

SLES for SAP, SLES

Using SUSE Automation to Deploy an SAP HANA Cluster on Google Cloud Platform

SUSE Linux Enterprise Server for SAP Applications
SUSE Linux Enterprise Server
Google Cloud Platform

Abdelrahman Mohamed, Public Cloud Solutions Architect - Google Alliance (SUSE)

Using SUSE Automation to Deploy an SAP HANA Cluster on Google Cloud Platform

Date: 2024-10-29

The document at hand walks you through the deployment of a two-node SAP HANA High Availability Cluster using the SUSE Automation Project into a sandbox environment, operated on Google Cloud Platform.

Disclaimer: Documents published as part of the SUSE Best Practices and the Technical Reference Documentation series have been contributed voluntarily by SUSE employees and third parties. They are meant to serve as examples of how particular actions can be performed. They have been compiled with utmost attention to detail. However, this does not guarantee complete accuracy. SUSE cannot verify that actions described in these documents do what is claimed or whether actions described have unintended consequences. SUSE LLC, its affiliates, the authors, and the translators may not be held liable for possible errors or the consequences thereof.

Contents

- 1 About the guide 4
- 2 Configuring the Cloud Shell 5
- 3 Ensuring Terraform is installed 6
- 4 Preparing the SAP HANA media 6
- 5 Downloading and configuring the SUSE Automation code 8
- 6 Finalizing the automation configuration 11
- 7 Deploying the project 11
- 8 Tearing down 13
- 9 Legal notice 14
- 10 GNU Free Documentation License 15

1 About the guide

This document will walk you through the deployment of a simple two-node SAP HANA HA Cluster using the SUSE Automation Project for SAP Solutions Project and operating on Google Cloud Platform.

This project uses Terraform and Salt to deploy and configure the operating system (SUSE Linux Enterprise Server for SAP Applications), SAP software (SAP HANA), and a SUSE Linux Enterprise High Availability (HA) cluster. If extensive configuration and customization are required, refer to the project documentation at <https://github.com/SUSE/ha-sap-terraform-deployments>.

For simplicity, this guide uses the Cloud Shell to perform the deployment, as it provides easy access to most of the required tooling.

It is possible to use a local Linux or macOS computer, but some commands may need modification or omission.

The architecture for the deployment is similar to the one shown below:

