

## E-Rate continues to help districts reach internet speed and affordability targets

*Roger Clark, Head of Education Technologies*



### Slide 2



#### Introducing ApplianceSys




- ≡ Customers in 150 countries
- ≡ Deep-rooted expertise in caching
- ≡ ApplianceSys **CACHEBOX** has been the most widely selected caching solution by far in the E-rate program since 2015.

Caching is both the most effective AND the most cost-effective method for schools to optimise internet connections.

ApplianceSys' caching appliance **CACHEBOX** is the most widely selected caching solution by far in the E-Rate program since 2015. It is the only schools-focused solution that handles 'whole school' traffic patterns including HTTPS, software updates, online testing, video and LMS password protected materials.

Around the world ApplianceSys works with National Education Authorities to plan how to deliver and optimise links to all the schools in their country

## Slide 3



Recap: Our findings last year

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### Caching has surpassed original expectations

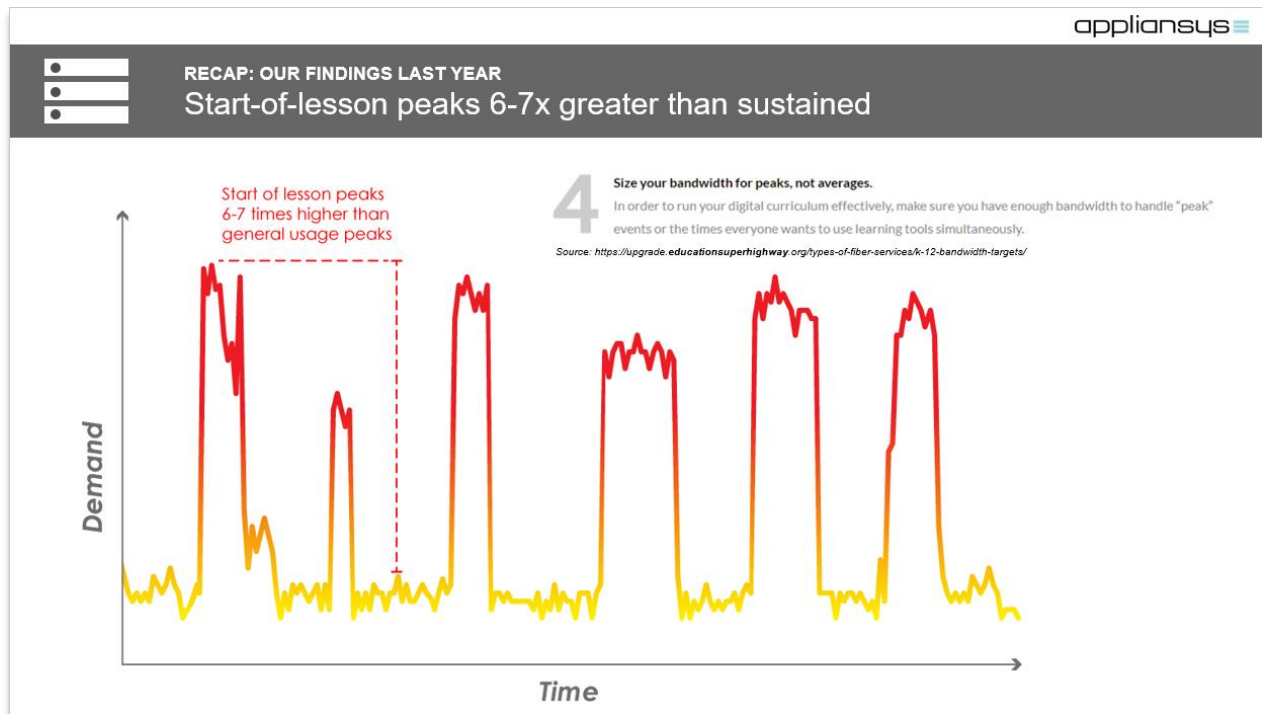
- ≡ Caching helps secure effectiveness of digital learning
  - ≡ Speeds up access in the classroom
- ≡ Caching technology reduces bandwidth overspend and drives ROI
  - ≡ Catering for peaks – typically 7 times higher than average traffic – with bandwidth alone is wasteful
- ≡ There is a disconnect between caching perception and reality
  - ≡ Low take-up correlates with low awareness and misconceptions
  - ≡ ApplianSys case studies provide empirical evidence that caching works well in schools context and can deliver substantial advantage
    - This is regardless of scenario (Urban/Rural) and/or connectivity background.

Last Summer and Fall Appliansys shared caching performance data with the FCC, accumulated from **CACHEBOXes** deployed across 40 states. This data clearly demonstrated how schools-focused caching is able to accelerate content in the classroom and deliver better value for money from investments in bandwidth.

ApplianSys also reported on the factors that tilt the landscape heavily in favour of broadband overspend and the consequences of over-reliance on annual upgrades.

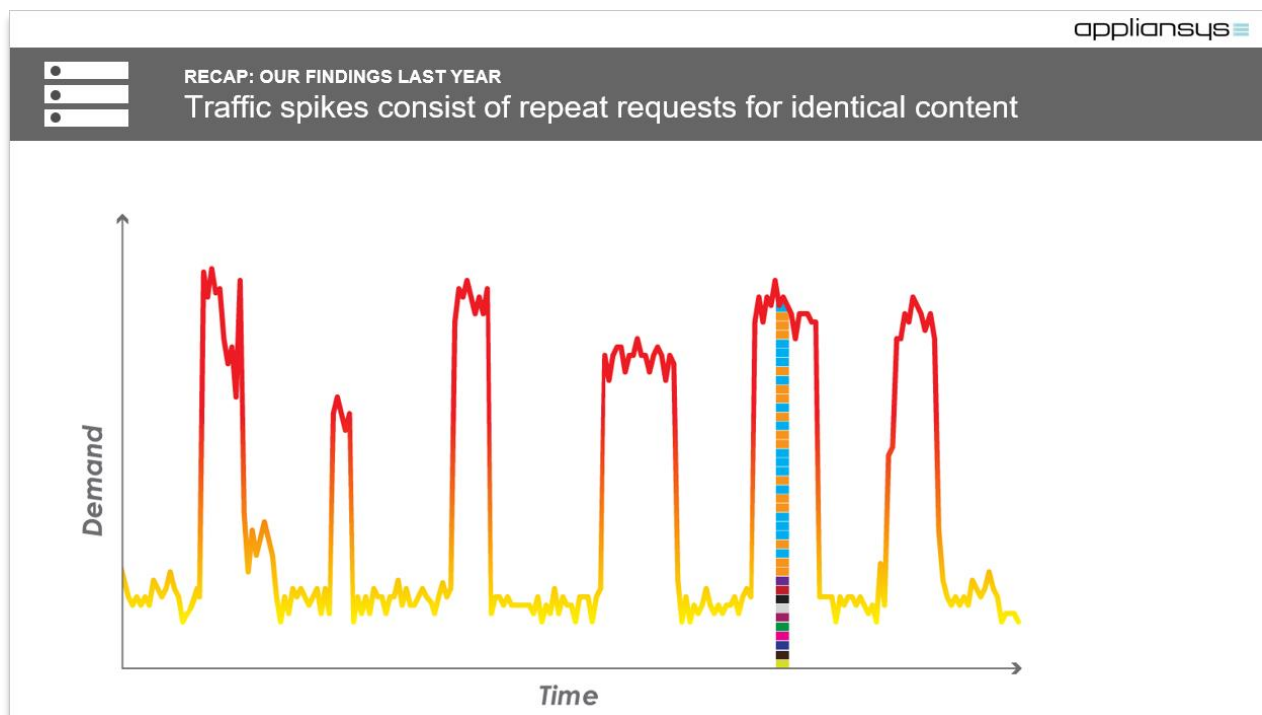
A brief summary of last years findings follow.

## Slide 4



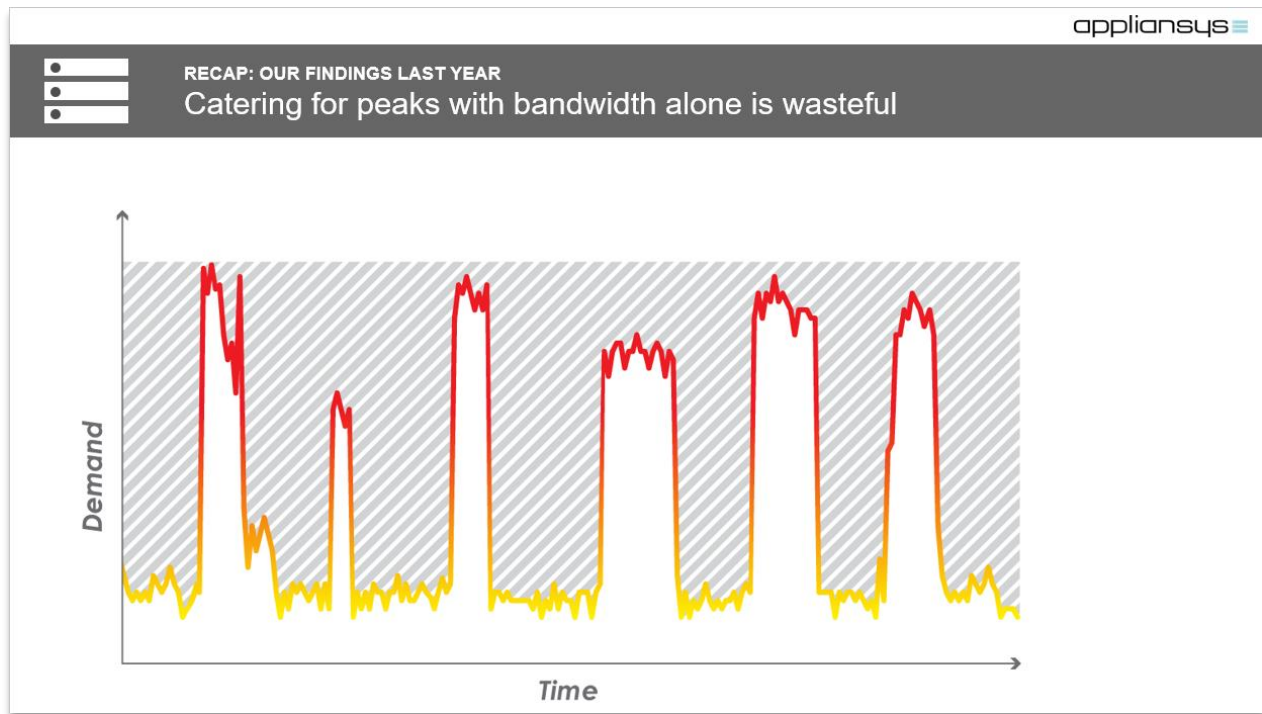
Last year, ApplianSys reported the traffic in schools is FAR more spiky than in other sectors – such as for ISPs. Start-of-Lesson peaks are typically 6-7x the average.

## Slide 5



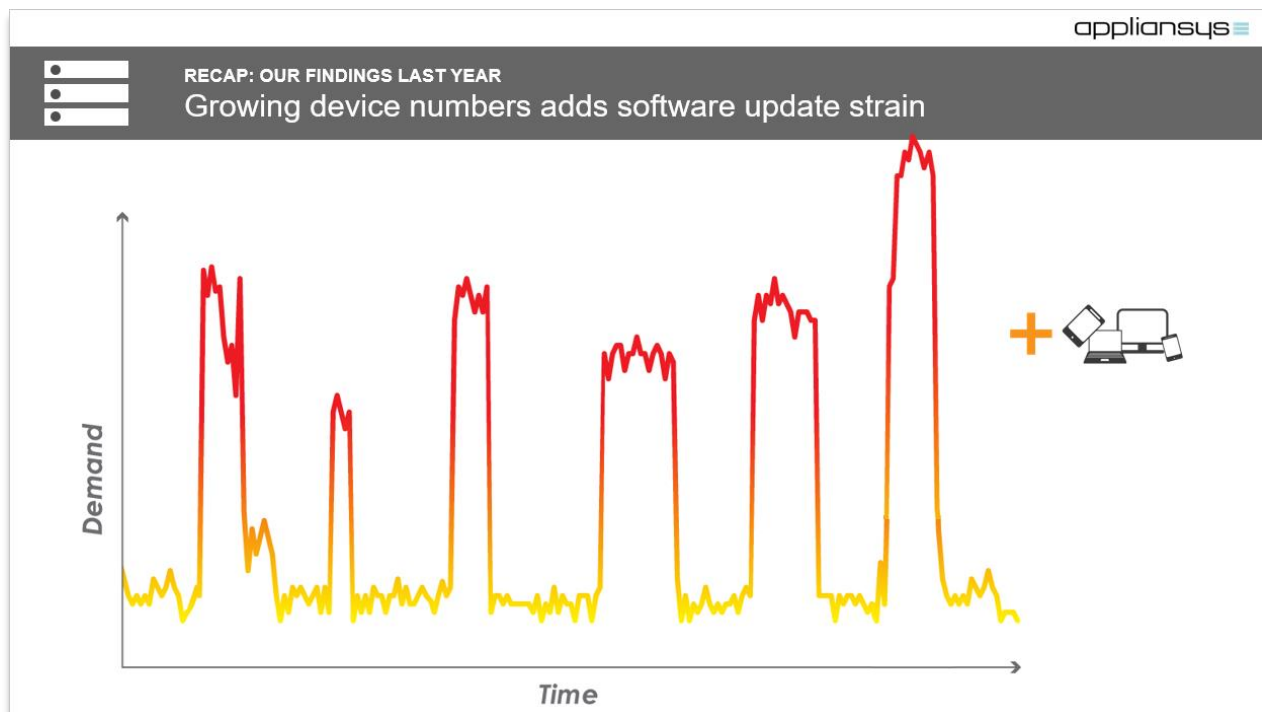
But peaks in K12 consist of repeat requests such as at the start of a lesson when 30 students access the same content at the same time. As such, these spikes can be significantly reduced by caching whereby a cache stores a copy of the first object requested from the internet and then serves that copy to the rest of the class locally, relieving the connection.

