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BUSINESS MODEL COMPETITION IN THE CONTENT DELIVERY MARKET - AN INFRASTRUCTURE ANALYSIS

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Abstract

The contribution of this paper is threefold. First, we characterize the participants of today's commercial CDN market according to their business model and their set of resources. Second, we use real-world Internet topology data in order to infer CDN infrastructure resources that are associated with market success. Third, we use resource-dependency theory in order to assess if a cooperation of market participants with different business models can change the CDN market concentration based on its resources. Our results indicate that the most successful CDNs use a large number of direct interconnections with networks that are situated close to the content consuming end-customer in order to improve termination quality. Moreover, we can show that White Label CDNs are successful in acquiring the resources that are associated with market success. Finally, our results point out that a large ISP coalition which includes today's Inhouse CDNs could reproduce the most important infrastructure properties of the current market leaders.

Keywords: Content Delivery Network, CDN, Business Model, Discriminant Analysis, Interconnection.

1 Introduction

The world-wide diffusion of broadband access, the development of new services and the increase of internet-based content provisioning contribute to the rapid increase of the traffic that is carried on the Internet (Labovitz et al, 2010). Content Delivery Networks (CDNs) have largely fostered this process. CDNs enable the efficient and correct delivery of content by replicating data to interconnected servers which are located close to the consumer (Buyya, Pathan and Vakali, 2008). This service enables content providers to optimize the perceived end-customer quality by reducing effects such as latency, jitter and packet loss.

While the carried data volume continues to rise, CDNs are increasingly faced with falling revenues per data volume entity. This development is caused by investments in ever more efficient network infrastructures and new market participants (Ha, Wildman and Bauer, 2010). These new participants such as Amazon, Telefonica or Deutsche Telekom are characterized by different resources and business models than the traditional CDNs but aspire to increase their revenues in an emerging market.

Thus, in the first part of this paper we will provide a typology for the classification of the current actors in the CDN market. This typology will consider the company's business model, resources and its conducted value added steps in the CDN value chain. In the next step we assess which resources are associated with success in the CDN market and how these resources are distributed among the different CDN types. Based on considerations from resource-dependency theory we will assess if a coalition of current market players is capable of acquiring the resources that are necessary for gaining additional market share.

2 The Content Delivery Market

In this section we will introduce the theoretical foundations and a provider typology for the assessment of the current CDN market.

2.1 Theoretical foundations

The main task of a CDN is the provisioning of static data, web applications and services by distributing content among servers that are close to the content consumers (Buyya, Pathan and Vakali, 2008). In order to accomplish this goal a CDN requires resources such as trained IT professionals, a sales force but also an infrastructure for the delivery of content. Experts and scientists agree that the content delivery infrastructure is the most important resource for the business success of content delivery networks (Rayburn, 2011b)(Hau and Brenner, 2009)(Wulf et al., 2010).

Generally this content delivery infrastructure is established based on peering and transit connections with other networks of the Internet. Peering connections refer to bilateral agreements between companies which use their direct interconnections with each other exclusively for the purpose of transferring the traffic of their own customers (Giovannetti, Neuhoff and Spagnolo,, 2005). Especially for the bidirectional exchange of large data volumes it can be economically efficient to agree on peerings (Norton, 2011). However, the establishment of peerings can be time-consuming as peerings are the result of bilateral negotiations between network owners. Transit connections are characterized by financial compensation for the transit provider and denote a business relationship that allows the internet-wide termination of data (Shakkottai and Srikant, 2006). The setup of transit connections is a fast way to extend the reach of a network and providers usually offer volume discounts to large customers (Norton, 2011). Moreover, transits are usually associated with better service and maintenance conditions as opposed to un-paid peering connections.

In designing the content delivery infrastructure CDNs need to consider the termination quality. In general termination quality parameters like jitter, delay or packet loss can be improved if the content can be terminated close to the content consumer. However, as the internet exhibits a hierarchical topology with large networks at its core and smaller networks at the edge, this implies the setup of many direct connections if a world-wide coverage is aspired (Labovitz et al., 2010). Quality parameters can also be influenced by traffic routing algorithms. Following (Krishnan et al., 2009) routing paths across few networks and routers are usually associated with good jitter, delay or packet loss values. Interconnections which exhibit the required quality parameters constitute a resource which is required for offering CDN services. Thus, resource-dependency theory can be applied to assess the interaction between networks (Wade and Hulland, 2003).

