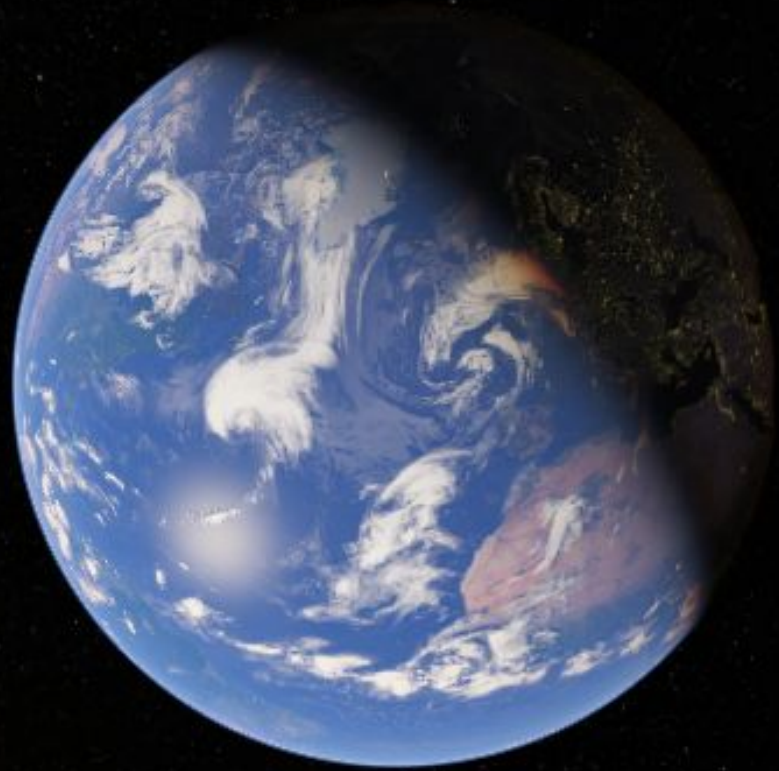


# The Small Potato Collider

or how to solve a multidisciplinary problem  
using a modular camera

---

Ricardo Ribalda, Ph.D.  
Lead Firmware Engineer  
@ribalda





Norway

Kaza

Estonia

Latvia

Lithuania

Belarus

Poland

Ukraine

Georgia

Turkey

Iraq

Saudi A

United Kingdom

Ireland

Denmark

Netherlands

Germany

Belgium

France

Portugal

Spain

Italy

Bulgaria

Greece

Syria

Lebanon

Israel

Jordan

Egypt

Morocco

Tunisia

North Sea

Baltic Sea

Caspian Sea

Black Sea

Tyrrhenian Sea

Mediterranean Sea



**France**

**Switzerland**

**Austria**

Salzburg

Munich

Strasbourg

Rennes

Nantes

Tours

Zürich

Liechtenstein

Graz

Slovenia

Zagreb

Trieste

**Croatia**

Zadar

Venice

Verona

Milan

Geneva

Lyon

Clermont-Ferrand

Limoges

Grenoble

Turin

Bologna

Genoa

San Marino

Pisa

**Monaco**

Marseille

Montpellier

Toulouse

ao

Gasteiz

**Andorra**

Girona

Corsica

Rome

