Verkada

Optimizing the Bandwidth Footprint of Verkada Cameras

Introduction

Bandwidth consumption is a primary concern for organizations with large-scale video security deployments. This concern is especially pronounced for organizations operating within bandwidth-constrained settings like remote locations, mobile deployments and sites with high camera density.

At Verkada, our approach from day one was to unlock the benefits of the cloud in a bandwidth-efficient way. Our cameras consume only 20-50 Kbps of upload bandwidth in steady state and 300 Kbps - 3 Mbps when streaming. For customers that need to further optimize bandwidth usage, Verkada offers tools like low bandwidth mode and Enterprise Bandwidth Manager to provide greater control.

In this whitepaper, we will take a deep dive into:

- Verkada's bandwidth-friendly architecture
- Our bandwidth optimization features
- Key use cases

Verkada's Bandwidth-Friendly Architecture

Verkada's hybrid cloud camera architecture is designed to provide organizations with the best user experience while minimizing bandwidth usage. We do this by:

1. Storing footage on the camera and streaming only when needed
2. Streaming via the most bandwidth-efficient method
3. Recording in adaptive quality

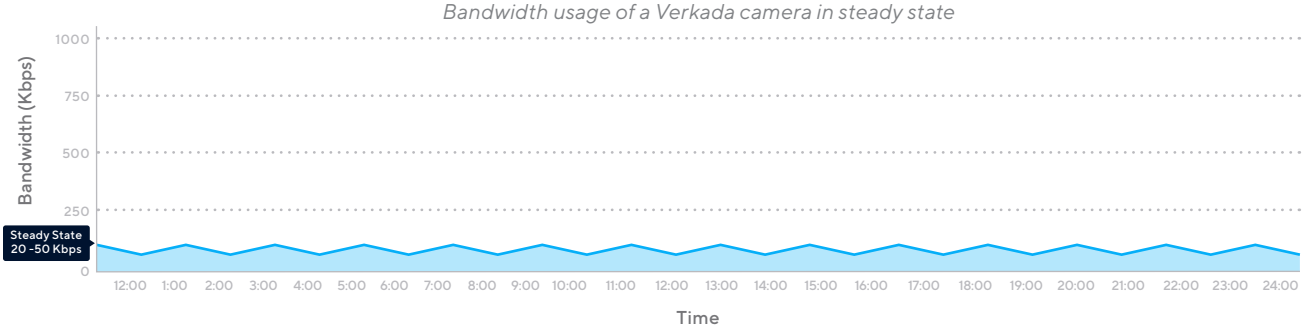
Storing footage locally and streaming only when needed

Verkada cameras are designed to store and process up to 30-365 days of continuous video on the device itself. Thus cameras consume streaming bandwidth only when an authorized user requests live/historical footage or creates an archive. The rest of the time, Verkada cameras operate in a **steady state** with a small bandwidth footprint of 20-50 Kbps.

Steady state

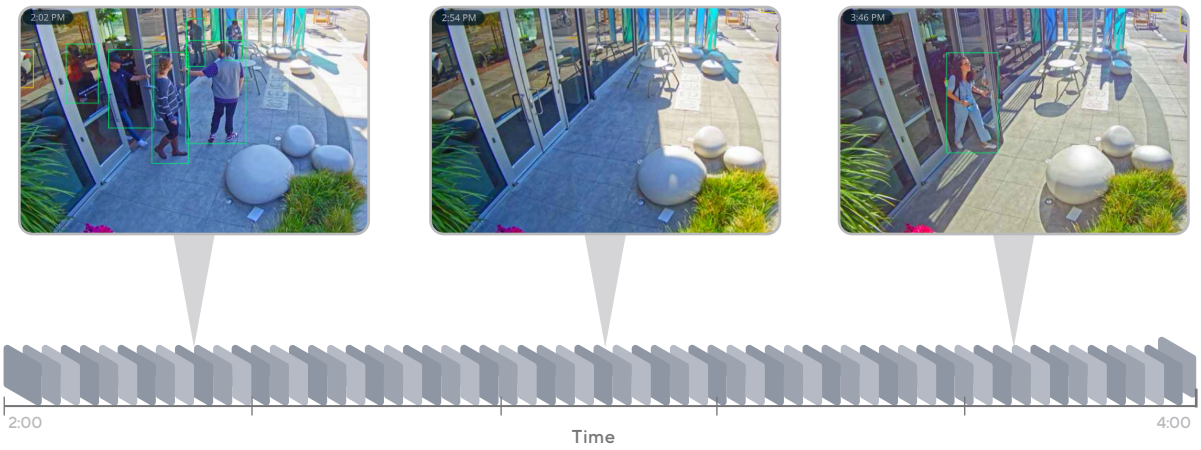
In order to provide the best experience for video investigations with minimal bandwidth usage, Verkada cameras upload an encrypted thumbnail image and related metadata to the cloud once every 20 seconds. If the camera detects any motion in the 20 second interval, it uploads an additional thumbnail to capture the motion event. Therefore, Verkada cameras send a total of two thumbnails every 20 seconds during periods of motion.

