vTorrent: A Decentralized BitTorrent Client with Paid Streaming and Downloading

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Abstract: In the current digital distribution environment, there are several longstanding issues in need of solutions. Firstly, indicators suggest that there is a significant demand for tail-end content which digital content providers are unable to fulfill. Secondly, the BitTorrent ecosystem is troubled with censorship attacks, slow and unreliable download speeds on the part of public torrent sites, and the lack of a protocol level streaming functionality. Thirdly, content creators hosting their art on traditional content providers such as Spotify are subject to limited artistic control, delayed payouts, and eroded revenues — byproducts of a distribution system heavily controlled by rent-seeking intermediaries. Lastly, high barriers to entry make the aforementioned system difficult to disrupt allowing the status quo to prevail. vTorrent is addressing all these issues by combining BitTorrent and blockchain technology to enable paid P2P streaming and downloading within a decentralized, user-friendly, private, and secure environment. The Paid Streaming and Downloading feature (PSD) will function as an incentive mechanism setting the stage for a market for tail-end content, and a market for fast downloads and streams. The decentralized architecture will ensure censorship resistance, and will also allow content creators to distribute their art without the limitations of intermediaries. The user-friendly, privacy, and security focused approach will make certain that everyday people can board safely and easily, opening the door for mainstream adoption. Lastly, startups wanting to partake in the quest to disrupt the digital distribution industry will save largely on cost, and gain significant in terms of potential, by building on top of vTorrent's open-source codebase.

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1 INTRODUCTION

1.1 PROBLEM

The internet, the digitization of content, and P2P file sharing technologies, have revolutionized the way content such as movies, songs, and books are distributed and consumed. However, there are still several long-standing issues deeply rooted in the field of digital distribution.

Firstly, the availability of tail-end content is poor across the field despite strong indicators of a significant collective demand. For instance, Netflix, Hulu, and Amazon supply some ten thousand of titles combined [1], but the number of registered titles in the film database IMDB exceeds four million [2]. Depending on the type of digital content provider in question, high licensing costs, high barriers to access and usage, or lacking incentive mechanisms are the culprits.

Secondly, while being subject to the above issue as well, the BitTorrent environment suffers from frequent censorship attacks, slow and unreliable download speeds on the part of public torrent sites, and the lack of a protocol level streaming functionality. BitTorrent sites are vulnerable to censorship due to their centralized access points, the issue of slow and unreliable download speeds is largely a consequence of poor incentive mechanisms, and BitTorrent's tit-for-tat seeding policy is the limiting factor in respect to streaming.

Thirdly, content creators distributing their art through conventional streaming and downloading platforms such as Apple Music and Spotify, are facing a reality of eroded revenues, limited artistic control, and delayed payouts — byproducts of a distribution system heavily controlled by rent-seeking intermediaries. For instance, an artist using Spotify will have to pay an aggregator in order to get on board, accept that Spotify takes a 20-30% revenue cut [3], deal with rigid pricing and format requirements, and pay a third party to collect and distribute payouts with delays of weeks and months [4].

Lastly, high barriers to entry, particularly in terms of high capital and operating costs on the part of digital content providers, protects the aforementioned system against disruption — to the detriment of content creators and consumers.

1.2 SOLUTION

While a solution to any of the above issues would be groundbreaking, a solution to all of them would be revolutionary. vTorrent is aiming for the latter with its proposal of a decentralized BitTorrent client enabling paid P2P streaming and downloading within a user friendly, private, and secure environment — all built on a code-base that will be open source.

The Paid Streaming and Downloading feature (PSD) will function as an incentive mechanism giving those in demand of tail-end content a way to reward seeds to meet their needs. The decentralized architecture will reduce the cost of seeding to a minimum, and the user-friendly, privacy, and security focused approach, will lower the barriers to access and usage. These factors will set the stage for a niche content market of unrivaled selection.

PSD will also be central in addressing the issues riddling the BitTorrent environment by enabling streaming, and by giving those in demand for fast downloads and fast streams a way to reward seeds to meet their needs. Moreover, vTorrent's decentralized architecture will remove any central points of failure ensuring censorship resistance.

The decentralized architecture will yield benefits to content creators as well. In essence, it takes rent-seeking intermediaries out of the equation to allow for full revenues, complete artistic control, and instant payouts.

While vTorrent has the potential to revolutionize the entire distribution industry alone, it will invite third-party distribution services to partake in the quest by making its code-base open source. Third-parties building on top of vTorrent will save largely on cost, and gain significant in terms of potential — giving them the leverage necessary for disruption. As a result, vTorrent might become a catalyst for a paradigm shift in which the balance of power gets tilted away from the middlemen and back into the hands of the content creators and the consumers.

2 DESIGN APPROACH

At a glance, vTorrent will likely resemble your regular BitTorrent client. It is being built around the popular and lightweight Transmission client, and will include all the BitTorrent functionalities with which many of us are familiar. However, a closer look will reveal a number of additional features setting it apart:

- Paid Streaming and Downloading (PSD)
- Digital Wallet(s) — Full Node and Thin Wallet
- Cryptocurrency Trader
- Browsing and Storage Functionality
- Encrypted Chat and Anonymous Social Network
- Anonymous Transactions
- Decentralized Architecture

Paid Streaming and Downloading (PSD) is vTorrent's primary feature — being central to its most disruptive use cases. It will allow for fast, low fee, and anonymous P2P exchange of digital content with a cryptocurrency called VTR. Underpinning PSD is the BitTorrent protocol, a Zerocash PoS blockchain, and BOLT payment channels. The additional features on the above list will serve ancillary purposes with common threads of user friendliness, privacy, and security. These are fundamental values of vTorrent and fall in line with its vision of mainstream adoption.

