

Adding Intelligence to an Existing CCTV System

Solution Brief



Too Many Cameras, Too Many False Alarms

In a world of data overload, video security and surveillance systems suffer from the same shortcomings - there are many more cameras than there are eyes to watch them, and the simple motion detection built into every modern device is restricted in its effectiveness because, by definition, it only detects motion.

Video Content Analysis, or VCA, offers hope in this overwhelming situation. Technology now exists that goes well beyond motion detection, and detects behavior instead. Do you really want an alarm to be raised every time someone steps into a bank's ATM vestibule - or only when they settle in for a long nap? Motion detection would trigger an alarm even when valid ATM users appeared, but loitering detection would use intelligence to understand the behavior of the person.

This kind of intelligence is unnecessary on all cameras: it should be applied selectively, using different kinds of behavior detection on different cameras. In addition, there are countless DVRs currently deployed with millions of analog cameras that depend on motion detection and these are often supporting a larger security system including an existing intrusion alarm panel which is centrally monitored. This solution brief introduces simple options to retrofit behavioral detection to existing systems, decrease the number of false alarms, and alert users to the threats they *really* need to know about. In particular, we describe a simple solution that is a true 'bolt-on' device, requiring no replacement of existing analog cameras, DVRs, alarm panels and the the monitoring station receiver and software, regardless of the manufacturer.

Embedded Analytics – The Game Changer

Bosch has a large automotive division, and for many years, part of it has focused on computer-assisted driving – more commonly known as Intelligent Video Analytics (IVA).

A few years ago, Bosch Security Systems applied this same R&D expertise to our CCTV division. As part of our strategy to create ever-smarter products, Bosch embedded intelligence into the actual IP camera, or IP video encoder. This means the IP camera has become self-sufficient, unlike other solutions that rely on stacks of PCs, analytics software, operating systems, and anti-virus software to process streams of video. The IP camera now has the intelligence needed to detect the most common behaviors we want to detect, such as loitering and objects left behind.

Bosch's IVA solution learns as it goes. It learns to ignore noise like rain and snow. It learns what the normal scene looks like so that it can raise an alarm if something is removed. It learns to do this 24x7, and if something changes, it adapts to that change and re-learns the "new" normal scene without any human intervention.

Because of this continuous learning and self-adaptation – and just like real people – the solution is not fool-proof. Because it develops by itself, it is not following a small set of simple "if-then" rules, so it is not 100% predictable. One option to further increase usefulness is to use a compatible recording system that can record details called metadata (effectively annotations) about everything it observes, so that it can be searched after-the-fact as part of a forensic search. This leverages the true power behind Bosch's IVA solution, but is outside the scope of this document which focuses on retro-fits to DVRs and Alarm Panels.

Extending Analytics into the Dark

In any intelligent video application, video images serve as raw data for software to process. As such, better images will produce better performance in IVA. Cameras, therefore, represent the front-end of the IVA system. The cameras' ability to produce high quality images - by day and at night - will help ensure optimal intelligence in the security application.

One field-proven effective technique for producing high quality images at night is to apply infrared illumination. Infrared illumination enhances the performance of day-night cameras, resulting in high quality surveillance video images under low-light and no-light conditions. In turn, the high quality video images help ensure optimal IVA performance by reducing false positives and false negative alerts.

Additionally, infrared illumination helps reduce night-time bit rates, typically often associated with automatic gain control. (AGC causes noisy images, which in turn causes high bit rates.) Therefore, using infrared illumination not only results in high quality low-noise images, but also lower bit rates for smoothly running networks.

Bosch Security offers stand-alone infrared illuminators and IVA-enabled cameras integrated with infrared illumination, both of which help extend analytics into the dark.

Common Configurations

Single camera retrofit

The power of embedded analytics can be used in various ways depending on the situation. At the simplest level, you could consider an existing system with fixed analog cameras and a traditional DVR. The figure below shows how to add IVA to one specific camera.

