Patrick Aichroth, Jens Hasselbach, and Daniel Thommes
Fraunhofer IDMT, Ehrenbergstr. 31, 98693 Ilmenau, Germany
{patrick.aichroth|jens.hasselbach|daniel.thommes}@idmt.fraunhofer.de
Matthias Ullrich
mail@matthiasullrich.de

LEGAL P2P WITH »FREEBIES«

Abstract: Peer-to-Peer (P2P) technologies provide technical and economic advantages which make them very interesting for cost-effective, legal content distribution. However, there are several issues to be addressed in order to fully exploit the potential of legal P2P, especially for commercial use. In this paper, we will analyze some of these requirements for legal P2P such as the promotion of legal content, the avoidance of copyright violations, and how existing advantages of P2P can be maintained for legal usage as far as possible. We will also propose the usage of »Freebies«, a DRM alternative developed by Fraunhofer IDMT, Germany, as an approach to exploit economically beneficial, and avoid economically harmful usages within P2P. The usage of »Freebies« for legal P2P will be discussed based on the requirements analyzed earlier. Finally, a prototype implementation combining Freebies and P2P based on BitTorrent and UniStore, a development of the DBIS group at the TU Ilmenau, Germany, will be briefly presented.

Keywords: P2P, Peer-To-Peer, legal P2P, copyright, content distribution, Freebies

1. The potential of Legal P2P

Because P2P technologies are often used for the unauthorized distribution of copyrighted material, they have become subject of many controversial discussions and a red rag to the media industry[1]. But despite many attempts to stop it, P2P remains extremely popular[2], and the legal and technical actions

[1] Arguments in the following apply to media in general, even though several examples are about music and the music industry.

[2] "P2P file sharing still is the application class producing, by a wide margin, most Internet traffic. Its share varies, in our observations, between 48% in the Middle East and 80% in Eastern Europe." [25]; "File-sharing traffic, whether using peer-to-peer networks or news groups, continues to increase in absolute terms while maintaining its relative position as the leading application with traffic levels similar to our study last year." [32]; "63% download music using P2P file-sharing networks. 42% have allowed P2P users to upload music from their computer" [38].

seem inappropriate to stop unauthorized file sharing[3]. However, P2P should instead be seen as a potentially powerful tool for legal distribution, anyway:

(1) P2P provides a number of *technical advantages* when compared to centralized solutions: higher resource availability and scalability, load balancing and fault tolerance, management of resources across heterogeneous platforms and support of direct communication between peers, which makes P2P especially suitable for supporting social interaction, a feature which becomes increasingly important for users [30]. Moreover, as infrastructure costs are shared, P2P also provides the opportunity for content providers to *lower distribution costs* and avoid potentially huge start-up costs [11].

(2) P2P is very popular among Internet users, which means that there are potentially huge audiences to be reached by using P2P, and at least some of the users sharing unauthorized content also spend a lot of money for content [6]. And, referring to a study of *British Music Rights* in the UK [38], three of four respondents are interested in a legal P2P service and say they would pay for it.

(3) While it is often assumed that P2P usage automatically has negative effects on content sales, this view is too simple. Potentially, P2P can do the exact opposite, i.e. promote sales. To describe this, we use Lessig's [27] definition of four different P2P music sharing cases:

A. This could be called the "*substitution*" case: It means users download content and don't purchase it. This type of use is not allowed, and even though not all downloads translate into lost sales (some users would not have bought the content anyway) it is *economically harmful*.
B. This could be called the "*sampling*" case: It means that users download content to "test" and then purchase it: This type of use is not allowed, but even though not all "testing" translates into purchases, it is *economically beneficial*.
C. This could be called the "*lost content*" case: It means that users download content which is copyrighted but not sold anymore. This type of use is not allowed, but it does *no economic harm and is good for society*.
D. This could be called the "*free content*" case: It means that users download content which is not copyrighted, or has been authorized for sharing explicitly or implicitly, e.g. because it is under a license that allows copying such as a CreativeCommons (CC) license [13]. This type of use *is allowed*, and both *society and author benefit*.

[3] "Unauthorized downloading is now at its highest level after last year's signs of decline – consumers are *less* concerned about prosecution." [30]; "efficient darknets will exist" [8].

