STRATEGYANALYTICS

Why AI Processors Matter

How to Select the Best AI Dash Cam for Your Fleet

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Introduction

There are many dash cam vendors on the market today that claim to leverage Artificial Intelligence (AI). However, not all dash cams are created equal due to the AI processors that power them.

All too often, limitations of AI processors don't reveal themselves as shortcomings until after the investment has been made and dash cams are already deployed in the field (note a trial experience is an easy way to identify these shortcomings immediately). These limitations can include a dash cam that gets too hot and malfunctions, completely misses the vast majority of unsafe driving behaviors, or simply generates very few accurate alerts.

That's why leaders overseeing commercial vehicle fleets must take a deeper look into the technical specifications of AI processors used in popular dash cams prior to making a long term investment in a safety technology. The right AI processor can significantly impact a dash cam's performance, power efficiency, and behavioral detection — and as a result, transform the way fleets manage driver safety and proactively prevent accidents. The best AI dash cams are an investment on spend for fleets rather than a cost. They should more than pay for themselves within the first year of the investment — whether from lower insurance costs due to safer driving, or from preventing costly accidents.

In this white paper, Strategy Analytics will detail a more technical approach for how to evaluate dash cams by looking at the characteristics of the AI processors that power them. Armed with this information, fleets will be able to take a more sophisticated approach to their dash cam evaluation process in order to choose the right safety partner for their business, and achieve maximum ROI.

How to Evaluate an AI Processor

After a thorough evaluation of the AI processors used in popular dash cams, Strategy Analytics determined key characteristics that impact dash cam performance, power efficiency, and behavioral detection.

An industry-leading AI processor used in a dash cam should have the following characteristics:
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1 ◦ Excellent real-world performance, allowing multiple AI models to be run on the edge simultaneously for faster and more accurate detection of high-risk behaviors

2 ◦ Very low power consumption (typically <5W for a dash cam's AI processor) to improve performance and reliability

3 ◦ A powerful image processing pipeline for creating clearer image quality and capturing more actionable data

4 ◦ Robust developer support from the vendor for custom AI models, leading to improved behavior detection and faster feature deployment

5 ◦ Strong price-to-value ratio and a wide range of chips to help control long-term costs and ensure maximum ROI

AI
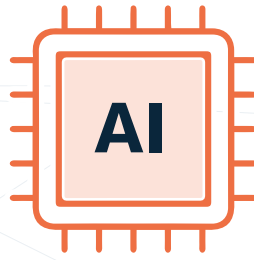
Industry-leading AI processor

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Excellent real-world performance + **Low power consumption** + **Powerful image processing** + **Robust developer support** + **Strong price-to-value ratio**

In the following 5 sections, Strategy Analytics will cover each of these characteristics in depth. An evaluation framework is included on page 17 to help you find the right safety technology for your business.

I.

Excellent Real-World Performance Means Faster and More Accurate Detection

An AI processor used in a dash cam should deliver on excellent real-world performance in order to accurately detect unsafe driving behaviors. To achieve higher performance on the road, fleets should ensure that their AI processor can run multiple AI models in parallel. This not only means **more precise and accurate** detection of high-risk behaviors (like cell phone use and close following); it means **faster** detection of those behaviors. This AI-based accuracy and speed is critical to providing the real-time insights needed to prevent

accidents. Running multiple models in parallel also means fewer missed behaviors, and fewer false alerts since the models can leverage additional context into what's happening on the road to make the right decisions.

A common industry practice leverages a complex chaining approach, where AI models are run sequentially rather than simultaneously. If the AI processor used in a dash cam is unable to run multiple models in parallel and chains models instead, you may run into a few issues:

- Error rates will increase dramatically
- Models are more difficult to maintain due to the linked complexity
- Your fleet may miss out on the accuracy and speed needed to detect high-risk behaviors on the road in real-time

There are a few ways fleets can determine whether their AI processor can run multiple AI models in parallel. Fleets should plan to look for a dash cam vendor with an AI processor that leverages its own in-house algorithm design with its own IP. That type of architecture should ensure that the dash cam hardware is kept 80-90% occupied during real-world workloads, such as analyzing video footage or detecting behaviors. An AI processor that is highly occupied during real-world workloads is more efficient and likely to capture more behaviors.

