Satellite Radio’s Success Still Uncertain

Few big, new automotive electronics products are being offered to the market in these days of de-contenting and cost reduction. One exception to that rule is digital satellite radio, which is finally emerging after a long and much delayed development process. If subscription satellite radio is widely successful, high volume production of its components will boost automotive electronics content in the typical U.S. vehicle, ultimately by about $20. At a 50% penetration, the OEM market for satellite radios in the U.S. could grow to as much as $159 million annually.

Despite extensive market research, nobody really knows the extent to which consumers will sign up for the subscription service. Market analysts will be carefully watching this year’s Christmas season sales, because even though in the long run most automotive satellite radios will be sold by carmakers, retail sales must carry the load for now. The two U.S.-licensed satellite radio providers, XM Satellite Radio (Washington, DC) and Sirius Satellite Radio (New York, NY) are both struggling financially, but Sirius’ financial predicament today is the most extreme.

Background

In 1997, the FCC granted licenses to Sirius, which was founded in 1990 and to XM, founded in 1992. Both companies offer roughly 100 stations of digital radio, which for music sounds as good as a CD. Each company operates its own satellite system: Sirius was first to get its three satellite network in orbit, but XM, with two satellites, was first to market with real programming and radios in the pipeline. XM Satellite Radio requires a $9.99 per month payment and Sirius Satellite Radio charges $12.95 per month, plus both are sold by carmakers, retail sales must carry the load for now. The two U.S.-licensed satellite radio providers, XM Satellite Radio and Sirius Satellite Radio are both struggling financially, but Sirius’ financial predicament today is the most extreme.

L I N Standard Going Global

Since late 1998 when the LIN (local interconnect network) Consortium was established, LIN planners wanted LIN to be a global standard. To meet that objective, their strategy was to first get LIN ready for production in the member companies’ vehicles. Once production was assured and the LIN standard pretty much frozen, the consortium turned its attention to the American carmakers and others in an effort to promote widespread adoption of LIN. This strategy is similar to the approach used by the MOST (Media Oriented Systems Transport) Cooperation, the multimedia fiber-optic network consortium, which successfully established MOST as a global standard. Two of the key founders of MOST—BMW and DaimlerChrysler—are among the founding members of the LIN consortium.

To advance the process of making LIN an international standard, the LIN Consortium invited interested parties from Europe, Japan and the United States to attend its first international conference in Ludwigsburg, Germany, outside of Stuttgart. The two-day conference, in German and English, opened on September 19, 2002, and attracted more than 200 people from around the world, twice what was expected, said Gerd Teepe, head of strategy and the advanced systems lab at Motorola SPS in Munich, Germany. Motorola is one of LIN’s founding members. “We had very positive feedback from attendees who told us they didn’t know that LIN already had so many companies offering products, services and tools,” said Mr. Teepe. More than ten companies exhibited at the meeting, including Motorola, which introduced a new 8-bit microprocessor, an analog product and a mechatronic product.

L I N and S A E

At the Ludwigsburg meeting, Mark Zachos, who runs the Dearborn Group, Farmington Hills, Michigan, made a presentation on ways that the LIN specification might be improved in order for it to be accepted as an SAE standard.

Turn to LIN, page 3

L I N Basics

◆ Definition: LIN (local interconnect network) is a low-cost, low-speed serial data communications network intended for distributed electronics systems in passenger vehicles. LIN is an open standard, no royalties or payments are required. The LIN protocol is based on the UART protocol used in most personal computer modems. LIN uses a single-wire, 12-volt bus on which there can be no more than 16 nodes, or connection points. Typically each LIN network will have no more than 12 nodes. Besides the basic protocol specifications, LIN is supported by a LIN development environment, a set of tools to help carmakers and their suppliers develop, test and implement LIN networks. A low-speed network, LIN will coexist on vehicles with a number of other networks, CAN for mid-speed data communications, FlexRay for X-by-wire, MOST for mid-speed multimedia and IEEE 1394 for high-speed multimedia.

◆ Typical Applications: LIN sub-buses in the roof, steering wheel, seat, door or climate control system. Each LIN sub-bus can be connected to a main vehicle CAN bus.

◆ Consortium Founders: Mercedes, BMW, Volvo, Audi, Volkswagen, Motrola (microcontrollers) and Volcano Communications Technologies (development tools).

◆ Benefits of LIN:
- Low cost
- Easy to implement
- Covers standards for hardware components
- Special features unique to a vehicle brand can be implemented with software.

