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AIOZ Ple Ltd

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Decentralized Video Streaming Network

https://aioz.network/

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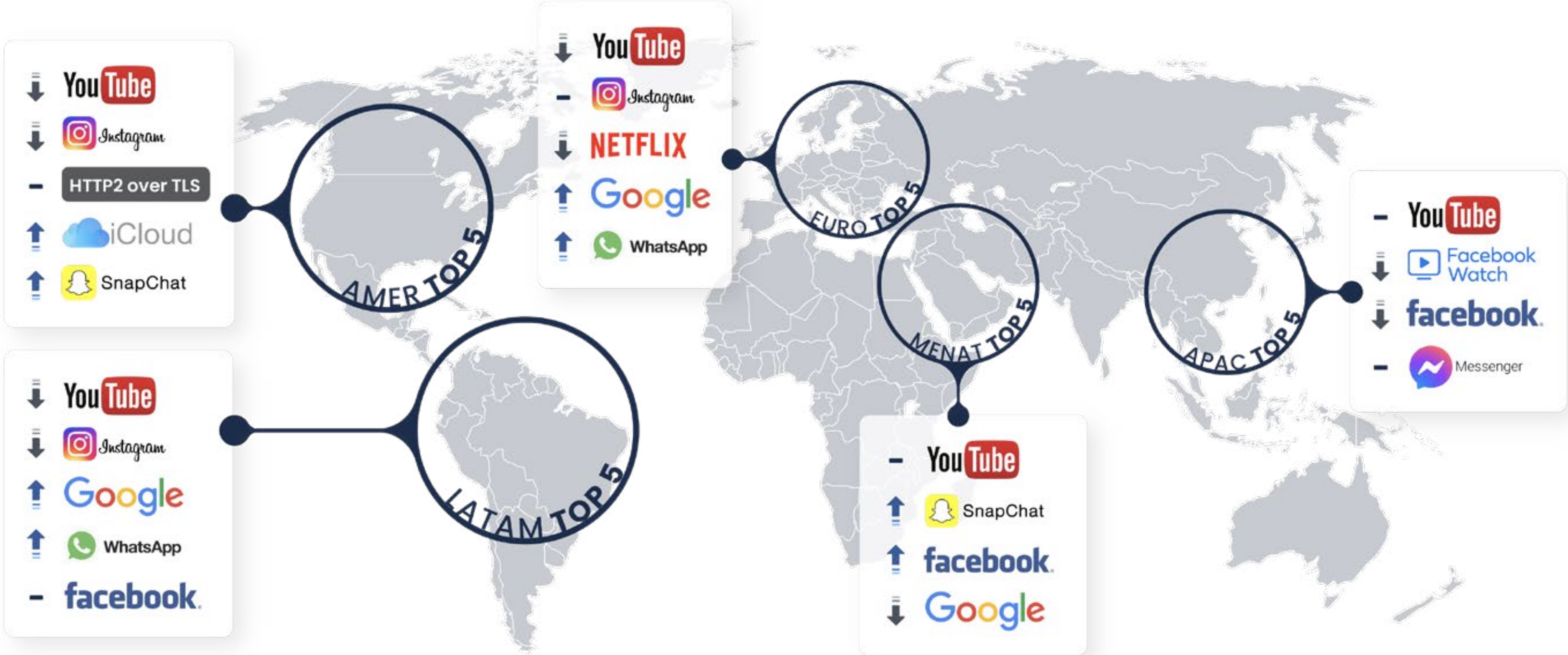
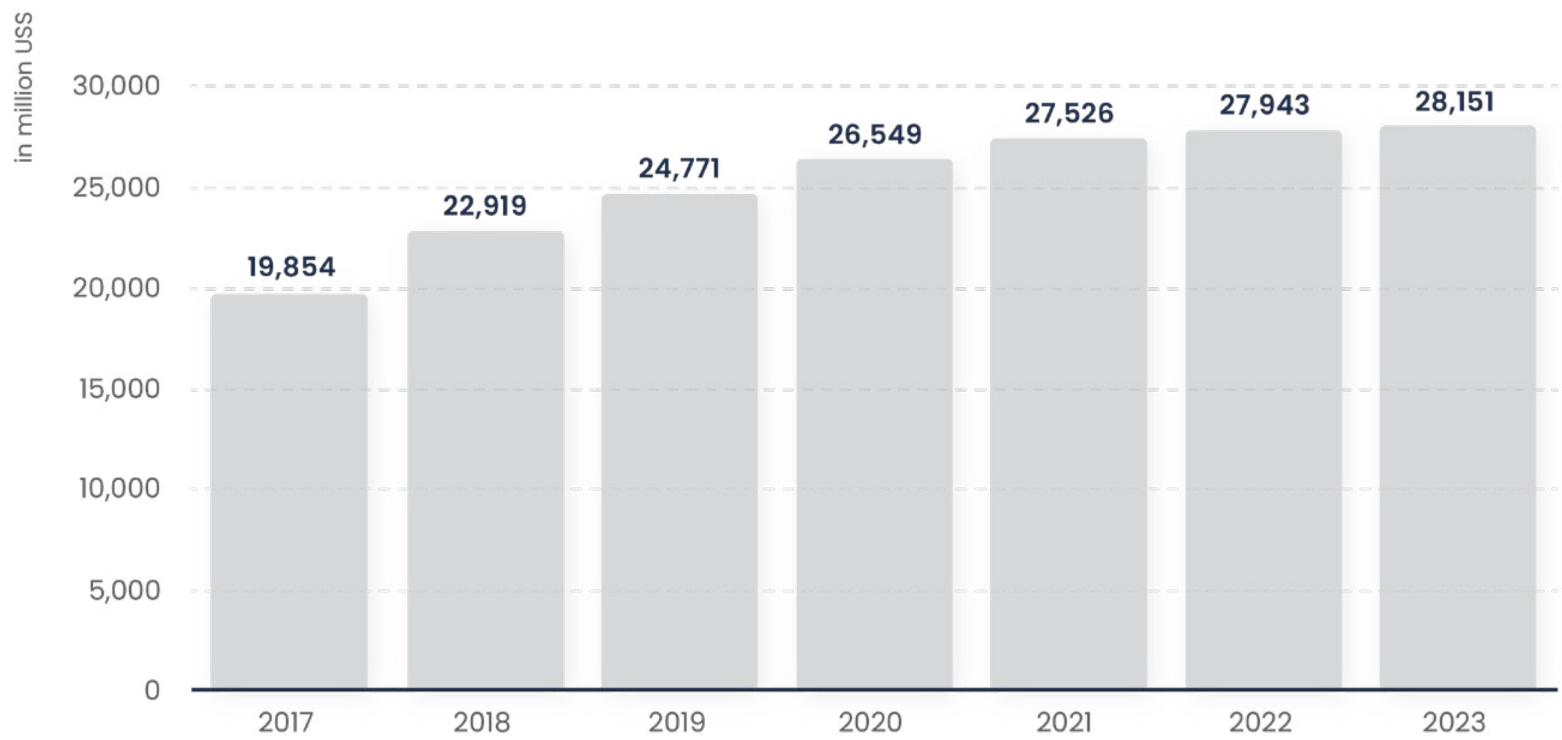
VIDEO STREAMING AND ITS DEVELOPMENT

In today's technological era, streaming, which is deemed an outstanding innovative technology, has become a norm to almost all people worldwide, both professionally and personally. For those who are confused with what 'streaming' really is, it is simply the activity of listening to or watching sounds or video directly from the Internet. Thanks to the streaming revolution, people can gain access to numerous online resources for entertaining at any time and from anywhere, with any devices as long as they have an Internet connection. Moreover, streaming technology enables people to overcome barriers in terms of geographical distance to build more connections as well as to widen their horizons.

Chronologically, it is the music industry that streaming started with, then it has been transferring to movies, technologies and video games and, in the near future, VR and AR would be the following items. At the present time, 'video streaming' is the most popular area after witnessing a phenomenal growth in recent years.

It is true that video streaming technology has nearly beaten obsolete broadcasting technologies such as cable and satellite because it offers viewers more significant benefits compared to traditional broadcasting services. For instance: video streaming provides people with a more diverse source of content; video streaming could be conducted on any electronic devices; we could enjoy high-quality videos whenever we want by streaming, and most importantly, through video streaming, anyone of us could become a content creator and earn more income. As per the '2019 Global Internet Phenomena Report', video streaming accounts for the highest percentage of total global internet traffic, with the figures for 2018 and 2019 were 57.7% and 60.6%, respectively. According to the latest statistics, video is forecasted to account for 82% of total internet traffic by 2022. Meanwhile, revenue obtained from video streaming witnessed a continuous increase from 2017 to 2020 and is expected to reach US$28,1 billion by 2023.





Such rapid development of the video streaming market has led to an increase in the number of video streaming services. So far, a plurality of the available video streaming platforms, including the most popular ones such as Youtube, Netflix, Hulu, Twitch, are supported by only three predominant centralized content delivery networks* (CDN), which are CloudFlare, Amazon Web Services, Akamai. This imbalance makes the global demand for CDNs has risen exponentially within recent years.

CDN is a highly-distributed platform of servers of which purpose is to provide faster content delivery with minimal delays in loading web page content by reducing physical geographical obstacles between servers and users.