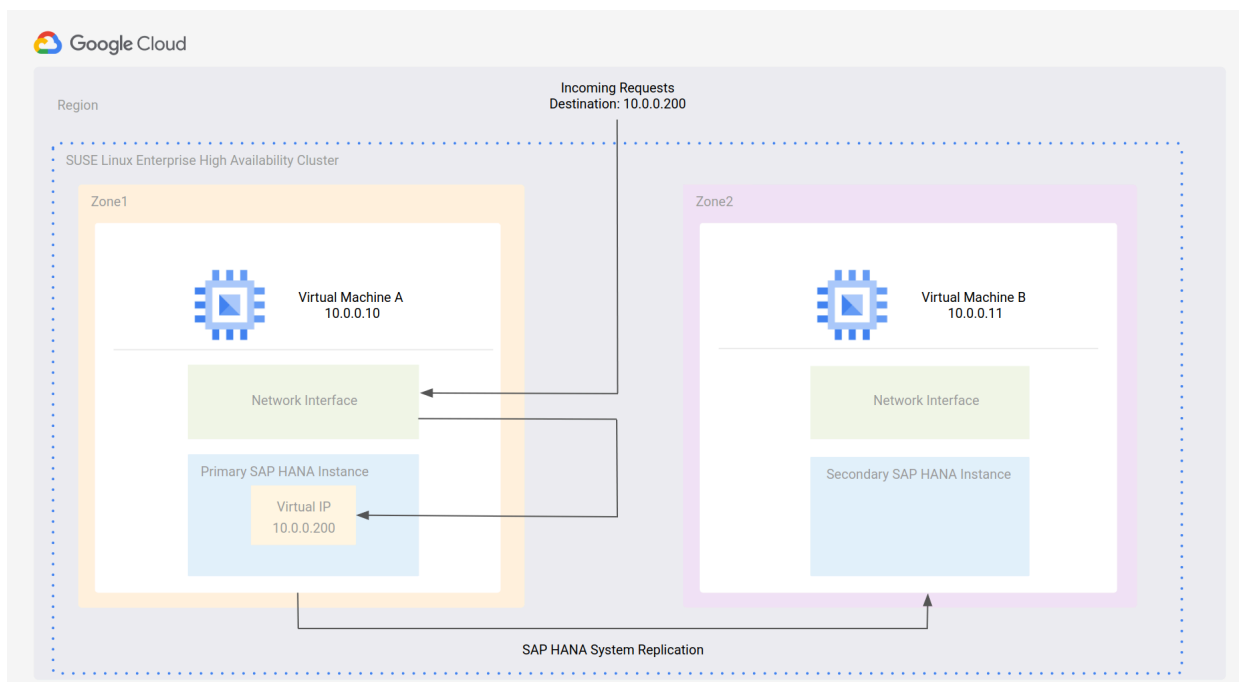


FIGURE 1: SUSE AUTOMATION FOR SAP HANA ON GOOGLE CLOUD PLATFORM ARCHITECTURE

The project will perform the following actions:

- Deploying infrastructure - including Virtual Network, subnet, firewall rules etc.
- Deploying instances - 2x SAP HANA Instances

- Configuring the operating system for SAP workload
- Running the SAP HANA installation
- Configuring SAP HANA System Replication (HSR)
- Configuring SUSE Linux Enterprise High Availability cluster components and resources

2 Configuring the Cloud Shell

Important

The Google Cloud Platform (GCP) user specified in the below-mentioned steps needs certain GCP Project permissions to ensure the deployment is successful. For simplification, the GCP user used in this guide has the *Project Owner* IAM role.

The following procedures show the minimum steps required to prepare the GCP infrastructure to host the SAP HANA environment:

1. Create a new GCP Project to host the SAP HANA environment.
2. Enable the GCP Compute Engine API.
3. Using the newly created GCP project console, start a GCP Cloud Shell.
4. Using the GCP Cloud Shell, create a new GCP Key for the default GCP Service Account. The key will be used by Terraform to access the GCP infrastructure.

Tip

For more details about creating a GCP Service Account key, refer to <https://cloud.google.com/iam/docs/creating-managing-service-account-keys#iam-service-account-keys-create-gcloud> ↗

Note

For simplification, the default GCP Service Account will be used in this guide.

3 Ensuring Terraform is installed

Terraform is already deployed as part of the GCP Cloud Shell. The following command output shows the Terraform version used at the time of creating this guide:

```
$ terraform -v
Terraform v1.0.0
on linux_amd64
```

4 Preparing the SAP HANA media

With the correct entitlement, SAP HANA media can be downloaded from the SAP Web site at <https://support.sap.com/en/my-support/software-downloads.html>. The SAP Media needs to be made available so it can be accessed during the deployment.

The SUSE Automation for SAP Applications project allows for three methods for presenting the SAP media:

1. SAR file and SAPCAR executable (SAP HANA Database only)
2. Multipart exe/RAR files
3. Extracted media

The different formats come with some benefits and drawbacks:

1. The compressed archives (SAR and RAR) provide a simple copy to the cloud but a longer install time because of extracting it during the process.
2. The uncompressed/extracted media are the fastest install, but more files are copied to the cloud share, which also takes time in forehand as preparation.

In this example, we use the extracted archives for the installation as it is the fastest deployment way.



Note

This however depends on the method used to download the SAP media. If multiple compressed files are downloaded, the official SAP extract tool SAPCAR tool must be used to extract the SAP media.



Tip

The extracted SAP Media can contain a lot of files. Depending on your network speed, it can consume time to upload the extracted SAP media files. Google Cloud infrastructure provides a breakneck network speed. Create a Google Cloud compute engine workstation machine to download/upload the SAP media. The other option is to use fast speed internet connection.



Tip

It is a good practice to have the SAP Media versioned on the cloud share to build a library for automatic installs and (re)deployments. Thus you should think about your SAP media structure first.

