

# Lecture #01

Campus	Lecture Date
Boston	01/11/2024
Seattle & Silicon Valley	01/13/2024

## Agenda

- Course Introduction
- Fundamentals of Cloud Computing

## Accessing O'Reilly Online Learning

Northeastern University students have access to tons of technical books and resources through O'Reilly for Higher Education. Follow [these instructions](#) to create account and get access. Most reference books referenced in this course are available in the O'Reilly catalog at no additional cost to you.

## Reading

### Cloud Computing

- [Cloud Computing: Concepts, Technology & Architecture \(ISBN: 9780133387520\)](#)
- [Cloud Computing, Server Utilization, & the Environment](#)

## Slides

Lecture slides can be found in this week's Canvas module.



# Lecture #02

Campus	Lecture Date
Boston	01/18/2024
Seattle & Silicon Valley	01/20/2024

## Agenda

- Introduction to DevOps
- Fundamentals of Cloud Computing
- Overview of Public Cloud Providers
- Identity & Access Management (IAM)
- Assignment #00

## Accessing O'Reilly Online Learning

Northeastern University students have access to tons of technical books and resources through O'Reilly for Higher Education. Follow [these](#) instructions to create account and get access. Most reference books referenced in this course are available in the O'Reilly catalog at no additional cost to you.

## Reading

### Cloud Computing

- [Cloud Computing: Concepts, Technology & Architecture \(ISBN: 9780133387520\)](#)
- [Cloud Computing, Server Utilization, & the Environment](#)

### IAM

- [Amazon Resource Names \(ARNs\)](#)
- [AWS Identity and Access Management \(IAM\)](#)
- [IAM Actions, Resources, and Condition Keys for AWS Services](#)
- [IAM JSON Policy Elements Reference](#)

## Slides

Lecture slides can be found in this week's Canvas module.

# Assignment #00

## Learning Objectives & Assignment Goals

The goal of this assignment is to setup local development environment and sign up for cloud & SaaS services we will use in this course. An easy way to relate to this assignment is to think of the work developers usually do in their first day/week at a new job.



### Note

1. This assignment is a prerequisite for getting future assignments graded.
2. Individual assignment weightage on the course grade of this assignment is 0%.
3. Students are solely responsible for the cost of tools and services used in the course. Northeastern University, College of Engineering, and the instructor will not be responsible for any of the charges incurred.
4. The cloud service provider might require a valid credit or debit card even for free tiers. If you do not have a credit or debit card, please let the instructor or TA know ASAP.

## Due Date

Section	Submission Due Date	Grading Due Date
Boston	N/A	N/A
Seattle & Silicon Valley	N/A	N/A

## Getting Help

**i** Info

Ask all your questions in Canvas discussion thread.

## Assignment Tasks

### Account Signups

**i** Info

- Don't create a new account for the course if you have an existing account with any of these services.

**A** Set up MFA

You are responsible for the security of your account. It is important that you use strong passwords for all accounts and set up [multi-factor authentication](#) for all accounts to add an extra layer of security.

1. Sign up for [Github Student Developer pack](#).
2. Sign up for [Amazon Web Services \(AWS\)](#).
3. Sign up for [Google Cloud Platform \(GCP\)](#). Do not use your Northeastern University email for account sign up.
4. Register for a [student license](#) from JetBrains. You will be able to use an IDE such as [IntelliJ IDEA Ultimate](#) with your choice of programming language such as Go, Java, PHP, Ruby, Python, JavaScript, etc.
5. Optionally sign up for [Namecheap](#) account.
6. Sign up for a [Github](#) account. Make sure to [personalize](#) your GitHub profile by setting your profile name and optionally profile picture.

### Setup Development Environment

- Download and install the latest version of [Git](#).
  - [Set your username in Git](#).
  - [Set your commit email address in Git](#).

- Configure your system to connect to GitHub with SSH.
- Install a text editor you are most familiar with. I highly recommend `Visual Studio Code` and following plugins for it:
  - `GitLens` – Git supercharged
  - `HashiCorp Terraform`
  - `HCL`
  - `Markdown All in One`
  - `Prettify JSON`
  - `ShellCheck`
  - `vscode-base64`
  - `YAML`
  - `Python`
- Install `IntelliJ IDEA Ultimate` if you plan to use it.
- Install `MySQL` or `PostgreSQL` database.

## Grading Rubric and Submission

### Info

Following guidelines are for information only. They are subject to change at the discretion of the instructor and TA.

N/A

# Lecture #03

Campus	Lecture Date
Boston	01/25/2024
Seattle & Silicon Valley	01/27/2024

## Agenda

- Review [Assignment #00](#)
- Introduction to Linux Command Line
- Discuss [Assignment #01](#)

## Reading

### Reference Books

- [Unix Shell Programming by Stephen G. Kochan](#)
- [UNIX and Linux System Administration Handbook by Dan Mackin, Ben Whaley, Trent R. Hein, Garth Snyder, Evi Nemeth](#)
- [Learning the vi and Vim Editors by Elbert Hannah, Linda Lamb, Arnold Robbins](#)

### Linux

- [The Linux Command Line](#)
- [Linux Documentation](#)
- [Linux Load Averages: Solving the Mystery](#)

## Slides

Lecture slides can be found in this week's Canvas module.



# Assignment #01

## Due Date

Section	Submission Due Date	Grading Due Date
Boston	01/31/2024 @ 9 PM ET	02/07/2024 @ 9 PM ET
Seattle & Silicon Valley	02/02/2024 @ 9 PM PT	02/09/2024 @ 6 PM PT

## Getting Help

### Info

Ask all your questions in Canvas Discussion. SEA/SJ0 can ask questions in Teams.

## Learning Objectives

The objective of this assignment is to select a technology stack for a backend (API only) web application and to implement health check API.

The technology stack must meet [Cloud-Native Web Application Requirements](#) as outlined below.

## Cloud Native Web Application Requirements

A cloud-native application is an application that is specifically designed for cloud computing architecture. It takes advantage of cloud computing frameworks, which are composed of loosely coupled cloud services.

- **Server Operating System:** CentOS 8

- **Programming Language:** Any high-level programming language such as Java, Python, Go, Node.js or PHP.
- **Relational Database:** Either MySQL or PostgreSQL. Do not use MongoDB, MSSQL, Oracle, etc.
- **Backend Framework:** Any open-source framework such as Spring, Hibernate, etc.
- **ORM Framework:**
  - **Java:** [Hibernate](#)
  - **Golang:** [GORM](#)
  - **JavaScript:** [Sequelize](#)
  - **Python:** [SQLAlchemy](#)
- **UI Framework:** N/A
- **CSS:** N/A

## Web Application Development



## RESTful API Requirements

1. All API request/response payloads should be in JSON.
2. No UI should be implemented for the application.
3. As a user, I expect all API calls to return with a proper [HTTP status code](#).
4. As a user, I expect the code quality of the application to be maintained to the highest standards using the unit and/or integration tests.



## Health Check RESTful API

- The question we want to answer is How to detect that a running service instance is unable to handle requests? .
- The health check API is a way for us to monitor the health of the application instance and alerts us when something is not working as expected.
- Health check API allows us to stop sending traffic to unhealthy instances of the application and to automatically replace/repair them. It also helps us improve user experience by not routing their requests to unhealthy instances.

A Health Check API may check for following:

1. **Database connection** - Make sure the application is connected to the database or is able to establish connection at the time of the health check.

2. **Downstream API Calls** - Your application may depend on other downstream APIs and outage of downstream API without which you cannot complete the users request.

For this assignment, we are going to implement an endpoint `/healthz` that will do the following when called:

1. Check if the application has connectivity to the database.
  - a. Return `HTTP 200 OK` if the connection is successful .
  - b. Return `HTTP 503 Service Unavailable` if the connection is unsuccessful .
2. The API response should not be cached. Make sure to add `cache-control: 'no-cache'` header to the response.
3. **The API request should not allow for any payload.** The response code should be `400 Bad Request` if the request includes any payload.
4. **The API response should not include any payload.**
5. Only HTTP `GET` method is supported for the `/healthz` endpoint.

## Example Requests

### Success

```
1 curl -vvvv http://localhost:8080/healthz
2 * Trying 127.0.0.1:8080...
3 * Connected to localhost (127.0.0.1) port 8080 (#0)
4 > GET /healthz HTTP/1.1
5 > Host: localhost:8080
6 > User-Agent: curl/8.1.2
7 > Accept: */*
8 >
9 < HTTP/1.1 200 OK
10 < Cache-Control: no-cache, no-store, must-revalidate;
11 < Pragma: no-cache
12 < X-Content-Type-Options: nosniff
13 < Date: Wed, 20 Sep 2023 01:18:37 GMT
14 < Content-Length: 0
15 <
16 * Connection #0 to host localhost left intact
```

### Failure

```
1 $ curl -vvvv http://localhost:8080/healthz
2 * Trying 127.0.0.1:8080...
3 * Connected to localhost (127.0.0.1) port 8080 (#0)
4 > GET /healthz HTTP/1.1
5 > Host: localhost:8080
6 > User-Agent: curl/8.1.2
7 > Accept: */*
```

```
8  >
9  < HTTP/1.1 503 Service Unavailable
10 < Cache-Control: no-cache, no-store, must-revalidate;
11 < Pragma: no-cache
12 < X-Content-Type-Options: nosniff
13 < Date: Wed, 20 Sep 2023 01:18:57 GMT
14 < Content-Length: 0
15 <
16 * Connection #0 to host localhost left intact
```

#### 405 Method Not Allowed

```
1  $ curl -vvvv -XPUT http://localhost:8080/healthz
2  * Trying 127.0.0.1:8080...
3  * Connected to localhost (127.0.0.1) port 8080 (#0)
4  > PUT /healthz HTTP/1.1
5  > Host: localhost:8080
6  > User-Agent: curl/8.1.2
7  > Accept: */*
8  >
9  < HTTP/1.1 405 Method Not Allowed
10 < Cache-Control: no-cache, no-store, must-revalidate;
11 < Pragma: no-cache
12 < X-Content-Type-Options: nosniff
13 < Date: Wed, 20 Sep 2023 01:38:11 GMT
14 < Content-Length: 0
15 <
16 * Connection #0 to host localhost left intact
```

## Submission



### Warning

The assignment will be considered late if uploaded to Canvas after the due date.

1. Create a folder with the naming convention `firstname_lastname_neuid_##` where `##` is the assignment number.
2. Copy complete code for the assignment into this folder.
3. Create a zip of the `firstname_lastname_neuid_##` directory. The zip file should be `firstname_lastname_neuid##.zip`.
4. Now unzip the zip file in some other directory and confirm the content of the zip files.
5. Upload the Zip to the correct assignment in Canvas.

6. You are allowed to resubmit. If you think there may be an issue with the ZIP file, feel free to submit it again. Only the latest submission will be graded.

## Grading Guidelines



Following guidelines are for information only. They are subject to change at the discretion of the instructor and TA.

### Web Application (100%)

- Students will demo the web application from their laptops. Download the zip uploaded to Canvas and use the submitted code for demo. Local code cannot be used for demo.
- APIs can be demoed using any Postman or Restlet or some other REST client but not via the browser.
- The application should not have UI.
- Verify the success and failure by shutting down the database server while the application is still running. Restarting the database without restarting the application should work.
- Verify that the only HTTP request method supported is `GET`. Making `POST`, `PUT`, `DELETE`, or `PATCH` requests should return HTTP status code `405 Method Not Allowed`.
- Verify that request and response have no payload requirement. The API response should NOT include a body. The request should NOT require any query parameters.
- The application connects to either `MySQL` or `PostgreSQL`. No other database is allowed.
- Verify code is not generated by ChatGPT or Google Bard or GitHub co-pilot.
- Application should not throw `500 Internal Server errors`.
- Application should not require restart between API calls.

# Lecture #04

Campus	Lecture Date
Boston	02/01/2024
Seattle & Silicon Valley	02/03/2024

## Agenda

- Review [Assignment #01](#)
- Editing with vi
- Introduction to Shell Scripting
- Version Control with Git
- Git Forking Workflow
- Continuous Integration
- Discuss [Assignment #02](#)

## Reading

### Recommended Books

- [Unix Shell Programming by Stephen G. Kochan](#)
- [Git Pocket Guide](#)

## VI

- [Mastering the vi editor](#)
- [Save a file \(that requires root permissions\) from within vim editor](#)

## Shell Scripting

- [BASH Programming - Introduction HOW-TO](#)

## Git

- [Pro Git](#)
- [Learn Git](#)
- [Understanding the GitHub Flow](#)
- [Forking Workflow](#)

## Slides

Lecture slides can be found in this week's Canvas module.

## Lecture Notes - Editing with vi



## Why We Should Learn vi

- `vi` is always available.
- `vi` is lightweight and fast.

## A Little Background

- First version written by Bill Joy in 1976, a University of California at Berkley student who later went on to co-found Sun Microsystems.
- Most Linux distributions don't include real `vi`; rather, they ship with an enhanced replacement called `vim` (which is short for "vi improved") written by Bram Moolenaar.
- `vim` is a substantial improvement over traditional Unix `vi` and is usually symbolically linked (or aliased) to the name `vi` on Linux systems.
- When we refer to `vi`, we will be actually referring to `vim`.

## The Two Modes of VI

- The VI editor is that it has two modes: `command` and `insert`. The `command` mode allows the entry of commands to manipulate text. These commands are usually one or two characters long, and can be entered with few keystrokes. The `insert` mode puts anything typed on the keyboard into the current file.
- The VI editor starts in `command` mode. There are several commands that put the VI editor into `insert` mode. The most commonly used commands to get into `insert` mode are `a` and `i`. Once you are in `insert` mode, you get out of it by hitting the `escape` key.

## Starting the VI editor

- The command to start the VI editor is `vi`, followed by the filename. For example to edit a file called `temporary`, you would type `vi temporary` and then return. You can start VI without a filename, but when you want to save your work, you will have to tell VI which filename to save it into later.

## Getting Out of VI

# WHEN YOU TRY TO EXIT VIM



- The VI editor has two modes and in order to get out of VI, you have to be in command mode. Hit the key labeled `Escape` or `Esc` to get into `command` mode.
- The command to quit out of VI is `:q`. Once in command mode, type `colon`, and `q`, followed by `return` or `enter` key.

## Running in Vi compatible mode

- *Running in Vi compatible mode* means that `vim` will run in a mode that is closer to the normal behavior of `vi` rather than the enhanced behavior of `vim`.
- To run `vim` with its enhanced behavior, you can do one of the following:
  - Try running `vim` instead of `vi`.
  - Add alias `vi='vim'` to your `.bashrc` file.
  - Add `set nocp` to your `.vimrc` configuration file.
- Different Linux distributions package `vim` in different ways. Some distributions install a minimal version of `vim` by default that only supports a limited set of `vim` features.

## Entering & Exiting Insert Mode

- In order to add some text to our file, we must first enter `insert` mode. To do this, we press the `i` key.
- To exit `insert` mode and return to command mode, press the `Esc` key.

## Saving File Changes

- To save the change made to our file, we must enter `command` mode. This is easily done by pressing the `:` key. After doing this, a colon character should appear at the bottom of the screen.
- To write our modified file, we follow the colon with `w` then `Enter`.

## Moving the Cursor

Key	Moves The Cursor
<code>l</code> or Right Arrow	Right one character.
<code>h</code> or Left Arrow	Left one character.
<code>j</code> or Down Arrow	Down one line.
<code>k</code> or Up Arrow	Up one line.
<code>0</code> (zero)	To the beginning of the current line.
<code>^</code>	To the first non-whitespace character on the current line.
<code>\$</code>	To the end of the current line.
<code>w</code>	To the beginning of the next word or punctuation character.
<code>W</code>	To the beginning of the next word, ignoring punctuation characters.
<code>b</code>	To the beginning of the previous word or punctuation character.
<code>B</code>	To the beginning of the previous word, ignoring punctuation characters.
<code>Ctrl-f</code> or <code>Page Down</code>	Down one page.
<code>Ctrl-b</code> or <code>Page Up</code>	Up one page.
<code>numberG</code>	To line <code>number</code> . For example, <code>1G</code> moves to the first line of the file.
<code>G</code>	To the last line of the file.

## Appending Text

- Since we will almost always want to append text to the end of a line, vi offers a shortcut to move to the end of the current line and start appending. It's the `A` command.

## Deleting Text

- vi offers a variety of ways to delete text, all of which contain one of two keystrokes.

Command	Deletes
x	The current character.
3x	The current character and the next two characters.
dd	The current line.
5dd	The current line and the next four lines.
dW	From the current cursor position to the beginning of the next word.
d\$	From the current cursor location to the end of the current line.
d0	From the current cursor location to the beginning of the line.
d^	From the current cursor location to the first non-whitespace character in the line.
dG	From the current line to the end of the file.
d20G	From the current line to the twentieth line of the file.

## Cut, Copy, & Paste

Command	Copies
yy	The current line.
5yy	The current line and the next four lines.
yW	From the current cursor position to the beginning of the next word.
y\$	From the current cursor location to the end of the current line.
y0	From the current cursor location to the beginning of the line.
y^	From the current cursor location to the first non-whitespace character in the line.
yG	From the current line to the end of the file.
y20G	From the current line to the twentieth line of the file.

- The `d` command not only deletes text, it also "cuts" text. Each time we use the `d` command the deletion is copied into a paste buffer (think clipboard) that we can later recall with the `p` command to paste the contents of the buffer after the cursor or the `P` command to paste the contents before the cursor.
- The `y` command is used to "yank" (copy) text in much the same way the `d` command is used to cut text.

## Search & Replace (Searching The Entire File)

- To move the cursor to the next occurrence of a word or phrase, the `/` command is used.
- When you type the `/` command a "/" will appear at the bottom of the screen. Next, type the word or phrase to be searched for, followed

by the Enter key. The cursor will move to the next location containing the search string.

- A search may be repeated using the previous search string with the `n` command.

## Global Search-And-Replace

```
:%s/Line/line/g
```

Item	Meaning
:	The colon character to enter command mode
%	Specifies the range of lines for the operation. % is a shortcut meaning from the first line to the last line.
s	Specifies the operation. In this case, substitution (search-and-replace)
/Line/line/	The search pattern and the replacement text.
g	This means "global" in the sense that the search-and-replace is performed on every instance of the search string in the line. If omitted, only the first instance of the search string on each line is replaced.

Save a file (that requires root permissions) from within vim editor

- [How To Save A File In Vim / Vi Without Root Permission With sudo](#)

## Lecture Notes - Git Forking Workflow

### Reading

- [Forking Workflow](#)
- [Collaborative development models](#)
- [Pull Requests](#)

## Setup

1. Sign up for GitHub.
2. Install git locally in your development virtual machine.
3. Set up an SSH key for GitHub.
4. Generate SSH key to use with git.
5. Add the SSH key to your GitHub account.
6. Run thru initial setup for git.
7. Setting your username in git.
8. Setting your commit email address in git

## SSH Config

Create a new file called `config` in `~/.ssh` directory. Add the following to the config file

```
1 Host github.com
2   HostName github.com
3   User git
4   IdentityFile ~/.ssh/<YOUR_GITHUB_PRIVATE_KEY>
```

## Git Forking Workflow Lab

Step-by-step example of this workflow:

1. Create a Fork - A developer 'forks' an 'official' server-side repository. This creates their own server-side copy.
2. The new server-side copy is cloned to their local system.
3. A Git remote path for the 'official' repository is added to the local clone.
4. A new local feature branch is created.
5. The developer makes changes to the new branch.
6. New commits are created for the changes.
7. The branch gets pushed to the developer's own server-side copy.
8. The developer opens a pull request from the new branch to the 'official' repository.
9. The pull request gets approved for merge and is merged into the original server-side repository

## Create a Repository in GitHub Organization

See <https://docs.github.com/en/github/getting-started-with-github/create-a-repo>

## Fork The Repository in Your Namespace

See <https://docs.github.com/en/github/getting-started-with-github/fork-a-repo>

## Clone the Fork Locally

See <https://docs.github.com/en/github/creating-cloning-and-archiving-repositories/cloning-a-repository>

```
1 git clone git@github.com:USERNAME/REPOSITORY_NAME.git
```

## Add Remote for Upstream

```
1 git remote add upstream git@github.com:ORG/YOUR-REPOSITORY_NAME.git
```

## Create and Work with Assignment Branches

1. For each assignment, you should create a new branch from the main branch using the command `git checkout -b <branch_name>`
2. Push this newly created branch to your fork on GitHub using the command `git push origin <branch_name>`.
3. Now start working on code changes.
4. Stage your changes using the `git add -A :/` command.
5. Commit the staged changes using the `git commit -m "COMMIT MESSAGE"` command.
6. Push the changes to the remote using the command `git push origin <branch_name>`.
7. Create a pull request to your organization repository.
8. Review & merge pull requests into the organization repository once the PR check has passed.

## Keeping Your Fork in Sync

1. Now that the code is merged sync your code with the organization repository. To pull the latest changes from the organization repository, run the command `git pull upstream main` in your repository.
2. Push the changes to your repository using the command `git push origin main`.
3. **Remember to never update your main branch directly or you will have merge conflicts.**

# Assignment #02

## Due Date

Section	Submission Due Date	Grading Due Date
Boston	02/7/2024 @ 9 PM ET	02/15/2024 @ 5 PM ET
Seattle & Silicon Valley	02/9/2024 @ 9 PM PT	02/16/2024 @ 6 PM PT

## Getting Help

### Info

Ask all your questions in Canvas Discussion. SEA/SJ0 can ask questions in Teams.

## Git & GitHub

### GitHub Subscription

- All students will need to subscribe to the GitHub Team plan.

### Create & Setup GitHub Repository

1. Create a new private GitHub repository for web applications in the GitHub organization you created.
2. The GitHub repository name must be webapp .
3. Update README.md in your repository. Your readme file must contain the following:
4. Prerequisites for building and deploying your application locally.

5. Build and Deploy instructions for the web application.
6. Fork the GitHub repository in your namespace. You will do all development work on your fork.
7. All web application code should now be in this repository.
8. Add appropriate `.gitignore` to your repository. A collection of useful `.gitignore` templates can be found [here](#).

## GitHub Repository Branch Protection Rules

1. [Learn more about protected branches](#).
2. Implement Branch Protection Rules shown in the image below:

**Branch name pattern \***

main

**Protect matching branches** **Require a pull request before merging**

When enabled, all commits must be made to a non-protected branch and submitted via a pull request before they can be merged into a branch that matches this rule.

 **Require approvals**

When enabled, pull requests targeting a matching branch require a number of approvals and no changes requested before they can be merged.

 **Dismiss stale pull request approvals when new commits are pushed**

New reviewable commits pushed to a matching branch will dismiss pull request review approvals.

 **Require review from Code Owners**

Require an approved review in pull requests including files with a designated code owner.

 **Restrict who can dismiss pull request reviews**

Specify people, teams, or apps allowed to dismiss pull request reviews.

 **Allow specified actors to bypass required pull requests**

Specify people, teams, or apps who are allowed to bypass required pull requests.

 **Require approval of the most recent reviewable push**

Whether the most recent reviewable push must be approved by someone other than the person who pushed it.

 **Require status checks to pass before merging**

Choose which [status checks](#) must pass before branches can be merged into a branch that matches this rule. When enabled, commits must first be pushed to another branch, then merged or pushed directly to a branch that matches this rule after status checks have passed.

 **Require branches to be up to date before merging**

This ensures pull requests targeting a matching branch have been tested with the latest code. This setting will not take effect unless at least one status check is enabled (see below).

