



# ***Improving security in transport systems: the role of Blockchain***

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# Outlines

1. Blockchain: a quick overview
2. Blockchain for logistics
3. Blockchain for automotive
4. Trials and experiments @ University of Rome Tor Vergata
5. Conclusions

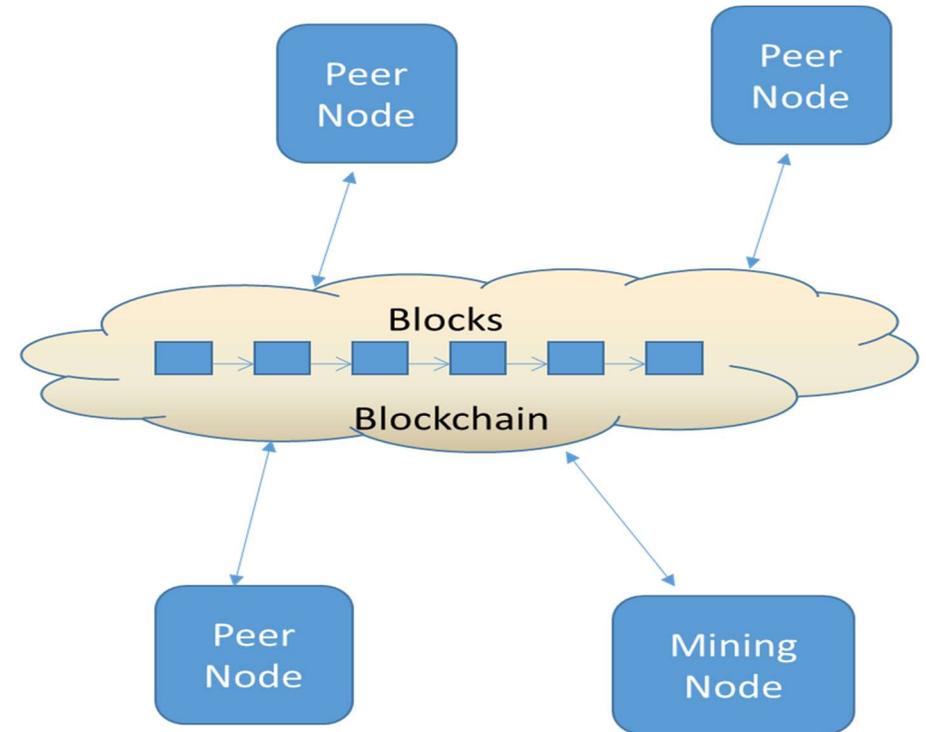
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# Blockchain: what?

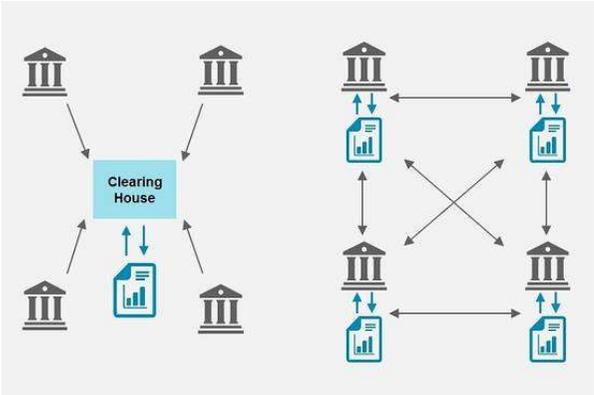
"The Blockchain is a distributed, decentralized, shared, encrypted and consensus-based database (the archive, open to all, can be modified only with the consent of each participant), able to guarantee the immutability of the information within it and characterized by the property of 'transparency' (everyone, at any time, can see everything) ".

- DB is structured in "blocks" linked together
- Decentralized Ledger
- Public key Signature (Public Key/Private key)
- Mining + Consensus mechanism (PoW, PoS)
- Peer-to-Peer Communications
- Transparency guaranteed through Pseudonymity
- Irreversibility and immutability of Data Records
- Data Tracking
- Conditional actions
- Antitampering
- Hashed-based data transaction (SHA256)



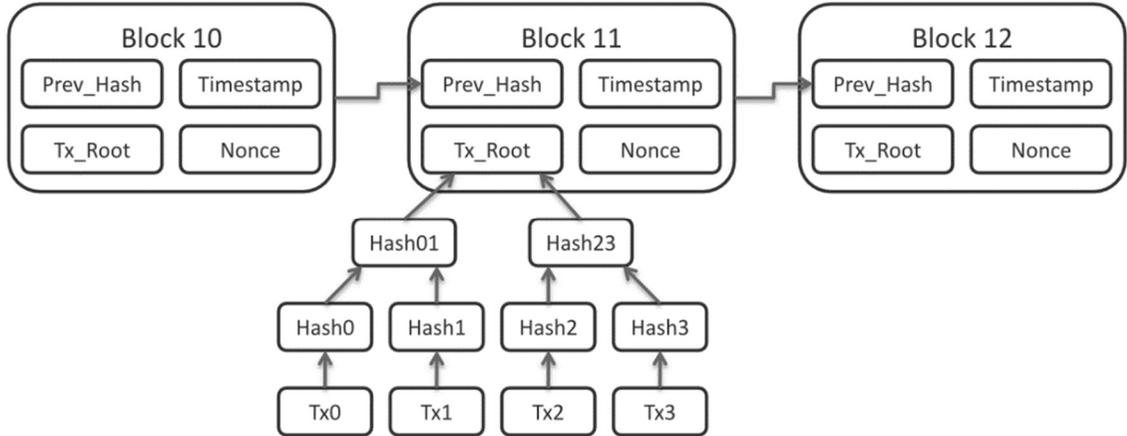
The blockchain is a technology enabling security-by-design solutions.

# Blockchain: The Chain of Blocks



version	02000000
previous block hash (reversed)	17975b97c18ed1f7e255adf297599b55330edab87803c817010000000000000
Merkle root (reversed)	8a97295a2747b4f1a0b3948df3990344c0e19fa6b2b92b3a19c8e6badc141787
timestamp	358b0553
bits	535f0119
nonce	48750833
transaction count	63
coinbase transaction	
transaction	
...	

Block hash  
 0000000000000000  
 e067a478024adffe  
 cdc93628978aa52d  
 91fabd4292982a50



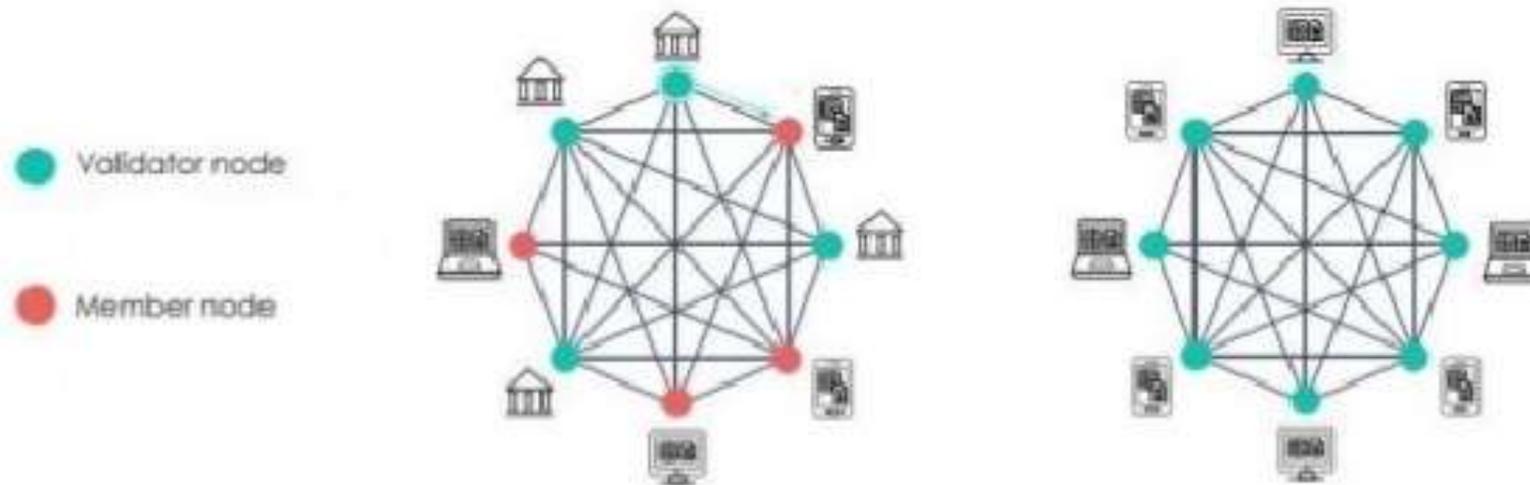
Size	Attribute
4 bytes	Block Size
80 bytes	Block Header
1-9 bytes (VarInt)	Transaction Counter
Variable	Transactions

