Simulating Humanoid Robots in the Cloud

the testing behind the biggest world competition

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Open Source Robotics Foundation (OSRF)
www.osrfoundation.org

let’s travel in time… 2011

Photo: this work by The Virtual Union

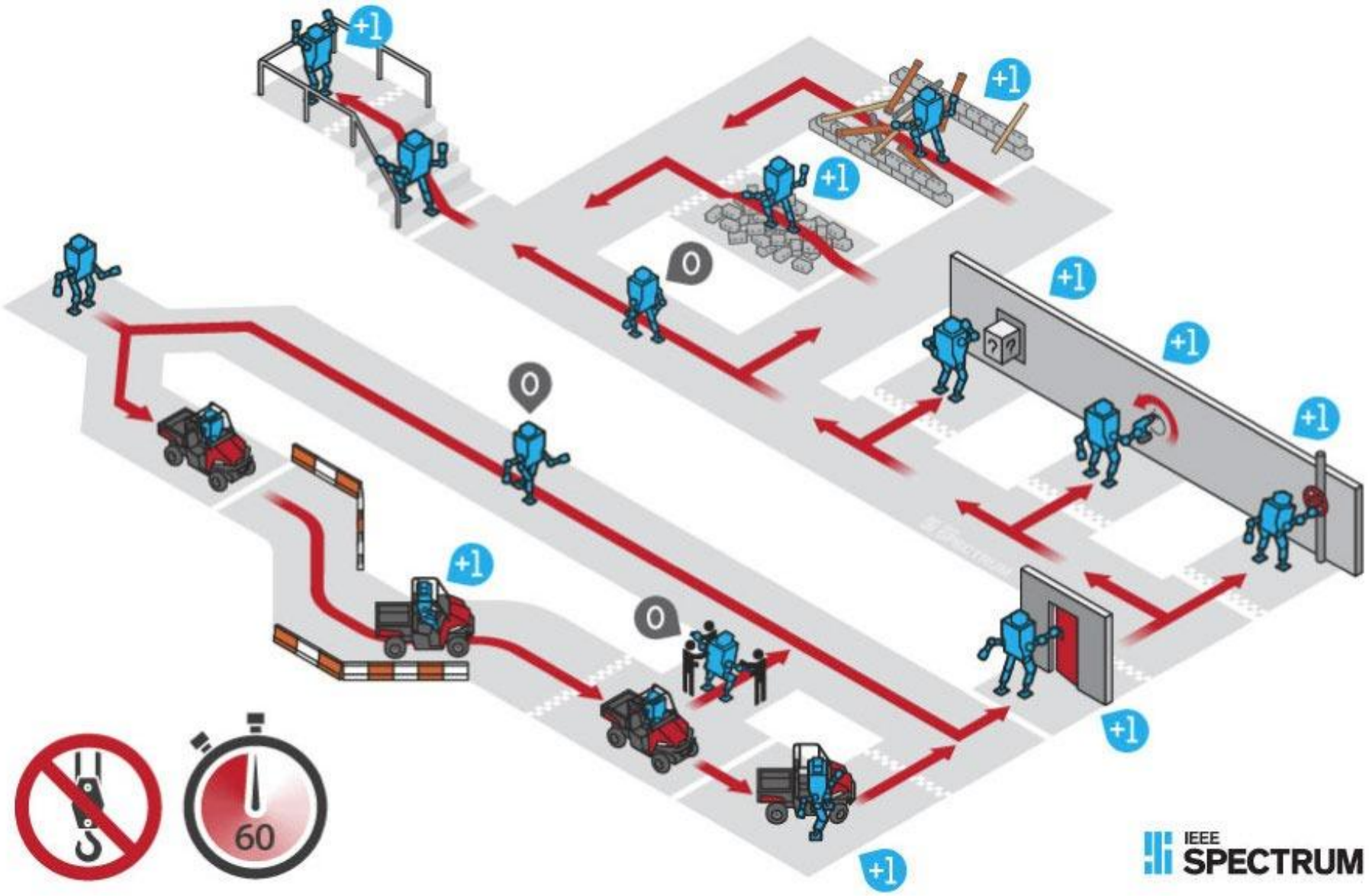
March, 2011. Japan.

let’s travel in time a bit more... 2015

June, 2015. California

DARPA ROBOTICS CHALLENGE

- The primary technical goal of the DRC is to develop **human-supervised ground robots** capable of executing **complex tasks** in dangerous, degraded, human-engineered environments.


+1
+1
+1
0
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+1
+1
0
+1
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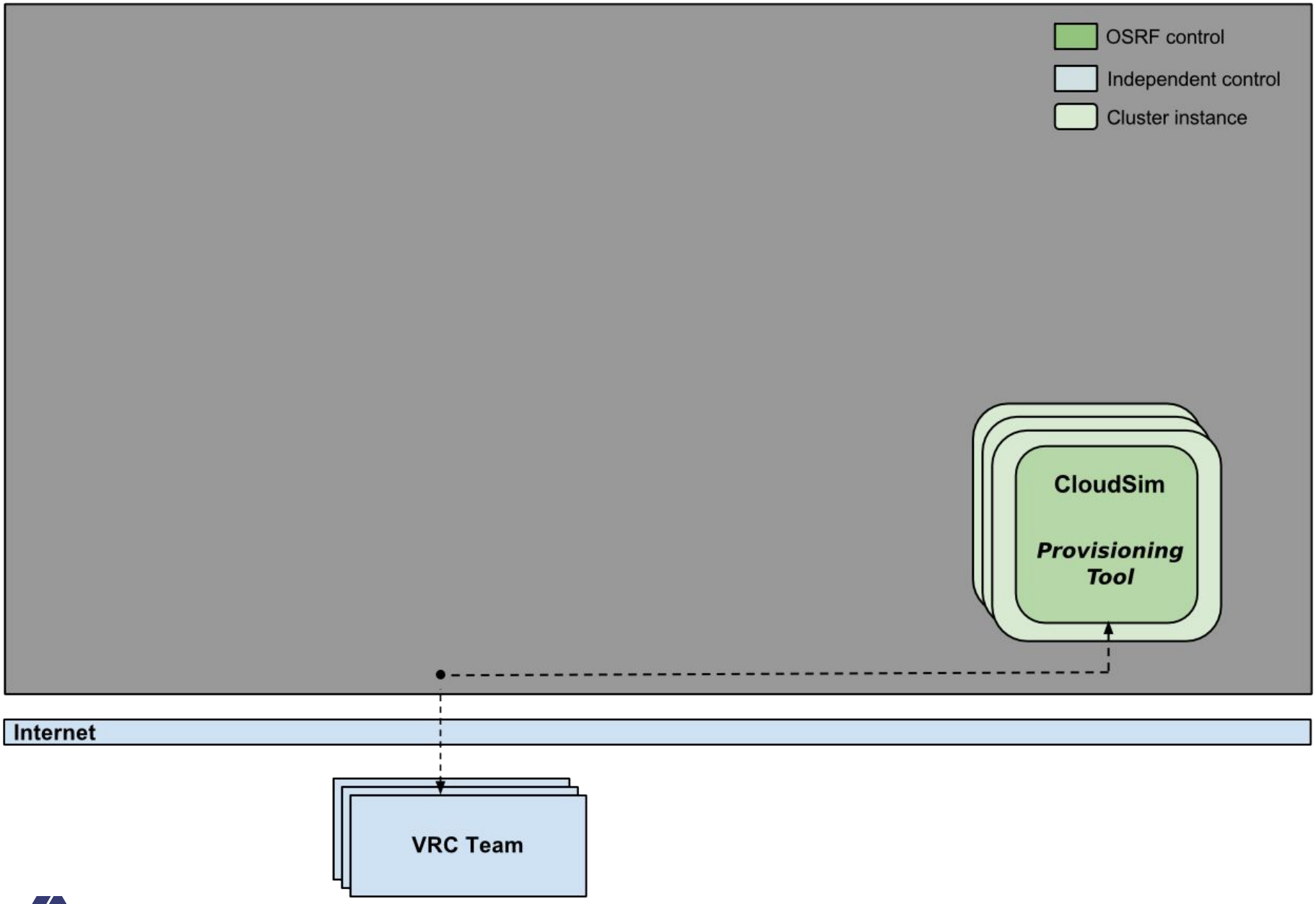
+1
60
IEEE SPECTRUM