According to Mercedes, LIN networks cost no more than a hard-wired alternative.

◆ Competing Standards: None
companies require a one-time activation charge between ten and fifteen dollars. The radio itself costs from $200 to $400 retail. Since satellite radio transmissions don’t penetrate buildings, bridges and mountains, each company had to set up terrestrial repeaters that transmit the satellite programming at a different frequency. To prepare for nationwide rollout, both companies had to set up all of their original program channels and keep them operating, regardless of how few, if any, paying subscribers they had. A s a result, both companies have piled up a great deal of debt.

As of June 30, 2002, XM owed $514 million and Sirius owed $720 million. Because neither company will break into the black for another three to six years, they will need to raise hundreds of millions in additional capital to keep their businesses running. A c c o r d i n g t o t h e W a l l S t r e e t Journal Online, XM needs to raise $300 million to fund the company through 2003 and another $300 million to fund it through 2005.

Raising funds has become all the more difficult given the state of the U.S. stock market and the extremely low valuations the market has given to satellite radio stocks. O n O c t o b e r 8, 2002, XM was trading in the range of $2.23 per share, down drastically from its peak in M a r c h 2000 of $50. O n the same day, Sirius’ stock was trading at 92 cents a share, down from its all-time high in 2000 of nearly $70 a share. It’s hard enough to raise borrowings in the face of historically low stock prices but both companies also have poor credit ratings. A s of S e p t e m b e r 16, 2002, Standard and Poor’s rated XM at CCC + and Sirius slightly worse, at CCC. In S & P’s parlance a CCC rating means that lenders are vulnerable to non-payment, particularly if business, financial and economic conditions worsen.

**Sirius Worse Off Than XM**

Sirius’ low stock price is a reflection of the many woes the company has faced since its founding—technical, managerial and financial. Sirius’ future financial health is very much dependent on its key partner, Ford, which has been remarkably reticent and inconsistent about whether and to what extent it would make Sirius radios available in its new cars and trucks. Just this past O c t o b e r 8, Ford announced which brands would offer Sirius radios, but made no commitment on which models. A nd further, Ford hasn’t been a major financial backer to Sirius, nor will it be in the near future. Ford has plenty of cash-flow problems of its own.

In contrast, General Motors is much more committed to supporting and promoting XM. G M expects to sell between 350,000 and 400,000 XM-equipped cars in the 2003 model year. G M is by far XM’s largest shareholder; together, G M, Hughes Electronics and Direct TV own 47% of the company.

Despite starting sooner, Sirius has come to the market seven months later than XM. Some of its biggest delays can be traced to the chip set, which, given the underpinning radio technology, was much more difficult to build than the XM chip set. The first Sirius chip set, consisting of 8 chips, was late and needed to be housed in a box roughly the size of a video tape cassette. In 2000 Sirius’ chip maker, Agere of Allentown, Pennsylvania, was quoted in EE Times saying that its lateness with the chip set led up radio shipments but that was because Sirius was late getting their satellites ready. Since then, Agere has developed a chip set that fits into a housing about the size of a credit card. ST Microelectronics exclusively makes two-chip sets for XM.

**Satellite Radio Market**

These are tough times. Consumers are getting tighter with their money, as the recent drop in U.S. consumer confidence indicates. A n o t h e r w e t b l a n k e t c o u l d b e thrown by IBOC (In-Band-On-Channel) digital radio, a free service, which competes directly with satellite radio. The FCC just approved IBOC and soon existing radio stations will begin broadcasting digital radio signals, which will sound much better than analog AM will sound like FM and FM will sound like CDs.

The short-term success or failure of XM and especially Sirius is now largely in the hands of consumers. If consumers immediately run by the hundreds of thousands to aftermarket retailers and to car dealers to sign up for subscriptions, financial backing will be easier to find. B u t i n t h e l o n g r u n , t h e f u t u r e o f s a t e l l i t e r a d i o **continued on following page**
Satellite...

Agreements with Carmakers

In the long run, Sirius' and XM's success will rest on the successful penetration of their subscription service into factory-installed satellite radios. Today there are two different radios, one can only receive XM signals, the other can only receive Sirius signals. Several years from now, a single receiver will be developed that can receive both broadcasts.

Agreements with Sirius

BMW: Sirius radios will be available on the 2003 model year BMW Mini, 3 series, 5 series and X5 as a dealer-installed option.

