

THE *ProHD* 2014 REPORT

First On-Air. First On-Line.

CLOUD
Centralcasting

Disruptive
Technology

GY-HM650



4G-LTE

LTE
Advanced

**LIVE Broadcast Quality HD Backhaul
over the Internet/through the Cloud**

Next
Generation
WiFi Hot-spots

CLOUD
Ready



GY-HM850 & GY-HM890

H.264
50Mbps

ProHD

**Breaking News:
Advanced Streaming Technology
Professional Streaming Services
Read all about it!**

ABSTRACT

This White Paper/Report details JVC's newly announced "disruptive" **Advanced Streaming Technology (AST)** and **Professional Streaming Services (PSS)** which move last year's built-in wireless backhaul capabilities of the GY-HM650 to a whole new level of cost effective and flexible mobile news/events operation. In addition, this White Paper/Report introduces two brand new state-of-the-art ProHD shoulder-mount GY-HM850 and GY-HM890 camcorders, joining the GY-HM650 handheld, with embedded capabilities to enable participation at any time in JVC's AST/PSS networks (over the Internet and UN-managed networks), designed to greatly reduce a TV station's reliance on expensive Microwave Vans and cumbersome (and expensive) Bonded Cellular systems. This Report also explains the current state of broadband cellular wireless and details future wireless developments (4G-LTE and WiFi Hot-spots), concluding that the future of Mobile News Acquisition and LIVE HD backhaul will NOT require Bonded Cellular operation, but will be very well served by the JVC ProHD approach of using just one (1) 4G-LTE USB modem which plugs directly into the Cameras.

These three Mobile News Cameras/Camcorders, from the supplied lens through camera front end, 3xCMOS image sensor block, dual Falconbrid processing and cost-effective dual recording on removable SD memory cards, are market leaders by any measure, technologically and operationally. Adding the cost effective LIVE streaming backhaul capabilities and the opportunity for CLOUD-based operations make these ProHD Cameras ready for flexible and cost effective use in 2014 and far into the future.

Although this Report discusses applications largely related to TV Stations, Group Station Owners, TV Networks and TV News Organizations, the three AST/PSS-ready Cameras (GY-HM650/850/890) are ideally suited for many other applications of LIVE streaming (and FTP) including within Worship, Government, Military, EFP and (advanced) Surveillance.

The Author concentrates primarily herein to introduce and explain JVC's new AST/PSS technology, **PSS being a unique subscription service providing highly versatile multi-format LIVE and on-demand HD content delivery for Web and Broadcast, offered exclusively by JVC in partnership with Zixi.** We also review in some detail the current status and future announced developments of broadband cellular wireless and video streaming. Note that the traditional camera/camcorder specifications are less detailed. Please review JVC's multipage color product brochures to learn much more about those traditional specifications, which surely will also impress you. Retrieve comprehensive product brochures for all three Cameras at <http://pro.jvc.com/>

IMPORTANT:

This ProHD-2014 Report has been authored by Tore B. Nordahl/nordahl.tv LLC on behalf of JVC Professional Products Company, a Division of JVC Americas Corp. Specifications stated herein are believed to be accurate at time of writing. Readers of this Report are encouraged to contact other sources to obtain the latest specifications, as well as points of view and analysis other than those presented and concluded in this Report. **Trademarks:** All company, product and system names and trademarks found in this Report are the sole property of their respective owners.

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Section 1: IP-centric Mobile News Cameras

Leaving the Competition behind . . .

Winning the On-Air Race through 4G-LTE LIVE Streaming Backhaul *Without Bonded Cellular!*

With JVC ProHD Mobile News Cameras, the choice is yours. Whether your camera preference is handheld or shoulder-mount, nothing shoots and delivers footage faster than JVC's handheld GY-HM650 and the new shoulder-mount GY-HM850 and GY-HM890, with the fully integrated FTP and LIVE streaming modes, over 4G-LTE and WiFi wireless backhaul through the Internet, and with an unbeatable performance/price ratio. The GY-HM650 handheld professional camcorder has a current list price of \$6,295 while the shoulder-mount GY-HM850 and the GY-HM890 list prices are \$7,995 and \$9,995 respectively (February 2014), including the new built-in Streaming Feeder Engine which formats the IP packets during LIVE streaming and works with Cloud-based and/or facility-based systems to provide reliable backhaul and a comfortable viewing experience for the TV audience (and a predictable QoS-Quality of Service).



Illustration shows the built-in capabilities of the cameras: WiFi USB Modem or 4G-LTE USB Modem may be plugged into the cameras' full size USB Host port to provide wireless connectivity to the Internet. Metadata (including MXF compliant) can be added to clips and streams (remotely over the Internet/WiFi and locally via WiFi-Direct) which may include GPS location data. Built-in Feeder Engine manages output IP packets for streaming and FTP over UN-managed networks (including Internet), with wireless connectivity to Access Point (AP).

Availability - Shipping

GY-HM650 has been shipping with the initial level of remote LIVE streaming backhaul capability since Q3-2013. However, the new much expanded AST/PSS capabilities will be firmware upgraded in the GY-HM650 later in 2014 with exact availability to be announced ahead of the NAB-2014. The two new shoulder-mount Cameras (GY-HM850/HM890) are scheduled to ship in March (before NAB-2014) fully compliant with the new AST/PSS capabilities.

Extreme Recording Flexibility to Dual SD Cards

All three ProHD Mobile News Cameras feature dual removable SD Memory Cards, offering unprecedented recording and playback flexibility. SDHC (High Capacity) and SDXC (Xtended Capacity) cards are the most cost effective, reliable and readily available memory for professional video applications. Compare street pricing for the Sandisk ULTRA 64GB SDXC at less than \$50 with the Panasonic proprietary 64GB P2 F-series card at \$639! Even the Sandisk SDXC Extreme Pro (90MB/s write) 64GB is only \$120. (All pricing from B&H website Feb.2014)

The extreme flexibility include (a) dual recording to both cards at the same time in same or different formats, (b) LIVE shoot recording to one card while playing back earlier recorded clip from the second card for purpose of FTP “background” transfer, and (c) LIVE shoot streaming back to News Room (at lower bitrate) while recording the same LIVE shoot to one card at a higher bitrate (to preserve a high quality record of the shoot). These features are made possible by the ProHD Cameras’ unique DUAL CODEC design as well as the dual SD card implementation.

HD Encoding Bitrates & Formats for Camera Recording	
50 Mbps	H.264 - MOV (XHQ - Extreme High Quality – near lossless)
35 Mbps	XDCAM EX, MOV, H.264 , MXF
28 Mbps	AVCHD (1080p60)
25 Mbps	XDCAM EX, MOV, MXF
22 Mbps	AVCHD HQ
19 Mbps	MOV
17 Mbps	AVCHD SP
9 Mbps	AVCHD LP
5 Mbps	AVCHD EP
3 Mbps	960x540p H.264 (SD - Web)
1 Mbps	480x270p H.264 (Proxy - Web)

The Remote LIVE Backhaul Evolution

Up to recently, TV stations had only one option for wireless backhaul from a remote (local) news location back to the News Room for LIVE reporting: The Microwave Truck or Van. (We don't really count the Satellite Truck, used much less in a local news environment.) The Microwave Van with its telescopic mast and microwave antenna, using the Broadcast Auxiliary Service (BAS) microwave spectrum, was generally very good BUT rather expensive in terms of CAPEX and OPEX. As major TV stations in a market needed to operate several if not a fleet of such Vans, those local TV news organizations were understandably very interested in listening to vendors offering new and cost-saving approaches to accomplish LIVE (and delayed) remote video reporting in the form of cellular wireless technology, first using 3G service. 3G did not provide sufficient bandwidth in a single channel, not even for SD, resulting in development of bonding several 3G wireless channels together in order to increase backhaul bandwidth and improve reliability. Bonded Cellular Backpacks containing the capability for each Backpack to utilize multiple 3G Upload channels simultaneously in a "bonding approach", where the LIVE video compressed data rate was split into the several Upload channels, then later to be "reconstituted" (combined) at the destination (News Room) for LIVE reporting on-the-air (OTA). This was necessary as this earlier 3G Upload speed was insufficient in 2010/2011 to transport compressed broadcast quality SD reliably over a single 3G Upload. The bonding electronics were generally housed in a backpack which the shooter would wear on his back with the camera hardwired to the Backpack. At that time, Bonding 3G saved the day for SD but not for HD.



The above illustration shows the "evolution" of LIVE Mobile News Acquisition and Backhaul over the past five years, from the Microwave Van through the Bonding Backpacks to the "lone ranger" video journalist (VJ) with just the 4G-LTE USB Modem-fitted ProHD Camera (switchable to WiFi Hotspot/Direct operation). It is obvious which is the most cost-effective.

As the major cellular wireless providers (Verizon, AT&T, Sprint, T-Mobile) developed and implemented 4G, and particularly LTE (Long Term Evolution), true broadband wireless service across the country became available starting in some areas in 2011. The Bonding Backpack vendors replaced their 3G modems with 4G-LTE modems, significantly increasing reliable backhaul bandwidth enabling the streaming of broadcast quality HD back to the TV station.

But, in the advancing wireless technology environment of 2014 and beyond, is bonding of several 4G-LTE wireless channels really necessary in most LIVE backhaul situations?

The answer is NO. We discuss this as follows:

The main operational problem with bonding is latency, generated by the time it takes to divide up the compressed HD datarate between the several 4G-LTE channels in use, the time it takes to transmit the divided IP packets over multiple paths, some packets arriving early and some arriving late, some not at all, plus the time it takes to process, re-order packets and combine (“reconstitute”) the several channels on the receiving end to deliver the single stream HD video to Master Control for LIVE OTA. It is generally agreed that LIVE remote interviews (between the news desk talent and the field reporter) require not more than 2 seconds of latency, preferably only 1. In a bonded cellular backpack system using four (4) 4G-LTE channels, the channels may be a combination of one from each of Verizon, AT&T, Sprint and T-Mobile, or two from Verizon and two from AT&T, or all four from Verizon. It may require the News Department to subscribe to a minimum of four 4G-LTE channels and as many as ten or more, subject to the local metro area’s coverage among the major wireless providers. One can easily imagine the Video Journalist having to bring with her a shoebox of 4G-LTE USB modems, and require to plug in and unplug modems as different remote locations require different combinations of wireless providers’ 4G-LTE modems for best coverage. Does it work? Yes, but the bonded cellular solution in the Author’s opinion will have a limited future life as 4G-LTE wireless providers in 2014 start to upgrade their networks to LTE-Advanced. And adding HEVC (High Efficiency Video Coding – H.265) compressing HD to half the bitrate as compared with current H.264 AVC, bonding will become an unnecessary technology. Not to mention the expense and complicated “shoe box modem” operation AND the bi-product of bonding latency.