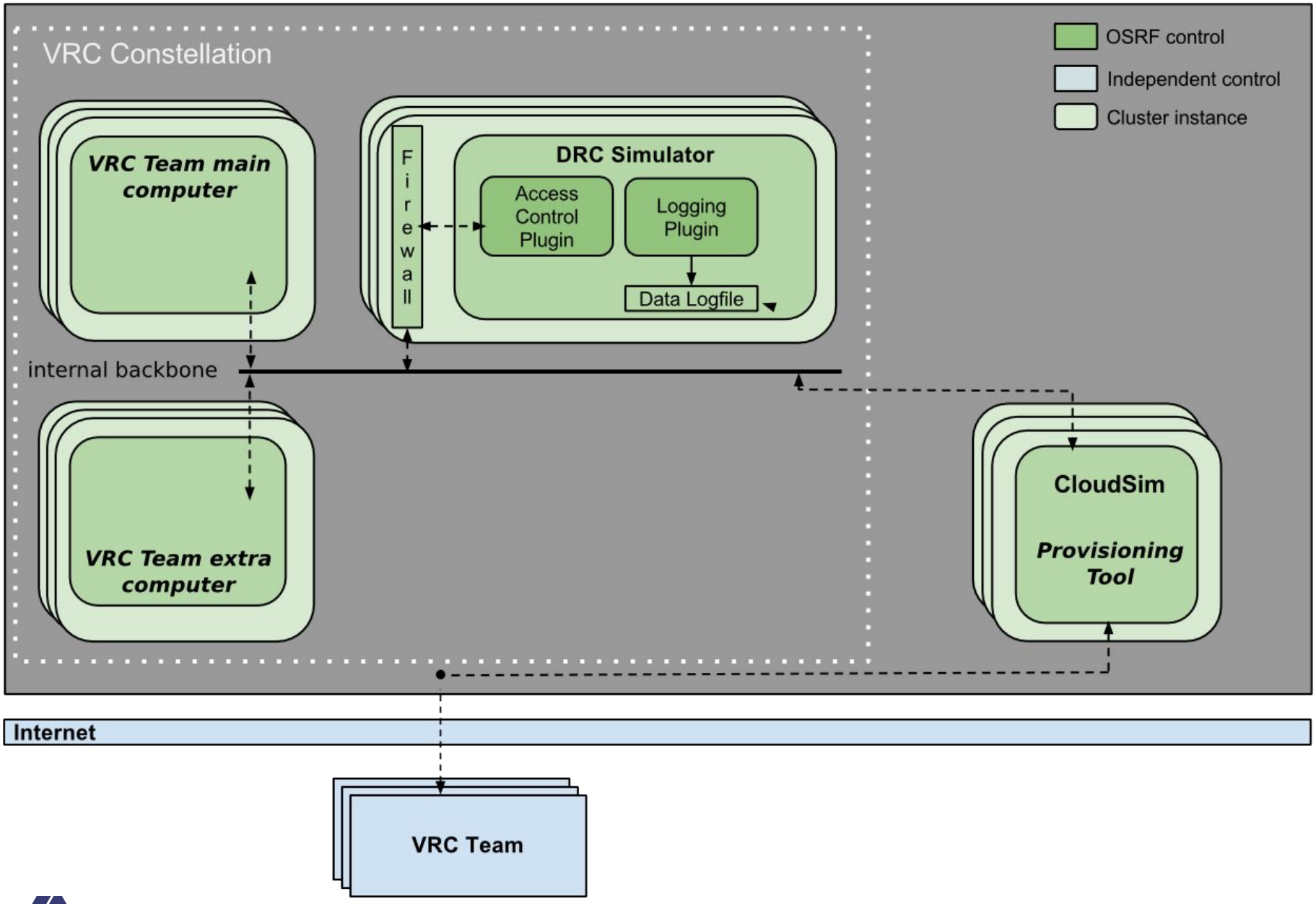
let’s travel in time even more... 2013

Virtual Robotics Challenge

VRC: virtual robotics challenge

VRC: virtual robotics challenge


OSRF control
Independent control
Cluster instance
CloudSim
Provisioning Tool
Internet
VRC Team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Logging Plugin
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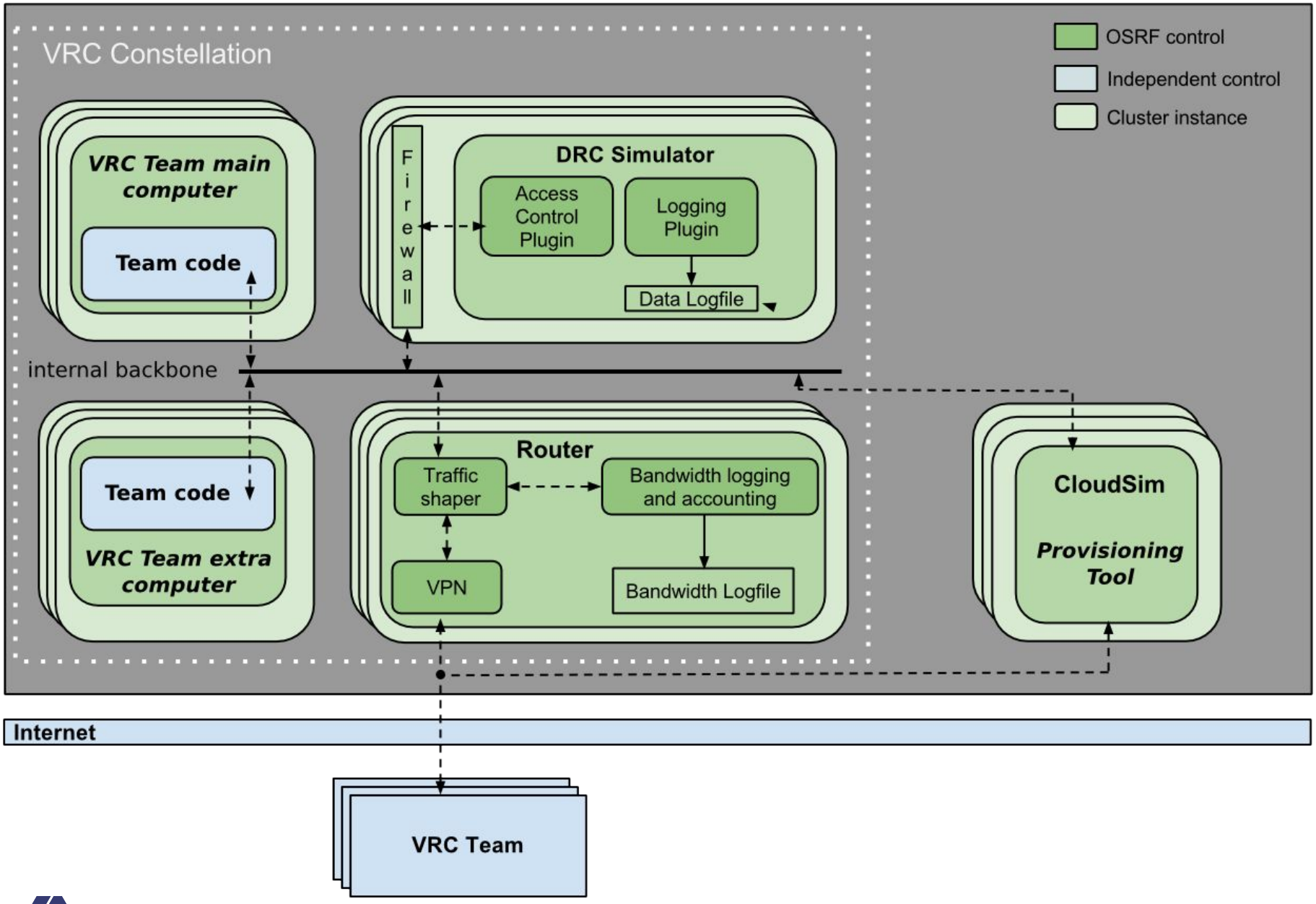
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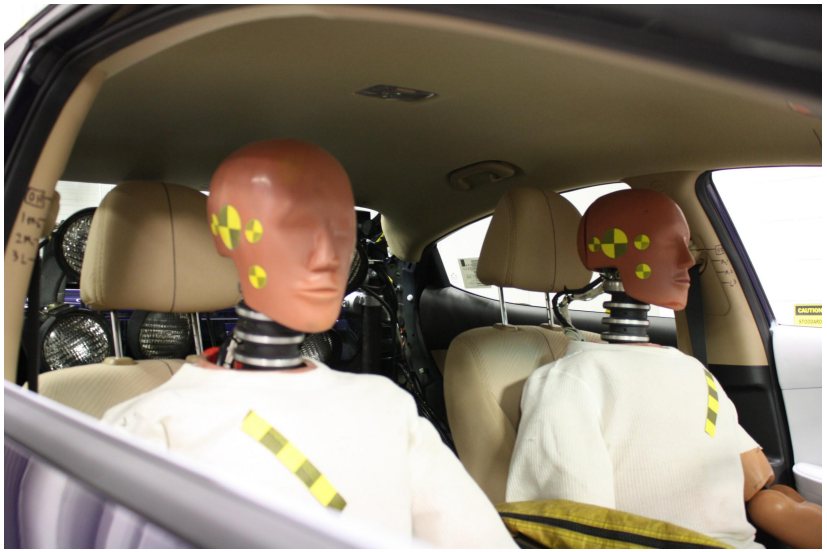
Planning the contest: getting testers for free



Prior to VRC

Preparing VRC

Prior to VRC

Preparing VRC

v1

GAZEBO

v2

GAZEBO

v3

GAZEBO

v4

GAZEBO

vrc_bytecounter overcounting certain messages

[redacted] <[redacted]@mit.edu> 6/5/13

to DRCSim, [redacted]

