ColdCDN Whitepaper

The next generation distributed CDN with faster cheaper and more stable service

Daqnext Foundation

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Overview

With the development of the Internet, demand for the speed of multimedia files such as web pages/files/videos/games is increasing exponentially. Companies large and small have purchased third-party CDN services in order to provide a better user experience. The entire CDN market has been exploding and is expected to double in size in the next 5 years.

Existing third-party CDN solutions such as Akamai, Cloudflare, AWS, Aliyun deploy several to dozens of centralized IDC host rooms around the globe for acceleration. Existing solutions need to pay an exorbitant fee for fixed bandwidth, resulting in excessively high cost for the entire CDN market. At the same time, a huge swathe of idle bandwidth resides in servers rented by cloud service providers or IDC managed servers and personal wifi networks. By utilizing the massive repertoire of idle bandwidth, we seek to solve the high cost cost problem of the CDN market. We propose "coldCDN": the next-generation CDN solution, which greatly reduces the cost of enterprise level CDN while improving the performance and speed of CDN.

Contents

1. Introduction to CDN and Existing Concepts

1.1 What is Content Delivery Network (CDN)

CDN is a cost effective and reliable solution to the user experience and access problems brought by an exponential explosion of content delivery, storage and distribution. CDN is a new web infrastructure that is made up of accelerator nodes that are distributed geographically. These service nodes will store your business content according to some caching strategies. When a user initiates a request for your business services, the request will be routed to the service node closest to the user so responses can be as quickly as possible, and delays can be minimized, effectively improving user experience and service usability.

1.2 Why CDN

1.2.1 Increasing Access Speed

Traditionally, most enterprises only deploy their servers in a few regions, which could not meet the need of servicing a global or even a national audience due to the complexity of regional networks, not to mention the complexity of a global network. Having a limited number of nodes that are topologically concentrated simply cannot guarantee access quality across the network. Because services provided by modern internet companies naturally cater to a national or even an international audience, this accessibility problem has become ever more critical to businesses. As users become further and further away from servers rooms, the time it takes to transmit information becomes longer, network uncertainty becomes bigger. CDN is a highly effective solution because CDN nodes can be deployed all around the world, and data can be cached in these nodes. This significantly improves access speed an accessibility of online services even in a massive and highly complex network.

1.2.2 Decreasing Network Usage Cost

Using CDN solution can greatly reduce the cost of R&D and network fees.

1.2.3 Security Against Attack

When an enterprise exposes its own servers' source IP addresses to end users, it makes itself extremely vulnerable to attacks such as DDoS that will damage the stability and security of its onlines services. Using CDN can hide the source IP addresses and protect the servers from DDoS.

1.3 The Current State of Growth of the CDN Market

The CDN market has a size of $23B USD, while growing at a fast and accelerating rate.

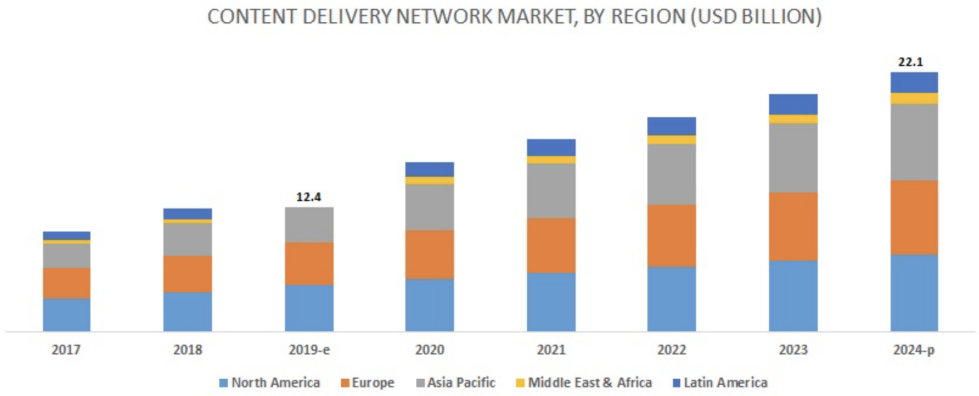

Figure 1.1: https://www.t4.ai/industry/cdn-market-share

1.4 Future Development Directions for CDN

With the continuous deployment and improvement of network edge computing capabilities as 5G era arrives, network operators are increasingly deploying MEC CDN to maximize return on computing resources and take advantage of the similarity between edge computing and CDN and the similar suitability of deployment locations.