JVC’s solution is simple: utilize only one 4G-LTE USB modem, plugged directly in to the Camera’s USB Host port, where the Camera’s built-in wireless connectivity engine communicates with the modem to transmit LIVE HD back to the TV Station. No backpack, and no additional belt-box or camera-back-box or shoe box! At NAB-2013, one year ago, JVC introduced the handheld GY-HM650 Mobile News Camera with the integrated 4G-LTE wireless connectivity (and WiFi), proving that a single 4G-LTE USB modem plugged directly in to the camera’s USB host port was indeed capable of reliable LIVE HD backhaul in many circumstances. And, this year at NAB-2014, JVC expands the capabilities of wireless backhaul by introducing and delivering their Advanced Streaming Technology enabling the new Professional Streaming Services. Read on.

Will Microwave Vans go away? Not entirely, but the number of such vans required by the TV news industry will continue to be greatly reduced over the next several years as 4G-LTE (and WiFi Hotspot) service continues to expand in area coverage and in Upload speed. An ideal combination seems to be the equipping of the remaining Microwave Vans (and Satellite Trucks) with JVC ProHD Cameras, to provide ultimate flexibility, using microwave backhaul in challenging situations while using the new JVC broadband wireless fitted cameras when appropriate. Bear in mind that the ProHD camera pricing is very competitive and includes the broadband wireless capabilities except for the ~\$50 4G-LTE USB modem and the ongoing wireless data usage. Why buy ENG camcorders without such “free” built-in capabilities? Especially when the Camera/Camcorder traditional specs are market leaders.



Will Bonded Cellular go away? A qualified yes is appropriate. The two leading wireless providers (Verizon and AT&T) have by now substantially completed the build-out of their 4G-LTE networks across the U.S. with T-Mobile not far behind. Sprint has initiated SPARK. Over the next five years, LTE-Advanced will be implemented, significantly increasing Upload speed on a year-by-year basis and thereby entirely eliminating the need for bonding, particularly when we consider the double compression efficiency of the emerging HEVC (H.265) encoding compared with the now ubiquitous H.264 AVC.

For current owners of Bonded Cellular Backpacks, and for the new near-term future owners having determined by local conditions or by special applications that Bonded Cellular is a shorter term solution for them, again, an ideal situation seems to be pairing Backpacks with ProHD Cameras, to provide ultimate flexibility, using Bonding Backpacks in situations where single 4G-LTE modem operation currently is difficult, like in fringe areas. Then, in most other LIVE backhaul situations, you can use the ProHD cameras with single 4G-LTE modem. You need cameras in any event. As said above, why buy camcorders without “free” built-in wireless capabilities. (An additional benefit is that you can possibly use that shoebox full of 4G-LTE modems with the ProHD Cameras –one per camera- eliminating buying even more modems.)



There is no doubt in the Author’s mind that 2014 will become the year when Bonded Cellular will yield the LIVE streaming backhaul market to the single 4G-LTE (LTE-Advanced) approach.

The ProHD Wireless Mobile News Cameras

UN-bonded HD Streaming = Advanced Streaming Technology (AST)

JVC's Camera-embedded approach to LIVE streaming backhaul is simple as it is sophisticated. Resident software clients (4G, WiFi and Web Server Clients) inside the Cameras support the efficient operation of a single 4G-LTE USB modem (or a single WiFi USB modem) plugged in to the Camera's USB Host port. In addition, a "Feeder Client" supports the formatting and feeding of IP packets contained in the video/audio/metadata LIVE backhaul stream including FEC (Forward Error Correction) as required. The Web Server Client makes it possible to operate, monitor and control the Camera remotely, by WiFi or 4G wireless (or Ethernet wired) access from anywhere in the world, next door or next continent, by using the browser of any PC, tablet or smartphone, addressing the Camera by its unique IP address.

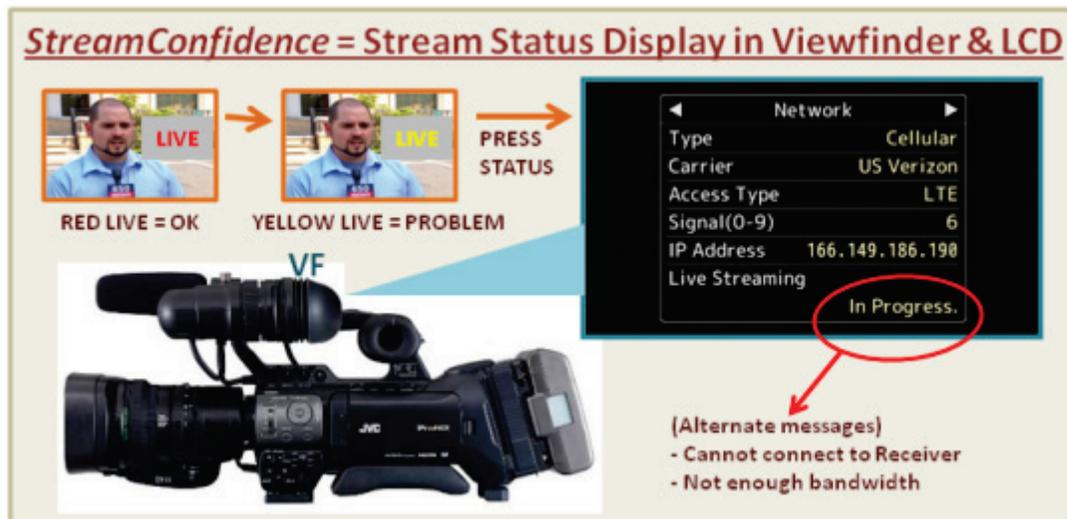


JVC's "UN-bonded" Streaming Solution

- AST is embedded in every Camera (GY-HM650/GY-HM850/GY-HM890)
- Just plug in one (1) 4G-LTE USB Modem (or WiFi) into Camera USB Host port
- Low, less than 2-second LIVE latency for News quality HD, two-way LIVE interview
- 5-second LIVE latency mode for high quality HD, one way LIVE contribution
- Streaming Connection and Link monitoring in Viewfinder & LCD flip-out
- Camera remote control over IP connection (LAN, WAN and Internet world-wide)
- Include FTP and Metadata transfers
- AST works in concert with JVC's Professional Streaming Services (PSS)
- High-level PSS operation require the ProHD Broadcaster Server
- The Server is installed locally or CLOUD-based as a Platform Service

The importance of *Streamconfidence*

With the operationally efficient AST/PSS-ready ProHD Cameras, the Video Journalist (VJ) may increasingly become “the lone ranger” out on LIVE assignment. No more 2- or 3-man teams with Microwave Van or Bonded Backpacks. Just the VJ, her SUV and the ProHD Camera. It is essential that the VJ can have full confidence that the LIVE backhaul transmission is progressing without issues and to be notified by the Camera if and when there is an issue. See following illustration.



Each of the three models of AST/PSS-ready ProHD Cameras offers *Streamconfidence* to monitor any LIVE streaming originating in the Camera, displayed in the viewfinder and on the flip-out LCD monitor. In the LIVE mode, a superimposed (over the video) word “LIVE” in the color red indicates that transmission is progressing OK while a problem is indicated when the color of “LIVE” switches to yellow. Pressing the status button will display the Network status details and indicate the nature of the problem. See red circle with arrow in the above illustration.

IP-Centric Camera Remote Control – From Next Door OR Next Continent

Any ProHD Camera connected to the Internet, by 4G-LTE, WiFi or Ethernet, may be remotely controlled by any PC, laptop, tablet and smartphone by accessing the Camera-embedded Web-server (using Browser) by specifying the unique IP address of the Camera (and provide password). This includes the ability to monitor the LIVE video at Web resolutions and, in addition, the News Room can download (push) Metadata to the Camera, to be embedded in clips as specified. The remote control connection may also monitor the LIVE shoot or play back clips stored on SD memory cards by selecting from thumbnails.



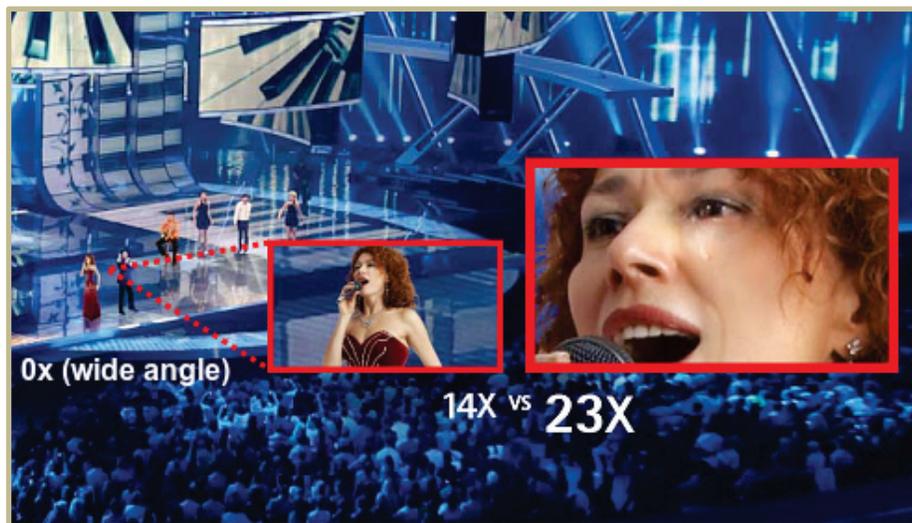
Not just for TV Broadcasters anymore!

AST-fitted Mobile News Cameras are also ideally suited for a wide variety of LIVE and recorded HD video acquisition/streaming applications, in Worship, Corporate, Education (including on-line & distance learning), Government, Military and High Resolution Surveillance, in addition to Mobile Event Coverage, Stage Production and Sports, where high quality imaging and cost effective flexible operation are sought.

A typical application may be shooting a Religious Service with LIVE streaming to one or more additional Houses of Worship, for LIVE display on large flat screen TV or by projection, and supply LIVE stream to Website and possibly provide LIVE coverage on local TV station or cable channel.

