Electronic Communications of the EASST
Volume 37 (2011)

Workshops der wissenschaftlichen Konferenz Kommunikation in Verteilten Systemen 2011 (WowKiVS 2011)

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13 Pages

Guest Editors: Horst Hellbrück, Norbert Luttenberger, Volker Turau
Managing Editors: Tiziana Margaria, Julia Padberg, Gabriele Taentzer
ECEASST Home Page: http://www.easst.org/eceasst/ ISSN 1863-2122

Service Distribution in IP Networks – A Business Model Analysis

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Abstract: In this paper we analyze different business models for the distribution of content and services over IP networks and outline their distinct characteristics and value propositions. Four business models are distinguished: Centralized Internet Hosting, Direct Homing, Content Delivery Networks and P2P Distribution. In contrast to prior research, we focus on the ability of present technology to support distribution quality. Moreover, we discuss required value chain activities and roles, technological resources, as well as revenue models and cost structures. Following an inductive approach, we generalize from business models in practice. We present case studies in order to demonstrate, how these business models are implemented. This structured business model analysis demonstrates the different courses of action of providers regarding the IP based distribution of their content and services.

Keywords: Content Distribution, Business Models, Content Delivery Networks, Peer-to-Peer Networks, Web Hosting

1 Introduction

Distribution management for tangible goods encompasses all activities associated with warehousing and transporting goods to customers as well as the associated information and controlling tasks. The objective is to *deliver the right goods at the right time in the right amount and quality* and meanwhile optimally balance the quality and the costs of the delivery service [1]. Even though the economics of information goods and services are fundamentally different [2], the objectives for the distribution of tangible goods also hold for the distribution of information goods.

Internet Protocol [3] based distribution refers to the delivery of information goods and services over IP networks, which include the Internet but also dedicated IP networks. Whereas traffic is routed in a best-effort class on the Internet, dedicated networks can exclusively reserve capacity for a specific service. Therefore, dedicated IP networks are not exposed to congestion and enable better distribution quality.

The distribution of information goods over the Internet has been subject to a discourse in research since the immense growth of the Internet in the late 1990s. Hess [4] analyses the state of the art for Internet distribution in the German media market. Gayer and Shy [5] acknowledge the importance of Internet distribution and distinguish between two fundamental Internet distribution channels: the distribution from a central server and the distribution via peer-to-peer (P2P) distribution channels. Dubosson-Torbay et al. [6] outline business models for the distribution of music over the Internet. Prior research does not sufficiently analyse the

different technical options and their implications with respect to business models for IP based distribution.

Two issues have a significant impact on the present and future evolution of IP based distribution, namely network congestion and digital rights management (DRM). As Internet traffic grows at a high speed, it is discussed whether network capacity will be able to handle the future traffic load [7]. Active traffic throttling already is enforced by some network operators [8]. Traffic throttling and network congestion endanger the quality of IP based distribution business models, which depend on best effort IP traffic. Secondly, the entertainment industry has suffered tremendous losses due to digital piracy and for this reason engages DRM technology for a better protection of the digital products [9]. The requirement to operate a DRM system imposes significant challenges to service distribution over IP networks.

The objective of this work is to analyse the different business models for IP based distribution and to outline their distinct characteristics and value propositions. We follow an inductive approach by creating systematic models of IP based distribution business models, which are presently found in practice. We present case studies in order to demonstrate, how these models are applied.

This paper is structured as follows: In Chapter 2, the general components of IP based distribution business models are described. In Chapter 3, we present four distinct IP based distribution business models, i.e., Centralized Internet Hosting, Direct Homing, Content Delivery Networks and P2P Distribution. Chapter 4 comprises a case study for each business model. The paper concludes with a summary and an outlook in Chapter 5.

2 General Characteristics of IP Based Distribution Business Models

According to Timmers [10], a definition of a business model consists of various aspects. Firstly, it comprises an architecture for the product, service and information flows and a description of the various business actors and their roles. Secondly, it encompasses a description of the potential benefits for the various business actors as well as a description of the sources of revenues. Osterwalder and Pigneur [11] identify four important pillars of business models: *product innovation, infrastructure management, customer relationship* and *financials*. The *product innovation* deals with aspects related to the offering of a firm, i.e., the value proposition, the target customers and the core capabilities. The *customer relationship* describes how a firm goes to market and maintains customer contact. It comprises an information strategy, distribution channels and trust establishment mechanisms. The *infrastructure management* determines the configuration of a value system, which is required to create value propositions. It is composed of an activity configuration, the partner network and a firm's resources. The *financials* segment defines a company's revenue model, cost structure and profit model.

