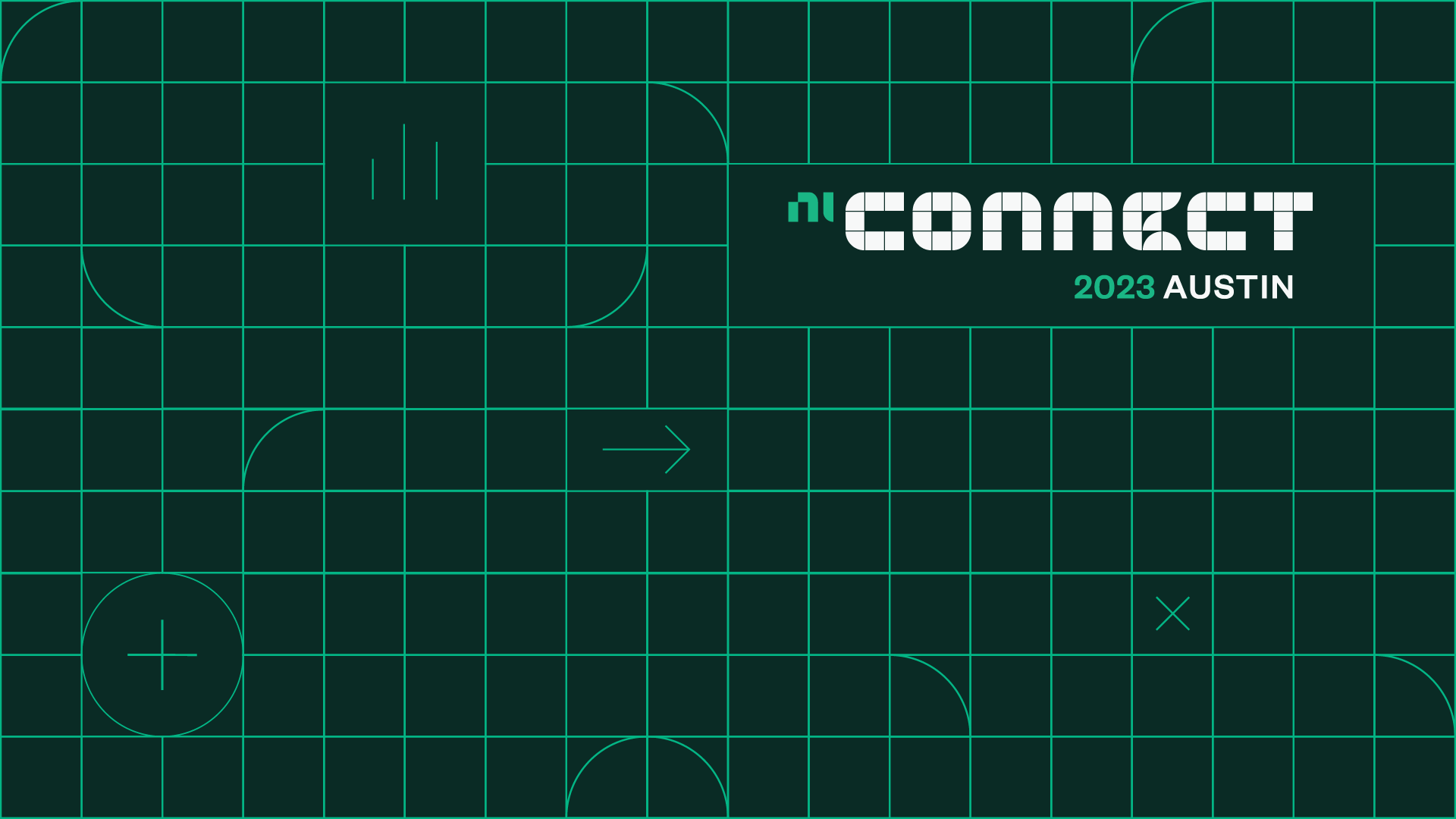

WELCOME TO AUSTIN

# CONNECT

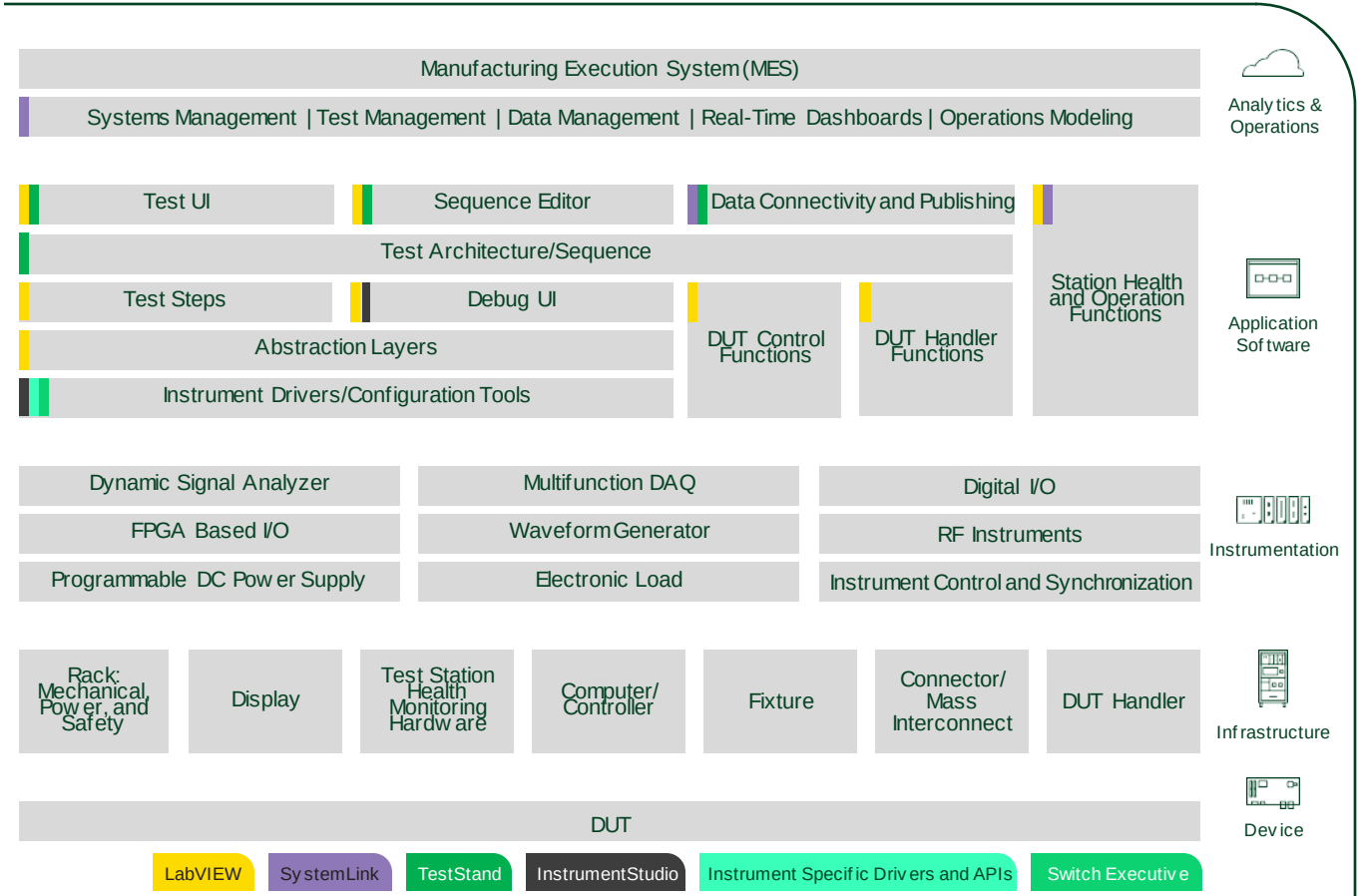

CONNECT
2023 AUSTIN

# Continuous Integration with LabVIEW and TestStand

Nathan Nims - Digitalisation
Business Manager, NI

Callum Eggleden – Test Engineering
Design Manager, Thales UK

# Elements of a Test Architecture

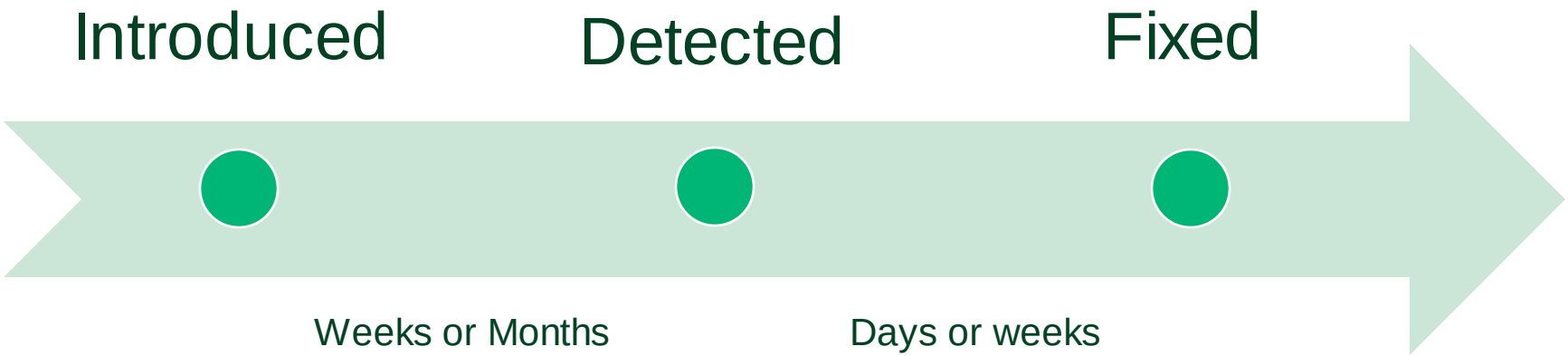



Operation, Maintenance, and Regulatory Documentation

# Bug lifecycle

## Where do things go wrong?

- Waiting a long time between code checks
- Don't run the checks thoroughly every time
- Don't bother to write good tests
- Don't look through the test/analysis results to see what broke
- Humans have a limited attention span
- Repetitive testing is boring and usually skipped by humans



