The Art of counting potatoes (with Linux)

Ricardo Ribalda

Latest Linux Milestones

Agenda

- Initial Questions
  - Why?
  - How?
  - Who?
- Potato Grader
  - DSP
  - FPGA
  - GPU
- Conclusions
- Open Discussion

Why?

Why Potatoes?

368M tons per year [1].

Price per kg: 0.104 € [2].

Kg per capita [3]:

  Europe: 88

  World: 31

[1] FAOSTAT 2013
[2] Potato Weekly (yes this exists….) 19/01/2015
[3] International Year of the potato 2008 (I do not make up the names)

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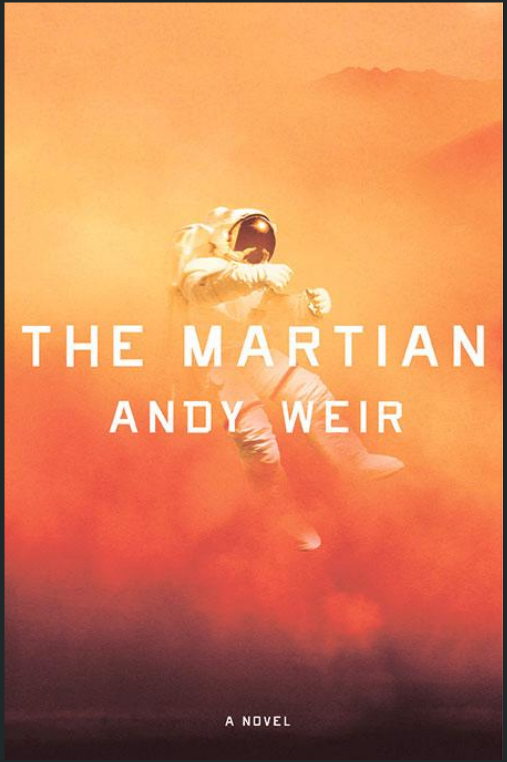
Why Potatoes?



Why Grade them?

WHAT'S THE SECRET?
It's the potatoes. Only the best potatoes make it into our World Famous Fries®
i'm lovin' it

[redacted]

Why Grade them?

Delirium

Diarrhea

Dilated pupils

Fever

Hallucinations

Headache

Loss of sensation

Hypothermia

Paralysis

Shock

Slow pulse

Slowed breathing

Abdominal pain

Vision changes

Vomiting

Solanine

Conclusion: Eat chocolate, not potatoes

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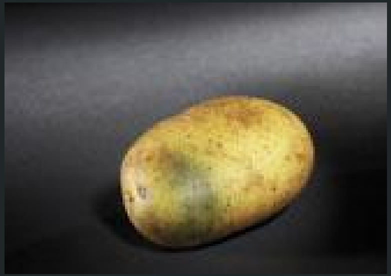
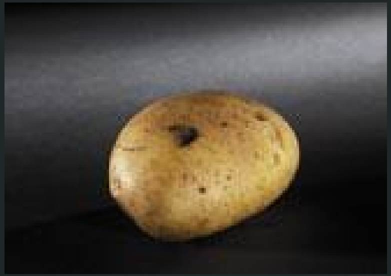
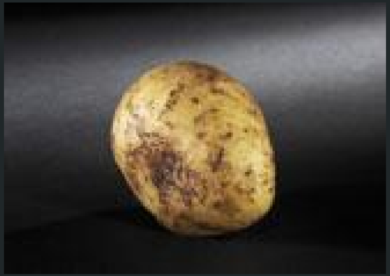
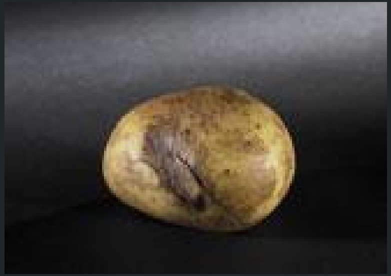
Why Grade them?

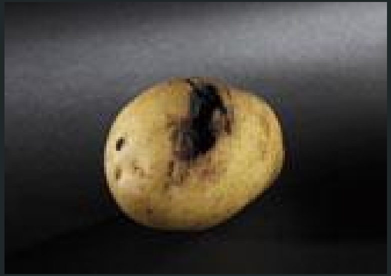

Green Spot

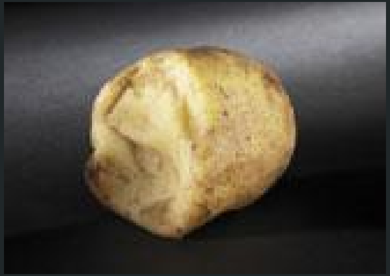

Black Spot

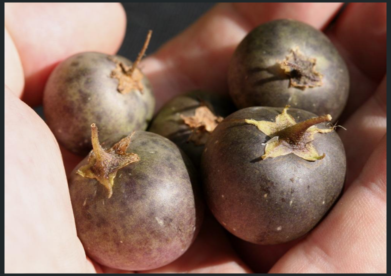

Scurf

Golf Ball


Grey Damage


Rot


Fresh Cut


Potato Fruit

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Why?

3 reasons:

Why?

3 reasons:

$

Why?

3 reasons:

$ €

Why?

3 reasons:

$ € £

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How?

How?

How it is done? Computer Vision 101

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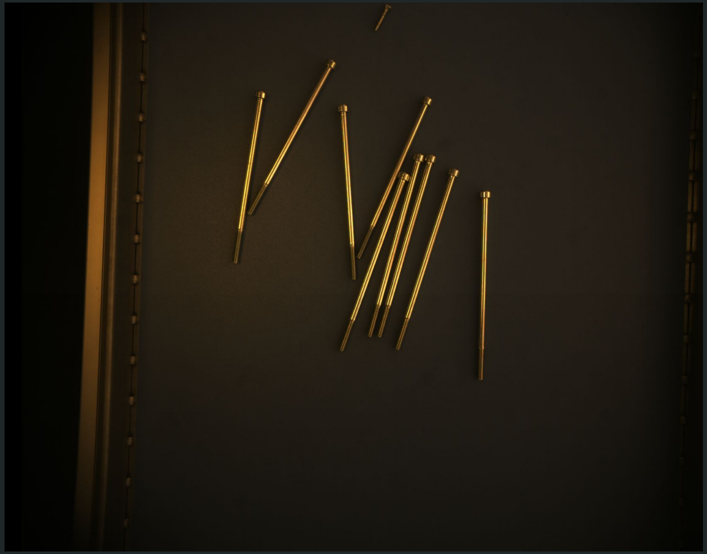

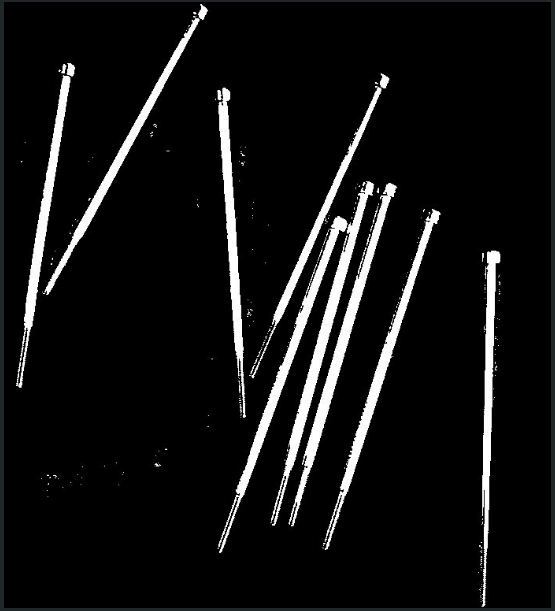

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How it is done? Computer Vision 101

?

