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AN APPROACH TO DEVELOPMENT OF GUIDELINES ON FORMULATION OF TECHNICAL REQUIREMENTS FOR SPECTRUM MANAGEMENT SYSTEMS

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Summary: *The communication administration of the Russian Federation actively participates in activities of Radiocommunication and Telecommunication Development Sectors of the International Telecommunication Union, particularly in the field of the technical assistance to developing countries in the creation and updating their national spectrum management systems, including radio monitoring ones. In the given article authors consider the plan of creation of a Guidelines for communication administrations of developing countries in the field of preparation of tender documentation for the implementation of national spectrum management systems, including radio monitoring ones.*

Keywords: *spectrum management, radio monitoring, Radiocommunication Sector of the International Telecommunication Union, Telecommunication Development Sector of the International Telecommunication Union, the technical assistance to developing countries.*

Introduction. The International Telecommunication Union (ITU) pays special attention to rendering technical assistance to communication administrations of developing countries in the field of creation and updating their national spectrum management systems (NSMS), including radio monitoring systems (RMS). In particular, since 1998 there is Resolution 9, the joint of ITU Telecommunication Development Sector (ITU-D) and to ITU Radiocommunication Sector (ITU-R) «Participation of countries, especially developing countries, in spectrum management». The communication administration of the Russian Federation actively participates in works of this joint ITU-D/ITU-R Group on Resolution 9 since the time of its formation.

The last version of this Resolution 9 approved at the 6th ITU World Telecommunication Development Conference (WTDC-2014), Dubai, the United Arab Emirates, 2014 [1], includes requests for development of Guidelines for communication administrations concerning NSMS issues including RMS ones. Formulating these requests, WTDC-2014 has reflected opinion of many developing countries on the necessity of working out of such practical materials, in spite of the fact that there are already numerous recommendations and reports of the ITU-R Study Group 1 (SG 1) «Spectrum management» [2], and also quite detailed ITU-R Handbooks on the given subjects [3 - 5]. From discussions with representatives of developing countries follows, that they feel significant needs in materials of the practical character of the issues, in the format that would be as much as possible ready to direct use by administrations.

In the given article, it is analyzed what contribution at the existing situation could be made to support the progress of the joint ITU-D/ITU-R Groups on Resolution 9 regarding NSMS issues in modern conditions.

Expediency of creation of the ITU Guidelines on a formulation of technical requirements to NSMS

Analyzing tasks facing joint ITU-D/ITU-R Group on Resolution 9 and the available detailed documentation of SG 1 concerning NSMS issues, it is possible to identify one aspect that insufficiently covered by the SG 1 documentation but which can present the great interest for communication administrations of developing countries. It concerns a stage of preparation of the tender documentation on the creation of NSMS of this or that volume and complexity and, in particular, technical requirements to corresponding networks and proper equipment.

Issues concerning preparation and evaluation of the tender documentation on NSMS, including RMS, are in critical details described in Annexes to ITU-R Handbooks [4, 5] and, especially, to [5]. However, this documentation concerns exclusively administrative and organizational aspects of preparation and carrying out of tenders whereas technical characteristics, such as accuracy and operational parameters of corresponding networks and the equipment, remain out of any consideration. On the other hand, Recommendation ITU-R SM.1392 [6] in significant details describes functions which should carry out RMS networks and proper equipment in developing countries with numerous references to other Recommendations, Reports and Handbooks of ITU-R SG 1. However, this recommendation also does not elaborate accuracy and operational characteristics of

RMS networks and equipment of different functionality (at least depending on ranges of monitored frequencies), but this is obviously crucial for a tender process. The information about accuracy and operational characteristics of RMS networks and proper equipment of different functionality is scattered among numerous ITU-R recommendations and reports, and also among various sections of ITU handbooks [3 - 5]. The process of their gathering together is the uneasy task requiring the enormous expenses of time and high qualification of the personnel. Therefore, for working out of the tender documentation for creation in countries more or less extensive RMS networks administrations of developing countries usually invite foreign experts that appear to be expensive enough and, as it will be shown below, not always guarantees a free competition of bidders in the tender process, and does not lead to decrease in expenses.

Availability of special ITU Guidelines on the given issues in which work would be carried out on systemization of accuracy, operational, etc. characteristics of systems and the equipment with reference to those of different functionality (for national systems of frequency assignments and licensing, for fixed and mobile monitoring stations as well as for portable monitoring equipment, for monitoring equipment in LF-HF, VHF-UHF and SHF frequency bands, for monitoring of terrestrial and satellite radio transmitters etc) would render a invaluable assistance to administrations.

