The MOST Cooperation is working hard to make MOST (Media Oriented Systems Transport) the world’s number-one standard for high-speed digital audio and video communications networks. Moving in that direction last month, the MOST Cooperation dropped its demand for $0.3 euros ($0.25) in royalties for every node that would plug into the plastic optical-fiber MOST network. That went a long way to winning endorsement from AMI-C (Automotive Multimedia Interface Collaboration), although with or without the AMI-C endorsement, MOST will become an important standard, used not only by carmakers in Germany, but by carmakers worldwide.

Mercedes, BMW, and Audi have already scheduled launches of MOST buses for MY 2002 production. More than a German initiative, Toyota, Saab (GM), Volvo and Jaguar (Ford) have indicated they too will deploy MOST systems within five to seven years. Yet, Toyota, GM, and Ford are also advocating the competing IEEE 1394 (FireWire) standard under the auspices of AMI-C.

We surveyed top electrical engineers at BMW, Ford, GM, DaimlerChrysler, and Toyota about standards including MOST and IEEE 1394. (See box below.) While consumer electronics products like camcorders and DVD players will likely come equipped with 1394 connections, and 1394-compatible vehicles would allow those devices to be plugged into a multimedia bus, none of the carmakers surveyed said it was likely to adopt 1394 standard buses within the next five to seven years, although DaimlerChrysler said maybe. It is not hard, however, to find backers of MOST. Visteon’s multimedia-systems architecture specialist A kram M udif is one of them. Readers looking for more detail might well refer to Mr. Mudif’s technical comparison of Ethernet, IEEE 1394 and MOST protocols in Convergence paper 2000-01-C-028.

Both MOST and 1394 were designed to interconnect information and entertainment components over high-speed digital networks using plastic optical-fiber cables. Such components include DVD players, video games, TV tuners, radio head units, rear displays, front displays, CD players, as well as other communications and telematics devices. Theoretically, automotive implementations of 1394, already widely-applied in larger industries like consumer electronics, would allow greater economies of scale.

These Carmakers Favor These Standards

In our informal poll, top electrical engineers at BMW, DaimlerChrysler, Ford, GM, and Volkswagen indicated that the following standards will probably be adopted in the next 5 to 7 years at their companies.

<table>
<thead>
<tr>
<th>Multimedia Buses</th>
<th>BMW, DaimlerChrysler, Ford (Jaguar, Volvo), GM (Saab), Toyota, VW</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOST</td>
<td></td>
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<tr>
<td>IDB-C</td>
<td>GM, Ford</td>
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<td>IEEE 1394</td>
<td>DaimlerChrysler (maybe)</td>
</tr>
<tr>
<td>Class-A Bus</td>
<td>BMW, DaimlerChrysler, VW</td>
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<tr>
<td>LIN</td>
<td>BMW, DaimlerChrysler, VW</td>
</tr>
<tr>
<td>Safety Critical Buses</td>
<td>BMW, DaimlerChrysler, Audi (part of VW Group)</td>
</tr>
<tr>
<td>FlexRay</td>
<td>Audi (also considering FlexRay)</td>
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<tr>
<td>TTP</td>
<td>BMW, DaimlerChrysler, Ford, GM, Toyota, VW</td>
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<td>BMW, DaimlerChrysler, Ford, GM, Toyota, VW</td>
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<td>Windows CE</td>
<td>BMW, DaimlerChrysler, Ford, GM, Toyota, VW</td>
</tr>
<tr>
<td>Middleware</td>
<td>BMW, DaimlerChrysler, Ford, GM, Toyota, VW</td>
</tr>
</tbody>
</table>

Note: Unless carmakers work together to define the Java standard in a governing body like AMI-C, there will likely be different versions.
AMI-C...

Continued from page 1

compatible multimedia devices. After the steering committee met at Convergence 2000 in October, the German carmakers decided to “take a break” from AMI-C, and they did not attend the AMI-C management committee meeting the following week in Japan. They are leaving the door open, however, to future dealings. “We haven’t committed, but we want to maintain a close relationship with AMI-C,” declared Hainz-Geporg Burghoff, DaimlerChrysler’s top electrical engineer.