## No status checks found

Sorry, we couldn't find any status checks in the last week for this repository.

[Learn more about status checks](#)

 **Require conversation resolution before merging**

When enabled, all conversations on code must be resolved before a pull request can be merged into a branch that matches this rule. [Learn more](#).

 **Require signed commits**

Commits pushed to matching branches must have verified signatures.

 **Require linear history**

Prevent merge commits from being pushed to matching branches.

 **Require deployments to succeed before merging**

Choose which environments must be successfully deployed to before branches can be merged into a branch that matches

this rule.

**Lock branch**

Branch is read-only. Users cannot push to the branch.

**Do not allow bypassing the above settings**

The above settings will apply to administrators and custom roles with the "bypass branch protections" permission.

**Restrict who can push to matching branches**

Specify people, teams, or apps allowed to push to matching branches. Required status checks will still prevent these people, teams, and apps from merging if the checks fail.

**Rules applied to everyone including administrators**

**Allow force pushes**

Permit force pushes for all users with push access.

**Everyone**

Permit force pushes for all users with push access.

**Specify who can force push**

Only these people, teams, or apps are allowed to force push.

**Allow deletions**

Allow users with push access to delete matching branches.

## Web Application Development

### About the field data types in Swagger Documentation

- [About the field data types in Swagger docs](#)

### Bootstrapping Database

The application is expected to automatically bootstrap the database at startup.

1. Bootstrapping creates the schema, tables, indexes, sequences, etc., or updates them if their definition has changed.
2. The database cannot be set up manually by running SQL scripts.
3. It is highly recommended that you use ORM frameworks such as Hibernate (for java), SQLAlchemy (for python), and Sequelize (for Node.js).

### RESTful API Requirements

1. All API request/response payloads should be in JSON.
2. No UI should be implemented for the application.
3. As a user, I expect all API calls to return with a proper [HTTP status code](#).
4. As a user, I expect the code quality of the application to be maintained to the highest standards using the unit and/or integration tests. **Not required for this assignment.**

## Authentication Requirements

1. The user must provide a [basic authentication](#) token when making an API call to the authenticated endpoint.
2. The web application must only support [Token-Based authentication](#) and [not Session Authentication](#).

## APIs To Implement

### [Swagger Docs](#)

1. Your web application must only support Token-Based Basic authentication and not Session Authentication.
2. As a user, I must provide a basic authentication token when making an API call to the authenticated endpoint.
3. Create a new user
  - a. As a user, I want to create an account by providing the following information.
    - i. Email Address
    - ii. Password
    - iii. First Name
    - iv. Last Name
  - b. `account_created` field for the user should be set to the current time when user creation is successful.
  - c. Users should not be able to set values for `account_created` and `account_updated`. Any value provided for these fields must be ignored.
  - d. Password should never be returned in the response payload.
  - e. As a user, I expect to use my email address as my username.

- f. Application must return 400 Bad Request HTTP response code when a user account with the email address already exists.
  - g. As a user, I expect my password to be stored securely using the BCrypt password hashing scheme with salt.
4. Update user information
- a. As a user, I want to update my account information. I should only be allowed to update the following fields.
    - i. First Name
    - ii. Last Name
    - iii. Password
  - b. Attempt to update any other field should return 400 Bad Request HTTP response code.
  - c. account\_updated field for the user should be updated when the user update is successful.
  - d. A user can only update their own account information.
5. Get user information
- a. As a user, I want to get my account information. Response payload should return all fields for the user except for password.

## Implement Continuous Integration (CI) with GitHub Actions

1. Add a GitHub Actions workflow to run simple check (compile code) for each pull request raised. A pull request can only be merged if the workflow executes successfully.
2. Add Status Checks GitHub branch protection to prevent users from merging a pull request when the GitHub Actions workflow run fails.

## Submission



### Warning

The assignment will be considered late if uploaded to Canvas after the due date.

1. Create a folder with the naming convention `firstname_lastname_neuid_##` where `##` is the assignment number.
2. **Clone** each (all) repository you have created for the course using `git clone` command into this directory. **It is important that you clone your Organization repository and not your fork.**
3. Create a create a zip of the `firstname_lastname_neuid_##` directory. The zip file should be `firstname_lastname_neuid##.zip`.
4. Now unzip the zip file in some other directory and confirm the content of the zip files.
5. Upload the Zip to the correct assignment in Canvas.
6. You are allowed to resubmit. If you think there may be an issue with the ZIP file, feel free to submit it again. Only the latest submission will be graded.

## Grading Guidelines



### Warning

Following guidelines are for information only. They are subject to change at the discretion of the instructor and TA.

## Previous Assignment Objectives

TAs must verify that students have resolved all open issues from the previous assignment(s).

## Git & GitHub Repository

### Git Repository Content Check (25%)

1. Check the repository for any IDE-specific files. IDE configuration files must not be in the repository.
2. Verify their `.gitignore` configuration.
3. Check the repository for build artifacts such as `.class`, `.jar`, `.war` files and `build`, `node_modules`, `venv` directory. None of these should be checked into the repository.
4. Check for dependencies. Dependencies from the Maven repository or `npm` or `python` should not be committed to the git repository.

### Git Forking Workflow (25%)

1. No direct commits are made to organization repository. Verify student is working from forked repository and using feature branch. There should be no direct commits to their main branch in their forked repository.
2. GitHub repository has branch protection rule setup.
3. GitHub Workflow is triggered when pull request is raised and pull requests can only be merged if the status check is successful. To test failure, ask student to raise a pull request updated the GitHub Actions workflow to execute `exit 1` command.

### Web Application (50%)

Students will demo the assignment from `CentOS 8` virtual machine running in Digital Ocean (or AWS or GCP).

#### Preparing for Demo

1. Launch `Centos 8` VM on Digital Ocean (or AWS or GCP).
2. Download code submission from Canvas and `SCP` the zip file to the VM.
3. Install MySQL or MariaDB or PostgreSQL RDBMS on the VM.
4. Install dependencies such as Node, Python, Java on the VM.
5. Build the application from source in ZIP file if needed.
6. Application configuration may be manually updated by the student at this point.
7. Launch the application and validate that you can hit the `healthz` endpoint and application is healthy.
8. No SQL script should be manually executed to set up the database.

#### Bootstrapping Database (20%)

1. Start the application.
2. The database objects such as tables, indexes, etc. should be automatically created when application is started.
3. Students are not allowed to run any SQL scripts manually.

#### Web Application APIs (30%)

1. Verify passwords are encrypted with `BCrypt` hashing and salt in the database.

2. Verify that authentication is done via `basic auth` (token-based) and not session-based.
3. APIs can be demoed using any Postman or Restlet or some other REST client but not from the browser.
4. Check the response payload to make sure it meets the assignment objective. The `password` field should not be part of the response payload.
5. Test for `duplicate` account creation in the application. The application should NOT allow multiple accounts with the same email address.
6. Test updating fields such as `account_created` and `account_updated`. Users should never be able to set values for them. These fields are set by the application.
7. Verify non-email username cannot be used for account creation.
8. No 500 internal server errors are returned by the application.
9. No restart of the application server between API calls.

# Lecture #05

Campus	Lecture Date
Boston	02/08/2024
Seattle & Silicon Valley	02/10/2024

## Agenda

- Review [Assignment #02](#)
- The Twelve-Factor App
- Unit, Integration, Performance, and Load Testing
- Networking Fundamentals
- Infrastructure as Code w/Terraform
- Discuss [Assignment #03](#)

## Reading

### The Twelve-Factor App

- [The Twelve-Factor App](#)

### Networking

- [Amazon Virtual Private Cloud Documentation](#)
- [Virtual Private Cloud \(VPC\) on Google Cloud Platform](#)
- [IPv4](#)
- [IPv6](#)
- [Network Address Translation \(NAT\)](#)
- [Reserved IP addresses](#)
- [Private network](#)
- [Multicast](#)

- Subnetwork
- CIDR Notation
- OSI Model
- Internet Protocol Suite

## Software Testing

- REST Assured
- Mockito
- TestNG
- JUnit
- Application Testing Survey Reveals Legacy Testing Processes No Longer Cut It
- Web Service Testing using Rest Assured

## Load Testing

- Apache JMeter
- The Rise of Test Impact Analysis
- How To Use Apache JMeter To Perform Load Testing on a Web Server

## Slides

Lecture slides can be found in this week's Canvas module.

## Lecture Notes - Terraform

- Terraform Init
- Init with Upgrade
- Reconfigure
- Terraform Plan
- Terraform Apply
  - with `-var-file`
- Terraform Destroy
- `.tfvars`

## Lecture Notes - gcloud CLI

- `gcloud auth login`
- `gcloud auth application-default login`
- `gcloud config set project`
- `gcloud auth revoke`
- `gcloud auth application-default revoke`

# Assignment #03

## Due Date

Section	Submission Due Date	Grading Due Date
Boston	02/15/2024 @ 4 PM ET	02/21/2024 @ 9 PM ET
Seattle & Silicon Valley	02/16/2024 @ 9 PM PT	02/23/2024 @ 6 PM PT

## Learning Objectives

### Install gcloud CLI

Install and configure `gcloud CLI` on your development machine (laptop). See [Install the gcloud CLI](#) for detailed instructions.

## Infrastructure as Code



### Note

Wherever supported, you must provide unique names to the resources. You may be asked to create multiple networks in the same account during the demo.

We are going to start setting up networking in our Google Cloud project. This assignment will focus on setting up our networking resources such as Virtual Private Cloud (VPC), Internet Gateway, Route Table, and Routes. We will use Terraform for infrastructure setup and tear down.

## Create & Setup GitHub Repository

1. Create a new private GitHub repository for web applications in the GitHub organization you created.
2. The GitHub repository name must be `tf-gcp-infra`.
3. Update `README.md` in your repository with instructions for setting up your infrastructure using Terraform.
4. Fork the GitHub repository in your namespace. You will do all development work on your fork.
5. All Terraform templates should be in this repository.
6. Add appropriate `.gitignore` to your repository. A collection of useful `.gitignore` templates can be found [here](#).

### **GitHub Repository Branch Protection Rules**

1. Learn more about protected branches.

2. Implement Branch Protection Rules shown in the image below:

**Branch name pattern \***

main

**Protect matching branches** **Require a pull request before merging**

When enabled, all commits must be made to a non-protected branch and submitted via a pull request before they can be merged into a branch that matches this rule.

 **Require approvals**

When enabled, pull requests targeting a matching branch require a number of approvals and no changes requested before they can be merged.

 **Dismiss stale pull request approvals when new commits are pushed**

New reviewable commits pushed to a matching branch will dismiss pull request review approvals.

 **Require review from Code Owners**

Require an approved review in pull requests including files with a designated code owner.

 **Restrict who can dismiss pull request reviews**

Specify people, teams, or apps allowed to dismiss pull request reviews.

 **Allow specified actors to bypass required pull requests**

Specify people, teams, or apps who are allowed to bypass required pull requests.

 **Require approval of the most recent reviewable push**

Whether the most recent reviewable push must be approved by someone other than the person who pushed it.

 **Require status checks to pass before merging**

Choose which [status checks](#) must pass before branches can be merged into a branch that matches this rule. When enabled, commits must first be pushed to another branch, then merged or pushed directly to a branch that matches this rule after status checks have passed.

 **Require branches to be up to date before merging**

This ensures pull requests targeting a matching branch have been tested with the latest code. This setting will not take effect unless at least one status check is enabled (see below).

## No status checks found

Sorry, we couldn't find any status checks in the last week for this repository.

[Learn more about status checks](#)

 **Require conversation resolution before merging**

When enabled, all conversations on code must be resolved before a pull request can be merged into a branch that matches this rule. [Learn more](#).

 **Require signed commits**

Commits pushed to matching branches must have verified signatures.

 **Require linear history**

Prevent merge commits from being pushed to matching branches.

 **Require deployments to succeed before merging**

Choose which environments must be successfully deployed to before branches can be merged into a branch that matches this rule.

**Lock branch**

Branch is read-only. Users cannot push to the branch.

 **Do not allow bypassing the above settings**

The above settings will apply to administrators and custom roles with the "bypass branch protections" permission.

 **Restrict who can push to matching branches**

Specify people, teams, or apps allowed to push to matching branches. Required status checks will still prevent these people, teams, and apps from merging if the checks fail.

**Rules applied to everyone including administrators** **Allow force pushes**

Permit force pushes for all users with push access.

 **Everyone**

Permit force pushes for all users with push access.

 **Specify who can force push**

Only these people, teams, or apps are allowed to force push.

 **Allow deletions**

Allow users with push access to delete matching branches.

3. Add status check to validate terraform templates when pull request is raised.

## Enable GCP Service APIs

Google Cloud Platform requires you to enable services (APIs) before you can use them. Services should be enabled for the project before they are used. Once services are enabled, it may take 10-15 minutes for them to work. You can do this from the Google Cloud Console and make sure you have these documented in the `README.md`. **DO NOT ENABLE ALL THE APIs.**

## Google Cloud Platform Networking Setup

Here is what you need to do for networking infrastructure setup:

1. Create `Virtual Private Cloud (VPC)` with following requirements:
  - a. auto-create subnets should be disabled.
  - b. Routing mode should be set to `regional`.
  - c. No default routes should be created.
2. Create `subnets` in your VPC.
  - a. You must create a `2` subnets in the VPC, first one should be named `webapp` and second one should be named `db`.

- b. The subnet has a /24 CIDR address range.
3. Add a route explicitly to 0.0.0.0/0 with next hop to Internet Gateway and attach it to your VPC.

### Infrastructure as Code with Terraform

For this objective, you must complete the following tasks:

1. Install and set up the gcloud CLI and Terraform .
2. Create a Terraform configuration file that will setup all the networking resources.
3. Values should not be hard coded in your terraform configuration files.
4. You must be able to use the same terraform configuration files in the same GCP project and region to create multiple VPCs including all of its resources.

## Web Application - Integration Tests



### Danger

Do not implement tests using curl or postman . You will need to execute the tests as part of pull requests and add them to status check.

1. Implement integration (and not unit) tests for the /v1/user endpoint with a new GitHub Actions workflow. Do not delete workflow from previous assignments as it must continue to function in parallel to the new one.
2. Test 1 - Create an account, and using the GET call, validate account exists.
3. Test 2 - Update the account and using the GET call, validate the account was updated.
4. This will require your GitHub action to install and setup an actual MySQL and PostgreSQL instance and provide configuration to the application to connect to it.

## Submission

 **Danger**

1. The assignment will be considered late if uploaded to Canvas after the due date.
2. **DO NOT UPLOAD CODE FROM YOUR FORKED REPOSITORY TO CANVAS**

1. All work for this assignment must be done on the feature branch in your fork and merged to the main branch.
2. Submit your code from `all` the repositories in this assignment. Read the instructions carefully to create your zip file.
  - a. Create a folder with the naming convention  
`firstname_lastname_neuid_##` where `##` is the assignment number.
  - b. In the `firstname_lastname_neuid_##` directory clone all of your GitHub (organization) repositories with the `git clone` command. It is important that you clone the repos so that your commit history and branches are preserved.
  - c. Once you have cloned all of your repositories, you will create a zip of the `firstname_lastname_neuid_##` directory. The zip file should be `firstname_lastname_neuid_##.zip` where `##` is the assignment number.
  - d. Now unzip the zip file in some other directory and confirm the content of the zip files.
  - e. Upload the Zip to this assignment.
3. You are allowed to resubmit `3` times. If you think there may be an issue with the ZIP file, feel free to submit it again. Only the latest submission will be used for grading.

## Grading Guidelines

 **Warning**

The following guidelines are for information only. They are subject to change at the discretion of the instructor and TA. A 10% penalty will be imposed if the application crashes due to unhandled exceptions/errors.

## Previous Assignment Objectives

TAs must verify that students have resolved all open issues from the previous assignment(s).

## Git Repository Content Check (10%)

### **Application Code**

1. Check the repository for any IDE-specific files. IDE configuration files must not be in the repository.
2. Verify their `.gitignore` configuration.
3. Check the repository for build artifacts such as `.class`, `.jar`, `.war` files and `build`, `node_modules`, `venv` directory. None of these should be checked into the repository.
4. Check for dependencies. Dependencies from the Maven repository or npm or python should not be committed to the git repository.

### **Infrastructure Code**

1. Check if the repository has been set up with `.gitignore` for Terraform.

## Git Forking Workflow (10%)

1. Verify student has followed the git forking workflow. Code is committed using pull requests and is not pushed directly to the `main` branch.

## GitHub Status Check for IaC (15%)

1. The main branch of the `tf-gcp-infra` repository has status checks and only allows merging PR when status check is successful. Test this updating terraform template with invalid syntax.

## Infrastructure as Code (40%)

1. Create VPC using terraform Template without modifications to the template. Students can only update `terraform.tfvars` file or provide values for variables using the `-var` argument.
2. The VPC has 2 subnets, each with a /24 CIDR. This CIDR range should not be hardcoded. Ask student to setup VPC with a range you provide such as `192.168.1.0/24` and `192.168.2.0/24`.

3. Terraform template creates routes explicitly with the `google_compute_route` resource. If this block is not in the terraform code, students did not do it correctly and gets 0 for this item
4. The VPC should have routing mode set to regional but not hardcoded. This should be configurable via variable.
5. The VPC is setup with auto-create subnet disabled.
6. Students should demo the creation of networking resources using the `terraform apply` command.
7. Students should demo the cleanup of networking resources using the `terraform destroy` command.

### Web Application - Integration Tests (25%)

1. Anytime a PR is raised against the repo, status check runs integration tests against the database. Ask students to first run these tests locally on their laptops and verify that it actually uses a real database. If the integration tests are not using testing framework but curl or cli, students get 0 points for this whole section of the assignment.
2. Have student modify the code (add comment) and raise PR and see if the integration tests run successfully.
3. Have student modify the code and demonstrate that integration tests will fail if there is an issue (update code to append string to returned data so it does not match)

# Lecture #06

Campus	Lecture Date
Boston	02/15/2024
Seattle & Silicon Valley	02/17/2024

## Agenda

- **Mid-Term Exam**
  - BOS: 02/29/2024
  - SJ0/SEA: 03/02/2024
- Review [Assignment #03](#)
- Network Firewall
- Virtual Machines
- Custom Machine Images
- Building Custom Machine Images using Hashicorp Packer
- `systemd` - System and Service Manager
- Discuss [Assignment #04](#)

## Reading

### Timezones

- [Falsehoods programmers believe about time](#)
- [Falsehoods programmers believe about time \(Hacker News\)](#)

### Setup Autorun Using Systemd

- [System and Service Manager](#)
- [Understanding and administering systemd](#)
- [Systemd Essentials: Working with Services, Units, and the Journal](#)
- [Running Your Node.js App With Systemd](#)

- [How To Setup Autorun a Python Script Using Systemd](#)
- [Understanding Systemd Units and Unit Files](#)

## Virtualization

- [Understanding virtualization](#)
- [Virtualization](#)

## Amazon EC2

- [Amazon Elastic Compute Cloud \(Amazon EC2\)](#)

## Google Compute Engine

- [Google Compute Engine](#)

## Packer

- [HashiCorp Packer](#)
- [Google Cloud Platform](#)
- [Amazon Machine Images \(AMI\)](#)
- [Building VM images using Packer](#)

## Slides

Lecture slides can be found in this week's Canvas module.

## Lecture Notes - Packer

<https://developer.hashicorp.com/packer/integrations/hashicorp/googlecompute>  
<https://github.com/hashicorp/packer-plugin-googlecompute/blob/main/docs/README.md>

## Validate Packer Template

```
1 | packer validate -var 'project_id=northeastern-university-6225' -var 'zone=us-east1-b' gcp.pkr.hcl
```

## Build Packer Image

```
1
```

```
packer build -var 'project_id=northeastern-university-6225' -var 'zone=us-east1-b' gcp.pkr.hcl
```

## Log

```

1  $ packer build -var 'project_id=northeastern-university-6225' -var
2  'zone=us-east1-b' gcp.pkr.hcl
3  googlecompute.csye6225-app-custom-image: output will be in this color.
4
5  ==> googlecompute.csye6225-app-custom-image: Checking image does not
6  exist...
7  ==> googlecompute.csye6225-app-custom-image: Creating temporary RSA SSH key
8  for instance...
9  ==> googlecompute.csye6225-app-custom-image: no persistent disk to create
10 ==> googlecompute.csye6225-app-custom-image: Using image: centos-stream-8-
11 v20240110
12 ==> googlecompute.csye6225-app-custom-image: Creating instance...
13     googlecompute.csye6225-app-custom-image: Loading zone: us-east1-b
14     googlecompute.csye6225-app-custom-image: Loading machine type: e2-
15 standard-2
16     googlecompute.csye6225-app-custom-image: Requesting instance
17 creation...
18     googlecompute.csye6225-app-custom-image: Waiting for creation operation
19 to complete...
20     googlecompute.csye6225-app-custom-image: Instance has been created!
21 ==> googlecompute.csye6225-app-custom-image: Waiting for the instance to
22 become running...
23     googlecompute.csye6225-app-custom-image: IP: 34.118.251.153
24 ==> googlecompute.csye6225-app-custom-image: Using SSH communicator to
25 connect: 34.118.251.153
26 ==> googlecompute.csye6225-app-custom-image: Waiting for SSH to become
27 available...
28 ==> googlecompute.csye6225-app-custom-image: Connected to SSH!
29 ==> googlecompute.csye6225-app-custom-image: Provisioning with shell
30 script: /tmp/packer-shell12306091588
31     googlecompute.csye6225-app-custom-image: CentOS Stream 8 - AppStream
32 437 kB/s | 27 MB 01:03
33     googlecompute.csye6225-app-custom-image: CentOS Stream 8 - BaseOS
34 16 MB/s | 10 MB 00:00
35     googlecompute.csye6225-app-custom-image: CentOS Stream 8 - Extras
36 69 kB/s | 18 kB 00:00
37     googlecompute.csye6225-app-custom-image: CentOS Stream 8 - Extras
38 common packages 13 kB/s | 6.9 kB 00:00
39     googlecompute.csye6225-app-custom-image: Google Compute Engine
40 35 kB/s | 11 kB 00:00
41     googlecompute.csye6225-app-custom-image: Google Cloud SDK
42 41 MB/s | 120 MB 00:02
43     googlecompute.csye6225-app-custom-image: Dependencies resolved.
44     googlecompute.csye6225-app-custom-image:
45 =====
46     googlecompute.csye6225-app-custom-image: Package
47 Arch Version Repository Size
48     googlecompute.csye6225-app-custom-image:
49 =====
50     googlecompute.csye6225-app-custom-image: Installing:
51     googlecompute.csye6225-app-custom-image: kernel
52 x86_64 4.18.0-539.e18           baseos      10 M
53     googlecompute.csye6225-app-custom-image: Upgrading:
```

```

54      googlecompute.csye6225-app-custom-image:  chrony
55      x86_64  4.5-1.el8                      baseos      357 k
56      googlecompute.csye6225-app-custom-image:  crond
57      x86_64  1.5.2-10.el8                   baseos      121 k
58      googlecompute.csye6225-app-custom-image:  cronie-anacron
59      x86_64  1.5.2-10.el8                   baseos      42 k
60      googlecompute.csye6225-app-custom-image:  dnf-plugins-core
61      noarch  4.0.21-25.el8                  baseos      77 k
62      googlecompute.csye6225-app-custom-image:  dracut
63      x86_64  049-233.git20240115.el8       baseos      447 k
64      googlecompute.csye6225-app-custom-image:  dracut-config-rescue
65      x86_64  049-233.git20240115.el8       baseos      63 k
66      googlecompute.csye6225-app-custom-image:  dracut-network
67      x86_64  049-233.git20240115.el8       baseos      123 k
68      googlecompute.csye6225-app-custom-image:  dracut-squash
69      x86_64  049-233.git20240115.el8       baseos      64 k
70      googlecompute.csye6225-app-custom-image:  firewalld
71      noarch  0.9.11-4.el8                  baseos      580 k
72      googlecompute.csye6225-app-custom-image:  firewalld-filesystem
73      noarch  0.9.11-4.el8                  baseos      78 k
74      googlecompute.csye6225-app-custom-image:  glib2
75      x86_64  2.56.4-163.el8                baseos      2.5 M
76      googlecompute.csye6225-app-custom-image:  glibc
77      x86_64  2.28-251.el8                 baseos      2.3 M
78      googlecompute.csye6225-app-custom-image:  glibc-common
79      x86_64  2.28-251.el8                 baseos      1.0 M
80      googlecompute.csye6225-app-custom-image:  glibc-gconv-extra
81      x86_64  2.28-251.el8                 baseos      1.7 M
82      googlecompute.csye6225-app-custom-image:  glibc-langpack-en
83      x86_64  2.28-251.el8                 baseos      941 k
84      googlecompute.csye6225-app-custom-image:  gmp
85      x86_64  1:6.1.2-11.el8               baseos      318 k
86      googlecompute.csye6225-app-custom-image:  gnutls
87      x86_64  3.6.16-8.el8.1              baseos      1.0 M
88      googlecompute.csye6225-app-custom-image:  google-cloud-cli
89      x86_64  464.0.0-1                  google-cloud-sdk 121 M
90      googlecompute.csye6225-app-custom-image:  iwl105-firmware
91      noarch  18.168.6.1-121.el8.1       baseos      267 k
92      googlecompute.csye6225-app-custom-image:  iwl135-firmware
93      noarch  18.168.6.1-121.el8.1       baseos      276 k
94      googlecompute.csye6225-app-custom-image:  iwl2000-firmware
95      noarch  18.168.6.1-121.el8.1       baseos      269 k
96      googlecompute.csye6225-app-custom-image:  iwl2030-firmware
97      noarch  18.168.6.1-121.el8.1       baseos      278 k
98      googlecompute.csye6225-app-custom-image:  iwl3160-firmware
99      noarch  1:25.30.13.0-121.el8.1     baseos      510 k
100     googlecompute.csye6225-app-custom-image:  iwl7260-firmware
101     noarch  1:25.30.13.0-121.el8.1     baseos      21 M
102     googlecompute.csye6225-app-custom-image:  kernel-tools
103     x86_64  4.18.0-539.el8             baseos      11 M
104     googlecompute.csye6225-app-custom-image:  kernel-tools-libs
105     x86_64  4.18.0-539.el8             baseos      10 M
106     googlecompute.csye6225-app-custom-image:  kexec-tools
107     x86_64  2.0.26-13.el8              baseos      545 k
108     googlecompute.csye6225-app-custom-image:  kpartx
109     x86_64  0.8.4-41.el8              baseos      120 k
110     googlecompute.csye6225-app-custom-image:  libdnf
111     x86_64  0.63.0-19.el8              baseos      720 k
112     googlecompute.csye6225-app-custom-image:  libmaxminddb

