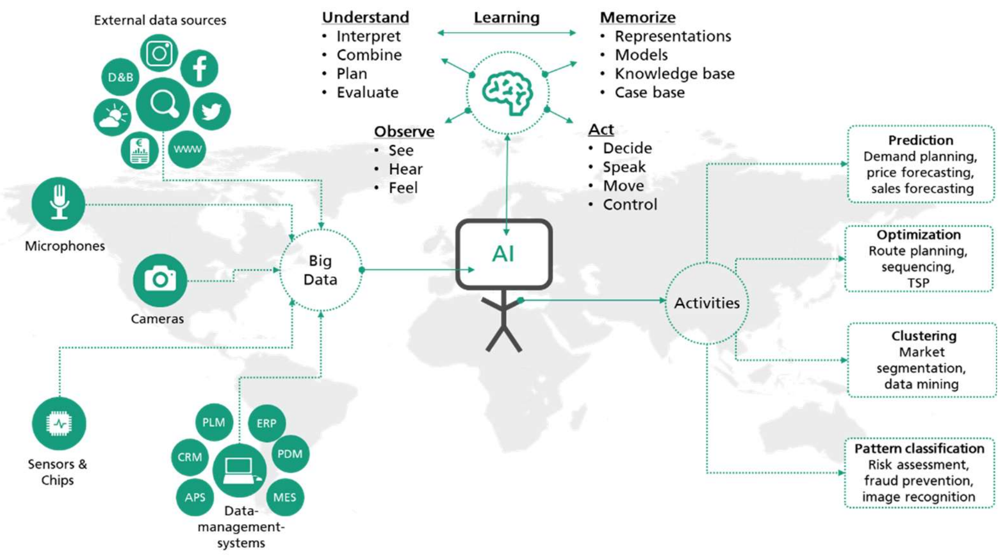

Figure 6: Application overview of AI

With the use of AI, it will be possible to make an additional economic output of $13 trillion worldwide by 2030.[2] By 2030, 70 percent of companies will be using at least one of the AI technologies, whether automatic image recognition, natural language recognition, virtual assistants, robotic process automation or machine learning.[3]

Methods of machine learning are being used to detect structures and patterns from large amounts of data using models. These models allow us to interpret data and to generate predictions for recommendations, warnings or decisions.

Machine learning
Machine learning as a core discipline of AI[4] is the technology of enabling a computer to learn from past experiences in order to solve certain tasks and make predictions without having been explicitly programmed for this function. There are three types of machine learning: a) supervised, b) unsupervised and c) reinforcement machine learning. In supervised machine learning, example data is used to train a specific interpretation and the associated output. The goal is to find general rules that connect the known input data with the required output data. Unsupervised machine learning works without a previous known assignment and identification of input data. The computer program has to recognize structures in the data to turn it into interpretable information. In reinforcement machine learning a computer program learns directly from experience.[5]

"With the application areas such as smart cities, smart grids, smart water managements, smart health, smart supply chain, and smart homes in the Internet of Things (IoT), we can

[1] Tractica 2016.
[2] McKinsey & Company 2018.
[3] McKinsey & Company 2018.
[4] Another discipline of AI would be symbolic learning. In contrast to machine learning, symbolic learning rules are created through human intervention.
[5] Kirste and Schürholz 2019.

consider the AI as a complementary package of the smart networked objects. From this perspective, it is essential to understand the role of AI which will provide a global backbone for the worldwide information sharing and processing in the near future.”[1]

Artificial intelligence (AI) to provide added values

The digital technologies will become actionable in many fields of application as autonomous systems without human intervention. Rapid technological development will create systems that are capable of learning and can decide and act independently. Information technology prerequisites for this are the performance improvements of computer hardware and more recent developments in the field of artificial intelligence.[2] AI is an attempt to develop a system that can work independently on complex problems.[3] The situation-specific adaptability and learning ability is the central characteristic of the systems and is termed Machine Learning or Deep Learning.[4]

Deep Learning

But whereas machine learning is like a tool with just one specific function, a deep learning algorithm can solve much more complicated tasks all by itself. So called "Neural Networks" are layers of mathematical functions which simulate a decision making process of a biological system. A completely generic Neural Network can learn how to play chess and even beat professionals, given enough data. Learning can be supervised, unsupervised and/or reinforced. Neural networks have been used increasingly in a variety of business applications, including forecasting and marketing research solutions. In some areas, such as fraud detection or risk assessment, they are the indisputable leaders. The major fields in which neural networks have found application are financial operations, enterprise planning, trading, business analytics, and product maintenance.[5]

Related Fields

Natural Language Processing

Natural Language Processing (NLP) deals with computer programs that enable machines to understand spoken or written human language.[6] The systems are designed to interpret information in languages and apply appropriate applications or techniques to accomplish desired tasks.[7]

The processing of the text or language can be divided into three steps. The first step is called the morphological analysis, where grammatical categories like gender, case or declension are extracted from the sentence. The following step, syntactic analysis, creates relations between the single words in the sentence, and the main and subordinate parts are extracted. Semantic analysis is the last and most difficult step for the NLP. Based on the knowledge of the machine for a specific field and the information received within the previous steps, the NLP compares the linguistic construction with the construction stored in the system memory.[8] In addition to artificial intelligence, other disciplines also play an

[1] Al-Turjman 2019.
[2] Hirsch-Kreinsen and Karačić 2019.
[3] Kirste and Schürholz 2019.
[4] Hirsch-Kreinsen and Karačić 2019.
[5] Jansen Schoonhoven et al. 2018.
[6] Kreutzer 2019.
[7] Chowdhury 2003.
[8] Posevkin and Bessmertny 2015 - 2015.

important role in NLP, including information science, linguistics, mathematics, electrical engineering and psychology.[1]

Artificial intelligence (AI) to provide added values

Biometrics

Awareness of security vulnerabilities and fraudulent transactions is increasing, making fraudulent, highly reliable and accessible personal authentication and identification techniques an inevitable requirement for human societies.[2]

Biometrics is the combination of science, biology technology and information technology that enables individuals to be identified through physiological or behavioral characteristics in the body. Biometric technologies focus on technology to automatically authenticate existing human characteristics such as DNA, fingerprint, iris or dynamic characteristics such as voice and movement.[3]

Computer Vision

Computer vision is the processing of signals that represent images, such as photos and video content. The result of image processing can be either an image or a data set that represents the characteristics of the processed image.

Software Assistance Systems

Software assistance systems have the objective to support and interact with a person. This is realized through optical, auditory or haptic signals and gives direct feedback. A well-known example is the automobile, which supports the driver with parking assistant or drives autonomously. In the industry, these assistance systems are used in the form of augmented-reality-glasses to simplify and automate tasks.[4]

Robotic Process Automation

Robotic Process Automation (RPA) is an umbrella term for tools that perform operations on structured data on different user interfaces of other computer systems, in the way a human would do.[5] This automation eliminates manual data entry and repetitive, simple tasks.

The characteristic of RPA is that the software does not interact between the applications through the Application Programming Interface or integration bus, but through the user interface. This creates the advantage that no additional changes in the existing system and interfaces are needed for robotic process automation. As a result, the implementation is very fast and significantly reduces costs.[6]

Due to its high relevance for the financial sector, this technology is considered separately in Chapter 9.

[1] Chowdhury 2003.
[2] Zhang.
[3] Kreutzer 2019.
[4] BMWi 2019.
[5] van der Aalst et al. 2018.
[6] Yatskiv et al. 2019 - 2019.

8.2 Relevance for trade and SCF

Artificial intelligence (AI) to provide added values

Digital applications are increasingly on the rise in the financial sector. Companies have recognized that they need to improve existing capabilities and technologies. Artificial intelligence is one of the most frequently used sublimating technologies.[1] The three areas in which banks apply AI are risk management, financial analytics and investment/ portfolio management.[2]

Application examples:

a) AI and credit decisions

Artificial Intelligence provides a faster, more accurate assessment of a potential borrower, at less cost, and accounts for a wider variety of factors, which leads to a better-informed, data-backed decision. Credit scoring provided by AI is based on more complex and sophisticated rules compared to those used in traditional credit scoring systems. Objectivity is another benefit of the AI-powered mechanism. Unlike a human being, a machine is not likely to be biased. Digital banks and loan-issuing apps use machine learning algorithms to make use of alternative data (e.g., smartphone data) to evaluate loan eligibility and provide personalized options.

b) AI and fraud prevention

Artificial intelligence has been very successful in battling financial fraud. Fraud detection systems analyze clients' behavior, location, and buying habits and trigger a security mechanism when something seems out of order and contradicts the established spending pattern.

Banks also employ artificial intelligence to reveal and prevent money laundering. Machines recognize suspicious activity and help to cut the costs of investigating the alleged money-laundering schemes.

c) AI and process automation

Employing robotic process automation for high-frequency repetitive tasks eliminates the room for human error and allows a financial institution to refocus workforce efforts on processes that require human involvement.[3]

d) AI and KYC

KYC verification becomes an automated affair with Artificial Intelligence. Any attempt at tampering with personal information or using a fake document to perform KYC can be detected in real-time with the help of smartly devised AI. Facial recognition technology enlists help from AI and can rid the online marketplace of the threat of facial spoof attacks, if integrated into a KYC software.[4]

f) Demand forecasting

Accurate prediction of the demand through the whole supply chain provides great saving potential and trading activities. However, due to the complexity and high effort for time-series stochastic models, artificial intelligence methods are attracting more and more

[1] Krah 2018.
[2] Koning 2016.
[3] Bachinskiy 2019.
[4] Imran 2018.

interest.[1] Statistical techniques have non-adaptive features with high forecasting errors and are dependent on human intervention to improve their accuracies through proposed adjustments and verifications. If this is not the case, the forecast yields suboptimal usage of goods and negatively impacts the operating costs.[2]

Artificial intelligence (AI) to provide added values

The main task of artificial intelligence for demand forecasting is to find functional relationships between the nonlinear variables of the SFM and SCM. A commonly used technique is the Artificial Neural Network (ANN), which is a network consisting of arrays which are linked together with different weights of connection. This method has been used in statistical model development, pattern recognition in data mining and decision making under uncertainty. The AI is able to learn how to perform a pattern recognition task by automatically changing the values of its weights.[3]

g) NLP for financial statements

Chatbots are becoming more and more popular across the financial service sector. The bots are powered by natural language processing and are assigned to automate certain tasks using algorithms. This makes for a powerful tool, which provides a personalized, conversational and natural experience to users in different domains.[4] The main application of chatbots is automated interaction with the customer and the improvement of self-service, for example the bot helps to answer asset management questions and compiles documents. Natural language processing is making it increasingly difficult for bank customers to tell whether they are talking to an AI interface or a human.[5]

Another use of NLP in the finance segment is the evaluation of market sentiment. Natural language processing automates the price prediction besides the technical and fundamental analysis. The software understands variables like risk-averse or risk-seeking behavior, investor confidence and psychological factors. With the built-in memory mechanisms, the NLP algorithm can be used to evaluate the sentiment (e.g. positive, negative, neutral) of various types of data like financial news channels, data trading sets or investor blogs achieved by word to word mapping. Thus, NLP can become a tool for identifying changing market trends and the impact of news on the trajectory of the market.[6]

8.3 Outlook on future developments

"There is a lot of work to do for trade finance to become investable as an asset. A lot of this is about better information and transparency." Although other technologies such as blockchain are known for being transparent, AI and ML can lack transparency, as not all techniques are interpretable. Another potential issue is that they are reliant on data quality and cannot use the "bigger picture" to predict outliers in the same way humans can. That considered, AI and ML allow for proactive supply chain management, increasing cost efficiency and accuracy. Machine learning also opens up a whole new field of quantum computing. This algorithm can solve complex financial problems much faster and more efficiently than traditional digital computers. With AI it is expected that ML will have a far more powerful impact in combination with quantum computing capabilities.[7] In addition, Fintechs should not be viewed separately in the future, but together so they can continue to merge, creating a greater value.

