

جامعة
الملك سعود
King Saud University



كلية علوم الحاسب والمعلومات

Blockchain 101

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Learning Objectives

1. Understand some key blockchain **fundamentals**.
2. Summarize some key blockchain applications **beyond cryptocurrency**.
3. Describe a **scientific blockchain use-case** for global patients.
4. Outline a **real-world blockchain use-case** for fundraising.
5. Know how to get started with blockchain **training** and **career planning**.

Shada @ a Glance





Blockchain Fundamentals

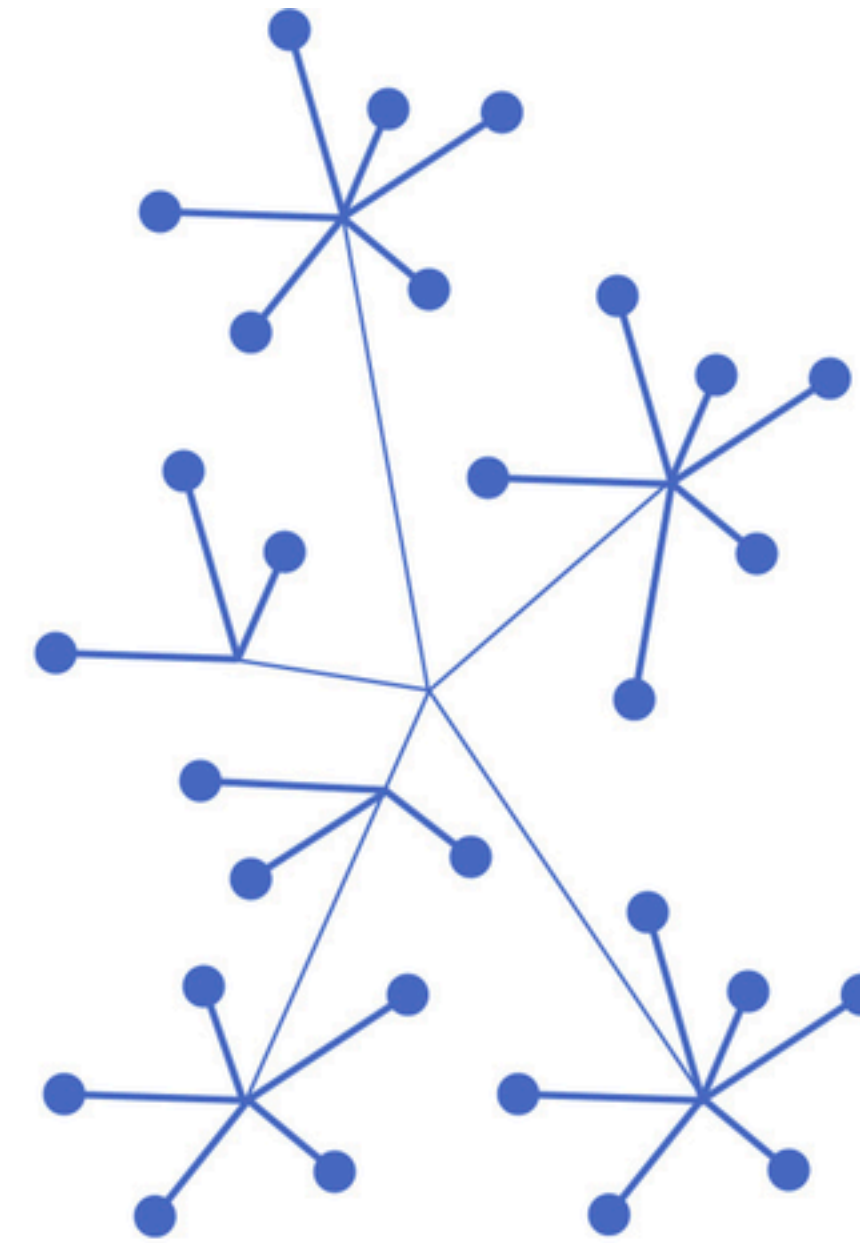


Blockchain- So what is blockchain?

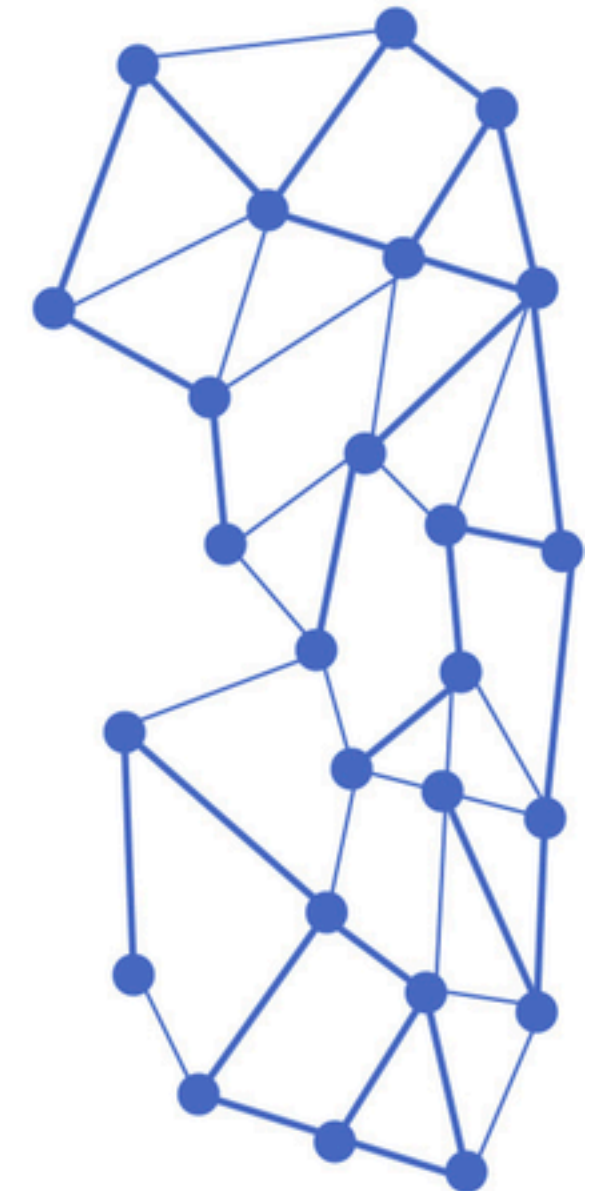
- A **distributed ledger** technology holds/ tracks transaction data (*a bookkeeper not a database solution*)
- Shared over **decentralized network of nodes** (parties)



Centralise



De-Centralised



Distributed

Blockchain- More about it

- Enables a peer-to-peer communication **without the need for an intermediary**
- Allows for a new generation **of transactional applications between the parties**



Distributed

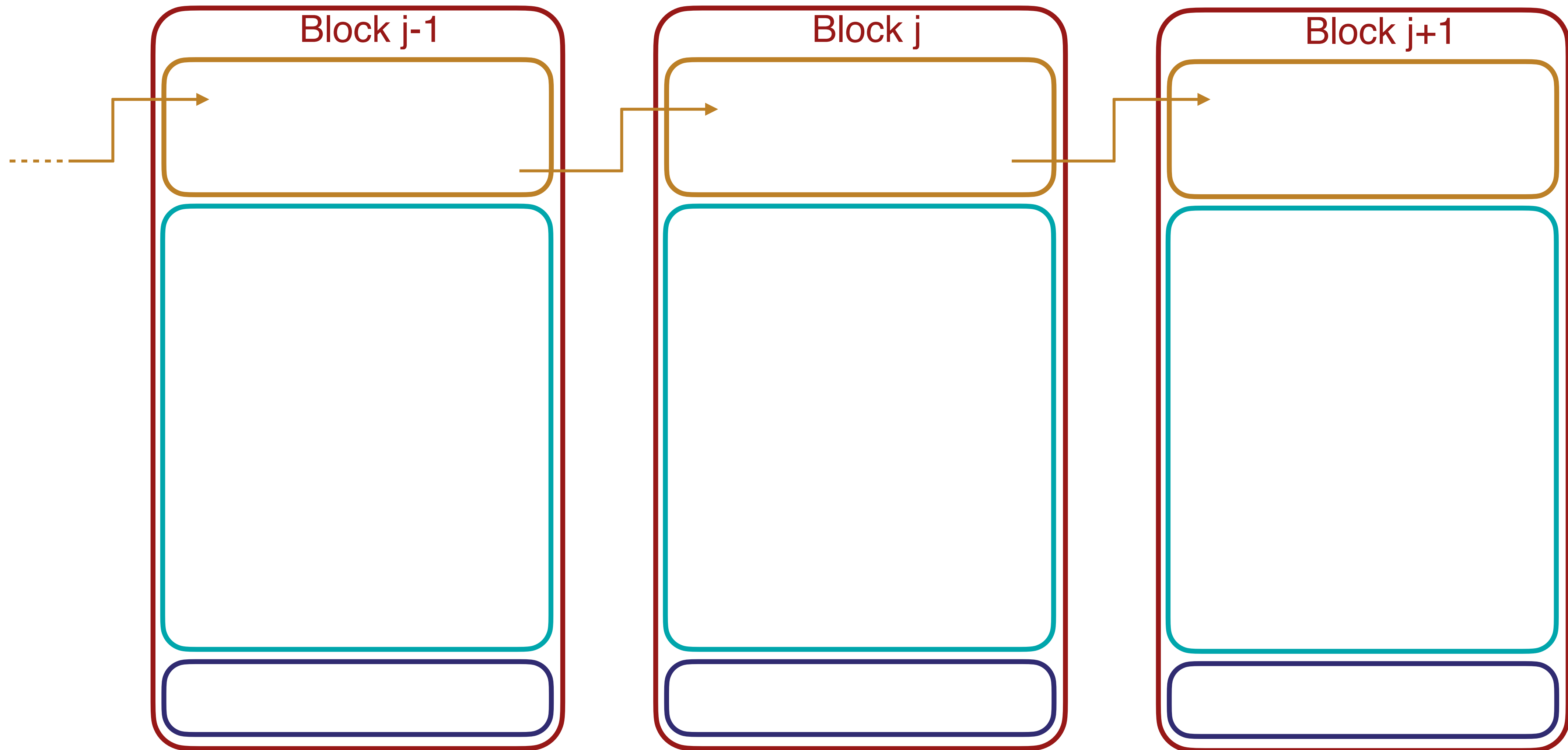
Blockchain- Development

Blockchain 1.0

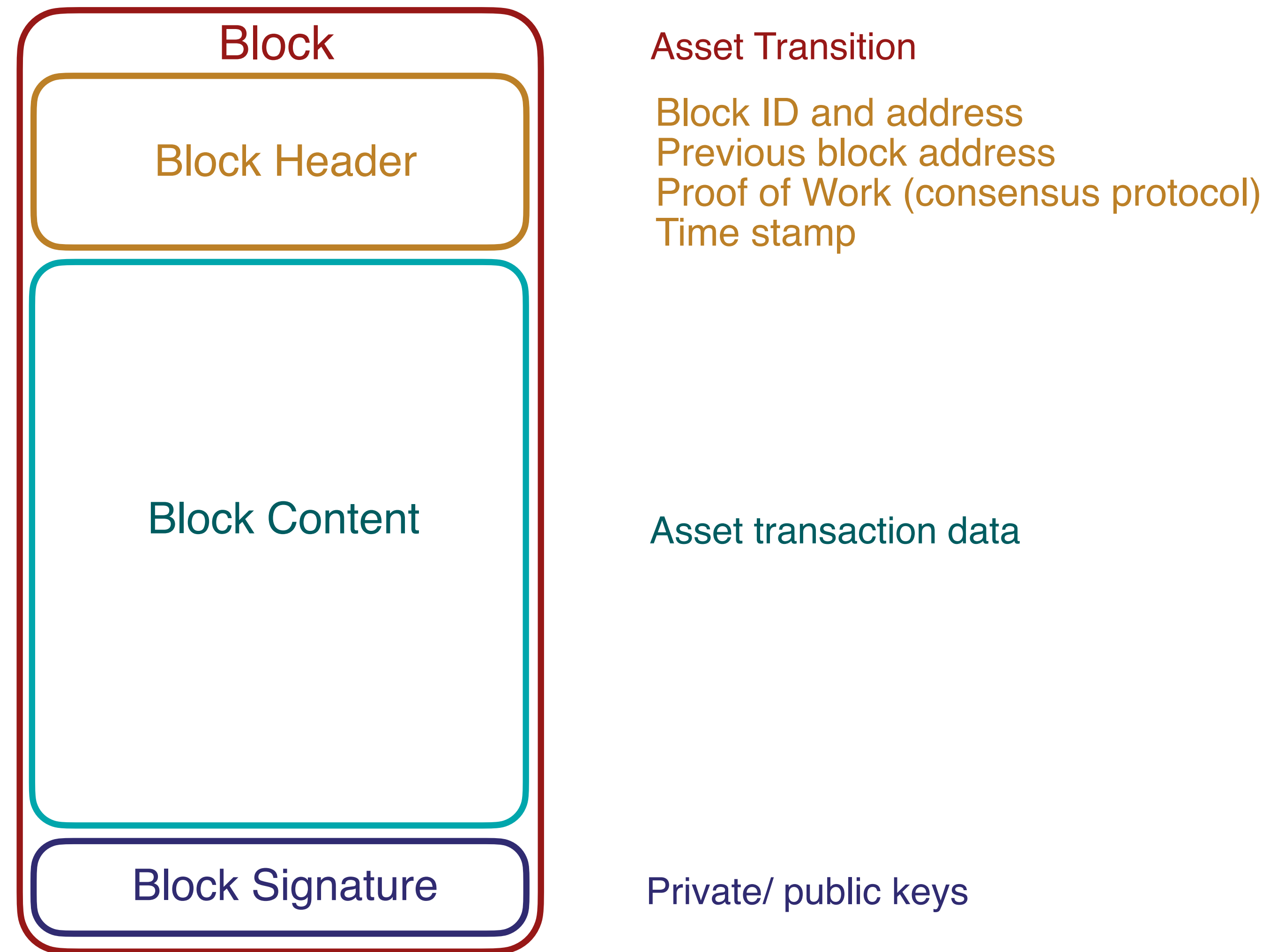
Blockchain 2.0

Blockchain 3.0

Blockchain- How the blockchain would looks like?



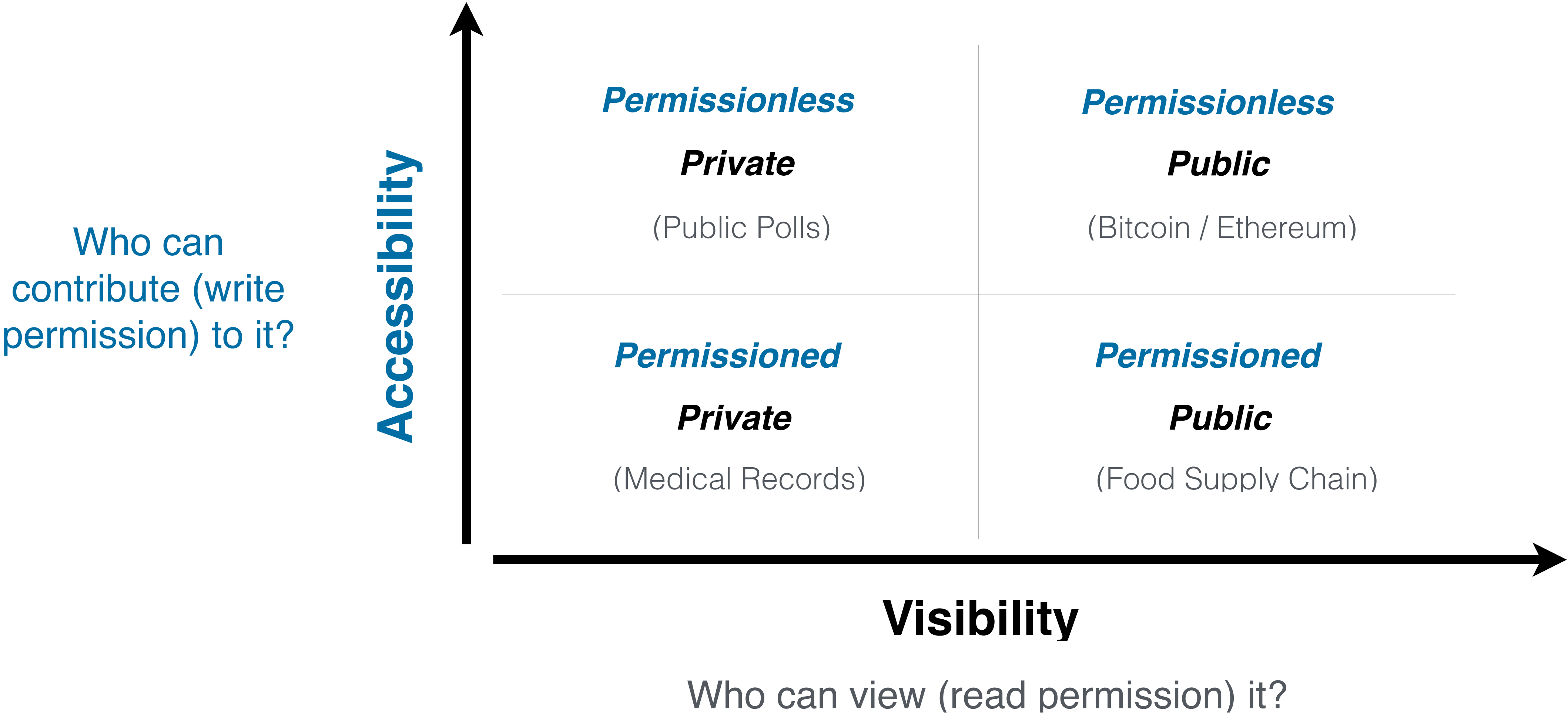
Blockchain- How a block would look like?



Blockchain- Benefits

- Digitally **tracks asset transaction** between a group of **parties**.
- Provides a **tamper-proof trail time-stamps** of **block** sequence.
- Establishes **transparency** and **trust between parties**.

Blockchain- Conceptual Metrics





Blockchain Use-Cases in Digital Sectors

2018 IEEE Confs on Internet of Things, Green Computing and Communications, Cyber, Physical and Social Computing, Smart Data, Blockchain, Computer and Information Technology, Congress on Cybermatics

Blockchain Use Cases in Digital Sectors: A Review of the Literature

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Abstract—Blockchain technology is a ledger system that is popularly known as the backbone of the Bitcoin cryptocurrency. Since its conception, the potential beneficial applications of blockchain in other digital sectors have been lauded in the literature, and related challenges have been disputed. In this study, the literature is reviewed for frameworks and use cases that fully realize the applicability of blockchain beyond financial applications and cryptocurrencies. A network analysis of the literature was performed to identify the most popularly documented digital sectors in this context, which include the Internet of Things (IoT), healthcare, supply chain management, and government sectors. For each sector, this review documents use cases in which an attempt is made to implement blockchain solutions. The main purpose of this paper is to probe each sector for the growing maturity of blockchain technology and to document the unique benefits and challenges arising from the use of this technology. The findings show that despite the growing reputation of blockchain technology, its implementation within these four sectors remains in infancy because the use cases lack concrete evaluations of its effectiveness and plausibility. Nevertheless, the categorization of current blockchain use cases demonstrates current applications and sector-specific concerns that suggest future directions for further research.

