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Test Automation in Continuous Integration for Hardware Validation

Mestrado Integrado em Engenharia
Informática e Computação

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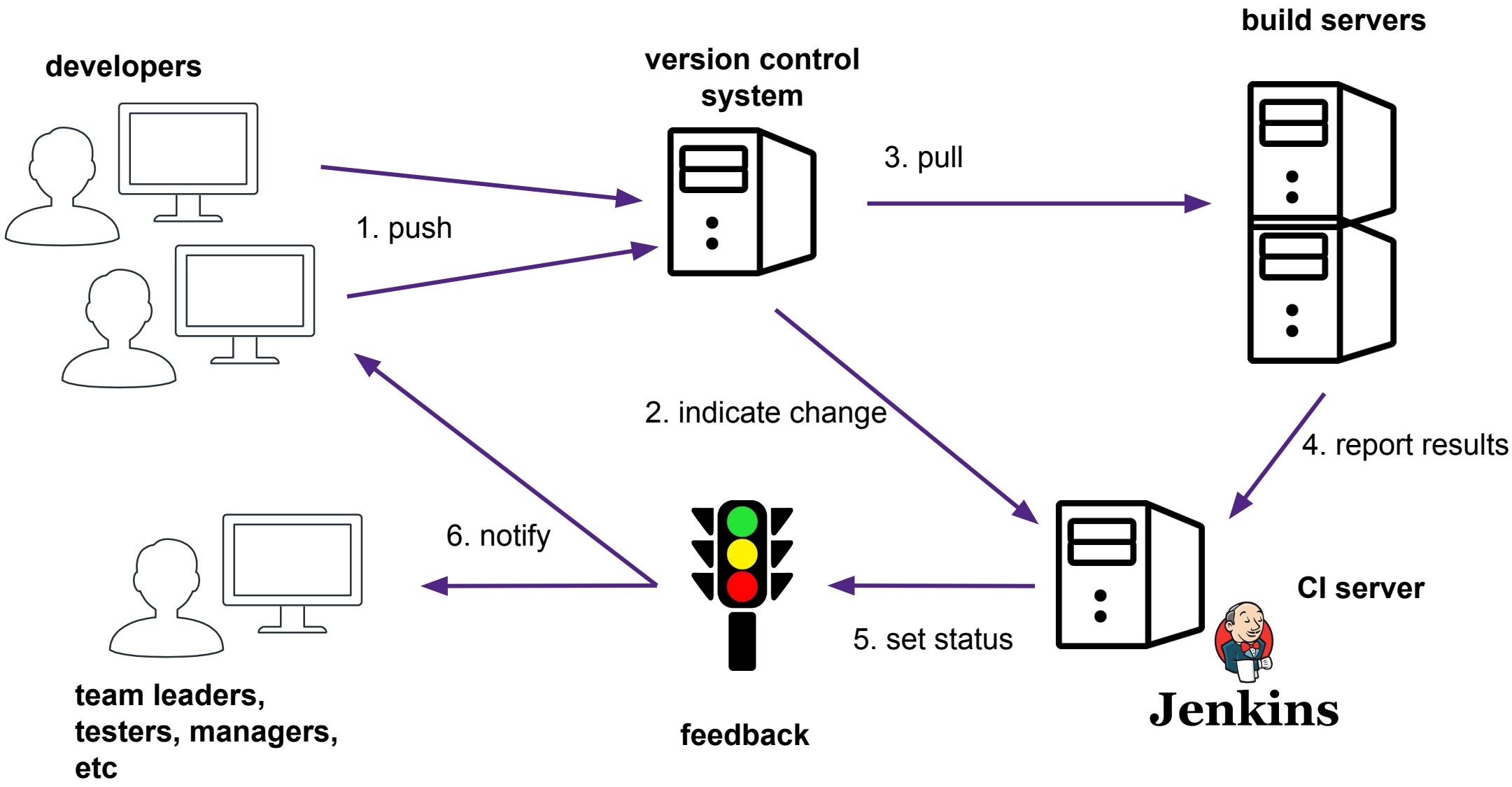
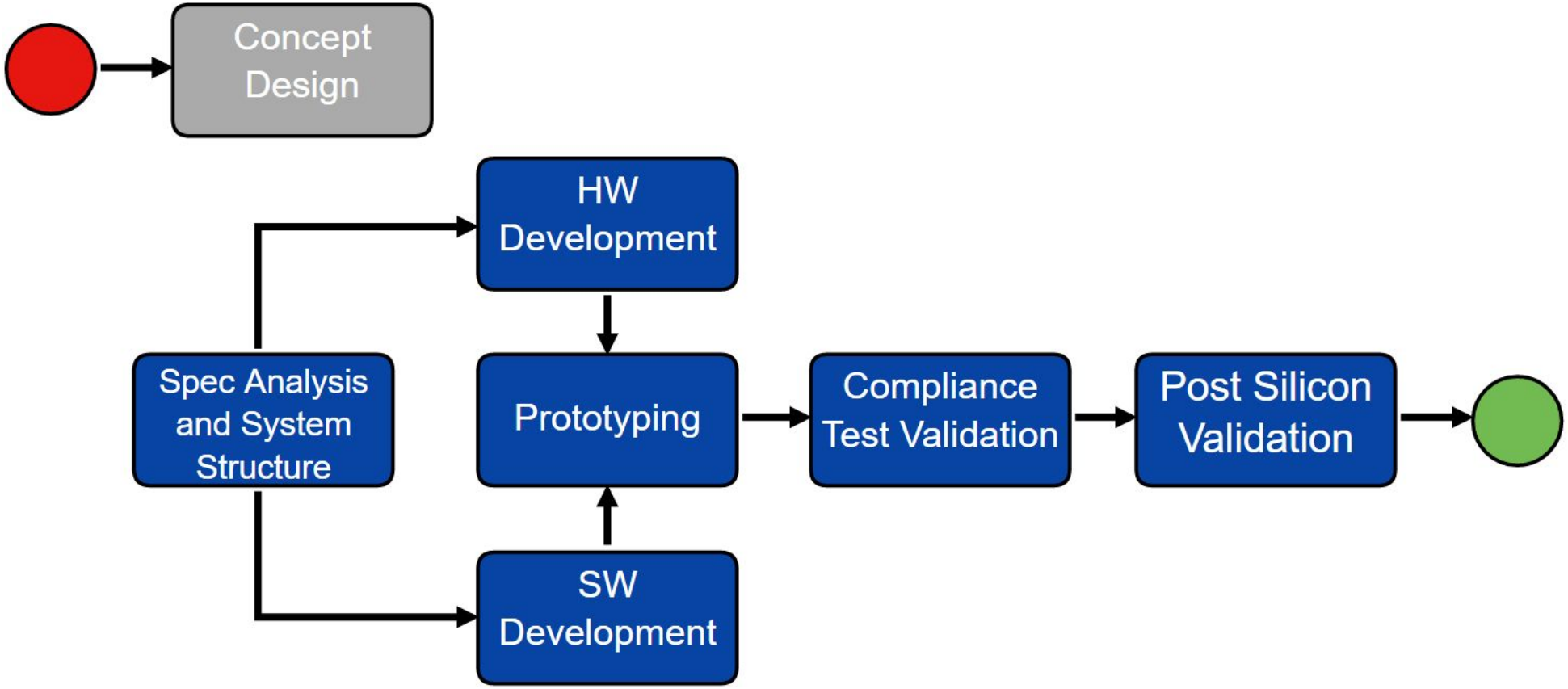
Outline

