Lenovo Network

Developer's Guide

for Lenovo Network Development Toolkit for Puppet, version 1.0

Lenovo™

Note: Before using this information and the product it supports, read the general information in the *Safety information and Environmental Notices and User Guide* documents on the Lenovo *Documentation* CD and the *Warranty Information* document that comes with the product.

Contents

Preface

The *Lenovo Network Development Toolkit for Puppet Developer's Guide* describes how to install, configure, and use the Lenovo Network Development Toolkit for Puppet.

Intended Audience for This Guide

This guide is intended for network installers and system administrators engaged in configuring and maintaining a network. The administrator is expected to be familiar with Ethernet concepts, IP addressing, and Spanning Tree Protocol. The user of this book is also expected to be familiar with the Ruby programming language.

Typographic Conventions

The following table describes the typographic styles used in this book.

Table 1. *Typographic Conventions*

| Typeface or Symbol	Meaning	Example
ABC123	This type is used for names of commands, files, and directories used within the text. It also depicts on-screen computer output and prompts.	View the readme.txt file. Switch#
ABC123	This bold type appears in command examples. It shows text that must be typed in exactly as shown.	Switch# **sys**
<ABC123>	This italicized type appears in command examples as a parameter placeholder. Replace the indicated text with the appropriate real name or value when using the command. Do not type the brackets. This also shows book titles, special terms, or words to be emphasized.	To establish a Telnet session, enter: Switch# **telnet** *<IP address>* Read your *User's Guide* thoroughly.
{}	Command items shown inside brackets are mandatory and cannot be excluded. Do not type the brackets.	Switch# **copy {ftp|sftp}**
[]	Command items shown inside brackets are optional and can be used or excluded as the situation demands. Do not type the brackets.	Switch# **ls [-a]**
|	The vertical bar (	) is used in command examples to separate choices where multiple options exist. Select only one of the listed options. Do not type the vertical bar.	Switch# **set {left|right}**
AaBbCc123	This block type depicts menus, buttons, and other controls that appear in Web browsers and other graphical interfaces.	Click the **Save** button.

Overview

Puppet is a configuration management tool that can be used to deploy, configure, manage, and maintain a data center node, including servers, storage, and network switches. You can use Puppet for the entire life of a node, starting from bootstrapping a node to shredding and giving up a node. You can use Puppet to define distinct configurations for every node, and to continuously check and confirm whether the required configuration is in place and is not altered. If a configuration is altered, Puppet reverts back to the required configuration on the node.

The Lenovo Network Development Toolkit for Puppet is designed to be used for configuring Link Aggregation Groups (LAGs), IP management, and telemetry.

Puppet uses a master/slave architecture as shown in Figure 1:

Figure 1. Puppet Architecture
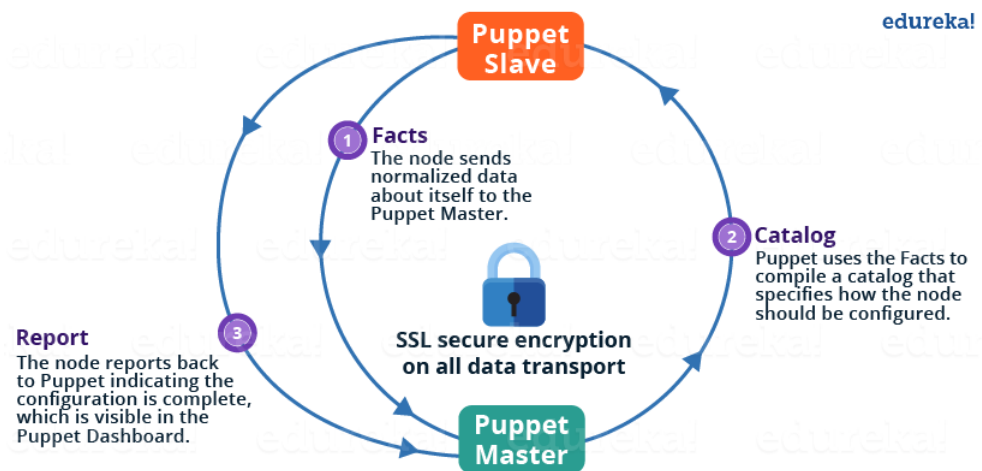
The following functions are being performed in Figure 1:

- The Puppet Agent, running directly on the node or from a proxy node*, sends the Facts to the Puppet Master. Facts are key/value data pairs that represent some aspect of the Slave (node or device**) state, such as its IP address, uptime, operating system, or whether the slave is a virtual machine.

