Joint Industry Response to

TRAI Consultation Paper
On
Differential Pricing for Data Services

Released on December 09, 2015

Preamble

1. **Introduction**

   a. At the outset, we would like to state that **COAI and AUSPI are fully committed towards connecting the 1 Billion Unconnected Citizens of India and fully supports the digital India vision** of the government and suggests adoption of policies and promoting ecosystem which enables fulfilment of this vision. In order to achieve digital literacy, the broadband/internet must be made affordable.

   b. Our submission to TRAI Consultation Paper on Differential Pricing for Data Services is as below.

2. **A Progressive Data Tariff Policy is crucial for the development of Mobile Broadband and Internet Ecosystem**

   a. In a price-sensitive market like India, the policy on data tariff will be a key determinant of take-up of data services usage. Data services usage means internet and broadband usage, which is the critical foundation of all the 9 pillars of Digital India and this therefore has to be accorded the highest policy priority. A flexible and progressive data tariff policy will lead to high mobile data services usage, which would translate into greater adoption of mobile internet and broadband services.

   b. The roll-out of broadband services is at the inflexion of growth and it is universally accepted that India has one of the most competitive telecom markets in the world and therefore any tariff offering or pricing structure that boosts the internet ecosystem needs to be seriously

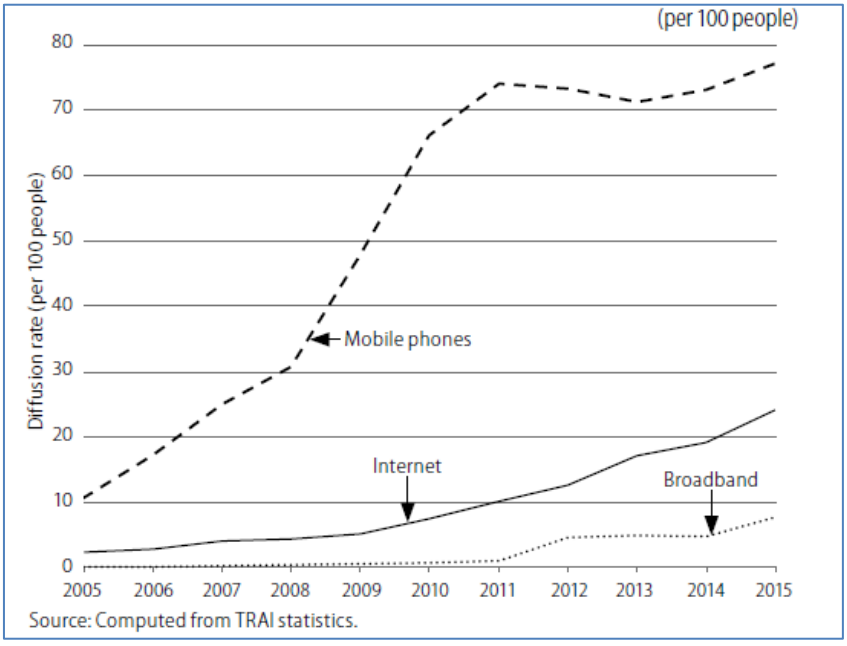
considered and not prejudged and forbidden through a blanket ruling on grounds of inapplicable apprehensions of discrimination. Such a ban would constitute a welfare-reducing measure of high concern by blocking a possible avenue for our less-advantaged citizens to move to increased economic growth and prosperity by harnessing the power of the Internet. In fact the growth of the voice market has been fueled by the various innovative tariff plans that have been designed by the TSPs to meet the wide and varied requirements of their subscribers. The fact that forbearance and hence differential pricing was permitted by TRAI was an acknowledgement of the existence of adequate competition and maturity level of the Indian market.

3. **State of Broadband/Internet Penetration in India**

a. **Status of Broadband:** India is a market where 80% of the population still does not have the benefit of mobile data services. From the numerous indicators for measuring the development of broadband in India, we understand:

i. As per the State of the Broadband Report - 2014 by Broadband Commission, ITU, India is ranked 142nd in terms of broadband penetration, way below some of its neighboring countries like Bhutan and Sri Lanka.
ii. In comparison to other BRIC countries, India ranks the lowest with the Internet adoption rate in other three member-nations of BRIC on an average being more than 3 times the adoption rate in India.

Diffusion Rate of Broadband, Internet and Mobile Phones in India



iii. In ICT Development Index (IDI), India ranks 129th out of a total 166 countries. Not only is our overall position in ICT Development extremely low, the situation is further

exacerbated by the fact that there is an enormous urban/rural digital divide which needs to be bridged rapidly to extend the benefits of ICTs to the common man. Towards this end, providing free/affordable access to data services has to be extended to the uncovered population.

b. **Importance of Broadband:** Improved access to broadband and internet services would promote economic and social growth. As per a Brookings Research Paper, extending internet access to levels seen in developed countries today means that long run productivity could be enhanced by as much as 25% in developing countries. It is estimated that the resulting economic activity could generate $2.2 trillion in additional GDP, a 72% increase in the GDP growth rate, and more than 140 million new jobs **(Refer to Annexure-1)**. As per Analysis Mason, an "increase in broadband penetration of 1% will contribute INR 162 billion, or 0.11% to Indian GDP in 2015.

Economic and Social Impact of Improved Internet Access in the Developing World	
Productivity Gains	+25%
Total GDP Improvement	$2.2 Trillion
GDP Growth Gain	+72%
New Jobs	140 Million Jobs
Personal Income Gains	$600 Per Person Each Year
Number Lifted Out of Extreme Poverty	160 Million People
Lives Saved Through Improved Health Care	2.5 Million Lives

Source: Brookings, Deloitte, Value of Connectivity: Economic and social benefits of expanding internet access, February, 2014.

c. **Affordable Broadband Services:** The immediate priority in India is to ensure that the affordable broadband services are adopted and utilized by a vast mass of unconnected and low net usage citizens. This is absolutely critical for the success of Digital India and for a speedier and inclusive economic development.

d. **Investments Required:** The roll-out of Broadband and Internet services requires enormous investments to the tune of INR 500,000 crores over the next 3-5 years. Moreover, as per the Government Commitments, the Digital India Programme itself will require investments to the tune of Rs. 113,000 crores. Additionally, the Planning Commission's 12th Five Year Plan requires an investment of INR 943,899 crores with 93% of the total investment expected to come from the private sector. It was the flexibility of service pricing that was permitted to the TSPs that led to the mass adoption of voice services. A similar approach is warranted for ensuring adoption of data services. However, the entrepreneurs are reluctant to start a new Internet based businesses when online customers are limited due to low adoption of data services. On the other hand, in such a price-sensitive market such as India, without local businesses providing relevant information, content and services in the local languages, the potential customers are unwilling to invest in expensive data plans for their smartphones. There is thus a serious danger of getting trapped in a low connectivity syndrome and slipping further behind other nations in the various connectivity indices. One of the ways to

break the spiral is to encourage a market friendly approach which allows price differentiation.

4. **Price Differentiation – How is it beneficial?**

a. As noted by the Authority, the TTO 1999 provides that the TSP shall not discriminate between subscribers of the same class and such classification shall not be arbitrary. Thus, as long as there is a clear differentiation in the classification of subscribers, differential pricing is permitted even under the existing regime.

b. Both online content providers and mobile broadband services are characterized by dynamic competition – that is, both industries make large, non-recoupable investments in R&D and physical infrastructure. In such industries, the average cost curve is declining over the relevant range of output: Simply put, it always costs less to produce an incremental unit of output than it costs, on average, to make the previous ones. In such industries, consumer welfare can be increased if firms are able to identify and offer discounts to "marginal" customers, that is, those with lower willingness (or ability) to pay, thus expanding the size of the market and generating the additional revenues that can be used to defray the fixed costs of investment and innovation. It is widely agreed that such differential pricing is not only widespread, but generally improves economic efficiency and increases consumer welfare. Since, connected and poorly connected are two distinct classes, so price differentiation should be allowed.

c. **The benefits of price differentiation are as follows:**

i. **Improves Economic Efficiency:** As per a Research Paper by Jeffrey A. Eisenach, Ph.D., bundling of wireless service and content is a mechanism by which mobile carriers engage in efficient price differentiation, thereby creating the ability for marginal consumers to pay a reduced price by choosing a differentiated product in the form of a "basic" form of online access. In doing so, it improves economic efficiency by supporting continuing investment and innovation in both networks and content while expanding Internet access to consumers who would otherwise be unserved **(Refer to Annexure-2).**

ii. **Increase in Broadband Penetration:** In the research paper by Economist Diana Carew, it has been shown that developing countries of sub Saharan Africa, Philippines, Turkey, etc. that had already adopted free access to data services show more people connecting to the internet in these countries **(Refer to Annexure-3).**

iii. **Enhance Social Benefits:** As per a Research Paper by Mr. Christopher S. Yoo, University of Pennsylvania Law School, when a market is two-sided, instead of bringing

together a single class of similarly situated users, networks bring together two completely different classes of users. In those cases, the value is determined not by the number of users of the same class, but rather by the number of users of the other class. As per the paper, it may be socially beneficial for content and application providers to subsidize the prices paid by end users. An advertiser's willingness to pay for an ad on a particular website depends on the number of end users viewing that website. Under these circumstances, the optimal solution may be for the website owner to subsidize the total number of end users by making payments to the network provider to help defray their costs of connection. The costs of subsidizing more users would be more than offset by the additional revenue generated by the fact that advertisers can now reach more potential customers. In the case of broadband, this would be both economically efficient and would be a boon to consumers both in terms of providing service in more geographic areas and in reducing the prices that consumers pay. **(Refer to Annexure - 4).**

iv. **Reduction in Cost Borne by Customers:** Granting network providers pricing flexibility with respect to content and application providers would reduce the percentage of the network costs borne by consumers.

v. **Benefits Consumers as well as Increases Competition:** Differential tariff plans would benefit consumers as it provides more value for money for the consumers and increases competition.

vi. **Essential for Providing a Satisfactory Quality of Service to Consumers:** As per a Research Paper by Dr. Jeffrey H. Reed and Dr. Nishith D. Tripathi on Technical Challenges of Mobile Broadband Networks, differentiation among users and user services is required to provide a satisfactory quality of service to consumers **(Refer to Annexure -5).**

vii. **Provision of Essential services:** There are certain essential services such as healthcare and emergency services that operators need to provide to customers. These are typically provided free of cost (in some cases are mandatory to be provided free of cost) for the benefit of customers. Thus, provision of such services requires price differentiation.

d. Thus, for developing world countries (like India), discounted plans can be an effective tool to bridge the digital divide and get millions on to the internet in a shorter timeframe. It can help deliver governance and services to millions. For a country like India, such innovation can only help replicate the mobile voice revolution in the data services/internet space. In the end, the customer should have the choice and should be free to decide what they want and the way they want. Our commitment should be to offer that content without discrimination. Thus, anything which facilitates the entry of unconnected citizens to the data services world should be permitted and encouraged.

5. **Price Differentiation – Concerns/Apprehensions of Misuse can be Addressed**

a. The Authority has raised a concern that TSPs could in the future come up with differentiated tariff offers wherein they disincentivize access to certain websites by putting higher tariffs for accessing them. We would like to highlight that the discounted data tariff plans are open for all the subscribers without discrimination, further discounted data tariffs are also open to all types of websites/applications without discrimination. However, it is brought out that by resorting to disincentivizing/prohibitive pricing practices, TSPs would risk to preclude a certain set of subscribers from its subscriber base, which no TSP can afford in such a highly competitive market as India. Operators should have flexibility whether to charge or not charge these websites for providing a particular discounted access to customers

b. TRAI has stated that differential tariffs may result in classification of subscribers based on the content they want to access (those who want to access non-participating content will be charged at a higher rate than those who want to access participating content). It is brought out that the service offerings of TSPs are based on the preferences of the customers only. We submit that classification of subscribers based on the content is beneficial for the subscribers as in the absence of discounted rates all subscribers pay at standard rate and thus, subscribers who cannot afford to pay the standard rates remain unconnected.

c. TRAI has pointed that providers may have difficulty in attracting users if substitutes exist for free. This may thus, create entry barriers and non-level playing field for these players stifling innovation. Therefore, the tariff offerings have to be studied from the perspective of whether it promotes or harms competition. As per a Research Paper by Diana Carew, the power of zero-rating to nourish an Internet ecosystem in poor and developing countries comes from its potential to increase connectivity by both people and businesses quickly and at low-cost. First, free access to popular sites encourages more people to sign up for data service plans, and enables greater data freedom to explore local content. Second, the increase in demand for local content spurs local businesses and entrepreneurs to create new online products and services—for example, information on Ebola outbreaks, typhoon warnings, or even wait times at local stores and government offices. Moreover, the higher share of population online justifies efforts of government agencies to go digital, which in turn encourages more business and individuals to join the internet ecosystem. Taken together, zero-rating can effectively jump start a virtuous feedback loop that moves the local economy into a high-connectivity equilibrium. Thus, such discounted plans foster innovation and do not harm the competition. New content providers generally don't have established infrastructure to deal with end users on an individual basis. The marketing, distribution and billing platforms of network operators can be utilised by these providers and the charges for these services built into a composite amount where the content provider pays the network operator and offers content free to the customers. Such arrangements help the smaller content providers to market their content and compete with established providers in the broader internet ecosystem. **(Refer to Annexure - 3).**

d. Concerns that discounted/zero rated plans could serve as a means of foreclosing competition, or limit freedom of expression, appear misplaced and lacking both theoretical and empirical support **(Refer to Annexure – 2).** Further, a Research Paper by Roslyn Layton, Center for Communication Media and Information Technologies concludes that there is no evidence that shows that zero rating creates harm. **(Refer to Annexure – 6).**

6. **Existence of Strong Legal Framework**

a. The overwhelming majority of countries do not require specific regimes as the existing legal regimes provide sufficient protection against truly distortive behavior by operators without stifling innovative offers that enable smaller competitors to enter the market. In India also, the existing legal regimes provide sufficient protection against any truly distortive behavior by operators. All Internet transactions are governed by the same laws that govern other commercial transactions. These include:

i. Indian Contract Act, 1872
ii. Indian Penal Code, 1860
iii. Intellectual Property Rights (especially Copyright Act, 1957)
iv. Competition Act, 2002
v. Information Technology Act, 2000
vi. Consumer Protection Act, 1986

b. In order to deal with various anti-competitive, ambiguous, predatory, monopolistic issues, etc., there are relevant provisions under Competition Act, Copyright (Amendment) Act, 2012, Consumer Protection Act, 1986.

c. Thus, adequate rules/acts are already in place to take care of any disadvantage resulting from price differentiation in case of data services.

d. Evaluation of tariff offerings on a case by case basis can be adopted by TRAI to check for consumer harm in consonance with global best-practices including those adopted by the Federal Communications Commission (FCC) in the United States and by the European Union. Further, the issue of content/data differentiation needs to be seen from the point of view of customer classification and not platform-operators classification as content regulation is outside the purview of TRAI Act.

7. **Price Differentiation versus price discrimination**

a. We would like to highlight the fact that differentiation is not discrimination. In fact, differentiation can be positively beneficial and enhance consumer welfare, while discrimination is a negative concept and consciously harms certain segments. In tariff plans that are positively differentiating, no segment is disadvantaged through increase in tariffs,

while some segments that are currently unconnected or poorly connected, are facilitated access to at least a part of the internet. There is no element of compulsion in such differential offerings nor is there any blocking or throttling.

8. **Examples of price differentiation in other industries and how it helped?**

a. Service Differentiation is a common business practice that is widely practiced across various industries. Examples:

i. E-commerce companies have recently signed deals with handset manufacturers to sell their handset exclusively on their website, which otherwise was not available on other platforms. Even the price of same product was different on different e-commerce platforms.
ii. Many insurance companies are selling their products on their website at a much lower rate than the usual (off-line) method to save their operational cost. Many tour and travel companies provide additional benefits to their customers if they buy tour packages online. While such discounts for a similar product/service vary from one website/platform to another website/platform; however, they are still not viewed as anti-competitive and discriminatory in any manner.
iii. Same room in the same hotel can be booked through different ways at different prices
iv. Tatkal rail ticket versus a normal rail ticket for the same journey in the same train.
v. Same seat in economy class in airlines sold at different price on different websites
vi. Same Mineral water sold at higher price in multiplex versus a retail shop

b. Price differentiation in these industries has helped them to flourish by reducing the consumer surplus and meeting the customized consumer demand. It has helped both the sides of the market; consumers get a choice in terms of offering while the suppliers/producers get the flexibility of tapping different segments of the market.

c. Thus, price differentiation is adopted as a legitimate business advocating strategy and similarly, TSPs too should be allowed to define products with differential pricing.

9. **Price Differentiation ought to be Principle based**

a. As per the provisions of the TTO, 1999 and its amendments, the tariff for data services (Internet) is under forbearance. However, all TSPs have to comply with regulatory principles of inter-alia, non-discrimination and non-predation. We support a principle based robust approach {(Fair, Reasonable and Non-Discriminatory (FRAND)}.

b. In the research paper by Economist Diana Carew, she has advised adoption of robust core principles for regulatory oversight of the system such as Transparency, Non-exclusivity, Local content, regular reporting **(Refer to Annexure -3).** For the growth of data services, price differentiation for data services can be allowed on the basis of following principles:

i. Focus on the foremost priority – connecting the unconnected.
ii. Transparency – all zero-rating offerings be equally accessible to all customers of the operator.
iii. Non-exclusivity – there should be no agreement that prohibits multiple operators from offering the same zero-rated content. This will mitigate fears of anti-competitive behavior.
iv. No anti-competitive behavior and no discrimination
v. Non predatory, non-ambiguous and not misleading
vi. Local content – when possible, mobile operators should also zero-rate some basic local content, such as local government services or local healthcare and weather alerts.
vii. Regular reporting from operators to facilitate ongoing evaluation and fine-tuning.

10. **Conclusion**

a. At our stage of development, our highest need is internet adoption and increased data usage and whatever facilitates that healthily needs to be supported.

b. Differential pricing plans are important to meet the needs of various segments of consumers. Imposing regulation that thwart such developments threaten to increase costs and discourage investment in ways that ultimately work to the detriment of the consumers that such regulation is ostensibly designed to protect.

c. Price differentiation should be based on the following principles:
   i. FRAND
   ii. Focus on priority of connecting the unconnected
   iii. Transparency
   iv. Non-exclusivity
   v. No anti-competitive behaviour and no discrimination
   vi. Non predatory, non-ambiguous and not misleading
   vii. Regular reporting

d. No ex-ante regulation is required since the market is vibrant enough. On ex-post basis, TRAI can examine tariff plans on a case by case basis after giving a reasonable opportunity to the operators of being heard.

In keeping with the stated aim of enhancing the adoption and usage of content available over the internet and not other services like M2M/VoIP, etc., our detailed response to TRAIs queries are as given in the subsequent paragraphs.

Issue-wise Response:

Question 1: Should the TSPs be allowed to have differential pricing for data usage for accessing different websites, applications or platforms?

Response

1. As highlighted in the preamble TSP's should be allowed to have differential pricing for data usage for accessing different websites, applications or platforms as long as the Differential Pricing Schemes does not violate Principles of Transparency, Non-exclusivity, Non-Discrimination, Not Anti-competitive, Non-Predatory. We support the principle of FRAND (Fair, Reasonable and Non-Discriminatory). For the growth of data service, price differentiation for data services can be allowed on the basis of following principles:

    a. FRAND
    b. Focus on the foremost priority – connecting the unconnected.
    c. Transparency – all zero-rating offerings be equally accessible to all customers of the operator.
    d. Non-exclusivity – there should be no agreement that prohibits multiple operators from offering the same zero-rated content. This will mitigate fears of anti-competitive behavior.
    e. No anti-competitive behavior and no discrimination
    f. Non predatory, non-ambiguous and not misleading
    g. Regular reporting from operators to facilitate ongoing evaluation and fine-tuning.

2. We firmly believe that the differential pricing is critical for promoting innovation in the Internet eco-system, bringing more people online and for greater digital equality, digital economy, digital infrastructure (such as high speed mobile broadband, digital identity, financial inclusion), digital empowerment (such as local content, digital literacy, participative governance through mobiles, digital locker) and promoting government & services on-demand. It is also essential for promoting the vision of 'Make in India' where getting small manufacturers on to supply chain of e-commerce players will need significant innovation in pricing and access.

3. TSPs are already offering differential tariffs for various voice and SMS components, such as Local Call, STD Call, ISD Call, Roaming Call, On and Off Net Call, Day and Night Call. Such differential tariffs for voice have only enhanced the affordability of telecom services in India. On the contrary, a uniform tariff for all types of calls would have increased the call rates in India especially the local call and would have adversely affect the interest of low-pricing customers.

4. TSPs should be allowed to offer differential tariff for specific content/website, provided it is non-discriminatory. Currently, Internet-based companies are experimenting with various

marketing innovations and business models to promote their websites/platform/services and differential data service plans including zero rating can facilitate such marketing innovation/business models. Therefore, TSPs should be allowed to offer differential tariff for specific content/website till it is non-discriminatory. Classification based on the Content Providers should be considered. A Content Provider can have a non-exclusive agreement with the TSP so that the zero-rated service could be made available to other TSPs. Furthermore, TSPs' zero/discounted rating platform should be open to all content providers in a non-discriminatory manner and based on FRAND principle.

Question 2: If differential pricing for data usage is permitted, what measures should be adopted to ensure that the principles of non-discrimination, transparency, affordable internet access, competition and market entry and innovation are addressed?

Response

1. As stated in the answer to Question-1 forbearance should apply on Data Tariffs and the Differential Pricing Schemes should be allowed if the same are defended successfully on the principles of non-discrimination, transparency, affordable internet access, competition and market entry and innovation.

2. The differential data plan being offered by the operators must conform to the set of principles as highlighted above. TRAI may examine a particular data plan of the operator and determine whether the tariff plan conforms to the above highlighted principles.

3. On ex-post basis, TRAI can examine tariff plans on a case by case basis after giving a reasonable opportunity to the operators of being heard.

Question 3. Are there alternative methods/technologies/business models, other than differentiated tariff plans, available to achieve the objective of providing free internet access to the consumers? If yes, please suggest/describe these methods/technologies/business models. Also, describe the potential benefits and disadvantages associated with such methods/technologies/business models?

Response

Differentiated pricing for data services is not the only method by which access can be promoted. At the same time, it is important to note that it was indeed TRAI's forbearance policy that resulted in the creation of such diverse offerings which has led to increased internet adoption in India. However, we believe that Direct Benefit Transfer (DBT) is not the right way of differential tariff as the same has the potential to be misused.

Question-4: Is there any other issue that should be considered in the present consultation on differential pricing for data services?

Response

1. In order to bridge the digital divide and ensure that all Indians have affordable access to the Internet, it is important for all concerned stakeholders come together to work towards universal and affordable access. In this regard, innovation in tariff offerings must be seen in the context of broader policy reforms required to promote this objective.

2. We encourage engagement on related issues including spectrum, networks and infrastructure reforms, adoption-promotion measures and the speedy implementation of BharatNet.

3. **We reiterate that COAI and AUSPI are fully committed towards connecting the 1 Billion Unconnected Citizens of India and fully supports the digital India vision** of the government and suggests adoption of policies and promoting ecosystem which enables fulfilment of this vision. In order to achieve digital literacy, the broadband/internet must be made affordable.

4. **A Progressive Data Tariff Policy is crucial for development of Mobile Broadband and Internet Ecosystem**

   a. In a price-sensitive market like India, the policy on data tariff will be a key determinant of take-up of data usage. A flexible and progressive data tariff policy will lead to high mobile data services usage, which would translate into greater adoption of mobile internet and broadband services.

   b. The roll-out of broadband services are at the inflexion of growth and it is universally accepted that India has one of the most competitive telecom markets in the world and therefore any tariff offering or pricing structure that boosts the internet ecosystem needs to be seriously considered and not prejudged and forbidden through a blanket ruling on grounds of inapplicable apprehensions of discrimination. Such a ban would constitute a welfare-reducing measure of high concern by blocking a possible avenue for our less-advantaged citizens to move to increased economic growth and prosperity by harnessing the power of the Internet.

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costs less to produce an incremental unit of output than it costs, on average, to make the previous ones. In such industries, consumer welfare can be increased if firms are able to identify and offer discounts to “marginal” customers, that is, those with lower willingness (or ability) to pay, thus expanding the size of the market and generating the additional revenues that can be used to defray the fixed costs of investment and innovation. It is widely agreed that such differential pricing is not only widespread, but generally improves economic efficiency and increases consumer welfare. Since, connected and poorly connected are two distinct classes, so price differentiation should be allowed.

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   i. Improves Economic Efficiency
   ii. Increase in Broadband Penetration
   iii. Enhance Social Benefits
   iv. Reduction in Cost Borne by Customers
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   vi. Essential for Providing a Satisfactory Quality of Service to Consumers
   vii. Provision of Essential services

d. Thus, for developing world countries (like India), discounted plans can be an effective tool to bridge the digital divide and get millions on to the internet in a shorter timeframe. It can help deliver governance and services to millions. For a country like India, such innovation can only help replicate the mobile voice revolution in the data services /internet space. In the end, the customer should have the choice and should be free to decide what they want and the way they want. Our commitment should be to offer that content without discrimination. Thus, anything which facilitates the entry of unconnected citizens to the data world should be permitted and encouraged.

e. Concerns/Apprehensions of TRAI related to price differentiation can be addressed.

7. Existence of Strong Legal Framework

a. Adequate rules/acts are already in place to take care of any disadvantage resulting from price differentiation in case of data services.

b. Evaluation of tariff offerings on a case by case basis can be adopted by TRAI to check for consumer harm in consonance with global best-practices including those adopted by the Federal Communications Commission (FCC) in the United States and by the European Union. Further, the issue of content/data differentiation needs to be seen from the point of view of customer classification and not platform-operators classification as content regulation is outside the purview of TRAI Act.

8. Price Differentiation ought to be Principle based

a. As per the provisions of the TTO, 1999 and its amendments, the tariff for data (Internet) is under forbearance. However, all TSPs have to comply with regulatory principles of inter-alia, non-discrimination and non-predation. We support a principle based robust approach {(Fair, Reasonable and Non-Discriminatory (FRAND)}.

b. In the research paper by Economist Diana Carew, she has advised adoption of robust core principles for regulatory oversight of the system such as Transparency, Non-exclusivity, Local content, regular reporting **(Refer to Annexure -3).** For the growth of data service, price differentiation for data services can be allowed on the basis of following principles:

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   ii. Focus on the foremost priority – connecting the unconnected.
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B | Center for Technology Innovation at BROOKINGS

February 2015

Digital divide: Improving Internet access in the developing world through affordable services and diverse content

By Darrell M. West

Darrell M. West is vice president and director of Governance Studies and founding director of the Center for Technology Innovation at Brookings. His studies include technology policy, electronic government, and mass media.

EXECUTIVE SUMMARY

Over 3.1 billion people in the world have access to the Internet. This includes around 642 million Chinese, 280 million Americans, 243 million Indians, 109 million Japanese, 108 million Brazilians, and 84 million Russians, among others.[1] These individuals use the Internet for economic development, entrepreneurship, education, and health care.

However, that leaves roughly 4.2 billion people outside the digital revolution. With Internet usage growing only 9 percent a year, around 58 percent of the world lacks Internet access.[2] Those individuals are unable to enjoy the social, economic, and civic benefits that derive from digital connectivity.

In this paper, I discuss the factors that make it difficult for people in the developing world to obtain Internet access and ways to promote greater connectivity. There are a number of steps that would narrow the current divide between Internet users and non-users, and foster a robust and open Internet. When individuals go online, they need affordable services, diverse content, reasonable costs, reliable infrastructure, uncensored information, and local language translation.

Zero rating programs represent effective ways to bring poor people from the developing world into the digital era and promote innovation and competition in the Internet sector. These programs enable people who lack the financial resources for expensive data plans to use certain applications without having that usage charged towards the individual's data cap. Around 45 percent of mobile operators around the world offer some type of zero rating services.[3] If countries can make progress in bringing unconnected people to the Internet, it would encourage greater economic development, improve education and health care, and strengthen civil society around the world.

Reducing taxes on mobile service providers and equipment also would boost Internet usage and thereby improve access to the digital economy. It is estimated that reducing mobile taxes would add up to 600,000 new subscribers in Mexico, 1,050,000 in Brazil, 620,000 in South Africa, 277,000 in Bangladesh, and 530,000 in Malaysia.[4]

Half of the world's unconnected (2.2 of the 4.3 billion) reside in China and India so those countries deserve special attention in terms of the need to improve Internet access and content. Addressing cost barriers, perhaps through zero rating programs, and providing diverse and uncensored content would go a long way toward reducing their digital divide. Those steps would bring their residents more closely to the technology era and provide access to valuable tools for economic development, social engagement, and public expression.

KEY BARRIERS TO INTERNET ACCESS IN THE DEVELOPING WORLD

There are a number of factors that make it difficult for people to obtain access to the Internet. These include things such as poverty; high device, data, and telecommunications charges; infrastructure barriers; digital literacy challenges; and policy and operational barriers. These challenges represent significant barriers for millions of people in the developing world.

Poverty, expensive devices, and high telecommunications fees

Lacking disposable financial resources makes it difficult to purchase devices or gain access to digital services. According to a Deloitte study, "income levels are a key barrier to internet access, and internet penetration is often the lowest in countries with the lowest GDP per capita."[5] Unless these individuals can utilize free or cheap products, they won't be able to gain the benefits of the technology revolution.

Global income statistics reveal that almost one-quarter of the world lives at a subsistence level on less than $1.25 per day. The Oxford Poverty & Human Development Initiative estimates that about 1.6 billion people fall below that threshold and live in extreme poverty. Around half of these individuals reside in South Asia and 29 percent live in sub-Saharan Africa.[6]

Even if people have higher incomes, expensive devices and data costs make it impossible to access digital services. Users must cover the device, connection fees, call costs, text messaging expenses, and broadband access. Cellphones and smartphones are expensive, and data plans put Internet access out of the range of many individuals.

In India, for example, smart phones run as much as $125, which is well above the affordability of many Indians.[7] According to a Gallup survey, the annual median household income there is $3,168.[8] Even though the price in some parts of that country has dropped below that level, that device cost still puts Internet-enabled phones beyond the financial capabilities of millions

In India, for example, smart phones run as much as $125, which is well above the affordability of many Indians. According to a Gallup survey, the annual median household income there is $3,168. Even though the price in some parts of that country has dropped below that level, that device cost still puts Internet-enabled phones beyond the financial capabilities of millions of people given their need to cover the costs of food, housing, and transportation.

of people given their need to cover the costs of food, housing, and transportation.[9]

Data charges also are very expensive. It is costly for users to access data and the more they use their phone, the more expensive it is going to be. And with video services coming online, data access fees likely will remain high in the near future.[10]

One of the reasons why telecommunications costs are high in India is that there are relatively few Internet service providers. The resulting lack of competition leads to large fees. Accessing one megabyte per second costs around $61, which makes it very expensive for the average person. Indians have broadband access charges that are "more than four times that of China, Brazil and Argentina, and 20 to 30 percent higher than that of Vietnam and Malaysia."[11]

In addition, per capita income in Brazil and China is double or triple that of India. Yet the average smartphone cost in those places runs between $200 to $300.[12] This again presents insurmountable barriers to digital access in those parts of the world.

In China, users complain about the high costs of 4G service.[13] They say this service costs five times what the same products run in Hong Kong. Expensive service makes it difficult to gain access to the Internet and give people the products they desire. Part of the problem on the mainland is the lack of telecommunications competition. China Mobile has a near-monopoly there, compared to the multiple providers in Hong Kong, and this keeps costs high.

These barriers are not limited to poorer countries. Even in a developed country such as the United States, there are access issues linked to income levels. There is a well-documented connection between income and smartphone ownership. According to survey data, 81 percent of people having incomes above $75,000 own smartphones, compared to 47 percent for those earning below $30,000.[14]

Poor infrastructure, digital illiteracy, and lack of digital trust

Weak infrastructure is a major barrier to digital access. This includes things such as fiber optic lines, cell towers, Internet routers, wireless spectrum, reliable electricity, and the like. It is one

of the reasons why Internet penetration is much lower in rural than urban areas. In India, for example, nine percent of rural dwellers have access to the Internet, compared to 64 percent of those living in metropolitan areas. Weak infrastructure is a serious limiting factor in that nation's Internet penetration level.[15]

In other countries, there are substantial differences in Internet usage based on age groups. In China, for example, around half of Internet users are under the age of 30 years old. When one looks at the overall usage distribution by age, 25.7 percent of those younger than 19 use the Internet, compared to 30.4 percent among those 20 to 29, 25 percent for those 30 to 39, 12.4 percent for people 40 to 49, and 6.2 percent among those 50 or older.[16]

Part of the challenge for older people is a lack of digital literacy. Many of them do not access the Internet because they do not understand its benefits or they fear its risks. In an online survey of India's businesses, numerous respondents "cited the lack of education on using the Internet as among the top three reasons that prevent consumers from using the Internet."

Part of the challenge for older people is a lack of digital literacy. Many of them do not access the Internet because they do not understand its benefits or they fear its risks. In an online survey of India's businesses, numerous respondents "cited the lack of education on using the Internet as among the top three reasons that prevent consumers from using the Internet." Overall, literacy remains low in India secondary school enrollment is limited among impoverished parts of the population. This is especially the case in rural areas.[17]

A number of senior citizens in India have disabilities that impede technology usage. Around 40 percent claim they have a "physical or health condition that makes reading difficult or challenging" or a "disability, handicap, or chronic disease that prevents them from fully participating in many common daily activities". People in this category are far less likely (49 percent) to go online compared to seniors with few physical impairments (66 percent).[18]

In China, many of the elderly cite a lack of trust in the Internet. For them, technology is new and unknown, and therefore seen as risky or dangerous. They report high levels of stress and anxiety in learning how to use the Internet. Others express worry about computer viruses, hacking, surveillance, or identity theft. They read stories about unwanted intrusions and fear that their identities will be compromised.[19]

For the world as a whole, a report from McKinsey estimates that 18 percent of non-Internet users are senior citizens, 28 percent are illiterate, 52 percent are female, and 50 percent have

incomes below their country's poverty line.[20] The variation in kinds of non-users suggests different groups face contrasting barriers to Internet access.

Policy, taxes, and operational barriers

Many countries in the developing world have policy and operational barriers that constrain Internet usage. This includes things such as monopoly telecommunications providers, tech sector taxes, lack of digital content, the absence of local language content, and censorship by civil or governmental authorities.

Monopolies keep telecommunications prices high and make it difficult for impoverished residents to access digital services. Insufficient digital content prevents people from understanding the benefits of the digital world and seeing how they personally could gain from the Internet. In many places, content may be available only in a non-native language and that keeps local speakers from accessing Internet services.

Some places, such as Mexico, South Africa, Bangladesh, Malaysia, and Brazil have taxes on mobile broadband that discourage Internet access. These "connectivity taxes" and fees increase the cost of mobile services and represent a significant barrier, especially for underserved communities where affordability is a major consideration. In those places, it is hard to expand Internet usage when people can't afford mobile devices or services due to high taxation. Similarly, some countries impose per-user fees on mobile operators, discouraging them from investing in services for unconnected communities (because they will generate less revenue, yet comparable tax bills.)

Reducing these taxes is an effective way to expand Internet access. As shown in Table 1, a Telecom Advisory Services study by Raul Katz, Ernesto Flores-Roux, and Judith Mariscal finds that reducing the Mexico mobile tax from 16.1 to 15.1 percent would increase the number of mobile subscribers between 300,000 and 600,000. Brazil has a 43.3 percent tax on mobile services that if reduced by one percentage point, could raise the number of subscribers between 520,000 and 1,050,000. The South Africa tax is 14.9 percent and a cut in it by one point would increase the subscribers between 310,000 and 620,000 people. The Bangladesh tax is at 54.8 percent. Cutting it by one point would raise the subscribers by 137,000 to 277,000 individuals. Malaysia has a 6.1 percent tax and a reduction there would increase subscribers between 260,000 and 530,000 people.[21]

TABLE 1: IMPACT OF MOBILE TAX REDUCTION ON NUMBER OF NEW MOBILE SUBSCRIBERS	
Mexico	300,000-600,000 new subscribers
Brazil	520,000-1,050,000
South Africa	310,000-620,000
Bangladesh	137,000-277,000
Malaysia	260,000-530,000

Source: Raul Katz, Ernesto Flores-Roux, and Judith Mariscal, "The Impact of Taxation on the Development of the Mobile Broadband Sector," Telecom Advisory Services for GSMA, 2014, pp. 6-7.

A study by Deloitte for GSMA of mobile sector taxes in 19 countries found that mobile operators paid over $13.5 billion in taxes. It concluded that "taxation on mobile services is more than 30 percent of mobile sector revenues in more than half of the 19 countries studied." In a number of these nations, half of the tax burden explicitly derives from taxes that target mobile operators. If this tax burden was decreased by one percentage point, its researchers estimated that mobile broadband penetration would increase by 1.8 percentage points and economic growth would rise by 0.7 percentage points (see Table 2).[22]

TABLE 2: IMPACT OF MOBILE TAX REDUCTION ON BROADBAND PENETRATION AND ECONOMIC GROWTH	
Broadband Penetration	+1.8 Percentage Points
Economic Growth	+0.7 Percentage Points

Source: Deloitte for GSMA, "Mobile Taxes and Fees," February, 2014, p. 6.

Other nations have proposed new Internet usage taxes. The government of Hungary, for example, suggested that it would add 150 forints (around 60 cents) to each gigabyte downloaded and uploaded by Internet service providers in that nation. Prime Minister Viktor Orban proposed that this monthly tax be capped at 1,000 forints (around $4).[23] However, following angry street protests, he shelved the excise tax, but indicated he wanted a broader discussion of ways to regulate and tax the Internet.[24]

In addition, proposed regulations on Internet applications and services known as over-the-top (OTT) content can stifle innovation, inflate costs, and undermine efforts to expand access. Despite these harms, India is considering regulations on web-based calls and texts through

In some places, policy barriers take the form of censorship from the government or civil society that puts information behind a firewall or makes it difficult to access useful content. This is true in authoritarian societies where there is overt censorship. In China, for example, there are substantial barriers that block Internet content for millions of people. It is estimated that the government employs over 50,000 people whose primary job is censorship enforcement.

platforms such as Skype and WhatsApp.[25] In Europe, there have been similar requests to regulate these kinds of mobile services.[26]

In some places, policy barriers take the form of censorship from the government or civil society that puts information behind a firewall or makes it difficult to access useful content. This is true in authoritarian societies where there is overt censorship. In China, for example, there are substantial barriers that block Internet content for millions of people. It is estimated that the government employs over 50,000 people whose primary job is censorship enforcement.[27] In other societies, isolationist values may insulate residents from the global world. Authorities in those nations use cultural rationales to keep digital information and services away from their people.

Addressing major policy and operational barriers is important because even though a rising number of people in the developing world have gained access to the Internet, many remain outside the digital revolution. Tanzania, for example, has seen substantial growth in access between 2010 and 2013, but most still do not use the web (see Table 3). Overall Internet usage has risen from 2.9 percent in 2010 to 4.4 percent in 2013. The number of individuals with fixed broadband subscriptions rose from 3,150 to 51,903 while those with mobile broadband subscriptions have risen from 466,918 to 1,332,519.

TABLE 3: INCREASE IN INTERNET USAGE IN TANZANIA				
	2010	**2011**	**2012**	**2013**
Percent Using Internet	2.9	3.5	3.95	4.4
Number with Fixed Broadband Subscriptions	3,150	26,943	39,805	51,903
Number with Mobile Broadband Subscriptions	466,918	569,979	1,093,085	1,332,519

Source: International Telecommunication Union, "World Telecommunication/ICT Indicators Database", June, 2014.

Similar patterns have been seen in other nations. In Zambia, Internet usage has risen from 10 to 15.4 percent of the population (see Table 4). The number with fixed broadband subscriptions has risen from 10,267 to 10,850. Those with mobile broadband subscriptions have increased from 34,436 to 107,952.

TABLE 4: INCREASE IN INTERNET USAGE IN ZAMBIA				
	2010	**2011**	**2012**	**2013**
Percent Using Internet	10	11.5	13.5	15.4
Number with Fixed Broadband Subscriptions	10,267	15,902	14,794	10,850
Number with Mobile Broadband Subscriptions	34,436	31,559	91,130	107,952

Source: International Telecommunication Union, "World Telecommunication/ICT Indicators Database", June, 2014.

Rwanda has seen an increase in the percentage of people using the Internet from 8 to 8.7 percent (see Table 5). The number with fixed broadband subscriptions has risen from 2,640 to 2,781 over the past four years. Those with mobile broadband subscriptions have gone from 3,502 to 686,800.

TABLE 5: INCREASE IN INTERNET USAGE IN RWANDA				
	2010	**2011**	**2012**	**2013**
Percent Using Internet	8	7	8	8.7
Number with Fixed Broadband Subscriptions	2,640	4,994	2,716	2,781
Number with Mobile Broadband Subscriptions	3,502	116,512	368,477	686,800

Source: Source: International Telecommunication Union, "World Telecommunication/ICT Indicators Database", June, 2014.

The Philippines has seen some of the greatest growth as Internet usage has increased from 25 to 37 percent (see Table 6). Those with fixed broadband has gone from 1,722,400 to 2,572,800, while those with mobile broadband has gone from 2.1 to 26.8 million people.

TABLE 6: INCREASE IN INTERNET USAGE IN THE PHILIPPINES				
	2010	**2011**	**2012**	**2013**
Percent Using Internet	25	29	36	37
Number with Fixed Broadband Subscriptions	1,722,400	1,791,000	2,146,600	2,572,800
Number with Mobile Broadband Subscriptions	2,175,300	3,190,000	23,200,000	26,800,000

Source: International Telecommunication Union, "World Telecommunication/ICT Indicators Database", June, 2014.

WAYS TO IMPROVE ACCESS IN THE DEVELOPING WORLD

Given the benefits of digital technology, it is important to expand Internet access and bring digital services to a wider range of people. Key to improving access is reducing telecommunications costs and improving network efficiency, keeping connectivity taxes

But improved access is not just a question of government policy. It is important to implement new data compression and caching techniques that make telecommunications networks operate more efficiently. This can be lines that help electronic signals travel quickly, redesigning file servers, deploying open source hardware, or making more efficient use of spectrum.

and licensing fees affordable, expanding digital infrastructure, strengthening digital literacy, providing diverse content, encouraging multilingualism and free expression, enabling affordable services, and promoting digital competition. As I discuss below, adoption of these ideas would narrow the gap between Internet users and non-users, and bring more people into the digital era.

Reducing Costs and Improving Network Efficiency

Reducing costs is vital to promoting access. There are different challenges in various countries ranging from high access charges and high taxes on service providers to pro-monopoly policies and insufficient networks. Data plans need to become more affordable and consumers must be able to benefit from policies that give them meaningful options.

An example of this is taking place in Mexico where a government agency, the Federal Telecommunications Institute, is seeking to promote consumer choice and thereby bring down telecommunications costs by reducing entry barriers into the sector. It is doing this by altering the rules on network sharing and allowing new firms to utilize the lines of established operators. The hope is that this new policy will double Mexico's current 26 percent Internet penetration level to something close to the 45 percent rate that exists in places such as Brazil.[28]

In other countries, governments are eliminating barriers that protect monopoly providers from new companies. This includes opening up markets, encouraging venture capital firms to provide financing of new players, and allowing smaller operators to use existing wireless or fiber-optic networks. In order to provide consumer choices, companies require affordable means of connecting to established networks.[29]

But improved access is not just a question of government policy. It is important to implement new data compression and caching techniques that make telecommunications networks operate more efficiently. This can be lines that help electronic signals travel quickly, redesigning file servers, deploying open source hardware, or making more efficient use of spectrum.[30]

Compression techniques can reduce the cost of service delivery and therefore help operators provide better services without depleting their profits. According to Facebook chief executive

officer Mark Zuckerberg, "implementing compression in large scale apps or developing services that you route all your data through and compress everything would yield large data use savings."[31] Continuing, he noted that "the technology that some of our partners have developed to amplify data signal from inside buildings is a good example of the type of improvement that will help us achieve an order of magnitude improvement."[32] The company has launched an Open Compute Project designed to develop improved servers and data centers.

Keeping connectivity taxes and licensing fees affordable

High connectivity taxes and fees discourage the growth of online services and the economic benefits they offer. It is harder for firms that provide Internet service to make the necessary investments when their cost structures are too high. That impedes investment and makes it more difficult for the ecosystem to offer the products that consumers and businesses need in order to grow.

With this in mind, governments need connectivity policies that lower the cost of market access and encourage economic, social, and civic development. It is understandable that governments in developing nations adopt revenue-generating actions, but they need to be careful that mobile regulations and policies don't stymie long-term economic growth. They should follow approaches that draw more people into the Internet and help them take advantage of digital goods and services. If people get higher quality Internet service, it will encourage them to engage in trade and commerce with others.

A similar rationale applies to licensing fees. Governments often use these to finance new projects or fund activities in other areas. Yet as shown in earlier sections, these kinds of fees can act as a disincentive for business investment and consumer access to the Internet. It is for that reason that mobile fees should be kept low in order to foster greater market access.

Expanding digital infrastructure

Other approaches to improving access involve improving digital infrastructure, especially in remote areas. For example, Google's Project Loon tries to promote access through balloons. In 2013, engineers launched 30 balloons over New Zealand to test connectivity prospects. It gave antennas to people to allow them to access the Internet via the balloons.[33] The company now has expanded its experiments to other nations.

Early projects suggest that these kinds of unmanned vehicles can affordably provide service to medium-sized cities or remote rural areas that currently have no service.

Several companies are testing drones as a vehicle for Internet service delivery. Google has purchased the

drone manufacturer Titan as part of its efforts. Facebook meanwhile is using its Connectivity Lab to determine if drones can be an effective delivery system.[34] Early projects suggest that these kinds of unmanned vehicles can affordably provide service to medium-sized cities or remote rural areas that currently have no service.

Still others have suggested that new optical systems or lasers should be part of the digital ecosystem. According to Zuckerberg, "free space optical communication, or FSO, is a way of using light to transmit data through space. These are basically invisible laser beams in the infrared part of the spectrum. FSO is a promising technology that potentially allows us to dramatically boost the speed of internet connections."[35]

Earth satellites furthermore should become part of the infrastructure network. This can be done through low-Earth or geosynchronous Earth orbits. Satellites are more expensive than drones or balloons due to high manufacturing and launch costs. But as countries develop economically, satellites are likely to become more affordable and therefore help reduce gaps in digital access.

Improving digital literacy

For certain populations, improving digital access requires education regarding the value of online services. For example, showing people the value of diverse content and having consumers expand their usage of basic services can propel digital activities in a variety of other areas.

In India, for example, instructional classes train adults (especially rural dwellers, senior citizens, and poor people) how to use the Internet. They learn that they do not have to physically go to stores or government offices to access services or complete transactions. Through digital platforms or mobile apps, people can find the latest information on business opportunities and market conditions. This improves their ability to make effective decisions.[36] Through initiatives such as the National Knowledge Network, AADHAR (Unique Identification Authority of India), and eSeva, Indians can bring the most up-to-date information to their fingertips.[37]

That country also has pioneered the National Optical Fibre Network that seeks to bring needed telecommunications service to rural areas and underserved populations. However, there isn't much money to support this network and it has been difficult to bring access to those who are outside the technology revolution.[38] Providing needed funding would improve service delivery and narrow the digital divide in Internet access.

The India Ministry of Information Technology has launched an "IT for Masses Program" program with the goal of improving digital literacy by 2020. This effort will train rural women on government services and provide loans and market information to would-be entrepreneurs.

India represents an interesting example of this problem as only around 12 percent of Indians speak English. For the country as a whole, there are 22 official languages, which complicate access to digital information. People are most likely to use the Internet when information is delivered in local languages, through multilingualism, or via image-based graphics. Reaching underserved populations or people who live in rural areas especially benefits from these kinds of presentations. Translations and pictures help people access information and gain the benefits of the digital era.

It has a budget of $20 million to meet this goal and matches those in need of training with stakeholders who are digitally literate.[39]

In other nations, officials have developed programs to train people on Internet usage. For example, Sri Lanka's Ministry of Education promotes digital literacy using computer learning centers and training programs.[40] They use libraries and schools after-hours to teach people how to make use of digital resources. This helps seniors understand the benefits of digital services for their day-to-day lives.

The value of diverse content

Having diverse content represents another way to encourage people to use digital services. For example, in the early days of desktop computing, having programs such as email, word processing, and spreadsheet management encouraged people to use computers. Once they mastered those programs, it was easy for them to find other software that appealed to them and enabled them to become more productive and efficient.

This also has been the case in terms of online services. One illustration is Ghana's CocoaLink project (www.worldcocoafoundtion.org) for the agricultural sector. It helps connect cocoa producers with industry experts in 15 communities. Those who have particular expertise can send text messages to others who need advice and consultation.

According to the World Cocoa Foundation, 3,720 people have registered for this service and around 100,000 SMS messages have been sent through the network. Among the inquiries that have been generated include information on production, distribution, and marketing. The goal is to generate additional revenue for markets and improve their overall livelihood. All it takes is a cell phone, with messages delivered in English or the local language. It is estimated that 65 percent of rural dwellers in western Ghana have cell phones.[41]

Similar developments have unfolded in India. Various agencies offer online services such as paying taxes, renewing driver's licenses, or ordering business permits. More than 40 percent of taxes now are paid online. This reduces the time required to visit government offices or provide paper documents for tax officials.[42] It demonstrates that people are open to digital services when those products are affordable and accessible.

Encouraging multilingualism and free expression

Another way to improve digital access is through multilingualism and the use of local languages. According to British Professor Richard Rose, there are more than 6,900 different languages in the world. About 400 of them have at least one million speakers.[43] This "Tower of Babel" creates enormous challenges in terms of information access. Although English is the most common language on the Internet, it is the native language of only seven percent of the global population.[44] For people who don't speak English or whose language is not available over the Internet, it is hard to make digital information and services useful to them.