- Introduction
- Context and Motivation
- Research Problem
- Dashboard Solution
- Results
- Conclusion

In Software Engineering



Hardware Creation Process

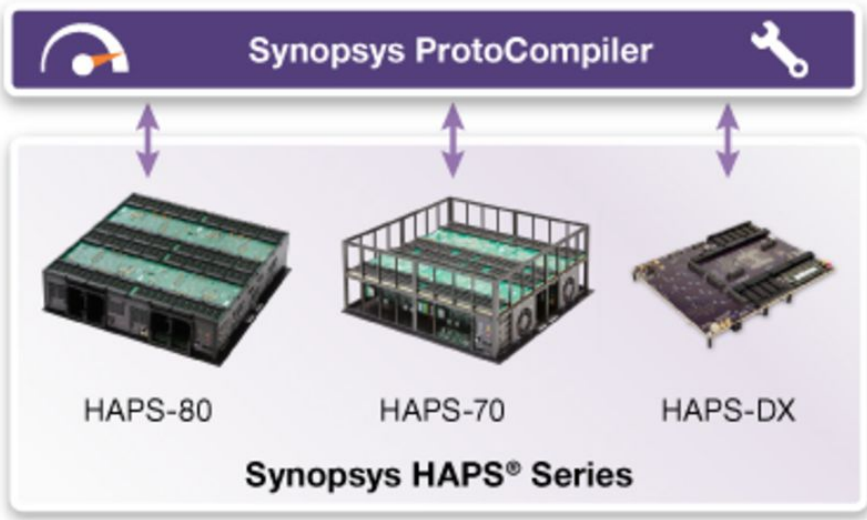


Hardware Creation

Despite the growing complexity of systems, including the interaction with the Firmware and Hardware, the temporal decrease in functional hardware validation process must be drastically reduced and more effective due to decreased *time-to-market*

Synopsys IPK R&D teams

- Design RTL for ARC and PCIe interfaces
- Test the Designs deployed in HAPS' FPGAs
- Make them compliant accordingly a set of requirements defined by consortia
- Validate the designs



HAPS (High-performance ASIC Prototyping Systems)

Motivation and Goals

The validation process is a **subjective** one:

- Determined how Hardware behaves with different conditions and applications;
- Consisted by system modeling, prototyping and user evaluation.

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The validation process is a **subjective** one:

- Determined how Hardware behaves with different conditions and applications;
- Consisted by system modeling, prototyping and user evaluation.

So there was a need to:

- Define an automatic test management structure for Hardware validation;
- Define techniques to label and manage the validation results;
- Develop an application to support the system.

The System Architecture

Compliance tests take long periods of time to conclude (aprox. 4h).

Added with manual labour time for test environment setup, could introduce:

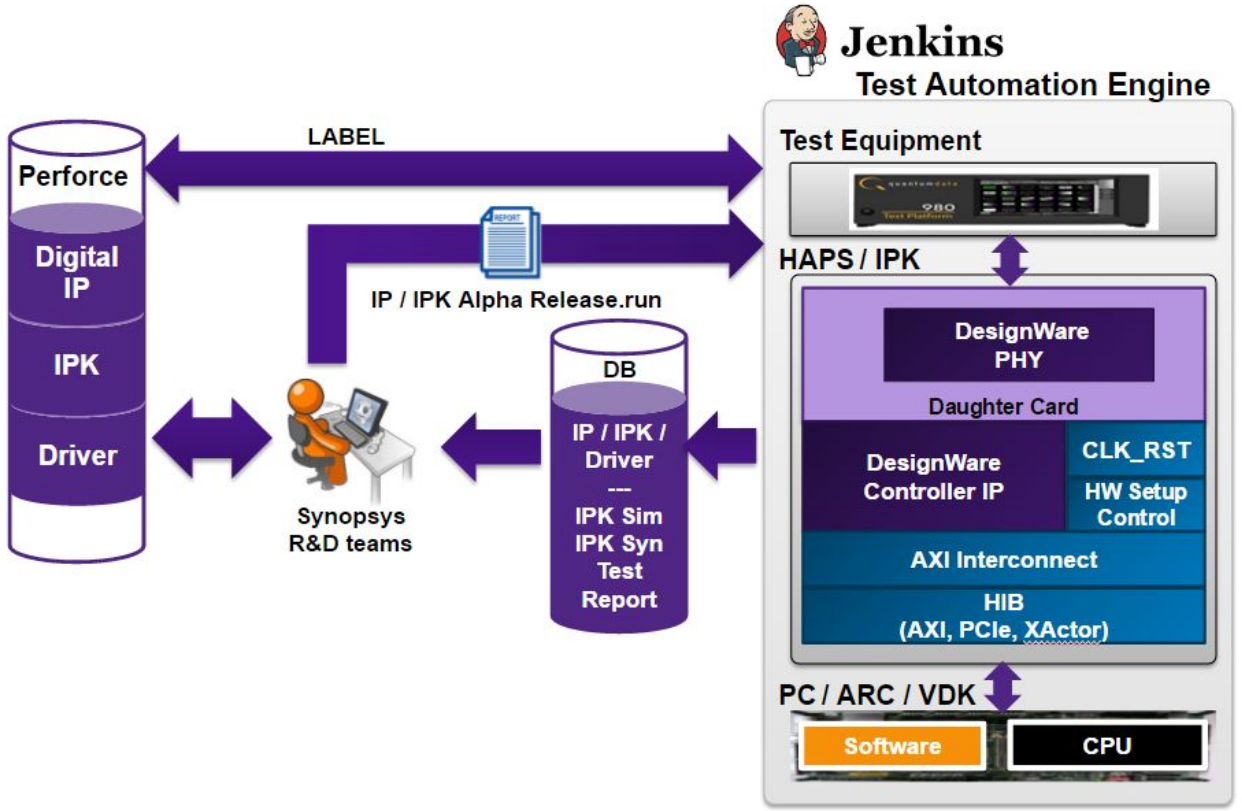
- Inconsistency between tests;
- Lack of traceability among product versions.

