Toyota's New Entune Connectivity Platform

An Answer to Ford Sync

"Sync was certainly a motivator for Entune," said Jim Pisz, corporate manager, advanced technology development at Toyota. "Ford is a big competitor. We are very conscious of the success that Ford has had with Sync. We think our system is better—it's the next generation."

After some fine tuning, the Entune connectivity platform, which connects the vehicle to the cloud by means of an iPhone, Android, certain BlackBerry smart phones or some other "data-enabled" phones, will be available as an option on select Toyota models this year. According to Mr. Pisz, Entune provides access to more music sources than any other multimedia platform. The Entune unit includes an AM/FM, XM and HD receivers, a CD player and a USB connection for music players, as well as access to Pandora radio and iHeartRadio via the Internet. IHeartRadio, which provides access to more than 750 local radio stations, is a Clear Channel product.

Unlike Ford Sync, Entune can be updated remotely. "To update the Sync platform, Ford has to stick a dongle into every car individually, at the dealer," said Mr. Pisz. "Our applications live on a server; we can bring in new applications over the air. That gets us [the auto industry] in step with consumer electronics lifecycles. From birth to death, the lifecycle of a telephone is nine months; for a vehicle it is ten years. A hot application today may not be popular three or four years from now. MySpace became irrelevant two years after Facebook got popular. We can keep applications fresh by downloading and changing the software."

"Our 'secret sauce' in Entune is the media player shell installed in each head unit. We can bring in new applications over the air. Our applications live on a server; we can bring in new applications over the air. That gets us [the auto industry] in step with consumer electronics lifecycles. From birth to death, the lifecycle of a telephone is nine months; for a vehicle it is ten years. A hot application today may not be popular three or four years from now. MySpace became irrelevant two years after Facebook got popular. We can keep applications fresh by downloading and changing the software."

NHTSA Decision to Potentially Regulate Due 2013

Automotive safety engineers have long known that one day cars could be able to tell each other where they are headed and how fast they are going. Collisions between them could be avoided, potentially saving thousands of lives every year. That day may come sooner than expected.

Researchers around the world have been working on vehicle-to-vehicle (V2V) communications and vehicle-to-roadside or infrastructure (V2I) communications since the late 1980s, and the technology is now nearly ready. The communications spectrum—5.9 GHz in Europe and the United States, 5.8 GHz in Japan—has been allocated, but carmakers have not been at all motivated to equip new vehicles with transceivers, the necessary onboard communications units. The biggest hang-up has been that owners of those first transceiver-equipped vehicles would get almost no safety benefit because initially there would be too few vehicles on the roads to communicate with.

U.S. Government Action

For V2V to work, governments will almost certainly have to get actively involved, and that is now happening in the United States. While at this point nobody knows how many lives could be saved if vehicles communicate with each other, top U.S. Department of Transportation officials believe the technology is promising enough to warrant possible regulation. By early 2013, the National Highway Traffic Safety Administration (NHTSA) will make a determination whether or not to begin the formal rulemaking process that would lead to a mandate.

If NHTSA opts not to undertake the lengthy, complicated rulemaking, another solution is to consider vehicle-to-vehicle communications as a safety feature under NCAP, the New Car Assessment Program. In that scenario, the government would strongly encourage carmakers to install V2V communications units in new vehicles by denying its top five-star safety rating to vehicles that don't have them. The U.S. government is even considering the possibility of requiring installation of communications devices in used vehicles.

Russ Shields, chairman of Ygomi LLC, thinks NHTSA will probably take the NCAP path to V2V deployment, not only because it is a far less difficult process than creating an outright mandate, but also because there is no framework for carmakers to appeal the decision and delay implementation. Without a NHTSA regulation, Mr. Shields suggested, "The industry could agree to a safe harbor regulation, which says if you install a [V2V communications] unit in your vehicle, here is how it must perform." A departure to a safe harbor regulation will protect carmakers from possible future lawsuits claiming the onboard unit failed to prevent a collision. The industry used a safe harbor regulation when it adopted airbag event data recorders.

Regardless of which approach NHTSA takes, the fleet of vehicles equipped with V2V communications units would likely build up quickly, starting with the 2016 model year.