In this article, we focus on general characteristics of IP based distribution business models rather than on specific instantiations. Based on the analysis of the above mentioned business model classifications, we selected the following aspects to be relevant for our business model descriptions:

- the value proposition,
- the value chain activities,
- the roles in IP based distribution,
- the technological resources, as well as

– the revenue model and cost structure.

Other business model aspects, such as customer relationship management, were not taken into account. Such aspects can not be generalized due to their specificity to a concrete business model implementation.

2.1 Value Proposition of IP Based Distribution

Similar to the distribution of physical goods, the core value proposition of IP based distribution is the delivery of goods and services in the *right time, and to the right amount and quality* [1]. Customers of information services and goods are not capable to distinguish between the influences of different actors of IP based distribution on the overall service quality. Hence, all actors of IP based distribution must cooperate during value creation (end-to-end principle). Quality of Experience, that is how a customer perceives the quality of a specific service in an IP based distribution system, is highly dependent on the specific service and customer and therefore hardly generalizable. However, for each type of service, bounds for certain technical parameters can be used to precisely describe what is considered an appropriate service quality. These technical characteristics of IP based distribution are subsumed under the term Quality of Service (QoS) in prior research [12], [13]. QoS describes the allocation of the following quality parameters to a service: bandwidth, delay, jitter and packet loss. The *bandwidth* defines the maximum volume of data per time unit being transmitted over a particular network connection. The *delay* comprises the length of time that a data package takes from the sender to the recipient. *Jitter* describes the fluctuation in the delay. *Packet loss* defines the number of data packets that are lost in the transmission from the sender to the receiver. The *right time* in IP based distribution is determined by bandwidth, delay and jitter, the *right amount and quality* of a good is influenced by the packet loss.

2.2 Value Chain Activities for IP Based Distribution

Timmers [10] recommends to employ the value chain conceptualization [14] for a systematic approach to identifying architectures for business models. In this conceptualization, a company's activities are divided into *technologically and economically distinct activities it performs to do business*.

In traditional operational distribution management one distinguishes between the following value activities [1]: Warehousing, consignment, packaging, shipment, and transport. The specific characteristics of information goods [2] affect the operational tasks for distribution over IP networks. Through an analysis of these characteristics, we identified the following core value activities for IP based distribution outlined in Figure 1: The *service production activities* encompass content creation, aggregation and packaging. As the information overflow in the Internet leads to a shortfall of attention, an emphasis is put on the customization of information goods, carried out during content creation and packaging. As information goods involve high production costs but negligible costs and time for reproduction, warehousing of stocks and consignment is not necessary. Instead, an information good is stored on a server. As a reaction to a download request, it is reproduced, packaged and fed into the IP network. These tasks form the *hosting activities*. For the *transport activities*, different rules are applicable than for the traditional logistics of tangible goods since transport is carried out over telecommunication networks. Since many information goods are requested and consumed almost simultaneously, route optimization (i.e. QoS) has even a higher priority than in

traditional logistics. Due to the complex structure of IP networks (see Section 0), transport often includes the passing on of IP packages between autonomous networks (transit) in addition to the delivery to the end customer (termination). In the *consumption activity*, the information good is consumed by end customers after delivery.

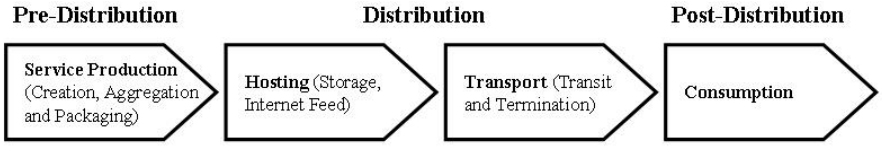

Fig. 1. Value Chain for Internet Distribution

2.3 Roles in IP Based Distribution

In IP distribution, one can identify the following roles: Content Providers (CP), Network Service Providers (NSP), Hosting Providers (HP), Content Delivery Network Providers (CDN), Distribution Software Providers (DSP), and End Customers (EC).