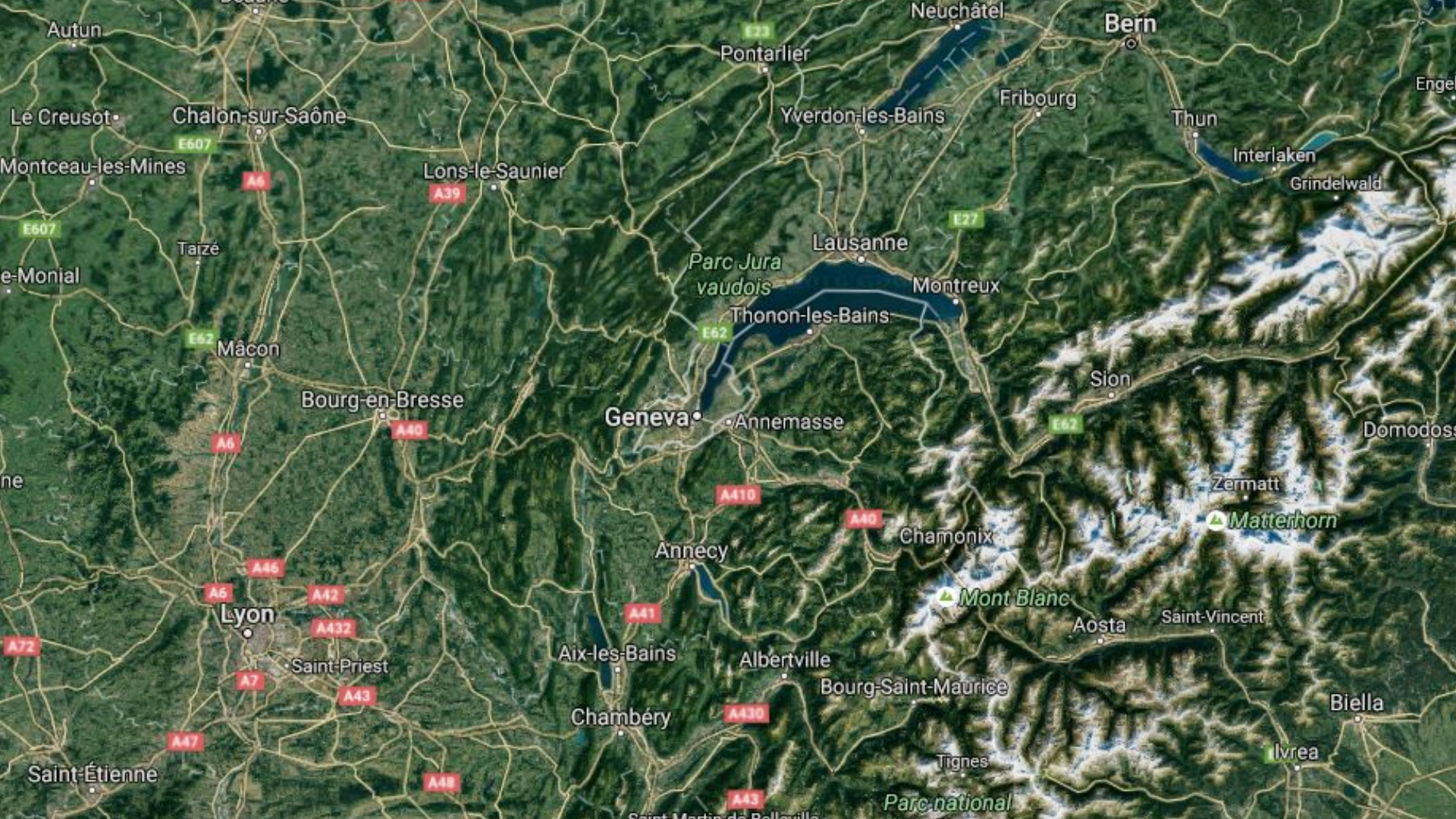
Zaragoza

Barcelona

Tarragona

Naples

Adriatic S



Autun

Neuchâtel

Bern

Le Creusot

Chalon-sur-Saône

Pontarlier

Yverdon-les-Bains

Fribourg

Thun

Interlaken

Grindelwald

Montceau-les-Mines

Lons-le-Saunier

Lausanne

Montreux

Tarzé

Parc Jura  
vaudois

Thonon-les-Bains

Mâcon

Bourg-en-Bresse

Geneva

Annemasse

Sion

Domodossola

Zermatt

Matterhorn

A6

A40

A410

A40

Chamonix

Mont Blanc

Lyon

A6

A42

A432

Annecy

A41

Aosta

Saint-Vincent

Saint-Priest

A7

Aix-les-Bains

Albertville

Bourg-Saint-Maurice

Biella

Saint-Étienne

A47

Chambéry

A430

Tignes

Ivrea

A48

A43

Parc national

Parc national de Ballaigosa

Wierlandsterweg

Oosternielandsterweg

Uithoermeerdstermaat

Landjuweel

Oosternielandsterweg

Maarvleweg

VW Parts Grunn



# CELOX XT-P Potato Grader



# 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)



# Why Grade them?



# 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

# Why Grade them?



Green Spot



