

innovation

3D virtual cluster design rendered using NVIDIA's UI Composer powered by the Tegra K1 processor.

Accelerating the introduction of hi-tech cars

By: Alan Tran

During the keynote at the 2014 GPU Technology Conference, while NVIDIA CEO Jen-Hsun Huang and head of Audi pre-development Andreas Reich discussed the future of the car industry, an Audi A7 drove onto stage.

"Audi and NVIDIA are partnering together to develop and build the next generation Audi with piloted driving," said Huang. The two opened the car doors to reveal no one inside the vehicle—the car was driving itself.

In the past, advanced driver assistance systems required a trunk full of computers. However, now advanced mobile supercomputer systems are making this a production reality. "The car is the ultimate mobile computer. With onboard supercomputing chips, futuristic cars of our dreams will no longer be science fiction," concluded Huang.

NVIDIA recently introduced the Tegra® K1 mobile processor, which will help self-driving cars advance from the realm of research into the mass market. Moving beyond standard features such as cruise control and back-up warning signals, in-vehicle processing technology is the

Danny Shapiro, senior director of automotive at NVIDIA.



key to more robust safety systems. With a quad-core CPU and a 192-core GPU using the NVIDIA Kepler architecture, Tegra K1 will enable camera, LIDAR and radar-based, advanced driver assistance systems (ADAS) - such as pedestrian detection, blind-spot monitoring, lane-departure warning and street sign recognition - and can also monitor driver alertness via a dashboard-mounted camera.

"To process the steady deluge of sensor and camera data generated by the systems in a self-driving car, NVIDIA is bringing highly-efficient supercomputer technology inside the vehicle," said Danny Shapiro, Senior Director of Automotive Business at NVIDIA. "Tegra K1 solves this by delivering 10 times the computing power of previous mobile processors while consuming minimal

energy." ADAS solutions currently in the market are based mainly on proprietary processors. NVIDIA Tegra K1 moves beyond this limitation by providing an open, scalable platform that enables innovative solutions. NVIDIA designed the Tegra K1 processor to be fully programmable, which can be enhanced via over-the-air software updates.

"Advanced computational technologies are the foundation for turning automobiles into the most innovative, capable and desirable mobile devices in the future," said Thilo Koslowski, vice president and lead automotive analyst at Gartner. "By offering over-the-air upgradeability of these technologies, automakers can improve existing in-vehicle features and offer new ones over the course of the vehicle lifecycle," adds Koslowski.

Tegra K1 can be used for a wide range of applications inside the car. In addition to computer vision and ADAS, the advanced rendering capabilities are enabling photorealistic digital dashboards, and allowing drivers to customize the look and feel of their vehicle. These systems also provide for much better integration with drivers and passengers Smart-phones. NVIDIA is working closely with Apple and Google on both Car-Play and integrating Android in the car respectively.

Automotive Industries (AI) asked Shapiro what impact he believes the new Tegra K1 mobile processor will have on the company's automotive business.

Shapiro: The advanced processing power of Tegra K1 brings a true supercomputing architecture to the car, enabling us to expand into advanced driver assistance systems and even self-driving cars. Active safety, connected car technology and enhanced visual experiences are all expected by today's consumers, further expanding NVIDIA's role inside the car.

With 192 cores, NVIDIA Tegra K1 enables revolutionary in-vehicle visual experiences, which were not possible before. It delivers an unprecedented combination of visual performance and energy efficiency – ideal for driving automotive innovation.

The automakers who are already engaged with NVIDIA and using our visual computing module (VCM) - a highly scalable computer



NVIDIA UI Composer Studio powered by the Tegra® K1 processor.

system – are able to easily upgrade their in-vehicle systems with new processors due to the VCM's modular approach. In addition, using tools like NVIDIA UI Composer with Material Definition Language libraries, OEMs are able to incorporate beautiful digital cockpits rendered in 3D with realistic-looking material finishes such as brushed metal, chrome and carbon fiber.

AI: Your strategy announced in 2013 is to grow NVIDIA's automotive sales to US\$ 1 billion in a few years' time. How close are you to achieving your target?

