Study Of Metaverse

E-Infochips

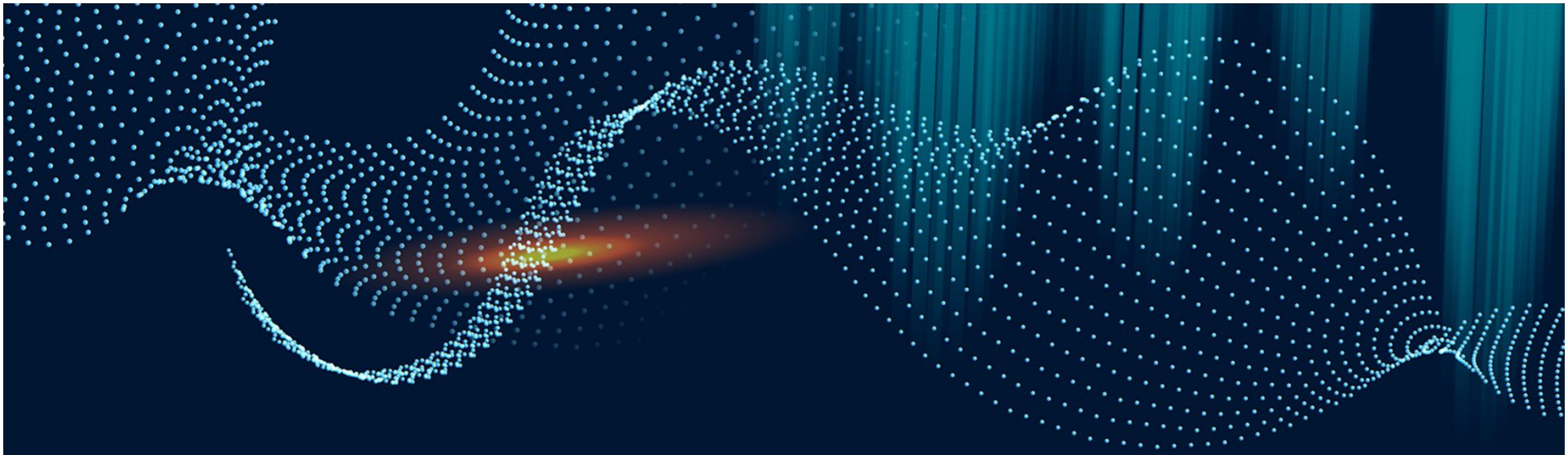
Contributors:
Meet Thakar (19BEC135)
Krishna Thakkar (19BEC136)
Yash Thakkar (19BEC137)
Saloni Vaghela (19BEC142)
Vanshika Gupta (19BEC143)
Abhi Vora (19BEC144)
Abhishek Zinzuvadiya (19BEC149)

Introduction

- Metaverse = Virtual Reality or Augmented Reality + Blockchain or Data based
- The link of the connections between the financial, virtual, and physical world's have been increasing day by day
- The metaverse will be driven by augmented reality, with each user controlling a character or avatar
- For example, you might take a mixed reality meeting with an Oculus VR headset in your virtual office, finish work and relax in a blockchain-based game(axie infinity)

Components of metaverse

1. Authentication Mechanism
2. Data Management and Computing
3. Cyber Reality and Interface
4. Network Infrastructure
5. Content Generation



01 Authentication Mechanism

- Blockchain based decentralization
- NFTs
- Biometrics

Blockchain-based decentralized identity platform

- A blockchain is like a distributed database system
- Maintains an ever-growing list of ordered records called blocks.
- These blocks are linked(chained) using encryption (cryptographic keys).
- Block = encryption hash + timestamp + transaction data(from previous block)
- Blocks have specific storage capacities

How does the blockchain provide an authentication mechanism?

- Relies upon the DLT (Distributed Ledger Technology) methods
- Blockchain ledgers (or networks) can store all types of data
    - Can store: NFTs, biometrics, cryptographic keys
    - Can remove the need for password authentication

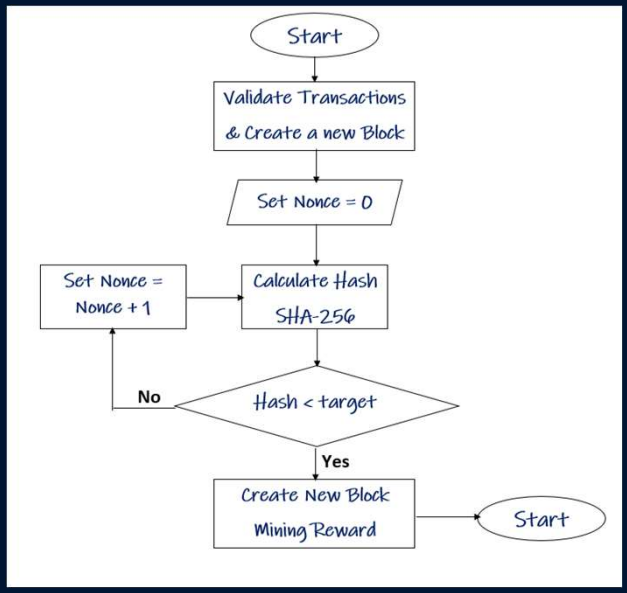
Example: Magic SDK

- Prefers key-based cryptographic authentication
- Can be integrated using Magic SDK

Ethereum blockchain

- It has a Smart Contract Functionality
- ETH is secured by the Ethereum blockchain
- Uses a Virtual Machine made up of many individual computers
- Efficient Computing power is provided by this network
- Creating a block of transactions referred to as mining

- Uses a proof-of-work (PoW) consensus
- PoW is like a race between miners to solve a cryptographic puzzle; upon solving the puzzle, they win the chance to add the block to the chain and get rewarded.



- Nonce: number only used once
- SHA-256 outputs a fixed-length number.
- Every number between 0 to 2^32 has the same chance to solve the puzzle, therefore a practical approach is to loop through from 0 to 2^32 until a number can meet the criteria.

Ethereum Mining Software

- Minedollars
- MinerGate
- Wineth
- Go Ethereum

Ethereum Development Software

- Remix IDE
- MetaMask
- **Solidity**
- Ganache
- Mist
- Ether.js
- Infura

What is the smart contract?

- Computer code that executes when certain requirements are met.
- Smart contracts allow several parties to reach a shared result
- Runs on a decentralized blockchain rather than a centralized server.
- Vending Machine Analogy:
    - With the right inputs, a certain output is guaranteed.
    - Just as a vending machine removes the need for a vendor employee, smart contracts can replace intermediaries in many industries

NFTs

- NFT is a digital asset that depicts real-world elements
- The blockchain is where NFTs are kept.
- The **smart contract** address pointing to the location of the NFT (on the blockchain) is obtained.
- A file-sharing mechanism is used to store the contents of the NFT's **smart contract** on the internet.
- NFTs help ensures that someone owns the Metaverse property or has the right to attend a virtual concert.

Biometrics

- The Biometric information of a user can be stored on a block of the blockchain.
- Like, when a user wears an intelligent device like AR/VR headsets, It brings new sensors that can provide better biometric technologies that uniquely identify gestures, hand gestures, body movements, etc.

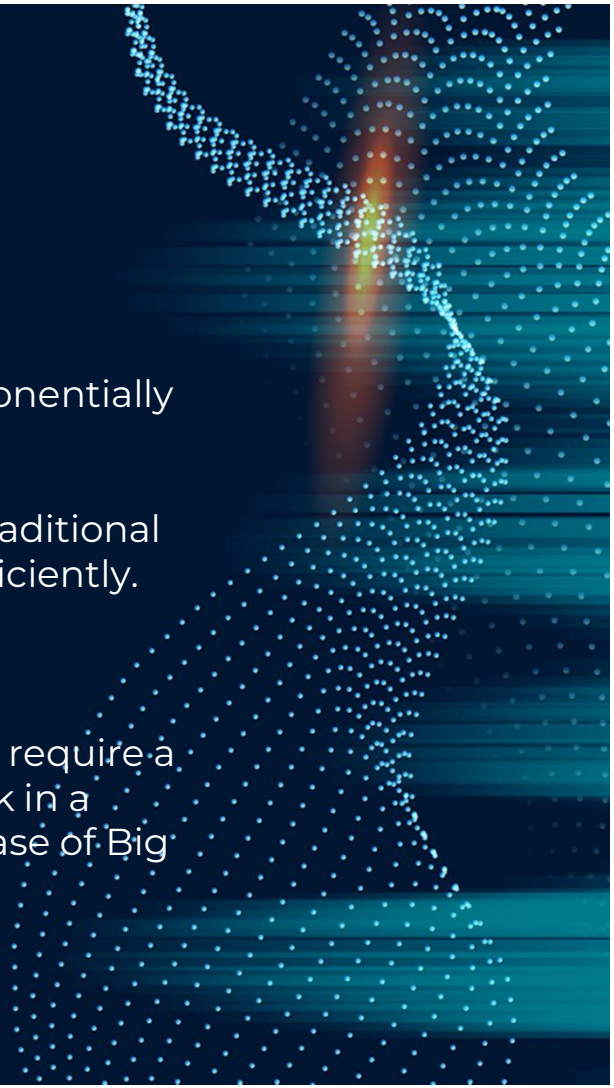
02

Data Management and Computing

- Cloud Computing
- Big Data
- Edge Computing

Big Data

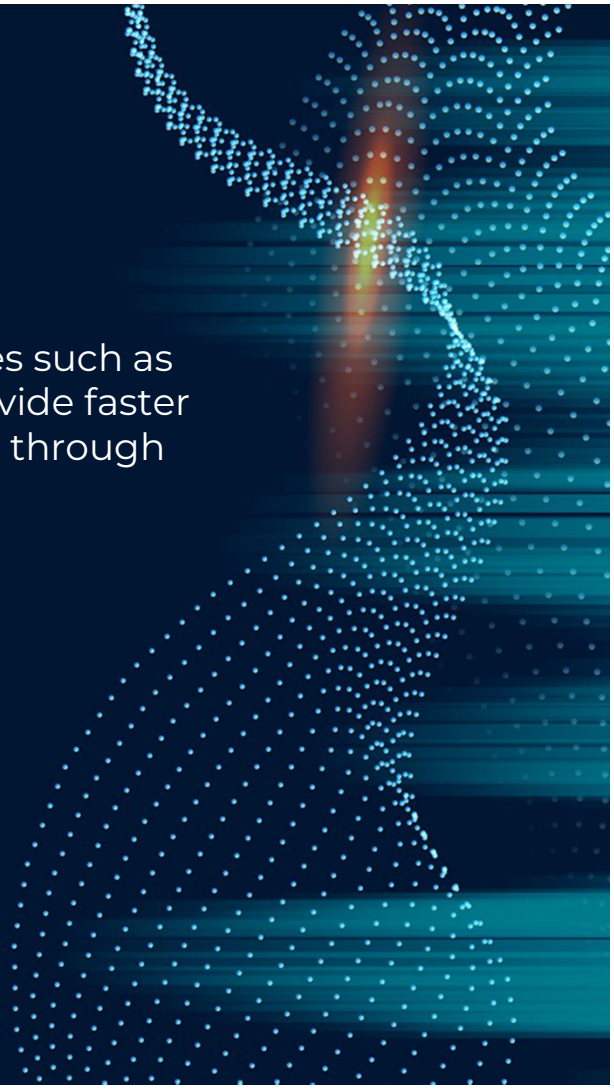
- Big data is a huge collection of data, but it grows exponentially over time.
- This is data of such a large size and complexity that traditional data management tools cannot store or process it efficiently.
- Big data is also data, but it is huge in size.
- As Blockchain and technologies related to metaverse require a huge amount of data to be transferred over a network in a short amount of time, it can be considered as a use case of Big data.