## Slide 6



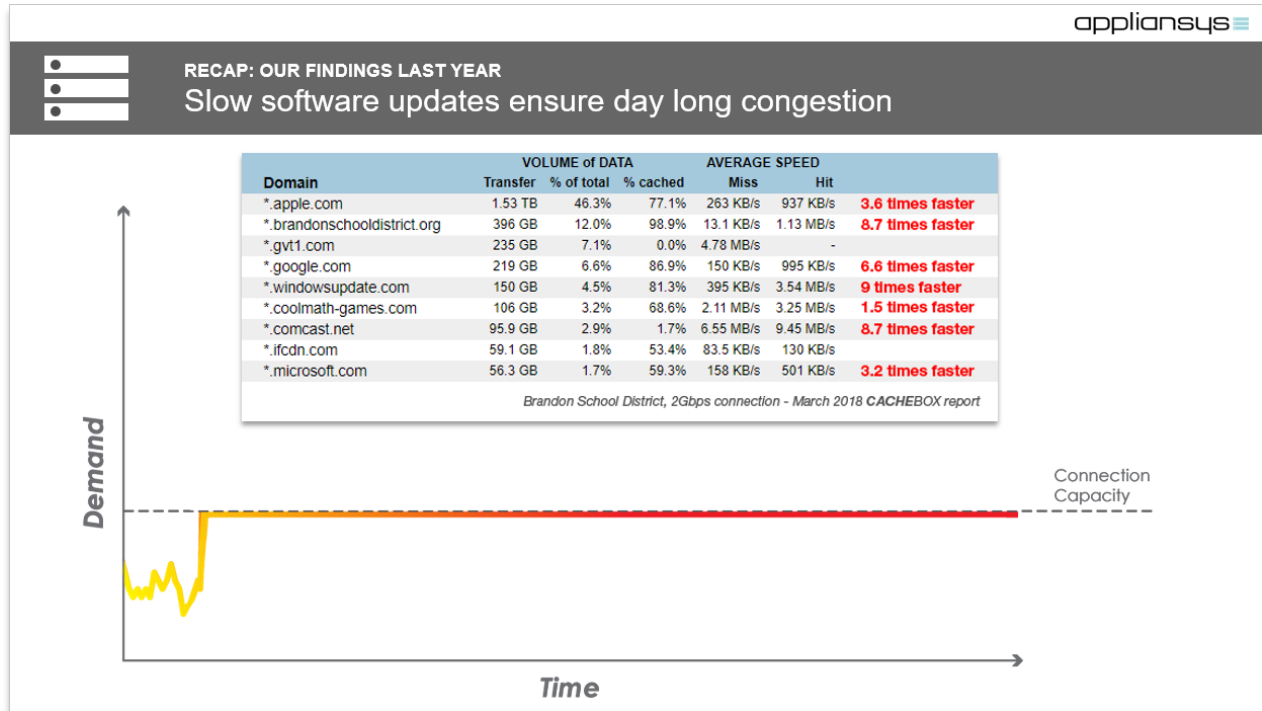
ApplianSys demonstrated how catering for demand with bandwidth alone is wasteful, comparing it to building a 20-lane highway to cater for the 5pm rushhour: this may clear traffic at peak times but you have very expensive unused concrete the rest of the day.

## Slide 7



ApplianSys showed how essential software updates files and Anti-Virus signatures can saturate internet connections when many devices request files at once. This problem is exacerbated by growth in the number of student devices with 1:1/BYOD schemes.

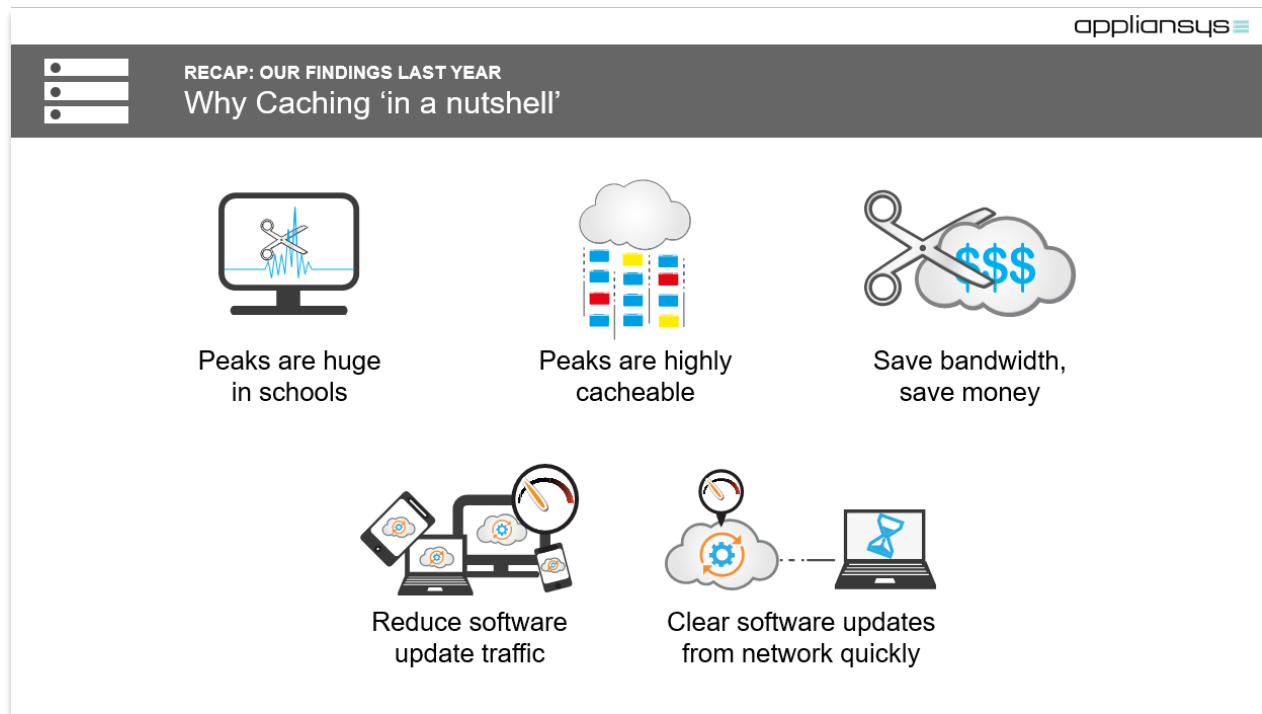
## Slide 8



In the absence of excessive bandwidth, highly cacheable software updates can saturate connections all day. Even with very high-capacity internet connections, update files are served slowly, prolonging congestion.

Serving these files locally, caching removes the strain on a district's internet connection. By serving files at far higher speeds, they also clear the WAN more quickly, eliminating a potential bottleneck.


## Slide 9



Traffic peaks are 6-7x average usage. Caching slashes those peaks because most of the traffic in schools is duplicate requests. In doing so, caching slows the annual upgrade cycle.

Caching offloads and accelerates software updates, protecting internet connections, LAN/WAN capacity & WiFi networks.

It delivers a radical improvement in browser speeds for rural schools that are unable to purchase high-capacity connections. But even with 10Gbps connections, districts like Anaheim Union see some key classroom content served 10x faster from cache. In either case, this increases learning time, raises lesson tempo, improves engagement and can make all the difference in timed assessments.



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## New for 2018: beyond 'performance' to 'impact'

**FCC asked ApplianSys to research real world impact:**

1. *Customer Survey:*
  - ROI far beyond financial savings
2. *Annual caching performance analysis 2017-18:*
  - Caching performance high, improving
3. *Awareness Survey:*
  - Low awareness of caching, low take-up rate
4. *Extrapolation from 'caching performance' & 'per-district bandwidth spend' :*
  - Widespread caching would save \$ hundreds of millions each year

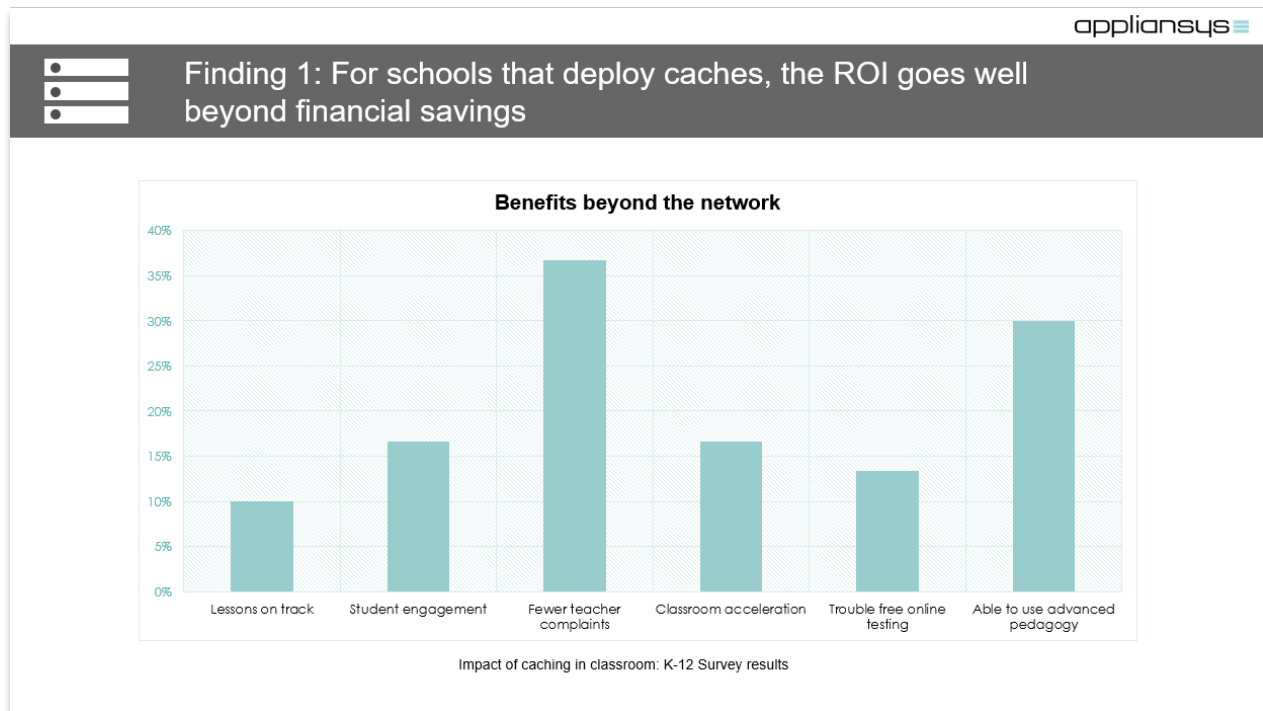
When ApplianSys Head of Education Technologies Roger Clark presented the findings of research to FCC representatives in 2017, he asked how ApplianSys could provide further insight into the value that e-rate funded caching delivers.

The FCC suggested that ApplianSys gather information beyond **CACHEBOX** performance data, specifically that it would be helpful to quantify the broader impact that content acceleration and reduction in bandwidth use has for schools.