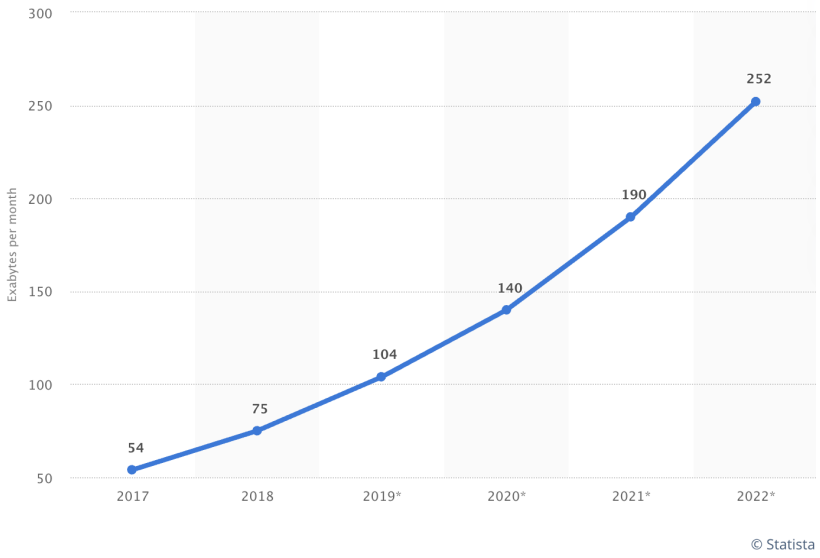

Figure 1.2: https://www.statista.com/statistics/267184/content-delivery-network-internet-traffic-worldwide/

According to relevant research data, more than 72% of total internet traffic will go through CDN by 2022, an increase of 28% from 2017. This shows that the CDN market will maintain high growth and gradually become the dominant solution for the increasing demand on higher speed delivery of content in the 5G and Web 3.0 era.

With the a accelerating growth of new network infrastructure such as 5G, IoT and Web 3.0, CDN and experience delivery network (EDN) will also continue to improve the access volume, speed and quality of online services and networks through the provision of highly stable content delivery and edge computing products. Therefore, better CDN products will be able to quickly obtain market share in the current expansion and mass adoption phase of the CDN market.

2. The Problems coldCDN is Solving

2.1 Saving Sunk Cost

With the rapid expansion of the global cloud computing industry, a large number of cloud service and peripheral service vendors have emerged. Looking at the structure of the industry chain, there exists several types of agents in the sector

1) Renters or owners of servers inside IDC host rooms;
2) Users of general cloud computing platforms;
3) Enterprises that possess their own servers.

At the business level, no agents can guarantee the full use of their computing resources, so at many points in time, a significant amount of computing power sits idle for any of the actors in the cloud computing industry. If the overall scheduling has been well optimized, then the proportion of idle resources is reasonable, and the cost would be relatively low. Otherwise, if growth had not been as good as expected, then it is highly probable that a significant portion of computing resources will be idle and wasted. These are the sunk costs.

Let us then take a look at the common household's daily bandwidth usage. On a weekday, an ordinary user usually works for 8 hours and sleeps for 7 hours. the home internet may only be used 8 hours a day for work, and even with entertainment activities after work accounted for, the average idle rate of household bandwidth still exceeds 2/3 on a usual working day. Regardless of the high idle rate, users still need to pay a fixed bandwidth fee for their subscribed internet services. These are the sunk costs.

Server resources can be categorized into computing resources, storage resources and bandwidth resources. Computing resources are the most easily utilized. For instance, a lot of servers or computers are used for mining ETH and XMR by contributing computing power to the network. This is a typical case of monetizing idle computing resources. however, cryptocurrency mining

predominantly uses computing resources to secure the network, bandwidth resources have not been utilized equally by the market and there exists a sea of untapped cheap bandwidth resources. Therefore, we propose an effective solution for monetizing idle bandwidth and storage resources via a specialized CDN network.

