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x86 vs ARM in Tomorrow's Vehicle Cabin: Reimagining In-Vehicle Infotainment

For the modern vehicle, onboard compute and graphics processing requirements are projected to climb at a staggering rate in the years ahead, fueled by a foundational change in the way we use automobiles.

As vehicles are assigned higher levels of autonomy, the forms and functions that have defined our automobiles for almost 150 years will forever change, at a time when media entertainment – games, TV, movies, music and more – is deeply pervasive in our lives and always accessible online, virtually everywhere we go.

These two trends point to a future where vehicle cabins will be fundamentally redesigned to entertain and inform passengers in new ways, as vehicles evolve away from driver-centric designs toward mobile living spaces, with all the media amenities we're accustomed to in our homes. We spend a lot of time in our vehicles, after all, and the continued proliferation of electric vehicles (EVs) likely means that we'll spend additional downtime within our EVs as they recharge at roadside charging stations.

Meanwhile the driving responsibility will grow increasingly automated in the years ahead, and as passengers we'll have even more time to tune in for our favorite digital game play, live sports, TV shows, etc – and consumers will expect push-button/voice-prompt access to all this and more. Vehicle drivers – while they're still needed – can simultaneously benefit from improved ADAS/information visualization, with capabilities like onscreen indicators that visually depict obstructions around the vehicle, for example. Increased vehicle automation will be enabled in part by increasingly complex sensor networks, which will in turn require greater compute power to process.

Customer expectations are aligning in this way even today, and forward-looking automotive OEMs understand that vehicle cabins, instrument clusters, consoles and screen configurations will likely look radically different in the years ahead. OEMs are challenged to meet customer demand for visually immersive in-cabin experiences that far transcend the primitive and frankly boring analog dials/gauges and 11 inch or smaller screens available in mainstream vehicles today.

Mobile processing solutions targeted for tomorrow's automotive applications will vastly outstrip the compute and graphics processing performance leveraged today for mobile handheld devices. Consumer car buyers want to be wowed by the infotainment experiences in their vehicle cabins, but this won't be possible absent a break from convention.

Automotive Processing, Yesterday and Today

Legacy ARM-based processors have capably serviced the automotive market for many years thanks in part to their suitability for mobile platforms as we've traditionally known them – smartphones, tablets, laptops, etc. System designers have looked to ARM processors for their energy efficiency, low heat dissipation, small size – and perhaps most of all, their low cost.

These attributes have helped to ensure long battery life and efficient cooling for electronic devices compact enough to fit in our hands, pockets and bags. Commodity ARM-based processors have likewise appealed to automotive system designers who are challenged to meet aggressive price/performance targets, and are inherently resistant to any design changes that invite redesigns in other areas and/or lengthy, resource-intensive automotive re-qualification processes.

In terms of multimedia applications, ARM processors have done a superb job in what they were primarily optimized for – capturing and holding the attention of a single user exposed to a single compact display. But ARM wasn't designed for desktop PC-class multimedia, multi-display, multitasking, and this will be essential for tomorrow's vehicles. The price/performance benefit curve for ARM-based processors in automotive applications has largely leveled off, however, and continued ARM architecture enhancements and performance gains aren't expected to bridge the wide and persistent gap between ARM and x86-caliber CPU, GPU and APU performance attributes common to our desktops and cloud datacenters. Among the key architectural differences, simultaneous multithreading (SMT) wasn't adopted into ARM until as late as 2018, when it became clear to industry watchers that ARM's competitiveness in automotive applications would be limited without it. SMT is by no means ingrained in ARM's DNA like it is in the x86 processing ecosystem.

To be clear, there will be a cost (mainly software) associated with transitioning from an ARM platform to an x86 based platform, and x86 processors must still accord to stringent energy efficiency requirements inherent to any battery-powered system. x86 processing performance and agility benefits more than outweigh these initial cost challenges, however, and can in fact promote additional design efficiencies and cost savings in other aspects of the vehicle's design.

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Achieving the Modern In-Vehicle Experience

The in-cabin infotainment experiences offered with next-generation driverless vehicles will look a lot different than today's. Consumers have endured 2D, smartphone-caliber graphics quality and media streaming experiences from their IVI systems. Forward-looking automotive OEMs readily acknowledge that this is an area where they can differentiate from the competition with eye-grabbing visual layouts and myriad media and entertainment options. This also reflects automotive OEMs' shifting focus from the information side of 'infotainment' to the entertainment side. And this trend is perhaps at least partially informed by OEMs' desires to more tightly bundle licensed media content within their in-vehicle entertainment offerings to further maximize revenue opportunities.

