BUILDING BLOCKCHAIN APPLICATIONS FOR THE TRANSPORTATION INDUSTRY

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Guide
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Thank you to the several thousand people, including our own customers and new readers, who read TMW Systems’ first whitepaper. Many of you contacted us to express your support and share feedback for building a Blockchain application for the trucking industry. Already we can see a community coming together in a way we haven’t seen before. In fact, your support and interest in this topic motivated us to write this second whitepaper.

The most common question that everyone seems to have is “How does Blockchain differ from other applications, like a traditional client-server app or a modern cloud-hosted, micro-service-based application?” Our simple answer to this question:

Back in the days when we developed a client-server or a cloud-hosted application, we first built the application to solve business problems and then looked-for ways to establish connections with other systems to share information. Blockchain technology works in reverse. It provides a network of systems and forces developers to build applications to work for the network. As a result, everyone follows a common set of guidelines and open standards for application development. In our opinion, this radical paradigm shift in application development is the biggest advantage of Blockchain technology.
In today’s connected world, it is all about networking and communication, so having an effective communication plan is essential. Integration is the key to having a successful transportation business, and it requires a significant amount of effort and time to implement. Remember the days when we spent countless hours figuring out an integration strategy for our business? “How do I connect my ERP to an external system? What protocol should I use? Does it have to be secure? How do I trigger actions when certain events occur? What events should be captured and audited?”

Traditional and modern technologies offer methods and features such as pub-sub model, transport protocols, certificates, keys, etc., to solve these problems. However, these capabilities are built as the underlying foundational elements in Blockchain. Applications built on Blockchain technology will automatically inherit these universal properties and will utilize common communication channels, rather than building their own feature set. These basic characteristics set Blockchain apart from other technologies — it focuses on the network first, and then the application logic. Because of these fundamental qualities, we believe Blockchain technology has the potential to meet connectivity demands in the market.

It is our belief that companies that quickly adopt and embrace Blockchain will win the race to increase productivity, enhance connectivity and improve transparency in freight handling. As a technology provider, it is our intent to help logistics and transportation companies identify ways to help create competitive differentiation. Hence, this paper focuses on connectivity concepts and other strategies required for effective and secure data exchange.

**Timothy Leonard**

EVP, CTO | TMW Systems

Founding Member & Board Director of BiTA

Member & Contributor of Government Blockchain Association (GBA)

Founder of BEST-L “Blockchain Engineering Standards for Transportation and Logistics”
Betting on Hyperledger Fabric

Before deciding on a framework to develop the next-generation platform for a technology-driven transportation industry, we evaluated a selection of frameworks, namely Ethereum and Hyperledger, along with a few others. After careful evaluation and detailed review, we found that most frameworks are developed to solve specific industry problems. For example, Ethereum for the financial industry, Power Ledger for the energy industry and so on.

Why:

Our research indicates Hyperledger Fabric to be a suitable technology to fit for our needs, mainly because of the following reasons:

- **It is open-source**, which means we have more control over the code. When errors occur, it is easier to debug and solve issues quickly.
- **A plug-and-play membership**, along with consensus services and modular design enables each deployment to be different. Consumers of technology can implement their own configurable rule set for consensus and build their own membership services with custom security roles.
- **Kafka-based** ordering service that can order, package and send transactions to peers on the network.
- **The grouping of peers** into channels to handle private transactions and execute confidential contracts.
- **Offers Java and Node.js SDK for application development**. It also plans to provide support for Python and Go programming languages in the future.
- **Extensive documentation**, detailed product roadmap and an effective project development model.
- **A choice between LevelDB and CouchDB** to record state transitions and query historical transactions.
- **Familiarity** with required toolset.
- **Most of all, it has an active, large development and support community** with 170+ members to help guide development efforts.

Speed, interoperability and flexibility are critical to building scalable enterprise business applications. We chose Hyperledger as the go-forward technology, in part because we already use Kafka and NoSQL technologies for our business intelligence and machine intelligence products. Adopting these technologies will help deliver the products faster. There have been talks about an imminent Ethereum-Hyperledger integration. When that happens, it would be easier for us to support both frameworks with minimal code modifications.
Use of Smart Contracts in Blockchain

In the previous whitepaper, we discussed the concepts of utilizing smart contracts to solve transportation problems. One potential action is to utilize the smart contracts to streamline the bidding process. We chose contract freight for our experimentation because there is arguably more complexity in dealing with contract freight than spot freight. TMW Systems provides a set of tools to deal with the complexities. Since our web-based bidding solution, Engage.Bid, has been well received in the market, it is our intention to take it to the next level through the use of Blockchain. Another reason why we picked the bidding process as a test case is because a contract is the point of entry to a freight transaction. It is our intent that we start with contracts and automate the entire freight transaction as much as we can with smart contracts.

