# Gigabit Network for the Car of the Future

*When the first digital display links with Gigabit data rates found their way into cars a few years ago, it looked like the bandwidth issue could be taken off the table for a while. Far from it!*

ROBERT KRAUS *

Image: Inova Semiconductors

***APIX next:*** *Gigabit data network for the car of tomorrow*

Starting next year, first vehicles will be on the road featuring infotainment systems that work at 3 Gbps. And there is no end in sight to this "Gigabit Inflation" – quite the contrary.

The overwhelming success of the iPhone & Co. further accelerates this rapid development, and vehicles will start to use HD resolution displays in only two years. Sophisticated driver assistance systems are upgraded with digital cameras with HD resolution, and the fast 100 MB Ethernet will find its way into on-board networks, replacing conventional data buses. To manage this huge data volume, leading vehicle manufacturers are intensely working on the definition of the requirements of a future gigabit network. Inova Semiconductors, who came out two years ago with the 3 Gbps data highway APIX2, will present a concept that implements the Gigabit network of the future – APIX next – at electronica 2012 (hall A6, booth 213).

For several years already, major European suppliers have strongly focused on one aspect when developing new infotainment systems. Displays are getting larger and more elaborate from one generation to the next, thus the graphics representation is getting more and more sharp and lifelike.

While simple analog 5-inch passive matrix displays with only 320x234 pixel resolution were quite common in 1994, the displays used today are 10.25 inch, with 1,280x480 pixel resolution and 18 bit color (figure 1).

Instrument clusters are state of the art. They do not feature mechanical parts anymore and implement all display systems – even classical round gauges –three-dimensionally and very realistically in a high-resolution display.

## Graphics performance of a PC, minimum energy consumption

Alongside the development of more and more elaborate displays for use in vehicles, the performance of graphic processors has literally exploded. The latest CMOS technologies, combined with intelligent and scalable multicore architectures, have paved the way for in-vehicle graphic display quality that could only be achieved with home PCs

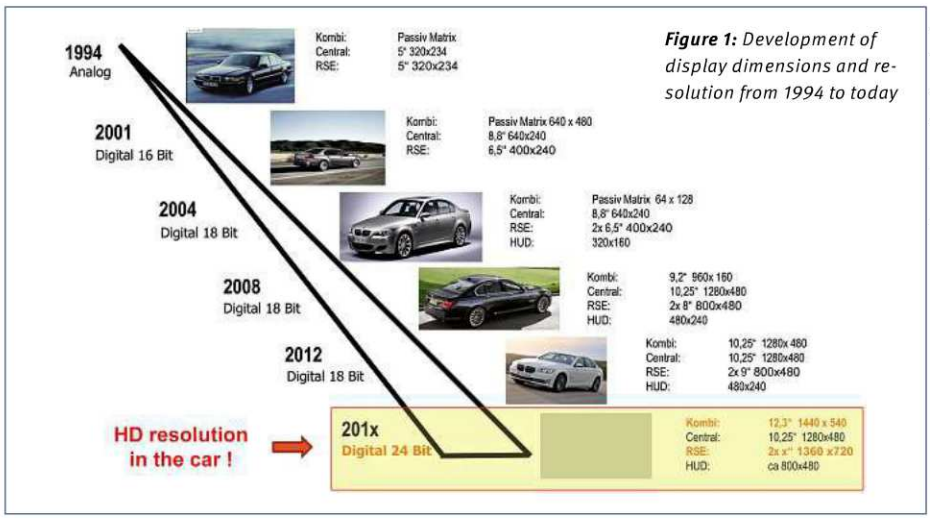


***Figure 1:*** *Development of display dimensions and resolution from 1994 to today*

Image: Inova Semiconductors

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before – with only a fraction of the power consumption of a PC. For example, a modern Freescale i.MX6Q with four ARM-Cortex-A9-cores calculates approximately 200 million 'triangles per second' – a measure of graphics rendering speed – accomplishing about 40% of the graphics performance of a powerful game console like the xBOX360 or Sony PlayStation 3 (figure 2).

