Developing Blockchain Real-Time Clearing and Settlement in the EU, U.S., and Globally

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Framing the issue

U.S. and European payment systems[1] as we fondly know them are notoriously antediluvian. In China,[2] all a consumer needs to do to send money is to input on their phone the beneficiary's 16-18 digit account number, name, and bank name. Final credit is typically received in 5 seconds – not up to 5 hours, as for a U.S. domestic wire. Nor do Chinese consumers experience the grotesque fees charged for Western Union's "instant money," which in most cases still requires a trip to clear physical cash. There is no shortage[3] of U.S. and European-based apps, but general standards and rules have yet to be developed. Simply put, financial infrastructure has vast potential[4] for disruptive innovation.[5] As a result, the European Commission[6] has conducted a broad-based review ways to make financial services regulation more efficient, less costly and, above all, more anticipatory, by reducing complexity and "future-proofing" laws.

Clearing comprises all processing from the time the commitment for a securities transaction is entered into until consideration is exchanged in settlement thereof – usually contemporaneously. Advanced clearing systems and legal provisions are needed as the speed of trading by far outpaces the ability to complete each such transaction. The settlement process includes a legal transition: during the time span between trade and settlement, a purchaser's rights are purely contractual and thus personal. Only after settlement, they become proprietary,

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[1] Nathan McAlone, *Jamie Dimon says banks are 'open to attack' from tech companies in one specific area*, BUSINESS INSIDER (May 23, 2016), http://www.businessinsider.com/jamie-dimon-says-tech-companies-could-disrupt-payments-2016-5?r=US&IR=T.

[2] Maltem Consulting Group, *Introduction to the China payments and clearing systems* (May 29, 2015), http://www.maltem.com/en/article_lab/introduction-to-the-china-payments-and-clearing-systems/.

[3] Patrick Allan, *Money Transfer Showdown: Square Cash vs. Venmo vs. PayPal*, LIFEHACKER.COM (Jan. 10, 2016), http://lifehacker.com/money-transfer-showdown-square-cash-vs-venmo-vs-payp-1752058723.

[4] Traxpay Team Market Research, *SWIFT, Myths and Shifts – Real-Time Payments Around the Globe*, TRAXPAY.COM (July 2, 2015), http://traxpay.com/2015/07/swift-myths-and-shifts-real-time-payments-around-the-globe/.

[5] Accenture Payment Services, Real-time Payments for Real-time Banking. How banks can seize the full opportunities of immediate payments, ACCENTURE.COM (2015), https://www.accenture.com/t20151002T215256__w__/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Dualpub_22/Accenture-Banking-Realtime-Payments-Realtime-Bank.pdf.

[6] Pinsent Masons, *Redesigning the EU Regulatory Framework for Fintech and Digital Financial Services*, OUTLAW.COM (Feb. 18, 2016), http://www.out-law.com/en/articles/2016/february/redesigning-the-eu-regulatory-framework-for-fintech-and-digital-financial-services/.

terminating counterparty risk. While settlement of equities, bonds, mutual funds and municipal securities in the U.S. is usually required to occur within three business days[7] after the transaction date (T+3) and by T+1 for listed options, options on futures contracts, and government securities, the European standard and that applicable in forex spot markets is T+2 (except trades between USD, CAD, EUR, RUB and TRY, which settle T+1). However, the target is real-time clearing and settlement[8] in accordance with ISO 20022 standards for real-time payments.[9] This objective, stated considerable time ago,[10] requires not only broad-based financial technology but also major investments in financial markets infrastructure[11] and legislative adjustments and harmonization. Of course, even with digitally assisted, ledger-based transfers and digital communications, it is far more accurate to speak of near-real time settlement.

Cost-benefit analysis is controversial in an age of skepticism over further market acceleration: "T+2 is probably one step the industry could find a way to cope with. For T+1, someone would really have to define what the benefit is and what problem is being eliminated."[12] One problem that would be almost certainly eliminated through real-time or quasi-instantaneous clearing and settlement is counterparty risk:[13] the risk that one party in the chain defaults by virtue of insolvency. Given that subsidiaries of DTCC (the Depositary Trust and Clearing Corporation,[14] the major U.S. clearing house and equivalent of Euroclear[15] and Clearstream[16]) settled securities trades in an amount of $1.7 quadrillion already in 2012,[17] and daily turnover in the forex markets exceeded $5.3 trillion[18] in 2013, it is easy to see that even

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[7] U.S. SEC. & EXCHANGE COMM'N, ABOUT SETTLING TRADES IN THREE DAYS: T+3 (May 21, 2004), http://www.sec.gov/investor/pubs/tplus3.htm.

