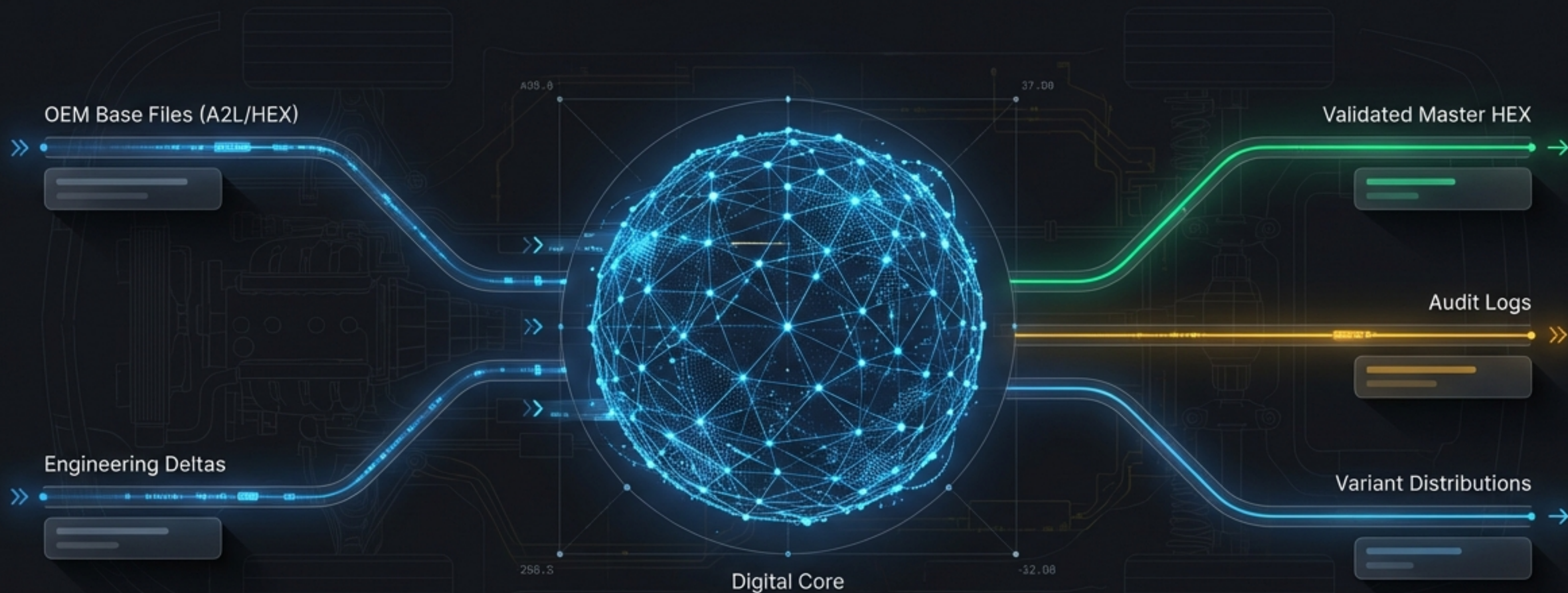


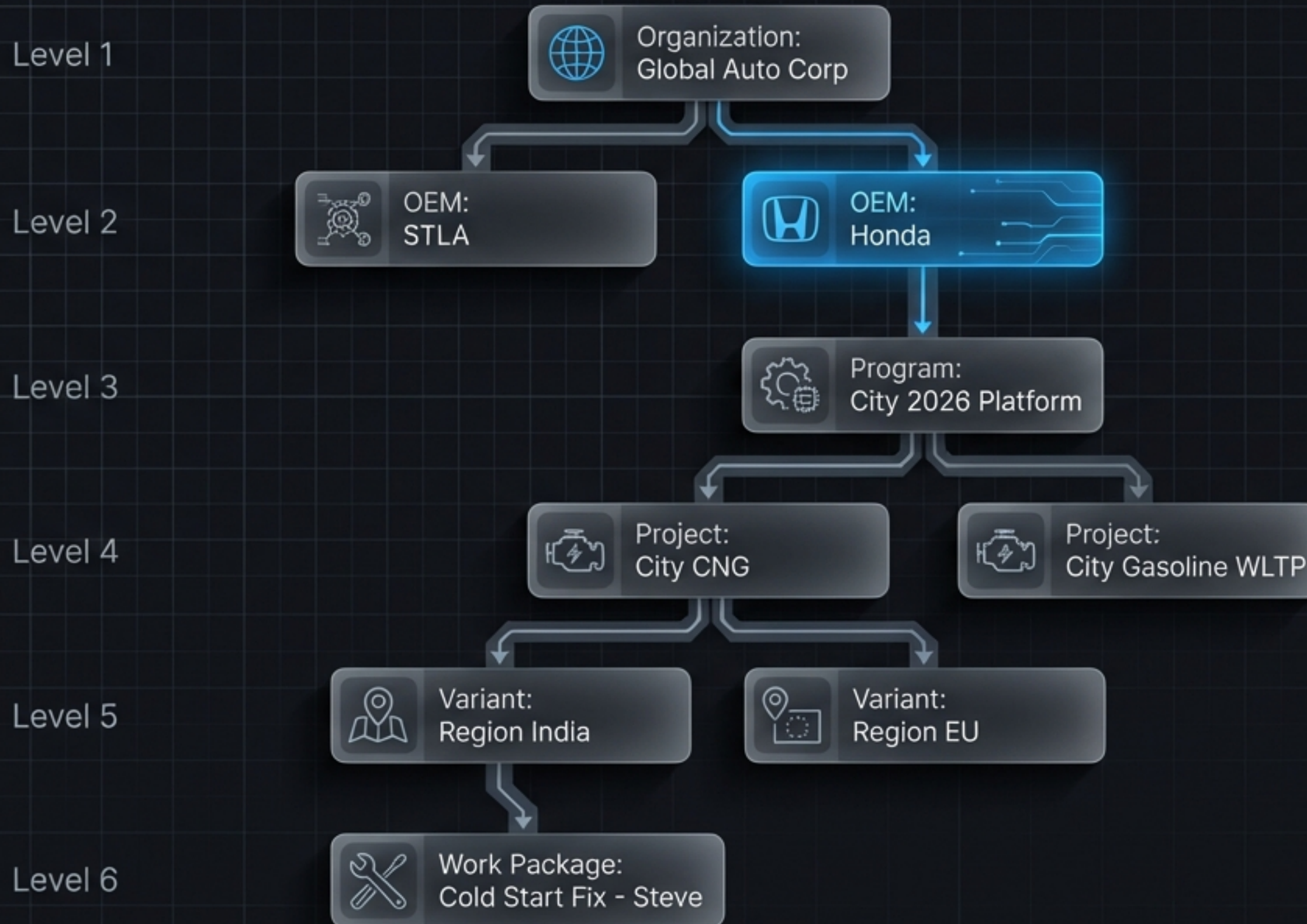
HELIX: Calibration Lifecycle Management Ecosystem

From Base HEX to Master Release – A Unified Workflow for OEMs



Control panel with a bar chart icon and a list icon, accompanied by two horizontal bars (one blue, one green).

