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A VATCoin PROPOSAL FOLLOWING ON THE 2017 EU VAT PROPOSALS – MTIC, VATCoin, and BLOCKCHAIN[1]

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The following proposal for an EU VATCoin was presented at the Digital Tax Transformations Conference, December 18 & 19, 2017 in Vienna, Austria at WU Global Tax Policy Center (WU GTPC) at the Institute for Austrian and International Tax Law of Vienna University of Business and Economics.

On October 4, 2017, in an effort to recover *some* of the VAT lost annually, the European Commission proposed "far-reaching reforms." The immediate target is a €50 billion slice of the estimated €150 billion annual loss. In its proposal, the Commission is concerned only with Missing Trader Intra-Community (MTIC) fraud in goods.[2]

Goods (alone) are targeted for a number of reasons: (a) the MTIC-enabling transitional arrangements of January 1, 1993 were predominantly goods-based rules and they need immediate correction; (2) the "VAT package," adopted by the Council on February 12, 2008 addressed services issues with two draft Directives and a draft Regulation;[3] (3) intra-community goods transactions are particularly complicated and need the simplification that will come with this proposal;[4] (4) the Commission's preferred solution builds on the one-stop-shop mechanism (OSS), and by limiting the focus of this reform to goods the Commission will be able to further perfect this mechanism in a staged roll-out;[5] and (5) cross-border trade in goods dominate intra-community trade, as services transactions are approximately one third the commercial volume of goods transactions.[6]

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[1] This is an abbreviated version of a longer paper which is forthcoming in TAX NOTES INTERNATIONAL. This version was presented at the *Digital Tax Transformation* conference December 18-19, 2017 in Vienna, Austria at the Institute for Austrian and International Tax Law, WU Global Tax Policy Center by Camille V. Tirand.

[2] Press Release – *European Commission, European Commission proposes far-reaching reform of the EU VAT system* (October 4, 2017) IP/17/3443, *available at*: http://europa.eu/rapid/press-release_IP-17-3443_en.htm

[3] COMMISSION STAFF WORKING DOCUMENT – IMPACT ASSESSMENT, *accompanying the document Proposal for a Council Directive amending Directive 2006/112/EC as regards harmonizing and simplifying certain rules in the value added tax system and introducing the definitive system for the taxation of trade between Member States*, SWD(2017) 325 final (October 4, 2017) at 11, *available at*: https://ec.europa.eu/transparency/regdoc/rep/10102/2017/EN/SWD-2017-325-F1-EN-MAIN-PART-1.PDF

[4] COMMISSION PRESS RELEASE, *VAT Package: Commission welcomes adoption by the ECOFIN Council of new rules on the place of supply of services and a new procedure for VAT refunds*, IP/08/208 available at: http://europa.eu/rapid/press-release_IP-08-208_en.htm?locale=en

[5] *Supra*, note 3, IMPACT ASSESSMENT, SWD at 11.

[6] *Supra*, note 3, IMPACT ASSESSMENT, SWD at 12, further referencing *Eurostat*. Of the roughly €8 billion in cross-border trade in the EU single market in 2015, €6.062 billion (75%) is trade in goods, and €1.939 billion (25%) is trade in services.

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The difficulty with the Commission's October 4 proposal and its impact analysis is that it ignores the fungibility of MTIC fraud. Stopping one MTIC manifestation, will not necessarily reduce the overall economic loss. MTIC is famous for mutating and migrating when it is pursued.

A system-wide fix is needed. We need a fix that can easily be extended to MTIC in tradeable services, and one which shuts down MTIC completely whenever, and wherever it is applied. The fix should not be one that simply reduces the amount of VAT open to theft in each transaction, as is the case with the Commission's proposal. The fix should be one that tightly closes off the fraud, and which can be rolled out through all goods and services transactions.

This paper concludes that if the Commission's current proposal placed cross-border transactional data on a blockchain, and if it utilized VATCoins instead of fiat currency for cross-border tax payments, then the Commission would resolve the problem of Member State *trust* in its solutions, and trust (or lack of it) is the factor that has doomed the Commission's efforts dating back to 1996. The solution proposed here can be rolled out over all cross-border trade (goods and services) at a later time. When this occurs, it should immunize the VAT from MTIC fraud.

The "far-reaching reform"

The Commission's 2017 proposal requires cross-border, business-to-business, sellers of goods to collect VAT at the *rate applicable in the buyer's jurisdiction*. In Figure A (below) the cross-border seller (the *Distributor*) collects 30 in VAT from the buyer (the *Wholesaler*). 30 is the product of the 20% rate, times the 150 price of the goods.

The seller will report this transaction and will remit the collected VAT on its *domestic* return. This will be a One-Stop-Shop (OSS) return indicating the buyer, the buyer's jurisdiction, and the amount of cross-border VAT collected. The domestic Treasury will transfer all foreign VAT collected in this manner to the appropriate foreign Treasury.

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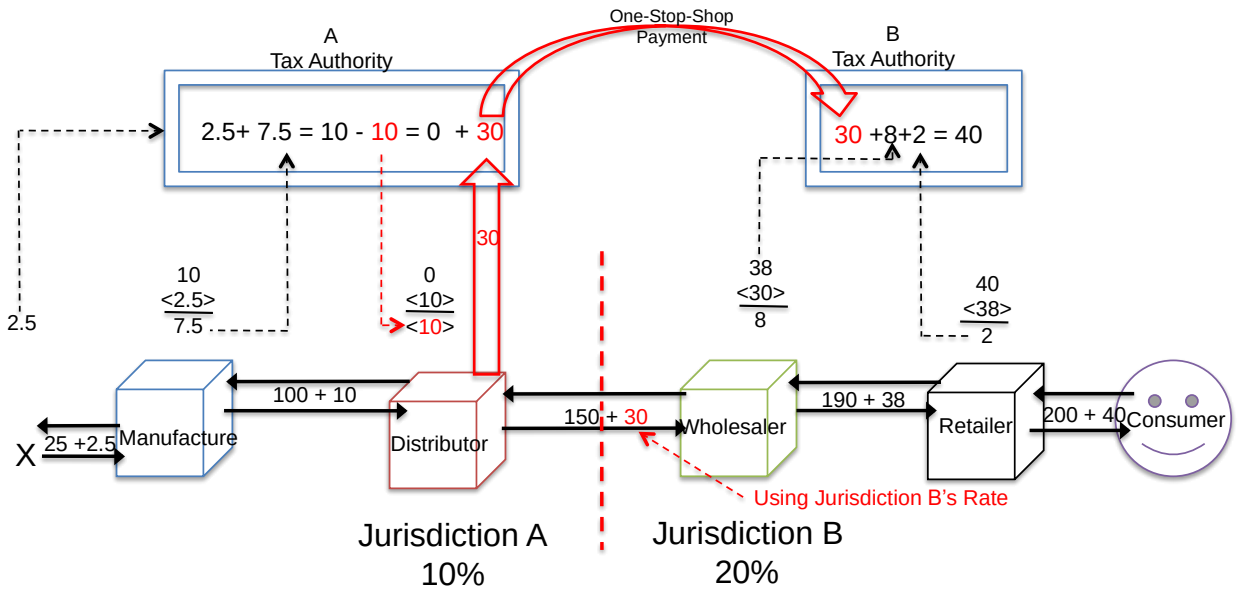
Figure A: October 4, 2017 Proposal
One-Stop-Shop replaces Clearing House



The problem with the Commission's solution is that it does not eliminate MTIC fraud in general, nor does it eliminate MTIC fraud in the goods areas that it specifically targets (details and examples of this shortcoming are available in the longer version of this paper). The Commission does not dispute that these problems are real. It agrees:

> [U]nder Option 2 [the preferred option] … there will still be an opportunity for MTIC fraud [in goods] to be perpetrated, it will be significantly reduced in scale. The magnitude of this reduction will be influenced by the level of the mark-up applied by businesses on their purchases.[7]

Although we can demonstrate (and the Commission agrees) that there will be lesser amounts stolen through MTIC *per fraudulent transaction* under the Commission's *far-reaching reform*, the fraud does not stop, and there is the distinct possibility that the *overall fraud* will accelerate. Not only are the audit/ enforcement incentives in the Commission's proposal misplaced, but the reform itself is likely to push the fraud into harder to detect areas – notably, tradeable services.[8]

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[7] *Supra* note 3, COMMISSION STAFF WORKING DOCUMENT – IMPACT ASSESSMENT, at 68. There are problems with this statement by the Commission that extend well beyond this paper, notably the phrase "significantly reduced." The type of MTIC targeted by this proposal is goods MTIC, and the services area remains wide open for MTIC fraudsters to migrate to. In addition, it is unclear what the term "significantly" is measuring, because we are not plugging holes in a dike, rather we are building half a dam in a river that still flows unimpeded around the far end of the barrier.

