Smart Enterprise Apps

- Automate projects, business processes, documents, issues
- Automate team collaboration with key resources, vendors, partners, customers
- Encapsulate knowledge / best practices
- Automate risk management
- Drive digital enterprise transformation

Smart City Apps

- Manage smart contracts in the palm of your hand
- Automated smart city curb price and park app
- Supply chain blockchain ledger automation

Manage safe, secure and reliable deployment of next generation transportation technologies
Outline of talk

- What is profoundly different? Is blockchain just another way to store data?
- Why is blockchain a game changer for boosting trust for in-memory databases?
- How to solve the blockchain performance bottleneck with In-memory computing?
- How do edge computing apps benefit from blockchain technology?
- How to achieve speed and reliability in edge computing without full cloud support?
- Which are the major public and private blockchain platforms?
- Smart city use case – autonomous vehicles and smart curbs driving transportation 2.0
- Sample blockchain and edge computing use cases benefiting from in-memory computing
Blockchain explosive growth predictions

Blockchain

From traceable supply chains to permanent identity for refugees, blockchain is pioneering transparent and secure business processes.

- Global Blockchain Technology Market is expected to grow at a CAGR of 42.8% (2018-2023) leading to global revenue of USD 19.9 Billion by 2023.
- Blockchain technology is being increasingly used in the Banking, Finance, Insurance segment to secure payments, maintain customer identities, settle cross-border payments, etc. Also in Healthcare Sector, Supply Chain Management, Energy, Media, and Informatics, etc.
What Blockchain technology provides

Shared, distributed, immutable and highly trustable ledgers

• Prove ownership (example: Bitcoin)

• Build and maintain trust among multiple parties (example: Supply chain)

• Achieve consensus and transact automatically using smart contracts without need for intermediaries (example: Market trading)
Commitments and actions are recorded and set in stone, in an immutable ledger.
So what is new?

Blockchain beyond Bitcoin

Bitcoin was the first use case that helped popularize blockchain, but blockchain benefits extend far beyond bitcoin.

We’re already seeing applications across industries such as:

- Banking
- Chemicals & Petroleum
- Financial Services
- Government
- Healthcare
- Insurance
- Music
- Oil & Gas
- Retail
- Supply Chain Management
- Travel & Transportation

Listed applications have been running successfully for several decades managed via application and database servers.
What is new and profound in Blockchain that cannot be done with traditional database servers?
Blockchain ledger more than just data storage

Traditional database server update

We made a commitment and acted on it. We pushed the button and communicated to server.

- The server was down. Did we really act?
- Is data on server current, unhacked and reliable?
- Can we trust the server administrators?
- Expensive, time consuming to make changes.

Blockchain ledger update

We made a commitment and acted on it. We recorded in a shared, immutable and trustable ledger.

- Actions are visible and clearly recorded.
- Data transparent and trustable.
Blockchain technology provides the ability for N parties to directly record and execute a trusted agreement without an intermediary, institution, escrow agent, broker, supervisor or the cloud.
Without blockchain
Blockchain Requirements

- Immutable Distributed Ledger
- Member Network with Operating Consensus
- Smart Contracts
- Trusted, Visible, Verifiable Transactions

Provides for the five security pillars: Availability, Auditability, Accountability, Integrity and Confidentiality.
Major benefit

• TRUST - Blockchain stores, drives, communicates trust tracking all transactions in immutable shared ledgers
  • CONTRACTS - Changes the world of contracts, the foundation of business and living commitments since humans have existed. Enter contracts without middle-institutions and escrow agencies
  • PROVENANCE – Tracing the origin, proving ownership without dependence on intermediaries and title companies
  • COLLABORATION – Allowing members to store and access data to drive collaborative processes
  • SECURITY – Tracking and flagging abnormal transactions, identifying insider threats
  • AUDIT – Track and verify all transactions to meet regulatory requirements
  • KNOWLEDGE – Capture and share best practices and their capabilities and benefits

© 2018 DSAPPS INC. All rights reserved
The Ridiculous Amount of Energy It Takes to Run Bitcoin
- Peter Fairley, IEEE Spectrum, 28 Sep 2017

Running Bitcoin uses a small city’s worth of electricity.
(Bitcoin mining center at Venezuela shut down due to power drain from 11,000 computers)

“Processing a bitcoin transaction consumes more than 5,000 times as much energy as using a Visa credit card.”
The greatest challenge to participating in a blockchain is performance.