Source: S. Nakamoto

# Blockchain: permissioned or permissionless?

Permissioned (Private)

Permissionless (Public)



## Potential risks

- 51% attack
  - node and network instability
  - Single point of failure
- Block confirmation and validation ~ 10 min
  - Double spending
  - Large community → no interest to attack

## Blockchain: monetary or non monetary applications?

- **Monetary**

- Bank
- Finance
- Insurance
- Cryptocurrency

- **Non Monetary**

- IoT
- Gate Access
- Smart Contract for IoT

## What's next in the market?

- The future for blockchain in the world of transportation and logistics is bright.
- According to [Morgan Stanley](#):
- ***“The revenue opportunity for blockchain within the freight and transportation space could end up being as much as \$500 billion.”***

## Blockchain for transport and logistics (1/2)

- The **global logistics market reached a value of \$4,730 billion in 2018** and has a **projected CAGR of 4.9 percent, to reach \$6,300 billion by 2024.**
- Due to this considerable growth, the **number of manufacturers, suppliers, and third-party intermediaries involved is increasing rapidly**, making today's global supply chains increasingly complicated to manage.
- At the same time, **increasing digitalization and data utilization** lead to **security and transparency** concerns across the industry.
- To solve these issues and overcome mistrust among the industry's countless players, companies are turning to **technology such as blockchain to achieve competitive advantage and, ultimately, unlock growth possibilities.**

<https://www.adlittle.com/en/Blockchainintransport>

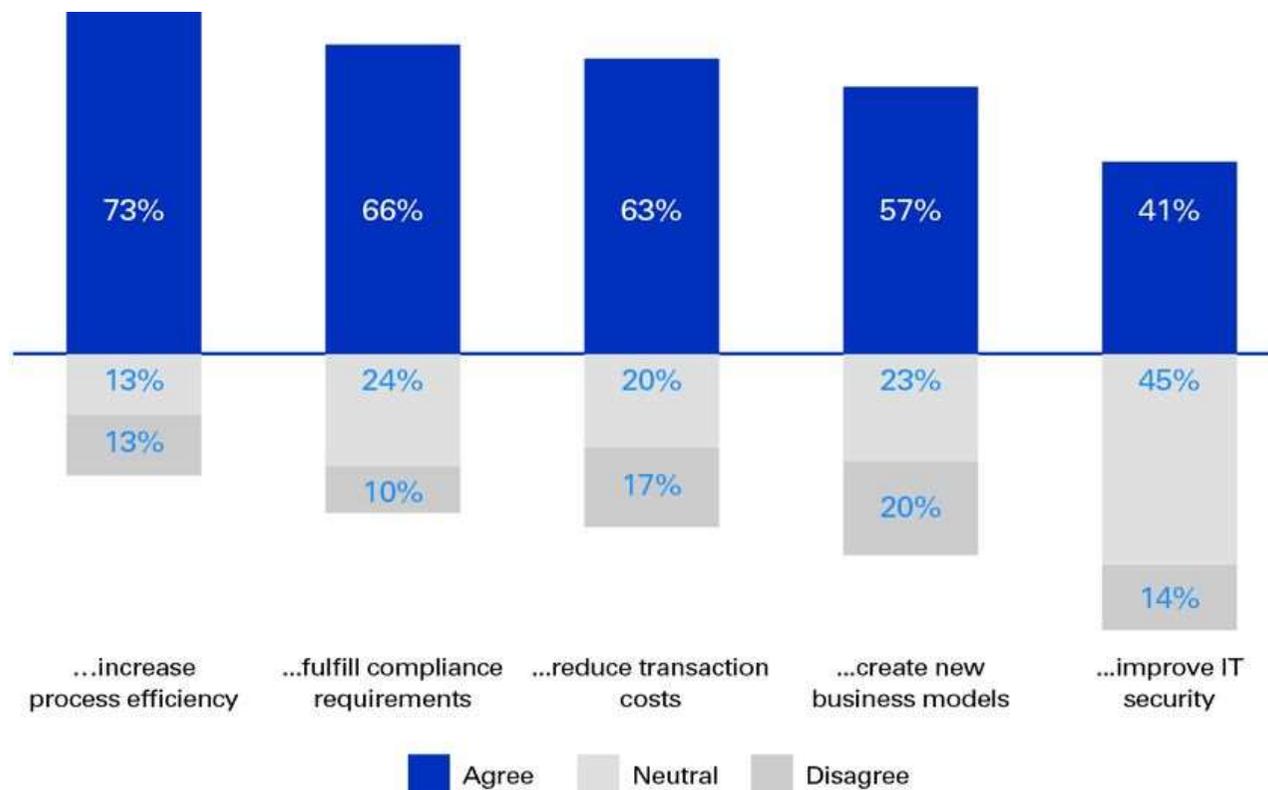
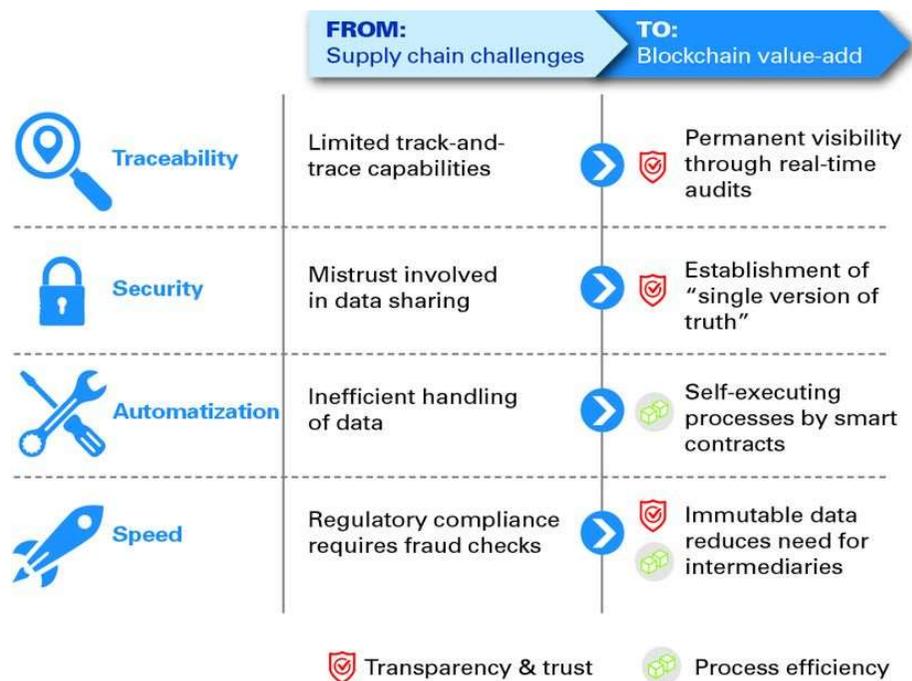