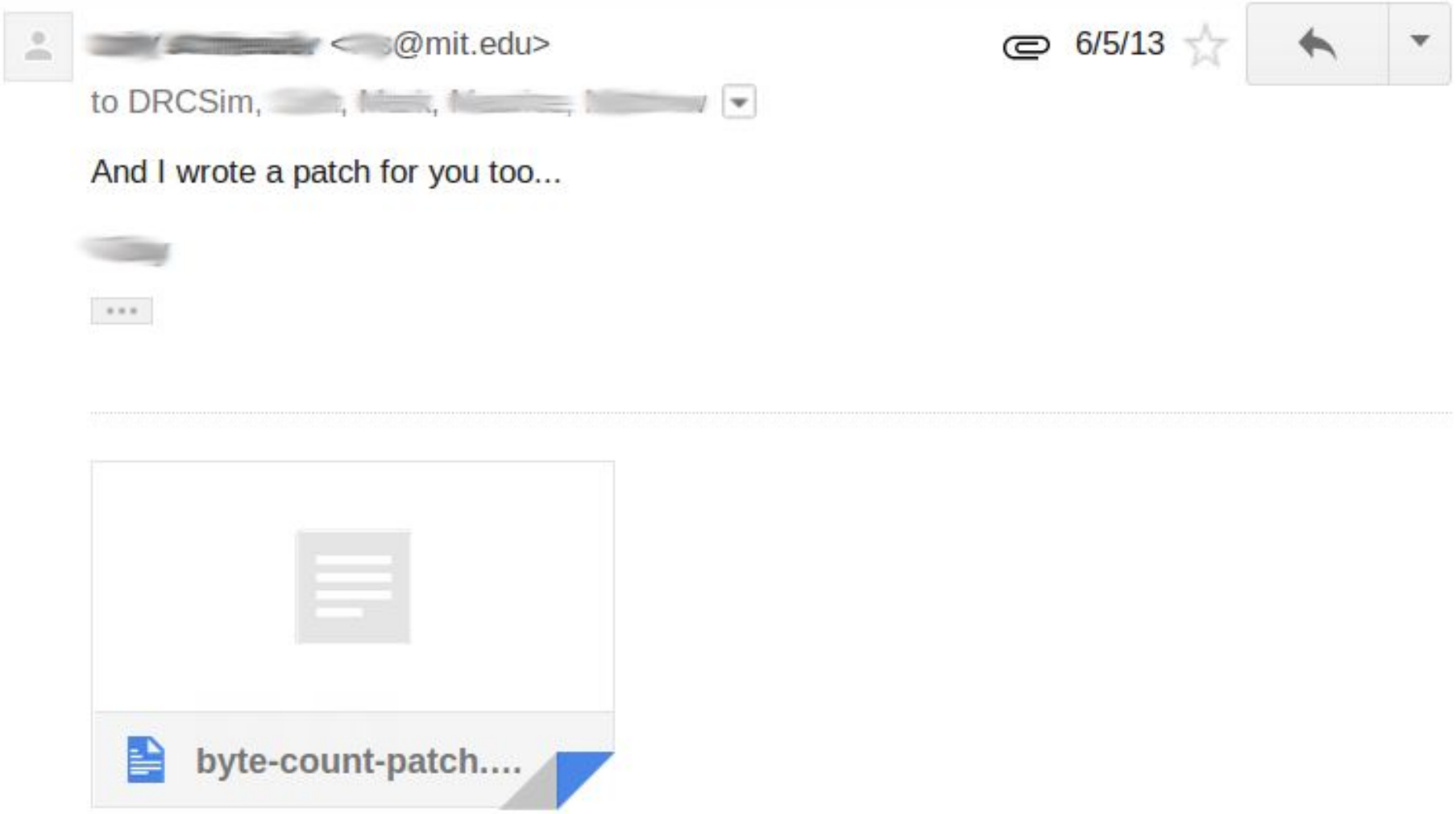
Dear DRCSim folks,

After some exhaustive hunting down, I have determined that vrc_bytecounter over-counts bytes in certain circumstances, because it relying on the (incorrect) assumption that the Ethernet contribution to a packet is always only 14 bytes. For small packets, the hardware layer may add a trailer to pad out the frame.

Executive summary: vrc_bytecounter needs to use the IPv4 total length field, not the total captured bytes. From here, it can subtract off the IP header (and protocol headers as appropriate).

See details below.

Thanks-
[redacted]


@mit.edu>
6/5/13
to DRCSim,
And I wrote a patch for you too...
byte-count-patch....

```
--- a/vrc_bytecounter/src/byteCounter.c Mon Jun 03 12:51:08 2013 -0700
+++ b/vrc_bytecounter/src/byteCounter.c Tue Jun 04 23:40:38 2013 -0400
@@ -139,9 +139,6 @@
     totalPackets++;
     totalLength += header->len;

-    /* Get ethernet header size */
-    total_header_length += SIZE_ETHERNET;
-
     /* Get IP header size */
     ip = (struct ip_header*) (packet + SIZE_ETHERNET);
     size_ip = IP_HL(ip) * 4;
@@ -228,13 +225,18 @@
      */
     total_header_length += protocol_header_length;

+    // get ip header and change  endianness (works for little endian only!)
+    int ip_len = ((ip->ip_len & 0x00FF) << 8) | ((ip->ip_len & 0xFF00)>> 8);
+
+    printf("ip_len: %d", ip_len);
+
     if (uploading)
     {
-        totalPacketsUploaded += (header->len - total_header_length);
+        totalPacketsUploaded += (ip_len - total_header_length);
     }
     else
     {
-        totalPacketsDownloaded += (header->len - total_header_length);
+        totalPacketsDownloaded += (ip_len - total_header_length);
     }

     /* Update Redis */
```

participation is great!!

power to participation

Power to participations

- Everyone is lazy. You are lazy. I'm super lazy.
- Gazebo is large piece of C++
  - More than 40 dependencies
  - More than 200K lines of code
  - Could take more than 1 hour to compile

v2

GAZEBO

send a patch
patch accepted
merged in code

v3

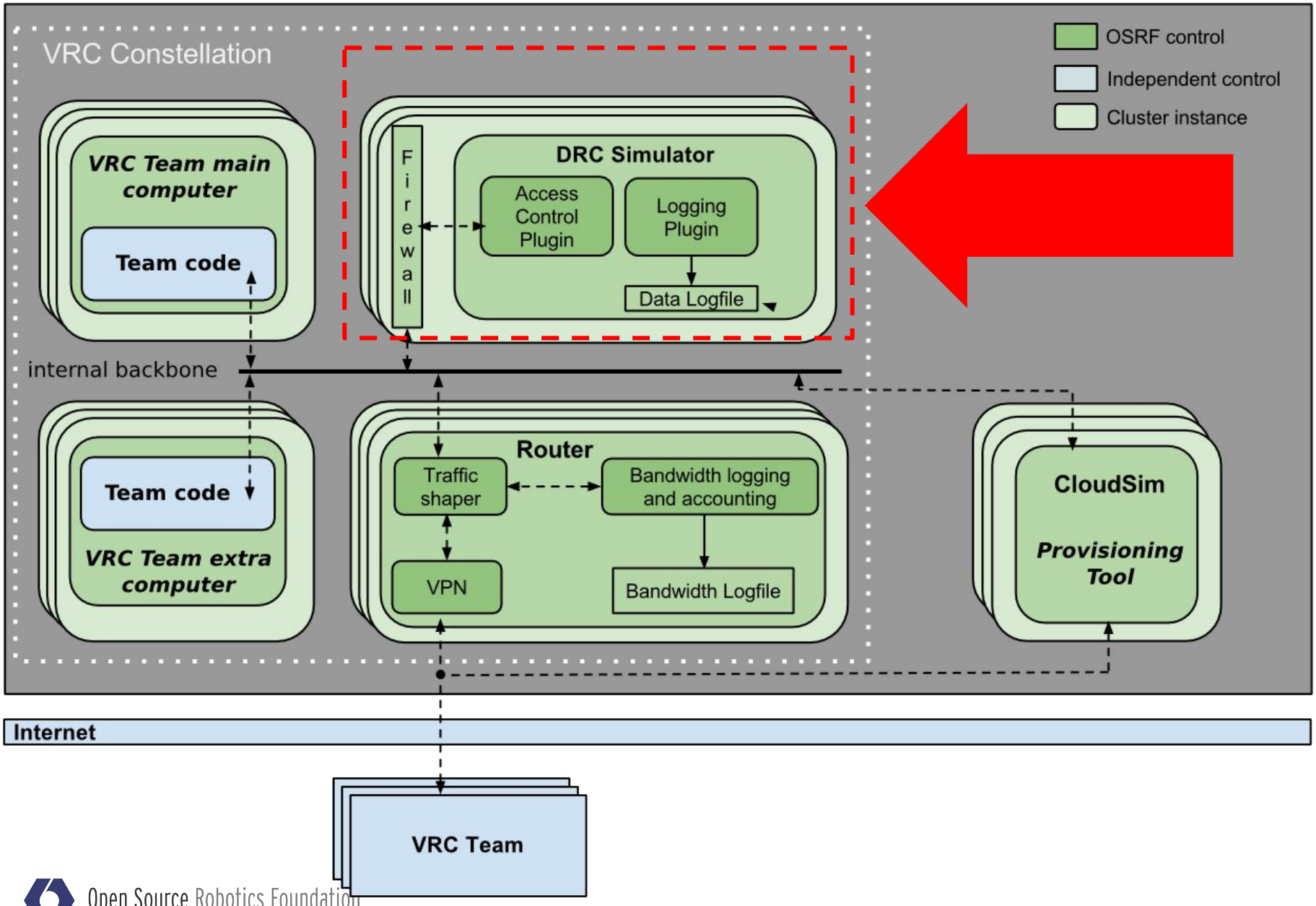
GAZEBO

nightly package generation

send a patch
patch accepted
merged in code

precious time

precious time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The million euro **question**:

Best way of simulating the whole contest?

The million euro **answer**:

Which is the best way of simulate the contest?

To run a contest.

running the contest without running the contest?