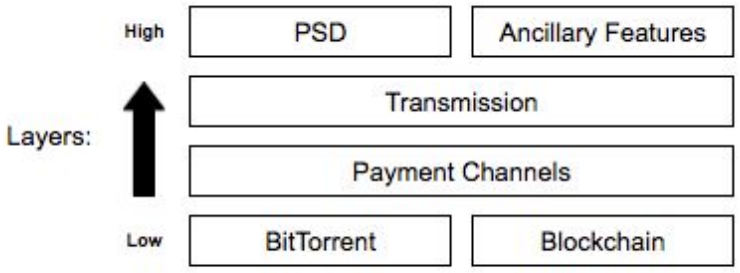

Figure 1: Architecture Overview.

Currently, BitTorrent and crypto applications are spread across a number of different sites and services. This makes for a slow and cumbersome user experience, as well as demanding a certain level of knowledge about the crypto and BitTorrent domains. The result is high barriers to access and usage incompatible with mainstream adoption. By unifying all relevant applications in one solution, vTorrent aims to lower such barriers to enable everyday people to get onboard. vTorrent's privacy and security features are intended to protect users against privacy breaches, thefts, and censorship by default. This will ensure that everyday people with limited technical knowledge on said subjects will be able to enjoy a safe ride.

3 FEATURES

3.1 PAID STREAMING AND DOWNLOADING (PSD)

The PSD feature will enable the exchange of digital content for payments in a peer-to-peer fashion over the BitTorrent protocol. Users will be free to exchange whatever content they want at whatever prices they choose using an anonymous cryptocurrency called VTR. Users will be able to download or stream different pieces of the same content from several uploaders simultaneously, as well as reselling said pieces during the downloading process. Transactions will be cheap, anonymous, and secure. The main underlying technologies of PSD are the following:

- The BitTorrent protocol
- A Proof-of-stake (PoS) Zerocash blockchain
- BOLT Payment Channels

Now, we will look at how these technologies work and how they will interact to enable the aforementioned properties.

3.1.1 BitTorrent

BitTorrent is a peer to peer content distribution protocol that allows for highly efficient transfer of large files such as movies and TV shows [5]. Central to BitTorrent's magic is its method of slicing files being transferred into a number of equally sized pieces. Another essential part of the protocol is a network of individuals who keep complete files available for anyone to download. These individuals are called seeds. The practice of keeping files available for anyone to download is called seeding.

If several individuals are downloading the same complete file from one or more seeds simultaneously, they will receive different pieces of the file. Each time they receive a new piece they will utilize their excess bandwidth to transfer a copy of the piece to any of the other downloading individuals. The group of downloaders will continue trading pieces in this manner until everyone has the complete file. Essentially, by following this process, they distribute the bandwidth burden between each other instead of leaving it all to the original seed(s). The result is downloading speeds that are vastly higher than can be achieved in a traditional client-to-server-scheme.

3.1.2 Blockchain

For BitTorrent's file-sharing efficiency to apply to a payment scheme, micro payments need to be exchanged for every piece of a file being transferred. This way, a paid downloader will be able to download or stream paid pieces of the same content from several seeds simultaneously, as well as reselling those pieces to other individuals at the same time.

For this to to be practical, payments need to be small, fast, irreversible, and low fee. Such set of features is foreign to any traditional payment system, but uniquely enabled by cryptocurrencies. The underlying technology of a cryptocurrency is called a blockchain. A blockchain is basically an immutable and decentralized database secured by cryptography and maintained by private computers all over the world [6]. This ensures that transactions cannot be tampered with, censored, or reversed. Also, because costly and ineffective intermediaries are out of the picture-transactions are allowed to be fast and cheap. vTorrent runs on a proof-of-stake (PoS) blockchain, which will get forked to the Zerocash protocol to make for fully anonymous transactions [7]. Below is an overview of the blockchain specifications:

Protocol:	Zerocash
Consensus:	Proof-Of-Stake (POS)
POS Interest:	5% Yearly
Max Coin Supply:	20 million

Table 1: Blockchain Specifications

3.1.3 BOLT Private Payment Channels

Despite its favorable properties, a blockchain alone is not enough to make a payment scheme integrated with BitTorrent feasible. While blockchain transaction fees are relatively low, they quickly add up to a prohibitively high number when taking into account that each piece of a file has to be exchanged for a payment with an associated transaction fee. Also, the resulting transaction frequency would lead to delayed settlements and in turn a bloated blockchain.

vTorrent will address this limitation by combining the use of a blockchain with an alternative payment scheme called Payment Channels. A payment channel allows a buyer to make a large number of small payments while only incurring the fees of two blockchain transactions. This method significantly lowers the total fee amount, reduces blockchain bloat, and ensures scaling in line with mainstream adoption. The type of payment channels vTorrent will integrate are called BOLT payment channels, and has the additional benefit that transactions running through the channels will stay completely anonymous. [8].