CPs create, aggregate and/or package content. By content, we not only refer to classical information and entertainment services, but also to B2B and communication services and user generated content. Providers of information goods rely on a good quality in IP based distribution in order to guarantee satisfactory service provisioning. They most often make use of distribution service providers for this task. Under the term distribution service providers we subsume HPs, NSPs, CDNs and DSPs. HPs operate servers and make content accessible from IP networks [15]. NSPs, operate IP networks and offer network access to CPs, HPs as well as to ECs [16]. In this work, we consider the HP to be a subrole of NSPs, because NSPs most often also carry out hosting or at least maintain close relationships to HPs. CDNs manage content distribution over a network of hosting servers applying technologies such as caching and route optimization [17], [18]. DSPs develop peer-to-peer (P2P) software for a client side optimization of content distribution [19]. ECs acquire access to IP networks from NSPs. They consume services offered by the CP and can be classified as being either private or business customers. In P2P distribution, ECs also host content.

2.4 Technological Resources for IP Based Distribution

An important aspect of business models is the type of resources, which are required. In this work, we particularly focus on the technological infrastructure such as networks, storage and processing capacity and software [20]. For a large part, IP based distribution relies on a communication network infrastructure, i.e. wireline and wireless transmission networks [21]. The Internet is a network of networks, formed by interconnected autonomous systems (AS), which are largely owned by companies with commercial interests. As peering (settlement free interconnection) and transit (charge based interconnection) agreements are negotiated individually, the Internet represents an economically very complex and often inefficient system of interconnections [22]. Due to this reason, interconnections represent potential bottlenecks for IP based distribution. Data is either passed through the Internet as best effort

traffic or through dedicated capacity, which requires additional routing and capacity management systems.

Apart from the transmission infrastructure, the location, connection and processing capacity of the hosting servers has a significant impact on IP based distribution. The strategic decision on where to host content is one of the main competencies of CDNs, which operate server networks. Lastly, also P2P systems are increasingly employed for IP based distribution [19].

2.5 Revenue Model and Cost Structure

The revenue model characterizes the revenue streams within IP based distribution. According to Wirtz and Kleineicken [23], revenue models can be characterized into either being transaction based or non transaction based as well as into generating direct or indirect revenues. Direct revenues are directly charged at end customers, whereas indirect revenues are drawn from a third party. Revenues are transaction based if they are collected in the course of a single transaction or user interaction. Otherwise, revenues are referred to as non transaction based. The ability to impose transaction based charges yields the advantage to closely tailor distribution prices and services to the type of transaction and as such to reach better price and service differentiation.

Main revenue sources with respect to IP services are ECs and advertisers [23]. For simplicity reasons, advertisement based financing is excluded in the following business cases. For distribution business models with direct revenues, advertisement based funding has a direct impact on the distribution business model but does not fundamentally alter its structure. IP transit payments between NSPs are also part of IP based distribution revenue models. Since they are not in the focus of this analysis, such payments are not taken into account.

The cost structure describes all the costs, which are incurred by a company to conduct service delivery. Costs significantly differ among IP based distribution business models. At the one extreme, IP based distribution potentially entails heavy capital and operational expenses for network or server infrastructure. At the other extreme, intelligent software based routing and distribution applications, which are far less cost intensive, can also have a significant impact on distribution quality.

3 IP Based Distribution Business Models

Four generally different business models for IP based distribution can be distinguished: Centralized Internet Hosting, Direct Homing, Content Delivery Networks and P2P Distribution. They are depicted in Figure 2 and discussed with respect to the above presented aspects in the following.

