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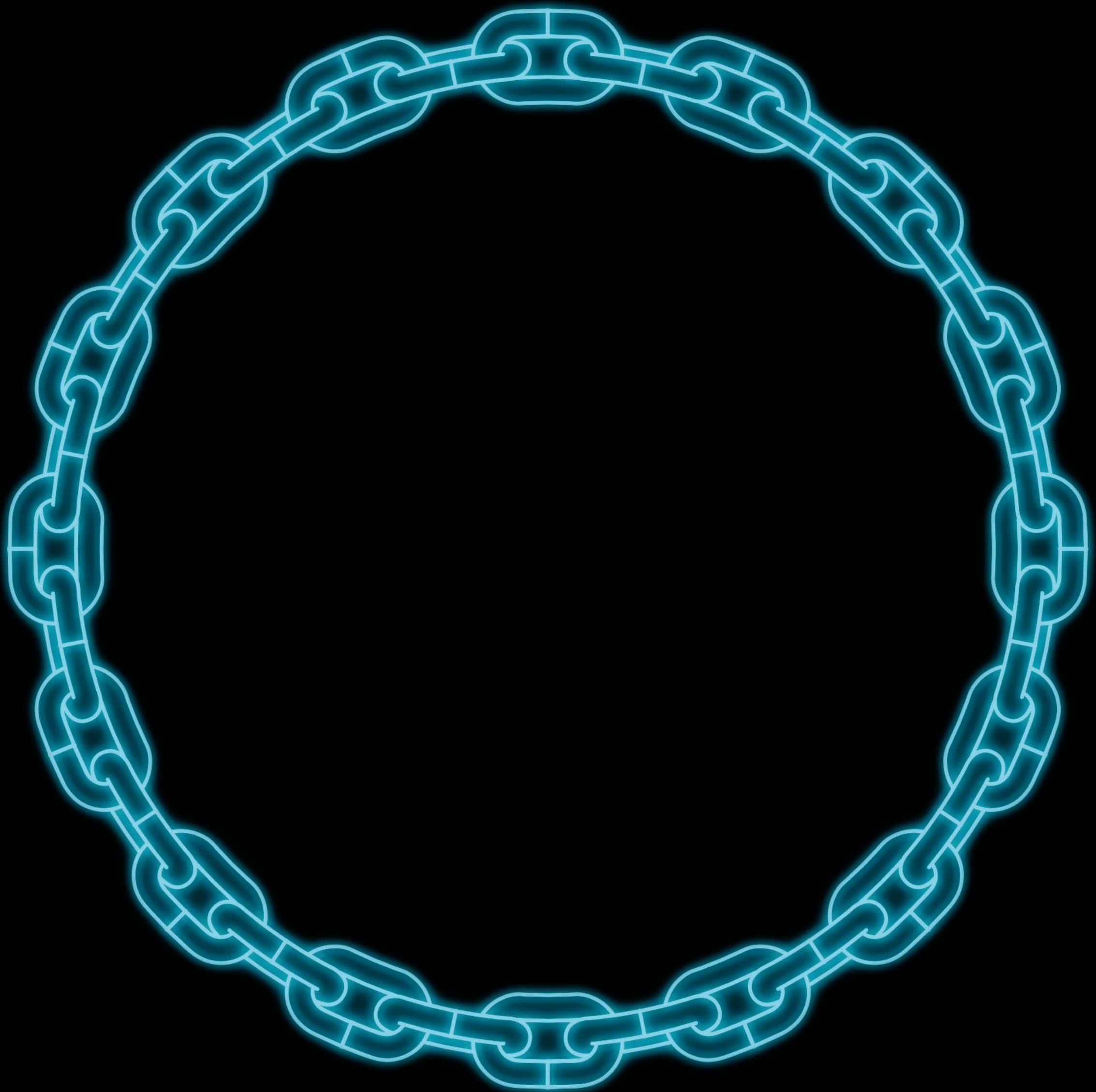

Blockchain @ Telco

How blockchain can impact the telecommunications industry and its relevance to the C-Suite

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Content

Introduction

Blockchain is currently one of the most widely-discussed and hyped technologies. There are not many industries that shouldn't be either excited or worried about its potential, with use cases, proof-of-concepts, and full-fledged businesses based on blockchain technology emerging at an increasing pace.

The technology carries the potential to disrupt business models in many industries, including telecoms, and can increase transparency and efficiencies in the process. However, blockchain applications are young and evolving and complementary industry-wide standards are most probably still a few years away. Nonetheless, to avoid disruptive surprises or missed opportunities, strategists, planners, and decision-makers in the telecom ecosystem should take the time now to investigate applications of the technology in both core and adjacent operations and business functions. Early familiarity with related opportunities and challenges will position them better to gain advantages in terms of revenue growth and cost reductions when the technology is mature and ready for wider adoption.

What is a blockchain?

Blockchain is currently one of the most widely-discussed and hyped technologies. There are not many industries that shouldn't be either excited or worried about its potential, with use cases, proof-of-concepts, and full-fledged businesses based on blockchain technology emerging at an increasing pace.

A blockchain's key characteristics as illustrated in Figure 2 are integral to its potential.

