Cloud, block chain and related technologies:

MPHO impacts and opportunities

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Australian Red Cross
BLOOD SERVICE

Declaration of interests

- No commercial declarations of interest

- Chair, ICCBBA Asia-Pacific Technical Advisory Group
- Chair, ICCBBA Technical Advisory Group on Information Technology
- Chair, RFID Taskforce, ISBT Working Party on Information Technology
- Member, Executive Committee, ISBT Working Party on Information Technology

Caveats

- This talk will mention:
  - technologies and processes,
  - various standards,
  - companies and their products;

  being mentioned does not constitute any form of endorsement by the Australian Red Cross Blood Service

- A number of the examples are sourced from commercial and internet resources; they are intended only to illustrate possibilities, and should not be interpreted as evidence of established practices or capabilities

Topics

- Current operating models of MPHO supply chains
- Cloud computing
- APIs, HL7 and the FHIR initiative
- Blockchain

Current Operating Models

Current operating models

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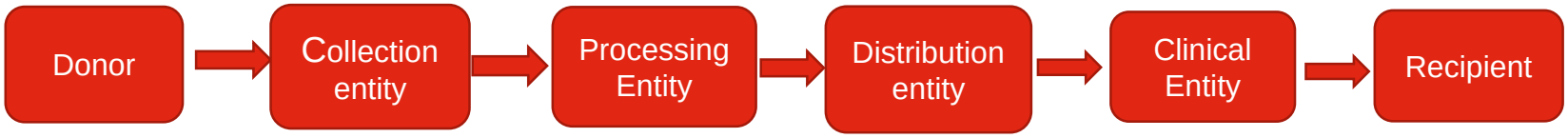

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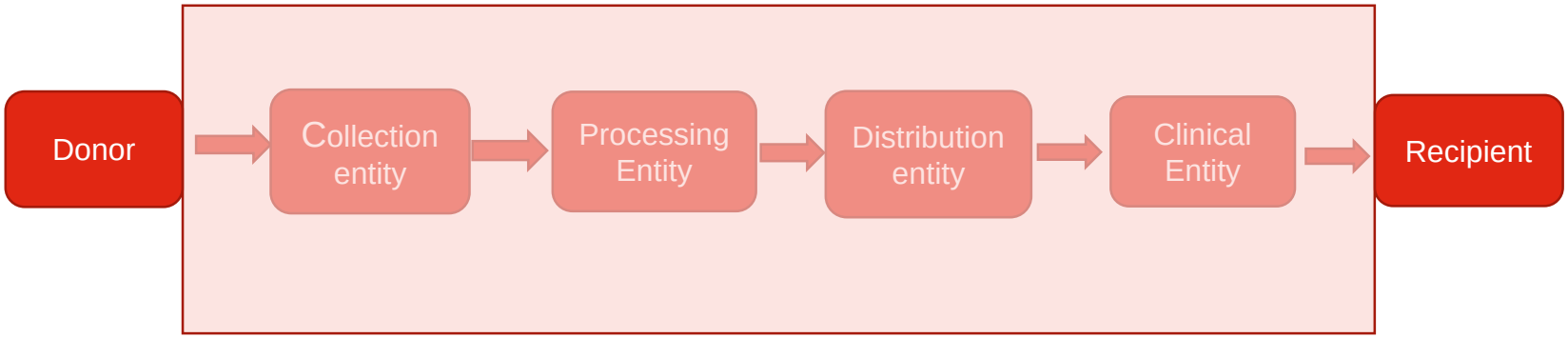

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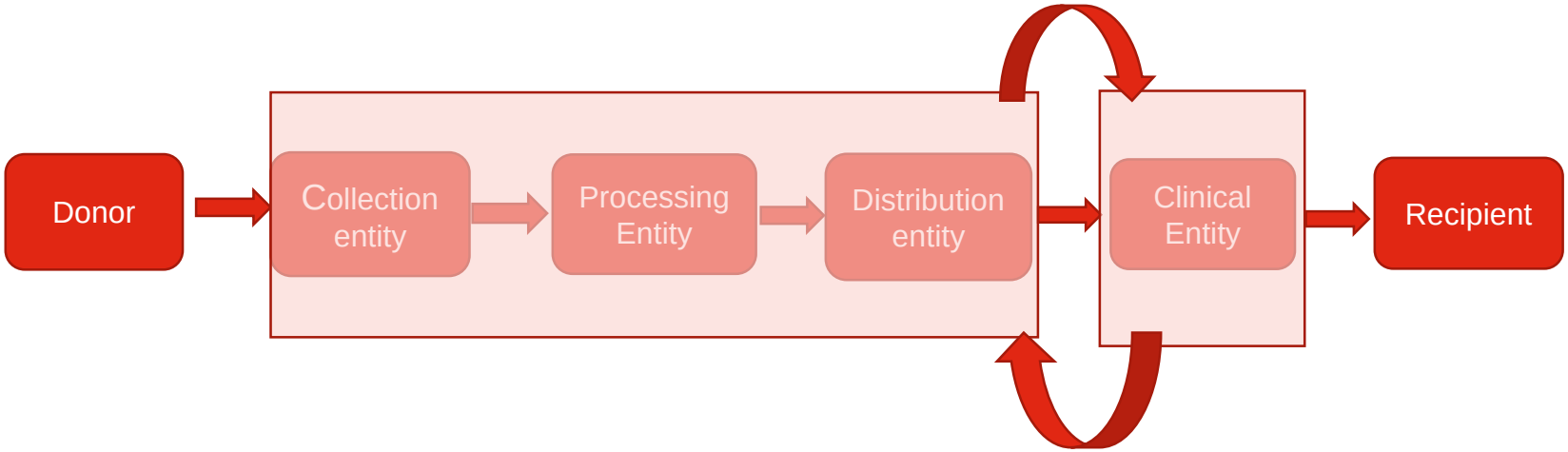

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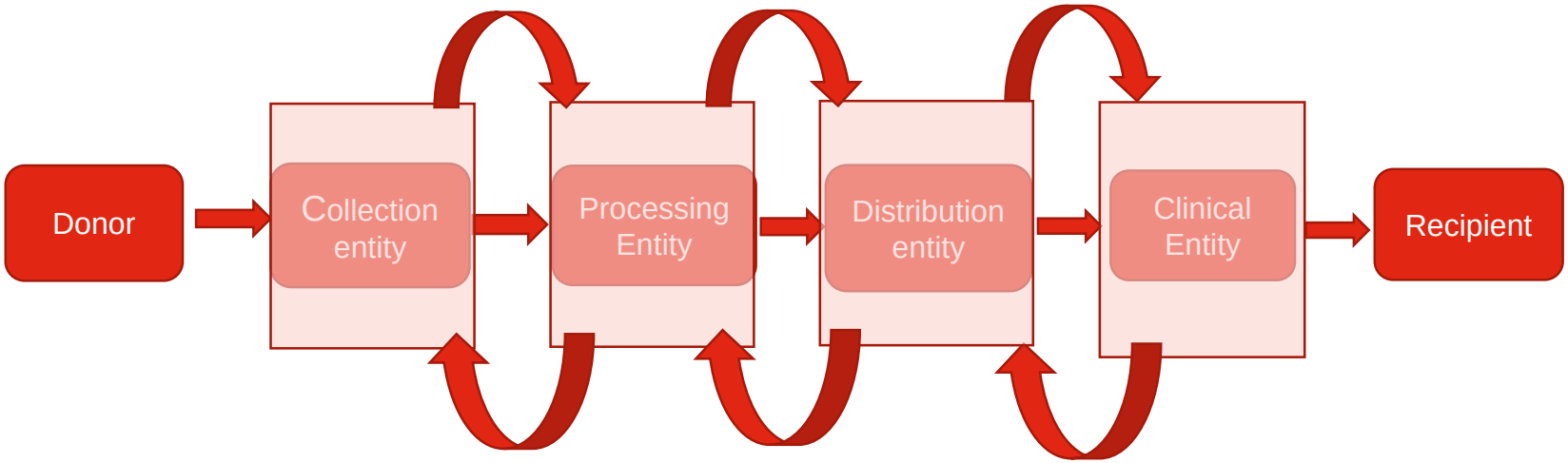

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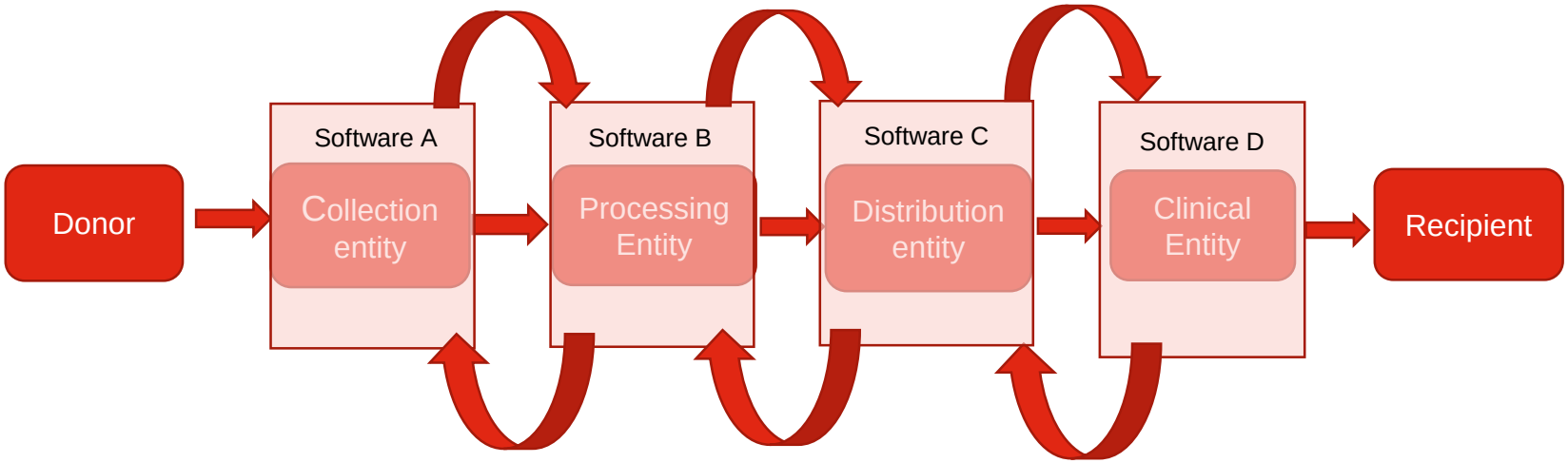

