Let's make better* scripts

* Improved readability, increased fault-tolerance, and more security

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CISOFY
AUDITING-HARDENING-COMPLIANCE

Before we begin...

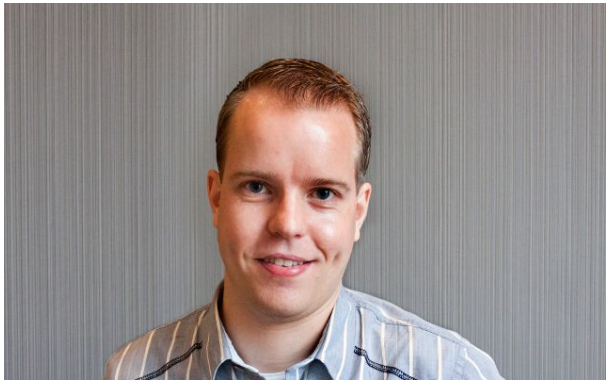
Topics (blue pill)

- Why Shell Scripting?
- Challenges
- Reliability
- Style
- Tools
- Tips and Tricks

Topics (red pill)

- When shell (and why not)
- Common mistakes
- More reliable scripts
- and readable...
- Tools for the lazy
- ~~Tips and tricks~~ (no time for that, homework)

Michael Boelen



- **Open Source since 2003**
  - Lynis, Rootkit Hunter
- **Business**
  - Founder of CISOfy
- **Other**
  - Blogger at linux-audit.com
  - Content creator at linuxsecurity.expert

Let’s do this together

Assumptions

You do Dev || Ops

Linux, BSD, macOS, 

Created a script before

Questions

During, at the end, and after the talk

Input welcome

Alternatives, feedback

Share

@mboelen @nluug #nluug

Lynis

- Security: system auditing tool
- 2007
- GPLv3
- 25000+ lines of code
- POSIX
- #!/bin/sh

My goals for today

1. Share my knowledge
2. Learn from yours
3. Improve your project (or mine)

Why Shell Scripting?

Why?

- Powerful
- Quick
- Low on dependencies

What?

Shell scripts = glue

Potential

Small scripts can grow...

… and become an open source project!

Why not?


PANEL NO.1

Challenges and Common Mistakes

Challenge 1: #!/bin/?

Shell	Pros	Cons
sh	Portable	Not all features available
bash	Features	Not default on non-Linux
ash/dash	Portable and fast	Some features missing
ksh	Features and fast	Not default on Linux
zsh	Features	Not default

Challenge 1: #!/bin/?

Portable	sh
Your company only	bash
For yourself	pick something

Tip: use #!/usr/bin/env bash

Challenge 2: Readability

```
1 #!/bin/sh
2 var_with_value="red"
3 : ${var_with_value:="blue"}
4 echo "${var_with_value}"
```

Red or Blue?

Challenge 2: Readability

: ${var_with_value:="blue"}

Assign a value when being empty or unset

Challenge 3: The Unexpected

```
#!/bin/sh
filename="test me.txt"
if [ $filename = "test me.txt" ]; then
    echo "Filename is correct"
fi
```

3: [: test: unexpected operator

You VS Script

Find the flaw (1)

```
1 #!/bin/sh
2 chroot=$1
3 rm -rf $chroot/usr/lib/ssl
```

Find the flaw (1)

```
1 #!/bin/sh
2 chroot=$1
3 rm -rf $chroot/usr/lib/ssl
```

You VS Script

1 - 0

Find the flaw (2)

cat /etc/passwd | grep michael

Goal: retrieve details for user ‘michael’

Find the flaw (2)

cat /etc/passwd | grep michael

Better:

~~grep michael /etc/passwd~~

grep "^michael:" /etc/passwd

awk -F: '{if($1=="michael") print}' /etc/passwd

getent passwd michael

You VS Script

2 - 0

Find the flaw (2)

```
1 if  [-d $i]
2 then
3     echo "$i is a directory! Yay!"
4 else
5     echo "$i is not a directory!"
6 fi
```

