Trends in Standardizing Protection against Electromagnetic Environment Effects in ITU-T SG5

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Abstract

With the increase in ubiquitous communication based on wireless technology, protection against electromagnetic environment effects is becoming more important. This includes ensuring compatibility between electrical equipment (which emits electromagnetic noise) and wireless communication systems and protecting radio base stations against lightning to achieve secure and safe telecommunication. ITU-T SG5 is responsible for studies related to protecting telecommunication equipment and facilities against electromagnetic effects and for ensuring human safety from electromagnetic effects.

1. Ubiquitous and broadband

Technologies for ubiquitous communication, like RF-ID (radio frequency identification) systems and wireless LAN (local area network) systems, are based on short-distance wireless communication. The number of such appliances is forecast to increase explosively in the future. On the other hand, broadband communication technologies based on high-speed telecommunication need a lot of radio frequencies and higher frequencies than used to date. Therefore, the probability of electromagnetic interference occurring will increase. Electromagnetic waves that are unintentionally radiated from electrical information technology equipment (ITE) are called “emission” as shown in **Fig. 1**. They affect wireless systems. Moreover, the electromagnetic waves radiated from wireless systems induce noise in metallic cables used for telecommunication. However, metallic-cable telecommunication systems need to maintain their telecommunication quality even when wireless systems are used nearby. In the study period from 2000 to 2004, ITU-T SG5*1 [1] investigated electromagnetic environment effects and discussed emission limits for and methods of measuring wired telecommunications networks *in situ* when actual interference occurs, with the aim of preventing interference between various telecommunication systems. The

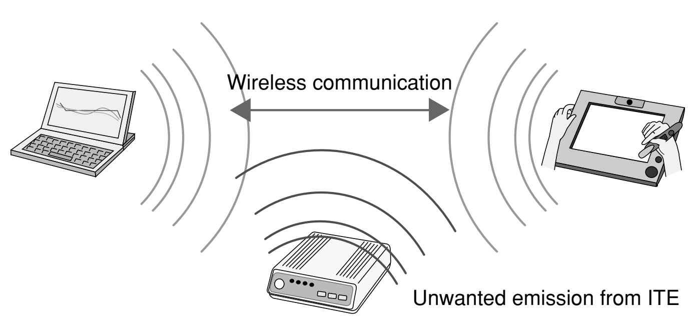

Fig. 1. Unwanted emission in ubiquitous communication.

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*1 ITU-T SG5: International Telecommunication Union Telecommunication Standardization Sector Study Group 5.

results became Recommendation K.60. This recommendation's limits and measurement methods cover a wider frequency range (from 9 kHz to 3 GHz) than the existing emission recommendations. In the next study period, items scheduled for discussion include limits for newer communication systems, such as power line communication (PLC), and emission evaluation methods for next-generation broadband communication.

2. Changes in telecommunication system usage conditions

The number of cellular phone users has increased rapidly in the last few years. This raises the possibility of a person with a cellular phone in his/her pocket being near telecommunication equipment, as shown in **Fig. 2**. However, the immunity of telecommunication equipment against radio waves from cellular phones is not covered by any recommendations. Therefore, there has been discussion to revise K.43 (generic immunity recommendation) and K.48 (product family electromagnetic compatibility (EMC) requirements). The revision states that telecommunication equipment should have sufficient immunity in the frequency band used by cellular phones. NTT is also planning to revise its immunity technical requirements [2] corresponding to K.43 and K.48. Thus, revisions of existing recommendations to cope with telecommunication system usage conditions will be an important subject in the future. In other examples, when the transmission rate fell even slightly, equipment failed some criteria of the existing immunity test. However, most services are provided on a best-effort basis, like ADSL (asymmetric digital subscriber line), with the expectation that speed will decrease with distance from the telecommunication center, etc. For such IP (Internet protocol) system services, discussion of what kinds of failure criteria are appropriate has been scheduled.

An increase in the number of cellular phones also means an increase in the number of radio base stations, which are usually installed high above the ground and are thus vulnerable to damage from lightning (**Fig. 3**). Therefore, protection of the radio base station itself and of neighboring buildings was considered. The setup conditions for radio base stations vary widely, so the first discussion covered the protection of general radio base stations against lightning discharges and protection of radio base stations sited on power line towers. The protection procedures, which include earthing, bonding, shielding, and installation of surge protective devices, were summarized and the results became new recommendations K.56 and K.57, respectively. Discussion of protection procedures in various installations and procedures for reducing the effect of the neighborhood has been scheduled.