U.S. Field Test to Start in 2011

Prior to deciding whether to mandate or to go with the NCAP solution, the U.S. government will run what it is calling a safety pilot: a $30 million field operational test of 2,000 to 3,000 vehicles equipped with 5.9 GHz DSRC (dedicated short range communications) units. The test will start at the end of 2011 and run...
RIM Gaining a Foothold in Automotive

With a 33.5% market share, RIM (Research in Motion) led its rivals in the highly competitive U.S. smartphone market for the three months ending November 2010. But during that period it actually lost 4% share. Google Android picked up 6.4% share, leaving Apple at number three, according to comScore Inc.

In their efforts to sell more smartphones and hang on to existing subscribers, all the market leaders are working to make sure their devices are compatible with the latest automotive industry standards and feature applications. Two recent acquisitions by RIM — Dash Navigation in June 2009 and QNX in April 2010 — are playing a key role in the company's automotive strategy.

Last November, RIM released a non-beta version of BlackBerry Traffic, a free application that uses probe or crowdsourced data from other vehicles to calculate driving times, report traffic congestion and accidents, and provide alternate routes. Dash Navigation developed the technology but was unable to make it commercially successful. Dash engineers are now part of RIM's core R&D and emerging technologies groups.

As a Harman International company, QNX was the world's number-one supplier of automotive operating systems and middleware. RIM's new tablet computer, the BlackBerry Playbook, will run on a QNX operating system.

Tyler Lessard, vice president of BlackBerry global alliances and developer relations, noted, "A automotive is a very important market for us. Our executives speak loud and clear about the BlackBerry being seamlessly connected to the vehicle to enable better services in the car and enhance services on the phone."

RIM is closely watching how and which connectivity standards are developing in the automotive industry and sees a role in helping drive standards such as the Bluetooth MAP (Message Access Profile). Beyond MAP, RIM is not yet supporting any output protocols such as Nokia's Terminal Mode standard, which is supported by German carmakers.

Separately, RIM is working with OEMs to develop smartphone applications that might control vehicle functions such as remote starting or door unlocking. RIM at present has only one person dedicated full time to working on automotive applications, primarily making sure the applications developed by automotive OEMs will work on BlackBerries. According to Mr. Lessard, however, RIM's Bluetooth team and some others are becoming more focused on in-car integration.

In June 2010, BMW announced that its ConnectEdrive's functions now include the ability to access e-mail received on a BlackBerry smartphone via the car's iDrive controller. Using a Bluetooth interface, e-mail can be shown on the vehicle display or read aloud.

Mr. Lessard pointed out that RIM was working with OEMs on Bluetooth integration, the Bluetooth MAP, and streaming music via BlackBerries through the car's infotainment system even prior to the QNX acquisition.

Camera-Based Sensors Market Growth Forecast

IMS Research (Wellingborough, U.K.), a market research firm that provides consulting on electronics markets, predicts that the demand for automotive camera-based sensors will grow by 28% per year during the next seven years, reaching nearly 35 million units by 2017.

The growth will be driven by increasing penetration of features such as night vision, road sign recognition, driver monitoring, lane-departure and blind-spot warning, and rear view systems. In the U.S., rear view camera systems will likely be required in all new vehicles starting in 2012, with 100% phase-in by 2014. The National Highway Traffic Safety Administration (NHTSA) is required by the Cameron Gulbransen Kids Transportation Safety Act to publish a final rule by the end of February 2011 directing carmakers to improve rear visibility.
V2V Communications... Continued from page 1

through 2012. The results of the safety pilot will be used to objectively estimate the potential safety benefits of full V2V deployment.

The safety pilot is part of IntelliDrive, a Department of Transportation initiative focused on making driving safer and greener through communications. Begun in 2003 as the Vehicle Infrastructure Integration (VII) program, the scope of the program expanded from research into commercial testing and marketing and in 2009 DOT’s Intelligent Transportation Systems Joint Program Office rebranded VII as IntelliDrive. The U.S. government has been funding all the DOT’s ITS research programs at $100 million per year. In 2010, $49 million of that funding was devoted to wireless connectivity.

IntelliDrive involves 18 people at the DOT’s Intelligent Transportation Systems Joint Program Office plus approximately 60 others from the Federal Highway Administration, NHTSA and the Federal Carrier Administration.

