In-Memory Computing SUMMIT NORTH AMERICA 2018

In-Memory Computing Driving Edge Computing and Blockchain Technologies

Sesh Raj

DSAPPS INC

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Smart Enterprise Apps

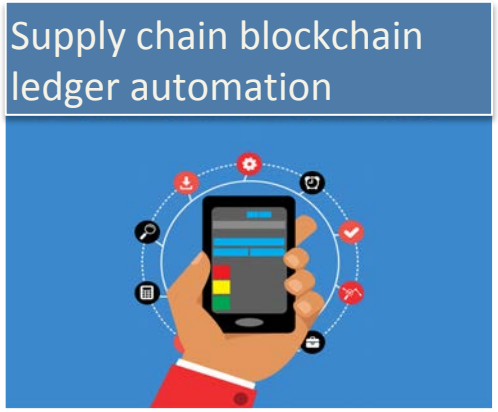
- Automate projects, business processes, documents, issues
- Automate team collaboration with key resources, vendors, partners, customers
- Encapsulate knowledge / best practices
- Automate risk management
- Drive digital enterprise transformation

Manage smart contracts in the palm of your hand

Smart City Apps

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

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- 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

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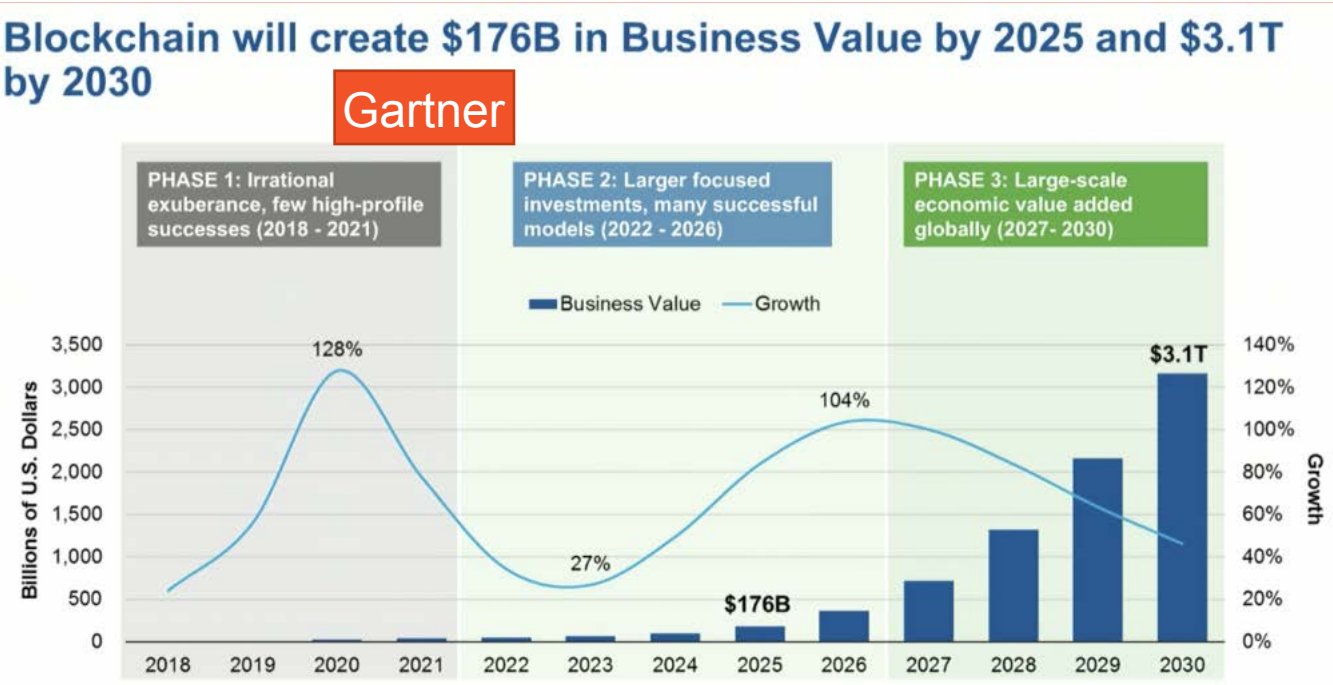
- Global Blockchain Technology Market is expected to grow at a CAGR of 42.8% (2018-2023) leading to global revenue of USD 19.9 Billion by 2023.
- Blockchain technology is being increasingly used in the Banking, Finance, Insurance segment to secure payments, maintain customer identities, settle cross-border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

MARKET REPORTS CENTER

Blockchain Market Size is anticipated to reach USD 60.7 billion by 2024



What Blockchain technology provides

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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)

Blockchain Basics

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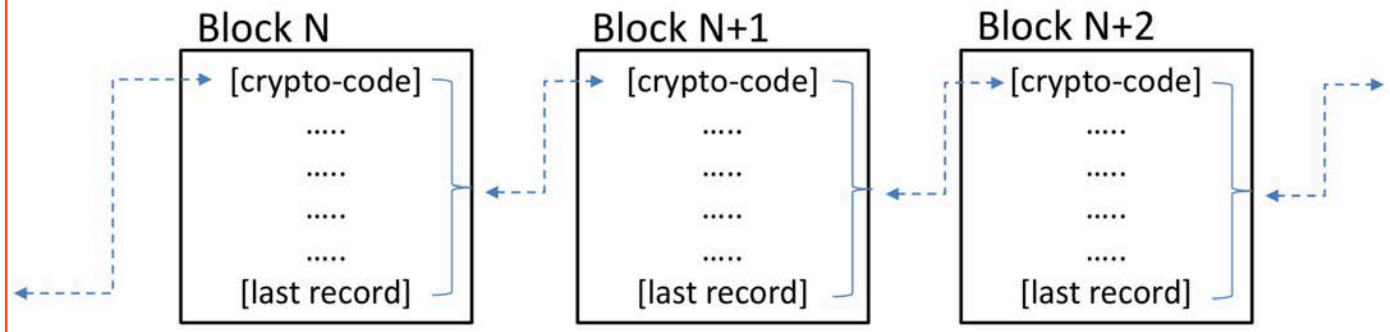
- This new block is chained to the prior block via a cryptographic link



So what is new?

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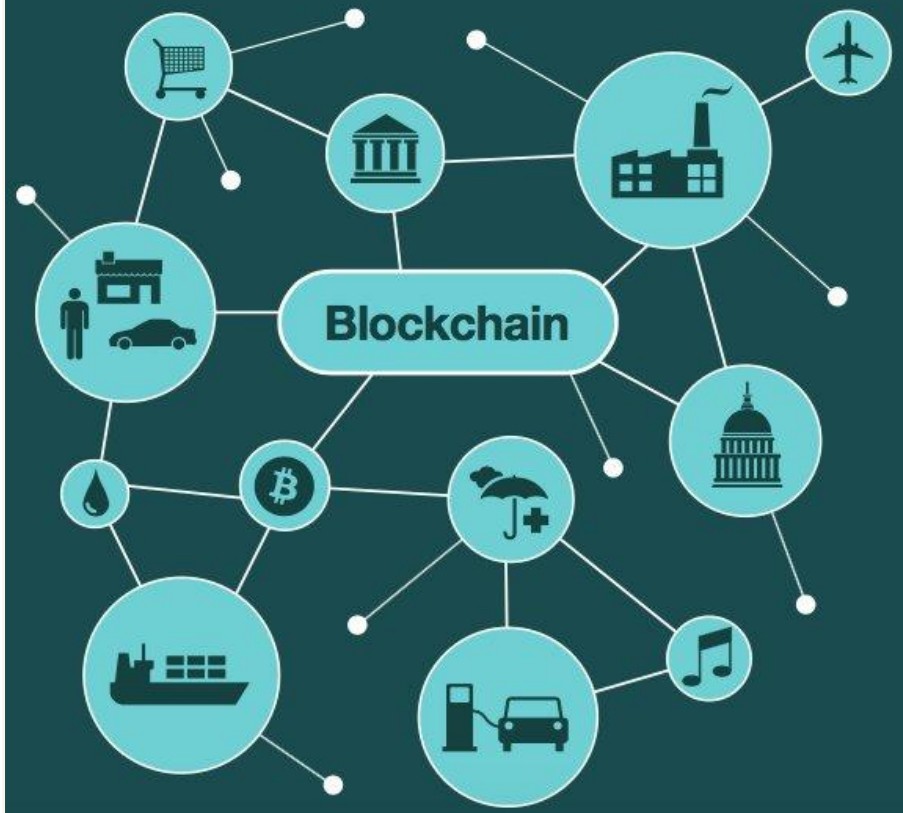
Blockchain beyond Bitcoin

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

Question?

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What is **new and profound** in Blockchain that cannot be done with traditional database servers?

