An Ethereum bill of lading under the UNCITRAL MLETR

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Abstract
The paper bill of lading remains pervasive despite numerous problems associated with its form. Blockchain heralds change as it allows unique tokens to be possessed and traded peer-to-peer instantaneously over the internet without the need for a trusted central administrator. Blockchain furthermore promises to ease processes thanks to its applicability in smart contracting procedures.

The Model Law on Electronic Transferable Records (MLETR), passed by UNCITRAL in 2017, provides the relevant legal framework for legal protection of the blockchain bill of lading. This paper proposes Ethereum as a viable smart contract-enabled blockchain platform for a bill of lading system and examines said system’s compatibility with the MLETR. The analysis also shows that blockchain technology may have significant consequences for the ‘control’ approach for establishing possession of an electronic transferable record.

Keywords
Bill of lading, UNCITRAL, MLETR, blockchain, control, smart contract

1. Introduction

A. The bill of lading

1. An abridged history

Evidence dating back to 1063 shows that clerks regularly kept records documenting goods that had been boarded onto ships. In the time since, the documentation has evolved significantly,

1. S.M. Williams, ‘Something Old, something new: the bill of lading in the days of EDI’, 1 Transnational Law & Contemporary Problems (1991), p. 557.

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becoming more complex and maturing in legal character,² with the precursor to our modern bill of lading (B/L) appearing around the beginning of the 19th century.³ Today, the B/L is a document of title issued on demand of the shipper, also known as the consignor, by a carrier or master or agent of the carrier acknowledging receipt of the goods to be shipped to the ultimate receiver, or consignee.⁴ It determines the rights and obligations both of the shipper and the carrier, and is recognized as an indispensable document in the shipping industry.⁵

2. Functions

There is some difference in the way B/Ls are treated by shipping parties around the world depending on the international convention applicable to the transaction;⁶ however, the B/L’s principal purpose lies in enabling the owner of the goods to dispose of the goods rapidly, even though they will be in the custody of the carrier by the time the B/L is finalized.⁷ Three main functions of the B/L render it capable of achieving this purpose.⁸

Firstly, as a document of title, the B/L indicates the party with interest in the goods and, in the case of a negotiable B/L, facilitates and documents title transfer through an ‘uncomplicated transaction.’⁹ Passing on the B/L in this manner transfers property rights in the goods, where that is the intention.¹⁰ The consignee can exchange the B/L for the goods once they arrive at their port of destination, but it also enables them to dispose of the goods through endorsement and delivery of the B/L.¹¹

In order to transport the goods, the shipper concludes a contract of carriage with a carrier.¹² The second function of the B/L is to serve as evidence of this contract, with the terms and conditions usually placed in fine print on the back of the B/L.¹³ This indicates both to the buyer and concerned intermediaries that the goods have been tendered for shipment.¹⁴

2. Ibid.; E. Ong, ‘Blockchain Bills of Lading’, NUS Law Working Paper 2018/020 (2018), http://dx.doi.org/10.2139/ssrn.3225520, p. 2.
3. S.M. Williams, 1 Transnational Law & Contemporary Problems (1991), p. 557.
4. S. Beecher, ‘Can the Electronic Bill of Lading Go Paperless?’, 40 The International Lawyer (2006), p. 628; M. Dubovec, ‘The problems and possibilities for using electronic bills of lading as collateral’, 23 Arizona Journal of International & Comparative Law (2006), p. 440.
5. UNCTAD Secretariat, Report on Bills of Lading by the Secretariat of UNCTAD, TD/B/C.4/ISL/6/Rev.1 (1971), §18-20; J. Herd, ‘Blocks of Lading: Distributed Ledger Technology and the Disruption of Sea Carriage Regulation’, 18 QUT Law Review (2018), p. 307; S.M. Williams, 1 Transnational Law & Contemporary Problems (1991), p. 560; M. Dubovec, 23 Arizona Journal of International & Comparative Law (2006), p. 439.
6. S.M. Williams, 1 Transnational Law & Contemporary Problems (1991), p. 560; M. Dubovec, 23 Arizona Journal of International & Comparative Law (2006), p. 440.
7. UNCTAD Secretariat, Report on Bills of Lading by the Secretariat of UNCTAD, TD/B/C.4/ISL/6/Rev.1 (1971), §20.
8. S.M. Williams, 1 Transnational Law & Contemporary Problems (1991), p. 560; M. Dubovec, 23 Arizona Journal of International & Comparative Law (2006), p. 441, 448; J. Herd, 18 QUT Law Review (2018), p. 307.
9. S. Beecher, 40 The International Lawyer (2006), p. 628.
10. S.M. Williams, 1 Transnational Law & Contemporary Problems (1991), p. 561; M. Dubovec, 23 Arizona Journal of International & Comparative Law (2006), p. 442.
11. UNCTAD Secretariat, Report on Bills of Lading by the Secretariat of UNCTAD, TD/B/C.4/ISL/6/Rev.1 (1971), §19.
12. S. Beecher, 40 The International Lawyer (2006), p. 628.
13. S.M. Williams, 1 Transnational Law & Contemporary Problems (1991), p. 560-561; UNCTAD Secretariat, Report on Bills of Lading by the Secretariat of UNCTAD, TD/B/C.4/ISL/6/Rev.1 (1971), §19, 22.
14. S. Beecher, 40 The International Lawyer (2006), p. 628.
Thirdly, the B/L functions as a receipt, identifying the shipper, the carrier and the receiver.\(^{15}\) It specifies details of the cargo, evidencing its condition, which prevents the carrier from claiming prior damage in the event of delivery of the goods in unsatisfactory condition.\(^{16}\) Furthermore, it references the carrier vessel and the goods’ port of arrival.\(^{17}\)

\section*{B. The paper-based bill of lading}

The B/L has traditionally come in the form of a paper document, and the paper B/L remains pervasive to this day.\(^{18}\) This means that the document has to be physically transported, which, coupled with the number of actors involved in the process, often causes delays. To give an idea, upon receiving the goods, the carrier issues the B/L, and the shipper must pick it up, to then send it to the buyer, or their agent or broker. The document should be ready for pick-up the day after the vessel sails, but the average delay is three days and can reach seven days.\(^{19}\) Once the B/L has been sent to the consignee or to their customs broker, a further 4 to 5 days have been added, meaning that the total time to transmit the B/L to all strictly necessary parties amounts to 5 to 13 days.\(^{20}\) This is a best-case scenario that does not take into account the multiple resales that may occur even on short voyages, which generate even more information and documentation requirements due to the increased number of actors.\(^{21}\) With courier services for the strictly necessary three parties averaging US$100, and with over 50 million B/Ls estimated to be created per year, the total cost of simple transportation of all B/Ls reaches US$5 billion.\(^{22}\) In reality, this figure will be higher, as the present estimate does not include the additional costs of requesting banks to issue letters of credit and the banks’ costs for doing so. Letter of credit procedures further exacerbate delays,\(^{23}\) adding the buyer’s bank and the seller’s bank to the process, which must each have the opportunity to examine the B/L, as the document provides collateral.\(^{24}\) With errors being all too common,\(^{25}\) discrepancies in the documentation require clarification. More often than not, in order to avoid the risk of not getting paid, discrepant documents are simply rejected without checking with the applicant’s bank or the applicant themselves.\(^{26}\)

While advances in technology have resulted in speedier voyages for carrier vessels,\(^{27}\) the paper B/L remains subject to the vicissitudes of a process involving multiple actors and slow mail services.\(^{28}\) This means that, increasingly often, goods arrive at their port of destination well in advance of the B/Ls required for the goods to be released to their prospective owner.\(^{29}\) Goods that

\begin{itemize}
\item \(\text{15. S.M. Williams, 1 }\) Transnational Law & Contemporary Problems (1991), p. 560.
\item \(\text{16. Ibid., p. 560-561.}\)
\item \(\text{17. UNCTAD Secretariat, Report on Bills of Lading by the Secretariat of UNCTAD, TD/B/C.4/ISL/6/Rev.1 (1971), §19.}\)
\item \(\text{18. K. Takahashi, ‘Blockchain technology and electronic bills of lading’, 22 The Journal of International Maritime Law (2016), p. 205.}\)
\item \(\text{19. S. Beecher, 40 The International Lawyer (2006), p. 633.}\)
\item \(\text{20. Ibid.}\)
\item \(\text{21. E. Ong, NUS Law Working Paper 2018/020 (2018), p. 2-3.}\)
\item \(\text{22. J. Herd, 18 QUT Law Review (2018), p. 307.}\)
\item \(\text{23. E. Ong, NUS Law Working Paper 2018/020 (2018), p. 2.}\)
\item \(\text{24. M. Dubovec, 23 Arizona Journal of International & Comparative Law (2006), p. 443.}\)
\item \(\text{25. S. Beecher, 40 The International Lawyer (2006), p. 632.}\)
\item \(\text{26. Ibid., p. 634.}\)
\item \(\text{27. E. Ong, NUS Law Working Paper 2018/020 (2018), p. 2.}\)
\item \(\text{28. Ibid., p. 18.}\)
\item \(\text{29. Ibid., p. 2.}\)
\end{itemize}
fail to change hands are locked in ports, attracting demurrage charges, a penalty levied for tardy pick-up of cargo. As a result, a parallel industry practice has developed which provides that the goods be delivered in exchange for letters of indemnity, rather than the B/L, which places the seller in the unenviable position of not having been paid while the cargo has been released, which can result in protracted litigation. Other issues associated with the paper B/L include increased risk of loss and fraud.