Resource-dependency theory is based on the idea that organizations require resources which may be possessed or controlled by other organizations. Moreover, it assumes that organizations need to interact in order to receive the resource mix required for production (Pfeffer and Salancik, 1978). According to (Sheppard, 1995) organizations are particularly willing to cooperate if resources are scarce and partners can improve their position by bundling complementary resources. For further analysis we will characterize the CDN companies in the next step.

2.2 Provider typology for the CDN market

According to an analysis conducted in this paper we can distinguish three commercial CDN provider types. In this section we characterize these types based on their resources and business models. Subsequently we consolidate the results in Figure 1.

The CDN market analysis is based on a CDN directory that lists all video-delivery-service providers (Rayburn, 2011a). By conducting an additional internet research we make sure that no major CDNs are missing in the list and that a CDN product is explicitly offered on the company website. We do not include pure resellers of CDN services in our subsequent analyses. Based on this methodology we identified 26 commercial providers of CDN services for our further analyses (cf. appendix).

2.2.1 Classic CDNs

Classic CDNs maintain a geographically distributed network of server clusters or data centers which are connected to an overlay network (Ni et al., 2003). Moreover, Classic CDNs use their own sales offices and establish direct business relationships with large content providers. For the subsequent analyses in this paper we define that Classic CDNs do not offer White Label products on their website.

In the content delivery value chain classical CDN-providers focus on server and delivery management and the establishment of new business relations with content providers. Moreover, Classic CDNs receive a direct financial compensation from content providers for distributing the content (Wulf et al., 2010). Classic CDNs do not have an internet access network with direct access to the content consuming end-customers. Therefore, they need to establish interconnections with internet service providers (ISPs) for the termination of their content. The ownership of an access network constitutes an important resource for the ISP as in most cases the classical CDN will financially compensate the usage of the last-mile termination-network. The most established representatives of this CDN type are Akamai, Limelight Networks and CDNetworks. Together these three networks account for more than 75% of today's CDN revenue (Tier1Research, 2011).

2.2.2 Inhouse CDNs

Inhouse CDN-providers denote ISPs that operate a proprietary CDN-infrastructure within their network. The required knowledge for the provisioning of this service can either be generated incrementally within the company or is bought from specialized companies. Important characteristics of most Inhouse CDNs are access to a large customer base via a last-mile access-network and a well-developed backbone network that enables the direct interconnection with content providers (Wulf et al., 2010).

The control over an access-network and the value added-steps network operation and server & delivery management constitutes a strategic competitive advantage for Inhouse CDNs over classical

CDN-providers as data requests can be handled in such a manner that important data quality parameters can be improved significantly (Poese et al., 2010). In a constantly changing internet-topology ISPs can utilize this advantage in order to address the danger of becoming a data pipe provider for large content-providers such as Google (Labovitz et al., 2010). Established representatives of this CDN-type are companies like AT&T, Verizon and British Telecom.

2.2.3 White Label CDNs

Besides classical CDN-providers and Inhouse CDNs a third commercial CDN-provider type could be identified in our analysis. This provider type offers CDN-technology as White Label product to ISPs. In this paper we define those CDNs as White Label CDN which actively promote White Label CDN products on their website. In analogy to the classical CDN-providers a White Label CDN accounts for server & delivery management while the ISP is responsible for network management and selling of CDN-services to the content-providers. This is a cooperation in which both partners contribute complementary and limited resources to a partnership in order to improve their market position (Pfeffer and Salancik, 1978)(Sheppard, 1995). While the CDN-provider contributes the knowledge about efficient and high-quality distribution of content into the cooperation, the ISP contributes its business relations with content providers and consumers. While White Label CDNs can commercialize their products at low sales costs, ISPs can expand their product portfolio and gain experiences in dealing with content-providers.

Figure 1. summarizes the commercial business models described in this section (cf. Limbach et al., 2012). In order to maintain clarity we abbreviate content consuming end-customers (E) and content-provider (C).

