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Blockchain for business: Vendor landscape

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Blockchain platforms have evolved from their cryptocurrency origins. They are now being built to target enterprise use cases across many different industries (from financial services, through manufacturing and the supply chain, to healthcare, insurance, government, telecoms, and more). They're also becoming far better integrated with business systems and complementary technologies like IoT and business analytics platforms – and coming ready-built as managed services, wrapped in enterprise-friendly tools and utilities to make it easier to adopt in production environments.

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Top takeaways

1 Moving from proofs-of-concept to production

Many organisations are now looking beyond their proof-of-concept and pilot projects, towards making blockchain work for them in a production environment. This transition tends to succeed when there's support and sponsorship from senior line-of-business / organisational representatives; and where there's an understanding of the project's context in the market or ecosystem in which it's designed to operate (as well as across a single business). Organisations are also looking to vendors with enterprise credentials to help their blockchain projects make the jump to production and make blockchain work for them in the way the rest of their IT works.

2 Enterprise IT demands enterprise blockchain

The main technology market focus is now on the practical aspects of production-readiness that help customers move from proofs-of-concept to deploying at scale, across ecosystems. Blockchain deployments need to behave more like traditional IT capabilities, so blockchain becomes 'just another part of the IT estate'. This requirement manifests in two areas:

- Development and test considerations – i.e. safer, easier, more robust coding environments for smart contracts and decentralised applications; integrations with key enterprise systems (such as systems of record, identity management, and IoT platforms); and interoperability with other ledgers (because, pragmatically, organisations will inevitably find themselves members of many blockchain networks across the business over time).
- Operational considerations – from setup (such as network provisioning, configuring and member on-boarding); through resilience (high availability, backup, disaster recovery, monitoring, etc.); security (encryption, transaction privacy, etc.); and performance (both of the network, and of the choice of consensus mechanism, the use of any sidechains for parallelism, etc.).

3 Blockchain platforms have evolved

First-generation blockchains can be typified by the Bitcoin blockchain network – public and open, relying on expensive and slow consensus mechanisms, and with limited on-chain functionality (though supporting the creation of 'trust anchors' that provide proofs-of-existence for hashed documents, databases, and so on). Ethereum's smart contract platform heralded the arrival of a second generation, built to execute autonomous, decentralised applications. A third generation is now taking the capabilities and characteristics of earlier incarnations and tailoring it for enterprise suitability – and that means wrapping blockchain services in the enterprise tooling outlined above, as well as developing targeted SaaS applications that utilise blockchain for specific use cases (like tracking and traceability).

The blockchain story so far: three generations

We covered the emergence of blockchain and what the technology is (and isn't) good for in our earlier report Blockchain for business: What is it and why should care?

What we've also seen is that, in the relatively short time that organisations have been developing blockchain technology applications, the technology has seen three major generations evolve. Each generation marks a step-change in capabilities, and a turning point in blockchain's applicability and adoption in mainstream business use cases.

The three sections below outline the three generations of blockchain technology to date.

From crypto origins, through token value exchange, to digital fingerprinting and 'trust anchors'

The first generation of blockchain is typified by the technology that underpins the Bitcoin cryptocurrency. It's open and public; it uses a *Proof-of-Work* consensus mechanism, requiring the incentivisation of *miners* (and so is expensive, and slow to run); and it was designed primarily to record transactions for the exchange of tokenised value (e.g. Bitcoin transfers between wallets).

On the surface the transaction cost, block size (and what you can store in blocks), scalability and speed of, say, the Bitcoin blockchain would appear to limit its appeal in the enterprise… unless your business is accepting retail payments in cryptocurrencies. Even if you're looking for a platform to facilitate payment transfers, you're better off considering something with a more modern architecture like Stellar, or Ripple (which doesn't rely on mining for its consensus) because Bitcoin's throughput just wouldn't keep up. However, even these examples have limited scope for further enterprise use beyond crypto token exchange – they're intended to rival inter-bank transfer systems like the SWIFT network, and in their current iteration they're not targeting wider use cases beyond financial payments.

However, the fact that Bitcoin is the most mature, longest unbroken, public blockchain also brings other benefits that organisations can take advantage of. It provides a chain upon which to 'anchor' data with a cryptographic fingerprint. Other public blockchains can be used for this too (we'll explore this more later).

As we explained in Blockchain for business: What is it and why should care? most first generation blockchains don't store 'real' (non-cryptocurrency) data in the blockchain itself, because too much of that can lead to 'chain-bloat' (where there's so much data being committed that it becomes too slow and costly to do anything useful). Instead they store 'digital fingerprints' (hash values) of the data that link to digital assets which have been stored elsewhere, off-chain (but somewhere accessible by *bone fide* interested parties – the InterPlanetary File System (IPFS) is often used in cases where decentralisation needs to be preserved across the storage layer, and so simply linking to a single organisation's cloud storage account wouldn't be acceptable). In these cases the blockchain then is used to track ownership of these assets, and act as an immutable log of activity. It means that these blockchains can provide a 'proof of existence' for an item of hashed content (such as a document, process output, database, or private blockchain sidechain) in addition to enabling trivial tasks like making cryptocurrency payments.