[8] Denise Bedell, *When Will Real-Time Clearing & Settlement Come?* GLOBAL FIN. (Oct. 12, 2015), https://www.gfmag.com/topics/conference-coverage/when-will-real-time-clearing-settlement-come.

[9] Tom Leander, *Harmony and Tempo: The Status of Real-Time Payments*, GLOBAL FIN. (Oct. 12, 2015), https://www.gfmag.com/topics/conference-coverage/harmony-and-tempo-status-real-time-payments.

[10] G30 WORKING GROUP, GLOBAL CLEARING AND SETTLEMENT: A PLAN OF ACTION (2003), http://group30.org/publications/detail/123.

[11] EUR. COMM'N – FINANCE AND BANKING, FINANCIAL MARKETS INFRASTRUCTURE (June 7, 2016), http://ec.europa.eu/finance/financial-markets/index_en.htm.

[12] Nina Mehta, *DTCC Plans Study on Faster Settlement for U.S. Securities*, BLOOMBERG (May 22, 2012), http://www.bloomberg.com/news/articles/2012-05-22/dtcc-plans-study-on-faster-settlement-for-u-s-securities-1-

[13] Damiano Brigo & Andrea Pallavicini, *Counterparty Risk and Contingent CDS Valuation Under Correlation Between Interest-Rates and Default*. Available at SSRN: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=926067.

[14] DTCC, http://www.dtcc.com/.

[15] Euroclear SA/NV, https://www.euroclear.com/en.html.

[16] Clearstream Deutsche Börse Group, http://www.clearstream.com/clearstream-en/.

[17] Nina Mehta, *supra* note 12.

[18] BANK FOR INTERNATIONAL SETTTLEMENTS, TRIENNIAL CENTRAL BANK SURVEY (Sept. 2013), http://www.bis.org/publ/rpfx13fx.pdf.

minuscule per-transaction savings or expenditures mushroom to substantial figures industry-wide. This summary references legal, institutional, policy and structural issues involved in arriving at real-time clearing and settlement.

While countries strive for near-real time clearing systems, the ambition to arrive at near-real time settlement systems is not keeping pace. This is so in part because it would adversely affect banks' access to funds technically in transit – a true real time payments system would reduce the negative float[19] to zero. This would potentially require banks to keep funds available at all times in order to make final payment in real time, when in reality banks do not have funds available but have to find them to make timely settlement, which they accomplish through a variety of liquidity optimization algorithms[20] that allow them to come up only with the necessary minimum of funds to cover payment orders. This is also the reason why Real Time Gross Settlement[21] (RTGS) systems are not scaled toward consumers but currently remain restricted to interbank settlements. To understand the tasks involved, it helps to realize that the task of reassigning and delivering a security consists of several rather complex steps that must be verifiable and traceable at the lowest possible cost.

Three elements of processing a securities transaction

- *Execution*

The commitment stage matches buyer and seller of a security in a public market through any execution platform,[22] be it a stock exchange, an electronic trading system, a brokered market or any other form of matching system, with or without intermediary.

- *Clearing*

Clearing consists of several steps:[23] matching the trade compares the records of both buyer and seller as to price, quantity, and other terms. Thereafter, the parties identify the accounts to which a security or payment is to be credited. Risk of failed trades is further minimized by interposing a central counterparty (CCP) between the dealers for either party. The CCP acts as seller to all

[19] Investopedia, *Negative Float* (undated), http://www.investopedia.com/terms/n/negative-float.asp.

[20] Elton-Pickford & Clearstream Deutsche Börse Group, *Collateral Optimisation. The Value Chain of Collateral: Liquidity, Cost and Capital Perspectives* (2014), https://www.clearstream.com/blob/66616/9250c222407c9aad032ff51f8e4befa3/eltonpickford-data.pdf.

[21] BANK FOR INT'L SETTTLEMENTS, REAL-TIME GROSS SETTLEMENT SYSTEMS. REPORT PREPARED BY THE COMMITTEE ON PAYMENT AND SETTLEMENT SYSTEMS OF THE CENTRAL BANKS OF THE GROUP OF TEN COUNTRIES (Mar. 2013), http://www.bis.org/cpmi/publ/d22.pdf.