- The Puppet Master uses the Facts to compile a Catalog that defines how the Slave will be configured. The Catalog is a document that describes the desired state for each resource that the Puppet Master manages on a Slave.

- The Puppet Slave reports back to the Puppet Master indicating that Configuration is complete, which is visible in the Puppet Dashboard.

Notes:

* A proxy node is a node that does not allow the Puppet Agent to run directly on it.

** Puppet refers to nodes that depend on proxy nodes as devices.

The Puppet Configuration Management Tool

A Puppet configuration consists of:

- a language
- client-server processes
- the Resource Abstraction Layer

The language allows you to describe a server configuration as an abstraction of resources that an administrator already thinks in, such as users, groups, packages, files, cron, mount, and services.

The relationships between the resources are also specified. For example, a service depends on a configuration file, and that configuration file requires a package to be installed. The relationships provide order as the policy is applied and allow Puppet to restart dependent services when their configurations change.

The resources can also be composed into logical collections. For example, a package, a configuration file, and a service can be grouped together. The group can then be reused and treated as a single logical entity in other Puppet code. The client-server setup provides a secure mechanism for transporting specific configurations from the central description to the individual hosts over HTTP with SSL authentication and encryption. Each host only receives its specific pre-compiled configuration to apply.

Puppet configurations are audited and applied by querying the current state, comparing the results with the desired state, and taking the appropriate action for each resource. Applying the configuration can take a base operating system to a fully configured server. Changes to the central policy can also update configuration files or apply patches. The cycle of auditing and syncing systems with the assigned policy is then used to manage systems throughout the system lifecycle.

The auditing and syncing cycle ensures consistency across the entire network, avoiding inconsistencies created by configuration drift that can cause confusion and mistakes.

Puppet Master and Slave Communication

The Puppet Master and Slave communicate through a secure encrypted channel with the help of SSL, as shown in Figure 2:

Figure 2. Puppet Master and Slave Communication
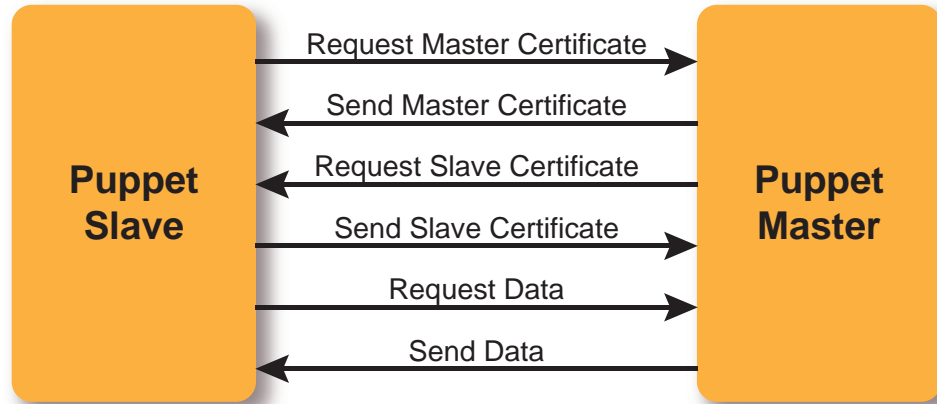
In this figure, the following communications are taking place:

1. The Puppet Slave asks the Puppet Master for the Master certificate.

2. After sending the Master certificate, the Master sends a request to the Slave for the Slave certificate.

3. The Slave sends the Slave certificate, and the Master signs it.

4. The Slave then requests configuration data.

5. The Puppet Master sends the configuration data to the Puppet Slave.

Puppet Components

Puppet is comprised of the following components:

- **Manifests**

  Every Slave has its configuration details stored on the Puppet Master in the native Puppet language. These details are written in the language which Puppet can understand and are called *manifests*. Manifests are Puppet "programs" composed of Puppet code. Manifest files use the *.pp* extension.