Figure 1: Blockchain use cases with proven potential in the transport industry

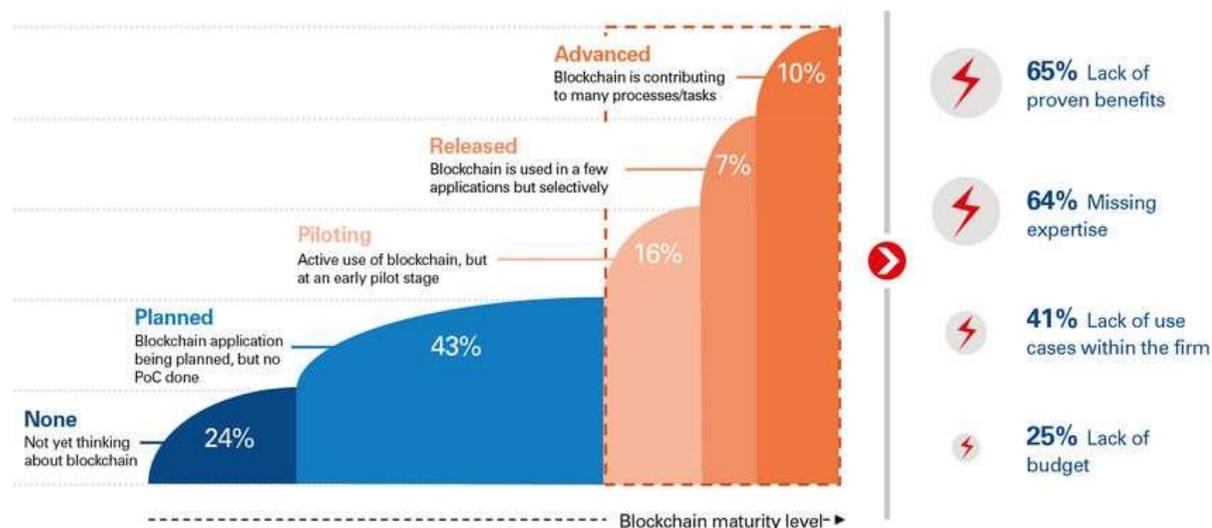
Source: Arthur D. Little and BITA (Blockchain in Transport Alliance)

# Blockchain for transport and logistics (2/2)

## Process efficiency



## Obstacles to blockchain adoption and success

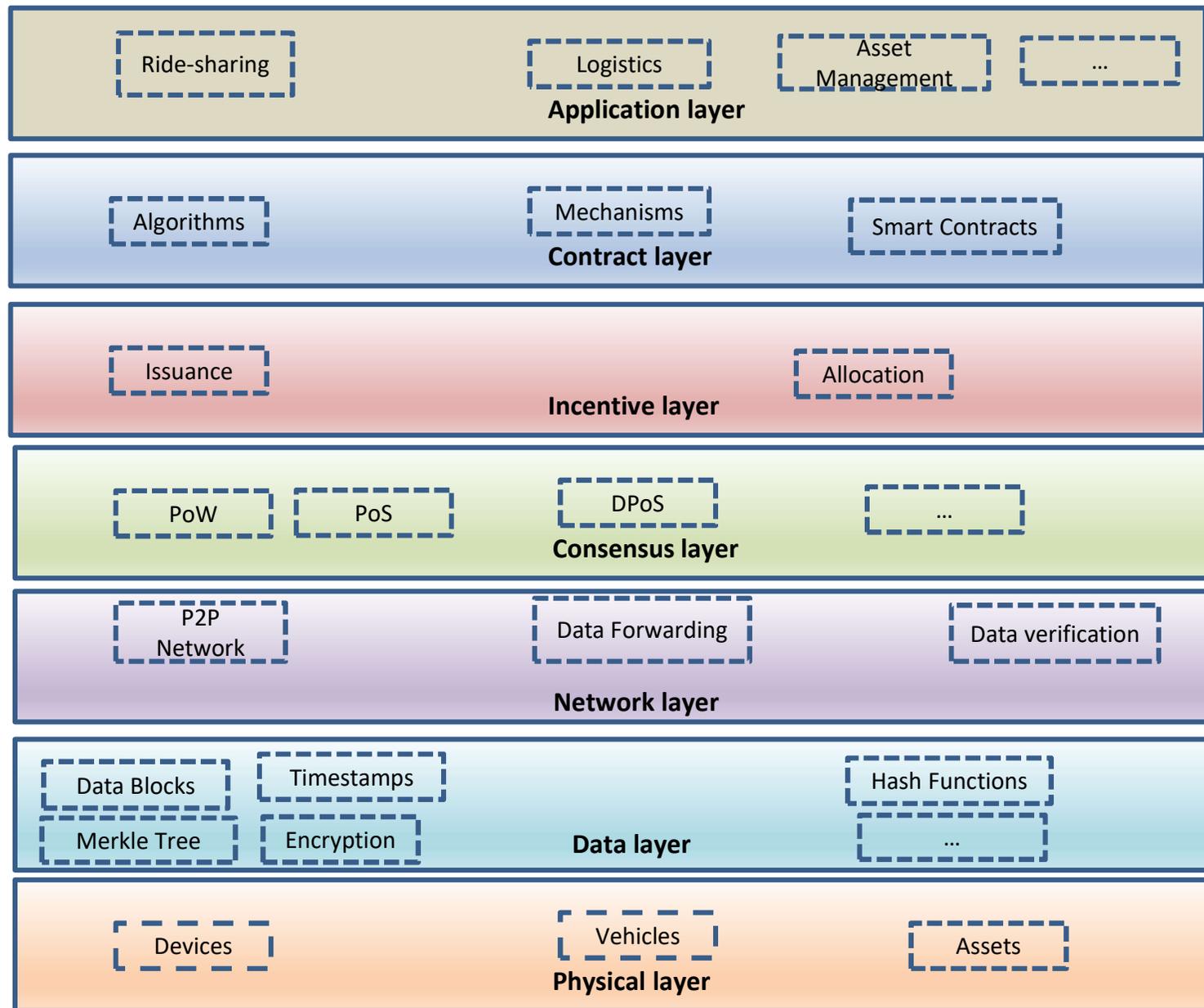


<https://www.adlittle.com/en/Blockchainintransport>

# Blockchain In Transport Alliance (BiTA)

- Blockchain In Transport Alliance (BiTA):
  - Founded in August 2017
  - Headquarter: Chattanooga, TN, USA
  - 500 members in over 25 countries (Note: they generate over a total of \$1 trillion in revenue annually), from from the freight, transportation, logistics and affiliated industries.
  - Mission: to drive the adoption of emerging technology forward
  - actions:
    - developing industry standards
    - educating members and others on **blockchain applications/solutions** and **distributed ledger technology (DLT)**
    - encouraging the use and adoption of new solutions

# An Intelligent Transport System (ITS)-Oriented Blockchain Model (\*)



(\*) Yuan, Yong. (2016). Towards Blockchain-based Intelligent Transportation Systems. 10.1109/ITSC.2016.7795984.