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Service providers there are starting to provide information in languages such as Hindi and Tamil in order to reach non-English speakers. Some of this is occurring through local content, while other services are incorporating translation features that allow people to tailor information to their own preferred language or dialect.[46]

Government censorship remains a challenge in many places around the globe. Internet service providers sometimes are asked for confidential information on web viewership or electronic communications. Some social media platforms have been blocked in order to limit grass roots organizing or free expression that is critical of political leaders.[47] Discouraging these kinds of overt limits is vital in order to encourage more people to go online.

The benefits of zero rating practices

Many firms have launched what they call "zero rating" practices as a way to improve Internet access among the disenfranchised. This policy allows people who lack the financial resources for expensive data plans to use certain applications without having that usage charged towards the individual's data cap. It frees them to use the Internet and access various services without additional fees, and in conjunction with free Wi-Fi networks or library-based devices,

represents a way to bring digital access to those who otherwise could not pay for desired services.

It is estimated that 45 percent of mobile operators around the globe provide some type of zero rating applications.[48] Zero rating programs for popular services free up data that users can employ to explore other sites, including local ones. In many places, platforms such as Facebook, Google, and Wikipedia are very popular. Even in a diverse digital marketplace such as the United States, surveys show that people spend about 40 minutes each day on Facebook, and they rely upon that site for about 24 percent of the total time they spend on mobile devices.[49] In the developing world, usage is more concentrated on global Internet sites like Facebook, especially when tight data caps exist.

By exempting high-usage sites from data caps, operators give people the ability to see more of the web without spending additional money. Or to put it differently, zero rating can reduce the cost of Internet access to local sites for poor consumers because their consumption of data on global applications does not take their entire data caps. In the end, poor people get more data for their money.

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In a number of countries, zero rating services have enabled people to get access to the Internet who otherwise had no access. As shown in Table 7, an analysis of the Filipino Network Globe found that "what we're seeing in Globe users is the number of people who are using the internet—the data—was doubled, and Globe subscribers have grown by 25%."[50]

In Paraguay, an Internet.org project has generated an increase in "the number of people using the internet by 50% over the course of the partnership and [an] increase [in the] daily data usage by more than 50%." A partnership between technology companies and the TIGO mobile operator has brought 3 million new people to the Internet who previously lacked service.[51]

Meanwhile, several African nations have reported substantial upticks in Internet usage following introduction of Facebook Zero. The number of Facebook users, for example, rose 154 percent in Nigeria, 85 percent in Ghana, and 50 percent in Kenya. For the continent as a whole, there was a reported 114 percent increase in Facebook users after the launch of Zero.[52]

TABLE 7: THE IMPACT OF ZERO RATING SERVICES ON INTERNET USAGE	
Paraguay	+50%
Kenya	+50%
Ghana	+85%
Nigeria	+154%

Source: The Paraguay figure comes from Internet.org, "Connecting the World from the Sky," undated report, and the Nigeria, Ghana, and Kenya numbers come from April Deibert, "Google Free Zone and Facebook Zero: Products Targeting Developing Populations, Innovation Series, February 19, 2013.

At a recent Internet Governance Forum, zero rating programs were cited as a popular way to provide Internet service in developing nations.[53] For example, Wikipedia offers a "zero" version of its informational website for mobile platforms to 350 million people in 30 developing nations and it attracts around 65 million page views each month.[54] Facebook meanwhile offers a "zero" service through 50 operators globally that has enabled Internet usage by low income people.[55]

Internet.org is an organization supported by companies such as Ericsson, Mediatek, Opera Software, Samsung, Facebook, Nokia, and Qualcomm dedicated to connecting the unconnected. Beginning in 2014, Internet.org is partnering with mobile operators to put together a diverse set of applications for people in a number of developing nations to access for free. The content is customized for local interest and language, providing access to basic services such as Accuweather, Facts for Life (how to raise healthy children), Kokoliko (a job board service), the Mobile Alliance for Maternal Action (information for new and expectant mothers), Facebook, Google Search, Wikipedia, and Women's Right Application (information on the rights of women), among many others.

This service has been popular in the countries where it has been launched. In Tanzania, for example, few individuals have Internet access, according to the Tanzania Communications Regulatory Authority. David Zacharia, the head of data and devices for mobile phone operator Tigo, predicted that the partnership would "accelerate internet penetration in the country but will also open new socio-economic opportunities to the users in the fields of education, technology and commerce".[56]

One zero rating service in Tanzania that has proved very popular is text messaging for mothers and pregnant women. The program regularly sends them information designed to reduce infant mortality and improve maternal health. Over a two-year period, 500,000 parents received 40 million text messages about "safe motherhood". This helped reduce infant mortality by 64 percent and maternal mortality by 55 percent. Airtel Tanzania supports

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this service on a zero rating basis in order to improve health care in that nation.[57]

In many parts of the developing world, telecommunications data plans are expensive and it is hard for people to afford plans themselves and the usage fees that accompany them. In these places, zero rating programs help people access valuable services in e-commerce, health care, education, and communications. For example, OLX is an online site for people to buy and sell things, and it attracts 360 million page views each day. Being included in the Internet.org app —which results in being able to access it without incurring data cap charges—is a major benefit for entrepreneurs.[58] This website dramatically expands access to digital services for natives who do not speak English.[59]

In Zambia, the Women's Rights Application (WRAPP) compiles information on women's health and legal rights. Before connecting with Internet.org, only 1,000 women had used its website. But through the broader partnership, 15 percent of the country's population that had access to the Internet was able to connect to the site.[60] This increased the reach and impact of the platform. According to Facebook chief operating officer Sheryl Sandberg, WRAPP allows a woman "to say to her husband, 'I have the right to a vote' or 'I have the right to access health care.' Sometimes women don't know those things. The goal is that giving out this information can be transformative and this is a very scalable way to do it."[61]

Having access to applications developed by the Mobile Alliance for Maternal Action has a positive impact on child care. In Bangladesh, for example, 69 percent of mothers who accessed the site received medical care, compared to 32 percent of non-users (see Table 8). On average, site users had at least four clinical appointments where they received medical care for their young child.[62]

TABLE 8: HOW TECHNOLOGY BOOSTS MEDICAL CARE	
Technology Users	69% Get Medical Care
Technology Non-Users	32% Get Medical Care

Source: Caroline Fairchild, "For Facebook, Access to Women's Rights Information Is a Basic one." Fortune, August 14, 2014.

Promoting competition

Some critics assert that zero rating programs limit competition and are discriminatory. Their fear is that services that don't count against the data cap disadvantage all the other services which do count. This has led nations such as Chile to ban zero rating programs on grounds that they are anti-competitive and discriminatory.[63] In addition, the Norwegian Communications Authority has argued that zero rating practices violate net neutrality by advantaging certain types of services or applications.[64] The European Union is considering legislation that could limit zero rating practices.

Yet there are several reasons to dispute those criticisms. First, zero rating programs may encourage competition and limit discrimination by increasing access and fueling demand for Internet usage and Internet content. As an example, providing free Wi-Fi or access through public terminals in schools or libraries allows people to access zero rating services as well as those that count against data caps. Those who worry about discrimination assume people who get free services will limit themselves to those offerings and not utilize other services. In reality, people who go online access other products and find ways to limit their data cap charges.

Mobile providers in a number of countries offer their own zero rating programs. They are combining services from other firms with video streaming or popular applications that people like to use. As long as they draw on services from large as well as small companies and feature a diverse range of applications, they do not seriously limit consumer options or harm competition.[65]

In fact, zero rating programs can promote competition, because they lead to more local eyeballs online, increasing demand for local content, and stimulating the local content creation sector. By offering costless access to global content and popular local content, zero rating gives consumers an incentive to get a phone and a data plan, which in turn, creates more of an audience for local content providers. Thus, zero rating can increase demand for local developers and local content, and promote greater competiveness and diversity in the process. It is also a way for mobile wireless firms to differentiate themselves from competitors by bundling "unique" content with their mobile wireless services, increasing competition among mobile operators and potentially further lowering data costs.

Officials in many places believe that zero rating programs benefit consumers, especially those from disadvantaged backgrounds. Alejandro Pisanty, director general for academic computing services at the National University of Mexico, says that "users of zero rated programs combine them with wifi network access to access the rest of the internet."[66] This brings the virtues of the Internet to people who otherwise would have no connectivity.

Participants in a recent Internet Governance Forum rejected the anti-competition argument on grounds that "the programs are offered on a non-discriminatory basis, so other services can also be a part of the package."[67] Helani Galpaya, the chief executive officer of LIRNEasia, claims that a way to promote competition is to combine partnerships with locally-developed apps and government services. That would guarantee there is diverse content and create a market for local programmers.[68]

A way to stimulate local applications is through prize competitions. In India, for example, an Innovation Challenge project awards $250,000 to the top app, website, or service that helps women, students, farmers, or migrant workers. There also are Impact Award prizes of $25,000 in each of these four categories. These kinds of cash prizes encourage developers to make digital services that will improve the daily lives of regular folks.

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In short, zero rating services offer the advantage of improving digital access for those who otherwise cannot afford Internet services, as well as increasing the amount of connectivity available to those who currently have minimal internet access. Concerns that these programs could threaten competition are mitigated because such efforts are designed to free up data under caps and allow users to browse content they would not otherwise choose to view. This stimulates demand for local content and innovation, and helps government and business pursue initiatives that provide inexpensive internet access through Wi-Fi or publicly-available terminals. Overall, zero rating programs build tremendous public value in developing markets by creating demand for local content and significantly expanding Internet access, including to sites that are not zero-rated. The benefits of free services encourage people to seek products that bring them into the electronic world.

THE BENEFITS OF IMPROVED INTERNET ACCESS IN THE DEVELOPING WORLD

If countries in the developing world can make progress on Internet access, it would stimulate consumer demand, move millions out of poverty, and create enormous opportunities for economic development and social inclusion on many different fronts. Having a robust, diverse, and open Internet ecosystem would be beneficial to many different people.

Economic growth

Improved Internet access would promote economic growth and move large numbers of people out of poverty. According to a Deloitte study, "extending internet access to levels seen in developed countries today means that long run productivity could be enhanced by as much as 25% in developing countries. Deloitte estimates that the resulting economic activity could generate $2.2 trillion in additional GDP, a 72% increase in the GDP growth rate, and more than 140 million new jobs" (see Table 9).[70]

TABLE 9: ECONOMIC AND SOCIAL IMPACT OF IMPROVED INTERNET ACCESS IN THE DEVELOPING WORLD	
Productivity Gains	+25%
Total GDP Improvement	$2.2 Trillion
GDP Growth Gain	+72%
New Jobs	140 Million Jobs
Personal Income Gains	$600 Per Person Each Year
Number Lifted Out of Extreme Poverty	160 Million People
Lives Saved Through Improved Health Care	2.5 Million Lives

Source: Deloitte, Value of connectivity: Economic and social benefits of expanding internet access, February, 2014.

This would have a dramatic impact on poverty alleviation and strengthening the middle class. The research found that "extending internet access in developing economies to the level seen in developed countries can raise living standards and incomes by up to $600 per person a year, thus lifting 160 million people out of extreme poverty in the regions covered by this study."[71]

The value of the Internet is that it leads to increased investment and creates jobs for high-skilled workers in the developing world. This has been the case in Rwanda, which has formed partnerships with leading technology companies. These kinds of collaborations have brought valuable new funding into the country and broadened Internet access across the

country. It has helped advance the knowledge society and provided benefits for millions of people.

Health care and education

Two of the sectors that are likely to grow as a result of improved Internet access are health care and education. In the developing world, both are vital to future economic growth and improved life quality. Both patients and health care providers benefit from timely access to medical information. They can use mobile devices to find out which drugs are most effective for certain illnesses, check for drug interaction effects, and access a database that will tell them whether particular medications are counterfeit.[72]

Increasingly, health care providers are using remote monitoring devices to check vital signs. Patients who live a great distance from treatment centers can electronically transmit health information to physicians, who can let them know if they have abnormal readings. This helps developing countries deal with health care disparities between rural and urban areas, and brings expert diagnosis even to physically remote locations.

According to a Deloitte study, "evidence on the link between health literacy and mortality rates suggests that access to the internet has the potential to save nearly 2.5 million lives across the regions covered by this study, if they were to achieve the level of internet penetration seen in developed economies."[73]

Technology also improves education. It connects students and teachers with electronic resources and digital textbooks. It gives them access to new forms of information such as instructional videos and computer games. Students appreciate digital education because it engages them in the learning process and provides instant feedback on their academic performance.[74]

Facebook has implemented an innovative education program with the non-profit edX and Airtel in Rwanda. Called SocialEDU, the project gives students free access to the group's educational software plus a free phone to access the information. Pupils can take online classes and collaborate with fellow students through social media accounts.[75]

Civic education, governance, and social cohesion

Expanded Internet access is helpful for governance and civil society. Having more people online with access to information improves transparency and accountability in the public sector. It helps to distribute information more broadly around the population. If people and reporters have access to budget information or policy decisions, it empowers them and helps them hold officials responsible for their governmental decisions.

Having more people online with access to information improves transparency and accountability in the public sector. It helps to distribute information more broadly around the population. If people and reporters have access to budget information or policy decisions, it empowers them and helps them hold officials responsible for their governmental decisions.

Civil society also benefits through improved connectivity and bringing diverse sets of people together. One of the biggest challenges in a disconnected world is getting people from different cultures and backgrounds to understand one another. It is easy in that situation for mistrust and intolerance to proliferate when people do not understand each other or have opportunities to communicate.

The virtue of the Internet is that it gives people a valuable means for interaction and communication. If people see themselves as part of a global community, it broadens their perspectives and helps them overcome parochial considerations. In that way, it promotes social cohesion and political integration.

CONCLUSION

To summarize, there are a number of ways to improve technology access and bring the benefits of a robust and open Internet to people around the world. This includes steps such as reducing telecommunications access costs, improving network efficiency, expanding digital infrastructure, strengthening digital literacy, providing diverse content, encouraging multilingualism, promoting free expression, enabling affordable services, and increasing digital competition. Each of these actions helps to reduce the gap between Internet users and non-users, and works to maintain the freedom, openness, and diversity that are the cornerstones of the Internet.

It is especially important to make progress on digital access in the cases of India and China. Those two nations are home to an estimated 2.2 of the 4.3 billion people with no Internet access. Addressing cost problems, providing diverse content, promoting free expression, and enabling affordable services in that part of the world would go a long way toward closing the digital divide. Since more than half of the world's population lacking Internet access reside in those countries, it is crucial to make changes there that will make it easier for the unconnected to use digital services. That would bring them into the technology era and give them access to valuable tools for economic development and social integration.

From this research, it is clear that zero rating programs represent effective ways to expand access by bringing impoverished people into a diverse and competitive digital world and

driving demand for local content and services. These approaches help to address the affordability challenges that exist, especially in many parts of the developing world. Some of the most significant barriers involve poverty, mobile or telecommunications taxes, and the high cost of computer devices and access fees. Zero rating practices improve access by allowing those with limited financial resources inexpensively to access digital services.

Policies that promote telecommunications competition help reduce access charges and thereby enable more people to use Internet services. And if people can access a wide range of digital content through multilingualism or their local languages, it will promote greater literacy and show people the social, economic, and civic benefits of Internet connectivity. With these kinds of changes, it is possible to narrow the digital divide and bring digital benefits to billions of people around the world.

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The Economics of Zero Rating

By **Jeffrey A. Eisenach, Ph.D.**

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The Economics of Zero Rating

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Introduction

Zero Rating plans enable mobile wireless customers to download and upload online content without incurring data usage charges or having their usage counted against data usage limits. Zero Rating has become increasingly popular in both developed and developing countries, but plays a particularly important role in developing countries, where the costs of mobile data services are higher relative to per capita incomes.

The obvious benefits of Zero Rating include lower prices for consumers, especially those who might have difficulty affording mobile data plans, and expanding Internet adoption, which has been demonstrated to generate substantial economic and social benefits. However, some have expressed concerns about whether such plans violate net neutrality principles by discriminating in favor of some content over other content. Critics of Zero Rating worry that it could harm competition in markets related to Internet access and/or online content, or interfere with consumers' unfettered access to online information (i.e., diversity of expression).

In this context, this study presents an assessment of the benefits and costs of Zero Rating. It concludes that Zero Rating programs in general represent an economically efficient mechanism for increasing consumer welfare given the unique characteristics of information technology markets, which make it beneficial to offer lower prices and other incentives to expand the size of the market, especially in developing countries where incomes, and market penetration, are low. Further, the most common types of Zero Rating programs are the ones most likely to benefit consumers, not harm them, and the ones most likely to expand consumer choice, not limit it. With respect to diversity of expression and related concerns, it is difficult to construct a scenario under which increasing access to online information and adoption of digital communications services would be harmful to online speech. While regulatory authorities should remain vigilant in monitoring business practices, broad-based bans or restrictions on Zero Rating plans are far more likely to harm consumer welfare than improve it.

The remainder of this paper is organized as follows. Section II describes the state of play with respect to both the types of Zero Rating plans currently in the marketplace and efforts by regulators in some countries to limit or prohibit their availability. Section III presents a brief explanation of the economic characteristics (i.e., dynamism, modularity and demand-side effects) that distinguish information technology markets from markets for other types of goods, and which affect both market performance and the nature of the competitive process. Based on this framework, it outlines the primary issues involved in assessing the impact of Zero Rating plans on economic efficiency, competition, and overall economic welfare. Section IV presents an assessment of the two primary criticisms of Zero Rating, namely the asserted potential for anticompetitive market foreclosure and concerns about diversity of expression. It explains that the Zero Rating plans currently being offered almost certainly generate benefits well in excess of any costs. Section V provides a brief summary of conclusions.

Zero Rating Plans: The State of Play

All Zero Rating plans share one characteristic: They allow mobile subscribers to access certain online content "for free" – that is, without having the associated data usage counted against their usage allowances under wireless service plans. The plans differ in two main respects: The types of content included, and the underlying business arrangements.

The type of content included in Zero Rating services varies widely, and includes access to online government and community service sites as well as access to popular services like Facebook, Google, Twitter and Wikipedia. In the U.S., T-Mobile offers its data plan subscribers zero-rated access to more than 25 online music services, including iHeartRadio, Pandora and Spotify. In some cases, carriers offer customized content designed specifically to be offered in conjunction with Zero Rating. For example, Facebook Zero and Internet.org provide customized content designed specifically for use on devices with limited capabilities or over networks with limited capacity.

Zero Rating business arrangements vary mainly according to the nature of the relationship between the access provider and the content provider. The most common form of Zero Rating plans are "carrier initiated" – that is, the mobile carrier simply chooses to zero-rate certain content as a means of attracting customers. "Sponsored data" plans represent a different model, under which content providers pay carriers to have their content zero rated. In some cases, carriers may choose to zero-rate their own content or content produced by affiliated companies, as was the case until recently with mobile TV plans offered by Canadian carriers Bell Mobility and Videotron.

Content-oriented applications like Facebook, Twitter and Wikipedia have been especially active in working with mobile operators to develop and promote Zero Rating plans in developing countries. Facebook Zero allows customers of participating mobile carriers to access Facebook's standard mobile site content, send messages, update their status and engage in other typical activities on a zero-rated basis. (Facebook Zero users can also access additional Facebook content, such as photographs, but when they do so the resulting data usage counts as paid usage.) First launched in 2010, Facebook Zero has been implemented by more than 50 mobile operators in over 40 countries.[1] Facebook Zero is carrier initiated: Facebook does not pay carriers for participating in Facebook Zero.

Internet.org is a global partnership involving Facebook and other technology companies, local governments and NGOs which focuses on decreasing the cost of delivering data and expanding Internet access in underserved communities outside of the U.S. and Europe.[2] The internet.org app, which is offered in partnership with local mobile carriers, allows subscribers zero-rated access to customized content from multiple providers, including Facebook, Wikipedia and a variety of local content providers. First launched in Zambia in 2014, the internet.org app has expanded to Tanzania, Kenya, Columbia, Ghana and India, as shown in Table 1 below. As with Facebook Zero, internet.org does not pay ISPs to zero-rate its content.

Table 1. **Internet.org Deployments, 2014-2015**

Country	Carrier	Launch Date	Free Services*
Zambia	Airtel	July 31, 2014	16
Tanzania	Tigo	October 29, 2014	19
Kenya	Airtel	November 14, 2014	18
Colombia	Tigo	January 14, 2015	16
Ghana	Airtel	January 22, 2015	17
India	Reliance	February 10, 2015	38

Source: internet.org. *Services listed are as of February 27, 2015

Despite its *prima facie* benefits, regulators in a handful of countries have taken steps to limit or ban Zero Rating programs.[3] For example, the government of Chile has found that Zero Rating plans violate the country's net neutrality law;[4] regulators in the Netherlands have fined mobile carrier Vodafone for zero-rating HBO;[5] and, regulators in Slovenia have fined the country's two largest mobile operators for zero-rating music and cloud storage services.[6] Canada's CRTC recently banned offerings by mobile providers Bell Mobility and Videotron which offered differential pricing for the companies' mobile TV services.[7] Regulators in other countries have either suggested that such programs are likely to violate neutrality rules (e.g., Norway),[8] or have initiated investigations (e.g., India).[9] In the U.S., Federal Communications Commission officials have indicated that Zero Rating plans will be evaluated on a case-by-case basis under the Commission's new Open Internet Order.[10]

The analysis below explains why broad-based bans or restrictions on Zero Rating plans are likely to be counterproductive and harm consumer welfare.

The Competitive Dynamics of Information Technology Markets

In general, the welfare effects of pricing schemes and other business practices depend on the characteristics of the markets in which they are deployed. Zero Rating programs are deployed in information technology (IT) markets, which are distinguished from more traditional "textbook" markets by three primary characteristics: *dynamism; modularity; and demand-side effects*.[11]

Dynamism refers to the significance of innovation as a measure of market performance: In dynamic markets, the ability of a firm to offer new and improved products plays at least as significant a role in its success (*i.e.*, its profitability) as the ability to produce and sell existing products at lower prices.[12]

Typically, firms create new products by making significant sunk cost investments (which may take the form of either "R&D" or capital expenditures in non-recoverable facilities). As a result, production benefits from economies of scale – i.e., average total costs that decline at higher levels of production, but always exceed marginal costs. Producers are able to recoup their sunk cost investments because products are differentiated through innovation (Innovation can be thought of as simply product differentiation over time.), meaning that long-term prices in such markets are higher than marginal cost, notwithstanding the existence of robust competition. Under traditional antitrust doctrine, the ability to earn high margins might be mistaken for monopoly power (the ability to earn excess profits), but assuming low entry barriers, they are not only consistent with, but necessary for, robust competition and the maximization of consumer welfare in these types of dynamic markets. In this such markets, high accounting margins not only allow firms to recoup sunk cost investments, but also provide the incentive to take the risks inherent in innovation.[13]

A second characteristic that distinguishes IT markets is *modularity*, or what is sometimes referred to as "platform competition." From an economic perspective, modularity is associated with strong complementarities in production or consumption: Operating systems are strong complements with personal computers; smart phones are strong complements with both communications networks and online content, such as mapping services, restaurant reviews, or social networks. Modularity also creates demand for compatibility or "interconnection." Firms that produce complementary products (e.g., Microsoft and Nokia, or Facebook and Bharti Airtel) may team up to create platforms (sets of compatible complements); in other cases (e.g., Apple, Blackberry) firms choose to achieve compatibility through vertical integration. Competition in such markets takes place both within platforms (e.g., between HTC and Samsung for share on the Android platform) and among them (e.g., between the Android and iOS operating environments).

Finally – and importantly for assessing Zero Rating – IT markets are also characterized by significant *demand-side effects*, including economies of both scale and scope. Demand-side economies of scale, also known as network effects, imply that a product is more valuable to consumers as the number of users increases. The prototypical, if now somewhat dated, example is the fax machine. Demand-side economies of scope, by contrast, imply that a product's value increases with the diversity (as opposed to simply the number) of users: The value of a credit card network to both consumers and merchants depends on the presence of the other *type* of participant. Markets characterized by demand-side economies of scope are referred to as "two-sided" or "multi-sided."

The relationship between competition and consumer welfare in markets with demand-side effects is more complicated than in more traditional markets in several ways. For example, it is well established that the operator of a two-sided market has strong incentives to set efficient relative prices (*i.e.*, to engage in efficient price discrimination).[14]

The Economic Foundations of Zero Rating

The discussion above provides a conceptual framework for assessing the effects of Zero Rating. This section applies this framework to assess the economic implications of Zero Rating for online content and applications, mobile access, and the Internet ecosystem overall. Specifically, it discusses: (a) the role of Zero Rating in capturing network externalities (demand side economies of scale); (b) Zero Rating as a form of efficient differential pricing; (c) Zero Rating as an efficient pricing mechanism in the two-sided market for mobile wireless services; and, (d) Zero Rating as a mechanism for competitive product differentiation on mobile wireless markets. In each of these respects, Zero Rating is a market-driven mechanism for achieving economically efficient (and socially desirable) outcomes.

Zero Rating and Network Effects

Online content providers and mobile networks operate in markets that can have network effects, in that the value of the network to customers grows with the addition of other customers. As described below, the extent and type of network effect can vary significantly in particular cases. In some cases, expansion increases the value for all customers on the network. In others, the effects are limited to additions within smaller groups. And in others, benefits arise when different kinds of participants join a network.[15] Thus, it is often in the interests of current participants in a network to promote its growth in some form, and sometimes in the interests of society generally to promote universal participation. Governments often subsidize participation in industries with network effects through direct or indirect government subsidies (e.g., universal service for telephone and, more recently, broadband adoption).

One obvious and likely significant benefit of Zero Rating is to expand participation in zero-rated online content and applications, while also increasing mobile wireless penetration, especially in developing economies.[16] There is a substantial literature in support of the proposition that expanded Internet access, principally through higher mobile wireless adoption, has a variety of economic and societal benefits.[17]

It is also important to understand that the power of network effects is greatest within "communities of use." That is, the value of adding an additional member is greater for members who are more closely connected with (*i.e.*, who value interactions with) existing members than those who are (in the same sense) further away. In this context, Zero Rating is appropriately understood as a mechanism for achieving increased participation within relatively small communities, including within lower-income populations in developing economies.[18]

By promoting the positive network effects of increased adoption, Zero Rating thus generates positive social as well as economic externalities.

Zero Rating and Differential Pricing

Both online content providers and mobile broadband services are characterized by dynamic competition – that is, both industries make large, non-recoupable investments in R&D and physical infrastructure which are largely invariant to the number of users. As discussed above, in such industries, the average cost curve is declining over the relevant range of output: Simply put, it always costs less to produce an incremental unit of output than it costs, on average, to make the previous ones.

In such industries, consumer welfare can be increased if firms are able to identify and offer discounts to "marginal" customers, that is, those with lower willingness (or ability) to pay, thus expanding the size of the market and generating the additional revenues that can be used to defray the fixed costs of investment and innovation. It is widely agreed that such differential pricing – referred to by economists as – "competitive price discrimination" – is not only widespread, but generally improves economic efficiency and increases consumer welfare.[19]

In this context, zero rating of offerings like Wikipedia Zero, Facebook Zero and the internet.org app can be understood economically as a mechanism by which mobile carriers engage in efficient price discrimination through the bundling of two goods (mobile wireless service and content), thereby creating the ability for marginal consumers to pay a reduced price by choosing a differentiated product in the form of a "basic" form of online access.[20] In so doing, Zero Rating improves economic efficiency by supporting continuing investment and innovation in both networks and content while expanding Internet access to consumers who would otherwise be unserved.

Zero Rating and Two-Sided Markets

The central economic challenge for an operator of a multi-sided platform is to set prices and other product characteristics in such a way as to attract the optimal mix of customers and thus maximize the value of the platform. Newspapers, for example, must run enough advertisements to defray costs, but not so many as to drive away customers.

The economics of multi-sided markets help to explain Zero Rating programs in at least two respects. First, thinking of mobile operators as the platform provider, Zero Rating is a means by which carriers create opportunities for distribution by content providers (by increasing the number of subscribers), while enhancing the value of the platform for subscribers (by increasing the amount of available content). To the extent content providers contribute financially to Zero Rating through sponsored data programs, they do so in reflection of the increased value (at least over the long run) of enhanced distribution. But carriers may (and do) choose to offer Zero Rating even without a financial payment from content providers simply because it increases the value of their platforms.

A second aspect of multi-sidedness relevant to Zero Rating relates to the dual nature of consumers in relation to platforms like Facebook, Twitter and Wikipedia, in which "consumers" are also content creators. Thus, by attracting additional participants onto the platforms of such services, Zero Rating increases *both* the number of content consumers and the amount of content available. This "double whammy" effect helps to explain why firms like Facebook are taking the lead in encouraging Zero Rating programs.[21]

Lastly, firms in dynamic industries are better able to defray their fixed costs to the extent they can differentiate their products and attract more consumers. Zero Rating programs are an instrument by which mobile wireless firms can differentiate themselves from competitors by offering access to customized content with their mobile wireless services. Product differentiation also can serve to intensify competition in such markets. In this context, it is notable that the most prominent examples of Zero Rating in the U.S. have involved MetroPCS, Sprint and T-Mobile, all of which have used zero-rate offerings in order to differentiate their products from larger competitors. Similarly, Zero Rating plays a significant role in product differentiation for Globe (Philippines), which has offered zero-rated access to Facebook and other applications as part of its marketing campaigns.[22] Thus, Zero Rating (like other types of innovative pricing plans) generally contributes to the competitiveness of mobile wireless markets.

Addressing Concerns about Zero Rating

As noted above, some net neutrality advocates have challenged Zero Rating by asserting that it violates the principle of non-discrimination and hence (a) risks anticompetitive effects and (b) limits freedom of expression.[23] For the reasons explained immediately below, however, Zero Rating programs typically do not raise serious concerns with respect to anticompetitive effects. Further, as explained in the second subsection below, concerns about diversity of expression appear to be based more on speculation than empirical evidence, and to ignore the positive effects of Zero Rating in increasing access to online communications and information.

Zero Rating and Competition

The types of Zero Rating programs currently observed in the marketplace do not appear to raise significant competition concerns.

First, as noted above, most Zero Rating programs are carrier initiated and do not involve payments to carriers by the providers of the zero-rated content. Particularly in the absence of payments, Zero Rating cannot plausibly be characterized as anticompetitive foreclosure by content providers. Rather, to the extent that carriers elect to include certain content providers in a Zero Rating plan, the decision reflects the carrier's unilateral determination that doing so improves the value of its platform.

Second, even in sponsored data programs where content providers are providing payments to carriers, there appears to be no evidence that such arrangements involve exclusivity: Rather, it appears that opportunities to participate are being held out to content providers of all kinds.[24] Without exclusivity – the inclusion of some participants and the exclusion of others – there is no foreclosure, and hence no anticompetitive concern.[25]

Third, there is no *prima facie* basis for concluding that Zero Rating programs involving exclusivity would be anti-competitive. Exclusivity arrangements are commonplace, and typically are justified by efficiency motivations, such as the desire to avoid "free riding" on brand-specific investments. Exclusivity raises competition concerns, on the other hand, only under limited conditions, including that the exclusive arrangement must be sufficiently widespread so as to foreclose entry (and expansion) by an otherwise equally efficient competitor (*i.e.*, by preventing such a competitor from achieving minimum efficient scale). The characteristics of the mobile wireless and online content markets suggest that exclusivity in Zero Rating programs, to the extent it occurs, is of the efficiency-enhancing variety.[26]

The case advanced by critics of Zero Rating amounts to a claim that any form of differentiated carriage necessarily advantages some firms over others, and thus has potential competitive effects, and that the "victims" of such discrimination are likely to be small, innovative firms that lack the financial wherewithal to engage in Zero Rating programs of their own.[27] There are powerful arguments against this view, including: (a) mobile broadband providers have incentives to maintain a diversity of actual and potential complementors (e.g., content providers) and thus are not likely to willingly participate in activities that might foreclose competition; (b) the most common Zero Rating programs are carrier initiated and do not require financial contributions from the content provider; (c) many small content providers engage in Zero Rating (e.g., Aquto, hipcricket, Syntonic)[28] and (as discussed above) Zero Rating is easily explained on efficiency grounds; and, (d) Zero Rating critics have not demonstrated any harm to competition or consumers from Zero Rating, or even shown that any individual competitors have been disadvantaged.[29]

Zero Rating and Freedom of Expression

While freedom of expression concerns arguably invoke values that go beyond economic efficiency *per se*, economic analysis can nevertheless inform the debate around the key issues. First, as noted above, Zero Rating programs do not generally involve exclusivity. Thus, no one's views are being foreclosed, or muzzled. Second, the firms engaging in Zero Rating are to a significant extent (e.g., Facebook, Twitter, Wikipedia) vehicles for the open expression of views by all participants, subject only to *de minimus* limitations. Increasing the number of Facebook (or Twitter or Wikipedia) users thus arguably enhances freedom of expression and the diversity of opinion in the public square – especially in developing countries, where such outlets have demonstrably enhanced freedom of political expression. Third, as an empirical matter, the diversity of content suppliers is growing rapidly; concerns about "a few media outlets controlling the news" seem increasingly anachronistic. Fourth, and finally, in order to argue that Zero Rating programs deprive subscribers of access to information ("the full and open Internet"), one needs to argue that nothing is better than something – that those who gain access to online content as a result of Zero Rating would be better off with no access than some access, an argument which seems difficult to sustain.

Conclusions

Concerns about Zero Rating are misplaced. The Zero Rating programs that are observed in the marketplace are readily explained as market-driven mechanisms for capturing economic efficiencies associated with the characteristics of information technology markets. By expanding the reach of online content and distribution services, they generate economic social benefits. Concerns that Zero Rating could serve as a means of foreclosing competition, or limit freedom of expression, appear misplaced and lacking both theoretical and empirical support.

Notes

[1] See Matt Hicks, "Fast and Free Facebook Mobile Access with 0.facebook.com," May 18, 2010 (available at https://www.facebook.com/notes/facebook/fast-and-free-facebook-mobile-access-with-0facebookcom/391295167130).

[2] See internet.org/about.

[3] For an interesting discussion of issues associated with Zero Rating programs, see "Net Neutrality, Zero Rating, and Development: What's the Data?" *Internet Governance Forum* (September 3, 2014) (available at http://www.intgovforum.org/cms/174-igf-2014/transcripts/1969-2014-09-03-ws208-net-neutrality-zero-rating-and-development-room-5) (hereafter *IGF Transcript*).

[4] See e.g., David Meyer, "In Chile, Mobile Carriers Can No Longer Offer free Twitter, Facebook or WhatsApp," GigaOm (May 28, 2014) (available at https://gigaom.com/2014/05/28/in-chile-mobile-carriers-can-no-longer-offer-free-twitter-facebook-and-whatsapp/) (hereafter, Meyer, Chile).

[5] Authority for Consumers & Markets, "Fines Imposed on Dutch Telecom Companies KPN and Vodafone for Violation of Net Neutrality Regulations," (January 27, 2015) (available at https://www.acm.nl/en/publications/publication/13765/Fines-imposed-on-Dutch-telecom-companies-KPN-and-Vodafone-for-violation-of-net-neutrality-regulations/)

[6] See "Mobile operators in Slovenia Fall Foul of Net Neutrality Rules," MobileWorldLive.com (January 26, 2015) (available at http://www.mobileworldlive.com/mobile-operators-slovenia-fall-foul-net-neutrality-rules).

[7] See Canadian Radio-television and Telecommunications Commission, CRTC, Broadcasting and Telecom Decision 2015-26 (January 29, 2015) (available at http://www.crtc.gc.ca/eng/archive/2015/2015-26.htm).

[8] See e.g., David Meyer, "Pro-Net Neutrality Norway Advises Carriers to Avoid Zero-Rating," GigaOm (November 18, 2014) (available at https://gigaom.com/2014/11/18/pro-net-neutrality-norway-advises-carriers-to-avoid-zero-rating/).

[9] See e.g., "Net Neutrality Also an Issue in Emerging Markets Like India," *Business Monitor* (February 3, 2015) (available at http://www.businessmonitor.com/news-and-views/net-neutrality-also-an-issue-in-emerging-markets-like-india); see also Anandita Singh Mankotia, "Trai examining Bharti Airtel's special deals on Facebook and WhatsApp," *The Economic Times*, November 25, 2014 (available at http://articles.economictimes.indiatimes.com/2014-11-25/news/56455517_1_net-neutrality-mobile-data-services-uninor).

[10] The FCC voted to approve a new Open Internet Order on February 26, 2015. See Federal Communications Commission, "FCC Adopts Strong, Sustainable Rules to Protect the Open Internet" (February 26, 2015). The text of the Order has not yet been released, but FCC officials have indicated they will evaluate Zero Rating plans on a case-by-case basis. See Lauren Walker, "Why the Net Neutrality Fight Isn't Over," *Newsweek* (February 6, 2015) (available at http://www.newsweek.com/why-net-neutrality-fight-isnt-over-305060).

[11] This section relies in part on Jeffrey A. Eisenach and Ilene Knable Gotts, "In Search of a Competition Doctrine for Information Technology Markets: Recent Antitrust Developments in the Online Sector," in Fabrizio Cugia di Sant'Orsola, Rehman Noormohamed, and Denis Alves Guimarães, eds., *Communications and Competition Law: Key Issues in the Telecoms, Media and Technology Sectors* (Wolters Kluwer Law and Business, 2014) 69-90. For a more extensive discussion of these phenomena and their implications for competition analysis, see Jeffrey A. Eisenach, *Broadband Competition in the Internet Ecosystem* (American Enterprise Institute, 2012); *see also* Oz Shy, *The Economics of Network Industries* (Cambridge University Press, 2001).

[12] See William J. Baumol, *The Free Market Innovation Machine: Analyzing the Growth Miracle of Capitalism* (Princeton University Press, 2002), at 4 ("Innovation has replaced price as the name of the game in a number of important industries. The computer industry is only the most obvious example, whose new and improved models appear constantly, each manufacturer battling to stay ahead of its rivals."); see also Joseph Schumpeter, *Capitalism, Socialism and Democracy* (1942).

[13] Especially in dynamic markets with high rates of innovation, high margins as measured by accounting data do not necessarily equate to high profits from the perspective of economics or competition analysis. The seminal reference is Franklin M. Fisher and John J. McGowan, "On the Misuse of Accounting Rates of Return to Infer Monopoly Profits," *American Economic Review* 73;1 (March 1983) 82-97

[14] See, e.g., Julian Wright, "One-Sided Logic in Two-Sided Markets," *Review of Network Economics* 3(1) at 44 (2004).

[15] The impact of network effects can depend on a variety of factors. For example, some of the network effects of increasing wireless penetration are shared among carriers thanks to the fact that carriers interconnect with one another (so subscribers to each network can call subscribers on other networks). Carriers may seek to capture some of these effects through programs ("friends and family" plans) that encourage in-network calling.

[16] The empirical evidence on the impact of Zero Rating on wireless penetration and mobile content usage, though limited, suggests the effects may be substantial. For example, a 2010 program by Turk Cell involving Twitter resulted in a 340 percent increase in Twitter traffic. See *IGF Transcript*.

[17] See e.g., *Value of Connectivity: Economic and Social Benefits of Expanding Internet Access* (Deloitte 2014 (available at https://fbcdn-dragon-a.akamaihd.net/hphotos-ak-ash3/t39.2365/851546_139803602045987 6_1878998841_n.pdf); see also Digital Entrepreneurship in Kenya 2014 (GSMA, 2014) (available at http://www.gsmaentrepreneurshipkenya.com/GSMA_KENYA-AR2014-060214-WEB-SINGLE-PGS.pdf).

[18] Social networks like Facebook and Twitter have been shown to play a significant role in driving Internet adoption in developing countries, where the proportion of Internet users who use such applications is higher than in the U.S. See e.g., Lee Rainie and Jacob Poushter, "Emerging Nations Catching Up to U.S. on Technology Adoption, Especially Mobile and Social Media Use," Pew Research Center (February 13, 2014) (available at http://www.pewresearch.org/fact-tank/2014/02/13/emerging-nations-catching-up-to-u-s-on-technology-adoption-especially-mobile-and-social-media-use/)

[19] See e.g., William J. Baumol and Daniel G. Swanson, "The New Economy and Ubiquitous Competitive Price Discrimination: Identifying Defensible Criteria of Market Power," *Antitrust Law Journal* 70 (2003) 661-685 at 665; see also See, e.g., Hal R. Varian, "Differential Pricing and Efficiency," *First Monday* 1;2 (August 1996) at 2 ("[M]any important industries involve technologies that exhibit increasing returns to scale, large fixed and sunk costs, and significant economies of scope. Two important examples of such industries are telecommunications services and information services. In each of these cases the relevant technologies involve high fixed costs, significant joint costs and low, or even zero, marginal costs. Setting prices equal to marginal cost will generally not recoup sufficient revenue to cover the fixed costs and the standard economic recommendation of 'price at marginal cost' is not economically viable. Some other mechanism for achieving efficient allocation of resources must be found.").

[20] Facebook and its partners in Internet.org have made extensive investments to understand the realities of Internet access in the developing world and to use this knowledge to develop ways to expand Internet access in such countries.

[21] Relatedly, to the extent Zero Rating ultimately increases the audience for mobile content services, it also implicates yet another "side" of the multi-sided mobile wireless ecosystem – advertisers. I understand that Facebook Zero does not depend on advertising, but the same is not true for other firms participating in Zero Rating programs, such as Google and Pandora.

[22] See "Globe Telecom Expands Mobile Data Business with Free Facebook, Free Viber Offer," *Adobo Magazine* (January 8, 2015) (available at http://www.adobomagazine.com/philippine-news/globe-telecom-expands-mobile-data-business-free-facebook-free-viber-offer).

[23] See e.g., Susan Crawford, "Zero for Conduct," *Medium.com* (January 7, 2015) (available at https://medium.com/backchannel/less-than-zero-199bcb05a868, viewed February 6, 2015).

[24] See, "AT&T Introduces Sponsored Data for Mobile Data Subscribers and Businesses," (January 6, 2014) (available at http://www.att.com/gen/press-room?pid=25183&cdvn=news&newsarticleid=37366&mapcode=consumer|mobile-devices).

[25] The fact that some content providers *choose* not to participate in zero rating does not mean they are "foreclosed" in any sense of the word, since they had the opportunity to do so.

[26] For example, it is worth recalling that each mobile network is not a distinct market, but rather that all mobile networks in a given geographic area compete in the same relevant product market. Hence, an exclusive arrangement with a single carrier does not foreclose competition in the entire market.

[27] See e.g., Crawford (2015).

[28] See AT&T, "Our Sponsored Data Providers" (available at http://www.att.com/att/sponsoreddata/en/index.html#fbid=PYLlaU9knHP, viewed February 8, 2015).

[29] The antitrust laws properly focus on protecting competition, not individual competitors. It is also noteworthy that the firms identified by Zero Rating's critics as potential "victims" tend to be established firms like Netflix and Skype (Microsoft), not startups and new entrants. See e.g., New American Foundation, Center for Media Justice, Media Access Project, *Notice of Ex Parte Presentation: GN Docket No. 09-191* (*Preserving the Open Internet*); *WC Docket No. 07-52* (*Broadband Industry Practices*) (January 10, 2011) (available at http://newamerica.net/publications/resources/2011/notice_of_ex_parte_presentation_gn_docket_no_09_191_preserving_the_open_).

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Zero-Rating: Kick-Starting Internet Ecosystems in Developing Countries

BY DIANA CAREW

MARCH 2015

The power of the Internet has redefined the global economy for the 21st Century. As of 2014, over three billion people around the world were connected. The corresponding boom in Internet-based retailers, news and information providers, and online entertainment and video companies has been just as impressive.[1] Businesses go where the customers are, and increasingly the customers are online or mobile.

Unfortunately, the online revolution is lagging in many of the least developed parts of the world. Consider that as of 2014, fewer than 30 percent of Africa's 1.1 billion population used the Internet.[2] At the same time, relatively few African businesses have participated in the Internet business boom. Less than one percent of all existing domain name registrations in 2013 originated from Africa, meaning African-based businesses have very little local or global presence on the internet.[3]

The problems are multiple. Building a broadband infrastructure to all homes, especially in rural areas, is too costly for many low-income countries. And mobile broadband service, while more broadly available, is also relatively expensive to provide and high-priced compared to incomes. As a result, broadband markets are limited in many poor and developing areas. In 2013, for example, there were 20 mobile broadband subscriptions per 100 people in the Philippines, and just three for every 100 people in Kenya.[4]

At the same time, a low level of connectedness keeps the local Internet ecosystems stunted. Entrepreneurs are unwilling to start new Internet-based businesses because there aren't enough customers online. Conversely, without local Internet-based businesses providing relevant information, content, and services, potential customers have less incentive to invest in expensive data plans for their smart phones.

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Consider the obstacles facing a potential local business that would collect agricultural prices across a poor country, and post them online. Such Internet businesses have increasing returns to scale—expensive to collect the information in the first place, but relatively cheap to provide it to more and more customers. That means such a business—which would be very beneficial to farmers—is far easier to start and far more profitable if the pool of potential customers is large. But if the pool of potential customers is small, the business may never get started, and there will be even less reason for poor mobile phone users to buy a data plan.

> The online revolution is lagging in many of the least developed parts of the world.

In other words, developing countries can get stuck in a low-connectivity equilibrium, where there are relatively few broadband customers and few local Internet-based businesses to serve them. How, then, can we jumpstart the local internet ecosystem in developing countries to move from a low-connectivity equilibrium to a high connectivity equilibrium where the number of users with data plans is higher and the country has viable local Internet-based businesses that both generate jobs and provide relevant content and services to mobile users? As more people connect to the Internet, local content and service providers will create and expand existing content to meet demand. This will boost growth in the local economy, which in turn will generate greater demand for local content and enable more people to connect to the Internet. This is a transition that many developed countries made in the late 1990s and early 2000s. How can we accelerate it in poor and developing countries?

This paper explores one approach for jump-starting local Internet ecosystems where connectedness is low—a practice known as "zero-rating." Under this program, mobile operators provide its customers with access to certain online content, or package of websites, for "free," in that such content does not count against monthly data caps. There are several variations of zero-rating programs, many of which do not involve any exchange of funds among firms. One type of zero-rating outside the scope of this analysis is where content providers directly reimburse operators for foregone data costs is called 'sponsored data.' This paper contemplates programs more like Internet.org or Wikipedia Zero where content providers do not directly compensate operators for lost data revenue.

It's important to note here that this paper focuses mainly on the use of zero rating in poor and developing countries, and the arguments are laid out with those situations in mind. In future work, we will explore the ways that zero-rating is useful in developed countries, and especially among less-connected populations.

The power of zero-rating to nourish an Internet ecosystem in poor and developing countries comes from its potential to increase connectivity by both people and businesses quickly and at low-cost. First, free access to popular sites like Google, Twitter, Wikipedia, and Facebook encourages more people to sign up for data plans, and enables greater data freedom to explore local content. Second, the increase in demand for local content spurs local businesses and entrepreneurs to create new online products and services—for example, information on Ebola outbreaks, typhoon warnings, or even wait times at local stores and government offices. Moreover, the higher share of population online justifies efforts of government agencies to go digital, which in turn encourages more business and individuals to join the internet ecosystem. Taken together, zero-rating can effectively jump start a virtuous feedback loop that moves the local economy into a high-connectivity equilibrium.

Zero-rating has already been adopted by mobile operators in poor and developing countries, including the Philippines, Turkey, India, and across Sub-Saharan Africa. And although these programs are relatively new, early indications show

more people are connecting to the Internet in these countries.

However, zero-rating has some detractors. Some argue for banning the practice, claiming that it violates net neutrality principles by prioritizing select content. Others argue that free access to select content is too limited to provide the digital literacy skills needed to fully participate in the data-driven economy.

Still, this paper argues that given the promise of early indications, it seems bad policy to squash the potential of zero-rating, especially in countries trapped in a low-connectivity equilibrium. Instead, this paper proposes several ways to enhance the potential effectiveness of zero-rating as a tool for growth for poor and developing communities. That includes being non-exclusive across mobile operators and transparent. We also suggest regular evaluation and reporting of zero-rating programs, to better inform mobile operators and relevant policymakers of the actual risks and rewards.

By banning zero-rating, poor and developing countries would deprive themselves of a possible avenue for economic growth and prosperity. They are closing a pathway for their citizens and businesses to harness the power of the Internet, moving them to a high-connectivity equilibrium. In the language of economics, that would mean forgoing one of the greatest positive externalities of having a vibrant Internet ecosystem: economic and social mobility.

LOW CONNECTIVITY EQUILIBRIUM

In a low-connectivity equilibrium, people and businesses have little motivation to connect to the Internet. A lack of access to Internet-based consumers keeps businesses away from online expansion and sidelines aspiring tech entrepreneurs. On both the consumer and business side of the market, being connected comes at a high cost and low marginal return.

A low-connectivity equilibrium is prevalent in many poor and developing countries. People have little incentive to spend precious income on data plans, given the lack of valuable content. It's no accident that, of the estimated 4.5 billion people worldwide still unconnected to the Internet, 90 percent—over 4 billion—are in the developing world.[5]

With low-connectedness, businesses are limited to their existing consumer base, and have little incentive to invest in creating online platforms for their products. Internet entrepreneurs have no motivation to transform their ideas into new start-ups, lacking the promise of growing profits or the ability to get seed money. The dearth of business formation and growth traps the local economy in an unconnected low-growth state, without access to global online markets.

> Advanced countries have about 84 active mobile subscriptions per 100 people, compared to about 21 per 100 people in developing countries.

Similarly, government agencies have little incentive to go digital if there are too few citizens with the capability to connect online. Why should they spend precious resources setting up webpages and digital access to services if only a small portion of the population have access?