Black Spot



Scurf



Golf Ball



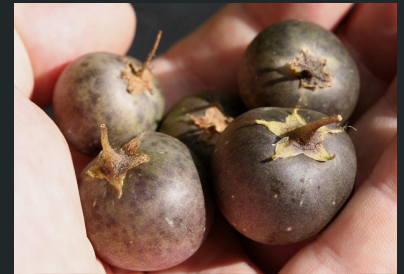
Grey Damage



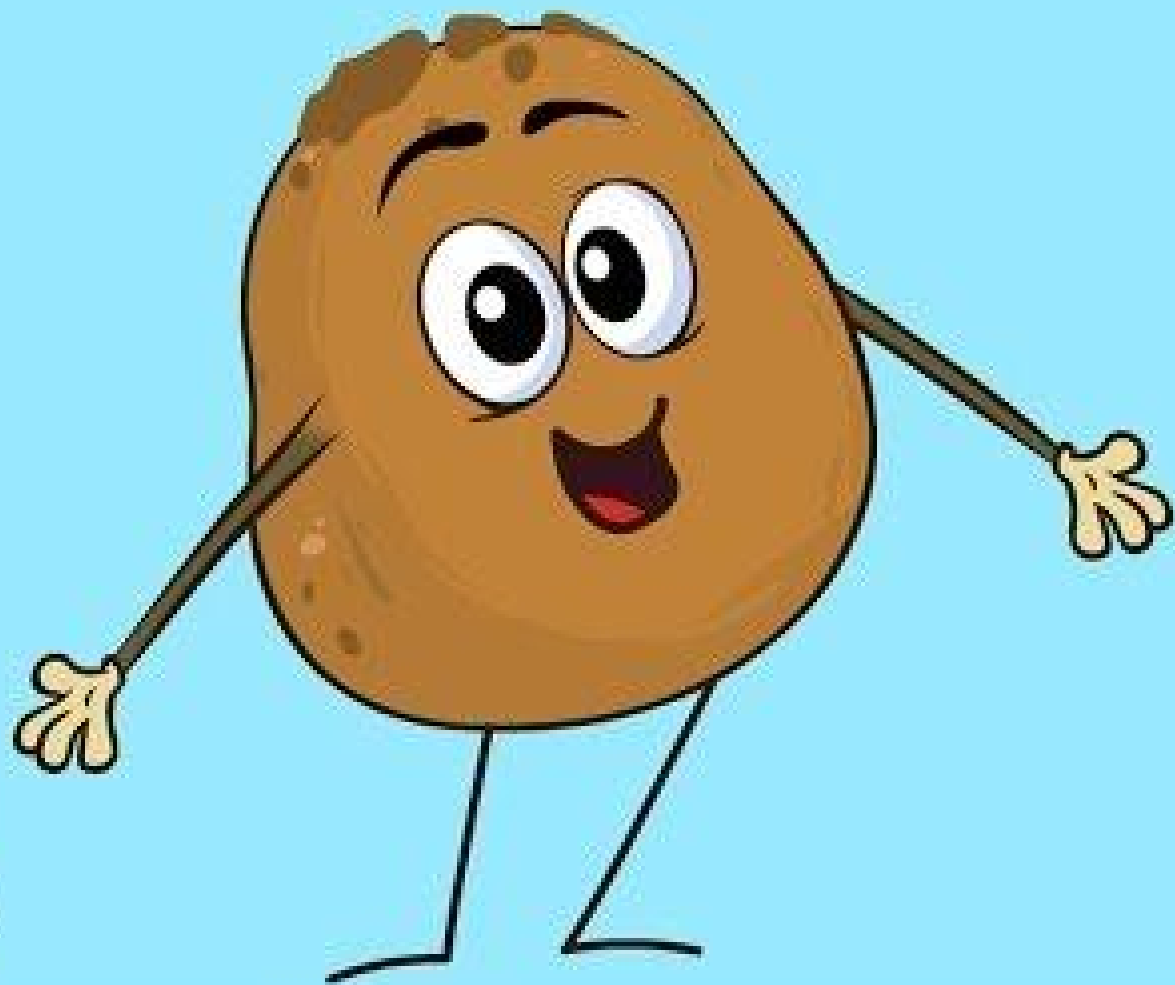
Rot



Fresh Cut



Potato Fruit



Super  
Simple  
Learning



# How it is done?

1 mm<sup>2</sup> resolution

Dimensions equivalent to  
old-school caliper

13 categories



© 2016 Google

© 2016 Google

1 2 3 4 5

6 7 8 9 10

11

12

13

Landjuweel 

14

15

16

17

© 2016 Google

© 2016 Google

© 2016 Google

© 2016 Google

Oosternielandsterweg

# Data Specs

8x12x40 = 3840 MBytes/sec

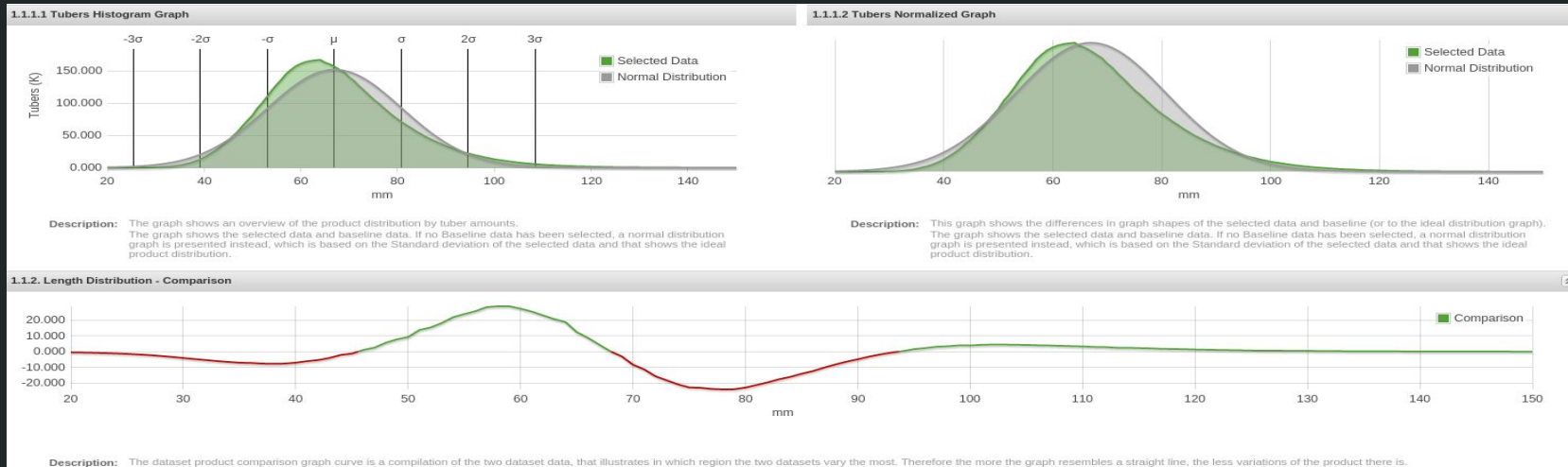
112.78 PBytes/year

Max Latency: 1 sec

Jitter: Close to zero

28 tons per hour

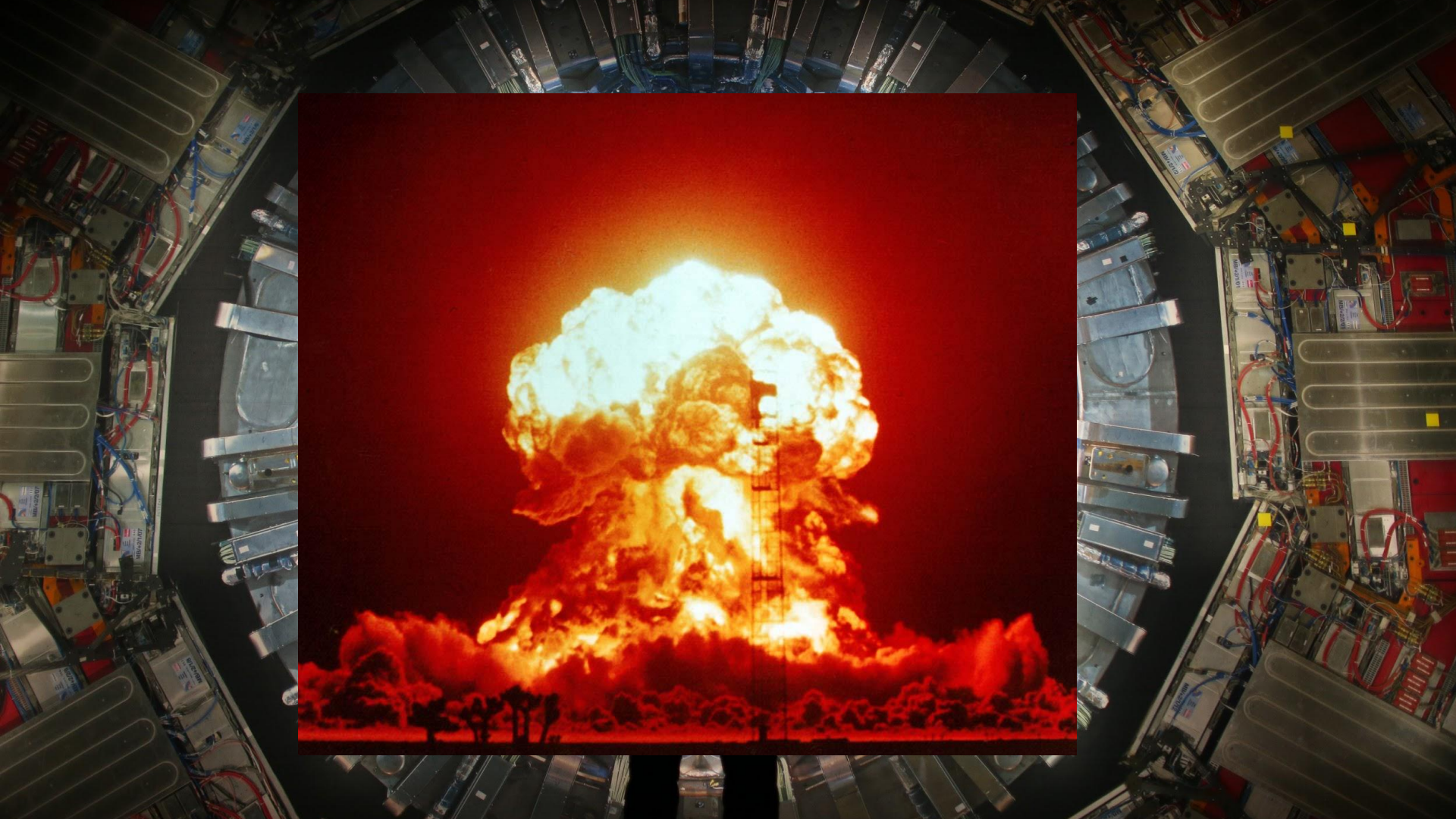
Web services enable



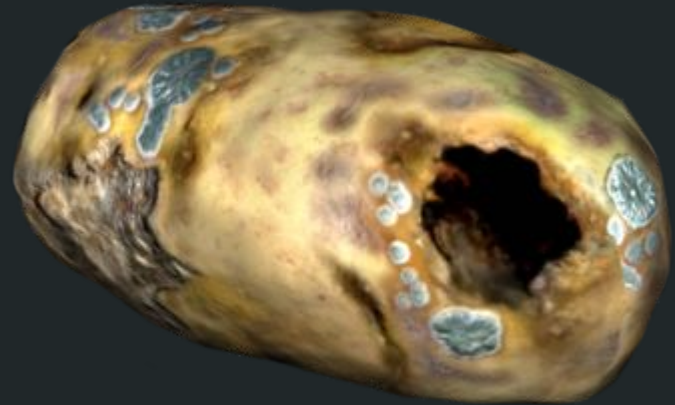


30 Pbytes/year





# CELOX XT-P Potato Grader



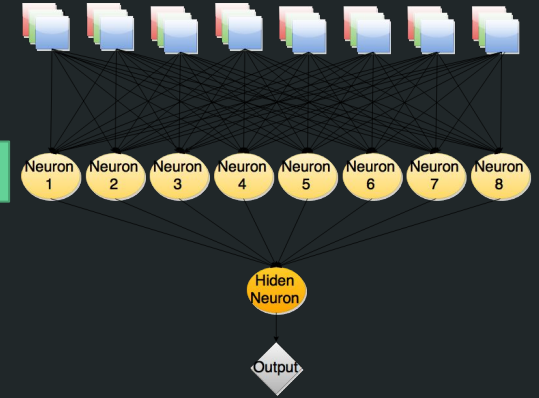
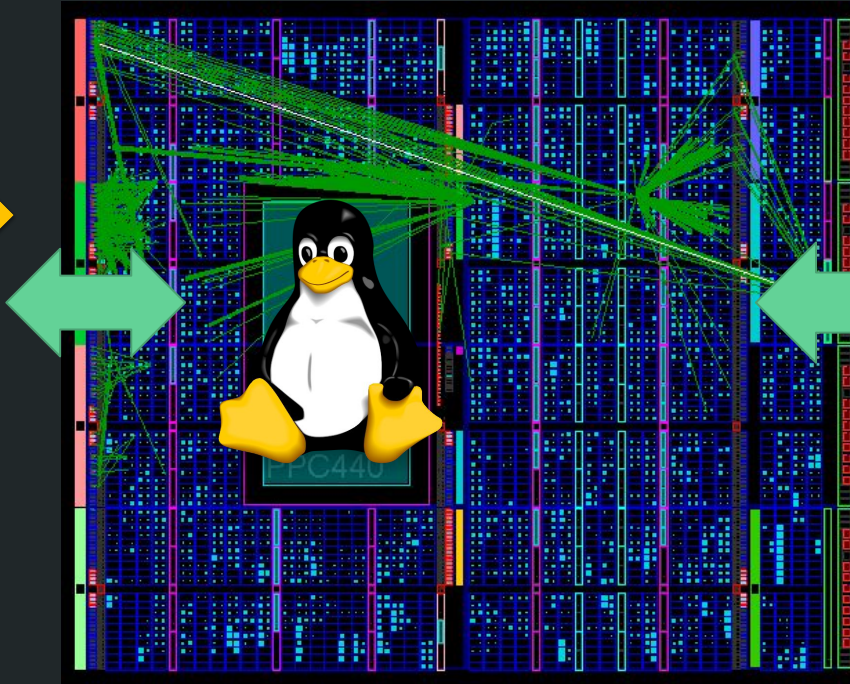
# Potato Grader: Celox v2002