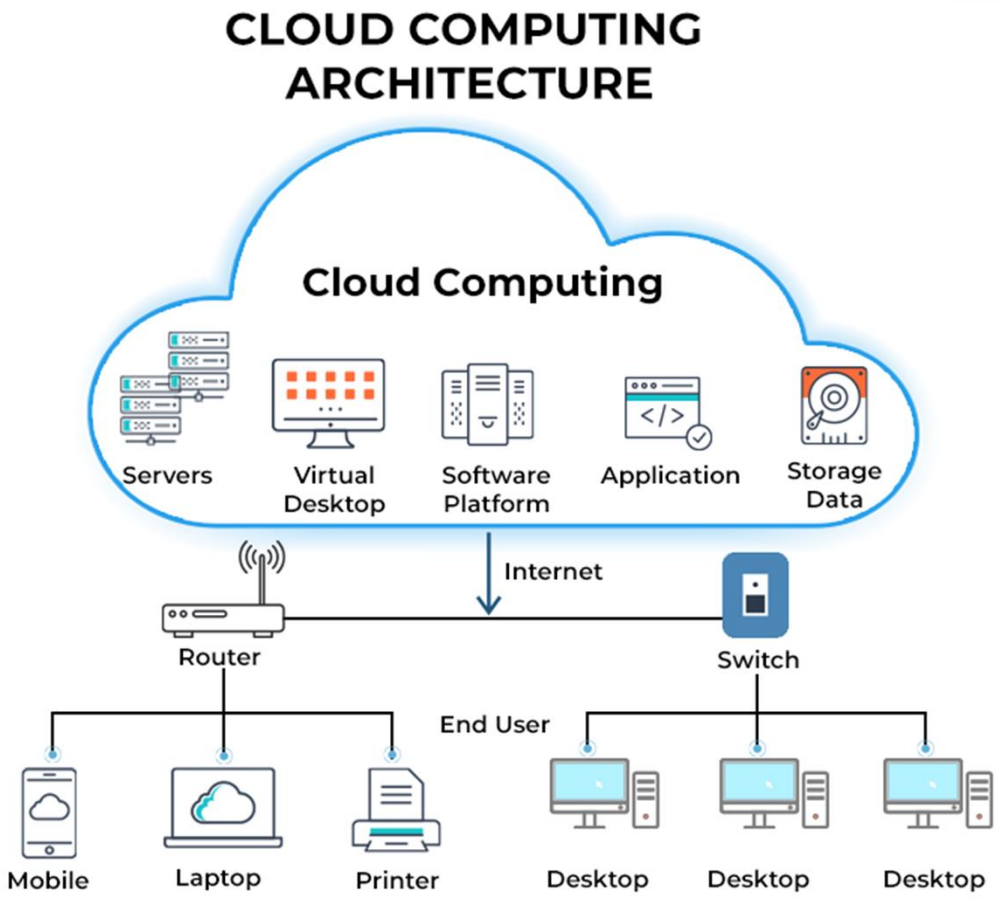


Cloud Computing

- Cloud computing is the delivery of computing services such as servers, storage, databases, networks, software to provide faster innovation, flexible resources, and economies of scale through the Internet.

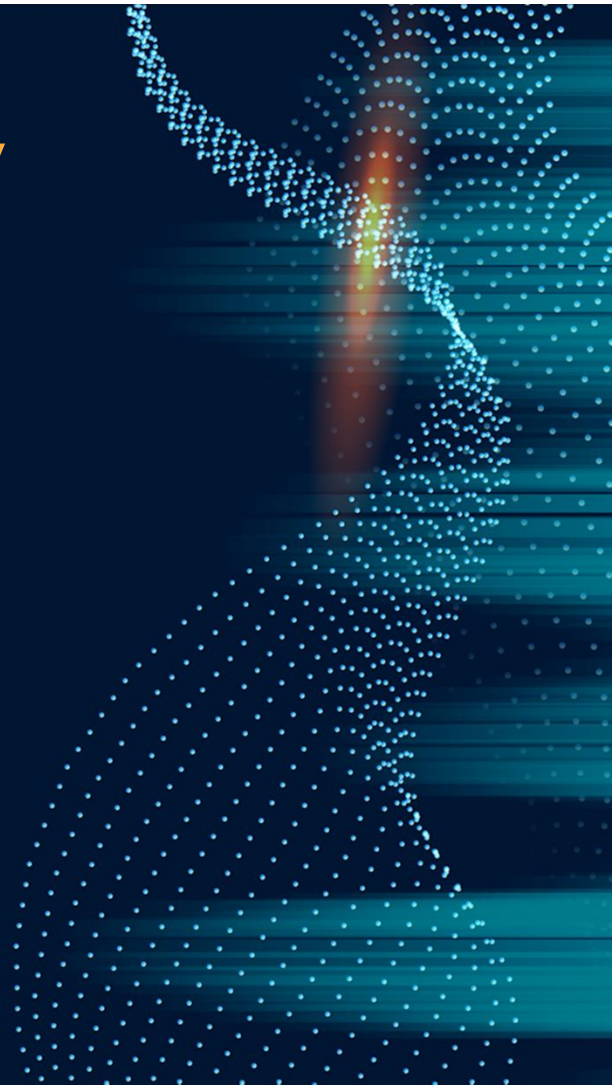
- Some platforms providing cloud services:
  - Amazon Web Services
  - Google Cloud Platform
  - Microsoft Azure
  - IBM Bluemix
  - DigitalOcean
  - Alibaba Cloud.




CLOUD COMPUTING
ARCHITECTURE
Cloud Computing
Servers
Virtual
Desktop
Software
Platform
Application
Storage
Data
Internet
Router
Switch
End User
Mobile
Laptop
Printer
Desktop
Desktop
Desktop

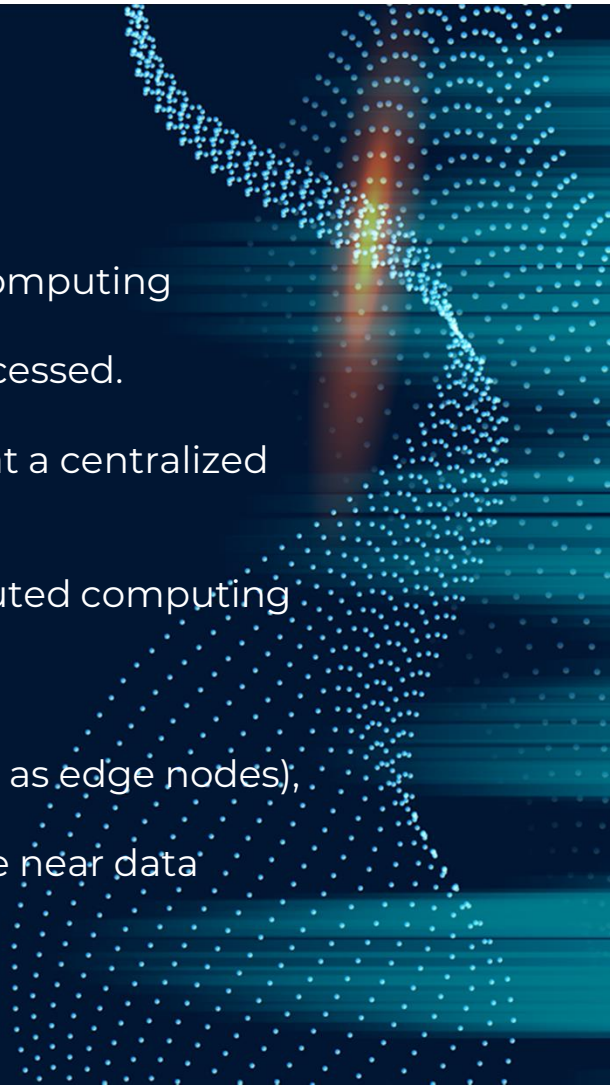
Programming languages widely used for Cloud computing