```

113	x86_64 1.2.0-10.el8.1	appstream	33 k
114	googlecompute.csye6225-app-custom-image: libssss_autofs		
115	x86_64 2.9.4-1.el8	baseos	130 k
116	googlecompute.csye6225-app-custom-image: libssss_certmap		
117	x86_64 2.9.4-1.el8	baseos	185 k
118	googlecompute.csye6225-app-custom-image: libssss_idmap		
119	x86_64 2.9.4-1.el8	baseos	132 k
120	googlecompute.csye6225-app-custom-image: libssss_nss_idmap		
121	x86_64 2.9.4-1.el8	baseos	140 k
122	googlecompute.csye6225-app-custom-image: libssss_sudo		
123	x86_64 2.9.4-1.el8	baseos	128 k
124	googlecompute.csye6225-app-custom-image: linux-firmware		
125	noarch 20240111-121.gitb3132c18.el8	baseos	355 M
126	googlecompute.csye6225-app-custom-image: nss		
127	x86_64 3.90.0-6.el8	appstream	753 k
128	googlecompute.csye6225-app-custom-image: nss-softokn		
129	x86_64 3.90.0-6.el8	appstream	1.2 M
130	googlecompute.csye6225-app-custom-image: nss-softokn-freebl		
131	x86_64 3.90.0-6.el8	appstream	376 k
132	googlecompute.csye6225-app-custom-image: nss-sysinit		
133	x86_64 3.90.0-6.el8	appstream	75 k
134	googlecompute.csye6225-app-custom-image: nss-util		
135	x86_64 3.90.0-6.el8	appstream	140 k
136	googlecompute.csye6225-app-custom-image: numactl-libs		
137	x86_64 2.0.16-4.el8	baseos	37 k
138	googlecompute.csye6225-app-custom-image: openssh		
139	x86_64 8.0p1-24.el8	baseos	529 k
140	googlecompute.csye6225-app-custom-image: openssh-clients		
141	x86_64 8.0p1-24.el8	baseos	650 k
142	googlecompute.csye6225-app-custom-image: openssh-server		
143	x86_64 8.0p1-24.el8	baseos	496 k
144	googlecompute.csye6225-app-custom-image: openssl		
145	x86_64 1:1.1.1k-12.el8	baseos	738 k
146	googlecompute.csye6225-app-custom-image: openssl-libs		
147	x86_64 1:1.1.1k-12.el8	baseos	1.5 M
148	googlecompute.csye6225-app-custom-image: pam		
149	x86_64 1.3.1-32.el8	baseos	852 k
150	googlecompute.csye6225-app-custom-image: platform-python		
151	x86_64 3.6.8-59.el8	baseos	87 k
152	googlecompute.csye6225-app-custom-image: python3-dnf-plugins-core		
153	noarch 4.0.21-25.el8	baseos	280 k
154	googlecompute.csye6225-app-custom-image: python3-firewall		
155	noarch 0.9.11-4.el8	baseos	472 k
156	googlecompute.csye6225-app-custom-image: python3-hawkey		
157	x86_64 0.63.0-19.el8	baseos	118 k
158	googlecompute.csye6225-app-custom-image: python3-libdnf		
159	x86_64 0.63.0-19.el8	baseos	788 k
160	googlecompute.csye6225-app-custom-image: python3-libs		
161	x86_64 3.6.8-59.el8	baseos	8.4 M
162	googlecompute.csye6225-app-custom-image: python3-perf		
163	x86_64 4.18.0-539.el8	baseos	10 M
164	googlecompute.csye6225-app-custom-image: python3-syspurpose		
165	x86_64 1.28.42-1.el8	baseos	348 k
166	googlecompute.csye6225-app-custom-image: qemu-guest-agent		
167	x86_64 15:6.2.0-47.module_el8+890+5e1fb8d4	appstream	367 k
168	googlecompute.csye6225-app-custom-image: selinux-policy		
169	noarch 3.14.3-135.el8	baseos	667 k
170	googlecompute.csye6225-app-custom-image: selinux-policy-targeted		
171	noarch 3.14.3-135.el8	baseos	16 M

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172      googlecompute.csye6225-app-custom-image: setup
173      noarch 2.12.2-10.el8                      baseos      185 k
174      googlecompute.csye6225-app-custom-image: sqlite-libs
175      x86_64 3.26.0-19.el8                      baseos      581 k
176      googlecompute.csye6225-app-custom-image: sssd-client
177      x86_64 2.9.4-1.el8                      baseos      251 k
178      googlecompute.csye6225-app-custom-image: sssd-common
179      x86_64 2.9.4-1.el8                      baseos      1.7 M
180      googlecompute.csye6225-app-custom-image: sssd-kcm
181      x86_64 2.9.4-1.el8                      baseos      265 k
182      googlecompute.csye6225-app-custom-image: sssd-nfs-idmap
183      x86_64 2.9.4-1.el8                      baseos      129 k
184      googlecompute.csye6225-app-custom-image: systemd
185      x86_64 239-79.el8                      baseos      3.8 M
186      googlecompute.csye6225-app-custom-image: systemd-libs
187      x86_64 239-79.el8                      baseos      1.1 M
188      googlecompute.csye6225-app-custom-image: systemd-pam
189      x86_64 239-79.el8                      baseos      511 k
190      googlecompute.csye6225-app-custom-image: systemd-udev
191      x86_64 239-79.el8                      baseos      1.6 M
192      googlecompute.csye6225-app-custom-image: tzdata
193      noarch 2023d-1.el8                      baseos      883 k
194      googlecompute.csye6225-app-custom-image: Installing dependencies:
195      googlecompute.csye6225-app-custom-image: kernel-core
196      x86_64 4.18.0-539.el8                  baseos      43 M
197      googlecompute.csye6225-app-custom-image: kernel-modules
198      x86_64 4.18.0-539.el8                  baseos      36 M
199      googlecompute.csye6225-app-custom-image:
200      googlecompute.csye6225-app-custom-image: Transaction Summary
201      googlecompute.csye6225-app-custom-image:
202 =====
203      googlecompute.csye6225-app-custom-image: Install  3 Packages
204      googlecompute.csye6225-app-custom-image: Upgrade  70 Packages
205      googlecompute.csye6225-app-custom-image:
206      googlecompute.csye6225-app-custom-image: Total download size: 678 M
207      googlecompute.csye6225-app-custom-image: Downloading Packages:
208      googlecompute.csye6225-app-custom-image: (1/73): kernel-4.18.0-
209      539.el8.x86_64.rpm   19 MB/s | 10 MB  00:00
210      googlecompute.csye6225-app-custom-image: (2/73): kernel-modules-4.18.0-
211      539.el8.x86_64.rpm  25 MB/s | 36 MB  00:01
212      googlecompute.csye6225-app-custom-image: (3/73): kernel-core-4.18.0-
213      539.el8.x86_64.rpm  23 MB/s | 43 MB  00:01
214      googlecompute.csye6225-app-custom-image: [MIRROR] libmaxminddb-1.2.0-
215      10.el8.1.x86_64.rpm: Curl error (28): Timeout was reached for
216      http://mirrors.cmich.edu/centos/8-
217      stream/AppStream/x86_64/os/Packages/libmaxminddb-1.2.0-10.el8.1.x86_64.rpm
218      [Operation too slow. Less than 1000 bytes/sec transferred the last 30
219      seconds]
220      googlecompute.csye6225-app-custom-image: (4/73): libmaxminddb-1.2.0-
221      10.el8.1.x86_64.rpm  1.1 kB/s | 33 kB  00:30
222      googlecompute.csye6225-app-custom-image: [MIRROR] nss-3.90.0-
223      6.el8.x86_64.rpm: Curl error (28): Timeout was reached for
224      http://mirrors.cmich.edu/centos/8-stream/AppStream/x86_64/os/Packages/nss-
225      3.90.0-6.el8.x86_64.rpm [Operation too slow. Less than 1000 bytes/sec
226      transferred the last 30 seconds]
227      googlecompute.csye6225-app-custom-image: (5/73): nss-softokn-freebl-
228      3.90.0-6.el8.x86_64. 1.4 MB/s | 376 kB  00:00
229      googlecompute.csye6225-app-custom-image: (6/73): nss-sysinit-3.90.0-
230      6.el8.x86_64.rpm    1.1 MB/s | 75 kB  00:00

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231      googlecompute.csye6225-app-custom-image: (7/73): nss-util-3.90.0-
232          6.el8.x86_64.rpm      2.0 MB/s | 140 kB    00:00
233          googlecompute.csye6225-app-custom-image: (8/73): qemu-guest-agent-
234          6.2.0-47.module_el8+89 4.7 MB/s | 367 kB    00:00
235          googlecompute.csye6225-app-custom-image: (9/73): nss-3.90.0-
236          6.el8.x86_64.rpm      25 kB/s | 753 kB    00:30
237          googlecompute.csye6225-app-custom-image: [MIRROR] nss-softokn-3.90.0-
238          6.el8.x86_64.rpm: Curl error (28): Timeout was reached for
239          http://mirrors.cmich.edu/centos/8-stream/AppStream/x86_64/os/Packages/nss-
240          softokn-3.90.0-6.el8.x86_64.rpm [Operation too slow. Less than 1000
241          bytes/sec transferred the last 30 seconds]
242          googlecompute.csye6225-app-custom-image: (10/73): chrony-4.5-
243          1.el8.x86_64.rpm      1.7 MB/s | 357 kB    00:00
244          googlecompute.csye6225-app-custom-image: (11/73): cronie-anacron-1.5.2-
245          10.el8.x86_64.rpm 546 kB/s | 42 kB    00:00
246          googlecompute.csye6225-app-custom-image: (12/73): cronie-1.5.2-
247          10.el8.x86_64.rpm      735 kB/s | 121 kB    00:00
248          googlecompute.csye6225-app-custom-image: (13/73): nss-softokn-3.90.0-
249          6.el8.x86_64.rpm      41 kB/s | 1.2 MB    00:30
250          googlecompute.csye6225-app-custom-image: (14/73): dnf-plugins-core-
251          4.0.21-25.el8.noarch. 836 kB/s | 77 kB    00:00
252          googlecompute.csye6225-app-custom-image: (15/73): dracut-049-
253          233.git20240115.el8.x86_64. 3.0 MB/s | 447 kB    00:00
254          googlecompute.csye6225-app-custom-image: (16/73): dracut-config-rescue-
255          049-233.git202401 478 kB/s | 63 kB    00:00
256          googlecompute.csye6225-app-custom-image: (17/73): dracut-network-049-
257          233.git20240115.el8 1.1 MB/s | 123 kB    00:00
258          googlecompute.csye6225-app-custom-image: (18/73): dracut-squash-049-
259          233.git20240115.el8. 697 kB/s | 64 kB    00:00
260          googlecompute.csye6225-app-custom-image: (19/73): firewalld-filesystem-
261          0.9.11-4.el8.noar 857 kB/s | 78 kB    00:00
262          googlecompute.csye6225-app-custom-image: (20/73): firewalld-0.9.11-
263          4.el8.noarch.rpm      3.3 MB/s | 580 kB    00:00
264          googlecompute.csye6225-app-custom-image: (21/73): glib2-2.56.4-
265          163.el8.x86_64.rpm      10 MB/s | 2.5 MB    00:00
266          googlecompute.csye6225-app-custom-image: (22/73): glibc-2.28-
267          251.el8.x86_64.rpm      10 MB/s | 2.3 MB    00:00
268          googlecompute.csye6225-app-custom-image: (23/73): glibc-common-2.28-
269          251.el8.x86_64.rpm      5.3 MB/s | 1.0 MB    00:00
270          googlecompute.csye6225-app-custom-image: (24/73): gmp-6.1.2-
271          11.el8.x86_64.rpm      2.6 MB/s | 318 kB    00:00
272          googlecompute.csye6225-app-custom-image: (25/73): glibc-gconv-extra-
273          2.28-251.el8.x86_64. 9.7 MB/s | 1.7 MB    00:00
274          googlecompute.csye6225-app-custom-image: (26/73): glibc-langpack-en-
275          2.28-251.el8.x86_64. 5.5 MB/s | 941 kB    00:00
276          googlecompute.csye6225-app-custom-image: (27/73): iwl105-firmware-
277          18.168.6.1-121.el8.1.n 2.2 MB/s | 267 kB    00:00
278          googlecompute.csye6225-app-custom-image: (28/73): iwl135-firmware-
279          18.168.6.1-121.el8.1.n 2.2 MB/s | 276 kB    00:00
280          googlecompute.csye6225-app-custom-image: (29/73): gnutls-3.6.16-
281          8.el8.1.x86_64.rpm      5.9 MB/s | 1.0 MB    00:00
282          googlecompute.csye6225-app-custom-image: (30/73): iwl2000-firmware-
283          18.168.6.1-121.el8.1. 2.2 MB/s | 269 kB    00:00
284          googlecompute.csye6225-app-custom-image: (31/73): iwl2030-firmware-
285          18.168.6.1-121.el8.1. 2.2 MB/s | 278 kB    00:00
286          googlecompute.csye6225-app-custom-image: (32/73): iwl3160-firmware-
287          25.30.13.0-121.el8.1. 3.3 MB/s | 510 kB    00:00
288          googlecompute.csye6225-app-custom-image: (33/73): kernel-tools-4.18.0-
289          539.el8.x86_64.rpm     24 MB/s | 11 MB    00:00

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290      googlecompute.csye6225-app-custom-image: (34/73): kernel-tools-libs-
291          4.18.0-539.el8.x86_6 17 MB/s | 10 MB 00:00
292          googlecompute.csye6225-app-custom-image: (35/73): kexec-tools-2.0.26-
293          13.el8.x86_64.rpm 2.5 MB/s | 545 kB 00:00
294          googlecompute.csye6225-app-custom-image: (36/73): kpartx-0.8.4-
295          41.el8.x86_64.rpm 1.1 MB/s | 120 kB 00:00
296          googlecompute.csye6225-app-custom-image: (37/73): libdnf-0.63.0-
297          19.el8.x86_64.rpm 4.6 MB/s | 720 kB 00:00
298          googlecompute.csye6225-app-custom-image: (38/73): libsss_autofs-2.9.4-
299          1.el8.x86_64.rpm 1.2 MB/s | 130 kB 00:00
300          googlecompute.csye6225-app-custom-image: (39/73): iwl7260-firmware-
301          25.30.13.0-121.el8.1. 20 MB/s | 21 MB 00:01
302          googlecompute.csye6225-app-custom-image: (40/73): libsss_certmap-2.9.4-
303          1.el8.x86_64.rpm 818 kB/s | 185 kB 00:00
304          googlecompute.csye6225-app-custom-image: (41/73): libsss_idmap-2.9.4-
305          1.el8.x86_64.rpm 723 kB/s | 132 kB 00:00
306          googlecompute.csye6225-app-custom-image: (42/73): libsss_nss_idmap-
307          2.9.4-1.el8.x86_64.rpm 1.3 MB/s | 140 kB 00:00
308          googlecompute.csye6225-app-custom-image: (43/73): libsss_sudo-2.9.4-
309          1.el8.x86_64.rpm 1.2 MB/s | 128 kB 00:00
310          googlecompute.csye6225-app-custom-image: (44/73): numactl-libs-2.0.16-
311          4.el8.x86_64.rpm 476 kB/s | 37 kB 00:00
312          googlecompute.csye6225-app-custom-image: (45/73): openssh-8.0p1-
313          24.el8.x86_64.rpm 3.7 MB/s | 529 kB 00:00
314          googlecompute.csye6225-app-custom-image: (46/73): openssh-clients-
315          8.0p1-24.el8.x86_64.rpm 4.2 MB/s | 650 kB 00:00
316          googlecompute.csye6225-app-custom-image: (47/73): openssh-server-8.0p1-
317          24.el8.x86_64.rpm 3.5 MB/s | 496 kB 00:00
318          googlecompute.csye6225-app-custom-image: (48/73): openssl-1.1.1k-
319          12.el8.x86_64.rpm 4.7 MB/s | 738 kB 00:00
320          googlecompute.csye6225-app-custom-image: (49/73): openssl-libs-1.1.1k-
321          12.el8.x86_64.rpm 7.5 MB/s | 1.5 MB 00:00
322          googlecompute.csye6225-app-custom-image: (50/73): pam-1.3.1-
323          32.el8.x86_64.rpm 5.3 MB/s | 852 kB 00:00
324          googlecompute.csye6225-app-custom-image: (51/73): platform-python-
325          3.6.8-59.el8.x86_64.rpm 954 kB/s | 87 kB 00:00
326          googlecompute.csye6225-app-custom-image: (52/73): python3-dnf-plugins-
327          core-4.0.21-25.el8 2.2 MB/s | 280 kB 00:00
328          googlecompute.csye6225-app-custom-image: (53/73): python3-firewall-
329          0.9.11-4.el8.noarch.rpm 3.4 MB/s | 472 kB 00:00
330          googlecompute.csye6225-app-custom-image: (54/73): python3-hawkey-
331          0.63.0-19.el8.x86_64.rpm 1.1 MB/s | 118 kB 00:00
332          googlecompute.csye6225-app-custom-image: (55/73): python3-libdnf-
333          0.63.0-19.el8.x86_64.rpm 4.6 MB/s | 788 kB 00:00
334          googlecompute.csye6225-app-custom-image: (56/73): python3-libs-3.6.8-
335          59.el8.x86_64.rpm 23 MB/s | 8.4 MB 00:00
336          googlecompute.csye6225-app-custom-image: (57/73): python3-perf-4.18.0-
337          539.el8.x86_64.rpm 24 MB/s | 10 MB 00:00
338          googlecompute.csye6225-app-custom-image: (58/73): python3-syspurpose-
339          1.28.42-1.el8.x86_6 1.8 MB/s | 348 kB 00:00
340          googlecompute.csye6225-app-custom-image: (59/73): selinux-policy-
341          3.14.3-135.el8.noarch.rpm 4.2 MB/s | 667 kB 00:00
342          googlecompute.csye6225-app-custom-image: (60/73): setup-2.12.2-
343          10.el8.noarch.rpm 1.5 MB/s | 185 kB 00:00
344          googlecompute.csye6225-app-custom-image: (61/73): sqlite-libs-3.26.0-
345          19.el8.x86_64.rpm 4.1 MB/s | 581 kB 00:00
346          googlecompute.csye6225-app-custom-image: (62/73): selinux-policy-
347          targeted-3.14.3-135.el8 30 MB/s | 16 MB 00:00
348          googlecompute.csye6225-app-custom-image: (63/73): sssd-client-2.9.4-
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349 1.el8.x86_64.rpm      1.7 MB/s | 251 kB    00:00
350      googlecompute.csye6225-app-custom-image: (64/73): sssd-kcm-2.9.4-
351 1.el8.x86_64.rpm      1.9 MB/s | 265 kB    00:00
352      googlecompute.csye6225-app-custom-image: (65/73): sssd-common-2.9.4-
353 1.el8.x86_64.rpm      10 MB/s | 1.7 MB    00:00
354      googlecompute.csye6225-app-custom-image: (66/73): sssd-nfs-idmap-2.9.4-
355 1.el8.x86_64.rpm     1.2 MB/s | 129 kB    00:00
356      googlecompute.csye6225-app-custom-image: (67/73): systemd-libs-239-
357 79.el8.x86_64.rpm     6.7 MB/s | 1.1 MB    00:00
358      googlecompute.csye6225-app-custom-image: (68/73): systemd-239-
359 79.el8.x86_64.rpm     12 MB/s | 3.8 MB    00:00
360      googlecompute.csye6225-app-custom-image: (69/73): systemd-pam-239-
361 79.el8.x86_64.rpm     3.2 MB/s | 511 kB    00:00
362      googlecompute.csye6225-app-custom-image: (70/73): systemd-udev-239-
363 79.el8.x86_64.rpm     9.4 MB/s | 1.6 MB    00:00
364      googlecompute.csye6225-app-custom-image: (71/73): tzdata-2023d-
365 1.el8.noarch.rpm      5.4 MB/s | 883 kB    00:00
366      googlecompute.csye6225-app-custom-image: (72/73):
367 2a7a8ec28613fc0b916d0f995d4c19824b4bb1 45 MB/s | 121 MB    00:02
368      googlecompute.csye6225-app-custom-image: (73/73): linux-firmware-
369 20240111-121.gitb3132c1 27 MB/s | 355 MB    00:13
370      googlecompute.csye6225-app-custom-image: -----
371 -----
372      googlecompute.csye6225-app-custom-image: Total
373 14 MB/s | 678 MB    00:47
374      googlecompute.csye6225-app-custom-image: Running transaction check
375      googlecompute.csye6225-app-custom-image: Transaction check succeeded.
376      googlecompute.csye6225-app-custom-image: Running transaction test
377      googlecompute.csye6225-app-custom-image: Transaction test succeeded.
378      googlecompute.csye6225-app-custom-image: Running transaction
379      googlecompute.csye6225-app-custom-image: Preparing      :
380 1/1
381      googlecompute.csye6225-app-custom-image: Running scriptlet: tzdata-
382 2023d-1.el8.noarch      1/1
383      googlecompute.csye6225-app-custom-image: Upgrading      : tzdata-
384 2023d-1.el8.noarch      1/143
385      googlecompute.csye6225-app-custom-image: Upgrading      : glibc-
386 common-2.28-251.el8.x86_64      2/143
387      googlecompute.csye6225-app-custom-image: Upgrading      : glibc-
388 gconv-extra-2.28-251.el8.x86_64      3/143
389      googlecompute.csye6225-app-custom-image: Running scriptlet: glibc-
390 gconv-extra-2.28-251.el8.x86_64      3/143
391      googlecompute.csye6225-app-custom-image: Upgrading      : glibc-
392 langpack-en-2.28-251.el8.x86_64      4/143
393      googlecompute.csye6225-app-custom-image: Running scriptlet: glibc-
394 2.28-251.el8.x86_64      5/143
395      googlecompute.csye6225-app-custom-image: Upgrading      : glibc-
396 2.28-251.el8.x86_64      5/143
397      googlecompute.csye6225-app-custom-image: Running scriptlet: glibc-
398 2.28-251.el8.x86_64      5/143
399      googlecompute.csye6225-app-custom-image: Upgrading      : openssl-
400 libs-1:1.1.1k-12.el8.x86_64      6/143
401      googlecompute.csye6225-app-custom-image: Running scriptlet: openssl-
402 libs-1:1.1.1k-12.el8.x86_64      6/143
403      googlecompute.csye6225-app-custom-image: Upgrading      : pam-
404 1.3.1-32.el8.x86_64      7/143
405      googlecompute.csye6225-app-custom-image: Running scriptlet: pam-
406 1.3.1-32.el8.x86_64      7/143
407      googlecompute.csye6225-app-custom-image: Upgrading      : sqlite-

