Autopilot for Firmware Validation(AFV) and Test Gap Identification(TGI)

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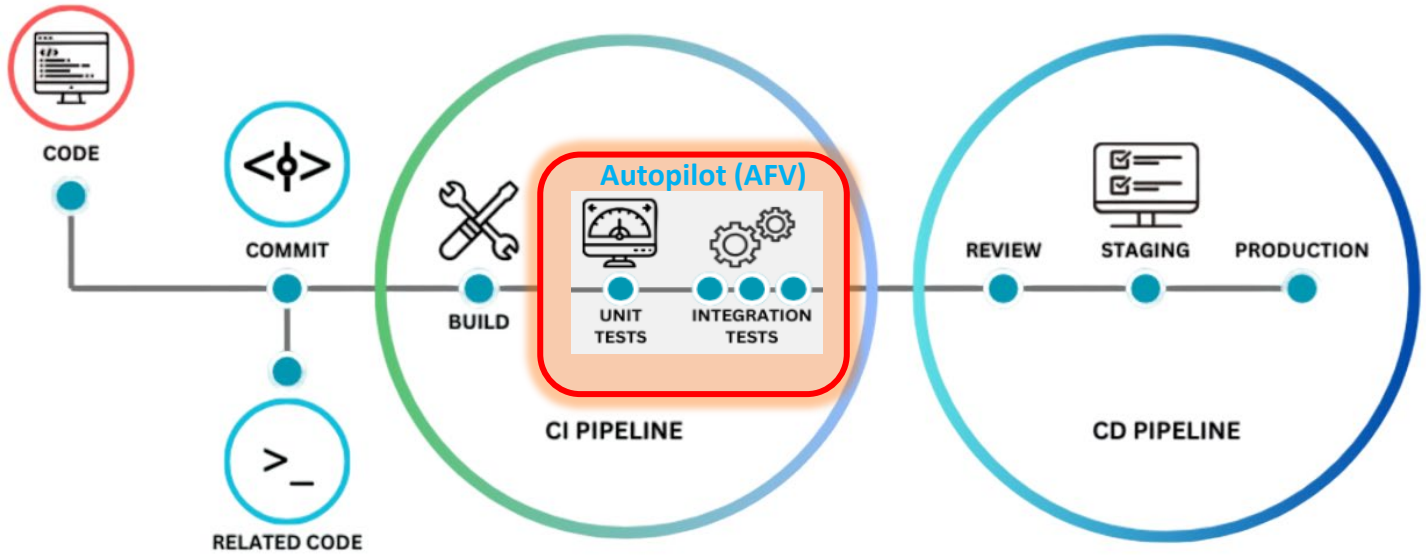
Outline

- Background
- Objective
- Modules Introduction (FBE/Spark NLP-DTCB-FV/TAM)
- Functional Flow
- Coverage Report (AFV/TGI)
- Conclusion

Background

- Testing **multiple Firmware builds** including incremental features across different products is a challenging task
- Manual **“Test Plan/Priority”** Creation is not scalable and industry more often goes with a **static test plan**

Autopilot (AFV) is a **Plug-n-Play Solution** that can prepare **dynamic test plans** in CI/CD and report **test gaps**



Objective

- Automated Test Plan Creation(Dynamic)
- Test Gap Identification
- Reduce Test Execution Time (Target Testing)
- Reduce TAT for Defect Detection