Bandwidth usage of a Verkada camera in steady state



The thumbnail images create a historical timeline view that allows for time/date-based search and a smooth video scrubbing experience without the need to retrieve hours of continuous video.

Thumbnails allow users to scrub through hours of footage without streaming



When it is necessary to review footage in detail, a user can access the video stored locally on the camera. This approach greatly reduces the amount of continuous video that users will need to stream for incident resolution.

Streaming via the most bandwidth-efficient method

When users need to stream live or historical footage, Verkada delivers the video to the user's device via the most bandwidth-efficient method.

Local streaming whenever possible

For authorized users on the same local area network as the camera, Verkada supports local streams for both live and historical footage. Local streaming does not consume any internet bandwidth and has lower latency.

Streaming historical video from the cloud

Every Verkada camera[1] comes with 30 days worth of free cloud backup. While the primary purpose of cloud backup is to ensure access to footage if a camera goes offline, this feature can also reduce a camera's streaming bandwidth when users remotely access historical footage. If the requested footage is present in the cloud, the video flows directly from the cloud to the client. As a result, the camera does not consume any additional bandwidth during historical playback.

Note: Cloud backup in itself is a bandwidth-intensive feature, so Verkada allows customers to schedule cloud backup uploads outside of business hours.

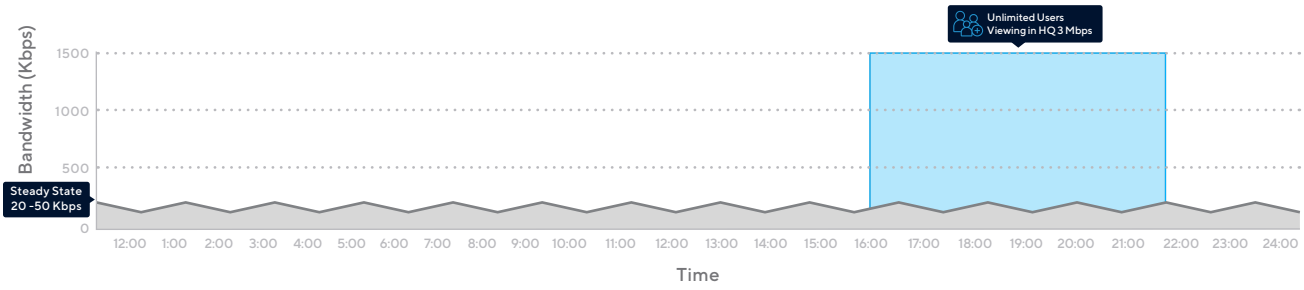
1. Except for the CD31 and CD31-E, which come with 15 days of free cloud backup

Multiplexing live streams

Multiplexing allows unlimited users to watch the same live stream without increasing the camera's bandwidth consumption beyond that of a single stream. When multiple users remotely access a camera's live feed at the same video quality, Verkada multiplexes the video stream in its cloud service. Unlike NVR/DVR-based solutions, which require opening an individual connection for each user, this approach allows multiple users to access the footage while opening a single uplink from the site.

The graph below shows an example where several users stream live footage in HQ from a Verkada CD52 Dome Camera.

