The Truth About EDGE

CDMA Development Group

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Executive Summary

With the first commercial launch of EDGE on June 30, 2003, the technology's proponents finally have a success story. Or do they? Despite their claims that EDGE provides a smooth, cost-effective way to provide 3G services today, the technology's business case and market potential have serious flaws. This white paper examines the availability and prices of EDGE devices, the technology's real-world data rates and whether EDGE is a viable option, particularly for operators with limited spectrum.

Overview of EDGE Technology

Enhanced Data rates for Global Evolution (EDGE) is a third-generation (3G) wireless technology that's capable of high-speed data. EDGE occasionally is called "E-GPRS" because it's an enhancement of the General Packet Radio Service (GPRS) network.[1] EDGE can't be deployed by itself; it must be added to an existing GPRS network. So, for example, an operator could offer GSM/GPRS/EDGE but not GSM/EDGE.

Like GPRS, EDGE divides the spectrum into "time slots," but EDGE squeezes more data into each time slot. Each GPRS time slot can handle a maximum of 20 kbps of user data, for a theoretical peak rate of 160 kbps when all eight time slots are used simultaneously. By comparison, a single EDGE time slot can handle up to 59.2 kbps, for a total of 473.6 kbps with all eight time slots.

EDGE is a data-only technology, but it does affect voice capacity in the adjunct GSM network. For example, one of the reasons why today's EDGE networks deliver barely one-quarter of their peak rate is that higher throughput comes at the expense of voice capacity. An operator could give each EDGE user all eight time slots rather than the current two or four, but that would reduce the amount of overall network capacity that can be devoted to voice calls.[2]

That limitation creates difficult choices for the operator: They could charge EDGE users a significantly higher rate than GPRS because they're using more than their share of capacity, but that would limit adoption and revenue. It also would result in more blocked and dropped voice calls, which isn't an option because voice will continue to drive the lion's share of revenue for the foreseeable future. Or they could charge only a small premium and limit the number of timeslots, but to potential customers EDGE then doesn't look like much of an improvement over GPRS.

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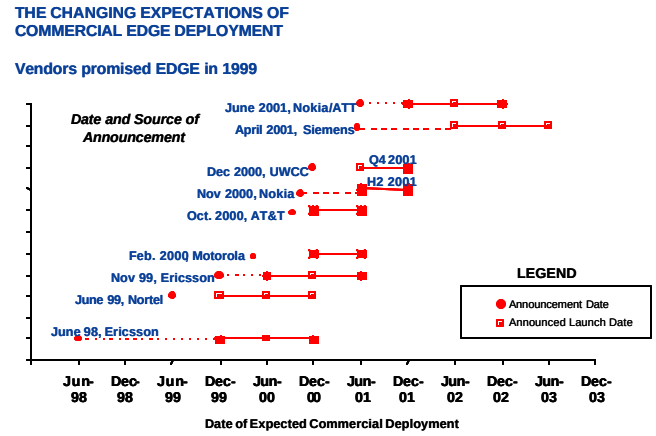
EDGE's Current Market and Outlook

Cingular Wireless launched the world's first commercial EDGE network in June 2003 in Indianapolis, Indiana.[3] In September, CSL deployed EDGE in Hong Kong.[4] Both operators introduced their services with a single handset model – the Nokia 6200[5] and Nokia 6220,[6] respectively – although they say more models will be available sometime in the near future. The EDGE device that's most likely to hit the market next is the Sony Ericsson GC82 PC card,[7] although its release date has been pushed back at least once.

Cingular's launch is noteworthy, if only because EDGE has been promised and then postponed so many times. For example, in 1998, Ericsson forecast EDGE deployments by 2000. Three years later, AT&T Wireless and Nokia forecast commercial launches by 2002 (Figure 1).[8]

Figure 1



Source: The Next Generation Transition for TDMA Operators: Assessing the GSM and CDMA Options,The Shosteck Group, October 2002

By being late out of the gate, EDGE may have missed its window of opportunity in two key respects. First, EDGE has to catch up with other 3G technologies such as CDMA2000®[9] and W-CDMA, which have been commercially deployed for more than three years.