Karl-Thomas Neumann, in charge of electronics research at Volkswagen Group, spoke frankly about his company’s view of IDB-C, “We don’t need it.” He speculated on why AMI-C has been unsuccessful to date: “AMI-C’s whole approach is too big and too complex. AMI-C is trying to write the whole story from the beginning to the end, covering every possibility you can imagine: the connector, the protocol, electromagnetic interference, the APIs (application program interfaces), even the applications. When you try to cover so many, nobody pays the maximum. Though, according to the CAN administration, manufacturers pay up to a maximum of $.20 per node sold. Low-volume manufacturers pay a one-time fee of about $20,000, whereas high-volume manufacturers pay up to a maximum of $577 (North America), $617 (elsewhere).”

Major decisions, such as what standards to endorse, would still require agreement by 80% of the steering committee members. AMI-C executive director Russ Shields described the new approach: “Instead of having one big AMI-C team working on 40 or so projects, there will be six or eight teams operating independently, with the interested carmakers supplying people to the teams. There will be a small central core of ten AMI-C people led by Michael Oblett, AMI-C program manager.”

AMI-C played 1394 against the Europeans to get them to drop MOST royalties. They did, so AMI-C should now adopt MOST.”

A nother top official involved in AMI-C, Peter Hüssermann, director of E/E-telematics for DaimlerChrysler, suggested that AMI-C could learn from the MOST Cooperation. Begun the same year that AMI-C got started, the MOST standard is already, or destined to be, a standard in at least six carmakers’ production vehicles. “The MOST model allows you to start with a small group to make decisions more easily, and once you are well underway, you collect interested partners.”

This approach—benefiting from so-called technology jackrabbits—could work at AMI-C, according an AMI-C steering committee member, who pointed out that it worked for Bluetooth. A wireless interconnection protocol, Bluetooth was pioneered by founding members IBM, Intel, Nokia, Toshiba and Ericsson.

German Proposals Embraced

BMW, DaimlerChrysler and Volkswagen believe that fundamental reforms that will allow AMI-C to move more quickly must occur. According to one source, the Japanese also wanted reform but were much less public about it. The Germans put forth an idea that has gained momentum among members: to run with a much leaner baseline budget and organization. The AMI-C steering committee incorporated the German approach into its revised legal agreement. The agreement was drawn up originally to spell out AMI-C’s status as a nonprofit corporation.

A according to the revised legal agreement, project selection would no longer require approval from 10 of the 12 carmakers. Instead, selection would need agreement from only five carmakers. Further, the carmakers would participate only in those projects that were of genuine interest to them, and they would be responsible for the project’s funding. These carmakers would set up a budget for the project with AMI-C-approved suppliers that express interest in working on the project. Later the subgroup would decide either to keep the results proprietary or open them up to all.

CAN Node Sales

Based on separately negotiated agreements, semiconductor manufacturers pay to CAN patent owner Bosch, royalty fees for each CAN node sold. Low-volume manufacturers pay a one-time fee of about $20,000, whereas high-volume manufacturers pay up to a maximum of $577 per node. Though, according to the CAN administration, nobody pays the maximum.

Data: CiA

<table>
<thead>
<tr>
<th>Year</th>
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<tr>
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<tr>
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<tr>
<td>2001</td>
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1999 CAN Node Sales by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>America</td>
<td>9%</td>
</tr>
<tr>
<td>Europe</td>
<td>85%</td>
</tr>
<tr>
<td>Asia</td>
<td>6%</td>
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</tbody>
</table>

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Publisher/Editor Paul Hansen
Senior Editor Heather Parker
Managing Editor Brianne Wolfe
Circulation Manager
The project-focused approach might very well solve another problem: AMI-C’s difficulty in motivating carmakers to do what they say they’ll do. According to a top AMI-C planner, some German carmakers have not contributed to AMI-C as expected. Speaking for Volkswagen, Karl-T homas N eumann explained, “We have to justify to our management what we achieve at AMI-C. If we report back, without even something we could use on production vehicles five years from now, plus a lot of struggle and problems rather than meaningful progress ... we stop sending the best people.”

Where Does AMI-C Go from Here?
AMI-C has put more than a year and much effort into the difficult legal agreement that would make AMI-C a nonprofit corporation. In addition to the new budgeting and project-selection process, the legal nonprofit agreement establishes three regional offices: in southeast Michigan, Japan and southern France. According to one key architect of AMI-C: “We needed a solid legal agreement so we could go to existing standards bodies as one voice. Our attitude has been, ‘You have to go slow to get the fundamentals right, so you can go fast.’”

The new contract now goes out to all 12 carmakers to sign. The Germans will be given plenty of time to consider whether to sign the agreement and commit once more to AMI-C. One key steering committee member believes that they will sign, but says he will not be terribly upset if they do not: “There are enough [carmakers] left; the nine are not only committed, but passionate, and that will carry it. I stopped thinking that this will fall apart.”