It is easy to see why some countries get stuck in low-connectivity equilibrium, even as the benefits of being connected are great. A major reason for this is cost. Even in areas where fixed or mobile broadband is accessible, the price for a mobile broadband subscription is simply too expensive for many. According to one recent estimate, people in developing countries with mobile phones pay between 8-12 percent of their average monthly income on mobile connectivity, and that is often just for voice and text.[6]

Consider that a mobile data plan in the Philippines costs on average the equivalent of $17 a month,

which does not seem like much. Yet this constitutes almost 10 percent of the per capita monthly average national income, according to International Telecommunications Union. That ranks the country as 87th out of 110 countries on affordability for mobile broadband.[7] It is not obvious to the millions who remain unconnected that it is worth spending a large share of their income on something that may not be essential. And without the online customer base, it is not obvious to businesses that they need to spend the time and money to develop an Internet presence. Thus we have a negative reinforcing cycle.

HIGH-CONNECTIVITY EQUILIBRIUM

Conversely, other countries in the global data ecosystem are highly connected. In a high-connectivity equilibrium, people and businesses are integrated online, constantly feeding off each other to create new content and services that enhance consumer well-being. The result is a strong foundation for economic growth and shared prosperity.

Many advanced countries are in a high-connectivity equilibrium. These countries have enjoyed rapid growth in the number of online businesses, mobile subscriptions, and tech-related job creation. According to a 2014 report, developed countries account for over 80 percent of domain name registrations, which all websites must have.[8] They have about 84 active mobile subscriptions per 100 people, compared to about 21 per 100 people in developing countries.[9] High-growth tech clusters are sprouting up across the United States, and in leading global cities like London and Sydney, creating millions of high-wage jobs.[10]

That's because in a high-connectivity equilibrium, businesses and entrepreneurs thrive in a vibrant digital marketplace. They are able to meet strong consumer demand for online content and services through an ever rising number of apps, online retailers, social media forums, and new products unique to the Internet.

Some of today's largest companies around the world would never have been as successful had it not been for a highly connected population. Some companies, like Apple and Samsung, produce sophisticated smartphones and other Internet-able devices. Others, like Amazon, provide consumers with a one-stop retail experience. Search and software giants like Google and Microsoft empower consumers and businesss with essential tools and services. All of these companies feed off each other's growth in a high-connectivity equilibrium.

Indeed, the power of online commerce has translated into an enormous rise in data-related consumption and trade. PPI has previously written on both these topics, showing just how important the Internet has become to driving productivity and national incomes.[11] In fact, the profound pace of data-driven innovation has been so rapid, researchers are still developing ways to accurately measure the Internet's impact on government economic statistics.

Another important part of high-connectivity equilibrium is having strong investment in the build-out of high-speed broadband networks. Such robust investment is evident in many developed countries, including the United States, whose private telecommunications and cable sector invests billions annually in fiber installation and high-speed 4G/LTE mobile networks. Overall, annual capital expenditures of mobile operators in developed countries well outpaces the developing world.[12]

SHIFTING FROM A LOW TO HIGH-CONNECTIVITY EQUILIBRIUM

It is possible to move from a low- to high-connectivity equilibrium. After all, developed countries were able to make this transition in the late 1990s and early 2000s. These countries also continue to enjoy a sustained momentum in the large share of the population purchasing a monthly mobile data plan, as the bevy of available online content and functionality grows and becomes more relevant in everyday life. In the United States, for example, there are more wireless connections than people, with many connecting to the Internet through multiple devices.[13]

The shift from a low-connectivity to high-connectivity equilibrium in developed countries occurred more organically than in developing countries. That's because a relatively large share of the population in developed countries had enough income that they could afford to sign-up for the Internet. It took a lower initial benefit from going online—less available online content—to convince many citizens in the developed world to spend their income on a fixed broadband connection. This led to an easy transition to mobile broadband plans once they became available.

> In high-connectivity Internet ecosystems, consumers and businesses feed off each other to create new content, generating income, jobs, and more demand.

Some researchers also credit the rise in Internet demand in developed countries to a few initial "killer apps." These offerings were widely believed to have helped influence on early Internet adoption. For example, the proliferation of social media is credited with encouraging people to spend on an Internet connection. Starting with online chat rooms and Compuserve, and continuing on through America Online, MySpace, Facebook, Twitter, Reddit, and LinkedIn, social media has transformed how people communicate, get the news, and create their own content to share.[14] It has connected traditionally harder to reach segments of the population, like those in rural areas and the elderly, who want a low-cost way to stay in contact with family and friends.

In these high-connectivity Internet ecosystems, consumers and businesses feed off each other to create new content, generating income, jobs, and more demand. Since the introduction of the iPhone, the number of available iOS apps increased from 800 in July 2008 to a staggering 1.3 million in September 2014.[15] The number of

Android apps in the Google Play store is just as high, if not higher. The rising demand for online video has resulted in companies designing an interactive watching experience across devices, with consumers able to watch movies, listen to music, and even catch their favorite shows on their tablet, phone, or TV.

GETTING FROM LOW TO HIGH-CONNECTIVITY

How can developing countries shift to a high-connectivity equilibrium? There are several forms of intervention that can encourage the transition. Each approach has its advantages and disadvantages, but the effectiveness will ultimately depend on how well it is able to jumpstart the Internet ecosystem. That is, how successful it is at getting more people and businesses connected to the Internet, by lowering the cost of access while encouraging more local content.

One approach is for governments to intervene directly, by providing subsidies to either people or businesses. Both have extensive histories of being employed in developing countries, with mixed success.

In developing countries, government subsidies are often used to get people to act in certain ways.

A well-regarded example is the Bolsa Familia program in Brazil, which gives poor families money if they vaccinate their children and send them to school.[16]

Some governments in developing countries have provided free broadband access to encourage greater adoption and improve the local business climate for content creation. In Macedonia, for example, the "Rural Broadband in 680 Locations" project has provided free WiFi access in 680 rural locations across the country since 2009. A World Bank evaluation considered the program to be successful at enabling greater access to agricultural and education information, and public online services.[17]

Governments can also provide subsidies to businesses, often in the form of what are generically known as 'universal service funds.' These government-controlled funds provide money to the private sector to build out broadband networks in poor or remote areas where there is no compelling business case. However, while popular, this approach has had limited success. According to a 2013 survey of 69 such funds, half reported little to no activity. The funds were collected but have yet to be utilized.[18]

> Although it's still too soon to assess the impact of many zero-rating programs, early results are promising.

Another approach to shifting to a high-connectivity equilibrium is more indirect. It involves the government allowing the private sector to offer Internet content people value at low-cost. Here, the private sector is providing the subsidy to consumers to increase the number of people purchasing a data plan, which will increase the amount of online content being created.

One such indirect approach is known as a practice called "zero-rating." Zero-rating is where mobile operators offer select online content for free, in that accessing it will not count against any monthly data caps (hence, it is "zero-rated"). In some cases, the mobile operator may offer zero-rated content to people even without data plans.

The idea behind zero-rating is simple: to get more people connected by providing access to popular websites, and to provide greater freedom to use data for local content, increasing demand. That is, when certain content is zero-rated, particularly high-demand services like Google and Facebook, people are free to use a higher percentage of their existing data cap on other content. This will jumpstart the local Internet ecosystem. And since the success of zero-rating is sparked by low-cost access to popular online content, it follows that the main sites being offered to date include social media giants Facebook and Twitter, along with Google and Wikipedia.

Zero-rating is widely offered across many developing countries. In fact, a recent study found that 45 percent of global mobile operators offer some form of zero rating. This includes offerings in many of the countries with the lowest incomes and broadband adoption rates, stuck in a low-connectivity equilibrium, like Tanzania, Cameroon, Ivory Coast, India, Moldova, Uzbekistan, and Pakistan.[19]

Zero-rating can take several forms, depending on the mobile operator. It can be offered on a temporary basis, over a few months, or it can be permanent. The content being zero-rated is also at the discretion of the mobile operator, which ranges from one high-demand website to several sites that may include local content.[20] Zero-rating is generally not monetized, so that there is typically no payment between the mobile operator and content provider. But there is usually a legal agreement between content provider and operator, that delineates terms of use and could include provision of technical assistance for implementation.[21]

ADVANTAGES OF ZERO-RATING

In shifting to a high-connectivity equilibrium, a zero-rating approach has several advantages over direct government subsidies. For developing countries that may have scare resources, these

advantages are important in considering ways to effectively jump-start local Internet ecosystems.

First, zero-rating can jumpstart an Internet ecosystem at a faster and significantly lower cost. Direct government subsidy programs can be very costly, and spread out over many years. They may also be harder to contain, especially programs that fund public broadband networks or subsidize Internet-capable devices. That's because mobile broadband technology is constantly evolving, as are the devices that run on the networks. It is very expensive to successfully build, operate, and maintain government-owned broadband networks, especially when increased public-take up of broadband is not guaranteed. Even in developed countries, government-owned broadband networks have a very mixed record of success.

Zero-rating is cheaper because mobile operators subsidize the costs to provide zero-rated data. They internalize the costs through their billing processing operations. Moreover, even if these operators are government-owned, there are typically no direct payments to the zero-rated content creator.

Second, with zero-rating, an Internet ecosystem can flourish relatively quickly, because such offerings can be more easily implemented and maintained, or adjusted according to public response. It is much easier, and cheaper, for example, to extend the zero-rated offering beyond a trial period than it is to increase the amount of a monthly public subsidy.

Third, zero-rating comes with significantly less government control. That not only reduces the burden on governments with limited resources, but it also limits the possibility of mismanagement. Without a large cash transfer program, there is much less room for misallocation or waste of funds, or worse, corruption.

For example, a 2013 opinion survey covering seven African countries found a dramatic impact from the availability of more information on the Internet. When asking people what had changed in communications over the last five years, it found that the Internet and greater access to information online "are interconnected as wider media generally drives a wider set of viewpoints and information[,] with the Internet acting as a backstop where people can get information not provided by traditional media or actually restricted by Government."[22]

> The rise in Internet users in Kenya is also helping drive the creation of more local online content.

Finally, although it's still too soon to assess the impact of many zero-rating programs, early results are promising. In several developing countries where mobile operators have already offered zero-rated content, Internet ecosystems are taking off. Mobile operators are reporting an impressive rise in mobile data plan subscriptions and mobile data consumption.

The Philippines, for example, a country whose mobile operators actively engage in zero-rating, has recently begun to enjoy a prosperous Internet start-up culture. A basic search online shows a large and wide variety of Filipino Internet companies, offering services like digital queuing,[23] selling products like folding bicycles, and helping citizens monitor their electricity use in real time. Tech incubators are springing up, and injecting Internet businesses with capital.[24]

Further, the Philippines has seen rapid growth in the population connecting to the Internet, including a double-digit rise in the last year.[25] So successful was a temporary offering of zero-rated Facebook content (known as Facebook Zero) by one of its main mobile operators, that it was later reinstated. According to reports, the original three-month program offered by Globe Telecom, a major carrier, led to a doubling of the company's mobile data user base.26 The Globe's latest annual report also shows the number of mobile subscribers increased by 16 percent year over year, 74 percent stronger growth than in the preceding year.[27]

Of course, the tremendous growth in Internet startups and Internet users cannot be directly attributed to the country's various zero-rating programs, but they certainly contributed. The Globe's annual report, for example, touts the program as a core component of its services offering.

Perhaps some of the most promising examples of early zero-rating success in jumpstarting Internet ecosystems are in Africa. Many African countries have mobile operators that offered some form of zero-rating, starting as early as 2010.

> Without any exposure to the Internet, there is no chance of moving from a low-connectivity to a high-connectivity equilibrium.

Within the first year offering zero-rated content, the evidence of increased Internet adoption across Africa—using new subscriptions to Facebook as a proxy—was remarkable. According to oArfrica, a data service that tracks Internet progress in Africa, the number of Facebook users across the entire African continent increased by an average 114 percent.[28] This includes a 4,000 percent increase in Central African Republic and a 2,000 percent increase in Chad and Somalia.

Certainly an increase of Facebook subscriptions does not mean more Africans are purchasing mobile broadband plans, or that more people creating Facebook accounts are initiating local Internet ecosystems. But it appears to be serving as an important catalyst on both fronts. According to one take on a 2009 Inveneo conference:

> The consensus of group, marketing and technical experts at African ICT companies, was that Facebook was creating demand for their services. Current clients wanted faster Internet connectivity to download all the images and video sent their way via Facebook, and more technology (cameras, video & image editing software) to create content for their Facebook pages. All the chatter about Facebook accounts was also driving new customers to buy computers and invest in Internet connectivity. "I need to get Facebook," is becoming a common refrain at retail computer stores.[29]

Egypt, in particular, has seen an impressive rise in their Internet economy over the last few years. While there may or may not be a connection, Egypt's participation in zero-rating programs began several years ago, and its main mobile operator Orange began offering Facebook Zero in 2012. Preliminary reporting showed a massive rise in customers connecting to the Internet, with 350,000 new subscriptions in the first month.[30]

Concurrently, Egypt's businesses have made a dramatic shift to go online. According to data compiled by the United Nations Conference on Trade and Development, over 2008-2012 the share of urban businesses using the Internet increased from 29 to 56 percent, while the share of rural businesses online increased from 9 percent to 38 percent.[31] The rise in rurally-located businesses on the Internet, serving the more vulnerable populations in terms of Internet connectedness, is especially promising.

Undoubtedly, the rapid adoption of Internet-based business models by businesses in urban and rural parts of the country was influenced by the rising number of people connecting to the Internet. Over the last year alone, the number of Internet users in Egypt rose 10 percent.[32] Taken together, this suggests the beginnings of a flourishing Internet ecosystem that could shift the country into a high-connectivity equilibrium.

Progress in Africa on creating Internet ecosystems in countries that have employed zero-rating is not limited to the northern part of the continent. In Kenya, for example, another country whose mobile operators offered Facebook Zero, the number of Internet users is steadily rising. In 2014, the number of Kenyans connecting to the Internet increased by a whopping 16 percent.[33]

The rise in Internet users in Kenya is also helping drive the creation of more local online content. According to an excerpt from the 2014 Ericsson Mobility Report:

> New business opportunities that have been created by the Internet have been boosted by consumers' increased access via mobile phones. This has led to the development of new business models. In Kenya, Mozambique, and Nigeria, TV and media services are increasingly being accessed using smartphones…influencing the development of local and regional content. Innovations such as this give rise to further market trends such as multiscreen consumer behavior. The rise in sophistication of social networking platforms has played a role in the growth of mobile traffic."[34]

These early indications of successful development of Internet ecosystems in countries with a low-connectivity equilibrium point to a promising role for zero-rating programs. As more data continues to be collected and reported, it is possible we will see further success on the development of these and other Internet ecosystems in countries where zero-rating is available.

CRITICISMS OF ZERO-RATING

There are critics who oppose using zero-rating as an approach to shifting to a high-connectivity equilibrium. These critics argue it will do little to benefit the local population or economy, and that it could even harm competition in local markets.

First, critics of zero-rating see it as a form of content prioritization.[35] Some opponents, such as Susan Crawford, claim it discriminates against the creation of local would-be content providers of similar services.[36] In this scenario the Internet ecosystem is not stimulated, because businesses are unable to compete with the few sites that receive preferential treatment. This view posits a zero-rating spiral, where any business that wishes to succeed will have to negotiate their own zero-rated deals with operators. This would keep local content developers out of the market, or at the very least discourage creation of non-zero-rated content.

Fear of discriminatory practices is why countries like Chile have already banned zero-rating.[37] Other developing countries that are considering similar measures are doing so on the grounds that any prioritization is a violation of net neutrality.

> Core principles encourage public and government trust in mobile operators' intentions when pursuing zero-rating programs.

Second, opponents of zero-rating argue that the shift to a high-connectivity equilibrium may not happen if consumers are unable or unwilling to go beyond the free content. Here, zero-rating forms a "walled garden" around the Internet, also referred to as a separate "Internet for poor people."[38]

The underlying presumption is that if people can't afford a data plan regardless of zero-rated content, even if they see the relevancy of having Internet access, then zero-rating is irrelevant. The ecosystem will never get off the ground, leaving people with a fragmented slice of the Internet. In this scenario, instead of bridging the digital divide, zero-rating will widen it, ultimately doing more harm than good.

These zero-rating opponents also point to evidence in some developing countries that people already believe sites like Facebook constitute "The Internet." According to one Quartz article, "Facebook is literally becoming the Internet." It cites the overwhelming share of Filipino citizens on Facebook as a share of those using the Internet, and details how a leading handset manufacturer even includes Facebook's logo in its advertising.[39]

Interestingly, however, the same article also explains why these claims of "Facebook being the Internet" are exaggerated. Facebook has penetrated just 6.5 percent of the population in Asia, and less

than 5 percent in Africa.[40] Moreover, it is not clear why increased use of social media—and any other zero-rated content—is negative. That could actually be a sign of the zero-rating's success in these countries at getting more people and businesses online.

Ultimately, exposure to 'some Internet' is far more likely to be a gateway to increased data consumption than to block Internet usage or reduce it. Without any exposure to the Internet, there is no chance of moving from a low-connectivity to a high-connectivity equilibrium. That makes it is all but assured people will not be able to learn the digital skills they need to participate in the digital revolution.

> Zero-rating also cannot work without basic broadband infrastructure in place, particularly for mobile broadband.

Moreover, people and businesses in poor and developing countries stand to gain the most from becoming connected. They are in some ways even more reliant on being connected than people in developed nations, and stand to lose out on more social and economic opportunities without it.

The popularity of social media sites like Facebook and Twitter is not the problem with zero-rating—it is an opportunity. According to a recent Pew survey, "Once people have access to the internet, they tend to engage in social networking."[41]

Not counting popular social media content against data caps will give people the freedom and incentive to explore local content and services. And instead of competing with the social media giants for customers, local enterprises can work with them as part of the larger Internet ecosystem. They can take advantage of the ability for people to use any zero-rated social media platforms, as an opportunity to reach potential customers. They can create their own social media pages for customers to follow, and even advertise their latest goods and services, at a relatively low-cost.

ENHANCING ZERO-RATING THROUGH POLICY

Rather than ban zero-rating, countries should follow certain core principles that will enhance its ability to successfully ignite a local Internet economy. That is, a set of characteristics for zero-rating programs to incorporate, as highlighted by the successes demonstrated in the preliminary evidence.

These principles will still enable the many shapes and sizes of zero-rating programs currently in practice. A one-size-fits-all approach to zero-rating simply does not make sense given the large variance in underlying social and economic demographics of the target low-connected populations.[42]

Rather, these principles should incorporate lessons from current practice, to establish a base set of features that should be common to all zero-rating programs. We believe this will give future programs the best chance of becoming a successful ecosystem jumpstart, while addressing some of qualms voiced by zero-rating critics. Such principles encourage public and government trust in mobile operators' intentions when pursuing zero-rating programs.

For example, we propose the following core principles for zero-rating programs:

1. Transparency—all zero-rating offerings should ban secret agreements between content provider and mobile operator.
2. Non-exclusivity—there should be no agreement that prohibits multiple operators from offering the same zero-rated content. This will mitigate fears of anti-competitive behavior.
3. Local content—when possible, mobile operators should also zero-rate some basic local content, such as local government services or local healthcare and weather alerts.
4. Evaluation—regular data collection and reporting from the mobile operators will help governments understand the effectiveness of zero-rating.

These principles will help foster a positive feedback loop for local economic development. For example, offering some zero-rated local content will entice content creators to go online faster, and it will show low-connectivity consumers the relevance of local content.

Regular reporting and evaluation of the outcomes of zero-rating programs will not only provide a better foundation for technology policy in developing countries, but will also enable mobile operators to adjust their zero-rating offerings as experience suggests. It will also boost transparency, which addresses many of the criticisms raised by zero-rating opponents.

With these principles, governments in developing countries should continue to allow zero-rated offerings, as a complement to other subsidy programs to encourage broadband adoption already in place. That means policies such as net neutrality—a strict approach to regulating a free and open Internet—should not be constructed in low-connectivity countries in a way that prohibits future zero-rating programs.

Of course, zero-rating is only one part of how developing countries can shift from a low to high-connectivity equilibrium. Zero-rating should be used in conjunction with other policies and programs aimed at cultivating thriving local Internet ecosystems.

Such policies include strong protections for data privacy and security. This is a hot topic in developed and developing countries alike. Striking the right balance between consumer protection and enabling data-driven innovation, though a combination of legislation and industry standards, is essential to maintaining public trust and safety. People are more likely to remain unconnected if they feel it is too risky to share personal information on the Internet.

At the same time, governments should also acknowledge the importance of Internet freedom. If online content is artificially censored, or if governments enforce strict content rules, there will be less consumer demand to access the Internet.

Zero-rating also cannot work without basic broadband infrastructure in place, particularly for mobile broadband.[43] Developing governments in

low-connectivity countries must support the build-out of broadband networks by creating national broadband plans and following through on them, and when applicable, making spectrum available for high-speed mobile broadband networks and Wi-Fi.

Governments in low-connectivity countries should also prioritize policies that encourage private investment in broadband networks. It is very expensive for the government to own, manage, and maintain broadband networks. Evidence from the experience of developed countries suggests robust private investment in high-speed broadband networks has enabled much of the tremendous growth in apps, videos, and other high-bandwidth mobile data traffic.

Moreover, governments should refrain from imposing Internet access taxes, or "connectivity taxes." This includes import taxes on mobile phones, and Internet connection and usage taxes. Increasing the cost of going online will discourage people from purchasing data plans, which could undermine the effectiveness of zero-rating.

Finally, governments in developing countries must also continue and build on efforts to ensure adequate digital literacy skills across their population.[44] Such training must start early, in schools and at home. This includes efforts to better prepare teachers, and it includes making sure schools have access to the Internet.

A FUTURE OF HIGH-CONNECTIVITY

A country trapped in a low-connectivity equilibrium faces serious challenges in terms of future growth and prosperity. As the data-driven economy continues to govern global growth and high-wage job creation, these countries risk being completely left out of the Internet's tremendous social and economic opportunities.

Fortunately, it is possible for countries trapped in a low-connectivity equilibrium to make the transition to high-connectivity. However, some approaches may work better than others, and one in particular may come with a cheaper price tag and more public trust: zero-rating.

In particular, this paper explains why zero-rating may be the most viable and low-cost approach in moving to a high-connectivity equilibrium. It has the power to boost local content and local demand for online goods and services, and early indications of its effectiveness are promising.

That's why, at the stage, it would be a mistake developing countries to dismiss the potential of zero-rating. Instead, there are ways governments debating the merits of zero-rating could think about core principles to make the practice more effective. Until these countries in low-connectivity equilibriums successfully make the transition to high-connectivity, it would be wise to keep all economy-boosting options on the table.

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About the Progressive Policy Institute

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Granting network providers pricing flexibility should reduce the costs borne by consumers.

Network Neutrality or Internet Innovation?

By Christopher S. Yoo
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Network neutrality has received sustained attention from both policymakers and academic commentators for the past several years, and it shows no signs of retreating from the forefront of the policy debate. President Obama effectively ensured that network neutrality will remain at the top of the policy agenda by including provisions in the 2009 stimulus package that require the Federal Communications Commission to formulate a national broadband plan. The stimulus package also requires that grants made by the National Telecommunications and Information Administration comply with four network neutrality principles first articulated by the FCC in 2005. On October 22, 2009, the FCC initiated proceedings to codify and expand the 2005 principles. President Obama reaffirmed his support for network neutrality in a YouTube interview conducted shortly after his 2010 State of the Union address.

Pinning down a precise definition of network neutrality is difficult. Roughly speaking, it requires network providers to route traffic without regard to the source or content of the packets of data that move across the Internet, the application with which those packets are associated, or the sender's willingness to pay. In the words of leading network neutrality proponent Lawrence Lessig, "Net neutrality means simply that all like Internet content must be treated alike and move at the same speed over the network."

It would be surprising if any two similar packets would be treated exactly alike when traveling through a network consisting of more than 30,000 autonomous systems that determine their terms of interconnection through arms-length negotiations. Indeed, many commentators have noted that such equal treatment did not occur over much of the Internet's past, when it was far less complex. Now, systematic changes in the architecture of the Internet make identical treatment even less likely, yet the changes are largely the result of network providers' attempts to reduce cost, manage congestion, and maintain quality of service. These changes may not represent network providers' efforts to promote their self interests at the expense of the public, as some network neutrality proponents have suggested, but instead they have the potential to yield substantial benefits both to individual consumers and to society as a whole.

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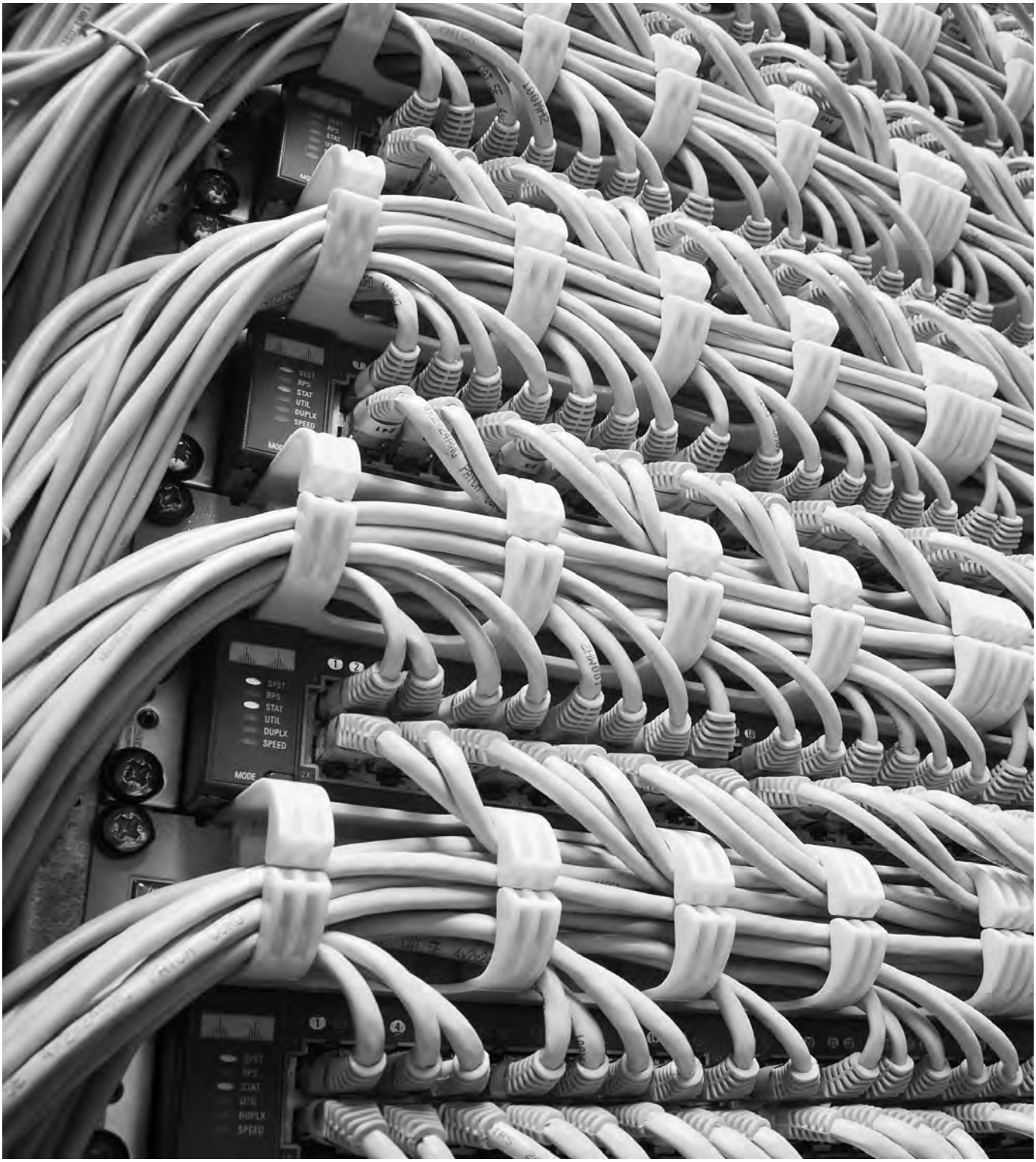
THE EARLY INTERNET

When the Internet first emerged, its topology and the business relationships comprising it were relatively simple. The Internet evolved out of the National Science Foundation's NSFNET backbone, which was created in 1986 (and decommissioned in 1997) to provide universities all over the country with access to federally funded supercomputing centers located at five major universities. The primary architects of NSFNET decided to give it a tripartite structure. At the top was the NSFNET backbone, which at its peak connected 16 research facilities across the country. At the bottom were the campus networks run by individual universities. In the middle were regional networks (typically operated by university consortia or state-university partnerships) that linked the campus networks to the major computing centers.

Every data packet had to travel through a parallel path traversing each level of the hierarchy. For example, traffic originating on one campus network would have to connect to the regional network with which it was associated, which hand-



MAXIM FILIPCHUK/ISTOCKPOHOTO

ed off the traffic to the NSFNET backbone, which in turn handed it off to the regional network that served the destination campus network. The result was to create a series of parallel hierarchies through which all traffic had to traverse.

The network retained this same basic architecture when it was privatized during the mid-1990s. The NSFNET backbone at the top of the hierarchy was replaced by a series of private backbone providers that interconnected with one another at four public network access points established by the National Science Foundation. The campus networks at the bottom of the hierarchy were replaced by last-mile providers that transported traffic from local distribution facilities located in individual cities (which in the case of digital subscriber lines are usually called "central offices" and in the case of cable modem systems are usually called "headend") to end users' residences and places of business. The regional networks evolved into regional Internet service providers (ISPs) that transported traffic between the four network access points served by backbone providers and the central offices and headends maintained by last-mile providers.

The privatization of the Internet did not change the hierarchical nature of the basic architecture. Each regional ISP still connected to a single backbone provider, and each last-mile provider still connected to a single regional ISP. Indeed, the early versions of the routing protocol employed by the backbones (known as "border gateway protocol") would not support more complex topologies.

This architecture conferred a number of advantages. It constituted a "spanning tree" that connected all of the nodes with the minimum number of links. Furthermore, the fact that the path between any two nodes was unique greatly simplified determining the path along which traffic should be routed. That said, tree architectures are also subject to a number of drawbacks. The uniqueness of the path connecting any two nodes means that the failure of any link or node in the network will inevitably disconnect part of the network. Even when all network elements are operating properly, if the rate at which traffic arrives exceeds any particular element's capacity to route the traffic, that network element will become congested and the quality of service provided will deteriorate. In addition, the hierarchical structure made each network participant completely dependent on the players operating at the level above them, which in turn provided backbones with a potential source of market power.

Peering and Transit The early Internet was also characterized by relatively simple business relationships. End users typically purchased Internet access through some form of "all-you-can-eat" pricing, which allowed them to consume as much bandwidth as they would like for a single flat rate. Relationships between network providers typically fell into two categories. Tier-1 ISPs entered into "peering" relationships with one another, in which they exchanged traffic on a settlement-free basis and no money changed hands. The primary justification for foregoing payment is transaction costs. Although the backbones could meter and bill each other for the traffic they exchanged, they could avoid the cost of doing so without suffering any economic harm so long as the traffic they exchanged was roughly symmetrical; such arrangements would not be economical if the traffic being exchanged were severely imbalanced. Thus tier-1 ISPs will not peer with other networks that are unable to maintain a minimum level of traffic volume. In addition, peering partners typically require that inbound and outbound traffic not exceed a certain ratio. Networks that cannot meet these requirements must enter into "transit" arrangements in which they pay the backbone to provide connectivity to the rest of the Internet.

Most early analyses of these arrangements focused on their financial terms. What is often overlooked is that interconnection agreements covered two distinct functions: the sending and receiving of traffic, and the announcing to the rest of the Internet where IP addresses served by various providers are located. To understand this latter function, consider the perspective of a small network, *A*, that serves a small number of its own customers and purchases access to the rest of the Internet through another ISP. The transit agreement between *A* and the ISP would not only require the ISP to receive traffic sent by *A* and to deliver traffic bound to *A*, but also require the ISP to announce to the rest of the Internet how to reach the IP prefixes associated with *A*'s customers. In addition, *A* can maintain a very simple routing table — it need only keep track of the prefixes of the customers that it serves; for all IP addresses outside of *A*, it can enter a "default route" into its routing table that directs all other traffic to the other ISP.

The existence of default routes creates a potential problem. If none of the routing tables involved in a particular routing session contained the location of the destination, by default the networks would simply hand the packets back and forth continuously and the packets would never reach their final destination. The only way to avoid this problem is for one or more network providers to maintain routing tables that map the entire Internet without employing any default routes. Thus, tier-1 ISPs are defined not only by their engaging in settlement-free peering with one another, but also by their maintaining routing tables that contain no defaults. Peering contracts also include a number of other requirements to guard against free riding and to ensure the proper functioning of the network.

THE INTERNET'S EVOLUTION

Over the past decade, ISPs have begun to enter into more complex interconnection arrangements that deviate from the strict tripartite hierarchy that characterized the early Internet. In addition, content providers have begun to experiment with a variety of ways to locate their content closer to end users. Both types of changes have significant implications that have largely been overlooked in the policy debate.

Private Peering, Multihoming, and Secondary Peering One of the first problems to emerge in the early Internet was congestion at the four network access points, which often caused throughput times and network reliability to degrade. Some estimate that this congestion caused packet loss at rates as high as 40 percent. As the network access points became increasingly congested, backbones began to find it advantageous to exchange traffic at private interconnection points, a practice known as "private peering."

In addition, regional ISPs have begun to connect to more than one backbone, a practice known as "multihoming," in part to protect against service outages and to limit their vulnerability to any exertion of market power by a backbone. Regional ISPs that did not have sufficient volume to peer with the tier-1 backbones also began to find that they did have sufficient volume to peer with other regional ISPs, a practice known as "secondary peering." Enabling regional ISPs to exchange traffic on a settlement-free basis reduced the costs borne by end users. In addition, secondary peering would often shorten the number of hops needed for particular packets to reach their final destination and make them subject to bilateral (as opposed to multiparty) negotiations, both of which should increase networks' control over quality of service. Secondary peering and multihoming also made the network more robust by creating multiple paths through

which network nodes could interconnect. In fact, as much as 70 percent of the nodes in the Internet can now communicate with one another without passing through the public backbone. This had the additional benefit of weakening the market position of the top-tier backbones, since any breakdown in the business relationship would not necessarily disconnect the ISP from the network and the ability to route along different paths places a natural limit on the backbones' ability to engage in supracompetitive pricing.

The emergence of interconnection relationships that deviate from the strict hierarchy that characterized the early Internet represents a substantial divergence from network neutrality. For example, assume that an end user is downloading content from both CNN.com and MSNBC.com. Assume further that the end user's regional ISP has a secondary peering relationship with the regional ISP serving CNN.com, but does not have a secondary peering relationship with the regional ISP serving MSNBC.com. The absence of a secondary peering relationship means that traffic from MSNBC.com will have to pay transit charges, while traffic from CNN.com will not. The result is that traffic that is functionally identical will end up paying different amounts. The differences in topology may also allow the traffic from CNN.com to maintain greater control over the quality of service.

The presence of multiple routes between these two points also complicates routing decisions. The presence of multiple paths connecting two points naturally means that someone must decide along which path to route the traffic. Although most networks choose routes that minimize the number of hops, networks may sometimes find it beneficial to route traffic in order to satisfy other requirements of their interconnection relationships. For example, a network may seek to enhance efficiency by balancing the loads between the two links. Multihomed entities can also monitor the quality of service provided by each connection and route the most delay-sensitive traffic along the link with the lowest latency.

In addition, transit contracts call for customers to pay a flat fee up to a predetermined peak volume (known as the committed rate) and pay additional charges for any volume that exceeds that level. For the same reason that consumers with two mobile telephones have the incentive to use up all of the prepaid minutes on both lines before incurring any additional per-minute charges, multihomed entities have the incentive to utilize all of their committed rate before paying additional fees. This lowers overall transit cost, but requires diverting some traffic along a path that is longer than the one stored in the routing tables. For similar reasons, a network may intentionally route traffic over a more costly path if doing so will help it maintain its traffic within the ratios mandated by its peering contract. Again, the effect is to introduce significant variance in the speed with which similarly situated packets will arrive at their destination and the cost that similarly situated packets will have to bear. This variance results not from anticompetitive motives, but rather from networks' attempts to minimize costs and ensure quality of service in the face of a network topology that is increasingly heterogeneous.

Server Farms and CDNS Large content providers have begun to employ other means to reduce cost and manage latency. One solution is to forgo maintaining a single large server and instead to deploy multiple points of presence in "carrier hotels" across the country. Doing so allows these content providers to avoid paying transit charges to reach the public backbone and instead transmit their traffic through secondary peering arrangements with tier-2 ISPs. Greater reliance on private networks also gives the content providers greater control over network security and performance. A recent study indicates that Google, Yahoo!, and Microsoft have been able to use server farms to bypass the backbone altogether for roughly a third of their traffic, and to keep their number of hops for traffic that had to pass through the backbone to no more than one or two.

> Secondary peering and multihoming have the benefit of weakening the market position of the top-tier backbones.

On other occasions, content providers are distributing their data through "content delivery networks" (CDNs) such as Akamai and Limelight. CDNs in effect substitute storage for long-distance networking capacity by maintaining a network of local caches across the Internet. When an end user sends a request for a webpage hosted by a CDN, that query is redirected to the cache. CDNs are thus able to use storage to serve multiple queries for the same content without using significant network resources. The geographic dispersion of the caches usually dictates that the file will be served by a location closer than would be possible if all of the content were stored in a central server, which minimizes cost and latency. The distributed nature of the caches also provides protection against denial-of-service attacks and allows the CDN to redirect queries to other caches when particular caches are overly congested.

CDNs represent an innovative way to deal with the increasing complexity of the Internet. The problem is that they are nonneutral. CDNs work best for static content; they are less well suited to interactive content that changes dynamically. More to the point, CDNs are commercial services; thus greater

reliability and quality of service are available only to those who are willing to pay for them.

To the extent that CDNs use the public backbone to deliver the content to their caches, they are best regarded as an overlay to the existing network. Increasingly, however, CDNs and server farms are bypassing the public backbone altogether and connecting to their caches through private networks, in the process transforming CDNs into a fundamentally different architecture.

All of these developments represent innovative adjustments to the realities of the Internet. The differences in topology mean that traffic that is otherwise similar may travel through the network at different speeds, with different costs, and with different levels of quality of service.

THE EVOLUTION OF BUSINESS RELATIONSHIPS

The evolution of the Internet has not been restricted to topology. Network participants have also been experimenting with an increasingly broad range of business arrangements. Some of these innovations have been driven by the increasing significance of peer-to-peer technologies. Other important developments are partial transit and paid peering.

The differences in topology mean that traffic that is otherwise similar may travel through the network at different speeds, with different costs.

Peer-To-Peer One of the primary forces causing business relationships to change is the growing importance of applications using peer-to-peer technologies. The traditional Internet employed what is known as a client-server architecture, in which files are stored in large computers at centralized locations (servers) and end users (clients) request files from those computers. The relationship is generally regarded as hierarchical, and the amount of data uploaded by clients is very small relative to the amount of data downloaded by servers. In the classic example of the World Wide Web, client traffic consists solely of uniform resource locators (URLs), the short bits of code identifying a particular website address. Server traffic, which consists of the data comprising the requested website, is much larger. For this reason, the technologies that took the early lead in broadband deployment (cable modem service and DSL) adapted an asymmetric architecture, allocating a larger proportion of the available bandwidth to downloading than to uploading. Newer technologies, such as fiber and wireless broadband, follow the same pattern.

Peer-to-peer technologies follow a very different approach. Edge computers in a peer-to-peer architecture are not divided into those that host files and those that request files. Instead, computers simultaneously perform both functions. Because this relationship is regarded as less hierarchical than client-server relationships, the computers in this architecture are known as peers and communications between them are known as peer-to-peer. Peer-to-peer is thus not synonymous with file sharing or user-generated content, as is often mistakenly assumed. On the contrary, many peer-to-peer applications (such as Vuze) support commercial broadcast services, and many platforms for user-generated content (such as YouTube) employ centralized servers. The real significance of the term "peer-to-peer" lies in the nature of the network architecture.

It is not yet clear what proportion of network traffic will follow each architecture. For example, peer-to-peer traffic had consistently outstripped client-server traffic for several years leading up to 2007. In 2007, however, client-server traffic staged a comeback, thanks primarily to the expansion of streaming video services like YouTube, and exceeded peer-to-peer traffic 45 percent to 37 percent. Many industry observers now predict that although peer-to-peer will remain important, it will decline as a percentage of total Internet traffic over the next several years. Even so, it is clear that peer-to-peer traffic is likely to remain a more important component of network traffic than during the Internet's early years.

The growing importance of peer-to-peer technologies is causing significant congestion in certain areas of the network and is putting pressure on the traditional approach to pricing network services. The emergence of end users as important sources of data is putting severe pressure on the limited bandwidth allocated to upload traffic. In addition, unlike in a client-server architecture where end users usually only generate traffic when a person is seated at the keyboard, edge computers in a peer-to-peer architecture can generate traffic for as long as the computer is left running. The result is that the lion's share of upload traffic is generated by a small number of superheavy peer-to-peer users. As few as 5 percent of end users may be responsible for generating more than 50 percent of all Internet traffic.

The most recent generation of peer-to-peer technologies can exacerbate congestion still further. In the first generation of peer-to-peer technologies, each end user stored the entirety of the files that the user hosted. As a result, anyone requesting those files was limited by the total bandwidth and the level of congestion associated with the network connection attached to that end user's computer. Technologies such as BitTorrent follow a different approach. Instead of storing entire files in one location, BitTorrent divides each file into

pieces and distributes them at multiple locations around the Internet. When a BitTorrent user requests a file, the software then retrieves the various pieces from multiple computers at the same time, which reduces the amount of bandwidth required from any one peer and improves download performance. BitTorrent also dynamically reallocates requests for pieces away from the slowest connections and toward the fastest connections, thereby placing the heaviest burden on those peers with the fast connections.

The congestion caused by peer-to-peer technologies weighs heaviest on last-mile technologies that share bandwidth locally, such as cable modem and wireless broadband systems. For example, cable modem technology requires that subscribers share bandwidth with the other households operating through the same neighborhood node. As a result, cable modem customers are significantly more vulnerable to the downloading habits of their immediate neighbors than are telephone-based broadband systems, which offer dedicated local connections. Service can slow to a crawl if as few as 15 of the 500 or so users sharing the same node are using peer-to-peer applications to download files.

The classic economic solution to congestion is to set the price of incremental network usage equal to the congestion costs imposed on the network by that usage. However, determining the congestion cost imposed by any particular user at any particular time can be quite complex. Subscribers that use large amounts of bandwidth can contribute very little to network congestion if they confine their usage to hours when network usage is low. Conversely, subscribers that use only small amounts of bandwidth may nonetheless impose significant congestion costs on the network if they generate traffic at peak times. The contribution of any particular usage cannot be determined simply by counting the number of bits being transmitted. The overall impact of any particular increase in network usage can only be determined in light of other subscribers' Internet usage. Thus it may make sense to charge different amounts to users who are using the Internet to access the same content or application if a sufficient number of other users sharing the same bandwidth are using the network at the same time.

The growth of peer-to-peer technologies has also heightened the pressure on the models that network providers have used to price their services. As noted earlier, the traditional approach charges content and application providers prices that increase with the peak bandwidth consumed, while end users are charged on an unmetered basis. The fact that every download had to pass through one link that charged on a volume-sensitive basis allowed this pricing approach to serve as a reasonable approximation of efficient congestion pricing. For example, 100 downloads of a 700 megabyte movie would generate 70 gigabytes of traffic from the server, which in turn would be reflected in the price paid by the content provider to its ISP.

The situation is quite different under peer-to-peer architecture. In that case, the movie could be downloaded once from the server, and the remaining 99 downloads could be served by other end users running the same peer-to-peer software. Because end users are provided with service on an all-you-can-eat basis, the additional 99 downloads served by the peer-to-peer network do not generate any additional revenue. The only revenue received by the network is for the initial 700 megabyte download. Thus, in a peer-to-peer architecture, the amounts that content providers pay under the traditional pricing regime no longer serve as a workable approximation of the total traffic they impose on the network. Moreover, the failure to charge network participants prices that reflect their incremental contribution to congestion causes excessive consumption of network resources that ultimately harms consumers.

It thus comes as no surprise that the network providers that are most subject to local congestion are experimenting with other means for managing the congestion caused by peer-to-peer applications. For example, Time Warner has recently experimented with bandwidth caps and other forms of metered pricing. Although many network neutrality proponents have no objection to metered pricing, recent attempts to impose metered pricing and bandwidth caps have met such a hostile reaction from the network neutrality community that the network providers had to back down. That said, metered pricing is far from a panacea. As I have discussed in greater detail elsewhere, true congestion-based pricing would vary from moment to moment based on the volume of traffic introduced into the network by other users. Such a pricing regime would challenge consumers' ability to process the relevant information, and the distributed nature of the Internet means that no one entity has the information needed to formulate such policies. As a result, other network providers have turned to proxies that are strongly associated with high-volume activity, which most importantly includes a ban on operating a server as required by peer-to-peer technologies. Although this would constitute a violation of network neutrality by discriminating against a particular type of application, even network neutrality proponents acknowledge that such a restriction represents a good proxy for bandwidth-intensive activity.

Partial Transit and Paid Peering Network providers have also begun to enter into business relationships that go beyond peering and transit relationships that dominated the early Internet. Some are driven by the emergence of secondary peering relationships discussed above. Before such relationships existed, a tier-2 or tier-3 ISP would have to buy transit from a tier-1 ISP that had obtained access to all of the IP addresses that it did not serve. In other words, a tier-2 or tier-3 ISP's transit relationships would cover the entire Internet (except for its own customers).

The advent of secondary peering reduces the scope of transit services that the ISP needs to purchase. The ISP no longer needs to buy transit to the entire Internet; the secondary peering relationships already provide the ISP with the ability to reach those customers served by its secondary peering partners. As a result, these ISPs have begun to purchase partial transit that covers only those portions of the Internet not already covered by their secondary peering relationships.

In addition, an ISP with inbound traffic that far exceeds its outbound traffic may run the risk of having traffic ratios that put it in violation of its peering contract. Under these circumstances, it may attempt to cover its deficit in outbound traffic by selling a partial transit contract that covers only outbound traffic, but not inbound traffic. Alternatively, it may reduce its inbound traffic by buying partial transit for inbound traffic.

Another interesting development is the emergence of paid peering, which involves all of the same aspects as conventional peering relationships. Peers announce to the rest of the Internet the addresses that their peering partners control, maintain a sufficient number of interconnection points across the country, and maintain the requisite total volume and traffic ratios. The key difference is that one peering partner pays the other partner for its services.

Paid peering is driven by both supply-side and demand-side considerations. Starting first with the supply side, settlement-free peering arrangements between tier-1 ISPs with similar traffic volumes make sense only if both networks have similar costs. Over time, backbones have begun to serve two different types of last-mile networks: those such as Cogent and Abovenet that primarily serve content and application providers (which are sometimes called "content networks"), and those such as Comcast and Verizon that serve end users (which are sometimes called "eyeball networks"). The costs of the first type of network are quite low, typically only requiring a single high-speed line to a small number of business locations. The costs of the second type of network are considerably higher, requiring the wiring and upgrading of equipment in entire neighborhoods. The presence of such asymmetric costs provides a substantial impetus for cash to flow from networks serving content and application providers to networks providing connections to end users.

These supply-side considerations are reinforced by demand-side considerations associated with the economics of two-sided markets, which illustrates the potential benefits of allowing network providers to charge differential prices to both end users and content and application providers. Conventional economics has long recognized the existence of "network economic effects," which cause a network to increase in value as the number of users connected to it increases. To use a classic example, the value of a telephone network to a particular consumer depends in part on the number of other subscribers connected to the network; the more people you can reach through the network, the more valuable it becomes.

The benefits created by the network economic effect for telephone networks arise with respect to a single class of customers. When a market is two-sided, instead of bringing together a single class of similarly situated users, networks bring together two completely different classes of users. In those cases, the value is determined not by the number of users of the same class, but rather by the number of users of the other class. A classic example is broadcast television, which brings together two groups: viewers and advertisers. Advertisers gain no benefit (and if anything suffer a detriment) from belonging to a network with a large number of other advertisers. The value of the network for advertisers is instead determined solely by the number of viewers, i.e., the size of the other class of users.

The literature suggests that social welfare would be maximized if the network provider were permitted to price discriminate on both sides of the two-sided market. It also suggests that the prices paid on each side of the market can differ widely, and that in many cases it is economically beneficial for one side to subsidize the other side. The fact that the Internet has become increasingly dominated by advertising revenue paid to content and application providers suggests that it may be socially beneficial for content and application providers to subsidize the prices paid by end users. An advertiser's willingness to pay for an ad on a particular website depends on the number of end users viewing that website. Under these circumstances, the optimal solution may be for the website owner to subsidize the total number of end users by making payments to the network provider to help defray their costs of connection. The costs of subsidizing more users would be more than offset by the additional revenue generated by the fact that advertisers can now reach more potential customers. In the case of broadband, this would be both economically efficient and would be a boon to consumers both in terms of providing service in more geographic areas and in reducing the prices that consumers pay.

Social welfare would be maximized if the network provider could price discriminate on both sides of the two-sided market.

These dynamics are again well illustrated by broadcast television. In many ways, broadcast television and the Internet are analogous. The studios that create television programs play a similar role to content and application providers. Television networks aggregate programs and deliver them nationally in much the same manner as content networks and backbone providers. Local broadcast stations provide last-mile connectivity that is quite similar to the role played by eyeball networks. In addition, the revenue structure is quite comparable, in that television networks receive advertising revenue

in much the same manner as content and application providers. Furthermore, the cost structure is somewhat similar in that connecting individual homes is much more costly than distributing programming nationally.