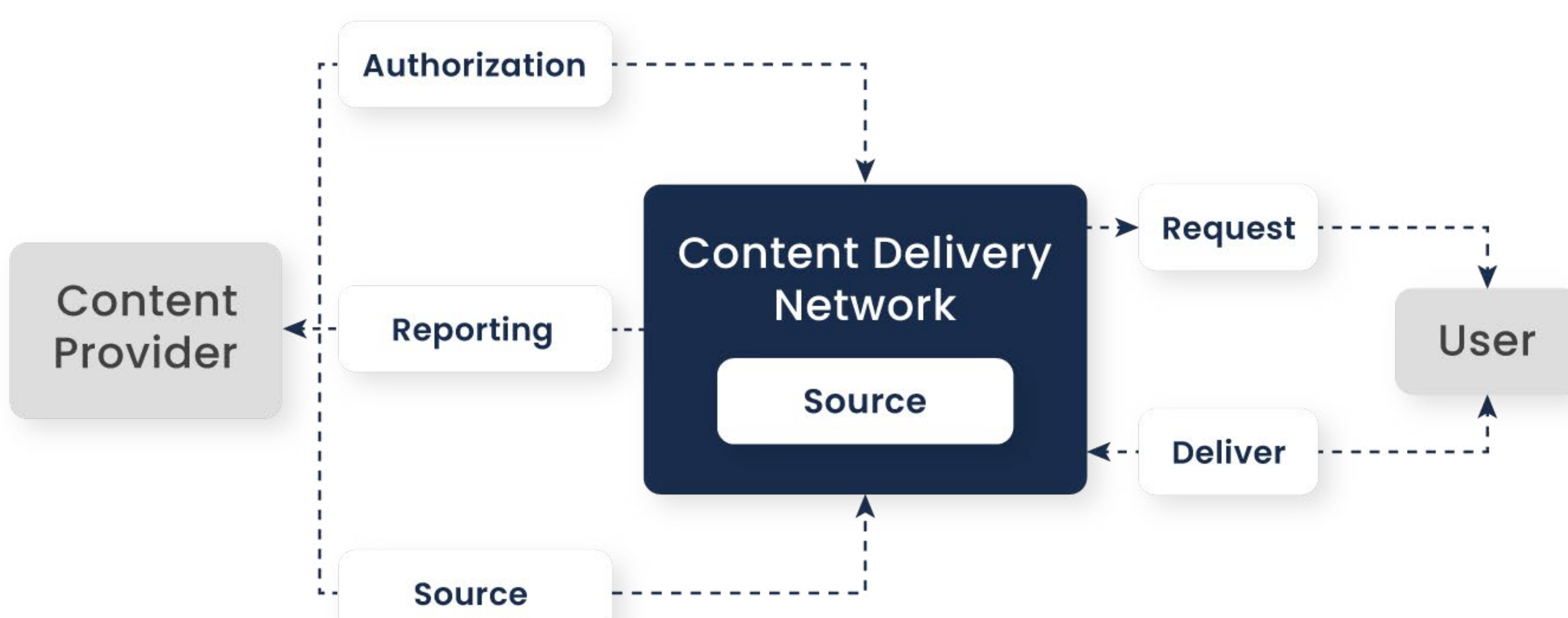


Figure. Model of a typical CDN

CENTRALIZED AND DECENTRALIZED NETWORKS

Centralized network is built around a single server which is called a 'Central server', and a number of less powerful workstations ('Client nodes') directly connecting to the Central server. In such systems, Client nodes will send their requests to the Central server (the place performs all the core processing) - and receive the response.

Decentralized network, on the other hand, is operated by several individual nodes without depending on a single central server. The final response is the total of the decisions of the individual nodes on processing requests.

Centralized

Decentralized

Up to the present, conventional centralized networks are the major systems supporting streaming services globally due to their consistency and efficiency. Nonetheless, within the context that more and more video streaming platforms have been launching (demand increases), while owing to tremendous expenses on construction, operating and maintenance, only a small number of prestigious corporations such as Amazon Web Services, Microsoft and Google Cloud are wealthy enough to develop their own centralized network infrastructure (limited supply), the pros of centralized network systems have been progressively outweighed by cons. Main disadvantages of centralized network are as follows:

- **Centralized networks can be censored, controlled, or even shut down.**
  In more detail, if the only central server were attacked by hackers, enterprises or governments AND/OR if client nodes lose connectivity due to some unique technical errors, abrupt failure of the entire system might take place.
- **Centralized networks have limited scaling possibilities.**
  It is because these types of networks operate with 100% dependence on the only master server. The only way to scale the network is to supplement the server with more CPU/GPU cycles for more processing power, more space for storage and more Internet bandwidth. Nevertheless, after a certain threshold, even if you increase the resources of the server node, the performance will not rise correspondingly. As a result, this is not a cost effective measure in the long run.
- **The operation around only a single master can soon result in a bottleneck effect**

especially within the context that the streaming services have been developing at a phenomenal rate. As a result, users' experience on these services could be negatively impacted (e.g. poor video quality, slow loading, buffering problem). Without a doubt, negative feedback from users is not what businesses expect

- **Centralized networks offer less possibility of data backup.**

  If the server node fails and there is no backup, data is lost straight away

- **Prices of services of centralized systems are high.**

  Consequently, it might take clients a long time to turn a profit as a majority of their revenue is paid to corporations that provide cloud services. In addition, the revenue of content creators/streamers would significantly reduce as well. A clear illustration for the main disadvantage in terms of high cost is Youtube - the most popular streaming platform at present.

Decentralized networks, by contrast, can fix all aforementioned issues and also offer a great deal of advantages over the traditional centralized network systems. Here are some benefits of decentralization:

- **There is no real single point of failure.**

  This is attributable to the fact that in decentralized networks, individual nodes work independently whereas there is no single 'Central server' to control and handle all processes. As a result, it is impossible to shut down the entire network.

- **Decentralized networks can be infinitely scaled.**

  The more individual nodes are added to the network, the more powerful the network would be because a lot of new connections would be established and the aggregate of resources including spare processor cycles, storage, Internet bandwidth would remarkably increase. Therefore, the probability that bottlenecks happen is extremely low.

- **Decentralized networks architecture offers higher privacy for users,**

  as all information is processed by a well-designed algorithm without the need to pass it to any third parties. This makes decentralized networks highly censorship-resistant and and more secure against cyberattacks.

- **More autonomy and control over resources.**

  As each node controls its own behavior, it will have better autonomy which leads to more control over resources.

- **Censorship is less likely to take place.**

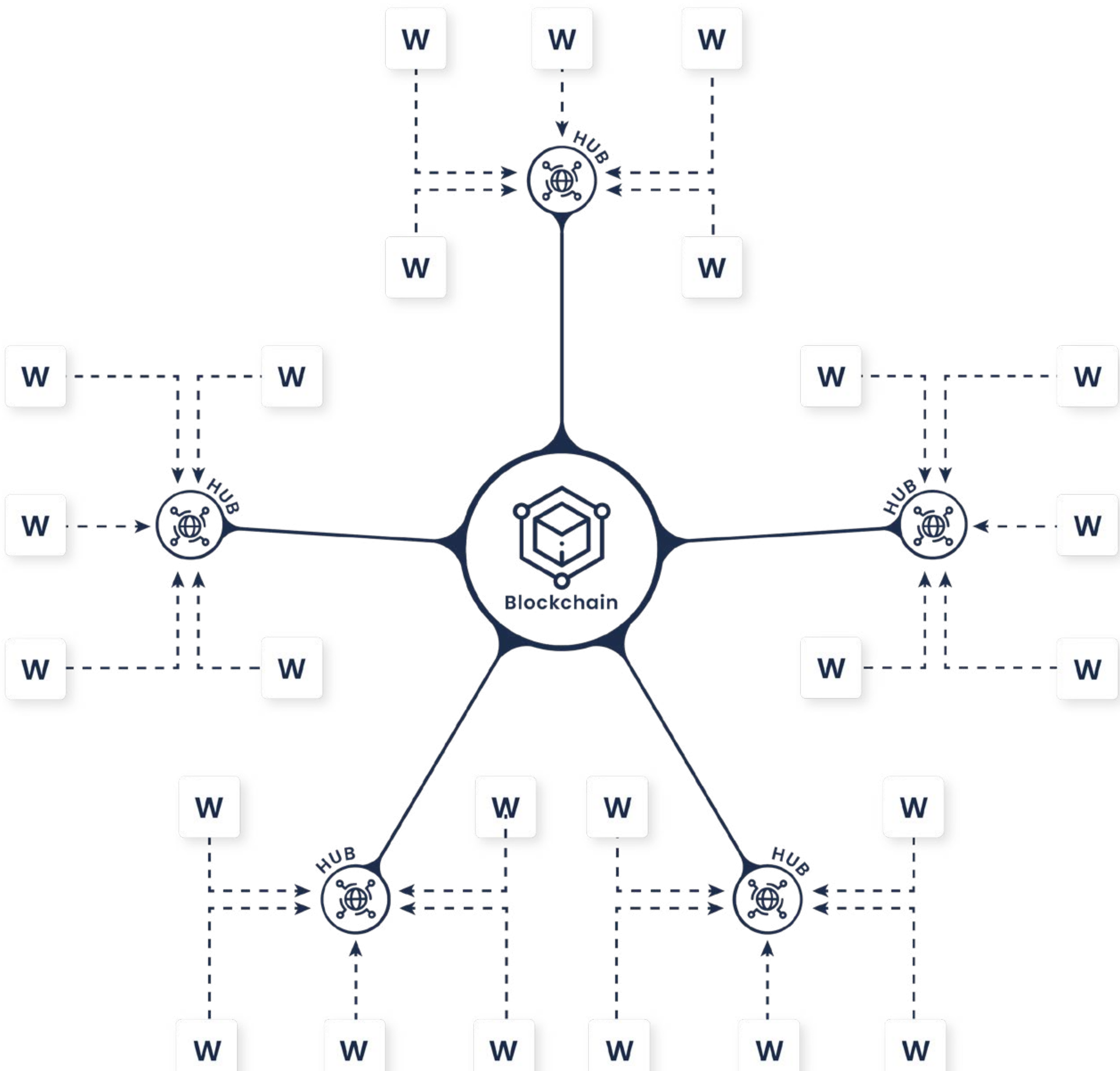
  It is more and more popular that governments shut down their citizens' access to social media sites due to some political reasons. All governments have to do is stop traffic going to the social media's central servers. By contrast, it is genuinely difficult for them to censor traffic on a peer to peer network, where every single outbound packet being sent could be communicating with another peer on the decentralized network, who can then forward that message along.

- **There is potential for network ownership alignment.**
  In decentralized networks, the people who contribute value will receive ownership or economic stake in the network, which becomes more valuable as the network grows.
- **Decentralized networks are more likely to be open development platforms.**
  This means that anyone can build their own tools, products, and services on top of decentralized networks. When more great products and tools are built, the networks will be rapidly widened, and thus business opportunities provided for individuals and companies will rise correspondingly.