In terms of standards implementation, AMI-C’s technical team recently completed the first phase for its current specifications, Release 1, which includes architecture, network and physical elements. AMI-C’s Release 2 program is just beginning. It will develop prototype implementations of the specifications. The prototypes will be AMI-C compliant electronic devices (entertainment, communication and information) that work interchangeably among all vehicle types. The second year of Release 2 will be devoted to testing and validating the preliminary specifications.

AMI-C’s Promise
Despite the difficulties, most of the world’s carmakers remain committed to AMI-C, with good reason, given its promise:
◆ To improve flexibility and expandability to add or remove components
◆ To lower prices for electronics
◆ To reduce time to market for new technologies
◆ To allow the interchange of hardware components and software applications
◆ To provide capacity to upgrade components during a vehicle’s life cycle without major redesign
◆ To provide capacity to smoothly evolve automotive multimedia devices with changing technology

AMI-C has interviewed suppliers who wish to be contributing organizations, and will choose them by December. Between January and March of 2001, AMI-C will gradually bring onboard selected suppliers to officially begin work on Release 2. The minimum contribution to participate is one full-time engineer assigned to work 75% at the AMI-C facility and 25% at their home organization.

MOST...

and give the automotive industry a supply of cheaper electronic components, while minimizing investments in engineering and tool development.

Unfortunately, an automotive optical version of the 1394 standard has not been developed and no one knows what a 1394 system comparable to MOST would cost. This past October, in an AMI-C demonstration at Convergence 2000, the International Conference on Transportation Electronics, GM, Ford, Honda, Nissan and Toyota demonstrated five proof-of-concept vehicles using 1394-bus technology. A Lincoln Navigator, an Oldsmobile Aurora, an Acura, a Lexus and an Infiniti had working multimedia components connected to each other, although most used copper wire, not fiber-optic cable.

Oasis Controls MOST Chips
MOST is an outgrowth of the D2B optical bus protocol, currently in use on Mercedes and Jaguar vehicles. MOST and D2B use the same physical layer. Herbert Hetzel helped invent D2B when he was employed by Becker, and he also worked on D2B when he was with C & C Electronics, the key developer of the D2B protocol. Mr. Hetzel is now the leading strategist and spokesperson for the MOST Cooperation, and he is also president and CEO, as well as a significant owner, of Oasis Silicon Systems. A small company located in Karlsruhe, Germany, Oasis is currently the only producer of MOST chips. With $10 million in sales from chips, development tools and consulting, Oasis Silicon Systems doesn’t manufacture the chips it sells, but has them made by such suppliers as ST Microelectronics.

Advantages of MOST
The world’s leading maker of electronic distribution systems, Yazaki, has been a very influential advocate for MOST, which it calls “the emerging network protocol for in-vehicle multimedia and entertainment applications.” At Convergence 2000, Yazaki was host to the MOST delegation, which demonstrated working MOST prototype components operating at 150 Mbps. Yazaki has published a number of papers on the advantages of MOST; some of the company’s comparisons of IEEE 1394 and MOST follow:
◆ MOST will be less than half the price of 1394.
◆ MOST is three to four years ahead of the 1394 development. According to a multimedia expert at another large auto electronics supplier, IEEE 1394 needs a lot of work to be a standard: five of the seven OSI layers still need to be specified.
◆ IEEE 1394 is an asynchronous communications system, but MOST can transmit data synchronously, a better approach for efficiently transmitting high-quality video and audio. Our multimedia expert told us 1394’s audio quality is not good enough for luxury-car sound systems, like continued on page 8
The Company Profile...

ON Semiconductor

**Headquarters:** 5005 East McDowell Road, Phoenix, Arizona 85008 USA; telephone: 602-244-6600; www.onsemi.com

**1999 Total Sales:** $1,750 million, 8.7% growth over 1998

**Products:** Analog, standard logic and discrete semiconductors for data and power management

**Employees:** as of June 2000, 13,400, of whom 3,000 are at JVs

**R&D:** as of October 2000, 4% of sales

**Transportation Segment Key Products:** Analog and smart-power ICs, discrete, power MOS, and semiconductor devices focused on power management

**1999 Transportation Segment Sales:** $385 million, 5.2% growth over 1998

**Transportation Segment Employees:** 85, as of October 2000

Note: Sales figures include Cherry Semiconductor, acquired April 3, 2000.