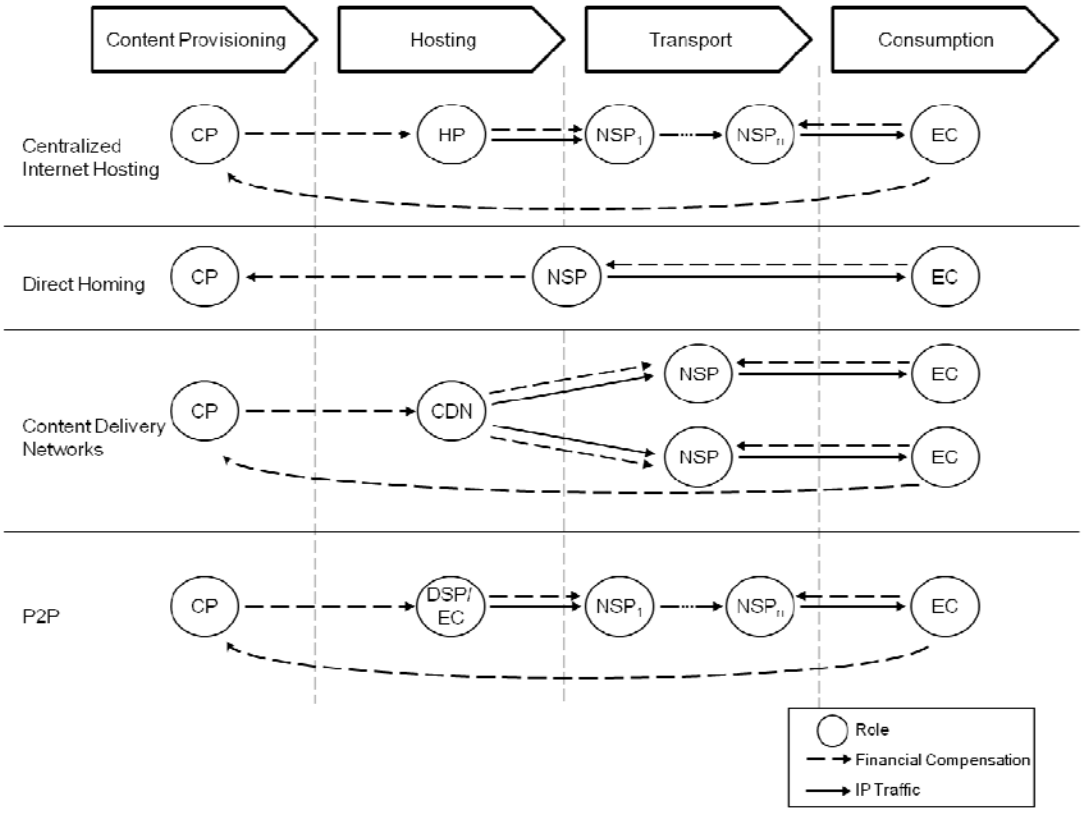

Fig. 2. IP Distribution Business Models

3.1 Centralized Internet Hosting

Activities and Roles - The centralized Internet hosting business model represents the traditional distribution method: A CP assigns hosting either to an independent HP or to a NSP. For simplicity reasons, only the second case is discussed. The HP/NSP connects the hosting servers to the Internet and makes the content accessible. It is then in the NSP's domain to further route the traffic.

Technological Resources - The centralized internet hosting distribution does not require resources additional to the classical hosting and network infrastructure. The content is only hosted and accessible at a single location. That is, a HP maintains a single access point to the infrastructure of one or various NSPs. Thus a HP requires only a central data centre infrastructure. NSPs pass on or terminate the traffic through their established interconnection or access network facilities.

Value Proposition - The distribution via centralized Internet hosting is suitable to make content accessible on the Internet, which does not need to fulfil high quality demands. The QoS highly varies, depending on the EC's location and the specific route: Whereas the QoS will most likely be perfectly acceptable if the EC is connected to the same NSP as the HP, QoS quickly exceeds acceptance thresholds, if traffic is passed on through various interconnections. The CP has no influence on the routing and as such no influence on distribution quality. In

hosting contracts, HPs generally only give guarantees with respect to server uptimes, but not with respect to QoS.

Revenue Model and Cost Structure - The IP based distribution business model does only allow indirect and transaction independent revenue models. Billing is carried out by CPs, distribution providers (HPs and/or NSPs) only receive a share: HPs charge per stored and accessed data volume, NSPs charge for access capacity. In both cases, charges are independent from individual transactions.

3.2 Direct Homing

Activities and Roles - In the direct homing distribution model, a CP directly contracts the access provider of its EC for distribution. The NSP carries out hosting and data transport. As the NSP already maintains a relationship to the ECs, it often also manages billing and takes over content related tasks such as content aggregation in a content portal.

Technological Resources - Distribution via direct homing often is realized on dedicated networks. IP traffic is not routed as part of the best effort Internet class, but as a privileged class or through reserved capacities. Routing through dedicated networks does not necessarily imply the need to install separate hardware, but requires at least a reconfiguration of routing systems.

Value Proposition - In contrast to centralized Internet hosting, the direct homing traffic is never routed through interconnections. In addition, the usage of dedicated networks enables a more reliable and configurable QoS. That is why direct homing distribution meets stricter QoS requirements and is especially suited for TV and video services.

Revenue Model and Cost Structure - In this business model, direct revenue models are often applied: NSPs charge for the package of content and distribution and pass on a license fee to the CPs. Also, transaction dependent revenue models are possible: As the NSP controls hosting and termination and often also manages content portals (such as online video shops or pay per view TV portals), it is possible to impose charges per transaction and also configure the QoS closely to the service requirements. Routing through dedicated networks does not necessarily imply the need to install separate hardware, but requires at least additional costs in the installation and operation of routing systems. Hosting and termination are carried out by the same party. This leads to synergies which potentially result in lower costs and better quality.