Thanks to these various benefits, especially the cost advantage, decentralized networks have increasingly come to a lot of video streaming platforms/applications providers' knowledge. More and more video streaming platforms/applications have been developed and run on a decentralized peer-to-peer network instead of conventional centralized servers. Such platforms/applications are known as 'Decentralized Applications' or as 'DApps'. Currently, Dapps are still in their infancy, with more than 3000 Dapps built on Ethereum. Nevertheless, they are forecasted to grow exponentially, with the market size being projected to reach USD 21,070.2 million by the end of 2025 - as per a study carried out by the Blockchain Examiner. The growth of Dapps will definitely give rise to the expansion of decentralized networks in the future.

AIOZ NETWORK ARCHITECTURE

'AIOZ CDN' is a decentralized peer-to-peer CDN built from the connection of different nodes by a pre-designed protocol of AIOZ team. Nodes in AIOZ CDN are categorized into HUB Node (a.k.a Satellite Node) and Worker Node.



AIOZ NETWORK OVERVIEW

AIOZ Worker Node

Worker Nodes are individual nodes with redundant resources and thus, they want to share these resources in exchange for AIOZ tokens. The monetization process will be determined based on two facets including the level of contribution and their commitment to our protocol. Worker Nodes are allowed to choose whichever HUB Node possessing high credibility to work with, and notably, they can select as many HUB Nodes as they want to gain more income sources. However, if Worker Nodes are detected to be non-compliant with requirements listed in the contract by HUB Nodes, then based on the nature and levels of violation, their payments will be cut down partially/fully, or they can be permanently eliminated from AIOZ CDN.

By installing AIOZ Worker Node Software, any PCs and laptops can become Worker Nodes of AIOZ CDN. Worker Nodes can opt for more than one task to handle among transcoding, storing and delivering.

There are a lot of aspects that must be taken into consideration when selecting which worker nodes are suitable to store data, including: ping time, latency, throughput, bandwidth caps, sucient disk space, geographic location, uptime, history of responding accurately to audits, and so on. In addition, these nodes can be configured maximum allowed disk space and bandwidth usage by HUB Nodes. In particular, they will be monitored how much both of these resources remain whereas their invalid operations will be rejected.

– AIOZ HUB Node

In AIOZ CDN, there are plenty of nodes that hold the responsibility of controlling, assessing and monitoring other Worker Nodes to ensure the smooth operation over the entire network. They are called HUB Nodes.

The main tasks of HUB Nodes are to deal with Worker Nodes on the clients' behalf, randomly require Worker Nodes to provide Proof of Transcoding, Proof of Storage and Proof of Delivery in order to keep track of their compliance to contract's terms and conditions, reward Worker Nodes after finishing the tasks requested by clients, preserve data when the lack of resources takes place, store technical indexes of each Worker Node. Most importantly, HUB Nodes are simultaneously technical and video segment indexers who know exactly the locations of segments among a great deal of Worker Nodes as well as the information relating to the storage, bandwidth properties of Worker Nodes. To avoid duplication error, data controlled by one HUB Node will not be available in the remaining HUB Nodes, through multiple layers of ingress and egress are planned.

Each HUB Node contains these core items:

- A complete node discovery cache
- A system managing and authorizing account
- A system storing worker nodes' reputation, statistics, and audit records
- A service fixing data
- A service fulfilling payment

HUB Nodes are being developed and will be released as open software

AIOZ NETWORK OPERATION

In AIOZ CDN, three major redundant resources that Worker Nodes share in exchange for tokens are CPU and/or GPU process cycles, Hard drive space and Internet bandwidth, which are used for Transcoding, Storing and Delivering video content (AIOZ CDN's three main tasks), respectively.

- **Transcoding task:** Transferring the original video resolution into different profile resolutions. It is because different types of electronic devices have their own requirements in terms of codec, colorspace and resolution; and video content can only be consumed if video properties satisfy all three above requirements.
- **Storing task:** Storing video in different codecs, resolutions. Transcoded videos are then moved into storage to make room for other videos being encoded. As usual, videos uploaded on the Internet are encoded once and stored until there is a request from viewers.
- **Delivering task:** Delivering video segments (a.k.a chunks) to users as requested.

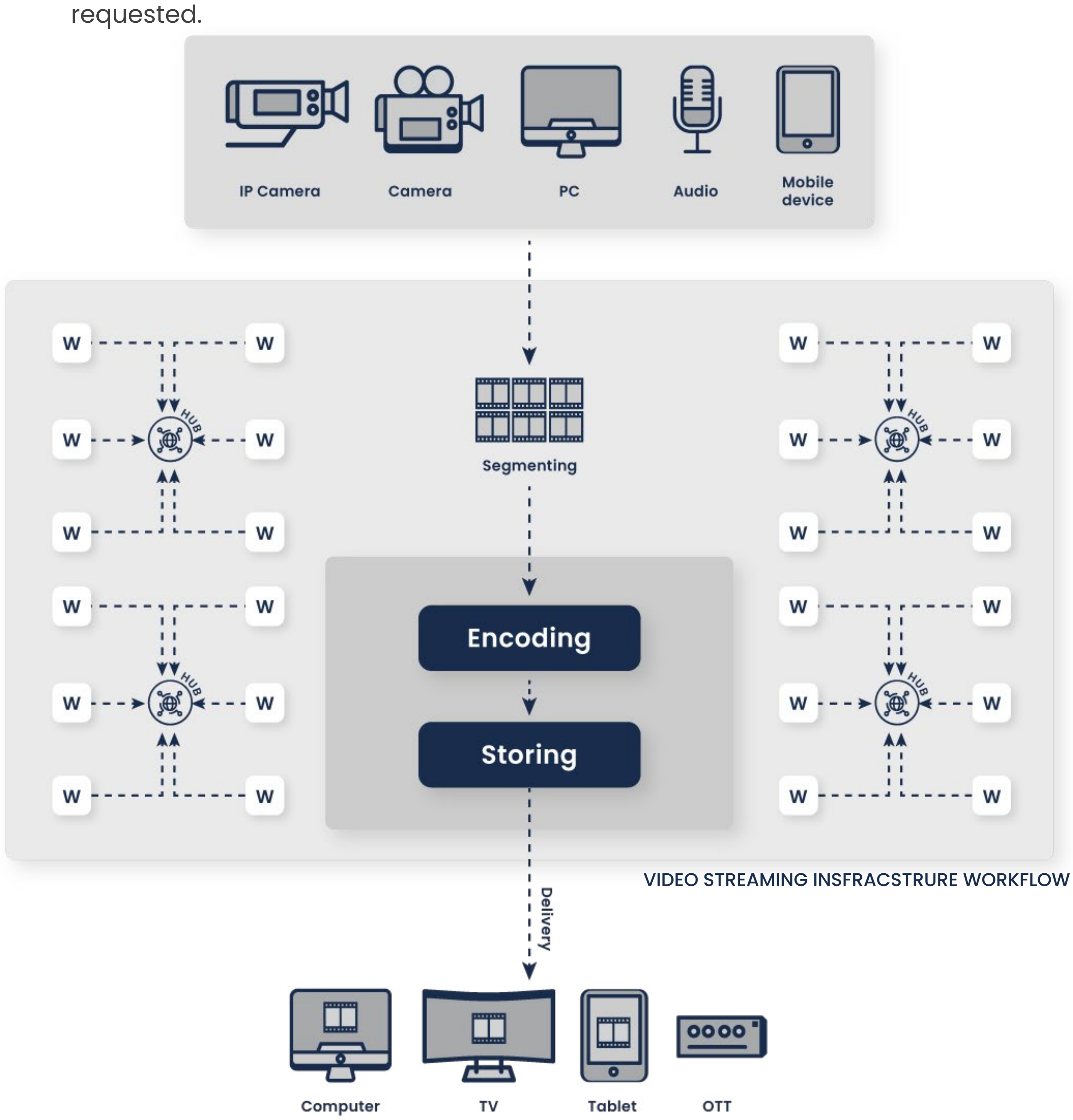
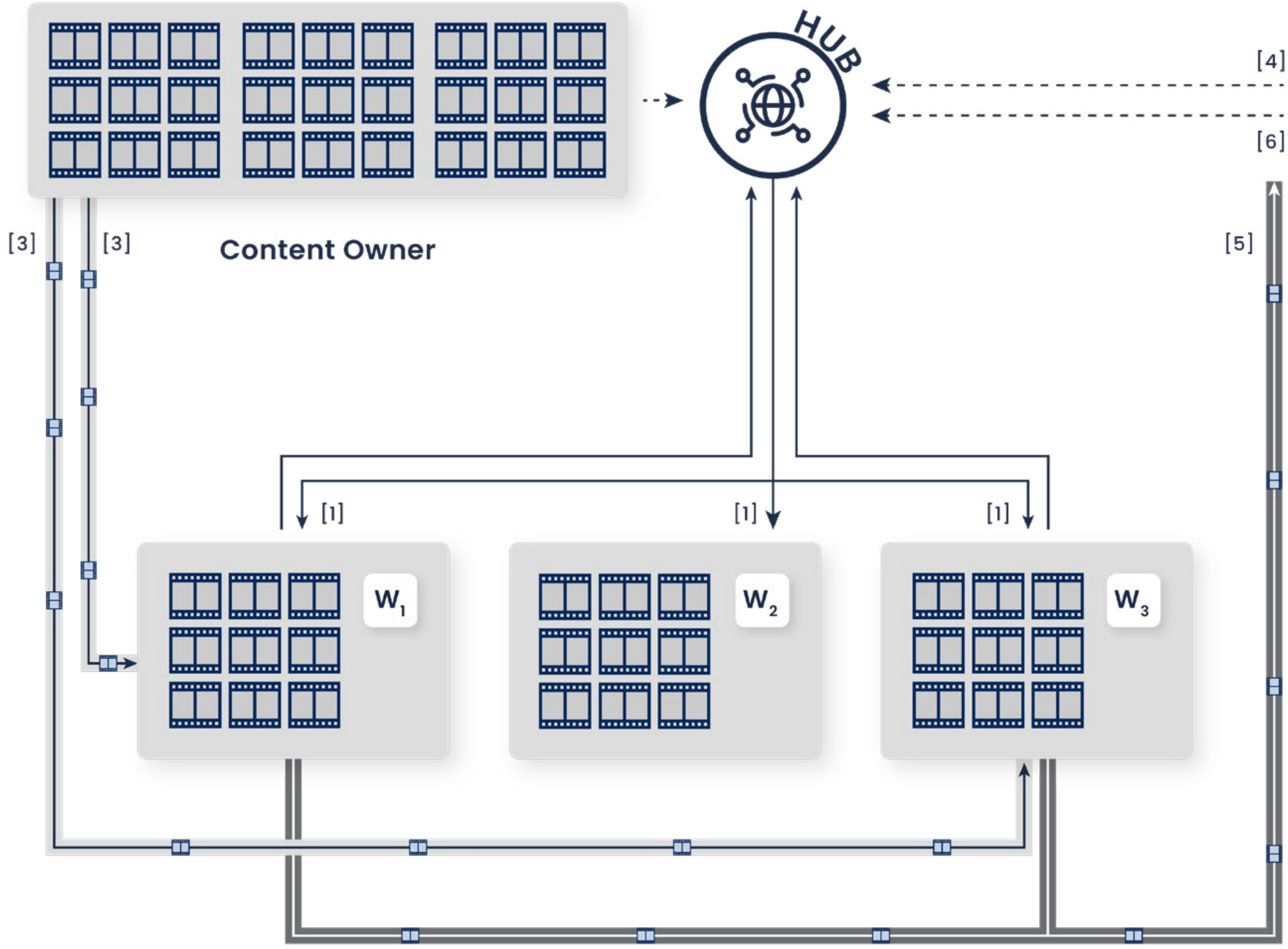