Bandwidth usage of a CD52 when multiple users livestream in HQ

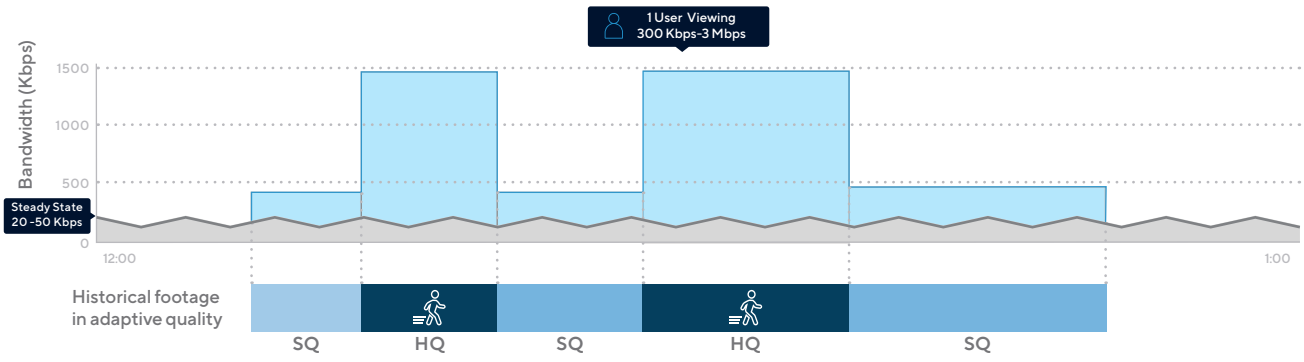


Recording in adaptive quality

Verkada cameras record in adaptive quality, meaning that standard quality (SQ) video is retained for the full retention period while high quality (HQ) video is also saved when motion is detected within the scene. In addition to optimizing the use of onboard storage, adaptive quality recording reduces bandwidth usage because historical footage streams at lower bitrates (SQ) for scenes without motion.

The graph below shows an example where a user remotely streams historical video from a CD52.

Bandwidth usage of a CD52 when streaming in adaptive quality

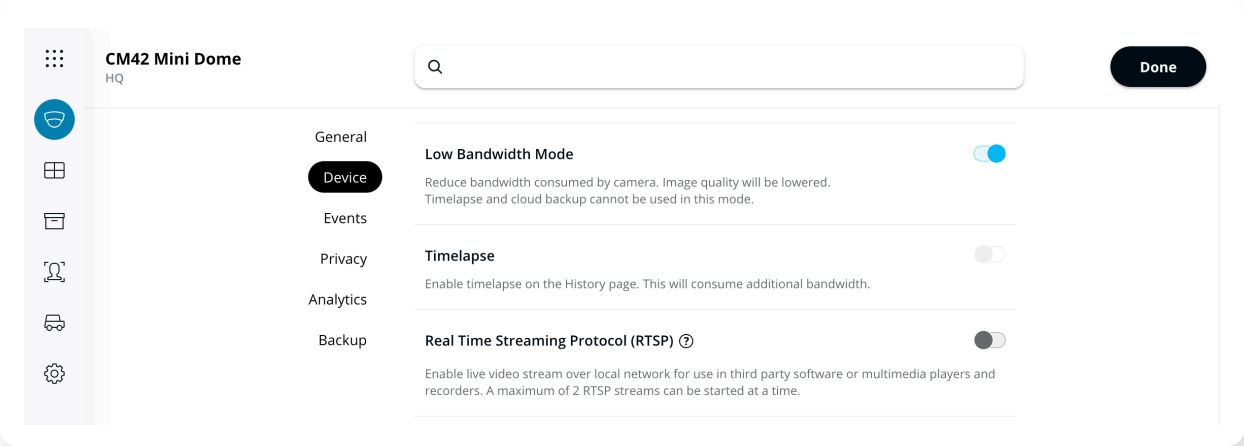


What about download bandwidth?

Verkada cameras consume minimal download bandwidth outside of firmware and configuration updates. Customers that are concerned about download bandwidth can schedule firmware updates outside of business hours.

Further Reduce Bandwidth Usage With Low Bandwidth Mode

Verkada offers low bandwidth mode on all camera models to further reduce bandwidth usage if needed. This is useful for deployments in bandwidth-constrained environments such as remote locations, mobile deployments, or sites with high camera densities. Low bandwidth mode reduces steady state bandwidth consumption by up to 75% and streaming bandwidth by up to 33% with only a slight reduction in video quality and video scrubbing granularity.



How low bandwidth mode works

Steady state bandwidth

In low bandwidth mode, non-motion thumbnails are uploaded only once every five minutes. Motion thumbnails are still uploaded at most once every 20 seconds if the camera sees motion during the 20 second interval. In addition to thumbnail upload frequency, thumbnail quality and size are also reduced. These measures reduce steady state bandwidth by up to 75% while still providing a great user experience for video investigations.