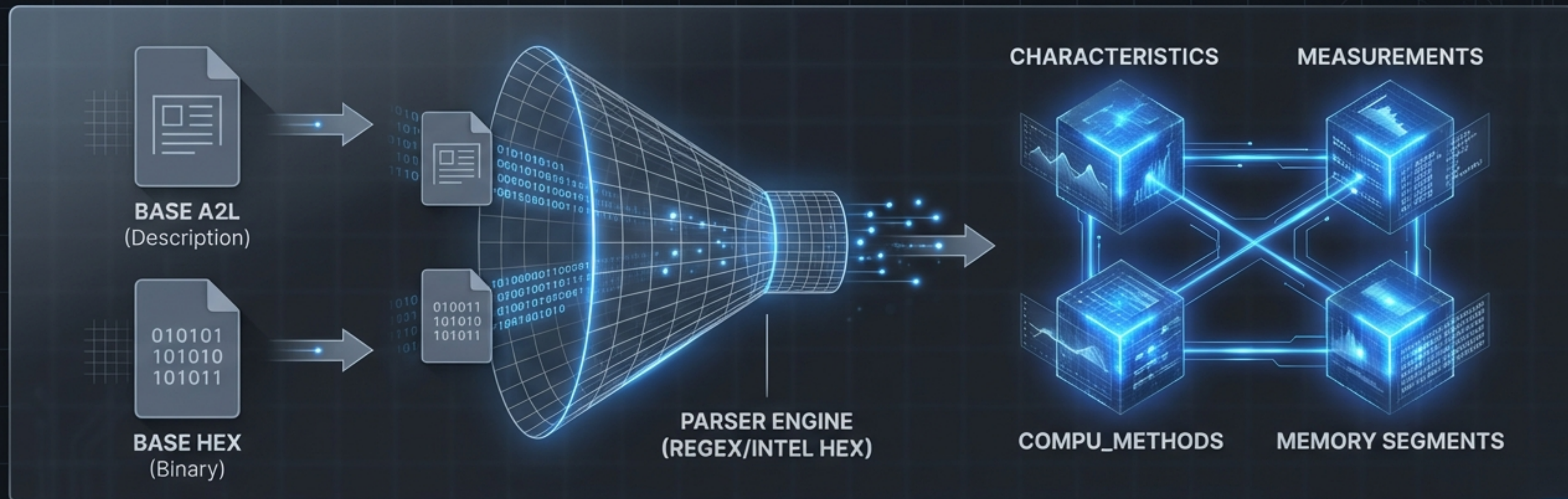
The High-Level Topology: A 'God View' for Managers



UNIFIED HIERARCHY & CONTEXT

- Unified Hierarchy:** Manage multiple OEMs and Projects in a single dashboard.
- Context Aware:** Every parameter change is strictly scoped to its specific hierarchy branch.

PHASE 1: INGESTION & PARSING



INPUT

Upload OEM Base A2L and HEX files to establish the "Gold Master" foundation.

PROCESSING

Extracts characteristics, maps, and axes into a relational database (SQLAlchemy models).

VALUE

Transforms static flat files into a queryable, living data structure.

THE DATA MODEL: BEYOND FLAT FILES

```
/begin
CHARACTERISTIC K_Engine_Map
...
CHARACTERISTIC K_Engine_Map >ontfr
CHARACTERISTIC K_Engine_Map -@ccom
CHARACTERISTIC MA_ARRAY_MAP Eoad_
CHARACTERISTIC K_CATAADCLASURE_FO
CHARACTERISTIC MR_THESTORY_BETATST
CHARACTERISTIC DB_INTREGENT_WEIGHT
CHARACTERISTIC DE_cond_pimointipa
CHARACTERISTIC DE_cond_ptmointliw
CHARACTERISTIC DT_couise_btoekinn
CHARACTERISTIC DE_svrn_permit_cond
CHARACTERISTIC HT_Engine_atmelima
CHARACTERISTIC UT_Engine_rourt_cor
CHARACTERISTIC KT_ENGINE_MAP _k_er
...
...
/end CHARACTERISTIC
```

STANDARD A2L (STATIC TEXT)



K_ENGINE_MAP
ARRAY[16X16]

MATURITY: BETA

AUTHOR: J. DOE

HISTORY: 3 VERSIONS

STATUS: FROZEN

HELIX RICH DATA OBJECT

RICH META MODEL

HELIX wraps every parameter in metadata: Maturity levels, comment threads, and modification history.

TRACEABILITY

Every data point is linked to a specific Author and Work Package.

COMPLIANCE

Built on ASAM MCD-2 MC standards.

PHASE 2: VARIANT MANAGEMENT STRATEGY

GLOBAL MASTER (GASOLINE)

REGION: INDIA (HIGH TEMP)

LOCAL DELTAS

REGION: EU (STRICT EMISSIONS)

HIGH PERFORMANCE TRIM

****Inheritance****: Derived variants automatically inherit values from the Master trunk.

****Delta Storage****: HELIX stores only the **changes** (Deltas), reducing database bloat and ensuring the Master remains the single source of truth.

