By John Meredith

Voice call continuity in 3GPP

Voice call continuity requires maintaining a voice call when a mobile terminal moves from one cell to another for second generation Global System for Mobile Communications (GSM) digital cellular communications systems. Operational for many years, this technique enables a conversation to continue when the Circuit-Switched (CS) call reroutes to use a new basestation as the mobile moves from one coverage area to another. The parties will perceive no break whatsoever.

Today, the scenario is rather more complicated, with calls being handed over not only from 2G to 2G cells and from 3G to 3G cells, but also between 2G GSM and 3G Universal Mobile Telecommunications System (UMTS) cells. This is relatively easy from an administrative point of view, given that generally the same cellular network is involved throughout.

Earlier work carried out within the 3rd Generation Partnership Project (3GPP) envisaged telephony using packet-switched connections – Voice over Internet Protocol (VoIP) – using either the 3GPP-defined IP Multimedia Subsystem (IMS) on the 3G Universal Terrestrial Access Network (UTRAN), or Wireless Local Area Network (WLAN) radio access technology based on IEEE 802.11, and other standards. This was covered by the WLAN interworking work items.

However, until now, handover between CS and IMS (packet-switched) calls was not addressed. 3GPP is now investigating the problem of handing over a voice (or potentially video or other multimedia conversational service) call between the cellular network and a WLAN, possibly operated by a completely different service provider. Again, for conversational service, the handover has to be seamless, with no break in service perceived by either party to the call. Until recently, such handover had only been considered for services that are not real-time, such as file-transfer, where short breaks during the handover process are acceptable and probably go unnoticed by the user.

The approach taken by 3GPP is to have the WLAN operator use the information registered by the home operator for the mobile terminal subscriber in this sequence:

1. Validate the eligibility of the handover to happen at all
2. Manage charging for the call that is effectively transferred from one network operator to another

It is generally, though not necessarily, the case that WLAN hotspots are also well covered by cellular service. Thus, such handover may take place when cellular coverage is reduced to an unacceptable level, yet an adequate WLAN hotspot service is available. The handover is more likely to occur when spare bandwidth exists on the WLAN but where excess demand for cellular channels exists.

The goal is to maintain the conversational service call, thus optimizing the service to the users, which in turn will maximize the revenue accruing to the operator(s). 3GPP embarked on the technical activity required to enable this service by approving a work item on Voice Call Continuity (VCC) in the June 2005 meeting of its Technical Specification Group *System Aspects and Architecture* (TSG SA). In order to be accepted onto the 3GPP work plan, any work item needs to have the support of at least four supporting member companies, and no sustained opposition. The VCC work item has no fewer than 16 supporters, and its progress can be tracked on the 3GPP website, www.3gpp.org. It is intended that this work be achieved in the Release 7 time frame.

A prerequisite of VCC is cooperation between the home network IMS and the WLAN operator. Given this prerequisite, an added bonus is that the VCC handover mechanism should be applicable regardless of the precise nature of the radio, or even wireline, access technology. For example, wireline *IMS over Internet* or radio *IMS over General Packet Radio Service (GPRS)* could replace WLAN, and the same basic mechanisms should be at work.

As if this were not complicated enough, due regard must be taken to security issues as they apply to GSM/UMTS CS calls, WLAN access, and IMS.

Feasibility study

The work item was immediately approved, and 3GPP TSG SA working group 2 started work on Technical Report (TR) 23.806. This TR would contain the result of an architectural feasibility study into the possible approaches to VCC. Approximately 150 pages, the TR was approved at the TSG SA meeting held December 5 to 7, 2005 in Malta. Although the TR is considered complete, working group members identified several points requiring detailed resolution during the ensuing specification work. Among these were further consideration of whether supplementary services would be best supported centrally or distributed among the cooperating networks, and the possible interactions with Customized Applications for Mobile network Enhanced Logic (CAMEL) services. The TR identifies several possible approaches, but participants narrowed the options down to two techniques dubbed *Original Domain Controlled* and *IMS Controlled Static Anchoring*. The pros and cons of each will be determined during the detailed specification phase.