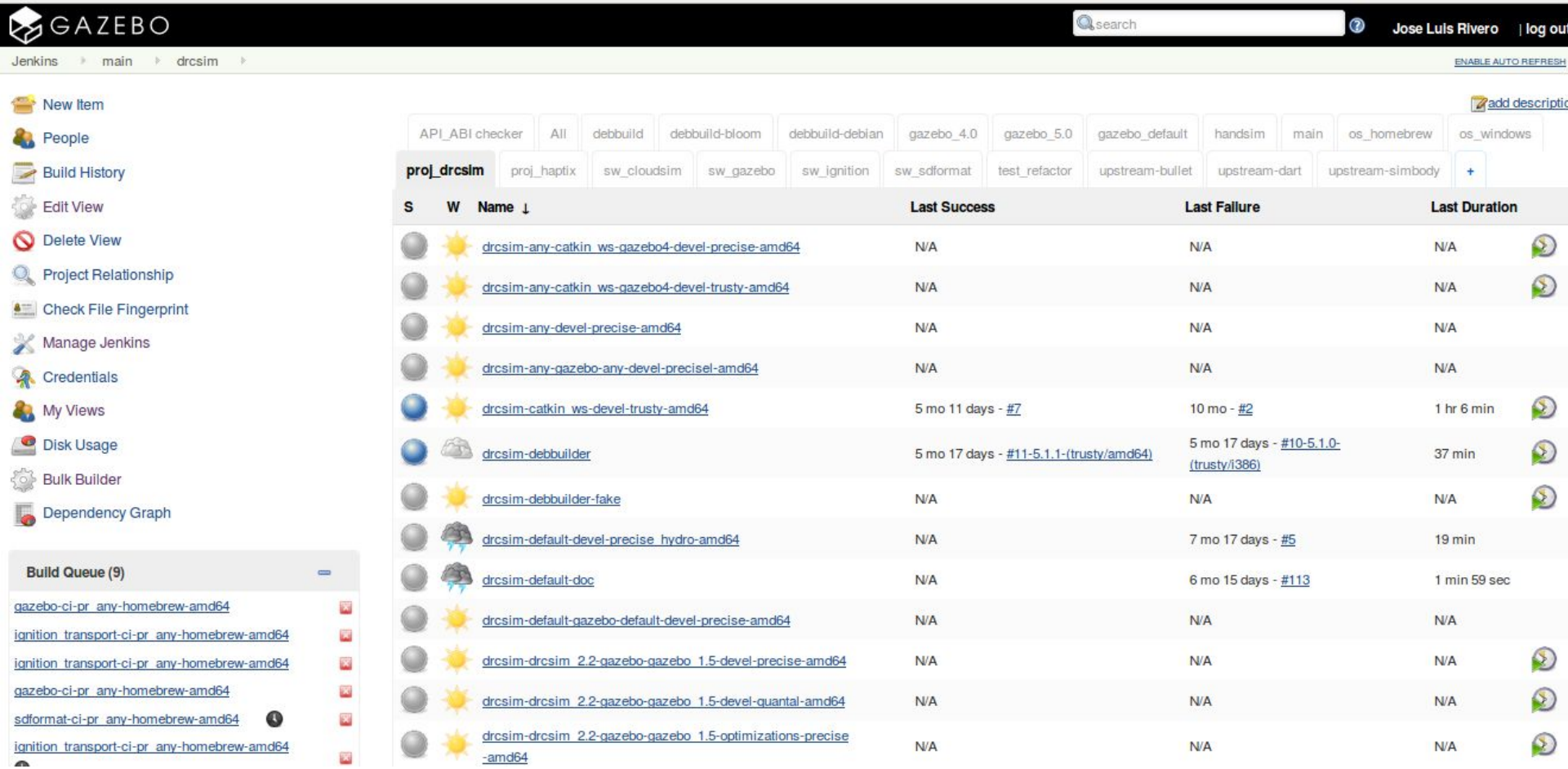
Organize a rehearsal or training session

Participants in the loop

The simulator: DRCSim

Continuous integration:

Jenkins


GAZEBO
search
Jose Luis Rivero
log out
Jenkins
main
drcsim
ENABLE AUTO REFRESH
New Item
People
Build History
Edit View
Delete View
Project Relationship
Check File Fingerprint
Manage Jenkins
Credentials
My Views
Disk Usage
Bulk Builder
Dependency Graph
Build Queue (9)
gazebo-ci-pr_any-homebrew-amd64
ignition_transport-ci-pr_any-homebrew-amd64
ignition_transport-ci-pr_any-homebrew-amd64
gazebo-ci-pr_any-homebrew-amd64
sdformat-ci-pr_any-homebrew-amd64
ignition_transport-ci-pr_any-homebrew-amd64
add description
API_ABI checker
All
debbuild
debbuild-bloom
debbuild-debian
gazebo_4.0
gazebo_5.0
gazebo_default
handsim
main
os_homebrew
os_windows
proj_drcsim
proj_haptix
sw_cloudsim
sw_gazebo
sw_ignition
sw_sdformat
test_refactor
upstream-bullet
upstream-dart
upstream-simbody
+
S
W
Name ↓
Last Success
Last Failure
Last Duration
drcsim-any-catkin_ws-gazebo4-devel-precise-amd64
N/A
N/A
N/A
drcsim-any-catkin_ws-gazebo4-devel-trusty-amd64
N/A
N/A
N/A
drcsim-any-devel-precise-amd64
N/A
N/A
N/A
drcsim-any-gazebo-any-devel-precisel-amd64
N/A
N/A
N/A
drcsim-catkin_ws-devel-trusty-amd64
5 mo 11 days - #7
10 mo - #2
1 hr 6 min
drcsim-debbuilder
5 mo 17 days - #11-5.1.1-(trusty/amd64)
5 mo 17 days - #10-5.1.0-(trusty/i386)
37 min
drcsim-debbuilder-fake
N/A
N/A
N/A
drcsim-default-devel-precise_hydro-amd64
N/A
7 mo 17 days - #5
19 min
drcsim-default-doc
N/A
6 mo 15 days - #113
1 min 59 sec
drcsim-default-gazebo-default-devel-precise-amd64
N/A
N/A
N/A
drcsim-drcsim_2.2-gazebo-gazebo_1.5-devel-precise-amd64
N/A
N/A
N/A
drcsim-drcsim_2.2-gazebo-gazebo_1.5-devel-quantal-amd64
N/A
N/A
N/A
drcsim-drcsim_2.2-gazebo-gazebo_1.5-optimizations-precise-amd64
N/A
N/A
N/A

Testing the simulator

- 3D Robotics simulator
  - rendering (integration tests)
  - integrated with Jenkins

Testing the simulator

- 3D Robotics simulator
  - rendering (integration tests)
  - integrated with Jenkins
- Server Fixture
  - GTest fixture
    - spawns a gzserver
  - Provides common operations
    - compare images
    - create sensors

Testing the simulator (contest features)

- Specific contest aspects
  - Tests for the **full duration** of contest
    - Hidden surprises: memory leaks, energy problems, heating, etc.

Testing the simulator (contest features)

- Specific contest aspects
  - Tests for the **full duration** of contest
    - Hidden surprises: memory leaks, energy problems, heating, etc.
  - Be sure to test scoring
    - standard and alternative/cheating cases
  - API based on network channels
    - specific tool to check ROS topic/services

Jenkins headless slave (GPU)

- No monitor machines
  - nvidia needs special config in xorg.conf
  - *nvidia-xconfig --allow-empty-initial-configuration*
- Auto login + script for permissions
  - lightdm to run a script on login
  - *display-setup-script=/etc/lightdm/xhost.sh*
    - xhost +si:localuser:jenkins

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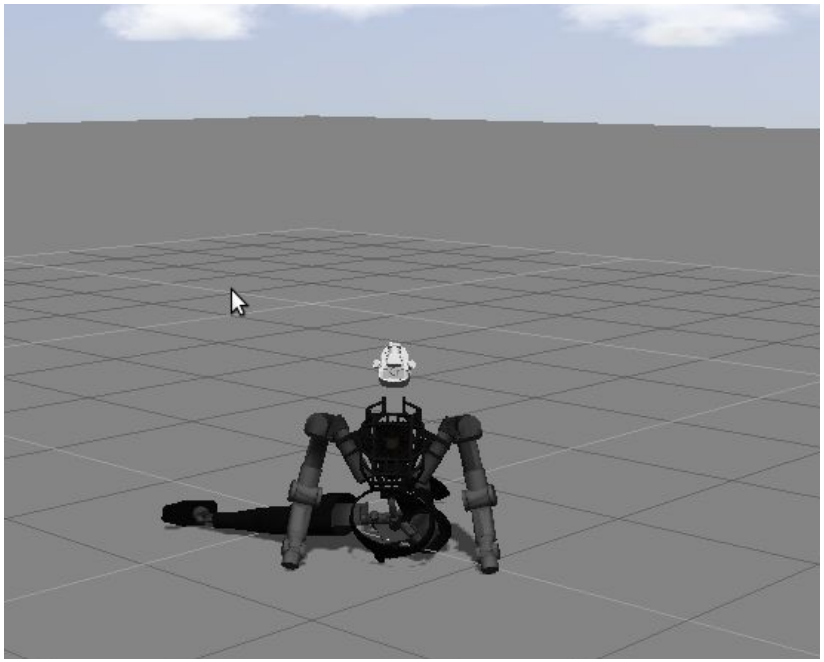
- Support for different linux distributions
  - **Important:** Xorg stack needs to be the same in host and chroot

going to the cloud



```
user@local.machine$ ssh user@cloud.machine
...
user@ip-10-254-666:~$
```

user@local.machine$ ssh

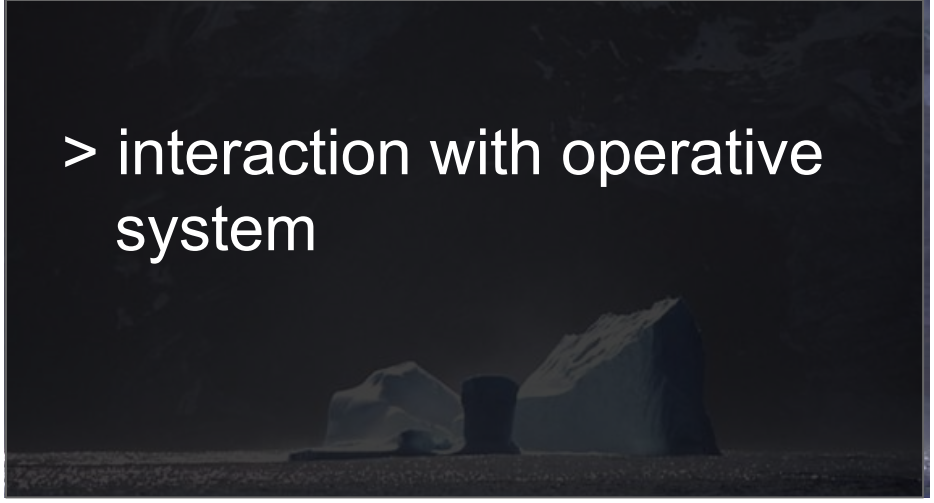
...

user@ip-10-254-666:~$

user@local.machine$ ssh

...