[8] Richard T. Ainsworth, *VAT Fraud: The Tradable Services Problem*, 61 TAX NOTES INTERNATIONAL 217 (January 17, 2011).

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There is a better way forward.

IMPLEMENTING THE 2017 PROPOSAL WITH A VATCOIN BLOCKCHAIN

By the middle of 2016 it became apparent to us that the strength and virtues of blockchain have a natural "fit" with MTIC fraud prevention. After a particularly engaging VAT course at NYU in the Spring of 2016 we began publishing our observations, and by 2017 conferences working toward practical blockchain applications in VAT became commonplace.[9] It is not surprising to us that the EU Commission appears to be positioning itself to announce that the "definitive VAT system" will be brought in on the back of blockchain technology.[10] The time has come (in our opinion) for the Commission to make a formal blockchain announcement.

We have also pointed out that the new VATs of the Gulf Cooperation Council (GCC)[11] are similarly poised to adopt blockchain technology. The GCC announced in their Framework Agreement[12] the digital structure needed to bring blockchain compliance to the GCC VATs.[13] We expect to see a GCC blockchain application in the very near future.

Blockchain technology creates a robust, secure, transparent *distributive* ledger.[14] The technique is revolutionary. Blockchain is a software protocol based on cryptography. It was devised in 2008, and was announced simultaneously with its most famous application – Bitcoin.[15] The application in this proposal for a VATCoin is derivative of Bitcoin. It is a limited-purpose cryptocurrency used only for payment of VAT obligations, denominated in local currency, convertible from cryptocurrency to fiat currency, but *only by the government*.

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[9] Consider for example the series of conferences sponsored by the WU Global Tax Policy Center (GTPC) at the Institute for Austrian and International Tax Law. It established a multistakehoder program to examine digital tax transformation: (1) Vienna: *Blockchain: Taxation and Regulatory Challenges and Opportunities* (March 15-16, 2017); (2) Singapore: *Digital Economy Symposium: Reimagining Taxation in the Age of Disruption* (August 15-16, 2017); (3) Vienna: *Digital Tax Transformation* (December 18-19, 2017).

[10] Richard T. Ainsworth & Andrew Shact, *Blockchain Technology Might Solve VAT Fraud*, 83 TAX NOTES INTERNATIONAL 1165.1166 (September 26, 2016)

[11] The GCC is a regional intergovernmental political and economic alliance of six Middle Eastern countries – Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and he United Arab Emirates. It was formed in 1981.

[12] Although originally issued in Arabic, by late November 2016 the *Unified VAT Agreement for The Cooperation Council for the Arab States of the Gulf* was available in authoritative English translations. See: THE UNIFIED GULF COOPERATION COUNCIL VALUE ADDED TAX FRAMEWORK AGREEMENT, *available at*: http://www.allaboutvat.com/wp-content/uploads/GCC-VAT-Framework-English-Version.pdf

[13] Richard T. Ainsworth & Musaad Alwohaibi, GCC VAT: The Intra-Gulf Trade Problem, 84 TAX NOTES INTERNATIONAL 315 (October 17, 2016).

[14] A ledger, as used in this sentence and in this field generally, means a value recording and transfer system. Simply stated, a ledger is an accounting tool that keeps track of who owns what. The ledger itself is a very old technology that has not changed much since its development by the Venetian Republic in the 15th century. Ledgers have long been digitized (in the 20th century), but it was only with blockchain that they have been *decentralized*. Prior to 2008 ledgers were only understood as *centralized*.

[15] Satoshi Nakamoto, Bitcoin, *A peer-to-peer electronic cash system* (2008) available at: https://bitcoin.org/bitcoin.pdf (note: Satoshi Nakamoto is a pseudonym).

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Bitcoin (the application) is often confused with blockchain (the technology). Bitcoin is only one application of blockchain technology, VATCoin is another. Ledger entries in the VATCoin application will be the VATCoins generated by the VATCoin protocol.

VATCoins are acquired by purchase from the national Treasury, and are denominated in local currency units. VATCoins are convertible into fiat currency (and *vice versa*) only by the same national Treasury. The Treasury that makes the coins, converts the coins. Thus, each Hungarian VATCoin (VATCoin-HUF) represents one Hungarian Forint. It is issued by the Hungarian Treasury in a 1 for 1 exchange for Hungarian currency, and is only transferrable in a VAT-payment transaction. The transaction is recorded on the blockchain.

If an invoice from a foreign seller (a French seller for example) is denominated in euro to a Hungarian buyer (rather than Forint) and if the Hungarian VAT regulations would accept payment of VAT in euro, then the Hungarian Treasury could issue VATCoin in euro (VATCoin-HU€) to the buyer. As will be demonstrated below, VATCoin is a "marker" more than a currency unit. It marks the payment of Hungarian VAT (in our example) by the Hungarian buyer to the Hungarian Treasury, which is marked as collected by the French seller, and returned to the Hungarian Treasury by the operation of the OSS. All exchanges (in VATCoin or currency units) are permanently recorded on a blockchain.

Blockchain allows detailed, real-time tracing of transactions and VAT payments with AI. The blockchain is *trustless*.[16] It is *trustless* in the sense that it does not require third party verification. It does not need a *trusted* third party (like a bank) to help it negotiate (exchange) value. Instead of trusted intermediaries, blockchain uses powerful consensus mechanisms to verify the authenticity of transactions in the database.[17]

The cryptoeconomic verification (and fraud detection) incentives of the Bitcoin "miners" can be applied to VATCoin.[18] Depending on the application, incentive mechanisms can change.[19] Robust consensus mechanisms make databases safe (highly *trustworthy*) even in the

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[16] The trust element is very important to the adoption of blockchain in tax compliance areas. It needs to be stressed that trusting the blockchain technology is different than trusting Bitcoin. Europol contends that it is not blockchain, but the "… Bitcoin [application that] is establishing itself as the single common currency for cybercriminals within the EU." Europol, 2015 INTERNET ORGANIZE CRIME THREAT ASSESSMENT, *Key Findings* available at: https://www.europol.europa.eu/iocta/2015/key-findings.html.

[17] Tim Swanson, *Great Wall of Numbers Cryptoeconomics for beginners and experts alike*, citing Vlad Zamfir of the Ethereum project at the Cryptocurrency Research Group conference (brainstorming session) on Cryptoeconomics as posted January 30, 2015 at: http://www.ofnumbers.com/2015/01/30/cryptoeconomics-for-beginners-and-experts-alike/. Cryptoeconomics is:

> A formal discipline that studies protocols that govern the production, distribution and consumption of goods and services in a decentralized digital economy. Cryptoeconomics is a practical science that focuses on the design and characterization of these protocols.

[18] See the application of "consumer miners" in the blockchain devised to eliminate excise tax fraud in cigarettes applied in the GCC at: Richard T. Ainsworth & Musaad Alwohaibi, The First Real-time Blockchain VAT: GCC Solves MTIC Fraud, 86 TAX NOTES INTRERNATIONAL 695 (May 22, 2017) and Richard T. Ainsworth, THE TAX-BASED BLOCKCHAINS, at the *Digital Innovation and Fiscal Management Seminar (La Gestión Fiscal en la Era Digital: Avances y Desafíos para America Latina)* Inter-American Development Bank (November 9, 2017)

[19] Cryptoeconomic incentives are most strongly associated with cryptocurrency systems. Bitcoin *mining* is such an incentive system. This is because Bitcoin uses pseudonymous and anonymous nodes to validate transactions, whereas a basic distributive ledger that engage entities with legal identities (banks, financial institutions,

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presence of powerful or hostile third parties trying to manipulate the registry. For this reason, *The Economist* called blockchain, "The Trust Machine."[20]

A Trust Machine is precisely what the EU Commission needs to make its "definitive solution" work. It has needed it since 1996.

