

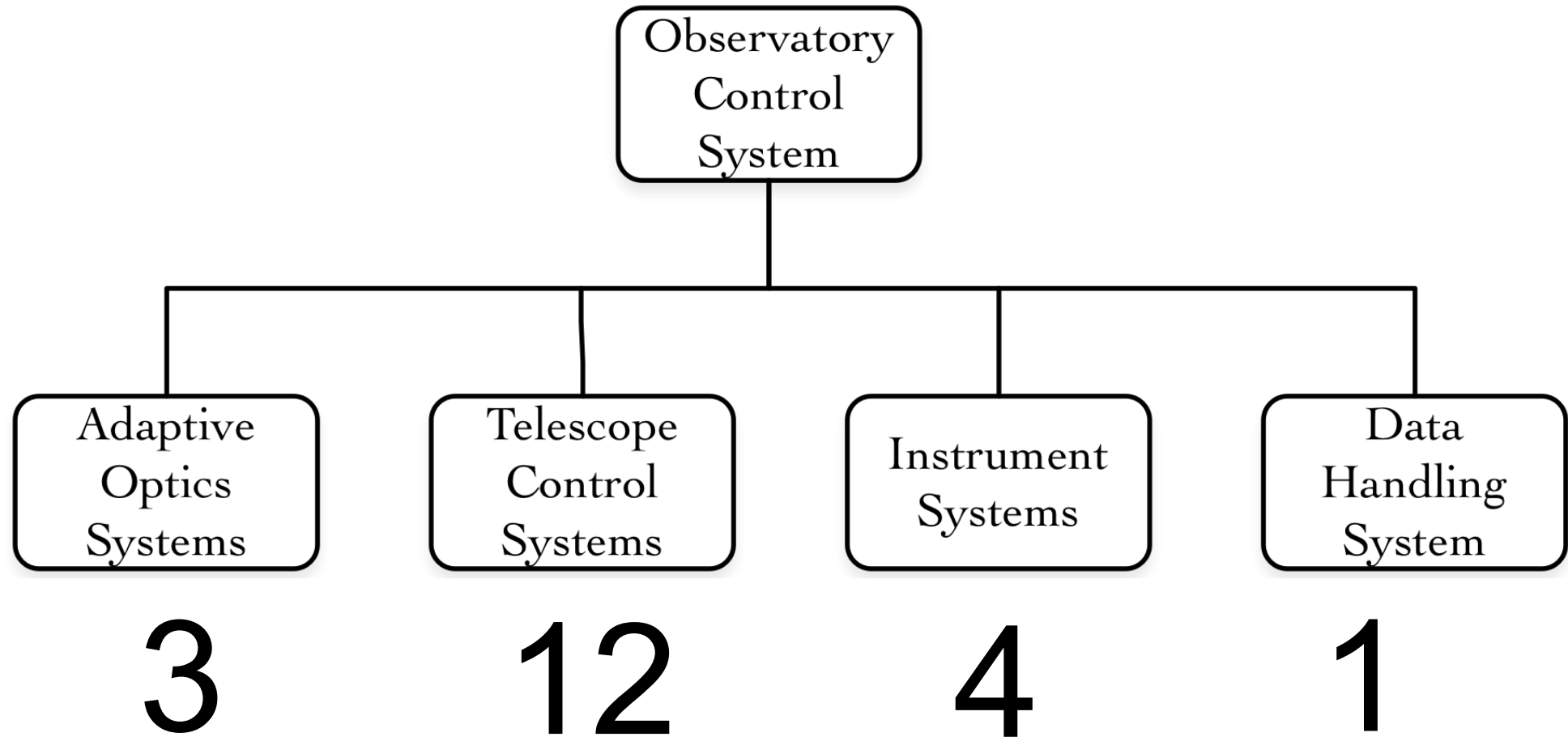


# Upgrading Control Systems at Gemini Telescopes

*Experiences and lessons learned*

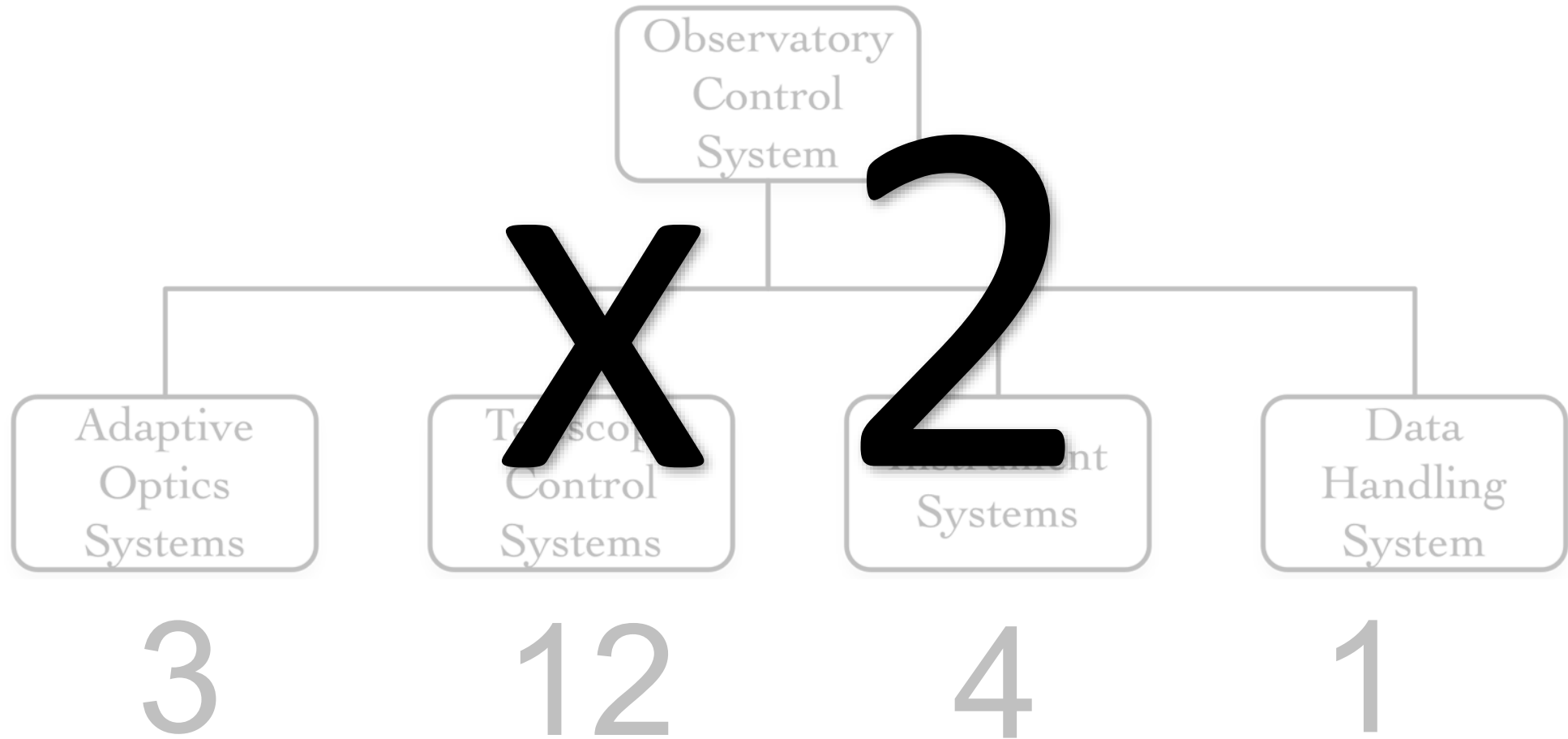


# Gemini Control Systems in a nutshell





# Gemini Control Systems in a nutshell



Why?

Created: July 20, 1994  
Modified: September 27, 2001

**Gemini  
Controls  
Group  
Interface  
Control  
Document**

# ICD 13—Standard Controller

---

**Bret Goodrich, Andrew Johnson and Corinne Boyer**

ICD-13/05

**This document describes the VME hardware and software which makes up a Gemini Standard Controller.**

Starting at 0x100000...

Attached TCP/IP interface to dc unit 0

Attaching network interface lo0... done.