Blockchain ledger more than just data storage

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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

Eliminating the middle person

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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

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Blockchain Requirements

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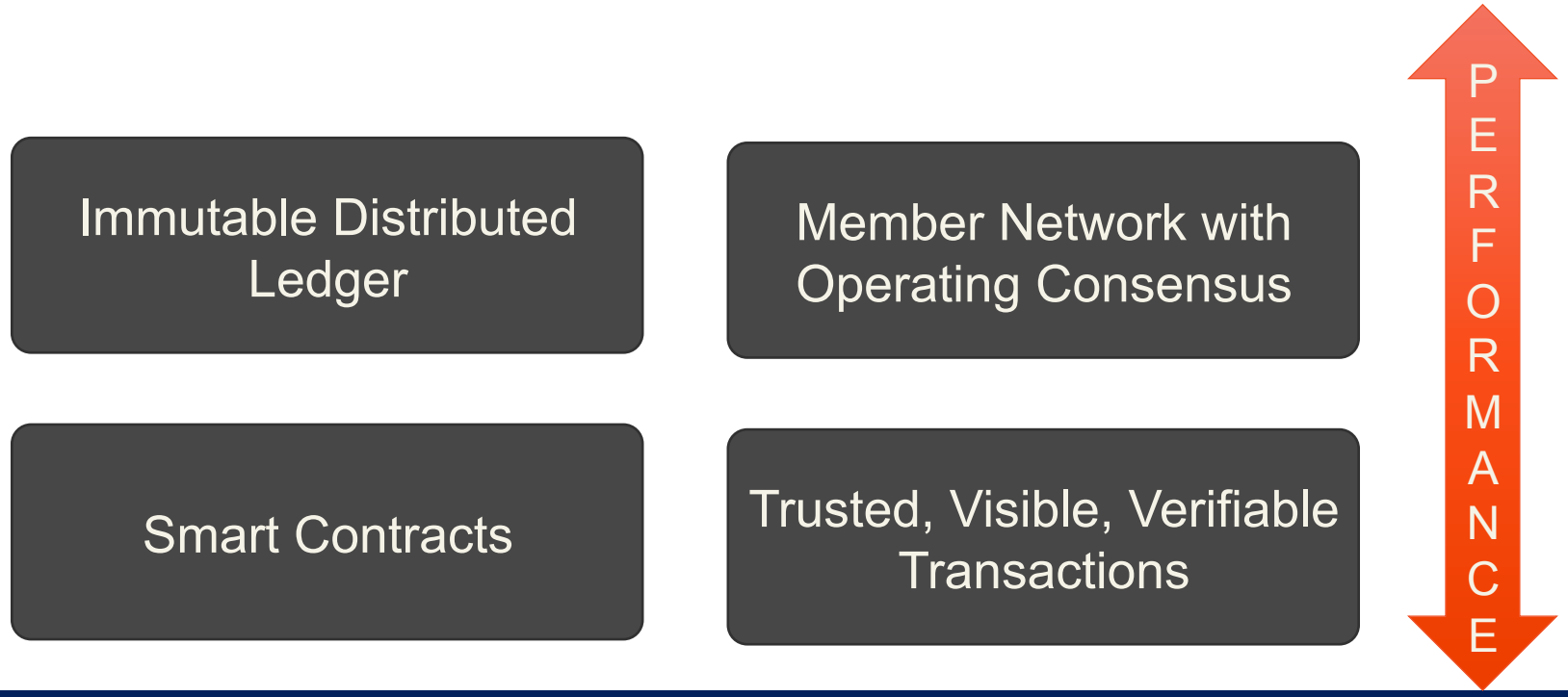

Provides for the five security pillars:
Availability, Auditability, Accountability, Integrity and Confidentiality.

Major benefit

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- 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

Energy requirement

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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."

Performance requirement

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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

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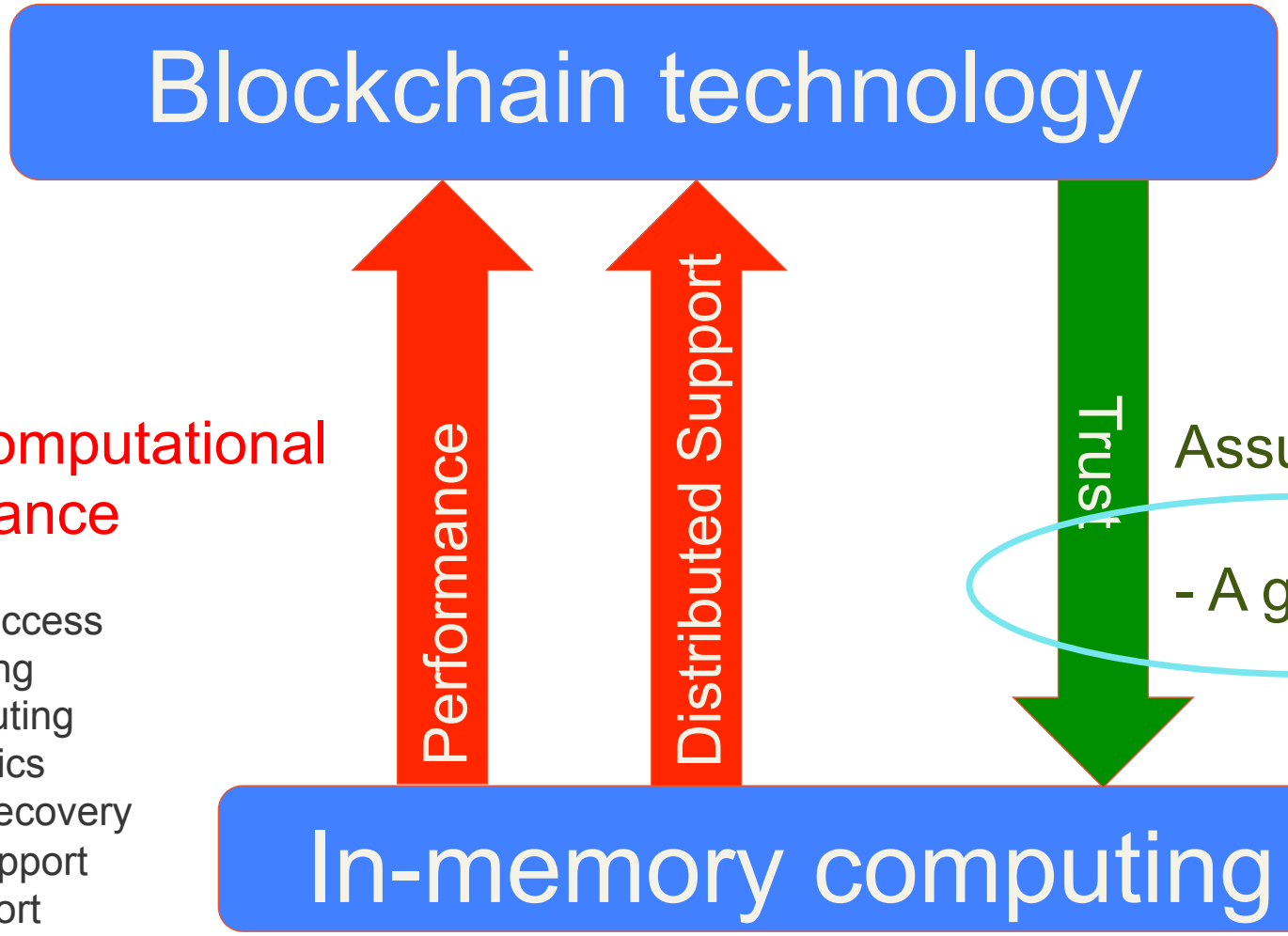

- Highly trustable shared data
- Multi-node distributed architecture
- Multi-members/devices
- Distributed apps support
- IAM and X509 security certificates

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

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Edge computing apps

A highly trusted app from the last century

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

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

Blockchain shared trusted ledger

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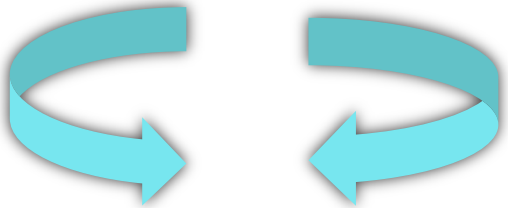
CLOUD COMPUTING

global transactions, large loans, analytics

Blockchain network



shop

Directly transact services

Directly pay and receive

Bank is optional, just another member of blockchain network

EDGE COMPUTING

synchronize ledgers, credit check, loans

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Why does edge computing benefit significantly from blockchain technology?

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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

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Smart traffic routing

Smart pricing and parking

SPEED AT THE EDGE

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

Global supply chains

Smart re-work of contracts

COMMUNICATE WITH POOR CLOUD ACCESS

Smart global supply chains
Re-working smart contracts
Dealing with unexpected and stormy events

Complex manufacturing

Automate reliability

MANAGING COMPLEX REMOTE MANUFACTURING

Smart monitoring of manufacturing
Demanding performance and reliability
Ensuring reliability without the cloud

Manage machine data

Ensure trust and obedience

HANDLING MASSIVE MACHINE DATA RELIABILY

Recording infinite numbers of data sensors reliably
Handling scale beyond capacity of central computing
Communicating and managing untrustable machines

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Comparing Traditional Cloud Services with Edge Smart Blockchain

Comparing Cloud with Edge Smart Blockchain

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

Drive performance. Ensure safety, security and trust.

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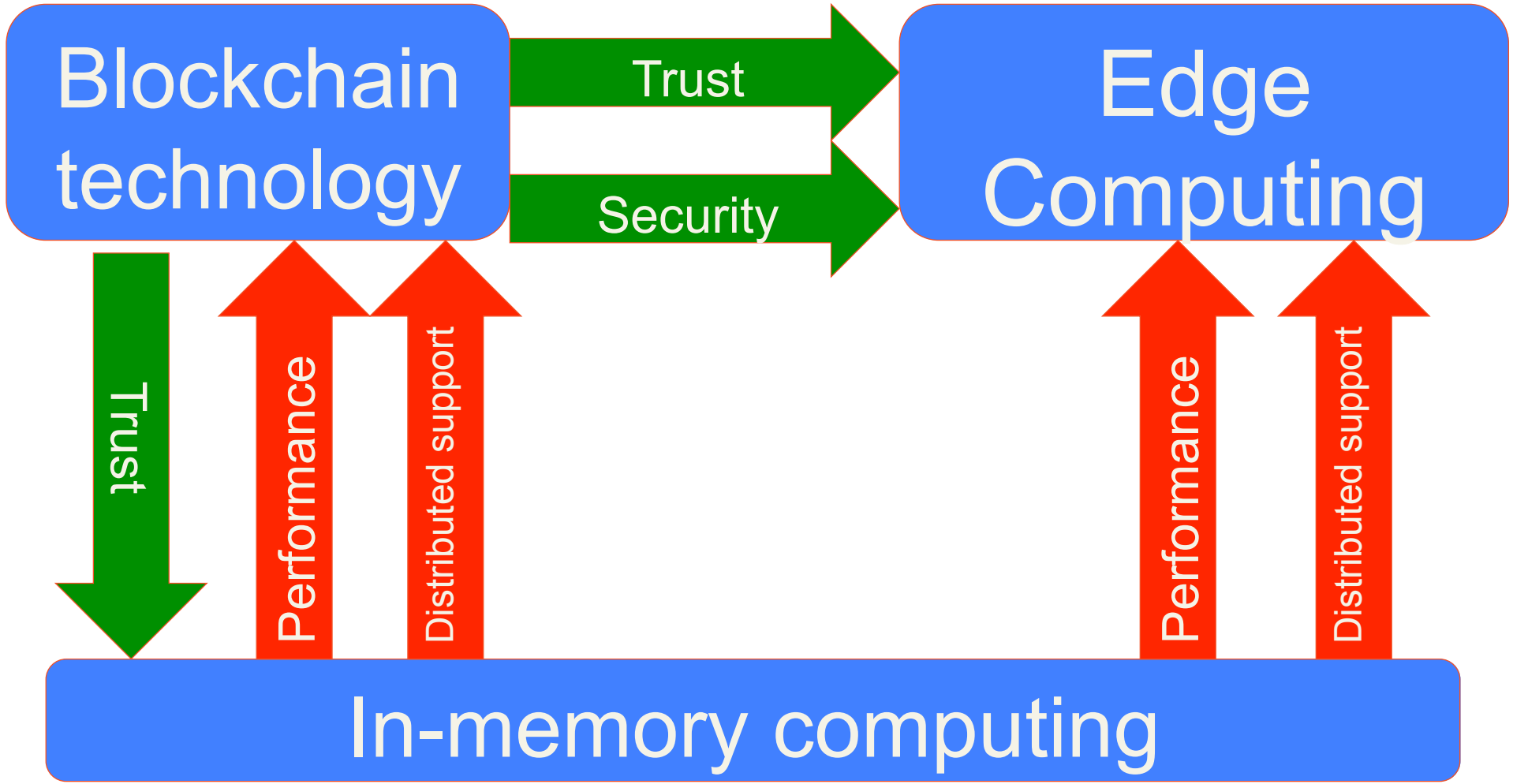

