SUSE

Mastering System Logs: From `systemd-journald` to `journalctl`

`systemd-journald` in SUSE Linux Enterprise Server for NVIDIA is a system service responsible for collecting, indexing and storing log data across kernel and application sources. By centralizing binary event logging and enabling structured querying through **`journalctl`**, administrators can efficiently filter logs, inspect system events and troubleshoot service failures without parsing disjointed plain-text files.

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1 The `systemd-journald` service

`journald` is a `systemd` service responsible for collecting, indexing, and storing log data. The collected events include kernel messages, initrd (initial RAM disk) messages, service startup/shutdown, application events, and authentication and session data.

On SUSE Linux Enterprise Server for NVIDIA, the `systemd-journald` service is enabled and started by default. The service logs the data into the journal described in *Section 2, "About the journal"*.

1.1 Configuring `systemd-journald`

You can configure the basic behavior of **`systemd-journald`** service by modifying `/etc/systemd/journald.conf`.

To configure **`systemd-journald`**, proceed as follows:

PROCEDURE 1: CONFIGURING `systemd-journald`

1. Open the **`systemd-journald`** configuration file:

```
> sudo  vi /etc/systemd/journald.conf
```

```
[Journal]

# Store journals on disk so logs survive reboot
Storage=persistent

# Disk space limits
SystemMaxUse=2G
SystemKeepFree=10%

# Per-file max size
SystemMaxFileSize=200M

# RAM (runtime) journal limits
RuntimeMaxUse=500M
RuntimeKeepFree=10%

# Log retention
MaxRetentionSec=4weeks

# Compression for old logs
```

```
Compress=yes

# Optional: also forward to rsyslog/syslog
ForwardToSyslog=yes
```

2. Modify the configurations:

   - To modify the storage type, modify **`Storage=auto`**.
     The available options are:

     - *volatile*: RAM only (clears on reboot).
     - *persistent*: stored in `/var/log/journal`.
     - *auto*: persistent if directory exists, otherwise volatile.
     - *none*: no logs written to disk or memory.

     If the journal log data is saved to a persistent location, it uses up to 10% of the file system the `/var/log/journal` resides on. For example, if `/var/log/journal` is located on a 30 GB /var partition, the journal may use up to 3 GB of the disk space. To change this limit, change (and uncomment) the **`SystemMaxUse`** option:

     ```
     SystemMaxUse=50M
     > sudo  systemctl restart systemd-journald
     ```

   - To limit the log rate to prevent flooding logs:

     ```
     RateLimitIntervalSec=30s
     RateLimitBurst=1000
     ```

   - To send the journal to a terminal device to inform you about system messages on a preferred terminal screen, for example `/dev/tty12`:

     ```
     ForwardToConsole=yes
     TTYPath=/dev/tty12
     ```

   - To forward logs to syslog, modify **`ForwardToSyslog=yes`**. `journald` is backward compatible with traditional syslog implementations such as rsyslog.

- Install rsyslog:

```
rpm -q rsyslog
```

- Enable rsyslog:

```
systemctl is-enabled rsyslog
```

- Enable forwarding to rsyslog in `/etc/systemd/journald.conf`:

```
ForwardToSyslog=yes
```

For more information on file descriptions, see **`man 5 journald.conf`**.

3. Save and restart **`systemd-journald`**.

```
> sudo  systemctl restart systemd-journald
```

2 About the journal

The journal is a centralized, unified storage system for log data from all sources. It stores events in a structured manner, which helps with error identification and crash recovery.

2.1 Where can I find the journal?

By default, `journald` stores the collected data in the volatile memory in `/run/log/journal`, so after reboot the data is lost.

If `systemd-journald` is configured to store the logs in a persistent manner, you can find the journal in `/var/log/journal`. See if the directory is there:

1. Check if the directory exist:

```
> sudo ls /var/log
...
journal
...
```

2. If the `/var/log/journal` directory does not exist, create it:

```
> sudo mkdir /var/log/journal
```

3. Set the correct ownership and access permissions:

```
> sudo   systemd-tmpfiles --create --prefix=/var/log/journal
```

4. *(Optional)* To flush the data from RAM to the directory:

```
> sudo   journalctl --flush
```

For details about the service configuration, refer to *Section 1.1, "Configuring* **systemd-journald***"*.

2.2 The journal log structure

The logs are stored in binary format across several files. To view the structure of a log entry, proceed as follows:

```
> sudo  journalctl -n 1 -o verbose

    Fri 2025-12-05 10:52:53.284321 CET [s=5b7ae2e926794210bf832d014f5f560a;i=d49752>
    _UID=1000
    _AUDIT_SESSION=3
    _AUDIT_LOGINUID=1000
    _SYSTEMD_OWNER_UID=1000
    _SYSTEMD_UNIT=user@1000.service
    _SYSTEMD_SLICE=user-1000.slice
    _MACHINE_ID=d3489468c8534c5d81a2860cf9a2a20e
    _RUNTIME_SCOPE=system
    _SELINUX_CONTEXT=unconfined
    PRIORITY=6
    _TRANSPORT=syslog
    _BOOT_ID=d095069bd59b4bc4bf67c8c71999243b
   SYSLOG_IDENTIFIER=sudo
    SYSLOG_TIMESTAMP=Dec  5 10:52:53
    _PID=25806
    _COMM=sudo
    _EXE=/usr/bin/sudo
    _CMDLINE=sudo journalctl -n 1 -o verbose

    ...
```