[1] Xu et al. 2014 - 2014.
[2] Luthuli and Folly 2016 - 2016.
[3] Hamid and Rahman 2010 - 2010.
[4] Buchanan.
[5] Buchanan.
[6] Datascience Foundation 2018.
[7] Buchanan.

Artificial intelligence (AI) to provide added values

9
Prevent repetitive and manual tasks with robotics and smart automation

9.1 Fundamentals / basics / definitions

The increased consideration of ecological aspects in the production process, the efficient use of resources and the differentiated customer requirements with a high variety of variants are just some of the numerous challenges of automation.[1] New technologies such as smart automation with IT-based automation technologies, intelligent control systems and robotics[2] are currently spreading quickly and leading to rapid changes in industrial production and consumer life.[3] By taking on dangerous, repetitive, tedious or boring tasks and bringing in their accuracy, precision and strength, robots make life easier.[4] In addition, they will increase the flexibility of applications and reduce costs.[5] By the end of 2022, 85 percent of large and very large companies are expected to have some form of robotic process automation (RPA) in place.[6] In the same year, expenditures on robotic process automation are expected to rise to around 2.4 billion dollars (from 680 million in 2018).[7]

Smart automation
Smart automation consists of IT-based automation technologies, intelligent control systems and robotics.[8]

Robotic process automation
RPA is a software technology which ensures that structured, rule-based processes can be automated and executed by virtual robots, so-called “bots”. These software robots mimic human interaction with user interfaces of software systems and work in a similar way to humans.[9]

The basis for smart automation is RPA.[10] Robot-controlled process automation is a technology derived from classical process automation and inspired by industrial robots.[11] This innovative technology enables the automation of repetitive and highly structured routine tasks previously performed by humans. These tasks are usually both tiring and prone to errors.[12] RPA aims to automate processes without changing existing applications or replacing them, and at the same time reducing costs.[13] Because these software robots operate similarly to the actual users, there is no need for additional system testing. In this robot-controlled process automation, the software robots take over the roles and tasks of users and interact with other software systems. Once a process has been defined, it can be flexibly adapted at any time to the rapidly changing specifications and requirements. Contrary to an initial assumption, software robots are not physically existing machines as known

1 Fraunhofer IPK 2012.
2 Fraunhofer IPK 2012.
3 Szewczyk et al. 2018.
4 DHL 2016.
5 Michel 2018.
6 Gartner 2018c.
7 Gartner 2018c.
8 Fraunhofer IPK 2012.
9 Smeets et al. 2019.
10 Lünendonk 2018.
11 Safar 2019.
12 Lünendonk 2018.
13 PWC 2019.

Prevent repetitive and manual tasks with robotics and smart automation

from the manufacturing industry, but instead an independently operating software. To clarify this, the term "bot" is therefore usually used to distinguish it from the term "robot".[1] The spectrum of robots used ranges from simple, manually set up workarounds to complex software on a virtual machine[2].

Processes with the characteristics stated below are particularly suitable for RPA automation:[3]

- less complex
- highly repetitive
- based on statistical rules
- large process volume (volume of designs)
- stable over time, i.e. have few changes in the process
- access structured data
- error prone
- completely digital and executed via different software systems

As a rule, a software robot can relieve up to five employees of repetitive processes.[4] With RPA, employees can take care of more demanding tasks and respond more closely to customers and their wishes.[5] However, employees can initially perceive these options as a danger.[6]

Types of RPA

Depending on the literature, RPA technologies can be divided into at least two[7] or three[8] different types. These are the *desktop RPA tool*, *RPA platforms* and *the IT software development tool*.

The **desktop RPA tool** is based on functionalities such as the execution of macros and scripts and the use of so-called "screen-scrapping technologies". In simple terms, the user's actions are first recorded before the desktop RPA tool supports the user in performing routine tasks. The focus here is therefore on the replay of user input, and less on the automation of standardized processes. In addition, each user has the option of carrying out suitable automation at his personal workstation. The **RPA platforms** are an extension of the desktop RPA tool. Unlike the desktop RPA tool, this technology is not installed and operated on the individual desktop, but on servers. In addition, hardly any user input is recorded here as explained in the example above - although it would be possible. The aim is to standardize the process flows in order to be able to access command libraries afterwards. Besides, it is also possible to monitor and control the process flows centrally. This can either be done by humans or by bots. The implementation of the desktop RPA tool and the RPA platform can be carried out by department or process experts, after a training and familiarization phase earlier. In order to automate processes with the **IT software development tool**, however, extensive IT and programming knowledge

[1] Smeets et al. 2019.
[2] Safar 2019.
[3] August Wilhelm Scheer Institut 2020.
[4] United News Network GmbH 2019.
[5] Lünendonk 2018.
[6] Lünendonk 2018.
[7] Allweyer 2016.
[8] Willcocks et al. 2017.

is required. Therefore, this technology is primarily a business process management tool, rather than an RPA technology as described in the definition.[1]

Prevent repetitive and manual tasks with robotics and smart automation

9.2 Relevance for trade and SCF

The RPA technology is currently attracting enormous attention from the financial sector. According to the McKinsey Global Institute, the (aggregated) technical automation potential for the financial sector amounts to 43%.[2] Even though this figure does not indicate whether this refers to specific processes or individual activities, it can still be deduced that there is enormous potential for increasing efficiency and saving costs through automation, and that this potential can be implemented by using RPA. At present, however, the number of companies that already use RPA comprehensively is still very manageable.[3]

As already described above, the RPA is particularly suitable for manual, repetitive and rule-based activities. Especially in the area of trade finance, many processes are still paper-based today and are duplicated across several parties. The processes are therefore not only expensive and very time-consuming, they are also inefficient. These processes can be detected for instance during the transmission of commercial documents. An example: A supplier creates the commercial documents and sends them to his house bank. After the bank has verified the documents, they are forwarded to the customer's house bank. Here, the documents will be checked for completeness and correctness as well, before they get sent to the customer in the final step. Although some processes have already been digitalized - with electronic bills of lading for example - this does not solve the actual problem. Individual checks still have to be carried out, regardless of whether the data is available in electronic or analogue form.[4] Many companies are already working on optimizing these processes by using RPAs. The following case study provides a practical example of it.

Bank Central Asia

Bank Central Asia (BCA) and the start-up 6Estates from Singapore are working on a solution to automate the letter of credit process. This is to be achieved with **intelligent process automation (IPA)** which consists of robotic process automation and artificial intelligence. The IPA is able to extract important information from the letters of credit while checking their compliance with the underlying international banking regulations and standards. The applied core technology is called machine reading comprehension (MRC) – a key natural language processing (NLP) technology. This technology is not only able to read texts, but also to understand them. With the elimination of these repetitive activities, BCA wants to entrust its employees with tasks that are of greater value to the customers. According to 6Estates, the initial goal is to save 30% of the processing time. Through semi-annual training, this number is to increase continuously.[5]

Intelligent Process Automation (IPA)

[1] Smeets et al. 2019.
[2] Manyika et al. 2017.
[3] Smeets et al. 2019.
[4] Sehgal 2018.
[5] Insider Inc. 2019.

IPA is the extension of RPA technology by an intelligent, cognitive component. Here, machine learning components or artificial intelligence raise the level of automation. In future, it could also be possible for IPA to simulate human thinking.[1]

Prevent repetitive and manual tasks with robotics and smart automation

9.3 Outlook on future developments

For banks and other financial service providers, robotic process automation promises high cost savings and a short payback period. For this reason, this technology is particularly suitable for counteracting the constantly increasing cost pressure in the financial services industry and achieving an increase in efficiency without incurring increased costs for the IT infrastructure.[2] With the increasing use of RPA, confidence in this technology is growing, and with it the connection to other processes.[3] Although the market for RPA is still relatively new, a study by ATKearney and Avarto shows that by 2026, 50% of all financial back-office processes could be handled using RPAs.[4]

In the future, employees will not only be able to focus on essential tasks, but will also be supported by intelligent robots when making decisions. The possibilities of automatically analyzing and evaluating mass data, as well as making predictions, offer enormous added value for companies, employees, suppliers and customers. The productivity of companies increases considerably, since the robots are in use 24/7 and can therefore deliver results faster. This in turn leads to a significantly higher quality of service and usually increases customer satisfaction. Viewed against the background that companies are already experiencing difficulties in mastering technological progress due to the increasing shortage of skilled workers, the digital workforce is a relief for companies.[5]

[1] Martens 2018.
[2] Leichsenring 2019.
[3] Butkovic 2018.
[4] Dickgreber et al.
[5] Lünendonk 2018.