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# Blockchain for transport industry: The opportunities (1/2)

## 1. Transportation Payment And Dispute Resolution

- “Every day, there are **\$140 billion tied up in disputes for payments** (\*) in the transportation industry.”
- For an invoice, a **company must wait about 42 days** before receiving payment typically → the **Blockchain can speed up the payment process** using secure money transfer

## 2. Administrative Costs

- Processing and administration costs have risen around the **20 percent** (\*\*) of transportation’s overall costs, due to over-reliance on paper transactions.
- IBM and Maersk trial: they **tracked a shipping container of flowers** (\*\*\*) from Mombasa, Kenya, to Rotterdam (as the major port in the Netherlands).
- They found that:
  - **over than 30 different organizations and over 200 separate communications managed a simple refrigerated shipment**
  - **losing forms and papers or delaying the necessary approvals could keep locked the container in port indefinitely, even get it lost.**

(\*) <https://www.fleetowner.com/technology/connectivity-cybersecurity/article/21701230/blockchain-in-trucking-what-about-the-middlemen>

(\*\*) <https://www.dcvelocity.com/articles/29429-maersk-ibm-launch-first-blockchain-joint-venture-for-trade-transportation>

(\*\*\*) <https://fortune.com/2018/01/16/ibm-blockchain-maersk-company/>

# Blockchain for transport industry: The opportunities (2/2)

## 3. Transportation Of Temperature Controlled Goods

- **8.5%** (\*) of sensitive pharmaceutical shipments are affected by temperature deviations (e.g. in the Middle East ~ 15-20%).
- It brings to increase of transportation costs, additional administrative inefficiency, and a loss of the product itself.

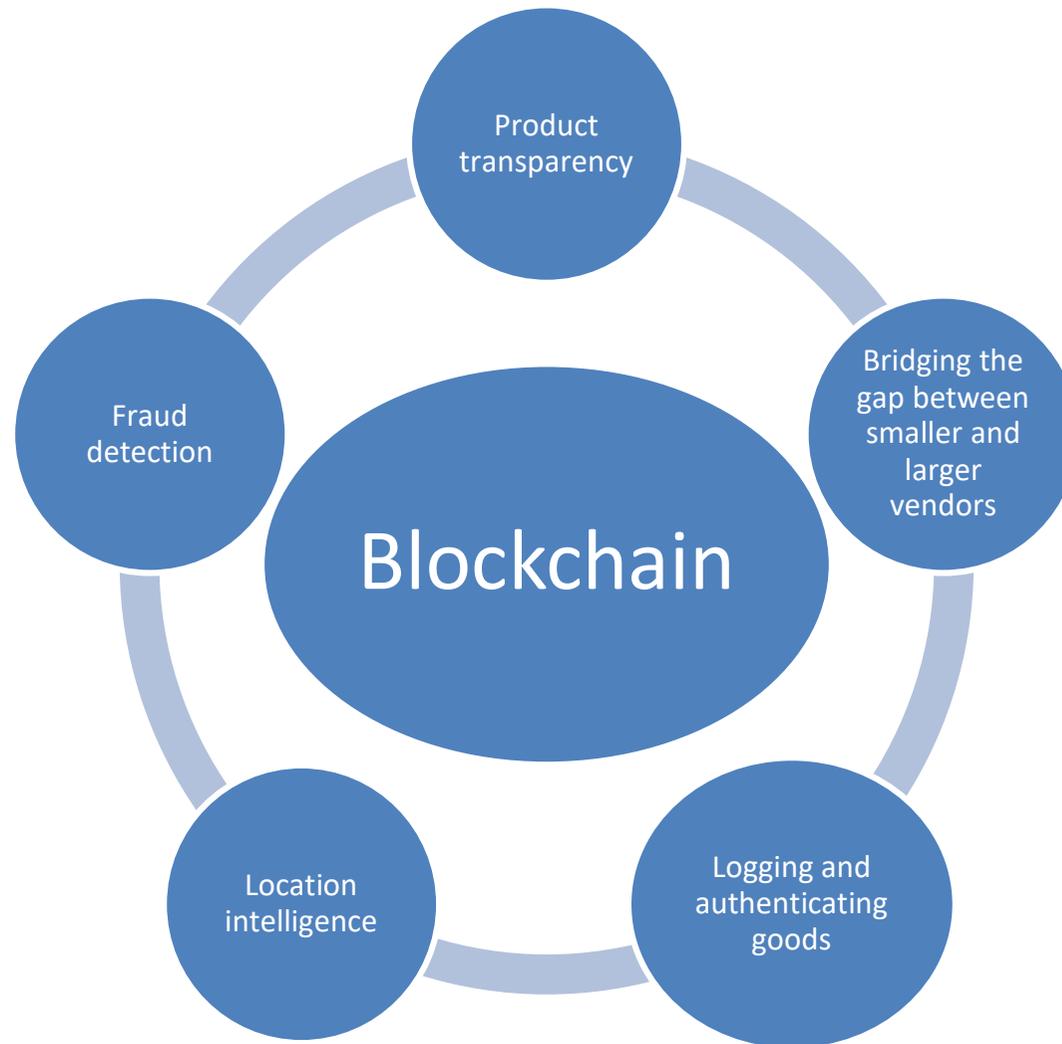
## 4. Less Than Load (LTL) Inefficiency

- 90% of trucking companies worldwide have six trucks or fewer
- a demand-supply mismatch
- truckers are estimated to drive up to **29 billion miles per year** with partial or empty truckloads
- Cost inefficiency in LTL loads
- Shipping costs for consumers.

(\*) <https://www.freightwaves.com/news/blockchain/skycellblockchaincoldchain>

(\*\*) <https://techcrunch.com/2018/03/02/blockchain-will-work-in-trucking-but-only-if-these-three-things-happen/?guccounter=1>

# Blockchain for transport industry: the benefits



# How Blockchain is changing Trucking, Logistics And Freight (1/4)

## 1. Blockchain Means Better Freight Tracking

- As demand for same day and on-demand delivery increases (\*) is becoming an important target to address
- transportation companies need to manage authenticated secure data to effectively improve their operations (font: TMW (\*\*))
- **Blockchain's Impact:** data authentication

## 2. Using The Internet Of Things (IoT) And AI To Increase Efficiency

- Blockchain, together with IoT devices, is particularly useful for **cargo capacity monitoring** and to control the corresponding costs
- The IoT sensors are also useful to monitor temperature, humidity and location (\*\*\*) . For example, in 2017 SkyCell was able to reduce the temperature-deviation rate down to less than 0.1%.
- **Blockchain's Impact:** data integrity and secure/immutable data record

(\*) [www.winnesota.com](http://www.winnesota.com)

(\*\*) <https://transportation.trimble.com/#blockchaindef>

(\*\*\*) <https://www.freightwaves.com/news/blockchain/skycellblockchaincoldchain>

# How Blockchain is changing Trucking, Logistics And Freight (2/4)

## 3. *Effective Tracking Of Fleet Or Vehicle Performance History*

- The tracking features are also applicable to the [performance of individual vehicles within a fleet](#).
- **Blockchain's Impact:** Authenticate information on the past performance of the “second hand” vehicle and its maintenance history without intermediators

## 5. *Using The Internet Of Things For Vehicle To Vehicle Communication (IOT)*

- [Vehicle to Vehicle \(V2V\) Communications](#) is becoming a reality in order to improve the fuel efficiency and safety.
- **Blockchain's Impact:** it is possible to store and validate the data created by V2V Communications

## 4. *Easier Carrier Onboarding*

- Carrier data information
- **Blockchain's Impact:** The blockchain can support the validation of the driver records of a new carrier.