C. Towards digitization

1. The sea waybill

It is evident that a shift away from a paper-based document is desirable. Although some progress has been made in the form of the sea waybill, an alternative document that can serve as evidence of the contract of carriage and as a receipt, this document is an inadequate substitute for the B/L as it cannot transfer title. A consignee receives the goods simply by proving that they are the party mentioned in the sea waybill. This makes the sea waybill incapable of functioning as a security or loan by banks for example to the seller, pending payment by the buyer, since the goods can be collected without banks’ documented approval. Furthermore, seeing as a sea waybill is made available only to pre-designated parties at its time of issuance, this ‘non-negotiable’ document is incapable of effectuating endorsement.

2. Digitization

Nowadays, it seems like there is hardly a problem that a digital solution cannot fix. However, a particular difficulty with digitizing the B/L is that, as a document that confers title, it allows for the performance of the obligation of handing over the goods in question. This is a problem in the virtual arena due to the fact that a digital signal is, in layman’s terms, little more than a succession of ones and zeros. This means that copies can be made that are indistinguishable from the original, enabling any party with such a copy to claim performance of the obligation.

3. The registry model approach

A proposed method for digitizing the B/L has been the registry model approach, whereby the party in control of the goods is referenced in a third-party registry maintained by a trusted

30. Ibid., p. 3.
31. S. Beecher, 40 The International Lawyer (2006), p. 634; J. Herd, 18 QUT Law Review (2018), p. 308.
32. E. Ong, NUS Law Working Paper 2018/020 (2018), p. 3; M. Dubovec, 23 Arizona Journal of International & Comparative Law (2006), p. 445.
33. E. Ganne, Can Blockchain revolutionize international trade? (World Trade Organization, 2018), p. 19; E. Ong, NUS Law Working Paper 2018/020 (2018), p. 2; M. Dubovec, 23 Arizona Journal of International & Comparative Law (2006), p. 447.
34. M. Dubovec, 23 Arizona Journal of International & Comparative Law (2006), p. 445.
35. S.M. Williams, 1 Transnational Law & Contemporary Problems (1991), p. 566.
36. Ibid., p. 567.
37. B. Kozolchyk, ‘Evolution and present state of the Ocean Bill of Lading from a Banking Law Perspective’, 23 Journal of Maritime Law & Commerce (1992), p. 216.
38. S.M. Williams, 1 Transnational Law & Contemporary Problems (1991), p. 566; M. Dubovec, 23 Arizona Journal of International & Comparative Law (2006), p. 443-444.
39. S. Beecher, 40 The International Lawyer (2006), p. 635; J. Herd, 18 QUT Law Review (2018), p. 308.
However, initiatives employing this approach have failed. One major obstacle is the requirement of subscription due to the closed nature of such a system. Legal uncertainty furthermore abounds regarding the relationship between users of the registry system and third parties, with users accepting contractual terms set out by the respective commercial providers, to which external parties are not privy. In these cases, substitution of the electronic record by a paper B/L is required, making the investment in subscription superfluous.

This approach also begets the common concern related to digitization, namely the loss of electronic data in the event of hardware or software failure. A third-party registry administrator introduces a host of problems: taking for granted that said administrator is competent and can be trusted not to act with malicious intent, this system introduces a clearly discernible centralized entity embodying a single point of failure.

D. A legal framework for the digital bill of lading

1. The United Nations Commission on International Trade Law

The United Nations Commission on International Trade Law (UNCITRAL) was established on 17 December 1966 by the United Nations General Assembly and is tasked with the modernization and harmonization of international trade rules to facilitate trade and investment. This is done through the preparation and promotion of legislative and non-legislative instruments targeting key areas of commercial law. This is important and necessary work, as information asymmetries between domestic and foreign companies form a non-tariff barrier to trade, with effective governance, policy and politics occurring, for the most part, at a national level.

2. The Model Law on Electronic Transferable Records

One tool at UNCITRAL’s disposal is the Model Law system. Model laws are legislative templates that jurisdictions can adopt through transposition into domestic law, with the aim of achieving as much harmony as possible among fragmented polities on issues with an international character.

40. E. Ong, *NUS Law Working Paper* 2018/020 (2018), p. 4-5; K. Takahashi, 22 *The Journal of International Maritime Law* (2016), p. 205.
41. E. Ganne, *Can Blockchain revolutionize international trade?*, p. 44.
42. K. Takahashi, 22 *The Journal of International Maritime Law* (2016), p. 205, 210; E. Ganne, *Can Blockchain revolutionize international trade?*, p. 44.
43. E. Ong, *NUS Law Working Paper* 2018/020 (2018), p. 4.
44. K. Takahashi, 22 *The Journal of International Maritime Law* (2016), p. 205.
45. S. Beecher, 40 *The International Lawyer* (2006), p. 635.
46. E. Ong, *NUS Law Working Paper* 2018/020 (2018), p. 4-5.
47. J. Herd, 18 *QUT Law Review* (2018), p. 309.
48. E. Ong, *NUS Law Working Paper* 2018/020 (2018), p. 12-13.
49. See the Homepage of the UNCITRAL website, https://unctrul.un.org/.
50. D. McWilliams, C. Niculescu-Marcu and B. Cruz, *The Economic Impact Of Smart Ledgers On World Trade*, Cardano Foundation (2018), p. 10.
51. E. Ong, *NUS Law Working Paper* 2018/020 (2018), p. 13.
52. H.D. Gabriel, ‘The UNCITRAL model law on electronic transferable records’, 24 *Uniform Law Review* (2019), p. 2.
UNCITRAL first focussed on issues of transferability and negotiability of rights in 1994. Subsequent action involved the creation of a Working Group to deliberate on Electronic Transferable Records, with a draft Model Law being considered at UNCITRAL’s 50th session, in 2017. The Model Law on Electronic Transferable Records (MLETR) was adopted by UNCITRAL on 13 July 2017.

3. Scope of the MLETR

The MLETR applies to electronic transferable records (ETRs), which are, broadly speaking, electronic substitutes for transferable documents, the latter being defined as ‘a document or instrument issued on paper that entitles the holder to claim the performance of the obligation indicated in the document or instrument and to transfer the right to performance of the obligation indicated in the document or instrument through the transfer of that document or instrument.’ Domestic law will determine which transferable documents or instruments should be included, but seeing as the B/L is one of the main negotiable instruments, this document is a prime target for the MLETR.

E. In this article

The MLETR is an effort at promoting conformity among jurisdictions on ETRs. However, it would remain an exercise in futility (or, at the very least, of far decreased worth) where B/Ls are concerned were it not for the fact that an exciting new technology, blockchain, is capable of succeeding in the digitization of B/Ls where others have failed.

Section 1. has introduced the B/L and highlighted the problems of the paper B/L, along with the inadequacies of the registry model. Section 2. will show how blockchain makes a B/L token possible. In order to engender a better understanding of how a blockchain B/L would work, blockchain technology will be explained through a description of the Bitcoin protocol. Section 3. will explain what smart contracts are and how blockchain breathes new life into this idea, and will then suggest Ethereum as a promising blockchain platform on which to build a smart contract-enabled blockchain B/L system. It bears mentioning, however, that many of the conclusions of this article may also apply to blockchain B/Ls built on other blockchain platforms with smart contracting capability, albeit with slight modifications due to differing technological specifications. Section 4. will examine whether and to what extent an Ethereum B/L token system will be covered by the MLETR in its current wording. Section 5 will conclude with a summary of the findings.

This article is timely as it may inform states such as Singapore in their deliberations on the transposition of the MLETR into their national legislation. It may also offer points of review to

53. E. Ong, NUS Law Working Paper 2018/020 (2018), p. 13.
54. Ibid.
55. Ibid.
56. Article 1(1) of the UNCITRAL Model Law on Electronic Transferable Records (‘MLETR’), 13 July 2017, A/CN.9/834.
57. H.D. Gabriel, 24 Uniform Law Review (2019), p. 2.
58. Article 2 MLETR.
59. H.D. Gabriel, 24 Uniform Law Review (2019), p. 3.
60. M. Dubovec, 23 Arizona Journal of International & Comparative Law (2006), p. 449-457; J. Herd, 18 QUT Law Review (2018), p. 308.
61. E. Ong, NUS Law Working Paper 2018/020 (2018), p. 13.
Bahrain, which introduced the MLETR into its domestic law on 29 November 2018, and remains the only state as yet to have done so.