As an **example**, see below how a full SAP Application media tree (in a compressed format) for a S/4HANA version 1809 install would look like:

```
<FS>/s4hana1809
  |SWPM_CD
  | |SWPM20SP07_5-80003424.SAR
  | |SAPCAR_721-20010450.EXE
  |
  |EXP_CD
  | |S4CORE104_INST_EXPORT_1.zip
  | |S4CORE104_INST_EXPORT_2.zip
  | |...
  |DBCLIENT_CD
  | |IMDB_CLIENT20_005_111-80002082.SAR
  |BASKET_CD
  | |SAPHOSTAGENT24_24-20009394.SAR
  | |figshelper_4-10010245.sar
  | |figsex_1-80001746.sar
  | |SAPEXEDB_400-80000698.SAR
  | |SAPEXE_400-80000699.SAR
  |HANA
  | |51053061_part1.exe
  | |51053061_part2.rar
  | |51053061_part3.rar
  | |51053061_part4.rar

HANA      : contains the HANA Database install
BASKET_CD : contains SAP kernel, patch + more like hostagent.
DBCLIENT_CD: contains the package corresponding to DB CLIENT, e.g HANA
```

```
EXP_CD      : contains the package corresponding to EXPORT files
SWPM_CD     : must contain the .exe file corresponding to SAPCAR and the
              .sar file corresponding to SWPM.
              The file suffix must be .exe and .sar.
```

In the next steps, we use a simple HANA install download.

A GCP Cloud Storage bucket is used to host the SAP HANA extracted media. Using the GCP Console, perform the following actions:

- Create a new GCP bucket. (The example shows a GCP Cloud Storage bucket called mysapmedia, but a unique name should be used.)
- Upload the SAP HANA media extracted directory to the GCP Cloud Storage bucket. The following figure shows the uploaded SAP HANA media extracted directory:

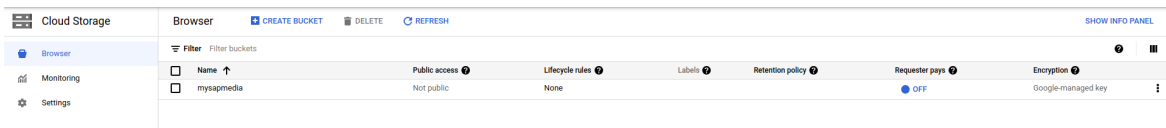


FIGURE 2: SAP HANA GCP STORAGE BUCKET

5 Downloading and configuring the SUSE Automation code

The SUSE SAP Automation code is published in GitHub.

The following command will clone the project to the Cloud Shell ready for configuration:

```
$ git clone --depth 1 --branch 7.2.0 https://github.com/SUSE/ha-sap-terraform-deployments.git
```

Next, move the generated GCP Service Account Key to the SUSE SAP Automation GCP directory:

```
$ cd ~
$ cp <GCP Service Account Key> suse-sap-automation/ha-sap-terraform-deployments/gcp
```



Note

If the following SSH keys already exist, the next step can be skipped.

Then, generate SSH key pairs to allow for accessing the SAP HANA instances:

```
#optional if ssh-keys already exist
$ cd ~
$ ssh-keygen -q -t rsa -N '' -f ~/.ssh/id_rsa
```

5.1 Configuring the deployment options and modifying the Terraform variables

The files that need to be configured are contained in a subdirectory of the project. Use that as the working directory:

```
$ cd ~/suse-sap-automation/ha-sap-terraform-deployments/gcp
```

A Terraform example template is provided. For a demo environment consisting of a simple HANA cluster, only a handful of parameters will need changing.

Copy the Terraform example file to `terraform.tfvars`:

```
$ cp terraform.tfvars.example terraform.tfvars
```

Edit the `terraform.tfvars` file and modify it as explained below. If you are duplicating the lines before modification, ensure the original is commented out, or the deployment will fail.