Since blockchains have no central data repository, each party must collect the blocks of transaction information sent out to all subscribers, and these blocks constitute an ever-growing amount of data that must be consumed in real time. For Bitcoin, for example, there is just one ever-increasing blockchain of all transactions since the beginning. Financial services firms not only need to store the incoming blocks, but also translate and validate the information. They need to maintain tables of security identifiers, validation information, cross-references, and so on. They also need real-time transaction processing and analytical capabilities to enhance existing process with blockchain technology.

As a result, any application involving storing and processing of blockchain data will require a high performance, scalable architecture. Interoperability is also a must in order to integrate blockchain into existing financial systems and processes. Key requirements of a blockchain-ready architecture include distributed parallel processing capabilities to speed the calculations needed to build and update blockchains. Some applications, such as Bitcoin mining, also require especially strong analytical capabilities and processing power. A blockchain-friendly architecture should also include streaming support, enterprise-level security features, and a high level of transactional consistency.

In-memory computing is the most cost-effective technology to deliver these capabilities. Because in-memory computing involves keeping data in RAM for extremely fast access, with no disk-related slowdowns, it is faster than any other storage-based computing method. In fact, an in-memory computing cluster platform has been shown to process transactions roughly 1,000 times faster than disk-based solutions. An in-memory computing cluster also delivers high availability, disaster recovery, and concurrency across systems—key requirements for a blockchain application. Further, to support the full range of blockchain use cases, in-memory computing cluster solutions are available that deliver a combination of high-volume ACID transactions, real-time analytics and hybrid transactional/online analytical processing (OLAP).

Nikita Ivanov, Founder & CTO, GridGain
Blockchain and In-memory mutual benefit

Boost computational performance
- Fast data access
- Data caching
- Fast computing
- Fast analytics
- Fast data recovery
- Session support
- ACID support
- Distributed architecture

Assuring data reliability
- A game changer

- Highly trustable shared data
- Multi-node distributed architecture
- Multi-members/devices
- Distributed apps support
- IAM and X509 security certificates
Edge computing apps
A highly trusted app from the last century

I cannot trust the bank, but I can always trust my passbook

All financial transactions require the bank – deposits, withdrawals, bill payments, revenue receipts etc.
Blockchain shared trusted ledger

Bank is optional, just another member of blockchain network

EDGE COMPUTING
synchronize ledgers, credit check, loans

CLOUD COMPUTING
global transactions, large loans, analytics

Directly transact services
Directly pay and receive

Blockchain network

Shop

© 2018 DSAPPS INC. All rights reserved

In-Memory Computing Summit 2014
Why does edge computing benefit significantly from blockchain technology?
The key is blockchain providing a highly trustable local data storage which is shareable, automatically synchronized and security enforced among members.
Use cases for edge smart blockchain

SPEED AT THE EDGE
Smart cities, managing fast changing traffic
Automating smart curbs, dealing with sudden contingencies
Getting ready for autonomous mobility economies

COMMUNICATE WITH POOR CLOUD ACCESS
Smart global supply chains
Re-working smart contracts
Dealing with unexpected and stormy events

MANAGING COMPLEX REMOTE MANUFACTURING
Smart monitoring of manufacturing
Demanding performance and reliability
Ensuring reliability without the cloud

