GUIDELINES FOR BROADBAND OVER POWERLINE (BPL) PHYSICAL NETWORK LAYER

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CONTENTS

Acknowledgement

Committee Representation

The Powerline Communications (PLC) Working Group which developed this Guideline comprises representatives from the following Telecommunication Service Provider, Government Related Bodies, Manufacturers, System Developers and Integrators and Higher Learning Institution:

Celcom (Malaysia) Berhad
Corinex Global
Energy Commission
Malaysian Communications and Multimedia Commission
Masers Digital Sdn Bhd
Maxis Communications Bhd
Realm Energy Sdn Bhd
SIRIM Berhad
Tenaga Nasional Berhad
Time dotCom Bhd
TMNet Sdn Bhd
TM Research & Development Sdn Bhd
Universiti Putra Malaysia

Foreword

This Reference Standards and Guidelines has been produced by the PLC WG in response to the designation by the *Malaysian Communications and Multimedia Commission (MCMC)* under the Malaysian Communications and Multimedia Act, 1998 (CMA).

This document is intended as a Reference Standards and Guidelines to establish clear understanding of the general requirement to facilitate potential *Broadband* over *Powerline* (BPL) service providers in rolling out the services.

Compliance with the Reference Standards and Guidelines does not of itself confer immunity from legal obligations.

Working Group Objectives

(a) To recommend standards and guidelines for BPL Physical Network Layer, applicable to Malaysia deployment of the technology.

(b) To promote BPL technology in Malaysia.

(c) To study and adopt the introduction on BPL technology from more matured International deployment; e.g. *OPERA, FCC, UPLC, PLC Forum*, *IDA*, etc. and local experiences.

(d) To work with and define requirements from regulatory and certification bodies that has jurisdiction; *Energy Commission (EC), Malaysian Communications and Multimedia Commission (MCMC)* and *SIRIM Berhad (SIRIM).*

(e) To be the only reference forum for BPL technology deployment in Malaysia.

Working Group Scope

(a) Applies to *Access* and *In-Building*.

(b) Electromagnetic Compatibility *(EMC),* Security, Safety, Quality of Service *(QoS),* Regulatory requirements and other recommendations.

(c) Reference standards to relevant *Regulatory Bodies* that has jurisdiction.

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1 Executive Summary

Broadband over Powerline (BPL) is a broadband access technology that uses the *Low Voltage (LV)* and *Medium Voltage (MV)* electric power lines to provide telecommunication services. It is also referred to as Powerline Communication (PLC), Digital Power Line (DPL) and Power Line Transmission (PLT). The concept has been around for many years used by power companies, transmitting at low frequencies and low speed. In the year 2005, a new generation chipset at 200 *Mbps* is commercially available that has improve performance and competitiveness of the technology. This development has made possible for data to be transmitted at a much higher speed.

Importantly, BPL technology and its elements shall be designed to offer the best performance without affecting or interfering with the performance of the conventional electricity supply and its components /devices as well as not being affected by the electricity disturbances (Voltage drops, sags, dips and other harmonic interferences).

BPL Opportunity - The lack of alternative telecommunications infrastructure has been the hindrance to the broadband penetration. It takes long lead times and high cost to build and deploy facilities to a wide coverage of end users. BPL technology, takes advantage of an existing widespread electric power line infrastructure, is the potential alternative for rapid deployment and low cost access solution to bridge the digital divide. However, the maturity of the BPL technology in terms of R&D and cost analysis is required to determine its full potential and convenience of implementation.

This Document does not constitute as an approval for the usage of electric power lines to transmit telecommunications signal. The necessary approvals from local authorities that has jurisdiction are still required prior to deployment.

1.1 Document Objective

(a) To provide an overview of BPL Technology.

(b) To provide general requirement for operational of BPL Physical Network Layer that is applicable to Malaysia.

(c) To provide general requirement and guidelines for the deployment of BPL Physical Network Layer that is applicable to Malaysia.

1.2 Document Scope

(a) Access application.

(b) Reference standards and guidelines for BPL Physical Network Layer;

i. BPL System compliance.

ii. Electromagnetic Compatibility and Interference requirements.

iii. Security requirements.