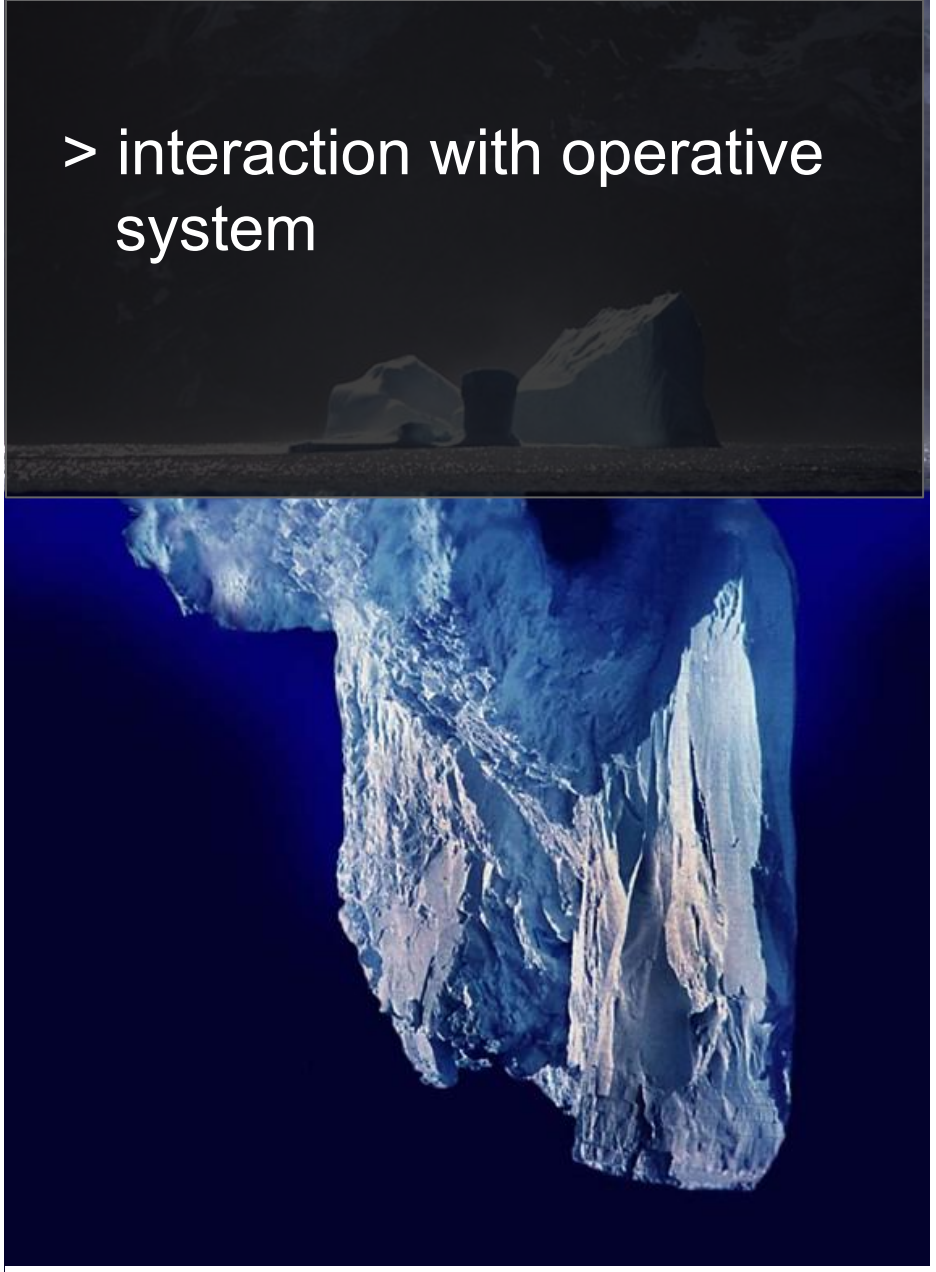
user@ip-10-254-666:~$



user@local.machine$ ssh

...

user@ip-10-254-666:~$



Created by Uwe Kils (iceberg) and User:Wiska Bodo (sky). - (Work by Uwe Kils) http://www.ecoscope.com/iceberg/

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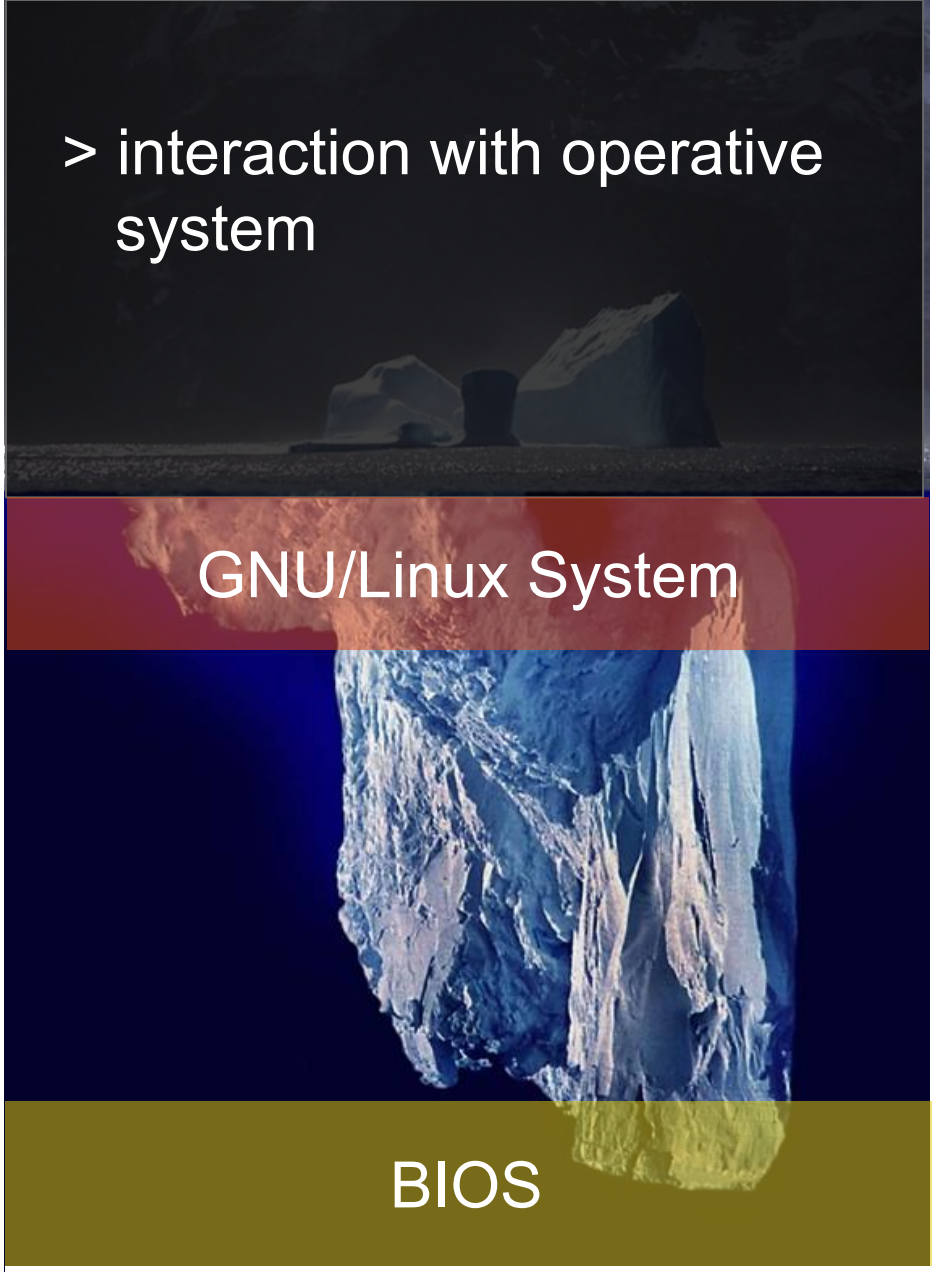
...

user@ip-10-254-666:~$



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...

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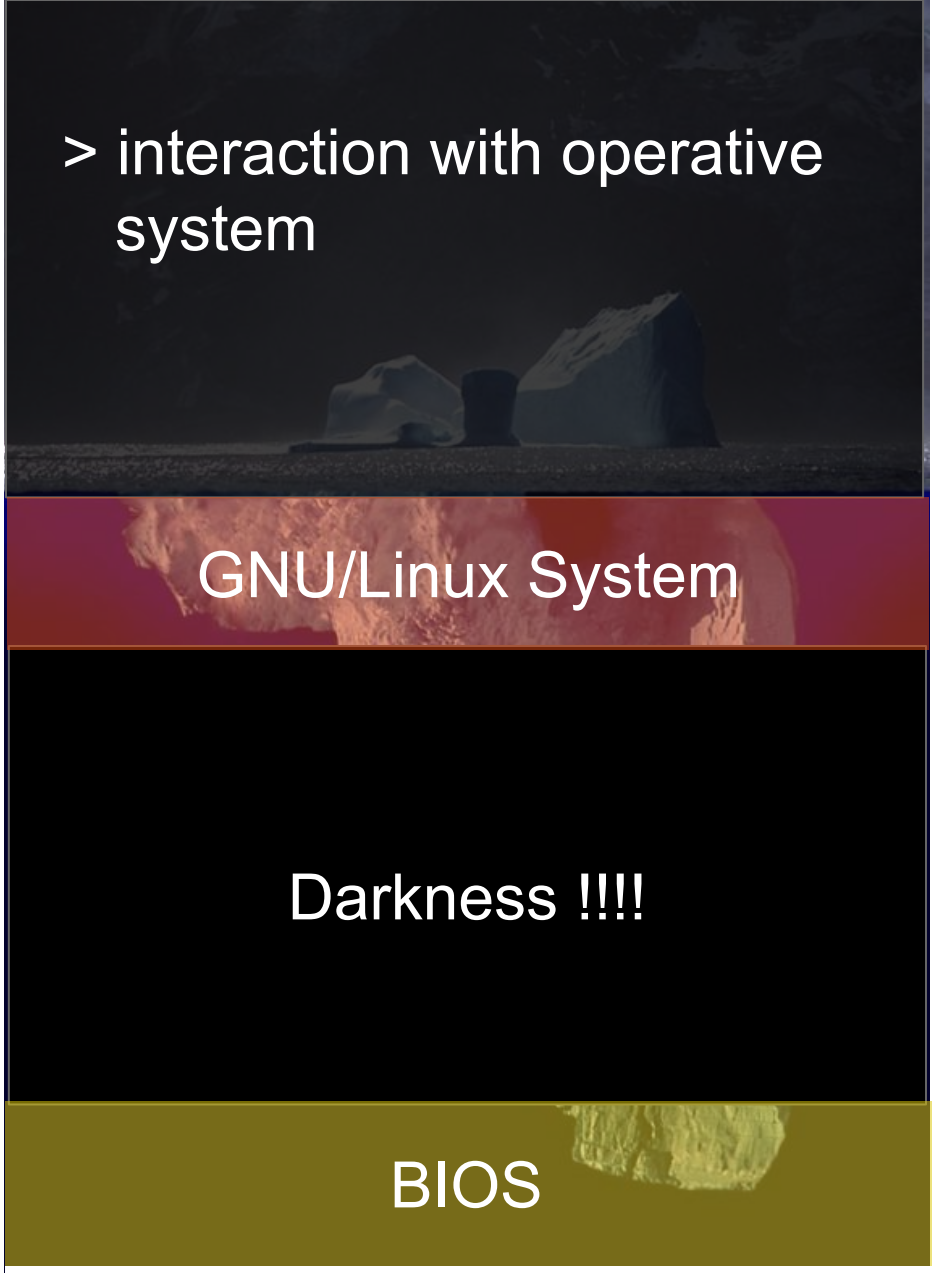