Video streaming bandwidth

Low bandwidth mode reduces the HQ video bitrate on 4K and fisheye cameras from 3 Mbps to 2 Mbps. This reduces bandwidth usage by up to 33% with minimal loss in video quality.

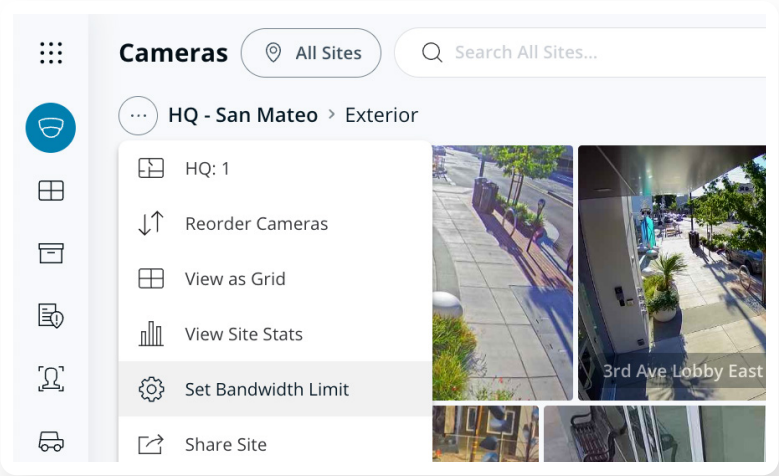
Note: Cloud backup and timelapse features cannot be enabled for cameras operating in low bandwidth mode.

Take Control With Enterprise Bandwidth Manager

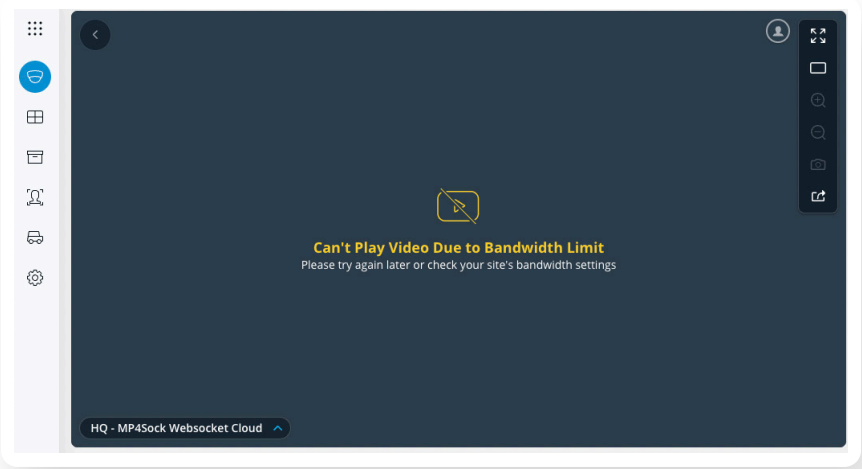
Organizations with large-scale deployments, where cameras must coexist with other critical systems, may need to manage their bandwidth with even greater precision and certainty. Enterprise Bandwidth Manager (EBM) gives admins real-time visibility and control over bandwidth usage, enabling them to prioritize video investigations without straining their network.

Set bandwidth limits

EBM allows Org Admins and Site Admins to set bandwidth limits for each leaf of the site hierarchy, meaning any site or subsite that does not contain subsites of its own.



Once configured, EBM will automatically start to monitor and manage the total upload bandwidth of all cameras[2] at that leaf. To enforce the bandwidth limit, EBM may prevent users from initiating bandwidth-consuming activities like video streaming or archiving.



