Streaming Video on the Rails: How To Ensure A Great Viewing Experience

Maximize brand value, improve customer satisfaction, and ensure repeat passengers.

As a rail operator, you know that your passengers have a choice. Not only between yourself and possibly other rail operators, but between rail, plane, and even driving. Although convenience and price are often driving factors in ticket purchase, amenities, such as wifi and video streaming, are rapidly becoming important influencers in initial travel provider selection, repeat voyages, and the critical driver behind both: customer satisfaction. In this whitepaper, you'll learn how rail operators can affordably implement local caching in the carriages to improve the streaming experience and, ultimately, improve the quality of the journey for each passenger and even create new revenue sources.

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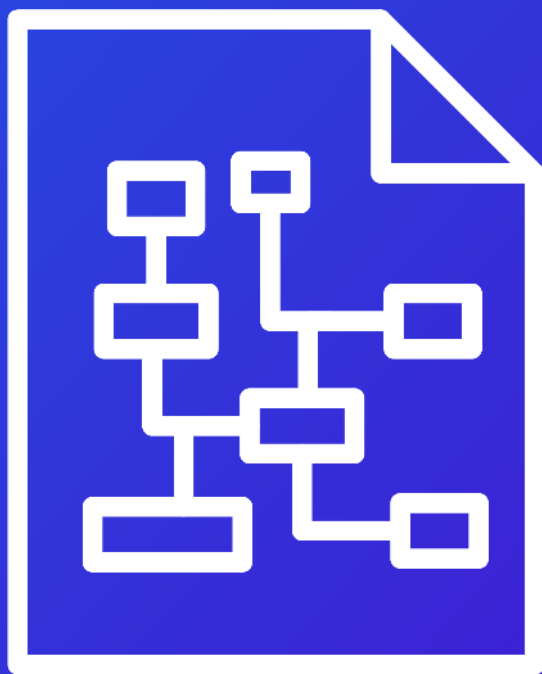
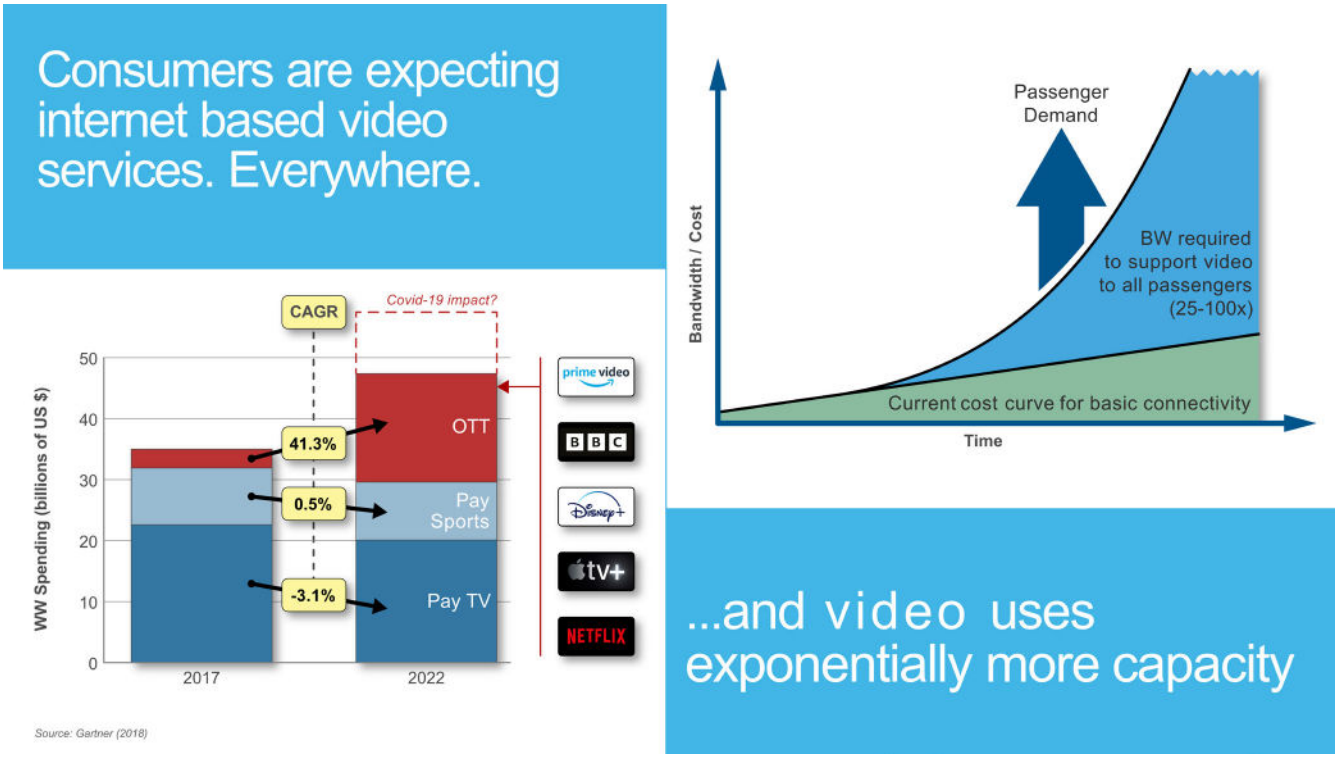
Introduction: Understanding The Challenges



Since 2019, streaming video has grown in popularity. With the pandemic behind us and people traveling again by plane, boat, and rail, the appetite for streaming content hasn't declined.