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408  libs-3.26.0-19.el8.x86_64           8/143
409    googlecompute.csye6225-app-custom-image: Upgrading      : systemd-
410  libs-239-79.el8.x86_64             9/143
411    googlecompute.csye6225-app-custom-image: Running scriptlet: systemd-
412  libs-239-79.el8.x86_64             9/143
413    googlecompute.csye6225-app-custom-image: Upgrading      : platform-
414  python-3.6.8-59.el8.x86_64         10/143
415    googlecompute.csye6225-app-custom-image: Running scriptlet: platform-
416  python-3.6.8-59.el8.x86_64         10/143
417    googlecompute.csye6225-app-custom-image: Upgrading      : python3-
418  libs-3.6.8-59.el8.x86_64           11/143
419    googlecompute.csye6225-app-custom-image: Upgrading      : nss-util-
420  3.90.0-6.el8.x86_64               12/143
421    googlecompute.csye6225-app-custom-image: Running scriptlet: openssh-
422  8.0p1-24.el8.x86_64              13/143
423    googlecompute.csye6225-app-custom-image: Upgrading      : openssh-
424  8.0p1-24.el8.x86_64              13/143
425    googlecompute.csye6225-app-custom-image: Upgrading      :
426  libsss_idmap-2.9.4-1.el8.x86_64   14/143
427    googlecompute.csye6225-app-custom-image: Running scriptlet:
428  libsss_idmap-2.9.4-1.el8.x86_64   14/143
429    googlecompute.csye6225-app-custom-image: Upgrading      : nss-
430  softokn-freebl-3.90.0-6.el8.x86_64 15/143
431    googlecompute.csye6225-app-custom-image: Upgrading      : nss-
432  softokn-3.90.0-6.el8.x86_64       16/143
433    googlecompute.csye6225-app-custom-image: Upgrading      : nss-
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435    googlecompute.csye6225-app-custom-image: Upgrading      : nss-
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443    googlecompute.csye6225-app-custom-image: Upgrading      : gmp-
444  1:6.1.2-11.el8.x86_64            21/143
445    googlecompute.csye6225-app-custom-image: Running scriptlet: gmp-
446  1:6.1.2-11.el8.x86_64            21/143
447    googlecompute.csye6225-app-custom-image: Upgrading      : gnutls-
448  3.6.16-8.el8.1.x86_64           22/143
449    googlecompute.csye6225-app-custom-image: Running scriptlet: systemd-
450  239-79.el8.x86_64               23/143
451    googlecompute.csye6225-app-custom-image: Upgrading      : systemd-
452  239-79.el8.x86_64               23/143
453    googlecompute.csye6225-app-custom-image: Running scriptlet: systemd-
454  239-79.el8.x86_64               23/143
455    googlecompute.csye6225-app-custom-image: Upgrading      : systemd-
456  pam-239-79.el8.x86_64            24/143
457    googlecompute.csye6225-app-custom-image: Upgrading      : glib2-
458  2.56.4-163.el8.x86_64           25/143
459    googlecompute.csye6225-app-custom-image: Upgrading      : libdnf-
460  0.63.0-19.el8.x86_64             26/143
461    googlecompute.csye6225-app-custom-image: Upgrading      : systemd-
462  udev-239-79.el8.x86_64            27/143
463    googlecompute.csye6225-app-custom-image: Running scriptlet: systemd-
464  udev-239-79.el8.x86_64            27/143
465    googlecompute.csye6225-app-custom-image: Upgrading      : python3-
466  libdnf-0.63.0-19.el8.x86_64      28/143

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467      googlecompute.csye6225-app-custom-image: Upgrading      : python3-
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469      googlecompute.csye6225-app-custom-image: Upgrading      : python3-
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471      googlecompute.csye6225-app-custom-image: Upgrading      : cronie-
472      anacron-1.5.2-10.el8.x86_64          31/143
473      googlecompute.csye6225-app-custom-image: Running scriptlet: cronie-
474      anacron-1.5.2-10.el8.x86_64          31/143
475      googlecompute.csye6225-app-custom-image: Upgrading      : cronie-
476      1.5.2-10.el8.x86_64                  32/143
477      googlecompute.csye6225-app-custom-image: Running scriptlet: cronie-
478      1.5.2-10.el8.x86_64                  32/143
479      googlecompute.csye6225-app-custom-image: Upgrading      : kernel-
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481      googlecompute.csye6225-app-custom-image: Running scriptlet: kernel-
482      tools-libs-4.18.0-539.el8.x86_64     33/143
483      googlecompute.csye6225-app-custom-image: Upgrading      : kpartx-
484      0.8.4-41.el8.x86_64                 34/143
485      googlecompute.csye6225-app-custom-image: Upgrading      : dracut-
486      049-233.git20240115.el8.x86_64     35/143
487      googlecompute.csye6225-app-custom-image: Upgrading      : dracut-
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489      googlecompute.csye6225-app-custom-image: Upgrading      : dracut-
490      squash-049-233.git20240115.el8.x86_64 37/143
491      googlecompute.csye6225-app-custom-image: Upgrading      :
492      libssss_autoofs-2.9.4-1.el8.x86_64   38/143
493      googlecompute.csye6225-app-custom-image: Upgrading      :
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495      googlecompute.csye6225-app-custom-image: Running scriptlet:
496      libssss_nss_idmap-2.9.4-1.el8.x86_64 39/143
497      googlecompute.csye6225-app-custom-image: Upgrading      : sssd-
498      client-2.9.4-1.el8.x86_64           40/143
499      googlecompute.csye6225-app-custom-image: Running scriptlet: sssd-
500      client-2.9.4-1.el8.x86_64           40/143
501      googlecompute.csye6225-app-custom-image: Upgrading      :
502      libssss_sudo-2.9.4-1.el8.x86_64    41/143
503      googlecompute.csye6225-app-custom-image: Running scriptlet:
504      libssss_sudo-2.9.4-1.el8.x86_64    41/143
505      googlecompute.csye6225-app-custom-image: Upgrading      : numactl-
506      libs-2.0.16-4.el8.x86_64           42/143
507      googlecompute.csye6225-app-custom-image: Running scriptlet: numactl-
508      libs-2.0.16-4.el8.x86_64           42/143
509      googlecompute.csye6225-app-custom-image: Upgrading      : sssd-nfs-
510      idmap-2.9.4-1.el8.x86_64          43/143
511      googlecompute.csye6225-app-custom-image: Running scriptlet: sssd-
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513      googlecompute.csye6225-app-custom-image: Upgrading      : sssd-
514      common-2.9.4-1.el8.x86_64          44/143
515      googlecompute.csye6225-app-custom-image: Running scriptlet: sssd-
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517      googlecompute.csye6225-app-custom-image: Upgrading      : selinux-
518      policy-3.14.3-135.el8.noarch     45/143
519      googlecompute.csye6225-app-custom-image: Running scriptlet: selinux-
520      policy-3.14.3-135.el8.noarch     45/143
521      googlecompute.csye6225-app-custom-image: Upgrading      : linux-
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523      googlecompute.csye6225-app-custom-image: Installing     : kernel-
524      core-4.18.0-539.el8.x86_64        47/143
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528 modules-4.18.0-539.el8.x86_64          48/143
529     googlecompute.csye6225-app-custom-image: Running scriptlet: kernel-
530 modules-4.18.0-539.el8.x86_64          48/143
531     googlecompute.csye6225-app-custom-image: Upgrading       :
532 firewalld-filesystem-0.9.11-4.el8.noarch 49/143
533     googlecompute.csye6225-app-custom-image: Upgrading       :
534 firewalld-0.9.11-4.el8.noarch          50/143
535     googlecompute.csye6225-app-custom-image: Running scriptlet:
536 firewalld-0.9.11-4.el8.noarch          50/143
537     googlecompute.csye6225-app-custom-image: Installing      : kernel-
538 4.18.0-539.el8.x86_64                 51/143
539     googlecompute.csye6225-app-custom-image: Running scriptlet: selinux-
540 policy-targeted-3.14.3-135.el8.noarch   52/143
541     googlecompute.csye6225-app-custom-image: Upgrading       : selinux-
542 policy-targeted-3.14.3-135.el8.noarch   52/143
543     googlecompute.csye6225-app-custom-image: Running scriptlet: selinux-
544 policy-targeted-3.14.3-135.el8.noarch   52/143
545     googlecompute.csye6225-app-custom-image: Upgrading       : sssd-kcm-
546 2.9.4-1.el8.x86_64                   53/143
547     googlecompute.csye6225-app-custom-image: Running scriptlet: sssd-kcm-
548 2.9.4-1.el8.x86_64                   53/143
549     googlecompute.csye6225-app-custom-image: Upgrading       : python3-
550 perf-4.18.0-539.el8.x86_64            54/143
551     googlecompute.csye6225-app-custom-image: Upgrading       : kexec-
552 tools-2.0.26-13.el8.x86_64            55/143
553     googlecompute.csye6225-app-custom-image: Running scriptlet: kexec-
554 tools-2.0.26-13.el8.x86_64            55/143
555     googlecompute.csye6225-app-custom-image: Upgrading       : dracut-
556 config-rescue-049-233.git20240115.el8.x86 56/143
557     googlecompute.csye6225-app-custom-image: Upgrading       : kernel-
558 tools-4.18.0-539.el8.x86_64            57/143
559     googlecompute.csye6225-app-custom-image: Running scriptlet: kernel-
560 tools-4.18.0-539.el8.x86_64            57/143
561     googlecompute.csye6225-app-custom-image: Upgrading       : dnf-
562 plugins-core-4.0.21-25.el8.noarch     58/143
563     googlecompute.csye6225-app-custom-image: Upgrading       : qemu-
564 guest-agent-15:6.2.0-47.module_el8+890+5e1f 59/143
565     googlecompute.csye6225-app-custom-image: Running scriptlet: qemu-
566 guest-agent-15:6.2.0-47.module_el8+890+5e1f 59/143
567     googlecompute.csye6225-app-custom-image: Running scriptlet: chrony-
568 4.5-1.el8.x86_64                     60/143
569     googlecompute.csye6225-app-custom-image: Upgrading       : chrony-
570 4.5-1.el8.x86_64                     60/143
571     googlecompute.csye6225-app-custom-image: Running scriptlet: chrony-
572 4.5-1.el8.x86_64                     60/143
573     googlecompute.csye6225-app-custom-image: Running scriptlet: openssh-
574 server-8.0p1-24.el8.x86_64            61/143
575     googlecompute.csye6225-app-custom-image: Upgrading       : openssh-
576 server-8.0p1-24.el8.x86_64            61/143
577     googlecompute.csye6225-app-custom-image: Running scriptlet: openssh-
578 server-8.0p1-24.el8.x86_64            61/143
579     googlecompute.csye6225-app-custom-image: Upgrading       : openssh-
580 clients-8.0p1-24.el8.x86_64           62/143
581     googlecompute.csye6225-app-custom-image: Upgrading       : python3-
582 syspurpose-1.28.42-1.el8.x86_64        63/143
583     googlecompute.csye6225-app-custom-image: Upgrading       : openssl-
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585      googlecompute.csye6225-app-custom-image: Upgrading      :
586      libmaxminddb-1.2.0-10.el8.1.x86_64          65/143
587      googlecompute.csye6225-app-custom-image: Running scriptlet:
588      libmaxminddb-1.2.0-10.el8.1.x86_64          65/143
589      googlecompute.csye6225-app-custom-image: Upgrading      : google-
590      cloud-cli-464.0.0-1.x86_64                66/143
591      googlecompute.csye6225-app-custom-image: Running scriptlet: google-
592      cloud-cli-464.0.0-1.x86_64                66/143
593      googlecompute.csye6225-app-custom-image: Upgrading      : setup-
594      2.12.2-10.el8.noarch                      67/143
595      googlecompute.csye6225-app-custom-image: warning: /etc/shadow created
596      as /etc/shadow.rpmnew
597      googlecompute.csye6225-app-custom-image:
598      googlecompute.csye6225-app-custom-image: Running scriptlet: setup-
599      2.12.2-10.el8.noarch                      67/143
600      googlecompute.csye6225-app-custom-image: Upgrading      : iwl7260-
601      firmware-1:25.30.13.0-121.el8.1.noarch    68/143
602      googlecompute.csye6225-app-custom-image: Upgrading      : iwl3160-
603      firmware-1:25.30.13.0-121.el8.1.noarch    69/143
604      googlecompute.csye6225-app-custom-image: Upgrading      : iwl2030-
605      firmware-18.168.6.1-121.el8.1.noarch     70/143
606      googlecompute.csye6225-app-custom-image: Upgrading      : iwl2000-
607      firmware-18.168.6.1-121.el8.1.noarch     71/143
608      googlecompute.csye6225-app-custom-image: Upgrading      : iwl135-
609      firmware-18.168.6.1-121.el8.1.noarch     72/143
610      googlecompute.csye6225-app-custom-image: Upgrading      : iwl105-
611      firmware-18.168.6.1-121.el8.1.noarch     73/143
612      googlecompute.csye6225-app-custom-image: Running scriptlet: openssh-
613      server-8.0p1-21.el8.x86_64              74/143
614      googlecompute.csye6225-app-custom-image: Cleanup       : openssh-
615      server-8.0p1-21.el8.x86_64              74/143
616      googlecompute.csye6225-app-custom-image: Running scriptlet: openssh-
617      server-8.0p1-21.el8.x86_64              74/143
618      googlecompute.csye6225-app-custom-image: Cleanup       : nss-
619      3.90.0-4.el8.x86_64                    75/143
620      googlecompute.csye6225-app-custom-image: Cleanup       : nss-
621      softokn-3.90.0-4.el8.x86_64            76/143
622      googlecompute.csye6225-app-custom-image: Running scriptlet: qemu-
623      guest-agent-15:6.2.0-44.module_el8+789+f85d 77/143
624      googlecompute.csye6225-app-custom-image: Cleanup       : qemu-
625      guest-agent-15:6.2.0-44.module_el8+789+f85d 77/143
626      googlecompute.csye6225-app-custom-image: Running scriptlet: qemu-
627      guest-agent-15:6.2.0-44.module_el8+789+f85d 77/143
628      googlecompute.csye6225-app-custom-image: Running scriptlet: sssd-kcm-
629      2.9.3-2.el8.x86_64                     78/143
630      googlecompute.csye6225-app-custom-image: Cleanup       : sssd-kcm-
631      2.9.3-2.el8.x86_64                     78/143
632      googlecompute.csye6225-app-custom-image: Running scriptlet: sssd-kcm-
633      2.9.3-2.el8.x86_64                     78/143
634      googlecompute.csye6225-app-custom-image: Running scriptlet: sssd-
635      common-2.9.3-2.el8.x86_64               79/143
636      googlecompute.csye6225-app-custom-image: Cleanup       : sssd-
637      common-2.9.3-2.el8.x86_64               79/143
638      googlecompute.csye6225-app-custom-image: Running scriptlet: sssd-
639      common-2.9.3-2.el8.x86_64               79/143
640      googlecompute.csye6225-app-custom-image: Running scriptlet: sssd-
641      client-2.9.3-2.el8.x86_64              80/143
642      googlecompute.csye6225-app-custom-image: Cleanup       : sssd-
643      client-2.9.3-2.el8.x86_64              80/143