Some vendors (such as Appian and Ultimus) have focused initially on 'anchoring' as a way of blockchain-enabling their offerings to provide capabilities that enhance trust in ecosystem scenarios when extending process reach beyond the enterprise boundary.

Smart contract platforms, and the era of decentralised applications

Post-Bitcoin developments in blockchain technology have enabled complex business logic (in the form of 'smart contracts' or 'chaincode') to be encoded into blockchains, running against data either held on-chain or elsewhere, and used as part of an autonomous, decentralised workflow. It's arguably this advance that's paved the way for an explosion of non-cryptocurrency interest in blockchain technology – enabling people to effectively develop distributed applications that reside and run on a blockchain (triggered by external events and pulling in data from the Internet or IoT).

The development of the Ethereum open-source, public blockchain-based distributed computing platform in 2015 signalled the dawn of blockchain's second generation. With Ethereum (and the myriad variants borne of forked Ethereum code, or based upon its principles), distributed applications can be built using 'smart contract' scripting functionality and executed on participating network nodes. In some cases these are performed on the public Ethereum mainnet; other instances make use of private Ethereum networks to enhance transaction confidentiality (and provide more control over transaction speed, network performance, and even choice of consensus mechanism). Some instances bring the ability to link or anchor these private transactions periodically to the mainnet, in order to provide an immutable log that guards against the threat of bad actors attempting to subvert the consensus on smaller networks.

Although Ethereum does have its own cryptocurrency (Ether), the tokens are mined as part of Ethereum's Proof-of-Work consensus process and used to pay for the computational resources that run the distributed applications on its platform.

In addition to organisations deploying the open source Ethereum itself, J.P.Morgan has developed what it refers to as an "enterprise-focused version of Ethereum" in the form of Quorum (addressing concerns around privacy and scalability, etc.) – which is available as part of a number of Blockchain-as-a-Service offerings. Microsoft announced its Azure Blockchain Workbench in October 2018, which features a *Proof-of-Authority* based Ethereum; and ConsenSys offshoot Kaleido has partnered with AWS to offer an Ethereum-based service through the AWS Marketplace.

The Ethereum Foundation, which oversees the development of the Ethereum platform, has begun to address some enterprise concerns too through the work of the Enterprise Ethereum Alliance (EEA). The EEA's members are drawn from enterprises, start-ups, academics, and technology vendors – all with an interest in how Ethereum develops for the enterprise. In July 2018 the EEA has announced the Enterprise Ethereum Architecture Stack – a conceptual framework which characterises and standardises components from the Ethereum ecosystem to show how the upcoming Enterprise Ethereum standards-based specification will fit together. Its hope is that this will provide user groups and vendors with the means to construct standards-based solutions on Ethereum that satisfy enterprise requirements (like privacy, scaling, tooling and application development), without having to build everything from scratch. Three months later, the EEA announced that it was entering into an agreement with Hyperledger (from the Linux Foundation) to become associate members of each other's groups – further strengthening the drive to bolster Ethereum's enterprise credentials as blockchains level-up to production-readiness (as well as fostering greater inter-ledger interoperation, as organisations start to become members of more diverse blockchain networks).

Production-ready, enterprise-grade, integrated blockchain at scale

A third generation of blockchains have focused specifically on the needs of enterprises wanting to deploy blockchains in full-scale production – boosting core enterprise-friendly capabilities (relating to consensus mechanism choices, privacy features through channels and sidechains, etc.), and also providing wrap-around tooling and integrations.

It's here where major established enterprise technology vendors are setting out their stalls with a spread of enterprise blockchain frameworks and tools, and blockchain-enabled applications, all designed to operate and integrate in production environments.

Although there are still concepts to be proven in some potential blockchain usage scenarios, many organisations are now starting to look beyond this phase to explore more about what the business benefit is (to the individual enterprise, and to the wider ecosystem it inhabits as a whole). Projects tend to succeed when there's a line-of-business / organisational strategy sponsor; and where there's an understanding of the context in the market / ecosystem, as well as across the business. Organisations are also looking to vendors with enterprise credentials to help their blockchain projects make the jump to production and make blockchain technology work for them in the way the rest of their IT works.

Many enterprise vendors are members of Hyperledger, and have offerings based on its projects (such as the Fabric blockchain framework); some offer Ethereum-based solutions, tailored for the enterprise; and R3 is marketing its Corda blockchain platform at use cases beyond its financial services base now (there's an open source version alongside a commercial variant, which sports enterprise extensions).