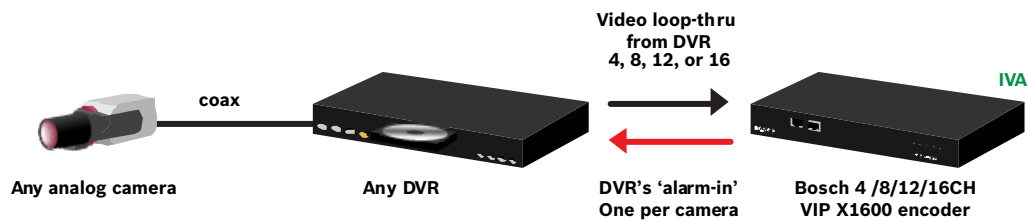


In this scenario, the video is simply looped through from the DVR to a single-channel Bosch encoder running IVA (such as the VideoJet X10). The encoder's relay output is triggered by the IVA, which is connected to the DVR's alarm input. The DVR is then configured to handle the IVA alarm. Bosch also offers these encoders in two- and four-camera versions. In the event that the IVA alarm needs to be detected by a central alarm monitoring station, the relay output from the encoder would go to the intrusion alarm panel instead of directly to the DVR. In some situations you may choose to have it go to both.

Multi-camera retrofit

Often, you have many more cameras that require IVA. In these instances Bosch offers 2 and 4 channel units which perform the same function, such as the VideoJet X20 and X40.

For larger systems the modular Bosch VIP X1600 encoder can be used to handle four, eight, 12, or 16 video "loop-throughs" from DVRs as shown below. Its modularity means that you can add 4-camera hot-swappable modules at any time to take you from 4 to 16 channels of analytics.



There are additional benefits that become obvious when the time comes to install and maintain your system. When compared to a PC-based VCA solution, we will assume an average of four cameras per PC for this example (the actual number may vary). A VIP X1600 has 16 inputs, so in this brief analysis, four PCs would be required to accept all 16 cameras.

Reliability

If reliability is critical, a VIP X1600 is an embedded device with four hot-swappable video modules, dual power supply inputs, and a fan (the only moving part, and even that will report an error if the fan stops). There is no hard drive. In contrast, four PCs would each contain fans, hard drives, single power supplies, and of course, an operating system.

Space

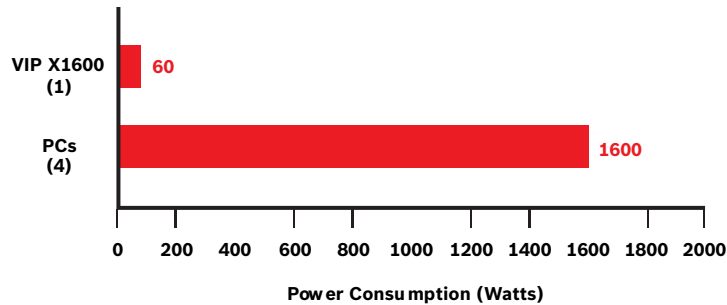
Is space important in your installation? In the above scenario— there are 16 channels of real-time video content analysis in a one-rack high unit. In comparison, a four-camera PC-based VCA system consumes 3RU per PC, for a total of 12RU for 16 cameras.

Total Cost of Ownership (TCO)

If your total cost of ownership is important, the picture shows no PCs. No PC-based VCA software or licenses. No operating systems or anti-virus software and regular patches. Estimates show that the true cost of ownership of a PC is equal to one to three times original purchase price – and that's just for one year!

Power and UPS

If your UPS system is already near capacity, you should know that a fully loaded VIP X1600 consumes about 60W, divided across 16 cameras. Typical PCs consume about 400W each – or a total of 1,600W for the 16 cameras in our example.