Some other architectures on the market, such as the DSP-based Qualcomm Snapdragon processors, can stumble with these real-world problems. They need to continuously send information back-and-forth between the processor and memory. As a result, the processor often sits idle while it waits on memory. Unfortunately, power is still being consumed during this idle process — meaning the dash cam completes less work for each watt of power expended. This can mean slower detection, less accurate detection, fewer features, or a combination of all the above.

Cell Phone Usage Detected
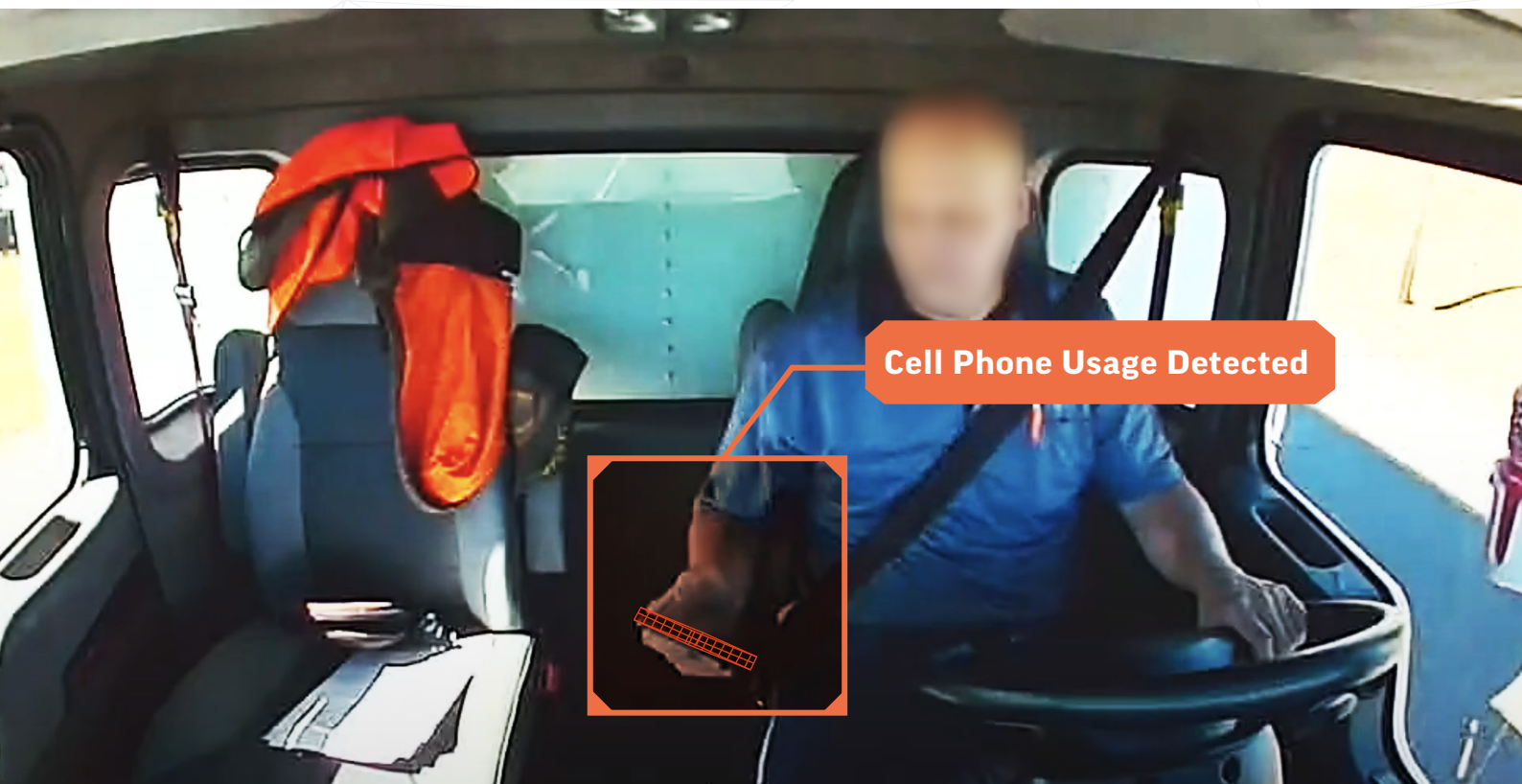
Fleets should also look for a processor that optimizes memory bandwidth usage to allow for a higher throughput. A higher throughput will result in a higher number of inferences per watt. These inferences are part of the AI algorithms that make decisions based on the data they see — for example, "this driver is using a cell phone"; or "this driver is following too closely." More inferences per watt is an excellent value add for fleets, and an AI processor with this type of high performance-per-watt can run multiple AI models in parallel.

