

Kernel Live Patching sous SUSE Linux Enterprise Server for SAP applications

CONTENU

Présentation et utilisation de Kernel Live Patching sous SUSE Linux Enterprise Server.

MOTIF

Vous souhaitez assurer la sécurité des systèmes critiques, sans temps d'arrêt.

EFFORT

20 minutes de lecture.

OBJECTIF

Comprendre le fonctionnement de Kernel Live Patching.

CONDITIONS REQUISES

- Connaissance pratique de Linux.

Date de publication : 11 déc 2025

Table des matières

- 1 Introduction à Kernel Live Patching 3


2	Présentation des correctifs de kernel Linux en direct	4
3	Activation de Kernel Live Patching à partir de la ligne de commande	6
4	Résolution des problèmes liés à Kernel Live Patching	6
5	Mentions légales	8
A	GNU Free Documentation License	8

1 Introduction à Kernel Live Patching

Kernel Live Patching (KLP) permet d'appliquer les dernières mises à jour de sécurité aux kernels Linux sans devoir redémarrer. Cela permet d'optimiser le temps de d'activité et la disponibilité du système, ce qui est particulièrement important pour les systèmes critiques. En tant que tel, KLP offre plusieurs avantages.

- La mise à jour automatique d'un grand nombre de serveurs est essentielle pour les organisations qui obtiennent ou souhaitent conserver certaines certifications de conformité. KLP peut contribuer à cette conformité, tout en réduisant les besoins en fenêtres de maintenance.
- Les entreprises qui travaillent avec des contrats de niveau de service doivent garantir un certain niveau d'accessibilité et de disponibilité du système. L'application de correctifs en direct permettent de corriger les systèmes sans temps d'arrêt.
- Comme KLP fait partie du mécanisme de mise à jour standard du système, il n'est pas nécessaire de dispenser une formation spécialisée ou d'introduire des routines de maintenance supplémentaires.

1.1 Champ d'application de Kernel Live Patching

Le champ d'application de SUSE Linux Enterprise Server for SAP applications Live Patching comprend des correctifs pour les vulnérabilités SUSE Common Vulnerability Scoring System (CVSS) de niveau 7+ et des correctifs de bogues liés à la stabilité du système ou à la corruption des données. Cependant, il peut être techniquement impossible de créer des correctifs en direct pour toutes les corrections relevant des catégories spécifiées. SUSE se réserve donc le droit d'ignorer les corrections lorsque la création d'un correctif de kernel Linux en direct n'est pas possible pour des raisons techniques. Actuellement, plus de 95 % des corrections concernées sont publiées en tant que correctifs en direct. SUSE CVSS est basé sur le système CVSS v3.0. Pour plus d'informations sur CVSS, reportez-vous à la page [Common Vulnerability Scoring System SIG \(https://www.first.org/cvss/\)](https://www.first.org/cvss/)  (Groupe d'intérêt dédié au système commun de notation des vulnérabilités).

1.2 Limites associées à Kernel Live Patching

KLP implique le remplacement de fonctions et le traitement gracieux du remplacement d'ensembles de fonctions interdépendants. Ce remplacement est effectué en redirigeant les appels à l'ancien code vers le code mis à jour à un autre emplacement de la mémoire. Les modifications des structures de données compliquent la situation, car les données restent en place et ne peuvent pas être étendues ou réinterprétées. Bien qu'il existe des techniques permettant une modification indirecte des structures de données, certaines corrections ne peuvent pas être transposées en correctifs en direct. Dans ce cas, le redémarrage du système est le seul moyen d'appliquer les corrections.

2 Présentation des correctifs de kernel Linux en direct

Les correctifs de kernel Linux en direct sont installés dans le cadre des mises à jour régulières du système. Les correctifs de kernel Linux en direct sont livrés en tant que paquets avec un code modifié distinct du paquet principal du kernel. Les correctifs en direct sont cumulatifs, de sorte que le dernier correctif contient l'ensemble des corrections des précédents pour le paquet du kernel Linux. Chaque paquet de kernel Linux en direct est lié à la révision exacte du kernel Linux pour lequel il est publié. Le numéro de version du paquet de correctifs en direct augmente au fur et à mesure l'ajout de corrections. Pour déterminer l'état d'application des correctifs du kernel Linux, utilisez la commande `klp -v patches`.

Les correctifs en direct ne contiennent que des corrections critiques et ne remplacent pas les mises à jour régulières du kernel Linux nécessitant un redémarrage. Considérez les correctifs en direct comme des mesures temporaires qui protègent le kernel Linux jusqu'à ce qu'une mise à jour correcte du kernel et un redémarrage soient effectués.

Le diagramme ci-dessous illustre la relation globale entre les correctifs en direct et les mises à jour du kernel Linux. La liste des CVE et des rapports d'anomalies traités par le correctif appliqué en direct peut être consultée à l'aide de la commande `klp -v patches`.

