

PETITION FOR RULEMAKING

Petition for Rulemaking to Amend and Modernize Part 54 of the Commission’s Rules to drive value in the Universal Service Fund E-Rate Program

To: Marlene H. Dortch, Secretary, Federal Communications Commission

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SECTION A: EXECUTIVE SUMMARY

ApplianSys LLC (“ApplianSys” or “The Company”) hereby submits this petition pursuant to section 1.401 of the Federal Communication Commission (“FCC” or the “Commission”) regulations¹. For the reasons stated herein, ApplianSys requests the Commission initiates a rulemaking proceeding to amend part 54 of the Commission rules, with respect to the Universal Service Fund (“USF”) Schools and Libraries Program (“E-Rate”) eligibility. Specifically, The Company proposes that Caching is moved to Category One in order to encourage cost-effective use of E-Rate funds and reduce wasteful spend on excessive Bandwidth

ApplianSys’ Caching appliance has been the most widely selected Caching solution in the E-Rate program since 2015. As such, The Company has been uniquely qualified to provide data to Commissioners and to the Wireline Competition Bureau on the impact of Caching in terms of cost-efficiencies and significant attendant speed increases in classrooms.

It is abundantly clear that Caching supports Order 50-54 of the 2014 modernization order: *Goal 2: Maximizing the Cost-Effectiveness of E-rate Spending*. Greater adoption of Caching would "maximize the benefit of each dollar spent".

ApplianSys has provided detailed evidence in 2017, 2018 and 2019 to illustrate how the widespread adoption of Caching will ensure best value for Universal Service Fund investment in schools internet connectivity. In each year, data from Caching deployments has been cross-referenced with USAC’s data on internet costs and capacities at schools

¹ 47 C.F.R. – Section 1.401 - https://www.ecfr.gov/cgi-bin/text-idx?SID=d791beebda82950e91f3b39c9d2b2c3a&node=pt47.1.1&rgn=div5#se47.1.1_1401

across the country, with results presented to Commissioners. Analysis has consistently shown that bandwidth use in schools is inherently inefficient and that widespread adoption of Caching could save the Commission \$1.5bn per year that would otherwise be spent on Bandwidth.²

However, these potential savings are not being realized due to low take-up because of factors that emanate from Caching being designated as Category Two (Cat 2):

In their guidance to schools, industry influencers conflate Connectivity with Bandwidth which is reinforced by Cat 1 status for Bandwidth. Bandwidth upgrades are treated as the top priority and industry associations encourage a perceived need for excessive internet capacity.

Network Efficiency has been held back by Cat 2 status for Caching where take-up is much lower than Cat 1. Within Category 2, caching ‘competes’ for attention and budget with other network technologies where it should be ‘competing’ with Bandwidth in order to drive value for money.

A poor understanding of the value of Caching continues to be widespread.

Because districts perceive Bandwidth to be freely available, there is no incentive to properly evaluate Caching-led efficiencies. In addition, solutions requested in Caching 471s highlight inadequacies in the process.

Caching is demonstrably part of external connectivity. By modifying the rules to move caching to Cat 1 the Commission will encourage schools to request E-Rate funding for best value connectivity: the package of Bandwidth + Caching. It will also encourage

² See ApplianSys 2019 comment on the proposed Eligible Services List <https://www.fcc.gov/ecfs/filing/10902329413854>

caching applications at schools in locations where the bandwidth they request is simply not available from the ISPs that serve their area.

Other adjustments that will be made possible by recategorizing caching will ensure that the solutions schools select under the Caching category are those which give the best Caching return on investment for their particular needs.

SECTION B: DISCUSSION

In this section, ApplianSys presents the logic and the empirical evidence that supports the proposed rule change:

- 1. Independent e-Learning in a 1:1 environment generates bandwidth demand that is problematic for efficient use of bandwidth and networks*
- 2. Web-caching deduplicates e-Learning requests and works particularly well in schools*
- 3. Category Two designation for Caching has proven detrimental to overall value-for-money*
- 4. Caching should be considered as an alternative to a Bandwidth increment*
- 5. Designation for Caching as Category One will drive value-for-money*