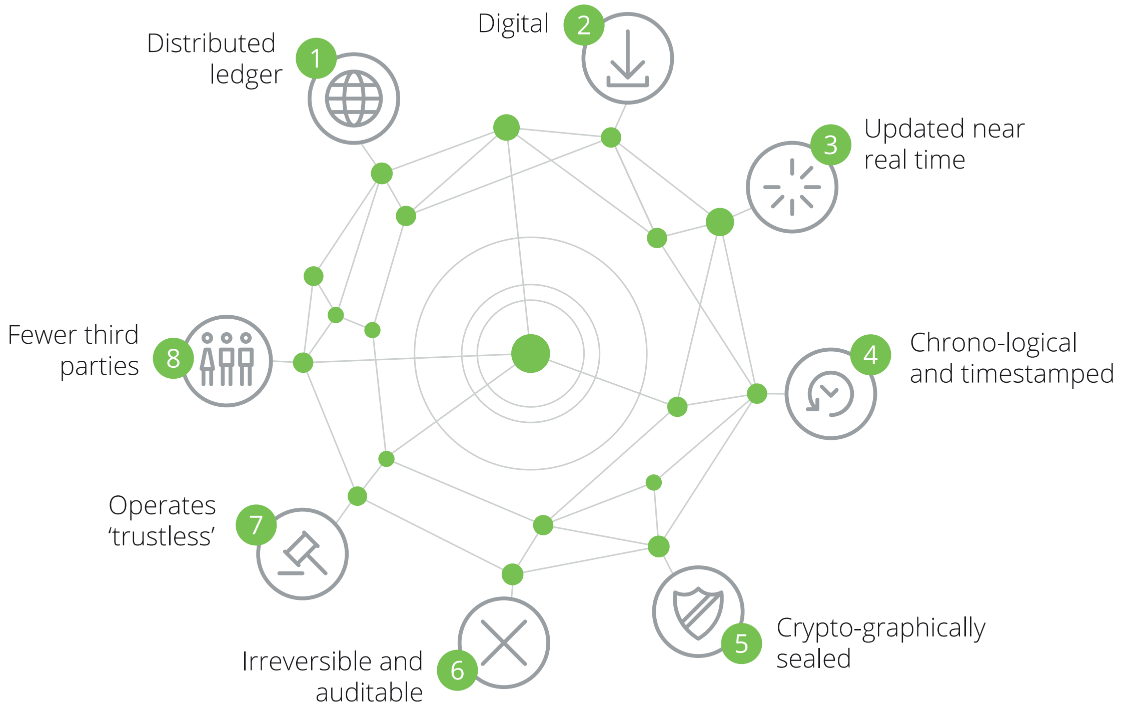


Figure 2: A blockchain's key characteristics

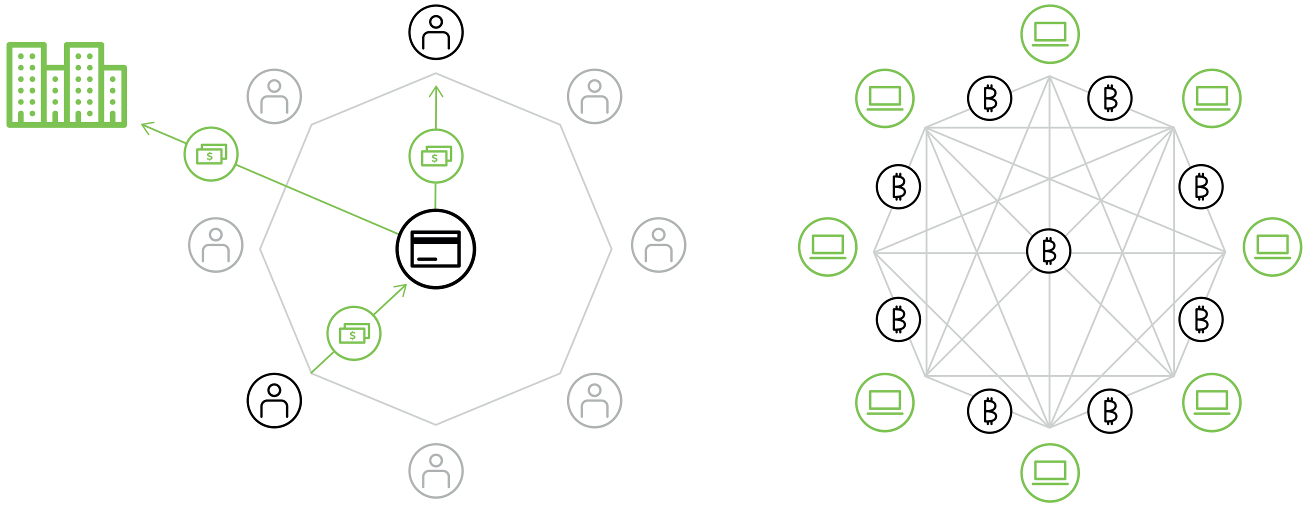


Figure 1: Centralized versus decentralized transactions

The advantages of this type of multiple, decentralized storage are robustness and trust, at the expense of confidentiality and processing performance. Every participant in the network has the ability to verify the correctness of transactions. Network consensus methods and cryptographic technology are used to validate transactions. Thus, trust is not established externally by a central authority or an auditor but continuously within the network as illustrated in Figure 1. Furthermore, decentralized storage in blockchains is known to be very failure-resistant. Even in the event of the failure of a large number of network participants the blockchain remains available, eliminating the single point of failure. New information stored in the blockchain is immutable. Its method of record-keeping prevents deletion or reversing of transactions once added to the blockchain, as soon as further blocks are added.

The use cases discussed below are all built around these unique blockchain characteristics as enablers for more reliable, tamper-proof, and failure-resistant applications.

CSP value chain and blockchain

Communications service providers (CSPs) have traditionally owned the end-to-end telecoms value chain for both consumers and businesses – spanning network infrastructure, provision of core voice and data connectivity, and related consumer services. However, in an environment of heightened competition in an increasingly digital world from infrastructure light over the top (OTT) players, together with decreasing revenues from voice and increasing costs due to the high band-width demands, there is a need to both reduce costs and find new sources of revenue.

Blockchain has the potential to be for 'value' what the Internet has been for 'information'. In addition to the many use cases being explored for industries such as finance, healthcare, and government, there are plausible applications of blockchain for a CSP, both within its current portfolio of operations and also to capitalize on some of the future telecom trends.

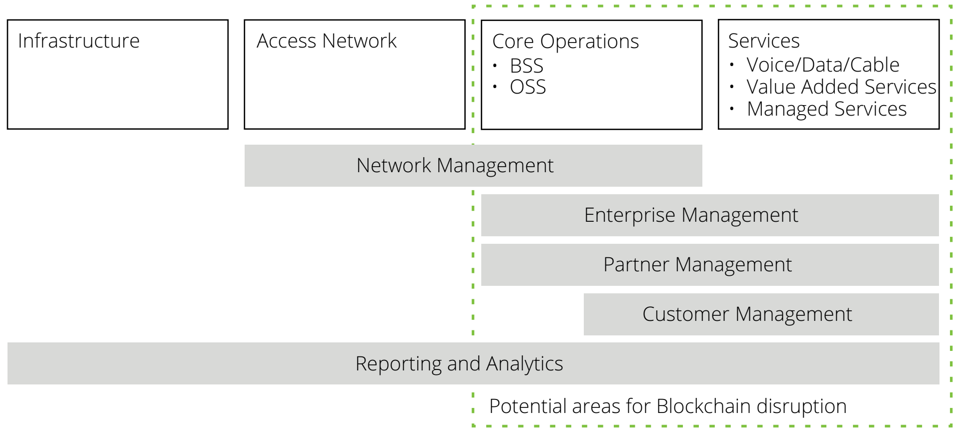
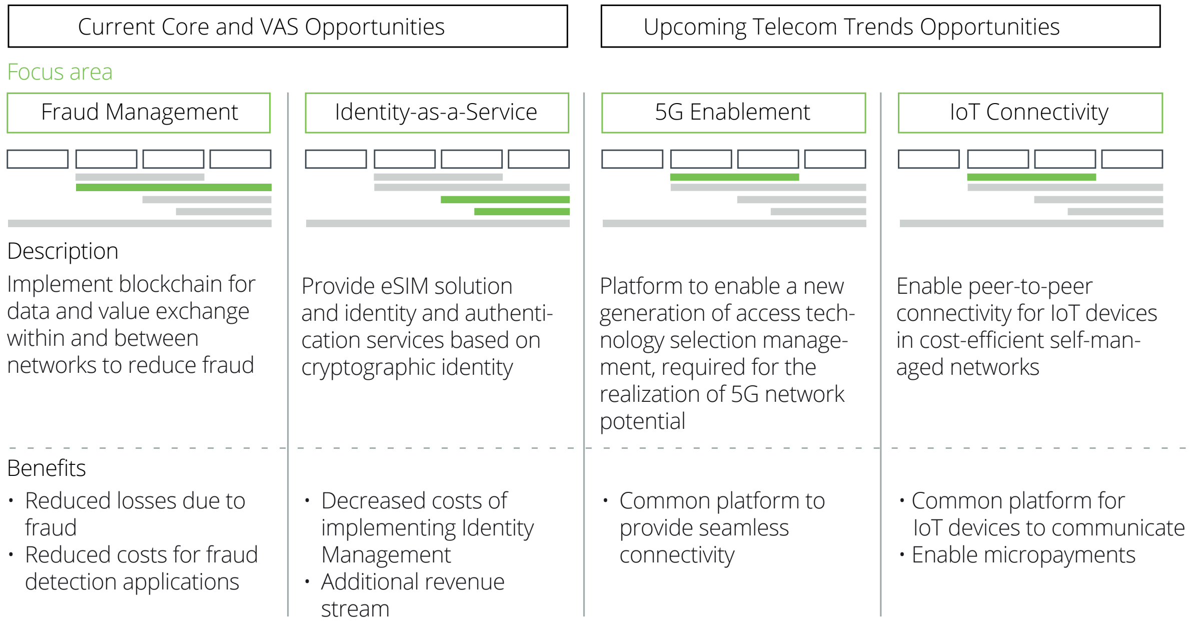