One of the safety pilot’s challenges is to come up with a methodology that will produce realistic densities of equipped vehicles on the road with just the 2,000 to 3,000 vehicles, something IntelliDrive engineers have not yet figured out how to do. IntelliDrive will soon begin the procurement process to find a collaborative team that can recommend the best approach and organize and execute the test.

NHTSA already has a cooperative agreement with industry partners including Ford, General Motors, Honda, Hyundai, Kia, Daimler, Nissan, Toyota and Volkswagen to evaluate the effectiveness of safety systems that use V2V communications.

DSRC

The DSRC units proposed for V2V communications conform to the IEEE 802.11p standard, an offshoot of the standard on which Wi-Fi is based. A close cousin of Wi-Fi, DSRC chips should be relatively inexpensive. Aaccording to a U.S. transportation official, adding V2V communications capability should cost carmakers tens of dollars per vehicle in high volume, very roughly. That assumes the vehicle already has GPS and a digital map onboard in order to know its precise location. DSRC transmissions in the 5.9 GHz band have a range of a few hundred meters. Wi-Fi connected devices operate in the 2.4 GHz and 5 GHz bands.

V2V First, Followed by V2I

Just a couple of years ago leading advocates for safety applications of DSRC were asserting that not much could happen without a communications infrastructure. They argued that with only V2V you have the inherent problem of providing a value proposition to early buyers because you need to rely on many other vehicles equipped to communicate with your vehicle. The likelihood that another vehicle driving nearby will have the same communications unit is pretty small, so to provide instant value from day one we would need to start with vehicle-to-infrastructure communications.

But in the post-recession world we live in today, governments do not have the billions of dollars required to implement a network of roadside beacons. In the U.S. alone, a nationwide network of beacons would cost more than $10 billion, plus hundreds of millions of dollars each year for maintenance. Without the funds to invest in a massive DSRC infrastructure, U.S. government safety officials now emphasize rapid deployment of V2V communications. A one U.S. safety official who wasn’t authorized to speak on the record told me recently, “We don’t necessarily need roadside beacons to support the vehicle-to-vehicle crash avoidance types of applications.”

While the initial emphasis in the U.S. and elsewhere will be on V2V applications, vehicle-to-infrastructure applications would not be ruled out. “The nice thing about these communications stations [onboard units] is they can receive information from other vehicles or from the roadside,” said Knut Evensen, chief technologist at Q-Free. “The vehicle and roadside stations are the same, providing station-to-station, peer-to-peer communications. It would cost a reasonably low amount of money to equip especially accident-prone intersections with hardware to help manage the intersection.” With headquarters in Trondheim, Norway, Q-Free produces toll collections systems and components. Mr. Evensen is the chief architect of the Cooperative Vehicle Infrastructure System (CVIS) project, one of several research projects underway in Europe to advance, test and standardize V2V and V2I communications.

Some communications with an infrastructure will also be necessary to support security credential management to ensure that the messages received from surrounding vehicles are indeed coming from bona fide vehicles. That could be done using 3G or 4G cellular networks that link to back-end security services.

Major Safety Potential

Many safety experts worldwide are convinced that the potential safety benefits to be realized with V2V communications make its eventual deployment almost inevitable. In a presentation at ITS America’s annual meeting in 2009, John M addox, deputy administrator for NHTSA, said: “Vehicle communications have the potential to save thousands of lives every year. ... V2V and V2I have a greater potential for safety than forward collision avoidance systems and lane departure warning systems, all while potentially costing less.”

Christian Weiss of Daimler’s group research and advanced engineering is the lead contact for SIMTD, the four-year German research project launched in 2008 that will soon begin a 400-vehicle test in the Frankfurt-Rhine-Main region of Germany—the largest field test yet in Europe of vehicles equipped with communications units. Field testing in this high-traffic density area will include all road safety and traffic functions under normal everyday conditions.

Dr. Weiss told us that he won’t know until the field test is completed how many lives V2V can potentially save, but he is confident that V2V is the next big step in safety after radar and cameras. “We will give the car the opportunity to communicate, to speak and to listen. Communications leading to cooperation between cars is the only thing that can bring us closer to the EU goal of halving road fatalities. No other safety technology has as much potential.”

Since the quality of V2V information depends on the number of vehicles that
A utoliv Inc.

