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# 6 Stages of Linux Boot Process (Startup Sequence)
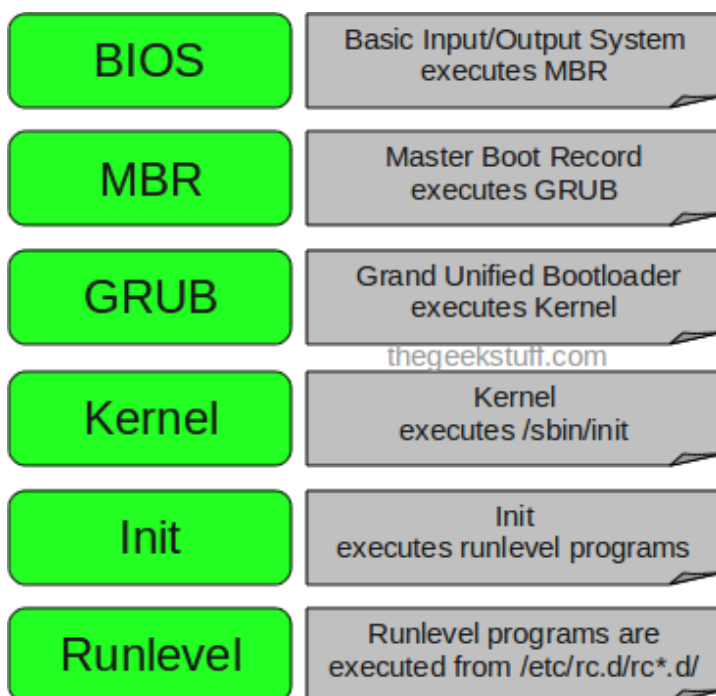
by Ramesh Natarajan on February 7, 2011

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Press the power button on your system, and after few moments you see the Linux login prompt.

Have you ever wondered what happens behind the scenes from the time you press the power button until the Linux login prompt appears?

The following are the 6 high level stages of a typical Linux boot process.



## 1. BIOS

- BIOS stands for Basic Input/Output System

- Performs some system integrity checks
- Searches, loads, and executes the boot loader program.
- It looks for boot loader in floppy, cd-rom, or hard drive. You can press a key (typically F12 of F2, but it depends on your system) during the BIOS startup to change the boot sequence.
- Once the boot loader program is detected and loaded into the memory, BIOS gives the control to it.
- So, in simple terms BIOS loads and executes the MBR boot loader.

## 2. MBR

- MBR stands for Master Boot Record.
- It is located in the 1st sector of the bootable disk. Typically /dev/hda, or /dev/sda
- MBR is less than 512 bytes in size. This has three components 1) primary boot loader info in 1st 446 bytes 2) partition table info in next 64 bytes 3) mbr validation check in last 2 bytes.
- It contains information about GRUB (or LILO in old systems).
- So, in simple terms MBR loads and executes the GRUB boot loader.

## 3. GRUB

- GRUB stands for Grand Unified Bootloader.
- If you have multiple kernel images installed on your system, you can choose which one to be executed.
- GRUB displays a splash screen, waits for few seconds, if you don't enter anything, it loads the default kernel image as specified in the grub configuration file.
- GRUB has the knowledge of the filesystem (the older Linux loader LILO didn't understand filesystem).
- Grub configuration file is /boot/grub/grub.conf (/etc/grub.conf is a link to this). The following is sample grub.conf of CentOS.

```
#boot=/dev/sda
default=0
timeout=5
splashimage=(hd0,0)/boot/grub/splash.xpm.gz
hiddenmenu
title CentOS (2.6.18-194.el5PAE)
          root (hd0,0)
          kernel /boot/vmlinuz-2.6.18-194.el5PAE ro root=LABEL=/
          initrd /boot/initrd-2.6.18-194.el5PAE.img
```

- As you notice from the above info, it contains kernel and initrd image.
- So, in simple terms GRUB just loads and executes Kernel and initrd images.

## 4. Kernel

- Mounts the root file system as specified in the "root=" in grub.conf
- Kernel executes the /sbin/init program
- Since init was the 1st program to be executed by Linux Kernel, it has the process id (PID) of 1. Do a 'ps -ef | grep init' and check the pid.
- initrd stands for Initial RAM Disk.
- initrd is used by kernel as temporary root file system until kernel is booted and the real root file system is mounted. It also contains necessary drivers compiled inside, which helps it to access the hard drive partitions, and other hardware.