Streaming video is continuing to grow as a primary internet activity. Although that growth was supercharged by the pandemic (2019-2021), it did not fall off even as people left their homes and returned to their offices. According to the Wall Street Journal, world-wide streaming subscriptions passed one billion during the pandemic.

As the world has begun to shift back to a pre-pandemic lifestyle, people have begun to travel again: by boat, by plane, by car, and by rail. According to the World Travel and Tourism Council (WTTC), travel is expected to return to normal levels by 2023. It's not hard to imagine, then, a collision of these two trends just on the horizon: increasing travel and increasing streaming. Which is exactly what is happening.



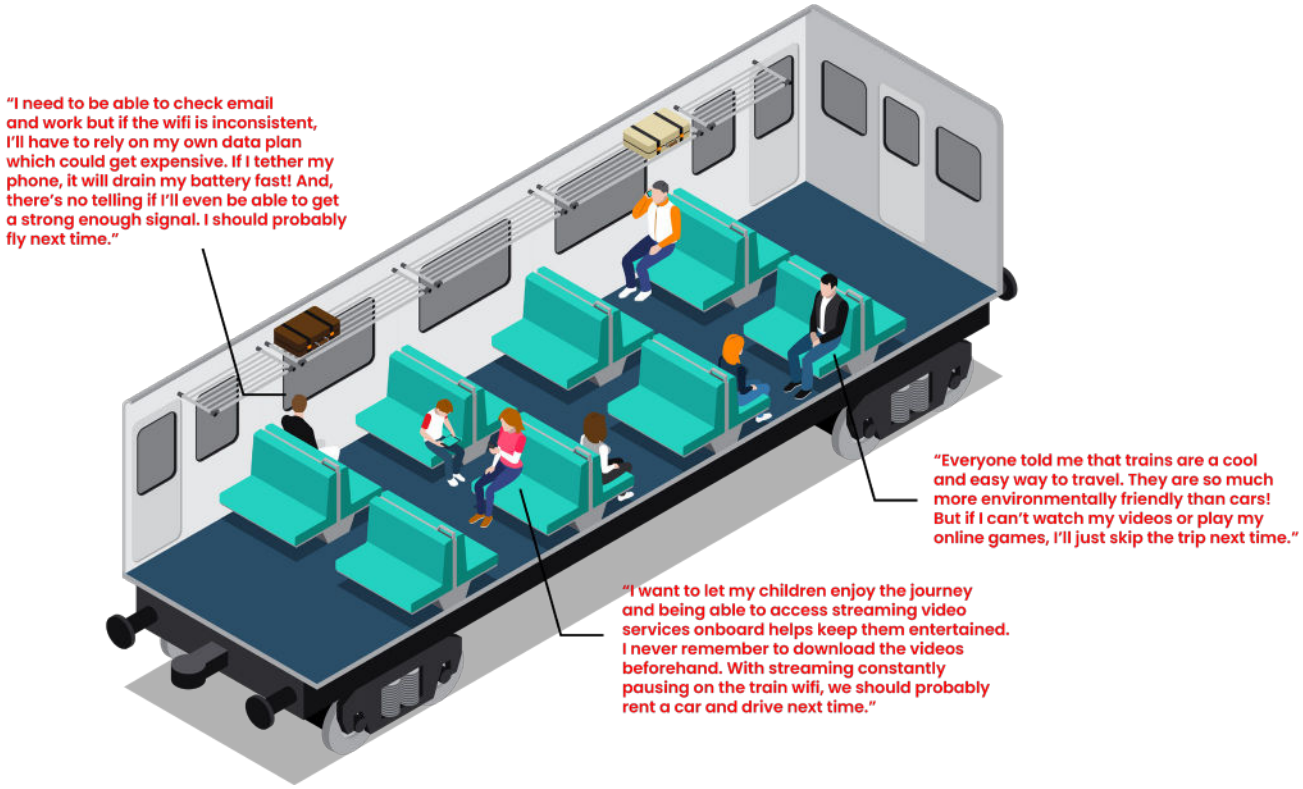
But providing an acceptable streaming experience in a moving vehicle, such as a train, poses a number of challenges. First is the bandwidth. Trains rely on cellular connections for in-carriage WiFi but that available bandwidth is difficult to predict and there is only so much to go around. As a result, passengers all accessing bandwidth-intensive services, like Netflix, could overwhelm the network. Imagine 200-500 passengers all sharing a 200Mbps link! When the available bandwidth drops because of a variable

signal or a spike in usage, everyone's experience suffers. Second, it's difficult to pre-position content. An obvious solution to inconsistent bandwidth would be to store content locally. Many plane internet operators do this, storing a library of material on board. But it may not be the content that passengers want to watch. So it's a limited pre-defined offering that can't compete with video streaming services passengers may have access to through their own subscriptions. Only enabling passengers to stream whatever they want may be too costly to implement. The third challenge, improving mobile signal strength, such as putting 5G in a rural pasture, isn't cost-effective for mobile operators which means that sufficient bandwidth for the in-carriage WiFi may only be available in pockets, such as near major stops. The final challenge for rail operators is the carriage itself whose construction inhibits the propagation of RF signals (such as cellular transmissions). So even if passengers can use their own bandwidth, the strength of the signal may not be consistent enough to stream.

Demand for streaming while traveling on trains is there. The challenges, though, present issues which will likely result in a poor streaming experience. And who will passengers blame first? Not Netflix.