DaimlerChrysler: Available starting in Q4 2002, Sirius will be a dealer accessory on 17 Chrysler and Mercedes models; satellite radios will be factory-installed on the PT Cruiser Dream Car and the 300M beginning in January 2003. Delphi supplies the radios.

Ford: Slow to develop and stick to an implementation schedule, Ford now says it has begun to make many of its models Sirius-ready. Beginning in calendar year 2003 and into 2004, Sirius will be offered on some select Ford, Lincoln, Mercury, Volvo and Land Rover vehicles. Mazda is expected to announce Sirius availability soon. Visteon will supply the radios.

Honda*: Sirius might be offered at a future date.

Nissan/Infiniti*: Over the next several months Nissan and Infiniti will make Sirius radios available on a total of 7 different 2003 models including the Infiniti Q45, M45, I35, G35 and FX45. The Nissan Pathfinder is already Sirius-ready; the new crossover vehicle, the Murano, will soon.

VW/Audi*: VW has an agreement with Sirius, but the rollout has not yet been announced.

Agreements with XM

GM: XM radios will be available on 25 GM models, starting this fall. GM is the only OEM widely offering factory installation on 2003 models. GM first offered XM on the MY 2002 Cadillac Seville and DeVille in November 2001, but its current rollout also includes moderately-priced cars like the Cavalier. As part of the distribution agreement, XM agreed to subsidize a portion of the cost of the radios and to make incentive payments to GM when the owners of GM vehicles subscribe to the service. Plus, GM receives a percentage of the subscription revenue.

Isuzu: XM has been available from dealers on the Axiom and Rodeo since April 2002. Isuzu dealers can also retrofit Rodeos back to the 1998 model year.

Honda*: XM radios can be purchased on the Accord, MDX and Pilot models starting with the 2003 model year. Honda has just barely begun its rollout.


VW/Audi*: VW has an agreement with XM, but hasn’t yet announced rollout plans.

*Has agreements with both Sirius and XM

L I N ...

Mr. Zachos is chairman of the SA E task force that will write J2602, the SA E standard based on LIN. That task force includes representatives from Ford, GM and Motorola. While the primary goal of both the SA E and the LIN consortium is a single, global standard, each side has some legitimate concerns that must be addressed before that will happen. Key LIN people stress that they want to accommodate SA E requests, but they are worried that in doing so a different LIN spec might emerge that isn’t backward compatible with existing LIN networks already in volume production at Mercedes.

The SA E task force is most concerned about interoperability; they want to be certain that any sensor, switch, motor or light, regardless of the manufacturer, will work in any LIN network. Secondly, the SA E task force would like the bit rates to be set at two or three frequencies. The current version of LIN permits any frequency from 2 Kbps (kilobits per second) up to 20 Kbps. While LIN recommends data rates of 2.4, 9.6 and 19.2 Kbps, the SA E task force is likely to request fixed bit rates of 10.4 Kbps and 19.2 Kbps. “While the SA E has some preference for one or possibly two bit rates only, we don’t want to restrict any of the adopters, in Europe or elsewhere, from using whatever bit rate they want to,” said Mr. Zachos, sounding quite flexible. SA E likes 10.4 Kbps, he added, “because it is easily implemented with standard UART and crystal oscillators and is compatible with CAN frequencies.” UART (universal asynchronous receiver-transmitter) is the most common type of receiver-transmitter circuit used in personal computer modems.

A noted potential sticking point, said Ford technical specialist Tim Thomas, is EM C (electromagnetic compatibility). “We on the J2602 task force want to make sure that LIN meets all of the OEMs’ requirements for EM C testing.” A according to Rich Means, also from the Dearborn Group, carmakers in the States are already using 10.4 Kbps. “It works well and we’ve done a lot of EM C testing at 10.4 Kbps.”

Beyond EM C and fixed operating frequencies, there are some other unnamed concerns. The SA E task force will meet on October 17 at Motorola facilities in Farmington Hills, Michigan, to decide exactly what changes it would like the LIN Consortium to consider. Those requests will be presented formally to the LIN Consortium soon after the October 17 meeting.

