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SERIES Y: GLOBAL INFORMATION
INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS
AND NEXT-GENERATION NETWORKS

Next Generation Networks – Future networks

Framework of energy saving for future networks

Recommendation ITU-T Y.3021

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Recommendation ITU-T Y.3021

Framework of energy saving for future networks

Summary

Recommendation ITU-T Y.3021 describes the framework of energy saving for future networks (FNs). It first describes the need for energy saving within networks themselves, and reviews potential energy-saving technologies. The Recommendation then identifies major functions and their cyclic interactions, analyses the possible impact of introducing certain energy-saving technologies and itemizes the high-level requirements for introducing such technologies.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T Y.3021	2012-01-13	13

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at <http://www.itu.int/ITU-T/ipr/>.

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Recommendation ITU-T Y.3021

Framework of energy saving for future networks

1 Scope

This Recommendation:

- describes the necessity for energy saving,
- reviews potential technologies,
- identifies multiple viewpoints to be considered,
- identifies major functions and their cyclic interactions,
- analyses any possible impact caused by introducing the technologies, and
- itemizes high-level requirements;

to achieve energy saving within and due to future networks (FNs).

The framework and ideas described in this Recommendation may also be applicable and useful for networks which are not categorized as future networks, although the description is produced through full recognition of the objectives and design goals of future networks [ITU-T Y.3001].

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T L.1400] Recommendation ITU-T L.1400 (2011), *Overview and general principles of methodologies for assessing the environmental impact of information and communication technologies*.
- [ITU-T Y.3001] Recommendation ITU-T Y.3001 (2011), *Future networks: Objectives and design goals*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 future network (FN) [ITU-T Y.3001]: A network able to provide services, capabilities, and facilities difficult to provide using existing network technologies.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 device: This is the material element or assembly of such elements intended to perform a required function.

3.2.2 energy saving within networks: This is where network capabilities and their operations are set up in a way that allows the total energy for network equipment to be systematically used in an efficient manner, resulting in reduced energy consumption, compared with networks that lack these capabilities and operations.

NOTE – Network equipment includes routers, switches, equipment at the terminating point e.g., optical network units (ONUs), home gateways, and network servers such as load balancers and firewalls. Network equipment is typically composed of various components such as switching fabric, line cards, power supply, and cooling.

3.2.3 equipment: A set of devices assembled together to form a physical entity to perform a specific task.

3.2.4 network energy efficiency: Throughput of the network divided by the power consumed.

NOTE – It is usually expressed in bps/W.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ALR	Adaptive Link Rate
BTS	Base Transceiver Station
CAM	Content Addressable Memory
CAPWAP	Control and Provisioning of Wireless Access Points
CDN	Content Delivery Network
CPU	Central Processing Unit
DDoS	Distributed Denial-of-Service
DPD	Digital Pre-Distortion
DVS	Dynamic Voltage Scaling
FN	Future Network
GHG	Greenhouse Gas
HVHBT	High Voltage Heterojunction Bipolar Transistor
ICT	Information and Communication Technology
LSI	Large Scale Integration
MIMO	Multiple Input Multiple Output
MPLS	Multi-Protocol Label Switching
NIC	Network Interface Card
ONU	Optical Network Unit
PA	Power Amplifier
PC	Personal Computer
SINR	Signal to Interference and Noise Ratio
SISO	Single-Input Single-Output
SLA	Service Level Agreement
SRAM	Static Random Access Memory

UE	User Equipment
WLAN	Wireless Local Area Network

5 Conventions

None.

6 Introduction

6.1 Background and motivation

Energy saving in the information and communication technology (ICT) field is an important issue, as has been identified in designing future networks [ITU-T Y.3001]. One of the basic objectives of the development of future networks is demonstrating environmental awareness, which may be realized via energy-saving technologies. Historically, energy saving has been studied for increasing benefits to the user or company, such as reduced energy costs and temperature management for stable machine operation.

The importance of these issues is increasing due to the more widespread implementation of network equipment and the greater energy consumption that this requires. It is also becoming increasingly important from a social aspect to support the reduction of greenhouse gas (GHG) emissions. These issues will gain more importance in the future. This Recommendation therefore studies potential technologies and their coordinated operation, which will contribute to saving energy and to various other objectives.

The contribution of ICTs to reduce the negative impact on the environment is often categorized into "Green by ICT" and "Green ICT". "Green by ICT" refers to reducing the environmental impact of non-ICT sectors by using ICTs. "Green ICT" refers to reducing the environmental impact of the ICT itself such as the reduction of electric power consumption of personal computers (PCs), servers, and routers. The contribution of future networks to reducing environmental impact can therefore be categorized as shown below.

– Green by future networks

A challenge to reduce the environmental impact in non-ICT sectors by using future networks.

Future networks must become a useful tool for reducing the environmental impact of other sectors. Network architecture designed for smart grids for electric power distribution, or ubiquitous sensor networks that monitor environmental changes of the Earth are a few examples of how "Green by Future Networks" may be interpreted.

– Green future networks

A challenge to reduce the environmental impact of future networks.

The fundamental principle for future networks is that they must have a minimum impact on the environment. As described above, the use of networks may provide the means to reduce the environmental impact of other sectors. Yet by doing so, it increases the volume of traffic flowing into networks, increases energy consumption of the networks accordingly, which then increases the environmental impact. Reducing the energy consumption of network facilities such as routers, switches and servers is a direct example of contributions of "Green Future Networks".

Each issue is important, but this Recommendation focuses on "Green Future Networks", which means energy saving within the networks themselves, because energy consumption by networks is rapidly increasing as the number of applications on the networks increases.