

How to select in-vehicle NVRs

By William Pao, asmag.com

What to Know About In-Vehicle NVRs

The in-vehicle NVR is suitable for a variety of use cases, from buses to delivery trucks to even garbage trucks. Since they are exposed to the outside environment, they should be strong and hardened, able to withstand various harsh conditions. In this article, we address some of the mobile NVR basics that SIs and users should know.

What Is an In-Vehicle NVR?

As its name suggests, the in-vehicle NVR is an on-board network video recorder which processes and stores video taken by IP cameras inside and around the vehicle. But its functions go beyond pure recording. It gathers various data about the vehicle – its location and its overall health – and integrates it with the video so that, should something happen, it leaves a detailed record of what happened. It also communicates with the control center, where the operator can have constant oversight of the vehicle and be able to retrieve video from the NVR when necessary.

“Aside from recording, in-vehicle NVRs take actions like pushing alarms and sending notification to remote monitoring devices – thus to call for rescue when emergency occurs. In-vehicle NVRs are capable of generating not only video data but also others information generated from a moving vehicle; ADAS system and onboard devices are among those to be integrated to get data for monitoring. With cloud server connected to the in-vehicle NVR, all data needed will be shown where they are wanted to be monitored,” said Lilian Yao, Sales Director at Deeplet.

“Mobile NVRs are designed for use in mobile or rugged environments working in demanding and harsh conditions to deliver high-quality surveillance solutions. It is specially designed for mobile video surveillance for different types of vehicles, such as buses, long-distance coaches, taxis, logistics vehicles, armored cars, private cars and external applications suiting public transport and law enforcement solutions,” said R. Nandakumar, Founder of Active Total Security Systems.

How Does an In-Vehicle NVR Work?

Needless to say, the in-vehicle NVR constantly records video taken by onboard IP

cameras. Due to wireless bandwidth constraints (even in 4G) and the cost associated with bandwidth usage, video is not transmitted to the central station all the time. Rather, only small packets of data, for example the vehicle's location, its overall condition and the health of the NVR itself (Is it recording? Are there any IP camera gone offline?) are constantly transmitted to the central station for monitoring purposes. Should an accident happen, the central station can retrieve relevant video – footage at the moment of collision and 30 seconds leading up to it, for example – from the mobile NVR; only during then will video transmission take place.

The mobile NVR has a storage capacity limitation. At the station, the video should be archived in a server for long-term storage. "Usually the archiving is done through Wi-Fi. The user should however beware that there might be a lot of video data to be archived, and the NVR will consume too much power from the battery when the vehicle is not ignited. As result, it's usually the case only important video data is archived, and this needs to be defined by the user," said Duncan Chou, CEO of Altasec.

What Features Should an In-Vehicle NVR Have?

As opposed to a commercial NVRs, an in-vehicle one must be strong and hardened to withstand different harsh conditions. In an extremely cold climate, for example, the mobile NVR should have a heater that heats the device to a certain level before activation, lest damage to the hard disk. It should be fan-less, as the fan can be easily damaged in an outside environment. Further, the NVR should be able to work in a wide power range to suit different vehicles.

"Some vehicles are equipped with power converters that provide AC power, but in many cases, 12V DC from a battery is used to power all the equipment. Battery power can vary, so the NVR and the other equipment require a wide voltage operating range. The battery used for NVR and other equipment shouldn't be used to start the vehicle. Using the same battery can cause power spikes that could damage the equipment," said Bob Mesnik, President of Kintronics.

According to Nandakumar, hardware-wise, an in-vehicle NVR should include the following features:

- Anti-vibration: When the vehicle is running on the road, the on-board shock and vibration are the main causes of HDD damage and video footage loss.
- Temperature protection: Working temperature should be -30°C (heater optional) to +60°C to cater to extreme working conditions inside the vehicle.
- Water- and dust-resistant: Since the in-vehicle NVR is often exposed to outside conditions, this feature is important, with IP69K-rating being ideal.
- G-Sensor: Built-in G-sensor can help users to detect the vehicle turnover and collision immediately.