Despite these areas of discussion, both sides expect that North America and European interests will come together, and we’ll have one LIN standard for Europe, North America and eventually Japan. Said Claas Bracklo, the top network engineer at Mercedes and leading LIN advocate, “the most important point for me is to harmonize the SA E activities with the LIN activities, rather than having two competing standards. Mark Zachos shares Mr. Bracklo’s wish. In a note to the Hansen Report he wrote, “We are seeing great cooperation between SA E and the LIN Consortium in developing a single worldwide specification for the new LIN protocol.” An agreement that continued on page 8
**The Company Profile... Siemens VDO Automotive AG**

- **World Headquarters**: Regensburg, Germany
  - 2001 Sales: €5.7 billion* ($5.6 billion)
  - 2002 Sales Estimate: €7.7 billion ($7.5 billion)
  - 2001 R&D: 9.6% of sales
  - 2002 R&D Estimate: 8% or less, down from 10% to 12% of sales each company typically spent separately on R&D
  - 2001 Capital Investment: €362 million ($354.3 million)
  - 2001 EBITA: negative €261 million ($255.3 million)

- **Top Products**: Diesel and gasoline direct injection systems, instrument clusters

- **Employees**: At fiscal year-end 2001 employee count was 44,879, including 5,500 in engineering work.

*2001 sales included €1.7 billion ($1.66 billion) from VDO, which accounts only for the period from May 2001 through September 2001, after the merger with VDO was completed.

Note: 2002 fiscal year ended September 30, 2002.

**Background**

Parent Siemens AG, with €87 billion ($85.1 billion) in sales and 484,000 employees at year-end 2001 is the second-largest maker of electrical and electronics goods in the world, second only to IBM. A world leader in information and communications, automation and control, power generation and distribution, medical and transportation systems, Siemens (Munich, Germany) created its automotive division in 1985. Siemens Automotive soon began investing heavily in acquisitions, including the purchase of Bendix Electronics from Allied Signal in 1988, which boosted Siemens Automotive into competition with Bosch and Motorola, the two largest independent, global auto electronics suppliers at the time.

Siemens’ largest and most recent acquisition, Atecs Mannesmann AG, resulted in the merger of Atecs’ VDO business with Siemens Automotive, creating the world’s third-largest maker of automotive electronics. Only Bosch, number-one, and number-two Delphi sell more automotive electronics products.

VDO, founded in 1921 and family-owned until 1986, began as a manufacturer of dashboard instrumentation and grew to be a world-class supplier of vehicle information and control systems, counting BMW, GM, Mercedes and Volkswagen among its top customers. Mannesmann Group acquired controlling interest in VDO in 1991, beating out rival bidder Siemens AG.

**The Siemens VDO Merger**

Final regulatory approvals for the merger of VDO and Siemens Automotive were completed in mid-April 2001. Siemens transferred all assets at that time for the start of business in May. A long time in the making, efforts to effect the merger began in earnest in April 2000 when Robert Bosch GmbH and Siemens Automotive jointly made an offer to acquire Atecs. Subsequently, to comply with EU antitrust regulations, Bosch and Siemens split up Atecs. Siemens took over the Atecs companies VDO, Sachs, Dematic (minus Dematic’s postal automation equipment business) and Demag industrial equipment; Bosch was given control of Rexroth, which was merged with Bosch’s automation technology business.

In September 2001, Dr. Franz Wressnegger, Siemens’ automotive board chairman and group president of Siemens AG’s worldwide Automotive Systems Group, announced the official launch of Siemens VDO, citing the...
synergies that would come to the new organization. “Our united company will benefit our customers in the form of even more integrated solutions.” While before the merger Siemens already had a leading position in gasoline engine technology with its direct gas injection system and common rail diesel injection system with piezo actuators, VDO brings additional gasoline engine technology, including its Variable Lift Control, fuel pump module and electronic throttle control products. A nother example of how the combined expertise of Siemens and VDO might benefit customers is the Java-based Top Level Architecture (TLA) introduced in 2001. Developed by Siemens VDO, TLA defines open interfaces and protocols that will allow future vehicle infotainment systems, both hardware and software, to be easily updated. 

While sales of some product segments such as powertrain have grown, that growth was offset by some divestments, for example, Siemens’ wire harness business, valued at €450 million ($440 million), was divested in 2001. In another cost-cutting move, on October 29, 2001, VDO North America announced that it would close down its Winchester, Virginia, production facility.

Business Climate
Siemens VDO operated at a loss in fiscal 2001. In a year-end speech, Dr. Wressnigg, who served as the first CEO of Siemens VDO, accounted for the shortfall as follows: “A part from the extraordinary expenditures in conjunction with the merger, the most significant effects have come from the slump in the automobile business in the USA, the increased purchase prices for electronic components resulting from the high dollar exchange rate, and the slowdown in production stemming from the shortage of electronic components. During the [2001] business year, considerable capital investments have been made in the establishment and expansion of our diesel injection technology.” On July 1, 2002, Wolfgang Dehen succeeded Dr. Wressnigg as CEO of Siemens VDO. Dr. Wressnigg currently holds a position on the Supervisory Board.