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Potatoes like diversity

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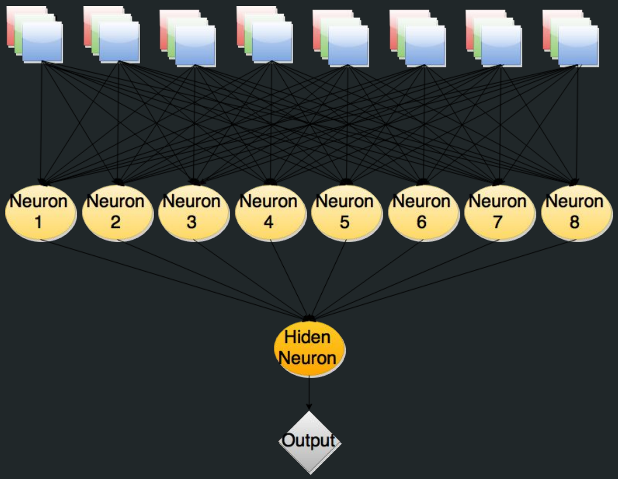
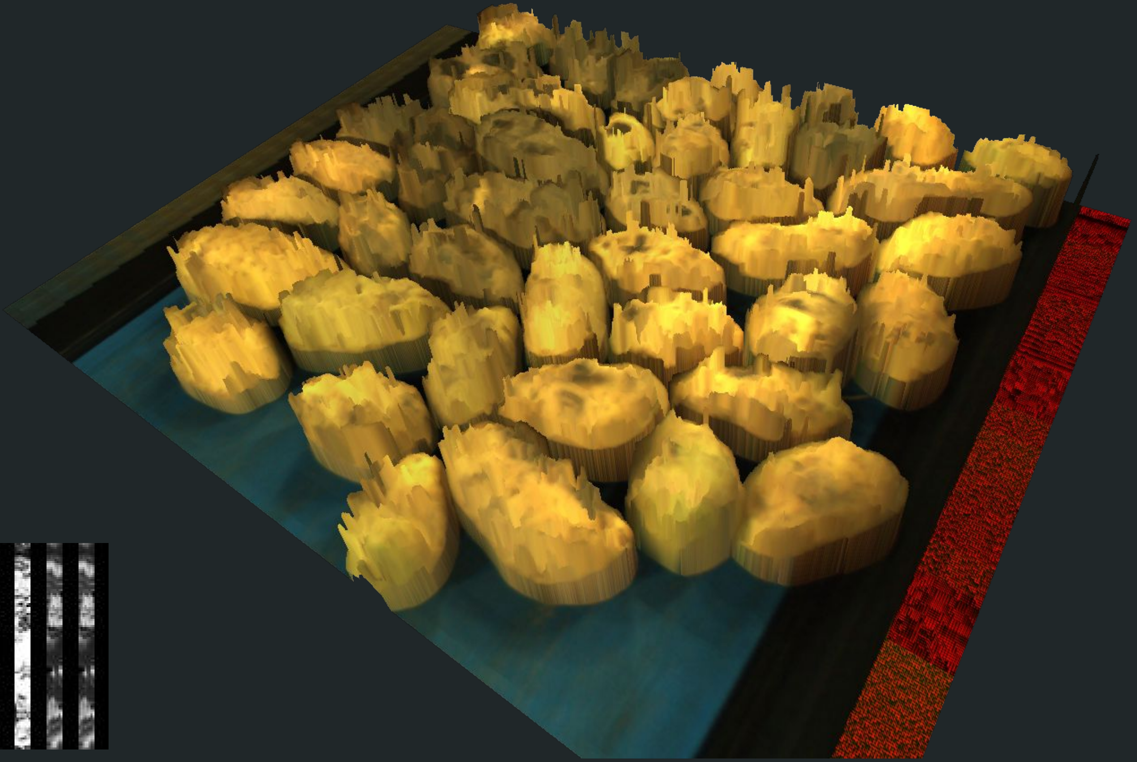
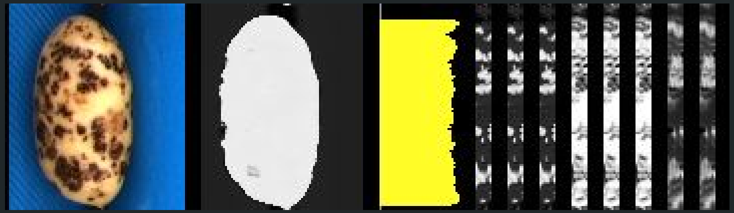
How it is done? Potatoes







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Who?

Who?

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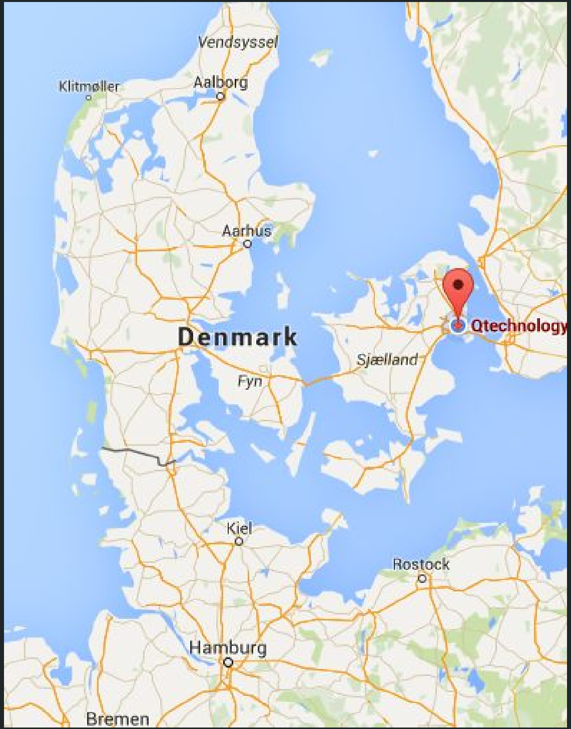
Who?


Vendsyssel
Klitmøller
Aalborg
Aarhus
Qtechnology
Denmark
Sjælland
Fyn
Kiel
Rostock
Hamburg
Bremen

NØRREBRO
Frederiksberg
Copenhagen
KØBENHAVN K
INDRE BY
KØBENHAVN V
Qtechnology A/S
VALBY
SYDHAVNEN
Amag
Sundb
Tårnby

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Potato Grader

Potato Grader: Initial Approach

- Noise
- Latency
- Framerate
- Low level sensor access

+

Potato Grader: Industrial Smart Cameras

- Black Box
- Limited selection sensors
- Closed source image processing software

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- Limited selection sensors
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2002

Potato Grader: Celox v2002

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Potato Grader: Celox v2002

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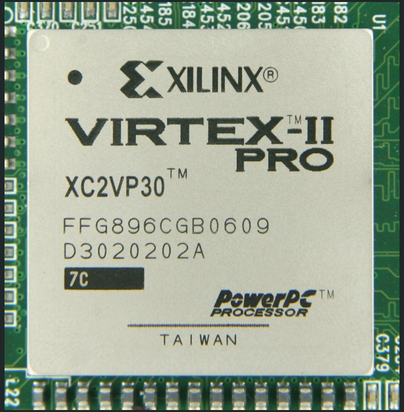
Potato Grader: Celox v2002

