Infrastructure Design Patterns with Python, Buildbot, and Linux Containers

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- Breaking out of CI: Infrastructure Design patterns with Buildbot framework pieces
- Hooking things up in weird ways: Ports, multi-masters, and pseudo-RPC
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- Pulling it all together with Python
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- Summary

Introduction: On Infrastructure

- What does it mean to have infrastructure?
- Is it automation? Is it orchestration? Is it task runners?
- Many options exist depending on what “needs” you have
  - Full on orchestration with Chef, Puppet
  - Dask, IPyParallel, Joblib (These are mostly numerical)
  - Celery, Kafka
- Many of these examples are heavy-handed or square peg/round hole problems

On Infrastructure (con’t)

- Examples
  - Trying to get a distributed task system such as Dask to run a CRON is not exactly the best use case
  - Trying to get Celery to do a map-reduce operation
  - Trying to get puppet to make a task graph
- In essence, every one of these frameworks are meant for vastly different things!

Breaking out of CI: Infrastructure Design patterns with Buildbot

- Buildbot is normally meant for Continuous Integration (CI), but you can construct things out of the elements in weird ways.
- Just like Lego blocks for infrastructure; this differs heavily from things such as Jenkins or TeamCity
- *CI Tasks* normally encompass interesting pieces: A scheduler, dependencies, a result
- However, these *main task* components are actually composed of many other primitives that have been assembled together

Breaking out of CI: Infrastructure Design patterns with Buildbot (Con't)

Examples:

- Resource pools
- Roles and triggers
- Task runners
- Distributed System + communications
- State Logic
- Change triggers
- Schedulers
- Build steps (scripting steps)
- Master/worker system
- Barriers and semaphores
- Dependency tree

Breaking out of CI: Infrastructure Design patterns with Buildbot (Con't)

- Because Buildbot splits all these items up, one may be able to wire the components up in unusual ways to meet commonly occurring infrastructure patterns
- ***Warning:*** Before going any farther, I want to reiterate that what I am about to show *is conceptual* and used for proof-of-concepts, and is no replacement for sound orchestration and proper security
- This is considered a very "off use" of Buildbot (and was not intended by the developers), so just be mindful of this

Breaking out of CI: Infrastructure Design patterns with Buildbot (Con't)

- Infrastructure design patterns are the common tasks/roles, and interconnects that occur in software deployments
  - Using Buildbot is just <u>one</u> way of solving such examples
  - One can utilize this to prototype something and then convert it to enterprise-level deployments
- Examples:
  - CI->Package->Deployment (common use)
  - Enterprise application deployment
  - License Server
  - Linux Session launching/landing on Servers
  - Home Weather Server w/ Machine Learning tasks

Hooking things up in weird ways: Ports, multi-masters, and pseudo-RPC

- Normally, most CI systems do not expose such controls, but because of the flexibility in Buildbot, one may use it quite freely
- The *change-port* allows for usage of a script or *symlinked* call to trigger a task-which gives user-level triggers
- By passing in arguments of the script in, one can essentially "RPC" to a worker with a known resource
  - i.e. run some task where the right version of Python/NumPy is
- Buildbot is controlled via the logic of the *master.cfg*, which is interpreted as majority Python code

Hooking things up in weird ways: Ports, multi-masters, and pseudo-RPC (Con't)

- In the buildmaster's configuration, normal change sources look like the following:
  - c['change_source'] = []
    c['change_source'].append(changes.GitPoller(
    'git://github.com/buildbot/pyflakes.git',
    workdir='gitpoller-workdir', branch='master',
    pollinterval=300))
- However, you can add a secondary trigger source:
  - c['change_source'].append(changes.PBChangeSource(port=9999, user='myApp', passwd='AppPassword'))

Hooking things up in weird ways: Ports, multi-masters, and pseudo-RPC (Con't)

- Matched with the "fakechange.py" script in buildbot-contrib, one can initiate and pass arguments (such as X11 info, user info) to a buildmaster
- Utilizes the *twisted.internet* and *twisted.spread* capabilities
- Sends change to the *scheduler* in the Buildbot *master.cfg*