As Lessig [27] points out, only type D sharing is clearly legal, even though only type A sharing is clearly economically harmful. Moreover, it depends on the specific circumstances whether A outweighs B or vice versa[4], i.e. P2P *has the potential to promote sales* if used adequately. Cases A and B are also referred to as *substitution effects* and *sampling effects* [3].

The claim that the above cases do exist is supported by empirical findings that P2P is not only used because content is free, but also to try before buying, and to get rarities and to find content which is not otherwise available [38][3]. The provision of a *huge selection* is obviously an important reason for the popularity of current P2P systems.

2. Requirements for Legal P2P

In summary, P2P has enormous potential for "legal distribution". But what are the important requirements for "legal P2P", apart from maintaining the described advantages of P2P as far as possible, namely *technical advantages*, *cost-effectiveness*, *huge selection, support for social interaction* and *popularity*?

Among the "TOP 10 ISSUES WITH LEGAL P2P" presented by Rodriguez [31], there are four which seem directly relevant for the analysis in this paper, and will be considered for the evaluation of our approach:

- **"Incentive mechanisms for cooperation"**[5]: To avoid free-riding, incentives for users who provide resources and promote content are needed. This would also support those users who are willing to recommend content to others [38].
- **"Corruption/Pollution/Privacy"**[6]**:** This obviously important issue is underlined e.g. by the fact that user's fear of "viruses" is on a similar level as to "get caught" [30].
- **"Play as you download / Streaming"**[7]: This requirement fits well to the fact that P2P is often used to sample / try out content.

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[4] This might explain why studies come to contradicting conclusions regarding this issue, including findings which indicate that filesharing tends to increase sales [6][3].

[5] "One critical element in P2P networks is that they rely on receivers willing to participate in the distribution process. […] incentives such as economic savings, access to premium content or community-based alternatives should be explored" [31].

[6] "P2P networks need to identify corrupted information on-the-fly and be robust in the face of such attackers. Another related issue with P2P networks is privacy. […] Thus, mechanisms must be in place to ensure that user's identity is kept private as much as possible" [31].

[7] "Even though P2P systems have been very successful in distributing large files, they fall short in providing a streaming media experience to the end user. Users often need to wait for the full file to be downloaded before it can be played, thus, adding significant delay before the content can be consumed" [31].

- **"Promoting distribution of legal content"**[8]: For "legal P2P", this is the most important requirement, and we will discuss it in more detail in the following.

2.1 Promoting the distribution of legal content

If a strict legal understanding is applied to the classification of P2P uses as described in chapter 1, only type D uses can be allowed and all other types should be avoided. In that sense, the requirement for legal P2P is *promoting the distribution of legal content*, while *avoiding copyright violations*.

If the goal of a "legal P2P" application is simply to distribute content, e.g. "free" software and media[9], as cheaply as possible, then it makes sense to *use existing P2P technology and software as is*. The purpose is not, and cannot be, to avoid copyright violations done by others using the same technology.

However, there are cases where it is desirable or even necessary to establish P2P systems in which *content exchange is controlled*: Only authorized content can be shared and copyrights violations within such a system are avoided. There are different technical approaches to create such systems[10], and in some cases they are combined with means to address another important requirement, *providing a fair compensation* for authors: If a source of financial income is available or can be established, such systems can be extended with some kind of account management, and distribute revenues among artists and authors accordingly. One example for this is DMX[11], where monthly fees from subscribers or their ISPs are used [28]. It is noteworthy that for such approaches, *accurate usage monitoring* is necessary to be able to distribute revenues fairly among authors, but this can be technically challenging. Such accuracy will become even more important as we increasingly deal with *Long Tail* [4] markets, where content items are consumed in small and very small quantities.

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[8] "Commercial P2P networks should make an effort to foster the distribution of legal content. […] it is important for commercial P2P distribution systems to publicize and encourage their legal uses and applications" [31].

[9] see e.g. [28] for a list of sites using P2P technology for legal media and software distribution.

[10] Examples for this are e.g. Fraunhofer IGDs *CONFUOCO* [33], or the P2P sharing approach by Fraunhofer IDMT chosen for the SemanticHiFi EU project [20], as well as many others.

[11] *Digital Media Exchange (DMX)* is "a P2P content service operated as a non-profit coop […] DMX allows the unlimited exchange […] with no technical protections or DRM constraints. […] DMX is fully copyright compliant […] DMX collects monthly fees from subscribers or their ISPs, and pays all the income to content suppliers (less admin costs) according to a royalty distribution formula that takes into account the types and amounts of use of each work".