- Java
- SQL (For database management)
- PHP
- .NET
- Python
- GO
- Java Script

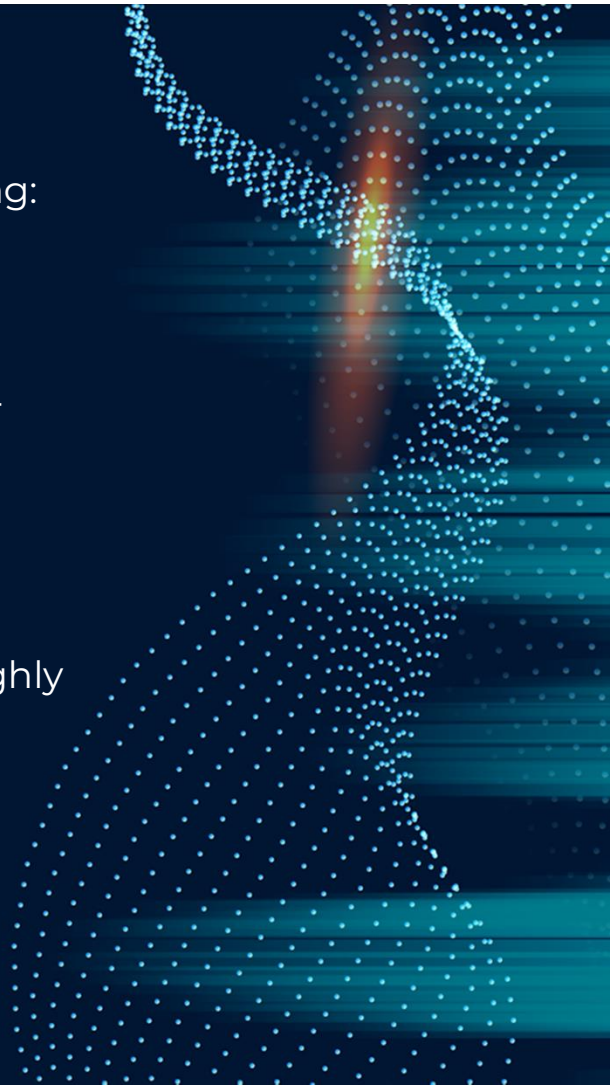


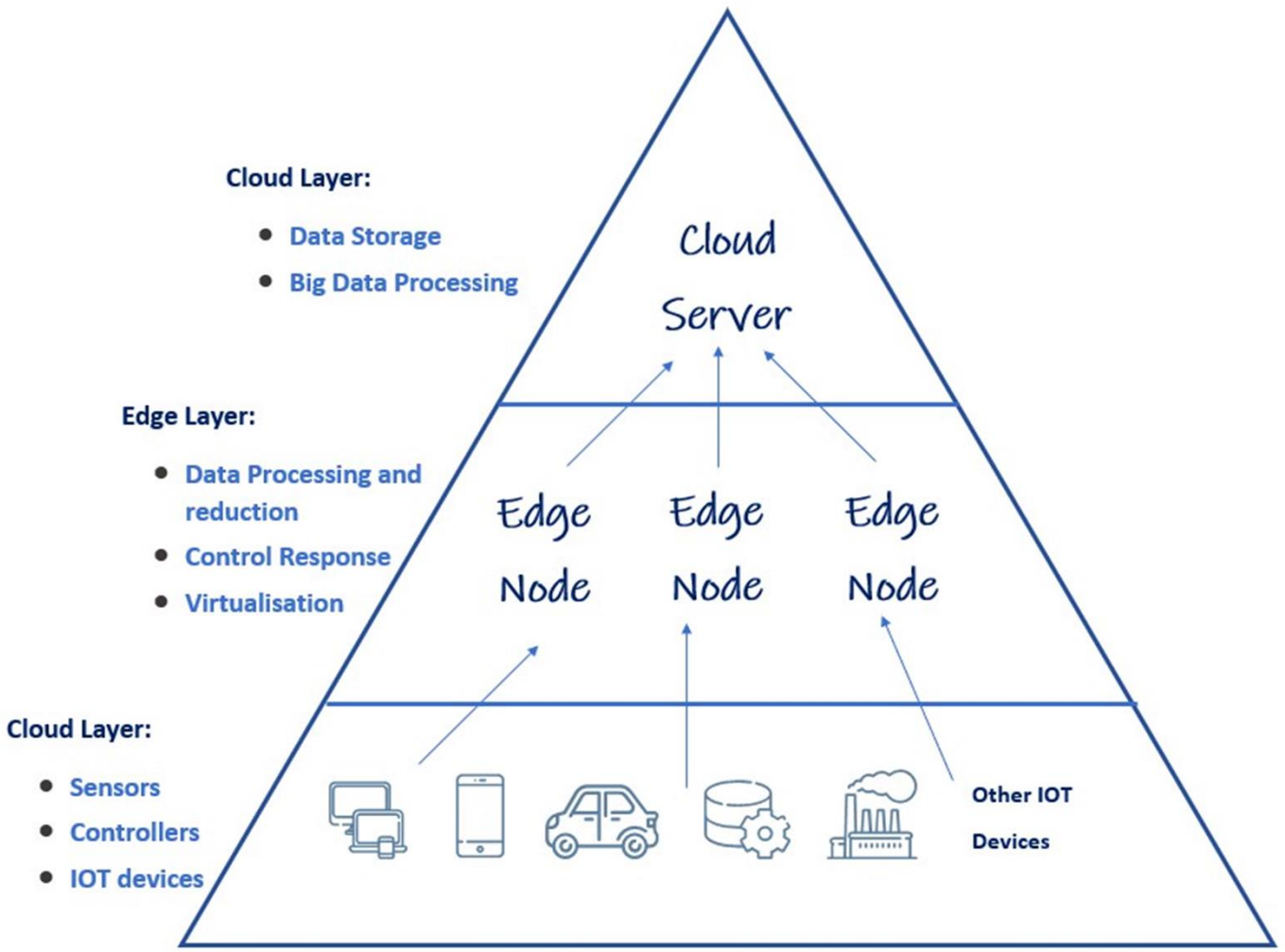
Edge Computing

- Edge Computing is more or less the same as cloud computing
- The key difference lies in where the data is being processed.
- In the cloud, data is stored, processed, and analyzed at a centralized location.
- But in the edge data processing is based on a distributed computing environment.
- It is a distributed computing concept
- Integrates intelligence into edge devices (also known as edge nodes),
- Allows data to be processed and analyzed in real-time near data collection sources.



- Advantages of edge computing over Cloud computing:
    - Its ability to process data in real-time
    - This is possible as you no longer need to transfer data to the
    - Its fast time response
- In applications such as IoT and Metaverse where a highly available network with minimum latency is required, edge computing can be helpful.




Cloud Layer:
Data Storage
Big Data Processing
Cloud
Server
Edge Layer:
Data Processing and reduction
Control Response
Virtualisation
Edge
Node
Edge
Node
Edge
Node
Cloud Layer:
Sensors
Controllers
IOT devices
Other IOT
Devices

03

Cyber Reality and Interface

- Extended Reality (AR + VR + MR(Mixed Reality))
- Brain-Computer (Human-Computer) Interface
- Intelligent Devices (e.x., VR headsets)

Brain Computer Interface

- It is a way of interacting with computers
- It is the direct interface between the brain's electrical activity and an external device.
- The Brain-Computer Interface (BCI) captures brain signals, analyzes them, converts them into commands, and sends them to output devices that perform the desired action.
- For metaverse, BCI may allow users to:
    - control avatars
    - various objects
    - digital transactions with their brain signals.

NextMind for BCI

- The NextMind sensor uses **EEG** technology
- Machine learning algorithms translate them into digital commands in real time.
- An electroencephalogram (EEG) is a test that measures the electrical activity of the brain using a small metal disk (electrode) attached to the scalp.
- Brain cells communicate via electrical impulses and are always active.

NextMind BCI DEV Kit

Extended Reality (AR + VR + MR)

- XR: fuse the physical and virtual worlds
- VR: replaces the vision of the real world In a scene
  (using software and headset devices)
- AR: It uses computer vision technology such as Object detection, plane detection, face detection, With motion tracking to detect the actual surface object.
- MR: The combination of Augmented reality and virtual reality.
  - It is also called hybrid reality because it includes both real and digital aspects.

Languages and Platforms for XR development

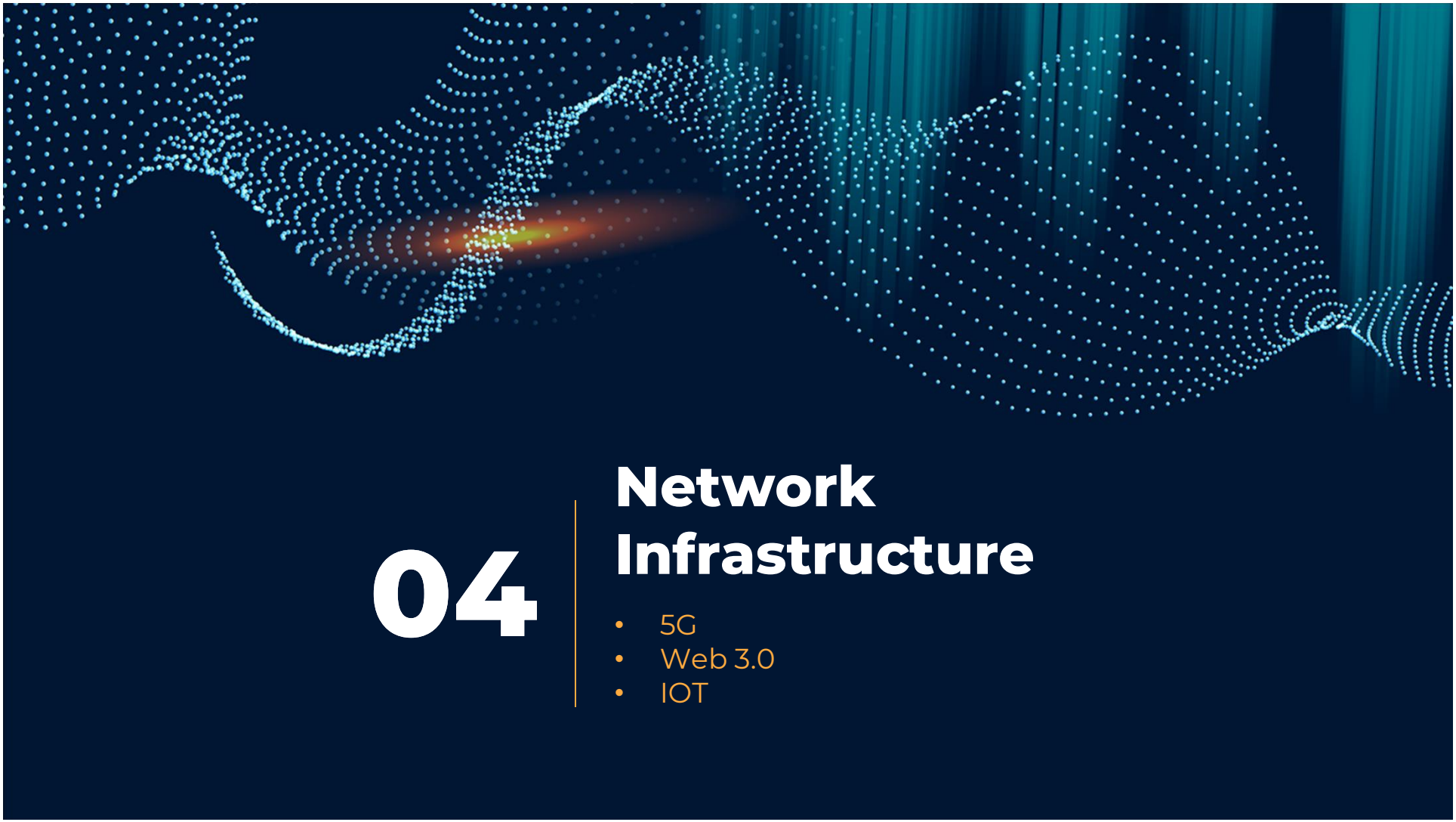
- **C#** and **C / C ++** are generally considered to be the top programming languages for XR development.
- Major game engines such as **Unity** and **Unreal Engine** that most XR devices support.
- web based apps: **Javascript +** (**webAR, webXR**)
- Android APPs: **Java** + **Kotlin + ARCore**
- **IOS** apps: **ARkit** + **Swift**

