Smart Terminal in Mobile Internet

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Abstract:
In the mobile Internet environment, smart terminals should be multi-mode and multi-standby, and have smart open platform as well as rich client. However, consumption, radio frequency interference between two networks and network cooperation issues emerge accordingly. This paper gives the solutions to the abovementioned problems: The video signal enhancer is used to improve the image quality and reduce power consumption; the radio frequency interference is reduced by avoiding interference caused by in-band leakage and by out-of-band block; and the effective cooperation between dual networks can be fulfilled by re-designing communication architecture, processor, service logic and User Interface (UI).

Global mobile Internet is in its rapid growth stage. Gathering innovation sources and engines for future services of mobile communications industry, mobile Internet has become the core of 3G services. With the increasing demand for high-rate data services in mobile Internet, as well as rapid development of mobile technologies and IP technologies, traditional telecom industry faces serious challenge.

Nowadays, as telecom networks become more and more mature and Internet develops quickly, mobile terminals, especially smart mobile terminals, play a significant role in the development of mobile Internet. Currently, the core of communication network development is services, while service development focuses on terminals. Being portable and mobile, terminals meet people's demands for communication with others anytime and anywhere, but smart communication terminals are more human-oriented, personalized and multi-purpose in terms of functionality. In future services, smart terminals will be the focus of the entire telecom industry as well as electronic industry.

Meanwhile, the coexistence of 2G and 3G networks is inevitable in China. At present, China has over 600 million 2G users. Because of their own use habits and consumption behaviors, they wouldn't transit to 3G network in a short time. On the other hand, three 3G licenses have been granted in China. Consequently, dual-mode (e.g. 2G&3G and 3G&3G) or even multi-mode mobile phones will be a good choice for the transition phrase and become an important market segment.

The dual-mode, dual-standby technology provides a platform for terminals to smoothly transit from 2G networks to 3G networks. It not only protects the interests of operators and users, but also paves the way for quick transition to 3G.

With continuous evolution of 3G networks and increasing demand of multimedia services on high-speed data transmission, all 3G standards introduce High Speed Downlink Packet Access (HSDPA) technology. This technology enables the operators to provide the users with more attractive, diverse new services and applications, satisfying the users' growing demands for media services, including Video on Demand (VoD), audio on demand, image/video short message and location-based services. Moreover, compared with traditional technologies, HSDPA is advantageous in spectrum efficiency, allowing the operators to deliver these services at lower costs and bring better user experience. In China, such services as video phone, VoD, audio on demand and Global Positioning System (GPS) navigation are great support to its 3G industry, where Time Division Synchronous Code Division Multiple Access (TD-SCDMA) standard is mainly adopted, and enrich 3G terminal products. With HSDPA technology, TD-SCDMA systems can transmit 8.4 Mbit/s and 2.8 Mbit/s services at frequencies of 5 MHz and 1.6 MHz respectively.

However, several technical issues have to be addressed before smart terminals are used for high-speed Internet access and meet various service requirements, such as dual-mode dual-standby, mobile TV, 3D navigation, animated game and video phone[1-4].

1 Power-Saving Technology of Smart Terminals

The power consumption of a smart terminal is subject to several factors, including wireless environment, network configuration, protocol stack control, the terminal's software and hardware, power management, and low-consumption design and feature of the chip. But the decisive factor is the power-saving technology of the terminal. Among 3G

applications, mobile TV, 3D navigation and online games require continuous long–time running of terminals. Furthermore, the power consumption of highlight backlight source accounts for about 40% of the total consumption. Therefore, how to lower the brightness of backlight without reducing the visual effect becomes one of important objectives to attain.

One solution is to improve the image quality with a video enhancer. The best visual effect can be achieved by measuring human eyes' sensitivities to backlight and adjusting the brightness of backlight accordingly.

First, an Application Processor (AP) senses brightness of external light source and gets its brightness level with the interface standard Inter–Integrated Circuit (IIC). Then the video enhancer uses a debugged algorithm to output the brightness parameter to enhance the images, and meanwhile, it controls the brightness of backlight source to save the power. The best visual effect can also be achieved by adjusting the brightness of backlight source and the engine of the video enhancer according to people's feelings.

In this way, the power consumption of the terminal can be reduced by over 25%. Consequently, the terminal's continuous navigation capability is improved and the lifetimes of the terminal and its battery are prolonged.

2 RF Interference Between Two Networks of Dual–Standby Terminal

To enable a dual–standby terminal to communicate in both GSM and TD–SCDMA networks, GSM Radio Frequency (RF) module of the terminal and TD–SCDMA receiver should function at the same time. This may lead to in–band leakage interference and out–of–band blocking interference of GSM transmitter's carriers on TD–SCDMA receiver, and similar case takes place if the terminal's TD–SCDMA RF module and GSM receiver work simultaneously. In addition, the noise interference between TD–SCDMA and GSM devices is inevitable and need to be suppressed, in particular, the interference of GSM 1800 MHz on TD–SCDMA.

Generally, interferences between TD–SCDMA and GSM systems of a terminal fall into three categories:

The first category is the interference occurring when both GSM and TD–SCDMA systems of the terminal are in standby status. If both modules are in monitor status, the interference between them can be ignored. This category of interference is likely to take place when GSM or TD–SCDMA transmits signals to update its status, as in the case of handover. In this case, the signal–sending system interferes with the receiving system. This interference may be classified into the second category of interference.

The second category is the interference occurring when GSM or TD–SCDMA system is in connected status, while the other one is in standby status. Such interference includes interference of GSM signals on TD–SCDMA receiver, interference of GSM spurious signals on TD–SCDMA signals, interference of TD–SCDMA signals on GSM and interference of TD–SCDMA spurious signals on GSM.