The Aftermarket segment of Siemens VDO brought in about $600 million worth of sales in fiscal 2001. Before the merger, Siemens Automotive had only about $260 million in aftermarket sales. VDO brought a number of brands familiar to consumers including Dayton, VDO and Kienzle.

According to John Sanderson, president and CEO of Siemens VDO Automotive’s North American operations, since automotive electronics comprise 50% to 60% of each company’s product line, the combined Siemens VDO will still be able to distinguish itself as “focused on electronics,” compared with other suppliers who make more mechanical, hydraulic and electrical parts than electronic parts. Still, said Mr. Sanderson, “Bringing the two companies together was very hard work, but I feel very confident about what we have and where we are going.”

How is the current business climate affecting Siemens VDO? “In the past...
couple years,” explained Mr. Sanderson, “things have gotten tougher than they have been, both in the U.S. and in Europe. Car production has been flat in both regions.” In the United States, price is the issue as consumers shop carefully for low prices and carmakers have deeply discounted new vehicles. That has kept supplier parts prices down. “In the U.S. for the past ten years or more, there has been a constant gap in the ability to pass on price increases for new features, no matter how interesting they are,” said Mr. Sanderson. In contrast, European and especially German carmakers have over the years found it less difficult to pass along price increases to consumers, though not at this time.

As of August 2001, Siemens VDO was planning to achieve EBITA (earnings before income taxes and amortization) of between 5% and 6% by fiscal 2003.

Technology

John Sanderson observed, “Over the last decade, new technology is not normally introduced first in the United States.” For example, European carmakers were the first to introduce fiber-optic (MOST) and copper networks (CAN), and stability control systems. The Japanese lead in fuel-efficient engine design and with navigation equipment. In North America, the trend for the last few years has been to use new technology for cost reduction, through the integration of functions, rather than to introduce new electronics features.

As they continue to force down prices, carmakers are putting the squeeze on supplier profits, and that has made suppliers scrutinize their R&D budgets more carefully. Also, especially in the United States, carmakers have learned that most consumers are unwilling to spend a lot of money on expensive high-tech features. “As a result,” said Mr. Sanderson, “suppliers shouldn’t be doing a lot of courageous engineering work if the end user is not going to pay a premium for it. ... Over the last few years, we have realized that we must be more selective and take greater care about which new technologies we introduce.” That’s not to say that Siemens VDO intends to dramatically lower its R&D budget. For Siemens VDO, R&D is essential. Mr. Sanderson emphasized, “We need sales growth to sustain profitability, and we need innovation to get the sales growth. Without profits, we can’t afford innovation.”

Prior to the merger both companies spent generously on R&D, compared with the competition. Siemens Automotive and VDO, with sales of about €3.4 billion ($3.3 billion) apiece, spent about 10% or 12% of sales on R&D. But while there wasn’t a tremendous amount of overlap in business fields when the two companies merged, Siemens VDO will be able to integrate R&D spending in telematics and navigation products, where both companies had business before the merger.

Siemens VDO also benefits from the enormous research capability of parent Siemens A.G. For example, the piezo crystal technology used in Siemens VDO common rail diesel systems was initially developed by Siemens A.G. Central Research Group.

New and Emerging Products

◆ Piezo Common Rail Diesel Injector Systems

Siemens VDO’s piezo common rail fuel injector is expected to bring more new sales to the company than any other new product. Since 1995, Siemens has invested more than $84 million in development of the piezo actuator. The world’s first supplier to make piezo common rail fuel injection systems, Siemens shipped a low-volume order in 2000 to Peugeot Citroen Group (PSA) for installation in the Peugeot 307. The first high-volume order for the piezo fuel rail system came soon after, again from PSA, for installation in the 2001 Citroen C3. This business, representing 500,000 units total was awarded in phases. Siemens VDO was awarded the first phase, but not the entire engine program.

