A Layered United States Universal Service Fund for an Everything-over-IP World

Abstract

Support through the United States Federal Universal Service Fund for high-cost areas has been principally defined in terms of telephone service. Fund growth due to increases in wireless lines and implicit support for broadband infrastructure has created an untenable situation, and fundamental reform is expected. The cause underlying this growth is convergence between the telephone network, wireless networks, the Internet, and cable networks. This convergence will pose additional serious long term challenges to the Fund. This paper proposes a restructuring of the high-cost funds based on a layered model. Both contributions and distributions are focused on network infrastructure, without distinction between voice and broadband. The proposal uses a new definition of communication services to guarantee technology neutrality, and includes service area reform and cost efficiency measures. This layered approach repositions the Fund for future converged networks.

Key words: policy formulation, universal service, Internet

1. Introduction

The United States Universal Service Fund (USF), as established in the 1996 Communications Act, was created to provide access to advanced telecommunications and information services in all regions of the Nation. Universal service, however, has to date been defined principally in terms of telephone services. Correspondingly, the high-cost funds have focused on support to Eligible Telecommunication Carriers (ETCs) to support telephone network infrastructure, and assessments have been placed on interstate revenue from telephone calls.

Communication and computer networks, however, are continuing a long term trend toward integration of physical facilities and the applications they support. Whereas four separate networks historically supported telephone calls, cable video broadcasting, Internet, and wireless communications, increasingly these networks are integrating into a merged infrastructure that supports a wide variety of voice, video, and data applications.

This convergence of physical networks and applications poses several long-term challenges to the Universal Service Fund. As technology has changed, revenue from telephone calls has decreased whereas revenue from video services, Internet access, and wireless services has increased. Furthermore, it is increasingly difficult to distinguish between revenue from intrastate and interstate telecommunication services. USF support to wireless ETCs has increased rapidly, and it is widely believed that this is the principal cause for the rapid growth of the Fund. Differences in the service areas of Incumbent Local Exchange Carriers (ILECs) and wireless ETCs has required new rules to combat cream-skimming. The development of Voice over IP (VoIP) presents a classification challenge, in that debate has started about whether VoIP infrastructure should be supported by the Fund and whether revenue from VoIP services should be assessed for the Fund. As video over IP starts to come into the consumer marketplace, this will pose a similar challenge to classification. In

addition, many policymakers wish to see the USF support broadband access, but there is some reticence to assess broadband access, and many worry that support for broadband will cause a further massive increase in the size of the Fund.

Because of all these problems caused by technological convergence, the fundamental structure of the high-cost funds must be reconsidered. This paper proposes an approach to reformulation of the high-cost funds. In recognition of convergence, a new term *communication services* is introduced to replace *telecommunication services*, based on a layered model, to restrict both contributions and distributions to network infrastructure not applications. Communications services infrastructure encompass the lower layers of all public interconnected networks, whether to support voice, video, or data. Support is thus focused directly on communications network infrastructure, without reference to a standardized basket of telecommunications services that qualify as universal service. Similarly, contributions are required from all communications services, whether to support voice, video, or data.

This technology-neutral approach repositions the USF for future converged networks. In particular, such a layered approach erases the distinction between support for telephone service and broadband access. To resolve the disappearing distinction between intrastate and interstate revenue, the proposal allows the Fund to assess both. To resolve incompatibilities between the service areas of multiple types of network providers, service area reform is implemented using disaggregation. Finally, data is presented that indicates that a significant component of USF growth has been caused by implicit support for wireline broadband; the proposals suggest that allowing policymakers to determine an overall limit on the size of the Fund is more viable in the long-term than artificial distinctions between voice and broadband distributions.

Although many components of the proposal strictly concern elements of the United States USF (e.g. intrastate versus interstate, and USF growth), a layered approach to USF may apply to other countries universal service programs.

Section 2 briefly reviews the related literature, the current debate, and recent Congressional bills. Section 3 briefly states updated goals for universal service. Section 4 proposes a layered approach to high-cost fund distributions, and section 5 proposes cost efficiency mechanisms based on this approach. Finally, section 6, applies this layered approach to Fund contributions.

2. Related Literature

There is a voluminous literature on problems of the Universal Service Fund and proposed modifications. Abernathy (2005) gives a good overview of issues with the Fund posed by the transition from circuit-switch voice services to packet-switched communication services. On the contribution side, she discusses decreasing long distance telephone call revenues, classification of VoIP, and whether the Federal Communications Commission (FCC) has authority to assess the telecommunications portion of information services such as broadband access. On the distribution side, she discusses support for broadband, whether the FCC has authority to support an information service under USF, and the identical support rule. Marcus (2005) discusses the burdens put on the Fund from wireless carriers, and motivations to expand the Fund to VoIP and broadband. Taylor (2007) discusses a future of everything-over-IP communication services in which it no longer makes sense to distinguish between interstate and intrastate, between wireline and mobile, or between the telephone network and the Internet. On the contribution side, he discusses whether contributions should be required from all those who benefit from the network, from infrastructure providers all the way up to content providers. On the distribution side, he argues that under everything-over-IP, there will be no minimum standard universal service package.

There is a large academic literature on the economic efficiency (or lack thereof) of the Fund. An excellent starting point for digesting this literature is Turner (2006). His economic analysis shows that USF assessments produce a financial burden that falls heaviest on rural consumers who make large amounts of long distance calls, due to the elasticity of demand for rural long distance. In contrast, he presents an analysis that concludes that subsidizing broadband would likely produce benefits that exceed costs. He argues for assessments based on numbers and capacity, a broadband mandate on USF recipients, and the use of actual forward-looking costs.

There are also many papers that compare the approaches to universal service taken by the United States and other countries. Schejter (2007) finds that European countries are deploying broadband more quickly than the United States using a system that is more focussed, simple, efficient, and responsive to technology change. Jayakar and Sawhney (2007) examine new universal service policies in countries that have high broadband growth rates and conclude that they offer a multiplicity of services instead of focussing on voice as a universal service, with consumers able to choose the services that they value the most.

A number of papers discuss whether there is a digital divide, and if so the nature of it. Downes and Greenstein (2006) studied availability of dial-up Internet Service Providers (ISPs). They found that in rural counties, population was the single most important determinant of ISP entry, and that entry was largely provided by ISPs with local focus. This leaves open the question of whether broadband Internet will become less universally available than dial-up service due to differences in explicit USF support for local phone versus broadband. Prieger (2003) presents an analysis that quantifies that differential in broadband availability between urban and rural areas, and finds that concentration of rural households is a more important factor than income.

A lively debate has been occurring about whether the USF should support broadband. Weinberg (2001) argues that the distinction between telecommunications services and information services is not appropriate for the USF. After discussing several classification problems with evolving IP-based services, he proposes that USF contributions and distributions should be associated with physical facilities rather than with services. Sicker (2003) applies a layered policy model to regulation of VoIP. With respect to the USF, he argues that only infrastructure should be assessed and subsidized, not application and content providers. The dividing line between infrastructure and applications is intended to be roughly that between distance sensitive and non-distance sensitive components. He also argues that VoIP is an application, not infrastructure. Oh (2006) argues that the FCC's classification of Internet access as an information service hinders USF support for broadband, and that USF distribution should be expanded to non-telecommunication carriers such as municipal Wi-Fi.

There have been several recent attempts in the United States Congress at reformulating the USF. The telecommunications industry has been actively lobbying on the issue. With regard to distributions, Regional Bell Operating Companies (RBOCs) generally receive only limited funding from the non-rural portions of the Fund. Consequently, since they receive less from the Fund than their subscribers contribute, they are lobbying for a *cap* to be placed on the size of the Fund and for cost-efficiency mechanisms such as *reverse auctions*. In contrast, most rural ILECs, who receive more from the Fund than their subscribers contribute, strongly oppose caps or reverse auctions. Increasingly, wireless carriers receive funds from the rural portions of the Fund, but since their subscribers contributions still dominate the distributions to these carriers, they generally support caps and auctions, provided that the caps do not discriminate against wireless over wireline. Currently, both ILECs and wireless ETCs receive support based on the costs of the ILEC (the *identical support* rule); ILECs are lobbying for wireless ETCs to receive support based on their *actual costs*, but wireless carriers generally oppose this approach unless spectrum costs are included in the cost calculation. The cost calculation for rural ILECs is based on *embedded costs*, whereas the cost calculation for non-rural ILECs is based on *forward-looking costs*; the RBOCs and wireless carriers generally want all calculations to be based on the lower forward-looking costs so that the Fund size decreases, but rural ILECs vigorously oppose such a change. Currently, if a rural household subscribes to multiple voice lines (e.g. voice and fax, or landline and wireless), then all of the household's carriers might receive USF distributions. RBOCs want support to be restricted to a single *primary line* in order to decrease the Fund size, but rural ILECs and wireless ETCs oppose this. Currently, rural ILECs can determine the size of the geographic regions within their service area on which support calculations are based. They would like to continue to have this control, but wireless ETCs would like further *disaggregation* so that they can compete in only a portion of these service areas. Rural ILECs would like the USF to explicitly support broadband, but RBOCs oppose explicit support if it will increase the size of the Fund. Opinions are widely varied about requiring that ETCs offer broadband service (called a *broadband mandate*), depending on the form of the mandate. With regard to contributions, there is general agreement that the Federal USF should assess intrastate telecommunications, but disagreement over assessing broadband and VoIP.