In some cases, administrations could themselves prepare tender documentations, providing appreciable economy of financial assets. Even if the tender documentation will still be prepared by foreign experts, the availability of such Guidelines would allow administrations to carry out the control over the activity of experts. The matter is that it is quite possible to imagine cases when foreign experts appear privately affiliated with this or that company – equipment provider which is planning to participate in the given tender, and in the tender documentation they would try to "stick out" characteristics of the equipment of the "own" company and to shade advantages of the equipment of other competing companies. Availability of relevant ITU Guidelines will allow administrations to reveal cases of essential difference of parameters offered by experts from specified in the Guideline, to request explanations from experts on such deviations and to make the decision on acceptance of the expert's proposal. This would promote the creation of wider and transparent competitive environment between companies - equipment providers in

the course of a tender that, finally, also would promote the increase of efficiency of financial expenses of administrations.

Besides, the availability of such Guidelines, together with materials of Annexes to ITU-R handbooks [3] and [5], in some cases would allow to prepare tender documentation for this or that country within frameworks of rather short technical assistance projects of the ITU-D Telecommunication Development Bureau (BDT) with guaranteed high quality of the output documentation.

Some Russian experts possess sufficient knowledge and considerable experience in the given field of activity, and they could bring the essential contribution to works of the joint ITU-D/ITU-R Group on Resolution 9 concerning NSMS issues, having offered for consideration by the Group the draft of such Guidelines.

Let us consider, what could look planned ITU Guidelines.

The approach to the Guidelines development. Under working out of the Guidelines, it is necessary to consider some factors.

Guidelines format

In order to Guidelines would be useful in a wide range of real needs of various communication administrations, it should cover a wide set of requirements - from creation of the whole NSMS, including RMS in all ranges of frequencies containing a great number of fixed and mobile monitoring stations in application to the monitoring of terrestrial and satellite radio transmitters at all or greater part of a country territory, to small local RMS containing only several fixed and mobile monitoring stations in the most demanded VHF-UHF frequency bands. Therefore, the Guidelines should be optimally structured.

It seems that the Guidelines should contain the detailed explanatory note that would concern objectives the Guidelines and recommendations on its use etc., which is not intended for inclusion in the developed tender documentation, and the main part which is designed to be a "skeleton" of the future technical requirements (specifications) in the tender documentation.

The explanatory note can contain, among other things, arguments "pro and contra" of the RMS development on the basis of angle of arrival (AOA) or time difference of arrival (TDOA) methods, and also a hybrid AOA/TDOA radio location method [7 - 9] with indication that the given Guidelines still is focused on AOA systems

because, as it is admitted in [8], planning procedures of TDOA and hybrid AOA/TDOA networks are still insufficiently well developed.

The note can also contain recommendations about those NSMS equipment providers which it is expedient to invite for participation in tenders, such information many administrations also require.

The main part of the Guidelines intended for inclusion in the tender documentation should contain some sections, beginning with technical requirements to the most probable elements of future NSMS, including RMS, in developing countries, and finishing the least probable ones. It is expedient to do for making the Guidelines materials to be the most easily adapted to various needs of the different administrations, as it concerns networks containing the national frequency centers (available, modernized or adapted for new RMS networks), and monitoring stations of various structure and destination with minimal renumbering of sections, subsections, drawings, tables, etc. From this point of view, it seems that the optimal sequence of sections in the Guidelines can be the following:

- The section, concerning the general description and the basic technical and operational requirements to the whole planned NSMS including RMS which with inevitability should be available in any tender documentation on the given subject. The section should describe planned RMS network in the interaction of monitoring stations among themselves and with the national frequency centre which is carrying out frequency assignments and licensing of transmitters, as well as management of RMS network planned within this tender. This section should also provide comprehensive provisions concerning infrastructures (including buildings, roads, protection and security means, etc.), maintenance service, including warranty and post-warranty service, calibration and repair of equipment, personnel training, etc.;
- The section, concerning technical and operational requirements to the national frequency centre (to the centre of frequency assignment and licensing of transmitters, and also managements of the RMS network) if the tender assumes creation or a significant modernization of such centre. If the administration already has such centre and the considered tender does not assume its considerable upgrading (for example, transferring to another, more perfect, software), the given section can be limited to the short description of the available centre and the formulation of requirements to management of a RMS network created within the frameworks of the given

tender. For this purpose, it will be necessary only to choose relevant parts from the text of the given section of the Guidelines;