This year, Siemens VDO will produce about two million units; by the end of 2005 the cumulative total will approach 10 million units, according to Siemens VDO. No other supplier has been able to ship volume production orders of fuel rail systems that are based on piezo actuators. Both Bosch and Delphi have stated their intentions to move to a piezo electronic system, but both are still a couple of years away. Common rail systems made by Delphi and Bosch today use solenoid actuators, a technology that’s been around for decades. The Siemens VDO actuators are made from piezo crystals, which respond to an electric charge by expanding. Because they are four times faster than solenoid, piezo actuators allow significantly greater precision in the diesel fuel injection process, including the ability to measure minimal quantities of fuel with extreme accuracy and to start injection more accurately.

More precise control helps diesel engines perform more quietly, with greater fuel efficiency, better performance and fewer emissions. And because diesel fuel is packed with 30% more energy than gasoline, diesel engines are significantly more fuel-efficient. Diesel engines are very popular in Europe where fuel economy and reduction of CO2 emissions appeal to consumers. Diesel engine penetration in Europe will grow from about 40% today to 50% by 2005 or 2006, with the fastest growth in France and Germany, according to a report by Ricardo Consulting Engineering (U.K.).

Key Emerging Technologies

Piezo common rail diesel injection systems
Air-fuel modules and complete air induction systems
Electronic throttle controls (ETC)
Mechatronic transmission controls
Multipoint, multiloop airbag controllers
Pressure sensor satellite for side airbags*
Electromechanical braking systems (EMB)*
24 GHz near-field radar sensing*
Occupant weight and classification sensors for airbags
Tire pressure monitoring systems
Intelligent switching units
Electronic climate-control units*
Window closure force limitation motors with anti-pinch
Passive keyless entry
Human factors optimized instrument clusters
Commercial vehicle mobile office systems
Advanced driver information and navigation systems
Re-configurable displays
Vehicle cockpit systems

*Not yet in high-volume production
Instrument Clusters and Driver Information Systems

Siemens VDO is Europe's number-one supplier of instrument clusters, a position VDO held before the merger. Over the last few years, VDO has picked up important new business from Mercedes and from BMW (7 series), which Siemens VDO says put the company in the forefront of the instrument business.

Siemens VDO expects carmakers will want the ability to present greater amounts of information without risking driver safety. The company took just 30 months to develop a brand-new three-gauge cluster for the Mercedes E class W/S211 (wagon/station wagon) and CLK class A/C209 (cabriolet/convertible/coupe) vehicles.

The new Mercedes cluster includes three stepper-motor driven gauges. In the center of the speedometer is a multipurpose display with two different cells. One is a 120 x 126 pixel dot matrix LCD illuminated with LED back-lighting; the second display employs 60 light segments arranged in a circular pattern. The dot matrix display can handle turn-by-turn navigation graphics, more than 240 warnings and a wide array of messages. It is also capable of presenting information in several languages including German, French, English, Italian, Spanish and Japanese. A 32-bit microcontroller controls the gauges and the multifunction display. It also handles a CAN bus. The cluster has a very thin profile front-to-back, thanks to a patented aluminum/plastic manufacturing process. Siemens VDO can produce about 1,500 clusters per day. At about $400, the Mercedes cluster is nearly four-times more expensive than the simple, low-tech clusters used in moderately priced vehicles.

Head-Up Displays

A decade ago, Delco Electronics was the world’s first supplier to introduce head-up displays (HUDs), but the price was high and the market was cool so demand never reached high volume. Siemens VDO has been working on its own version of HUD in response to concerns that drivers will want more information, and they will want it presented in a way they can process it safely. According to a Siemens VDO press release, “The average driver requires one second to read information from the instrument cluster; HUD cuts this time in half.” The HUD will present an image in color, and according to Siemens VDO spokesman Dave Ladd, “With color, you won’t lose images, there is no wash-out in the sun.”

HUDs project graphics and alphanumeric data a couple of meters beyond the windshield, in the area where the driver normally looks as he keeps his eyes on the road. “We look to HUDs as a place to put our navigation display instead of down in the center console,” said Mr. Sanderson. At the Geneva Motor Show in March 2003, a European carmaker will announce its plans to start factory installation of Siemens VDO HUDs in an upscale vehicle. In a company statement, Siemens VDO says that North America represents the biggest potential market for HUD.

Tire Pressure Monitors

Tire pressure monitoring promises additional new revenues to Siemens VDO. The company developed its tire pressure monitoring system following a survey it did with Renault in 1998. The companies learned that European consumers wanted tire pressure monitoring to be featured in driver information systems.