Second, many GSM operators have decided to go directly from GPRS to W-CDMA because W-CDMA offers greater benefits and infrastructure and devices are already available. In the case of most European operators, the tight timetables for their

3G licenses force them to devote all of their resources to building W-CDMA networks. Some of those networks are already in commercial service, so it's difficult for an operator to make a business case for going back and adding EDGE.[10]

As of September 2003, only 50 operators expressed interest in EDGE and the majority of them were in the Americas,[11] as a result, unlike GSM, GPRS or W-CDMA, EDGE doesn't have a global cost structure, which means that devices and infrastructure will cost more, hampering its ability to compete with more widely used technologies. Those characteristics make EDGE more like TDMA than GSM. Without support of Europe, EDGE will become a niche technology.

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So far, investors' and analysts' reception to EDGE has been lukewarm at best. For example, as Deutsche Bank Securities wrote in June 2003:

> We thought about doing a feature on [AT&T Wireless'] EDGE network since we have owned the Nokia 6200 EDGE phone for the last 1.5 weeks. However, AWE still has not rolled out commercial EDGE service (maybe Q4) and the world's first EDGE phone is nothing to write home about, in our view, let alone to 4,000 readers. For one, in the absence of EDGE, the phone only works in GPRS mode and our modem cable is still on backorder. Even if our cable had arrived, the phone only supports 2 timeslots in the downlink and one time slot in the uplink so its performance would not leave us breathless.[12]

The fact that the selection of EDGE devices is still so limited, even down to the scarcity of accessories such as modem cables, suggests that EDGE still wasn't ready when the first network launched in June 2003. One is left to believe that it was launched prematurely as an attempt to silence critics. But its underwhelming performance has just given them more ammunition.

EDGE's Weak Business Case

One of EDGE's key selling points is that it's part of the GSM family, which has the largest worldwide market share in terms of users and networks. As a result, the argument goes, EDGE will be able to leverage GSM's cost structure and selection of devices and infrastructure.[13]

But that argument withers in the harsh light of current and proposed EDGE deployments. First, although 50 operators worldwide have committed to launching EDGE,[14] there's a big difference between a commitment and a commercial launch.

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Time will tell whether the operators that have committed to EDGE actually launch it or go straight to W-CDMA, which has a much stronger business case.[15] Meanwhile, rival 3G technologies such as CDMA2000 and W-CDMA are already in commercial service and thus driving equipment volumes and user adoption.

Second, even if all 50 operators do launch EDGE, that's only a fraction of the 400 operators that already use GSM.[16] So it's difficult to understand how EDGE's cost structure could approach, let alone match, GSM's.

EDGE already carries a premium simply because it's a brand-new technology. For example, the wholesale price of hardware necessary to add EDGE to handsets currently is about 15% more than GPRS, according to vendors such as Broadcom.[17] EDGE doesn't appear to be in a position to achieve the volumes necessary to reduce that premium. Deutsche Bank Securities expects worldwide shipments of EDGE devices to hit 19.2 million units by the end of 2004 and 61.3 million by the end of 2005. By comparison, its forecast for CDMA2000 is 110 million in 2004 and 134 million in 2005.[18]

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EDGE's backers point to recent commitments by European operators as a sign that the technology will be heavily adopted outside of the Americas. But most European operators hold 3G licenses that have stringent timetables for launching commercial W-CDMA service, so they don't have time for an EDGE detour. In addition, W-CDMA is a markedly different technology than GSM/GPRS, so European operators already have their hands full learning the nuances of a new technology. Finally, the capital markets are still tight. Squeezed between these three factors, European operators will have a difficult time devoting limited resources to EDGE when investors and regulators demand that they remain focused on W-CDMA.

EDGE may have a limited future just within the Americas. For example, Latin American operators must sell into markets that are particularly sensitive to handset prices. If the retail price of an EDGE device is significantly higher than the market will bear, then the service has a poor chance of recouping its investment. Of course, the operator could heavily subsidize the retail price, but in the hypercompetitive South American market, that may not even be an option.

