Blockchain Technology in Industrial Internet of Things Applications

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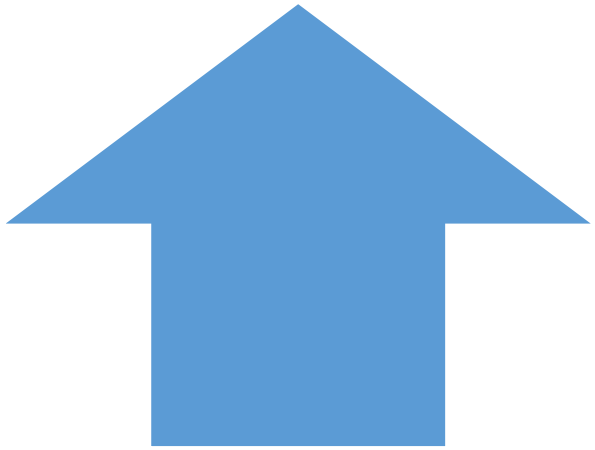
Dispelling the Hype: When (not) to use Blockchain in IIoT



When to use blockchain technology

- You need a shared database
- You need a database with multiple writers
- You have a situation with multiple non-trusting writers
- You do not want to rely on a trusted intermediary
- You desire interaction between transactions in the database

Avoid using block chain technology

- If you lack any of the five above conditions
- “If trust and robustness aren’t an issue, there’s nothing a blockchain can do that a regular database cannot”, Gideon Greenspan, CEO of Coin Sciences Ltd. (www.multichain.com)

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Prominent Blockchain Use Cases for IIoT

Distributed Processes Synchronization

- Synchronize Distributed Operations
- E.g., Automation, Data Analytics

Security

- Secure & Trustful Sharing of Data
- Coordination of different security platforms

Trustful Supply Chain Management

- Virtualized Production Operations
- Using Smart Contracts

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“Enterprise” Features of Permissioned Blockchains

- Industrial Deployments are most based on permissioned rather than public blockchains
  - Improved Privacy Management (Control their members)
  - Performance (not subject to Proof of Work)
  - Support for Smart Contracts (i.e. sophisticated applications

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Benchmarking & Comparison of Permissioned Blockchains

Characteristic/ Attribute	Ethereum	Enterprise Ethereum (Quorum)	Hyperledger Fabric	R3 Corda
Blockchain Type	Permissionless (public or private)	Permissioned	Permissioned	Permissioned
Consensus Mechanism	PoW at the level of the entire ledger	Multiple Mechanisms at the Transaction Level	Multiple Mechanisms at the Transaction Level	Notary Nodes at the Transaction Level
Currency	Ether or Tokens via Smart Contracts	Tokens via Smart Contracts	None, possible to implement via ChainCode	None
Reported Performance	15 TPS	~100s of TPS	~1000s of TPS	15-1768 TPS
Smart Contracts Support	Smart Contract Code (e.g., Solidity)	Smart Contract Code	Smart Contract Code (e.g., Java, Go)	Smart Contract Code (e.g., Java, Kotlin) & Legal Prose
Interoperability across networks	No	No	No	Yes
Key Value Proposition	Generic Blockchain Platform – Community – Cryptocurrency Support	Community – Cryptocurrency Support	Performance and Modularity	Legal Prose and Interoperability