Notwithstanding the work of the EEA (described above), there's also a range of third generation blockchain platforms that have sprung up in an effort to plug Ethereum's perceived gaps in meeting enterprise needs. However, with the drive towards standardisation in the Ethereum landscape, and the interoperability amongst the Hyperledger stable, smaller independent players will find it increasingly difficult to differentiate a novel platform in a way that doesn't put off enterprise buyers (with their need for stability, reliability, scalability, interoperability, etc.).

The shape of the vendor landscape

Now we've outlined the way that blockchain technology has evolved, and explained the most important standardisation and ecosystem initiatives, in this section we go on to highlight the work that vendors large and small are doing in this fast-moving space.

Start-ups and niche players

Although the bulk of this report focuses on the offerings and positioning of the major enterprise software vendors and their partners, it's also vital that we highlight some of the emerging vendors establishing themselves as providers to enterprises (either through partnerships, or in offering niche capabilities directly).

We want to particularly draw attention to:

- Bitfury. Alongside its bitcoin mining hardware business, Bitfury offers software solutions like the Exonum extensible enterprise blockchain, which can be 'anchored' to the public Bitcoin blockchain by having blocks hashed there periodically so that it's publically auditable (increasing trust); LightningPeach, a second-layer protocol for peer-to-peer micropayments (originally built on top of the Bitcoin blockchain); and Crystal, which provides blockchain analytics.
- Cardano. Like Ethereum, Cardano offers a smart contract platform – but one that seeks to address some of Ethereum's scalability and security challenges with a standards-based layered architecture; sidechains for parallel, private execution of smart contract code; and the use of a cheaper-to-run 'proof-of-stake' consensus mechanism.
- Factom. Factom offers a blockchain-based distributed document management platform called Harmony, and the dLoc authentication solution for securing physical documents on the blockchain using RFID.
- Neo. Designed to support the concept of a 'smart economy', Neo integrates digital assets, digital identity, and smart contracts – all on a single platform. It also boasts an in-built storage protocol – negating the need to rely on Interplanetary File System (IPFS).
- Sphereon. Sphereon anchors documents on Ethereum, Hyperledger, Multicoin, Factom, and VeChain blockchains for authenticated proof of existence; it integrates with Alfresco Content Services, Microsoft SharePoint, Office 365, Xillio and others.
- Stratumn. Stratumn's open-source Proof-of-Process based IndigoCore blockchain network and IndigoTrace API service provide end-to-end traceability of both process outcomes and physical assets in a supply chain.

Established enterprise technology vendors

The remainder of this report comprises a set of profiles summarising the activity and offerings of key vendors in the enterprise blockchain space.

To summarise, we cover:

- **Appian** – which is adding blockchain technology to its Digital Business Platform to help customers more easily develop blockchain-enabled process applications).
- **Kaleido** – a ConsenSys company, providing Blockchain-as-a-Service on AWS (and we also summarise some of other ConsenSys projects, products, platforms, and services of note).
- **IBM**, **Oracle**, and **SAP** – all of which are members of Hyperledger and provide Hyperledger fabric-based blockchain services on their respective clouds; in some cases, now amongst other blockchain protocols).
- **Microsoft** – which offers a range of blockchain services on Azure.
- **OpenText** – which is looking to integrate blockchain alongside IoT and AI technologies to bring what it refers to as the 'autonomous supply chain' to members of its OpenText Business Network.
- **R3** – whose Corda blockchain platform, having been conceived with the aid of a consortium of financial institutions, is now eying use cases for the application of its technology outside financial services.
- **TIBCO** – which is focusing on a suite of products that provide the components of an overall blockchain-based solution stack.
- **Ultimus** – which focuses on blockchain anchoring to provide 'proofs of existence'.
- **VMware** – which has recently open sourced its scalable Byzantine Fault Tolerant blockchain libraries as *Project Concord*.

Appian

Appian's main interest in applying blockchain technology is as a means of augmenting its Digital Transformation Platform, with support for both the autonomous execution of business logic (via blockchain smart contracts), thereby extending the reach of process execution into ecosystem scenarios; and the use of blockchain's immutable, distributed ledger to hold an irrefutable record of process state (for audit purposes, etc.).

Appian's platform brings together low code development, case management, and automation (including process automation, RPA – via partner Blue Prism, AI, and business rules management) in a single experience, with an extensible library of actions and a BPMN standards-based graphical UI.

The company has introduced 'blockchain-enablement' into its platform so that customers can develop blockchain applications in the same way that they might build any other Appian-based business applications, following the same principles (and accelerating the blockchain development cycle by simplifying the process of interfacing enterprise applications with smart contracts); as well as offering Blockchain-as-a-Service to other enterprise systems via web APIs.

So far, the company has created a number of demo applications (built using the Appian Platform, anchoring digital fingerprints of process output data to Ethereum and the distributed file network IPFS – though Hyperledger support was also announced at Appian World 2018); and cites proof-of-concept work with customers across the healthcare / life sciences, automotive supply chain, government, and energy sectors – although no specific product or service has become generally available as yet.