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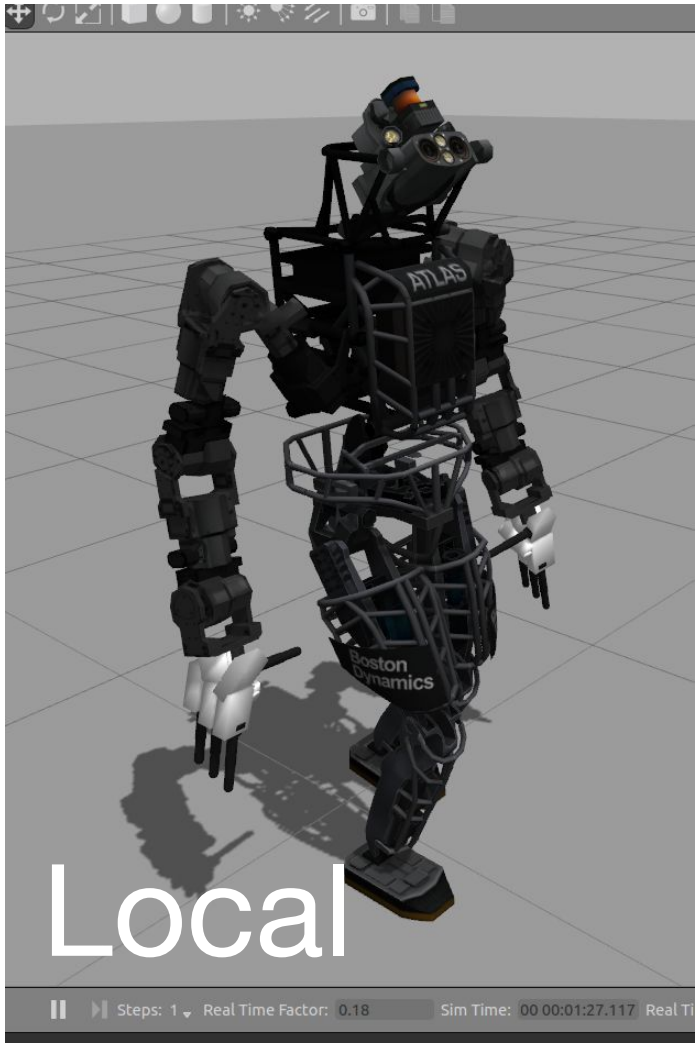
Beverly & Pack - https://www.flickr.com/photos/walkadog/3484426248

Cloud first experience



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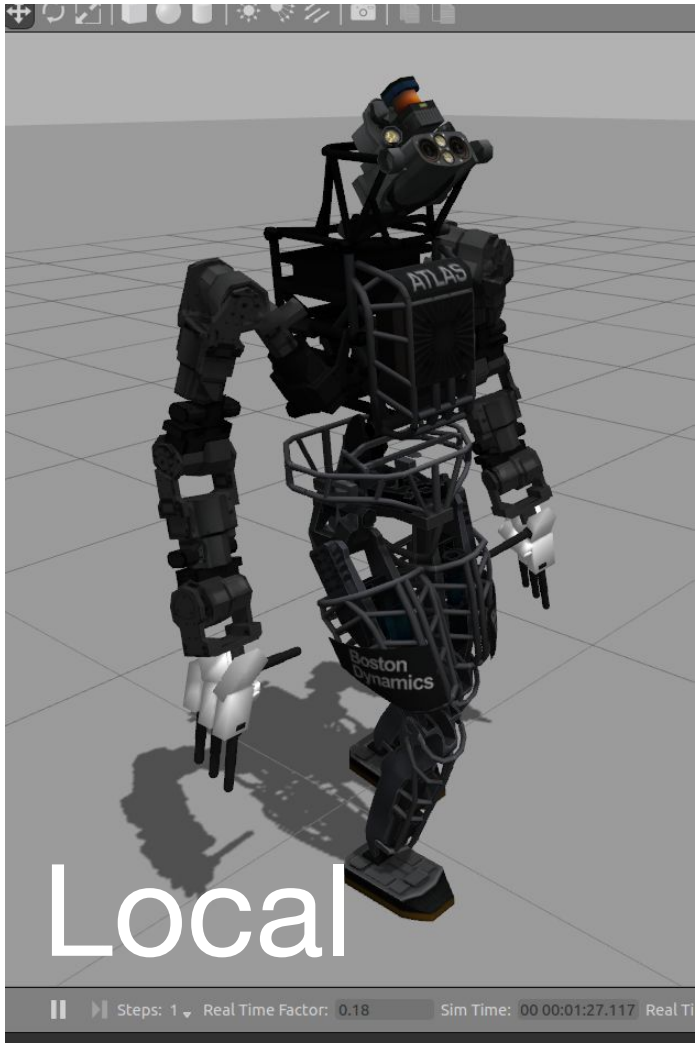
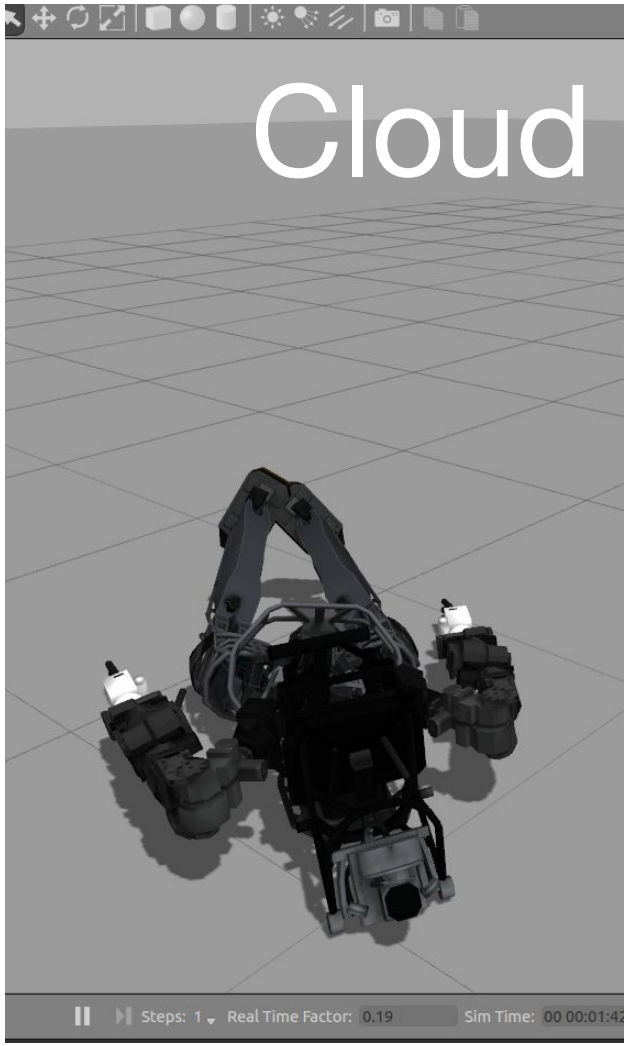
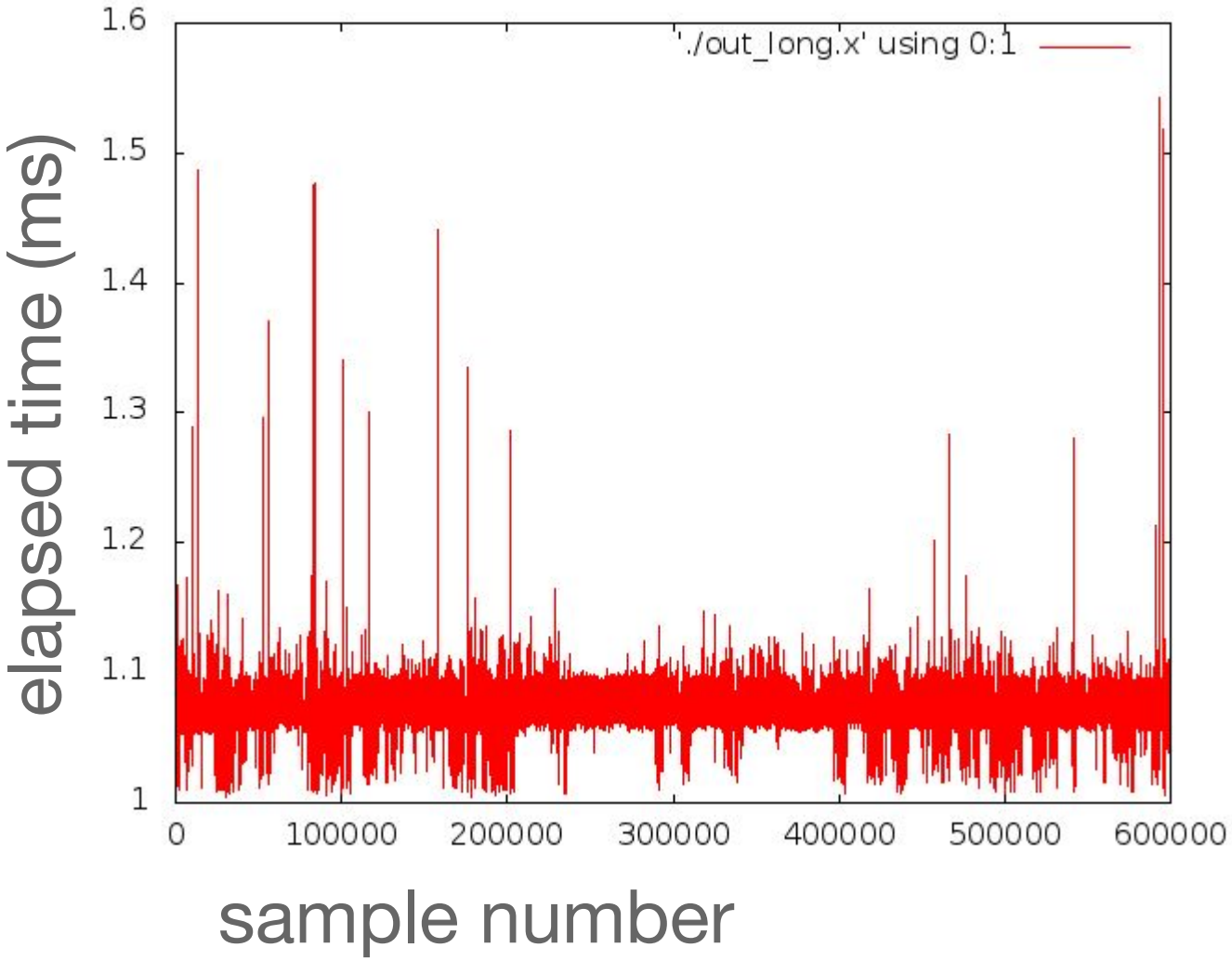