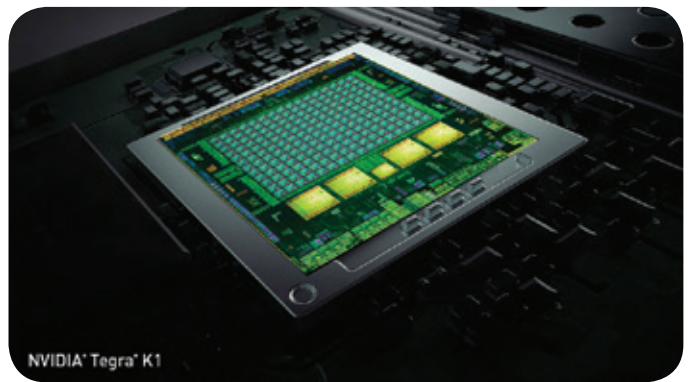
Shapiro: NVIDIA powers over five million cars on the road today, with design win forecasts to reach over 25 million more in the near future. Consumer demand for more mobile functionality in cars and emerging regulations to enhance driver safety are just a few factors driving an increase in the number of electronic components and systems in cars. Strategy Analytics expects the market for advanced drivers assistance systems, or ADAS, to be worth around US\$15 billion by 2015. With more functionality and ADAS systems added into luxury as well as mainstream car models, NVIDIA is well positioned to achieve its goals.

AI: What has been the response to the Tegra K1 mobile processor by auto-makers?

Shapiro: NVIDIA has a long standing relationship with many automakers, including Audi, Volkswagen, BMW, and Tesla. Based on our discussions, they are excited about the powerful processing power that Tegra K1 delivers. Audi, for example, which was the first to deliver Google Earth and Google Street View navigation using NVIDIA technology, recently unveiled new advanced in-vehicle solutions including a 12.3-inch 3D virtual digital cluster as well as a 10.1inch automotive-grade tablet called Smart Display. And at Audi's CES keynote, after one of their vehicles drove itself onto the stage, Audi announced that Tegra K1 will power its piloted-driving and self-parking initiatives.

AI: What are some of the ADAS applications that it will be able to support?

Shapiro: The Tegra K1 is the first mobile processor to support CUDA – NVIDIA's parallel processing architecture - bringing the algorithmic power of a supercomputer, to the car. Sophisticated processing of camera inputs enables blind spot monitoring, lane detection, as well as object and pedestrian detection. It is then up to the automakers to determine what type of driver alerts, visual, auditory, haptic or a combination, they prefer to install in their models based on the computer vision and sensor analysis performed by the Tegra K1 processor.



The Tegra® K1 mobile processor.

AI: What are some of the drivers of NVIDIA's automotive business?

Shapiro: Consumers are demanding the same functionality and connectivity they have with their Smartphones, in their cars. In addition, driver safety is top of mind for car buyers. Advanced driver assistance systems, for example lane keeping aids, pedestrian detection and even collision avoidance all require powerful processing power coupled with energy efficiency. To bring all this to the car, automakers have learned they need a true technology partner that knows how to build computer systems, not just supply chips. NVIDIA is that computer company, dedicated to bringing new innovation and automated driving to market.

AI: What role will NVIDIA play in the newly set up Open Automotive Alliance in terms of promoting the Android platform in cars?

Shapiro: Audi, GM, Google, Honda, Hyundai and NVIDIA have joined together to form the Open Automotive Alliance (OAA), which will start bringing the Android platform to cars starting in 2014. NVIDIA was the only computer company to initially join the alliance. Given our vast software engineering team, we are able to leverage our deep Android experience in Smartphones, tablets and consumer gaming devices to quickly enable Android-based solutions in the car.

AI: How do you see the future of Android in cars?

Shapiro: NVIDIA technology supports a range of operating systems including Linux, Windows, Genivi, QNX and Android. Android is a widely adopted familiar platform with a huge established base that will expand as automakers bring Android connectivity into their cars. Working with alliance members in an open environment will drastically speed up the ability to bring appropriate applications into the car.

AI: What were some of the highlights at the recent GPU Technology Conference this year?

Shapiro: The GPU Technology Conference provided a unique opportunity for leading researchers, scientists, doctors and engineers to come together and discuss how advances in parallel computing technologies are revolutionizing industries from energy exploration to visual effects production to automotive. Throughout the week, there were over 500 different technology sessions, including more than 30 automotive related talks, panels and tutorials focused on design and styling, in-vehicle infotainment, virtual cockpits and advanced driver assistance systems. At next year's conference, automotive will play an even bigger role. Only time will tell what innovative breakthroughs will end up on stage at the keynote. **AI**