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iv. Safety requirements during Installation, Operation and Maintenance.

v. Quality of Service requirements.

vi. Regulatory requirements.

vii. Other recommendations.

(c) Reference standards to relevant Regulatory Bodies that has jurisdiction.

(d) Approvals required for implementation.

2 General Requirements For Operational of Broadband over Powerline Physical Network Layer

2.1 Broadband over Powerline Network Overview

The system architecture should consist of the backhaul data network that connects the BPL network to the telecommunications network and the BPL network which overlays the electricity distribution network.

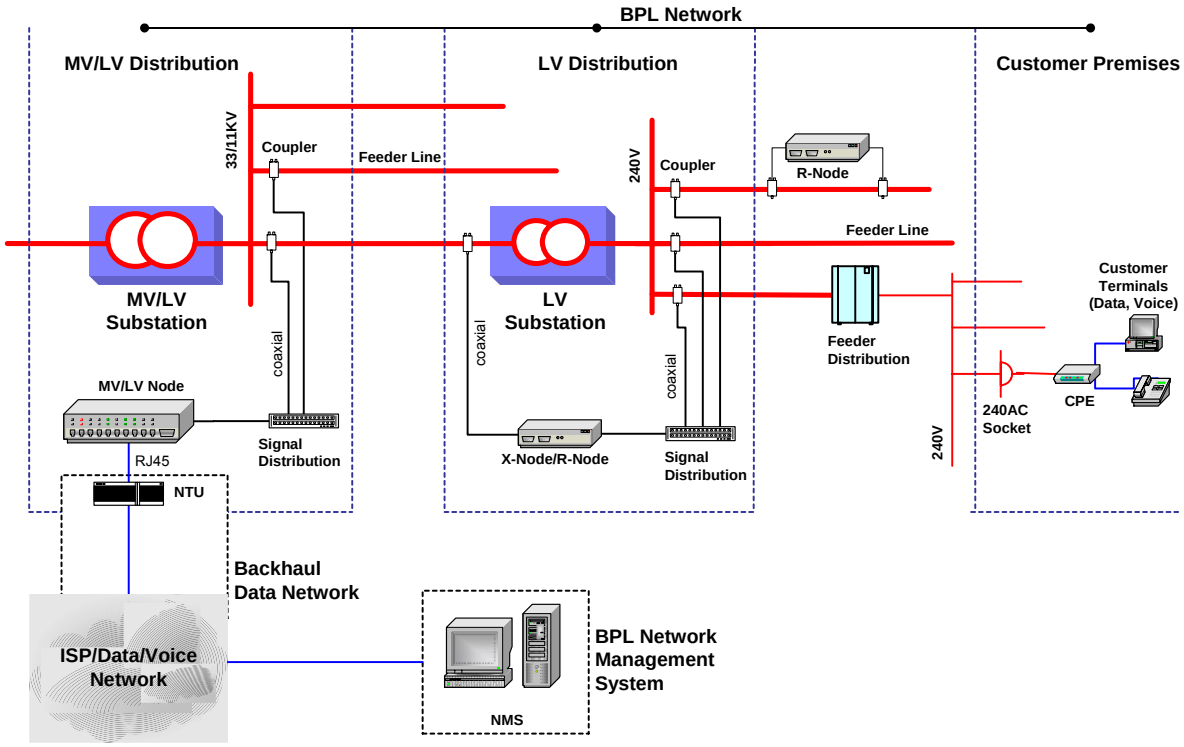

Figure 1: Broadband over Powerline Network Overview

2.1.1 Electricity Distribution Network

Electric power lines constitute the physical layer or transport mechanism for the BPL network.

In Malaysia, the electricity distribution systems licensed providers are;

- *Tenaga Nasional Berhad (TNB)* – electricity provider for West Malaysia.
- *Sarawak Electricity Supply Corp (SESCo)* – electricity provider for Sarawak (East Malaysia).
- *Sabah Electricity Sdn Bhd (SESB)* - electricity provider for Sabah (East Malaysia) and Federal Territory of Labuan.

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The governing body or authority that regulates the provisioning of electricity supply in Malaysia is the Energy Commission (EC), which is under the Ministry of Energy, Water and Communications.