Finally and most importantly for this paper, if the goal of a legal P2P system is to support *content purchase*, and if only for a specific part of the content supported, some additional requirements come into play:

- **Acceptable pricing**: The consumer's willingness to pay seems to be lower than the current prices. Price cuts would increase sales. [9]
- **Support for value-added content**: Many users are willing to pay more for value-added content[12]. [10]

More importantly, type A and B usage now become relevant, and it becomes crucial to *increase sampling effects and avoid substitution effects* to achieve a positive net benefit. But avoiding substitution effects is difficult without content protection, and especially so if they are to be avoided not only within a system but also *across systems and distribution channels*: If access to unprotected content in a legal P2P system is only granted to those who pay for the content, what will keep users from taking that content and distribute it elsewhere?

Rodriguez [31] considers Digital Rights Management (DRM)[13] to be the solution to this[14], as applied e.g. by *in2movies*[15]. DRM seems indeed potentially suitable to reduce substitution effects and to accurately monitor usage. However, there are many serious concerns regarding DRM e.g. with respect to technical, legal and security aspects [7][18][8]. One of the most problematic issues is *interoperability*, which makes DRM very unpopular among consumers, which is why they are willing to pay more for DRM-free content[16].

As an alternative to DRM, we will now present the usage of »Freebies« for legal P2P: a lightweight approach to content protection which can increase sampling effects, limit substitution effects, and avoid some of the problems of DRM at the same time.

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[12] The willingness to pay more actually refers to physical media, but should be valid for digital distribution, as well.

[13] We refer to the following definition: "A system for authorizing the viewing or playback of copyrighted material on a user's computer or digital music player. DRM has centered around copyrighted music, with Apple's FairPlay and Microsoft's Windows Digital Rights Manager being the two predominant DRM systems" [34].

[14] e.g. "Piracy and content security can be tackled to a great extent by protecting the content using DRM techniques" [31], whereas we raised serious concerns about DRM.

[15] See [24]. Note that this service has been cancelled.

[16] "almost 70% of consumers feel digital tracks are only worth downloading if they are DRM-free, and around 40% of consumers would be willing to pay more for DRM-free music" [10]; see also [30].

3. »Freebies« for legal P2P[17]

3.1 The basic idea

The aim of Freebies is to provide a legal, attractive way of presenting, sharing and promoting media content, while preserving the incentive to purchase. The basic idea is to separate personal use from "sharing", by providing purchasers with two versions of content:

1. the unencrypted, full version of the content for personal use.
2. a partially encrypted, time/quality-limited[18] tryout version, a "Freebie". It can be enhanced with user-generated promotional information and can be freely shared with others. Subsequent purchases based on this file are rewarded, which provides an incentive for the purchaser to distribute the "Freebie" and not the original content, thus becoming a "promoter".

By default, time/quality-limitation is realized by applying partial encryption[19] to support Superdistribution: The files can be distributed in a decentralized way and only a small license needs to be downloaded to "unlock" the files. In contrast to DRM, content is stored as plain, unencrypted content after purchase, thus avoiding any interoperability issues for purchasers.

3.2 Creation and Superdistribution

The initial version of a "Freebie" is created in a central and trusted registration process, with the explicit consent from the rights holder. The rights holder determines the limitation level, and can provide bonus features such as additional media objects, metadata annotations or surround sound, to enhance the attractiveness of the "full" content for purchasers[20]. Security mechanisms are also applied to enable authenticity / integrity verification of the files at any time, thus avoiding corruption or manipulation.

In order to analyze how C2C (Consumer-To-Consumer) Superdistribution works, let us assume that Joe, who has purchased the original content, e.g. a song as mp3 file, distributes his personal "Freebie" to other users (Figure 1):

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[17] For more information see [17] and [2], where »Freebies« are referred to as "personalized previews". The related concept and technology have been developed and applied for patenting by Fraunhofer IDMT.

[18] The "tryout version" should be much more than e.g. a 30 sec preview, but this is to be determined by the rights holders.

[19] There is also a variant »Small Freebies« which uses previews instead of partially encrypted content, resulting in smaller file sizes. However, they do not support Superdistribution, i.e. the full version needs to be downloaded after each purchase.