Index Terms—Blockchain; review; network analysis; healthcare; government; Internet of Things (IoT); supply chain.

1. Introduction

The blockchain is a ledger system that is popularly known as the underlying technology of the Bitcoin cryptocurrency that makes it possible to maintain the integrity of transaction data [1]. The technology’s ledger is decentralized and distributed, with transactions, agreements, and controls stored in digital records. In 2015, The Financial Times [2] stated that “At its core, blockchain is a network of computers, all of which must approve a transaction has

taken place before it is recorded, in a ‘chain’ of computer code. [...] The details of the transfer are recorded on a public ledger that anyone on the network can see” [2].

Since the conception of Bitcoin, several improvements have been proposed to overcome some of blockchain’s weaknesses [3], e.g., scalability and lack of anonymity. The underlying features of blockchain technology lend themselves to financial services. In particular, blockchain technology distributes the control of the registration of transactions, the verification of identity, and the finalization of contracts, which are financial services that are traditionally centralized and managed by a third-party organization [4].

Numerous studies have also investigated the application of blockchain technology in multitudinous digital sectors that go beyond financial services. This increased interest spans several diverse fields, including corporate, governmental, and cross-industry applications. Blockchain technology has the potential to invigorate established corporate operations, such as those in healthcare and supply chain management, to overcome issues relating to security, privacy, and shareability by maintaining a common database of information. Blockchain initiatives for new-generation information infrastructures in the government domain have been undertaken by several digital champion countries, including the United Kingdom, the United States, Estonia, New Zealand, and Israel [5]. Cross-industry interest in blockchain solutions is similarly blooming due to the technology’s attractive capabilities of maintaining a distributed immutable ledger and thus creating a secure network among untrusted users.

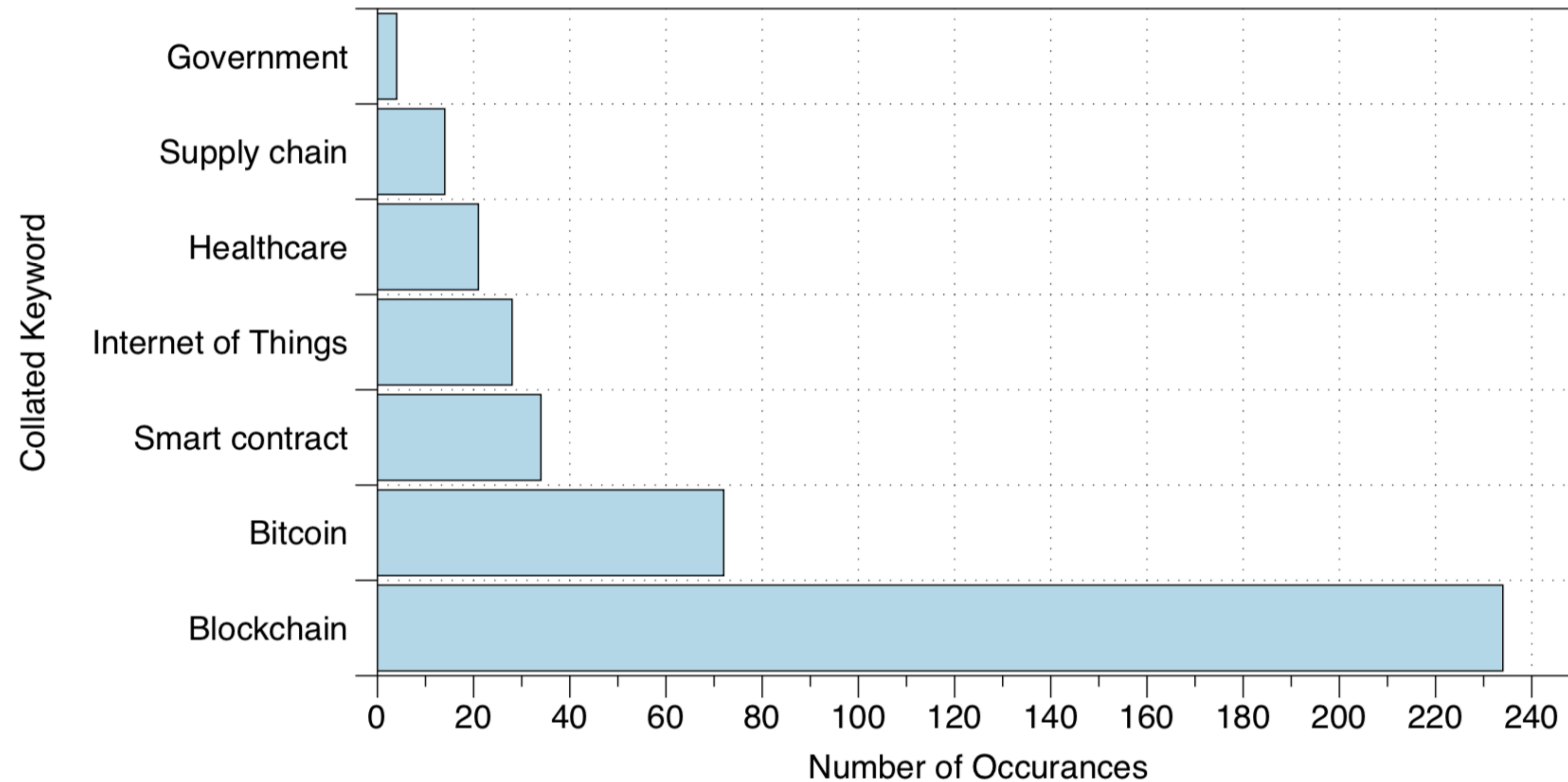
There have been several surveys of blockchain technology that have acknowledged its growth and progression as a technical paradigm. General overviews of the advancement of blockchain have been conducted to gauge current research topics, challenges, and future directions from a technical perspective (e.g., [6], [7], [8], [9]). These reviews were often systematic, and their findings revealed the main focus of blockchain research. The potential of blockchain has also been reviewed in the literature for numerous domains and

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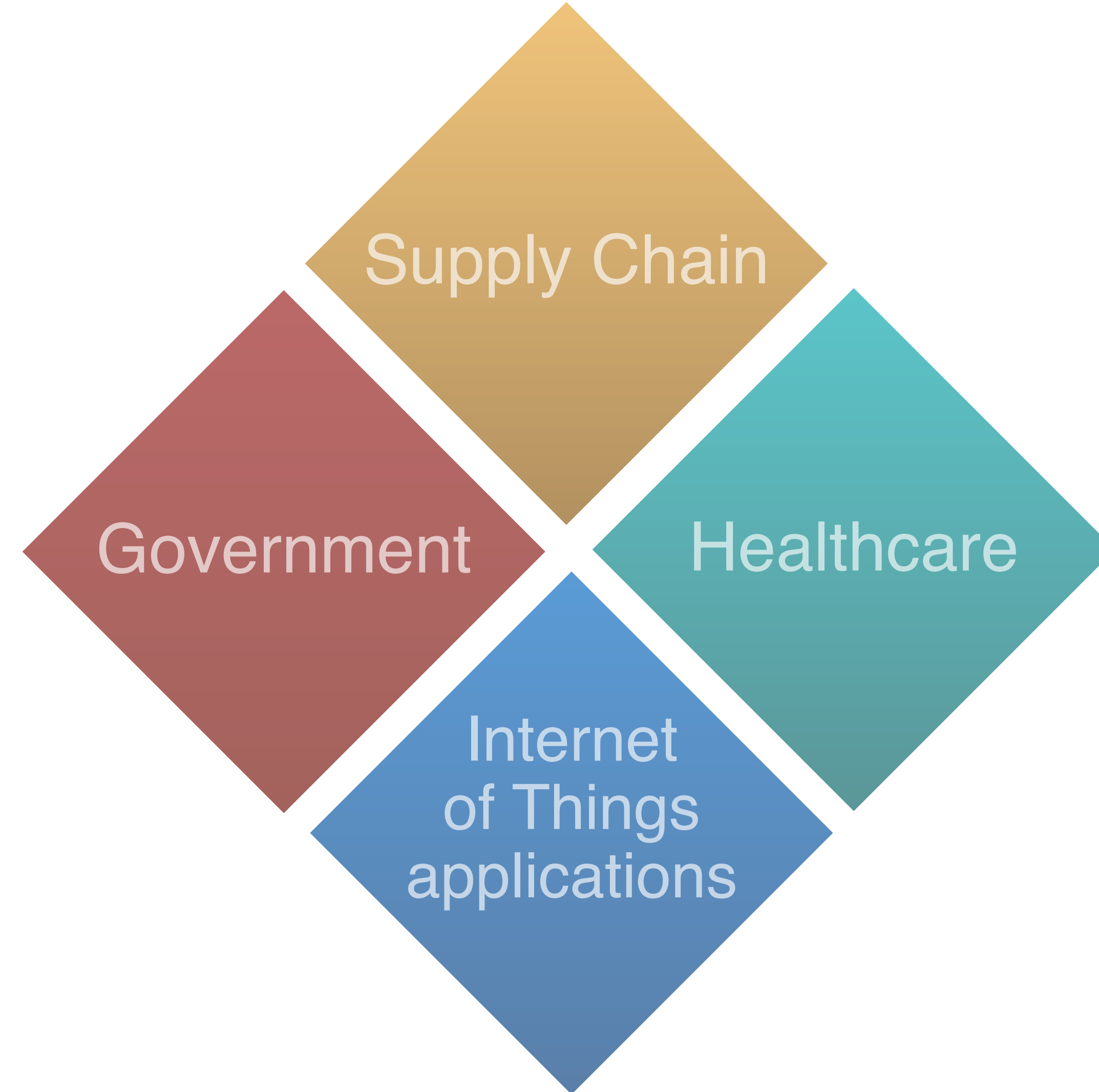


Blockchain Keyword in The Literature



Collated keywords for each digital sectors and the number of occurrences in the literature

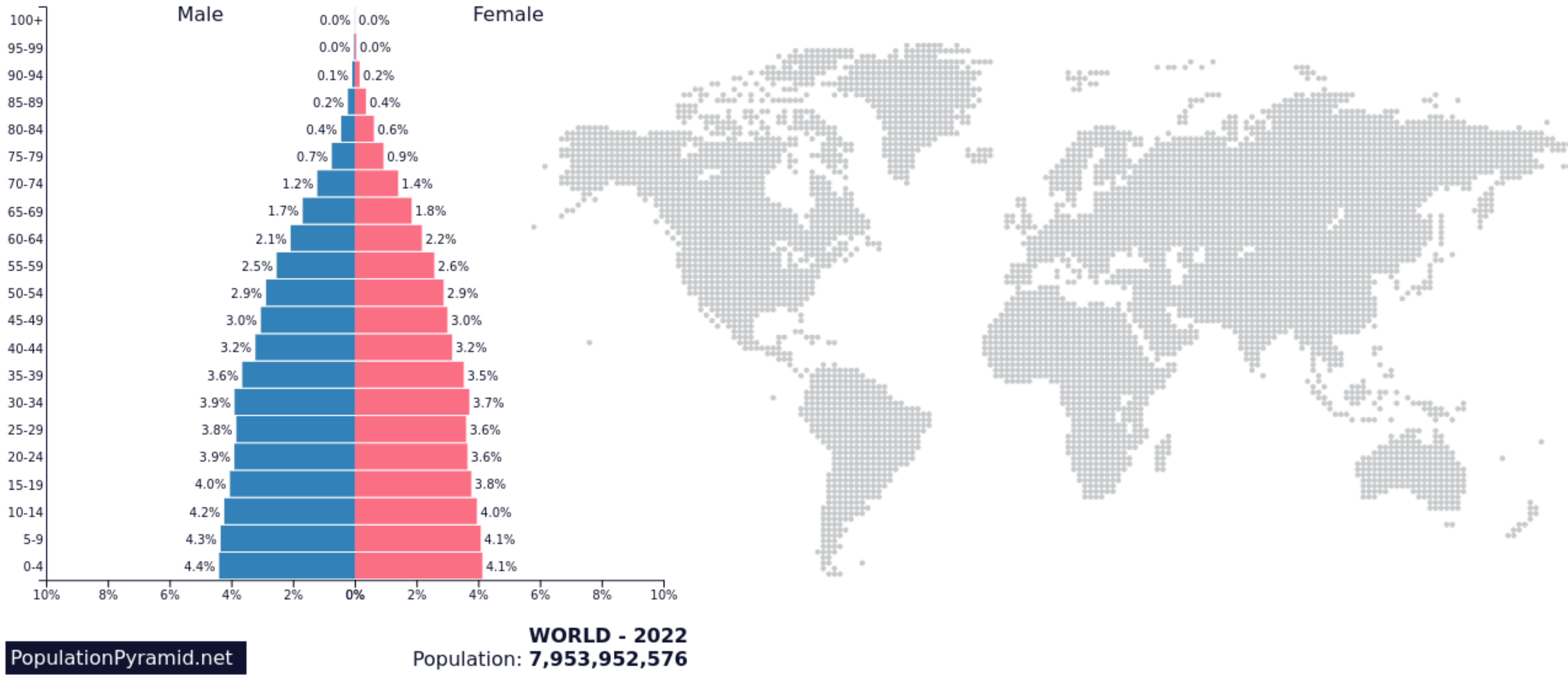
Most Fully-Developed Blockchain Solutions are in 4 Digital Sectors





Use Case 1: *HealthyBlockchain* For Global Patients

Global Healthcare Systems Modernization Movement



#Envision2030 Sustainable Development Goals



#Envision2030 Goal 3: Good Health and Well-being



- ▶ Goal 3: Ensure healthy lives and promote well-being for all by having access to quality essential health-care services



Global Modernization Efforts- **UK** & **K.S.A**

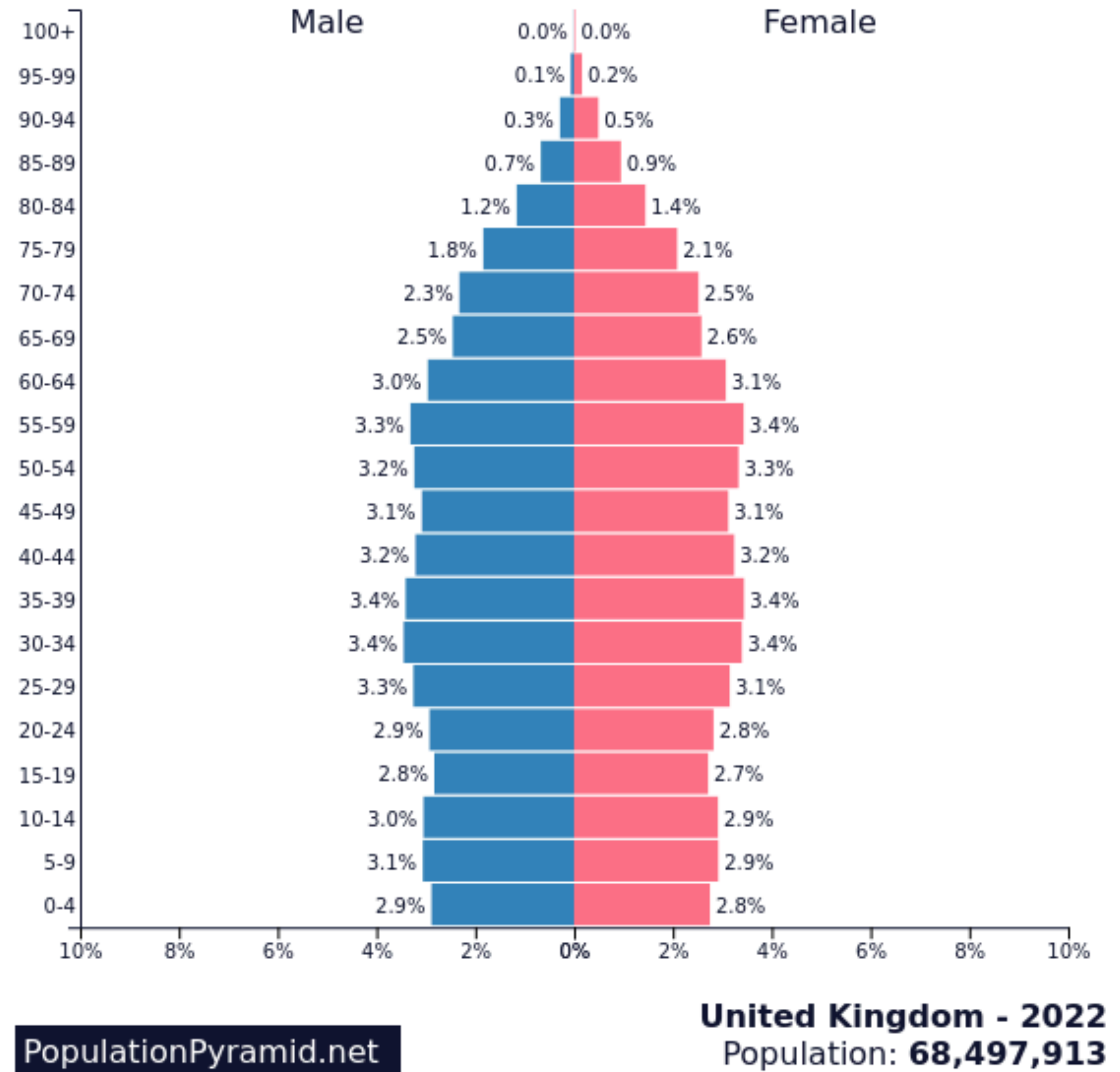


Global Modernization Efforts- **United Kingdom**



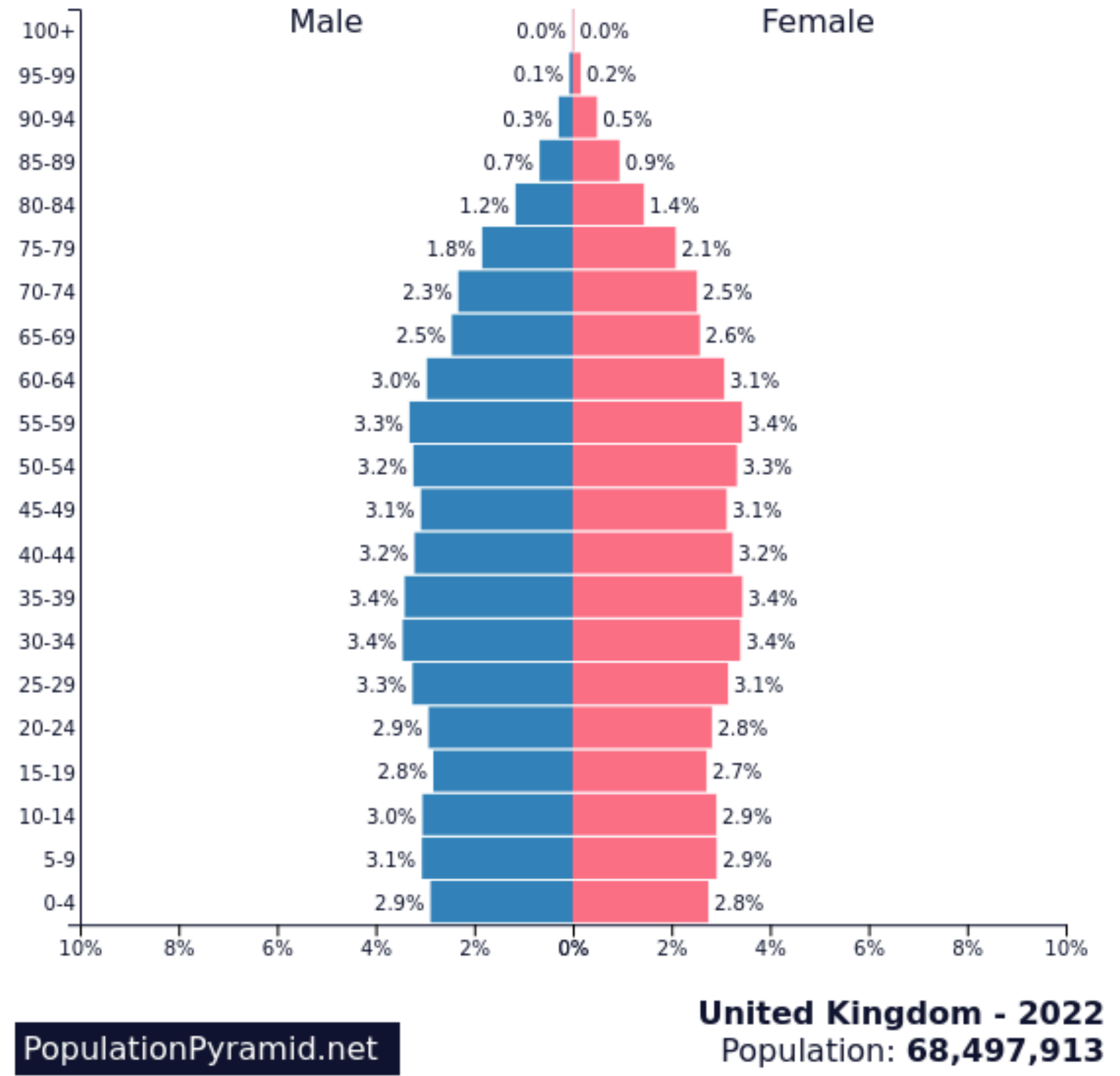
United Kingdom- Population Pyramid

- **0-14 years (children): 17.63%**
- **15-24 years (early working age): 11.49%**
- **25-54 years (prime working age): 39.67 %**
- **55-64 years (mature working age): 12.73 %**
- **65 years and over (elderly): 18.48%**