For Apps

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

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The Challenge: How do we integrate blockchain with edge and cloud?

Map edge computing to cloud

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

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

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

Compare Blockchain Platforms

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Characteristics	Ethereum and Ripple	Hyperledger
Age	Founded 2015 or earlier	Founded 2017
Purpose	For B2C and public facing apps	For B2B businesses
Currency	Ether / XRP	None
Mode of participation	Public/private and permissionless network	Private and permissioned network
Consensus mechanism	Ethereum - Proof of work Ripple – FBA consensus circles	Pluggable consensus algorithm
Cost of operation	Ethereum – gas tax for smart contracts on public network	Privately controlled. No public charge.
Programming language	Ethereum - Solidity / Ripple – Codius still under development	Chaincode written in Golang
Governance	Ethereum Alliance / Ripple labs Ripple banking network circles	Linux foundation
Transaction visibility	Everyone has total transparency in public networks	Controlled
Performance	Poorer performance and scalability	Can be scaled up adding unlimited nodes
Ease of use	Simpler, quicker to build smart contracts	Complex and powerful platform
IAM Security	Vendor support, not from platform	Very extensive identity and access controls

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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

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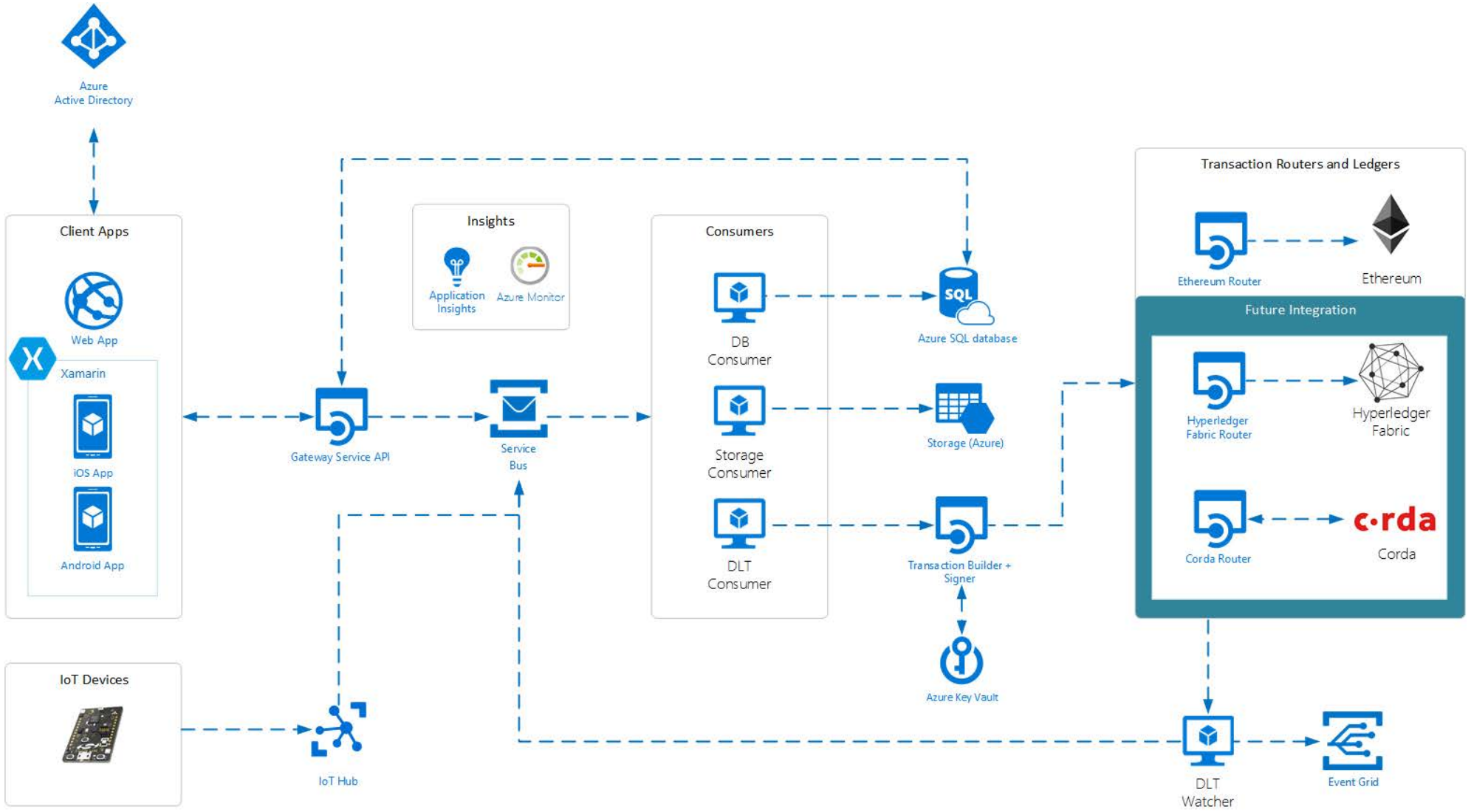

IBM Blockchain Platform

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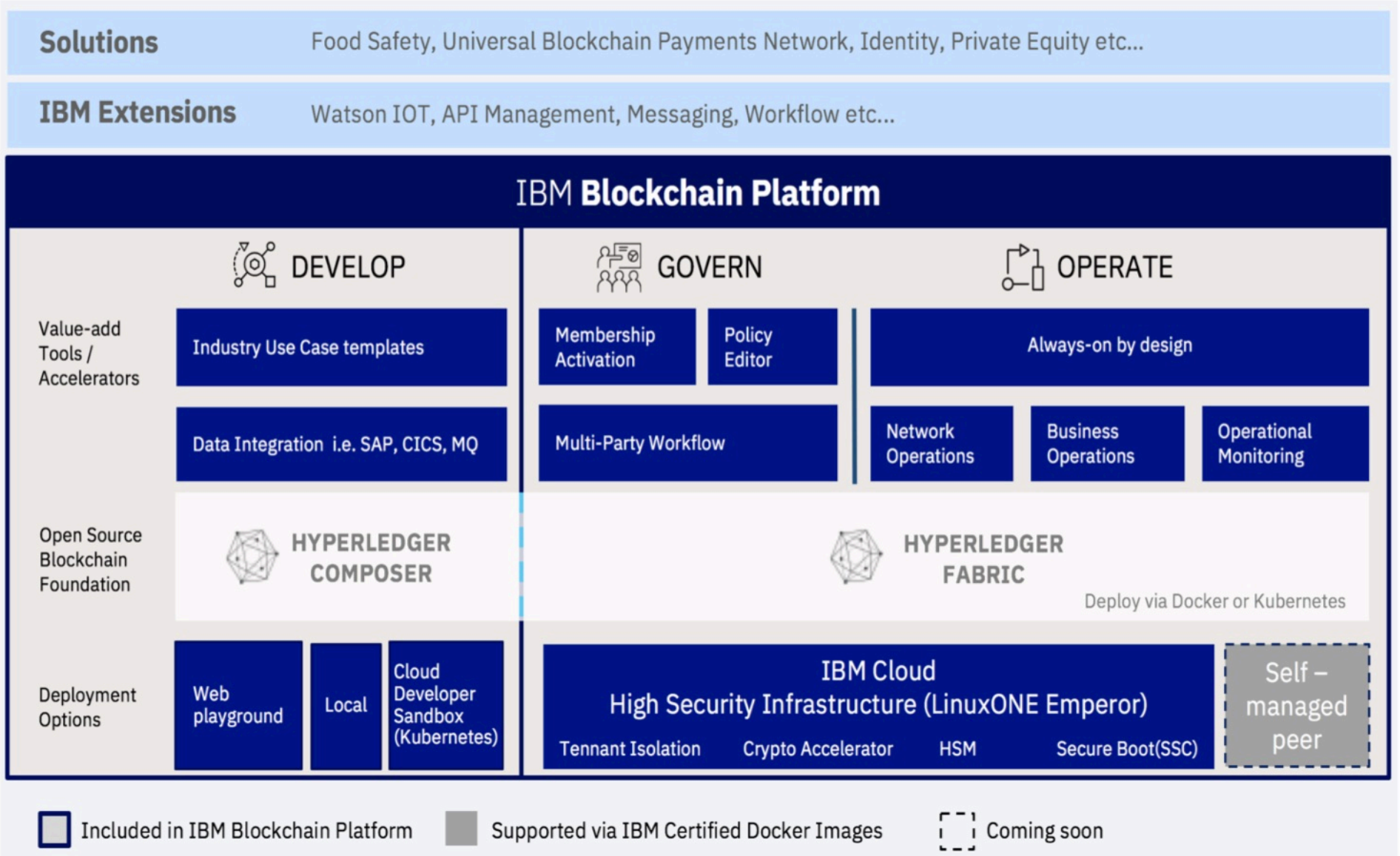
Figure 1. IBM BLOCKCHAIN PLATFORM