It is worth remarking at the outset that this article is at times couched in technical jargon, which may perhaps seem out of place in a legal analysis. However, technical details not only provide context for the analysis, but, as the digital encroaches further upon not just our private but also our professional lives, it is felt that a greater understanding of a truly revolutionary technology — one that we are becoming ever more likely to come into contact with in the future — will be an asset to any reader.

2. The blockchain bill of lading

A. Blockchain

Blockchain is a comparatively recent iteration of distributed ledger technology (DLT). Its chief contribution lies in the fact that it has managed to create a peer-to-peer (P2P) platform for value exchange while eliminating the need for a central trusted arbitrator. It was first conceptualized in 2008 in a paper by the pseudonymous Satoshi Nakamoto as the technology underpinning Bitcoin, a protocol that allows users to transfer bitcoin. As noted above, this decentralized model may avoid problems such as higher transaction costs, increased risk of fraud, and a single point of failure. A simple description of how Bitcoin works follows.

1. The Bitcoin protocol

Participants within the Bitcoin network are called nodes. Anyone can become a node by generating a Bitcoin address from which to send and receive bitcoin, with the protocol maintaining a ledger detailing the amount of bitcoin at each address. As such, Bitcoin is a ‘state transition machine’ in which ‘unspent transaction outputs’ (UTXOs) are recorded, with requests for transfers and approvals of said requests resulting in the changing of the ‘state’ of the addresses in question.

62. J. Herd, 18 QUT Law Review (2018), p. 316.
63. UNCITRAL Secretariat, ‘UNCITRAL Model Law on Electronic Transferable Records (2017) – Status,’ United Nations, https://unctrul.un.org/en/texts/ecommerce/modellaw/electronic_transferable_records/status; H.D. Gabriel, 24 Uniform Law Review (2019), p. 1.
64. I. Bashir, Mastering blockchain (Packt Publishing Ltd, 2017), p. 9; J. Maupin, ‘The G20 countries should engage with blockchain technologies to build an inclusive, transparent, and accountable digital economy for all’, 48 Economics Discussion Papers (2017).
65. I. Bashir, Mastering blockchain, p. 17.
66. S. Nakamoto, ‘Bitcoin: A peer-to-peer electronic cash system’, (2008), https://bitcoin.org/bitcoin.pdf; E. Ganne, Can Blockchain revolutionize international trade?, p. 2.
67. Bitcoin with a capital is used to denote the protocol, whereas bitcoin with a lowercase is used for the denomination of the eponymous currency.
68. S. Nakamoto, ‘Bitcoin: A peer-to-peer electronic cash system’, (2008), p. 1.
69. I. Bashir, Mastering blockchain, p. 35.
70. The author recommends 3Blue1Brown, But How Does Bitcoin Actually Work?, YouTube video, 26 m, 20 s, July 7, 2017, https://www.youtube.com/watch?v=bBC-nXj3Ng4. This video has been used in conjunction with the cited literature to inform the explanation of the Bitcoin blockchain.
71. I. Bashir, Mastering blockchain, p. 21.
72. Ibid., p. 20, 145.
Verification of each party’s intent to change the state of the ledger is done through digital signatures attached to transactions. This is done through public key cryptography, a cryptographic technique whereby two sets of ‘keys’ (made up of a string of ‘bits’, or ones and zeros) are generated. One of these keys, the private key, is kept secret by the user, as, together with the information in the transaction message, it constitutes an element in the function to generate the digital signature. This digital signature allows users to approve changes in the state of the address to which they have access by virtue of the secret key. A second function using the public key is used to verify the validity of the digital signature. A new signature for each transaction is therefore required to differentiate transactions from each other, as copying a signed transaction request message would allow a malicious node to duplicate past transactions ad infinitum.

The digital signature method makes it all but impossible for anyone without the secret key to have signed off on a transaction. However, the above is merely the application of an established practice for data integrity purposes, while the information that is generated needs to reside somewhere. Whereas ledger storage and maintenance has traditionally been within the purview of a centralized entity, the Bitcoin protocol achieves decentralization by giving each node their own personal copy of the ledger, nodes broadcast any changes they wish to make to the network, thus allowing all nodes to record the updates in their ledger.

Without a method to achieve consensus between the distributed ledgers, the system would not work as there would be no assurance that all nodes are recording transactions in the same order. This is where the so-called ‘miners’ come in. Miners are nodes who perform the bulk of the upkeep of the system. The method for achieving consensus in Bitcoin is called Proof of Work (PoW). PoW is based on the Hashcash protocol, a technique established in 1997 by Adam Back to thwart email spam. Sending an email involved the sender expending computing power to solve a complex computational puzzle. Doing so requires an investment of energy, and the amount of energy expended means that the sender of the email is limited to a number that a usual user would send, and not the overload that is generally the case with spam. The receiver could input the answer to the computational puzzle, thus verifying that the sender was not a spammer. In this manner, proof of computational work ensures that the receiver can trust that the sender is acting without malicious intent.

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73. K. Korpela, J. Hallikas and T. Dahlberg, ‘Digital supply chain transformation toward blockchain integration’, Proceedings of the 50th Hawaii international conference on system sciences (2017), https://scholarspace.manoa.hawaii.edu/bitstream/10125/41666/paper0517.pdf, p. 4185; I. Bashir, Mastering blockchain, p. 69.
74. I. Bashir, Mastering blockchain, p. 70.
75. Ibid.
76. K. Korpela, J. Hallikas and T. Dahlberg, Proceedings of the 50th Hawaii international conference on system sciences (2017), p. 4185.
77. E. Ong, NUS Law Working Paper 2018/020 (2018), p. 10; I. Bashir, Mastering blockchain, p. 22.
78. A. Wright and P. De Filippi, ‘Decentralized blockchain technology and the rise of lex cryptographia’, (2015), http://dx.doi.org/10.2139/ssrn.2580664, p. 12-13.
79. I. Bashir, Mastering blockchain, p. 26.
80. Ibid., p. 15-16.
81. Ibid., p. 15.
82. Ibid.
83. Ibid., p. 111.
In Bitcoin, miners listen for the transaction requests and bundle a number of these transactions together. They then apply the cryptographic hash function SHA-256 to arrive at a specific output. SHA-256 involves the input of an arbitrary message and results in an output (a ‘hash’) of a string of 256 bits. Changing the input in any way changes the hash. The specific output that must be arrived at is preordained by the Bitcoin protocol. Due to the fact that it is impossible to reverse-engineer the SHA-256 process to arrive at the correct input, the only way that miners can get a hash that meets the specifications is by guessing the input, which involves expending computing power. Guessing the correct input results in a bitcoin reward for the miner, which adds an element of competition and incentive to the miners.

Once a miner has guessed the input required to achieve the specified hash, the answer is broadcast to other miners, who verify that the input arrived at is indeed the answer to the puzzle by simply running the hash. The ‘winner’ is then allowed to combine the answer together with their list of transactions into a ‘block’ that includes a timestamp, in order to guarantee chronological order, and a hash of the previous verified block.

Making each block dependent on the block preceding it means that changing the history of the chain would involve redoing not only the work on the targeted block, but also redoing the work on the blocks that follow it. Having the input to these already established blocks does not mean that a miner can simply input this answer again, as the puzzle is variable due to its cryptographic nature. Redoing all the work in order to change the recorded history of the chain would require an immense, almost impossible amount of computing power, which is why the blockchain can be said to be immutable.

A reason that someone may want to change the history of a chain could be to achieve consensus on their address containing more bitcoin. It is possible that someone does the work on a block to include a false transaction, and then broadcasts this block to the system. However, maintaining this lie would require a higher amount of the computing power than all the other miners combined due to the PoW logic. As long as the rest of the network has a greater percentage of computing power than the malicious miner (an attack on the blockchain would require more than 50% of the computing power, hence the term ‘51% attack’), the chance becomes overwhelming that the rest of the network will be the first to win the computational lottery and be in a position to add blocks to the chain. The whole process of verification, clearance and storage into a block happens roughly every ten minutes. It takes the addition of approximately six subsequent blocks before the block in question can be deemed trustworthy.
by logic of irrefutable mathematical probability.\textsuperscript{90} Therefore the longest chain will always serve as the consensus chain.\textsuperscript{91}

With an idea of how blockchain works, this paper will now examine the blockchain B/L.