- The section, concerning technical and operational requirements to fixed monitoring stations in VHF-UHF frequency bands, including corresponding antennas; the equipment in these particular frequency bands, except some very special cases, is the most demanded in recent conditions;
- The section, concerning technical and operational requirements to mobile and transportable monitoring stations in the VHF-UHF frequency bands, including corresponding antennas and vehicles;
- The section, concerning technical and operational requirements to portable monitoring equipment in the VHF-UHF-SHF frequency bands, including corresponding antennas, because in the majority of cases such equipment is requested and with its help the monitoring in SHF frequency band is the most effectively carried out. The last can be explained by the fact that emissions in the SHF band, as a rule, are very highly directional ones and monitoring equipment located at fixed stations and even at mobile stations with low located antennas in the majority of cases are not capable to "intercept" such emissions, that catastrophically reduces efficiency of such monitoring. The required monitoring, in most cases, can be carried out only by means of the portable equipment which is placed in the immediate proximity to antennas of radio equipment suffering harmful interferences, etc.;
- The section, concerning technical and operational requirements for fixed and mobile monitoring stations in LF – HF frequency bands, including corresponding antennas; it seems that requests concerning such equipment recently are not rather probable;
- The section concerning monitoring of satellite communication systems, including corresponding antennas. It seems that requests on such equipment will be single ones due to its high price and efficiency only when the country possesses the vast number of the satellite communication systems of different functionalities requiring monitoring. Even less likely appear requests concerning systems for a satellite geolocation of terrestrial radio transmitters for what the availability of two stations of the satellite monitoring separated by sufficiently significant distance is necessary. It leads to increase, at least in twice, required financial assets. It seems that preparation of the tender documentation on rather expensive geolocation systems will hardly be within the power of administrations of developing countries without the attraction of foreign experts, therefore, for not to

complicate the Guidelines, provisions on this very rare option for developing countries can be excluded from it.

Accuracy and operational characteristics of networks and the equipment

It seems that as such characteristics in Guidelines the parameters given in Recommendations, Reports and Handbooks of ITU-R SG 1 should be presented, so much all leading companies – NSMS equipment providers declare conformity of characteristics of their systems and the equipment to the « ITU values». For these features, data on which are absent in documentation ITU-R SG 1, it is expedient to specify some "average" values which are presented by all leading providers, such as LS Telcom (Germany) and ATDI (France) regarding the software for NSMS, and also the Rohde-Schwarz (Germany), IRCOS (Russia) [10], TCI and Agilent Technologies (USA), Thales (France) etc. regarding RMS equipment. The practice has shown, that the pursuit for increased (and furthermore – for unique) technical characteristics of NSMS and its equipment in the tender documentation do not give any significant advantages in real conditions of developing countries. Quite contrary, it leads to an essential rise in the price of systems and the equipment, also taking into account essential limitation of a free competition and increased requirements for the qualification of operators. Funny cases are also possible when as technical requirements in the tender documentation the best values for one group of parameters of one equipment vendor get out, for another group of parameters - of another vendor, etc. Such approach imposes additional difficulties for providers regarding the preparation of the tender documentation. Moreover, as a result of such approach, it can easily happen that any participant of the tender can meet all complex of requirements. Therefore the tender formally should be canceled or it will be necessary to choose the winner of the tender on the basis of any other principles. The last imposes additional loading on communication administration and also creates conditions for submission of legal claims, etc.

Therefore, emphasis on documentation of ITU-R SG 1 and on the certain "average" characteristics which are carried out by all (or at least by the majority) potential bidders, is the optimal approach for developing countries from all points of view.

Network planning

In practice of developing countries, RMS networks concern the fixed monitoring stations of different functionality with the addition of mobile and transportable stations, as well as portable equipment. All stations of RMS in one or other way go through the national frequency centre which is carrying out frequency assignments and licensing of transmitters and management of the RMS network. However, such centre, despite all its importance for communication administration, is only one

element of NSMS network. From this follows that exactly the RMS network is the most costly part of NSMS for administration, therefore its optimization, by providing the effective planning, has a special value [6], [8].

In certain cases, particularly in big and rather expensive NSMS, the regional frequency centers are also created for providing frequency assignments and licensing of low power transmitters at the regional level which, as a rule, are combined with regional control centers of local RMS networks. However, it seems not expedient to extend considered Guidelines on such complicated NSMS whose planning would hardly be within the power of communication administrations of the majority of developing countries without the attraction of foreign experts.