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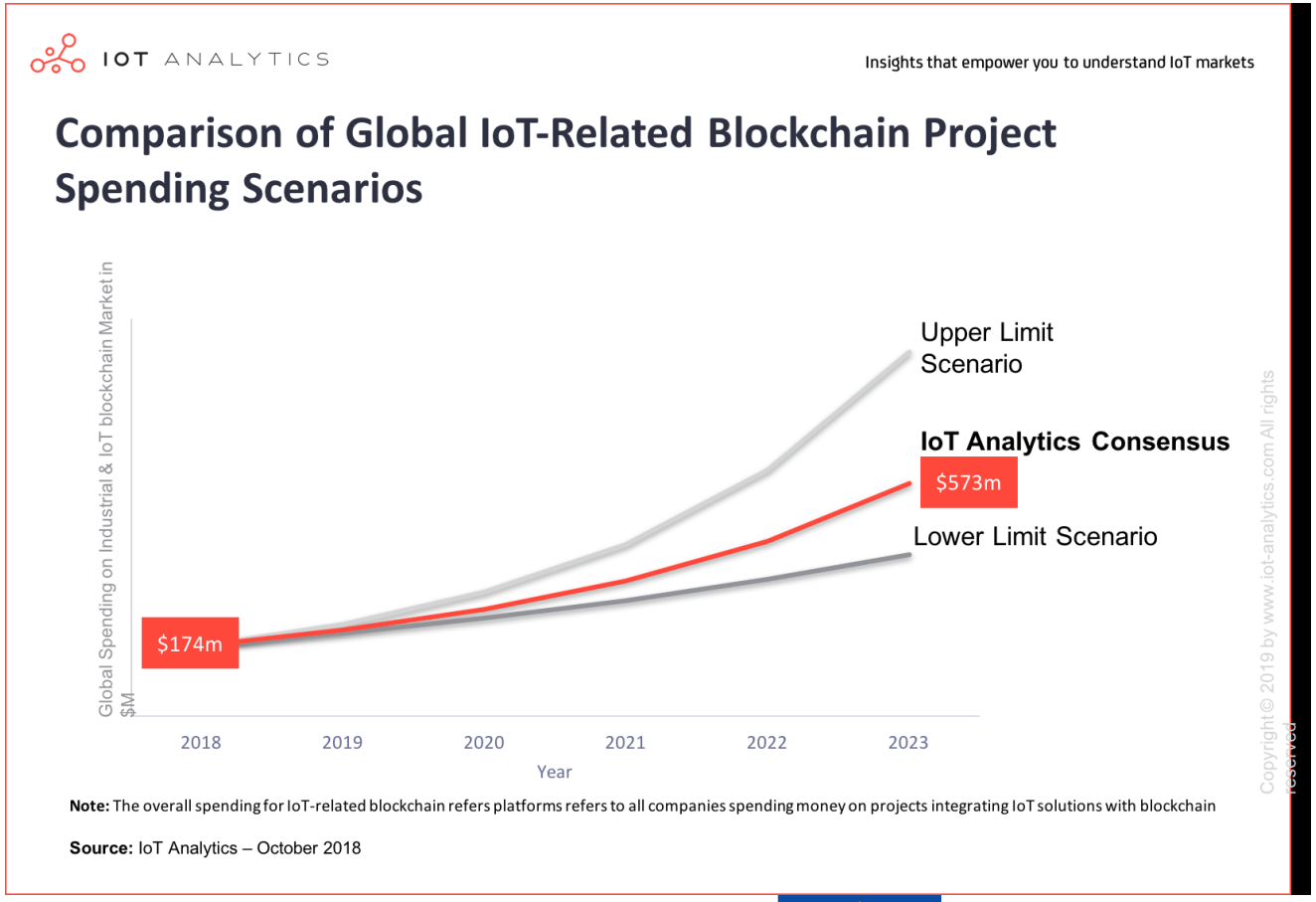
Market Insights (source: IoT Analytics)

- Tangible market interest & many pilot projects
- Large scale deployments in their infancy
- Today: $174M spent in Industrial & IoT Blockchain
- The market is likely to expand to $573M by 2023
- Driven by encouraging pilot project results and ongoing corporate investments
- 15+ different types of use cases reported



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FAR EDGE Project at a Glance

H2020 FoF-11-2016 RIA

Project Summary	
Starting Date	01/10/2016
Duration	36 months
Partners	12
Results	**www.edge4industry.eu**