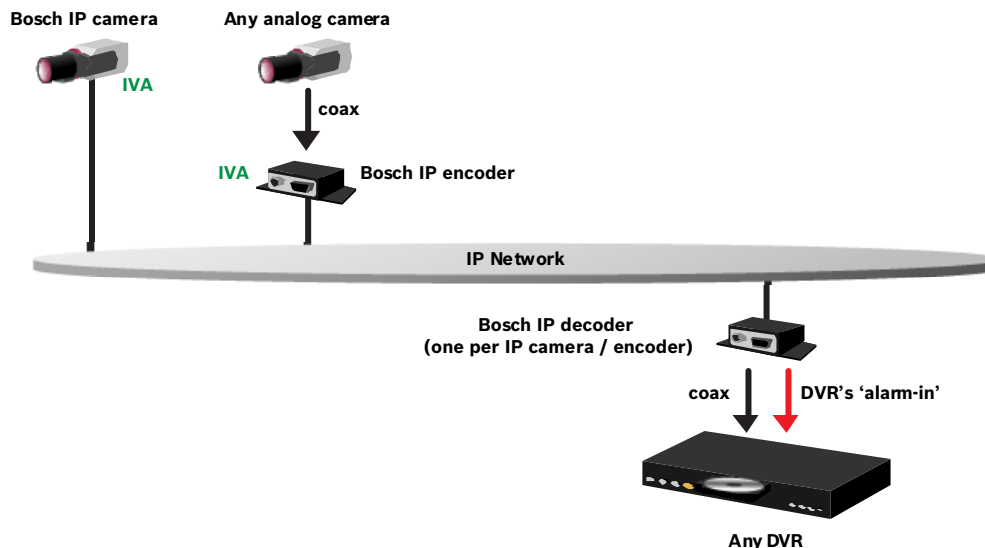


Cooling

In confined spaces, cooling can be an issue – and sometimes forces you to upgrade the air conditioning. A VIP X1600 generates about 205 BTU per hour, whereas four PCs will generate upwards of 5,500 BTU per hour.

Extending intelligence across the network

It's common to want to extend the reach of an existing DVR: one way to accomplish this is to use a network, especially one that has wireless sections. You can achieve this by using encoder-decoder pairs, or by using a Bosch IP camera paired with a decoder.



In this scenario, the cameras could be far away from the DVR, and the IVA running either inside the IP camera or the IP encoder at the remote location. Once an IVA alarm triggers the IP camera or encoder, it activates the decoder's relay output, which in turn triggers the alarm input on the DVR. It is a remarkably simple – yet effective and affordable – way to extend the reach, and intelligence, of your existing DVR.

IP camera as an intelligent sensor

In some cases, you want a DVR to be triggered by an IP camera with nothing in between. For example, Bosch's Dinion IP camera runs IVA, but instead of triggering a decoder, it can trigger its own relay output, which in turn can be wired directly into a DVR.

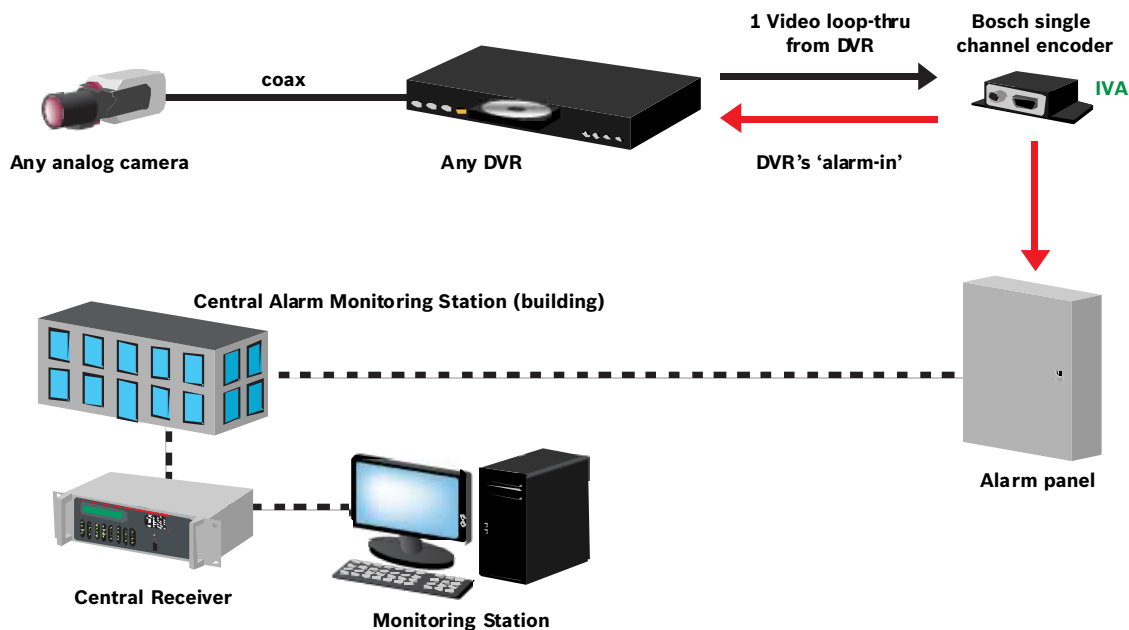


It seems remarkable to have an IP camera with no network in sight. Bosch's innovation in this area has been to move the intelligence to the "edge," which means that our IP cameras are intelligent in their own right. The IVA runs full-speed *inside the camera*, and the DVR simply takes advantage of its hybrid output capability.

