D igital R adio B roadcasting

While CDs and DVDs have brought digital to today’s audio systems, radio broadcasts have remained analog. In the next few years, however, consumers will have two new digital audio options for the vehicle. As early as summer or fall of this year, two companies will begin digital satellite radio broadcasts, and perhaps by the second half of 2002, terrestrial AM/FM radio broadcasters in the United States will begin transmitting digital audio signals. A third digital broadcasting option for drivers is digital Internet radio, already in the home. The market for Internet radio using a cell connection to the vehicle will stay rather small for more than a decade.

Digital signal reception is virtually immune to interference, so the static, hiss, fades and pops that are typical of analog AM/FM radio will be a thing of the past. According to developers, digital FM will sound crystal-clear, with CD-like quality, and digital AM will sound like analog FM, even though AM has only one-tenth the bandwidth of FM. Digital radio will use the same radio band as analog radio currently uses. Drivers will need to purchase new radio receivers capable of decoding digital signals. Initially, there will be a separate receiver for terrestrial broadcasts and separate receivers for picking up signals from one or the other of the satellite radio broadcasters. In five years or more, car owners will be able to purchase just one radio that can receive digital or analog AM/FM, as well as both satellite radio broadcasts, assuming both satellite subscriptions are paid.

While it’s still too early to say exactly what role data will play in digital radio broadcasting, it seems clear that data products and services will eventually make a large contribution to broadcaster revenues. For example, while the driver listens to the radio, graphic information and text could be displayed on a multipurpose monitor, and some information might be held and displayed later when it is safe for the driver to read it. A product with synthesized speech might allow information coming in as data to be read aloud to the driver.

Digital AM/FM stations will display data about local events, like sports, news, weather and traffic, while satellite radio will send data of national interest; both will display general information about what motorists are listening to, such as the music title and artist’s name. Since they serve local audiences, AM/FM stations could broadcast traffic data for use by route-guidance navigation systems that determine travel times and fastest route. XM Satellite Radio (Washington, D.C.), one of two satellite radio broadcasters licensed by the Federal Communications Commission (FCC) to operate in the United States, has an agreement with GM’s OnStar division to broadcast data to OnStar subscribers. (A company profile of XM Radio Satellite begins on page 4 of this issue.) The other satellite broadcaster is Sirius Satellite Radio (New York, N.Y.).

S atellite R adio

Today the area covered by each AM/FM radio station is geographically small, so there are not enough listeners to make niche programming economical. The top 50 radio markets in the United States cover 54% of the population yet broadcasters offer an average of just 15 radio formats in those markets. Satellite radio broadcasters XM Satellite Radio and Sirius Satellite Radio will each provide up to 100 channels of music and talk programming. Satellite radio can provide a wide range of programming seamlessly, coast-to-coast—a big advantage over local AM/FM programming that fades as you drive outside the range of local stations. Further, satellite radio should appeal to
continued from page 1

Despite a difficult second half, Lear managed considerable growth in sales. According to president and CEO Bob Rossiter, “Foreign exchange volatility, rising interest rates and customer production cuts made the second half of the year particularly challenging.” General Motors and Ford are Lear’s top customers.

In May 1999, Lear acquired Ut Autoliv and subsequently organized the electrical/electronics business into LEED (Lear Electronics and Electrical Division). From May 1999, to December 1999, LEED had sales of $1.6 billion, $2.4 billion if annualized. LEED sales in 2000 included a full year of sales from its acquisition of UTA.

TRW Automotive Segment
2000 Sales: $10,993.8 million
Change from 1999: down 3.0%
2000 Before-Tax Profit Margin: $720.3 million, or 6.6% of Automotive Segment sales, compared with 7.2% of sales in 1999 (excluding unusual items)
A utomotive Electronics 2000 Sales: $1,663.9 million, including new business worth $400 million
Change from 1999: A utomotive Electronics sales grew 2.0% over 1999

Continued on page 3

THE HANSEN REPORT ON AUTOMOTIVE ELECTRONICS
©2001 Paul Hansen Associates, 11 Wentworth Rd., Rye, NH 03870 USA; Telephone: 603-431-5859. Fax: 603-431-5791. Email: hansen@nh.ultranet.com. All rights reserved. Materials may not be reproduced in any form without written permission. The Hansen Report on Automotive Electronics is published 10 times a year, monthly; July/August and December/January are combined issues. The annual subscription rate is $617 in North America; $657 elsewhere. Back issues are available for $45 each. See our online index at www.hansenreport.com. Paul Hansen Associates is a strategy and market research firm consulting to the electronics industry.