# Celox V1

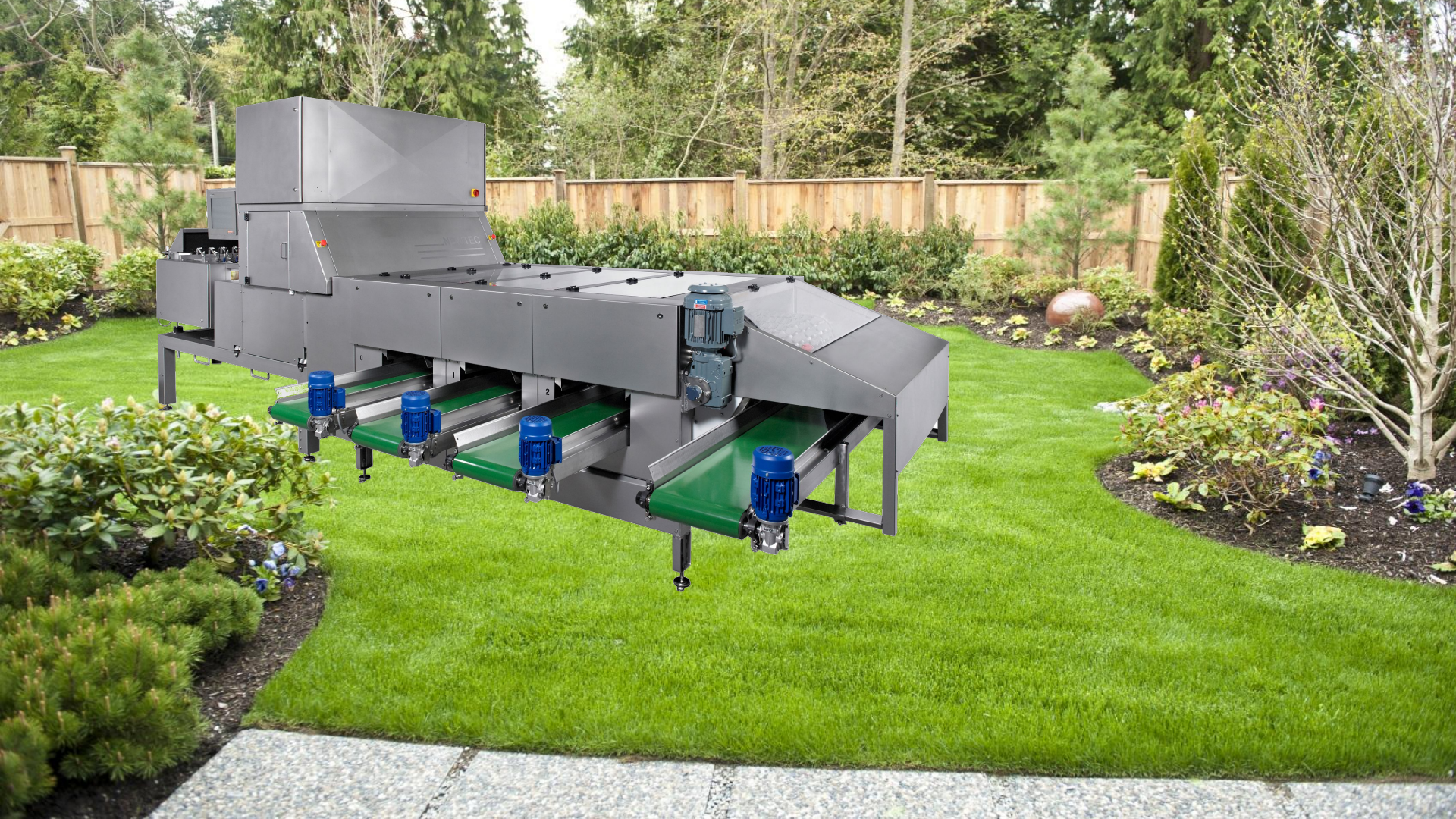


# Celox V2



# Celox V3



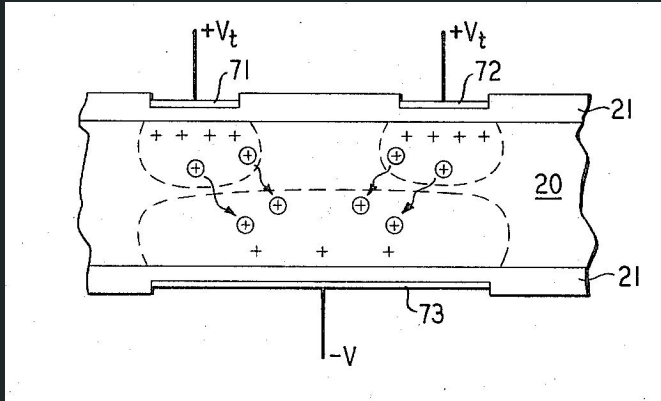






**SPECIAL  
OFFER**

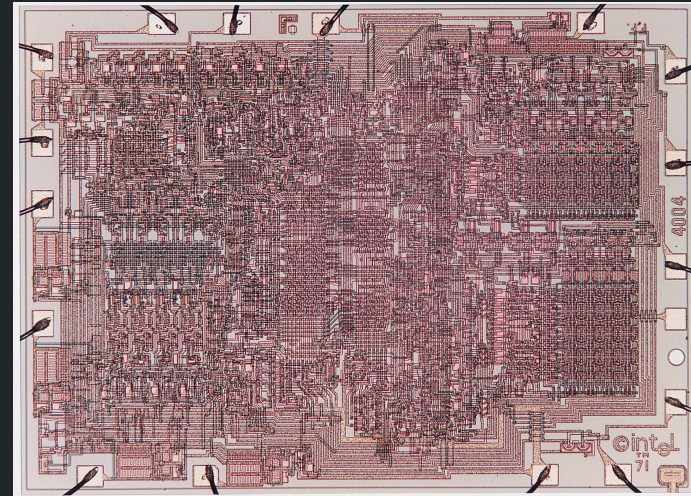
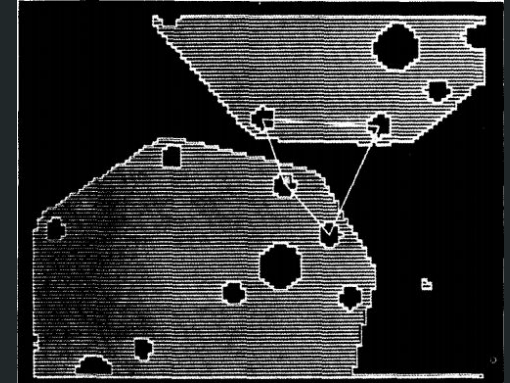
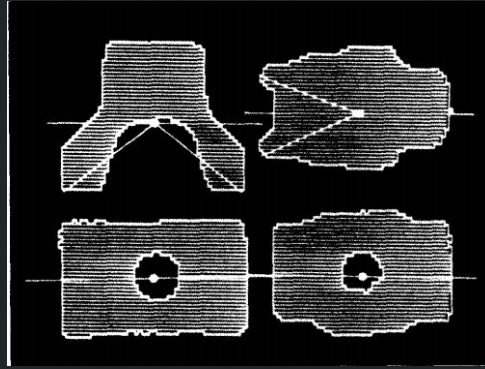
# The first CCD



INVENTORS **W. S. BOYLE**  
**G. E. SMITH**  
BY *Patent Office*



# SRI Vision Module



1972

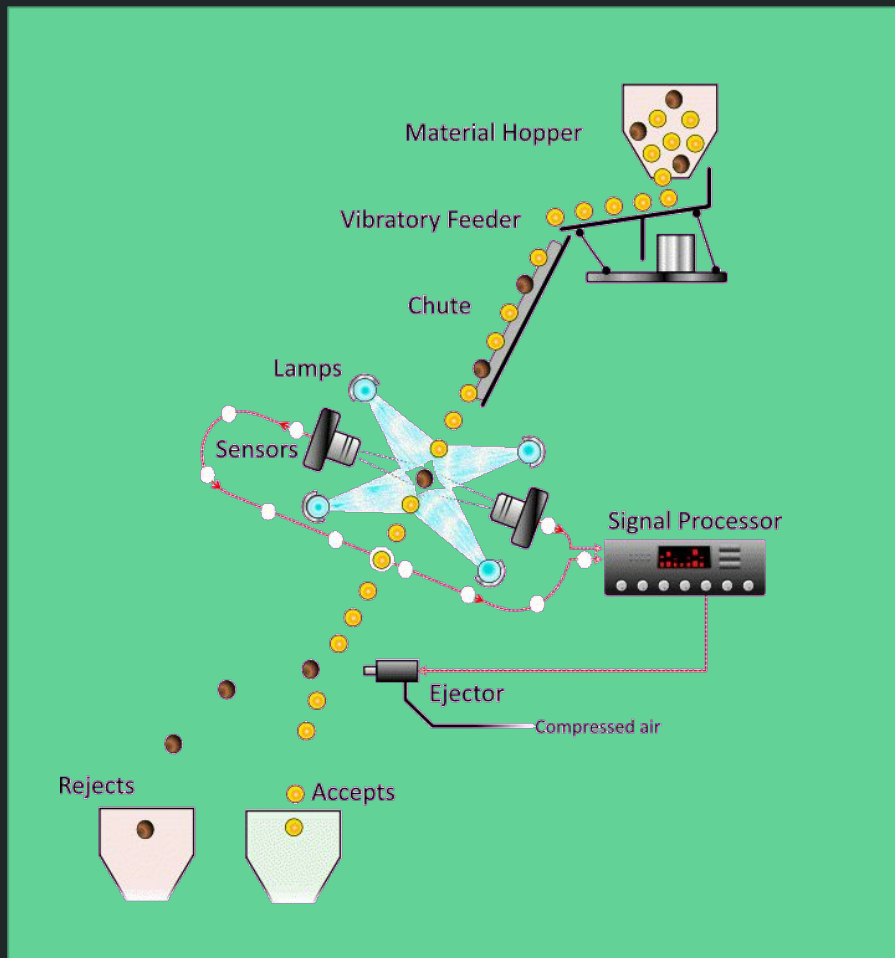
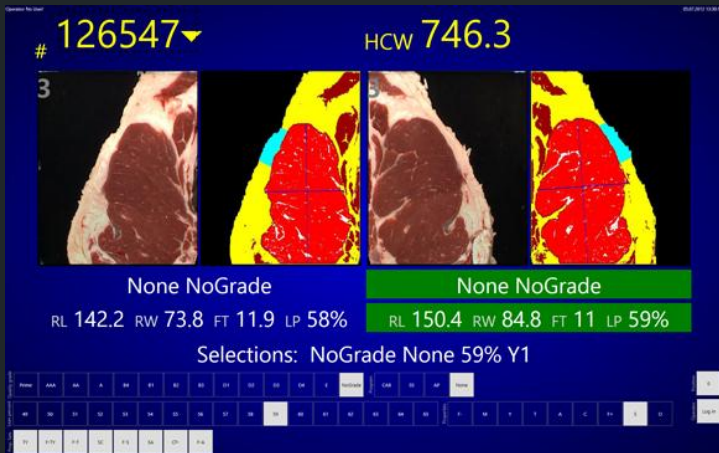


*Custom-designed computer vision systems are being applied to specific manufacturing tasks. Current development may lead to general-purpose systems for a broad range of industrial applications.*