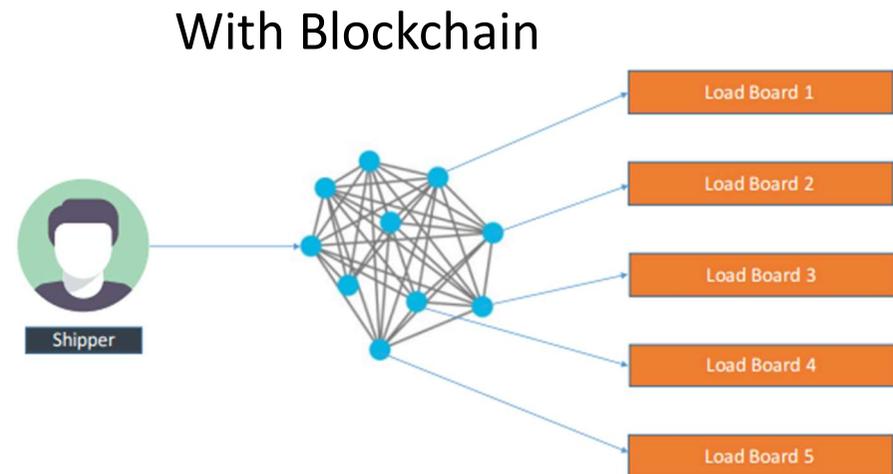
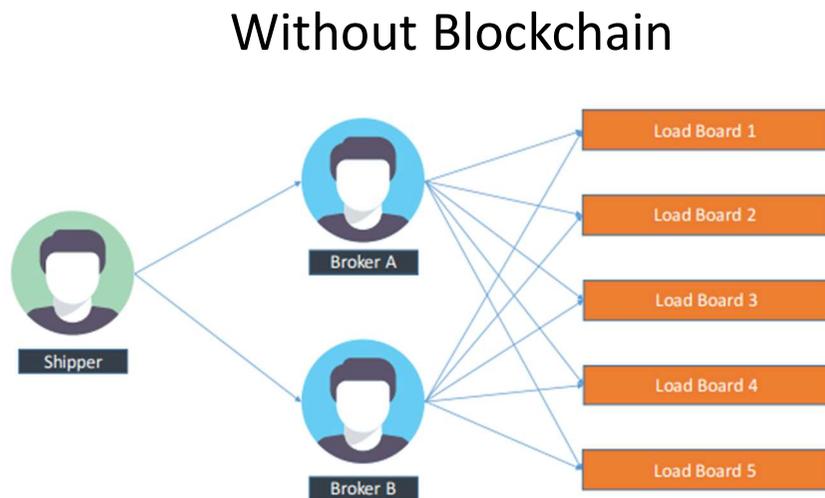
## 6. *Making Load Boards More Reliable*

- Data can often get muddled or duplicated
- **Blockchain's Impact:** Thanks to the blockchain, shippers can manage timestamped loads to be recorded and verified by the decentralized network. In this way, the data cannot be duplicated and can maintain their integrity.

# How Blockchain is changing Trucking, Logistics And Freight (3/4)

## 7. Smart Contracts Cut Costs And Eliminate Middlemen

Smart Contracts are self-executing tasks coded and performed under conditional commands.



# How Blockchain is changing Trucking, Logistics And Freight (4/4)

## ***8. Sweetbridge Uses Blockchain To Increase Liquidity In The Supply Chain***

- A blockchain-based technology can solve important inefficiencies in the global supply chain.
- Problem statement: companies wait an average of **42 days** before receiving payment → there is a 42 days period of reduced liquidity and unnecessary administrative work.
- **Blockchain's Impact:** companies can:
  - **reduce borrowing costs by 75% and increase liquidity by 25%**. (e.g. Sweetbridge solution)
  - make **2% to 4% more profit.**"

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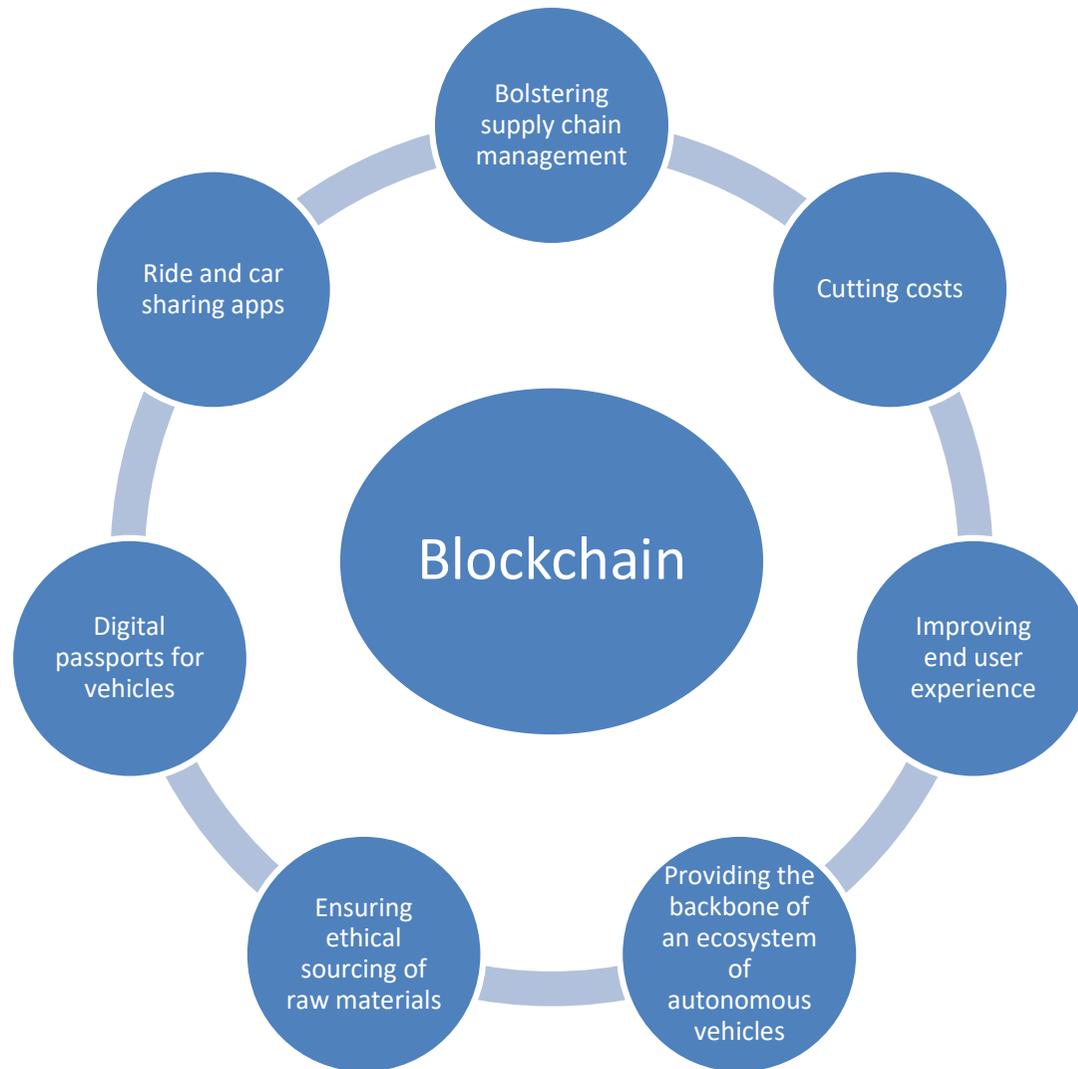
# How can blockchain help the automotive industry?