Background

A utoliv Inc. was founded in 1997 with the merger of A utoliv A B of Sweden and Morton Automotive Safety Products of Ogden, Utah, a pioneer in airbag technology development and one of the earliest suppliers. Morton supplied the inflator for the first commercially successful airbag, which Mercedes debuted in 1980. (General Motors was the first to apply for a patent for airbags, in 1953.) A utoliv A B had been producing seatbelts since 1956. At the time of the merger with Morton A SP, A utoliv A B was a public company traded on the Stockholm Stock Exchange and thus provided the corporate structure for the new, merged entity.

A utoliv Inc. is an American company incorporated in Delaware but maintains its headquarters in Stockholm, Sweden, and most of the company management team is Swedish. Sixty percent of A utoliv’s employees work in low-cost countries. Forty-three percent of A utoliv’s purchased components come from suppliers operating in low-cost countries.

Competitive Strengths

One of the main advantages A utoliv has over its major competitors—TRW, Takata and Key Safety Systems—is its size and global presence. With a 35% share of its served market, A utoliv operates in 30 countries and does business with every major carmaker worldwide. A utoliv maintains production facilities for airbags, seatbelts and steering wheels in more countries than any of its competitors.

At the time of the merger with Morton Automotive Safety Products (Autoliv ships 120 million seatbelts per year), 20,000 lives saved by its products every year.

Shipped 100 million airbag ECUs so far.

World’s number-one supplier of airbag ECUs with integrated IMUs, which serve as both crash and ESC sensor.

World’s number-one supplier of ultra-wideband radar sensors.

World’s number-one supplier of far infrared night vision systems.

World’s number-one supplier of pretensioning seatbelts.

Autoliv’s employees work in low-cost countries.

Takata and Key Safety Systems—but not A utoliv—significantly outspend the others on R & D. As a result, A utoliv sees itself as the market’s technology leader, responsible for most of the product innovation. In addition to its early frontal airbag collaboration with Mercedes, A utoliv also claims the first side curtain airbag, side thorax airbag, knee airbag, the safety-vent airbag, the buckle pretensioner and the anti-whiplash seat.

Much of A utoliv’s technology came by means of its many acquisitions over the past two decades. A utoliv remains acquisitive; it is especially interested in finding active safety products and technologies.

A motive safety is A utoliv’s only business. Steve Rodé, president of A utoliv Electronics, is proud of the company’s focus on safety. Mr. Rodé believes that focus is reflected in strategic decisions regarding

Distinctions Claimed by the Company

◆ The only major airbag system supplier to offer in-house, whole-vehicle crash testing
◆ More safety patent first-filings than Takata and TRW
◆ World’s number-one share of airbag and seatbelt sales, 35% of served market (Autoliv ships 120 million seatbelts per year.)
◆ 20,000 lives saved by its products every year.
◆ Shipped 100 million airbag ECUs so far.
◆ World’s number-one supplier of airbag ECUs with integrated IMUs, which serve as both crash and ESC sensor.
◆ World’s number-one supplier of ultra-wideband radar sensors.
◆ World’s number-one supplier of far infrared night vision systems.
◆ World’s number-one supplier of pretensioning seatbelts.

Takata and Key Safety Systems—are its size and global presence. With a 35% share of its served market, A utoliv operates in 30 countries and does business with every major carmaker worldwide. A utoliv maintains production facilities for airbags, seatbelts and steering wheels in more countries than any of its competitors.

Among the world’s three largest suppliers, only A utoliv and Takata have production capability in Japan, and A utoliv successfully competes with Takata for business with Japanese carmakers. (Most of Toyota’s seatbelt, airbag and steering wheel business goes to its keiretsu partner suppliers.) The number two suppliers, TRW and Takata, each have 20% market share; the remaining 25% of the market is split among roughly a dozen suppliers, the largest of which are Toyota’s affiliated suppliers and Key Safety Systems. A utoliv estimates its share of the rapidly growing market in China at 30% and expects to own a third of that market in three years.

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acquisitions and new business: “Our priorities are clear. Our decisions are based on our mission and our vision—improving automotive safety is why we exist.”

The problem that Autoliv’s products are trying to answer is immense. This year more than 1.2 million people were killed and 50 million people injured in motor vehicle accidents. According to the World Health Organization, the number of people killed in motor vehicle accidents is expected to double by 2030, to 2.4 million. By 2030, deaths resulting from road traffic injuries will be responsible for 3.6% of all deaths, the fifth leading cause of death worldwide.