The third category is interference when both GSM and TD–SCDMA systems are in connected status, which will not take place in reality, so we will not discuss it here.

The frequency interference is a critical problem in the implementation of dual–mode terminals. Solving this problem would be significant for development of dual–mode terminals.

When the strengths of GSM transmit signals reaching TD–SCDMA receiver are much higher than the strengths of signals transmitted by TD–SCDMA base stations, TD–SCDMA signals will be drowned by GSM signals, leading to increase in error code rate when TD–SCDMA receiver demodulates useful weak TD–SCDMA signals. In other words, the sensitivity of TD–SCDMA receiver decreases, and more seriously, TD–SCDMA call drops or call setup fails.

There are two solutions for frequency interference.

(1) To use two independent communication modules

This solution adopts existing GSM and TD–SCDMA modules. The two modules are independent and shielded separately, and connected to the motherboard with connectors. In this way, the interference between them is minimized. Moreover, to avoid interference signals transferring via Flexible Printed Circuit Board (FPC), several isolation capacitors and single–point grounding can be used.

(2) To avoid the two communication modules being in connected status at the same time

To further reduce frequency interference, software approach can be used to avoid the two communication modules being in connected status simultaneously, thus ensuring communication quality for the users. The software approach is mainly applicable to the following two cases.

a) In case of call origination, where the user selects one network (GSM or TD–SCDMA) to originate a call (voice or packet data services), the software checks the other network for any call.

- If there are call(s) in the other network, it prompts the user that communication is busy and cancels the new call request.
- If there is not any active call in the other network, the software then checks to see whether there is any active data service in the other network. If there are active data service(s), it prompts the user to hang up current network connection first.
- If there is not any data service or call, the call request will be processed as usual.

b) In case of incoming call

- If there is an active call in the other network, the software gives an incoming call prompt tone and asks the user whether to answer or hang the incoming call via the interface. If the user decides to answer the incoming call, current call is released, and the audio channel of the communication module corresponding to the incoming call is connected to sound adapter and Microphone (MIC). Or the user selects to hang the incoming call directly. If the user makes no choice within 20–30 seconds, the terminal's controlling module will request the system to hang the incoming call.
- If there are data service(s) being processed in the other network, the user can select to answer the incoming call and release current data services;

otherwise, current data services go on.

• If there is not any call or data service in the other network, the incoming call will be processed as usual.

3 Cooperation Between Two Networks of Dual–Standby Terminal

The difficulty involved in the cooperation between two networks is how to ensure dual–mode terminals to enjoy the same user experience as single–mode terminals. The cooperation should not affect user experience of any dual–mode terminal in either of the two networks. For example, the terminal's processing speed should not decrease considerably. Besides, the service procedure for single–mode terminals should not be changed.

To achieve such a cooperation between GSM and TD–SCDMA networks, the following have to be done:

First, reconstruct traditional communication architecture, allowing the call procedure to support dual–standby communication. The calls in the two networks should be independent (i.e. two threads) as well as coordinate with each other as to share resources.

Second, use three independent processors. Two of them are assigned to GSM and TD–SCDMA networks respectively, and the third one acts as an application processor, which coordinates system resources and schedules them for the two networks.

Third, define a full set of dual–standby service logics and work out specifications accordingly. These service logics should not only produce convenience and practicality for the users, but also bring the operators benefits and services. Service specifications are made up of these service logics, service policies and user experience standards.

Fourth, design dual–standby User Interface (UI) to reflect the requirements of dual–standby service specifications. In each specific service, its calls, short messages, call records and contacts should reflect the coexistence of two networks.

Architecturally, GSM module has to be added but existing TD–SCDMA module acts as the controlling module. The functions of the controlling module are as follows:

(1) When the terminal is standby, it controls peripheral interfaces and UIs according to the information it receives from GSM and TD–SCDMA networks. For example, it displays signal quality and clocks of both GSM and TD–SCDMA networks at the same time.

(2) When the terminal is standby, it activates a module based on the user's operations and sends messages and data to the module. For example, when a user inputs a number on the terminal and sends it to a network, the controlling module activates the module of the network, letting the network enter dialing and call status.

(3) When a user makes a call in a network, if another call comes in from the other network, the controlling module holds the status of the communication module of the old call, instructing the module of the other network to communicate with the network via the background, for example, to obtain the incoming call number. Meanwhile, it controls peripheral software to display the incoming call or play incoming call beep.

(4) When a user makes a call in a network, if a short message comes in from the other network, the controlling module holds the status of communication module of the call, instructing the module of the other network to communicate with the network via the background, for example, to obtain and save the short message. Meanwhile, it controls peripheral software to display the short message or play short message beep.

4 Conclusions

In either mobile networks or Internet, more and more contents directly come from UGCs, including forum, blog, community, e–commerce and video sharing. Adapting themselves to the change from voice communication to data communication, mobile terminals are facing a radical architectural change. Nowadays, intelligent mobile terminals are with more powerful functions than the computers 10 years ago. With the terminals, the users can "place" Internet into their pockets, produce and send pictures and videos to others anytime and anywhere and share photos via mobile Internet, which is a good platform for such activities as mobile office, mobile payment, blogging, instant messaging and chatting. Intelligent mobile terminals play more and more important roles in our daily life and gradually become our personal information center.

Evidently, these changes pose new challenges to mobile terminal's processing capability, power consumption and performance. Meanwhile, they drive technical innovations one after another and promote the development of new types of intelligent mobile terminals that would be powerful processing capability, small size, low power consumption and with many applications integrated.

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