Figure. Overall workflow of AIOZ CDN



[1]. **HUB** Assign Storage Task for Workers
[2]. **Workers** approve & sign Storage Contract
[3]. **Content Owner** upload video segments to workers
[4]. **Viewers** request HUB for workers that storing video chunks
[5]. **Viewers** ask workers to deliver content
[3]. **Viewers** acknowledge delivery for HUB

The detailed operation procedure of AIOZ CDN for video streaming is shown in Figure. , which undergoes these following steps:

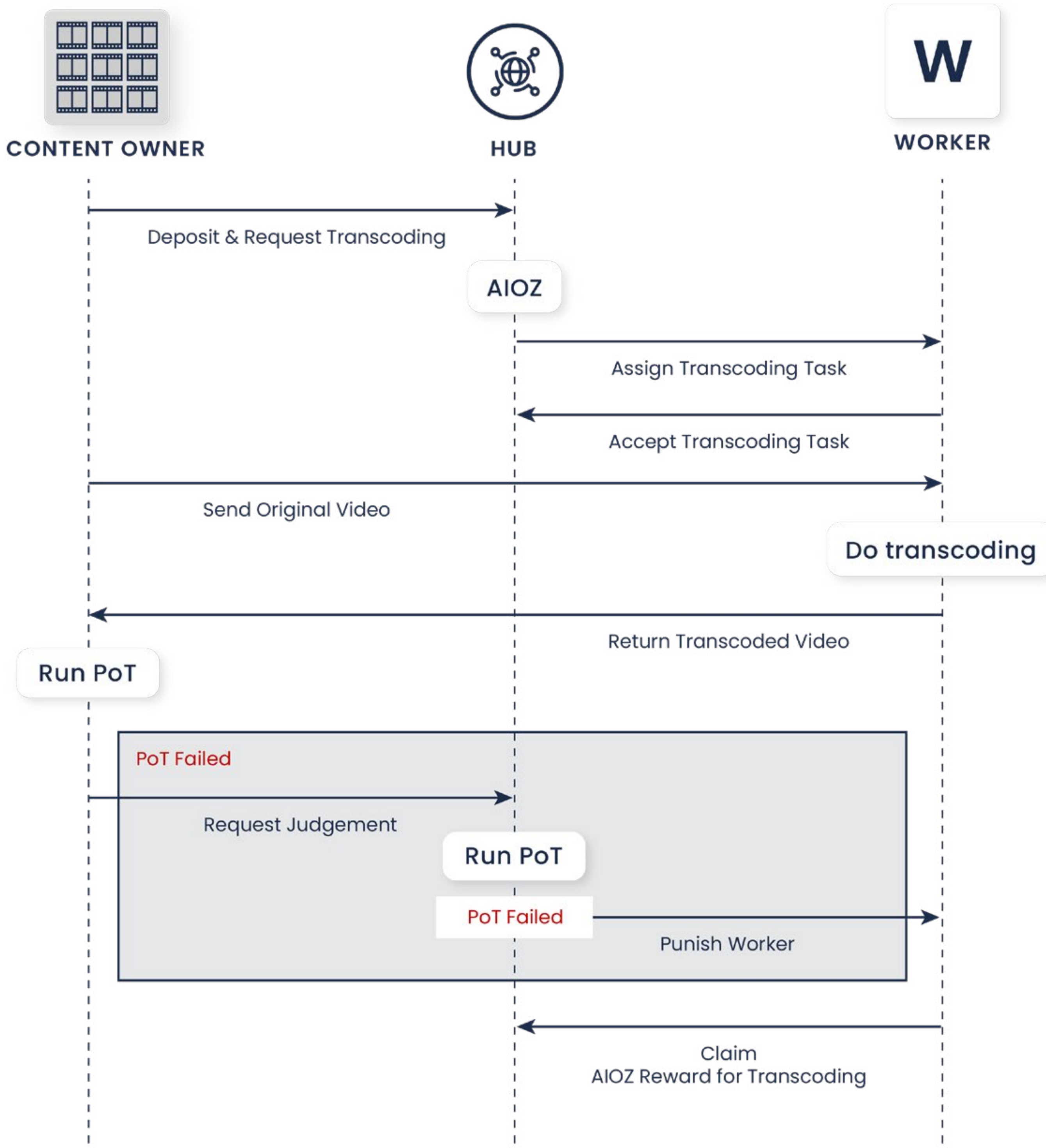
- Original video content holded by Content Owners (COs) is first splitted into multiple smaller segments, wherein the checksum of each segment is calculated by the AIOZ SDK.
- Next, HUB Nodes will determine which Worker Nodes can satisfy COs' requests (about the type, size, relocation factor of files, duration to store files and COs' budget) and connect qualified Worker Nodes to COs afterwards.
- If COs and Worker Nodes reach a consensus on collaboration, a contract will be sent to AIOZ Blockchain.
- Thereafter, COs upload their original video content segments to Worker Nodes for being transcoded.
- The transcoded segments will then be checked for the accuracy and completeness compared to their original chunks by COs by running the **Proof of Transcoding (PoT).**

- All original and transcoded segments will be stored at Worker Nodes that handle the storing task if no errors in the transcoding process are detected. Otherwise, all the work will be reassigned to other Worker Nodes. By nature, video segments could be stored permanently unless they are deleted, which seems to be inconvenient and resource-wasting. Therefore, each video segment will be attached with a 'lifespan time' and automatically deleted after their expiration dates.
- After finishing the storing task, Worker Nodes will provide a **Proof of Storage (PoS).**
- When viewers have a request to view a certain video, HUB Nodes will lead them to Worker Nodes storing segments of that video to receive a complete content. Each segment can be stored in different Worker Nodes, however, HUB Nodes will only recommend to viewers the most optimal Worker Nodes in terms of geographical distance and price.
- After content was delivered, a **Proof of Delivery** will be sent back to HUB Nodes for verifying that viewers already received content and thus, Worker Nodes can earn tokens.

> *Please note that the term 'Content Owners' used in this section refers to providers of video streaming platforms that build their service on top of AIOZ CDN, and 'Viewers' refers to those using the platform of the 'Content Owners' to watch videos.*

1. Proof of Transcoding

As mentioned, transcoding is the process converting a digital source video file into different formats to match different device requirements. H265, H264, VP9, and VP8 are currently the most utilized codecs because they achieve high degrees of compression. High-quality compression is essential because it reduces video's sizes, while the quality of the video nearly remains constant. Smaller video files require less storage, which makes it easier to distribute them across many platforms, and makes the end-user playback experience seamless.



This section will elaborately clarify how Worker Nodes receive the transcoding task and how to prevent them from cheating (Figure). To start with, COs who want to have their videos transcoded will send their request and payment to HUB Nodes of AIOZ CDN. Next, HUB Nodes assess which Worker Nodes can handle COs' request and assign the task to them. Worker Nodes have the right to accept or to refuse the task assigned by HUB Nodes as well as to freely choose which video segments to handle.

If they agree to carry out the task, COs will upload their video segments onto corresponding Worker Nodes and wait to get transcoded segments from Worker Nodes. After that, COs will run a PoT to check whether all original segments and their transcoded counterparts are similar in terms of content. In other words, PoT is an algorithm used to check whether all segments are precisely transcoded. To make it clearer, please see the following process, which compares an original segment (V1) and its transcoded segment (V2) (Figure):