**Background**

Before being spun off by Motorola on August 4, 1999, ON Semiconductor was the Semiconductor Components Group, a wholly-owned subsidiary of Motorola's Semiconductor Products Sector. Motorola, which calls the spin-off a management buyout, retained approximately 10% of the stock in the new company and received $1.6 billion in cash and notes from buyer Texas Pacific Group, a private investment partnership with capital of $2.5 billion. Texas Pacific Group still controls 21 of the 25 companies it purchased since its founding in 1993. Texas Pacific initially offered ON stock to the public on April 27, 2000. ON Semiconductor Corporation's logo, a green button with the word ON written across it, symbolizes a switch and emphasizes that the company makes the semiconductors that turn on the technologies that connect us to the world.

ON Semiconductor has 39 sales offices operating in 22 countries and serves customers in 37 countries. The company has nine product development centers: Anaheim and San Jose, California; Phoenix, Arizona; East Greenwich, Rhode Island; Toulouse and Grenoble, France; Roznov, Czech Republic; Hong Kong and Tokyo. In addition to the Phoenix, Arizona location, there are eight other manufacturing facilities, most in countries where labor costs are low: China, Czech Republic, Malaysia, Mexico, Philippines and Slovakia, and also in Japan. To minimize shipping costs and maintain complete control over quality, three of these facilities are total product integration sites, from foundry to packaged and tested products.

ON plans to grow business from within the company and from acquisitions. Since the company will focus on low-cost manufacturing to maximize value to its customers, it will continue to consider Eastern Europe and other global manufacturing sites and opportunities that will help it meet that objective.

Moving from four-inch to six-inch wafers is an example of the company's strategy to be a low-cost manufacturer. The Phoenix, Arizona, COM-1 wafer manufacturing facility began qualifying six-inch wafers with 35 micron features in the third quarter of 2000.

**Spin-Off From Motorola**

CEO and president of ON Semiconductor, Steve Hanson, was senior vice president and general manager of the Motorola Semiconductor Components Group before he came to ON; he was with Motorola for 28 years. Before spinning off the Semiconductor Components Group, Motorola considered many options, including selling the components business to a competitor or setting it up as a separate part of the corporation.

We asked Mr. Hanson about Motorola's decision to spin off the group. "Motorola's long-term strategy is to be a system-on-a-chip company, with microcontrollers and DSPs, not a components company," he said. "In February 1998, when Hector Ruiz came in [to run Motorola SPS], we reorganized the entire semiconductor business at Motorola and created four market-focused businesses. ... We pulled out the analog, logic and discrete businesses and put them in a stand-alone semiconductor components category. They asked me to take that [business], and I told them I would if they would allow me to create some value out of it, instead of bleeding it for all its profit and cash to fund other things [at Motorola]." For the last ten years the components businesses at Motorola generated positive cash flow; between $100 million and $130 million was typical, according to Mr. Hanson.

**ON Semiconductor Sales**

1999 Total (including Cherry Semiconductor): $1,750 Million

**By Market**

- Networking & Computing, 35%
- Analog, 26%
- Discrete (including power MOS & IGBTs), 49%
- Standard logic, 9%
- Europe, 22%
- Americas, 46%

**By Region**

- Japan, 8%
- Asia/Pacific, 24%
- Americas, 46%
- Europe, 22%

**Distinctions Claimed by ON Semiconductor**

- World's leading supplier of analog, logic and discrete semiconductor components
- Third-largest share of automotive semiconductors in the Americas, behind Motorola and Toshiba
- World's seventh-largest analog semiconductor supplier to automotive market
- World's tenth-largest automotive semiconductor supplier

**Toulouse and Grenoble, France; Roznov, Czech Republic; Hong Kong and Tokyo. In addition to the Phoenix, Arizona location, there are eight other manufacturing facilities, most in countries where labor costs are low: China, Czech Republic, Malaysia, Mexico, Philippines and Slovakia, and also in Japan. To minimize shipping costs and maintain complete control over quality, three of these facilities are total product integration sites, from foundry to packaged and tested products. ON plans to grow business from within the company and from acquisitions. Since the company will focus on low-cost manufacturing to maximize value to its customers, it will continue to consider Eastern Europe and other global manufacturing sites and opportunities that will help it meet that objective. Moving from four-inch to six-inch wafers is an example of the company's strategy to be a low-cost manufacturer. The Phoenix, Arizona, COM-1 wafer manufacturing facility began qualifying six-inch wafers with 35 micron features in the third quarter of 2000.**
Technology
Forty-nine percent of ON production is discrete semiconductors, either individual diodes or transistors, which perform basic signal conditioning or switching functions. Despite the trend to integrate semiconductors, the demand for discrete devices is not going away. Randy Frank, technical marketing manager, explained, “Typically, power-supply circuits don’t get integrated, and some discrete devices are so inexpensive, it doesn’t make sense to go to the trouble of integrating them.”