2.2 The Lack of Closed Blockchain Business Loops

In the current state of the blockchain world, many projects could be greatly hyped in a short period of time, but most of them disappeared or became silent before long. The reason for such phenomena is that most of their business models are not closed loops, meaning they need to rely on stimulating constant speculation and price appreciation in order to get more and more buyers of their token. This inevitably leads to collapse of the token price and of the project that needs token price appreciation to stay relevant.

coldCDN has a clearly viable commercial closed loop business model. It is able to generate more profit as its server resource network becomes larger. Combine this with an effective blockchain based token economic design will allow us to connect idle server resources to those who need cheap and reliable server resources. We believe this closed loop ecosystem is able to become a front-running CDN solution that will create extraordinary value for both the providers and the users of coldCDN. We seek to utilize tokens as basic incentive legos to drive the contribution of server resources to the network, as well as continuous development and optimization of products, ultimately helping coldCDN evolve into a sustainable growth economy.

3. coldCDN Commercial Milestones and Technical Roadmap

3.1 Our Customers and Business Goals

Business service customers include all small, medium and large size internet companies

Any internet companies or platforms need CDN acceleration to ensure optimal user experience. Amazon's example of one second service disruption would cost it $1.6 billion in sale is a testament to how critical stability and easy accessibility have become for online services. Even very small service access disruptions may incur significant loss on the service providers. The commercial goals of coldCDN in this consumer segment are

1) Extremely stable global acceleration;
2) Extremely fast global acceleration;
3) Significantly lower cost of acceleration service;
4) On click access without the need of any SDK or client installation.

Household users

This type of users mainly needs to download multimedia files. coldCDN's business goals for this group of users are

1) relatively more stable
2) relatively higher speed
3) Free of basic usage cost

3.2 Technical Roadmap

coldCDN 1.0 will be geared towards serving business customers;
coldCDN 2.0 will gradually implement services towards household customers.

4. coldCDN

4.1 Design Philosophy

We adhere to the following principles in designing coldCDN:

Simplicity: The architecture and communication components should be as simple as possible, so that the average engineer can effectively implement the defined specifications with ease and introduce the protocol through their applications and works. We would not add overly complex optimization schemes unless absolutely necessary.

Open: the protocol does not impose any restrictions, any terminals that comply with the specification and requirements of the protocol can join the network. The network behaviors are not restricted. Users can use the resources within the network as long as they pay the necessary fees stipulated by the protocol.

Modular: The coldCDN design is modular. Each module should be as independent and decoupled from each other as possible so that one module would not have a significant impact on the other.

Ease of use: End users only need double click on a program in Windows or copy paste a command line in Linux in order to join the network. Generated return should be displayed visually, alongside the contribution and withdrawal of server resources. User friendliness has always been an important tenet for coldCDN.

4.2 Network Roles

We hereby define several roles and functions in the network

- Terminal: A terminal node that joins the CDN network to store data and respond to service request in order to gain revenue.

- Router: Responsible for allocating and scheduling network requests.

- Hunter: Responsible for finding bugs and vulnerabilities in terminals by sending requests to terminals in order to evaluate their reliability and integrity. It submits information about problematic or at risk terminals to the council to receive high bounty rewards after verification.

- Council: Responsible for governance and oversight.
- Client: Ordinary Internet users
- Business User: Customers who have a need for the CDN network.

4.3 Protocol and Information

The core functions of the terminal is to carry out data caching, deletion and response services, as well as providing heartbeat packets and local configuration information to ensure the Core can perceive the existence of the terminal. In addition, if the terminal is down, the integrity of the flies needs to be self-checked and updated when the terminal is restarted. Since the terminal code is open sourced in the design, there exists the possibility of malicious actions, thus it is necessary to do spot checks and verifications on data and transmission.