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Roundup...

reduced vehicle production by G M, Ford and Chrysler in the fourth quarter. The acquisition of Japanese seatbelt maker N SK also reduced margins.

New business highlights include the company’s first electronics order from BMW, plus a major U.S. contract for weight-sensing systems for advanced airbags. A joint venture, A utoliv M ando Corporation, formed in 2000 with M ando Corp. (Korea), is expected to generate $200 million in sales in its first year of operation. A utoliv owns 65% of the joint venture.

A utoliv expects sales to decline by 1% in 2001. A participating lower demand from U.S. carmakers, A utoliv plans to reduce its U.S. workforce by about 1,000, consolidate its manufacturing operations in the U.S. and Europe, and shift some production to countries with lower labor costs.

DaimlerChrysler Huntsville Electronics
2000 Standard Costs: $995 million
Change from 1999: down 5.2%
An in-house components division serving DaimlerChrysler’s U.S. operations, which account for 95% of shipments, Huntsville counts its shipments as standard costs, not sales. Core products manufactured by H untsville are electronic control units for engine and powertrain control, radios and instrument clusters. In 2000, 44% of total shipments were powertrain controllers. (For an in-depth look at H untsville, see the Company Profile in the March 2001 issue of T he H ansen Report.)

Delphi Automotive Systems
2000 Net Sales: $29,139 million
Change from 1999: down slightly, 0.2%
2000 Operating Margin: 6.0% of sales, or $1,744 million, a slight improvement over its 1999 margin, which was 5.8% of sales
2000 Sales by Product Sector:
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2000 Sales by Product Sector:
Digital A M/FM
Development of digital audio broadcasting (DA B) technology began more than a decade ago. As yet, there is no one single global digital radio standard. Eureka DA B, mandated by the European Commission several years ago and recently adopted in Canada, has not been able to resolve problems with band allocation, and sales of Eureka DA B receivers have been disappointing.

With digital satellite radio about to begin in the United States, A M/FM radio broadcasters in the United States are feeling pressure to upgrade from analog to digital to improve sound quality. iDA B for in-band on-channel (IBOC C) DA B is a digital radio transmission technology developed by iBiquity Digital (Columbia, Maryland). iDA B, which will likely become the U.S. standard, will be widely used in the United States and elsewhere. iBiquity has the backing of 15 of the top 20 A M/FM broadcasters in the United States, some of whom intend to begin digital broadcasting as early as 2002. iBiquity Digital is a privately held company, the result of a merger in 2000 between Lucent Digital Technology and USA Digital.

Digital AM/FM

The FCC has not yet given final approval to iDA B, although it is expected. Not only will iDA B technology enable transmission of digital A M/FM signals, CD-like audio and crystal-clear reception, but the IBOC C approach will enable A M/FM broadcasters to transmit digitally in the same radio spectrum allocated for their analog signal. Furthermore, the analog signal can be transmitted along with the digital signal, using the same frequency. That way consumers will not have to immediately abandon their analog receivers and purchase new digital receivers.

It is not very expensive for radio stations to add iDA B. “It’s the easiest thing in the world... you roll in a couple refrigerator-sized racks of equipment and three days later, you’ve got digital [A M/FM] radio,” declared Robert Struble, president and CEO of iBiquity. The total investment required to convert all 13,000 stations in the U.S. from analog to digital will be less than $1 billion—on average, $70,000 for each broadcaster—not much when you consider that U.S. radio broadcasters took in $20 billion in revenues last year.

continued on page 8

Roundup...
A utomotive Electronics 2000 Before-Tax Margin: 6.7% of sales, or $111 million, (including $17 million in restructuring charges); compared with 7.8% of sales in 1999.