Find the flaw (2)

```
if  [ -d $i ]
    then
        echo "$i is a directory!"
    else
        echo "$i is not a directory!"
fi
```

You VS Script

3 - 0

Style

Why style matters

- Craftsmanship
- Code reviews
- Bugs

Example

Option 1

```
if [ "${var}" = "text" ]; then
    echo "found text"
fi
```

Option 2

```
[ "${var}" = "text" ] && echo "found text"
```

Example: be concise?

Option 1

```
command
if [ $? -ne 0 ]; then
    echo "command failed"; exit 1
fi
```

Option 2

```
command || { echo "command failed"; exit 1; }
```

Option 3

```
if ! command; then echo "command failed"; exit 1; fi
```

var or VAR?

var

Few variables

Few times used

VAR

Many variables

Used a lot in script

Commands

Use full options

--quiet instead of -q

--verbose instead -v

etc

Style guide

Shell Style Guide

Revision 1.26

Paul Armstrong
Too many more to mention

Each style point has a summary for which additional information is available by toggling the accompanying arrow button that looks this way: ▶ . You may toggle all summaries with the big arrow button:

▶ Toggle all summaries

Table of Contents

Focus on reliability

Reliability

- Quality
- Do(n’t) make assumptions
- Expect the unexpected
- Consider worst case scenario
- Practice *defensive programming*

Defensive programming

Wikipedia:

“is a form of defensive design intended to ensure the continuing function of a piece of software under unforeseen circumstances.”

“practices are often used where high availability, safety or security is needed.”

Defenses

Intended operating system?

```
1 #!/bin/sh
2 if [ ! "$(uname)" = "Linux" ]; then
3     echo "This is not a Linux system and unsupported"
4     exit 1
5 fi
```

Defenses

```
1 #!/bin/sh
2 if ! $(awk -F= '{if($1 == "NAME" \
3       && $2 ~ /^"CentOS|Ubuntu"$/){rc = 1}; \
4       {exit !rc}}' /etc/os-release 2> /dev/null)
5 then
6     echo "Not CentOS or Ubuntu"
7     exit 1
8 fi
```

Defenses

set -o nounset

(set -u)

Stop at empty variable

Useful for all scripts

Defenses

set -o errexit

(set -e)

Exit upon $? -gt 0

Useful for scripts with dependant tasks

Use **command || true** to allow exception

Defenses

set -o pipefail

Useful for scripts with pipes: mysqldump | gzip

(Not POSIX…)

Defenses

set -o noglob

(set -f)

Disable globbing (e.g. *)

Useful for scripts which deals with unknown files

Defenses

set -o noclobber

(set -C)

Don’t truncate files, unless >| is used

Defenses

```
1 #!/bin/sh
2 set -o noclobber
3 MYLOG="myscript.log"
4 echo "$(date --rfc-3339=seconds) Start of script" >| ${MYLOG}
5 echo "$(date --rfc-3339=seconds) Something" > ${MYLOG}
```

11: ./script: cannot create myscript.log: File exists

Defenses

Caveat of set options

Enable with - (minus)

Disable with + (plus)

Learn more: The Set Builtin

Defenses

Reset localization

export LC_ALL=C

Defenses

Execution path

export PATH="/bin:/sbin:/usr/bin:/usr/sbin"

Defenses

Use quotes and curly brackets, they are free

```
[ $foo = "bar" ]
[ "$foo" = "bar" ]
[ "${foo}" = "bar" ]
```

Defenses

Read-only variables

readonly MYVAR="$(hostname -s)"

(Not POSIX…)