Technical specification

The service requirements as perceived from a user's point of view are essentially identical to those for existing voice calls, so no new Stage 1 specification is needed. However, some aspects of the effects on, for example, charging and supplementary service operation need to be documented. So far, seven change requests to the Stage 1 specification TS 22.101 have been approved. Most technical specification work will be captured in a Stage 2 (architecture and functional information flows) specification. A draft has been prepared for this specification, TS 23.206, and it is envisaged that several existing Stage 3 (detailed function and protocol) specifications will be modified to cater for the required signaling. Generally, the group agreed that this signaling should be minimized in order not to place an excessive burden on the two networks during the handover process and also to keep to an acceptable level the capability negotiation between terminal and network as the mobile unit moves in and out of service coverage, which may be different for CS and IMS service.

Meanwhile, detailed architectural discussions are taking place in of SA working group two, largely via e-mail. A couple of dozen VCC enthusiasts exchange an average of approximately 20 e-mails daily to thrash out solutions to the open issues.

The companies most active in the discussions represent a wide geographical spread that includes Europe, North America, and Asia and encompass both equipment providers such as Motorola, Ericsson, Nokia, ZTE, Lucent, Nortel, Huawei, Siemens, and others, and network operators such as Vodafone, Cingular, and others.

CAMEL

The VCC concept relies on CAMEL functionality (3GPP TS 22.078, TS 23.078, 29.078). Refer to TS 21.978 for a feasibility study of VoIP support via CAMEL. Presently, no alternative mechanism is envisaged. From the standardization point of view, minimizing the number of options is a good thing. However, it is a fact of life that there are mobile networks in the world that do not support CAMEL. If this state persists, then VCC implementation would obviously be adversely affected.

Network domain selection

Probably the major topic that has exercised the engineers has been the consideration of the Network Domain Selection (NeDS) function, and where this function should best be situated. This function is the point where the decision is taken to deliver a call either in the CS domain or in the IMS domain. While it is logical for a call that was originated in the CS domain to remain CS end-to-end, and similarly for an IMS-originated call to remain IMS throughout, there are circumstances when a change of domain is appropriate.

Apart from technical issues, there are the questions of terminal capability, whether or not the destination terminal is already CS-attached or IMS-registered, and not least the preference and subscription options of the terminating user. Although the feasibility study identified many of the issues to be examined, by its nature, it provided very little in the way of concrete answers.

NeDS functionality has been conceptually split into two:

- Functionality required to determine whether an incoming CS call should be routed to IMS
- Functionality required to determine whether a call currently in the IMS should remain in IMS or be transferred to CS

The current mindset is that the first area need not be standardized, but various techniques might be described in an informative annex to the standard. For the second area, several possibilities are being discussed, though it is not proposed to have a standardized reference point. This implies that, when it comes to writing Stage 3 specifications, signaling is also likely to have at least some proprietary element. The NeDS entity will interact either with the Serving Call Session Control Function (S-CSCF) or with the Call Continuity Control Function (CCCF) (refer to TR 22.806), implying the use of either IMS Service Control or Diameter. Part of the thinking behind the placement of NeDS is whether or not it may one day be desirable to support VCC in pre-Release-7 networks. That is, VCC effectively becomes release-independent.

As is often the case with abstract architectural discussions, there is a tendency to map functionality onto known or envisaged physical boxes. After all, the implementation will be in equipment manufactured and sold to operators, not in ethereal clouds in Stage 2 specifications. The trick is not to start this mapping process too early, to allow correct functionality to be specified in advance of detailed considerations of marketable products. It is clear that a great deal of work remains to be done on this topic before the TS can hope to reach stability. Nevertheless, time scales are aggressive, and the target is to have all the major standardization work completed by June 2006.

This column has touched upon some of the current considerations of the VCC work currently unfurling in 3GPP. A more detailed review can be found via the VCC exploder list digest. While participation in the 3GPP meetings is limited to 3GPP member organizations, anyone may join exploder lists and contribute to discussions. To join, visit www.3gpp.org/email/lists.htm.

For more information, contact John at john.meredith@etsi.org.

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