Only recently have decentralized, distributive ledgers been possible. Blockchain was not a solution available in 1996 when the EU Commission proposed Clearing House solutions. Advances in technology, computing capacity, and connectivity (post-2000) have made blockchain possible. Replacing very expensive *centralized ledgers* with *decentralized distributive ledgers* captures huge cost savings and efficiencies.[21] Decentralized distributive ledgers ride three exponentially declining cost curves:

1. *Moore's Law*: the cost of processing digital information (speed), halves every 18 ORTmonths;[22]
2. *Kryder's Law*: the cost of storing digital information (memory) halves every 12 months;[23]
3. *Nielson's Law*: the cost of shipping digital information (bandwidth) halves every 24 months.[24]

VATCoin's Blockchain

A VATCoin is a digital asset acquired in exchange for fiat currency. It is denominated in the local currency that was used to initially acquire it. VATCoin is a VAT payment system utilizing open source software.[25] The system is peer-to-peer. Transactions take place between users directly. There is no intermediary (bank or other trusted third party).

Transactions are verified by network nodes, and recorded in a *private* distributed ledger where the VATCoin itself is the unit of account. This is the blockchain. There is no central depository of VATCoins. There is no administrator.

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government agencies) will use "permissioned" nodes to validate transactions. This proposal uses permissioned nodes. Tim Swanson, *Consensus-as-a-Service: A Brief Report on the Emergence of Permissioned, Distributed Ledger System* (April 6, 2016) *available at*: http://www.ofnumbers.com/wp-content/uploads/2015/04/Permissioned-distributed-ledgers.pdf.

[20] THE ECONOMIST, *The Promise of Blockchain: The Trust Machine* (October 31, 2015) available at: http://www.economist.com/news/leaders/21677198-technology-behind-bitcoin-could-transform-how-economy-works-trust-machine.

[21] Sinclair Davidson, Primavera De Philippi & Jason Potts, *Economics of Blockchain* (March 8, 2016) *available at*: http://ssrn.com/abstract=2744751

[22] Gordon E. Moore, Cramming More Components onto Integrated Circuits, Proceedings of the IEEE, Vol. 86, No. 1, January 1998) reprinting the same title from Electronics, 114-117 (April 19, 1965) available at: http://www.cs.utexas.edu/~fussell/courses/cs352h/papers/moore.pdf. Mr. Moore is the founder of Intel and Fairchild Semiconductor.

[23] Mark Kryder, *Kryder's Law*, SCIENTIFIC AMERICAN (August 2005) *available (as a reprint) at*: https://web.archive.org/web/20060329004626/http://www.sciam.com/article.cfm?chanID=sa006&colID=30&articleID=000B0C22-0805-12D8-BDFD83414B7F0000. Mr Kryder was the senior Vice President of Research and the Chief Technology Officer at Seagate Corp.

[24] Jakob Nielson, *Nielson's Law of Internet Bandwidth*, NIELSON NORMAL GROUP https://www.nngroup.com/articles/law-of-bandwidth/. Mr. Nielson was an engineer at Sun Microsystems.

[25] Open source software is computer software where its source code is made available (with a license) in which the copyright holder provides the right to study, change, and distribute the software to anyone and for any purpose.

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One of the great novelties of Bitcoin's blockchain is that it is a *public* ledger that is maintained by a network of anonymous communicating nodes running the Bitcoin software.[26] The European Central Bank is considering blockchain for post trading activities in securities, but the ECB rejects *public* ledgers, preferring *private* ledgers in the securities field.[27] This allows the selection of a less costly consensus mechanism than the *proof-of-work* used by Bitcoin. Up through the end of 2016 most writers in this field agreed with the ECB – a *private* distributed ledger works best in a governmental context.[28] That assessment may be changing.

Proof-of-stake and proof-of-identity are two of the alternate (less expensive) consensus processes identified by the ECB. Both are well suited for *private* distributed ledgers. The ECB indicates:

> A second type of validation system is proof-of-stake (PoS) consensus process. This assigns shares of validation rights to users according to their stake in the system … or the reputation of the validator in a restricted DLT (known as proof-of-identity (PoI)).

However, if a *public* distributed ledger is desired, then strong consideration needs to be given to Algorand, developed by MIT Professor Silvio Micali, one of the world's leading cryptographers. Algorand is a more efficient alternative to Bitcoin's public blockchain design that retains the "public" aspect of consensus.[29]

Regardless of the public or private nature of the blockchain adopted for VATCoin, transactions will be constructed in the form of "X sends Y number of VATCoins to Z." Network nodes receive this transaction and if they validate it the transaction will be added to *their copy* of the ledger. This copy is then broadcast to the other nodes. In the Bitcoin blockchain approximately six times per hour a new group of accepted transactions (a block in the blockchain) is created. This "block" is what is added to the "chain" that comprises the "blockchain." Each block contains a cryptographic hash of the previous block. The Bitcoin

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[26] Terminology can be confusing. Different terminology (different from *public* v. *private*) is used by the European Central Bank (ECB) to draw the same distinctions about blockchain. The ECB discusses *unrestricted* (i.e., *public*) ledgers, and prefers *restricted* (i.e., *private*) ledgers. Other writers employ still different terminology. They distinguish between *permissioned* (i.e., *private*) and *un-permissioned* (i.e., *public*) distributive ledgers. (Tim Swanson *Great Wall of Numbers Cryptoeconomics for beginners and experts alike*, Supra note, 17). They do this to bring into sharp relief the use of white lists (or black list) of users, who are identified through KYB (know your bank) or KYC (know your customer) procedures. This process is common in traditional finance.

[27] European Central Bank, *Distributed Ledger Technologies in Securities Post-trading: Revolution or Evolution?* OCCASIONAL PAPER SERIES, No. 172 (April 2016) available at: https://www.ecb.europa.eu/pub/pdf/scpops/ecbop172.en.pdf

[28] Marcella Atzori, *Blockchain Technology and Decentralized Governance: Is the State Still Necessary?* (December 2015) at 16-24, *available at*: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2709713 (discussing the difference between *private* (aka, *permissioned*) and *public* (aka, *un-permissioned*) distributive ledgers and opting strongly for permissioned ledgers in the government sphere).

[29] Silvio Micali, *Algorand: The Efficient Public Ledger* (November 18, 2016) available at: http://www.the-blockchain.com/blockchain-news-research-library/

> Algorand is a truly democratic and efficient way to implement a public ledger. Unlike prior implementations based on proof of work, it requires a negligible amount of computation, and generates a transaction history that will not fork with overwhelmingly high probability.

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blockchain uses the SHA-256 hashing algorithm to *chain* the new block to the previous block, VATCoin will use the same hashing algorithm.[30]

Owning and spending VATCoins requires an individual to have a specific address. A payer must digitally sign a transaction with a private key.[31] If the private key is lost, the VATCoin network (unlike the Bitcoin network) will have mechanisms in place to identify ownership.[32] The Bitcoin network does not recognize any other evidence of ownership.[33]

VATCoin transactions must have one or more inputs. For the transaction to be valid, every input must be an *unspent output* of a previous transaction. Every input must be digitally signed.[34] (In cases of multiple inputs, the VATCoin system is simply indicating that multiple coins are being used to consummate a single transaction. The same is true in reverse, for a transaction with multiple outputs. Multiple payments can be made through the same transaction.)[35]

Specific Application

[30] Andreas M. Antonopolous, MASTERING BITCOIN: UNLOCKING DIGITAL CRYPTOCURRENCIES at Chapter 8: *Mining and Consensus* 175-216 (2015) (explaining that to be acceptable by the rest of the network each new block must contain a proof-of-work. The proof-of-work requires miners to find a number (called a nonce) such that when the block is hashed along with the nonce the result is numerically smaller than the network's *difficulty target*. The proof is easy for any node to verify, but very difficult to generate. For a secure cryptographic hash miners must try many different nonce values before meeting the difficulty target.)

[31] Cryptographic systems use a pair of keys, one of which is public and can be shared widely, and the other of which is private and known only to the owner. Using a public key a message can be authenticated as originating with a holder of the paired private key. Additionally, encrypting a message with a public key will assure that only the holder of the paired private key can decrypt the message. Public-key cryptographic systems rely on cryptographic algorithms based on mathematical problems that currently admit no efficient solution.