3.3 Content Delivery Networks

Activities and Roles - In the CDN business model, the CP tasks a CDN with hosting its content and with managing IP transit. The CDN operates a network of hosting servers and maintains transit agreements with a multitude of NSPs. Ideally the CDN interconnects directly with the access provider of the EC.

Technological Resources - The core technology of this business model is a complex network of hosting servers operated by CDNs. Content is distributed and cached on these servers based on an optimization strategy, which takes into account the location of the ECs. In addition to caching, CDNs also apply prefetching and route optimization technologies [17].

Value Proposition - The quality of distribution is highly dependent on the CDN's efficiency of server management and route optimization. For cacheable content, significant improvements in the QoS can be realized in comparison to centralized Internet hosting. For

non cacheable content, the CDN technology cannot tap its full potential, because no caching can be applied.

Revenue Model and Cost Structure – In the CDN business model, only indirect revenue models are realized, i.e. CPs charge the ECs and pay a hosting fee to the CDNs. The CDNs offer different technologies for different types of content, and as such are able to realize service and price differentiation. Nevertheless, transaction based charges are not imposed.

3.4 P2P Distribution

Activities and Roles - In the P2P distribution business model content distribution is managed by P2P software applications running on the ECs' clients. The software application, which controls content distribution is provided by a DSP, which sometimes also maintains additional hosting servers. ECs in this business model not only are consumers but also carry out hosting.

Technological Resources – Required resources for P2P distribution are limited to the P2P software and an established Internet connection of the uploading and the downloading parties. To enable content protection, a DRM system needs to be installed additionally, which for example activates content after the download is finished (superdistribution) [33]. Such a system can also be used for billing. Optionally, the DSP also installs and operates seeding servers to improve QoS.

Value Proposition – The quality of IP based distribution in P2P business models is dependent on various factors: Firstly, the P2P application and the implemented mechanisms for exchanging content have a dominant impact on service quality. Secondly, in all P2P applications, QoS is dependent on characteristics of the seeding clients, such as the number of seeds, their upload bandwidth and their location. Additionally, dependent of the route between seed and client, the network as well has influence on QoS. Bottlenecks such as interconnections or access bandwidth limitations have a negative impact on QoS. Also, NSPs can actively disturb P2P traffic, which is referred to as throttling. The complexity of these factors leads to a high variance and low predictability of P2P QoS.

Revenue Model and Cost Structure – P2P distribution providers usually have an indirect revenue model, which is not transaction based. But, dependent on the P2P system and the specific contract, transaction based revenue models are possible. The P2P business model requires very little investments into network and hardware infrastructure. Having implemented an effective P2P distribution system, DSPs can offer services at relatively low costs.

4 IP Based Distribution Case Studies

In order to illustrate, how the above presented business models are applied in practice, a single case study is further described for each business model in the following.

4.1 Centralized Internet Hosting - Strato AG

The Strato AG [34] is a German corporation, which provides web hosting services, and which operates dedicated and virtual servers. For web hosting, it offers preconfigured service packages with fixed storage space and limited traffic volume from up to 1€ per month. In addition to hosting, it also provides software systems to support content provisioning, e.g., to enable homepage development. The Strato AG is owned by freenet AG, a German NSP with a proprietary IP backbone. According to the general terms and conditions, the Strato AG

guarantees an average availability of its servers of 99%, excluding downtimes due to maintenance jobs in the customer's interest and excluding external interferences. Additionally it explicitly excludes guarantees concerning data throughput. It operates two large data centers in Karlsruhe and Berlin and maintains traffic exchanges with Hurricane Electric (US), German freenet, British Cable&Wirless and Swisscom (among others).

For SMEs with low website traffic, this is the common and most economic way of making their information accessible on the Internet.[1] But as traffic exchange points often represent bottlenecks for traffic throughput, this business model is not adequate for traffic intensive multimedia content and content with high end-to-end quality requirements.