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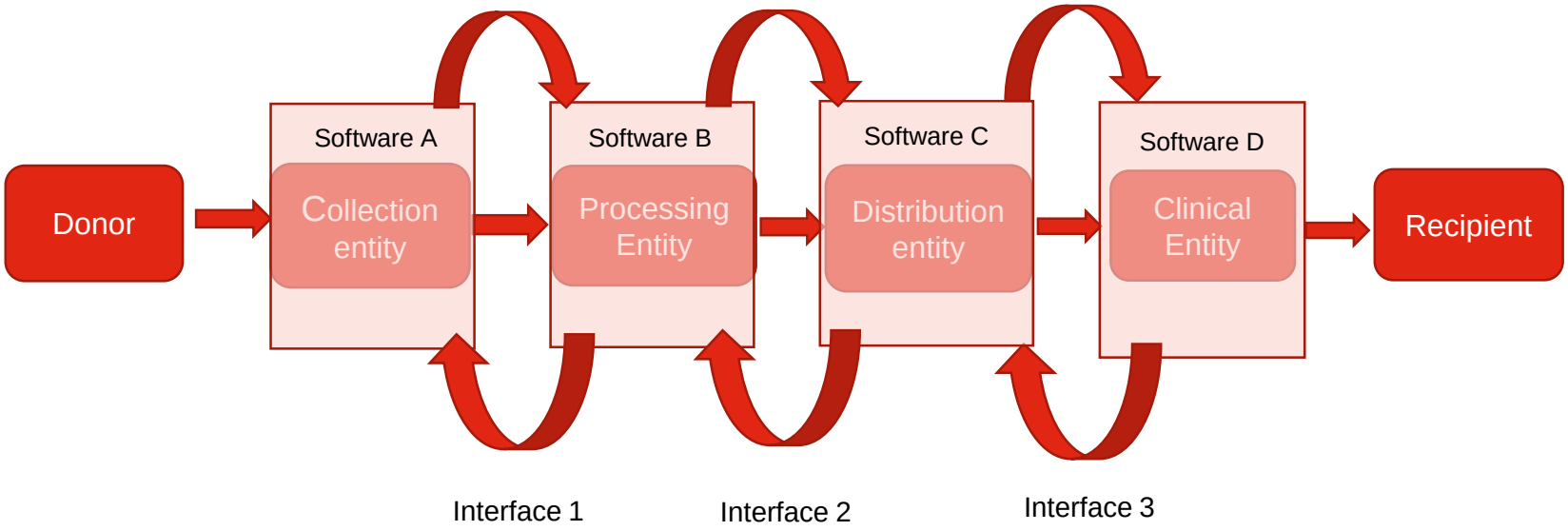

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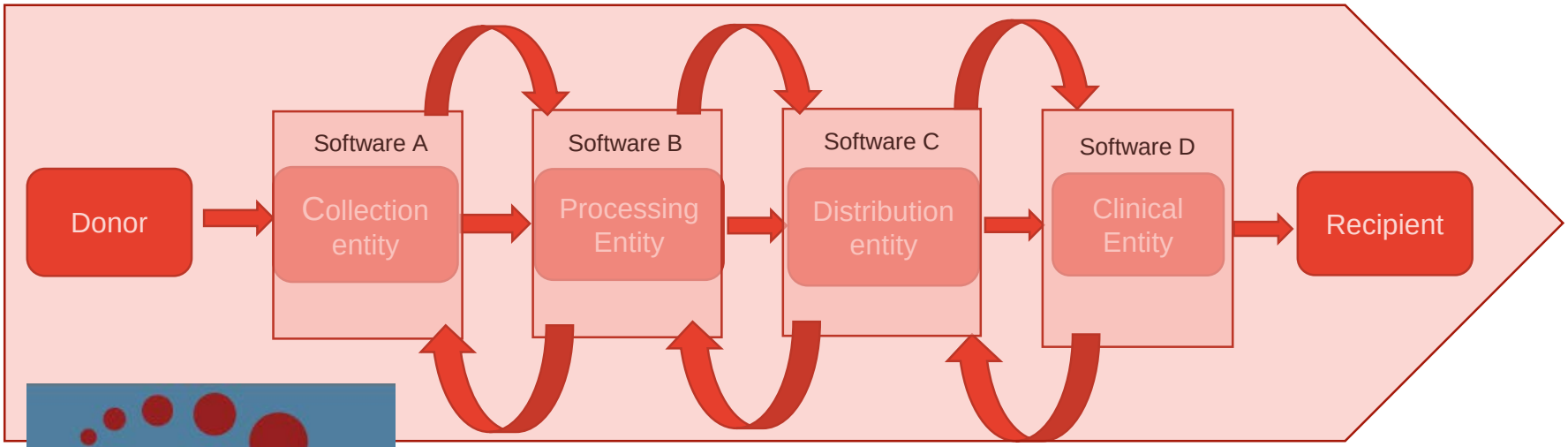
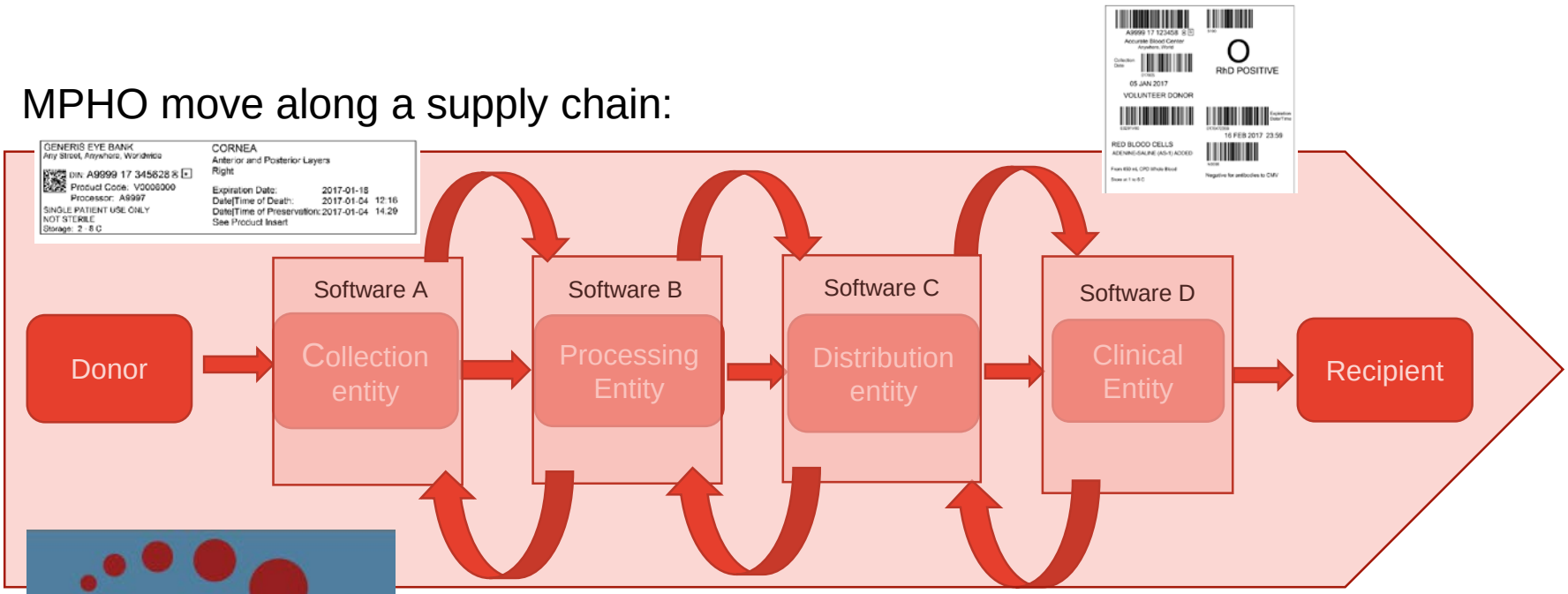


ISBT 128 defining product identification and traceability,
and perhaps defining the nature of the messages exchanged,
but not how they are exchanged

Current operating models

MPHO move along a supply chain:



Currently, the majority of these interfaces, in the majority of MPHO supply chains are more likely to be the product label, rather than any direct interaction between software systems

Current operating models

- The transfer of ISBT 128 encoded data along the supply chain is currently predominantly in the form of scanning barcodes (linear or 2D) or other data carriers (RFID) which are on, or associated with, physical product labels

- Some of the data-capture technologies (2D and RFID) increase information density, but there are limitations to what can be physically encoded and stored on, or associated with, a physical product label

- There are technologies such as electronic messaging supported by the aspects of the ISBT 128 standard (including OID, HL7) but the standardised means to exchange them is less defined

Current operating models – challenges:

- As the amount and the complexity of the information to be exchanged on MPHO increases so will:
  - the need for the direct communication between supply chain entities
  - the need for standardisation of the exchange of that information, in a secure manner
- Drivers of this increase are factors such as the rise of personalised medicine, driven by genomics, proteomics etc.
- Direct communication between software systems - or shared data repositories - will likely need to supplement the physical product label as a data carrier

Current operating models – challenges:

- Currently, we know ISBT 128 provides us with:
  - Detailed and flexible nomenclature for describing MPHO
  - Data structures for codifying this nomenclature
  - Mechanisms to present these data structures in machine-readable formats
  - Some options to describe how these data structures can be exchanged

Current operating models – challenges:

- However, if we need options for greater interoperability – what technologies exist, or are emerging?

- How do we deal with the challenges of different software systems, security requirements, proprietary interface specifications etc.?