Figure 3: The CSP Value Chain and areas of likely blockchain impact

CSPs will most probably see the greatest impact of blockchain in their core management systems and in adjacent services, providing opportunities for cost reduction through process efficiency gains, and revenue growth through new value propositions. Four use cases help illustrate the potential of blockchain for CSPs: Fraud Management, Identity-as-a-service and Data Management, 5G enablement, and secure IoT connectivity


Current Core and VAS Opportunities
Upcoming Telecom Trends Opportunities
Focus area

	Fraud Management	Identity-as-a-Service	5G Enablement	IoT Connectivity
Description	Implement blockchain for data and value exchange within and between networks to reduce fraud	Provide eSIM solution and identity and authentication services based on cryptographic identity	Platform to enable a new generation of access technology selection management, required for the realization of 5G network potential	Enable peer-to-peer connectivity for IoT devices in cost-efficient self-managed networks
Benefits	• Reduced losses due to fraud • Reduced costs for fraud detection applications	• Decreased costs of implementing Identity Management • Additional revenue stream	• Common platform to provide seamless connectivity	• Common platform for IoT devices to communicate • Enable micropayments

Figure 4: Potential use cases of blockchain for a CSP

Use Cases

Use Case #1 –

Fraud Prevention

Fraud detection and prevention continue to be topics of relevance for most CSPs, as a result of fraud costs in the industry of over USD 38 billion[11] annually. Given that the telecoms industry has not yet found a way to effectively and sustainably prevent fraud, blockchain is in principle a good contender for significantly decreasing the cost of fraud e.g. in roaming and in identity management.

Roaming fraud
Current system - When a call/event is placed, the Visited Public Mobile Network (VPMN) queries the Host Public Mobile Network (HPMN) about the services to which the roaming user has subscribed, by querying the Home Location Register (HLR). The Call Detail Records (CDRs) are sent to the billing systems in their respective networks. These systems are in charge of processing CDRs and the generation of invoices to subscribers.

The VPMN sends CDR information to the HPMN as a Transfer Account Procedure (TAP) file. Certain companies act as a Data Clearing House (DCH) for these files. A DCH is responsible for the transmission and conversion of the TAP files on behalf of the CSP which has hired it.

Once the TAP files are received, the HPMN must settle accounts per costs incurred with the VPMN in accordance with the corresponding roaming agreement tariffs.

Blockchain has the potential to reduce losses due to fraud and minimize costs for fraud detection applications.

Current challenges – Roaming fraud occurs when a subscriber accesses the resources of the HPMN via the VPNM but the HPMN is unable to charge the subscriber for the services provided, but is obliged to pay the VPNM for the roaming services. Roaming fraud exploits two characteristics:

- *Longer detection time:* since the fraud occurs when the subscriber is in a network other than that of the HPMN, the time required to detect the fraud is longer due to delays in the exchange of data between VPMN and HPMN.
- *Longer response time:* due to lack of control over the systems in which the fraud has occurred, the time to respond to the fraud is longer than if the fraud had occurred in a system owned by the HPMN.

[1] Communications Fraud Control Association (CFCA) 2015 Global Fraud Loss Survey

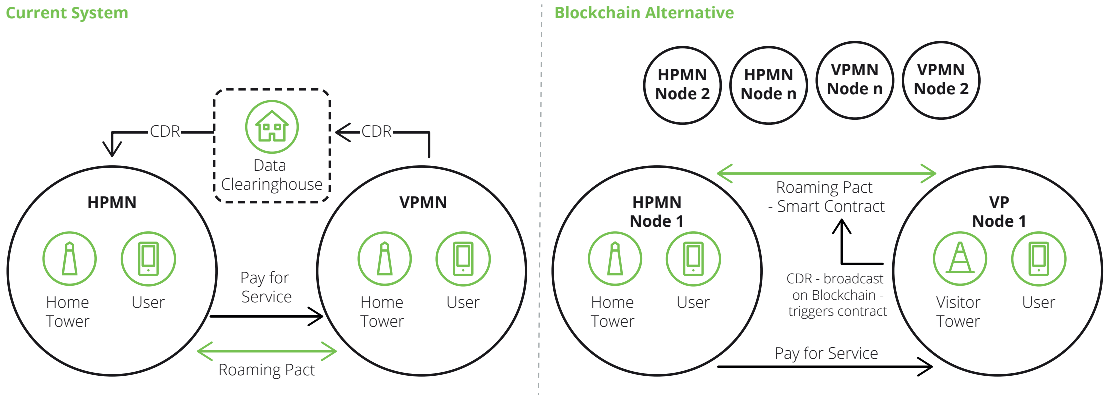


Figure 5: Roaming Fraud prevention use case - illustrative

Blockchain-based solution - A permissioned blockchain could be implemented between every pair of operators which have a roaming agreement. Designated nodes from both operators act as miners to verify the sanctity of each transaction broadcasted on the network. The roaming agreement is implemented between the HPMN and the VPMN as a smart contract that is triggered when a transaction containing the CDR data is broadcasted on the blockchain network. Every time a subscriber triggers an event in a visiting network, the VPMN broadcasts the CDR information as a transaction to the HPMN. This data triggers the smart contract and the terms of the agreement are executed. The HPMN can thus automatically calculate the billing amount based on the services rendered and send this information back to the VPMN.