Long Zoom Range

The GY-HM650 is equipped with a fixed newly-developed **Fujinon wide angle 23x zoom lens**, giving the highest magnification in the industry. Delivering superior low-light performance and ensuring brightness at the tele end, the lens offers F1.6-3.0, a focal range of 29 to 667mm (35mm equivalent) and includes servo zoom, manual focus, and iris rings, along with a four-position (clear, 1/4, 1/16 and 1/64) ND filter. Other features include an optical image stabilizer and chromatic aberration correction. The GY-HM650's long zoom range means that you can get shots not possible with other cameras its size. The shoulder-mount GY-HM850 and GY-HM890 models come standard with an **interchangeable wide angle 20x zoom lens** (29 to 580 mm).



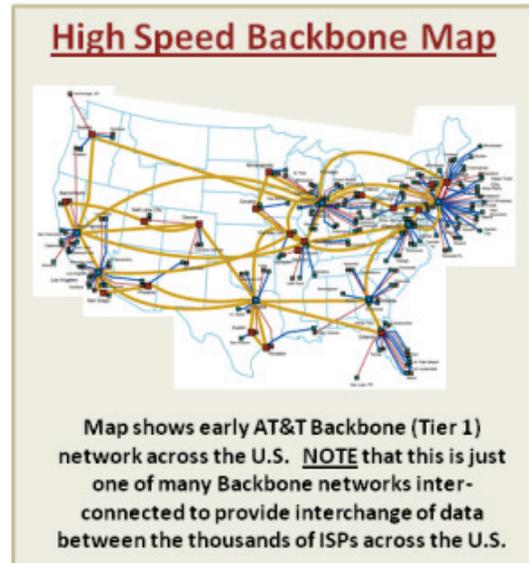
Picture shows the dramatic close-up performance of the 23x zoom fixed lens of the GY-HM650, comparing the 23x tele position with that of a 14x position. The AST-fitted ProHD Cameras are not just for TV Broadcasters anymore!

Section 2: Advanced Streaming Technology

Media Streaming Challenges over the Internet

The Internet is the world-wide-web OPEN to all people and entities subscribing to ISP (Internet Service Provider) services. Most people subscribe through CATV companies and/or through a data plan with their cellular wireless provider. Unless you make special arrangements and pay extra, you get no priorities over anyone else. **The Internet is a huge UN-managed network.**

The big data-users are companies like Netflix, HULU, Amazon streaming VOD 24 hours a day, where a part of the data traffic is first routed over their own (or leased) managed networks to local or regional servers. BUT, as they supply VOD to the Internet home subscribers, they must use the public Internet for the last many miles. Each of these companies pays millions of dollars a month for data transmissions to the managed network and high speed backbone owners (Tier 1 Network Operators and others) to gain local Internet access for the last miles to reach their VOD home customers and subscribers. The Tier 1 Network Operators in the U.S. are a limited number of telecom companies operating national and/or regional backbones, where they often participate in “peering” or transit-free agreements with each other, and where each Tier-1 company can reach any other Tier 1 company without going outside “the Tier 1 club”. It is THE backbone of the Internet in the U.S. and recently include AT&T, Century Link, XO Communications, GTT, Verizon, Sprint, Level 3, Zayo Group, and Cogent. Many of these Tier 1 operators also own Tier 1 backbones around the world. Bottom line: Mobile News acquisition and LIVE backhaul operators (i.e. TV broadcasters) have no option but to use the UN-managed Internet as best you can! **Fortunately, JVC ProHD Mobile News Cameras are here to make LIVE backhaul streaming reliable in 2014, through AST/PSS.**



The LIVE Backhaul Challenges are several, from Camera to Master Control:

- The LIVE Wireless Upload – from Camera 4G USB modem to Cell Tower transceiver
- From Cell Tower through Cell Network to handover to the (public) Internet
- Through the Internet to IP address destination at TV Station/Master Control
- IP Receiver/Processor reconstituting the many IP packets to broadcast LIVE HD

Receiving most (if not all) of the “LIVE” IP packets:

The Camera’s embedded firmware configures the LIVE video/audio to a stream of IP packets for 4G-LTE (or WiFi) and Internet transmission, following certain standard protocols of TCP and UDP, combined with ARQ (Automatic Repeat ReQuest) to provide FEC (Forward Error Correction). Ideally, all IP packets sent from the source (Camera in the field) should be received in a timely fashion at destination (receiver/decoder at TV Station) to produce perfect LIVE video/audio without significant latency. But the world is not ideal or perfect, so, to make the LIVE streaming reliable, JVC with partner Zixi have coined the new term “acceptable HD viewing experience” where IP packets containing significant picture information (such as I-frames) must be present and fully corrected at destination (or simply re-sent by the Camera), while loss of IP packets containing some B- and P-frames (and slices) may be concealed without materially affecting the “acceptable HD viewing experience” of the LIVE streaming HD backhaul.

TCP = Transmission Control Protocol

This is the “mother protocol” of Internet transmissions. This transport layer protocol includes an acknowledgement (hand shaking) feature where any IP packet not arriving at destination is requested to be re-sent from the source. It is possible to use TCP for video streaming provided the Internet connection is of high quality and buffering is applied. LIVE video streaming using just TCP is difficult, as buffering is limited in LIVE transmissions. Unacceptable latency is often a result of using TCP as the packet loss tolerance is only around 0.6%.

UDP = User Datagram Protocol

UDP uses a simple transmission model with a minimum of protocol mechanism, to mitigate latency. This transport layer protocol has no handshaking dialogues, and thus exposes any unreliability of the underlying network protocol to the user's program. There is no guarantee of delivery. Time-sensitive applications often use UDP because dropping packets is preferable to waiting for delayed packets, which may not be an option in a real-time LIVE system. Packet loss tolerance is only around 0.3% for streaming video, often resulting in unwatchable video. For that reason, UDP is often combined with some level of FEC and ARQ.

ARQ = Automatic Repeat ReQuest

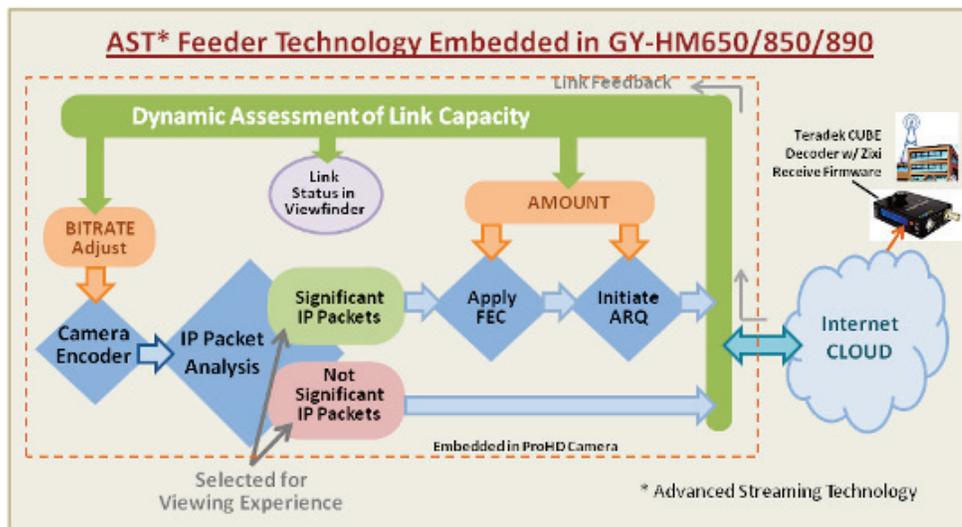
ARQ is an error-control method that uses acknowledgement messages sent by the receiver at destination indicating that it has correctly received a data frame or packet, and timeouts covering specified periods of time allowed to elapse before an acknowledgment is to be received for each packet, upon which the IP packet not acknowledged is automatically re-sent.

FEC = Forward Error Correction (and Concealment)

FEC is combined with ARQ and UDP (or TCP) to provide the overall capability of JVC’s Advanced Streaming Technology powered by Zixi. Any loss of IP packets containing I-frames must be received (fully corrected), while loss of IP packets containing B- or P-frames may in some cases be just concealed, possibly by interpolation of neighboring data, or even ignored in some cases.

The JVC/Zixi Streaming Partnership

Zixi makes software for highly reliable video-over-IP delivery, for LIVE and on-demand streaming applications over UN-managed networks such as the Internet. **Zixi's Feeder software** is optimized for JVC and embedded into the ProHD Cameras (see illustration below) making the Cameras ready to perform reliable LIVE backhaul streaming regardless of the distance from source to destination (local or coast-to-coast or even world-wide), over the Internet to the TV Station for immediate LIVE OTA. The Cameras' built-in 4G-LTE/WiFi wireless capabilities only requires the plugging in of a 4G-LTE USB modem (or a WiFi USB modem). The LIVE streaming may in its simplest form just go "non-stop" directly back to the TV Station to go on air LIVE, or be distributed to several destinations via the new **ProHD Broadcaster Server** (operating under the PSS subscription service) enabling concurrent LIVE coverage on sister/duopoly/ group TV stations and/or on websites, transcoded on-the-fly into different formats if and as required by each destination. The ProHD Broadcaster Server may be locally installed (i.e. at a TV station) OR all of its features may be available as a CLOUD-based Platform-as-a-Service (PaaS) through **Amazon Web Services**, powered by Zixi.