United Kingdom- Population Pyramid

- **70.88%** is **old** population
- **Comorbidity** is more **common** in older patients
- Needs **holistic** care
- **Aim:** Move from re-active to **pro-active**

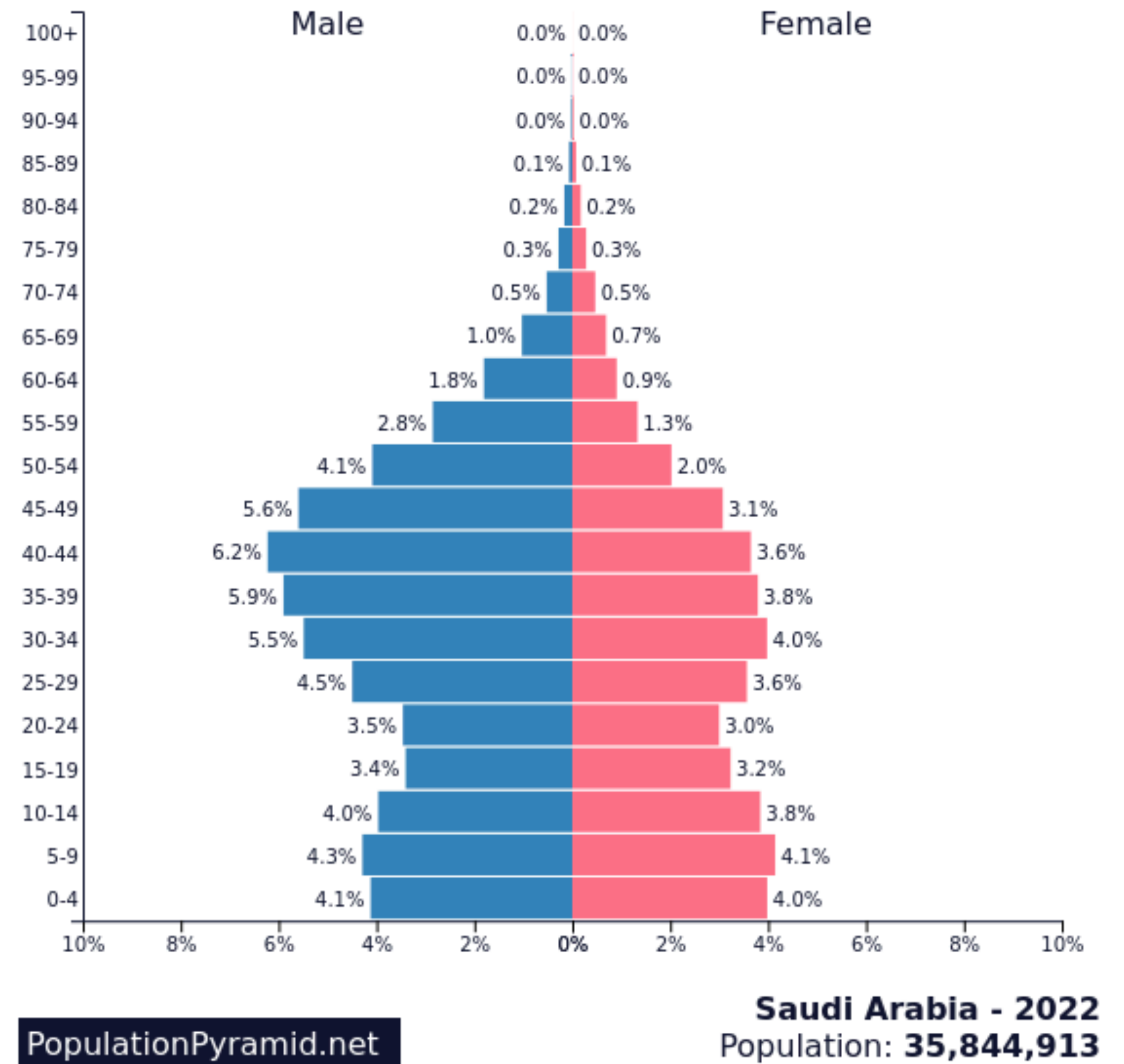


Global Modernization Efforts- K.S.A



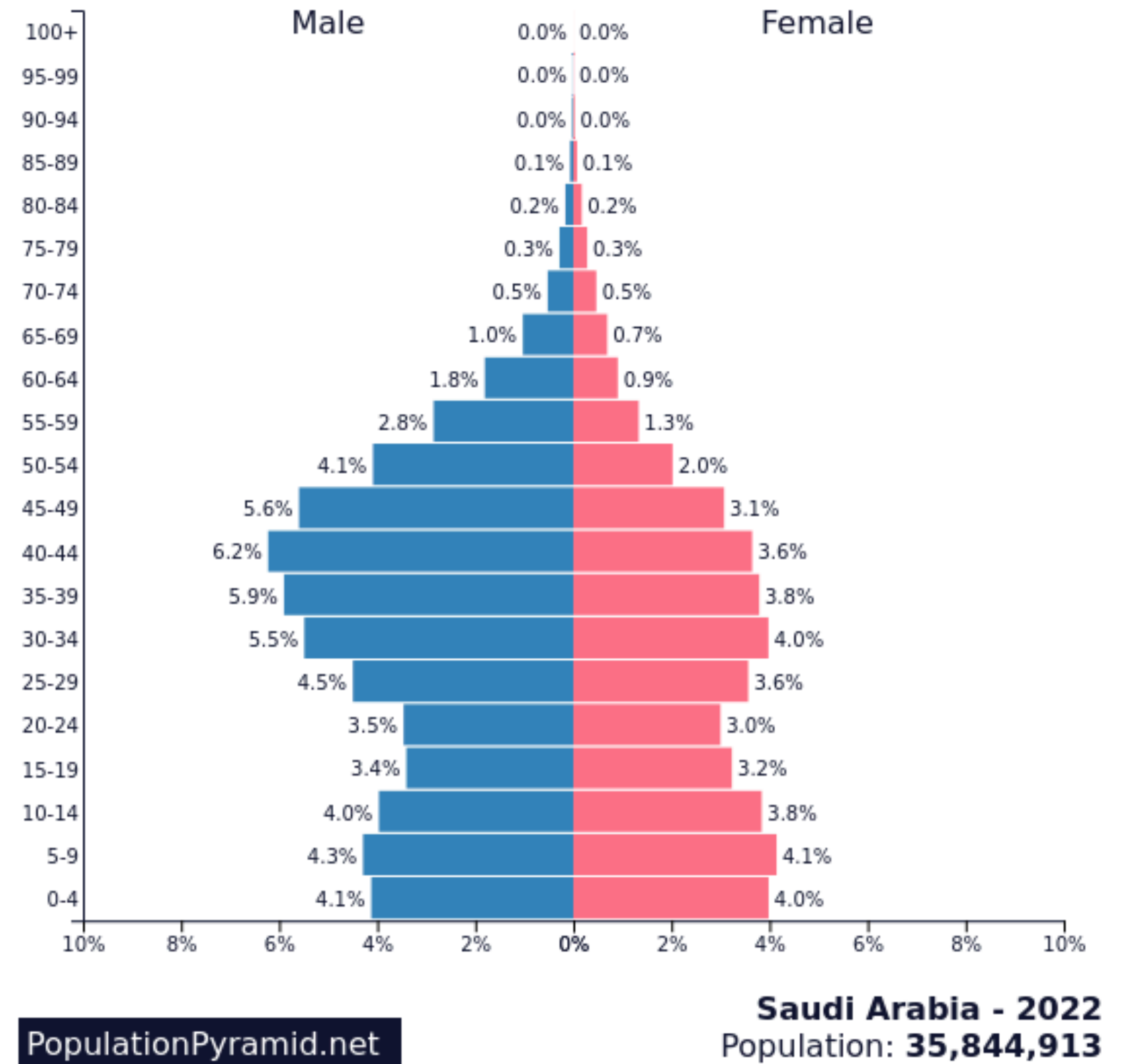
Kingdom of Saudi Arabia- Population Pyramid

- **0-14 years (children): 24.84%**
- **15-24 years (early working age): 15.38%**
- **25-54 years (prime working age): 50.2%**
- **55-64 years (mature working age): 5.95%**
- **65 years and over (elderly): 3.63%**



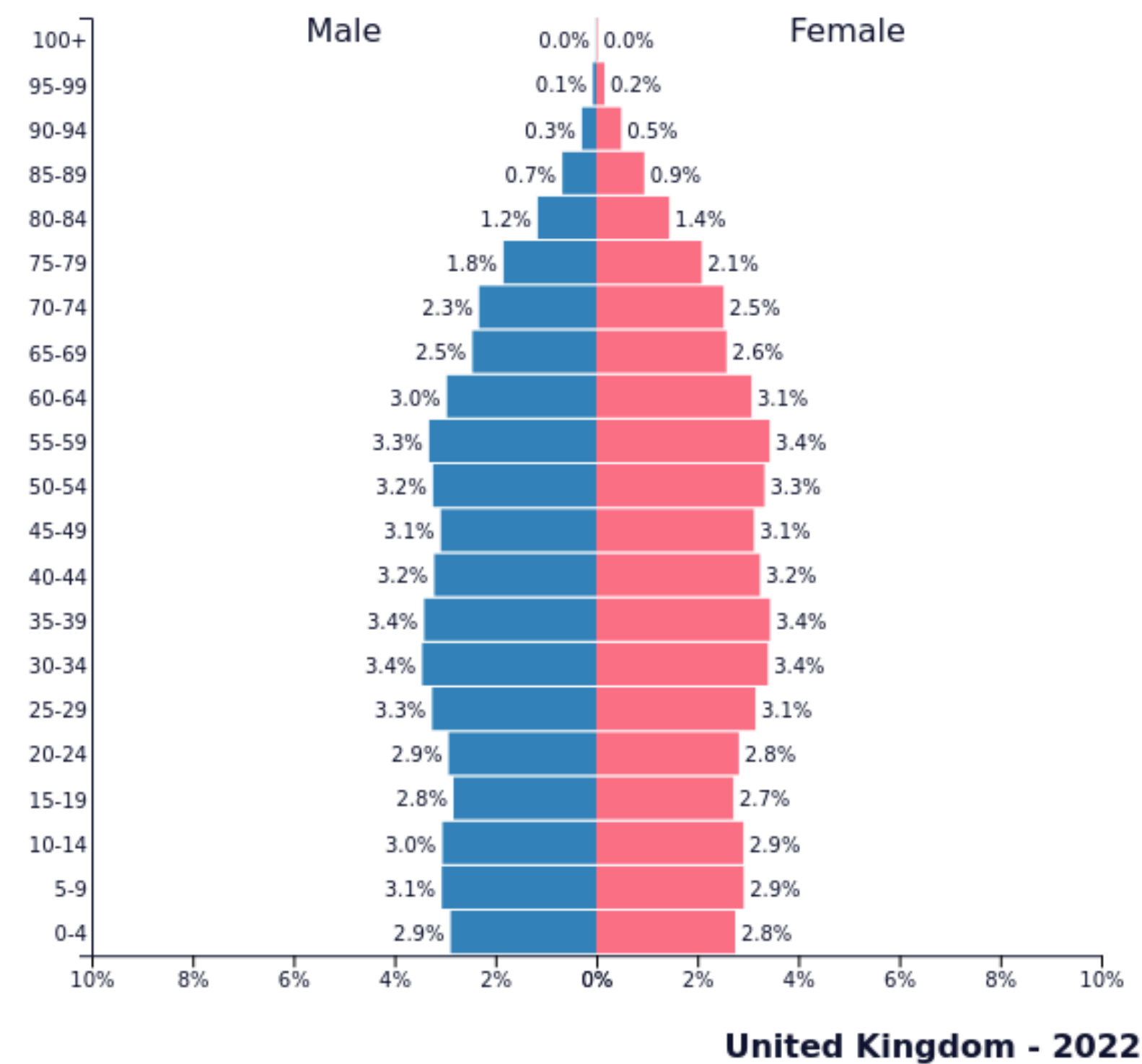
Kingdom of Saudi Arabia- Population Pyramid

- **91.53%** is **young** population
- Needs to be **kept out of hospitals** (Pre-patient phase)
- **Aim:** make the person **responsible** for their **health** and the main **driver** of their healthcare **choices & outcomes**



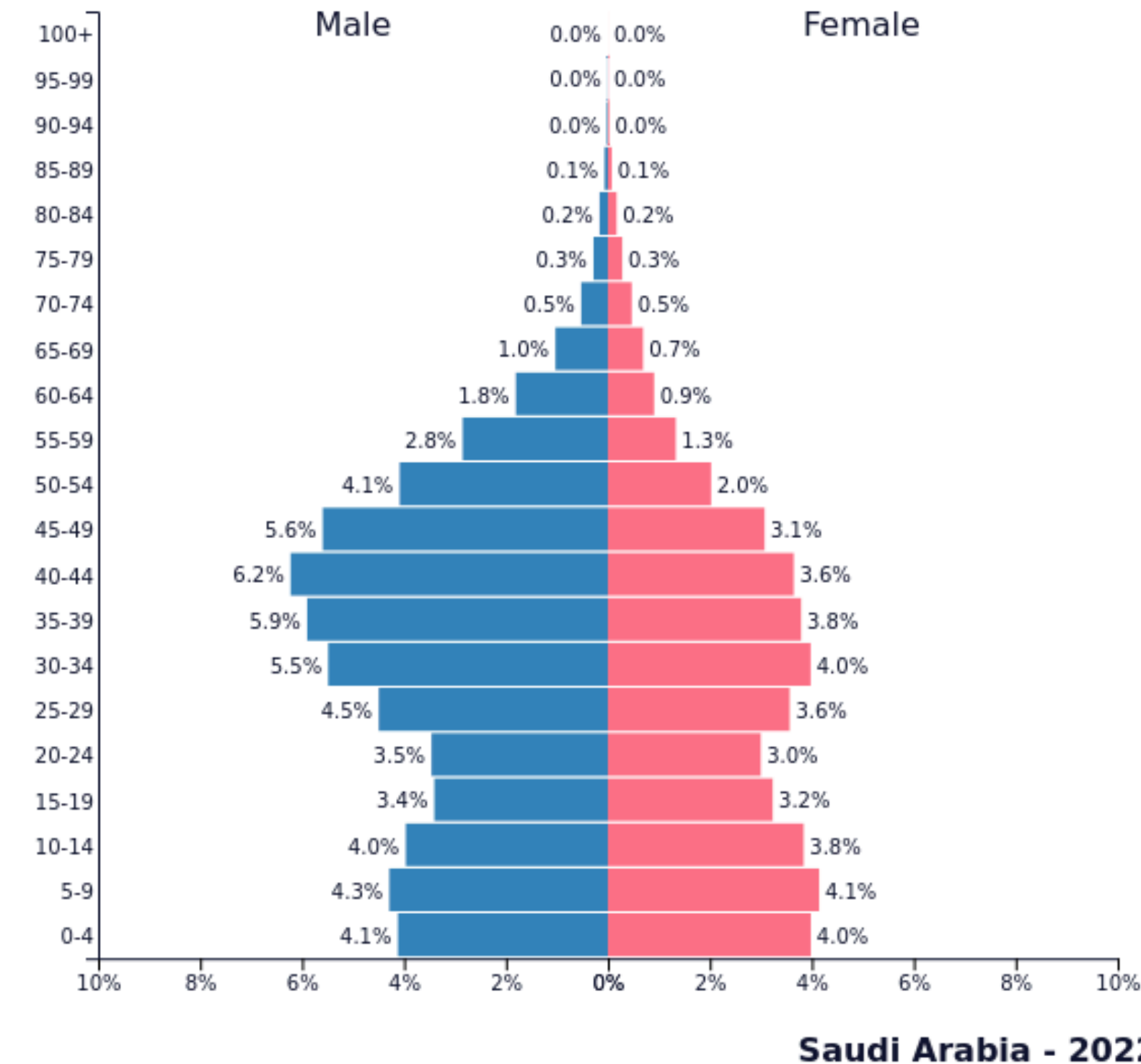
Global Healthcare Sector Modernization Movement

Older Population



**Holistic care that considers
co-morbidities**

Younger Population



**Make the person responsible for their health
and keep them out of hospitals**

Blockchain Contribution to Global Modernization Movement

Modernizing healthcare delivery
(Healthy Blockchain)

Healthy Blockchain: Modernizing Healthcare Delivery Using Blockchain



Computers, Materials & Continua
DOI:10.32604/cmc.2021.016618
Article

Tech Science Press

HealthyBlockchain for Global Patients

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Abstract: An emerging healthcare delivery model is enabling a new era of clinical care based on well-informed decision-making processes. Current healthcare information systems (HISs) fall short of adopting this model due to a conflict between information security needed to implement the new model and those already enforced locally to support traditional care models. Meanwhile, in recent times, the healthcare sector has shown a substantial interest in the potential of using blockchain technology for providing quality care to patients. No blockchain solution proposed so far has fully addressed emerging cross-organization information-sharing needs in healthcare. In this paper, we aim to study the use of blockchain in equipping struggling HISs to cope with the demands of the new healthcare delivery model, by proposing HealthyBlockchain as a granular patient-centered ledger that digitally tracks a patient's medical transactions all along the treatment pathway to support the care teams. The patient-centered ledger is a neutral tamper-proof trail time-stamp block sequence that governs distributed patient information across the decentralized discrete HISs. HealthyBlockchain connects patients, clinicians, and healthcare providers to facilitate a transparent, trustworthy, and secure supporting platform.