  For example, you can write a manifest on the Puppet Master that creates a file and installs an Apache server on all Puppet Slaves connected to the Puppet Master.

  The default main manifest file is located on your Puppet Master server at:

  ```
  /etc/puppetlabs/code/environments/production/manifests/site.pp
  ```

- **Modules**

  A Puppet *module* is a collection of manifests and data (such as facts, files, and templates) with a specific directory structure. Modules are useful for organizing your Puppet code because they allow you to split your code into multiple manifests. Modules are self-contained bundles of code and data.

  For information on writing manifests and modules, see:

  https://docs.puppet.com/puppet/4.5/modules_fundamentals.html

- **Resources**

  A *resource* is the fundamental unit for modeling system configurations. Each resource describes some aspect of a system, like a specific service or package.

- **Facter**

  The *facter* gathers basic information (facts) about the Puppet Slave such as hardware details, network settings, OS type and version, IP addresses, MAC addresses, and SSH keys. These facts are then made available in the Puppet Master's manifests as variables.

  To see a list of facts that are automatically being gathered on your slave node, enter:

  ```
  $ /opt/puppetlabs/bin/facter
  ```

- **Catalogs**

  A *catalog* describes the desired state of each managed resource on a Puppet Slave. It is a compilation of all the resources that the Puppet Master applies to a given Slave, as well as the relationships between those resources. Catalogs are compiled by a Puppet Master from manifests and Slave-provided data (such as facts, certificates, and an environment, if one is provided), as well as optional external data (such as data from an external Slave classifier, exported resources, or functions). The Master then serves the compiled catalog to the Slave when requested.

Installing the Puppet Development Toolkit

The Puppet Development Toolkit installation consists of the following components:

- Puppet Master
- Puppet Slave (proxy node for Lenovo switches)
- The CNOS Ruby APIs
- Lenovo CNOS Puppet Module

Software Requirements

The following software is required for running the Puppet Development Toolkit:

- Lenovo CNOS 10.6 or later
- Puppet Enterprise 2017.3
- Ruby 2.2.3 or later

  To download Ruby, go to:

  https://www.ruby-lang.org/en/downloads/

- The REST Client Ruby gem.

  To download the REST Client Ruby gem, go to:

  https://rubygems.org/downloads/rest-client-2.0.2.gem

  For information about the REST Client Ruby gem file and how to install it, go to:

  https://rubygems.org/gems/rest-client

- One of these supported versions of Linux to deploy Puppet:
  - Ubuntu Linux 14.04/16.04
  - Red Hat Enterprise Linux 6.x/7.x

Install Puppet Enterprise 2017.3

Use the following steps to install Puppet Enterprise 2017.3:

1. Review System Requirements at:

   https://puppet.com/docs/pe/2017.3/installing/system_requirements.html

2. Install Puppet Enterprise.

   The following link contains instructions on how to install Puppet Enterprise on Linux:

   https://puppet.com/docs/pe/2017.3/installing/installing_pe.html#concept-3157

3. Install the Puppet Agent on Slave Linux machine (proxy node).

   The following link contains instructions on how to install the Puppet agent on Linux:

   https://puppet.com/docs/pe/2017.3/installing/installing_agents.html#ariaid-title4

4. Set up the Puppet Master and Slave on their respective systems per the instructions in the respective installation links.