2.1.2 Backhaul Data Network

The backhaul data network is the telecommunications backbone to which the BPL-empowered distribution system is connected via high-speed data link.

2.1.3 BPL Network

The BPL network is integrated with the electricity distribution system and is utilizing the electric power lines for broadband access communications.

The BPL system should have *Network Management System (NMS)* as parts of the network.

The BPL system should only be deployed on the MV and LV distribution systems.

2.2 BPL Physical Network Layer Components

A number of electronic devices (or nodes) are deployed at various points in the electricity distribution network to overlay a communications network on the electric power lines. These devices are characterized as "Physical Network Layer components" and are designed to accomplish specific tasks along the BPL network. The list of nodes includes:

2.2.1 Medium/Low Voltage Node (MV/LV-Node)

The Medium/Low Voltage Node (MV/LV-Node) is a device that converts the normal *IP* based communication signal to other signal appropriate for transmission over the electric power lines. It should be capable to support a variety of interfaces and functions, such as;

i. Backhaul connections to the telecommunications backbone.

ii. BPL signals aggregation for transmission over the MV/LV feeder lines.

iii. BPL local network management that provides various functions such as sub-elements configurations, controlling and monitoring, error correction and security.

Due to a safety reason, the MV/LV-Node interface to the electric power lines should not be designed to directly connect to the electric power lines, instead using a coupling device either inductive or capacitive. The connection between the MV-Node and coupling unit is realized with a *BNC* cable.

A standard data interface ports *(RJ-45)* should be made available for connection to the telecommunications backhaul equipment.

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2.2.2 Transformer Node (X-Node)

The Transformer Node (X-Node) is a device, which is installed in the transformer room and can provide two functions: to transfer (by-pass the transformer) communication signals between medium voltage and low voltage lines and as a repeater along the medium voltage line.

2.2.3 Repeater Node (R-Node)

The Repeater Node (R-Node) is a device, which is installed somewhere along the electric power lines (external or internal types) and used to provide greater reach on long lines or lines with high attenuation so that the end to end communication quality is maintained without much degradation. In some cases the R-Node is a modified X-Node.

2.2.4 Customer Premises Equipment (CPE)

The *Customer Premises Equipment (CPE)* contains a BPL interface to the low voltage line, terminates and converts the BPL signal back to the normal IP based.

The CPE should be modular in construction to allow a variety of other interfaces for in-home services. These will include support for an in-home data network and for telephony services with standard *(RJ-11)* analog telephone ports.

2.2.5 Couplers

Couplers provide the means to transmit on and receive the communication signals from the electric power line. There are two methods for coupling the signal to the line - capacitive and inductive coupling.

i. Capacitive coupler – The usage of capacitive coupler for the overhead MV and LV lines is preferred where as their usage for the indoor applications has to be ensured that suitable space and safety clearance issues in the Malaysian electrical environment are taken care.

ii. Inductive coupler – passive coupler, easy-to-install, low-maintenance, should be installed without interrupting the supply across the electric power lines. It should operate in overhead, pad mounted and underground scenarios and is capable of withstanding high levels of voltage, weather elements, external elements, and withstand surges due to lightning and switching.

2.2.6 Line Conditioning Devices

Line conditioning devices are placed on both the MV and LV distribution lines and are responsible for the sectionalizing of the electricity distribution network.

In all cases these devices should be designed to be active in the communications frequency band and not in the electricity frequency band. The functionality of the devices is to pass or block the signal as appropriate.

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2.3 BPL System Compliance

The operation of BPL system in Malaysia should be allowed subject to the following conditions;

2.3.1 BPL Network Protocols

The BPL system should be a *Layer 2 network* and transparent for IP communications.

The BPL system should support duplex, broadcast and multicast communications in an efficient way.

2.3.2 BPL System Operating Frequency

The BPL system installed in MV and LV distribution system should operate within the frequency band from 1 *MHz* to 40 *MHz*.

The operating frequency used should not cause any interference to other licensees' frequency or frequencies, or reserved frequencies used by the Government of Malaysia's authorities, enforcement agencies and military, or neighboring countries used frequencies.

Other frequency bands should be considered subject to further development of the technology and deployment scenarios.