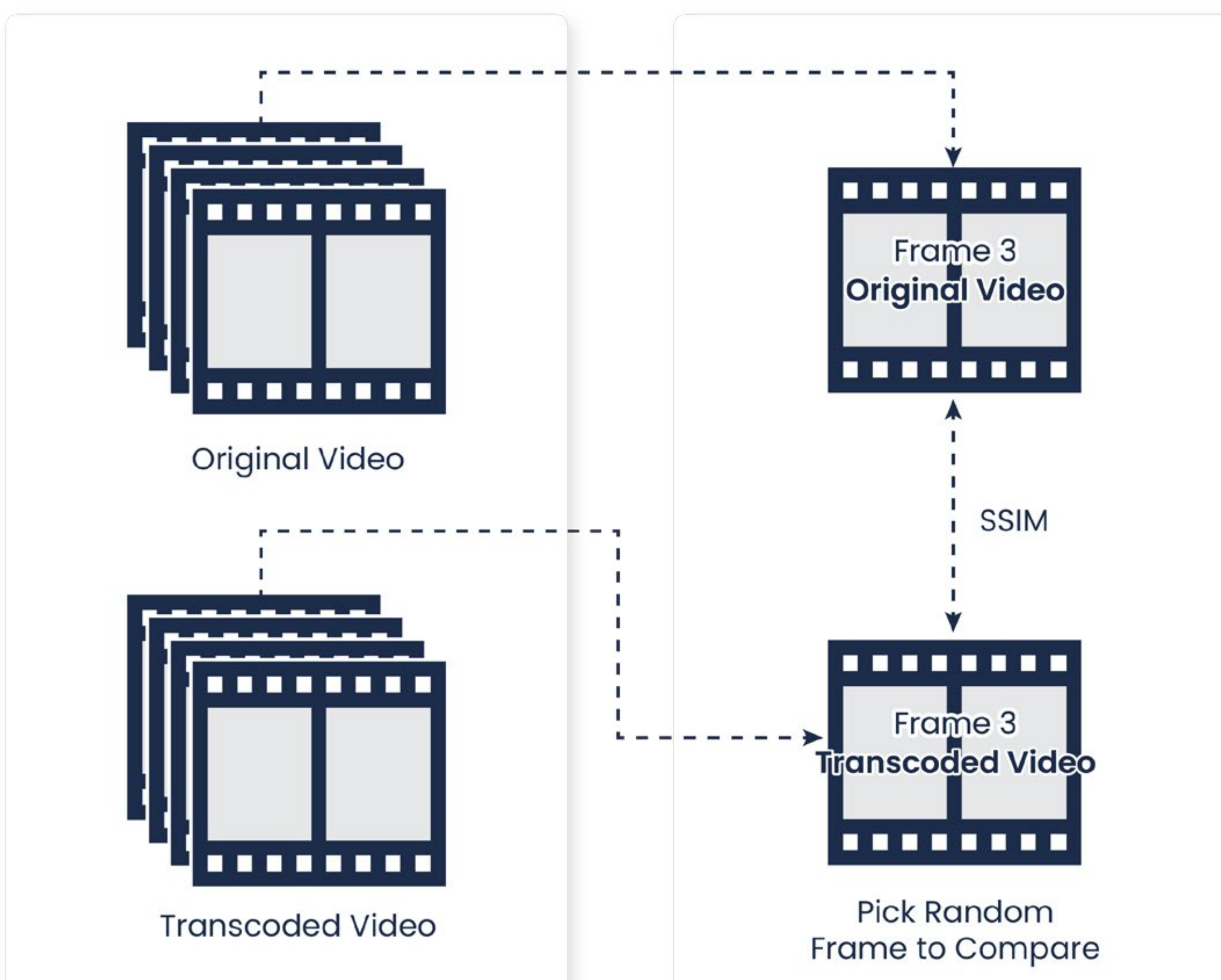
- Firstly, N indexes (index is an numerical representation of a frame's position in a video segment) are randomly selected **(Indexes = {idx1, idx2 ..., idxN}**, with N ranging from 0 to the total number of frames contained within V1 and V2)
- Next, N frames from V1 (F1 variable) and N frames from V2 (F2 variable) of which positions match indexes determined at the previous step are picked out
- Finally, each pair of frames selected from V1 and V2 is computed the S and Score. This could be displayed as:

For i in (1..n):

$S = S \cap \{ssim(F1[i], F2[i])\}$ (ssim stands for Structural Similarity Index)

By SVM (Support Vector Machine) categorizing algorithmIn, SSIM and other indexes are simultaneously used to evaluate the similarity between V1 and V2

$$Score = svm(\bar{S}, size(V1), bitrate(V1), size(V2), bitrate(V2))$$



After COs run PoT, there are 2 cases that Worker Nodes will encounter:

- If COs have no complaints in **all** segments, the entire payment from the escrow account will be automatically sent to Worker Nodes' AIOZ wallet within a certain period of time after they return transcoded segments to COs.
- If COs detect any flaws in any segments from running the PoT, COs must submit both unqualified/broken transcoded segments and the PoT to HUB

Nodes within a certain period of time after Worker Nodes return transcoded segments to COs in order for HUB Nodes to re-verify these flaws

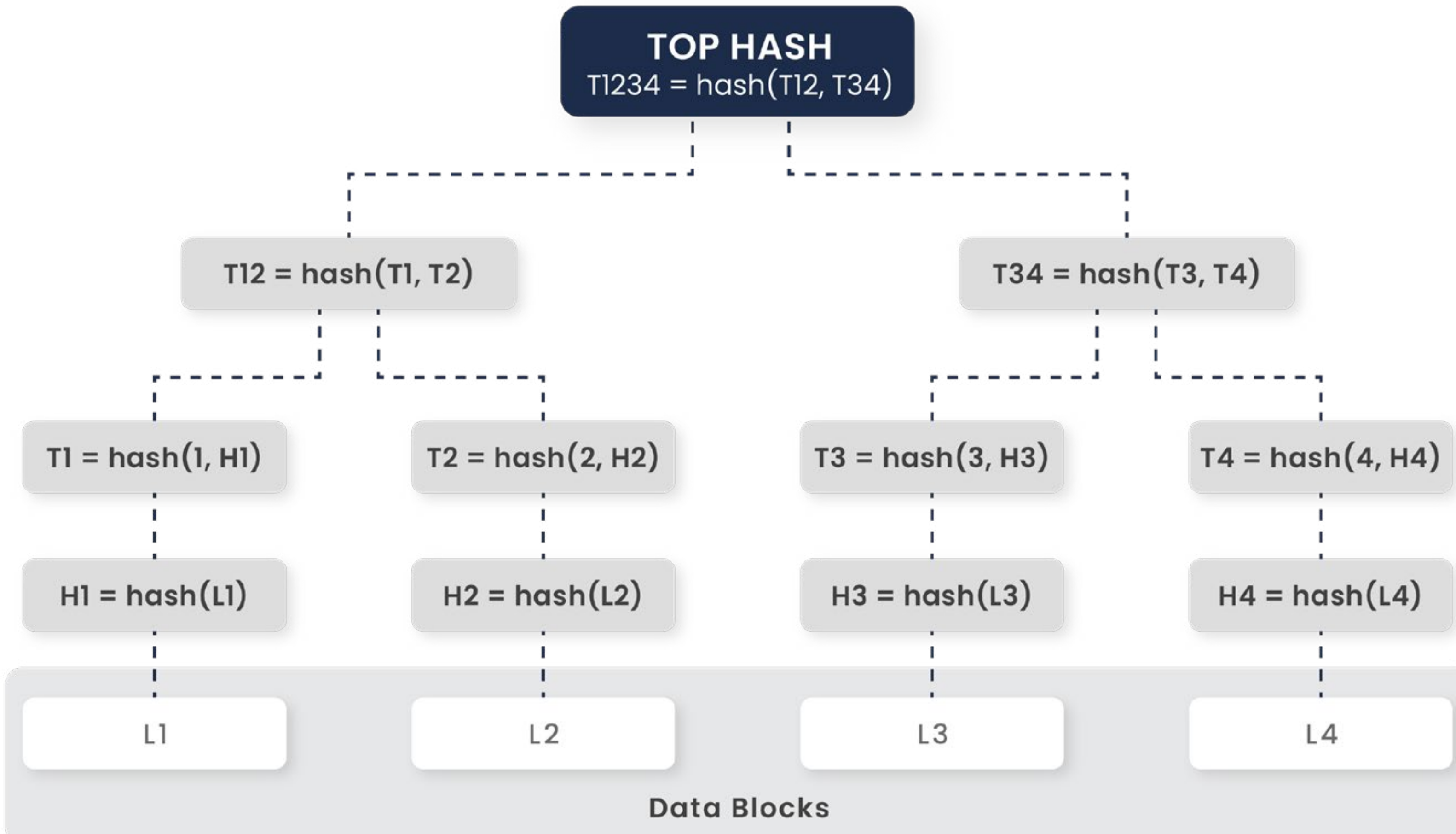
- If these flaws are judged to be the mistakes of Worker Nodes, Worker Nodes not only cannot receive the rewards for this task but also are given further punishments depending on the severity of flaws. For example, they would be assigned fewer tasks later on, their prestige on AIOZ CDN would decrease, or they might be kicked out from the network. Thereafter, the uncompleted tasks will be reallocated to other Worker Nodes
- By contrast, Worker Nodes are still able to receive the whole payment from the escrow account

2. Proof of Storage

It is the fact that the process of storing data usually goes along with risks such as data loss, data hacking, data breach or broken data. This is also the case for the task of storing video segments handled by AIOZ CDN's Worker Nodes, which might affect the entirety and accuracy of video content. Therefore, before delivering video content to viewers, HUB Nodes must check the entirety of each video segment stored by Worker Nodes to ensure input content and ready-to-be-delivered content are ubiquitously constant.

In AIOZ CDN, the video segment verification process is designed based on the Merkle root tree principle and put under the supervision of HUB Nodes. Instead of checking all segments, Merkle root minimizes the amount of video segments being sent back and forth over the Internet by comparing the hashes of these segments. This is obviously a much faster, more resource-efficient and secure solution because hashes of files are much smaller than the actual files themselves. For instance, the hash of a 2,000,000-byte file is only around 544 bytes in size.