[32] A business in possession of VATCoins that forgets a private key could contact the tax authority. The tax authority could identify all VATCoin purchased by the taxpayer, follow them through the blockchain, and identify all of the VATCoins not already spent. The un-spent VATCoins could be destroyed, new VATCoins issued, and the Taxpayer provided a new private key within minutes.

If the loss of the private key is associated with the theft of VATCoins, then this too could be found by the tax authority. It would follow the VATCoins through the blockchain, and identify all of the transactions where the VATCoins were used. However, if the theft is followed quickly by the use of the stolen VATCoins in another commercial transaction it might be possible to complete the fraud before getting caught. If however, the VATCoin mechanism is adopted in conjunction with the Digital Invoice Customs Exchange (DICE) then there would be a third-party (the tax administration) engaged in validating each transaction in real-time. Thus, VATCoin, and DICE in conjunction with AI would solve the potential fraud. See Richard T. Ainsworth & Goran Todorov, *Stopping VAT Fraud with DICE – Digital Invoice Customs Exchange* 72 TAX NOTES INTERNATIONAL 636 (November 18 2013). The specific application of a VATCoin cyber-theft in a system that applied DICE with VATCoin is considered in the *Immunity to Cyberattack* heading and Figure 4 in: Richard T. Ainsworth, Musaad Alwohaibi, & Mike Cheetham, *VATCoin: Can a Crypto Tax Currency Prevent VAT Fraud?* 84 TAX NOTES INTERNATIONAL 703, 711-712 (November 14, 2016).

[33] CBS-DC, *Man Throws Away 7,500 Bitcoins, Now Worth $7.5 million* (November 29, 2013) available at: http://washington.cbslocal.com/2013/11/29/man-throws-away-7500-bitcoins-now-worth-7-5-million/

[34] See the diagram at page 2 in Satoshi Nakamoto, Bitcoin, *A peer-to-peer electronic cash system* (2008) supra note 15.

[35] As with a transaction in real currency, if the sum of the inputs (cash in your pocket) exceeds the sum of the outputs (funds used to make a purchase), the difference is returned to the payer in the form of an additional output.

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The adoption of a VATCoin blockchain as a tax payment, recordkeeping, and fraud prevention mechanism is a natural "fit" with the EU Commission's efforts to achieve "far-reaching reforms" in 2017. This application is narrow, and specific. It is an application designed to "fit" with the specific changes advanced by the Commission. There is a wider application considered in the larger version of this paper.

The Commission indicates that it wants a system that is "… simpler … robust to fraud … exploiting … digital technology [that] … enhanc[es] greater trust …" This is the precise recipe for blockchain.

> The purpose of this initiative is to put in place a definitive VAT system so as to pave the way for the creation of a genuine single EU VAT area for the internal market. This means a VAT system *simpler* for businesses trading across the EU while at the same time *more robust to fraud*, to the benefit of the Member States and also of compliant businesses. The efficiency of the VAT system needs to be further improved, in particular by *exploiting* the opportunities of *digital technology* and by *enhancing greater trust* between business and tax administrations and between EU Member States' tax administrations. (emphasis added)[36]

Figure B (below) shows the first steps in a VATCoin blockchain application. The taxpayer-buyer seeking to make a cross border purchase requests an allotment of VATCoins denominated in the local currency, sufficient to pay the VAT due on the cross-border supply. 30 VATCoins-Currency Type B are requested.[37] VATCoins are denominated in local currency, because the VAT in a cross-border transaction is also stated in the local currency. Thus, if the buyer (*Wholesaler*) was in the UK it would be requesting VATCoins denominated in pounds, whereas if he were in France the request would be for euro-based VATCoins, or forint-based VATCoins if the *Wholesaler* was in Hungary. The critical point is that the VATCoin requested is the VATCoin denomination which the buyer would use to satisfy a VAT obligation domestically.

Formally, this request is for Jurisdiction B to "make" or "mint" 30 VATCoins. In this case the price of the goods at 150 times the 20% VAT rate requires an allocation of 30 VATCoins. The diagram indicates that Jurisdiction B already has 500 VATCoins in circulation from other cross-border transactions entered into by other importing businesses. These transactions have not been completed/ closed yet, and as a result VATCoins are outstanding (or in circulation within various commercial chains).

[36] COMMISSION STAFF WORKING DOCUMENT – IMPACT ASSESSMENT, *supra*, note 3, at 11.

[37] VATCoins are denominated in the local currency. The EU Commission's "far-reaching reforms" require the seller in Jurisdiction A to collect VAT from the buyer in Jurisdiction B at the rate applicable in Jurisdiction B. Thus, the VAT due is 20% x 150 = 30

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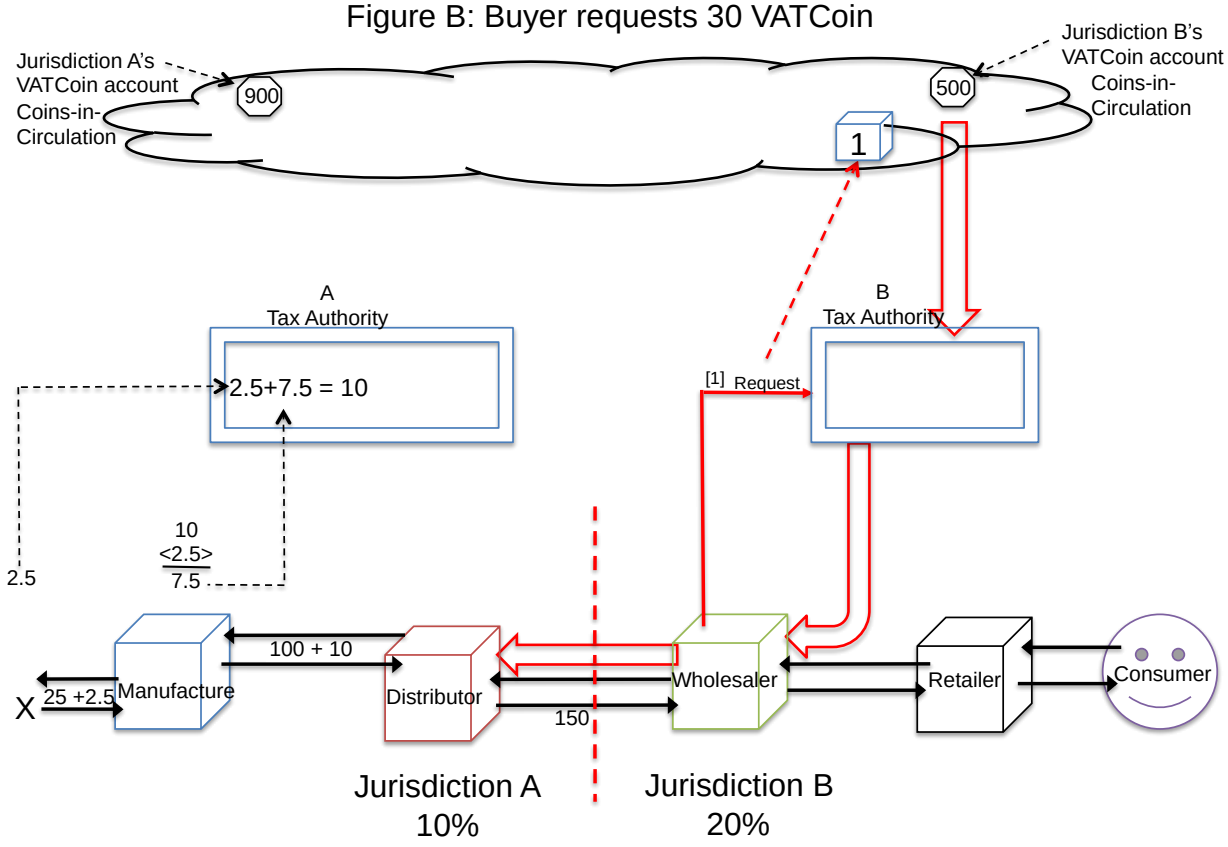
Figure B: Buyer requests 30 VATCoin



The request will be made on-line, and must be digitally signed by the Taxpayer-buyer (*Wholesaler*). The red arrows in the diagram indicate the formal elements that are needed in the request (essentially the data needed is the data presented on a pro-forma invoice):

- The number of VATCoins needed (30 in this instance);
- Identifying information about the Taxpayer-buyer (name, address, VAT ID number);
- Identifying information about the Taxpayer-seller (name, address, VAT ID number); and
- The nature and quantity of goods (or services) being purchased.

