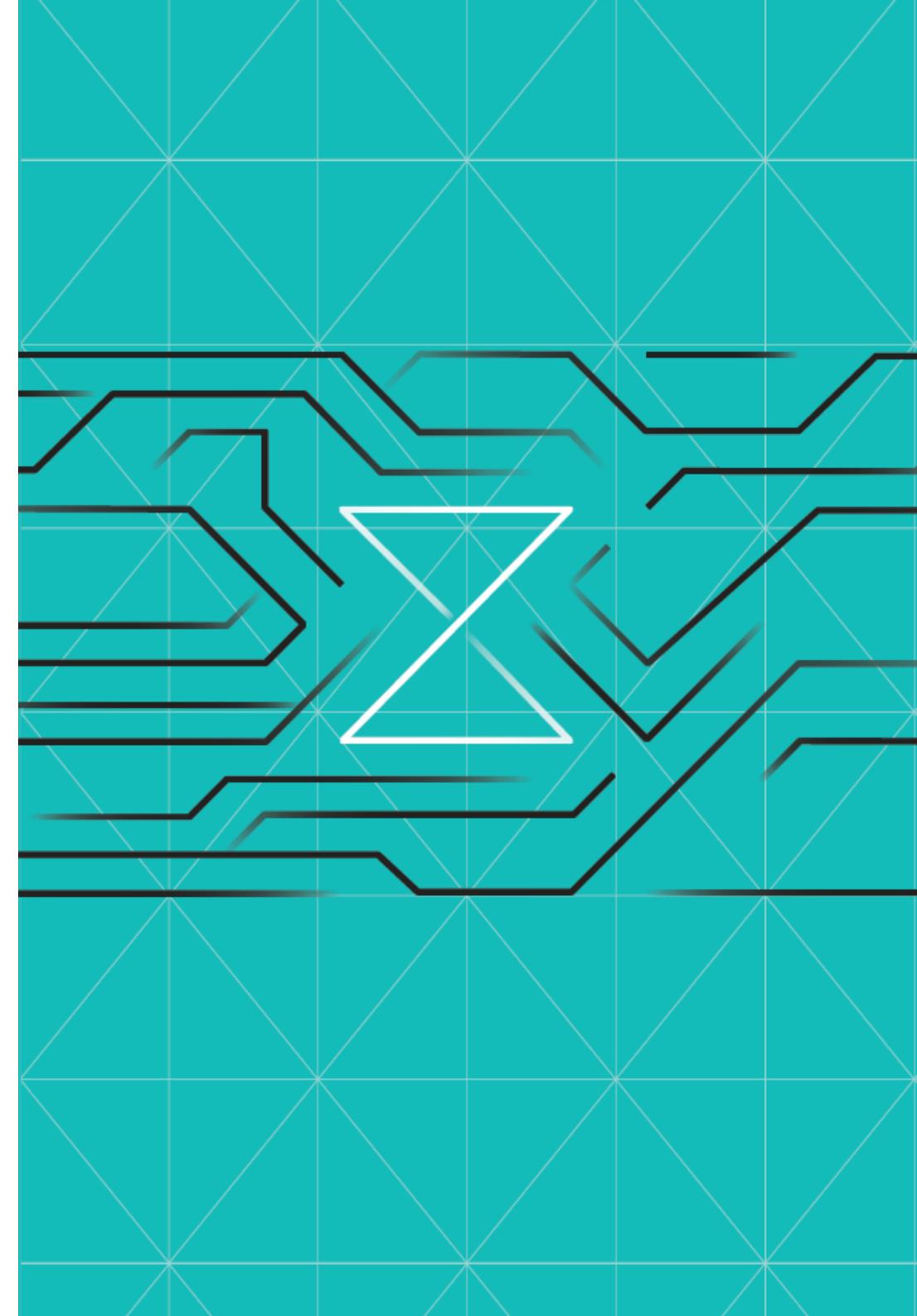


LNX2

Linux on Z: Go Worldwide

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TAKE CONTROL OF YOUR LINUX INSTANCE AND START BUILDING

The Challenge

Linux started as a hobbyist alternative to expensive UNIX systems, which were only available to those in universities or large companies.

