

IP Video Standards

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This whitepaper provides a brief overview of IP video standards and recommends best practices to follow during security system design and implementation.

Video Standards

Early IP network cameras utilized proprietary protocols, which were specific to each manufacturer and required custom integration between such cameras and network video recorders (NVR) or video management systems (VMS). Since then, the security industry has developed and adopted several open standards, which greatly improve interoperability of network video products regardless of manufacturer.

There are three broad categories that are required for proper interoperability, illustrated in the table below and explained in more detail in the rest of this section.

	RTSP	PSIA	ONVIF
Camera discovery		✓	✓
Configuration		✓	✓
Live streaming	✓	✓ (using RTSP)	✓ (using RTSP)

RTSP and RTP

Most IP video systems utilize the Real-Time Streaming Protocol (RTSP) [1] to establish and control video and audio streams. The stream content is delivered using the Real-time Transport Protocol (RTP) [2]. RTP offers a variety of delivery mechanisms to support different network configurations and performance requirements.

Many NVRs support camera integration directly through RTSP, as a fallback option if more advanced integration is not available. RTSP does not provide device discovery or camera configuration and the user is required to manually enter the camera IP address as well as an appropriate Uniform Resource Identifier (URI) for the stream, which is not standardized and depends on the camera type and/or model. The NVR then receives a video stream as it was configured on the camera, with no ability to change it. Any configuration changes must be done separately using a camera web interface.

PSIA

Physical Security Interoperability Alliance (PSIA) [3] is a global consortium of physical security manufacturers and system integrators. PSIA was founded in 2008 and it has broad focus, with specifications covering IP Media Devices (IPMD) for IP cameras, Recording and Content Management for recorders, Video Analytics, and Area Control for both access control and intrusion systems.

While the PSIA IPMD specification was implemented by a number of manufacturers, the adoption of PSIA for video has stalled. The last update of the IPMD specification was published in February 2010 and as of this writing (April 2014), the list of PSIA-conformant products includes approximately 200 cameras from 22 manufacturers and only 3 NVR/VMS systems.

ONVIF

Open Network Video Interface Forum (ONVIF) [4] is an open industry forum promoting and developing standards for IP-based physical security products. ONVIF was also started in 2008, same as PSIA, but it is significantly more active in the area of IP video. As of April 2014, the ONVIF website listed over 2800 cameras and over 100 clients conformant to the Profile S specification.

The initial ONVIF specification version 1.0 was released in November 2008 and covered Network Video Transmitters (cameras) and Network Video Clients. New versions of the specification are typically released every 6-9 months; the latest 2.4.1 version from December 2013 covers more features and an expanded scope including recorders, displays, video analytics, and access control.

In addition to the protocol specification, ONVIF also provides conformance tools that must be used to verify conformance of devices. The ONVIF Device Test Tool is updated every 6 months, in June and in December every year and each new release includes additional test cases and scenarios. As a result, the interoperability of ONVIF devices and clients has steadily improved over the past several years.

In December 2011, ONVIF introduced the concept of Profiles and released the specification of Profile S (streaming). A profile defines a set of mandatory and conditional features that must be implemented by any ONVIF device conformant to that profile. ONVIF clients must use the same features to integrate with ONVIF devices. Once a profile is published, it is guaranteed not to change, even if new ONVIF specification versions are released. The goal of this policy is to improve interoperability. For example, a Profile S camera based on ONVIF specification version 2.1 will work correctly with a Profile S recorder based on ONVIF specification version 2.4, because the Profile definition is fixed.

As of April 2014, ONVIF has released three Profile specifications:

- Profile S: Video and Audio Streaming
- Profile G: Recording and Playback
- Profile C: Physical Access Control

Profile S is now the de-facto standard for IP video, with over 2800 conformant devices. The adoption of Profile C for access control is just starting, the ONVIF website lists a single device conformant to Profile C, but multiple manufacturers have publicly demonstrated prototype Profile C devices and clients.

For Profile G, the profile definition has taken longer than expected, release candidate version 2.0 was published in March 2014 and it has not yet been finalized.

Best Practices

Given the evolution of IP-based security products and the emergence of open standards, this section describes best practices and provides recommendations to follow during security system design and implementation.

Interoperability Testing

The ONVIF standard, and especially ONVIF Profile S, provides an excellent baseline for interoperability of IP cameras and recorders. Most of the time, a Profile S device will work correctly with a Profile S recorder, out of a box. However, despite the extensive test tools and despite increasing maturity of the ONVIF standard, there is still some risk of encountering integration problems. To mitigate such risks, interoperability testing of specific camera and recorder combinations is very important.

Interoperability testing is frequently performed by manufacturers. Typically, the NVR manufacturer will publish a compatibility matrix of tested devices and their supported features. The list can be used to confirm that the camera and NVR combination has been tested and to confirm the set of integration features that have worked correctly.

In the ideal case, the specific camera model is explicitly listed in the NVR software, for example in a camera model drop-down list, to indicate that the manufacturers tested interoperability of this product combination and provide full integration between the camera and the NVR.

Native or Standards-based Integration

Many IP cameras support not only ONVIF, but also a proprietary protocol specific to that camera manufacturer. If the same protocol is supported by the recorder, it is possible to use native integration based on the proprietary protocol.

Native integration may provide more features, because there are fewer variations in cameras from a single manufacturer compared to a standard that covers devices from many manufacturers. However, there are risks even for native integrations, especially when new devices are introduced or when the proprietary protocol version is updated. Again, the risk can be mitigated by interoperability testing for the specific devices, exactly the same as integration testing based on a standard.

The advantage of standard-based integration is the added flexibility during system design. Some sites may require specialty cameras or have requirements that are best met by a mix of cameras from different manufacturers. Integration through ONVIF provides uniformity and consistent behavior for the overall system, although it is of course possible to use ONVIF integration for some cameras and native integration for other cameras.

IP Video Recommendations

- All selected cameras and recorders should support ONVIF Profile S, which is now the dominant open standard for IP video. This provides the best flexibility to select the most suitable products for each project. Individual cameras can be integrated either through ONVIF, or through a native protocol, if appropriate.
- The camera models should be explicitly listed in the NVR software, or explicitly listed as tested in a compatibility matrix published by the manufacturer.
- Testing or compatibility matrix data should confirm proper function of basic integration features:
 - Camera discovery to simplify installation. Rather than manually entering information for every camera, all cameras should be discovered automatically and can then be added by selecting from a camera list.
 - Video and audio streaming
 - Stream configuration such as setting resolution and frame-rate
- If the project requires additional features, such as Video Motion Detection alarms or Pan-Tilt-Zoom control, interoperability for such features must also be confirmed or tested.

References

[1] "RFC 2326: Real Time Streaming Protocol": <http://www.ietf.org/rfc/rfc2326.txt>.

[2] "RFP 3550: RTP: A Transport Protocol for Real-Time Applications":
<http://www.ietf.org/rfc/rfc3550.txt>.

[3] "PSIA website": <http://www.psialliance.org>.

[4] "ONVIF website": <http://www.onvif.org>.