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An Innovation in the Development of a Mobile Radio Model for a Dual-Band Transceiver in Wireless Cellular Communication

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Abstract. A modern telephone can only be used if it is a dual-band transceiver. Also, an indispensable condition is the availability of Internet access. Modern cell phones can only be used for their intended purpose: making calls. Due to the fact that the operating system is preinstalled on devices, the list of possibilities for gadgets could be expanded almost indefinitely. So you can even do a full-fledged dual-band transceiver from a cell phone. In this paper, an innovation in the development of mobile radio models dual-band transceivers in wireless cellular communication is proposed. For the dual-band transceiver in the phone to work, you need an Internet connection. Progress in the development of technologies for mobile networks does not stand still, and with each new standard and technology for mobile networks, new opportunities for using the network open up for end subscribers. It is based on packet voice data transmission called push-to-talk.

Keywords: Telephone, dual-band, transceiver, Internet, cell phone, wireless, cellular, communication, data, transmission, push-to-talk.

INTRODUCTION

In general, “push-to-talk” (PTT) technology, or, to be precise, proof of concept (POC) (cellular through PTT) in mobile networks, is not a new service, but the uniqueness of providing such technology involves the introduction of new elements in the architecture [1, 2]. Global system for mobile communication networks “borrow” operators from the IP multimedia subsystem (IMS) architecture, thereby encouraging the introduction of more efficient communication methods in the operator’s network and somewhat simplifying the evolution of the network to new standards [3]. However, second-generation (2G) Internet works in most suburban areas, allowing you to freely connect to the radio and send messages [4]. To send a message on the radio, you need to press and hold the round button display and talk [5]. As soon as the button is released, the message will start broadcasting. Despite the convenience and ease of use of the dual-band transceiver application, it is worth considering that it cannot act as the main communication channel [6]. The fact is that the work of the radio application and its work, combined with the connection and mobile network data transfer, quickly drains the phone’s battery [7, 8]. Therefore, if radio communication is required continuously for a long time and the ability to constantly recharge the battery is not provided [9], it will be easier to use a conventional dual-band transceiver tuned to the common frequency of all participants in the communication [10].

Now, a hybrid dual-band transceiver phone is rare. Somewhat ironically, yes, since progress has already gone far enough [11]. We use smart phones with touch screens, the diagonal of which has already reached six inches, we surf the Internet at incredible speeds, and we play games on phones that previously only worked on standard cellular devices, but hybrid devices that function as phones and have a dual-band transceiver cannot be advertised on the market [12–15]. A dual-band transceiver phone is not that expensive [16]. Rather, it has to do with need. It can be said that in earlier years the principle of “PTT” was used [17]. It is designed to work in dual-band transceiver mode, but cellular communication occurs only when there is a signal [18]. Here's a phone with a dual-band transceiver that actually works [19]. Each voice message is delivered to the recipient through a dedicated PTT server of the mobile operator's network [20]. The adaptive multirate audio codec (5.15 kb/s) is used for speech coding. A user can send voice data to another user (unicast) or to a group of users (multicast) [21, 22]. In the case of PTT, the optimal response time is determined to be 1–1.5 s plus transmission time [23]. The voice message (delay) is measured in increments of up to 2 s. It is impossible to interfere with voice communication like "classic" radio transmission using dual-band transceivers [24]. In the case of a live broadcast, interlocutors are presented in the order in which they press the "Talk" button (the "PTT" key) [25]. The conversation is carried out in the classic half-duplex mode (simultaneous one-way communication), i.e., the interlocutor hears you only when you hold down the "Talk" key, and in turn, you can hear other members of your group only when you release "PTT."

LITERATURE REVIEW

A telephone with a dual-band transceiver can provide communication between subscribers even in areas where there is no normal coverage. The declared distance is 2 km. But don't forget that this is only valid for open areas [26]. In urban areas with a high density of buildings and other elements, the distance is reduced. Still, a phone with a dual-band transceiver has some advantages over a conventional device [27].