Through rapid adoption, it has ended up on servers, laptops, phones, and devices all around the world. Of course, one of those servers is the IBM Z mainframe, where it benefits from the extreme resiliency, performance, and scalability that the platform offers.

Before You Begin

Access to a Linux system is required for this challenge, so you will definitely want to complete the first Linux challenge, [LNX1](#), before attempting this challenge.

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Investment

Steps	Duration
15	90 minutes

1 INSTALL THE WEB SERVER

```
httpd-filesystem.noarch : The basic directory layout for the Apache HTTP server
python38-mod_wsgi.s390x : A WSGI interface for Python web applications in Apache
mod_ldap.s390x : LDAP authentication modules for the Apache HTTP Server
python3-mod_wsgi.s390x : A WSGI interface for Python web applications in Apache
mod_proxy_html.s390x : HTML and XML content filters for the Apache HTTP Server
mod_auth_mellon.s390x : A SAML 2.0 authentication module for the Apache Httpd Server
mod_md.s390x : Certificate provisioning using ACME for the Apache HTTP Server
pcp-export-pcp2spark.s390x : Performance Co-Pilot tools for exporting PCP metrics to Apache Spark
mod_intercept_form_submit.s390x : Apache module to intercept login form submission and run PAM authentication
mod_lookup_identity.s390x : Apache module to retrieve additional information about the authenticated user
MM> sudo yum install httpd.s390x
Last metadata expiration check: 0:06:28 ago on Mon 17 Aug 2020 09:30:18 AM EDT.
Dependencies resolved.

=====
Package           Architecture   Version      Repository  Size
=====
Installing:
httpd             s390x        2.4.37-21.module+el8.2.0+5008+cca404a3  rhel8-appstream  1.3 M
Installing dependencies:
mailcap            noarch       2.1.48-3.el8          rhel8-base     39 k
redhat-logos-htpd noarch       81.1-1.el8           rhel8-base     26 k
apr-util           s390x       1.6.1-6.el8          rhel8-appstream 104 k
apr                s390x       1.6.3-9.el8          rhel8-appstream 122 k
httpd-filesystem  noarch       2.4.37-21.module+el8.2.0+5008+cca404a3  rhel8-appstream 36 k
mod_http2          s390x       1.11.3-3.module+el8.2.0+4377+dc421495  rhel8-appstream 152 k
httpd-tools         s390x       2.4.37-21.module+el8.2.0+5008+cca404a3  rhel8-appstream 102 k
Installing weak dependencies:
apr-util-bdb       s390x       1.6.1-6.el8          rhel8-appstream 24 k
apr-util-openssl  s390x       1.6.1-6.el8          rhel8-appstream 27 k
Enabling module streams:
httpd              2.4

Transaction Summary
=====
Install 10 Packages

Total download size: 1.9 M
Installed size: 5.6 M
Is this ok [y/N]: y
```

Return to your Linux instance at the LinuxONE Community Cloud (L1CC).

In the ssh terminal, type `yum search apache` to look for installable packages related to the [Apache web server](#).

httpd.s390x is the one you want. As a note, **s390x** is shorthand for “64 bit Z architecture”. Install that package with the command:

```
sudo yum install httpd.s390x
```

It will show you a number of dependencies that it also needs to install, and ask you if this is OK. Enter ‘y’ to tell it to proceed.

2 APACHE, GO!

You have now installed the Apache web server, but it won't do anything until it is started.