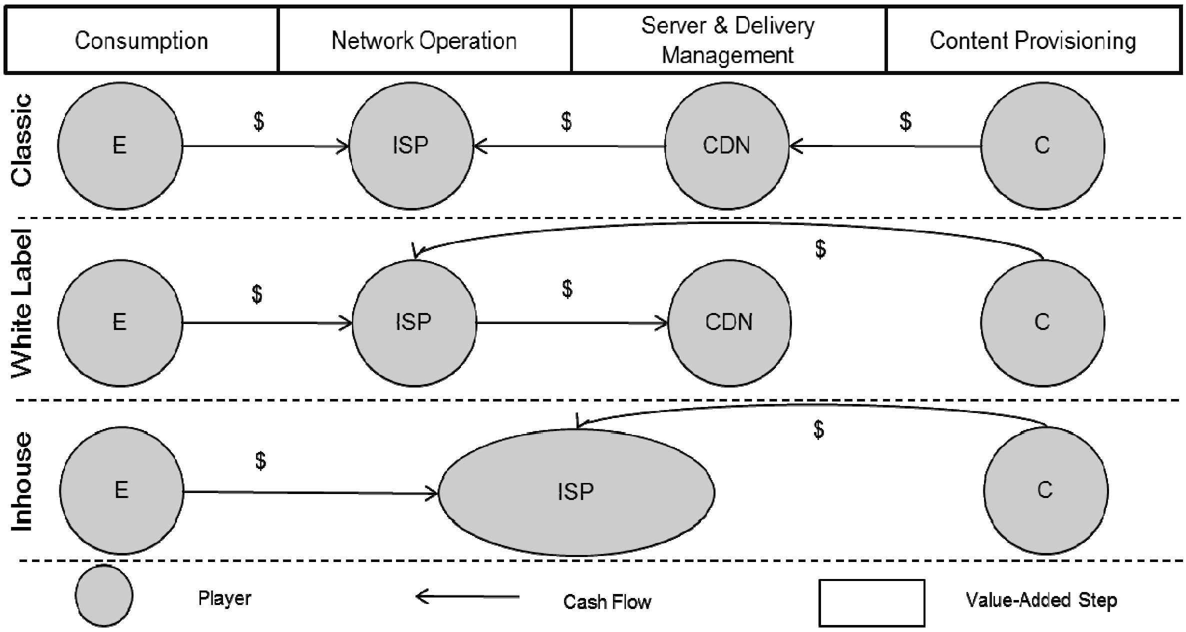

Figure 1. Simplified visualization of commercial CDN-Business Models.

2.3 Research questions

In the current CDN market most companies do not report their CDN-revenues but announce new strategies and products on a regular basis (Rayburn, 2011b). This situation leaves the current market participants but also new entrants guessing about the required steps to increase the market share. We aim to address this situation by assessing real-world infrastructure properties in order to answer the following research questions:

1. Which infrastructure properties are associated with success in the CDN market?
2. How do different CDN types of today's market differ with respect to those properties?
3. Can a cooperation of today's Inhouse CDNs and new market entrants change the current market based on its resource profile?
4. Would such a coalition be stable from a resource-dependency point of view?

The analyses in Section 4 will address research questions 1 and 2 while the analyses in Section 5 addresses research question 3 and 4.

3 Research methodology

We address our research questions in a four-step procedure. In a first step we conduct a discriminant analysis in order to identify network properties that discriminate CDN market leaders from the remaining market participants. In order to ensure the reliability and objectivity of this analysis we follow the directives for content analysis research as proposed by (Kassarijian, 1977) and (Kolbe and Burnett, 1991). The analysis incorporates network properties of all commercial CDNs that could be identified with the market analysis described in the previous section.

In the second step we perform a longitudinal analysis for those network properties that were identified significant for discriminating market leading CDNs from the remaining CDNs. This analysis will reveal how different CDN business models differ with respect to those properties.

In a third step we deepen the analysis for those network properties which were identified to be most important in the first and the second analysis step. Based on additional data which is available for the year 2011 we will conduct a second discriminant analysis. This analysis leads to a more profound understanding of the infrastructure properties which are associated with market success.

Finally, we perform an intersection analysis for the infrastructure resources of a possible ISP-CDN coalition and today's market leading CDNs. This way we infer if an ISP-CDN coalition can acquire the required tangible resources to gain a large market share. In a last step we conduct an similarity analysis for the coalition's resources in order to assess its stability according to resource-dependency theory.