[20] Supported bonus features depend on the media type and codec used.

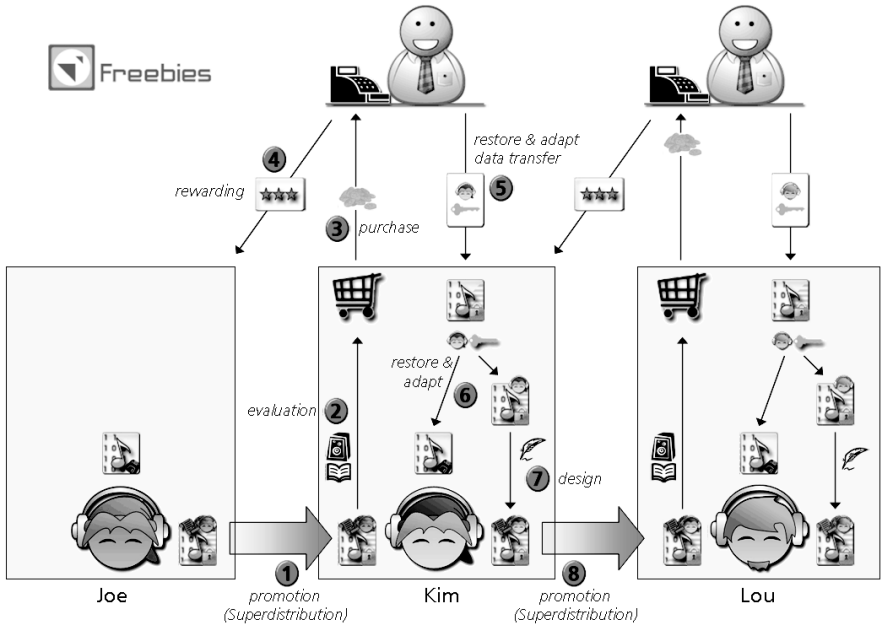

Figure 1. Superdistribution of Freebies

1. **Promotion/Superdistribution**: Joe transfers his Freebie to his friend Kim, e.g. via P2P, mobile phone, E-Mail, CD-R etc.
2. **Evaluation:** Kim evaluates the Freebie using e.g. a multimedia player with Freebie plug-in: She listens to the music and takes a look at the embedded information.
3. **Purchase**: Kim likes the song and purchases it.
4. **Reward**: Joe receives a reward, e.g. credits, or a commission[21].
5. **License Transfer**: After purchase, a license is transferred to Kim.
6. **Unlock/Restore&Adapt**: Using her license and Joe's Freebie which is already stored at Kim's device, two files are created:
   - the original mp3 is restored for Kim's personal use and
   - a new personalized Freebie for Kim is created.
7. **Design/Customize**: Kim can now design and customize her Freebie as she likes, e.g. add reviews, metadata, pictures, or create collections.
8. **Promotion/Superdistribution**: Kim transfers her Freebie to her friend Lou, and the whole process starts again (see above).

[21] Rewards can also be donated ex-ante, e.g. to the artist or an organization.

3.3 Combining »Freebies« and P2P

If Freebies are used for P2P, they can be used as a legal replacement for otherwise unauthorized content. Regarding implementation, combining Freebies and P2P can be done with different levels of integration: In its simplest form, P2P is only used to exchange Freebies, as any other file type. In more "integrated" forms Freebies functionalities are tightly integrated into a P2P system (and client), or P2P functionalities are tightly integrated into a Freebie multimedia player plug-in or standalone application, thus of course improving the user experience.

4. Evaluation of the approach

Based on the requirements collected so far, we will now evaluate how the usage of Freebies as replacements for unauthorized content within P2P can address the issues of legal P2P.

Maintain the technical advantages of P2P and cost-effective distribution: Higher resource availability and scalability, load balancing and fault tolerance, management of resources across heterogeneous platforms and support of direct communication between peers are all features which should remain largely unaffected by the usage of Freebies for P2P: Once Freebies are created, only the actual Freebie purchase process needs communication to a central server. However, such a step is necessary with any system involving a purchase process, and it does not affect the distribution of the actual content.

Freebies contain a user/promoter-specific part, so in order to support efficient data transfer, it is useful to provide a functionality to transport generic and the user-specific parts separately. This is supported by the Freebies technology. However, there is room for improvement regarding the sharing of partially encrypted files, which might also affect the P2P protocol.