3. Changes for using telecom centers and cables

Network operators around the world are tending to increase co-location use of telecommunication center buildings, as shown in **Fig. 4**. Thus, it is necessary to provide reliable telecommunications to customers even when systems from multiple operators are installed in a building and interconnected. Moreover, there is a growing trend for several operators to share an access line, which is called "unbundling". Therefore, it is important to make recommendations for EMC, overvoltage, and safety based on international decisions, so that no operators are at a disadvantage.

First of all, the telecommunication system configuration for multiple operators and relevant issues were discussed. Recommendations for each item, which

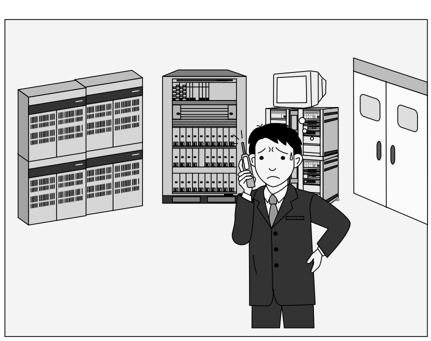

Fig. 2. Immunity recommendations should be revised because of the increased risk of radio frequencies being used by nearby equipment.

Fig. 3. Radio base stations need to be protected against lightning.

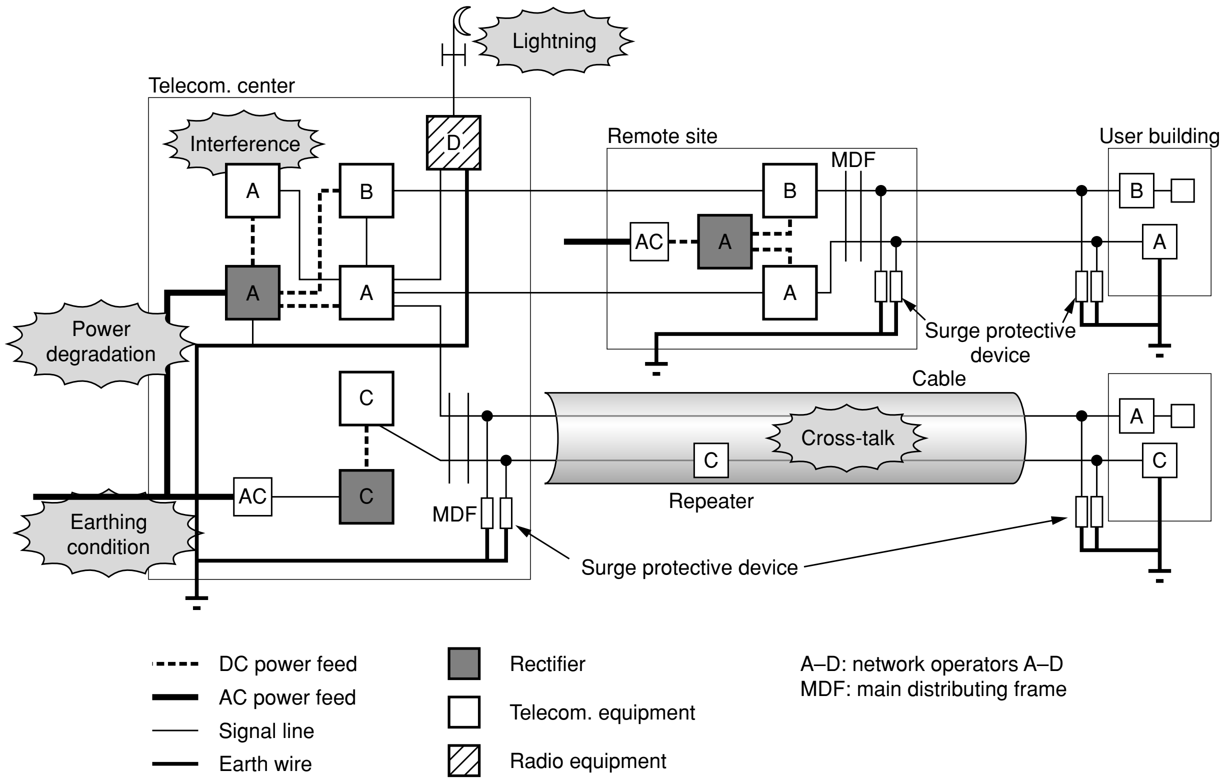

Fig. 4. Co-location and unbundling.

should be referred to as requirements, were listed. Regulations and corresponding procedures for co-location and unbundling were made into Recommendation K.58 and K.59, respectively.