Defenses

Use traps

trap cleanup INT TERM

trap status USR1

Defenses

Untrap

trap - EXIT

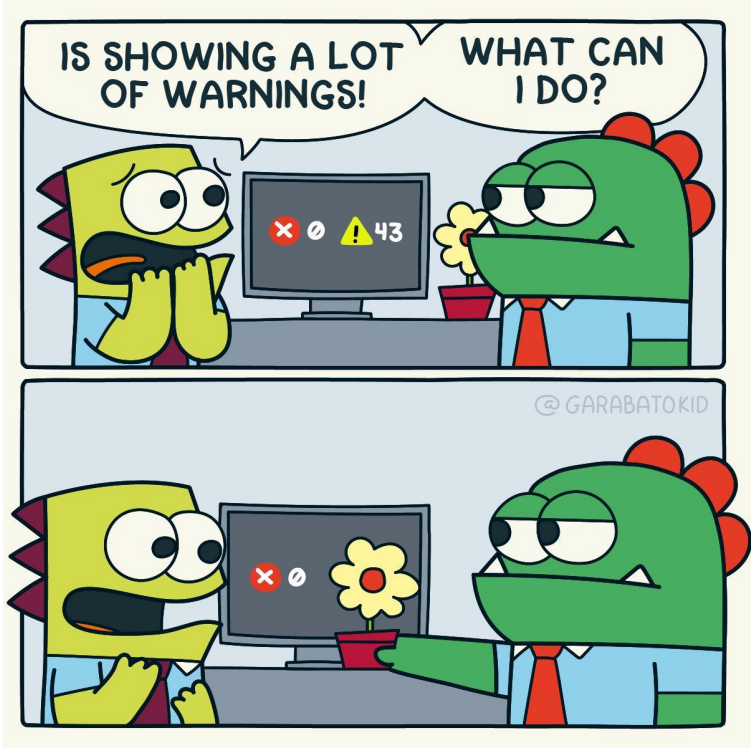
Defenses

Temporary files

mktemp /tmp/data.XXXXXXXXXX

Tools

Linting



bash -n

$ echo 'myvar="TEST' | bash -n

bash: line 1: unexpected EOF while looking for matching `"'

bash: line 2: syntax error: unexpected end of file

17: ./sync-vm-backups-to-usb: Syntax error: "(" unexpected (expecting "then")

Alternative: bash -n script

sh

- Name?
- Formatting

https://github.com/mvdan/sh

```
usage: shfmt [flags] [path ...]

If no arguments are given, standard input will be used. If a given path
is a directory, it will be recursively searched for shell files - both
by filename extension and by shebang.

  -version  show version and exit

  -l        list files whose formatting differs from shfmt's
  -w        write result to file instead of stdout
  -d        error with a diff when the formatting differs
  -s        simplify the code

Parser options:

  -ln str   language variant to parse (bash/posix/mksh, default "bash")
  -p        shorthand for -ln=posix

Printer options:

  -i uint   indent: 0 for tabs (default), >0 for number of spaces
  -bn       binary ops like && and | may start a line
  -ci       switch cases will be indented
  -sr       redirect operators will be followed by a space
  -kp       keep column alignment paddings
  -mn       minify program to reduce its size (implies -s)

Utilities:

  -f        recursively find all shell files and print the paths
  -tojson   print syntax tree to stdout as a typed JSON
```

sh: POSIX check

$ echo ‘((total=5*7))’ | ./shfmt -p

((total=5*7))

$ echo 'my_array=(foo bar)' | ./shfmt -p

<standard input>:1:10: arrays are a bash/mksh feature

Tool: checkbashisms

$ checkbashisms

Usage: checkbashisms [-n] [-f] [-x] script ...

or: checkbashisms --help

or: checkbashisms --version

This script performs basic checks for the presence of bashisms

in /bin/sh scripts and the lack of bashisms in /bin/bash ones.