However, in April 2018 Appian also announced that Luxoft's blockchain network integration will be exclusively available through the Appian Platform – marking another route to enable Appian process applications with blockchain technology.

IBM

IBM's blockchain focus is on permissioned blockchain networks, leveraging the trust and relationships inherent in existing business networks (see the MWD Advisors report Blockchain for business: What is it and why should I care? for more information on the different types of blockchains).

The company is a founding premier member of the Linux Foundation's Hyperledger Project (see the MWD Advisors report Hyperledger: Permissioned blockchains for every industry for background). It has invested heavily in contributing to the open source Hyperledger Fabric blockchain framework and Hyperledger Composer tool, which offers business-centric abstractions for creating smart contracts and developing blockchain applications. These provide the main components for IBM's commercial cloud-based offering.

Originally launched in October 2016 as IBM Blockchain on Bluemix High Security Business Network, IBM relaunched its offering in August 2017as the IBM Blockchain Platform. Overall, the package has been designed to make it easier for the members of a consortium to create, govern, manage and operate a permissioned blockchain network. It's fully integrated with the company's cloud-based development and production environments, marrying open source frameworks and tools with IBM's own management tools, utilities, and support (and leveraging a modular cloud-based architecture for security, performance, and resilience).

In June 2018 IBM announced Blockchain Starter Plan, which can be accessed in 10 different languages, with a goal of making it easy for developers, academics, start-ups and established enterprises to develop, test and deploy blockchain solutions. IBM has engaged with over 500 companies worldwide, across a range of industries, to develop blockchain proofs-of-concept and applications in areas as diverse as secure global payments, trading and settlement, insurance, food safety, supply chain logistics, procurement, digital rights management, utility grid balancing, and student learning. Notable products to have come to market in this time are the TradeLens platform joint venture with Maersk for sharing information across a supply chain ecosystem (launched in August 2018); the IBM Food Trust food safety management solution (anchored by Walmart, Nestle, and others in the US, and now additionally Carrefour in Europe), generally available from October 2018); and the we.trade trade finance platform for European SMEs (from a consortium of nine banks, formerly known as the Digital Trade Chain consortium), which announced in October 2018 it was to merge with the other IBM Blockchain based trade finance network, Batavia.

Integration with IBM Business Process Manager and IBM Operational Decision Manager provides interoperation with internal process management for end-to-end process automation (including processes that are fully private, private processes with external participants, and fully inter-organisational processes). For instance, IBM Business Process Manager enables customers to automate private control processes, triggering blockchain transactions from private processes, and triggering private processes from events on a blockchain (for example, handling exceptions); IBM Operational Decision Manager automates these private control processes and also shared network processes; and the IBM Blockchain Platform provides the automation of shared network processes. Customers can also integrate the IBM Blockchain Platform with the IBM Watson IoT Platform, allowing instrumented and connected devices to participate in blockchain transactions as defined by smart contracts (and where the information is available to be accessed by members of the business network).

Kaleido from ConsenSys

Kaleido, a ConsenSys company, offers the Blockchain Business Cloud – a SaaS offering that currently features the Ethereum variants Geth (the Golang implementation of Ethereum) and Quorum (JP Morgan's "enterprise-focused" version of Ethereum). It's available on the AWS Marketplace across multiple worldwide regions.

The Blockchain Business Cloud provides the ability to link between the public Ethereum mainnet and private Ethereum networks (anchoring private blockchains using Kaleido Relay). It supports multiple consensus mechanisms to balance performance and fault tolerance issues (Proof-of-Authority – using identity as stake, where individuals earn the right to become validators; RAFT – which relies upon an elected 'leader'; and Istanbul Byzantine Fault Tolerance), and also comes with an integrated analytics tool (Kaleido Scope block explorer, which provides visibility into ledger and smart contract transactions) and an operations dashboard for real-time network monitoring. Kaleido also sports a private Ether pool for token economy use cases.

By enmeshing Kaleido Blockchain Business Cloud within the AWS cloud-based ecosystem, the company intends to make blockchain easier to get started with, and faster to scale into production. It also benefits from cloud economics and elasticity, and offers ready-made integration to other AWS services (such as Amazon KMS for Key Management, Amazon Athena for rich query, Amazon CloudWatch for monitoring, Amazon S3 for storage, and Amazon Virtual Private Cloud for private networking). Customers can also leverage Kaleido Connect's suite of options to integrate Kaleido with applications and on-premises systems.

Kaleido's partnership with AWS is intended to bring together capabilities that effectively become a 'turnkey' solution for full stack blockchain implementations – leveraging AWS' plethora of developer-friendly services to provide an environment where much of the heavy lifting is done, not only around the provisioning of blockchain – but also concerning related components of a typical technology stack. Where the likes of IBM and Oracle have their own cloud-based blockchain services, with easy integration primarily amongst their own stable of applications or via their own cloud service integrations, Kaleido is targeting a market more aligned with AWS' public cloud environment, where clients' next-generation applications and data sit today, while still easily integrating with legacy back-office systems from the more traditional vendors.