TRW Automotive Electronics accounted for 15.1% of the A utomotive Segment’s sales in 2000. During the year, TRW Automotive Electronics integrated 19 former LucasVarity facilities and sold four non-strategic Lucas businesses. In the other major sectors of the A utomotive Segment, Chassis Systems sales grew 13.5% over 1999, with slightly lower profits, and Occupant Safety Systems sales decreased by 6.9%.

TRW attributes the 3% drop in A utomotive Segment sales in 2000 primarily to the effect of the strong dollar (much of TRW’s sales are in Europe) and price reductions conceded by TRW, partially offset by higher volumes and the net effect of the LucasVarity acquisition, which was completed in March 1999.

TRW also felt the effects of production cuts by the U.S. carmakers in the fourth quarter of 2000 and expects light-vehicle production in North America will be 10% lower in 2001 compared with 2000. Anticipating continued price pressures in 2001, TRW began restructuring its automotive businesses and eliminated 1,000 salaried positions in the first quarter. The company will continue to invest in products it believes have significant growth potential or technological advantage, such as electric steering, advanced braking systems, advanced electronic components and new airbag technologies.

Visteon Corp.
2000 Sales: $19,467 million
Change from 1999: up 5.5%
2000 Operating Margin: 1.4% of sales or $270 million, compared with $735 million in 1999.

Ford’s spin-off of Visteon was completed June 28, 2000. Visteon operates in three business segments: Comfort, Communications and Safety; Dynamics and Energy Conversion; and Glass.

Visteon won $2.6 billion in new business in 2000, of which 37% was non-Ford business. New business included a deal with GM for a DVD-based rear-seat entertainment system. In 2000, new aftermarket business contributed $250 million in sales. Significant alliances in 2000 include agreements with XM Satellite Radio and Sirius Satellite Radio, as well as a joint development agreement in powertrain technology with Motorola SPS.

The Hansen Report Roundup of European-based suppliers will be published in the May issue.

Digital Radio...

...Continued from page 1

consumers because it will have much less advertising than conventional A M/FM; some stations will be completely commercial-free.

According to International Data Corp. and Woods and Poole Economics Inc., there are currently 104 million households and an estimated 191.1 million vehicles on the road in the United States—that’s an enormous potential market for satellite radio. Given how ubiquitous cable TV and satellite TV have become, a case can easily be made that satellite radio will also become ubiquitous, since it will provide a similarly wide selection of programming, and for only about $10 per month. According to the Federal Communications Commission, as of June 2000, 67% of TV households subscribed to cable TV, which provided roughly 100 channels at an average monthly fee of $32.40, and more than 13% of TV households subscribed to satellite TV. The National Cable Television Association estimates satellite TV subscribers receive roughly 200 channels, at an average monthly fee of $32.40, and more than 13% of TV households subscribed to satellite TV. Higher rates of cable-subscriber growth.

Continued from page 2

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continued on page 8
The Company Profile... XM Satellite Radio

Background

Founded in 1992 as American Mobile Radio Corp., the company now known as XM Satellite Radio hopes to leverage proven digital audio technologies into the first major advancement in radio since FM took hold in the 1970s. In October 1997, XM was awarded a license from the FCC (Federal Communications Commission) allowing the company to begin serious development of its satellite broadcasting system, which will cover the entire continental United States, including urban and rural listeners of almost all ages, economic groups and numerous specialty interests. (Please see the list of XM channels on page seven.)

Major stockholders own approximately 66.1% of XM's stock, effectively controlling XM. Fully-diluted XM stock was first offered to the public in October 5, 1999. During 2000, the price ranged between $12 and $50 per share, and in mid-March 2001, it closed at $9.02, a new 52-week low. XM is listed on the NASDAQ under the symbol XMSR.