5. Verify that Ruby 2.3.3 or greater is installed on the Puppet Master system:

   ```
   $ ruby -v
   ```

6. Make sure the REST Client gem is installed on the Master system:

   ```
   $ gem list --local | grep rest-client
   ```

7. Make sure the Puppet Server service is running on the Master system:

   ```
   $ systemctl start puppetserver
   ```

   or:

   ```
   $ service puppetserver start
   ```

8. Make sure the Puppet Agent service is running on the Slave system:

   ```
   $ /opt/puppetlabs/bin/puppet resource service puppet ensure=running
   enable=true
   $ /opt/puppetlabs/bin/puppet agent --test
   ```

   or

   ```
   $ puppet agent-t
   ```

9. Make sure a connection is established between the Puppet Master and the Puppet Slave by running the following command on the Master system:

   ```
   $ /opt/puppetlabs/bin/puppet cert list -all
   ```

Installing the Lenovo Network Development Toolkit for Puppet

To install the Lenovo Network Development Toolkit for Puppet:

1. Download the Lenovo Network Development Toolkit for Puppet on the Puppet Master system from the download link at:

   https://forge.puppet.com/lenovo/cnos

2. Install the Lenovo CNOS Puppet module onto the Master and Slave systems:

   ```
   $ puppet module install lenovo-cnos --version 0.1.0
   ```

3. Install the Lenovo CNOS Ruby API gem (Agent) onto the Master and Slave systems:

   ```
   $ gem install lenovo-rbapi -v 0.0.5
   ```

4. On the Puppet Slave (proxy node), create a *device.conf* file in the directory */etc/puppetlabs/puppet* that contains the following:

   ```
   [<Fully Qualified Domain Name (FQDN) of the switch>]
   type cnos
   url https://<admin ID>:<admin ID password>@<IP address of the switch>
   ```

5. Run the **puppet device** command on the Slave system:

   ```
   $ puppet device -v --user=root
   ```

   Notes:

   - Ensure that the switch is configured with a hostname resolvable by both the Puppet Master and Puppet Agent.

   - Ensure that the REST API feature is enabled on the switch with HTTPS. To start the REST server listening on the HTTPS port (443), enter Global Configuration Mode on the switch and run the following command:

     ```
     Switch(config)# feature restapi
     ```

   - When the **puppet device** command is run for the first time for a CNOS switch, it generates a SSL certificate and sends a certificate signing request to the Puppet Master. To enable communication and control of the CNOS switch, the Master must sign switch certificate. For more details, see "Puppet Master and Slave Communication" on page 8.

   - When dealing with multiple switches, you can either:
     - append the specific details for each switch to the device.conf file as separate lines, or
     - create multiple *.conf* files. For example: *switch1.conf* or *group1.conf*. Append **--deviceconfig** *<filename.conf>* to the **puppet device** command:

       ```
       $ puppet device -v --user=root --deviceconfig <filename.conf>
       ```

6. Run the **puppet cert** command on the Puppet Master to verify if the certificate for the CNOS switch is listed:

```
$ puppet cert list --all
```

Sample command output:

```
root@master:~# puppet cert list --all

"switch.lenovo.com"        (SHA256)
A9:F5:AO:61:BO:3F:64:37:F3:2A:CF:01:C5:73:03:6B:EF:0A:A2:15:A5:47:0A:2C:0
A:DD:80:EC:C6:D5:17:16
```

Note: switch.lenovo.com is an example FQDN of a CNOS switch, configured in the device.conf file on the Puppet Slave.

7. On the Puppet Master, sign the CNOS switch SSL certificate:

```
$ puppet cert sign <FQDN of CNOS Switch>
```

Sample command output:

```
root@master:~# puppet cert sign switch.lenovo.com

Notice: Signed certificate request for switch.lenovo.com
Notice: Removing file Puppet::SSL::CertificateRequest switch.lenovo.com
at '/etc/puppetlabs/puppet/ssl/ca/requests/switch.lenovo.com.pem'

root@master:~# puppet cert list -all

+ "switch.lenovo.com"        (SHA256)
A9:F5:AO:61:BO:3F:64:37:F3:2A:CF:01:C5:73:03:6B:EF:0A:A2:15:A5:47:0A:2C:0
A:DD:80:EC:C6:D5:17:16
```

Note: The plus symbol (+) before the switch FQDN indicates that the SSL certificate has been signed by the Puppet Master.