3.1 Data

In order to conduct the CDN market infrastructure analyses we aggregate and consolidate data from two sources. The first data source is the AS-relationship dataset which is provided by the research institution (CAIDA, 2011). This dataset distinguishes amongst others transit- and peering relationships between more than 36,000 autonomous systems (AS) that make up the internet. CAIDA educes this dataset from publicly accessible Border Gateway Protocols (BGP) based on an algorithm which was first proposed by (Gao, 2001). A review based on the results determined from the Gao-algorithm shows, that 96.5 % of the transit- and 82.8% of the peering relationships are ascertained correctly (Dimitropoulus, 2007). In addition to the data described above CAIDA offers two 2011 figures for the estimation of a network's size. The first figure is denoted as *AS degree* and refers to a network's number of direct connections with other networks. The second figure is a network's *AS number* which includes the number of networks which can be reached by recursively following all transit- and peering relations. Subsequently we will use these two figures in order to infer the size of transit provider's termination-network. By using the CAIDA-data we accept the limitation, that connections which are not announced in public BGP tables cannot be considered in our analyses. Furthermore, paid and un-paid peerings cannot be distinguished due to similar routing characteristics (Dimitropoulus, 2007). The second data source provides information about a network's applied routing algorithms by measuring the average number of traversed networks and routers of a data package with any other network on the internet (Fixedorbit , 2011). Based on this data we assess the influence of routing decisions on market success. As Fixedorbit does not provide historical data we use the Internet Archive project in order to retrieve data for the last four years (Internet Archive, 2011). Table 1 aligns the analysis steps of the subsequent section with the applied research method and the research question to be addressed.

Analysis step	1	2	3	4
Research method	Discriminant analysis	Longitudinal Analysis	Discriminant analysis	Similarity & intersection analysis
Data	CAIDA AS Relationship & FixedOrbit data for 2007 - 2011		CAIDA termination-network data for 2011	
Addressed research questions	1	2	1 & 2	3 & 4

Table 1. Analysis sequence for the assessment of our research questions.

The first discriminant analysis and the longitudinal analysis are based on the assessment of 18,001 interconnections and 392 path lengths measurements for the years 2007-2011. We aggregate and join this data and receive 117 datasets *n* for further analyses.

4 Discriminant and longitudinal analyses for the current CDN market

Based on the collected data described above we assess CDN network parameters with a univariate ANOVA analysis and a stepwise discriminant analysis. For this purpose we classify the datasets into two groups. The first group contains the datasets of the top 3 CDNs in matters of market share as proposed by (Tier1Research, 2011) for the years 2007 to 2011. This group generates more than three-fourths of overall revenues in the market. The second group contains the datasets of the remaining CDNs.

	Univariate Analysis			Stepwise discriminant analysis[abc]		
	Group mean 'Top 3 CDNs' (n=20)	Group mean 'Others' (n=97)	F for group mean equality test	F	Wilks-Lambda	Discriminant loadings[d]
Avg. # Networks traversed	2.70	2.53	3.367*	2.288*	.972	.029
Avg. # Routers traversed	4.08	3.76	1.704	.008	.985	.233
# Transits	28.80	6.99	26.850***	26.850***	.811	1.000
# Peerings	17.60	30.44	.701	.057	.994	-.110

Table 2. ANOVA and stepwise discriminant analyses for the current CDN market.

[a] Minimal partial F-statistic for acceptance:3.84, Maximal partial F-statistic for exclusion: 2.71.
[b] Wilks Lambda of discriminant function: 0.811 , Number of Steps: 1.
[c] Class mean values of discriminant function: Top 3 CDNs = 1.32 , Others = -0.19.
[d] Correlation between discriminating variables and the canonical discriminant function.
* $p<0.10$, ** $p < 0.05$, *** $p<0.01$.

The univariate and the stepwise discriminant analyses show that the top 3 CDNs significantly differ from other CDNs in terms of the number of transit interconnections. According to our analysis the average number of transit connections is four times higher within the group of the market leading CDNs. Moreover, market leading CDNs differ weakly significant in terms of the average number of networks traversed. However, the analysis shows that the group of the top 3 CDNs on average routes data across more networks then CDNs in the second group. The number of peerings and the number of traversed routers does not make a significant contribution to discriminating the two groups.

Subsequently we perform a longitudinal analysis for the parameters that significantly contribute to distinguishing successful networks from less successful networks. By performing this analysis we aim to assess network dynamic differences between different business models and market leading CDNs. For this purpose we assess four CDN groups. The first group comprises the top 3 CDNs. The remaining CDNs are grouped by their business model. The results depicted in Figure 2 indicate that all types of CDNs have increased the number of transit connections during the last four years. Moreover, the Figure 2 shows that the top 3 commercial CDNs are classical CDN providers. These successful CDN providers have established more transit connections than other companies. Though White Label CDNs do not belong to the top CDNs as a matter of market share they also largely increased their average number of transit connections during the last years. Other CDN providers and Inhouse CDNs have hardly increased the number of transit connections.