[22] U.S. SEC. & EXCHANGE COMM'N, TRADE EXECUTION (Jan. 16, 2013), https://www.sec.gov/investor/pubs/tradexec.htm.

[23] DERMOT TURING, CLEARING AND SETTLEMENT IN EUROPE (2012), http://www.bloomsburyprofessional.com/uk/clearing-and-settlement-in-europe-9781780431109/.

buyers and vice versa, minimizing failure risk through set-off (netting) buy and sell transactions. Netting substantially reduces the need for actual exchange of funds and securities at settlement.

- *Settlement*

Settlement involves the exchange of consideration:[24] security against payment. In advanced financial markets, physical certificates are seldom held (as a matter of authentication). Rather, they are held indirectly through a book entry system run by a custodian, typically a central securities depository[25] (CSD), which transfers ownership on its records upon evidence of payment. Taking possession in the settlement of a cross-border trade is more involved: local or global custodians acting for international and institutional investors may establish a link for the investor to the foreign CSD holding the security certificate. Countries also differ in settlement cycles, currencies, legal systems, and by a large number of settlement arrangements used for various types of securities.

The Blockchain Revolution – harnessing the power of fintech

Blockchain clearing and settlement could be conducted in very near real time. It is based on a fintech first applied by the Bitcoin virtual currency. The name refers to a chain of data blocs[26] that include the entire history of origin of payments made for securities, goods or other assets Following execution of a transaction, all clearing steps are entered into a database that functions like a register[27] for monetary units and their origin, for property rights, securities, gemstones, commodities or any other asset exchanged for payment, by way of gift, court order, or other title underlying the exchange. The blockchain enables the buyer to recognize the asset within the limits of identification and registration technology. It significantly increases confidence as to legitimacy of title and provenance. Information regarding the new owner is converted into an encrypted data block that cannot be deciphered by unauthorized parties.

Thus, blockchain technology provides for legitimate transactional anonymity. Mirrored versions of the blockchain exist on numerous computers connected globally via internet. They all verify the new data block representing the transaction. Because ex-post-facto 'corrections' of prior data blocks on a single system will not be accepted by the rest, they will ignore the

[24] Linda Goldberg, John Kambhu, James M. Mahoney, Lawrence Radecki & Asani Sarkar, *Securities Trading and Settlement in Europe: Issues and Outlook*, 8 CURRENT ISSUES IN ECON. & FIN., no. 4, Apr. 2012, at 1. https://www.newyorkfed.org/medialibrary/media/research/current_issues/ci8-4.pdf.

[25] EUR. COMM'N – BANKING & FIN., CENTRAL SECURITIES DEPOSITORIES (CSDS) (June 7, 2016), http://ec.europa.eu/finance/financial-markets/central_securities_depositories/index_en.htm.

[26] Jens Tönnesmann & Claus Hecking, *Ein Netz voller Milliarden. Politiker wollen verhindern, dass Terroristen mit digitalem Geld handeln. Ist das sinnvoll?* [*A Net Full of Billions. Politicians Want to Prevent Terrorists from Trading with Digital Money. Does That Make Sense?*], ZEIT ONLINE (Nov. 27, 2015), http://www.zeit.de/2015/48/bitcoins-terrorismus-spenden-is.

[27] Bettina Schulz, *Das ärgert Betrüger* [*This Annoys Fraudsters*], ZEIT ONLINE (Jan. 28, 2016), http://www.zeit.de/2016/03/blockchain-bitcoin-digital-sicherheit-anonymitaet/komplettansicht.

doctored version and the transaction going forward. This built-in stumbling block substantially elevates the complications and cost of forgeries or manipulations. The current transaction can be added to the blockchain only upon global validation of its history. One of the technology's many advantages is that it renders it impossible for one seller to convey the same asset to more than one party.

According to a 2014 study by SWIFT and Oliver Wyman,[28] the banking industry currently spends between $65-80 billion a year on clearing and settlement. EU-wide, costs of EUR 420 million[29] are anticipated for implementation of the emerging European TARGET2-Securities[30] (T2S) RTGS settlement engine. While not a CSD, T2S offers CSDs delivery versus payment (DvP, ISO 15022[31]) in central bank funds across all European securities markets starting between June 2015 and September 2017.[32]

Blockchain technology is also capable of documenting, transmitting and securing entire contractual relationships. It is at the brink of revolutionary breakthrough – only very recently, Newsweek Europe devoted a major feature article[33] to its potential. It is considered a central element of "smart contracts."[34] When used in conjunction with distributed ledger technology[35] and blockchains, smart contracts are capable of revolutionizing key cost and risk factors, specifically[36] by:

- delivering cost savings through streamlined back office processes

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[28] OLIVER WYMAN & SWIFT, THE CAPITAL MARKETS INDUSTRY: THE TIMES THEY ARE A-CHANGIN' (2014), http://www.oliverwyman.com/content/dam/oliver-wyman/global/en/files/insights/financial-services/2015/March/The_Capital_Markets_Industry.pdf.