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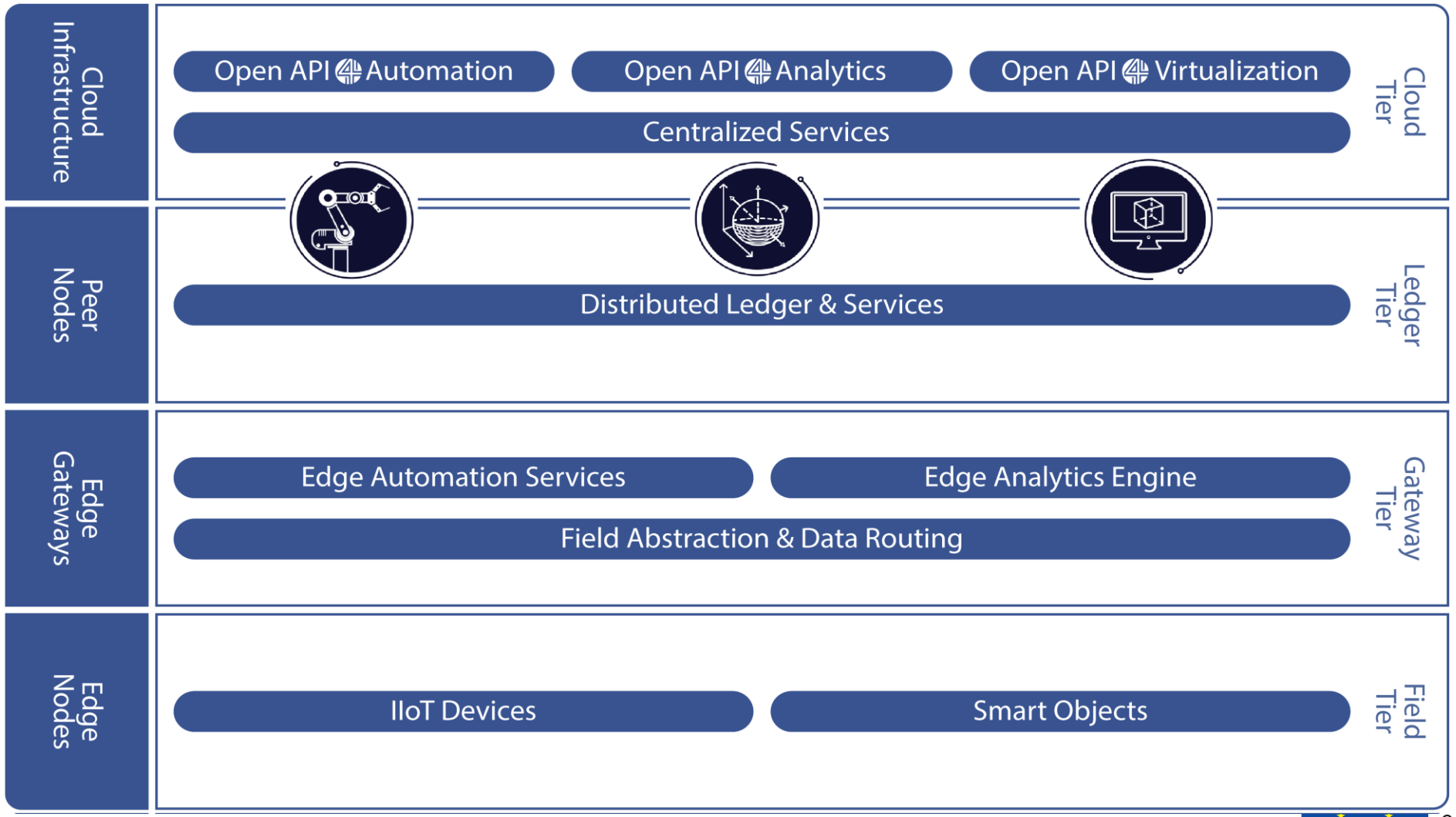
Blockchains in H2020 FAR-EDGE Project: Reference Architecture



