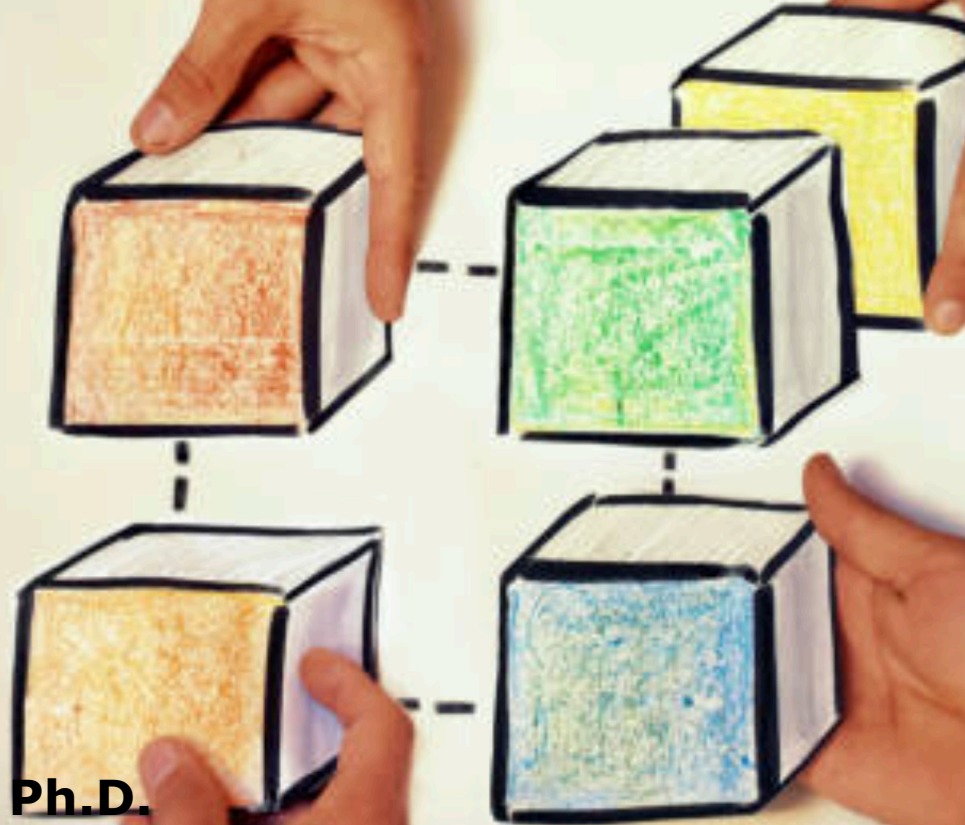


Blockchain in Telecom

Interoperability



Claudio Lima, Ph.D.

*Blockchain Engineering Council – BEC, Co-Founder
IEEE DLT/Blockchain Standards, Chair*

Agenda

- Blockchain Fundamentals and Benefits
- Evolution Roadmap
- Blockchain Reference Models
- Main Challenges
- Key Takeaways

Note: **Distributed Ledger Technologies (DLT)** is the technical term that defines this technology, where blockchain is the main type of DLT.

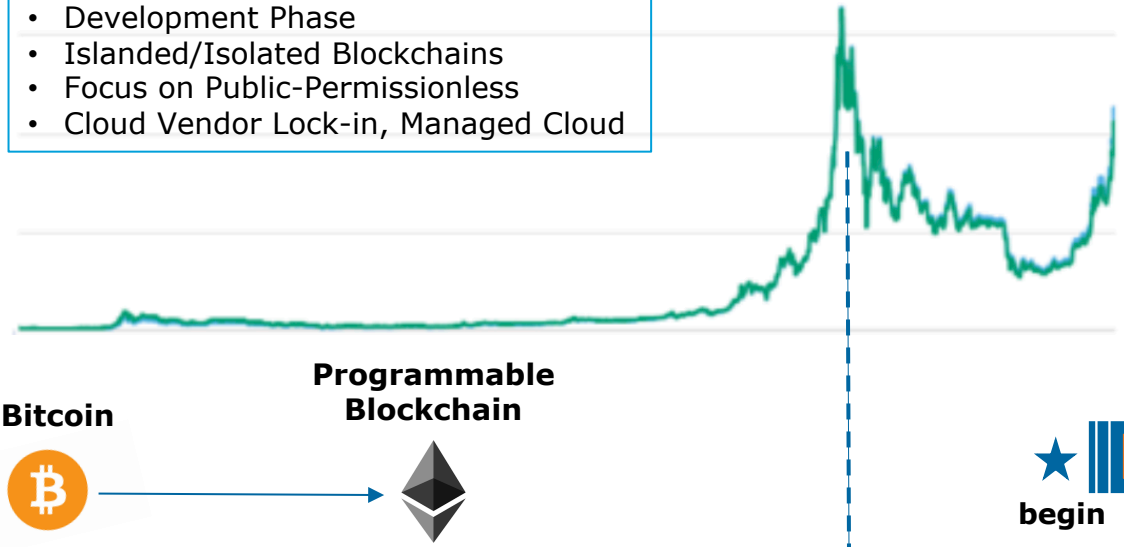
Blockchain Telecom Roadmap

Future Outlook 2030

Phase 1

- Development Phase
- Islanded/Isolated Blockchains
- Focus on Public-Permissionless
- Cloud Vendor Lock-in, Managed Cloud

Initial Coin Offering (ICO) Hype



Phase 2

- Mainstream Adoption
- Focus on Private-Permissioned/Hybrid
- Standards, Scalability
- Interconnected/ Interchains Protocols
- Interoperability
- "Carrier/Telco-Grade" Design
- Multi-Cloud, Multi-Ledger

Blockchain Telecom

enterprise processes

network, services

5G, IoT, Cloud

2008



Satoshi's Bitcoin paper

2013
Ethereum

2017

2018



2019



WS-27: IEEE GLOBECOM 2019 WORKSHOP ON BLOCKCHAIN IN TELECOMMUNICATIONS: EMERGING TECHNOLOGIES FOR THE NEXT DECADE AND BEYOND

2022

2030

enterprise mainstream adoption (similar to SaaS, billing, CRM, ERP)

Towards a Secure, High Performance DLT Blockchain Web 3.0

level of technology and business disruption

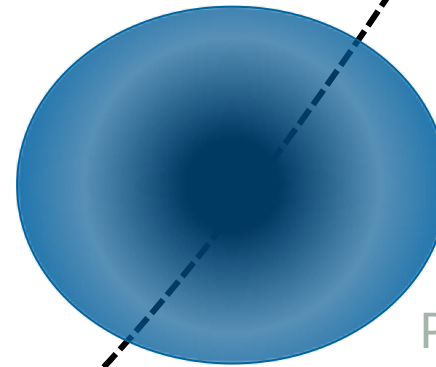
2P2S
Enterprise-Grade
Inter-Chain Sidechain