Finally, it's vital for the in-vehicle NVR to have power-off protection. In this regard, a super-capacitor is often used. "In an accident, the video at the moment and leading up to the accident is the most important and critical. So we must make sure this data is kept in the hard drive," Chou said. "That's why a good mobile NVR should have a super capacitor. In the event of an accident and the power is gone, the super capacitor will squeeze out extra power that lasts 5 to 15 seconds to enable the writing of the data to the hard drive."

What Applications Are In-Vehicle NVRs Suitable for?

In general, any agency or end user entity that has the need to centrally manage a fleet can benefit from in-vehicle NVRs. Buses of course are a major application. Besides that, there are other use cases as well, including:

- School bus: School buses often rely on mobile surveillance, including in-vehicle NVRs, to keep students safe. "In Europe and North America, a lot of school buses use mobile NVRs. In those market, schools have outsourced school bus services to Internet of Vehicle companies, which need to manage the individual buses. They then turn to in-vehicle NVRs for easier and more effective management," said Kevin Cheng, Senior Manager for Sales and Marketing at 3S System Technology.
- Delivery trucks: Delivery trucks can also benefit from the in-vehicle NVR, which serves as a tracker for the vehicle whose status and position can be known to the operator.

- **Garbage trucks:** Garbage truck operators often rely on in-vehicle NVRs for protection and management. “Garbage truck operators use mobile NVRs to protect themselves and others. There are rollers at the back of the truck, and typically two cameras are installed, one on each side. This way, if someone throws the wrong stuff into the truck, or there’s an injury, there’s recorded video for post-event investigation. Plus, if the operator wants to manage their trucks, the NVR can come in handy as well,” Chou said.
- **Police cars:** Police rely on in-vehicle NVRs while in the line of duty. “Police cars have on-board automatic numeric plate recognition (ANPR) and registration/footage for law enforcement and parking-fee enforcement in city areas. Here a moderate storage capacity for the NVR is sufficient,” said Walter Verbruggen, Sales Director at AVUTEC.

What Intelligent Features Are Available for In-Vehicle NVRs?

More and more, mobile NVRs have the processing power for certain analytics, which can help with driver/passenger safety, operational efficiency and law enforcement. These analytics include the following:

- **People counting:** The operator may need to know the number of people on the vehicle for safety and operational purposes. “People counting applications vary according to the use case. For example, a bus operator might want to control the number of people on each vehicle amid the pandemic. Or, the bus operator might want to find out which station has more people getting on, and during which hours. They want to analyze these data for related planning in the future,” Cheng said.
- **Technology-based law enforcement:** These can help detect individuals or objects that should not be in a vehicle’s way. “In combination with the IP camera and object detection analytics, the mobile NVR on the bus, for example, can detect an object at the bus stop that’s not a bus – for example a four-door sedan. This data then can be provided to the police for enforcement and fine issuance,” Cheng said.

- ANPR: Law enforcement officials need automatic numeric plate recognition in their mobile NVR to identify suspicious vehicles, stolen vehicles or illegally parked vehicles.
- Behavioral prediction: According to Sanjay Kumar, Chairman of Railway Recruitment Board, Indian Railways, the in-vehicle NVR GPU can power behavioral prediction analytics that allow for quicker response times. “Behavioral predictive algorithms identify signs of distracted or impaired drivers on the road sooner, gradually allowing truck drivers more warning. In-cab cameras capturing driver behavior and in-vehicle NVR computers implementing a robust mix of analytics can even collate vehicle telematics like speed, positioning and braking with images of the person behind the wheel to note signs of dangerous driving in the truck drivers themselves. Algorithms used to identify facial features can easily detect signs of drowsy or sleeping drivers, prompting an alert to rouse the driver and direct them to take corrective action,” he said.

It needs to be mentioned that when it comes to analytics in an onboard device, privacy is an issue that needs to be considered. “One of the main issues within Europe is the GDPR (privacy) compliancy. Things like facial recognition are more of a concern than a feature. So even smarter things will be required, like flexible face blurring, synchronised time server based stamping, activation only when a certain object is detected, et cetera. So it needs an almost infinite flexibility for many variable requirements,” Verbruggen said.

How Do You Select the Right Mobile NVR?

This again depends on the user’s own application scenario. Typically, from a user’s perspective, the things to look for when selecting an in-vehicle NVR include the following.