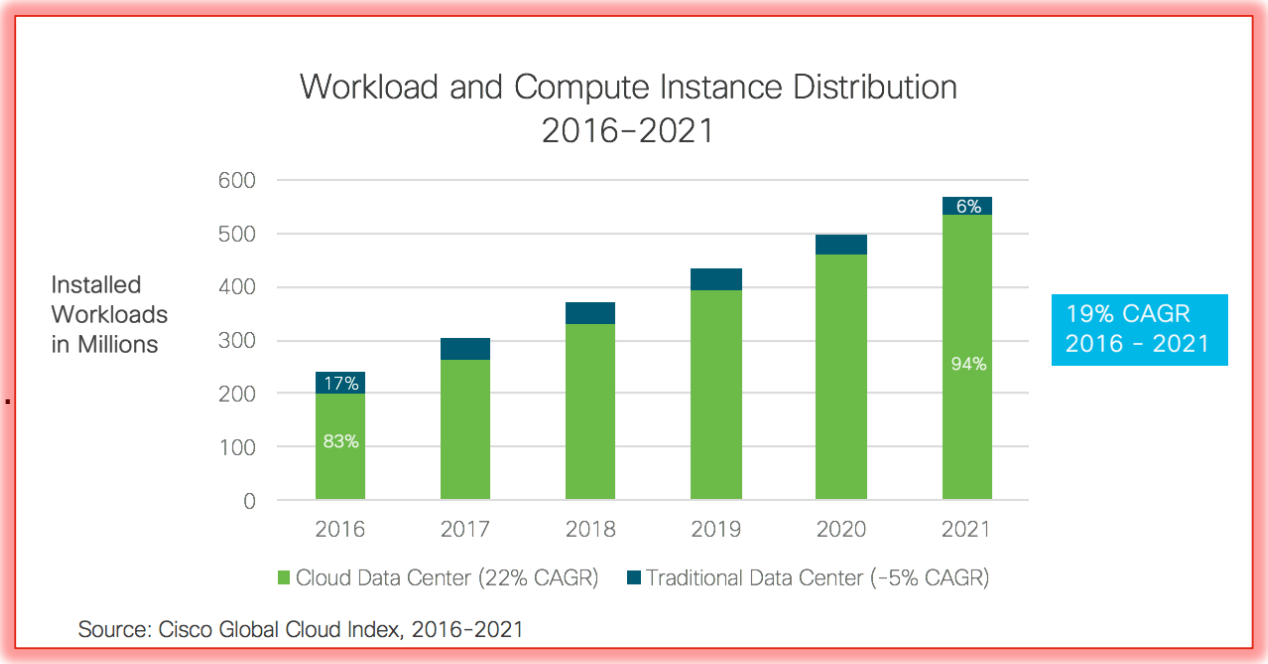
Cloud Computing

Cloud Computing

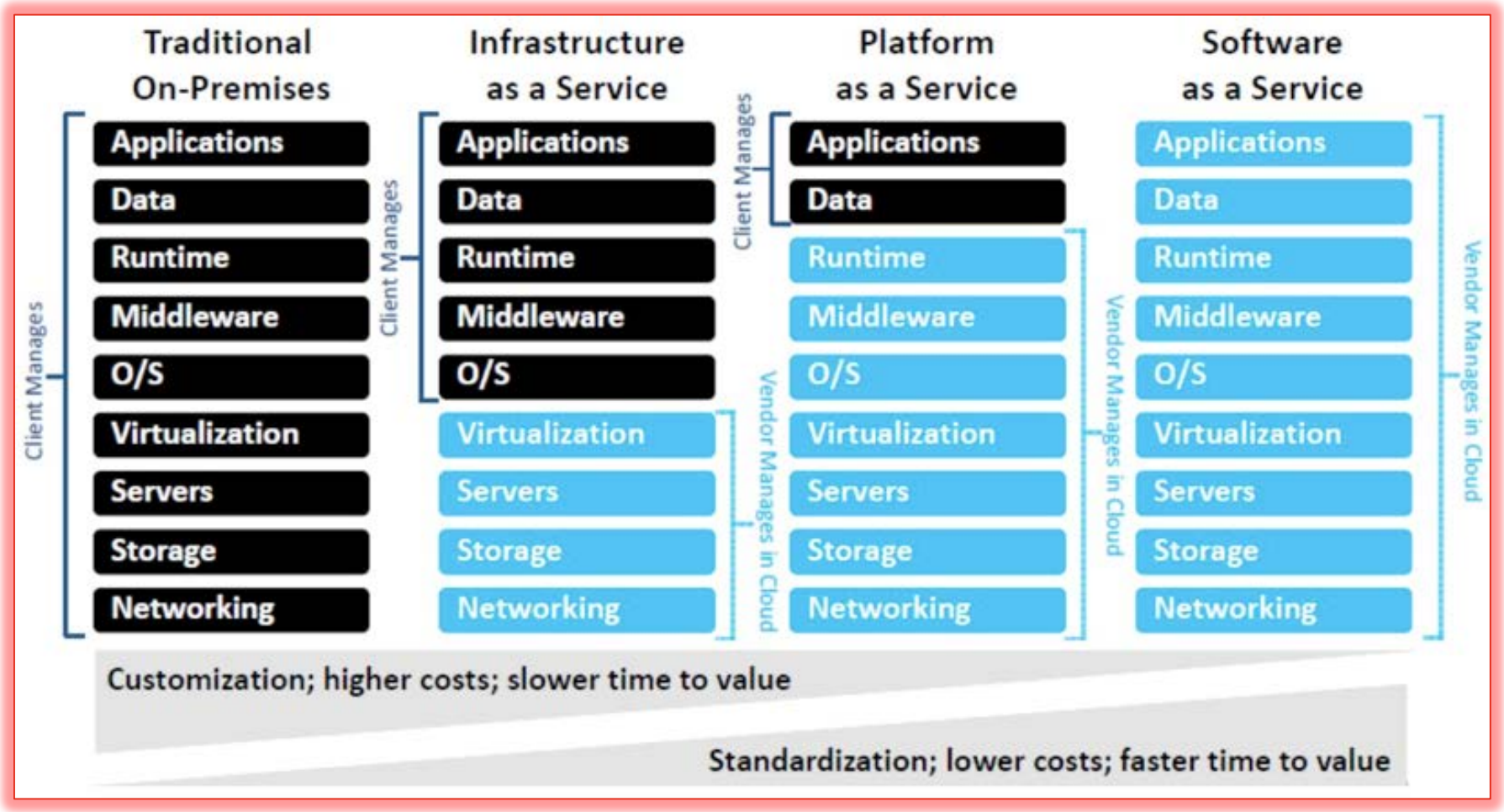
- Cloud computing is largely a metaphor for the internet
- It is accessing of software and hardware services across the internet, rather than running providing them inside an enterprise
- Cloud adoption is already mainstream.

  It is largely no longer a question of if the time is right,

  or if it is a good idea …



Cloud models



Source IBM: https://www.ibm.com/blogs/cloud-computing/2015/03/03/find-your-perfect-cloud-adoption-pattern/

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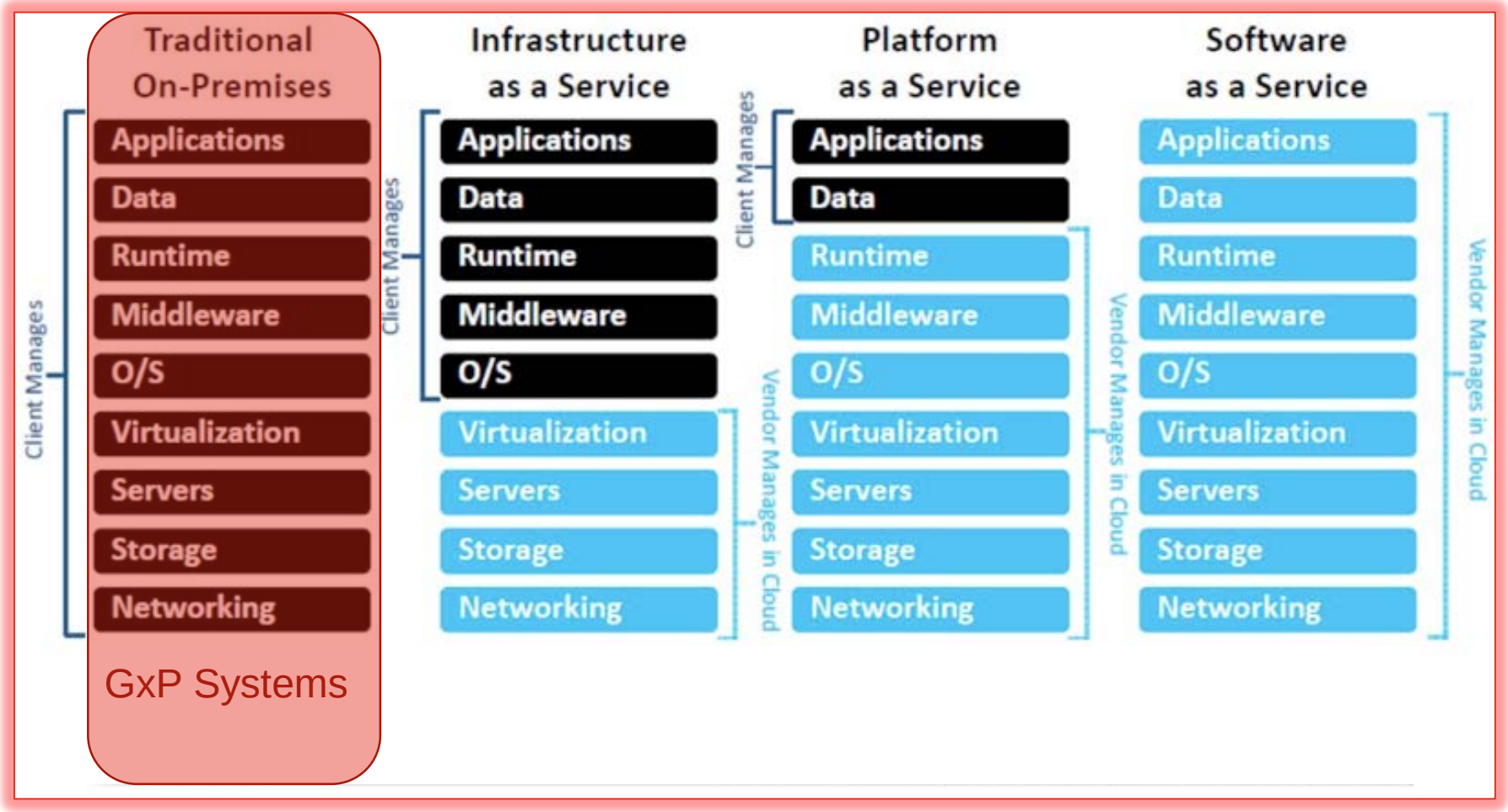