HANDLING MASSIVE MACHINE DATA RELIABLY
Recording infinite numbers of data sensors reliably
Handling scale beyond capacity of central computing
Communicating and managing untrustable machines

Smart traffic routing
Smart pricing and parking
Global supply chains
Smart re-work of contracts
Complex manufacturing
Automate reliability
Manage machine data
Ensure trust and obedience
Comparing Traditional Cloud Services with Edge Smart Blockchain
# Comparing Cloud with Edge Smart Blockchain

## Table of Comparisons

<table>
<thead>
<tr>
<th></th>
<th>Traditional Cloud Server</th>
<th>Edge Smart Blockchain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control and Communication</strong></td>
<td>Centralized control, excellent for global communication</td>
<td>Distributed shared ledger (supporting local copies)</td>
</tr>
<tr>
<td><strong>Reliability</strong></td>
<td>Can be down sometimes</td>
<td>Highly trustable</td>
</tr>
<tr>
<td><strong>Performance</strong></td>
<td>Can be slow sometimes</td>
<td>Edge can be very fast</td>
</tr>
<tr>
<td><strong>Simplicity</strong></td>
<td>Complex to set up, rigid rules</td>
<td>Simple, everyone understands a ledger</td>
</tr>
<tr>
<td><strong>Typical deployment</strong></td>
<td>Data center operation</td>
<td>On the field, on the road, on the ship</td>
</tr>
<tr>
<td><strong>Data Structure</strong></td>
<td>Highly structured</td>
<td>Flexible, could be unstructured</td>
</tr>
<tr>
<td><strong>Adaptive - New commitments New actions</strong></td>
<td>Not designed for fast changes</td>
<td>Perfectly suitable for change Supports smart contracts</td>
</tr>
</tbody>
</table>
Drive performance. Ensure safety, security and trust.

For Apps
- Requiring speed and reliability
- Work without cloud and central computing
- Distributed architecture
- Requiring distributed security
- Requiring edge analytics for speedy decision making

Blockchain technology

Edge Computing

In-memory computing

Trust

Security

Performance

Distributed support
The Challenge: How do we integrate blockchain with edge and cloud?
Map edge computing to cloud

Edge computing
- Create/maintain members
- create/maintain contracts
- receive notifications
- communicate locally

Cloud
- Centralized and legacy databases
- global communication
- advanced Analytics
- data mining
- regulatory reporting

Edge Smart Node or Gateway with Blockchain support
- Share and communicate blockchain ledger
- Maintain session status
- Maintain encryption keys
- Encrypt / decrypt data
- Register and Track parties
- Update commitments
- View commitments
- Generate reports
- Execute smart contracts
- OffCloud / OnCloud management
- Application specific configuration
## Compare Blockchain Platforms

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Ethereum and Ripple</th>
<th>Hyperledger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Founded 2015 or earlier</td>
<td>Founded 2017</td>
</tr>
<tr>
<td>Purpose</td>
<td>For B2C and public facing apps</td>
<td>For B2B businesses</td>
</tr>
<tr>
<td>Currency</td>
<td>Ether / XRP</td>
<td>None</td>
</tr>
<tr>
<td>Mode of participation</td>
<td>Public/private and permissionless network</td>
<td>Private and permissioned network</td>
</tr>
<tr>
<td>Consensus mechanism</td>
<td>Ethereum - Proof of work</td>
<td>Pluggable consensus algorithm</td>
</tr>
<tr>
<td></td>
<td>Ripple - FBA consensus circles</td>
<td></td>
</tr>
<tr>
<td>Programming language</td>
<td>Ethereum - Solidity / Ripple - Codius still under development</td>
<td>Chaincode written in Golang</td>
</tr>
<tr>
<td>Governance</td>
<td>Ethereum Alliance / Ripple labs</td>
<td>Linux foundation</td>
</tr>
<tr>
<td></td>
<td>Ripple banking network circles</td>
<td></td>
</tr>
<tr>
<td>Transaction visibility</td>
<td>Everyone has total transparency in public networks</td>
<td>Controlled</td>
</tr>
<tr>
<td>Performance</td>
<td>Poorer performance and scalability</td>
<td>Can be scaled up adding unlimited nodes</td>
</tr>
<tr>
<td>Ease of use</td>
<td>Simpler, quicker to build smart contracts</td>
<td>Complex and powerful platform</td>
</tr>
<tr>
<td>IAM Security</td>
<td>Vendor support, not from platform</td>
<td>Very extensive identity and access controls</td>
</tr>
</tbody>
</table>
Ethereum is fully decentralized with each node running the Ethereum Virtual Machine. Centralization of computing though is forced with users having to pay a transaction fee where they are charged for every smart contract execution.