At the North American Logistics CIO Forum and BiTA (Blockchain in Trucking Alliance) conferences, many of you might have caught a glimpse of the product demonstration during TMW System’s webinar and tech talk, but we couldn’t share all of our knowledge due to time constraints. Here is an attempt to fully share our findings. Let’s look at the process to better understand the problem and solution offered.
**Smart Contract Process**

**Shippers**
In a Blockchain, shippers can use their public key to easily broadcast a RFP to their selected list of carriers.

**Carriers**
Carriers could then use their private key to respond to the RFP with their rates, commitments, etc.

**Rounds**
Shippers and carriers use blockchain to communicate, negotiate and agree on terms - mainly rates and lanes.

**Award**
Shippers can award freight to carriers of their choice and notify them via Blockchain.

**Operation**
Carriers commit capacity for the terms listed on the contract and provide updates.

### Business Process Execution Steps

1. **Shipper issues an RFP**
   - Adds business justification/overview
   - Add rules
   - Adds lanes & modes
   - Invites carriers

2. **Carriers bid on RFP with their interested lanes, freight volume and preferred rates**

3. **Shipper and carrier negotiate on the terms. Usually there are two to three rounds of negotiation**

4. **Shipper awards business, carriers sign contracts**

5. **Once finalized, shipper starts sending load tenders**

6. **Carrier accepts loads and provides location updates**

7. **Carrier submits invoice for completed freight transactions**

8. **Shipper verifies invoice and pays for completed loads**
The common problem with this process is that the data is transmitted in files. The shipper sends Excel files with RFP information to carriers, who spend a significant amount of time and effort in determining prices for each lane (depending on their density, contractual agreements with other shippers, economic factors, etc.). Remember, carriers receive an Excel file from each shipper and they will have to perform this task for each individual shipper. Since everything is stored in files, there is not an easy method for providing or reviewing historical references.

TMW Systems and 10-4 Systems provide tools for both shippers and carriers to easily interact with and to analyze the data for faster execution. Since the scope of this whitepaper is to discuss Blockchain, we wanted to provide a couple of screenshots of the tools without getting too much into the specifics. If you are interested in learning more about the toolset, please refer to the TMW Systems and 10-4 Systems websites.

While TMW Systems’ Engage.Bid and 10-4 Systems’s RFP tools have simplified these routine tasks by providing an interface for shippers and carriers to work with, the problem still lies in the execution:

**Problem 1**
Information is still exchanged in file formats

**Problem 2**
Contracts aren’t fully enforced during the load tendering process
TMW Systems plans on solving these problems through Blockchain technology. Since the platform provides a network, it naturally solves the connectivity issues. There is no need for files and emails to exchange data. Shippers and carriers could use Blockchain for communication. (One could argue that a multi-tenant application hosted on a cloud platform could offer the same capabilities. The difference is that every transaction between the parties is logged in an unalterable, secure Blockchain ledger that provides trust and much-needed transparency for both shippers and carriers.)

The second biggest problem in freight management is contract compliance. There are very few companies that cross-check freight rates with the rates finalized on a contract. Often, shippers or carriers re-rate the freight, ignoring the terms agreed to on the contract. While this simplifies the process and moves freight faster, it causes delays in invoicing, and hence, the 21 to 45 days needed to settle payments. In this scenario, a contract is just a piece of paper in a cabinet, and it’s not necessarily honored during the tendering process.

One of our customers that uses the TMW Systems’ Engage.Bid product found that their sales people are taking more loads than agreed to in the contract while there is an opportunity to reposition their fleet in the spot market to improve its profit margins. With slight adjustments, the customer was able to reposition its fleet and improve its profit by $70,000 a week. That is a $250,000 a month or a $3 million a year improvement in profit.

Similarly, there are abundant ways to analyze data and adjust business processes that can result in higher revenue and better profits. The key elements are the data and contract enforcement, which is exactly what we intend to solve. TMW Systems has a massive data lake with an extensive amount of data that could help predict the future. There are whitepapers available on our website that discuss our data strategy in detail. Please refer to them for more information.