[29] Jean-Michael Godeffroy, *T2S in Europe…And Beyond?* EUR. CENT. BANK (Oct. 19 2012), https://www.ecb.europa.eu/paym/t2s/pdf/speeches/20121017_t2s_in_europe_and_beyond_jmg.pdf?4837dff72f331c9f2ab2e7cf17e82a04.

[30] PWC, THE 300-BILLION-EURO QUESTION. SURVEY ON THE BENEFITS OF TARGET2-SECURITIES (Aug. 2013), http://www.clearstream.com/blob/6220/fea603b397e51f16a0256b31fda02ad2/migrated-9b3hc6580nsgden-t2s-pwc-paper-pdf-data.pdf.

[31] ISO 15022, *Catalog of Messages*, http://www.iso15022.org/message.asp?src=msg&id=2.

[32] EUR. CENT. BANK, PROGRAMME PLAN – T2S MIGRATION PLAN (2016), http://www.ecb.europa.eu/paym/t2s/progplan/html/index.en.html.

[33] Kevin Maney, *Trust and Verify: The Coming Blockchain Revolution*, NEWSWEEK (May 23, 2016), http://europe.newsweek.com/blockchain-technology-will-remake-global-financial-system-462537?rm=eu.

[34] Norton Rose Fulbright, *FinTech Law and Regulation: Blockchains, Distributed Ledgers, Smart Contracts and Cryptocurrencies*, http://www.nortonrosefulbright.com/knowledge/technical-resources/blockchain/.

[35] UK GOV'T OFF. FOR SCI., DISTRIBUTED LEDGER TECHNOLOGY: BEYOND BLOCK CHAIN. A REPORT BY THE UK GOVERNMENT CHIEF SCIENTIFIC ADVISER (2016), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492972/gs-16-1-distributed-ledger-technology.pdf.

[36] Norton Rose Fulbright, *Smart Contracts: Coding the Fine Print* (Mar. 2016), http://www.nortonrosefulbright.com/knowledge/publications/137955/smart-contracts-coding-the-fine-print.

- verifying identity and certifying transactions
- providing an indelible record of transaction history
- enabling strangers to trade directly with each other without need for a trusted third party intermediary
- automating buy, sell and supply transactions on a B2B and B2C basis, including combinations with the internet of things.

An analysis of Bank Santander[37], the largest bank in the Eurozone[38] by market capitalization, suggests that "distributed ledger technology could reduce banks' infrastructure costs attributable to cross-border payments, securities trading and regulatory compliance by between $15-20 billion per annum by 2022." This may be a hefty amount for securities processing infrastructure, but it pales before the simple example of a blockchain transaction via Bitcoin that clocks in at a processing fee of $0.0004 (as opposed to $0.0035 for a typical credit card transaction[39]).

Public blockchains[40] can be crowdsourced and are processed in a distributed, decentralized fashion. They are accessible to anyone, producing publicly verified transactions that remain in the public domain, but beyond control of any private or governmental party. Evolution occurs through user consensus,[41] as in the case of Wikipedia, and also creates powerful incentives to rely on the technology in a broad range of applications with mass participation. For example, Bitcoin transactions are not suitable for real-time clearing and settlement as they may take ten hours to complete[42] due to their globally distributed ledger technology, involving thousands of unaffiliated computers around the world.

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[37] SANTANDER INNOVENTURE, OLIVER WYMAN & ANTHEMIS GROUP, THE FINTECH 2.0 PAPER: REBOOTING FINANCIAL SERVICES (2015), http://santanderinnoventures.com/wp-content/uploads/2015/06/The-Fintech-2-0-Paper.pdf.

[38] *The World's Biggest Public Companies 2011*, 18 FORBES (2012), http://www.forbes.com/lists/2012/18/global2000_2011.html.

[39] WHITE & CASE, BEYOND BITCOIN: THE BLOCKCHAIN REVOLUTION IN FINANCIAL SERVICES (2016), http://www.whitecase.com/sites/whitecase/files/files/download/publications/the-blockchain-thought-leadership.pdf.