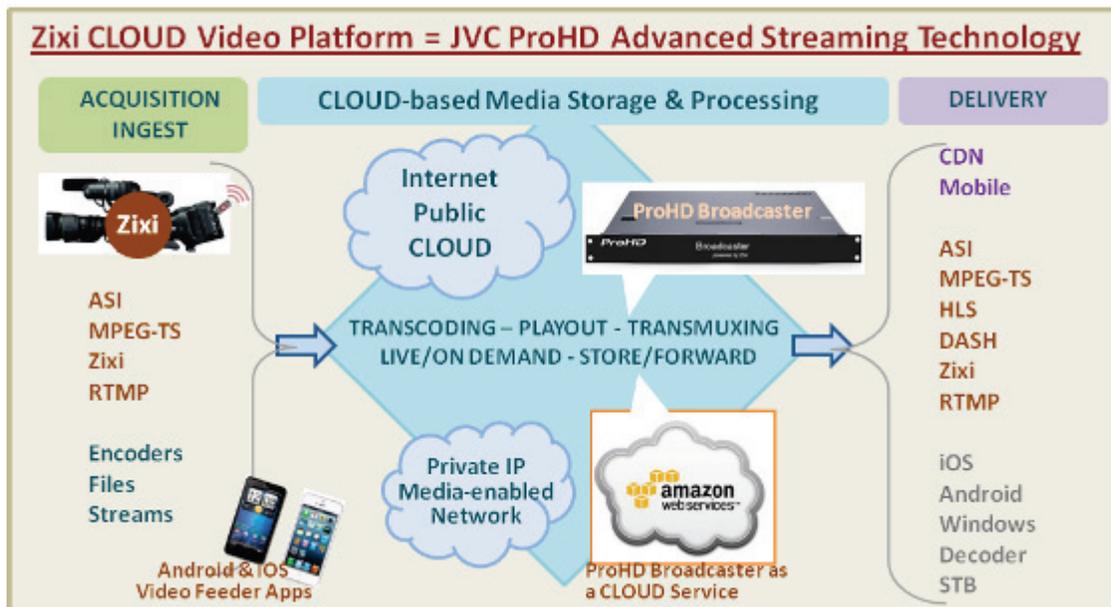
The Illustration shows the data flow diagram of the Cameras' embedded Zixi Feeder circuits which primary function is to establish a reliable video streaming connection between the ProHD Camera and the destination located anywhere within the World-Wide-Web (the Internet), specified by a unique IP address. The destination shown above is terminated by the Teradek CUBE Decoder with embedded Zixi receive firmware necessary to decode and error correct the proprietary JVC/Zixi LIVE stream. Note that the Cameras' Encoder's bitrate is controlled by the closed loop Link Capacity Assessment function, designed to deliver the highest possible compressed video quality as available by network conditions, working in concert with the FEC and ARQ functions. Also note that FEC and ARQ are selectively applied to the significant IP packets and not to IP packets which are not significant in achieving an acceptable HD viewing experience.

The AST/PSS maximizes the available Internet bandwidth by knowing and consuming the free average capacity of the link at all times during the LIVE HD backhaul.

Obviously, we cannot be idealists when it comes to acquire and deliver remote roaming HD news footage to be backhauled LIVE to go instantly on air. After all, you are not on the news set with studio cameras! But we can expect very good LIVE HD giving the home audience an acceptable “happening right now” HD viewing experience, most of the time. Without any microwave van, without any bonded cellular or camera back add-on box; just shooting HD with the finest and most cost effective Mobile News Cameras available, fitted with AST/PSS.

The Next Big Thing . . . The CLOUD Video Platform

“The Next Big Thing” . . . It’s a Silicon Valley VC term. Look at the illustration below. The underlying technology for the JVC/Zixi CLOUD Video Platform is highly sophisticated, yet easy to implement and to operate. The brain is the rack-mountable **ProHD Broadcaster Server** (a powerful PC with Linux OS or Windows Server), hardware installed on a TV Station’s premises and connected to the Internet and LAN/WAN, OR running in the CLOUD as a Platform-as-a-Service, containing software applications to support a wide array of services, ensuring pristine quality IP video transport (LIVE, FTP and on-demand) in addition to video processing features such as time shifting, VOD play-out, DVR functionality, store-forward, and stream switching.



The **ProHD Broadcaster Server** is indeed the **CLOUD Video Platform**. From an operational point of view, the ProHD Broadcaster Server offers an easy-to-use Web Administration Interface, with the ability to fully manage and monitor all inputs, outputs and internal functions. Alternatively, to suit Group Station Owners with multiple station properties across the country, identical ProHD Broadcaster Server services and functionalities can be obtained “in the CLOUD” through **Amazon Web Services** as PaaS (Platform-as-a-Service).

Web Administration Interface (One of several screens)

JVC Broadcaster Version 1.7.0.13564 Linux 64-bit

Status Inputs Outputs Adaptive VOD Files Settings Cluster Event Log

Inputs x Delete Stop Edit Stop Recording TR101

Status	ID	Type	Source	Bitrate[kbps]	Up Time	TR 101 290
Offline	jvc	Push		0	00:00:00	Not analysed
Offline	jvc_0002	Push		0	00:00:00	Not analysed
Offline	jvc_0005	Push		0	00:00:00	Not analysed
Offline	jvc_0007	Push		0	00:00:00	Not analysed
Offline	jvc_0017	Push		0	00:00:00	Not analysed
Offline	jvc_0039	Push		0	00:00:00	Not analysed
Recording - 84 %	jvc_0045	Push	166.239.166.38	3225	00:53:53	Not analysed
Offline	jvc_0382	Push		0	00:00:00	Not analysed
Offline	jvc_0487	Push		0	00:00:00	Not analysed
Offline	jvc_5678	Push		0	00:00:00	Not analysed
Offline	jvc_jp	Push		0	00:00:00	Not analysed

Statistics

Bitrate (kbps): 3179
Up Time: 00:53:58
Reconnections: 3
RTT(ms): 236
Jitter(ms): 120
Latency(ms): 4000

Total Packets: 1002270
Packet Rate: 294
Packet Loss %: 0
Dropped Packets: 219
Recovered Packets: 217
Not Recovered Packets: 2

The highlighted row (jvc_0045) in the above screen shot shows about 54 minutes of LIVE streaming at a bitrate of 3.2 Mbps, transmitting a total of about 1 million packets. 219 were dropped of which 217 were recovered. Only 2 packets were not recovered.

Packet Loss Tolerance

The Zixi Internet real time transmission support software dramatically increase the packet loss tolerance at the destination, from less than 1% (TCP, UDP, RTMP) to 5% in the low latency (2-Sec) mode and up to a whopping 30% in the medium latency (5-Sec) mode. This is accomplished through applying FEC, Re-transmission of lost packets, and controlling the source LIVE encoding bitrate. The customer-specified latency determines the available reliable bitrate over the connection, subject to the connection traffic and hub congestion. Specifying the 2-sec low latency mode (LIVE two-way interview) may produce a reliable 3 Mbps on a certain day, while only producing 1.5 Mbps on a different day or from a different news event location. Specifying the 5-sec medium latency mode (LIVE one way coverage) may similarly produce a reliable 6 Mbps from one location while only 4 Mbps from a different location. This is life in the fast lane on the UN-managed “Streaming Public Super Highway”!

Cameras' LIVE Streaming Encoding Options

The great news for the new ProHD Cameras in 2014 includes the addition of the ability to record 50 Mbps H.264 compressed HD to the internal SDHC/SDXC memory cards, providing true network quality near lossless HD acquisition. Unfortunately, it is not possible for anyone to achieve LIVE wireless roaming backhaul at 50 Mbps over UN-managed networks like the Internet. That will take a few more years!

But, fortunately, in 2014, it is possible to reliably backhaul LIVE local news quality HD using the IP-centric ProHD Cameras and JVC's Advanced Streaming Technology (AST), powered by Zixi, by choosing the optimum LIVE encoding option from the table below to suit the remote location's 4G-LTE wireless Upload and Internet backhaul bandwidth conditions. Note that in the first (current) version of AST/PSS, the encoding bitrate is limited to 3 Mbps for AST applications (see RED numbers in table below), but this is sufficient to deliver very good news quality HD intercuts in both 1080i (at 2.5 Mbps) and in 720p (at 1.5 and 3 Mbps). The subsequent second release is expected to increase this limit to 5 Mbps later in 2014.

HD-SD-Proxy LIVE Streaming Encoding Options (All compressed by H.264 AVC)			
Format	Resolution/FPS	Bitrate (Mbps)	Remarks
1080i	1920x1080 60i	8.0	Broadcast Network HD Quality
		5.0	
		2.5	Local News HD Quality
720p	1280x720 30p	5.0	Broadcast Network HD Quality
		3.0	
		1.5	Local News HD Quality
480i	720x480 60i	5.0	Broadcast Network SD Quality
		3.0	Broadcast Network SD Quality
		1.5	
		0.8	Local News SD Quality
		0.3	Proxy

The 8 Mbps and 5 Mbps stream modes (currently not AST supported) may be used over LAN/WAN (Private Network) where the camera is wired to the AP (Router) via a USB-Ethernet converter and where network traffic can be managed or with known available bandwidth. The implementation of LTE-Advanced over the next several years will prepare the 8 Mbps and 5 Mbps stream modes for future wide area LIVE wireless backhaul success, enabled by AST.

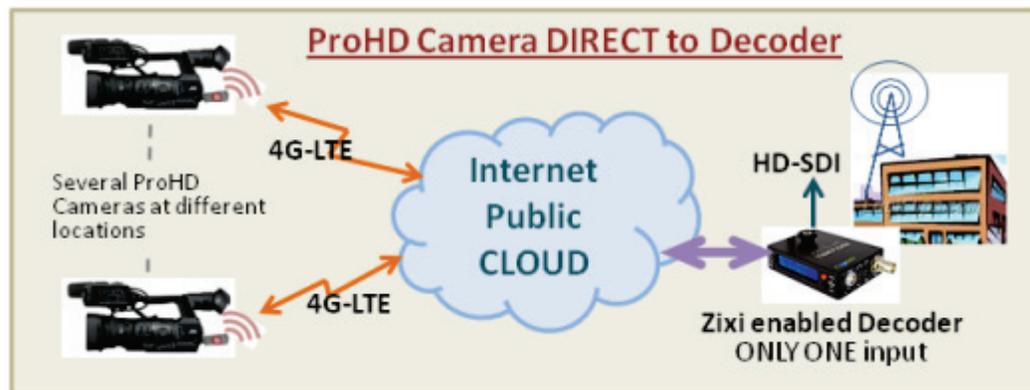
Service Plans - Professional Streaming Services

Concurrent with the introduction of the two new shoulder-mount Mobile News Cameras (GY-HM850 and GY-HM890), JVC is unveiling three (3) initial Service Plans under its new and exclusive **Professional Streaming Services (PSS)**, with availability as of April 2014 (NAB):

- Camera streaming Direct to Decoder
- Cameras streaming to locally installed ProHD Broadcaster Server
- Cameras streaming to CLOUD-based Platform-as-a-Service (PaaS) by Zixi/Amazon Web Services

Base Level: Camera to Decoder – Direct

The illustration immediately below shows the Base Level approach to LIVE backhaul streaming taking full advantage of the Advanced Streaming Technology, without the need for the ProHD Broadcaster Server. This is suitable for a single TV Station where the only objectives are two-fold: (a) to receive reliable remote LIVE HD streams which are immediately decoded to HD-SDI for Master Control LIVE OTA, and (b) to receive FTP transfers, for facility routing, storage and editing. With this basic Direct Service level, any video processing required of the LIVE HD backhaul (and FTP) for Website (or other) purposes must be performed as a separate function by the TV Station.



