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IP ADDRESS ALLOCATION THROUGH THE LENSES OF PUBLIC GOODS AND SCARCE RESOURCES THEORIES

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Abstract

The current Internet Protocol (IP) addressing system, Internet Protocol version 4 (IPv4), is a resource with limitations. All IPv4 address blocks have now been allocated, posing a risk that not all IP address requests will be satisfied. As IP addresses may be considered public goods, it is important that they are allocated efficiently in order to comply in an equitable manner with the demands of all Internet participants. At the moment it is uncertain as to when, or even whether, Internet Protocol version 6 (IPv6) will replace IPv4. This article looks at the current system of IP address allocation and the risks and benefits of introducing an IP address transfer market in compliance with constitutional principles.

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1. Introduction

The Internet has become a valuable tool in everyday life and is a phenomenon that encompasses social, cultural, economic, and legal facets. Originally, the Internet address system was based on unique IP numbers assigned to every website. This allowed their identification by the system. In 1984, these addresses were translated from numbers into words, thereby facilitating their use.[1] At the time of the Internet's inception, scarcity of IP address space seemed to be unlikely as information and communication technologies ("ICT") were cost-intensive and therefore only few networks were interested in Internet connections.[2]

In the course of the last fifteen years the demand for IP addresses has enormously increased. As IPv4 only makes available about four billion IP addresses,[3] a capacity shortage was soon anticipated and is about to happen now. Being a limited resource[4] IPv4 is at risk to be unable to satisfy all IP address requests made by Internet hosts. In June 2010, 6% of the capacity was still available in the pool, i.e. approximately 250 million IPv4 addresses, however, scholars did not agree when the shortage would become an actual problem. Geoff Huston's assumptions, for instance, counted on slightly less than 410 days;[5] hence, the last IPv4 address blocks would be allocated in August 2011. According to other appraisals IPv4's free pool exhaustion would occur sometime between 2011 and 2012.[6] Contrary to these assumptions, IPv4's free pool exhaustion occurred in February 2011.[7]

The problem of shortage could be mitigated by various techniques such as "Network Address Translation" ("NAT"), which hides multiple Internet hosts behind a single IP address by connecting private networks to the public Internet. However, such a procedure would have the disadvantage of breaking end-to-end connectivity. As a

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[1] Jonathan Postel, the Internet pioneer and coordinator of the DNS, defined seven "generic top level domains" (gTLDs): three for universal use (".com" for commercial activities, ".org" for organisations and ".net" for networks), three for use in the US (".gov" for governments, ".edu" for universities, ".mil" for the military), and one for intergovernmental treaty organisations (".int"). Countries and territories were given their own last names with the so-called "country code top level domains" (ccTLDs).

[2] B Edelman, "Running out of Numbers: The Impending Scarcity of IP Addresses and What to Do about It" (2009) available at http://www.hbs.edu/research/pdf/09-091.pdf (accessed 28 Mar 2011).

[3] The text of this subchapter is partly based on some thoughts the first author developed in *Shaping Internet Governance: Regulatory Challenges* (Zurich: Springer Verlag, 2009), at 189-190.

[4] J Malcolm, *Multi-Stakeholder Governance and the Internet Governance Forum* (Perth: Terminus Press, 2008), at 10.

[5] G Huston, "IPv4 Address Report" (2010) available at http://www.potaroo.net/tools/ipv4/index.html (accessed 28 Mar 2011).

[6] APNIC, "Prop-050: IPv4 address transfers" (2009) available at http://www.apnic.net/__data/assets/text_file/0009/12420/prop-050-v005.txt (accessed 28 Mar 2011); M Beckman, "Beware the black market for IP addresses" (2010) available at http://features.techworld.com/networking/3222451/beware-the-black-market-for-ipv4-addresses/ (accessed 28 Mar 2011).

[7] See http://www.ripe.net/internet-coordination/ipv4-exhaustion (accessed 28 March 2011); for further details see 3.1.1. below.

result, Internet interactivity would no longer be fully granted, making it difficult to establish Internet telephone calls directly between two hosts using standard voice over IP (VoIP) protocols. Furthermore, the method would increase complexity since there are two classes of computers (some with public addresses and some with private addresses) as well as costs for design and maintenance of networks and for the development of applications.[8]

Another measure would consist in establishing a market to enable a trade of IPv4 addresses; a further alternative could envisage offering incentives to sell unused addresses and reclaiming those already-allocated address blocks that are under-utilised. However, these methods also have drawbacks, as IP addresses are not property in a strict legal sense, and mechanisms for enforcing the return of addresses do not exist.[9] Nevertheless, despite such technical and administrative means, sooner or later the demand for IP addresses can no longer be satisfied by the IPv4 version.

The impact a shortage will have on the Internet's interactivity underlines the difficulty in establishing architectural change. Already more than ten years ago (in 1998), the substitute for IPv4, namely IPv6, was recommended as the next generation IP addressing scheme for implementation.[10] The design of IPv6 aims at providing quantitative and qualitative advantages compared to the current IPv4. Originally, it was assumed that IPv6 would be adopted by 2005; however, the process has been delayed. In any case, it remains certain that the Internet's technical architecture must be re-engineered in order to cope with the future addressing needs.

IPv6 is deemed the best way forward, as it provides for a long term solution to the address space problem, with a vast number of addresses[11] which can be managed more easily than within the framework of IPv4. Furthermore, IPv6 includes issues such as service, auto-configuration, security, and mobility. Developing and deploying services and applications promises to be less complicated and less costly than under IPv4, thereby providing a basis for innovation and for allowing users to have their own networks connected to the Internet.[12]

Even though IPv6 was developed to succeed IPv4, the two Internet protocols are currently not fully compatible. Since no formal transition plan exists regarding the coordination of the parallel use of both protocols and the market-driven coordination across the Internet has so far failed, the intended transition from IPv4 to IPv6 has been insufficiently worked out;[13] IPv6 is not yet widely adopted.[14] While most computing

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[8] Commission of the European Communities, "Advancing the Internet: Action Plan for the deployment of Internet Protocol version 6 (IPv6) in Europe" COM(2008) 313 (2008), at 4, available at http://ec.europa.eu/information_society/policy/ipv6/docs/european_day/communication_final_27052008_en.pdf (accessed 28 Mar 2011).

[9] Commission of the European Communities, see note 8 above, at 4.

[10] J Malcolm, see note 4 above, at 13.

[11] IPv6 is told to make available about 600 billion IP addresses.

[12] Commission of the European Communities, see note 8 above, at 5; see also L Latif, "Widening the Internet Address Space: Towards IPv6" in W Kleinwächter (ed), *The Power of Ideas: Internet Governance in a Global Multi-Stakeholder Environment* (Berlin, 2007) 227-242, at 228 and 240-242.

[13] See J Hofmann, "Before the Sky Falls Down: A 'Constitutional Dialogue' over the Depletion of Internet Addresses" in B M Hutter (ed), *Anticipating Risks and Organising Risk Regulation* (Cambridge: CUP, 2010) 46-67, at 51.

platforms already support IPv6 adoption, acceptance by Internet service and content providers ("ISPs") has been quite limited: most ISPs still rely on IPv4.[15] With this in view the still existing demand for IPv4 addresses will soon exceed the remaining pool of IPv4 address space, now in the hands of the RIRs,[16] again entailing important implications for the evolution of Internet infrastructure and technology.