For decades, the standard business arrangement has been for television networks to subsidize the operations of local broadcast stations by paying them to be members of their television networks. The industry's revenue and cost structure make such arrangements quite logical. The cost of paying these broadcast stations to affiliate with a network is more than offset by the increase in advertising revenue made possible by the fact that the network is now able to reach a larger audience. Broadcast television thus represents a prime example of when firms operating on one side of the market find it economically beneficial to subsidize end users on the other side of the market.

Furthermore, the magnitude of the affiliation fees that the networks pay to broadcast stations is anything but uniform. The precise amount varies with the relative strength of the network and the relative strength of the broadcast station. Stronger broadcast stations receive more, while weaker ones receive less. Equally interesting is the fact that in recent years, the cash flow has begun to vary in its direction as well as magnitude, with weaker stations having to pay rather than being paid to be part of the television network. The dynamic nature of this pricing regime benefits consumers by providing incentives for networks to invest in better quality programming and by providing an incentive for stations to provide better carriage.

The two-sided market analysis reveals the potential drawbacks of preventing network providers from charging differential prices. As a general matter, pricing flexibility makes it easier for network providers to recover the costs of building additional bandwidth. Granting network providers pricing flexibility with respect to content and application providers should reduce the percentage of the network costs borne by consumers. Conversely, preventing network providers from exercising pricing flexibility with respect to content and application providers would simply increase the proportion of the network costs that providers must recover directly from end users. This simultaneously raises the prices paid by consumers and decreases the likelihood that the capital improvements will ever be built. Charging content and application providers differential prices thus has the potential to increase social welfare and can reduce, not increase, the burden borne by consumers.

CONCLUSION

It is all too easy to forget that the Internet is not a monolith with a brooding omnipresence overseeing the entire system. Instead, it is a collection of autonomous systems that determine the terms of interconnection between them through a series of arms-length negotiations. Given the Internet's essence as a network of networks, it should come as no surprise that no two packets will pay the same amount for the same service.

The developments that I have outlined in this article have made such differences even more likely. The network no longer adheres to the rigid and uniform hierarchy that characterized the early Internet and its predecessor, NSFNET. Data packets can now travel along radically different paths based on the topology of the portion of the network through which they travel. This is the inevitable result of reducing costs and experimenting with new structures. At the same time that network providers are experimenting with new topologies, they are also experimenting with new business relationships. Gone are the days when networks interconnected through peering and transit and imposed all-you-can-eat pricing on all end users. That fairly simple and uniform set of contractual arrangements has been replaced by a much more complex set of business relationships that reflect creative solutions to an increasingly complex set of economic problems. Again, these differences mean that the service that any particular packet receives and the amount that it pays will vary with the business relationships between the networks through which it travels. Although many observers reflexively view such deviations from the status quo with suspicion, in many (if not most) cases, they represent nothing more than the natural evolution of a network trying to respond to an ever-growing diversity of customer demands. Imposing regulation that would thwart such developments threatens to increase costs and discourage investment in ways that ultimately work to the detriment of the consumers that such regulation is ostensibly designed to protect. R

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September 4, 2014

VIA ELECTRONIC FILING

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: *Protecting and Promoting the Open Internet,* GN Docket No. 14-28;
***Framework for Broadband Internet Service,* GN Docket No. 10-127**

Dear Ms. Dortch:

The Commission's tentative conclusion to extend a mobile-specific Open Internet framework is grounded in three aspects of the mobile marketplace: mobile broadband faces unique operational constraints; mobile broadband technologies are rapidly evolving; and the "generally greater amount of consumer choice" for mobile broadband services than for fixed.[1] CTIA—The Wireless Association® submits the attached technical paper to help detail the operational constraints in these ever-evolving mobile networks, the complexity of mobile network management, why flexibility is needed, and how prescriptive regulation would undermine mobile broadband operators' ability to provide consumers with the level of service they have come to expect.

The paper, *Net Neutrality and Technical Challenges of Mobile Broadband Networks*, is co-authored by Dr. Jeffrey H. Reed, Willis G. Worcester Professor of Electrical and Computer Engineering at Virginia Tech University and Director of Wireless@Virginia Tech, and Dr. Nishith Tripathi, senior consultant who writes and lectures on mobile technologies. Wireless@Virginia Tech is one of the largest and most comprehensive university wireless research groups in the U.S.

In their paper, Drs. Reed and Tripathi explain in great detail the primary technical factors affecting mobile network management; how mobile broadband providers apply differential treatment to different traffic streams on a real-time, dynamic basis; the stark technological differences between wireless and wireline networks and network management; and the problems that would arise from imposing prescriptive Open Internet regulation on mobile providers. The technical factors they highlight include the following:

- ***Scarcity of radio resources.*** With the explosion in the amount of mobile data traffic, spectrum resources have not kept pace. Mobile broadband operators

[1] Protecting and Promoting the Open Internet, *Notice of Proposed Rulemaking*, GN Docket No. 14-28, FCC 14-61, ¶ 91 (rel. May, 15, 2014); *see also id.* ¶ 62.

are thus constrained, necessitating aggressive and efficient management of limited radio resources.

- ***Radio resource sharing.*** As the number of users being served by the same base station fluctuates, the challenge of providing high-quality service to each of them also grows, requiring providers to make choices regarding how to manage network resources.

- ***Dynamic channel conditions.*** The allocation of radio resources constantly changes due to changing channel conditions and the interference environment, as often as every millisecond.

- ***Varying resource consumption.*** For a given channel condition, different services consume different amounts of resources. Thus, resource allocations change as users shift among different uses – often many times during a given session.

- ***Integration of devices and the network.*** Even when two devices experience identical channel conditions and allocation of radio resources, their design characteristics may dictate widely different throughput, further complicating network management.

- ***Ever-evolving network.*** Mobile broadband providers constantly manage user mobility across various technology generations and revisions across the network, offering differing levels of achievable network performance.

- ***Challenges of network capacity additions***. The intricacies of capacity growth (adding spectrum and wireless infrastructure deployment), along with ever-rising user traffic, make efficient utilization of the existing radio resources extremely critical to the user experience and network efficiency.

Drs. Reed and Tripathi also explain that mobile and fixed networks face vastly different technical challenges. Fixed networks have significantly higher capacity and predictability of resource requirements, whereas mobile networks are far more capacity constrained, with constantly changing user requirements and operating environments. Fixed networks involve channels that are relatively clean with signal regeneration, while mobile channels are impaired with interference, multipath and blockage, varying by location and from one millisecond to the next. As they observe, "The wireline network engineer knows precisely how much bandwidth is available in a single fiber optic strand and (other than losses over distance) will have a near-constant understanding of the performance of the transport layer. In contrast, wireless networks are faced with ever-changing radio environments."

Mobile broadband providers need more flexibility to manage their networks and to ensure that their customers have the service they have come to expect. As the paper explains, that flexibility must include the ability to manage applications to avoid harm to the network and to maintain reliable and efficient service for the aggregate user experience. Similarly, mobile operators should be free from any anti-discrimination or commercial reasonableness requirement that would restrict their ability to innovate, optimize, and differentiate service to deliver a high quality product. In addition, expanded transparency requirements are infeasible in the context of dynamic, ever-changing mobile network operations. As Drs. Reed and Tripathi conclude, more prescriptive mobile rules "would stifle innovation and competition, negatively impact the user-experience and system capacity, and severely limit the ability of mobile wireless networks to meet the unique challenges faced by modern wireless networks."

The paper paints a detailed picture of the difficulties that would be created by the application of an overly broad or overly prescriptive set of rules on mobile broadband. As Reed and Tripathi explain, "subjecting this type of network and network management to broad prophylactic rules with a vague 'exception' standard would provide no clarity to carriers, edge providers, or consumers as to how these networks will be managed. The exception would either simply subsume any rules (e.g., blocking or non-discrimination) or providers would be stripped of their ability to evolve and manage networks for the betterment of the entire subscriber base."

The paper also explains that mobile broadband inextricably intertwines transmission and processing capabilities, and thus remains an "integrated information service." Mobile broadband service involves extensive and complex processing throughout the network to ensure that customers can seamlessly navigate among multiple applications and services, and different network nodes must constantly engage in service-specific processing to support the user's activities. As Drs. Reed and Tripathi show, this tight integration between transmission and processing is essential whether the user is browsing a website, engaged in mobile video conferencing, or undertaking any of the myriad other activities made possible by mobile broadband. This factual finding further confirms the FCC's prior determinations in 2007 and 2010 that mobile broadband Internet access is an integrated information service that must remain subject to a Title I framework. Moreover, the engineering and operational complexities outlined in this report make a Title II common carrier regulatory approach even more problematic.

We look forward to exploring these principles further as the Commission considers how best to promote mobile broadband and the interests of the American consumer.

Sincerely,

/s/ *Scott Bergmann*

Scott Bergmann
Vice President – Regulatory Affairs
CTIA – The Wireless Association®

Net Neutrality and Technical Challenges of Mobile Broadband Networks

Dr. Jeffrey H. Reed and Dr. Nishith D. Tripathi

September 4, 2014

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Abstract

As this paper describes in detail, the management of mobile broadband networks is a constantly evolving task. From millisecond to millisecond, handsets with differing capabilities, consumers with different usage patterns, applications that utilize different aspects and capabilities of both the handset and the network, and content consumption, including video, must be integrated with the network and managed adroitly to deliver a world-class broadband experience for the customer. Now imagine that millisecond to millisecond process happening while the consumer is in motion, while the handsets vary in capability (think flip-phone to smartphone), while the available network changes from 3G to 4G and from one available spectrum band to another, while traffic moves into and out of a cell sector, and while spectrum capacity is limited. **This entire process – the integration of all of these different variables – is unique to mobile broadband.** This paper is designed to illustrate and explain this extremely complex, very dynamic process in the context of the FCC's 2014 Notice of Proposed Rulemaking ("NPRM") on net neutrality.

The NPRM seeks comment on several proposed rules and associated mechanisms. In particular, the NPRM seeks comment on three rules that impact the management of mobile broadband networks. First the "transparency rule" requires mobile broadband providers to publically disclose accurate information regarding network management practices, performance, and commercial terms of their broadband Internet access service. Second, the "no-blocking rule," which was vacated by the D.C. Circuit, prohibited mobile broadband providers from blocking consumers from accessing lawful websites, as well as prohibited blocking applications that compete with the provider's voice or video telephony services, subject to "reasonable network management." The Commission is now exploring modifications to these rules. And third, though it tentatively concludes that such a rule should not be imposed on mobile broadband providers, noting its previous findings distinguishing mobile broadband in the context of net neutrality regulation, the Commission also seeks comment on whether it should apply to mobile broadband networks an "anti-discrimination/commercial reasonableness" rule, that would enforce a "commercially reasonable" standard of conduct for broadband provider practices.

This paper demonstrates that any extensions of, or additions to, the FCC's 2010 rules would be unwieldy and over-inclusive when applied to the complex and constantly-evolving management of mobile broadband networks. In fact, with the introduction of LTE, networks are managed and operated in a far more complicated and complex manner than the networks in place in 2010 when the Open Internet Order was adopted. As more of the LTE standard's advanced functionalities are incorporated into wireless networks, the complexity and prioritization in the networks will only grow, as will the benefits to consumers.

This paper addresses, based on the complexity and constantly-evolving management of mobile networks, why several of the proposals could be disruptive to a robust consumer broadband experience, and why some of the Commission's tentative conclusions should be maintained. For example, requiring mobile broadband providers to develop and/or report metrics regarding network management would be extremely difficult from a technical perspective and is unlikely to be useful due to the millisecond-to-millisecond adjustments that are inherent to a mobile broadband network. As described throughout, ever-increasing usage and scarcity of spectrum resources requires active management of the network to address capacity issues in a rapid fashion at the cell (or sector) level based on the demands placed on

the network. Similarly, while the competitive pressures on wireless carriers make imposition of a no-blocking rule unnecessary, broad application of a rule could have a significant negative technical impact on wireless broadband networks.

This paper explains how wireless applications can consume very large quantities of bandwidth, potentially causing problems for the end user or for others nearby. Third-party mobile apps and services can also interfere with and undermine network performance, and wireless network operators must be permitted the flexibility to manage their networks to prevent these negative effects. The NPRM also seeks comment on the feasibility of defining a minimum level of service that broadband networks must provide, proposing several possible standards that could be used. As discussed, such standards cannot be readily quantified for mobile wireless networks given the millisecond-to-millisecond adjustments in the network and would prevent wireless network operators from using techniques critical to ensuring a robust user experience. Also, as handset technology, base station technology, network technology and application technology rapidly change, it is unclear what metrics and standards would apply universally over time to fairly judge capabilities or performance.

The paper also demonstrates that the NPRM's tentative conclusion that an "anti-discrimination/commercial reasonableness" rule need not apply to wireless is the correct one. Differentiation among users and user services is required to provide a satisfactory quality of service to consumers. This is due to the dynamic nature of the radio environment and the need to operate good scheduling algorithm designs in a wireless network that maximize network performance while providing a good user-perceived experience. It is also due to product differentiation within a competitive marketplace in terms of what devices, features, and services might be offered as part of a carrier's service plan.

Finally, the paper explains that without today's real-time sophisticated scheduling algorithms that support network management that enables the service operator to cost-effectively provide services to many users simultaneously, overall user experience and network throughput will suffer. Treating all users alike at all times will degrade network performance by driving delivery to the lowest common denominator, and make the network less efficient. Adapting delivery to the predicted data delivery performance based on dynamic radio channel assessments promotes more efficient performance overall, across all users, even though at any single moment a network's site will distinguish between users based on channel quality.

The paper concludes that if adopted or expanded, several of the rules proposed in the NPRM would place constraints on mobile wireless networks that would stifle innovation and competition, negatively impact the user-experience and system capacity, and severely limit the ability of mobile wireless networks to meet the unique challenges faced by modern wireless networks. The result, in turn, would be harm to wireless users – the very outcome the Commission seeks to prevent.

From an engineering perspective, the concept that a network management exception to Open Internet rules is sufficient to allow wireless networks to evolve and operate is nonsensical. A modern wireless network must be managed aggressively. It is not an exception, it is a daily reality. Subjecting this type of network and network management to broad prophylactic rules with a vague "exception" standard would provide no clarity to carriers, edge providers, or consumers as to how these networks will be managed. The exception would either simply subsume any rules (e.g., blocking or non-discrimination) or

providers would be stripped of their ability to evolve and manage networks for the betterment of the entire subscriber base.

This paper demonstrates the following:

- *Minimal regulatory constraints for mobile broadband networks would facilitate achieving higher spectral efficiency and improved user experience.*
- *Network Management is practiced extensively in mobile broadband networks and is critical for wireless operations.*
- *Preserving the ability for wireless carriers to block websites or applications as necessary for reasonable network management is important to avoid harm to the network or degradation and is critical to maintaining reliable and efficient service.*
- *Application of an anti-discrimination/commercial reasonableness rule to mobile broadband providers would hamper their ability to innovate, optimize, differentiate, and deliver high quality products and services.*
- *Expanding the transparency rule would increase costs and negatively impact network management option, but will not provide any meaningful benefit to consumers.*
- *Mobile broadband Internet Access service is an integrated information service due to the tight coupling between the device and the many network elements, needed for customized processing of different types of information, and the distributed nature of the complex wireless network.*

1. Overview

This technical paper demonstrates the unique technical aspects of wireless broadband networks that make the imposition of prescriptive net neutrality regulations highly problematic. Mobile broadband networks are highly dynamic, with constant changes in network standards, technology, and capacity needs. Mobile broadband operators are also managing their networks with limited spectrum resources, which must be managed actively and quickly to provide a high quality of service to consumers. As a result, wireless network management practices are necessarily complex. Further, congestion-related metrics are highly variable both temporally and spatially, and also change by the millisecond, making meaningful reporting impractical.

The 2014 Net Neutrality NPRM. With respect to mobile broadband service, the NPRM discusses the transparency rule, the no-blocking rule, and a revised anti-discrimination/commercial reasonableness rule. The existing transparency rule requires the service provider to disclose items such as network management practices and performance, though the FCC now seeks comment on whether and how to expand the transparency requirements for mobile wireless providers. The proposed no-blocking rule would prohibit mobile broadband service providers from blocking consumer's access to lawful websites and from blocking consumer's voice or video telephony applications that compete with mobile broadband service provider's services, though the NPRM seeks comment on whether to apply this rule more broadly to mobile wireless services. The NPRM proposes an anti-discrimination/commercial reasonableness rule that prohibits commercially unreasonable practices based on the totality of circumstances. The NPRM tentatively concludes that this rule should not be applied to mobile broadband service, but it seeks comment on whether to reverse that finding. Comments filed in response to the NPRM affirm the technical findings explained in this paper.

Mobile Wireless Networks Undergo Constant Technical Evolutions. Mobile wireless networks have evolved from first-generation analog systems to fourth-generation high-performance digital systems with multiple revisions within a given generation. These generations and revisions have widely different capabilities for both the networks and the mobile devices. Commercial mobile providers typically have multiple generations and revisions of generations simultaneously operating to serve legacy and new devices. Each time a new revision is introduced network management practices must change. The mobile broadband network and the mobile device perform numerous operations and interact with each other so that the end users have anytime and anywhere seamless communications experience. And the wireless industry has not reached the end of the road on innovation – the industry is already turning to the development of 5G technologies, injecting further complexity in the design and management of mobile wireless networks.

Mobile Wireless Networks Have Unique Technical Characteristics. The difficulty of quantifying guaranteed network performance and user experience is increased further due to the unique characteristics of mobile wireless networks. Examples of such characteristics include:

- scarcity of spectrum,
- dynamic radio channel conditions,
- the need to share radio resources among numerous users and user services with different Quality of Service (QoS) requirements,
- mobility,
- vast variability in loading due to both variations in user density per area and variations in usage and data rates,
- inherently complex process of network capacity growth, and
- integration of devices and network technologies with widely different data use and application capabilities.

These characteristics pose significant challenges to mobile wireless networks and make the imposition of the prescriptive net neutrality rules infeasible. In particular, determination of any reliable universal thresholds or metrics to quantify user experience or network performance is infeasible. Further, imposing such specific metrics would then distort optimization and would impose conditions that would degrade consumers' mobile experiences. Furthermore, mobile broadband providers need a high degree of flexibility to efficiently and effectively manage precious radio resources to ensure the best possible aggregate service experience for all subscribers.

QoS and the ability to treat different types of traffic differently based on their service needs are essential in a mobile network. In a mobile network, where the connectivity performance is not as stable as with a wired network, some services will simply not work well if they are not subjected to differentiated treatment. VoLTE is one example – it is meant to replace the traditional, circuit-switched phone service available on cellphones. Without prioritization of this traffic, the quality and reliability of the phone service would be severely impacted. Other future services such as LTE multicast have similar requirements. As new services are layered onto the networks, and historical separation of data and voice services vanishes the need to address QoS issues will only increase.

Wireless Operators Engage in Numerous Network Management Techniques. The network management practices in mobile wireless networks are extremely complex and consist of numerous

mechanisms that are distributed among various components (or nodes) throughout the wireless and core network. Examples of network management mechanisms include the scheduling algorithm for downlink and uplink resource allocation, the handover algorithm, the load balancing algorithm, handling of the connected mode-idle mode transitions, adaptation to the changing channel conditions, power control, and interference coordination. These network management mechanisms are proprietary and are key competitive differentiators. Providers continually refine their network management practices to dynamically reflect changes in network equipment, application demands, and consumer usage patterns. Indeed, the rapid evaluation of these practices may well mean that by the time a given practice is challenged and adjudicated the practice may no longer be in use. Hence, a mandate to fully disclose these mechanisms, or to impose sweeping no-blocking or anti-discrimination rules, would discourage innovations, violate intellectual property rights, and harm consumers.

Wireless Network Operators Make the Most of Scarce Spectrum Resources. Wireless providers need maximum flexibility in the management of their networks to make the best use of the *scarce radio spectrum* in the presence of exponentially rising data traffic. Due to the scarcity of spectrum, innovative, high-performance, and ever-evolving network management mechanisms are absolutely essential to the overall network performance and user experience. For example, wireless providers must take steps to contain data-intensive applications from flooding the network with excessive amounts of traffic that would degrade service for many users. Wireless network operators require the flexibility to fairly balance network performance and user performance among users, devices, user services, and overall services on the network.

Net Neutrality Regulation Imposes Numerous Unique Challenges on Wireless Networks. As this paper demonstrates, application of the 2014 NPRM's proposed enhanced transparency rule to mobile wireless networks is nearly impossible, as network management practices are highly complex and are constantly changing. Furthermore, flexibility with respect to network management is essential to enable continued innovation in this area and these characteristics counsel strongly against far-reaching no blocking or anti-discrimination rules. Indeed, application of the no-blocking rule, meanwhile, is infeasible as the Commission has defined a "minimum level of service" that is not possible to guarantee for mobile wireless networks. The revised anti-discrimination rule is not intended to be applicable to mobile broadband service, and the findings of this technical paper strongly support this FCC conclusion. The FCC should continue to distinguish between mobile and fixed broadband with respect to the "no discrimination rule" and "anti-discrimination/commercial reasonableness rule." The dynamic and resource constrained (and at times, congested) nature of mobile wireless networks requires differentiation among users and user services to ensure a high quality of network performance and a satisfactory user experience.

Mobile Broadband Internet Access is an Integrated Information Service. Mobile broadband service is a highly integrated service that enables a subscriber to access a variety of services at once. The Commission itself observed that wireless broadband Internet access service offers a single, integrated service to end users that inextricably combines the transmission of data with computer processing, information provision, and computer interactivity. This level of integration requires cross-layer optimization in the network to ensure optimal network performance. Without the flexibility to actively manage their networks, mobile broadband providers will not be able to deliver integrated services at the level of quality that consumers have come to expect.

Recommendations. Due to the challenges faced by mobile network operators, which are outlined below, this paper recommends that the Commission:

- recognize that mobile wireless networks must be treated differently from other communications networks,
- strive for minimal regulation of mobile wireless networks to promote continued innovation, and refrain from applying far-reaching no blocking rules or an anti-discrimination/commercially reasonable rule,
- grant to network providers maximum flexibility regarding the design, management, and optimization of networks to serve consumers,
- refrain from establishing minimum performance standards (or metrics) for wireless networks, as these are impractical to define or enforce in the face of spectrum scarcity and variability, and
- ensure that proprietary and competitive network optimization and management processes are respected, which will ensure continued innovation and differentiation.

Flexibility in tuning and adapting the network management mechanisms to the fast-paced technology evolution, implementation of new features and uncertainty regarding the requirements of emerging applications or services urge that the network management mechanisms in mobile wireless networks should not be subject to broad disclosure, sweeping no-blocking, or anti-discrimination requirements. In other words, these network management mechanisms are intended, by their very nature, to optimize the aggregate performance for the benefit of all users. A focus on specific metrics may work to the detriment of the aggregate network performance and user experience. Conversely, reporting aggregate metrics will not reveal meaningful insights into specific instances.

2. Mobile Wireless Networks: Evolution, Network Architecture, and Operations

In order to fully appreciate the complexities associated with managing a wireless network and the difficulty of imposing an inflexible net neutrality framework, it is helpful to have an understanding of the rapid evolution of wireless networks and technology as well as the underlying architecture. In the more than 30 years that the wireless service has been provided to consumers, there has been a near-constant evolution of the underlying network. Section 2.1 summarizes this evolution of commercial mobile wireless networks. Section 2.2 illustrates the network architecture for the most popular 4G standard – Long Term Evolution (LTE). The wireless network and the mobile station (referred to as the user equipment or UE, mobile device, or handset device) perform numerous operations and interact with each other so that end users have anytime and anywhere seamless communications experience, processes which are quite different from wireline systems. Section 2.3 provides a glimpse of such operations and interactions.

2.1 Evolution of Mobile Wireless Networks

Mobile wireless networks have evolved from the first generation (1G) to the fourth-generation (4G) in just about three decades. Numerous 1G systems were used throughout the globe. Advanced Mobile Phone System (AMPS) is an example of the 1G system in the U.S. First generation systems were analog (radio air interface) in nature and offered primarily voice services. First generation systems evolved to second-generation (2G) digital systems. The 2G systems provided better voice quality and higher capacity compared to the 1G systems. Global System for Mobile communications (GSM), Interim

Standard-54 (TDMA), and later Interim Standard- 95 (IS-95 or CDMAOne) are examples of 2G digital systems engineered primarily for voice services used in the U.S. These digital systems evolved to '2.5 G' systems to better support low data rate uses, including GPRS for GSM, IS-136/EDGE for TDMA, and CDMA 2000 1X for CDMA. Due to expanding needs for wireless data at higher rates, third generation standards for mobile wireless networks focused on supporting data services more efficiently separated from voice channels. The 3G systems include a packet-switched core network to facilitate Internet access. Universal Mobile Telecommunication System (UMTS), High Speed Packet Access (HSPA), and 1xEvolution-Data Optimized (1xEV-DO as a CDMA derivative) are examples of true 3G cellular systems. The 3G systems support peak user data rates on the order of few megabits per second (Mbps). Finally, fourth generation systems such as Long Term Evolution (LTE) were developed to provide higher data rates (e.g., many megabits per seconds) and higher spectral efficiency. In addition, LTE would allow both data and voice to be provided in an integrated fashion using Internet Protocol (IP) for transport, also known as VoIP (Voice over IP). LTE is currently being deployed in the U.S. and around the globe and is expected to be the most dominant wireless standard for the near term. Mobile wireless networks will continue to evolve—indeed providers are already working on 5G—with future generations of technologies bringing new capabilities and challenges. It is key that this evolution and innovation be able to progress unfettered by restrictive regulation. Figure 1 depicts the evolution of mobile wireless networks.

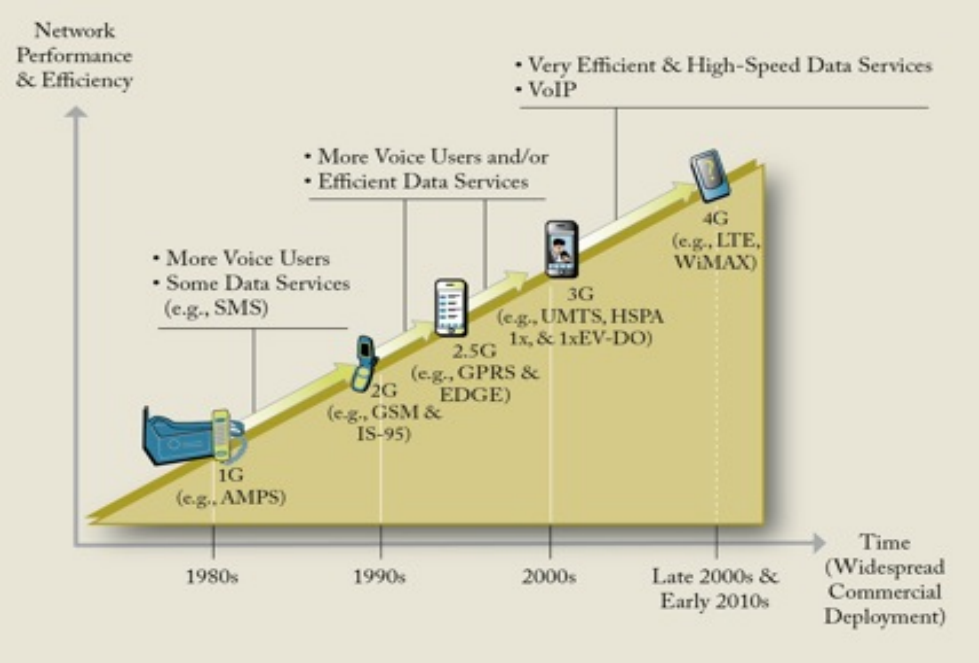

Figure 1. Ever-Changing Mobile Wireless Networks

Even for a given generation of wireless standards, multiple in-generation revisions that offer different features and capabilities exist. For example, 3G UMTS Release 99 supports a peak data rate of 2 Mbps in the downlink, while the 3G UMTS Release 5 feature called High-Speed Downlink Packet Access (HSDPA) supports a peak data rate of 14 Mbps in the downlink. The UMTS Release 7 feature called HSPA+ supports 21 or 42 Mbps in the downlink.

A mobile broadband provider typically has multiple revisions of multiple generations of technologies simultaneously operating. For example, in a given wireless service provider's network, some mobile devices may support GSM, some may support revisions up to HSDPA, some may support revisions up to HSPA+, and some may support revisions up to LTE. As the user switches from one generation of technology to another or from one revision to another, the performance can vary quite significantly. User mobility across different technologies needs to be properly managed by the mobile service provider. This involves complex network management.

The mobile service provider's network is never static. The network needs to be upgraded from one revision to another revision of a given generation technology and from one generation to another generation. Furthermore, once the network is upgraded with new features and capabilities, troubleshooting and then on-going optimization are carried out. The achievable peak performance keeps changing as the network undergoes never-ending upgrades. Even though LTE provides superior performance compared to prior generations of mobile wireless networks, LTE networks are currently undergoing upgrades with new features such as carrier aggregation and Voice over LTE (VoLTE), with each upgrade requiring changes to network management.

2.2 Network Architecture

The network architecture is different for 2G, 3G, and 4G (e.g., LTE) systems. This paper focuses on the network architecture for LTE due to its current dominance; however we will briefly describe simplified 3G and 4G network architectures below. In this section, we will describe the complex and decentralized nature of the wireless network and why application of net neutrality principles in this environment is so difficult. Moreover, with the move to an all IP-based infrastructure, the core wireless infrastructure is more intrinsically integrated into the radio network which in turn requires the wireless provider to calibrate and manage the radio resources and the core resources more carefully to ensure that subscribers are receiving an appropriate level of service.

LTE is defined by an organization or a standards body called the Third Generation Partnership Project (3GPP). 3GPP has defined a radio network called the Evolved-Universal Terrestrial Radio Access Network (E-UTRAN) and a core network called the Evolved Packet Core (EPC). The combination of the E-UTRAN and the EPC is termed Evolved Packet System (EPS) that can be viewed as the end-to-end LTE network. The LTE EPS uses the help of auxiliary networks such as IP Multimedia Subsystem (IMS) and the Policy and Charging Control (PCC) to provide a variety of services to end users. We will look at the main functions of the E-UTRAN, EPC, IMS, and PCC after a brief discussion of the simplified network architectures of 3G (e.g., UMTS) and 4G (e.g., LTE) network architectures illustrated in Figure 2.

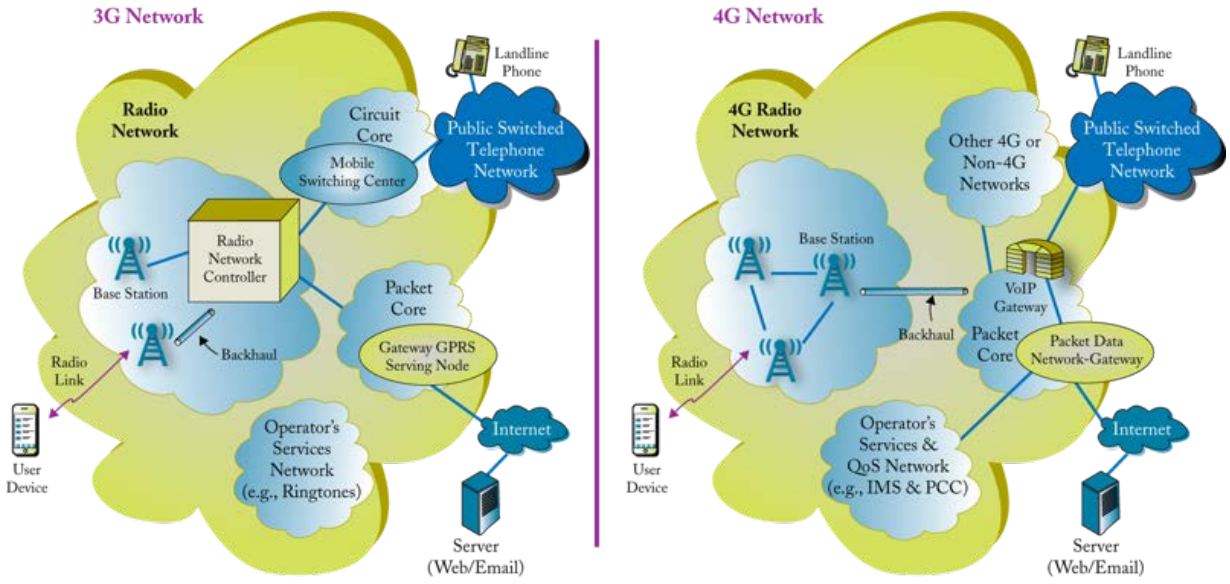

Figure 2. Simplified 3G and 4G Network Architectures

A 3G network consists of a radio network, a circuit-switched core network, a packet switched core network, and a services network. The radio network includes multiple Radio Network Controllers with each Radio Network Controller controlling hundreds of Base Stations. The Base Station communicates with the mobile device (referred to as the user device) via the air interface. The circuit-switched core network interfaces with the Public Switched Telephone Network so that the mobile device can communicate with a landline phone. The packet-switched core network enables the mobile device to access web and email servers via the Internet. The Mobile Switching Center is one of the nodes residing in the circuit-switched core network and controls the voice calls. The Gateway GPRS (General Packet Radio Service) Serving Node is an example of the packet-switched core network node and is in charge of assigning an IP address to the mobile device.

A generic 4G network consists of a radio network, a packet-switched core network, and a services and Quality of Service (QoS) network. The radio network includes the base stations. The packet switched network interfaces with the Internet using the help of a node such as the Packet Data Network Gateway. The packet-switched core network also interfaces with other 4G or non-4G networks. Since there is no circuit-switched core network in a typical 4G network, special nodes such as a VoIP gateway are needed to support calls between the 4G mobile device and the Public Switched Telephone Network. Auxiliary networks such as IP Multimedia Subsystem (IMS) and Policy and Charging Control (PCC) can be viewed as part of the operator's services and QoS network; these networks enable the service provider to offer to its subscribers a variety of IP-based services that have different QoS requirements. *We take a closer look at the LTE-specific 4G network architecture next.*

Wireless Radio Networks are Complex and Decentralized. The E-UTRAN has a decentralized and flat architecture. The E-UTRAN consists of the Evolved Node B (eNodeB or base station). The eNodeB communicates with mobiles over the wireless interface. The eNodeB makes the network management decisions related to the radio resource utilization. For example, the eNodeB evaluates the availability of the radio resources to determine if the subscriber can be offered services or not. The eNodeB implements a scheduling algorithm that allocates radio resources (radio bands and within one band,

Resource Blocks (RBs)) to the active users based on numerous factors including the target quality of service (QoS) of the applications of users, the amount of data, the number of users and the types of the user applications vying for resources, the radio channel conditions of users, the capabilities of the eNodeB and the mobiles, and the available spectrum. The eNodeB executes the scheduling algorithm as often as every 1 millisecond (ms). The eNodeB also determines the type of multiple antenna technique and the combination of the modulation and coding scheme for a given mobile device to reflect the prevailing radio channel conditions for the mobile. The eNodeB also carries out load balancing and interference coordination with the neighboring eNodeBs. The eNodeB implements a handover algorithm that utilizes the measurement reports of the radio environment received from the user equipments (UEs) and makes a handover decision if appropriate.

The Core Network is Tightly Integrated with the Radio Network. The Evolved Packet Core includes several entities such as the Mobility Management Entity (MME), Serving Gateway (S-GW), Packet Data Network Gateway (P-GW), and Home Subscriber Server (HSS) with specific responsibilities assigned to these entities. The Mobile Management Entity authenticates the LTE subscriber by working with the Home Subscriber Server. The Home Subscriber Server stores the subscriber database including the authentication related information. The Mobile Management Entity keeps track of the mobile device location when the mobile is in the idle mode so that a page can be sent to the mobile device to bring it out of the idle mode. The Mobile Management Entity coordinates the setup of Evolved Packet System bearers[1] for a mobile device; the Evolved Packet System bearers help carry the user traffic between the mobile and the Packet Data Network Gateway. The Packet Data Network Gateway allocates one or more IP addresses to the mobile device. The Packet Data Network Gateway is a mobile's gateway to the outside world such as the Internet. The Serving Gateway helps move the traffic between the eNodeB and the Packet Data Network Gateway. When the mobile goes from one eNodeB area to another eNodeB area, the Serving Gateway learns about such user mobility from the Mobile Management Entity and is able to forward the traffic between the Packet Data Network Gateway and the correct eNodeB. When the user is receiving information from a web server, the IP packets from the web server pass through the routers in the Internet and arrive at the Packet Data Network Gateway. The Packet Data Network Gateway forwards the user traffic to the correct Serving Gateway. The Serving Gateway forwards the IP traffic to the eNodeB that is currently serving the UE. The eNodeB allocates suitable radio resources to the mobile device and sends the IP packets to the mobile over the air interface.

The End-to-End LTE Network is Carefully Calibrated to Provide Quality of Service to Consumers. The Evolved Packet System works with the IP Multimedia Subsystem (IMS) and the Policy and Charging Control so that subscribers can be offered a variety of IP Multimedia Subsystem-based services with suitable QoS. The QoS benchmarks are derived from the standards work in 3GPP and are not set by the individual wireless provider. Examples of IMS-based services include Voice over IP (VoIP), Short Message Service (SMS), and Instant Messaging (IM). The wireless service provider is aware of the IMS-based services of the subscriber and the signaling associated with the IMS-based services passes through the Evolved Packet System and the IMS network. The IMS network performs its own service authentication for the cellular subscribers to allow the subscribed IMS services. The IMS network processes the signaling messages and extracts QoS for a given IMS service. The IMS network specifies

[1] A bearer in this context refers to a "pipeline" connecting two or more points in the communication system in which data traffic flows. An "EPS Bearer" would be the pipeline through which data traffic flows within the Evolved Packet System.

such QoS to the Policy and Charging Control network, which compares the service-requested QoS with the subscribed QoS and determines the QoS and charging rules based on operator policies and user subscriptions. The Policy and Charging Control network uses the help of the Packet Data Network Gateway to initiate the setup of an Evolved Packet System bearer[2] to meet the QoS requirements of the subscribed IMS service. Non-IMS services such as regular email and web browsing use the best-effort Evolved Packet System bearer toward the Internet, and signaling and traffic for such non-IMS services do not pass through the IMS network. Once a suitable Evolved Packet System bearer is in place, the Policy and Charging Control and the Packet Data Network Gateway implement the negotiated service-specific QoS. Although the resource bottleneck is usually radio resources at the eNodeB, the QoS control is needed on the link between the eNodeB and the Serving Gateway and the link between the Serving Gateway and the Packet Data Network Gateway.

2.3 Typical Wireless Network Operations

The 3G and 4G mobile wireless networks are quite complex, with various mobile device and network operations combining to support high data speeds and ever-improving quality of service. Figure 3 provides examples of such operations of mobile devices and the network for LTE.

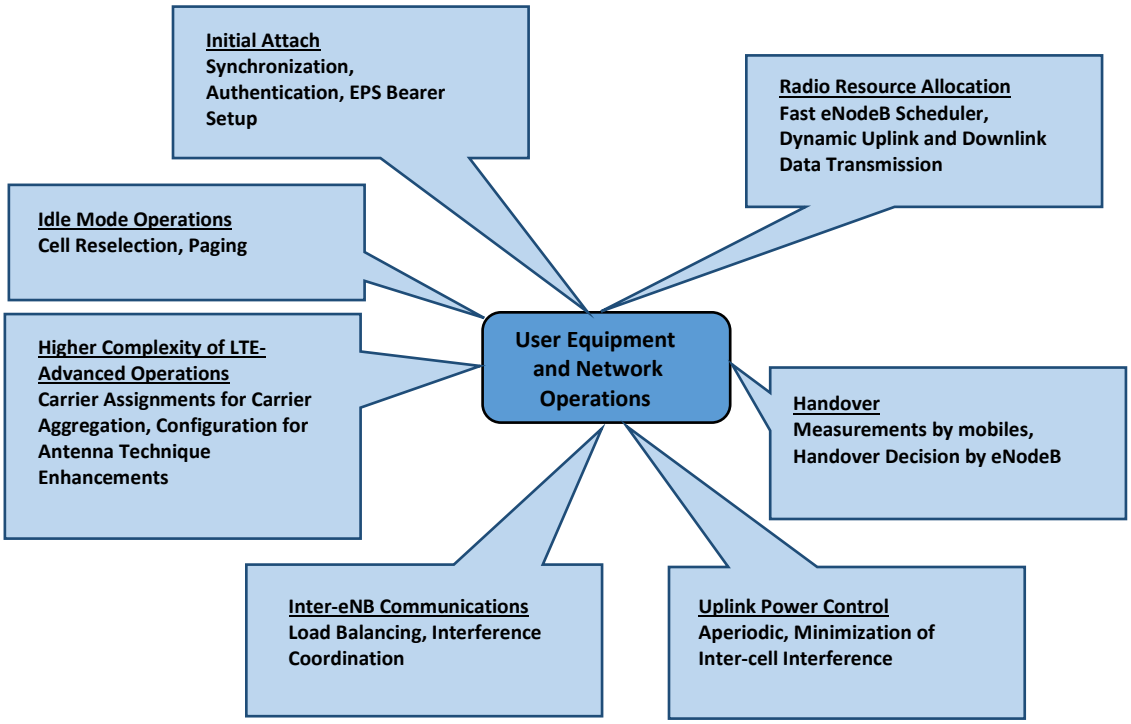

Figure 3. Operations of the Wireless Mobile Device and the Network

The mobile device carries out an initial attach procedure after power-up. During the attach procedure, the mobile achieves downlink and uplink synchronization with the eNodeB. The mobile and the network authenticate each other, and security is established. A default Evolved Packet System bearer with best-effort service is established toward a default packet data network to carry information without any

[2] End-to-end QoS is controlled at the EPS bearer level in LTE. Hence, if two applications need two different levels of QoS, two different EPS bearers with distinct QoS characteristics are needed. Furthermore, two applications with same QoS needs can be placed onto the same EPS bearer.

guaranteed data rate but with the target delay of 300 ms between the mobile and the Packet Data Network Gateway. The mobile is typically allocated an IP address during the default Evolved Packet System bearer setup.

Active mobiles have one or more Evolved Packet System bearers, and, the eNodeB scheduler dynamically allocates radio resources to the mobile for the downlink data transmission and the uplink data transmission. The eNodeB scheduler executes as fast as every millisecond to adapt to the radio channel conditions and to modify the allocated downlink and uplink resources.

The serving eNodeB configures the active mobile with measurements of neighboring cells that can be on the same carrier frequency as the serving cell or a different carrier frequency, or a different radio access technology (e.g., UMTS). The mobile device provides measurement reports when configured measurement events occur. The serving eNodeB makes a handover decision (if appropriate) and works with the target eNodeB to obtain resources for the mobile. Handover may occur without the movement of a user if the handover would balance traffic between eNodeBs.

In addition to allocating spectrum resources to the mobile, the eNodeB also controls the transmit power of the mobile by sending power control commands. Power control in LTE may be implemented as aperiodic and multiple power step-up and step-down sizes can be used. Power control helps minimize inter-cell interference in the uplink.

The eNodeB may communicate with the neighboring eNodeBs to carry out load balancing and to coordinate interference. Minimizing interference improves the achievable user throughput and cell throughput. Scheduling provides a compromise between fairness in serving all users and throughput for the overall network.

Complexity of the LTE network increases further with LTE-Advanced. The eNodeB scheduler needs to decide when to use multiple carrier frequencies simultaneously for a given mobile to improve throughput as part of the carrier aggregation feature of LTE-Advanced. More antenna technique enhancements are available in LTE-Advanced compared to LTE, and, the eNodeB dynamically needs to determine the type and configuration of the multiple antenna technique.

In the absence of data activity for a configurable time period, the eNodeB asks the mobile to enter the idle mode. The network needs to keep track of mobiles in the idle mode so that the network can page the mobile in the correct geographic region for incoming voice or data traffic. Even though the mobile in the idle mode does not consume any radio resources, it performs cell reselection to observe the strongest cell so that it is in the best possible cell when it needs to exit the idle mode to do some activity such as signaling exchange or data transfer.

3. Characteristics of Mobile Wireless Networks and Differences Between Wireless Networks and Wireline Networks

In Section 3.1, the characteristics of mobile wireless networks are discussed in detail. These characteristics dictate the complexity of network management and the need for flexibility for wireless providers to respond to changing circumstances within the network. Section 3.2 describes the significant differences between wireless and wireline network architectures that warrant differences in how mobile wireless networks are managed.

3.1 Characteristics of Mobile Wireless Networks and Resulting Implications

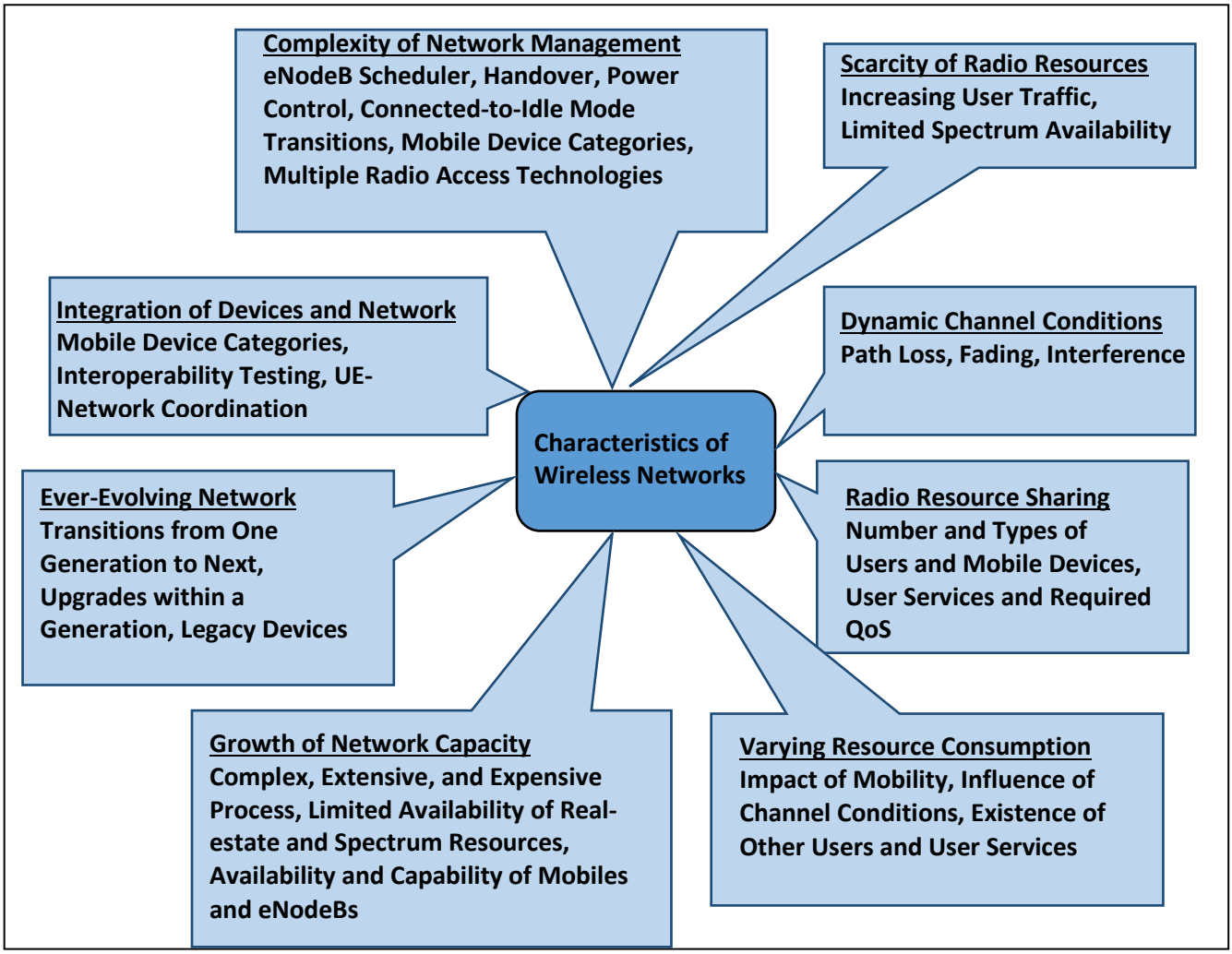

Figure 4. Characteristics of Mobile Wireless Networks

Figure 4 summarizes the characteristics of mobile wireless networks. These characteristics as a whole pose significant challenges to mobile wireless networks and make the application of prescriptive net neutrality principles to mobile wireless networks practically infeasible. In particular, determination of any reliable thresholds to quantify user or network performance is impossible. Furthermore, service providers need a high degree of flexibility to efficiently and effectively manage precious radio resources to ensure the best possible service experience for all subscribers.

Scarcity of Radio Resources. The popularity of the Internet and IP-based services such as video streaming have contributed to the explosion in the amount of data traffic traveling through the mobile broadband network. 4G services such as LTE bring with them higher data speed and greater video quality. The result has been more intensive use of 4G devices for bandwidth-heavy services, such as streaming video. Globally, in 2013 a 4G connection generated 14.5 times more traffic on average than a

non-4G connection.[3] Although 4G connections represent only 2.9 percent of worldwide mobile connections today, they already account for 30 percent of mobile data traffic worldwide.[4] In the United States, the average 4G smartphone generated 1,739 MB of traffic per month in 2013, compared to 906 MB for non-4G smartphones.[5] Cisco estimates that "In the United States, mobile data traffic by 2018 will be equivalent to 383xthe volume of U.S. mobile traffic ten years earlier (in 2008)."[6] However, spectrum does not become available with the same growth rate as data traffic. Mobile broadband operators are constrained by the amount of spectrum available and the growth rate of new spectrum availability will not keep up with constant increases in user demand. This is exacerbated by the rapid rate of data intensive applications, now enabled by mass adoption of screen based smartphones and tablets that encourage use of pictures, graphics and video, and hence drive data demand as well as driving requirements for lower latency (real time response). Scarcity of radio resources, such as spectrum, necessitates efficient management of aggregate radio resources that needs to strike a balance among numerous competing factors such as the number of active users, target QoS of user services, and prevailing radio channel conditions.