Streaming Video on Trains: The Current Situation… Unreliable or Unavailable

For rail passengers, the on-board Wi-Fi experience is often poor or simply unavailable.



As illustrated above, three central use cases–a business passenger, a family with kids, and a younger passenger looking for entertainment while traveling–have issues with the current state of the rail WiFi experience. Whether or not there is WiFi on the train doesn't really matter. A bad streaming experience because of inconsistent cellular signal or congested WiFi results in the same question: "should I take this train again?" Ultimately, it's about satisfaction with a solution to lost time. When passengers choose to take a train, they are gaining back the lost time of driving to their destination. As such, if they aren't able to make productive use of their time, or be entertained on the train, their satisfaction with the journey might drop. In many cases, those activities will require online access. Consider the following activities passengers might engage with on the train and how they would involve the on-board network.

Traffic Shaping Alone Isn't Enough

The challenges of ensuring bandwidth is managed efficiently to provide an optimal passenger online experience require more than just a single technology approach.

There are traffic shaping solutions which can help rail operators better manage available bandwidth for passengers.

They do this by flow shaping at the headend and rate limiting passenger traffic on the train, often differently for different classes of service.

But traffic shaping alone can't cure the problems associated with limited bandwidth.

To effectively manage bandwidth in constrained environments (i.e., the bandwidth is not unlimited), network operators must employ multiple tools and technologies.

Local caching can be an effective technology tool for managing bandwidth in a constrained environment such as a train.

When combined with a cache and other features, such as manifest manipulation in the context of title-awareness, the management of bandwidth is improved while also ensuring the best viewer experience with the video: the user gets the right quality video for their request from the cache while preventing a cache miss from running into the traffic shaping at the head-end.

A layered solution for bandwidth management ensures the optimum application of that bandwidth to the many different use cases.

ACTIVITY	HOW IT REQUIRES ONLINE ACCESS	THE RESULT OF OVERLOADED BANDWIDTH
Checking emails	Connect to email server	A connection cannot be established or emails won't load
Watching missed episodes of a TV show, or catching up on the news	Request and receive content from a streaming platform	Interruptions in the connection could result in more buffering events making the stream unwatchable
Playing an online game	Connection to game server	The inability to remain connected to the game server can result in game losses
Searching the destination for restaurants and other activities	Using a search engine to find results and loading resulting websites	Websites will be loaded very slowly
Engaging with social media	Social media platforms are completely online based	Social websites or their equivalent app on a phone may fail to load at all

It's clear that forcing passengers to rely on their own cellular connections isn't tenable, especially if the train passes through long stretches of rural area. But why is it so difficult to provide a consistent, reliable, and high-speed WiFi experience on the train? There are three primary reasons:

- Bandwidth management
- Variable internet access bandwidth
- Supporting multiple use cases

Bandwidth Management

There is only a finite amount of internet access bandwidth available. But when there is a lack of proper network management, that available bandwidth can get consumed by just a few users. Consider passengers who are streaming videos. Video players, whether on a phone or in a computer browser, are greedy by nature. They will always seek the highest bitrate possible. So if a 4K version of a title is available from a streaming service, the player can support it, and the bandwidth is available, the player will ask for that version. Even if just a few passengers do that, the available bandwidth can be consumed quickly leaving others, even those performing much less bandwidth-intensive activities such as reading email, with a very poor experience. Bandwidth needs to be managed in a way that facilitates all passengers and their online-access

use cases receiving the appropriate bandwidth.

The combination of caps and latency as part of bandwidth management can result in a poor user experience.

Variable Bandwidth

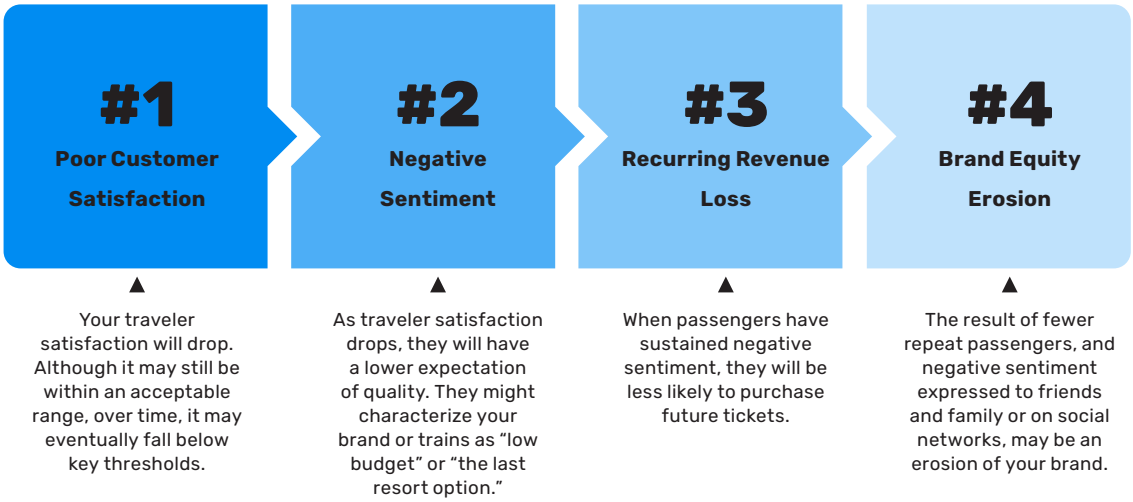
Train operators don't have fixed bandwidth to work with. Because their trains are on the move, they require partnerships with ISPs that can provide connectivity in motion. But that is ultimately an inconsistent proposition. When that connectivity is provided through satellite, tunnels or cuttings could cause interruptions. When that connectivity is provided through cellular networks, weak RF signal areas could result in poor bandwidth. Regardless of the ISP, train operators often have to deal with variable bandwidth environments and the result is the same: there is just never enough bandwidth.