Before the spin-off from Motorola, the components group was investing about 2.3% of sales in R&D. Currently, R&D is 4% of sales, and “moving rapidly toward 5% to 6%, focused on power management and broadband applications,” pointed out Mr. Hanson. ON definitely expects to be running at 5% to 6% by the end of next year.

ON recently brought in a chief technology officer from Motorola, Peter Zdebel, who holds a doctorate from Aachen University in Germany. Mr. Zdebel and the team he is assembling will focus ON’s internal technology work on broadband high-speed data management and on next-generation power management, including smart power. Currently, about 300 of the 10,400 ON employees are in R&D, with 400 in sales and marketing, 500 in administration and 9,200 in manufacturing and information services.

Automotive Industry Commitment
ON is proud of its automotive history, which goes back to 1955 when Motorola first put a high-power transistor into commercial production for automobile radios. In 1961, Motorola started making under-the-hood electronics in volume, beginning with a silicon rectifier for Chrysler alternators.

A number of semiconductor suppliers have become less interested in the auto industry as they have found it more profitable to focus on faster growing markets. ON Semiconductor, on the other hand, is dependent on and committed to the automotive industry: 22% of its sales come from the auto industry. Among major semiconductor suppliers, only Motorola has a higher percentage of sales going to automotive.

In the next five years, the company expects the percentage of its products that go to the automotive market to grow beyond the current 22%. “We love the fact that automotive really does drive quality, cost, and performance for us,” noted Mr. Hanson. “We are committed to QS 9000, and all the capabilities beyond that.” ON is confident in the automotive arena, given its ability to create synergy and to integrate components between the analog and power MOS domains. The company makes almost all the semiconductor components that surround the basic automotive computing core, such as diodes, small signal, power MOS, logic, bipolar power, analog and POWERSENSE (ON’s trade name for smart power devices). ON does not make microcontrollers, digital signal processors or memory devices.

With its analog IC and discrete semiconductor product lines, ON says it addresses 50% of the market for automotive semiconductors, $5 billion of the total $10 billion market. According to ON, the total automotive semiconductor market will grow to $15.1 billion by 2004, an 8.6% annual rate of growth, with the discrete and analog portion of the market remaining almost 50%.

While specializing in power management in automotive applications, ON will move away from custom IC applications for specific customers. Instead it will focus on application specific standard products (A SSP), those semiconductors designed for a particular application but for multiple customers. A good A SSP example is the safety module for an airbag controller, suggested Tim Phillips, product marketing applications manager within the Transportation Business Unit. “You’ve got several standard products that can be sold to any customer, but for the most part, [the module] is designed specifically as a safety system, with power supply and squib driver that actually deploy the airbag.”

Continued on following page
ON Semiconductor

Key Automotive Customers

ATECS Siemens  Lear
Automotive  Mitsubishi
Bosch  Motorola AIEG*
DaimlerChrysler*  Temic
Delphi*  TRW*
Denso  Valeo
Hella  Visteon*
Hyundai AUTONET  Yazaki

*Top 5 customers

Investment in Automotive: Cherry Semiconductor Acquisition

Cherry Semiconductor started in the auto industry nearly 20 years ago, serving Chrysler's in-house electronics manufacturer ELD and also Ford. ON purchased Cherry for $250 million, $220 million of which was financed by borrowing. Sales in Cherry's fiscal year, which ended on February 29, 2000, totaled $129 million, $89 million from the auto industry. Cherry Semiconductor's focus on auto electronics, about 70% of its sales, was a very positive factor in ON's decision to acquire Cherry, which brought analog and mixed-signal expertise back in-house after the Motorola split.

"Motorola kept low-voltage smart power," Mr. Frank pointed out, "ON kept high-voltage smart power, but the Cherry acquisition puts us right back into the low-voltage smart-power arena." A co-locating ON, smart power devices are those that combine low on-resistance power drivers with microcontroller compatible communication and/or fault protection circuitry. ON's smart power devices, called PowerSense, combine the robustness of bipolar with the dense logic capabilities of DMOS, according to the company.