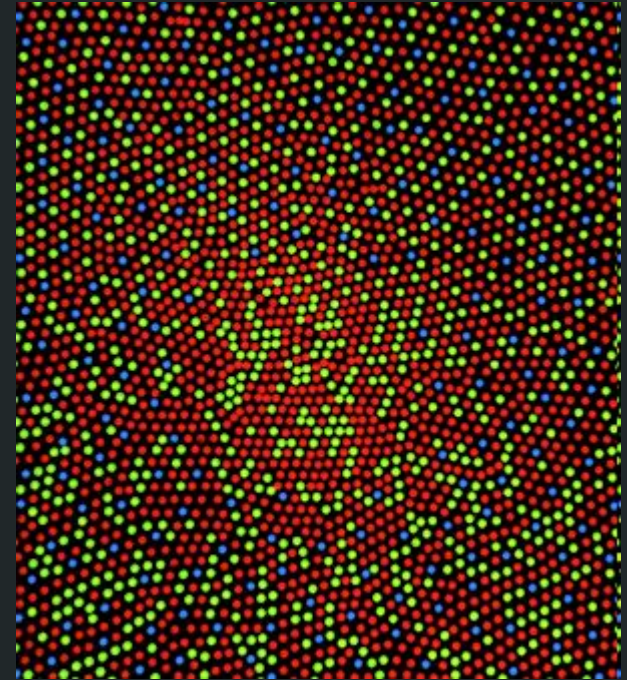
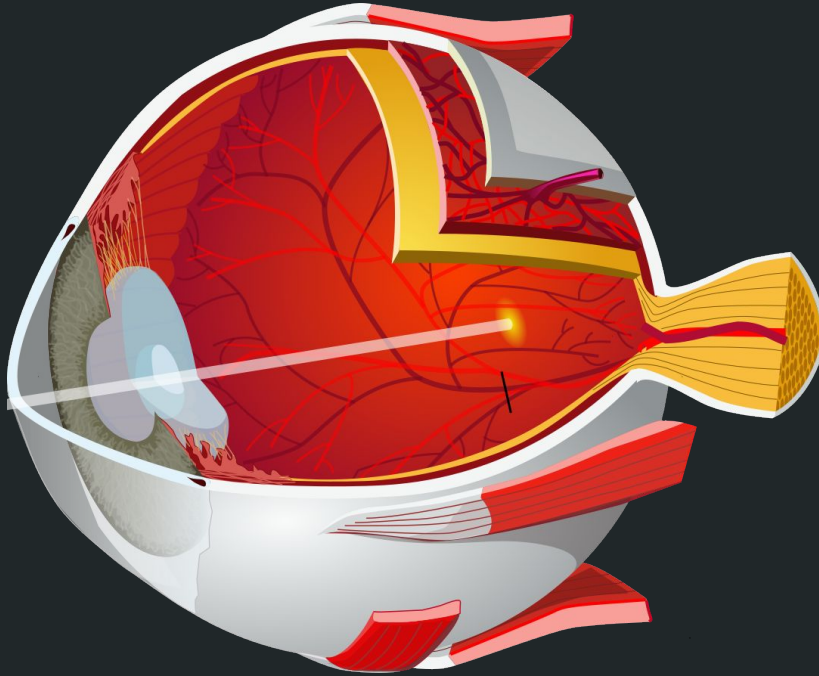
Gerald J. Agin, 1980

Stanford Research Institute

Agin, Gerald J. "Computer vision systems for industrial inspection and assembly."  
*Computer 5* (1980): 11-20.



# Bio-Sensor



# Sensor

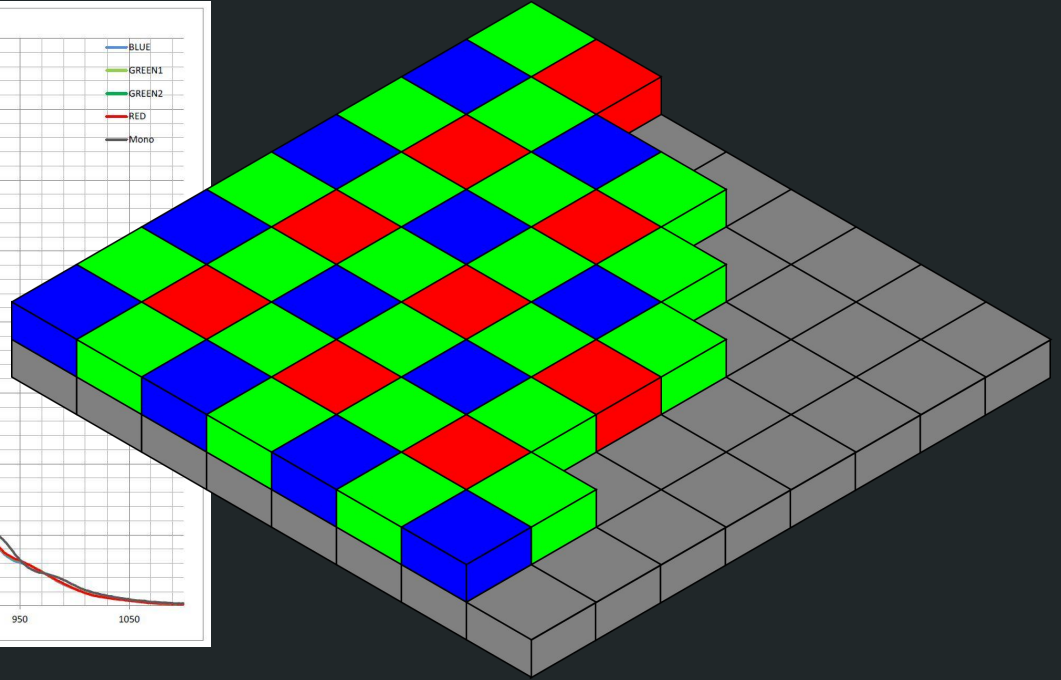
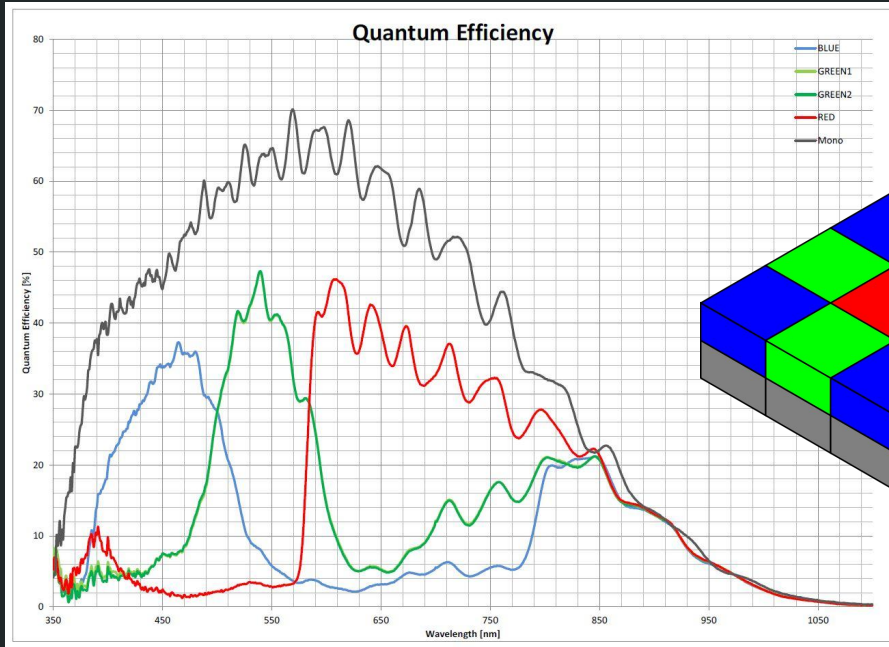


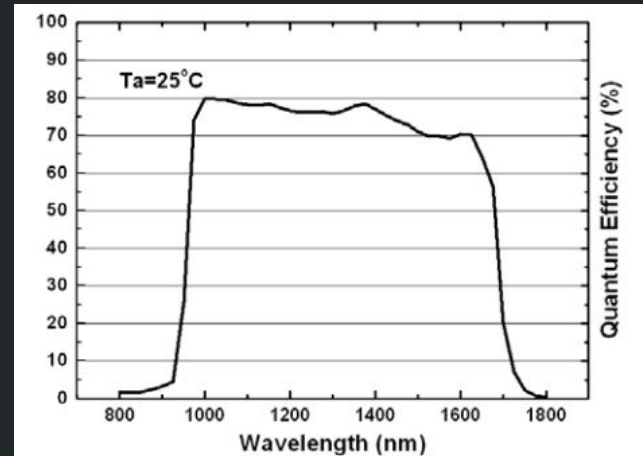
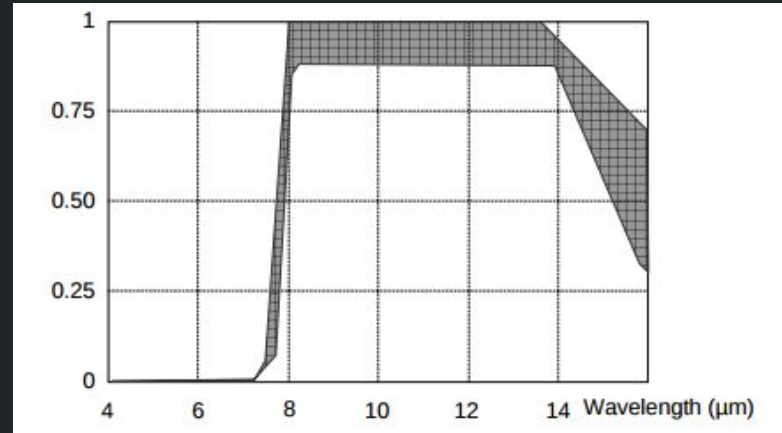
Image Credit: Wikipedia CC BY-SA 3.0