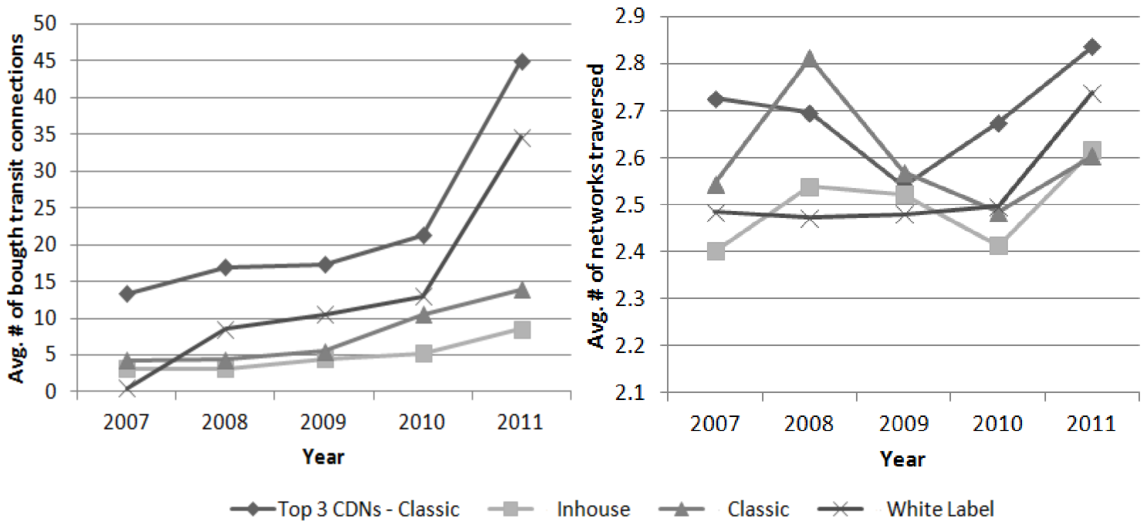

Figure 2. Longitudinal analysis for group discriminating network parameters.

The right-hand side of Figure 2 shows that CDN networks hardly differ with respect to the routing parameter *networks traversed*. Moreover, our analysis indicates the that the top 3 CDNs on average traverse more networks than other CDNs. Moreover, the analysis shows that classical CDN providers on average route data across more networks than Inhouse and White Label CDNs. Since a short path-lengths does not seem to be characteristic for successful CDNs we will exclude the parameter *networks traversed* from the third step of our analysis. Instead we will focus on the question how transit connections contribute to success in the CDN market.

In the last step of the current CDN market analysis we assess the characteristics of networks that connect with CDNs via transit connections. By conducting this analysis we aim to understand if the CDN transit providers differ with respect to their *AS degree* and the *AS number*. As the CDNs pass on content to their transit providers this analysis will reveal insights into the characteristics of the termination-networks of different CDN types. For this analysis we use 278 datasets about transit providers of today's 26 CDNs.

	Univariate Analysis					Stepwise discriminant analysis[efg]		
	Group mean 'Top 3 CDNs' (n=93)	Group mean 'Other Providers' (n=82)	Group mean 'White label' (n=53)	Group mean 'Inhouse' (n=50)	F for group mean equality test	F	Wilks-Lambda	Discriminant loadings[h]
□ AS Degree	834.38	1023.96	681.60	1258.62	5.47***	5.47***	.941	1
□ AS Number	27165.20	28204.16	22758.55	30756.88	2.32*	2.32*	.974	.69

Table 3. Discriminant analysis for the termination-network of different CDN types.

The ANOVA and the stepwise discriminant analyses show that the average number of directly connected networks to a transit provider significantly contributes to the discrimination of CDN groups. The number of indirectly connected networks is close to the overall number of networks and contributes only weakly significant to the discrimination of CDN groups. Moreover, the analysis indicates that the top 3 CDNs and White label CDNs on average use transit providers with a smaller network. Usually smaller networks can be found at the edge of the internet, this means closer to the content consuming end-customer (Labovitz et al, 2010). Less successful Classic providers and Inhouse CDNs preferably establish transit connections with networks which are close to the core of the internet and reach most content consuming end-customers via indirect connections.