- Barebone application
  - updates?
  - multitask?
- Expensive
- Complicated

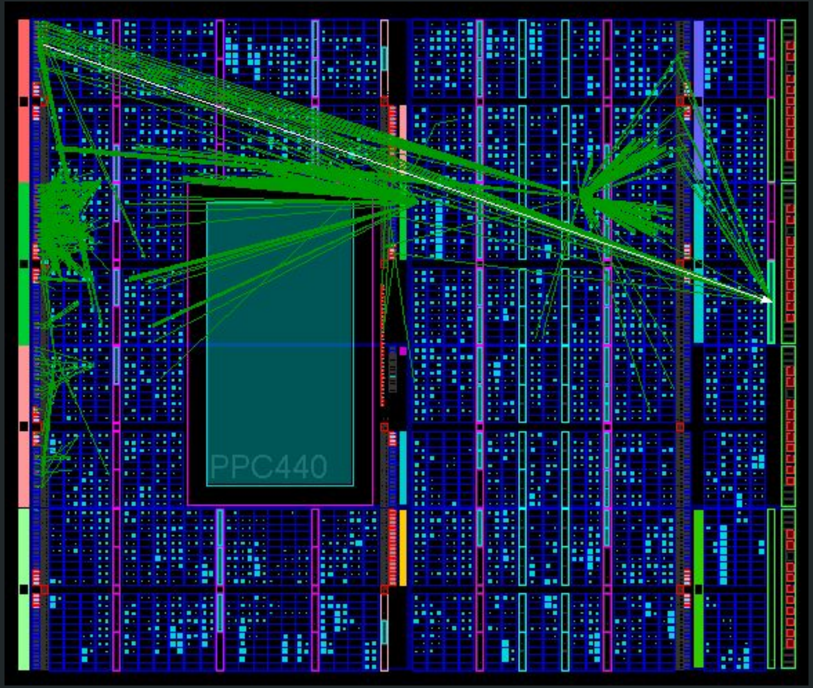
2005

Potato Grader: Celox v2005

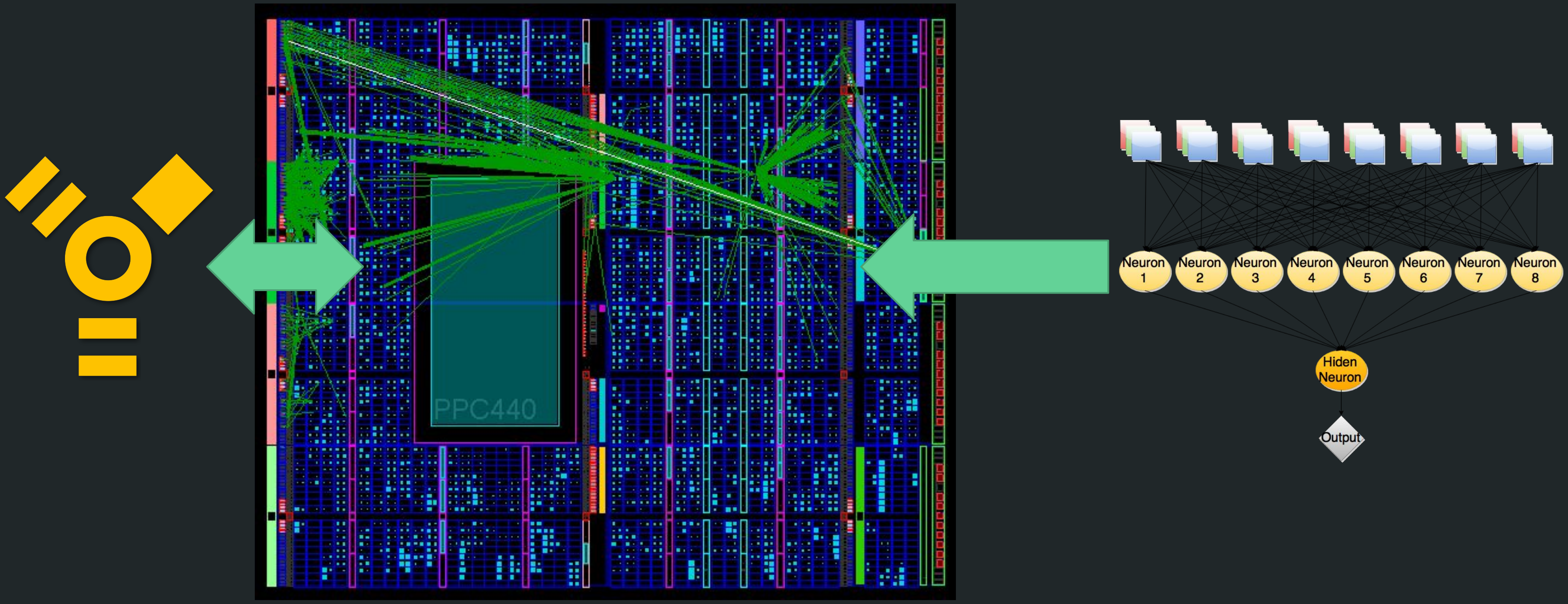
Potato Grader: Celox v2005



Potato Grader: Celox v2005



Potato Grader: Celox v2005



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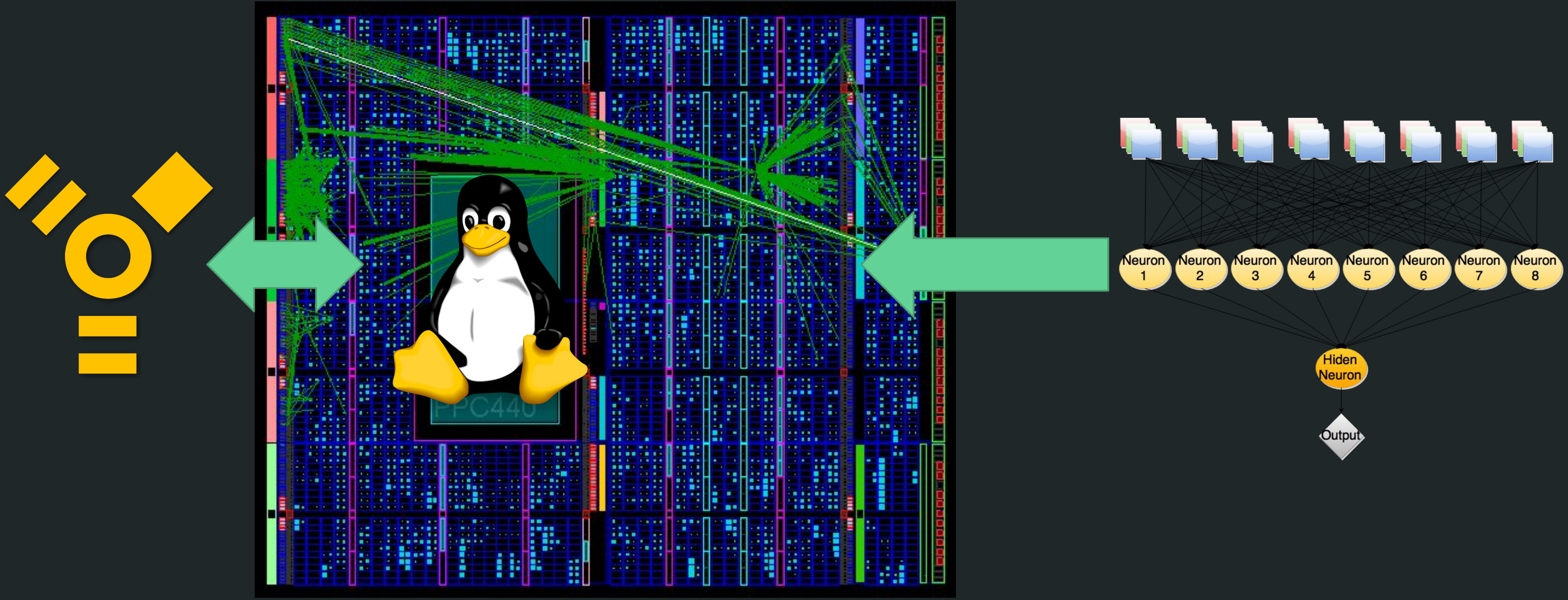
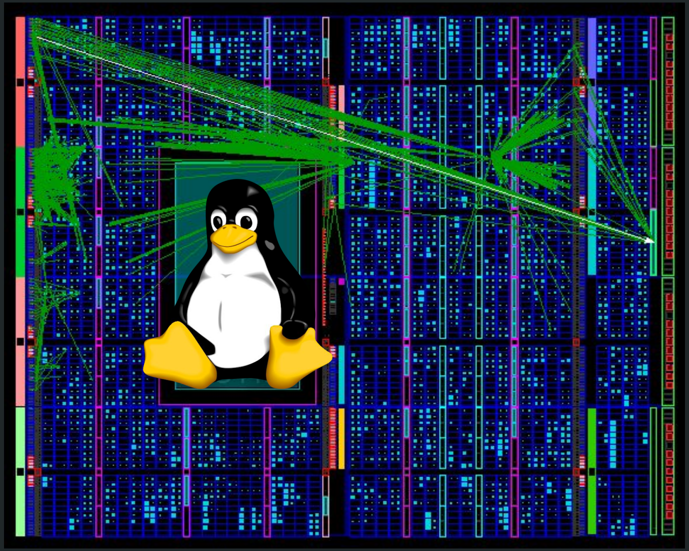
Potato Grader: Celox v2005