****Scope****: Supports massive variant trees for global platforms.

PHASE 3: THE WORK PACKAGE (vCDM COMPLIANT)

WP-2026-045: Idle Speed Adjustment


IN PROGRESS



Engineer: Sarah



Variant: Honda City CNG

1. K_Idle_Target Old: 800 | **New: 850**
2. Map_Warmup_Enrichment [Map Data] 
3. Cur_Ignition_Idle [Curve Data] 
4. N_Eng_Max_Limit Old: 6500 | New: 6500
5. T_Coolant_Fan_On Old: 95 | **New: 98**

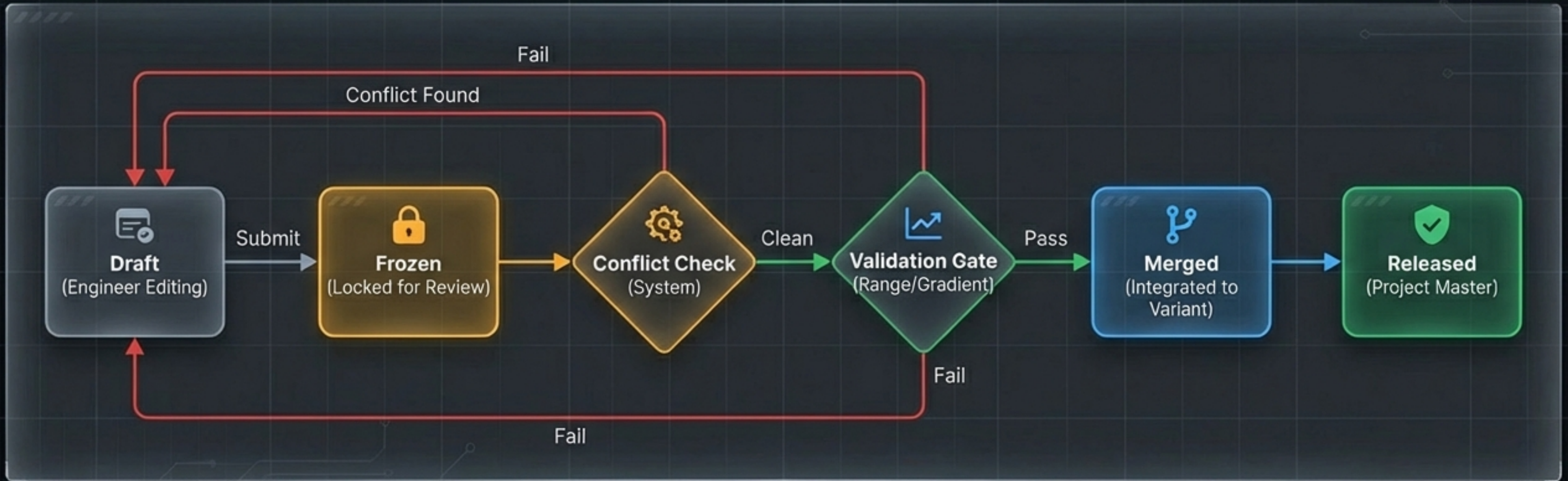
Comments (2) | Attachments (1) | Maturity: B-Sample

****Definition****: A container for a specific set of calibration changes linked to a specific task and engineer.

****Isolation****: Engineers work in isolated packages, preventing accidental overwrites of the Master.

****Context****: Includes comments, attachments, and maturity tags for every change.

THE STATE MACHINE: LIFECYCLE LOGIC



Strict transitions ensure no unvalidated data enters the Master branch. Automated system checks occur between 'Frozen' and 'Merged' states.