1. Bandwidth-use in schools is inherently inefficient

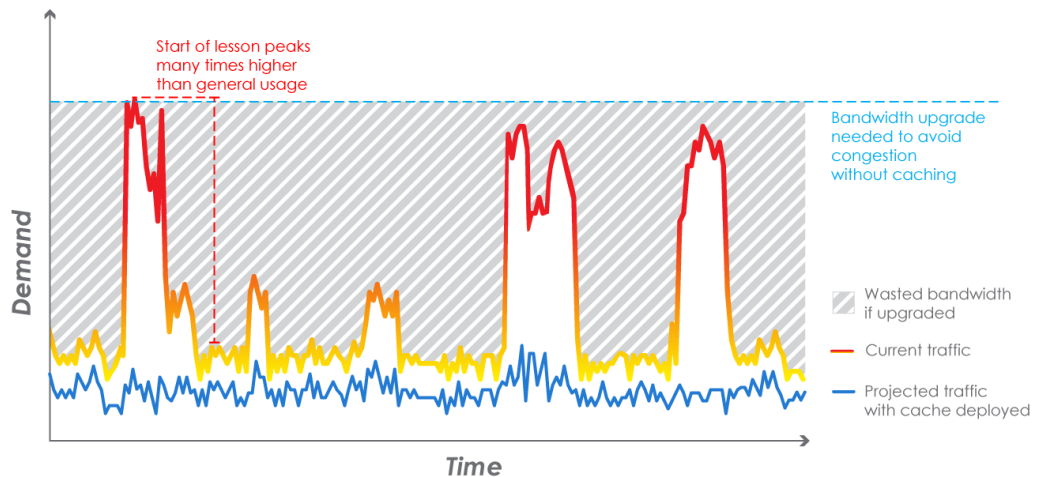
The Teaching & Learning process in K12 generates a profile of e-Learning network traffic that raises issues for connection capacity; there are acute start-of-lesson peaks in demand consisting of mostly duplicate requests. Catering for that with Bandwidth alone is inevitably inefficient.

K-12 web traffic has unique characteristics which limit the effectiveness and value of Bandwidth investments. Internet use is highly concentrated into ‘start-of-lesson peaks’ in demand, and that demand is largely for ‘repeat requests’.

1.1. Demand is compressed into short windows causing spikes in demand

Peaks in demand typically occur at the start of each lesson, as teachers – orchestrated by the school timetable – aim to get lessons off to a good start to build learning momentum. Devices download updates, students access resources.

These peaks define the amount of Bandwidth capacity that a school needs in order to prevent congestion. If a school purchases Bandwidth to cover these spikes in demand - without deploying Caching - the amount of unused capacity is dramatic (as represented by the shaded area, below).



Because it is unused much of the time, this excess capacity represents significant wastage of both school and E-Rate funds – this is true whether the Bandwidth available to a given school is deemed to be affordable or not.

1.2. Schools fetch the same content/software updates multiple times

Start-of-lesson peaks in demand are caused by, for example, 30 students all accessing the same content at the same time, resulting in 29 copies of the request made by the first student. Fetching the same objects over and over – sometimes thousands or even hundreds of thousands of times – simply doesn't represent an efficient approach to managing networks.

2. Caching works particularly well in schools – saving \$10 per \$

The same Teaching & Learning-generated traffic profile that is problematic for Bandwidth-only is highly responsive to caching, which deduplicates the requests and vastly reduces those demand spikes; the impact in K12 since 2015 is around \$10 of Bandwidth cost saving per \$ spent on Caching.

While ‘peak demand spikes’ and ‘repeated downloads’ render bandwidth use in schools inherently inefficient, those same two characteristics play to the strength of Caching meaning that it delivers exceptional results in the classroom context:

- Caching saves the content from the first requestor to cached memory from where it can serve subsequent requestors
- Because those peaks in demand are largely repeat requests, Caching can serve that peak demand without impacting or utilizing the internet connection.
- Start-of-lesson peaks in demand in a US K12 classroom are typically reduced in size by 75%