Radio Resource Sharing. Limited radio resources must be shared among the active users in a given geographic area. Basically all of the channel capacity is divided among the various users and the speed for every user will go down as more users are added. A small number of very heavy data users using apps that are extremely data intensive can have a disproportionate impact on a large number of users. The eNodeB scheduler, as often as every millisecond, needs to consider a number of factors such as the number of active user devices, capabilities of these devices, capabilities of the eNodeB, prevailing channel conditions of different devices on the network, and target QoS of different services to determine the amount of radio resources for individual users. Even if best-effort service were the goal for all users, these users would typically experience different data rates as the eNodeB scheduler would try to improve overall network throughput and overall user throughput.

Dynamic Channel Conditions. For a given level of service quality, the required amount of radio resources is a function of the channel conditions, and the channel conditions not only vary over time, but also as a function of distance from the serving cell. The signal-to-interference plus noise ratio (SINR) directly influences the required radio resources. SINR is influenced by a variety of factors such as the propagation-based signal attenuation, the severity of fading (e.g., shadow fading and Rayleigh fading), and the amount of interference. Furthermore, the channel conditions hardly remain static. The channel conditions change due to factors such as user mobility. Network operators need maximum flexibility to manage radio resources to quickly adapt to changing channel conditions. Even to preserve a given data rate, the user may need 36 times more radio resources when the channel conditions degrade.[7] For

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[3] Cisco, Cisco Visual Networking Index, Global Mobile Data Traffic Forecast Update, 2013-2018 at 2 (Feb. 5, 2014) ("Cisco Feb. 2014 VNI Report"), available at http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.pdf.

[4] *Id.*

[5] Cisco, VNI Mobile Forecast Highlights, 2013-2018 at "United States – Accelerating Network Speeds" ("Cisco VNI Highlights"), *at* http://www.cisco.com/assets/sol/sp/vni/forecast_highlights_mobile/index.html#~Country (last visited June 10, 2014).

[6] *See* Cisco VNI Highlights at "United States – 2018 Forecast Highlights."

[7] To quantify downlink channel conditions, the LTE standard has defined Channel Quality Indicator (CQI) that is a measure of achievable spectrum efficiency. CQI=1 corresponds to poor channel conditions, while CQI=15 corresponds to excellent channel conditions. The efficiency of transmission decreases from 5.5547 bits to 0.1523

example, a far-away user may require more coding (effectively more redundancy, meaning a higher real radio data rate to support the same effective data rate) and more retries (faulty packets with too high an error rate to be properly decoded are resent). Thus not all users are the same, even though their perceived data rates (the data rate the end user observes) appear the same. There are no definable metrics that could 'fairly' assess the achieved data rate. It takes the network effectively more network air interface resources (radio capacity) to serve such far-away (poor radio channel) customers. There is no such analogous situation for wired or fiber optic networks, because the channel quality conditions do not vary by such a large ratio, nor are the channel conditions so variable over time or space.

Varying Resource Consumption. Users in different channel conditions and using different services consume different amounts of resources. Even for the fixed throughput, different users would consume different amounts of radio resources depending upon the device-specific channel conditions. For a given channel condition, different services such as email and a VoIP call would consume different amounts of resources. It is nearly impossible to determine the exact amount of radio resources for a given user due to the highly dynamic nature of mobile wireless networks.

Challenges of Network Capacity Additions. Mobile broadband providers invest heavily to increase network capacity and keep up with rising user traffic and user expectations. Capacity can be increased by adding more spectrum (more different bands or more channels within the existing band(s)), deploying capacity-enhancing features such as advanced antenna techniques, and adding more cells (either by deploying 'split' macro cells or small cells) via cell-splitting techniques to gain more capacity via more 'frequency reuse.' In general, many of these techniques are quite expensive and take a long time from the concept to full commercial realization. Also, many of these radio capacity enhancing techniques have practical limitations. Deploying multiple bands requires replacing the users' handsets, and the costs rise as the devices are more complex to serve multiple bands. Base station cell splitting techniques cannot be implemented indefinitely because co-channel interference levels rise as the cells get smaller. Advanced antenna techniques require larger antenna arrays.

Thus, as noted above, mobile wireless broadband providers cannot simply build their way out of capacity constraints but instead are dependent on government allocation of spectrum resources and must purchase rights to use these resources at auction. Purchasing spectrum resources and implementing other capacity-increasing techniques can be quite expensive. Adding macro cells poses an additional challenge of finding real estate. To exploit the full potential of the standard, the user equipment and the eNodeB need to have compatible capabilities. It may take years before the commercial incarnations of user equipment and the eNodeB are coordinated and can deliver the target theoretical peak performance aimed by the standard. The intricacies of capacity growth along with ever-rising user traffic imply that efficient utilization of the existing radio resources is absolutely critical to the user experience and the network efficiency.

Ever-Evolving Network. As mentioned in Section 2, the mobile broadband service provider's network keeps changing to adapt to the newer generations of cellular standards and multiple revisions within a given generation of the cellular standard. The network has to manage the user equipment (UE) across various generations and revisions. As the newer standard emerges, the older standard does not

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bits for a given modulation symbol, leading to 5.5547/0.1523=36.4 more resources under the poor channel conditions to preserve a given data rate in poor and excellent channel conditions.

disappear immediately. Even the first-generation analog standard in the U.S., AMPS, survived for more than two decades! There are wide variations in achievable network performance and user-experienced QoS change among generations and even revisions within a generation. For example, a user may experience data rates of tens of Mbps (megabits per second) in an LTE network, but this speed could go down to hundreds of kbps (kilobits per second) when the user enters a UMTS network. Such wide disparity of the achievable performance makes it difficult to quantify even the minimum level of QoS or any metric (used for assessing performance and network neutrality) that relies on the apparent user experience.

Integration of Devices and Network. The user equipment and the network need to be tightly integrated to ensure satisfactory user experience. The standards typically define multiple categories of user equipment with different capabilities. Common ground needs to be found between a given category of user equipment and the eNodeB. In LTE, the network learns about the capabilities of the user equipment during the initial attach procedure and properly configures the equipment to ensure seamless communications between the device and the network. The network often works with user equipment of differing capabilities. Hence, even when two devices have identical channel conditions and identical allocation of radio resources, they could experience widely different throughput depending upon their capabilities as well as the proprietary aspects of the devices, such as antenna design. Extensive integration testing is carried out to ensure proper operations of user equipment and the eNodeB and error-free interactions between the device and the network. Tight integration between the user equipment and the network (e.g., eNodeB, Evolved Packet Core, and IMS) plays an important role in ensuring good user experience. Again, no 'fair' metrics could be defined to account for such differences in performance.

Complexity of Network Management. The network management in modern mobile wireless networks is extremely complex. Numerous interactions among the user equipment, the eNodeB, the Mobile Management Entity, the Serving Gateway, the Packet Data Network Gateway, the IMS network, and the Policy and Charging Control network occur to provide seamless communications experience and end-to-end QoS to the user. As mentioned in Section 2, the eNodeB scheduler allocates radio resources for the downlink and the uplink data transfer to achieve target QoS levels for the established Evolved Packet System bearers. The eNodeB executes a handover algorithm to choose the best possible serving cell for a user. The eNodeB also manages uplink power control commands to the mobiles to minimize inter-cell interference. The user equipment would be allowed to transmit more power if its uplink channel conditions are poor and/or its uplink throughput requirements are high. The eNodeB and the Mobile Management Entity manage connected-to-idle transitions for the user equipment. The network management must consider different capabilities of different mobile device categories to optimize the experience for the user. Ensuring seamless mobility across different radio access technologies is a non-trivial task. The network needs to configure the user equipment with suitable measurements and needs to connect radio networks supporting different radio access technologies. Integration testing within the network is also required to verify error-free coordination across radio access technologies. Nevertheless, this cross-layer optimization of the overall network is important for overall system performance and continues to be a promising area for further improving overall network performance.

3.2 Differences Between Wireline Networks and Mobile Wireless Networks

Any proposals to extend network neutrality principles conceived in a wireline context to mobile operations must contend with the vastly different technical challenges of these two types of communication networks. This section provides an overview of the differences in technical challenges between wireline and wireless systems as they relate to network neutrality regulation.

Wireless channels are quite different from wireline channels. First, the bandwidth for a wireless service provider might be on the order of 10s of MHz (~10^7 Hz) (5-30 MHz), but a fiber optic system could be 10s of GHz (~10^{10} Hz). The difference represents at least a one thousand-fold difference and in many cases is much greater in total bandwidth. The number of users or data rates that can be accommodated is directly proportional to the total bandwidth (and, in wireless systems, is also affected by the relative dispersion of the users within particular cells). Although 3G and 4G technologies can enable multi-megabit per second wireless transfer rates (assuming adequate spectrum resources), wireless systems will never have the bandwidth of wireline systems. A wireline network can exploit advances in optical fiber technologies to achieve extremely high bandwidth exceeding thousands of Gbps (gigabits per second). In contrast, the limited amount of radio spectrum in mobile wireless networks puts a severe constraint on the achievable data rates on a wireless link. Additionally, the wireline network is very consistent with respect to capacity capabilities of the channel over time (no fading) and space (low loss per distance of fiber). The wireline network engineer knows precisely how much bandwidth is available in a single fiber optic strand and (other than losses over distance) will have a near-constant understanding of the performance of the transport layer. In contrast, wireless networks are faced with ever-changing radio environments. Temporal issues such as multipath, clutter, blockage, channel fading, and extraneous interference will result in changes in the performance of the network and the quality of service experienced by subscribers. Also, the quality of the radio channel necessarily degrades rapidly as a function of distance from the serving cell. Without extensive management (and the inherent compensation mechanisms used within the radio air interface: variable rate coding, variable modulation, retry, etc.) of the wireless network to account for these transport layer issues, customers would not receive the types of services and data rates that they expect.

Moreover, a “build more infrastructure” approach is much less of a solution to capacity issues in wireless systems than in wireline systems for a number of reasons. First, spectrum constraints place outside limits that simply do not exist in wireline. Overall aggregate wireline bandwidth can be expanded infinitely by adding more cables or fibers, or by technology upgrades. Wireless bandwidth is ultimately constrained by fundamental performance limits, available spectrum and interference. Second, mobility and propagation issues combine to create much greater variability in the channel as compared to wireline channels. Third, mobility and propagation issues combine to create much greater variability in wireless traffic—the spread between peak and average traffic levels is typically much wider for wireless than wireline—which makes it infeasible to design networks to meet anything approaching peak demands. Fourth, issues unique to wireless networks are associated with deploying more capacity. Wireless carriers continue to spend billions of dollars annually on infrastructure upgrades, but they will continue to face severe capacity constraints, particularly with demand growing far faster than anticipated and faster than new bands can be added.

In wireline systems, in contrast, capacity improvements without the large expense of laying new fiber have been made possible through better technology at the fiber ends. Such technology options simply

are unavailable for wireless systems, and dynamic prioritization and other management techniques are and will remain essential. While wireless network providers have taken efforts to use their spectrum resources more efficiency, such as by using small cell technology, as explained above wireless operators simply cannot "build out" of capacity constraints to the same extent as their wireline counterparts. In the 30 year history of commercial mobile networks, wireless providers have moved from analog (1G) to digital (2G) to 3G and now 4G services. However, each radio interface change requires substantial time and investment to bring about the gains in efficiencies expected from the more robust standards. Each base station must be updated via software and/or hardware to accommodate the changes in the air interface. All of the existing mobile devices in the network must be replaced to provide the full benefits to spectrum efficiency that the new radio standards allow. In contrast, wireline networks are able to upgrade solely at the edge of their networks to help gain efficiencies and do not require the extensive costs associated with wireless network technology migration to provide capacity gains. Fiber also presents extensive capacity availability throughout the network that has not yet been tapped for use, but is readily available for carrying traffic with updates to the technology at the fiber ends. Not only is the bandwidth of the wireless channel severely constrained compared to wireline channels, the reliability of the wireless channel is well below that of a wireline channel. The reliability issue is due to a number of factors, such as blockage of the radio signal (called shadowing), echoes or multipath of the signal, thermal noise, and, more importantly, interference. These impairments to the channel create substantial additional complexity and variability. Planning and operating a wireless deployment to ensure Quality of Service (QoS) and coverage is extraordinarily difficult because these impairments are random and unpredictable.

Interference is often the most important of these impairments, and, by its very nature, is constantly changing between and within cells. Interference occurs when multiple signals share the same spectrum. These signals are typically associated with the same service provider but are sometimes due to another service provider using the same or adjacent spectrum bands. Interference limits capacity in a wireless system on a dynamic basis, varying by location and from one millisecond to the next, and this problem has no counterpart in wireline systems.

Deployment and maintenance of wireline systems is less dynamic than wireless systems. Although wireline electronics and services continue to evolve, the advent of fiber has brought relative stability and efficiency to the wireline network architecture. In contrast, only change is constant in wireless standards and networks. As a result, network management practices must constantly evolve to address new architectures, new technologies, new standards, and new wireless applications with new performance needs.

These various features of mobile wireless networks make them much different than wireline networks. Table 1, below, summarizes the differences between wireless and wireline networks.

Table 1. Summary of Differences Between Wireless and Wireline Networks

Characteristic	Wireline	Wireless
Communications Channel	Relatively clean with signal Regeneration	Impaired with noise, interference, multipath, and blockage
Bandwidth	No spectrum limitations	Severe Spectrum limitations
Mobility	None	Constant, complex, often unpredictable, and often consuming extensive resources
Power	No need to manage power/battery life in wireline network for end user devices.	Limited power/battery on user device that must be accommodated through network management
Security	A lesser concern due to the physical path between the provider and the user (buried or on aerial infrastructure).	A greater challenge due to the possibility of tracking a user and variety of interfaces
Response to Increased Traffic Demand (i.e., the Capacity Problem)	Capacity increases may be feasible, although soaring demand and increasing congestion issues may call for additional pricing, bandwidth limitations, and prioritization mechanisms	Primarily managed dynamically through prioritization, scheduling, and power allocation
Network Complexity	Relatively simple	Extremely complex
Network Stability, Deployment, and Maintenance	Comparatively stable platform and systems, although high growth in demand and new applications are issues	Extremely dynamic platforms and systems; Deployment and maintenance require constantly dealing with real estate acquisition and zoning issues; Planning and maintenance are more difficult, and continuous maintenance and frequent resetting of network parameters is required; Infrastructure changes to address localized capacity issues can have ripple effects through adjacent cells

Characteristic	Wireline	Wireless
Quality of Service	Easier to implement due to availability of higher capacity and predictability of resource requirements	Quite difficult to implement due to variable capacity, unpredictability of resource requirements, and existence of proprietary mechanisms; Industry moving toward IMS and PCC

4. Challenges of Implementing the FCC's Proposed 2014 Rules on Net Neutrality to Mobile Wireless Networks

The NPRM seeks feedback on the *transparency rule*, the *no-blocking rule*, and the *anti-discrimination/commercial reasonableness rule* in the context of mobile broadband service providers. The NPRM proposes to apply the transparency rule to both fixed and mobile broadband wireless access. Regarding the no-blocking rule, the NPRM proposes to treat mobile and fixed broadband services differently. Furthermore, just as the FCC chose not to apply the 2010 unreasonable discrimination rule to mobile broadband service, the 2014 NPRM tentatively concludes that the replacement rule – or "anti-discrimination/commercial reasonableness" rule – would not be applicable to mobile broadband. Section 4.1 discusses the challenges of applying the enhanced transparency rule to mobile wireless networks. Section 4.2 describes the problems encountered while applying the enhanced no-blocking rule to mobile wireless networks. Section 4.3 briefly explains why the NPRM's view of not applying the unreasonable discrimination rule and the "anti-discrimination/commercial reasonableness" rule to mobile wireless networks is the correct approach. Extensions of the transparency and no blocking rules beyond those adopted in 2010 would be unwieldy and over-inclusive. Application of an anti-discrimination/commercial reasonableness rule to mobile broadband providers would hamper their ability to innovate, optimize, differentiate, and deliver high quality products and services.

4.1 Transparency Rule and Mobile Wireless Networks

The 2014 NPRM seeks comment on expansions of the transparency rule that would require mobile service providers to disclose information in several categories, including *network management practices*, *performance*, *congestion specifics (e.g., speed and packet loss)*, *peak load management*, and *parameters of default or best-effort service*. However, as explained below, for mobile providers there are numerous technical and practical problems in meeting these proposed expanded disclosure requirements that make implementation of any enhanced transparency rule problematic, resulting in increased costs, less responsive service due to limitations on network management and would not provide consumers with relevant or useful information.

4.1.1 Network Management Practices

In a typical wireline network, the only variable is the amount of traffic on a given link – all other things such as capacity, etc. are typically static. This makes management of the traffic relatively straightforward using standard queuing techniques (e.g. Weighted Fair Queuing) to ensure all customers receive a fair share of the available bandwidth during congestion caused by a small number of users.

With wireless networks, there are many variables that are all changing simultaneously – signal strength and interference affect capacity, orientation of antenna affects throughput, and obstacles can dynamically interrupt data, among other things. Using just standard wireline techniques would not work well in this environment, and as described below, there are many methods used to make the network function well. During times of congestion, heavy users may have to be treated differently based on multiple variables to ensure proper throughput for all users. This is something accounted for in the standards as well as in most network management practices, and requiring all these technically-driven capabilities to be suspended simply to ensure a "neutral" network can have significant negative consequences.

eNode B Base Station. The *network management practices* in mobile wireless networks are extremely complex and consist of numerous mechanisms that are distributed among various nodes in the network architecture illustrated in Section 2. The achievable radio network performance and user experience are influenced heavily by these network management mechanisms. Sections 2 and 3 identified several network management mechanisms implemented by the eNodeB such as the scheduling algorithm for downlink and uplink resource allocation, the handover algorithm, the load balancing algorithm, handling of the connected mode-idle mode transitions, adaptation to the changing channel conditions, power control, and interfere coordination. Although the standard defines auxiliary tools such as (i) measurement reporting by user equipment and (ii) inter-eNodeB signaling exchange via the standardized X2 interface, these network management mechanisms are proprietary to the infrastructure vendors. Infrastructure vendors differentiate their products based on abilities of these mechanisms. Hence, a mandate to fully disclose these mechanisms would discourage innovations, violate intellectual property rights, and harm both competition and consumers.

Core Network. Just like the network mechanisms implemented at the eNodeB, the network management mechanisms implemented in the Evolved Packet Core and the auxiliary networks of IMS and the Policy and Charging Control networks[8] could provide a competitive edge and serve to differentiate service providers. The load balancing among the Mobile Management Entities and management of idle mode mobile devices are examples of network management in the Evolved Packet Core that are vendor-proprietary. The service provider may have a specific way of providing a certain level of QoS for a given service by configuring the IMS and the Policy and Charging Control networks (e.g., certain target data rates and certain latency targets). Furthermore, the routers that carry signaling and user traffic between the eNodeB and the Evolved Packet Core and within the Evolved Packet Core may be configured by the implementation-specific network management framework.

Service providers need maximum flexibility in the network management of mobile wireless networks to make the best use of the *scarce radio spectrum* in the presence of the exponentially rising data traffic. For example, [Neel_MobileDataTraffic] reports that the mobile data traffic is expected to grow by a factor of 450 from 2005 to 2015. Furthermore, *scarcity of the radio spectrum* is clearly evident in Exhibit 11 of [Deloitte_SpectrumShortage], where the FCC estimates that the U.S. would experience a spectrum

[8] While we have mentioned examples of major network management mechanisms, we note that these are not the only mechanisms that exist. Numerous other algorithms that manage radio resources, core network resources, transport network resources, IMS and PCC resources exist. For example, some mechanisms to configure the operations of the radio channels and to coordinate resource utilization between macro cells and small cells would be needed.

deficit of 275 MHz relative to the demand in 2014. Due to the scarcity of precious spectrum, innovative, high-performance, and ever-evolving network management mechanisms are absolutely essential to the overall network performance and user experience. Flexibility in tuning and adapting the network management mechanisms to fast-paced technology evolution, implementation of new features and the uncertainty of the requirements of emerging applications or services require that the network management mechanisms in mobile wireless networks should not be subject to any disclosure requirements. In the fast-paced evolution of wireless standards, multiple revisions exist, as discussed above. Even for a given revision of the standard, the user equipment and the network vendors have multiple software releases to update. Revelations of the network management mechanisms in the eNodeB, the Evolved Packet Core, and the IMS and Policy and Charging Control networks would ultimately harm consumers due to a reduced rate of innovation resulting from adherence to counter-productive implementation of the transparency rule.

The situation is too complex to summarize with a small set of easily defined comparative metrics, and expansion to a more complex, detailed set of base station and/or network performance metrics would violate the confidential nature of the network providers' proprietary technical optimization choices. This would severely impact the pace of innovations in the area of network management.

4.1.2 User Experience and Network Performance

Performance is extremely difficult to estimate reliably for mobile wireless networks, because there are numerous factors that influence the achievable network performance perceived and user performance (user experience). To complicate the performance estimation further, many of these factors are dynamic. Also, many of these factors are application specific, in that they are more important for some applications than for others. As discussed in Section 3, the wireless network is characterized by a variety of factors including dynamic channel conditions, varying number of active users, differing QoS requirements for the services of active users, the available amount of spectrum, user mobility, the capabilities of user equipment and the eNodeB, the types of applications considered, and the generation and the revision within the generation of the wireless standards. All these factors together determine the network and user performance at a given instant. Furthermore, this performance would change from one instant to another as one or more factors change. Reporting average performance over a particular period of time may not make sense and could be misleading to consumers.

The achievable user throughput is a function of the signal-to-interference plus noise ratio, which is influenced by the radio channel conditions that reflect propagation-based path loss, type and severity of signal fading, and amount of interference. Signal-to-interference plus noise ratio, in conjunction with other measurements[9], also dictates the configuration of the advanced antenna techniques that can be used for a given mobile device at a given instant.

The number of active users and the specific QoS requirements of the services of these users determine how the available radio resources of the network are distributed. For example, in LTE one active user could get up to around 75 Mbps in a case of excellent channel conditions that are conducive to the use of spatial multiplexing technique. In contrast, poor channel conditions resulting from a weak signal (e.g., due to fading and large propagation path loss because the user is far away from the serving base

[9] Examples of these measurements include rank indication (RI) and precoding matrix indicator (PMI).

station) and strong interference may be able to support only about 1 Mbps.[10] If there are multiple active users with guaranteed bit rate (GBR) requirements, other users involved in non-GBR services such as email and web browsing will experience much lower average throughput. As noted above, the numerous variables inherent to a wireless network may mean that during times of congestion, heavy users may have to be treated differently to ensure proper throughput for all users. Should the FCC mandate the suspension of such network management practices in the name of "neutrality," significant negative consequences could result.

The throughput experienced by a user would also depend on the service (or application) being received by the user. A seemingly low instantaneous data rate of about 300 kbps would be more than adequate for a VoIP call, while a much higher instantaneous data rate (e.g., few Mbps) would be needed for video streaming or a file download to provide satisfactory user experience. In the absence of the context of the specific service or application and their related QoS requirement, a given value of data rate, or any other metric, such as latency, is not a reliable indicator of the user performance or experience.

The available amount of spectrum directly affects the achievable performance. If a service provider has a 10 MHz LTE channel in one market but only a 5 MHz LTE channel in another market, the achievable throughput can easily differ by a factor of more than two. The larger the channel bandwidth, the higher the achievable throughput. Frequency selective scheduling could provide larger gains in case of larger channel bandwidths.

The impact of user mobility on achievable performance is also significant. In general, a higher velocity of the user equipment results in a larger Doppler shift and typically implies frequent and more severe short-term fades. In contrast, a slowly-moving device (e.g., pedestrian speed) has a smaller Doppler shift and experiences fewer varying signal fades, but the time period for the fade may be much longer and more impactful, as the user may remain within a performance null area for a longer period of time. The signal-to-interference plus noise ratio required to achieve a target throughput (or error rate) can vary significantly due to the impact of the user mobility and the distance from the serving cell.

The network performance and the user performance are affected by the capabilities of the user equipment and the eNodeB. All the eNodeBs do not have support for all the configurations defined by the standard. For example, Release 8 LTE supports parallel transmission of data from four antennas. However, commercial Release 8 LTE deployments typically have two transmit antennas for parallel data transmission. Similarly, not all devices have these same capabilities. Five categories of user equipment are defined for release 8 LTE, and, Category 3 devices are widely used in current commercial deployments in the U.S. and around the globe. Category 3 devices receive signals on two antennas. Furthermore, Category 3 equipment supports QPSK and 16-QAM modulation schemes to transmit data in the uplink. In contrast, Category 5 devices have four antennas to receive the downlink signals and support QPSK, 16-QAM, and 64-QAM to transmit data in the uplink. Such differences in equipment categories are a key reason why the downlink peak data rate is around 300 Mbps for a Category 5 device and around 100 Mbps for a Category 3 device and the uplink peak data rate is around 75 Mbps for a Category 5 device and around 50 Mbps for a Category 3 device [3GPP_TS36.306].

[10] These calculations assume that a (2x2) MIMO (Multiple Input Multiple Output) technique is used when the channel conditions are excellent (i.e., with CQI=15) and a non-MIMO technique at CQI=1 is used.

The generation and the revision within the generation of the wireless standards also have a significant influence on the achievable performance. For example, Release 8 LTE supports theoretical peak data rates of 300 Mbps downlink and 75 Mbps uplink. In contrast, Release 10 LTE-Advanced supports a theoretical peak data rate of 3 Gbps downlink and 1.5 Gbps uplink. Again, defining one set of reasonable metrics is impossible in the face of different generations of handsets.

In summary, mobile broadband providers are committed to complying with the existing transparency rule but, recognizing that the specifics of network and handset performance will vary constantly, the granularity contemplated by the proposed expanded transparency rule would be infeasible. There are simply too many factors (most of which are highly dynamic or variable) that influence network and user performance, making it impractical to predict, guarantee, and/or verify user performance in the context of the expanded transparency rule.

4.1.3 Congestion

The 2014 NPRM envisions disclosure of congestion-related statistics such as speed (i.e., throughput) and packet loss. In the context of mobile wireless networks, such disclosure requirements are unhelpful for several reasons explained below.

First, the dynamic nature of mobile wireless networks leads to wide variations of throughput as discussed in Section 4.1.2 above. For data-centric systems, packet loss is reflected in the overall throughput. Furthermore, some throughput degradation and/or packet loss may not be due to congestion at all; it may simply be due to changes in channel conditions, user mobility, and/or service change. The packet loss rate may not really reflect any congestion.

Separating congestion issues from non-congestion issues through analysis and storing and maintaining such data for the sole purpose of compliance with the transparency rule would need significant investment of resources without any tangible benefit to consumers. As mentioned in Section 3, the eNodeB scheduler operates as fast as every millisecond, and the number of active users can change within a few seconds due to transitions between the idle and connected modes. So-called congestion can widely fluctuate in matter of few seconds. Network optimization processes aimed at addressing congestion can respond to these temporary congestion issues just as quickly. As a result, real-time disclosure of network congestion would be problematic to implement and confusing for consumers, as the network is constantly responding to ever-fluctuating levels of traffic. Section 2 illustrated the LTE network architecture. The complexity of the overall architecture means that network upgrades due to revisions or new feature implementations would almost certainly need extensive troubleshooting efforts which would likely lead to temporary congestion issues. Engineers seeking to comply with such a rule would face an unnecessary burden that could delay solutions to real problems, and cause harm to the subscribers instead of helping users (which is the real goal of the transparency rule). The key to keeping overall network capacity high is to adapt to the traffic over time using sophisticated and proprietary scheduling algorithms. Network neutrality rules which place strict demands on traffic handling and may restrict or prevent certain schedule techniques, would require infrastructure and capacity to be over-engineered to handle otherwise manageable peaks, and hence result in higher costs for consumers.

Since network optimization is an ongoing and iterative process, it is quite likely that some congestion issues that are reported will have been remedied long before they could be incorporated into any required disclosure. Mobile wireless networks have numerous challenges on the radio channel, and,

service providers need to invest heavily in ongoing technology upgrades, network RF planning, design, and optimization activities. The technology for wireless is changing very quickly and will continue to change quickly for the foreseeable future. Service providers will have a learning curve to understand how to deploy this technology and realistically, regulatory policy will (and perhaps must) adjust more slowly to these technology developments. Undue regulation at this point will stifle technology deployment that could increase bandwidth availability and lower costs for the consumer.

4.1.4 Peak Load Management

There are many legitimate reasons why a wireless network operator needs to manage data traffic on its network. In such cases, reporting of such peak load management would have little benefit. Recall from Section 2 that the Policy and Charging Control network works with the Evolved Packet Core to ensure suitable QoS. Such interworking between the Policy and Charging Control network and the Evolved Packet Core means that peak load management of traffic may be carried out such that the QoS for a given Evolved Packet System bearer is met. Each Evolved Packet System bearer has QoS parameters such as the maximum data rate. If the incoming data rate exceeds the subscribed data rate, the Packet Data Network Gateway manages the data to meet the data rate constraint toward the Serving Gateway. Such peak load management is carried out as part of the 3GPP standard's QoS characteristics [3GPP_TS23.203]. The network needs to manage the traffic so that all users can satisfactorily receive services instead of just few users consuming disproportionate amounts of resources. If excessive amount of traffic is received at the eNodeB, the eNodeB may have to buffer the packets, delaying the packets and potentially causing packet loss if the device-specific buffer overflows. Hence, even for the user with higher data rate needs, suitable peak load management is needed.

The resources in mobile wireless networks are scarce, and these scarce resources must be shared among numerous users. If suitable optimization is not carried out, some applications could flood the network with excessive amounts of data traffic (and even signaling traffic), causing degradation to many users in the network. In general, higher data rates result in the consumption of more resources, and, concentration of radio resources among only few subscribers would be unfair to other users. Hence, network optimization could be viewed as a network management mechanism to provide some level of fairness among the uses and users of radio resources. Network operators need the flexibility of such legitimate management to strike a balance among fairness, network performance, and aggregate user performance. The network management in mobile wireless networks must have at its disposal all means, including optimization, to safeguard the interests of all subscribers and to provide the best possible experience to all subscribers instead of just a select few subscribers. This balancing is dynamic and load dependent, so again, one set of uniform metrics cannot meaningfully capture overall performance.

4.1.5 Parameters of Best-Effort Service

The NPRM asks if any parameters can be specified to quantify the best-effort service. Numerical parameter settings that quantify the best-effort service and that are reliable are difficult to guarantee in mobile wireless networks. First of all, commercial mobile wireless networks have a mix of radio access technologies, mobile devices with different capabilities, and eNodeBs with different capabilities. Hence, the achievable performance varies depending upon the specific combination of the technology, the mobile devices, and the eNodeB for a given channel condition.

Even within the narrow scope of a given standard such as LTE and ignoring differences among technologies, compliance with the NPRM-proposed transparency rule in the form of target parameters would be quite challenging. LTE defines nine levels of QoS in terms of QoS Class Indicators (QCIs) [3GPP_TS23.203]. A QoS Class Indicator (QCI) specifies the QoS class. Defining different data rates for these services offers operators additional flexibility. An operator could also define proprietary QCIs. For example, QCI = 1 is suitable for applications such as VoIP. Its priority is 2, and it seeks to provide a minimum data rate, e.g., around 12 kbps. (Of course, keep in mind that a wireless network cannot provide an absolute guarantee. "Guarantee" here means that if the network agrees to grant service with QCI = 1 for a user, it will try its best to honor the granted GBR (Guaranteed Bit Rate). In the worst-case, the call may drop due to a hostile radio environment.[11])

Now, let's contrast QCI = 1 with QCI = 8. An application such as email might fall into QCI = 8. Since VoIP has more stringent delay requirements than email (e.g., 100 ms for VoIP vs. 300 ms for email), its priority is higher than email's. Also, the target error rate for email is lower than that for VoIP because the integrity of email bits is much more critical than the integrity of VoIP bits. So our goal is to lose no more than one of one million IP packets for email.

A web browsing session typically uses QCI = 8 or 9, which corresponds to so-called best-effort service. However, according to the 3GPP recommendations, the Evolved Packet System bearer with QCI = 8 or 9 is a non-guaranteed bit rate (non-GBR) bearer and therefore has absolutely no guarantee of any minimum data rate. The maximum data rate for such Evolved Packet System bearer is operator-configurable. Commercial LTE networks determine the maximum data rate as a function of the mobile device category. Since there is no guarantee of any minimum data rate for the best-effort service, the most critical parameter (i.e., throughput or data rate) cannot be specified for the best-effort service. Furthermore, the priority of traffic associated with the best-effort bearer is the lowest among all types of Evolved Packet System bearers. Hence, when the eNodeB scheduler becomes busy serving higher-priority bearers, the average throughput can be expected to be impacted for the best-effort bearers.

In summary, the absence of the specification within wireless standards of even the minimum data rate for a best-effort service is a hurdle that cannot be overcome by the transparency rule.

In light of the practical issues described above in Sections 4.1.1 through 4.1.5, applying an enhanced transparency rule to mobile wireless networks is impractical, would stifle innovations, and (most importantly) would not benefit users at all. Even if some information about network management practices were to be disclosed to comply with the transparency rule, such information would most likely be too vague. Metrics for gauging network neutrality do not exist and if they did they would likely become obsolete quickly with the rapid development of technology and new applications. Enforceability of such a rule would be highly questionable and this rule would, in practice, reduce network performance.

[11] The packet delay is the one-way time between the device and the edge of the operator's network. QCI = 1 aims for a delay of less than 100 ms. (The lower the number for priority is, the higher the actual priority.) The packet loss rate of 10^{-2} = 0.01 or 1% means that an application with QCI = 1 can tolerate the loss of one of 100 packets.

4.2 No-Blocking Rule and Mobile Wireless Networks

The *no-blocking rule* specifies that mobile broadband service cannot prevent consumers from accessing lawful websites and cannot prevent users from using voice or video telephony applications that compete with the mobile broadband service provider's services, subject to reasonable network management. The NPRM further clarifies that mobile broadband service providers would not be violating the rule if they do not degrade a lawful service or content below the minimum level of service. The NPRM is seeking a definition for such minimum level of service and exploring the feasibility of using measurements such as speed, packet loss, and latency delay to quantify the minimum level of service.

Application of the no-blocking rule has several unique challenges in mobile wireless networks. To begin with, the definition of the minimum level of service is not feasible for mobile wireless networks. Throughput is the most important performance metric for data-centric mobile broadband systems, and, as explained in Section 4.1.5 on the best-effort service, LTE does not define any minimum data rate guarantee for such service. Note that non-IMS applications such as consumer-chosen voice and video applications do not travel through the IMS network and are typically placed onto the Evolved Packet System bearer with QCI = 8 or QCI = 9. Recall from Section 2 that signaling for IMS applications such as operator-aware VoIP (e.g., Voice over LTE or VoLTE) travel through the IMS network and that the IMS and Policy and Charging Control networks work with the Evolved Packet Core to provide target QoS, which would include guaranteed bit rate (GBR) for QCI = 1 Evolved Packet System bearer. Hence, any non-IMS user application such as voice and video cannot be expected to have the IMS application-like QoS.

The issues associated with expansion of the no-blocking requirements for mobile wireless networks are similar to those addressed in Sections 4.1.1-4.1.5, above, for implementation of an enhanced transparency requirement. When a single user or single application could overwhelm the limited resources provided to wireless providers, such a provider must be able to block this interfering use to ensure the quality of service expected for many other users. As has been discussed throughout this paper, unlike wireline networks, mobile wireless networks have scarce spectral resources (capacity) that are affected by interference, multipath, blockage, clutter and other conditions which require active management, including blocking of particular applications or users. Without the ability to manage blocking effectively, a wireless provider would be faced with situations where a single user or application could occupy all the radio resources associated with a particular eNodeB – leaving any other subscriber seeking access to that eNodeB without the ability to connect and receive the service expected. Therefore, the current no-blocking regulation continues to be the most appropriate technical path forward. Attempting to apply a broader no blocking rule—even with a safe harbor set of guidelines or other means to cabin off "reasonableness" – is extremely impractical, as discussed in more detail below.

In case of resource crunch, the eNodeB gives higher priority to Evolved Packet System bearers carrying IMS signaling and guaranteed bit rate traffic (e.g., VoIP traffic). Furthermore, according to the Quality of Service Class Indicator characteristics defined in [3GPP_TS23.203], Evolved Packet System bearers are set with a certain Allocation and Retention Priority (ARP), and, by design, best-effort bearers have a lower Allocation and Retention Priority compared to other higher-priority bearers. The best-effort Evolved Packet System bearers carrying email, web browsing, and consumer-installed non-IMS voice and

video applications could potentially be affected adversely as part of routine and legitimate network management.

Without the differentiation capabilities described above, the LTE network will simply not function reliably for some services, or will function in a very inefficient manner. Standards organizations such as 3GPP have spent years working out the details of these capabilities and how they will interoperate, and they should not be modified without thorough technical analysis.

The NPRM is seeking comment on the feasibility of using the following methods to define a *minimum level of service*: a best-effort standard, a minimum quantitative performance standard, and a reasonable person standard. As discussed in Section 4.1.5, a best-effort standard cannot be really quantified for mobile wireless networks. The minimum quantitative performance standard would also be impractical. Finally, the main problem with the reasonable person standard is that a typical end user cannot be expected to be knowledgeable about how mobile wireless networks operate and different people would have different expectations from their networks. The absence of reliable and quantifiable estimates of "reasonableness" makes the reasonable person standard highly subjective and non-enforceable. Wireless providers, based on network management requirements developed within industry standards, should have the right to block any use or application on their wireless network if such use would preclude other subscribers from accessing service. Attempting to limit wireless providers' ability to block (such as attempting to define "reasonableness") would not allow the scarce spectral resources available to wireless providers to be used in the most effective and efficient manner.

4.3 Unreasonable Discrimination Rule and Anti-Discrimination/Commercial Reasonableness Rule, and Mobile Wireless Networks

The FCC has stated that the newly-proposed anti-discrimination/commercial reasonableness rule, just like the original 2010 rule, is not intended to be applicable to mobile broadband service. Our view concurs with the FCC view that different treatment for mobile broadband should be continued because differentiation among users and user services is required to provide a satisfactory quality of service to consumers.

As discussed in detail in Section 3.1 above, wireless networks are characterized by: (1) scarce radio resources; (2) radio resource sharing; (3) dynamic channel conditions and varying performance; (4) varying resource consumption; (5) ever-evolving networks and (6) the need to integrate differing devices and infrastructure. Because of these factors, user differentiation due to the dynamic nature of the radio environment is fundamental to the operation of any good scheduling algorithm design for a wireless network. A good scheduling algorithm maximizes network performance while providing good user-perceived experience, not necessarily by treating all users or all applications identically. If the scheduler treats two users with two different channel conditions (e.g., one excellent channel and one poor/noisy channel) in the same manner, the overall network performance would certainly degrade and the average user experience would also deteriorate. Consider Figure 5, where two users are downloading an email with a huge attachment and their channel conditions are constantly changing. Good channel conditions can support a higher data rate, and poor channel conditions support a lower rate as illustrated in Scenario 1 and Scenario 2.

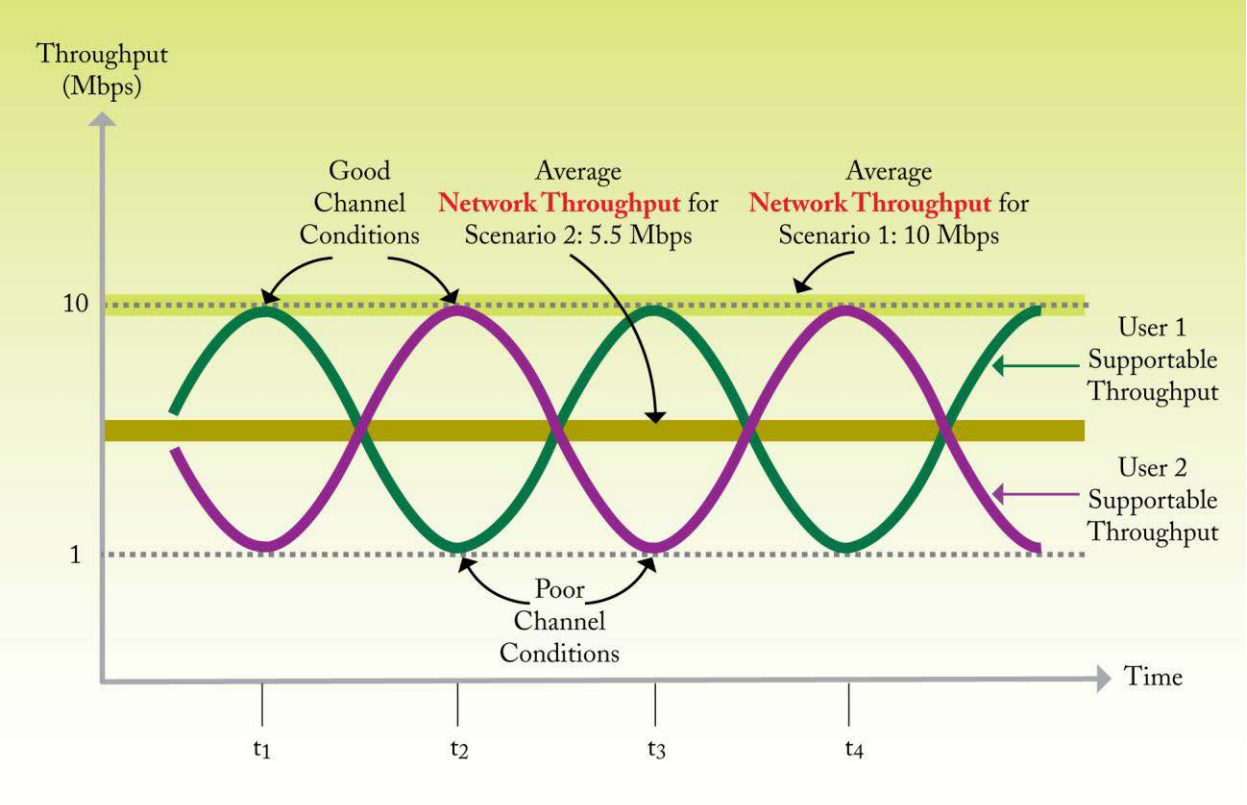

Figure 5. Necessity of User Discrimination Due to Dynamic Radio Environment

Figure 5 shows the user supportable throughput when all the available resources are allocated to the users. In Scenario 1, a high-performance scheduler allocates all the available resources to a user with the best channel conditions and transmits packets to such user. Observe that at time t_1, User 1 has the best channel conditions and can support 10 Mbps if allocated all resources. The scheduler dedicates the entire 100% of network resources to User 1 and sends a packet to User 1 at 10 Mbps at time t_1. At time t_2, User 2 has better channel conditions, and the scheduler allocates all network resources to User 2 and sends a packet to User 2 at 10 Mbps. The average network throughput is 10 Mbps as the network is always sending the packets at 10 Mbps. Sometimes the network sends packets to User 1, while other times, the network sends packets to User 2. The average user throughput that User 1 experiences is 50% of 10 Mbps = 5 Mbps, and the average throughput User 2 experiences is also 50% of 10 Mbps = 5 Mbps because these users are scheduled 50% of the time.

In Scenario 2, an equal-opportunity scheduler equally distributes the network resources at all times. At time t_1, the network allocates 50% of resources to User 1, leading to User 1 throughput of (50% of 10 Mbps = 5 Mbps). Note that User 1 throughput is 5 Mbps and not 10 Mbps because User 1 is allocated just 50% (and not all 100%) of resources. Similarly, at time t_1, the network allocates 50% of resources to User 2, leading to User 2 throughput of (50% of 1 Mbps = 0.5 Mbps). The network throughput at t_1 is 5.5 Mbps (User 1 throughput + User 2 throughput = 5 Mbps + 0.5 Mbps = 5.5 Mbps). Now, consider time t_2, where the allocation of 50% of resources to User 1 results in User 1 throughput of (50% of 1 Mbps = 0.5 Mbps) and the allocation of remaining 50% of resources to User 2 results in User 2 throughput of (50% of 10 Mbps = 5 Mbps). Again, note that the users experience only 50% of the throughput values shown

in Figure 5 because the throughput values correspond to a hypothetical case where all of the network resources are allocated to a single user. The network throughout at t_2 is (User 1 throughput + User 2 throughput = 0.5 Mbps + 5 Mbps = 5.5 Mbps). The average network throughput is then 5.5Mbps. Let's calculate average user throughput. User 1 experiences 5 Mbps 50% of the time and 0.5 Mbps remaining 50% of the time, leading to the average user throughput of 2.75 Mbps (0.5*5 Mbps + 0.5* 0.5 Mbps = 2.75 Mbps). Similarly, the average user throughput for User 2 is also 2.75 Mbps. In other words, since the network equally distributes resources between the two users, the network throughput of 5.5 Mbps is equally divided between the two users as (5.5 Mbps/2 = 2.75 Mbps).

In our simple example, the network throughput is reduced by almost 50% (i.e., from 10 Mbps to 5.5 Mbps) in Scenario 2 compared to Scenario 1. Just imagine what would happen to the business models of service operators if the cost of supporting their customers doubles overnight? While the scheduler has optimized network performance in Scenario 1, User 1's throughput and User 2's throughput are also better in Scenario 1 compared to Scenario 2 (e.g., 5 Mbps in Scenario 1 compared to 2.75 Mbps in Scenario 2). Better network performance enables the service operator to cost-effectively provide services to many users simultaneously. Subscription plans for users can then be relatively inexpensive, promoting growth of cellular subscribers and services. The comparison of network performance in Scenarios 1 and 2 shows that differentiation is best for the aggregate network and for all users. Treating all users the same all the time appears more fair at first, but adapting to the radio channel by having the scheduler weight the service schedule against predicted data delivery performance results in better performance for everyone, even though at any moment, not all users are treated the same.

Combined service and user differentiation is also quite important. Assume that User 1 has an ongoing email application and has in the past been promised a maximum data rate of 10 Mbps, and assume further that all the network resources are being consumed by such a user. Suddenly, ten users start making voice calls. The network simply lacks the resources to simultaneously support ten voice users and an email user with a 10 Mbps data rate. If the network's resource management algorithms downgrade the email data rate to perhaps 9 Mbps, then the network can accommodate both the email user and all ten voice calls. If the network fails to differentiate between the voice users and the email user, all ten voice calls would be blocked. In summary, user and service differentiation is essential to aggregate service fairness for the average consumer. Here again, the scheduler is not treating every application identically ('fairly'), but the net aggregate result benefits more users. What set of metrics would represent this fairness? These considerations evolve as the applications mix changes.

Differentiation based on resource consumption is also inherent in a wireless network and facilitates network efficiency and fairness. The network management algorithms must differentiate between users based on the amounts of network resources each user is consuming. For example, current mobile wireless networks commonly limit the amount of resources a single user can consume. If one user consumes an excessive amount of network resources due to a hostile radio environment and/or such user is using bandwidth-intensive data applications, that user may dominate the network so much that no other user can get any service in the absence of pro-active network management.

There are several situations where it is legitimate and beneficial for wireless network operators to differentiate traffic. For example, Wireless technologies are increasingly being used for machine-to-machine services and public welfare systems. It is critical that these systems – such as, for example, wireless monitoring of bridges – be fully functional at all times, and this may require prioritization. In

addition, public safety personnel clearly should have higher priority than regular users. More "ordinary" services, such as voice call, email, and streaming video, all require different quality of service levels, and wireless network operators should be allowed the flexibility to prioritize these diverse services in a manner that ensures that an end user experiences the quality of service necessary for these services to function. User and service differentiation is also essential to service fairness – one user should not be permitted to monopolize network resources at the expense of others.

In summary, the dynamic nature of mobile wireless networks requires a reasonable, necessary, and *dynamic*differentiation among users by the network management to ensure an acceptable aggregate quality of service for all wireless subscribers. To subject mobile broadband providers to claims that such non-uniform network management techniques are 'unfair' and violate commercial practices, particularly when combined with the prospect of regulatory rebuke, would significantly impair the ability of providers to experiment with new and innovative network management tools designed to improve consumers' experiences. Any rule that would prohibit discrimination on mobile wireless networks would be impractical and would actually work against the FCC's goals of promoting innovation and benefiting consumers.

5. Mobile Wireless Broadband Internet Access: An Integrated Information Service

Mobile broadband service is an integrated service that enables the wireless subscriber to access a variety of services in a wireless fashion. The subscriber's device communicates with the mobile broadband service provider's network via complex interactions. The nodes of the entire wireless network infrastructure work together to present a single unified view of the network to the subscriber's device and to provide service-specific QoS for a user's services according to the 3GPP LTE framework. All the network components need to do specific processing, which often needs to be customized for a given service, to provide seamless and satisfactory experience of a variety of services for the user. All the complexities associated with subscriber's experience of wireless services are handled by the subscriber's device and the broadband service provider's network without the active involvement of the subscriber.

When the FCC classified wireless broadband Internet access service as an "information service," it did so based on the correct finding that this service "offers a single, integrated service to end users, Internet access, that inextricably combines the transmission of data with computer processing, information provision, and computer interactivity, for the purpose of enabling end users to run a variety of applications."[12] This statement, which was made by the FCC in 2007, has only become more emblematic of the wireless ecosystem. As technologies and networks have evolved, subscribers are increasingly using advanced networks for multiple simultaneous data services, such as email, web browsing, and various other applications. Extensive and complex processing in the mobile broadband network allows customers to seamlessly navigate among multiple mobile broadband applications and services at the same time, enjoying a good experience of various applications.