XM believes one of its biggest advantages over analog AM/FM is its "digital-quality, crystal-clear" audio signal. While conventional radio stations will continue to broadcast A.M./F.M. analog for at least the next decade or so, they will begin...
transmitting digital AM/FM in the second half of 2002. Digital signals can be broadcast simultaneously with analog signals, using the same infrastructure. The quality of conventional radio-station digital sound will then be as good as or better than XM’s sound quality. XM’s digital-quality advantage over AM/FM analog will last for about five more years.

Within its 12.5 MHz satellite broadcast allocation, XM can transmit a total of four megabits per second, most of which will carry digital entertainment. The remainder will be allocated for data primarily, and then error correction. On average, transmission allocation with 100 channels would allow 40 Kbps per channel. Running at a maximum bit rate of nearly 64 Kbps per channel, however, XM says that its hi-fi digital music channels will be almost indistinguishable from the sound made by CDs, which are played back at 1.4 Mbps. XM will broadcast talk channels at 24 Kbps each.

Competition

Satellite radio’s main competition will come from conventional AM/FM radio. Even though XM’s competitive advantage with digital sound will diminish in the near future as conventional radio goes digital, XM hopes to appeal to consumers whose taste in music and programming is broader than what is currently offered. More than 22 million Americans receive fewer than five FM stations because they are not in major markets. Further, more than half the existing commercial radio stations in the country have one of just three programming formats: country, adult contemporary or news/talk/sports. Yet less mainstream and generally unavailable programming formats such as reggae and salsa comprise 21% of annual recorded music sales, according to a 1999 Veronis, Suhler & Associates’ Communications Industry Forecast.

XM’s only satellite radio competition is the other broadcaster with an FCC S-band license, Sirius Satellite Radio Inc. While XM intends to serve the automotive and home markets, Sirius is focusing almost exclusively on automotive applications. XM’s receiver-manufacturer partners are developing products with wider appeal beyond automotive. For instance, Sony is developing a radio that the driver can unplug from an automobile and plug into a home stereo system; other suppliers are developing radios designed especially for the home. XM Radio managers also believe XM will have better programming than Sirius because it will have more programming expertise and more live talent on the air. Sirius has the same subscription price, $9.95 per month, and intends to broadcast 50 commercial-free music channels and 50 news, talk and sports channels, which will carry advertising. The company expects to start broadcasting by September 2001. Sirius has alliances to install radios in Ford, Chrysler, BMW, Mercedes, Mazda, Jaguar and Volvo vehicles, as well as Freightliner and Sterling heavy trucks. Several Sirius radio manufacturers will supply automakers and provide electronics retailers with adapters that allow radios in older vehicles to receive Sirius broadcasts.

XM and Sirius Interoperable Radios

The FCC S-band operating license was contingent on XM and Sirius unifying

continued on following page

Audio Listening in the Vehicle

Roughly 200 million cars and light trucks are on the road in the U.S. The following percentages of consumers listen to this type of audio in the vehicle.

- Radio, 75%
- CDs, 11%
- Cassette tapes 3%
- Other formats 3%
- Did not answer 8%

Data: Survey of consumers by Digital Radio in 2000

The Company Profile Continued

XM Satellite Radio Board of Directors

<table>
<thead>
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<th>Nominations to the ten seats on the board are controlled by the companies below.</th>
<th># of Seats</th>
<th>Company</th>
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<td>XM Radio’s president and CEO</td>
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<td>Recognized industry leaders whose nominations are approved by Motient, GM and Series C investors</td>
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Key Strategic and Financial Investors

| American Honda | Clear Channel Communications, the largest U.S. radio station operator |
| Columbia Capital | DIRECTV, the largest U.S. distributor of multichannel digital video programming |
| General Motors, the largest U.S. auto and truck manufacturer | Madison Dearborn Partners |
| Telcom Ventures LLC |

XM Investments

- FCC license: $140,220,000
- Satellite system: 533,154,000
- Terrestrial system: 84,715,000
- Spacecraft control facilities: 13,046,000
- Broadcast facilities: 27,970,000
- System development: 6,458,000
- Total: $805,563,000