## 5. Init

- Looks at the /etc/inittab file to decide the Linux run level.
- Following are the available run levels
    - 0 – halt
    - 1 – Single user mode
    - 2 – Multiuser, without NFS
    - 3 – Full multiuser mode
    - 4 – unused
    - 5 – X11

- 6 – reboot
- Init identifies the default initlevel from /etc/inittab and uses that to load all appropriate program.
- Execute 'grep initdefault /etc/inittab' on your system to identify the default run level
- If you want to get into trouble, you can set the default run level to 0 or 6. Since you know what 0 and 6 means, probably you might not do that.
- Typically you would set the default run level to either 3 or 5.

## 6. Runlevel programs

- When the Linux system is booting up, you might see various services getting started. For example, it might say "starting sendmail …. OK". Those are the runlevel programs, executed from the run level directory as defined by your run level.
- Depending on your default init level setting, the system will execute the programs from one of the following directories.
  - Run level 0 – /etc/rc.d/rc0.d/
  - Run level 1 – /etc/rc.d/rc1.d/
  - Run level 2 – /etc/rc.d/rc2.d/
  - Run level 3 – /etc/rc.d/rc3.d/
  - Run level 4 – /etc/rc.d/rc4.d/
  - Run level 5 – /etc/rc.d/rc5.d/
  - Run level 6 – /etc/rc.d/rc6.d/
- Please note that there are also symbolic links available for these directory under /etc directly. So, /etc/rc0.d is linked to /etc/rc.d/rc0.d.
- Under the /etc/rc.d/rc*.d/ directories, you would see programs that start with S and K.
- Programs starts with S are used during startup. S for startup.
- Programs starts with K are used during shutdown. K for kill.
- There are numbers right next to S and K in the program names. Those are the sequence number in which the programs should be started or killed.
- For example, S12syslog is to start the syslog deamon, which has the sequence number of 12. S80sendmail is to start the sendmail daemon, which has the sequence number of 80. So, syslog program will be started before sendmail.

There you have it. That is what happens during the Linux boot process.

Linux provides several powerful administrative tools and utilities which will help you to manage your systems effectively. If you don't know what these tools are and how to use them, you could be spending lot of time trying to perform even the basic administrative tasks. The focus of this course is to help you understand system administration tools, which will help you to become an effective Linux system administrator.

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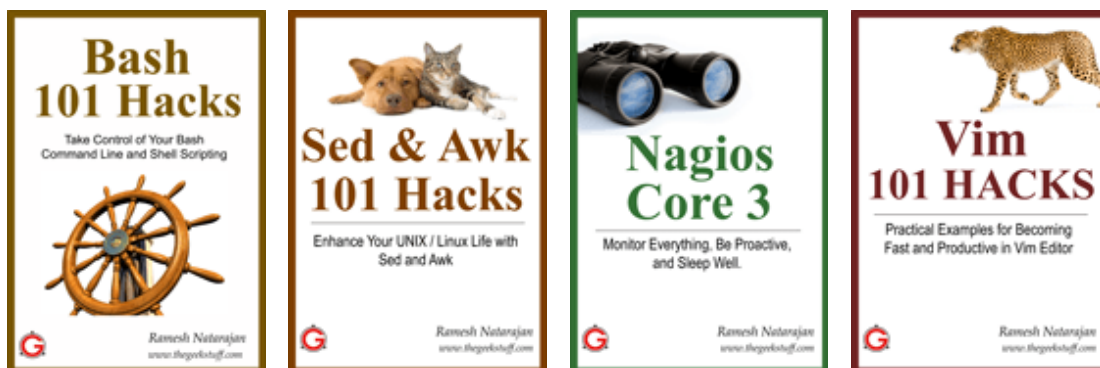
Tags: Debian Boot Process, Fedora Boot Process, Linux Kernel Boot Process, Ubuntu Boot Process, UNIX Boot Process

{ 128 comments… read them below or add one }

1 Pushpraj February 7, 2011 at 1:11 am

Excellent……!!! 2011 seems to be rocking for TGS viewers….