A wide range of formerly allocated address space is no longer used; according to some estimates, only between 10 to 15% of allocated IP addresses are currently in use.[17] Therefore, the possibility of carrying on a trade of allocated but unused IP addresses gains importance. From a legal perspective, trading with domain names is basically permissible provided that there is no injury of third-party rights, such as naming rights or other rights.[18] Therefore, looking from the angle of a casual observer, trade with IP addresses should be permissible, too. However, trade of IP addresses is not accepted[19] mainly based on the IP addresses' public good character.[20]

2. Public Goods and Scarce Resources

2.1. Notion and Characteristics of Public Goods

2.1.1. Notion of Public Goods

The idea that knowledge is a public good and that access to it should be open to all has become a truism.[21] However, it cannot be overlooked that the provision and distribution of knowledge, notwithstanding its public good qualities, raise several difficulties. Public goods are manifold and framing them with an abstract definition might be unduly limiting. However, the vast and varied literature on the subject mainly delineates public goods in opposing them to private goods, thus mapping out their key characteristics rather precisely.[22]

Public goods have been classified according to different criteria: (i) There are norm-dependent and norm-independent as well as pure and impure public goods. (ii) A further categorisation is possible according to the scope of effect: public goods can be

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[14] T Claburn, "Internet Runs out of IP Addresses" (2011) available at http://www.informationweek.com/story/showArticle.jhtml?articleID=229201157 (accessed 28 Mar 2011).

[15] J Hofmann, see note 13 above, at 51.

[16] See 3.1. below.

[17] J Hofmann, see note 13 above, at 51.

[18] F Koch, *Internet-Recht*, 2nd ed (München: R. Oldenbourg Verlag, 2005), at 478.

[19] J Hofmann, see note 13 above, at 52.

[20] See 2.1.3. below.

[21] See R Weber, "Traditionelles Urheberrecht: Sprengstoff für die Informationsgesellschaft?" in R Hilty and M Berger (eds), *Urheberrecht am Scheideweg?* (Berne: Stämpfli Verlag, 2002) 69-86, at 81-84; P Drahos, "The Regulation of Public Goods" (2004) 7(2) *Journal of International Economic Law* 321-339, at 1; L Lessig, *The Future of Ideas: The Fate of the Commons in a Connected World* (New York: Random House, 2002).

[22] The first rigorous definition of public goods is provided by P Samuelson, "The Pure Theory of Public Expenditure" (1954) 36(4) *Review of Economics and Statistics* 387-389.

local, national, regional and global. Ideally, global public goods are those which benefit humanity as a whole, meaning that public goods have to fulfill three criteria – geographical, socio-economic, and generational – in order to qualify as global:[23] Accordingly, global public goods should provide benefits (i) to more than one group of countries or geographic regions, (ii) to a broad spectrum of the global population, crossing population segments, and (iii) to the present generation without jeopardising the ability of future generations to meet their own needs.

2.1.2. Characteristics of Public Goods

(1) Public goods can either be constituted by law or contribute to general benefits independently from any norm.[24] They ideally have two qualities that stem from their public nature: everybody is, in principle, able to derive benefits from the provision of such goods. They are non-rivalrous in consumption and non-excludable:

- The non-rivalry characteristic means that the good has the potential to be enjoyed by all without becoming depleted; consumption by one individual does not detract from the good's utility and does not hamper consumption by other persons.[25]
- The non-excludability property implies that no one can be excluded from enjoying the benefits of the good; exclusion from a public good is theoretically possible, but usually costly and complex in political, social, and economic terms.[26]

These qualities are easy to elaborate in the rare case of public goods that possess both characteristics – the so-called pure public goods – like peace. The case of goods that only respond to one of the characteristics appears more complex. These so called mixed or impure public goods possess mixed benefits: they either meet one criteria and not the other or are partly non-rival and/or partly non-excludable.[27] Moreover, the degree of "publicness" of a good is influenced by social norms and technologies and may change over time.[28]

Furthermore, public goods are characterised by problems of their provision; due to their non-rivalry and non-excludability qualities, they cannot be optimally provided by the market.[29] A rational individual's action does not contribute to a collective optimum in the case of public goods: Since everyone gets benefits out of a public good at zero marginal costs, i.e. without having to provide payment for the additional sharing of the public good,[30] there is no incentive for a private provision. In this

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[23] See I Kaul, I Grunberg and M Stern (eds), *Global Public Goods: International Cooperation in the 21st Century* (Oxford: OUP, 1999), at 10-12.

[24] P Drahos, see note 21 above, at 321, states as examples (i) peace, order and good government on the side of public goods constituted by norms and (ii) forest and algae that consume carbon on the other side.

[25] I Kaul, I Grunberg and M Stern, see note 23 above, at 3-4.

[26] *Ibid*, 4.

[27] *Ibid*, 4-5.

[28] P Drahos, see note 21 above, at 326-327.

[29] Public goods are often addressed in connection with "market failures" in public economics.

[30] D Begg, S Fischer and R Dornbush, *Economics*, 8th ed (London: McGraw Hill, 2005), at 282.

respect, the free-rider problem[31] and the prisoners' dilemma[32] have been highlighted, advocating the need for applying additional mechanisms in the public goods provision, such as state intervention and cooperation.[33]

(2) Externalities are usually defined as the "unintended positive or negative effects arising from any action, which are not borne directly by the person(s), organisation(s) or country(ies) responsible for the action".[34] Externalities can thus be seen as "by-products", or "spillovers" of certain activities into the public sphere.[35] However, the concept of externalities is closely linked to the construct of public goods: Indeed, public goods and notably public "bads" can be envisaged as special cases of externalities,[36] focusing on an action's utility or disutility to third parties. For instance, a firm that releases polluting chemical products into a river may eventually harm the environment and human beings, resulting in a public bad. The considerations around externalities are paramount in the public goods regulatory discussion. Indeed policy-making often addresses the activities occasioning externalities, instead of dealing directly with the externalities seen as public goods or bads; thereby, activities producing positive externalities can be incentivised, while negative ones can be curbed.

2.1.3. The Public Good Character of IP Addresses

The term "public good" does not imply that the concerned "good" is an object in the traditional meaning that the owner can touch and control it; as already mentioned, knowledge and information can constitute a public good. Obviously, IP addresses are not physical and not directly controllable by the user since the allocation is (directly or indirectly) derived from Internet Address Registries. This fact, however, does not mean that IP addresses cannot be qualified as public goods since (apart from

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[31] A free-rider is someone who benefits from a good without paying for its production costs. The free-rider problem particularly concerns public goods: As these goods benefit everybody once they are available, no one has an incentive to contribute and thus let the others benefit without paying. Hence, no one is likely to pay for public goods, although everybody would be better off by contributing to them. See *Ibid*, 47, 269 and 281.

[32] The prisoner's dilemma was originally used to illustrate global policy-making issues: It analyses the choices made by two suspects arrested by the police who are in different cells. Each of them is offered the same deal: if one testifies against the other and the other remains silent, the betrayer goes free and the silent accomplice receives for example the full ten-year sentence. If both stay silent, both prisoners are only partially sentenced for a minor charge. If each betrays the other, each receives for example a five-year sentence. However, prisoners are forbidden to communicate and therefore no one knows what the other will chose, betrayal or silence. Developed in game theory, the prisoner's dilemma model reaches the conclusion that the only concern of each individual prisoner is maximising his or her own payoff, without any concern for the other. Although both would be better off by cooperating and remaining silent, i.e. following a common strategy, the dominant choice is betrayal, i.e. following an individually-driven strategy. See L L Martin, "The Political Economy of International Cooperation" in I Kaul, I Grunberg and M Stern, note 23 above, at 54-57.

[33] For detailed explanations see I Kaul, I Grunberg and M Stern, note 23 above, at 6-9.

[34] P Accuosto and N Johnson, "Financing the Information Society in the South: A Global Public Goods Perspective" in Instituto del Tercer Mundo (ITeM), *Information Society for the South: Vision of Hallucination?* (Montevideo, 2005), at 15.

[35] I Kaul, I Grunberg and M Stern, see note 23 above, at 5.

[36] *Ibid*, 5-6; D Begg, S Fischer and R Dornbush, see note 30 above, at 283.

intellectual property rights) many intangible goods are treated like property-like knowledge, information, or databases (even without copyright protection). Looking at the actual handling of a "transfer" the additional question could be asked whether IP addresses are indeed goods or rather services since the "trade" with IP addresses requires the execution of registration services. From a private law point of view, the "purchase" of the IP address is the key element, the registration services are merely an accompanying act (notwithstanding the fact that registration might be a condition precedent). Nevertheless, the question of qualifying a "transfer" of an IP address as sale of a good or rendering of a service is not relevant for the public good aspect since such a qualification does not depend on the private law qualification.