Potato Grader: Celox v2005

- Linux From Scratch
- (Very) Low Latency Requirements
    - All code in kernel-space
- Difficult to debug
- Difficult to update
- Difficult to replicate



2009

Potato Grader: Celox v2009

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Potato Grader: Celox v2009

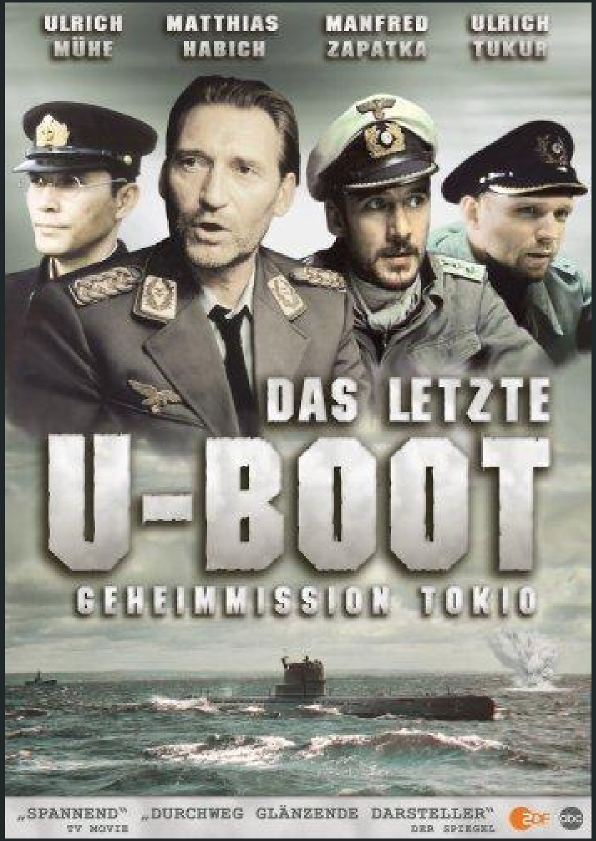
Potato Grader: Celox v2009

Potato Grader: Celox v2009

- Hardware
  - Modularity
  - Low access to Sensor
- Software
  - Build System
  - Userland

Use case: U-boot

- No upstream support for Embedded PowerPC440
- We managed to use it!



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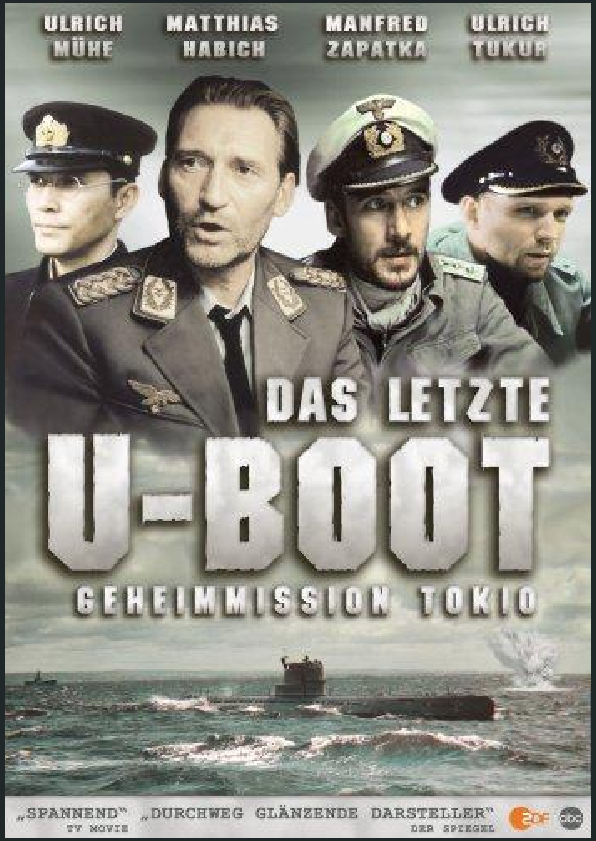

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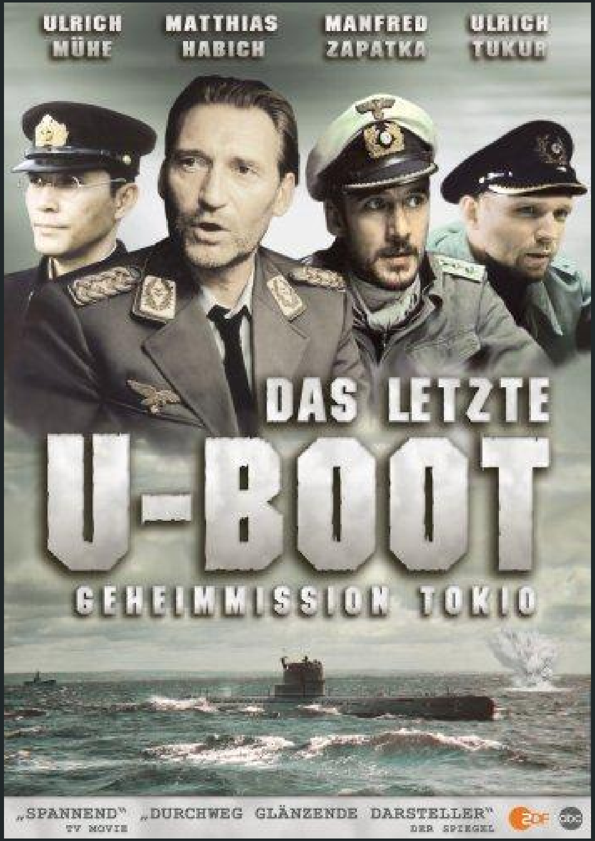
Use case: U-boot

- Bigger challenge than expected
  - Need to allocate time
  - CodeStyle matters
- Great Benefit
  - Support



Lesson Learned

Remember you need to make this trivial to review in order to get it accepted.