First, choose the GCP Project ID for the deployment:

```
# GCP project id
project = "<PROJECT ID>"
```

Then, choose the GCP Service Account Key file path. With the following parameter, Terraform will use the GCP Service Account Key file created above:

```
# Credentials file for GCP
gcp_credentials_file = "<GCP Service Account Key Path and Name>"
```

Choose the region for the deployment, for example:

```
# Region where to deploy the configuration
region = "europe-west1"
```

The following parameters select the version of SUSE Linux Enterprise Server for SAP Applications to deploy:



Note

The values shown equal the default values. All defaults point to PAYG images for an easy start. Thus you only need to enable or change the variables if you want to work with different values.

```
#os_image = "suse-sap-cloud/sles-15-sp2-sap"
```

Next, enter the path for the public and private SSH keys that were generated earlier. Below is an example using the default created SSH keys:

```
# SSH Public key location to configure access to the remote instances
public_key = "~/ssh/id_rsa.pub"

# Private SSH Key location
private_key = "~/ssh/id_rsa"
```

To keep the cluster architecture and deployment simple and to provide additional packages needed to deploy, uncomment and set the following parameters:

```
ha_sap_deployment_repo = "https://download.opensuse.org/repositories/network:/ha-
clustering:/sap-deployments:/v7/"
```

Then, enable the `pre_deployment` parameter:

```
pre_deployment = true
```

The Jump host server (Bastion Host Server) is enabled by default, and provide the public IP address to the database. Otherwise the two HANA servers will get a public IP.

Disable the Bastion Host Server creation parameter `bastion_enabled`:

```
bastion_enabled = false
```

Next, set which SAP HANA instance machine type should be selected: The default is set to some standard types, and you only need to enable and change the variable if you want other sizes.

```
#machine_type = "n1-highmem-32"
```

Modify the following parameter to point to SAP media that was uploaded to the storage location:

```
hana_inst_master = "mysapmedia/51054623"
```

To create the cluster, we need to set this parameter to **true**, otherwise only a single system is created.

```
# Enable system replication and HA cluster
hana_ha_enabled = true
```

Finally, to ensure a fully automated deployment, it is possible to set passwords within the `terraform.tfvars` file. Uncomment and set the following parameters to your own value:

```
hana_master_password = "SAP_Pass123"
```



Note

If the parameters are not set in the `terraform.tfvars` file, they must be entered when running the deployment.



Important

All passwords must conform to SAP password policies or the deployment will fail.

Optional: If a monitoring instance should be as part of the deployment, find and uncomment the following:

```
monitoring_enabled = true
```

6 Finalizing the automation configuration

Ensure that the GCP Project used to host the SAP HANA HA cluster meets the infrastructure quota requirements set by Google Cloud. For more info, refer to <https://cloud.google.com/solutions/sap/docs/sap-hana-planning-guide#quotas>

7 Deploying the project

Terraform will create and name resources when running the deployment based on the "workspace" in use. It is highly recommended to create a unique workspace from which to run the deployment.

```
$ terraform init
$ terraform workspace new demo
$ terraform workspace select demo
$ terraform plan
$ terraform apply
```



Tip

The Cloud Shell has a timeout of around 20 minutes and the shell will close if left unattended, resulting in a failed deployment. It is strongly advised to retain focus on the Cloud Shell window to ensure the timeout does not occur.

If successful, the output lists the public IP addresses for the cluster nodes. This will look similar to the following considering the different Public IP addresses for each deployment:

```
module.hana_node.module.hana_provision.null_resource.provision[1] (remote-exec): Summary
for local
module.hana_node.module.hana_provision.null_resource.provision[1] (remote-exec):
-----
module.hana_node.module.hana_provision.null_resource.provision[1] (remote-exec):
Succeeded: 33 (changed=23)
module.hana_node.module.hana_provision.null_resource.provision[1] (remote-exec): Failed:
0
module.hana_node.module.hana_provision.null_resource.provision[1] (remote-exec):
-----
module.hana_node.module.hana_provision.null_resource.provision[1] (remote-exec): Total
states run:    33
module.hana_node.module.hana_provision.null_resource.provision[1] (remote-exec): Total
run time: 1028.670 s
module.hana_node.module.hana_provision.null_resource.provision[1] (remote-exec): Wed Jun
23 10:14:22 UTC 2021::demo-hana02::[INFO] deployment done
module.hana_node.module.hana_provision.null_resource.provision[1]: Creation complete
after 27m24s [id=3463680564647535989]

Apply complete! Resources: 26 added, 0 changed, 0 destroyed.

Outputs:

bastion_public_ip = ""
cluster_nodes_ip = [
  "10.0.0.10",
  "10.0.0.11",
]
cluster_nodes_name = [
```

```
"demo-hana01",
"demo-hana02",
]
cluster_nodes_public_ip = tolist([
  "34.127.16.75",
  "34.145.94.26",
])
cluster_nodes_public_name = []
drbd_ip = []
drbd_name = []
drbd_public_ip = []
drbd_public_name = []
iscsisrv_ip = ""
iscsisrv_name = ""
iscsisrv_public_ip = ""
iscsisrv_public_name = []
monitoring_ip = ""
monitoring_name = ""
monitoring_public_ip = ""
monitoring_public_name = ""
netweaver_ip = []
netweaver_name = []
netweaver_public_ip = []
netweaver_public_name = []
```