In response, ApplianSys has:

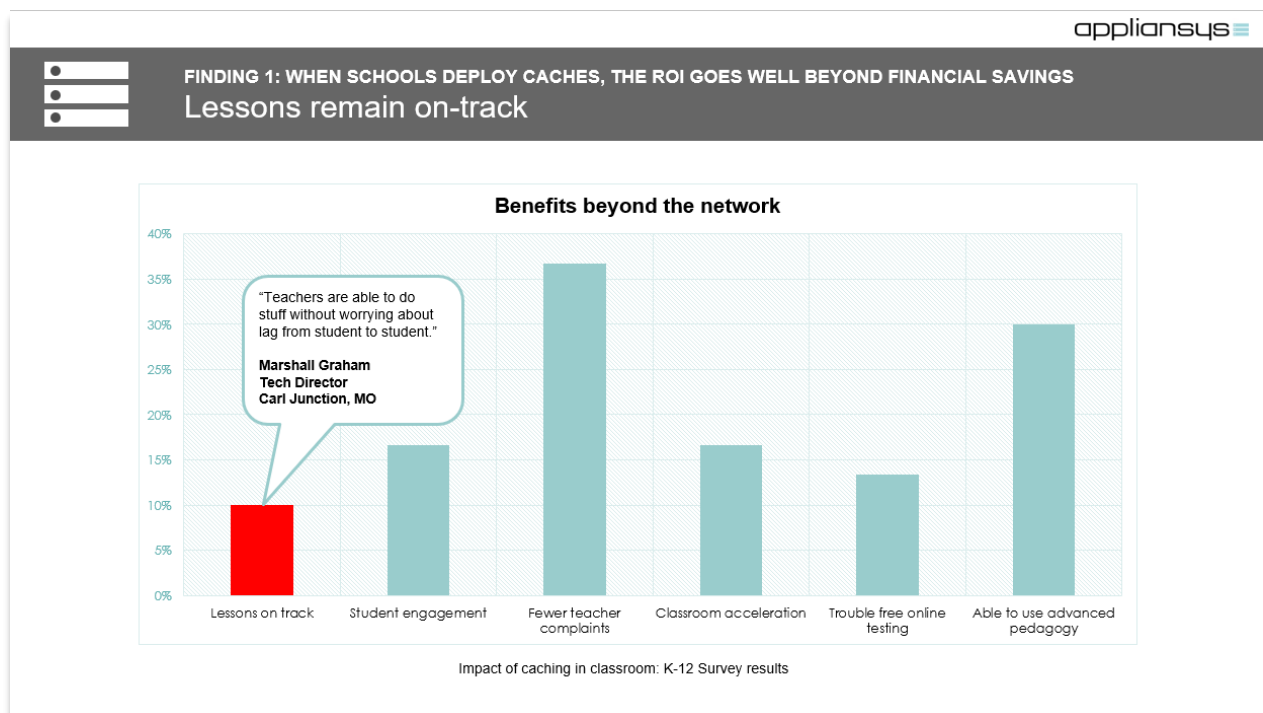
- gathered and analysed more performance data
- gathered statements from customers on the impact of caching in their district
- undertaken research to understand the perspectives of non-customers.
- accumulated data on the ROI that caching delivers now and extrapolated to identify what it would mean if caching was commonplace in US schools

## Slide 11



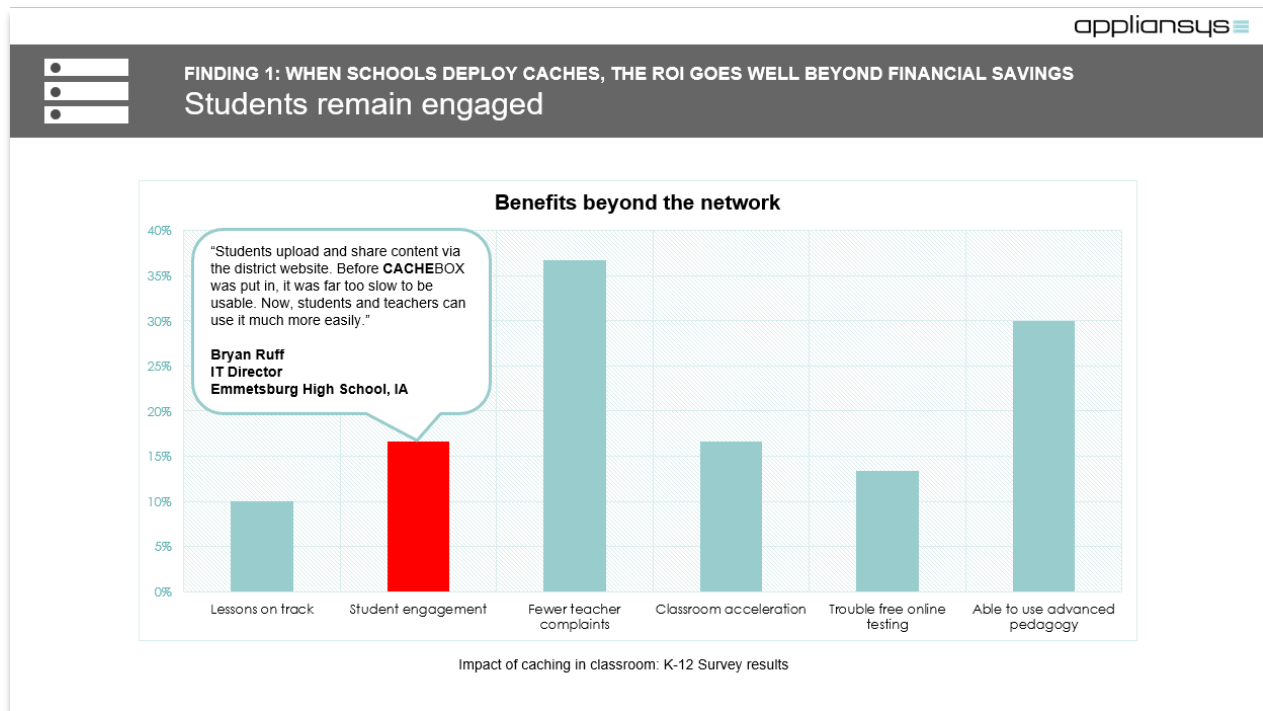
ApplianSys asked Technology Directors what impact caching has had in the classroom and across the network. Responses were categorised as displayed.

## Slide 12



Responses categorized as 'lessons on track' describe how, before caching, lesson plans would need to change or would be abandoned altogether when congestion rendered web content unusable. This includes rural schools who previously needed to start an online lesson one table at a time and abandoning planned lessons to teach from the front of the class had become the norm, putting e-learning teacher adoption at risk.

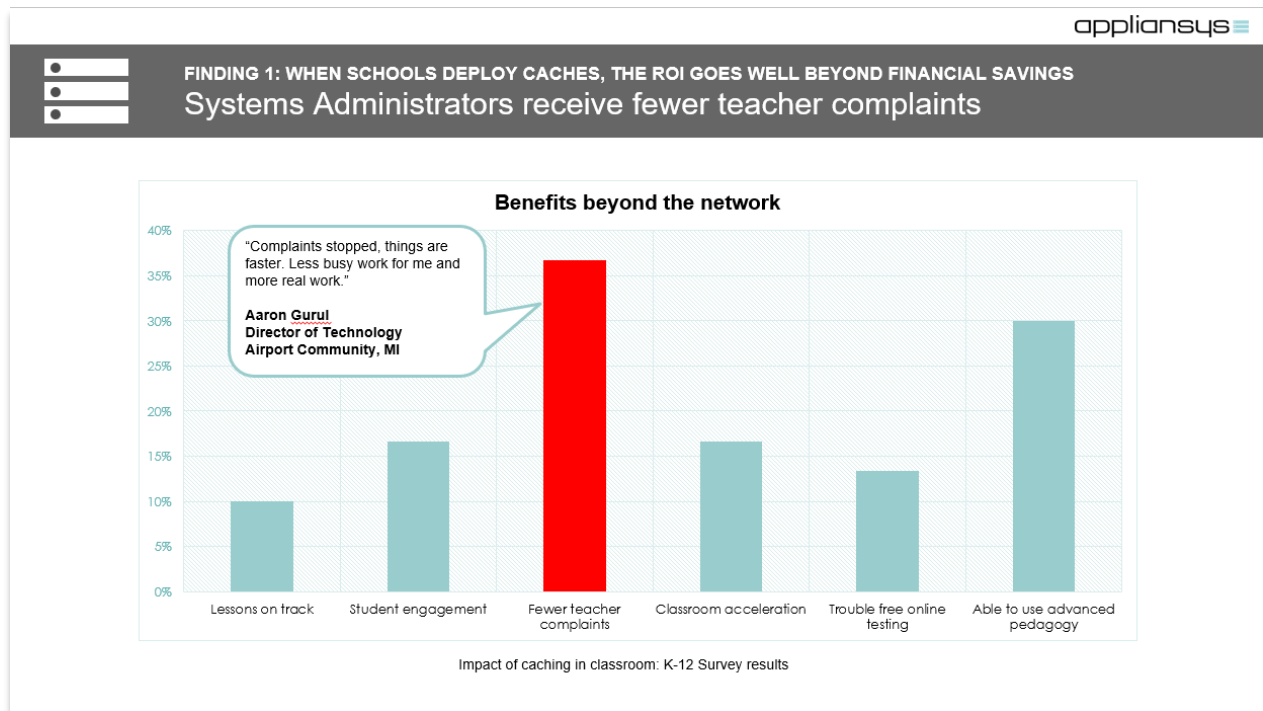
## Slide 13



'Student engagement' comments described how, with caching, students can now work independently even when a whole cohort is utilising a narrow connection at the same time.

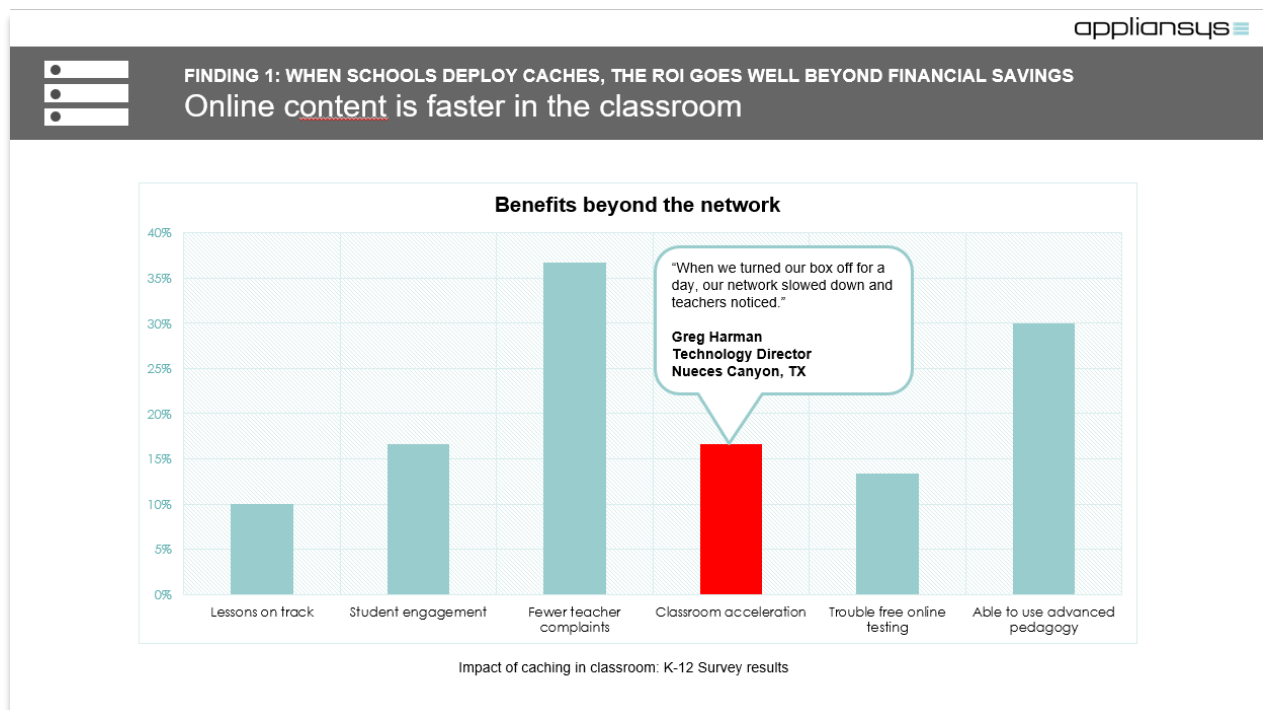
We saw a 97% saving of bandwidth for a large-scale rollout of an online Pearson Education application at Miami Dade – previously unusable and now faultless with continuous and instant feedback to each student while the teacher is freed from the shackles of content delivery to focus on differentiated facilitation of learning

## Slide 14



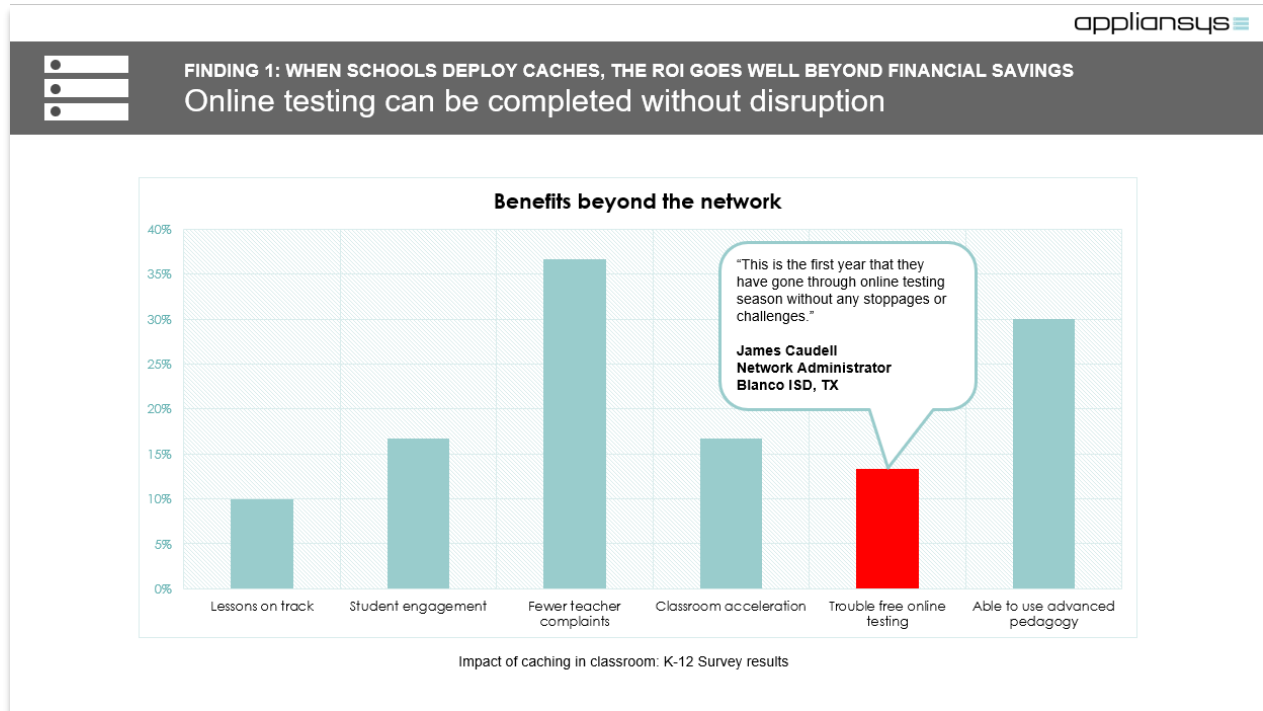
ApplianSys heard from technology teams who described how, daily, issues related to congestion would consume their attention to rectify. These problems completely disappeared with the deployment of caching.