Benefits

- Cost savings from eliminating the third-party clearing house.
- Automatic triggering of roaming contract based on call/event data which enables near-instantaneous charging and reduction in roaming fraud.
- Repository of verifiable transactions between operators, allowing for quick dispute resolution.

This helps instantaneous and verified authorization as well as settlement to occur in line with blockchain-based smart contract terms. CSPs can also do away with the DCH acting as middleman, resulting in further cost savings.

Subscription identity fraud

Current system - Subscriber identity information is necessary to create an account and assign services to the subscriber. Subscription ID theft occurs when a subscriber uses false identification or another subscriber's (victim) ID to obtain services. Fraudsters can for example use the stolen identity information to obtain a SIM card in the victim's name.

The physical SIM stores the International Mobile Subscriber Identity (IMSI) and the related key is used to identify and authenticate subscribers on mobile devices. Each time a mobile device is turned on, it broadcasts a signal containing the IMSI to the nearest base station. That identification number links the device to the account with the carrier.

Some telecom providers maintain their own fraud databases to identify potential fraud activities. Current solutions are either weak (CSP asks customers to create passcode while creating a wireless account) or expensive (stand-alone ID protection systems such as Equifax), and are sometimes not up-to-date.

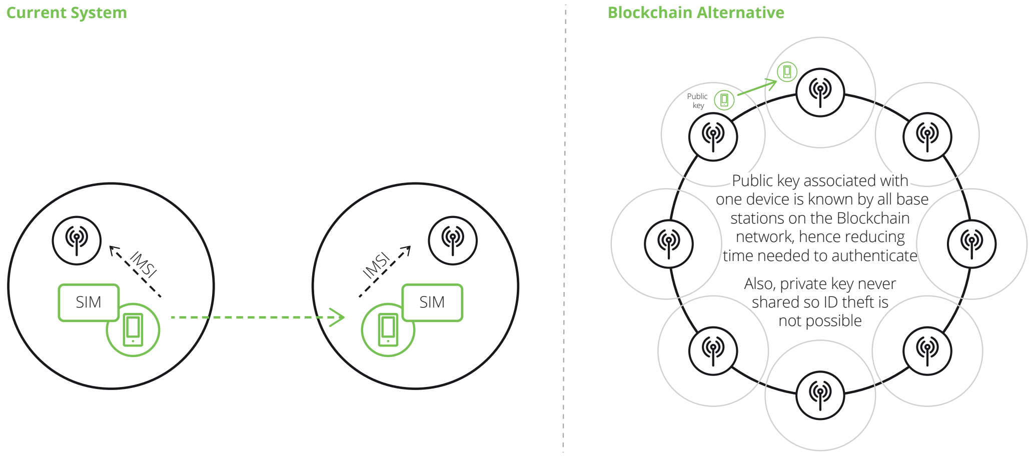

Current System
Blockchain Alternative
SIM
IMSI
IMSI
SIM
Public key
Public key associated with one device is known by all base stations on the Blockchain network, hence reducing time needed to authenticate
Also, private key never shared so ID theft is not possible

Figure 6: Subscription identity use case

Current challenges - There are many ways in which a subscriber's identity can be compromised (email phishing, SIM cloning, etc.). Due to the multiple-play services provided by telecom operators, an ID theft can result in compounded losses through the access to many services under a stolen identity.

Blockchain-based solution – Public-private cryptography which is inherent in a blockchain can be used to identify a device and link that device to a subscriber's identity. Instead of broadcasting the IMSI to the network to identify the device, the phone-generated public key is broadcasted instead. The device generates this public key from the private key that is stored securely on it. Neither the carrier nor any other third party needs to know the private key.

This 'eSIM' solution can help protect private information that is encrypted in the private key. The private key is associated with only one particular device and is hence difficult to steal. The public key is used to identify the device and to authorize it on the network. The subscriber is uniquely identified by this public key, while able to keep the private key information secret. This way, the services can only be used by the subscriber who has subscribed to them and the ID cannot be easily stolen.
This process also avoids the device information having to be authenticated by the base station every time the device enters a new cell territory. Instead, due to the base stations being nodes on a common blockchain, the device information is already available at the base station and can be authenticated quickly, once the public key is sent to it by the device.

Benefits

- Reduced subscriber or other ID-based fraud.
- Easier and faster device identification during mobility, due to shared database having the device public key information and history.
- Can be used to provide identity to machines in an M2M or broader IoT environment, instead of having to embed physical SIMs into distributed devices.
- Elimination of cost to manufacture and distribute physical SIMs.

Use Case #2 –

Identity-as-a-service and Data Management

CSPs can create new sources of revenue by providing identity and authentication as well as data management solutions to partners, enabled by a blockchain.

> Blockchain adoption could significantly reduce roaming fraud and also optimize ID management through instantaneous and automated processes based on smart contracts.

Currently, every time a person wants to sign up at a vendor, they need to prove their identity and credentials using physical or digital documents. They would need to provide their PII (Personal Identity Information) even though most of the information would not be needed by every vendor; the vendor would only need a subset of that information. Also, signing up online either requires creating many username/password combinations or utilizing the services of third party providers (such as Google and Facebook) to use their SSO (Single Sign On) functionalities.

This leads to many challenges such as lack of convenience (many username/ password combinations) and security (personal data shared with third parties) in current identity and authentication services. And while there are a few alternatives, CSPs currently do not play a significant part in identity and authorization services, even though they possess substantial amounts of relevant subscriber data.

Opportunity for CSPs -
A blockchain can be used as the shared ledger that stores identity transactions. The CSP can provide identity-as-a-service to partners, thus allowing for additional revenue generation by negotiating appropriate agreements.

When a subscriber opens an account with a CSP, the CSP creates a digital identity. The private key associated with this identity is stored safely on the eSIM. The CSP creates a virtual identity, using the public key from the digital identity and adds a set of standard fields (name, address, etc.) as required. It then adds a digital signature using its own private key. A pointer to this virtual identity along with necessary descriptors is then added to the blockchain.

If the subscriber now visits a partner website, say an e-commerce site, the site will need to know their identity, so the merchant site starts running the corresponding app on the phone to provide the identity. A copy of the ledger entry is sent to the e-commerce site app. Now the e-commerce app can look at all entries for that same virtual identity. Once the virtual identity is established, the e-commerce site needs to know that the virtual identity belongs to the subscriber so its app takes the public key from the virtual identity, encrypts a challenge and sends it to their app which decrypts it (because it has the associated private key) and responds. Now the e-commerce site generates an e-commerce virtual identity which is then stored in the ledger itself.

The next time the subscriber visits the same e-commerce site, he can be authenticated using the same mechanism. Also, the ledger already holds his transaction history and hence knows his preferences. The e-commerce site can use related insights for a recommendation engine. The subscriber can also use the same e-commerce virtual identity to login to a completely different e-commerce site using the same mechanism.