- Core features of blockchains:
  - Decentralized nature
  - Transparency
  - Immutability
- Very useful for the automakers, in several contexts:
  - security: data storage, no data duplication, data integrity (e.g. to track the complete history of a given vehicle, post-sales support,..)
  - Smart contract: conditional instructions (very useful for the assisted/driverless cars)
  - Safety: secure data management of the vehicles

# Requirements from the automotive sector

- both **maintain** and **secure certain data**, like physical and geographic location of vehicles
- allow **sufficient operation space** for **vehicles** and **control traffic**
- **allowing** and **securing communication** between **vehicles** and **each other** as well as other **network-connected devices**
- providing **collision warning** and **evasion techniques**
- providing **security against attacks** from **malicious entities, faulty SW/HW or malicious updates**
- enable **transport-based financial transactions**, like **public transportation systems**

# Blockchain and the automotive industry: the benefits



# Some blockchain-based initiatives in the automotive sector

- **Mobility Open Blockchain Initiative (MOBI):**
  - a **nonprofit consortium**, including BMW, Ford, GM, Hyundai, Honda, IBM, Ripple, R3, Hyperledger, Accenture and ARXUM.
  - Mission:
    - ✓ use **distributed ledger technologies (DLT)** to bolster the **autonomous vehicle sector**
    - ✓ create industry standards for possible DLT solutions for vehicle identity, usage-based insurance, electric vehicle grid integration, tokenization of carbon credits and more.
- BMW Group joined several blockchain-based pilot projects to perform an efficient and easy tracking of minerals and materials.
- RCS Global, together with IBM, created a blockchain-based platform called the **Responsible Sourcing Blockchain Network (RSBN)**, adopted by Volkswagen Group, Ford Motor Company and LG Chem as founding members.

# Blockchain-based initiatives in the automotive sector

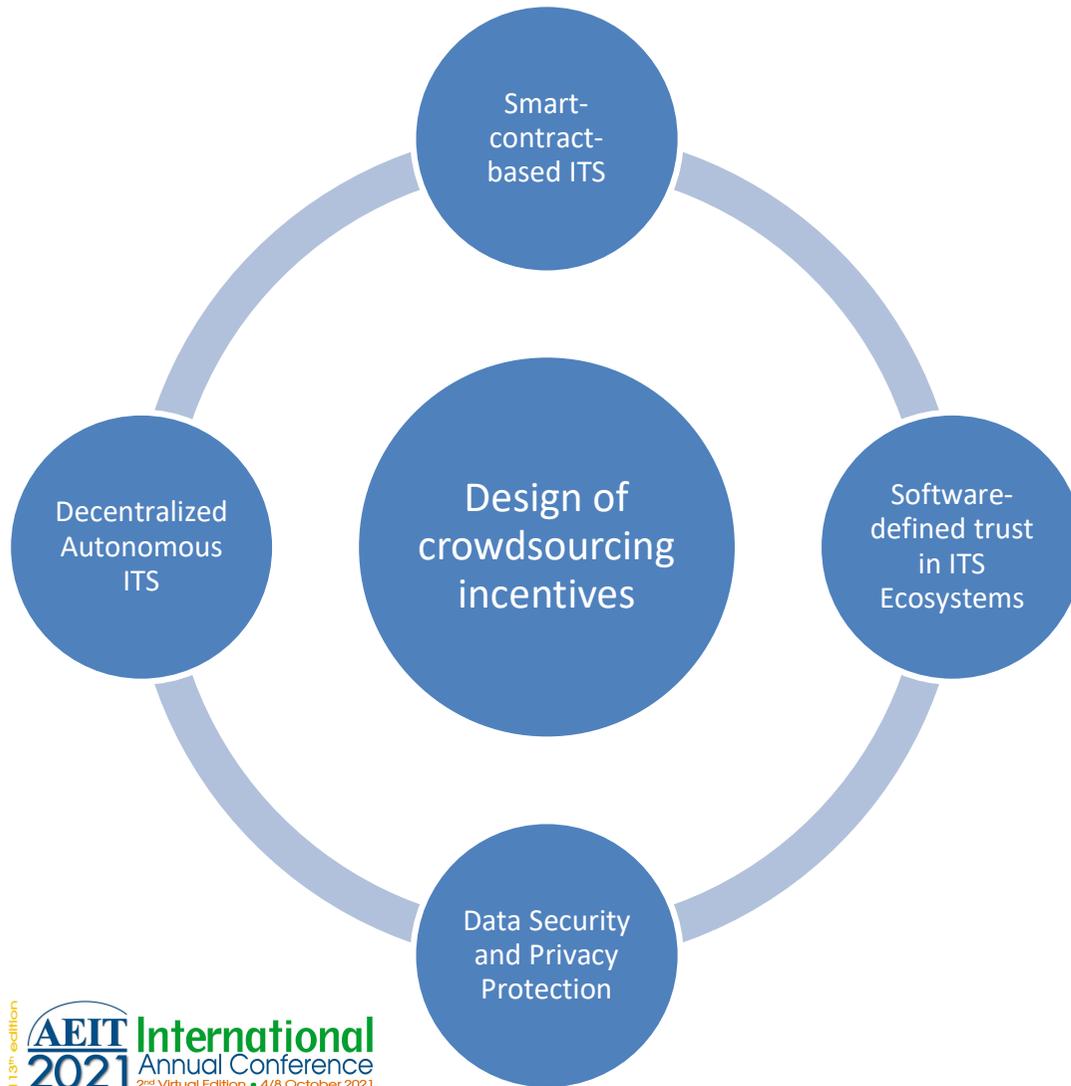
## IEEE Society on blockchain standards

P2140.1 - Standard for General Requirements for Cryptocurrency Exchanges  
P2140.2 - Standard for Security Management for Customer Cryptographic Assets on Cryptocurrency Exchanges  
P2140.3 - Standard for User Identification and AntiMoney Laundering on Cryptocurrency Exchanges  
P2140.4 - Standard for Distributed/Decentralized Exchange Framework using DLT (Distributed Ledger Technology)  
P2140.5 - Standard for Custodian Framework of Cryptocurrency  
P2141.1 - Standard for the Use of Blockchain in AntiCorruption Applications for Centralized Organizations  
P2142.1 - Recommended Practice for E-Invoice Business Using Blockchain Technology  
P2143.1 - Standard for General Process of Cryptocurrency Payment  
P2143.2 - Standard for Cryptocurrency Payment Performance Metrics  
P2143.3 - Standard for Risk Control Requirements for Cryptocurrency Payment  
P2144.1 - Standard for Framework of Blockchainbased Internet of Things (IoT) Data Management

P2144.2 - Standard for Functional Requirements in Blockchain-based Internet of Things (IoT) Data Management  
P2144.3 - Standard for Assessment of Blockchainbased Internet of Things (IoT) Data Management  
P2418.1 - Standard for the Framework of Blockchain Use in Internet of Things (IoT)  
P2418.2 - Standard Data Format for Blockchain Systems  
P2418.3 - Standard for the Framework of Distributed Ledger Technology (DLT) Use in Agriculture  
P2418.4 - Standard for the Framework of Distributed Ledger Technology (DLT) Use in Connected and Autonomous Vehicles (CAVs)  
P2418.5 - Standard for Blockchain in Energy Access the P2418.5 Working Group website  
P2418.6 - Standard for the Framework of Distributed Ledger Technology (DLT) Use in Healthcare and the Life and Social Sciences Access the P2418.6 Working Group website  
P2418.7 - Standard for the Use of Blockchain in Supply Chain Finance  
P2418.8 - Standard for Blockchain Applications in Governments  
P2418.9 - Standard for Cryptocurrency Based Security Tokens  
P2418.10 - Standard for Blockchain-based Digital Asset Management  
P825 - Guide for Interoperability of Transactive Energy Systems with Electric Power Infrastructure (Building the Enabling Network for Distributed Energy Resources)