[40] Kim S. Nash, *Public vs. Private Blockchain Sparks 'Emotional' Debate*, WALL ST. J. (Mar. 9, 2016), http://blogs.wsj.com/cio/2016/03/09/public-vs-private-blockchain-sparks-emotional-debate/.

[41] Vitalik Buterin, *On Public and Private Blockchains*, ETHEREUM.ORG (Aug. 7, 2015), https://blog.ethereum.org/2015/08/07/on-public-and-private-blockchains/.

[42] *Bitcoin Transaction Processing Takes Up To 10 Hours*, YCOMBINATOR.COM (2016), https://news.ycombinator.com/item?id=11230247.

Private blockchains,[43] by contrast, feature all the typical benefits of barring public involvement. Parties are authorized to access a system maintained by a private entity or consortium by stringent security protocols. Under the terms of the private network, transactions verified in private blockchains may be altered ex-post-facto, including error correction, based on a set of authorizations. By definition, closed blockchains invite the use of blocking new players.[44] Transaction speed is higher as networks are smaller and more centralized, which simplifies authentication. Preselection of participants enables additional access limitations for security and other purposes.

At mid-2016, blockchain technology is still in its infancy;[45] it neither permits netting of transactions nor ex-post-facto corrections or amendments, nor does a legal standard exist for relevant aspects relating to the passing of property rights within a blockchain. Banks have not accepted dependency on a system where third-parties (including competitors) are processing their data and may be gathering intelligence as to transactions processed by individual financial institutions, raising issues of confidential trading.[46] A broad range of legal implications[47] and technical issues remains challenging aside from ownership and netting, including[48] creating uniform standards, data security, and assignment of liability and risk, securities lending, foreign exchange, allocations and confirmations, fractional ownership and handling physical securities. Similar technological challenges[49] remain in the areas of custody, institutional sell-side and retail brokerage. In any event, blockchain technology goes a long way toward the vision of a Consolidated Audit Trail[50] (CAT) with which, once operational, it has to be closely integrated. The level of transparency will have a critical impact on whether people will use blockchains for

[43] *Private Blockchains, Demystified*, TRUTHCOIN.COM (Mar. 16, 2016), http://www.truthcoin.info/blog/private-blockchains/.

[44] Kim S. Nash, *Major Banks Complete 'Modest' Blockchain Test*, WALL ST. J. (Jan. 20, 2016), http://blogs.wsj.com/cio/2016/01/20/major-banks-complete-modest-blockchain-test/.

[45] Bettina Schulz, *supra* note 27.

[46] Steve Quinlivan, *Limitations on Blockchain Technology*, DODD-FRANK.COM (Mar. 6, 2016), http://dodd-frank.com/limitations-on-blockchain-technology/.

[47] Judith Alison Lee, Arthur Long, Jeffrey Steiner, Stephenie Gosnell Handler & Zachary Wood, *Blockchain Technology and Legal Implications of 'Crypto 2.0'*, 104 BNA BANKING REP. 654 (Mar. 31, 2015), http://www.gibsondunn.com/publications/Documents/Lee-Long-Blockchain-Technology-BNA-Banking-03.31.2015.pdf.

[48] Larry Tabb, *Blockchain Clearing and Settlement: Crossing the Chasm*, TABBGROUP.COM (Feb. 16, 2016), https://research.tabbgroup.com/report/v14-009-blockchain-clearing-and-settlement-crossing-chasm.

[49] Shagun Bali & Terry Roche, *Blockchain Technology: Pushing the Envelope in Fintech*, TABBGROUP.COM (Nov. 5, 2015), https://research.tabbgroup.com/report/v13-049-blockchain-technology-pushing-envelope-fintech.

[50] Alexander Tabb & Shagun Bali, *The Consolidated Audit Trail – 3 Part Series Bundle*, TABBGROUP.COM (Mar. 19, 2015), https://research.tabbgroup.com/report/v13-015-consolidated-audit-trail-3-part-series-bundle.

clearing and settlement.[51] Equally unclear is their use for collateral management.[52] Blockchains fundamentally reorder the mechanics of financial transactions in ways we did not envision some years ago, while as yet unidentified data risks and concerns[53] they may create have not surfaced to date. As a matter of principle, it would be the first quantum leap of innovation not susceptible to abuse.