The CSP virtual identity can be used to help create further virtual identities similar to the e-commerce one (such as a travel virtual identity). This identity need not know all of the details from the subscribers digital identity, only the ones that are relevant (such as his home location) and add other attributes (such as his preferred mode of travel) to create a travel virtual identity. The possibilities of such identity management are limited only by the number of partner service providers that the CSP can sign on to the blockchain-based system.

Application to Data Management

The CSP can extend such a blockchain-enabled identity and access solution to provide data storage and verification services to private clients. Consider the example of an educational institution. Educational institutions issue certificates and degrees to their students to signal the completion of a course. The current system of managing certificates is slow, unreliable, and disjointed. It often still requires maintaining a paper copy of the certificate to be physically submitted to third parties legitimately requesting proof of course completion and grades. Additional steps today might include an employer, for example, calling a university to verify that a certificate is not a fake, or relying on a third-party to perform that verification.

CSPs could provide blockchain based Identity verification, data management and storage services to both private clients and subscribers, generating additional revenue in the process. The educational institution signs up with the CSP to digitize and store certificates of subscribers on the blockchain. For those subscribers who also sign up (and are, of course, alumni of the university), their identity and degree certificate are verified by the university through traditional channels, and the university assigns the digital copy of that certificate along with all details (course name, date of issue, etc.) to the subscriber.

If a prospective employer of the subscriber now wants to verify the credentials and inspect the certificate, the subscriber only needs to produce the digital certificate available on the blockchain and the employer can be sure that this has been issued by the university and is genuine. The CSP can further benefit by extending related authentication services to corporate clients for all types of documents, such as insurance certificates, airline tickets, hotel reservations, etc., where digital storage and verification may be required at some point.

Benefits

- Cost savings from a blockchain-based federated identity management solution as compared to traditional IDM software.
- New revenue stream from providing an identity-as-a-service solution to partners and end-consumers.
- Improved subscriber ease of use as regards ID management.
- Opportunity to form a locked-in ecosystem through strategic partnerships with partners that use identity solutions provided by the CSP.

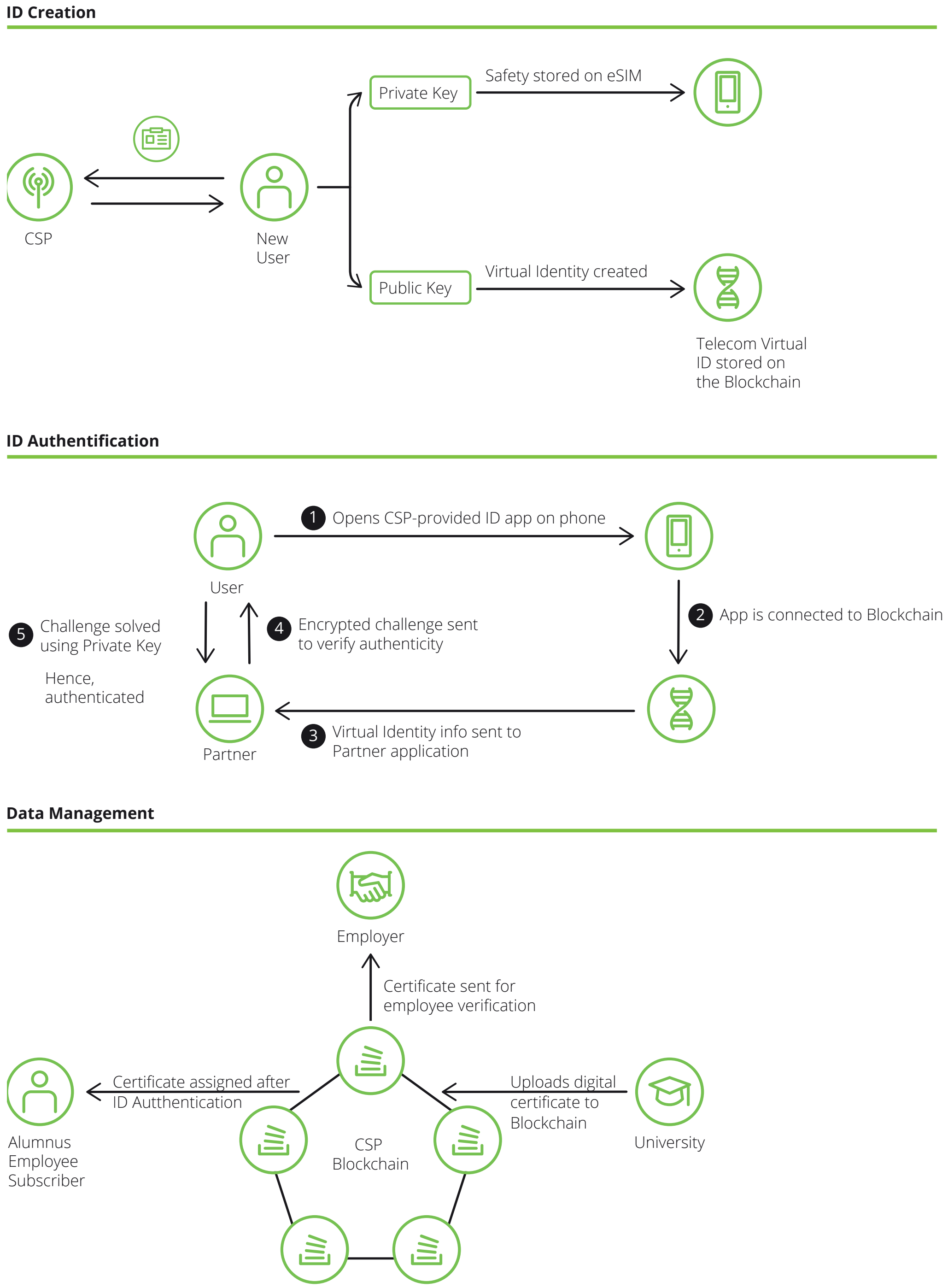

ID Creation
CSP
New User
Private Key
Safety stored on eSIM
Public Key
Virtual Identity created
Telecom Virtual ID stored on the Blockchain
ID Authentification
User
1 Opens CSP-provided ID app on phone
2 App is connected to Blockchain
3 Virtual Identity info sent to Partner application
4 Encrypted challenge sent to verify authenticity
5 Challenge solved using Private Key
Hence, authenticated
Partner
Data Management
Employer
Certificate sent for employee verification
Certificate assigned after ID Autthentication
Alumnus Employee Subscriber
CSP Blockchain
Uploads digital certificate to Blockchain
University

Figure 7: Identity-as-a-Service and Data Management use case

Use Case #3 –

5G enablement

5G technology implementation is another example to potentially benefit from the blockchain to streamline processes. To realize the 5G promise of ubiquitous access across various networks, CSPs will need to handle heterogeneous access nodes and diverse access mechanisms. Selecting the fastest access node for every user or machine will be a central challenge in the future. Blockchain can enable a new generation of access technology selection mechanisms to build sustainable solutions.