Loading symbol table from icarus:/gemini/external/vxWorks/tornado2.0/mv2700/vxWorks.sym ...done

```

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      XXXXXXXXXXXX  XX  XXXXXXXXXXXX      XX      XXXX      (R)
X  XXXXXXXXXXXX  XXXXX  XXXXXXXXXXXX      XX      XXXX
XX  XXXXXXXXXXXX  XXXXXXXXXXX  XXXX  X  XX      XXXX
XX  XXXX  XXXX  X  XX  X  XXXX  XX  XXXXXXXXXXX  XXXX  XX  XXXX
XXXX  XXXX  XX  XX  X  XX  XX  XXXXX  XXXXXXX  XXXX  XXX  XXXX
XXXX  XXXX  X  XXXX  XXXXX  XXXXXXXXXXX  XXXX  XXXX  XXXX  XXXX
XXXXXX  XXXX  XXXX  XXXXXXX  XXXX  XXXX  XXXX  XXXXXXXXXXX  XXXX
XXXXXX  XXXX  XXXX  XXXXXXX  X  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX
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XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

Development System

VxWorks version 5.4.2

KERNEL: WIND version 2.5

Copyright Wind River Systems, Inc., 1984-1999

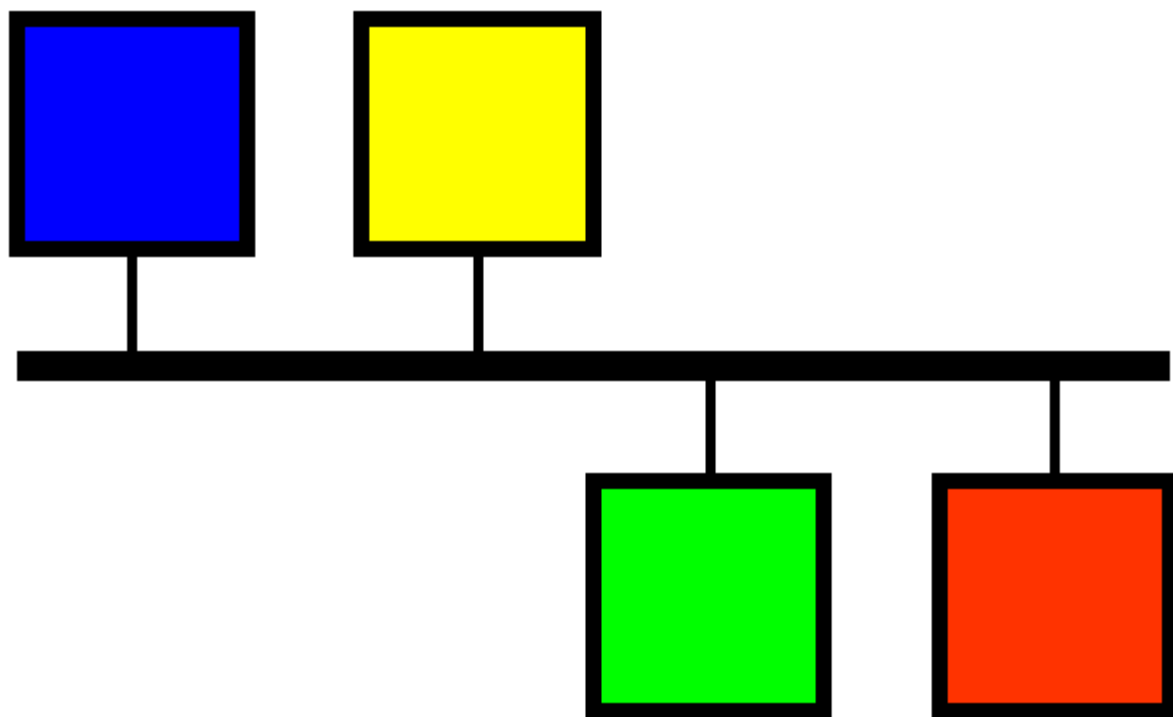
CPU: Motorola MVME2700 - MPC 750. Processor #0.

Memory Size: 0x4000000. BSP version 1.2/0.

WDB: Ready.

Executing startup script /gemini/GEM8.5/tcs/V9-11-3/bin/ppc604\_long/startupTCS1 ...

# EPICS





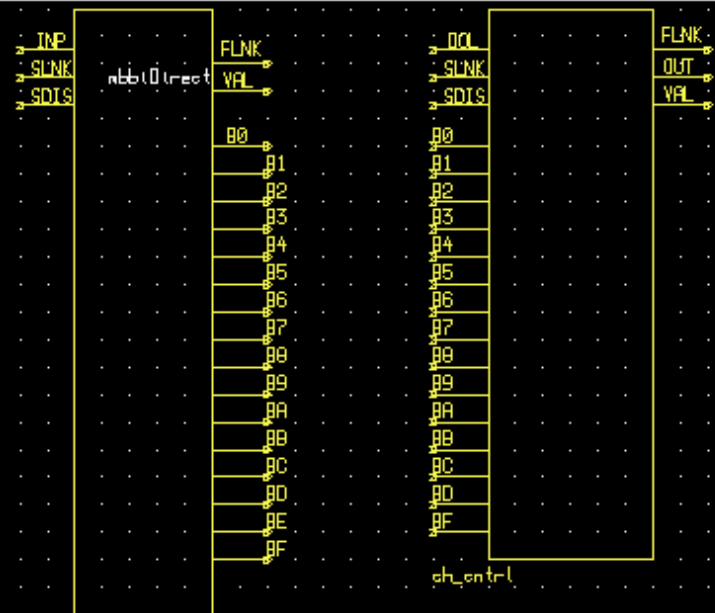
```
sbfsr1% cd /usr/local/epics/  
/usr/local/epics
```

```
sbfsr1% ls -l
```

```
total 136
```

drwxr-xr-x	15	epics	epics	4096	Sep	7	2009	./
dr-xr-xr-x	58	root	sysadmin	8192	Sep	7	2011	../
-rw-r--r--	1	epics	epics	320	Feb	4	2003	Distfile.config
drwxr-xr-x	5	epics	staff	4096	Feb	27	2004	epics3.12.2GEM5/
drwxr-xr-x	5	epics	staff	4096	Feb	22	2000	epics3.12.2GEM6/
drwxr-xr-x	5	epics	staff	4096	Feb	27	2004	epics3.12.2GEM6T/
drwxr-xr-x	4	epics	epics	4096	Jun	23	2001	epics3.13.4GEM7/
drwxr-xr-x	4	epics	epics	4096	May	14	2002	epics3.13.4GEM8.4/
drwxr-xr-x	4	epics	epics	4096	Dec	18	2003	epics3.13.9GEM8.5/
drwxr-xr-x	4	epics	epics	4096	Feb	26	2004	epics3.13.9GEM8.6/
drwxr-xr-x	4	epics	epics	4096	Sep	4	2007	epics3.14.6GEM9/
lrwxrwxrwx	1	epics	epics	15	Nov	19	2010	epics3.14.6GEM9.0 -> epics3.14.6GEM9/
drwxr-xr-x	11	epics	epics	4096	Sep	4	2007	epics3.14.6GEM9.1/
drwxr-xr-x	12	epics	epics	4096	Sep	4	2007	epics3.14.8.2GEM9.2/
drwxr-xr-x	2	root	other	4096	Jul	5	2000	old/

(0 0)



status



ch0



ch1



ch2



ch3



ch4



ch5



ch6



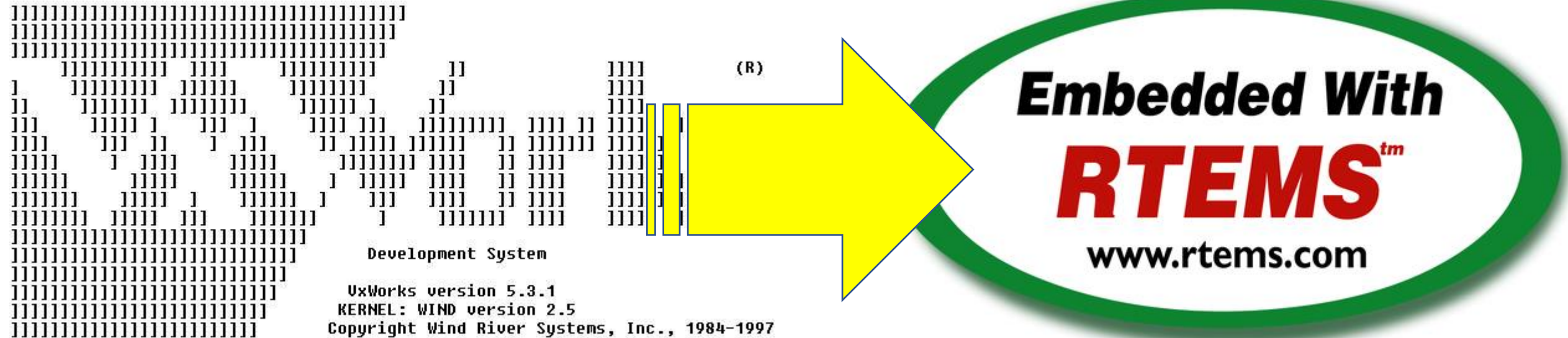
ch7

“This software is unfortunately no longer available for download from this website. If you need a copy, you'll have to ask on tech-talk for anyone who still has a copy of the tarfile.”

*–EPICS web page in reference to CapFast Tools*



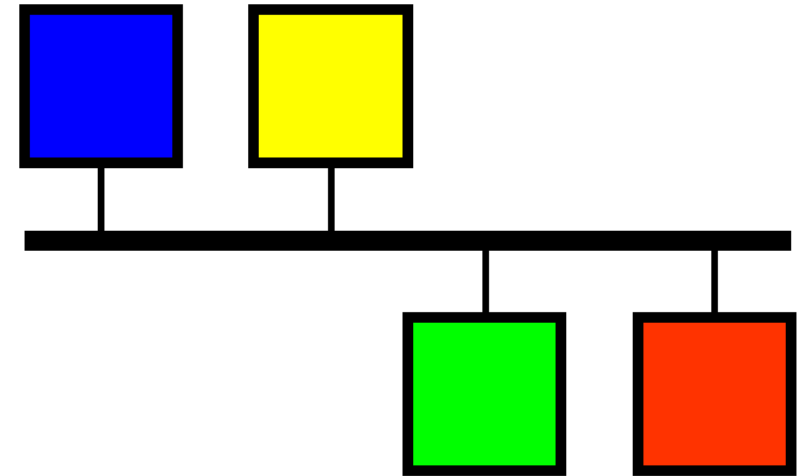
# The Upgrades



# The Upgrades

```
sbfsr1% cd /usr/local/epics/  
/usr/local/epics  
sbfsr1% ls -l  
total 136  
drwxr-xr-x 15 epics    epics    4096 Sep  7  2009 ./  
dr-xr-xr-x 58 root     sysadmin 8192 Sep  7  2011 ../  
-rw-r--r--  1 epics    epics    320 Feb  4  2003 Distfile.config  
drwxr-xr-x  5 epics    staff    4096 Feb 27  2004 epics3.12.2GEM5/  
drwxr-xr-x  5 epics    staff    4096 Feb 22  2000 epics3.12.2GEM6/  
drwxr-xr-x  5 epics    staff    4096 Feb 27  2004 epics3.12.2GEM6T/  
drwxr-xr-x  4 epics    epics    4096 Jun 23  2001 epics3.13.4GEM7/  
drwxr-xr-x  4 epics    epics    4096 May 14  2002 epics3.13.4GEM8.4/  
drwxr-xr-x  4 epics    epics    4096 Dec 18  2003 epics3.13.9GEM8.5/  
drwxr-xr-x  4 epics    epics    4096 Feb 26  2004 epics3.13.9GEM8.6/  
drwxr-xr-x  4 epics    epics    4096 Sep  4  2007 epics3.14.6GEM9/  
lrwxrwxrwx  1 epics    epics      15 Nov 19  2010 epics3.14.6GEM9.0 -> epics3.14.6GEM9/  
drwxr-xr-x 11 epics    epics    4096 Sep  4  2007 epics3.14.6GEM9.1/  
drwxr-xr-x 12 epics    epics    4096 Sep  4  2007 epics3.14.8.2GEM9.2/  
drwxr-xr-x  2 root     other    4096 Jul  5  2000 old/
```

# EPICS



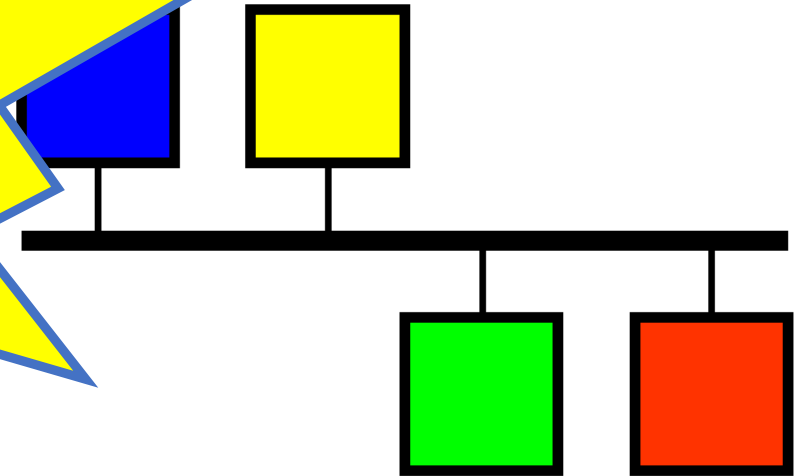
3.14.12

# The Upgrades