With RFP automation the customer was able to improve its weekly profit by: $70,000

This is an example that illustrates how a contract is enforced and updated when loads are tendered and accepted.
This example assumes a carrier has a negotiated contract with a couple of shippers for 18 different lanes. Information, such as rate per mile, length, discount, penalty and accessorial charges, are stored at the lane level. In most cases, when a shipper tenders a load, the contract rates aren’t enforced. More importantly, there is not a step in the process to determine if the rates tendered and invoiced are the same rates specified in the contract. This often results in process and payment delays that result in dissatisfaction. We intend to resolve this problem with the following approach:

### New Contract Process

A finalized freight contract becomes a smart contract in the Blockchain system.

When a shipper tenders an offer for a shipment, the smart contract would look for the cheapest contract in place among the various carriers and extract the necessary information, such as rate per mile, penalty cost, accessorial charges, other nonstandard fees, detention rules, etc., and auto-populating them on the freight record, eliminating manual entries that are prone to error.

In addition, the smart contract could offer the load tender to a list of pre-selected carriers. If carrier A rejects, the system would automatically send notifications to the next carrier on the list, and the process continues until a carrier accepts the load.

For the carriers, the smart contracts would keep track of loads booked against the loads agreed. This would help carriers easily identify under-utilized and over-utilized contracts.

- In the previous example, the system highlights the first record in red, indicating that the carrier booked more loads than committed. Hauling more loads for a shipper may not be profitable all the time, especially when the spot market rates are higher.
- Record eight is highlighted in blue, indicating that carriers booked fewer loads than committed. This could be used as an important metric during the next contract negotiation.
- It would also protect the carriers in regard to payment terms, accessorial charges, etc. (the inverse of the above).

For those looking to analyze shipping networks to increase efficiency, the smart contracts could be a great help. First, it automates some of the work for the application users. Second, executives and decision makers no longer have to wait for weekly reports to take actions. Actionable data is available from the beginning.
Permissioned Blockchain

While freight contract automation appears highly beneficial, one of the biggest concerns with a public Blockchain is confidentiality. Although contract information is stored in a secure ledger, and only peers with appropriate security can access them, there is reluctance in the industry to adopt such technology — no carriers want to have their data on a competitor’s system.

The very first version of Hyperledger Fabric (ver. 0.6) is a decentralized network. Any information written on a node is replicated on another peer, which is essential for mining in the financial industry. However, this won’t work for the transportation industry. The success of transportation companies depends on their rates, network and customers. Subsequently, carriers would do anything to protect that information. Fortunately, the second version of Hyperledger Fabric (ver. 1.0) offers channels that support private transactions and confidential contracts.

The latest version supports “channels” that enable the logical grouping of peers on a network. Once a channel is formed, anything transmitted to a peer on a channel would live within those channels. The information would be completely invisible to peers outside of the channel, providing the data protection carriers seek. There are many technical details involved in constructing a channel. How does an ordering service need to be configured? Who would act as endorsing peers on a channel? How does a membership service provider work for a dynamically configured channel? Since this paper is targeted for a general audience, please contact TMW Systems for more information on technical details.

Multi-Ledgering

Source: www.altoros.com
How to Get **Started**

Blockchain technology requires collaboration among the members representing each domain of a business transaction. As a result, several consortiums have formed over the past few years to facilitate this collaboration:

**Consortiums**

- **R3** for financial institutions
- **B3i** for insurance industry
- **Blockchain Alliance** to promote Blockchain Technology
- **Blockchain in Transportation Alliance**

Since we are in the transportation industry, the most relevant alliance is BiTA. Nearly 500 companies have joined the alliance and it is growing at a rate of 20 members per day. We highly recommend shippers and carriers join other Blockchain enthusiasts in the alliance to learn about what the industry has in store for the future of transportation.

If you are planning on developing your own distributed application, then we recommend a couple of frameworks — Ethereum and Hyperledger. Hyperledger supports several tools, and the ones highlighted for this topic are Composer and Fabric. Composer is a single-node, rapid application development platform that lets you develop a single-node Blockchain application. Fabric is the extensive framework that supports full Blockchain implementation. These links will help you get started with these frameworks.

- [https://hyperledger.github.io/composer/index.html](https://hyperledger.github.io/composer/index.html)

Both sources provide detailed information on building “Hello, World!” and other enterprise applications. If you are struggling or need any technical guidance, feel free to contact TMW Systems.
While we are just getting started with Blockchain technology, it is worth knowing the current technical challenges and limitations of the technology. Without going into the specifics, here are a few key challenges:

1. **Scalability** — There are some technical limitations with the number of transactions per second. Metrics vary based on the transaction.