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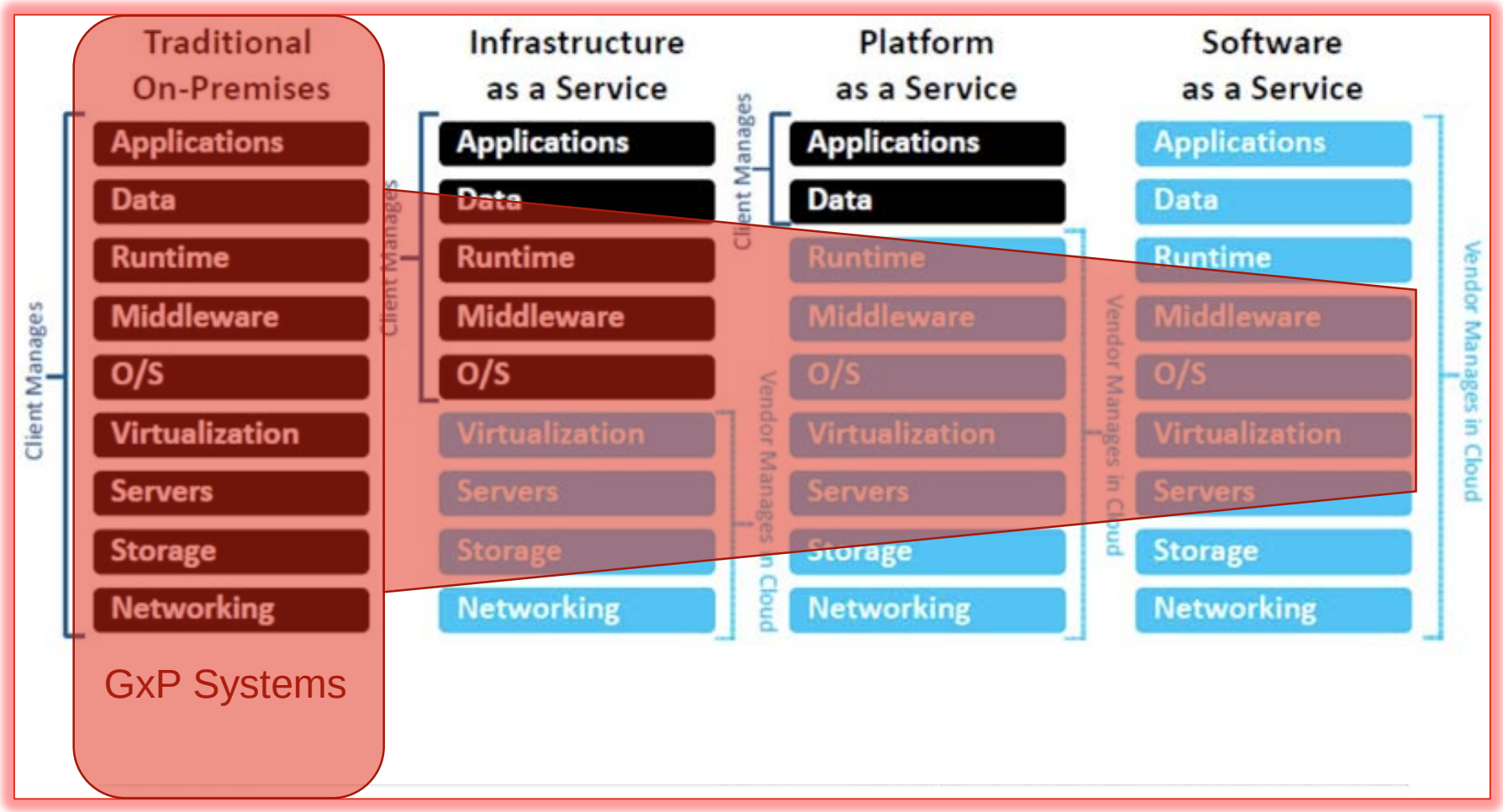


Source IBM: https://www.ibm.com/blogs/cloud-computing/2015/03/03/find-your-perfect-cloud-adoption-pattern/

Why Cloud?

Agility:

- Faster “speed to market”
  - Purchase services
  - Not buy/build/deploy hardware

Scalability:

- Cloud services are inherently more scalable:
  - Little to no lead-in to acquire new infrastructure
  - The usage model can be either pay for what you need, or pay for what you use.
  - The ability to scale quickly, without capital expenditure

The Cloud

The Mayo Clinic's Plummer Building in Rochester, Minn. Mayo has struck a deal with Google to store about three petabytes of the hospital system's data. PHOTO: ANDREW LINK/THE ROCHESTER POST-BULLETIN/ASSOCIATED PRESS

Tech giants in battle to store health data in the cloud. Alphabet Inc.'s Google will announce Tuesday a 10-year deal with the Mayo Clinic to store the hospital system's medical, genetic and financial data.

https://www.wsj.com/articles/google-amazon-and-microsoft-in-battle-to-store-health-data-in-the-cloud-11568122202

Why Cloud?

Security and Availability:

- Due to their scale and business model, cloud service providers are typically able to make cyber-security investment that is generally not feasible for “on premises” systems

- Gartner predicts that through 2020, services on public cloud infrastructure will suffer at least 60% fewer security incidents than those in traditional data centres.

- Cloud providers are also able to:

  - achieve very high levels of redundancy in their environments
  - provide a wider array of options to improve system resilience such as wider geographical separation of data centres.
  - This also can address data sovereignty issues – keep your data anywhere

Why Cloud?

Cost:

- This can be one of the more challenging benefits to achieve
  - Just running it in the cloud won't necessarily make it cheaper
  - The challenge is not to over-provision
- Cost reductions are often dependent on the ability to dynamically manage workloads and resources.
  - There is a transition from CapEx to OpEx – can be a challenge for your CFO and Finance Department

Workforce Skills:

- With a growing reliance on diverse technologies, it is increasingly difficult to keep in-depth expertise on every needed infrastructure pattern or service, inside an organisation.
- The use of Cloud-based services means it is possible rely on the full scale of vendor support expertise

Cloud opportunities

- As workloads migrate to the cloud, the ability to connect them is enhanced: the basis of the internet is connectivity
- There are standard approaches that allow us to imagine the transfer of information for MPHO between disparate systems, without proprietary “point to point” interfaces
- In the cloud world, this is increasing standardising on communication by web services, or APIs

API:

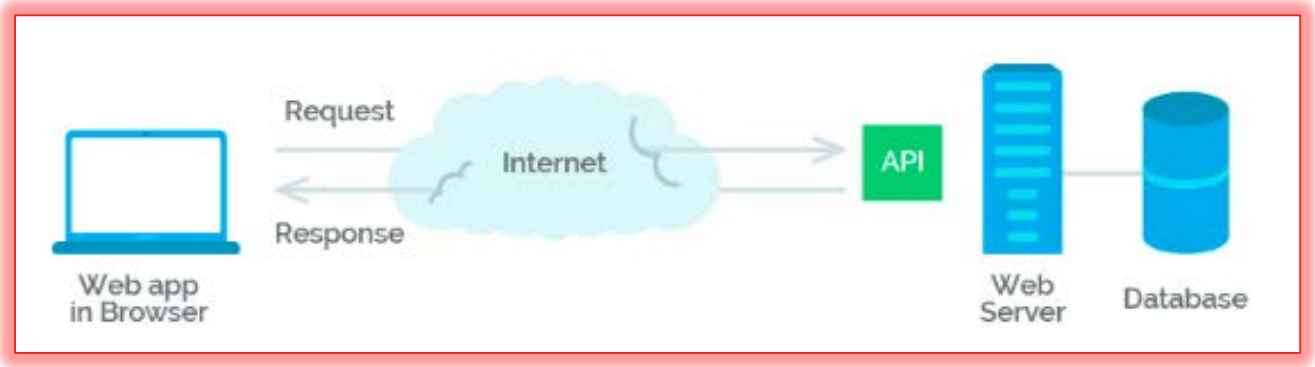
Application Programing Interface

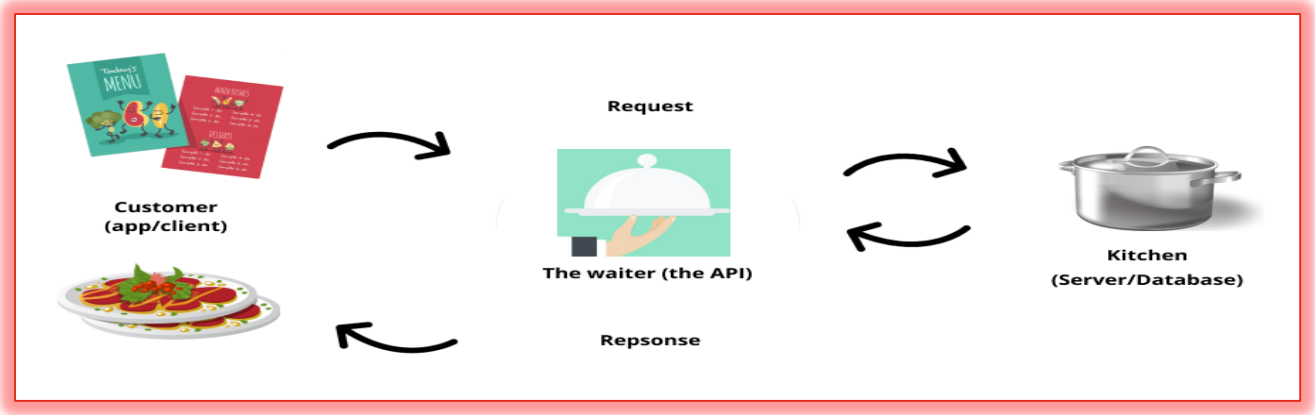
Cloud – Web APIs

- **A**pplication **P**rogramming **I**nterface:
  - An API is a set of routines, protocols, and tools for specifying and building software application interactions.
  - There are different types of APIs for interaction between web-based systems
  - Increasingly popular are RESTful APIs (based on **Re**presentational **S**tate **T**ransfer architecture):
    - The have advantages of relative simplicity, excellent scalability and performance
    - They also encourage security and governance, through standardisation – they represent “contracts” between web systems

Cloud – Web APIs

- **A**pplication **P**rogramming **I**nterface: “the waiter analogy”





HL7 and MPHO

- “HL7 is a comprehensive framework and related standards for the exchange, integration, sharing, and retrieval of electronic health information”

http://www.hl7.org/about/

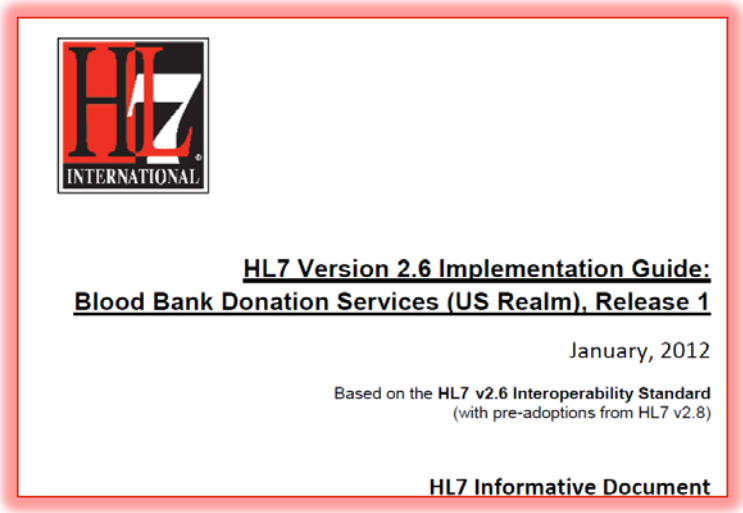
- The existing ISBT 128 Technical Specification already contains a reference table that specifies how ISBT 128 data structures can be included in HL7 messages