## Smartphones carry HD resolution to vehicles

The trend towards higher-quality in-vehicle graphics has been accelerated further by the smartphone hype. About one billion smartphones have already been sold worldwide; with some 23 million smartphones only in Germany in 2012. Smartphones now hold 93% of the mobile phone market, conventional mobile phones only 7%.

Both their versatility and brilliant graphics quality don't stop at vehicles either. Especially among younger buyers, demand is high for in-vehicle solutions that allow them to plug their smartphones or iPads into elaborate display equipment with high graphics performance. Experts already talk about the "iPad-ing of the Automotive Industry". And leading vehicle manufacturers are now upgrading their infotainment systems to meet this demand.

By end of 2014, first vehicle models will come into the market that are equipped with large, high-resolution displays both for the cockpit and the rear-seat entertainment. Cameras as integrated elements of rear-seat displays facilitate web based video telephony or enable a mother at the wheel to see if her baby is still asleep in the back seat – simply by checking the display and without having to turn her head. And of course, smartphones or iPads connect directly to on-board electronics and play their content through the on-board infotainment system (figure 3).

The next phase of vehicle display development has already started. First manufacturers are already looking into 3,840 pixel so-called 4k displays that offer twice the resolution of today's 1,920 pixel 2k displays.

## Data network – the bottleneck

The display and head unit are no longer assembled together in a bulky box. Instead, they are integrated in the car separately, which is the only way to implement modern interior designs with five and more displays. A data link between the head unit and display is required that is powerful and cost-efficient and reliably transmits ever increasing data volumes. And the data to be transmitted are no longer just video signals.

For new features like video telephony or "baby watch", image data have to be transmitted from the head unit to the display and, at the same time, camera images have to be transmitted back to the head unit. The multitude of new convenience functions and performance features causes data traffic in on-board networks to rise to a level that exceeds the bandwidth of conventional bus systems by far.

Consequently, major manufacturers have agreed to use the Ethernet as communication bus in future to cope with the amount of control and programming data in more and more

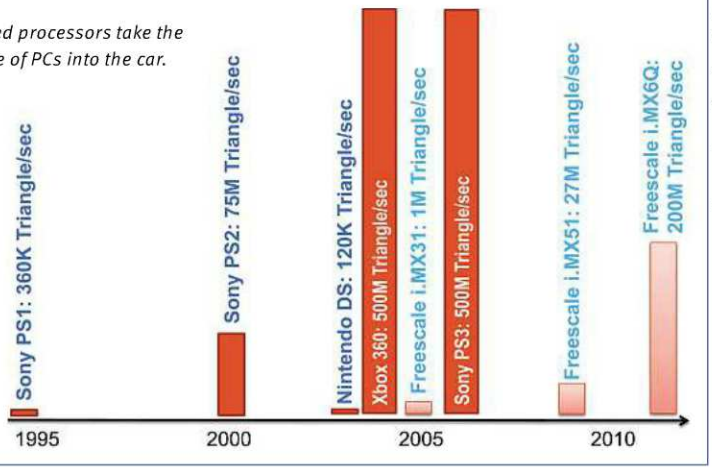


***Figure 2:*** *Sophisticated processors take the graphics performance of PCs into the car.*

Image: Inova Semiconductors

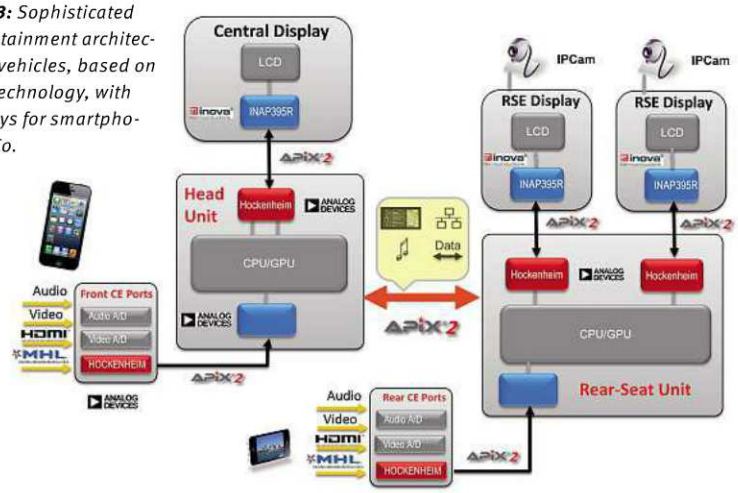


***Figure 3:*** *Sophisticated HD infotainment architecture in vehicles, based on APIX2 technology, with gateways for smartphones & Co.*