Intelligent Devices

Microsoft HoloLens2 (MR Device)

Oculus Quest 2 VR Headset

Google Cardboard VR (discontinued)



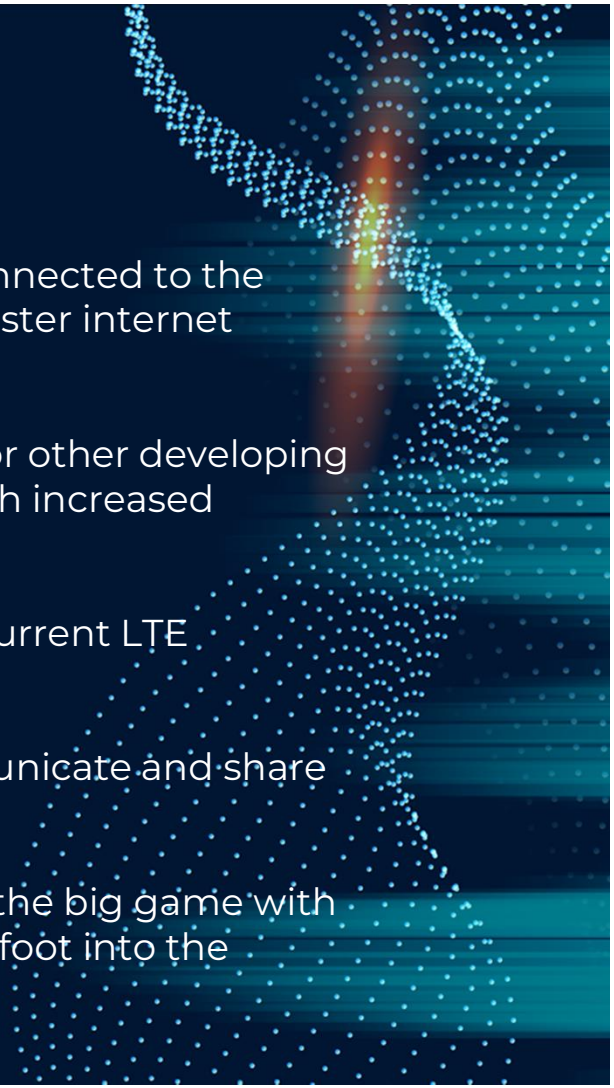
04

Network Infrastructure

- 5G
- Web 3.0
- IOT

5G

- virtual world continuously as well as to keep users connected to the virtual world, A metaverse application will require a faster internet connection between the system and all its users.
- And From the current scenario, only 5G technology (or other developing network technologies like 6G) will be able to cope with increased transmission data and required speed.
- According to reports, 5G will be 10 times faster than current LTE networks.
- This increase in speed will allow IoT devices to communicate and share data faster than ever.
- 5G Augmented Reality will allow users to experience the big game with up-close, realistic live-stream video without stepping foot into the stadium.



IOT

- IoT refers to the networking of physical objects with computing devices for sensing and communication.
- The biggest challenge in the Metaverse is the ability to map real data and transform it into virtual reality.
- IoT may work in correspondence with Artificial Intelligence to collect this data.
- IoT enables the Metaverse to analyze and interact with the real world
- The Metaverse also acts as a 3D user interface for IoT devices, paving the way for new, customized IoT user experiences.

Web 3.0

- The three key foundations of Web 3.0:
  - AI
  - IOT
  - Blockchain
- companies use and track the digital footprints of users.
- Web 3.0 will aim to reverse this mechanism.
- Make the users the sole owner of their data.
- It makes use of technologies like NFTs to give the user ownership of their digital asset or property.
- User will have control over Ads.

05 Content Generation

- Digital Twins
- AI

Digital Twins

- According to the physical world, a digital twin will be created With a digital copy of the physical environment as a "many" virtual world.

- Human users with avatars are working on new creations in such a virtual world. As digital natives.

- IBM’s definition:
  “A digital twin is a virtual representation of an object or system that spans its lifecycle, is updated from real-time data, and uses simulation, machine learning ,and reasoning to help decision-making.”

- Digital Twin Platforms like Azure Digital Twin take input from IoT devices.

AI

- Artificial intelligence (AI):

theories + techniques + algorithms -> develop automatic digital twins

- A digital twin is a digital clone with a high degree of integrity and awareness of a physical entity or system that continues to interact with the physical world.

- These digital clones can be used to provide physical entity classification, recognition, prediction, and decision services.

- AI can automatically extract knowledge from large amounts of advanced data and express it in different types of applications without the need for manual feature engineering.

APPLICATIONS OF METAVERSE

FUTURISTIC BLOCKCHAIN APPLICATIONS

- Blockchain is the technology behind bitcoin, ethereum, and other digital currencies, as well as non-fungible tokens (NFTs) and blockchain games.
- These technologies have the potential to be the building elements of a metaverse, to develop viable, scalable, and long-term virtual economy that does not require the usage of fiat money such as currencies.
- A highly advanced combination of barter systems and blockchain-based technology can be a catalyst for expanding and empowering the metaverse and establishing a parallel Universe that forever expands into new horizons.

REVOLUTIONALIZED ONLINE EDUCATION

- Online education has grown more mainstream as a result of the pandemic.
- Students can now create their own digital avatars and attend lessons in the metaverse as if they were in the real world, learning and grasping the knowledge from the lecturers with remarkable clarity and depth.
- Metaverse will ignite an immersive learning experience, powered by graphics-intensive virtual platforms and digital platforms for interacting, collaborating, and engaging with classmates in real-time, and also learning concepts practically and understanding theories, probably better than in real life.
- Online education will be revolutionised by metaverse, which will include three-dimensional learning tools, visible learning aids, and fast access to top academics and teachers.

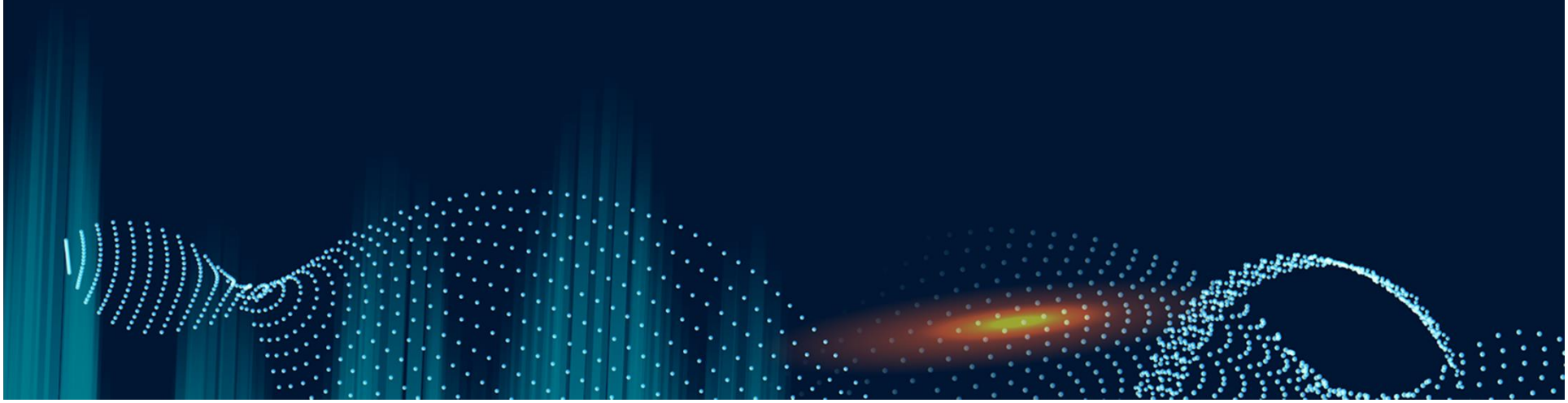
HEALTHCARE APPLICATIONS

- The use of augmented reality in the healthcare sector has a significant impact on the training and upgrading of future medical professionals' skills and knowledge.
- Surgical assistive tools, such as the Microsoft Hololens, are technologies that surgeons use to aid and speed up surgical processes. AR headsets are utilised to see vital real-time patient data such as heart rate, body temperature, blood pressure, and breathing rate, in addition to pre-operative images from CT, MRI, and 3D scans.
- Augmented reality is currently being used by nurses and physicians to increase vein detection.
- In the healthcare industry, visual-driven technology such as X-rays and CT scans are prominent. They help medical professionals detect, diagnose, and treat patients by allowing them to peek inside their bodies.

MILITARY APPLICATIONS

- Military applications of AR and VR have also witnessed significant advancements. Tactical Augmented Reality (TAR) is a technology that looks like night-vision goggles (NVG) but has a lot more features.
- It shows the specific location of a soldier as well as the positions of allied and hostile forces. The system, like the goggles, is affixed to the helmet and can be worn at any time of day or night. As a result, TAR essentially replaces the traditional handheld GPS device as well as eyeglasses.
- Furthermore, Synthetic Training Environment is an augmented reality system developed to give soldiers a more realistic training experience by immersing them in physically and psychologically challenging combat scenarios.
- One of the main goals of the STE developers is to develop a training option that will allow commanders to construct adaptive troops with a higher level of preparedness.