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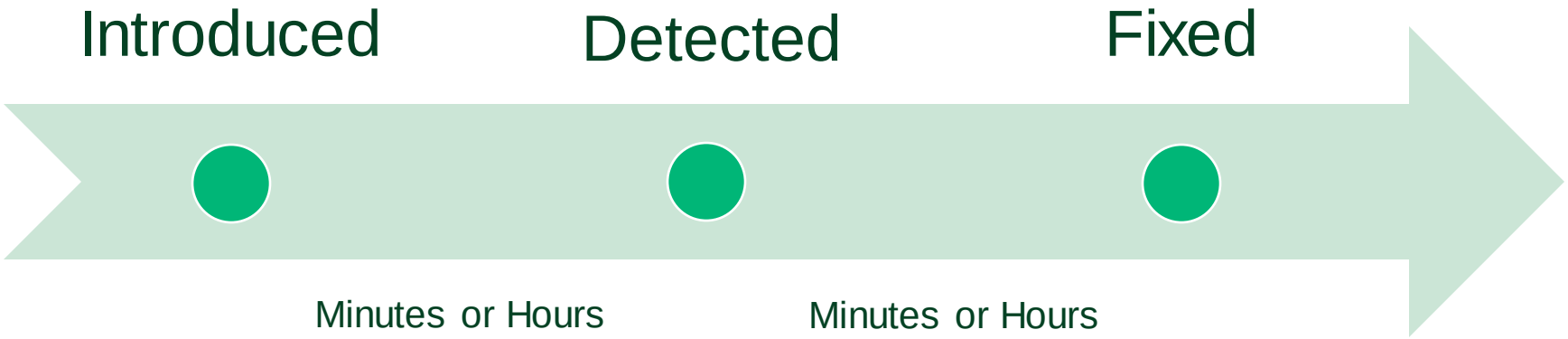
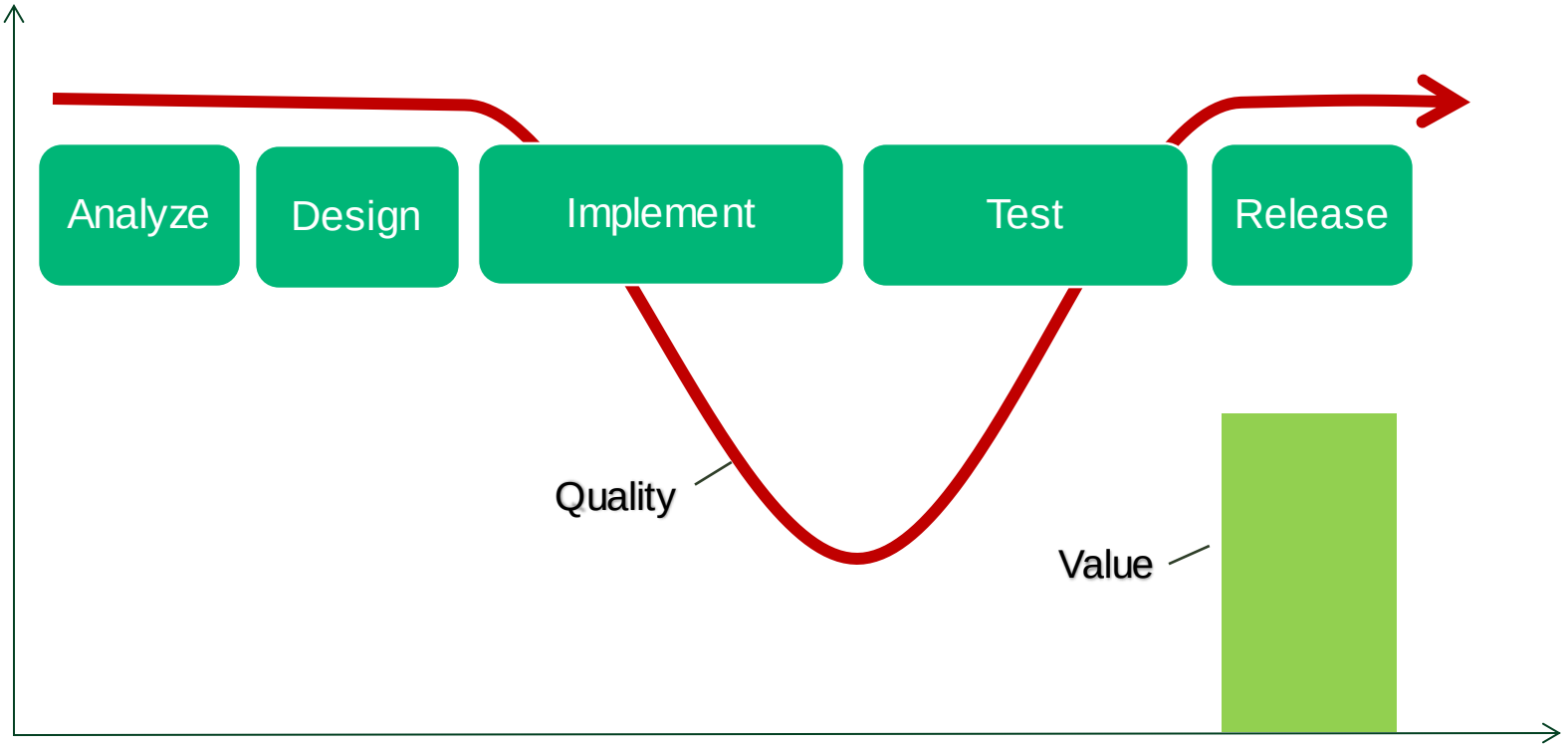
# Bug lifecycle – After CI