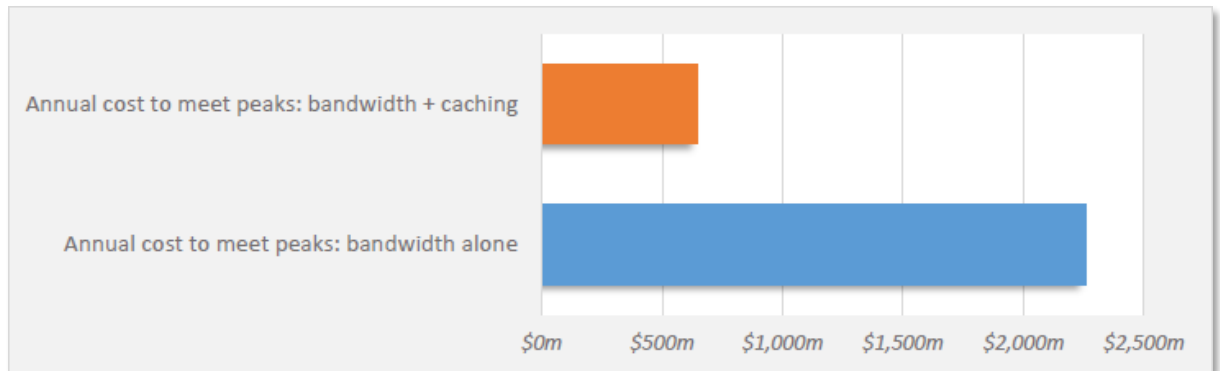
2.1. Ubiquitous Caching would save E-Rate over \$1.5bn savings per annum

In 2019, the company presented the Commission with data that demonstrated the cost difference between delivering peak requirements with Bandwidth alone and doing so with Caching.

ApplianSys looked at how much it would cost using internet connections alone to provide for peaks of 4 times³ the capacity that each district currently has and

³ This is a conservative estimate considering that ApplianSys routinely sees peaks in excess of 6 times a schools average demand – a sample of such data is available at <http://why-schools-cache.appliansys.com/#peaks>

compared this to the cost of **CACHEBOX**. The annual cost to deliver peak demand with Bandwidth alone would be over \$2.2bn compared with \$648m with Caching (current Bandwidth cost plus \$88.1m annualized cost of Caching for all schools).



3. Bandwidth is Cat 1. Caching is Cat 2. This designation perpetuates focus on Bandwidth to the detriment of value for money

Separate categorisation of Bandwidth and Caching has had unintended consequences. And the position is accentuated by influential bodies. Reversing that separation would drive value-for-money.

3.1. Conflation by industry influencers of Connectivity with Bandwidth

The goal to get all schools connected to high speed internet connections is clearly valid and the progress made has been impressive. But, in the process of lobbying and publicising achievements, the profile of the need for 'Bandwidth' rather than 'Connectivity' is now disproportionate.

Schools are given questionable advice which does not take into account alternative approaches to achieving appropriate Connectivity, risking wasteful investment in excess Bandwidth.

Education Super-Highway's guide for schools suggested that they 'size Bandwidth for your peaks, not averages' and 'add 20% padding on top'⁴. As demonstrated, whilst this approach is indeed necessary if you neglect to augment Bandwidth with Caching, it will see most of the Bandwidth unused for most of the day.

SETDA's 'Broadband Imperative' targets were referenced in FCC's 2014 modernisation order lending them an 'official' status. Their latest 2023 per student target⁵ would be enough to support each student watching 6 standard definition YouTube videos at once. Whilst it's clear that demand for online content in schools will continue to grow, meeting this demand with ever higher capacity connections is a recipe for waste.

Because Bandwidth is perceived as equivalent to Connectivity, E-Rate applicants intend to purchase ever more bandwidth before they consider making a Category Two request. Fundsforlearning's recent survey⁶ finds that "66% of applicants need dual internet connections for reliable Connectivity and would request it if the FCC allowed". By localising content, Caching delivers the reliable access to content that schools need, even where appropriate when internet connections have failed - and without the high ongoing cost of maintaining a second connection. Tellingly, this 66% of applicants that would double down on internet connections is a greater proportion than those who expect to raise a Category Two request next year;

⁴ Summary of Funds For Learning 2020 applicant survey:
<https://ecfsapi.fcc.gov/file/1071774292501/2020-07-17%20Applicant%20Survey%20Results%20WCB%20Ex%20Parte.pdf>

⁵ Between 1.4 and 2.8Mbps per students depending on school size. See https://www.setda.org/final110519_overview_broadband-imperative-iii/

⁶ See guidance published June 24 2019:
<https://www.educationsuperhighway.org/blog/planning-future-Bandwidth-needs/>

adding yet more bandwidth dominates the bandwidth management thinking of technology directors, while caching – that would address network efficiency – doesn't get due consideration.