While the demand in Europe may come from consumers, tire pressure monitoring will soon be required by law in the United States. NHTSA’s ruling in response to the U.S. TREAD Act of 2000 directs carmakers to begin phasing in some sort of tire monitor on new vehicles, beginning November 1, 2003. Carmakers can meet the requirement with either a monitor that directly measures tire pressure or one that indirectly measures tire pressure based on wheel speed. In time for the 2006 model year, the mandate is likely to forbid the use of indirect measurement and require that all vehicles use direct pressure measurement, which is more accurate than indirect. The initial phase-in schedule calls for 10% of light vehicles to be in compliance (using either indirect or direct measuring) the first year, 35% the second year and 65% the third year. By March 1, 2005, NHTSA will make a final ruling on the long-term requirements, which cover MY 2007 and beyond.

In September 2001, Siemens VDO announced a product and market development agreement with Goodyear (Akron, Ohio) for a system that will continuously display to the driver each tire’s pressure and temperature. High tire temperatures are linked to tire separations and blowouts. A Siemens VDO micromachined silicon sensor with a piezo-resistive sensor will be installed in each tire. The temperature-pressure sensor attaches to the rim of each wheel with a valve-stem nut. Pressure and temperature information is sent wirelessly from the tire to a display device in the vehicle.

Separately from the Goodyear alliance, Siemens VDO has developed its Tire Warning System for other applications. Beginning this past spring, Siemens VDO will ship over one million units annually to Renault. Two North American applications are booked and will come on line in 2003.

How Suppliers Can Help

Always welcome, given the pressure on carmakers to reduce costs, are technologies that reduce vehicle complexity, technologies that lead to greater integration of functions and technologies that increase parts commonality across platforms. Said Mr. Sanderson, “We have seen a shift over the last few years, particularly in North America, toward a greater emphasis on cost reduction.”

Facilities

Siemens VDO Automotive has manufacturing facilities in the following countries:

- Germany (15)
- France (5)
- Mexico (5)
- USA (4)
- Canada (4)
- China (4)
- Czech Republic (3)
- Korea (3)
- Brazil (2)
- Great Britain (2)
- Italy (2)
- Malaysia (2)
- Australia (1)
- Austria (1)
- Hungary (1)
- India (1)
- Indonesia (1)
- Ireland (1)
- Poland (1)
- Slovakia (1)
- South Africa (1)
- Spain (1)
- Switzerland (1)
meets that end is expected by mid-2003 at the latest.

**LIN-Equipped Vehicles**

Mercedes was the first to put LIN networks into production, in 2001. A simple LIN network was used in Mercedes SL vehicles to implement point-to-point connections from the dashboard cluster ECU to the clock display and to the parking-aid display. A bout 20,000 SL’s are made each year.

Mercedes next applied LIN in early 2002 in the E class. E class vehicles are equipped with a LIN steering-column link from the main steering-column module to the volume control switch and the menu switch. The steering-column network will be installed in each Mercedes platform as it comes up for renewal. Eventually other sensors, such as the steering-wheel position sensor could be added to the LIN steering-column network. Starting in the 2004 model year, Mercedes will implement door-control LIN networks that will connect to actuators such as seat adjustment motors, window lift motors and mirror adjustment motors.

In about 2005, Mercedes will begin to implement LIN roof networks, which connect the roof control module to roof opening and closing actuators, to interior light switches and to sensors, such as a rain sensor. By 2010 Mercedes will be using 50 million LIN nodes in production vehicles, said Claas Bracklo. "A nod that's a conservative number. The growth in the number of LIN nodes per Mercedes is expected to continue after 2010.

Besides Mercedes, other carmakers have indicated their intentions to put LIN into production. For example, in model year 2004, Volkswagen will install LIN networks in its new VW Golf and Audi will use LIN in the A8, according to Mr. Bracklo. Audi will use a tire pressure monitoring system made by Beru (Ludwigsburg, Germany). Beru’s second generation Tire Safety System uses a LIN bus to connect the antenna and transmitter to the ECU. The same system will be used by BMW beginning in 2003.

Chrysler will probably be the first North American carmaker to implement LIN networks. General Motors has picked some platforms where it would like to employ LIN buses by the 2007 or 2008 model year.

To follow the developments of the LIN Consortium, visit their website www.lin-subbus.de.