4.2 Direct Homing - BT Vision

In the United Kingdom, British Telecom (BT) Retail offers an entertainment service called BT Vision [35]. This service uses the Internet Protocol to deliver on demand films and video streams, TV, and music. BT manages hosting, data transport and also content related tasks: BT aggregates content from film and music companies, TV channels and soccer leagues and hosts a Video-on-Demand (VoD) portal. It cooperates with Hollywood studios such as Buena Vista, Sony BMG and Dreamworks. High Definition Television content is also offered but must be downloaded before it can be viewed. BT Vision is only available for BT Retail's broadband access customers. It is realized by reserving 1.6 Mbit/s of the available access bandwidth for the VoD content in a QoS session. Customers require a set-top-box to make use of this offer. In their terms and conditions, BT does not give any quality guarantees: *We aim to provide a continuous, high-quality service but we do not guarantee either the quality of the service or that the service will be available at all times. From time to time faults in the service may occur. We will repair these faults as soon as we can.* [35] Nevertheless, through their capacity reservation technology, BT is able to offer better QoS than distributors which rely on the Internet technology. BT does not impose compulsory monthly payments, but charges on a pay per view basis. It also offers flatrates for specific offers such as pay TV channels. In both cases, BT generates direct and transaction based revenues. A percentage of this revenue is forwarded as a license fee to the CPs.

Similar direct homing business models are realized by other NSPs. In all cases, they are only applied for entertainment services, such as IPTV and VoD. Due to necessary investments into infrastructure management and customer premises, this business models is not applicable for low revenue services with less QoS requirements.

4.3 Content Delivery Network - Akamai

Akamai Technologies Inc. is an American company providing a distributed computing platform for Internet content and application delivery [36]. Its services are focussed on hosting and route optimization. Akamai is neither involved in content provisioning nor does it own IP backbone infrastructure. To improve QoS, Akamai develops and employs several technologies such as caching, route optimization and intelligent prefetching. As a basis, Akamai operates its EdgePlatform, a network of about 34000 rented servers deployed in 70 countries. Akamai's services are used by many companies such as Amazon.com, Audi, Fujitsu, HP and NBC. For Audi, Akamai distributes marketing video streams, manages model configurators and

[1] E.g., http://www.david-berlin.de/ is the homepage of a youth hostel in Berlin, Germany. From the published information about the hosting AS number, this website is hosted by Strato AG (AS 6724).

accelerates Audi's Web-based content management system [37]. According to their own claims, it is possible to improve latency and throughput by at least a factor of 10 compared to centralized Internet hosting [36]. For a streaming service, Akamai charges around 50 Eurocents per Gigabyte as a hosting fee [38]. Akamai offers content specific services and prices, but does not impose transaction based charges. Also, it relies on a strictly indirect revenue model.

4.4 P2P Distribution - BitTorrent

BitTorrent, Inc. is an American corporation, which develops P2P distribution technology [39]. BitTorrent develops a software, which enables to publish, search and download digital content. The BitTorrent Delivery Network Accelerator (DNA) speeds up video streams and software downloads. A central component is a P2P client, which integrates existing content hosting servers to seed the managed P2P network. It enables to draw on peers rather than the hosting server, if possible. It includes advanced bandwidth management to fully leverage available capacity without disrupting other applications. DNA reference customers include Aeria Games, a dynamic gaming community of Massive Multiplayer Online games and IAHGames, a leading publisher, operator and distributor of online and console games in Southeast Asia. As a value proposition, BitTorrent promises a traffic offload from the hosting server of about 50%. QoS improvements are also predicted but not guaranteed. With the DNA, BitTorrent implements an indirect and non transaction based revenue model in accordance with the above presented P2P distribution business model.

5 Summary and Outlook

In this work, we gave an overview on current business models for IP based distribution. In contrast to prior research, we focused on the ability of present technology to support distribution quality. Following an inductive approach, we generalized from business models in practice. In some cases, these business models are not disjoint, e.g., Direct Homing and P2P Distribution can be applied jointly.

In order to enable or support new data intensive real-time services, IP based distribution providers constantly further develop distribution technologies which enhance distribution and at the same time take into account the performance and capacity limitations of IP networks and the Internet. As demonstrated by successful IP based distribution business models such as AKAMAI, there is a demand for the support of quality distribution, which is superior to the plain centralized Internet hosting business model. In conjunction with the refinement of distribution technologies, new distribution business models continue to emerge. E.g., the refinement of P2P technologies [40] potentially leads to new distribution business models.

The structured presentation of business models in this work serves a twofold purpose. Firstly, it makes transparent the different options content and service providers face with respect to distribution. As such, it can support the decision, which distribution method fits best to a specific content or service. Secondly, these models can serve as a basis for the development of future distribution business models.

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