To function properly IP address blocks can only be used by one network so as not to lead to conflicts in routing.[37] Hence IP address resources are rival; they have to be exclusive and globally unique to serve their purpose. Furthermore, compared to other public goods, the amount of IP addresses is a limited resource, as the address space of the Internet cannot be expanded when it reaches its limits; the much larger address space of IPv6 is also finite.[38] This evaluation holds even if IPv6, in comparison to IPv4, supports a larger address space and is based on 128 bit addresses; it corresponds roughly to $2^{128} = 3.403 \times 10^{38}$ unique addresses.

As a global common pool resource[39] which does not belong to anyone,[40] Internet address space falls within the definition of public goods, too, even though the non-rivalry and non-excludability characteristic[41] (partially) fails. IP addresses are considered as public resources [42] or not priced public goods.[43] Since the amount of IP addresses is limited and the consumption is rivalled, a well-functioning common pool resource management is needed to ration or limit private occupancy by establishing and enforcing limits on appropriation.[44]

2.2. Regulatory Models for Allocation of Scarce Resources

Although from the economic point of view each good may become a scarce resource by cutting the price and therefore increasing the demand, some goods are scarce resources by nature as their substitution is almost impossible. If the availability of a good is limited, a (re)distribution procedure is needed in order to decide on its usage. Regarding the goods' allocation a variety of options exist, among others the allocation

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[37] M Mueller, "Economic factors in the allocation of IP addresses" (2009), at 8, available at http://www.itu.int/dms_pub/itu-t/oth/3B/02/T3B020000020003PDFE.pdf (accessed 28 Mar 2011).

[38] For further details see S Deering and RM Hinden, "Internet Protocol, Version 6 (IPv6) Specification, RFC 1883" (1995) available at http://www.faqs.org/rfcs/rfc1883.html (accessed 28 Mar 2011).

[39] W Lehr, T Vest and E Lear, "Running on Empty: the challenge of managing Internet addresses" (2008), at 26, available at http://cfp.mit.edu/publications/CFP_Papers/Lehr%20Lear%20Vest%20TPRC08%20Internet%20Address%20Running%20on%20Empty.pdf (accessed 28 Mar 2011).

[40] J Hofmann, see note 13 above, at 52.

[41] For details see 2.1.2. above.

[42] M Mueller, see note 37 above, at 8.

[43] See G Huston, note 5 above.

[44] M Mueller, see note 37 above, at 7.

(i) based on historical facts, (ii) based on merits, (iii) by a bidding process,[45] (iv) by discretion and (v) by implementation of a market.

(i) Allocation based on historical facts: Within the scope of the allocation based on historical facts, the applicant is awarded so many goods obtained in the past as long as there are no valid reasons to the contrary. Theoretically, this type of allocation is easy to handle; based on theoretical experiences, offer and demand are estimated; thereafter a pro-rata-allocation takes place.[46]

(ii) Allocation based on merits: The most prevalent type of allocation is based on the applicants' merits. This method of selection awards the contract to the applicant that complies with the public requirements supposedly most and therefore entails the comparatively largest attraction. In order to compare the applicants selection criteria have to be established.[47] Furthermore, a difficult and time-consuming selection procedure is needed.[48]

(iii) Allocation based on bidding process: Furthermore, the allocation of scarce goods can take place within the framework of an auction. There are different types of auction sales,[49] among others the English auction and the first-price sealed-bid. In an English auction starting prices are determined for each product on sale and all potential buyers bid orally on the respective products advancing the offer successively until no higher bid is launched (ascending bid). In comparison, within the first-price sealed-bid all bidders bid secretly by writing and the highest bid is awarded the contract. In either case the one who is willing to pay the highest price gets the scarce resource/good.

(iv) Allocation by discretion: In addition, an allocation can also be made by discretion. Within the scope of this allocation mechanism the applicant has to demonstrate his need for resources; thereafter, the person in charge allocates the resources by using his discretion. Obviously, discretion cannot mean that a complete "freedom" of allocation exists; a decision must be taken based on good faith and objective-orientation of the matter.

(v) Allocation based on market implementation: Finally, the allocation of scarce resources can be determined by the market itself. Market structures influence the allocation of resources among competing market participants insofar as the market allows for the discovery of prices; therewith potential buyers are provided with information about the respective scarcity of a good. A prerequisite is, however, the institutionalisation of proprietary rights with regard to the scarce resources; the resource's "proprietor" needs to have the ability to use his/her proprietary rights.

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[45] R Weber, *Wirtschaftsregulierung in wettbewerbspolitischen Ausnahmebereichen: Studien zur staatlichen Wirtschaftsregulierung und zum Einsatz der Regulierungsinstrumente in den Transport-, Kommunikations- und Energiemärkten in der Schweiz und den Vereinigten Staaten von Amerika* (Baden-Baden, 1986), at 250.

[46] S Breyer, *Regulation and Its Reform* (Cambridge, MA/London: Harvard University Press, 1982), at 120.

[47] N Malaviya, *Verteilungsentscheidungen und Verteilungsverfahren* (Tuebingen: Mohr Siebeck, 2009), at 161-162.

[48] S Breyer, see note 46 above, at 73.

[49] For more details see P Klemperer, *Auctions: Theory and Practice* (Oxford: OUP, 2004), at 11.

Hence, the applicant paying the highest price to the "proprietor" is getting the scarce resource.

(vi) Evaluation: The historical allocation mechanism has partly been adopted for the allocation of resources within the energy sector in case of temporary scarcity. The longer the allocation based on historical facts is maintained, however, the more unfair are the effects since this allocation mechanism does not take into account the market players' needs. In contrast, this allocation mechanism adversely affects "new" applicants in a substantial manner making it almost impossible for them to get hold of the respective good.[50] The allocation by merit largely avoids the discrimination of certain market participants by not differentiating between "old" and "new" applicants even if the establishment of selection criteria happens in a subjective manner.[51] However, the overall processes are often not very transparent and lobbying and regulatory capture problems following from the wide discretion of the authorities remain an important problem. This also holds good for the allocation by discretion which in the end might be confronted with good faith problems if the discretion is misused. Taking into account the market rules, allocation based on a bidding process establishes a real price for the resource[52] and, most importantly, a well-designed auction is the method most likely to allocate resources to those who can use them most valuably.[53] Finally, the allocation based on market implementation takes into account the market players' needs. However, the quality of the service rendering is less assured; the principle of deep pockets does not necessarily take into account the public interest.

Since each allocation mechanism possesses advantages and disadvantages it is a debatable point, which method of allocation with regard to the (re-)allocation of IP addresses might potentially be feasible. However, no mechanism should be principally excluded; therefore, the market approach will be subsequently discussed in more detail.

3. Regulatory Framework for IP Addresses Market

According to the current rules, the selling of IP addresses is precluded which leads to an absence of trading and market prices.[54] Nevertheless, as the Internet is at risk of running out of IPv4 addresses, other mechanisms must be implemented to allocate the address spaces, such as market-based allocation schemes for the transfer or the reuse of already allocated but unused IP addresses which could induce a more efficient use of the available resources.[55] The consideration of new allocation mechanisms is justified even if the proper handling of the address use has become better since the Regional Internet Address Registries (RIRs) are applying audit measures in order to hold address "owner" accountable for the address use since many address blocks have been allocated between the 1980s and 1992 which are unused, i.e. hoarded. Therefore,

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[50] N Malaviya, see note 47 above, at 157.

[51] *Ibid*, 161.

[52] M Mueller, see note 37 above, at 28.

[53] P Klemperer, see note 49 above, at 170.

[54] M Mueller, see note 37 above, at 9.

[55] W Lehr, T Vest and E Lear, see note 39 above, at 1.

light should be shed on the governance and ownership of the address space, followed by approaches to introduce market mechanisms taking account of the potential benefits and relevant risks of a transfer market.