- focus on
- ✓ **Standards**
 - ✓ **Interoperability**
 - ✓ **Security**



Programmable Blockchain

- ✓ fragmented technologies
- ✓ no-standards
- ✓ crypto-frenzy



PERMISSIONED

- ✓ highly secure (client, p2p, encrypted protocols, trusted environment)
- ✓ scalable (inc. machine micro-transactions)
- ✓ high-performance (use of SLA)
- ✓ high levels of privacy (assets and transactions), level 1 GDPR compliance



2008

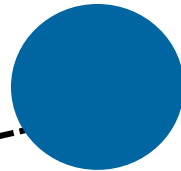
cryptocurrency



PERMISSION LESS

2013-present

cryptocurrency/
 programmable
 smart contract

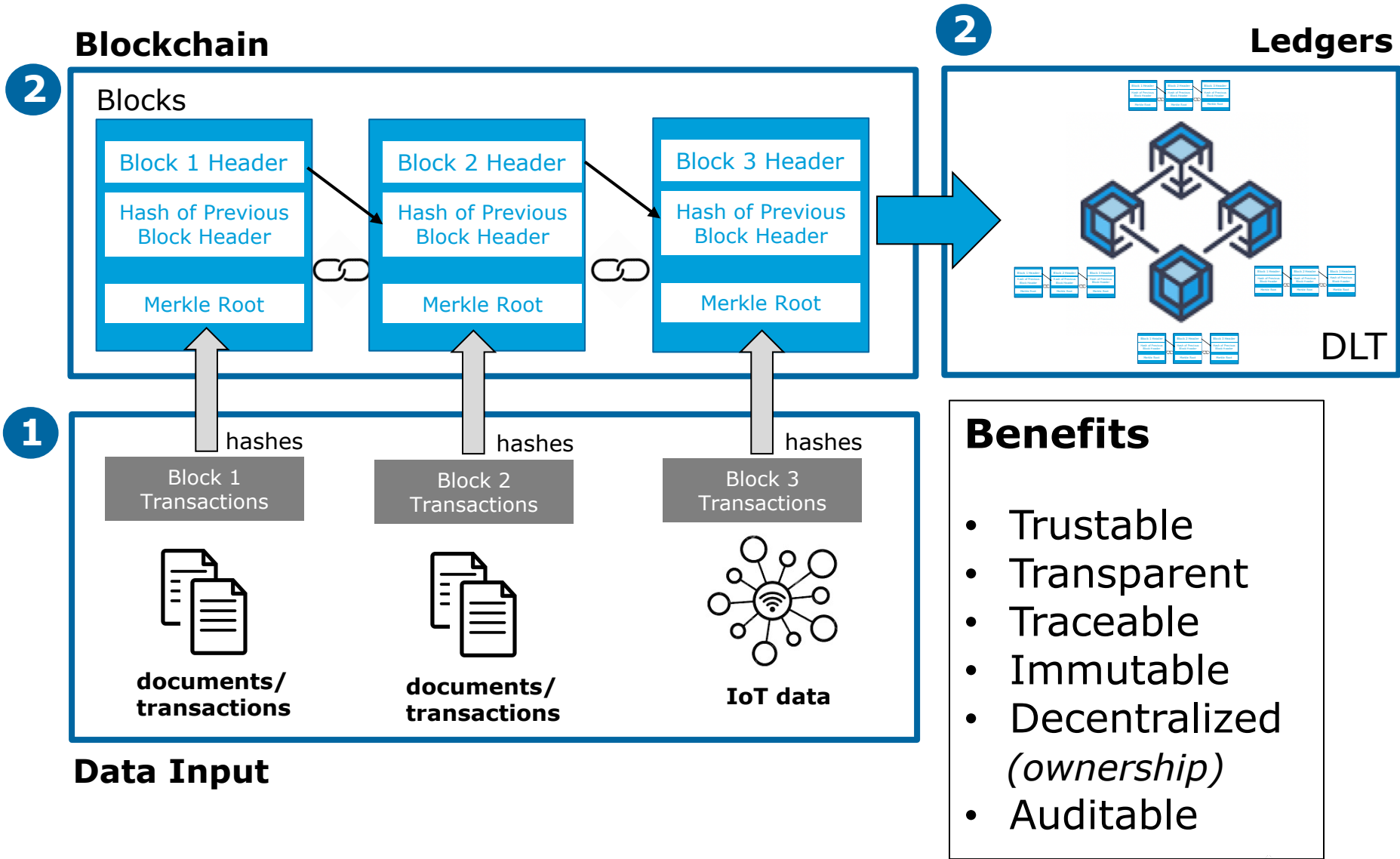


2019 →

2P2S Inter-chain
 Enterprise-Grade DLT