system clock



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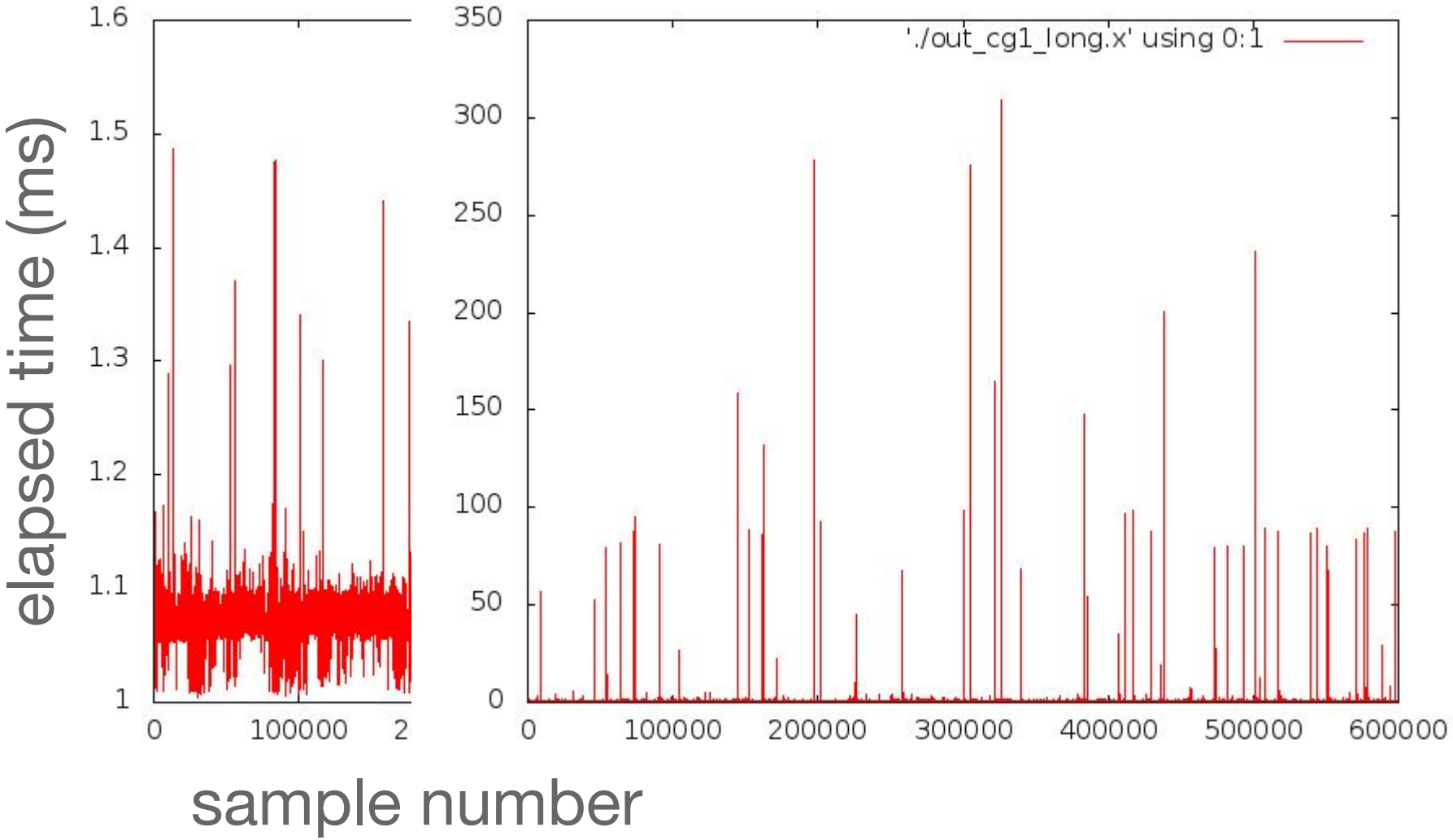
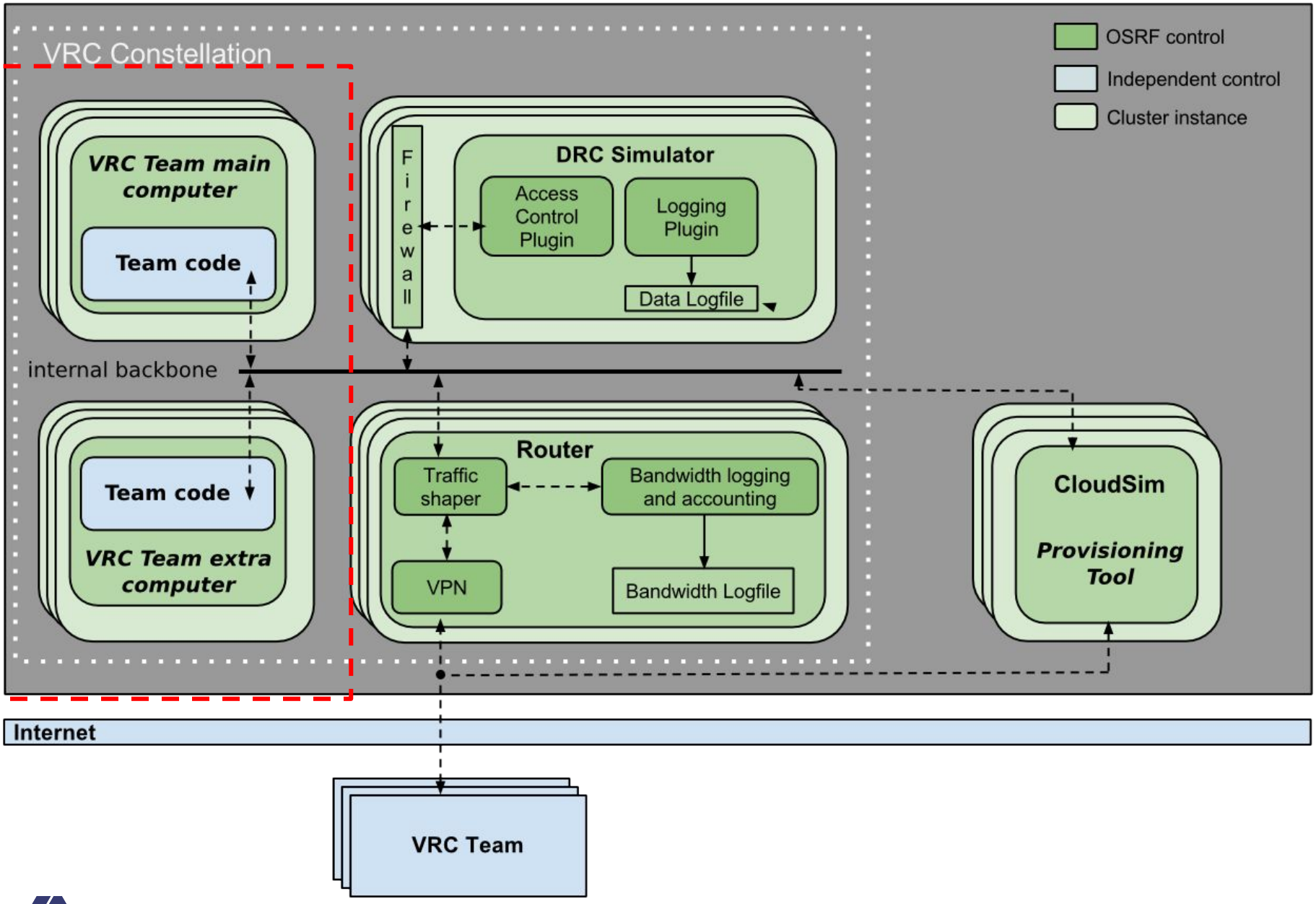
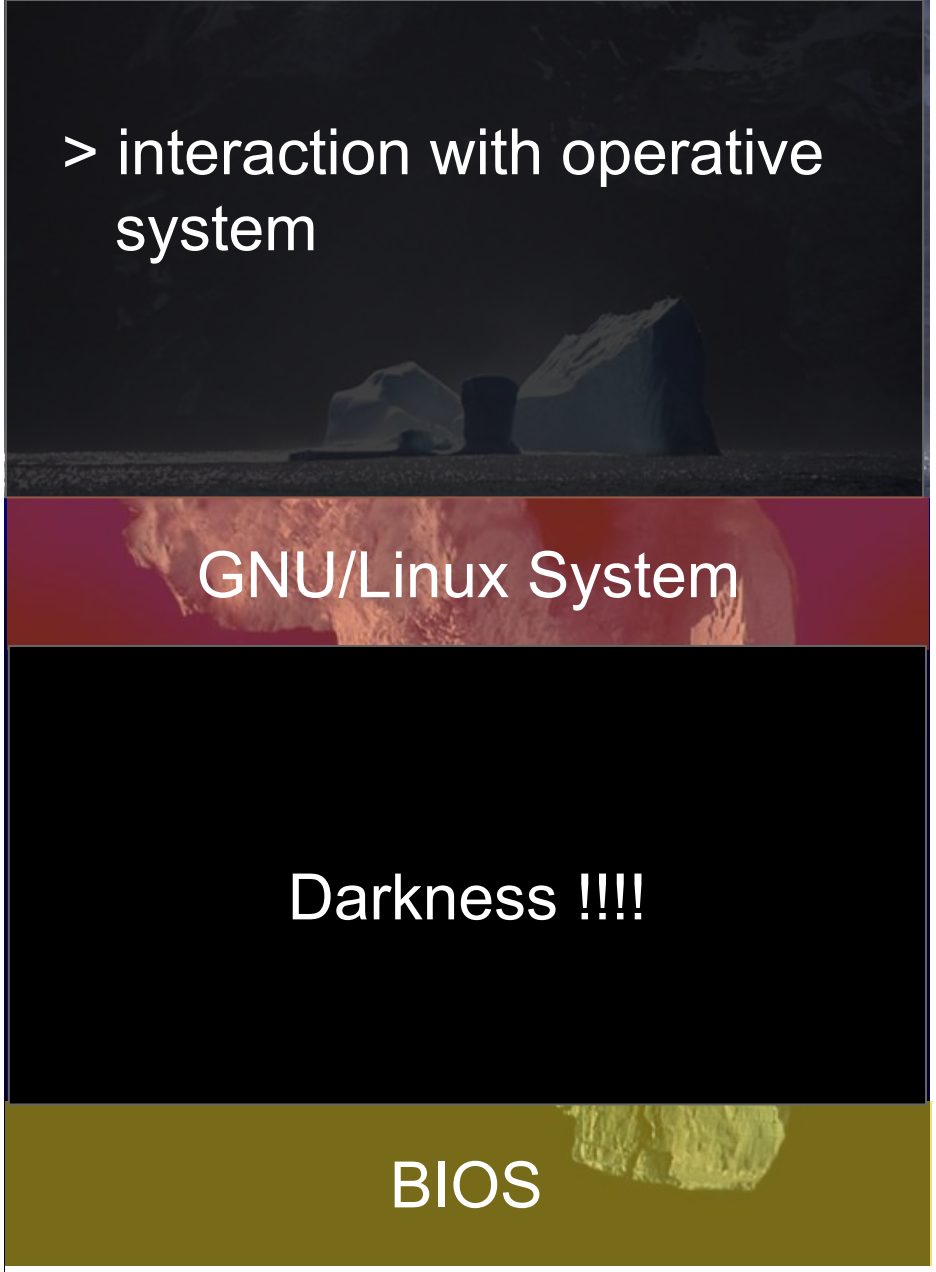