Ripple focuses on cross-border payments and has been adopted by banks to set up member circles.

Hyperledger platform is decentralized with nodes independently executing a copy of the hyperledger fabric. Networks have a choice of connecting to the cloud of a major vendor such as IBM, Oracle, SAP, AWS etc to ensure network control, governance and integrate with legacy applications.
Microsoft Azure blockchain workbench with Ethereum
IBM Blockchain Platform

Solutions
Food Safety, Universal Blockchain Payments Network, Identity, Private Equity etc...

IBM Extensions
Watson IOT, API Management, Messaging, Workflow etc...

Figure 1. IBM BLOCKCHAIN PLATFORM
Hyperledger Architecture

IDENTITY
Pluggable, Membership, Privacy and Auditability of transactions.

LEDGER | TRANSACTIONS
Distributed transactional ledger whose state is updated by consensus of stakeholders

SMART-CONTRACT
“Programmable Ledger”, provide ability to run business logic against the blockchain (aka smart contract)

APIs, Events, SDKs
Multi-language native SDKs allow developers to write DLT apps
Hyperledger Fabric

- **N**: Blockchain network
- **P**: Peer node
- **S**: Smart contract (aka chaincode)
- **L**: Ledger
Edge computing is dependent on a strong identity management system for edge devices often through X509 certificates.
Peer Identities via X509 certificate

Register identity, Issue enrollment certificates
Renew and revoke certificates
Smart city use case

For smart curbs leveraging blockchain technology powered by in-memory computing architecture
What is Vision Zero?

Reduce traffic deaths to zero by 2025
Autonomous vehicle technology will reshape the transportation infrastructure of Los Angeles

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Number</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>94%</td>
<td>7.5M</td>
<td>1#</td>
</tr>
</tbody>
</table>

- Percent of crashes caused by human error
- Number of motor vehicles in Los Angeles
- Los Angeles's rank among cities with the worst traffic congestion

Source: NHTSA, California DMV, Inrix
What if we never widen another roadway?
What if we never build another parking spot?
The Promises and Perils of Automation

Automated vehicle technology holds many promises for cities, but the potential benefits of automation are not guaranteed. City policies must proactively guide the technology to prioritize people-centric design.

Zero Emissions Vehicles

Access for All Ages and Abilities

Affordable, Reliable and Frequent Mobility

Slower Speeds, Safer Streets
Determine a safe and equitable way to price curb access for uses like farmers markets, freight delivery, vehicle storage, etc.

**Smart curb management – to solve traffic congestion and optimize city resources**

**TOS PRODUCT – SHORT TERM**

**MANAGE THE CURB**

- Use dynamic routing to modify trip end-points for ride-hailing companies
- Manage destinations for bike / scooter sharing
- Restrict curb access for special events, accidents, etc.
#1: The Detection Problem

**What it is:** The perceptual and computational abilities of automated systems to detect, predict, and respond to pedestrians and cyclists in various conditions.

**Why it matters:** Pedestrian injury and fatal crashes often occur at intersections and involve cyclists as well. Predicting pedestrian and cyclist movements accurately can significantly reduce the risk of accidents and injuries.