An unexpected radio station on a mobile device or cellular device was detected. Among the advantages are the geolocation policy and the search for channels with no registration at first start. The two-way interface is as simple as possible, and the number of user settings is minimal [28]. With this application, a person (of the open type) can communicate with other users around the world while viewing the communication topic and coverage region. It can also access closed channels [29]. This development is most popular in the "walk and talk" style during flash mobs and street searches. It is worth noting that dual-band radio is installed not only on personal computers but also on mobile devices. So, you can even communicate with people who are somewhere on the road. If any user is offline for a certain moment, you have the option to send him or her a voice message [30].

PROPOSED SYSTEM DESIGN

The proposed model allows the phone to be used as a dual-band transceiver in the conventional sense and allows voice messages to be sent to an active group/subscriber. Just like a regular dual-band transceiver, you have to hold down a special key called "PTT" during a conversation. At the same time, the main difference from a regular circuit-switched conversation is that your short voice message

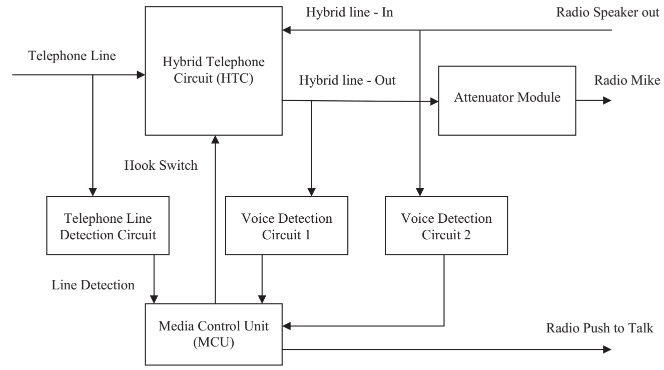

Figure 1. Mobile radio model for dual-band transceiver.

packet is sent over data channels, i.e., general packet radio service/EDGE, which are naturally much cheaper for the end user. The main advantage of this technology over "classic" portable radios is, of course, the distance you can get to other participants. In this case, the only limitation is the coverage area of ??the mobile operator. In this case, the conversational mode is very similar to the implementation scheme of voice services in Internet protocol (IP) telephony because the same protocols are used. The proposed construction is shown in Figure 1.

- SIP is used as the signaling protocol.
- RTP is used to transfer live voice data.

Establishing a session with another subscriber, i.e., sending a voice message over the air, is very similar to voice communication over an IP phone because the SIP protocol is used. It should be noted that there is a wide range of mobile devices that support POC service in the mobile device market; the main part of the devices is represented by Nokia and Motorola, which developed the POC standard the most widely. The POC service is used by taxi services, travel agencies, and groups of subscribers to continuously exchange short voice data and is an alternative to conference calls. A general plan for implementing a PTT service can be represented graphically in Figure 2.

- AAA Server: Authentication, Authorization and Accounting Server
- BDS: Base Transceiver Station
- ISC: Inter System Communication
- MIM: Mobile Instant Messaging
- MMS: Multimedia Messaging Service
- PS Core: Pocket Switched Core
- RADIUS: Remote authentication dial in user service
- RTCP: RTP Control Protocol
- RTP: Real Time Transport Protocol
- UE: User Equipment

The introduction of the service itself shows that operators are gradually shifting to the IMS concept, which is a

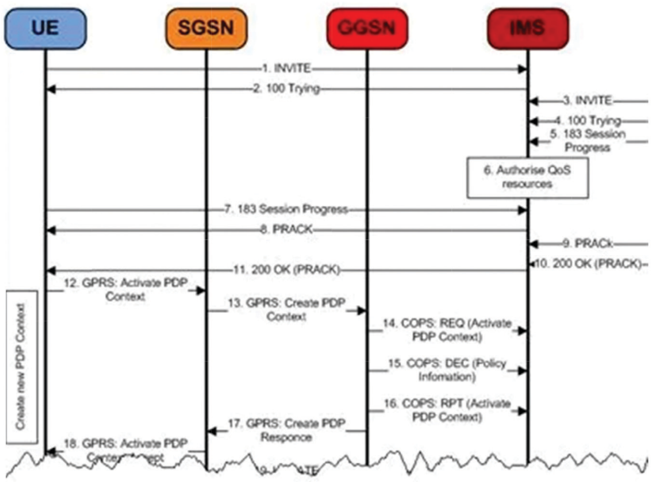

Figure 2. Proposed transceiver design.