The System Architecture

The final architecture should:

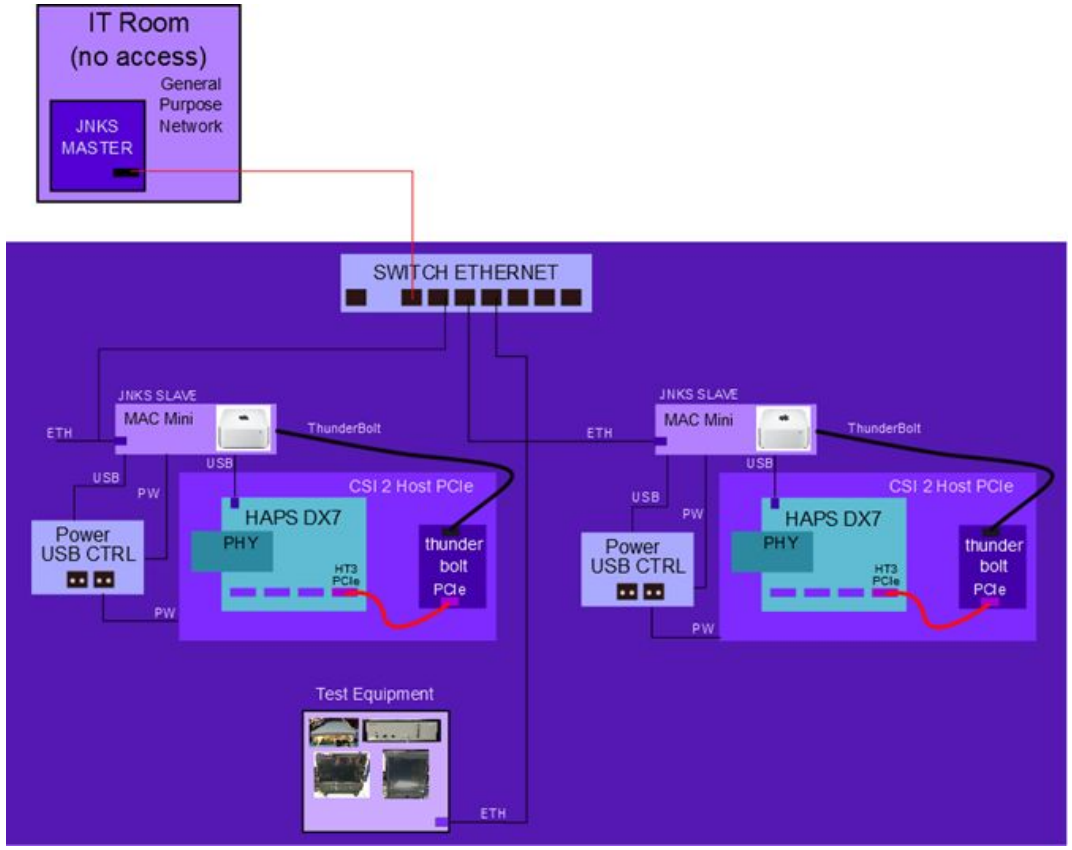
- Speed up testing to allow for accelerated releases which:
  - Reduces testing costs;
  - Reduces time in testing phase.
- Allow testing IP's features continuously;
- Improve test coverage;
- Ensure consistency;
- Improve the reliability of testing;
  - Consolidate the testing process

The System Architecture



CI environment for Hardware Validation Context

The System Architecture



PCIe Interface Architecture at Synopsys

Test Automation
Rack

The Object of Focus

- The need to trace the results of testing

The Object of Focus

- The need to trace the results of testing

1	Agilent Gen3 PTC - Gen1	_ahsata_h7dx_v7gth_sspcs_151209_0226	_pcie_h7dx_c10_se_gen3x1_151111_19155	_pcie_h7dx_c8_se_gen3x1_151217_222643	_pcie_h7dx_gth_se_gen1x1_160120_03130	_pcie_h7dx_gth_se_gen1x4_160120_03134	_pcie_h7dx_gth_se_gen1x8_160120_03143	_pcie_h7dx_gth_se_gen2x1_160120_0315	_pcie_h7dx_gth_se_gen2x4_	_pcie_h7dx_gth
2	**Overall Result**	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
3	Agilent Gen3 PTC Software version	8.73	8.73	8.62	8.73	8.73	8.73	8.73	8.73	8.73	8.73
4	Detected Error Window	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
5	PASS	1	1	1	1	1	1	1	1	1	1
6	FAIL										
7	DLL_04_01_02 To check that receiver ignores the reserved fields of the received DLLPs (ReservedFieldsDLLPReceive).	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
8	PASS	1	1	1	1	1	1	1	1	1	1
9	FAIL										
10	DLL_05_02_01 The intent of this test is to ensure that a DUT will retransmit a transaction for which a NAK has been issued (RetransmitOnNAK).	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
11	PASS	1	1	1	1	1	1	1	1	1	1