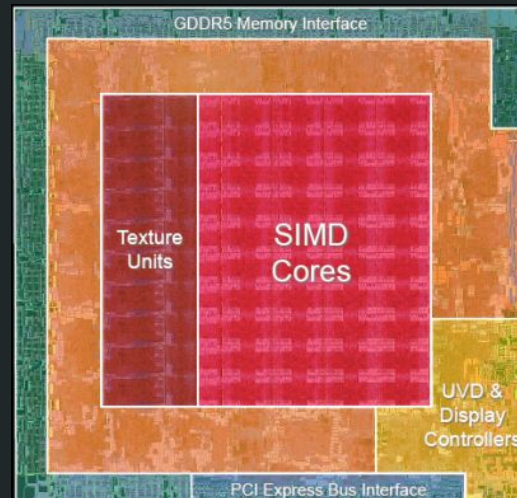
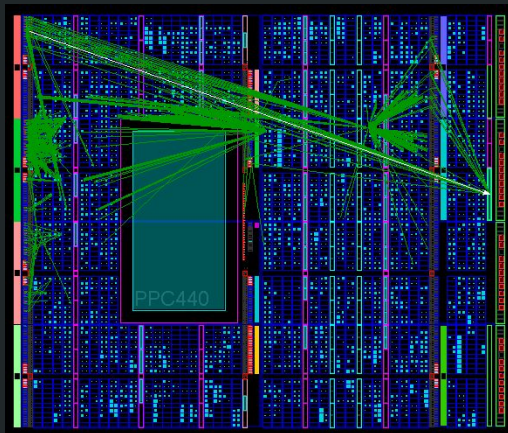
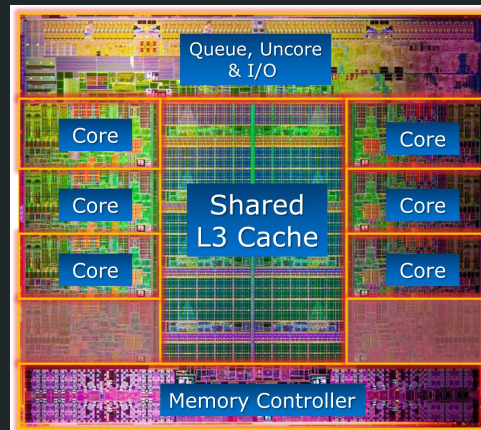
# Other sensors



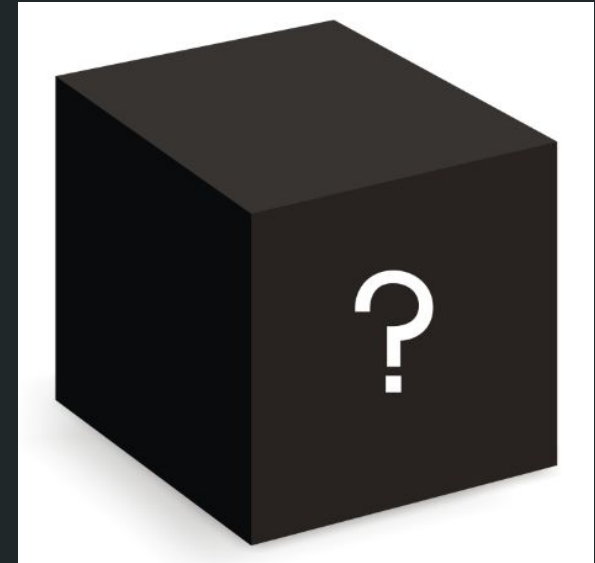
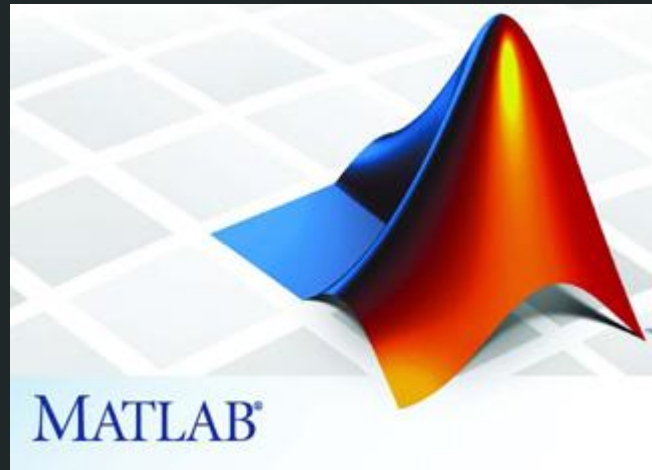
Image Credit: Wikipedia CC BY-SA 3.0



# Processing



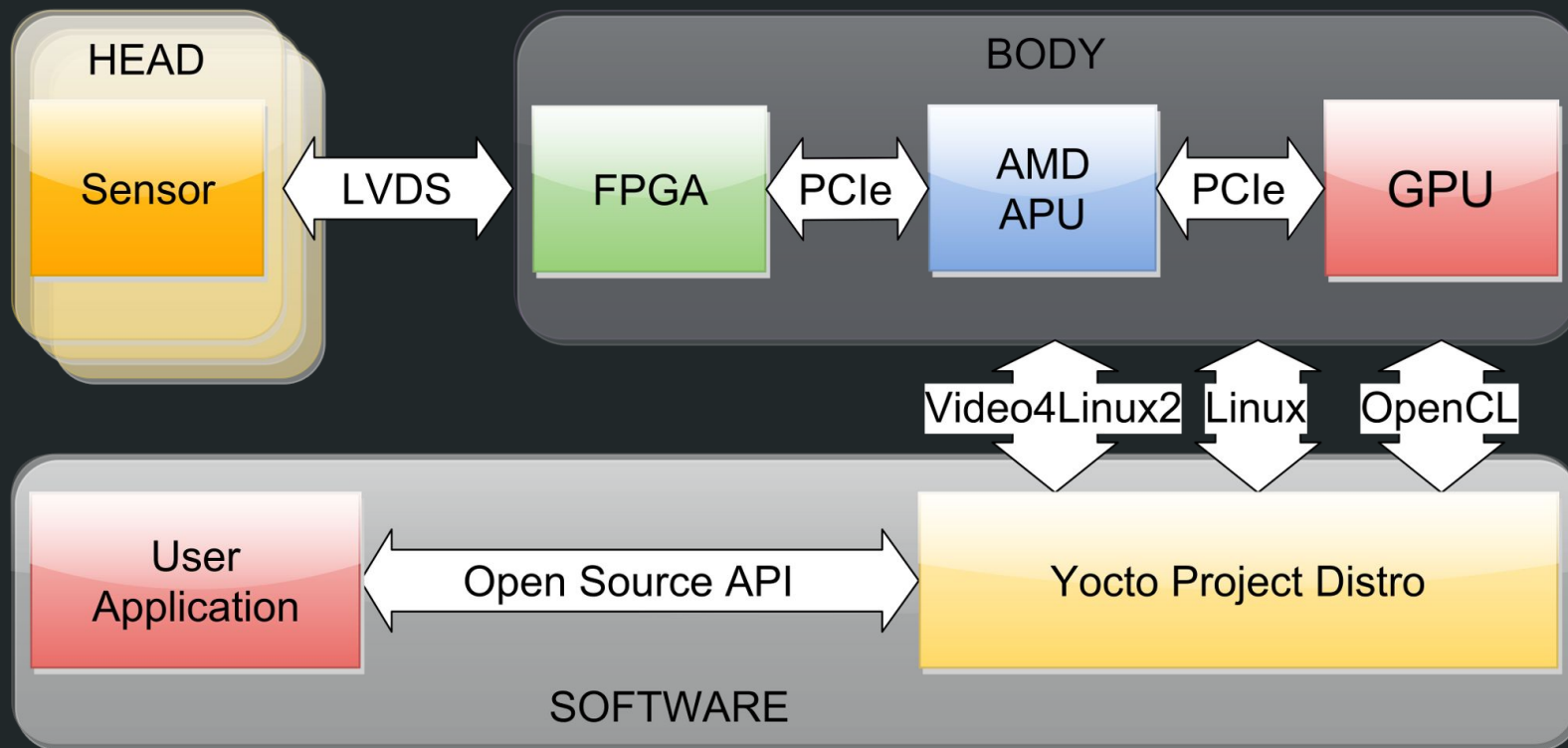
# Vision Software



# Modular Open Source Camera



# Hardware Modules



HOW STANDARDS PROLIFERATE:  
(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC)

SITUATION:  
THERE ARE  
14 COMPETING  
STANDARDS.