The FCC recently placed an interim cap on high-cost fund distributions to competitive ETCs (CETCs),

to control growth of the Fund until more fundamental reforms can be implemented (FCC, 2008a). As of the date of writing, the FCC is currently considering a set of recommendations by the Federal-State Joint Board on Universal Service (Federal-State Joint Board on Universal Service, 2007). The Joint Board recommends that such reforms include conversion of the high-cost funds to three separate funds for ILECs, wireless ETCs, and broadband ETCs, with an overall cap on these funds. Emphasis in the wireless and broadband funds would be placed on deployment of infrastructure in unserved areas. The Joint Board also recommends that only a single provider in each category be supported, potentially using reverse auctions, and that ETCs receive support based on their actual costs rather than on the costs of the ILEC.

The *Universal Service for Americans Act* (U.S. Congress, 2007b) [1] , introduced by Senators Stevens, Lott, and Hutchinson, was based on the Universal Service title of the 2006 *Advanced Telecommunications and Opportunities Reform Act* (U.S. Congress, 2006), which passed out of the Senate Commerce Committee, but never made it to the Senate floor. With regard to distributions, the bill adds a separate $500M fund for broadband providers in unserved areas and creates a separate fund for support in insular areas (e.g. Alaska and Hawaii). The bill does not place a cap on the Fund or implement reverse auctions, maintains identical support, prohibits restriction of support to a primary line, and is silent on embedded versus forward-looking cost and on disaggregation. With regard to contributions, the bill expands the Federal USF base to include intrastate communications, VoIP, and broadband, and expands the State USF base to include interstate communications and VoIP but not broadband. It allows contributions to be based on revenue, numbers, and/or capacity.

The *Universal Service Reform Act of 2007* (U.S. Congress, 2007a), introduced by Representatives Boucher and Terry, is most comprehensive proposal in the House. With regard to distributions, the bill places a cap on the high-cost funds, adopts actual costs (excluding spectrum), prohibits restriction of support to a primary line, defines a wireless carrier's service area as their basic trading area, disaggregates support in the non-rural fund to wire centers, explicitly funds broadband, and includes a broadband mandate. With regard to contributions, the bill expands the Federal USF base to include intrastate communications, VoIP, and broadband, and similarly expands the State USF base to include interstate communications, VoIP, and broadband. It allows contributions based on revenues and/or numbers.

3. Goals of universal service

This section briefly states updated goals for Universal service. These goals will be implemented through a layered approach to high-cost fund distributions in sections 4 and 5, and to fund contributions in section 6.

The principal stated goal of the USF to date has been to increase the deployment of voice service and to equalize the charges for basic phone service between urban and rural areas. The percentage of households with phones peaked at about 96% in the early part of this decade, and has been decreasing since then, partially due to substitution of cell phones for wireline phones (FCC, 2007). Telephone penetration remains significantly lower for households with low income, but USF LifeLine and LinkUp are not addressed in this paper.

Much of the current debate over the USF has shifted from voice service to broadband Internet, since there remain substantial differences between urban and rural deployment of broadband. Rural areas can be more costly to serve, and deployment of new communications technology such as broadband is less developed (U.S. General Accounting Office, 2002; Kruger and Gilroy, 2007). It is widely believed that ubiquitous and rapid adoption of broadband would result in a large increase in jobs and gross domestic product (Kruger and Gilroy, 2007).

The size of the high-cost funds increased from $2.93B in 2002 to $4.29B in 2007, while assessed revenues decreased from $302B to $300B in a similar time period [2] . Due to both the growth of the size of the Fund and the increase on the contribution factor (the USF assessment expressed as a percentage of interstate and

[1] All bills from the 110th Congress expired at the end of 2008. However, similar bills are likely to be reintroduced in the 111th Congress in 2009.

[2] 2001 to 2006.

international telecommunications revenue), Congress views the current system as not sustainable (Goldfarb, 2006).

The principal purpose in this proposal is to reposition the USF for an everything-over-IP world. Much of the current debate over the USF concerns whether it should explicitly adopt a goal to increase the deployment of broadband. Based on technological convergence, this proposal accepts this goal and aims to refocus the Fund on a broader set of objectives that includes both voice and broadband. Not only should rural broadband be a goal of the Fund, but the Fund should encourage future communication services.

The second purpose in this proposal is to encourage competition. In recognition that technological convergence is tearing down technology barriers between various providers of communication services, competition should be encouraged for service in rural areas.

The third purpose in this proposal is to tightly focus the program. The current program expresses objectives in terms of access and pricing of telecommunication services to *consumers* but provides subsidies for infrastructure to *carriers*. This conflation of application and infrastructure creates confusion over the purpose and operation of the Fund in reference to new technologies such as VoIP.

The final purpose in this proposal is to make the Fund viable for a period of many years, so that statutes do not have to be rewritten when the next change in technology might make the term *broadband* dated and of limited use.

Throughout this paper, proposed statute language is included that could be included in a Congressional bill. Proposed statute language is formatted indented and in *italics*. These updated goals for Universal Service could be summarized by Findings and Purposes, as are commonly included in bills:

SEC. 1. FINDINGS.

The Congress finds the following:

(1) *The Universal Service Fund has contributed to the nearly universal deployment of voice service and the equalization of charges for basic phone service between urban and rural areas.*

(2) *New communication services such as broadband Internet have become a significant enabler of economic growth, and rural areas lag in deployment of such services.*

(3) *The current State and Federal mechanisms used to collect and distribute universal service support are not sustainable in a competitive and rapidly changing technological environment.*

SEC. 2. PURPOSES.

The purposes of this Act are-

(1) *to broaden the goals of universal service and to encourage the deployment of new and future communications services in rural areas;*

(2) *to encourage competition for communications services, so that rural Americans can have access to modern communications technologies at equitable prices;*

(3) *to ensure the universal service high-cost program is tightly focused on these goals and results in efficient investments; and*

(4) *to reform the universal service contribution base to ensure its long-term viability, to make it sustainable under future changes in technology, and to make it consistent with revised program goals.*

4. Eligible Telecommunications Carriers and Supported infrastructure

This section considers which network infrastructure should be supported by the high-cost funds. The first two subsections discuss current ETC obligations and supported infrastructure and briefly restate the problems with the current approach. The following three subsections propose a layered approach to defining supported infrastructure and service areas. With the new layered model in hand, section 5 considers fund growth. Sections 4 and 5 therefore together address the distribution side of the Fund. Section 6 addresses the contribution side of the Fund.

4.1. *Current ETC obligations and supported infrastructure*

Common carriers can apply to state commissions or the FCC to be designated as an Eligible Telecommunications Carrier (ETC), and thus be eligible to receive universal service funds. In order to be designated as an ETC, a common carrier must offer the services supported by the federal universal service mechanisms, upon reasonable request, throughout the designated service area, either by using its own facilities or by using a combination of its own facilities and resale of another carriers services, and must advertise these services throughout the designated service area. The default service area for an ETC is the study area of the ILEC that serves that region. However, an ETC can be certified for only a portion of an ILEC's rural study area if the ETC is not judged to be disproportionably serving the high-density low-cost subsets of the study area. The FCC interprets reasonable requests as those within the ETC's licensed service area that can be accommodated at reasonable cost.

In addition, an ETC must: (1) provide a five-year plan demonstrating how high-cost universal service support will be used to improve its coverage, service quality or capacity in every wire center for which it seeks designation and expects to receive universal service support; (2) demonstrate its ability to remain functional in emergency situations; (3) demonstrate that it will satisfy consumer protection and service quality standards; (4) offer local usage plans comparable to those offered by the incumbent local exchange carrier in the areas for which it seeks designation; and (5) acknowledge that it may be required to provide equal access if all other ETCs in the designated service area relinquish their designations pursuant to section 214(e)(4) of the Communications Act (FCC, 2005b).