Active IEEE Standards Projects (Font: <https://blockchain.ieee.org/standards> )

# Blockchain and Intelligent Transport Systems



## Key Research Issues in Blockchain-based ITS

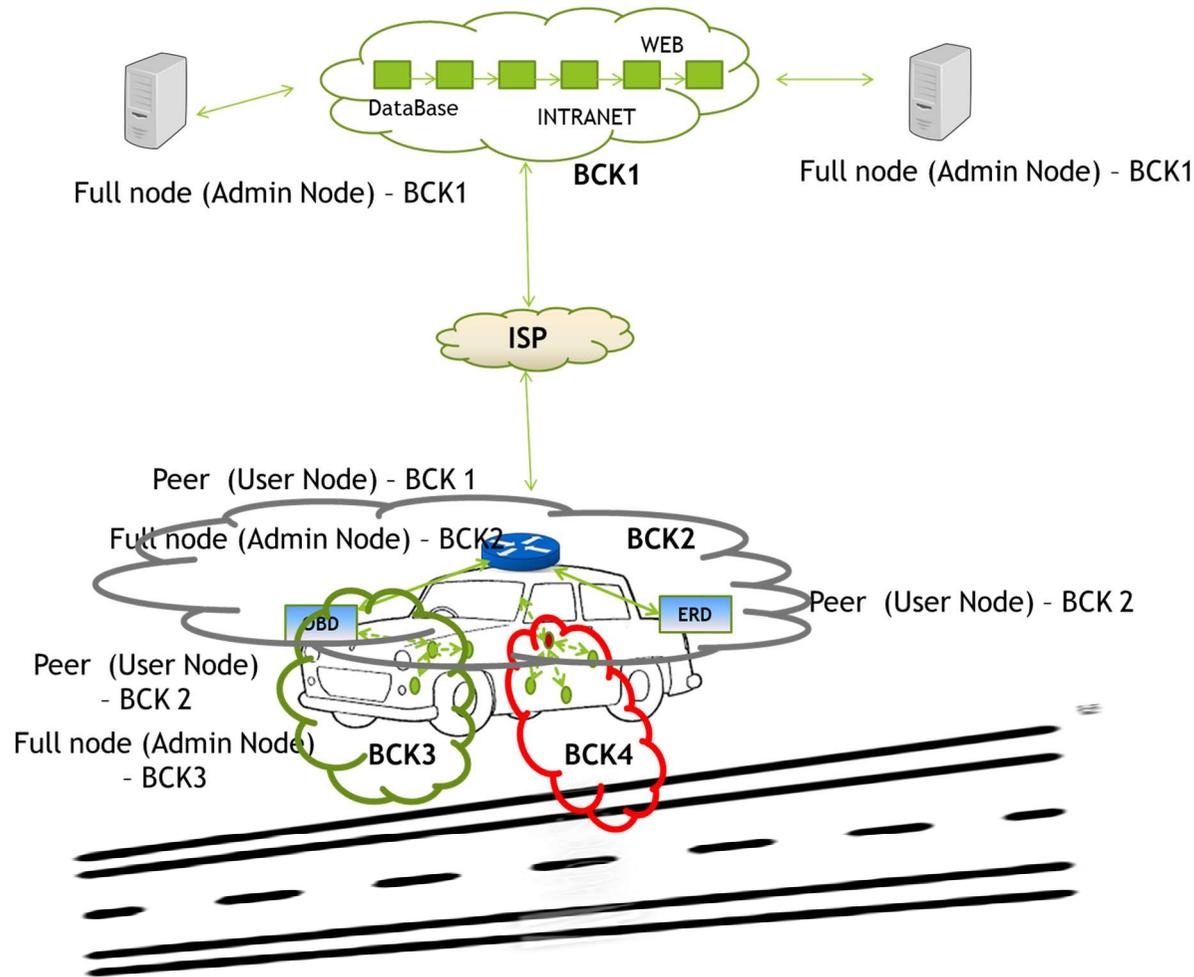
Font: Yuan, Yong. (2016), "Towards Blockchain-based Intelligent Transportation Systems", 10.1109/ITSC.2016.7795984.

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# Blockchain & IoT

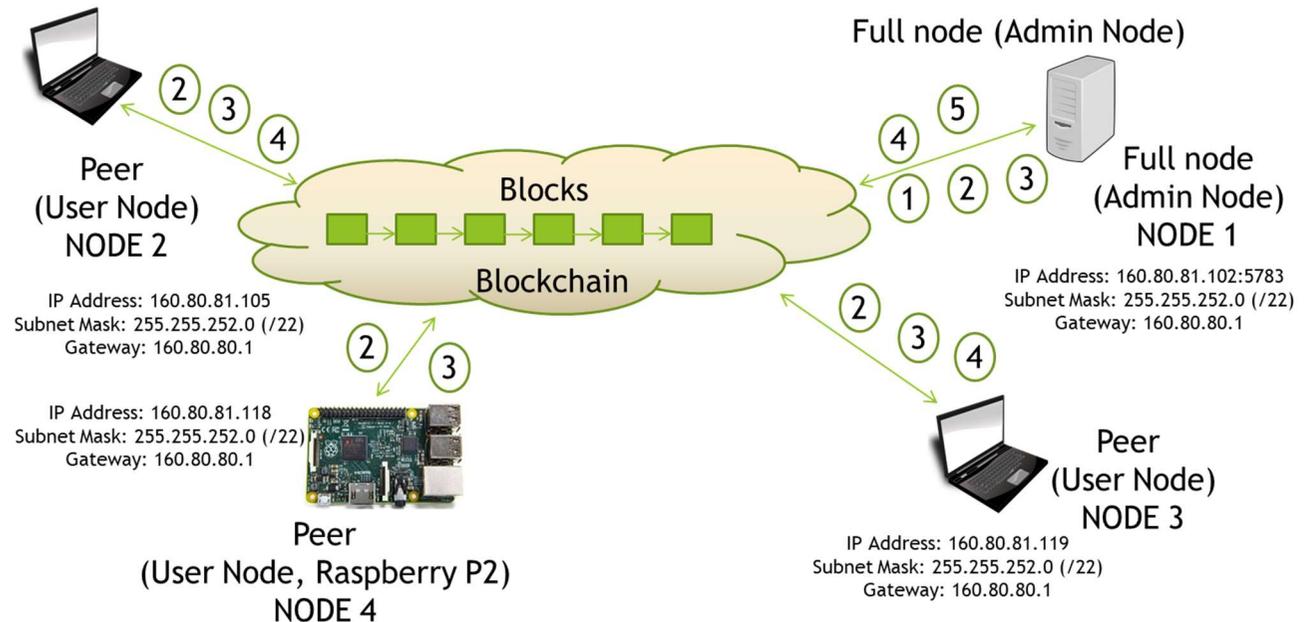
**Blockchain is the overlay network for IoT systems Networks**