5 CDN-market impact of a possible CDN-ISP cooperation

According to a formal model proposed by (Hau and Brenner, 2010) ISPs can fundamentally change the current CDN market because classical CDNs and White Label CDNs critically depend on the access to their termination -network. However, until 2010 no Inhouse CDN could be found among the top ten CDNs with the highest revenues (Tier1Research, 2011). Our results from Section 4 indicate that the main reason for this situation might be a termination-network which exhibits too few transit connections. Based on resource-dependency theory and our previous analyses we argue that the existing network interconnections constitute tangible resources which are required for being successful in the CDN market (Wade and Hulland, 2003). Thus, we aim to predict the market success of a cooperation based on properties that are related with the coalition's termination-network. For our cooperation analysis we will assume based on (Rayburn, 2011b) that all ISPs which have announced their own CDN activities and all current Inhouse CDNs will form a cooperation.

In a first analysis step we calculate the coalition's number of transit relations by identifying and eliminating redundant connections. In the course of this analysis we also assess a member's contribution to the coalition by calculating the bilateral similarly index *SI:*

[e] Minimal partial F-statistic for acceptance:3.84, Maximal partial F-statistic for exclusion: 2.71.
[f] Wilks Lambda of discriminant function: 0.941 , Number of Steps: 4.
[g] Class mean values of discriminant function: Top 3 CDNs = 1.32 , Others = -0.19.
[h] Correlation between discriminating variables and the canonical discriminant function.
* $p<0.10$, ** $p < 0.05$, *** $p<0.01$.

$$SI(A,B) = \frac{2 \times |A \cap B|}{|A| + |B|}$$

In this formula A denotes the number of transit connections of ISP A and B the number of transit connections of ISP B. The similarity index is equal to 1 if two networks use exactly the same transit providers. In this case one of the networks does not make an additional contribution to the ISP-coalition in terms of extending the network with additional transit connections. Accordingly, the mutual contribution of two networks is large if the similarity index is close to 0.

In a second step we assess the termination-network property *AS Degree* which was identified to be highly significant for discriminating CDNs types during current CDN market analyses. Finally, we aim to understand how the cooperative infrastructure of the ISP-coalition can impact the current CDN market. For this purpose we perform an intersection analysis based on the infrastructure of the current market leader Akamai, the infrastructure of the top 3 CDNs and Telefonica which is the ISP with the largest number of transit providers. The results of the termination-network analysis are consolidated in Table 4. In this table the first number of each cell refers to the number of transit connections that both networks have in common. The second number indicates the average network size of the transit providers that both networks have in common.

Intersection analysis	Akamai	Top 3 CDNs	Telefonica	ISP-cooperation
Akamai	53 I 582.31	53 I 582.31	37 I 736.68	47 I 727.15
Top 3 CDNs	-	93 I 834.38	57 I 728.72	73 I 716.63
Telefonica	-	-	63 I 634.57	63 I 634.57
ISP-cooperation	-	-	-	92 I 774.99

Table 4. Intersection analysis for the ISP-cooperation network.

The results of the intersection analysis show that a CDN-ISP cooperation consisting of the current Inhouse CDNs and those ISPs which already have announced CDN activities could cover up to 88,7% of the termination-network of the present CDN market leader Akamai. Even Telefonica as the ISP-coalition member with the largest number of transit connections could cover only 69% of the current termination-network of Akamai. Moreover, the analysis shows that the ISP-coalition would exhibit as many transit connections as the three market leaders exhibit together. The assessment of the average termination-network size per transit connections shows that ISP-coalition partners on average establish transit connections with termination-networks that are larger than those of the market leader Akamai and thus usually further away from the content consuming end-customer. However, the average network size connected to the ISP-cooperation is smaller than the average network size of the top 3 CDNs.

The similarity index analysis showed that the ISP-cooperation members on average have a similarity index of 0.22 with a standard deviation of 0.03. That is, the cooperation members have on average 22% of their transit connections in common. With as similarity index of 0.64 Telecom Italia and Bell Canada exhibit the largest similarity between two coalition members. In contrast British telecom and Deutsche Telekom have a similarity index of 0.04 as both networks have only one transit connection in common. In the subsequent section we will interpret the findings of our current CDN market analysis and the results of ISP-cooperation analysis.