Blockchain can enable a new generation of access technology selection mechanisms required for the realization of 5G networks.

Current system – ANDSF, which stands for Access Network Discovery and Selection Function, is an entity within the EPC (Evolved Packet Core) which helps in the discovery/selection of access networks, such as WiFi, WiMax, and LTE, in the device vicinity, providing them with rules policing the connection to these networks. It consists of a list of access networks, such as WiFi, that may be available in the vicinity of a device. This information is received in response to a device request which contains its location and capability, such as types of supported interfaces, among others. The received information assists the device in expediting connection to these networks.

The ANDSF response contains the following information: the type of access technology (WiFi, WiMAX, etc.), the access network identifier, and technology-specific information (such as one or more carrier frequencies).

Current challenges – The system is centralized in a client-server model where the rules stored on the server (ANDSF) are pushed to the client (device). This causes delays and does not allow for seamless provisioning between access networks for the device. Also, the provisioning of rules is not a real-time process – meaning the rules cannot be changed dynamically.

Blockchain-based solution - The 3GPP (LTE, GPRS) and non-3GPP (WiMax, WLAN, WiFi) access networks in a given area can be networked via a blockchain where each access point (WiFi router, SP cell tower, etc.) can serve as a node in the network monitoring the devices.

Rules and agreements between the various access providing networks can be coded as smart contracts. These contracts can be dynamic in nature wherein any time a policy needs to be changed, only the contract code needs to be changed.

When a device broadcasts its identity, it is accepted into the network by the corresponding CSP cell. Once the device broadcasts its location, the access node that can best provide service to the device is called upon to do so.

This also allows for seamless rating and charging of all services between the various access nodes. If, for example, a WLAN from an office or a home network has provided access to a device, then the CSP can conceivably give a reduction in the bill amount appropriately for the invoice of the accommodating company or home. Location-based services can also be enabled by being a part of this blockchain network and hence always knowing which devices are in the vicinity.

Benefits

- Sharing of faster and regulated local connectivity for reliable service to device.
- Instant monetization of diverse connection types through smart contracts.
- Enables local connection prices purely based on supply and demand in the area.
- New business models to use idle capacity for non-prioritized traffic.

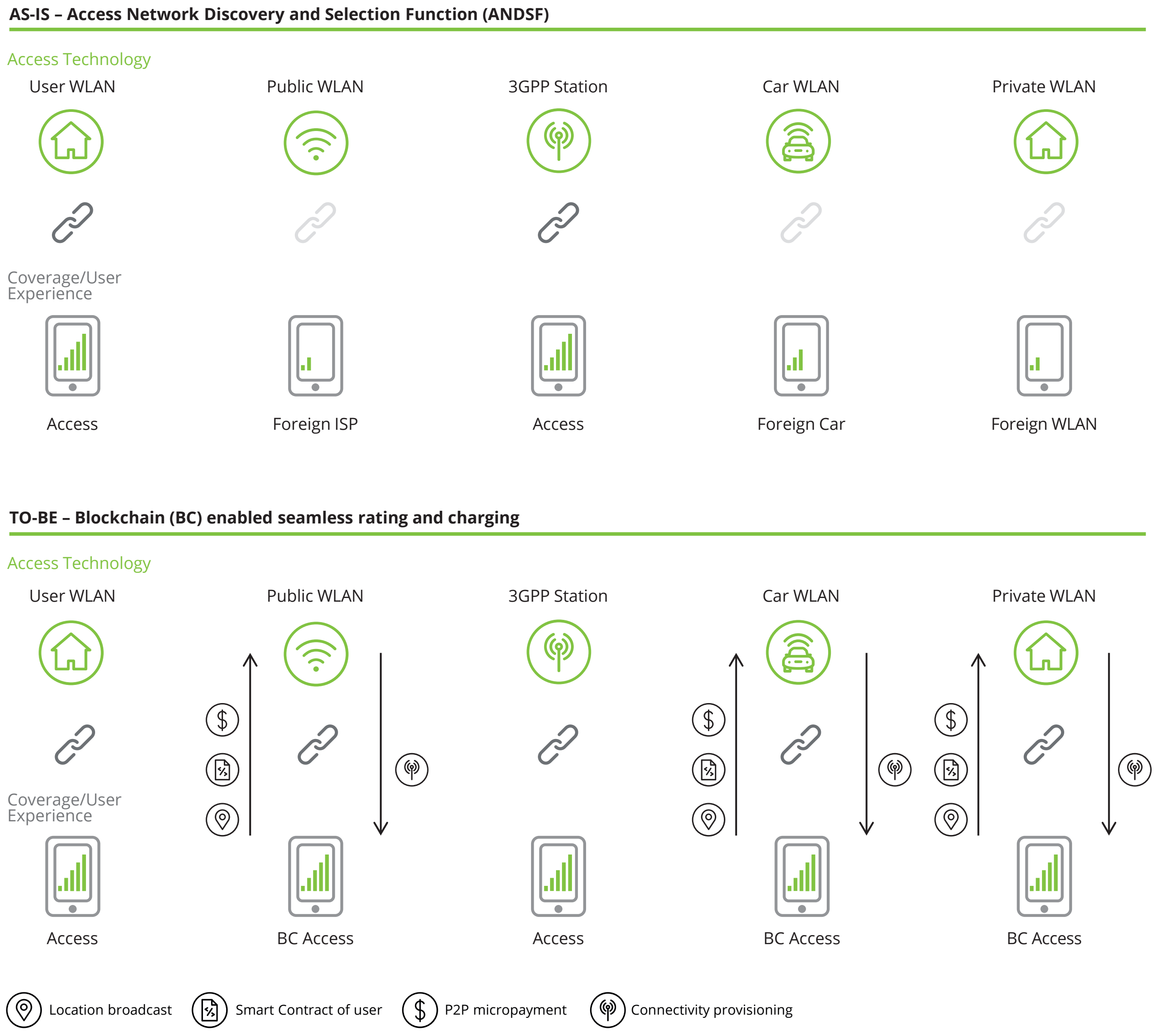


Figure 8: 5G enablement use case

Use Case #4 –

IoT connectivity

A blockchain can enable secure and error free peer-to-peer connectivity for thousands of IoT devices with cost-efficient self-managed networks. For example, machines within a manufacturing plant will be able to communicate and authenticate themselves via the blockchain to steer production processes. Active manual intervention by the workforce will for example only be needed if individual machines require service on the basis of predictive maintenance indicators. In addition, the risk of a production shut-down owing to corrupted or hacked machines could be limited, thanks to the distributed and consensus-based authentication of data in the blockchain network.

Current system – To cope with the increased connectivity demand for devices with low-power consumption, traffic, and bandwidth needs, current network operators build Low Power Wide Area Networks (LPWAN). Telcos are facilitating appropriate IoT use cases for regionally and globally operating companies to push and fully amortize LPWANs. These use cases often require appropriate platforms to manage single IoT devices and connect the internal application landscapes accordingly.