```
sbfsr1% cd /usr/local/epics/  
/usr/local/epics  
sbfsr1% ls -l  
total 136  
drwxr-xr-x 15 epics      epics      4096 Sep  7  2009 ./  
dr-xr-xr-x 58 root       sysadmin   8192 Sep  7  2011 ../  
-rw-r--r--  1 epics      epics      320 Feb  4  2003 Distfile.config  
drwxr-xr-x  5 epics      staff      4096 Feb 27  2004 epics3.14.12  
drwxr-xr-x  5 epics      staff      4096 Feb 22  2000 epics3.14.12  
drwxr-xr-x  5 epics      staff      4096 Feb 27  2004 epics3.14.12  
drwxr-xr-x  4 epics      epics      4096 Jun 23  2001 epics3.13.4  
drwxr-xr-x  4 epics      epics      4096 May 14  2002 epics3.13.4  
drwxr-xr-x  4 epics      epics      4096 Dec 18  2003 epics3.13.4  
drwxr-xr-x  4 epics      epics      4096 Feb 26  2004 epics3.13.4  
drwxr-xr-x  4 epics      epics      4096 Sep  4  2007 epics3.14.12  
lrwxrwxrwx  1 epics      epics      15 Nov 19  2010 epics3.14.12  
drwxr-xr-x 11 epics      epics      4096 Sep  4  2007 epics3.14.12  
drwxr-xr-x 12 epics      epics      4096 Sep  4  2007 epics3.14.12  
drwxr-xr-x  2 root       other      4096 Jul  5  2000 old/
```

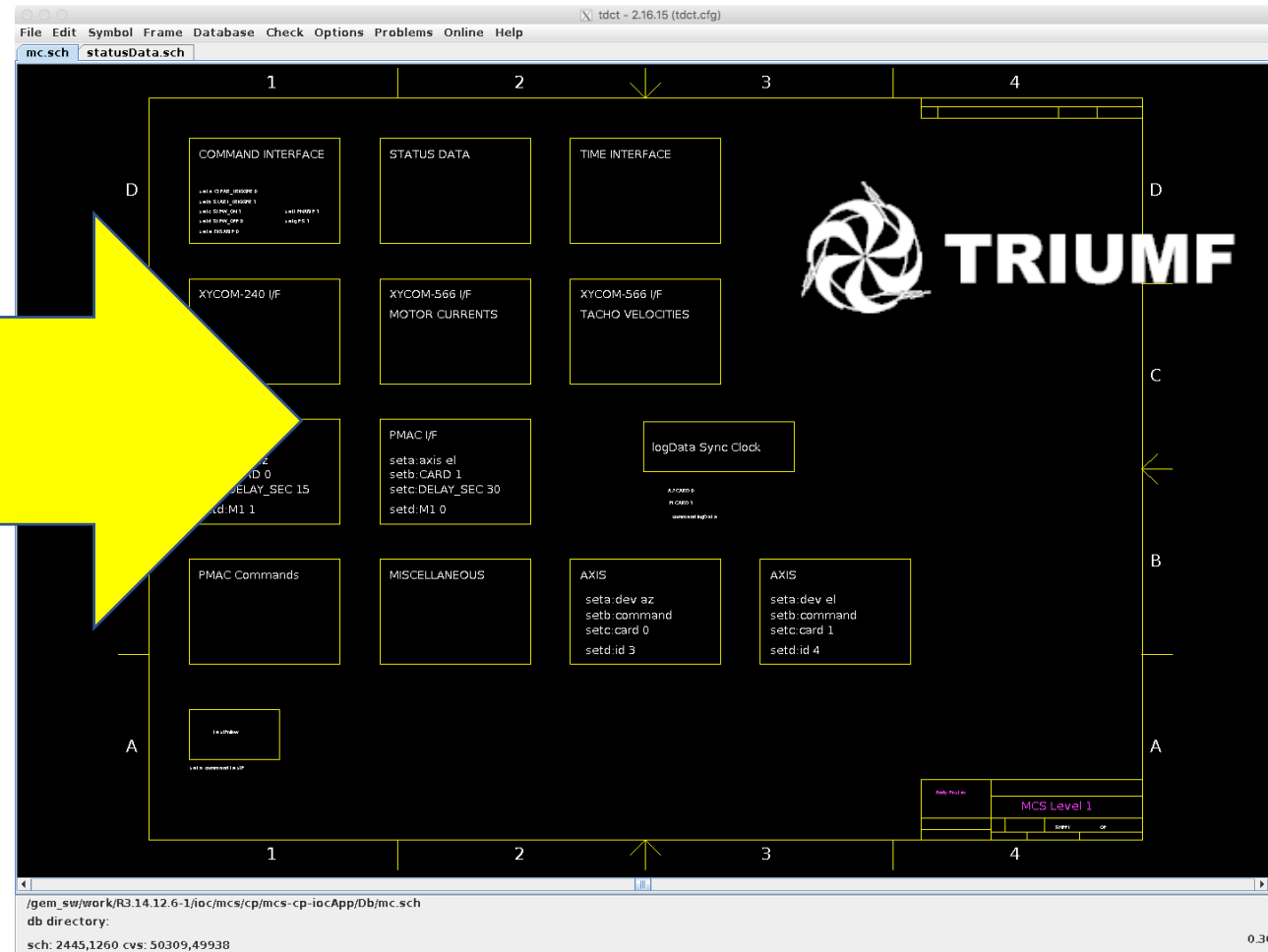
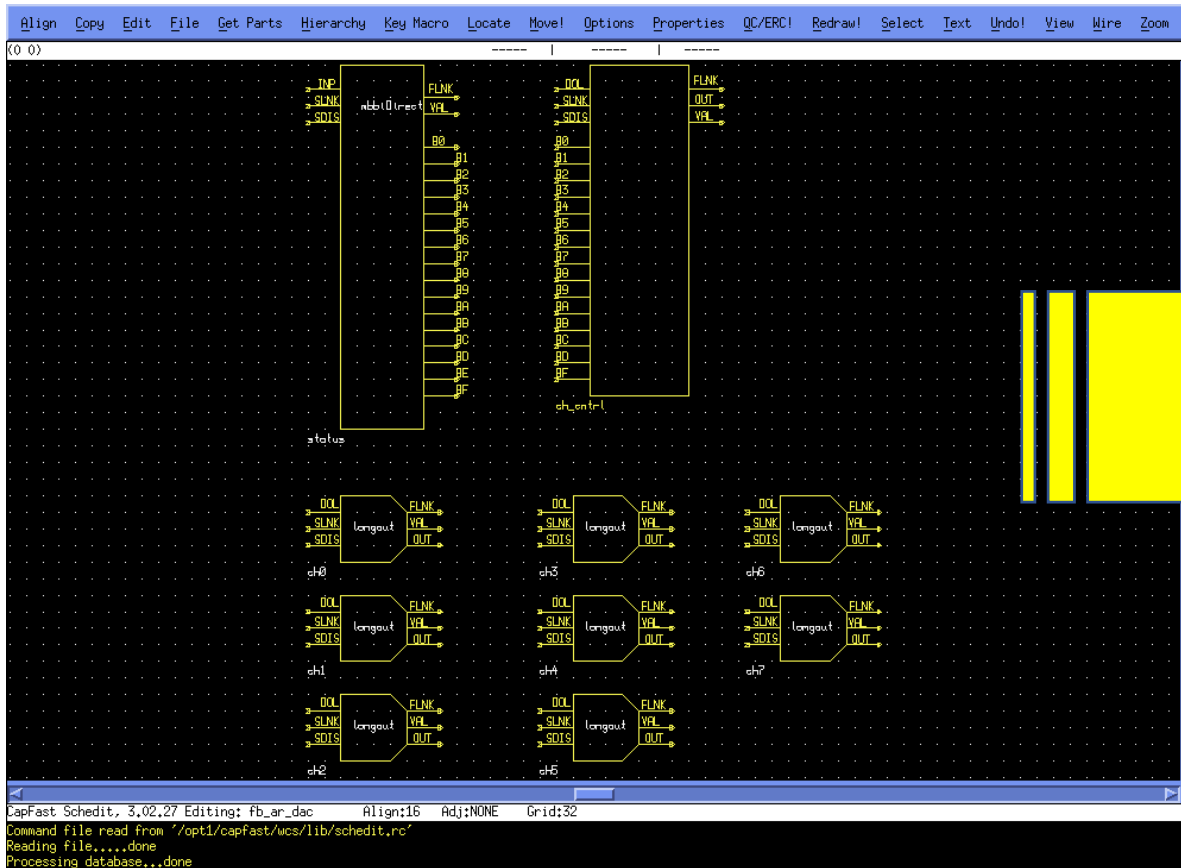
**+COMMON  
CODE  
LIBRARIES  
AND  
DRIVERS!!!**

# EPICS

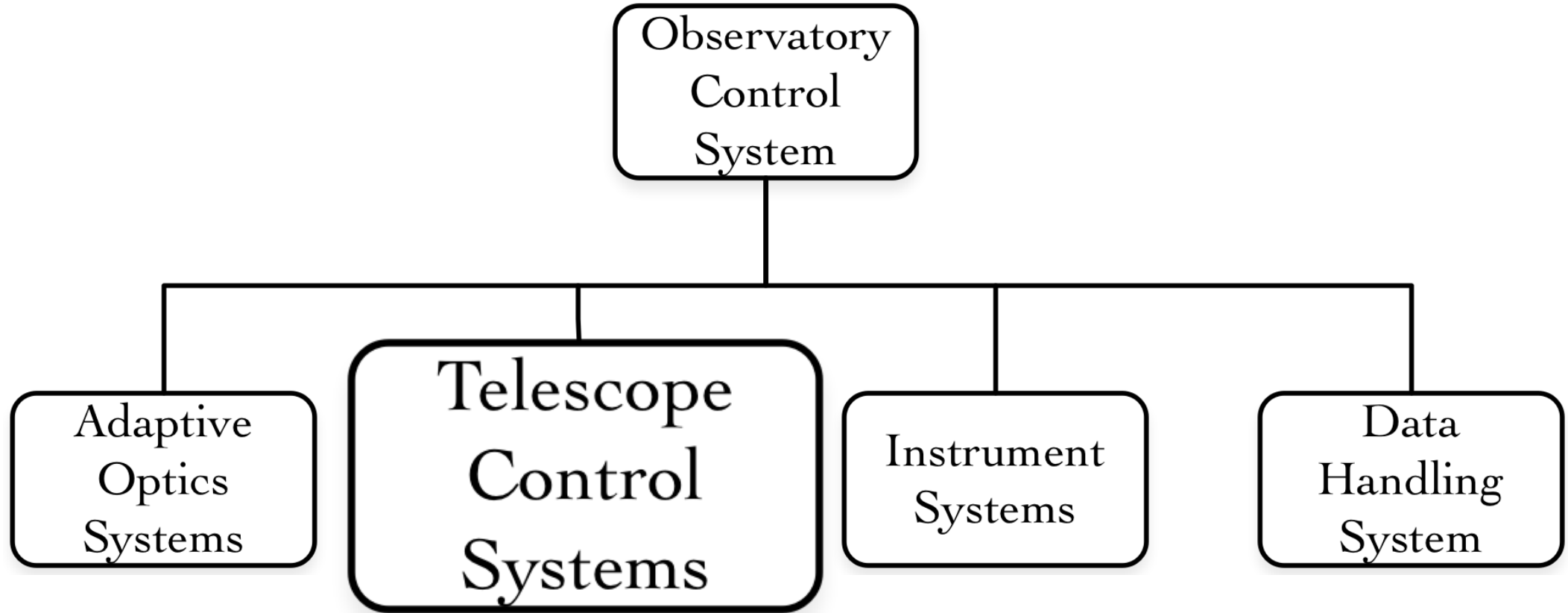


3.14.12