Excel Spreadsheet created by Synopsys IP Prototyping Team - Hardware Test Summary Results

The Object of Focus

- The need to trace the results of testing

Tool Versions	ahsata_h7dx_v7gth_sspcs_151209_022657_snps_	pcie_h7dx_c10_se_gen3x1_151111_191556_0x05_snps_	pcie_h7dx_c8_se_gen3x1_151217_222643_0x14_snps_	pcie_h7dx_gth_se_gen1x1_160120_031309_0x74_snps_	pcie_h7dx_gth_se_gen1x4_160120_031348_0x74_snps_	pcie_h7dx_gth_se_gen1x8_160120_031430_0x74_snps_	pcie_h7dx_gth_se_gen2x1_160120_031506_0x74_snps_	pcie_h7dx_gth_se_gen2x4_160120_031546_0x74_snps_	pcie_h7dx_gth_se_gen2x8_160120_031615_0x74_snps_	pcie_h7dx_gth_se_gen3x
DWC_pcie	4.60a	4.60a	4.70a-ea02	4.60a	4.60a	4.60a	4.60a	4.60a	4.60a	4.60a	4.60
vcs	2012.09-3	2014.12-SP1	2014.12-SP1	2014.12-SP1	2014.12-SP1	2014.12-SP1	2014.12-SP1	2014.12-SP1	2014.12-SP1	2014.12-SP1	2014.12
synplicity	2013.03-SP1-1			2014.03-SP1	2014.03-SP1	2014.03-SP1	2014.03-SP1	2014.03-SP1	2014.03-SP1	2014.03-SP1	2014.03
identify	2013.03			2014.09-SP1	2014.09-SP1	2014.09-SP1	2014.09-SP1	2014.09-SP1	2014.09-SP1	2014.09-SP1	2014.09
protocomp		2014.09-SP2	2015.12	2014.03-SP2	2014.03-SP2	2014.03-SP2	2014.03-SP2	2014.03-SP2	2014.03-SP2	2014.03-SP2	2014.03
xilinx	14.4		14.7								
vivado		2013.3	2015.4	2014.3	2014.3	2014.3	2014.3	2014.3	2014.3	2014.3	2014
ct	2013.03-SP1-2	2015.06-SP2	2015.06-SP2	2015.06-SP2	2015.06-SP2	2015.06-SP2	2015.06-SP2	2015.06-SP2	2015.06-SP2	2015.06-SP2	2015.06

Excel Spreadsheet created by Synopsys IP Prototyping Team - Different tools and controller Versions

The Object of Focus

The problems of this solution:

- **Traceability;**
- **Susceptible to Human Error;**
- **Availability;**
- **Difficulty on troubleshooting**.

Finding a solution with Jenkins

- Open Source
- Automated Jobs
- Jobs Management
- Building Report
- Distributed

Generic Projects View

Previously:

- A unidimensional project View;
- Not enough information about the tests

Bluetooth | DDR | EQOS XGMAC | **HDMI** | IPK | MIPI | PCIe | SATA | Software | USB | +

S	W	Categorized - Job ↓	Primary Owner	Último Sucesso	Última falha	Duração da Última
		DWIPK HDMI RX PIPE	pmmoreir	2 mês 0 dias - #11	N/A	2 h 0 min
		DWIPK_HDMI_RX_dotRun_test	psousa	1 yr 0 mês - #38	1 yr 0 mês - #31	5 h 30 min
		DWIPK_HDMI_RX_multijob	pmmoreir	22 dias - #147	1 mês 5 dias - #144	2 h 29 min
		DWIPK_HDMI_RX_multijob_HW_arc	psousa	22 dias - #132	1 mês 11 dias - #122	1 min 22 seg
		DWIPK_HDMI_RX_multijob_HW_haps	pmmoreir	22 dias - #144	1 mês 5 dias - #141	17 seg
		DWIPK_HDMI_RX_multijob_HW_quantum	pmmoreir	22 dias - #118	1 mês 8 dias - #112	2 h 23 min
		DWIPK_HDMI_RX_multijob_p4sync	pmmoreir	22 dias - #167	3 mês 16 dias - #95	2 min 17 seg
		DWIPK_HDMI_RX_multijob_p4trigger	psousa	3 mês 21 dias - #27	N/A	42 seg
		DWIPK_HDMI_RX_multijob_WS	unknown	N/D	3 mês 22 dias - #2	2 min 18 seg
		DWIPK_HDMI_RX_multijob_WS_p4	unknown	3 mês 22 dias - #10	3 mês 22 dias - #6	1 min 0 seg
		DWIPK_HDMIQPRX	pmmoreir	6 mês 25 dias - #1	N/A	4 min 12 seg
		HDMI_Compliance_Automation	hfaria	N/D	1 yr 6 mês - #4	30 seg
		HDMI_TX_IPK	unknown	2 mês 9 dias - #80	6 dias 13 h - #89	28 seg

Ícone: S M L

Legenda | RSS para todos | RSS só para falhas | RSS só para últimas builds

Project Views organized in the Jenkins system.