The high-cost funds of the USF provide support for ETCs operating in rural, high-cost, and insular areas. Support is provided through eight funds [3] that differ by recipients (rural ILECs, non-rural ILECs,

[3] The eight high-cost funds are:

HCLS: The High-Cost Loop Support fund is available to rural ILECs and ETCs to help with non-traffic sensitive intrastate costs. It reimburses 65%-75% of the ILEC's non-traffic sensitive local loop embedded costs exceeding 115% of a national average cost benchmark. Prior to 2000, support was also available to non-rural ILECs at lower rates, but this support has been phased out by 2006. There is a cap on the fund that adjusts according to the rate of growth in working loops of rural carriers plus the rate of inflation as measured by the Gross Domestic Product Chained Price Index (GDP-CPI).

SNAS: The Safety Net Additive Support fund is also available to rural ILECs and ETCs to help with non-traffic sensitive intrastate costs. It effectively removes the cap on the HCLS fund for those carriers whose costs per loop increase by more than 14% annually. The SNAS fund is capped.

SVS: The Safety Valve Support fund is also available to rural ILECs and ETCs to help with non-traffic sensitive intrastate costs. It effectively removes the cap on the HCLS fund for those carriers that acquire high cost exchanges. The SVS fund is capped.

HCMS: The High-Cost Model Support fund is available to non-rural ILECs and ETCs to help with non-traffic sensitive intrastate costs. In contrast to the HLCS fund which is based on embedded costs of each carrier, the HCMS fund is based on aggregated statewide forward-looking costs. It provides aggregate support to non-rural carriers in a particular state if the total statewide forward-looking costs of intrastate supported services is above a national cost average benchmark. In states that receive HCMS support, funds are allocated to wire centers with forward-looking costs above the benchmark. The amount that a non-rural carrier receives through HCMS depends on the wire center cost and on the number of lines served by the carrier. The fund is not capped.

ICLS: The Interstate Common Line Support fund is available to rate of return regulated carriers (and corresponding ETCs) to help with non-traffic sensitive *interstate* costs. It is gradually replacing Common Carrier Line (CCL) charges, and the amount provided is based on rate-of-return regulation. The fund is not capped.

LTS: The Long-Term Support fund was also available to rate of return regulated carriers that participated in the National Exchange Carrier Association pool (and corresponding ETCs) to help with non-traffic sensitive interstate costs. It reduced CCL charges, and the amount provided was based on rate-of-return regulation. The fund was merged into the ICLS fund in 2004.

IAS: The Interstate Access Support fund is available to price cap regulated carriers (and corresponding ETCs) to help with non-traffic sensitive *interstate* costs. It is gradually replacing CCL charges. Funds are targeted to low density areas, and the amount provided is based on the amount of CCL charges replaced above the Subscriber Line Charge (SLC). The fund has a $650M target size.

LSS: The Local Switching Support fund is available to ILECs with study areas of 50,000 or fewer access lines (and corresponding ETCs) to help with traffic-sensitive switching costs. It reduces traffic-sensitive access charges to inter-exchange carriers, and the amount is based on rate-of-return regulation. The fund is not capped.

ETCs, rate of return carriers, price cap carriers), by geography (intrastate, interstate), and by the type of infrastructure (non-traffic sensitive, traffic-sensitive) (FCC, 2007).

4.2. *Problems*

There are several problems that have been discussed in the literature concerning obligations of an Eligible Telecommunications Carrier and supported infrastructure. The high-cost funds were originally intended to expand the number of residences with wireline phones, and to equalize the rates charged for phone service in urban and rural areas. As a consequence, the obligations of an ETC are principally concerned with phone service, and the distributions of the high-cost funds only explicitly address telephone network costs.

However, since the last revision of USF statutes, the number of wireline phone lines has peaked and the number of wireless phone lines has skyrocketed. The number of wireless lines now exceeds the number of wireline lines, and in many rural areas wireless service has become more cost-effective than wireline service. As a result, many wireless providers have become CETCs and high-cost fund distributions to CETCs have risen from $46M in 2002 to $1137M in 2007 (FCC, 2007). Many blame the growth of the USF almost entirely on this growth in CETCs, although the analysis below indicates blame should be shared with increases in ILEC line costs.

In funds that support rural carriers, distributions are based on the costs of the ILEC (the original provider of wireline phone service) in each ILEC study area. Wireless providers, however, have different service areas (based on spectrum licenses) that do not entirely coincide with ILEC study areas. As a consequence, wireless ETCs have often requested to serve only a portion of an ILEC study area, and have often been accused of cream-skimming (serving only those portions of an ILEC study area that are relatively low cost). In addition, VoIP has become an alternative voice service. Most cable companies now offer phone service using VoIP, and a few have become ETCs to support this service. Similar problems can occur with cable company service areas.

Finally, although the high-cost funds currently *implicitly* support broadband infrastructure, there are active debates over whether USF should *explicitly* support broadband.

The historic distinctions between the telephone network, cable video networks, the Internet, and wireless networks are disintegrating. Integration is creating networks that support a wide variety of voice, video, and data applications. In an everything-over-IP network, many existing distinctions no longer apply. Voice becomes only one of a large number of services that carriers offer. Definition of a standardized basket of universal services thus becomes difficult, since users will differ greatly in which services are of interest to them. Requiring a carrier to offer all services will likely be overly restrictive and inefficient. References to ILEC costs and service areas become arbitrary. Costs become much less distance-sensitive, and thus are less often identifiable as intrastate or interstate. The future will bring challenges to the USF far in excess of today's debate around supporting broadband. In an everything-over-IP network, there will be no distinction between telephone network infrastructure and Internet infrastructure, and hence no clear distinction between costs related to voice and broadband.

The current USF program expresses objectives in terms of access and pricing of telecommunication services to consumers but provides subsidies for infrastructure to carriers. This conflation of application and infrastructure creates confusion over the purpose and operation of the Fund in reference to new technologies.

As an example, consider VoIP service. Should VoIP providers receive USF distributions? Consider the following scenarios:

(a) A rural local exchange carrier offers VoIP over twisted-pair lines, and routes the traffic onto the Public Switched Telephone Network (PSTN).
(b) A rural cable operator offers VoIP over cable, and routes the traffic onto the PSTN.
(c) A rural cable operator offers VoIP over cable, and routes the traffic over the Internet.
(d) A rural local exchange carrier also operating as a cable operator offers VoIP over cable.

(e) A company offers VoIP service for a fee to rural consumers who already purchase broadband service from another provider.
(f) A company offers VoIP service to rural consumers who already purchase broadband service from another provider, but charges only for calls routed onto the PSTN.

Which of these VoIP providers should receive USF distributions? Does it matter if the VoIP service provider is a facilities-based carrier or not? If so, what type of facilities count – local loops? lines? routers? Does it matter if the VoIP traffic is routed from the Internet to the PSTN (or vice versa) or if it runs entirely over the Internet? Does it matter if the carrier is a local exchange carrier or a cable operator?

Similar problems arise with broadband service. Which of the following should be eligible for USF distributions?
(a) a rural local exchange carrier offering broadband over Digital Subscriber Line (DSL).
(b) a rural cable operator offering broadband over cable.
(c) a wireless carrier offering fixed broadband in a rural location.
(d) a wireless carrier offering mobile broadband including rural areas.
(e) an Internet Service Provider who offers Internet services in conjunction with a local exchange carrier offering DSL service?

Convergence will only make the issue worse. How should USF address rural local exchange carriers or cable operators who provide video over the same IP networks as broadband? Application providers who offer services that integrate voice, video, and data for specific interactive applications such as gaming? Packages in which the voice component is provided free on top of other higher end services?

The distinction between voice network infrastructure and broadband network infrastructure is quickly disappearing, and USF funds are already being used by many carriers to deploy combined voice and broadband network infrastructure (discussed more below).

4.3. *Layered network architecture*

Much of the confusion regarding what the USF should support emanates from difficulties with classification of evolving communication services. The current program expresses objectives in terms of access and pricing of telecommunication *services* but provides subsidies for *network infrastructure*. It attempts to assess revenue from voice applications in order to subsidize voice infrastructure; in reality, it assesses revenue from voice applications and subsidizes combined voice and broadband infrastructure. Many of the questions above concern whether VoIP or broadband is principally a service or network infrastructure, whether the type of network infrastructure matters, and whether the type of service provider matters.

The principal idea in this paper is to separate this conflation of support for network infrastructure but assessment of revenue from network applications by both support for and assessment of only network infrastructure. Furthermore, the goal is to remove reference to voice (or any specific list of applications) as the principal supported service. This approach relies on the ability to partition the network into applications and infrastructure.

Telephone networks, cable video networks, cellular networks, and the Internet are all based on the concept of a layered architecture. Each network device, and the network as a whole, is abstractly modeled as being composed of a number of vertical layers. Each layer provides certain functionalities.