## Slide 15



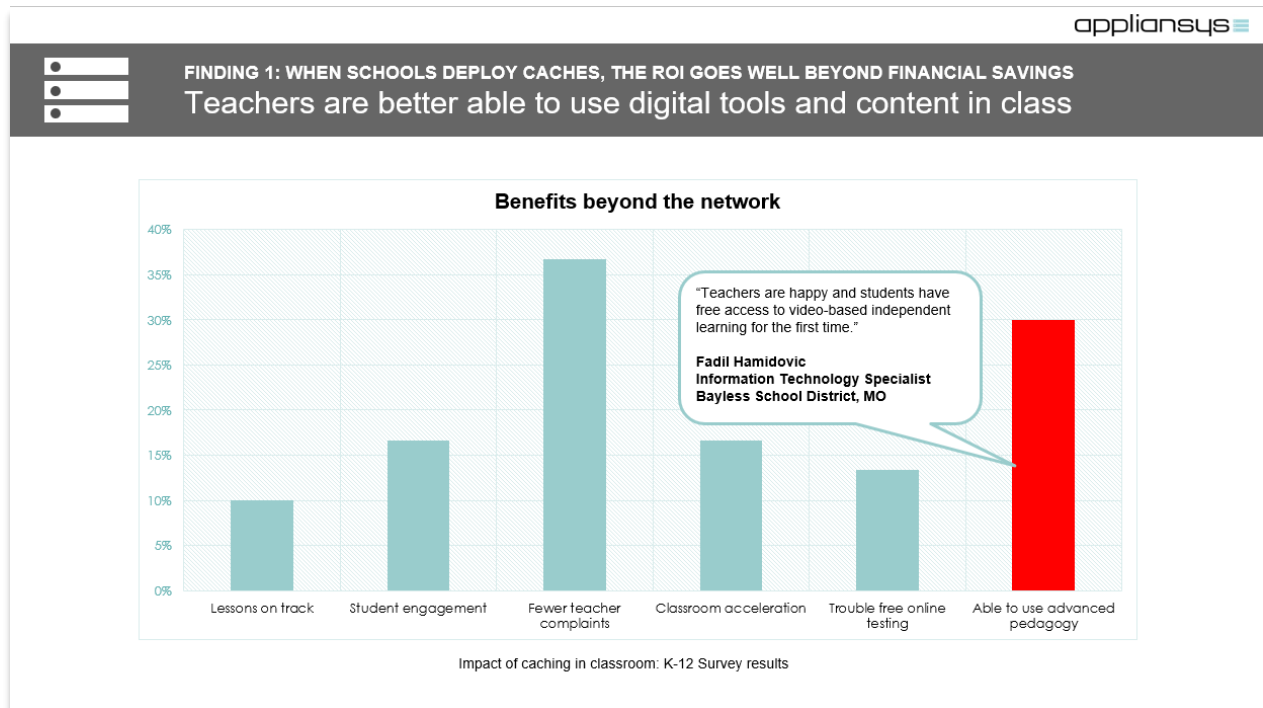
Customers told ApplianSys that the speed difference in the classroom pays dividends, especially during those crucial first 5 minutes which can set the pace and tempo for the rest of a lesson.

## Slide 16





Caching online testing content in advance has eliminated connectivity issues that would previously present technical difficulties at a very sensitive time - even at districts with fibre connections. A national standard 2-second page load during a short-question arithmetic test could waste 5% of the time allocated on browser wait.

## Slide 17



With caching in place, teachers are able to make a decisive shift towards pupil-centred learning and facilitating the development of 21<sup>st</sup> Century skills.

**Slide 18**

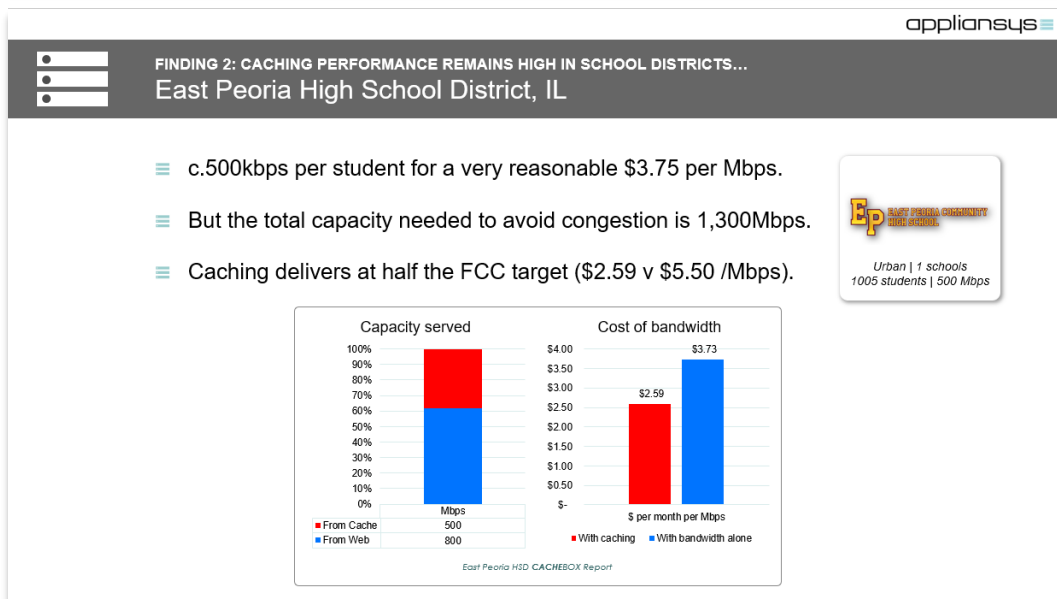
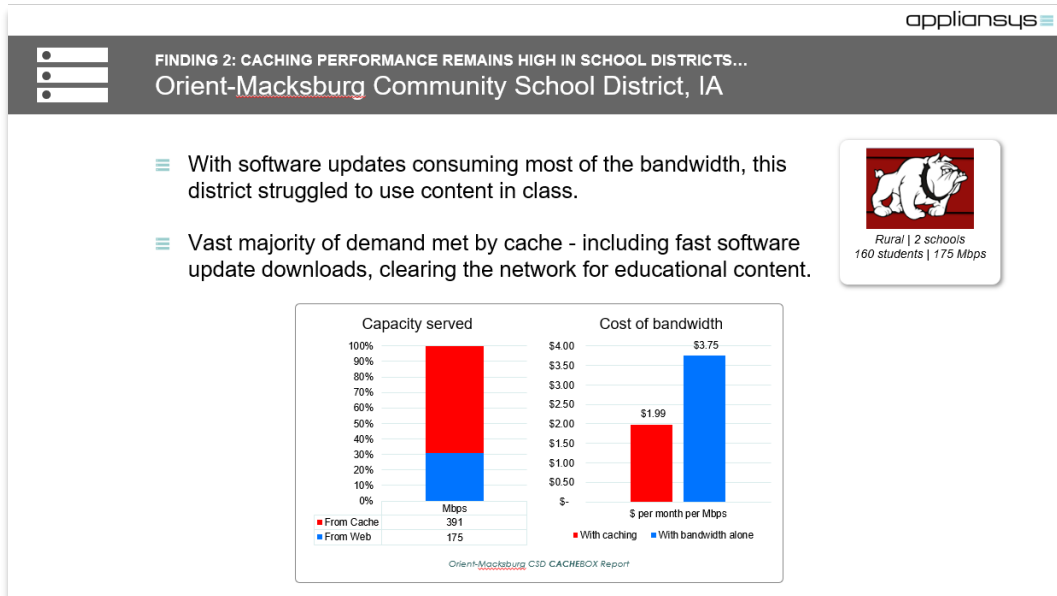
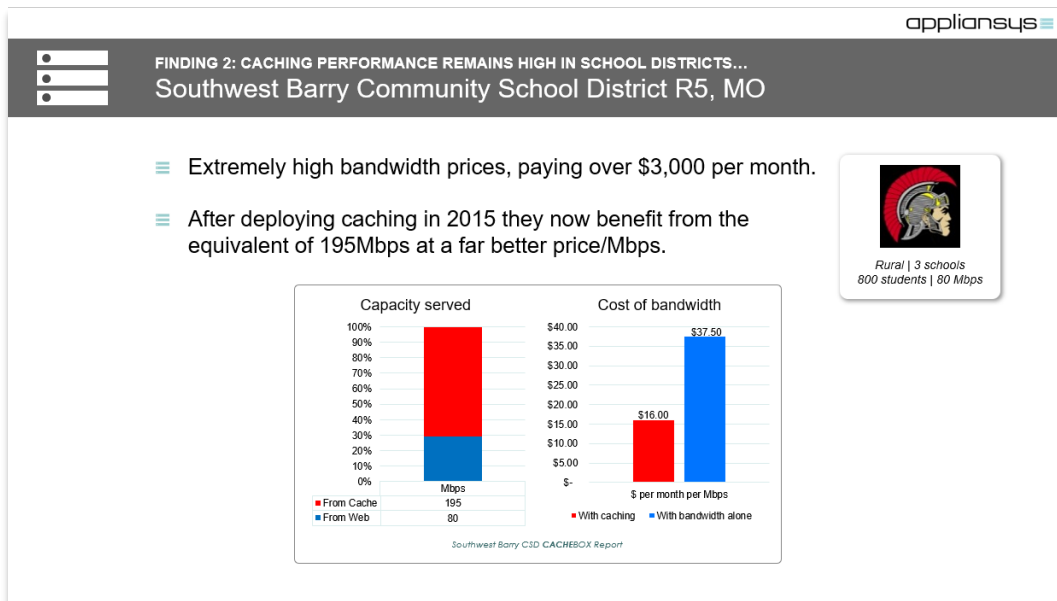
### Finding 2: Caching performance in K12 remains high, improving

Our findings demonstrate that caching continues to:

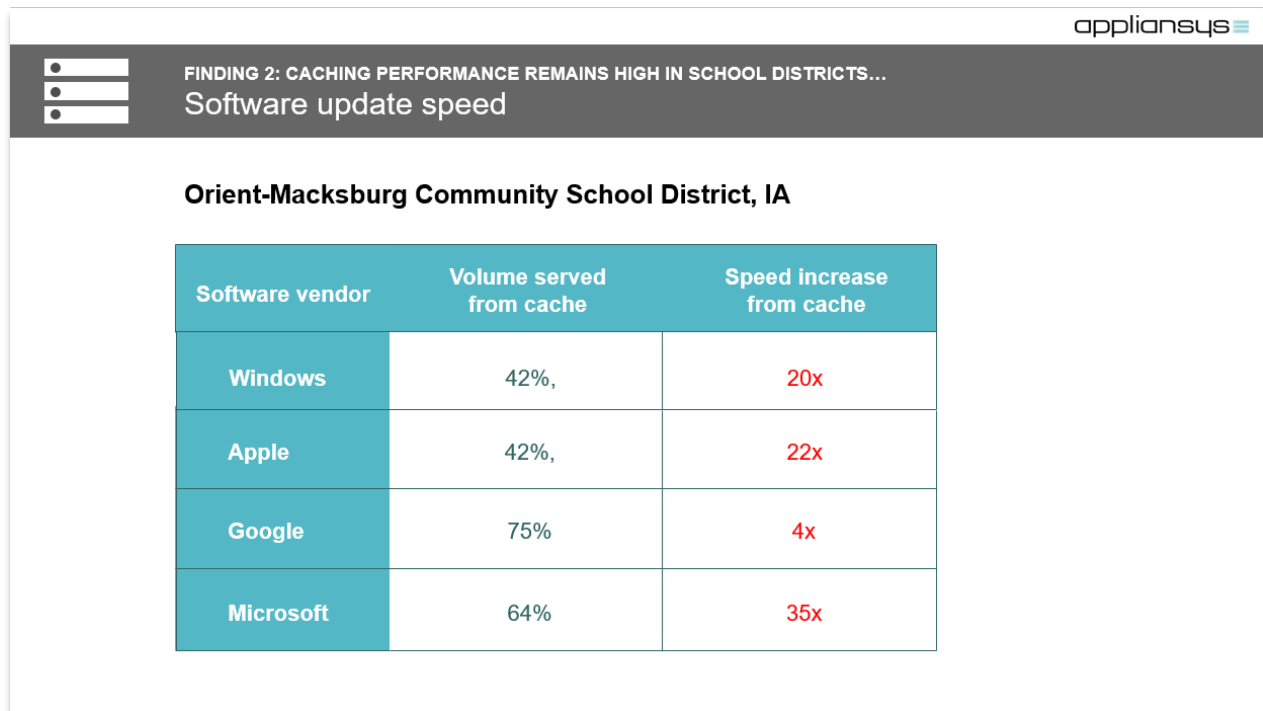
- ≡ Speeds up access to personalized, flexible digital learning
- ≡ Lowers bandwidth usage, reduces broadband inflation
- ≡ Makes existing bandwidth as much as 10 times more effective
- ≡ Slows the rate of network infrastructure upgrade

ApplianSys analyzed this year's performance data and produced case studies on individual school districts. ApplianSys is providing the FCC with a sizeable dossier of studies in its full report. 3 studies were presented to illustrate our findings.