If a Latin American GSM operator believes that it needs to add a 3G

technology as soon as possible, it may consider W-CDMA simply because that technology is clearly on a path to have the global cost structure that attracted it to GSM in the first place. W-CDMA also makes more efficient use of network capacity for both voice and data.[19] The catch is that W-CDMA isn't a viable option for most Latin American operators because they don't have the new, 3G spectrum necessary to deploy the technology. CDMA2000 is a better option because it delivers broadband in existing spectrum.

Finally, many GSM and TDMA operators in North and South America have saturated networks, so deploying GPRS/EDGE or GSM/GPRS/EDGE overlays, respectively, may not be an option because there isn't enough spectrum to accommodate high-bandwidth data services. This limitation suggests one reason why the initial EDGE networks and devices deliver only a fraction of the technology's theoretical peak data rate: the operators may have only enough spectrum to launch a bare-bones version of EDGE, let alone support a version that runs all of the available time slots. If device vendors believed that EDGE networks will soon support the technology's maximum throughput, they would have already announced devices that support all of the time slots.

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Data That Isn't 3G

EDGE's real-world data rates are far lower than its theoretical peaks of 473 kbps. For example, Cingular acknowledges that its EDGE network can support peaks of only 170 kbps and average rates of 75 kbps-135 kbps,[20] while AT&T Wireless says that based on its extensive tests, users can expect average rates of 110 kbps - 130 kbps in a loaded network.[21] Yet, a current EDGE phone supports only 80 kbps.

So although its average rates are faster than GPRS' average rates, EDGE is ill-positioned to compete with, for example, CDMA2000 1xEV-DO, which provides average rates of 500 kbps. In fact, at 75 kbps, EDGE is barely competitive with CDMA2000 1X, which provides average rates of 60-100 kbps.

EDGE's data rates also are determined by the design of the phone or PC card modem. For example, when Cingular Wireless launched EDGE in June 2003, the only commercially available device was the Nokia 6200 phone,[22] which is designed to run no faster than 80 kbps.[23]

Many analysts and investors have been aware of the factors that affect EDGE's real-world data rates. A March 2003 Deutsche Bank Securities report provides a concise summary of the situation:

> First, there is the matter of processing power required in the handset to support the higher data rates. According to Motorola, due to processing power limitations, its current handset is limited to 3 downlink time slots and only 1 uplink time slot. We note that there are 8 potential time slots in either direction. In order to achieve the maximum data rates, the handsets have to support all 8 time slots and the operator has to be willing to dedicate all 8 time slots to one data user at the expense of its voice users and its other data users. We believe that [AT&T Wireless] is currently dedicating 2 time slots for EDGE in its Dallas trial although during periods of low overall usage, additional time slots could be dynamically assigned.
>
> Under the most optimistic (in our view unrealistic) scenario, the MOT EDGE handset can only handle approximately 177 kbps, not 474 kbps, which is often touted by AWE and which requires all 8 slots. At Cannes and at CTIA, the Nokia handset, which is limited to 118 kbps in the downlink (2 time slots), has only demonstrated average data rates in the 80 kbps range, despite being in an unloaded network and sitting under the base station. We note that EDGE devices will probably never be designed to support more than 4 time slots since operators will be reluctant/unable to dedicate more than 4 time slots to any one user. In the uplink, EDGE handsets will be limited to 2 time slots due to radiation restrictions (PCMCIA cards could potentially support more time slots in the uplink.)[24]

Why would an operator muzzle EDGE so that it can't deliver maximum throughput? Besides the fact that no commercially available EDGE device is capable of handling more than 177 kbps, spectrum is the other limiting factor. Indeed, the claim that "EDGE is the most spectrally efficient technology below 100 kbps"[25] could be interpreted to mean that it's a poor fit for higher-bandwidth applications if spectrum is in short supply.