2 BalaC February 7, 2011 at 2:53 am

@Ramesh: This is offtopic discussion. Could you write a article on ack. Thanks

3 shezars February 7, 2011 at 4:02 am

you are rock,,, lol
nice,

[4](#) Adam February 7, 2011 at 4:20 am

Great article 😃
You could also write few words about grub2 – configuration files for grub doesn't work in grub2. (Tested in ubuntu)

[5](#) Edward February 7, 2011 at 4:30 am

very very nice,

tanx

[6](#) Ajeya February 7, 2011 at 4:58 am

Hello Ramesh,

It would have been better if if you could have explained more on each topic. Probably each high level boot process would need a separate page.

This doc is good for begineers.

Thanks,
Ajeya Krishna K R

[7](#) Abhijeet February 7, 2011 at 5:02 am

Good Graphics
Great Tutorial

Keep it up

[8](#) sagar February 7, 2011 at 5:36 am

nice piece of information
thanks lot

[9](#) sandeep February 7, 2011 at 6:38 am

Amazingggggggg good job Guys carry on

[10](#) jameslee February 7, 2011 at 6:56 am

Thank u…

[11](#) Kuldeep February 7, 2011 at 8:09 am

very well explained !!!!!!!!
Thanx alot…..

plz explain GRUB in detail…….How to use GRUB command prompt at system startup ??

[12](#) Kyle February 7, 2011 at 11:02 am

These are very helpful. Keep 'em coming please!

[13](#) Yogesh Upadhyay February 7, 2011 at 1:22 pm

Excellent !!! TGS Rocks…

[14](#) shanil February 7, 2011 at 2:08 pm

thanks alot, just in time to futher clarify things lol..As always, TGS rocks!!!

15 Júlio Hoffimann Mendes February 7, 2011 at 8:15 pm

I learn to much with your blog. Thank you.

Regards,
Júlio.

16 Steeven Paul Y February 7, 2011 at 10:04 pm

I know the terms GRUB, KERNEL,INIT, MBR. But i do not know how they work together. Thanks to Ramesh Natarajan, for his blog and useful posts.

17 Lord February 8, 2011 at 12:42 am

Thank you RAMESH. this was so good…

18 analogtek February 8, 2011 at 1:01 am

The file that most would want is. The menu.list that is in the /boot/grub/ directory on my debian system. I often edit this file for a manual kernel update,time out,boot image change.

19 Suresh.G February 8, 2011 at 2:33 am

Short and Sweet

20 Sameer Ambekar February 8, 2011 at 8:03 am

Really nice document for quick reference to Linux boot process!!!

21 afujita February 8, 2011 at 8:09 pm

Great article, thank you 😃

22 Renjith G February 10, 2011 at 1:45 am

Good one. Thanks.

23 Mohan February 11, 2011 at 10:25 am

plz explain about how to configure zimbra mail server and how to migrate sendmail to zimbra

24 Roberto February 11, 2011 at 6:17 pm

An excelent article, I see another great article here.

25 Hem Chander March 1, 2011 at 2:57 pm

This is very helpful I was looking for similar one..thanks

26 Pablo March 7, 2011 at 10:16 am

Great article Ramesh! But is not completely valid for Ubuntu, which use upstart. Nothing on /etc/inittab, for eg.

27 Sameer June 7, 2011 at 7:07 am

Good doc.
Thanks

28 Verbila June 21, 2011 at 5:44 pm

Love this site, your explanations are excellent, and I like how you define terms and acronyms. Sometimes a

man page can make my head spin – your site is the antidote to that – thanks!!

29 ethaqer July 4, 2011 at 8:50 pm

the best explanation ever …

thanks TGS

30 robin July 7, 2011 at 1:30 am

How many times did i ask myself how to find out order of linuxs' start ?
when this time i saw your blog via TSG, i see thoroughly.

thanks a million

Best Regards
Robin Guo

31 Senthilkumar July 29, 2011 at 12:38 am

Awesome !! For beginners helped a lot..

32 D VIjay August 11, 2011 at 5:48 am

Excellent, in detail and simple. Thanks very much

33 karthick September 4, 2011 at 2:14 am

Actaully i have failed in my first interview for not answering the above question,but after reading the above
answer.i ensure i will get success.its really gud explanation,especially beginners lyk me.Thanks a lot

34 dulanja September 19, 2011 at 1:11 am

great article! very useful! thanks a lot.