- This also cross-references a separate ISO/IEC standard based on Object Identifiers (OID)

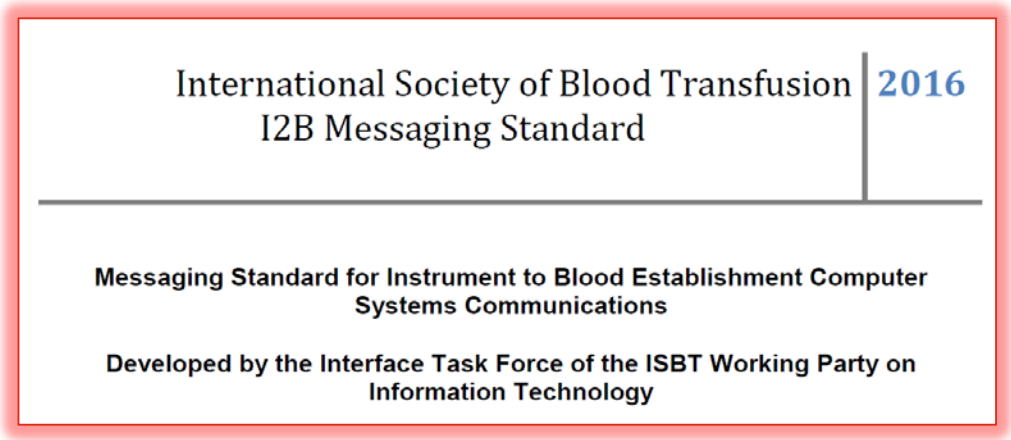
Object Identifier (OID)	Text Name	Description	Data Example	HL7 IBT0001 Code Table Value
2.16.840.1.113883.6.18.2.1	Donation Number	Thirteen character donation number element from an ISBT 128 Donation Identification Number [Data Structure 001]. (In this case includes the second data identifier which is also the first data character)	A999908123456	IBT1-0001

HL7 and MPHO - Blood

- There has previously been work to define some US-specific HL7 messages for the registration, eligibility screening, and collection processes



- In addition, the Interface Taskforce of the ISBT Working Party on Information Technology (WPIT), encompassed HL7 messages in a draft standard for the communication between laboratory and collection devices, and BECS



HL7 - FHIR

- HL7 FHIR (**F**ast **H**ealthcare **I**nteroperability **R**esources)
- FHIR is a “next generation” standards framework created by HL7.
- FHIR combines the best features of HL7 v2 , v3 and CDA product lines while:
  - leveraging the latest web standards;
    (XML, JSON, HTTP, OAuth, support for RESTful architectures etc,)
  - having concise and easily understood specifications
  - applying a tight focus on implementability.

FHIR

- FHIR deals with some of the issues of using HL7 in a B2B context, versus use for communication within an enterprise:
  - HL7 doesn't however have good support for information requests, such as:

    "for this DIN, give me the special test results in data structure [012] and [030]"

  - FHIR security layer is evolving, but it will support
    - full web-based authorisation and access control
    - encryption "in flight"
    - digital signatures etc.

    and other capabilities not natively addressed by the HL7 Standard

FHIR

- The vision is FHIR will be a “lingua franca” to providing a universal adaptor for sharing health data:

Apple, Google, Microsoft (Azure), Amazon (AWS), IBM, Salesforce and others :
Joint Statement on healthcare interoperability:

> “*We are jointly committed to removing barriers for the adoption of technologies for healthcare interoperability, particularly those that are enabled through the cloud and AI. We share the common quest to unlock the potential in healthcare data, to deliver better outcomes at lower costs.”*

> Open standards, open specifications, and open source tools are essential to facilitate frictionless data exchange. This requires a variety of technical strategies and ongoing collaboration for the industry to converge and embrace emerging standards for healthcare data interoperability, such as HL7 FHIR and the Argonaut Project.

2018 Blue Button 2.0 Developer Conference

FHIR

Secure messaging interoperability now scaling up: ADHA

Written by Kate McDonald on 09 September 2019.

The Australian Digital Health Agency (ADHA) says it is now working with 42 software companies on implementing new FHIR-based interoperability standards for secure messaging, covering 56 separate software products.

https://www.pulseitmagazine.com.au/australian-ehealth/5111-secure-messaging-interoperability-now-scaling-up-adha?utm_source=Pulse%2BIT+-+eNewsletters&utm_campaign=c30627f55f-PulseIT_eNews_13_09_2019

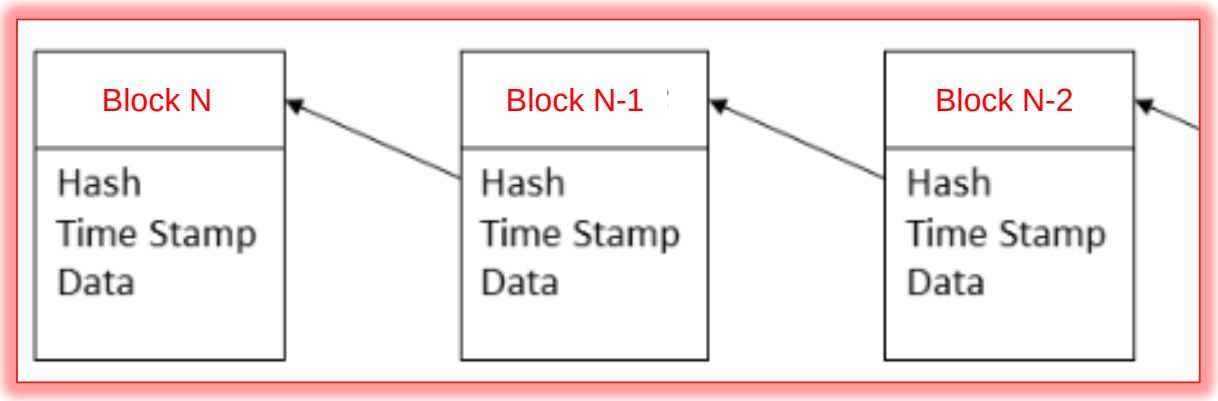
Blockchain

Blockchain

- A blockchain is a distributed digital leger:
- this leger:
  - is a database, a copy of which is held by all participants in the blockchain network
  - is an expanding, chronologically ordered list of cryptographically signed transactional records
  - each record is called a block – the list of blocks is a blockchain

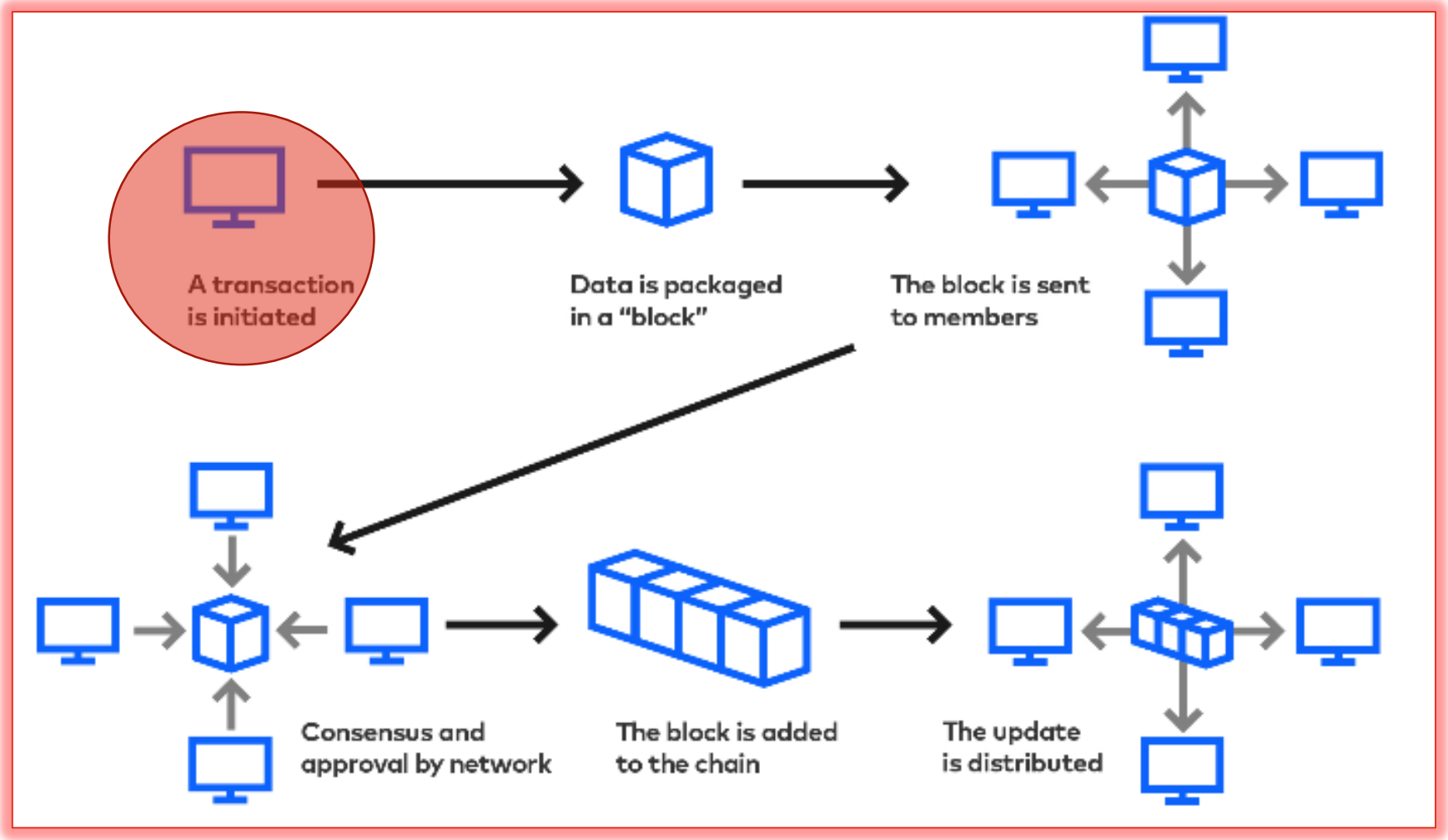
Blockchain

- Each block contains:
  - A cryptographic hash, which is a summary of the previous block
  - A timestamp
  - The data for the transaction



- Once committed to the chain, a transaction (at least in theory) cannot be reversed or altered, because it links to preceding blocks