So use the following commands to:

- start it now
- tell the system to enable it for starting automatically
- check on its status (look for "active (running)")

```
sudo apachectl start  
sudo systemctl enable httpd  
sudo apachectl status
```

```
[linux1@competition ~]$ sudo apachectl start  
[linux1@competition ~]$ sudo systemctl enable httpd  
[linux1@competition ~]$ sudo apachectl status  
● httpd.service - The Apache HTTP Server  
   Loaded: loaded (/usr/lib/systemd/system/httpd.service; enabled; vendor preset: disabled)  
   Active: active (running) since Tue 2021-08-03 11:53:58 EDT; 17min ago  
     Docs: man:httpd.service(8)  
    Main PID: 23274 (httpd)  
      Status: "Total requests: 4; Idle/Busy workers 100/0;Requests/sec: 0.0038; Bytes served/sec: 18 B/sec"  
         Tasks: 213 (limit: 23781)  
        Memory: 16.8M  
       CGroup: /system.slice/httpd.service  
              ├─23274 /usr/sbin/httpd -DFOREGROUND  
              ├─23275 /usr/sbin/httpd -DFOREGROUND  
              ├─23276 /usr/sbin/httpd -DFOREGROUND  
              ├─23277 /usr/sbin/httpd -DFOREGROUND  
              └─23278 /usr/sbin/httpd -DFOREGROUND  
  
Aug 03 11:53:57 competition systemd[1]: Starting The Apache HTTP Server...  
Aug 03 11:53:58 competition httpd[23274]: AH00558: httpd: Could not reliably determine the server's fully qualified domain name, using fe80::a1:41f>  
Aug 03 11:53:58 competition systemd[1]: Started The Apache HTTP Server.  
Aug 03 11:53:58 competition httpd[23274]: Server configured, listening on: port 80
```

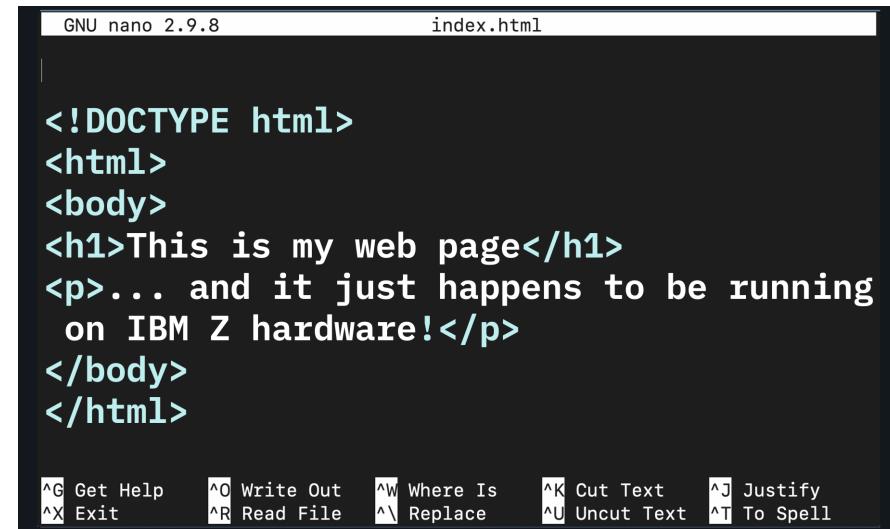
If the output of the "status" command is longer than can fit in your window, you may need to scroll to the bottom, or press Q to quit out.

3 CREATE THE HOME PAGE

Change directory into `/var/www/html` and create a file called “index.html” as the new default home page for the web server.

(Since this is a protected directory, remember that you'll need root authority to create/save files here...)

```
<!DOCTYPE html>
<html>
<body>
<h1>This is my web page</h1>
<p>... and it just happens to be running
on IBM Z hardware!</p>
</body>
</html>
```



The screenshot shows a terminal window titled "GNU nano 2.9.8" with the file "index.html" open. The content of the file is the same HTML code as shown in the previous code block. At the bottom of the terminal window, there is a menu bar with various keyboard shortcut options for navigating and editing the text.

```
GNU nano 2.9.8          index.html

<!DOCTYPE html>
<html>
<body>
<h1>This is my web page</h1>
<p>... and it just happens to be running
on IBM Z hardware!</p>
</body>
</html>

^G Get Help    ^O Write Out   ^W Where Is    ^K Cut Text   ^J Justify
^X Exit        ^R Read File   ^\ Replace     ^U Uncut Text ^T To Spell
```

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If you're familiar with HTML, then go nuts. Otherwise, feel free to copy/paste the sample code above into a nano edit session. When you are ready, press *Control-O* to save and *Control-X* to quit the nano editor.