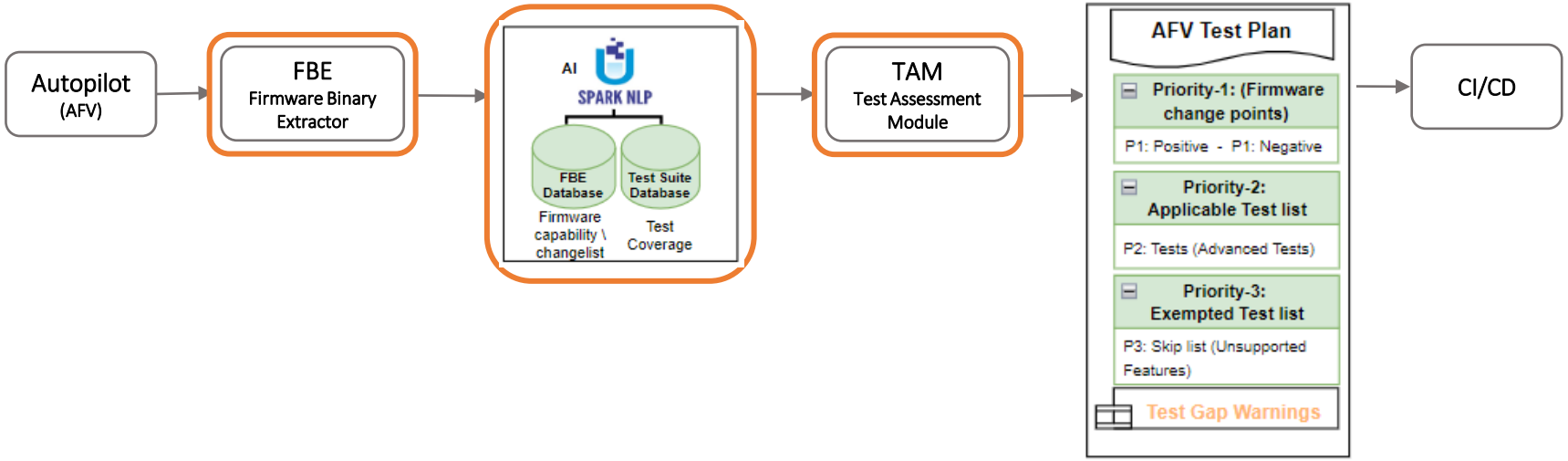
Reference: Open Source

- **Firmware:** QEMU \ NVMe Spec
- **Test Suite:** PyNVMe

Modules Introduction

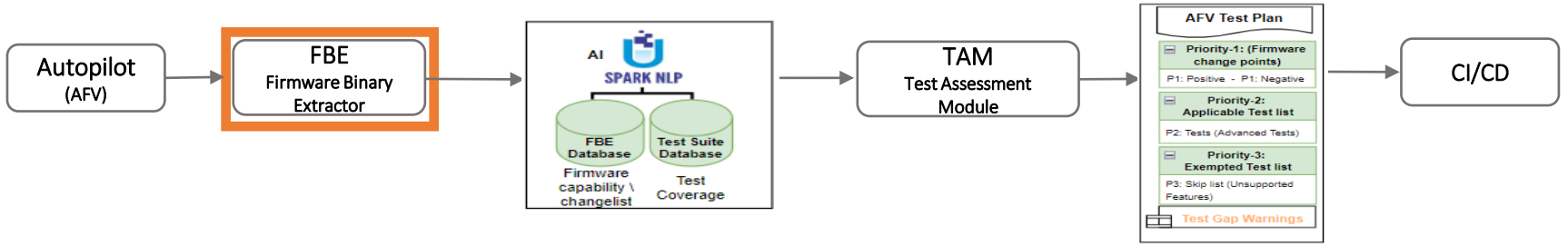
Autopilot is an AI/ML-powered tool that can be integrated in CI/CD to automate Test Plan/Priority

- **Firmware Binary Extractor (FBE):** Creates a database with all firmware, Controller Capabilities and Change Points
- **Spark NLP-DTCB-FV:** Identifies keywords and map test cases as per each command enabled/disabled or modified in firmware
  (Spark NLP Based Dynamic Test Case Bundling for Firmware Validation)
- **Test Assessment Module (TAM):** Processes the FBE vs Test Suite Database and dynamically prepares priority test list and reports errors for test gaps using **Spark NLP-DTCB-FV**

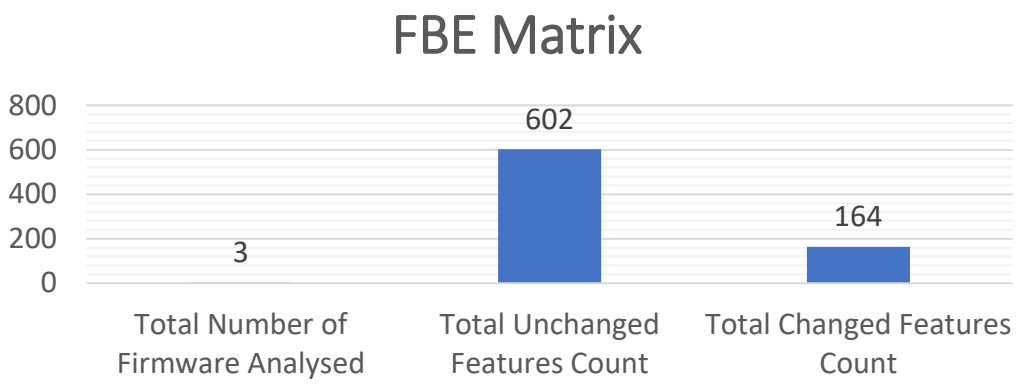


Firmware Binary Extractor

- FBE extracts all **Firmware/Controller properties** and creates a database
- FBE tracks change points from source code repo linked based on code diff and maps respective opcodes affected using **SPARK NLP-DTCB-FV**