Some operators have said publicly that they're concerned about significant variations in EDGE's data rates, even when the user is in the same location on different days or when the signal strength meter is peaked. Those variations are difficult to justify to customers, especially if they're paying a premium for EDGE devices and services, so the inconsistent quality almost certainly will limit EDGE's potential market. "That is something we have to address, and we are struggling with

that internally . . . how we're going to explain that to our customers," said Don Hjort, AT&T Wireless' senior product manager for data platforms and product development, at an August conference.[26]

The Coverage Problem

Part of EDGE's lackluster data performance stem from the fact that it's different than GSM and GPRS. For example, Hjort said that in EDGE, signal strength isn't an accurate indicator of performance. "Once deployed, EDGE is orders of magnitude more difficult to operate," Hjort said.[27]

The task and cost of adding EDGE to an existing cell site varies and helps determine whether an operator can make a business case for deploying the technology. For example, although EDGE's backers say that the cost of adding it to a GSM/GPRS base station is only $1-$2 per POP,[28] that claim assumes that the operator has infrastructure that's no older than 1999, depending on the vendor,[29] and thus capable of a software upgrade rather than a forklift upgrade.

An operator also can't simply add EDGE to a GSM/GPRS cell site and assume that EDGE coverage will be the same as the GSM/GPRS coverage. Indeed, in a 1999 presentation, Nokia said that EDGE's link budget is 4 dB-7 dB weaker than GSM's.

An obvious solution for plugging coverage holes is to add cell sites to cover large ones and repeaters for smaller gaps. That may be a viable option in small geographic areas, such as a business district, but if the holes are scattered throughout an entire market or multiple markets, the costs of additional infrastructure and creating a separate RF engineering plan for EDGE quickly add up, undercutting the technology's business case.

Spotty coverage reduces the data rate because EDGE sends data only at speeds that channel conditions can bear. So if the user is in an area where the signal is weak, the network will throttle back the speeds so that it doesn't have to retransmit lost packets.

Worse, spotty coverage reduces the data rate because EDGE sends data only at speeds that channel conditions can bear. So if the user is in an area where the signal is weak, the network will throttle back the speeds so that it doesn't have to retransmit lost packets.[30] If an operator's EDGE coverage is inconsistent, users will notice the change in throughput.

In Hong Kong, CSL deployed EDGE at 250 cell sites, but that covers only 40% of its current GPRS footprint and focuses EDGE only on high-use areas such as downtowns and airports.[31] But if 60% of its market isn't covered by EDGE, then

customers who use bandwidth-intensive applications that require EDGE have a good chance of winding up in an area where their applications work poorly or don't work at all.

Granted, CSL plans "to progressively develop EDGE in other areas when the demand grows," but no concrete timetable has been announced. So for now, EDGE users will pay a premium for spotty coverage. It's difficult to see how an operator's marketing message could acknowledge these types of serious drawbacks and still convince potential customers that EDGE is worth paying for.

CDMA2000 Delivers 3G Today

CDMA2000 is a much better alternative than EDGE. Unlike EDGE, CDMA2000 can be easily and cost-effectively deployed throughout an entire market, and it supports advanced, high-speed data applications today.[33]

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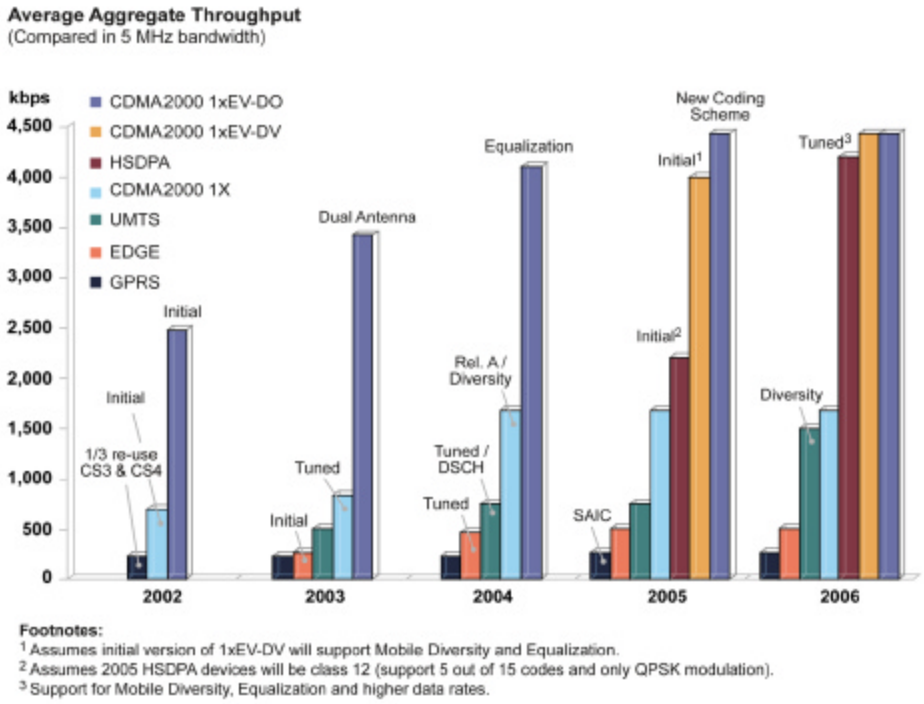
CDMA2000 has been commercially deployed for three years, and it already serves more than 60 million users on 71 commercial networks on all continents. One of the key reasons for its commercial success is that the technology can be deployed rapidly throughout the coverage area and with small capital outlays.