Hyperledger Architecture

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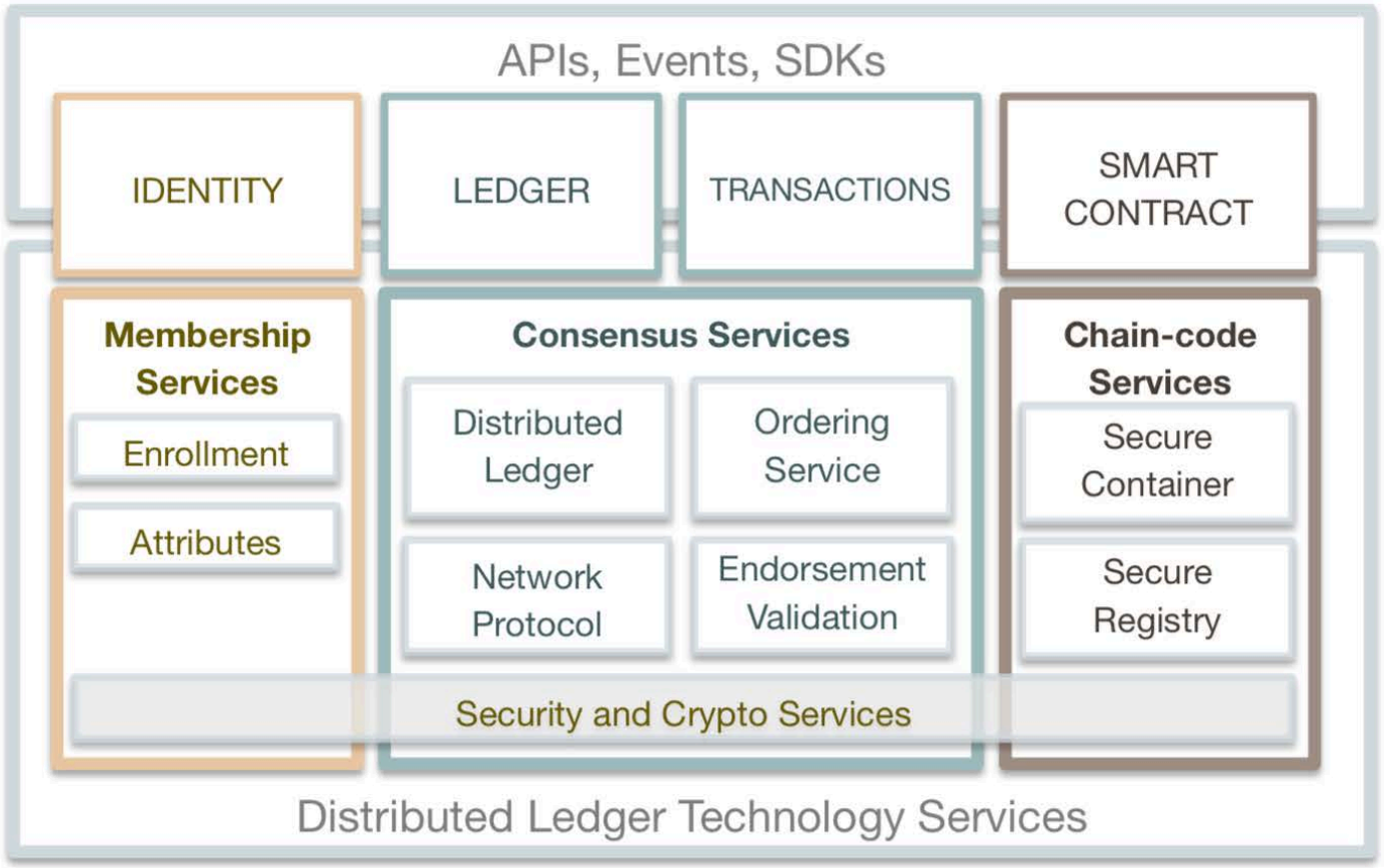

IDENTITY
Pluggable, Membership, Privacy and Auditability of transactions.

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

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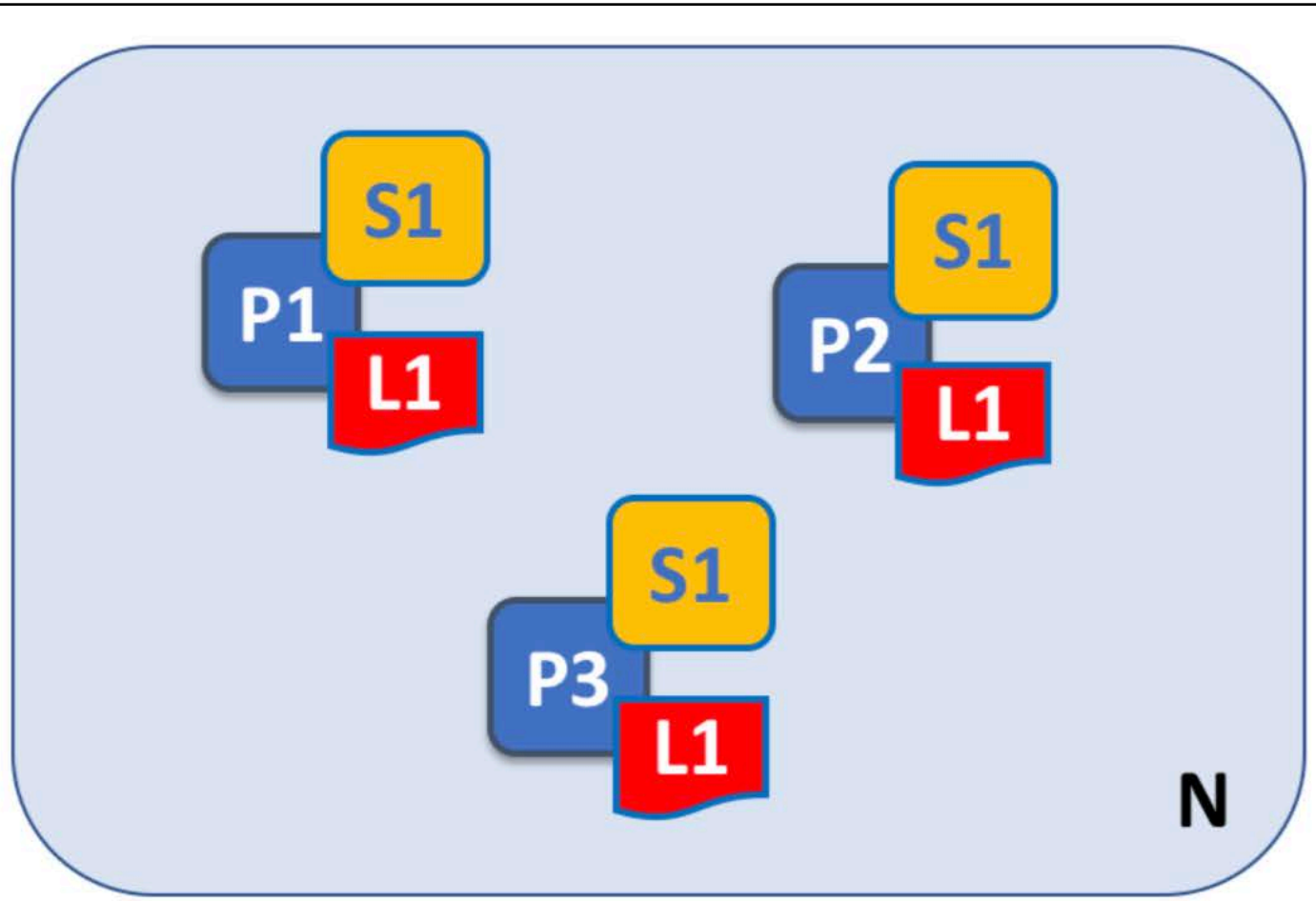

N	Blockchain network
P	Peer node
S	Smart contract (aka chaincode)
L	Ledger

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Edge computing is dependent on a strong identity management system for edge devices often through X509 certificates

Peer Identities via X509 certificate

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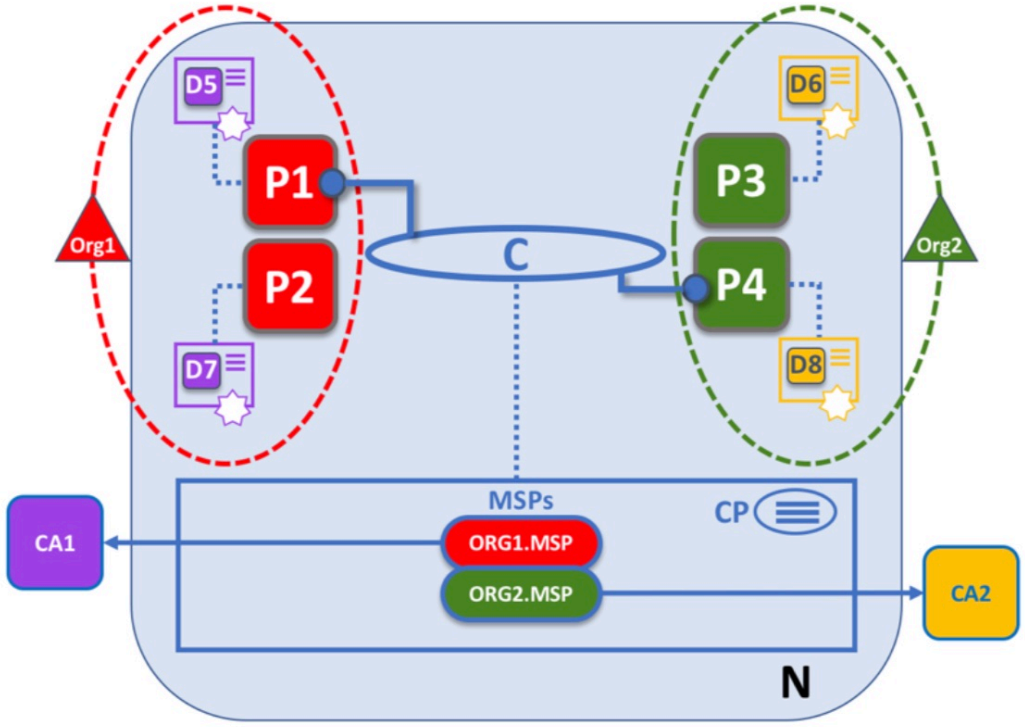
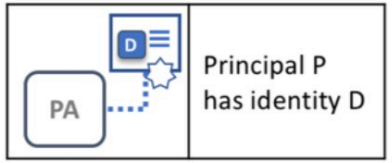


N	Blockchain Network	P	Peer
C	Channel	Org	Organization
I	Identity	PA / C	Principal PA (e.g. P1,P4) communicates via channel C.
CP	Channel policy		
CA	Certificate Authority	MSP	Membership Service Provider
A1 / R / P1 / P2	Organization R owns application A1 and peers P1, P2.		
C / CP	Channel C subject to policy CP.	MSP1 / MSP2 / CP	Channel policy CP contains MSPs: MSP1 and MSP2.
MSP1 → CA1	MSP1 selects the Certificate Authority CA1 to provide certificates for it.		