source: BEC, 2018

Blockchain Fundamentals and Benefits



Principles

Key Principles

10 Best Principles & Recommendations

Open Standards

Secure

Technology Agnostic

Future Proof

Interoperable

Scalable

Modular

Manageable

Reliable

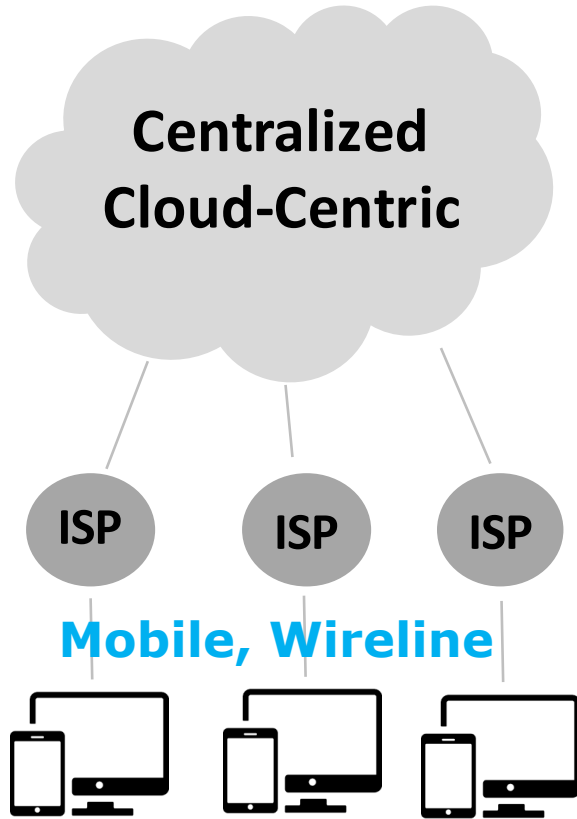
Inclusive

**Recommended
Approach**

**"Open" and
Interoperable
DLT/Blockchain
Standards-Based**

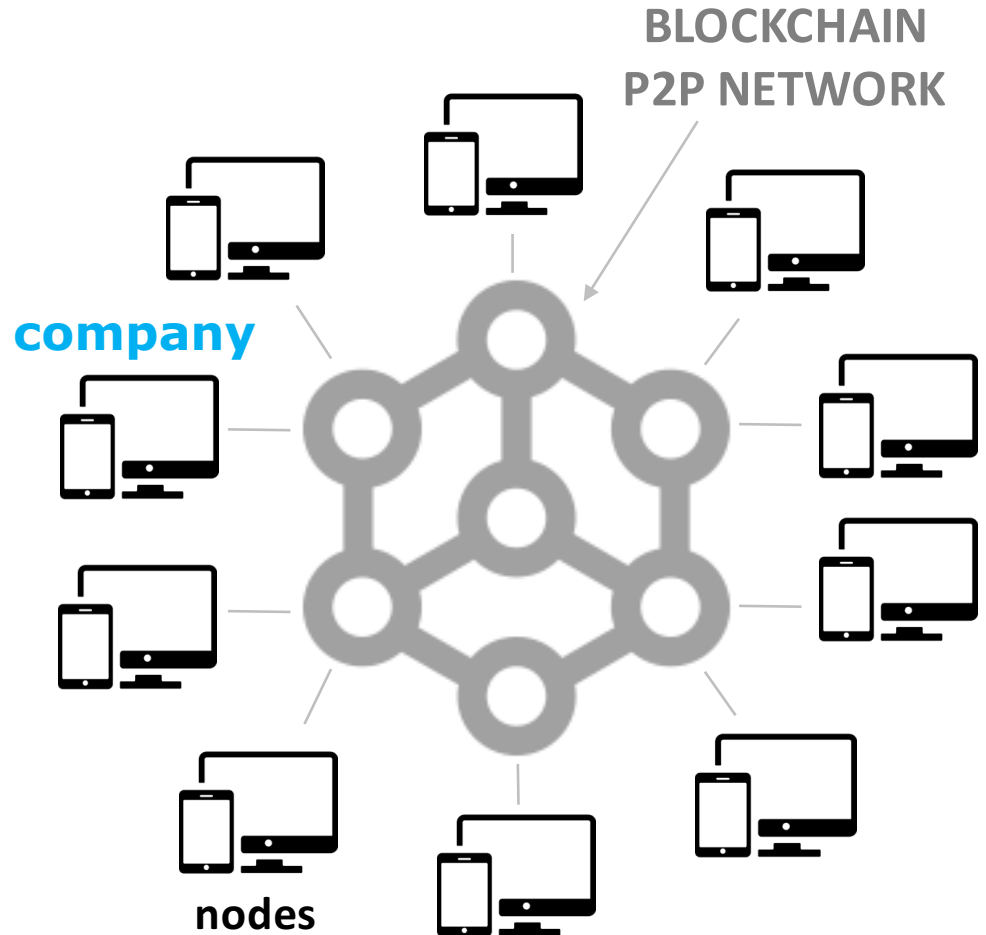
Decentralized Applications - DApp

TELCOS



(centralized) Apps

Today



Decentralized Applications (DApps)

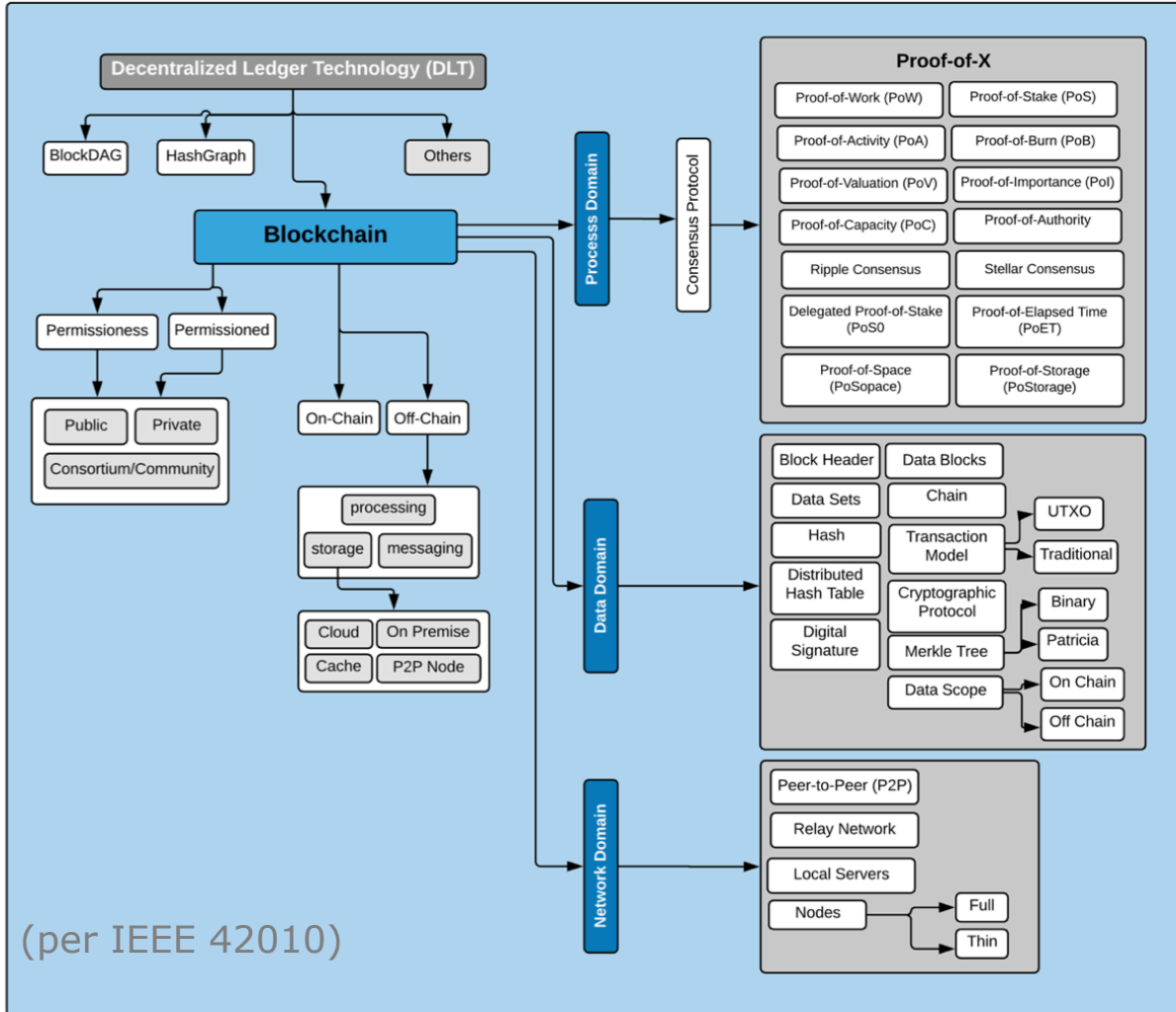
2019 →

Blockchain DLT (BDLT) System-of-Interest

(per IEEE42010)