For example, KDDI's CDMA2000 1X network covered 70% of the Japanese population when it launched in April 2002, and by the following December, coverage had been expanded to 90% of the population. Yet the total CAPEX for KDDI's upgrade to CDMA2000 1X and evolution to CDMA2000 1xEV-DO is just 25% of what NTT DoCoMo estimates that it will spend on its W-CDMA network.[34]

CDMA2000 also offers far higher data rates than EDGE and even W-CDMA. With typical data throughput of 60 -100 kbps on CDMA2000 1X and 300 - 600 kbps on CDMA2000 1xEV-DO, operators can deliver a wide variety of high-bandwidth services, such as video on demand (VOD), music on demand (MOD), videoconferencing, MMS and TV broadcasts. In several U.S. cities, businesses and consumers use CDMA2000 1xEV-DO as an alternative to dial-up, DSL and cable for their desktop and laptop PCs.[35]

Finally, CDMA2000 does not require a large chunk of new spectrum, so it's an attractive option for operators that need to launch 3G today but have no new spectrum (Figure 2).

Figure 2



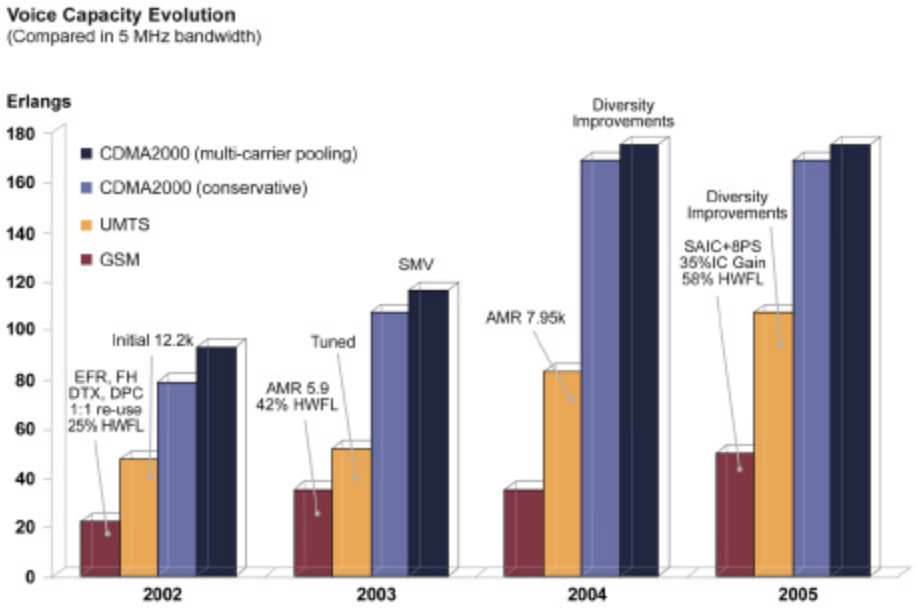
Footnotes:
[1] Assumes initial version of 1xEV-DV will support Mobile Diversity and Equalization.
[2] Assumes 2005 HSDPA devices will be class 12 (support 5 out of 15 codes and only QPSK modulation).
[3] Support for Mobile Diversity, Equalization and higher data rates.