Keywords: Blockchain; eHealth; electronic health record; global patient; healthcare information system; information security; legacy system; patient-centered care; privacy; smart contract; trust

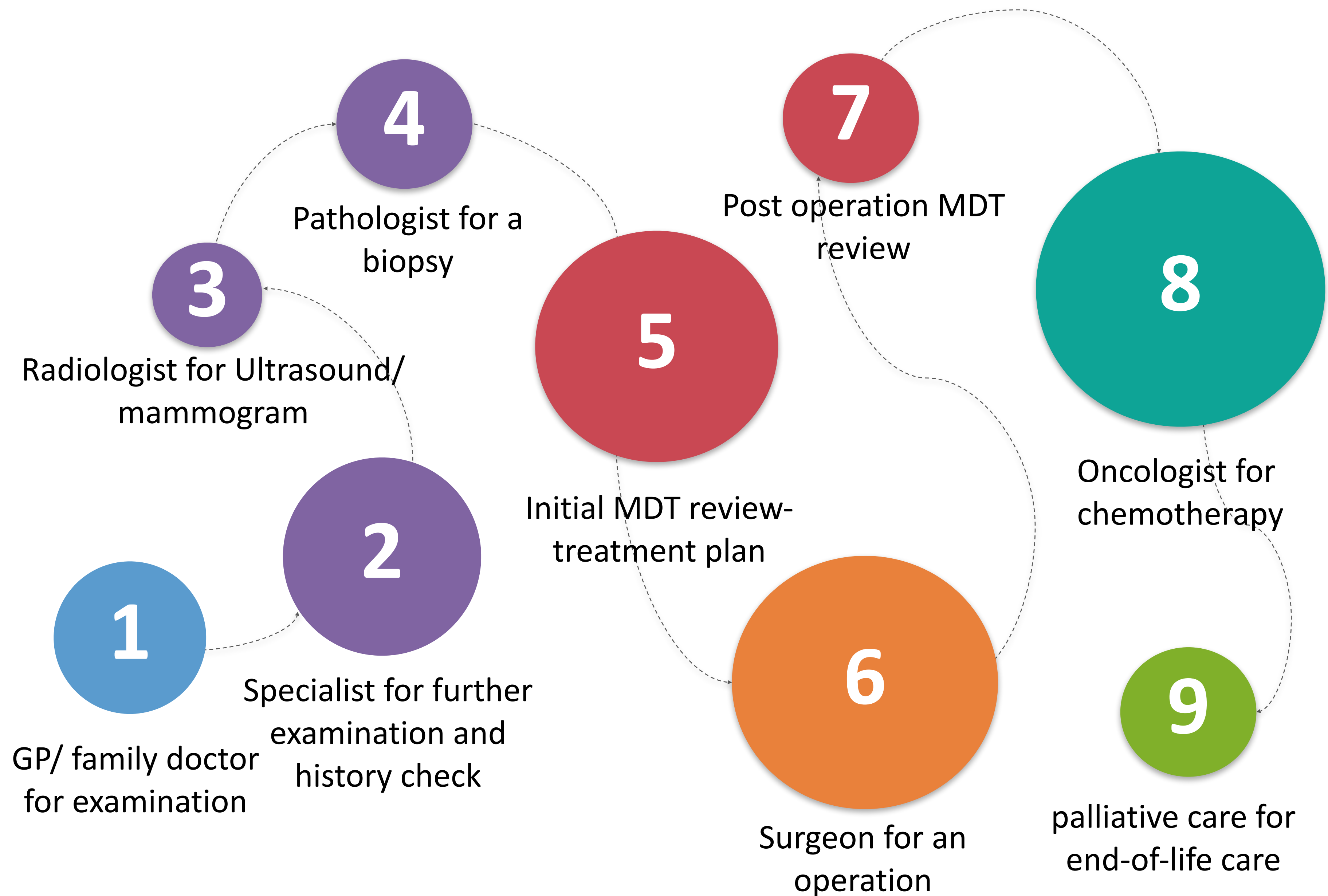
1 Introduction

Emerging eHealth models are enabling a new era of clinical care that ignites today's global modernization movement toward an individualized, holistic, and integrated healthcare delivery model. This model of care requires the flow of medical information across various healthcare information systems (HISs) to allow its seamless access by the right care team member at the

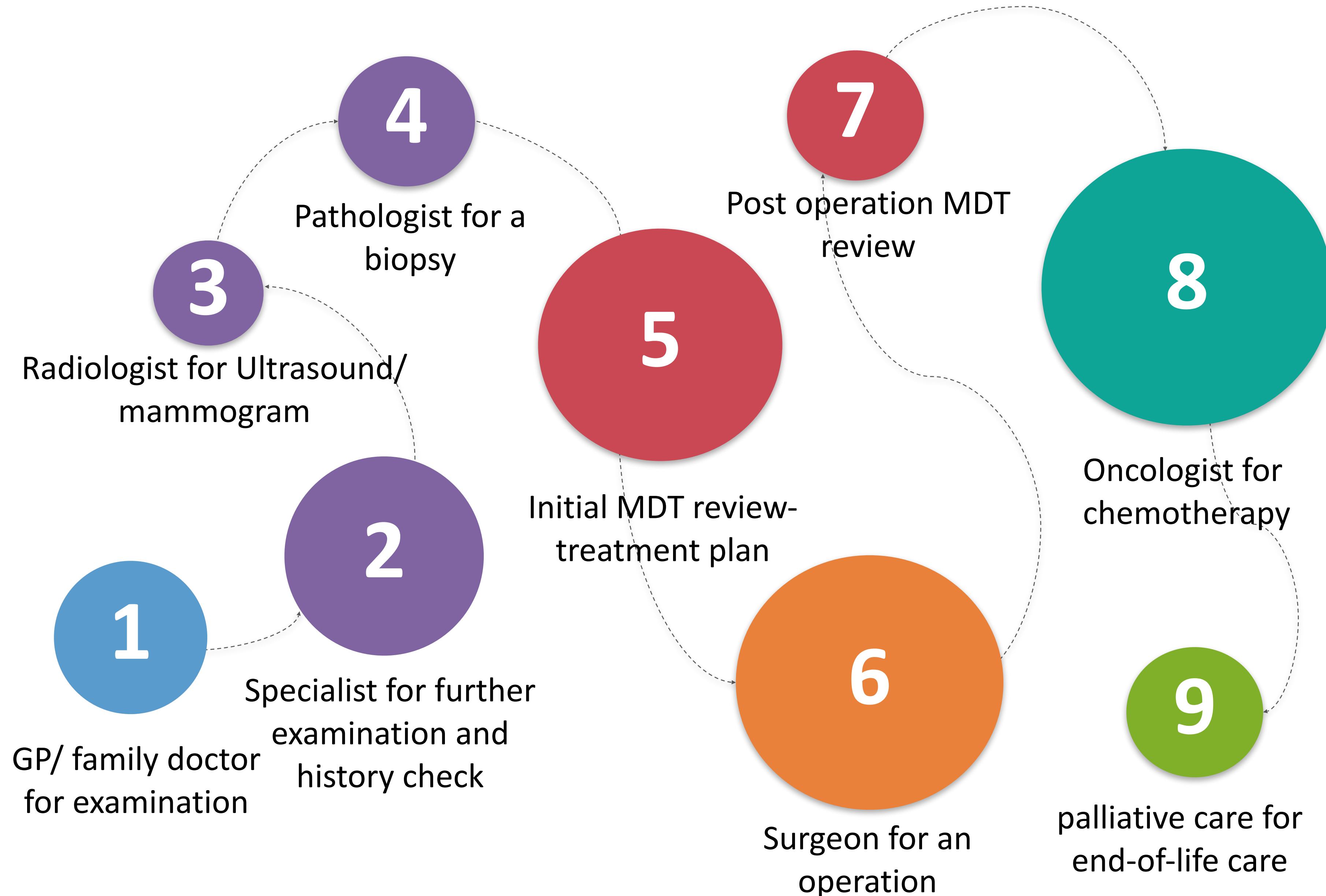


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Breast Cancer Treatment Scenario- Wales, UK



Multiple Discrete Information Systems



Modern Healthcare- “Shared Care”

- **Integrated (holistic) care**
- **Care teams**
- **Shared informed decisions**
- **Pro-active systems**



Patient-Centered Care Movement

“

A collaborative effort [...] where **patients** and the
healthcare professionals collaborate as a team, share
knowledge and work toward the common **goals of**
optimum healing and recovery.

”

Source: Kotz, D. et al., 2016. Privacy and Security in Mobile Health: A Research Agenda. Computer. IEEE Computer Society, 49(6), p.22–30. Los Alamitos, CA, USA.

Modern Healthcare Models

eHealth (*electronic health*)

mHealth (*mobile health*)

uHealth (*ubiquitous healthcare*)

Virtual healthcare

Tele-medicine

...

Healthcare Models- **share a common goal**

... to facilitate seamless **information sharing** for
informed decisions.



Why informed-decisions are important?



A patient's **history** is as **important** as their
symptoms. It is what helps us **decide** if
heartburn is a **heart attack**, or a **headache** is
a tumor.



~ Dr. Thame Nouh, 2017

Trauma Surgeon

*Trauma and Acute Care Surgery Unit, Department of Surgery, College of
Medicine, KSU, KSA*

Data Sharing Dilemma- **Balancing Act**

Sharing **VS.** Protecting

“

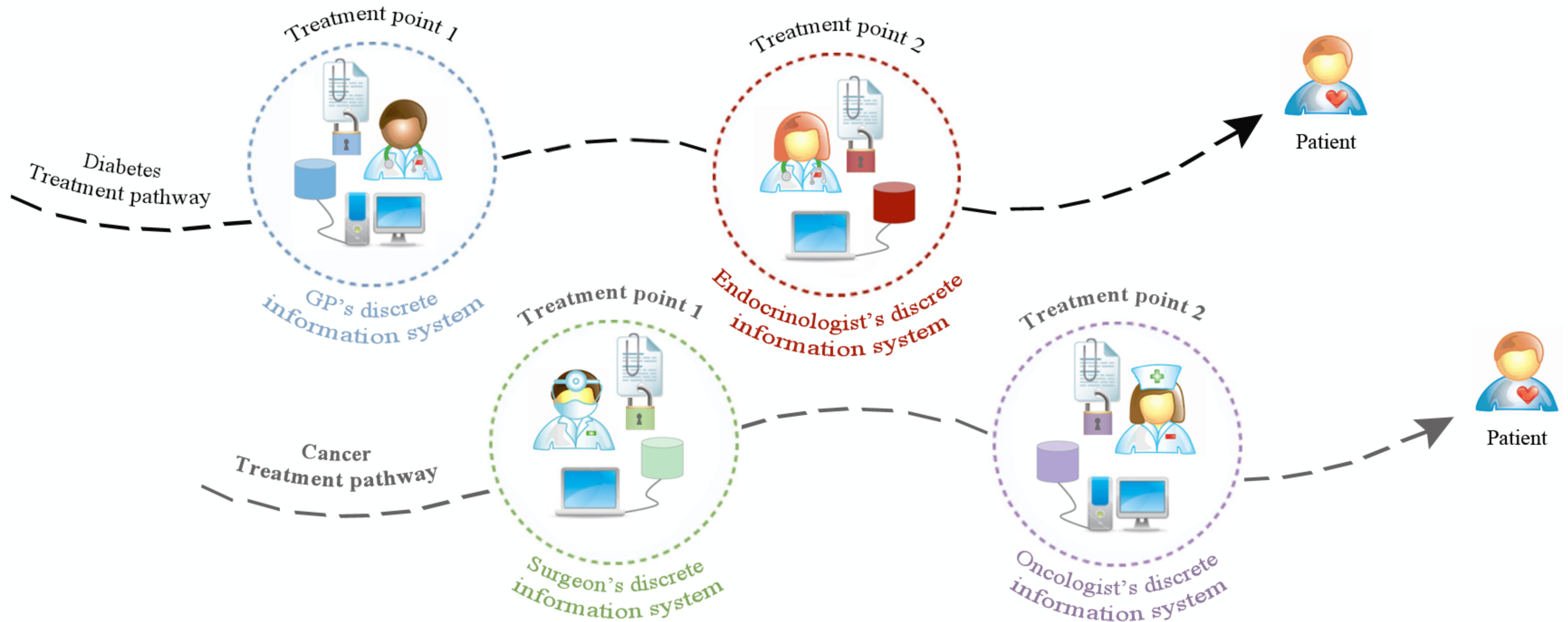
More harm is done to the patient if his **information** is **not available** to the care team member when needed than it **falling** into the **wrong hands**.

”

~ Dr. Tom Crosby, 2013

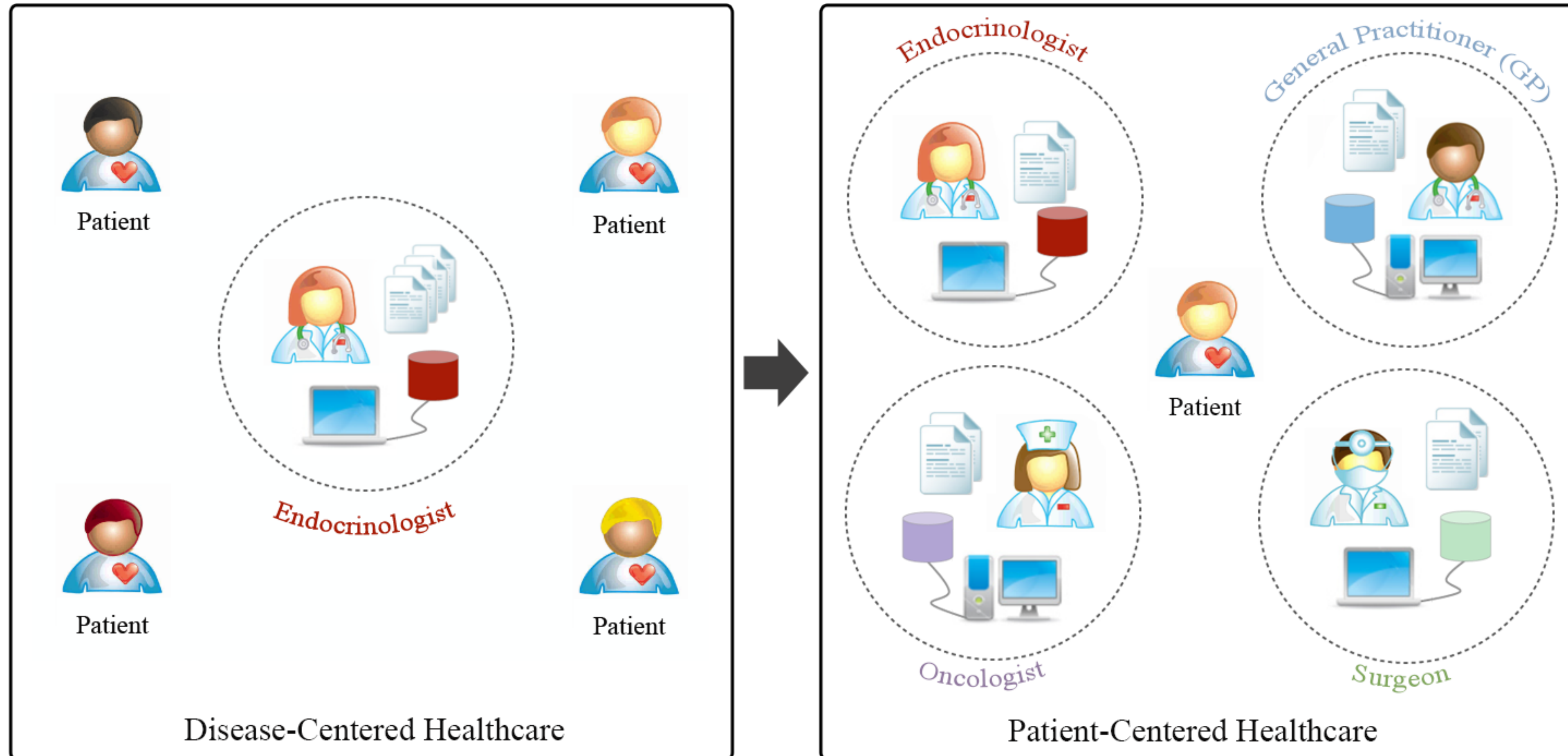
*Caldicott **Guardian** for the Cancer Centre,
Clinical Director of the Velindre Cancer Centre, Velindre Cancer NHS Trust*