*Figure 2.* A key challenge area for automated technologies lies in their ability to detect and predict the movement of pedestrians and cyclists in a range of conditions.
#4: The Right-Of-Way Problem

Pedestrians or human drivers, or other unintended consequences will arise as more of these AV-pedestrian interactions take place. For example, if pedestrians or drivers are not aware of the AV's right-of-way expectancy, accidents may occur. It is crucial for both the AV and the human to understand and respect each other's right-of-way intentions.
#7: The Pickup/Dropoff Problem

What it is: Vehicles attempting to enter or exit parking spaces often must maneuver around bicyclists and pedestrians (many of whom are also getting into or out of nearby vehicles). Sight lines may be limited by parking lot columns, other vehicles, or vehicle mirror design. Many drivers, particularly seniors, face mobility challenges that restrict head turning movements and the ability to fully scan their environments when entering/exiting parking spaces. Hence, in some localities more than a quarter of pedestrian crashes occur in parking lots and/or involve backing vehicles (Sandt

Figure 8. Navigating in/out of parking spaces or dropoff zones presents specific challenges for ADS interaction with pedestrians and bicyclists.
The design challenge

You cannot depend on cloud, even 5G for high speed life-critical automation

You have to have local data caching, if so

• How can we trust the data cache against data corruption, hacking etc?
• How can we share and synch the data cache among participating members of a network (such as cars, cabs, trucks, bikers, etc) who need to make life-critical decisions. Example – when to yield, when to pass, where to park and pick-up/drop-off?
• How do we keep in synch with the city-wide cloud on global traffic routing, pricing, policies etc.
• How do we ensure security of node (curb) sensors and enforce identity and access management for the network devices
DSAPPS smart curb management technology for smart cities of the future looking to reduce city traffic congestion with the introduction of connected and autonomous vehicles. (Patent Pending)

Features include:
- Connected apps for vehicles and passengers, guiding them smartly to curbs for picking up, dropping off and for short term waiting and longer term parking.
- Curb level sensors tracking safe and correct vehicle parking. Ensuring safety of passenger pick-ups and drop-offs.
- Image privacy filtering technology. Ensures images used for vehicle navigation safety are privacy filtered and not transmitted or saved to cloud.
- Leverages blockchain technology for trusted data handling.
- Curb pricing management – automatically built into the app.
- Supports connected and autonomous vehicles. Ideal for autonomous city shuttles ensuring passenger safety.
Drive performance, ensure safety, security and trust

Blockchain technology

Curb management architecture

In-memory computing

Trust

Security

Performance

Distributed support

DSAPPS distributed smart apps

© 2018 DSAPPS INC. All rights reserved
# Smart Curb API

<table>
<thead>
<tr>
<th>Step</th>
<th>Rest API</th>
<th>Edge Blockchain</th>
<th>Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add curbs in a street to a blockchain network connecting them with local area networks including bluetooth</td>
<td>POST</td>
<td>• Add curb to blockchain</td>
<td>• Synch cloud data to blockchain</td>
</tr>
<tr>
<td>Register vehicle requesting a curb for parking or pickup</td>
<td>POST</td>
<td>• Register vehicle request accessible only by permissioned member network.</td>
<td>• Stores vehicle data for later analytics and communication. <strong>•</strong> Does not store privacy related data such as personal images.</td>
</tr>
</tbody>
</table>
| Vehicle requests a curb, provide free curb | GET | • Curb request details added to blockchain  
• Abnormal alternate curb allocation situations handled via blockchain  
• Perform optional vehicle verification and safety check, generate alarms if safety problems detected | • Curb request data synched with cloud and blockchain  
• Alarm notifications sent to admins if abnormal requests detected based on limits set. |
| Process to provide alternate curb based on situation on ground, such as an alternate vehicle blocking curb | PUT | • Members reach consensus  
• Alarm limits updated in blockchain | • Alarm limits updated in database |
| Update security alarm notifiers | PUT | • Alarm limits updated in database | |
| Update member profile | PUT | | • Profile updated in cloud database |
| Get access analytics | GET | | • Generated from cloud database |
# Sample Blockchain apps