Passive Safety Still a Growing Market

According to conventional wisdom, the market for passive safety systems including airbags, airbag ECUs and seatbelts has matured, but in A utoliv’s view of the market, that is not at all the case. It expects the market for passive safety still to rise. Because curtain airbags are twice as effective in any given crash compared with passenger, driver and side airbags and cost no more, Autoliv expects the market for them to grow at an annual rate of 10.3% from 2010 to 2014, reaching $4.0 billion. In the United States, roughly 80% of 2010 cars already have side curtain airbags, according to A utoliv estimates.

A utoliv sees great growth potential for passive safety in emerging markets, particularly China, as not only vehicle production increases, but the safety content in those vehicles rises as well. An airbag penetration, while still low, is growing and conventional seatbelts are being replaced by seatbelts with pretensioners.

The company’s investments in China, which it began in the late 1980s, have served A utoliv well. In 2010, sales in China are expected to account for nearly 12% of total sales, up from 9% in 2009 and just one percent five years ago. “We currently have nine plants in China and a tenth under construction,” noted M ats Odman, Autoliv vice president, corporate communications. “We have a full tech center with a crash facility for full-scale tests of complete cars. We have more than five thousand employees in China, nearly 300 in R&D.”

Safety content per vehicle in China averages $200, compared with $500 in premium vehicles and $300 in average vehicles in Western markets. A utoliv sees potential in the Indian market as well; the average safety content per vehicle there is just $70, according to M ats Odman. In 2009, A utoliv invested approximately $20 million in research and development of safety products targeted for the small cars that typically predominate in emerging markets. A utoliv cites field data that indicate small cars have twice the fatality rate as larger cars.

A utoliv Electronics

Nearly one-tenth of A utoliv’s sales come from electronics. 90% of those electronics sales are associated with its restraint systems business, so-called passive
electronics. In 2009, Autoliv held an 18% share of the passive safety electronics market. Ford and GM account for nearly half of all Autoliv's electronics sales. Its largest electronics product category by far today is airbag ECUs.

Autoliv is investing more in electronics than in its other technologies; the emphasis is seen in its R&D priorities. While today just 10% of sales comes from electronics, 30% of advanced development funding is aimed at electronics, roughly half for passive safety and half for active safety.

**ECU and Sensor Integration**

Among Autoliv's most promising new product developments is the integration of the IMUs (inertial measurement units), which perform as ESC (electronic stability control) system sensors, into a single box within the restraint system ECU (electronic control unit). The integrated system provides carmakers with savings of $20 to $40 per vehicle by eliminating redundant sensors, connectors and wiring.

Ford was the first customer to adopt Autoliv's integrated solution. A utoliv's sales for airbag ECUs with integrated ESC sensors is expected to reach more than $100 million in 2010, which corresponds to about 25% of all Autoliv airbag ECU sales. By 2013, annual volume will reach four million units.

**Active Seatbelt with Pre-Tensioner**

A utoliv's seatbelt systems provide two stages of belt-tightening. The first stage is driven by a motor and is reversible, the next, which is triggered at the onset of a crash, is pyrotechnic. The belt takes information from radar sensors, cameras and/or stability control systems to restrain occupants before the crash.

**Active Safety**

A utoliv has recently been building a portfolio of electronics products that serve active safety applications including night vision, pedestrian detection, blind spot detection, collision avoidance and mitigation, sign recognition and lane departure warning. In 2010, A utoliv's electronic business sales were about $770 million, with active safety products accounting for roughly 11%. By 2013, electronics sales should reach $1 billion, with the active safety portion growing to 30% of the total. By 2015, A utoliv expects sales of active electronics to account for more than $450 million, or 35% of electronics sales. That's a 34% annual percentage growth rate from 2009 to 2015 for active safety electronics.

**Radar**

Two major acquisitions gave Autoliv the foundation from which to build its radar expertise very quickly. In 2008, it acquired the radar sensor business of Tyco Electronics for $42 million, and that business produced $30 million in sales in 2009. A utoliv's purchase of Visteon Radar Systems was completed in February 2010, though two companies had been working closely together for most of the prior year.