The above Illustration shows a Zixi enabled Teradek Decoder connected to the Internet via wired Ethernet (RJ45) or, if desirable, via TV Station's WiFi LAN. The Decoder is reached by the Camera specifying the unique IP address of the Decoder. Note that the Decoder is a single channel device in the HD-SDI output mode. If two or more Cameras are streaming at the same time, then each Camera require a separate Decoder back at the TV Station, each with a unique IP address, to provide multiple HD-SDI concurrent outputs. Operating cost is the 4G-LTE data use plus the annual license fee (currently \$1,000) to enable the Teradek Decoder for Zixi operation. 4G-LTE data use per Camera of 50GB/month would cost \$375. Purchase price for Teradek Decoder is

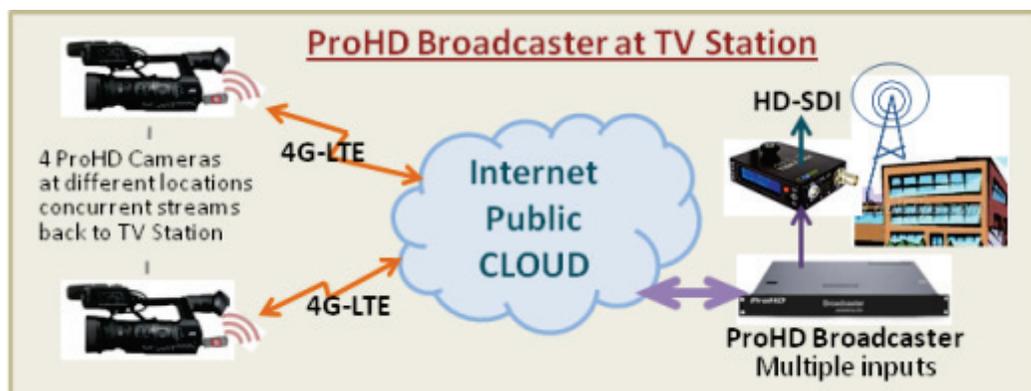
less than \$2,000 or \$34/month depreciated over 5 years. Excluding Camera cost (you need Cameras in any event), monthly operating cost is about \$500/month. Compare that with the cost of Bonded Cellular Backpack and Camera-Backs! Ever tried to attach a Bonded Cellular Box to a handheld size camera?

The operating cost advantage with this Direct service plan is that you are only charged for 4G-LTE data consumption by your cellular wireless provider, while there is NO additional charge for data consumption over the Internet for the AST-formatted transmissions, as you are NOT subscribing to the Professional Streaming Service (PSS).

NOTE: Each 4G-LTE USB modem requires to be registered with a unique IP address, in order for home base (i.e. TV Station) to initiate contact with a Camera in the field and to identify the source of any stream. This is accomplished with Verizon by setting up a wireless business account costing a \$500 one-time fee, which may register an unlimited number of 4G-LTE USB modems. Also note that the price of the 4G-LTE USB modem is about \$50 (or less, sometimes free) with a 2-year broadband wireless contract.

Level 2: Cameras streaming to local ProHD Broadcaster Server

The illustration below shows a **Professional Streaming Service (PSS)** solution for a major TV station operating a number of ProHD Cameras, where the **ProHD Broadcaster Server** is installed locally at the TV station/News Room, which makes it possible for the TV Station to pre-program the sharing of LIVE streaming from one or more Cameras simultaneously to additional destinations, such as sister/duopoly TV stations, Websites etc. with each stream capable of being in a different format as required. See Illustration on page 15 above.



The **ProHD Broadcaster Server** offers multiple (virtual IP) inputs and outputs, specified as "unlimited" number of listed unique IP addresses. There is obviously a limit on the ability to receive and process concurrent LIVE streams from multiple Cameras, but this limit is believed not to be operationally significant in any TV Station application.

As the **ProHD Broadcaster Server** ports are all IP-centric (Ethernet), it does not provide any decoded HD-SDI output for Master Control routing, thus, at the TV Station/News Room, there is a need for a broadcast quality HD-SDI decoder accepting the ProHD Broadcaster Server's LAN output of MPEG-TS over UDP or RTP which most of the traditional decoders do (Harmonic, Harris, Tandberg, Sencore, etc). Again, a cost effective HD-SDI decoder is the Teradek (Ethernet IN – HD-SDI OUT) which need not have Zixi Receive enabling as the MPEG-TS output from the ProHD Broadcaster is not Zixi coded. However, in the event that it is convenient to place the Decoder at a location far away from the ProHD Broadcaster (i.e. connection through an UN-managed network or the Internet) it may be prudent to add Zixi coding to the output and enable Zixi Receive at the Teradek Decoder to protect the transmission, as the annual Zixi license for each Teradek unit is only \$1,000.

At first, for the basic one Camera operation, the cost analysis is similar to Camera to Decoder – Direct at \$500/month, except you need to add the purchase or lease of the ProHD Broadcaster Server at only \$1,995 (purchase) or about \$100 (monthly lease). This brings the monthly cost to \$600 with a lease. In addition, you will be charged a fixed PSS subscription amount based upon the total data usage “passing through” the Broadcaster Server in each month, in blocks of 500GB. Call JVC for quote as this price is not yet finalized as of February 2014, however, JVC indicates the price will be highly cost effective, meaning “just a fraction” of any cellular provider's 4G-LTE data pricing. And, this PSS data usage fee is only assessed on the data flowing out of the ProHD Broadcaster Server, NOT on the flow in, which will eliminate “double billing” as what goes in must come out sooner or later, except for the clips and streams not of any interest to any destination.

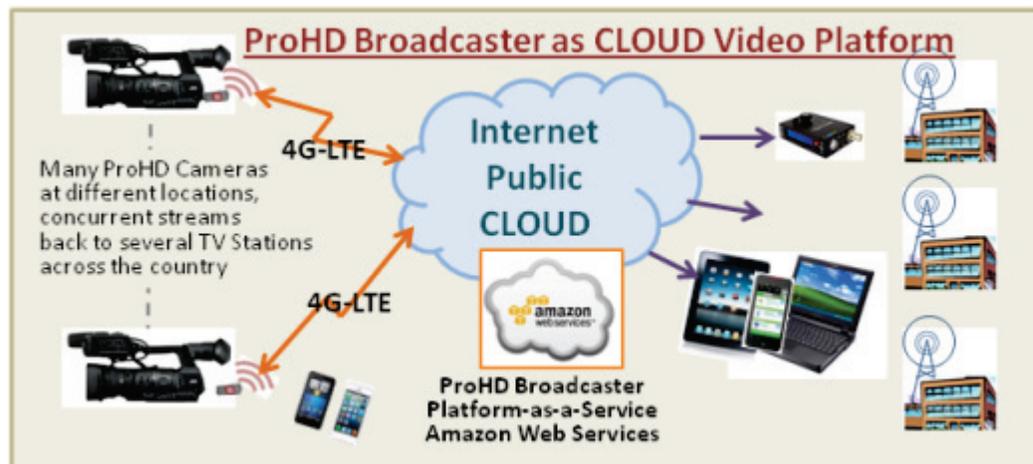
Operating multiple ProHD AST/PSS-ready Cameras and assuming that each Camera is consuming less than 50GB average data flow per month, a block of 500GB of data flow from the ProHD Broadcaster Server to the various destinations (primarily TV Station/News Room/Website) is sufficient for supporting up to ten (10) Cameras, unless the “various destinations” are many and frequent, the same clips played out multiple times, and high quality clips by FTP and/or significant multicast transmissions are undertaken frequently.

Without the Camera purchases (you need Cameras anyway), we end up with a base level cost of \$600/month + the PSS (data out flow) subscription. Additional Cameras fitted with 4G-LTE USB modems are likely on the average to consume less than the 50GB/month. At 40GB/month, the Verizon data cost is \$300/Mo. Thus a total of four (4) Cameras supported by this locally installed ProHD Broadcaster Server Service Plan is estimated to cost about \$1,500/month + the PSS (data out flow) subscription. Compare that with buying and operating several Bonded Cellular Backpacks and/or Camera-back Boxes!

CLOUD Level: Cameras streaming to CLOUD Video Platform

The illustration below shows the most advanced application of JVC's AST supporting **Professional Streaming Services (PSS)**, where the ProHD Broadcaster Server is offered as a Platform-as-a-Service (PaaS) running under **Amazon Web Services, powered by Zixi**. This highest level of AST/PSS service is ideally suited for Group Station Owners operating multiple TV stations regionally or across the country, where substantially all video clips are stored and processed in the CLOUD, and made available to all TV stations in the Group according to pre-programmed (or on the fly) permissions, whether LIVE, Store/Forward or FTP.

Is this the NEW total IP approach to finally being able to implement centralcasting?



It is difficult indicate an overall operational cost estimate for comparison purposes, as it depends upon the number of TV stations attached to the PaaS network and the number of Cameras capable of feeding it. Thus we look at a single Camera and a single TV station, and the only difference between this highest level of PSS and the previous mid-level is that the monthly subscription for the 500GB/month block of data use is about twice the price of mid-level subscription, but still only a fraction of the 4G-LTE data plan cost. The 500GB block of data is NOT per TV station or per Camera, but all shared data usage.

The Web Administration Interface is the same for the mid-level and the high-level AST service plans, making expansion of services to CLOUD-based PaaS relatively easy.

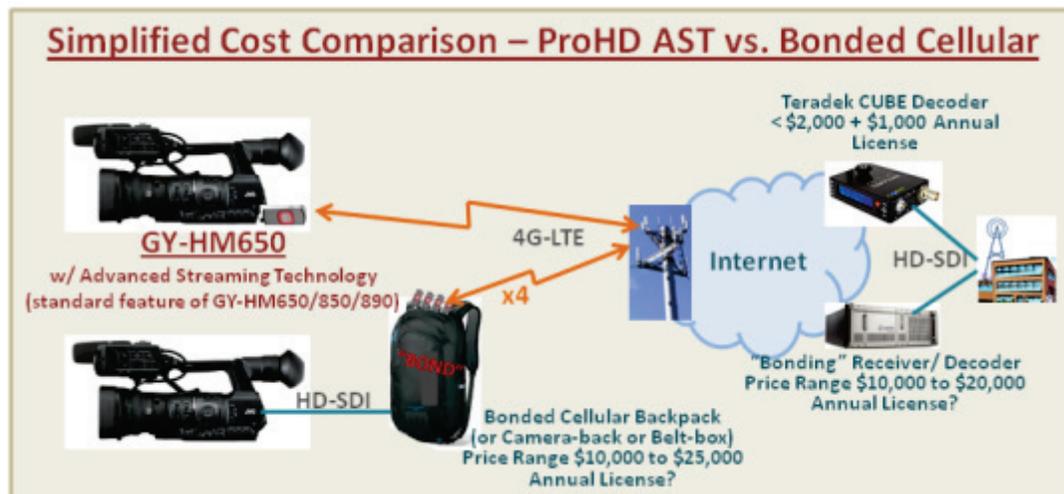
Smartphone HD Video Camera Acquisition and LIVE Backhaul

As a part of the AST/PSS offering, Android and iOS LIVE video streaming Apps are available for download and installation in Smartphones, providing back-up LIVE reporting over 4G-LTE and WiFi using the Smartphone's built-in HD video camera. At destination, a Zixi-enabled Decoder is required.