8 Tearing down

When finished with the deployment, or even if the deployment has failed, ensure that Terraform is used to tear down the environment.

```
$ terraform destroy
```

This method will ensure all GCP resources, such as instances, disks, VPCs, and roles are cleaned up. You need to delete the following GCP components manually:

- GCP Cloud Storage bucket
- GCP Project

9 Legal notice

Copyright © 2006–2024 SUSE LLC and contributors. All rights reserved.

Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.2 or (at your option) version 1.3; with the Invariant Section being this copyright notice and license. A copy of the license version 1.2 is included in the section entitled "GNU Free Documentation License".

SUSE, the SUSE logo and YaST are registered trademarks of SUSE LLC in the United States and other countries. For SUSE trademarks, see <https://www.suse.com/company/legal/>.

Linux is a registered trademark of Linus Torvalds. All other names or trademarks mentioned in this document may be trademarks or registered trademarks of their respective owners.

Documents published as part of the SUSE Best Practices series have been contributed voluntarily by SUSE employees and third parties. They are meant to serve as examples of how particular actions can be performed. They have been compiled with utmost attention to detail. However, this does not guarantee complete accuracy. SUSE cannot verify that actions described in these documents do what is claimed or whether actions described have unintended consequences. SUSE LLC, its affiliates, the authors, and the translators may not be held liable for possible errors or the consequences thereof.

Below we draw your attention to the license under which the articles are published.

10 GNU Free Documentation License

Copyright © 2000, 2001, 2002 Free Software Foundation, Inc. 51 Franklin St, Fifth Floor, Boston, MA 02110-1301 USA. Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

0. PREAMBLE

The purpose of this License is to make a manual, textbook, or other functional and useful document "free" in the sense of freedom: to assure everyone the effective freedom to copy and redistribute it, with or without modifying it, either commercially or noncommercially. Secondly, this License preserves for the author and publisher a way to get credit for their work, while not being considered responsible for modifications made by others.

This License is a kind of "copyleft", which means that derivative works of the document must themselves be free in the same sense. It complements the GNU General Public License, which is a copyleft license designed for free software.

We have designed this License in order to use it for manuals for free software, because free software needs free documentation: a free program should come with manuals providing the same freedoms that the software does. But this License is not limited to software manuals; it can be used for any textual work, regardless of subject matter or whether it is published as a printed book. We recommend this License principally for works whose purpose is instruction or reference.

1. APPLICABILITY AND DEFINITIONS

This License applies to any manual or other work, in any medium, that contains a notice placed by the copyright holder saying it can be distributed under the terms of this License. Such a notice grants a world-wide, royalty-free license, unlimited in duration, to use that work under the conditions stated herein. The "Document", below, refers to any such manual or work. Any member of the public is a licensee, and is addressed as "you". You accept the license if you copy, modify or distribute the work in a way requiring permission under copyright law.

A "Modified Version" of the Document means any work containing the Document or a portion of it, either copied verbatim, or with modifications and/or translated into another language.

A "Secondary Section" is a named appendix or a front-matter section of the Document that deals exclusively with the relationship of the publishers or authors of the Document to the Document's overall subject (or to related matters) and contains nothing that could fall directly within that overall subject. (Thus, if the Document is in part a textbook of mathematics, a Secondary Section may not explain any mathematics.) The relationship could be a matter of historical connection with the subject or with related matters, or of legal, commercial, philosophical, ethical or political position regarding them.