Register identity,

Issue enrollment certificates

Renew and revoke certificates

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Smart city use case

For smart curbs leveraging blockchain technology powered by in-memory computing architecture

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WHAT IS VISION ZERO?

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Reduce traffic deaths to zero by 2025

VISION ZERO
LOS ANGELES | 2015-2025

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+ Autonomous vehicle technology will reshape the transportation infrastructure of Los Angeles

94%

Percent of crashes caused by human error

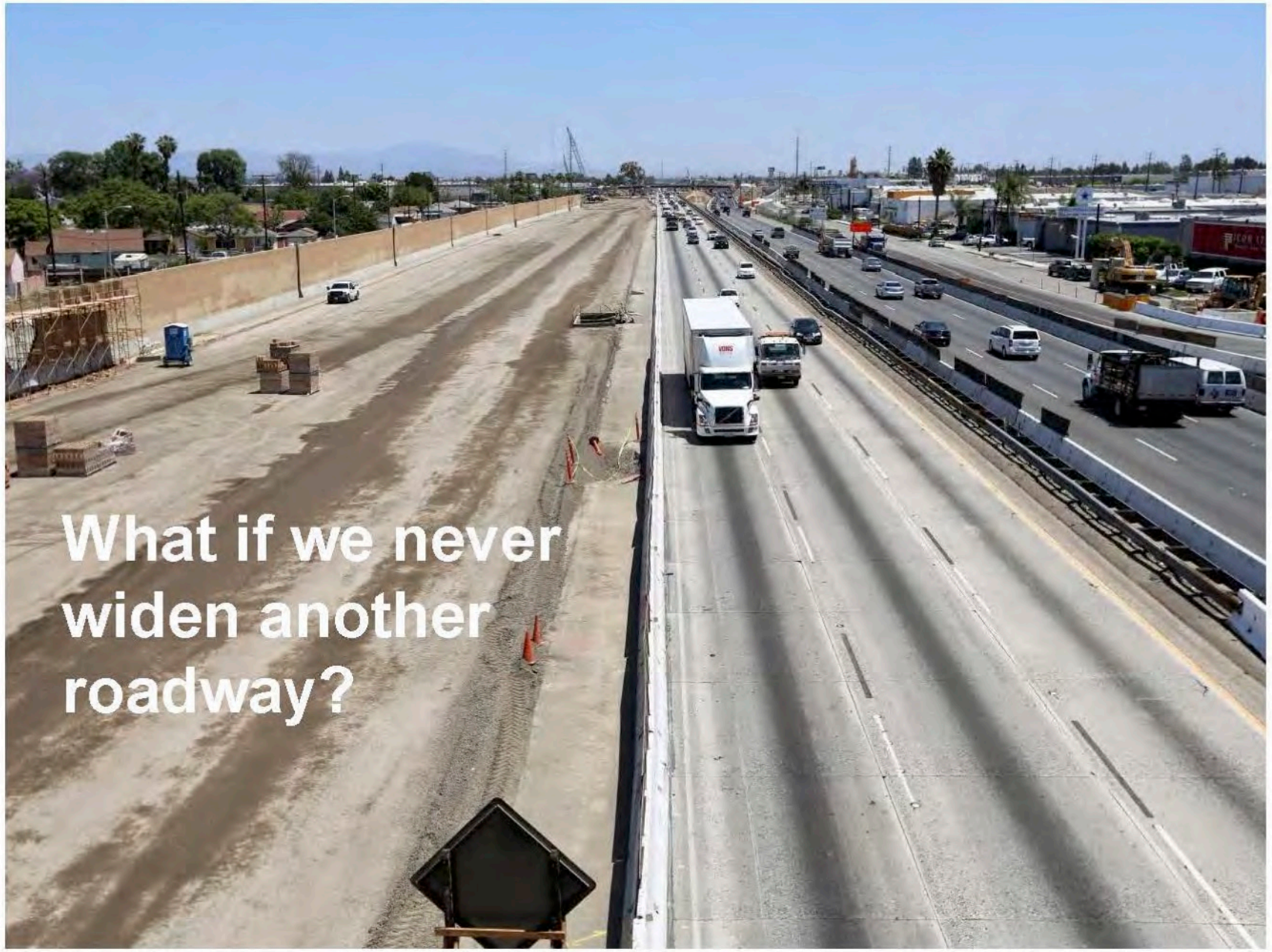
7.5M

Number of motor vehicles in Los Angeles

1#

Los Angeles's rank among cities with the worst traffic congestion

Source: NHTSA, California DMV, Inrix



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NACTO.ORG – Blueprint for autonomous urbanism

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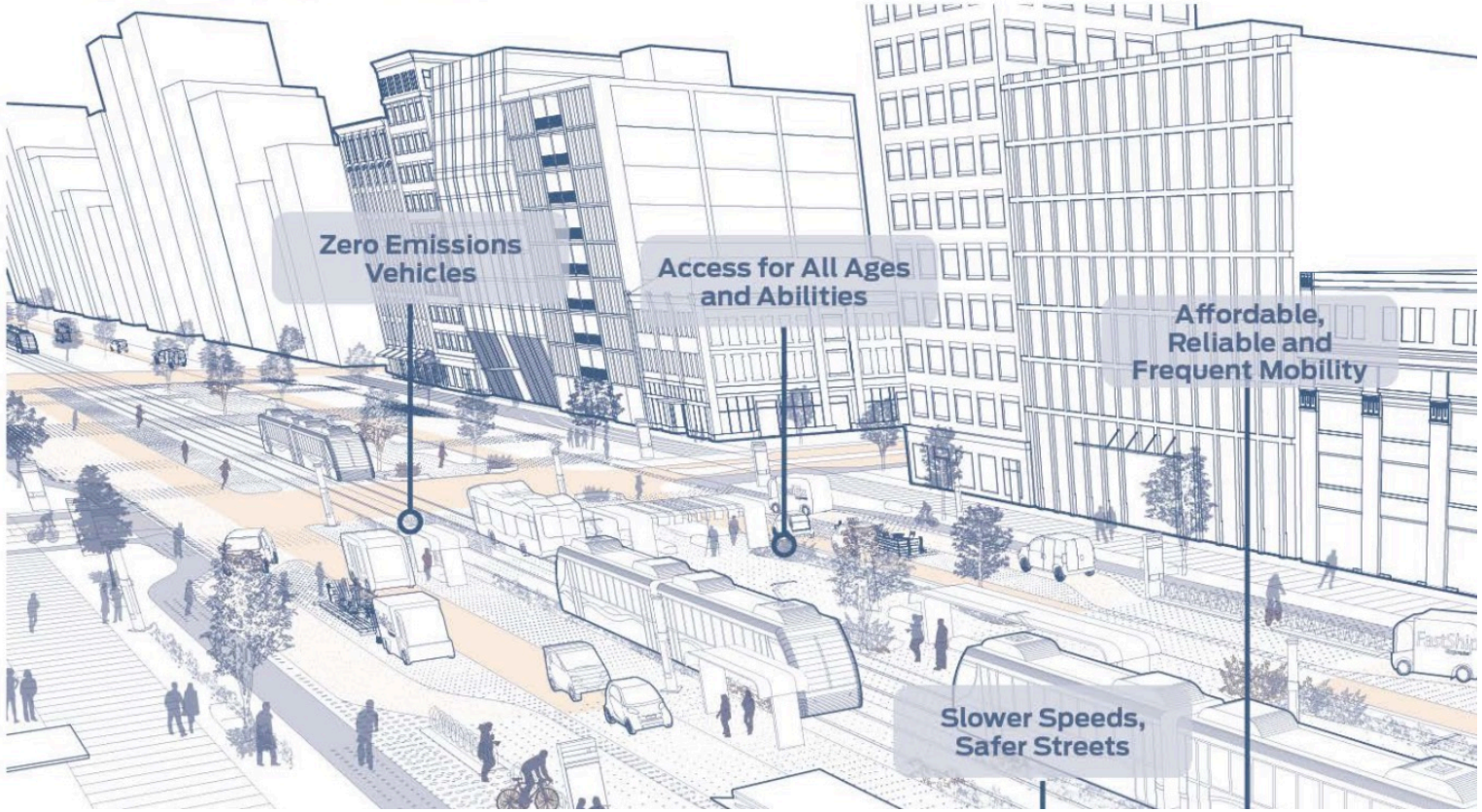
The Promises and Perils of Automation

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.



BLUEPRINT FOR AUTONOMOUS URBANISM

NACTO
National Association of City Transportation Officials
120 Park Avenue, 20th Floor
New York, NY 10017
www.nacto.org

ABOUT NACTO

NACTO's mission is to build cities as places for people, with safe, sustainable, accessible and equitable transportation choices that support a strong economy and vibrant quality of life.