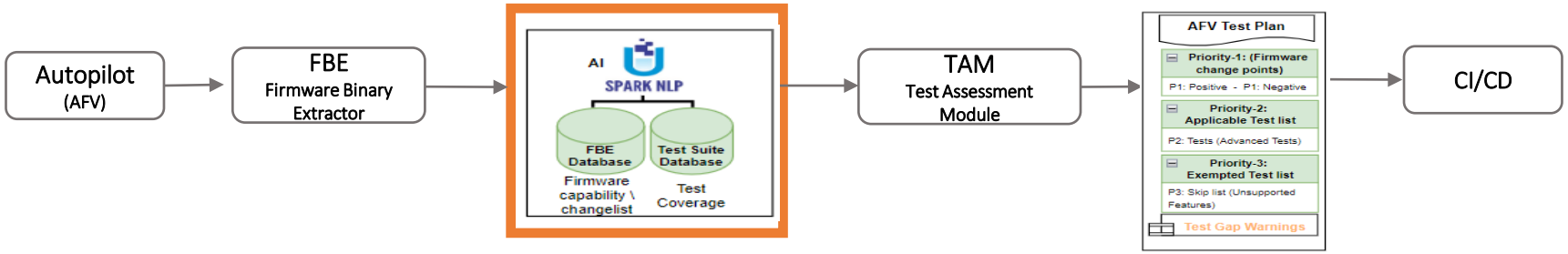


Structure Name	Description	Change Points	Firmware-1	Firmware-2	Firmware-3
Controller Type	Controller Supported	Changed	2	1	2
Identify Controller Structure	OACS	Unchanged	0	0	0
Identify Controller Structure	ACL	Changed	64	32	32
Identify Controller Structure	ACWU	Changed	65532	0	0
Identify Controller Structure	AERL	Changed	16	8	16
Identify Controller Structure	APSTA	Unchanged	0	0	0
Identify Controller Structure	NPSS	Unchanged	1	1	1
Identify Controller Structure	AVSCC	Unchanged	0	0	0

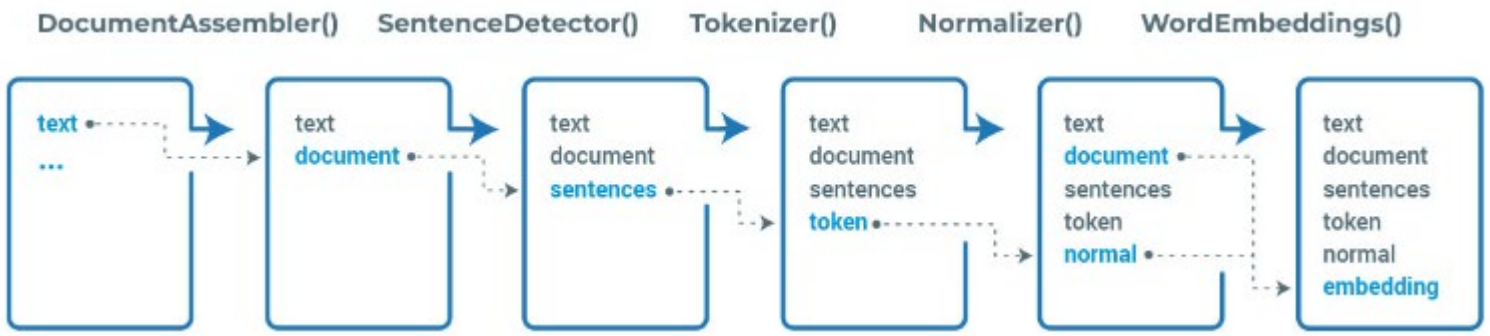


Spark NLP-DTCB-FV (Spark NLP Based Dynamic Test Case Bundling for Firmware Validation)

Spark NLP is an open-source library maintained by John Snow Labs built on top of Apache Spark and Spark ML