Healthcare Legacy Systems Sickness



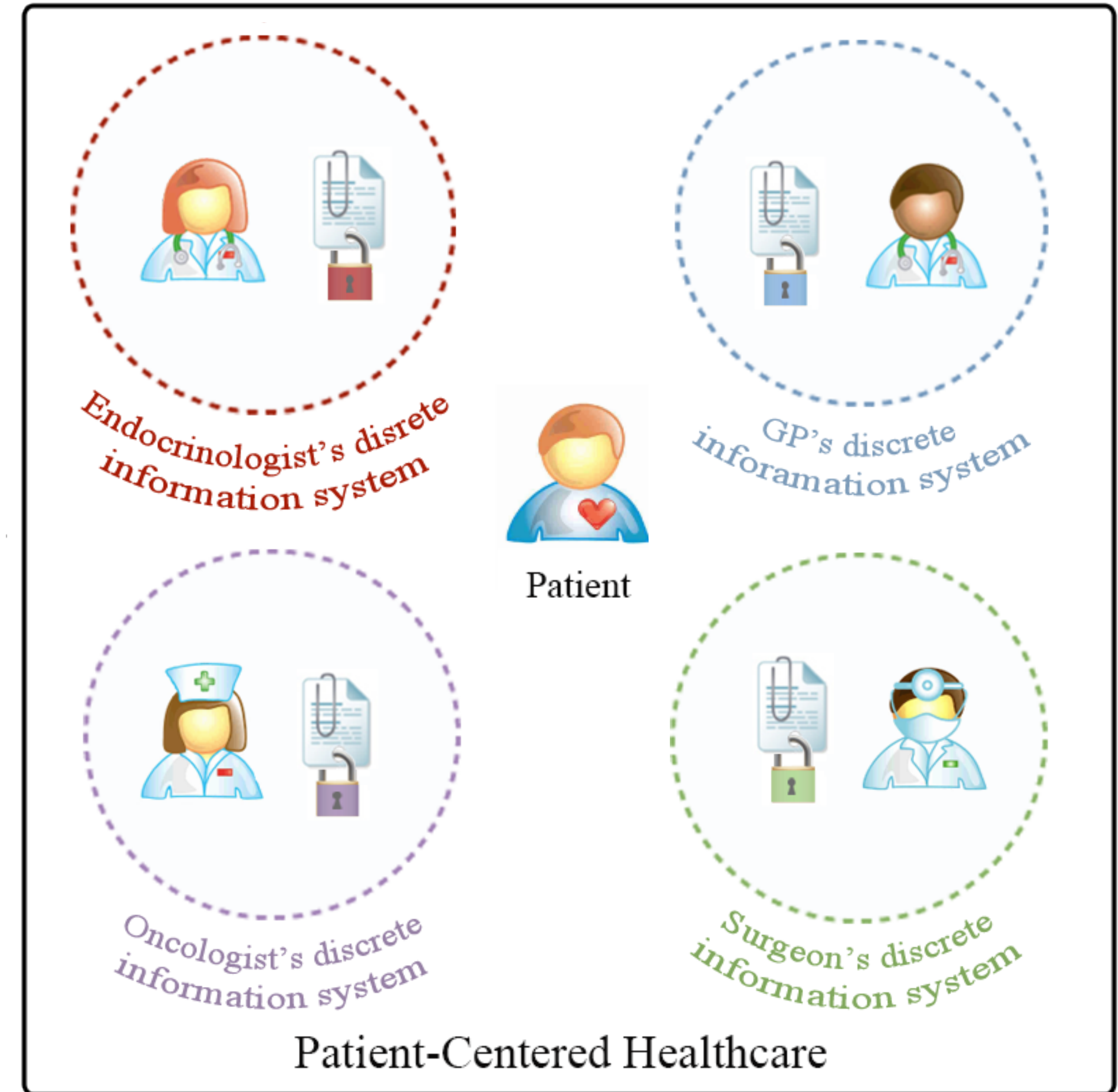
Block information flow

Healthcare Legacy Systems Sickness



Healthcare Legacy Systems Sickness

- **Designed** as information **silo**
- **Incompatible** information **policies**
- **Cannot** be **enforced** **outside** their physical premises
- **Lack** of **unified** information security **policy** to **govern** patient-centered data across legacy systems



Protection using
GP's local
information security

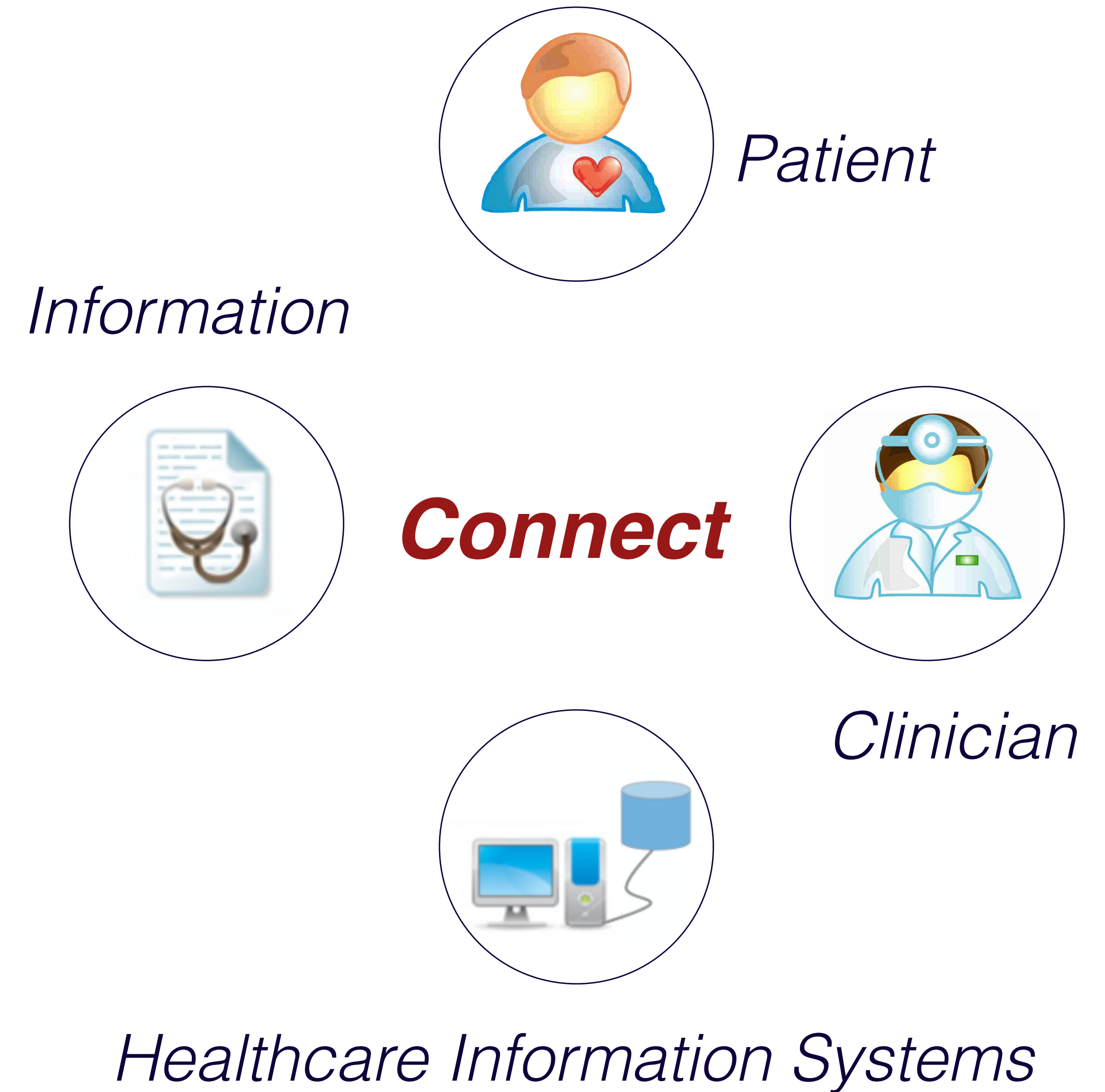
Protection using
surgeon's local
information security

Protection using
oncologist's local
information security

Protection using
endocrinologist's local
information security

Healthy Blockchain - Our Aim

The right **information** is available
to the right **person**,
at the right **time**.

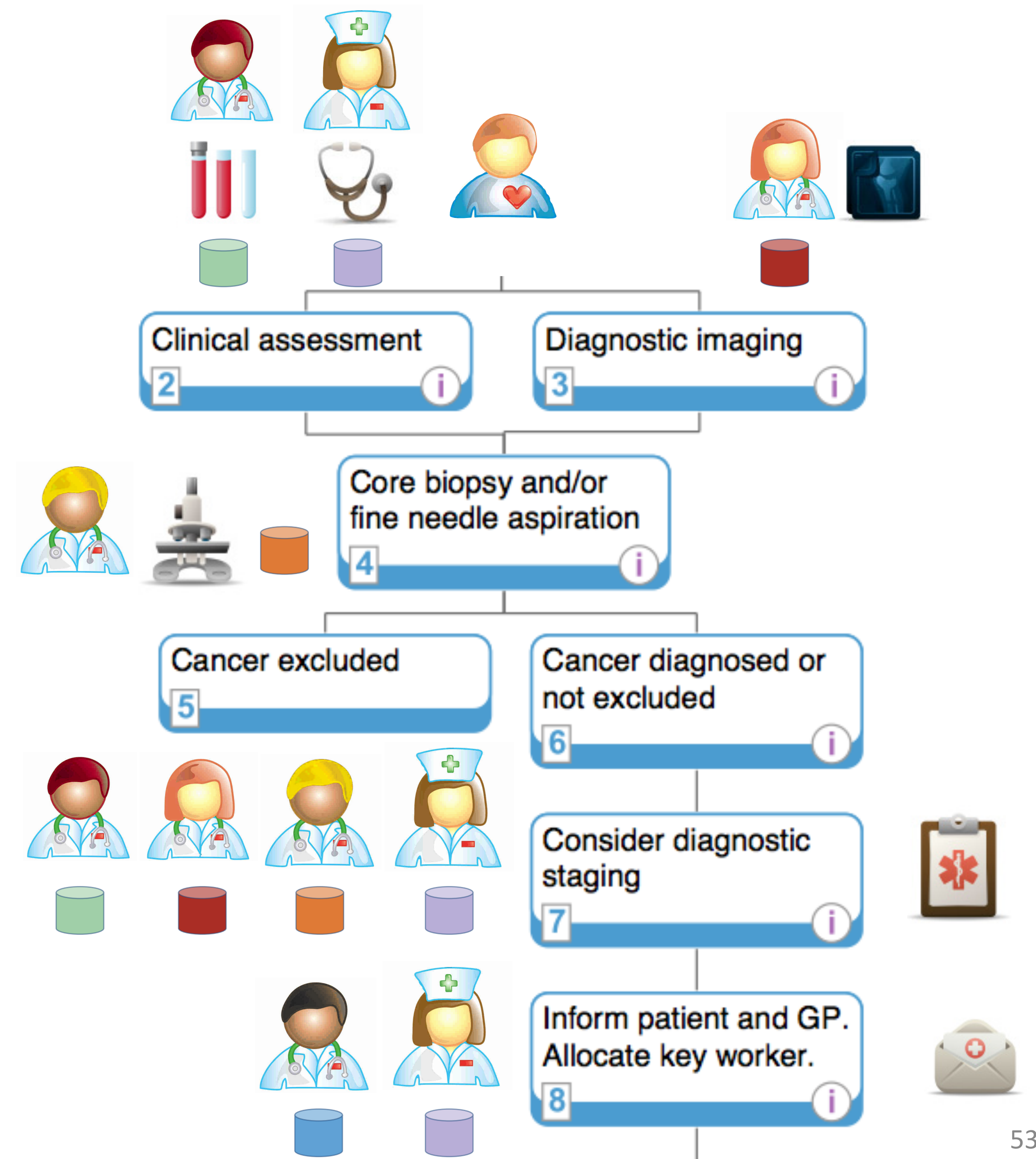


Healthy Blockchain - **Proposal**

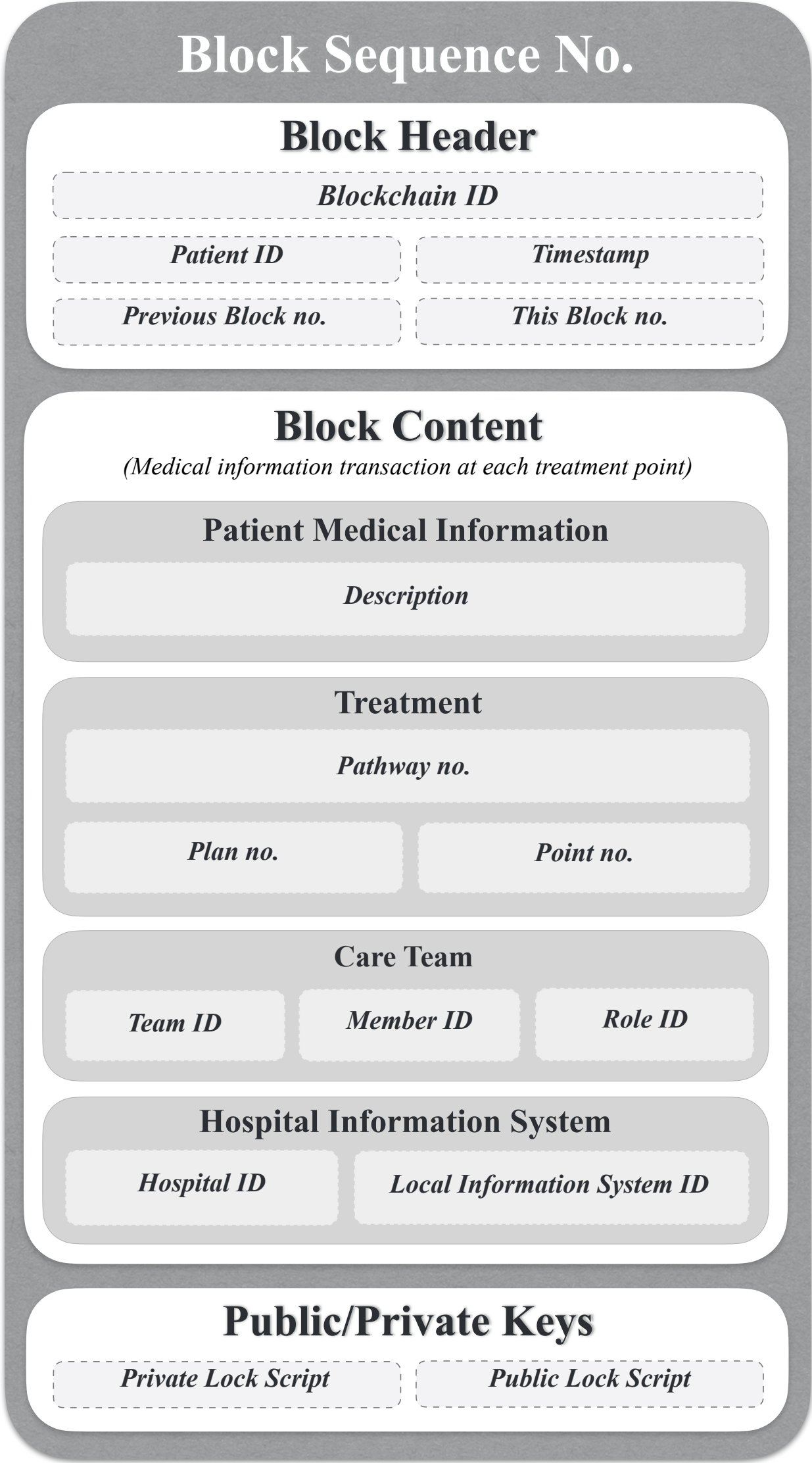
.. to allow a **seamless cross-**

systems information **flow** to

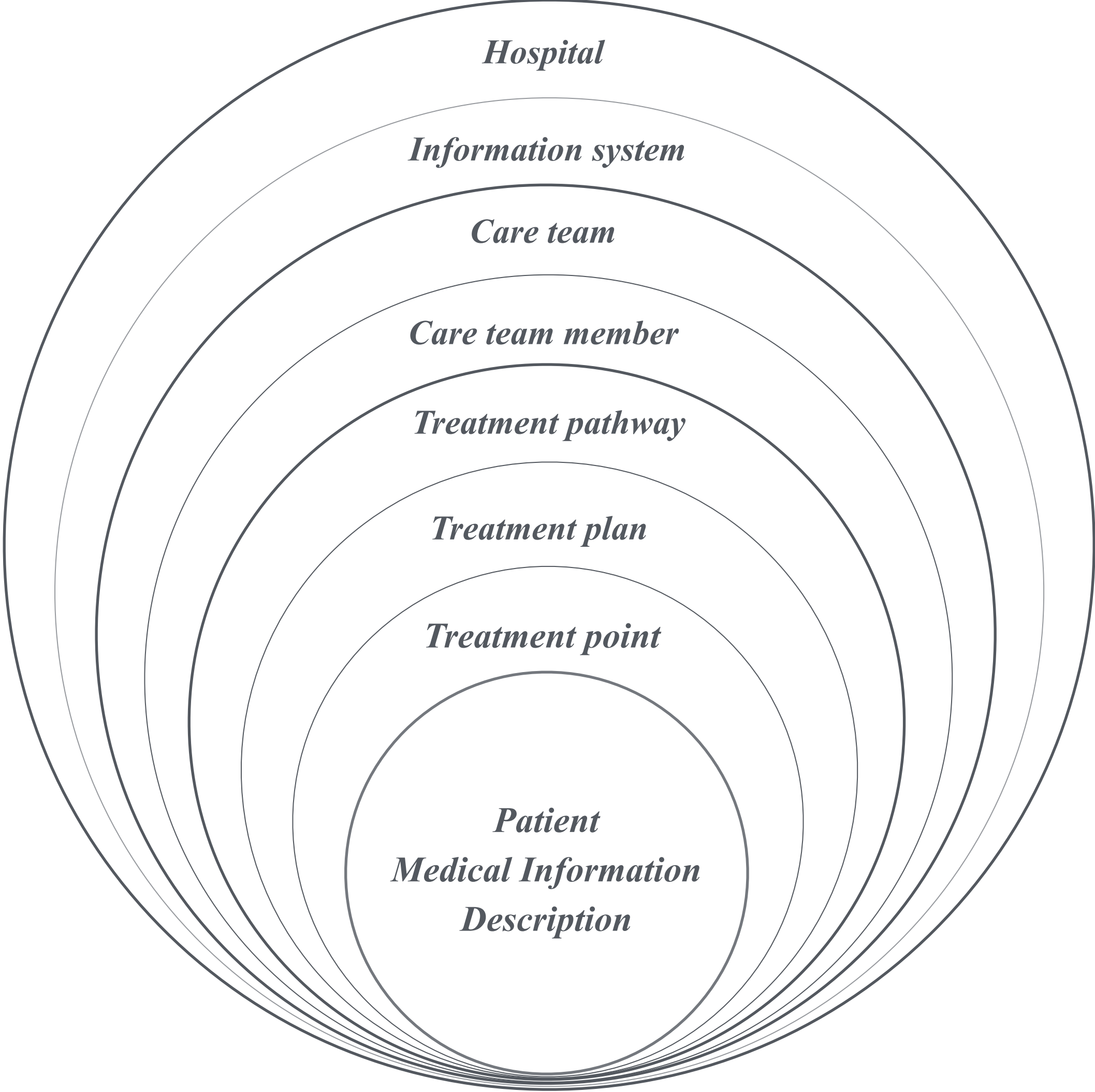
each **treatment point**.