An All inclusive Framework

DLT/Blockchain System of Interest

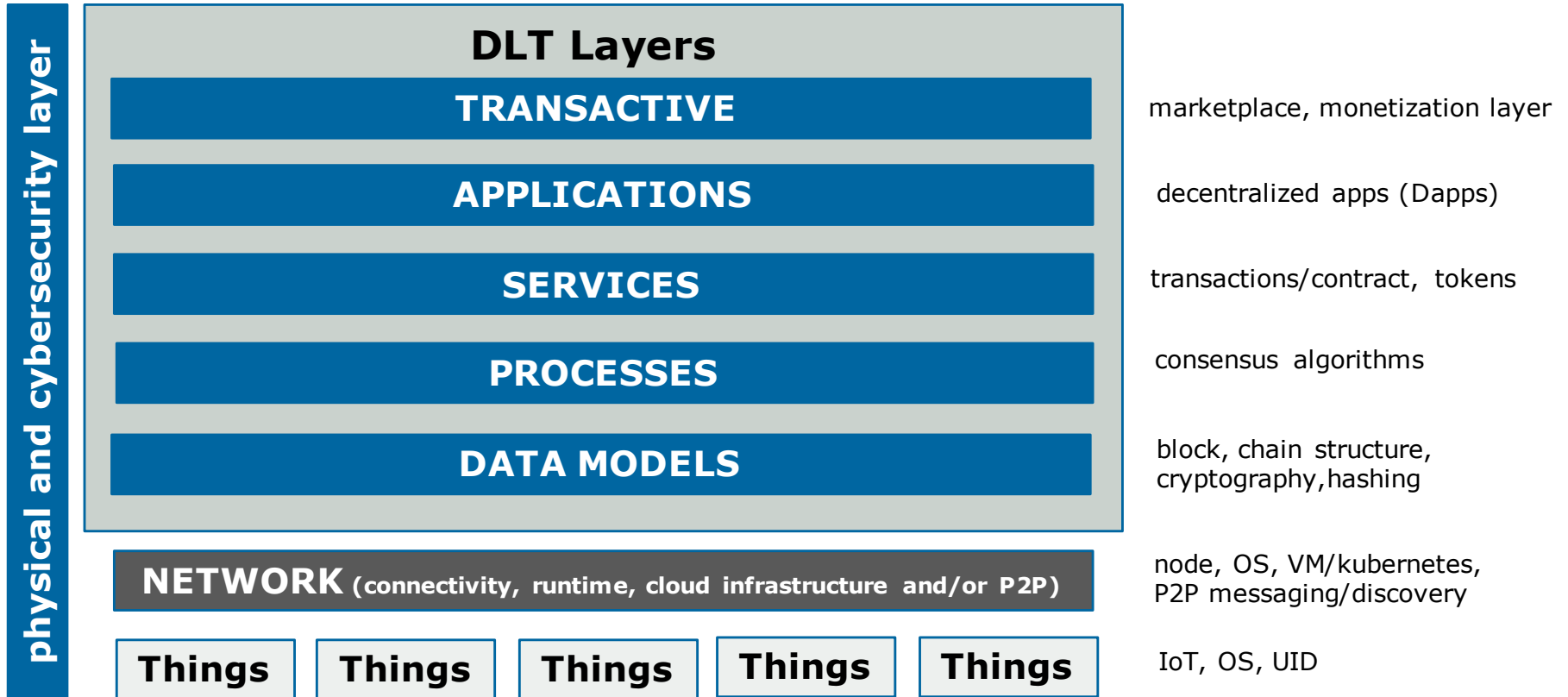


(per IEEE 42010)

- ✓ Blockchain-IoT Reference Architecture, based on IEEE 42010 framework (undergoing)
- ✓ All alternatives included - considers more than Blockchain as technology enabler
- ✓ Addresses key domain/layer levels
- ✓ Includes (most) Blockchain/DLT technologies elements

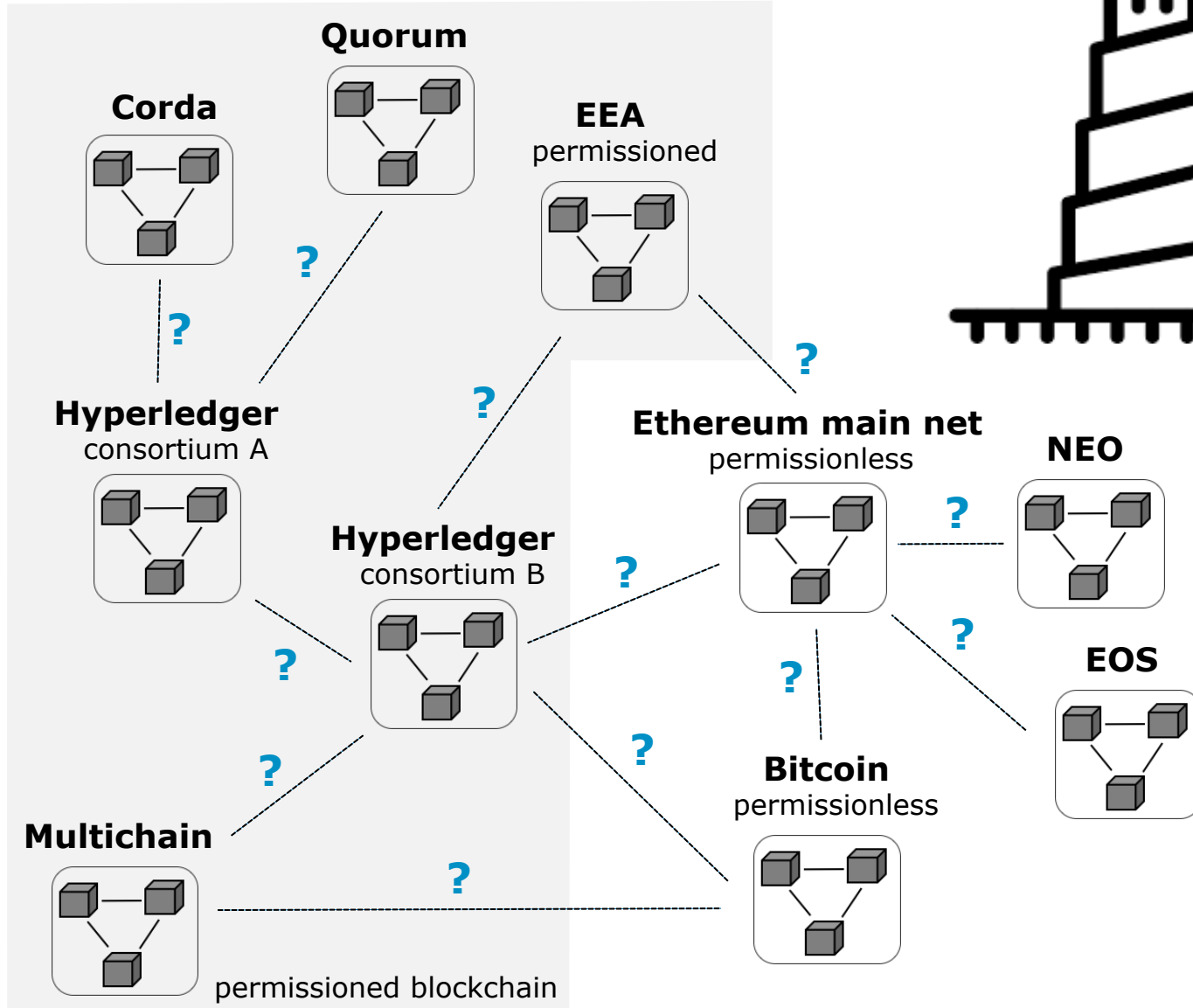
Defining the Key BDLT Blockchain-DLT Layers