3.1.4 Streaming

A central component of BitTorrent is its tit-for-tat seeding policy. Essentially, it requires that individuals downloading content pursue a rarest-piece-first or random piece picking strategy to optimize the download time. However, this prevents users from consuming the content prior to a full download barring the possibility of streaming. vTorrent's payment scheme will alleviate this constraint enabling pieces to be downloaded in order, which in turn will allow for paid streaming. Earlier, we explained that seeding is referring to the process of keeping a complete file available for anyone to download. In the context of vTorrent, we will also refer to seeding as the process of keeping a complete file available for anyone to stream.

3.1.5 Security

In any well functioning P2P file sharing protocol, let alone one in which payments are involved, the risk of any form of cheating needs to be reduced to a minimum. For instance, there has to be a mechanism preventing a buyer from receiving content without making a proper payment, and vice versa. vTorrent’s payment channels are designed to eliminate this risk by means of multi-signature addresses. In essence, these work like decentralized escrows effectively preventing any party from cheating in the aforementioned manner. The addresses also include time-locks which allow a buyer to get his funds back at a predetermined time in case a seller leaves or attempts extortion. Another risk inherent in P2P file sharing on the side of a recipient, is that a sender transfers to him content that is inconsistent with the terms upon which the parties agreed beforehand. An example of such scenario would be one in which a malicious sender attaches a virus to the file which the recipient originally consented to receive. vTorrent’s development team has emphasized the importance of reducing this risk and a solution is currently on the development roadmap.

3.2 DIGITAL WALLETS - FULL NODE WALLET AND THIN WALLET

vTorrent will provide two different wallets each sitting in their own client. The clients will be similar in every way except for their wallets. Let’s take a look at them.

3.2.1 The Full Node Wallet

The full node wallet will require a complete copy of the blockchain be downloaded and synced. Running such wallet will assist in validating blockchain transactions. As a reward, up to 5% yearly interest will be yielded based on the VTR held in the wallet. The interest is derived from the coin supply inflation and transaction fees. The process of validating transactions and receiving interest is called staking and happens automatically when keeping the wallet open and online. Due to the aforementioned requirements, downloading the client housing this wallet will be a slow process and will demand a lot of hard-disk space. As such, the client will not be compatible with mobile use, nor convenient for users who want fast and easy access to vTorrent.

3.2.2 The Thin Wallet

The thin wallet will not require a copy of the blockchain be downloaded and synced. Therefore, downloading the client housing this wallet will be a quick process and storage requirements will be low. However, running the wallet will not assist in validating transactions which means that no interest will be yielded. Due to the low storage requirements, the client housing this wallet will be compatible with mobile use and will be a good choice for everyday users who want fast and easy access to vTorrent. Both an iOS and Android version are planned.

3.2.3 Shared functionalities

The differences between the wallets, and thus the clients in which they are housed, are limited to those mentioned above. In terms of similarities, both wallets enable basic functionalities such as sending, receiving, and storing VTR. Both can be protected with a password as well as 2FA as an extra layer of security. The wallets are heuristic determined to make backing up and restoring fast and easy. Users only need to remember a randomly generated twelve word phrase in order to restore a lost wallet. In addition, both clients will be compatible with standard operating systems such as Windows, MacOS, and Linux. To keep it simple, since the clients are similar in every way except for the aforementioned differences of the wallets, we will refer to them in singular from here and on unless otherwise is stated.

3.3 CRYPTOCURRENCY TRADER

Within the client is a Cryptocurrency Trader that enables buying and selling of VTR. The intention is to relieve users of the hassle of going to a third party exchange every time they need to trade VTR.

3.4 BROWSING AND STORAGE FUNCTIONALITY

Functionalities for browsing and storing of magnet links will be available in the client. The storage medium will be the underlying blockchain. Storing a magnet link on the blockchain will incur a transaction fee of a few cents in order to reward the stakers. The browsing functionality will be based on an integrated block explorer. As with the Cryptocurrency Trader, the intention of integrating these functionalities is to relieve users of having to jump across third party sites to find or seed content. The latter approach is both cumbersome as well as representing a barrier of knowledge for beginners not familiar with what torrent sites are safe or what torrent sites host the type of content they are looking for.

3.5 ENCRYPTED CHAT AND ANONYMOUS SOCIAL NETWORK

The vTorrent client will include an encrypted private chat as well as an anonymous social network application called Riot. Both will be end-to-end encrypted to prevent metadata and IP information from leaking during communication. Moreover, the solutions will be fully decentralized and open source.

The private chat will be useful during the trading process. For instance, if a buyer has any questions regarding the content he wishes to download or stream, he will have a fast and easy way of getting in touch with the seller.

Riot is built around chat rooms and anyone are free to create rooms with any topic to their liking. We can imagine users creating rooms with topics of the categories of content being traded in vTorrent. Prospective buyers unable to find seeds can visit the room relevant to the category of content they're looking for and either post a bounty or ask to be directed to seeds. Moreover, content creators distributing their art through vTorrent can create their own rooms to stay in close touch with their fans, or gain new fans by being active in rooms with topics relevant to their art genre. Last, users might also use Riot purely for socializing. Ultimately, vTorrent may end up having thousands of rooms covering all kinds of categories and purposes.