To fully achieve our shared vision for the vehicle cabin of the future, significant innovations must be achieved in the following infotainment domains:

3D Digital Gaming

Just as desktop PC-class x86 processors are commonly targeted for home gaming consoles, we anticipate that this trend will extend to next generation IVI systems as well. The ability to transpose the home gaming experience to the vehicle – enabling seamless, 3D graphics and gameplay at home and on the go – will undoubtedly be a compelling selling point for vehicle buyers in the future.

This can be achieved with x86 GPUs integrated within compact, energy-efficient single-chip Accelerated Processing Unit solutions, or with add-on discrete GPUs. x86 processor architectures with expansive PCI Express® (PCIe®) connectivity are well suited to scale graphics performance with seamless support for discrete GPUs capable of powering today's premier AAA games. This PCIe I/O flexibility isn't readily achievable today with ARM-based processors. More importantly, x86 is supported with a massive technology ecosystem and likewise supports a huge catalog of consumers' favorite console-based games.

Video Streaming

In today's vehicles, passengers' entertainment options are extremely limited. At best, we can access a modest selection of apps via Apple and Android's display mirroring interfaces – maps and messaging, mostly – and even today we can't 'phone mirror' popular streaming services to our vehicle cabins.

If there is truly a demand for this premium content in the cabin then this presents automotive OEMs with an opportunity to make this content available natively and tap into new revenue streams. Phone mirroring will no longer be necessary when streaming applications like these and others reside within the automotive infotainment software package itself. For the captive audiences of the driverless cars of tomorrow, push-button/voice-prompt access to HD-quality streamed TV shows, live sports, and movies will be a much-welcomed amenity, and x86-caliber graphics performance will be key to the solution.

Multi-Display Versatility

ARM-based processors can be adept at running one or two compact video displays simultaneously, and this has been adequate for some legacy in-vehicle infotainment systems – until today. Automotive OEMs are envisioning HD display configurations numbering up to ten or more in the vehicle cabin, well beyond the pair of headrest displays one might find in a higher end vehicle today.

The interior layouts for tomorrow's autonomous vehicles will expose new eye-grabbing opportunities to immerse passengers in rich visual content – almost any smooth surface within the vehicle could conceivably be (re)purposed as a screen display. x86 processors can support flexible, multi-display capabilities in a wide range of configurations, powering multiple independent displays that can then be scaled out using any number of companion devices.

x86 Design and Cost Efficiencies

There are important cost considerations to weigh when transitioning from commodity ARM-based processors to x86 processing solutions for in-vehicle infotainment systems, and OEMs can measure these considerations in multiple dimensions.

In terms of bill of materials, x86 will introduce a modest cost increase over ARM-based processors. In terms of differentiating vehicle brands in a hyper competitive marketplace, x86-caliber graphics performance enables vehicles to stand out from the pack with brilliant HD graphics and visually enticing consoles and media displays – and this could prove invaluable to carmakers both new and established.

At the engineering level, system designers are also targeting to exploit x86 processors' performance headroom to consolidate componentry and functionality and therefore conserve costs and improve manufacturing efficiencies. Where previously they've been limited to one-to-one device-to-ECU (electronic control unit) configurations, x86 processors with expansive performance and I/O can help absorb and integrate the IVI workload into dozens of ECUs where previously it might have required hundreds. With the accelerating trend toward software defined zonal architectures, the transition to x86 with virtualization technologies makes it easy to partition and redistribute compute resources to different subsystems.

Automotive system designers are also thinking well beyond traditional infotainment features as they identify capabilities and functions to consolidate. Driver monitoring systems (DMS) tasked with detecting driver fatigue and/or agitation are among the likely candidates for inclusion, as are other camera sensors that could draw on x86 processing horsepower to enhance object detection by providing object classification and identification.

Into the future, as AI plays a more prominent role in our vehicles, x86 processing performance and GPU-enabled hardware acceleration will be critical for AI-guided, real-time decision making and automation. As sensing and communication grows increasingly interconnected across vehicles and roadway infrastructure, x86 technology can provide the processing performance headroom to help orchestrate and streamline these operations while minimizing overall power consumption at the processing layer.

For automotive OEMs designing their next-generation vehicle cabins for a future of high performance, ultra-immersive media experiences – from digital gaming to media streaming and beyond – AMD Embedded Automotive processing solutions provide the optimal balance of computing and graphics performance, multi-display flexibility and energy efficiency.

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