(This should not need to be said, but don't put anything out here in poor taste or questionable judgment. Actions will be taken for improper use of this system.)

4 FIND YOUR LINUX IP ADDRESS

Before going much further, make sure you know your system's IP address.

It is listed on the LinuxONE Community Cloud page where you created the server instance, or you can run the command

```
ip -c addr
```

(interface address config) and look for the **inet** address attached to the **enc1000** interface (shown below with the "3:" prefix).

```
[linux1@competition ~]$ ip -c addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
        inet 127.0.0.1/8 scope host lo
            valid_lft forever preferred_lft forever
        inet6 ::1/128 scope host
            valid_lft forever preferred_lft forever
3: enc1000: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP group default qlen 1000
    link/ether 02:a1:41:5b:85:30 brd ff:ff:ff:ff:ff:ff
        inet 148.100.76.111/22 brd 148.100.79.255 scope global noprefixroute enc1000
            valid_lft forever preferred_lft forever
        inet6 fe80::a1:41ff:fe5b:8530/64 scope link
            valid_lft forever preferred_lft forever
```

Write that down somewhere, or just make a note how you can find it again when you need it (Hint: you are going to need it!).

5 YOU ARE MY FIREWALL

By default, the LinuxONE Community Cloud blocks all incoming access besides SSH.

This is a security precaution to prevent unexpected access or abuse of your system.

To look at your new web page, you need to make an exception in the firewall for TCP port 80, on which the web server listens for http requests.

Use the following commands to

- tell the system to start the network firewall service
- add your web server port, and save it so that it is always enabled
- refresh the firewall settings to add your update
- tell the system that you want the firewall service to automatically start if the system restarts

```
● sudo systemctl start firewalld
● sudo firewall-cmd --zone=public --add-port=80/tcp --permanent
● sudo firewall-cmd --reload
● sudo systemctl enable firewalld
```

```
[linux1@competition ~]$ sudo systemctl start firewalld
[linux1@competition ~]$ sudo firewall-cmd --zone=public --add-port=80/tcp --permanent
success
[linux1@competition ~]$ sudo firewall-cmd --reload
success
[linux1@competition ~]$ sudo systemctl enable firewalld
Created symlink /etc/systemd/system/dbus-org.fedoraproject.FirewallD1.service → /usr/lib/systemd/system/firewalld.service.
Created symlink /etc/systemd/system/multi-user.target.wants/firewalld.service → /usr/lib/systemd/system/firewalld.service.
```

"WHY DO I HAVE TO KEEP TYPING SUDO?"

Perhaps you have heard the expression "Measure twice, cut once". The idea there being that if you rush during the planning stages, you are more likely to make a mistake.

If only you had taken another few seconds to think about what you were about to do, it could have saved a lot of time and heartache.

By using a default non-privileged user, and only elevating your access when you *really* need it, you are less likely to accidentally erase an important file or directory. It reminds you that you are about to do something that could have potentially dangerous consequences.