On the contrary, planning of RMS networks even containing, except one national frequency centre, a good many of monitoring stations connected to it, after issuing such ITU Guidelines, should appear on forces to such communication administrations in view of the availability of the following addition documentation of ITU-R SG 1:

- detailed annexes on administrative and organizational aspects of the tender process in ITU-R handbooks [4] and [5];
- Recommendation ITU-R SM.1392-2. Essential requirements for a spectrum monitoring system for developing countries [6];
- Report ITU-R SM.2356-0. Procedures for planning and optimization of spectrum-monitoring networks in the VHF/UHF frequency range [8].

Report ITU-R SM.2356-0 [8] also contains useful instructions for choosing an optimum ratio of fixed and mobile monitoring stations as well as attended and unattended (automatic) ones that should be noted in the Guidelines.

Cost characteristics of networks and equipment

Practices have shown that administrations of developing countries, as a rule, experience great difficulties in determination of some RMS stations of different functionality, answering to the financial resources allocated for this purpose. This results from the fact that providers of RMS equipment usually do not give in advance associated costs referring that the costs depend on many factors related to the volume of the equipment, its structure, transport expenses, the volume of future civil works and a created infrastructure, etc. Administrations usually try to obtain such data in roundabout ways that not always provides reliable results, when the administration (even using foreign experts) tries to define structure and volume of the equipment which it can procure in accordance with available financial resources.

For helping administrations in this important matter, Guidelines can contain very approximate costs of NSMS and its equipment of different functionalities,

including civil work and the creation of a corresponding infrastructure. Such costs are presented in Table 1. Given Table 1 is based exclusively on expert estimations and its figures are rather tentative.

TABLE 1

System and equipment of NSMS	Tentative costs in millions US dollars
National frequency centre provided by modern software and the equipment for management of RMS network	0.7 – 1.5
Fixed monitoring station in the VHF-UHF frequency bands, including a building, an infrastructure and corresponding antennas	1 - 2
Mobile or transportable monitoring station in the VHF-UHF frequency bands, including antennas and a vehicle of a Mercedes Sprinter type for a mobile station	0.7 - 1.5
Set of portable monitoring equipment in the VHF-UHF-SHF frequency bands for VHF-UHF mobile monitoring station	0.5 – 1.3
Fixed monitoring station in LF-HF frequency bands, including a building, an infrastructure, and SSL antenna	0.7 – 1.5
Additional LF-HF equipment for a mobile monitoring station in the VHF-UHF frequency bands	0.5 – 1.0
Station for satellite monitoring, including a building, an infrastructure and antennas for monitoring of radiocommunication satellites at the geostationary orbit	5 - 10

On the other hand, equipment providers who are planning to take part in the tender, by any ways try to learn (and, as a rule, successfully) the budget of the future project to adjust their proposals to this budget. If it happens, that an administration, due to the lack of information, would overestimate the budget on offered structure and volume of equipment, it will nevertheless spend such overestimated sums because bidders can adjust a total cost to this budget.

It seems that more efficient and less costly can be the alternative approach: to issue a tender not on proposed structure and volume of equipment (estimated by an administration as corresponding to available financial resources), but on system and equipment delivery corresponding to an available financial resource. For this purpose, the administration in the tender documentation should present the planned network calculated on the most optimistic cost indexes according to Table 1 (the left values of cost in the right column of the table) with the indication of their priority as it concerns monitoring stations. The administration should also present the concrete financial resource which cannot be exceeded in any case, and request bidders to submit proposals on the creation of the maximum number of monitoring stations from the specified list according to indicated priorities.

It is hoped that bidders due to competitive reasons will try to present for implementation the greatest possible number of the stations corresponding to accuracy and operational criteria formulated in the tender documentation.

Such procedure should also considerably simplify the tender evaluation process by administrations. If the structure and volume of proposed monitoring stations would appear identical in the offers presented by all bidders (but it seems to be hardly probable), it will be necessary to carry-out bid evaluation in accordance with usual criteria such as accuracy and operational characteristics of the equipment, conditions of maintenance service and equipment repair, etc.

Conclusion

Following the example of Report ITU-R SM.2356-0 [8], it is expedient to present the Guidelines in the form of an exhaustive complex of requirements for a certain virtual NSMS network containing one national frequency centre and some monitoring stations of different functionality connected to the center in the full complete set presented above. It will provide greater demonstrability of the material that should facilitate to communication administrations of developing countries working out of the tender documentation meeting their particular needs in frameworks limited to available financial resources. Even if an administration invites external foreign (or national) experts for working out of the tender documentation, following from available funds, such Guidance will provide an effective control of the tender process by the administration.

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