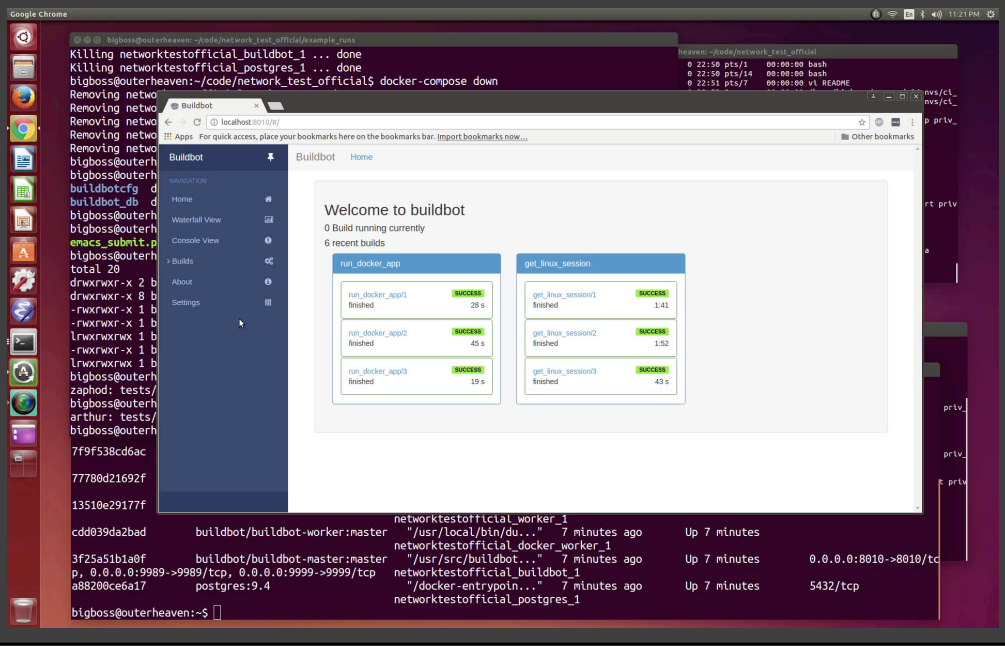
```
def send_change(remote):
    who = random.choice(users)
    if len(sys.argv) > 1:
        files = sys.argv[1:]
    else:
        files = [makeFilename()]
    comments = commands.getoutput("fortune")
    change = {'who': who, 'files': files,
              'comments': comments,
              'project': 'start-term'}
    d = remote.callRemote('addChange', change)
    d.addCallback(done)
    print("%s: %s" % (who, " ".join(files)))


f = pb.PBClientFactory()
d = f.login(credentials.UsernamePassword("laura", "fpga"))
reactor.connectTCP("localhost", 9999, f)
err = lambda f: (log.err(), reactor.stop())
d.addCallback(send_change).addErrback(err)

reactor.run()
```

```
c['schedulers'].append(schedulers.SingleBranchScheduler(
    name="external_emurun",
    change_filter=util.ChangeFilter(project='start-term'),
    treeStableTimer=None,
    builderNames=["get_linux_session"]))
```

Example of using the change-port to launch apps



Hooking things up in weird ways: Ports, multi-masters, and pseudo-RPC (Con't)

- Multi-master gives the ability to chain tasks and resource pools together to grant capabilities such as load balancers to certain tasks
- Don't hesitate to have one task kick off another subset of Buildbot instances