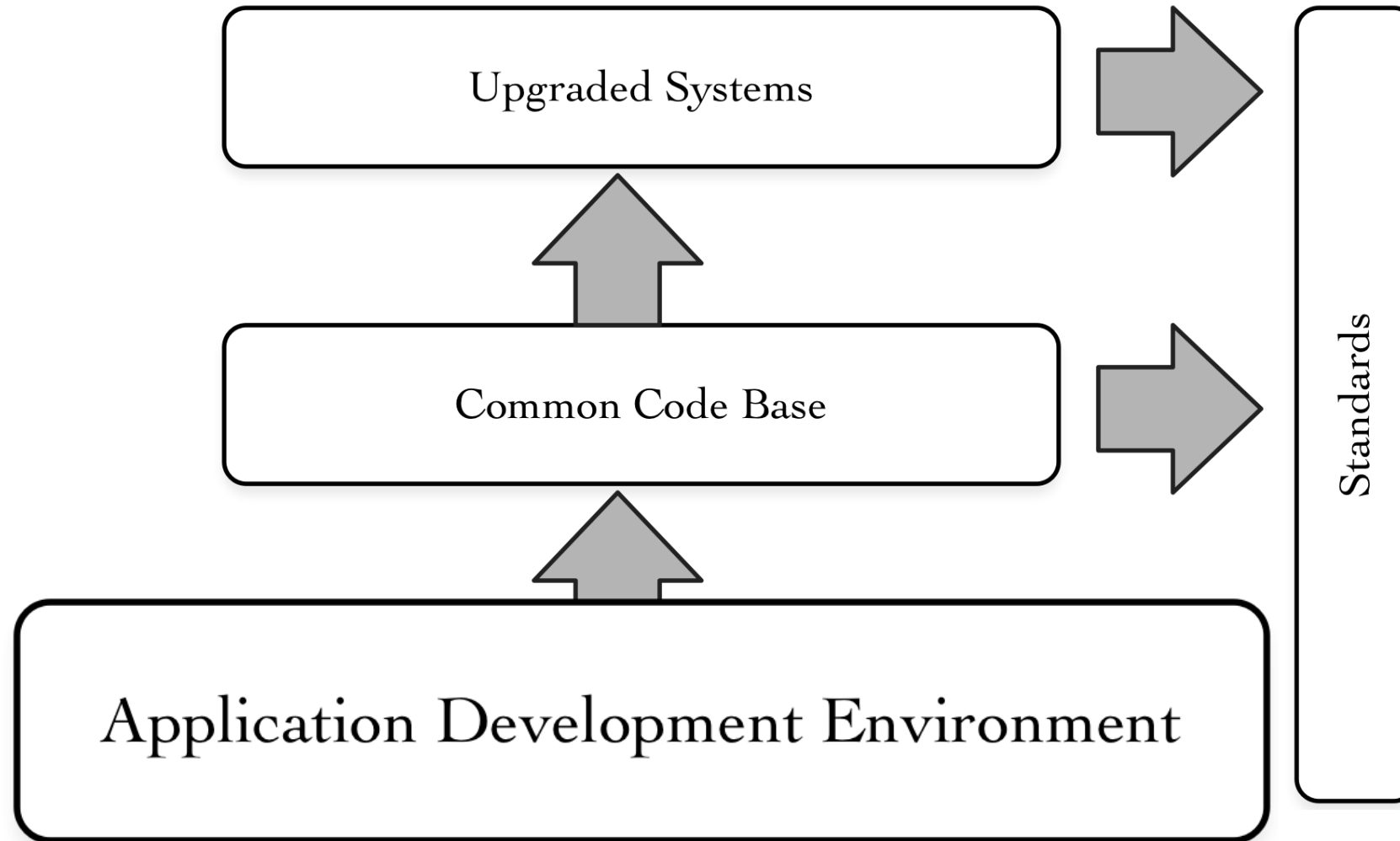
# The Upgrades



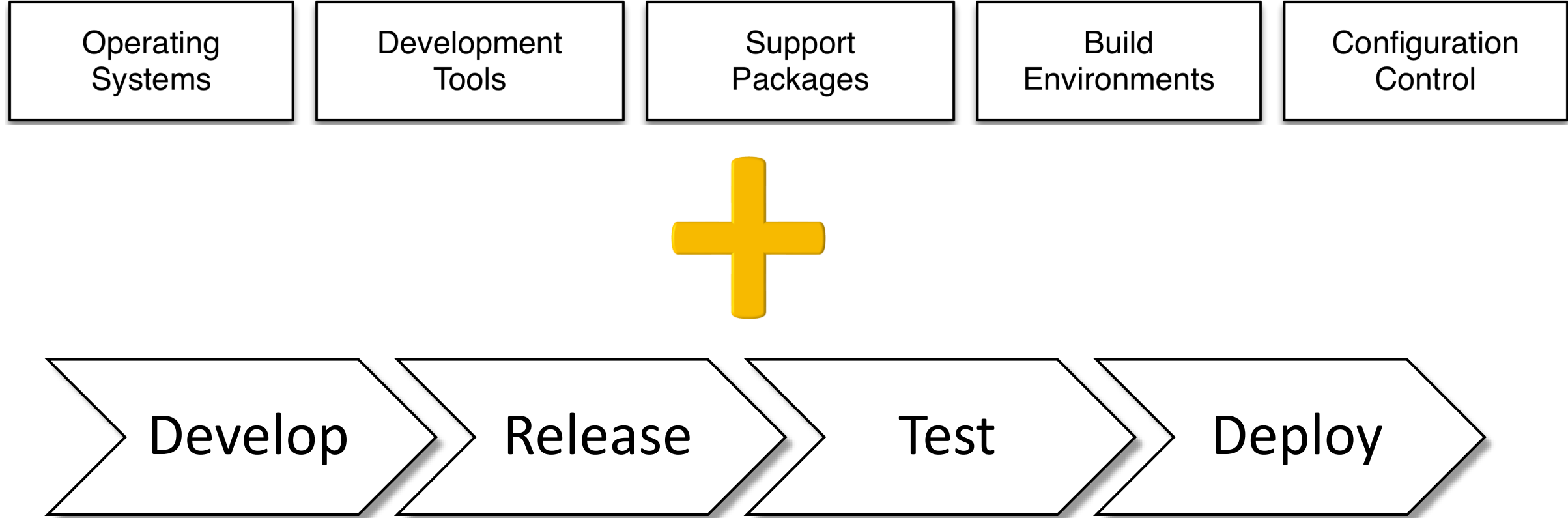
# The Upgrades



# Upgrade Strategy



# Application Development Environment



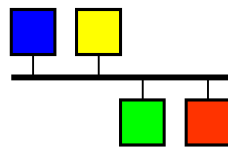
# Application Development Environment



**diamond**



**EPICS**



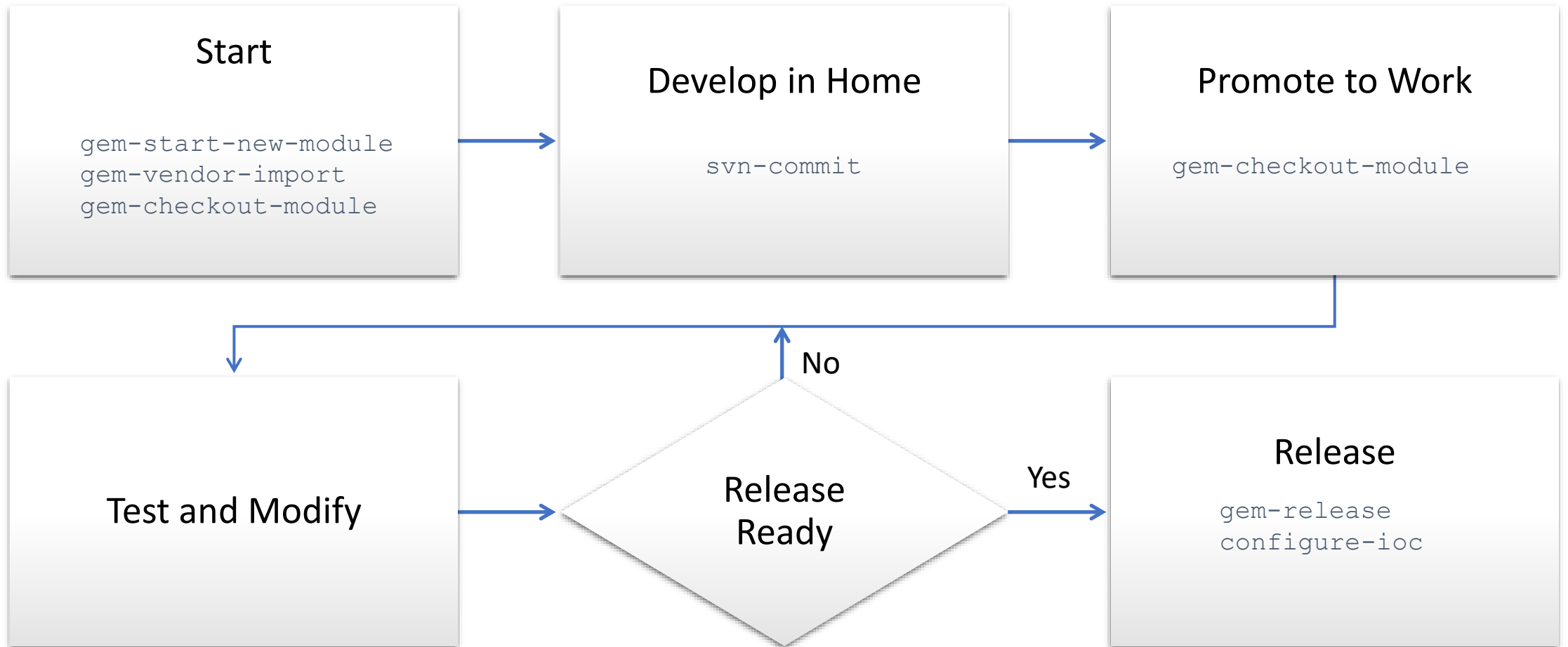
3.14.12



**CentOS**



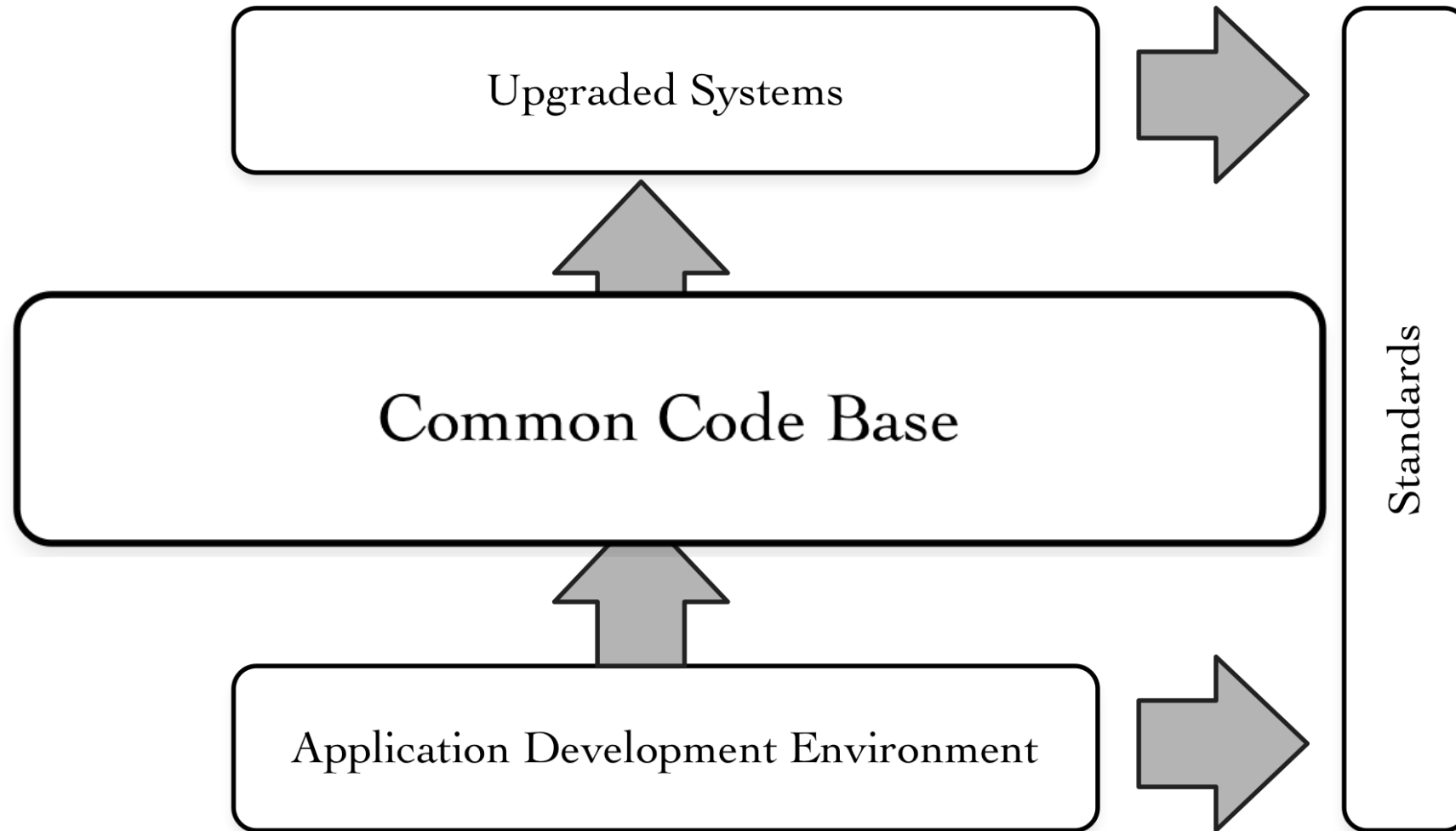
# ADE Development Overview

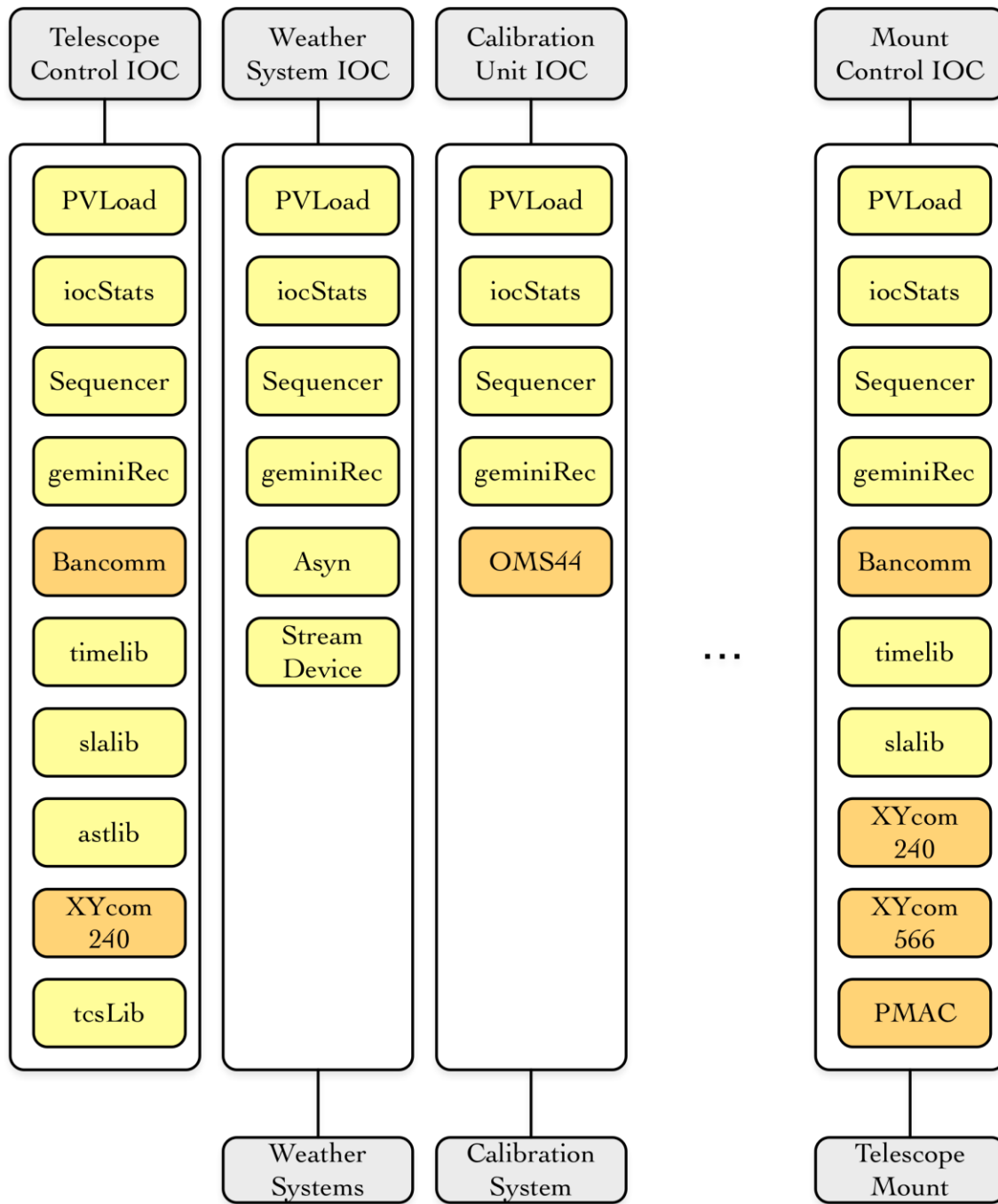


# Recommendations

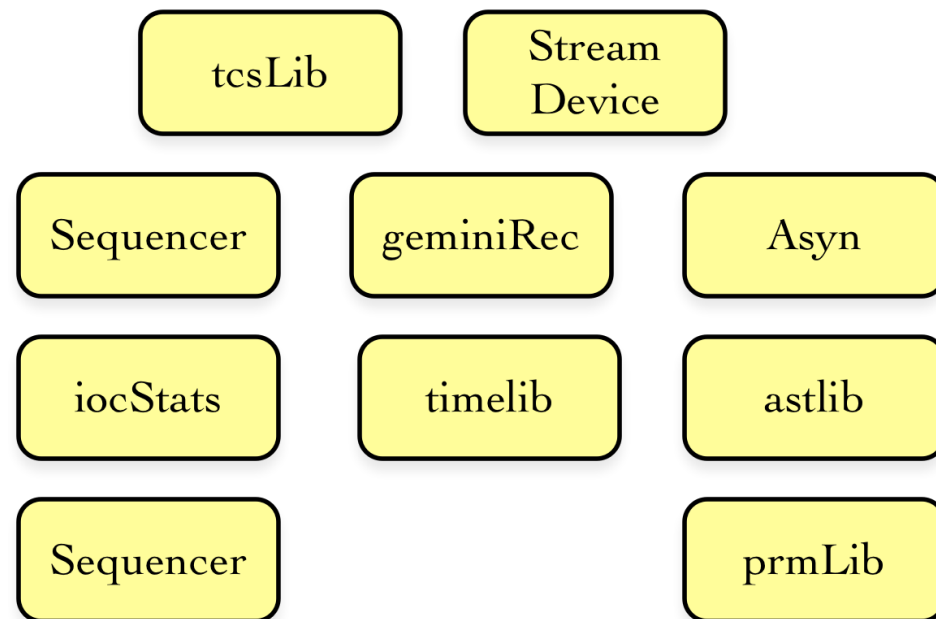
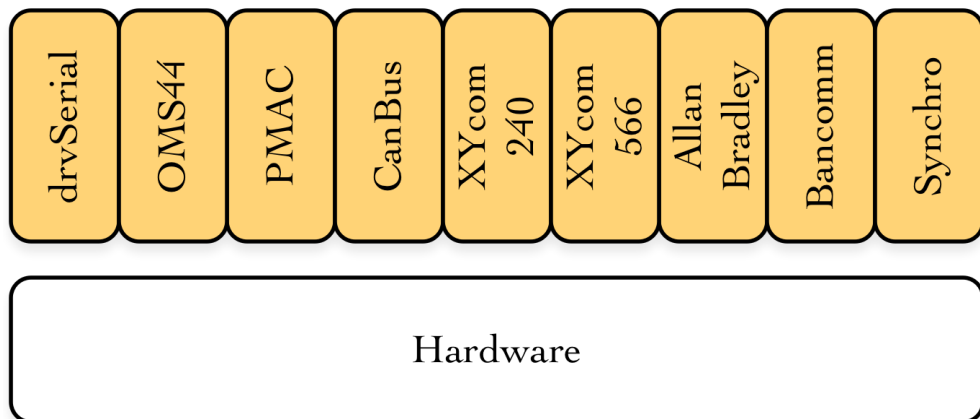
- Create a **common development framework** and **process**
- Choose **current** and **well supported** software packages and tools
- Don't reinvent the wheel
- Use **experts**

# Upgrade Strategy





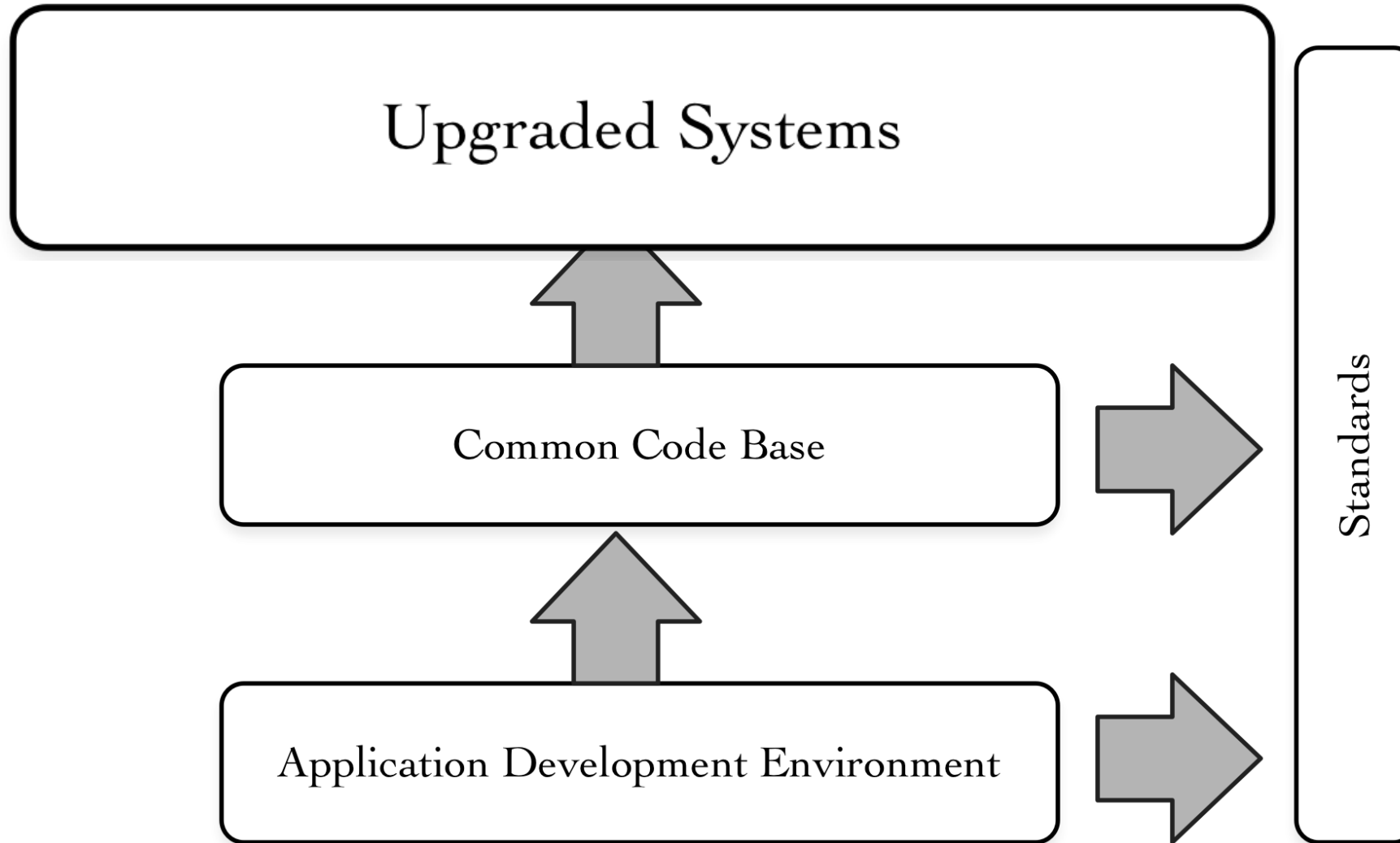
- **Update** modules that have evolved
- **Move** copies of modules into libraries
- **Manage** customization



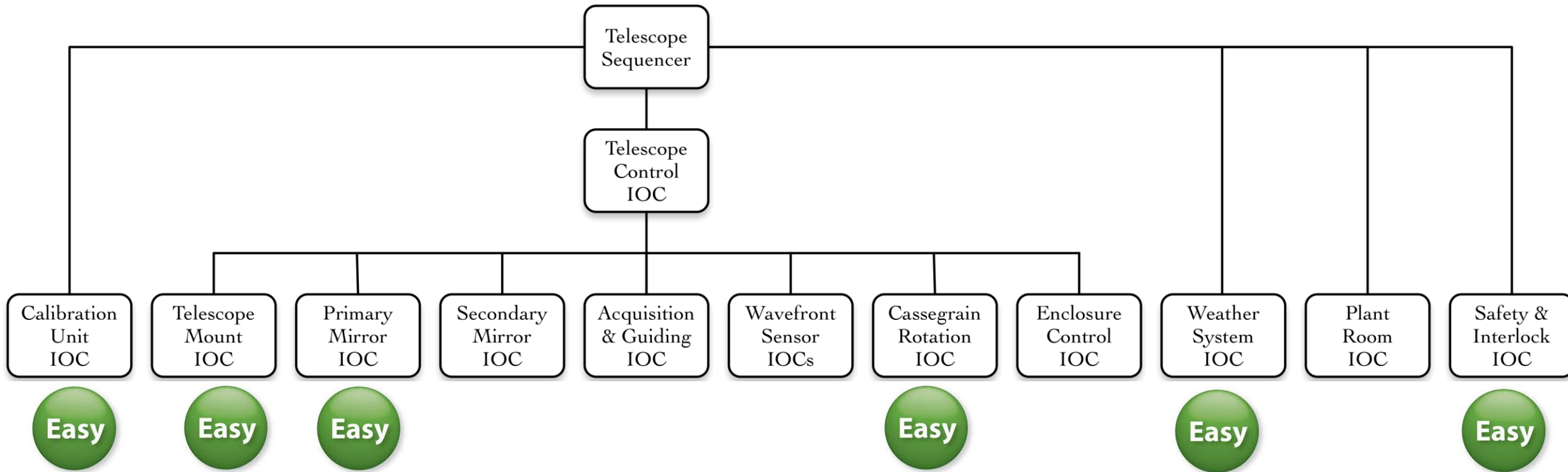
# Lessons Learned

- **Analyze** your current situation
- **Consolidate** and merge changes in different modules
- **Manage customization**
- Plan for **hardware inventory** needed for testing
- Create **consistent** set of **requirements** and **test plans**

# Upgrade Strategy



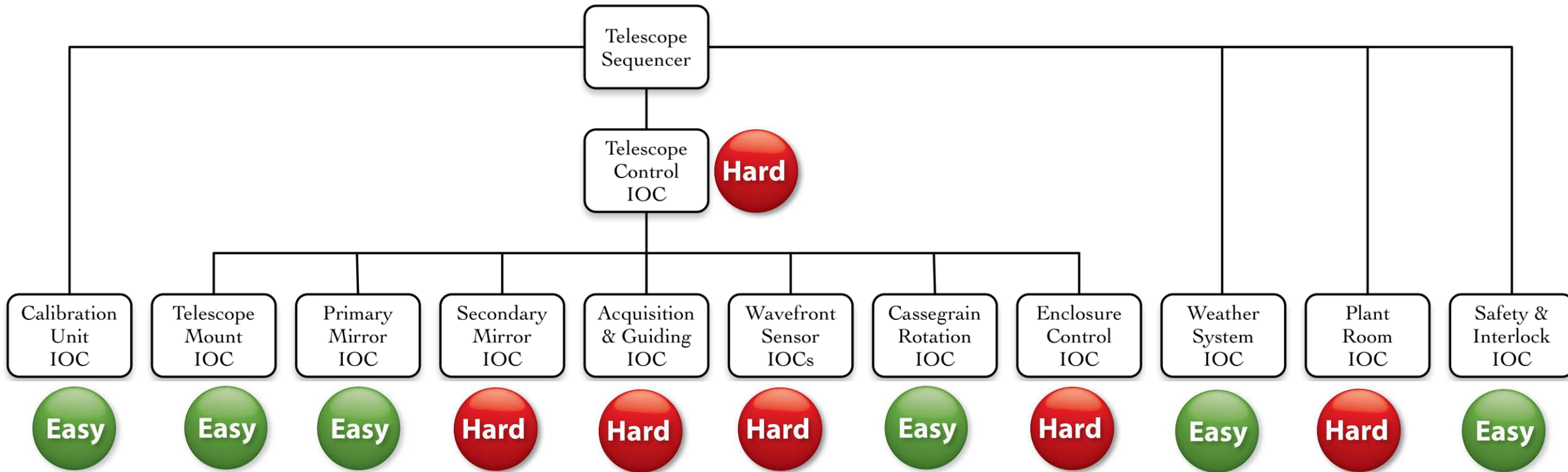