Current challenges – IoT sensors usually carry sensitive information about core assets or in some way pertaining to customers of the company, which makes data and network security an essential and costly pillar of IoT connectivity. Also, the size of the network defines network routing and management complexity, leading to varying system landscapes without a common platform.

Blockchain-based solution – A blockchain allows for highly secure peer-to-peer self-managed mesh networks using a sufficiently large number of nodes. These blockchain network nodes can be represented by single embedded IoT sensors with the ability to verify every block being changed within the blockchain. For a start, these networks can be introduced into a private environment based in mid-range cell-towers with relatively low investment requirements. By establishing such a network in a public blockchain language (e.g. Bitcoin or Ethereum), further expansion or evolution into a public blockchain enables seamless connectivity and security. CSPs could then provide private/public key security and global, always-on connectivity to enable such a public blockchain network with global reach.

Benefits

- Self-managed, peer-to-peer networks taking over regional routing.
- High security levels for IoT devices within public blockchain networks.
- Low-cost setup options for SME purposes.

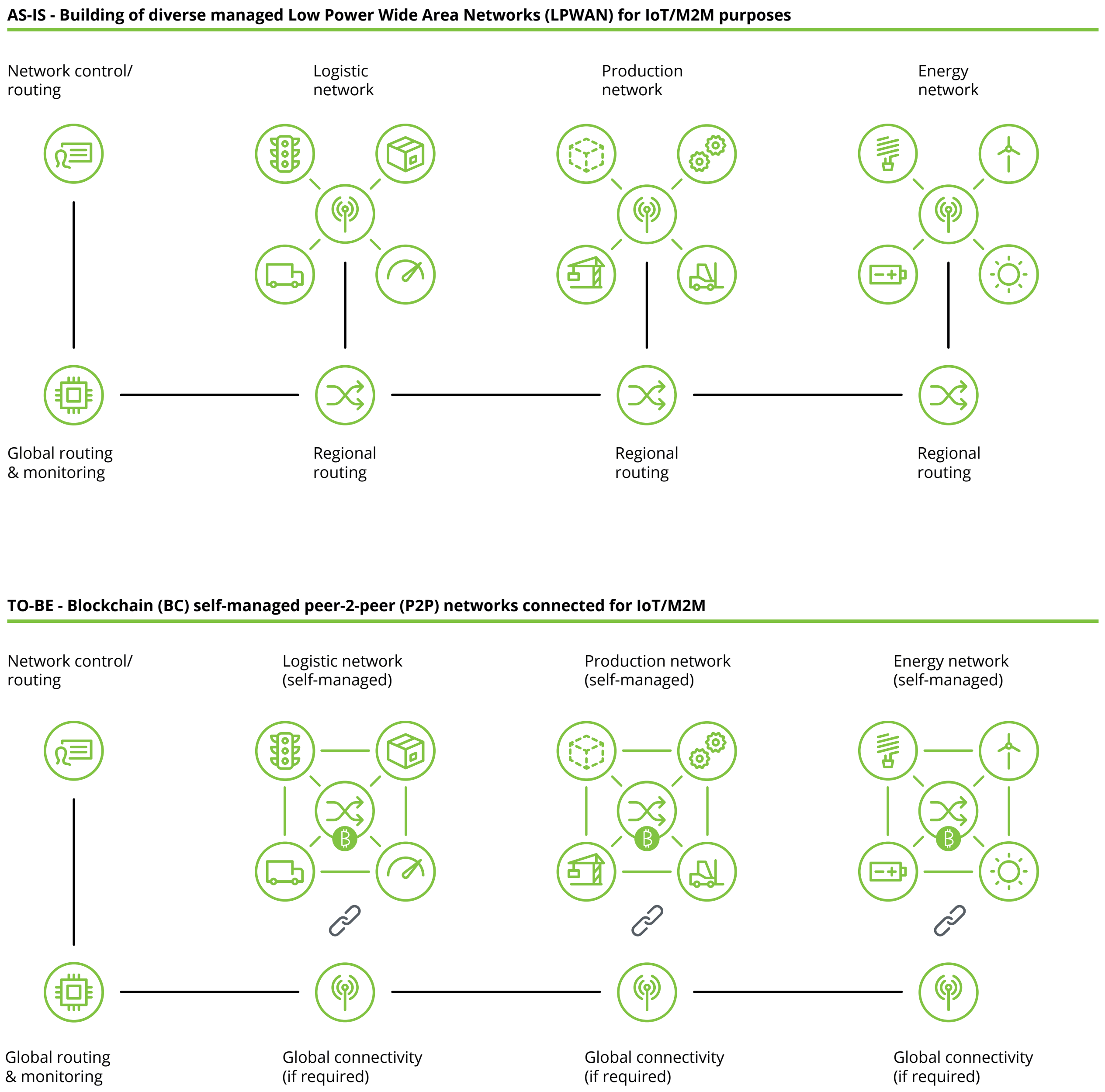

AS-IS - Building of diverse managed Low Power Wide Area Networks (LPWAN) for IoT/M2M purposes
Network control/ routing
Logistic network
Production network
Energy network
Global routing & monitoring
Regional routing
Regional routing
Regional routing
TO-BE - Blockchain (BC) self-managed peer-2-peer (P2P) networks connected for IoT/M2M
Network control/ routing
Logistic network (self-managed)
Production network (self-managed)
Energy network (self-managed)
Global routing & monitoring
Global connectivity (if required)
Global connectivity (if required)
Global connectivity (if required)

Figure 9: IoT connectivity use case

Relevance for the C-Suite

Trust is the cornerstone of business. Blockchains permit trust to be intrinsically embedded into a technological solution, thus enabling smooth partnerships and transactions with potentially little friction between the various stakeholders.

Embracing the blockchain and adopting blockchain-enabled business models could have relevance for numerous functions and executives at a CSP:

- **CEO relevance –**
  Embracing blockchain will compel the CEO to comprehensively rethink the CSP's strategy with regard to various stakeholders, since new business models could thoroughly disrupt the existing tel com value chain.

  New revenue streams –
  Blockchain could enable new business models to be conceived, beyond the traditional role that a telecom provider has played in the past. This could enable the cash-starved CSP to open new avenues for revenue generation.

  For example, the CSP could act as the pivot of a blockchain-based identity, access management and a data storage and verification system, as explained in the Identity-as-a-Service use case. This enables the CSP to charge both business clients and subscribers for the services it provides. The 5G mesh network use case also points to opportunities for increasing the shared revenue pie by providing seamless services to subscribers.

  Forging new partnerships –
  Blockchain would force a reformulation of the telecom eco-system and the relative influence of each player. The CEO would have to evaluate the CSP's new position in such an ecosystem and forge new strategic partnerships as well as redefine existing ones.

