Wireless Video Best Practices Guide
Using Digital Video Manager (DVM) with the OneWireless Universal Mesh Network

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Abstract

Due to the rapid advances and maturation of wireless technology, many plants are enhancing their wired network by extending it wirelessly. Honeywell Process Solutions has a long history of providing robust video solutions for control and security applications at industrial sites, and has extended its capabilities to delivering systems that incorporate wireless video cameras and wireless access to video, using the OneWireless network architecture.

The OneWireless network consists of industrial access points called Multinodes, which are capable of self-discovering each other and forming a mesh network. Unlike the access points in an office environment, these industrial access points do not need to be physically connected to the wired network and communicate with each other wirelessly. This network is uniquely designed for the signal obstructions, maintenance constraints and scalability needs of industrial plant networks.

Honeywell Digital Video Manager (DVM) is a highly flexible and easily expandable video management solution using standard Ethernet networks, eliminating the need for dedicated coaxial cables. DVM provides the ability to scale bandwidth based on individual camera needs, and is therefore ideally suited for low bandwidth networks including wireless networks.

Business drivers

When operators are confined to isolated or remote control rooms, visual plant information is often beneficial to their job function. Access to video to facilitate review of the actual situation by the control room operator or with subject matter experts around the world, is having a profound impact on the ability to provide fast and decisive responses. In addition, video can automatically monitor situations and raise alarms, even when no one is looking, further improving operator effectiveness.

The use of video in industrial plants directly addresses the following key aspects:

- Safety, layers of protection reducing incidents
- Reliability, improving uptime of processes
- Efficiency, improving performance

The need to wire cameras in remote or out-of-reach locations has hindered the full deployment of industrial cameras in the plant. Wireless technology reduces the cost of installation and also improves portability of cameras for situations not requiring permanent observation. This creates a reliable and flexible infrastructure for cameras in the plant. The ability to only present camera information to the operator when and where it is needed, using the same interface employed for process monitoring, allows adding many more cameras in the field than was previously possible, without overloading the operator.

Architecture elements overview

Both wired and wireless networks play a key role in the deployment of video cameras in the plant. A typical video network may contain the following camera devices:

- Wired cameras connected directly to the wired network (i.e., analog- or IP-based cameras)
- Wired cameras connected to the wireless network using a Multinode (i.e., analog- or IP-based cameras)
- Wireless cameras connected to the wireless network (i.e., WiFi-based IP cameras)
**Analog versus IP-based cameras**

Analog cameras can be digitized using a video streamer between the camera and the network switch or Multinode. A video streamer transforms traditional analog video into high-quality digital images and manages communication between the camera and the operator, such as during “Pan-Tilt-Zoom” operator commands.

**Wireless cameras**

Wireless cameras are IP-based cameras with a built-in wireless capability, which do not require a physical wiring to the nearest Multinode.

**Industrial cameras**

An industrial camera network may include a variety of camera types, including:

- Industrial cameras for use in harsh and intrinsically safe areas
- Specialized camera units such as thermal cameras
- Commercial off-the-shelf cameras, such as those designed for standard CCTV operations

Not all camera types are available as wireless- or IP-based cameras, hence Digital Video Manager, combined with the OneWireless universal mesh network, consolidates different camera types into one system architecture providing transparent and consistent operational experience across all cameras in the plant.

Apart from cameras, the OneWireless system supports other critical plant applications. For example, XYR 6000 Transmitters, Experion Mobile Station and other 802.11 a/b/g-enabled devices may also be part of the OneWireless architecture. An overview of the common architectural element is provided below:
Wireless mesh network configuration

The OneWireless solution consists of at least one Multinode configured to act as the wireless gateway, which can also serve as a wireless access point. Gateways support additional Multinodes to expand the network capacity and range of coverage.

The most common difference between a wireless network and a traditional wired network, affecting video transmission, is the reduced level of bandwidth within the wireless network.