The reference model for layered architectures is the Open Systems Interconnection (OSI) model, developed by the International Standards Organization. The OSI model is composed of 7 layers, as pictured in figure 1. OSI layer 1, called the physical layer, implements encodes a bit into a physical signal and vice versa. OSI layer 2, the data link layer, translates a packet into a set of bits and vice versa, and implements a set of rules (called a protocol) about which device can transmit when. OSI layer 3, the network layer, is concerned with routing a packet from one network device to the next. OSI layer 4, the transport layer, is concerned with functionality required to form a complete connection between a source and destination, including dealing with lost packets and responding to congestion. OSI layer 5, the session layer, manages an entire communication session, e.g., logging onto a service. OSI layer 6, the presentation layer, concerns data presentation, e.g., file or video compression. Finally, OSI layer 7, the application layer, deals with user

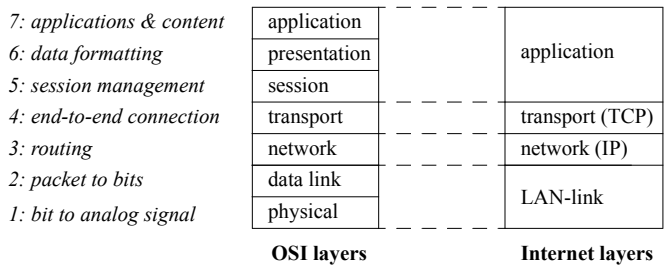

Fig. 1. OSI and Internet layered models

applications and other high-level functionality, e.g., web browsing, e-mail, file transfer, file sharing, instant messaging, gaming, etc.

Not every network device contains all 7 layers. Personal computers do contain all 7 layers - the network interface card (e.g., Ethernet card) implements OSI layers 1 and 2, the operating system (e.g., Windows) implements OSI layer 3 and part of layers 4 through 7, and user-installed software implements the remainder of layers 4 through 7. A network router, however, often contains only layers 1 through 3.

Layers 1 through 3 can be thought of as network infrastructure, while layers 4 through 7 can be thought of as network applications. This distinction will be discussed in more detail below as the impact of layered architectures upon communications policy is considered.

Although the OSI model serves as a reference for all network architectures, different networks have modified the model for their own use. As an example, the Internet uses a model with a reduced number of layers, as pictured in figure 1. OSI layers 1 and 2 are combined into a single Internet LAN-link layer. OSI layer 3 is also called the Internet network layer; it includes the Internet Protocol (IP). OSI layer 4 is also called the Internet transport layer; it includes the Transmission Control Protocol (TCP). OSI layers 5 through 7 are merged into a single Internet applications layer.

4.4. *A layered regulation model*

The rationale of this proposal is that the USF should both support and assess physical network infrastructure not applications. More specifically, the Fund should support network infrastructure whose cost per subscriber is sensitive to geographical subscriber density. The question is how to determine which portions of the network are infrastructure and which are applications.

The FCC has provided little useful guidance on this matter. The result of the Computer I (FCC, 1971) and Computer II (FCC, 1980) inquiries was roughly to classify the Internet LAN-link layer as basic or telecommunication services and to classify the IP and higher Internet layers as enhanced or information services. More recently, the FCC classified broadband offered over DSL and broadband over cable networks as information services (FCC, 2002, 2005a). As of the date of writing, the FCC is currently considering adding broadband as USF supported network infrastructure (FCC, 2008a), but not as an assessed application. Although VoIP has not been classified, the FCC is treating facilities-based VoIP providers as infrastructure but non facilities-based VoIP as an application. The FCC has yet to classify other IP-enabled services.

The goal is to specify which network infrastructure to support. Supported network infrastructure should consist of components whose cost per subscriber is sensitive to geographical subscriber density. Fortunately, this is easy to identify using the OSI model. OSI layers 1 through 3 must be implemented at every network hop from source to destination; these layers therefore include those network mechanisms that must be provided by each carrier on their portion of the network, namely those that are sensitive to subscriber density. In contrast, OSI layers 4 through 7 need only be implemented at the endpoints (the source and destination); these layers include mechanisms that are not sensitive to subscriber density. USF supported infrastructure should therefore be restricted to OSI layers 1 through 3. As a result, supported infrastructure will include network infrastructure that is high barrier-to-entry, and exclude applications that are low barrier-to-entry.

This layered approach works equally well with both circuit-switched and packet-switched networks, including the PSTN, the Internet, wireless networks, and cable networks, since all are based on layered models.

Communication at or below the network layer does not meaningfully change the content of the information, whereas some protocols above the network layer create, store, or change the presentation of information, so this definition roughly complies with the original intent (but not more recent FCC implementation) of the distinction between telecommunication and information services.

Note, however, that the layers of a service are defined by its functionality, not by the device that implements the service. Many implementations of the functionality within a specific layer will combine both hardware and software [4] . Supported infrastructure will thus include all infrastructure required for transport functionality in both telephone and broadband networks (e.g. loops and switches for circuit-switched voice and video conferencing, and loops and switches for packet-switched voice, video, and data), but exclude higher-level functionality (e.g. call-forwarding, voicemail, IP-enabled service, email storage, and other applications).

Services offered to the consumer require functionality at multiple layers. The terms *broadband service* and *Internet access* are often used imprecisely to mean various functionalities at various layers. Only the portion of broadband service at network layer and below should be supported. This includes the basic high barrier-to-entry functionality that allows a subscriber to access the Internet, but excludes value-added low barrier-to-entry services (e.g. email or web-hosting) that are competitively offered by many application providers. Similarly, only the portions of VoIP at network layer and below should be supported. This is consistent with the current implementation, which allows support only for facilities-based VoIP providers.

This use of layers to delineate infrastructure from applications differs from other layered approaches taken in the USF literature. Weinberg (2001) proposes associating both USF high-cost contributions and distributions with physical facilities, defined in a layered manner. He does not, however, specify which layers to define as physical facilities. Sicker (2003) proposes a four layer model consisting of content, applications, transport, and access that does not necessarily map directly into the Open Systems Interconnection (OSI) model. With respect to the USF high-cost funds, he proposes that both the contribution base and the distribution base be restricted to transport and access providers. He classifies VoIP as an application, and thus excludes VoIP from the USF. Although the proposal in this paper agrees with assessing services at the same layers to which distributions flow, the idea is to use the OSI model to delineate the layers, and exclude the OSI transport layer (which resides just above the network layer) from USF since the cost of this layer is not density dependent, whereas Sicker (2003) would probably include the OSI transport layer in his transport layer. This proposal also disagrees with the classification of VoIP solely as an application layer service, and includes within USF those portions of VoIP at the network layer and below.

This delineation of infrastructure from applications is potentially of use more broadly within telecommunications policy. Wherever it has been of value to consider the distinction between telecommunication services from information services, this new definition of communication services may help make a case for substantially different regulation of infrastructure than of applications. In particular, Jordan (2007) uses a similar distinction to argue that net neutrality can be implemented by requiring an open interface between infrastructure and applications. Whereas many papers in the literature have argued for similar horizontal regulation (see e.g. (Lessig, 2001; Werbach, 2002; Solum and Chung, 2003; Whitt, 2004)), most of these layered models combine OSI layers 3 and 4 (the Internet network and transport layers) into a single logical layer, whereas the approach taken here proposes that OSI layer 3 should be classified as infrastructure and OSI layer 4 should be classified as applications.

This layered approach can be formalized using new definitions. A new term *communication services* is introduced to replace *telecommunication services* to restrict both contributions and distributions to network infrastructure not applications:

SEC. 3. DEFINITIONS.

Section 3 of the Communications Act of 1934 (47 U.S.C. 153) is amended-

***(1)** by inserting after paragraph (10) the following:*

> ***"(10A)** COMMUNICATIONS INFRASTRUCTURE.- The term 'communications infrastructure' means all network infrastructure required to support communication services.*

[4] *Firmware* is software that is embedded within a hardware device; while it usually is used to implement functionality at OSI layers 1 through 3, it can be used to implement higher layer functionality at an endpoint. *Middleware* is software that allows multiple processes to interact across a network; it is implemented in the Internet application layer.

*"**(10B)** COMMUNICATIONS SERVICES.- The term 'communications services' means all services-*
*"**(A)** over a network that uses a public right-of-way;*
*"**(B)** over a portion of the network that interconnects to other networks; and*
*"**(C)** that reside at or below the network layer or are required to manage the network."; and*
***(2)** by inserting after paragraph (29) the following:*
*"**(29A)** NETWORK LAYER.- The term 'network layer' means the third layer of the 7-layer Open Systems Interconnection Model responsible for message addressing and for routing information within the network, including routing within the telephone network and including the Internet Protocol within the Internet.".*

Start with the term *communications services* [5] . Item (C), together with the definition of *Network Layer* implements the delineation between infrastructure and applications discussed above. Item (A) restricts USF support to networks that use a public right-of-way, and is assumed to include the rights-of-way used by ILECs, cable companies, and spectrum used by wireless providers [6] .