The building layers of Blockchain DLT systems need to be defined to categorize its key elements, independent of the DLT technology adopted



Blockchain "Tower of Babel"

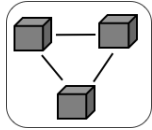
The need for Blockchain DLT interoperability!



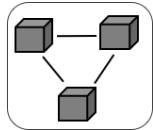
Permissioned Blockchain "Silos"

Single company, inter and intra-companies

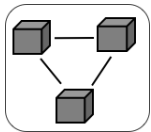
Blockchain consortiums silos



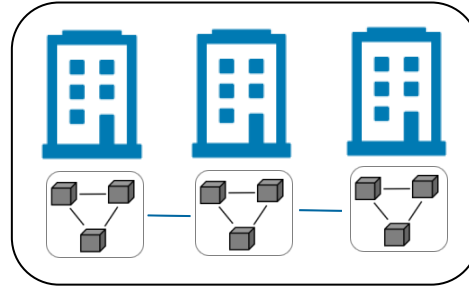
single company
blockchain A



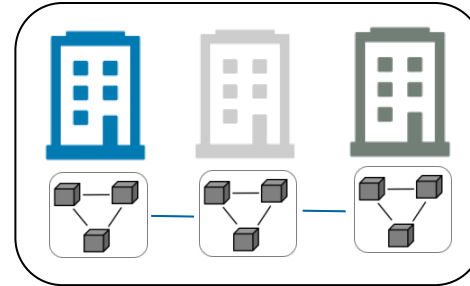
single company
blockchain B



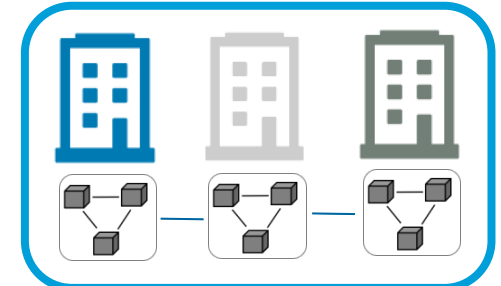
single company
blockchain C



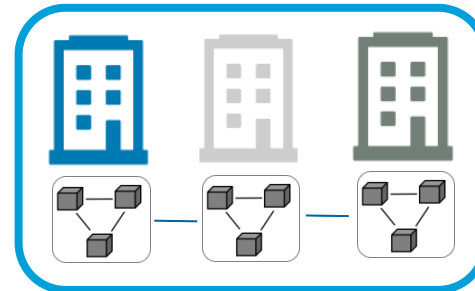
intra-company consortium
blockchain A



inter-company consortium
blockchain B



inter-company consortium
blockchain (vertical market A)



inter-company consortium
blockchain (vertical market B)

Blockchain DLT Interoperability Definition

“**Blockchain DLT Interoperability** is the ability of distributed ledger computing systems to interconnect multiple intra and inter-DLT blockchain sub-systems and systems to create, destroy, modify, change, transfer, register and validate digital assets and transactions and its states, across multi-ledgers in a secure, scalable, trusted and consensus-based approach.”

BEC, September 16th 2019

3 important design criteria

- open-protocols
- multi-chain, multi-ledger frameworks
- 2P2S (privacy, performance, scalability & security)

Blockchain Telecom Multi-Layer Design

Blockchain in Telecom requires “carrier-grade” design principle

National Wide Backbone

Regional Backbone

Metro Networks

Access Networks (micro, pico, nano, femto)