The "Invariant Sections" are certain Secondary Sections whose titles are designated, as being those of Invariant Sections, in the notice that says that the Document is released under this License. If a section does not fit the above definition of Secondary then it is not allowed to be designated as Invariant. The Document may contain zero Invariant Sections. If the Document does not identify any Invariant Sections then there are none.

The "Cover Texts" are certain short passages of text that are listed, as Front-Cover Texts or Back-Cover Texts, in the notice that says that the Document is released under this License. A Front-Cover Text may be at most 5 words, and a Back-Cover Text may be at most 25 words.

A "Transparent" copy of the Document means a machine-readable copy, represented in a format whose specification is available to the general public, that is suitable for revising the document straightforwardly with generic text editors or (for images composed of pixels) generic paint programs or (for drawings) some widely available drawing editor, and that is suitable for input to text formatters or for automatic translation to a variety of formats suitable for input to text formatters. A copy made in an otherwise Transparent file format whose markup, or absence of markup, has been arranged to thwart or discourage subsequent modification by readers is not Transparent. An image format is not Transparent if used for any substantial amount of text. A copy that is not "Transparent" is called "Opaque".

Examples of suitable formats for Transparent copies include plain ASCII without markup, Texinfo input format, LaTeX input format, SGML or XML using a publicly available DTD, and standard-conforming simple HTML, PostScript or PDF designed for human modification. Examples of transparent image formats include PNG, XCF and JPG. Opaque formats include proprietary formats that can be read and edited only by proprietary word processors, SGML or XML for which the DTD and/or processing tools are not generally available, and the machine-generated HTML, PostScript or PDF produced by some word processors for output purposes only.

The "Title Page" means, for a printed book, the title page itself, plus such following pages as are needed to hold, legibly, the material this License requires to appear in the title page. For works in formats which do not have any title page as such, "Title Page" means the text near the most prominent appearance of the work's title, preceding the beginning of the body of the text.

A section "Entitled XYZ" means a named subunit of the Document whose title either is precisely XYZ or contains XYZ in parentheses following text that translates XYZ in another language. (Here XYZ stands for a specific section name mentioned below, such as "Acknowledgements", "Dedications", "Endorsements", or "History".) To "Preserve the Title" of such a section when you modify the Document means that it remains a section "Entitled XYZ" according to this definition. The Document may include Warranty Disclaimers next to the notice which states that this License applies to the Document. These Warranty Disclaimers are considered to be included by reference in this License, but only as regards disclaiming warranties: any other implication that these Warranty Disclaimers may have is void and has no effect on the meaning of this License.

2. VERBATIM COPYING

You may copy and distribute the Document in any medium, either commercially or noncommercially, provided that this License, the copyright notices, and the license notice saying this License applies to the Document are reproduced in all copies, and that you add no other conditions whatsoever to those of this License. You may not use technical measures to obstruct or control the reading or further copying of the copies you make or distribute. However, you may accept compensation in exchange for copies. If you distribute a large enough number of copies you must also follow the conditions in section 3.

You may also lend copies, under the same conditions stated above, and you may publicly display copies.

3. COPYING IN QUANTITY

If you publish printed copies (or copies in media that commonly have printed covers) of the Document, numbering more than 100, and the Document's license notice requires Cover Texts, you must enclose the copies in covers that carry, clearly and legibly, all these Cover Texts: Front-Cover Texts on the front cover, and Back-Cover Texts on the back cover. Both covers must also clearly and legibly identify you as the publisher of these copies. The front cover must present the full title with all words of the title equally prominent and visible. You may add other material on the covers in addition. Copying with changes limited to the covers, as long as they preserve the title of the Document and satisfy these conditions, can be treated as verbatim copying in other respects.

If the required texts for either cover are too voluminous to fit legibly, you should put the first ones listed (as many as fit reasonably) on the actual cover, and continue the rest onto adjacent pages.