Key Technology Partners

- Boeing Satellite Systems, builder of XM’s satellites
- Hughes Electronics Corp., provides XM’s terrestrial repeaters through Hughes Network Systems
- Alcatel, for XM’s satellite communications payload
- Telesat Canada, builder of XM’s tracking and control system
- LCC International, for XM’s repeater network
- Lucent Technologies
- STMicroelectronics supplies XM chipsets
- Fraunhofer Institute, with STMicroelectronics, developed XM’s digital waveform processing software.
their radio designs so that in the future, consumers can listen to either XM or Sirius’ broadcasts with the same receiver. While XM and Sirius have reached agreement to cooperate in the development of a unified technology standard, the companies have not begun that development. Development will take at least three to four years to complete, as XM and Sirius each use different digital technologies. XM receivers cannot decode Sirius broadcasts, and Sirius receivers currently cannot decode XM broadcasts.

Work on an interoperable receiver cannot begin in earnest until both Sirius and XM complete the development of their own proprietary chipsets. XM has not provided its chipset developer, ST Microelectronics (Geneva, Switzerland), with unified chipset specifications, requirements or a development schedule for the project. ST M microelectronics’ North American automotive vice president, Dan Merchant, told us, “We don’t have a clue about it.”

Interim-step cooperation will start with the antenna. By fall 2001, a single antenna will be available, which can receive both companies’ satellite radio transmissions. After developing the antenna, the companies will try to agree on common software and a common radio control-head bus. Consumers could then choose between an XM tuner module or a Sirius tuner module; either module would easily plug into the radio control head.

### Subscription Revenue Forecasts
XM believes that it may attract as many as seven million subscribers by 2005 or 2006, giving the company $836 million in subscription revenue. Seven million subscribers would represent a 7.5% penetration of existing light vehicles, or 5% penetration of OEM and aftermarket car radio sales over a five-year period.

According to a study of the radio market done for XM Radio, 49 million subscribers will sign up for satellite radio by 2012. Since the only other FCC-licensed satellite radio broadcaster is Sirius Satellite Radio, the company could theoretically have a 50% share of its served market in 2012. If that were so, XM would have 24.5 million subscribers, and if the subscription price remained the same as in 2001, $9.95 per month or $119.40/year, XM would have $2.925 billion in subscription sales alone in 2012. Plus, the company expects substantial additional revenue from advertising and from data broadcast.

### Other Revenue Sources: Advertising and Data Broadcasting
While initially the vast majority of revenues will come from subscriptions, by 2007 or 2008 as much as 40% of revenues could come from advertising, according to Mr. Cook. W hile all but 15 of XM’s 100 channels will have commercials, XM will not do nearly as much advertising as AM/FM radio stations, which typically carry 18 to 20 minutes of advertising each hour. XM’s music channels will have about six minutes of advertising per hour, and talk channels will have up to ten minutes of advertising each hour. Other XM channels will have very limited advertising, similar to PBS’ (Public Broadcasting Service’s) abbreviated advertising delivered via announcements about program sponsorship. These companies or advertising agencies have already signed up for reduced-rate, national advertising packages: A listate, A merican Express, AT & T, Bayer, Goodyear, J. W ater T hompson, K raft, N BC, O ffice Depot, Radio Shack, S ears and the W all Street J ournal.

In addition to audio programming, significant revenues might come from broadcasting data in five to 10 years. However, “at this point, we don’t have a clear picture of the commercial prospects of data,” said Mr. Cook. “Thus far, our business model is based solely on entertainment, but there is tremendous upside potential for data. A t some point we could decide that we need only 75 channels for entertainment and the rest of our bandwidth could be used for data. W e’ll have to wait and see.”

From the outset, some data will be broadcast. XM Satellite Radio signed an agreement with the OnStar division of

### XM Radio Markets
XM Radio has a long-term distribution agreement with General Motors to integrate XM-ready radio receivers into GM vehicles. Compensation will be paid to XM for OnStar systems in non-GM vehicles. XM has agreed to subsidize GM’s XM radio purchases for four years in order to insure widespread distribution. GM has agreed to maintain specified installation levels. XM radios will first be installed in GM vehicles in MY 2002. GM is committed to reaching a total installation level of at least 1,240,000 units by MY 2006. XM has a distribution agreement with Freightliner Trucks, and beginning in the fourth quarter of 2001, Peterbilt will offer XM radio in trucks. Honda has invested $50 million in XM but has not yet formalized a distribution agreement. XM Satellite Radio is also working on non-exclusive agreements with other carmakers.