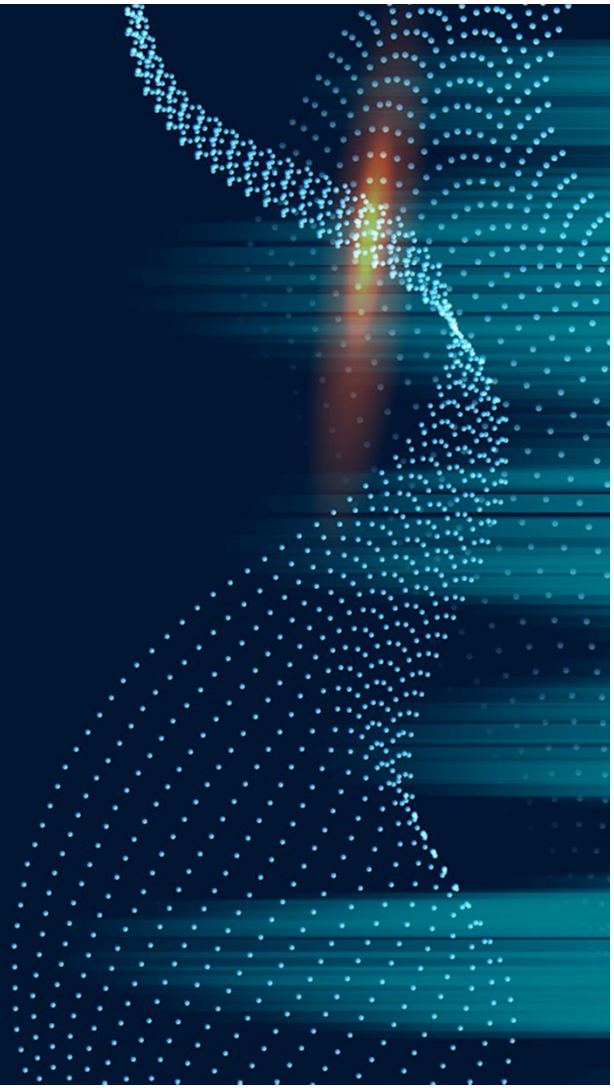
Metaverse Platforms



DECENTRALAND

- This means the platform is completely decentralised, making it an excellent choice for anyone with a basic understanding of crypto and augmented reality who wants to explore the Metaverse virtual world.

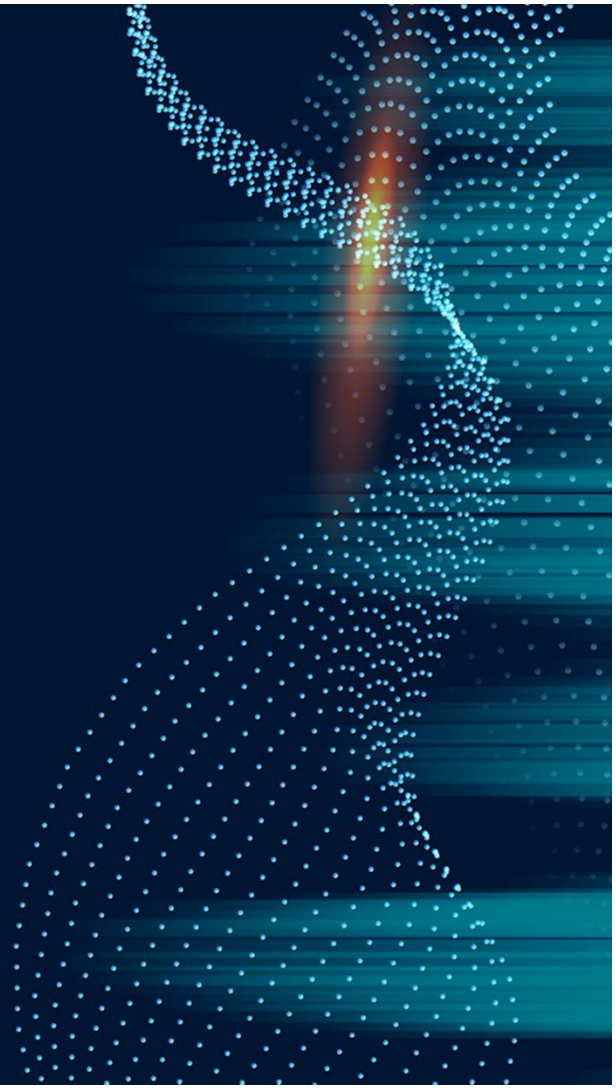
- It's a one-of-a-kind platform that lets users produce, exchange, and monetize digital content and virtual real estate properties.



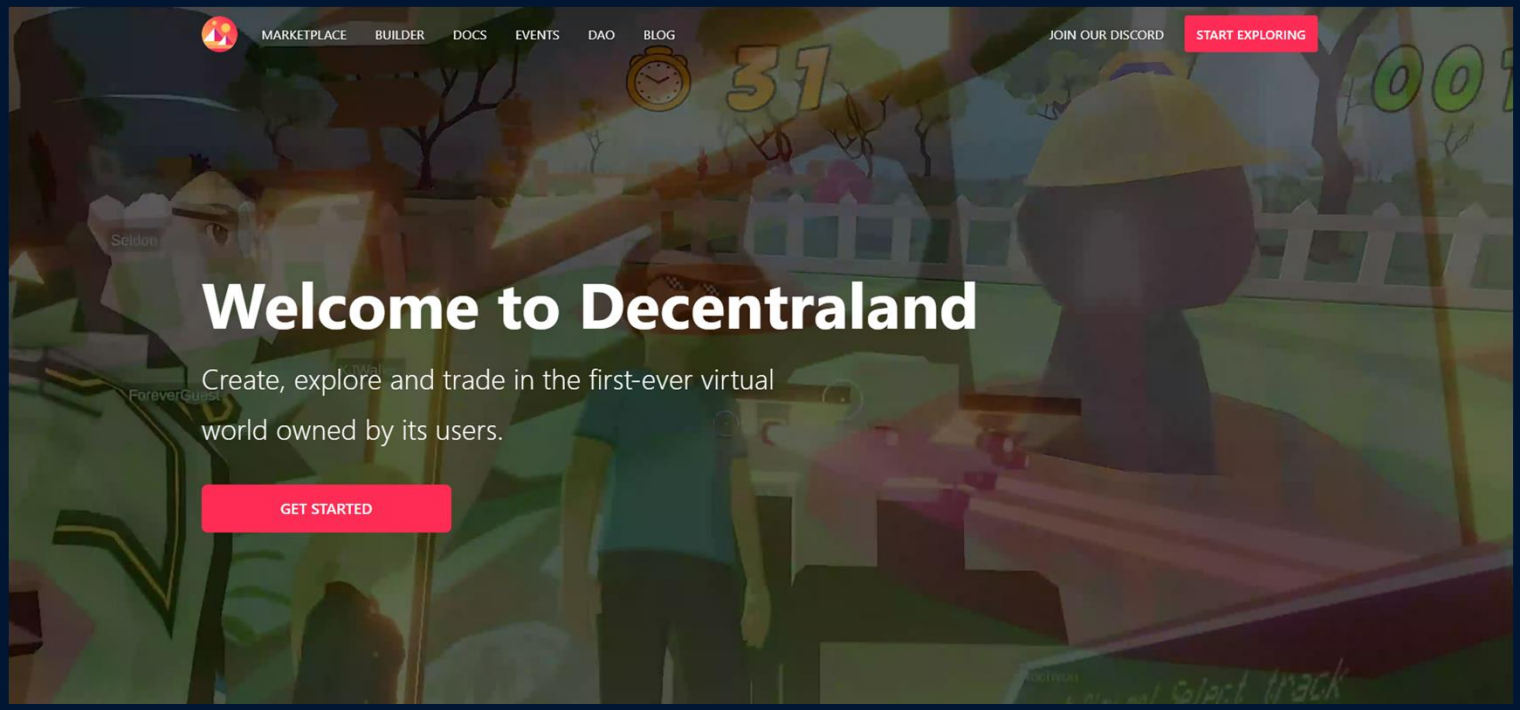
DECENTRALAND Infrastructure

The protocol has a three-layer infrastructure:

- Consensus Layer: This layer tracks the ownership of LAND via an Ethereum smart contract.
- Land Content Layer: It uses a decentralized module to download the virtual assets for the owners.
- Real-time Layer

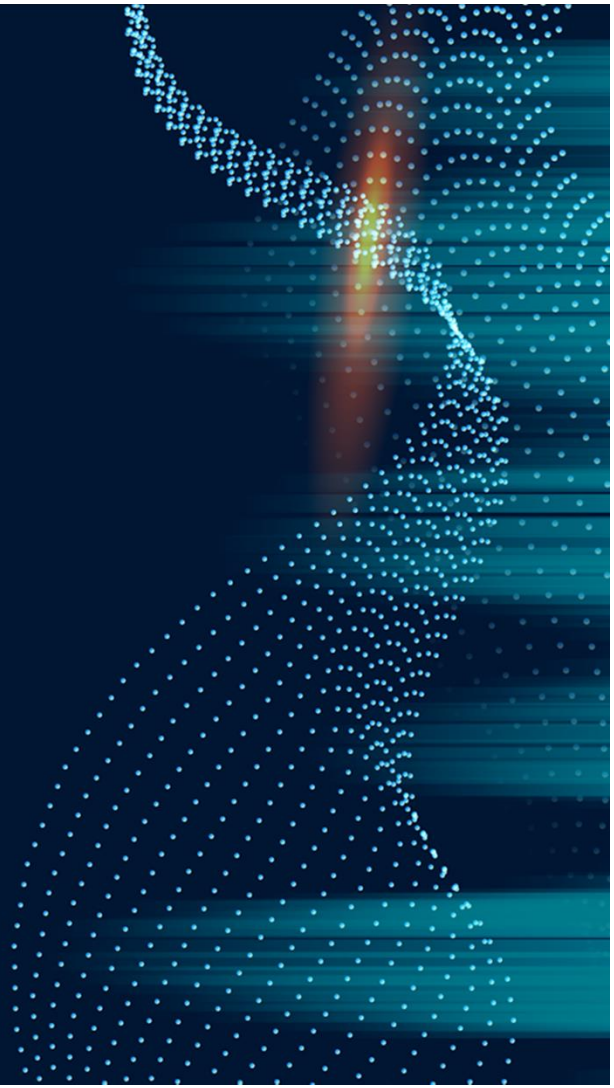


- Platform: https://decentraland.org/



How does it work?

- Marketplace: Sell land, estates, and one-of-a-kind names, as well as wearables. You have complete control over the offer's pricing and expiration date.
- Purchase tracts and estates, as well as wearables and one-of-a-kind names. Discover who owns what, what wearables are available, and whose names have been claimed using a map. Give your plots and estates a name and a description that the public can see.



LAND

- Decentraland is made up of LAND, an Ethereum-based non-fungible token.
- LAND is divided into parcels, each of which is distinguished by its x,y cartesian coordinates. Each LAND token contains information on the land's location and owner, as well as a link to a content description file or parcel manifest that explains and encodes the stuff that the land's owner wishes to distribute.