Supporting Multiple Use Cases

Part of the challenge lies in the different use cases that passengers have for bandwidth use. If the only use case was checking email, it would be much easier to optimize the network bandwidth for just that. But it's not. And because there are multiple use cases to address, there is no single way to optimize the network. Tune it for streaming and game players suffer. Tune it for game play and business users have issues. From favoring specific traffic types to prioritizing one domain over another, there are many things that can be done to optimize the use of network bandwidth but not when there are so many different uses.

The Consequences Of Failing To Overcome Streaming Challenges

You could always just ignore the problem. But it's clear that WiFi access and connectivity are involved in traveler decision making. If they have a bad experience on your train with the Wi-Fi, they might choose an alternate operator or a different mode of transportation. Ultimately, failing to provide a good Wi-Fi experience can have four negative impacts:



But alongside the question of ignoring the problem is asking yourself, "can you afford to allow streaming at all?" One of the obvious solutions to those challenges is to block streaming. If there isn't any streaming then all of the other use cases will most likely perform as intended even when bandwidth management or variability is an issue. Only enabling streaming may be a costly proposition. If an operator opens up their network to let people stream (rather than blocking streaming services), it's actually cost prohibitive as user requests are fulfilled through backhaul across the internet.

How To Solve The Wi-Fi Experience Challenges

The Four Keys to Overcoming the Challenges of Streaming On the Rails

Although blocking streaming is a solution to the challenges of ensuring a positive Wi-Fi experience for passengers on your train, there are other ways.

Through the four ways below, you can overcome those challenges outlined in Section 1 without taking the drastic step of blocking streaming on your train's WiFi network:

1. Local caching
2. Smarter use of bandwidth
3. Better logging for improved optimization
4. Being title aware to ensure consistency

Local Caching

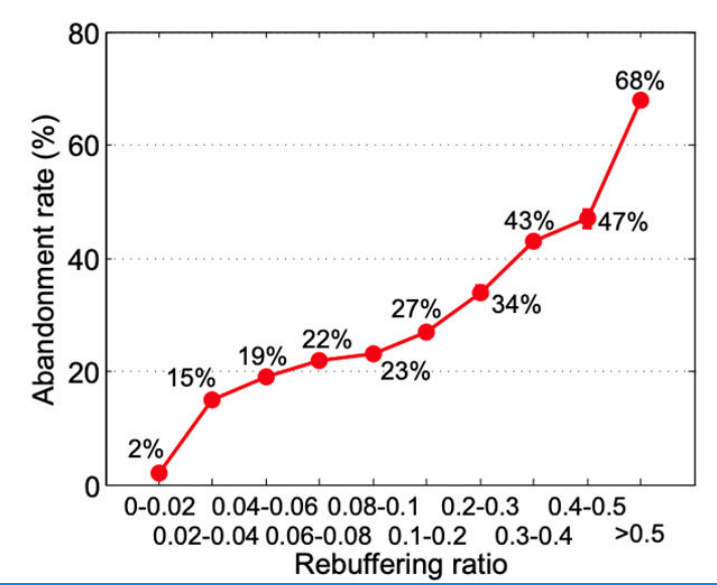
Streaming efficiency is primarily about caching. When requests for titles are handled by a streaming operator, they are first redirected to the cache which is closest to the user. This cache may be one of hundreds or even thousands but represents a first line of response. If the content is in the cache, it can be served right from there with no need to travel across the internet to the content source. Caching provides a way for streaming operators to provide a better video experience to their viewers: faster start-up times and less buffering. Solving the challenge of streaming video demand consuming the available bandwidth on your trains starts with deploying local caches in the carriages. Doing so can help reduce some of the bandwidth consumption by redirecting duplicative requests (i.e., two passengers requesting the same piece of content): the second request is pulled from the local cache rather than having to be served by the streaming operator's cache.

Smarter Use of Available Bandwidth

The next key to solving these challenges is a smarter use of bandwidth. This can mean a lot of things, but when it comes to streaming, it's all about connection sharing/re-use and network Quality of Service (QoS) management such as policy-based routing to address domains that are out of cache. By being smarter about how the bandwidth is being used, you can ensure a better experience for all the use cases.

What Happens to Viewer Satisfaction When Videos Buffer?

Every video player has a buffer that is filled with content before playback begins. This helps ensure playback continuity in the event the connection between the player and content origin or cache is severed. When the buffer is empty, the viewer experiences the "spinning wheel."



One of the biggest impacts of inconsistent or poor bandwidth on streaming video is buffering. But what happens when videos buffer?

According to research by Columbia University, New York, NY rebuffering events have a strong influence on user behavior. Their analysis of the ratio of buffering to viewing time indicates that relatively low levels of rebuffering leads to >20% abandonment. Buffering of 10 seconds in 100 seconds of viewing is a ratio of 0.1. 20% abandonment is reached with 4 – 6 seconds of rebuffering in 100 seconds of viewing

In the standard case, this is the loss of 1 or 2 requests for objects that contain 6 seconds of video.