In view of the above functions, the terminal needs to include the following basic operations

- save/cache file(s) (originURL, verified hash, TTL)
- delete file (file hash)
- get file (file hash)
- heartbeat
- hardware configuration
- index of local cached files
- shards spot check

4.4 Transmission Verification

The key to CDN is data transmission acceleration. Under a certain level of total system resources, it is ideal for terminals to store as much cached files as possible, while also moving frequently requested files to be cached at locations close to the requester. After a terminal is started, it will start to cache files. When a certain threshold is reached, the terminal will delete files that have low request frequency. The deletion operation is initiated by the terminal, and verified by the dispatcher. Alternatively, Deletion operation can also be directly made by the control terminal. When assigning caching tasks, the control needs to know the remaining storage space of the terminal and whether it has the ability to continue to cache files so as to optimize network efficiency.

Since terminal code is open sourced, users may perform malicious actions, thus the network requires transmission verification for security. coldCDN

uses spot checks and bounty hunters as means of verification and checks against potential attackers. The malicious behaviors of users can be divided into two categoriesModify data or decline to store corresponding data.

When dealing with maliciously modify data, the scheduling module has a hash check of the data source and randomly stores part of the fragmented data. The system will randomly check the data stored in the terminals according to certain proportions and weights. If it is found that the data returned by the user is different from stored data, then the user will be punished with a fine.

For attacks that involve not storing data, we propose the defense of random checks by the system on one hand, and the introduction of bounty hunters on the other hand. When hunters request terminal services, if the data is missing or damaged, the hunter can submit information directly to the council and obtain rewards after verification. if terminals are found to be malicious, their tokens will be confistigated and distributed to the cheated parties according in order to disincentivize destabling factors in the network.

4.5 Reliability and Redundancy

A key feature of CDN is its ability to keep content online even when faced with common network problems such as hardware failures and network congestions. By means of load balancing internet traffic, using intelligent failover, and maintaining servers across many data centers and locations, CDN can avoid network congestions and resist service interruptions.

Data centers can use load balancing to distribute incoming requests to available server pools to ensure traffic peaks are handled in the most effective manner. Load balancing can increasing data processing speed and optimize server capacity usage. Proper balancing the load of incoming traffic is a key component in mitigating peak traffic during periods of atypical internet activities (such as when a website encounters an unusually large number of visitors, or when a distributed denial of service attack occurs). Using load balancing can also help make swift and effective changes when the supply of server resources fluctuate significantly up and down. If a server fails and a failover occurs, the load balancer will redirect the traffic allocated to the failed server and redistribute it proportionally to the remaining servers. This will decrease the possibility that a hardware failure will interrupt traffic, thereby providing flexibility and reliability to the entire network. When a new server comes online, the load balancer will offload other servers proportionally and increase the utilization rate of the new hardware. Leveraging software-based load balancing services, CDNs can quickly expand load bal-

ancing capacity without encountering bottlenecks when using physical load balancing hardware.

Making use of the Anycast routing method to transmit internet traffic to a specific terminal helps coldCDN reduce response time and prevent any terminals from becoming overwhelmed in the event of abnormal demands such as DDoS attacks. Thanks to Anycast, multiple computers can share the same IP address. When the request is sent to the Anycast IP address, the router will direct it to the nearest computer in the network. If the entire network fails or is unable to cope with a large amount of communication due to other reasons, the Anycast network can respond to service interruptions similar to how a load balancer transmits communication across multiple servers: data is transferred from the failed location and routed to another functioning terminal.

4.6 Economic and Governance Model

4.6.1 Token Incentives

coldCDN uses blockchain tokens as a means of providing and changing incentives. In BitTorrent network, users would contribute their upload bandwidth to get a better download speed, but in many cases, they would exit the network(close the software) after the download is completed. At this time, the network is idle, but because there is no download needs and no other incentives, users will not continue to be on the network after their downloads. The main problem with the original BitTorrent network is that there is only the possible exchange of similar resources, if users want more download bandwidth, they have to provide upload bandwidth in exchange. however, once they have fulfilled their download needs, the exchange ceases and that decreases the overall networking effect of BitTorrent. Now, if the exchanges can be manifolds, not just an exchange of bandwidth, but also with tokens and other value stores, users will be much more inclined to be on the network even without download need.

The tokens are distributed to network terminals as rewards for providing server resources. Users can evaluate the expected return of contributing resources based on their hardware situation. The role of hunters is to constantly look for cheating and malicious behaviors in the network. If hunters discovered such behaviors, they can submit relevant information to the council and pledge a certain amount of tokens on their claims. If the council confirms the claim, the terminals in question will be punished. Otherwise, the tokens pledged by hunters will be deducted as punishment. If coldCDN adopted

a DAO governance model, then holding tokens can initiate proposals and participate in voting, including joining the council and having a claim in dividend from protocol revenue.