The actual bandwidth available for the transmission of video in a wireless network depends on two key factors:

- Signal strength – typically indicated as a value between 0 and 100%
- The number of Multinodes passed between the camera and the DVM server (also referred to as the number of “hops”)

With a total capacity of 54 Mbps (the theoretical bit transfer rate also referred to as “data rate”), the total aggregated wireless video traffic for any particular OneWireless node should not exceed 15 Mbps. A good rule of thumb is to configure each Multinode used for video with a Tx radio setting between 5 and 12 Mbps. In addition, the following network configuration aspects optimize the bandwidth available for video:

- Limiting the number of Multinodes within the path between the camera in the field and the DVM camera server will improve the throughput available for video images
- Placing Multinodes with camera connections, or wireless cameras, in areas with high signal strength will improve the throughput available for video images
- Using the built-in Quality-of-Service capability in the OneWireless network, which gives priority to sensor traffic over video traffic where required

OneWireless Multinodes support the Simple Network Management Protocol (SNMP), enabling bandwidth and latency to be monitored to ensure system performance.

Camera configuration

When a wired digital camera, wired streamer or wireless camera is configured for the first time, it is configured using a wired connection. Generally, cameras and streamers come with a default IP address that can be used for the first time access via a browser.

The camera configuration will directly impact bandwidth consumption. As such, a detailed bandwidth calculation needs to be performed prior to connecting the camera to the network. The key configuration parameters, configurable for each camera individually, include:

- **Video compression type** – Cameras typically support different video compression types. MPEG-4 is commonly used for low-bandwidth connections such as wireless networks, but depending upon the application, Motion JPEG and H.264 (future) may also be used.
- **Video compression** – A higher compression will result in a lesser quality video stream and lower bandwidth consumption. Compression is commonly referred to in terms of minimum, low, medium, high and maximum. A medium compression is most often used as the default starting point for compression on wireless networks.
- **Resolution** – Changing the resolution (i.e., the size of the image) changes the number of pixels, which, in turn, changes bandwidth consumption significantly. Common resolutions for wireless networks include CIF resolution, equivalent to 384 x 288 pixels. Higher resolutions are also available for wireless networks, depending on the number of cameras and the bandwidth availability. Lower resolutions are a good option for images with fewer details.
- **Frames per second** – This parameter determines how fast the image will update. More frames per second will make the camera send more data per second, which will consume significantly more bandwidth.

**Video compression differences**

Motion JPEG compression sends a series of compressed JPEG still images to the client, resulting in a motion JPEG video stream. MPEG-4 compression goes one step further than Motion JPEG by only streaming the differences between the still JPEG images. Frames containing only the differences are also referred to as the delta frames. The main resulting differences between MPEG-4 and Motion JPEG compression types are:

<table>
<thead>
<tr>
<th>MPEG-4</th>
<th>Motion JPEG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sends a complete video frame at a defined interval with delta frames in between.</td>
<td>Sends a complete image for every video frame.</td>
</tr>
<tr>
<td>Reduced bandwidth required for images with few changes, since a delta frame is smaller than a complete video frame image.</td>
<td>Higher bandwidth is required because an entire new image is streamed with each frame.</td>
</tr>
<tr>
<td>The maximum frame rate for a recording cannot exceed the live view frame rate. Rationale: the camera cannot add delta frames without affecting the total set of images to be decoded on the client side.</td>
<td>The live view and recording frame rates are independent. For example, users can view at a low frame rate, but record at a high frame rate. Rationale: the camera can add frames without affecting the client decoding.</td>
</tr>
<tr>
<td>Requires additional processing power on both the camera device and viewing client.</td>
<td>Requires less processing power on the cameras, device and viewing client.</td>
</tr>
</tbody>
</table>

When deciding between Motion JPEG and MPEG-4 compression types, consider the following impact on the network design and user experience:

**Motion JPEG**

**Advantages:**
- Graceful degradation – if bandwidth is reduced, image quality is maintained at the cost of a lower frame rate.
- Constant image quality – quality remains constant regardless of image complexity.
- Clear individual images – user can step frame-by-frame through a recording.
- Resilience – fast image stream recovery in the event of packet loss.
- Predictable bandwidth consumption – bandwidth can be configured to a maximum threshold.

**Disadvantages:**
- Higher bandwidth consumption and higher storage requirement

**MPEG-4**

**Advantages:**
- Constant frame rate – if bandwidth availability goes down, the frame rate may be maintained at the cost of image quality.
- Lower bandwidth consumption and storage requirements – especially in situations where there are few changes in the image (i.e., scenes with little or moderate motion).
- Predictable bandwidth consumption - bandwidth can be configured using Constant Bit Rate (CBR) setting.
Disadvantages:

- Less robust – if bandwidth goes below a certain threshold, frames need to re-synchronize and data may be lost.
- Higher bandwidth usage when there is a lot of motion in the frame (i.e., during “Pan-Tilt-Zoom” camera movements and vibration of the camera or the object in view.