AVTAR

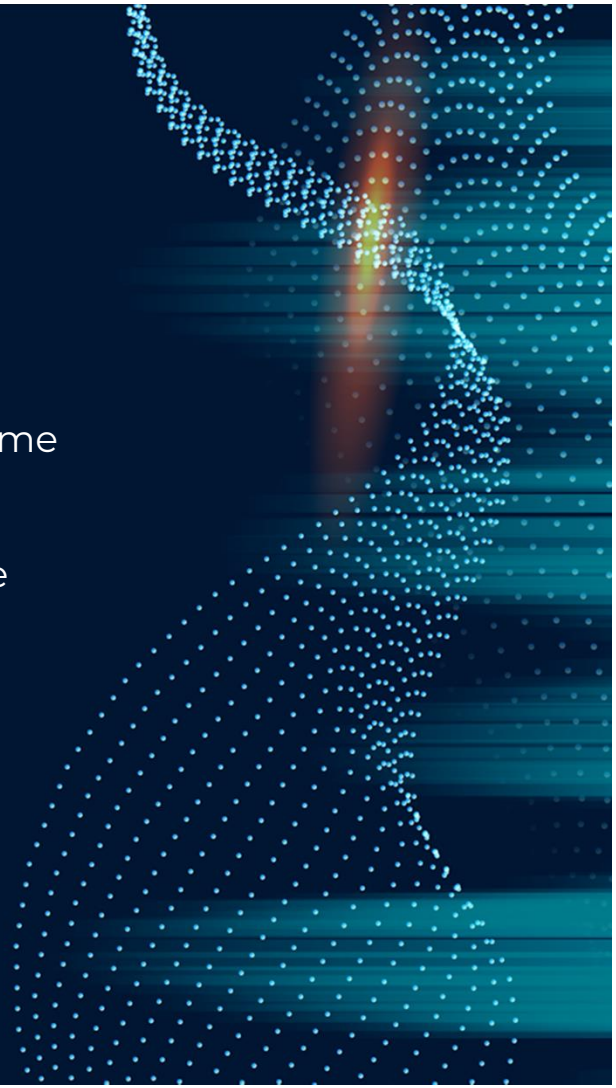
- A Decentraland avatar is a fully customized figure that acts as your virtual representation.
- Having an avatar is essentially the same as creating a username/account on a website.

SCENES

- The type of content you deliver to your LAND is
- referred to as a scene.
- A scene is a dynamic program that generates content, such as a game, an interactive experience, or an exhibition.
- Decentraland's virtual LAND is where scenes are installed.

NAMES

- Decentraland names are ERC721 coins that may be traded and are fully integrated into the Ethereum Name System (ENS).
- Users can send and receive tokens across memorable addresses like 'anirudh.dcl.eth' using these distinct human-readable names.



SandBox

- The Sandbox is the third-largest Ethereum blockchain-based metaverse. It enables users to build, share, and monetize assets (such as real estate) as well as game experiences.

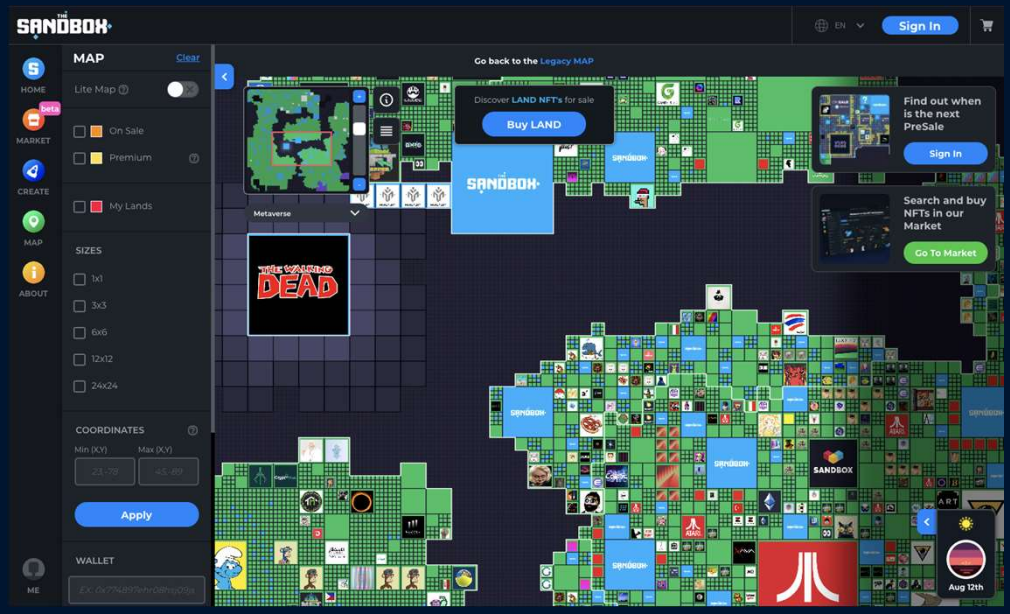
- In the virtual world, people can own assets, play, develop, and own their properties and in-game assets. Furthermore, people can sell such assets for real-world money.

- While The Sandbox is far from the only metaverse service provider, it stands out for the breadth of its product offering. It consists of three products that offer gamers a complete gaming experience:

- **VoxEdit**
- **The Sandbox Game Market**
- **The Sandbox Marketplace**

- Platform: https://www.sandbox.game/en/login/?r=BRfi9bS3OdLtnIW5wetMY

Map Features:



Filtered Searching:

- A multitude of filters are available on the map's left side to assist you in locating specific LANDs or locations.
- Filter for LANDs that are currently available for purchase.
- Only premium LANDs will be displayed. When used with the "On Sale" filter, only premium LANDS for sale will be displayed.
- My Lands: Displays your metaverse LANDs.
- Filter LANDs by their size.
- Filter LANDs between a set of coordinates using coordinates.
- If you know the wallet address, you can use it to filter the LANDs held by that wallet.
- Partners: Our network of collaborators continues to grow! To filter their LANDs, select any partner.

Lite Map:

- On the map, on the left toolbar, there is also a "light mode." This setting hides all small graphics on the map, which helps some devices and networks load faster. If this option is enabled, images will only load based on the zoom level. To notice the changes, switch between the gallery tabs below.

Mini Map:

- A smaller, mini-map can be found in the top-left corner of the map. This can be used to guide you through the larger map. You can also utilise the drop-down box below it to jump to a specific location on the map, such as the area featured in The Walking Dead's LAND auction.

Nvidia OmniVerse Platform

- Based on Pixar's Universal Scene Description and NVIDIA RTXTM technology, NVIDIA OmniverseTM is a scalable, multi-GPU real-time reference development platform.
- Used for 3D simulation and design collaboration.
- With a modular programming architecture, NVIDIA Omniverse is created from the ground up to be easily expandable and customized. While end-users and content creators use the Omniverse platform to connect and expedite existing 3D processes, developers may easily construct new tools and services.

FEATURES

- Connects to industry-leading 3D design tools
- Unlimited multi-app collaboration
- Multi-user collaboration for more than 2 users.
- Scalable, real-time RTX rendering
- Tested & optimized for NVIDIA-Certified Systems
- Physically-accurate simulation with PhysX 5.0, Blast, Flow
- Enterprise Security Management(SSO,SSL)

Why is it Used?

- Develop Quality Tools, Faster than Ever

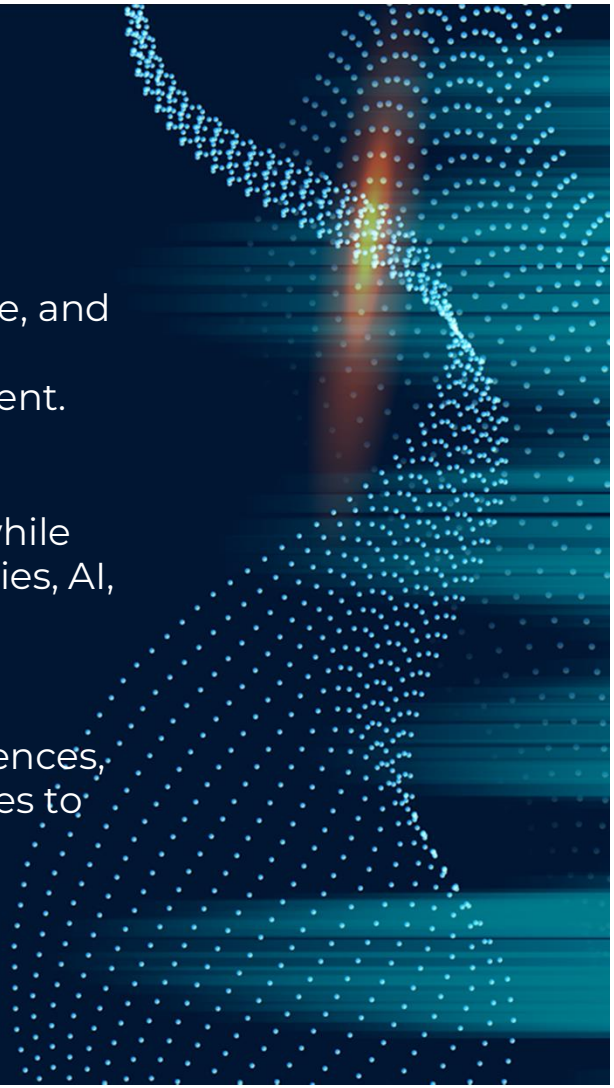
Monolithic development is replaced by a modular, extensible, and flexible platform so one can produce rapidly, efficiently, and sustainably with Python-based low- and no-code development.

- Build More Advanced Technology with Minimal Effort

Building on the Omniverse platform saves time and effort while leveraging over 20 years of key NVIDIA rendering technologies, AI, and simulation SDKs.

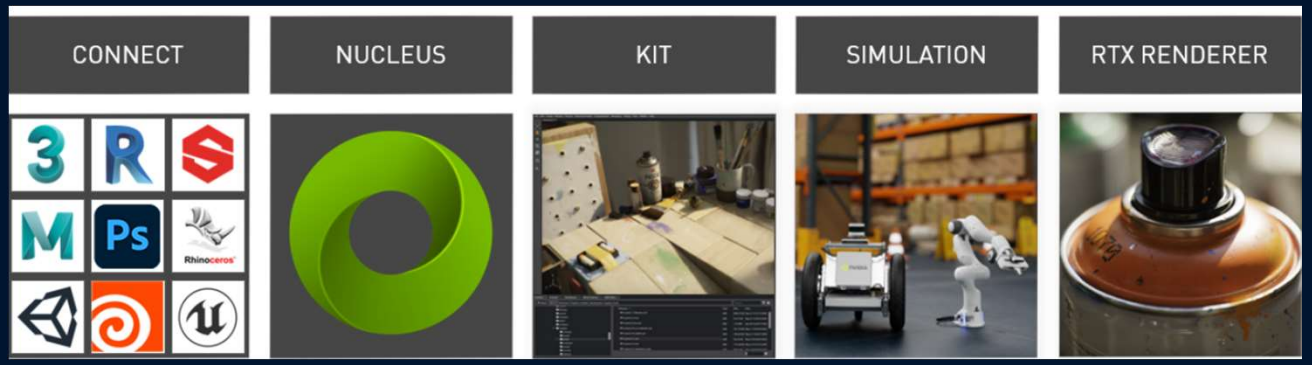
- Connect to New Markets, Expand Your Audiences

Take advantage of NVIDIA's reach across all industries, audiences, and workflows and gain access to new markets and use cases to grow your user base.