The mobile broadband network consists of numerous network nodes that interact among themselves in different and complex ways and that do custom processing depending upon the type of service or application. Such interactions and custom processing enable the wireless subscriber to obtain an

[12] *Appropriate Regulatory Treatment for Broadband Access to the Internet Over Wireless Networks,* Declaratory Ruling, 22 FCC Rcd 5901, 5911 ¶ 26 (2007).

integrated information service that integrates different types of information to provide a unified service experience (user experience) and that meets specific requirements of applications (e.g., guaranteed data rate or very low packet error rate or very low latency). *Indeed, the mobile broadband service is an integrated information service that requires (i) tight coupling between the mobile device and the network,*[13] *(ii) numerous complex interactions*[14] *between the mobile device and the network and among the network components, and (iii) service-specific custom processing at different network nodes*.[15] Let's take a closer look at these three areas.

Tight coupling between the mobile device and the network is essential in providing seamless and satisfactory services to the subscriber. For example, each service requires a certain quality of service, and, the network properly configures the mobile device and the network nodes so that the user has satisfactory experience. According to the 3GPP LTE standard, the overall packet error rate cannot be greater than 0.0001% for services such as email and web browsing (see Table 6.1.7 in 3GPP TS 23.203). However, the raw packet error rate on the LTE air interface is 10%.[16] Hence, the network configures a suitable number of packet retransmissions to reduce the effective packet error rate from 10% to 0.0001%. Furthermore, the mobile device provides feedback on the prevailing downlink radio channel conditions so that the network can use suitable transmission parameters (e.g., the modulation scheme, the amount of redundancy, the type of multiple antenna technique, and the number of Physical Resource Blocks) to provide a satisfactory downlink data rate and hence a satisfactory user experience. Similarly, the mobile device informs the network about the amount and type of data it has in its uplink buffers and the available transmit power. The network allocates a suitable amount of uplink radio resources based on such information and the subscriber can send the data traffic (e.g., email) within acceptable delay limits (e.g., less than 0.3 second). This tight coupling enables end users to receive email, for example, at a data rate that would be expected with very limited errors. Without this network management, the quality of service would deteriorate and be unacceptable to subscribers.

Complex interactions between the mobile device and the network and among the network components take place before the subscriber can obtain even basic wireless services. Mobile devices typically do not have pre-assigned fixed IP addresses, and, the devices cannot obtain any IP-based services such as email and web browsing without IP addresses. Hence, the network *must* allocate an IP address to the mobile device. To provide security over the wireless interface, the network and the device first perform mutual authentication and then locally generate security keys. For example, LTE can secure the wireless interface by encrypting user traffic. The network also sets up several logical connections called Evolved Packet System bearers that help carry user traffic such as email and streaming video. The network

[13] Such tight coupling is exemplified by packet retransmissions occurring between the user device and the radio network to provide essentially error-free information to the applications such as e-mail and web browsing.
[14] An example of such interaction is the invocation of a Domain Name System (DNS) server by the user device so that the name of a web site (e.g., www.cnn.com) can be translated into an IP address of the server that is in charge of the web site.
[15] An example of such custom processing include fast packet forwarding of delay-sensitive traffic by an IP router and delayed packet forwarding of delay-tolerant traffic by an IP router. The operator's network utilizes multiple IP routers within the network (e.g., between the Serving Gateway and the Packet Data Network Gateway in the LTE network).
[16] The LTE air interface uses the instantaneous target block error rate (BLER) of 10% to improve efficiency of precious radio resources. A suitable combination of the modulation scheme and Turbo coding is used to meet such target BLER for a given radio channel condition.

nodes interact among themselves and the network interacts with the mobile device so that the bearers can be set up. Selected information about the mobile device is stored at different nodes so that packets can reach the correct user via the bearers. Without all these integrated actions, the user would not be able to obtain the Internet services expected (i.e., would not be able to access the desired web site). The wireless provider must manage these complex interactions to provide the seamless experience expected by consumers.

Service-specific custom processing is carried out at different network nodes. Depending upon the policies of the service provider, different types of IP addresses could be allocated to the mobile device for different packet data networks. For example, for the packet data network of the Internet, an IPv4 address could be allocated to the mobile device because of prevalence of IPv4 addresses. In contrast, for IMS-based applications, an IPv6 address could be allocated to the mobile device to benefit from the abundance of IPv6 addresses. Quality of Service (QoS) in an IP network can be provided by an Integrated Services or Differentiated Services framework. The network node provides different QoS to different services to meet the service requirements and user expectations. When a Differentiated Services framework is used, Differentiated Services Code Point (DSCP) is used to mark each IP packet. IP routers use correct packet forwarding treatment to an incoming IP packet. For example, assume that two IP packets arrive at a Packet Data Network Gateway: a delay-sensitive IP packet carrying a streaming video and a delay-tolerant IP packet carrying email. The delay-sensitive IP packet carrying a streaming video can be marked with the DSCP value of 30 and the delay-tolerant IP packet can be marked with the DSCP value of 0. In case of heavy traffic, the IP routers between the Packet Data Network Gateway and the Serving Gateway would quickly forward the delay-sensitive packets (i.e., video streaming packets) and would delay the forwarding of the delay-tolerant packets (i.e., email packets). The IMS and the PCC network nodes also work with one another such that the bearers can help meet different QoS requirements for different services. This in turn allows the wireless provider to ensure that subscribers that are not affected adversely by latency to be delayed, while those applications that are latency sensitive are not delayed. For example, video streaming would not be delayed so that playback is acceptable for a subscriber, while email packets could be marginally delayed but consumers would not be affected by this delay. This network management allows the provider to manage the scarce spectrum resources in an efficient, effective manner, without degrading the subscriber experience.

Close cooperation between the mobile device and the network is needed for cohesive and seamless integrated service experience for the wireless subscriber.

Examples of Integrated Wireless Broadband Services

The tight integration needed to provide wireless broadband services is demonstrated below by how a consumer obtains two services, web browsing and video conferencing. For both of these cases, the mobile device and the broadband network must work together to provide a seamless and integrated service experience for the consumer. Before any services are rendered to the consumer, the mobile device synchronizes with the radio network and performs an attach operation with the network. As part of the attach operation, mutual authentication occurs, and security between the mobile device and the network is established. Furthermore, two default bearers are established, one for the Internet packet data network and one for the IMS Packet Data Network. The Packet Data Network Gateway allocates to the mobile device an IP address for the Internet Packet Data Network and a separate IP address for the IMS Packet Data Network. Additionally, IP addresses of the DNS server and the IMS server are conveyed

to the mobile device. When the consumer initiates video conferencing, additional bearers[17] are established to carry voice and video through numerous interactions among the mobile device, the radio network, the core network, the IMS network and the PCC network. Now that all the groundwork for data traffic has been completed, the IP packets for the email and video conferencing packets start flowing through the network and the consumer reaps the benefits of all the hard work that the mobile device and network nodes have been doing.

Web Browsing on Mobile Broadband Networks

Let's summarize the *major steps involved when the consumer is browsing the web* as illustrated in Figure 6.[18]

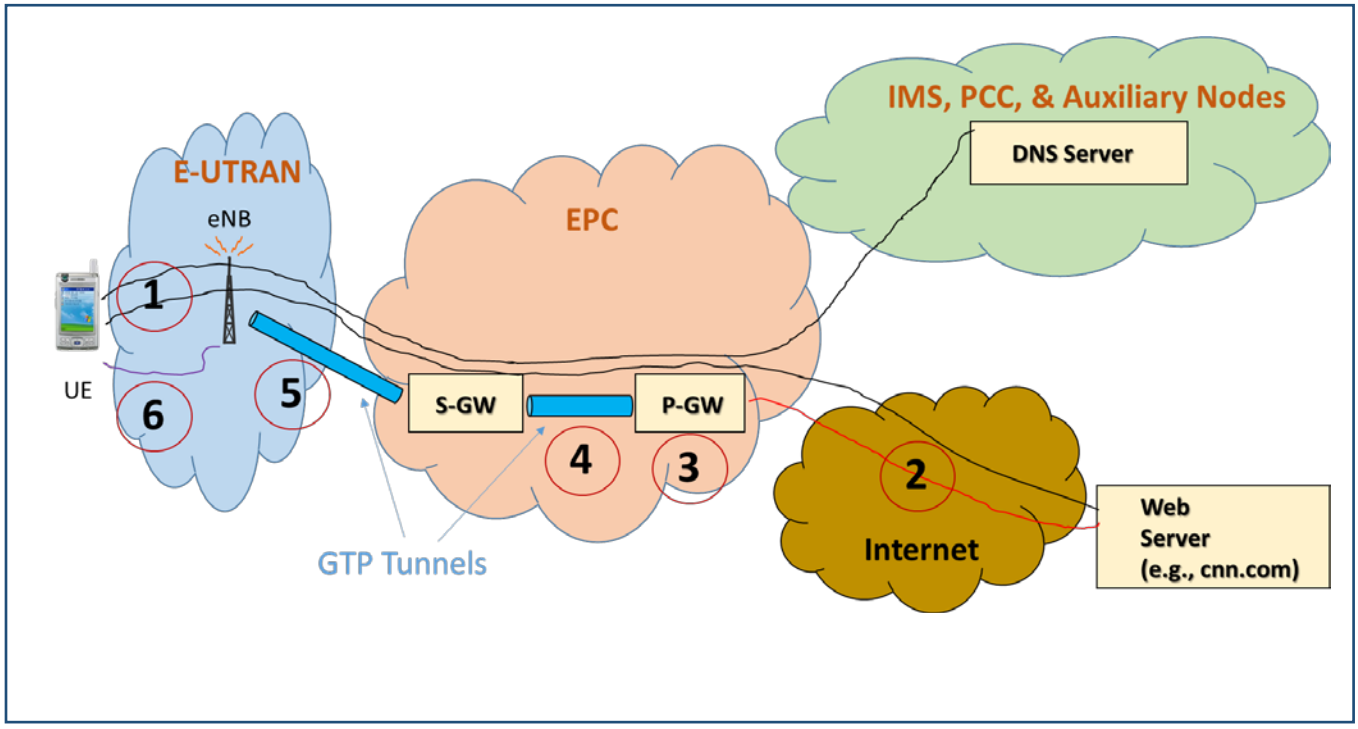

Figure 6. Major Communication Steps for Web Browsing

When the consumer selects www.cnn.com as the web site for browsing in Step 1, the mobile device communicates with the DNS server to find the IP address of the web server in charge of www.cnn.com and then communicates with the web server to set up an end-to-end connection with the web server. In Step 2, the web page from the web server passes through the IP routers of the Internet and arrives at the Packet Data Network Gateway. The Packet Data Network performs translation between the public IP address and the private IP address (if needed) in Step 3. In Step 4, the Packet Data Network

[17] LTE controls QoS at the levels of the EPS bearers. Hence, two bearers are required for two services that need two different QoS levels.

[18] The simplified description here represents one possible approach for providing web browsing and video conferencing services. The LTE standard is quite flexible and operators can choose a variation of the approach described here to offer services to the user. In the interest of simplicity, only selected nodes and connections are shown in the figure.

determines the correct bearer for the incoming IP packet containing the web page and places the IP packet inside a tunnel (representing part of the bearer) toward the Serving Gateway using a protocol called GTP.[19] The Serving Gateway extracts the IP packet and places it inside another tunnel toward the eNodeB using GTP protocol in Step 5. The eNodeB uses several protocols of the air interface protocol stack to format the original IP packet for air interface delivery (including encryption for security) in Step 6 and then transmits the web page packet over the air to the mobile device. In Step 7, the mobile device also uses the protocols of the air interface protocol stack to extract the original IP packet from the air interface (including decryption) and then presents the web page to the consumer. *As is evident from these steps, the mobile broadband network nodes and the mobile device work closely together to present web browsing to the consumer as an integrated information service*.

Video Conferencing on Mobile Broadband Networks

Figure 7 summarizes the main steps involved when the consumer is participating in video conferencing [Radisys_October2012] [Ericsson_ Feb2012].

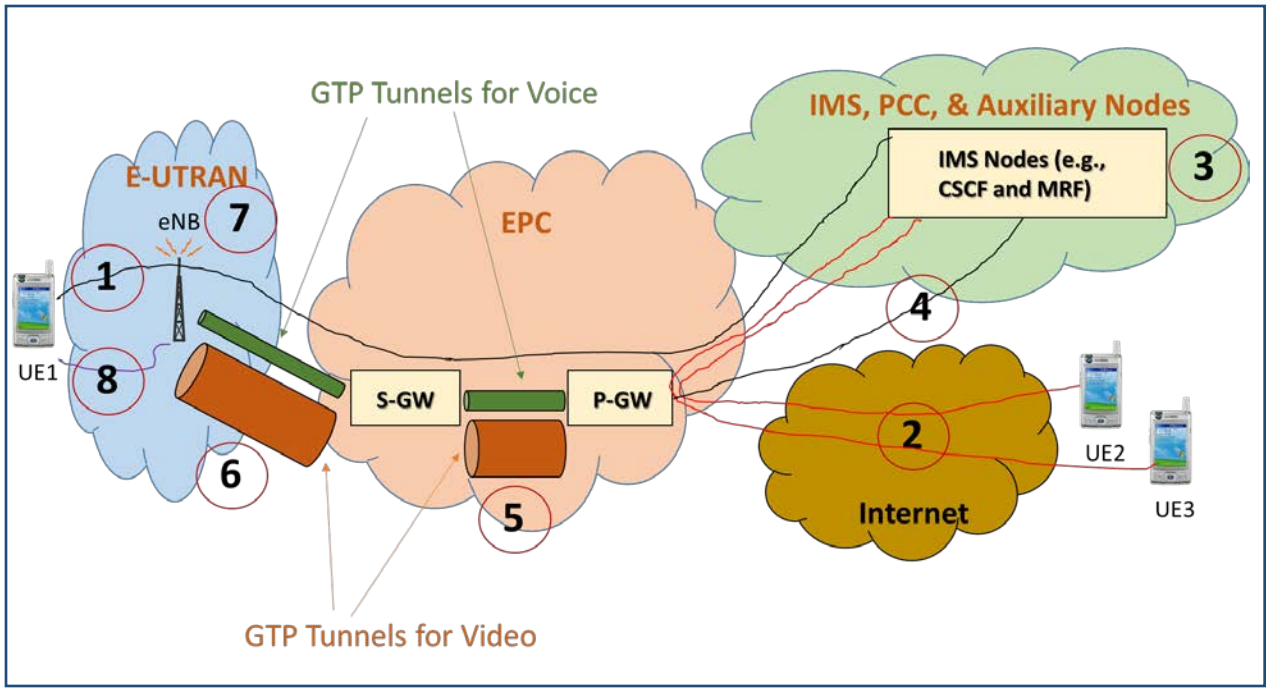

Figure 7. Major Communication Steps for Video Conferencing

[19] GTP stands for GPRS Tunneling Protocol, where GPRS is General Packet Radio Service. GTP enables LTE to support IP mobility, where the user can move from one geographic location to another while maintaining the same IP address. IP mobility is one of key elements of a mobile broadband service.

When the consumer chooses a video conferencing application in Step 1, the mobile device 1 communicates with the IMS network to create communication paths among the participating devices. In Step 2, the voice and video media from other devices such as mobile device 2 and mobile device 3 arrive at the Media Resource Function in the IMS network. The Media Resource Function properly mixes the voice and video media streams (and performs media codec conversion if needed) in Step 3. In Step 4, the Media Resource Function sends the IP packets containing voice and video to the Packet Data Network Gateway. The Packet Data Network Gateway in Step 5 determines the correct bearers for the incoming IP packets, places the voice packets inside one tunnel toward the Serving Gateway using GTP, and places the video packets inside another tunnel toward the Serving Gateway using GTP. The Serving Gateway extracts the IP packets and places them inside other tunnels toward the eNodeB using GTP in Step 6. The eNodeB uses several protocols of the air interface protocol stack to format the original voice and video IP packets for air interface delivery in Step 7 and then sends these IP packets over the air to the mobile device in Step 8. In Step 9, the mobile device 1 uses the help of the air interface protocols to extract the original voice and video packets from the air interface and then plays voice and video to the consumer in the video conferencing application. *As is evident from these main steps, the mobile broadband network nodes and the mobile device work very closely together to offer video conferencing to the consumer as an integrated information service*.

See Appendix I for a more detailed discussion of how the mobile broadband network provides an integrated information service to subscribers.

6. Recommendations

Mobile wireless broadband networks face unique challenges such as the scarcity of spectrum and other radio resources, dynamic radio environment, varied and changing technologies for devices, base stations, and networks, differentiated and evolving services and applications, and exponentially-rising data traffic. Based on the in-depth analysis of the modern mobile wireless networks, we respectfully recommend the following to the FCC.

- ✓ Mobile wireless broadband networks must be treated differently from other communications networks such as fixed wireless networks and wireline networks.
- ✓ Aim for minimal regulations for mobile wireless networks to promote innovations and thereby facilitate achieving the ultimate goals of superior network and spectral efficiency and excellent user experience.
- ✓ Give maximum flexibility to the design and optimization of complex and distributed wireless network management so that the networks operate with maximum possible efficiency under the constraint of limited spectrum.
- ✓ Refrain from establishing any minimum performance standards, because these standards are simply impractical to define or enforce in mobile wireless networks.
- ✓ Ensure that proprietary and competitive management processes are respected and encouraged to motivate continuing innovation and differentiation.

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Appendix I

A Closer Look at the Mobile Broadband Internet Access Service

as an Integrated Information Service

Let's dive into the details of how the mobile broadband network provides an integrated information service to the subscriber.[20] Consider Figure 8, where the wireless subscriber is using an LTE network for three simultaneous services- web browsing, email, and video conferencing.[21]

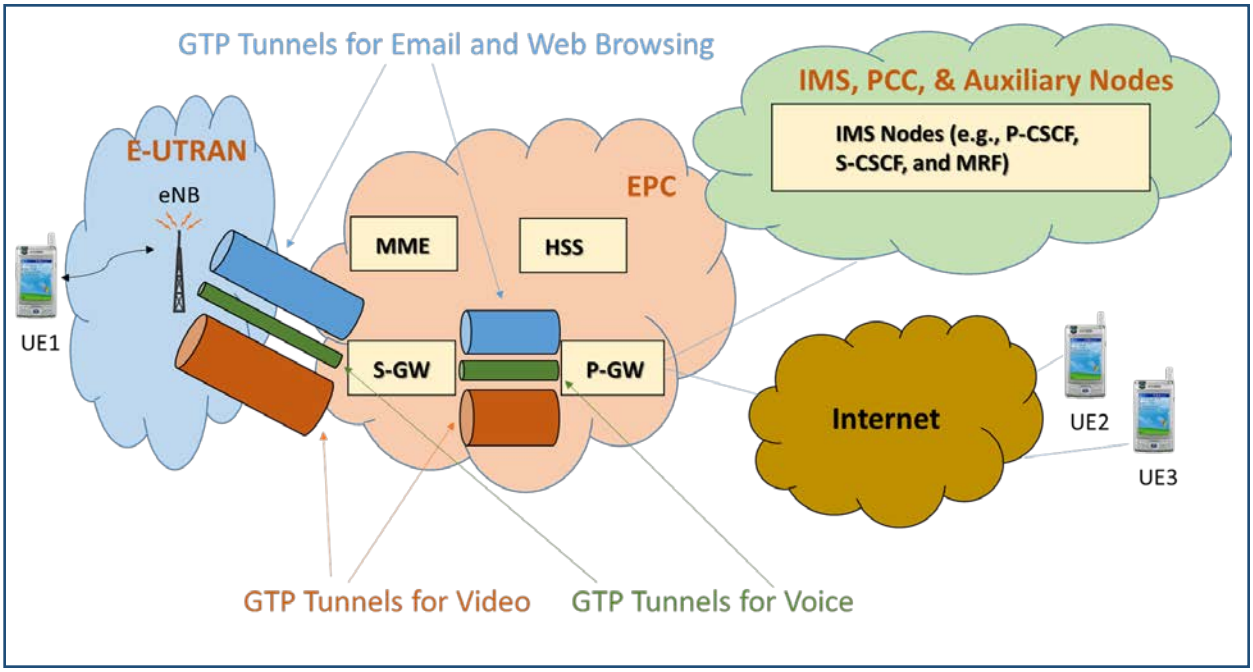

Figure 8. Integrated Information Service Offered by the Mobile Broadband Network

Different network nodes process different aspects of signaling and/or traffic. The following steps are executed to provide the integrated information service to the wireless subscriber: (I) initial attach and default EPS bearer setup toward the IMS network, (II) default EPS bearer setup toward the Internet, (III) dedicated EPS bearer setup toward the IMS network, and (IV) data transfer. Let's take a closer look at these steps below. *These steps show that complex interactions and node-specific custom processing are instrumental in providing an integrated information service experience to the wireless subscriber*.

Initial Attach and Setting up of the Default EPS Bearer Setup toward the IMS Network

As summarized in Section 2.2, the UE carries out the initial attach procedure upon power-up. The UE synchronizes with the eNB and establishes an RRC (Radio Resource Control) signaling connection with a cell. This RRC connection helps the UE and the eNB exchange signaling messages such as the messages

[20] The description given here is one possible implementation. The LTE standard is quite flexible and the operator can choose a variation of the approach

[21] This figure is based on the information given in [Ericsson_February2012] and [Radisys_October2012].

related to handover and EPS bearer setup. The UE and the MME perform mutual authentication. The HSS helps the MME in the authentication process. The signaling connection between the UE and the MME is a NAS (Non-Access Stratum) connection, which can be used for messages such as EPS bearer setup messages. Security is activated for the RRC connection and the NAS connection. The responsibility of securing the air interface between the UE and the eNB lies with the UE and the eNB. The responsibility of securing the NAS signaling connection between the UE and the MME lies with the UE and the MME. The service provider determines which packet data network should be used as the default packet data network. In Figure 6, the Internet and the IMS network are potential candidates as the default network. In our scenario, the network establishes a default EPS bearer with QCI = 5 (which is recommended by the 3GPP [3GPP_TS23.203]) that has the highest priority among the QCIs. During the default EPS bearer setup, the P-GW allocates an IP address to the UE, and, this address is conveyed to the UE by the MME. The MME also conveys to the UE IP addresses of the P-CSCF (Proxy- Call Session Control Function) and the Domain Name System (DNS) server. The P-CSCF is the first point of contact of the UE with the IMS network and performs various functions such as compression of SIP signaling messages and interactions with the PCC to provide end-to-end QoS for IMS-based services. The DNS server is used by the UE to resolve the website names to the IP addresses so that the UE can exchange IP packets with websites. The default EPS bearer toward the IMS network helps the UE and the network exchange SIP signaling messages.

Setting up of the Default EPS Bearer Setup toward the Internet

After the default EPS bearer with the default packet data network (e.g., the IMS network in our scenario) is set up, a different default EPS bearer with QCI-8 or 9 toward the Internet is established. The P-GW allocates an IP address to the UE for the Internet access. This default EPS bearer helps carry traffic corresponding to applications such as email and web browsing.

Setting up of the Dedicated EPS Bearers toward the IMS Network

As discussed earlier in Section 3, LTE controls the QoS at the level of EPS bearer. Although a default EPS bearer toward the IMS network has already been established, the QoS of this EPS bearer is inadequate to carry voice and video traffic. The QCI = 5 EPS bearer is a non-GBR bearer, while the voice and video need data rate guarantees for satisfactory user experience. When a user initiates video conferencing, SIP signaling messages are exchanged between the UE and the IMS network. The P-CSCF observes such signaling messages and conveys the information about the QoS requirements of the call to the Policy and Charging Rules Function (PCRF). The PCRF consults Subscription Profile Repository to check if the QoS requested by the video conferencing application can be accepted. The PCRF translates the generic QoS description extracted from SIP signaling messages into the LTE-specific QoS parameters (e.g., a numerical values for QCI and determination of the GBR) and conveys the LTE-specific QoS to the Policy and Charging Function (PCEF). According to 3GPP, P-GW acts as the PCEF. The P-GW initiates the setup of (i) the dedicated EPS bearer that can carry the voice traffic with suitable QoS and (ii) the dedicated EPS bearer that can carry the video traffic with suitable QoS. The S-GW conveys the dedicated EPS bearer requests to the MME. The MME works with the eNB and the S-GW to set up network resources for the new dedicated EPS bearers. The eNB accepts the dedicated EPS bearer requests if it has adequate radio resources to support the QoS required for the video conferencing service.

The IMS network, and in particular, the Media Resource Function (MRF) plays an important role in supporting the video conferencing service. The MRF consists of the signaling entity called Media Resource Function Controller (MRFC) and the user traffic entity called Media Resource Function Processor (MRFP). The MRFC works with other IMS entities and facilitates the establishment of communication paths among the devices that are participants of video conferencing. The MRFP is responsible for mixing voice streams and video streams so that the mobile device can receive audio and video from all other participants.

Data Transfer

Consider the web browsing service. When the subscriber enters the website name in the browser (e.g., Internet Explorer or Chrome), the mobile device contacts the DNS server to receive the IP address of the website. The mobile device and the web server can now exchange IP traffic such as web pages and acknowledgements to the received IP packets. The IP packets containing the web page from the web server pass through the Internet routers and arrive at the P-GW that gave the UE the IP address associated with the Internet. In case a private IP address had been assigned to the UE, the P-GW translates the public IP address into a private IP address for the journey of the IP packet within the operator's LTE network. The P-GW places the IP packet on the GTP tunnel (associated with the default EPS bearer for the Internet) toward the S-GW. The S-GW removes the IP packet from the P-GW side of the GTP tunnel and places the IP packet on the GTP tunnel toward the eNodeB. The eNodeB extracts the IP packet and passes it through these protocols of the air interface protocol stack so that IP packet is in the format that can survive the hostile and dynamic radio environment- Packet Data Convergence Protocol,[22] Radio Link Control,[23] Medium Access Control,[24] and Physical Layer.[25] The eNodeB then transmits the formatted IP packet over the air. The mobile device acquires the formatted IP packet from the air interface and recovers the original IP packet by using the air interface protocols. Finally, the IP packet is made available to the web browser that displays the actual content to the subscriber.

Let's focus on the video streaming service now. After the video conferencing service has been initiated and the IMS network has helped establish communication paths among the participants, the voice and video traffic can start flowing. Voice and video streams from the participants of the video conferencing arrive at the MRF. The MRF mixes the audio and video streams of the participants and sends the IP packets carrying voice and video to the P-GW. The P-GW has two dedicated bearers with the UE in support of video conferencing, one for voice traffic and one for video traffic. The IP packets containing voice are placed onto the tunnel associated with the voice traffic and the IP packets containing the video are placed onto the tunnel associated with the video traffic. Once the S-GW retrieves the IP packets from the P-GW side of the tunnels, it removes the IP packets from the P-GW side of the GTP tunnels and places the IP packets on the GTP tunnels toward the eNodeB. The eNodeB extracts the IP packets and passes them through the layers of the air interface protocol stack mentioned above. The eNodeB then transmits the formatted IP packets over the air. The mobile device retrieves the formatted IP packets from the air interface and recovers the original IP packets carrying voice and video by using the air

[22] Example functions of Packet Data Convergence Protocol are encryption and header compression.
[23] Example functions of Radio Link Control are in-sequence delivery of packets and retransmissions of erroneous packets.
[24] Example functions of Medium Access Control are scheduling and management of radio resources and control of physical layer retransmissions.
[25] Physical Layer takes care of functions such as modulation, coding, power control, and multiple access.

interface protocols. Finally, the IP packets are sent to the video conferencing application that plays the voice and video content for the subscriber.

The transport network that carries the traffic between eNB and the S-GW and between S-GW and the P-GW also needs to provide different QoS treatments to best-effort traffic such as email and web browsing and delay-sensitive traffic such as voice and video packets. The mechanism such as Differentiated Services (DiffServ) is widely used for QoS in an IP network. DiffServ involves marking of the IP packet by a code called DiffServ Code Point (DSCP). Different values of DSCP are defined for different services so that the IP router that forwards the IP packet containing a given service (e.g., email, web page, voice, or video) toward the destination gives a suitable priority to the incoming IP packet. For example, DSCP=0 means that the service is a delay-tolerant and the IP router could let this IP packet wait in the buffer for some time when it is busy with IP packets carrying other higher priority services. In contrast, DSCP=30 means that the IP packet is carrying a video streaming packet and hence warrants faster packet forwarding from the IP router.

As discussed in the paragraphs above, numerous and complex interactions among the mobile device, the radio network, the core network, the IMS network, and the PCC network are required so that the subscriber can access a variety of Internet access services. *Multiple services are offered to the consumer as a single integrated information service with the mobile device and the network working closely together and carrying out complex, intense, and custom processing*.

ZERORATING

Do hard rules protect or harm consumers and competition? Evidence from Chile, Netherlands and Slovenia

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INTRODUCTION

Zero rating, the practice of not charging data to a mobile broadband subscriber's contract, is emerging a potent issue in telecom policy. The zero rating of mobile subscriptions has been extant for almost two decades with SMS, MMS, Blackberry Messenger, and WAP services[1] and with smartphone subscriptions for almost a decade with little to no controversy.

Zero rating has become increasingly popular in both developed and developing countries and plays a particularly important role in developing countries, where the costs of mobile data services are higher relative to per capita incomes. About half of all mobile operators employ the strategy in some way.[2] In fact network operators have used the equivalent of such strategies to incentivize both subscribers and content providers to be part of their network for well over a century.

In the last two years, however, zero rating become a flashpoint in the net neutrality debate.[3] Whether a country allows it has become a litmus test for net neutrality supporters to certify the strength of the rules. At issue is whether operators and their customers should have the freedom to create contracts for mobile broadband service based on their preferences and constraints or whether mobile Internet service must be sold in a so-called "neutral" fashion where the only differentiating parameters are speed and megabytes. As the Internet increasingly transitions to mobile platforms, and the likelihood that the next two third of world who yet to come online will do so via mobile, who and how to provision mobile bandwidth has is an important, complex issue.

This paper examines the arguments for and against zero rating and the charges that zero rating hurts competition and consumers. It formulates 5 assertions based on the alleged harms and attempts to test them with empirical analysis from quantitative and qualitative perspectives. The paper reviews the leading database of financial information of the world's mobile operators to see whether the impact of zero rating may be observed, for example with undue financial benefits earned by operators through the use of zero rating. To understand the issue more closely, the paper reviews zero rating in Chile, Netherlands, and Slovenia, countries which have banned some forms of the practice. The paper then examines whether there is harm to consumers and innovation by reviewing a leading database of mobile application market data. The paper concludes by suggesting reasons why zero rating is maligned in telecom policy debates.

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Arguments against zero rating

A recent white paper by net neutrality advocacy organization Public Knowledge provides an overview of the arguments against zero rating.[4] It argues that zero rating violates net neutrality, the principle that all data must be treated equally, and given that zero rating is not a neutral practice, it must be banned. In its place, they assert that only "Affordable Full Access" is acceptable. They claim as well that a zero rated offer is the operator's, not users, choice, and therefore zero rating is discriminatory and wrong. They declare that zero rating limits a user's choice, and that he will only choose zero rated services. They observe that zero rating limits innovation of third party applications and services.

Their opposition to zero rating might also be understood in relation to their advocacy against data caps. Public Knowledge explains,

> Zero-rating and data caps may lead to a backslide into the world of scarcity. Data caps have been used as limitations on content usage and designed to create artificial scarcity. This type of scarcity is harmful because of its affect on a user's behavior, specifically regarding users' fear of going over their caps. Playing on users' fears of exceeding their data caps makes cap-exempt regimes more attractive which incentivizes the content providers to pay for prioritization. The potential for data cap abuse in discriminatory ways may outweigh any purported benefit.[5]

A related advocacy paper calls on the Federal Communications Commission to outlaw data caps as part of its new Open Internet Rules.[6]

Though no money changes hands in the bulk of zero rating offers, detractors are concerned about "pay to play" situations, in which they claim startups can't get Internet access, but we have not been able to find such a case. A type of zero rating is called sponsored data in which a content provider subsidizes the cost of a user's subscription. A key application for sponsored data is health care education and delivery. A health provider wants to ensure that low-income pregnant women watch a series of pre-natal videos, a preventative form of health care that improves infant and mother outcomes. Similarly the health care provider is willing to subsidize the entire mobile subscription to encourage adoption of preventative health care and monitoring tools. The cost of avoiding an adverse health event is well worth the price of a broadband. The patient benefits with better health outcome and the health care provider reduces costs.

Another concern is that zero rated programs such as Facebook's Internet.org will create parallel Internets and users will never venture outside of the social network. This situation is examined in the country case studies.

It should be noted that not all net neutrality supporters believe zero rating to be problematic,[7] however the issue appears to be a growing schism between those who favor soft and hard approaches.

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[7] Mike Godwin, "What the 'Zero Rating' Debate Reveals About Net Neutrality," *Reason.com*, April 8, 2015, http://social.reason.com/archives/2015/04/08/nothing-but-net.

Arguments in favor of zero rating

Some key assumptions in the arguments against zero rating are worth examining. At its heart, net neutrality implies a pure, ideal way in which a user connects, navigates and learns on the Internet, free from influence and intermediaries. However this notion of a neutral experience conflicts with the established theories of the sociology of knowledge[8] which posit that knowledge is mediated by social constructs. Neutrality is impossible because the Internet, like any medium, is by definition *mediated* or conveyed by intermediaries.[9] Calling a longing for a "paradise lost"[10] of a golden age of Internet neutrality that never was, net neutrality advocate Alejandro Pisanty critiques the excessive idealism of the net neutrality movement in favor of practical measures. In any case, one shortcoming of net neutrality is that it overwhelming focuses on internet service providers (ISPs) but fails to recognize the influence and non-neutral practices of global platforms, which have significant market power, users bases in the hundreds of millions (if not billions), and far high profitability and market shares than ISPs.

One proof point against neutrality is the popularity of walled gardens. Apple's hardware and software designs are part of a tightly-controlled, vertically integrated, closed product ecosystem. Apple would not exist if there was the equivalent of network neutrality for computer hardware and software. Similarly "curated" Internet experiences are demanded by users, including The J Net for conservative Jews which blocks offending content; Islamic Mobile[11] which offers zero rated mobile access to the Koran and other religious content for Muslims; broadband packages bundled with software and support tailored for the elderly in Denmark;[12] zero rated mobile plans for the World Cup,[13] and mobile plans designed for grandmothers to message with the grandchildren via WhatsApp.[14]

The assertion that all plans must be "affordable full access" assumes that users value all data equally. But many would gladly substitute "low cost limited access" without feeling any twinge of discrimination; rather they feel it is their right. Consumers increasingly demand the ability to pick and choose among the cable channels and eschew paying for the full packages; they see no difference with internet access.

For many users, selecting a provider purely on speed and price is not only difficult, it's boring. It is preferable for some users to select a plan based upon brand identity,[15] cross-marketing, cross-selling, a particular phone, features, benefits, or functionality they value. In this way, users are looking for operators who best cater to their needs, not necessarily the provider that provides the most data at the lowest price.

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[8] Karl Mannheim. *Ideology and utopia: an introduction to the sociology of knowledge*. Translated by Louis Wirth and Edward Shils. New York: Harcourt, Brace and Company; London: Kegan Paul, Trench, Trubner & Co., 1936

[9] Christopher Yoo, "Free Speech and the Myth of the Internet as an Unintermediated Experience," *George Washington Law Review, Vol. 78, Pg. 697, 2010 University of Pennsylvania, Inst for Law & Econ Research Paper No. 09-33 University of Pennsylvania Law School, Public Law Research Paper No. 09-26 TPRC 2009*, September 2009, 77.

[10] Comments by Alejandro Pisanty: "Dynamic Coalition on Network Neutrality" (The Internet Governance Forum, September 2, 2014), http://www.intgovforum.org/cms/174-igf-2014/transcripts/1923-2014-09-02-dynamic-coalition-on-network-neutrality-room7.

[11] "Free Islamic Ramadan App from Amadan Omantel," OmanTel, accessed August 5, 2015, http://www.omantel.om/Omanweblib/Individual/Mobile/islamic_mobile_app.aspx?L.

[12] NemPC or EasyComputer is a bundled service designed for the elderly in Denmark sold as a monthly subscription. It consists of a (1) software package that becomes a "skin" for computers and devices optimized for the key digital activities for the elderly in Denmark (official Danish government websites for health, home care, pension, digital signature etc) and the national banking security for financial applications, NEMID (Easy Identification); (2) 24/7 call center and online tech support; (3) a broadband connection; (4) connected computers and devices. All the items can be purchased a la carte. The service is popular and expanding to similar segments in other countries.
The packages comes with enhanced security features: "NemPC," accessed August 12, 2015, http://nempc.dk/produkter.php?page=nempc.

[13] http://www.fonearena.com/blog/131758/rcom-offers-free-access-to-twitter-during-world-cup-2015-introduces-data-recharge-offers.html

[14] http://www.hyderabadass.com/2014/02/20/my-indian-grandmother-convinced-me-to-download-an-app-that-just-sold-for-19-billion/

[15] Virginia Postrel. The Substance of Style: How the Rise of Aesthetic Value Is Remaking Commerce, Culture, and Consciousness. Harper Perennial, 2004.

For many users, their choice of phone is personal statement, and though they may buy the newest model, they use only a fraction of its functionality, perhaps only a third of its features,[16] meaning that a large data plan is not always necessary. Others may have a more standard phone, but use it like a workhorse. Offers such as the zero rated version of WhatsApp[17] by EPlus, a leading Germany MVNO, offers free WhatsApp even when the user has no balance on the account.

Some have no interest to access all internet content, even if it is free. A number of users consider the Internet a mecca for pornography, gambling, piracy, and other digital vice. Many are legitimately concerned that mandated all or nothing offers put them at risk to have their security and privacy compromised, particularly for malware that may be embedded in certain content. Such users may also buy subscriptions that block ads because they do not want to come in contact with offending tracking software, as well as to reduce data consumption from advertisements. It follows that not all broadband offers, zero rated or not, appeal to users equally. Baseball lovers might not buy a zero-rated mobile offer tailored for the football fan, but they are not necessarily worse off because those offers are in the marketplace.

There are some valuable reasons to support zero rating which include but are not limited to positive spillovers, network effects, market competition, and lower prices. Simply put, zero rating is a way to increase the number of users, which increases the value of the network. [18] There is a value to get more people on the network, whether it's through universal service, broadband subsidies, or zero rating. Proponents of corporate social responsibility may recognize zero rating as one way a company makes its product more affordable and available to disadvantaged communities. Orange describes it as one of their CSR initiatives.[19] Proponents of government subsidies may see a role for zero rating, as they know public money is not unlimited.

Eisenach observes the double benefit stimulated by zero rating is that users are both content consumers and creators (e.g. Facebook, Wikipedia, Twitter etc).[20]

Zero rating can also be a driver of competition in the marketplace and is a model most frequently used by entrant operators. As the case studies will show, zero rating is generally deployed by mobile virtual network operators (MVNOs) and resellers. As they cannot differentiate on network quality or price, they only have marketing and customer service. Zero rating becomes increasingly important for them both to establish themselves against incumbents, and perhaps to offer zero rated forms of customer service applications, similar to an 800 toll free number for support.

Zero rating is a type of price differentiation, the practice of offering the same or similar product to different segments and different prices. Network industries, such as broadband networks, have high upfront costs which are generally fixed for a large set of users. Once established, the cost of incremental output declines. It makes sense, therefore, to charge users with lower willingness to pay a discount, and thus cover the overall costs. Yet price differentiation occurs in industries with low-barriers to entry as well, which led William Baumol to conclude that competition forces firms to adopt price differentiation.[21] In many cases, firms cannot enter the market without it.[22]

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[16]Leopoldina Fortunati and Sakari Taipale. The advanced use of mobile phones in five European countries. The British Journal of Sociology Volume 65, Issue 2, pages 317–337, June 2014 http://onlinelibrary.wiley.com/doi/10.1111/1468-4446.12075/abstract

[17] "WhatsAppen Ohne Guthaben Und Ohne WLAN.," *Eplus*, accessed August 7, 2015, https://www.eplus.de/WhatsApp.

[18] Jeffrey Eisenach, "The Economics of Zero Rating," Nera Economic Consulting, (March 2015), http://www.nera.com/content/dam/nera/publications/2015/EconomicsofZeroRating.pdf.

[19] "Commited to Europe - Ensuring an Open Internet for All," *Orange*, April 2015, http://www.orange.com/en/content/download/30121/838284/version/2/file/Orange_open_internet2015.pdf.

[20] Supra

[21] Baumol, William J., "Regulation Misled by Misread Theory - Perfect Competition and Competition-Imposed Price Discrimination" (AEI-Brookings Joint Center 2005 Distinguished Lecture Presented at the American Enterprise Institute,

It is puzzling why price differentiation is so maligned for mobile broadband access and yet embraced, if not demanded, in many other areas. An eminent example is differential prices for medicines, particularly in developing countries. A recent study[23] by the British government observes,

> Adapting drug prices to the purchasing power of consumers in different geographical or socioeconomic segments could potentially be a very effective way to improve access to medicines for people living in low and middle-income countries. A well-implemented differential pricing system could also lead to increase in sales for pharmaceutical manufacturers.

Price differentiation is commonplace in ticket sales for movies, sports, and cultural events. For example discount tickets for students and the elderly are a matter of course, as are reduced prices for off-peak performance times. With regard to transportation, whether bus, plane, train, or ferry, reduced ticket prices are also offered to certain segments of the population. Additionally there are discounts for early purchase, off peak purchase, and so on. Many plan their visits to restaurants to take advantage of early bird specials, late night specials, half-priced happy hour, and so on.

Even the US Federal Trade Commission[24] recognizes that loss leader pricing strategies can be competition enhancing, the practice of selling one product at below cost to stimulate related products and services. For example, supermarkets may stock bread and milk at or below cost but earn revenue on other items. Pubs may sell low-priced food but earn a profit on alcohol. Many establishments may offer low cost entertainment but earn revenue on refreshment.

Similarly the freemium[25] model is widely practiced in digital industries. This consists of a free digital offer for software, media, games, or other service, but a charge or premium charged for special features, increased functionality, or virtual goods. LinkedIn, Amazon, online newspapers, and countless other companies offer freemiums. It is not logical that such companies should be allowed to offer for free—or zero rate[26]—certain aspects of their service to stimulate adoption and yet broadband providers cannot.

September 22, 2015), http://www.aei.org/wp-content/uploads/2014/03/-regulation-misled-by-misread-theory_105820523401.pdf.

[22] Baumol explains, "Not only will each firm be forced to adopt discriminatory prices, but each firm is likely to be forced to adopt a unique vector of prices, each of which is dictated by the market. Thus, this paper seeks to show why price discrimination may occur-and may occur frequently-not despite relative ease of entry (or other competitive pressures) but because of it. In fact, I will show that in highly competitive markets, firms may have no choice: Competition can force them to adopt the vector of profit maximizing discriminatory prices. Moreover, the second central proposition of the paper argues that, in equilibrium, these discriminatory prices are not haphazard in their welfare properties but will generally constitute a Ramsey optimum-satisfying the second-best welfare attributes of revenue constrained economic welfare. Neither conclusion means that the public interest requires all industries that employ discriminatory prices to be exempted automatically from regulation. But it does imply the converse: that such industries should not automatically be deemed appropriate objects of regulatory oversight."

[23] Prashant Yadav, "Differential Pricing for Pharmaceuticals: Review of Current Knowledge, New Findings and Ideas for Action" (MIT - Zaragoza International Logistics Program Zaragoza Logistics Center, August 2010), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/67672/diff-pcing-pharma.pdf.

[24] Federal Trade Commission and Patrick DeGraba, *Volume Discounts, Loss Leaders, and Competition for More Profitable Customers* (Pennyhill Press, 2013).

[25] Lukin, Jarid, "Jarid Lukin (@jblukin) | Twitter," November 7, 2014, https://twitter.com/jblukin.

[26] Michael Katz, comments: "Should Wireless Technologies Be Regulated Differently?," ISOC-DC TV - Live Events, (October 15, 2014), http://www.isoc-dc.org/isoc-dc-tv/.

ANALYSIS

This paper has covered arguments for and against net neutrality. This section discusses mobile operators' financial performance in specific countries and the issue of Internet traffic at exchange points and the backbone. Zero rating comprises one element of an operator's sales and marketing strategy which it uses to earn revenue. Such revenue is necessary to be viable to make network investments and upgrades. Thus the ways in which bandwidth is paid—whether by end users, content/application providers, or both—is both important and complex.

The analysis attempts to test the following assertions made by the opponents of zero rating.

1. The operator that offers zero rating will win market share.
2. The zero rated service will win market share.
3. The presence of zero rating will preclude the emergence of new applications and services.
4. Users do not go to non- zero rated content. If Facebook is free, they don't venture beyond it.
5. Operators that zero rate their own content foreclose other content.

This section provides an overview of a large financial database for mobile operators and then drills down to three countries which have specifically banned zero rating practices. Case studies are offered to describe the factors which emerged to make zero rating illegal. Thereafter a brief review of the tests of harm is offered. Finally the assertions of zero rating detractors are tested using data on mobile applications. The Merrill Lynch Bank America Wireless Matrix is a database of collected publicly available financial statements from the world's mobile operators collated and organized by country with on a set of metrics over a period of time. For some measures data is not available, so that table is blank for the particular country.

Financial Analysis

The data examined covers the period 2007 to 2013. The analysis is started in 2007, the year in which the iPhone was launched and because it marks the shift to the modern era of broadband data subscriptions sold for smartphones. We focus on Year on Year (YoY) increments and assume that user demand for digital service will drive the purchase of zero-rating contracts and interest to access sites.

It should be noted that some data, particularly for developing countries may have been collected or estimated with heterodox methods and may be inconsistent or incomplete. We note any items that we believe to be material.

The following countries were chosen because of their dynamic emerging economies, fast development of mobile services, the existence of zero-rating contracts, and in some cases, the presence of net neutrality rules. For the data set, we tried to identify per country whether zero-rating was implemented, the correlation with the year in which smartphones were introduced to the local market, and the type of tariffs available.

The block of Latin America countries (Argentina, Brazil, Chile, Colombia, Mexico, and Peru) in the study share a common geographical location and multiple similar cultures, however the history of mobile networks is quite different in each and their net neutrality policies.

Argentina is a country with one of the longest-running commercial mobile network (1989), with the use of smartphones and data contracts established around 2010-2011.

Brazil and Mexico follow with similar numbers. The other countries have been able to fast forward their assimilation to digital services in the last three of four years.

As shown in table 1, the some countries had years of continuous expansion but others such as Colombia and Peru, the saturation of the urban market has reduced expansion. Mature markets such as Brazil and Argentina are still growing, but at low rates.

For comparison a set of Africa countries were selected: Algeria, Egypt, Nigeria and South Africa. They have been chosen because of the faster development of mobile networks, adoption of mobile payments, and clear drive towards the generalized mobile technology for both private and public use.

South Africa is one of the African countries with the oldest mobile networks, followed closely by Egypt and Nigeria. The rapid adoption and success of mobile networks in Africa is well documented,[27] though it appears that hyperfast growth has slowed since 2010. Growth in subscribers remains above 10% per year.

The explosion of mobile networks in Latin America and Africa parallels a reality where a significant proportion of population still lacks basic access to food, clothing and shelter.[28]

	%	CY07	CY08	CY09	CY10	CY11	CY12	CY13
Latin America	**Argentina**	32.7%	30.2%	15.0%	20.7%	21.9%	18.9%	18.0%
	Brazil	27.3%	20.8%	9.1%	10.0%	11.9%	6.3%	1.3%
	Chile	29.4%	16.7%	-5.9%	17.1%	15.1%	10.3%	5.0%
	Colombia	22.8%	3.8%	-1.9%	7.3%	14.7%	7.5%	4.4%
	Mexico	22.3%	11.6%	3.7%	10.0%	0.4%	9.1%	-1.2%
	Peru	31.5%	22.3%	6.7%	13.7%	13.3%	10.1%	8.7%
Africa	**Algeria**	14.9%	3.3%	-1.4%	1.9%	12.5%	15.2%	3.7%
	Egypt	31.2%	30.9%	9.5%	6.8%	-1.0%	4.7%	4.5%
	Nigeria	56.4%	26.8%	21.6%	-3.5%	31.4%	6.4%	4.6%
	South Africa	16.0%	5.4%	9.5%	12.4%	4.2%	4.2%	-1.8%

Table 1: The growth of subscribers Year to Year (YoY) in the period 2007 to 2013.

One interpretation of table above is that as adoption slows, incentives such as zero rating can help get more people on the network. It might also reflect a point of diminishing marginal returns. All of those who have had the wherewithal to adopt mobile broadband to date have done so. In order to get the next tranche on board requires a stimulation to demand, either in the form of incentive (lower price, zero rating etc) and/or increase in the user's interest, skills etc. It might be observed that zero rating offers a self-reinforcing way to educate new users about the Internet; they get a free trial to do something they haven't used before. Getting new customers on the network also helps to cover costs and provide revenue for further investments.

Table 2 is a summary of the mobile network operators in the regions studied. All these companies are registered in local and international stock markets and many have strategic partnerships with telecom operators from outside the region such as Telefonica, Telecom Italia and others.

[27] GSMA. "Women&Mobile: A Global Opportunity - A Study on the Mobile Phone Gender Gap in Low and Middle Income Countries." London, UK: GSMA Development Fun -Cherie Blair Foundation for Women, 2010. http://www.gsmworld.com/images/mwomen_pr_assets/women_mobileReport.pdf.
[28] GSMA, and Deloitte. "Brazil Mobile Observatory." London: GSMA, 2012. http://www.gsma.com/spectrum/wp-content/uploads/2012/10/gsma_brazil_obs_web_09_12-1.pdf.

Country	Telecom providers
Argentina	Telecom Argentina (TI), Movistar Argentina (TEF), Movicom (BLS), Claro (AMX),NIHD
Brazil	Vivo (Telefonica), TIM Brazil (TI), Claro Brazil (AMX), Oi (PT), NIHD, Other
Chile	Movistar Chile (TEF), Entel Chile, Bellsouth (CHL), Claro Chile (AMX)
Colombia	Comcel (AMX), Movistar Colombia (TEF),Tigo Colombia (MICC)
Mexico	Telcel (AMX), Iusacell, Movistar Mexico (TEF), Unefon, NIHD
Peru	Movistar Perú (TEF), Claro Perú (AMX) ,BellSouth, Nextel
Algeria	Djezzy, Mobilis, Ooredoo
Egypt	ECMS (Mobinil), Vodafone, Etisalat Egypt
Nigeria	MTN, Airtel (Bharti), Globacom, Etisalat, Others
South Africa	Vodacom, MTN, Cell C, Telkom

Table 2: Mobile providers by country.