3.1. Current Governance of the Global Address Space

3.1.1. Competent Authority

The whole pool of IP addresses as common good is managed by the Internet Assigned Numbers Authority ("IANA"),[56] which has since the early 1990s delegated the allocation of Internet resources to five established Regional Internet Address Registries ("RIRs")[57] that are obliged to take due regard to global addressing policies.[58] Although IANA's tasks were transferred to a great extent to the Internet Corporation of Assigned Names and Numbers ("ICANN"),[59] IANA among other things is still responsible for the global coordination of the Internet Protocol addressing system allocating the IP addresses from the pools of unallocated addresses to the RIRs according to their needs. IANA grants to the RIRs address space in units of large /8 blocks of 2^{24} addresses[60] and does not directly allocate addresses to end users.[61] On 3 February 2011 IANA allocated the last IPv4 address blocks to the RIRs[62] causing a situation that IPv4 addresses are no longer available for allocation from IANA to the RIRs. The projected (final) depletion of the RIRs' address pools is now forecasted for 15 August 2011.[63]

The non-profit RIR corporations[64] oversee the allocation of IP addresses, both IPv4 and IPv6, to Internet Service Providers (ISPs),[65] National Internet Registries

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[56] In 1989, the US Department of Commerce (DoC) concluded a contract with the Department of Post and Telecommunications' Information Sciences Institute (ISI) at the University of Southern California, establishing the Internet Assigned Numbers Association (IANA); for further information see http://www.iana.org/numbers/ (accessed 28 Mar 2011).

[57] For further details see B Edelman, note 2 above, at 3.

[58] At the beginning of the Internet, a single authority combined both service areas and distributed the information through the RFC document series; for further details see W Lehr, T Vest and E Lear, note 39 above, at 9.

[59] IANA is operated by ICANN that was created through a Memorandum of Understanding between the United States Department of Commerce and itself in 1998 as a non-profit public benefit organization, among other things aiming at the preservation of the operational stability of the Internet. For further details see R Weber, "Internet Corporation for Assigned Names and Numbers (ICANN)" in C Tietje and A Brouder (eds), *Handbook of Transnational Economic Governance Regimes* (Leiden: Martinus Nijhoff Publishers, 2009), at 603-619.

[60] B Edelman, see note 2 above, at 5.

[61] See http://www.iana.org/numbers/.

[62] See "Free Pool of IPv4 Address Space Depleted" (2011) available at http://www.nro.net/news/ipv4-free-pool-depleted (accessed 28 March 2011); "The IANA IPv4 Address Free Pool is now Depleted" (2011) available at https://www.arin.net/knowledge/v4-v6.html (accessed 28 Mar 2011).

[63] G Huston, see note 5 above.

[64] At the present time there are five RIRs in operation, namely the American Registry for Internet Numbers (ARIN) for North America and Parts of the Caribbean, the RIPE Network Coordination Centre (RIPE NCC) for Europe, the Middle East and Central Asia, the Asia-Pacific Network Information Centre (APNIC) for Asia and the Pacific region, the Latin American and Caribbean

("NIRs"), and individual network institutions. They are self-regulated and they set their own policies to govern the allocation of addresses. As these RIRs' policies are developed through a formal development process encompassing deliberation via email lists and debates in periodic policy meetings that are open to all interested parties,[66] each region has developed slightly different policies.[67] According to these policies applicants are obliged to prove their need for the address space; the RIRs review these plans and award address blocks correspondingly for a small fee. These fees bear no proportion to the value of the associated addresses; they are intended only to cover the RIRs' costs.[68]

Furthermore, the RIRs are accountable for the maintenance of the WHOIS-database, which records all allocations and contains information on the holder of allocated Internet addresses.[69] They base their power on the consent of their membership which primarily consists of the main users of addresses, ISPs and organizations with large networks.[70]

3.1.2. Management of the Internet Address Space

According to the agreements concluded with the RIRs, the recipients of IP addresses inter alia are obliged to maintain accurate WHOIS contact information and to return no longer required IP addresses to the RIRs' free pool of IPv4 address space. Since an independent trade with unused IP addresses is precluded,[71] a network with excess IPv4 address blocks should get more incentives to search for unused address space und return it to the respective Internet registry. Accordingly, the whole management of the IP address space allocation lies within the competence of the RIRs. These contracts concluded with the RIRs also contain contractual remedies enforcing compliance with the address usage policies; however, de facto such contractual remedies were almost never used in the past.[72]

As they require further address space due to the ongoing growth, most resource recipients need to obey the RIRs' policies since on each such occasion the RIRs are able to evaluate ongoing compliance. Nevertheless, as observed in recent years, several IP address "owners" seem to contravene their contractual regulations by trading IP addresses for their own accounts[73] without being penalised by the RIRs.

Internet Addresses Registry (LACNIC) for Latin America and parts of the Caribbean region and the African Network Information Centre (AfriNIC) for Africa.

[65] Internet Service Providers ("ISPs") are also known as Local Internet Registries ("LIRs").

[66] W Lehr, T Vest and E Lear, see note 39 above, at 9.

[67] The respective policies can be found on the RIRs homepages, see https://www.arin.net/ , http://www.ripe.net/ , http://www.apnic.net/ , http://lacnic.net/en/index.html and http://www.afrinic.net/ (accessed 28 Mar 2011).

[68] B Edelman, see note 2 above, at 22.

[69] The WHOIS-database provides the interested party with information like owner of the address space, contact person and postal address.

[70] J Hofmann, see note 13 above, at 50.

[71] B Edelman, see note 2 above, at 19.

[72] W Lehr, T Vest and E Lear, see note 39 above, at 10.

[73] J Hofmann, see note 13 above, at 46: T Claburn, see note 14 above.

Even though the RIRs try to enforce the prohibition on independent IPv4 address space transfers by refusing to update their WHOIS-databases,[74] this instrument of power not really constitutes a hurdle to applicants since the entry into the databank is unrelated with the proper functioning of the respective IP address blocks.

With this in mind the current IP address allocation method should be reassessed; in particular, transfer mechanisms for the (re)allocation of this scarce resource, especially regarding the resale, are to be considered.

3.2. Reform Steps within the Current IP Address Allocation

3.2.1. Approaches for Improving IP Address Allocation

Since 2007 many proposals have been made within the RIRs' regions in respect of the reorganisation of allocated but unused address space. As to the content, they range from making little modifications of the existing policies up to a completely liberalised market that allows for a trading of IP address blocks.[75]

In the last three years the policies within almost all RIRs have been modified regarding IPv4 address allocation, the latest discussed proposals were presented (i) in the Asia and Pacific region (APNIC), (ii) in Europe (RIPE), (iii) in the Latin America and the Caribbean region (LACNIC), and (iv) in North America (ARIN). As summarised hereinafter; the African Network Information Centre (AfriNIC) currently has no similar policy or proposal under discussion.

(i) APNIC: Within the APNIC-area the latest version of the proposal regarding the IPv4 address transfer between current APNIC account holders ("Prop-050") was tabled on 24 July 2009, aiming at the amendment of removing APNIC policy restrictions on the transfer of registration of IPv4 address locations and IPv4 portable address assignments.[76] Having passed a variety of debates and hearings the proposal was implemented on 10 February 2010.[77]

Since the value of the APNIC IPv4 address registry[78] is based on an accurate description of the current state of address distribution each address movement transaction needs to be registered, otherwise the registry will have decreasing value to the broader community.[79] Therefore, section 3 of the new "APNIC transfer, merger, acquisition, and takeover policy" (transfer-policy)[80] states that APNIC will process and record IPv4 address transfer requests between current APNIC account holders under specific listed conditions. Among other things the respective address block must be allocated or assigned to a current APNIC holder, the minimum transfer size is

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[74] B Edelman, see note 2 above, at 19.

[75] J Hofmann, see note 13 above, at 52.

[76] APNIC, see note 6 above.

[77] See http://www.apnic.net/policy/proposals/prop-050 (accessed 28 Mar 2011).

[78] As with the value of each RIR.

[79] APNIC, see note 6 above, summary of current problem.