<table>
<thead>
<tr>
<th>App</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryptocurrency</td>
<td>Provenance, establish ownership, track titles, certifications traceability</td>
</tr>
<tr>
<td></td>
<td>Manage supply chains, automate contract management, integrate with ERP and procurement apps</td>
</tr>
<tr>
<td></td>
<td>Audit (example export compliance, SEC regulatory, Foreign investments)</td>
</tr>
<tr>
<td></td>
<td>IOT applications as sensors for data capture and asset traceability for smart cities, smart buildings etc.</td>
</tr>
<tr>
<td></td>
<td>Manufacturing applications such as maintenance management, flow control sensors.</td>
</tr>
<tr>
<td></td>
<td>Micro applications (system reliability engineering for aircraft and autonomous vehicles)</td>
</tr>
</tbody>
</table>
Sample Blockchain apps

<table>
<thead>
<tr>
<th>App</th>
<th>Type of blockchain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryptocurrency</td>
<td>Public (exchange trading, investment) and Private (cross-border payments, guaranties)</td>
</tr>
<tr>
<td>Provenance, establish ownership, track titles,</td>
<td>Public (public property transactions) and private (maintain key contractual multi-party ownership interests)</td>
</tr>
<tr>
<td>certifications traceability</td>
<td></td>
</tr>
<tr>
<td>Manage supply chains, automate contract management,</td>
<td>Public blockchain (credit history, optional performance history) and private (contractual details)</td>
</tr>
<tr>
<td>integrate with ERP and procurement apps</td>
<td></td>
</tr>
<tr>
<td>Audit (example export compliance, SEC regulatory,</td>
<td>Public blockchain (gov't and regulatory related) and private blockchain (private information)</td>
</tr>
<tr>
<td>Foreign investments)</td>
<td></td>
</tr>
<tr>
<td>IOT applications as sensors for data capture and asset</td>
<td>Public blockchain (public IOT such as smart city) and private blockchain (private IOT)</td>
</tr>
<tr>
<td>traceability for smart cities, smart buildings etc.</td>
<td></td>
</tr>
<tr>
<td>Manufacturing applications such as maintenance management,</td>
<td>Public blockchain (such as regulatory reporting) and private blockchain (shop floor etc. related)</td>
</tr>
<tr>
<td>flow control sensors.</td>
<td></td>
</tr>
<tr>
<td>Micro applications (system reliability engineering for</td>
<td>Public blockchain (where public interfaces) and private blockchain (inside systems and sub-systems)</td>
</tr>
<tr>
<td>aircraft and autonomous vehicles)</td>
<td></td>
</tr>
</tbody>
</table>
### Sample Blockchain apps

<table>
<thead>
<tr>
<th>App</th>
<th>Type of blockchain</th>
<th>Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryptocurrency</td>
<td>Public (exchange trading, investment) and Private (cross-border payments, guaranties)</td>
<td>Traders, buyers, sellers</td>
</tr>
<tr>
<td>Provenance, establish ownership, track titles, certifications traceability</td>
<td>Public (public property transactions) and private (maintain key contractual multi-party ownership interests)</td>
<td>Owners, buyers, sellers, institutions</td>
</tr>
<tr>
<td>Manage supply chains, automate contract management, integrate with ERP and procurement apps</td>
<td>Public blockchain (credit history, optional performance history) and private (contractual details)</td>
<td>Suppliers, purchasers, contracting parties</td>
</tr>
<tr>
<td>Audit (example export compliance, SEC regulatory, Foreign investments)</td>
<td>Public blockchain (gov’t and regulatory related) and private blockchain (private information)</td>
<td>Companies, institutions, investors, exporters, importers</td>
</tr>
<tr>
<td>IOT applications as sensors for data capture and asset traceability for smart cities, smart buildings etc.</td>
<td>Public blockchain (public IOT such as smart city) and private blockchain (private IOT)</td>
<td>Parties and objects of interest (example curbs, street lights, vehicles, passengers etc.)</td>
</tr>
<tr>
<td>Manufacturing applications such as maintenance management, flow control sensors.</td>
<td>Public blockchain (such as regulatory reporting) and private blockchain (shop floor etc. related)</td>
<td>Manufacturing organizations, plants, systems, sub-systems,</td>
</tr>
<tr>
<td>Micro applications (system reliability engineering for aircraft and autonomous vehicles)</td>
<td>Public blockchain (where public interfaces) and private blockchain (inside systems and sub-systems)</td>
<td>Engineering systems, sub-systems, components, users, suppliers, technicians etc</td>
</tr>
</tbody>
</table>
## Sample Blockchain apps