**B. The blockchain bill of lading**

1. The satoshi bill of lading

The blockchain B/L would work in a similar way to Bitcoin, by bundling digitally signed transfers of B/Ls into blocks and timestamping them on the chain.\textsuperscript{92} In fact, the possibility exists to create B/Ls on the Bitcoin blockchain by loading the metadata required to establish a B/L onto a ‘satoshi’, the smallest possible bitcoin denomination.\textsuperscript{93} The satoshi B/L could then be traded over the Bitcoin network. This is a technique called ‘colouring’ coins, and is an appealing prospect as traders can use an already existing and highly secure system.\textsuperscript{94} Furthermore, due to the fact that Bitcoin is a public blockchain, it is easy to run a node, which does away with the burdensome registration requirements of the registry system.\textsuperscript{95}

2. Disadvantages of a Bitcoin bill of lading

There are, however, some disadvantages to using the Bitcoin blockchain for transferring B/L tokens. Crucially, such a B/L would not be considered legally valid due to the absence of a relevant legal framework. This is something that the MLETR seeks to change. The MLETR will be examined in more detail at a later stage.

Another disadvantage stems from the technology itself. Bitcoin suffers from scalability issues and requires a high energy consumption to achieve PoW consensus.\textsuperscript{96} Furthermore, the 51\% attack possibility remains a looming problem with potential miner centralization, whereby miners pool their resources to achieve a collective advantage over the rest of the miners. Although Nakamoto asserts that nodes will choose not to destroy the foundation of their wealth by undermining the trustworthiness of the blockchain,\textsuperscript{97} this possibility does in fact exist, and was brought about by opportunistic miners on another blockchain.\textsuperscript{98} Fortunately, a large amount of research is being done on the 51\% attack issue, and on other issues related to blockchain, and in this fast-evolving industry, there are many promising solutions being developed. In time, technical issues could be solved, provided they are not foundational in nature.

\textsuperscript{90} I. Bashir, Mastering blockchain, p. 119.

\textsuperscript{91} P. Hacker, ‘Corporate Governance for Complex Cryptocurrencies? A Framework for Stability and Decision Making in Blockchain-Based Organizations’, in P. Hacker et al. (eds.), Regulating Blockchain. Techno-Social and Legal Challenges (Oxford University Press, 2019), http://dx.doi.org/10.2139/ssrn.2998830, p. 148.

\textsuperscript{92} E. Ong, NUS Law Working Paper 2018/020 (2018), p. 11; J. Herd, 18 QUT Law Review (2018), p. 309-310.

\textsuperscript{93} K. Takahashi, 22 The Journal of International Maritime Law (2016), p. 204.

\textsuperscript{94} I. Bashir, Mastering blockchain, p. 172-173.

\textsuperscript{95} Ibid., p. 26; E. Ganne, Can Blockchain revolutionize international trade?, p. 9.

\textsuperscript{96} K.B. Letourneau and S.T. Whelan, ‘Blockchain: Staying Ahead of Tomorrow’, 35 The Journal of Equipment Lease Financing (2017), p. 2-3; P. Hacker, in P. Hacker et al. (eds.), Regulating Blockchain. Techno-Social and Legal Challenges (Oxford University Press, 2019), p. 156.

\textsuperscript{97} G. Jenkinson, ‘Ethereum Classic 51\% Attack – The Reality of Proof-of-Work’, Cointelegraph, (2019), https://cointelegraph.com/news/ethereum-classic-51-attack-the-reality-of-proof-of-work.

\textsuperscript{98} R. Koulu, ‘Blockchains and online dispute resolution: smart contracts as an alternative to enforcement’, 13 SCRIPTed: A Journal of Law, Technology and Society (2016), p. 53.
A more glaring disadvantage to using Bitcoin for blockchain B/Ls is that technological limitations prevent Bitcoin from capitalizing on the unique applicability of blockchain as a foundation for smart contracts.99

3. The smart contract paradigm: an Ethereum bill of lading

A. Smart contracts

Contracts are a cornerstone of our society in that they govern the relationships both between and among individuals and businesses.100 However, legal agreements are only as reliable as their parties, and the possibility of a breach creates the necessity for an accompanying ecosystem that is inefficient and expensive. Blockchain poses new challenges due to the fact that it has reinvigorated interest in a field that can make contracts self-executing and automatically enforceable.101

A standard contract is little more than ‘if this, then that’ logic manifested in a human language. This format is particularly susceptible to translation into machine-readable script.102 The concept of smart contracts, proposed in 1994 by Nick Szabo,103 involves contractual terms being executed by a digital protocol.104 The objectives of smart contract design are, in the words of their originator, ‘to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), minimize exceptions both malicious and accidental, and minimize the need for trusted intermediaries’,105 resulting in lowered transaction costs, such as those arising from fraud or arbitration and enforcement.106 A primitive analogy to the concept is the common vending machine,107 whereby the fulfilment of terms results in the performance of a specific action, namely a product being dispensed, with minimal human influence. A smart contract can thus be said to be a ‘secure and unstoppable computer program representing an agreement that is automatically executable and enforceable.’108

99. C. Shen and F. Pena-Mora, ‘Blockchain for Cities—A Systematic Literature Review’, 6 IEEE Access (2018), p. 76790.
100. S. Farrell, H. Machin and R. Hinchliffe, ‘Lost and found in smart contract translation – considerations in transitioning to automation in legal architecture’, Modernizing international trade law to support innovation and sustainable development. Proceedings of the congress of the United Nations commission on international trade law 4 (2017), https://www.uncitral.org/pdf/english/congress/Pap ers_for_Programme/14-FARRELL_and_MACHIN_and_HIN CHLIFFE-Smart_Contracts.pdf, p. 7; I. Bashir, Mastering blockchain, p. 198; A. Wright and P. De Filippi, ‘Decentralized blockchain technology and the rise of lex cryptographia’, (2015), p. 10.
101. S. Farrell, H. Machin and R. Hinchliffe, Modernizing international trade law to support innovation and sustainable development. Proceedings of the congress of the United Nations commission on international trade law 4 (2017), p. 13.
102. S. Nakamoto, ‘Bitcoin: A peer-to-peer electronic cash system’, (2008), p. 4.
103. C. Shen and F. Pena-Mora, 6 IEEE Access (2018), p. 76790.
104. I. Bashir, Mastering blockchain, p. 198.
105. N. Szabo, ‘Smart Contracts’, Phonetic Sciences Amsterdam (1994), http://www.fon.hum.uva.nl/rob/Courses/Infor mationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart.contracts.html; D. Tapscott and A. Tapscott, Blockchain Revolution: How the Technology behind Bitcoin and other Cryptocurrencies is Changing the World, p. 101-102; I. Bashir, Mastering blockchain, p. 198.
106. I. Bashir, Mastering blockchain, p. 198.
107. J.G. Allen, ‘Wrapped and Stacked: ‘Smart Contracts’ and the Interaction of Natural and Formal Language’, 14 European Review of Contract Law (2018), p. 313-314; C. Shen and F. Pena-Mora, 6 IEEE Access (2018), p. 76790.
108. I. Bashir, Mastering blockchain, p. 199.
The activation of business logic in and by the smart contract through data triggers makes the inputting of said data a fundamental part of the process.109 ‘Oracles’ are trusted entities that perform an inputting function; an example could be an algorithm that collects information on the stock price of a security, with the detection of a certain price triggering payment in the form of dividends.110

B. Smart contracting in the bill of lading process

The B/L process is a collaborative one involving multiple actors that are both a repository of data but also, through their interaction, generate it. Another example of an Oracle, perhaps more applicable to our area of inquiry, is a GPS device feeding data on the location of goods in transit into a smart contract. This smart contract could be built into the B/L token system, and could effectuate payment to the carrier once the GPS device has registered the arrival of the goods to the port of destination and the port authority or buyer of the goods registers the goods as having arrived in proper condition.

I. Privacy and interoperability issues

Banks collect and retain data that is then used for compiling letters of credit to help finance trade. The current paradigm is one in which data is siloed off in centralized databases, thus reducing the impact potential of the gathered information.111 Although organizations have come to realize that blockchain can streamline processes involving multiple actors, its application will for the moment be limited mostly to internal processes, as companies may be wary of the teething problems common to a young technology and will not want to risk revealing sensitive data.