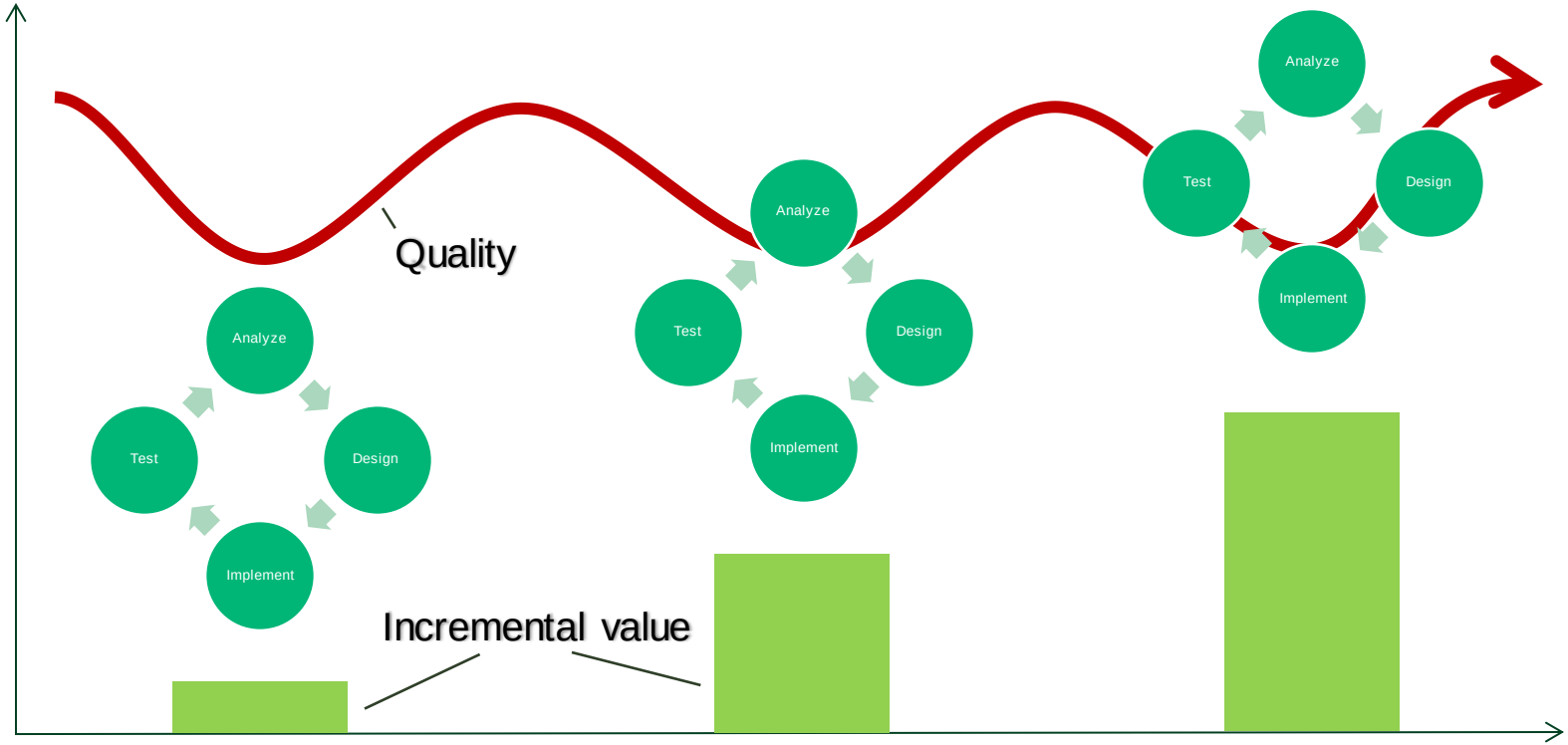




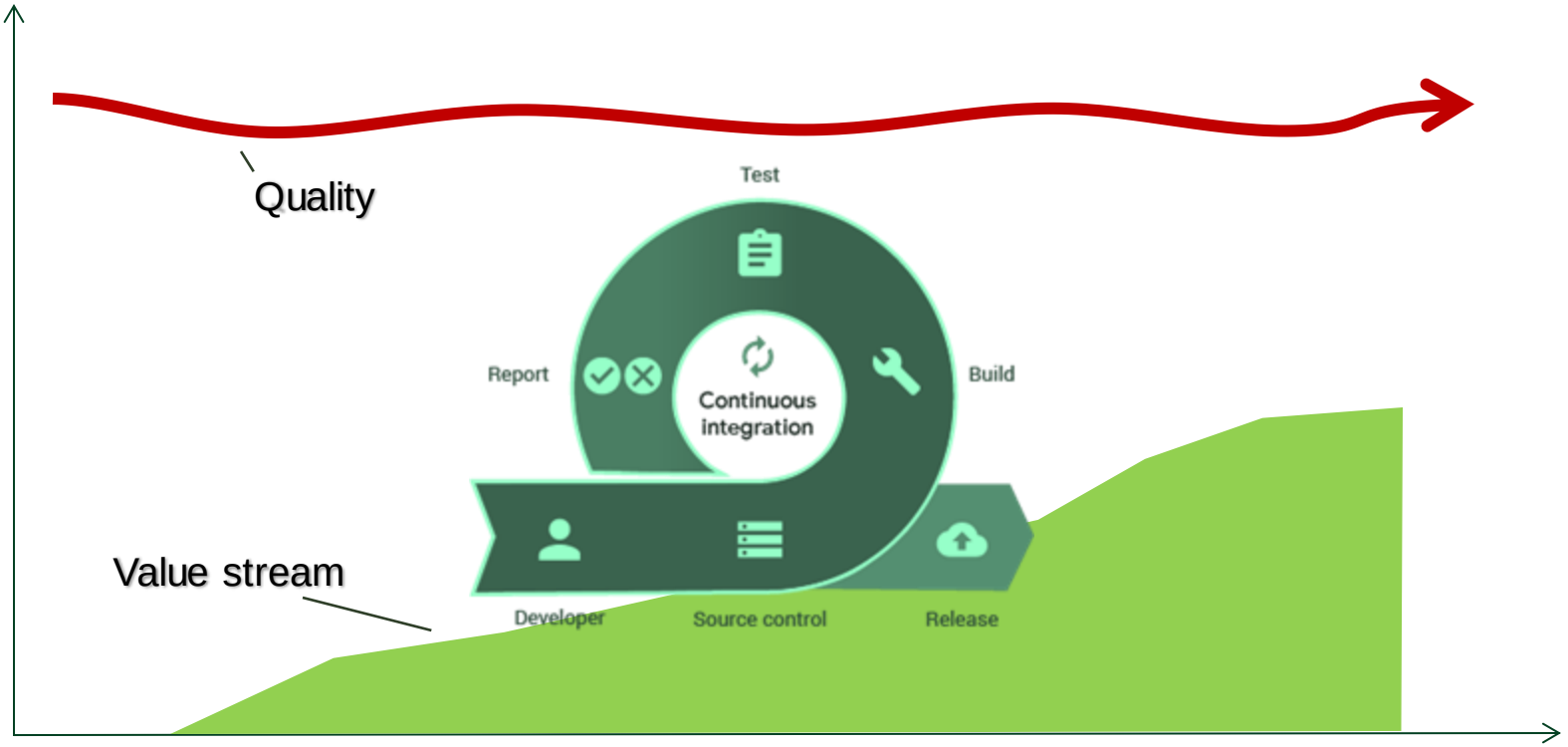
# Traditional Waterfall Development



# Agile



# Continuous Integration Continuous Deployment (idealized)



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THALES
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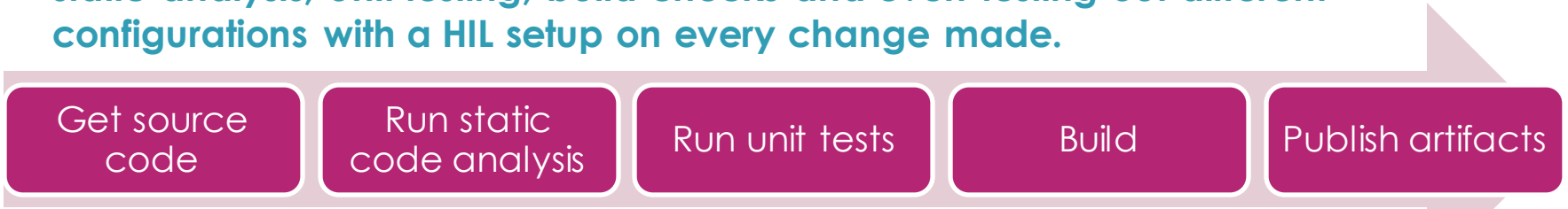
# Continuous Integration with LabVIEW and TestStand

## Test Engineering at Thales UK

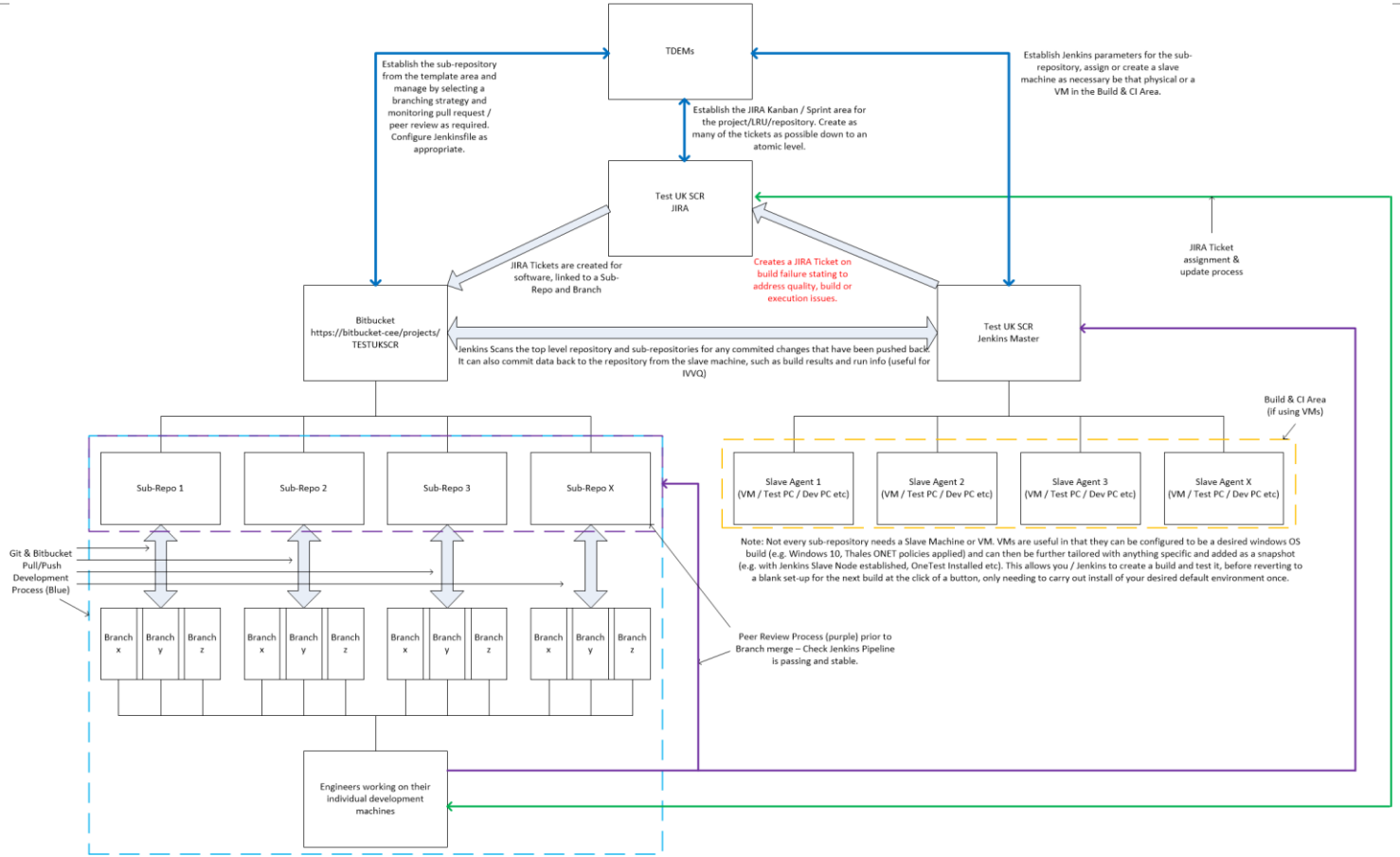
Callum Eggleden – Test Design Engineering Manager

# What is a Pipeline?

- When triggered, an orchestrator (build automation server) will execute a staged set of actions (the pipeline) on your target source code and publish the results back to the orchestrator.
- This set of actions is user defined and the tasks to be executed can be tailored for each branch of each project or project phase that wishes to use a pipeline.
- The ability to trigger automatic execution of these tasks on detection of a SW change makes pipelines perfect for CI tasks. Carrying out static analysis, Unit testing, build checks and even testing out different configurations with a HIL setup on every change made.