Maintain a huge selection: This depends on many factors and also on how interesting Freebies are with respect to their time/quality-limitation. Nevertheless, it can be said that Freebies are a way to combine commercial and non-commercial content in one system. It can provide legal tryout versions of content which would otherwise be completely absent in a legal P2P system.

Maintain popularity: It seems impossible to judge on this issue, and we will not do so, because it is influenced by too many factors. What can be said is that any legal P2P solution will have difficulties to come close to the popularity of current P2P filesharing systems, it will remain an important goal.

Freebies are designed for legal distribution and "try before you buy", and are only created with the explicit consent of the rights holder. As such, their usage represents **promotion of legal content**. Moreover, they provide a

possibility to **promote sampling effects**, and **avoid substitution effects** for commercial content, and thus represent an interesting solution for dealing with the type A + B uses of P2P described in chapter 1. This also seems to be the case outside a specific P2P system, because the economic incentive to use the "legal content version" is not bound to a specific system or distribution channel, as long as there are legal alternatives, i.e. systems that support the technology. Whether or not the economic incentive and the opportunity to act "legally" are sufficient in order to convince a majority of users is another question, but chances are good to receive a net benefit from applying the technology, and there is virtually no risk involved.

In contrast to DRM, **interoperability issues** for purchasers are avoided and conventional soft- and hardware players can be used for consumption, because content is only protected *until* purchase, not after. As Freebies do not restrict access to content nor enforce usage rules after purchase, many of the mentioned security and legal DRM issues are avoided. And while they cannot provide a detailed monitoring of usage as DRM can, all purchases are accurately counted. That means that Freebies can also be used to **distribute revenues fairly** among authors in systems which do not sell content. In this case, the "unlocking" would not be bound to a purchase, but to other user actions, or even executed automatically.

Beyond the issues of content purchase, it is desirable to develop P2P systems that support both content which can be freely shared (type D), possibly applying mechanisms for controlling content exchange as mentioned in chapter 2, and Freebies for content to be sold (type A/B). Such **support for several content/usage types** as defined in chapter 1 is desirable, and could even be supplemented with legal and/or technical mechanisms to resolve issues around "lost content" (type C), thus completing the picture.

As for creating **incentives for cooperation**, the Freebies technology provides its rewarding mechanisms for successful promotion to the P2P system where it is integrated. It makes sense to complement these mechanisms with incentives for the provision of resources within the P2P system itself, and if possible to harmonize such rewarding schemes of P2P with those of Freebies.

With certain limitations the current implementation of Freebies is capable of **streaming**, but there could be some room for improvements as this topic has not yet been deeply investigated. **Acceptable pricing** is an important requirement which is mostly independent from the usage of Freebies. As for **support for social interaction** and **support for value-added content**, Freebies provide means for introducing user-generated information and promoting content, and support for extra features for content, depending on the media type / codec used. Thus, they can help improve a legal P2P with respect to these requirements.

As Freebies are created by a trusted, central service, and as means for authenticating Freebies are provided by the technology, **corruptions** can be detected. However, the effectiveness of avoiding corrupted content finally depends on how authentication mechanisms are integrated into the P2P client. As for the problem of **pollution**, this depends on the P2P system, but as Freebies can always be authenticated, it is comparatively easy to develop respective filters at least for them. As for **privacy**, several features of Freebies are designed to address this issue, but there is room for improvement. Most importantly, however, this issue must be tackled within the P2P system itself.

5. Exemplary implementation based on BitTorrent and UniStore

A first prototype implementation for P2P search and distribution of Freebies was pursued by Matthias Ullrich [37] 2007 in his diploma thesis and will be described in the following. The goal was to implement a completely decentralized P2P system for sharing Freebie files and a metadata search to find these files.

Based on criteria described by Dustdar et. al. [15], Hauck [21], Hauswirth and Dustdar [22] several P2P protocols which support completely decentralized sharing mechanisms could be used: Gnutella, Chord/DHASH, P-Grid, eDonkey2000 and *BitTorrent*. BitTorrent was, and still is, the most popular protocol of them, and in fact the most popular P2P altogether [25]. There are also a lot of freely available open source implementations of the protocol, and the protocol itself is public domain [12]. Considering these factors, the choice regarding the file sharing functionality was for the BitTorrent protocol.