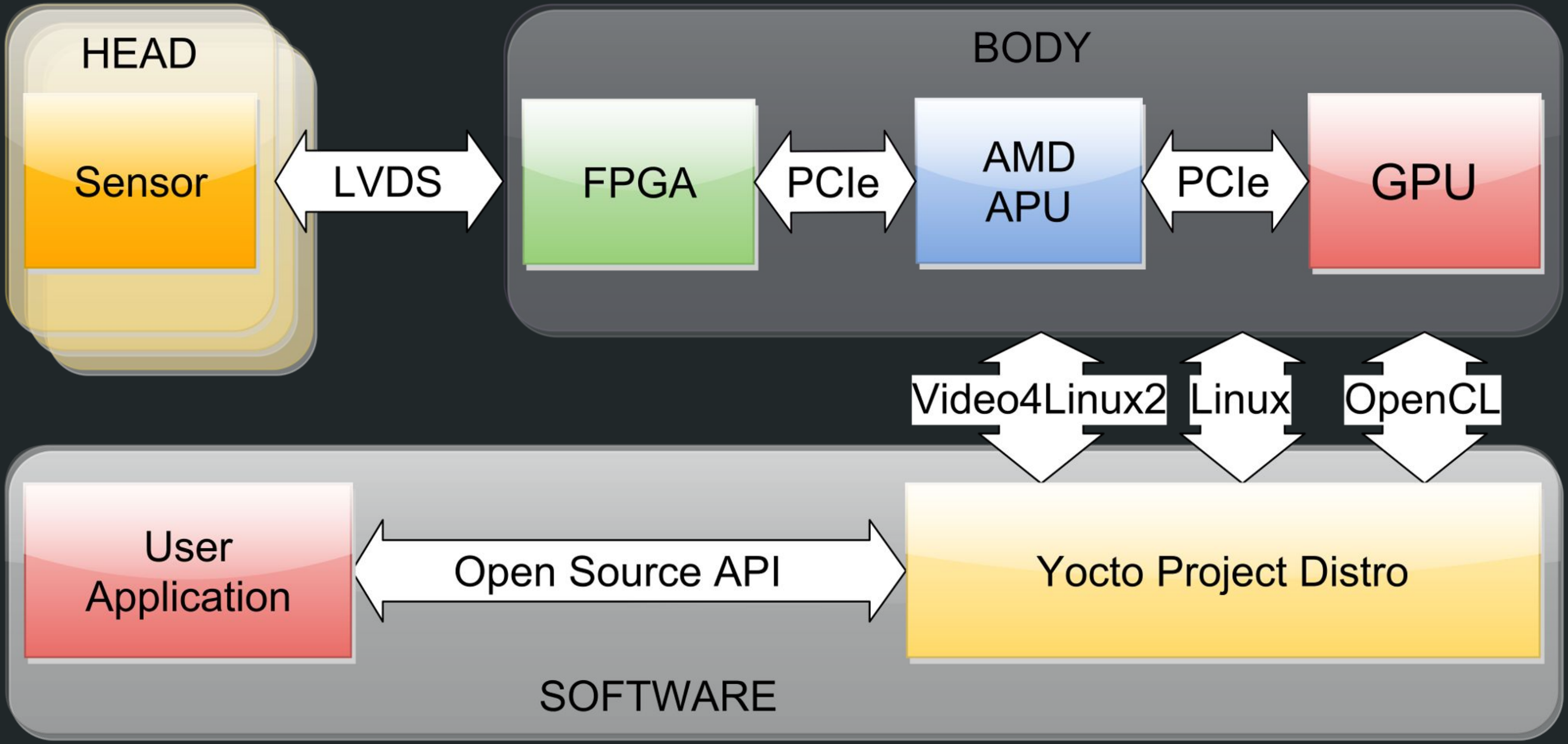
You have to do extra work because of this: our limited resource is reviewers and maintainers, not developers.

Greg Kroah-Hartman

2012

The Epiphany

Potato Grader: Celox v2015



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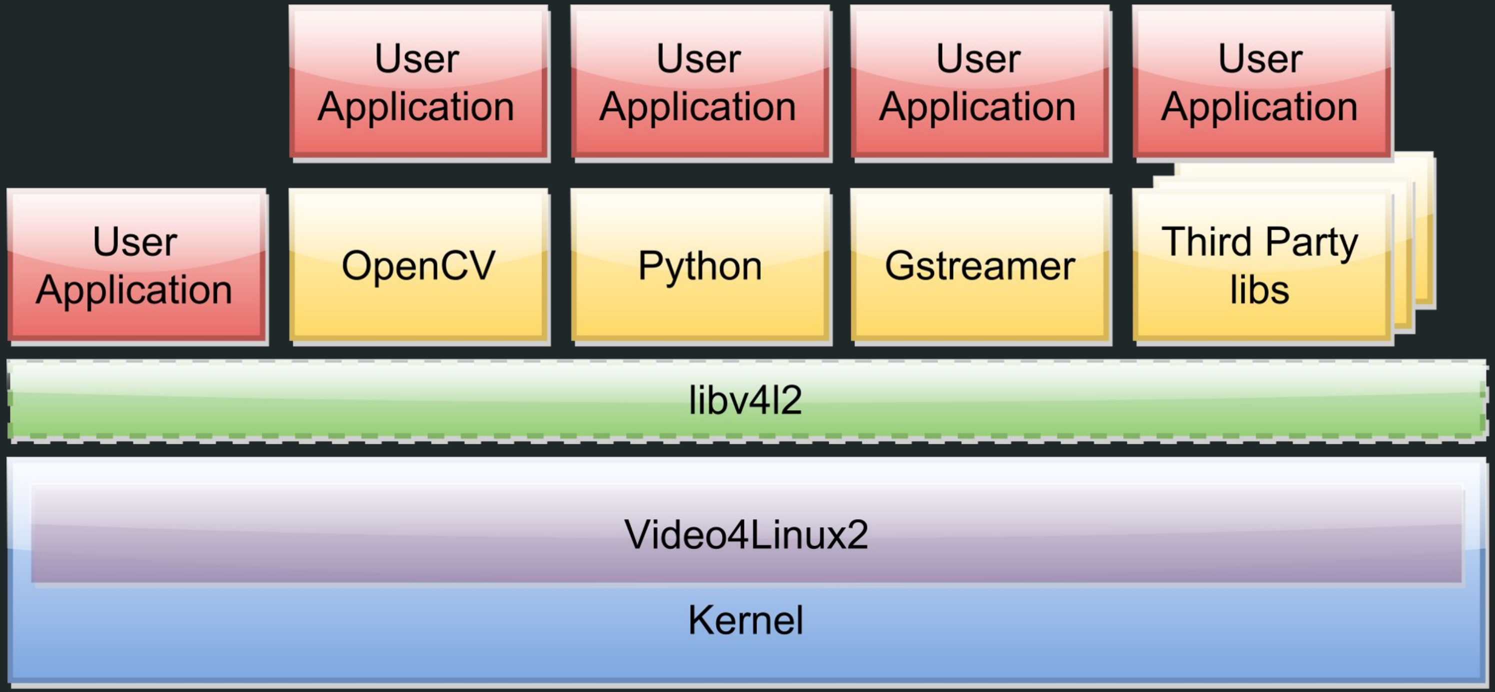
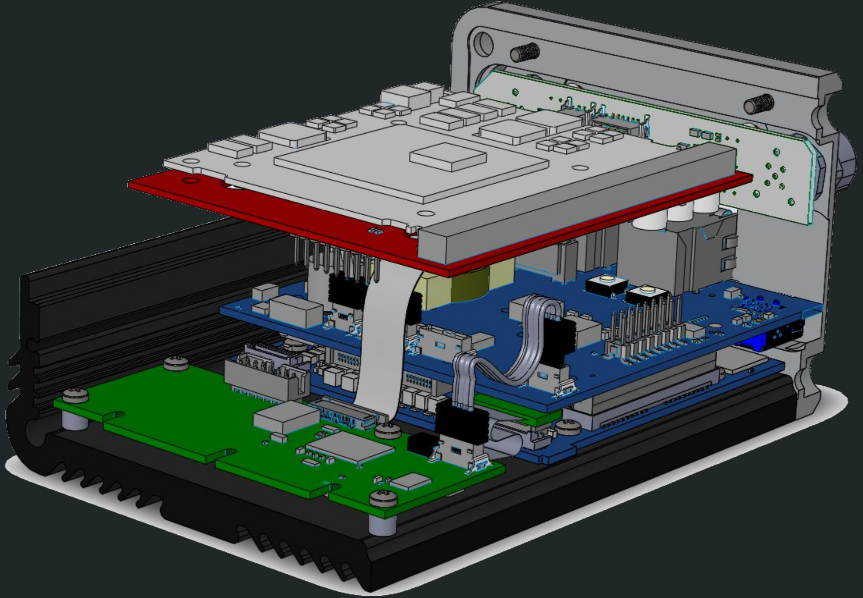
Potato Grader: Celox v2015