<table>
<thead>
<tr>
<th>App</th>
<th>Type of blockchain</th>
<th>Members</th>
<th>Major benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryptocurrency</td>
<td>Public (exchange trading, investment) and Private (cross-border payments, guaranties)</td>
<td>Traders, buyers, sellers</td>
<td>Proof of ownership, transactional history, establishing trends</td>
</tr>
<tr>
<td>Provenance, establish ownership, track titles, certifications traceability</td>
<td>Public (public property transactions) and private (maintain key contractual multi-party ownership interests)</td>
<td>Owners, buyers, sellers, institutions</td>
<td>Proof of ownership, establishing trust</td>
</tr>
<tr>
<td>Manage supply chains, automate contract management, integrate with ERP and procurement apps</td>
<td>Public blockchain (credit history, optional performance history) and private (contractual details)</td>
<td>Suppliers, purchasers, contracting parties</td>
<td>Establishing trust, automating contracts</td>
</tr>
<tr>
<td>Audit (example export compliance, SEC regulatory, Foreign investments)</td>
<td>Public blockchain (gov’t and regulatory related) and private blockchain (private information)</td>
<td>Companies, institutions, investors, exporters, importers</td>
<td>Proof of performance, transactional trail, proof of adherence to regulatory requirements</td>
</tr>
<tr>
<td>IOT applications as sensors for data capture and asset traceability for smart cities, smart buildings etc.</td>
<td>Public blockchain (public IOT such as smart city) and private blockchain (private IOT)</td>
<td>Parties and objects of interest (example curbs, street lights, vehicles, passengers etc.)</td>
<td>Proof of performance, transactional records, boosting trust, automating smart contracts etc.)</td>
</tr>
<tr>
<td>Manufacturing applications such as maintenance management, flow control sensors.</td>
<td>Public blockchain (such as regulatory reporting) and private blockchain (shop floor etc. related)</td>
<td>Manufacturing organizations, plants, systems, sub-systems,</td>
<td>Proof of performance, transactional records, boosting trust, automating smart contracts etc.)</td>
</tr>
<tr>
<td>Micro applications (system reliability engineering for aircraft and autonomous vehicles)</td>
<td>Public blockchain (where public interfaces) and private blockchain (inside systems and sub-systems)</td>
<td>Engineering systems, sub-systems, components, users, suppliers, technicians etc)</td>
<td>Proof of performance, transactional records, boosting trust, automating smart contracts etc.)</td>
</tr>
</tbody>
</table>
### Sample Blockchain apps