  For example, in both the 5G mesh network and the IoT connectivity use cases, the CEO would need to forge partnerships with players who might be new to the telecom ecosystem (e.g. smart meter or sensor manufacturers, WLAN infrastructure providers, etc.) and work in partnership with these new and existing players (e.g. other CSPs).

  Rethink role of intermediaries –
  As a concept, blockchain promotes a broad reduction in the role of intermediaries, if they are not eliminated entirely. This gives the CEO better control over costs and a wider area of operations.

  For example, the eSIM eliminates the need to have multiple partnerships with SIM card manufacturers. The CEO can have better control of operations and focus on relationships with device manufacturers who would embed the eSIM.

  Also, in the case of roaming agreements, the clearing house can be completely eliminated as an intermediary.

  Streamline operations –
  A blockchain provides the opportunity to rationalize various aspects of a CSP's operations due to the modularity provided by using a smart contract.

  For example, implementing roaming agreements as smart contracts introduces modularity, hence agreement with a new partner can be built on top of existing smart contract structures. The success of such an approach would permit the CEO to reach out more easily to more CSPs to sign up as roaming partners, thereby enabling better roaming coverage for subscribers.

- **CFO relevance –**
  Chief Financial Officers at CSPs are looking for possible avenues for reducing costs and improving the bottom line in a highly regulated and competitive market. Blockchain has the potential to help facilitate just that.

  Cost savings –
  The blockchain can contribute to reducing costs substantially by eliminating

intermediaries and decreasing instances of fraud. For example, roaming settlement costs can reach 15% of operating profit for a CSP, most of which is spent on the clearing house and also on roaming software solutions.

With the blockchain-based solution, CSPs can look to significantly reduce costs due to peer-to-peer (or CSP-to-CSP) implementation of a roaming data exchange, eliminating the need for a clearing house and for licensing end-to-end roaming software.

Also, the costs of manufacturing and distributing physical SIMs can be eliminated with an eSIM solution.

Near real-time settlements –
Due to the ability to charge customers in near real-time, the CFO could have a more timely view of cash flows. Fraud, such as roaming fraud which currently accounts for USD 10.8 billion in global revenue loss, can be substantially reduced due to faster settlements.

One source of truth for transactions –
The blockchain ledger provides one view of almost all transactions to the CFO, instead of relying on disparate systems to find and collate different financial views.

- **CTO relevance –**
CTOs work at the intersection of technology and business and will be the executives who are best positioned to gauge the impact from blockchain on CSPs and also would be responsible for driving its adoption.

Technology Innovation –
The adoption of blockchain provides opportunities to introduce and offer technology in the market in innovative ways, as the 5G enablement and IoT use cases illustrate.

Improved Security –
One of the biggest pain points of the CTO is around system and data security. Security is one of the core propositions of a blockchain-enabled system, and hence very relevant to a CTO.

Redundancy of legacy systems –
Blockchain can also potentially make certain legacy systems that are core to the CSP technology landscape redundant. For example, the use of blockchain in the roaming fraud scenario could make fraud management systems redundant or at least less important.

- **CMO relevance –**
Chief Marketing Officers would primarily benefit from the ability to introduce new offers to the market at a faster rate than previously possible, enabled by the modularity of a smart contract.

For example, a blockchain-based roaming agreement between operators allows a CMO to introduce new roaming offers and services at a faster pace, which can then be coded into the smart contract(s) and charging can be nearly instantaneous. A blockchain also enables faster gathering of roaming details, which also reduces the time needed to bring new customized offers to market, based on the subscriber's previous roaming patterns, whereas currently it takes a long time for the operator to receive roaming usage details for a subscriber.

Use of eSIMs in M2M would also allow the CMO to offer convergent offers with multiple devices (e.g., smart appliance and smart watch) under a single contract with the consumer, thus allowing the CSP to take a leading role in the IoT market.

eSIMs, however, would equally reinforce the importance of differentiated customer ser-vice and experience to solidify the status as a provider of choice where alternatives exist.

The new business model enabled by the mesh network also provides an opportunity for the CMO to introduce unique offers to subscribers, enabled by strong partnerships with the other players in the ecosystem.

For example, CSPs would be able to introduce bundles of premium consumer hardware for either exclusive private connectivity or for sharing the access node with other blockchain-enabled consumers and their smart contracts to directly market idle access capacities and achieve monetary benefits for both consumers and CSPs.

Benefits, challenges and conclusion

We have seen that blockchains may be able deliver a broad variety of applications across the telecom industry, and that the technology has the potential to significantly impact CSPs operating models.

The impact ultimately depends on how actively the adoption of use cases is driven by CSPs. Going forward, there is a need to further facilitate blockchain benefits and to overcome the remaining challenges:

Benefits:

1. A blockchain's 'enabled' trust improves coordination between various partners, due to a shared view of transactions and liabilities. This in turn permits the elimination of third parties, resulting in cost savings.
2. Facilitates a single view of data instead of the need for consolidation across various disparate systems. Also allows for reliable audit trails due to the history of all transactions being available in the ledger.
3. Implementation of smart contracts in roaming and other cases allows for near-instantaneous charging, thus leading to improved revenue assurance and fraud reduction.
4. Potential to facilitate new business models for revenue generation for Communication Service Provider who are looking for new avenues to increase both top and bottom lines.
5. A blockchain can act as the ledger that enables, for example, an M2M economy to prosper based on the common platform available, in which M2M transactions can be recorded. It can thus act as the enabler for an IoT ecosystem.

Challenges:

1. Since a blockchain retains all historical data, the size of an established blockchain at each node might become unsustainable. Instead, a mechanism to archive historical data needs to be looked at. Several alternatives are currently being explored in this regard by various players in the blockchain ecosystem.
2. Conforming to existing data standards in terms of both structure and transport for sharing of information could prove to be an initial hurdle.
3. Clear regulatory frameworks need to be defined for the implementation of agreements as digital, smart contracts

In conclusion, the benefits of adopting a blockchain in the core and auxiliary operations of a Communications Service Provider are plenty, as highlighted above. CSPs should take a long term view of blockchains and their potential to add value to the enterprise in both their current and new business models.

There will be challenges to adoption of the blockchain, as with any new technology that holds the promise of significant disruption. However, CSPs would do well to work together to enable the full realization of the benefits, just as many of the global financial institutions are currently doing (e.g. in the R3 Consortium). Working in a silo will limit the potential of blockchain, as disintermediation, robustness, and the need for trust at the intersection of many stakeholders drives real value. Organizations such as the GSMA, which represents the interests of many mobile CSPs globally, could equally take a more active role in exploring and promoting blockchain use cases in the industry.

Companies such as Orange and Verizon, amongst others, have already invested in startups in the blockchain area to explore the synergies and potential use cases. Many more players are researching potential use cases in-house. It is time for everyone to agree on a unified approach to enable meaningful realisation of benefits.

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