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644     googlecompute.csye6225-app-custom-image: Running scriptlet: sssd-
645     client-2.9.3-2.el8.x86_64                         80/143
646     googlecompute.csye6225-app-custom-image: Running scriptlet: chrony-
647     4.2-1.el8.x86_64                                     81/143
648     googlecompute.csye6225-app-custom-image: Cleanup      : chrony-
649     4.2-1.el8.x86_64                                     81/143
650     googlecompute.csye6225-app-custom-image: Running scriptlet: chrony-
651     4.2-1.el8.x86_64                                     81/143
652     googlecompute.csye6225-app-custom-image: Cleanup      : openssh-
653     clients-8.0p1-21.el8.x86_64                        82/143
654     googlecompute.csye6225-app-custom-image: Running scriptlet: kexec-
655     tools-2.0.26-12.el8.x86_64                         83/143
656     googlecompute.csye6225-app-custom-image: Cleanup      : kexec-
657     tools-2.0.26-12.el8.x86_64                         83/143
658     googlecompute.csye6225-app-custom-image: Running scriptlet: kexec-
659     tools-2.0.26-12.el8.x86_64                         83/143
660     googlecompute.csye6225-app-custom-image: Cleanup      : openssh-
661     8.0p1-21.el8.x86_64                                84/143
662     googlecompute.csye6225-app-custom-image: Cleanup      : openssl-
663     1:1.1.1k-11.el8.x86_64                            85/143
664     googlecompute.csye6225-app-custom-image: Running scriptlet: kernel-
665     tools-4.18.0-532.el8.x86_64                         86/143
666     googlecompute.csye6225-app-custom-image: Cleanup      : kernel-
667     tools-4.18.0-532.el8.x86_64                         86/143
668     googlecompute.csye6225-app-custom-image: Running scriptlet: kernel-
669     tools-4.18.0-532.el8.x86_64                         86/143
670     googlecompute.csye6225-app-custom-image: Running scriptlet: cronie-
671     1.5.2-8.el8.x86_64                                87/143
672     googlecompute.csye6225-app-custom-image: Cleanup      : cronie-
673     1.5.2-8.el8.x86_64                                87/143
674     googlecompute.csye6225-app-custom-image: Running scriptlet: cronie-
675     1.5.2-8.el8.x86_64                                87/143
676     googlecompute.csye6225-app-custom-image: Cleanup      : python3-
677     perf-4.18.0-532.el8.x86_64                        88/143
678     googlecompute.csye6225-app-custom-image: Cleanup      :
679     libsss_nss_idmap-2.9.3-2.el8.x86_64                89/143
680     googlecompute.csye6225-app-custom-image: Running scriptlet:
681     libsss_nss_idmap-2.9.3-2.el8.x86_64                89/143
682     googlecompute.csye6225-app-custom-image: Cleanup      :
683     libsss_certmap-2.9.3-2.el8.x86_64                 90/143
684     googlecompute.csye6225-app-custom-image: Running scriptlet:
685     libsss_certmap-2.9.3-2.el8.x86_64                 90/143
686     googlecompute.csye6225-app-custom-image: Cleanup      : numactl-
687     libs-2.0.16-3.el8.x86_64                           91/143
688     googlecompute.csye6225-app-custom-image: Running scriptlet: numactl-
689     libs-2.0.16-3.el8.x86_64                           91/143
690     googlecompute.csye6225-app-custom-image: Cleanup      : nss-
691     softokn-freebl-3.90.0-4.el8.x86_64                92/143
692     googlecompute.csye6225-app-custom-image: Cleanup      :
693     libsss_idmap-2.9.3-2.el8.x86_64                  93/143
694     googlecompute.csye6225-app-custom-image: Running scriptlet:
695     libsss_idmap-2.9.3-2.el8.x86_64                  93/143
696     googlecompute.csye6225-app-custom-image: Cleanup      :
697     libsss_sudo-2.9.3-2.el8.x86_64                   94/143
698     googlecompute.csye6225-app-custom-image: Running scriptlet:
699     libsss_sudo-2.9.3-2.el8.x86_64                   94/143
700     googlecompute.csye6225-app-custom-image: Cleanup      : nss-
701     sysinit-3.90.0-4.el8.x86_64                      95/143
702     googlecompute.csye6225-app-custom-image: Cleanup      : nss-util-
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703 3.90.0-4.el8.x86_64           96/143
704   googlecompute.csye6225-app-custom-image: Cleanup      : sssd-nfs-
705 idmap-2.9.3-2.el8.x86_64       97/143
706   googlecompute.csye6225-app-custom-image: Cleanup      :
707 libmaxminddb-1.2.0-10.el8.x86_64 98/143
708   googlecompute.csye6225-app-custom-image: Running scriptlet:
709 libmaxminddb-1.2.0-10.el8.x86_64 98/143
710   googlecompute.csye6225-app-custom-image: Running scriptlet:
711 firewalld-0.9.11-1.el8.noarch   99/143
712   googlecompute.csye6225-app-custom-image: Cleanup      :
713 firewalld-0.9.11-1.el8.noarch   99/143
714   googlecompute.csye6225-app-custom-image: Running scriptlet:
715 firewalld-0.9.11-1.el8.noarch   99/143
716   googlecompute.csye6225-app-custom-image: Cleanup      : selinux-
717 policy-targeted-3.14.3-133.el8.noarch 100/143
718   googlecompute.csye6225-app-custom-image: Running scriptlet: selinux-
719 policy-targeted-3.14.3-133.el8.noarch 100/143
720   googlecompute.csye6225-app-custom-image: Cleanup      : python3-
721 syspurpose-1.28.40-1.el8.x86_64   101/143
722   googlecompute.csye6225-app-custom-image: Cleanup      : python3-
723 firewall-0.9.11-1.el8.noarch    102/143
724   googlecompute.csye6225-app-custom-image: Cleanup      : dracut-
725 network-049-231.git20231115.el8.x86_64 103/143
726   googlecompute.csye6225-app-custom-image: Cleanup      : dracut-
727 squash-049-231.git20231115.el8.x86_64 104/143
728   googlecompute.csye6225-app-custom-image: Cleanup      : dracut-
729 config-rescue-049-231.git20231115.el8.x86 105/143
730   googlecompute.csye6225-app-custom-image: Cleanup      : dnf-
731 plugins-core-4.0.21-24.el8.noarch 106/143
732   googlecompute.csye6225-app-custom-image: Cleanup      : python3-
733 dnf-plugins-core-4.0.21-24.el8.noarch 107/143
734   googlecompute.csye6225-app-custom-image: Cleanup      : selinux-
735 policy-3.14.3-133.el8.noarch     108/143
736   googlecompute.csye6225-app-custom-image: Running scriptlet: selinux-
737 policy-3.14.3-133.el8.noarch     108/143
738   googlecompute.csye6225-app-custom-image: Cleanup      :
739 firewalld-filesystem-0.9.11-1.el8.noarch 109/143
740   googlecompute.csye6225-app-custom-image: Running scriptlet: google-
741 cloud-cli-459.0-1.x86_64        110/143
742   googlecompute.csye6225-app-custom-image: Cleanup      : google-
743 cloud-cli-459.0-1.x86_64        110/143
744   googlecompute.csye6225-app-custom-image: Running scriptlet: google-
745 cloud-cli-459.0-1.x86_64        110/143
746   googlecompute.csye6225-app-custom-image: Cleanup      : setup-
747 2.12.2-9.el8.noarch            111/143
748   googlecompute.csye6225-app-custom-image: Cleanup      : linux-
749 firmware-20231121-120.git9552083a.el8.noar 112/143
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751 firmware-1:25.30.13.0-120.el8.1.noarch 113/143
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774      googlecompute.csye6225-app-custom-image:   Cleanup      : glib2-
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797      libs-1:1.1.1k-11.el8.x86_64     132/143
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799      1:6.1.2-10.el8.x86_64          133/143
800      googlecompute.csye6225-app-custom-image:   Running scriptlet: gmp-
801      1:6.1.2-10.el8.x86_64          133/143
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865 softokn-freebl-3.90.0-6.el8.x86_64    10/143
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942     googlecompute.csye6225-app-custom-image: Verifying      : gmp-
943 1:6.1.2-10.el8.x86_64                  49/143
944     googlecompute.csye6225-app-custom-image: Verifying      : gnutls-
945 3.6.16-8.el8.1.x86_64                  50/143
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957 firmware-18.168.6.1-121.el8.1.noarch  56/143
958     googlecompute.csye6225-app-custom-image: Verifying      : iwl2000-
959 firmware-18.168.6.1-120.el8.1.noarch  57/143
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961 firmware-18.168.6.1-121.el8.1.noarch  58/143
962     googlecompute.csye6225-app-custom-image: Verifying      : iwl2030-
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964     googlecompute.csye6225-app-custom-image: Verifying      : iwl3160-
965 firmware-1:25.30.13.0-121.el8.1.noarch 60/143
966     googlecompute.csye6225-app-custom-image: Verifying      : iwl3160-
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969 firmware-1:25.30.13.0-121.el8.1.noarch 62/143
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971 firmware-1:25.30.13.0-120.el8.1.noarch 63/143
972     googlecompute.csye6225-app-custom-image: Verifying      : kernel-
973 tools-4.18.0-539.el8.x86_64          64/143
974     googlecompute.csye6225-app-custom-image: Verifying      : kernel-
975 tools-4.18.0-532.el8.x86_64          65/143
976     googlecompute.csye6225-app-custom-image: Verifying      : kernel-
977 tools-libs-4.18.0-539.el8.x86_64    66/143
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979 tools-libs-4.18.0-532.el8.x86_64    67/143
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986     googlecompute.csye6225-app-custom-image: Verifying      : kpartx-
987 0.8.4-40.el8.x86_64                71/143
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990     googlecompute.csye6225-app-custom-image: Verifying      : libdnf-
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994     googlecompute.csye6225-app-custom-image: Verifying      :
995 libsss_autoofs-2.9.3-2.el8.x86_64   75/143
996     googlecompute.csye6225-app-custom-image: Verifying      :
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1007	libssss_nss_idmap-2.9.3-2.el8.x86_64	81/143	
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1027	clients-8.0p1-21.el8.x86_64	91/143	
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libs-3.6.8-58.el8.x86_64             111/143
    googlecompute.csye6225-app-custom-image: Verifying      : python3-
perf-4.18.0-539.el8.x86_64          112/143
    googlecompute.csye6225-app-custom-image: Verifying      : python3-
perf-4.18.0-532.el8.x86_64          113/143
    googlecompute.csye6225-app-custom-image: Verifying      : python3-
syspurpose-1.28.42-1.el8.x86_64     114/143
    googlecompute.csye6225-app-custom-image: Verifying      : python3-
syspurpose-1.28.40-1.el8.x86_64     115/143
    googlecompute.csye6225-app-custom-image: Verifying      : selinux-
policy-3.14.3-135.el8.noarch       116/143
    googlecompute.csye6225-app-custom-image: Verifying      : selinux-
policy-3.14.3-133.el8.noarch       117/143
    googlecompute.csye6225-app-custom-image: Verifying      : selinux-
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    googlecompute.csye6225-app-custom-image: Verifying      : selinux-
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    googlecompute.csye6225-app-custom-image: Verifying      : setup-
2.12.2-10.el8.noarch                120/143
    googlecompute.csye6225-app-custom-image: Verifying      : setup-
2.12.2-9.el8.noarch                121/143
    googlecompute.csye6225-app-custom-image: Verifying      : sqlite-
libs-3.26.0-19.el8.x86_64          122/143
    googlecompute.csye6225-app-custom-image: Verifying      : sqlite-
libs-3.26.0-18.el8.x86_64          123/143
    googlecompute.csye6225-app-custom-image: Verifying      : sssd-
client-2.9.4-1.el8.x86_64          124/143
    googlecompute.csye6225-app-custom-image: Verifying      : sssd-
client-2.9.3-2.el8.x86_64          125/143
    googlecompute.csye6225-app-custom-image: Verifying      : sssd-
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    googlecompute.csye6225-app-custom-image: Verifying      : sssd-
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    googlecompute.csye6225-app-custom-image: Verifying      : sssd-kcm-
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    googlecompute.csye6225-app-custom-image: Verifying      : sssd-kcm-
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    googlecompute.csye6225-app-custom-image: Verifying      : sssd-nfs-
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    googlecompute.csye6225-app-custom-image: Verifying      : sssd-nfs-
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    googlecompute.csye6225-app-custom-image: Verifying      : systemd-
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```

```

googlecompute.csye6225-app-custom-image: Verifying : systemd-
pam-239-79.el8.x86_64 136/143
googlecompute.csye6225-app-custom-image: Verifying : systemd-
pam-239-78.el8.x86_64 137/143
googlecompute.csye6225-app-custom-image: Verifying : systemd-
udev-239-79.el8.x86_64 138/143
googlecompute.csye6225-app-custom-image: Verifying : systemd-
udev-239-78.el8.x86_64 139/143
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googlecompute.csye6225-app-custom-image: Upgraded:
googlecompute.csye6225-app-custom-image: chrony-4.5-1.el8.x86_64
googlecompute.csye6225-app-custom-image: cronie-1.5.2-10.el8.x86_64
googlecompute.csye6225-app-custom-image: cronie-anacron-1.5.2-
10.el8.x86_64
googlecompute.csye6225-app-custom-image: dnf-plugins-core-4.0.21-
25.el8.noarch
googlecompute.csye6225-app-custom-image: dracut-049-
233.git20240115.el8.x86_64
googlecompute.csye6225-app-custom-image: dracut-config-rescue-049-
233.git20240115.el8.x86_64
googlecompute.csye6225-app-custom-image: dracut-network-049-
233.git20240115.el8.x86_64
googlecompute.csye6225-app-custom-image: dracut-squash-049-
233.git20240115.el8.x86_64
googlecompute.csye6225-app-custom-image: firewalld-0.9.11-
4.el8.noarch
googlecompute.csye6225-app-custom-image: firewalld-filesystem-0.9.11-
4.el8.noarch
googlecompute.csye6225-app-custom-image: glib2-2.56.4-163.el8.x86_64
googlecompute.csye6225-app-custom-image: glibc-2.28-251.el8.x86_64
googlecompute.csye6225-app-custom-image: glibc-common-2.28-
251.el8.x86_64
googlecompute.csye6225-app-custom-image: glibc-gconv-extra-2.28-
251.el8.x86_64
googlecompute.csye6225-app-custom-image: glibc-langpack-en-2.28-
251.el8.x86_64
googlecompute.csye6225-app-custom-image: gmp-1:6.1.2-11.el8.x86_64
googlecompute.csye6225-app-custom-image: gnutls-3.6.16-8.el8.1.x86_64
googlecompute.csye6225-app-custom-image: google-cloud-cli-464.0.0-
1.x86_64
googlecompute.csye6225-app-custom-image: iwl105-firmware-18.168.6.1-
121.el8.1.noarch
googlecompute.csye6225-app-custom-image: iwl135-firmware-18.168.6.1-
121.el8.1.noarch
googlecompute.csye6225-app-custom-image: iwl2000-firmware-18.168.6.1-
121.el8.1.noarch
googlecompute.csye6225-app-custom-image: iwl2030-firmware-18.168.6.1-
121.el8.1.noarch
googlecompute.csye6225-app-custom-image: iwl3160-firmware-
1:25.30.13.0-121.el8.1.noarch
googlecompute.csye6225-app-custom-image: iwl7260-firmware-

```

```

1:25.30.13.0-121.el8.1.noarch
    googlecompute.csye6225-app-custom-image: kernel-tools-4.18.0-
539.el8.x86_64
    googlecompute.csye6225-app-custom-image: kernel-tools-libs-4.18.0-
539.el8.x86_64
    googlecompute.csye6225-app-custom-image: kexec-tools-2.0.26-
13.el8.x86_64
    googlecompute.csye6225-app-custom-image: kpartx-0.8.4-41.el8.x86_64
    googlecompute.csye6225-app-custom-image: libdnf-0.63.0-19.el8.x86_64
    googlecompute.csye6225-app-custom-image: libmaxminddb-1.2.0-
10.el8.1.x86_64
    googlecompute.csye6225-app-custom-image: libsss_autofs-2.9.4-
1.el8.x86_64
    googlecompute.csye6225-app-custom-image: libsss_certmap-2.9.4-
1.el8.x86_64
    googlecompute.csye6225-app-custom-image: libsss_idmap-2.9.4-
1.el8.x86_64
    googlecompute.csye6225-app-custom-image: libsss_nss_idmap-2.9.4-
1.el8.x86_64
    googlecompute.csye6225-app-custom-image: libsss_sudo-2.9.4-
1.el8.x86_64
    googlecompute.csye6225-app-custom-image: linux-firmware-20240111-
121.gitb3132c18.el8.noarch
    googlecompute.csye6225-app-custom-image: nss-3.90.0-6.el8.x86_64
    googlecompute.csye6225-app-custom-image: nss-softokn-3.90.0-
6.el8.x86_64
    googlecompute.csye6225-app-custom-image: nss-softokn-freebl-3.90.0-
6.el8.x86_64
    googlecompute.csye6225-app-custom-image: nss-sysinit-3.90.0-
6.el8.x86_64
    googlecompute.csye6225-app-custom-image: nss-util-3.90.0-6.el8.x86_64
    googlecompute.csye6225-app-custom-image: numactl-libs-2.0.16-
4.el8.x86_64
    googlecompute.csye6225-app-custom-image: openssh-8.0p1-24.el8.x86_64
    googlecompute.csye6225-app-custom-image: openssh-clients-8.0p1-
24.el8.x86_64
    googlecompute.csye6225-app-custom-image: openssh-server-8.0p1-
24.el8.x86_64
    googlecompute.csye6225-app-custom-image: openssl-1:1.1.1k-
12.el8.x86_64
    googlecompute.csye6225-app-custom-image: openssl-libs-1:1.1.1k-
12.el8.x86_64
    googlecompute.csye6225-app-custom-image: pam-1.3.1-32.el8.x86_64
    googlecompute.csye6225-app-custom-image: platform-python-3.6.8-
59.el8.x86_64
    googlecompute.csye6225-app-custom-image: python3-dnf-plugins-core-
4.0.21-25.el8.noarch
    googlecompute.csye6225-app-custom-image: python3-firewall-0.9.11-
4.el8.noarch
    googlecompute.csye6225-app-custom-image: python3-hawkey-0.63.0-
19.el8.x86_64
    googlecompute.csye6225-app-custom-image: python3-libdnf-0.63.0-
19.el8.x86_64
    googlecompute.csye6225-app-custom-image: python3-libs-3.6.8-
59.el8.x86_64
    googlecompute.csye6225-app-custom-image: python3-perf-4.18.0-
539.el8.x86_64
    googlecompute.csye6225-app-custom-image: python3-syspurpose-1.28.42-
1.el8.x86_64

```

```

googlecompute.csye6225-app-custom-image: qemu-guest-agent-15:6.2.0-
47.module_el8+890+5e1fb8d4.x86_64
googlecompute.csye6225-app-custom-image: selinux-policy-3.14.3-
135.el8.noarch
googlecompute.csye6225-app-custom-image: selinux-policy-targeted-
3.14.3-135.el8.noarch
googlecompute.csye6225-app-custom-image: setup-2.12.2-10.el8.noarch
googlecompute.csye6225-app-custom-image: sqlite-libs-3.26.0-
19.el8.x86_64
googlecompute.csye6225-app-custom-image: sssd-client-2.9.4-
1.el8.x86_64
googlecompute.csye6225-app-custom-image: sssd-common-2.9.4-
1.el8.x86_64
googlecompute.csye6225-app-custom-image: sssd-kcm-2.9.4-1.el8.x86_64
googlecompute.csye6225-app-custom-image: sssd-nfs-idmap-2.9.4-
1.el8.x86_64
googlecompute.csye6225-app-custom-image: systemd-239-79.el8.x86_64
googlecompute.csye6225-app-custom-image: systemd-libs-239-
79.el8.x86_64
googlecompute.csye6225-app-custom-image: systemd-pam-239-
79.el8.x86_64
googlecompute.csye6225-app-custom-image: systemd-udev-239-
79.el8.x86_64
googlecompute.csye6225-app-custom-image: tzdata-2023d-1.el8.noarch
googlecompute.csye6225-app-custom-image: Installed:
googlecompute.csye6225-app-custom-image: kernel-4.18.0-539.el8.x86_64
kernel-core-4.18.0-539.el8.x86_64
googlecompute.csye6225-app-custom-image: kernel-modules-4.18.0-
539.el8.x86_64
googlecompute.csye6225-app-custom-image:
googlecompute.csye6225-app-custom-image: Complete!
googlecompute.csye6225-app-custom-image: Last metadata expiration
check: 0:07:08 ago on Thu 15 Feb 2024 08:26:31 PM UTC.
googlecompute.csye6225-app-custom-image: Dependencies resolved.
googlecompute.csye6225-app-custom-image:
=====
googlecompute.csye6225-app-custom-image: Package
Arch      Version          Repo      Size
googlecompute.csye6225-app-custom-image:
=====
googlecompute.csye6225-app-custom-image: Installing:
googlecompute.csye6225-app-custom-image: nginx
x86_64   1:1.14.1-9.module_el8.0.0+1060+3ab382d3 appstream  570 k
googlecompute.csye6225-app-custom-image: Installing dependencies:
googlecompute.csye6225-app-custom-image: dejavu-fonts-common
noarch    2.35-7.el8           baseos     74 k
googlecompute.csye6225-app-custom-image: dejavu-sans-fonts
noarch    2.35-7.el8           baseos     1.6 M
googlecompute.csye6225-app-custom-image: fontconfig
x86_64   2.13.1-4.el8         baseos     274 k
googlecompute.csye6225-app-custom-image: fontpackages-filesystem
noarch    1.44-22.el8          baseos     16 k
googlecompute.csye6225-app-custom-image: gd
x86_64   2.2.5-7.el8          appstream  144 k
googlecompute.csye6225-app-custom-image: jbigkit-libs
x86_64   2.1-14.el8           appstream  55 k
googlecompute.csye6225-app-custom-image: libX11
x86_64   1.6.8-7.el8          appstream  612 k
googlecompute.csye6225-app-custom-image: libX11-common

```

```

noarch 1.6.8-7.el8                               appstream 211 k
      googlecompute.csye6225-app-custom-image: libXau
x86_64 1.0.9-3.el8                               appstream 37 k
      googlecompute.csye6225-app-custom-image: libXpm
x86_64 3.5.12-11.el8                             appstream 59 k
      googlecompute.csye6225-app-custom-image: libjpeg-turbo
x86_64 1.5.3-12.el8                             appstream 157 k
      googlecompute.csye6225-app-custom-image: libtiff
x86_64 4.0.9-31.el8                            appstream 190 k
      googlecompute.csye6225-app-custom-image: libwebp
x86_64 1.0.0-9.el8                             appstream 274 k
      googlecompute.csye6225-app-custom-image: libxcb
x86_64 1.13.1-1.el8                            appstream 229 k
      googlecompute.csye6225-app-custom-image: libxslt
x86_64 1.1.32-6.el8                           baseos 250 k
      googlecompute.csye6225-app-custom-image: nginx-all-modules
noarch 1:1.14.1-9.module_el8.0.0+1060+3ab382d3 appstream 23 k
      googlecompute.csye6225-app-custom-image: nginx-filesystem
noarch 1:1.14.1-9.module_el8.0.0+1060+3ab382d3 appstream 24 k
      googlecompute.csye6225-app-custom-image: nginx-mod-http-image-filter
x86_64 1:1.14.1-9.module_el8.0.0+1060+3ab382d3 appstream 35 k
      googlecompute.csye6225-app-custom-image: nginx-mod-http-perl
x86_64 1:1.14.1-9.module_el8.0.0+1060+3ab382d3 appstream 46 k
      googlecompute.csye6225-app-custom-image: nginx-mod-http-xslt-filter
x86_64 1:1.14.1-9.module_el8.0.0+1060+3ab382d3 appstream 33 k
      googlecompute.csye6225-app-custom-image: nginx-mod-mail
x86_64 1:1.14.1-9.module_el8.0.0+1060+3ab382d3 appstream 64 k
      googlecompute.csye6225-app-custom-image: nginx-mod-stream
x86_64 1:1.14.1-9.module_el8.0.0+1060+3ab382d3 appstream 85 k
      googlecompute.csye6225-app-custom-image: perl-Carp
noarch 1.42-396.el8                           baseos 30 k
      googlecompute.csye6225-app-custom-image: perl-Data-Dumper
x86_64 2.167-399.el8                           baseos 58 k
      googlecompute.csye6225-app-custom-image: perl-Digest
noarch 1.17-395.el8                            appstream 27 k
      googlecompute.csye6225-app-custom-image: perl-Digest-MD5
x86_64 2.55-396.el8                            appstream 37 k
      googlecompute.csye6225-app-custom-image: perl-Encode
x86_64 4:2.97-3.el8                           baseos 1.5 M
      googlecompute.csye6225-app-custom-image: perl-Errno
x86_64 1.28-422.el8                           baseos 76 k
      googlecompute.csye6225-app-custom-image: perl-Exporter
noarch 5.72-396.el8                           baseos 34 k
      googlecompute.csye6225-app-custom-image: perl-File-Path
noarch 2.15-2.el8                            baseos 38 k
      googlecompute.csye6225-app-custom-image: perl-File-Temp
noarch 0.230.600-1.el8                           baseos 63 k
      googlecompute.csye6225-app-custom-image: perl-Getopt-Long
noarch 1:2.50-4.el8                           baseos 63 k
      googlecompute.csye6225-app-custom-image: perl-HTTP-Tiny
noarch 0.074-3.el8                            baseos 59 k
      googlecompute.csye6225-app-custom-image: perl-IO
x86_64 1.38-422.el8                           baseos 142 k
      googlecompute.csye6225-app-custom-image: perl-IO-Socket-IP
noarch 0.39-5.el8                            appstream 47 k
      googlecompute.csye6225-app-custom-image: perl-IO-Socket-SSL
noarch 2.066-4.module_el8+339+1ec643e0       appstream 304 k
      googlecompute.csye6225-app-custom-image: perl-MIME-Base64
x86_64 3.15-396.el8                           baseos 31 k

```

```

googlecompute.csye6225-app-custom-image: perl-Mozilla-CA
noarch 20160104-7.module_el8+645+9d809f8c      appstream 15 k
googlecompute.csye6225-app-custom-image: perl-Net-SSLeay
x86_64 1.88-2.module_el8+339+1ec643e0          appstream 402 k
googlecompute.csye6225-app-custom-image: perl-PathTools
x86_64 3.74-1.el8                            baseos    90 k
googlecompute.csye6225-app-custom-image: perl-Pod-Escapes
noarch 1:1.07-395.el8                          baseos    20 k
googlecompute.csye6225-app-custom-image: perl-Pod-Perldoc
noarch 3.28-396.el8                            baseos    86 k
googlecompute.csye6225-app-custom-image: perl-Pod-Simple
noarch 1:3.35-395.el8                          baseos   213 k
googlecompute.csye6225-app-custom-image: perl-Pod-Usage
noarch 4:1.69-395.el8                          baseos    34 k
googlecompute.csye6225-app-custom-image: perl-Scalar-List-Utils
x86_64 3:1.49-2.el8                            baseos    68 k
googlecompute.csye6225-app-custom-image: perl-Socket
x86_64 4:2.027-3.el8                          baseos    59 k
googlecompute.csye6225-app-custom-image: perl-Storable
x86_64 1:3.11-3.el8                            baseos    98 k
googlecompute.csye6225-app-custom-image: perl-Term-ANSIColor
noarch 4.06-396.el8                            baseos    46 k
googlecompute.csye6225-app-custom-image: perl-Term-Cap
noarch 1.17-395.el8                            baseos    23 k
googlecompute.csye6225-app-custom-image: perl-Text-ParseWords
noarch 3.30-395.el8                            baseos    18 k
googlecompute.csye6225-app-custom-image: perl-Text-Tabs+Wrap
noarch 2013.0523-395.el8                      baseos    24 k
googlecompute.csye6225-app-custom-image: perl-Time-Local
noarch 1:1.280-1.el8                            baseos    34 k
googlecompute.csye6225-app-custom-image: perl-URI
noarch 1.73-3.el8                             appstream 116 k
googlecompute.csye6225-app-custom-image: perl-Unicode-Normalize
x86_64 1.25-396.el8                          baseos    82 k
googlecompute.csye6225-app-custom-image: perl-constant
noarch 1.33-396.el8                            baseos    25 k
googlecompute.csye6225-app-custom-image: perl-interpreter
x86_64 4:5.26.3-422.el8                      baseos    6.3 M
googlecompute.csye6225-app-custom-image: perl-libnet
noarch 3.11-3.el8                             appstream 121 k
googlecompute.csye6225-app-custom-image: perl-libs
x86_64 4:5.26.3-422.el8                      baseos    1.6 M
googlecompute.csye6225-app-custom-image: perl-macros
x86_64 4:5.26.3-422.el8                      baseos    73 k
googlecompute.csye6225-app-custom-image: perl-parent
noarch 1:0.237-1.el8                            baseos    20 k
googlecompute.csye6225-app-custom-image: perl-podlators
noarch 4.11-1.el8                             baseos    118 k
googlecompute.csye6225-app-custom-image: perl-threads
x86_64 1:2.21-2.el8                            baseos    61 k
googlecompute.csye6225-app-custom-image: perl-threads-shared
x86_64 1.58-2.el8                             baseos    48 k
googlecompute.csye6225-app-custom-image: Enabling module streams:
googlecompute.csye6225-app-custom-image: nginx
1.14
googlecompute.csye6225-app-custom-image: perl
5.26
googlecompute.csye6225-app-custom-image: perl-IO-Socket-SSL
2.066