Image: Inova Semiconductors

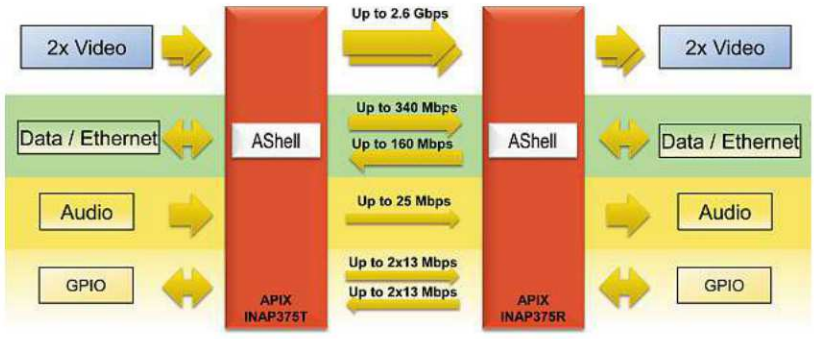


***Figure 4:*** *APIX2 is a multi-functional 3 Gbps data highway*

Image: Inova Semiconductors

complex systems. And while the 100 MB Fast Ethernet is just about to make its way into the car, there have already been initial considerations regarding the 1,000 MB Gigabit Ethernet.

## APIX next to follow APIX and APIX2

After the first 1 Gbit/s APIX link was presented in 2007, Inova Semiconductors launched the second APIX generation with a data rate of 3 Gbps in 2010. APIX2 already meets most requirements of sophisticated in-vehicle data networks and is therefore used in new infotainment systems by car manufacturers throughout Europe.

APIX2 not only serves as simple data link in these systems. It is a multi-functional data highway that transmits a multitude of data formats over one link with partly completely different bandwidth, fail safe or latency requirements. APIX2 not only transmits two video streams, digital 8-channel audio and control data at real-time but also the Ethernet at full 100 MB through a standard-compliant MII (media independent) interface, as shown in figure 4. Right from the start, Inova Semiconductors has licensed the APIX technology to other semiconductor manufacturers. Thus, a wide range of compatible APIX products has become available. These are not only Inova products but also graphic processors and controllers by Toshiba and Fujitsu and, as of late, first products with consumer interfaces and HDCP function as presented by Analog Devices also at electronica.

This proven concept has been widely used in millions of cars and is now the basis for the latest APIX generation. In cooperation with Fraunhofer Gesellschaft and publicly funded by the Bavarian Ministry of Economic Affairs, Inova has already initiated the development of APIX next. APIX next will be downward compatible with the two earlier product generations and will offer considerably higher bandwidth; the development objective is "5 Gbit/s plus x" (figure 5).

It will also offer much higher return channel bandwidth in order to support Gigabit Ethernet network architectures in future. APIX next will transmit infotainment and