The log entry is a data structure containing the log message and metadata fields:

Timestamp

The exact time the event occurred

Source fields

- `_PID`: process ID of the sender
- `_UID/_GID`: User/Group ID of the sender
- `_EXE`: path to the executable
- `_COMM`: name of the executable

System fields

- `_SYSTEMD_UNIT`: The systemd unit (service) that generated the log (for example, `sshd.service`)
- `_BOOT_ID`: A unique identifier for the specific system boot session

Kernel fields

`_TRANSPORT`: How the message was logged (e.g., kernel, syslog, stdout)

Priority level

A numeric value indicating the severity of the message (0=emerg, 7=debug)

3 The **`journalctl`** command

`journalctl` is a command-line utility used to query and display logs collected by the **`systemd-journald`**.

Because the logging system stores data in a binary format (for performance and security) rather than plain text, you cannot use standard tools like **`cat`** or **`less`** to open the files directly. So, the **`journalctl`** command decodes the data and displays it according to the provided parameters.

3.1 Using **`journalctl`**

This section describes the generic usage of the **`journalctl`** command.

Running **`journalctl`** without any options displays all logged messages, usually starting from the oldest, and pipes the output through a pager (like **`less`**) for easy navigation.

The general syntax of the **`journalctl`** command is as follows:

```
> sudo journalctl [OPTIONS...] [MATCHES...]
```



Tip: Messages related to a specific executable

To show all journal messages related to a specific executable, specify the full path to the executable:

```
> sudo journalctl /usr/lib/systemd/systemd
```

Listed below are the common useful options to enhance the default **`journalctl`** behavior:

-f

Shows only the most recent journal messages, and prints new log entries as they are added to the journal.

-e

Prints the messages and jumps to the end of the journal, so that the latest entries are visible within the pager.

-r

Prints the messages of the journal in reverse order, so that the latest entries are listed first.

-k

Shows only kernel messages from the current boot. This is equivalent to `-b` with the field match `_TRANSPORT=kernel`.

-u

Shows only messages for the specified `systemd` unit. Besides messages with `_SYSTEMD_UNIT=`*`UNIT`*, the output includes what `systemd` logs about the unit, such as start and stop messages and core dump reports.

```
> sudo journalctl -u apache2
```

For a complete list of options refer to man page, man 1 **`journalctl`**.

4 Filtering the journal output

This section describes how to refine searches in logs, for example, by boot number, by a specific time interval, or to view specific data fields. By default, the journal lists the oldest entries first. The output can be filtered using specific switches and fields.

You can filter journals based on boot number, time interval, and fields. For details, refer to the following sections.

4.1 Filter logs based on a specific system boot

To list logs for all the available boots, run the command as follows:

```
> sudo journalctl --list-boots
```

The first column lists the boot offset: `0` for the current boot, `-1` for the previous one, `-2` for the one before that, etc. The second column contains the boot ID followed by the limiting time stamps of the specific boot.

To show all messages from the current boot:

```
> sudo journalctl -b
```

To view journal messages from the previous boot, add an offset parameter. The following example command shows the previous boot messages:

```
> sudo journalctl -b -1
```

To view boot messages based on the boot ID, `156019a44a774a0bb0148a92df4af81b`:

```
> sudo journalctl _BOOT_ID=156019a44a774a0bb0148a92df4af81b
```

4.2 Filtering logs based on time interval

You can filter the output of **`journalctl`** by specifying the starting and/or ending date. The date specification should be of the format `YYYY-MM-DD H:MM:SS`. If the time part is omitted, midnight is assumed. If seconds are omitted, `:00` is assumed. If the date part is omitted, the current day is assumed. Instead of a numeric expression, you can specify the keywords `yesterday`, `today` or `tomorrow`. They refer to midnight of the day before the current day, of the current day, or of the day after the current day. If you specify `now`, it refers to the current time. You can also specify relative times prefixed with `-` or `+`, referring to times before or after the current time.

To view only new messages since now, and update the output continuously:

```
> sudo journalctl --since "now" -f
```

To view all messages since last midnight until `3:20am`:

```
> sudo journalctl --since "today" --until "3:20"
```

4.3 Filtering logs based on fields

You can filter the output of the journal by specific fields. The syntax of a field to be matched is `FIELD_NAME=MATCHED_VALUE`, such as `_SYSTEMD_UNIT=httpd.service`. You can specify multiple matches in a single query to filter the output messages even more. See **`man 7 systemd.journal-fields`** for a list of default fields.