The Cost of Bonded Cellular

Bonded Cellular Products require the VJ to wear (or be near) a Bonding Backpack or a Belt-box, or attach a Camera-back Unit, where multiple (generally 4, 6 or even 8) 4G-LTE USB modems are “bonded” to divide up the LIVE compressed video/audio IP packets between the multiple streaming backhaul channels (one channel for each 4G-LTE connection path used). Then, at the destination, a proprietary Internet connected receiver unit accepts the multiple streaming channels and combines them into a single LIVE stream of IP packets for decoding into HD-SDI for Master Control use to go LIVE OTA. There are about half a dozen manufacturers of Bonded Cellular Systems, and the performance of all of them is generally very good.

So, the question in 2014 is not performance, but rather purchase and operational costs and of course the question of whether Bonded Cellular is required now and in the future. JVC’s position is that its Advanced Streaming Technology (AST) and Professional Streaming Services (PSS), combined with high quality lower bitrate Camera-embedded HD encoding and the expected increase in Upload data speed in 2014 and beyond will only require a single 4G-LTE connection to deliver reliable remote LIVE streaming backhaul to the TV Station in the large majority of cases. **It becomes a question of economics, i.e. the cost of Bonded Cellular.** Let’s look at the “simple case” of providing one remote LIVE streaming backhaul connection between a remote news event location and TV Station’s Master Control.



Look at illustration above. The Camera cost may be the same, so we take that out of the equation. The purchase cost for the Backpack and the Receiver/Decoder is in the range of \$20,000 to \$45,000. One major supplier is selling through B&H where the combo (Backpack & Receiver/Decoder) price is about \$38,000 (Feb.2014). There may be additional license fees. The JVC ProHD transmission equipment needed are the Teradek Decoder and the Camera-plugged-in 4G-LTE USB modem, at about \$2,000. Add \$1,000 annual Teradek license fee for ProHD AST (Zixi) enabling. The data consumption through four (4) 4G USB modems (circuits) will be higher than through ProHD AST-fitted single 4G modem, even comparing backhauling the same data

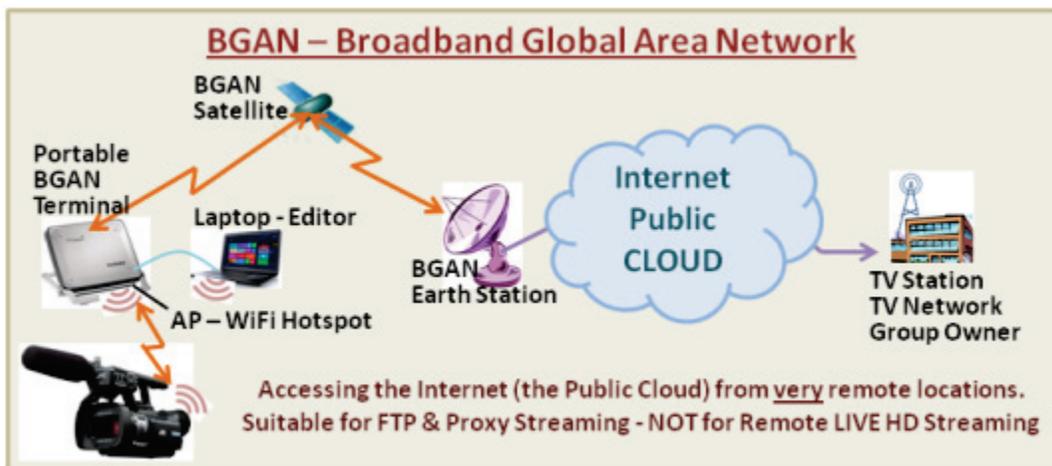
chunk, as the four 4G USB modems each require overhead although each only carry one quarter of the LIVE video (average). For more accurate costing of Bonded Cellular, contact the major “Bonding” suppliers.

The following are primary reasons why JVC believes that Bonded Cellular is not needed in a majority of LIVE streaming applications for the future:

- Upload cellular (4G-LTE) data speed in 2014 is in the range of 6 to 8Mbps average in many metro locations, which is sufficient for most remote LIVE streaming backhaul
- ProHD LIVE streaming bitrates of 1.5Mbps and 3 Mbps for 720p produces good HD video, as does 2.5 Mbps for 1080i, at Master Control
- With implementation of LTE-Advanced, Upload data speed is expected to increase to 10 to 15Mbps average in many metro locations by 2016

BGAN – Broadband Global Area Network

Although not directly related to AST, we need to include BGAN in this White Paper/Report. **BGAN** is a Satellite Internet/Telephone Network using a (highly) portable transceiver terminal as the link between the satellites and laptops (or satellites and ProHD camera direct to BGAN terminal) to connect to the Public Internet in (remote) locations around the world and to provide telephone service. Line-of-sight to the satellite is required. As the standard maximum datarate is only about 500 Kbps (specifically 492 Kbps) for each of Upload and Download, BGAN is NOT suitable for Remote LIVE backhaul of HD, but may work quite well for FTP applications although slow, and for proxy level LIVE streaming from remote places. In today’s fast datarate environment, one can hardly call 500 Kbps broadband! But a name is a name . . .



The portable BGAN terminal (the size of a larger laptop, including satellite transceiver/antenna) is self-contained, only at the mercy of a power source, being mains plug-in or battery.

All BGAN Terminals **also have access to (paid) streaming services**, which are unshared channels over the satellite link to the Internet backbone. Broadcasters may use these premium streaming channels to avoid dropouts during a Remote LIVE backhaul if using the standard shared channels. While streaming low quality video (less than SD quality) is possible over the standard shared BGAN service, it is unpredictable with dropouts. Unlike standard BGAN charged-by-the-Megabyte Service), streaming service is charged-by-the-minute of use. Streaming is specified as maximum 450 Kbps, at a price of \$27 per minute or \$1,620 per hour. Guaranteed no drop-outs, AST not required. Just connect the ProHD Camera to the BGAN terminal by WiFi or wired. Relatively expensive? Definitely.

The regular 384 Kbps service is charged at an average of \$5 per MB of transfer (prepay large block). At 384 Kbps, one (1) MB (x8 = 8 Mbps) equals about 20 seconds of real time. In other words, about \$15 per minute (for about 3 MB) or \$900 per hour (for about 180 MB). Contact the BGAN vendors for the latest specs and pricing.

What is possible within 384 Kbps?

Look at the available ProHD Camera streaming bitrates on page 17. Proxy at 300 Kbps LIVE is possible. You send LIVE proxy quality back to the News Room half a world away, while you concurrently record higher quality HD (but not too high, i.e. 5 Mbps AVCHD-EP) on the ProHD Camera's SD memory, for later FTP back to the News Room. Remember that, at 384 Kbps data rate, it will take about 13 times real time ($5 \text{ Mbps}/384 \text{ Kbps} \approx 13$) to FTP the recorded AVCHD video clip back to the News Room. If the news clip had a real time duration of 5 minutes, then the FTP would take about 65 minutes (5 min. x 13) costing over \$900 to transfer the HD video back to the News Room. But the News Room already had the 5-minute proxy an hour earlier, so the news editor had ample time to edit the proxy, then immediately conform the HD to the edited proxy once FTP is received, ready to go on air with high quality HD after one hour+ delay.

Remember Satellite Latency

BGAN geosynchronous satellites are in stationary earth orbit about 20,000 miles above the earth, making the up/down signal round trip distance in excess of 40,000 miles. This will produce about one (1) second of satellite path delay (including basic terminal up/down processing). Additional latency may be caused by internet routing and processing.

BGAN is last resort!

You're out in the sticks somewhere in North America, without cell/smartphone coverage, no WiFi Hotspot and no Internet connection. Or you're somewhere in outer Mongolia under extreme pressure from the news department back home to produce immediate video, both LIVE streaming and FTP. Fortunately, you are equipped with JVC's ProHD cameras and the \$2,500 BGAN terminal! (\$5,500 special BGAN terminal if you need guaranteed streaming services).

The Difference: LIVE and VOD Streaming

It's important to recognize the primary difference between LIVE shoot streaming and Video-On-Demand streaming. VOD streaming is playback of a previously recorded video clip (or movie), while a LIVE shoot is "happening right now". The Author is "hooked on" OTT television, subscribing to Amazon Prime Video and several other VOD services. It is simply amazing that good quality HD VOD can be delivered time and time again without even a single viewing problem. Or is it? Remember that the pre-recorded video can be played back very fast (much faster than real time) and pushed down to my local ISP area and buffered long before the IP packets are needed at the destination's decoder. There is plenty of time to replace lost packets and do concealment.

NOT so with LIVE shoot streaming over UN-managed networks and the Internet, for LIVE OTA. There is no pre-recorded video from which you can establish a buffer as the video is "happening right now". There is no acceleration available. The only option is to specify a delay between the LIVE source (the Camera) and the LIVE OTA destination decoding (i.e. Master Control) and to allow enough time to replace lost IP packets and apply FEC to achieve a certain reliable data rate. JVC has established two standard latency levels: 2 seconds or less for LIVE two-way interview and 5 seconds for LIVE one-way reporting. Simplistically said, it is obvious that one can do a lot more IP packets replacement and FEC in 5 seconds than what is possible over 2 seconds, thus, over the same Internet connection, the 2 sec mode may reliably support LIVE shoot streaming at 1.5 Mbps while the 5 sec mode may support reliable LIVE connection at 3 Mbps. The available average LIVE streaming data rate generally increases as longer latency becomes acceptable, limited by the condition of the Internet connection at that time (including any 4G-LTE Upload limitation).

What about FTP?