Blockchain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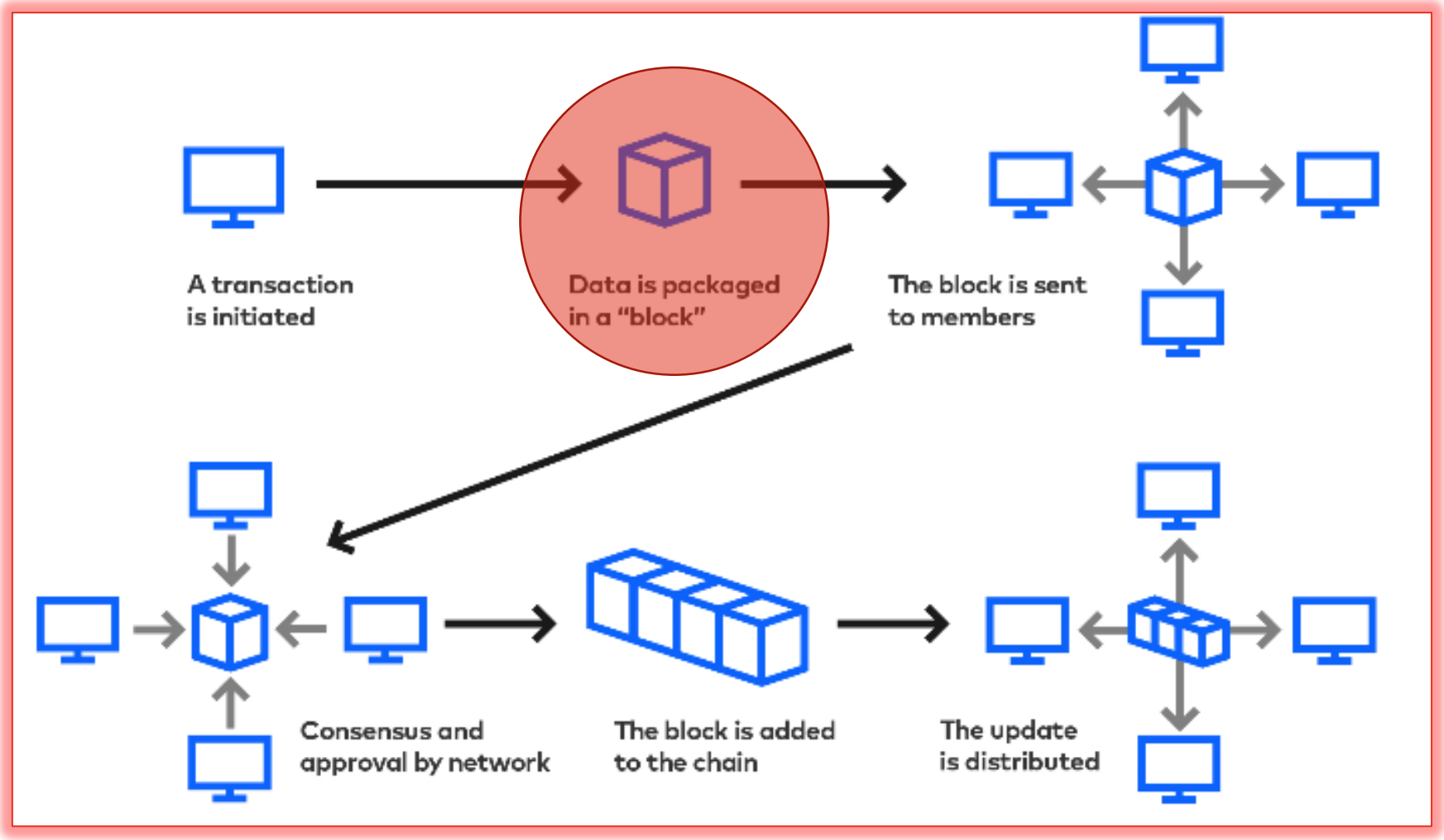
Data is packaged in a "block"
The block is sent to members
Consensus and approval by network
The block is added to the chain
The update is distributed