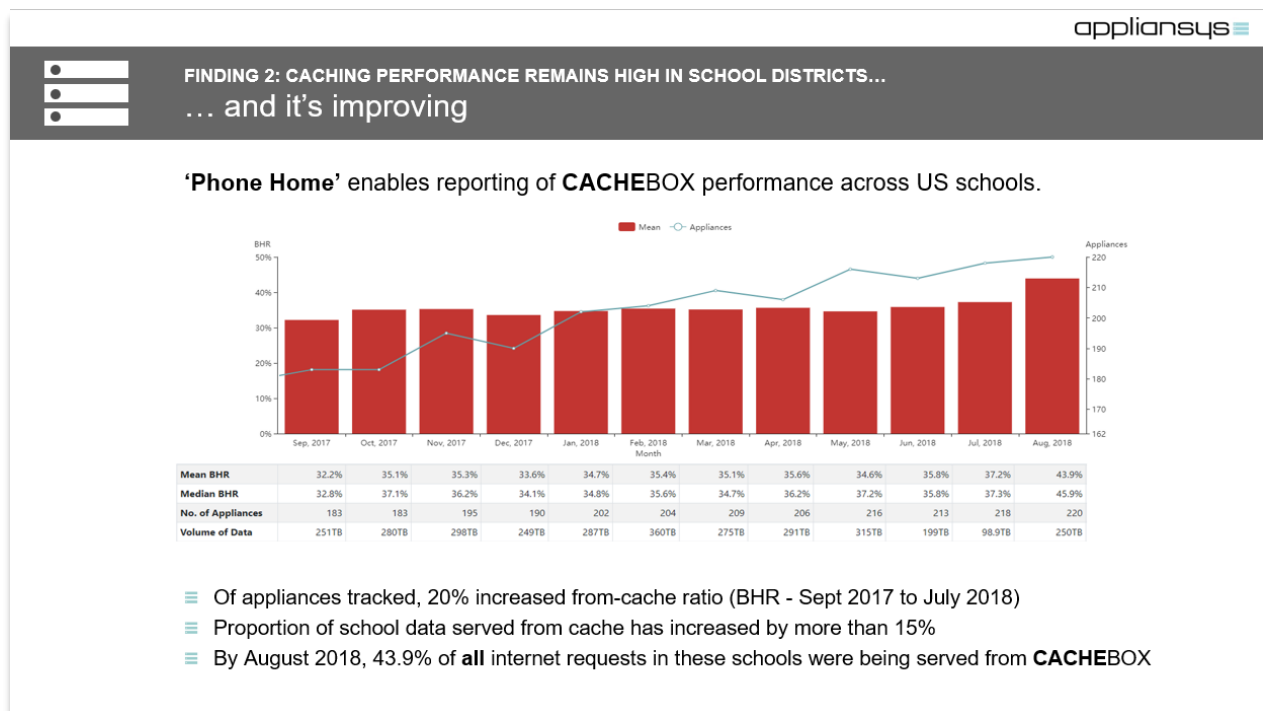
# Slide 19-21



## Slide 22



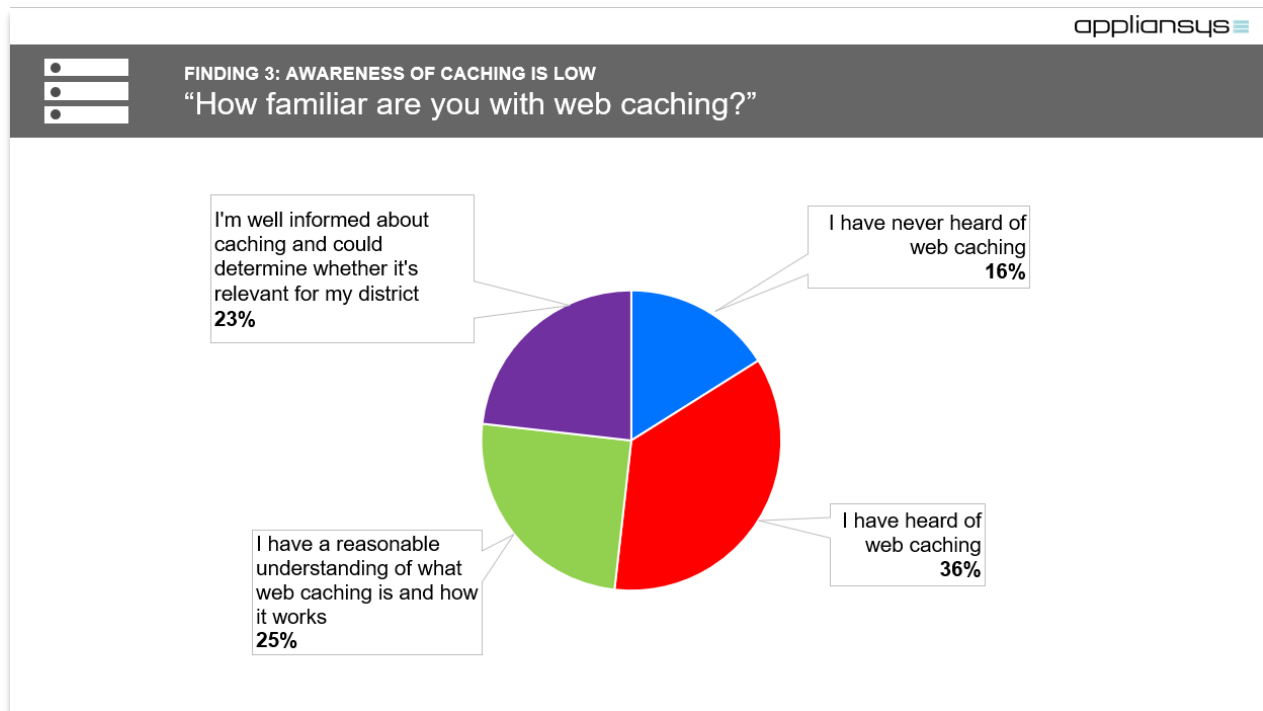
## Slide 23



ApplianSys has seen an increase of 20% in the numbers of schools utilising its performance monitoring and analysis service, providing further confidence in the observations made.

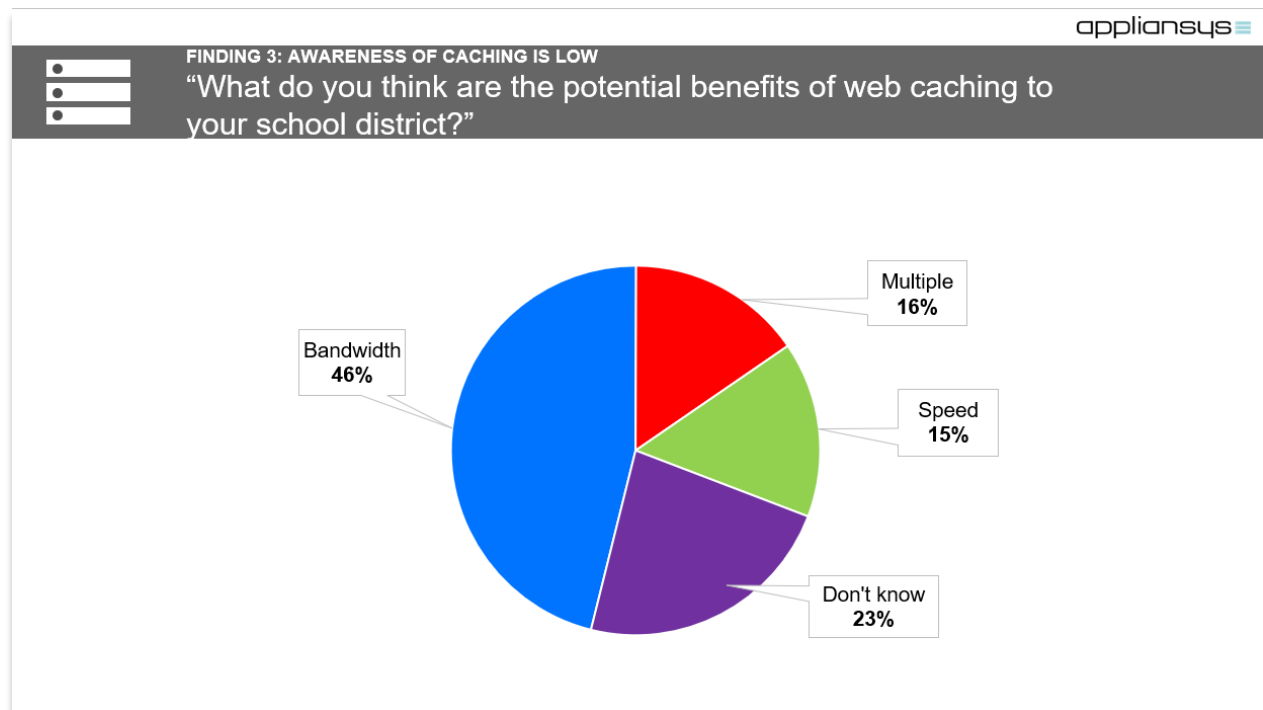
The proportion of traffic served from cache is growing – up 15% on the year, as ApplianSys engineers develop new rules to tackle content and software identified as popular in K12.

## Slide 24



An online and telephone questionnaire to US school districts yielded 56 respondents and showed that less than half claimed to have a reasonable understanding of what web caching is. Just 23% were confident that they were well informed enough to determine the relevance for their district

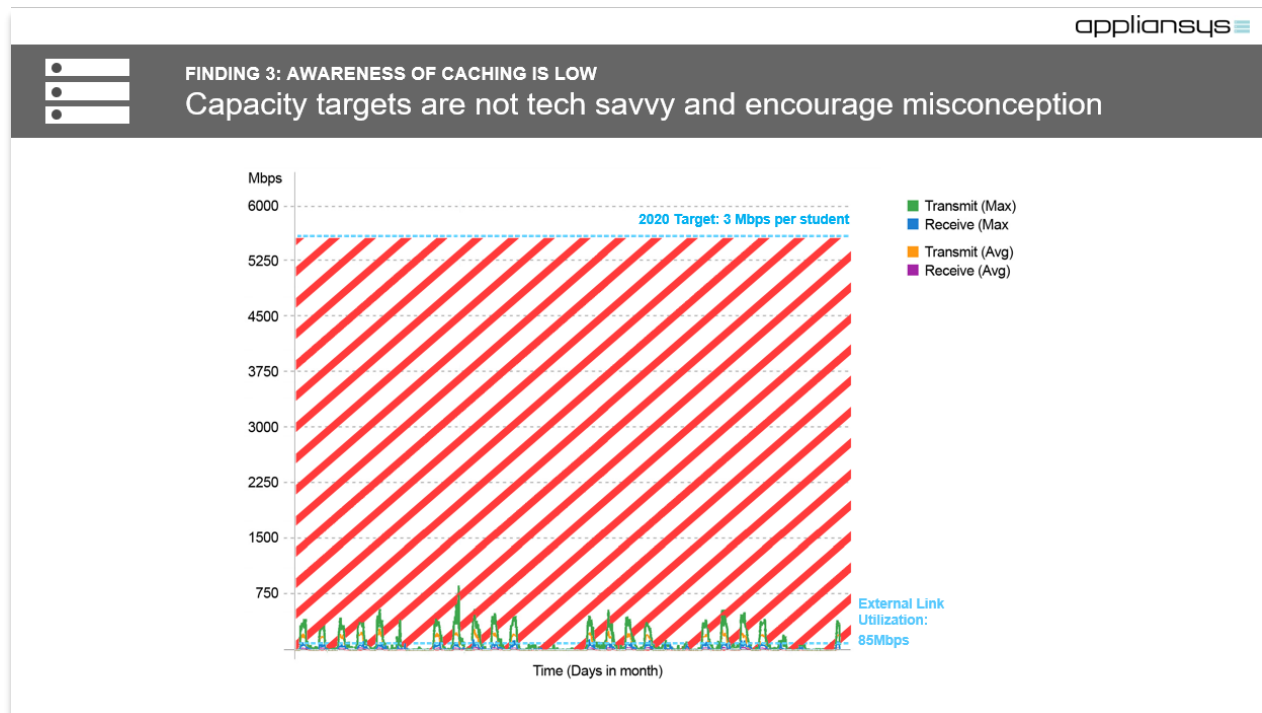
## Slide 25



Of those who claimed to be fairly well informed, 69% of respondents didn't know that caching has benefits beyond saving bandwidth. For many E-rate applicants there's a decision to apply for bandwidth 'or' for caching.

