

# A growing shift in

Phil Medd of Racal Instruments Wireless Solutions – an Aeroflex Company – examines the vital components of Inter-System Hand Over – regarded as an essential requirement for all 3G UMTS networks

After all the hype and speculation regarding the 'killer features' that 3G networks may bring, one of the basic features seems to have been taken for granted: the ability to place and hold voice calls wherever the mobile is located. When GSM networks were first introduced about 10 years ago, the ability to handover a call from the current analogue networks to the new digital ones was not considered necessary. Given the success of the digital networks, and GSM in particular, the situation is now quite different, and the ability to hand over a voice call between 2G and 3G networks will remain essential until the geographical coverage of the 3G infrastructure has expanded to match. The capability to handover between 2/2.5G and 3G technologies has been designed into the standards, but as the new networks are rolled out, will the early offerings provide this essential feature?

## 3G will be a success

That the WCDMA 3G network will succeed is not in doubt. There are too many major players involved with large vested interests for it to fail. Even if users don't yet need all the new features offered, the network operators will gain from reduced costs and increased capacity. The data services being introduced in the 2.5G networks will readily migrate to 3G, where they can be improved over time with, for example, MMS superseding SMS. 3G will succeed – it's just a question of when.

Networks are being installed at a rapid rate – Vodafone has installed over 1000 base stations in the UK alone – and the first networks have been in commercial service for a number of months. However, although early

adopters tend to be tolerant, the mass market will stay away until the service is reliable, the coverage is good and value for money is reasonable. Any perceived problems will inevitably delay mass adoption. Also, if a price premium is to be charged, the quality of service will have to be higher than current services – no backward performance step will be tolerated.

As the new technology is introduced, it will take some time for the geographical coverage of the network to match that achieved by the existing 2/2.5G networks. Where 3G coverage is absent, the user will need to make use of the 2/2.5G network, bringing with it the requirement for the mobile to be able to support both Radio Access Technologies (RATs). For this reason, all 3G mobiles currently being introduced are 'dual-RAT'. Not only does the mobile need to be able to search for either type of network at power-on, but also re-select the network type when moving out of the 3G coverage area. When a mobile is in a call, it needs to be able to be handed over from one network type to the other without the user being aware of it happening. For GPRS terminals, the packet service connection also needs to be transferred to the other network.

The assumption has been made that 2/2.5G coverage will be ubiquitous, so handover from 2/2.5G to 3G has been given a lower priority. However, this assumption will become less safe as 3G network coverage increases. Thus it is essential that current mobiles are capable of supporting 2/2.5G to 3G inter-system handover if a future performance problems are to be avoided.

## Early teething problems

Current networks do not support reliable inter-system handover during voice calls, and is not even attempted for 2G to 3G transitions on the assumption that the 2G network is always available. This unreliability, due mainly to protocol errors, results in calls unexpectedly being dropped, and

there can be a temporary loss of any service, sometimes requiring the handset to be power-cycled to recover.

Early evidence indicates that some users are not happy with their first experience of 3G technology. Price reductions are attracting subscribers, but retaining them is proving difficult due to poor network performance. One disgruntled user reports difficulty making calls, while another has had difficulty sustaining a call after moving out of 3G coverage area.

The 2G networks have set expectations, and the natural assumption is that the new service will be at least as good, and certainly not worse. The key message is that a backward step in service quality will not be acceptable.

## Technical challenges

Integrating a dual-RAT handset represents some significant technical challenges for the handset designer. The handset needs to incorporate two different RF sections. The 3G bands extend up to 2.1GHz and have very demanding linearity characteristics due to the high crest-factor of WCDMA signals. Two different baseband processors are needed to support the fundamentally different WCDMA and TDMA modulation and channel coding schemes. To support both 2G and 3G, two quite different protocol stacks need to be integrated. In practice, existing, well-trying 2/2.5G protocol stacks are updated to work in parallel with new UMTS stacks.

Fitting all this into one handset, while retaining acceptable battery life represents just part of the problem. In the 2/2.5G network, the hand over mechanism relies on measurements made by the mobile, feeding back information about the neighbouring cells to the network, where the hand over decision is made. The pulsed nature of the TDMA air interface leaves spare slots when the mobile is able to rapidly search for, decode and measure the level and quality neighbouring cells, feeding this information back to the network in regular measurement reports. However, in a pure 3G network, the WCDMA technology uses constant transmission and reception, with no

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# Expectations

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free slots available for the mobile to re-tune and search for 2/2.5G networks.

Therefore, to provide inter-system hand over capability a transmission gap is created to allow the mobile time to search for 2/2.5G signals and provide the measurement reports needed by the network. To provide this transmission gap, in what is known as compressed mode, without affecting normal use of the handset represents another challenge for the designer. Different mechanisms are used to compensate for the gap, such as increasing the data rate either side of the gap so that the overall data rate remains unchanged.

After all this, once the network has decided to make an inter-system hand over, the signalling mechanism is relatively straightforward, with a single message exchange used to start and acknowledge the transfer. The final challenge for the handset designer is to devise a means of testing this procedure. Trying to bring together the resources needed for an in-house solution can be a time-consuming exercise, and is unlikely to result in a system that is suitable for conformance testing.

## The way forward

Test equipment that provides rigorous inter-system hand over test capability has been lacking, but is now starting to appear, including formal conformance test capability. Conformance test cases exist in 3GPP documents TS 34.123 (for 3G to 2G cell selections and handovers) and TS 51.010 (for the corresponding 2G to 3G transitions). However, only a small number are being provided at high priority and these mostly use blind handover, where compressed mode is not required and the mobile is not required to perform the measurements during the transmission gap.

None of these dual-RAT test cases have yet been ratified by the Global Certification Forum (GCF), the industry body responsible for prioritising and approving the tests applied during handset certification. It is unlikely that a sufficient number of test cases will have been approved by the GCF until the middle of 2004 for 3G handset certification to become mandatory. Until then, network operators are running the risk that handsets will be released to the public that may fail the conformance tests.

To minimise this risk, handset

manufacturers must ensure that their handsets will pass whatever test cases are available. Where necessary this could include early versions of the test cases, for example in the case of the dual-RAT ones.

## Conclusion

Lessons have been learnt from the introduction of GSM, but dealing with handover to/from a legacy system was not one of them as there was no analogue/digital handover capability, at least in European networks. Remember that analogue networks struggled to handover from one cell to the next.

The pressure to introduce 3G services must be immense, due to the need to start recovering the investment made in the licence and infrastructure, but there is a danger in introducing the new technology before it is fully tested. Until recently there were no test solutions available, but this is no longer the case.

In the near future, other forms of inter-system handover are likely to be necessary – for example 3G - WiFi – so ensuring that an effective test method is available as a high priority, not an afterthought, is a lesson that needs to be heeded.



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