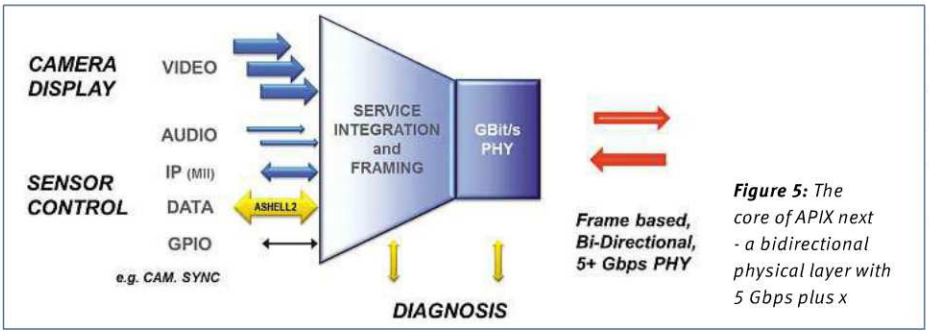


***Figure 5:*** *The core of APIX next - a bidirectional physical layer with 5 Gbps plus x*

Image: Inova Semiconductors

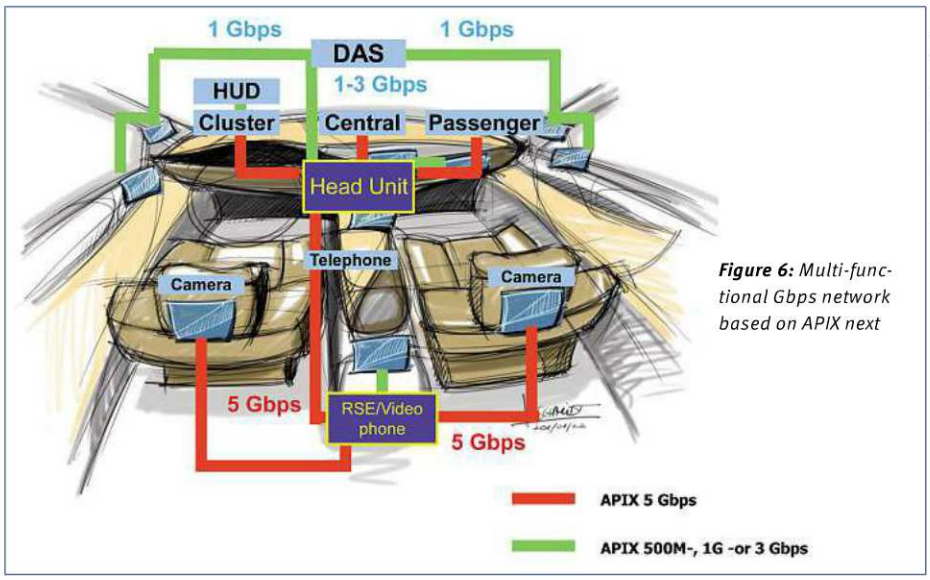


***Figure 6:*** *Multi-functional Gbps network based on APIX next*

Image: Inova Semiconductors

on-board network data, including safety-relevant data if required – at the same time and completely independent of each other - through one single link. APIX next will be scalable, thus facilitating the use of simple cables or connector systems, e.g. in low data rate nodes (figure 6).

## Reliable transmission: STP, UTP or coaxial cable?

The cable is crucial to the reliable transmission of such high data rates. Like its predecessors APIX and APIX2, APIX next also uses 4-wire STP cable as medium. In 2006, German vehicle manufacturers in cooperation with company Rosenberger defined this cable type as standard for high speed data transmission in vehicles, and it has established itself in the market ever since.

Differential signal transmission via two pairs of wire, arranged as 'star quad' with 100 Ohm impedance, physically qualifies to be the best solution for reliable and fail-safe data transmission even beyond the 5 Gbps range. For this reason, Inova Semiconductor works closely with Rosenberger in the development of APIX next to harmonize chip and cable technologies.

The objective is not only to implement reliable data transmission at 5 Gbps and higher but also to consistently continue the price/learning curve of this cable to make sure it can be used universally in the Gigabit network in future. // JW

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■ More about APIX, APIX2 und APIX next

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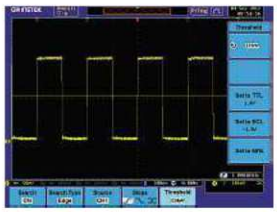
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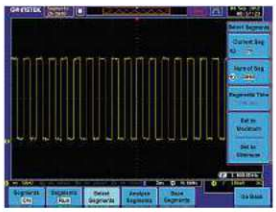
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