2. EBM does not oversee PTZ camera live streams, which may exceed the bandwidth limit.

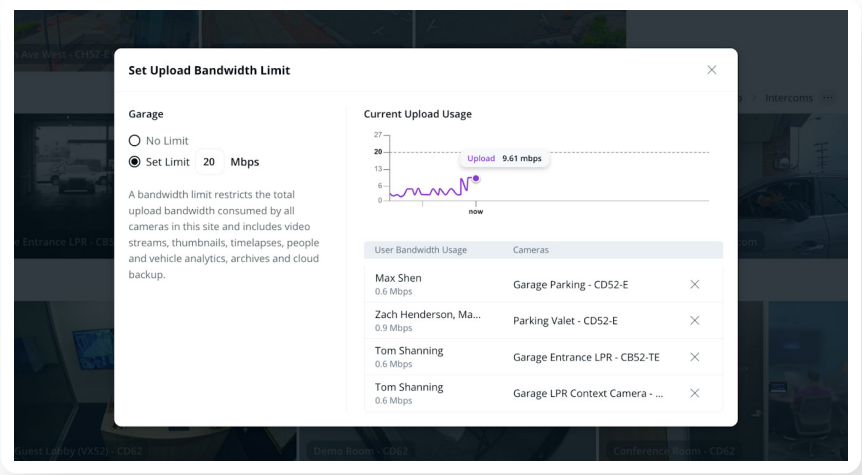
How EBM works

EBM enforces the configured bandwidth limit with a traffic shaper in the Verkada cloud. The traffic shaper dynamically adjusts the transmission rate for all camera upload traffic, including steady state thumbnails, analytics data, video archiving, cloud backup and video streams. It does so by tracking all data packets at the transport layer and using TCP's built-in congestion control algorithm to rate-limit the camera's egress traffic to Verkada endpoints. Similar to how TCP uses congestion window sizes on applications to avoid saturating the receiver of a data stream, EBM leverages TCP's congestion window to prevent Verkada cameras from exceeding the configured bandwidth limit.

Because it is agnostic to traffic type, EBM is designed to be forward compatible with features that Verkada launches in the future. Organizations can have peace of mind that their video security system will not impact other critical systems.

Monitor and manage in real time

In addition to setting bandwidth limits, EBM allows Org Admins and Site Admins to monitor bandwidth usage and selectively terminate active video streams. This allows customers to free up bandwidth for time-sensitive video investigations.



For each leaf, admins can see a list of active video streams and their real-time bandwidth consumption. A multiplexed stream with more than one viewer will appear as one stream in this view. Terminating a stream will lock out the associated user(s) for at least 30 seconds. After 30 seconds have elapsed, the user may reopen the stream if sufficient bandwidth is available; otherwise, the lockout period will continue. During this time, the user(s) can still stream from another leaf provided there is sufficient bandwidth.

View bandwidth usage trends

Users can also view upload and download bandwidth consumption over a period of time at both the leaf and camera level. This can help inform the optimal bandwidth limit for EBM.

Traffic Out indicates the upload bitrate, which is affected by steady state thumbnails, metadata, analytics, streaming, archiving and cloud backup.

Traffic In indicates the download bitrate, which is affected by firmware updates, configuration changes and commands sent from the cloud such as reboot requests.

Key Use Cases

Verkada's hybrid cloud architecture, coupled with powerful features like EBM, is suitable for a variety of bandwidth-constrained use cases. Here are a few examples.

Large retailers

Large retailers often have dozens of cameras in each store and monitor them remotely at a security operations center. During an investigation, many people may try to stream footage from a store's cameras, straining the network and putting critical systems like point-of-sale systems and IP phones at risk. With EBM, retailers can limit the total bandwidth used by Verkada cameras at the store and control how it is used. For example, admins can terminate non-essential video streams to clear bandwidth for investigators to access footage immediately.

Distributed warehouses

Manufacturers, retailers and logistics companies often have distributed warehouses in areas without robust network infrastructure. While Verkada cameras are bandwidth-efficient by design, problems may arise when centralized security teams try to stream footage from multiple cameras simultaneously during an investigation. With EBM, organizations can avoid overwhelming their network by setting a bandwidth limit, while retaining the flexibility to unblock time-sensitive footage retrieval.

Mobile deployments

Municipalities and school districts often need video security in places like public transit, city streets and school buses. These deployments can have tight bandwidth constraints, as multiple devices are often connected to a single cellular modem. Verkada's bandwidth-friendly architecture is designed to work in these environments. And with EBM's real-time bandwidth management capabilities, customers can access vital footage without delay even when connectivity is poor.

Remote deployments with Starlink

Verkada's small bandwidth footprint makes it suitable for Starlink deployments in remote locations like national parks, oil rigs and ships at sea. Starlink provides an upload bandwidth of 2-25 Mbps depending on location, which is sufficient for most Verkada camera deployments without additional network optimization. For sites with high camera density, such as a large cruise ship, customers can use low bandwidth mode or EBM to limit bandwidth consumption and reduce impact on other systems that share the network.

Additional information

To learn more about networking best practices when deploying Verkada cameras, please see our camera setup best practices guide.

Other helpful links:

- Bandwidth Consumption & Uplink Requirements for Verkada Cameras
- Local Streaming on Verkada Cameras
- Low Bandwidth Mode
- Enterprise Bandwidth Manager