A utoliv Electronics is responsible for both the sensors and algorithms in its radar systems. "The Tyco acquisition gave us very strong sensor expertise. The Visteon radar group brought us more algorithm strength. The two acquisitions together positioned us to leap forward in the market," said Mr. Rodé. "The timing was great because we saw the market really turn early this year, both in terms of the number of quotes we're giving and the take rates of existing systems."

Chrysler, for example, ramped up installation of blind spot detection on its Town and Country van, and the feature was so well received the carmaker decided to make it a standard feature going forward. Chrysler is the company's largest blind spot warning customer, followed by Daimler. A utoliv also has business with GM, which it expects to grow significantly.

A utoliv has focused on developing near-range applications like blind spot warning for its ultra-wideband radar. Mr. Rodé explained that ultra-wideband is the superior technology, with the best resolution in ranges shorter than 60 to 80 meters. He believes A utoliv is the market leader in blind spot detection, both in performance, with ultra-wideband yielding fewer false positives in testing compared with competitors' products, and in price. The company currently has one million units in booked radar business. By 2013 it will be shipping in the range of 1.5 million radar sensors annually.
Radar sensors cost OEMs roughly $130 each today; that price is expected to drop to near $80 per sensor by 2013. Blind spot systems typically require two sensors per vehicle.

For longer range requirements such as adaptive cruise control, Autoliv is developing narrow-band sensors. According to the company, its radar could also provide front and side pre-crash sensing by scanning up to 30 meters around the vehicle. The additional time gained before a collision could be used to prime airbags and activate seatbelt pretensioners.

**Night Vision**

A utoliv has about a 40% share of the small but growing night-vision market, estimated at $90 million in 2010. The market is expected to grow to $250 million by 2015.

The company decided in 2000 to focus development efforts on far infrared, believing that while more expensive than near (or active, meaning IR illumination is required) infrared, a passive heat-sensing approach with far infrared had more potential in safety systems because it would provide more accurate detection of people and animals. A utoliv's first night vision system went into production in 2005. Pedestrian detection and warning was added in 2008; BMW was the first carmaker to install the A utoliv system, followed by Audi and Rolls-Royce. The infrared bolometers, a critical component of the camera, are supplied by FLIR.

A utoliv night vision can detect a pedestrian up to two times farther away than headlight range would illuminate. Using algorithms developed by A utoliv engineers in Linköping, Sweden, the system analyzes the scene content and vehicle dynamics to determine if a pedestrian is at risk and if so alerts the driver two to four seconds, depending on the driving environment, prior to a potential impact. According to A utoliv, the risk for pedestrian fatalities is four times greater at night. Its next generation of night vision, due in 2012, will also have animal detection capability. Surprisingly, in the U.S. alone there are 1.5 million car accidents per year involving deer, said M. R. Rodé, and another half million in Europe.

Cost reduction of night vision is A utoliv's goal. Currently night vision with pedestrian detection and warning costs about $1,000, not including a monitor. "By 2013 we will have reduced the cost to less than half what it is today. We are aiming for something in the range of $250 for the system by 2016," M. R. Rodé said. Future systems will not require a display; the driver can be alerted by a visual, audible or haptic warning.

**Vision**

A utoliv has developed active safety systems based on single and stereo cameras, targeting what it sees as the three core segments of the forward looking vision market: automatic street sign recognition, lane departure warning and high beam assist. While the vision market today is fragmented and crowded with many players, M. R. Rodé believes future safety systems will require a combination of vision, night vision and radar with software as the competitive differentiator.

"Monovision cameras are a commodity, something we believe we can buy from low cost manufacturers. Our goal is to have the best system and our algorithms will make the difference. Our vision development is focused on safety applications. That's the pattern we've followed with night vision and radar," he said.

In the long term, A utoliv foresees combining forward-looking radar, vision and night vision sensors into a single system that would serve multiple applications.
V2V Communications...

have the system, Dr. Weiss expects the first applications of V2V in Europe to be informational, providing warnings about emergency vehicles, traffic jams or bad weather conditions. Information provided by V2V will later be applied to adaptive cruise control systems— not to replace the radar sensor and camera, but to complement those sensors.

V2V will provide extra information that will significantly improve autonomous braking systems. "The biggest advantage of V2V is you get more range, and that will let the vehicle start its correction sooner," said Q-Free's Mr. Evensen.