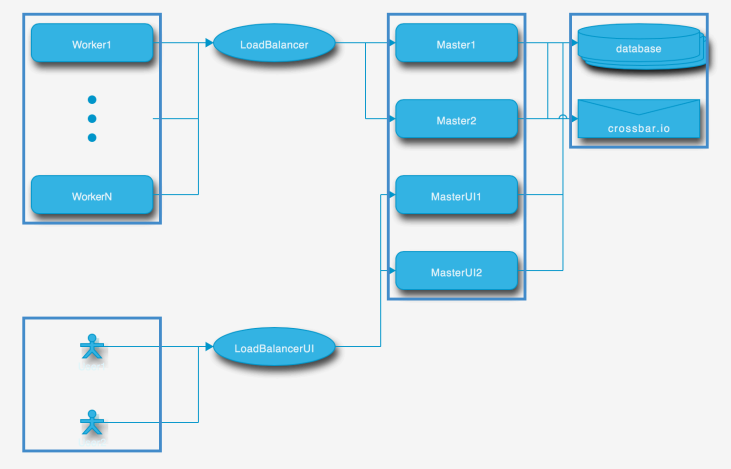


Image from Buildbot Docs

Hooking things up in weird ways: Ports, multi-masters, and pseudo-RPC (Con't)

- Use *util.BuildFactory()* to send commands to workers via *ShellCommand*
- Note that the worker must be privileged to run command and must have resources, so define workers well

```
display_var = "DISPLAY=:0"
emacsapp_factory = util.BuildFactory()
emacsapp_factory.addStep(steps.ShellCommand(command=["docker", "run",
                                                     "--rm", "-v", "/:/files",
                                                     "-e", display_var,
                                                     "-v","/tmp/.X11-unix:/tmp/.X11-unix",
                                                     "silex/emacs"]))

# Runs a retro session for the terminal
session = util.BuildFactory()
session.addStep(steps.ShellCommand(command=["docker" ,"run",
                                            "-v", "/tmp/.X11-unix:/tmp/.X11-unix",
                                            "-e", display_var, "jess/1995"]))
```

When things don't fit: Linux Containers, and keeping things movable

- What happens when things don't want to fit together? or you have security concepts to worry about?
- Use Linux Containers to provide additional design flexibility through composition techniques (docker-compose, as an example)
- Use Containers to also cordon off the riskier bits (prevent volume maps, etc.)
- Provide privilege/non-privileged barriers to separate users from full-privileged resources

When things don't fit: Linux Containers, and keeping things movable (con't)

- At some point, you may need orchestration to pull off tasks, so just know what responsibilities you want in what technologies
- Depending on how you approach the problem, you might be able to get away with little or no orchestration
- If all else fails, you can somewhat cheat by having the entire Buildbot + logic inside of a container, and use those as building blocks

Pulling it all together with Python

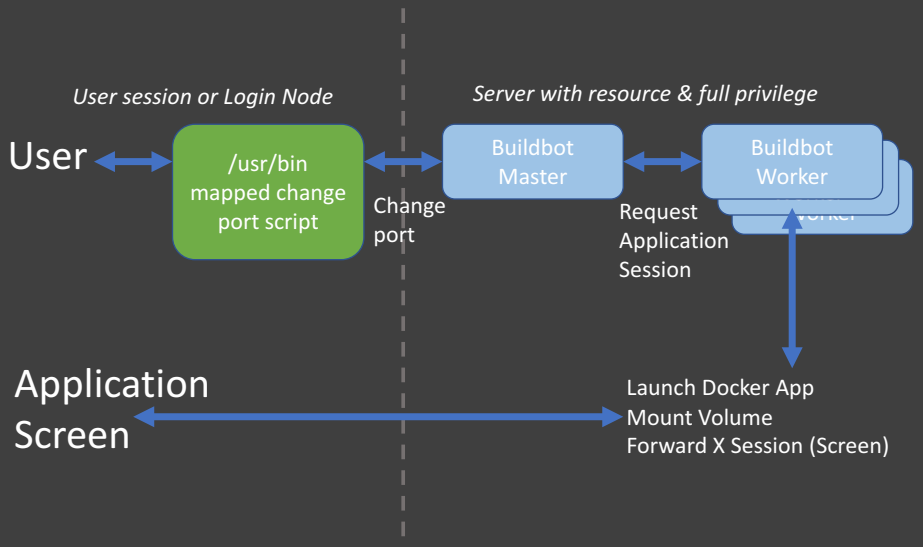
- So with Python at the forefront, you can utilize the Python scripts injected into buildbot itself, or have the master.cfg *unpack* code that it receives
- The scripting capabilities mean that you can use calls in build steps to achieve things in an RPC format on the workers
- Python can call the build masters easily, so scripting it to do your bidding is free-form
  - Mixing this with file opening, web calls and requests, are just some of the advantages of using Python "glue"

