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TDD SOLVES 3G HOTSPOT PROBLEM

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As the launch date for the first third generation/3G network looms ever closer, the mobile communications industry seems to be talking of little else. Within 3GPP/3GPP2 the standardization process continues apace, new content providers and applications developers are setting out their stalls, trials of 3G network elements are announced with growing frequency and some operators have even signed tentative deployment contracts.

Much of the discussion to date has been focused on the 3G technology which will be the first to be deployed-Wideband CDMA. Japan's NTT DoCoMo is committed to launching commercial 3G services over its W-CDMA network in the second quarter of 2001. Yet despite its high profile, the W-CDMA technology being deployed in Japan represents only part of the 3G UMTS story.

UMTS, the 3G solution developed by ETSI and approved by the ITU for IMT-2000, is based on a W-CDMA air interface that offers two complementary modes: Frequency Division Duplex (FDD) and Time Division Duplex (TDD). Although much of the attention has been focused on FDD, work on the TDD component of the standard continues. TDD standardization was included in 3GPP's Release 99 and will form a major part of Release 2000. The ITU's World Radiocommunications Conference (WRC) has allocated spectrum for both FDD and TDD and may allocate additional unpaired spectrum in the 3.5 GHz band for TDD.

Advantages of TDD

It is important to note that FDD and TDD are complementary rather than competitive technologies. The classical deployment strategy for cellular networks, which will also be adopted for 3G implementation, is hierarchical. In the first phase, large macro cells will be installed to provide the maximum coverage possible. Typically such cells in 3G will have coverage areas of up to 5km and will be used for urban, suburban and rural service provision. In

the second phase, micro cells with coverage areas of up to 1km will be deployed, providing higher capacity and deeper coverage in areas of high traffic density. FDD technology will be used for both macro and micro cell deployment.

The third phase involves the deployment of pico cells with coverage areas of up to 100 meters. These are used to provide coverage and capacity for traffic hotspots such as airports, shopping malls, corporate buildings, conference centers and large hotels. It is in this phase of deployment that TDD will be used.

TDD is optimized for the high data rates that will be required for these traffic hotspots. The majority of this data traffic is likely to comprise Internet or intranet access which is highly asymmetric, with high bandwidth required in the downstream direction and minimal bandwidth upstream. TDD offers an optimal solution for such asymmetric traffic patterns. TDD, for example, can be configured to provide 384kbit/s downstream, in the direction of the major data traffic movement, and 64kbit/s upstream, where the traffic largely comprises requests for information and acknowledgements. FDD on the other hand is symmetrical, with equal data bandwidth in both directions. Thus TDD offers a very adaptable and flexible solution for high data rates and it provides operators with greater capacity in their networks.

Other radio approaches that have been proposed as solutions for high speed data communications in traffic hotspots include wireless LAN, IEEE802.11 and BRAN (ETSI's Broadband Radio Access Network). However, TDD offers a superior solution to all of these for a number of reasons. Firstly, TDD operates in licensed spectrum whereas other proposed solutions are designed for unlicensed spectrum operation (normally the ISM band). The openness of the unlicensed spectrum to any user makes interference a serious problem, one not faced by systems operating in clean licensed bands.

However, the major advantage that TDD will offer over other solutions will be the ability to deliver seamless service. As operators deploy both FDD and TDD infrastructure, new tri-mode terminals (GSM/FDD/TDD) will be developed. These are likely to quickly become the norm, offering users a seamless transition between modes depending on their communications needs. A user moving from a highly mobile environment, in which he or she is using voice and low speed data, can switch on arrival at an airport lounge

to using a PC over his or her terminal for high speed data, completely transparently.

Terminals involving FDD, GSM and an alternative technology such as BRAN or wireless LAN could attract cost premiums. Tri-mode terminals will attract a cost premium initially, but the industry consensus is that this will be economically feasible and considerably less than the alternatives, and prices will fall as volumes increase. The impact of FDD/TDD dual mode deployment on infrastructure costs are likely to be minimal, involving only minor changes in the base stations; the radio network controller is able to handle both modes.

Finally, as 3G matures, demand for data services will increase dramatically and operators will be looking to find new spectrum. A major advantage of TDD is that it will be much easier to find unpaired spectrum than the paired spectrum required for FDD operation.

Allocating the spectrum

Whether operators will deploy TDD will depend on the availability of the unpaired spectrum. The WRC has allocated spectrum for both FDD and TDD but the decision on actually issuing the spectrum is a matter for national regulators. In the recent UK auctions, FDD and TDD spectrum were bundled so winning bidders acquired both automatically. Having unused spectrum is anathema for operators so the UK 3G operators are almost certain to deploy TDD for pico cell hotspot coverage.