3.2. Priority status for Bandwidth is reinforced by the current categorisation

Bandwidth subscriptions in Cat 1 enjoy a practically unlimited budget and little perceived control over how much Bandwidth E-Rate will fund. This has led to schools requesting more Bandwidth year-after-year – nearly 15,000 applicants filed 471s for Cat 1 in all of the last five years (documented in section 3.3.1 below)

When making a Cat 1 request, schools need only consider what they think they need and, in many cases, are supported by state and local initiatives to cover the proportion of a request that a school must fund itself. This accessibility has, rightly, encouraged schools to get connected.

However, the lack of alternatives to Bandwidth in Category One is dangerously at odds with the stated intent of the 2014 Modernization Order to provide a 'whole network' approach to connecting schools and students. Once applicants identify a need for upstream capacity, the category that supports 'connectivity to' schools (rather than 'within schools') contains only data transmission technologies. An applicant could be forgiven for thinking that transmission upgrades are the only way to increase connection capacity.

Encouraging 'competition' between Bandwidth and Caching – and thereby flagging up their respective roles in Connectivity - would be a thoroughly constructive approach to delivering best value connectivity.

3.3. Network Efficiency has been held back by Cat 2 status for Caching

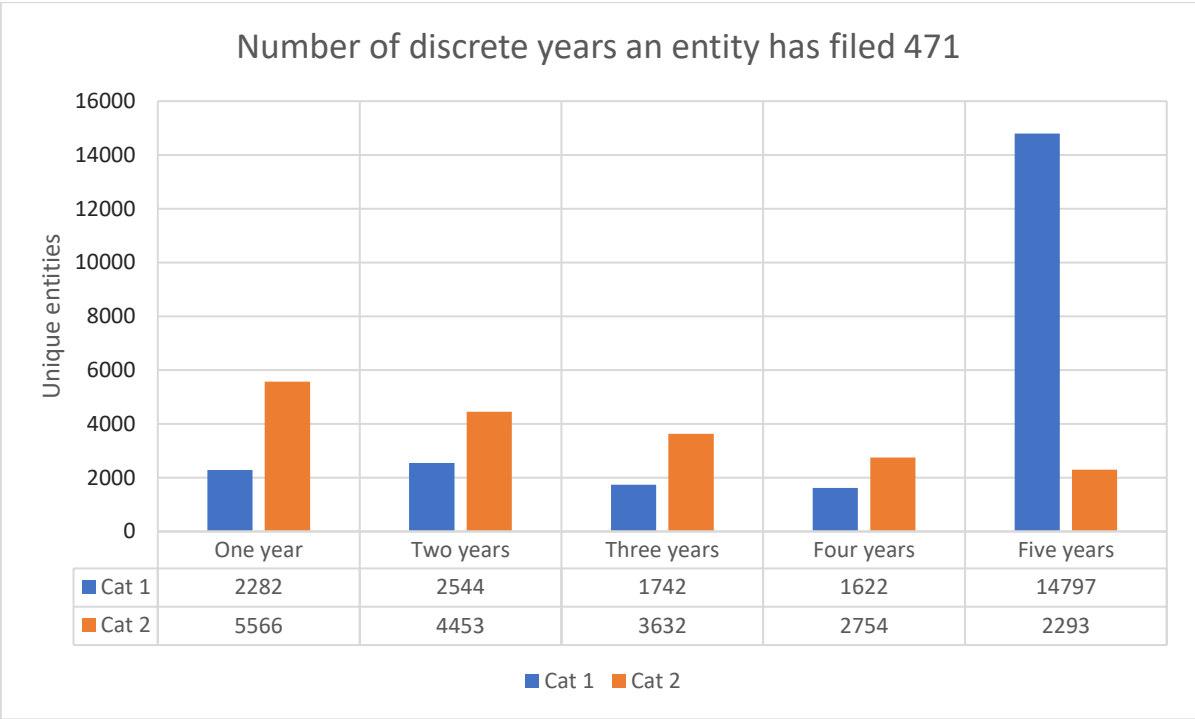
Category Two technologies have been regarded by District Technology teams as lower priority than Bandwidth. The E-Rate program, while not intending to encourage excessive bandwidth provision, has nevertheless made it possible, with few incentives for the development of more efficient networks.