2. **Archiving and Pruning** — We don’t want the database to grow unhindered. Doing so will lead to performance issues. Luckily for us, the Hyperledger community has planned to address these gaps in the next version.

3. **REST Wrapper** — Representational State Transfer (REST) wrappers require apps to interface with each other seamlessly.

For more information about Blockchain and Hyperledger development, stay tuned to TMW Systems and BEST-L. We will do our best to offer as much information as possible.
Several consortiums have formed in recent months to address the various business problems facing each industry. Some of them are outlined above. However, as a leading transportation technology provider, we feel that there isn’t an organization to address the technical challenges associated in using Blockchain to solve transportation problems. Hence, a few of us have stepped forward and formed an association named BEST-L, which purely focuses on establishing open standards for the transportation and logistics industry. The organization isn’t restricted to TMW Systems Customers and its affiliates, but open to all technology enthusiasts. We invite business users, developers, architects, network administrators, executives, professors, college students, research staff, entrepreneurs and blog writers to join the organization and become a part of the Blockchain journey. As a first step, we have a web portal set up for everyone to collaborate and share ideas. There are also virtual classes to stimulate the collaboration.

For more information visit: bestl.io
Conclusion

Blockchain is all about building a system between the parties involved in the freight transaction, built on trust. In order to build such a system, both shippers and carriers need to work together. Every transaction executed between the parties need to be logged into a decentralized ledger to provide higher transparency across different organizations benefiting not only the stakeholders, but the entire ecosystem. Again, referring to the comment from the previous paper, implementing a Blockchain application couldn’t prevent an e-coli outbreak from happening, but connecting social data with business data using the technology would help organizations to identify a root cause and act faster. Thus, for the benefit of everyone, we highly suggest organizations adopt Blockchain technology sooner rather than later.

TMW Systems feels that the transportation and logistics industry has been due for an overhaul. The wider adoption of blockchain technology across other industries is a good indication that it is time for us to take the leap and start thinking about reshaping our industry using better and more efficient tools. For the last few months, we have been working hard on developing a suite of Blockchain-based transportation technology solutions. The goal is to not only to create a decentralized ledger, but also to leverage the opportunity to streamline business processes, eliminating inefficiencies. We highly suggest every transportation and logistics professional start thinking about this major paradigm shift.

For more information on upcoming blockchain demos and events, stay tuned to TMW Systems. Interested in being a part of our design-thinking process and staying ahead of the game?

Contact:

Tim Leonard
tleonard@tmwsystems.com

Vasanth Srinivasan
vsrinivasan@tmwsystems.com

In the News

If you still aren’t convinced, here is some of the latest industry news:

- Peak Blockchain Hype? Firm with no revenues and no product Is Worth $1.2 Billion (source: news.bitcoin.com)
- Luna DNA gets funding for Blockchain initiative (source: healthdatamanagement.com)
- Control Energy establishes Blockchain Advisory Board and Appoints Mr. Manie Eagar (source: markets.businessinsider.com)
- Drone + Blockchain Technology with the power of Blockchain to increase safety, intelligence, and protection of data to power Drones and Robots (source: mota.com)
- The Blockchain Education Network $100,000 Challenge (source: bitcoin magazine)
- Kenya’s real-estate industry goes hi-tech with blockchain (source: standardmedia.co.ke)
- Dubai Sets Its Sights On Becoming The World’s First Blockchain-Powered Government (source: forbes.com)
TMW is a leading transportation software provider to commercial and private fleets, brokerage and 3PL organizations. Founded in 1983, TMW has focused on providing enterprise software to the transportation industry, including asset-based and non-asset-based operations as well as heavy duty vehicle service centers. With offices in Cleveland, Dallas, Nashville, Oklahoma City, Raleigh, Vancouver and Melbourne, Australia, the company serves over 2,000 customers, including many of the largest, most sophisticated and complex transportation service companies in North America. TMW is a Trimble Company (NASDAQ: TRMB) and part of the Transport and Logistics Division.

Ready to get started?
Be part of the ground-up solutions that will change the way business is conducted in transportation and logistics. Blockchain technology is a radical shift with a common set of guidelines and open standards for application development.

WIN WITH BLOCKCHAIN TECHNOLOGY