10
Platforms and networks essential in the future

10.1 Fundamentals / basics / definitions

Platforms have been in use for decades - shopping centers connect retailers and consumers, newspapers connect subscribers with interested parties. However, these examples presuppose the ownership of physical infrastructure and assets. In contrast, with the help of information technology, the requirement of a physical connection is no longer necessary and it is much easier and cheaper to set up or expand platforms.[1]

In today's business world, platform-based business models are becoming increasingly widespread throughout the industry. Not only start-ups use this business model; global enterprises have also been building on this type of business model for several years. The aim of these corporates is to bring together both, producers and consumers on one platform to generate benefits through their interaction. The resulting ecosystem is therefore characterized by strong network effects between the various homogenous participants, as each group is influenced by the behavior of the others. The core business of a platform operator is the management of the supply and demand side in order to ultimately monetize the underlying interactions by means of a transaction fee.[2]

Digital platforms
A digital platform links two or more different groups of players in the market, such as buyers and sellers, where each group benefits from the size of the other group.[3] Moreover, platforms generate network effects that enable interaction within the same user group, such as within a social network.[4] Without the platform, the user group is not able to interact efficiently, as the attractiveness of a platform depends on the number of potential transaction partners due to the positive indirect network effects.[5]

Although there are many different types of platforms, all have an ecosystem consisting of the same basic structure and four types of actors. The owner of the platform controls their intellectual property and management. The providers serve as the interface between the platform and the users, while the producers create their offers and the consumers use these offers.[6]

The added value of the platforms consists of three main aspects. First of all, the functions enable an acceleration in application development, which in turn enables solutions to be integrated more quickly in the company. Secondly, they connect different devices, software and service providers to enable better customer service, which in turn creates a greater potential for innovation among ecosystem participants. Ultimately, this value will increase over time and leads to a positive value creation cycle as new data, devices and users are added. To generate this additional benefit requires intensive preparatory work on the part of the company. In the first instance, the company should therefore decide how it wants to operate in the platform business. On the one hand, there is the possibility to offer services

[1] van Alstyne et al. 2016.
[2] Thies 2017.
[3] AUTONOMIK für Industrie 4.0 2017.
[4] Bundeskartellamt 2016.
[5] AUTONOMIK für Industrie 4.0 2017.
[6] van Alstyne et al. 2016.

on an already existing platform, on the other hand to develop one's own platform to connect external buyers and sellers.[1]

Platforms and networks essential in the future

Platform business models differ from classic, linear business models in that the added value is not only created by the producers and passed on to the customers at the end of the value chain. Producers and customers can get in touch with each other already in the value creation phase, and thus customers can even participate in the creation of the product or service. The platform itself creates a marketplace-like framework by establishing contact between producers and consumers. If this contact leads to a transaction, the participants pay a fee to the platform. In return, producers and consumers are able to find each other and exchange the product or service against payment.[2]

As shown in Figure 3, consumers, producers and providers of a platform create benefits for a company. However, if they find that their needs are more satisfactorily met elsewhere, there is a risk of losing these participants to the competition. In addition, there is always the risk that producers decide to develop their own platform and thus become a competitor to the previous platform provider. Another special feature comes with the fact that producers and consumers can swap roles. What the consumer asks for today can be made available on the platform the next day. Based on these reasons, it is important for platform providers to drive new innovations and to keep an eye on the activities of the platform users.[3]

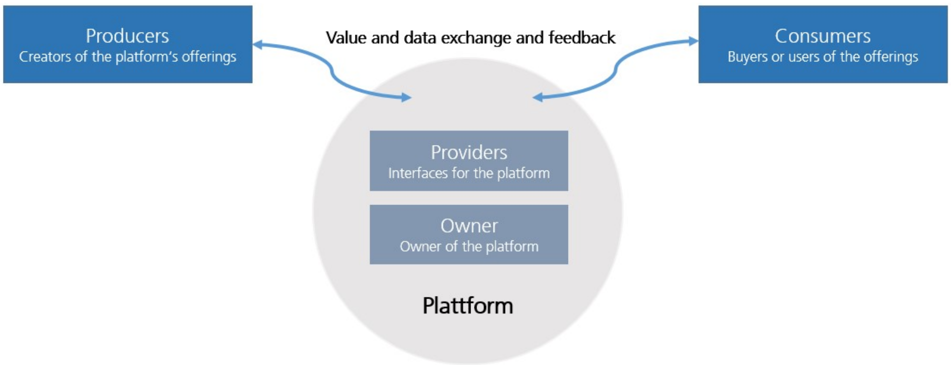

Figure 7: Participants in a platform ecosystem
Source: Own illustration based on van Alstyne et al. 2016

Digital platforms can be divided into **transaction-centric** and **data-centric platforms**. With transaction-oriented platforms, the focus is on bringing supply and demand together, in order to realize the respective transactions as a function of the intermediary or digital marketplace. This type of platform offers users a suitable information and search function, as well as an appropriate offer and evaluation mechanism. The provider incurs costs for access to the platform as well as for the underlying transaction volume. One such marketplace is Amazon, for example.

[1] Elliot et al. 2018.
[2] Zielonka 2018.
[3] van Alstyne et al. 2016.

With data-centered platforms, on the other hand, the main focus is on networking, whereby a data-based overall system is created, in which complementary products are linked to form an overall system. Ideally, this type of platform offers the actors processing and evaluation of the data streams, whereas the quality of the ecosystem plays an important role as well. In addition to the access fees, data evaluations are charged.[1] Leading global companies are, for example, Facebook or Google.

Platforms and networks essential in the future

10.2 Relevance for trade and SCF

Global internet availability formed the foundation for new business models in the financial sector and therefore also enabled the development of platforms.[2] Letters of credit and guarantees in particular, with their relatively high costs for small values, are not particularly attractive financing instruments in trade finance. Platforms that have focused on trade and supply chain financing offer some innovative solutions to reduce costs and simplify operation.[3]

Artificial intelligence, blockchain or the internet of things are some of the underlying technologies for today's trade and supply chain finance platforms. With the help of these technologies and the corresponding platforms, it is possible to simplify international trade processes. Processing times can be shortened, and costs of border crossings reduced. In addition, the platforms make it possible to reduce trade barriers and eliminate paper documents, which are in any case prone to errors and risky due to their partly manual creation and allocation. The advantage of these platforms lies in the combination of different technologies. Thus, IoT enables a better insight into the supply chain, whereas AI can, among other things, reduce the risk of money laundering.[4]

Banco Bilbao Vizcaya Argentaria:

An example of the advantages of such a platform is provided by the Spanish Banco Bilbao Vizcaya Argentaria (BBVA). With its platform, the bank was able to reduce a trade finance transaction, which usually took more than a week, to two and a half hours. This transaction was initially a first test run, in which a Spanish company ordered goods from Mexico. The payment was made with a letter of credit issued by BBVA and further processed by the Mexican bank Bancomer.

According to an estimate by Bain & Company, the platforms could reduce operating costs in trade finance by between 50% and 70% and improve the products in trade finance by a factor of three to four.[5]

Some banks are already working on different approaches in regards to building a trade and supply chain finance platform. There is already the *Batavia* consortium between UBS and IBM, or the association of several 100 financial institutions that have jointly created the *R3* platform. On the European market, the trade finance platform *we.trade* has merged from seven banks which focus particularly on the needs of small and medium-sized enterprises. In addition, there is also the possibility for banks to join forces with financial start-ups and use their knowledge to build a common platform.[6]

[1] AUTONOMIK für Industrie 4.0 2017.
[2] Dhar and Stein 2017.
[3] Olsen et al. 2018b.
[4] Olsen et al. 2018b.
[5] Olsen et al. 2018b.
[6] Olsen et al. 2018b.

Yet, in order to be able to guarantee the success of a platform, certain criteria are required.[1]

Platforms and networks essential in the future

a) Standardized developer ecosystems: At present, banks still work with individual software. However, in order to develop a successful platform, it will be necessary to use a standardized system so that all participants benefit equally.

b) Open interfaces: In order to integrate new applications into existing systems, open interfaces, so-called Application Programming Interfaces (APIs), are required. These in turn allow data exchange and interaction between the parties involved. There are RESET APIs to avoid having to make all software functions publicly available. Necessary software functions are made publicly available, while other functions are protected. This has the advantage that the banks' core system does not have to be accessed in the event of necessary changes, and at the same time the integration of new services and products is faster. Aside from that, with APIs it is easier to integrate banking applications with other market players, such as Fintechs.

c) Low-code development: In order to be able to create applications in the past, the codes were written from scratch in software development. To become more efficient and thus reduce costs, effort and the factor of time, so-called low coding is now used. Here, applications are created from prefabricated components.

d) Scalable cloud environments: To avoid the need for new IT infrastructures, platforms should use a cloud to ensure maximum flexibility and performance. Data security can also be guaranteed by a cloud. Institutions such as BaFin explicitly support the use of clouds and promote them by means of appropriate legislation.

e) App-Store as a central marketplace: In order for customers to find and access the developed platform quickly, it is imperative to make the banking platforms available to the broad masses in an App-Store, besides the available web applications. On the one hand, this naturally offers the opportunity to establish a new distribution channel and monetize the applications; on the other hand, it gives the financial institutions as well as the customers the chance to benefit from innovations.

However, building a digital ecosystem does not have to mean limiting oneself to financial products. Some banks abroad are already combining banking and non-banking products on their platform, thus forming the cornerstone of their platform.

The Chinese bank ICBC is currently the global leader in the non-banking sector. The bank provides over 10,000 products from external companies on its *Rong E Gou* platform. On the European market the Spanish bank BBVA with its platform *De Compras* likewise sells non-banking products. The platform offers a wide range of products from used cars to health services. Also, in the Netherlands there are already first approaches to non-banking offers. ING, for example, offers a wide range of different products to its customers who have a special account model. By using special banking products, customers can collect bonus points and redeem them later in the online shop.

Such offers are not yet to be found on the German market. Only a few direct banks, such as Deutsche Kreditbank, offer discounts and cashback campaigns with individual partner companies. Especially for German banks there is therefore the possibility to use this potential for themselves and to become the market leader.[2]

10.3 Outlook on future developments

[1] Häring 2019.
[2] Zierhofer and Kammering 2019.

Platforms and networks essential in the future

Due to their omnipresence, digital platforms will be one of the most important strategic issues for companies in the future. Digital platforms will largely regulate access to products and services. Virtually all companies, regardless of their industry, use digital platforms in some form. Some large companies are working on their own digital ecosystem, while others are looking at how to dock their product range to the incumbent operators.[1]

German banks should - if they want to continue to grow in the future - improve their product range sustainably and also adapt the current vertically integrated banking system to an ecosystem consisting of partnerships. Conditions in the future will change and therefore new approaches will be necessary, as market growth in the banking sector is likely to stagnate due to an ageing population and the fact that more liquidity is currently being provided outside the banking system.[2]

Consumer behavior changes as well over time. As far as personal data is concerned, the banks still enjoy the greatest trust of their customers, at around 70%.[3] However, this will change dramatically within the next ten years. The digital generation X and Y will make up about 70% of the global workforce. According to the United Nations, 54% of UK consumers aged 54-64 would not trust their personal account information to anyone, compared to 15% of people aged 18-24.[4] This change is likely to occur even earlier in emerging markets. Already 40% of Kenya's GDP is generated on mobile money platforms.[5]

By 2030, financial services will be completely transformed. In order to ensure a positive outcome of the transformation, significant steps will therefore have to be taken by the industry, new market entrants and regulators. A missed opportunity or delayed market entry would have serious implications for the customer choice, the diversity of providers and the level of risk in the system. Ultimately, a financial system would emerge from a few large Fintechs and a couple of companies already operating today.[6]

One thing is already for sure - these platforms will permanently change the financial industry. It has not yet been decided which platform will ultimately win the race. For this reason, the traditional banks should use their current lead. Especially in the financial sector, security and trust play a major role. The traditional banks have years of experience and a large customer base. At the moment, it is mostly Fintechs that are behind the platforms, as most banks are currently still focused on digitizing processes and basic tasks. The important thing now is to build up one’s own platform, which includes the strengths of one’s own company.[7] New technological developments, such as blockchain technology, can strengthen the platforms, especially in terms of reducing transaction costs.[8]

[1] Krämer 2019.
[2] Junghanns and Niebudek 2019.
[3] Elliot et al. 2018.
[4] World Economic Forum and United Nations Economic Commission for Europe 2017.
[5] World Economic Forum 2018a.
[6] World Economic Forum 2018a.
[7] Strietzel 2019.
[8] AUTONOMIK für Industrie 4.0 2017.