About ConsenSys

ConsenSys is an AWS Partner Network (APN) Advanced Technology Partner and member of the Enterprise Ethereum Alliance, describing itself as a global organisation dedicated to furthering the adoption of Ethereum-based blockchain "to transform the ways in which economic, political and social systems will be built around the world". Its venture-studio incubation arm has a current roster of over 50 initiatives that cover a diverse range of Ethereum-related activity.

Some notable ventures (besides Kaleido, the blockchain SaaS outlined above) include:

- **Core components** – such as uPort (self-sovereign identity management and KYC / AML attestation); MetaMask (browser-based identity and transaction management); and Alethio (analytics platform).
- **Infrastructure** – such as Infura (API endpoint for Ethereum and IPFS); and Pegasys (an Ethereum protocol engineering team providing a framework for collaborative innovation for the public-chain community and leading enterprises).
- **Developer tools** – such as Nethereum (a .NET integration library for Ethereum); and Truffle (a development environment, testing framework and asset pipeline for Ethereum).

- **Services** – such as ConsenSys Academy (blockchain education for developers and non-developers alike); ConsenSys Media (news and education material from and about the blockchain industry); ConsenSys Capital Asset Management (support for emerging digital asset / token economies); ConsenSys Ventures (supporting scaling blockchain projects); ConsenSys Labs (a "venture production studio" supporting Ethereum projects); ConsenSys Energy (blockchain solutions in the energy industry); ConsenSys Social Impact (exploring the use of blockchain in addressing social and economic challenges); Diligence (best practices in blockchain security, ethics, and legal considerations); and Solutions (targeted blockchain consultancy for the testing and deployment of both public and private blockchain projects); and Token Foundry (digital asset marketplace and token design studio).
- **Platforms and applications** – such as Benefactory (a community-curated crowdfunding platform); Bounties Network (freelance task fulfilment); Civil (a blockchain-based token economy to support independent journalism); Fathom (a decentralised protocol for assessing credentials through the consensus of knowledge communities); Gnosis (an open platform for prediction market applications); Grid+ (providing direct consumer access to wholesale energy markets); Kauri (an 'open knowledge' network of Ethereum technical know-how, designed to build a community-curated blockchain knowledge base); Linnia (a platform for consumers to store and permission access to longitudinal health data); Meridio (a platform for shared property ownership); Rhombus (connecting smart contracts with real world data to form 'smart oracles'); Ujo (a digital rights management platform for music and creative works); Viant (a platform for modelling business processes and tracking assets); Gitcoin (a network for funding contributions to open source software); Balanc3 (accounting for digital assets); OpenLaw (a platform for the creation and execution of legally binding agreements on the Ethereum blockchain); and DrumG (distributed ledger technology solutions for the banking sector).

Microsoft

Microsoft offers pre-built blockchain networks and infrastructure in the cloud through the Azure Blockchain Workbench (launched in May 2018, currently in Preview). The service is designed to accelerate blockchain development time and make it easier to build both proofs-of-concept and production services. It provides integrations and extensions to common Azure cloud services and apps – such as Azure Active Directory for identity management; Azure Key Vault for private key management; signing, hashing and routing tools; off-chain data storage synchronisation tools; and Service Bus and Event Hubs for smart contract messaging and event trigger management); making it easier to integrate with existing systems (using Microsoft Flow, Logic Apps – which provide hundreds of connectors into thousands of applications, and message-based APIs); and provides APIs for further client development.

Azure Blockchain Workbench is configured to use Ethereum with Proof-of-Authority consensus as standard. However open source varieties of the main enterprise blockchain / ledger platforms and their consensus mechanisms (Hyperledger Fabric, Ethereum using Proof-of-Work, and R3 Corda) are all available as Blockchain-as-a-Service on Azure – along with a range of variants based on these protocols (such as Quorum, Chain, and Waves), which can be configured through the Azure Marketplace.

In addition, Microsoft announced in October 2018 that it plans to develop a blockchain-based encrypted personal data store, and a 'wallet-like app' where users can manage permissions for access to their personal data – both aligning with the principles of data self-sovereignty and enabled through decentralised identifiers. Although still in the 'whitepaper' stage (with no timetable for product release), the company has alluded to the development of a separate, blockchain platform agnostic layer providing this functionality (rather than extensions to individual ledger protocols in isolation). The company also announced in 2017 that it intended to open source its Confidential Consortium (CoCo) framework. CoCo implements an Ethereum-based protocol and provides base components that are designed to integrate with a range of blockchains / ledgers, as well as enhancing confidentiality by leveraging trusted execution environments, such as Intel SGX and Windows Virtual Secure Mode, alongside underlying blockchain protocol capabilities.