35 R.YADAV September 30, 2011 at 2:52 am

really…….my total confuse remove after read this article.Thank you………….

36 Gregory October 7, 2011 at 2:35 am

Are you sure that "Depending on your default init level setting, the system will execute the programs from
one of the following directories." ?
For example my system is running on level 3 but executes VERITAS init scripts from rc2.d during the boot
as well.

37 Arun October 15, 2011 at 8:13 am

Very Nice.

38 rajesh October 20, 2011 at 10:02 pm

Excellent !!!!!!!!!!!!!!!!!!!!!!
Enough detail and simple .
Thanks very much

Best regard,
rajesh

39 ender October 21, 2011 at 1:20 am

good work fine to know how linux boot and the basic's of the init run level's only by ubuntu you have init s

(single user) and init u (re run init) as extra

[40](#) evaa November 12, 2011 at 9:12 pm

wow, your explaination is simple yet full with information
very helpful ! <3

[41](#) brijesh November 19, 2011 at 2:49 pm

greate usefull

[42](#) Ketan November 30, 2011 at 1:34 pm

I am flabbergasted.. I have made automation on these parts on S and K .,.. It was too Easy to understand this.. The person who post this.. is really a cool techie.. U rock man..

[43](#) [hossein](#) January 2, 2012 at 12:06 am

That was very useful information.
Thanks.

[44](#) NARESH January 17, 2012 at 9:45 pm

Excellent. keep it up..

[45](#) Arun January 24, 2012 at 9:52 pm

Nice. Very useful

[46](#) Omkar January 27, 2012 at 9:32 am

short and sweet and precise explanation

[47](#) Anonymous February 3, 2012 at 3:53 am

very good material and easy to understand …great work

[48](#) 54nju1 February 19, 2012 at 1:59 pm

Thanks dude, that was so helpful..

[49](#) subhash March 13, 2012 at 8:27 am

it's very nice material…..i like it……..superb ………

[50](#) sandeep samale March 21, 2012 at 9:37 pm

HI this is very very useful information as interview point of view as well as for study how Linux boots. Great info Thank you very much Ramesh

[51](#) Anuj April 12, 2012 at 9:28 am

Great and brief doc for Linux boot process. I truly liked it!!!

[52](#) Ravi May 4, 2012 at 11:05 pm

Thanx

[53](#) Deepika May 9, 2012 at 11:03 pm

Superb article with detailed information.

54 Deepak May 14, 2012 at 11:11 am

> It is very nice article 😃

55 divya May 21, 2012 at 5:19 am

> how to create kickstart server in rhel 6.0

56 sasidharan May 25, 2012 at 4:54 am

> Excellent stuff from TGS!!!

57 Anand June 3, 2012 at 1:41 pm

> gr8 article , got a lot of other info while reading this awesome stuff, thx alot

58 Sumen June 22, 2012 at 5:09 am

> Great…very well explained…

59 VIKAS June 26, 2012 at 5:15 am

> Very nice, very neatly explained.

60 Saravana Kumar July 12, 2012 at 2:18 am

> Keep on the work going

61 Kuldeep Kulkarni July 14, 2012 at 1:58 pm

> Nice Stuff !!
>
> Thanks a lot !!

62 Rakesh yadav jaipur July 19, 2012 at 10:20 pm

> really…….my total confuse remove after read this article.Thank you………….

63 Sudhakar July 26, 2012 at 1:14 am

> Good One, will be helpfull for new leaners!!!