# How to start?



*Complexity = No CCB Dependencies*

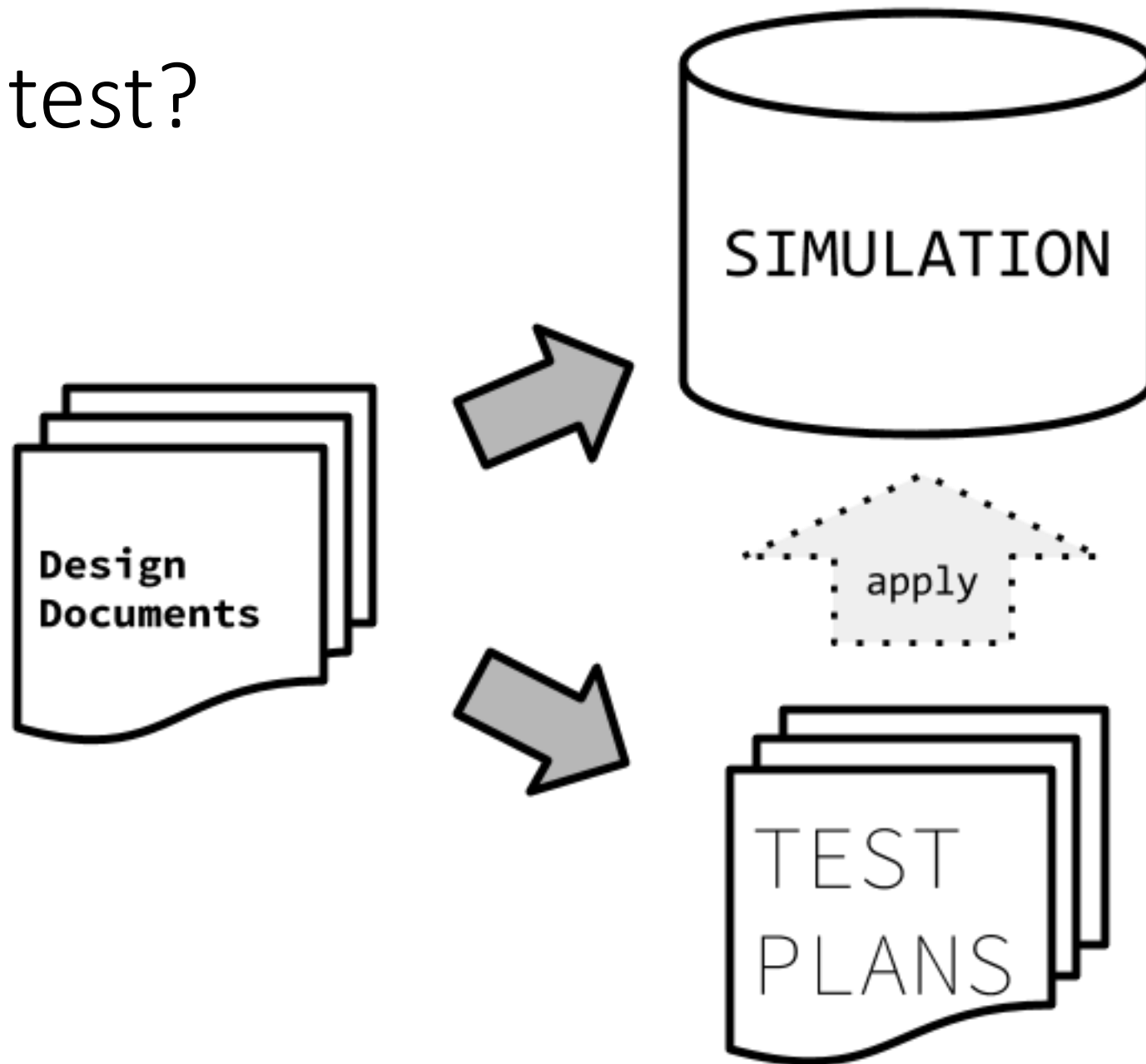


# How to start?

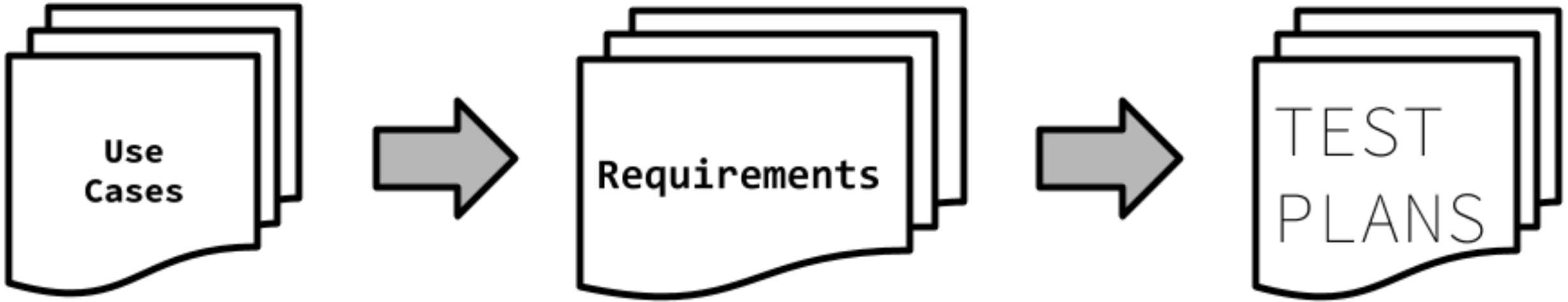


*Complexity = No CCB Dependencies*

# How to test?



# How to test?

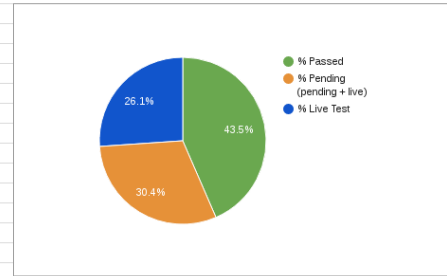


# Making sure it works: Lab and Live Testing

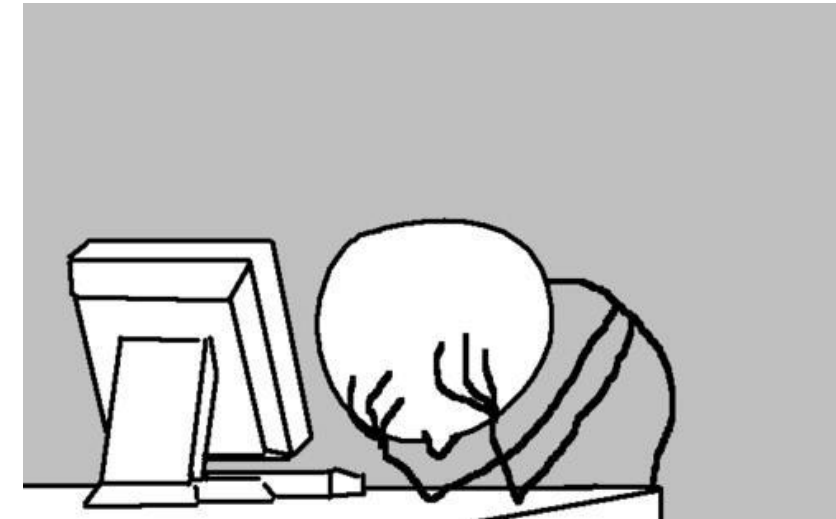
- Porting
- Test Plan: Lab Environment
- Test Plan: Live Environment

Test Bench Specs		
Date of Test	Start	End
	3/4/2017	
Engineer	R Rojas/M Westfall/I Arriagada	
Test Environment	Lab	
Software Configuration		
GCAL Version	1-1	
OS Version	RTEMS	
EPICS Version	3.14.12.4	
Additional Software		
Name/Version		
Hardware Configuration		
CPU		
I/O HW		
Additional Testing Tools		
Oscilloscope		
Bread Board		
Electrical components & Wires		

Tests Passed	10
Tests Pending	7
Tests Failed	0
Tests Waived	0
Pending for Live Test	6
Total Tests	23
% Passed	43.48%
% Pending (pending + live)	30.43%
% Failed	0.00%
% Waived	0.00%
% Live Test	26.09%



1. The diffuser follows commands as issued. Status messages are displayed correctly	FAILED	
1. The filter follows commands as issued. Status messages are displayed correctly	PASSED	
1. The IR Shutter follows commands as issued. Status messages are displayed correctly	PENDING	