Tool: checkbashisms

possible bashism in /development/lynis/include/functions line 2417 (type):

if type -t typeset; then

possible bashism in /development/lynis/include/functions line 2418 (typeset):

typeset -r $1

Tool: ShellCheck

```
Usage: shellcheck [OPTIONS...] FILES...
 --check-sourced           Include warnings from sourced files
 --color[=WHEN]            Use color (auto, always, never)
  --include=CODE1,CODE2..  Consider only given types of warnings
  --exclude=CODE1,CODE2..  Exclude types of warnings
  --format=FORMAT          Output format (checkstyle, diff, gcc, json, json1, quiet, tty)
  --enable=check1,check2.. List of optional checks to enable (or 'all')
  --source-path=SOURCEPATHS  Specify path when looking for sourced files ("SCRIPTDIR" for script's dir)
  --shell=SHELLNAME        Specify dialect (sh, bash, dash, ksh)
  --severity=SEVERITY      Minimum severity of errors to consider (error, warning, info, style)
  --external-sources       Allow 'source' outside of FILES
```

Tool: aspell

Grammar check?

Tool: Automated testing

Verify expectations

Projects:

- Bash Automated Testing System
- shUnit2
- shpec

Conclusions

- Scripts = glue
- Portability or features
- Use other language when needed
- Protect variables
- Check your scripts

What questions do you have?

Get connected

- Twitter (@mboelen)
- LinkedIn (Michael Boelen)

Tips and Tricks

POSIX

Useful links

[The Open Group Base Specifications Issue 7, 2018 edition](#)

Shell & Utilities

→ [Shell Command Language](#) and [Utilities](#)

Utilities

- admin
- alias
- ar
- asa
- at
- awk

Base Definitions

1. Introduction
2. Conformance
3. Definitions
4. General Concepts
5. File Format Notation
6. Character Set
7. Locale
8. Environment Variables
9. Regular Expressions
10. Directory Structure and Devices
11. General Terminal Interface
12. Utility Conventions
13. Headers

When to use bash

declare/typeset	Define a variable type (integer, array)
arrays	Data entries
type	Describe command
extended globbing	Expand file names
for loops with integers	for ((i=0; i<10; i++)); do echo $i; done
extended operator	if [["$1" =~ ^m*$]]; then
and more...	

[and [[

[

POSIX

Binary and built-in

Basic comparisons

[[

Not POSIX

Keyword

Advanced features

Builtins VS binaries

Differences

- Builtin has lower overhead
- Binary may have more features

Commands

- enable -a | awk '{print $2}'
- compgen -b
- builtin
- man builtins
- command -v cd
- type -a [

Variables

	POSIX	**bash**	**ksh**
Scope	global	global, unless ‘local’ is used	global or local (based on function or funcname())
Local overrides global?	yes	no	yes

Variables

Variable possibly unset? Use:

```
if [ "${name:-}" = "Michael" ]; then
    …
fi
```

Screen output

Use printf instead of echo

Output of echo strongly depends on flags and how it handles escape sequences.

Dealing with fatal errors

```
#!/bin/sh
Fatal() {
    msg="${1:-"Unknown error"}"
    logger "${msg}"
    echo "Fatal error: ${msg}"
    # optional: call cleanup?
    exit 1
}
command || Fatal "Something happened"
```

Versioning

Semantic versioning!