11
5G Network as a key enabler for new technologies

11.1 Fundamentals / basics / definitions

5G

5G is a new development stage in mobile communications. It is the answer to the requirements of the future in terms of data speed, network capacity, reaction time and data security. While 2G, 3G and 4G were mainly radio oriented, 5G stands for an entire system consisting of radio, systems and a telecommunication core that support various end-to-end telecommunication services which aim to meet the new requirements coming from megatrends.

5G technology is leading the society to a hyper-connected era[1] – the fifth generation of cellular network is considered as a key enabler for new technologies such as the internet of things, autonomous driving (advanced vehicular communications), smart cities or smart healthcare.[2] Many nations have recognized the high relevance of this technology. As a first mover, South Korea delivered nationwide 5G accessibility and is now the leading nation in this technology. Germany in contrast is ranked in the middle of 42 other countries.[3] Here, the auction of 5G mobile phone licenses took place in 2019, from which the Federal Government raised 6.6 billion euros – this marks the start of the 5G expansion in Germany. The market participants Deutsche Telekom, Vodafone, Telefónica and newcomer Drillisch will compete on the German market for 5G.[4] A new aspect is that unused frequency bands are allocated to companies. With this approach, Germany is acting as a pioneer in an international context.[5] Like many other technologies, 5G will not arrive at once; instead, the rollout of 5G and its novel features will be introduced in waves. We are currently in the first wave of 5G expansion, where 5G operates Non-Stand-Alone (NSA) utilizing existing 4G infrastructure, which results in evolutionary improvements. Only the deployment of an entire independent 5G architecture will bring new capabilities, which will be available in 2022/2023, according to The Boston Consulting Group.[6]

The main targets of 5G mobile communication systems, as defined by 3rd Generation Partnership Project[7] (3GPP), can be summarized in the following sub-objectives:

- higher system capacity
- higher data rate
- massive device connectivity
- lower energy consumption
- low latency[8]

Technically speaking, 5G often refers to 5G NR (New Radio), a global standard for an air interface that utilizes frequency ranges below 6 GHz (frequency range 1) and above 20 GHz

[1] Dan and Dewar 2014.
[2] Dan and Dewar 2014.
[3] Taga et al. 2019.
[4] BMVI - Bundesministerium für Verkehr und digitale Infrastruktur 2020.
[5] Handelsblatt 2019.
[6] Breitenstein et al. 2019.
[7] Several organizations that define the global specifications for mobile telecommunication standards.
[8] Kabalci and Kabalci 2019.

(frequency range 2). As a reason for the increased spectrum of frequencies, the expansion of services addressing consumer and multiple industries can be seen.

5G Network as a key enabler for new technologies

5G differs significantly from previous generations in terms of usage scenarios and supported applications. In the vision for 5G systems, three main usage scenarios were defined and specified:

- Enhanced Mobile Broadband (eMBB)
- Massive Machine-type Communications (mMTC)
- Ultra-reliable and Low Latency Communications (URLLC)[1]

Enhanced Mobile Broadband (eMBB): Mobile Broadband is the first use case with growing requirements, especially in higher data rates. Technologies to meet the requirements are **Massive MIMO** (Multiple Input, Multiple Output), that makes much higher network capacities achievable, **Network Slicing** and the usage of **higher radio frequencies**.[2]

Massive Machine-type Communications (mMTC): **mMTC** means 5G technology provides connectivity to a high number of low-cost and low-complexity (IoT) devices, which occasionally transmit small amounts of data. In addition, and unlike **eMBB**, the transmitted data is not latency critical. Up to 1 million devices per square kilometer are enabled to communicate with one another by **mMTC**. In contrast, 4G can support 4000 devices per square kilometer and thus may easily reach its limits in urban areas.[3]

Ultra-reliable and Low Latency (URLLC): This application scenario is for time-critical applications with strict requirements for availability, throughput and latency in the lower millisecond range. To meet the diverse requirements of 5G systems, network slicing can be used. In contrast, to meet the different needs of customers, 5G networks can be divided into virtual networks that are tailored to specific business cases. In remote management, a factory may order a URLLC slice from the operator for industrial automation, allowing the robots in the production line to be controlled and monitored.[4]

With **Network Slicing**, multiple logical networks can run as independent business operations on a common physical infrastructure.[5] Moving network functions into software indicates the increased importance of virtualization coming with 5G. An example that uses this function to solve the diverse challenges in long-distance rail transport is Deutsche Bahn, which has tested the **Network Slicing** function of 5G to bundle train control, train monitoring and on-board entertainment on a shared physical infrastructure.[6]

A cellular network is a communication network where the last link is wireless. The system which provides wireless connectivity to customers is called Access Network. It is contrasted with the core network, which interconnects local providers. Significant changes with 5G take place in these two main components of the network architecture.

The **Radio Access Network** is one main interface between mobile devices and the internet. Via radio access controller and radio access nodes, RAN connects the user equipment to the main core network. Radio access nodes are different types of facilities such as small cells or masts. Small cells are used to cover small geographical areas with short-range wireless transmission. At extremely high

[1] International Telecommunication Union 2015.
[2] Siemens o.J.
[3] Ericsson SE 2018.
[4] GSMA Intelligence 2017.
[5] Rost et al. 2017.
[6] Ericsson GmbH 2020.

frequencies, in connection with 5G, better known as millimeter wave (**mmWave**), small cells are capable of handling high data rates.[1] To provide wide-area coverage, macro cells are used. A higher number of devices can be handled with higher data rates and bandwidth for more users while latency is kept low. The extension of MIMO, **Massive MIMO**, will be used commercially to improve spectral efficiency in frequency range 1, the sub 6 GHz radio frequency bands.[2]

5G Network as a key enabler for new technologies

The **Core Network** is the mobile exchange and data network that manages all of the mobile voice, data and internet connections. In the second wave of the technology implementation, the Evolved Packet Core, the core network of the LTE System, will be replaced by a redesigned 5G Core.[3] Several advanced features of 5G, i.e., network slicing and network function virtualization, are managed in the core.[4]

11.2 Relevance for trade and SCF

As soon as 5G is available nationwide, companies will particularly benefit from this technology. It is not surprising that the industry will be the number one generator of incremental 5G revenue for mobile operators compared to the core consumer business.[5] In order to attain the vision of industry 4.0, communication with IoT devices is the most popular use case for 5G, according to a study by Gartner.[6] Due to the current lack of availability, the following chapter will therefore discuss the possibilities in logistics and the supply chain.

The information and communications technology sector is particularly relevant for the logistics industry. With the demand from the industry for real-time information and delivery forecasts, highly automated systems are required.[7] 5G is seen as a catalyst for time-sensitive IoT device applications.[8] In this way, the entire manufacturing supply chain will be interconnected and will enhance information dissemination across the network.[9]

A study by DotEcon and Axon evaluates 5G opportunities via convergence of technology and logistic trends. High opportunities for 5G are seen in the development areas of high-speed internet, robotics and automation, and unmanned area vehicles (drones). The logistics sector in particular can benefit from this by making supply chains more transparent and improving delivery and warehouse management as well as cost and delivery efficiency.[10]

UCOT

UCOT, an industrial internet company, works on solutions that utilize the potential of 5G to optimize supply chains. In their supply chain management ecosystem based on 5G and blockchain technologies, they offer real-time product supply chain

[1] Khan 2020.
[2] T-Systems International GmbH 2020.
[3] Breitenstein et al. 2019.
[4] EMF explained.
[5] GSMA Intelligence 2019.
[6] Fabre 2018.
[7] DotEcon Ltd and Axon Partners Group 2018.
[8] Deutsche Post DHL Group 2020.
[9] Huawei 2016.
[10] DotEcon Ltd and Axon Partners Group 2018.

traceability. The customer gains independence from third-party logistics providers, as reports are no longer required. In practice, UCOT's IoT sensors embedded in the packaging of products send information in real time over Narrowband-IoT (NB-IoT), a low energy 5G technology, and write them on to a decentralized blockchain. Afterwards the customer can investigate the product to prove authenticity and ensure that it will be received in optimum condition as intended by the manufacturer.[1]

5G Network as a key enabler for new technologies

Telekom

Telekom also offers an IoT module that emerged in collaboration with Fraunhofer IML. On a similar principle to UCOT, the **Low Cost Tracker** tracks sensor data and transmits energy-efficiently measured values and location information with Narrowband-IoT (NB-IoT) to an application platform, where the data can be viewed and further analyzed. These approaches try to overcome the challenge of a non-transparent supply chain, since a significant number of logistics and shipping providers count the lack of supply chain visibility as a major challenge.[2]

When using IoT to achieve transparency, 5G offers its low-energy advantages and "will pave the way for new globally utilizable tracking and condition monitoring capabilities" according to DHL's latest Logistics Trend Radar report.[3]

Another promising aspect is autonomous driving, based on vehicle-to-everything communication (V2X). Vehicles communicate with their environment, but also with each other. However, some modern vehicles already contain elements for automated driving. The automotive industry supports the 5G-based cellular vehicle-to-everything (C-V2X) standard due to 5G's low latency, reliability features and better performance compared to the WLAN-based solution.[4] On the way to full autonomy, the industry is currently shifting its focus from passenger cars to commercial vehicles, especially trucks.

11.3 Outlook on future developments

While the 5G roll out has just begun, the industry and academia have started to conceptualize 6G for the needs of the 2030s.[5] In the interim, a quarter of the world's population will gain broadband 5G coverage. A higher share is not expected by 2030, as improving connectivity is related to costs of $700 billion to $900 billion.[6] In terms of 5G-IoT modules, the industry will become the largest market. Here, industry 4.0 applications will account for almost half of all 5G IoT sales. In total, hardware sales of 5G IoT modules are expected to reach $9.6 billion by 2030.[7]

"Ubiquitous wireless intelligence" is the research vision statement from the first 6G Wireless Summit in March 2019, organized by the Finnish 6G Flagship Program. The Vision is based on three cornerstones and describes the ambitions for the next generation of cellular network:

"Ubiquitous – services follow users everywhere seamlessly

[1] UCOT 2020.
[2] Moor Insights & Strategy 2015.
[3] Deutsche Post DHL Group 2020.
[4] 5G Automotive Association 2017.
[5] Deloitte 2020b.
[6] Grijpink et al. 2020.
[7] Burkacky et al. 2020.