good indicator. Further development of the POC service includes deep integration with multimedia services; for example, a subscriber can locate another subscriber using a so-called "location-based service" (LBS), and can then use the POC service to send him a text message, perhaps sending him or her a short text message (MIM) or multimedia message (MMS). Another direction in the development of POC services is so-called "provisioning." Push video services that allow sending/starting a video message to another subscriber/group of subscribers using a mobile terminal:

- "Available." This item allows you to immediately listen to received messages, indicating your open access to the chat.
- "Separate." Enables receiving information from one account, all other messages are automatically saved in the history.
- "Excitement." Archive all received messages so you can listen to them at any time.
- "Offline." Disables the program, but continues to receive push notifications.

Modern cell phones can only be used for their intended purpose: to make calls. Due to the preinstalled operating system on the devices, the list of gadget capabilities could be expanded almost to infinity. So you can even make a full-fledged dual-band transceiver out of a cell phone. Signal status information can be obtained from any 3G/4G modem. To do this, explore its settings and find the "Signal Level" or "RSSI" item. Below is an example of how to find out the signal level on a 3G modem. Connect the 3G/4G modem to your cellular device/laptop, start the program for the modem to work, go to the "Settings" menu, and select "Modem Information." After you determine the strength of the 3G/4G signal, the proposed design to assign it to the appropriate group is:

Table 1. Comparison of frequency range management.

Signals	DBRT	MDBT	CDBT	DBAD	MRM
100	49.74	58.72	63.73	71.66	92.48
200	50.24	58.72	64.82	71.92	92.59
300	50.74	58.72	65.91	72.18	92.70
400	51.24	58.72	67.00	72.44	92.81
500	51.74	58.72	68.09	72.70	92.92
600	52.24	58.72	69.18	72.96	93.03
700	52.74	58.72	70.27	73.22	93.14

- Group 1, -50 dBm to -60 dBm—best signal level;
- Group 2, -60 dBm to -70 dBm—good signal level;
- Group 3, -70 dBm to -80 dBm—average signal level;
- Group 4, -80 dBm to -90 dBm—poor signal level; and
- Group 5, -90 dBm to -100 dBm and below—obnoxious signal level.

If your result falls in the first group, you do not need a 3G/4G antenna because there will be no significant increase in Internet speed. If your signal strength is in the second or third group, you should buy a simple "weak" antenna for 3G. If the measurement result comes in the final or last group, you need to buy a high-gain antenna for 3G, which is for 4G. If you do not have a 3G signal, but you know that the operator's tower is 30 km away, from your end, it will help you. With its help, you will be able to "catch" the 3G signal, and you will have the opportunity to use high-speed Internet. If you cannot "catch" a 4G signal, then you know that the operator's tower is located 5 km away.

RESULTS AND DISCUSSION

The proposed Mobile radio model (MRM) was compared with the existing dual-band RF transceiver (DBRT), MICS dual-band transceiver (MDBT), concurrent dual-band transceiver (CDBT), and dual-band low noise amplifier design (DBAD).

Frequency Range Management: The proposed model involves strengthening the cellular communication signal. The experts of the cellular managers, whose main profile is to strengthen communication, gave some tips for self-measuring the level of cellular signal to further improve the quality of communication. The comparison of frequency range management is shown in Table 1.

Figure 3 shows the comparison of frequency range management. After performing a series of simple actions with a smart phone, you can receive data on the signal strength from the base station, as well as find out which frequency range is used by a given operator in your area.

Signal Management: It will need to make at least 8–10 measurements because, first of all, the measurement results will change slightly in time and at different points in space (this is a dynamic value), so, it is necessary to take several measurements and calculate the average value. The comparison of signal management is shown in Table 2.