Blockchain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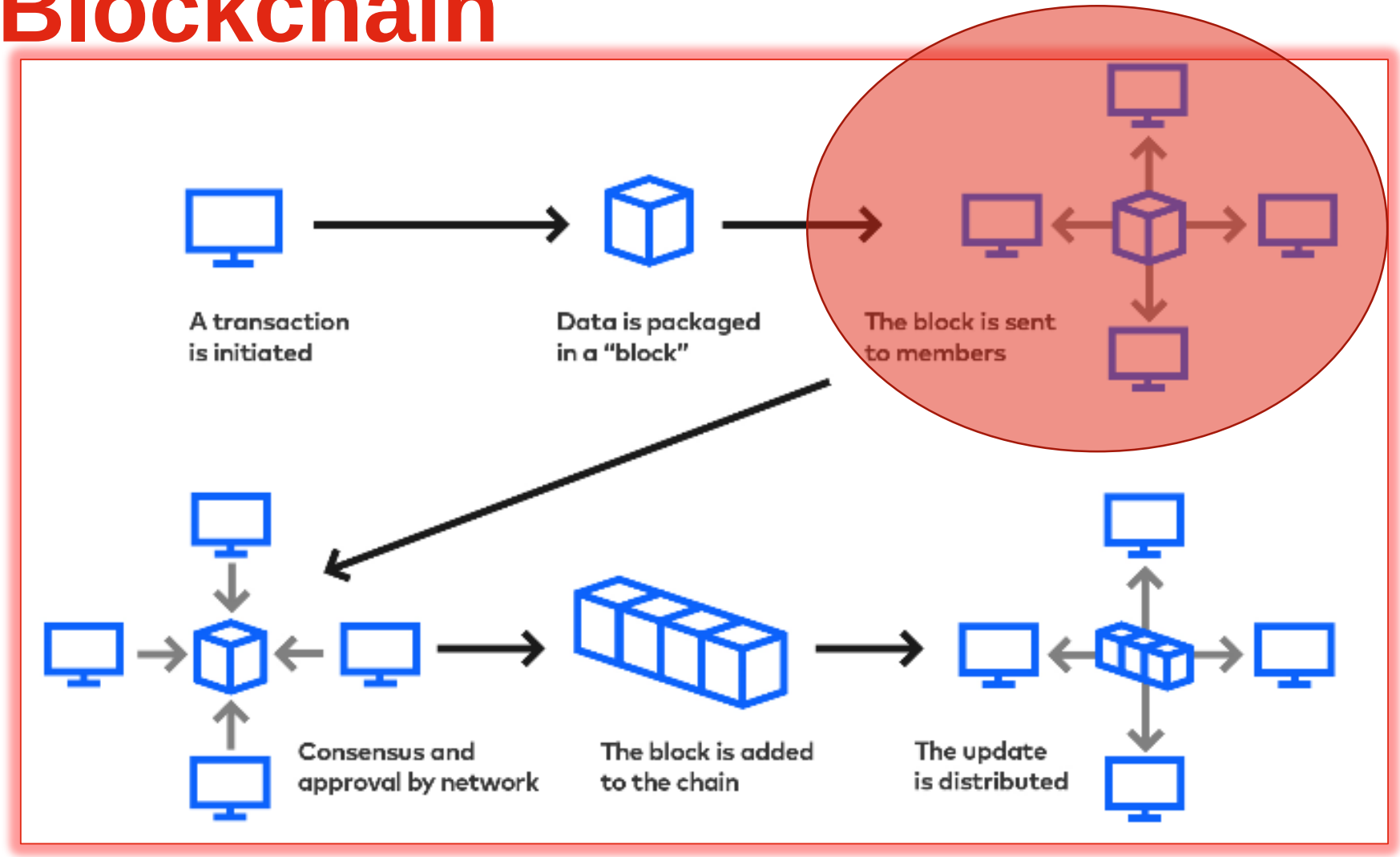
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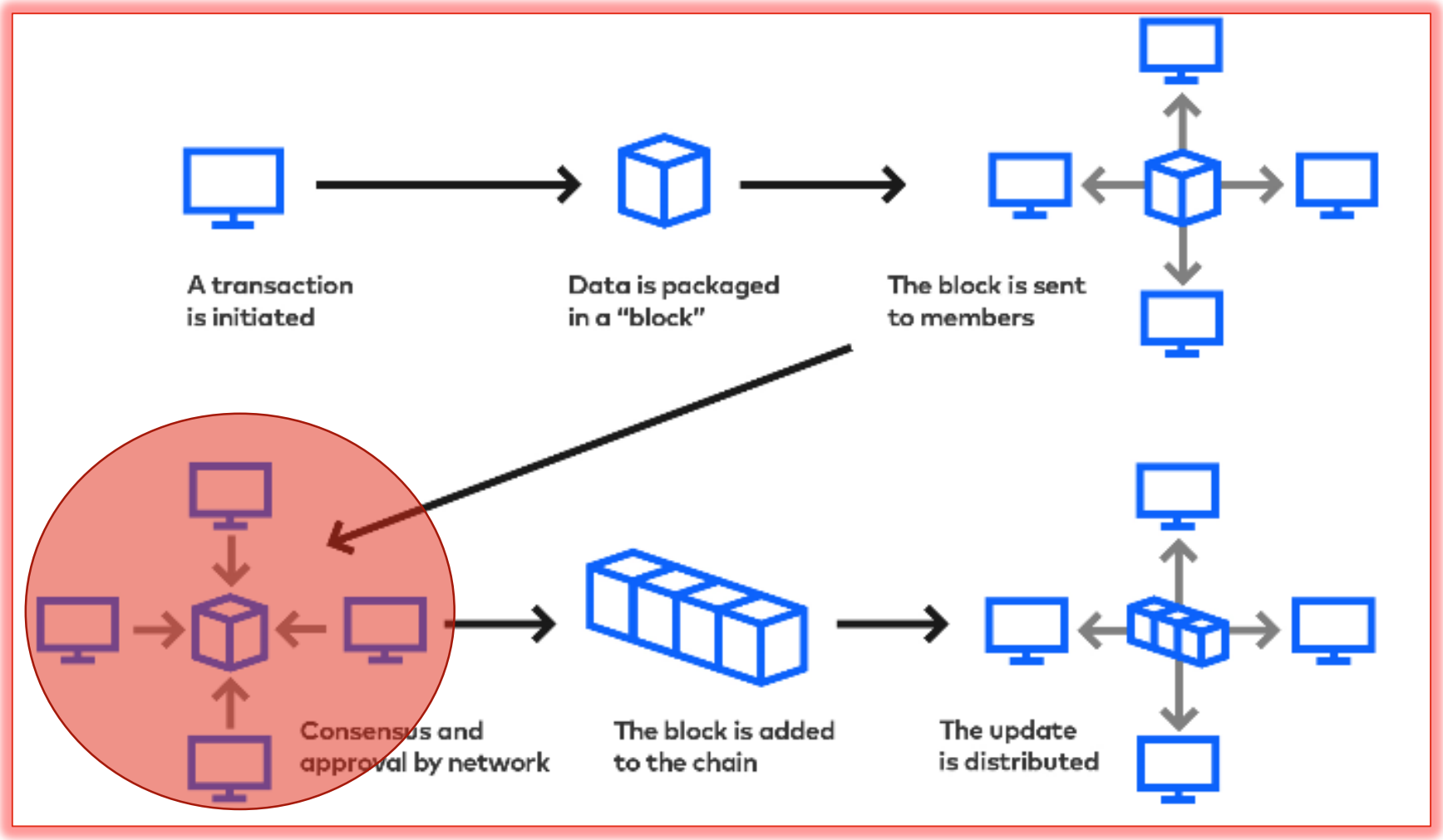
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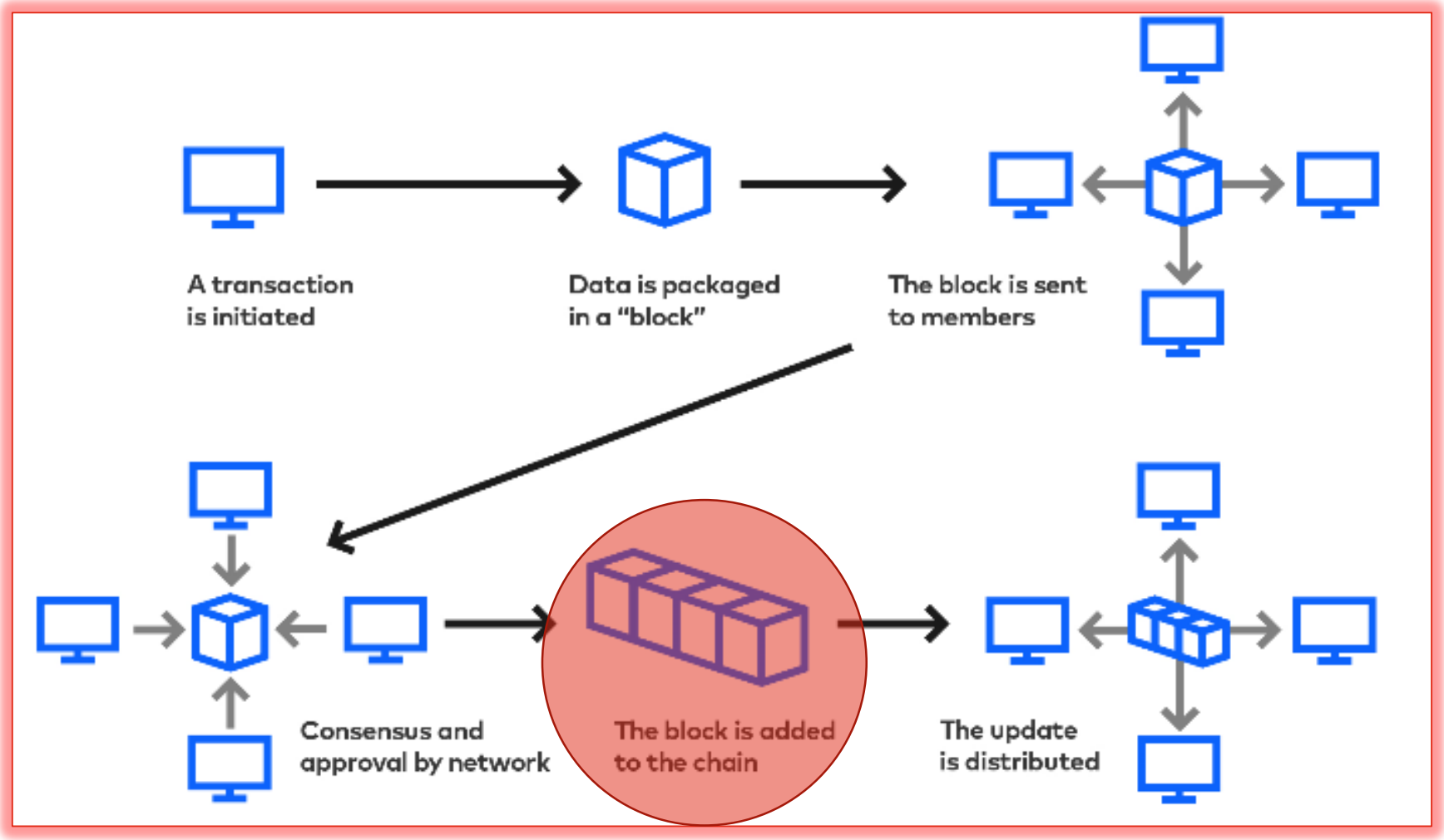
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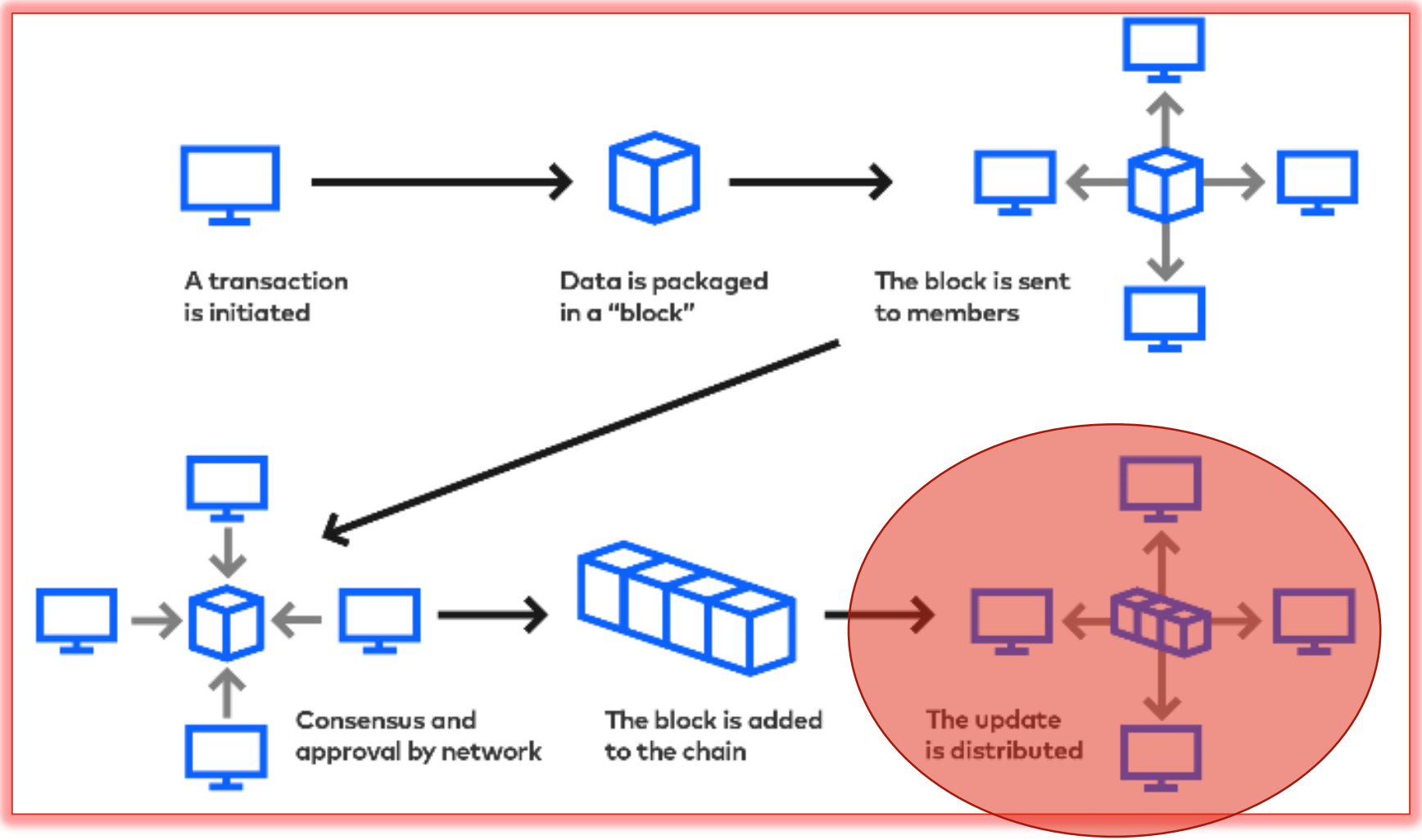
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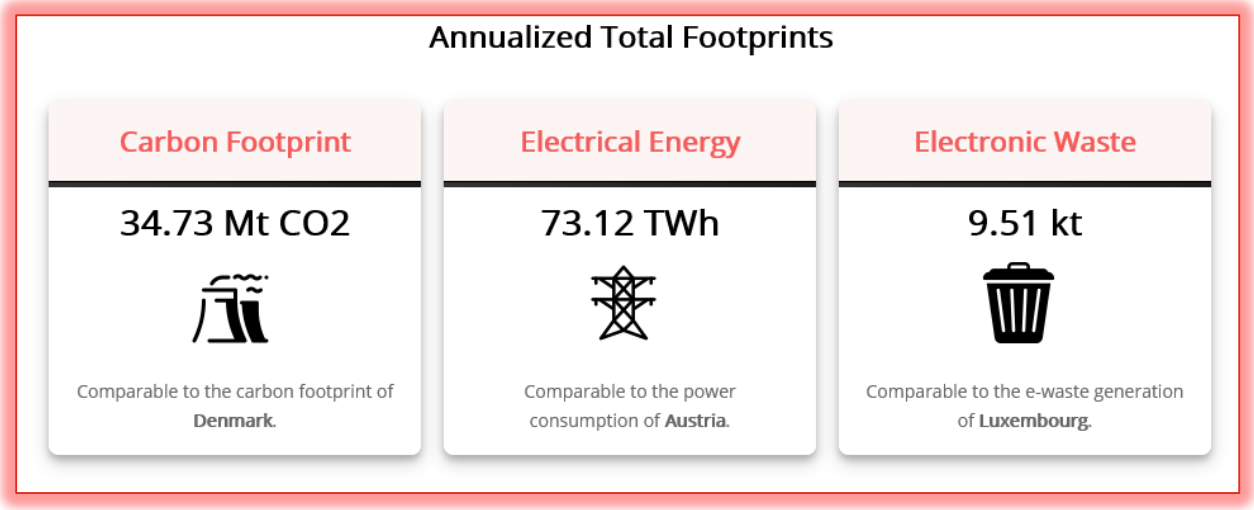
Blockchain

- A copy of the blockchain is then held by all participants – there is no central authority on the data
- The adding of a block to the blockchain is decided by a consensus group of participants
- Blockchain has applications that began in cryptocurrency and finance, but have expanded to:
  - Supply chain
  - Government
  - Healthcare
  - Manufacturing

Blockchain, cryptocurrency and hype

- The most widespread use of blockchain technology has been cryptocurrency (Bitcoin, Ethereum etc.)
- This has been subject to a good deal of publicity and interest/concern from financial and other regulators
- “Proof of work” blockchains, such as bitcoin, have also been criticised for the intense computational effort needed to “mine” bitcoins, which consumes considerable energy



https://digiconomist.net/bitcoin-energy-consumption

Blockchain, cryptocurrency and hype

- As with all new technologies, blockchain is not without its challenges – reported difficulties include;
  - slow speed to record transactions
  - lack of native interoperability
  - concerns over scalability
  - limited or inadequate governance models and standards – which reflects the disruptive origins of the technology

- However to counter this there are enterprise platforms emerging, from giants such as IBM and AWS - “Blockchain as a Service” (BaaS)
- This is definitely seeing the technology mature and joining the services that are offered by large cloud providers

Blockchain and sevices

Amazon Quantum Ledger Database (QLDB).