According to the BitTorrent-FAQ [19], the most popular client software 2007 for BitTorrent was *Azureus*[22] [5]. Azureus supports decentralized tracking, provides a plug-in interface for extending its functionality and was therefore chosen for the file sharing part of the Freebie P2P application (to be described later).

As BitTorrent did not include any search capabilities [12], another solution was necessary to implement the functionality needed to search and find Freebie files. One option was to use a centralized database providing a search of *.torrent* files based on Freebie metadata queries. This is how Torrent search engines are mostly implemented, because this way, .torrent files can be found by a web-based search. The goal, however, was to find a completely decentralized

[22] According to the Website, now it seems to be µTorrent [1].

solution to benefit from the fault tolerance, availability and scalability of such systems.

Some of the decentralized P2P protocols mentioned above (e.g. eDonkey) provided search capabilities by using the concept of *Supernodes* which administer a distributed search index. However, only string search for file names was supported [16][23][35] and this was considered insufficient for Freebies, where metadata like artist, title, album, year, promoter etc. should be searchable with more advanced queries.

Considering these requirements, the distributed P2P database system *UniStore* [26], developed by the Databases and Information Systems (DBIS) group of TU Ilmenau's Faculty of Computer Science and Automation, became the development of choice to implement the search functionality. UniStore is a P-Grid [36] based P2P database which implements "a large-scaled but still light-weight distributed data system on top of popular structured overlay systems (DHTs)" [14].

The following sections describe how BitTorrent and UniStore where combined to realize the Freebies P2P application.

5.1 System Architecture

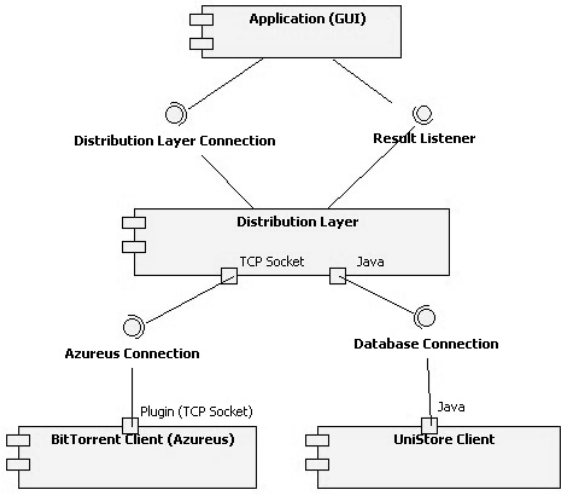

Figure 2. Sequence diagram for the "search and download Freebie" flow

Figure 2 shows the main components of the Java based Freebies P2P implementation. The Distribution Layer builds the heart of the architecture. It is a facade component encapsulating the complete file sharing and search functionality needed by the standalone user application. As mentioned before, it

provides this functionality by using the Azureus BitTorrent implementation and a UniStore Client component. While the Unistore client component is directly bound to the Distribution Layer via a Java interface, Azureus is managed via TCP Socket connection and a special Azureus-PlugIn that has been developed for this purpose.