This information will be important when the transaction is completed, VAT returns are filed, and input deductions are being verified.

The request, if accepted by the Tax Administration of Jurisdiction B, will become a *smart contract*[38] that will lodge data on the blockchain.[39] Smart contracts have been proposed in a

[38] Tim Swanson, *Consensus-as-a-Service: A Brief Report on the Emergence of Permissioned, distributed Ledger Systems* (April 6, 2015).

> A smart contract is a simple rules engine; cryptographically assured business logic that has the ability to execute and move value. (5)

[39] This diagram is a simplification. Blocks, in fact, are written randomly on the blockchain. They are composed by those transactions that took place after the writing of the last block (for example, they are composed of the transactions the can be validated by the smart contracts of the peers involved in the consensus mechanism that has been implemented). The data itself is logically associated as per the business process instance that is implemented in the smart contract. Data is not chained physically according to the sequence (as suggested in these diagrams).

These simplifications were for ease of representation. It allows for a smoother presentation to a wider tax audience. Overall, the design is intended to follow *hyperledger*. In *hyperledger*, it is not the smart contract (the

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number of tax compliance areas to simplify data storage, increase accuracy and overall efficiency. Those areas range from estate tax, to VAT, to payroll tax compliance.[40]

In this diagram, the *smart contract* that is formed as a result of the request is associating some initial data with "block 1." This particular *smart contract* will be responsible for other (more significant data points involving VATCoin exchanges) with respect to Jurisdiction B. They will be validated as they arise.

Omitted from the diagram are any blocks formed ahead of block 1. The prior blocks are associated with the 500 VATCoins-type B that are in circulation prior to this transaction. When block 1 is validated by the consensus mechanism, it will be bound to the prior blocks (thus making a chain of blocks of transactional data).

Figure C indicates that the *smart contract* has been executed. In this case 30 VATCoins are created by Jurisdiction B's Treasury, transferred to the Tax Authority [2], and then further

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chaincode in *hyperledger* jargon) that is written in the blockchain; it is the data that the "client"(the application) asks to write and which are validated by the smart contracts running in all peers involved in the consensus making. Basically, the *chaincode* controls data against the state of the business process execution that is stored in the blockchain as result of previous transactions and it adds the additional data once it is validated within the business process history.

[40] Aaron Wright & Primavera De Filippi, *Decentralized Blockchain Technology and the Rise of Lex Cryptographia*, (March 12, 2015) *available at*: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2580664

> The technology [of blockchain] could be employed to create smart contracts that automatically check the state death registries and allocate assets from a testator's estate, send applicable taxes to government agencies without the need of administering the will through probate. (at 12)

UK Government Office for Science, *Distributed Ledger Technology: Beyond block chain* (2016) available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492972/gs-16-1-distributed-ledger-technology.pdf. The discussion in the VAT portion of this document focuses on efficiency gains in government auditing, and recommends the development of an …

> ⋯ EU-wide series of VAT standards and protocols [that] would enable DLT to be deployed across Europe, with unilateral alignment of all VAT accounting transactions, from invoices to bank receipts. The system could include *smart contracts* designed to outsmart the tax quasi-compliant economy, which would also help to address the various threshold differences in VAT applicability across EU member states.
>
> With machine-learning devices reading the EU's VAT transactions in real time, erroneous transactions (including so-called carousel fraud) are far more likely to be spotted than by the current methods of auditing. Increasing traceability and transparency — including payment providers, banks and other financial institutions — would make the black-market economy more difficult to conceal. (at 70-71)

UK Government Chief Scientific Advisor, Government Office for Science, *Distributed Ledger Technology: Beyond Block Chain* (December 2015).

> Blockchains are not just powering digital currencies. They are also enabling the creation of smart contracts, one of the first truly disruptive technological advancements to the practice of law since the invention of the printing press. Using a distributed database like blockchain, parties can confirm that an event or condition has in fact occurred without the need for a third party. … To date, smart contracts have mostly been created to automatically execute derivatives, futures, swaps, and options. … The development of smart contracts is expanding rapidly. Over the past several months, a number of open source projects – such as Ethereum, Counterparty, and Mastercoin – have been developed to create programming languages that enable the creation of increasingly sophisticated smart contracts. Using these programming languages, smart contracts could be used to enable employees to be paid on an hourly or daily basis with taxes remitted to a governmental body in real time. (at 18)

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transferred to the *Wholesaler* who requested them [3]. Both transfers [2] and [3], are recorded on the blockchain. We have assumed some time-lag between these steps. The diagram represents that these steps are recorded in two different blocks (numbers 2 and 3 respectively).

It should be noted, that there is no requirement that Jurisdiction B "sell" its VATCoins 1-to-1 for Jurisdiction B's currency units. There could be other arrangements. For example, a concern about cash flow for domestic businesses that are importing heavily, could be accommodated in the smart contract, which might issue VATCoins for partial payment up front, but with an automatic withdrawal from the *Wholesaler's* bank account at a fixed date, or subject to a fixed contingency later in time.

Figure C: TA-"B" creates & sells 30 VATCoin

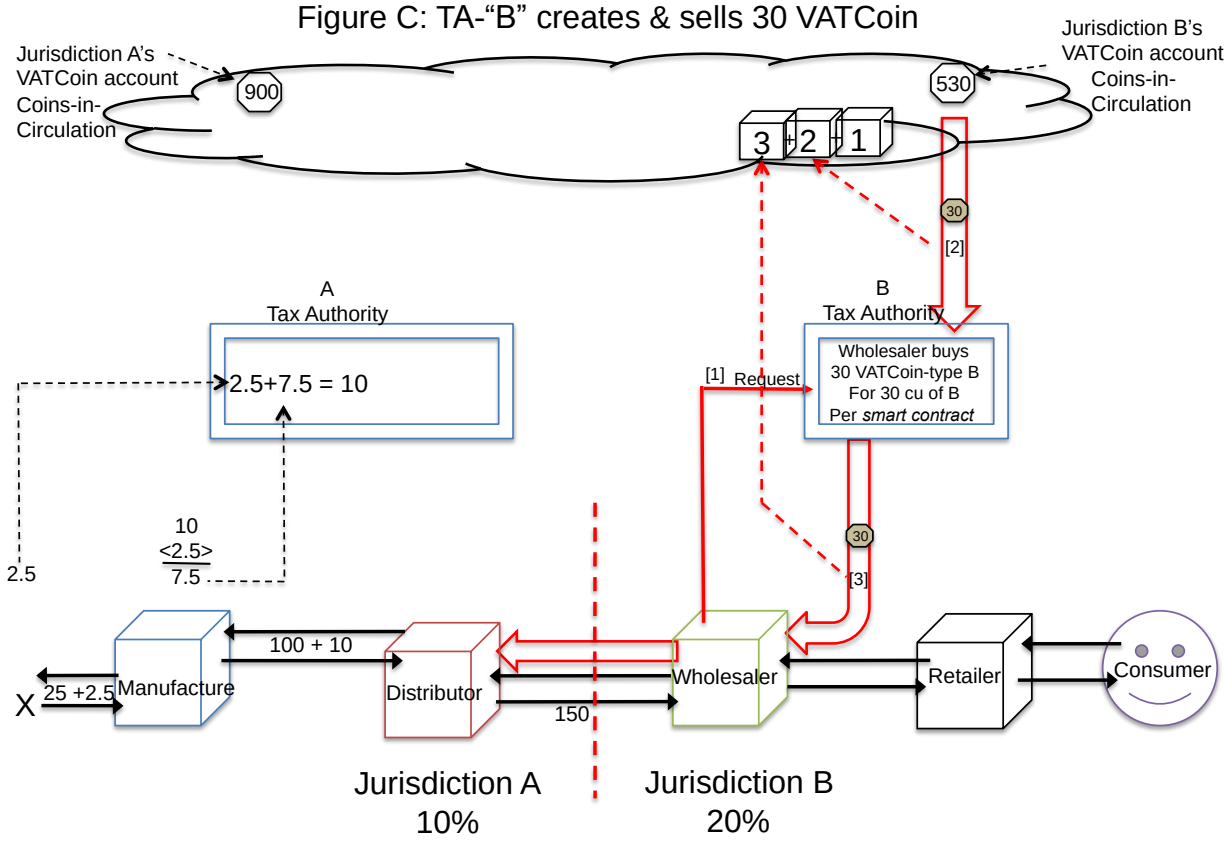

Figure C also indicates that Jurisdiction B's VATCoins in circulation have increased by 30, from 500 to 530. This amount will decrease after the One-Stop-Shop return is filed by the *Distributor*, and the 30 VATCoins are returned and then destroyed. Figure C also assumes that if the *Distributor* in Jurisdiction A is able to enter into a cross-border contract with the *Wholesaler*, then the transactions with the *Manufacturer* are complete, and Jurisdiction A has received 10 in net VAT revenue from the commercial chain up to now.