File Transfer Protocol is used to transfer a pre-recorded clip (a File) from the Camera to the News Room. Although we seek to get the file back to the News Room as fast as possible, we are generally not under any critical time constraint. There is plenty of time to re-order IP packets and apply error correction. The process can be similar to VOD, as data may be accessed faster than real time (off the Camera's internal memory cards), buffered and streamed under TCP to destination at a data rate which can be supported by the connection with the optimum level of re-ordering and correction.

The 4G-LTE transmission cost of the FTP transfer is based on the amount of total data transferred (i.e. 100 MByte = 800 Mbit), and not on the time it takes to transfer the data. A slow connection at 1 Mbps would take 800 seconds (13 minutes) while a fast connection at 10 Mbps would take 80 seconds (1 minute 20 seconds) or one tenth time. Total data consumption in both cases is 100 MB at a consumption price of less than \$1 (40GB per month cost \$300).

Section 3: The Future of LIVE Wireless Backhaul

The Major (4G-LTE) Wireless Providers

Of the two wireless backhaul options to reach the News Room via the Internet (WiFi and 4G-LTE), 4G-LTE is the most flexible from a roaming camera point of view, although WiFi may offer faster Upload speed unless limited by the WiFi Hot-spot provider. But, as roaming (or roving) is a critical use of the Cameras (handheld and shoulder-mount), we see 4G-LTE in 2014 as the primary backhaul path both for Remote LIVE and FTP purposes.

Which of the four (4) major 4G-LTE wireless providers are likely to provide the best average consistent Upload speed in any one specific metro TV market? It varies from market to market, requiring each TV Station to survey 4G-LTE coverage in its local metro area, to find the best one or two broadband wireless providers. Note that rural/fringe 4G-LTE coverage is poor or non-existent without regard to which wireless company is serving the rural area. AT&T and Verizon both claims to have reached near full national coverage in 2013, with AT&T seemingly having the fastest Upload on the average (Internet search results of several field tests in Q4-2013). But remember that we are looking for sustained Upload speed through-out the metropolitan area covered. Going into 2014, T-Mobile is coming on strong. See table below.

Wireless Provider	Upload Speed* 4G-LTE Mbps (Avg.)	Remarks (by Author for backhaul purposes)
	7 Mbps	Offering the largest national coverage area by far, combined with good average Upload speed. NOTE Verizon is rolling out LTE Advanced in 2014.
	8 Mbps	Offering the fast Upload speed with near full national coverage, but total 4G-LTE coverage area somewhat less than Verizon. NOTE AT&T is rolling out LTE Advanced in 2014.
	8 Mbps	Offering the fastest average Upload speed in the areas where they compete with AT&T and Verizon, but their 4G-LTE network is not yet at a full national level.
	Insufficient 2013 UPLOAD speed. (Less than 3 Mbps, Often less than 1Mbps)	Insufficient Upload speed in 2013 nationally. NOTE that, as of 2014, Sprint is rolling out 4G-LTE service availability in 300 markets, in addition to starting to roll out the Sprint Spark LTE Tri-band service. See write-up below.

*Upload speed data from Internet research. Approx. average of several field tests in Q4-2013.

The above chart suggests that there are really only three wireless providers with 4G-LTE Upload speeds sufficient for Remote LIVE backhaul of broadcast news quality HD: Verizon, AT&T and T-Mobile. **But wait . . .** Sprint is now becoming a serious contender in 2014, particularly with its new Tri-band LTE service already rolling out. (Read “**Sprint SPARK**” below.)

Obviously, the TV Station or News Organization must undertake local tests to find out which wireless provider performs the best in its local metro area. The test results may indicate that contracts with more than one broadband wireless provider may be required in order to best cover a large metro area. I.e. Verizon 4G-LTE service may best perform when covering west side remote metro locations, while AT&T modem may best perform for east side locations.

Upload speed may vary significantly by time and location, even within a cell, for a number of reasons. Although signal strength theoretically should not materially affect the Upload speed, “four or five bars” are generally better than three or less.

Bottom line Upload speed with 4G-LTE in early 2014 is a sustained 6 – 8 Mbps on the average. We expect to see marginal improvements through 2014 into 2015 up to average sustained at 10 Mbps, with substantial increases up to 12 – 15 Mbps average through 2016 as LTE-Advanced is implemented market-by-market across the country. Who needs Bonded Cellular with sustained LTE Upload speed in the range 12 - 15 Mbps? The Author cannot think of any . . .

“True 4G” is coming this year . . . LTE-Advanced

4G stands for Fourth Generation. LTE stands for Long Term Evolution. The next major expansion of broadband wireless capacity is through the LTE-Advanced industry specification. The wireless industry is calling LTE-Advanced “true 4G” because it meets the ITU’s specifications for Fourth Generation wireless systems. LTE-Advanced can theoretically achieve downlink speed up to 3Gbps and Upload speed up to 1.5 Gbps. But don’t hold your breath for 1.5 Gbps. We’ll be in great shape for LIVE HD backhaul (even for LIVE 4K/UHD H.265 streaming backhaul in the future) at **a sustained Upload speed of 15 Mbps**, or only 1% of max theoretical Upload speed. LTE-Advanced will offer higher network capacity, better connections, and less cost per GB of monthly data usage, according to the cellular industry. And 4G-LTE phones and devices are compatible with LTE-Advanced, subject to having compatible receiver RF bands. Both Verizon and AT&T have already started to implement LTE-Advanced.



Implementation of LTE-Advanced will contribute to the elimination of Bonded Cellular backhaul, as widely available sustained Upload speed becomes available exceeding 10 Mbps. LTE Advanced (first stage) actual performance in South Korea at the end of 2013 produced Upload speed in the range 13 to 20Mbps. Thus there is no doubt that JVC’s choice of using a single 4G-LTE modem is the right approach, particularly when considering the power of JVC’s Advanced Streaming Technology.

Sprint Spark:

A New Upload “Super-Highway” for LIVE HD Backhaul?

Our 4G-LTE interest is in the Upload speed reaching a sustained 12+ Mbps, which will support reliable LIVE real-time connection through the Internet (Public Cloud, UN-managed networks) for any of the H.264 compressed streaming video formats listed on page 17, up to 8 Mbps, plus provide sufficient additional bandwidth capacity for overhead when JVC’s Advanced Streaming Technology is applied.

The Sprint Spark Tri-band 4G-LTE wireless service was introduced in 2013, promising an initial peak (download) speed in the range 50 – 60 Mbps and growing in future years to much more than that (future speed up to 1 Gbps, Sprint says). But, so far, Sprint says nothing about Upload speed. However, industry sources indicate that the Tri-band technology seems to initially support a gross Upload speed of 17 Mbps which should easily perform at 12+ Mbps net, giving maximum support to JVC’s Advanced Streaming Technology system, and with Sprint’s promise we’ll see significant capacity growth in future years.

The Sprint Spark’s secret is the Tri-Band radio, splitting the download payload between three different cellular bands 800 MHz, 1900 MHz and 2100 MHz, requiring the smartphone or other mobile device (i.e. plug-in USB Modem) to have the capability to receive all three RF carriers simultaneously and then combining the data from three RF paths into one for decoding and display purposes. (How about that. Sounds like bonding! Built into the single modem 4G-LTE service.)



What about the Upload process? This is unclear at the moment. At max Upload speed of up to 17 Mbps, it is possible that the single radio band which offers the best Upload speed is chosen in each case, but this is not likely to achieve 12+ Mbps net anytime soon. It is likely that it will take more work by Sprint to achieve SPARK Upload speed approaching 17 Mbps. But the clear message is that Upload speed is on a growth path just as Download speed is, with the certainty that a single 4G-LTE or single LTE-Advanced USB wireless modem will be sufficient for reliable LIVE HD backhaul. Bonding is on the way out in the Author’s opinion.

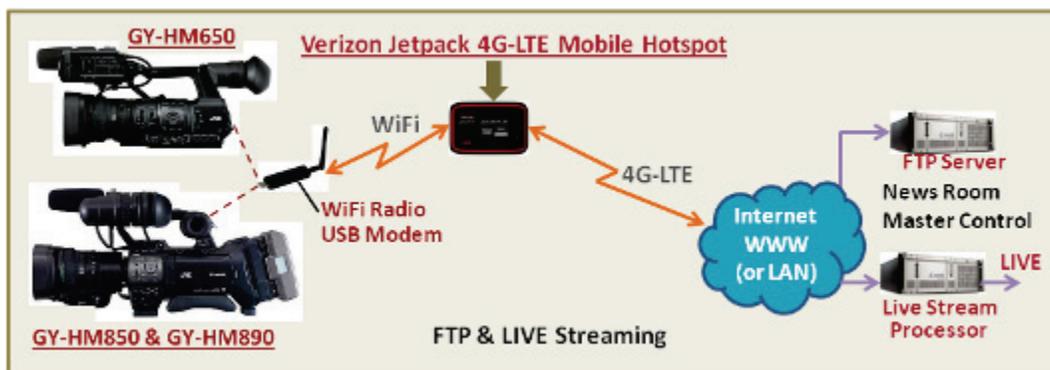
What about current Coverage? As of February 2014, Sprint claims SPARK coverage in the following markets: Austin, TX – Chicago – Dallas – Fort Lauderdale – Fort Worth – Houston – Kansas City – Los Angeles – Miami – New York – San Antonio – Tampa . **Note** that, at this time, SPARK coverage initiated in any one metro-area does not mean complete metro-wide coverage.

The Sprint SPARK website states: “By the end of the year, Sprint plans to extend Sprint Spark coverage to 100 million Americans, with the long-term goal of launching the capability in about 100 of the nation’s largest cities.”

Using 4G-LTE Mobile WiFi Hot-spots

There really is a need for WiFi Hot-spot connectivity . . .

You’re covering a story LIVE where you and your camera are by necessity located in 4G-LTE dead-zone. But fortunately your “ProHD remote tool box” contains a WiFi USB Modem and a Verizon “MiFi” Jetpack Hot-spot box (or similar) with a communications range of up to a hundred+ feet. You place the Hot-spot box in a location with proper 4G-LTE coverage, plug in the WiFi USB modem into the camera, and, presto, you have WiFi Direct connectivity and LIVE HD streaming backhaul opportunity.