<table>
<thead>
<tr>
<th>App</th>
<th>Type of blockchain</th>
<th>Members</th>
<th>Major benefit</th>
<th>In-memory computing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryptocurrency</td>
<td>Public (exchange trading, investment) and Private (cross-border payments, guaranties)</td>
<td>Traders, buyers, sellers</td>
<td>Proof of ownership, transactional history, establishing trends</td>
<td>Boost performance</td>
</tr>
<tr>
<td>Provenance, establish ownership, track titles, certifications traceability</td>
<td>Public (public property transactions) and private (maintain key contractual multi-party ownership interests)</td>
<td>Owners, buyers, sellers, institutions</td>
<td>Proof of ownership, establishing trust</td>
<td>Support distributed data security</td>
</tr>
<tr>
<td>Manage supply chains, automate contract management, integrate with ERP and procurement apps</td>
<td>Public blockchain (credit history, optional performance history) and private (contractual details)</td>
<td>Suppliers, purchasers, contracting parties</td>
<td>Establishing trust, automating contracts</td>
<td>Mobility support, boost performance for smart contracts, support edge analytics</td>
</tr>
<tr>
<td>Audit (example export compliance, SEC regulatory related and private blockchain (private information))</td>
<td>Public blockchain (gov’t and regulatory related) and private blockchain (private information)</td>
<td>Companies, institutions, investors, exporters, importers</td>
<td>Proof of performance, transactional trail, proof of adherence to regulatory requirements</td>
<td>Support distributed edge applications</td>
</tr>
<tr>
<td>IOT applications as sensors for data capture and asset traceability for smart cities, smart buildings etc.</td>
<td>Public blockchain (public IOT such as smart city) and private blockchain (private IOT)</td>
<td>Parties and objects of interest (example curbs, street lights, vehicles, passengers etc.)</td>
<td>Proof of performance, transactional records, boosting trust, automating smart contracts etc.)</td>
<td>Protect privacy, support edge computing and analytics</td>
</tr>
<tr>
<td>Manufacturing applications such as maintenance management, flow control sensors.</td>
<td>Public blockchain (such as regulatory reporting) and private blockchain (shop floor etc. related)</td>
<td>Manufacturing organizations, plants, systems, sub-systems,</td>
<td>Proof of performance, transactional records, boosting trust, automating smart contracts etc.)</td>
<td>Boost reliability through parallel architectures, support edge computing and analytics</td>
</tr>
<tr>
<td>Micro applications (system reliability engineering for aircraft and autonomous vehicles)</td>
<td>Public blockchain (where public interfaces) and private blockchain (inside systems and sub-systems)</td>
<td>Engineering systems, sub-systems, components, users, suppliers, technicians etc)</td>
<td>Proof of performance, transactional records, boosting trust, automating smart contracts etc.)</td>
<td>Support micro-components supporting edge computing</td>
</tr>
</tbody>
</table>
Introducing FAR-EDGE

Flexible Decentralized Factory Automation

FAR-EDGE

- Joint effort of global leaders in manufacturing and IoT towards adoption of virtualized Factory Automation

Focuses on

- Cloud and Edge Computing for Manufacturing
- Decentralization of control
- RAMI 4.0 & Industrial Internet standards

Expected Outcomes

- Reduced Time to deploy new automation concepts and technologies
- Better Exploitation of Data
- Increase automation in factories
- Improve process agility
- Enable factory collaboration
- RAMI Compliant Implementation
Factory automation, edge computing

Conventional Centralized Control

Business Drivers:
- Manufacturing Flexibility
- New Production Models (e.g., MTO)
- Increased Automation

IoT/CPS based Decentralized Control

Technological Enablers:
- IoT/CPS
- Edge/Fog Computing
- Distributed Analytics and Simulation Services
Blockchain layer in edge computing for factory automation

Role of Distributed Ledger in FAR-EDGE (Blockchain)
Drive performance, ensure safety, security and trust

Blockchain technology

Trust

Security

Edge Computing

For Apps
• Requiring speed and reliability
• Work without cloud and central computing
• Distributed architecture
• Requiring distributed security
• Requiring edge analytics for speedy decision making

In-memory computing
Sesh Raj, DSAPPS INC

email: info1@dsapps.com

text: 408-940-5003

@dsapps

www.dsapps.com