Components

- Omniverse consists of 5 key parts:
  1-Nucleus
  2-Connect
  3-Kit
  4-Simulation
  5-RTX Renderer



- These components, along with interoperable third-party digital content creation (DCC) tools and renderers - and third-party and NVIDIA-built extensions, apps, and microservices make up the full Omniverse ecosystem.

Nucleus:

- The Omniverse platform's database and collaboration engine is called Nucleus.
- It enables a wide range of client apps, renderers, and microservices to exchange and modify virtual world representations.
- Nucleus works on a publish/subscribe basis.
- Omniverse clients can either publish or subscribe to updates to digital assets and virtual environments that are transferred in real time between apps via bi-directional Omniverse Connectors.

Connect:

- Asset libraries and DCC tools can be connected to Omniverse in a variety of methods, each with differing degrees of fidelity.
- The highest fidelity connections to Omniverse are provided by Omniverse Connectors—plugins that enable client applications to connect to Nucleus and publish and subscribe to individual assets and complete worlds
- The Omniverse Connect SDK, which is accessible for free in the Omniverse Launcher, allows developers to create their own Connectors.

Kit:

- Omniverse is meant to be extremely modular, unlike monolithic development platforms, for maximum flexibility and expansion.
- Developers can use Omniverse Kit to create their own extensions, apps, microservices, or plugins for their ecosystem.

Simulation:

- Developers can use the Omniverse platform to leverage NVIDIA's scalable, physically realistic world simulation, which is driven by the company's core physics simulation capabilities.
- Developers can take advantage of and incorporate key technologies such as NVIDIA PhysX, an advanced physics simulator that delivers high-performance rigid, deformable, and vehicle dynamics.

RTX Renderer:

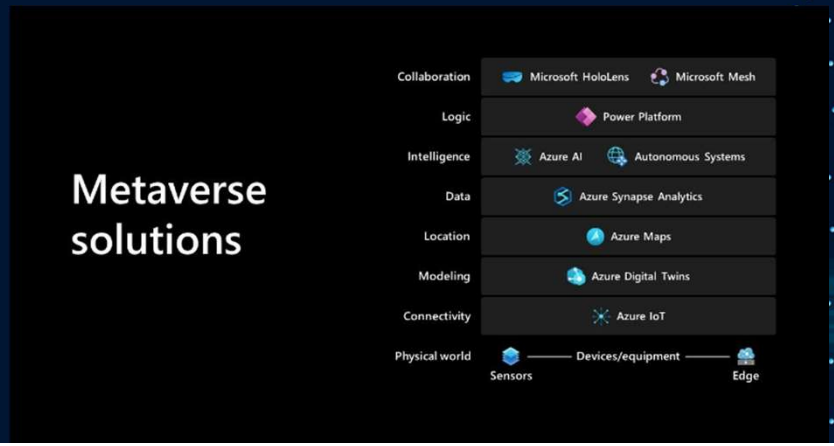
- The platform comes pre-installed with renderers that follow Pixar's Hydra architecture.
- Omniverse also has a multi-GPU scalable renderer that uses RTX technology to speed it.
- End users can choose between real-time ray tracing for ultra-fast interactive performance and referenced path tracing for final-frame cinematic quality with ease.

Omniverse Extensions:

- Omniverse Extensions are small pieces of code purpose-built to achieve a specific task.
- Extensions are authored in Python, enabling developers of any level to build or customize their own extensions.
- Explore an extract of the extensions available in the Omniverse platform below to see what is possible.
    - Core Extensions
    - AI Toy Box Extensions
    - HDR Light Studio
    - Replica Studios

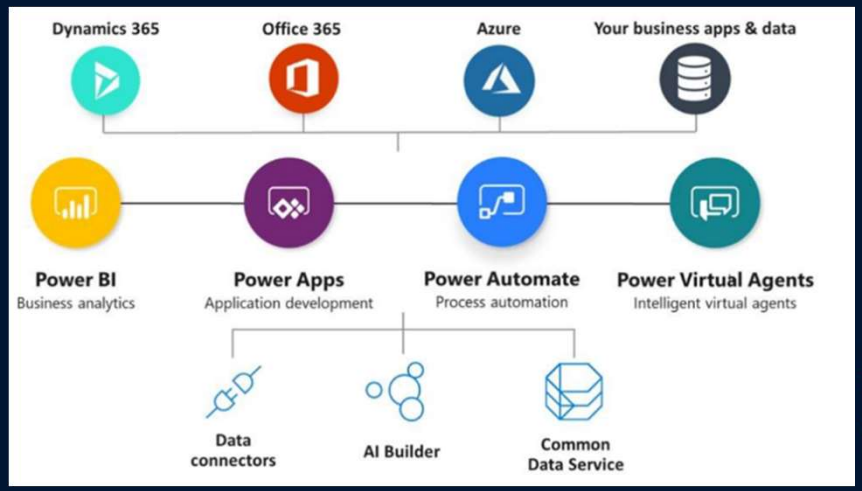
MICROSOFT METAVERSE STACK

- Microsoft Mesh and Holo Lens:
  - HoloLens together with Microsoft Mesh enables anyone across the globe to collaborate.
  - in a mixed reality environment. Even other Mesh enabled devices such as PC, Mobiles and VR.
  - headsets can also be used to connect and collaborate with each other virtually.



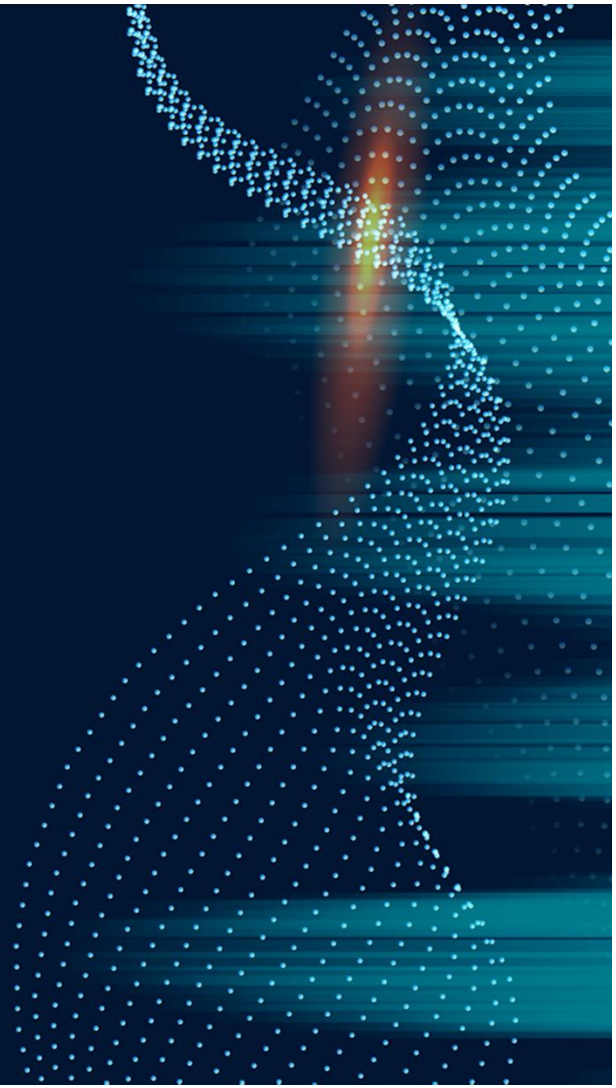
Power Platform

- It is a low code platform, meaning that it allows for development of applications with minimal or no coding required.
- It can be used to build applications, dashboards and chatbots as well.
- It provides different Microsoft services as shown in a picture below.



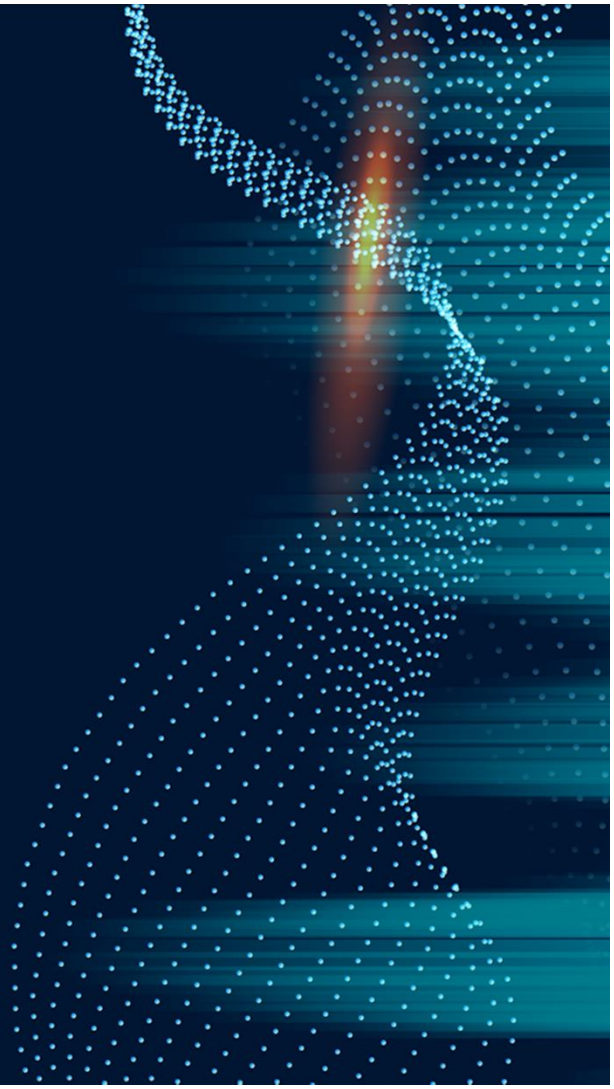
Azure AI and Autonomous Systems

- It consists of project bonsai which is a low-code solution for AI and Machine learning development.
- With the help of autonomous systems, provide solutions that adapt to changing environments, handle complex processes, and build solutions that combine human and machine intelligence.