Another feature to look for in an AI processor is if it allows "sparsification." This is a technique applied while an AI model is being trained to continually restructure it and reduce its complexity, removing redundancies and overlapping connections in the data that might slow down detection. This is one of the key ways to reduce power consumption for a dash cam, without affecting the accuracy of detection.

2.

Low Power Consumption Improves Performance and Reliability

A fleet of vehicles has engines that can generate tens or hundreds of kilowatts of power, fed by fuel tanks that store huge amounts of energy. Therefore, it may not be immediately obvious why fleets should be concerned about the power consumption of their dash cam processor.

Power consumption matters because it's not about the power as much as the heat that the power inevitably creates. An automotive windshield is one of the toughest sites to place an electronic device like a dash cam because of the heat from the sun. The temperatures immediately behind the windshield can easily reach over 150°F for a vehicle in the summer. Adding in a lot of extra heat from a power-hungry processor means fleets may have to throttle-back the dash cam's performance on hot days. In a worst-case scenario, the dash cam may not be able to run at all.

Another factor to consider for a processor with high power consumption is that it will require cooling down. A dash cam that needs a fan to actively cool its processor can be noisy, and requires ventilation holes that can clog over time. Active cooling introduces an unwanted potential failure mode from a dash cam — which can not only be expensive to replace, but can cause significant vehicle downtime. Inadequate or faulty cooling can also be a safety hazard — the camera may shut off or distract drivers, negating the benefit of it being installed in the first place.

A long-standing automotive rule-of-thumb is that a device mounted on the windshield should not exceed a total power consumption of around 10W. Fleets should look for a dash cam that only dissipates less than 5W for the AI processor — however, anything in the 2-3W range is ideal. A lower consumption from the AI processor means the remaining watts of power (totaling to 8-10W max) can be applied across other functional areas of the camera — such as image sensors, memory, and audio — for improved performance.

A low power consumption also helps the AI processor to perform its operations more efficiently — it can run the same processing tasks, but in a lower power envelope. This then leaves plenty of headroom for the dash cam to operate in a smaller, sophisticated device size and shape for ease of use. It also means the device will be able to operate across a wider temperature range.

3.

Powerful Image Processing Pipeline Creates Clearer Image Quality and Captures More Actionable Data

The AI processor used in a dash cam can significantly impact the quality of the video and images it captures. In order to capture the highest quality visuals, fleets should look for a dash cam powered by an AI processor with an excellent image processing pipeline.

The image signal processor (ISP) behind this pipeline should be able to handle and enhance many different situations. If your AI processor has an excellent image processing pipeline, your fleet should see excellent image quality even in challenging lighting scenarios, such as nighttime or when exiting a tunnel (where the foreground can be in deep shadow and the tunnel exit is bright sunshine).

If your AI processor has this type of high performance, the data coming from your dash cam can be processed in multiple different ways. This is important because humans and computers see things differently.

- One processing pass could be used to process the data for human consumption – creating the best-possible looking videos for fleets to review (as well as the safety vendor's own in-house safety team, if applicable).

- Another pass could process the same data for optimal image recognition accuracy by embedded computer vision algorithms, leading to smarter detection of high-risk behaviors and dangerous situations.

An AI processor with a robust image processing pipeline can capture more actionable data from each dash cam video frame. Any dash cam that leverages an AI processor with robust processing power can use this actionable data to continue to train its AI models, ensuring that the product continues to improve its precision to help with accident prevention.

Better image processing can also lead to better in-cab performance of the dash cam. This means the dash cam is not as reliant on help from the outside, and it can intelligently select the data that it needs to send to the cloud. The result is reduced cellular data costs and excellent performance in areas with poor connectivity.

4.

Developer Support For Custom AI Models Leads to Improved Detection and Faster Feature Deployment

For safety technology companies that build dash cams, the AI processor vendors they partner with can fall into one of two camps:

○ Some vendors just want technology companies to buy the chip. They may offer some support for code examples — but once a deal is signed on the dotted line, technology companies are largely on their own. Companies may have the desire and capability to develop their own custom AI models, but without support from the AI processor vendor, those models may lack quality or take years to mature to a high level of performance.

○ Others don't just want technology companies to buy the chip; they want technology companies to buy into their entire software ecosystem. There's a huge amount of functionality and code, but all of it needs to be paid for — and ultimately, that cost gets passed on to customers.