The next study period is scheduled to discuss methods for evaluating electromagnetic environments and their effects and eliminating problems in co-located and unbundled conditions, including emission requirements for broadband access systems used in multiple systems existing on one cable, a methodology for distinguishing responsibilities for EMC trouble under co-located conditions, and a method for installing different equipment in new access network structures under unbundling conditions while meeting EMC, safety, and resistibility requirements.

4. Revision of the overvoltage and overcurrent resistibility recommendations

Recommendations for resistibility to overvoltage and overcurrent specify the degree to which telecommunication equipment should withstand overvoltage and overcurrent caused by lightning discharges, power induction, power contact, and so on. The basic recommendation K.44, which provides a test method, introduces a test from one external port to another external port for unearthed equipment, an internal port test, and conditions (termination) for untested ports. Moreover, K.20, K.21, and K.45, which were product family recommendations, were also revised. However, many telecommunication ports are not covered by the test. Test methods and levels for recently introduced telecommunication ports include USB (universal serial bus) and IEEE 1394 (also known as FireWire, iLink, and Lynx). Moreover, in high-speed networks such as those using digital subscriber lines, the equipment is continuously connected and in operation. Since lightning surges will almost always be induced in the equipment while it is operating, testing should be performed under this condition. However, K.44 does not describe testing while equipment is operating. The test requires a de-coupling network, which can decrease the effect of lightning on auxiliary equipment and can handle high-speed communication such as xDSL or LAN. Discussion of test devices is also scheduled.

Besides the abovementioned background, SG5 is scheduled to make recommendations or handbooks about i) protection against electromagnetic environment effects for various equipment and devices covering various user conditions and service types and ii) human safety from electrical hazards. **Table 1** shows

Table 1. List of recommendations revised or created during the 2000–2004 study period.

K.20	Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents	Revised
K.21	Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents	Revised
K.34	Classification of electromagnetic environmental conditions for telecommunication equipment—basic EMC recommendation	Revised
K.43	Immunity requirements for telecommunication equipment	Revised
K.44	Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents—basic recommendation	Revised
K.45	Resistibility of telecommunication equipment installed in the access and trunk networks to overvoltages and overcurrents	Revised
K.46	Protection of telecommunication lines using metallic symmetric conductors against lightning induced surges	Revised
K.48	EMC requirements for each telecommunication network equipment—product family recommendation	Revised
K.55	Overvoltage and overcurrent requirements for insulation displacement connectors (IDC) terminations	New
K.56	Protection of radio base stations against lightning discharges	New
K.57	Protection measures for radio base stations sited on power line towers	New
K.58	EMC, resistibility and safety requirements and procedures for co-located telecommunication installation	New
K.59	EMC, resistibility and safety requirements and procedures for connection to unbundled cables	New
K.60	Emission limits and test methods for telecommunication networks	New
K.61	Guidance to measurement and numerical prediction of electromagnetic fields for compliance with human exposure limits for telecommunication installations	New
K.62	EMC prediction through mathematical modelling	New
K.63	Maintaining the suitability of production telecommunications equipment to its intended environment	New
K.64	Safe working practices for outside equipment installed in particular environments	New
Handbook	Earthing & bonding handbook	New

the recommendation list issued as a result of the discussion in the study period from 2000 to 2004.

5. Global environment

Global environmental conditions are being studied so that equipment that conforms to the recommendations may be used in any country in the world. In particular, the earthing and power distribution systems in user buildings differ from country to country. The existing recommendation K.21 covers resistibility against overvoltage and overcurrent for equipment installed in a user building. It assumes that earthing and power distribution have a common bonding system*2 such as the TN system, which is covered by K.31, because many European countries and the U.S.A. use it. Consequently, it is unwise to apply K.21 resistibility specifications in countries that use the TT distribution system (such as Japan) and IT distribution systems, because the probability of damage from lightning will be higher. As a result, NTT uses a different resistibility level [3].

SG5 previously recognized that when equipment is installed in IT or TT systems, there is a high probability of high voltage appearing between telecommunication line and power line if the telecommunication and power line protection devices are not connected together (i.e., if a double line does not exist in **Fig. 5**). During the discussion of the revision of K.44, SG5 recognized that the same problem also exists for equipment installed in TN systems.