In Figure D the *Wholesaler* uses the VATCoins to complete its transaction with the *Distributor* [4]. This transfer is recorded in block 4, which is bound to blocks 1, 2, and 3 after validation by the consensus mechanism. The transfer of the VATCoins confirms the cross-

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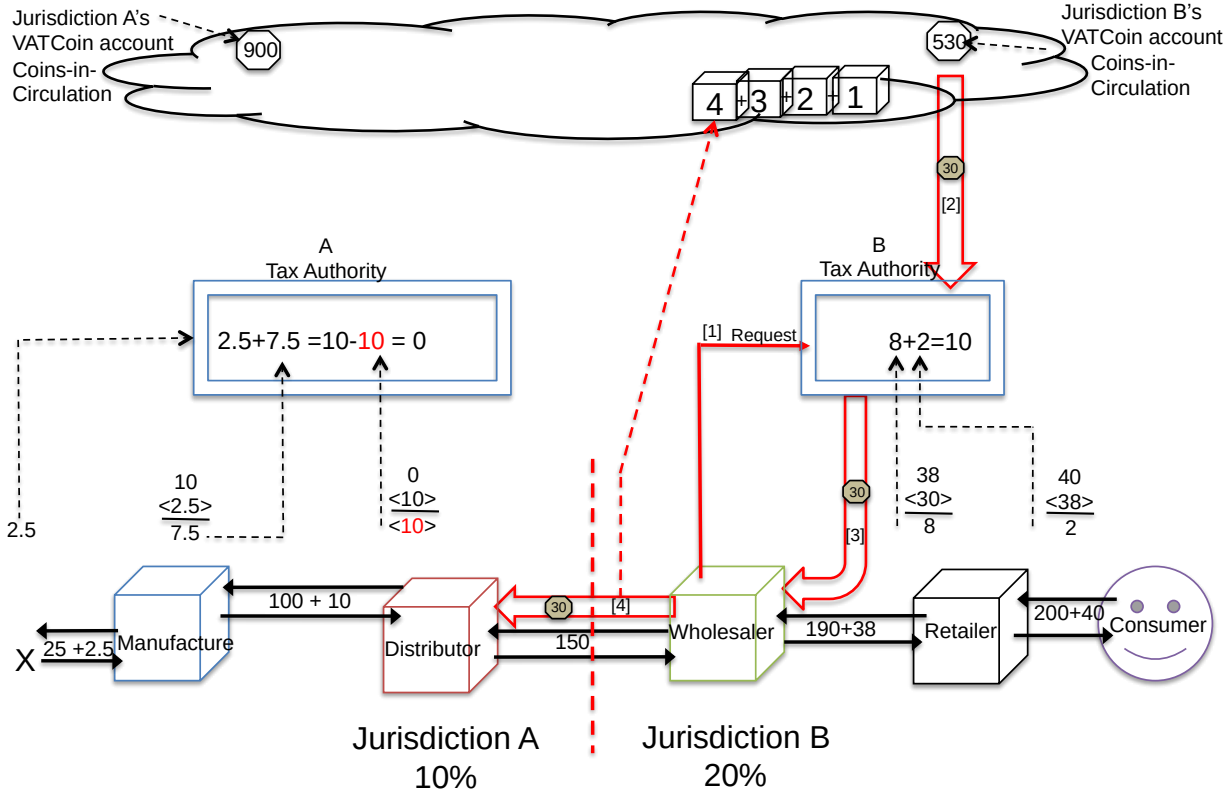
border transaction, and the *Distributor* is able to claim a full refund for input VAT. This can be immediately checked by Jurisdiction A by accessing the blockchain.

Figure D also assumes that the *Wholesaler* and the *Retailer* in Jurisdiction B are able to conclude the sale to the final consumer. The aggregate VAT collected in Jurisdiction B is 10, but it should (eventually) be 40. The missing VAT of 30 resides with the *Distributor* in Jurisdiction A, awaiting the filing of the OSS return, and the formal transfer of the 30 VATCoin through the OSS mechanism.

Figure D: Wholesaler pays Distributor 150+30 VATCoin for a supply, then sells on



It needs to be observed however, that there is no real revenue delay in this system. Jurisdiction B may already have the 30 in local currency from the transaction it engaged in through the executed *smart contract*. Traces of the contract are associated with block 1, and data from its execution is in blocks 2 and 3. Jurisdiction B still has 530 VATCoins in circulation, and it can find each one of them by consulting the full blockchain.

Figure E shows the 30 VATCoin being submitted to the Tax Authority in Jurisdiction A [5]. The transfer is recorded on the blockchain in block 5, and is bound to the other blocks. Importantly, the number of VATCoins in circulation for Jurisdiction A does not change when they receive the 30 VATCoins from the *Distributor*. These VATCoin's have been called "type B," because they originated in Jurisdiction B. They cannot be mixed with "type A" VATCoins, which are issued by Jurisdiction A, to Jurisdiction A businesses, that are importing goods from other Member States. There remains 900 VATCoins "type A' in circulation. Nothing in the current transaction has changed that.

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Figure E: Distributor files O-S-S return & transfers 30 VATCoin to TA-"A"

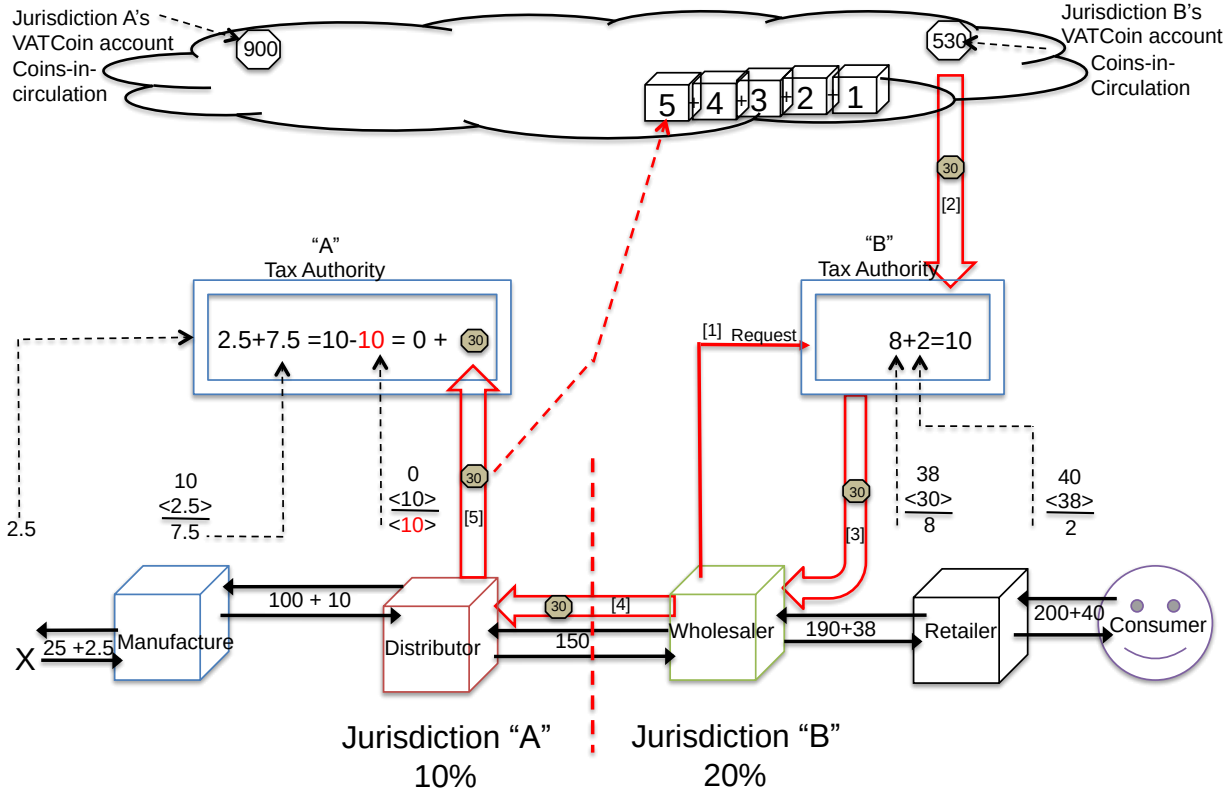

Figure F shows the final steps in this sequence. After verification and aggregation of all the transactions and all the VATCoins available to the Tax Administration of Jurisdiction A[41] the 30 VATCoins passed up with the OSS return will be sent to the Tax Administration of Jurisdiction B [6]. The transfer is recorded in block 6.