Verizon’s Jetpack/MiFi 4G-LTE Mobile Hot-spot Unit (see illustration above) is capable of performing such an interface task, including handling up to 10 WiFi devices and being 802.11 b/g/n compliant. However, on the 4G-LTE Internet “side”, the unit may be facing a limited (but sufficient) Upload speed of 6 – 8 Mbps, the same spec as if a 4G-LTE Modem is plugged directly into the USB host connector on the back of the Camera. We can therefore reason that the Jetpack is not likely to improve the backhaul data rate as compared with the 4G-LTE USB Modem plugged directly in to the Camera. (But as said above, the camera may be in a 4G-LTE dead zone.) In any event, the Video Journalist (VJ) should as matter of course have field access to all the WiFi and 4G-LTE ProHD tools available, as the VJ may face remote locations where camera’s WiFi connectivity performs better (and less expensive) than the camera’s 4G, for whatever reasons. The “shirt pocket size” Jetpack can possibly be located where connectivity is superior for both the WiFi side and the 4G side.

WiFi connectivity is also very important in covering LIVE in specific locations which may be known to have good WiFi service, like at public venues (City Hall, State buildings, etc.). But public WiFi currently has one major obstacle for fast paced HD-ENG: You generally need to sign in with a password and to click to accept the terms to gain access which is awkward for the VJ.

This WiFi access problem can possibly be solved by agreement with the public WiFi operator, to allow immediate access once a pre-registered device (such as a ProHD Camera) is detected. This will be sorted out as more and more TV News organizations request such WiFi instant access.

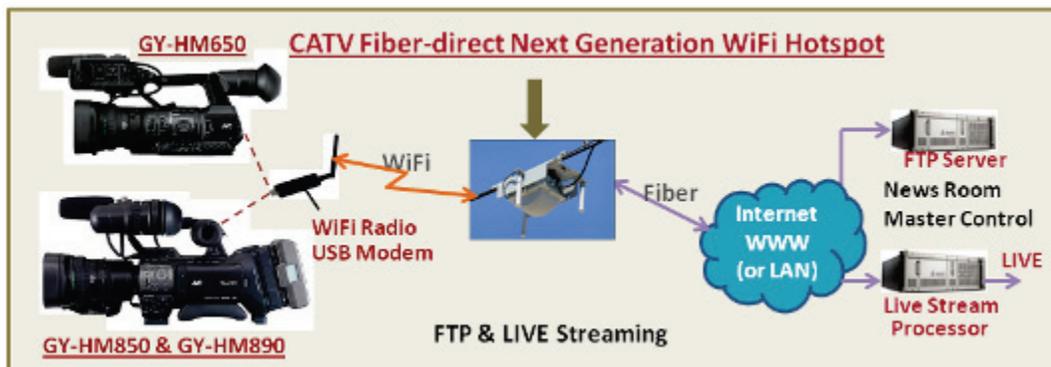
Obviously, the Camera's WiFi capabilities are extremely important in making it possible to remotely control its functions, to monitor the LIVE Camera remotely, in the field and back at the studio and edit facility, when transferring clips, and managing the memory cards.

Advanced WiFi capabilities is a requirement for future Mobile News/Events Cameras, as the integration between WiFi and LTE becomes tighter in the future.

Next Generation (WiFi) Hot-spot Networks

A blurring of 4G-LTE and WiFi data traffic?

WBA (Wireless Broadband Alliance) forecast that WiFi offload will contribute about 20% of additional mobile data capacity by over the next five years, plus another 20% will come from small (4G-LTE) cells with integrated WiFi. WiFi is unlicensed spectrum, and the WBA members (the likes of AT&T, Intel, Cisco, T-Mobile, TWC, Cox, Comcast, and many more) can see the profit opportunities without spectrum acquisition costs. After all, the major Cable companies currently operate an estimated 250,000 WiFi Hot-spots across the U.S.

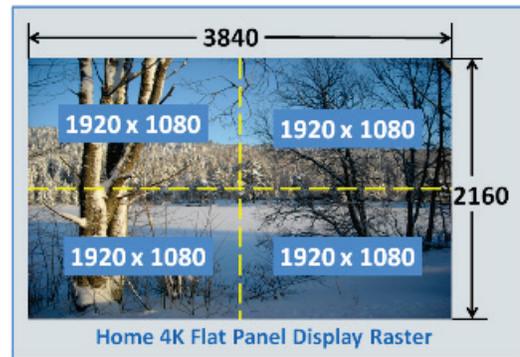


What is WiFi offload? Simply said, in the future, in areas where there are both 4G-LTE and WiFi service, more and more of the wireless data traffic will be offloaded (seamlessly, no sign in, no password) to the WiFi network to create more overall cellular wireless data capacity. But this approach requires more advanced WiFi performance, one of which is the capability to seamlessly transition from WiFi cell to WiFi cell, and between 4G and WiFi cells, in a mobile/moving environment. WBA refers to this as the Next Generation Hotspot (NGH) WiFi Networks, some already being installed in the U.S. Last year (2013), WiFi Network provider Boingo Wireless launched the world's first commercial NGH WiFi network at Chicago O'Hare Airport.

Not to worry about Ultra HD

Local Remote LIVE News Contribution at 1080p60 will handle it

UHD (consumer 4K or 3840x2160) is primarily driven by the flat screen (CE – consumer electronics) manufacturers, as they all are looking for the next hot TV sales cycle. UHD offers 4x the spatial resolution of full HD 1920x1080. When will TV/Cable news organizations want/need to add remote LIVE UHD streaming backhaul video to their newscasts? The good news is NOT for many years. Netflix recently stated that it will initiate UHD movie test streaming in 2014, and that the compressed bitrate is likely to be in the range of 16Mbps (for the test streaming) using HEVC (High Efficiency Video Coding – H.265), twice as efficient as H.264.



If we take Netflix' 16 Mbps gross stream bitrate, presumably with consumer 4:2:0 sub-sampling, including some overhead, for delivering consumer quality UHD video (which still needs to be pretty good) over the Internet, and compare with Sinclair Broadcast UHD over-the-air test (January 2014 in Las Vegas at the CES) where the gross bitrate was reported to be 27 Mbps (DVB-T2, also 4:2:0) presumably including a substantial amount of error correction overhead, we can expect a professional quality (but not TV network quality) compressed UHD video to require around 20 Mbps 4:2:0 HEVC . With 4x the screen resolution and 2x the frame rate, UHDp60's uncompressed bitrate is 8x higher than 1080i60, but only 4x higher than 1080p60, other factors being the same. Thus, "professional 4:2:0 delivery" of 1080p60 with HEVC encoding at about 5 Mbps is likely to result in good UHD display quality, providing "an acceptable viewing experience" with LIVE streaming 1080p60, when professionally upconverted to UHD and intercut with studio UHD video before going on-air.

The Author believes that UHD news programs, once a reality, will be very well served by remote LIVE news contribution being "just HD" at 1080p60, which will display extremely well on even a large UHD flat screen TV, whether professionally up-converted by the TV station or by the flat screen home UHD set.

With LTE-Advanced being implemented and overall Internet bandwidth capacity expanding, it is easy to understand why Bonded Cellular is a difficult sell for the next several years. **Will there be a possible Bonding come-back in a few years to stream real UHD back from a remote news event? The Author does not think so. A single LTE-Advanced USB Modem will handle Remote LIVE UHD streaming backhaul, when that time comes.**

Section 4: ProHD Models, Features & Support

JVC delivers the most for the money . . . Whether Handheld, Shoulder-mount or Studio

Over the nine years since JVC introduced the first ProHD camcorder GY-HD100 at the NAB in 2005, JVC's professional HD camera/camcorder strategy has been (and is) to condense its models to a price range from about \$2,500 (handhelds) up to about \$10,000 (shoulder-mount) and to include features and performance well beyond what are available from the competition in that price range. The fact that competitors offer cameras in multiple price ranges, from less than \$2,000 to more than \$50,000, often results in a requirement to "ration" features and performance, often telling a customer that feature X (although not costly to include) is not available in the \$10,000 camcorder but it is in the \$20,000 model range. The competitors have no option but to reserve some options for the \$20,000+ models in the hope of selling some! No such range rationing with the JVC cameras, as JVC only has one model range: ProHD.

ProHD Camera Product Family Features




Feature	GY-HM600	GY-HM650	GY-HM850	GY-HM890
USB Host - LTE		✓	✓	✓
GPS		✓	✓	✓
TC in/out	✓	✓	✓	✓
4-ch. Audio	2-ch.	2-ch.	✓	✓
Genlock			✓	✓
Studio Remote			✓	✓
Studio Conn				✓
Studio Config				✓
HD Pool Feed				✓




The above Features Matrix is limited to AST capabilities, Studio configurations and external connectivity. Please go to <http://pro.jvc.com> to view all camera specs and to download multi-page brochures for the various models. You'll be impressed.

JVC Broadcast Direct

A Sales & Support Organization dedicated to TV Broadcasters

JVC Broadcast Direct is a new program offered largely to Group Station Owners to achieve successful transitioning at their local TV station properties to full and highly competitive HD news operations through the adoption of cost effective ProHD acquisition systems, and, as importantly, to assure the ongoing uninterrupted daily operation of ProHD equipment at the highest possible level. JVC's core commitments under a Broadcast Direct group adoption agreement include:

- Direct buying from JVC under net-30 or capital lease
- Purchase at substantial discounts (Adoption pricing)
- Direct station-level support by JVC technical/operations staff
- Depot service and product loaner program (Immediate turn-around)
- Exclusive performance and features
- JVC Support Web Portal (Repair, purchase history, manuals, pricing)

ProHD

JVC Broadcast Direct simplifies the ongoing purchasing and transition process, and includes initial setup of cameras and lenses, an exclusive depot service support program, and the very important training for technical and production staff by JVC product experts. All this to assure a highly successful ownership experience on a daily basis, including JVC placing ProHD camera/recorders at strategic locations as backup equipment when a TV station's equipment is sent to our depot for repair. Such gear is owned by JVC but available to the TV stations for the life of the adoption agreement. JVC's endeavor is to generate a win-win situation that will benefit all parties for now and the future. The success of ProHD will assure longevity and continued product developments to the benefit of the Group Station Owners through product continuum.

Join the Win-Win JVC Broadcast Direct Relationship today!



FALCONBRID: JVC'S Next-generation High-speed Picture Engine

Falconbrid is JVC's high-speed processor developed for advanced video camera applications. 40nm processing is incorporated into a single chip, offering high performance and low energy-consumption with an economical design. The Falconbrid Picture Engine can handle any image data including RGB, YCC and RAW conversions in real time with virtually no processing latency. Multiple Falconbrid processor(s) may be used to encode and format the video in any one Camera model.



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ProHD

GY-HM850/890 Mobile News & Events Cameras
The "UN-bonded" Remote HD Streaming Solution

First On-Air. First On-Line.