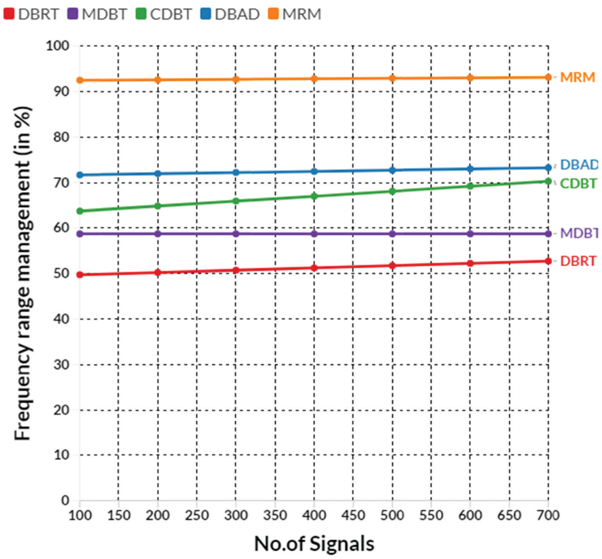

Figure 3. Comparison of frequency range management.

Table 2. Comparison of signal management.

Signals	DBRT	MDBT	CDBT	DBAD	MRM
100	49.87	57.47	64.35	70.32	92.74
200	49.86	57.34	64.09	70.34	92.77
300	49.51	56.92	63.46	69.91	92.79
400	49.39	56.69	63.08	69.78	92.82
500	49.21	56.42	62.63	69.57	92.84
600	49.03	56.14	62.19	69.37	92.87
700	48.85	55.87	61.74	69.16	92.89

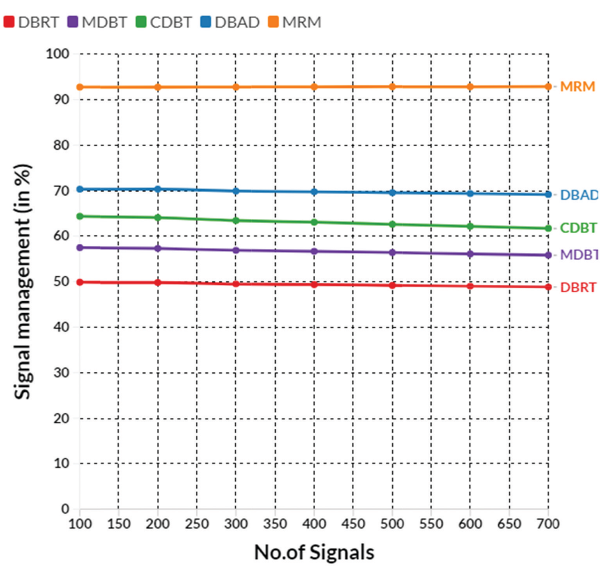

Figure 4. Comparison of signal management.

Figure 4 shows the comparison of signal management. Second, the signal is measured only for the operator, whose subscriber identity module (SIM) card is currently installed in the slot. Third, calibration must be done separately for each frequency range.

Table 3. Comparison of blocking management.

Signals	DBRT	MDBT	CDBT	DBAD	MRM
100	49.92	58.38	65.02	71.38	92.66
200	49.79	57.56	64.55	70.19	92.70
300	49.66	56.74	64.08	69.00	92.74
400	49.53	55.92	63.61	67.81	92.78
500	49.40	55.10	63.14	66.62	92.82
600	49.27	54.28	62.67	65.43	92.86
700	49.14	53.46	62.20	64.24	92.90