Number of channels: The number of channels is directly linked to how many IP cameras connected to the mobile NVR. “This shall be considered according to the project scope, budget and actual installation environment,” said Gary Chien, Senior Product Manager for Intelligent Edge Computing BU at Lanner. “For example, a taxi



may only need four cameras, transit bus may need eight, and train cabin properly needs 16.”

“It all depends on the function and size of the vehicle. For example, passenger bus drivers are required to watch out for passengers and pedestrians all at the same time. Cameras will be needed in all exits/entrances to make sure doorways are cleared before closing the doors. All blind spots alongside the car body, should be watched by cameras,” said Yao.

Type of storage: Today’s mobile NVRs mostly use hard disk drives. For users who have more budget to work with, they can consider SSD, which has more reliability and less power consumption. For users with less budget, they can opt for SD cards for recording purposes.

Others: Different in-vehicle features and requirements apply to different users. “Many of the hardened NVRs don’t have all the features of standard NVRs, so the system integrator must ensure that the model they choose includes the capability they need. For example, you may require a joystick to control the PTZ camera or PoE network connections for the cameras. Some applications may request a wireless connection (Wi-Fi/3G/4G) from the mobile unit to a command station,” Mesnik said. “We have sold mobile NVR units that are used for surveillance in police vans. These systems are used as mobile command control centers. They usually include a specialized PTZ camera that is placed on an extendable tower. The camera is controlled using a joystick so the NVR must be able to support this option.”

Kumar mentions cash-in-transit vehicles. “These vehicles are also critical fleets as they transport valuable assets like cash, jewelries and other valuable assets,” he said. “Therefore, it is a mandatory procedure to reduce the risks of robbery, theft and unidentified personnel, while securing the vehicle and the assets in it. Due to the security concerns towards hijacking, robbery, or theft, the NVR computing gateway shall have essential functions like IP camera connections, visioning technology, fingerprint identification access control and anti-tailing detection incorporated and enabled by the in-vehicle computer gateway to secure the vehicles and assets.”

How Should an In-Vehicle NVR Be Installed?

According to Kumar, installation of an in-vehicle NVR system is different for various types of fleet, yet the common among all is to get the power supply from vehicle power source and to connect various vehicle sensing devices for data logging and telematics analysis. That said, he provides the following tips for installation:

- The NVR should be connected to a fuse box in the passenger compartment before it is connected to the vehicle battery, and the fuse in a fuse box should be UL listed as an automotive fuse.
- The system must be disconnected from all sources of power and the power cord removed from the power supply module(s) before accessing the chassis interior to install or remove system components.
- Do not run signal or communications wiring and power wiring in the same routing conduit. Wires with different signal characteristics should be separately routed.
- The product should be mounted on a properly grounded mounting surface, such as a metal equipment panel. Since NVR is designed to perform without a cooling fan, it is recommended that it should be installed with at least a 5mm clearance on all sides for heat dissipation.
- The user can connect the wiring through the vehicle electrical panel. When connecting to the chassis ground, it is important that the user is connecting to a grounding point that is not rusted. If connecting to a non-steel ground screw, resistance can be high causing problems with voltages supply.

What Cybersecurity Features Should the In-Vehicle NVR Have?

Being a networked device, the in-vehicle NVR is as much subject to cyber threats as other end points on the Internet. The cybersecurity of the mobile NVR, then, becomes important. Passwords used to log into the device should be encrypted, and so should be the video stored in the device.

Other best practices should also be employed. “The user should secure in-vehicle communications using mature COTS (commercial off-the-shelf) cryptographic products for primary functions such as onboard network segregation, intrusion detection, or data filtering. They should also maintain security over time using surveillance techniques such as continuous vulnerability management or firmware and software updates using out-of-band channels,” Chien said.

asmag.com Editor’s Choice of Top 10

In-Vehicle NVRs

In-vehicle network video recorders are devices that record video from onboard IP cameras as well as ingest different vehicle data, which is sent back to the central station for monitoring and management. Since they are exposed to the outside environment, in-vehicle NVRs must be ruggedized and hardened to withstand harsh conditions. Below please find a&s editor’s choice of Top 10 in-vehicle NVRs based on the popularity of web search and mentions by buyers. They are listed in alphabetical order.