If you publish or distribute Opaque copies of the Document numbering more than 100, you must either include a machine-readable Transparent copy along with each Opaque copy, or state in or with each Opaque copy a computer-network location from which the general network-using public has access to download using public-standard network protocols a complete Transparent copy of the Document, free of added material. If you use the latter option, you must take reasonably prudent steps, when you begin distribution of Opaque copies in quantity, to ensure that this Transparent copy will remain thus accessible at the stated location until at least one year after the last time you distribute an Opaque copy (directly or through your agents or retailers) of that edition to the public.

It is requested, but not required, that you contact the authors of the Document well before redistributing any large number of copies, to give them a chance to provide you with an updated version of the Document.

4. MODIFICATIONS

You may copy and distribute a Modified Version of the Document under the conditions of sections 2 and 3 above, provided that you release the Modified Version under precisely this License, with the Modified Version filling the role of the Document, thus licensing distribution and modification of the Modified Version to whoever possesses a copy of it. In addition, you must do these things in the Modified Version:

- A. Use in the Title Page (and on the covers, if any) a title distinct from that of the Document, and from those of previous versions (which should, if there were any, be listed in the History section of the Document). You may use the same title as a previous version if the original publisher of that version gives permission.
- B. List on the Title Page, as authors, one or more persons or entities responsible for authorship of the modifications in the Modified Version, together with at least five of the principal authors of the Document (all of its principal authors, if it has fewer than five), unless they release you from this requirement.
- C. State on the Title page the name of the publisher of the Modified Version, as the publisher.
- D. Preserve all the copyright notices of the Document.

- E. Add an appropriate copyright notice for your modifications adjacent to the other copyright notices.
- F. Include, immediately after the copyright notices, a license notice giving the public permission to use the Modified Version under the terms of this License, in the form shown in the Addendum below.
- G. Preserve in that license notice the full lists of Invariant Sections and required Cover Texts given in the Document's license notice.
- H. Include an unaltered copy of this License.
- I. Preserve the section Entitled "History", Preserve its Title, and add to it an item stating at least the title, year, new authors, and publisher of the Modified Version as given on the Title Page. If there is no section Entitled "History" in the Document, create one stating the title, year, authors, and publisher of the Document as given on its Title Page, then add an item describing the Modified Version as stated in the previous sentence.
- J. Preserve the network location, if any, given in the Document for public access to a Transparent copy of the Document, and likewise the network locations given in the Document for previous versions it was based on. These may be placed in the "History" section. You may omit a network location for a work that was published at least four years before the Document itself, or if the original publisher of the version it refers to gives permission.
- K. For any section Entitled "Acknowledgements" or "Dedications", Preserve the Title of the section, and preserve in the section all the substance and tone of each of the contributor acknowledgements and/or dedications given therein.
- L. Preserve all the Invariant Sections of the Document, unaltered in their text and in their titles. Section numbers or the equivalent are not considered part of the section titles.
- M. Delete any section Entitled "Endorsements". Such a section may not be included in the Modified Version.
- N. Do not retitle any existing section to be Entitled "Endorsements" or to conflict in title with any Invariant Section.
- O. Preserve any Warranty Disclaimers.

If the Modified Version includes new front-matter sections or appendices that qualify as Secondary Sections and contain no material copied from the Document, you may at your option designate some or all of these sections as invariant. To do this, add their titles to the list of Invariant Sections in the Modified Version's license notice. These titles must be distinct from any other section titles.

You may add a section Entitled "Endorsements", provided it contains nothing but endorsements of your Modified Version by various parties—for example, statements of peer review or that the text has been approved by an organization as the authoritative definition of a standard.

You may add a passage of up to five words as a Front-Cover Text, and a passage of up to 25 words as a Back-Cover Text, to the end of the list of Cover Texts in the Modified Version. Only one passage of Front-Cover Text and one of Back-Cover Text may be added by (or through arrangements made by) any one entity. If the Document already includes a cover text for the same cover, previously added by you or by arrangement made by the same entity you are acting on behalf of, you may not add another; but you may replace the old one, on explicit permission from the previous publisher that added the old one.

The author(s) and publisher(s) of the Document do not by this License give permission to use their names for publicity for or to assert or imply endorsement of any Modified Version.

5. COMBINING DOCUMENTS

You may combine the Document with other documents released under this License, under the terms defined in section 4 above for modified versions, provided that you include in the combination all of the Invariant Sections of all of the original documents, unmodified, and list them all as Invariant Sections of your combined work in its license notice, and that you preserve all their Warranty Disclaimers.