3.6 ANONYMOUS TRANSACTIONS

The world is turning increasingly Orwellian with companies selling privacy information to the highest bidder and governments spying on their own people. vTorrent will go against this dystopian trend by integrating state of the art privacy features to protect the privacy rights of its users rather than violating them.

In its early days, Bitcoin was renowned for being anonymous. However, it has later become clear that this is not the case. All Bitcoin transactions, along with the addresses of senders and recipients, get stored in a public blockchain for everyone to see [9]. Based on this information, sophisticated analysis tools can reveal the identity of Bitcoin users. Unlike Bitcoin transactions, vTorrent transactions will automatically hide the sender, recipient, and the value sent. This anonymity feature is by virtue of the Zerocash protocol [7]. Transactions running through the BOLT payment channels will be anonymous as well. BOLT eliminates the linkage between payments within a channel, which will ensure that a buyer's payments are hidden within the set of all payments made to the seller [8].

3.7 DECENTRALIZED ARCHITECTURE

In November 2016 the hugely popular private music tracker What.CD got shut down after a raid on several of its servers in France [10]. Almost a decade worth of carefully curated content got wiped away. Takedowns like this happen frequently, and authorities are steadily increasing their efforts to stop torrenting. The factor that makes existing torrent sites and trackers vulnerable is centralization. The files themselves get stored across decentralized mediums, but the access point where the magnet links are categorized and stored is centralized.

When fully developed, vTorrent will not quite fit the category of a torrent site, nor a private tracker. However, it will indeed include all the same features which make the aforementioned services targets of censorship. What will differentiate vTorrent though, is that its architecture will be fully decentralized. This will effectively remove any central point of failure — making censorship extremely hard. Simply said, there won't be any site to block or server to crack. Transactions and magnet links will get stored in the immutable blockchain — backed up by computers all over the world, the private chat and the Riot app will run on decentralized networks as well, while the integration of distributed hash tables will remove the need for a centralized tracker.

This section will talk about some of vTorrent's use cases:

- A Tail End Market.
- A Market for Fast Downloads and Fast Streams
- A Free File-Sharing Alternative for Current BitTorrent Users.
- A Distribution Solution for Independent Content Creators.
- A Platform for Third Party Content Providers.

4.1 A TAIL END MARKET

4.1.1 The Long Tail Theory

In a famous 2004 WIRED article, author and entrepreneur Chris Anderson introduced the theory of the long tail [11]. Essentially, it says that the collective demand for niche content can rival or even exceed the demand for mainstream content such as hits and blockbusters. The main rationale is that niche items make up for their low individual demand by being much larger in numbers than the relatively few items that end up becoming mainstream. The theory has since become widely popular and can be illustrated in what is called a Long Tail graph.

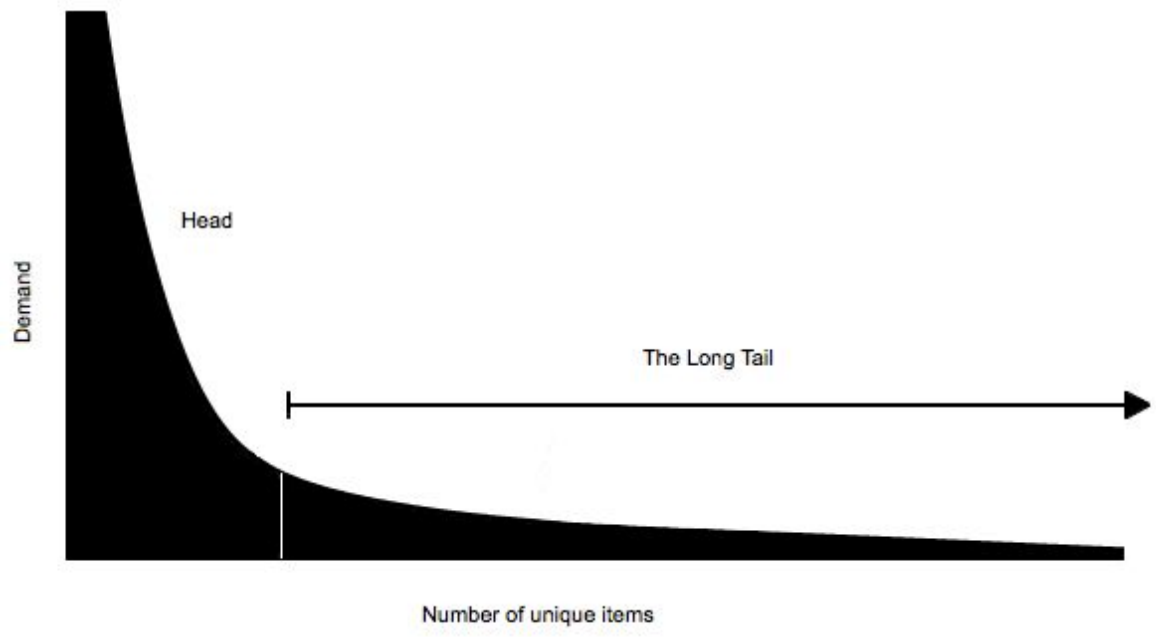

Figure 2: The Long Tail.