Importantly, this is not a transfer of currency. There are no banking fees associated with it, nor are there concerns with currency inflation or deflation during the time it takes to complete this circle. The funds (or *smart contract* based agreements to get them) have always resided with Jurisdiction B. The blockchain and the *smart contract* entered into at [2] and [3] make this clear. The transaction is completed.

Receipt of the 30 VATCoins brings the record of VAT revenue from this commercial chain back up to 40. Based on sales to final consumers at 200 under a 20% VAT all revenue is accounted for.

[41] It needs to be stated that this set of diagrams is only a thin sliver of all the transactions, OSS returns, and VATCoins that are deposited with the Tax Authority. It is difficult to imagine that this entire process might not take a few days or longer to make sure everything is properly done. Although nothing indicates this in the Commission documents, it should be anticipated that if a VATCoin and blockchain system were to be established, then the OSS returns and VATCoin transfers would most likely be done in close to real-time. Quarterly returns are a function of a paper system. Technology should change this.

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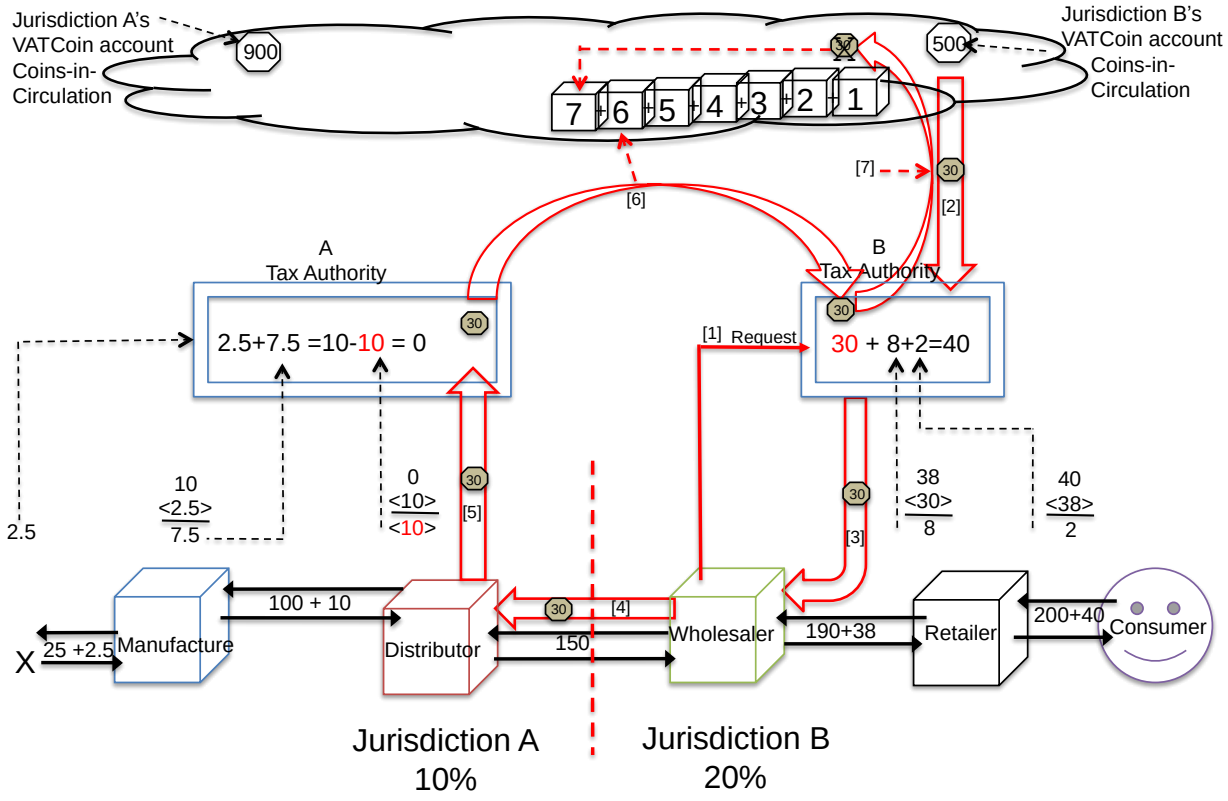
Figure F: TA-"A" remits 30 VATCoin to TA-"B" … VATCoins are destroyed



The last remaining step is for the Tax Administration of B to transfer the 30 VATCoins to its Treasury where they will be destroyed. The coins-in-circulation for VATCoin-"type B" falls from 530 to 500 upon the destruction of these VATCoins.

This step is necessary to prevent the collection of unused VATCoins in the system which might leave them vulnerable to hackers. Importantly, in this system every VATCoin has an identified commercial place where it belongs, it has a discernable history, and can be located on the blockchain at a moment's notice. Theft of a VATCoin would not provide the thief with currency, it would only provide him with a VAT payment mechanism that could be used to satisfy a VAT obligation, but the provenance of a stolen VATCoin would be immediately visible through the consensus mechanism. There are no VATCoins unassociated with an immediate transaction.

Figure G (below) presents a summary of the transactions. When the data trails are seen in aggregate, and when it is realized that hundreds, if not thousands of transactions like this will happen each minute in the EU, it becomes apparent why one thing more is needed. Each Member State will want to secure a robust artificial intelligence (AI) engine to risk-analyze the data streams, both within their own tax authority and within the Community blockchains. It would be exceedingly helpful if the Community-level risk analysis was overseen by the Commission.

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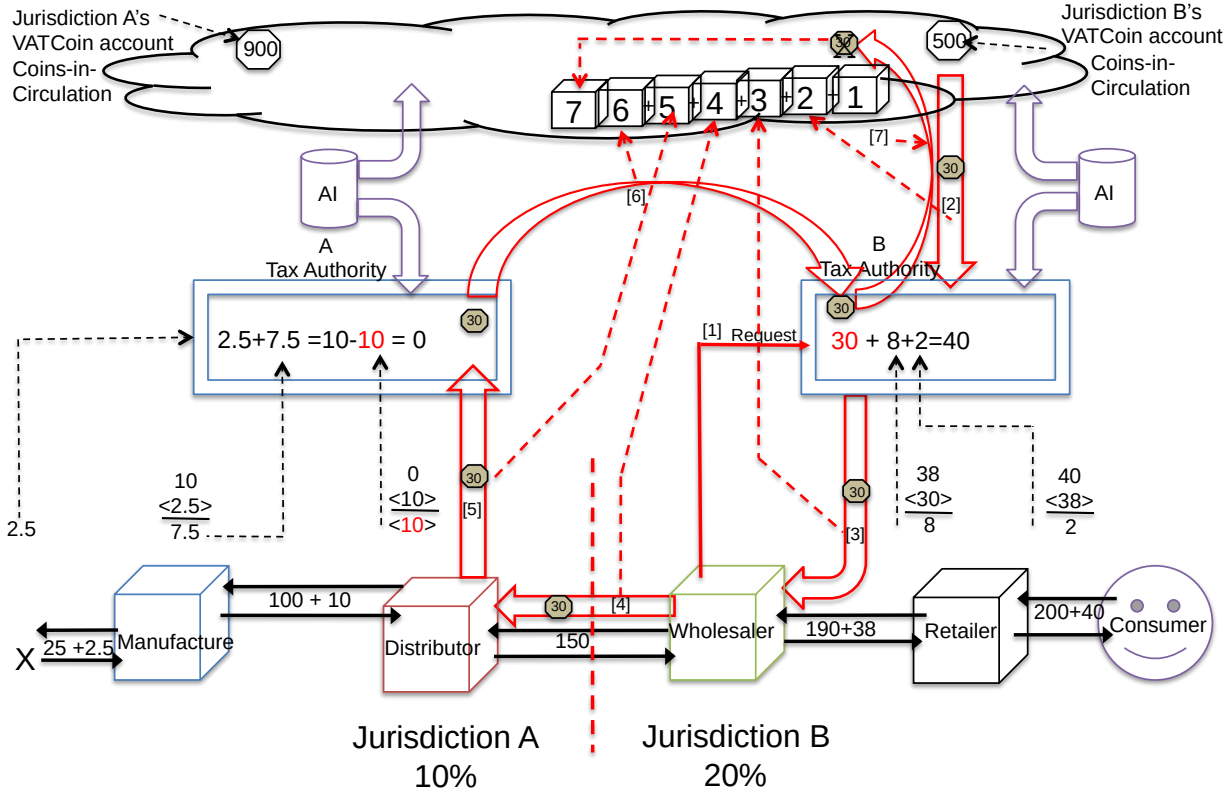
Figure G: Summary & AI