Open Source Robotics Foundation

The dragon was probably virtualization



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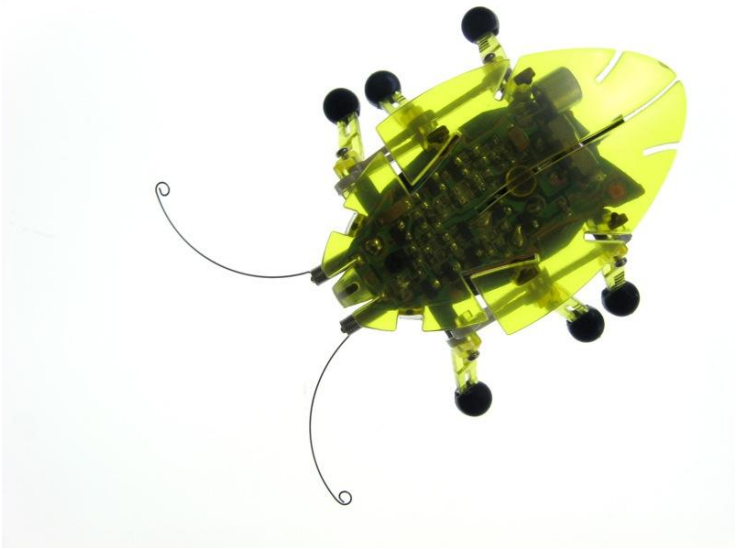
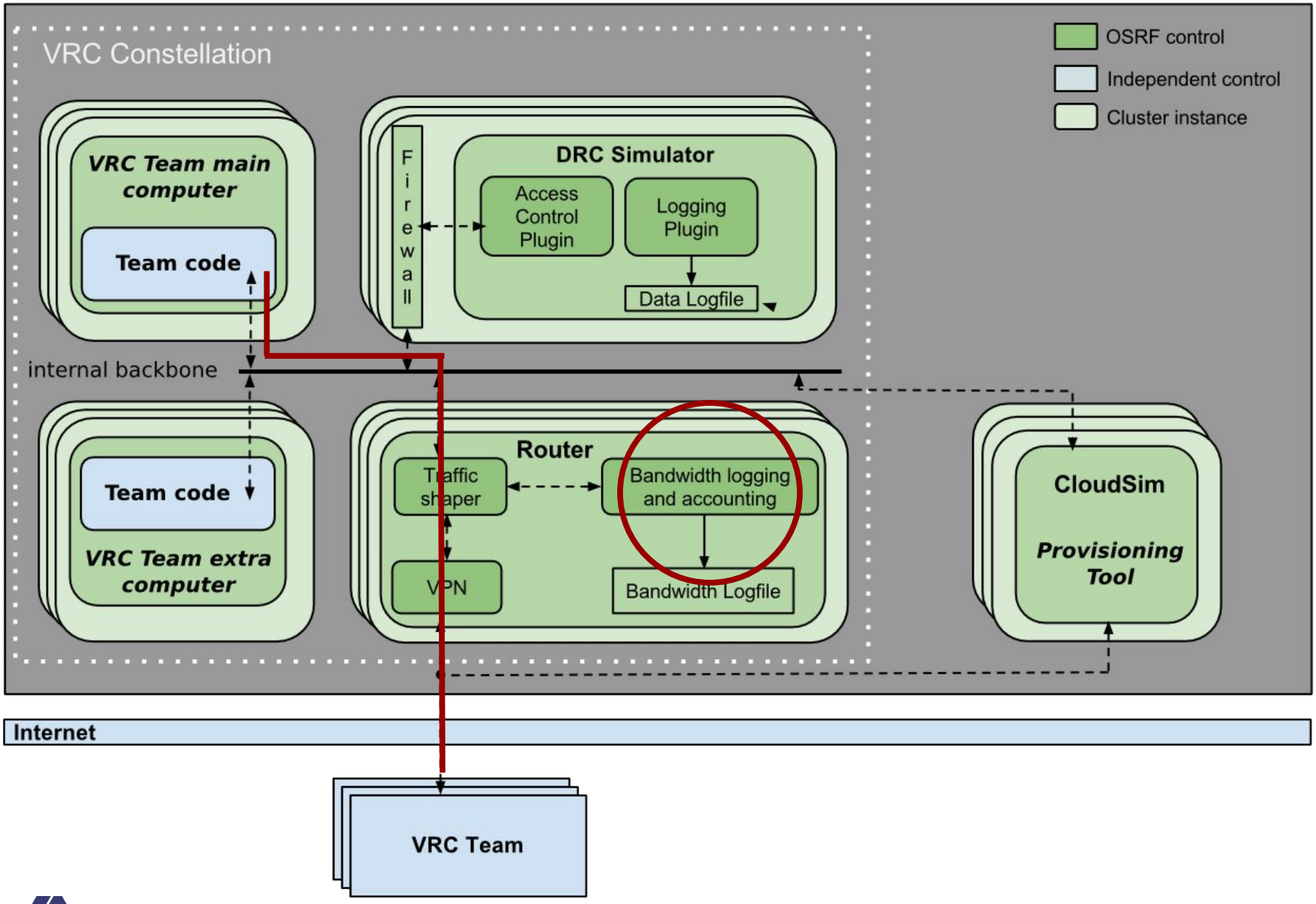
production systems in the loop

last minute security bug?

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There is only one rule:

don’t change or write code

"What kind of world is this that can send machines to Mars and does nothing to stop the killing of a human being?"

Questions and beers here.