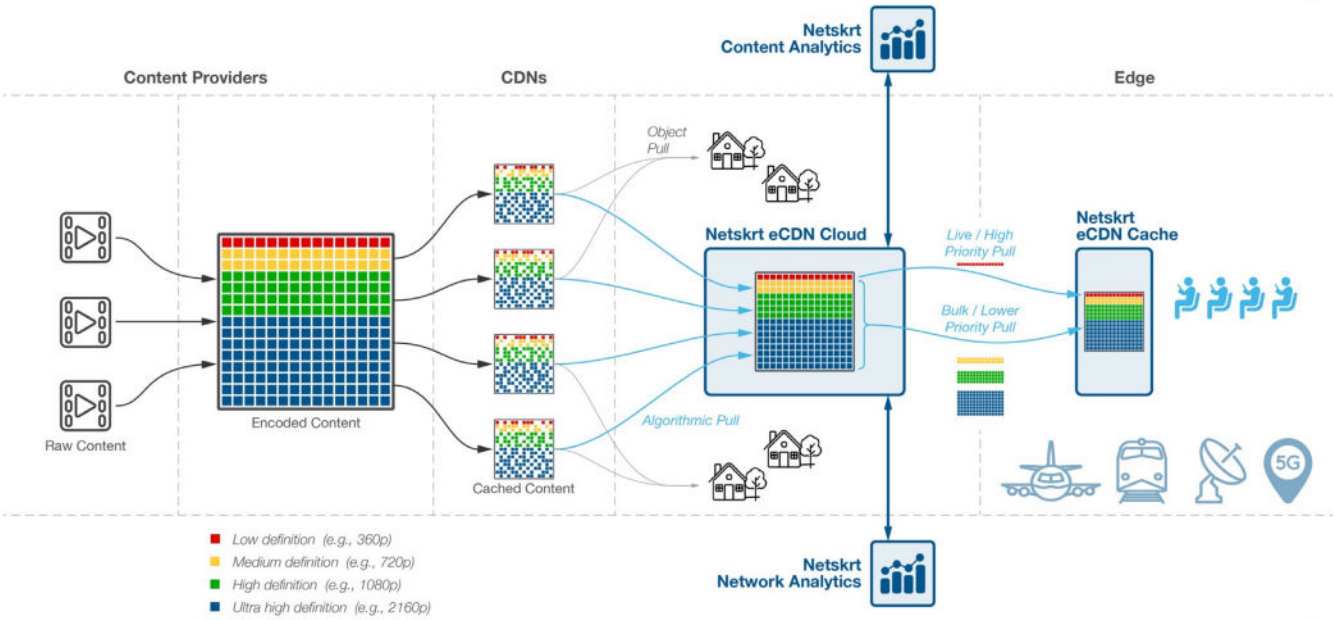
There are many ways to address buffering issues but the most common is through caching. By locating caches closer to end users and improving the cache efficiency (that is the ratio of finding a segment of the video in the cache versus having to go to the origin to retrieve it).

If your passengers experience a lot of buffering, who will they blame? The streaming provider, such as BBC or Disney+? Or will they blame the WiFi situation on the train?

Better Logging For Improved Optimization

Long-term optimization of the network requires usage data. But if you aren't logging session-based information, then it's impossible to do the analysis that will reveal insights into how the network can be tuned for better performance. Detailed logging is critical to improving network operation.