Healthy Blockchain— Block Anatomy and Granularity

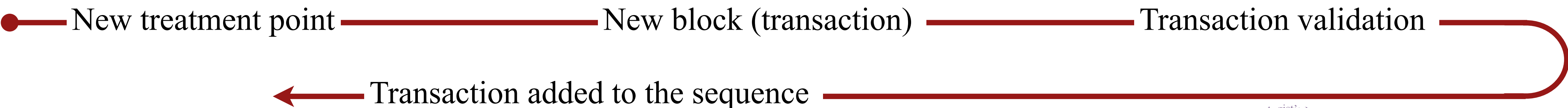


Anatomy



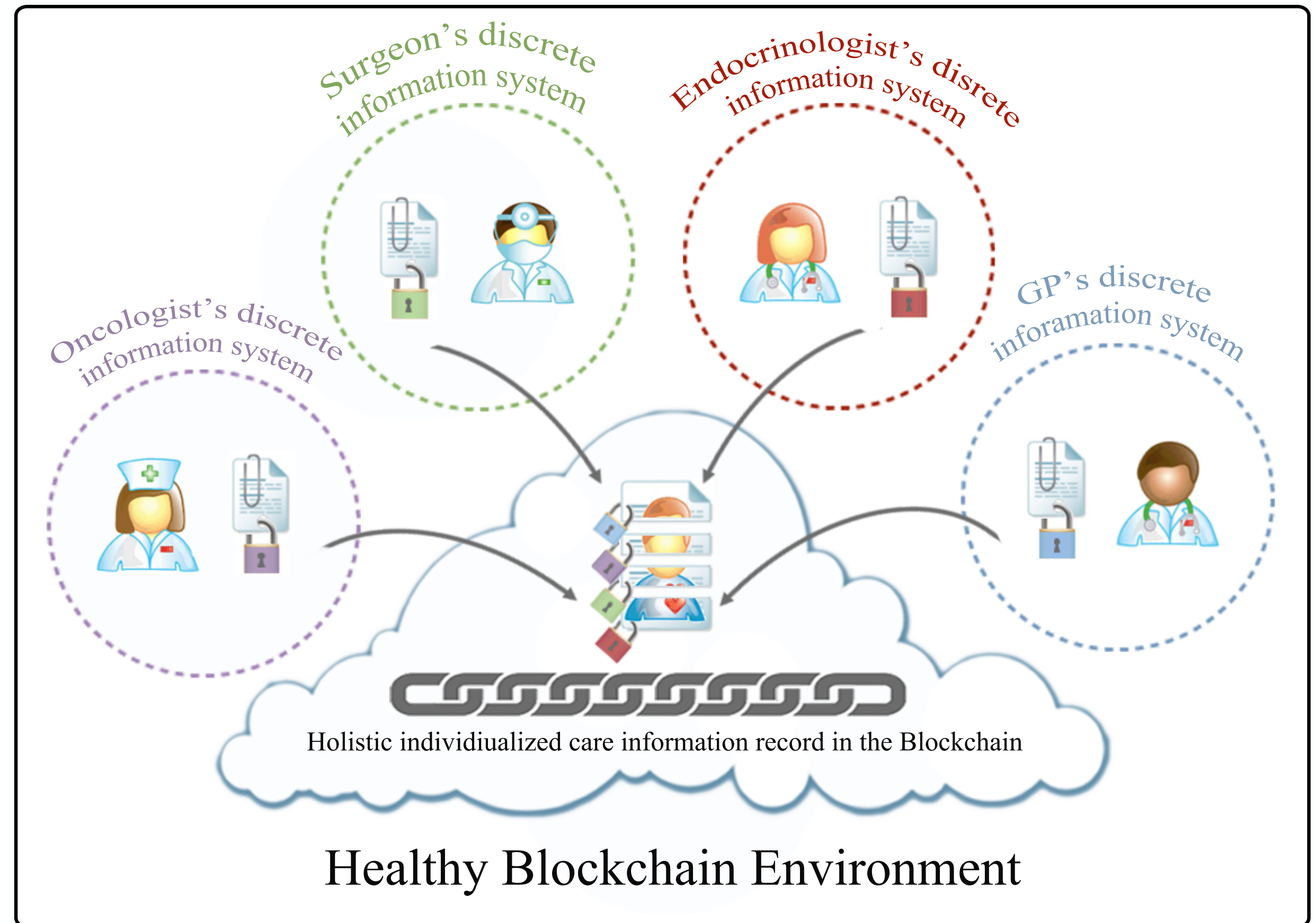
Granularity (8 Levels)

Healthy Blockchain— How it Works



Healthy Blockchain- Putting it all together

- **Unified, neutral**, conflict-free information **policy** (smart contracts)
- Govern a **fine-grained patient-centered, comorbid-friendly, and decentralized ledger** across healthcare legacy systems.



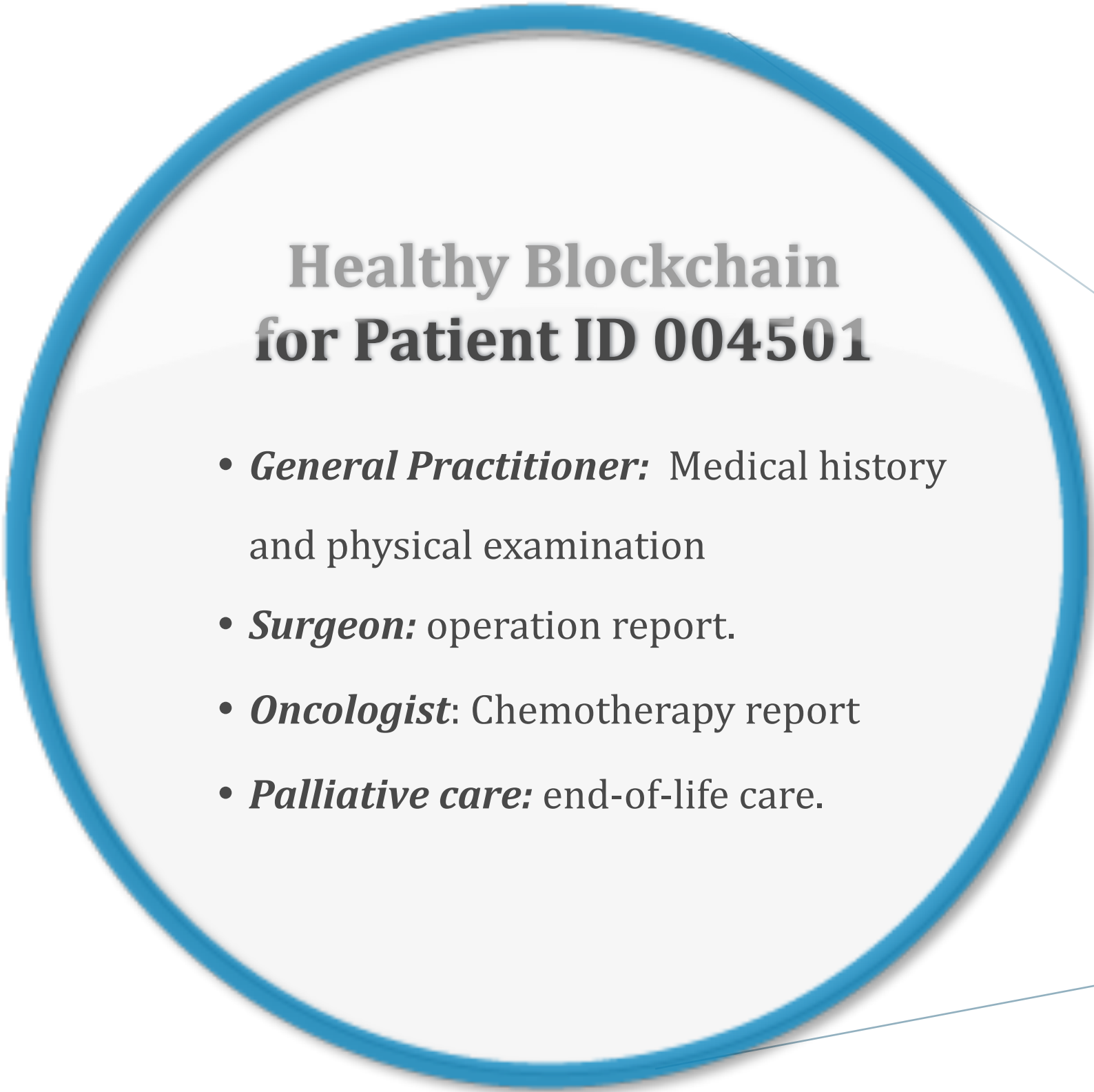
Protection using
GP's local
information security

Protection using
surgeon's local
information security

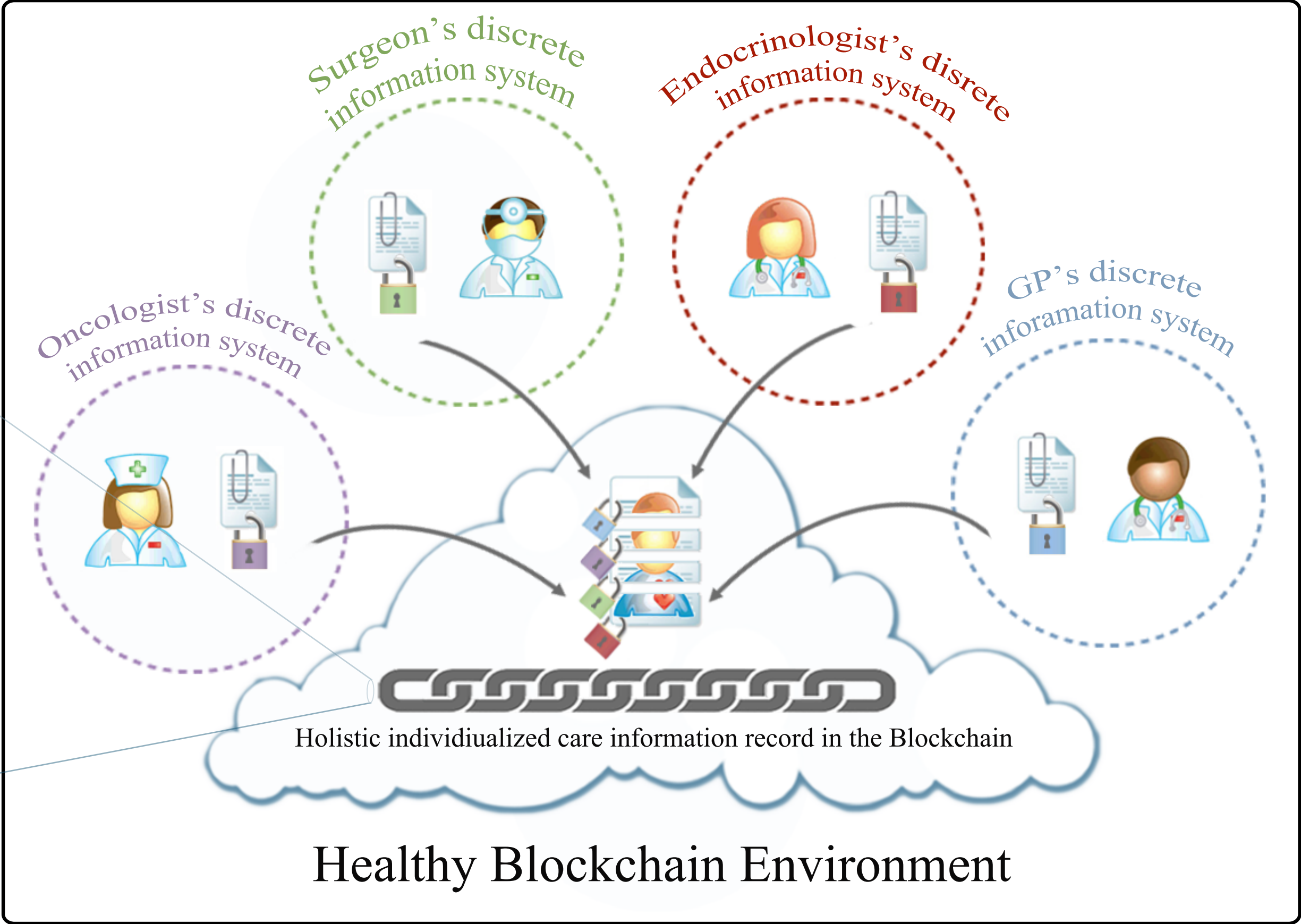
Protection using
oncologist's local
information security

Protection using
endocrinologist's local
information security

Healthy Blockchain- Putting it all together



Ledger



Protection using
GP's local
information security

Protection using
surgeon's local
information security

Protection using
oncologist's local
information security

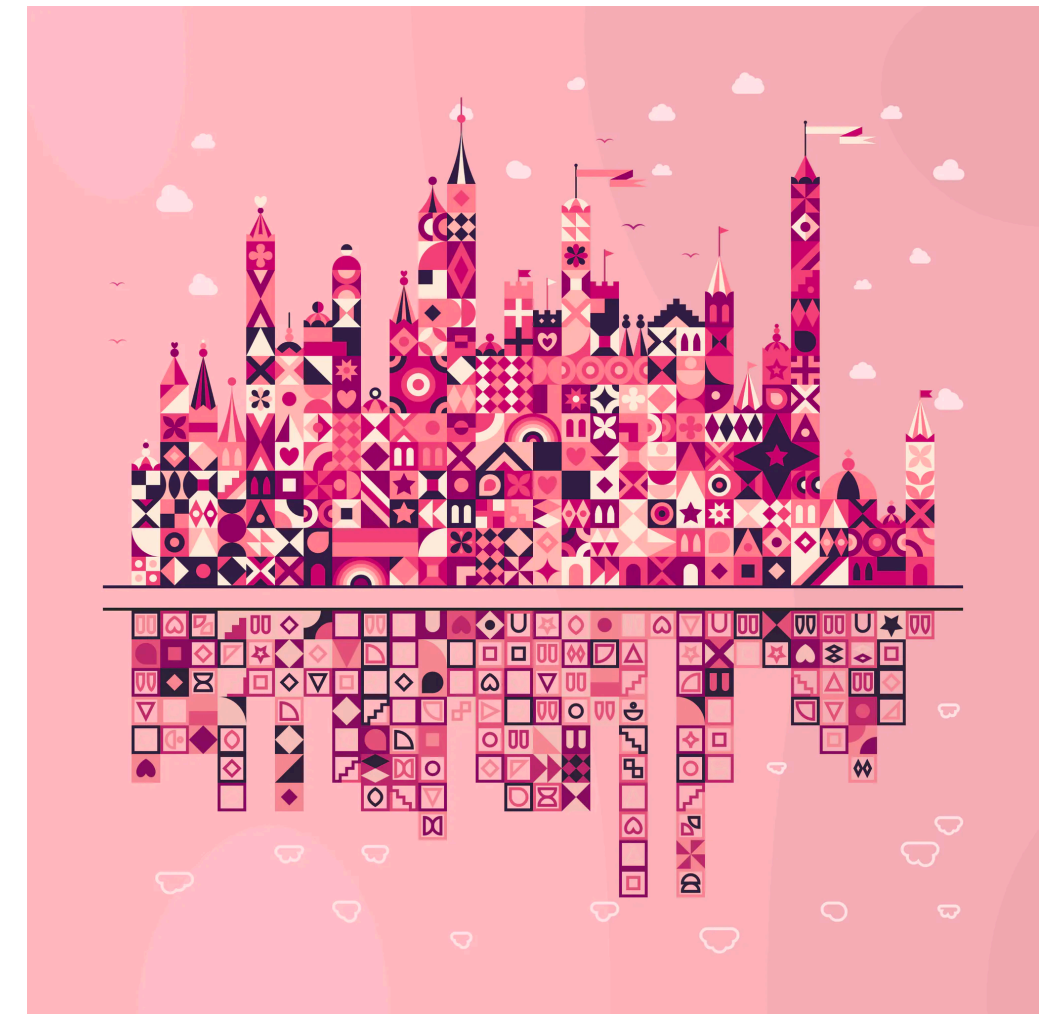
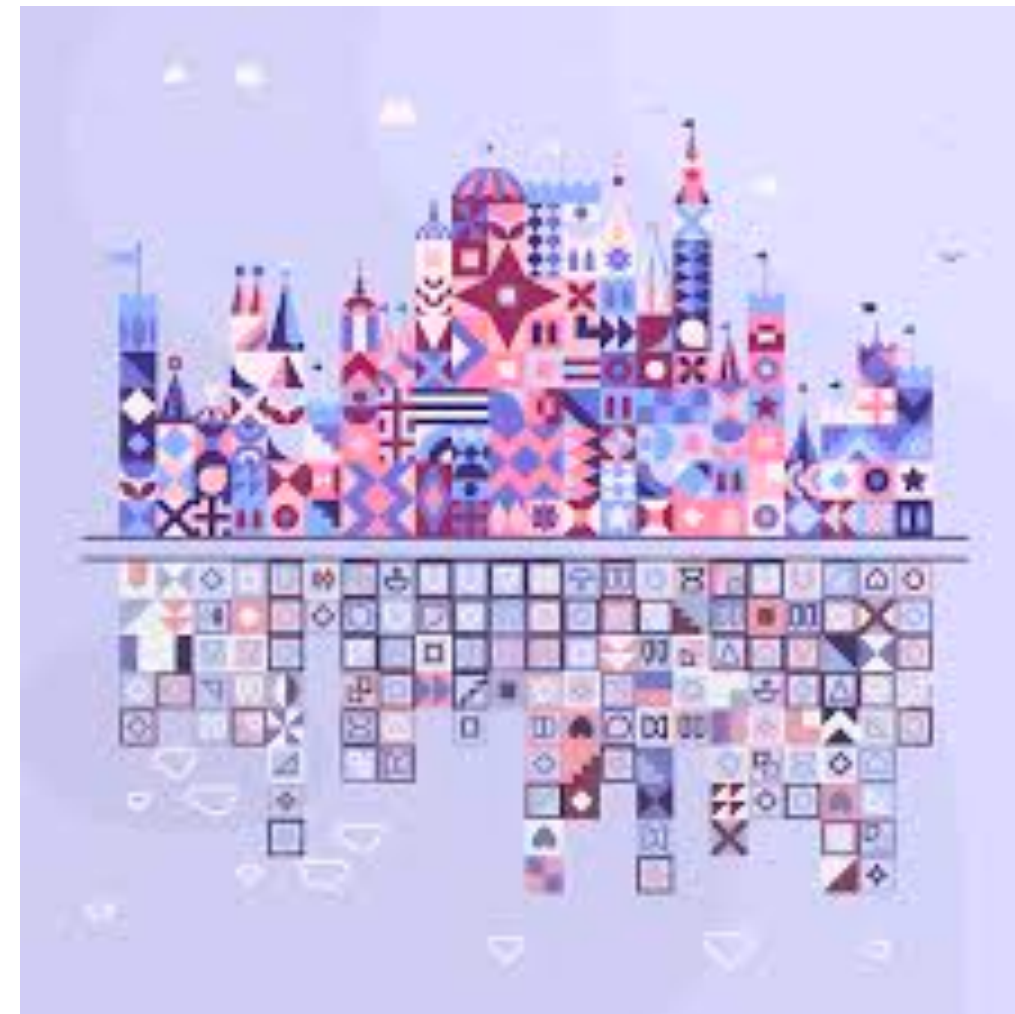
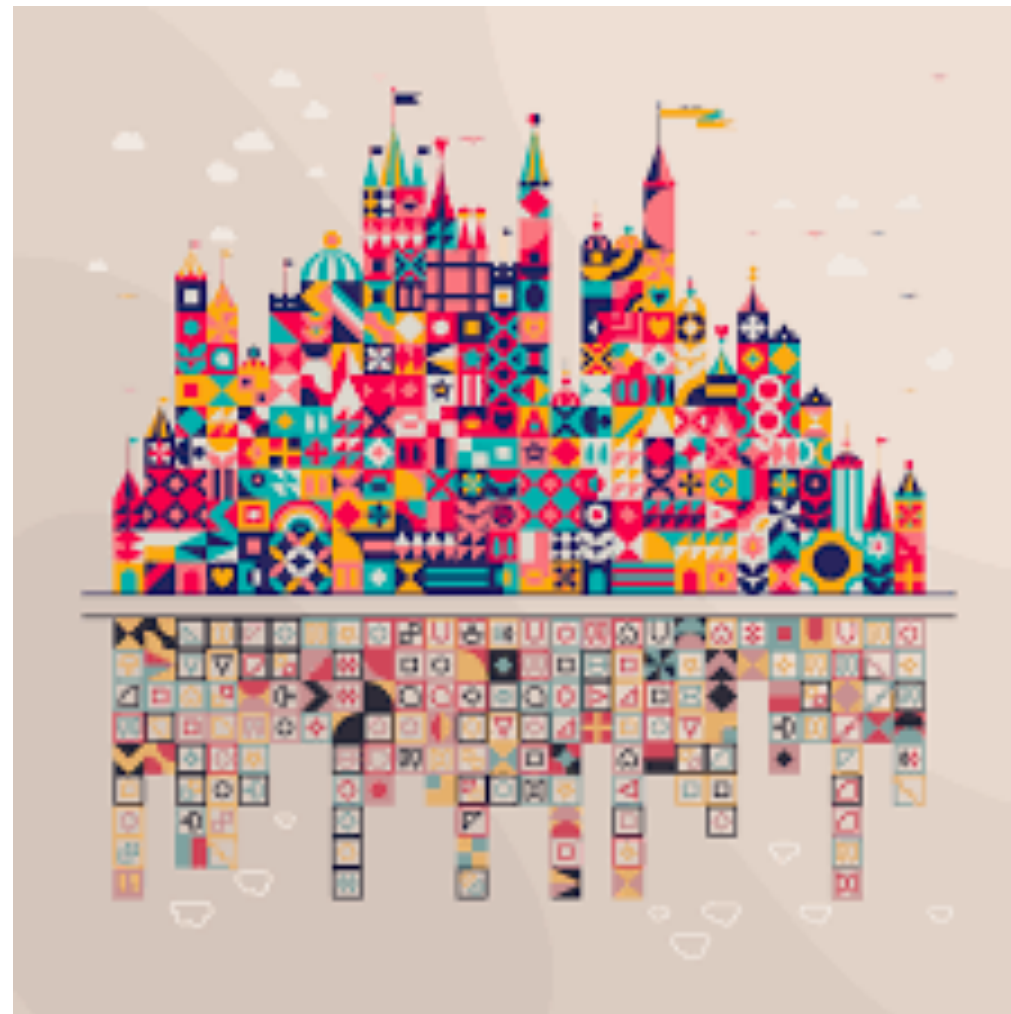
Protection using
endocrinologist's local
information security