Given that Category 1 budgets are not capped but Category 2 is, it is therefore not surprising that most would choose to request funding for bandwidth and retain Category 2 budgets for other eligible services.

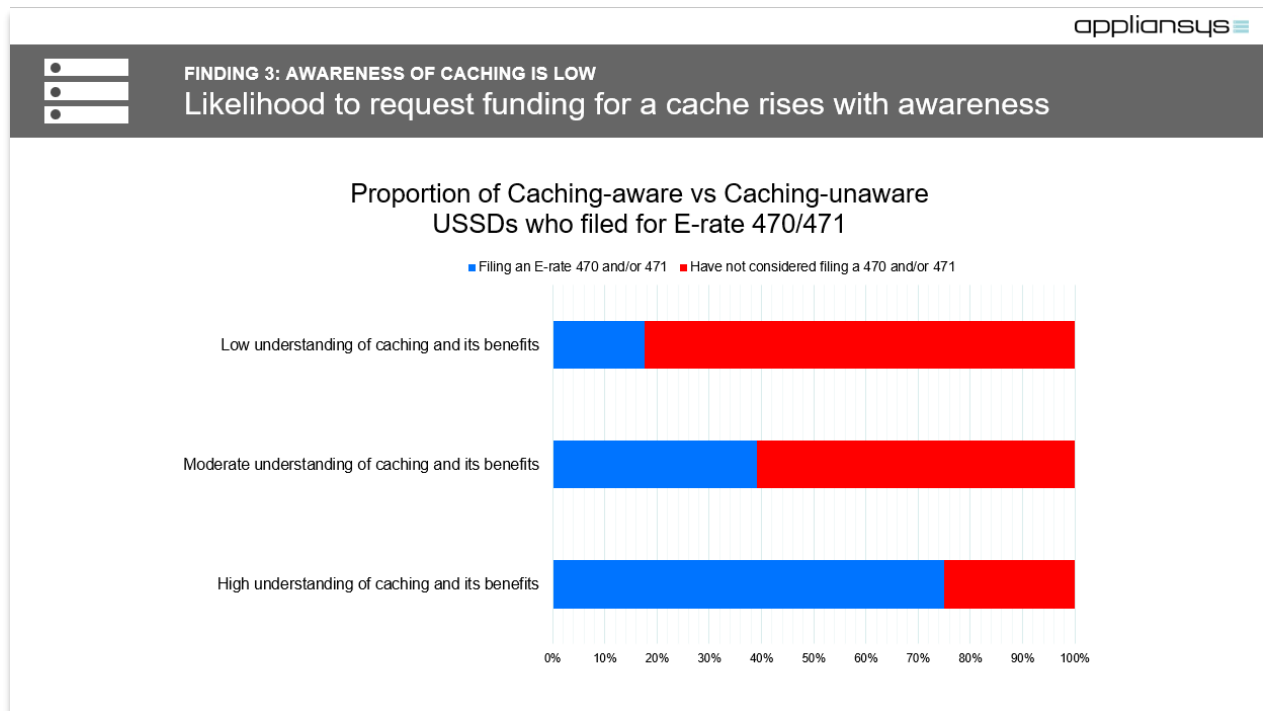
## Slide 26



The lack of caching awareness is in stark contrast to the perception that 'you can't have too much bandwidth'. FCC targets propagated by outlets like Education Super Highway are advocated as de rigueur. These get unchallenged airtime on high profile platforms skewing the national discourse.

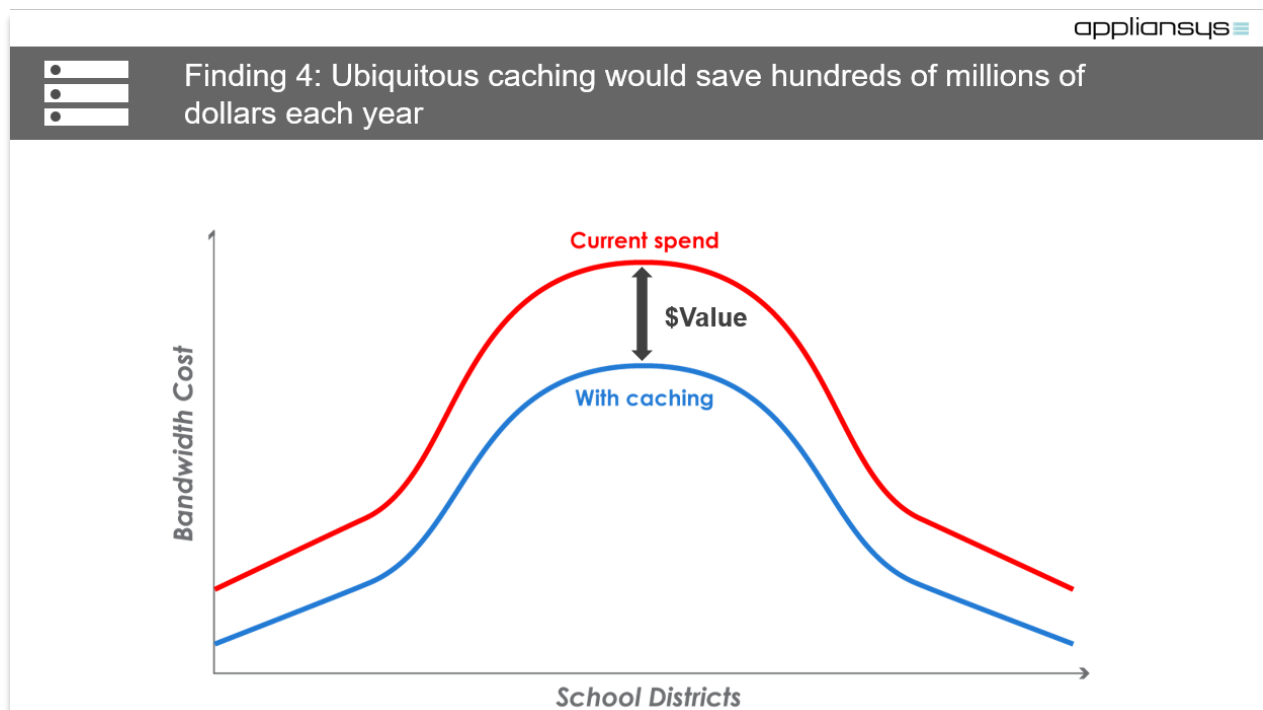
These targets do not take account of caching and the evidence is clear that they are at best a blunt instrument. We've seen school districts double their bandwidth when they don't need to in order to avoid missing out on funding from their State DoE. We've seen districts increase their bandwidth to 10x what they reasonably need, incurring additional costs to get their networks 'ready' for higher throughput.

## Slide 27



Data collected confirms what ApplianSys reported - from anecdotal evidence - to FCC in 2017: there is a direct link between awareness of caching and funding applications. Those who understand caching are very likely to apply, those that don't are not.

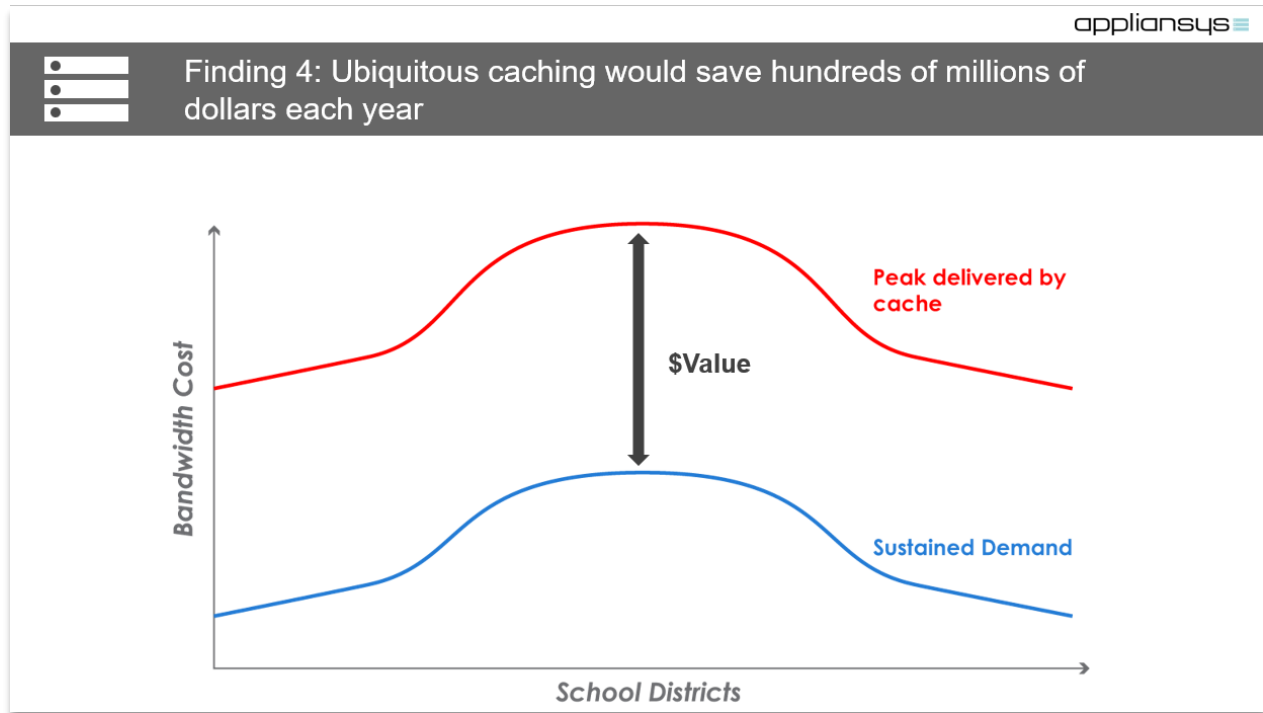
## Slide 28





ApplianSys most substantial piece of research in 2018 was to analyse the potential impact. If there was a level playing field, and caching was ubiquitous across US schools, what financial Return on Investment could FCC expect.

ApplianSys took 2 separate approaches: firstly the most conservative approach, which may be applicable in an ISP environment. We imagined a scenario where schools already had caching – and we calculated how much less bandwidth would be needed to have the same combined capacity as today.

## Slide 29



ApplianSys second ROI analysis approach reflected the specific nature of schools traffic, dominated by highly cacheable peaks. We looked at what result we would get if we added caching to current b/w, what is the value of the additional peak headroom that caching would deliver.



### Finding 4: Nationwide caching would save \$hundreds of millions p/a

A: Notional connectivity cost savings if caching was already in place

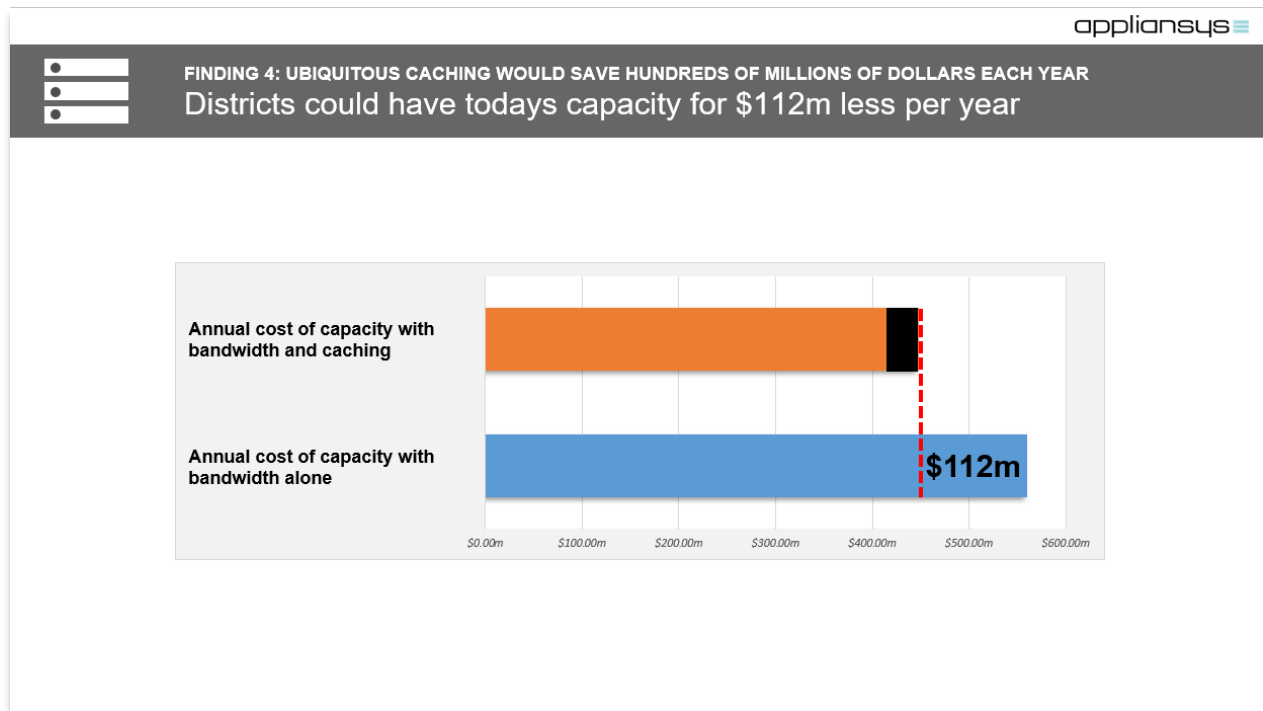
B: If all schools adopted caching on top of today's bandwidth