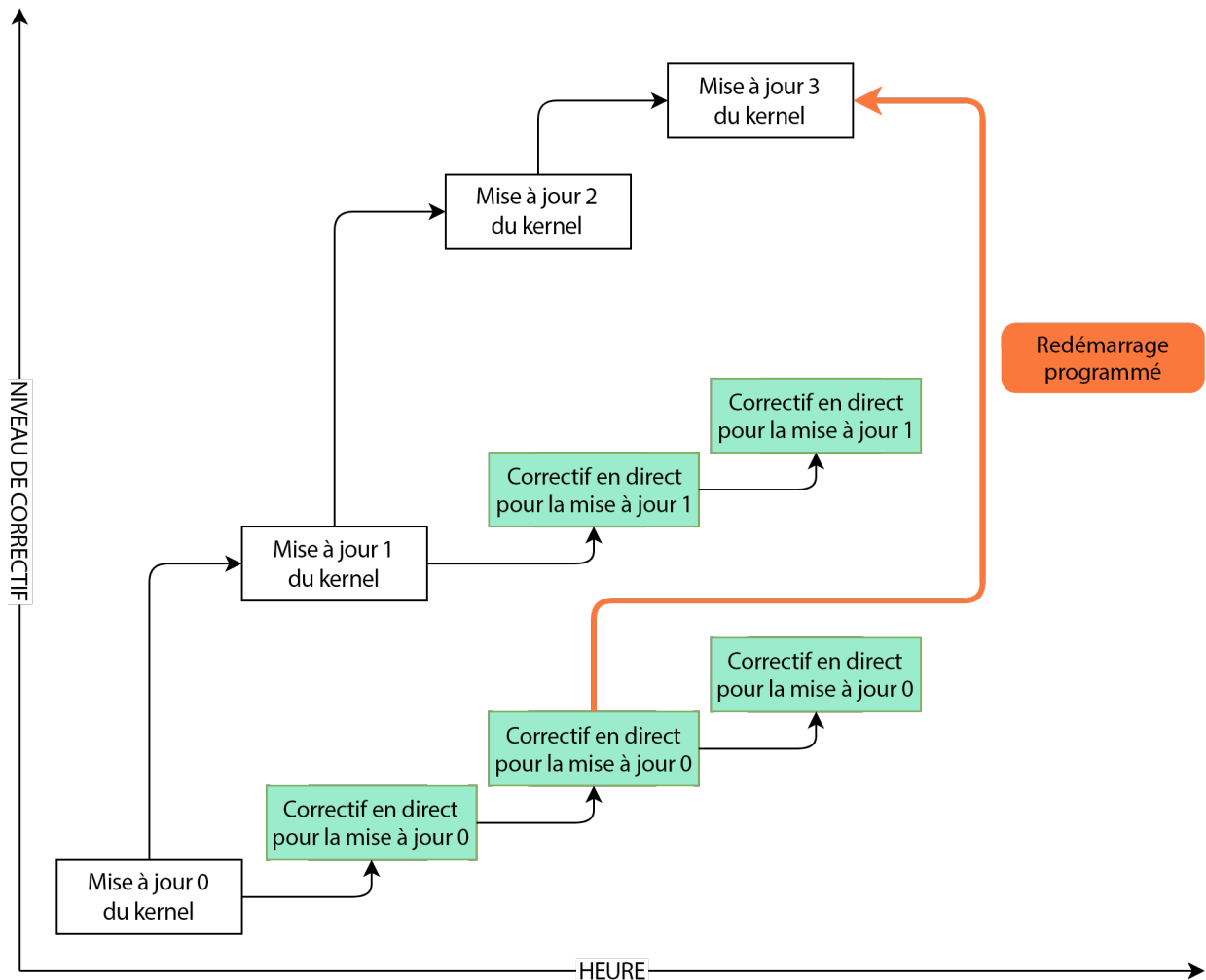


FIGURE 1 : RELATION ENTRE LES CORRECTIFS EN DIRECT ET LES MISES À JOUR DU KERNEL LINUX

Il est possible d'avoir plusieurs versions du paquet de kernel Linux installées avec leurs correctifs en direct. Ces paquets ne sont pas en conflit. Vous pouvez installer des paquets de kernel Linux mis à jour ainsi que des correctifs en direct pour le kernel en cours d'exécution. Dans ce cas, vous pourriez être invité à redémarrer le système. Les utilisateurs abonnés à SUSE Linux Enterprise Server for SAP applications Live Patching sont éligibles au support technique tant qu'il y a des mises à jour de correctifs en direct pour le kernel Linux en cours d'exécution.

Lorsque KLP est activé, chaque mise à jour du kernel Linux est accompagnée d'un paquet de correctifs en direct. Ce correctif en direct ne contient pas de corrections et sert de point de départ pour les futurs correctifs en direct du kernel Linux correspondant. Ces correctifs vides servant de point de départ sont appelés initial patches.