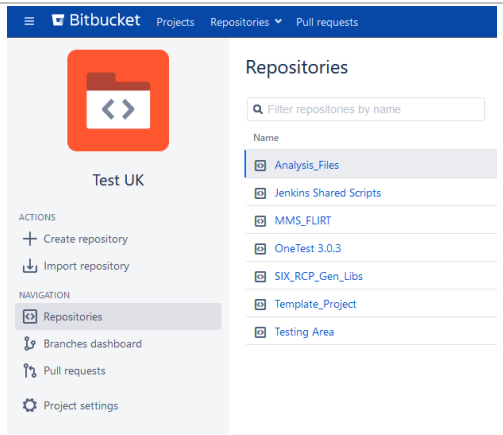
# Tools & Process Overview

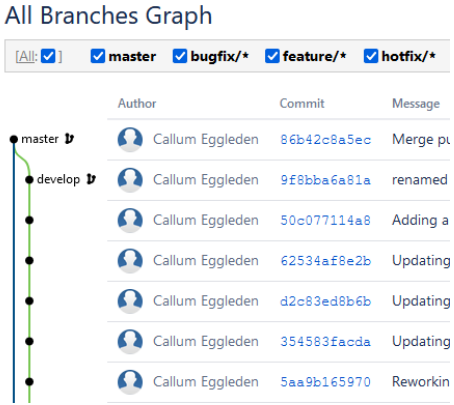


# Test SW Framework – Source Control (Bitbucket & Git)

- This is our SW project area. All repositories are kept here, including common departmental code and project specific code.
- Git based system, develop locally and store remotely – each commit is tracked and can be rolled back to when required.
- Each repository can have different levels of user access – useful for controlling security for those who have/haven't signed project SALs.
- Multiple Engineers can work on the same code at once using Branches. If SW is designed and managed properly (JIRA), merge conflicts can be minimized.

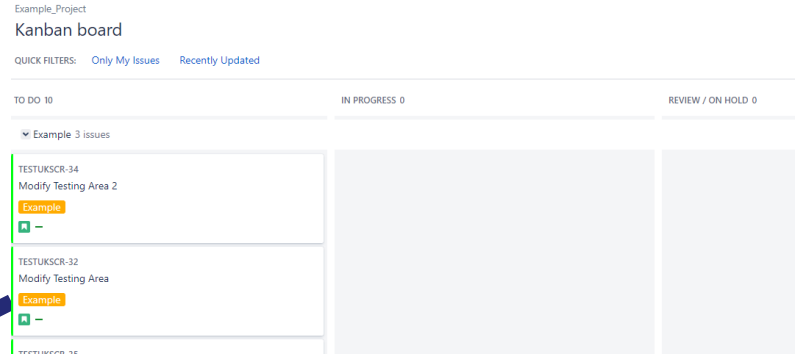
| | | |
|---|---|---|
| Lilly Pipe | 4106dff9508 | Merge pull request #39 in TOPSIS-X/systems-ivvq from feature/TOPSISX-6386 to develop * commit |
| Callum Eggleden | 8795c82b469 | TOPSISX-6386 Resolve Conflicts |
| Callum Eggleden | 1f8858c8b10 | TOPSISX-6386 Fixing CCP VI to work with CCP Type Enum |
| Callum Eggleden | b29cdcbddc1 | TOPSISX-6386 Resolving Merge Conflicts |
| Callum Eggleden | b1236eca293 | Merge pull request #38 in TOPSIS-X/systems-ivvq from feature/TOPSISX-6336 to develop * commit |
| Lilly Pipe | 86a6af6019a | TOPSISX-6386 Calling correct Type Defs |
| Callum Eggleden | b88db1e8d21 | TOPSISX-6336 Updated Tiger CCP Status FGV and added a new utility to find uncalled VIs within th |
| Callum Eggleden | 8aad553e9ec | TOPSISX-6386 trial VI |
| Callum Eggleden | 8f333b8c12e | TOPSISX-6336 Tiger Typedefs updated to be of correct type in order to work with CCP general VI |

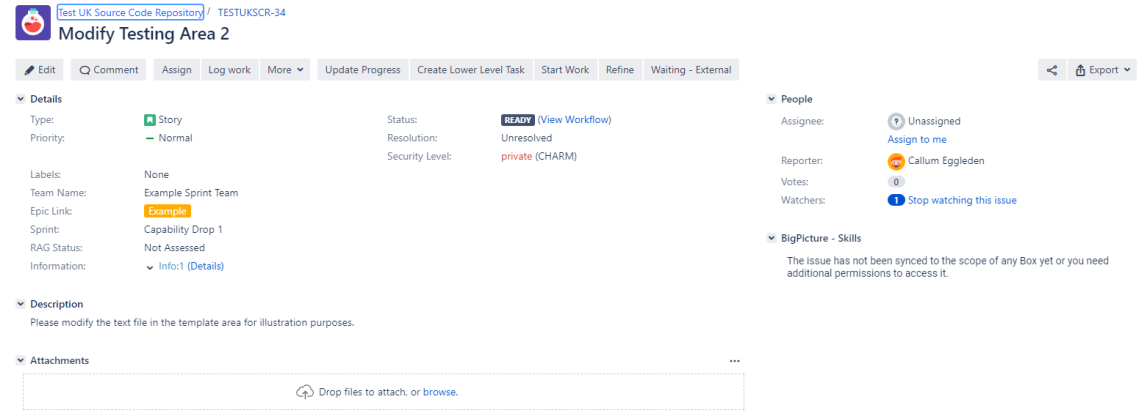


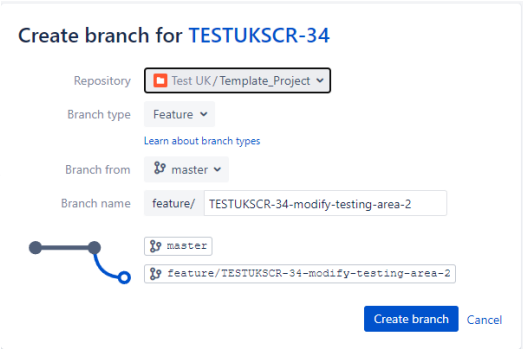



# Test SW Framework – SW Management (JIRA & Bitbucket)

- This is our Project Management area in JIRA.
- Create Kanban boards / sprints to show the status of tickets for individual projects, using a naming convention to filter.
- Create ticket detail with data from project requirements (HW & SW) and internal SW design documentation.
- Create Bitbucket Branches from Tickets to manage SW Development.