```

```
googlecompute.csye6225-app-custom-image: perl-libwww-perl
6.34
googlecompute.csye6225-app-custom-image:
googlecompute.csye6225-app-custom-image: Transaction Summary
googlecompute.csye6225-app-custom-image:
=====
googlecompute.csye6225-app-custom-image: Install 64 Packages
googlecompute.csye6225-app-custom-image:
googlecompute.csye6225-app-custom-image: Total download size: 17 M
googlecompute.csye6225-app-custom-image: Installed size: 50 M
googlecompute.csye6225-app-custom-image: Downloading Packages:
googlecompute.csye6225-app-custom-image: [MIRROR] gd-2.2.5-
7.el8.x86_64.rpm: Curl error (28): Timeout was reached for
http://mirrors.cmich.edu/centos/8-stream/AppStream/x86_64/os/Packages/gd-
2.2.5-7.el8.x86_64.rpm [Operation too slow. Less than 1000 bytes/sec
transferred the last 30 seconds]
googlecompute.csye6225-app-custom-image: [MIRROR] jbigkit-libs-2.1-
14.el8.x86_64.rpm: Curl error (28): Timeout was reached for
http://mirrors.cmich.edu/centos/8-
stream/AppStream/x86_64/os/Packages/jbigkit-libs-2.1-14.el8.x86_64.rpm
[Operation too slow. Less than 1000 bytes/sec transferred the last 30
seconds]
googlecompute.csye6225-app-custom-image: [MIRROR] libX11-1.6.8-
7.el8.x86_64.rpm: Curl error (28): Timeout was reached for
http://mirrors.cmich.edu/centos/8-
stream/AppStream/x86_64/os/Packages/libX11-1.6.8-7.el8.x86_64.rpm
[Operation too slow. Less than 1000 bytes/sec transferred the last 30
seconds]
googlecompute.csye6225-app-custom-image: (1/64): jbigkit-libs-2.1-
14.el8.x86_64.rpm      1.7 kB/s | 55 kB    00:31
googlecompute.csye6225-app-custom-image: (2/64): gd-2.2.5-
7.el8.x86_64.rpm      4.6 kB/s | 144 kB   00:31
googlecompute.csye6225-app-custom-image: (3/64): libXau-1.0.9-
3.el8.x86_64.rpm      536 kB/s | 37 kB    00:00
googlecompute.csye6225-app-custom-image: (4/64): libX11-1.6.8-
7.el8.x86_64.rpm      19 kB/s | 612 kB   00:31
googlecompute.csye6225-app-custom-image: (5/64): libXpm-3.5.12-
11.el8.x86_64.rpm     858 kB/s | 59 kB    00:00
googlecompute.csye6225-app-custom-image: (6/64): libX11-common-1.6.8-
7.el8.noarch.rpm      1.0 MB/s | 211 kB   00:00
googlecompute.csye6225-app-custom-image: (7/64): libjpeg-turbo-1.5.3-
12.el8.x86_64.rpm     2.1 MB/s | 157 kB   00:00
googlecompute.csye6225-app-custom-image: (8/64): libtiff-4.0.9-
31.el8.x86_64.rpm     1.4 MB/s | 190 kB   00:00
googlecompute.csye6225-app-custom-image: (9/64): libxcb-1.13.1-
1.el8.x86_64.rpm      2.8 MB/s | 229 kB   00:00
googlecompute.csye6225-app-custom-image: (10/64): libwebp-1.0.0-
9.el8.x86_64.rpm      1.9 MB/s | 274 kB   00:00
googlecompute.csye6225-app-custom-image: (11/64): nginx-all-modules-
1.14.1-9.module_el8. 348 kB/s | 23 kB    00:00
googlecompute.csye6225-app-custom-image: (12/64): nginx-filesystem-
1.14.1-9.module_el8.0 357 kB/s | 24 kB    00:00
googlecompute.csye6225-app-custom-image: (13/64): nginx-1.14.1-
9.module_el8.0.0+1060+3ab 4.0 MB/s | 570 kB   00:00
googlecompute.csye6225-app-custom-image: (14/64): nginx-mod-http-image-
filter-1.14.1-9.m 515 kB/s | 35 kB    00:00
googlecompute.csye6225-app-custom-image: (15/64): nginx-mod-http-perl-
1.14.1-9.module_el 672 kB/s | 46 kB    00:00
googlecompute.csye6225-app-custom-image: (16/64): nginx-mod-http-xslt-
```

```
filter-1.14.1-9.mo 478 kB/s | 33 kB 00:00
    googlecompute.csye6225-app-custom-image: (17/64): nginx-mod-mail-
1.14.1-9.module_el8.0.0 891 kB/s | 64 kB 00:00
    googlecompute.csye6225-app-custom-image: (18/64): nginx-mod-stream-
1.14.1-9.module_el8.0 1.2 MB/s | 85 kB 00:00
    googlecompute.csye6225-app-custom-image: (19/64): perl-Digest-1.17-
395.el8.noarch.rpm 393 kB/s | 27 kB 00:00
    googlecompute.csye6225-app-custom-image: (20/64): perl-Digest-MD5-2.55-
396.el8.x86_64.rpm 546 kB/s | 37 kB 00:00
    googlecompute.csye6225-app-custom-image: (21/64): perl-IO-Socket-IP-
0.39-5.el8.noarch.rpm 690 kB/s | 47 kB 00:00
    googlecompute.csye6225-app-custom-image: (22/64): perl-IO-Socket-SSL-
2.066-4.module_el8+ 4.0 MB/s | 304 kB 00:00
    googlecompute.csye6225-app-custom-image: (23/64): perl-Mozilla-CA-
20160104-7.module_el8+ 210 kB/s | 15 kB 00:00
    googlecompute.csye6225-app-custom-image: (24/64): perl-Net-SSLeay-1.88-
2.module_el8+339+ 5.0 MB/s | 402 kB 00:00
    googlecompute.csye6225-app-custom-image: (25/64): perl-URI-1.73-
3.el8.noarch.rpm 1.6 MB/s | 116 kB 00:00
    googlecompute.csye6225-app-custom-image: (26/64): perl-libnet-3.11-
3.el8.noarch.rpm 1.6 MB/s | 121 kB 00:00
    googlecompute.csye6225-app-custom-image: (27/64): dejavu-fonts-common-
2.35-7.el8.noarch. 487 kB/s | 74 kB 00:00
    googlecompute.csye6225-app-custom-image: (28/64): fontpackages-
filesystem-1.44-22.el8.no 587 kB/s | 16 kB 00:00
    googlecompute.csye6225-app-custom-image: (29/64): fontconfig-2.13.1-
4.el8.x86_64.rpm 1.8 MB/s | 274 kB 00:00
    googlecompute.csye6225-app-custom-image: (30/64): perl-Carp-1.42-
396.el8.noarch.rpm 1.1 MB/s | 30 kB 00:00
    googlecompute.csye6225-app-custom-image: (31/64): libxslt-1.1.32-
6.el8.x86_64.rpm 3.1 MB/s | 250 kB 00:00
    googlecompute.csye6225-app-custom-image: (32/64): perl-Data-Dumper-
2.167-399.el8.x86_64. 2.0 MB/s | 58 kB 00:00
    googlecompute.csye6225-app-custom-image: (33/64): dejavu-sans-fonts-
2.35-7.el8.noarch.rpm 6.7 MB/s | 1.6 MB 00:00
    googlecompute.csye6225-app-custom-image: (34/64): perl-Errno-1.28-
422.el8.x86_64.rpm 2.6 MB/s | 76 kB 00:00
    googlecompute.csye6225-app-custom-image: (35/64): perl-Exporter-5.72-
396.el8.noarch.rpm 1.2 MB/s | 34 kB 00:00
    googlecompute.csye6225-app-custom-image: (36/64): perl-File-Path-2.15-
2.el8.noarch.rpm 1.3 MB/s | 38 kB 00:00
    googlecompute.csye6225-app-custom-image: (37/64): perl-File-Temp-
0.230.600-1.el8.noarch. 2.1 MB/s | 63 kB 00:00
    googlecompute.csye6225-app-custom-image: (38/64): perl-Encode-2.97-
3.el8.x86_64.rpm 13 MB/s | 1.5 MB 00:00
    googlecompute.csye6225-app-custom-image: (39/64): perl-Getopt-Long-
2.50-4.el8.noarch.rpm 1.3 MB/s | 63 kB 00:00
    googlecompute.csye6225-app-custom-image: (40/64): perl-HTTP-Tiny-0.074-
3.el8.noarch.rpm 1.8 MB/s | 59 kB 00:00
    googlecompute.csye6225-app-custom-image: (41/64): perl-IO-1.38-
422.el8.x86_64.rpm 4.4 MB/s | 142 kB 00:00
    googlecompute.csye6225-app-custom-image: (42/64): perl-MIME-Base64-
3.15-396.el8.x86_64.rpm 971 kB/s | 31 kB 00:00
    googlecompute.csye6225-app-custom-image: (43/64): perl-PathTools-3.74-
1.el8.x86_64.rpm 2.7 MB/s | 90 kB 00:00
    googlecompute.csye6225-app-custom-image: (44/64): perl-Pod-Escapes-
1.07-395.el8.noarch.rpm 748 kB/s | 20 kB 00:00
    googlecompute.csye6225-app-custom-image: (45/64): perl-Pod-Perldoc-
3.28-396.el8.noarch.rpm 3.0 MB/s | 86 kB 00:00
```

```

googlecompute.csye6225-app-custom-image: (46/64): perl-Pod-Simple-3.35-
395.el8.noarch.rpm 6.6 MB/s | 213 kB 00:00
googlecompute.csye6225-app-custom-image: (47/64): perl-Pod-Usage-1.69-
395.el8.noarch.rpm 1.2 MB/s | 34 kB 00:00
googlecompute.csye6225-app-custom-image: (48/64): perl-Scalar-List-
Utils-1.49-2.el8.x86_2.4 MB/s | 68 kB 00:00
googlecompute.csye6225-app-custom-image: (49/64): perl-Socket-2.027-
3.el8.x86_64.rpm 2.0 MB/s | 59 kB 00:00
googlecompute.csye6225-app-custom-image: (50/64): perl-Storable-3.11-
3.el8.x86_64.rpm 3.4 MB/s | 98 kB 00:00
googlecompute.csye6225-app-custom-image: (51/64): perl-Term-ANSIColor-
4.06-396.el8.noarch 1.6 MB/s | 46 kB 00:00
googlecompute.csye6225-app-custom-image: (52/64): perl-Term-Cap-1.17-
395.el8.noarch.rpm 830 kB/s | 23 kB 00:00
googlecompute.csye6225-app-custom-image: (53/64): perl-Text-ParseWords-
3.30-395.el8.noarch 646 kB/s | 18 kB 00:00
googlecompute.csye6225-app-custom-image: (54/64): perl-Text-Tabs+Wrap-
2013.0523-395.el8. 890 kB/s | 24 kB 00:00
googlecompute.csye6225-app-custom-image: (55/64): perl-Time-Local-
1.280-1.el8.noarch.rpm 1.2 MB/s | 34 kB 00:00
googlecompute.csye6225-app-custom-image: (56/64): perl-Unicode-
Normalize-1.25-396.el8.x8 2.8 MB/s | 82 kB 00:00
googlecompute.csye6225-app-custom-image: (57/64): perl-constant-1.33-
396.el8.noarch.rpm 866 kB/s | 25 kB 00:00
googlecompute.csye6225-app-custom-image: (58/64): perl-macros-5.26.3-
422.el8.x86_64.rpm 2.4 MB/s | 73 kB 00:00
googlecompute.csye6225-app-custom-image: (59/64): perl-libs-5.26.3-
422.el8.x86_64.rpm 26 MB/s | 1.6 MB 00:00
googlecompute.csye6225-app-custom-image: (60/64): perl-parent-0.237-
1.el8.noarch.rpm 620 kB/s | 20 kB 00:00
googlecompute.csye6225-app-custom-image: (61/64): perl-threads-2.21-
2.el8.x86_64.rpm 2.1 MB/s | 61 kB 00:00
googlecompute.csye6225-app-custom-image: (62/64): perl-podlators-4.11-
1.el8.noarch.rpm 3.0 MB/s | 118 kB 00:00
googlecompute.csye6225-app-custom-image: (63/64): perl-threads-shared-
1.58-2.el8.x86_64. 1.7 MB/s | 48 kB 00:00
googlecompute.csye6225-app-custom-image: (64/64): perl-interpreter-
5.26.3-422.el8.x86_64 32 MB/s | 6.3 MB 00:00
googlecompute.csye6225-app-custom-image: -----
-----
googlecompute.csye6225-app-custom-image: Total
530 kB/s | 17 MB 00:33
googlecompute.csye6225-app-custom-image: Running transaction check
googlecompute.csye6225-app-custom-image: Transaction check succeeded.
googlecompute.csye6225-app-custom-image: Running transaction test
googlecompute.csye6225-app-custom-image: Transaction test succeeded.
googlecompute.csye6225-app-custom-image: Running transaction
googlecompute.csye6225-app-custom-image: Preparing :
1/1
googlecompute.csye6225-app-custom-image: Installing : fontpackages-filesystem-1.44-22.el8.noarch 1/64
googlecompute.csye6225-app-custom-image: Installing : libjpeg-turbo-1.5.3-12.el8.x86_64 2/64
googlecompute.csye6225-app-custom-image: Installing : dejavu-fonts-common-2.35-7.el8.noarch 3/64
googlecompute.csye6225-app-custom-image: Installing : dejavu-sans-fonts-2.35-7.el8.noarch 4/64
googlecompute.csye6225-app-custom-image: Installing : fontconfig-2.13.1-4.el8.x86_64 5/64

```

```

googlecompute.csye6225-app-custom-image: Running scriptlet:
fontconfig-2.13.1-4.el8.x86_64           5/64
googlecompute.csye6225-app-custom-image: Installing : perl-
Digest-1.17-395.el8.noarch               6/64
googlecompute.csye6225-app-custom-image: Installing : perl-
Digest-MD5-2.55-396.el8.x86_64           7/64
googlecompute.csye6225-app-custom-image: Installing : perl-
Data-Dumper-2.167-399.el8.x86_64          8/64
googlecompute.csye6225-app-custom-image: Installing : perl-
libnet-3.11-3.el8.noarch                 9/64
googlecompute.csye6225-app-custom-image: Installing : perl-URI-
1.73-3.el8.noarch                      10/64
googlecompute.csye6225-app-custom-image: Installing : perl-Pod-
Escapes-1:1.07-395.el8.noarch            11/64
googlecompute.csye6225-app-custom-image: Installing : perl-Net-
SSLeay-1.88-2.module_el8+339+1ec643e0.x86 12/64
googlecompute.csye6225-app-custom-image: Installing : perl-
Mozilla-CA-20160104-7.module_el8+645+9d809f8c 13/64
googlecompute.csye6225-app-custom-image: Installing : perl-Io-
Socket-IP-0.39-5.el8.noarch              14/64
googlecompute.csye6225-app-custom-image: Installing : perl-
Time-Local-1:1.280-1.el8.noarch           15/64
googlecompute.csye6225-app-custom-image: Installing : perl-Io-
Socket-SSL-2.066-4.module_el8+339+1ec643e0 16/64
googlecompute.csye6225-app-custom-image: Installing : perl-
Term-ANSIColor-4.06-396.el8.noarch        17/64
googlecompute.csye6225-app-custom-image: Installing : perl-
Term-Cap-1.17-395.el8.noarch              18/64
googlecompute.csye6225-app-custom-image: Installing : perl-
File-Temp-0.230.600-1.el8.noarch          19/64
googlecompute.csye6225-app-custom-image: Installing : perl-Pod-
Simple-1:3.35-395.el8.noarch             20/64
googlecompute.csye6225-app-custom-image: Installing : perl-
HTTP-Tiny-0.074-3.el8.noarch              21/64
googlecompute.csye6225-app-custom-image: Installing : perl-
podlators-4.11-1.el8.noarch              22/64
googlecompute.csye6225-app-custom-image: Installing : perl-Pod-
Perldoc-3.28-396.el8.noarch              23/64
googlecompute.csye6225-app-custom-image: Installing : perl-
Text-ParseWords-3.30-395.el8.noarch       24/64
googlecompute.csye6225-app-custom-image: Installing : perl-Pod-
Usage-4:1.69-395.el8.noarch              25/64
googlecompute.csye6225-app-custom-image: Installing : perl-
MIME-Base64-3.15-396.el8.x86_64          26/64
googlecompute.csye6225-app-custom-image: Installing : perl-
Storable-1:3.11-3.el8.x86_64              27/64
googlecompute.csye6225-app-custom-image: Installing : perl-
Getopt-Long-1:2.50-4.el8.noarch            28/64
googlecompute.csye6225-app-custom-image: Installing : perl-
Errno-1.28-422.el8.x86_64                29/64
googlecompute.csye6225-app-custom-image: Installing : perl-
Socket-4:2.027-3.el8.x86_64              30/64
googlecompute.csye6225-app-custom-image: Installing : perl-
Encode-4:2.97-3.el8.x86_64                31/64
googlecompute.csye6225-app-custom-image: Installing : perl-
Carp-1.42-396.el8.noarch                 32/64
googlecompute.csye6225-app-custom-image: Installing : perl-
Exporter-5.72-396.el8.noarch              33/64
googlecompute.csye6225-app-custom-image: Installing : perl-

```

```

libs-4:5.26.3-422.el8.x86_64           34/64
    googlecompute.csye6225-app-custom-image: Installing      : perl-
Scalar-List-Utils-3:1.49-2.el8.x86_64   35/64
    googlecompute.csye6225-app-custom-image: Installing      : perl-
parent-1:0.237-1.el8.noarch             36/64
    googlecompute.csye6225-app-custom-image: Installing      : perl-
macros-4:5.26.3-422.el8.x86_64          37/64
    googlecompute.csye6225-app-custom-image: Installing      : perl-
Text-Tabs+Wrap-2013.0523-395.el8.noarch 38/64
    googlecompute.csye6225-app-custom-image: Installing      : perl-
Unicode-Normalize-1.25-396.el8.x86_64   39/64
    googlecompute.csye6225-app-custom-image: Installing      : perl-
File-Path-2.15-2.el8.noarch             40/64
    googlecompute.csye6225-app-custom-image: Installing      : perl-IO-
1.38-422.el8.x86_64                   41/64
    googlecompute.csye6225-app-custom-image: Installing      : perl-
PathTools-3.74-1.el8.x86_64            42/64
    googlecompute.csye6225-app-custom-image: Installing      : perl-
constant-1.33-396.el8.noarch          43/64
    googlecompute.csye6225-app-custom-image: Installing      : perl-
threads-1:2.21-2.el8.x86_64            44/64
    googlecompute.csye6225-app-custom-image: Installing      : perl-
threads-shared-1.58-2.el8.x86_64       45/64
    googlecompute.csye6225-app-custom-image: Installing      : perl-
interpreter-4:5.26.3-422.el8.x86_64    46/64
    googlecompute.csye6225-app-custom-image: Installing      : libxslt-
1.1.32-6.el8.x86_64                  47/64
    googlecompute.csye6225-app-custom-image: Running scriptlet: nginx-
filesystem-1:1.14.1-9.module_el8.0.0+1060+3a 48/64
    googlecompute.csye6225-app-custom-image: Installing      : nginx-
filesystem-1:1.14.1-9.module_el8.0.0+1060+3a 48/64
    googlecompute.csye6225-app-custom-image: Installing      : libwebp-
1.0.0-9.el8.x86_64                   49/64
    googlecompute.csye6225-app-custom-image: Installing      : libXau-
1.0.9-3.el8.x86_64                  50/64
    googlecompute.csye6225-app-custom-image: Installing      : libxcb-
1.13.1-1.el8.x86_64                51/64
    googlecompute.csye6225-app-custom-image: Installing      : libX11-
common-1.6.8-7.el8.noarch           52/64
    googlecompute.csye6225-app-custom-image: Installing      : libX11-
1.6.8-7.el8.x86_64                53/64
    googlecompute.csye6225-app-custom-image: Installing      : libXpm-
3.5.12-11.el8.x86_64               54/64
    googlecompute.csye6225-app-custom-image: Installing      : jbigkit-
libs-2.1-14.el8.x86_64              55/64
    googlecompute.csye6225-app-custom-image: Running scriptlet: jbigkit-
libs-2.1-14.el8.x86_64              55/64
    googlecompute.csye6225-app-custom-image: Installing      : libtiff-
4.0.9-31.el8.x86_64                56/64
    googlecompute.csye6225-app-custom-image: Installing      : gd-2.2.5-
7.el8.x86_64                      57/64
    googlecompute.csye6225-app-custom-image: Running scriptlet: gd-2.2.5-
7.el8.x86_64                      57/64
    googlecompute.csye6225-app-custom-image: Installing      : nginx-
mod-http-perl-1:1.14.1-9.module_el8.0.0+1060 58/64
    googlecompute.csye6225-app-custom-image: Running scriptlet: nginx-
mod-http-perl-1:1.14.1-9.module_el8.0.0+1060 58/64
    googlecompute.csye6225-app-custom-image: Installing      : nginx-
mod-http-xslt-filter-1:1.14.1-9.module_el8.0 59/64

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googlecompute.csye6225-app-custom-image: Running scriptlet: nginx-
mod-http-xslt-filter-1:1.14.1-9.module_el8.0 59/64
    googlecompute.csye6225-app-custom-image: Installing : nginx-
mod-mail-1:1.14.1-9.module_el8.0.0+1060+3ab3 60/64
        googlecompute.csye6225-app-custom-image: Running scriptlet: nginx-
mod-mail-1:1.14.1-9.module_el8.0.0+1060+3ab3 60/64
            googlecompute.csye6225-app-custom-image: Installing : nginx-
mod-stream-1:1.14.1-9.module_el8.0.0+1060+3a 61/64
                googlecompute.csye6225-app-custom-image: Running scriptlet: nginx-
mod-stream-1:1.14.1-9.module_el8.0.0+1060+3a 61/64
                    googlecompute.csye6225-app-custom-image: Installing : nginx-
1:1.14.1-9.module_el8.0.0+1060+3ab382d3.x86_ 62/64
                        googlecompute.csye6225-app-custom-image: Running scriptlet: nginx-
1:1.14.1-9.module_el8.0.0+1060+3ab382d3.x86_ 62/64
                            googlecompute.csye6225-app-custom-image: Installing : nginx-
mod-http-image-filter-1:1.14.1-9.module_el8. 63/64
                                googlecompute.csye6225-app-custom-image: Running scriptlet: nginx-
mod-http-image-filter-1:1.14.1-9.module_el8. 63/64
                                    googlecompute.csye6225-app-custom-image: Installing : nginx-
all-modules-1:1.14.1-9.module_el8.0.0+1060+3 64/64
                                        googlecompute.csye6225-app-custom-image: Running scriptlet: nginx-
all-modules-1:1.14.1-9.module_el8.0.0+1060+3 64/64
                                            googlecompute.csye6225-app-custom-image: Running scriptlet:
fontconfig-2.13.1-4.el8.x86_64 64/64
                                                googlecompute.csye6225-app-custom-image: Verifying : gd-2.2.5-
7.el8.x86_64 1/64
                                                    googlecompute.csye6225-app-custom-image: Verifying : jbigkit-
libs-2.1-14.el8.x86_64 2/64
                                                        googlecompute.csye6225-app-custom-image: Verifying : libX11-
1.6.8-7.el8.x86_64 3/64
                                                            googlecompute.csye6225-app-custom-image: Verifying : libX11-
common-1.6.8-7.el8.noarch 4/64
                                                                googlecompute.csye6225-app-custom-image: Verifying : libXau-
1.0.9-3.el8.x86_64 5/64
                                                                    googlecompute.csye6225-app-custom-image: Verifying : libXpm-
3.5.12-11.el8.x86_64 6/64
                                                                        googlecompute.csye6225-app-custom-image: Verifying : libjpeg-
turbo-1.5.3-12.el8.x86_64 7/64
                                                                            googlecompute.csye6225-app-custom-image: Verifying : libtiff-
4.0.9-31.el8.x86_64 8/64
                                                                                googlecompute.csye6225-app-custom-image: Verifying : libwebp-
1.0.0-9.el8.x86_64 9/64
                                                                                    googlecompute.csye6225-app-custom-image: Verifying : libxcb-
1.13.1-1.el8.x86_64 10/64
                                                                                        googlecompute.csye6225-app-custom-image: Verifying : nginx-
1:1.14.1-9.module_el8.0.0+1060+3ab382d3.x86_ 11/64
                                googlecompute.csye6225-app-custom-image: Verifying : nginx-
all-modules-1:1.14.1-9.module_el8.0.0+1060+3 12/64
                                    googlecompute.csye6225-app-custom-image: Verifying : nginx-
filesystem-1:1.14.1-9.module_el8.0.0+1060+3a 13/64
                                        googlecompute.csye6225-app-custom-image: Verifying : nginx-
mod-http-image-filter-1:1.14.1-9.module_el8. 14/64
                                            googlecompute.csye6225-app-custom-image: Verifying : nginx-
mod-http-perl-1:1.14.1-9.module_el8.0.0+1060 15/64
                                                googlecompute.csye6225-app-custom-image: Verifying : nginx-
mod-http-xslt-filter-1:1.14.1-9.module_el8.0 16/64
                                                    googlecompute.csye6225-app-custom-image: Verifying : nginx-
mod-mail-1:1.14.1-9.module_el8.0.0+1060+3ab3 17/64
                                                        googlecompute.csye6225-app-custom-image: Verifying : nginx-