"Cherry fits perfectly with our focus on power management and gives us some unique technology in the BCD arena," related Mr. Hanson. ON is committed to developing the next two generations of BCD technology at the Cherry facility in East Greenwich, Rhode Island, a 260,000-square-foot plant with about 965 employees. Used in smart-power applications, BCD is a hybrid of bipolar, CMOS and DMOS technologies.

In July 2000, ON and Siliconix, a subsidiary of Vishay Intertechnology, expanded their existing alliance to a cross-licensing agreement, giving ON access to Siliconix's TrenchFET and BCD analog process technology.

Cherry, which uses a lot of the same packages as ON, shipped about 150 million devices in 1999, compared with ON, which shipped 19 billion devices. John M. Frank, director of ON's Transportation Business Unit, came from Cherry. "A t Cherry our costs were often not very competitive, but now that we are part of ON, we will have lower costs because of ON's greater economies of scale. We're going to take advantage of some of ON's facilities to drive down die costs and [packaged] assemblies."

Cherry's Products Complement ON's

Interface Products
Multiplex line drivers & transceivers
Intelligent MOS pre-drivers
Sensors
Power Supplies
Precision voltage references
Smart regulators
SMPS (Switchmode power supply)

Drivers
Solenoid/relay/lamp drivers
Gauge drivers
Motor drivers

New Products
ON will make investments in new products, particularly A SSPs (application specific standard products), and in technologies that enhance these strategic areas: 42-volt systems, power supplies, ignition/injection products, body electronics, HID lighting and telematics/in-car multimedia. These strategic areas are each described in more detail below.

42 Volts: "42 volts will definitely happen, and if you want to be part of that in five or seven years, you've got to be focused on it today," advised Mr. M. etro. The automotive industry will begin the transition to 42-volt power supplies in 2002 with some early, limited-volume applications in luxury vehicles and vehicles that promote fuel economy, for example, those with the stop-start feature, which automatically turns off the engine at stops and restarts it when the gas pedal is depressed.

The transition to 42 volts will promote the use of solid-state switches at the expense of electromechanical switches and relays. Since mechanical relays are more vulnerable at 42 volts to arcing and welding of contacts, there will be less noise and more reliability as solid-state devices replace them. Plus, intelligence can be integrated with solid-state switches, an improvement in power management. Reflecting on the fact that an increase in the voltage by a factor of three reduces current by a factor of three for the same power, Mr. Frank noted that with less current, only one-third the die size is needed, so costs of smart power will be lower than at 14 volts.

The transition to 42 volts creates a huge new market worth hundreds of million of dollars annually for power management semiconductors. Good news for ON since it specializes in power management semiconductors, and since its low-cost strategy is right for this market. For example, new DC-to-DC converters will require as much as $8 worth of MOSFETs and $1 worth of diodes per vehicle, plus an additional $6 to $8 worth of analog regulators for each vehicle. A iso required in the transition to 42 volts will be Zener, Schottky and ultra-fast rectifier diodes, about 100 devices per vehicle. Three to six high-side current drivers will be needed per application, five to eight applications per vehicle. ON has already come out with a number of N-channel, MOSFET smart-power devices suitable for 42-volt applications in D2PA K, TO-220, and DPAK packages, handling 30 or 60 amps of current.

"With a 10% to 15% share of the market, ON has been a leader in the 14-volt alternator-regulator market for some time, and we're trying to take that experience and apply it to new systems," added Mr. Phillips. ON ranks the top semiconductor suppliers of 14-volt alternator-regulators worldwide as STMicroelectronics first, Motorola second and then ON Semiconductor, with Motorola expected to drop out, according to ON.

Forty-two volt applications are particularly strong in Europe, according to Wolfgang Stammel, ON regional sales manager for central Europe. "We are about..."
3 to 4 years ahead of the U.S. in developing 42-volt systems. The European design centers of Delphi and Visteon are paying a role."

**Power Supplies:** ON brings a solid power-management background to power supply applications, and as the demands for power increase, there will be a shift from linear power supplies to switching power supplies, expertise brought in from Cherry Semiconductor’s computer applications. "There's probably going to be an absolute, tremendous switchover in the general philosophy of how power is managed and distributed throughout a vehicle (from linear power supplies to switching power supplies)," Mr. Phillips told us. "That's even before 42-volt systems come along, because of the emerging applications that demand more electrical power." A s vehicles demand more power, linear power supplies are at a disadvantage from a cost standpoint and a thermal standpoint.