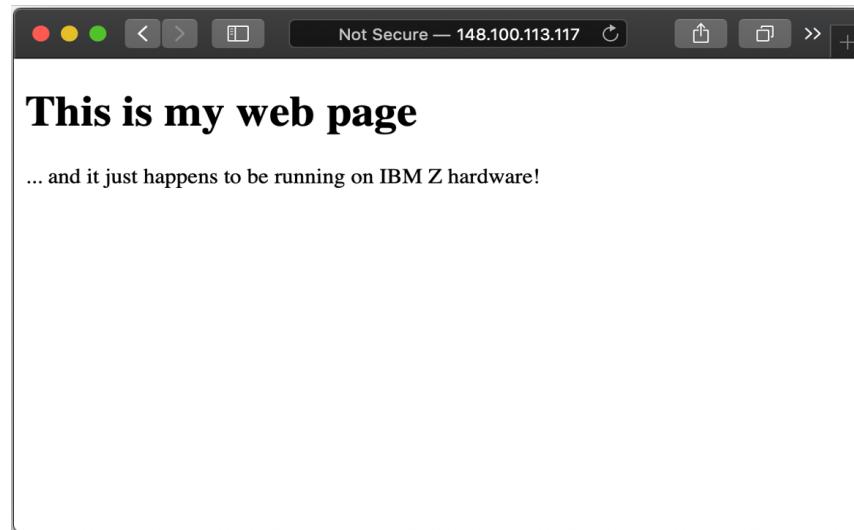
Whenever you are about to use a command with *sudo*, take a few seconds to double-check your command *before* you press Enter.

6 VIEW YOUR MASTERPIECE

Open a web browser and connect to the IP address of your system.

For example, <http://148.100.244.250>

If the server is running, the firewall is modified and enabled, and you saved the HTML in *index.html*, you should be able to see your creation in a web browser.



7 WATCH THE ACCESS LOG

Do you remember using the `tail` command to watch a file as it changes?

Enter the command:

```
sudo tail -f /var/log/httpd/access_log
```

This file is a record of any time your web page has been requested, including the date+time, the requesting IP address, and browser information.

```
MTM> sudo tail -f /var/log/httpd/access_log
17.255.237.30 - - [17/Aug/2020:10:33:13 -0400] "GET / HTTP/1.1" 304 -
Intel Mac OS X 10_15_6) AppleWebKit/605.1.15 (KHTML, like Gecko) Version
17.255.237.30 - - [17/Aug/2020:10:33:15 -0400] "GET / HTTP/1.1" 200 139
Intel Mac OS X 10_15_6) AppleWebKit/605.1.15 (KHTML, like Gecko) Versi
17.255.237.30 - - [17/Aug/2020:10:33:16 -0400] "GET / HTTP/1.1" 200 139
Intel Mac OS X 10_15_6) AppleWebKit/605.1.15 (KHTML, like Gecko) Versi
17.255.237.30 - - [17/Aug/2020:10:33:20 -0400] "GET / HTTP/1.1" 200 139
Intel Mac OS X 10_15_6) AppleWebKit/605.1.15 (KHTML, like Gecko) Versi
17.255.237.30 - - [17/Aug/2020:10:33:20 -0400] "GET / HTTP/1.1" 200 139
Intel Mac OS X 10_15_6) AppleWebKit/605.1.15 (KHTML, like Gecko) Versi
17.255.237.30 - - [17/Aug/2020:10:33:21 -0400] "GET / HTTP/1.1" 200 139
Intel Mac OS X 10_15_6) AppleWebKit/605.1.15 (KHTML, like Gecko) Versi
17.255.237.30 - - [17/Aug/2020:10:33:22 -0400] "GET / HTTP/1.1" 200 139
Intel Mac OS X 10_15_6) AppleWebKit/605.1.15 (KHTML, like Gecko) Versi
17.255.237.30 - - [17/Aug/2020:10:33:22 -0400] "GET / HTTP/1.1" 200 139
Intel Mac OS X 10_15_6) AppleWebKit/605.1.15 (KHTML, like Gecko) Versi
17.255.237.30 - - [17/Aug/2020:10:33:22 -0400] "GET / HTTP/1.1" 200 139
Intel Mac OS X 10_15_6) AppleWebKit/605.1.15 (KHTML, like Gecko) Versi
```

Watch the access log update as you request your web page from a browser window.

If you can, try to open it from another browser on another computer or a phone and see the differences.

Press *Control-C* to end the `tail` command, when you have seen enough.