But the revolution is not limited to business application: blockchain technology will also transform how government works in a wide variety of areas of supervision and approval not limited to the financial sector. It may simplify and render reliable authentication for election processes,[54] opening the door to practicality for direct democracy in more areas than are commonly envisioned for its application to date. At a minimum it opens the door to a hybrid combination of direct and indirect democracy dubbed "liquid democracy,"[55] not only in elections, popular propositions, referenda or petitions conducted by different levels of government, but also in shareholder's meetings. This will permit devolution of competences of deliberative bodies to parties directly affected by decisions.

Legislative and Policy Challenges

In the EU, blockchain technology[56] will be affected by a wide array of regulations, including the E-Money Directive (Directive 2009/110/EC,[57] but only to the extent an "issuer" is identified pursuant to art. 2.2), the Payments Services Directive (Directive 2007/64/EC[58]), and

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[51] Ian Allison, *How Will Blockchains Cross the Clearing and Settlement Chasm?* INT'L BUS. TIMES (Mar. 1, 2016), http://www.ibtimes.co.uk/how-will-blockchain-overcome-apparently-insurmountable-problems-clearing-settlement-1546943.

[52] Louise Gullifer, *What Should We Do About Financial Collateral?* 65 CURRENT LEGAL PROBS. 377 (2012), http://clp.oxfordjournals.org/content/65/1/377.abstract.

[53] Charlie Warzel, *Satan's Credit Card: What the Mark of the Beast Taught Me About the Future of Money*, BUZZFEED (May 21, 2016), https://www.buzzfeed.com/charliewarzel/yes-we-scan?utm_term=.yxz3mNA06#.gk48mwMXr.

[54] B. Holmes, *Blockchain Based Voting Could Be Ready for 2016 Elections*, BRAVE NEW COIN (Nov. 7, 2015), http://bravenewcoin.com/news/blockchain-based-voting-could-be-ready-for-2016-elections/.

[55] Matthew Daniel, *Blockchain Technology: The Key to Secure Online Voting*, BITCOIN MAG. (June 27, 2015), https://bitcoinmagazine.com/articles/blockchain-technology-key-secure-online-voting-1435443899.

[56] *EDCAB Addresses European Parliament Hearing on Virtual Currencies*, EUR. DIGITAL CURRENCY & BLOCKCHAIN TECH. F. (Jan. 25, 2016), http://edcab.eu/.

[57] Directive 2009/110/EC of the European parliament and of the Council of 16 September 2009 on the taking up, pursuit and prudential supervision of the business of electronic money institutions amending Directives 2005/60/EC and 2006/48/EC and repealing Directive 2000/46/EC (OJ L 267/7) (Oct. 10, 2009), http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009L0110:EN:HTML.

[58] Directive 2007/64/EC of the European Parliament and of the Council of 13 November 2007 on payment services in the internal market amending Directives 97/7/EC, 2002/65/EC, 2005/60/EC and 2006/48/EC and repealing Directive 97/5/EC (OJ L 319/1) (Dec. 5, 2007), http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32007L0064&from=EN2007/64/EC.

the MIFID-Directive (Directive 2004/39/EC[59] and Directive 2008/10/EC[60]). Characteristically, one of the first considerations in the context of new technology in the EU was its utility for levying financial transaction taxes.[61] But the regulation with the greatest impact on European fintech to date is the Second Directive on Payments Services[62] (PSD2, Directive (EU) 2015/2366[63]) compelling banks to open their systems to fintechs, allowing them to act as intermediaries between bank and customer.[64]

The EU Commission, the Bank for International Settlements, the World Bank, the United Nations, Europol, ESMA, the UK Treasury, the Bank of England, Nasdaq, as well as startups Blockchain and Epiphyte, hosted a non-commercial roundtable on cryptocurrencies and blockchain in mid-April 2016 to educate MEPs and set the stage for future regulatory initiatives.[65] The EU Parliament intends to hold off on regulation for now to monitor technological development, and the U.S. CFTC concurs with this Hippocratic "do no harm" approach.[66]

While physical delivery of funds and securities necessitated time for physical processes and posed challenges for authentication, the same can no longer be claimed in the age of

[59] Directive 2004/39/EC of the European Parliament and of the Council of 21 April 2004 on markets in financial instruments amending Council Directives 85/611/EEC and 93/6/EEC and Directive 2000/12/EC of the European Parliament and of the Council and repealing Council Directive 93/22/EEC (OJ L 145/1) (Apr. 30, 2004), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02004L0039-20060428&from=EN.