8. Run the **puppet agent** and **puppet device** commands on the Puppet Slave (proxy node) to establish connectivity between the CNOS switch (Device) and the Puppet Master, and enable the CNOS switch to send its facts to the Master:

```
$ puppet agent -t
$ puppet device -v --user=root
```

Sample command output:

```
root@clients:~# puppet device -v --user=root

Info: starting applying configuration to switch.lenovo.com at
https://10.21.10.39:443/
Info: Using configured environment 'production'
Info: Retrieving pluginfacts
Info: Retrieving plugin
Notice: Key  = operatingsystem , Value = cnos
Notice: Key  = Name , Value = G8272
Notice: Key  = Description , Value = G8272 ("48x10GE + 6x40GE")
Notice: Key  = Model , Value = Lenovo RackSwitch G8272
Notice: Key  = Manufacture Date , Value = 1542 (YYWW)
Notice: Key  = Serial Number , Value = YO52MVXXXXXX
Notice: Key  = Part Number , Value = OOCJO66
Notice: Key  = Software Revision , Value = 10.7.1.O
Notice: Key  = Electronic Serial Number , Value = XXXXXX
Notice: Key  = Mgmt mac , Value = AA:CC:BB:DD:FF:EE
Notice: Key  = Machine Type Model , Value = 7159-HCV
Notice: Key  = UpTime , Value = 44024400
Info: Caching catalog for switch.lenovo.com
Info: Applying configuration version '1522761668'
Notice: Applied catalog in 0.48 seconds
```

CNOS Puppet Manifests

The following sample manifests are available for managing CNOS:

Manifest Filename	Function
arp.pp	Manage ARP
arp_sys.pp	Manage ARP system properties
bst_feature.pp	Manage the BST feature
bst_track.pp	Manage BST tracking
ip_intf.pp	Manage IP interface properties
lacp.pp	Manage LACP properties
lag.pp	Manage LAG properties
sys.pp	Manage BST system properties
vlag.pp	Manage vLAG properties
vlag_conf.pp	Manage vLAG configuration
vlag_health.pp	Manage vLAG Health Check properties
vlag_isl.pp	Manage vLAG ISL properties
vlan.pp	Manage VLAN properties
vlan_intf.pp	Manage VLAN interface properties
vrrp.pp	Manage VRRP properties

To run a manifest:

1. On the Puppet Master, modify manifests to meet your network requirements:

```
$ cd /etc/puppetlabs/code/environments/production/modules/cnos/manifests/
$ vim <manifest-file>.pp
```

Sample command output:

```
root@master:/etc/puppetlabs/code/environments/production/modules/cnos/man
ifests# vim vlan.pp

class cnos::vlan {
  cnos_vlan { '11':
    ensure      => 'present',
    vlan_id     => 11,
    admin_state => 'up',
    vlan_name   => 'test11',
  }
}
```

Note: The above sample *vlan.pp* manifest is for creating (presenting) and enabling VLAN 11 with its name configured to *test11*.

2. Use one of the following commands:

- On the Puppet Master:

```
$ puppet apply <path to manifest file>
```

Sample command output:

```
root@master:/etc/puppetlabs/code/environments/production/modules/cnos/
manifests# puppet apply vlan.pp

Notice: Compiled catalog for master.lenovo.com in environment
production in 0.05 seconds
Notice: Applied catalog in 0.32 seconds
```