8 WOULD YOU LIKE TO PLAY A GAME?

Sometimes the software you want isn't readily available through a package manager like `yum`, or in the spirit of open source software, you want to make your own adjustments to the source code and build things on your own.

That is all possible with the compilers available here.

In the next few steps, you will

- download the public source code for a game, **Vitetris**
- extract the source code
- compile that code so it will run on your system
- play the game!

Curl is a command-line utility for interacting with URLs. It supports FTP, HTTP, LDAP, and many other protocols. In this case, we're going to use it to download a file from a remote web server onto our Linux server.

Download the game source code with the following command:

```
curl -LO https://github.com/vicgeralds/vitetris/archive/v0.58.0.tar.gz
```

```
<ZXP> curl -LO https://github.com/vicgeralds/vitetrис/archive/v0.58.0.tar.gz
% Total    % Received % Xferd  Average Speed   Time   Time     Time  Current
                                         Dload  Upload Total Spent    Left  Speed
100  128  100  128    0      0  2666      0  --:--:-- --:--:-- --:--:--  20
100 96957  0 96957    0      0  422k      0  --:--:-- --:--:-- --:--:--  5
<ZXP> ls -lah
total 116K
drwx-----. 5 linux1 linux1 168 Aug 17 11:02 .
drwxr-xr-x. 3 root   root   20 Jul 27 16:33 ..
-rw-----. 1 linux1 linux1 482 Aug 14 12:49 .bash_history
-rw-r--r--. 1 linux1 linux1 18 Aug 30 2019 .bash_logout
-rw-r--r--. 1 linux1 linux1 141 Aug 30 2019 .bash_profile
-rw-r--r--. 1 linux1 linux1 312 Aug 30 2019 .bashrc
drwx-----. 3 linux1 linux1 20 Jul 27 16:47 .config
-rw-----. 1 linux1 linux1 35 Aug 14 11:44 .lesshst
drwxrwxr-x. 2 linux1 linux1 26 Aug 12 12:03 my_directory
drwx-----. 2 linux1 linux1 29 Jul 27 16:33 .ssh
-rw-rw-r--. 1 linux1 linux1 95K Aug 17 11:02 v0.58.0.tar.gz
<ZXP> █
```

9 UNPACK THE CODE FROM THE TARBALL

The file you just downloaded has an odd suffix, in fact it has got two; **tar** and **gz**.

This tells you that it has been both encoded and compressed so that its structure and permissions will be preserved after uploading and downloading.

Type the following command to extract the file, which is commonly referred to as a "tarball"

```
tar xvf v0 (then just hit tab to auto-complete the rest)
```

then press Enter.

```
drwx----- 2 linux1 linux1 29 Jul 27 16:33 .ssh
-rw-rw-r-- 1 linux1 linux1 95K Aug 17 11:02 v0.58.0.tar.gz
|<ZXP> tar xvf v0.58.0.tar.gz
vitetris-0.58.0/
vitetris-0.58.0/.gitignore
vitetris-0.58.0/INSTALL
vitetris-0.58.0/Makefile
vitetris-0.58.0/README
vitetris-0.58.0/changes.txt
vitetris-0.58.0/config.mk
vitetris-0.58.0/configure
vitetris-0.58.0/icon.ico
vitetris-0.58.0/icon.rc
vitetris-0.58.0/licence.txt
vitetris-0.58.0/pc8x16.fnt
vitetris-0.58.0/src-conf.sh
vitetris-0.58.0/src/
vitetris-0.58.0/src/Makefile
vitetris-0.58.0/src/cfgfile.c
vitetris-0.58.0/src/cfgfile.h
```

10 INSTALL BUILD TOOLS

Before we can go much further, we need to install some development tools. Use **yum** to install **make** and **gcc**

make is a utility for building software from a configuration file, and **gcc** is the GNU C Compiler, used to compile software from source.