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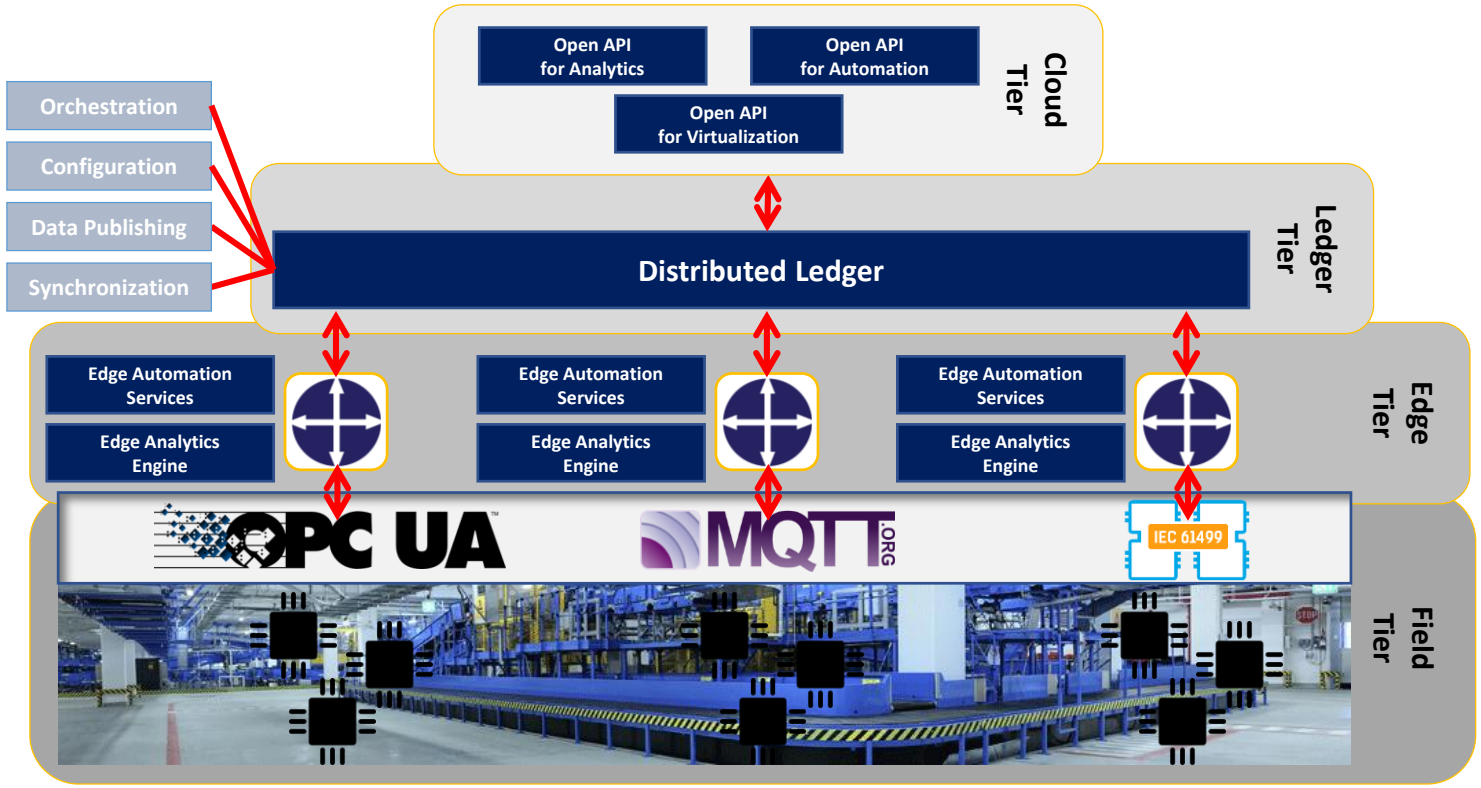
Blockchains in H2020 FAR-EDGE Project: Overview



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Blockchains for Distributed Data Analytics

Local Level Analytics ("Edge Scoped")