Being Title Aware To Ensure Consistency

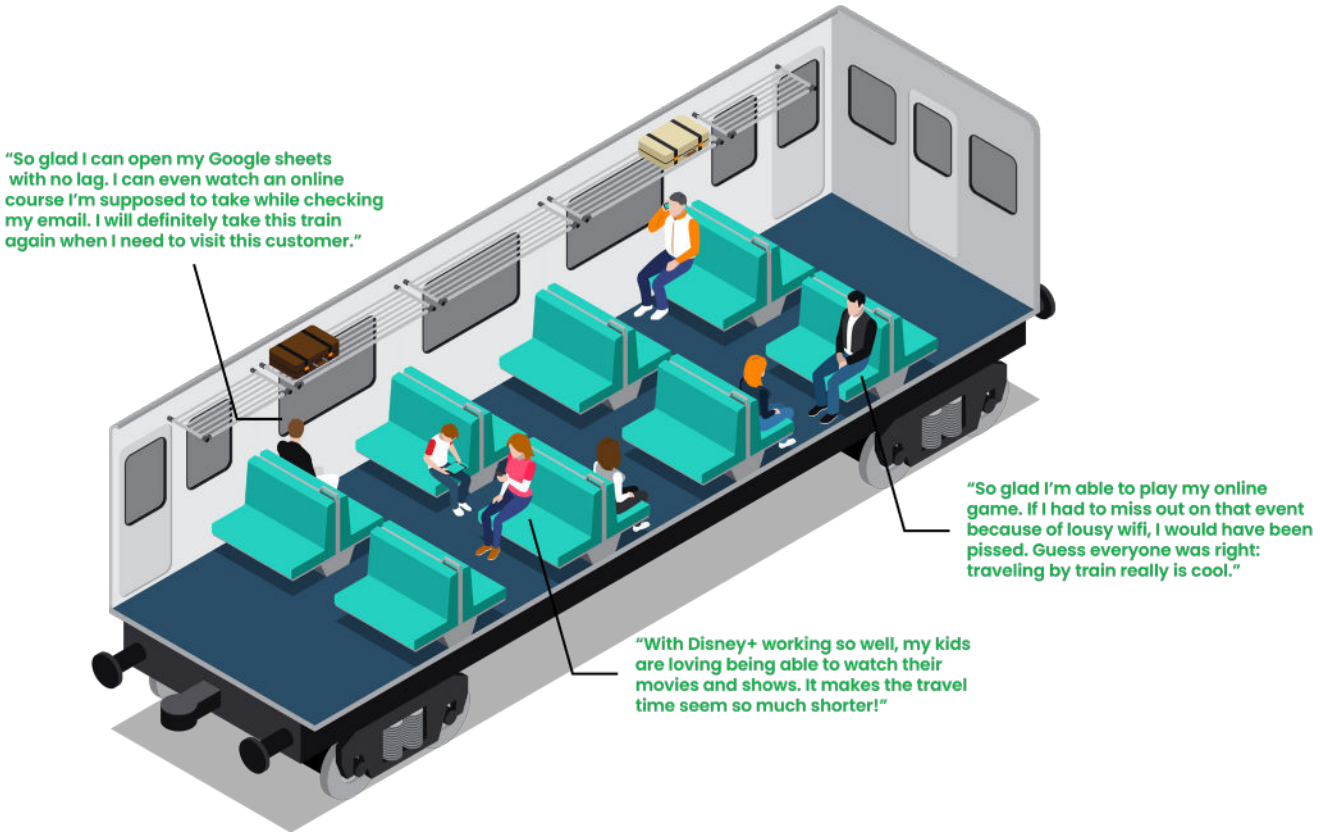


A single streaming video title is often a collection of different formats (such as HLS, DASH, etc.) as well as different bitrates within each format. Just one title may actually be dozens of files. Being title aware, then, means understanding all of the variations for that title, and identifying which versions to cache. For example, prioritizing a lower bitrate first (which is a smaller file size so can be cached more quickly) means the content is available for watching immediately. We don't waste bandwidth downloading parts of other bitrates while we are focused on getting the title playable. Higher bitrates can be cached even as the lower is playing allowing the player to gracefully move up the bitrate ladder. The overall objective of being title aware is to ensure the entire title is in cache, rather than just the beginning or the end.

Netskrt: All Four Keys In A Turnkey Solution

Netskrt Rail Edgecasting: Providing a Better Rail Traveler Experience For Streaming

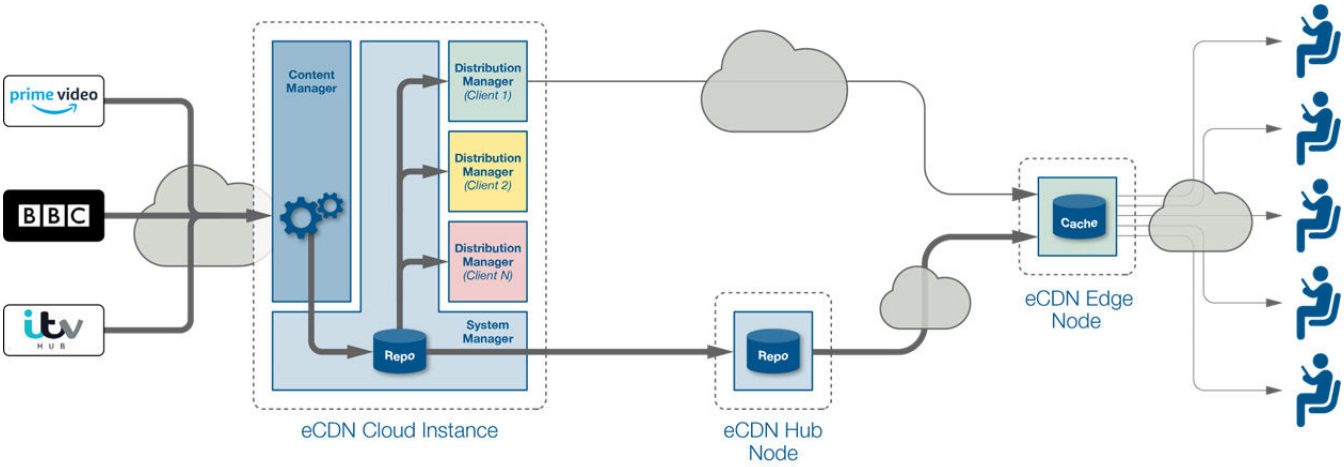
When your passengers have a positive Wi-Fi experience, they are more opt to think highly of your brand and travel again.



As we saw in the earlier version of this illustration, each traveler type (business person, family, and millennial) was upset because the in-carriage WiFi experience couldn't provide them what they needed. But after implementing the Netskrt eCDN, those reactions have changed dramatically.

The Netskrt eCDN: What It Is And How It Is Implemented

At the heart of a better in-carriage streaming and online experience is an innovative approach to delivering content to moving passengers: the Netskrt eCDN. Our approach is to enhance the existing train infrastructure with caching and delivery intelligence that will better utilize the available bandwidth.