Ygomi's Mr. Shields thinks V2V's impact will be seen mostly in rural areas where its ability to see beyond the reach of radar and cameras can prevent intersection collisions and head-on collisions. He agreed that V2V penetration will probably start around 2016 and take up to six or eight years to become pervasive enough to have a major impact on safety. At that point he estimates it could reduce highway deaths by 20%. In the U.S., that would save more than 7,000 lives a year.

The aggressive stance on V2V taken by the U.S. government has invigorated the community of researchers and standards makers, many of whom have been working on the technology for more than ten years. Mr. Evensen predicted: "If V2 V gets going in the U.S., then European carmakers, particularly those up-market brands with a safety reputation, will have to also introduce this in their other major markets. They will not be able to sell cars that save lives in the U.S. and not sell them in Europe."

At an October 2010 meeting of the Car 2 Car Communication Consortium in Boulogne, France, a representative from Renault indicated that Renault is aiming to introduce a vehicle with V2V onboard by 2015. Renault officially does not confirm any such plans and stated that no decisions have yet been made, even as to whether the 5.9 GHz spectrum would be used.

In early 2009 several Japanese government agencies jointly conducted large scale field tests of V2V safety applications, according to Kaoru Seki, senior chief researcher, ITS Center, Japan Automobile Research Institute (JARI). Onboard communications units using both the 5.8 GHz band and 700 M Hz were evaluated. The Japanese are considering 700 MHz especially for collision avoidance at intersections because it is better than 5.8 GHz at penetrating large buildings. Toyota is a supporter of research in the 700 M Hz band and Denso provided the onboard units for the 2009 test.

Toyota...

unit," said Mr. Pisz. "When the information comes from the connected mobile device to the head unit via Bluetooth, it is displayed much like a video would be uploaded to a PC. ... We have programmed each application so what is displayed on the vehicle's display looks quite like the mobile application you are familiar with, so you don't have to rethink the user interface, and that makes it less distracting." Like Sync, Entune connects to the cloud by means of the driver's smartphone. It doesn't have an embedded modem.

The Entune platform provides access to Microsoft's Bing search engine, MovieTickets.com, and OpenTable for restaurant reservations. All destinations found can be sent to the navigation system, which provides directions. Entune also delivers real-time traffic from INRIX, as well as fuel prices, weather, stocks and sports reports. Entune senses the vehicle's GPS location and provides local information.

A further distinction compared to Ford Sync according to Toyota is the voice recognition capability provided by Entune, which the carmaker describes as best in class. "Our casual language speech processing is much easier to use than Sync's," said Mr. Pisz. The way the speech processing is done varies depending on which tier-one supplier built the system.

**Denso and Harman Supply Head Units**

For the Entune head units, Toyota split the business between **Denso**, which got the high-end system with seven-inch display, and **Harman International**, which developed the next two classes down from the high end, each of which have a six-inch display. The bottom two classes don't have a display.

The Denso system uses **VoiceBox's Conversational Voice Platform**. Rather than loading A SR (A utomatic Speech Recognition) software in the vehicle, the Denso Entune system records the speaker's commands and sends a WAV file to be interpreted offboard. It then goes to the Bing server to get the requested information, which is sent back to the car through the cellular network.

Entune systems supplied by Harman use embedded Nuance automatic speech recognition software.

For Harman to win a significant piece of the infotainment business with Toyota is noteworthy, given Toyota's habit of awarding such business to keiretsu partners Denso and Aisin Seiki, two companies that are partially owned by Toyota. A sked why Toyota chose Harman, Mr. Pisz said, "Harman is a very capable supplier and we use their Mark Levinson branded audio system, so they aren't strangers to us."

While many of the components used in Harman's Entune system are different from the components used in Denso's Entune—for example, Harman uses the QNX operating system and Denso uses a proprietary operating system—the two systems have in common a single software systems integrator: **Tweddle Group Technologies**. Formerly called UIE A utomotive, Tweddle Group Technologies was a joint venture between UIE Evolution and Tweddle G roup. UIE A utomotive created myCA R, a mobile technology platform for delivering information- and location-based services. Tweddle Group Technologies has offices in Seattle, Detroit and Shanghai.

Entune was developed at Toyota's facilities in Torrance, California.