### Aftermarket
These major consumer electronics retailers will market XM Satellite Radio services and radios:

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<th>Al and Ed’s</th>
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<td>Cowboy Maloney’s</td>
<td>Radio Shack</td>
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</table>
General Motors to make some bandwidth available to broadcast data to OnStar vehicles. In addition to OnStar data, other text data will include information on what the driver is listening to, like the channel name and number, program type or artist name and song title. Later, data such as national weather, news and sports may be included. XM-ready head units will be capable of displaying at least 16 alphanumeric characters.

**Vehicle Radio System: Receivers and Antennas**

Fraunhofer Institute (Itzehoe, Germany) and ST Microelectronics are responsible for developing digital waveform processing software for XM. ST Microelectronics is developing and producing the two most important integrated circuits that will be used in XM Radio receivers. The proprietary chips will perform digital-analog decoding, sort satellite and repeater signals, and process audio, speech and data decoding. First-pass custom chips were sent to radio developers in October 2000. Shipments of qualified and tested parts will begin in April 2001. A nd ST is planning to start volume IC shipments for production radios in late summer 2001, about the same time as commercial broadcasts are supposed to begin.

Consumers will be able to purchase an XM receiver and antenna for between $150 and $200, over and above the price of existing AM/FM radios. Installation will be extra. XM-ready radio components include:

- The XM receiver module houses the two ST Microelectronics ICs, along with other components, in a box about the size of a videocassette. Typically installed in the trunk, the receiver module can be hard-wired into the vehicle between the S-band antenna and the head unit. Eventually it will be integrated into the AM/FM head unit.
- The in-dash control unit with AM/FM radio and cassette or CD player
- The antenna, which receives signals from the satellites and the terrestrial repeaters.

Together with antenna manufacturers Terk and Antenna Specialists, XM is developing a variety of antenna options.

Both antenna companies will develop, manufacture and distribute antennas, some of which are designed to be rear- or side-window mounted, or drilling into the vehicle will not be required. The companies will also bring to market antennas for long-haul trucks, boats and off-road vehicles, as well as indoor and outdoor antennas for the home.

**Transmission:**

**Satellites and Terrestrial Repeaters**

XM will rely on two satellites manufactured by Boeing Satellite Systems. At 15 kilowatts each, they are the most powerful satellites commercially available. While XM’s first satellite was scheduled for launch in December 2000, it was successfully launched on March 18, 2001. The second and final satellite launch has been delayed until May. A third satellite will be built in case of the first two fails.

The two satellites will have geostationary orbits. The latitude will be zero degrees, over the equator, and the already launched satellite, “XM Rock,” is positioned at a longitude of 115 degrees west, which bisects the United States north and south roughly through Las Vegas, Nevada. The second satellite, “XM Roll,” will be positioned at a longitude of 85 degrees west, which runs through Lexington, Kentucky, and Detroit, Michigan. These positions provide optimal signal strength, and each satellite will cover the entire continental United States, ensuring ongoing operation in the event of failure of one of the satellites.

Hughes Electronics Corporation has a contract for the design, development and manufacture of the 1,500 terrestrial repeaters that will complement satellite transmissions. To avoid transmission problems around large buildings, bridges and tunnels in 70 U.S. cities, repeaters will synch up the satellite signals.

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**XM Programming: Up To 100 Channels**

The following list is representative of the music and information programming channels that XM Radio will offer: XM Radio’s programming unit, XM Originals, will create the content unless another content provider is listed in parentheses directly after the channel name.