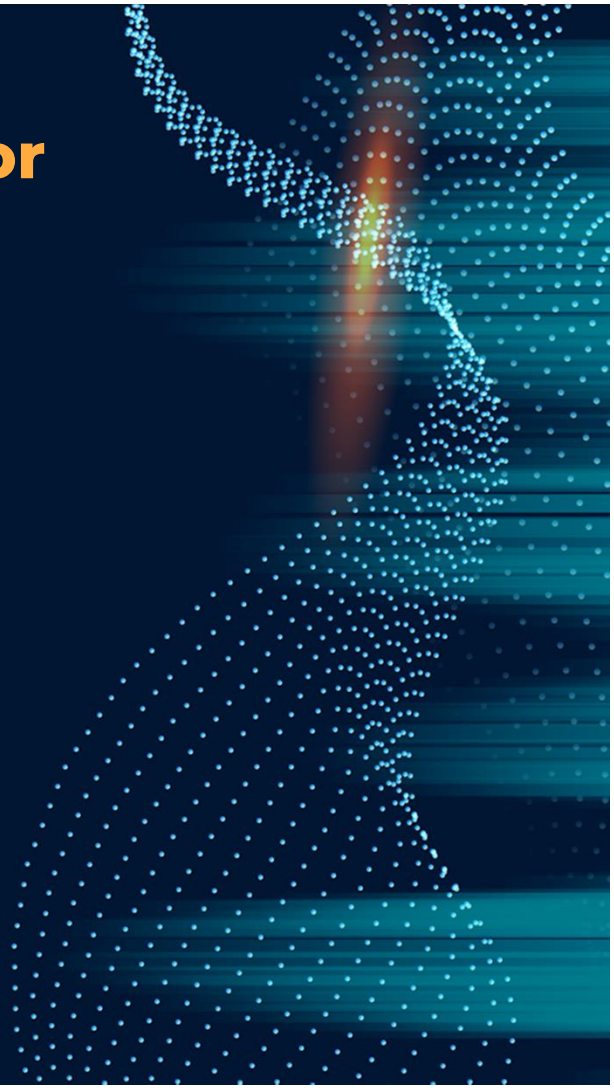
Azure Synapse Analytics

- Azure Synapse Analytics is a borderless analytics service that integrates data integration, enterprise data warehousing, and big data analytics.
- You are free to query data about terms with serverless or dedicated options on a large scale.
- Azure Synapse combines these worlds with an integrated experience to capture, explore, prepare, transform, manage, and deliver data to meet the immediate needs of Business Intelligence and machine learning.



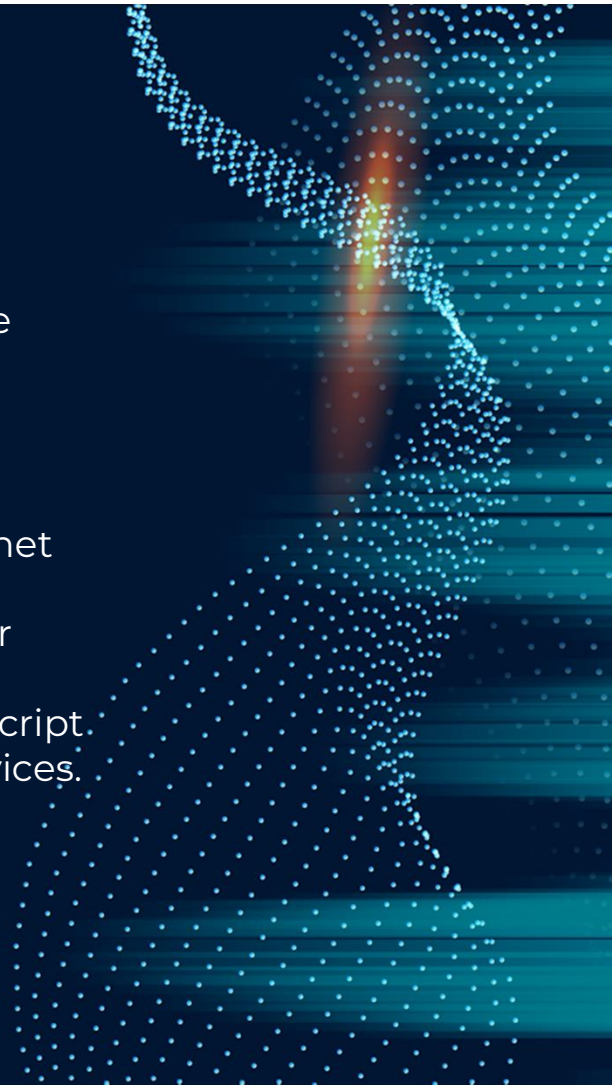
Choice of languages Provided for database management:

- T-SQL
- KQL
- Python
- Scala
- Spark SQL
- Net



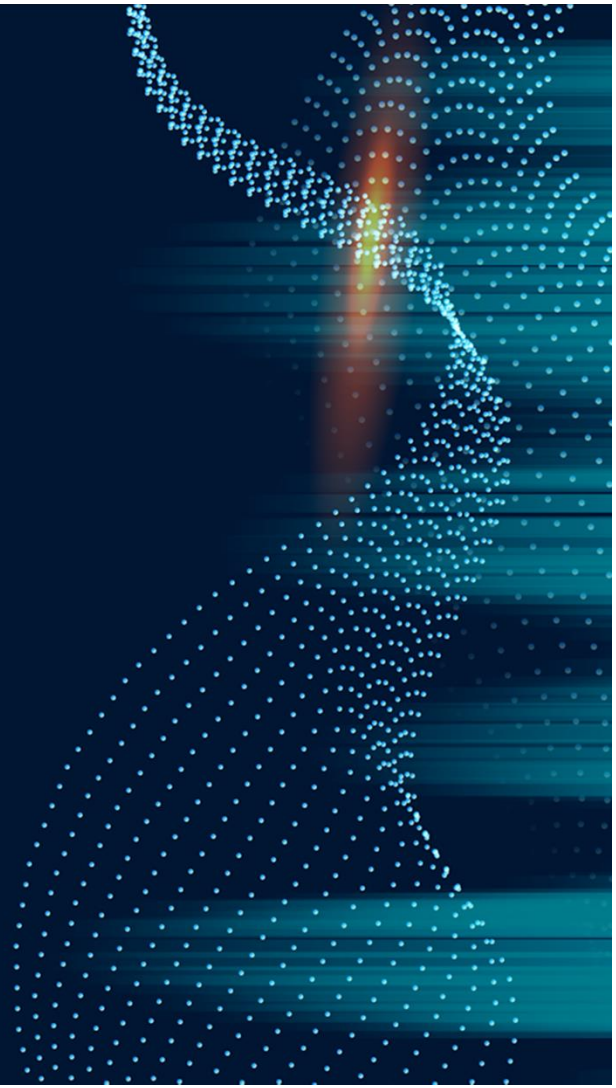
Azure Maps

- Provides secure Geospatial services, APIs and SDKs in Azure to help develop location - aware web and mobile applications.
- The Azure Maps Web SDK helps you to customize interactive maps together with your personal content material and imagery.
- You can use this interactive map for each of your internet or cell applications.
- The map manager uses WebGL, so that you can render huge factories with excessive performance. You can increase with the SDK via means of the usage of JavaScript or TypeScript.Also, provides Azure Maps REST APIsServices.



Azure Digital Twins

- Azure Digital Twins is an Internet of Things (IoT) platform that allows you to create digital representations of real things, places, business processes, and people.
- Supports Digital twins definition language (DTDL).

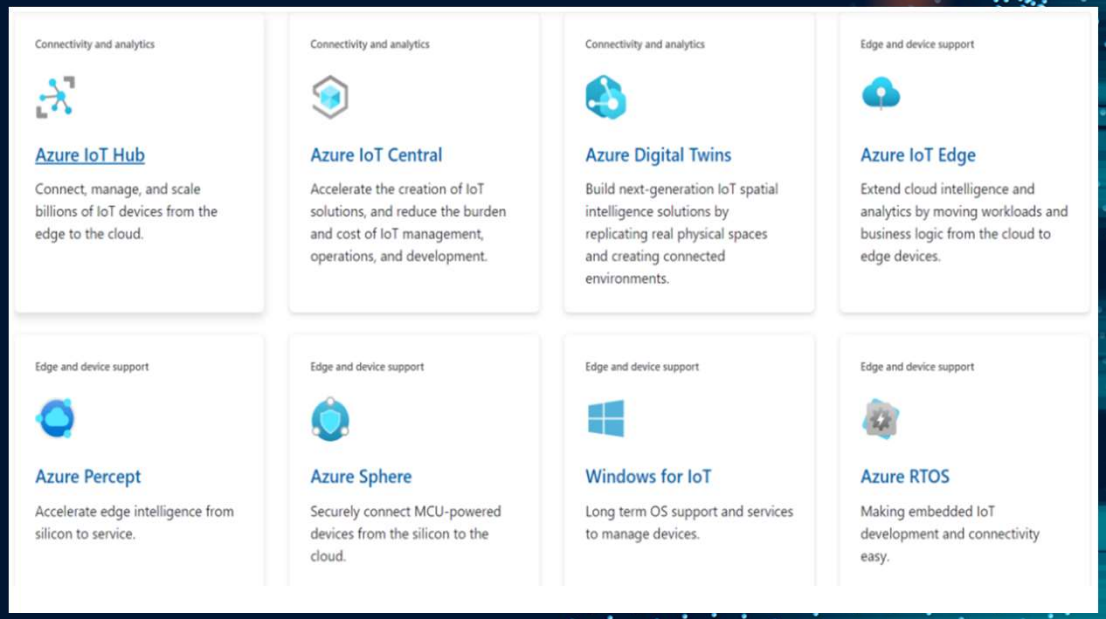


What is DTDL?

- DTDL is a flexible language that covers all industries or model types. This is a solution for modeling complex relationships in the built world.
- Create a neural network type data structure.
- This allows digital twins to take advantage of higher levels of analysis and machine learning to perform complex calculations.
- Azure Digital Twins takes Input from IoT and business systems to connect assets, including IoT devices, using Azure IoT Hub, Logic Apps, and REST APIs.
- After processing it outputs the twin changes to Azure Data Explorer, Azure Synapse Analytics, Event Hubs and other downstream services

What is DTDL?

- It can connect physical assets and run cloud intelligence on premises.
- Sense and monitor your physical environment using edge to cloud technologies.
- Services:
  - Azure IOT hub
  - Azure IOT Central
  - Azure Digital Twins
  - Azure IOT edge
  - Azure Percept
  - Azure Sphere
  - Azure RTOS




Thank You