6 Interpretation

The empirical assessment of the current CDN market indicates that successful CDNs use content-delivery infrastructures which differ significantly from other content-delivery infrastructures in terms of the number of transit connections and the average size of the connected termination-networks. Moreover, our results show that successful CDNs pay a large number of transit providers which provide a rather small termination-network. Following (Labovitz et al., 2010) this can be explained by the fact that smaller networks are usually located closer to the edge of the internet and accordingly the content terminating ISPs. This way termination quality parameters like delay, jitter and latency can be improved for the content consumer (Krishnan et al., 2009). Furthermore, the results show that the success of a CDN does not primarily depend on a short routing path. As CDNs usually deliver large amounts of data it can be more efficient to redirect user request with an elaborated multi-step routing algorithms that selects the best server in terms of optimized quality parameters as opposed to serving the request via the shortest routing path (Buyya, Pathan and Vakali, 2008). Thus, routing information about the average number of traversed networks should not be used as a measure of termination quality in the CDN market.

In addition to the identification of infrastructure properties that are related with market success we were able to show a trend towards cooperation within the CDN industry. This trend becomes manifested in the growing importance of the White Label business model which is based on close cooperation with ISPs. During the last four years White Label CDNs have established a termination-network that exhibits properties which are similar to today’s top 3 CDNs. Inhouse CDNs have been less successful in setting up a termination-network which is close to many content consumers.

Accordingly the announcement of Inhouse CDNs and ISPs to establish a CDN-ISP cooperation is comprehensible. Based on the infrastructure assessment of a possible CDN cooperation we can derive the implication that such a cooperation would be capable of reproducing the network properties which are associated with market success. Furthermore, our network similarity analysis showed that most networks of the announced coalition would contribute complementary infrastructure resources to the cooperation. Thus, we can deduce from resource dependency theory that such a coalition is likely be stable once it is established (Pfeffer and Salancik, 1978)(Sheppard, 1995)(Wade and Hulland, 2003).

7 Summary and Outlook

In this paper, we provide an assessment of all major commercial CDNs of today’s market. Moreover, we present a typology for the classification of CDN networks which is based on the characteristics of their value chain activities. In a quantitative analysis we infer from real-world infrastructure data that the most successful CDNs pay a large number small networks for the termination of their content. In the course of this analysis we argue that this strategy can improve important quality parameters for content delivery. Based on a longitudinal analysis we can point out that White Label CDNs are increasingly successful in the setup of market leading termination-networks. Finally, we show that a large ISP coalition which includes the current Inhouse CDNs could reproduce the most important infrastructure properties of the current market leaders. Based on our analyses we can conclude that the CDN market is moving towards less market concentration and manifold CDN offers.

The generalization of our results is limited do the usage of CAIDA data. Even though there is currently no more advanced research project for the assessment of the internet infrastructure it is not possible to assess private network interconnections. Moreover, it is obvious that even in a network industry an infrastructure analysis can only make a partial contribution to a holistic explanation of success factors in the CDN market. Thus, further research should focus on assessing the impact of intangible resources on success in the CDN market.

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Appendix

Name	Business Model	Number of Transit connections 2011	Name	Business Model	Number of Transit connections 2011
Akamai	Classic	53	Mirror image	White Label	1
Amazon.com	Classic	34	NTT	Inhouse	10
AT&T	Inhouse	18	Orange France	Inhouse	16
BitGravity, Inc.	Classic	46	PCCW Global	Inhouse	8
British telecom	Inhouse	45	Savvis	Classic	24
CacheFly	Classic	28	TeliaSonera	Inhouse	18
CDNetworks	Classic	71	Telstra International	Inhouse	34
ChinaCache	Classic	22	Velocix	White Label	1
Cotendo	Classic	13	Verizon Business	Inhouse	1
EdgeCast	White Label	67	Voxel dot Net, Inc.	Classic	49
Fastweb	Classic	37	**ISP that have announced CDNs**		
Highwinds	Classic	53	Bell Canada	ISP	20
Internap	White Label	45	Deutsche Telekom	ISP	1
KPN	Inhouse	3	France Telecom	ISP	6
Level 3	Classic	17	Telecom Italia	ISP	11
Limelight Networks	Classic	11	Telefonica	ISP	63

Table 5. Commercial providers of the current CDN market.