[60] Directive 2008/10/EC of the European Parliament and of the Council of 11 March 2008 amending Directive 2004/39/EC on markets in financial instruments, as regards the implementing powers conferred on the Commission (OJ L 76/33) (Mar. 19, 2008), http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:076:0033:0036:EN:PDF.

[61] Helene Schuberth & Stephan Schulmeister, *Settlement Systems and Financial Transactions Taxes*, ÖSTERREICHISCHES INSTITUT FÜR WIRTSCHAFTSFORSCHUNG (Sept. 2011), http://www.wifo.ac.at/jart/prj3/wifo/resources/person_dokument/person_dokument.jart?publikationsid=42610&mime_type=application/pdf.

[62] EUR. COMM'N – BANKING & FIN., REVISED DIRECTIVE ON PAYMENT SERVICES (PSD2) (Oct. 8, 2015), http://ec.europa.eu/finance/payments/framework/index_en.htm.

[63] Directive (EU) 2015/2366 of the European Parliament and of the Council of 25 November 2015 on payment services in the internal market, amending Directives 2002/65/EC, 2009/110/EC and 2013/36/EU and Regulation (EU) No. 1093/2010, and repealing Directive 2007/64/EC (OJ L 337/35) (Dec. 23, 2015), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015L2366&from=EN.

[64] Sarah Kocianski, *The Fintech Regulation Report: How European regulators are creating fertile ground for fintech growth*, BUS. INSIDER (June 15, 2016), http://www.businessinsider.com/the-fintech-regulation-report-2016-4?nr_email_referer=1&utm_content=BISelect&utm_medium=email&utm_source=Sailthru&utm_campaign=BI%20Select%20%28Wednesday%20Friday%29%202016-06-15&utm_term=Business%20Insider%20Select?r=US&IR=T.

[65] Gabrielle Patrick, *Europe's Regulatory Blockchain Shift on Display at Private Parliament Event*, COINDESK (Apr. 29, 2016), http://www.coindesk.com/the-eu-regulatory-blockchain-shift/.

[66] Erin Hobey, *EU Holds Off on Blockchain Regulation…For Now*, CROWDFUND INSIDER (Apr. 27, 2016), http://www.crowdfundinsider.com/2016/04/84825-eu-holds-off-on-blockchain-regulation-for-now/.

indirectly held securities[67] and ledger entry payments. Digitization of securities custody, delivery, and payment reduces the clearing and settlement processes largely to a software issue. But since not even the Hague Securities Convention[68] (Convention of 5 July 2006 on the Law Applicable to Certain Rights in Respect of Securities held with an Intermediary) has entered into force yet ten (!) years later, we see clearly that technology is not the bottleneck here. Its supplement,[69] the Geneva Securities Convention[70] (Unidroit Convention of 9 October 2009 on Substantive Rules for Intermediated Securities) was negotiated by forty states[71] but thus far ratified by only one (Bangladesh), and has not entered into force. Rather, it is characteristic of the enormous time lags international negotiation and coordination involve and of the threats this engenders for timely responses to adequate and effective state and legal responses to situations arising under new technologies. Additionally, clearing and settlement involves an area of law that, by its technocratic nature, is inaccessible to meaningful regulation by national authorities and legislatures except in a very small number of very large entities with massive domestic financial markets, such as the U.S., EU, China, Japan, or Russia. The inadequate speed of the judicial process in resolving controversies arising in such a fast-paced environment is another issue.

However, and regardless of the deficiencies of the legislative and regulatory process on a national as well as international scale, the perception of blockchain's potential[72] is very clearly reflected in investment trends.[73] Over the last three years, venture capital firms have invested about one billion dollars with a geometrically rising trend.[74] The reason for that is the

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[67] Anatoly Ostrovskiy, *The Intermediated Securities System: Brussels I Breakdown*, 5 EUR. LEGAL F., Doc. 693, 2007, at 197, http://www.simons-law.com/library/pdf/e/693.pdf.

[68] Convention of 5 July 2006 on the Law Applicable to Certain Rights in Respect of Securities Held With an Intermediary, https://www.hcch.net/en/instruments/conventions/full-text/?cid=72.

[69] *See* INTERMEDIATED SECURITIES: THE IMPACT OF THE GENEVA SECURITIES CONVENTION AND THE FUTURE EUROPEAN LEGISLATION (Pierre-Henri Conac, Ulrich Segna & Luc Thévenoz eds., 2013), http://www.cambridge.org/us/academic/subjects/law/corporate-law/intermediated-securities-impact-geneva-securities-convention-and-future-european-legislation.