[80] APNIC, "Transfer, Merger, Acquisition, and Takeover Policy, Transfers of IPv4 addresses (3.)" available at http://www.apnic.net/policy/transfer-policy (accessed 28 Mar 2011).

/24,[81] and the buyer must be a current APNIC account holder.[82] In order to ensure the utility and value of the APNIC address registry APNIC will maintain a public log of all transfers made under this policy.[83]

Furthermore, a proposal ("Prop-095") on the transfer of IPv4 address space between APNIC account holders and organisations in other RIRs was tabled on 25 January 2011.[84] Since the current APNIC transfer-policy[85] is restricted to IPv4 transfers within the APNIC region this policy's goal is to help distribute no longer needed IPv4 addresses to organisations that need the addresses, but can no longer obtain them from their "own" RIRs.[86] Prop-095 starts from the premise that the counterpart Regional Internet Address Registry has a policy that allows transfers of address space with APNIC account holders. To date this proposal has not been implemented.

(ii) RIPE NCC: The RIPE NCC community's current "IPv4 Address Allocation and Assignment Policies" ("RIPE policies"),[87] developed through a bottom-up, consensus-driven, open policy development process,[88] were updated in January 2011. According to section 5.5 (Transfer of Allocations) of the RIPE policies, any Local Internet Registries (LIRs) within the RIPE NCC region are allowed to re-allocate IPv4 blocks to another RIPE LIR provided that RIPE approved the recipient's need and the said address blocks are not assigned to an end user.[89] Beyond that the re-allocation needs to be registered in the RIPE database and a further re-allocation of the re-allocated address space is blocked for a period of twenty-four months.

In contrast to APNIC Prop-095 no re-allocation of RIPE IPv4 blocks to organisations in other RIRs is envisaged. However, RIPE NCC has initiated a change of the rules in respect of the deregistration of LIRs,[90] replacing sections in two RIPE documents, ripe-301[91] and ripe-475.[92] The reason for this revision is to be seen in the attempt to induce LIRs to fully comply with the RIPE rules; this review includes the audit of the

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[81] *Ibid*, sec 3.1, 3.2.

[82] *Ibid*, sec 3.3.

[83] *Ibid*.

[84] APNIC, "Inter-RIR IPv4 address transfer proposal" available at http://www.apnic.net/policy/proposals/prop-095 (accessed 28 Mar 2011).

[85] See note 80 above.

[86] See note 84 above, at 3.

[87] RIPE, "IPv4 Address Allocation and Assignment Policies for the RIPE NCC Service Region" (2011) available at http://www.ripe.net/ripe/docs/ripe-509 (accessed 28 Mar 2011).

[88] *Ibid*.

[89] The re-allocated blocks of IPv4 address space must not be smaller than the current minimum allocation block size.

[90] RIPE, "Closure of LIR and Deregistration of Internet Number Resources" (2011) available at http://www.ripe.net/lir-services/ncc/legal/ClosureofLIRandderegistrationofINRs_finaldraft.pdf (accessed 28 Mar 2011).

[91] RIPE, "Mergers, Acquisitions, Takeovers and Closures of Organisations Operating an LIR" (2004) available at http://www.ripe.net/ripe/docs/ripe-301 (accessed 28 Mar 2011).

[92] RIPE, "Independent Internet Number Resources – Contractual Relationships Changes between sponsoring LIR and End User" (2009) available at http://www.ripe.net/ripe/docs/ripe-475 (accessed 28 Mar 2011).

use of IPv4 address blocks in line with the conditions laid down at the time of the allocation application.

(iii) ARIN: Regarding the transfer of IPv4 address space the current ARIN Number Resource Policy Manual[93] was modified on 1 June 2009[94] and on 9 September 2010.[95] Provided ARIN expressly and in writing approved a request for transfer, IP address blocks are transferable within the ARIN region; apart from that, address space is non-transferable and non-assignable to any other interested party. Since IPv4 address space is assigned to an organisation based on the purpose stated in their request and is not "sold" under ARIN administration, individuals do not have the authority to sell, transfer, assign, or give the address space to any other interested party.[96] With this in mind the person in charge is obliged to inform ARIN about an organisation's failure and, subsequently, has to take care that the organisation's IPv4 address space can be returned to the available pool of number resources as far as a resource transfer is not requested and justified.

(iv) LACNIC: Within the LACNIC region, the transfer of IPv4 blocks was modified in the current LACNIC policy manual[97]on 26 August 2010 by implementing proposal LAC-2009-04.[98] Since the function of the RIR in updating the databases of the holders of IPv4 address space is of major importance for maintaining the proper function of the Internet this policy proposal aims at the authorisation of address space transfers under certain circumstances. Hence, the current LACNIC policy manual authorises the sale or transfer of IPv4 address space under certain circumstances listed in section 2.3.2.18.[99] As to that effect IPv4 block transfers are allowed between LIRs and/or end users provided the concerned parties are within the LACNIC region. Thereby, the applicant for IPv4 address space must first justify its resource needs to LACNIC[100] which then verifies whether the offering party is the recorded holder of the requested address space in order to ensure the correctness of its own IPv4 holder database. As with the other RIR policies the minimum transferred block size is set. According to the manual these regulations will not come into force until LACNIC or any of its National Internet Registries (NIR) becomes unable to satisfy IPv4 address space requirements due to address pool exhaustion.

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[93] ARIN, "Number Resource Policy Manual" (2011) available at https://www.arin.net/policy/nrpm.pdf (accessed 28 Mar 2011).

[94] ARIN, "Draft Policy 2009-1: Transfer Policy" available at https://www.arin.net/policy/proposals/2009_1.html (accessed 28 Mar 2011).

[95] ARIN, "Draft Policy 2010-6: Simplified M&A transfer policy" available at https://www.arin.net/policy/proposals/2010_6.html (accessed 28 Mar 2011).

[96] ARIN, see note 93 above, at sec 8.1, para 3.

[97] LACNIC, "Policy Manual" (2010) available at http://www.lacnic.net/documentos/politicas/manual-politicas-en.pdf (accessed 28 Mar 2011).

[98] LACNIC, "LAC-2009-04" (2009) available at http://lacnic.net/en/politicas/propuesta-politicas.html (accessed 28 Mar 2011).

[99] LACNIC, see note 97 above; this section will come into force when LACNIC or any of its NIRs becomes unable, for the first time, to cover an IPv4 block allocation or assignment because of lack of resources.

[100] *Ibid*, 2.3.2.18.2.

3.2.2. Evaluation of the Status Quo

When summarising the aforementioned transfer policies, it can be said that the new approaches remain within the previously applied mechanisms, even if improvements (such as the new RIPE NCC approach towards LIRs) are convincing moves. Market-driven innovations regarding the re-allocation of allocated but unused address space are still missing. Although all modified policies at first glance contain the possibility to trade with no longer required IP addresses independently, complete supervision remains with the RIRs since they have the final word as to whether an IP address block or parts of it may change hands.[101]

Because the demand for IPv4 addresses will continue beyond the depletion of IPv4 address space, new approaches should be considered in order to avoid applicants trading behind the Internet registries' backs and thus limiting their competence. Provided there is a successful transition to IPv6, a long-term active IPv4 trading market remains a desirable aim.

As mentioned above, all RIRs are self-regulating and set their own policies to govern the allocation of addresses. Self-management is often used by the participants of a specific community to enhance the image of the market segment and improve marketing possibilities. Furthermore, self-regulation tends to be used as a measure to induce government legislators not to pass any formal laws. These tactical and psychological factors, however, do not mean that self-regulation has no further advantages.

The general benefits of self-regulation include the following:[102] rules created by the participants of a specific community are efficient because they respond to real needs and mirror the technological aspects as they actually occur. Furthermore, meaningful self-regulation provides an opportunity to adapt the legal framework to changing technology in a flexible way. Since rules are not imposed by a specific authority in cases of self-regulation, chances are good that the rules contain incentives for compliance. In addition, self-regulation can usually be implemented at reduced costs (saving effect) and effective self-regulation induces the concerned people to be open to a permanent consultation process in respect to development and implementation of the rules. Their involvement is necessary to ensure that the self-regulatory mechanism accurately reflects real needs.

