

**Boundless Security Systems**  
*the communications bandwidth experts*

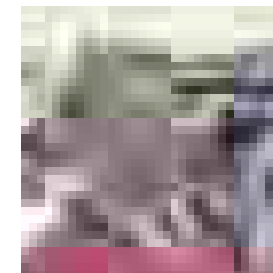
# Bandwidth of Wide Area Networks, Not Cameras, Limits Image Quality in Digital Video Surveillance for Public Safety



If a video camera gives this live image...



Wouldn't you rather record sharp images ?



Instead of blurry, blocky images ?

The **Boundless Security System™** is a digital video surveillance system that is optimized for use over public wireless wide area networks. It uniquely meets competing imaging needs for the investigation of criminals and terrorists, monitoring safety and operations, and situation assessment. It is internally IP-based for the ultimate in communications efficiency, reliability and display versatility. It continuously provides three to eight, different digital video streams per camera to meet the competing needs for image quality and ultra low communications bandwidth. All video streams are available time-shifted and recorded, and, bandwidth-permitting, live. Other systems try to handle this wide range of imaging needs with only one or two digital video streams per camera, compromising image quality and communications speed requirements.

Four fixed / PTZ CCTV cameras or some IP-PTZ cameras (e.g., Sony SNC - RZ25N, RZ30N, RZ50N)



Boundless' **Multi-Stream Video Server** continuously creates and internally records many different, digital, video streams for each camera



128 Kbps (typ) to view 4 cameras live at 5 to 15 fps, 0 Kbps if none are viewed

Cellular Modem or Router



Mobile PC with Cellular Card

PDA with Windows Media Player, or recent BlackBerry

**Investigation Stream** for each camera has sharpest images with highest, full-camera resolution and fewest artifacts, low to medium frame rate, and highest internal data rate (0.5 to 2 Mbps)

**Monitoring Stream** for each camera has medium resolution, smoothest motion at medium to high frame rate, and medium internal data rate (64 to 512 Kbps)

**Situation Assessment Stream** for each camera has lowest resolution, low to high frame rate, and ultra low internal data rate (8 to 64 Kbps)



Deeper shadow indicates higher data rate

**Boundless uses bandwidth-saving, video on demand with near-camera recording of many different digital video streams per camera, not bandwidth-wasting video streaming of a single digital video stream to central recording.** Remotely view live and recorded video from dozens of cameras simultaneously at multiple fps per camera on laptops with cellular communications at ultra low data rates. Remotely perform motion searches and review time-shifted and recorded video rapidly, even with ultra low communications speeds. Remotely view 24 cameras live simultaneously at 10 fps per camera with only 756 Kbps total bandwidth. Live and recorded video are only sent over the air when requested for viewing, minimizing the communications burden on wireless wide area networks and Internet. Optimized MPEG-4 video encoding maximizes frame rate and image quality for a given data rate. PDA requires Boundless' **Broadcast Control Panel** software on a PC. BlackBerry requires Boundless' **Transcode Server**. Dynamic IP addresses require Boundless' name service.

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# Bandwidth of Wide Area Networks, Not Cameras, Limits Image Quality in Digital Video Surveillance for Public Safety

by Steve Morton, CEO, CTO, Boundless Security Systems, Inc., [www.BoundlessSecurity.com](http://www.BoundlessSecurity.com)

**We have all seen exciting movies and TV shows of police performing outdoor video surveillance stakeouts to capture thieves, vandals, drug dealers and gang members.** The common perception is that command and control in a distant, safe location, and officers in patrol cars blocks away or on foot, can all see clear video in real time as if a camera were pushed in the subject's face.

## The public perception is wrong !

One can't get a live, TV-like image over a wide area wireless network. Seemingly good IP-video, when viewed small, often produces a poor image when magnified. If the frame rate is too low, one may not capture any images of a moving subject at all. And, when multiple cameras are needed in the same neighborhood, the more IP-cameras that are used, the worse all the video becomes.

Let's examine these problems in the context of the large image on the front cover. We'll focus on the man in a red shirt. We chose this image because a subject is often far from the camera and occupies only a small fraction of the camera's field of view, hence the subject's image must be enlarged.

## What makes Hollywood unrealistic ?

**The reality is that the #1 cause** of poor, remotely viewed, live and recorded IP-video surveillance images is inadequate uplink (sending) speed of the wireless wide area network. We can't have a fiberoptic connection to each camera.

Broadband wireless wide area networks -- primarily 3G cellular IP-data networks -- simply were not built for continuous transmission, either up or down, of high data rate video. They were built for browsing the web and sending e-mail, which only require occasional short bursts of data, and which enable shared access by many users. Many carriers protect their quality of service with fair usage bandwidth policies that prohibit users from streaming video at high data rates over too long a period of time over their networks.

It is becoming popular to connect a digital, IP-camera to a cellular network and continuously send, or stream, video at as high a resolution and frame rate, and thus data rate, as possible to a distant, central monitoring and recording location. Users assume that broadband, wireless wide area cellular networks are replacements for wired local area networks, where high sustained traffic from even multiple IP-cameras can likely be supported.

However, the raw data rate of a standard definition video camera is 200 Mbps. With significant, 50-fold compression, we have a "low" data rate of "only" 4 Mbps -- still 25+ times the usable uplink speed of most cellular networks. So, users of IP-cameras outdoors must reduce video quality.

## The primary causes of poor recorded image quality in IP-video streaming systems are:

**Low Resolution:** Often, only 25% of the resolution of an IP-camera can be recorded remotely, producing the same low resolution (320 pixels / line x 240 lines / frame) as a child's *toy web cam*.

**Excessive Quantization:** Each frame is compressed too much, causing blockiness or blurring.

**Low Frame Rate:** Only 25% or fewer of the frames per second from the camera are sent live, viewed and recorded, reducing the chance a fast-moving subject can be seen completely or at all.

**Inadequate Compression Technology:** JPEG compression is often used but it does not remove similarities in successive frames, wasting data. More complex, MPEG-4 or like compression removes redundancies, often giving a 3:1 to 5:1 reduction in the amount of data for a given image quality for moderate motion, and a much bigger improvement when there is little or no motion.

The images on the cover show how streaming video from an IP-camera over even a broadband, wireless wide area network to a network video recorder can ruin image quality. Enlargement of the man in the red shirt yields the blurry, blocky image on the lower right when the video resolution in the IP-camera is reduced to 25% of camera resolution and compressed excessively in an effort to increase frame rate for a given uplink speed. **In contrast**, Boundless uses bandwidth-saving, video-on-demand with many different video streams per camera and continuously internally records much better images than can be sent live.

## Conclusion

The #1 cause of poor image quality in digital video surveillance systems for public safety that use IP-video streaming over wireless wide area networks is the network's low bandwidth, not the camera. The ultra low bandwidth, *Boundless Security System*<sup>™</sup> from Boundless Security Systems, Inc., in Newtown, CT, not only avoids this problem but also enables users to have more cameras per square mile, and to avoid violating wireless carriers' fair usage bandwidth policies.