However, the real potential of blockchain will be unlocked when the technology is implemented at a level whereby data can be placed on public blockchains and made available on a need-to-know basis.112 Despite the name, data on a public blockchain can be made private. Zero knowledge proofs (ZKPs) ‘are used to prove the validity of an assertion without revealing any information whatsoever about the assertion.’113 Such ZKPs offer properties regarding privacy that is highly desirable in the financial, health and law fields. A successful recent implementation of ZKPs came in the form of Zcash, a cryptocurrency that uses the zero-knowledge Succinct Non-interactive Argument of Knowledge (zk-SNARK) ZKP mechanism to achieve privacy.114 Monero is another cryptocurrency with a privacy focus.115

109. Ibid., p. 43-44.
110. Ibid., p. 206.
111. E. Ganne, Can Blockchain revolutionize international trade?, p. 31.
112. D. Tapscott and A. Tapscott, Blockchain Revolution: How the Technology behind Bitcoin and other Cryptocurrencies is Changing the World, p. 15-16.
113. I. Bashir, Mastering blockchain, p. 104.
114. Ibid., p. 104.
115. Ibid., p. 172.
Blockchains exchanging information with each other requires a certain level of interoperability. Currently there are many different blockchain solutions tailored to specific uses. However, advances in interoperability efforts have come, for example, in the form of Qtum, a blockchain that utilizes the bitcoin UTXO mechanism for value transfer while implementing the Ethereum Virtual Machine (EVM) for smart contracts.116

2. The smart contract plus
Solving the issue of interoperability and privacy on public blockchains allows us to envision the (as yet) utopian ideal of many different blockchains running alongside each other in the virtual space, capable of gathering data from one another. This would bring huge benefits in terms of availability of data to improve processes within the B/L process. Smart contracts in the B/L process would be able to eliminate uncertainties stemming from the unpredictability of the parties to the B/L procedure by gathering information from the respective parties’ blockchains, and contribute to automating processes. This would result in a positive feedback loop of information generation, as big data can work its analytical magic. An example could be the likelihood of timely payment of invoices through the automatic detection of funds in a bank account or cryptocurrency address. Although this ideal is one from which we are still far removed, implementing a blockchain B/L token system with smart contracting capability would bring us one step closer.

C. An Ethereum-based bill of lading token system
The benefits of smart contracts are clear. They are expected to reduce transaction costs, thus increasing the accuracy and speed of business transactions, and reduce litigation risks and costs through automated performance of contractual terms.117 Although not a new concept, and while smart contracts can work without blockchain,118 it is only now with blockchain technology that the true potential and benefits of smart contracts can be appreciated.119 Due to the distributed consensus mechanism and security benefits of the blockchain, the implementation of a blockchain solution for smart contracts is becoming almost a standard.120

However, there are a number of blockchain platforms that provide smart contracting capability, which begs the question: which one should be used? For reasons outlined below, this author proposes Ethereum as the platform of choice on which to launch a blockchain B/L token system.

116. Ibid., p. 468.
117. R. O’Sheilds, ‘Smart contracts: Legal agreements for the Blockchain’, 21 North Carolina Banking Institute (2017), p. 183, 177-178; R. Greene and B. McDowall, Liquidity Or Leakage: Plumbing Problems With Cryptocurrencies, Cardano Foundation (2018), p. 36; S. Farrell, H. Machin and R. Hinchliffe, Modernizing international trade law to support innovation and sustainable development. Proceedings of the congress of the United Nations commission on international trade law 4 (2017), p. 2.
118. H. Halaburda, Bank of Canada Staff Analytical Note 5 (2017), p. 1-2.
119. I. Bashir, Mastering blockchain, p. 198.
120. Ibid., p. 43, 208.
1. Ethereum

Ethereum is a PoW blockchain platform envisioned by Vitalik Buterin in 2013. Unlike Bitcoin’s coding language, Ethereum’s is ‘Turing-complete’, theoretically allowing it to ‘express all practical computations in smart contracts’. Where applicable, payment on the Ethereum Virtual Machine (EVM) is settled in Ethereum’s native cryptocurrency, ether.

2. Popularity as an advantage

Being ‘the most mature open blockchain with Turing complete programming capabilities’ confers specific advantages on Ethereum. As mentioned above, interoperability of blockchains presents an issue in the blockchain field. Although this is an area being researched, it makes sense to examine the largest blockchains due to the fact that they have the biggest community, which is invested in Ethereum’s continuous improvement. With the market capitalization of Ethereum at US$18,504,462,636 at the time of writing, and the next-biggest smart contract-capable blockchain platform at US$2,420,339,706, it is clear which is the largest, and therefore the one most likely to be able to benefit from a vast pool of information in the shortest timeframe. Its size also makes it the most likely to be the target of interoperability efforts, with Qtum being a case in point. Aside from this, Ethereum has mainstream appeal, attracting interest from market leaders such as IBM, Samsung and Microsoft, as well as Barclays and UBS.

Furthermore, Ethereum boasts the most tried-and-tested network, with many Initial Coin Offerings (ICOs) having been launched on it in the past years. The fact that some ICOs have been scams whereby users traded in their ether for other tokens and the scammers absconded with the ether implies a deficiency of morals and regulation and oversight more so than deficiencies in Ethereum’s technology; ether was traded for tokens through a smart contract system built on the Ethereum network, showing that the system works.

3. Governance on Ethereum as an advantage

There is always room for improvement. This was made especially clear with the infamous DAO hack. The DAO (or ‘Decentralized Autonomous Organization’) was an organization made up of smart contracts that functioned as an investment vehicle. Investors traded in ether for other tokens and the scammers absconded with the ether. However, a bug in the DAO code allowed a hacker to steal US$150 million worth of ether.

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121. Vitalik Buterin, ‘A next-generation smart contract and decentralized application platform,’ (2013), https://cryptorating.eu/whitepapers/Ethereum/Ethereum_white_paper.pdf; D. Tapscott and A. Tapscott, Blockchain Revolution: How the Technology behind Bitcoin and other Cryptocurrencies is Changing the World, p. 87.
122. R. Koulu, 13 SCRIPTed: A Journal of Law, Technology and Society (2016), p. 53.
123. S. Tikhomirov, ‘Ethereum: State of Knowledge and Research Perspectives’, Lecture Notes in Computer Science (2018), http://orblu.uni.lu/bitstream/10993/32468/3/ethereum-sok.pdf, p. 1.
124. I. Bashir, Mastering blockchain, p. 244.
125. S. Tikhomirov, Lecture Notes in Computer Science (2018), p. 2.
126. Adapted from data on 8 April 2020 from ‘All Cryptocurrencies’, CoinMarketCap, https://coinmarketcap.com/all/views/all/.
127. Ibid.
128. R. Koulu, 13 SCRIPTed: A Journal of Law, Technology and Society (2016), p. 53.
129. P. Hacker, in P. Hacker et al. (eds.), Regulating Blockchain. Techno-Social and Legal Challenges (Oxford University Press, 2019), p. 152.
Problems will arise in any system; how these problems are handled will to a large extent determine the success of a venture. What followed the DAO hack was a controversial move whereby a majority of the computing power was turned on the Ethereum blockchain by agreement among miners following a vote by some of the user base, and the blockchain was rewritten in order to reallocate the stolen funds to their correct addresses.

Although this 51% attack called into question the immutability of blockchain, it is essentially an example of governance on a public blockchain. The question of governance is one highly relevant to open blockchains, although a detailed discussion hereof is beyond the scope of this paper. For our present purpose, Ethereum has shown that where the stakes are high, its community is capable of mobilizing. Criticism of the manner in which this mobilization occurs forms part of the dialectic process that should lead to an improved system.

It is clear that in the digital realm, a solution is only as good as its code. However, ex post methods such as 51% attacks can work with ex ante ones. In this, Ethereum stands out due to its established culture of implementing standards. The best-known of these is the ERC-20 standard, which provides a template for so-called fungible tokens, or tokens that are indistinguishable from each other and can therefore be divided and traded for one another, as would be required in utility or investment tokens. However, our B/L token requires a different standard. ERC-721 is an Ethereum standard for a ‘non-fungible token’ (NFT), or a token that remains unique and cannot be divided. NFTs are useful in representing documents, such as deeds, and the ERC-721 standard is therefore the natural choice for a B/L token. That being said, the standards would benefit greatly by being further tested and potentially adopted by relevant standard-setting organizations, such as the International Organization for Standardization (ISO). This is especially relevant as Turing-complete scripts offer further challenges in the area of language design and programming practices.

4. Prospective improvements to Ethereum

The final reason given here for proposing Ethereum as the platform of choice for a blockchain B/L token is because of the prospective improvements to the system. ‘Casper’ is an update planned for Ethereum that includes switching Ethereum from the PoW consensus mechanism to a variant of the more energy-friendly Proof of Stake (PoS) consensus mechanism; besides this, research is also being done on zk-SNARK implementation. Furthermore, thanks to efforts by Ethereum co-founder Vitalik Buterin, the 51% attack could become a matter of malicious nodes requiring a full 99% of miner computing power to compromise the system.

130. Ibid.
131. Ibid., p. 10.
132. M. Westerkamp, F. Victor and A. Kupper, ‘Tracing manufacturing processes using blockchain-based token compositions’, Digital Communications and Networks (2019), p. 3.
133. P. Hacker, in P. Hacker et al. (eds.), Regulating Blockchain. Techno-Social and Legal Challenges (Oxford University Press, 2019), p. 148.
134. M. Westerkamp, F. Victor and A. Kupper, Digital Communications and Networks (2019), p. 3.
135. Ibid.
136. S. Tikhomirov, Lecture Notes in Computer Science (2018), p. 1.
137. I. Bashir, Mastering blockchain, p. 477, 480.
138. V. Buterin, ‘A Guide to 99% Fault Tolerant Consensus’, (2018), https://vitalik.ca/general/2018/08/07/99_fault_resilient.html; E. Ganne, Can Blockchain revolutionize international trade?, p. 7.
Ethereum is a promising platform for our blockchain B/L token. This paper now turns to the MLETR in order to examine the critical issue of compatibility of such a token system with its relevant legal framework.