However, certain weaknesses of self-regulatory mechanisms cannot be overlooked. These mainly concern the processes of implementation of "private norms" as well as the procedure for their enforcement. Among others, it should be taken into account that in the context of the creation of self-regulatory provisions the quality of the "legislative" process can hardly be judged since the process often is not transparent. Furthermore, self-regulatory mechanisms are not generally binding in legal terms. Regardless of their legal quality as such, "private norms" are only applicable to those parties who have accepted the regulatory framework. The need for some kind of submission to self-regulation results in the problem of "outsiders" or "black sheep"; if

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[101] With the exception of APNIC, if the as yet unimplemented Prop-095 will enter on the APNIC transfer, merger, acquisition, and takeover policy, see note 84 above.

[102] D Johnson and D Post, "Law and Borders – The Rise of Law in Cyberspace" (1996) 48 *Stanford Law Review* 1367-1402, at 1370; K Grewlich, *Governance in "Cyberspace": Access and Public Interest in Global Communications* (The Hague, 1999), at 324-325.

the number of outsiders is substantial, the self-regulatory regime loses its legitimacy. Besides, a main problem of self-regulation concerns the lack of enforcement procedures; non-compliance with "private norms" does not necessarily lead to sanctions.

Nevertheless, even considering the weaknesses of self-regulatory mechanisms, the advantages of having efficient and flexible rules in an area where government regulations are hard to establish should not be underestimated. Self-regulation is thus an adequate tool to tackle "legal" problems in the Internet world.

With regard to the aforementioned strengths and weaknesses of self-regulated organisations, the RIRs' regulations feature some advantages and disadvantages. Since the RIRs' policies are developed through a formal development process encompassing deliberation via email lists and debates in periodic policy meetings that are open to all interested parties the RIRs' policies to a certain degree reflect the opinions of the involved people. They do not exclude anyone from the decision-making arena and anybody can follow the discussions and developments. The now occurred IANA's and almost occurred RIRs' depletion of IPv4 address space might result in the implementation of regulations regarding the re-allocation of unused IPv4 address space and thus follow the concerned parties' needs. But a question has to be asked about whether the RIRs' policies to date encompass sufficient real enforcement mechanisms; non-compliance with the respective policy does not seem to draw serious consequences for the counteracting party, at least not in case of all RIRs. Furthermore, enforcement mainly covers the recent IPv4 address block allocation, not the addresses allocated some twenty years ago. Whether the most recent attempts to tackle this problem (for example by RIPE NCC) will overcome the problem of hoarded addresses remains to be judged. Practical experience has shown that only a few IPv4 address space holders follow the obligation to return unused address space to the respective Internet registry if the compliance with the rules is not strictly sanctioned. Furthermore, the limited effect of not strictly applied enforcement mechanisms combined with the imminent depletion of IPv4 address space might promote the development of a market behind the Internet registries' back.

3.3. Introduction of an IP Address Transfer Market

With regard to the aforementioned policy amendments[103] and the depletion of the remaining IPv4 address pool[104] a trading market for allocated but unused address space could (and should) be considered. Since the introduction of a trading system implies an enormous change of the prior IP address management, light must be shed on the benefits and risks related to the establishment of an IP address transfer market. In view of the aforementioned regulatory models for allocation of scarce resources[105] the allocation based on market mechanisms[106] seems to be the most likely adequate allocation model.

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[103] See 3.2.1 above.

[104] See Introduction above.

[105] See 2.2. above.

[106] See 2.2.(iv) above.

3.3.1. Benefits and Risks of Transfer Market

(i) Benefits: When "regulated" by supply and demand, a well functioning transfer market would create an allocation mechanism based on prices for buying and selling IPv4 addresses.[107] Since an address transfer market creates monetary value for the common pool resource and makes opportunity costs directly attainable, already allocated but unused IPv4 address space will probably change hands instead of being left unexploited. In view of the fact that not more than 15% of the already allocated IP addresses are currently in use, a developing transfer market will substantially improve IPv4 resource utilisation. Furthermore, an appropriately working market is often viewed as more fair than administrative processes[108] since there is no preference of certain stakeholders; markets follow the efficient mechanism of "survival of the fittest".

(ii) Risks: Even if a developing IP addresses transfer market contains noteworthy benefits, the potential disadvantages of an emerging transfer market should not be disregarded since the transformation from a shared public resource into a tradable good involves a number of risks. The assessment of markets being fairer than administrative processes is based on the theory of the appropriately working markets; in reality, however, markets are often unlikely to function in an undisturbed way, i.e. unequal entry and exit criteria in all probabilities produce unfair competitive advantages.

Because the transfer policy discussions and the executed policy amendments create monetary value for IPv4 address space, market participants have been kept from returning unused IP addresses to the resource pool. Instead of making the remaining IPv4 address space available to all applicants there is a risk that few holders of large resources will hoard addresses in order to create monopolies or inflate prices. After the depletion of the remaining RIRs' IPv4 resources financially weak market participants with regard to the market mechanism of "survival of the fittest" would not be able anymore to acquire this formerly common good, in turn contradicting the concept of public goods.[109] Assuming that the transition to IPv6 at this point in time is still incomplete these participants will practically be excluded from the market.

Even if the re-allocation of IPv4 addresses remains under the control of the Internet Registries it is uncertain whether all market participants will act according to the set rules since punitive measures have not yet been put in place by the RIRs. Furthermore, in consequence of developing an IPv4 transfer market, the lifetime of IPv4 addresses could be significantly extended; as a result, the introduction of the new address space IPv6 might be delayed in the long run.

3.3.2. Compliance with Constitutional Principles

Since Internet communications are organised through a network of networks which transcends national borders the development of an IP address transfer market should also be compliant with constitutional principles. As to this aspect, (i) human rights

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[107] W Lehr, T Vest, E Lear, see note 39 above, at 15.

[108] *Ibid*, 17.

[109] See 2.1. above.

issues, (ii) the principle of fair and equitable allocation of scarce resources, and (iii) the proportionality principle need to be considered.

(i) Human Rights: Defined as basic moral guarantees that people in all countries and cultures are due to their being human, human rights reflect a full universe of human life and of the condition *humaine*.[110] Human rights are often called the "missing link"[111] between the technology-oriented and the value-oriented line of thinking. Given the increasing need for guidance with regard to dealing with public issues, human rights approaches have to seize the multi-stakeholder characteristics of the online world.[112] In the field of Internet governance, particularly the freedom of expression and information (apart from privacy rights) apply beyond the general guarantees of human dignity, integrity, and equality. The information society provides individuals with unprecedented opportunities to exercise some of their most basic human rights, such as their free expression and information, as well as the guarantee of cultural rights, i.e. the communication possibilities introduced by the Internet enlarge the audience and increase the chances to get involved in information exchanges.[113]

The Universal Declaration of Human Rights (UDHR)[114] of 1948 universalised global concern for defining a set of inalienable human rights. Article 19 of the UDHR is of particular importance in understanding global human rights within the context of the information society. This provision states that everyone has the right to "hold opinions without interference and to seek receive and impart information and ideas through any media regardless of frontiers". It further stipulates that people should have the right to "the widest possible access to sources and information, to travel unhampered in pursuit thereof, and to transmit copy without unreasonable or discriminatory limitation and should be guaranteed by action on the national and international plane". Furthermore, Article 27 of the UDHR declares that "everyone has the right to...share in scientific advancement and its benefits". This human right can be considered as specific basis for those individuals interested in getting access to scientific information.

However, potential advantages and opportunities of information and communication technologies are of value only if civil society has access to them. Access to information and the free flow of information must therefore be considered as one of the most fundamental human rights. Their notion exceeds technical issues, as often seen in the discussions of Internet governance experts; moreover, access includes financial dimensions (in the sense of affordability) and "human" elements.[115] Since

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[110] T Cottier, "Trade and Human Rights: A Relationship to Discover" (2002) 5 *Journal of International Economic Law* 111-132, at 111.