○ If the features offered by AI processor vendors don't meet the precise needs of the technology company, then technology companies could be out-of-luck, as the "black box" nature of the platform means there is no insight as to what goes on inside it. This lack of knowledge can stifle technology companies' attempts at creativity, because they may not be able to get access to the data they need to build the additional features their customers request.

The right AI processor should operate in a sweet spot between these extremes. The AI processor vendor should offer developer support to the dash cam provider, while still allowing the dash cam provider the freedom to develop its own AI models. More developer support from the AI processor vendor creates faster development cycles. This means that the AI models can be deployed at a faster rate, leading to more model improvements and more detection of high-risk behaviors. The ideal dash cam vendor should be partnering with their AI processor to deploy model improvements on a weekly basis.

Developer support results in:

Faster deployment of AI models

More detection of high-risk behaviors

Model improvements
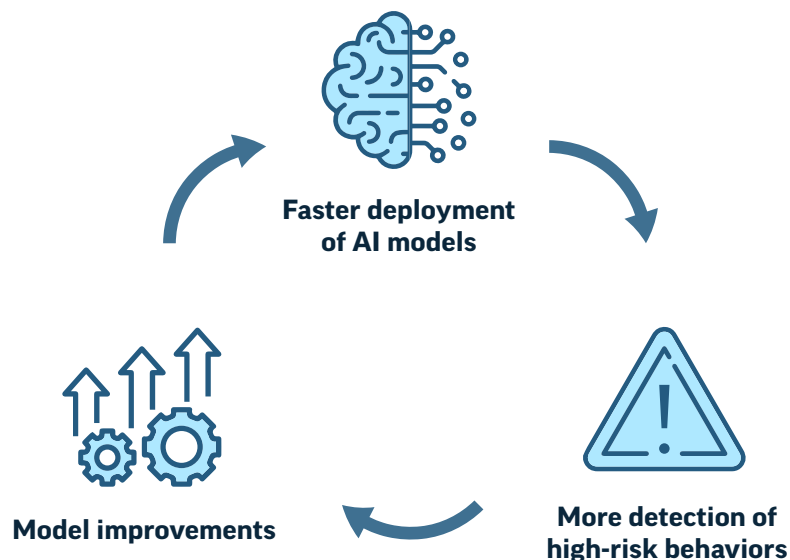
A leading dash cam will not rely on the generic, off-the-shelf AI models offered by their AI processor vendor. These types of out of the box models may not offer the optimal performance needed by fleets, and limit future customization.

Instead, fleets should look for a dash cam vendor that has developed their own bespoke neural networks in partnership with their AI processor. With this toolset, dash cam vendors can develop AI models specifically built and trained to detect the most unsafe behaviors that cause accidents, like cell phone use and close following.

5.

Strong Price-to-Value Ratio and a Large Range of Chips Help Control Long-Term Costs

AI processors can be extremely costly. A more expensive AI processor significantly raises the price of the dash cam it's embedded in — and that cost is passed through to the fleet purchasing the dash cams.

Fleet should look for a high performance AI processor that doesn't need complicated power circuitry. This significantly reduces bill-of-materials (BOM) costs, without compromising on quality of behavior detection. The end result is a dash cam that is not only more powerful when it comes to edge computing; it's also one that is more affordable for fleets.

A key factor for fleets to evaluate is if the safety vendor can continue to improve its technology with over-the-air (OTA) updates on the dash cam hardware and the AI processor inside it. Selecting an AI processor that supports updates in this OTA format increases the velocity at which fleets can deploy new technology across their fleet, and increases the speed at which they can start using new, incremental functionality. That means that when new features and behavioral detections are available, they can be seamlessly added to the dash cam via OTA updates without any disruption in service for fleets.

An AI processor with a robust ecosystem will also help control long-term costs for fleets. With a vendor that has a flexible infrastructure for their AI processors, safety technologies will not need to re-write any of their AI software when the newest AI processor comes out. This means less change management for fleets; older dash cam devices will not need to be swapped out when a new AI processor is released because the previous AI software will simply be mirrored onto the new chip. In addition, the code running on the ISP, which converts the raw camera data into the final image, can be carried over from one chip to another. Fleets should look for an AI processor vendor that offers a range of chips — this will provide the dash cam vendor with a number of price-performance points to build future products around.

This platform longevity helps control long-term costs and ensure maximum return-on-investment for fleets when it comes to safety.