4. MLETR-compatibility of an Ethereum bill of lading

A. Three foundational principles to the MLETR

The MLETR applies to electronic transferable records (ETRs). According to Article 10, an ETR is an electronic record that contains the same information that would be required in the equivalent paper transferable record. From this, it may be inferred that the MLETR covers only ETRs that have a paper equivalent.

It is highly likely and, due to the problems associated with paper B/Ls, highly advisable that transposing countries will follow Bahrain’s example and include electronic versions of B/Ls in the scope of their domestic legislation. However, to what extent can two instruments be considered the same after such a dramatic change of form? In order to address this issue, the MLETR relies on the three principles that have guided UNCITRAL in their work on e-commerce.

The principle of non-discrimination against electronic communications holds that an ETR should not be discriminated against solely on the grounds that it is in electronic form. This principle is set forth in Article 7(1) of the MLETR. Although the blockchain B/L is in the form of an electronic token, this cannot be a reason for the denial of the token’s ‘legal effectiveness, validity or enforceability.’ That being said, the token is not a legally valid B/L per se, as legal validity is derived from substantive law. The blockchain B/L will thus remain invalid if substantive law does not adopt a domestic MLETR equivalent that includes B/Ls.

The second principle, the principle of technological neutrality, states that there should be neither the requirement nor the assumption that a specific technology be used to store or communicate information electronically. This is a useful principle as it allows for the accommodation of unforeseen technological developments. Blockchain solutions may thus be considered as within the purview of the MLETR, despite the fact that the technology had not been invented when these principles were formulated and was only mentioned in the Model Law project as late as

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139. Article 1(1) MLETR.
140. Article 10(1)(a) MLETR; H.D. Gabriel, 24 Uniform Law Review (2019), p. 3; J. Herd, 18 QUT Law Review (2018), p. 315.
141. H.D. Gabriel, 24 Uniform Law Review (2019), p. 3.
142. J. Herd, 18 QUT Law Review (2018), p. 317; H.D. Gabriel, 24 Uniform Law Review (2019), p. 3.
143. Explanatory Note to the MLETR, §44.
144. Article 7(1) MLETR.
145. Article 7(1) MLETR.
146. Explanatory Note to the MLETR, §59-60.
147. K. Takahashi, ‘Implications of the Blockchain Technology for the UNCITRAL Works’, Modernizing international trade law to support innovation and sustainable development: Proceedings of the congress of the United Nations commission on international trade law 4 (2017), http://www.uncitral.org/pdf/english/congress/Papers_for_Programme/30-TAKAHASHI-Implications_of_the_Blockchain_Technology_and_UNCITRAL_works.pdf, p. 3; J. Herd, 18 QUT Law Review (2018), p. 315.
148. K. Takahashi, Modernizing international trade law to support innovation and sustainable development: Proceedings of the congress of the United Nations commission on international trade law 4 (2017), p. 3; J. Herd, 18 QUT Law Review (2018), p. 315.
The Explanatory Note to the MLETR further reinforces the idea that blockchain technology may be considered under the MLETR by explicitly referencing DLT and stating that there is no implied existence of centralized control or the existence of a system administrator when reference is made to records management in the MLETR. With blockchain’s unique applicability in this area, the implication is clear.

The third principle is the principle of functional equivalence. This principle holds that in order to replace a paper-based transferable record, the electronic version needs to replicate the paper document’s objectives, which it does by fulfilling its ‘essential functions.’ This principle allows states to retain the legal infrastructure that has been created to accommodate paper-based transactions, rather than forcing them to set up a radically different regime.

The provisions on functional equivalence are to be found in the MLETR in Articles 8, 9, 10 and 11. Scrutiny of these and other articles will aid us in our appraisal of the MLETR-compatibility of our proposed Ethereum B/L token system and will highlight issues that should be addressed in substantive law.

B. Information

I. Information and interpretation

Article 8 provides that where information in writing is required in a transferable record, this requirement is met in an ETR ‘if the information contained therein is accessible so as to be usable for subsequent reference.’ Such information can be loaded as metadata onto the token upon creation, prima facie satisfying the Article 8 requirement. However, seeing as the information needs to be ‘usable for subsequent reference’, clarification is necessary regarding the form of the information. This is because the token may contain relevant information in code, as would be the case with smart contract commands. Ethereum’s smart contracting code can exist on the storage trie (a component of the Ethereum address), or be loaded onto the token itself. It is likely that at least some of this information will need to be accessible and understandable to people without a background in Information Technology.

149. K. Takahashi, Modernizing international trade law to support innovation and sustainable development: Proceedings of the congress of the United Nations commission on international trade law 4 (2017), p. 3; K. Takahashi, 22 The Journal of International Maritime Law (2016), p. 207.
150. Explanatory Note to the MLETR, §18, §66, §78, §117, §143, §197; K. Takahashi, Modernizing international trade law to support innovation and sustainable development: Proceedings of the congress of the United Nations commission on international trade law 4 (2017), p. 5.
151. E. Ong, NUS Law Working Paper 2018/020 (2018), p. 14.
152. K. Takahashi, 22 The Journal of International Maritime Law (2016), p. 207.
153. E. Ong, NUS Law Working Paper 2018/020 (2018), p. 14.
154. Article 8 MLETR.
155. J. Herd, 18 QUT Law Review (2018), p. 316.
156. J.G. Allen, 14 European Review of Contract Law (2018), p. 315.
157. T. McCallum, ‘Diving into Ethereum’s World State’, Medium (2018), https://medium.com/cybermiles/diving-into-ethereums-world-state-c893102030ed; S. Tikhomirov, Lecture Notes in Computer Science (2018), p. 2; Buterin 2013, p. 14.
The legibility of coding is part of a wider debate within the blockchain field.158 Smart contracts are not yet enforceable in courts of law even though issues related to them may attract liability claims.159 In a shift from the traditional ‘law is code’ paradigm to a ‘code is law’ one due to the self-enforcement of terms,160 issues with coding may not be settled satisfactorily in courts that do not recognize the legal validity of smart contracts.161

Once smart contracts are made subject to traditional enforcement mechanisms, the question can be raised as to the expertise required by courts. Mention here should be made of Article 3(1), which states that regard should be had to the Model Law’s international origin and, crucially, to the need to promote uniformity among many different legal systems in the application of the law.162 Article 8 read in conjunction with Article 3 may indicate that some consensus among countries as to the benchmark of ‘subsequent reference’ is desirable.

Issues such as these call for cooperation at an international level. One possible solution to ensure the compatibility of domestic laws with the B/L token requirements of each country could be simply coding all the possibilities and granting the option to output the code into a human language. With its potential for simplifying processes, smart contracts can form an integral part of the templates in a B/L token system.

2. Additional information

In order to realize the potential benefits of smart contracts to the B/L process, these must be able to be included in the B/L token system. Article 10 establishes the conditions that the token must meet for it to attain the status of a transferable document. Article 10(1)(a) requires that the electronic record contain the same information as needed in a transferable document in order for it to be seen as the latter’s electronic equivalent.163 As mentioned already, the information can be loaded onto the token. However, Article 10(1)(a) could be confusing, as it might be interpreted to preclude inclusion of information other than that required in a transferable document.

Article 10 should be read in conjunction with Article 6, which allows for the inclusion in the ETR of information additional to that which would otherwise be required in a transferable record.164 For the purpose of creating a B/L token complex enough to react to data inputs and execute business logic based on those inputs, Article 6 is highly relevant, as it allows the additional lines of code that make up the smart contract and other important information to be covered by the MLETR.

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158. K.B. Letourneau and S.T. Whelan, 35 The Journal of Equipment Lease Financing (2017), p. 5; A. Wright and P. De Filippi, ‘Decentralized blockchain technology and the rise of lex cryptographia’, (2015), p. 24-26; S. Farrell, H. Machin and R. Hinchliffe, Modernizing international trade law to support innovation and sustainable development. Proceedings of the congress of the United Nations commission on international trade law 4 (2017), p. 2-4.
159. Ibid., p. 8; J.G. Allen, 14 European Review of Contract Law (2018), p. 311.
160. A. Wright and P. De Filippi, ‘Decentralized blockchain technology and the rise of lex cryptographia’, (2015), p. 47-49.
161. J.G. Allen, 14 European Review of Contract Law (2018), p. 342.
162. Article 3(1) MLETR.
163. Article 10(1)(a)
164. Article 6 MLETR.
3. Changing information

Throughout the lifetime of the token B/L, changing or adding data may be required. Article 16 deals with amendment, mandating a ‘reliable method (…) for amendment in the electronic transferable record so that the amended information is identified as such.’\textsuperscript{165} Article 17, in dealing with another type of change, namely the replacement of a transferable record with an ETR, notes that ‘[f]or the change of medium to take effect, a statement indicating a change of medium shall be inserted in the electronic transferable record.’\textsuperscript{166}

Due to the fact that our proposed Ethereum B/L would come in the form of a non-fungible and unique token due to its ERC-721 compliance, this might seem to indicate that changing the token in any way would not be possible. However, ERC-721 ‘does not mandate a standard for token metadata or restrict adding supplemental functions.’\textsuperscript{167} Therefore, a unique, non-fungible electronic token is capable of being amended and capable of having additional metadata loaded onto it, satisfying the requirements of Article 16 and Article 17(2). In case of technological or legal hurdles, another scenario could involve the information from the original token being copied onto another token, adding the required additional information, and re-minting the new token as an ERC-721-compliant token. The original token could then be ‘burned’ or blacklisted.\textsuperscript{168} The possibility to burn tokens and thus make them inoperable not only has potential bearing on Articles 16 and 17, but is also useful for the purpose of Article 18(3), which requires the ETR be made inoperable in case of a change of medium from electronic to paper.