# Permissioned Blockchain for IoT Automotive System (IoT-based Non-Monetary Applications)

Service: data extreme exchange

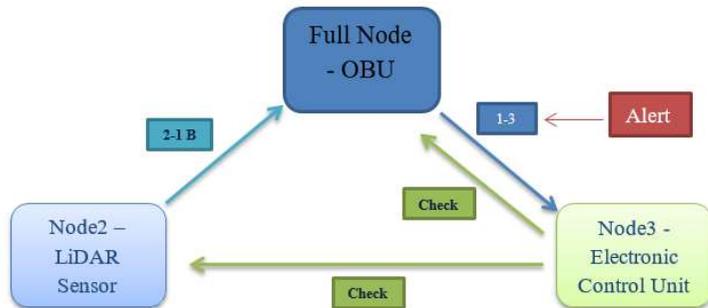
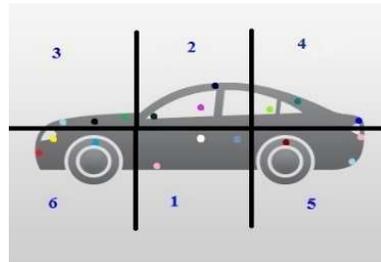
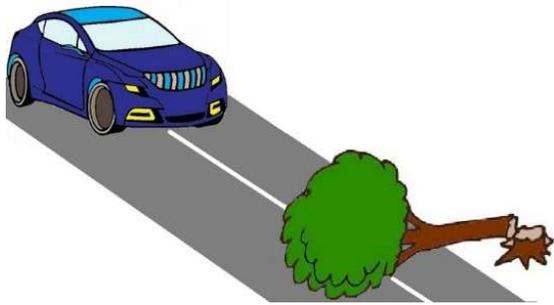
- All nodes send data streams to The Full Node (Node1)
- Functions based on OP\_RETURN (Bitcoin)
- Data streams:
  - dimension: 4 KB
  - Hashed: SHA(256)
  - Content: Log files, Passwords, URLs for data repository



- 1 Permission Assignment
- 2 Read
- 3 Write
- 4 Update
- 5 Delete

# Permissioned Blockchain for IoT Automotive System (IoT-based Non-Monetary Applications)

## Smart Contract in IoT Systems for Automotive Sector



## Smart Contract

```

# Invio Transazione Iniziale, trasferimento di 50 Credits dal Nodo2 al Full Node:
if api.gettotalbalances()[0]['qty'] == 100:
    n = FineMisuraTx21A
    i = MisuradiInizioTx21A
    while i > n:
        i = i - 1
        print(api.sendwithdata(IndirizzoWalletFullNode, {'MetriOstacolo': 1}, {'for': Stream21, 'key': 'CreditsA', 'data': HashData21A.decode('utf-8')}))
        api.publish(Stream21, 'TotTransferA', HexCreditsTrasferiti.decode('utf-8'))
        api.publish(Stream21, 'Messaggio1', HexMessaggio1.decode('utf-8'))
  
```

## Output

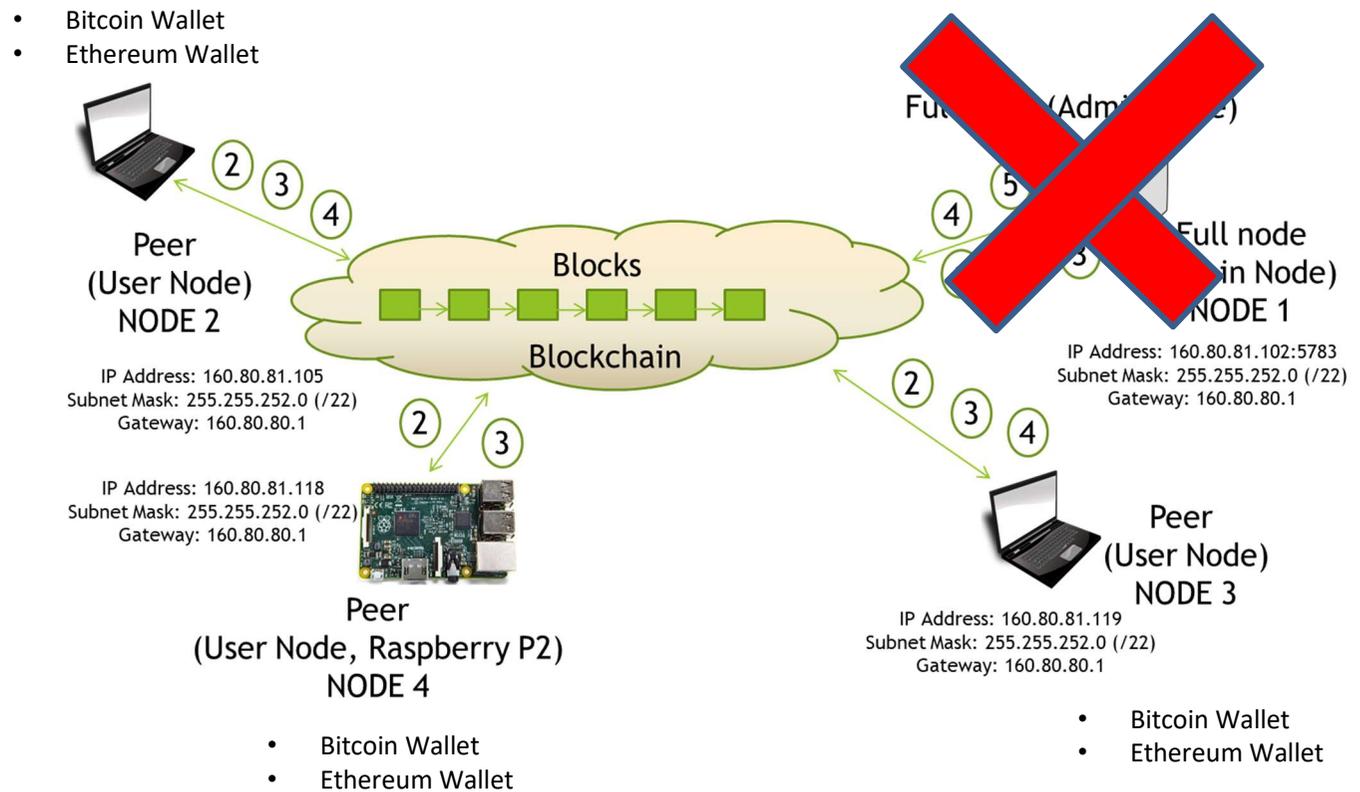
Ti Trovi a 50 Metri dall'Ostacolo

Distanza Superiore a 5 Metri

Distanza Superiore a 10 Metri

# Permissionless Blockchain for IoT Automotive System (IoT-based Non-Monetary Applications)

- Bitcoin
- Ethereum



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# Conclusions (1/2)

- Blockchain: not **only for cryptocurrency** («monetary applications».... But also for «non monetary applications»)
- **Crucial relationship with IoT systems** («overlay networks for IoT», as Lora, 4G NB-IoT, 5G,..)
- Enabler of **identification, data integrity and certification, conditional actions**
- Blockchain in transport sector as:
  - **data tracking** solution (overall supply chain)
  - **Anti-frodes** instrument
  - **controller of IoT** systems

# Conclusions (2/2)

## Key Challenges for Blockchain Technology

- Blockchain:
  - has the potential to deliver large savings.
  - improves operational efficiency and generates value through new business models.
- As with many emerging technologies, important challenges and obstacles
- **Main challenges**
  - Gaining **industry adoption** is the most critical challenge
  - the development of **standards and governance** of blockchain in each industry.
- Progress with blockchain technology itself in order to overcome current technical limitations in case of permissionless blockchain:
  - high latency, scalability and performance issues
- Organization and culture: blockchain adoption will require a collaborative mindset to engage with a large number of stakeholders. Therefore, within organizations, a culture of embracing new opportunities from blockchain technology should be fostered.
  - Managers, particularly those in IT functions, must gain blockchain expertise to proactively push organizational exploration and, if applicable, adoption of blockchain-based solutions.