64 rajendra July 31, 2012 at 8:22 am

> excellent

65 Naveen August 8, 2012 at 12:17 am

> Its very Good article and helpful for linux beginers

66 Ranjit Rajput September 10, 2012 at 12:57 am

> Excellent …

67 Hughe September 10, 2012 at 5:21 am

> You can bypass the first three stage using kexec program for fast boot. This saves time when you have to reboot a lot for tuning system or handling init script.
>
> Debian provides it as kexec-tools package.
>
> Find the kernel options:

```
$ cat /proc/cmdline
BOOT_IMAGE=/vmlinuz-3.4.0-10.dmz.1-liquorix-amd64 root=UUID=07cf8c3a-d5a5-4b41-833f-
16a9afebf70c ro quiet
```

Add a kernel image:
vmlinuz is the kernel image file I uses. If the kernel image uses initrd file, add –initrd option. Without it kernel will panic next boot.

```
$ sudo kexec -l /vmlinuz –append="root=UUID=07cf8c3a-d5a5-4b41-833f-16a9afebf70c
ro quiet" –initrd=/initrd.img
```

Or

In my Linux box, boot partition is /dev/sda1
```
$ sudo kexec -l /vmlinux –append="root=/dev/sda1 ro quiet" –initrd=/initrd.img
```

Start warm boot:
```
$ sudo kexec -e
```

Linux will boot up without going through BIOS, MBR, and Grub.

[68](#) manoj sharma September 18, 2012 at 9:14 am

   thanks

[69](#) Guru Reddy September 24, 2012 at 8:04 am

   Excellent.., and thank you a lot..,

[70](#) karunakar September 27, 2012 at 2:22 pm

   Excellent and simple explanation and a great deal for beginners !! Thank you.

[71](#) Rajeev September 28, 2012 at 3:23 am

   very nice

[72](#) Mithun Shrivastav October 11, 2012 at 3:01 am

   Hi its excellent. Thanks.

[73](#) Amaresh Samal November 13, 2012 at 12:34 pm

   thanks friend…….

[74](#) krish November 14, 2012 at 2:11 pm

   what is 1st stage boot loader and what is 2nd stage boot loader ? kindly clear this point also.

[75](#) Rajgopal H.G. November 19, 2012 at 12:58 am

   I am working on Linux since decade. Some times I am unable explain the basic stuff like this. Thanks for explaining Ramesh Natarajan. Today onwards, I am the member of your fan club.

[76](#) saurabh December 5, 2012 at 2:41 am

   Thanks for this excellent article………… 😃

[77](#) Purna December 18, 2012 at 3:26 pm

   Hello,

Description is good and very easy to understand, thanks for this.
If possible please explain in detail about each and every config file or script, how is jumping from on script/config-file to another

Anyways I am happy for this post.
Thank you once more….

78 Rajshekhar December 28, 2012 at 11:49 am

Excellent material. So simple to understand it. Doing a great job!!!!!

79 niky December 28, 2012 at 1:08 pm

The Article is good And explained Simple …
tnx 4 this

80 C subhash January 1, 2013 at 6:36 am

Thanks for this excellent article……

81 Amit Bhandari January 18, 2013 at 12:31 am

its a superb article……….and simple and superb explanation.

82 Rajaswaminathan January 24, 2013 at 8:33 am

This is really nice article. Appreciate your excellent work.

83 karthi prasanth February 16, 2013 at 7:12 am

sir now i am using windows7 and linux in one computer.i dont want to use linux that have 250gb harddisk then how to boot(delete) a linux and how to plaace 250gb in windows7? Pls hlp me.

84 Aswathy February 25, 2013 at 11:33 am

Thanks Mr.Linux natarajan

85 lakshman March 1, 2013 at 4:59 am

it was simply good.

86 prathamesh March 1, 2013 at 11:43 am

thanks dude

87 chrly chacko March 1, 2013 at 11:15 pm

good keep itup

88 Kapil March 20, 2013 at 3:46 am

Very Good Explanation.

Thank you very much .

89 Lily April 4, 2013 at 12:36 pm

Hey,you explained all,excellent.Thanks

90 Ranjith April 6, 2013 at 1:34 am

Thanks Friend

[91](#) shipra April 13, 2013 at 11:51 pm

thnkss ..very useful fo me..;) 😊

[92](#) Magesh April 16, 2013 at 5:29 am

Great Man…..

[93](#) laks April 19, 2013 at 3:13 am

its really useful.

[94](#) googler April 22, 2013 at 2:25 pm

Oh yes .. this is what i am seeking for .. something simple and effective ..
i don't know why most people who talk about boot process and FHS love to make it
very difficult…
but you my friend .. u r brilliant .. this really easy and useful explanation ..
thanks as enormous as the sky

[95](#) shruti April 27, 2013 at 1:18 am

good explanation & easy to understand!!!