Other alarm recipients

DVRs are not the only devices that need to know when something unusual is happening. In fact, in the case of remote alarm monitoring services, a DVR is probably not even connected to the burglar alarm panel or access control panel.

By connecting to an alarm panel instead of a DVR, or connecting the IP camera/decoder to both a DVR and an alarm panel, you can use IVA as a highly sophisticated sensor – one that detects behavior. Since it's video-based, it complements the myriad more conventional sensors.



The role of the PC

The only time an IP camera or IP encoder needs to be connected to a PC is to:

- Initially configure the device's IP address
- Initially configure the device's IVA parameters
- Set up the alarm triggers so that the camera triggers the appropriate relay output, whether it's in the camera itself or a remote decoder

After that, the PC can be switched off and removed.

Examples of what you can do with this technology

Scenario 1: Nothing should move

"Nothing is supposed to move in this area at night. I want to know if anything moves, except I don't want it triggered by the trees, random shadows, or adverse weather like wind, rain, snow, or leaves, within reason of course. I assume a hurricane will be picked up as a motion event!"

Motion+ is built into every Bosch Video Over IP device and features sophisticated motion detection and tamper detection. This is free of charge and independent of IVA.

Scenario 2: Illegal or dangerous parking

"I want to know if someone parks in an area where they shouldn't be, like an emergency exit, fire lane, or other restricted zones."

IVA can be configured to detect idle objects or objects left behind.

Scenario 3: Loitering

"I want to know if someone is loitering in a particular area. We're concerned about crimes like graffiti, vandalism, burglary, and drug dealing – or even people residing on doorsteps or taking a nap in our nice, warm enclosed ATM area during the night."

IVA can be configured to detect whether someone enters an area, and does not leave it within a specified time. A camera pointing at a wall or bridge where graffiti is common-place will detect people loitering in the vicinity. Because innocent people are expected to walk through the scene, it's important to configure delays so that a person has to loiter long enough to constitute a threat – otherwise, you'll be swamped with false alarms.

Scenario 4: Stealing and unauthorized removal

"I have two storage areas – one inside with boxes, and one outside with massive containers. I want to know anytime one of them is removed."

IVA can be configured to detect when part of the scene is removed. After it's removed and the alarm is raised, IVA automatically re-learns the new scene in preparation for the possibility that something else will be removed.

Scenario 5: Wrong direction

"I have separate and defined vehicle entrances and exits, but I know they're being abused – which has led to dangerous situations. We've been lucky so far but I want it to stop. I want to know when the rules are violated so that I can warn the offenders." IVA can be configured to detect when an object enters or leaves an area from the wrong direction.

Scenario 6: Speeding

"I have a parking lot where some people drive way too fast, which is causing a threat to our employees and visitors. I want to know when the speed limits are being abused so that I can warn the offenders."

IVA has filters for speed and size – so you can configure IVA to ignore all movement below a certain speed, and alert you when the movement is faster. IVA uses perspective to automatically compensate for the fact that remote objects appear to move slower.

Scenario 7: Trip-wire

"I have large fenced perimeter. I have some sensors on the fence, but I'd like to add some visual verification if someone crosses the perimeter line. I want to know when they're getting too close. I wouldn't mind knowing if someone leaves the public road around the outside and parks near the fence. That would be a perfect early warning system."

IVA can be configured to detect when an object crosses an imaginary line in the image. To improve reliability, draw two lines that have to be crossed before the alarm is raised.

Scenario 8: Ambush at doorways

"We have a controlled door that our receptionist can open remotely to allow people to enter when people hit the buzzer. The security guard operates this at night. Unfortunately we had an incident where at the end of the day the receptionist opened the door to leave but didn't know someone was hiding on the other side - it's fire resistant and partially opaque - not just plain glass. What made it more sad was that we had a camera on that side for security, so we even had it recorded but couldn't do anything to warn her. She has gone through that door perfectly fine every night for 5 years and there is no way she would bother checking a camera to see if it was safe. He assaulted her and broke in. No wonder the staff are frightened of walking around corners now."