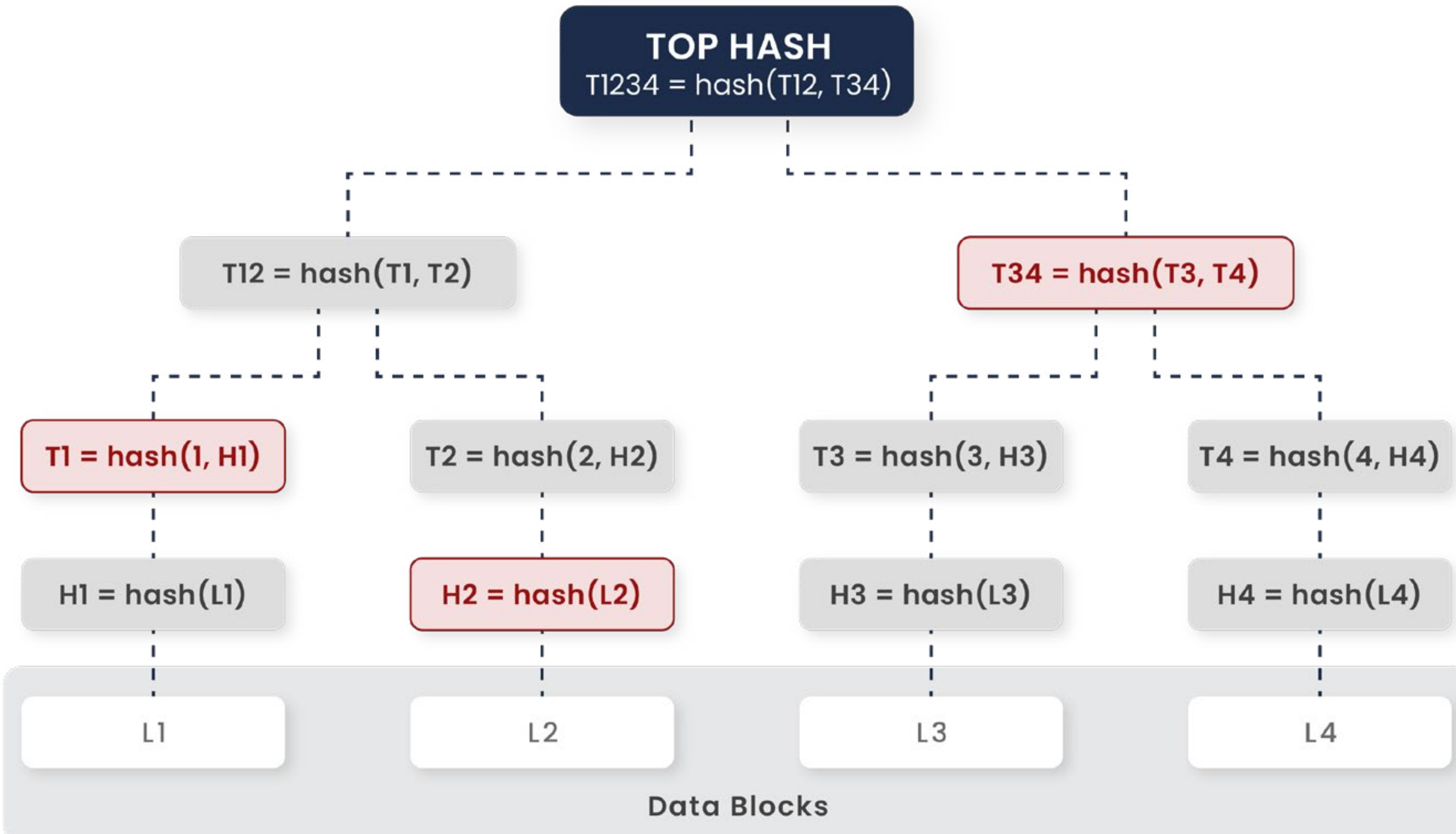
A Merkle tree is a hash-based data structure that is a generalization of the hash list. It is a tree structure in which each leaf node is a hash of a block of data, and each non-leaf node is a hash of its children. Typically, Merkle trees have a branching factor of 2, meaning that each node has up to 2 children. Currently, their main uses are in peer-to-peer networks such as Tor, Bitcoin, and Git and of course, AIOZ CDN.



The illustration for a typical Merkle root in AIOZ CDN is shown in Figure. Instead of only 4 blocks shown in Figure, in reality, a video segment contains n blocks, which n is computed so that the size of each block ranges from 32 to 64 bits. Via gradual pairing, we will finally achieve a TOP HASH, which is unique for one video segment. In other words, either any changes in any blocks or any block disorders of a video segment will lead to a totally different TOP HASH.

Before assigning a task of storing a certain video segment to a Worker Node, HUB Node will first compute and then save the TOP HASH of that video segment into its memory. This TOP HASH is later used to check whether there is any discrepancy between the original and the stored video segment.

However, if Worker Nodes compute TOP HASHES by themselves and send back to HUB Nodes for verifying, the verification process cannot ensure 100% reliability. This is because Worker Nodes might compute and save the TOP HASHES as soon as they receive the video segments but then delete all segments or make some changes to these segments. Consequently, the video segments no longer stay the same although TOP HASHES are exactly the same. To avoid this risk, HUB Nodes will also take charge of computing TOP HASHES of stored video segments.

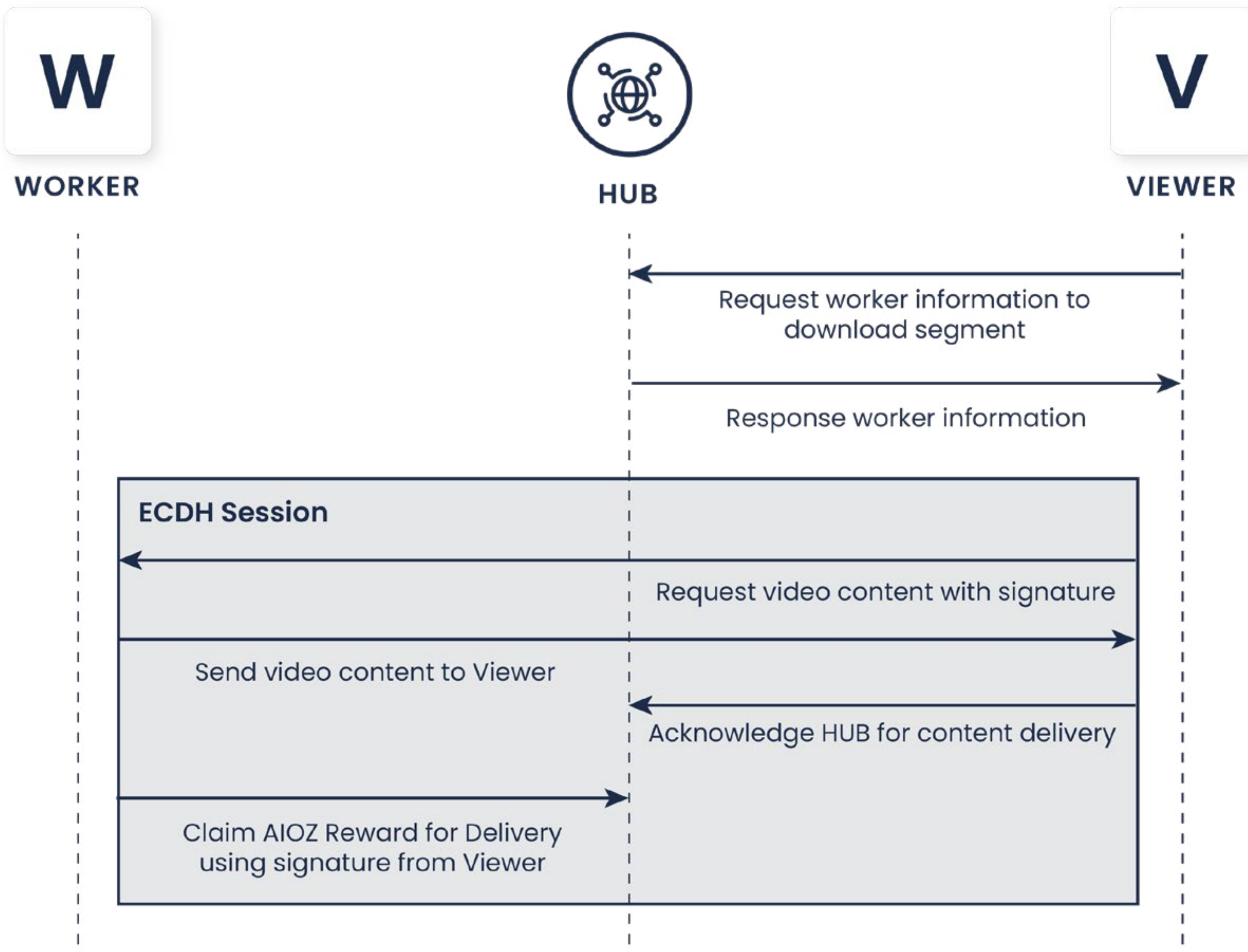


In AIOZ CDN, a complete merkle root tree of a video segment which is being stored in Worker Nodes could be constructed from different hashes, with one hash per level being sufficient (Figure). From this tree, HUB Node will get the final TOP HASH of which size is log2(X) (X is the number of nodes in the tree).

To do this, HUB Nodes will challenge Worker Nodes by requesting them to provide random hashes, with the block index and location of hashes requested may significantly vary. HUB Nodes' request will be coupled with a deadline to eliminate the risk that Worker Nodes might delay or forget to submit their PoS. If Worker Nodes fail to submit the proof within the timeframe given, the storing contract will be cancelled and these nodes will be penalized.

3. Proof of Delivery

Delivering content to viewers is the final step in AIOZ CDN. Theoretically, after video content was delivered to viewers, Worker Nodes will be rewarded with AIOZ tokens for completing assigned tasks. However, in reality, there might be some problems. For example, viewers do not inform HUB Nodes that they already received the video content and thus Worker Nodes are not rewarded; or Worker Nodes can cheat by creating unlimited fake viewers to earn digital tokens. As a result, it is vitally significant to strictly control this step by a Proof of Delivery.



The process of delivering content to viewers in AIOZ CDN is summarized in Figure . Initially, viewers have to send their requests to HUB Nodes. After viewers' request being approved, HUB Nodes will help viewers to contact Worker Nodes storing the requested content. In order to get desired Worker Nodes, viewers have to continue sending their requests coupled with a digital signature to Worker Nodes. This signature acts as an evidence which Worker Nodes can base on to claim the money from HUB Nodes after delivering content to viewers.

All transactions between viewers and Worker Nodes are conducted within the ECDH (Elliptic-curve Diffie–Hellman) session - a secure contact channel between 2 parties that absolutely avoids information leaking or hacking. Please note that ECDH sessions can be activated only if viewers are carrying a black box of AIOZ to ensure that they are real and trusted viewers. Via ECDH session, it is secure in knowledge that after receiving the video content, viewers will inform HUB Nodes and therefore, Worker Nodes can successfully claim AIOZ reward using the initial digital signature of viewers.

— BENEFITS OF AIOZ CDN

– AIOZ CDN is cheaper than other centralized CDNs.