Workability

This VATCoin proposal is a technology-intensive administrative structure, narrowly designed to fit the legal constraints of the Commission's *far-reaching reform*, which is crafted to resolve MTIC fraud in goods by changing the tax treatment of B2B cross-border sales. Both VATCoin and the Commission's reform proposal are targeted at the heart of MTIC fraud – the pairing of a zero-rated sale with a reverse charged purchase across internal EU borders.

Apart from the theory of VATCoin, there is a very practical workability concern embedded in this technology structure. Can an effective blockchain be constructed given the huge amount of data processing contemplated? In other words, do we have the computing capacity to place VATCoins from all cross-border B2B goods transactions on a blockchain where the scope of the data streams spans the entire EU? And further, if we can do this in *cross-border B2B goods*, do we have the capacity to "scale-up" to all B2B transactions, and then further to all B2B and B2C transactions?

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The size of the problem can be estimated.[42] There are (roughly) 10 billion cross-border B2B transactions in the EU. The Commission's Staff Working Document which is concerned with revenue losses measured this trade in euro, not transactions. It indicated that there was €3,068,000 export transactions (dispatches) in goods, and €2,993,000 import transactions (arrivals) in goods throughout the EU in 2015.[43]

For the technology piece of this system, the important figures are the number of transactions. Our question is: can present blockchain technology deal with 10 billion transactions per year? The Red Belly blockchain, which is still in laboratory development at the University of Sydney's School of Information Technologies, is giving every indication that it could handle this data stream easily.[44]

The most recent reports out of the Australian research team indicates that the Red Belly Blockchain can process more that 660,000 transactions per second on 300 machines in a single data center. As a result, it would take Red Belly a little less than 5 hours to place a *full year* of cross-border VATCoin transactions (in goods) on a blockchain.[45]

We conclude, based on these early indications that with present technology, we *may be able* to place the entire EU's cross-border transaction record in goods on a blockchain. We certainly could not do it with the blockchain utilized by Bitcoin. Even if we assume that there are seven distinct transaction records (as in Figure G above), each of which needs to be added to the blockchain, we only need 35 hours, or a day and a half to place a full year's worth of VATCoin transactions, the entire EU cross-border trade in goods, on the Reb Belly Blockchain.

Red Belly has been tested across 14 diverse geographical regions including Australia, the US, Canada, UK, Germany, Brazil, Japan, India, South Korea, and Singapore, with up to ten machines participating in each region. Vincent Gramoli, who heads up the Concurrent Systems Research Group that is developing the Red Belly Blockchain compares the processing of the system with the global VISA network which has a peak capacity of 56,000 transactions per second. Bitcoin is limited to about 7 transactions per second.[46]

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[42] During conversations with Theodoros Vassiliadis, DGTCU, Head of Unit, Taxation systems and IT compliance, we came to a rough estimate of 10 billion B2B transactions in the EU, based on 7.5 million traders engaged in B2B transaction in 2016. Personal e-mail communications November 8, 2017.

[43] These figures are extrapolated from COMMISSION STAFF WORKING DOCUMENT – IMPACT ASSESSMENT, *supra*, note 3, at 12. The source figures are the volumes of trade in goods taken from *Eurostat* records by the EU Commission. These figures are not counting transactions, but are aggregating commercial values. There are €3.068 billion in goods exports (dispatches) and €2.996 billion in imports (arrivals) in the base year of 2015. The figures above derive a rough estimate of the number of transactions by assuming that all transactions were for €100.

[44] Jennifer Peterson-Ward, *University of Sydney's Super-fast Blockchain Gets Even Faster*, PRESS RELEASE UNIVERSITY OF SYDNEY (October 25, 2017). Neither this Press Release, nor other articles on the Red Belly Blockchain explain its capacity or operations with respect to complex *smart contracts* or its effectiveness with particular consensus mechanisms. While the reports are promising, more data is necessary to evaluate the Red Belly Blockchain. Press Release available at: https://sydney.edu.au/news-opinion/news/2017/10/25/university-of-sydneys-super-fast-blockchain-gets-even-faster.html

[45] 10,000,000,000/660,000 = 15,152 seconds, or 253 minutes, or 4 hours and 22 minutes.

[46] Asha McLean, *University of Sydney touts Red Belly Blockchain as Outperforming VISA*, ZDNet (October 25, 2017) *available at*: http://www.zdnet.com/article/university-of-sydney-touts-red-belly-blockchain-as-outperforming-visa/

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CONCLUSION

The EU Commission has proposed "far-reaching reforms" to solve *some* of the fraud in the EU VAT. It hopes to capture €50 billion lost annually to MTIC fraud in goods. It hopes to do this without addressing tradable services, a MTIC mutation which by all accounts is running strong.

Fortunately, the Commission is open to technological solutions, and realizes that *trust* is the heart of the matter. Over the years, a large number of very good proposals dealing with MTIC have been rejected because one or more Member States do not *trust* the solution.

However, *trust* leads directly to blockchain. This advance in technology is not called the "Trust Machine" for nothing. Well-designed code is inherently trustworthy. In the age of cyberspace – code (computer code) is the new regulator. Code regulates better than laws written in the legal texts.

We have presented a workable solution to some problems in the Commission's "far-reaching reforms." It is a technology-intensive solution to long-troubling tax law problem. It is a solution that is similar to the VATCoin solution we presented to the GCC as they prepared to adopt a VAT. It follows some of the GCC insights in terms of harnessing the blockchain to share cross-border trade information. It relies in part on technology observations in the GCC Framework Agreement, but it goes further than any of the GCC sources by specifying the mechanisms through which VATCoins will work within the blockchain.

This paper is not critical of the "missing pieces" in the EU Commission's "far-reaching reforms" (largely the failure to deal with tradable services). It is fairly easy to see how services can be added-on to the VATCoin approach we have taken, but the Commission is not anxious to do this (yet). Fraudsters, particularly when they have adopted VAT fraud as their means to raise funds for terrorist organizations, are not deterred by half-measures. The Commission is very aware of the people who are on the other side of this tax fraud fight. It should be anxious to close the circle.

We believe that blockchain will align the government's interest in improving revenue yields, simplifying compliance for businesses, and opening the VAT to verified observation. We know more than enough about how blockchain works from all the efforts expended in this field since Satoshi Nakamoto's Bitcoins first appeared in 2008. We also understand how *smart contracts* (enforceable digital agreements) can be associated with the blockchain after Vitalik Buterin showed us how to do it with Ethereum in 2013. We can also craft a fully *public* distributed ledger if we adopt Silvio Micali's Algorand as a consensus mechanism. And if the Red Belly Blockchain lives up to its early reports, we can bind 660,000 transactions per second into a blockchain, and out-perform VISA by a factor of 10.

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It is clear to us that VATCoin's time has come. As Larry Lessig observed, in the Age of Cyberspace "code is law."[47] We believe the time has come for the EU Commission to look at encoding the VAT in a blockchain and solve MTIC once and for all with VATCoin.

[47] Lawrence Lessig, CODE AND OTHER LAWS OF CYBERSPACE (1999); Lawrence Lessig, *Code Is Law*, HARVARD MAGAZINE (March 11, 2015).

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