```

```

mod-stream-1:1.14.1-9.module_el8.0.0+1060+3a 18/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
Digest-1.17-395.el8.noarch 19/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
Digest-MD5-2.55-396.el8.x86_64 20/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
Socket-IP-0.39-5.el8.noarch 21/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-IO-
Socket-SSL-2.066-4.module_el8+339+1ec643e0 22/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
Mozilla-CA-20160104-7.module_el8+645+9d809f8c 23/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-Net-
SSLeay-1.88-2.module_el8+339+1ec643e0.x86 24/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-URI-
1.73-3.el8.noarch 25/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
libnet-3.11-3.el8.noarch 26/64
    googlecompute.csye6225-app-custom-image: Verifying      : dejavu-
fonts-common-2.35-7.el8.noarch 27/64
    googlecompute.csye6225-app-custom-image: Verifying      : dejavu-
fontconfig-2.13.1-4.el8.x86_64 29/64
    googlecompute.csye6225-app-custom-image: Verifying      : libxslt-
fontpackages-fs-1.44-22.el8.noarch 30/64
    googlecompute.csye6225-app-custom-image: Verifying      : libxslt-
1.1.32-6.el8.x86_64 31/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
Carp-1.42-396.el8.noarch 32/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
Data-Dumper-2.167-399.el8.x86_64 33/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
Encode-4.2:97-3.el8.x86_64 34/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
Errno-1.28-422.el8.x86_64 35/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
Exporter-5.72-396.el8.noarch 36/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
File-Path-2.15-2.el8.noarch 37/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
File-Temp-0.230.600-1.el8.noarch 38/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
Getopt-Long-1:2.50-4.el8.noarch 39/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
HTTP-Tiny-0.074-3.el8.noarch 40/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-IO-
1.38-422.el8.x86_64 41/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
MIME-Base64-3.15-396.el8.x86_64 42/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-
PathTools-3.74-1.el8.x86_64 43/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-Pod-
Escapes-1:1.07-395.el8.noarch 44/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-Pod-
Perldoc-3.28-396.el8.noarch 45/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-Pod-
Simple-1:3.35-395.el8.noarch 46/64
    googlecompute.csye6225-app-custom-image: Verifying      : perl-Pod-
Usage-4:1.69-395.el8.noarch 47/64

```

```

googlecompute.csye6225-app-custom-image: Verifying      : perl-
Scalar-List-Utils-3:1.49-2.el8.x86_64          48/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
Socket-4:2.027-3.el8.x86_64          49/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
Storable-1:3.11-3.el8.x86_64          50/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
Term-ANSIColor-4.06-396.el8.noarch      51/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
Term-Cap-1.17-395.el8.noarch      52/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
Text-ParseWords-3.30-395.el8.noarch      53/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
Text-Tabs+Wrap-2013.0523-395.el8.noarch      54/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
Time-Local-1:1.280-1.el8.noarch      55/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
Unicode-Normalize-1.25-396.el8.x86_64          56/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
constant-1.33-396.el8.noarch      57/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
interpreter-4:5.26.3-422.el8.x86_64          58/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
libs-4:5.26.3-422.el8.x86_64          59/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
macros-4:5.26.3-422.el8.x86_64          60/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
parent-1:0.237-1.el8.noarch      61/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
podlators-4.11-1.el8.noarch      62/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
threads-1:2.21-2.el8.x86_64          63/64
googlecompute.csye6225-app-custom-image: Verifying      : perl-
threads-shared-1.58-2.el8.x86_64          64/64
googlecompute.csye6225-app-custom-image:
googlecompute.csye6225-app-custom-image: Installed:
googlecompute.csye6225-app-custom-image: dejavu-fonts-common-2.35-
7.el8.noarch
googlecompute.csye6225-app-custom-image: dejavu-sans-fonts-2.35-
7.el8.noarch
googlecompute.csye6225-app-custom-image: fontconfig-2.13.1-
4.el8.x86_64
googlecompute.csye6225-app-custom-image: fontpackages-filesystem-
1.44-22.el8.noarch
googlecompute.csye6225-app-custom-image: gd-2.2.5-7.el8.x86_64
googlecompute.csye6225-app-custom-image: jbigkit-libs-2.1-
14.el8.x86_64
googlecompute.csye6225-app-custom-image: libX11-1.6.8-7.el8.x86_64
googlecompute.csye6225-app-custom-image: libX11-common-1.6.8-
7.el8.noarch
googlecompute.csye6225-app-custom-image: libXau-1.0.9-3.el8.x86_64
googlecompute.csye6225-app-custom-image: libXpm-3.5.12-11.el8.x86_64
googlecompute.csye6225-app-custom-image: libjpeg-turbo-1.5.3-
12.el8.x86_64
googlecompute.csye6225-app-custom-image: libtiff-4.0.9-31.el8.x86_64
googlecompute.csye6225-app-custom-image: libwebp-1.0.0-9.el8.x86_64
googlecompute.csye6225-app-custom-image: libxcb-1.13.1-1.el8.x86_64
googlecompute.csye6225-app-custom-image: libxslt-1.1.32-6.el8.x86_64
googlecompute.csye6225-app-custom-image: nginx-1:1.14.1-

```

```
9.module_e18.0.0+1060+3ab382d3.x86_64
    googlecompute.csye6225-app-custom-image: nginx-all-modules-1:1.14.1-
9.module_e18.0.0+1060+3ab382d3.noarch
    googlecompute.csye6225-app-custom-image: nginx-filesystem-1:1.14.1-
9.module_e18.0.0+1060+3ab382d3.noarch
    googlecompute.csye6225-app-custom-image: nginx-mod-http-image-filter-
1:1.14.1-9.module_e18.0.0+1060+3ab382d3.x86_64
    googlecompute.csye6225-app-custom-image: nginx-mod-http-perl-
1:1.14.1-9.module_e18.0.0+1060+3ab382d3.x86_64
    googlecompute.csye6225-app-custom-image: nginx-mod-http-xslt-filter-
1:1.14.1-9.module_e18.0.0+1060+3ab382d3.x86_64
    googlecompute.csye6225-app-custom-image: nginx-mod-mail-1:1.14.1-
9.module_e18.0.0+1060+3ab382d3.x86_64
    googlecompute.csye6225-app-custom-image: nginx-mod-stream-1:1.14.1-
9.module_e18.0.0+1060+3ab382d3.x86_64
    googlecompute.csye6225-app-custom-image: perl-Carp-1.42-
396.e18.noarch
    googlecompute.csye6225-app-custom-image: perl-Data-Dumper-2.167-
399.e18.x86_64
    googlecompute.csye6225-app-custom-image: perl-Digest-1.17-
395.e18.noarch
    googlecompute.csye6225-app-custom-image: perl-Digest-MD5-2.55-
396.e18.x86_64
    googlecompute.csye6225-app-custom-image: perl-Encode-4:2.97-
3.e18.x86_64
    googlecompute.csye6225-app-custom-image: perl-Errno-1.28-
422.e18.x86_64
    googlecompute.csye6225-app-custom-image: perl-Exporter-5.72-
396.e18.noarch
    googlecompute.csye6225-app-custom-image: perl-File-Path-2.15-
2.e18.noarch
    googlecompute.csye6225-app-custom-image: perl-File-Temp-0.230.600-
1.e18.noarch
    googlecompute.csye6225-app-custom-image: perl-Getopt-Long-1:2.50-
4.e18.noarch
    googlecompute.csye6225-app-custom-image: perl-HTTP-Tiny-0.074-
3.e18.noarch
    googlecompute.csye6225-app-custom-image: perl-Io-1.38-422.e18.x86_64
    googlecompute.csye6225-app-custom-image: perl-Io-Socket-IP-0.39-
5.e18.noarch
    googlecompute.csye6225-app-custom-image: perl-Io-Socket-SSL-2.066-
4.module_e18+339+1ec643e0.noarch
    googlecompute.csye6225-app-custom-image: perl-MIME-Base64-3.15-
396.e18.x86_64
    googlecompute.csye6225-app-custom-image: perl-Mozilla-CA-20160104-
7.module_e18+645+9d809f8c.noarch
    googlecompute.csye6225-app-custom-image: perl-Net-SSLeay-1.88-
2.module_e18+339+1ec643e0.x86_64
    googlecompute.csye6225-app-custom-image: perl-PathTools-3.74-
1.e18.x86_64
    googlecompute.csye6225-app-custom-image: perl-Pod-Escapes-1:1.07-
395.e18.noarch
    googlecompute.csye6225-app-custom-image: perl-Pod-Perldoc-3.28-
396.e18.noarch
    googlecompute.csye6225-app-custom-image: perl-Pod-Simple-1:3.35-
395.e18.noarch
    googlecompute.csye6225-app-custom-image: perl-Pod-Usage-4:1.69-
395.e18.noarch
    googlecompute.csye6225-app-custom-image: perl-Scalar-List-Utils-
```

```
3:1.49-2.el8.x86_64
    googlecompute.csye6225-app-custom-image: perl-Socket-4:2.027-
3.el8.x86_64
    googlecompute.csye6225-app-custom-image: perl-Storable-1:3.11-
3.el8.x86_64
    googlecompute.csye6225-app-custom-image: perl-Term-ANSIColor-4.06-
396.el8.noarch
    googlecompute.csye6225-app-custom-image: perl-Term-Cap-1.17-
395.el8.noarch
    googlecompute.csye6225-app-custom-image: perl-Text-ParseWords-3.30-
395.el8.noarch
    googlecompute.csye6225-app-custom-image: perl-Text-Tabs+Wrap-
2013.0523-395.el8.noarch
    googlecompute.csye6225-app-custom-image: perl-Time-Local-1:1.280-
1.el8.noarch
    googlecompute.csye6225-app-custom-image: perl-URI-1.73-3.el8.noarch
    googlecompute.csye6225-app-custom-image: perl-Unicode-Normalize-1.25-
396.el8.x86_64
    googlecompute.csye6225-app-custom-image: perl-constant-1.33-
396.el8.noarch
    googlecompute.csye6225-app-custom-image: perl-interpreter-4:5.26.3-
422.el8.x86_64
    googlecompute.csye6225-app-custom-image: perl-libnet-3.11-
3.el8.noarch
    googlecompute.csye6225-app-custom-image: perl-libs-4:5.26.3-
422.el8.x86_64
    googlecompute.csye6225-app-custom-image: perl-macros-4:5.26.3-
422.el8.x86_64
    googlecompute.csye6225-app-custom-image: perl-parent-1:0.237-
1.el8.noarch
    googlecompute.csye6225-app-custom-image: perl-podlators-4.11-
1.el8.noarch
    googlecompute.csye6225-app-custom-image: perl-threads-1:2.21-
2.el8.x86_64
    googlecompute.csye6225-app-custom-image: perl-threads-shared-1.58-
2.el8.x86_64
    googlecompute.csye6225-app-custom-image:
    googlecompute.csye6225-app-custom-image: Complete!
==> googlecompute.csye6225-app-custom-image: Deleting instance...
    googlecompute.csye6225-app-custom-image: Instance has been deleted!
==> googlecompute.csye6225-app-custom-image: Creating image...
==> googlecompute.csye6225-app-custom-image: Deleting disk...
    googlecompute.csye6225-app-custom-image: Disk has been deleted!
Build 'googlecompute.csye6225-app-custom-image' finished after 11 minutes
19 seconds.

==> Wait completed after 11 minutes 19 seconds

==> Builds finished. The artifacts of successful builds are:
--> googlecompute.csye6225-app-custom-image: A disk image was created in
the 'northeastern-university-6225' project: csye622-1708028665
[centos@ip-172-31-92-143 packer]$
```

## Lecture Notes - SystemD

### csye6225.service

```
1 [Unit]
2 Description=CSYE 6225 App
3 ConditionPathExists=/opt/application.properties
4 After=network.target
5
6 [Service]
7 Type=simple
8 User=csye6225
9 Group=csye6225
10 WorkingDirectory=/opt/app
11 ExecStart=/opt/app/healthcheck
12 Restart=always
13 RestartSec=3
14 StandardOutput=syslog
15 StandardError=syslog
16 SyslogIdentifier=csye6225
17
18 [Install]
19 WantedBy=multi-user.target
```

# Assignment #04

## Due Date

Section	Submission Due Date	Grading Due Date
Boston	02/21/2024 @ 9 PM ET	02/28/2024 @ 9 PM ET
Seattle & Silicon Valley	02/23/2024 @ 9 PM PT	03/01/2024 @ 6 PM PT

## Learning Objectives

The objective of this assignment is to learn how to build custom machine images with our application and dependencies baked in.

## Install gcloud CLI

Install and configure `gcloud CLI` on your development machine (laptop). See [Install the gcloud CLI](#) for detailed instructions.

## Packer & Custom Images - Building Custom Application Images using Packer

 **Note**

For this assignment only, install MySQL/MariaDB/PostgreSQL locally in the custom image.

1. Use Centos Stream 8 as your source image to create a custom image using Packer.
2. All custom images you build should be private. Only you can launch instances from it.

3. All custom image builds should happen in your `DEV` GCP project.
4. Custom image builds should be set up to run in your `default` VPC.
5. The custom image should include everything needed to run your application and the application binary itself. For e.g., if you are using Tomcat to run your Java web application, your custom image must have Java & Tomcat installed. You should also make sure the Tomcat service will start up when an instance is launched. If you are using Python, make sure you have the right version of python and the libraries you need to be installed in the custom image.
6. The packer template should be stored in the same repo as the web application.
7. **For this assignment only**, install MySQL/MariaDB/PostgreSQL locally in the custom image.

## Packer Continuous Integration - Add New GitHub Actions Workflow for Status Check

When a pull request is raised, this GitHub Actions workflow should do the following:

1. Run the `packer fmt` command. If this command modifies the packer template, the workflow should fail and prevent users from merging the pull request.
2. Run the `packer validate` command. If this command fails to validate the packer template, the workflow should fail and prevent users from merging the pull request.

## Packer Continuous Integration - Add New GitHub Actions Workflow to Build Packer custom image



### Danger

Make sure you do not trigger your workflow to build custom image when pull request is raised. It should only build custom image when pull request is merged.

### Setup

1. You will need to create a new IAM service account (manually in GCP console) in the `DEV` GCP project for GitHub Actions and configure the security credentials in your organization repository. Refer to [this](#) for more details.
2. Grant the service account the roles needed. See [documentation](#) for more details.
3. Install & configure `gcloud cli` on your GitHub Actions runner with [this](#) marketplace action.

**When a pull request is merged, this GitHub Actions workflow should be triggered to do the following:**

1. Run the integration test.
2. Build the application artifact (war, jar, zip, etc.). This artifact should be build on the GitHub actions runner and not in the custom image i.e. do not `git clone` your repository in the packer template and then build it. You will build the artifact on the runner and copy it into the custom image.
3. Build the custom image with following
  - a. Create a local user `csye6225` with primary group `csye6225`. This user should not have a login shell i.e. login shell should be `/usr/sbin/nologin`. See <https://www.baeldung.com/linux/create-non-login-user> for details.
  - b. Install application dependencies and set up the application by copying the application artifacts and the configuration files.
  - c. The application artifacts, configuration, etc. must be owned by user `csye6225` and group `csye6225`.
  - d. Add your `systemd` service file to `/etc/systemd/system` and configure it to start your service when instance is launched.
  - e. Run `systemctl daemon-reload` with `sudo`
  - f. Run `systemctl enable <service_name>` with `sudo`
4. No custom image should be built if the any of the jobs or steps in the workflow fail.

## Infrastructure as Code w/Terraform

In this assignment, you will update the Terraform template to add the following resources.

## Firewall

Set up firewall rules for your custom VPC/Subnet to allow traffic from the internet to the port your application listens to. Do not allow traffic to SSH port from the internet.

### References

- [google\\_compute\\_firewall](#)

## Compute Engine Instance (VM)

Create a compute engine instance with the following specifications. For any parameter not provided in the table below, you may go with default values. The instance must be launched in the VPC created by your Terraform IaC code. You cannot launch the instance in the `default` VPC.

Parameter	Value
Boot disk Image	CUSTOM IMAGE
Boot disk type	Balanced
Size (GB)	100

### References

- [google\\_compute\\_instance](#)
- [GCP Operating system details](#)

## Submission



### Danger

1. The assignment will be considered late if uploaded to Canvas after the due date.
2. **DO NOT UPLOAD CODE FROM YOUR FORKED REPOSITORY TO CANVAS**

1. All work for this assignment must be done on the feature branch in your fork and merged to the main branch.

2. Submit your code from `all` the repositories in this assignment.  
Read the instructions carefully to create your zip file.
  - a. Create a folder with the `ncustom imageng` convention  
`firstname_lastname_neuid_##` where `##` is the assignment number.
  - b. In the `firstname_lastname_neuid_##` directory clone `all` of your GitHub (organization) repositories with the `git clone` command.  
It is important that you clone the repos so that your commit history and branches are preserved.
  - c. Once you have cloned all of your repositories, you will create a zip of the `firstname_lastname_neuid_##` directory. The zip file should be `firstname_lastname_neuid_##.zip` where `##` is the assignment number.
  - d. Now unzip the zip file in some other directory and confirm the content of the zip files.
  - e. Upload the Zip to this assignment.
3. You are allowed to resubmit `3` times. If you think there may be an issue with the ZIP file, feel free to submit it again. Only the latest submission will be used for grading.

## Grading Guidelines

Grading Guidelines will not be provided for this assignment. They will be based on the requirement above.

# Lecture #07

Campus	Lecture Date
Boston	02/22/2024
Seattle & Silicon Valley	02/24/2024

## Agenda

- **Mid-Term Exam**
  - BOS: 02/29/2024
  - SJ0/SEA: 03/02/2024
- Review [Assignment #04](#)
- Cloud Storage Solutions
  - Relational Databases
  - NoSQL Databases
  - Object Storage
  - Instance Store (Local Hard Drive)
  - Block Storage
- Discuss [Assignment #05](#)

## Reading

### [Using startup scripts on Linux VMs](#)

A startup script is a file that performs tasks during the startup process of a virtual machine (VM) instance.

- [AWS EC2 UserData](#)
- [Using startup scripts on Linux VMs on Google Cloud](#)
- [Indented Heredocs](#)

## AWS Cloud Storage Solutions

- [AWS Storage Services Whitepaper](#)
- [Cloud Storage with AWS](#)
- [Amazon Elastic Block Storage \(Amazon EBS\)](#)
- [Amazon Elastic File System \(Amazon EFS\)](#)
- [Amazon Simple Storage Service \(Amazon S3\)](#)
- [Cloud Databases with AWS](#)
- [Amazon RDS](#)
- [Amazon DynamoDB](#)
- [Amazon EC2 Security Groups for Linux Instances](#)
- [Amazon RDS Security Groups](#)

## Google Cloud Storage Solutions

- [Storage Options for Compute Engine](#)
- [Cloud \(Object\) Storage](#)
- [Google Cloud databases](#)
- [Filestore](#)

## Slides

Lecture slides can be found in this week's Canvas module.

## Lecture Notes - Packer Template with Startup Script

```
1 resource "google_compute_instance" "webapp" {
2
3   # depends_on = [
4   #   google_service_account.csye6225-gce-sa,
5   # ]
6
7   ...
8
9   boot_disk {
10     auto_delete = true
11     initialize_params {
12       image =
13       "projects/${var.project_id}/global/images/${var.custom_image_id}"
14       ....
15     }
16   }
17 }
```

```
15      }
16    }
17
18  metadata = {
19    startup-script = <<<-EOT
20  #!/bin/bash
21
22  set -e
23
24  echo "Hello World!"
25
26 EOT
27  }
28
29 ....
30 }
```

# Assignment #05

## Due Date

Section	Submission Due Date	Grading Due Date
Boston	02/29/2024 @ 4 PM ET	03/13/2024 @ 9 PM ET
Seattle & Silicon Valley	03/04/2024 @ 9 PM PT	03/15/2024 @ 6 PM PT

## Learning Objectives

The objective of this assignment to learn how to auto-configure our web application with details for the database server and setup autorun for our service so that it starts up without requiring any manual intervention from the administrator.

## Infrastructure as Code

### VPC Update

Setup `private services access` in your VPC. You will need to enable the Service Networking API in your project.

Reference Implementation: [PRIVATE SERVICES ACCESS](#)

### CloudSQL Instance (`google_sql_database_instance`)

#### Warning

Setting Public accessibility to true will expose your instance to the internet.

The CloudSQL instance should be created with the following default configuration with option to override them with variables. You may use any values/settings for any property not mentioned below.

Doc: [google\\_sql\\_database\\_instance](#)

Property	Value
deletion_protection	false
availability_type	regional
disk_type	pd-ssd
disk_size	100
ipv4_enabled	false
private_network	YOUR CUSTOM VPC

## CloudSQL Database (google\_sql\_database)

Create a database in the CloudSQL instance.

Doc: [google\\_sql\\_database](#)

Property	Value
name	webapp
instance	REF_TO_CLOUDSQL_INSTANCE

## CloudSQL Database User (google\_sql\_user)

Create a user in the CloudSQL database with a randomly generated password.