Item (B) ensures that USF supports infrastructure only when it is available to support applications that can be provided by any party, not just by the communications service provider that provides subscribers end access to the network. It can be integrated with network neutrality or other open access requirements to strengthen this intention (see e.g. (Jordan, 2007).) As a result, companies that offer services entirely over their own networks are excluded from the definition of communication services, and therefore from participation in USF; the most common example of this would be cable companies that offer services entirely over their own networks through title VI.

The term *communications infrastructure* is simply defined as all network infrastructure required to support communications services.

In the following sections, these terms will be used to limit the scope of both USF distributions and contributions. Support is thus focused directly on communications network infrastructure, without reference to a standardized basket of telecommunications services that qualify as universal service. Similarly, contributions are required from all communications services, whether to support voice, video, or data. This technology-neutral approach repositions USF for future converged networks. In particular, such a layered approach erases the distinction between support for telephone service and broadband access.

4.5. *Proposal for supported infrastructure*

As discussed above, it has been less than clear which VoIP components should be eligible for USF distributions. In addition, if broadband is to be supported, it is also less than clear which broadband components should be eligible for support. Future IP services that integrate telecommunication components will make the situation even murkier. The distinction between voice network infrastructure and broadband network infrastructure is quickly disappearing. The evolving network infrastructure will support integrated voice, video, and data applications.

This evolution toward an everything-over-IP network makes the current definition of universal services problematic. Under section 254(c) of the Communications Act, universal service is "an evolving level of telecommunications services that the Commission shall establish periodically under this section, taking into account advances in telecommunications and information technologies and services." The definition of supported services must take into consideration whether a service has been subscribed to by a substantial

[5] One note of caution: the term *telecommunications service* pervades the Communications Act of 1934. Corresponding changes from *telecommunications service* to *communications service* could be carefully considered elsewhere, but are not required for this proposal.

[6] This is a bit tricky, as different parts of the Communications Act apply to different types of communication. In particular, since *telecommunication service* is defined as "the offering of telecommunications for a fee directly to the public, or to such classes of users as to be effectively available directly to the public, regardless of the facilities used", it may be of value to modify the definition of communication services proposed here to consider public services rather than just use of public right-of-way. However, this may cause two problems. First, it is preferable to have a definition that does not rely on the end service sold to the user, since many communication services will not be directly sold to the public but instead support applications that are sold to the public. Secondly, networks that do not use a public right-of-way may be regulated in a very different manner.

majority of residential customers; this provision has delayed inclusion of broadband into the definition. However, as voice, data, and video services merge, how will the FCC determine which should be included in the definition of universal service. Should adoption by a minority of residential customers disqualify a service? What will they do about network infrastructure shared between a wide variety of services, some of which qualify and some of which do not?

The only viable long-term strategy for the USF is to support the integrated network infrastructure that underlies all combinations of such applications. Convergence should be embraced and the USF should support all communication services. These services may be offered on networks engineered to provide superior service for a targeted set of applications, or more likely be offered on broadband IP networks that support a wide variety of integrated applications. This approach removes the need for a definition of *Universal Service*, and hence section 254(c) of the Communications Act could probably be removed. At a minimum, 254(c)(1)(B) should be deleted to remove the requirement that universal services be subscribed to by a substantial majority of residential customers.

The groundwork for this approach has been laid with the introduction of the terms *communication services* and *communication infrastructure* in the previous section. Using this layered approach, the USF can directly support communications infrastructure, without reference to a standardized basket of telecommunications services that qualify as universal service:

SEC. 4. UNIVERSAL SERVICE HIGH-COST FUNDS DISTRIBUTION.

(a) *QUALIFYING UNIVERSAL SERVICE INFRASTRUCTURE LIMITATIONS.- In carrying out section 254(b)(3) of the Communications Act of 1934 (47 U.S.C. 254(b)(3)), the Federal Communications Commission, acting through the Universal Service Administrative Company, shall ensure that-*

- ***(1)*** *support under the Universal Service Fund high-cost funds is made available exclusively for communications infrastructure in rural, insular, and high-cost areas;*
- ***(2)*** *in areas in which only a portion of the network infrastructure is communications infrastructure, support under the high-cost funds is prorated to reflect the ratio of communications infrastructure to all network infrastructure;*

This proposed statute language requires that the USF high-cost funds be used exclusively for *communications infrastructure* in high-cost, rural, and insular areas. As discussed below, USF funds are already being used by many carriers to deploy combined voice and broadband network infrastructure. Support for broadband is therefore currently implicit. Since communications infrastructure can be used to support both voice and broadband service, section 4(a)(1) makes support for broadband infrastructure explicit, but it does this in a technology-neutral manner that will survive future changes in technology. Such an approach would allow for a reduction in the number of high-cost funds. It would also elegantly remove the distinction between wireline voice, wireless voice, and broadband, and therefore remove the need for the three separate wireline, wireless, and broadband funds proposed by the Joint Board.

There are likely to be situations when network infrastructure is shared between communications services and non-communications services, e.g. a local access network that is used to support voice, broadband, and video. If the video is offered over a portion of the network that resides entirely in the access providers domain, as is likely if it is offered under title VI, then it does not qualify as a communications service. Correspondingly, under 4(a)(2), the carrier is eligible for funds only for the portion of the infrastructure that qualifies as communications infrastructure.

A summary of this proposal, in comparison to current law and Congressional bills, is presented in figure 2. None of the congressional bills explicitly goes this far toward integrating voice and broadband. The Stevens bill (U.S. Congress, 2007b) creates a separate $500M fund for broadband in unserved areas, with a single broadband provider in each area qualifying for these funds. It also creates a separate fund for insular areas, but does not otherwise modify USF distributions. The Boucher/Terry bill (U.S. Congress, 2007a) expands the definition of universal services to include broadband, and therefore explicitly includes support for broadband in USF distributions. It also includes a mandate that ETCs offer broadband (at a rate of at least 1Mbps within 5 years). None of these bills uses a layered approach.

In contrast, this proposed approach is technology-neutral. It erases the distinction between support for telephone service and broadband access, and it should survive future changes in network technology and services.

Issue	Subissue	Current law	Stevens	Boucher/Terry	Joint Board proposal	This proposal
Contributions	assessed services	interstate & international telecommunication services	adds intrastate, VoIP, broadband	adds intrastate, VoIP, broadband	silent	adds intrastate, communication services, including facilities-based VoIP and broadband
	methodology	telecommunication services revenues	revenue, numbers, and/or capacity	revenues and/or numbers	silent	revenues associated with communication services infrastructure
	state USF	intrastate telecommunication services	adds interstate, VoIP	adds interstate, VoIP, broadband	silent	adds interstate; assess all communication services based on primary place of use, including infrastructure portions of facilities-based VoIP and broadband
High Cost Distributions	ETC obligations	must offer universal services (see description in text)	silent	broadband mandate; all ETCs must act as a COLR	obligation associated with fund	replaces mandated services with distributions for services rendered and for costs related to COLR obligations
	supported infrastructure	see list of current funds	as current, plus adds separate fund for insular areas	as current	single wireline, wireless, and broadband provider per area	support all communication services infrastructure, defined by layers
	broadband	implicit support for shared voice/bb infrastructure	supports single facilties-based provider per unserved area through a separate fund	supports	primarily for construction in unserved areas	supports portion included in communication services infrastructure
	primary line	silent	prohibits	prohibits	silent	oppose; support based on customers served & services rendered
	aggregation	rural: several choices by rural ILEC; non-rural: wire center	silent	silent	silent	wire center, with recommendation for smaller granularity
	service area	case by case cream-skimming analysis if serving less than rural study area	silent	wireless service area = basic trading area	silent	subset of wire center in which ETC is licensed
	actual costs	ILEC costs	silent	actual costs (excluding spectrum)	actual costs	actual costs
	cap	on some funds; some caps indexed	silent	cap on total high-cost funds indexed by inflation & line growth	cap on each fund, decreasing over time	recommend cap indexed by communication services revenue
	reverse auctions	not used	silent	silent	recommended	oppose

Fig. 2. Summary of recommendations

4.6. *Service Area Reform*

The normal situation is that an eligible telecommunications provider will provide service upon request in the entire study area of a rural local exchange carrier (RLEC). For wireless communication providers, however, this can be a problem since they may have spectrum licenses over only a portion of a study area. It is thus increasingly common for an ETC applicant to request to serve only a subset of a RLEC's study area.