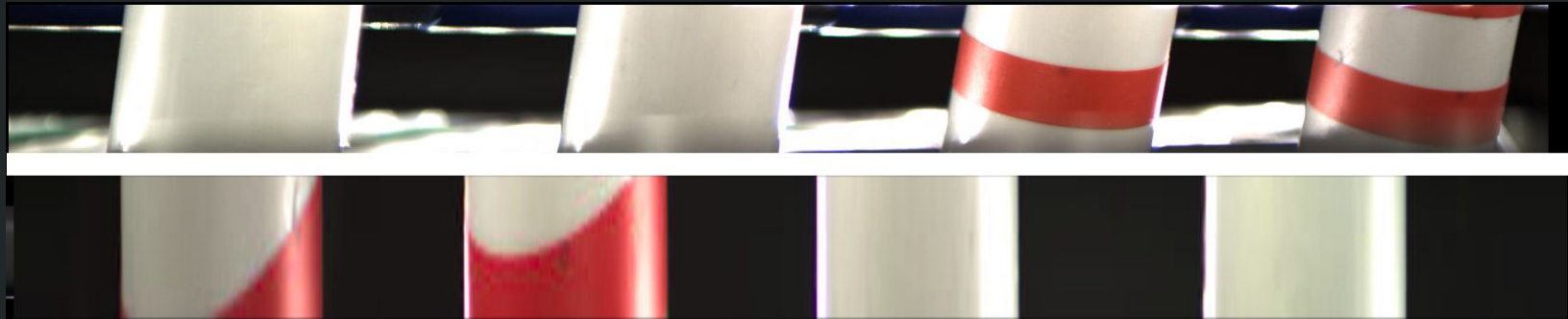
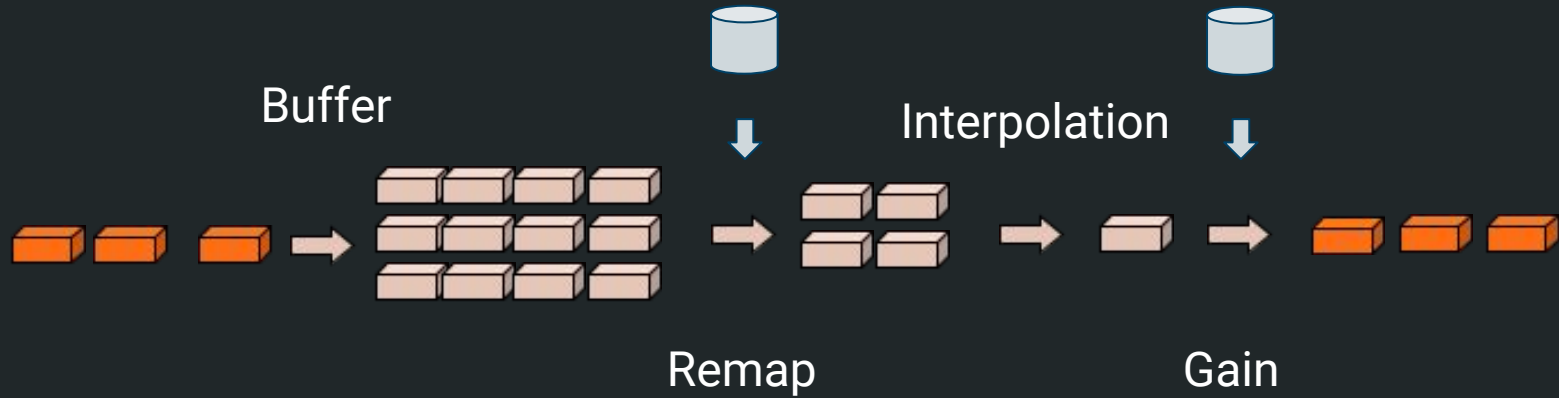
14?! RIDICULOUS!  
WE NEED TO DEVELOP  
ONE UNIVERSAL STANDARD  
THAT COVERS EVERYONE'S  
USE CASES.



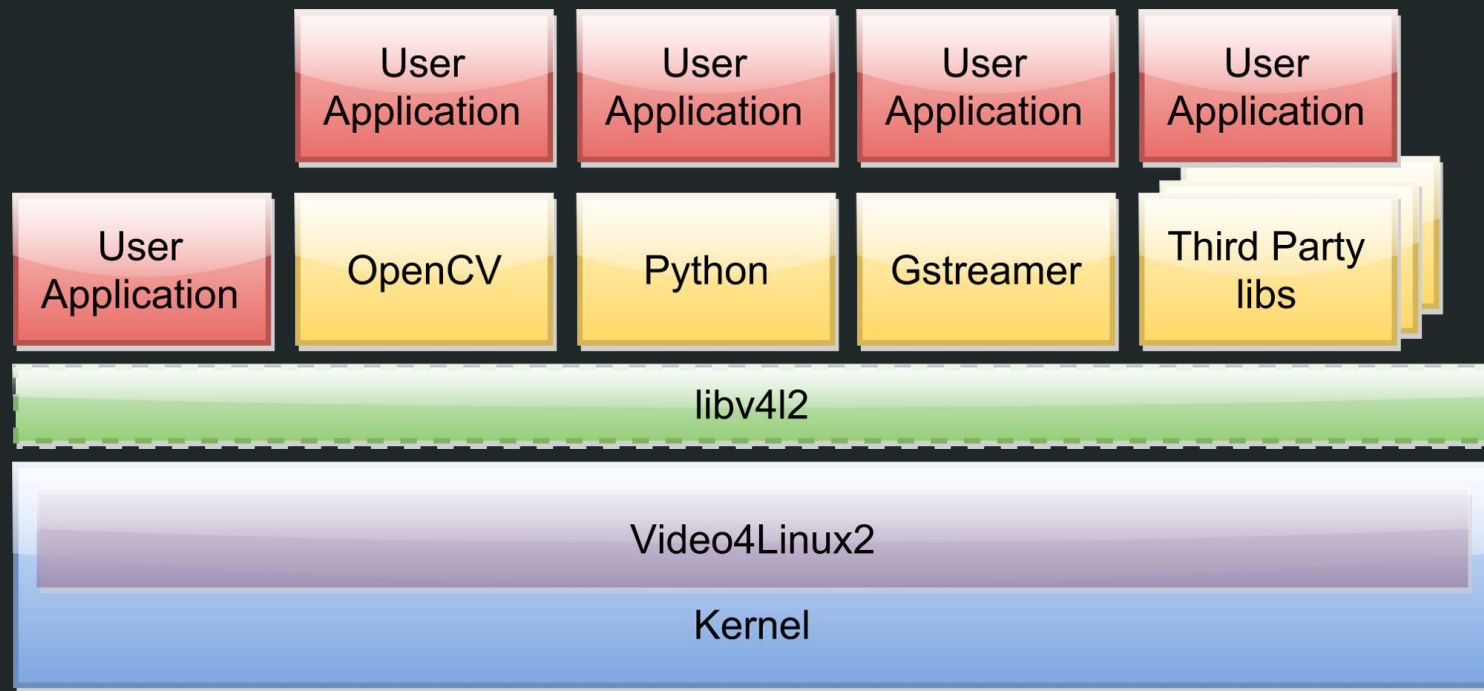
SOON:

SITUATION:  
THERE ARE  
15 COMPETING  
STANDARDS.