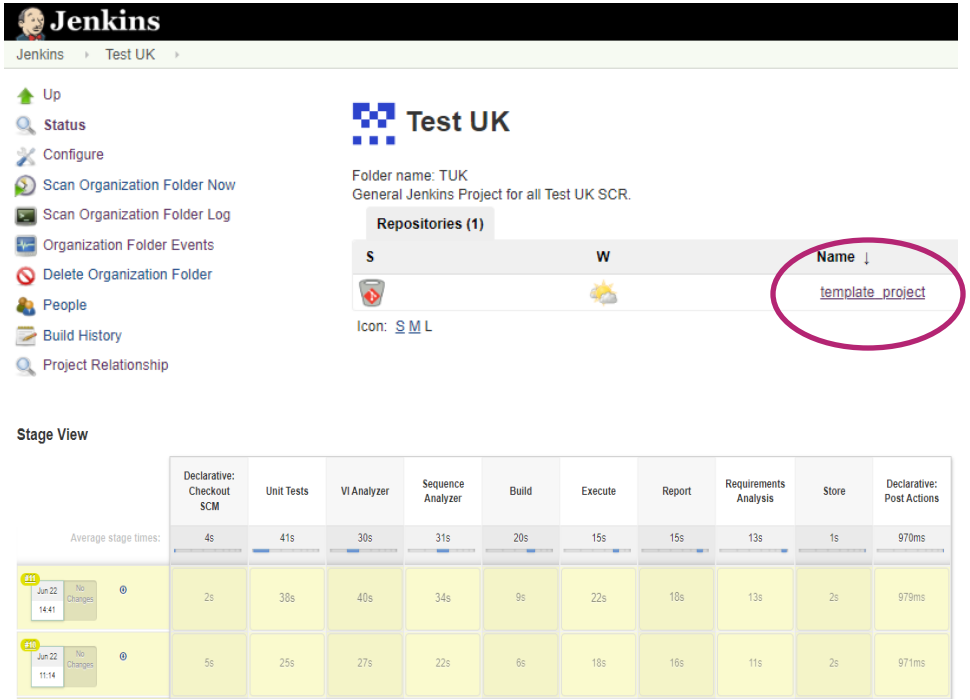


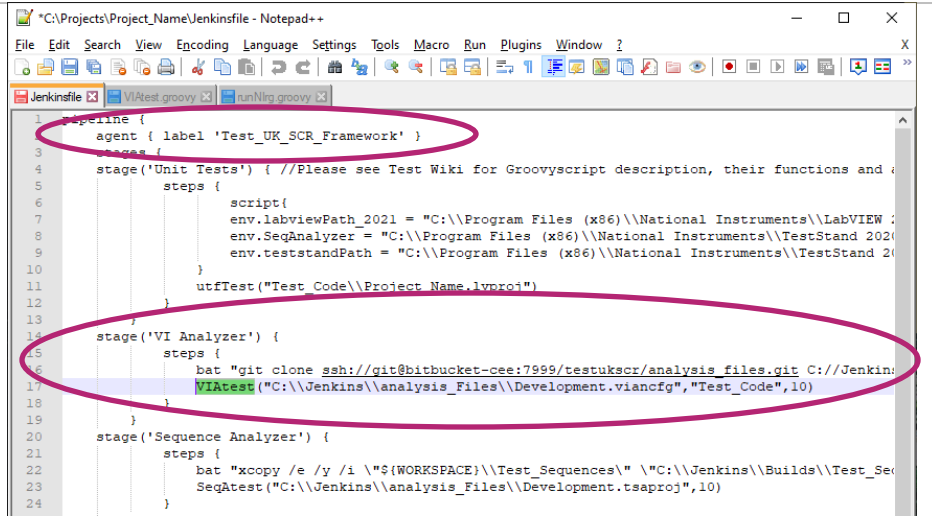
# Test SW Framework – Jenkins

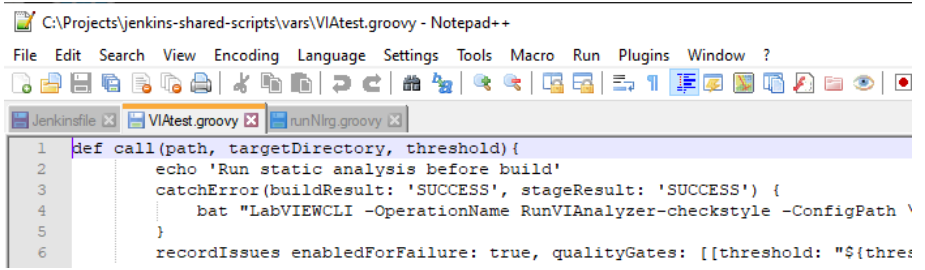
- Jenkins is a Build Automation Server. This instance of it is the project area for Test UK at Thales.
- It is linked to our Test UK project in Bitbucket & scans all repositories in there for a "Jenkinsfile" – A text file with this exact name & no extension.
- This Jenkinsfile is set up by the user and defines our CI Pipeline for that instance/branch of the project.
- Any repositories with a Jenkinsfile are presented in the project view. Clicking the repository will open up Jenkins view of it and present all active branches.
- A slave agent is set up by Jenkins and created on the target machine, usually a VM or test machine connected to hardware.
- Results dashboard detailing a history of each pipeline execution and changes in quality, errors etc.



# CI Pipeline Tools – Jenkinsfile, Groovyscripts

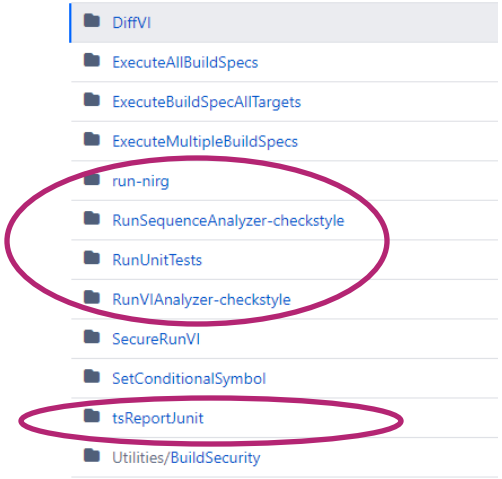
- "Jenkinsfile" – This is a text file that sits in the main area of a repository with this exact name & no extension, that defines our CI Pipeline.
- It tells Jenkins which Build Executor (Agent / Slave) to use. Each stage is defined and environment variables setup.
- The Jenkinsfile can be configured to switch stages in or out, create new stages etc. We have standard pipelines but these can be configured per project and/or on maturity of project.
- The Jenkinsfile calls "Groovyscripts". These are re-usable functions, kept in a separate repository (library) that Jenkins calls without needing to deploy to the target. The Jenkins Slave on the target machine executes the Jenkinsfile & Groovyscripts.
- We keep the groovyscripts as a repository in bitbucket that Jenkins calls as a shared library. This means the groovyscripts are under source control and aren't deployed with each project, preventing accidental changes, uncontrolled scripts etc.

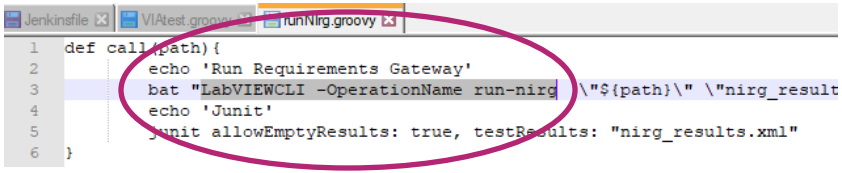


# CI Pipeline Tools – LabVIEW CLI / CMD

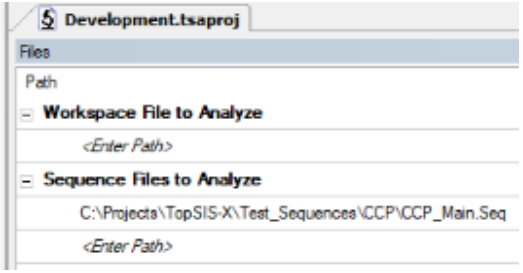
- Jenkins can use command line commands. These are either in the Jenkinsfile or part of a Groovyscript (set function).
- Some commands are standard CMD prompts for directory changing and file manipulation, others use LabVIEW CLI. LabVIEW CLI must be installed to drive LabVIEW to control the NI Suite of tools that forms our pipeline.
- Most LV CLI commands come as standard but we have created custom ones which we store in a separate repository. These need to be deployed to target PCs / VM before the pipeline can operate properly.
- The image on the right shows both Standard & Custom (circled) LV CLI functions.
- The image below this shows how it is called inside a Groovyscript.
- Without support from NI to create these & tie the rest of our framework together, we wouldn't have a CI pipeline. We estimate a saving of 6 months to setup.

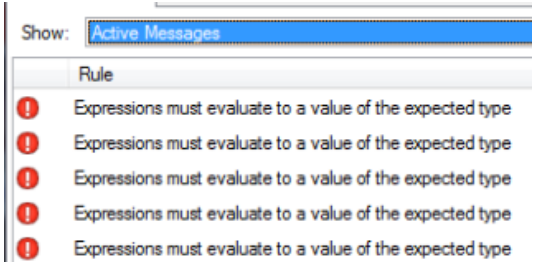


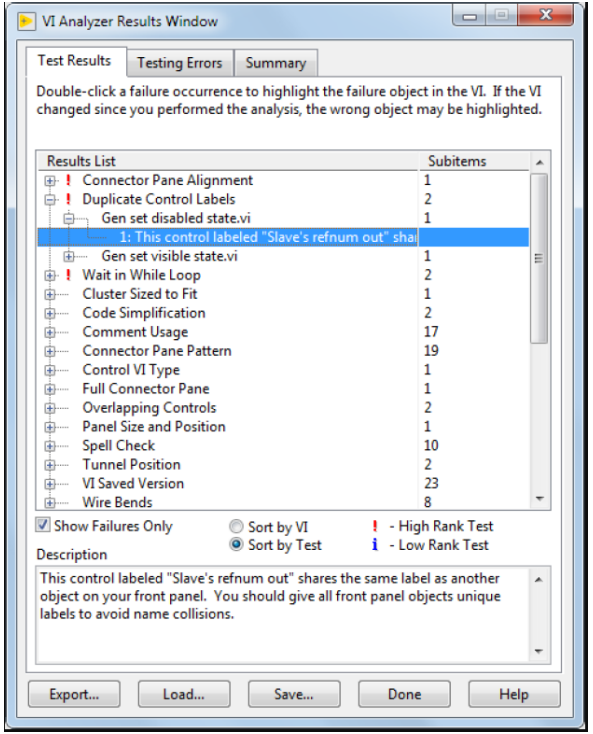



# CI Pipeline Tools – Static Analysis (VI Analyzer & Sequence Analyzer)

- These are the tools we use to check the VIs & sequences we create to ensure they meet our coding standards. This increases bug detection, maintainability and re-use. Currently performs 75 checks per VI and over 10 checks per sequence step.
- The config files for both analyzers are kept in a separate repository, which is deployed to the target machine and automatically used by the CI Pipeline, it does not require any user training or interaction post kick-off.
- The pipeline is configured to target a LabVIEW project and Sequence file(s) / workspace for analysis through the Jenkinsfile.