Currently, however, the support level is determined by the RLEC's average per line cost over the study area. Since the per-line cost often varies substantially over a study area, inversely proportional to subscriber density, this creates a potential for *creamskimming*, which occurs when ETCs serve a disproportionate share of the low-cost, high revenue customers in a RLECs study area. When an ETC applies for USF distributions in a subset of a RLEC's study area, the FCC conducts a creamskimming analysis that compares the population density of each wire center in which the ETC applicant seeks designation against that of the wire centers in the study area in which the ETC applicant does not seek designation (FCC, 2005b). Based on this analysis, the Commission denies designation if it concludes that the potential for creamskimming is contrary to the public interest.

The root cause of this issue is again technological convergence. Since different providers have deployed network infrastructure in different geographical regions, reference to average costs over the LEC's service area is now outdated.

The solution requires addressing both the definition of a service area and the geographical units over which costs are calculated. The two are connected – the service area determines the region in which an ETC is required to provide service upon reasonable request, and the cost basis determines the extent to which an ETC has motivation to cover an area.

One approach that would solve both issues is to disaggregate costs to very small geographical units. If wireline, wireless, and cable ETCs service areas could all easily be described in terms of these small geographical units, then reference to any particular type of provider's service area can be avoided. Furthermore, if costs are disaggregated to small enough units so that costs accurately represent residential density, then the requirement to serve an entire service area can also be removed; the financial incentive should be enough to attract providers to each geographical unit. This approach would also easily accommodate service areas that change whenever a provider obtains or loses access to public right-of-way or spectrum in different areas.

However, disaggregation to very small geographical units may increase the complexity of accounting too much to be politically acceptable. A more moderate approach that can still make substantial progress on both problems (service area definition and cost basis) is to recognize that three types of providers are currently recognized in the Communications Act: wireline, wireless, and cable. Reliance on the ILEC's study area can be removed by allowing wireless and cable ETCs to serve a subset of a study area if it serves all areas for which it is licensed:

SEC. 5. UNIVERSAL SERVICE AREA REFORM.

(a) *MODIFICATION OF SERVICE AREA DEFINITION FOR WIRELESS AND CABLE.- Section 214(e)(5) of the Communications Act of 1934 (47 U.S.C. 214(e)(5)) is amended by adding at the end "In the case of a commercial mobile service (as defined in section 332(d)) that is an eligible telecommunications carrier, the term 'service area' may, at the election of such carrier, be all areas within an incumbent local exchange carrier's service area for which the commercial mobile service has spectrum licenses. To the extent that a cable operator (as defined in section 602(5)) is treated as a common carrier and, as such, is an eligible telecommunications carrier the term 'service area' may, at the election of such carrier, be all areas within an incumbent local exchange carrier's service area for which the cable operator has a franchise (as defined in section 602(9)).".*

Subsection 5(a) codifies the service areas for wireless carriers and cable companies offering communication services. Such providers may elect a service area that consists of the subset of an ILEC's service area for which the provider has spectrum or franchise licenses.

This does not completely solve the cream-skimming issue, since the CETC's licensed area may be lower-cost than the ILEC's average cost over its study area. A moderate approach to solving this problem has been

suggested in past years using *wire center averaging*, in which USF distributions are based on the average cost in each wire center. An example of such an approach is taken from the *Rural Universal Service Equity Act of 2003* (U.S. Congress, 2004):

> ***(b)*** *FCC TO REVISE SUPPORT LEVEL.- Section 254 of the Communications Act of 1934 (47 U.S.C. 254) is amended by adding at the end the following new subsection:*
>
> *"**(m)** UNIVERSAL SERVICE SUPPORT FOR HIGH-COST AREAS.-*
>
> *"**(1)** CALCULATING SUPPORT.- In calculating Federal universal service support for eligible telecommunications carriers that serve rural, insular, and high-cost areas, the Commission shall revise the Commission's support mechanism for high-cost areas to provide support to each wire center in which the carrier's average cost per line for such wire center exceeds the national average cost per line by such amount as the Commission determines appropriate for the purpose of ensuring the equitable distribution of universal service support throughout the United States.*
>
> *"**(2)** HOLD HARMLESS SUPPORT.- In implementing this subsection, the Commission shall ensure that no State receives less Federal support calculated under paragraph (1) than the State would have received, up to 10 percent of the total support distributed, under the Commission's support mechanism for high cost areas as in effect on the date of the enactment of this subsection.*
>
> *"**(3)** LIMITATION ON TOTAL SUPPORT TO BE PROVIDED.- The total amount of support for all States, as calculated under paragraphs (1) and (2), shall be equivalent to the total support calculated under the Commission's support mechanism for high cost areas as in effect on the date of the enactment of this Act.*
>
> *"**(4)** CONSTRUCTION OF LIMITATION.- The limitation in paragraph (3) shall not be construed to preclude fluctuations in support on the basis of changes in the data used to make such calculations.*
>
> *"**(5)** IMPLEMENTATION.- Not later than 180 days after the date of the enactment of this Act, the Commission shall complete the actions (including prescribing or amending regulations) necessary to implement the requirements of this subsection.*
>
> *"**(6)** COMMISSION'S SUPPORT MECHANISM FOR HIGH-COST AREAS DEFINED.- In this subsection, the term 'Commission's support mechanism for high-cost areas' means the mechanism described in sections 54.309 and 54.311 of the Commission's Regulations (47 C.F.R. 54.309 and 54.311, respectively).".*

Because wire centers are not small enough geographical units to remove the incentive to cream-skim, the requirement in FCC regulations to serve all residential customers within a service area must be maintained. With that provision, the combination of 5(a) and 5(b) ensures that ETCs cannot cream-skim, while removing the burden upon State commissions and the FCC to make case by case determinations (and the resulting inconsistencies).

It should be noted, however, that although this moderate approach puts wireline, wireless, and cable providers on an almost equal footing, it does maintain reference to the topology of the telephone network through the use of the term "wire center". In the future, it may be preferable to move to the use of smaller geographical units to remove this dependence.

The Boucher/Terry bill defines a communication provider's service area as a geographic area that aligns with the area in which the provider is licensed to provide service; for wireless service providers, this is explicitly defined as the company's basic trading area. This approach is similar to section 5(a). The bill does not address disaggregation. The Stevens bill does not include service area reform. These differences are displayed in figure 2.

5. Fund Growth

The previous section proposed a layered approach to defining supported infrastructure and service areas. With the new layered model in hand, this section continues discussion of the distribution side of the USF, but now focusses specifically on Fund growth. Section 6 addresses the contribution side of the Fund.

The first subsection presents a brief analysis of growth of the high-cost fund over the last 5 years. The

second subsection reviews challenges posed by this growth and by technological convergence. The third subsection proposes cost saving measures.

5.1. *Analysis*

USF support to wireless ETCs has increased rapidly, and it is widely believed that this is the principal cause for the rapid growth of the USF. In addition, many believe that USF support for broadband would cause the size of the fund to double or triple. In this subsection, data is presented that indicates that a significant component of USF growth has been caused by implicit support for wireline broadband. On this basis, policymakers' determination of an overall limit on the size of the Fund is more viable in the long-term than artificial distinctions between voice and broadband distributions.

This analysis of USF growth is based on high-cost funds distributions during the fiscal years 2002 through 2007 (FCC, 2007) [7]. During this 5 year period, the high-cost funds experienced real annual growth of approximately 5.3%, for a total growth of $974M on a 2002 base of $3317M. Of this $974M increase, approximately 55% ($537M) can be attributed to an increase in per line costs above the SLC, mostly due to an increase in the rural National Average Cost per Loop (NACPL) from $289/loop to $335/loop. Approximately 51% ($501M) can be be attributed to an increase in the number of lines supported by the USF. (The remaining -7% is unaccounted for.)

The increase in per line costs above the SLC contributes to approximately 3.0% real annual growth in the high-cost funds. This increase can be attributed to upgrading of local loops to support broadband. Since the HCLS and HCMS funds are indexed by line growth and inflation, most of the increase in the size of the high-cost funds attributed to increases in per line costs appear as growth in the ICLS fund due to rate of return regulation.

The increase in the number of lines supported by the USF contributes to approximately 2.9% real annual growth in the high-cost funds. Almost all of this growth is due to an increase in the number of rural lines supported. During the 5 year period considered, there was an annual decrease of approximately 2.7% in the number of rural lines on wireline networks (from 21.9M to 19.2M), so all of this growth (plus some) is due to increases in supported wireless lines.

5.2. *Problems*

There are several problems that have been discussed in the literature concerning growth of the USF. As discussed above, the high-cost funds were originally intended to expand the number of residences with wireline phones, and to equalize the rates charged for phone service in urban and rural areas. As a consequence, the Fund was originally designed to adjust the contributions to match required distributions. Furthermore, required distributions were calculated on the basis of ILEC wireline costs, which it was presumed, would increase no faster than the growth in lines.