The left hand side of the graph, the head, represents mainstream items such as blockbusters and hit albums. The right hand side is called the long tail and represents niche items such as movies or albums by big name artists that didn't fare so well, indie content, old and obscure stuff, low budget films, etc. While the tail is much lower than the head, it is much, much longer. In other words, the quantity of long tail items in existence totally dwarfs the quantity of mainstream items. There really is no way to quantify its contents, but some might say the tail is close to infinite. Just think about all the movies, ebooks, songs, games, etc, that get produced every year, and how few of those end up becoming hits.

The mainstream adoption of the internet and the digitization of content have spawned a number of digital content providers of various types. For example, streaming platforms like Netflix and Hulu, downloading platforms like iTunes, and P2P file sharing services like public torrent sites and private torrent trackers. Not limited by physical shelving space, or costs related to physical content, digital content providers are able to provide far more content than traditional brick and mortar retailers.

4.1.2 The Tail End

Still, current providers are far from able to make available the entire long tail of digital content. For example, Netflix, Hulu, and Amazon host some ten thousands of titles combined [1], but the number of registered titles on the film database IMDB exceeds four million [2]. iTunes and Spotify provide millions of songs [12] but really old, rare, and obscure music still elude their catalogs. Even the libraries of public torrent sites are poorly supplied with the contents of the long tail. In actual fact, current digital content providers are collectively only able to make available the upper part of the long tail. The more rare and obscure items residing further out in the tail are hardly represented.

For the sake of clarity, we will label such items as “tail-end” from this point forward. Exactly where the cutoff lies between long-tail content and tail-end content is hard to pinpoint. However, as a rule of thumb, think of a typical tail-end item as being so rare or obscure that you will have trouble finding it anywhere. For example, an old Norwegian documentary about lutefisk, a song never officially released, the weird tv show from your childhood, etc. It is also impossible to measure the exact number of tail-end items in existence. However, taking into account that the Long Tail may be nearly endless, it might be fair to assume that the Tail End amounts to millions of items. Hence, if the Long Tail Theory holds true, which is likely given the numerous successful providers using it to their advantage, the collective demand for tail-end content should be significant despite the presumably low demand per item.

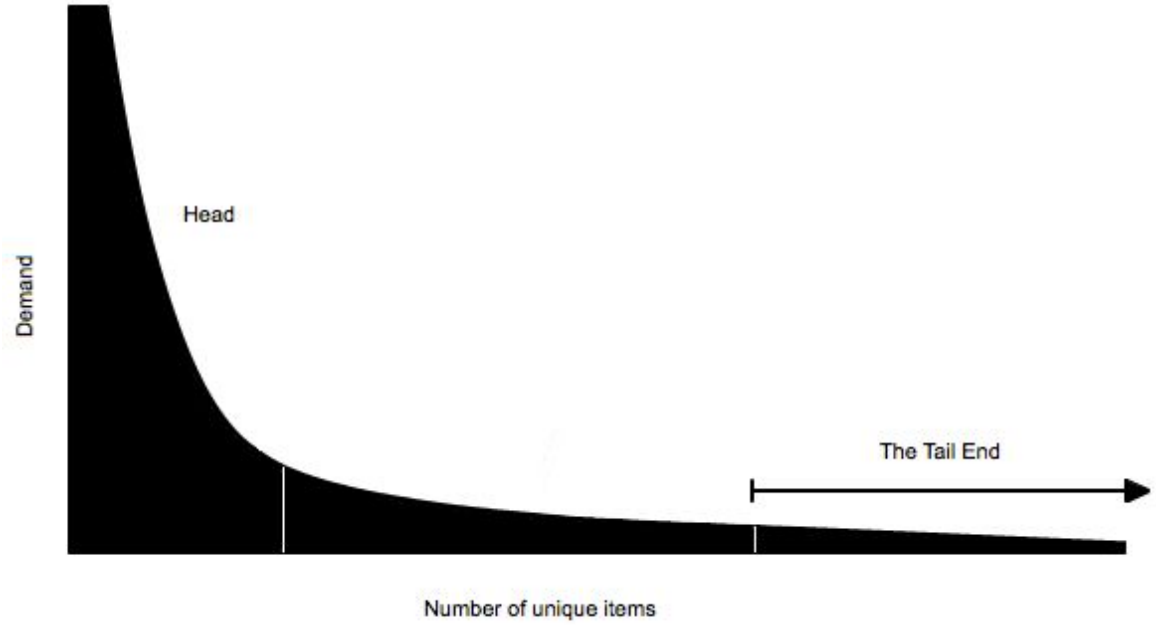

Figure 3: The Tail End

This also makes sense anecdotally. While most of us prefer content of somewhat mainstream nature, most of us also have a few preferences straying toward really obscure stuff. For example, someone may generally prefer the shows and movies available in the Netflix catalog, but also have a hunch for old Japanese science fiction movies. Moreover, we all have occasions in which we find ourselves searching for really obscure content that don't necessarily relate to our general preferences. For instance, I once came across a Youtube commenter describing how he for years had been trying to find a commercial from the 70's in which an actor from The Flew Over The Cuckoo's Nest had a guest-role, even though he didn't have any particular interest in old commercials in general [13].

4.1.3 Limitations of Current Digital Content Providers

Given that the collective demand for tail-end content seems to be significant, why doesn't the supply measure up? The answer depends on the type of digital content provider in question.