[111] See R Jørgensen and M Marzouki, "Human Rights: The Missing Link" in O Droussou and H Jensen (eds), *Vision in Process II – The World Summit on the Information Society*: *Geneva 2003 to Tunis 2005* (Berlin: Heinrich Boll Foundation, 2005) 17-23.

[112] See also W Benedek (ed), *Understanding Human Rights: Manual on Human Rights Education* (Vienna, 2006).

[113] See for example L Lessig, note 21 above, at 103.

[114] United Nations, "Universal Declaration of Human Rights" Doc. A/810 (1948), available at http://un.org/Overview/rights/html (accessed 28 Mar 2011).

[115] See R Weber and V Menoud, *The Information Society and the Digital Divide: Legal Strategies to Finance Global Access* (Zurich: Schulthess, 2008), at 35-36.

the freedom of expression and the freedom of information can be seen as the most fundamental co-existing human rights in the online world, legal frameworks must be designed in such a manner that any restrictions of freedom of expression and information serve legitimate purposes and do not go beyond what is necessary in a democratic society.[116] Obviously the proper balancing of interests involved plays an increasingly important role in the context of the use of new technologies such as the Internet.

According to a worldwide poll of more than 27,000 adults across twenty six countries, four out of five participants called Internet access a basic human right.[117] With this in mind and with regard to the fact that financially weak Internet participants could practically be excluded from the IPv4 market, a developing IP address transfer market might result in a violation of human rights. Therefore, protection measures need to be developed, in particular preserving the need-based condition. Accordingly, allocation rules should be designed in a way which allows all members of civil society to get an IP address at reasonable and affordable terms.

(ii) Principle of Fair and Equitable Allocation of Scarce Resources: Within international law the principle of fair and equitable allocation of scarce resources needs to be mentioned, too. As experience has shown, the global pool of resources, which is essential for the functioning of the Internet, is largely managed by non-governmental actors (such as ICANN and IANA). This fact raises the question of what entity should have the power of allocation.[118] Furthermore, the protection of the public interest in this transnational community cannot fully rely on the exercise of sovereign powers of states. Private sector developers, service providers, and civil society, subject to their own independent accountability mechanisms, push the evolution of the communications network forward.

In view of these considerations the question arises whether states have a shared responsibility for the realisation of fundamental rights protection not only at the national level but also at the international level and whether states have a shared responsibility based on shared sovereignty to ensure fair and equitable allocation of resources. Certain elements of the information and communication infrastructure of the Internet are scarce resources; the phenomenon of scarce resources is not completely new in the international legal order and did not only come up at the beginning of the Internet age. In many other societal areas, encompassing aspects of resource allocation, the establishment of an equitable resource management is also important. Therefore, inspiration can be drawn from international law relating to the fair and equitable use of certain common resources:[119]

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[116] Council of Europe, "Democracy, Human Rights and the Rule of Law in the Information Society" (2002), at sec 13, available at http://www.itu.int/dms_pub/itu-s/md/03/wsispc2/c/S03-WSISPC2-C-0032!!PDF-E.pdf (accessed 28 Mar 2011).

[117] BBC Internet Poll, "Four in Five Regard Internet Access as a Fundamental Right: Global Poll" (2010), available at http://www.worldpublicopinion.org/pipa/pdf/mar10/BBC_Internet_Poll.pdf (accessed 28 Mar 2011).

[118] J Jackson, "Sovereignty-Modern: A New Approach to an Outdated Concept" (2003) 97 *The American Journal of International Law* 782-802, at 782.

[119] R Weber, "New Sovereignty Concepts in the Age of Internet" (2010) 8 *Journal of Internet Law* 12-20.

- The Declaration on Principles Guiding Relations between Participating States, based on the Helsinki Final Act of 1975 and developed under the auspices of the later established Organisation for Security and Co-operation in Europe (OSCE) obliges the states to "recognize the universal significance of human rights and fundamental freedoms, respect for which is an essential factor for the peace, justice and wellbeing necessary to ensure the development of friendly relations and cooperation" among all states.[120]
- The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Treaty) states that "all activities on the moon, including its explorations and use, shall be carried out in accordance with international law, in particular the Charter of the United Nations, and taking into account the Declaration on Principles of International Law concerning Friendly Relations and Co-operation among States in accordance with the Charter of the United Nations" (Art. 2).[121]
- The United Nations (UN) Convention on the Law on the Non-navigational Uses of International Watercourses of 1997 obliges the member states to utilise watercourses in an equitable and reasonable manner in their respective territories (Art. 5 para. 1 and para. 2).[122]
- The Kyoto Protocol to the United Nations Framework Convention on Climate Change of 1992 refers to the importance of appropriate burden sharing among developed countries (Art. 11 para. 2[b]).[123]
- The Convention on the Transboundary Effects of Industrial Accidents of 1992 describes its scope of application as the prevention of, preparedness for and response to industrial accidents by appropriate measures (Art. 2) in order to "protect human beings and the environment against industrial accidents by preventing such accidents as far as possible, by reducing their frequency and severity and by mitigating their effects" (Art. 3.1).[124]
- The International Law Commission's (ILC) Draft Convention "Responsibility of States for Internationally Wrongful Acts" refers to the promotion of universal respect leading to a reasonable and equitable behaviour in cross-border

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[120] Conference on Security and Co-operation in Europe Final Act, "Declaration on Principles Guiding Relations between Participating States" (1975) available at http://www.osce.org/mc/39501 (accessed 28 Mar 2011).

[121] United Nations, "Agreement Governing the Activities of States on the Moon and Other Celestial Bodies" Doc. A/Res/34/68 (1979) available at http://www.nti.org/e_research/official_docs/inventory/pdfs/moon.pdf (accessed 28 Mar 2011).

[122] United Nations, "UN Convention on the Law of the Non-navigational Uses of International Watercourses" Doc. A/Res/51/229 (1997) available at http://untreaty.un.org/ilc/texts/instruments/english/conventions/8_3_1997.pdf (accessed 28 Mar 2011).

[123] United Nations, "Kyoto Protocol to the United Nations Framework Convention on Climate Change" (1998) available at http://unfccc.int/kyoto_protocol/items/2830.php (accessed 28 Mar 2011).

[124] United Nations Economic Commission for Europe (UNECE), "Convention on the Transboundary Effects of Industrial Accidents" (1992) available at http://www.unece.org/env/teia/about.html (accessed 28 Mar 2011).

relations.[125] In particular, this document contains provisions related to international wrongful acts of a governmental body, and addresses for example preparations, objects and limits of countermeasures.

- The Cybercrime Convention of the Council of Europe of 2001 includes general principles relating to mutual assistance and measures for common protection against cyber attacks. The provisions partly try to achieve a minimum substantive harmonisation of criminal provisions and introduce specific procedural norms enabling states to combat cyber terrorism.

This overview of the already existent international treaties that deal with the management of scarce resources shows that the notion of an equitable and reasonable use of critical resources is crucial. Only if the resources are allocated in accordance with principles which can be legally and socially justified, a common acceptance of the allocation is likely to grow in civil society. The principle of fair and equitable use of resources could become a part of an international *ordre public* based on a normative understanding of its contents, representing common interest of the entire society based on a cultural and moral foundation of such society.[126] When applied to the allocation of IPv4 addresses, the principle of fair and equitable use should lead to a regulatory framework allowing the taking into account of the needs of all regions around the world and the requirements of all parts of civil society, thereby avoiding a (new) digital divide.