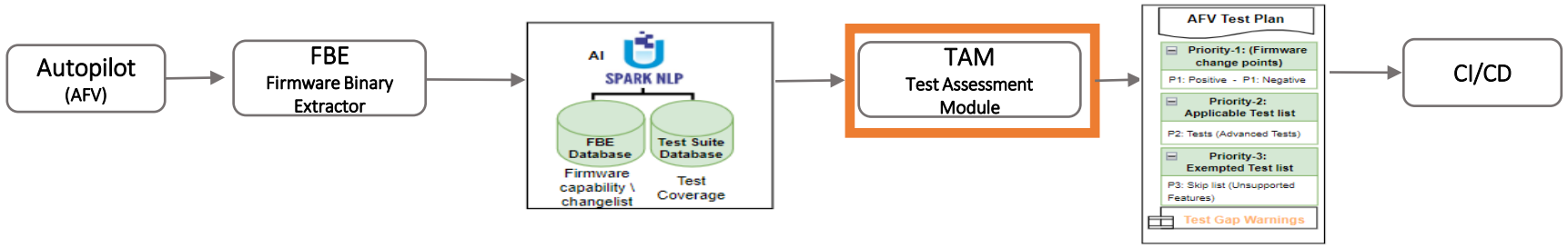
- Spark NLP processes the data using Pipelines and structures
- Each annotator has input(s) annotation(s) and outputs new annotation



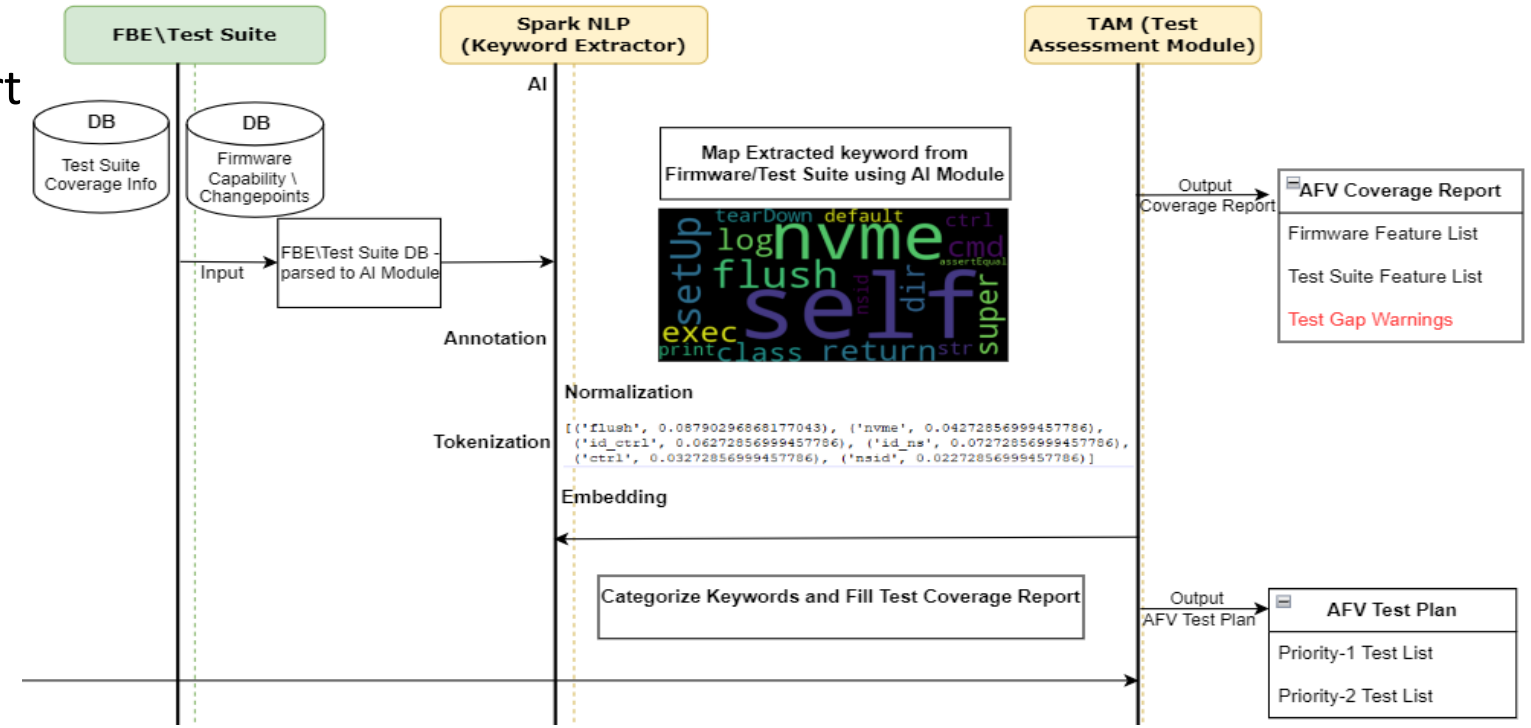
Spark NLP Pipelines

Test Assessment Module

- TAM Module using SPARK NLP extracts keywords from Firmware/Test Suite Database



- Keywords are tokenized and normalized using annotators to dynamically prepare
  - AFV Test Plan
  - AFV Coverage Report