OpenText

OpenText is focusing on the potential benefits that blockchain can bring, alongside IoT and AI capabilities, as part of what it refers to as the 'autonomous supply chain'. This initiative is being led from the company's Business Network division, responsible for OpenText's cloud platform for secure and compliant collaboration across extended digital ecosystems (designed to simplify business to business (B2B) data exchange and offer operational insights, etc. to over 600,000 companies spread across the retail, consumer goods, automotive, high-tech, industrial manufacturing, financial services and healthcare sectors).

Global supply chains are evolving into more network-like, collaborative ecosystems – with implications for all the parties involved. OpenText argues that, once a foundational 'digital backbone' is in place (facilitating the electronic exchange of business transactions), IoT, AI and blockchain technologies (in isolation, but especially in combination) can deliver smarter, more intelligent, more autonomous supply chain management – particularly in use cases around tracking, traceability and asset provenance; digital twinning and whole-life lifecycle management; and end-to-end insurance, global payments, and logistics administration. Although certain approaches to solutions in many of these areas are possible *without* a blockchain component, the addition of this technology provides for both autonomous execution of business logic across a decentralised supply chain network, under no single entity's / intermediary's control. It also provides an immutable audit trail, providing independently verifiable and irrefutable provenance as to the condition of goods *en route*, the status of payments, and so on.

Although the concept of the autonomous supply chain has yet to coalesce into specific products and services for OpenText Business Network customers, the company already has many of the bases covered – from enabling the end-to-end digital supply chain with its Trading Grid platform; to its acquisition of the Covisint cloud platform for digital identity management, IoT applications, and a supplier portal for the automotive sector in July 2017; the launch of its Magellan AI platform in the same month; and a partnership announced with UK-based blockchain start-up BlockEx (which focuses on financial and capital markets) in November 2017. OpenText is orchestrating these components in combination to give form to its vision of the autonomous supply chain, providing an opportunity for customers to leverage an integrated solution rather than exploring each technology independently.

Oracle

Oracle initially launched its Hyperledger Fabric-based Blockchain Cloud Service at its OpenWorld conference in October 2017, two months after the company joined the Linux Foundation's Hyperledger project. It became generally available, as Oracle Autonomous Blockchain Cloud Service, in July 2018 (offering the automated recovery capabilities inherent in Oracle Cloud Platform's suite of autonomous services). It's a fully-managed PaaS (part of the Oracle Cloud Platform) built on the Hyperledger Fabric permissioned blockchain framework. The Oracle Autonomous Blockchain Cloud Service features a variety of enterprise-grade services that provide continuous backup, point-in-time recovery, rapid provisioning, and simplify the operational management of a blockchain network. The product offers plug-and-play integrations with key business applications within or through Oracle Cloud (leveraging Oracle's container lifecycle management, identity management, and event services), recognising the need to support heterogeneous environments – including on-premise environments and non-Oracle clouds alongside Oracle Cloud (the Autonomous Blockchain Cloud Service also provides support for interoperability with non-Oracle Hyperledger Fabric instances).

Oracle's aim is to offer-an enterprise-friendly platform that leverages the advantages of blockchain to a customer base more at home with 'traditional' business applications. The Oracle Autonomous Blockchain Service leverages-Oracle's enterprise-grade integration, provisioning, support, and management capabilities to offer customers a platform designed to help them take the next steps beyond proofs-of-concept to bring production services online (with all the attendant issues around scalability, on-boarding, security, integration, etc.)

Oracle has positioned its Autonomous Blockchain Cloud Service as a distributed ledger cloud platform for customers looking either to build new blockchain-based applications, and/or extend their current SaaS, PaaS, IaaS and on-premises applications with blockchain capabilities to provide "tamper-resistant transactions on a trusted business network." Oracle's 'extras' (on top of Hyperledger Fabric) are designed to build on the open source framework with capabilities that simplify and accelerate blockchain deployment, leverage identity management cloud to provide high level of security protections, and provide tailored support for specific use cases (through the involvement of the company's industry teams) in the areas of ERP, supply chain / manufacturing, and open banking.

Oracle's go-to-market approach for Autonomous Blockchain Cloud Service has four parts, focusing on:

- Customers of its wider platform and on-premises applications.
- Targeting start-ups via the company's start-up accelerator programme; SaaS and packaged applications.
- Software vendors looking to incorporate blockchain into their offering or build on a pre-assembled platform.
- System integrators (global SIs, regional firms, and specialist blockchain boutiques).

R3

R3 is an enterprise blockchain software vendor, working with an ecosystem of over 200 members and partners (including banks, regulators, trade associations, professional services firms, and other technology vendors) to develop on its Corda blockchain platform, which the vendor open-sourced in November 2016.