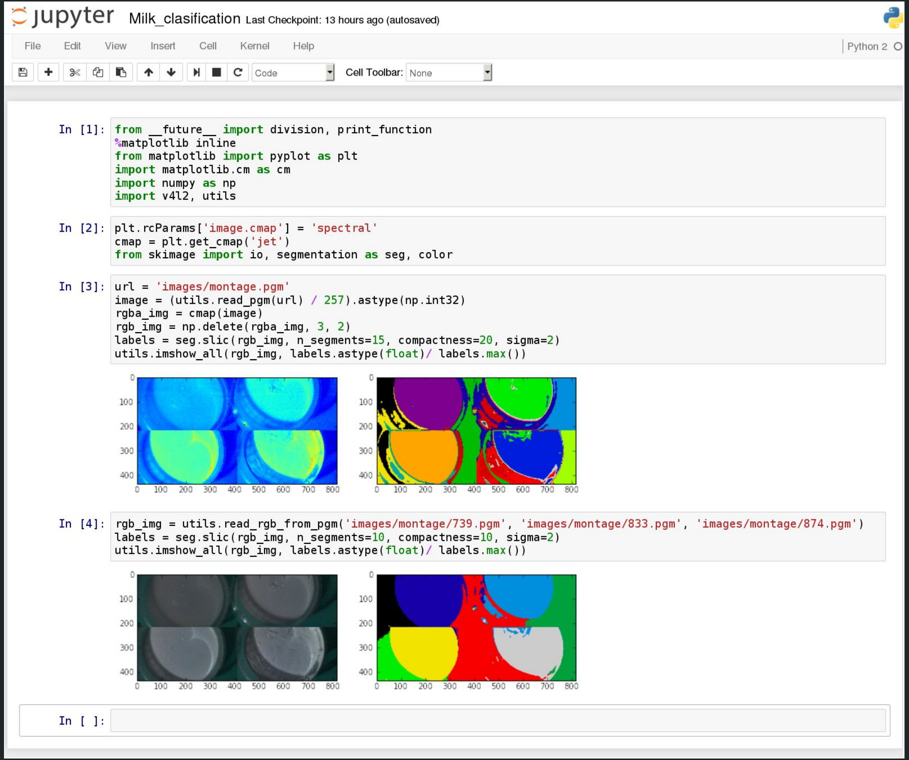


Why Standard interfaces?

- Pre documented code :)
- Validation Tools
- Easy to get help in work peaks



Potato Grader: Celox v2015



```
In [1]: from __future__ import division, print_function
        %matplotlib inline
        from matplotlib import pyplot as plt
        import matplotlib.cm as cm
        import numpy as np
        import v4l2, utils

In [2]: plt.rcParams['image.cmap'] = 'spectral'
        cmap = plt.get_cmap('jet')
        from skimage import io, segmentation as seg, color

In [3]: url = 'images/montage.pgm'
        image = (utils.read_pgm(url) / 257).astype(np.int32)
        rgba_img = cmap(image)
        rgb_img = np.delete(rgba_img, 3, 2)
        labels = seg.slic(rgb_img, n_segments=15, compactness=20, sigma=2)
        utils.imshow_all(rgb_img, labels.astype(float)/ labels.max())
```

```
In [4]: rgb_img = utils.read_rgb_from_pgm('images/montage/739.pgm', 'images/montage/833.pgm', 'images/montage/874.pgm')
        labels = seg.slic(rgb_img, n_segments=10, compactness=10, sigma=2)
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```
In [ ]:
```

IP[y]: Notebook

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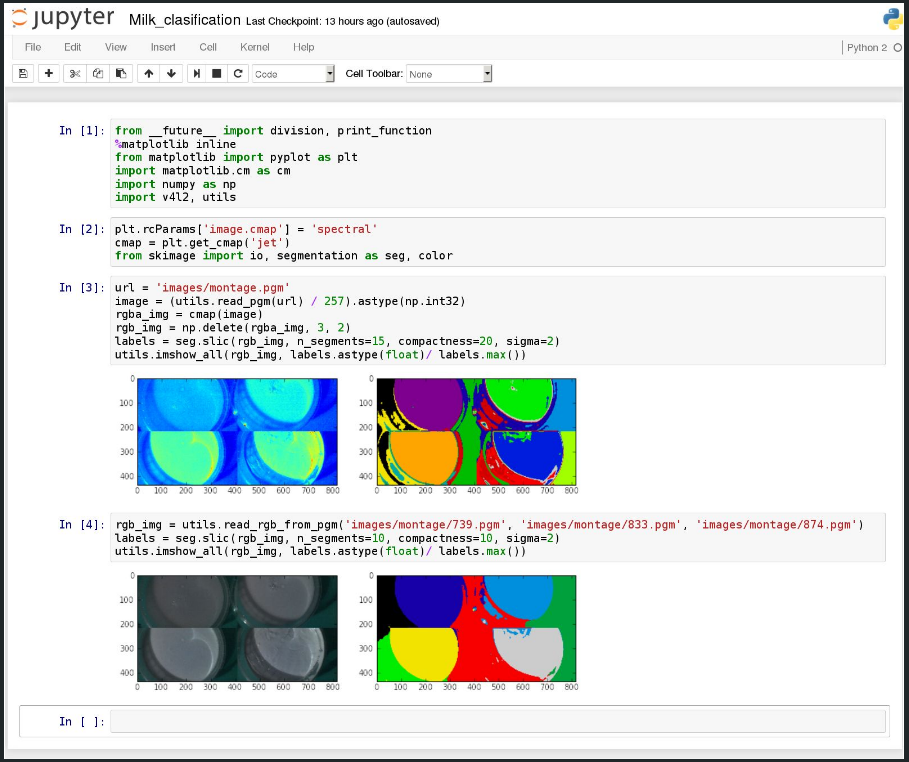
Potato Grader: Celox v2015



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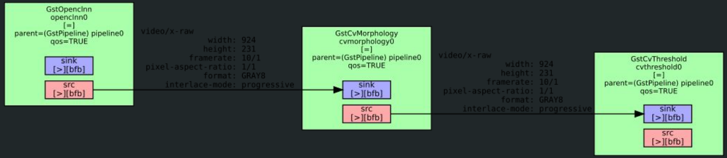
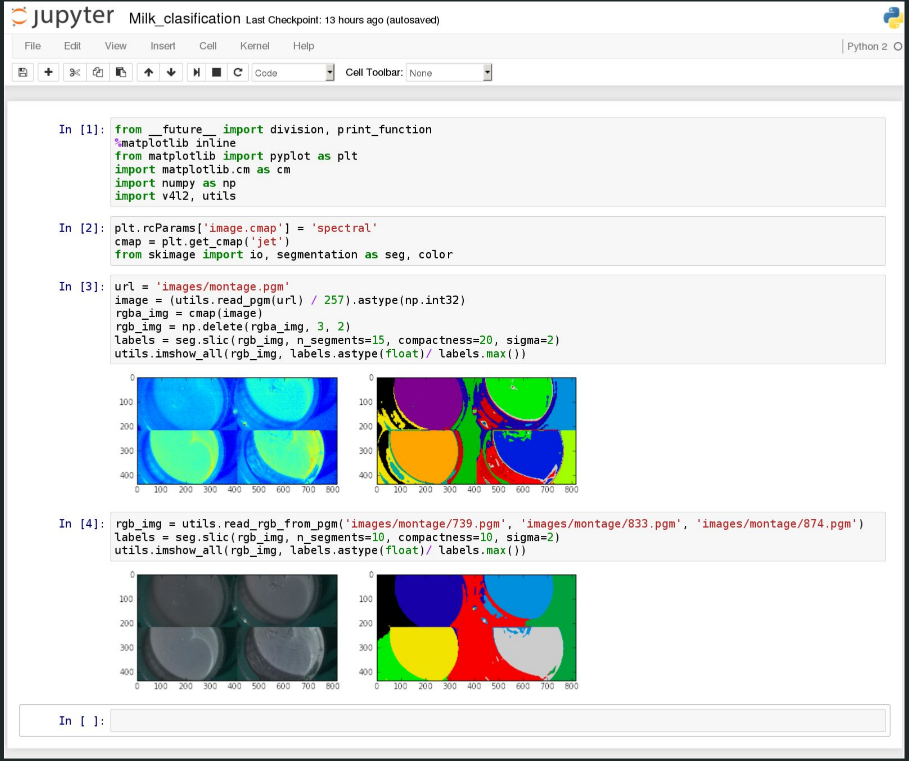