Home-Local Networks

Blockchain DLT Interoperability Layers

There are different levels of Blockchain DLT interoperability

Semantic Interoperability

dApps, Smart Contract Interoperability

Multi-Ledger Interoperability

Middleware Layer Interoperability

Multi-Cloud/P2P Network Interoperability



Blockchain DLT Interoperability Techniques and Use Cases

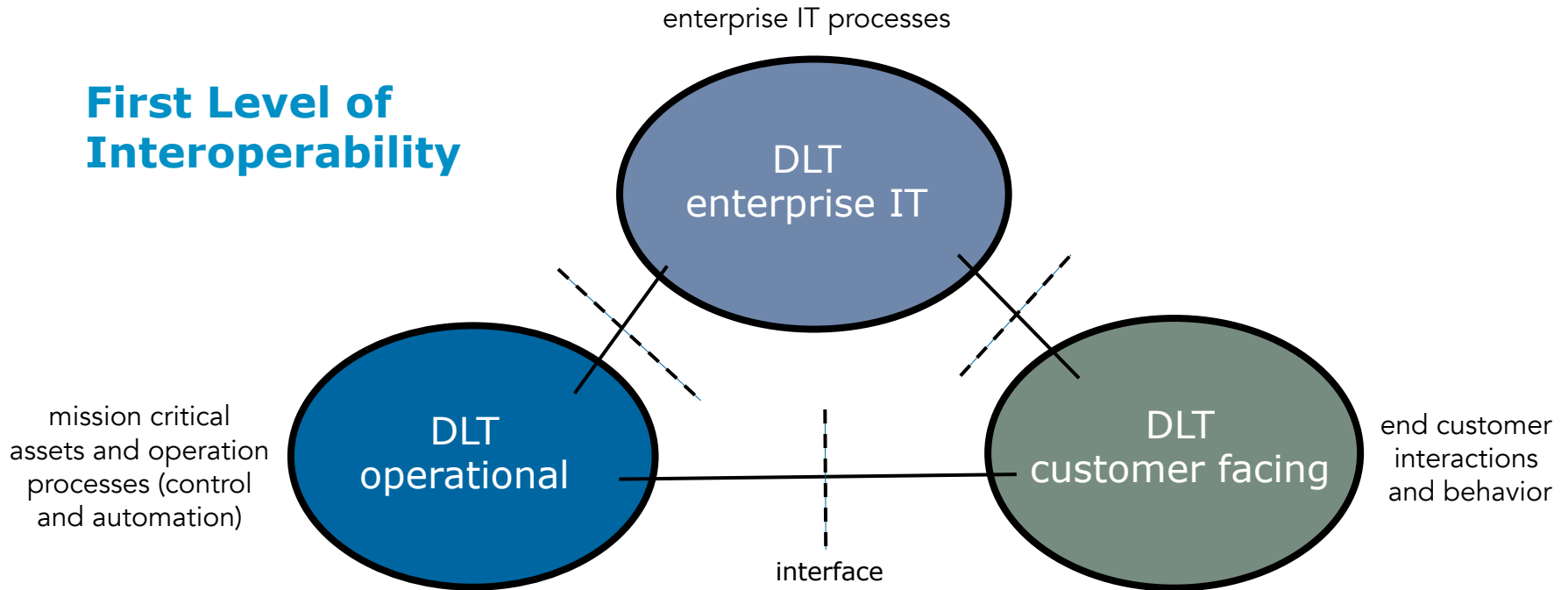
- Notary schemes
- Relays and sidechains
- Hash-locking

use cases

- Asset portability
- Atomic swap
- Cross-chain oracle
- Cross-chain contracts

3 Main Categories of Blockchain DLT Systems

The first design criteria for permissioned DLT systems is to identify which DLT category applies for a particular application



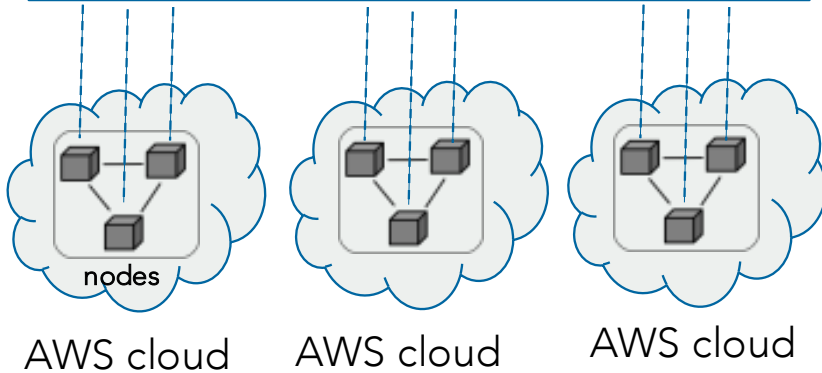
There isn't a "one-size fits all" solution in Blockchain design

Multi-Cloud, Multi-Ledger Interoperability

OPTION A

multi-cloud, single-vendor single-ledger

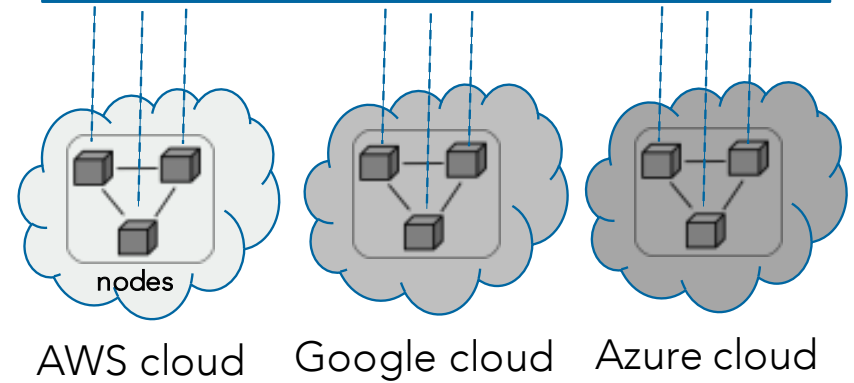
DLT Ledger



OPTION B

multi-cloud, multi-vendor single-ledger

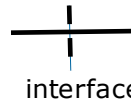
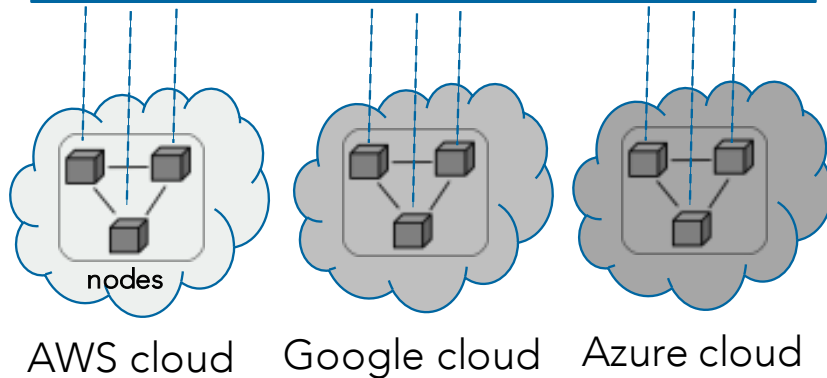
DLT Ledger