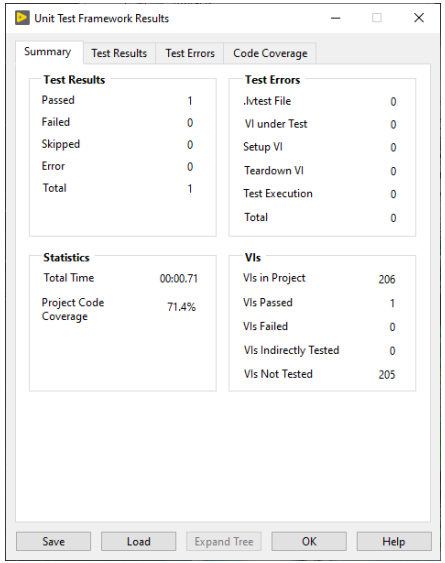


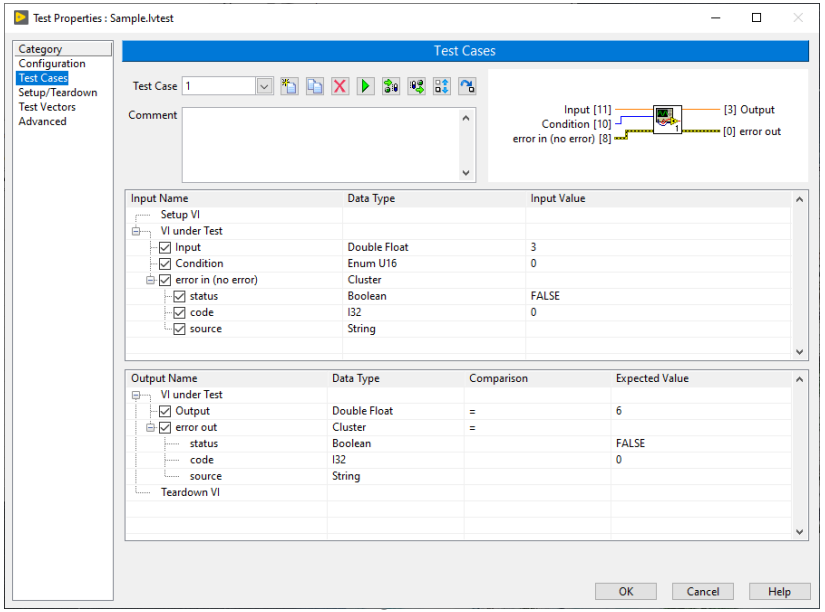



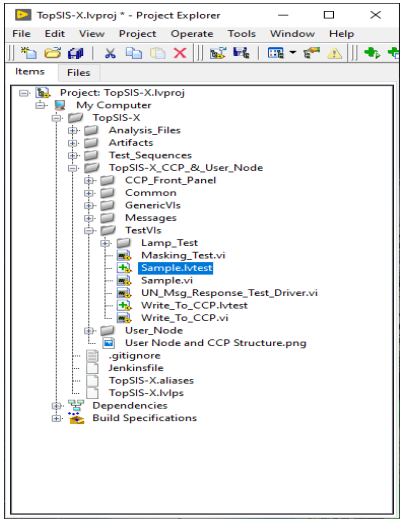



# CI Pipeline Tools – SW Testing (Unit Test Framework)

- Unit Test Framework – allows repeated functional validation as part of the pipeline. A test is created for each relevant VI. This could be; safety critical test VIs, VIs tied directly to a requirement, VIs simulating the functionality of a product or even VIs that get heavily re-used (HAL).
- The CI Pipeline targets the project file and executes all unit tests within, executing the tests every time the pipeline is run.
- This is ideal for regression testing & can be used to automatically generate validation documents.





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# CI Pipeline Tools – Test Execution

- By setting up a physical PC as a Jenkins slave agent and installing the required tools (LV / TS / Analysis tools etc), we schedule builds of our CI pipeline connected to actual test hardware and UUT. Allowing us to execute full tests.
- With proper error handling, this allows for a majority of longer tests to be run reliably overnight/weekends.
- Different configurations of simulators are setup in different Bitbucket branches using config files. This allows for easy R&R, regression, integration testing. All scheduled in Jenkins.
- Test results overview displayed starting with any failures, then all differences highlighted. We use a custom LV CLI step to parse the TestStand results report to into Junit format to allow for this.

### All Failed Tests

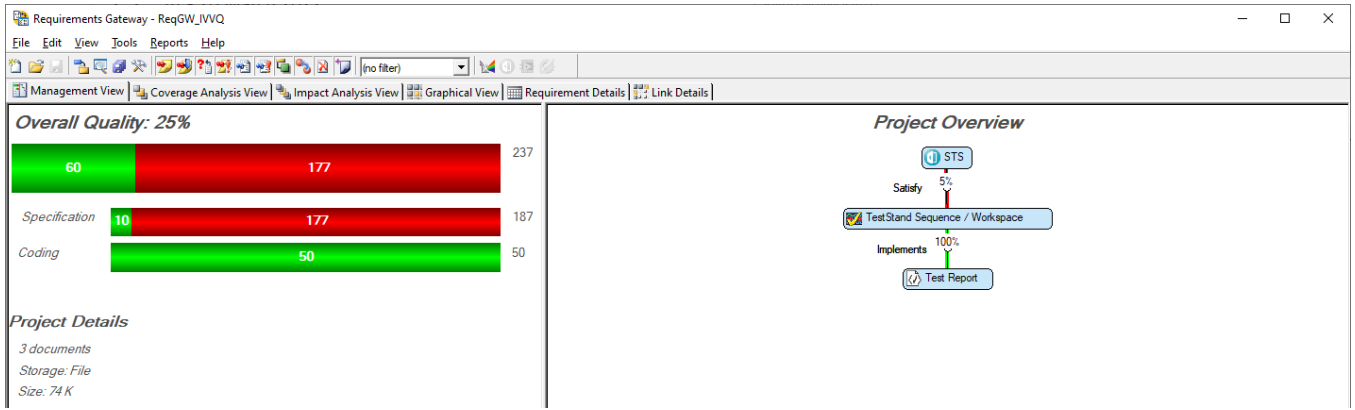
| Test Name |
|---|
| − Report / Module_1.seq\.CPU Test\.Register Test..Test_Step |
| − **Error Details** |
| Data Name: Register Test  Details: Start Date / Time : 2023-05-04 @ 14:35:22.023<br>End Date / Time : 2023-05-04 @ 14:35:22.023<br>Step Type : PassFailTest<br>Step Group : Main<br>Test Time : 3.93e-05<br>Test Data : Name = PassFail ---- Value = TRUE |
| + Requirements Analysis / IVVQ.rqtf\.Requirement\.PAS_PRJ..Requirement |
| + Requirements Analysis / IVVQ.rqtf\.Requirement\.Output Voltages Diagnostics..Requirement |
| + Requirements Analysis / IVVQ.rqtf\.Requirement\.Power Supply Diagnostics..Requirement |
| + Requirements Analysis / IVVQ.rqtf\.Requirement\.Input Voltages Diagnostics..Requirement |
| + Requirements Analysis / IVVQ.rqtf\.Requirement\.Advanced Power Management Diagnostics..Requirement |

### All Tests

| Package | Duration | Fail (diff) | Skip (diff) | Pass (diff) | Total (diff) |
|---|---|---|---|---|---|
| IVVQ.rqtf\.Requirement\ | 0 ms | 5 -10 | 0 | 46 +10 | 51 |
| **Module_1.seq\.CPU Diagnostics** | 0 ms | 0 | 0 | 5 +5 | 5 +5 |
| Module_1.seq\.CPU Test\ | 0 ms | 1 +1 | 0 | 4 -1 | 5 |
| Module_1.seq\.Main Sequence\ | 0 ms | 0 | 6 +4 | 5 | 11 +4 |
| Module_1.seq\.Power Supply Test\ | 0 ms | 0 | 0 | 3 | 3 |

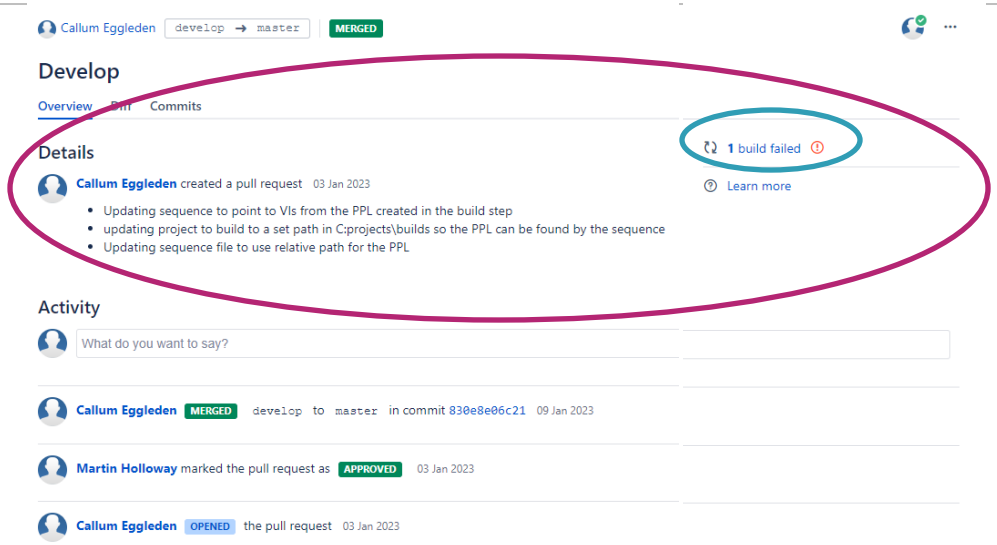
# CI Pipeline Tools – Requirement Analysis (Requirements Gateway)

- Allows linking between requirements documentation (DOORs/PAS) <> Test Code (Sequences / VIs) <> output reports of an execution of that test code. Automates tracking of progress through a project so far.
- Shows coverage between each link, i.e. how much of the requirements are covered in the sequence? How much of that sequence was executed in the last run? Therefore showing how many requirements were last met in that SW run.
- Bitbucket branches can contain SW configured to test all aspects in situations where test code may not execute a requirement in ideal conditions. E.g. a diagnostics subsequence may not execute when every test passes, but that subsequence must still exist, still be called on a failure and still be tested properly to ensure requirements are met.
- Only needs to be configured at project kick-off or when entering a new development phase (e.g. transitioning from IVV to Production).