Wireless – wireless connectivity is part of critical infrastructure

Intelligence – context-aware smart services and applications for human and non-human users”[1]

Besides download speeds of 1 terabit per second, it is assumed that the increase in artificial intelligence will be the driver of 6G and cause interference. Therefore, artificial intelligence will play a major role in the design and optimization of 6G architectures, protocols, and operations[2] – even distributed and autonomous 6G networks are possible. This would mean less human involvement and the enabling of global reachability and scalability.[3]

5G Network as a key enabler for new technologies

[1] University of Oulu, Finland 2019.

[2] Letaief et al. 2019.

[3] Wang et al. 2020 - 2020.

12
Creating 3D models with Additive Manufacturing

12.1 Fundamentals / basics / definitions

Additive manufacturing (AM) has a history of more than 30 years and continues to play an important role in product manufacturing, more than ever before.[1] In additive manufacturing, digital 3D models are transformed into real objects using a 3D printer.[2] Initially, this method was used for the production of prototypes, as it considerably shortened the time-to-market.[3] Today, however, this technology is not only used for the creation of prototypes, but has become an integral part of companies' supply chains. It is estimated that by the end of 2020, additive manufactured products worth $5 billion will be sold.[4]

Additive manufacturing

The term additive manufacturing refers to various manufacturing processes in which objects are automatically produced layer by layer to form three-dimensional physical components. This is achieved using 3D printers that transform computer-aided design data into a physical object. In everyday language, the process of additive manufacturing is commonly named 3D printing.[5]

In order to remain competitive, companies must be able to react quickly to the wishes of their customers, and to respond to changes in the market respectively. Additive manufacturing represents one possible approach.[6]

Today, additive manufacturing is mainly used in prototype construction, for components with a high degree of individualization or complex geometry. Moreover, it is also becoming increasingly popular in the manufacture of end products.[7] Industries where this manufacturing process is particularly used are the aerospace, automotive, toolmaking and medical industries.[8]

The objects in additive manufacturing are produced using the 3D printing process and not, as is usually the case, by an ablative process using tools. Generally, the manufacturing process consists of several steps. Initially, the construction plan is created on the computer using a CAD program.[9] In order for the 3D printer to create the underlying 3D file, the so-called slicing is required. This is done by using a software that specifies the geometry of the component to be generated as a grid. The software program cuts the 3D drawing into individual horizontal layers and thus describes the process path for the 3D printer for each layer.[10] Based on these data, the object is created by the 3D printer in the last step. The components are produced by printing the underlying body layer by layer. In order for the individual layers to bond together, they are either hardened or melted before an additional

[1] Roland Berger 2013.
[2] Özceylan et al. 2018.
[3] Gibson et al. 2015.
[4] Özceylan et al. 2018.
[5] Gebhardt 2016.
[6] Walter et al. 2004.
[7] Liu et al. 2014.
[8] Auer 2019.
[9] Liu et al. 2014.
[10] Slic3r 2020.

layer is applied. The combined individual layers finally result in a three-dimensional physical copy of the CAD file. Various manufacturing processes are available, tailored to the geometry of the individual item design. Currently the preferred production materials are plastics, metals, ceramics or synthetic resins.[1]

In the traditional supply chain, raw materials are delivered by the supplier before being processed into products and delivered to the customer. With additive manufacturing on the other hand, these intermediate steps are reduced, since the product to be manufactured is based on a digital file (Figure 4).[2] The usage of AM technology therefore results in the following benefits:[3]

a) Tools are not required

b) Possibility to produce small quantities (even of lot size 1) and customer- specific products at low cost

c) Design can be quickly adapted

d) Increase in product quality

e) Chance to produce complex geometries

f) Shorter lead times and lower inventories resulting from simpler supply chains

g) Reduction of material waste

Other advantages of 3D printing are the lower number of errors caused by humans, and the fact that even untrained employees can operate the 3D printer, which is less the case with conventional machines. Furthermore, the companies are dependent on fewer suppliers, since additive manufacturing usually uses much less material, which enables the enterprises to place the production closer to their customer.[4]

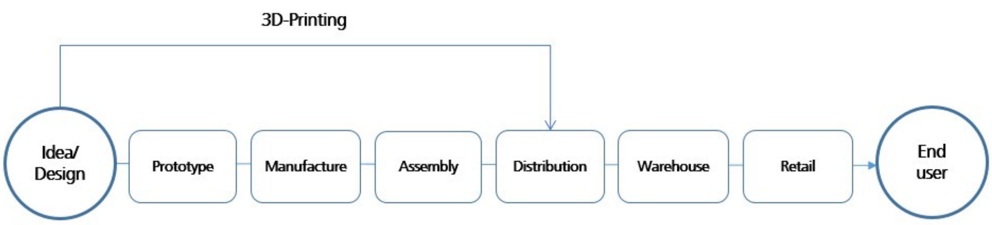

Figure 8: Comparison of 3D printing and traditional supply chain
Source: Own illustration based on Özceylan et al. 2018

However, additive manufacturing also poses challenges. Parts that must be within a given tolerance range, or need to have a certain surface quality, are less suitable for 3D printing, as subsequent finishing would be required.[5] Another obstacle is the production of different object sizes, since the print volume of a 3D printer determines the maximum dimensions of the objects. In addition, with regard to the lead time, additive manufacturing does not achieve the same efficiency as conventional manufacturing. Although additive

[1] Liu et al. 2014.
[2] Özceylan et al. 2018.
[3] Holmström et al. 2010.
[4] Janssen et al. 2014.
[5] IPH-Institut für Integrierte Produktion Hannover 2020.

manufacturing is becoming faster, mass production as we know it today cannot be achieved with 3D printers at this time.[1] Other aspects that should not be neglected are product liability and industrial property rights.[2]

Depending on the geometry of the respective component and the material used, several manufacturing processes are available. The most important processes are compared in the following.[3]

Fused Deposition Modeling (FDM)

This manufacturing process is the most widely used. Plastic wires, so-called filaments, are the starting material for FDM. These plastic wires are melted and then piled into a component, layer by layer. FDM is especially used for the production of prototypes. Due to its low cost, it is also often used in private households. FDM is not used for the production of end products, because of its low strength and accuracy.

Selective Laser Melting (SLM)

In selective laser melting, the desired component is produced in layers from metal powder and under the influence of a laser beam. Before a new layer can be applied, it must first harden. Afterwards the base plate is lowered, and a new layer follows - whereby the excess powder is collected and reused after each layer.

Selective Laser Sintering (SLS)

For this manufacturing process, laser beams are used to produce three-dimensional components from a plastic or metal powder. However, the quality of the components is worse with the SLS process compared to the SLM process. Since the SLS process, unlike the SLM process, only heats the powder particles until they can be bonded together, the SLS process is more advantageous in terms of speed.

Stereolithography (SLA or STL)

Stereolithography is the oldest additive manufacturing process. In this process a basin is filled with a platform and liquid resin. A laser beam then travels along the surface of the resin and engraves the contours of the mold in slices. The laser beam hardens the resin. As soon as one layer is finished, the platform moves down, and the process is repeated. Gradually, the shape of the final product is thus created.

Electron Beam Melting (EBM)

In contrast to laser melting, the material in this method is melted with an electron beam and joined together in layers to form a component. Since the powder particles can be melted at several locations simultaneously in the EBM process, the production speed is higher than in the laser process. However, the electron beam is also wider than a laser beam, which in turn affects the surface quality.

Laser Metal Deposition (LMD)

[1] Roland Berger 2013.
[2] Auer 2019.
[3] Riemann and Guggenberger 2020.

In LMD, the powder is melted with the help of a laser and then applied directly to the intended location using a nozzle. This process is mainly used for repairs or for the production of different components.

Binder Jetting (BJ)

From the inkjet print head, a liquid adhesive (binder) is applied precisely to the powder particles. After the powder has bonded with the adhesive, the building platform is lowered. By repeating this process several times, the object is created. To complete the process, a so-called sintering pass must be carried out after the last layer.

12.2 Relevance for trade and SCF

Since the additive manufacturing technology is fairly new in the area of Trade and Supply Chain Finance, this section will therefore consider the application of additive manufacturing with reference to supply chain management in more detail.

Supply Chain Management
Supply Chain Management comprises the integrated process-oriented planning and control of the flow of goods, information and money over the entire value and supply chain from the supplier to the customer.[1] Having said that, the satisfaction of the customer always comes first.[2]

Oettmeier and Hofmann conducted a study which examined the effects of introducing additive manufacturing technologies on supply chain management processes and components, using hearing aid manufacturers as examples. The researchers came to the conclusion that, when switching from purely physical production to AM production, not only internal processes are affected, but also processes between suppliers and customers. The study also revealed that, with the help of additive manufacturing, companies now have the opportunity to consider customer-specific wishes and at the same time be economical. The well-known problem of a large product range with simultaneous economies of scale should therefore be minimized.[3]

Some practical examples of how companies in other industries are already using additive manufacturing in their current supply chain are shown in the following section.

Bugatti

In the automotive sector, Bugatti is increasingly focusing on additive manufacturing for some vehicle components. In order to reduce the weight of the Bugatti Chiron, its tail lights were manufactured using the 3D printing process. Switching the manufacturing process ultimately saved a total of 34 kilograms per car.[4] To reduce the weight of a brake caliper, Bugatti worked together with the Fraunhofer Institute for additive production technologies. Through the use of titanium and a bionic design, it was possible to reduce the weight by 41% through additive manufacturing.[5]

BMW

[1] Oettmeier and Hofmann 2016.
[2] Chen and Paulraj 2004.
[3] Oettmeier and Hofmann 2016.
[4] Walsworth 2019.
[5] Bravo 2018.