2.3.3 BPL System Operating Power

The BPL system installed in MV and LV distribution system should have the capability to limit the output power to –50 *dBm/Hz* or below, and the aggregated output power to not higher than 13 *dBm.*

2.3.4 BPL System Compatibility

In general, the BPL system should be compatible to work in the Malaysian's electricity distribution environment physically and technically without any modifications to the electricity distribution systems and components.

For operational compatibility, the BPL system should comply with the Electromagnetic Compatibility/Immunity (EMC/EMI) regulations, specifications and recommendations as outlined in Section 4.2.

It should be made mandatory that the BPL system installed in the MV and LV distribution system to have the following features to enhance its service performance and reliability, and to prevent possible interferences with other frequencies users;

(a) Frequency notching

(b) Frequency band blocking

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(c) Power adjustment

2.3.5 Compliance with MCMC and EC Requirements

(a) Type Approval - All BPL devices (as regulated by MCMC and EC) should be certified by SIRIM and Type Approved for deployment in Malaysia.

(b) Type Test - The BPL devices should be tested by SIRIM or Test Laboratories accredited by Accreditation Bodies who are signatories of *APLAC/ILAC MRA*. The test report issued should be accompanied with test certificate.

No.	Equipment	Standard Codes	Remarks
1.0	• MV/LV Node • X-Node • R-Node	MS IEC 60950 MS IEC 61000-3-2 MS IEC 61000-3-3 MS CISPR 22 MS CISPR 24 IEC 664 & CE 0682	Safety of Information Technology Equipment. Refer to Section 4.2.2 Refer to Section 4.2.2 Refer to Section 4.2.2 Refer to Section 4.2.2 Compliance standards for Over voltage protection.
2.0	CPE	MS IEC 60950 MS IEC 61000-3-2 MS IEC 61000-3-3 MS CISPR 22 MS CISPR 24 IEC 664 & CE 0682	Safety of Information Technology Equipment. Refer to Section 4.2.2 Refer to Section 4.2.2 Refer to Section 4.2.2 Refer to Section 4.2.2 Compliance standards for Over voltage protection.
3.0	Coupler	IEC 60358 IEC 60481 IEC 61334-3-22 IEC 60664-1 IEC 60185 IEC 60186 IEC 664 & CE 0682	Coupling Capacitors and Capacitors Dividers. Coupling Devices for Power Line Carrier Systems. MV Phase-to-Earth and Screen-to-Earth Coupling Devices. Insulation Coordination for Equipment Within Low-Voltage Systems. Current Transformer. Voltage Transformer. Standards for Over voltage protection.
4.0	Line Conditioning	IEC 60358 MS IEC 61000-3-2 MS IEC 61000-3-3 MS CISPR 22 MS CISPR 24 IEC 664 &	Coupling Capacitors and Capacitors Dividers. Refer to Section 4.2.2 Refer to Section 4.2.2 Refer to Section 4.2.2 Refer to Section 4.2.2 Standards for Over voltage

		CE 0682	protection.

(c) Field Test - In accordance to the Malaysian environment, additional tests should be conducted at field to ensure the reliability and safety of the system.

The Field Test results should satisfy the EMC/EMI (Section 4.2) and Safety (Section 4.4) requirements.

3 Guidelines and Requirements for Deployment of Broadband Over Powerline Physical Network Layer

3.1 Scope

The deployment of BPL on the MV and LV distribution network in Malaysia should follow the minimum guidelines and requirements, set below;

3.2 Eletromagnetic Compatibility and Interference Requirements

3.2.1 General

The BPL equipments should have features to perform efficiently under the electrical environment and they should be Electromagnetic Compatible *(EMC)* to work with surrounding equipment and immune to the Electromagnetic Interferences/Radiations *(EMI).*

3.2.2 EMC Requirements for BPL Equipment

(a) BPL equipment should comply with *MS CISPR 22* (emission) – and operate within the *MS CISPR 22* limits for the conducted common mode voltage/current when measured at the multi purpose port for BPL *(class B equipment)*, specified as follows:

i. Conducted common mode voltage or current limits at the power line during data transmission (74 *dBμV*-quasi peak or 30 *dBμA*-quasi peak in the frequency range from 150 *kHz* to 30 *MHz*);

ii. Radiated emission limits (30 *dB μV/m*, measuring at 10 *m*, in the frequency range from 30 to 230 *MHz*, and 37 *dBμV/m*, measuring at 10 *m*, in the frequency range from 230 to 1000 *MHz*).