3.3.1. Cat 2 is lower priority for Districts

There have been significant improvements in Category Two utilization since the 2014 modernization order. However, **Category Two usage is still significantly lower than Category One** with schools less likely to apply and applications less likely to result in corresponding 471s.

ApplianSys has interrogated USAC data on 471 applications, made available for the years 2016 to 2020 at opendata.usac.org. The Company found that, in a given year, no more than 58% of schools that filed a 471 included a Category Two request: the average was 49%.

Many schools didn't use Category Two at all, with less than 90% of schools that filed a Category One 471s also making a Category Two request. 54% of the applicants that used Category Two, did so on just two occasions or less. In sharp contrast, over 64% of districts that filed Category One requests did so in every year.



ApplianSys expects Category Two applications to continue to lag behind Category One. Indeed, Fundsforlearning’s 2020 applicant survey found that only 51% of respondents strongly agree with the statement “My organization intends to apply for Category Two discounts next year.”

3.3.2. Caching competes for attention & budgets with Wifi

Schools that used Category Two also needed to determine where to spend their limited budgets and make decisions about whether to request Caching or other network equipment. In the first and second cycle following 2014’s modernization order, a large number of districts used Category Two funding to purchase Wi-Fi equipment. There is anecdotal evidence that Category Two is primarily intended to be used for WiFi - it is colloquially referred to as ‘the

WiFi budget⁷. Indeed, fundsforlearning's recent applicant survey found that 79% of applicants intend to upgrade WiFi in the next three years.⁸

ApplianSys expects that problems with Category Two take-up may be mitigated by the increase in Category Two budgets introduced in the 2021 funding cycle. However, this remains to be seen and, we expect that further steps will be required to encourage Caching takeup.

3.3.3. Lack of incentive to properly evaluate caching-led efficiencies

There are knock-on effects to Caching takeup in E-Rate because Bandwidth grants are perceived to be relatively uncontrolled.

Not only is there little incentive to look for network efficiencies, there's also no incentive to properly evaluate caching solution impact, so many technology teams are unaware of the benefits – beyond maybe online testing for which the platform providers prescribe the use of caching

In addition, Form 471s for Caching highlight inadequacies in the current process and betray a lack of understanding of this area by both districts and USAC. Districts routinely claim 100% eligibility for ultra-high spec general purpose servers that will be used for online test Caching only, a relatively light task for a low-spec server.

⁷ See examples at <https://www.fcc.gov/news-events/blog/2014/06/30/answers-common-questions-about-e-rate-modernization-proposal-get-wi-fi> and <https://www.educationsuperhighway.org/blog/how-e-rate-made-high-speed-Connectivity-possible/>

⁸ See p32 of Funds For Learning Notice of Ex Parte for its National Survey of E-rate Applicants <https://www.fcc.gov/ecfs/filing/1071774292501>

These additional process considerations can be addressed with simple regulatory amendments as suggested in Section C.

4. Caching is demonstrably part of external Connectivity, not the internal Connectivity supported by Category Two

Several network technologies could lay claim to being ‘essential’ for the correct functioning of External Links and therefore to being considered eligible for Category One. But Caching has the right credentials.

Caches do indeed functionally - and usually topologically as well - sit between the external link and on-premises Category Two LAN equipment.