**Ignition Control Systems:** A nother fast-growing application for ON Semiconductor is ignition systems, an example of an ASSP (application specific standard product) line that ON will promote. In the late 1980s, ignition systems were designed without distributors, and IGBTs (insulated gate bipolar transistor) began to replace Darlington s. ON supplies IGBTs and also the other chips that are part of ignition driver circuits. Spurred on by the analog ignition drivers from Cherry Semiconductor, ON will move to develop smart ignition IGBTs, co-packaged with ignition drivers. ON makes transient voltage suppressors, rectifiers, voltage regulators and gate drivers.

Currently, every two cylinders need one IGBT, but because the industry is now transitioning to coil-on-plug ignitions, that number would double as each cylinder will need one IGBT. ON believes it now has about 25% of the worldwide market for ignition IGBTs; the company shipped about 30 million in 2000, priced up to $1 each. Increasingly, IGBTs are being shipped as bare die used in multichip packages, and bare die will account for 40% of the IGBT market by 2005. Other IGBT makers include Intersil, Infineon and Delphi Delco Electronics.

**Body Electronics:** Exploiting experience in power management, ON will also focus on body electronics with these products: FET pre-drivers, linear regulators, switching power supplies, gauge drivers, VFD and LED drivers, motor drivers, operational amplifiers, high-side and low-side drivers.

ON has targeted mechanical relays for replacement by MOSFETs and high-side drivers. Currently, 20% of the relays used in the body are solid state. In 2000, as many as 15 relay functions for lighting and motor control could potentially be replaced with $1.30 solid-state devices for each function, according to ON, and by 2003, a whopping 45 relay functions could potentially be replaced by solid-state devices costing $9.95 each.

**HID Drivers:** ON is also active in developing drive circuitry for lighting, both inside and outside the vehicle. Of particular interest to the company are HID (high intensity discharge) headlamps, which yield about two times the lumens per watt of a standard halogen or incandescent lamp. While today smart MOSFETs help ignite automotive high-pressure, fluorescent (or xenon) HID lamps, ON uses IGBT lamp drivers for the consumer segment of its HID market and believes IGBTs will work well in automotive lighting. In the future, 600-volt, eight-amp IGBTs could be used, four per lamp, for a total of eight per vehicle. Today, one or two smart MOSFETs are used per lamp.

**Telematics:** Before the Cherry Semiconductor acquisition, ON already had plenty of business in telematics, a key market for ON products. ON has telematics experience with switching power supplies for the communications and computing markets, the same markets that Cherry served. For instance, ON makes 40 or so discrete components that go into every cell phone made by Motorola. Mr. Phillips noted that memory and micros in telematics systems use varying voltages, and Cherry’s low-voltage smart devices will complement ON’s existing product expertise.

**ON Manufacturing Facilities**

One of the things that sets ON apart from its competitors is low-cost, high-quality manufacturing, the best examples of which are the company’s three factories that are totally integrated: raw materials come in one end, are assembled and tested, and come out the other end as finished products. “We have total control over the manufacturing process,” said Mr. Frank, summarizing the benefit. “That’s how we keep our costs so low.” ON runs front-end facilities in Phoenix, Arizona; Aizu, Japan; Piestany, Slovakia. Back-end facilities are located in Leshan, China and Carmona, Philippines. A joint venture in Roznov, Czech Republic (62.5% owned by ON) also produces raw wafers.

<table>
<thead>
<tr>
<th>ON’s Integrated Manufacturing Facilities</th>
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<tbody>
<tr>
<td><strong>Roznov, Czech Rep.</strong></td>
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<tr>
<td><em>Standard</em> analog</td>
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<tr>
<td>Seremban, Malaysia</td>
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<tr>
<td>Discrete</td>
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<tr>
<td>Guadalajara, Mexico</td>
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<tr>
<td><em>Tesla JV, 58.7% owned by ON</em></td>
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Those in the BMW 7 series, Mercedes S class and Cadillac.

- MOST is more open than IEEE 1394. According to a multimedia expert outside Yazaki, some Japanese were initially behind the 1394 standard since it is compatible with consumer products using i-Link already on the market, but i-Link is not necessarily compatible with all 1394 protocols because 1394 doesn’t define messages.

- Since MOST’s communication protocol is dramatically more efficient than 1394’s, its 25-Mbps optical system has a net throughput of 23 Mbps. Compare that with 1394’s existing 100-Mbps copper bus that has net throughput of just 18 Mbps. With only 17% efficiency, the future 200-Mbps 1394 optical fiber bus has a net throughput of just 33 Mbps. Compare that with the future 150-Mbps MOST optical fiber bus, which is 94% efficient and yields net throughput of 140 Mbps.