It is because AIOZ CDN's giant resources, by nature, are spare resources contributed by individual nodes in the network, while centralized CDNs have to spend an enormous amount of money building and maintaining their physical servers. Compared to centralized CDNs, the overhead cost of AIOZ CDN is much more significantly lower, which consequently helps its clients alleviate their financial burden, or in other words, clients can earn additional revenue.

– AIOZ CDN ensures high security and privacy.

By distributing content segments to Worker Nodes within the network, with each node staying in their own location, the risk of losing the entire content is less likely to happen. Meanwhile, centralized CDNs have to encounter the single point of failure issue, as all the data is stored in a central entity.

– AIOZ CDN supports smooth streaming for high-quality videos.

With a high delivering speed, AIOZ CDN eliminates all barriers which usually serve as a deterrent to users while they enjoy 4K or 8K videos, such as poor video quality, slow loading, buffering

– Anyone could earn more income by consenting to participate in AIOZ CDN.

As a decentralized network, AIOZ CDN also works on the principle that individual nodes participating in the network (Worker Nodes) provide their spare resources to process, store or deliver video services; and thereafter, they will receive token reward for their contribution.

BYZANTINE FAULT TOLERANCE

In any decentralized distributed systems, the participants often communicate with each other in an uncontrolled, open, and permission-less system. Their actions may vary based on their individual interests and can be malicious. Therefore, it is vitally necessary for participants in decentralized systems to reach consensus in order to minimize the risk of encountering *Byzantine Generals Problem (BGP)*. This necessity gave birth to *Byzantine Fault Tolerance (BFT)* concept. So, ***what is BGP and BFT?***

The Byzantine Generals Problem was firstly defined by Leslie Lamport, Robert Shotak, and Marshall Pease in 1982. To be more understandable, let's imagine that before a battle, a kingdom divides its national army into many different battalions, each of which is situated in different locations and commanded by a Byzantine general. The generals need to reach a consensus on either attacking or retreating to achieve victory. However, the communication among generals has to be conducted via messages delivered by couriers, which might lead to the different problems. For instance, the messages might be delayed, destroyed or lost, or there might be a possibility that some generals/couriers are traitors who choose to act maliciously or change the message content. As a result, the kingdom might face a risk of failure. If we apply the BGP to the context of blockchains, each network node will represent a general whereas couriers will be replaced by connections or messaging protocols. Likewise, network nodes also need to reach a secure and efficient consensus to avoid complete failure for the entire network.

Meanwhile, the Byzantine Fault Tolerance is a property of a network that can still ensure the continuous operation even if up to ⅓ of the nodes in the network fail or act maliciously. In other words, a network is Byzantine fault tolerant when it can keep operating accurately as long as ⅔ of network nodes reaches consensus.

There is more than one approach which could tackle the BGP problem before a true battle and similarly, in blockchain technology, there are many different consensus algorithms that could be built to achieve BFT. For instance, the consensus mechanisms applied to Bitcoin and Ethereum networks are Proof of Work and Proof of Stake.

AIOZ DBFT

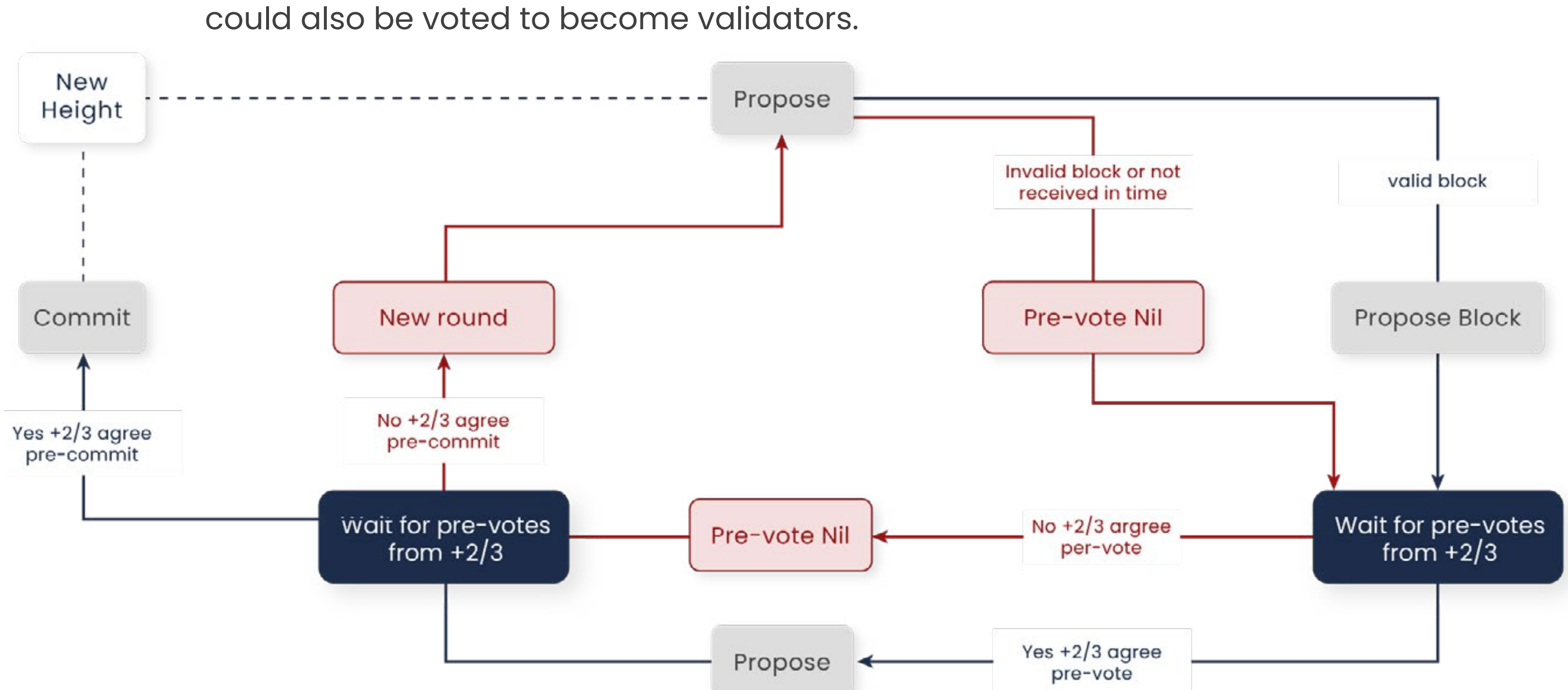
AIOZ dBFT is the consensus algorithm developed for AIOZ Blockchain on top of Tendermint, wherein "dBFT" stands for "Delegated Byzantine Fault Tolerance". In AIOZ Blockchain, there are an enormous number of micro-transactions, such as payment for Worker Nodes or viewers, concurrently taking place. Therefore, it might take validators a lot of time to come to a consensus on verifying all these transactions. Among different BFT protocols, dBFT is the algorithm which possesses the highest speed of processing micro-transactions. That is the reason why the AIOZ team decided to build AIOZ dBFT.

In AIOZ dBFT, there are three major subjects including 21 ***"Validators"*** with an unlimited number of ***"AIOZ token holders"*** and ***"Witnesses"***:

- Validators (also known as Delegates): Validators are a group of nodes taking charge of preserving AIOZ Blockchain data and validating all the transactions. They join the consensus procedure and vote to produce blocks. In more detail, validators will take turns proposing blocks of transactions and voting on them. The block is added to the blockchain if more than two-thirds of the validators reach a consensus and validate it. In AIOZ Blockchain, the fees are collected and equally allocated among all validators.

- AIOZ token holders are those who have the right to vote for any validator candidates to become the official validators. These AIOZ token holders must stake token(s) to vote. The more money they stake, the greater their voting power/voting weight would be, which means that the candidate(s) that they voted for will have a higher probability to become the official validator(s).

- Witnesses do not participate in the consensus procedure and blocks generation, but they (1) take care of the witness consensus process, (2) act as data replicas and help to spread the chain state across the network and (3) receive transactions and broadcast them to all other nodes. Witnesses could also be voted to become validators.