The National Association of City Transportation Officials is a 501(c)(3) nonprofit association that represents large cities on transportation issues of local, regional, and national significance. The organization facilitates the exchange of transportation ideas, insights, and best practices among large cities, while fostering a cooperative approach to key issues facing cities and metropolitan areas. As a coalition of city transportation departments, NACTO is committed to raising the state of practice for street design and transportation by building a common vision, sharing data, peer-to-peer exchange in workshops and conferences, and regular communication among member cities.

NACTO MEMBER CITIES

Atlanta
Austin
Baltimore
Boston
Charlotte
Chicago
Denver
Detroit
Houston
Los Angeles
Minneapolis
New York
Philadelphia
Phoenix
Pittsburgh
Portland
San Antonio
San Diego
San Francisco
San José
Seattle
Washington, DC

INTERNATIONAL MEMBERS
Halifax, NS
Montréal, QC
Puebla, Mexico
Toronto, ON
Vancouver, BC

TRANSIT AFFILIATE MEMBERS
CARTA
Chicago Transit Authority
King County Metro
Los Angeles Metro
Miami-Dade County
New York MTA
Portland TriMet
Vancouver TransLink

AFFILIATE MEMBERS
Alexandria, VA
Arlington, VA
Boulder, CO
Burlington, CT
Cambridge, MA
Charleston, SC
Ch attanooga, TN
El Paso, TX
Fort Collins, CO
Fort Lauderdale, FL
Hoboken, NJ
Indianapolis, IN
Long Beach, CA
Louisville, KY
Madison, WI
Memphis, TN
Miami Beach, FL
Nashville, TN
New Haven, CT
Oakland, CA
Palo Alto, CA
Raleigh, NC
Salt Lake City, UT
San Luis Obispo, CA
Santa Monica, CA
Somerville, MA
Vancouver, WA
Ventura, CA
West Hollywood, CA
West Palm Beach, FL

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

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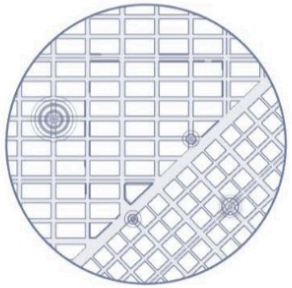
TOS PRODUCT – SHORT TERM

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.



Manage Streets in Real Time

Street Management with Data

Use third party data platforms to exchange data about the street securely and seamlessly, supporting street management in real time.

Price the Curb

Create delivery and pick-up and drop-off management plans that maximize customer experience while minimizing the fight for the curb that endangers people across modes.

Code the Curb to Optimize Access

Maintain a dynamic, digitally-visible curbside inventory to democratize curbside access while guarding safe function of the roadway.

Determine a safe and equitable way to price curb access for uses like farmers markets, freight delivery, vehicle storage, et

Challenge – detect and predict pedestrians

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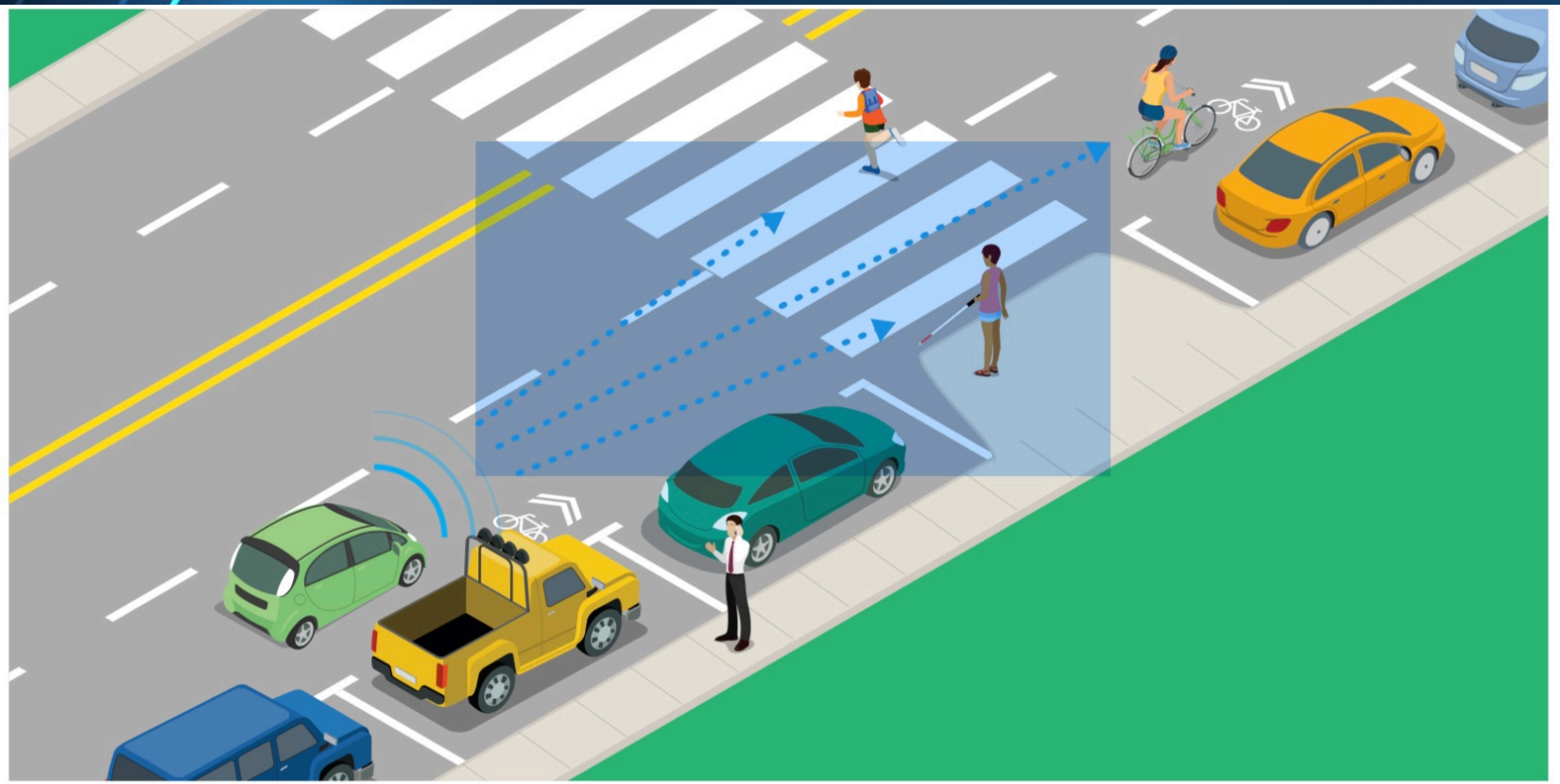

Figure 2. A key challenge area for automated technologies lies in their ability to detect and predict the movement of pedestrians and bicyclists in a range of conditions.

#1: The Detection Problem

What it is: The perceptual and computational abilities of automated systems to detect,

pedestrian injury and fatal crashes occurred at intersections and 37 to 65 percent of bicycle injury and fatal crashes occurred at intersections, depending on the data source (Thomas, 2017).

Challenge – How to handle pedestrians right of way

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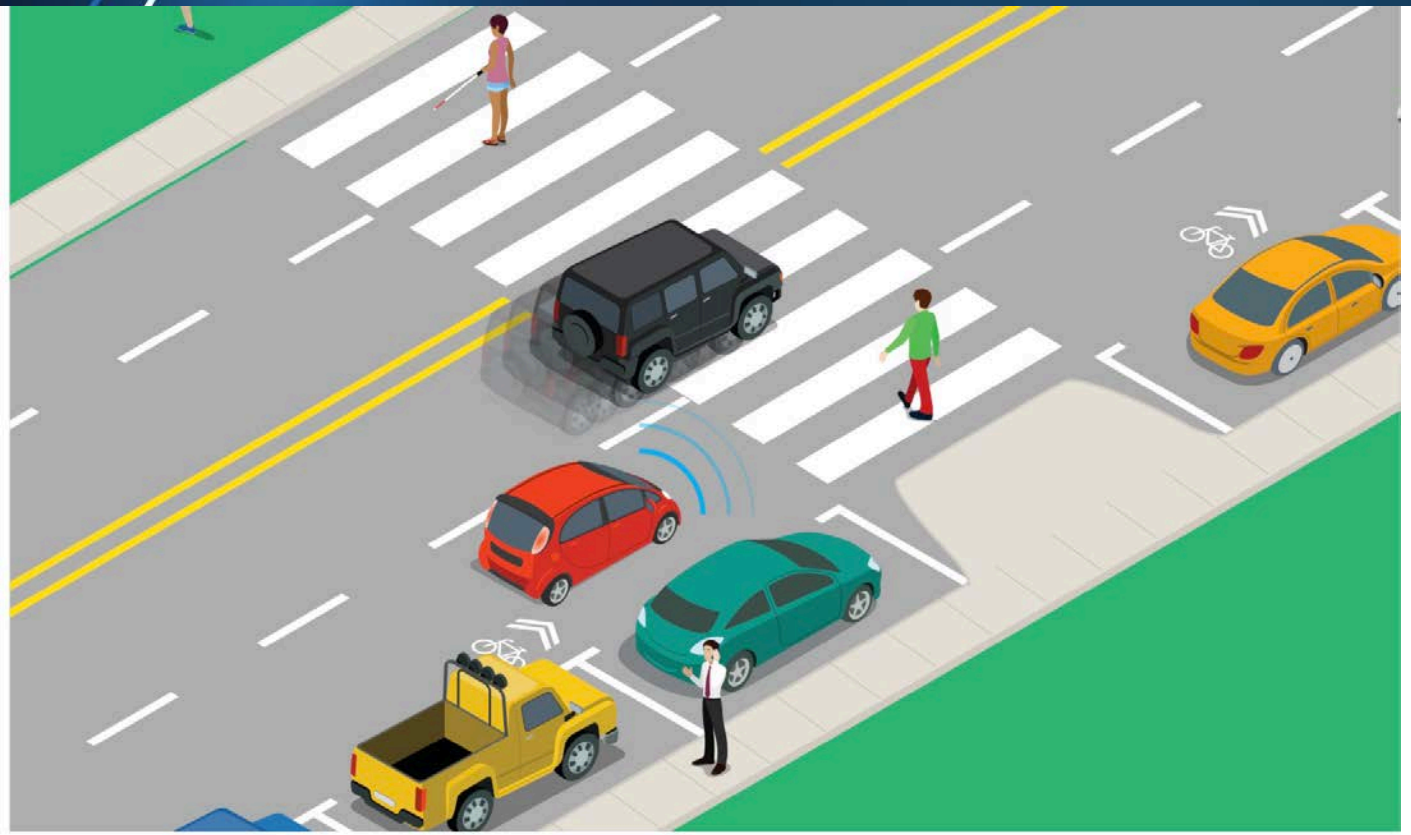

Figure 5. There are many unanswered questions with respect to how ADS will adhere to varying laws requiring yielding right-of-way to pedestrians, and the ripple effects that ADS interactions will have on human driver and pedestrian expectations and behaviors.