- Use the Puppet Enterprise console to pin the manifest to run on the CNOS switch:
  - Access the Puppet Enterprise console
  - On the left panel, navigate to **Configure** and select **Classification**
  - Select the switch (node) on which to apply the manifest
  - Click **Commit Changes**
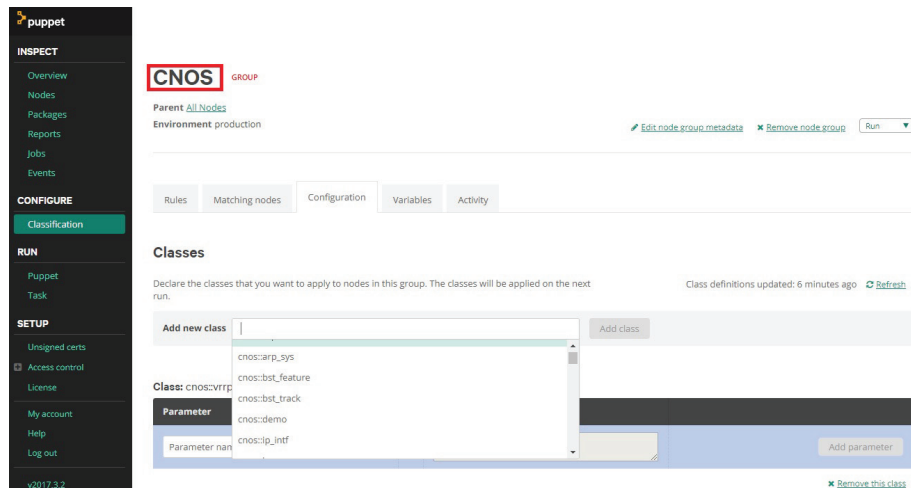
- On the Puppet Salve (proxy node):

```
$ puppet agent -t
$ puppet device -v --user=root
```

3. Verify that the configuration is applied on the switch.

For information about the Lenovo Ruby APIs, see the *Lenovo Network Ruby API Reference Guide*.

Product Support

This is a free and open source product from Lenovo. There are no support entitlements available for this plug-in. Alternatively, you can file an issue or request via the GitHub repository at:

https://github.com/lenovo/puppet-cnos/issues

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Contaminant	Limits
Gaseous	• Copper: Class G1 as per ANSI/ISA 71.04-1985[3] • Silver: Corrosion rate of less than 300 Å in 30 days

[1] ASHRAE 52.2-2008 - *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

[2] The deliquescent relative humidity of particulate contamination is the relative humidity at which the dust absorbs enough water to become wet and promote ionic conduction.

[3] ANSI/ISA-71.04-1985. *Environmental conditions for process measurement and control systems: Airborne contaminants*. Instrument Society of America, Research Triangle Park, North Carolina, U.S.A.

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Das Gerät erfüllt die Schutzanforderungen nach EN 55024 und EN 55022 Klasse A.

Nach der EN 55022: "Dies ist eine Einrichtung der Klasse A. Diese Einrichtung kann im Wohnbereich Funkstörungen verursachen; in diesem Fall kann vom Betreiber verlangt werden, angemessene Maßnahmen durchzuführen und dafür aufzukommen."

Nach dem EMVG: Dieses Produkt entspricht den Schutzanforderungen der EU-Richtlinie 2004/108/EG (früher 89/336/EWG) zur Angleichung der Rechtsvorschriften über die elektromagnetische Verträglichkeit in den EU-Mitgliedsstaaten und hält die Grenzwerte der EN 55022 Klasse A ein.

Um dieses sicherzustellen, sind die Geräte wie in den Handbüchern beschrieben zu installieren und zu betreiben. Des Weiteren dürfen auch nur von der Lenovo empfohlene Kabel angeschlossen werden. Lenovo übernimmt keine Verantwortung für die Einhaltung der Schutzanforderungen, wenn das Produkt ohne Zustimmung der Lenovo verändert bzw. wenn Erweiterungskomponenten von Fremdherstellern ohne Empfehlung der Lenovo gesteckt/eingebaut werden.

Deutschland:

Einhaltung des Gesetzes über die elektromagnetische Verträglichkeit von Betriebsmittein
Dieses Produkt entspricht dem "Gesetz über die elektromagnetische Verträglichkeit von Betriebsmitteln" EMVG (früher "Gesetz über die elektromagnetische Verträglichkeit von Geräten"). Dies ist die Umsetzung der EU-Richtlinie 2004/108/EG (früher 89/336/EWG) in der Bundesrepublik Deutschland.