Terms:
CS1 - CS4: GPRS Modulation Schemes
DSCH: Downlink Shared Channel
HSDPA: High Speed Downlink Packet Access
Rel. A: Release A of CDMA2000
SAIC: Single Antenna Interference Cancellation

Source: CDMA Development Group

CDMA2000 1X also doesn't ignore the importance of voice, which will remain wireless' killer app for the foreseeable future. Granted, EDGE can – in theory – free up spectrum for more voice calls, but CDMA2000 already offers five times more voice capacity in the same amount of spectrum, a lead that it will maintain over other technologies (Figure 3).

Figure 3



Footnotes:
Assumes 100% loading of voice traffic.
Assumes 2% blocking.
Gains assume 100% of users using latest technology.
Actual gains would depend on handsets penetration.

Terms:
AMR: Adaptive Multi-Rate Vocoder
DPC: Dynamic Power Control
DTX: Discontinuous Transmission
EFR: Enhanced Full Rate Vocoder
FH: Frequency Hopping
HWFL: Hardware Fractional Loading
IC: Interference Cancellation
SAIC: Single Antenna Interference Cancellation
SMV: Selective Mode Vocoder

Source: CDMA Development Group

Finally, CDMA2000 already has a wider variety of devices to appeal to a broad range of demographics and user needs. For example, as of October 2003, more than 425 models of CDMA2000 phones and PC card modems were commercially available, including 40 for CDMA2000 1XEV-DO.[36] By comparison, less than a half-dozen EDGE devices were available at the same time. For an operator that needs to launch 3G today and can't wait for device supplies to catch up, CDMA2000 is the best option.

Conclusion

EDGE is finally here – sort of – but there are few signs that it can deliver on its ambitious promises. Few operators outside of North America have committed to EDGE, let alone launched commercial service, so the technology doesn't leverage GSM's market share and cost structure. EDGE's current data rates are far slower than other commercially deployed technologies, such as CDMA2000 and W-CDMA, and increasing those rates comes at the expense of voice capacity.

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[6]http://www.nokia-asia.com/nokia/0,,27108,00.html
[7]http://www.sonyericsson.com/spg.jsp?template=P3_1&B=ie&PID=10049&LM=PSM_V
[8]See also Nokia's 2000 presentation, "Positioning of 3G Technologies"
[9]http://www.cdg.org/technology/3g.asp
[10]Just an offhand comment that they're considering EDGE has forced some European operators to quickly backpedal. For example, O2 Ireland had to reiterate its commitemnt to W-CDMA after saying that it was considering EDGE. http://www.3gnewsroom.com/3g_news/feb_03/news_3105.shtml
[11]http://www.3gamericas.org/English/statistics/EDGE_commitments_list.cfm
[12]"Signals to Noise," volume 78, June 1, 2003, Deutsche Bank Securities
[13]See slide 24 of Rod Nelson, AT&T Wireless CTO, September 2003 presentation at a Morgan Stanley conference. In the discussion of GSM's economy of scale, EDGE is notably absent.
[14]http://www.gsacom.com/news/gsa_149.php4
[15]http://www.shosteck.com/news/sep03.htm
[16]http://www.3gamericas.org/English/technology_center/gsmfacts.cfm
[17]"Broadcom takes Edge to 200 Kbits/s," *EE Times*, June 18, 2003
[18]"Signals to Noise," volume 78, June 1, 2003, Deutsche Bank Securities
[19]http://www.shosteck.com/news/sep03.htm
[20]http://www.cingular.com/about/latest_news/03_06_30
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[30]http://www.ericsson.com/products/white_papers_pdf/edge_wp_technical.pdf
[31]http://www.telecomasia.net/telecomasia/article/articleDetail.jsp?id=69075
[32]http://www.hkcsl.com/show.jsp?pid=6&cnid1=9&type1=2&rhtID1=2&gf1=1&lid=1#
[33]In the United States, CDMA2000 1XEV-DO has been commerically available since October 2002 in several Midwestern cities. See http://www.monetmobile.com/showcontent.asp?contentname=About_PressreleaseDetail_50
[34]Morgan Stanley, June 2002
[35]http://www.monetmobile.com/showcontent.asp?contentname=About_PressreleaseDetail_50
[36]http://www.cdg.org/technology/product_pavilion/subscriber_device.asp?searchtype=999