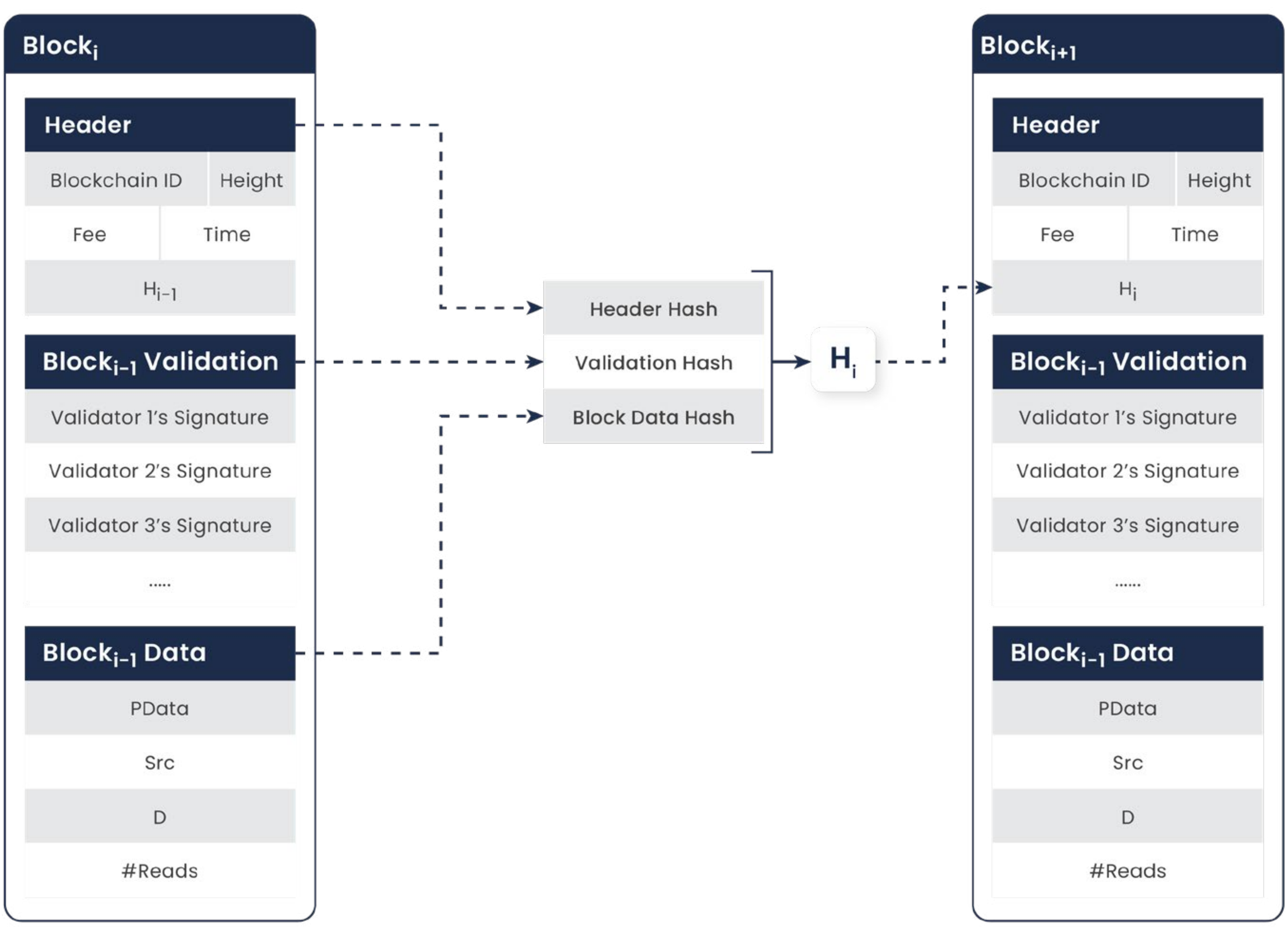


The block proposing process is summarized in Figure : Validators take turns proposing blocks for the transaction and voting on the proposed blocks. The blocks are submitted to the chain with each block on the chain at each height. However, the block may also fail to submit. In this case, the protocol will select the next certifier to propose a new block at the same height and start voting again.

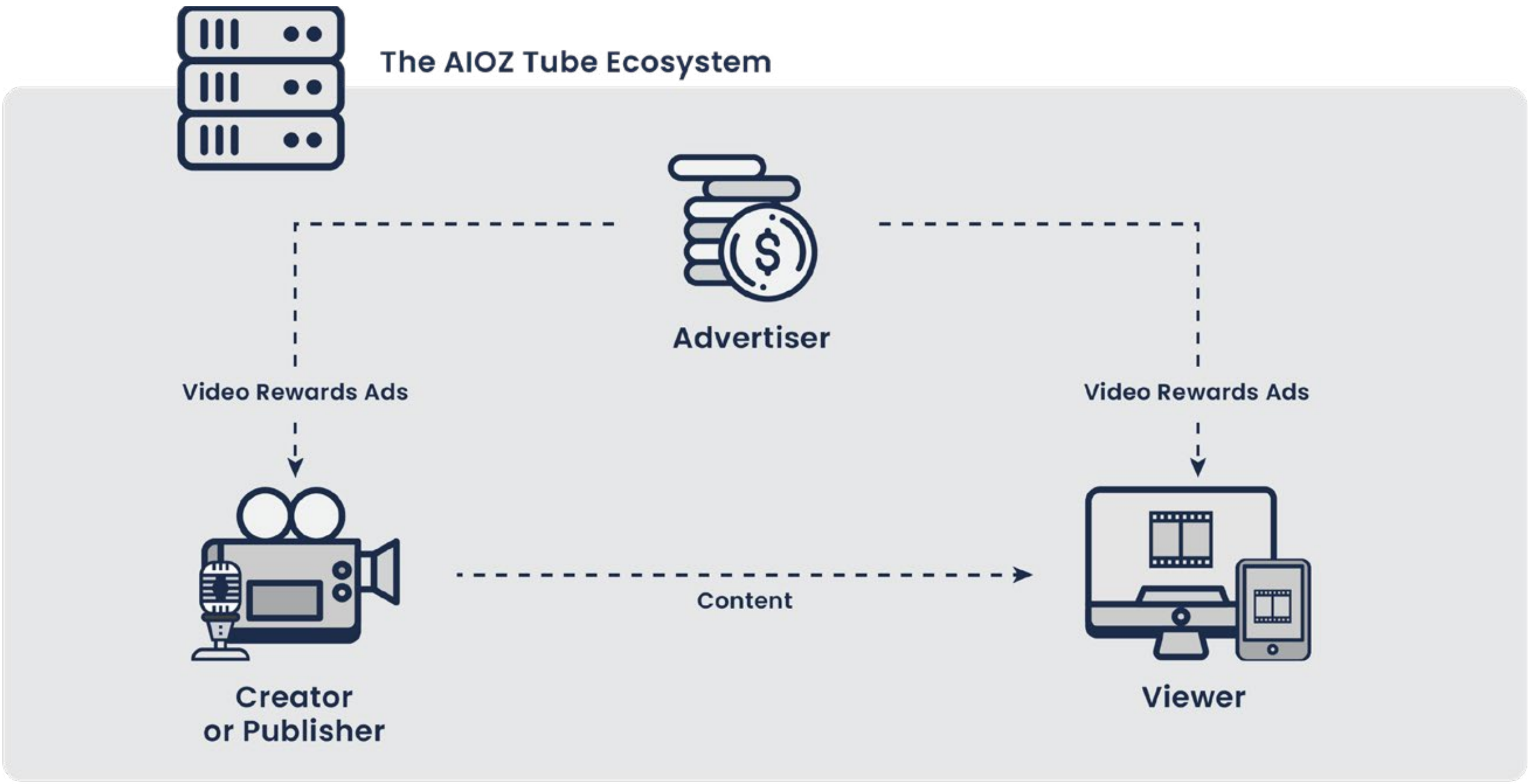
In order to successfully submit a block, two stages of voting, called a pre-vote and a pre-commit must be undergone. When more than 2/3 of the certifiers pre-commit the same block in the same round, the block will be submitted.

The algorithm that makes 21 validators rotate to propose blocks complies with the round-bin strategy. It is a deterministic non-blocking polling selection algorithm that chooses the block-proposing-validator based on the proportion of voting weights of the AIOZ token holders. The higher the voting power, the faster the validator moves to the front of the queue and becomes a block-proposing-Validator.

Valid transactions are grouped into blocks of which structure is presented in Figure . The hashes for validation and transactions are merkle tree root hashes of the signatures and transaction data stored in the block. The state hash (in the header), is the merkle root hash of the persistent account state after applying the transactions of the block. Finally the block hash is computed by hashing the header, validation, and transactions hashes. A block is regarded to be valid if all the transactions in the block are valid and sufficient signatures are included in the validation.



D. D-APPS ON TOP OF AIOZ STREAMING NETWORK



Any video streaming platforms/D-apps could be built on top of AIOZ CDN and become a part of the overall AIOZ Ecosystem in company with 'HUB Nodes' and 'Worker Nodes'. The goal of AIOZ CDN is to become an 'all-win' CDN, where individual nodes can earn tokens by completing assigned tasks timely and accurately, while video streaming platforms/D-apps' providers and their partners (content creators, advertisers) as well as their users can benefit in different aspects which are as follows:

- **With AIOZ CDN, video streaming platforms/D-apps' providers could** alleviate their financial burden and increase their profit because AIOZ CDN is remarkably cheaper than commonly used CDNs these days. As the AIOZ CDN grows and expands (more 'HUB Nodes' and 'Worker Nodes' are added), the price would even more reduce.
- **Viewers can receive dual benefits while using online streaming platforms which are built on top of AIOZ CDN.**

  In addition to the benefit that viewers will no longer face annoying experiences such as buffering, stuttering, low resolution videos or slow loading, they can also make money just by watching ads inserted into videos on streaming platforms who are AIOZ CDN's partners. After finishing watching a full advertisement, viewers are automatically rewarded with an appropriate number of AIOZ tokens which are determined based on the property, the length, and the popularity of the advertisement.
- **Content creators can generate more income.**

  It is a fact that the average salary of content creators is much lower than what they really deserve, because most of today's popular streaming services pay a great amount of money to cloud services for processing raw videos and distributing content to consumers/viewers. This is definitely not the case for platforms collaborating with AIOZ CDN because services offered by AIOZ

CDN are inexpensive, as mentioned above. As a result, content creators will be more likely to have a higher salary.

– **Promoting on platforms built on top of AIOZ CDN is a cost-effective solution for advertisers.**

The way advertisers gain advantage from the low price of AIOZ CDN is similar to that for content creators. Furthermore, with the property that viewers can earn tokens by watching ads, we believe that the number of viewers who use platforms built on top of AIOZ CDN will exponentially increase in the near future. In brief, advertisers can not only approach their targeted audience effectively, but also save costs remarkably.

Likewise, AIOZ CDN is a good choice for over-the-top (OTT) services (e.g. Netflix, Hulu,...) aiming to expand their business in remote areas or places with limited Internet bandwidth but still maintain the high quality (up to 4K or 8K) of videos delivered to viewers.

AIOZ CDN additionally provides a low-cost clouding solution for a separating group of audience whose businesses are not specialized in streaming but they have the demand of storing video content. The group of audience being referred to are developers of social networking sites or applications such as Tiktok, Instagram, Tinder,...,OR developers of electronic newspapers.

E. FUTURE WORK

In the next few years, AIOZ will continue focusing on the research and development activities to increase the number of Worker Nodes and businesses deployed on top of AIOZ CDN. So far, all individual nodes wanting to become our network's Worker Nodes to earn tokens must open TCP/IP ports, which is a minus. To eliminate this disadvantage, AIOZ team will integrate the WebRTC into the Worker Node Software so that individual nodes could join us easily. AIOZ team will also apply AI technology into the content filtering tool to block obscene materials as well as illegal and violent content. The current PoT is not genuinely optimal, which necessitates further upgradation of the algorithm built for it. Finally, AIOZ team will build and implement a mechanism assessing the 'Reputation Score' of Worker Nodes. 'Reputation Score' would be determined based on a set of different criterias consisting of Worker Nodes' working status/attitude, working history, number of tasks completed, duration of nodes' participation in AIOZ CDN. The higher the 'Reputation Score' of Worker Nodes is, the more important tasks and rewards they would receive and vice versa.