Major.Minor.Patch

Learn more: semver.org

Common issues with software

- No clear license
- Unclear goal
- Authorship
- Versioning
- Changelog missing

Changelog

Keep a changelog

- History
- Trust
- Troubleshooting

Learn more: keepachangelog.com

Options

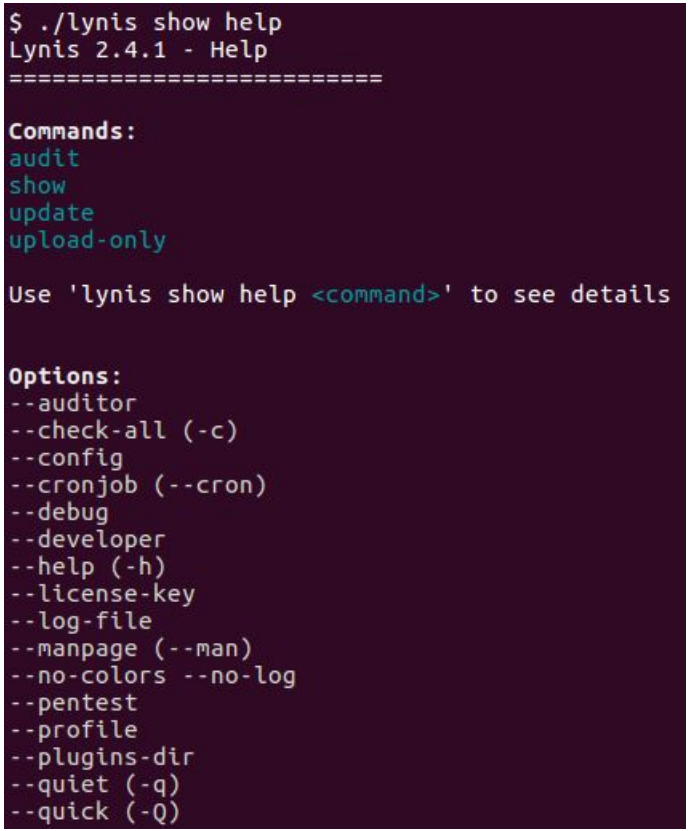
--full-throttle-engine, -f

--help, -h, or help

--version, -V

https://github.com/docopt/docopts

Learn more: docopt.org



Troubleshooting

Use ‘set’ options for debugging:

-v (verbose) - input is written stderr

-x (xtrace) - show what is executed

FOSS tool? Focus areas

Basics

Project description

Tool category

Typical user

License

Author

Language

Keywords

Latest release

Quality

Changelog

Popularity

Documentation

Code

Releases

Usage

Installation

Ease of use

Tool review

Tool and Usage

Project details	
Inception	2007
License	GPLv3
Programming language	shell script
Author	Michael Boelen
Latest release	2.6.8 [2018-08-23]

Project health

This score is calculated by different factors, like project age, last release date, etc.

Let’s torn down something!

```
#!/bin/sh
set -u
hostname=$(hostname)
lockfile=/var/lock/create-backups
timestamp=$(date "+%s")
today=$(date "+%F")
gpgkey=$(gpg --keyid-format LONG --list-keys backup@rootkit.nl 2> /dev/null | awk '/^pub/ { print $2 }' | awk -F/ '{ print $2 }' | head -1)

if [ -z "${hostname}" ]; then echo "Error: no hostname found"; exit 1; fi

if [ ! -z "${lockfile}" ]; then
    if [ -f ${lockfile} ]; then
        echo "Error: Backup still running. Removing lock file to prevent backup script running next day"
        rm ${lockfile}
        exit 1
    fi
fi
touch ${lockfile}

# Add a daily timestamp to the file for restore checking
echo "${hostname}-${timestamp}-${today}" > /etc/backup.data
```

Useful reads

Bash documentation: https://www.gnu.org/software/bash/manual/html_node/

The Bash Hackers Wiki: https://wiki-dev.bash-hackers.org/

Bash pitfalls: http://mywiki.wooledge.org/BashPitfalls

Cheat sheet: https://devhints.io/bash

Rich's sh (POSIX shell) tricks: www.etalabs.net/sh_tricks.html

And check out Lynis source code: https://github.com/CISOfy/lynis

Credits

Images

Where possible the origin of the used images are included in the slides. Some came without an origin from social media and therefore have no source. If you are the owner, let us know and we add the source.

Ben Nadel

@BenNadel

Nothing makes you more humble than having to maintain a single codebase for years. Only then do you really get see the full extent of your poor choices and ill-informed thinking. I feel lucky to have this learning opportunity.

15:00 · 10 Nov 19 · TweetDeck