Other automobile manufacturers, such as BMW, like to use the advantages of AM for their production as well. For the BMW i8 Roadster, it was not possible to cast the holder for the tonneau cover as is usually the case. For this reason, it was decided to produce the holder with AM. In the end, the holder was not only lighter, but also had better stability.[1]

Airbus

The aviation industry also profits to a particular extent from the advantages of additive manufacturing. To reduce the negative impact of air traffic on the environment, Airbus is currently working on making existing aircraft components lighter and at the same time just as stable. With the help of generative design and additive manufacturing, Airbus has so far succeeded in doing so. For instance, it has been possible to produce a partition wall that is 45% lighter than the current model. If this partition wall were to be used in the existing A320 aircraft, it would save about half a million metric tons of CO2 emissions per year, according to Airbus.[2]

Amazon

The online retailer Amazon wants to reduce its storage and personnel costs as well as delivery times, using AM. 3D printers will be installed in Amazon's delivery vehicles, and while other goods are being delivered, the 3D objects will be produced simultaneously.[3]

12.3 Outlook on future developments

At present, the full potential of additive manufacturing is far from being exploited because of the limited choice of manufacturing materials.[4] In addition, mass production with additive manufacturing is not currently possible due to the high costs and slow throughput.[5]

Traditional manufacturing methods are still the first priority for companies. In the long run, however, this does not have to remain, and the probability that additive manufacturing will be preferred to traditional manufacturing is increasing.[6] The efforts of 3D printer manufacturers to improve these impairments confirm this.[7] For instance, researchers at the University of Illinois have developed a 3D printer that can produce an area of approximately 46 cm within one hour.[8]

Additive manufacturing will have relevant effects on future business models as well as on supply and value chains. Current business relationships could become redundant and be replaced by a few new business partners.[9] Companies that have relocated their production abroad for cost reasons could switch to backsourcing through AM, and resume production locally. The small number of personnel required to operate the 3D printers makes this feasible.[10]

[1] BMW AG 2019.
[2] Tyrrell 2020.
[3] Krämer 2018.
[4] Oettmeier and Hofmann 2016.
[5] Berman 2012.
[6] Deloitte 2020a.
[7] Campbell et al. 2012.
[8] Essop 2019.
[9] Deloitte 2020a.
[10] Berman 2012.

By 2030, the market volume of additive manufacturing could grow to around 23 billion euros. The winners in this industry are likely to be the manufacturers of 3D printing technology, as well as the producers of the base materials.[1]

In order not to get left behind, companies today should look into the possibilities of additive manufacturing at an early stage. Products and services are becoming increasingly blurred. The additive manufacturing process supports this fact. In addition to the production of three-dimensional components in industry, the digital trade of intellectual property also represents a new financial product for credit institutions.[2]

[1] Auer 2019.

[2] Deloitte 2020a.

13
Looking into the future with Digital Twins

13.1 Fundamentals / basics / definitions

Achieving competitive advantages through efficiency, precision and adaptivity is a fundamental aspect for every business and organization. Digital twins help to accomplish these advantages through highly information-rich digital modeling and its analysis. In its core, the technology helps to understand performance, improve processes and develop new revenue opportunities by simulating state and behavior in physics-based virtual environments.[1]

Digital twins

Digital twins are fundamentally the digital representations of assets, systems or entities that capture attributes and behaviors. They can represent everything, from a component to a machine or production line and even more abstract things such as a replica of a human being. Therefore, digital twin systems are also subdivided into physical and psychological systems. Every digital twin is able to communicate, store, interpret or process information in a certain context and represents either already existing things or those that will potentially exist in the future.[2] Digital twins of existing things are called digital twin instances. They can help with the monitoring and analysis. Things that could potentially exist in the future and are displayed via the technology are called digital twin prototypes and help in exploring upsides and downsides. Therefore, they enable any business or engineer to react preventatively in the creation or construction of the virtually displayed concept or system.[3] Furthermore, there is a clear differentiation between one single and many connected digital twins. First, there is the discrete digital twin, which is always associated with one single counterpart. And then there is the composite digital twin, which is a combination or a network of multiple ones. Both forms are always unique in themselves.[4]

The creation of a digital twin is mostly initially done with data from the physical world. This could be product data about the manufacturing process, design data or via information about any supportive specifications like, for example, operation manuals or maintenance timeframes. The available data is then used for the modeling. Through the utilization of these models, simulations can be created to answer many potentially upcoming questions. Those questions could be regarding performance, behavior in specific situations or the modification of products and processes. Furthermore, the created digital twin can constantly either be updated or update itself via e.g. sensors or other open interfaces, and is therefore able to respond to changes in its state.[5] Besides state analysis and future projections, the digital twins can also be used to look backward. With necessary information available, it is therefore possible to reconstruct systems or whole scenarios, for instance to help with a troubleshooting process.[6]

[1] Altran 2019.
[2] Bao et al. 2019.
[3] Grieves and Vickers 2017.
[4] Malakuti et al. 2020.
[5] Parrot and Warshaw 2017.
[6] Fraunhofer-Gesellschaft e.V. 2018.

To effectively utilize digital twins, users have to apply further technologies. Underlying technologies are, for example, the internet of things, artificial intelligence and virtual reality, which are further described in chapters six, eight and fourteen of this white paper.[1]

Besides fundamentally necessary technologies, digital twins are converging with other technologies to become even more useful. One complementary technology is, for example, the blockchain technology, which creates transparency and accessibility regarding data, while simultaneously securing it from hacking through immutability. These features are of importance to digital twins, because they enable the transmission, exchange and monitoring of data and value over the internet in a secure manner, thus increasing the efficiency, overall data flow and interconnectivity of the digital twin.[2]

All the information necessary for the creation of a digital twin is to be found in the digital thread. The digital thread ensures that all data necessary for the creation and functionality of the digital twin is available. It is a record of all information connected to a system or product.[3] Examples of covered information could be:

- Original design
- Construction
- Production
- Price history
- Functionality
- Operations
- Maintenance
- Supply Chain Data
- Software used for its creation

Generally, the accuracy of a digital twin grows with the amount of data deployed into it.[4]

Digital Twins in companies

There are many companies which are already either implementing digital twins in their business or plan on doing so in the future. Examples of the utilizations are:

Kronsberg

The software company Kronsberg Digital signed an agreement on a digitalization partnership with the oil and gas company Shell to digitize the Nyhamna gas facility in Norway. Through the utilization of the digital twin technology, Kronsberg Digital wants to establish a dynamic virtual representation of the gas plant and its behavior. Due to the continuously updated information, the status of the facility can be observed in real time. This gives Shell as a technical service provider the ability to work through different scenarios via simulation and, furthermore, it offers the possibility to uncover new optimizations regarding the plant and its processes.[5]

Tesla

[1] Dohrmann et al. 2019.
[2] Sallaba et al. 2018.
[3] Deloitte 2016a.
[4] General Electric 2016.
[5] Kronsberg 2019.

The electric car manufacturer Tesla has a digital twin for every car the company produces, which is tied to the unique vehicle identification number (VIN). Through the constant data flow between the car and the factory, Tesla is able to identify issues with specific cars and react accordingly with matching software updates for individual cars.[1]

Looking into the future with Digital Twins

Further key players in the digital twin market are companies like IBM, ANSYS, Microsoft Corporation, Siemens AG, SAP or Oracle.

13.2 Relevance for trade and SCF

The digital twin is still under development in the trade and SCF area. For this reason, the next chapter first deals with the supply chain with regard to the digital twin.

In the area of SCM and SCF composite digital twins play an essential role. Supply chains are usually very complex due to a variety of players and dependencies. One company's supply chain can easily consist of a few thousand assets, warehouses and logistic flows. This complexity often leads to lost value and compromises, which is why predicting bottlenecks and risks in general plays an important role. Through simulating all the assets and processes in the form of digital twins, companies can gain insights which help in decision-making processes and risk management. Instead of managing a crisis, a digital twin enables the company to identify execution risks early and is therefore able to mitigate those risks. Moreover, a specific sales plan can be simulated to highlight risks as well as missed opportunities, which leads to optimized sales and operation planning. Finally, the digital twin even enables the company to simulate long-term plans, for example in the form of growth plans. The results would then reveal possible structural bottlenecks or a lack of capacity.[2]

A different role will be taken by the technology in customer-centric industries. So called Behavioral digital twins – which are categorizable as psychological systems - will be used for consumer choice modeling and were first introduced by PricewaterhouseCoopers. Back in 2012, when the paper was released, the model was only based on historic data and about making assumptions with the help of artificial intelligence. But with the introduction and growing possibilities of digital twins new simulation possibilities are emerging. Through Behavioral digital twins an accurate prediction of the behavior of any agent of the system will be possible. Anyone and anything that is able to make a decision can be an agent. Therefore, it could be individuals, customer segments, companies or even whole economies. Everything will be categorizable. An individual for example will be categorized with attributes and behaviors. Attributes could be the age, gender, occupation or risk profile. Behaviors will be defined by e.g. employment choices, spending habits, investment choices or retirement goals. Additionally, the environment of the simulation will be constructed. The simulation could then, for example, predict the behavior of a specific customer segment, individual or company in case of a changing tax system or an economic crisis. Additionally, any Behavioral digital twin can learn and adapt as well as react to changes in the environment or to changes in the behavior of other agents. Moreover, it is not only the agents who can react to changes in the environment, but the environment will also change based on behavioral changes of agents. It will be influenced by any individual and is therefore not universal in the simulation, but adapts to every agent. An example of this case would be the lifecycle of one individual person. Thus, the environment involves factors like a person being a pre-retiree or part of a new generation.[3]

[1] Overton and Brigham 2017.
[2] Schuster et al. 2020.
[3] Lombardi et al. 2012.

Overall, this application of digital twins will enable optimal pricing and design, capital and risk management, strategic analysis and policy developments.[1]

Looking into the future with Digital Twins

Therefore, any stakeholder in trade and SCM will benefit from the utilization of the technology. Examples of the outcome of applying the technology could be:

- Logistic companies can anticipate capacity needs prior to the actual order initiation with high accuracy
- Suppliers can adjust production cycles or production processes regarding specific products in anticipation of demand changes
- Risks of experiencing e.g. bullwhip effects are reduced, due to demand and environment forecasting in various scenarios
- An overall reduction in warehousing costs, due to the possibility of even more accurate Just-In-Time deliveries
- Less risk in financing a trade, due to the possibility of analyzing and managing risk in a much more efficient and adaptable way

13.3 Outlook on future developments

Gartner already named digital twins one of the top 10 strategic technology trends for 2019[2], and it is expected that, by 2022, over two thirds of the companies that implemented IoT solutions will at least have one digital twin in usage.[3] By 2025 the market will have reached a size of approximately 35.8 billion USD, at a CAGR of 45.4%. The main growth drivers will be industries such as healthcare, aerospace and automotive[4], but the technology will also have impacts on financial services and especially the insurance business.

But while the main use case anticipated today is a digital twin of an object or system like a machine or production cycle, in the future we could see even whole organizations having a digital twin. This would mean that every system, process and human as well as every interaction in between them, would be represented digitally.[5] This development would also enable an analysis of everything happening inside the organization, which results in the possibility of an interdepartmental functional analysis. A CIO would therefore highly benefit from using digital twins to virtually display different processes and their optimization. Moreover, the usage of the digital twin would result in decision guidance for any person in charge. Therefore, digital twins are an essential part of building and managing smart factories.[6]

Furthermore, the National Digital Twin program, delivered by the Digital Framework Task Group in the UK, has the goal to create a national digital twin. To realize this, an ecosystem of connected digital twins from all over the country is to be created. Therefore, in 2019 the Centre for Digital Built Britain established the Digital Twin Hub, a web-based platform that connects those that either own or develop digital twins, to explore and unlock the potential of digital twins in the UK.[7] The new digital infrastructure created through the program aims

[1] Levina and Duerk 2018.
[2] Gartner 2018b.
[3] Gartner 2019.
[4] MarketsandMarkets 2020.
[5] Pradeep et al. 2018.
[6] Gartner 2018b.
[7] Digital Twin Hub 2020.

to offer optimized decision-making solutions in a broad range, e.g. in terms of population growth, congestion, climate change or the development of new technologies.[1]

Deloitte also concludes in a publication that connectivity and interoperability between different stakeholders and their digital twins are essential. It states that a so called "Supra-Platform" will connect all the isolated digital twin hubs through open interfaces and enable a much broader, international and more efficient ecosystem in the future. This platform must still be created by an organization or company. Moreover, the creator has to operate internationally and be trusted to be able to orchestrate and coordinate the data management layer.[2] Banks, for example, could try to position themselves to become a provider of such a platform, since they are trusted by many companies and individuals globally.