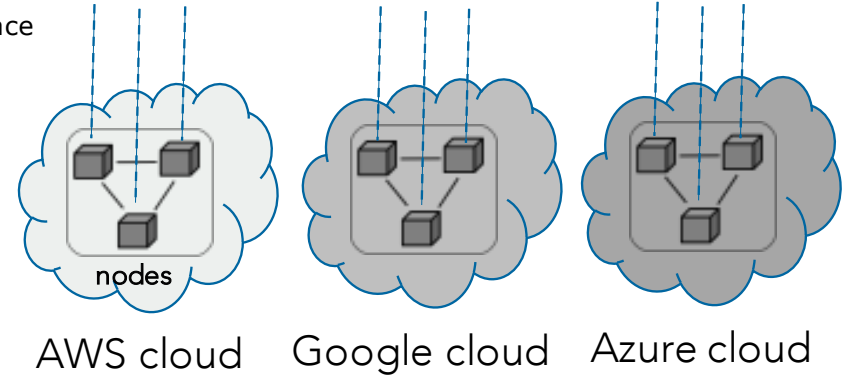
OPTION C

multi-cloud, multi-vendor multi-ledger

DLT Ledger 1



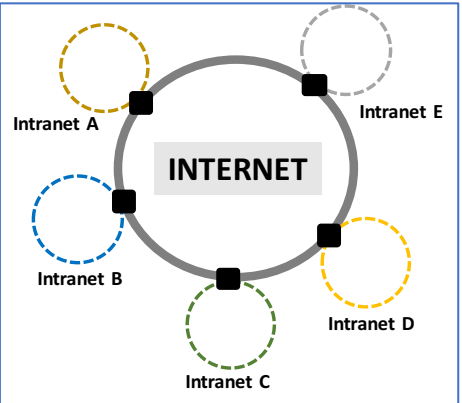
DLT Ledger 2



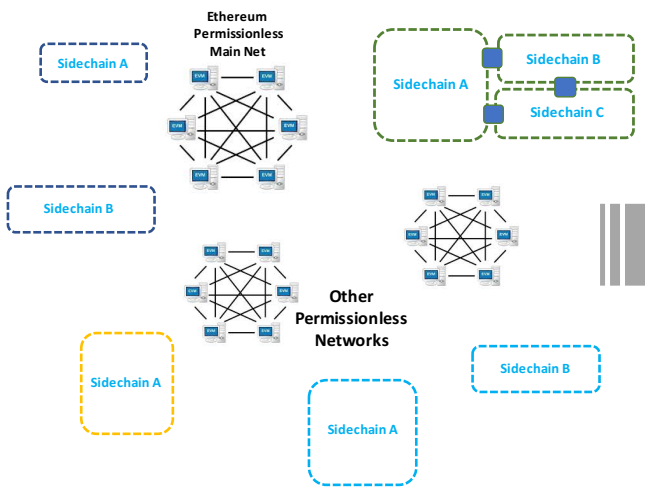
Next Step: Blockchain Interoperability

Connecting the Dispersed Blockchains!