Elsewhere the picture is less clear. Germany has indicated that TDD spectrum will be available but it will not be bundled with the FDD spectrum. Operators requiring both spectrum allocations will be required to make separate bids for each band. There will be considerable industry interest in gauging the level of interest in the TDD spectrum and it could have a profound impact on the long term deployment of TDD technology. If a particular operator does not have a business strategy which includes TDD deployment then patently he will not be interested in buying TDD spectrum. This is seen as an unlikely scenario because deploying FDD for hotspot coverage, although feasible, is an inefficient use of spectral resources. Other European administrations planning to issue 3G licenses during 2000 have not yet announced their plans with regard to TDD spectrum.

In Japan, TDD spectrum was not licensed in the first round of 3G licensing, Japanese operators were only allowed access to FDD spectrum. However, the incredible success of NTT DoCoMo's I-mode service has shown the level of demand for data services and particularly Internet access, and Japan seems likely to license TDD spectrum within the next two to three years. TDD trials are expected to take place in Japan sometime in the next twelve months.

China is one of the most interesting markets. The country already has a TDD-like technology, TD-SCDMA, which has ITU approval under the IMT-2000 family concept. However, China has the capability, should it so wish, to issue TDD spectrum and current information suggests it may think about doing so for wireless local loop applications. There is considerable pressure in China to pursue homegrown 3G technologies such as TD-SCDMA, and the latest entrant LAS-CDMA, but UMTS TDD remains a possible future route.

Making money from TDD

The key issue for operators is of course how can they generate revenues from the deployment of TDD? First, and most obviously, the provision of high bandwidth in areas of high user demand will generate service revenues. The capability to download large amounts of data from the Internet or a corporate intranet whilst waiting in an airport lounge or hotel room, will be a tremendous boon to the global business community and they will certainly use such a capability extensively.

However, with imagination, other new and exciting potential revenue generating opportunities can be identified which build on the unique capabilities of TDD. Operators in the future will have a great deal of information about their subscribers, which could be utilized to deliver information specifically tailored for the end user. Take, for example, the scenario of the shopping mall. On entering the mall, the user could be offered the opportunity of scanning, from his mobile terminal, advertisements generated by retailers within the mall. A young person, for example, could be directed towards CD shops or trendy clothing outlets with special offers. Other customer groups would have similar targeted advertising based on their defined preferences. All customers would have the opportunity to find details of all retail outlets within the mall.

Major supermarkets would also be interested in having such a service. When a user enters the building, he or she would be alerted through their mobile terminal to special offers on food and drink, and given specific directions on how to get to the relevant counter-an essential requirement in today's massive supermarkets.

Services such as these offer considerable benefits to operators. Firstly, new revenue streams in terms of payment for advertising from retailers would be opened up. Airtime usage, and hence revenues, from subscribers would be increased as they surfed the system searching for particular items or special bargains.

The most significant feature of such services is that they will be seamless. The user's tri-mode terminal will switch transparently into TDD mode immediately on entering the coverage area of the pico cell within the shopping mall or supermarket. No conscious effort would be required by the user. This represents an important service differentiator for traditional mobile operators over potential competitors who may be trying to deliver such services using other technologies such as BRAN or wireless LAN. The seamlessness offered by the tri-mode phone and TDD would enable the traditional operator to win the traffic hotspot business, using spectrum that he already owns and technology-TDD-that is already incorporated into his network.

Conclusion

The main focus of the standardization activity first within ETSI and later 3GPP has been very much on completing the specification of the FDD elements of UMTS. The reason for this pressure is obvious, the launch date for 3G services is 2002 and it is important for the credibility of 3G that this timeline is adhered to.

However, as has already been pointed out, standards groups are continuing to work on TDD standardization, in particular on the air interface and on layer2/3 protocol stacks. The FDD technology is now in the field trial phase and TDD trials are planned to start within twelve to eighteen months. Siemens

which is focusing much of its 3G development activity on TDD, is planning a TDD trial in South Africa in the near future. Although other major vendors are working to achieve the FDD deadline, they are also developing TDD solutions.

The gap between the launch of WCDMA FDD 3G networks and the advent of TDD was planned from the outset. Given the hierarchical rollout strategy outlined earlier-macro, micro, pico-TDD will not be required in the first phase of deployment where the main aim will be rapid, widespread coverage via FDD. As 3G matures, and the demand for additional, focused capacity and higher data speeds increases, TDD will be ready and waiting in the wings ready to meet the needs of operators and subscribers.