Looking even further ahead into the future, humans will be able to have their own personal digital twin – a replica of themselves in the digital world – also called digital double. It will not only be usable in simulations, but will work for its human, as Forrester Vice President and Principal Analyst on Customer Experience Rick Parrish says. The doubles will act in the interest of the human and could, for example, book vacations based on preferences or manage the calendar and budget – saving time and money. Furthermore, they could filter content and shield the human from irrelevant spam or advertising. This level of personalization and individualization will be made possible through data aggregation. Unlike the situation today, this data will most probably be controlled by the individual and not directly by companies.[3]

The Data Transfer Project is an example and first step in this direction. It was launched in 2018 and enables people to move their data between online service providers whenever they want, which will not only give those people more control, but also increase competitiveness between platforms and service providers. Current contributors to the project include e.g. Apple, Facebook, Google, Microsoft and Twitter.[4]

[1] National Infrastructure Commission 2017.
[2] Sallaba et al. 2017.
[3] Curtis and Cotton 2019.
[4] Data Transfer Project 2018.

14
Diving into Virtual Reality

14.1 Fundamentals / basics / definitions

Virtual Reality (VR) has become an omnipresent topic that is being taken up across all industries and promises nothing less than a revolution in the consumption of digital content. The technology is not only celebrated by early adopters and technology enthusiasts, more and more enterprises are making their products accessible to potential customers via VR. In addition to communication and entertainment, there is also great potential in education, research, medicine and therapy.[1]

Virtual reality
Virtual reality describes a computer-generated environment that stimulates different senses of the user and allows interaction in real time. Through an almost realistic replication of reality, the user is given the feeling of being immersed in the virtual world. VR glasses, so-called head-mounted-displays (HMD), provide access to the new medium.[2]

Virtual reality is not a new technology, as one might initially assume. Research in this field was already being conducted in the 1960s and 1970s, but the lack of computing power initially brought the technology to a standstill. Only a few years later, in 1985, this technology was taken up again by the military and space research. At that time, a lot of money was invested in this technology, thus paving the way for the current state of VR technology.[3] The scientist and technician Jaron Lanier significantly influenced this technology; it was he who coined the term virtual reality and made it known beyond expert circles.[4]

In virtual reality the environment reacts to user input and therefore enables a direct interaction between the user and the virtual world. This is made possible by the corresponding hardware and software with which the users can enter the virtual world and at the same time modify it interactively.[5] An artificial space is thus created alongside the real world.[6]

At first glance, the words *virtual* and *real* may not match, but today's technology makes it possible for the artificially created space to appear authentic and real.[7] Through the visual, acoustic and tactile perceptions, as well as the possibility to actively interact with the environment, the user gets the feeling of being in the middle of the virtual world. VR is able to recreate places artificially and thus enables the user to reach places that are nearly or completely impossible to reach in reality. Unlike in a computer game, we are no longer separated from the story by a screen, but are supposedly in the middle of it. In this context one also speaks of immersion, i.e. the feeling of being completely immersed in the virtual world. Two essential points play an important role here. Firstly, how strongly the virtual and real environments match and, secondly, how strongly the user can influence the

[1] Hammer 2016.
[2] KPMG 2016.
[3] Menzel 2004.
[4] Kołodziej 2017.
[5] KPMG 2016.
[6] Witt and Gloerfeld 2018.
[7] Lohmann and Ladwig 2016.

virtual world.[1] So the more captivating and interactive this world is made, the greater the immersion effect appears. VR glasses make this interaction possible. Hand scanners or controllers, as well as treadmills help to make the virtual world tangible.[2]

The technology behind this illusion is implemented with the help of sensitive sensors, which convert movement, pressure, noise and additional analogue data into digital signals and send these back to a data centre in a bundled form. From here onward the data is then merged with stored 3D data. Finally, the data is calculated in real time in live rendering, whereas the screen information is passed on to the output devices. This is realized either via a mobile or a permanently installed VR system.[3]

With the help of virtual reality, the simulation of processes, procedures or devices can be supported. A study by KPMG has shown that VR is used primarily for internal processes, in marketing and sales and in after-sales. Furthermore, this technology is frequently used in research and development as well as in prototyping.[4]

Where VR technology is already in use, some positive effects have been noticed. Enterprises of various industries could therefore increase their productivity and efficiency and improve the safety of their employees. Further advantages can be seen in the processing industry, where production time as well as complexity and error rates have been significantly reduced.[5] However, data security represents a challenge for companies, since VR devices generate a large amount of information about their users. Companies should therefore ensure a closed infrastructure in advance and work with appropriate authentication.[6]

In contrast to virtual reality, in which the user is completely immersed in a virtual world, **augmented reality (AR)** still offers the possibility of perceiving the real world, for example through a display, but additional information can be shown as if it were available in the real world. With AR, the user is therefore still in his real environment, and immersion, as in VR, does not take place. The end device used in AR is not the HMD, but the user's own smartphone, tablet or data glasses. The aim of AR is to support people in their everyday activities, to facilitate communication and to expand perception. With the available intuitive visual aids, AR can therefore greatly reduce the complexity of tasks. The areas of application of AR are in medicine, education, in the games and lifestyle industry, in the military and even in process optimization. Estimates show that AR devices worth almost 7.5 billion euros will already be purchased by 2020. In order to fully exploit the potential of AR, however, the technical, economic and political hurdles still have to be overcome. For example, sufficient battery and computing power must be provided, but data protection plays an important role too. In addition, short product introduction times are required for implementation in research. Due to the increasing use of smartphones, synergy effects between VR and AR can arise. Both technologies are also assigned to the same research area, as the hardware and software structure used is almost identical.[7]

[1] Brill 2009.
[2] KPMG 2016.
[3] Dörner et al. 2019.
[4] KPMG 2016.
[5] Cohen et al. 2018.
[6] Dorn 2019.
[7] Heng 2015.

DHL

DHL is one of the first companies to use data glasses in its order picking processes at several locations worldwide. As a result, no hand scanners or paper lists are required for the respective process, making order picking significantly more efficient.[1]

14.2 Relevance for trade and SCF

Virtual Reality is already successfully applied in some industries. In the trade and supply chain finance sector, the use of VR is still in its infancy. For this reason, this section will focus on the importance of virtual reality in the supply chain sector.

According to a Deloitte study, the supply chain in particular benefits from the implementation of virtual reality, notably the areas of product and process design, data and process visualization, employee collaboration and experience-based learning.[2] Some practical examples already implemented in companies are presented below.

Airbus

With the help of virtual reality, Airbus was able to reduce its inspection time from three weeks to three days. This was made possible by integrating digital models into the production field, thus providing employees with a complete 3D model of the aircraft during assembly.[3]

Ford

Ford also uses the advantages of VR in the area of occupational safety. The movement sequences of the employees could be recorded and optimized with VR-based body movement sensors, thus reducing 70% of the injuries that occurred during assembly and 90% of the ergonomic problems**.** But it is not only occupational safety that benefits from this technology. Ford designers no longer have to undertake long business trips in order to work together on a new vehicle. Virtual reality enables employees to meet in a virtual space and work together from there. Travel expenses can thus be avoided.[4]

Pacific Gas and Electric

The largest energy provider in the United States, Pacific Gas and Electric, provides its employees with VR technology to enable them to check the equipment more quickly and safely and ultimately reduce the risk of injury to technicians.[5]

Many of these examples show that VR enables users to gain a clear understanding of a system.[6] It can be assumed that companies will initially focus on optimizing the current value chain and that the development of new business models will only take place when the technology has reached a certain maturity and market penetration is increasing.[7]

[1] Deutsche Post DHL Group 2019.
[2] Fitzgerald et al.
[3] Airbus 2016.
[4] Cohen et al. 2018.
[5] Cohen et al. 2018.
[6] Cohen et al. 2018.
[7] KPMG 2016.

14.3 Outlook on future developments

The question is not if, but when and how virtual reality will become an integral part of our everyday life, as the gap between virtual reality on the one hand and reality on the other hand will become smaller and smaller.[1]

Possible applications in the future are already under discussion. The construction of prototypes, for example, will no longer be necessary, and real estate can be visited virtually even before the construction project has even started. It will also no longer be necessary to fly in cost-intensive experts from abroad for maintenance and repairs. The experts can enter the workplace together with the fitter on site and solve the problem together.[2] A visit to a local bank branch may also no longer be necessary in the future. Digital bank branches with virtual advisors could help.

Especially Chinese and US American companies are currently the leaders when it comes to implementing VR. In China, around 51% of companies have already started to integrate VR technology into their business processes, whereas in the US the figure is around 42%. German companies are still somewhat hesitant, with only 28% of companies currently implementing VR solutions.[3]

VR technology is still in its infancy, but the future possibilities look promising. Nevertheless, every new technology brings not only advantages, but also challenges. Especially in Germany, the topic of data protection plays an important role, and in order for users to place their trust in the new technology, it is important to use the latest authentication and IoT security techniques.[4] At the moment, it is not yet clear in which direction VR technology will develop, but it already exists and will therefore not disappear again. Due to the ongoing technology development, HMDs will not only become cheaper in the future, but above all they will become smaller, lighter and more comfortable, which should promote access to the mass market.[5] Especially for banks, there is now the possibility to use the advantages of VR technology to unite the digital world more closely with the physical world and thus satisfy the increasing expectations of the customers. At the same time, new financial products can be created and access to customers improved.

[1] Schuster 2017.

[2] Fitzgerald et al.

[3] Cohen et al. 2018.

[4] Dorn 2019.

[5] Hammer 2016.