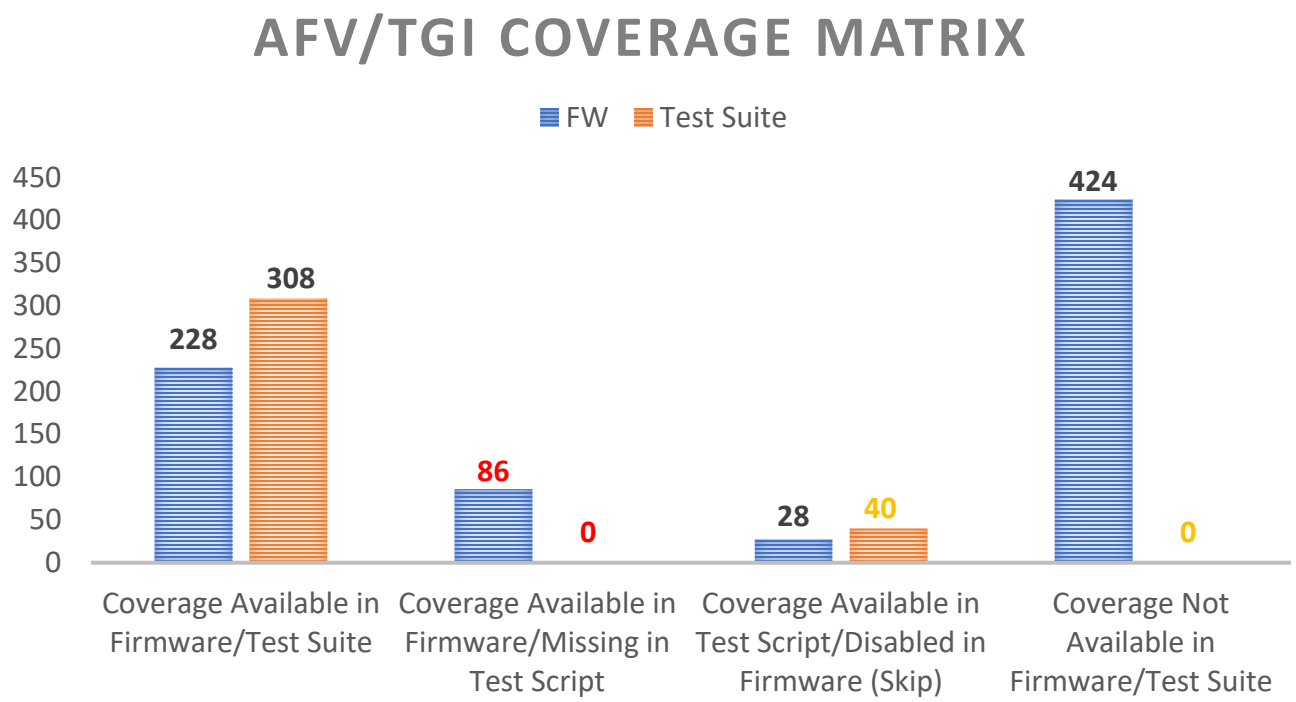


Coverage Report

Reference: Opensource

- **Firmware:** QEMU - Features Count extracted from NVMe Spec fields (IDFY, PEL, LID, FID, PCIe Registers)
- **Test Suite:** Data Extracted from PyNVMe

AFV/TGI Coverage Report	Firmware	Test Suite
Coverage **Available** in Firmware/Test Suite	228	308
Coverage Available in Firmware/**Missing** in Test Script	86	To Be Developed
Coverage Available in Test Script/**Disabled** in Firmware (**Skip**)	28	40
Coverage **Not Available** in Firmware/Test Suite	424	Left Shift Readiness
Total Firmware Feature's / Test Script	**766**	**348**



Conclusion

- Test Coverage
  - Target Testing - prioritizing Firmware Change points coverage
  - Supports Test Case Identification/Test Gap Identification
- Test Execution
  - Dynamic Test Plan improves TAT for Defect Detection
  - Reduces Test Execution Time and SKIP analysis effort
- Automated Solution
  - Plug-n-Play Solution over any Test Suites/Firmware
  - End-to-End Automation Solution

THANK YOU