Docs :

- [google\\_sql\\_user](#)
- [random\\_password](#)

Property	Value
name	webapp
instance	REF_TO_CLOUDSQL_INSTANCE
password	RANDOMLY_GENERATED_PASSWORD

## Startup Script for Web Application Compute Engine Instance

- The web application's database must be the CloudSQL instance launched by with Terraform when running on the GCE instance.
- GCE instance should be created with startup script.
- Database configuration such as username, password, and hostname should be passed to the web application by the startup script.
- [Optional] You want want to configure your systemd unit to wait for startup script to have completed successfully.

## Web Application Packer Image Updates

- You can no longer install/use the local database on the GCE instance. Update your packer template to remove the local database server from the custom image.
- Note: You will use local database for your integration tests in your GitHub Actions.

## Network Security

1. CloudSQL instance should not be accessible from the internet.
2. CloudSQL instance can only be accessed by the compute engine instance running the web application.
3. ~~CloudSQL instance should be in the database subnet.~~

## Submission

 **Danger**

1. The assignment will be considered late if uploaded to Canvas after the due date.
2. **DO NOT UPLOAD CODE FROM YOUR FORKED REPOSITORY TO CANVAS**

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  - d. Now unzip the zip file in some other directory and confirm the content of the zip files.
  - e. Upload the Zip to this assignment.
3. You are allowed to resubmit `3` times. If you think there may be an issue with the ZIP file, feel free to submit it again. Only the latest submission will be used for grading.

# Lecture #09

Campus	Lecture Date
Boston	03/14/2024
Seattle & Silicon Valley	03/16/2024

## Agenda

- Review [Assignment #05](#)
- Mid Semester Feedback
- Domain Name System (DNS)
- Email Service
- Role of SRE
- Observability
  - Logging
  - Metrics
  - Monitoring & Alerting
- Discuss [Assignment #06](#)

## Slides

Lecture slides can be found in this week's Canvas module.

## Demos

- DNS Zone Delegation

## Reading

### Emails

- Amazon Simple Email Service
- SendGrid

## DNS

- Root name server
- An Introduction to DNS Terminology, Components, and Concepts
- DNS Best Practices, Network Protections, and Attack Identification
- AWS Route 53

## Observability

### Logs & Metrics

- Apache logging services
- Effective Logging
- Java Logging Standards and Guidelines
- Retrieve Custom Metrics with StatsD
- StatsD Client Libraries

### STRUCTURED LOGGING

- Structured logging
- Structured logging: What it is and why you need it
- What Is Structured Logging and Why Developers Need It

### JSON LOGGING

- JSON logging in Python
- JSON logging in Java
- JSON logging in Javascript/Node.js

### Google Cloud Observability

- Observability in Google Cloud
- Cloud Logging
- Cloud Monitoring
- Ops Agent Overview
  - Install the Ops Agent
  - Authorize the Ops Agent (Service Account)

## AWS CloudWatch

- What is Amazon CloudWatch Logs?
- Amazon CloudWatch
- The Log: What every software engineer should know about real-time data's unifying abstraction

## Lecture Notes

```
1  logging:
2    receivers:
3      my-app-receiver:
4        type: files
5        include_paths:
6          - /tmp/myapp.log
7        record_log_file_path: true
8    processors:
9      my-app-processor:
10        type: parse_json
11        time_key: time
12        time_format: "%Y-%m-%dT%H:%M:%S.%L%Z"
13    service:
14      pipelines:
15        default_pipeline:
16          receivers: [my-app-receiver]
17          processors: [my-app-processor]
```

```
1  sudo vi /etc/google-cloud-ops-agent/config.yaml
2  sudo systemctl restart google-cloud-ops-agent
```

# Assignment #06

## Due Date

Section	Submission Due Date	Grading Due Date
Boston	03/20/2024 @ 9 PM ET	03/27/2024 @ 9 PM ET
Seattle & Silicon Valley	03/22/2024 @ 9 PM PT	03/29/2024 @ 6 PM PT

## DNS

### Register Domain Name

**Note**

Namecheap offers a free domain with the Github Student Developer pack but only `.me` TLD domain.

1. Register a domain name with a domain registrar such as [Namecheap](#), [AWS](#), [gandi.net](#), [GoDaddy](#).
2. You are free to pick a domain name with any TLD.

### DNS Setup - Cloud DNS

**Note**

This setup should be done manually from the GCP console.

Your new domain will be set up to use the registrar's name servers by default.

Reference Documentation:

- [Create, modify, and delete zones](#)
- [How to Change DNS For a Domain in Namecheap](#)

### Create A Public Zone & Setup Nameservers for Cloud DNS

1. Create a public zone in Cloud DNS manually from the GCP console for the `your-domain-name.tld`.
2. Configure Namecheap to use custom name servers provided by Cloud DNS to use the Cloud DNS name servers.

### Infrastructure as Code w/Terraform



#### Note

`<port>` refers to the port number at which your application listens.

1. Cloud DNS zone should be updated by Terraform. Add or Update A record to the Cloud DNS zone so that your domain points to your VM instance and your web application is accessible at `http://your-domain-name.tld:<port>/`. Note that the `port` numbers are not part of DNS record.
2. Your application must be accessible using root context i.e. `http://your-domain-name.tld:<port>/` and not `http://your-domain-name.tld:<port>/app-0.1/`. Note: This only applies to application build with Java & uses Tomcat to run the application. For most students there is no work to do.

### Application Logging & Metrics

#### Enable Project APIs

- [Troubleshoot Ops Agent installation and start-up](#)

#### Update Custom Machine Image

1. Update your packer template to install the Ops Agent in your custom image.
2. The Ops Agent must be configured for your application logs (even if these log files don't exist yet).

## Create a Service Account for Virtual Machine & Attach to the Virtual Machine

1. Create a [Service Account](#) to attach to your virtual machine.
2. Attach the service account to the compute instance. See [https://registry.terraform.io/providers/hashicorp/google/latest/docs/resources/compute\\_instance#service\\_account](https://registry.terraform.io/providers/hashicorp/google/latest/docs/resources/compute_instance#service_account).

## Bind IAM Role to the Service Account

1. Bind the [appropriate role](#) to the service account with [google\\_project\\_iam\\_binding](#)
2. Roles:
  - a. Logging Admin
  - b. Monitoring Metric Writer

## Email Configuration



### Note

The following steps are done manually. You only need to configure Sendgrid or Mailchimp and not both.

- [Sendgrid](#).
- [Mailchimp](#)

## Web Application Updates

1. Update application to write Structured Logs in JSON.
2. All application log data should be streamed to Google Cloud Observability and available in Log Explorer.

## Submission

 **Danger**

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  - e. Upload the Zip to this assignment.
3. You are allowed to resubmit `3` times. If you think there may be an issue with the ZIP file, feel free to submit it again. Only the latest submission will be used for grading.

## Grading Guidelines

 **Warning**

The following guidelines are for information only. They are subject to change at the discretion of the instructor and TA. A 10% penalty will be imposed if the application crashes due to unhandled exceptions/errors.

## Previous Assignment Objectives

TAs must verify that students have resolved all open issues from the previous assignment(s).

## Git Repository Content Check

1. Check the repository for any IDE-specific files. IDE configuration files must not be in the repository.
2. Verify their .gitignore configuration.
3. Check the repository for build artifacts such as `.class`, `.jar`, `.war` files and `build`, `node_modules`, `venv` directory. None of these should be checked into the repository.
4. Check for dependencies. Dependencies from the Maven repository or npm or python should not be committed to the git repository.

## Git Forking Workflow

1. Verify student has followed the git forking workflow. Code is committed using pull requests and is not pushed directly to the `main` branch.

## DNS

1. Student has registered domain name or has pre-existing one to use for the course.
2. Verify a public Cloud DNS zone has been created in GCP and Nameservers configured with the registrar (namecheap, gandi.net, aws, godaddy, etc). Verification can be done with the command `dig NS domainname.tld`
3. Launching an instance from terraform updates (or creates) an A record for the instance with public IP. Verify this with `dig A domainname.tld` command. It should return a public IPv4 address of the instance. Verify this by deleting the A record from console and running `terraform apply`. The plan should have one update for the A record.
4. The application is accessible using `http://domainname.tld` endpoint. Validate existing APIs with this endpoint.

## Application Logging & Metrics

1. Verify the Ops Agent is installed in the custom image when build with Packer
2. The IaC Terraform template creates a service account.
3. The IaC Terraform template creates a project level IAM binding for Logging admin role
4. The IaC Terraform template creates a project level IAM binding for Monitoring metrics writer role
5. The IaC Terraform template assigns the service account to the compute instance
6. Application writes structured logs in JSON. Log messages should not be split into multiple log entries in Google Logging Explorer.
7. The timestamp of the log message in the log file and GCP logging explorer match
8. The severity (INFO, DEBUG, ERROR, WARN) of log message is accurately displayed in CP logging explorer. Log messages should not have DEFAULT severity.

# Lecture #10

Campus	Lecture Date
Boston	03/21/2024
Seattle & Silicon Valley	03/23/2024

## Agenda

- Review [Assignment #06](#)
- Content Delivery Network (CDN)
- Microservices Architecture
- Event-driven architecture (Publish/Subscribe)
- Serverless Computing
- Discuss [Assignment #07](#)

## Slides

Lecture slides can be found in this week's Canvas module.

## Reading

### Content Delivery Network (CDN)

- [Cloud CDN overview](#)
- [Content delivery best practices](#)
- [Use negative caching](#)

### Serverless Computing

- [Cloud Functions overview](#)
- [Write Cloud Functions](#)

- Deploy a Cloud Function
- Cloud Functions triggers
  - Pub/Sub triggers
  - HTTP triggers

## Event-Driven Architecture & Pub/Sub

- What is Pub/Sub?
- Overview of the Pub/Sub service

# Assignment #07

## Due Date

Section	Submission Due Date	Grading Due Date
Boston	03/27/2024 @ 6 PM EDT	04/03/2024 @ 9 PM EDT
Seattle & Silicon Valley	03/29/2024 @ 9 PM PDT	04/05/2024 @ 6 PM PDT

## Google Cloud APIs To Enable from Console

- Cloud Build API
- Cloud Functions API
- Cloud Logging API
- Cloud Pub/Sub API
- Eventarc API
- Cloud Pub/Sub API
- Cloud Run Admin API

## Serverless w/Cloud Functions

### Create & Setup GitHub Repository for Cloud Functions

1. **Create** a new `private` GitHub repository for infrastructure in the GitHub organization you created.
2. The GitHub repository name must be `serverless`.
3. Update `README.md` in your repository.
4. Fork the GitHub repository in your namespace. You will do all development work on your fork.
5. All code for Lambda Functions should now be in this repository.

6. Add appropriate `.gitignore` to your repository. A collection of useful `.gitignore` templates can be found [here](#).

## Implement Cloud Function

1. The Cloud function will be invoked by the pub/sub when a new user account is created.
2. The Cloud function is responsible for following:
  - a. Email the user a link they can click to verify their email address. The verification link should expire after 2 minutes. This low limit will allow for quicker demo. An expired link cannot be used to verify the user.
  - b. Track the emails sent in CloudSQL instance. You can use the same instance & database used by the web application

## Pub/Sub

1. Create a topic `verify_email` and set up a subscription for the Cloud Function.
2. Set data retention period for the topic to be 7 days.

## Web Application Updates

1. Update web application to now publish a message to pub/sub topic when a new user account is created. The payload (message) should be in JSON with all relevant information (you decide what this is) that will be needed by the Cloud Function to send email to the user and track the link verification.
2. All API calls from user account that has not been verified are blocked until the user completes the verification.
3. You are not expected to add new API endpoints for user to request a new verification link once the current one has expired.
4. Bind appropriate IAM role (cannot be admin) to publish message to the topic.

## Infrastructure as Code w/Terraform

- Create the pub/sub topic, subscription, IAM, service accounts, role bindings, Cloud Functions and any other resources required using Terraform.
- Note: I ran into this permission issue Service account(s) might not have enough permissions to deploy the function with selected trigger. To mitigate potential errors, you can grant them the following roles:  
`roles/iam.serviceAccountTokenCreator to service-<project-id>@gcp-sa-pubsub.iam.gserviceaccount.com`

## Terraform Resources

- `google_pubsub_topic`
- `google_pubsub_subscription`
- `google_cloudfunctions_function`
- IAM policy for Cloud Functions CloudFunction
- IAM policy for Pubsub Subscription
- IAM policy for Cloud Pub/Sub Topic

## Submission

### Danger

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## Grading Guidelines

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## Previous Assignment Objectives

TAs must verify that students have resolved all open issues from the previous assignment(s).

## Git Repository Content Check

1. Check the repository for any IDE-specific files. IDE configuration files must not be in the repository.
2. Verify their `.gitignore` configuration.
3. Check the repository for build artifacts such as `.class`, `.jar`, `.war` files and `build`, `node_modules`, `venv` directory. None of these should be checked into the repository.
4. Check for dependencies. Dependencies from the Maven repository or npm or python should not be committed to the git repository.

## Git Forking Workflow

1. Verify student has followed the git forking workflow. Code is committed using pull requests and is not pushed directly to the main branch.

## Cloud Function & Pub/Sub

1. Verify new github repository has been created for Cloud functions & Git Forking Workflow is used to commit code to the repository.
2. Pub/Sub topic is created by terraform
3. CloudFunction is invoked by pub/sub
4. CloudFunction sends email to user with verification link
5. CloudFunction stores the token & it's expiry in the CloudSQL instance used by the webapp
6. CloudFunction cannot be invoked by allUsers

## Web Application

1. Web application publishes message to pub/sub topic when a new user account is created
2. User cannot verify account with expired link
3. User cannot make calls to API until the account is verified. Web app must return 403 response code.

## Emails

1. Email sent by CloudFunction do not go to SPAM
2. Validate SPF record for the domain <https://dmarcly.com/tools/spf-record-checker>
3. Validate DKIM for the domain with <https://dmarcly.com/tools/dkim-record-checker>

# Lecture #11

Campus	Lecture Date
Boston	03/28/2024
Seattle & Silicon Valley	03/30/2024

## Agenda

- Review [Assignment #07](#)
- Load Balancing
- High Availability
  - Availability Zones
  - Auto Scaling
- Discuss [Assignment #08](#)

## Slides

Lecture slides can be found in this week's Canvas module.

## Reading

### Auto Scaling & Load Balancing

#### **Amazon Web Services**

- [Auto Scaling in the Amazon Cloud - Netflix](#)
- [AWS AutoScaling](#)
- [AWS Elastic Load Balancing](#)
- [AWS Classic Load Balancer](#)
- [AWS Application Load Balancer](#)

#### **Google Cloud Platform**

- Autoscaling Groups of VMs in Google Cloud Platform
- Instance groups
- Scaling based on CPU utilization
- Adding an instance group to a load balancer
- Choose a load balancer
- GCP Load balancing and scaling
- Understanding autoscaler decisions
- View autoscaler logs

## Infrastructure at Scale

- How Twitter Handles 3,000 Images Per Second
- The Infrastructure Behind Twitter: Scale
- Caching at Reddit
- How Uber Manages A Million Writes Per Second Using Mesos And Cassandra Across Multiple Datacenters
- Instant Messaging at LinkedIn: Scaling to Hundreds of Thousands of Persistent Connections on One Machine
- Big Data in Real-Time at Twitter

# Assignment #08

## Due Date

Section	Submission Due Date	Grading Due Date
Boston	04/03/2024 @ 6 PM EDT	04/10/2024 @ 9 PM EDT
Seattle & Silicon Valley	04/05/2024 @ 9 PM PDT	04/12/2024 @ 6 PM PDT

## Learning Objectives

The goal of this assignment is to set up the web application to auto-scale up as the demand increases and to scale down when the demand/load goes down. Because of the dynamic nature of the auto-scaler, the lifecycle of instances is now auto managed. To provide a static endpoint for our users, we now need to put a load balancer in front of the web application. The load balancer will track active instances and route traffic to them based on the policy we have defined.

## IAM

All service accounts & IAM roles bindings needed to meet the assignment objectives must be created in Terraform template.

## Autoscaling Web Application

1. Create a regional compute instance template that matches your current VM deployment. You will remove the compute instance resource from your terraform.
2. Create a compute health check. This health check should use the `/healthz` endpoint in the web application.

3. Create a compute autoscaler resource that will scale up when CPU usage exceeds 5% CPU.
4. Create a regional compute instance group manager with the above resources.
5. Update firewall ingress rules to make sure only load balancer can access the endpoints on your virtual machines. External users can no longer access APIs using the public IPs of the virtual machines.

## Load Balancer

1. Create a external Application Load Balancers. The load balancer will only support HTTPS protocol.
2. Set up SSL certificates [Use Google-managed SSL certificates](#).
3. The APIs must now be accessible using HTTPS protocol on the default port 443 .
4. HTTP to HTTPS redirection does not need to be supported.

## DNS Updates

1. Update the DNS record to point the domain to load balancer IP address.

## Selected Terraform Resources & Resources

### Warning

This is not a complete list of terraform resources you will need to complete the assignment.

## Autoscaling

- [google\\_compute\\_region\\_instance\\_template](#)
- [google\\_compute\\_region\\_autoscaler](#)
- [google\\_compute\\_health\\_check](#)
- [google\\_compute\\_region\\_instance\\_group\\_manager](#)

## Load Balancer

- [Terraform examples for external Application Load Balancers](#)
- [Global HTTP Load Balancer Terraform Module](#)
- [Set up a regional external Application Load Balancer with VM instance group backends](#)

## Submission



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# Lecture #12

Campus	Lecture Date
Boston	04/04/2024
Seattle & Silicon Valley	04/06/2024

## Announcements

- Final exam for the course will be held on following day and time based on the University's Final Exam Schedule:
  - 04/25/2024 at 6:10 PM EDT for BOS
  - 04/27/2024 at 10:00 AM PDT for SEA & SJ0
- Last day to submit assignments is April 10th, 2024 for BOS and April 12th, 2024 for SJ0 & SEA. No submissions will be accepted after this day. Assignments missing submission after these dates will receive 0. No exceptions!
- Last day to get assignments graded is April 18th, 2024. Any assignments not graded by then will receive 0. No exceptions!

## Agenda

- Review Assignment #08
- Continuous Deployment
- Cloud Security
- Securing Cloud Infrastructure
  - Operating System
  - Network
  - AWS, GCP, etc. Accounts
- Securing Your Application
  - SQL Injection

- Cross-Site Scripting (XSS)
- Cross-Site Request Forgery (CSRF)
- Discuss [Assignment #09](#)

## Slides

Lecture slides can be found in this week's Canvas module.

## Reading

### CI/CD



#### Note

Access ACM articles using ACM Digital Library

- [Manual Work is a Bug](#)
- [Continuous Delivery Sounds Great, but Will It Work Here?](#)

## SSL

- [Let's Encrypt](#)
- [An Introduction to Let's Encrypt](#)
- [Why HTTPS for Everything?](#)
- [The HTTPS-Only Standard](#)
- [Server Name Indication](#)

## Key Management Service

- [Cloud Key Management Service overview](#)
- [Create a key ring](#)
- [Create a key](#)
- [Access control with IAM](#)
- [Key rotation](#)

## Managed Instance Groups (MIG) - Instance Template Updates

- `gcloud compute instance-groups managed set-instance-template`
- `gcloud compute instance-groups managed recreate-instances`

# Assignment #09

## Due Date

Section	Submission Due Date	Grading Due Date
Boston	04/10/2024 @ 6 PM EDT	04/18/2024 @ 6 PM EDT
Seattle & Silicon Valley	04/12/2024 @ 6 PM PDT	04/18/2024 @ 6 PM PDT

## CMEK - Cloud Key Management Service

1. Create a Key Ring in the region you deploy your resources.
2. Create a separate Customer-managed encryption keys (CMEK) for each of the following resources:
  - a. Virtual Machines
  - b. CloudSQL Instances
  - c. Cloud Storage Buckets
3. Customer-managed encryption keys (CMEK) should be setup with 30 day rotation period.
4. Use Customer-managed encryption keys (CMEK) when launching resources in Terraform.

## CI/CD for Web Application - Update Pull Request Merged Workflow

 **Note**

No changes required for the Pull Request Raised Workflow.

1. Update GitHub actions workflow that is triggered when a pull request is merged. This workflow should now do the following:
  - a. Run the unit test. (No changes from current CI implementation)
  - b. Validate Packer Template (No changes from current CI implementation)
  - c. Build Application Artifact(s) (No changes from current CI implementation)
  - d. Build machine images (No changes from current CI implementation)
    - i. Upgrade OS packages
    - ii. Install dependencies (python, node.js, etc.)
    - iii. Install application dependencies (pip install for Python)
    - iv. Set up the application by copying the application artifacts and the configuration files.
    - v. Configure the application to start automatically when VM is launched.
  - e. [NEW] Create a new Instance Template version with the latest machine image id for the managed instance group.
  - f. [NEW] Configure the managed instance group to use this new template using `gcloud` cli.
  - g. [NEW] Issue command to the managed instance group to [starting a basic rolling update](#) using `gcloud` cli.
  - h. [NEW] GitHub Actions workflow must wait for managed instance group refresh to complete before existing. The status of GitHub Actions workflow must match the status of instance refresh command. See [monitoring updates](#) for additional details.
  - i. [NEW] You are not required to handle rollback for failed deployments.

## Submission



### Danger

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## Grading Guidelines

Grading Guidelines will not be provided for this assignment. They will be based on the requirement above.



### Warning

The following guidelines are for information only. They are subject to change at the discretion of the instructor and TA. A `10%` penalty will be imposed if the application crashes due to unhandled exceptions/errors.

## Previous Assignment Objectives

TAs must verify that students have resolved all open issues from the previous assignment(s).

## CI/CD

- Verify that no resources exist in Google Console. Check IAM for existing service accounts and remove permissions that are suppose to be setup by Terraform
- Students should bring up the infra using Terraform & update GitHub Workflow with environment variables & secrets
- Validate the APIs, SSL certificate, Load Balancer & Autoscaling
- Ask the student to change the /v1/user API to /v2/user and raise a pull request. Verify that the status check works on PR. Merge the PR.
  - New Machine Image is created
  - New Instance Template is created with the new machine image by the GitHub Workflow action. Have student show you the command in the workflow action and the logs in GitHub UI
  - The managed instance group is updated by the GitHub workflow to use the new Instance Template. Have student show you the command in the workflow action and the logs in GitHub UI
  - The GitHub Actions triggers a rolling update. Make sure the GitHub actions workflow does not complete before all instances have been updated
  - Verify application logs are being sent to Log Explorer
  - Verify the new instances use the same customer managed encryption key and not the default key
  - Validate the new API is working as expected

## CMEK

- Verify keyring is created from Terraform
- Verify key is created and used for VMs. In the console check the KMS key attached. It should not be the default key.
- Verify key is created and used for CloudSQL. In the console check the KMS key attached. It should not be the default key.

# Lecture #13

Campus	Lecture Date
Boston	04/11/2024
Seattle & Silicon Valley	04/13/2024

## Announcements

- Final exam for the course will be held on following day and time based on the University's Final Exam Schedule:
  - 04/25/2024 at 6:10 PM EDT for BOS
  - 04/27/2024 at 10:00 AM PDT for SEA & SJ0
- Last day to get assignments graded is April 18th, 2024 . Any assignments not graded by then will receive 0 . No exceptions!

## Agenda

- Review [Assignment #09](#)
- Architecting for the Cloud: Best Practices

## Slides

Lecture slides can be found in this week's Canvas module.

## Reading

- [Azure Architecture Center](#)
- [AWS Architecting for The Cloud](#)
- [AWS Whitepapers](#)
- [Building scalable and resilient applications](#)