Although the growth is impressive in the countries selected, the use of contracts differ according to local conditions. There are many niche markets depending which sector of the population is experiencing fast economic growth.

Strategies for sales and marketing differ and impact service revenue growth. Because of the diverse economies and inflation rates, we compare the percentage of year to year expansion in the local currency. For all countries in the study, service revenue as a whole has been declining for years. This is part of a larger global trend for operators which are transitioning from a paradigm of selling voice and messaging to one of selling data.

The shift is not necessarily profitable for operators, even though the amount of data consumed by end users is generally increasing. Net neutrality advocates assert that operators should simply compete on data, but most operators face heavy price competition because of multiple providers in the marketplace. Additionally their largest source of revenue, voice and messaging, has been significantly reduced by the proliferation of free alternatives such as Skype, WhatsApp, Facebook Messenger etc. Thus net neutrality rules are a double-whammy for operators; not only are they not allowed to manage their networks with increasing data demands, they cannot make offers to cover their costs.

		CY07	CY08	CY09	CY10	CY11	CY12	CY13
Latin America	**Argentina**	32.7%	30.2%	15.0%	20.7%	21.9%	18.9%	18.0%
	Brazil	27.3%	20.8%	9.1%	10.0%	11.9%	6.3%	1.3%
	Chile	29.4%	16.7%	-5.9%	17.1%	15.1%	10.3%	5.0%
	Colombia	22.8%	3.8%	-1.9%	7.3%	14.7%	7.5%	4.4%
	Mexico	22.3%	11.6%	3.7%	10.0%	0.4%	9.1%	-1.2%
	Peru	31.5%	22.3%	6.7%	13.7%	13.3%	10.1%	8.7%
Africa	**Algeria**	14.9%	3.3%	-1.4%	1.9%	12.5%	15.2%	3.7%
	Egypt	31.2%	30.9%	9.5%	6.8%	-1.0%	4.7%	4.5%
	Nigeria	56.4%	26.8%	21.6%	-3.5%	31.4%	6.4%	4.6%
	South Africa	16.0%	5.4%	9.5%	12.4%	4.2%	4.2%	-1.8%

Table 3: Service Revenue Growth. % calculated on local currency.

Our table 4 shows a different perspective, but data is available only for a few countries. While total service revenue is declining, average revenue *per user* (ARPU) is growing. This demonstrates that users want to access to more applications and services with their mobile broadband subscription. It would seem to be the proof that assertion #4 is false, that users do not go to non- zero rated content. This chart clearly shows that subscribers

are increasingly paying for data subscriptions. However this chart does not tell us what percentage of any operator's subscriber base has been transitioned to data packages. To be sure, operators want to increase the value of any single customer, but the rate of success likely varies across operators and with the sophistication of their networks. It is also important to note that these figures are not necessarily synchronized with profitability. Though any one customer could be more profitable for an operator with a data package, it is not necessarily the case that selling data is more profitable for operators as traditional SMS or voice was before.

		CY07	CY08	CY09	CY10	CY11	CY12	CY13
Latin America	**Argentina**	18.8%	24.9%	28.9%	31.4%	36.6%	40.8%	45.8%
	Brazil	7.4%	9.2%	12.4%	15.7%	18.7%	22.5%	26.3%
	Chile	N.A	N.A	N.A	N.A	N.A	N.A	N.A
	Colombia	N.A	N.A	N.A	N.A	N.A	N.A	N.A
	Mexico	13.3%	15.9%	20.3%	24.2%	29.7%	35.0%	39.0%
	Peru	N.A	N.A	N.A	N.A	N.A	N.A	N.A
Africa	**Algeria**	N.A	N.A	N.A	N.A	N.A	N.A	N.A
	Egypt	4.6%	6.6%	8.5%	9.8%	11.0%	12.5%	13.7%
	Nigeria	3.5%	4.0%	5.0%	6.0%	7.4%	21.0%	22.7%
	South Africa	9.9%	12.8%	15.6%	19.0%	22.0%	26.4%	30.2%

Table 4: Monthly ARPU YoY Growth.

Smartphones in 2007 were extremely expensive for users of the countries in this analysis. However smartphones have significantly fallen in price (as well as used smartphones have become available), something that helps make data packages more affordable. Though some data is missing the following table, it shows the relative success that operators' have made in transitioning to selling data instead of voice and SMS. Operators in these countries still earn more than half of their revenues from voice and SMS, in many cases on 2G infrastructures. This presents a challenge and opportunity.

The challenge is meeting the expectation of the international community that operators should deploy broadband infrastructure, even though relative demand for broadband is low and the revenue to support it has yet to be earned. The opportunity is finding the business model to bridge the gap. This is where zero rating, along with other types of offers come into play.

To explain the situation, a column showing the percentage of the population using the Internet is added. Though the 2014 operator data is not available, the comparison between the 2013 percentage of data service revenues compared to the 2015 estimated internet adoption provides some indication of the opportunity for operators to sell mobile broadband to people who have yet to adopt the Internet, provided offers can made in a compelling way. In the countries below, at least a quarter, if not half, of the population has yet to come online. This population generally represents people of lower income and perhaps education, so it is of particular importance that offers be low-cost and accessible. There should not too be many contract restrictions or signup requirements (e.g. bank references etc); as such, prepaid offers are so important.[29] For those who

[29] Roslyn Layton, Role of Prepaid in Africa, Chapter in The African Mobile Story, River Publishers, 2014.

have never tried the Internet, having an incentive such as a free trial, will support adoption.

More generally the mobile broadband penetration in the developing world is 39.1 persons for every 100. This exceeds the number of people who have computers and Internet at home, roughly one third of the population of the developing world.[30]

	CY07	CY08	CY09	CY10	CY11	CY12	CY13	% Pop using Internet 2015[31]
Argentina	18.8%	24.9%	28.9%	31.4%	36.6%	40.8%	45.8%	64.70
Brazil	7.4%	9.2%	12.4%	15.7%	18.7%	22.5%	26.3%	57.60
Chile	N.A	N.A	N.A	N.A	N.A	N.A	N.A	72.35
Colombia	N.A	N.A	N.A	N.A	N.A	N.A	N.A	52.57
Mexico	13.3%	15.9%	20.3%	24.2%	29.7%	35.0%	39.0%	44.39
Peru	N.A	N.A	N.A	N.A	N.A	N.A	N.A	40.20
Algeria	N.A	N.A	N.A	N.A	N.A	N.A	N.A	18.09
Egypt	4.6%	6.6%	8.5%	9.8%	11.0%	12.5%	13.7%	31.70
Nigeria	3.5%	4.0%	5.0%	6.0%	7.4%	21.0%	22.7%	42.68
South Africa	9.9%	12.8%	15.6%	19.0%	22.0%	26.4%	30.2%	49

Table 5: Data % of service revenues

Another challenge in the provision of mobile services is that prices generally have no relation to fixed costs such as spectrum, and in some cases, operating costs such as traffic delivery. Mobile service markets are so competitive, that spectrum is generally a sunk cost. Another issue for mobile operators in developing countries is that users disproportionately request data from far away countries. This also adds to the challenge of pricing mobile broadband competitively and affordably.

Traffic analysis

An important issue that is overlooked in the discussion of zero rating is an economic analysis of the disproportionately high level of traffic generated by the top 10 mobile applications and the aggregation of traffic at exchanges and backbones. Net neutrality wants to ensure equal access to sites and services for end users, but such performance can only be achieved by keeping good provision, upgrade, and maintenance of the telecom network, which implies costs and relationships between the pricing of services and expenditure.

How traffic is aggregated and the impact the transport cost of data through backbone networks is transferred to users is not clearly understood, nor is such vital information

[30] "Core Household Indicators" (ITU World Telecommunication/ICT Indicators Database., 2015), http://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2015/CoreHouseholdIndicator.xls.
[31] Metadata for Percentage of Individuals Using the Internet," 2015, http://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2015/Individuals_Internet_2000-2014.xls.

readily available. Not having the information or mischaracterizing the situation can lead to false conclusions. Some basic trends are known however and are helpful to review.[32]

Video is a huge and growing portion of the traffic delivered to mobile devices, comprising more than two-thirds of all traffic in some countries. Significantly, just two entities, Google/YouTube and Netflix take an overwhelming share of this traffic.

Data centers are integral to the way the Internet works, not only because of the prevalence of virtualization and cloud services, but also because they provide the means to structure traffic worldwide. This puts considerable power in the hands of a few big players, including Google, Facebook, and Amazon. Akamai, Level 3, and other content delivery providers are important, as are the data centers of banks and telecom providers.

The structure of the traffic flows differ significantly from the archetypal model of the three layered internet (infrastructure, transport, service/data). Internet exchanges and private contracts for peering and transit re-draw routing worldwide. The structure today is more modular and "platformized." The idea of content/application providers passively accessing transport networks has given way to the reality of proactive approaches in which content provider develop individualized solutions and relationships for advanced, dynamic delivery and competitive differentiation. Content providers avail themselves to non-neutral pricing as a matter of course. This means that Internet service providers (ISPs), including mobile operators, simply don't have the market power that net neutrality advocates claim.

Differential treatment of traffic is the norm, and this is what content providers want when they purchase traffic delivery solutions from a range of intermediary providers.

Decisions about transit and data centers by content/applications providers have material impacts to end users. For example, people in Latin America use global (American) platforms such as Google, Facebook and Twitter to talk with people around the corner. How those platforms are provisioned locally and regionally has technical, regulatory, and geopolitical implications. For example Google built a CDN in Chile, allowing traffic to be redistributed from the Miami internet exchange. This improves the experience for its end users in Chile.

In Europe, the practical evidence shows that Europeans largely use American platforms to communicate with other Europeans. Unfortunately the Amsterdam Internet Exchange (AMIX) has not been forthcoming to allow academics to measure or test these traffic trends.[33]

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[32] Weller, Dennis, and Bill Woodcock. "Internet Traffic Exchange: Market Developments and Policy Challenges." OECD Digital Economy Papers, No. 207, OECD Publishing., 2012. http://www.internetsociety.org/doc/weller-d-and-b-woodcock-2012-internet-traffic-exchange-market-developments-and-policy-challenges.
Liebenau, Jonathan, S. Elaluf-Calderwood, and P. Karrberg. "European Internet Traffic: Problems and Prospects of Growth and Competition - White Paper." London: London School of Economics and Political Science, 2013.
Liebenau, Jonathan, S. Elaluf-Calderwood, and P. Karrberg. "Strategic Challenges for the European Telecom Sector: The Consequences of Imbalances in Internet Traffic." *Journal of Information Policy* 2 (2012): 248–72.

[33] Silvius, Stephanie. "Internet Exchange Points: A Closer Look at the Differences between Continental Europe and the Rest of the World." Amsterdam: EURO-IX, 2011.

Case studies of zero rating in Chile, Netherlands, and Slovenia

Given that the country level financial information offers limited opportunity to address the five assertions, case studies are offered to give further insight and context. Chile, Netherlands, and Slovenia are three countries with hard net neutrality laws and bans on forms of zero rating. This section explores a number of factors and dynamics related to the banning of zero rating. It generally starts with a belief amongst net neutrality advocates that regulators are not doing enough to enforce net neutrality rules. While advocates recognize that blocking and throttling either don't happen or are rare occurences, it is seen as urgent to address what they consider a growing problem, the presence of price differentiated offers in the marketplace. The net neutrality organizations make formal complaints to regulators and competition authorities with a similar argumentation: The country has a net neutrality law requiring all data to be treated equally. Ergo zero rating is a violation.

In each of the three countries, the first response of telecom regulator was that zero rating is not a violation. There seems to be a reluctance of the regulator to rule that zero rating is discriminatory, whether for a recognition of its benefits, a waste of political capital on an insignificant issue in light of more pressing priorities; or even misgiving about net neutrality itself.

Undeterred, net neutrality advocates step up the campaign against zero rating by writing blogs and enjoining sympathetic journalists to take up the story. In each of the three countries, advocates have succeeded with bans. However, the rulings decisions are flawed, according to net neutrality advocates. Bans are not uniform across all offers and providers. Many stakeholders complain that efforts made to provide more clarity end up creating more confusion. Moreover regulators find themselves in embarrassing situations in which they have to backtrack on judgements, correct earlier statements, and mediate moral decisions about why zero rating is ok for Wikipedia but not for WhatsApp.

We find as well that net neutrality advocates and organizations are closely tied to the regulatory authority and government. In one case, a net neutrality advocate rises to a position of regulatory power to implement the zero rating ban himself. Victory is declared by net neutrality advocates when operators raise or remove data caps.

Chile

In 2010 Chile was the first country in the world to make a net neutrality law.[34] The effort was an outcome of many years of lawsuits between operators and attempted telecom regulation that was ultimately found unlawful. To make rules, the country's communications laws needed to be updated to vest the proper authority within the telecom regulator, a situation currently in play in the US, as the FCC faces lawsuits for its attempt to make net neutrality rules. The situation is indicative of outdated communications laws that Congress needs to modernize. But just because net neutrality rules are in place does not necessarily mean the issue has more clarity. The Chilean case illustrates that rules can create more disputes.

Virgin Mobile launched an MVNO on Movistar network's in Chile in April 2012. Because virtual operators resell network access, they cannot differentiate on speeds or quality, so they must differentiate on marketing, customer service, and other non-network parameters. As such zero rating is an important tool for MNVOs.

Virgin Mobile Chile used a common marketing strategy employed by MNVOs: paint the established operators as dinosaurs and celebrate customers as "rock stars". "Chileans

[34] *Consagra el Principio de Neutralided en la Red Para Los Consumidores y Usuarios de Internet*, General de Telecomunicaciones Ley 18.168 (August 26, 2010), http://www.leychile.cl/Navegar?idNorma=1016570&buscar=NEUTRALIDAD+DE+RED

can now get fair flat rate calling and great Data bundles and "Anti-Plans"[35] with everything they need. And Virgin Mobile Chile throws in extra goodies like Unlimited Whatsapp when you buy data. The Rock Star customer support team has brought a new level of care to the Chile market, and customers are the most satisfied in the market," notes the operator's Chilean website.[36]

A year after launch, the company had 200,000 customers which the CEO owes to "a simple offer, without asterisks, flat rate data, convenient bags of minutes, and a call center."[37] Over three years, the company earned 1% of the Chilean market and is on track to have 400,000 customers by the end of 2015, half of which are post-paid.[38] Other explanations for its success include laws in 2012 that allow number portability and unlocking of phones.[39] Virgin Mobile has extended its concept to Mexico and Colombia and has a goal of winning 5% of the Chilean market.[40]

To be sure, with 70 percent of its customers aged 15-35, of which 70% have data plans and 85% have smartphones, WhatsApp would be one of the popular apps to include in an offer. In response to Subtel's decision to ban zero rating, the CEO explained,

> Well, certainly it had an impact because we had to revise our offer. We have not eliminated the promotion, but we had to change it. Back when you bought a package of data, we gave free Whatsapp for the 30 day duration of the package, and if a customer left without any balance, the customer could continue using WhatsApp to the end of the period. Now we continue offering this service for free, that is, that the use of data Whatsapp not count toward the package, but the moment in which the client runs out of contract data, he cannot continue using WhatsApp. That is, customers have Whatsapp free while having data package.[41]

However the CEO asserts that zero rating has less importance in light of other activities, which include its distribution strategy through the large retail chains Ripley and Falabella and wholesaling with small shops. Virgin Mobile operates its own distribution channels with kiosks in subway stations and its website. The country also adopted a framework to support MVNOs[42] and made a law to ensure number portability. The success of Virgin Mobile cannot be attributed directly to its zero rated offer.

It would be expected that net neutrality advocates would appreciate such service-based competition in the market, but no. Neutralidad Sí! in concert with CivicoONG complained to the regulator that Virgin Mobile's offer of free WhatsApp was an attack on the law of net neutrality. They asserted that Virgin Mobile is creating a disincentive to use competing messaging services such as Line and Telegram. Correspondence between Neutralidad Sí and the regulator was reviewed. The original complaint, No. 324923 posted on January 29, 2013, has been removed, [43] but the rest of the exchange remains.

In the correspondence, the regulator reiterated that the Chilean rules state that operators cannot arbitrarily block, interfere, discriminate, hinder or restrict the right of any Internet user to use, send, receive or offer any content, application, or legal service. Offers cannot arbitrarily distinguish content, applications, or service based on source or

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[35] Anti-plan was the idea of an offer that is not constrained to the traditional telecom contract, e.g. long contract life, termination fees, extra charges etc
[36] "Virgin Mobile Chile," *Virgin.com*, accessed August 5, 2015, http://www.virgin.com/company/virgin-mobile-chile.
[37] "Virgin Mobile Cuenta En Chile Con Más de 200.000 Clientes," *CIOAL The Standard IT*, April 17, 2013, http://www.cioal.com/2013/04/17/virgin-mobile-cuenta-en-su-primer-ano-en-chile-con-mas-de-200-000-clientes/.
[38] Markus Zallman, "Virgin Mobile Chile Targets 400,000 Mobile Subs by End- 2015," *MVNO Dynamics*, April 22, 2015, http://www.mvnodynamics.com/2015/04/22/virgin-mobile-chile-targets-400000-mobile-subs-end-2015/.
[39] "Virgin Mobile Chile's MVNO Signs up 36,000 Subscribers," *MVNO Dynamics*, July 24, 2012, http://www.mvnodynamics.com/2012/07/24/virgin-mobile-chiles-mvno-signs-up-36000-subscribers/.
[40] Leticia Pautasio, "'Queremos Alcanzar 300.000 Clientes Al Cierre de 2014,'" *Telesemana*, April 13, 2014, http://www.telesemana.com/blog/2014/08/13/queremos-alcanzar-300-000-clientes-al-cierre-de-2014/.
[41] Ibid
[42] Ibid
[43] Civico ONG, "Denuncia Por 'Whatsapp Gratis' En SUBTEL," Storify, accessed August 5, 2015, http://storify.com/ongCivico/denuncia-por-whatsapp-gratis-en-subtel.

owner. The legislation still allows operators to manage traffic within a set of constraints, provided that the actions do not impact competition. The purpose of the law is to ensure that services, applications, and content are offered without discrimination to the time the user access is allowed without arbitrary restrictions and that access be provided in a competitive way.

The offer by Virgin Mobile and WhatsApp did not prevent access to other applications, according to the regulator. It only releases metering for the one application for the period of the offer, and therefore does not constitute a breach of net neutrality. The user can also access the application even when he has no balance.

Neutralidad Sí! responds the same day. They extrapolate that it will lead to situations in which users are coerced with rebates and discounts to use "search engine X" or "video provider Y". Secondly they object to the idea that "traffic management and network management" do not harm competition. They note that if access to WhatsApp is free then it effectively harms other competitors because to access to them must be paid.

The regulator replies that it has revisited the net neutrality law and reiterates the points. As for the threat described, that an operator is favoring one application over another, this is not case because the offer is not restricting the right of users to access the Internet, which is the point of the law.

Neutralidad Sí! responds with a reference to Article 19 of the Civil Code: "When the meaning of the law is clear, its wording be disregarded under the pretext of consulting its spirit." They reiterate the words "discriminate" and "offer" that exist in the net neutrality law and the Royal Academy of the Spanish language definition of discrimination being "select excluding". They suggest that if other services receive the same treatment as WhatsApp, the arbitrary nature of the discrimination will be eliminated.

The complaint was brought to the Secretariat of the Regulator and then closed with the explanation that the regulator had provided an adequate explanation. The Neutralidad Sí! blog says that the regulator's response was "awkward" and did not rule on the merits.

It appears that the issue gets no further attention until a new chair comes to the telecom regulator. Pedro Huichalaf, former head of related net neutrality advocacy organization ONGMeta, took office in March 2014.[44] The ban on zero rating of selected social media sites is pronounced illegal the following month.[45]

The official decision notes that companies are not punished for offering zero rating, but are invited to end the practice, or to provide the benefits to all traffic of the same class. Some confusion emerged once the decision was released as to nature of the word "arbitrary", whether traffic is treated an an "arbitrary" or deliberate way. At the time of the ruling, Wikipedia Zero was not yet available, but the rule obstensibly outlawed it. Wikipedia noted the Chilean decision is "example of when net neutrality — which is an important principle for the free and open internet — is poorly implemented to prevent free dissemination of knowledge."[46] The regulator then needed to relent and allow Wikipedia to be an exclusive zero rated service, noting that there is a clear difference between Wikipedia Zero and unlimited social messaging. [47] Neutralidad Sí called the exception for Wikipedia, the "last unicorn of the 'good Internet'", a double standard.

Neutralidad Sí appears to be dissatisfied because the regulator while pronouncing the practice illegal, does not do enough to prosecute or punish telecom providers for the

[44] "Renuncia de Pedro Huichalaf Por Nominación Como Subsecretario de Telecomunicaciones," *ONG META*, accessed August 5, 2015, http://ongmeta.cl/renuncia-de-pedro-huichalaf-por-nominacion-como-subsecretario/.
[45] *Zero Rating of Such Social Media as Pronounced Illegal*, 2014, http://www.subtel.gob.cl/transparencia/Perfiles/Transparencia20285/Normativas/Oficios/14oc_0040.pdf.
[46] Yana Welinder, "[Wikimedia Announcements] [PRESS RELEASE] Airtel Offers Nigerians Free Access to Wikipedia," June 1, 2014, https://lists.wikimedia.org/pipermail/wikimedia-l/2014-June/072336.html.
[47] http://www.vpschile.cl/servidor-virtual/3821/1/internet/wikipedia-zero-avanza-en-chile.html

practice. The organization says that the situation is contradictory and calls on the regulator to clarify. The comments under the blog blame Neutralidad Sí for making the zero rating complaint in in the first place. The commenter notes that the ban hurts poor people who can't communicate with their family through WhatsApp. Another comment refers to the slippery slope of ill-defined rules such as the ban on zero rating, what may be legal today will not be tomorrow and vice versa. Additionally he faults the organization for not recognizing how internet companies (Facebook) take advantage of users' information with free services. Another commenter criticizes the net neutrality rhetoric of "free Internet" because technically a zero rated offer is free access.

Earlier heads of the Chilean regulator criticized the ruling. On Twitter, one called it "populist idiocy from a small group of activists. A new form of regulatory capture."[48] Another penned an opinion piece in the leading newspaper titled "positively discriminatory, but not arbitrary, in favor of the poor."[49]

To put the issue into perspective, we reviewed official materials of the Chilean telecom regulator. Along with the consumer authority, it publishes an annual report of complaints related to telecommunications. The report[50] for 2012-2013 is telling in what consumers complain about; which companies; and how complaints are resolved. Specifically we were interested to see whether consumers complained to the regulator that zero rating is harmful.

Complaints about mobile communications make up about half of all the complaints in the country for the period. About 2 of every 200 mobile subscribers complain. For mobile communications, the single largest set of complaints is about phones (13%) and problems with phones connecting with networks leading to slow speeds (11%). Thereafter the bulk of complaints (56%) have to do with the contracts themselves, issues of customer care information is faulty, wrong or inadequate; disputes on charges for additional services; charges made for services not used; contract termination; term of warranty for phone; lack of accurate and timely information; and billing cycle change. In fact the largest single complaint across all telecommunications networks is incorrect charges, 27%. The report notes that complaints were resolved at least two-thirds of the time for all but one mobile operator. The report notes that total complaints declined 3.6% from 2012 to 2013.

Importantly the report does not list specific net neutrality or zero rating complaints, and if they exist, they do not to amount any more than 1.8% of complaints, the smallest category of any collected complaint. It would be expected that if zero rating was so destructive to consumer welfare and competition that it would garner at least 1.8% of complaints to the regulator. Moreover, if the zero rated version of WhatsApp was hurting competition, it would be expected that Facebook Messenger, Line, Telegraph, and other services would have complained. No evidence of this can be found on the regulator's website. The only complaint we could find was that of Neutralidad Sí!

Chilean consumers increasingly demand content that is not Chilean. It is housed in far locations and takes time to reach Chile. This can also be observed that when one is in Europe accessing a Chilean website, one may experience latency. Sandvine notes,

> In Latin American mobile networks, two companies, Facebook and Google, now control over 60% of total traffic in the region. This dominance is driven by the popularity of low cost Android smartphones in the region as well as Facebook's

[48] "Sobre Redes Sociales Gratis (with Image, Tweets) · ongCivico," *Storify*, accessed August 5, 2015, http://storify.com/ongCivico/sobre-redes-sociales-gratis.
[49] Pepe Huerta, "Redes Sociales Gratis Y La Circular de SUBTEL. ¿Donde Surgió El Problema?," *Neutralidad Si*, June 2, 2014, http://www.neutralidadsi.org/2014/06/02/redes-sociales-gratis-y-la-circular-de-subtel-donde-surgio-el-problema/.
[50] "Servicio Nacional Del Consumidor | SERNAC Y SUBTEL Dan a Conocer Ranking de Reclamos En El Mercado de Telecomunicaciones," Sernac, (January 24, 2014), http://www.sernac.cl/sernac-y-subtel-dan-a-conocer-ranking-de-reclamos-en-el-mercado-de-las-telecomunicaciones/.

> decision to embrace social networking and messaging through their acquisitions of Instagram and WhatsApp. With such concentration, corporate decisions by these major players, like Facebook's decision to auto-play videos uploaded to its site, can instantly and dramatically impact subscribers and network operators. [51]

The issue can be resolved with intermediaries such as content delivery services, video encoding, and content formatting. Generally content owners purchase these services to ensure the fidelity of their content, as well as to lower their operating costs (better formatting reduces storage cost and energy consumption). However it is not necessarily clear that all content owners will have a strategy for Chile, especially if they don't license their content for the country.

Given that contract complaints are a leading issue, it begs the question why the regulator does not focus more on transparency requirements. Such an approach was taken by the Swedish regulator (PTS) in 2009, establishing guidelines in 2009[52] in lieu of making a net neutrality law. In the Swedish perspective, net neutrality is about ensuring transparency in pricing, service offerings, network quality, as well as upstream and downstream capacity so that consumers are clear in what they purchase and can easily switch providers. PTS claims its consumer-centric, light-touch approach is successful and has improved operating norms so much that adopting to the EU's new solution is a step backward. [53]

In a recent presentation[54] to the Body of European Regulators for Electronic Communications (BEREC), Subtel chair Huichalaf declared that zero rating is attractive from the point of view of users. However he believes that the regulator still has a role to decide whether such offers should be allowed.

Netherlands

The Netherlands is recognized by the OECD as the world's most competitive broadband market for the number of multiple broadband facilities available.[55] On account being the world's flattest and most densely populated country, there are nearly two wired infrastructures (copper and cable) to every residence, three mobile networks (and a fourth under construction), resellers on top of the copper infrastructure; and dozens of virtual mobile providers. Fiber is available in some cities as well. It is counterintuitive that net neutrality laws should be so strict, for if ever a market existed where consumers could switch if they didn't like their provider, it is the Netherlands.

Since adopting the net neutrality law, a number of financial indicators reveal a worsening situation for Dutch telecoms, though a number of trends were already in play well before the law, including declining voice revenue and service revenue growth. The Netherlands is a saturated market in both fixed and mobile. Growth of subscribers is flat in fixed. In mobile, it has been declining since 2011 when it had a high of 105% and has fallen below 100%. There are no new customers for operators; the only possibility is to poach each other's customers. Frequently this can mean a race to the bottom. The monthly churn rate for the industry is 2.5%, relatively high for a postpaid market. This indicates that customers can and do change providers.

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[51] "Sandvine - Global Internet Phenomena - Latin American Report May 2015," Sandvine, (May 2015), https://www.sandvine.com/trends/global-internet-phenomena/.
[52] Post-och Telestyrelsen (PTS), "Nätneutralitet", http://www.pts.se/sv/Bransch/Internet/Oppenhet-till-internet/
[53] ETNO, "Ola Bergström, Director at Swedish Post and Telecom Authority - PTS, Gives an Interview at ETNO-MLex Summit 2014," viEUws, July 7, 2014, www.vieuws.eu/etno/etno-etno-mlex-summit-2014-interview-with-ola-bergstrom-director-for-international-affairs-swedish-post-and-telecom-authority-pts/
[54] Pedro Huichalaf, "Neutralidad de La Red: Explorando El Impacto En REGULATEL," *Gobierno de Chile*, July 2015, http://berec.europa.eu/files/doc/4.%20PPT-%20CHILE%20-%20REGULATEL%20-%20BCN.pdf
[55] See section 3 on Coverage and Geography. "OECD Broadband Portal," July 23, 2015, http://www.oecd.org/sti/broadband/oecdbroadbandportal.htm.

Nevertheless financial results reveal that costs are managed prudently. To maintain profitability in a strict regulatory environment where new business models are not allowed, the only recourse is to lay off workers. In 2014, KPN laid off 2000 in the consumer branch and another 500 in the corporate.[56] This follows other cuts in recent years across the industry.

Net neutrality advocacy organization Bits of Freedom has been instrumental to bring attention to net neutrality.[57] Though they had conducted campaigns for a number of years on the topic, they found little interest with the general public. However a statement from a KPN executive, suggesting that the company would charge users to access WhatsApp, catapulted Bits of Freedom (BoF)'s efforts to center stage. In addition to viral take-up of the issue in the media, the stakeholders BoF had cultivated, including key parliamentary sponsors, allowed the organization, in just two months, to push through the legislation it had created. There was no hearing of mobile operators or investigation of traffic management. The Law was promulgated in 2012 and came into force the following year.

The Dutch Parliament had been revising its Telecommunication Act during this period, and BoF found support among a number of Parliamentarians It also provided the lawmakers with a proposed text for the law[58] as well as position papers developed under the support of the Council of Europe (an agency empowered to protect human rights) to support the legislation.[59] Encouraging Dutch innovation in internet services and applications was a reason given to support net neutrality.

From the operators' side, the uptake of the free SMS applications in lieu of proprietary services materially affected revenue. KPN, for one, was not prepared for the shift. For the first time in many quarters, the company issued a profit warning.

In its quarterly announcement, it noted a large drop in SMS revenue in Q1 of 2011 and lowered EBITA projections by €200 million euros from the prior year. KPN also noted that to lower costs, it would lay off 25% of its Dutch workforce, about 4000-5000 employees.[60] Before making the suggestion of charging for WhatsApp, KPN obtained permission from the Dutch telecom regulator OPTA.[61] The regulator approved the offer and noted, "This means more choice for consumers, which allows subscriptions can take better suited to use. We therefore welcome such a development, on condition that the provider is transparent about the cost."[62]

What is frequently described as a predatory situation between operators and third party applications, might also be viewed as operators having the wrong business model in a time of change. Until 2010, data consumption on mobile devices was limited in the Netherlands, and the price reflected that users did not demand it very much. But with smartphones and emerging online services, consumers started to shift their consumption. This came at a time where the prevailing terminating regime in the caller

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[56] Janene Van Jaarsveldt, "KPN to Cut 580 Jobs," *NL Times*, December 10, 2014, http://www.nltimes.nl/2014/12/10/kpn-cut-580-jobs/.
[57] Roslyn Layton, "Net Neutrality in the Netherlands: Dutch Solution or Dutch Disease?," 24th European Regional ITS Conference, Florence 2013 (International Telecommunications Society (ITS), 2013), http://econpapers.repec.org/paper/zbwitse13/88488.htm.
[58] Matthijs van Bergen, intern at Bits of Freedom "played a consulting role in the establishment of net neutrality legislation in the Netherlands." https://www.linkedin.com/in/matthijsvanbergen
[59] "Protecting Human Rights through Network Neutrality: Furthering Internet Users' Interest, Modernising Human Rights and Safeguarding the Open Internet" (Steering Committee on Media and Information Society (CDMSI), December 3, 2013), http://www.coe.int/t/dghl/standardsetting/media/CDMSI/CDMSI(2013)Misc19_en.pdf.
[60] "2011 EBITDA Outlook Adjusted Downwards, Free Cash Flow Confirmed," KPN, (April 21, 2011), http://corporate.kpn.com/press/2011-ebitda-outlook-adjusted-downwards-free-cash-flow-confirmed.htm. Hear KPN CEO Elco Blok http://nos.nl/audio/234661-ontwikkelingen-hebben-negatieve-invloed-op-omzet.html
[61] OPTA is the Dutch Post and Telecommunications Authority, the now closed Dutch telecom regulator. It was subsumed into ACM (Consumer and Market Authority) in early 2013
[62] Arnoud Wokke, "KPN: 'Chatheffing' Voor Mobiel Internet Komt Deze Zomer," Tweakers, (April 21, 2011), http://tweakers.net/nieuws/74017/kpn-chatheffing-voor-mobiel-internet-komt-deze-zomer.html.

pays, both increased the price of voice and SMS, but also created an incentive for off-net termination.[63]

It is important to note that WhatsApp has remained in the top position as the most popular messaging app in the Netherlands for years. No operator or competitor has succeeded to impact its position.

Once the law came into effect, there were no reports of net neutrality violations for some time.[64] One view is that the law was working to deter violations. On the other hand, it be embarrassing politically if no violations occur, for it may appear that the law was made too hastily. As such, there could be political pressure to find a problem to justify the law ex post.

In January 2013 the new telecom regulator, now rationalized in the Dutch Consumer and Market Authority (ACM) commissioned a study[65] of over-the-top (OTT) services. Rather than prohibiting the development of third party applications and services, operators facilitate OTT services through their provision of mobile broadband. Increasingly consumers use these services. It also noted the declining power of mobile operators, specifically, "On sales level we see a shift from KPN to cable and a parallel of shifting market shares. Mobile data market is the engine of growth, with WiFi as a substitute for mobile or mobile data. The mobile service revenue and ARPU show a slight downward trend."[66]

Meanwhile in Brussels, the European Parliament passed a net neutrality resolution on April 3, 2014. The Alliance for Liberal Democrats for Europe (ALDE) drove its passage with Dutch Member of Parliament Marietje Schaake.[67] She celebrated the passage on the websíte of D66, the Dutch Democratic Party, noting "Conversely, Europe must also ensure that Internet and communication technologies are regulated too. More and more countries and the UN are working on laws and regulations to enhance the control of governments."[68] Though the Parliament's resolution requires the agreement of the European Commission and the Council of Ministers (head of state of the EU member nations) to become law,[69] the resolution triggered the Dutch to strengthen the interpretation of their net neutrality law, specifically to eliminate exceptions for zero rating.

The Dutch Ministry of Economic Affairs started a process to discuss how the net neutrality law should be interpreted, how strict it should be, and what to do about the practice zero rating, called "loose" or stand-alone services. A consultation was held in May 2014.[70] Among the 30 respondents was Netflix,[71] which just a few months before, signed on as

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[63] An important point to underscore for the US is that having a termination in which both sides paid reduced any incentive to block VOIP and SMS applications on smartphones.
[64] There was on complaint about T-Mobile throttling wifi on trains. ACM ruled that it is acceptable for T-Mobile to manage its networks for congestion. Peer to peer and file sharing applications create a lot of traffic and this harms other applications, especially on a train where 2G/3G service is offered. The moving trains also makes the connection difficult. Managing the traffic is acceptable in this circumstance. "Correspondentie Afsluiten onderzoek 'T-Mobile HotSpot in de trein' | ACM.nl," Correspondentie, (December 30, 2013), https://www.acm.nl/nl/publicaties/publicatie/12508/Afsluiten-onderzoek-T-Mobile-HotSpot-in-de-trein/.
"Nieuwsbericht T-Mobile mag gratis internet in NS-treinen beperken," Nieuwsbericht, (December 30, 2013), https://www.acm.nl/nl/publicaties/publicatie/12507/T-Mobile-mag-gratis-internet-in-NS-treinen-beperken/.
[65] "Onderzoek Overzicht markt voor over-the-top diensten Nederland - januari 2013 (Telecompaper) | ACM.nl," Onderzoek, (July 23, 2013), https://www.acm.nl/nl/publicaties/publicatie/11717/Overzicht-markt-voor-over-the-top-diensten---Nederland---januari-2013-Telecompaper/.
[66] Ibid
[67] Marietje Schaake, "Europees Parlement Steunt Voorstel Schaake Voor Netneutraliteit in Europese Wet," *D66*, April 3, 2014, https://d66.nl/europees-parlement-steunt-voorstel-schaake-voor-netneutraliteit-europese-wet/.
[68] "Digitale Vrijheid Prioriteit in EU-Buitenlandbeleid - Doe Mee, Word Lid!," *D66*, November 7, 2014, https://d66.nl/ep-commissie-steunt-d66-digitale-vrijheid-prioriteit-in-eu-buitenlandbeleid/.
[69] This was ultimately resolved on June 30, 2015 with rules coming into force on April 30, 2016. "Commission Welcomes Agreement to End Roaming Charges and to Guarantee an Open Internet," *European Commission*, June 30, 2015, http://europa.eu/rapid/press-release_IP-15-5265_en.htm.
[70] "Consultatie Beleidsregel netneutraliteit," consultatie, (May 2, 2014), http://www.internetconsultatie.nl/netneutraliteit.
[71] "Consultatie Beleidsregel netneutraliteit, reactie," webpagina, (May 28, 2014), http://www.internetconsultatie.nl/netneutraliteit/reactie/71331718-03d9-43be-9d87-43d2cdff1355.

the first customer in the New York office of the Amsterdam Internet Exchange[72] (The company has since moved its European headquarters to Amsterdam and plans to use the location to help grow its business in the Middle East and Africa.[73]) Netflix commended the Ministry's efforts, supported a strict policy against zero rating, noted that net neutrality stimulates innovation, and suggested a broad interpretation of net neutrality, effectively ensuring that consumers increasingly choose flat rate packages. The outcome of the consultation is strict version of net neutrality with a strict interpretation which the regulator must enforce.[74] Interestingly Netflix is zero rated in Australia as part of its partnership with fixed lined operator iiNet.[75] The company calls the introduction of Netflix to the Australian market a game changer.[76]

On June 5, 2014 in "Net neutrality the work in progress"[77] Bits of Freedom described the process conducted by the Ministry of Economic Affairs to clarify ambiguities in the Dutch net neutrality law. It criticized Facebook, Vodafone, RTL, and Endless Spotify[78], a zero rated program offered by Hi, a virtual mobile provider (owned by KPN) offering discount services focused on the youth market. The blog refers to an article[79] mentioning the Vodafone's Sizz[80] and T-Mobile's Deezer. The article includes a quotation from the Dutch regulator, calling Endless Spotify a "stand alone service", meaning that purchase of the subscription is not tied to the purchase of a data package, therefore it does not violate net neutrality.[81]

It notes that such stand-alone services are by "allowed by the letter of the law, but runs counter to the intent of the law. Positive discrimination is discrimination. The ACM sees no problem." BoF continues, "We thought about whether other Internet areas must meet the same kind of neutrality values. Some claim that 'soft neutrality' is not enough and that efforts should be made for 'hard neutrality', including peering and transit. And what about search? Or application stores? Another response to the consultation argued that the rules should also apply to the provision of IPv4 and IPv6."

For the week of September 20, 2014 BoF notes on its blog,[82] "We were visiting the ACM to discuss net neutrality and its enforcement. We began our analysis of the law in the Netherlands; very interesting in light of the upcoming European law[83] and the current debate in the US."[84]

Some two years after the Dutch net neutrality law took effect, ACM fined two operators for violations. Vodafone had only 3200 customers on its HBO Go app, was fined €200,000, and was ordered to end the offer. It is likely that the fine is more than the company earned on the service.

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[72] "Netflix Signs On To New York Open Internet Exchange," *Amsterdam Internet Exchange*, December 2, 2013, https://ams-ix.net/newsitems/124.
[73] http://www.iamsterdam.com/en/business/invest/business-news/netflix-officially-opens-european-headquarters-in-amsterdam
[74] "Besluit van de Minister van Economische Zaken van 11 mei 2015, nr. WJZ/15062267, houdende beleidsregel inzake de toepassing door de Autoriteit Consument en Markt van artikel 7.4a van de Telecommunicatiewet (Beleidsregel netneutraliteit)," officiële publicatie, *officielebekendmakingen*, (May 15, 2015), https://zoek.officielebekendmakingen.nl/stcrt-2015-13478.html.
[75] https://gigaom.com/2015/03/02/netflix-wont-count-against-iinet-broadband-caps-in-australia/
[76] http://www.iinet.net.au/about/mediacentre/releases/2015-03-03-quota-free-netflix.html
[77] Floris Kreiken, "Netneutraliteit Blijft Work-in-Progress," *Bits Og Freedom*, June 5, 2014, https://www.bof.nl/2014/06/05/netneutraliteit-blijft-work-in-progress/.
[78] "Hi Introduceert Eindeloos Spotify: Onbeperkt Muziek Streamen Op Je Mobiel Zonder Dat Dit MB's Kost," KPN, (January 6, 2014), http://corporate.kpn.com/pers/persberichten/hi-introduceert-eindeloos-spotify-onbeperkt-muziek-streamen-op-je-mobiel-zonder-dat-dit-mbs-kost.htm.
[79] Arnoud Wokke, "Hi Haalt Verbruik Spotify-App Niet Meer van Databundel Af," *Tweakers*, January 6, 2014, http://tweakers.net/nieuws/93502/hi-haalt-verbruik-spotify-app-niet-meer-van-databundel-af.html.
[80] Andreas Udo de Haes, "Vodafone En T-Mobile Schenden Netneutraliteit," *Webwereld*, June 17, 2013, http://webwereld.nl/netwerken/78147-vodafone-en-t-mobile-schenden-netneutraliteit.
[81] The price to the user is the same whether he buys the subscription from Spotify or Hi, but in the latter, the data use is not charged to the subscription.
[82] Door Tim Toornvliet, "De Week in 417 Woorden," *Bits of Freedom*, September 20, 2014, https://www.bof.nl/2014/09/20/de-week-in-417-woorden/.
[83] Link in article points to https://www.bof.nl/2014/04/03/persbericht-netneutraliteit/
[84] Link in article points to "ISPs Mislead Public, FCC About Protecting the Open Internet," *Electronic Frontier Foundation*, September 15, 2014, https://www.eff.org/press/releases/isps-mislead-public-fcc-about-protecting-open-internet.

KPN was fined €250,000 for what amounted to blocking on a free wifi network. The company admitted its mistake, a setting that had been on place its wifi networks, which it forgot to update once the net neutrality rules came into effect. About one third of the wifi traffic was at Schiphol Airport and the free service was designed as a convenience for travelers for a short and quick internet connection upon landing, for example to check messages and email. Bittorrent, FTP, SSHA, Telnet and VoIP were blocked to ensure the smooth functioning of the free service. The blocks are now removed but presumably the free basic internet service doesn't run as well. Interestingly a number of comments under the BoF blog mention that they have 4G services so wifi not important to them anyway.

In May 2015 KPN was ordered to end zero rated Spotify contracts, though the traffic generated by Spotify traffic is negligible on KPN networks. It is interesting to note that while zero rated offers of Spotify may be maligned by net neutrality advocates, for Spotify, one of only a handful of successful European startups, the partnership with telecom operators has proven important for its growth.[85] Not only can Spotify leverage an operator's billing system (avoid the cost of using its own system and give customers the benefit of not having to enter payment credentials into a new system), Spotify earns valuable paying customer. Most free users of Spotify never upgrade to the premium version, but in a telco partnership, subscribers who are already paying for a mobile subscription are more willing to take on an additional paid service because of the convenience of the bundle.

Not only is the sale of premium subscriptions essential for Spotify's survival, the revenue earned plays an important role to lessen music piracy and to help bring revenue to the music industry. Sweden's music industry was decimated by the rise of digital music on the Internet; revenues declined steadily from 2002 to 2009. With the introduction of Spotify, however, the industry has managed a 20% gain in the last three years.[86]

The Netherlands fared even worse with its traditional music industry than Sweden, but Spotify helped to reduce piracy in the country, with 29% of the 1.8 million Dutch BitTorrent pirates taking just 1 music file in 2012. The top 10% of the pirates account for half of the content obtained illegally, some 16 files each or more.[87] Passive pirates don't bother to pirate material when then can get a reliable, quality music experience for a good price.

In Sweden, digital music revenues account for almost 60% of all music industry revenue. In Netherlands the amount is just 27%, but if it could increase to the level of Sweden, ideally with more uptake of services such as Spotify, there would be an additional $124 million for the music industry and musicians. In any case, digital music sales grew by increased by 66% in the country in 2012, the highest of any country in Western Europe.[88]

While music piracy may be on the wane as a number of viable music streaming alternatives have emerged, piracy of film is going strong. Having more Spotify-like solutions for film is preferable to criminalizing pirates. And yet HBO Go, one such solution, is maligned by net neutrality advocates.

In a statement on June 1, 2015, the ACM praised the state of Dutch 4G networks and increased mobile data consumption. They note,[89]

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[85] "Adventures in the Netherlands:" (Spotify, July 17, 2013), https://press.spotify.com/dk/2013/07/17/adventures-in-netherlands/.
[86] Ibid p. 9
[87] Ibid p. 1
[88] Ibid p. 24
[89] "Investeringen uitrol 4G bijna voltooid, apps besparen op dataverbruik," Nieuwsbericht, *ACM*, (June 1, 2015), https://www.acm.nl/nl/publicaties/publicatie/14305/Investeringen-uitrol-4G-bijna-voltooid-apps-besparen-op-dataverbruik/.

> After Mobile operators' investment to roll out 4G is almost complete. After a peak of investment in 2013 of €2 billion, the investment in 2014 fell back to more than € 800 million. Henk Don, board ACM: "With the introduction of 4G has paved the way for fast internet on your smartphone. And there are many uses. The consumption of mobile data is doubled. "This is attributable to approximately 4 million consumers who are relatively common and many Internet via their phone. For example, to stream movies or music. The number of customers using 4G also doubled in a year to about 40 percent. What is evident from the Telecom Monitor is that the rapid growth of data consumption is leveling off.

The net neutrality law that was supposed to be a "silver bullet" has created new problems.[90] Instead of a flowering of local content and services, the Netherlands experiences the "Netflix effect"[91] in which a single American company consumes twenty percent of the country's bandwidth with a small subset of users. Netflix is one of the most downloaded apps in the Dutch Google Play store. Its competitor HBO Go which was ultimately impacted in the net neutrality debate is far from a threat, sitting in the long tail distribution.

As for innovation in Dutch mobile services and applications in August 2015, only two Dutch apps feature in the top 25; Marktplaats, the second hand marketplace and Buienradar for the weather. In the Google Play Store they are #12 and #13 respectively and in the Apple App Store, #18 and #19. The flowering of Dutch content and innovation has not occurred since the implementation of the country's net neutrality law.

Slovenia

Zero rating, called free data transfer in Slovenia, was a common practice among operators and existed in country since 2007. Consumers could choose from a number of zero rating programs, including free access to music, online storage, and customer service applications to manage their mobile subscriptions. The net neutrality law in Slovenia was created primarily about concerns of theoretical harms and was the culmination of more than a year of public proceedings[92], but did not include an official investigation of traffic management practices.[93] A line about price differentiation was removed in the final version of the law which was promulgated on December 31, 2012.[94] This omission appears to be a linchpin for the legal battle on zero rating going forward.

To understand the sequence of events, a personal interview[95] was conducted with Dr. Dusan Caf, a leading net neutrality advocate who has been instrumental to effecting a ban on zero rating in Slovenia.[96]

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[90] Ibid
[91] van Eijk, Nico, *The Proof of the Pudding Is in the Eating: Net Neutrality in Practice, the Dutch Example*, SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, August 2, 2014), http://papers.ssrn.com/abstract=2417933.
[92]"Posvet v Zvezi Z Osnutkom Predloga Novega Zakona O Elektronskih Komunikacijah," *Ministrstvo Za Visoko Šolstvo, Znanost in Tehnologijo*, November 10, 2011, http://www.arhiv.mvzt.gov.si/si/delovna_podrocja/informacijska_druzba/elektronske_komunikacije_in_posta/javne_obravnave_predlogi/arhiv/.
[93] "I am afraid that there wasn't any comprehensive analysis carried out (related to net neutrality) prior to the adoption of the current electronic communications law and net neutrality provisions - neither by the NRA nor the ministry," notes Dusan Caf in an email August 9, 2015.
[94] Article 203 of the Electronic Communications Act (Official Gazette of the Republic of Slovenia, Nr. 109/12, 110/13, 40/14 – ZIN-B and 54/14 – CC dec.)
[95] Telephone Interview August 7, 2015
[96] "Pripombe Na Osnutek Predlog Zakona O Elektronskih Komunikacij," *Svet ZA Elektronske Kommunikacije*, July 5, 2012, http://www.sek-rs.si/1/Aktualno/tabid/107/ID/3/Pripombe-na-osnutek-predlog-Zakona-o-elektronskih-komunikacij-ZEKom-1.aspx#.Vc4MNa1J24B.
"Pripombe Na Predlog Zakona O Elektronskih Komunikacijah (ZEKom-1) - EPA: 667 - VI > SEK," *Svet ZA Elektronske Kommunikacije*, November 18, 2012, http://www.sek-rs.si/1/Aktualno/tabid/107/ID/275/Pripombe-na-predlog-Zakona-o-elektronskih-komunikacijah-ZEKom-1--EPA-667--VI.aspx#.Vc4MnK1J24B.
"Predlog Amandmajev K Predlogu Zakona O Elektronskih Komunikacijah (ZEKom-1, Druga Obravnava, EPA 667 - VI) > SEK," *Svet ZA Elektronske Kommunikacije*, December 20, 2012, http://www.sek-rs.si/1/Aktualno/tabid/107/ID/274/Predlog-amandmajev-k-predlogu-Zakona-o-elektronskih-komunikacijah-ZEKom-1-druga-obravnava-EPA-667--VI.aspx#.Vc4M8a1J24B.