(b) BPL equipment should comply with *MS IEC 61000-3-2*: Limits- Limits for harmonic current emissions (equipment input current <= 16 *A* per phase).

(c) BPL equipment should comply with *MS IEC 61000-3-3*: Limits- Limitation of voltage changes, voltage fluctuations and flicker in Public Low-Voltage supply systems, for equipment with rated current <= 16 *A* per phase and not subject to conditional connection.

(d) BPL equipment should comply with the *MS CISPR 24*: (ITE product- immunity characteristics- limits and methods of measurements).

3.2.3 EMI Requirements for BPL Installation

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(a) The radiated emission limits for BPL installation should follow the *Federal Communications Commission (FCC)* Part 15 § 15.209, specified as follows:

i. BPL equipments working in the frequency range of 1 to 30 *MHz* is 30 *μV/m* (29.59 *dBμV/m*) measured at 30 *m* from the source in a 9 *kHz* bandwidth using a *QP detector*.

ii. BPL equipments working in the frequency range of 30 to 88 *MHz* is 100 *μV/m* (40 *dBμV/m*) measured at 3 *m* from the source in a 120 *kHz* bandwidth using a *QP detector*.

(b) The radiated emission should be measured as recommended in FCC Part 15, 15.31, 15.33 & 15.35.

3.3 Security Requirements

3.3.1 General

Security of the BPL system should be mandatory to ensure reliability of the BPL system itself and the existing electricity services quality. Due to criticalness of electricity services and to follow the national regulations on the electrical energy quality of service, priority of service should be given to electricity in any case.

For deployment of BPL system, two (2) security measures should be adopted;

(a) Security to the electricity distribution system and services.

(b) Security to the BPL system.

3.3.2 Security Requirements for Electricity Distribution System and Services

(a) All BPL system devices, active and passive components should be Type Approved by SIRIM and the deployment should be as per the EC and MCMC guidelines.

(b) Only competent personnel with valid qualifications are allowed to conduct or supervise BPL implementation, maintenance and operational activities.

(c) All BPL system devices, active and passive components should be tested after complete installation according to the approved test requirements and the test results should meet the required performance and standards.

(d) The BPL system should be designed and implemented in segments for purpose of easy operation and maintenance, and minimize disturbances to the electricity distribution elements in case of upgrading or decommission of the system.

(e) A NMS should be incorporated into the BPL Network for easy operation and management of the network elements.

(f) The BPL system users should not have access or capable to gain access to any electricity distribution network elements or systems, physically or virtually.

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(g) Access or connection to the BPL network should be strictly via CPE and home UK-type 240 *AC* socket outlet. There should be no unauthorized or illegal tapping or other physical modifications to the electric power lines in order to gain access or connectivity to the BPL network.

3.3.3 Security Requirements for BPL System

(a) The CPE is allowed to gain access into any BPL network with proper login and authentication procedures.

(b) Service activation, deactivation, installation and operating software upgrade of customer CPEs should be make available through ISP's NMS or BPL's NMS.

(c) By default, a customer CPE is not allowed to communicate directly with another one in the same BPL network. However, this should be allowed when declared as such.

(d) No customer CPE should be able to receive unicast traffic addressed to another customer's CPE in the same BPL network.

(e) It should be possible to activate encryption. A "by default" activation should be possible.

3.4 Safety Requirements during Installation, Operation and Maintenance

3.4.1 General

The Safety of personnel and equipment involved during the installation, operation and maintenance of the BPL system should be highly considered since the BPL working environment involves the electricity infrastructure and it is totally different from the normal telecommunication infrastructure.

3.4.2 BPL Equipment Requirements

(a) The BPL equipment should comply with the MCMC and EC requirements as outlined in Section 3.3.5.

(b) All BPL equipment should comply with the EMC/EMI Requirements as outlined in Section 4.2.2.