3S F20321 NVR for ATM or In-Vehicle



With input and output bandwidth of 320Mbps, 3S’s F20321 NVR features an Intel i5 processor with 8GB memory. It has operating temperature of -40°C to 55°C, with humidity of 5-95% RH. These features make the NVR ideal for various harsh conditions, including in-vehicle and ATM.

Key features:

1. USB3.0 x 6

2. 16 Isolated DIO: 8 DI, 8 DO
3. Support 2.5" SSD/HDD x2

AAEON VPC-3350S Fanless In-Vehicle/Industrial NVR



The VPC-3350S Mobile NVR from AAEON offers the Intel Atom x5 E3940 processor as standard, with options for Pentium N4200, Celeron N3350 and Atom x7 E3950. The four PoE ports allow the system to connect to a wide range of devices. Its modular design offers flexibility, customization and fast deployment.

Key features:

1. Fanless system
2. 204-pin single channel DDR3L 1866 MHz SODIMM up to 8 GB
3. Intel integrated graphics engine supports two display by HDMI x 1, DP x 1

Advantech ARK-2121V In-Vehicle NVR w/4 PoE Ports



The NVR features up to 4 x 10/100 Mbps – 4 ports full-load, IEEE802.3af Class 2 (7 Watt) and 2 ports full-load, IEEE802.3af Class 3 (15.4Watt). It features extended temperature peripherals of up to -40 to 70° C with relative humidity of 95 percent at 40°C, making it ideal for in-vehicle applications.

Key features:

1. Intel Atom E3825 dual core 1.33 GHz & E3845 quad core 1.91 GHz SoC
2. Diversity communication abilities, for example WWAN, WLAN
3. Intelligent vehicle power ignition

Arcdyn 8 Channel Vehicle NVR



Arcdyn, is a US distributor of security and access control equipment. Its 8-channel vehicle NVR features 8 IP channels of audio and video inputs; each channel supports up to 1080p resolution with H.264 encoding technology. The device is equipped with ignition start and 24-hour scheduled startup/shutdown.

Key features:

1. User-friendly GUI providing easy and flexible operations
2. Supports connecting 8 IP Cameras through PoE ports on back.
3. Two HDD/SSD hard disks with 1T capacity can be plugged for data storage.

Deeplet DM-6012H Hybrid MDVR



Deeplet's DM-6012H hybrid MDVR is ideal for all kinds of vehicles and suitable for safety driving and drive recorder applications. It has up to 16CH for IP Cam/AHD/TVI/CVI and allows simultaneously record, playback and backup. H.265/H.264 video compression is also available for bandwidth management.

Key features:

1. 1-Din design
2. Low power consumption
3. Detachable DVR host

Lanner V6S 10-Port PoE Fanless Vehicle NVR



Designed for public transit video surveillance, V6S can operate under wide temperature range (-20~60°C), indicating good reliability under harsh conditions. The NVR also offers 2 removable 2.5" HDD/SSD drive bays for the storage of recorded footages. For wireless connectivity, V6S supports both Wi-Fi and 4G/LTE.

Key features:

1. Intel Core i7-7600U Dual Cores Processor
2. MIL-STD-810G and E-mark certified
3. 10x PoE (supports 5x PoE+) and 1x GbE RJ45 ports

LEX 3I610NM In-Vehicle NVR w/ 4 x PoE



The LEX 3I610NM is based on Intel 6th/7th Skylake/Kabylake U processor, integrated

Nexcom NViS 3720 Mobile NVR Surveillance Fanless System



NViS 3720 features the Intel Core processor i7-4650U allowing users to adapt to what they need in any surveillance application. The Intel HD graphics 5000 engine enables users to take advantage of a wide variety of display I/O configurations. The NVR is also equipped with 2 externally accessible SSD/HDD trays allowing easy swapping.

Key features:

1. Intel Core processor dual core i7-4650U
2. Three SIM cards + dual WWAN modules support
3. Dual externally accessible SATA 3.0 SSD/HDD

Streamax A5-E0804 (V5.0) Mobile NVR



Streamax's A5-E0804 (V5.0) is a function-extensive equipment specially designed for mobile surveillance. It uses high-speed processor combined with H. 264, network and GPS locating technologies, delivering high definition video recording and vehicle driving information recording.



Key features:

1. Supports GPS for location tracking
2. Supports WIFI for video files download
3. Built-in 3G/4G for live view and remote management