[70] Unidroit Convention of 9 October 2009 on Substantive Rules for Intermediated Securities, http://www.unidroit.org/instruments/capital-markets/geneva-convention.

[71] *See* INTERMEDIATED SECURITIES: LEGAL PROBLEMS AND PRACTICAL ISSUES (Louise Gullifer & Jennifer Payne eds., 2010), http://www.hartpub.co.uk/books/details.asp?isbn=9781849460132.

[72] Daniel Roberts, *Goldman Sachs: Here Are 5 Ways Blockchain Can Change the World*, YAHOO FIN. (May 25, 2016), http://finance.yahoo.com/news/goldman-sachs-identifies-5-big-ways-blockchain-tech-can-change-the-world-153801655.html.

[73] Kevin Petrasic & Matthew Bornfreund, *Beyond Bitcoin: The Blockchain Revolution in Financial Services*, WHITE & CASE (Mar. 7, 2016), http://www.whitecase.com/publications/insight/beyond-bitcoin-blockchain-revolution-financial-services.

[74] Adrien Henni, *Life.Sreda Launches Global Fund for Banks to Invest in Blockchain Startups*, VENTUREBEAT (May 24, 2016), http://venturebeat.com/2016/05/24/life-sreda-launches-global-fund-for-banks-to-invest-in-blockchain-startups/.

technology's ability to facilitate the exchange of a wide variety of assets beyond financial instruments through the exchange of virtual tokens that represent underlying assets. R3CEV LLC leads a consortium of 42 of the world's largest banks and financial firms[75] in R&D of blockchain technology in the financial industry. Its work will not only transform banking and securities processing but also banking regulation and supervision by unlocking Big Data algorithms to identify patterns of fraud or money laundering, rendering the origin, ultimate destination and use of funds transparent and traceable, and improving the ability to identify suspicious parties and networks. Implicitly, this will raise very serious concerns about pre-emptive sanctions as systems like Google's ContentID[76] are capable of automatically disabling YouTube videos as *potential* violators of copyright laws. In the near future, blockchain may enable Fedwire to identify systemic payment risks[77] – raising the question of whether access to critical financial infrastructure may be blocked on mere algorithmic suspicion of future risks. Big Data implications on current European data protection standards appear inevitable. In the case of eugenics and HIV prevention, many advanced societies have declined to permit technology's potential for preventive action to be fully utilized by limiting prenatal testing or identification and quarantine of carriers.

A central lesson from the discourse on emergent blockchain technology is that the current speed of global constitutional, legislative, regulatory and adjudicatory systems not only should but must accelerate by quantum leaps commensurate to those of the underlying technologies they relate to. Dealing appropriately and not merely in a dilatory fashion with the multitude of consequences of continuously accelerating innovation and data volume will arguably be one of humanity's primary challenges in the 21st century and beyond. As a result of new technologies, society transitions out of individual, collective and operational life experiences. It is important to understand that anything "real-time" not only accelerates the individual transaction in issue – it also compresses virtually all subsequent transactions into a perpetually shrinking time window that is kept from lapsing into infinitesimal smallness only by our ability to audit, analyze, and integrate in forward-looking decisions. Technology has unquestionably accelerated in the past at least since the industrial revolution, but it had done so in a linear, not in a hyper-geometric fashion. The possibilities opened up by blockchains are merely one, albeit poignant, example of the incubatory and acceleratory power of innovation that will soon transcend every physical person's comfort zone for purposes of accommodation. Our generation is the first to be faced with this change affecting not merely one but virtually all paradigms contemporaneously.

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[75] Jamie Redman, *R3 CEV: 40 Major Banks Just Tested the Blockchain*, BITCOIN.COM (Mar. 3, 2016), https://news.bitcoin.com/r3-cev-40-major-banks-just-tested-blockchain/.

[76] Paul Tassi, *The Injustice of the YouTube Content ID Crackdown Reveals Google's Dark Side*, FORBES (Dec. 19, 2013), http://www.forbes.com/sites/insertcoin/2013/12/19/the-injustice-of-the-youtube-content-id-crackdown-reveals-googles-dark-side/#678713ee6247.

[77] BD. OF GOVERNORS OF THE FED. RES. SYS., PAYMENT SYSTEM RISK, https://www.federalreserve.gov/paymentsystems/psr_about.htm.