#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

Challenge – How to maneuver around bicyclists and pedestrians

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#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

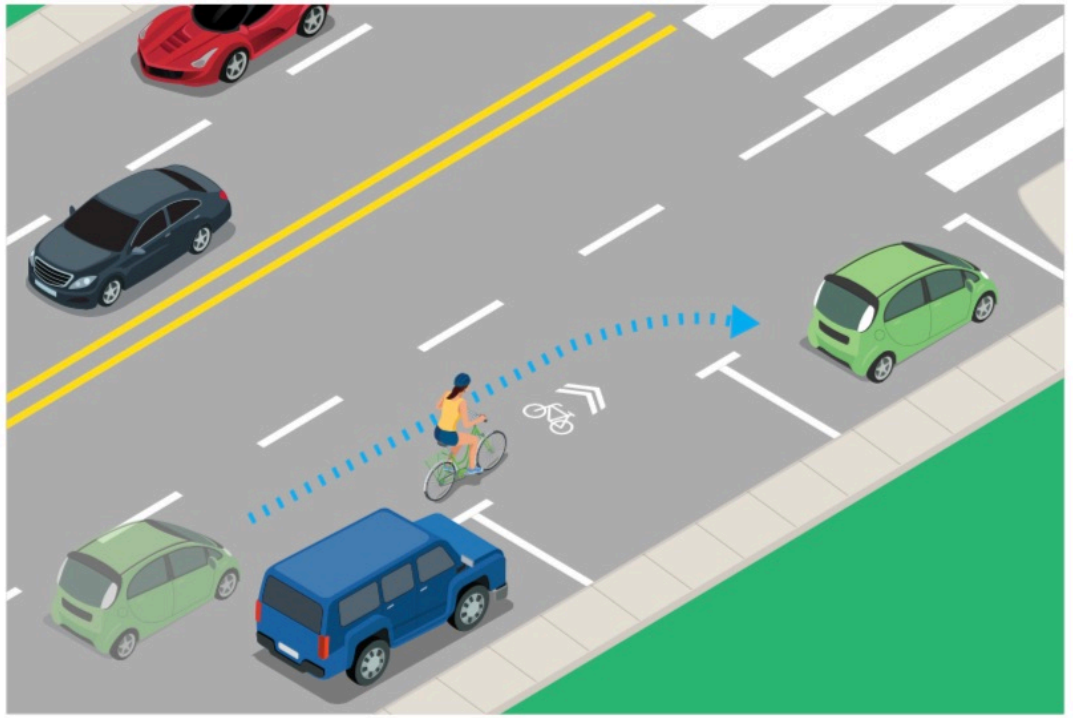

Figure 8. Navigating in/out of parking spaces or dropoff zones presents specific challenges for ADS interaction with pedestrians and bicyclists.

The design challenge

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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

Automated Smart City Curb Parking App

Major Benefits

- Focus on passenger safety for entering and exiting vehicles
- Monetize the curb through smart curb pricing
- Automate curbside inventories
- Reduce traffic congestion routing vehicles to nearest curb for pick-up and drop-off.

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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

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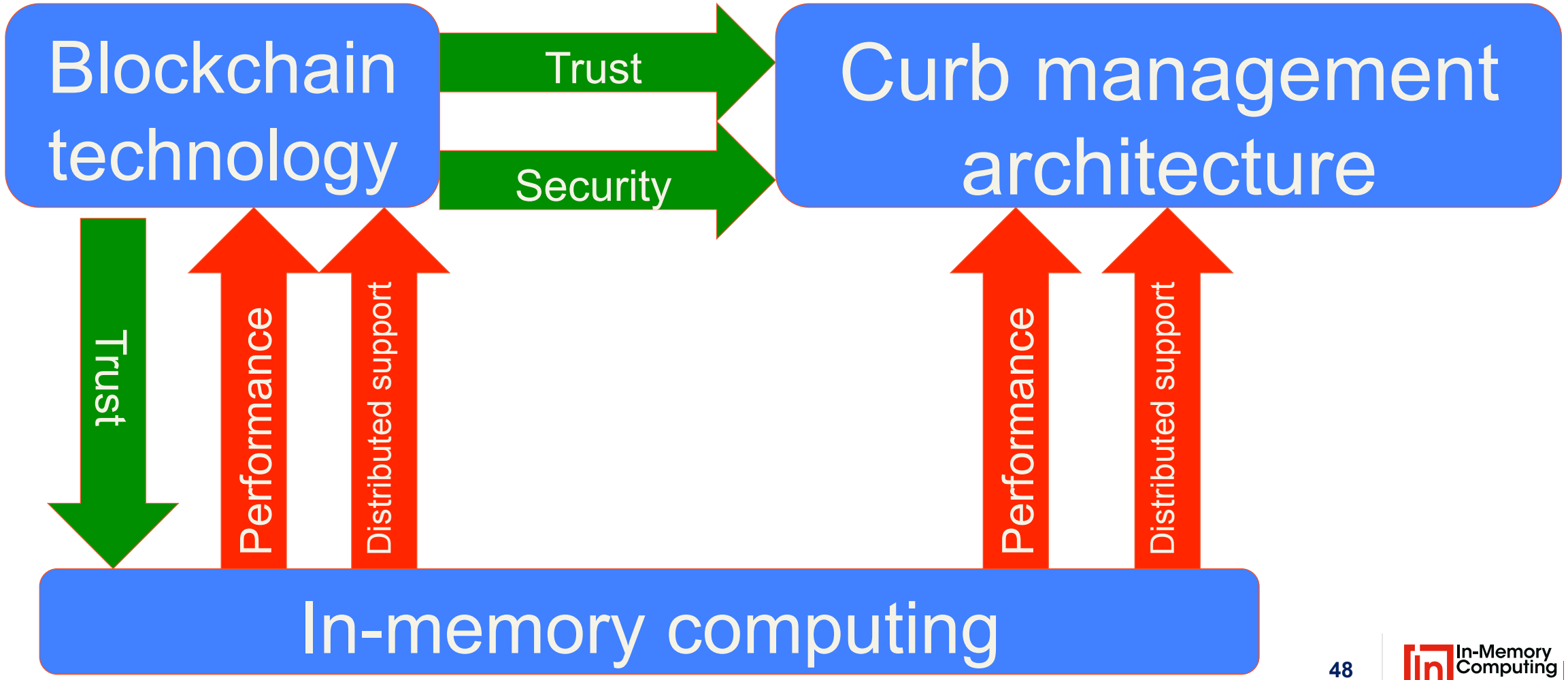

Smart Curb API

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Step	Rest API	Edge Blockchain	Cloud
Add curbs in a street to a blockchain network connecting them with local area networks includng bluetooth	POST	• Add curb to blockchain	• Synch cloud data to blockchain
Register vehicle requesting a curb for parking or pickup	POST	• Register vehicle request accessible only by permissioned member network.	• Stores vehicle data for later analytics and communication. • Does not store privacy related data such as personal images.
Vehicle requests a curb, provide free curb Process to provide alternate curb based on situation on ground, such as an alternate vehicle blocking 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.
Update security alarm notifiers	PUT	• Members reach consensus • Alarm limits updated in blockchain	• 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

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

Sample Blockchain apps

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

Sample Blockchain apps

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

Sample Blockchain apps

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

Sample Blockchain apps

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

Introducing FAR-EDGE

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Flexible Decentralized Factory Automation

FAREDGE

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

Whirlpool
POLITECNICO DI MILANO
ENGINEERING
ATHENS INFORMATION TECHNOLOGY
SIEMENS
Sens@p systems
VOLVO
THE Open GROUP
SUPSI
UNPARALLEL INNOVATION
smartFactory KL

H2020 Research and Innovation Action - This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N. 723094