In the case of large movie and TV-show providers such as Netflix, Hulu, and Amazon Prime, cost is the limiting factor. They have to carefully pick titles that deliver most views compared to the cost of licensing in order to maintain their low prices [14]. The result is that popular titles tend to get priority.

Lacking incentives is the culprit on public torrent sites like the Pirate Bay. Since downloading is free on such sites, there is no monetary incentive to seed. Also, their public nature implies that the incentive to seed based on a sense of community is weak. Consequently, a relatively tiny

fraction of users bears the burden of seeding. Naturally, they have to prioritize their limited bandwidth, and in that regard it makes more sense to seed mainstream items of high popularity.

Private torrent communities, called private trackers, are the few oases on the internet in which the coverage of the entire tail is amazing. The catch is that their barriers to access and usage are high, leaving them inaccessible to everyday people. An invite is usually required to get access, and obtaining one is no easy task. Depending on the tracker in question, you either need to have a friend being a member with the privilege to issue invites, pass an interview with BitTorrent related questions, have a satisfying upload/download-ratio history in a previous tracker, or patiently wait for a tracker to hand out open invites which some trackers do for limited time periods. In other words, you either need connections, knowledge, experience, or lots of patience, just to be able to get your foot in the door. And that is only the first hurdle. Most trackers also require that you adhere to strict and cumbersome rules and that you maintain a certain upload/download ratio in order to maintain your membership.

In sum, due to either cost constraints, poor incentive mechanisms, or high barriers to access and usage, current providers are unable to fulfill what seems to be a significant demand for tail-end content.

4.1.4 vTorrent's Solution

An obvious solution is to address all the aforementioned limitations in one single service. That is exactly what vTorrent aims to do. With PSD, low seeding costs, and low barriers to access and usage as key features, vTorrent seeks to balance the supply and demand for tail-end content once and for all. Let's take a closer look at how these features will contribute to achieving this goal.

- **PSD - Incentive Mechanism**

  Earlier, we saw that lack of incentives is the main cause of the poor selection of tail-end content on public torrent sites. With the PSD feature, vTorrent will give those representing the unfulfilled demand for tail-end content a means to reward seeds to fulfill said demand. With the opportunity of getting paid, seeds will have an incentive to meet this need. In essence, PSD functions as an incentive mechanism facilitating the free market forces to bridge the supply and demand gap of tail-end content.

  The low availability of tail-end content (while private trackers collectively host a rich supply of such content, their high barriers to access and usage significantly limit the availability) in the current digital distribution environment implies that there will barely be any price competition outside of vTorrent. This is also likely to become the reality within the vTorrent landscape. The quantity of unique tail-end items in existence is so high, and the copies of each unique item so low, that the average tail-end item will only be in the hands of a few people. For instance, due to its age and obscurity, the "A Flew Over The

Cuckoo's Nest commercial" mentioned earlier, is probably only in the possession of a handful of people. Moreover, many seeds will likely seed content unique to their geographic area further decreasing the likelihood of overlap between seeds' sets of tail-end content. In such an environment of low price competition, seeds will naturally be able to set higher prices, which in turn will strengthen the incentive to seed.

There is a common concern that seeds may set in motion something called a race to zero. A race to zero is a vicious cycle in which seeds buy each other's content with the purpose of reselling said content for a lower price, triggering a race to price levels so low that only a few seeds will be able to stay in the market. While long-tail content closer to the head of the graph may be susceptible to this effect, content further down the Long Tail is less likely to be affected. In particular, tail-end content should be largely insulated due to the low demand per item. Rational seeds are simply not likely to take the risk of buying a tail-end item with the purpose of reselling it for a lower price given the high likelihood that a buyer will not show up in a long time.

- **Low Seeding Cost**

The ability to set high prices will not be much of an incentive if the costs related to seeding end up shaving off most of the profit margin. Luckily, this will not be the case. The only direct cost imposed on a seed is a low fee (a few cents) for adding to the blockchain the magnet link of the content to be seeded. This fee can be offset with interest revenue if the seed chooses to stake some of his income. There will also be indirect costs derived from the bandwidth required during the seeding process, from the electricity required to keep the computer turned on while seeding, and from the storage required to host content. The relevance of these costs depends on the type of seller in question.

At one extreme, we can imagine an everyday internet user who mostly engages in low bandwidth-requiring activities, who rarely bothers to turn off his computer, and who has some spare tail-end content sitting in his hard-disk. Stated differently, such an individual is in possession of spare bandwidth, spare electricity, and spare content that is already being paid for but which provide no value. By seeding his spare content on vTorrent he will be able to utilize these surplus resources to earn passive income.

At the opposite extreme, we can imagine someone with a large selection of tail-end content who will need to acquire additional storage, bandwidth, and electricity in order to maintain his seeding operation. Although these commodities will indeed add more costs to the equation, their prices are relatively low — and in the case of storage and bandwidth, the prices are continuously dropping [15, 16]. For instance, for the past 35+ years or so, the hard-drive prices have decreased till today's level of only $0.03 per gigabyte [15]. Moreover, a large seed will enjoy economies of scale - further decreasing his unit cost of content.

Thus, seeds will have strong incentives to seed tail-end content, regardless of the size of their content selection.