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### Target Applications for LIN

- Roof
- Rain sensor
- Light sensor
- Sun Roof
- Climate
- Steering Wheel
- Cruise control
- Wiper
- Turning light
- Optional:
  - Climate Control
  - Radio
  - Telephone
- Seat
- Seat position motors

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### Estimated World Vehicle Production Growth by Region, 2001 - 2006

<table>
<thead>
<tr>
<th>Vehicle Production (millions of units)</th>
<th>2001</th>
<th>2006</th>
<th>Annual Growth %</th>
</tr>
</thead>
<tbody>
<tr>
<td>W Europe:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger Cars</td>
<td>14.99</td>
<td>15.41</td>
<td>0.55</td>
</tr>
<tr>
<td>Trucks</td>
<td>2.10</td>
<td>2.39</td>
<td>2.62</td>
</tr>
<tr>
<td>Total</td>
<td>17.09</td>
<td>17.80</td>
<td>0.82</td>
</tr>
<tr>
<td>N America:</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Passenger Cars</td>
<td>7.35</td>
<td>8.89</td>
<td>3.88</td>
</tr>
<tr>
<td>Trucks</td>
<td>8.53</td>
<td>9.88</td>
<td>3.08</td>
</tr>
<tr>
<td>Total</td>
<td>15.88</td>
<td>18.77</td>
<td>9.37</td>
</tr>
<tr>
<td>Japan &amp; S. Korea:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger Cars</td>
<td>10.46</td>
<td>11.11</td>
<td>1.21</td>
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<tr>
<td>Trucks</td>
<td>2.11</td>
<td>2.72</td>
<td>2.96</td>
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<tr>
<td>Total</td>
<td>12.57</td>
<td>13.83</td>
<td>2.50</td>
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<tr>
<td>ROW:</td>
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<tr>
<td>Passenger Cars</td>
<td>7.65</td>
<td>10.32</td>
<td>6.17</td>
</tr>
<tr>
<td>Trucks</td>
<td>3.62</td>
<td>7.3</td>
<td>15.06</td>
</tr>
<tr>
<td>Total</td>
<td>11.27</td>
<td>17.62</td>
<td>9.35</td>
</tr>
<tr>
<td>World Total</td>
<td></td>
<td></td>
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<tr>
<td>Passenger Cars</td>
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<td>45.73</td>
<td>2.48</td>
</tr>
<tr>
<td>Trucks</td>
<td>16.36</td>
<td>22.29</td>
<td>6.88</td>
</tr>
<tr>
<td>Total</td>
<td>56.81</td>
<td>68.02</td>
<td>3.67</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Vehicle Fleet (millions of units)</th>
<th>2001</th>
<th>2006</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>W Europe:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger Cars</td>
<td>189.52</td>
<td>198.77</td>
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<tr>
<td>Trucks</td>
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<td>28.62</td>
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<tr>
<td>Total</td>
<td>216.22</td>
<td>227.39</td>
<td></td>
</tr>
<tr>
<td>N America:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger Cars</td>
<td>153.99</td>
<td>150.82</td>
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</tr>
<tr>
<td>Trucks</td>
<td>97.77</td>
<td>116.51</td>
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</tr>
<tr>
<td>Total</td>
<td>251.76</td>
<td>267.33</td>
<td></td>
</tr>
<tr>
<td>Japan &amp; S. Korea:</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Passenger Cars</td>
<td>60.27</td>
<td>65.89</td>
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<tr>
<td>Trucks</td>
<td>23.53</td>
<td>24.89</td>
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</tr>
<tr>
<td>Total</td>
<td>83.80</td>
<td>90.78</td>
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</tr>
<tr>
<td>ROW:</td>
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</tr>
<tr>
<td>Passenger Cars</td>
<td>140.84</td>
<td>177.77</td>
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</tr>
<tr>
<td>Trucks</td>
<td>71.89</td>
<td>92.31</td>
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</tr>
<tr>
<td>Total</td>
<td>212.73</td>
<td>270.08</td>
<td></td>
</tr>
<tr>
<td>World Total</td>
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<td></td>
</tr>
<tr>
<td>Passenger Cars</td>
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<td>593.25</td>
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</tr>
<tr>
<td>Trucks</td>
<td>219.89</td>
<td>262.33</td>
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</tr>
<tr>
<td>Total</td>
<td>764.51</td>
<td>855.58</td>
<td></td>
</tr>
</tbody>
</table>

The increasing use of trucks as passenger vehicles, especially in the U.S., plus the proliferation of “crossover” vehicles makes it difficult to categorize cars and trucks. In the U.S., 95% of vehicles are passenger vehicles; the remaining 5% are medium and heavy trucks and buses.

Data: Pemberton Associates, Rugby, Warwickshire, U.K. Phone and fax +44 1327 260374