To view messages produced by a specific process ID: `PID_1039`:

```
> sudo journalctl _PID=1039
```

To view messages belonging to a specific user ID: `UID_1000`:

```
> sudo  journalctl _UID=1000
```

To view messages from the kernel ring buffer (the same as **`dmesg`** displays):

```
> sudo journalctl _TRANSPORT=kernel
```

To view messages from the service's standard or error output:

```
> sudo journalctl _TRANSPORT=stdout
```

To view messages produced by a specified service only:

```
> sudo journalctl _SYSTEMD_UNIT=avahi-daemon.service
```

If two different fields are specified, only entries that match both expressions at the same time are shown:

```
> sudo journalctl _SYSTEMD_UNIT=avahi-daemon.service _PID=1488
```

If two matches refer to the same field, all entries matching either expression are shown:

```
> sudo journalctl _SYSTEMD_UNIT=avahi-daemon.service _SYSTEMD_UNIT=dbus.service
```

You can use the `+` separator to combine two expressions in a logical `OR`. The following example shows all messages from the Avahi service process with the process ID 1480 together with all messages from the D-Bus service:

```
> sudo journalctl _SYSTEMD_UNIT=avahi-daemon.service _PID=1480 +
 _SYSTEMD_UNIT=dbus.service
```

5 Troubleshooting `systemd` errors

This section introduces ways to interpret and fix the log messages retrieved through **`journalctl`**.

5.1 View `systemd` errors

1. View the list of failed `systemd` units:

   ```
   systemctl --failed
   ```

   The list of all failed services appears.

2. Identify the severity and content of the error.

   ```
   journalctl -p 0..7 -b
   ```

   The list of errors with priority levels `0 to 7` appears. The errors are marked with priority level:

   - *0-2*: **`emerg, alert, crit`**: Critical issues, system collapse imminent.
   - *3*: **`err (Error)`**: A service or application failed to complete a requested operation.
   - *4*: **`warning`** : Something undesirable happened but is not an immediate failure.
   - *5-7*: **`notice, info, debug`**: Normal operational information and developer diagnostics.

3. View the error log for the failing service using the following command:

   ```
   journalctl -u <failing_service_name>
   ```

   The lines preceding the termination message include information about the error.

- *Exit Status*: If a service stops, look for a message like `Process xxx exited` with status 1/FAILURE. A status of 0 indicates success. Any nonzero status indicates an error.
- *Configuration Errors*: Messages containing phrases like `No such file or directory`, `Permission denied` or `Address already in use` usually point to a problem in the service's configuration file.
- *Out-of-Memory (OOM)*: The service was terminated because it exceeded memory limits.

4. Use detailed views of logs to get detailed information about the error.

```
journalctl -xe
```

For example, to view all messages from the Apache service during the current boot with detailed explanations, run the following command:

```
journalctl -u httpd.service -b -xe
```

5.2 Troubleshoot `systemd` error

This section introduces an example to illustrate how to find and fix the error reported by `systemd` during **`apache2`** start-up.

1. Start the apache2 service:

```
systemctl start apache2
Job for apache2.service failed. See 'systemctl status apache2' and 'journalctl -xn'
 for details.
```

2. View the service status:

```
> sudo systemctl status apache2
apache2.service - The Apache Webserver
   Loaded: loaded (/usr/lib/systemd/system/apache2.service; disabled)
   Active: failed (Result: exit-code) since Tue 2025-09-03 11:08:13 EDT; 7min ago
  Process: 11026 ExecStop=/usr/sbin/start_apache2 -D SYSTEMD -DFOREGROUND \
           -k graceful-stop (code=exited, status=1/FAILURE)
```

The ID of the process causing the failure is 11026.

3. View the verbose version of messages related to process ID 11026:

```
> sudo journalctl -o verbose _PID=11026
```

```
[...]
MESSAGE=AH00526: Syntax error on line 6 of /etc/apache2/default-server.conf:
[...]
MESSAGE=Invalid command 'DocumenttRoot', perhaps misspelled or defined by a module
[...]
```

4. Fix the typo inside `/etc/apache2/default-server.conf`, start the apache2 service, and print its status:

```
> sudo systemctl start apache2 && systemctl status apache2
apache2.service - The Apache Webserver
   Loaded: loaded (/usr/lib/systemd/system/apache2.service; disabled)
   Active: active (running) since Tue 2025-09-03 11:26:24 EDT; 4ms ago
  Process: 11026 ExecStop=/usr/sbin/start_apache2 -D SYSTEMD -DFOREGROUND
           -k graceful-stop (code=exited, status=1/FAILURE)
 Main PID: 11263 (httpd2-prefork)
   Status: "Processing requests..."
   CGroup: /system.slice/apache2.service
           ├─11263 /usr/sbin/httpd2-prefork -f /etc/apache2/httpd.conf -D [...]
           ├─11280 /usr/sbin/httpd2-prefork -f /etc/apache2/httpd.conf -D [...]
           ├─11281 /usr/sbin/httpd2-prefork -f /etc/apache2/httpd.conf -D [...]
           ├─11282 /usr/sbin/httpd2-prefork -f /etc/apache2/httpd.conf -D [...]
           ├─11283 /usr/sbin/httpd2-prefork -f /etc/apache2/httpd.conf -D [...]
           └─11285 /usr/sbin/httpd2-prefork -f /etc/apache2/httpd.conf -D [...]
```

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