The combined work need only contain one copy of this License, and multiple identical Invariant Sections may be replaced with a single copy. If there are multiple Invariant Sections with the same name but different contents, make the title of each such section unique by adding at the end of it, in parentheses, the name of the original author or publisher of that section if known, or else a unique number. Make the same adjustment to the section titles in the list of Invariant Sections in the license notice of the combined work.

In the combination, you must combine any sections Entitled "History" in the various original documents, forming one section Entitled "History"; likewise combine any sections Entitled "Acknowledgements", and any sections Entitled "Dedications". You must delete all sections Entitled "Endorsements".

6. COLLECTIONS OF DOCUMENTS

You may make a collection consisting of the Document and other documents released under this License, and replace the individual copies of this License in the various documents with a single copy that is included in the collection, provided that you follow the rules of this License for verbatim copying of each of the documents in all other respects.

You may extract a single document from such a collection, and distribute it individually under this License, provided you insert a copy of this License into the extracted document, and follow this License in all other respects regarding verbatim copying of that document.

7. AGGREGATION WITH INDEPENDENT WORKS

A compilation of the Document or its derivatives with other separate and independent documents or works, in or on a volume of a storage or distribution medium, is called an "aggregate" if the copyright resulting from the compilation is not used to limit the legal rights of the compilation's users beyond what the individual works permit. When the Document is included in an aggregate, this License does not apply to the other works in the aggregate which are not themselves derivative works of the Document.

If the Cover Text requirement of section 3 is applicable to these copies of the Document, then if the Document is less than one half of the entire aggregate, the Document's Cover Texts may be placed on covers that bracket the Document within the aggregate, or the electronic equivalent of covers if the Document is in electronic form. Otherwise they must appear on printed covers that bracket the whole aggregate.

8. TRANSLATION

Translation is considered a kind of modification, so you may distribute translations of the Document under the terms of section 4. Replacing Invariant Sections with translations requires special permission from their copyright holders, but you may include translations of some or all

Invariant Sections in addition to the original versions of these Invariant Sections. You may include a translation of this License, and all the license notices in the Document, and any Warranty Disclaimers, provided that you also include the original English version of this License and the original versions of those notices and disclaimers. In case of a disagreement between the translation and the original version of this License or a notice or disclaimer, the original version will prevail.

If a section in the Document is Entitled "Acknowledgements", "Dedications", or "History", the requirement (section 4) to Preserve its Title (section 1) will typically require changing the actual title.

9. TERMINATION

You may not copy, modify, sublicense, or distribute the Document except as expressly provided for under this License. Any other attempt to copy, modify, sublicense or distribute the Document is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

10. FUTURE REVISIONS OF THIS LICENSE

The Free Software Foundation may publish new, revised versions of the GNU Free Documentation License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns. See <http://www.gnu.org/copyleft/>. Each version of the License is given a distinguishing version number. If the Document specifies that a particular numbered version of this License "or any later version" applies to it, you have the option of following the terms and conditions either of that specified version or of any later version that has been published (not as a draft) by the Free Software Foundation. If the Document does not specify a version number of this License, you may choose any version ever published (not as a draft) by the Free Software Foundation.

ADDENDUM: How to use this License for your documents

Copyright (c) YEAR YOUR NAME.

Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.2

```
or any later version published by the Free Software Foundation;  
with no Invariant Sections, no Front-Cover Texts, and no Back-Cover Texts.  
A copy of the license is included in the section entitled "GNU  
Free Documentation License".
```

If you have Invariant Sections, Front-Cover Texts and Back-Cover Texts, replace the “ with... Texts.” line with this:

```
with the Invariant Sections being LIST THEIR TITLES, with the  
Front-Cover Texts being LIST, and with the Back-Cover Texts being LIST.
```

If you have Invariant Sections without Cover Texts, or some other combination of the three, merge those two alternatives to suit the situation.

If your document contains nontrivial examples of program code, we recommend releasing these examples in parallel under your choice of free software license, such as the GNU General Public License, to permit their use in free software.