Real-world architectures that have worked

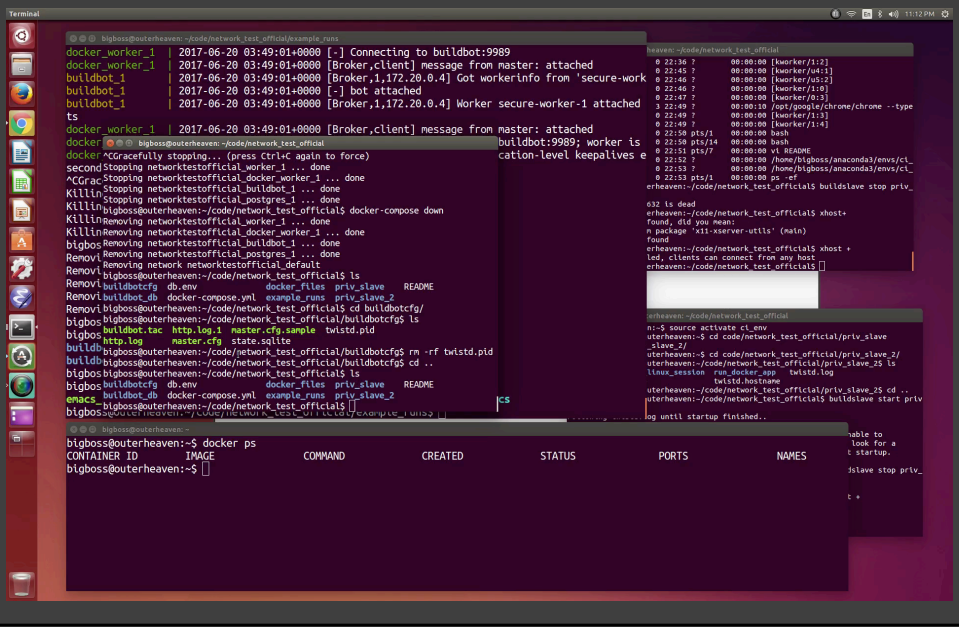
- **Company-wide server application deployment**
  - Used Applications set in containers, called by symlinked python scripts calling ports to start program
  - Company used Orchestration to scale up and down the available workers as a "resource pool" depending on server loads
- **License server for a "floating license"**
  - Company only had one license, and software had no ability to gate phone home data or queue
  - Implemented with buildbot worker, and a master that queued/scheduled/gated the users.

Company-wide server application deployment

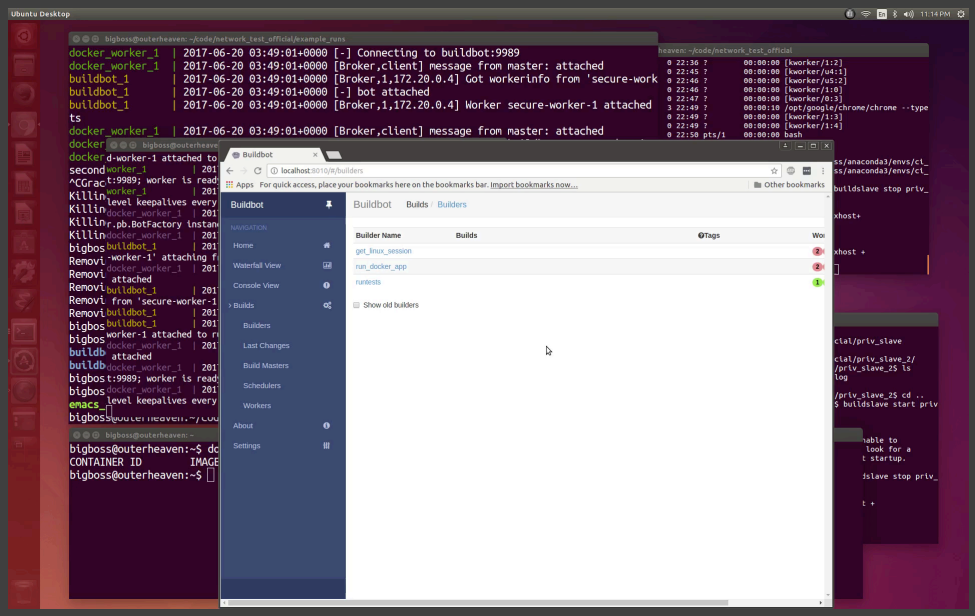
- Buildmaster handles queue, session details
- Spin up new workers for larger pool
- Update applications via Docker repository on Worker