<table>
<thead>
<tr>
<th>Rock Music</th>
<th>Country Music</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classic Rock</td>
<td>Mainstream Country</td>
</tr>
<tr>
<td>Classic Hard Rock</td>
<td>Classic Country</td>
</tr>
<tr>
<td>Hard Rock</td>
<td>Bluegrass/Traditional Country</td>
</tr>
<tr>
<td>New Alternative</td>
<td>All Request Country</td>
</tr>
<tr>
<td>Soft Rock</td>
<td>Urban Music</td>
</tr>
<tr>
<td>Eclectic Music</td>
<td>Urban Dance Mix (Radio One)</td>
</tr>
<tr>
<td>Contemporary</td>
<td>Classic Soul (BET/Radio One)</td>
</tr>
<tr>
<td>Christian (Salem)</td>
<td>Gospel (BET/Radio One)</td>
</tr>
<tr>
<td>Traditional Christian (Salem)</td>
<td>Adult Urban (BET/Radio One)</td>
</tr>
<tr>
<td>Blues</td>
<td>Top 20 Urban</td>
</tr>
<tr>
<td>Traditional Jazz</td>
<td>Environmental Music (Soft)</td>
</tr>
<tr>
<td>Reggae/Island</td>
<td>Soft Jazz</td>
</tr>
<tr>
<td>World Music</td>
<td>New Age</td>
</tr>
<tr>
<td>American Folk</td>
<td>Electronic</td>
</tr>
<tr>
<td>Pop Classical</td>
<td>Environmental (Earth Sounds)</td>
</tr>
<tr>
<td>Traditional Classical</td>
<td>Hispanic</td>
</tr>
<tr>
<td>Modern Jazz</td>
<td>Broadway Show</td>
</tr>
<tr>
<td>Progressive/Fusion</td>
<td>Tunes</td>
</tr>
<tr>
<td>Pop Music</td>
<td>Hits</td>
</tr>
<tr>
<td>Top 20 Contemporary</td>
<td>Disco/Dance</td>
</tr>
<tr>
<td>Hits</td>
<td>Broadway Show</td>
</tr>
<tr>
<td>Contemporary</td>
<td>Tunes</td>
</tr>
<tr>
<td>Modern Adult</td>
<td>Modern Adult</td>
</tr>
<tr>
<td>Contemporary</td>
<td>Classical Vocalists</td>
</tr>
<tr>
<td>Classic Vocalists</td>
<td>All Request</td>
</tr>
<tr>
<td>All Request</td>
<td>Contemporary Hits</td>
</tr>
</tbody>
</table>

**Digital Radio**

In addition to development and commercialization of IBOC DA B, iBiquity has also developed perceptual audio coder (PA C), an audio compression technology that A M/FM radio broadcasters and XM Satellite Radio will use. PA C uses psychoacoustics and advanced signal processing, which for at least 90% of listeners, will make radio content delivered at 96 Kbps, hard to distinguish from CDs, which are played at 1.4 M bps.

### Internet Radio

According to a report titled “Reinventing Radio: Audio Broadcasting in the Digital Age,” published in March 2001 by William Blair & Company, Chicago, Illinois, 2,500 to 3,000 of the 12,717 radio stations operating in the United States simulcast their broadcasts over the Internet. Further, more than 25,000 Internet sites feed radio to the Internet, 24 hours a day, 7 days a week. Internet radio can originate from radio stations, which feed both their transmitters and the Internet, or from radio consolidators, who feed a number of radio stations to the Internet. The signals sent to the Internet are digitized and compressed, using M P3, W MA (Windows’ version of M P3) or other digital audio-compression technology.

However, Internet radio, is a very long way from being economically feasible in the vehicle. Listening at one’s home computer, radio music is streamed into the computer for listening in real time, or it is cached, that is, downloaded into memory for playback later. Internet radio is delivered to the home via telephone lines or cable. Cellular phone companies hope that enough cellular bandwidth will be available to support wireless Internet connections. Talk radio requires bandwidth wide enough to handle at least 14.4 Kbps of digital signal, and music requires 28.8 Kbps, at the very least.