Factory automation, edge computing

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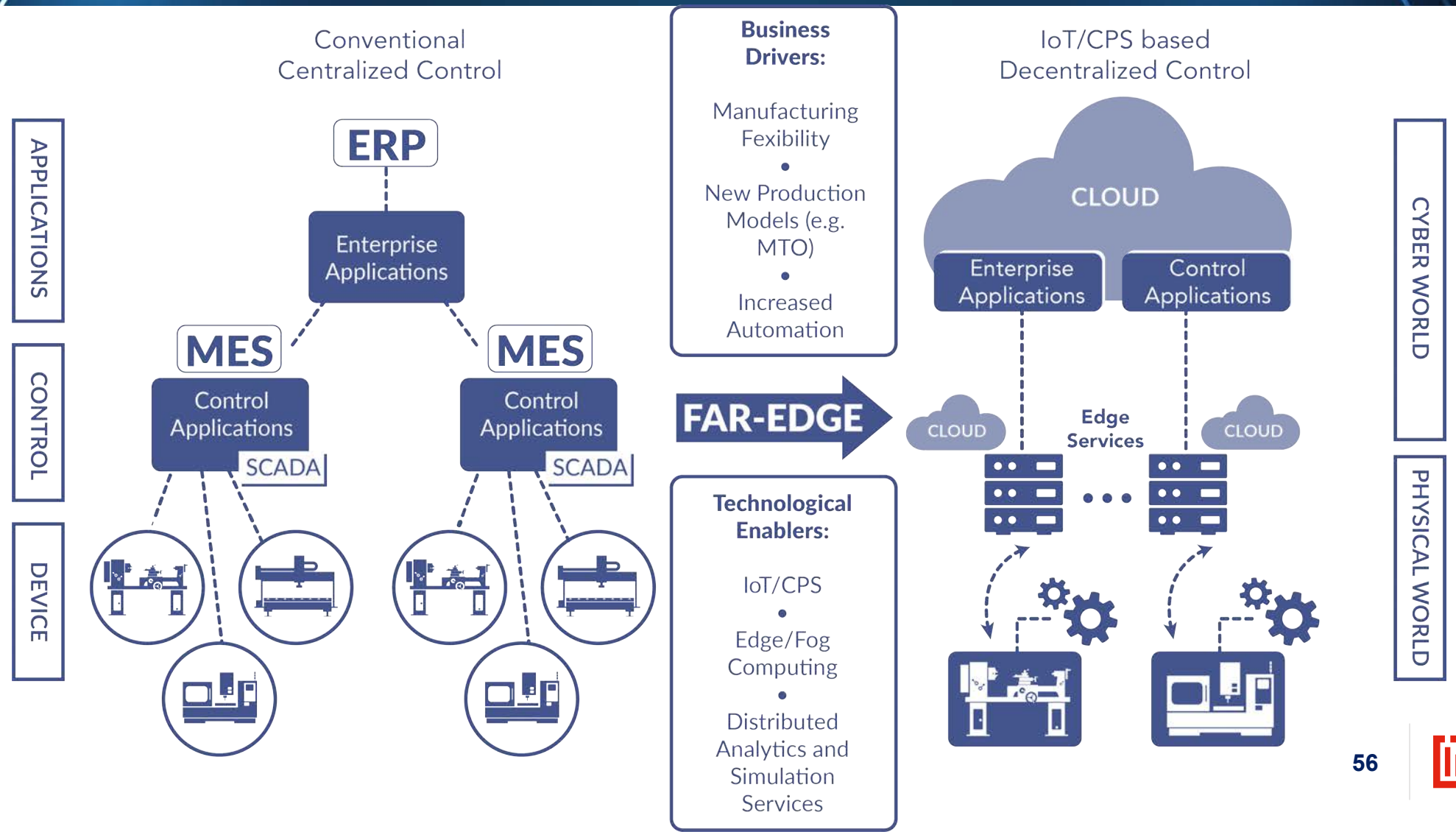

Blockchain layer in edge computing for factory automation

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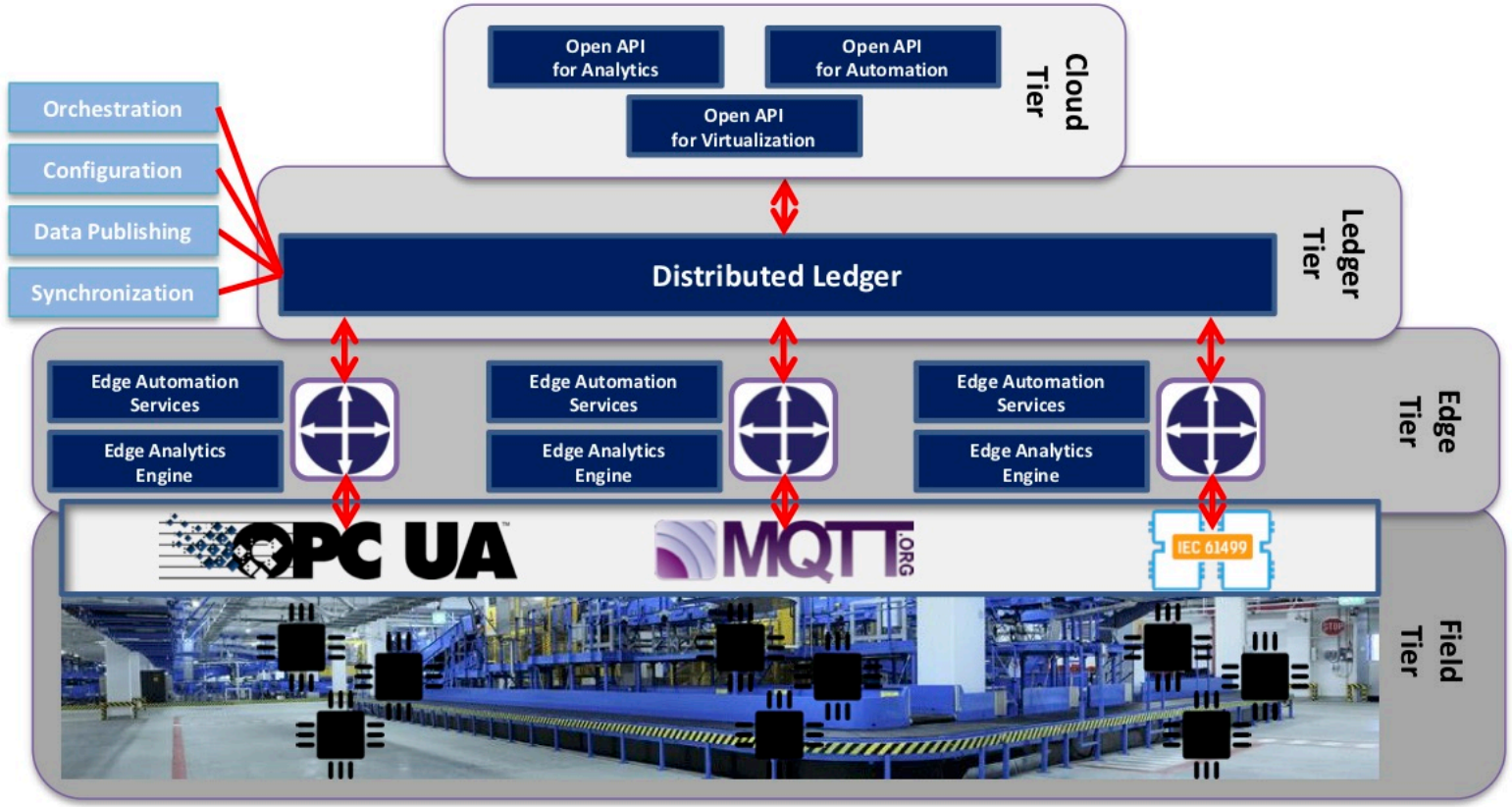
Role of Distributed Ledger in FAR-EDGE (Blockchain)



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Drive performance, ensure safety, security and trust

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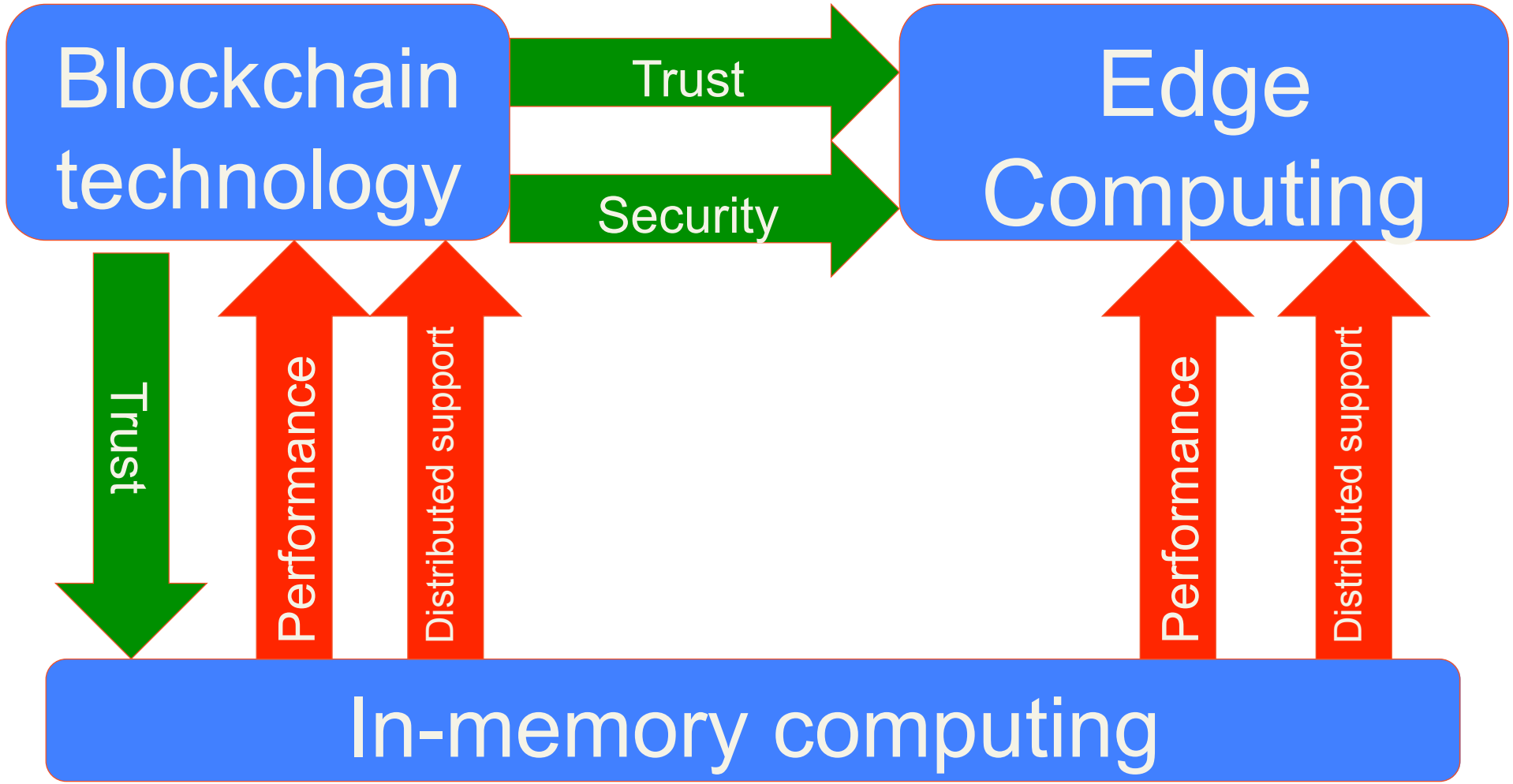

For Apps

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

Contact

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