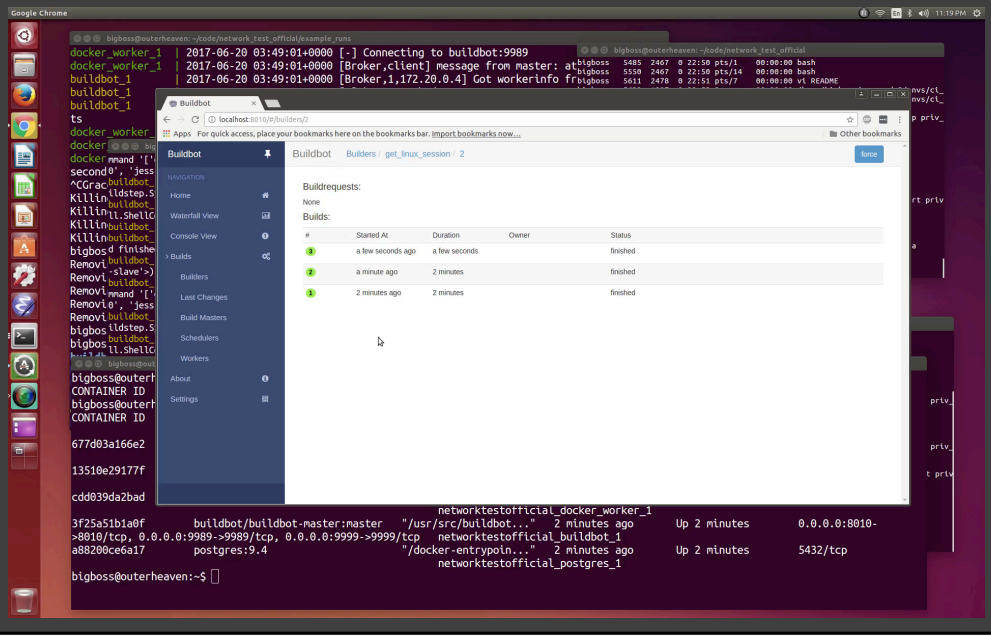
Company-wide server application deployment



Company-wide server application deployment (con't)

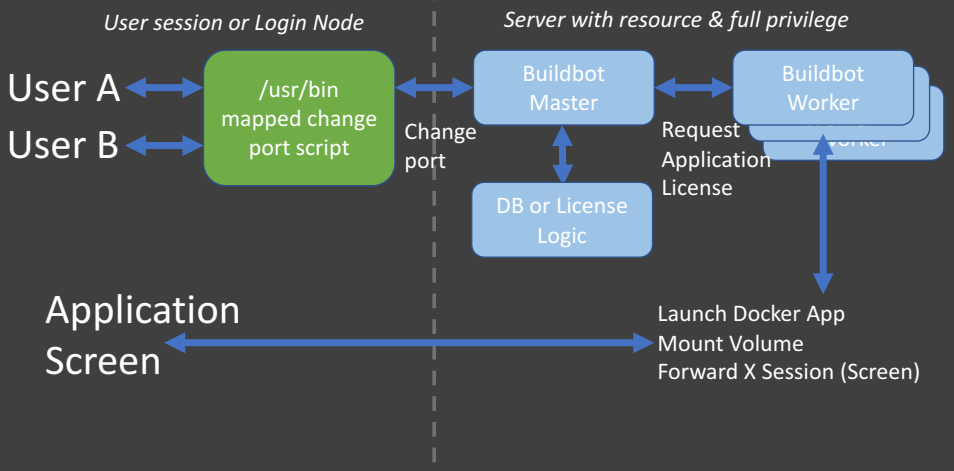


Company-wide server application deployment (con't)