- 1: Value 'peak demand' performance
- 2: Bandwidth affordability improvement
- 3: Effective connectivity (bandwidth + caching) provision per pupil

ApplianSys' analytical approaches resulted in 4 scenarios: the notional savings if we already had caching in place and three ways of dicing and slicing the impact of adding caching to today's bandwidth levels:

- How much the additional peak capacity would have cost if we had provided it with bandwidth instead
- What the impact would be on the average cost of bandwidth if the cost and benefits of caching were included in affordability measures
- How much bandwidth per pupil would districts have compared with current connectivity targets

## Slide 31

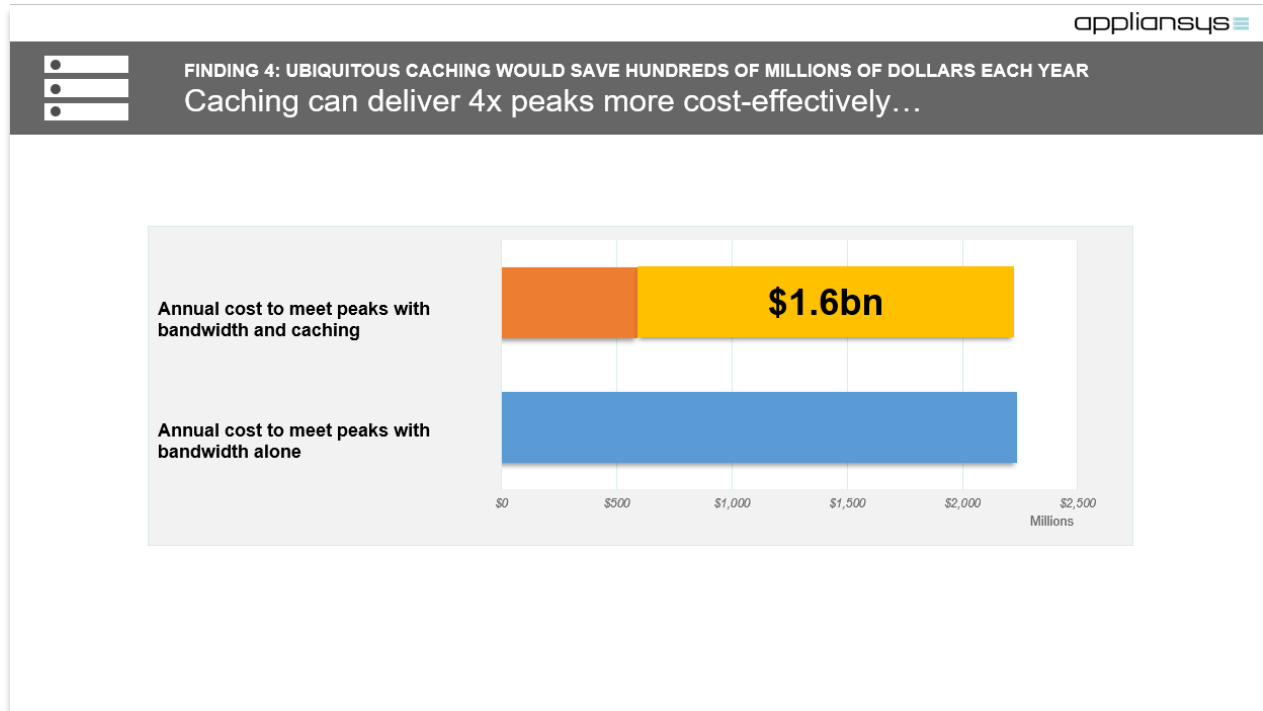


If caching were already in place, districts would need to spend \$112m less per year on bandwidth.

This figure is based on average bandwidth savings which is not a good reflection of the value to schools, it's a backstop. No school would fare worse than that rate of benefit, most would see very much larger savings.

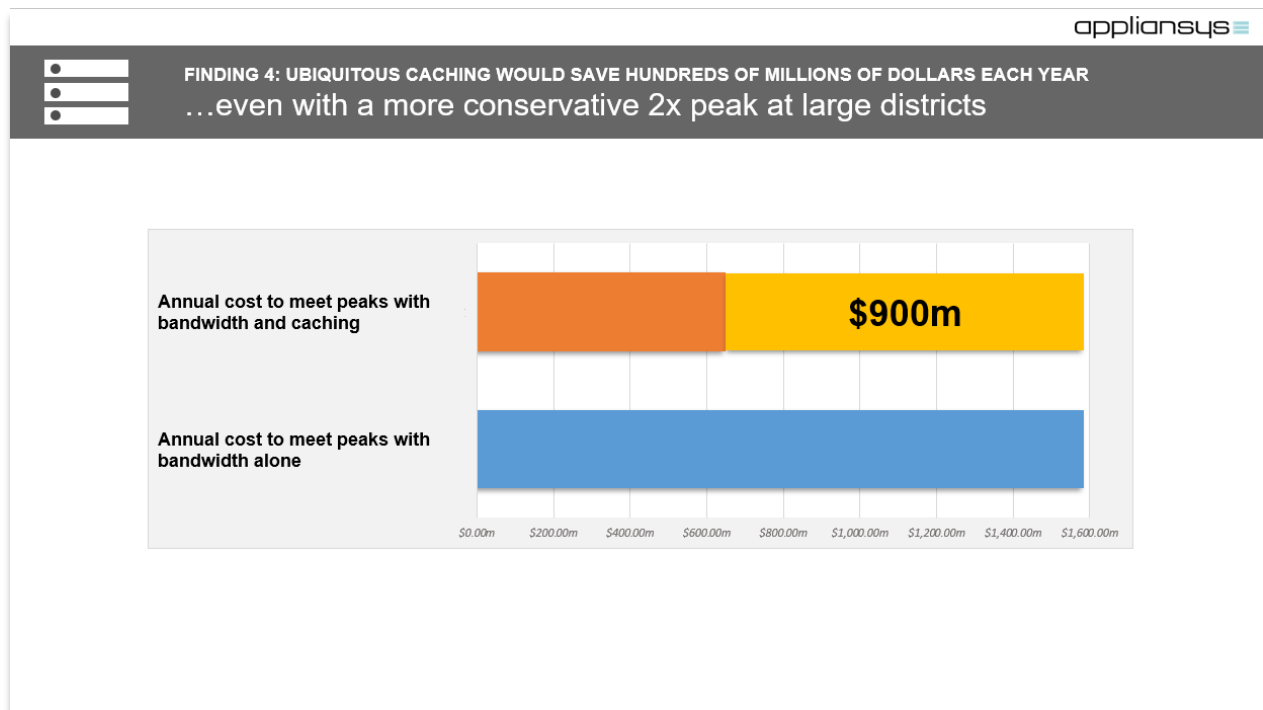
Of course, in practice, we can't expect that schools would reduce current bandwidth following the deployment of a cache, so this saving is just notional.

## Slide 32



To what extent would caching deployed nationwide today avoid the need to purchase future upgrades. Assuming a 4x peak capacity improvement, the annual cost to deliver the same peak demand with bandwidth alone would be over \$2.2bn compared with \$647m with caching.

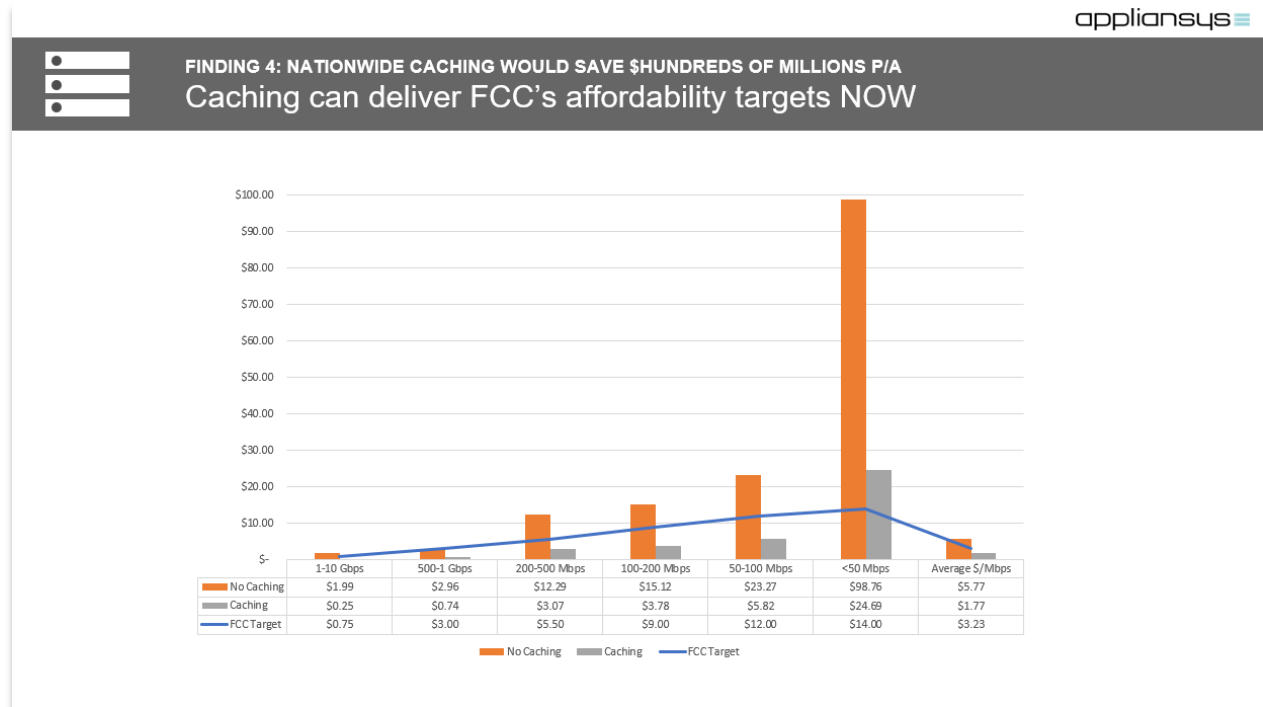
## Slide 33



For a single school, where all lessons start simultaneously at the ringing of a bell, **CACHEBOXes** regularly report peaks of 6-7x, even 10x the demand generated by the rest of the lesson.

But in some multi-grade districts those lessons can be staggered with Elementary and High School lessons starting at different times. In these cases, last mile WAN connections still see very large peaks but the district core internet connection traffic is somewhat smoother. To compensate for this ApplianceSys has conservatively assumed that districts with more than 2000 students might see peaks of only 2x average demand. Even with this adjustment, annual savings would total nearly \$1bn.


## Slide 34



With caching deployed universally, FCC affordability targets could be met now. The average cost per Mbps would fall from \$5.77 to \$1.77. By extrapolating from the affordability targets at each of FCC's defined thresholds, caching would deliver affordability across the board, with an average cost of \$3.23 per Mbps per month.



## Slide 36




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2017/18 K12 caching research findings summary:

- Finding 1:**
  - ROI = (\$Cat1+ \$Cat2) + (Speed->learning outcomes) + (tech team efficiencies)
- Finding 2:**
  - Caching performance in K12 is rising
- Finding 3:**
  - Awareness & take-up low
- Finding 4:**
  - National rollout would save in excess of \$1bn over 5 years

## Slide 37



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Reasons for FCC to take action

The analysis demonstrates compelling benefits of taking steps to encourage caching:

- E-rate funding goes much further
- Students benefit from better responsiveness in class
- Teachers are better able to innovate and drive up standards
- Technology teams can focus on improvement activity rather than resolving connectivity issues
- Bridges the rural digital divide

## Slide 37

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### ApplianSys recommendations

In response to 2017's draft ESL, ApplianSys recommended FCC:

- switch caching to Category One
- avoid WiFi and caching competing for insufficient funds
- modify bid evaluation methodology
- refine affordability measurements
- refine capacity targets

We urge FCC/ECB reconsider these in reviewing impact of 2014's E-rate modernization order

Roger explained that, as part of the ApplianSys submission last year, we had put forward suggestions as what might be done towards these objectives. Overall any measures taken would:

- level the playing field, make caching as accessible as bandwidth
- marshal, guide & persuade to drive a change in buying behaviours