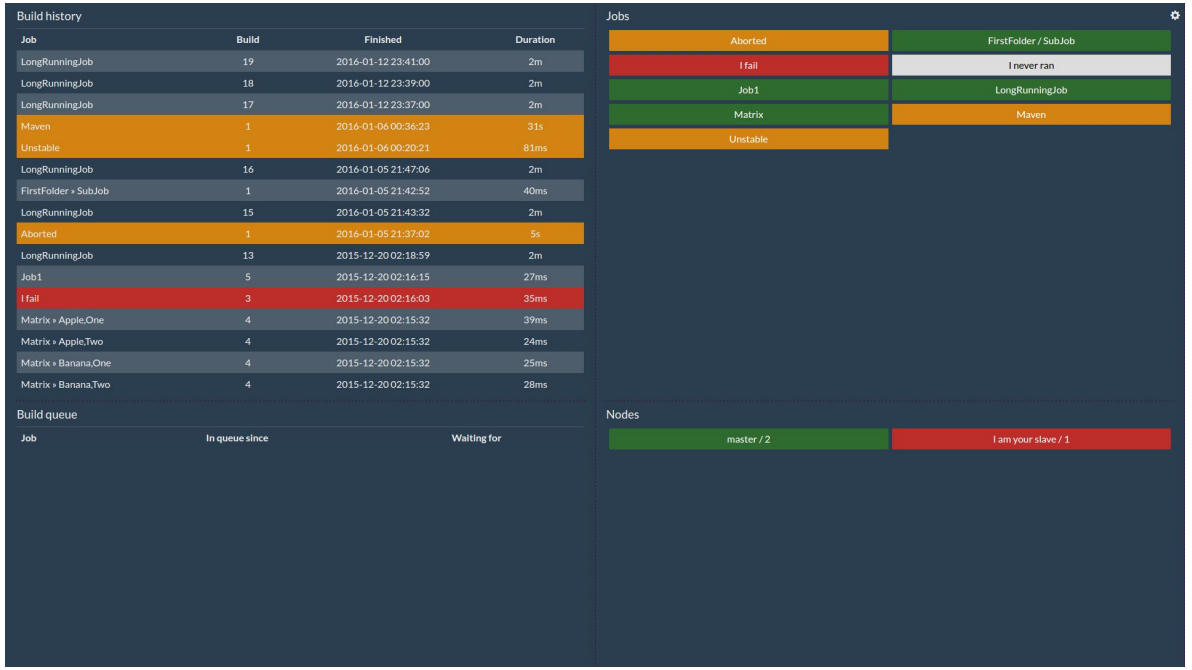
Filtered Dashboard View Solution - Aux. Plugins

Solved with the introduction of auxiliary Plug-ins:

- Metadata inclusion for labeling
- Dashboard streamlined for better traceability

```
<com.sonyericsson.hudson.plugins.metadata.model.MetadataBuildAction plugin="metadata@1.1.0b">
  <values class="linked-list">
    <metadata-string>
      <name>core_version</name>
      <parent class="com.sonyericsson.hudson.plugins.metadata.model.MetadataBuildAction" refer
      <generated>false</generated>
      <exposedToEnvironment>false</exposedToEnvironment>
      <value>1.0</value>
    </metadata-string>
    <metadata-string>
      <name>core_name</name>
      <parent class="com.sonyericsson.hudson.plugins.metadata.model.MetadataBuildAction" refer
      <generated>false</generated>
      <exposedToEnvironment>false</exposedToEnvironment>
      <value>DWIPK_PCIE</value>
    </metadata-string>
```

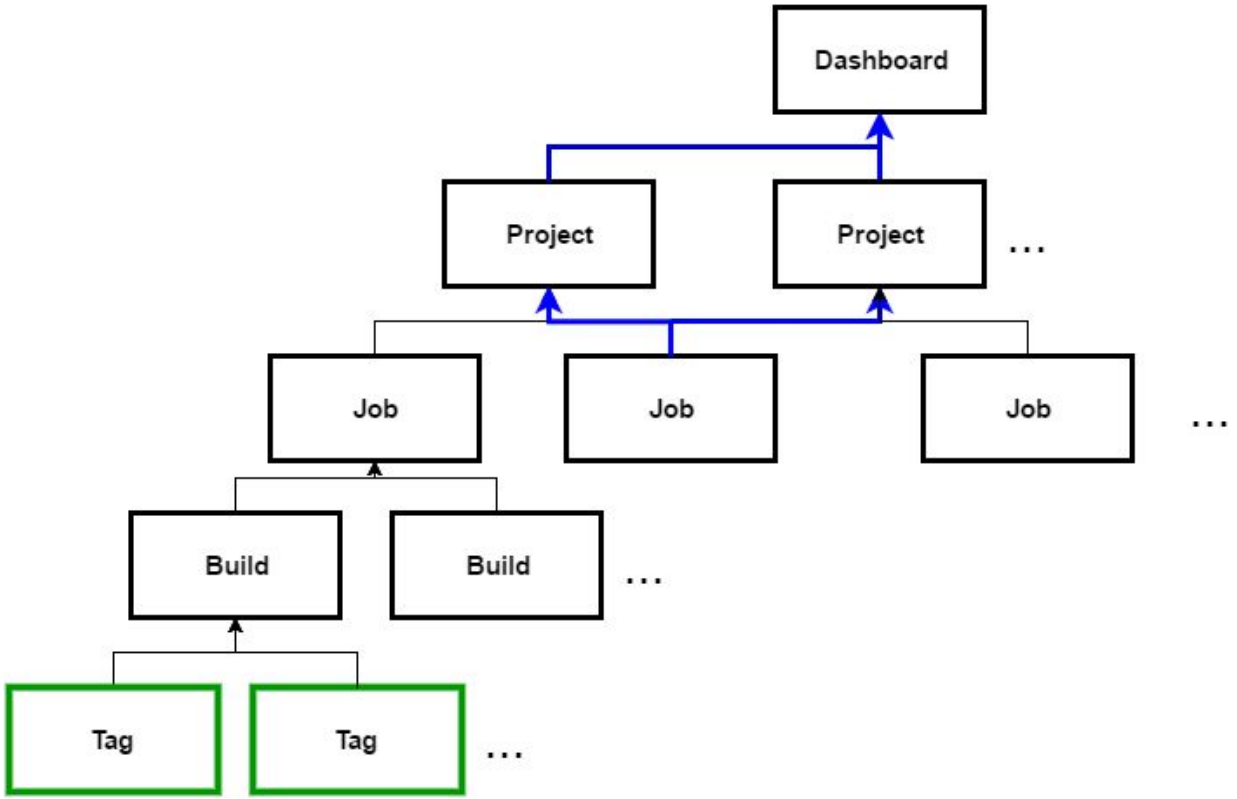
XML file containing a Builds' information