15 Relevant stakeholder and technology providers

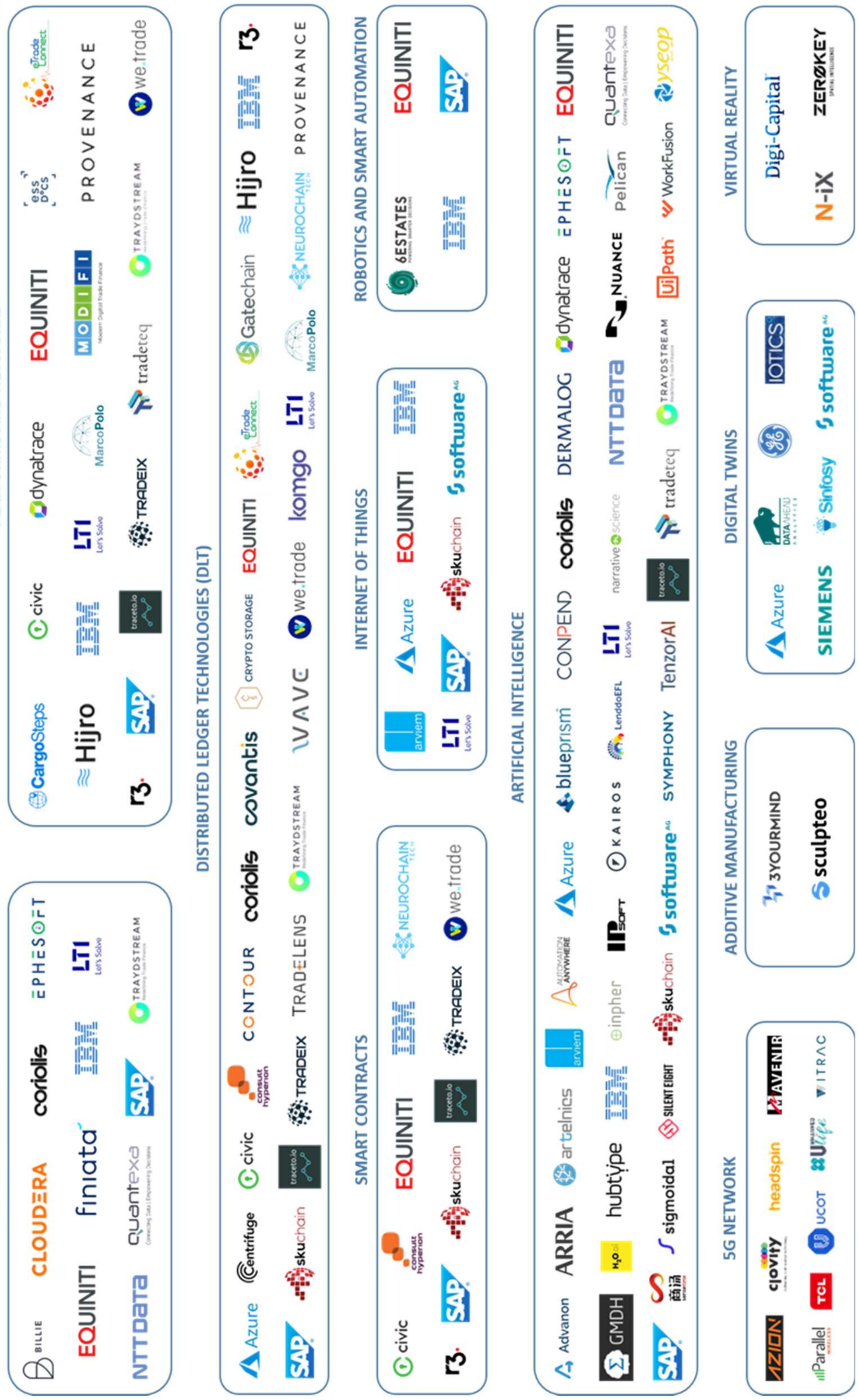

Figure 9: Ecosystem of relevant stakeholder and technology providers

Relevant stakeholder and technology providers

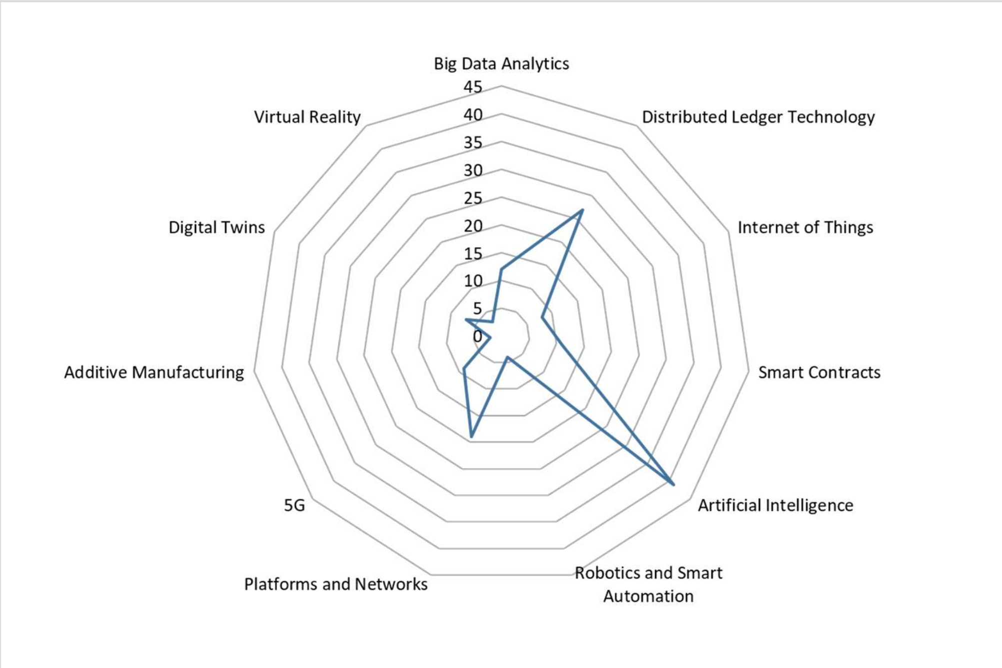

Figure 10: Overview regarding the number of stakeholders depending on the technology

The ecosystem shown in Figure 10 assigns relevant stakeholders and technology providers for trade and supply chain finance to technologies discussed in this white paper by considering the current state of the art. Due to overlapping topics, some actors are assigned to several fields, as the full potential of the respective technologies can often be realized only in combination with each other. In this context, the number of stakeholders varies between the several areas, as some technologies are already more integrated than others in the field of trade and supply chain finance. In particular, the technologies 5G Network, Additive Manufacturing, digital twins, Virtual Reality at the bottom of the ecosystem are still new to the financial sector, so the focus of stakeholders here is more on the state of the art in supply chain management. However, the advantages of these technologies have already been recognized, so that the applications of these areas and possible relevance for supply chain finance will certainly become established in the future. As the radar chart shows, the most strongly represented fields are Artificial Intelligence with 41 and Distributed Ledger Technology with 27 actors. In contrast, the smallest represented areas here are Additive Manufacturing and Virtual Reality with two and three stakeholders, due to the comparatively early development stage of the technologies. Each technology and its applications in trade and supply chain finance have been explained in the chapters above, and more detailed descriptions of the companies listed here can be found in the appendix.

16 Glossary

Algorithm	A well-defined and finite procedure by which a problem can be solved. It contains instructions that are followed step by step to achieve a certain goal. The individual steps are clearly defined so that they are always carried out in the intended manner and order.[1]
Anti-money-laundering policies	Framework for the fight against money laundering and terrorist financing.
Basel III regulations	The core element of Basel III is to strengthen the quality and quantity of banks' equity capital. Basel III is primarily intended to improve supervisory regulations, prudential supervision and risk management.[2]
Bitcoins	Crypto currency which is created, distributed, traded, and stored with the use of blockchain.[3]
Bullwhip effect	The bullwhip effect describes a phenomenon of inaccuracy in estimating demand in multi-stage supply chains. Actors within the supply chain do not take the demand of the end customer as a reference, but the demand transmitted by the predecessor in the chain. The misinterpreted signals then lead to order fluctuations and are reflected in imbalances in inventory.[4]
Bill of lading	The bill of lading is issued by the carrier and represents the goods during overseas transport. The goods can therefore be traded and sold during the transport.[5]
Emerging technologies	These are technologies that will fundamentally change the current business models and working methods. The most promising technologies are highlighted in this report.
FinTech	The term FinTech is composed of the words *financial services* and *technology.* It is a collective term for modern technologies in the financial services sector and is often used to connect to startups.[6]
Inventory financing	The process of obtaining capital for a business by borrowing money with inventory used as collateral.[7]

[1] Lackes 2020.
[2] Bundesministerium der Finanzen 2019.
[3] Commerzbank AG 2020.
[4] *Bullwhip-Effekt* 2006.
[5] Tarver 2020.
[6] Gründerszene 2019a.
[7] Kenton 2018.

Know-your-customer policies

In this process, the identity of the customers is verified by the banks, before transactions are processed. The policies may vary from bank to bank, but collecting basic data and information about customers, usually through electronic identity verification, is one of the first steps to be taken.[1]

Letter of credit

A letter of credit is a common instrument used in international trade to secure payment. It serves to reduce risks in the export and import of goods and thus fulfils an important function in international trade.[2]

Megatrends

Long-term change processes with enormous dimensions and effects. Megatrends are not one-dimensional, but rather diverse and networked. They unfold their dynamics in a cross-sectional manner, in part across all social and economic sectors. They do not act in isolation, but influence each other and thus reinforce each other's impact.[3]

Metadata

Structured data that contains information about characteristics of other data.[4]

Purchase order financing

Is an agreement whereby a third party, usually a bank, agrees to provide a supplier with enough money to finance a customer's purchase order. This type of financing mainly affects small companies that do not have sufficient financial resources to finance large customer orders.[5]

Quantum computing

Traditional computers are programmed with bits as data units (zeros and ones). Quantum computers, on the other hand, use so-called Qubits, which can represent a combination of zero and one simultaneously. This difference gives quantum computers the potential to be exponentially faster than today's mainframe computers and servers.[6]

Reverse factoring

In reverse factoring, the purchased goods are pre-financed by a bank. Example: A company buys goods and a commissioned bank pays the supplier. The company in turn has to pay back the purchases to the bank at a later date, including interests and fees.[7]

Smart devices

Electronic devices that are wireless, mobile, networked and equipped with various sensors. These include smartphones, tablets and data glasses.[8]

[1] Siller 2020.
[2] Trade Finance Global 2020a.
[3] zukunftsInstitut 2020.
[4] Wikipedia 2020.
[5] Trade Finance Global 2020b.
[6] IBM 2020.
[7] Factoring-Mittelstand 2020.
[8] IT Wissen 2019.

Smart factories	Refers to a production environment that organizes itself. The actual production process no longer requires human intervention.[1]
StartUp	A StartUp describes a recently founded company, which, with the help of an innovative product, has set itself the goal of achieving rapid growth in the shortest possible time.[2]
Tokens	In the context of cryptographic values, tokens are special units that entitle the holder to an operation on a common, decentralized resource. Usually this resource is a blockchain.

[1] Bundesministerium für Wirtschaft und Energie 2020.

[2] Gründerszene 2019b.

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