Potato Grader: Celox v2015



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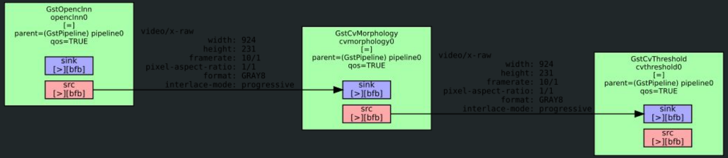


gstreamer

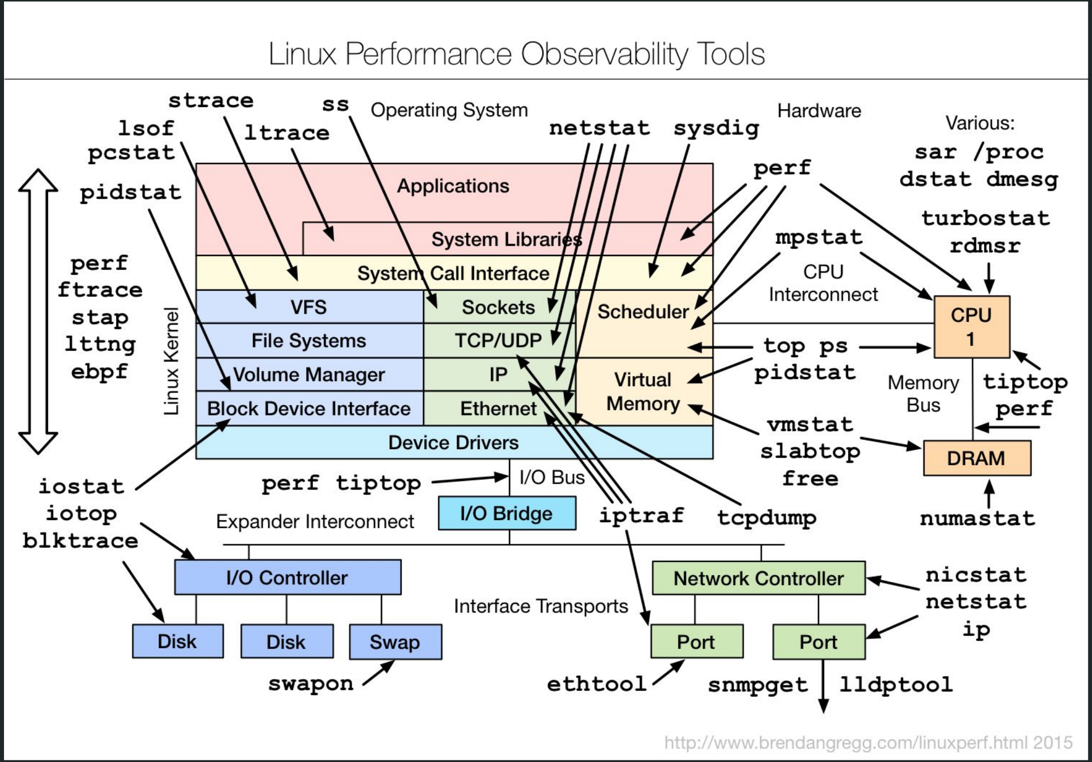
OpenCL

IP[y]: Notebook

LINUX TV

OpenCV

Potato Grader: Celox v2015



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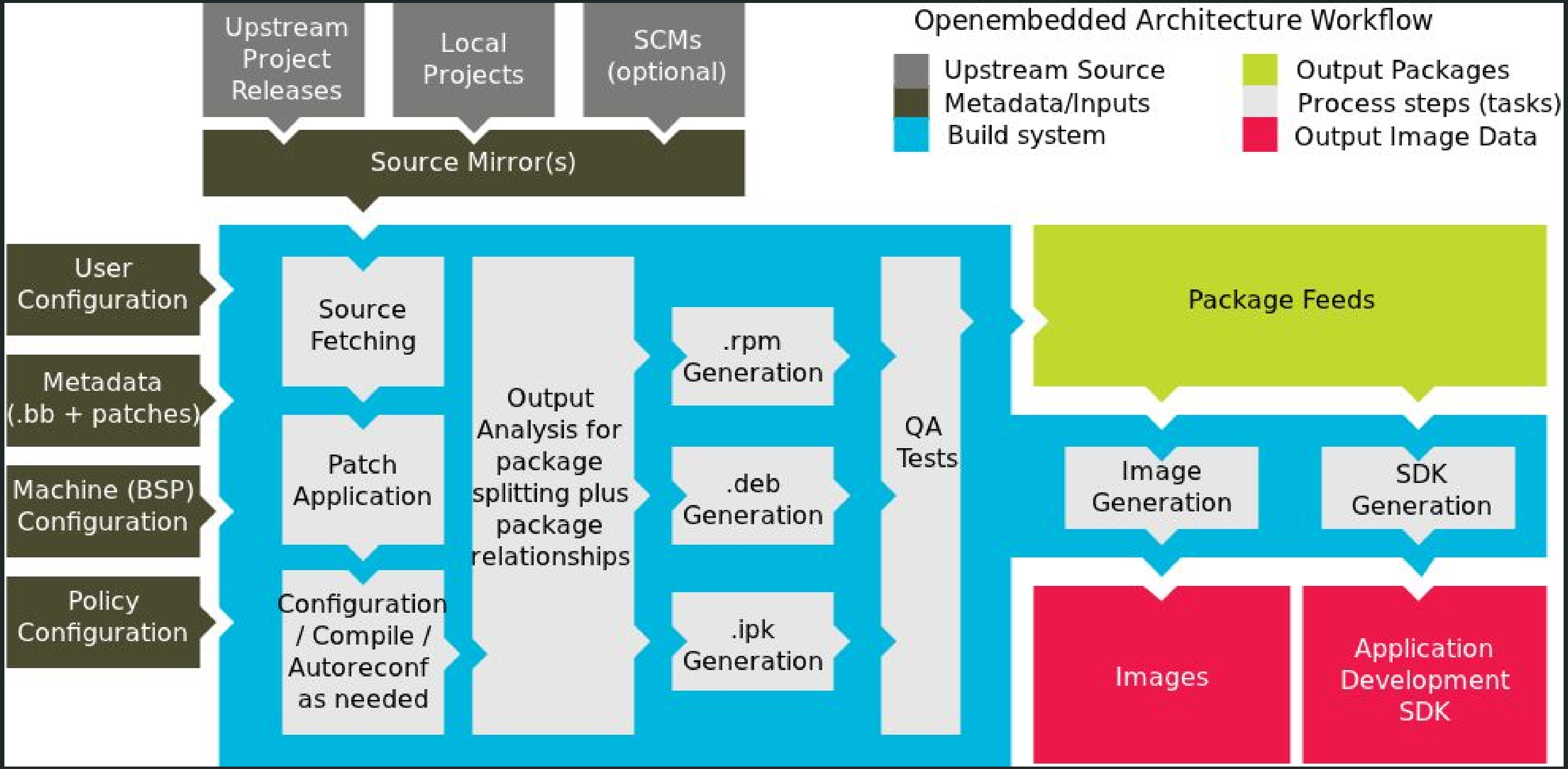
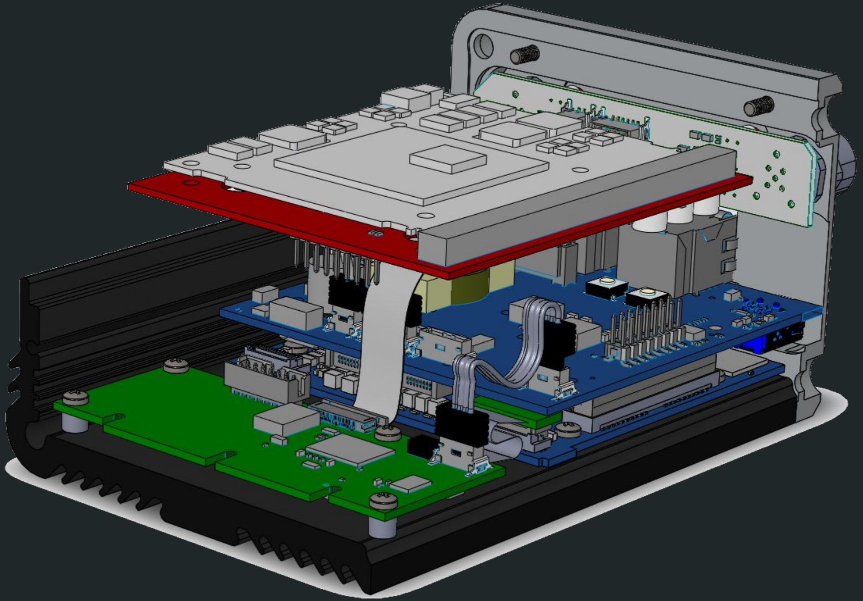
Credit to: Brendan D. Gregg