- Close to the Field
- E.g., Level of a Station in the Factory
- Supported by Edge Analytics ("Edge Analytics Engine")

Global Analytics ("Ledger Supported")

- Factory-wide (or even across factories)
- E.g., spanning multiple stations & instances of local level analytics
- Supported by Open API for Analytics

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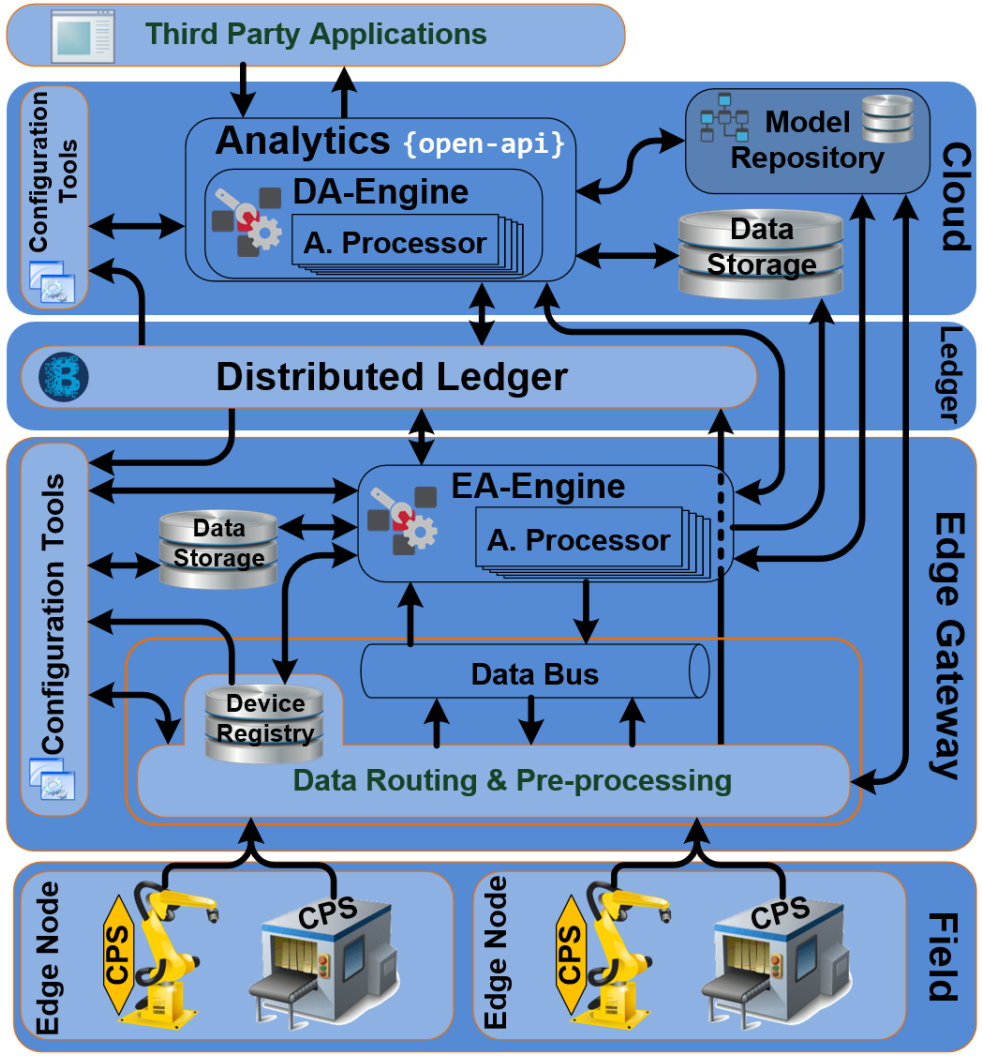
Blockchain Empowered Distributed Data Analytics



Distributed Data Analytics system integrated with:

- Data Routing & Pre-processing,
- Data Bus,
- Device Registry,
- Data Storage (cloud and local) and
- Model Repository