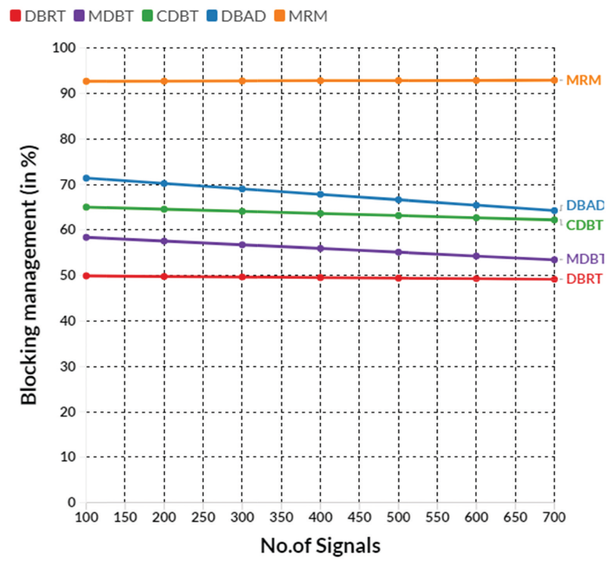

Figure 5. Comparison of blocking management.

Blocking Management: Internet blocking via a mobile device can be used as a temporary measure to avoid accidental connections. It needs to know the correct set of unstructured supplementary service data commands for additional options connected to the SIM card and which of them should be disabled. The comparison of blocking management is shown in Table 3.

Figure 5 shows the comparison of blocking management. All existing models provide Internet access; however, some of them require additional connections for packages with specific traffic. A similar option is "highway." If you want, you can disable mobile Internet completely or offer a package deal only. In the first case, with Beeline Internet, MMS and wireless application protocol functions will be disabled.

Dual-Band Management This provides Internet using 3G and 4G modems, and wired Internet is also available. When using a 3G modem, the client disconnects as soon as they stop using the device. Modem's account is debited only for spent traffic; therefore, there is no need to terminate the contract additionally. The comparison of dual-band management is shown in Table 4.

Figure 6 shows the comparison of dual-band management. Additionally, you can delete settings from the cellular device. The dual-band transceiver is an application that follows the work of a radio station over a global network.

Table 4. Comparison of dual-band management.

Signals	DBRT	MDBT	CDBT	DBAD	MRM
100	48.88	57.66	60.40	68.34	92.49
200	50.17	58.41	65.02	71.74	92.59
300	51.46	59.16	69.64	75.14	92.69
400	52.75	59.91	74.26	78.54	92.79
500	54.04	60.66	78.88	81.94	92.89
600	55.33	61.41	83.50	85.34	92.99
700	56.62	62.16	88.12	88.74	93.09

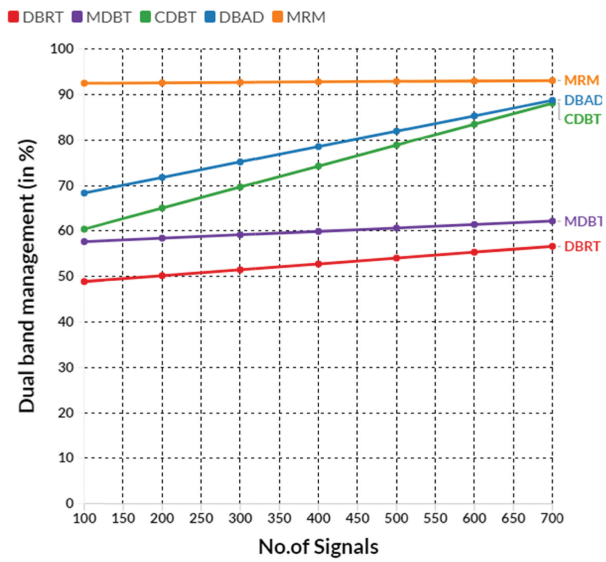

Figure 6. Comparison of dual-band management.

The app works like standard radio transmitters. The main difference is in the network; the program uses almost any type of Internet connection for data transfer.

CONCLUSION

The Internet works in most suburban areas, allowing you to freely connect to the radio and send messages. To send a message on the radio, press and hold the round button on the display to speak. Once the button is released, the message will start broadcasting. Despite the convenience and ease of use of the dual-band transceiver application, it is worth considering that it cannot serve as the main communication channel. The fact is that the operation of the dual-band transceiver application and its operation are connected to the mobile data network, which quickly drains the phone's battery. Therefore, if radio communication is required continuously for a long time and the ability to constantly recharge the battery is not provided, it will be easier to use a conventional dual-band transceiver tuned to the common frequency of all participants in the communication.

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