To build the game from source code, you will need both.

```
<ZXP> sudo yum install make gcc
Last metadata expiration check: 0:02:25 ago on Mon 17 Aug 2020 11:23:02 AM EDT.
Dependencies resolved.
=====
 Package           Arch    Version        Repository      Size
 =====
Installing:
  make              s390x  1:4.2.1-10.el8   rhel8-base       496 k
  gcc               s390x  8.3.1-5.el8    rhel8-appstream 18 M
Installing dependencies:
  pkgconf-pkg-config s390x  1.4.2-1.el8   rhel8-base       15 k
  libcrypt-devel     s390x  4.1.1-4.el8   rhel8-base       25 k
  pkgconf            s390x  1.4.2-1.el8   rhel8-base       38 k
  pkgconf-m4          noarch 1.4.2-1.el8   rhel8-base       17 k
  libpkgconf          s390x  1.4.2-1.el8   rhel8-base       34 k
  glibc-headers       s390x  2.28-72.el8   rhel8-base      461 k
  glibc-devel         s390x  2.28-72.el8   rhel8-base      1.0 M
  libatomic            s390x  8.3.1-5.el8   rhel8-base       21 k
  libubsan             s390x  8.3.1-5.el8   rhel8-base      143 k
  binutils             s390x  2.30-73.el8   rhel8-base       5.9 M
  libgomp              s390x  8.3.1-5.el8   rhel8-base      198 k
  libasan              s390x  8.3.1-5.el8   rhel8-base      370 k
  kernel-headers       s390x  4.18.0-193.14.3.el8_2 rhel8-base      4.0 M
  isl                 s390x  0.16.1-6.el8   rhel8-appstream 801 k
```

Some Linux distributions include these types of development tools by default. Other times, it makes sense to leave them out to save disk space. In this case, you will have to install them, but it should only take a few seconds.

11 CONFIGURE AND BUILD

Change directory into the **vitetris*** directory and type `./configure` to set everything up, and then `make` to actually build the program from source.

Make sure you include the dot-slash before `configure` or else it probably not work.

```
<ZXP> pwd  
/home/linux1/vitetris-0.58.0  
[<ZXP> ./configure && make  
checking for linux/joystick.h... yes  
checking for linux/input.h... yes  
checking for Xlib... no  
checking for conio.h... no  
checking for stdint.h... yes  
checking for sys/types.h... yes  
checking for sys/select.h... yes  
checking for sys/un.h... yes  
updating src/config.h  
updating config.mk  
  
INSTALLATION DIRECTORIES:  
prefix = /usr/local  
bindir = ${prefix}/bin  
datarootdir = ${prefix}/share  
docdir = ${datarootdir}/doc/vitetris  
pixmapdir = ${datarootdir}/pixmaps  
desktopdir = ${datarootdir}/applications
```

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You can also chain the command together with a pair of ampersands (`&&`), as in the screenshot. This means “Run this command, and if it runs without errors, then run this command, too”. It will spin for a little bit, and then let you know when it is finished.

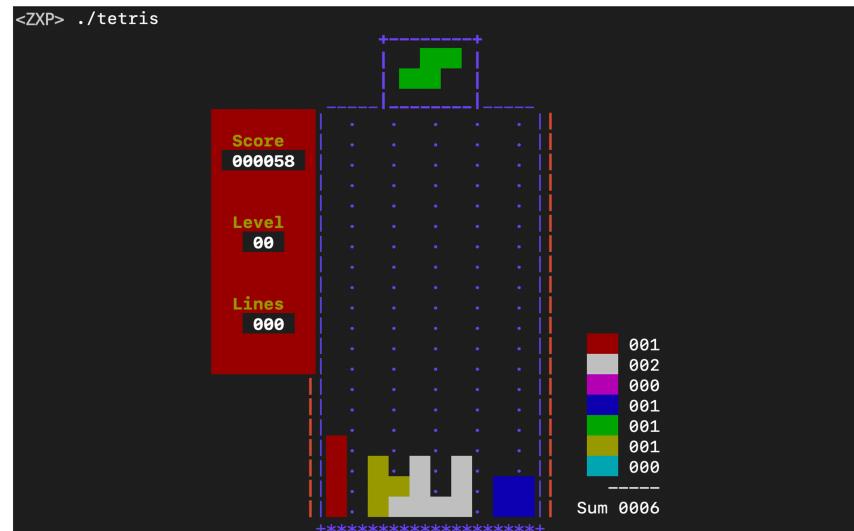
12 VERIFY BUILD (PLAY THE GAME)