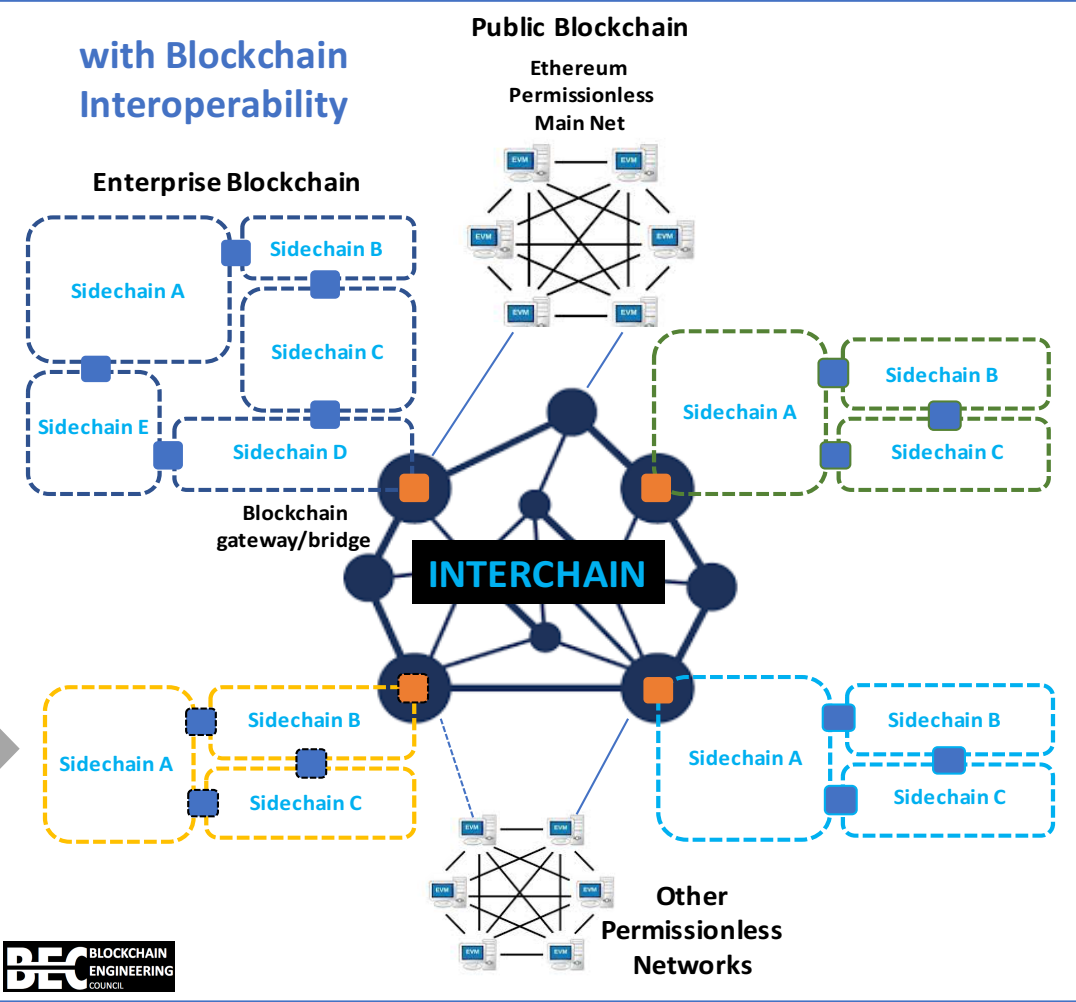
early days of Internet



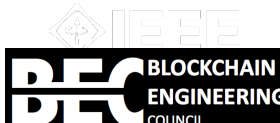
2018 Blockchain Fragmented Ecosystem



with Blockchain Interoperability



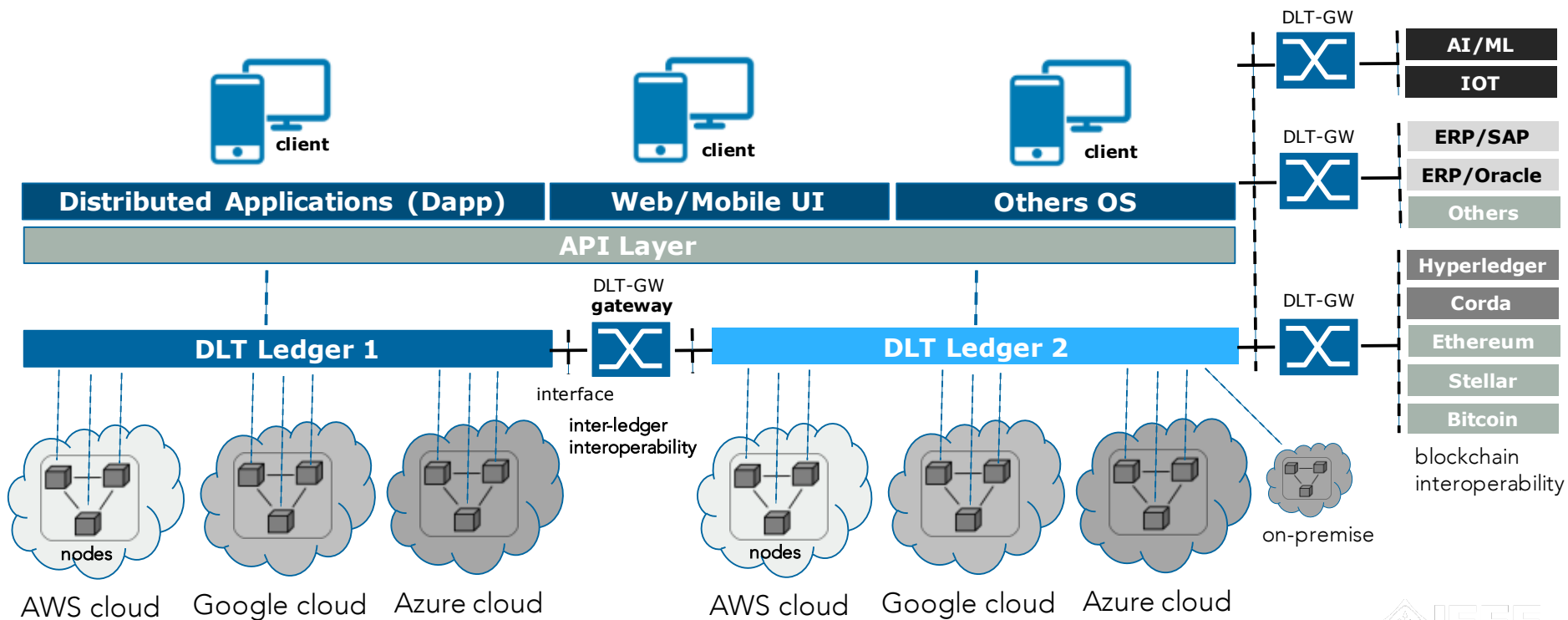
DLT Interoperability Labs (DLT-i-Labs)



Blockchain DLT Interoperability Framework

DLT Gateway

- Interconnects multi-cloud, multi-ledger
- Interconnects blockchains with legacy systems (e.g. ERPs and other database)
- Interconnects blockchains to augmented and edge intelligence (AI/ML, IoT)
- Supports single and multi-ledger API
- Supports multi-client interfaces and Dapps



Key Takeaways

- Blockchain DLT silos and multi-ledger permissioned and permissionless technologies create a “Tower of Babel”, similarly to the early days of the Internet networks and protocols.
- There are 3 main categories when designing DLTs: operational, enterprise IT and customer-facing, each one with a distinct set of functional requirements.
- Multi-cloud, multi-ledger interoperability is the first infrastructure layer to be considered.
- DLT gateways can interconnect multi-blockchain ledgers, and legacy IT, including new AI/ML and IoT solutions.
- “Carrier/telecom-grade” design – needs redundant, scalable, secure and high performance blockchain networks.
- **Blockchain DLT interoperability** is very important for global adoption of blockchain, and the IEEE standards will address this topic.

IEEE Blockchain in Telecom Workshop, Globecom 2019

(December 13th)

WS-27: IEEE GLOBECOM 2019 WORKSHOP ON BLOCKCHAIN IN TELECOMMUNICATIONS:
EMERGING TECHNOLOGIES FOR THE NEXT DECADE AND BEYOND

TOPICS TO BE COVERED

This workshop will be aligned with IEEE Blockchain Initiative strategic directions and promoted as a joint initiative with Globecom

The IEEE Globecom Telecommunications Blockchain Workshop invites prospective authors to submit their original technical work on any aspect of engineering, science, and technology of current interest to the workshop. Topic areas include, but are not limited to, the following:

- Blockchain in 5G Technologies
- Blockchain in IoT
- Blockchain in Networking and Cloud Technologies
- Blockchain in Telecommunications Process, Operation and Customer Management
- Blockchain Telecom Enterprise Applications
- Blockchain Telecom in Home Automation and Communications
- Blockchain Telecom Cybersecurity
- Blockchain Telecom Scalability, Performance and Privacy
- Blockchain Telecom Interoperability
- Blockchain Telecom Pilots and Applications
- Blockchain Telecom Regulatory Challenges and Requirements
- Blockchain Telecom Emerging Technologies



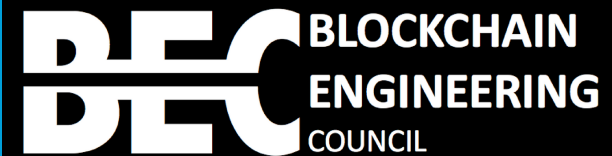
<https://globecom2019.ieee-globecom.org/workshop/ws-27-ieee-globecom-2019-workshop-blockchain-telecommunications-emerging-technologies-next>

IEEE GLOBECOM 2019

THANK YOU!

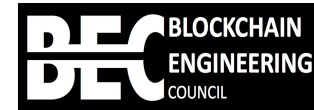
CONTACT

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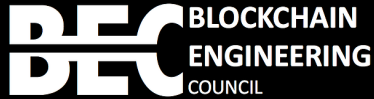
Bio

Claudio Lima, Ph.D.



- *Chair IEEE **Blockchain Global Standards***
- ***IEEE Blockchain Initiative Telecom**/Energy Lead*
- *Chair IEEE **Blockchain Telecommunications** Workshop 2019, Globecom Hawaii, Dec 2019*
- *Co-Author "Blockchain Blockchain for 5G: Opportunities and Challenges, Globecom 2019*
- *Tutorial IEEE Globecom 2019 – **Blockchain Telecom Interoperability***
- *Former Head of Sprint-Nextel Digital Media Innovation, Distinguished MTS/Research Scientist Sprint Advanced Technology Labs (Silicon Valley)*
- *Global CTO Huawei Technologies, Smart Grid*
- *Former Global Standards Director of Ethereum Enterprise Alliance (EEA)*
- *Vice-Chair and Author of IEEE 2030 Smart Grid Standards and Smart Grid Architectures*
- *Advisory Board Member of Department of Energy-DOE/PNNL **Blockchain Cybersecurity***
- *Smart City-IoT City of Houston, Member of Advisory Board*
- *13+ USPTO Patents in Advanced Telecom, Mobile and Digital Media*
- *Ph.D. Electronic Engineering (UKC, UK), M.Sc./B.Sc. Electrical Engineering*

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