However, the Fund has experienced rapid growth in the past 10 years. The high-cost funds have grown (in nominal dollars) from $1264M in 1997 to $2935M in 2002 to $4290M in 2007. Continued growth at these rates is considered politically unacceptable. As a consequence, the FCC over time has placed caps on many of the funds.

Payments from high-cost funds to CETCs have grown (in nominal dollars) from $0M in 1997 to $46M in 2002 to $1137M in 2007. Many assume that this increase, driven largely by increases in payments to wireless providers, is the principal cause for growth of the overall high-cost funds. As a consequence, the FCC has placed an interim cap on high-cost fund distributions to CETCs (FCC, 2008a).

[7] Since distributions in 2002 through 2007 were based on costs in 2000 through 2005, loop costs and number of loops are analyzed for the period from 2000 through 2005. All dollar figures are indexed for inflation during 2000 through 2005 and are given in 2007 dollars. Costs per line are measured by the rural National Average Cost Per Line (rNACPL). The decrease in real IAS distributions to CETCs during the period are attributed to the CAP on IAS. Growth in CETC distributions not associated with increases in cost per line or the IAS cap are attributed to CETC line growth.

As discussed in the previous subsection, however, the growth in high-cost funds has been caused both by increases in the number of lines supported and by increases in the real cost per line. Several proposals are under consideration. One general approach is to place a cap on the overall Fund, or on the high-cost funds that are not currently capped. A few approaches are focussed on reducing the cost per line. One idea is to use reverse auctions, in which carriers would bid on how much support they require in order to provide universal service in a particular geographical region. Another idea is to remove the identical support rule, which in rural study areas awards support on the basis of the embedded costs of the ILEC, and to calculate support on the basis of the actual costs of each provider. Yet another idea is to change the support calculation in rural study areas from embedded costs to forward-looking costs, which are presumed to be generally lower. Other approaches are focussed on reducing the number of lines supported. The most common of these is to restrict support to a single primary line per household.

Finally, the debate over whether the USF should explicitly support broadband is intimately tied to the size of the Fund. Opponents often believe that adding support for broadband will dramatically increase the size of the Fund, and that including a broadband mandate will increase the cost per line.

Additional problems will arise as the technology progresses toward everything-over-IP, rendering distinctions between wireline communications, wireless communications, telephone networks, and the Internet less meaningful. Reference to a particular provider (e.g. ILECs) and to its costs become increasingly arbitrary. So do references to a particular service (e.g. voice or broadband).

As a consequence, some of the ideas proposed are not feasible in the long run. As of the date of writing, the FCC is currently considering the use of reverse auctions (FCC, 2008c). Reverse auctions would most likely require definition of a standardized basket of universal services to be supported. The FCC is tentatively concluding that universal service be initially defined as the current universal service obligations plus broadband at a rate of at least 768kbps in one direction. In addition, the geographical area must also be specified in the auction. The FCC is tentatively concluding that ILEC study areas be used. However, if in the future users will be able to choose among a wide variety of IP-enabled services, definition of a standardized basket of universal services becomes very difficult. Furthermore, different providers have overlapping service areas, which makes design of an auction much more challenging.

Similarly, restriction to a primary line or to a single auction winner per geographical area is awkward. Already, users often choose different providers for voice, data, and video services. As users may choose to receive various services over various interfaces, it is strange to specify a single ETC per region that must provide all services.

5.3. *Proposed Efficiency Measures*

As noted, about approximately half of the real growth of the USF high-cost funds in the last 5 years was caused by increases in real per line costs above the SLC, with the other half caused by an increase in the number of lines served. To address this growth, several widely discussed cost-saving measures can be incorporated into this proposal.

The first measure is to provide high-cost fund support on the basis of subscribers rather than on the number of residences in the geographical region. This approach prevents growth caused by multiple networks serving a service area, except when customers receive service from multiple providers. One potential problem with providing support per-subscriber is that ILECs have carrier-of-last-resort obligations that require investment for customers not served. As of the date of writing, the FCC is currently considering whether there should thus be explicit support for carrier-of-last-resort obligations in addition to per-subscriber support.

The second measure is to switch from providing support to CETCs on the basis of ILEC costs to providing support to each ETC on the basis of its own costs. Such an *actual cost* approach is also tentatively proposed by the FCC (FCC, 2008b). Maintaining a reference to ILEC costs (as is currently done) requires an evolving set of predefined services and presumes that the ILEC is the reference for each such service, which is contrary to the benefit of using *communication services* as a stable technology-neutral definition. Switching to actual costs, therefore, has not only the benefit of the expected cost savings, but also of removing reference to a particular provider.

One additional measure is proposed here that has not been discussed in the literature. Support should be prorated on the basis of services rendered. For instance, if a carrier's communications infrastructure is used to provide both voice and broadband, but the customer only elects to purchase voice service, then the carrier should receive support only a prorated portion of the infrastructure. This prevents growth caused by customers receiving different services from multiple providers, and is required in this proposal since support is provided for communications infrastructure independent of a specified set of universal services.

These three measures would require substantial accounting to determine the support due to each ETC. However, the FCC does not seem to view this as a substantial barrier to the use of actual costs or per-subscriber support (FCC, 2008b,c).

These measures can be implemented using this statute language:

SEC. 4. UNIVERSAL SERVICE HIGH-COST FUNDS DISTRIBUTION.

(a) *QUALIFYING UNIVERSAL SERVICE INFRASTRUCTURE LIMITATIONS.- In carrying out section 254(b)(3) of the Communications Act of 1934 (47 U.S.C. 254(b)(3)), the Federal Communications Commission, acting through the Universal Service Administrative Company, shall ensure that-*

(3) *support under the high-cost funds is provided in a nondiscriminatory manner*

(A) *on the basis of customers actually served;*

(B) *prorated on the basis of services received;*

(C) *as necessary to meet carrier-of-last-resort obligations; and*

(D) *based on the actual cost of providing, maintaining, and upgrading facilities and services in the service area for which such support is intended.*

(b) *PHASE-IN OF CHANGES.- In carrying out subsection (a), the Commission shall ensure that the changes required in the Universal Service Fund high-cost funds required by this Act are implemented on an incremental basis over a period of not more than 5 years.*

In addition to these measures, more aggressive approaches to control of USF growth could be considered. Fund growth due to increases in per line cost could be eliminated by placing a statutory cap on the per line cost. A regulatory approach to accomplish similar purposes could be implemented by placing inflation plus line growth caps on the ICLS and LSS funds, similar to the current cap on the HCLS fund. In contrast, one could consider a cap on the high-cost funds in terms of a percentage of communications services revenue, to allow for growth in infrastructure to match growth in services. Any of these caps, however, might require eliminating the requirement that rates charged in rural areas be comparable to rates charged in urban areas, ensconced in Sec. 254(b)(3) of the Communications Act.

The Boucher/Terry bill includes a few of these approaches. The bill requires that all high-cost fund support be based on actual costs, exclusive of the cost of acquiring spectrum, or on forward-looking costs. It also requires all ETCs to act as carriers of last resort (whereas this proposal provides support for such obligations but does not interfere with the current designation process). The bill removes the individual caps on the HCLS, SNAS, and SVS funds, and replaces them with a cap on the total of the high-cost funds that adjusts according to the GDP-CPI. The Stevens bill does not include any such provisions. Both bills include prohibitions on restriction of support to a primary line. None of these bills explicitly address costs when infrastructure is shared between multiple services or when customers subscribe to a subset of these services. These differences are displayed in figure 2.

6. Contributions

This section turns to the contribution side of the USF. The first subsection briefly recounts the problems with USF assessments. The second subsection considers how to revise the contribution base to survive technological convergence. The third subsection considers the relationship between contributions to the Federal and State universal service funds.

6.1. *Problems*

Consider the contributions side of the USF. Interstate and international telecommunications revenues, which currently serves as the basis for Federal USF assessments, peaked in 2001 (FCC, 2007). In contrast, revenues from video services (cable tv, satellite tv), Internet access (cable modem, DSL), and wireless communications (cell phone, wireless Internet) have continued to increase substantially. As has commonly been observed, this makes reliance on interstate and international telecommunications revenues unsustainable.

There are two separate issues here. First, the distinction between intrastate and interstate telecommunications revenue is becoming problematic. A few decades ago, the cost of a telephone call had a substantial distance-dependent component. Today, however, most communications services are not priced by distance, but only by time. Divisions of revenue between intrastate and interstate are increasingly arbitrary. A commonly suggested fix to this problem is to add intrastate telecommunications services to the assessment basis, and this solution is proposed below.

A second issue, however, is the distinction between telecommunication services and information services. Currently, every telecommunications carrier that provides interstate telecommunication services is required to contribute to the USF (except for de minimis contributions). The bulk of these contributions come from wireline and wireless telephone calls. Whether VoIP providers and/or broadband providers should contribute to the USF remains under debate. The FCC has tentatively agreed that facilities-based VoIP providers must contribute but that broadband providers do not. However, the future of these decisions is unclear.