**Camera bandwidth – Examples**

<table>
<thead>
<tr>
<th>Specification</th>
<th>MPEG-4 Low motion</th>
<th>MPEG-4 Medium motion</th>
<th>MPEG-4 High motion</th>
<th>Motion JPEG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical configuration</td>
<td>Resolution: 384 x 288 pixels (also known as CIF resolution, PAL) Compression: medium Complexity: typical Frame rate: 25 frames/sec.</td>
<td>178 Kbps</td>
<td>267 Kbps</td>
<td>356 Kbps</td>
</tr>
<tr>
<td>Higher resolution</td>
<td>Resolution: 720 x 576 pixels (also known as D1 resolution, PAL) Compression: medium Complexity: typical Frame rate: 25 frames/sec.</td>
<td>420 Kbps</td>
<td>630 Kbps</td>
<td>840 Kbps</td>
</tr>
<tr>
<td>Complex image</td>
<td>Resolution: 384 x 288 pixels (also known as CIF resolution, PAL) Compression: medium Complexity: complex Frame rate: 25 frames/sec.</td>
<td>445 Kbps</td>
<td>667 Kbps</td>
<td>890 Kbps</td>
</tr>
<tr>
<td>Small image, low frame rate</td>
<td>Resolution: 160 x 120 pixels Compression: medium Complexity: typical Frame rate: 1 frame every 5 sec.</td>
<td>1 Kbps&lt;sup&gt;2&lt;/sup&gt;</td>
<td>1 Kbps&lt;sup&gt;2&lt;/sup&gt;</td>
<td>1 Kbps&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Note 1 – Results are provided as an example only. Actual bandwidth results vary with each camera. Always check the DVM documentation for actual numbers based on the streamer or camera used. For a definition of complexity in an image, please refer to the DVM documentation. Source: DVM R300 Compatibility Matrix.

Note 2 – For low frame rates (typically below 1 frame per second), the use of Motion JPEG is recommended.
Video with audio

When audio is combined with the video stream, users should normally reserve an additional 42 Kbps bandwidth for an audio stream. Where both the camera microphone and camera speaker are being used, reserve 84 Kbps (actual bandwidth may vary depending on the device that is being used).

Camera standby rate

Cameras not used for viewing or recording are in standby mode. The maximum bandwidth requirement for a standby camera is 0.4 Kbps per camera. This bandwidth is used to maintain an active connection between the camera and DVM camera server.

Video analytics

Honeywell Digital Video Manager includes support for a wide range of video analytics, providing the ability to analyze video automatically and raise alarms based on preconfigured event detection algorithms. Video can be automatically shown to the operator when an event is detected, such as a field operator moving into a restricted zone or a person entering an emergency shower. The recommended default frame rate for standard and premium motion detection algorithms is three frames per second, while advanced algorithms such as Honeywell Active Alert require 12 frames per second. Typically, this results in a minimum bandwidth requirement between 150 Kbps and 1.5 Mbps for video analytics.

Recommendations

- Even though MPEG-4 delivers substantial benefits in terms of bandwidth consumption, the use of Motion JPEG with a combination of lower frame rates may still be considered due to its graceful degradation (dropping frame rates only and a quicker recovering during network upsets) compared to MPEG-4.
- Video compression type, compression rate, frame rate and resolution can be configured individually per camera, enabling a mixture of camera sizes and frame rates on site. Note that not all camera types support all options available within DVM, so check the camera or streamer specification prior to making a decision on camera and network layouts.
- Placing a camera in the field in standby mode, optionally combined with scheduled or event-based background recording at lower frame rates than live-view frame rates, enables a larger number of cameras to be deployed in the field.

Conclusion

A reliable wireless video infrastructure enables plants to take advantage of new and innovative applications using live video streams. There is no “one size fits all” wireless video architecture; each site may select the most convenient deployment of wired and wireless cameras, based on their needs. A OneWireless network may comprise many cameras on standby with selective use of active cameras, or a small number of high quality cameras that are monitored or record constantly (or any combination of both). Honeywell’s OneWireless video management solution, designed for industrial sites, ensures reliability and performance as well as the flexibility to place cameras just about anywhere in the field.
More Information
For more information about Honeywell OneWireless and Digital Video Manager, visit www.honeywell.com/ps or contact your Honeywell account manager.

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