1394 Rejoiner

Still, a lot of reasonable people favor IEEE 1394 and don’t much care that it is years behind MOST. Many lower-priced vehicles will not need a multimedia bus for several years. Two who favor 1394 are Brad Little of Texas Instruments and Frank Desjarlais of Ford, co-chairs of the 1394 A technology Working Group, formed in January 2000 by the 1394 Trade Association in cooperation with the IDB Forum. Ford, GM, and Toyota are the only carmakers involved with the working group; Yazaki is listed among suppliers working with the group. Worthy reading, SA E Paper # 2000-01-3060, by Messrs. Little and Desjarlais, compares 1394 to MOST, and the authors plan to write a white paper to answer Yazaki’s white paper that favors MOST.

An advantage of 1394 is that tools are widely available, explained Mr. Dejarlais, “in contrast to MOST, whose tools, chips, software and training are available only from Osama’s.” The Ford team used 1394 design tools when they equipped a Lincoln Navigator with 1394-compatible multimedia features for the A M I-C demonstration at Convergence 2000: It took just two months.

MOST Standards Open

In May 2000, the MOST Cooperation published MOST’s network definitions and application framework on its web site (www.mostcooperation.com), and the Cooperation will make additional specifications available as they are approved and finalized. To belong to the nonprofit organization, MOST members (see the list below) pay $8,000, which gives them a chance to influence the spec’s development and gives them early access to information. It does not give members the plans to make the integrated circuits. That difference between the information that the Cooperation is making open and that which is proprietary to Osaka—the blueprints for making the silicon devices (the integrated circuits)—is what led some in the industry to suggest that MOST is not really open.

Since 1993, Osaka Silicon Systems has invested $50 million in the development of MOST technology, including design of MOST integrated circuits, and the company would like to profit from its investment. Mr. Hetzel reasons, “Everybody has to make money... we cannot just give away our VHDL (Very High Speed IC Hardware Description Language) model and other intellectual property free of charge.”

Every component tied to a MOST bus must have two bus circuits; for example, a CD player would have one network interface controller and one fiber-optic transceiver (FOT), which transmits and receives the optical signals. Availability of MOST chips might be a problem with Osaka’s as the only chipmaker, since getting MOST chips means going to Osaka and cutting a deal, or doing what Osaka did, use the specs to design MOST chips. That concern could be alleviated if Osaka’s current negotiations with several semiconductor suppliers work out.

MOST’s 150 M bps Optical-Fiber Systems Need More Research

Set for MY 2002, the first implementations of MOST will operate at 25 M bps, followed later by 50 M bps. The last implementations will operate with the same physical layer, plastic optical fiber and connectors as 25-Mbps implementations. The third stop on MOST’s technology roadmap is 150 M bps, and Osama Silicon Systems will sample a new 150-Mbps chip and architecture in the first quarter of 2001. While making transceiver chips that perform at 150 M bps is feasible, it is not certain how communications will perform in actual automotive systems over the inexpensive, roughly $.20-per-meter, plastic optical fiber that the auto industry intends to use. Testing of actual systems is needed to completely prove out the concept. There would be similar concerns about the high-speed optical-fiber applications of IEEE 1394.

MOST: Successful Standards Making

Disappointed by the slow pace of standards development within A M I-C, some in the industry point to the MOST Cooperation as a good model of how to get standards done quickly. In 1998, DaimlerChrysler, BMW, entertainment system maker Harman/Becker, and Osaka Silicon Systems formed the MOST Cooperation. Later the four founders brought Audi onto the steering committee, and this core group has finally said over the direction that MOST takes. In addition to the five members of the steering committee, 11 carmakers and 48 suppliers have joined the consortium. A mong the major carmakers, only Mitsubishi Motors and Honda are missing from the list; while GM isn’t on the list, GM-owned Opel and Saab are.}

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Members of MOST Cooperation

Steering Committee

Audi
BMW
DaimlerChrysler
Oasis Silicon Systems
Harman/Becker

Other Carmaker Members

Fiat
Ford
Nissan
Opel
Porsche
PSA

48 suppliers from Europe, Japan and the United States are MOST members; among them are: Asin AW, Bosch, Clarion, Delphi Automotive, Denso, Infineon, Johnson Controls, Magneti Marelli, Nokia, Matsushita Electric, Motorola, Philips, Pioneer, Siemens, Sumitomo Wiring, Tycor/Amp, VDO, Yazaki. (Visteon was a member through Ford, but now it is independent; Visteon will join MOST as a separate company.)