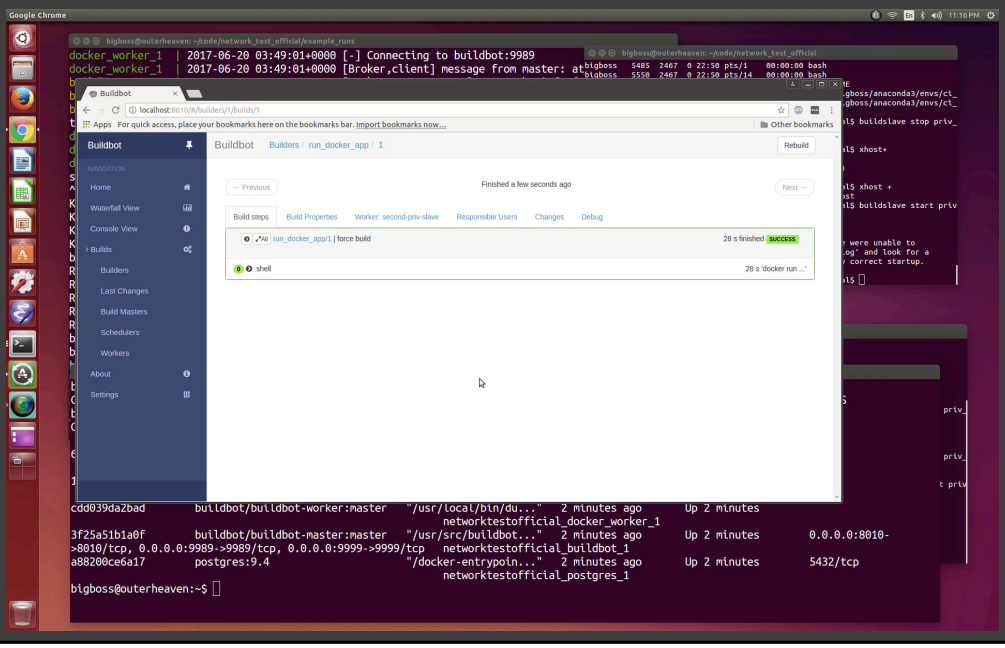


License Server for a “floating license”

- License(s) can be held by master or the attached stock DB
- Either use available pool to block licenses, or via DB or logic
- Can also just hold a lock on the license file instead of application screen



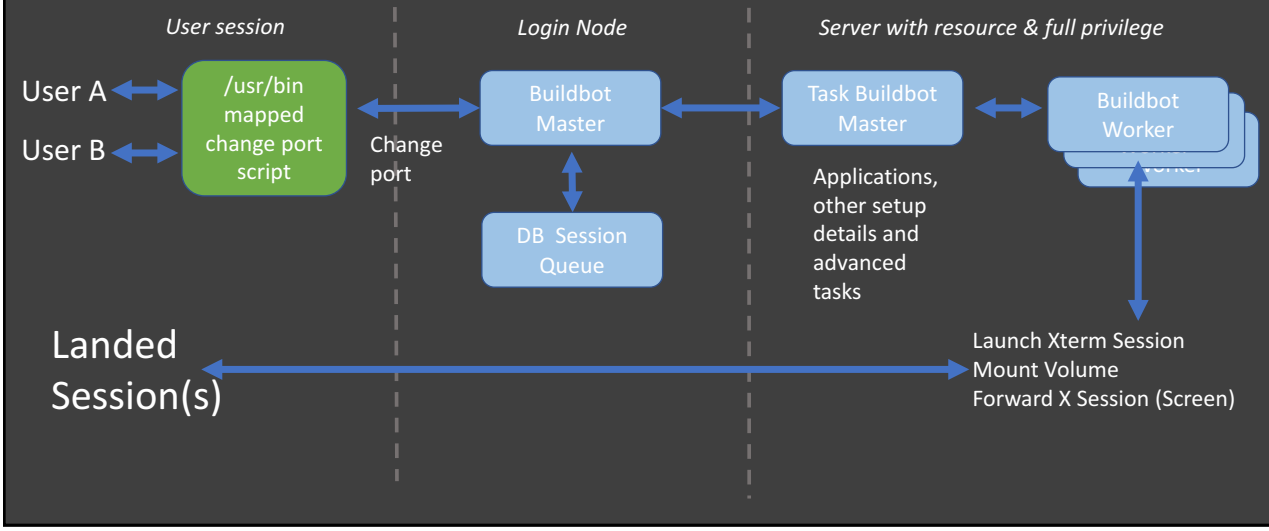
License Server for a “floating license”