Although now referred to by R3 as a 'blockchain platform', Corda is a distributed ledger platform that only shares transaction information with participants that require it to provide transaction privacy. Corda instances can be run on-premises or in the cloud. A Corda network comprises nodes running Corda, and Corda Distributed Applications (CorDapps). It's permissioned and semi-private (with access controlled by a doorman service that enforces access requirements), with communication between nodes being point-to-point (rather than global broadcast).

Corda comes in both open source and commercial enterprise flavours (the latter including some commercial extensions, providing support for deployment within corporate firewalls, Oracle and SQL Server integration, high availability and disaster recovery, 24/7 support and monitoring), and – despite R3's fintech origins – is being used beyond the financial services sector, in use cases for healthcare, insurance, and logistics / shipping too.

SAP

SAP is offering blockchain capabilities in two ways:

- The **SAP Cloud Platform Blockchain service** (in General Availability since June 2018) is designed to provide a low-cost, low-risk way for companies to explore integrating blockchain technology amongst rest of their SAP services (to help customers either extend existing SAP applications with blockchain or build new ones).
- The **SAP HANA Blockchain Service** (planned for release for the end of 2018; SAP HANA Blockchain Adapter is currently available in Beta) connects external blockchain networks to SAP HANA to enable companies to build apps that put HANA's in-memory analytics capabilities to work on blockchain data (alongside data from other sources) in real time. Additionally, SAP HANA's blockchain integrations work both ways – allowing it to commit data from HANA to any blockchain supported by SAP to form an irrefutable record of existence.

Although it's been a premier member of Hyperledger since March 2017, the SAP Cloud Platform Blockchain service isn't restricted to Hyperledger Fabric alone. The company has instead taken a more agnostic and heterogeneous approach, so as to provide easy integration access with both private, permissioned blockchain networks as well as open, public ones. It's chosen to provide not only the Hyperledger Fabric framework as a service, but also offer the MultiChain open source private / permissioned blockchain platform from Coin Sciences, and (announced in October 2018 as available for early adopters) the Quorum "enterprise-focused" and permissioned version of Ethereum. In addition, customers can combine their applications with blockchain via the SAP API Business Hub, using SAP Cloud Platform Blockchain Enablement Services for greater abstraction from the underlying technologies.

Although the services described above are very much aimed at SAP customers who want to integrate blockchain capabilities into their own applications, going forward the company has plans to integrate the technology into its own products and services where use cases align. For example, SAP is working on introducing a blockchain element into SAP Advanced Track and Trace for Pharmaceuticals to address the problem of product verification in the drug supply chain by sending identification data to a blockchain to be recorded for all relevant parties to be able to inspect. The company also reports having conducted pilots across a range of other industry use cases, such as digital twin asset management, distributed manufacture, shipping, secure bidding in procurement, trusted digital credentials, and real-time payments. To this end SAP has joined the Alastria consortium (a national, multi-sector, permissioned blockchain ecosystem in Spain, designed to establish a semi-public infrastructure for blockchain use right across Spanish markets); the Blockchain in Trucking Alliance, dedicated to developing blockchain standards and education for the freight industry worldwide; and is a founding member (and co-chair) of the Chinese Trusted Blockchain Alliance. It's also formed three consortia of its own during 2018 to help it explore permissioned blockchain applicability, in an ecosystem setting, across specific industry use case scenarios: one for the high-tech industry; one for pharmaceuticals and life sciences; and one for agribusiness, consumer products and retail.

SAP is also looking firmly integrate blockchain amongst other 'new' technologies (such as machine learning, IoT, analytics and big data) under SAP Leonardo Intelligent Technologies (alongside SAP's design thinking services). SAP Leonardo is designed to inspire customers to experiment and innovate atop their existing SAP infrastructure – pairing the business process / system of record world of SAP S/4 HANA, SAP SuccessFactors, SAP Ariba, SAP FieldGlass, SAP Hybris, and Concur with new "systems of intelligence" technologies, with which customers can look to modernise their business and leverage their SAP existing investments in pursuit of digital transformation goals.

TIBCO

TIBCO is directing much of its blockchain efforts on working with customers on emerging, but well-defined, use cases in the supply chain (encompassing full product lifecycle management in manufacturing, through transportation / logistics, to retail), finance, healthcare, and digital media sectors. Its strategy is to use blockchain along with supporting IoT, AI/ML, and cloud capabilities in order to approach customers' problems holistically (with a focus on integration issues and extracting value from data).

On the operational side, TIBCO is pragmatic about the applicability of, and customer interest in, different technology platforms at this stage in the blockchain market's development – preferring instead to offer agnostic support for popular frameworks such as R3 Corda and Hyperledger Fabric.

TIBCO does offer its own blockchain SaaS network (TIBCO Blocklayer, part of the TIBCO Connected Intelligence Cloud (CIC), and currently in Beta), but it's not seeking to focus on being a blockchain platform provider. Instead, it is orchestrating a suite of CIC products to provide the components of an overall blockchain-based solution stack that need to be in place in order to leverage the technology as a distributed data management and business logic platform.