1. Each lamp turns on/off	LIVE TEST	2. Remove the 'on'. Click the OFF button. 5. same here. Removing 'on' avoids ambiguity.
1. The IR Lamps turns on/off	LIVE TEST	2. Remove the 'on'. "Click the IR lamp ON button." 5. same here Removing 'on' avoids ambiguity.

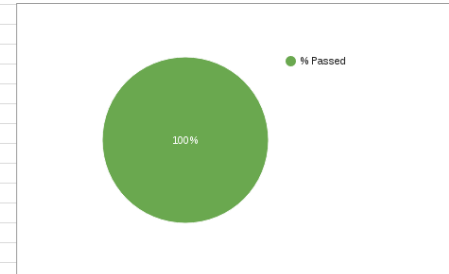


# Making sure it works: Lab and Live Testing

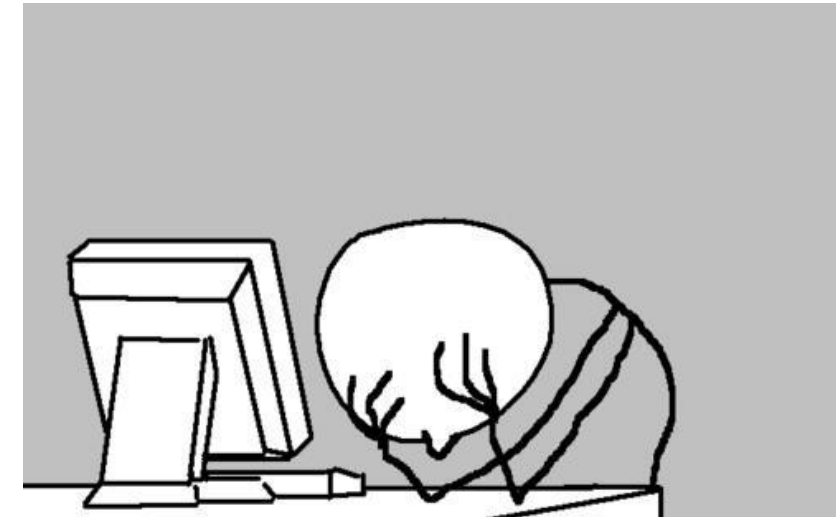
- Porting
- Test Plan: Lab Environment
- Test Plan: Live Environment

Test Bench Specs		
Date of Test	Start	End
	3/4/2017	
Engineer	R Rojas/M Westfall/I Arriagada	
Test Environment	Lab	
Software Configuration		
GCAL Version	1-1	
OS Version	RTEMS	
EPICS Version	3.14.12.4	
Additional Software		
Name/Version		
Hardware Configuration		
CPU		
I/O HW		
Additional Testing Tools		
Oscilloscope		
Bread Board		
Electrical components & Wires		

Tests Passed	23
Tests Pending	0
Tests Failed	0
Tests Waived	0
Pending for Live Test	0
Total Tests	23
% Passed	100.00%
% Pending (pending + live)	0.00%
% Failed	0.00%
% Waived	0.00%
% Live Test	0.00%



1. The diffuser follows commands as issued. Status messages are displayed correctly	PASSED	
1. The filter follows commands as issued. Status messages are displayed correctly	PASSED	
1. The IR Shutter follows commands as issued. Status messages are displayed correctly	PASSED	