Mission Control Plugin UI

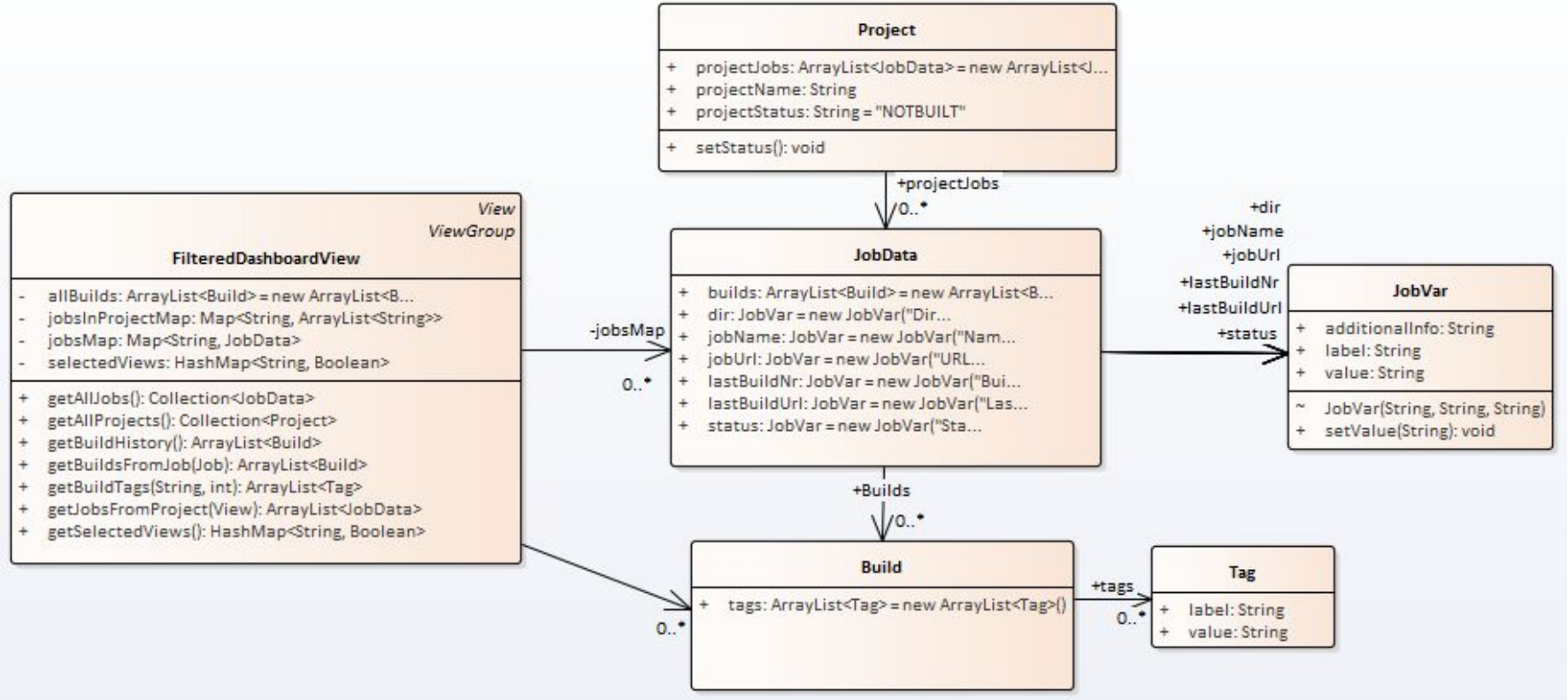
Filtered Dashboard View Solution - Design

- Information structured with a Top-Down approach



Filtered Dashboard View Solution - Design

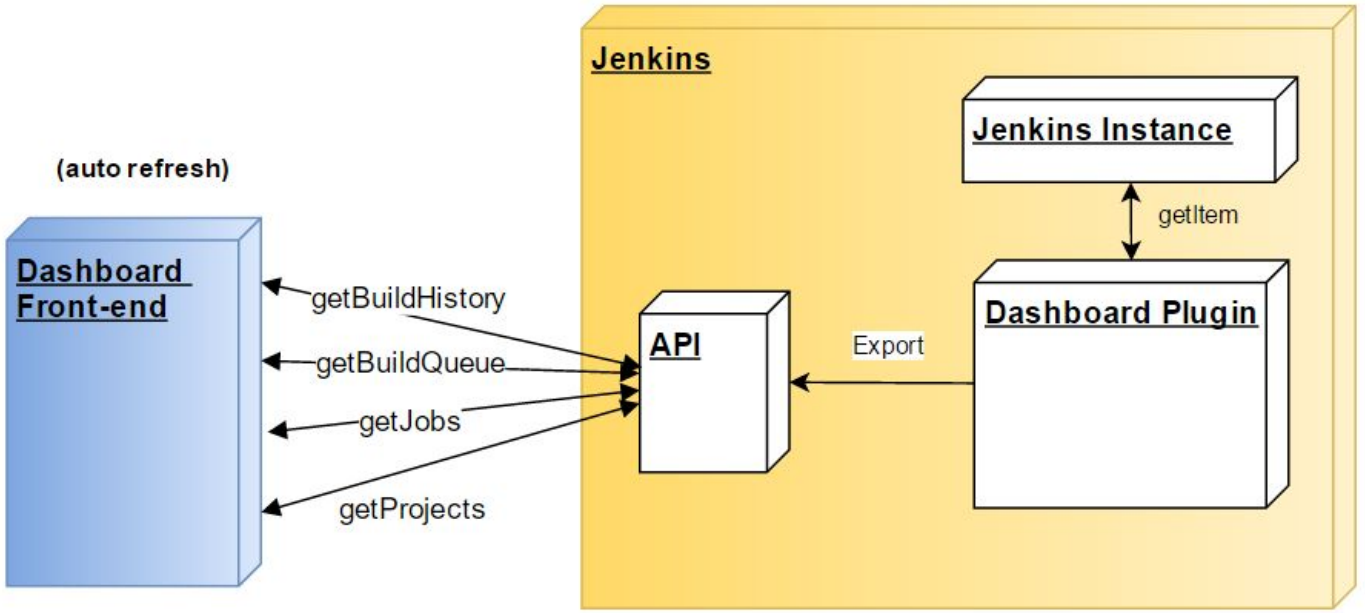
- Information structured with a Top-Down approach
  - Enough abstraction to add extra information