These CIC products and their use include:

- **TIBCO Spotfire**, a data visualisation and analytics tool which may be configured to access on-chain data in order to, say, drive blockchain-based solutions for predictive maintenance; or audit transactions with compliance reporting.
- TIBCO Mashery for API management.
- TIBCO Messaging for a data distribution transport.
- TIBCO Hybrid Integration as a blockchain proxy layer, and for creating supporting microservices and process automation / case management functions.
- TIBCO BusinessEvents for event handling and providing an extension of the business logic contained within Ethereum smart contracts, Hyperledger chaincode, etc. (including integrating contextual and declarative business rules with blockchain solutions).

TIBCO is also releasing new products, namely:

- **TIBCO Cloud AuditSafe** (currently in Beta, announced at TIBCO NOW 2018). This provides an immutable, searchable, cloud-based ledger for transaction audit trails (for both cloud-based and on-premise applications). With a capability introduced as part of TIBCO LABS, that audit trail can now be hashed to a blockchain via TIBCO Blocklayer to provide a greater degree of transparency (with automation provided by blockchain smart contracts).
- Project Dovetail (also part of TIBCO LABS, and announced at TIBCO NOW 2018) provides a model-driven environment for the development and testing of blockchain-agnostic smart contracts.

With these offerings, TIBCO is seeking to make blockchain technology more consumable by enterprises – addressing key business concerns around the production-readiness of blockchain technologies (e.g. by enabling blockchain projects to be better integrated and managed as part of more traditional IT operations) and assisting organisations with making the jump from pilots and limited proofs-of-concept to robust components of business-critical infrastructure. TIBCO is focused on streamlining business logic for decentralised applications, such that the logic can become encoded into immutable smart contracts, which operate autonomously outside of any single enterprise's control.

Ultimus

Ultimus has incorporated blockchain technology into its Composed Process Solutions low-code development platform in order to support process automation externally, beyond the enterprise – i.e. the capability for organisations to execute business processes securely and transparently across multiple parties (suppliers, partners, customers, devices, etc.) which do not necessarily trust each other. A common domain model for process- and case-related applications sits at the core of the Ultimus Composed Process Solutions platform; and this now includes blockchain-related aspects, such as the UI, anchor validations and credentials, communications with the blockchain service selected for anchoring to, match proof validation, etc. – meaning that applications can include this functionality alongside other composable elements.

Ultimus is leveraging the Chainpoint open standard blockchain anchoring protocol via partner Tierion's Blockchain Proof Engine (which can anchor to the public Ethereum or Bitcoin blockchains, or the customer's own blockchain). It provides the means for applications (built on Ultimus' Composed Process Solutions platform) to hash and encode process outcome information to a blockchain, thereby providing a timestamped digital fingerprint of that outcome which can subsequently be independently verified to elicit evidence of its existence in that state, at that time – and so providing a distributed, transparent audit trail of business process transactions amongst multiple parties.

Ultimus is currently focusing on blockchain capabilities that assure trust in the authenticity of a process outcome (say, a document, or a decision) to protect it from being altered. At present it has no plans to incorporate decentralised smart contracts into its business process automation tooling.

VMware

VMware is a founding member of Hyperledger, and actively contributes to the development of the Fabric framework and Cello module toolkit (the latter designed to provide multi-tenant service atop bare-metal, virtual machine, and container platforms). The company has been working on its own permissioned, private blockchain prototype – designed to provide cross-ledger transaction support, high-throughput data replication, and built-in reconfiguration capability – since 2016; and in the summer of 2018 it announced that this work was being taking forward under the name *Project Concord*, open-sourcing its libraries on GitHub to gain some community traction.

VMware describes Project Concord as providing the core building blocks for constructing "a decentralised trust infrastructure" (deploying a scalable Byzantine Fault Tolerance consensus mechanism at its heart), upon which organisations can develop highly-scalable, permissioned blockchain solutions for the enterprise (on a VMware platform).

Project Concord has yet to spawn any products or services for general availability, but the company is planning to expand upon its library over the course of late 2018 / early 2019 (incorporating community contributions, as well as its own in-house development) – promising a generic key-value interface; an execution engine compatible with smart contracts written to run under the Ethereum Virtual Machine; and integration with other VMware offerings in order to further develop Project Concord as a Blockchain-as-a-Service platform with a focus on enterprise scale, performance, and manageability.

With Project Concord now released as open source code, VMware is keen to develop enterprise tooling around the Concord core, addressing issues such as the health of nodes on the network, key management across multiple parties in an ecosystem, data sovereignty, tools for auditors, and zero-knowledge proofs. It means to cement its position as the preferred blockchain solution on VMware infrastructure, and make it easier to transition proof-of-concept projects into production without stalling for want of technical support.