- **Ease of Access and Usage**

As demonstrated by the private trackers, however great the selection of tail-end content might be, it will be incapable of fulfilling the corresponding demand in the face of high barriers to access and usage. Obviously, such restrictions will also reduce the number of seeds, limiting the supply side of the market as well. In order to avoid this walled garden problem, vTorrent focuses on keeping the barriers to access and usage as low as possible. In contrast to private trackers, vTorrent will not require an invite for access nor impose any strict rules or ratio requirements for usage. vTorrent users will only need to download the free client to enter the ecosystem, and to obtain VTR with the in-client trader in order to buy or seed content. This convenient approach, in combination with the all-in-one design, and the default privacy and security features, will ensure that both the demand and supply side of the market will be allowed to reach their full potential.

- **A Tail-End Market of Unrivaled Selection**

In sum, the combination of low price competition and high collective demand will allow seeds to set higher prices, low seeding costs will enable anyone with spare tail-end content to become a seed — regardless of the size of their content selection, and ease of access and usage will enable anyone to take part of the market. These factors will set the stage for a Tail-End market of unrivaled selection comprising both streamed and downloadable content.

4.2 A MARKET FOR FASTER DOWNLOADS AND STREAMS

The PSD feature will be integral in vTorrent's aim at connecting those in demand for faster downloads and streams with those being willing and able to provide the corresponding supply.

Earlier, we learnt that the main culprit behind the poor niche content selection on public torrent sites, is lacking seeding incentives. Lacking seeding incentives is also the reason why the tiny fraction of tail-end content that actually is available on the public torrent sites tend to suffer from painfully slow download speeds. Sometimes, large, long-tail files can take days and even weeks to download. With PSD, those in demand for such files will be able to reward seeds to provide them with the download speed of their need. With the opportunity of getting paid, seeds will have an incentive to prioritize their bandwidth to fulfill the demand.

While it may seem less obvious, there is likely an unfulfilled demand for fast downloads and fast streams for mainstream content as well. This demand is likely to mostly comprise of people falling between the cracks of current content providers. To give an example, imagine a person who for some reason needs to download all the seasons of an award winning show in the course of a very short time span. Streaming services will obviously not have what he is looking for due to his downloading requirement — and at the other extreme — public torrent sites will be a hit or miss owing to the big variations of the download speeds of the content being hosted there.

The potential income to be earned for fulfilling the demand in the above examples, along with low seeding costs, and low barriers to access and usage — are the key factors designed to attract people all over the world to utilize their spare content and spare bandwidth — or acquire such commodities — to take part of the supply side of vTorrent's market for faster downloads and streams. In contrast to the tail-end market described earlier — the supply side of this market will contain all kinds of contents.

4.3 A FREE FILE-SHARING ALTERNATIVE FOR CURRENT BITTORRENT USERS

While the aforementioned use cases mostly have revolved around the PSD feature, vTorrent will provide significant benefits with respect to free file-sharing as well. Firstly, vTorrent's decentralized architecture will ensure resistance against censorship — an issue that is plaguing current public torrent sites and private trackers. Secondly, vTorrent's anonymous communication tools provide users with better privacy protection than the insecure and cumbersome solutions often utilized by current sites and trackers. Thirdly, vTorrent's all-in-one approach will ensure that the user experience is faster and easier than the current norm of which BitTorrent applications are spread across a number of different sites and services. For these reasons, many of the over 170 million monthly BitTorrent users[17] — A number larger than the combined user base of Netflix, Amazon, and Hulu [18] — may end up making vTorrent their new home.

Provided that this scenario manifests, and the immigrating seeders continue their seeding activities on vTorrent — a library comprising of free mainstream and upper long-tail content, will follow in the wake. This adds an important piece in the puzzle of vTorrent's content selection, complementing the selection of paid content described earlier.

4.4 A DIGITAL CONTENT PROVIDER FOR INDEPENDENT CONTENT CREATORS

Traditionally, content creators have been reliant upon third parties such as labels (the music industry), film studios (the film industry), or publishers (the book industry), in order to promote and distribute their art. However, the internet and digitization of content have enabled a growing number of content creators to go independent — with the benefits of higher profit margins and more artistic freedom. Despite this, they still have to deal with a distribution system comprising of rent-seeking intermediaries imposing limitations of various forms. Digital content providers, royalty collectors, aggregators, etc, all want their piece of the pie. In addition, artistic control is still under par in the industry, while delayed payouts and restrictive gatekeepers come with the territory. vTorrent looks to solve these issues with the goal of providing a much better distribution solution for independent content creators.

4.4.1 No Service Fee, Low costs

In order to cover costs and to make a profit, streaming and downloading providers retain a certain percentage of the revenue generated by the content creators using them for distribution. For instance, Apple Music and Spotify both retain roughly 20-30% [3,19]. Since vTorrent is decentralized, it is not subject to the costs common with the aforementioned services, such as credit card fees, data center costs, bandwidth costs, marketing costs, staff salaries, etc. Nor is it governed by any central entity requiring a profit on top. As such, content creators distributing their art through vTorrent will retain 100% of the revenue they earn, as well as being subject to significantly less costs.