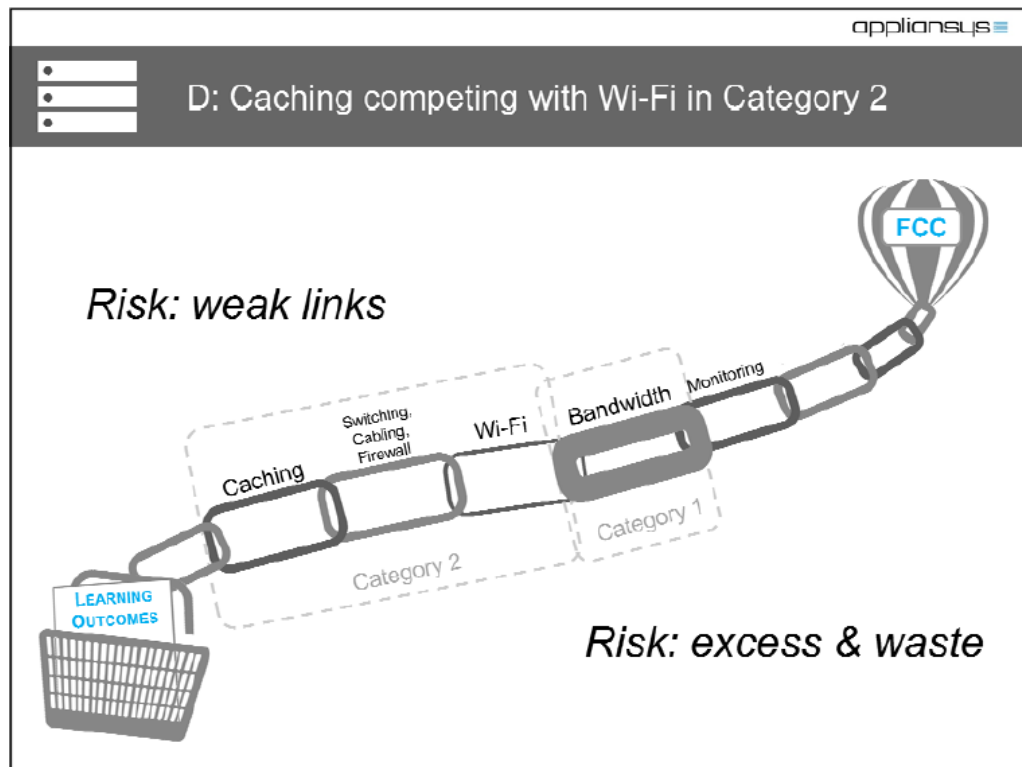
Their primary functions are:

1. to provide a cost-effective alternative to a Bandwidth upgrade – reducing the amount of Bandwidth capacity that needs to be maintained
2. In so doing, Caching helps schools to avoid the associated costs of network equipment upgrades
3. to accelerate slow web-content being requested down that External Connection – improving broadband functionality even on multi-gigabit links

So - while Wi-Fi and other Category Two LAN devices either distribute or ensure the safe distribution of digital access provisioned by Category One external connections, Caching both improves the functionality of existing links and is a replacement for a needed increment of Bandwidth.

The e-learning network needed for modern internet-enabled independent learning is an interdependent ecosystem as illustrated in Figure A. There's no value in pumping up one link in the school's technology chain disproportionately to the other. Everything needs to be in balance and failing that, *the weakest link will define the limits of the network's capabilities.*

Bandwidth is in effect pumped up disproportionately in the FCC model today. Unlimited funding under Category One encourages schools to rely solely on Bandwidth upgrades - neither a cost effective nor prudent use of E-Rate funds.



For Caching to properly contribute to a 'whole network approach' and E-Rate value for money, the key outcomes that are needed are

- firstly, for districts to base their Bandwidth upgrade decisions on a proper sense of relative value for money in comparison with Caching
- funding for Caching to be as readily accessible as funds for Bandwidth.

The focus in Category One should be on helping a school get the best possible value from its Bandwidth investment before addressing any need to increase Bandwidth capacity in due course. Today, broadband spend is uncontested, where it should be in competition – driving a like-for-like comparison – with Caching.

5. Put Caching in Category One to reduce waste

Given the findings above, it's clear that many districts do not recognize a link between Caching and Bandwidth, instead seeing Caching as an answer to a very specific problem like online testing. In the majority of cases this results in missed opportunities to get more value from E-Rate funded external connections. In the worst cases, it represents significant and unacceptable waste.

By moving Caching to Category One, the Commission would both clarify that Caching should be considered as an alternative to Bandwidth and send a clear signal that school districts must give significantly more weight to value than convenience.

Such a move would enable service providers to propose best-value solutions to Category One Connectivity requests.

- Awards could be conditional - as is currently the case with lit & dark fibre - on districts carrying out value-for-money comparisons between Bandwidth and Caching (or Caching-augmented Bandwidth) — before additional bandwidth increments are approved
- Requests for capacity increments specifying bandwidth could be compulsorily open to bids for Caching or for smaller/lower cost Bandwidth increments augmented with Caching

SECTION C: PROPOSED RULE CHANGE

A clearer link between bandwidth and caching would be achieved by moving Caching into Category One. The rule change would require modification of §54.502 (a)(1) regarding eligible services.