Conclusion

In looking at the various AI processors available on the market, Strategy Analytics believes that the Ambarella CV22 processor excels in all five areas outlined above. The AI processor has:

1 Excellent real-world performance, allowing multiple AI models to be run on the edge simultaneously for faster and more accurate detection of high-risk behaviors

2 Very low power consumption to improve performance and reliability

3 A powerful image processing pipeline for creating clearer image quality and capturing more actionable data

4 Robust developer support for custom AI models, leading to improved behavior detection and faster feature deployment

5 Strong price-to-value ratio and a wide range of chips to help control long-term costs and ensure maximum ROI

Ambarella CV22 processor

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Excellent real-world performance + **Low power consumption** + **Powerful image processing** + **Robust developer support** + **Strong price-to-value ratio**

The best AI dash cams should be an investment on spend for fleets, not a cost. Ambarella's cost-effective, high-performance AI processor, coupled with the custom-built, high-quality AI models can help prevent accidents and reduce costs for larger fleets to drive quick returns on their investment.

Using the Ambarella CV22 processor at the heart of a dash cam gives it the low-power, high-performance platform that it needs to be the premier dash cam solution for large vehicle fleets.

Evaluation Framework

As we just reviewed, the AI processors used in dash cams can significantly impact performance, power efficiency, and behavioral detection. To help you uncover the right safety technology for your business, Strategy Analytics recommends the following two strategies:

Head-to-Head Trial

One of the best ways to quickly identify any shortcomings with an AI processor is to trial dash cams head-to-head. This will easily demonstrate the speed of alerts, accuracy of detection, whether or not the dash cam generates false alerts, the quality of the video footage and visuals, and the dash cams' compute efficiency. It is important to trial the different dash cams in the same vehicle at the same time, so you can experience how accurately they're able to detect behaviors side-by-side. For example, when you mount cameras next to one another, you will be able to see the speed and accuracy of detection for the same event (ex - dash cam #1 may detect and alert driver about the behavior in <5 seconds; dash cam #2 may alert in <25 seconds, or completely miss the behavior). Pay close attention specifically to detection for cell phone use and close following, two of the most dangerous driving behaviors.

Evaluation Questions

Whether before, during, or after your trial, we recommend asking the following questions to dash cam vendors in the evaluation process. Their responses about the dash cam device and the corresponding AI processor used in the device can help you uncover the right safety technology for your business.

Real-world Performance

⊙ **Can their dash cam's AI processor run multiple AI models simultaneously?**
If not, the performance may not be what you need to accurately and precisely detect and alert drivers of high-risk behaviors in real-time. This can result in missed behavior detection, or false alerts.

⊙ **How occupied is the hardware during real-world workloads?**
If the device is less than 80-90% occupied, your device will waste power, and possibly miss out on quick, accurate detection of high-risk behaviors.

⊙ **Does the AI processor allow for "sparsification"?**
If not, your detection will be slower and less accurate.

Power Consumption

⊙ **How is the dash cam device cooled?**
If the device requires active cooling, that means the processor demands too much power. This can result in a higher risk of mechanical failure from the dash cam — which can not only be expensive to replace, but can cause significant vehicle downtime.

⊙ **How much power does the AI processor consume?**
If it is more than 5W, there isn't a lot of room for power to be applied across other areas of the camera — resulting in compromised image sensors, memory, and audio.

Image Processing

○ **Can their processor's ISP do multiple passes on the same data?**
If it can not, you can expect images with burnt-out highlight areas, or very noisy shadows. These are signs of a poor ISP, which results in less than ideal image quality.

○ **Does the vendor have an in-house team of safety experts that reviews every dash cam video for real-time labeling and performance assessment?**
If not, your AI detection may not be as accurate without the continuous model training. Your dash cam footage will also not be enriched with the contextual information you need to coach, and you may not catch failure modes.

Developer Support

○ **Has the dash cam developed their own bespoke AI models in partnership with their processor vendor?**
If not, your dashcam may miss some of the most unsafe behaviors that cause accidents (like cell phone use and close following) because out-of-the-box models have not been specifically built and trained for these high-risk behaviors. Your dash cam vendor also risks not being in control of what they can develop, which can stifle any future customization to meet your fleet's needs.

Price-to-value Ratio

○ **What's the plan for the future? How will they continue to support your business in the coming years?**
If there is not a platform approach, be aware that there may be additional long term costs, limited functionality, and change management issues with dash cam devices.