The Netskrt eCDN is a "hands-off" solution. Once installed and configured, the rail operator can just sit back and enjoy the improved customer satisfaction with their online activities. The Netskrt eCDN solution is comprised of five core components:

- **Content Manager.** The Content Manager manages the collection of content from the content partner's apps and libraries. It ensures that the Netskrt system is aware of all the titles that a content partner has, how they are organized and what level of priority each title in the library should have. This ensures that the content that is most popular and content that is being promoted is prioritized for distribution to the edge nodes
- **Distribution Manager.** The Distribution Manager ensures that the identified content is distributed out to the Edge Nodes and made available in the caches for delivery to end users. Title aware features are used to ensure the best use of network resources when updating the caches.
- **eCDN Hub.** The Hub can be used as a scaling and cost optimization for distributing content that needs to be delivered to edge nodes, further enhancing the benefits that the Netskrt service brings to a network.
- **System Manager.** The System Manager is the brains of the Netskrt eCDN and includes such features as intelligent policy-based routing to manage the relationship between the Distribution Manager, upstream ISP network, and other networks related to fulfilling user requests in the most efficient way possible.
- **Edge Node.** The Edge Node is the local cache which can store and deliver streaming video content and is considered to be a general purpose CDN, able to

cache and deliver small objects from popular webpages, and other pre-positioned content from content partners if configured to do so. The Edge Node can be used to optimize the experiences of both web browsing and video streaming.

From Congested Bandwidth To Optimized Network... Hands Free

At the heart of a better in-carriage streaming and online experience is an innovative approach to delivering content to moving passenger

Implementation is relatively simple and handled by Netskrt engineers. In short, we integrate with the onboard WiFi environment and make some small changes to the on-board DNS. In more detail, Netskrt engineers add our hardware to an existing rack or a set of expansion storage to an existing compute environment. Once installed, we configure the Netskrt eCDN to work with the on-board network to utilize the upstream connectivity and any secondary networks that are available at stations, depots, etc. Finally, once the system is engaged and working, we employ policy-based routing for each implemented content provider to ensure that the requests for their content get routed through our cache and cloud environments.

Our Technology + Your Problems = Satisfied Passengers

So how do the components and features of the Netskrt eCDN meet the needs of your passengers?

ACTIVITY	HOW IT'S ADDRESSED BY NETSKRT ECDN
Checking emails	Caching and more intelligent bandwidth management ensure there is plenty of bandwidth available
Watching missed episodes of a TV show, or catching up on the news	Content can be cached allowing the traveler's request for content to be served locally resulting in higher bitrates and fewer buffering events
Playing an online game	Makes more bandwidth available for gaming
Searching the destination for restaurants and other activities	Small objects can be cached resulting in faster website loading and better performance
Engaging with social media	Small objects can be cached resulting in faster website loading and better performance

Ultimately, when you provide the kind of functionality from Netskrt eCDN into your train WiFi experience, both you and your passengers will experience tangible benefits:

- Increased satisfaction. Passengers able to stream, play, and browse more will have a more positive experience on your train that may result in higher satisfaction and, ultimately, more repeat passengers.
- Leveraging existing investment. Trains are already being equipped with 10Gbps and on-board caching can enable greater than 10 Gbps connectivity.
- Benefit sooner. Many years and billions of pounds will be required to build out trackside 5G. You can benefit today, and with dramatically lower cost, by deploying eCDN.

Bringing Premium Content To Your Passengers

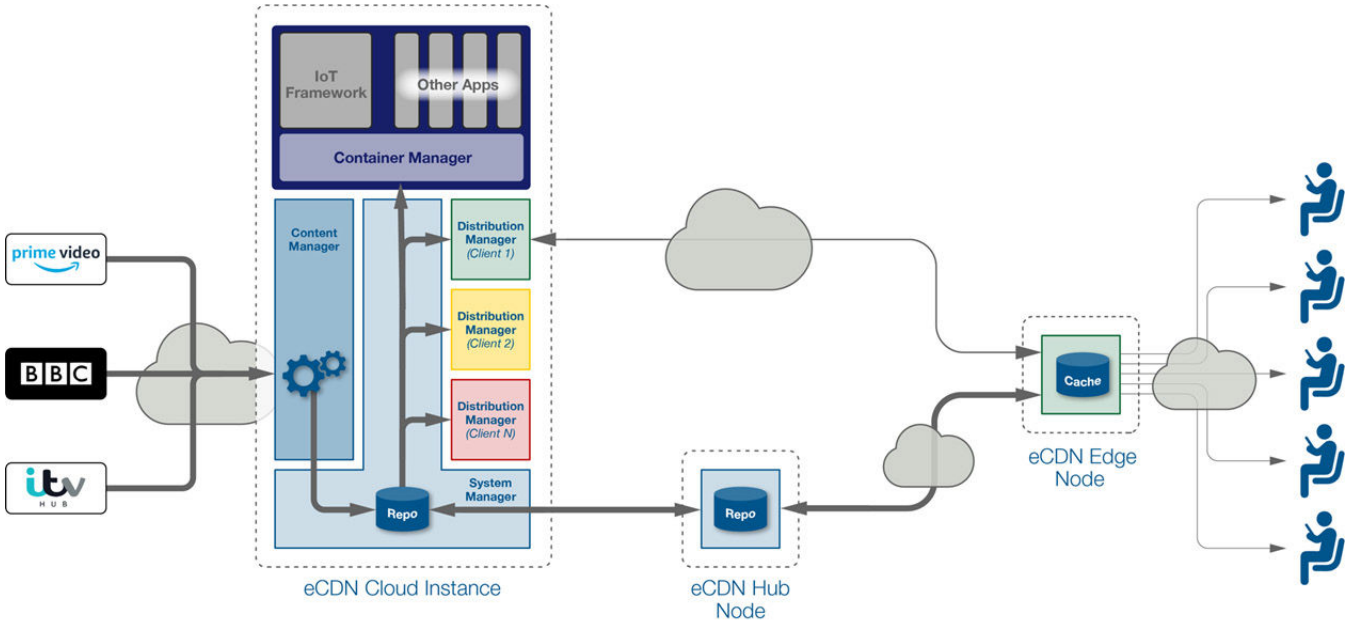
We have already seen plane operators, such as American Airlines, partner with content providers and ISPs to bring premium content to their passengers. By employing on-board storage systems, they can offer their customers a library of content. Although airplane passengers may enjoy the content, it may not be exactly what they want to watch. It may be just “good enough.”