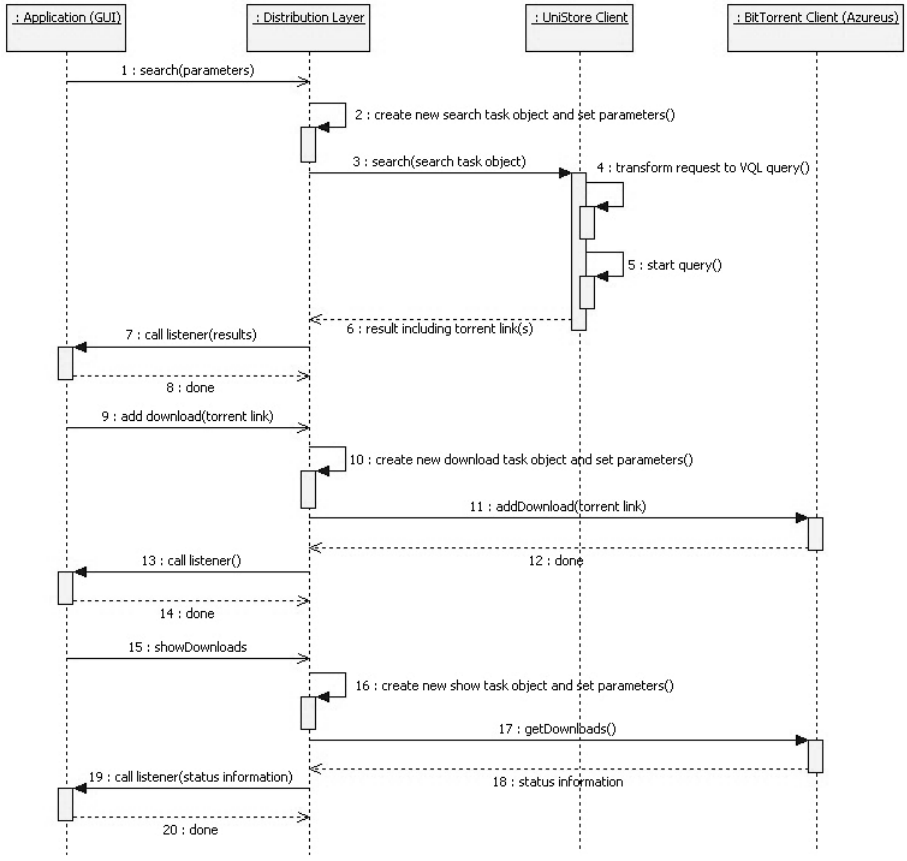

Figure 3. Component diagram showing the high level system architecture

5.2 Exemplary flow: Searching and downloading a Freebie

In order to illustrate the process flows within the system, a flow containing some of the most common operations (Figure 3) has been chosen as example for this paper: Searching for Freebies and subsequent download:

The *Application* triggers the search process by calling the *search* method of the *Distribution Layer* interface (1). Possible parameters could be the name of an artist or song, or even the identifier of a certain Freebie promoter. The

Distribution Layer creates a new task object representing the query (2). All required parameters can be set as key-value-pairs. In order to use the flexibility of the underlying database regarding search, the task object provides a number of methods for setting filter options, for instance *setDateRange* (for searching within a range of numbers) and *setTolerantSearch* (for sub-string search). Furthermore it is possible to perform pre-sorting of the results using the *setResultLimit* and *addOrder* methods. The query task is then passed to the *UniStore Client* component (3) which transforms the information contained in the query task object into a VQL[23] query (4). This query is sent to the distributed database (5) which responds with a list of results including links to the Torrent files needed for downloading the found content (6). These results are reported to the user application which displays them (7)(8).

The user can now choose to download one or more of the found items which results in the user application triggering the download process by using a link to a Torrent file as parameter (9). The *Distribution Layer* creates a new task object dedicated to perform this particular download (10) and calls *Azureus* via the TCP based plug-in, which responds with the results of this task's execution (12)(13)(14). The download has now been started.

In order to retrieve information about the status of the current download processes, the Application calls the *showDownloads* method of the *Distribution Layer* interface (15). Also this call will be transformed in a task object and sent to *Azureus* (16)(17). The *Azureus* plug-in returns the status values such as *state*, *health* and *size* which provide information about the number of actual downloaded bytes or the availability of the resource in the network (18). The status values are reported to the user application which displays them (19)(20).

5.3 Summary

As a summary, a completely decentralized P2P system was implemented for sharing Freebie files, including advanced metadata search which is an especially important feature for Freebies. The prototype implementation represents a first and important step towards legal P2P with Freebies. Of course, there is room for many further improvements, and respective work is currently being done or planned for the near future.

6. Conclusion and outlook

For many reasons, P2P promises enormous potential for legal, cost-effective content distribution. In this paper, we have identified and discussed a number of

[23] Vertical Query Language as described in [26].

requirements for legal P2P in order to use this potential, e.g. the promotion of legal content in a non-commercial and commercial context, avoiding copyright violations, introducing incentive mechanisms for cooperation, and others.

Considering the list of requirements, it becomes obvious that there is a lot of work ahead before the full potential of legal P2P will be exploited. However, the proposed approach of using Freebies for P2P seems promising, as it addresses some crucial issues of legal P2P.

The presented prototype implementation combining Freebies and P2P is a first and important step. Based on the requirements mentioned, several improvements will be made, both for the Freebies technology itself, and for the combination of P2P and Freebies. This includes security and privacy issues, metadata search, efficient sharing of Freebies and improved integration of Freebie and P2P functionalities.

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