- Amazon QLDB is a fully managed service providing a cryptographically verifiable ledger for applications that need a trusted authority to provide a permanent record of transactions.
- document-oriented data model enables customers to store structured and unstructured data in the ledger.
- Serverless architecture , so clients are not required to provision capacity or set read and write limits.
- Automatically scale to support application demands - unlike the ledgers in common blockchain frameworks
- Amazon QLDB does not need a distributed consensus, so that it can execute more transactions in the same time as common blockchain frameworks – very high performance levels

Blockchain in healthcare

- Most healthcare applications are focussed on the advantages of the distributed ledger:
  - Supply chain integrity
  - Consent management
  - Healthcare Provider credentialing

- Some make use of “smart contracts” - a computerized transaction protocol that executes the terms of a contract – held on a blockchain:

  - Monetization of data – such as patients paid when their data is used
  - Micropayments – small payments to patients for achieving a health outcome, such as a lifestyle change
  - Tokenisation – record health outcomes achieved by social enterprises

Blockchain – Some healthcare examples

- IBM and Chainyard are launching a blockchain network to boost supply chain management for pharmaceutical companies, as well as firms in other industries:
  - The new blockchain network - ”Trust Your Supplier” – delivers a digital identity on the blockchain network that enables suppliers to share information with any permissioned buyer
  - It is designed to improve supplier qualification, on-boarding, and manage the life cycle of exchanged data

Blockchain – Healthcare Supply Chains

- SAP has announced a blockchain network called “Information Collaboration Hub for Life Sciences”:
  - One of the aims is the identification of counterfeit pharmaceutical products
  - The technology allows a participant in the supply chain the barcode of the product to check the item's serial number, product code and other information - against information entered by the manufacturer onto the blockchain.
  - This can be with something as simple as a smartphone app

Blockchain and MPHO - Blood

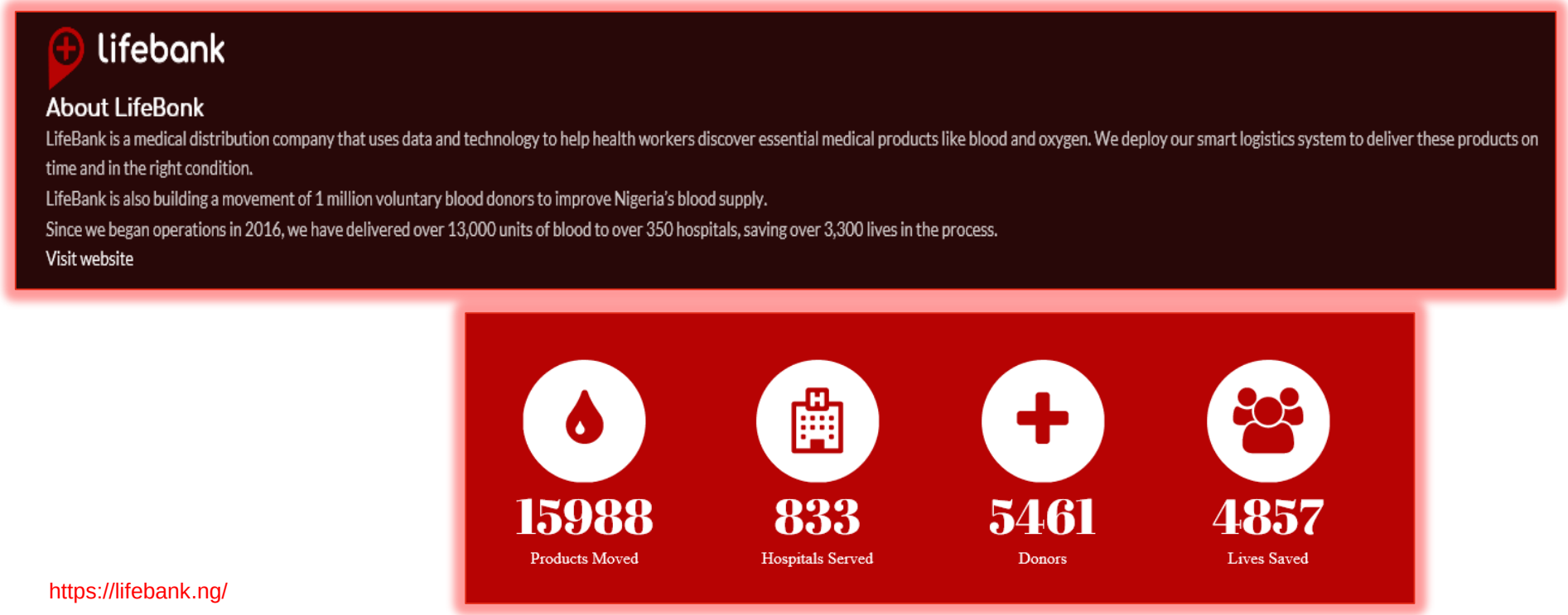
- HamroLife – cloud-based blockchain solution for tracing provenance in the blood supply chain

- HambroLifeBank in Nepal:

https://hamrolifebank.com/#mission

Blockchain and MPHO - Blood

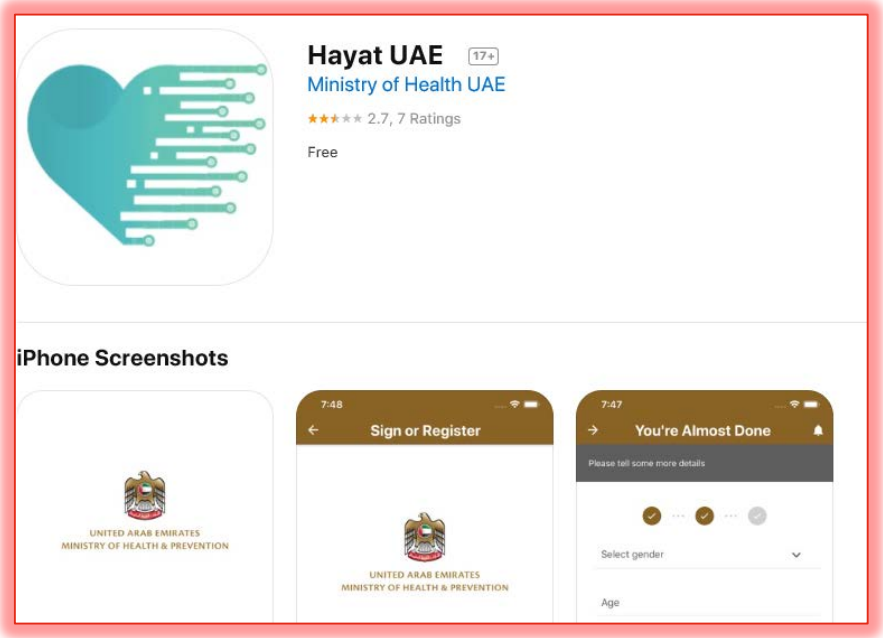
- LifeBank in Nigeria – cloud-based blockchain solution for tracing provenance in the blood supply chain, also providing medical oxygen



https://lifebank.ng/

Blockchain and MPHO - Organs

- UAE - first country in the world to use blockchain for Organ Donation
  - First phase involves patient registration, and donor registration on an iOS app



  - Second phase aims to improve the matching and traceability of transplanted organs using AI and Blockchain.

"Using AI and Blockchain, we will ensure that organs being donated are verified using DNA swabs that have already been uploaded onto the blockchain. Hospitals can verify that the DNA of the organ they have matches the DNA information of an organ donor on the blockchain. Using AI we can also optimize matching organs from donor to patients. This will make the UAE number one country when it comes to eradication of organ trafficking and also in terms of success rate when it comes to organ implantation procedures."

http://www.unlock-bc.com/news/2019-02-01/uae-first-country-in-the-world-to-use-blockchain-for-organ-donation

Blockchain opportunities

- Currently strengthening in a number of domains – particularly supply chain
- Currently, some “early adoption” in MPHO is occurring
  - Some low cost, social enterprise type approaches
  - Some “proof of concept” exercises, by Blood Services etc.
- The technology also lends itself to mobile device applications and technology
- This could be significant as less developed economies “skip the wired internet”

Blockchain opportunities

- May represent the potential for MPHO supply chains:
  - with large numbers of loosely affiliated constituents
  - where authentication/accreditation is an issue
  - High commercial value/rare products

Conclusions

- Current MPHO supply chains largely rely on information transfer from the machine and human readable elements on the physical release labelling of MPHO
- It is likely that the volume of information, and the complexity of that information, that needs to transferred about MPHO will increase
- In a world where computational workloads, including those containing personal health information and managing GxP processes, native web connectivity becomes increasingly important

Conclusions

- It is highly likely API connectivity, and in particular HL7 FHIR, will be a drive of this connectivity evolution
- Blockchain technology, while early in mainstream adoption, shows promise for distributed supply chain data, especially for applications where a central trusted authority for the data is not available, or not appropriate
- The emergence of commercial “Blockchain as a Service” may hasten its inclusion in mainstream supply chains

Conclusions

- APIs and Blockchain offer two different models:
- APIs
  - Collaborative standards-based interoperability with data exchange
    - Security and authentication part of the transaction

- Blockchain
  - Distributed data with no central authority
    - Security and authentication part of the architecture

- Not necessarily “either or” – especially at this point in time – and there are others we have not discussed
- Both may have application for different MPHO, in different supply chain situations

Thank you

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