Netskrt is approaching this problem differently by partnering with streaming operators to pre-position popular content in the eCDN caches on board. By addressing local storage of content this way, Netskrt ensures that all the popular content from a provider is available from the on-board cache, rather than just a couple of titles. Netskrt already has relationships with iTV and PrimeVideo and is forging more with Tier 1, global streaming platforms.

A Solution For Today...And The Future

Deliver Streaming Video Services Today, Build For A Future Of Opportunities

When you implement the Netskrt eCDN to help improve your current on-board Wi-Fi experience, you are opening future of possibilities for in-train online services that leverage your Netskrt investment.



When you deploy the Netskrt eCDN solution, you are doing more than just providing on-board caching and better bandwidth management. You are deploying a contained cloud environment with ample storage and compute to handle a variety of innovative use cases. We have outlined just a few of them below:

- Store CCTV and sensor-based data
- Store raw data (and forward later)
- Advertising

Store CCTV and Sensor-Based Data

You may have a variety of sensors located throughout the carriage that are carrying out activities throughout the journey. Rather than collecting a very limited set of that data (because of local storage limitations) when the train pulls into a station, you can push that data into the Netskrt eCDN and store everything for future analysis.

Case Study: A Major U.K. Rail Operator

A look at how the Netskrt eCDN helped this rail operator improve their passenger experience with the on-train Wi-Fi.

The Problem

A major U.K. rail operator saw that streaming video and other bandwidth-intensive passenger activities was causing poor WiFi network performance and impacting customer satisfaction. They believed that by adding on-board or "edge" caching, they could alleviate the pressure on network bandwidth and improve the overall performance of their on-board WiFi network.

The Solution

This rail operator selected the Netskrt eCDN solution as their on-board caching solution. Netskrt implemented their platform onto three railsets. In addition to the general technology, Netskrt also brought ITV as a content partner to demonstrate how pre-positioned premium content could further optimize network performance. The configured environment included 8,000 maintained titles which were updated daily.

The Results

During the course of the trial, Netskrt logged 815 hours of viewed content through their eCDN with 93% delivered from cache. As indicated by the graph above, over 50% of passengers involved in the trial watched at least 30 minutes of their travel duration with 40% watching at least 60 minutes. The trial clearly showed that not only could the Netskrt eCDN solution improve in-train network performance (especially for streaming video) but it could also increase passenger engagement with online services. This level of engagement portends the possibility of future, revenue-generating services on board.

Store Raw Data (And Forward Later)

Most CCTV footage is expunged as local storage for the camera is limited. But if you wanted to store all the raw footage, you could simply push it into the Netskrt eCDN storage and then transfer it to cloud or other storage facilities when the train is done for the day.

Advertising

By deploying a simple ad server in a container within the Netskrt eCDN environment, you could deliver ads against operator-controlled resources such as a WiFi login page, rail operator webpages, and even a content catalog (where passengers could select from content partner titles). Ad impressions could be much higher for such captive audiences especially when targeted demographically (i.e., a businessman sees a different ad than a mom).

Building For The Future With The eCDN Cloud

The Netskrt eCDN is more than just local caches to optimize performance. It's a powerful platform through which you can expand in-train WiFi offerings that both improve your operational efficiency and potentially generate incremental revenue.

The Netskrt eCDN cloud environment hosts the services that analyze usage and decide how to prioritize bandwidth usage for passenger content requests. The environment's software is a containerized framework connected to on-board storage which allows operators to deploy other services, such as an ad server or log collector, that can be managed by the eCDN intelligence.

Can You Afford Not To Address Your Wi-Fi Experience Challenges?

It's not a matter of if, but when, passengers will begin to express their discontent with your on-board Wi-Fi services.

When passengers have a positive experience with their online access on the train, whether it's streaming, gaming, or doing work, the duration of the trip can appear to

compress. For example, during a Netskrt test, 70% of passengers watched videos for more than 20 minutes. That's 20 minutes they weren't focused on the time to their destination!

A positive experience equates to better customer satisfaction, more repeat trips, and, ultimately, high brand value. But while the Netskrt eCDN solution will help you get there faster than waiting for trackside 5G or other solutions that may take years and lots of money to implement, it will also enable you to take advantage of exciting new opportunities that can be deployed within the Netskrt environment.

Think about it like this. You have minimal WiFi on your trains now which forces customers to use their own mobile data. But that's an inconsistent experience. Your customers are dissatisfied. So you take the next step and improve your WiFi but restrict apps to keep email working. A lot of your passengers are still dissatisfied. So you deploy Netskrt which allows you to better manage bandwidth, cache locally, and offer premium content from providers that users can access locally (for a better experience) through their own streaming apps. Everyone is satisfied and even happy. Finally, you launch additional services within the Netskrt eCDN which generate incremental revenue.

Even you are happy now.


Netskrt