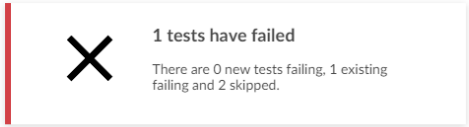
# Review Process – Bitbucket & Jenkins

- When an engineer initiates a pull request to merge a branch back into develop, the reviewer is presented with an overview of the changes.
- The changes are immediately clear from commit comments & the fact that the build failed shows there are issues present.
- Following circled link takes you through to the Jenkins Dashboard (BlueOcean in this case)



# Review Process – Bitbucket & Jenkins

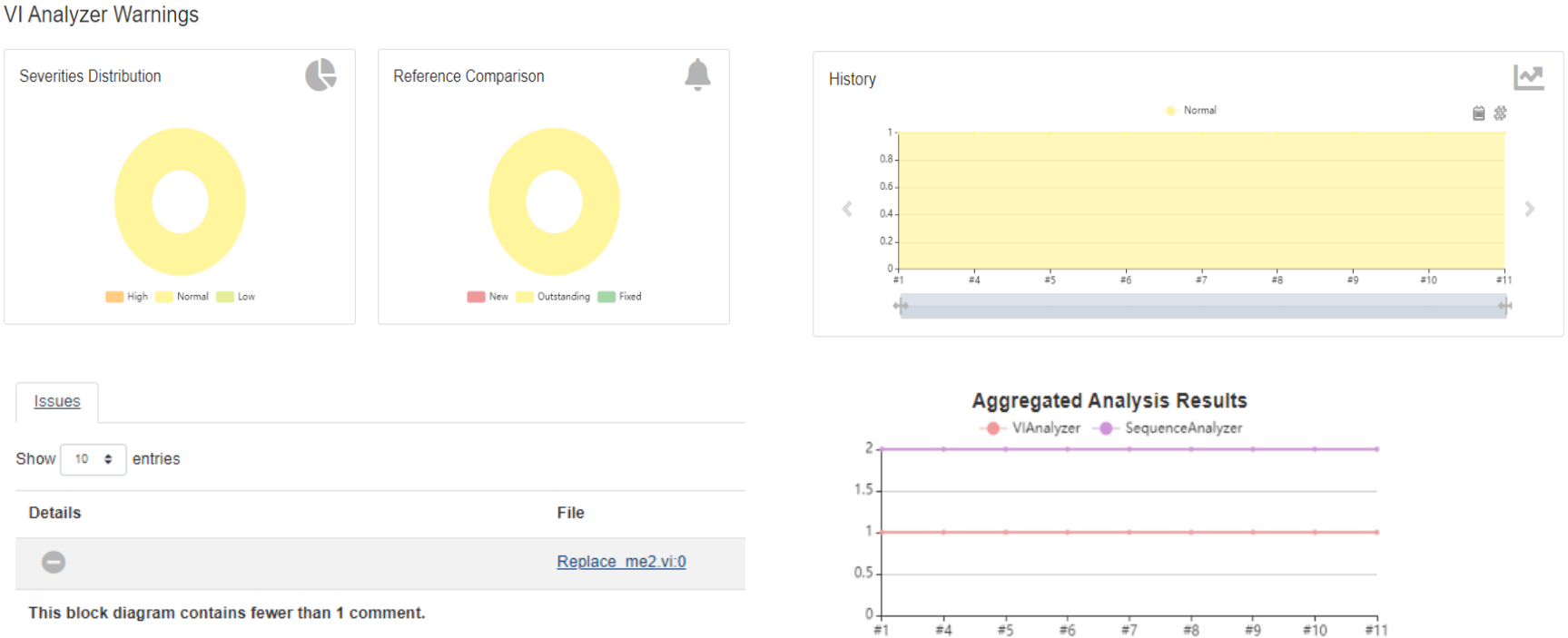




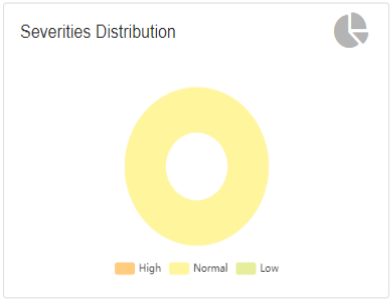

Existing failures - 1

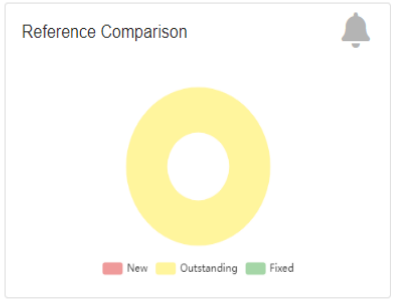
# CI Pipeline Tools – Jenkins Dashboard View (VI Analyzer)

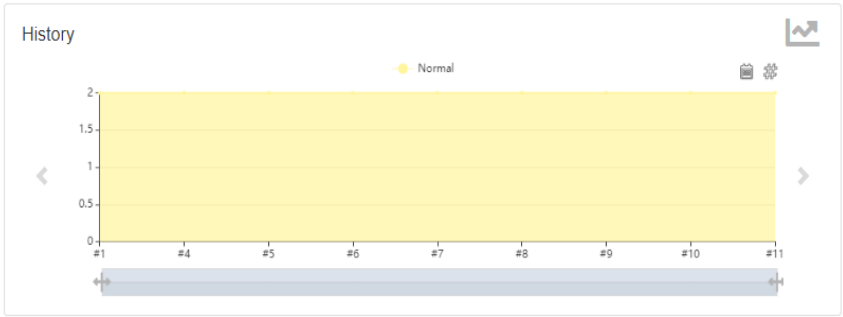




# CI Pipeline Tools – Jenkins Dashboard View (Sequence Analyzer)




Details

Issues

Show 10 entries

| Details | File |
|---|---|
| ⊖ | Module_1.seq:0 |

Step run mode is set to Skip. in Data.Seq["MainSequence"].Setup["Simulation Dialog"].TS.Mode

# CI Pipeline Tools – Junit Test Result Detail



## Test Result

17 failures (±0)

### All Failed Tests

| Test Name |
|---|
| Unit Tests / Project_Name.lvproj\.Unit_Tests\._Test Case 1 |
| Unit Tests / Project_Name.lvproj\.Unit_Tests\._Test Case 2 |
| Requirements Analysis / ReqGW_Prod.rqtf\.Requirement\.CPU Diagnostics..Requirement |
| Requirements Analysis / ReqGW_Prod.rqtf\.Requirement\.ROM Diagnostics..Requirement |
| Requirements Analysis / ReqGW_Prod.rqtf\.Requirement\.RAM Diagnostics..Requirement |
| Requirements Analysis / ReqGW_Prod.rqtf\.Requirement\.Video Diagnostics..Requirement |
| Requirements Analysis / ReqGW_Prod.rqtf\.Requirement\.Keyboard Diagnostics..Requirement |
| Requirements Analysis / ReqGW_Prod.rqtf\.Requirement\.Else..Requirement |
| Requirements Analysis / ReqGW_Prod.rqtf\.Requirement\.Power Supply Diagnostics..Requirement |
| Requirements Analysis / ReqGW_Prod.rqtf\.Requirement\.Register Diagnostics..Requirement |
| Requirements Analysis / ReqGW_Prod.rqtf\.Requirement\.Instruction Set Diagnostics..Requirement |
| Requirements Analysis / ReqGW_Prod.rqtf\.Requirement\.Cache Diagnostics..Requirement |
| Requirements Analysis / ReqGW_Prod.rqtf\.Requirement\.FPU Diagnostics..Requirement |
| Requirements Analysis / ReqGW_Prod.rqtf\.Requirement\.Speed Diagnostics..Requirement |
| Requirements Analysis / ReqGW_Prod.rqtf\.Requirement\.Input Voltages Diagnostics..Requirement |
| Requirements Analysis / ReqGW_Prod.rqtf\.Requirement\.Output Voltages Diagnostics..Requirement |
| Requirements Analysis / ReqGW_Prod.rqtf\.Requirement\.Advanced Power Management Diagnostics..Requirement |

## Test Result

4 failures (+4) , 16 skipped (+16)