3.4.3 BPL Accessories Requirements

(a) The BPL equipment should comply with the MCMC and EC requirements as outlined in Section 3.3.5.

(a) All BPL equipment should comply with the EMC/EMI Requirements as outlined in Section 4.2.2.

(b) All BPL accessories should adhere to the Malaysian Electricity Regulations 1994.

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(c) All BPL accessories should be certified to not caused or be harmed within its installed environment;

(d) Any BPL accessories for the purpose of connection to an electrical installation should be sufficient in size, power and number to serve the purpose for which it is intended and should be constructed, installed, arranged, protected, worked and maintained in such a manner as to prevent danger.

(e) No BPL accessories except those designed to be connected to an electrical socket outlet by means of a plug, should be connected to an installation unless the connection is carried out by or under the control of a competent person.

3.4.4 Safety Guideline on BPL Works

3.4.4.1 Public installation

(a) No BPL works should be conducted on any public installation without first obtaining the approval in writing from a licensed provider or supply authority.

(b) Any BPL works conducted within any public installation should adhere to the Malaysian Electricity Regulations 1994, where relevant and licensed providers's or supply authority's Standards of Practice.

3.4.4.2 Private installation

(a) No BPL works should be conducted on any private installation without first obtaining the approval in writing from the owner.

(b) Any BPL works conducted within a private installation should adhere to the Malaysian Electricity Regulations 1994, where relevant, and owner's Standards of Practice.

3.5 Quality of Service Requirements

The service quality of the BPL Network should comply with the MCMC guidelines and requirements during normal electricity operating condition.

3.6 Regulatory Requirements

Any provision of BPL services using the electricity distribution network should fall within the domain of;

(a) The Malaysian Communications and Multimedia Act 1998.

(b) The Malaysian Electricity Supply Act 1990.

(c) The Malaysian Electricity Distribution Code 1999.

(d) The Malaysian Electricity Regulations 1994.

(e) The Malaysian Energy Commission Act 2001.

4 Other Recommendations

4.1 Training for BPL System

The BPL technology is not new and it has been commercially used in other countries since few years back. However in Malaysia, the technology is still in trial stage and no commercial deployment has been executed so far.

Since the BPL technology is utilizing the electric power lines to enable communication of data signals, all parties interested to deploy this system should be trained and have knowledge in both communication and electrical system.

The following are some of the recommended learning topics and training modules for BPL;

(a) Basic BPL Training Course
   i. Module 1.1: Basic Electricity Distribution systems
   ii. Module 1.2: Basic communications systems
   iii. Module 1.3: Broadband Access Network Technologies
   iv. Module 1.4: Safety and Security in Electricity Distribution systems
   v. Module 1.5: BPL Technologies and Standards

(b) BPL Training Course for Installers
   i. Module 2.1: Installation
   ii. Module 2.2: Network Management System
   iii. Module 2.3: Electricity Management Systems

(c) BPL Training Course for Testers
   i. Module 3.1: BPL Tests and Measurements: Data Communications
   ii. Module 3.2: BPL Tests and Measurements: Electricity Supply Quality
   iii. Module 3.3: EMC Tests and Measurements

The BPL training courses should be conducted by training providers.

4.2 Disaster Recovery Plan

The BPL Network is highly depending on the electric power lines to enable communications and services delivery to the end users. Any disruptions or disturbances on the electric power lines would affect the BPL availability and quality of service.

The BPL Network is also radiating frequencies as it goes along bare conductors or un-insulated power lines. These frequencies may be harmful and cause interferences to other service operators and users if they are operating within the same frequency bands.

In order to limit and eliminate problems arise from BPL system, the following are some measures to be considered;

(a) Importing and deployment of BPL equipments should be monitored by MCMC, EC and SIRIM.

(b) MCMC should mandate the use of frequency notching, frequency band blocking and power adjustment features for deployment of BPL System.

(c) All BPL System should have NMS for controlling and monitoring purposes.

(d) MCMC should conduct regular frequency scanning to check on the radiating frequencies at installation sites.

(e) The BPL users should be advised that in the event of electricity supply disturbances or outages, the communication services (data and voice) might be affected or completely unavailable.