Going Beyond Legacy Systems?

- Use case 1.0: **Unified** patient-cantered **record** *(with Legacy Systems)*
- Use case 2.0: **IoT wearables**, and **mobile** healthcare **applications**.
- Use case 3.0: **Big data** decentralised analytics *(with OPAL)*.
- Use case 4.0: Patient **informed consent** *(EU GDPR compliance)*
- Use case 5.0: Health **insurance**.
- Use case 6.0: **Organ** procurement, transplant list, donors registry.
- Use case 7.0: **Pharmaceutical**, drug research, and **trials**.



Use Case 2: *Patchwork Kingdoms of Data-Driven Digital Tokens*



Giga Project- Patchwork Kingdoms Background



The Kingdom's Architecture- Grouping & Placing the Schools

Schools with unavailable data are placed in the sky

All schools **connected** to the internet

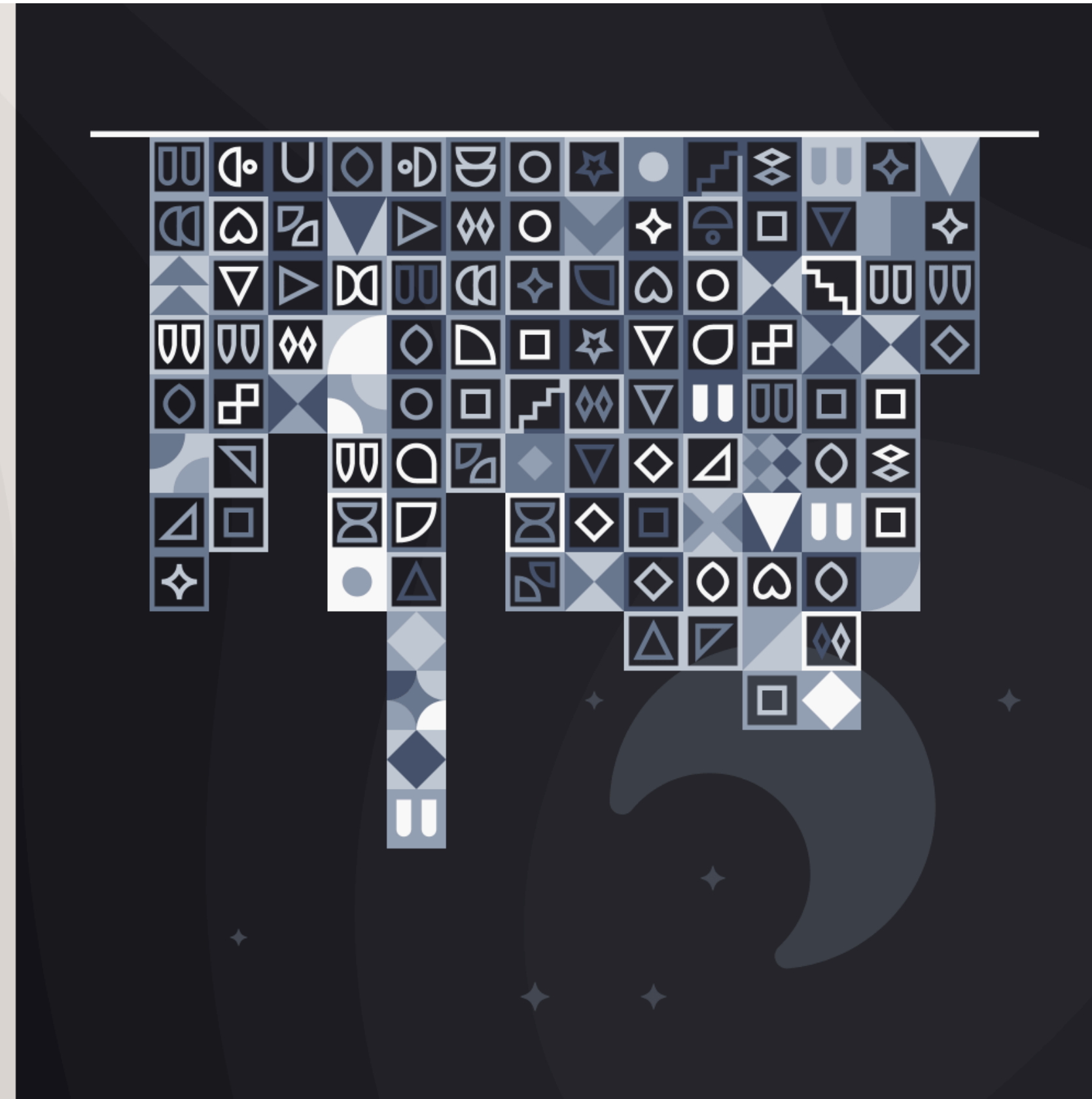
All schools **NOT connected** to the internet



Intended Future vs Stark Reality



**An all-connected-schools
Kingdom**



**A completely-disconnected
Kingdom**

1000 Non-Fungible Token (NFT) Kingdoms from 283'000 Schools Data

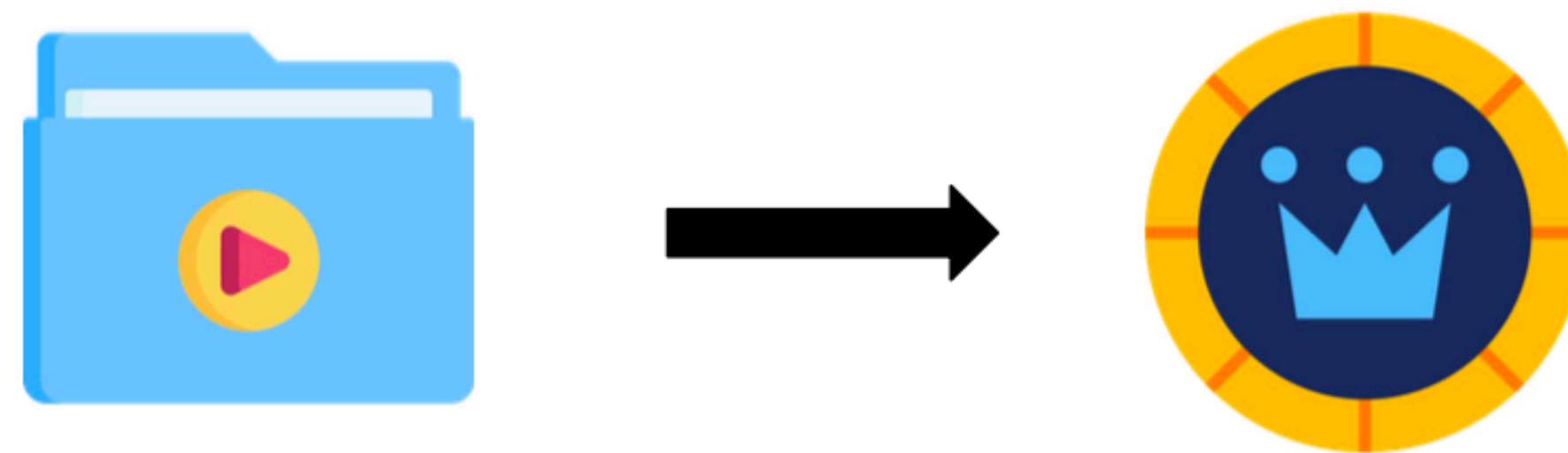


Non-Fungible Token (NFT)

non-fungible token (NFT) noun

non-fun·gi·ble token | \ ,nän-'fən-jə-bəl-'tō-kən \

A unique digital identifier that cannot be copied, substituted, or subdivided, that is recorded in a blockchain, and that is used to certify authenticity and ownership of a specific digital asset (such as the original version of an online photo or video).

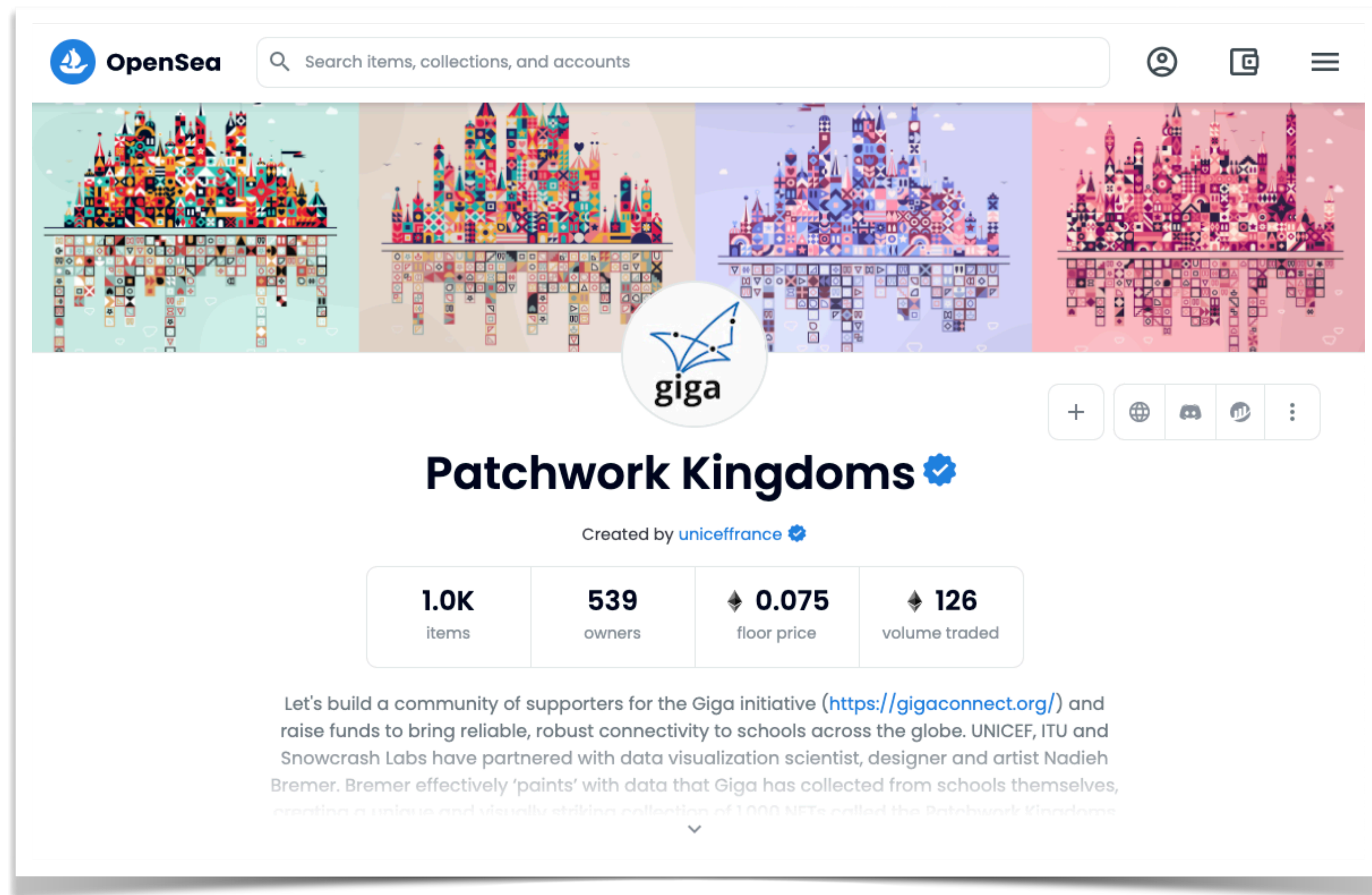


Non-Fungible Token (NFT)



- As the world becomes more digitized, there is a need to replicate the properties of physical items - scarcity, uniqueness, and proof of ownership.
- Non-fungible digital assets have been around since the beginning of the internet, and NFTs solve for digital ownership.





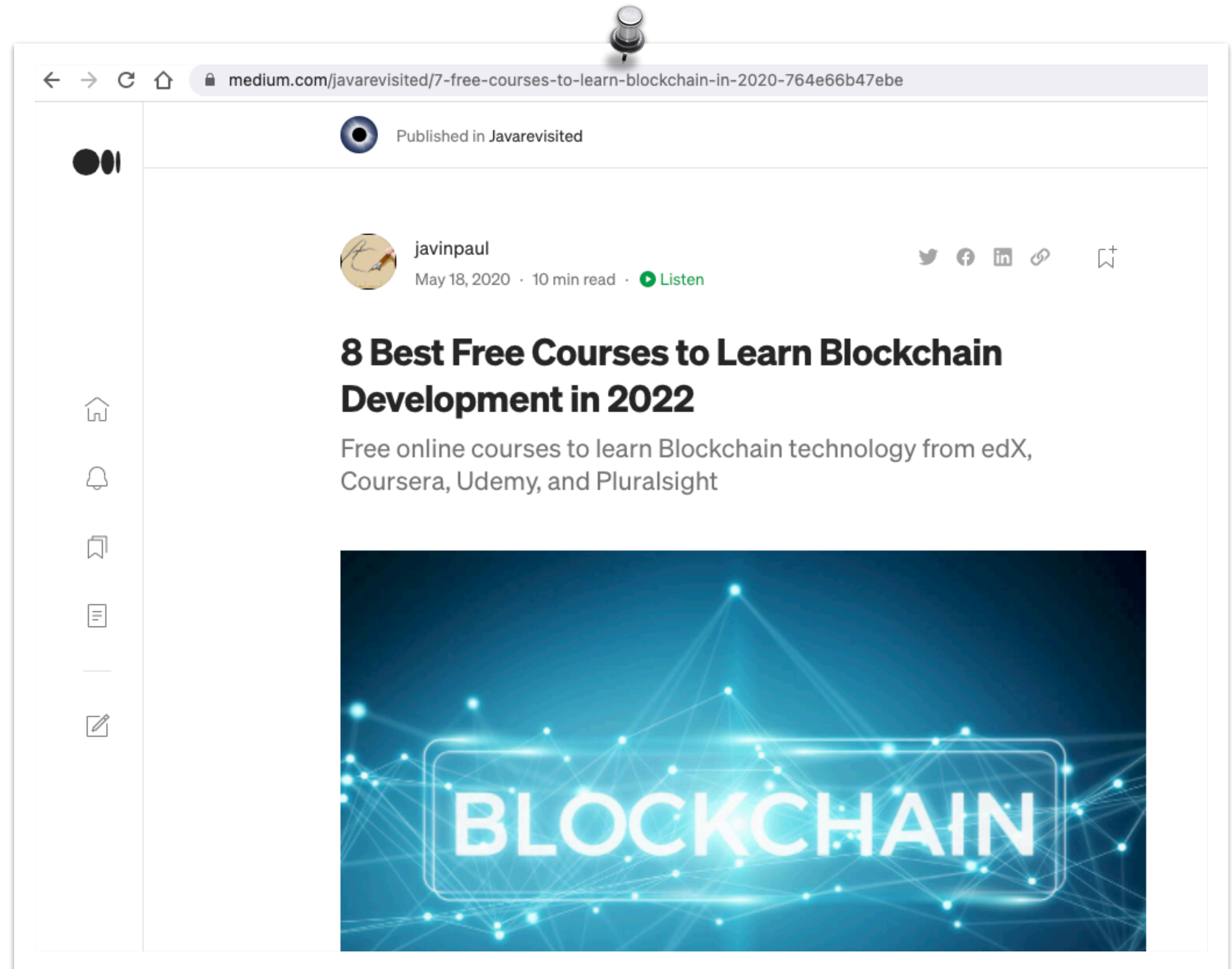
“We as humanity can fundamentally shift things using technology as the energy behind that shift.”