Zulassungsbescheinigung laut dem Deutschen Gesetz über die elektromagnetische Verträglichkeit von Betriebsmitteln, EMVG vom 20. Juli 2007 (früher Gesetz über die elektromagnetische Verträglichkeit von Geräten), bzw. der EMV EG Richtlinie 2004/108/EC (früher 89/336/EWG), für Geräte der Klasse A.

Dieses Gerät ist berechtigt, in übereinstimmung mit dem Deutschen EMVG das EG-Konformitätszeichen - CE - zu führen. Verantwortlich für die Konformitätserklärung nach Paragraf 5 des EMVG ist die Lenovo (Deutschland) GmbH, Gropiusplatz 10, D-70563 Stuttgart.

Informationen in Hinsicht EMVG Paragraf 4 Abs. (1) 4: **Das Gerät erfüllt die Schutzanforderungen nach EN 55024 und EN 55022 Klasse A.**

Nach der EN 55022: "Dies ist eine Einrichtung der Klasse A. Diese Einrichtung kann im Wohnbereich Funkstörungen verursachen; in diesem Fall kann vom Betreiber verlangt werden, angemessene Maßnahmen durchzuführen und dafür aufzukommen."

Nach dem EMVG: "Geräte dürfen an Orten, für die sie nicht ausreichend entstört sind, nur mit besonderer Genehmigung des Bundesministers für Post und Telekommunikation oder des Bundesamtes für Post und Telekommunikation betrieben werden. Die Genehmigung wird erteilt, wenn keine elektromagnetischen Störungen zu erwarten sind." (Auszug aus dem EMVG, Paragraph 3, Abs. 4). Dieses Genehmigungsverfahren ist nach Paragraph 9 EMVG in Verbindung mit der entsprechenden Kostenverordnung (Amtsblatt 14/93) kostenpflichtig.

Anmerkung: Um die Einhaltung des EMVG sicherzustellen sind die Geräte, wie in den Handbüchern angegeben, zu installieren und zu betreiben.

Japan VCCI Class A Statement

この装置は、クラス A 情報技術装置です。この装置を家庭環境で使用すると電波妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されることがあります。　　　　　VCCI-A

This is a Class A product based on the standard of the Voluntary Control Council for Interference (VCCI). If this equipment is used in a domestic environment, radio interference may occur, in which case the user may be required to take corrective actions.

Japan Electronics and Information Technology Industries Association (JEITA) Statement

高調波ガイドライン適合品

Japan Electronics and Information Technology Industries Association (JEITA) Confirmed Harmonics Guidelines (products less than or equal to 20 A per phase)

高調波ガイドライン準用品

Japan Electronics and Information Technology Industries Association (JEITA) Confirmed Harmonics Guidelines with Modifications (products greater than 20 A per phase).

Korea Communications Commission (KCC) Statement

이 기기는 업무용(A급)으로 전자파적합기기로
서 판매자 또는 사용자는 이 점을 주의하시기
바라며, 가정외의 지역에서 사용하는 것을 목
적으로 합니다.

This is electromagnetic wave compatibility equipment for business (Type A). Sellers and users need to pay attention to it. This is for any areas other than home.

Russia Electromagnetic Interference (EMI) Class A statement

ВНИМАНИЕ! Настоящее изделие относится к классу А.
В жилых помещениях оно может создавать радиопомехи, для
снижения которых необходимы дополнительные меры

People's Republic of China Class A electronic emission statement

中华人民共和国 "A类" 警告声明

声 明
此为A级产品，在生活环境中，该产品可能会造成无线电干扰。在这种情况下，
可能需要用户对其干扰采取切实可行的措施。

Taiwan Class A compliance statement

警告使用者：
這是甲類的資訊產品，在
居住的環境中使用時，可
能會造成射頻干擾，在這
種情況下，使用者會被要
求採取某些適當的對策。