Potato Grader: Celox v2012



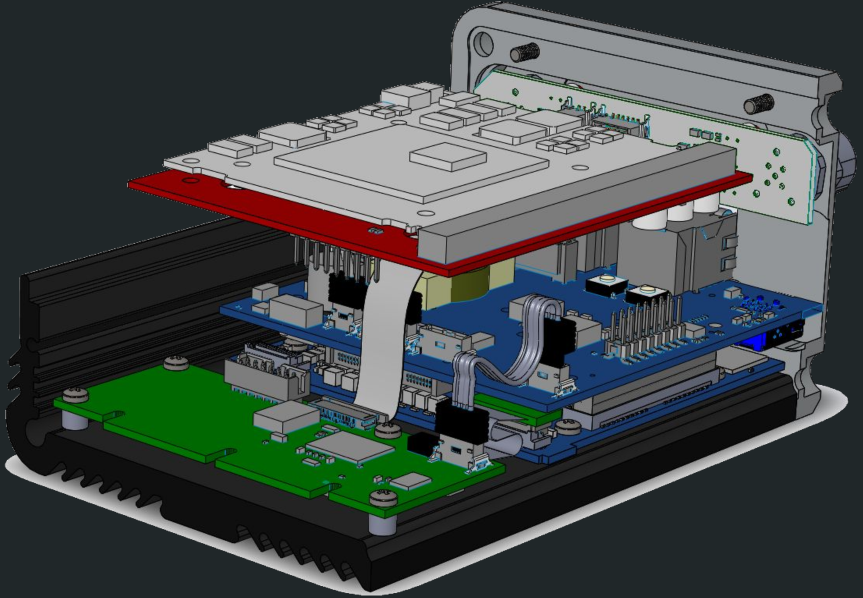
Potato Grader: Celox v2012

- Two track Strategy
  - Open Source
  - Upstream



Why Upstream?

- Support [1]
- Training experience
- Code Review
- Distro Independent!



[1] Kernel Newbies Autoresponder:

What changes are you making to the kernel that you are sticking with such an old version (X.Y is Z years old now, and over KKK thousand changes have happened to the kernel since then)?

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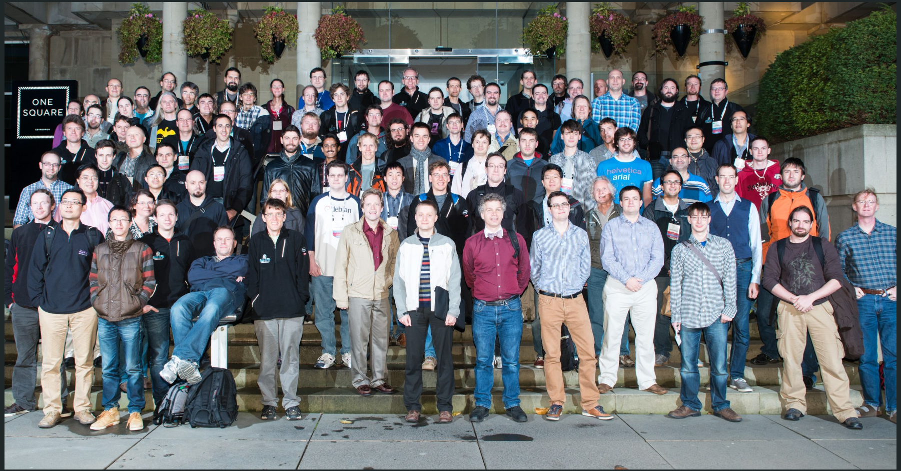
Use case: Kernel

- Great Community
- Infinite Patience
- Port to last version under 2 hours!!



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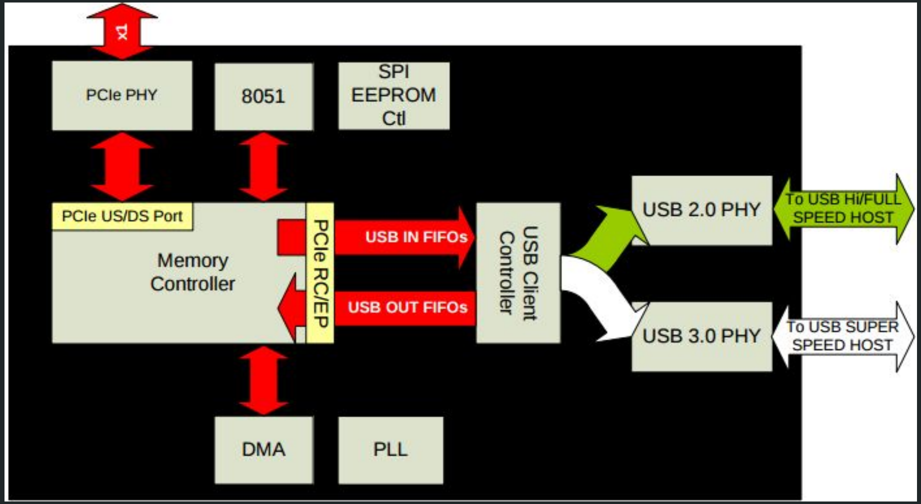
Use case: USB Gadget 3380

- Upstream driver
- Access to engineers from:
  - Samsung
  - Texas Instruments
  - Intel



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Video Demo

Today

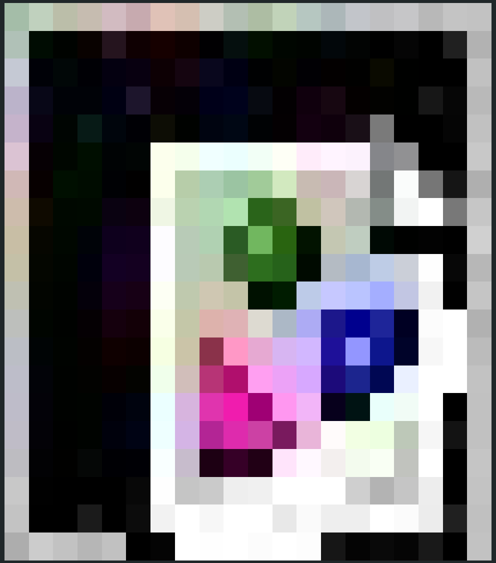
Qtechnology Contributions

- **Linux Kernel:** 172 patches. Including a 9+ year old bugfix.
- **U-boot:** 25 patches. Maintainers of Virtex PowerPC boards.
- **Yocto project:** 17 patches. Supporting organization of the project.
- **v4l-utils/libv4l2:** 7 patches.
- **Gstreamer:** 1 patch accepted. CHECK OUT GSTREAMER CONFERENCE.
- **Flashrom:** Support for the first board with EEprom memory.
- **Gerbil:** 2 patches.
- **Clpeak:** 2 patches.
- **Video Lan Client:** 1 patch.

More Machines

Batch analyzer

Checkweigher



Spectral Camera

Conclusions

- Upstreaming is extremely beneficial.
  - Even for Small Companies!
  - But Allocate resources!
- Use standard Interfaces
- DO NOT reinvent the wheel
- 1st Portability
  2nd Performance

The Art of counting potatoes (with Linux)

Ricardo Ribalda