In addition, as noted above, there is currently a mismatch between defining the contribution base according to the applications included in universal services and defining the distribution base according to supported infrastructure. This mismatch leads to accusations that the Fund is not neutral, either by favoring some providers over others or by some technologies over others. Such problems will get worse as technological convergence increases the variety of applications supported over a merged telephone network and Internet.

6.2. *Neutrality*

Some have suggested adding VoIP and/or broadband services to the USF assessment basis. However, consider the following services:

(a) A local exchange carrier offers VoIP over twisted-pair lines, and routes the traffic onto the Public Switched Telephone Network (PSTN).

(b) A cable operator offers VoIP over cable, and routes the traffic over the Internet.

(c) A company offers VoIP service for a fee to consumers who already purchase broadband service from another provider.

(d) A company offers integrated IP-based voice and video service for a fee to consumers who already purchase broadband service from another provider.

(e) A company offers gaming service for a fee to consumers who already purchase broadband service from another provider, and includes voice service for free.

Which of these are telecommunications carriers that provide telecommunications services? Which should be classified as VoIP service? Which should be classified as broadband service? Which revenue should be assessed? Adding VoIP and/or broadband to the assessment basis leaves it to the FCC to classify services one by one, and the FCC's actions with regard to service classifications has been less than reassuring. In addition, as a wider range of applications is supported by a common networking infrastructure, it is likely that they will often be sold in packages, and it will be increasing difficult to determine whether the associated revenue falls within the assessment basis.

Some have suggested that all information services should contribute based on their reliance on telecommunication services. This approach would solve the problem of service classification, but it would be both infeasible and politically impossible to assess revenue from *all services* that rely on the Internet.

USF should assess services not based on the type of application (e.g. voice or data), nor on the type of network supporting that application (e.g. PSTN and/or Internet), but instead on the layer of the service. The purpose of the Fund is to support infrastructure in rural, insular, and high cost areas. As discussed in

the previous section, with regard to distributions, this should be interpreted as supporting *communications infrastructure* (as defined above). A symmetric approach, with regard to contributions, would be to require contributions from all *communications services*:

SEC. 6. UNIVERSAL SERVICE CONTRIBUTIONS.

(a) *FEDERAL USF CONTRIBUTIONS.- Section 254(d) of the Communications Act of 1934 (47 U.S.C. 254(d)) is amended to read as follows:*

*"**(d)** CONTRIBUTION BY COMMUNICATIONS SERVICE PROVIDERS.- Every provider of intrastate, interstate, or international communications shall contribute, on an equitable and nondiscriminatory basis, to the specific, predictable, and sufficient mechanisms established by the Commission to preserve and advance universal service. The Commission may exempt a provider, or class of providers, of communications services from this requirement if the provider's communications services are limited to such an extent that the level of such provider's contribution to the preservation and advancement of universal service would be de minimis.".*

Subsection 6(a) changes the USF contribution base (i) from *telecommunications providers* to *communications providers* and (ii) to include intrastate communications. The base is thus expanded beyond circuit-switched voice and voice only applications, in a manner that is consistent with the distribution base. Revenues are derived from the same infrastructure that is funded through the program. This approach also implements technology neutrality on the contribution side, and does not discriminate between various methods of providing voice, or between voice and broadband. In particular it includes the infrastructure portion of VoIP, broadband, and wireless communications.

The layered approach taken here differs markedly from those taken in Congressional bills. Both the Stevens and Boucher/Terry bills require contributions from communications service providers. The Stevens bill defines these as providers of telecommunications service, broadband service, or VoIP, and hence keeps the focus on the application rather than the infrastructure. The Boucher/Terry bill defines communications service providers as voice providers who use telephone numbers or IP addresses (thus including VoIP) and providers of physical transmissions facilities that allows access to a network used for electronic communications; this definition is a hybrid between application and infrastructure.

The Stevens bill allows contributions to the Federal USF to be based on communications service revenue, numbers, and/or capacity. The Boucher/Terry bill allows contributions to the Federal USF to be based on communications service revenue and/or numbers, but does not define which services qualify as communications services when a communications service provider is defined by services other than voice. In contrast, this proposal maintains revenue as the basis for assessments, and defines communication services in a layered fashion. The numbers approach creates an artificial incentive to reduce the number of network identifiers, and network capacity is a poor proxy for the value of communications service provided.

Both bills allow the Federal USF to assess intrastate communications services (in addition to interstate and international), similar to this proposal. These differences are displayed in figure 2.

6.3. *Federal and State funds*

Finally, turn to the relationship between contributions to the Federal and State universal service funds. In 2006, twenty-two states had high-cost state USF funds. All such states assess intrastate revenues of ILECs, competitive LECs, and interexchange carriers; most also assess intrastate revenues of wireless providers, and a few assess intrastate revenues of some VoIP providers (The National Regulatory Research Institute, 2006). The states, however, have widely varying manners of distributing high-cost state USF support.

If the Federal USF is changed to assess intrastate services, then the National Association of Regulatory Utility Commissioners (NARUC), representing state public service commissioners, supports allowing states assess interstate and international services (National Association of Regulatory Utility Commissioners (NARUC), 2006). In addition, if the Federal USF is changed to assess broadband, NARUC would prefer that states have the ability to assess broadband.

Since the proposal in this paper allows the Federal USF to assess all communication services, a symmetric approach would be to allow State USFs to similarly assess all communication services. This can be

accomplished using this statute language:

(b) *STATE USF CONTRIBUTIONS.- Section 254(f) of the Communications Act of 1934 (47 U.S.F. 254(f)) is amended-*

(1) *by striking "telecommunications carrier that provides interstate telecommunications" and inserting "provider of intrastate, interstate, or international communications"; and*

(2) *by adding at the end "Nothing in this subsection precludes a State from requiring contributions with respect to communications services for which contributions are required under subsection (d) if the primary place of use of which is within the State, regardless of where the services originate or terminate or through which the services transit.".*

First, this language changes the USF contribution base from *telecommunications* providers to *communications* providers. Secondly, it allows states to assess interstate and international communications services. To ensure that communication services can not be assessed by more than one State, services can only be assessed by the State of the primary place of use (the customer's residence or business address), an approach that was used in the *Mobile Telecommunications Sourcing Act* (U.S. Congress, 2000). Parity will thus exist between the Federal and State USF funds. The broadening of the Federal contribution base will decrease the assessment rate but include intrastate communications. If a State chooses to do so, it can similarly decrease its assessment rate but include interstate and international communications.

Finally, a corresponding change is required to one of the USF principles:

SEC. 7. EXPANSION OF UNIVERSAL SERVICE PRINCIPLES.

Section 254(b)(4) of the Communications Act of 1934 (47 U.S.C. 254(b)(4)) is amended to read as follows:

"(4) EQUITABLE AND NONDISCRIMINATORY CONTRIBUTIONS.- All providers of communications services should make an equitable and nondiscriminatory contribution to the preservation and advancement of universal service based on revenue derived from communications services without regard to whether such services are intrastate, interstate, or international in character.".

Again, *telecommunication services* has been changed to *communication services*, and the restriction to interstate and international revenue has been removed.

This approach to state funds is similar to that taken in Congressional bills. Both the Stevens and Terry/Boucher bills allow the Federal USF to assess interstate and international communications services (in addition to intrastate), similar to the approach taken here. The Terry/Boucher bill allows state to assess the same base as the Federal fund, whereas the Stevens bill only allows states to assess communications and VoIP but not broadband. These differences are displayed in figure 2.

7. Conclusion

This paper has proposed a layered approach to restructuring the high-cost funds of the USF to reposition the Fund away from a focus on telephone service and toward an everything-over-IP world. Key elements of the proposal include a new definition of *communication services* and *communications infrastructure* to replace reliance on the out-dated definition of *telecommunication services*; restructuring of high-cost USF distributions from voice network infrastructure to communications infrastructure; service area reform to allow wireless and cable providers to use their own service areas and to remove incentives for cream-skimming; introduction of cost-saving measures; and revision of contributions methodology to allow both Federal and State USF to assess all communications services. A summary of this proposal, in comparison to current law and Congressional bills, is presented in figure 2. In order to complete any such approach, further consideration should be given to a cap on the high-cost funds, to finer disaggregation, and to the other portions of the Fund such as Lifeline and E-rate.

The principal idea in this proposal is the delineation of infrastructure from applications. Such a delineation is potentially of use more broadly within telecommunications policy. Wherever it has been of value to consider the distinction between telecommunication services from information services, this new definition of communication services may help make a case for substantially different regulation of infrastructure than of applications.

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