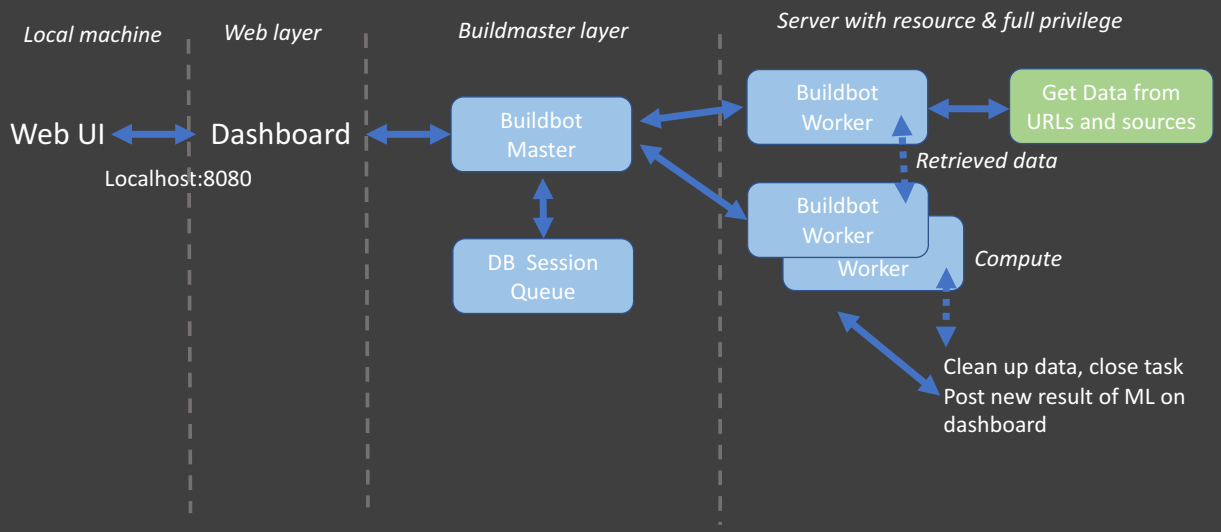
Real-world architectures that have worked

- **Compute server Linux session handler**
  - Company used Buildbot master/worker with workers and X11 forwarding to hand sessions to users; queue system via the master's bone stock scheduler
- **Home Machine Learning server**
  - Used successfully to create a "dashboard" and "compute center" for my home system, which pulls in aggregate data and does ML on large datasets with classifiers

Compute server Linux Session Handler (Tier setup w/ Multimaster)



Machine Learning Server



Summary

- Through a little bit of ingenuity and creative use of components, one may fashion many of the infrastructure design patterns that appear in software and IT
- Being able to rapidly design proof-of-concepts is possible with this method, and can reveal design considerations before making a proper solution
- Remember that the examples shown are not shown with any security or orchestration
- Keeping an open mind and an eye on upcoming technology can widen the available infrastructure patterns one can design
- Experiment with new tools often to see what patterns can be made next

References

- http://buildbot.net
- https://github.com/buildbot
- Repo for examples (To be posted soon):
  - https://github.com/triskadecaepyon/infrastructure_patterns

Q&A?

https://github.com/triskadecaepyon

https://triskadecaepyon.github.io/