Caf holds two key positions[97] in telecommunications, one as Chair of the Electronic Communications Council (a body appointed by the National Assembly) and another as Chair of the Council of the Agency for Communications Networks and services of the Republic of Slovenia (AKOS, the telecom regulator).[98] An engineer by training, Caf has been a consultant to a number of telecom and IT companies in Slovenia, though he assures that his honorary positions are not a conflict of interest, and if they were, he would exclude himself from voting.[99]

In a blog[100] on December 9, 2013 Caf decried the state of the Slovenian telecom market 15 years after liberalization. The media is a poor observer, and the debate as lacking depth, he wrote. "Professional analysis" is needed to explain the gap, and "Captured regulators" are the root of the problem, he declared. To address these problems, he proposed increasing the transparency of the regulatory process, strengthening the efficiency and effectiveness of regulation, strengthening the development of electronic communications, and improving the wellbeing of citizens.

Caf called Slovenia's net neutrality law strict, but not being implemented prior to 2015. The problem with zero rating emerged with mobile broadband prices being too low. He cited the offer of €25 for 1 GB of data and €30 for 100 GB. Caf called these offers "good for consumers in the short run, but not sustainable in the long run" and believed that they needed to be stopped. "This is not a two-sided market," he said.

Caf does not know whether consumers complained about the offers to the regulator. His organization is not privy to such complaints. They only learn what is published by the telecom regulator or the competition authority. However one person did complain to the SEK, that he wanted to use his account balance to choose which sites should be zero rated.

One June 22, 2014 Caf published a blog[101] titled "Free download mobile content jeopardizes the neutrality of the Internet" critiquing the zero rating offers of Telekom Slovenia and Si.mobil which "unduly encourage (users) to procure their services or applications and their partners, because of the high price of data transfer but they complicate the selection and use of competing products." Caf also notes, "Mere legal protection of net neutrality is not enough. It is important that AKOS enforce the regulatory principles" and that the SEK discusses the situation at its June meeting, he notes. Caf said that he made a point to write in English to bring international attention to the issue in Slovenia

On behalf of SEK on July 17, 2014, Caf made a formal complaint about zero rating to the telecom regulator, but did not receive a response. He believed that the regulator was reluctant to make a ruling on zero rating.

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[97] "Dusan Caf to Head Slovenian Regulator - Report," *Telecompaper*, January 14, 2014, http://www.telecompaper.com/news/dusan-caf-to-head-slovenian-regulator-report--993155.

[98] The Agency Council is authorised to give opinions to the programme of work, the financial plan and the annual report of AKOS; approve the statute adopted by the Agency Director; propose the appointment or dismissal of the Agency Director; propose a temporary prohibition on the performance of functions by the Director; propose the early dismissal of members of the Agency Council. The Members of the Agency Council or persons authorised by the Agency Council may inspect the business accounts as defined in the Slovenian Accounting Standards and the AKOS' accounting documents. Upon every such request by the Agency, the Agency director must submit to the Council a report on the operations of the Agency and any other information that the Agency Council requires in order to carry out its functions. The Agency Council may suggest improvements in the operation of the Agency to the Agency director, as well as point out to him any irregularities in the AKOS operations and notify the competent bodies of these irregularities. "Profile of AKOS," February 6, 2014, http://epra3-production.s3.amazonaws.com/organisations/documents/30/original/Profile_AKOS_SI_02_2014_final.pdf?1391706889.

[99] Ales Percic, "Neuradno: Na Čelo Sveta Akosa Dušan Caf," *Finance.si*, January 29, 2014, http://www.finance.si/8355990/Neuradno-Na-%C4%8Delo-sveta-Akosa-Du%C5%A1an-Caf.

[100] "Competitive Analysis & Foresight: Ugrabljeni Regulatorji," *CAF*, December 9, 2013, http://blog.caf.si/2013/12/ugrabljeni-regulatorji.html.

[101] "Competitive Analysis & Foresight: Brezplačen Prenos Vsebine Ogroža Nevtralnost Mobilnega Interneta," Competitive Analysis & Foresight, (June 22, 2014), http://blog.caf.si/2014/06/brezplacen-prenos-vsebine-ogroza-nevtralnost-mobilnega-interneta.html.

Caf said he made a point to mention only Telekom Slovenia and Si.Mobil in his complaint. He did not want to implicate the smaller providers Tusmobil and Amis because they need zero rating offers to differentiate themselves in the marketplace. The complaint describes that Telecom Slovenia's unlimited data transfer offers the ability to view the matches of the UEFA Champions League, watch films HBO GO, and access proprietary online storage. Telecom's own service" discriminates against end users using competing products", notes the complaint.

The complaint is critical of Si.Mobil's unrestricted offer to view the World Cup and unlimited access to the VOYO content over a two year period. It claims that free video data is problematic because it is a fastest growing category of service and makes up the bulk of internet traffic, and that offers with unmetered traffic exceed the amount of data used on basic packages. Moreover operators are offering unmetered service to the exclusive content they have licensed but not giving the same conditions to competing content. It is described as discriminatory to users because they have to use metered access to enjoy competing services on the same platform. The letter states that operators are violating Slovenia's net neutrality rules and that Telecom Slovenia is abusing its dominant position in the marketplace.

Caf regrets that, in the end, the regulator punished the smaller providers by ordering them to stop all their zero rated practices, while the incumbent received a lighter reprimand. Telekom Slovenia was required only to end the zero rated music service for Deezer, but was allowed to keep zero rating its proprietary video application. That the smaller operators received a tougher punishment supports Caf's assertion that the telecom regulator favors the state-owned Telecom Slovenia.

Concurrently Caf sent the complaint to the Slovenia Competition Protection Agency, which did reply on September 4, 2014.[102] They recognized the concerns about discriminatory traffic management, but note that the risk is significantly lower in a transparent and competitive environment. Net neutrality puts emphasis on the requirement that operators transparently disclose their practices regarding managing internet traffic. In a transparent environment, consumers, if unhappy with traffic management practices, can switch providers. They observe that differentiated offerings are important because they are

> . . . the fruit of competitive advantages and therefore increase efficiency and bring consumers the benefits (i.e. cheaper cinema tickets for students). Thus price discrimination increases the availability of the product to more cost-sensitive consumers and ensures an overall increase in sales volume, thereby lowering average the overall costs and increasing efficiency. The boundary between pro-competitive and anti-competitive conduct can be thin, so borderline cases should be assessed. But intervention is necessary only in cases where economic analysis shows that the injury to the consumers outweigh the benefits to consumers.

The competition authority notes that Telecom Slovenia has not abused its market power. It could be tested with an in-depth investigation that would begin with defining the relevant market, in this case the market for data transfer. It notes that Slovenia is a market with at least three mobile providers which will evolve significantly in the coming years. It notes that the market for mobile services is primarily characterized by call services, and with the different prices for calls on and off net, the effect of data transfer services is negligible. Moreover, even though Telecom Slovenia has a 50 percent market

[102] A copy of the reply is not available on the authority's website, however it is referenced in the EU Scoreboard document on the link for Slovenia. "Scoreboard 2015 - Report on the Implementation of the Telecommunications Regulatory Package (per Country)," *Digital Agenda for Europe*, June 19, 2015, http:///digital-agenda/en/news/scoreboard-2015-report-implementation-telecommunications-regulatory-package-country.

share and falling, it does not have the power to control the market for Internet applications, even with its zero rated offer. It notes,

> Vertical relationships can be bring benefits to consumers. For example, by offering free Internet encourages Telecom Slovenia to invest in expensive exclusive content such as UEFA Champions League. Si.mobil might not have invested EUR 60 million in the acquisition of spectrum if it expected that it would be not be able to grow the market for newly built broadband 'highways' through various campaigns for free use of data transmission.

It notes further that sports rights and copyrighted content when licensed to a buyer (e.g. Telecom Slovenia) and offered in a zero rated program do not constitute a violation of competition. Moreover the operator's offer of Deezer and a proprietary cloud service does not harm the market for such services, as there are many choices worldwide from which users can access.

As for the price of the offer, the competition authority notes that the operator does not engage in either improving the quality of the zero rated products or degrading other applications, but rather in a form of discount or positive discrimination. To assess this, it is necessary to examine the price and costs of the offer and the services contained within. It observes that the voice is the largest cost driver and that the use of Deezer is negligible, amounting to a few cents out of an offer of €26 per month.

> The competition authority notes that the emergence of zero rating reflects fierce competition in the mobile marketplace and even with current limits, consumers still have the freedom to decide what kind of content they want.

It notes further that the net neutrality rules are designed to protect competition for the purpose of the benefit of consumers. It is therefore necessary to determine the effect of zero rating on consumers. No intervention should be made if there is no evidence of consumer harm. The competition authority describes situations in which it considers extreme and necessary for intervention, for example the Microsoft browser case, but the zero rating issue in Slovenia is not one. The authority made a point as well that critics consider the Dutch net neutrality too extreme because operators are restricted from making offers.

Caf rejected the competition authority's conclusion, in particular because it made an analysis based on mobile prices from 2012. However if 2014 prices were used, the impact of zero rating would likely be even smaller because prices have fallen in the period.

Caf worked with the country's leading newspaper to bring attention to the issue. On November 12 an article[103] appeared in the newspaper *Delo* (English: Labour) by Matjaž Ropret[104] introducing the topic of zero rating as problematic and reporting on developments in the USA. The article concludes with a screen shot of Frank Underwood of Netflix's "House of Cards" with the caption "You need the gatekeeper." Underneath the photo is the caption "Providers such as Netflix in the US have paid operators for smooth transfer of content to subscribers."

The article links to another article that appeared in *Delo* from Slovenian correspondents in the US titled "Political cuisine on the future of the Internet: White House asks independent telecom commission for the Internet be declared a public service, which is

[103] Matjaz Ropret, "Izmuzljiva Internetna Nevtralnost," *Infoteh*, November 12, 2014, http://www.delo.si/mnenja/blogi/izmuzljiva-internetna-nevtralnost.html.
[104] Matjaz Ropret, "Tehnokamra – Internetna Nevtralnost," *Delo*, November 14, 2014, http://www.delo.si/multimedija/video/tehnokamra-internetna-nevtralnost.html.

controlled by the state." [105] The article describes President Obama's net neutrality announcement and some political background in the US. In a sidebar it notes that after ratifying its own net neutrality law two years earlier, Slovenia experienced its first complaint under the concept of zero rating.

On November 14, *Delo* published a short article[106] embedded with a video[107] highlighting Barack Obama's previous net neutrality announcement[108] followed by a presentation by Dusan Caf and *Delo* tech journalists Matjaž Ropret and Lenart J. Kučić[109] discussing the situation of net neutrality in Slovenia. During the discussion Caf produces a tablet where he points to a copy of the Slovenia net neutrality law and how the section on zero rating was removed as part of the final rulemaking.

A blog[110] by Caf on December 5 characterizes Slovenia as a country that has net neutrality rules but does not enforce them. It describes a country where "Net neutrality (is) weakened by industry lobbying and inactive regulator" and recounts how zero rating, originally included in the Slovenia rules was removed by "lobbying from the industry". Caf also warns about the "spreading of discriminatory practices" and refers to a study of zero rated offers in the EU.[111] He notes that SEK sent a letter to AKOS describing the discriminatory practices of Telekom Slovenije but "based on the regulator's strong pro-industry stance the outcome is uncertain."

It is not clear whether from media pressure or international influence, but AKOS relented and commenced a review on zero rating on December 18. Soon after Caf appeared in an interview[112] in *Europolitics* in which the journalist questioned whether undue pressure has been put on the Slovenian telecom regulator. Caf notes that even though authorities pronounce zero rating beneficial to consumers, the practice is still problematic. "An efficient regulator is required in order that legislation adopted should really be implemented. However, I think it is important to resolve the matter of zero rating, and not to tie competition law on neutrality, since procedures and market analyses take too long," he notes.

On January 10, 2015 *Delo* published an article[113] of some 2500 words explaining net neutrality by comparing the internet to the road network where all drivers have the same rights. Telecom operators are characterized as deploying sneaky business models such as zero rating. Dusan Caf's efforts to end the practice are described.

A blog[114] from Caf appeared two days later in an attempt to increase the pressure on the telecom regulator to ban zero rating. He refers to the complaint SEK made to the regulator in July 2014 followed by "nearly three months of analysis, in which we analyzed the controversial business practice of mobile operators." He notes that at the end of 2014 Telekom Slovenia had 50% market share and Si.Mobile 36%.

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[105] Sebastijan Kopusar, "Politične Kuhinje O Prihodnosti Interneta," *Delo*, November 12, 2014, http://www.delo.si/znanje/infoteh/politicne-kuhinje-o-prihodnosti-interneta.html.
[106] Matjaz Ropret, "Tehnokamra – Internetna Nevtralnost," Delo, (November 14, 2014), http://www.delo.si/multimedija/video/tehnokamra-internetna-nevtralnost.html.
[107] *Tehnokamra - Internetna Nevtralnost*, 2014, https://www.youtube.com/watch?t=186&v=_PBaeuvDC_w.
[108] Ezra Mechaber, "President Obama Urges FCC to Implement Stronger Net Neutrality Rules," *The White House*, November 10, 2014, http://www.whitehouse.gov/blog/2014/11/10/president-obama-urges-fcc-implement-stronger-net-neutrality-rules.
[109] Lenart Kucic, "Lenart J. Kučić Blog," accessed July 27, 2015, http://www.lenartkucic.net/about/. The journalist also writes books critiquing the media. Lenart Kucic, "Lenart J. Kučić's Bibliography," accessed July 27, 2015, http://www.lenartkucic.net/bibliography/.
[110] "Competitive Analysis & Foresight: Zero-Rating Violates Slovenian Net Neutrality Law," *Competitive Analysis & Foresight*, December 5, 2014, http://blog.caf.si/2014/12/zero-rating-violates-slovenian-net-neutrality-law.html.
[111] "List of 75 Zero-Rated, Potentially Anti-Competitive Mobile Applications/services, Violating Net Neutrality, in EU28," *DF Monitor*, October 2014, http://dfmonitor.eu/insights/2014_oct_zerorate/.
[112] Nathalie Steiwer, "Zero Rating: Slovenian Regulator Exposed to Excessive Pressure," *Europolitics*, January 5, 2015, http://europolitics.info/tech/zero-rating-slovenian-regulator-exposed-excessive-pressure.
[113] Lenart Kucic, "Internet Nevtralen Kot Javno Cestno Omrežje?," *Delo*, January 10, 2015, http://www.delo.si/sobotna/internet-nevtralen-kot-javno-cestno-omrezje.html. See appendix for Google translated article
[114] "Competitive Analysis & Foresight: Nevtralnost Interneta vse Bolj Vroča," *CAF*, January 12, 2015, http://blog.caf.si/2015/01/nevtralnost-interneta-vse-bolj-vroca.html.

On January 23, 2015 AKOS announced its decision,[115] finding Telecom Slovenia's zero rating of Deezer and Si.Mobil's zer roated offering of the cloud platform Hangar Mapa to be net neutrality violations. An announcement in English followed on January 26, the only news story on the English language section of its website.[116] Telekom Slovenia's zero rating of UEFA Champions League, HBO GO, and the online storage TviN continues. In neither case did the regulator mention any evidence for harm to consumers or competition because of the offers.

On February 20, 2015 AKOS similarly found Amis Mobile with its proprietary TV service and Tusmobil with its customer service platform in violation of net neutrality. [117] The operators were required to end the banned practices in 60 days.

In response Caf posted a blog[118] celebrating the regulator's decision banning offers from Telekom Slovenia and Si.Mobil. He notes that SEK conducted an examination of the practices and that telecom regulators attended its meetings. He notes that the competition authority "issued the opinion after a consultation with AKOS in which regulators exchanged and shared views and information on net neutrality issues." He describes the competition authority opinion as "based on dubious facts and presumptions." He faults the competition protection authority for declining to begin an investigation.

Caf recounts his efforts to speed the regulatory process and enlighten senior officials whose views were "generalized and lacked thorough analysis". He recounts the steps that made the ban possible: his blogs and articles, his analysis indicating a potential breach of competition law, and the support of leading technology journalists. He reiterates his earlier blog of December 5 of why zero rating is a violation of the Slovenian net neutrality law. He notes that while the decisions only apply to music and cloud services, that they should also apply to video streaming. He notes that, "Consumers may shortly expect new data plans and enjoy open and non-discriminatory access to the internet."

Following the announcement of the banning of the zero rated services of Tusmobil and Amis, Caf penned another blog.[119] While he was pleased with the action against the other operators, he called the allowance of zero rating by Telekom Slovenia "unacceptable and AKOS shall intervene as soon as possible. There is no legal ground in communications or media law for any exemption of internet streaming of sporting events or cloud storage traffic."

He notes that these "the decisions have already had a positive impact and, as we correctly predicted, consumers benefited from the regulator's net neutrality decisions. Telecom Slovenia and Si.mobile have both come up with special offers and packages with larger data caps or inexpensive data cap options. Consumers may shortly expect even more plans with larger data caps."

Caf describes the mobile market today as competitive, particularly because of price competition driven by American owned cable provider Telemach in their cross-selling of service from Tusmobil.

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[115] "Akos Ugotovil Kršitve Načela Nevtralnosti Interneta," *Akos*, January 23, 2015, http://www.akos-rs.si/akos-ugotovil-krsitve-nacela-nevtralnosti-interneta.
[116] "AKOS Finds Violations of the Principle of Net Neutrality," *Akos*, January 26, 2015, http://www.akos-rs.si/akos-finds-violations-of-the-principle-of-net-neutrality.
[117] "Akos Ugotovil Kršitve Načela Nevtralnosti Interneta Tudi Pri Storitvah Amisa in Tušmobila," *Akos*, February 20, 2015, http://www.akos-rs.si/akos-ugotovil-krsitve-nacela-nevtralnosti-interneta-tudi-pri-storitvah-amisa-in-tusmobila.
[118] "Competitive Analysis & Foresight: Telekom Slovenije and Si.mobil Found in Breach of Net Neutrality," *Competitive Analysis & Foresight*, January 25, 2015, http://blog.caf.si/2015/01/telekom-slovenije-and-simobil-found-in-breach-of-net-neutrality.html.
[119] "Competitive Analysis & Foresight: Another Win for Net Neutrality Advocates in Slovenia: AKOS Issues New Decisions Limiting Zero-Rating," *Competitive Analysis & Foresight*, February 22, 2015, http://blog.caf.si/2015/02/another-win-for-net-neutrality-advocates-in-slovenia-akos-issues-new-decisions-limiting-zero-rating.html.

On June 27, 2015 an article[120] explores Caf's evolution from professor and consultant to the telecom industry and Chamber of Commerce to his most recognizable position as the leader of the Council for Electronic Communications. The same day two additional articles[121] [122] appear on Caf and his accomplishments.

On July 1, 2015, the day after the EU's concluded agreement on net neutrality, Caf is interviewed[123] by Slovenian Radio and TV saying that Slovenia users are less protected, as the new EU rules "override" Slovenia's. The article notes a tweet from a Ministry of Education official who sees it differently, Slovenia "is (was) alone in demonstrating the principle is the wrong approach," he notes.

The European Union is the midst of an effort to create a Digital Single Market. One of goals of which is to strengthen European based small and medium enterprises (SME) on the Internet.[124] Once it took effect, AKOS's ban on zero rating caused traffic to certain Slovenian content and applications to fall by half. Operators' customer support centers saw a five-fold increase in telephone calls because subscribers could no longer top up their account balance online for free.[125] A Slovenian cloud provider experienced a marked, but not devastating, decline in traffic as a result of the ban.[126] To be sure, no content provider's marketing strategy relies entirely on zero rating.

Operators are appealing the regulator's decision on material and procedural grounds. They have also requested a constitutional review of the nation's communications law. Should the national court be unable to address the issue, it will be referred to the Court of Justice of the European Union. Operators argue that AKOS' decisíon contravenes BEREC's and EU's view on zero rating, which they call "sponsored connectivity" and a competitive practice. They charge that AKOS acted prematurely, given that pan-EU rules were still be considered. The current regulatory framework prohibits regulation beyond the exhaustively listed authorizations, of which the ban is. Moreover Slovenia and Netherlands are the only two European countries with "fundamentalist interpretation" of net neutrality, and they cannot exceed EU norms.

Testing the alleged harms of zero rating

The case studies provide some information about zero rating in the specific countries. Together with market research on mobile applications, we attempt to find evidence for the claims of those opposed to zero rating. Given their specific arguments, we pose the following assertions and attempt to test them.

1. The operator that offers zero rating will win market share.
2. The zero rated service will win market share.
3. The presence of zero rating will preclude the emergence of new applications and services.
4. Users do not go to non- zero rated content. If Facebook is free, they don't venture beyond it.
5. Operators that are zero rating their own content foreclose other content.

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[120] Ales Lednik, "Večer: Kršijo Zakon, Nihče Ne Trzne," *Vecer*, June 27, 2015, http://www.vecer.com/clanek/201506276125307.
[121] "Dušan Caf : V Državni Lasti Bo Telekom Težko Konkurenčen," *Finance.si*, June 27, 2015, http://www.finance.si/8824292/Du%C5%A1an-Caf-V-dr%C5%BEavni-lasti-bo-Telekom-te%C5%BEko-konkuren%C4%8Den.
[122] "STA: Caf Za Večer: V Državni Lasti Bo Telekom Težko Konkurenčen," *Sta*, June 27, 2015, https://www.sta.si/2150491/caf-za-vecer-v-drzavni-lasti-bo-telekom-tezko-konkurencen.
[123]"Zvodeneli Kompromis Medmrežne Nevtralnosti Pustil Nezadovoljstvo," *Prvi Interaktivni Multimedijski Portal, MMC RTV Slovenija*, July 1, 2015, http://www.rtvslo.si/znanost-in-tehnologija/zvodeneli-kompromis-medmrezne-nevtralnosti-pustil-nezadovoljstvo/368779.
[124] http://ec.europa.eu/priorities/digital-single-market/
[125] Confidential interview
[126] Confidential interview

Additionally we want to know whether consumers experience harm. A consumer harm test[127] examines whether the following results from a particular activity: higher prices, lower output; or reduced product innovation. A related set of questions in competition analysis have to do with whether a firm possesses significant market power (SMP) and whether the firm exercises it. So for example, if a firm without market power employs zero rating, it need not be banned because it is not a threat to the marketplace. The Slovenian competition authority described this.

Testing the assertions is not necessarily easy because critics of zero rating don't provide specifics for their charges. For example, how is market share for operators defined, as subscribers or revenue? How is market share defined for services, by number of downloads, users, usage, or revenue per user? These are just a few of the relevant parameters to consider, but the market research data is limited to app store rank. It does not provide the specific number of downloads or revenue per application.

The market for mobile applications has some similarity to search engines and web traffic in that the most popular destinations gather a disproportionate amount of traffic. They have a typical power law distribution in which the top twenty destinations gather 80 percent or more of traffic. But while it is next to impossible to break into the top 10 or even 25 of the world's most popular websites, new applications emerge in the top 10 of mobile app stores every month. New apps tend to emerge by "viral" means (popularity in social networks). There is a notion that an app could get a shortcut to the top rank in the app store through zero rating, but our investigation could find no examples of such overnight success. In any event, we did observe that there are a number of mobile apps that are popular worldwide, regardless of the country or offer.

To understand the market for mobile applications we used the public version of AppAnnie.com, a leading market research tool for mobile applications which aggregates download and revenue data for app stores by country and app marketplace (Google Play, Apple App Store etc). The number of downloads per app is not given, but appearance in the top ten of the app store indicates high level of downloads, approximately 10,000 to 25,000 per day. While it will depend on the country and the category, the top 100-200 apps are significant for the market, assuming the depth of the particular category. After position 200 the significance falls precipitously and below 300 ceases to matter. One can understand the phenomena from Google's search engine that the first three results get the lion's share of clicks, followed by the remaining 7 on the first page, but generally users never go past the first page. Thus appearing in the top 10 for the category is important.

AppAnnie.com offers more than a dozen categories for apps including health, travel, kids, business and so on, but three key categories are messaging/social networking apps (WhatsApp, Facebook Messenger, Line, KakaoTalk, WeChat); Entertainment (Netflix, YouTube, HBO, Hulu), and Games (Clash of Clans, Candy Crush, Game of War). The platform also organizes the information for free and paid applications. This is significant because how an application earns revenue varies. For example, some apps earn a fee when a user downloads them in the store. In other cases, the app is free but revenue is earned inside the app either through advertising (itself a form of zero rating, free app subsidized by advertising) or in-app purchases, for example micro-transactions within game play. So, popularity does not necessarily translate to profitability.

Music streaming took off quickly on mobile phones, but video streaming has taken a longer time to take hold. This is due to in part to large file size (which been addressed through better content formatting and application design, more advanced devices, and

[127] *The Foundations of European Union Competition Law: The Objective and Principles of Article 102* http://www.oxfordscholarship.com/view/10.1093/acprof:oso/9780199226153.001.0001/acprof-9780199226153-chapter-8

new networks) and copyright. This is important from a net neutrality perspective because while one may want to access a particular mobile entertainment application, it may be blocked because of geographic or copyright restriction. As such, Netflix, HBO Now and Hulu are highly ranked apps and top revenue earners in the US where they have licensed content for the region.

However Netflix has licensed content for a number of geographies as is a popular app in many countries. The rise of video streaming via mobile is driving a trend for cord cutting.[128] It is important to note that, with the exception of certain copyright content, mobile app markets are essentially global. Users are able to access applications and services from around the world, as well as from their own country. However it brings attention to important issues for the European Union as they would like to see greater visibility and success for European-based innovation.

While Google and Facebook dominate a number of categories, games is one area where new players from a variety of countries have emerged with popular titles and sustainable business models. This includes of course publishers from the US, China, South Korea, and Japan, but a massive multiplayer game such as Agar.io from Miniclip in Switzerland has taken the world by storm, as have other titles from Vietnam and France.

While the web has been, and remains to a large extent, an American phenomenon, as measured by the proliferation of American websites dominating traffic and revenue, the mobile Internet is driven in large part by China, a country with large base of broadband-connected smartphone users and world class application providers. In fact Apple's App Store has more downloads in China than in the US.[129] China has a number of powerhouse video streaming providers including Tencent, Baidu's iQIYI, Sohu TV, Youku Tudou ,and LeTV. AppAnnie.com notes,

> Over the past few years, these services evolved from YouTube-like user-generated content video platforms to Netflix-like providers of professional shows. They have successfully attracted audiences form traditional broadcasting TVs by offering the content on omni-platforms including desktop, mobile, set-top boxes and digital TV. They have also enticed users to their platforms by securing rights to a broad range of foreign and domestic premium content including drama series like House of Cards and The Wife's Lies, hit TV shows like Voice of China and Happy Camp, recent movies like Interstellar and Gone With the Bullets and live broadcasting of premium sports like the English Premier League and the NBA, as well as making their own exclusive content. Mobile video streaming delivers significant value to consumers by enabling them to consume content anytime and anywhere on devices that are more affordable than TVs and PCs. Recognizing this huge opportunity, traditional TV networks in China like Hunan Broadcasting System have also joined the competition for mobile audiences by launching their own apps like ImgoTV.[130]

Our examination consisted of reviewing the performance of the various zero rated applications in the app stores amongst other mobile applications the period of January 2013 through July 2015 for Netherlands (Spotify, Sizz, HBO Go) and Slovenia (TViN, Deezer, and others). For Chile we began the observation from January 2012 through the present for WhatsApp. Data is offered on a monthly basis, so we developed annual averages to describe relevant movement year over year. We also examined the prevalence of local country applications, as this is seen as an important outcome for many policymakers. Market share data on the operators was found on the respective regulators' websites.

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[128] "HBO NOW Pushing the Cord-Cutting Trend," *App Annie Blog*, August 4, 2015, http://blog.appannie.com/hbo-now-pushing-the-cord-cutting-trend/.
[129] "Report: China Surpasses United States by iOS Downloads," *App Annie Blog*, April 28, 2015, http://blog.appannie.com/china-surpasses-united-states-ios-downloads/.
[130] Ibid

	Chile	Netherlands	Slovenia
The operator that offers zero rating wins market share.	Since launch, Virgin Mobile has grown consistently since launch but has less than 1% of the Chilean mobile market. It is difficult therefore to attribute its success to zero rating because the rate is the same with or without the zero rated offer.	No. Between 2012-2014, market share amongst mobile operators in the Netherlands was relatively constant, within 5 percent. A modest gain for service providers and virtual providers has been recorded over the period.[131] KPN, which had a zero rated offer, experienced a modest decline.	No. The incumbent with two zero rated offers experienced a reduced market share.
The zero rated service wins market share.	Can't be definitively determined. WhatApp was already a popular service in Chile before zero rating began. On Apple devices it actually lost market share while on Android it stayed relatively constant. Messenger, Twitter, Skype, Badoo, Google Hangouts, Emoji, LINE, Telegram, imo, Talking Tom and Viber are also popular messaging apps.	Vodafone's Sizz never entered the top 500 most downloaded apps for the period. HBO Go was #450 in 2012, #483 in 2013 and not in the top 500 in 2014-2015. There is no consistent offer for Spotify during the period, and it was frequently not zero rated. However its ranking increased from an average of 42 (Apple) and 30 (Android) in 2013 to from 12 and 8 respectively in 2015. Globally Spotify has increased ranking in all countries, whether zero rating is present or not.	No for Telecom Slovenia's TViN. The ranking falls from 67 to 85 between 2013 and 2015 in the Apple store. No for Deezer; it fell from 116 to 133 for the period. VOYO fell from 116 to 125. For Hangar Mapa, Tsukabina, and TV.Si, they either never appear or show briefly with a low rank. For HBO Go, it rises from 282 to 68. As of Aug 15, 2015, it ranks at 291 for Apple.
The presence of zero rating will preclude the emergence of new applications and services.	Can't be determined. Facebook's Messenger and WhatsApp, ranked closely. Twitter, Instagram and Snapchat are popular. For Chilean apps as of Aug 15, 2015 in Apple, The Voice TV show app #1; marketplace Yapo at 12 (14 in Google), and the government's "Youth Card" at 21, allows youth differentiated pricing for various activities in Chile.	No. New apps from a variety of countries appear each month in the ranking. However it does not appear that the Dutch net neutrality law stimulates new Dutch applications, as was hoped. Only two Dutch apps appear in the top 25 of top ranked apps in either Apple or Android.	No. New apps from a variety of countries appear each month in the ranking. As of Aug 15, 2015 for Slovenia apps in Google Play, the market Bohla appears at 48, and 24ur.com, Slovenian news at 76. For Apple, the ASfalt traffic app at 19, bohla.com at 30, BOX app by Telekom Slovenija to manage TV programs, and 24ur.com at 90.

[131]"Onderzoek Telecommonitor derde kwartaal 2014," Onderzoek, *ACM.nl*, (February 11, 2015), https://www.acm.nl/nl/publicaties/publicatie/13838/Telecommonitor-derde-kwartaal-2014/.

As for the assertion that users to do not go beyond zero rated content, we could not find evidence for that assertion in any of the three countries. As for the assertion that operators which zero rate their own content foreclose other content, we could not find any evidence for that either. The only country with proprietary content was Slovenia. The operators' content was extremely niche-oriented competing in a large, global marketplace. The content appears to be non-rivalrous, that is its presence is appreciated by those who value it, but it does not detract from the experience of other users. In any event, its rank is so low that it does not "threaten" other content.

As pointed out by the competition authority in Slovenia, the zero rated offers in many cases consume only minimal data, and at best, may only impact price by a few cents per month. In other words, the data consumption for apps such as Spotify, WhatsApp, and Deezer is so small in relation to other services that it cannot be observed. If anything, purveyors of the most popular applications work to reduce the data consumption of their applications. Facebook re-engineered its mobile platform, decreasing average monthly data use from 14MB/mo to 2MB/mo.[132]

Naturally video applications consume the most data, so these cases are interesting to review. Vodafone Netherlands only had 3200 subscribers for its zero rated HBO Go application when it was ordered to end the practice. That the application was zero rated did not deter other content in the marketplace. Vodafone did not gain an advantage over competitors by zero rating the app.

In the case of Slovenia, the zero rated offers actually increased output on the market, even though they were not the most widely demanded application. For example Telecom Slovenia purchased sports rights and extended that benefit to its customers doubly with its investment and by zero rating the application. But the zero rated TViN service actually suffered a loss in ranking in the app store during the period. VOYO was a content service that was zero rated for a two year period, and it suffered a decline in app store rank as well. It shows that not all content is valued equally if it is free. Zero rating is not the competitive advantage that detractors like to describe it. More likely, as Baumol described, it is just one of a range of offers that providers have to make to survive in the marketplace.

It cannot be observed that zero rating has reduced innovation in any of the countries. In anything bans on the practice have hurt users the most. This is particularly the case for the subscribers of Vodafone and Tusmobil. The bans against customer service applications such as Sizz (Vodafone Netherlands) and Tuskabina (Tusmobil Slovenia) were offered as courtesies, so that customers would not have to use data to top up their mobile subscription or minutes to call customer support. Neither of these operators hold dominant market positions anyway so punishing them for consumer-friendly activities seems harsh.

On balance for the three countries, it appears that the impact of zero rating is negligible but not negative.

[132] *See* Mark Zuckerberg comments at Mobile World Congress in 2014 at 28:20 https://www.youtube.com/watch?v=VHwkHZpXqWc.

Zero Rating and Freedom of Speech

There is no doubt that zero rating is a potent policy issue. For advocates in many countries, zero rating and the larger net neutrality debate has become synonymous with free speech.

However it has been observed that making net neutrality laws in developing countries is premature because the majority of the population of these countries has never been online, and as such, cannot experience the Internet for themselves. Zero rating is perhaps the quickest, cheapest way to get the poor online, but that option is vigorously challenged.

It may be the case that people in developing countries could benefit from net neutrality, but the choice of how the Internet should be is made for them. The decision to make net neutrality rules has path dependencies with implications for more than just network access. Net neutrality rules across 20 countries have provisions related to copyright, data retention, pricing, surveillance, and more.[133]

Compared to people who are not online, net neutrality advocates are elite, sophisticated, and well-educated. They probably have computers at home with wireline access as well as the latest smartphone. A low or no data cap plan is their preference. But people who have never been online do not the same expectation of Internet access. For a Chinese, the Internet might be equated a non-branded smartphone, WeChat messaging, Baidu search, and Youku video. It need not conform to a gold standard of neutrality, but it still can be thrilling experience.

For Westerners, concepts such as free speech and freedom of expression are established and enshrined in constitutions and case law. But for a number of developing countries, these concepts are still in the making. There is no doubt that Internet freedom is important in these countries, as it is everywhere. But where Internet penetration is low and television, radio and print are still the dominant media, the pursuit of freedom for all media may be more appropriate than just net neutrality.

In any case, the question may boil down to whether those not yet online have sufficient economic power. As mentioned, developing countries may have mobile networks but still lag on key indicators for quality of life. There is no doubt that zero rating offers an opportunity for poor people to access the Internet, become politically aware, and hold leaders more accountable. Such empowerment could be destabilizing for the status quo.

This paper has focused specifically on Chile, Netherlands, and Slovenia. The following section offers an American perspective on net neutrality, particularly in light of nine legal challenges to the FCC's net neutrality rules, the third time the telecom authority is in court for making rules. However even Slovenia has free enterprise laws. Such arguments may be important in a former communist and war-torn country where entrepreneurs and private enterprises try to build a market economy.

Critics contend that zero rating is "discriminatory", but in the United States, zero rating is likely a form of speech that is protected by the First Amendment of the Constitution.[134] Zero rating conforms to all aspects of the classic definition of marketing: product, price, place, and promotion.[135] Thus bans on zero rating may be bans on free speech. To be sure, "deception" and false advertising are not allowed, but the freedom to make an offer in the marketplace is a fundamental as speech itself.

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[133] See forthcoming paper by Roslyn Layton for a comparison of net neutrality rules in 20 countries.
[134] "Advertising and the First Amendment," *LawPublish*, accessed August 5, 2015, http://www.lawpublish.com/amend1.html.
[135] McCarthy, Jerome E. (1960). *Basic Marketing. A Managerial Approach*. Homewood, IL: Richard D. Irwin.

This argument[136] will soon have a test in court. It holds that a broadband provider is no different from a newspaper, printing press, or broadcaster from a constitutional perspective. Broadband access is speech just as print or broadcast.

The distinction between technical and commercial reasons is irrelevant for the First Amendment. Indeed for a network, technical and commercial concerns are one in the same. Thus some net neutrality rules against how operators price and manage their networks may be unconstitutional. Legal scholar Fred Campbell explains[137]

> It is constitutionally irrelevant that the content-related restrictions in the open Internet rules also implicate business concerns.[138] The Court has long held that the commercial nature of the press does not deprive it of First Amendment protection, because there is no constitutionally permissible way for the government to separate the business interests of the press from its editorial function.[139] The existence of "'commercial activity, in itself, is no justification for narrowing the protection of expression secured by the First Amendment,'"[140] in part because even early printers were capitalists who were regarded as innovators.[141] The combination of the profit motive "with other motives that were self-serving and altruistic, and even evangelistic, at times," played a role in the "rapid expansion of early printing industries.[142] The editorial and business interests of the press have always been inextricably intertwined,[143] and the Press Clause has always forbidden government attempts to unravel them.[144]

While the court may recognize an argument for common carriage, this does mean free carriage. Thus an operator's discretion of how to charge for delivery is protected as well. Price differentiation is enshrined in almost every country through the post, with priority, regular, and reduced rate postage. It is understood that there is social value to give mass media and books a lower price of delivery because it supports communication, expression and the exchange of ideas.

> Moreover rather than declare such practices inherently harmful, however, the Supreme Court has upheld the government's right to engage in paid prioritization of the mail for the purpose of subsidizing particular forms of speech.[145]

In this way, it is no different for some Internet content to get the "book rate" or the zero rate. It supports overall expression.

In some respects the zero rated Internet.org, a platform for Facebook and locally relevant content for developing countries is not unlike the very original conception of zero rating, a term[146] that comes from the international trade and tax policy of the European Economic Community in the 1950s. When value added tax (VAT) was imposed on goods distributed in what is today the European Union, certain "essential" items such as food, medicines, books, equipment for the disabled and were "zero rated" and not taxed. While it probably makes net neutrality advocates wince, Facebook is an essential for the Internet.

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[136] Fred Campbell, "CBIT Amicus Brief: FCC Net Neutrality Rules Violate First Amendment," *Center for Boundless Innovation in Technology*, August 6, 2015, http://cbit.org/blog/2015/08/cbit-files-amicus-brief-fcc-net-neutrality-rules-violate-first-amendment/.
[137] Fred Campbell, *The First Amendment and the Internet: The Press Clause Protects the Internet Transmission of Mass Media Content from Common Carrier Regulation*, 94 NEB. L. REV. ___ (2016). See also http://cbit.org/blog/2015/06/cbit-white-paper-how-net-neutrality-invites-the-feds-to-ignore-the-first-amendment-censor-the-internet/at p 32-33, 51
[138] *Bigelow*, 421 U.S. at 818, quoting *Ginzburg v. United States*, 383 U.S. 463, 474 (1966). ("The existence of 'commercial activity, in itself, is no justification for narrowing the protection of expression secured by the FirstAmendment.'").
[139] *See Tornillo*, 418 U.S. 241, 258.
[140] *Bigelow*, 421 U.S. at 818, quoting *Ginzburg v. United States*, 383 U.S. 463, 474 (1966).
[141] Elizabeth L. Einstein, *The Printing Press as an Agent of Change*, p. 22 (Cambridge University Press, 14th printing, 2009).
[142] *See id.* at p. 23.
[143] *See id.* ("It seems more accurate to describe many publishers as being *both* businessmen *and* literary dispensers of glory.").
[144] The Press Clause has not been amended since its initial ratification.
[145] *Hannegan v. Esquire, Inc.*, 327 U.S. 146, 151 (1946).
[146] Harry Wallop, "General Election 2010: A Brief History of the Value Added Tax," April 13, 2010, http://www.telegraph.co.uk/news/election-2010/7582869/VAT-a-brief-history.html.

But it is not the case that all expression must be treated equally. "The Supreme Court has rejected the notion that the government has an interest in equalizing the relative ability of individuals or groups to speak.[147] "[T]he concept that government may restrict the speech of some elements of our society in order to enhance the relative voice of others is wholly foreign to the First Amendment,"[148] notes Campbell.[149]

Marketing and advertising to support the provision of service, content, access to users has a been quintessential part of every medium, whether radio, TV, print, search engine, social network, and music streaming. Classified advertisements, a forerunner to search advertising, supported Benjamin Franklin's *Pennsylvania Gazette* in 1728. The telephone newspaper of the 1890s, a forerunner of today's mobile broadband, was funded both by spoken ads and price differentiated subscriptions for different audiences.[150] Radio broadcasting would have been unknown in America had it not been for content providers' zero rated programming.

To stimulate purchase of receivers from the De Forest Radio Company, owner Lee De Forest negotiated the Metropolitan Opera and the Columbia Graphophone Co., to zero rated their music content. Free broadcasts helped introduce America to this new medium. Thereafter it became commonplace for consumer product companies to sponsor radio shows. This was a norm for American television. Revenues from advertisers were used to expand radio and television networks and technologies. Unsurprisingly Internet companies such as Google, Facebook, Yahoo and others have availed themselves to zero rating style business models, so that their users need not pay money for the service. Google zero-rates search and its other products. Facebook sponsors its platform with advertising.

Marketing is also important to promote devices. Imagine if AT&T had not able to make an exclusive distribution agreement with Apple for the iPhone in 2007. Nokia, in fact, invented the smartphone in 1996 but never got the credit because it failed to communicate to customers in a compelling way.[151] Consumers were able to take advantage of the iPhone in spite of its high price of $399 because AT&T through its subsidy of the phone created a form of zero rating of the cost of the phone to the end user. Additionally Apple could leverage the marketing and distribution of its device in AT&T's subscriber network. Such an partnership was needed to launch the idea of the smartphone in the consumer imagination[152]; it opened the door to other smartphones and fostered the development mobile platforms on which WhatsApp, Spotify, Netflix, and other mobile applications have flourished. A zero rating like ban on partnerships between operators and device makers could have precluded significant mobile innovation

Marketing is also essential for firms to differentiate themselves in the marketplace, and even more important for service based competitors which resell service on established networks. Consider the communication on the following two Chilean websites, one for Movistar and the other for WOM. Movistar, the market leader, features a bourgeois husband and wife in their properly appointed home with an offer of 150 voice minutes or 500 MB of data for a set price. Wom, an MNVO, features two girls at party sharing a lemon wedge by mouth with the offer is 30 GB of data for $25. These are two different customer sets with different needs and budgets. Marketing is essential for each operator to acquire customers.

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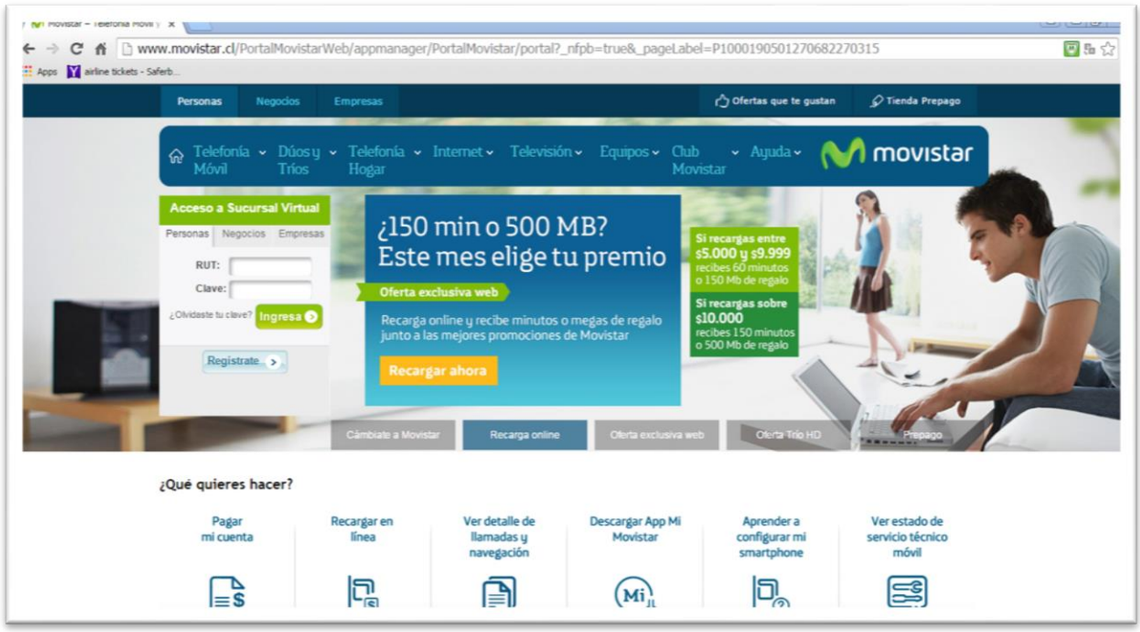
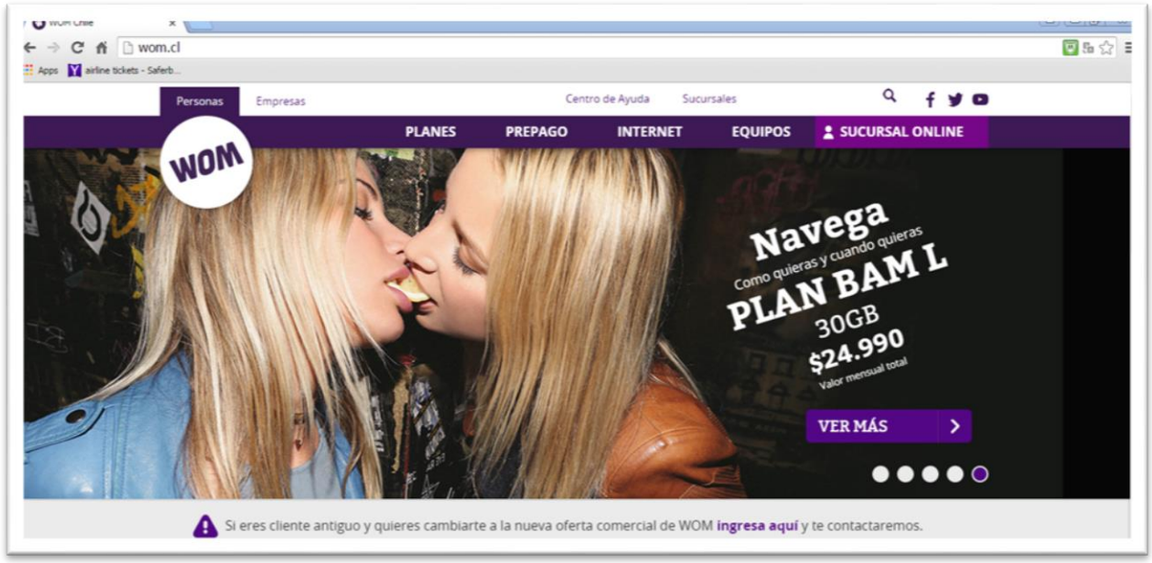
[147] *See Citizens United*, 558 U.S. at 350.
[148] *Buckley v. Valeo*, 424 U.S. 1, 48-49 (1976).
[149] Supra
[150] Roslyn Layton. "What the 19th Century Telephone Newspaper Tells us about Today's Internet." August 13, 2015. http://www.techpolicydaily.com/internet/telephone-newspaper-todays-internet/
[151] "Nokia 9000 Communicator Detailed Specs," *PDAdb.net*, accessed August 14, 2015, http://pdadb.net/index.php?m=specs&id=879&view=1&c=nokia_9000_communicator.
[152] Strand Consult iPhone Report, 2009. http://www.strandconsult.dk/sw3896.asp



Movistar's Hompage



WOM's Homepage

Why the War on Zero Rating

This paper has examined the arguments for and against zero rating. It examines the key concerns about zero rating and attempts to find evidence for the claims. It reviewed the leading database of financial information for mobile operators and the leading database of application performance in mobile app stores. We conducted primary research in the three countries that ban zero rating. The case studies highlighted a number of similarities in the countries, including strong net neutrality laws, reluctant regulators, and the role of powerful advocacy organization to make zero rating illegal. While this demonstrates the success of these organizations to activate the media and policymakers, the case studies highlight the lack of analysis, evidence, and investigation in net neutrality policy, showing that each country is highly idiosyncratic in its rulemaking.

Through a variety of quantitative and qualitative techniques, we have attempted to find evidence for the harm that zero rating allegedly creates to consumers and competition.

In short, we cannot find evidence that shows that zero rating creates harm. We find that zero rating has a negligible but not negative impact on the marketplace.

Zero rating is one of a number of marketing techniques that mobile operators need to employ in competitive marketplace. For some operators in the study, they outcomes are the opposite predicted by critics. Some operators that deployed zero rating actually lost market share, and their zero rated applications were insignificant in terms of rank. We do not believe that this is a result of zero rating, but rather that zero rating is the result of the operator's competitive situation. To rephrase Baumol, operators don't deploy zero rating because they can, but because they must.

It is strange however that a service that has such a minimal impact should be so maligned. It is also an inconsistent that zero rating is rampant across Internet applications and services (e.g. advertising supported games, search, social networks, music streaming etc) but arbitrarily prohibited on mobile broadband services.

We noticed that in the three countries that advocates have a goal to make flat rate internet subscriptions and high data caps (preferably no data caps) the norm, if not the law. While such offers have appeal, they necessarily mean low volume users, whether by choice or budget constraint, are forced to pay more for internet access. Meanwhile high volume users, those who want to stream movies or play video games, pay proportionately less for their service. Such a situation would be a particular boon to companies such as Netflix, whose streaming service takes up a disproportionate share of mobile traffic. Thus it appears that campaigns against zero rating are waged as a way to pressure mobile operators to change their pricing in favor of users who consume high volume video and against those users who have never used the Internet but want an incentive to try.