By using IVA's tripwire on the external camera the receptionist or guard can be warned that someone is approaching to enter the building or other protected area like a suite in an office block, regardless of intent. This early warning is followed by the usual procedure of buzzing and requesting entry. However if someone approaches and hides you will still get this 'early warning'. Additionally you can use loitering detection to really raise an alarm if someone is hanging around the doorway when they shouldn't be. If you had used a motion sensor to do the same thing it would fire everytime someone enters and leaves the building, which rapidly becomes a nuisance and eventually ignored.

Scenario 9: Lonely outdoor location

"I have hundreds of cell towers spread out along the I-95. They're surrounded by open farmland and woods. Our technicians visit them for routine maintenance and occasionally for repair – usually following adverse weather. We're recording a few sites on motion-only using DVRs, but because the cameras are outdoors, they always seem to be recording. It could be the trees, leaves, rain, snow, or just shadows from clouds. And we're not sure, but we think we're getting much less than the seven days we were originally promised."

IVA is intelligent enough to ignore many different kinds of environmental distractions – which reduces the number of false alarms and increases its reliability. Fewer false alarms means less wasted disk space, so you'll have more retention time, or you could even increase the quality of the video (for example, to 4CIF resolution or 30 FPS) without using more space than before.

Scenario 10: Tampering

"We have a real problem in one area of the warehouse where someone keeps shifting the cameras away from their respective aisles. We know we're suffering from shrinkage, but we've never been able to catch it on film."



Bosch's IP encoders and IP cameras are intelligent enough to detect camera tampering. By analyzing the video, the device can detect when an entire camera has been moved to point in a new direction, when it has been spray-painted or hooded, or when a bright light is shining directly into the lens. As soon as it detects tampering, it can raise an alarm. Depending on how this alarm is handled, it could include making a PTZ camera jump to a preset and catch the event live.

Bosch devices supporting Intelligent Video Analytics







IP Cameras

NWD-0495		FlexiDome Day/Night IP Camera
NWD-0455		FlexiDome IP Camera
NWC-0495		Dinion Day/Night IP Camera, hybrid analog and IP outputs, relay output
NWC-0455		Dinion IP Camera, hybrid analog and IP outputs, relay output
AutoDome 100		AutoDome Modular 100 Series Day/Night Fixed IP Camera, relay output
EX71P		Low-profile, vandal Resistant, no-grip ceiling IP Camera
EX301P		350ft detection, single day-night sensor IP Infrared Imager Camera
EX361P		Corner Mount, vandal resistant IP camera
EX801P		200ft detection, dual sensor, standard resolution IP Infrared Imager Camera
EX821P		250ft detection, dual sensor, high resolution IP Infrared Imager Camera


IP Encoders

VideoJet X10SN		1-CH high-performance encoder with CF slot, relay output, 4 alarm-in and 4 relay-out
VideoJet X20SN		2-CH high-performance encoder with CF slot, 4 alarm-in and 4 relay-out
VideoJet X40SN		4-CH high-performance encoder with CF slot, 4 alarm-in and 4 relay-out
VIP X1600		4, 8, 12 or 16-CH high-performance modular encoder, 4 alarm-in and 4 relay-out per four-camera module






Rugged IP Encoders

VideoJet X10S		1-CH high-performance rugged encoder, 4 alarm-in and 4 relay-out
VideoJet X20S		2-CH high-performance rugged encoder, 4 alarm-in and 4 relay-out
VideoJet X40S		4-CH high-performance rugged encoder, 4 alarm-in and 4 relay-out
VideoJet X10S-H004		1-CH high-performance rugged encoder with 40GB HDD, 4 alarm-in and 4 relay-out
VideoJet X20S-H004		2-CH high-performance rugged encoder with 40GB HDD, 4 alarm-in and 4 relay-out
VideoJet X40S-H004		4-CH high-performance rugged encoder with 40GB HDD, 4 alarm-in and 4 relay-out

IP Decoders

VIP XD		1-CH high-performance decoder. 4 alarm-in and 1 relay-out
VIP XDA		1-CH high-performance decoder with audio, 4 alarm-in and 1 relay-out

Recording (optional)

iSCSI		iSCSI Disk Array
VRM		Video Recording Manager
BOSCH VMS		Bosch Video Management System
VIDOS		VIDOS Video Management System
ARCHIVE PLAYER		Software to playback, search, and export video