The process for changing data on or related to the token B/L would be a matter for substantive law and applicable process design. However, this is an important consideration due to the amount of data that may be required regarding smart contract functionality. Fortunately, it seems that the MLETR and Ethereum are mutually compatible when it comes to information addition and amendment.

C. Integrity of the electronic transferable record

1. Reliability and signatures

Where a signature is required in the transferable record, this requirement is met in the ETR ‘if a reliable method is used to identify that person and to indicate that person’s intention in respect of the information contained in the electronic transferable record.’\textsuperscript{169} The reliability standard for the method referred to here, as well as for the methods referred to in Articles 10, 11, 13, 16, 17 and 18, is to be found in Article 12, which mandates that ‘the method referred to shall be: (a) As reliable as appropriate for the fulfilment of the function for which the method is being used . . . or (b) Proven in fact to have fulfilled the function by itself or together with further evidence.’\textsuperscript{170}

Article 9 includes intention ‘so as to better capture the different functions that may be pursued with the use of an electronic signature.’\textsuperscript{171} Signatures have a variety of

\textsuperscript{165} Article 16 MLETR.
\textsuperscript{166} Article 17(2) MLETR.
\textsuperscript{167} ERC-721, http://erc721.org/.
\textsuperscript{168} I. Bashir, Mastering blockchain, p. 161, 435.
\textsuperscript{169} Article 9 MLETR.
\textsuperscript{170} Article 12 MLETR.
\textsuperscript{171} Explanatory Note to the MLETR, §76.
uses, but endorsement provides a good illustration. In this case, ‘it is sufficient for signatures to establish that endorsements are back to back as under bills of lading’. This can be achieved with blockchain due to the fact that the token would come in the form of a chain of digital signatures, with the blockchain technology establishing the order of the signatures.

However, where signatures fulfil the purpose of identification of parties, it is conceivable that problems arise, as parties cannot be identified based on their pseudonymous address only. The Explanatory Note does in fact proffer pseudonymous identification as acceptable, provided that this pseudonym can be linked to a real name, which may also be established using facts outside of the distributed ledger system. Although one author notes that ‘[t]his stands to reason since sensitive information is not supposed to be stored on open ledgers’, this point may become moot in the face of technological progress, such as the aforementioned zk-SNARK implementation and other privacy advancements in blockchain. It is important then that these privacy advancements be implemented in such a way so as not to completely obfuscate the identity of the parties to the B/L transaction, as identification of the parties will be necessary where relevant issues arise.

2. A tamper-proof and unique virtual bill of lading

Because a transferable document allows for the holder to claim the performance of an obligation, it must be impossible for the document to be distributed multiple times. In law, this is achieved through the requirement that there be only one original paper copy (or one set of original copies) circulating. This is called the guarantee of singularity or guarantee of uniqueness. Article 10(1)(b)(i) advances this requirement in the virtual setting by requiring that a reliable method be used to ascertain that the electronic record with the requisite information is the ETR in question. Article 10(1)(b)(iii) furthermore mandates ‘a reliable method’ in order to ‘retain the integrity of that electronic record.’ What the latter means is that an ETR should be tamper-proof.

The blockchain B/L would be more tamper-proof than an ordinary B/L because the digital signature is more reliable than a handwritten one. Blockchain also provides for immutability of transactions, ‘a function which a handwritten signature cannot perform.’ Finally, decentralization offers a host of improvements: there is no single point of failure, and concerns of censorship by registry administrators or governments are mitigated.

Blockchain can meet the uniqueness requirement due to the token coming in the form of a digital signature chain, ‘with the additional ledger technology to single out the earliest transfer of a
blockchain B/L as the authorized transfer.\textsuperscript{183} In this instance it is again worthwhile to recall the set of standards readily available to an Ethereum token in the form of ERC-721. The registry system can in fact theoretically succeed in establishing the functional equivalent to a unique document.\textsuperscript{184} However, it fails in a related aspect, namely establishing an appropriate equivalent to possession.

\textbf{D. Control}

\textit{1. Control as the functional equivalent of possession} \\
Although possession results in legal consequences that may vary from country to country,\textsuperscript{185} its prime function is the determination of who is entitled to the rights to the goods in question, and it is this function that needs to be replicated in the electronic environment.\textsuperscript{186}

Article 11 formally establishes control as the functional equivalent to possession,\textsuperscript{187} by stating:

Where the law requires or permits the possession of a transferable document or instrument, that requirement is met with respect to an electronic transferable record if a reliable method is used: (a) To establish exclusive control of that electronic transferable record by a person; and (b) To identify that person as the person in control.\textsuperscript{188}

The person referred to may be any natural or legal person capable of possession under substantive law.\textsuperscript{189} This in itself is an exciting prospect, as it could allow for decentralized autonomous organizations to play a key role in a more automated, and therefore smoother and less error-prone, future B/L process. Such a decentralized entity would however require control over the ETR. Unfortunately, the notion of control is nowhere defined in the MLETR, the rationale being that it is the functional equivalent of possession, which may vary depending on the jurisdiction.\textsuperscript{190} How should such a notion be interpreted for the uses of the MLETR? The Explanatory Note to the MLETR merely states that control ‘needs to be interpreted autonomously in light of the international character of the Model Law.’\textsuperscript{191}

Article 11 is based on draft Article 17 of the UNCITRAL draft provisions on electronic transferable records. This article states that ‘[a] person has control of an electronic transferable record if a method used for evidencing transfer of interests in the electronic transferable record reliably establishes that person as the person to which the electronic transferable record was issued or transferred.’\textsuperscript{192} This already provides an indication as to the concept of control. Draft Article 17 seems to have more in common with United States’ Uniform Commercial Code § 7-106, on which it was based,\textsuperscript{193} than it

\begin{thebibliography}{99}
\bibitem{183}E. Ong, \textit{NUS Law Working Paper} 2018/020 (2018), p. 16.
\bibitem{184}H.D. Gabriel, 24 \textit{Uniform Law Review} (2019), p. 15.
\bibitem{185}K. Takahashi, 22 \textit{The Journal of International Maritime Law} (2016), p. 207.
\bibitem{186}H.D. Gabriel, 24 \textit{Uniform Law Review} (2019), p. 13.
\bibitem{187}Explanatory Note to the MLETR, §105.
\bibitem{188}Article 11(1) MLETR.
\bibitem{189}Explanatory Note to the MLETR, §115.
\bibitem{190}Ibid., §106.
\bibitem{191}Ibid., §109.
\bibitem{192}UNCITRAL Draft provisions on electronic transferable records: Note by the Secretariat, 4 March 2013, A/CN.9/WG. IV/WP.122, article 17.
\bibitem{193}Ibid., §26.
\end{thebibliography}
§ 7-106 U.C.C. states: ‘A person has control of an electronic document of title if a system employed for evidencing the transfer of interests in the electronic document reliably establishes that person as the person to which the electronic document was issued or transferred.’

In other words, a person can be said to be in control once the system (which should be reliable) employed to identify a person as the person to whom the rights in the goods have been transferred through the passing on of an electronic record purporting to be an ETR has been updated to reference that person as the person to whom the ETR was transferred.

The idea of control from § 7-106 U.C.C. has been noted as a ‘a well-established statement of the concept’ and therefore carries significant weight. Is this how the Article 11 MLETR notion of control should be interpreted? Regardless of the seemingly circular reasoning employed to establish control, the question may be posed if the ETR can be said to be an ETR only by virtue of the system referencing the person who has the electronic record purporting to be the ETR. In a purely semantic sense, requiring a ‘system’ seems to be an odd addition, as this goes against the varied ways in which the word ‘control’ is used in our everyday language. However, a theme that emerges from the definitions of the word ‘control’ is one whereby control can be said to be had over something, with the ability to manipulate the fate of the object in question being instrumental in establishing the entity that has control. A slight difference is noted when the word is used in the example of a passport control: ‘the place from which a system or activity is directed or where a particular item is verified.’