It seems silly to go through all of the trouble of downloading and configuring a game and then NOT play it, right?

Type

```
./tetris
```

and it's "Game: On!"



We could include a lot more text here to help fill up that empty space at the bottom, but you're playing Tetris on a mainframe, so we'll just end there :-)

13 NEXT STEPS

Where you go from here is up to you.

You can keep exploring Linux and use this as your go-to system, or maybe keep installing software (see python examples below) or build out that fine web page.

```
python3-dnf-plugin-spacewalk.noarch : DNF plugin for Spacewalk
python3-dnf-plugin-spacewalk.noarch : DNF plugin for Spacewalk
python3-dnf-plugin-versionlock.noarch : Version Lock Plugin for DNF
python3-spacewalk-backend-libs.noarch : Spacewalk client tools libraries for Fedora 23
python3-sphinx-theme-alabaster.noarch : Configurable sidebar-enabled Sphinx theme
python3-rhn-virtualization-host.noarch : RHN/Spacewalk Virtualization support specific to
                                         : Host system
python3-dbus-signature-pyparsing.noarch : Parser for a D-Bus Signature
python3-sphinxcontrib-websupport.noarch : Sphinx API for Web Apps
python3-rhn-virtualization-common.noarch : Files needed by rhn-virtualization-host
python3-keycloak-httpd-client-install.noarch : Tools to configure Apache HTTPD as Keycloak
                                         : client
python3-dnf-plugin-post-transaction-actions.noarch : Post transaction actions Plugin for
===== Summary Matched: python =====
pygtk2.s390x : Python bindings for GTK+
pygobject2.s390x : Python 2 bindings for GObject
blivet-data.noarch : Data for the blivet python module.
sip.s390x : SIP - Python/C++ Bindings Generator
rhnlib.noarch : Python libraries for the Spacewalk project
rhnlib.noarch : Python libraries for the Spacewalk project
babel.noarch : Tools for internationalizing Python applications
pykickstart.noarch : Python utilities for manipulating kickstart files.
boost-numpy3.s390x : Run-time component of boost numpy library for Python 3
libstoragemgmt-nfs-plugin-clibs.s390x : Python C extension module for libstoragemgmt NFS
                                         : plugin
libdnf.s390x : Library providing simplified C and Python API to libolv
```

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If you intend to "Master the Mainframe", having Linux system skills can be mighty handy.

You mark this challenge completed by running another *curl* command:

```
curl -X POST -d email={your-ibmxplore-email} http://192.86.32.12:1880/LNX2
```

Make sure to include the email address parameter.

Note that this command uses the **POST** option - the email parameter is sent as the "body" of the request, rather than as a URL option

Nice job - let's recap	Next up ...
<p>You may have been asking yourself what any of this has to do with enterprise systems... or even mainframe in general.</p> <p>As you may know, an IBM Z mainframe is able to run many different operating systems at the same time.</p> <p>One of those operating systems is z/OS and it also happens to excel at running Linux. In most big companies, there is a mix of z/OS, Linux, and possibly other operating systems (zVM, zVSE, zTPF) being used.</p> <p>This is Linux on IBM Z hardware, so keep that in mind.</p>	<p>Where to go from here? Well, let your interest be your guide. If you want to do more coding/compiling, look into software sources for tools you might like to experiment with. Maybe you want to look into those "stacks" mentioned earlier.</p> <p>Wherever you end up, make sure you have fun!</p>

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