Filtered Dashboard View classes diagram

Filtered Dashboard View Solution - Design

- Traceability is assured by accessing the Jenkins Server information
  - None outside source information



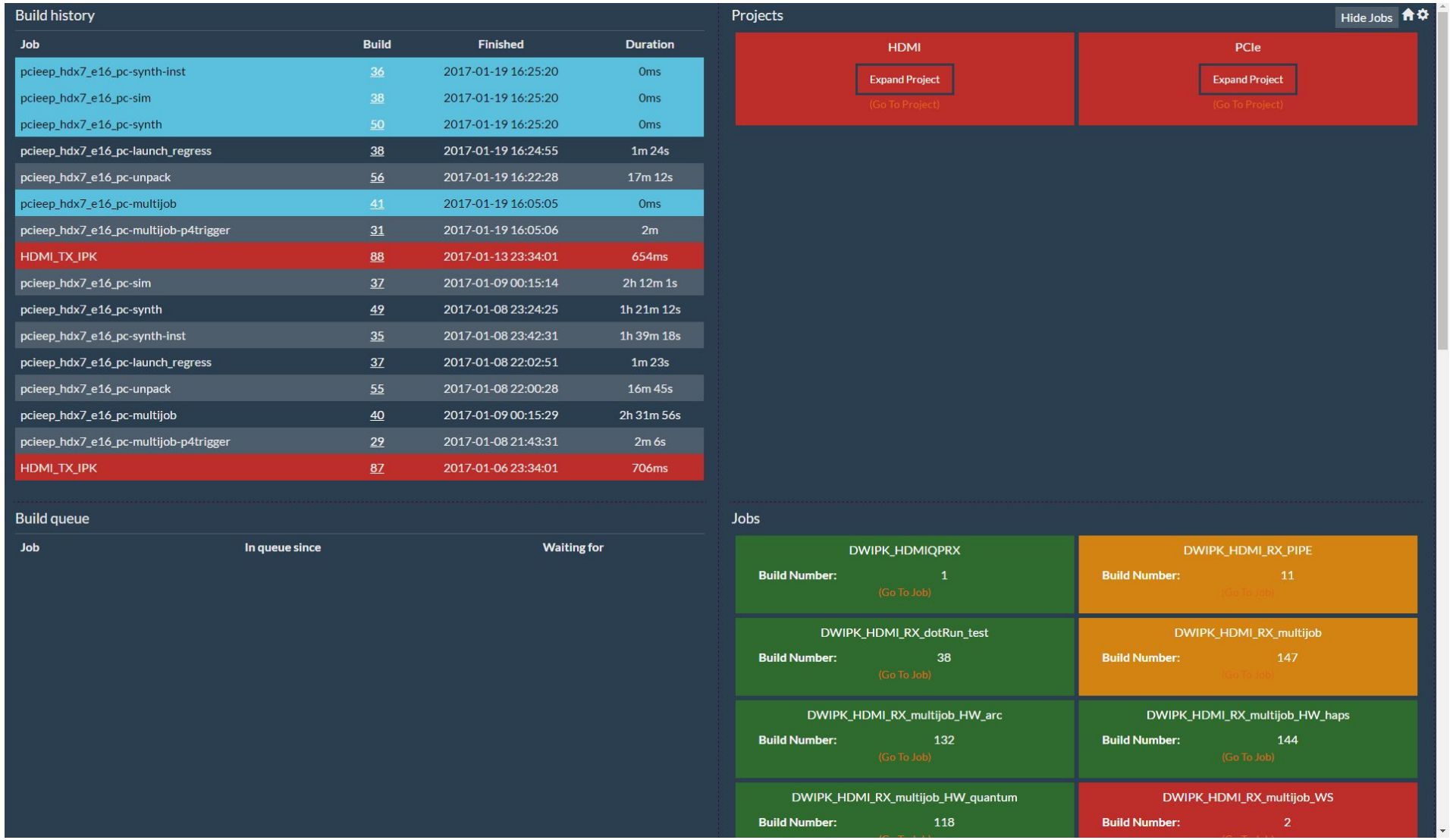
Plugin Interaction Diagram

Filtered Dashboard View Solution - User Interface

Based on the previous Plugin, adding:

- View organization by projects:
  - With Test Jobs results and overall project result
- Quick Project/Job access for troubleshoot;
- Labels filtering

Filtered Dashboard View Solution - User Interface



Dashboard Landing page - Displaying HDMI and PCIe projects associated to the IPK team

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Filtered Dashboard View Solution - User Interface

HDMI

Go Back

Filter by:

CORE_VERSION: 1.0

CORE_NAME: dwipk_hdmirx

Show 10 entries

Search:

Row#	DWIPK_HDMI_RX_dotRun_test	DWIPK_HDMI_RX_multijob	DWIPK_HDMI_RX_multijob_HW_arc	DWIPK_HDMI_RX_multijob_HW_haps	DWIPK_HDMI_RX_multijob_HW_quantum	DWIPK_HDMI_RX_multijob_p4sync	DWIPK_HDMI_RX_multijob_p4trigger	DWIPK_HDMI_RX_multijob_WS	DWIPK_HDMI_RX_multijob_WS_p4	DWIPK_HDMI_RX_PIPE	DWIPK_HDMIQPRX	HDMI_Compliance_Automation	HDMI_TX_IPK
1	SUCCESS #38	UNSTABLE #147 Tags: 1.0 dwipk_hdmirx	SUCCESS #132	SUCCESS #144	SUCCESS #118	SUCCESS #167	SUCCESS #27	FAILURE #2	SUCCESS #10	UNSTABLE #11	SUCCESS #1	FAILURE #4	FAILURE #88
2	SUCCESS #37	UNSTABLE #146 Tags: 1.0 dwipk_hdmirx	SUCCESS #131	SUCCESS #143	SUCCESS #117	SUCCESS #166	SUCCESS #26	FAILURE #1	SUCCESS #9	UNSTABLE #10	NO DATA	FAILURE #3	FAILURE #87
3	SUCCESS #36	UNSTABLE #145 Tags: 1.0 dwipk_hdmirx	SUCCESS #130	SUCCESS #142	SUCCESS #116	SUCCESS #165	SUCCESS #25	NO DATA	SUCCESS #8	UNSTABLE #9	NO DATA	FAILURE #2	FAILURE #86
4	SUCCESS #35	FAILURE #144 Tags: 1.0 dwipk_hdmirx	SUCCESS #129	FAILURE #141	SUCCESS #115	SUCCESS #164	SUCCESS #24	NO DATA	SUCCESS #7	UNSTABLE #3	NO DATA	FAILURE #1	FAILURE #85
5	SUCCESS #34	FAILURE #143 Tags: 1.0 dwipk_hdmirx	SUCCESS #128	FAILURE #140	SUCCESS #114	SUCCESS #163	SUCCESS #23	NO DATA	FAILURE #6	NO DATA	NO DATA	NO DATA	FAILURE #84

Showing 1 to 5 of 5 entries

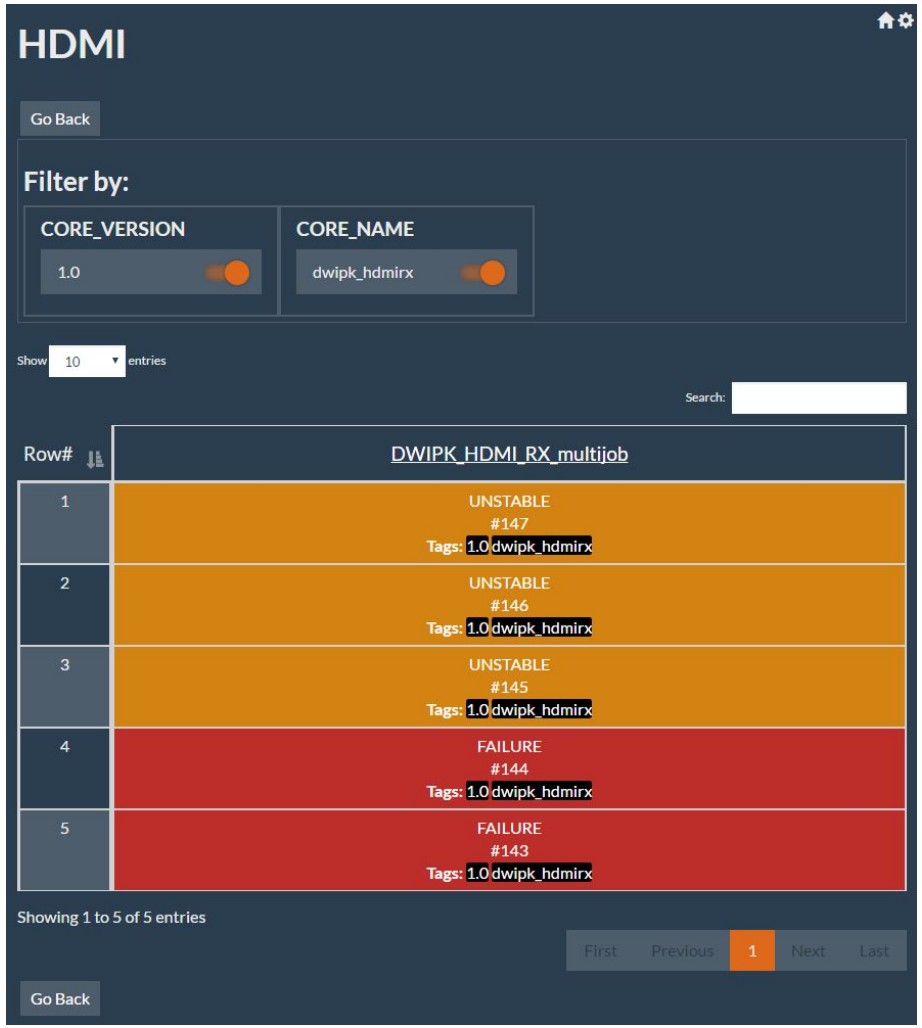
First Previous 1 Next Last

Go Back

Overall view of the HDMI project

Filtered Dashboard View Solution - User Interface

When filtered for faster troubleshooting:



Overall view of the HDMI project with filters applied

Spreadsheet Faults Solved

Excel spreadsheet problems were surpassed:

- **Traceability** - Automatic update on the Dashboard;
- **Susceptible to Human Error** - All the information gathering process lacks human interference
- **Availability** - Dashboard is always up as long the CI server is
- **Difficulty on troubleshooting** - Every item is linked to the original inside the server

Evaluation - Requirements

The Dashboard Plugin improves:

- Analysis;
- Readability;
- Useability;
- Traceability

Within a single snapshot monitoring

Evaluation - Feedback from Synopsys

Although not enough time for bigger conclusions, it was demoed at Synopsys and given feedback:

- A powerful tool to reduce the analysis of the state of specific IP configuration / version;
- Effective, accurate and complete in showing defined important metadata information:
  - Job state display of each build;
  - Well presented data
  - Time required to find successful and unsuccessful builds reduced
- Ease of categorization of product configurations

Contributions

- Creation of a powerful and streamlined Dashboard:
  - Gathers all needed information for any development team in Jenkins;
  - Friendly UI for non accustomed Jenkins users;
  - Centralized information with needless outside software support;
  - Easy categorization for better information organization and access

Plugin available in Jenkins Plugins open source repository, under the name "**Filtered Dashboard View Plugin**".

Future Work

- Plugin maintenance;
  - Both our Dashboard and the Metadata Auxiliary plugin
- UI improvement;
- Addition of metrics and indicators;
  - Can be easily implemented with the current abstraction of the classes

References

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