## Slide 38

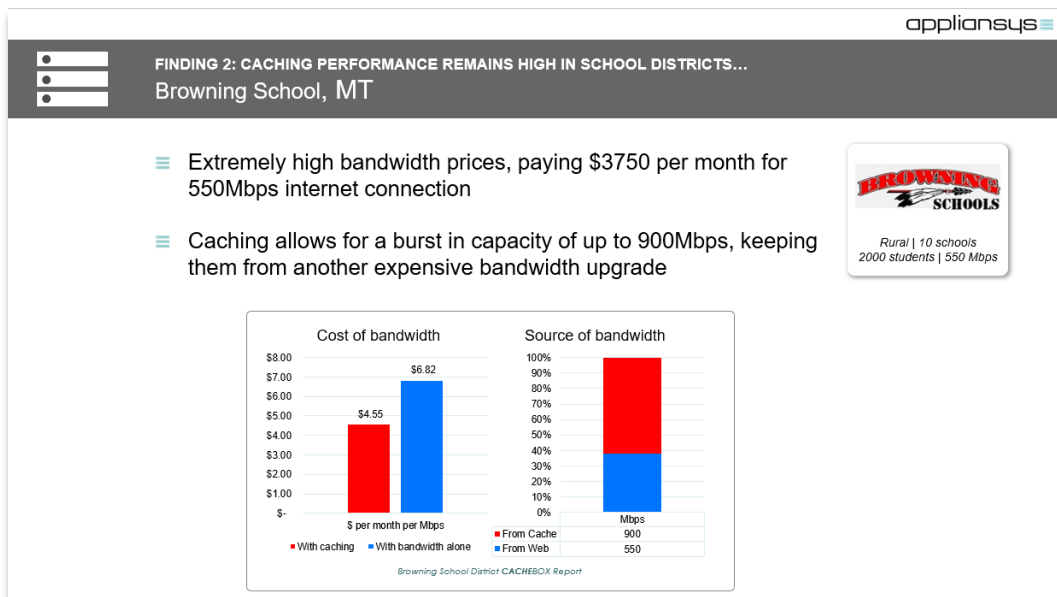
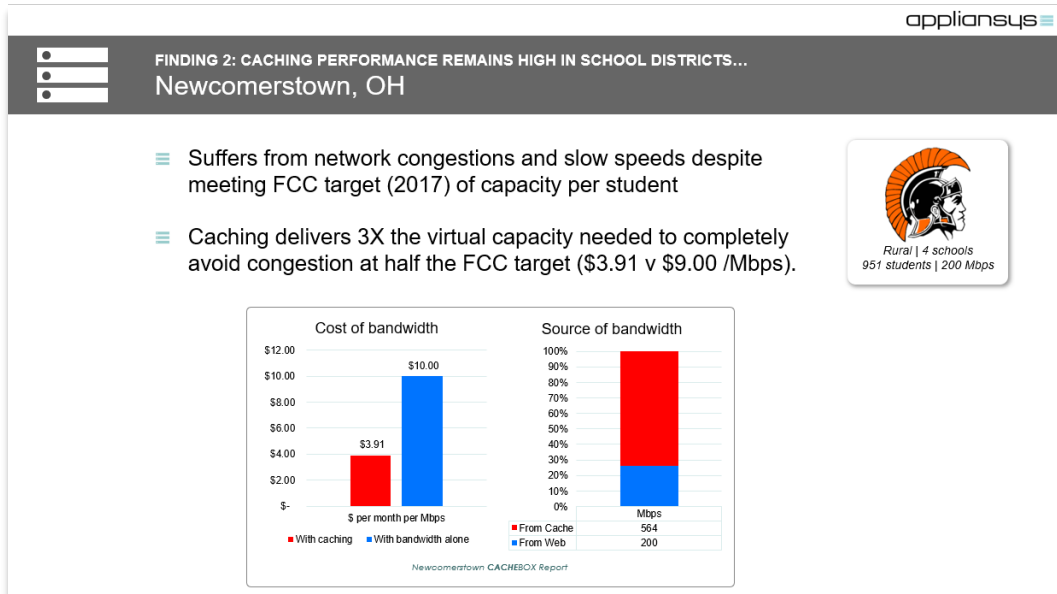
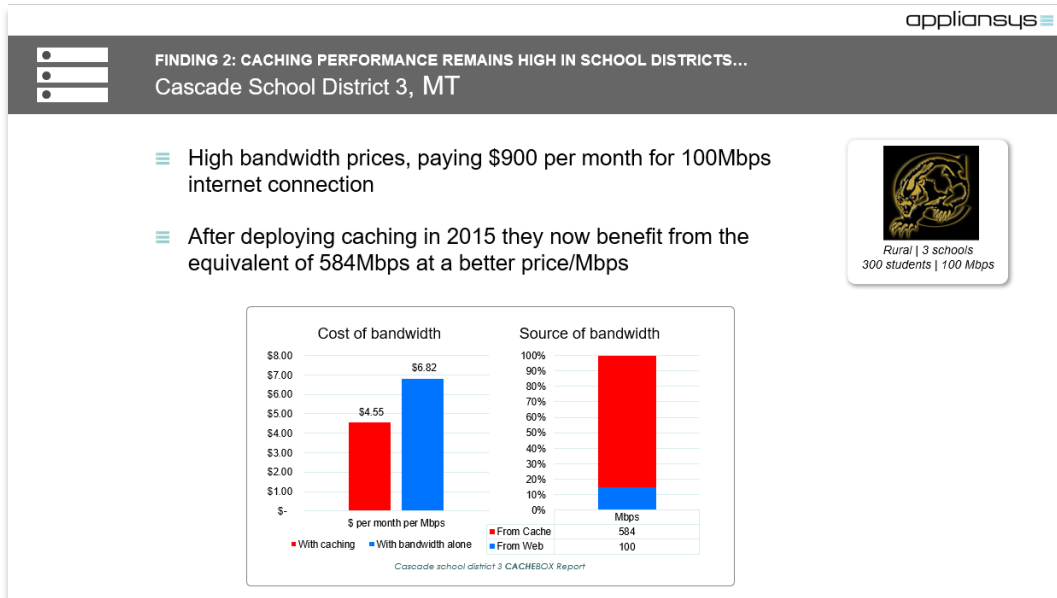
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### Further evidence of the value delivered at districts nationwide

|   |                               |                          |  |  |
|---|-------------------------------|--------------------------|--|--|
| <br>Technology Center of Du<br>Page, IL | <br>Newcomerstown, OH         | <br>Southwest Barry, MO  | <br>Big Horn, WY                             | <br>Highland Local Schools, OH         |
| <br>Cascade School, MT                  | <br>Hannibal SD, MO           | <br>Orient-Macksburg, IA | <br>Airport Community School<br>District, MI | <br>North Ottawa County USD<br>239, KS |
| <br>Browning School, MT                 | <br>Ronan School District, MT | <br>East Peoria, IL      | <br>Calexico Mission School, CA              | <br>Claremont Unified, CA              |

ApplianSys made available for discussion 15 additional district profiles to demonstrate the benefits that **CACHEBOX** customers have realised by deploying a cache.

# Slides 40-51

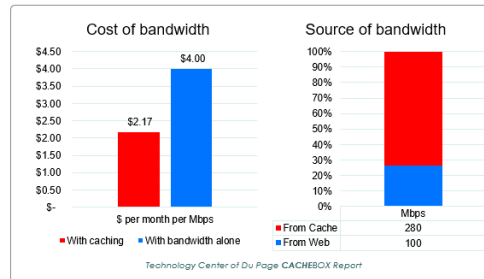
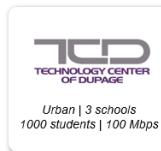




## FINDING 2: CACHING PERFORMANCE REMAINS HIGH IN SCHOOL DISTRICTS...

### Technology Center of Du Page , IL

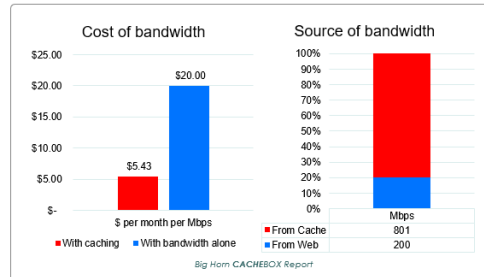
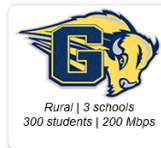
- Caching delivers 2X their original capacity at ½ the price per Mbps
- Haven't upgraded bandwidth for over 3 years since **CACHEBOX** was deployed in their network



## FINDING 2: CACHING PERFORMANCE REMAINS HIGH IN SCHOOL DISTRICTS...

### Big Horn, WY

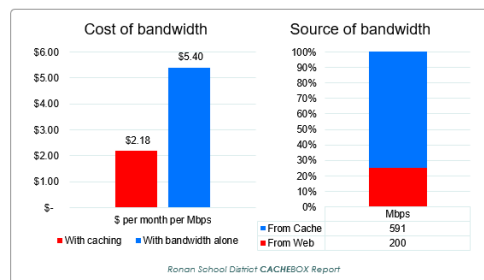
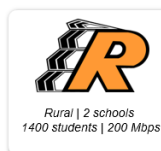
- Despite the good student to bandwidth ratio, Big Horn suffered from slow internet access and their location made it expensive and difficult to upgrade bandwidth
- With **CACHEBOX** in their network, they now get 4X their original capacity at ¼ the price per Mbps; enabling their 1:1 program.



## FINDING 2: CACHING PERFORMANCE REMAINS HIGH IN SCHOOL DISTRICTS...

### Ronan School District , MT

- High bandwidth prices (over \$1000 a month) due to it's location were discouraging web-based learning and 1:1 programs
- After deploying caching, Ronan accelerated classroom content by an average of 7X faster, increased their capacity to 591 Mbps and slashed their Mbps monthly cost to less than half





## FINDING 2: CACHING PERFORMANCE REMAINS HIGH IN SCHOOL DISTRICTS... Highland Local Schools , OH

- The rural location of Highland Local Schools meant that it was impossible for them to meet the 100 Kbps per student target without incurring extremely high costs.
- With caching, education content from various providers is delivered between 20 and 40 times faster



Rural | 5 schools  
1800 students | 100 Mbps

| Domain                     | From Web<br>(Mbps) | From Cache<br>(Mbps) | Speed<br>Increase |
|----------------------------|--------------------|----------------------|-------------------|
| starfall.com               | 1.3                | 51.1                 | 46.5              |
| microsoft.com              | 12.1               | 514.1                | 42.6              |
| abcya.com                  | 1.3                | 49.2                 | 37.6              |
| turner.com                 | 0.3                | 11.3                 | 37.0              |
| storylineonline.net        | 0.3                | 10.6                 | 32.7              |
| roomrecess.com             | 0.4                | 10.1                 | 28.3              |
| www.thelearningodyssey.com | 1.1                | 27.4                 | 23.8              |
| mathplayground.com         | 2.8                | 59.8                 | 21.1              |
| aniefrank.org              | 1.8                | 38.5                 | 20.5              |
| netmartz.org               | 13.8               | 273.9                | 19.8              |
| abcya.com                  | 2.5                | 45.4                 | 17.9              |
| apple.com                  | 6.1                | 104.6                | 17.2              |
| ballparksofbaseball.com    | 1.8                | 28.3                 | 16.0              |
| edgesuite.net              | 1.6                | 23.5                 | 14.7              |
| kidschallenge.com          | 5.9                | 85.9                 | 14.5              |
| naturalhistory.si.edu      | 3.6                | 50.5                 | 13.9              |
| windowsupdate.com          | 1.2                | 15.8                 | 13.5              |



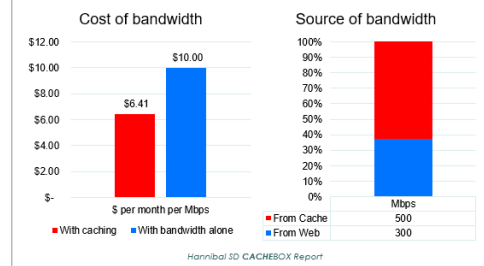
## FINDING 2: CACHING PERFORMANCE REMAINS HIGH IN SCHOOL DISTRICTS... Hannibal SD , MO

- Constantly congested, Hannibal was limiting it's internet usage disrupting lesson plans and banning the use of band-width intensive content like video
- CACHEBOX** is freeing up their bandwidth and accelerating their content, and the enforced YouTube ban has been overturned



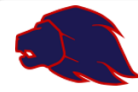
Rural | 8 schools  
3700 students | 300 Mbps

| Domain                   | % served<br>from cache | From Web<br>(Mbps) | From Cache<br>(Mbps) | Speed<br>Increase |
|--------------------------|------------------------|--------------------|----------------------|-------------------|
| *.rosettastone.com       | 92.0%                  | 0.12               | 120.5                | 97x               |
| *.bbc.co.uk              | 90.7%                  | 0.13               | 43.4                 | 34x               |
| *.starfall.com           | 84.5%                  | 0.14               | 44.4                 | 32x               |
| *.adaptedmind.com        | 97.2%                  | 0.10               | 21.6                 | 22x               |
| *.hannibalclinic.com     | 94.2%                  | 0.23               | 42.7                 | 18x               |
| *.k12.mo.us              | 88.1%                  | 0.05               | 7.5                  | 16x               |
| *.usc.edu                | 86.2%                  | 0.08               | 12.7                 | 15x               |
| *.commoncoresheets.com   | 92.8%                  | 0.10               | 15.8                 | 15x               |
| *.discoveryeducation.com | 66.3%                  | 0.45               | 40.6                 | 9x                |



## FINDING 2: CACHING PERFORMANCE REMAINS HIGH IN SCHOOL DISTRICTS... North Ottawa County USD 239 , KS

- Web requests are typically twice as fast and as much as 14x faster from **CACHEBOX** than from the internet.
- CACHEBOX** is maximizing the school's 100 Mbps connection, allowing them to benefit from great acceleration in the classroom and instant internet access.



Rural | 2 schools  
641 students | 100 Mbps