The main profit generator of coldCDN is the provision of CDN services to businesses. Since the cost of running a terminal node is mostly a sunk cost, node operators can safely contribute resources for a profit so long as attention cost is minimal and no additional cost is incurred. Due to the standardization at the protocol level, users can join and exit at will without much hassle, making it easier to from a super-large-scale distributed CDN network. The effect of the network is proportional to the square of the number of nodes, so the coldCDN network has the potential to grow very rapidly. Because of token incentives, terminal nodes would voluntarily join the network. The more nodes, the higher the network effect capacity and value, leading to more demand and a higher price tag for our CDN services. The controller transfers fees paid by the CDN users to server resources contributors through the repurchase and destruction of tokens, aligning the interest of the investors, users and the protocol as a whole.

4.6.2 Governance Model

In order to make sure the continuous evolution and development of the network, coldCDN allows its token holders to vote to modify various parameters of the protocol. Anyone can submit a proposal to initiate a token vote, not just the token holders.

Changes to protocol variables are unlikely to take immediate effect after they pass voting. If the community decided to immediately adopt the governance results, then these changes will likely take place at the latest in 24 hours. This period gives token holders the opportunity to act, and if necessary, trigger a shutdown mechanism to oppose malicious governance proposals (for instance, making significant changes to the proportion of revenue distribution, which would likely hurt the interest of some token holders).

Council plays the role of maintaining order and stability in the network. Council members run the verification code in the Trusted Executive Environment (TEE). The council also inspects malicious behavior reports submitted by hunters in order to determine and carry out penalties. Members enter councils through a voting process, they also need to pledge/take tokens in order to take up a seat. The implementation of all proposals and actions is supervised by the council, such as carrying out punishment and handing out rewards.

4.7 The Adoption by Household Users

For household users, the cost of bandwidth is relatively low, but the idle rate is high. Following the current trend that CDN nodes are gradually becoming more and more accepted by households, increasing the rate of adoption is the main goal of stage 2.0. Limted by physical constraints, this type of users will have problems when attempting to join the network. These problems include but are not limited to home broadband uplink and downlink are generally not equal, there may not be a fixed public IP, the network environment is different, and the computer is not very suitable as a terminal to be turned on for a long time. Therefore, in order to provide household terminal users with an integrated software and hardware solution that is highly efficient, we need to make certain trade-offs between CDN acceleration and storage, routers, storage boxes, video acceleration and other additional multi-functional solutions to meet the needs of terminal nodes.
Design principles for terminal node hardware:

1. Low power consumption arm architecture chips such as allwinner h3/h6 rockchip, etc.
2. An operating system based off Linux and Openwrt.
3. users can freely insert their own custom size mobile hard disk.
4. Hardware and hardware based p2p software are completely open source.