# Generic Operations



# Software Stack





# Why Open Source ?

```
jupyter Milk_classification Last Checkpoint: 13 hours ago (autosaved)
File Edit View Insert Cell Kernel Help Python 2
Cell Toolbar: None

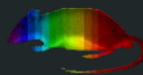
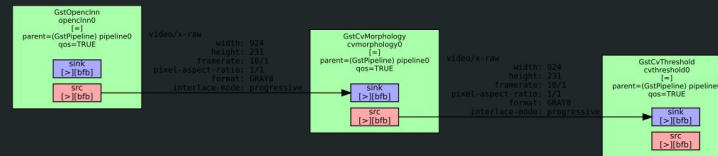
In [1]: from __future__ import division, print_function
import matplotlib inline
from matplotlib import pyplot as plt
import matplotlib.cm as cm
import numpy as np
import v4l2, utils

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

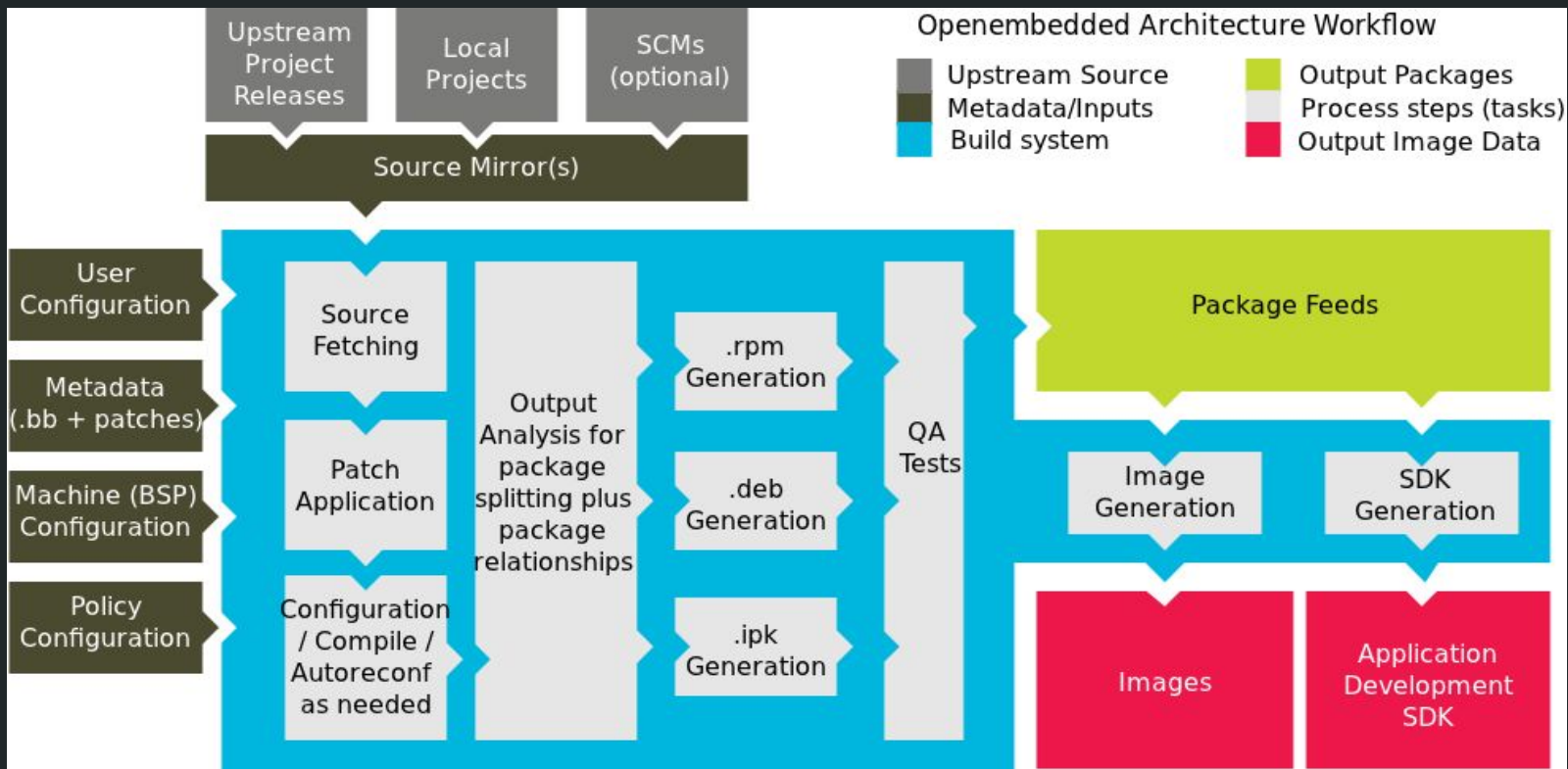
In [3]: url = 'images/montage.pgm'
image = (utils.read_pgm(url) / 257).astype(np.int32)
rgba_img = cmap(image)
rgb_img = np.delete(rgba_img, 3, 2)
labels = seg.slic(rgb_img, n_segments=15, compactness=20, sigma=2)
utils.imshow_all(rgb_img, labels.astype(float) / labels.max())

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)
utils.imshow_all(rgb_img, labels.astype(float) / labels.max())

In [ ]:
```



# Yocto Project



# Our Upstream Contributions

- **Linux Kernel:** 200+ patches. Including a 9+ year old bugfix.
- **U-boot:** 25 patches. Maintainers of Virtex PowerPC boards.
- **Yocto project:** 38 patches. Supporting organization of the project.
- **v4l-utils/libv4l2:** 7 patches.
- **Gstreamer:** 3 patches on core and Maintainers of gst-instruments
- **Flashrom:** Support for the first board with EEprom memory.
- **Gerbil:** 2 patches.
- **Clpeak:** 2 patches.
- **Video Lan Client:** 1 patch.



# Effort for upstream

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

# Why Upstream?

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

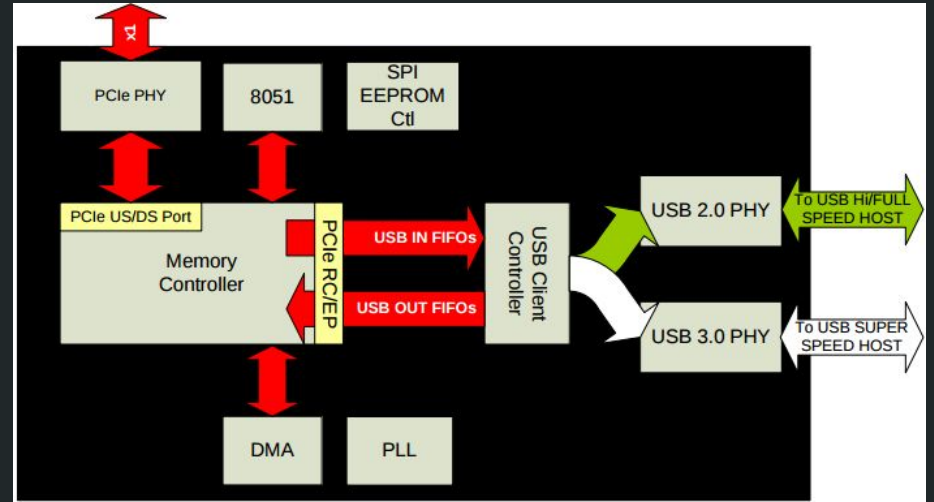
[1] Kernel Newbies Autoresponder:

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)?

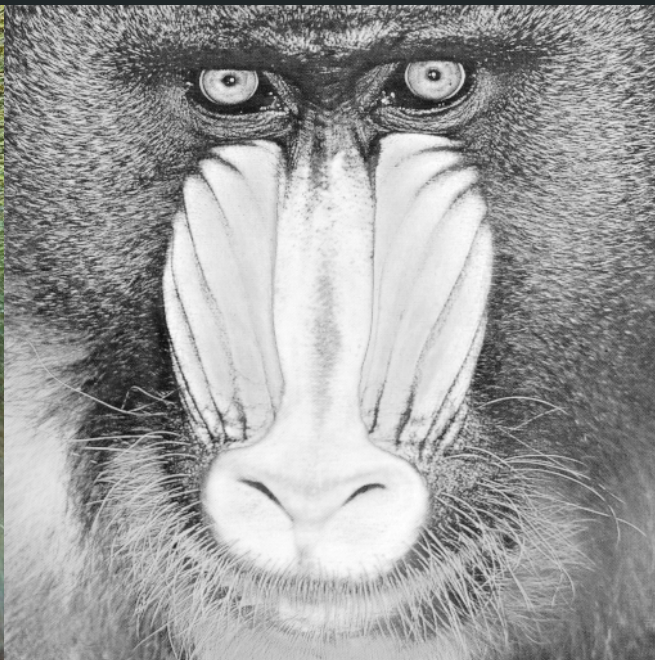


# War Story: USB Gadget 3380

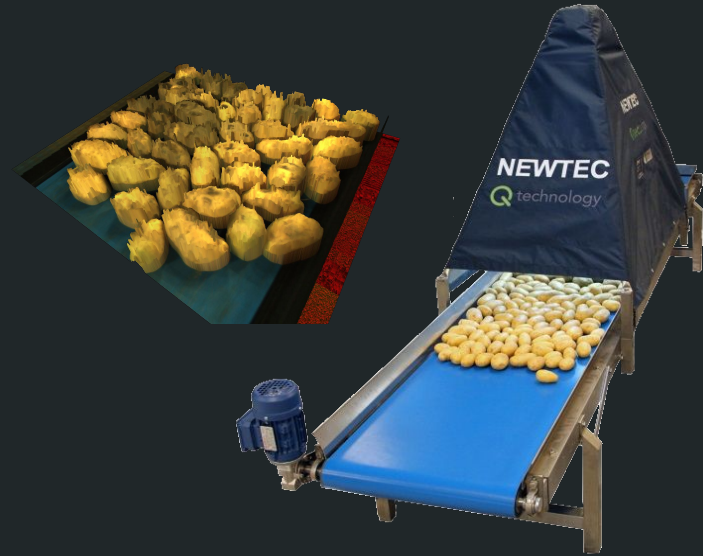
- Upstream driver
- Access to engineers from:
  - Samsung
  - Texas Instruments
  - Intel



# War Story: HSV



# Results:



Batch analyzer



Checkweigher



Spectral Camera



# Conclusions

- Open Source is the new Standard
- Be part of the standard by:
  - Be up to date
  - Sharing your code
  - Upstreaming your code
- You will get the best support and magically meet your deadlines

Questions?



# More Information

<http://qtec.com>

[info@qtec.com](mailto:info@qtec.com)

@ribalda