4.3 Endorsement to Use Powerline

(a) A prior written approval should be obtained from EC and MCMC before deploying the BPL System.

(b) A Field Trial on the BPL System to be used should be conducted and monitored by EC and MCMC to ensure that all the mandatory conditions are adhered to.

(c) A written approval from the electricity provider (who has the jurisdiction on the power lines to be used) on the BPL Network deployment and implementation plans should be obtained before starting any activities.

(d) All approvals should follow the Regulatory Requirements as outlined in Section 3.6

5 Definitions

For the purposes of this Reference Standards and Guidelines, the followings definitions apply.

Access BPL (Access Broadband over Powerline)	:	A carrier current system installed and operated on an electric power lines as an unintentional radiator that sends radio frequency energy on frequencies between 1.705 MHz and 80 MHz over medium voltage lines or over low voltage lines to provide broadband communications and is located on the supply side of the electricity service provider's points of interconnection with customer premises. Access BPL does not include power line carrier systems or In-House BPL.
Broadband	:	A wide band frequencies used to transmit information in which the information can be multiplexed and sent on many different frequencies or channels within the band concurrently, allowing more information to be transmitted in a given amount of time.
Class B equipment	:	A category of apparatus which satisfies the class B ITE disturbance limits. Class B is intended primarily for use in the domestic environment and may include: – Equipment with no fixed place of use; for example, portable equipment powered by built-in batteries; – Telecommunication terminal equipment powered by a telecommunication network; – Personal computers and auxiliary connected equipment.
Customer	:	Customer (End User, Subscriber) is a common legal term meaning an individual, firm, partnership, corporation, or organization.
Customer Premises Equipment	:	An Equipment employed on the premises of a customer, which can originate, route or terminate telecommunications, is customer premises equipment
dB	:	A unit of measurement which expresses changes in signal power levels or signal attenuation along a logarithmic scale. dB=10 times the log of the ratio of the power of the two signals. This is equal to 20 times the ratio of their voltages, if the signals are driving equal impedances.
dBm	:	A unit that defines a signal level by comparing it to a reference level. The reference level of 0dBm is defined as 1mW. The signal level in dBm is 10 times the log of the signal's power over that of the 0 dBm reference.

In-Building BPL (In-Building Broadband over Powerline)	:	A carrier current system, operating as an unintentional radiator, that sends radio frequency energy by conduction over electric power lines that are not owned, operated or controlled by an electric service provider. The electric power lines may be aerial (overhead), underground, or inside the walls, floors or ceilings of user premises. In-Building BPL devices may establish closed networks within an end user's premises or provide connections to Access BPL networks, or both.
Layer 2	:	Layer 2 refers to the Data Link Layer of the commonly referenced multi-layered communication model, Open Systems Interconnection (OSI). The Data Link layer is concerned with moving data across the physical links in the network. In a network, the switch is a device that redirects data messages at the layer 2 level, using the destination Media Access Control (MAC) address to determine where to direct the message.
Mbps	:	Mbps stands for *millions of bits per second* or *megabits per second* and is a measure of bandwidth (the total information flow over a given time) on a telecommunications medium.
MHz	:	MHz stands for the number of oscillations of electromagnetic radiation per second.
PLC Forum	:	A leading international Association that represents the interests of manufacturers, energy utilities and other organisations in the field of access and in-home PLC (Powerline Communications) technologies.
Powerline	:	An electric wire or cable or infrastructure that conducts and brings electricity supply to homes and businesses.
RJ-11	:	Registered Jack - Type 11 is a physical interface often used for terminating twisted pair type cables. It has six pins or electrical connections.
RJ-45	:	Registered Jack - Type 45 is a physical interface often used for terminating twisted pair type cables. It has eight "pins" or electrical connections.
Regulatory Bodies	:	The Ministry, State or Local Authority or any other Government Agencies who regulates the implementation standards and guidelines of the multimedia and communication, and energy related services in Malaysia.

6 Abbreviations

For the purposes of this Reference Standards and Guidelines, the followings abbreviations apply.