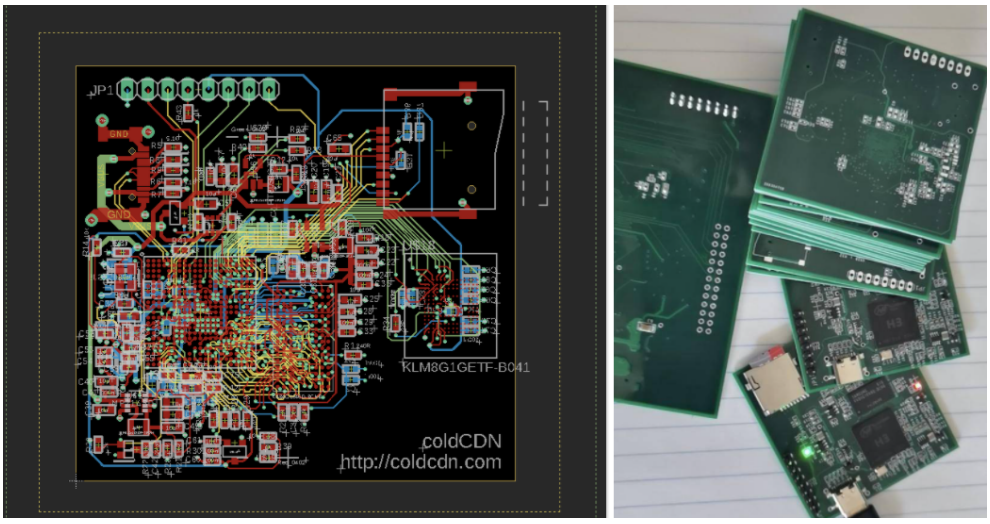

Figure 4.1: prototype

4.8 Comparison with Filecoin

Filecoin proposed a scheme for storing data, but because the official design route puts too much emphasis on encryption algorithms and ignores the nature of commercial profitability, this design leads to the actual use of storage costs far higher than the storage prices of third parties such as AWS. In essence, it cannot form a closed loop of commercial competitiveness and profitability, and thus cannot be used for commercial purposes at a large scale.

On the other hand, coldCDN is not used for file storage but for file acceleration. Compared with storage, accelerated services have greater commercial value. the initial goal of designing coldCDN is to create a commercially viable closed loop business model, leveraging on service price that is significantly lower than traditional CDN providers. Both the economic model and the distributed approach to transmission are fundamentally in service to real business interests.

4.9 Comparison with BitTorrent

BitTorrent is a transmission method based on traditional P2P client. it is made for householder users in mind. This transmission requires the user to install the client or the SDK. However, since all network nodes are based on household clients, acceleration in the network will be relatively unstable. Commercial users tend not to use this service because of the non-universal nature of the integrated SDK and reservations about the uneven performance. In sum, BitTorrent is in essence a household P2P network that provides storage and acceleration services.

In addition, the native BitTorrent network has problems on the incentive layer. Because the the resources exchanged are the same (contribute upload bandwidth to obtain download bandwidth), many users are not sufficiently motivated to provide services to the network after their own download tasks have been finished, resulting in greater overall uncertainty.

coldCDN draws on the advantages of BitTorrent while seek to solve the problems associated with BitTorrent. coldCDN aims to attract idle IDC resources and cheap household bandwidth resources in order to create the next generation CDN distributed protocol that takes advantage of a more reasonable incentive model to develop the cheap, highly stable and fast.

5. Applications

5.1 Large scale commercial CDN

Early data center users were motivated by token incentives to join the network. They seek to make revenue from their idle server resources, or at least save a portion of their sunk costs, thus their contribution enabled low cost but good quality service. In addition, CDN buyers will begin to pay to test the network due to cost and other considerations. The revenue from fees will be used in the repurchase of token, which strengthens the incentive effect and attracts an increasing number of users to the network. The effect of geometric growth will make the network exponentially more capable, which further entices businesses to use the coldCDN network and provides positive feedbacks to the nodes.

5.2 Edge Node CDN Access

With the adoption of infrastructure such as 5G, which has the traits of low latency and large bandwidth, a large number of edge nodes can serve as terminals for CDN service provision. IoT services, even smartphones, can join the network to earn revenue, in the process forming a large-scale distributed CDN network.

5.3 Idle Resource Access

Providing a way to monetize idle bandwidth.

6. Conclusion

We are in a great era of continuous technological advancement and progress. As more and more things obtain an information and data side, the demand for better internet speed and capacity has grown higher and higher. The end user experience has become a key area to invest in for many companies, with CDN at the forefront. However, at the same time, I also noticed that the solutions of many centralized vendors are not only costly, but also have the problem of performance instability. With the improvement of existing terminal node data processing capabilities, networks and storage, the basic conditions for establishing a new generation of CDN networks have gradually matured. Since the each type of terminal nodes serve different functions, such as coping with peak traffic, creating redundancy, testing and idle, there are many differences in their maintenance costs. Therefore, it is hoped that a set of agreements can be formulated so that users can choose to join the CDN network and use token to motivate users. Since the network is distributed and the cost is determined by the terminal nodes, it can provide a CDN service network with a relatively reasonable price and a reliable architecture. The rapid growth of the CDN market can bring significant positive incentives to the network, thus creating a reliable business model and ultimately create better experience for end users.