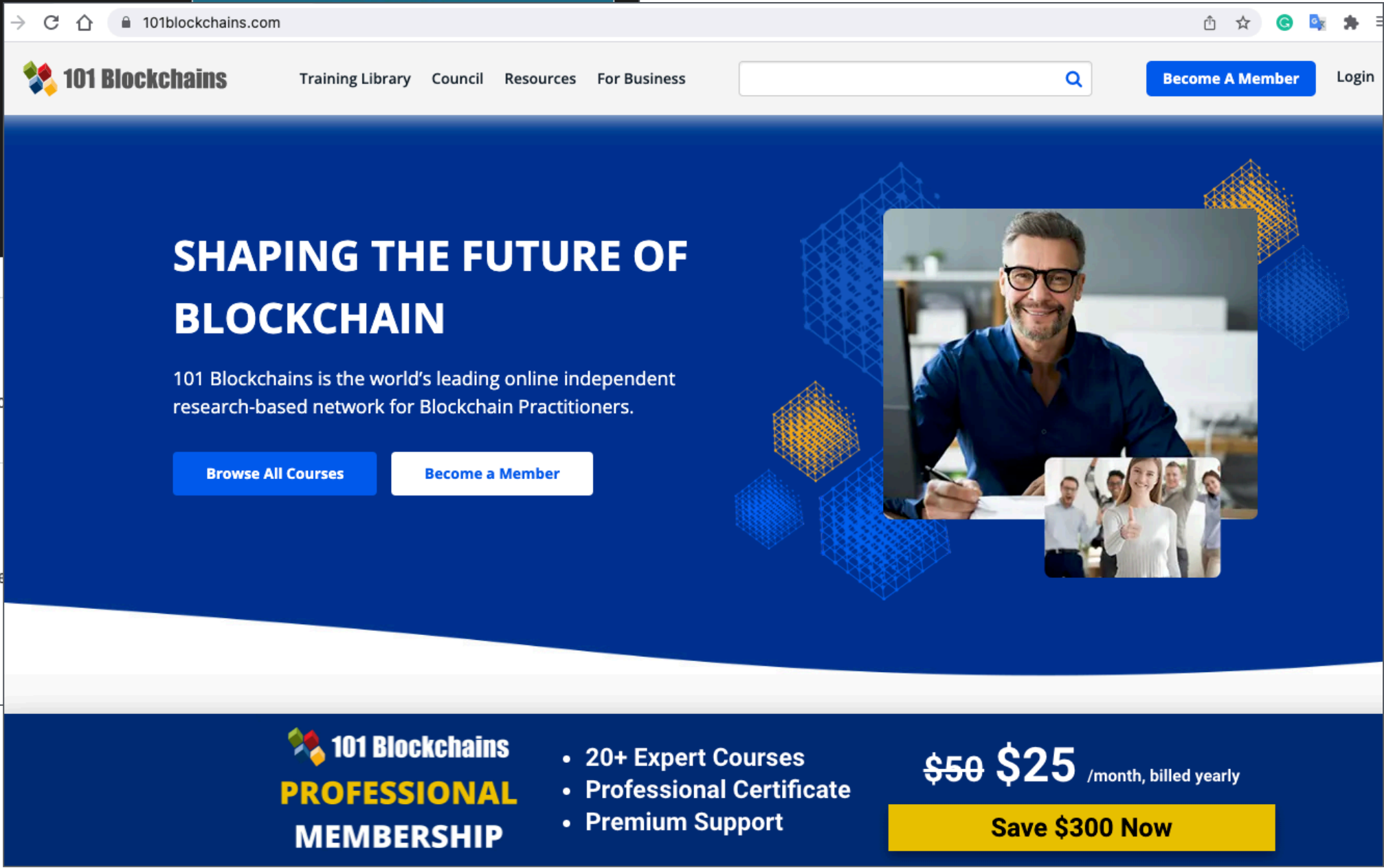
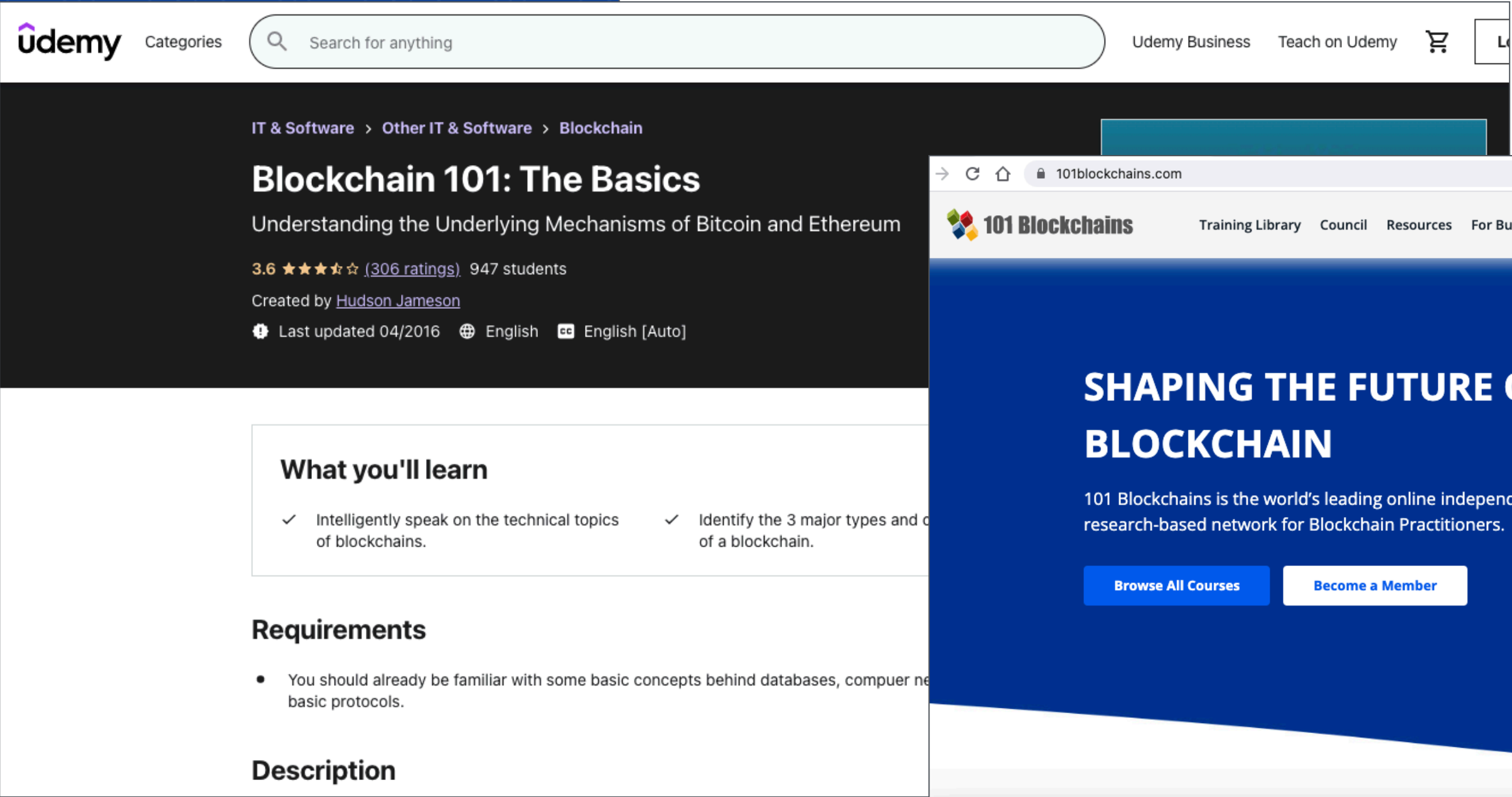
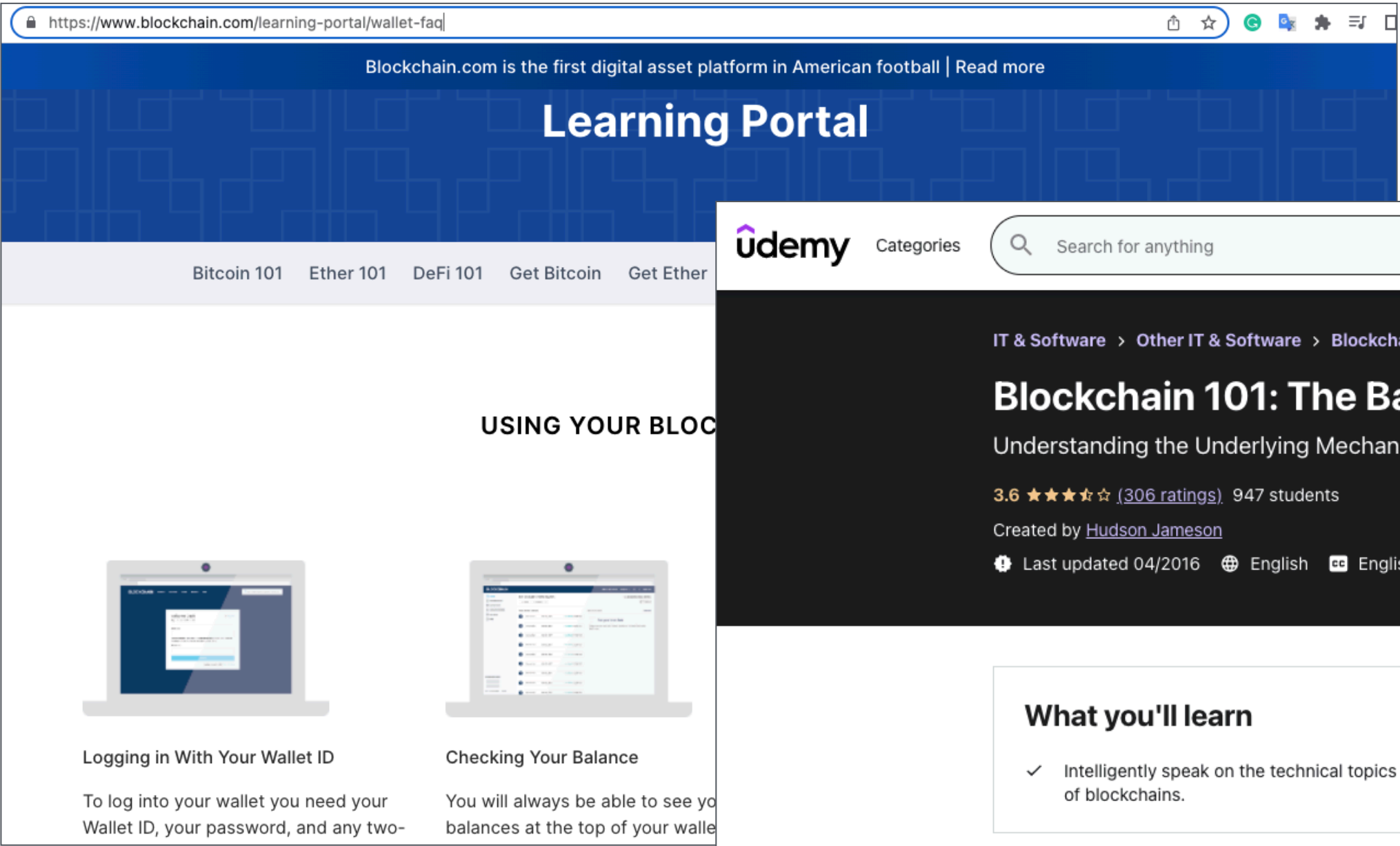
How to Get Started?



Getting Started Today with The 8 Best Free Blockchain Development in 2022



More Learning Portals



Building a Career in Blockchain with Blockchain Online Programs Offered at 54 Universities Around the World



Start your blockchain developer career!

LEARN MORE

Online Blockchain Programs



As with all educational majors and minors, educational facilities offer a complete curriculum entirely online. This allows you to learn about blockchain from the same computer you will be using to interact with and manage it for your personal needs. There are several major schools that offer degrees in the blockchain that can help you learn what you will need.

1. **Amity University Online:** A school in India that offers certification courses in Blockchain Technology & Management and Blockchain Management.
2. **Austral University:** A school in Argentina offers a Spanish-only course in Blockchain Disruption.
3. **Dalhousie University:** A school in Canada that offers certification for blockchain.
4. **Duke University:** A school in the United States of America that offers Entrepreneurial Finance, FinTech Law & Policy, and Blockchain Business Models courses as well as a certification for Blockchain Applications.
5. **EU Business School:** A school in Switzerland that offers a degree plan for an MBA in Blockchain Management.
6. **Harvard University:** A school in the United States of America that has courses in Introduction to Blockchain & Bitcoin and Breakthrough Innovation with Blockchain Technology and offers certification in FinTech.
7. **Hong Kong University of Science & Technology:** A school in Hong Kong that offers courses in FinTech Security, FinTech Risk Management, FinTech Disruptive Innovation, and FinTech Foundations & Overview and a specialization course in FinTech Industry Transformation & Regulation.
8. **'IEBS' Digital School:** A school in Spain that offers a postgraduate diploma plan in blockchain as well as a degree plan for master's degrees in Blockchain & FinTech but only for Spanish speakers.
9. **IIT Bangalore:** A school in India that offers a postgraduate diploma plan in Software Development for blockchain and a postgraduate certification in Blockchain Technology.
10. **IIT Kanpur:** A school in India that offers a certification course in Introduction to Blockchain Technology & Applications.
11. **IIT Kharagpur:** A school in India that offers a certification course in Blockchain Architecture Design & Use Cases.
12. **IIT Madras:** A school in India that offers a certification course in Software Engineering for blockchain.
13. **Imperial College London:** A school in England that offers a course in FinTech Program.
14. **IMT Ghaziabad:** A school in India that offers a certification course in Blockchain Technology Management.
15. **INSEAD:** A school in France that offers courses in Transacting on the Blockchain, Introduction to Blockchain Technologies, Introduction to Blockchain for Financial Services, Blockchain Transformations of Financial Services, Blockchain in Financial Services, blockchain Opportunity Analysis, Blockchain Cryptoassets & Decentralized Finance, and Blockchain & Business as well as specialization courses in

16. **International University of La Rioja:** A school in Spain that offers a course in Blockchain Applied to Business for a degree and a certification in Blockchain Application Development.
17. **Liverpool John Moores University:** A school in England that offers a degree plan for an MS in Computer Science that specializes in Blockchain.
18. **London School of Economics:** A school in England that offers a specialization course in Cryptocurrency & Disruption.
19. **Loyola Marymount University:** A school in the United States of America that offers courses in Blockchain Foundations & Frameworks, Blockchain Cases, and Blockchain & Industry.
20. **Massachusetts Institute of Technology:** A school in the United States of America that offers courses in Blockchain Technologies and Blockchain Ethics as well as a certification in Digital Transformation.
21. **Miguel de Cervantes European University:** A school in Spain that offers a degree plan for a master's degree in Applied Blockchain for Spanish-speaking students.
22. **Moscow Institute of Physics & Technology:** A school in Russia that offers a course in Introduction to Blockchain Technology.
23. **Ngee Ann Polytechnic:** A school in Singapore that offers a course in FinTech.
24. **Polytechnic University of Catalonia:** A school in Spain that offers a degree plan for a master's degree in Blockchain & Business Applications for Spanish speakers.
25. **Pontifical Xavierian University:** A school in Colombia that offers a course in Blockchain Technology Fundamentals.
26. **Portland State University:** A school in the United States of America that offers certification courses in Business Blockchain.
27. **Princeton University:** A school in the United States of America that offers a course in Bitcoin & Cryptocurrency Technologies.
28. **Ramon Llull University:** A school in Spain that offers a certification course in Innovation in Finance for Spanish speakers.
29. **RMIT University:** A school in Australia that offers courses in Developing Blockchain Strategy and Designing Blockchain Solutions and certification courses in Emerging Technologies & Law and Blockchain-Enabled Businesses.
30. **Rutgers University:** A school in the United States of America that offers a course in New Technologies for Business Leaders.
31. **Ryerson University:** A school in Canada that offers a course in Blockchain Risk Management.
32. **Saxion University:** A school in the Netherlands that offers a course in Bitcoin.
33. **SP Jain School of Global Management:** A school in India that offers a certification course in FinTech.
34. **Stanford University:** A school in the United States of America that offers courses in Blockchain & Cryptocurrency.
35. **Universidad Europea:** A school in Spain that offers a degree plan for a master's in FinTech & Blockchain for Spanish speakers.
36. **University at SUNY – Buffalo:** A school in the United States of America that offers courses in Smart Contracts, Decentralized Applications, Blockchain Platforms, and Blockchain Basics and a specialization course about blockchain.
37. **University Canada West:** A school in Canada that offers a certification course in Blockchain Entrepreneurship.
38. **University College London:** A school in England that offers courses in Blockchain & Distributed Ledger Technology and a certification course in UCL Blockchain Rules.
39. **University of Alcalá:** A school in Spain that offers degree plans for a master's in Blockchain, Smart Contracts & Cryptoeconomics or Blockchain Engineering or a global masters in Blockchain Technologies.
40. **University of California, Berkeley:** A school in the United States of America that offers courses in Blockchain Technology and Bitcoin & Cryptocurrencies and a certification course in Blockchain Fundamentals.
41. **The University of California, Irvine:** A school in the United States of America that offers courses in blockchain, The Merkle Tree & Cryptocurrencies, Cryptography & Hashing Overview, and The Blockchain System and a specialization course about blockchain.
42. **University of Cape Town:** A school in South Africa that offers courses in Start Up Your FinTech Future, Financial Regulation & FinTech Companies, Entrepreneurs in Emerging Markets & Blockchain Technology, Building FinTech Startups in Emerging Markets, a specialization course in FinTech Startups in Emerging Markets, and a certification course in Disruption in Finance.
43. **University of Geneva:** A school in Switzerland that offers a certification course in Advanced Studies in Blockchain & DLT.
44. **University of Hong Kong:** A school in Hong Kong that offers courses in Introduction to FinTech, FinTech Ethics & Risks, and Blockchain & FinTech Applications and a certification course in FinTech.
45. **University of Nicosia:** A school in Cyprus that offers courses in Security Token Strategy, Blockchain Regulatory Academy, Blockchain Law, Applied Forecasting, and Introduction to Digital Currencies, certification courses in Blockchain Financial Analyst, Blockchain Business Analyst, and Blockchain Developer Certification, and degree plans for an MS in Computer Science and Digital Currency.
46. **University of Oxford:** A school in England that offers a certification course in Blockchain Strategy.
47. **University of Pennsylvania:** A school in the United States of America that offers a course in Cryptocurrency & Blockchain and a specialization course in Foundations & Applications of FinTech Specialization.
48. **University of Salamanca:** A school in Spain that offers degree plans for a master's or diploma plans for an expert's in either FinTech or Blockchain & Smart Contracts for Spanish-speakers.
49. **University of Technology Sydney:** A school in Australia that offers a course about blockchain.
50. **University of the Cumberlands:** A school in the United States of America that offers a degree plan for an MS in Global Business with Blockchain Technology.
51. **University of Zurich:** A school in Switzerland that offers a course in Deep Dive into Blockchain.
52. **Wayne State University:** A school in the United States that offers a certification course about blockchain.
53. **York University:** A school in Canada that offers certification courses in Full Stack Blockchain Developer, Master Blockchain, Back-End & Blockchain Development, and Blockchain Development.
54. **Zigurat Business School:** A school in Spain that offers a course in Blockchain Essentials.

As you can see, there is no shortage of facilities that offer online education into blockchain and its associated fields. Understanding finances is crucial to the cryptocurrency domain, and these programs help you manage how to operate blockchain databases in the field.



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