[96](#) Anonymous May 4, 2013 at 12:36 pm

excellent, very well explained

[97](#) sudhakar May 21, 2013 at 11:24 pm

Good article ….

[98](#) sreejith ks May 26, 2013 at 6:01 pm

awesome man, what a simply way to explain such a difficult process.,, thanks a lot,,keep going,,

[99](#) Mitesh May 30, 2013 at 3:22 am

Really Nice Article…. learn much from this…
Thanks

[100](#) Ashokraj R May 30, 2013 at 5:45 am

Thank you

[101](#) Akshay June 23, 2013 at 12:05 pm

Perfect article on Great topic.

[102](#) Shams July 20, 2013 at 1:19 pm

Ramesh,

Thanks a ton for your efforts to provide such a excellent information by keeping it simple.

You rock man …… Keep it up…

[103](#) karthik July 25, 2013 at 1:32 am

nice job.any one can understand this . good explantion

[104](#) Suraj August 2, 2013 at 1:12 am

Superb Article !!! Excellent explanation.

Keep it on.

105 Kaali Dasu August 9, 2013 at 1:50 am

I got confused by studying the process in another sites however this one is very easy to understand and remember.

106 hariharasudhans August 28, 2013 at 10:01 am

i have littile bit confusion in bootprocessor .nw i clrd & esay to understand…
good article of boot processor

107 Arun September 6, 2013 at 12:26 am

Thank you for simple, compact and clear explanation . . . 😃

108 Pradeep September 14, 2013 at 7:47 am

Good,Easy to understand and very useful for starters……..:)

109 yang September 23, 2013 at 7:33 pm

good! the article is easy to understand,

110 Ramesh October 22, 2013 at 10:42 am

very nice , thanks

111 Akshay Kalra October 24, 2013 at 11:37 pm

Thanks for such a nice explanation…..
This article has cleared my all doubts.

112 montana November 13, 2013 at 12:01 am

Simple and Powerful.
Thanks.

113 Mehbub November 19, 2013 at 5:16 am

Thanx a lot for ur great explanations buddy……………………..suprm performance
nw i hv nt any confusn

114 Pradeep December 13, 2013 at 5:14 am

Good work, Thanks

115 mohammed tousif December 13, 2013 at 7:40 am

excellent

116 Ravi singh December 14, 2013 at 2:17 pm

Thanks bro … It is realy excellent and easy to understand

117 nisha December 27, 2013 at 11:34 pm

Thanks for sharing …good article to understand linux boot up process…………………

118 Narender January 14, 2014 at 11:43 pm

that is why lappy takes so much time for startup, actually this guy is busy in doing this or that, offcourse useful.

119 Srikanth January 30, 2014 at 4:49 am

Thanks a lot. very nice….

120 viji February 3, 2014 at 4:32 am

Thanks much

121 Satheesh Kumar G February 17, 2014 at 12:17 am

Hi Ramesh,

This is the best explanation i've seen so far.

ThnQ very much,…

122 Choperro February 28, 2014 at 12:11 am

The role of initrd is not clear at all.
What does it contain?
Where does it come from?
When and how is it used?

Also the possibilities and methods to configure each step and its pieces are not
clear at all. We can change boot device (interactively or not), we can change the kernel (interactively or not), we can change the boot menu and give orders to grub….. can we change initrd? how? what for? and the init proces? inittab seems to be deprecated in Debian…..

123 Choperro February 28, 2014 at 1:43 am

"Programs starts with S are used during startup. S for startup.
Programs starts with K are used during shutdown. K for kill."

or

The S set are the programs that are started when we enter in that runlevel and K is the set of programs that are killed when we enter in that runlevel?

124 Harshit Shrivastava March 12, 2014 at 3:56 am

Awesome Tutorial. Linux Boot Process Cleared Very Well.

125 Gurpreet Singh March 14, 2014 at 6:15 am

Excellent Tutorial

126 Spatik March 26, 2014 at 10:18 pm

Nice and well explained, thank you so much.

127 Syam April 11, 2014 at 12:16 am

good one 😃 great

128 Damodhar Taklakar April 18, 2014 at 6:34 am

Very well explained….! 😃

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Ramesh Natarajan

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