4.4.2 Instant and Low Fee Payouts

The revenue which a content creator generates by distributing through a content provider, does not go directly into his pocket. Instead, intermediaries facilitate the transfer. As compensation, they take a cut of the brokered revenue. Usually, they distribute payouts long after the revenue generating downloads or streams took place. For instance, the intermediaries collecting and distributing payouts in the music industry commonly operate with quarterly payout dates [4]. While delayed payouts may not be a concern for big commercial artists, they indeed represent an issue for small independent ones on a tight budget. Since payments on vTorrent are P2P, costly and ineffective intermediaries will be out of the equation. If a consumer pays for a song, his payment will go instantly and directly to the artist owning the song. The only cost involved is a minuscule transaction fee to compensate the stakers.

4.4.3 Low Barriers to Access

Another advantage of using vTorrent for content distribution is low barriers to access. Current digital content providers rarely deal with content creators directly. If an artist wants to add his songs to a provider such as Spotify, he has to pay an aggregator to do this for him. In other words, aggregators are gatekeepers between content creators and providers. Using an aggregator is not only costly. It also demands time and effort which the content creator could have spent developing his art. With vTorrent there are no gatekeepers. If an artist wants to expose his songs to an audience, he only needs to download the free client, get some VTR, and start seeding.

4.4.4 Free Price Setting and No Format Requirements

Content creators using vTorrent will enjoy total freedom in regards to what content they can sell and what prices they can set. They can even choose to offer content for free if they prefer so. Such privileges, which are seldom a reality on traditional content providers, enable content creators to tailor their products in line with their different audience segments. For example, if an emerging artist is trying to build a larger fan base, he may choose to share a collection of free songs on the premise that the downloaders sign up to his mailing list. On the other side of the spectrum, an established artist might want to sell an exclusive collection of high quality songs to his most loyal fans for a premium price.

4.4.5 Unique Global Audience

Indeed, vTorrent makes the process of distribution faster, easier, and cheaper. However, such benefits are useless if there is no audience to distribute to. Since independent content creators usually produce art ending up somewhere in the tail, their target audience are not exactly the average consumers getting their fill of entertainment through Netflix and the like. A better fit of audience are consumers with eclectic tastes with a penchant for art outside of the narrow

confines of the mainstream. Luckily, vTorrent will have what it takes to attract this type of consumers.

Firstly, since vTorrent is not subject to region locks, its libraries will consist of content from all over the world — an attractive feature to anyone with diverse tastes. The lack of region locks will benefit content creators as well by increasing their global reach. Secondly, the fact that payments to content creators won't get eroded by intermediaries should be attractive as well. Those seeking art outside of the mainstream are usually not only fed up with mainstream art — but also the entire industry surrounding it. More specifically, the many intermediaries who use art solely as a vehicle of making money with the consequence of reducing the diversity of said art. By being able to pay content creators fully, consumers will be sure that they support the arts rather than the aforementioned money making scheme.

Moreover, vTorrent's additional use cases are set to draw in users fitting the description of the target audience of independent content creators. For instance, it should go without a saying that the Tail-End market poised to emerge within vTorrent will bring along individuals with an above average interest for niche content. Similar preferences can be attributed to BitTorrent users — of which a large fraction may choose to switch over to vTorrent — as described in the previous use case. Studies have found that BitTorrent users are avid, eclectic consumers of art, and that they spend far more money on digital content than average internet users [18]. For instance, a study conducted by the American Assembly in 2012 found that BitTorrent users buy 30% more music than the average internet user [20].

While these findings run counter to the popular belief that BitTorrent users are only interested in getting content for free, those who have hung out in any of the numerous BitTorrent communities on the web are likely not surprised. In these communities, discussions about the motivation behind torrenting and the willingness to pay for content pop up frequently. Commonly, participants state that they torrent to find content not available elsewhere, and that they would be more than willing to pay if possible. In other words, vTorrent seems to be the perfect matchmaker between independent content creators and the around 170 million monthly BitTorrent users.

4.4.6 Unique Fan Interaction

The days when artists were positioned as unreachable idols are long gone. In today's digital world, artists have to forge personal relationships with their audience to keep their interest. vTorrent's Riot app will be the perfect tool to facilitate this. Here, artists will be able to create their own chat rooms to stay in close touch with their fans, or they can join rooms relevant to their genre to connect with potential new fans.

4.5 A PLATFORM FOR THIRD PARTY CONTENT PROVIDERS

vTorrent's combination of being open source and decentralized makes it an ideal platform on which third parties can build streaming or downloading services. Traditionally, building such services from scratch is a complicated endeavor with high capital investments and draining operating expenses. However, a large fraction of these costs can be eliminated by building on top of vTorrent. These cost saving benefits come in addition to the ability to leverage the disruptive potential of the PSD feature. Simply put, vTorrent lowers the barriers to entry for small start-ups looking to disrupt the field of digital distribution.

Initially, most services built on top of vTorrent will likely include some centralized components since these generally pose less challenges with respect to development. However, given the numerous benefits of decentralization we may witness a race towards fully decentralized services. We can imagine services where activities such as content curation and content discovery are outsourced to users through clever incentive-mechanisms powered by blockchain technology.

5 CONCLUSION — A BRAVE NEW ECONOMY

vTorrent leverages the BitTorrent protocol and blockchain technology to create a decentralized BitTorrent client which will enable paid P2P streaming and downloading within a user friendly, anonymous, and secure environment. This removes the limitations of intermediaries and authorities, as well as lowering the barriers to access and usage — setting the stage for a brave new economy of digital commerce in which hundreds of millions of content creators, fans, seeds, and consumers all over the world will be free to participate.

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