Methodologies for solving problems for user buildings in such a global environment were discussed and three solutions were proposed: (1) improve earthing, (2) install additional overvoltage protection devices, and (3) specify a special resistibility level for cases where the earth is not improved. SG5 is now discussing K.pcp (protection at customer premises) with a view to adopting special resistibility levels equiva-

*2 Common bonding systems: Systems for distributing commercial power include TN-C, TN-S, and TN-CS, which are widely used in Europe and the United States, IT used in Northern Europe and other places, and TT used in Japan. The TT system supplies commercial electric power using two wires, one of which is grounded on the customer side of the transformer on the utility pole. In the IT system, neither of the two wires running to the customer from the utility pole's transformer is grounded; instead, these wires are insulated from earth. The power supply system is not grounded. The TN system grounds the power supply system at one location and features a protective earth conductor to ground the device to that point when supplying power.

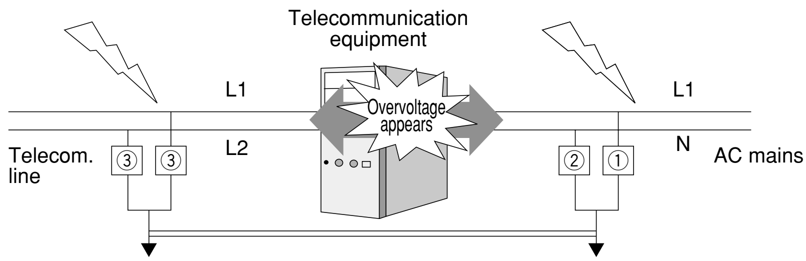

Fig. 5. Global earthing environment and resistibility against overvoltage.

Table 2. List of questions during the 2000–2004 study period.

	Title	Working party
1	Resistibility, EMC and safety aspects of unbundling and interoperability in telecommunications networks	2
2	EMC related to broadband access systems	2
3	Radio-frequency environmental characterization and health effects related to mobile equipment and radio systems	2
4	Resistibility of new types of communication equipment and access networks	1
5	Lightning protection of fixed, mobile and wireless systems	1
6	Bonding configurations and earthing of telecommunication systems in the global environment	1
7	EMC prediction through mathematical modelling	2
8	Quality processes using electromagnetic compatibility	2
9	Interference produced by power lines and electrified railway lines into telecommunications networks	1
10	Methodology for solving electromagnetic problems in telecommunications installations	1
11	Maintenance and enhancement of existing recommendations related to human safety in the telecommunications environment	1
12	Maintenance and enhancement of existing EMC recommendations	2
13	Maintenance and enhancement of existing resistibility recommendations	2
14	Terminology	–

lent to NTT's technical requirements [3].

6. Future topics

As mentioned above, problems related to the electromagnetic environment will appear along with new telecommunication services, new usage conditions, and so on. Therefore, it is important to keep discussing specifications that suit new electromagnetic environments. And for human safety, it is necessary to coordinate with IEC and WHO standards (IEC: International Electrotechnical Commission, WHO: World Health Organization). **Table 2** shows the list of questions studied in the period from 2000 to 2004. All these questions will be studied in the next period except for question 8, because K.63 has already been provided and question 8 will be merged with question 12. In addition, three more questions will be added:

(a) Security of telecommunication and information systems regarding electromagnetic environment
(b) EMC requirements for the information society
(c) Home networks

The reason for proposing question (a) is that information technology equipment is becoming important as a basic infrastructure for society, and risks such as cyber terrorism are increasing. Therefore, security should be managed according to customer needs or service levels. This question will cover electromagnetic threats involving malicious artificially induced high-power transient phenomena and electromagnetic security involving information leaks from telecommunication networks via unexpected radio emission from equipment. Mitigation techniques, such as shielding, and methods for evaluating protective measures will also be discussed. The EMC requirements for ubiquitous and broadband systems will be discussed in question (b). For such equipment used in home networks, the requirements will be discussed based on research into the actual electromagnetic environment in homes.

References

[1] http://www.itu.int/ITU-T/studygroups/com05/index.asp

[2] Technical requirement for immunity of telecommunications equipment (2nd edition), TR549001 May, 2002.

[3] Technical requirements for resistibility of telecommunications equipment to overvoltage and overcurrent (1st edition), TR189001 Jan., 2003.

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