40 tests (+20)
Took 3 min 43 sec.
add description

### All Failed Tests

| Test Name | Duration | Age |
|---|---|---|
| CHROME_48_0_2564_97_Linux_.guineaPig_1.Guinea Pig Assert Title 1 - A | | |
| Error Details: Testing if the page title equals "I am a page title - Sauce Labs - A". | 4.3 sec | 1 |
| Stack Trace | | |
| FIREFOX_45_0_LINUX_.guineaPig_1.Guinea Pig Assert Title 1 - A | | |
| Error Details: Testing if the page title equals "I am a page title - Sauce Labs - A". | 7.1 sec | 1 |
| Stack Trace | | |
| INTERNET EXPLORER_11_WINDOWS_.guineaPig_1.Guinea Pig Assert Title 1 - A | 7.9 sec | 1 |
| MICROSOFTEDGE_undefined_ANY_.guineaPig_1.Guinea Pig Assert Title 1 - A | 16 sec | 1 |

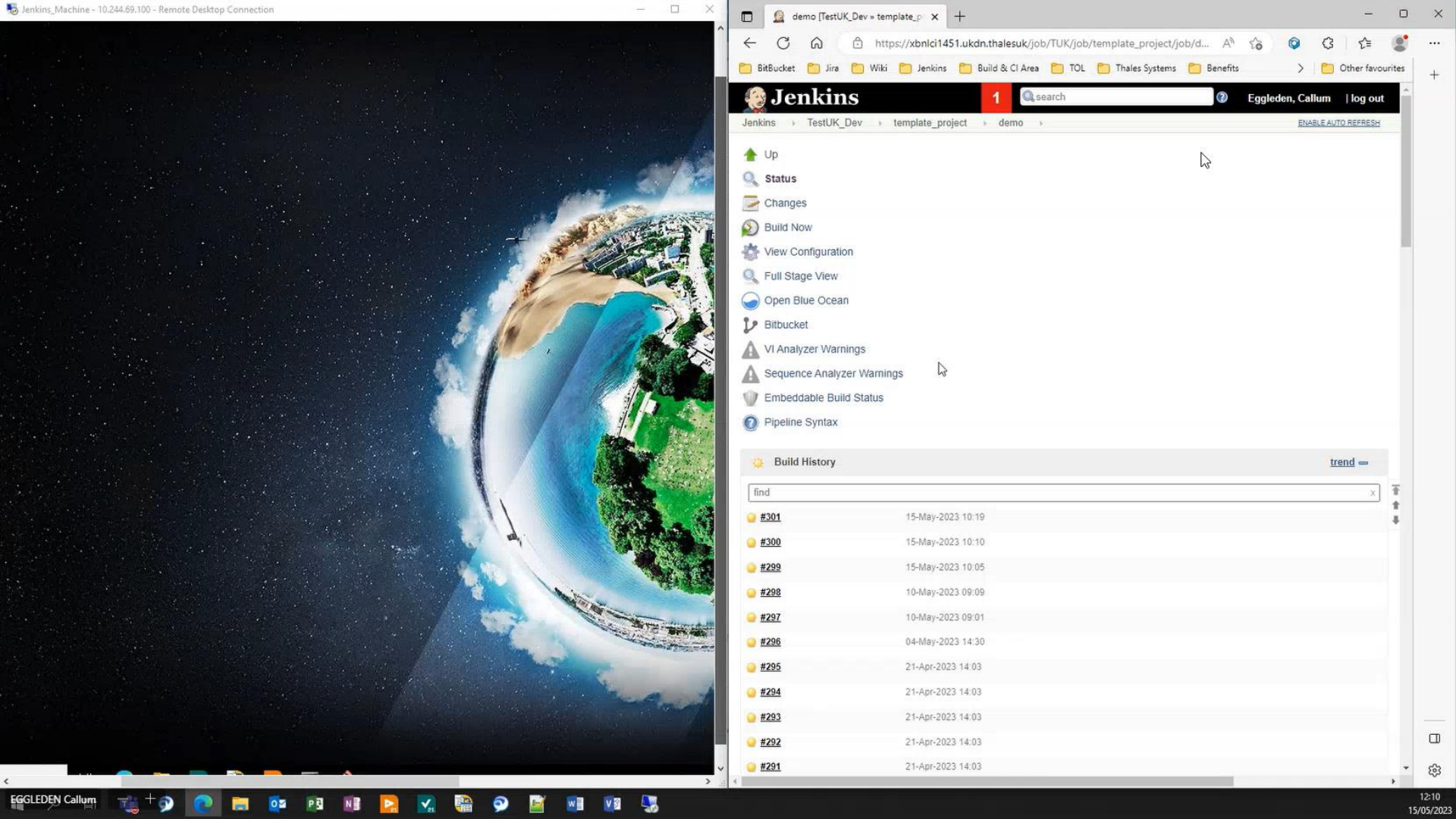
### All Tests

| Package | Duration | Fail | (diff) | Skip | (diff) | Pass | (diff) | Total | (diff) |
|---|---|---|---|---|---|---|---|---|---|
| CHROME_48_0_2564_97_Linux_ | 24 sec | 1 | +1 | 4 | +4 | 5 | | 10 | +5 |

| Package | Duration | Fail (diff) | Skip (diff) | Pass (diff) | Total (diff) |
|---|---|---|---|---|---|
| Project_Name.lvproj\.Unit_Tests\ | 52 ms | 2 | 0 | 0 | 2 |
| ReqGW_Prod.rqtf\.Requirement\ | 0 ms | 15 | 0 | 38 | 53 |

# Summary of Benefits

- Automated regression testing - SW Unit testing ensures the detection of unexpected changes & behaviour in existing code which can be fixed before it becomes a bigger issue – saves a large number of wasted hours. This testing occurs on every push back to the repository and every merge.
- Automated requirements capture - Links requirements from test sequences back to DOORs / PAS documents for IVVQ / Production. Captures project status and any scope creep - will aid in understanding & estimating of future projects.
- Automated quality checks - Enforces coding standards on VIs & Sequences, making it easier for multiple engineers to work on and understand.
- "Passive training" where people will naturally adjust their code to meet coding standards prior to pipeline feedback.
- Improved code quality & bug detection – Better, clearer code makes it easier, maintain understand and re-use. Faster bug detection allows for quick fixes while in the same headspace.
- Can execute fully automated tests in either VMs or Physical Machines & report back (useful for HIL or Gauge R&R).
- A Dashboard of pipeline results - Reduced time spent in reviews, quality status available "at a glance". Results from each build are kept together with the individual build so it's all tied together.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template_project
demo
ENABLE AUTO REFRESH
Up
Status
Changes
Build Now
View Configuration
Full Stage View
Open Blue Ocean
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Sequence Analyzer Warnings
Embeddable Build Status
Pipeline Syntax
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#301 15-May-2023 10:19
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#299 15-May-2023 10:05
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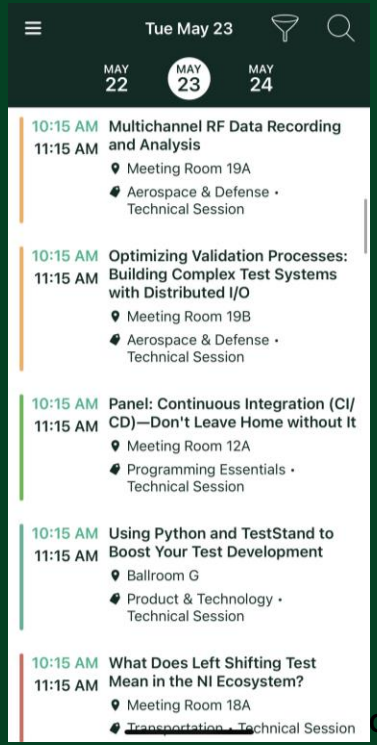
# Questions

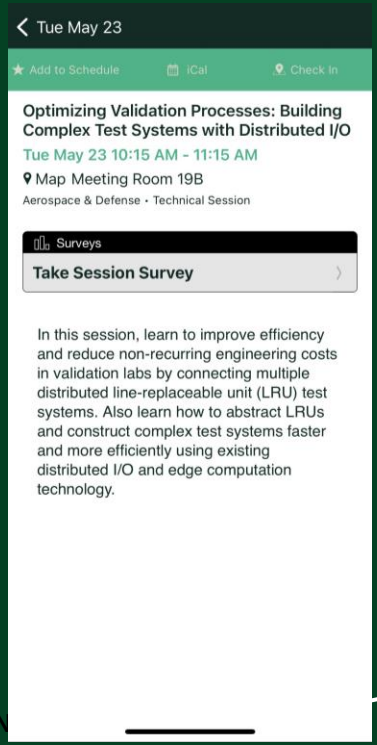
# Links

- Continuous Integration – Learning Path
  - https://learn.ni.com/learning-paths/continuous-integration
- VI Analyzer – checkstyle
  - https://github.com/LabVIEW-DCAF/VIA-Checkstyle
  - https://forums.ni.com/t5/Continuous-Integration/VI-Analyzer-Results-gt-Checkstyle-Format/td-p/3741067?profile.language=en
- Requirements Gateway - JUnit
  - https://forums.ni.com/t5/Distributed-Control-Automation/Requirements-Gateway-in-Continuous-Integration/td-p/3915133?profile.language=en

# Give us your feedback!
# Quick 2 Question Survey

In the mobile app, click into the session you would like to provide feedback for




Click “Take the Session Survey”