The notion of control is interesting in the latter, space-bound definition, as it can be said that a person has a passport merely at the behest of the issuing authorities. A parallel to be drawn here is that in which a third party establishes the rights that the holder of the document can enjoy by virtue of their possession of this document. The delineation of these rights is where the authorities’ influence stops, however: what such an external body should not do is introduce itself into the process by making the existence of the ETR as an ETR overly dependent on its system. This constrains the rightful holder’s control, in the intuitive sense of the term, over the document that the parties intended, by agreement, to transfer. As such, it would seem that being in control, similar to being in possession of something, attracts the inclusion of third parties into its definition only by way of said third parties’ exclusion over the relevant process of the object over which control is had. This is corroborated in the Explanatory Note to Article 11(1)(a), which states that ‘the notion of “control”, similarly to that of “possession”, implies exclusivity in its exercise.’

The U.C.C. clarification of control prima facie fulfils the requirement of the functional equivalence of possession through the creation of a framework by which to establish a system to determine who has possessor rights to the goods. However, intuitively, it can be said that the reference to a system is redundant. Our definition of possession in the physical world does not reference humanity’s cognitive capabilities, which is what underpins our understanding of the notion, and there is no reason for such a requirement in an electronic environment.

Reference to a system is merely a capitulation to the requirements of the registry system, hitherto the best system for establishing a functional equivalent to possession, albeit simply the

\[194. \text{Uniform Commercial Code § 7-106 (Control of Electronic Document of Title) of the United States of America.} \]
\[195. \text{H.D. Gabriel, 24 Uniform Law Review (2019), p. 13.} \]
\[196. \text{Oxford Dictionary of English (Oxford University Press, 2017).} \]
\[197. \text{Ibid.} \]
\[198. \text{Explanatory Note to the MLETR, §111.} \]
\[199. \text{Black’s Law Dictionary 1281, (9th edition, West Publishing Co., 2009).} \]
least bad alternative. Indeed, it appears that the entire control approach’s raison d’être ‘was that
possession of an electronic record prior to the advent of the blockchain technology was not capable
of being replicated.’

However, even with a U.C.C.-style definition for the functional equivalent of possession to back
it up, the registry system has significant flaws. This is because, unlike a symbolic key to a ware-
house, transferring control in a registry system only changes the listed identity of the person said to
be in control of the electronic record, and therefore fails to enable the act of delivery, or the acts of
endorsement and delivery. By contrast, a blockchain token is capable of being delivered to a
person who is then able to access the relative possessory and contractual rights by virtue of this
delivery.

The roundabout way of establishing who has control over the ETR in a registry system becomes
unnecessary with blockchain technology. This is because a blockchain B/L token is capable of
being possessed. Although the token B/L would conform to the U.C.C. definition of control, due
to its transfer being noted in a publicly available, tamper-proof and immutable ledger, the differ-
ence is that the token is not only referenced, but this reference is inextricably linked, through
mathematical certainty, to the transfer of the token from one address to another. Control over a
token is granted not by virtue of a reference, but by virtue of the act of transfer, and the holder can
access the possessory rights simply by proving that they have access to the address at which the B/
L token is held, which was already confirmed would be possible.

It can thus be said that blockchain technology has far-reaching consequences for the entire
notion of control as the functional equivalent to possession, seeing as it seems to allow for
possession in a digital environment. This calls for a review by countries of the notion of control
in a digital environment. Due to the perceived differences between the virtual and the real world,
there may still be some room for the control approach, but the definition hereof should be adapted.
Perhaps it could be modelled into a more intuitive definition such as the following: a person can be
said to be in control when they are capable of exercising their rights over the ETR at their pleasure
to the exclusion of all other persons.

2. Smart contracts - ceding control?
Since data triggers may be required to effect release of the B/L token to the consignee, one might
presume a conflict with the more intuitive approach to control described above. However, this
would not be the case. B/Ls have traditionally been issued in sets, with each set a physical
manifestation of its intended recipient’s rights in the B/L process, as each recipient has their own
purpose with their set of the B/L. Each set should be seen as an unbroken continuation of the B/L
process, pending completion.

With blockchain technology, the need for such a set may disappear, as sets were issued pri-
marily due to the slow pace of mail services. What does not disappear, however, is the implication
that possession in this manner, that is, influence over various parts of the B/L process, can be

200. E. Ong, NUS Law Working Paper 2018/020 (2018), p. 6-7.
201. Ibid., p. 5.
202. Ibid.
203. Ibid., p. 7.
204. This definition leans somewhat on the definition of possession at note 199, above.
205. E. Ong, NUS Law Working Paper 2018/020 (2018), p. 17-18.
206. Ibid., p. 18.
delegated. An example is the letter of credit requirement. The hindrances that the smart contract component erects to one holder’s control over the token would merely reflect an electronic equivalent to the hindrances that said holder might have encountered when dealing with a paper document. Therefore, provided that the system does not introduce more hindrances to the rights of the parties to the B/L process than would be justifiable in the paper variant, adding a smart contract component to the blockchain B/L cannot be said to cause an issue regarding the notion of control.

5. Conclusion

A. Summary

This article has proposed and examined an Ethereum B/L token system and discussed it in light of the MLETR as the relevant legal framework. The B/L was introduced in Section 1. This included a description of the B/L, as well as the drawbacks of a paper B/L, which include the high cost and amount of time required when transporting a tangible document in a process that involves multiple actors. The unique problems associated with a document of title were presented by way of assessment of the sea waybill as a replacement for the B/L. Although digitization offers the best option for a change in the form of the B/L, efforts in this direction have failed to catch on.

In Section 2., blockchain was discussed in light of its disruptive potential in the B/L process as it enables the transfer of value (or information coupled to that value) P2P without the need for a trusted central administrator. In order to engender a better understanding of the technology, blockchain was described using the Bitcoin protocol.

It was noted that, although a B/L token could utilize the Bitcoin blockchain, doing so would mean foregoing the benefits of smart contracting. Section 3. examined the smart contracting paradigm, and discussed how smart contracts could enhance the efficiency of an online B/L process. Ethereum was suggested as a promising blockchain platform on which to build a smart contract-enabled blockchain B/L system due to its size and mainstream appeal, which means that interoperability issues are especially likely to be targeted on this blockchain. Furthermore, a history of standard-setting and governance is a promising sign, while future updates should address technological bottlenecks. Whether these improvements will truly be delivered remains to be seen. In the meantime, Ethereum remains a highly promising public blockchain for a smart contract B/L token system.

Section 4. discussed the proposed Ethereum B/L token system against the backdrop of the legal framework that would be relevant to it. The three principles on which the MLETR rests are crucial in allowing for a blockchain B/L to be covered. Our analysis focussed on the articles on functional equivalence and combined these with other relevant MLETR articles.

B. Concluding remarks

It has become clear that an Ethereum B/L system may be made legally valid through transposition of the MLETR into domestic legislation. The technological specifications of the discussed blockchain technology allow for the addition and amendment of the information required in an ETR. Furthermore, Article 6 was found to be a crucial component when it comes to the inclusion of legally valid smart contracting capabilities in the blockchain B/L.

Blockchain allows for a tamper-proof and unique document to be traded P2P over the internet. This has the potential to put the final nail in the coffin of the registry system, which, it was found,
does not allow for transfer of the ETR in an appropriate manner. Furthermore, as blockchain allows for the possession of a B/L token, states wishing to capitalize on the benefits of a B/L token system by transposing the MLETR into their own domestic law may need to review their notion of control.

If the B/L process is to be streamlined through a blockchain B/L system, the crucial step now is worldwide domestic implementation of the MLETR. Unfortunately, one study found comparatively high levels of skepticism among government officials of the perceived benefits of blockchain technology.\textsuperscript{207} This would have to change. Fortunately, efforts to effect such change have been made, such as the launch at the World Trade Organization of a publication highlighting the potential benefits of blockchain to international trade.\textsuperscript{208}

The accompanying launch event brought together government officials and promising start-ups, such as FastTrackTrade, which applies blockchain solutions to international trade processes. The study mentioned above found that blockchain technology may induce benefits totalling between US$35 billion and US$140 billion to the field of international trade.\textsuperscript{209} Although this is merely a prediction, albeit an informed one, implementation of an Ethereum B/L system under the MLETR would be a good step towards reaching it.

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\textsuperscript{207} D. McWilliams, C. Niculescu-Marcu and B. Cruz, The Economic Impact Of Smart Ledgers On World Trade, Cardano Foundation (2018), p. 54.

\textsuperscript{208} E. Ganne, *Can Blockchain revolutionize international trade?*, p. 2018.

\textsuperscript{209} D. McWilliams, C. Niculescu-Marcu and B. Cruz, The Economic Impact Of Smart Ledgers On World Trade, Cardano Foundation (2018), p. 6.