μ	Micro (SI unit denoting a factor of 10^{-6} or one millionth)
A	Ampere (SI unit measuring current)
AC	Alternate Current
APLAC	Asia Pacific Laboratory Accreditation Cooperation
BNC	Bayonet Neill-Concelman type of RF connector
BPL	Broadband over Powerline
CISPR	International Special Committee on Radio Interference
CMA 1998	Communication and Multimedia Act 1998
CPE	Customer Premises Equipment
dB	Decibel
DB	Distribution Board
EC	Energy Commission, Malaysia
EMC	Electromagnetic Compatibility
EN	European Norm
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission (MD, USA)
HF	High Frequency (3-30MHz)
Hz	Hertz (SI unit measuring frequency)
IDA	Info-Communications Development Authority of Singapore
IEC	International Electrotechnical Commission
ILAC	International Laboratory Accreditation Cooperation
IP	Internet Protocol
K	Kilo (SI units denoting a factor of 10^3 or one thousand)
kV	Kilo Volt
LV	Low Voltage
M	Meter (SI unit measuring length)
M	Mega (SI units denoting a factor of 10^6 or one million)
Mbps	Megabit per second
MCB	Miniature Circuit Breakers
MCMC	Malaysian Communications and Multimedia Commission
MRA	Mutual Recognition Agreement
MS IEC	Malaysian Standard International Electrotechnical Commission (Malaysian Standard which is identical to IEC Standard of the same number)
MV	Medium Voltage
NMS	Network Management System
OPERA	Open PLC European Research Alliance
PLC	Powerline Communications
QP Detector	Quasi – Peak Detector
SESB	Sabah Electricity Sdn. Bhd.
SESCo	Sarawak Electricity Supply Corp
SIRIM	SIRIM Berhad
TNB	Tenaga Nasional Berhad
UPLC	United Power Line Council
V	Volt (SI unit measuring potential difference)

7 Reference Documents and Links

The following reference documents contain provisions, which, through reference in this text, constitute provision of this Reference Standards and Guidelines.

For dated references, where there are subsequent amendments to, or revisions of, any of these publications of the Technical Standard should be amended or revised accordingly.

For undated references, the latest edition of the publication referred applies.

This Reference Standards and Guidelines are based on the following references:

(a) The Malaysian Communications and Multimedia Act 1998.

(b) The Malaysian Electricity Supply Act 1990.

(c) The Malaysian Electricity Distribution Code 1999.

(d) The Malaysian Electricity Regulations 1994.

(e) The Malaysian Energy Commission Act 2001.

(f) The Department of Standards Malaysia, Malaysia Standards 2004.

(g) The Federal Communications Commission (MD, USA), Title 47 of the Code of Federal Regulations – Part 15.

(h) Other related links for information:

- BPL chipset Developer; www.ds2.es, www.intellon.com, www.xeline.com
- Forum to develop IP, QoS & Powerline integration; www.ipv6forum.com
- BPL forum; www.istopera.org, www.upaplc.com, www.plcforum.org
- International Standard Bodies & Regulators; www.ieee.org, www.etsi.org, www.cenelec.org, www.fcc.gov, www.ida.gov.sg

8 Conclusion

The PLC WG has recommended that the naming convention used in Malaysia to be Broadband over Powerline (BPL), specific to communications via broadband services inline with FCC. It is also to avoid confusion over the established abbreviation used for PLC - Programmable Logic Controller.

Recommendations in this document are applicable to deployment of BPL Physical Network Layer in Malaysia, based on studies and tests criteria's set by EC and MCMC, which were conducted by the PLC WG under Malaysian environment.

The PLC WG is in favor of BPL technology deployment in Malaysia to start off with Commercial Trials under the supervision of EC and MCMC. This would facilitate a learning curve experience to further understand and mitigate associated risks before BPL technology rollout.

Standards and Guidelines where mentioned in this document is valid at the time, **July 2005.** The interested parties are responsible to verify with the accordance to the latest validated updates of Standards and Guidelines.

In moving forward, the PLC WG will continue developing and recommending the applicable Standards and Guidelines for BPL Network Layer for deployment in Malaysia. The Reference Standards and Guidelines of BPL Network Layer will provide the functional and procedural means of transferring and delivering of data from a source to a destination via devices on the same or on different physical networks that are interconnected.

Acknowledgment

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