Benefits:

- Configurable
- Extensible
- Dynamic
- Stream Handling

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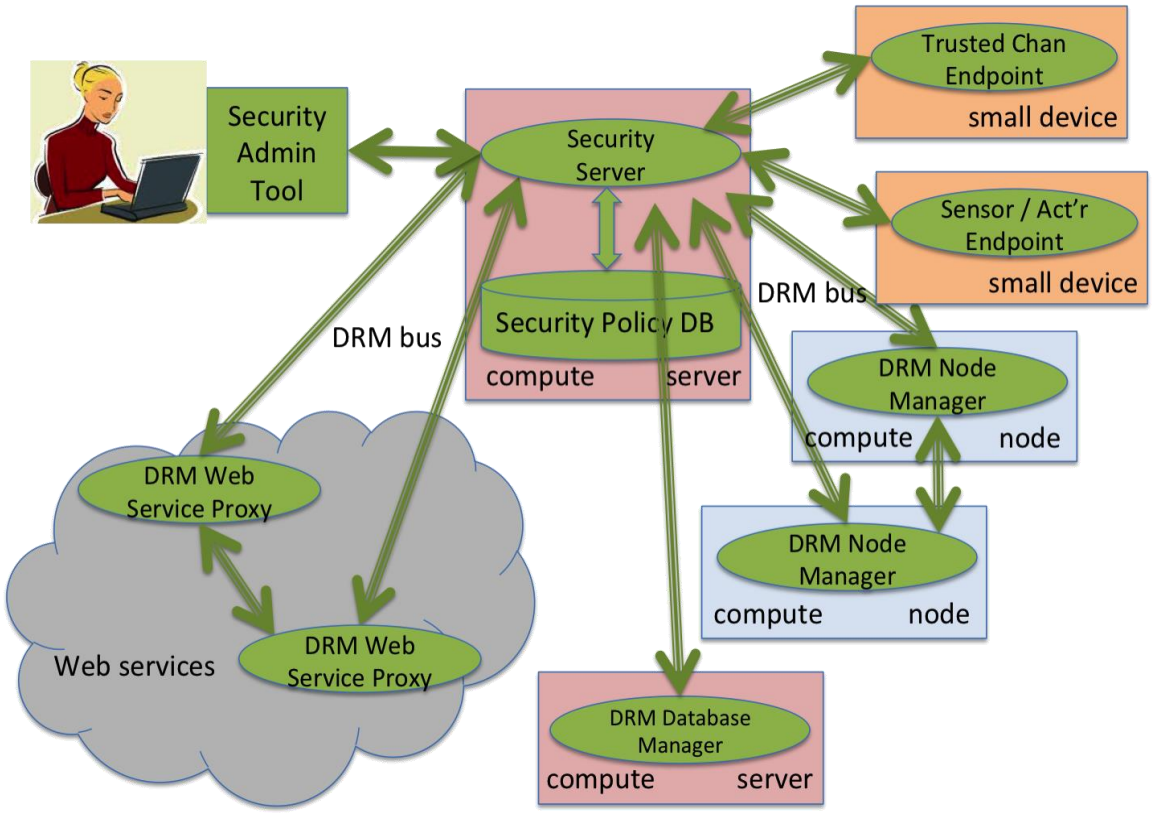
IIoT Security: NGAC for IIoT



NGAC functional architecture:

- Multiple Policy Enforcement Points (PEP)
- Multiple Resource Access Points (RAP)
- At least one Policy Decision Point (PDP)
- One Policy Access Point (PAP)
- One Policy Information Point (PIP)
- An optional Event Processing Point (EPP)

Ledger Tier use:

- Smart Contracts (SCs) used to effect changes to the distributed information and to enforce constraints on such changes
- Having multiple PDPs, and a distributed PIP, adds fault tolerance to the operation of the distributed reference monitor (DRM)
- Smart contracts used to implement updates to the security policy that maintain consistency across the distributed PIP

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