To compete with the other forms of digital radio, Internet radio will need more bandwidth, but there is very little new bandwidth currently available. It will be a decade or more before the FCC can resolve the cellular phone industry’s requirement for more bandwidth. By the time bandwidth is available for wireless cell phone networks, digital satellite radio and digital terrestrial radio will have been in business for several years, perhaps a decade, providing listeners with a wide range of listening choices. Kenwood sales and marketing vice president in charge of automotive audio products, Bob Law, told us “In our view, given the 100 channels of quality audio programming that each satellite broadcaster will deliver, Internet radio doesn’t presently have a good business case.”

Further, the upgrade to cellular broadband including the build-out of all cell sites will require a multibillion dollar investment. Robert Struble noted that A M/FM radio is paid for by advertisers, and he estimated that transmitting streaming Internet radio to vehicles would require a wideband cell connection charge of about $0.30 per minute. If that’s correct, consumers listening to just one hour per day would pay over $500 per month for the connection—an unlikely scenario.

Of course, consumers have other options besides receiving wireless digital radio in real time. For example, a driver could bring digital audio programming from the home computer to a vehicle storage device such as a hard drive, a disk or a MemoryStick. A nother option: the driver could send a file of audio programming from her home computer over a wireless LAN to a large rewritable memory device in the vehicle, for example a hard drive. These options will be too complex and time-consuming for many consumers, considering that digital A M/FM radio will be without charge and satellite radio will deliver 100 channels of quality audio programming for about $10 per month.

### Comparison of the Three Pipelines for Delivering Digital Radio to Vehicles

<table>
<thead>
<tr>
<th></th>
<th>Satellite</th>
<th>AM/FM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distinguishing Aspects</strong></td>
<td>National coverage, wide range of choice with 100 programs; limited advertising</td>
<td>Local coverage; digital AM will sound like FM; digital FM like CD</td>
</tr>
<tr>
<td><strong>Operation Starting</strong></td>
<td>Summer or fall 2001</td>
<td>Second half 2002, or 2003</td>
</tr>
<tr>
<td><strong>Coverage</strong></td>
<td>Seamless throughout the U.S.</td>
<td>Local; slightly wider coverage than with analog</td>
</tr>
<tr>
<td><strong>Price</strong></td>
<td>$9.95 per month subscription; radio an extra $150 - $200</td>
<td>Free; radio an extra $100</td>
</tr>
<tr>
<td><strong>Bit Rates</strong></td>
<td>64 Kbps max, for hi-fi music</td>
<td>96 Kbps max, for hi-fi music</td>
</tr>
<tr>
<td><strong>Number of Providers</strong></td>
<td>2 in the U.S. with 100 channels each</td>
<td>Potentially 13,000 broadcasters in the U.S.</td>
</tr>
<tr>
<td><strong>Amount of Advertising</strong></td>
<td>6 - 10 minutes/hour*</td>
<td>Up to 20 minutes/hour</td>
</tr>
<tr>
<td><strong>Advertising Revenue</strong></td>
<td>40% of total by 2007*</td>
<td>May decline initially as AM/FM competes with satellite radio</td>
</tr>
</tbody>
</table>

*For XM Satellite Radio

### Advertising

- Satellite: 6 - 10 minutes/hour*, 40% of total by 2007*
- AM/FM: Up to 20 minutes/hour, May decline initially as AM/FM competes with satellite radio
- Internet: Not known, Probably limited

### Price

- Satellite: $9.95 per month subscription; radio an extra $150 - $200
- AM/FM: Free; radio an extra $100
- Internet: Worldwide, determined by Internet portal/service provider Internet platform: $500 cellular connection: very expensive

### Bit Rates

- Satellite: 64 Kbps max, for hi-fi music
- AM/FM: 96 Kbps max, for hi-fi music
- Internet: 14.4 Kbps for talk (minimum) 28.8 Kbps for music (minimum) Not known

### Coverage

- Satellite: Seamless throughout the U.S.
- AM/FM: Local; slightly wider coverage than with analog
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### Number of Providers

- Satellite: 2 in the U.S. with 100 channels each
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### Amount of Advertising

- Satellite: 6 - 10 minutes/hour*, 40% of total by 2007*
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