Gardez à l'esprit que même si plusieurs paquets de kernel Linux sont installés sur le système, seul l'un d'entre eux est en cours d'exécution à un moment donné. De même, il peut y avoir plusieurs paquets de correctifs en direct installés, mais un seul est chargé dans le kernel Linux. Le correctif actif en direct est inclus dans le système `initrd`. Cela signifie qu'en cas de redémarrage inopiné, le système se remet en marche avec les correctifs en direct appliqués, de sorte qu'il n'est plus nécessaire de les réappliquer.

3 Activation de Kernel Live Patching à partir de la ligne de commande

Kernel Live Patching est inclus dans l'abonnement standard de SUSE Linux Enterprise Server for SAP applications. Pour l'utiliser, vous devez installer le modèle suivant :

```
# zypper install -t pattern lp_sles
```


À ce stade, un correctif en direct a déjà été appliqué au système.

Voici comment le processus fonctionne en coulisses : lorsque le système d'installation des paquets détecte qu'un kernel Linux installé peut être corrigé en direct et qu'un correctif en direct est disponible pour ce kernel Linux dans le canal logiciel, le système sélectionne le correctif en direct pour l'installation. Le kernel Linux reçoit alors les correctifs en direct dans le *cadre de l'installation du paquet*. Le kernel Linux est corrigé en direct avant même la fin de l'installation du produit.

4 Résolution des problèmes liés à Kernel Live Patching

4.1 Vérification de la date d'expiration du correctif en direct

Assurez-vous que `lifecycle-data-sle-module-live-patching` est installé, puis exécutez la commande `zypper lifecycle`. Vous devriez voir les dates d'expiration des correctifs en direct dans la section `Package end of support if different from product` de la sortie.

Chaque correctif en direct reçoit des mises à jour pendant 13 mois à compter de la publication du paquet du kernel Linux sous-jacent. La page [Maintained kernels, patch updates and lifecycle](https://www.suse.com/products/live-patching/current-patches/) (<https://www.suse.com/products/live-patching/current-patches/>)  (Maintenance des

kernels, mises à jour et cycle de vie des correctifs) vous permet de consulter les dates d'expiration en fonction de la version du kernel Linux en cours d'exécution sans installer l'extension du produit.

4.2 Vérification des paquets de correctifs en direct installés dans le kernel Linux

Le kernel Linux est corrigé en direct si un paquet `kernel-livepatch-*` a été installé pour le kernel en cours d'exécution. Vous pouvez utiliser la commande `zypper se --details kernel-livepatch-*` pour vérifier quels sont les paquets de correctifs en direct du kernel Linux sont installés sur votre système.

4.3 Évitement des redémarrages

Lorsque le paquet `kernel-default` est installé, le gestionnaire de mise à jour vous invite à redémarrer le système. Pour éviter que ce message s'affiche, vous pouvez filtrer les mises à jour du kernel Linux lors de l'application du correctif. Cette opération peut être effectuée en verrouillant des paquets à l'aide de Zypper.

4.4 Vérification de l'état d'application du correctif

Vous pouvez vérifier l'état d'application des correctifs à l'aide de la commande `klp status`. Pour examiner les correctifs installés, exécutez la commande `klp -v patches`.

4.5 Rétrogradation d'un correctif de kernel Linux

Si vous découvrez que le dernier correctif en direct est problématique, vous pouvez restaurer le correctif en direct actuellement installé vers sa version précédente. Gardez à l'esprit qu'un système présentant des avertissements ou des traces d'erreurs de kernel dans le journal système peut ne pas convenir à la procédure de rétrogradation du correctif. Si vous n'êtes pas certain que le système réponde aux exigences d'une rétrogradation de correctif, contactez le support technique de SUSE pour obtenir de l'aide.

Pour rétrograder le dernier correctif de kernel Linux en direct, utilisez la commande `klp downgrade`. Cette commande détecte automatiquement la version du dernier correctif en direct et installe le précédent.

5 Mentions légales

Copyright © 2006–2025 SUSE LLC et contributeurs. Tous droits réservés.

Il est autorisé de copier, distribuer et/ou modifier ce document conformément aux conditions de la licence « GNU Free Documentation License » version 1.2 ou (à votre discrétion) 1.3, avec la section permanente qu'est cette mention de copyright et la licence. Une copie de la version de licence 1.2 est incluse dans la section intitulée « GNU Free Documentation License ».

Pour les marques commerciales SUSE, consultez le site Web <https://www.suse.com/company/legal/>. Toutes les autres marques de fabricants tiers sont la propriété de leur détenteur respectif. Les symboles de marque (®, ™, etc.) désignent des marques de SUSE et de ses sociétés affiliées. Des astérisques (*) désignent des marques commerciales de fabricants tiers.

Toutes les informations de cet ouvrage ont été regroupées avec le plus grand soin. Cela ne garantit cependant pas sa complète exactitude. Ni SUSE LLC, ni les sociétés affiliées, ni les auteurs, ni les traducteurs ne peuvent être tenus responsables des erreurs possibles ou des conséquences qu'elles peuvent entraîner.

A GNU Free Documentation License

Copyright (C) 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 non-commercially. 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 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 non-commercially, 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 <https://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.