§54.502 Eligible services (**Proposed additional language in bold**)

(a) Supported services. All supported services are listed in the Eligible Services List as updated annually in accordance with paragraph (d) of this section. The services in this subpart will be supported in addition to all reasonable charges that are incurred by taking such services, such as state and federal taxes. Charges for termination liability, penalty surcharges, and other charges not included in the cost of taking such service shall not be covered by the universal service support mechanisms. The supported services fall within the following general categories:

(1) Category One. Telecommunications services, telecommunications, and Internet access, as defined in §54.5 and described in the Eligible Services List are Category One supported services. **This includes Caching solutions which deliver capacity that would otherwise have required a larger internet connection.**

Additionally, applicants can be directed to make best value comparisons between caching, bandwidth or a combination of the two by stipulating that applicants do so in the Eligible Services List.

(Proposed additional language in bold)

Notes: (1) Eligible costs include monthly charges, special construction, installation and activation charges, modulating electronics and other equipment necessary to make a Category One broadband service functional (“Network Equipment”), and

maintenance and operation charges. Network Equipment and maintenance and operation costs for existing networks are eligible. All equipment and services, including maintenance and operation, must be competitively bid.

(2) Applicants that seek bids for leased dark fiber must also seek bids for leased lit fiber service and fully consider all responsive bids. Similarly, applicants that seek bids for self-provisioned broadband networks must also seek bids for the needed connectivity via services provided over third-party networks, and fully consider all responsive bids.

(3) Applicants that seek bids for Internet Access must also seek bids for web caching and fully consider all responsive bids.

(4) Applicants may seek special construction funding for the upfront, non-recurring costs for the deployment of new or upgraded facilities. The eligible components of special construction are construction of network facilities, design and engineering, and project management.

(5) Staff salaries and labor costs for personnel of the applicant or underlying beneficiary are not E-Rate eligible.

A further administrative step could be taken encourage schools to ensure appropriate solutions are selected under the Caching category which give good Caching return on investment.

This can be addressed with changes to the competitive bidding regulations. These changes would not alter the spirit of competitive bidding – which already demand that the most cost-effective solution is chosen – they would simply provide clearer guidance on what is required by the existing rules.

§54.503 Competitive bidding requirement (**Proposed additional language in bold**)

(2) The FCC Form 470 shall be signed by a person authorized to request bids for eligible services for the eligible school, library, or consortium, including such entities.

(ii) A person authorized to both request bids and order services on behalf of the entities listed on an FCC Form 470 shall, in addition to making the certifications listed in paragraph (c)(2)(i) of this section, certify under oath that:

(A) The services the school, library, or consortium purchases at discounts will be used primarily for educational purposes and will not be sold, resold, or transferred in consideration for money or any other thing of value, except as allowed by §54.513.

(B) All bids submitted for eligible products and services will be carefully considered, with price being the primary factor, and the bid selected will be for the most cost-effective service offering consistent with §54.511.

(i) Requests for servers to deploy software for eligible services will include comprehensive narrative to explain a) how the specific hardware requested was determined as the correct specification to deliver the eligible service, b) how the applicant set about comparing bids for alternative hardware and appliance solutions in order to carry out a fair process.

SECTION D: CONCLUSION

ApplianSys is a proud participant in the E-Rate programme and appreciates the overwhelmingly positive impact that it has had on connecting schools and libraries throughout the country.

The company has unapologetically sought to increase the proportion of traffic that is delivered by web caches in school districts – it's the most cost-effective, reliable way to deliver equitable internet access to all students. To accomplish this, ApplianSys has routinely delivered hard data from school districts to evidence the impact that caching has had so far and extrapolate the impact that it could have.

Following several E-Rate cycles of analysing this data with consistent results and insight, ApplianSys is confident that fundamental changes are now required in order to avoid unacceptable waste of E-Rate funds and missed efficiencies.

In order to ensure ongoing value for E-Rate funds, ApplianSys urges the Commission to amend its regulations in the manner described above.

Respectfully submitted,

/s/ Roger Clark

Roger Clark

General Manager

K12 Web Acceleration Technologies

ApplianSys LLC