1. Each lamp turns on/off	PASSED	2. Remove the 'on'. Click the OFF button. 5. same here. Removing 'on' avoids ambiguity.
1. The IR Lamps turns on/off	PASSED	2. Remove the 'on'. "Click the IR lamp ON button." 5. same here Removing 'on' avoids ambiguity.

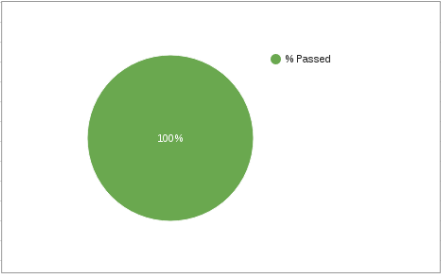




# Making sure it works: Lab and Live Testing

- Porting
- Test Plan: Lab Environment
- Test Plan: Live Environment

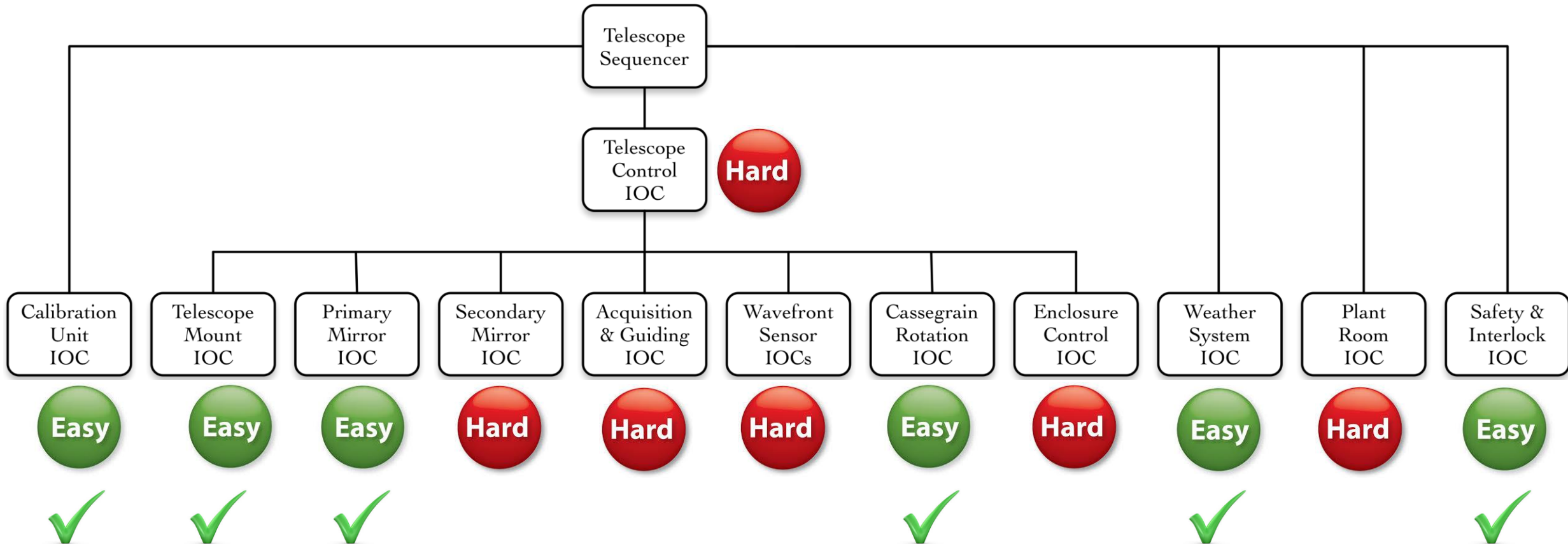
Test Bench Specs			
Date of Test	Start	End	
Engineer	3/4/2017		
Test Environment	R Rojas/M Westfall/ Arriagada		
Lab			
Software Configuration		Tests Passed	23
GCAL Version	1-1	Tests Pending	0
OS Version	RTEMS	Tests Failed	0
EPICS Version	3.14.12.4	Tests Waived	0
Additional Software		Pending for Live Test	0
Name/Version		Total Tests	23
Hardware Configuration		% Passed	100.00%
CPU		% Pending (pending + live)	0.00%
I/O HW		% Failed	0.00%
		% Waived	0.00%
		% Live Test	0.00%
Additional Testing Tools			
Oscilloscope			
Bread Board			
Electrical components & Wires			



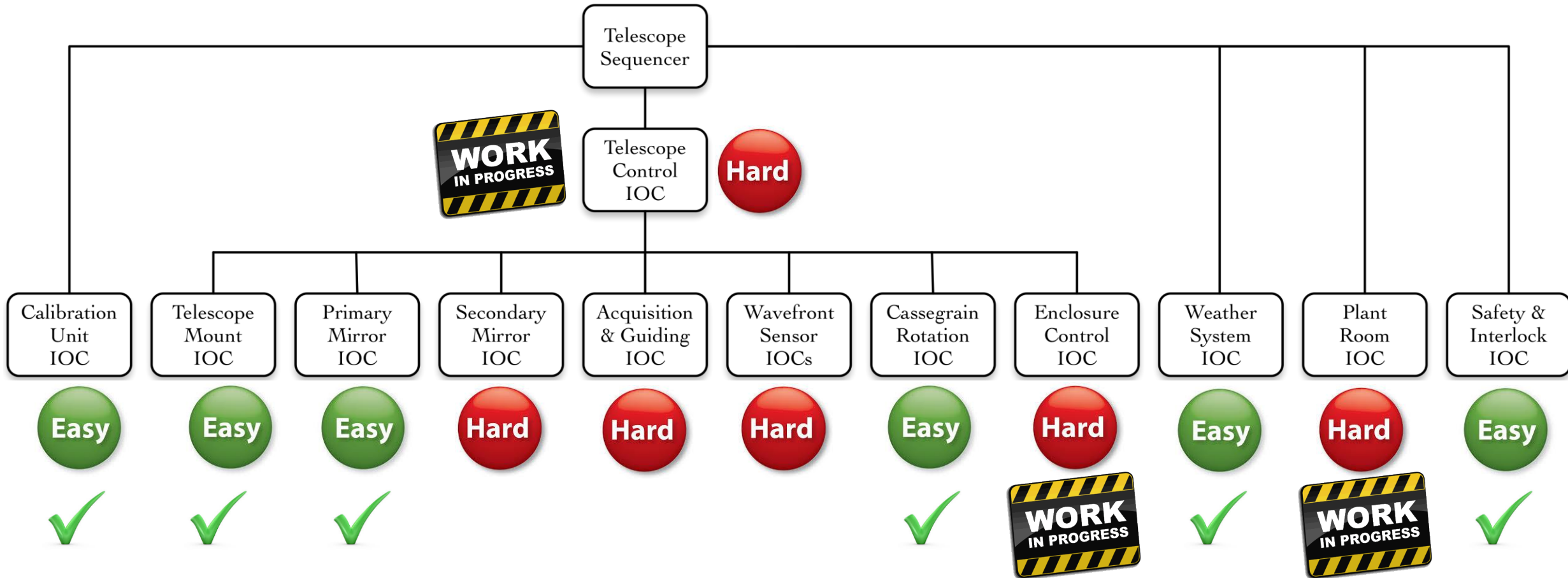
1. The diffuser follows commands as issued. Status messages are displayed correctly	PASSED	
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1. Each lamp turns on/off	PASSED	2. Remove the 'on'. Click the OFF button. 5. same here. Removing 'on' avoids ambiguity.
1. The IR Lamps turns on/off	PASSED	2. Remove the 'on'. "Click the IR lamp ON button." 5. same here Removing 'on' avoids ambiguity.



# Current Status



# Current Status





# Lessons Learned

- Start with **simple systems first**
- Develop comprehensive **test plan** and procedures
- Functional requirements are important, but don't forget about **performance**
- **Communicate** the change and impact
- Have **contingency plans**

# Future Work

- Completion of systems upgrades by April 2018
- Standards updated by end of Q2/2018
- Upgrade of other telescope infrastructure:
  - Reflective Memory
  - Secondary Control System hardware
  - CPU Upgrades

# Conclusions

- Don't be afraid – things will be better
- Use **experts** – don't do it all by yourself
- Focus on **simple things first**
- Create comprehensive **test plans**
- **Communicate** extensively your plans
- **Update standards**, so this work can be sustained in the future
- Include **obsolescence management** right off the bat



# Upgrading Control Systems at Gemini Telescopes

*Experiences and lessons learned*

# Thank you!

Arturo Núñez  
anunez@gemini.edu

Ignacio Arriagada  
Ricardo Cárdenes  
Tim Gaggstatter  
Pedro Gigoux  
Matt Rippa  
Roberto Rojas  
Michael Westfall