(iii) Proportionality Principle: The principle of proportionality means that if a measure taken by a competent body is not legally indispensable, it must be proportional, i.e. there must not be a less restrictive measure "reasonably available".[127] Consequently, a measure needs a forward-looking adjustment to the attempted policy objectives and it should be apt for the envisaged purpose. The proportionality principle is generally acknowledged in public law and deserves special attention in case of resources having a public good character.[128]

According to Art. 38 of the Statute of the International Court of Justice, four sources of international law can be identified, amongst others the general principles of law: good faith, human rights, equal treatment, and fairness in trade are considered to be general legal principles.[129] The proportionality principle is so fundamental that it can be found in virtually every legal system and is recognised by individuals as well as organisations.[130] Applying the proportionality test implies a weighting and balancing process between the relevant factors at stake encompassing the contribution made by

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[125] United Nations, "Draft Articles on the Responsibility of States for Internationally Wrongful Acts" Doc. A/Res/56/83 (2001) available at http://untreaty.un.org/ilc/texts/instruments/english/commentaries/9_6_2001.pdf (accessed 28 Mar 2011).

[126] See also R Weber and R Weber, "International Ordre Public for Terrorism-Related Internet Content?" (2009) 4 *Humboldt Forum Recht* 52-73.

[127] C Button, *The Power to Protect Trade: Health and Uncertainty in the WTO* (Oxford/Portland: Hart Publishing, 2004), at 29-33.

[128] See 2.1.3. above.

[129] R Weber, *Regulatory Models for the Online World* (Zurich: Schulthess Jur. Medien, 2002), at 66.

[130] For more details see W Friedmann, "The Uses of 'General Principles' in the Development of International Law" (1963) 57 *American Journal of International Law* 279-299.

the compliance measure to the importance of the common interests and values protected by the applicable laws and regulations. An important aspect concerns the question of whether an alternative measure or a measure imposing less heavy burdens on the affected person(s) or only a measure which does not actually serve the interests pursued would be available. A proportional allocation of IP addresses implies the task to introduce a regulatory framework which globally considers the needs of all interested users of Internet services.

3.3.3. Rules on Restrictive and Unfair Competition

A developing IP address transfer market also needs to be assessed in the light of the rules on restrictive and unfair competition. In this respect, the distortion of normal trading conditions in the context of hoarding addresses coupled with the risk of abusing a dominant position or of speculating as well as the lack of fairness due to the potential development of a black market come into consideration.

(i) Market Distortion by Address Hoarding: Giving IPv4 address space a monetary value or even holding out the prospect of IPv4 addresses being of value involves the risk of hoarding address space resources[131] instead of "recycling" them by making them available to the whole public and also contradicts the concept of public goods.[132]

Until now, according to the RIR policies, address space holders have been obliged to give back no longer required address space. Once a company goes out of business within the process of disintegration the whole previously awarded IP addresses accrue to the public resource pool. According to the envisaged development of an IPv4 transfer market it seems probable that a particular line of business will emerge by solely buying up no longer required IPv4 address space and, thus, reaching a position of power. Having bought a certain amount of address space and hoarding these address blocks can put the address space holder in a dominant position; from there it would be just a small step to the abuse of this market power by unilaterally controlling prices.

(ii) Market Distortion by Speculation: Furthermore, a developing address market might increase the risk of speculation since IPv4 address space is known as a scarce resource since the transition to IPv6 is still not satisfactory. Instead of selling IPv4 addresses, the address space holder could challenge the community's view of IP addresses as numeric identifiers.[133] Speculators could buy and hold IPv4 addresses in anticipation of future appreciation and would therewith block valuable resources for an indefinite time. Driving up prices, even if only temporarily, makes prices unpredictable for applicants and causes the emergence of market disturbances. Transfer market policy mechanisms require regulations regarding the prevention of various forms of trading that may lead to market distortions such as hoarding, monopolistic control, cartels, price fixing and speculation.

(iii) Lack of Fairness due to a Black Market: Even if some experts have doubts about the existence/emergence of a black market for IPv4 addresses,[134] observers agree to a

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[131] J Hofmann, see note 13 above, at 58.

[132] See 2.1. above.

[133] B Edelman, see note 2 above, at 27.

[134] J Hofmann, see note 13 above, at 60.

great extent that a black market for Internet addresses already exists or will exist soon.[135] In June 2008, for instance, an IP address block was offered for sale on an electronic trading platform.[136] As a consequence, the risk potential of the uncontrolled re-allocation of Internet address space requires detailed consideration.

Unlike the current valid allocations, controlled by the RIRs, arbitrary IP address transfers are not reflected in the registries' WHOIS-database.[137] Maintaining an up-to-date database is of major significance precisely because otherwise information regarding the holders of certain IP addresses could become less and less reliable which implies risks for the prospective purchasers of IP addresses. Internet addresses could lose their uniqueness[138] and, as a consequence, the function and value of Internet addresses themselves would be put at risk. Furthermore, since the WHOIS-database will be at risk of becoming wrong in substance only some market participants would possess sufficient knowledge about what facts like what party has the power of controlling which address resources.

According to the RIRs' modified address transfer policies,[139] the re-allocation of unused address space is subject to regional restrictions to the effect that both the holder and the buyer of a respective address block have to be current account holder of the same RIR in order to avoid IP address transfers from poor to rich regions and thus deepen the digital divide.[140] Since actual punitive measures (in form of monetary sanctions) have not yet been put in place by the RIRs, they currently lack the authority to prevent both the transfers of IP address space between regions and the emergence of a black market. Beyond that, as a consequence of private IP address block trading behind the registries' backs, the RIRs are at risk of losing their autonomy and could eventually be put out of business by market players with a more liberal approach tackling markets as a new business model.[141]

As it undermines the established and generally valid rules, a black market is unfair; only a few market participants get rich at the expense of others and thereby affect the IP address market negatively by driving market participants that act according to the rules out of the market. Hence, a developing black market has counter-productive effects on the protection of market participants and of an undistorted competition and therefore constitutes a violation of the law against unfair competition.

4. Outlook

Presently, the management of the IP address space allocation lies within the competence of the five non-governmental Regional Internet Address Registries

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[135] *Ibid*, 46; M Beckman, "Beware the Black Market for IPv4 Addresses" (2010) available at http://features.techworld.com/networking/3222451/beware-the-black-market-for-ipv4-addresses/?pn=2 (accessed 28 Mar 2011); T Claburn, see note 14 above.

[136] J Hofmann, see note 13 above, at 46.

[137] See note 69 above.

[138] J Hofmann, see note 13 above, at 54-55.

[139] See 3.2.1. above.

[140] For further details concerning the digital divide see R H Weber and V Menoud, note 115 above, at 3-20.

[141] J Hofmann, see note 13 above, at 55.

(RIRs) that allocate IPv4 address space according to their policies. Having previously obliged address space recipients to return no longer required IP addresses to the respective Internet Registries free pool of addresses by prohibiting IPv4 address space transfers among Internet participants, most RIRs have recently changed their policies slightly towards a restricted transfer of already allocated but unused IPv4 address blocks. With regard to the current policy amendments the development of a trading market for allocated but unused address space is in the making implying a change of the prior IP address management and, furthermore, entailing both a variety of benefits and risks. Furthermore it is a debatable issue whether the development of an IPv4 transfer market changes the classification of IP addresses as public goods since market allocation is the most common option for private goods. Changing from a self-regulated common pool resource without residual value (that cannot be owned) into a private property regime entails a variety of changes since criteria like transparency, accountability, due process and third party protection gain in importance and current enforcement mechanisms are insufficient.

Since the modified policies are not sufficient to allow the implementation of a market-driven IP address allocation and since actual innovations with regard to the re-allocation of unused address space are not debated, new approaches should be considered in order to avoid the implementation of uncontrollable trade movements behind the Internet Registries' backs. A further delay in developing new transfer mechanisms could result in the development of a black market involving a wide range of risks. On the one hand, a well-functioning transfer market regulated by supply and demand could develop an allocation mechanism based on prices for buying and selling IPv4 addresses and therewith create a real monetary value for the common pool resource and lead to an improved IPv4 resource utilisation. On the other hand, creating a monetary value could also lead to a further deceleration of IP address transfers since there is a risk that a few holders of large resources might hoard addresses in order to create monopolies or inflate prices with the consequence that weak market participants could become excluded from the market. The compliance with certain constitutional principles like human rights, the fair and equitable allocation of scarce resources, and the proportionality principle need to be considered and, additionally, a developing transfer market should be assessed in the light of the rules on unfair competition.