CONFLICT RESOLUTION & MERGING

⚠️ CONFLICT DETECTED: Map_Ignition_Angle

Three-Way Merge

Base Value

18.0	20.0	22.0	24.0	26.0
18.0	20.0	22.0	24.0	26.0
18.0	20.0	22.5	24.0	26.0
18.0	20.0	22.0	24.0	26.0
18.0	20.0	22.0	24.0	26.0

Work Package A

18.0	20.0	22.0	24.0	26.0
18.0	20.0	22.0	24.0	26.0
18.0	20.0	24.0	24.0	26.0
18.0	20.0	22.5	24.0	26.0
18.0	20.0	22.0	24.0	26.0

Work Package B

18.0	20.0	22.0	24.0	26.0
18.0	20.0	22.5	24.0	26.0
18.0	20.0	23.5	24.0	26.0
18.0	20.0	22.5	24.0	26.0
18.0	20.0	22.0	24.0	26.0

****Protection*:** The system prevents silent overwrites. Conflicts must be explicitly resolved.

****Granularity*:** Conflict detection happens at the individual parameter level.

PHYSICAL LINKAGE: VEHICLE MANAGEMENT

Fleet Matrix

Physical Asset ID	Project	Software Variant	Allocated Engineer	Status
Test Car 01 (VIN...883)	City CNG	Build v2.4 (India)	Mike T.	● Active
Dyno Bench 3	City Gasoline	Build v2.1 (Base)	Sarah J.	● Idle
Test Car 04 (VIN...992)	City CNG	Build v2.5 (High Alt)	--Unassigned--	● Maintenance

N-Cars per Project:

Define and track multiple physical vehicles per project.

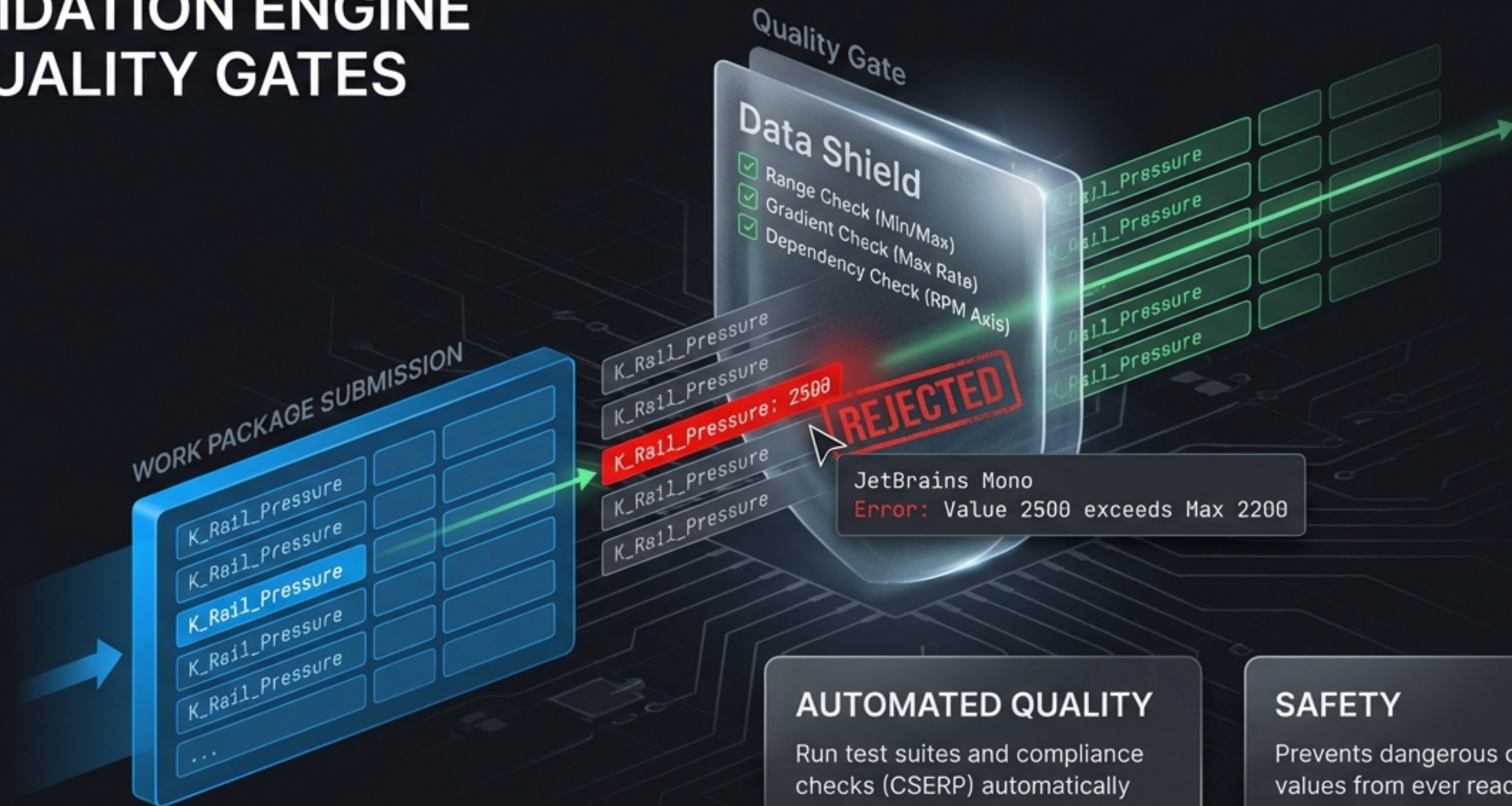
Visibility:

Instantly see which software variant is running on which physical asset.

Utilization:

Track engineer allocation to specific vehicles.

VALIDATION ENGINE & QUALITY GATES



AUTOMATED QUALITY

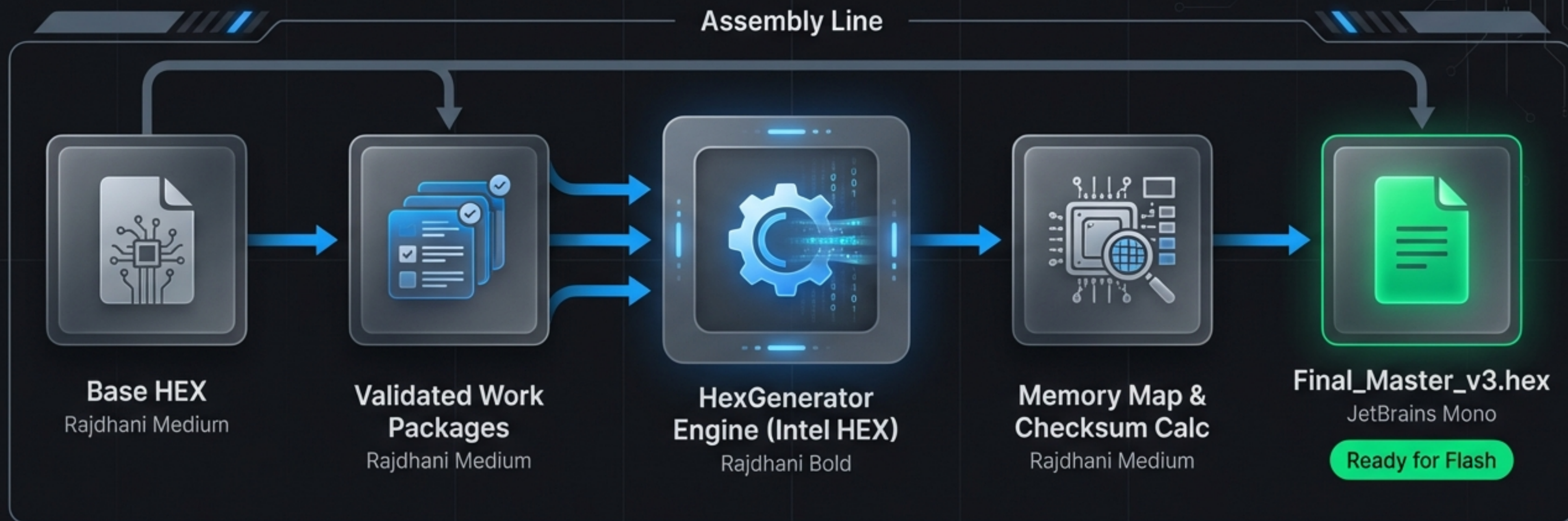
Run test suites and compliance checks (CSERP) automatically upon submission.

SAFETY

Prevents dangerous calibration values from ever reaching the physical ECU.

Phase 4: HEX Generation (The Output)

Rajdhani Bold



Reconstruction: The system reconstructs the binary on-demand by applying validated deltas to the base image.

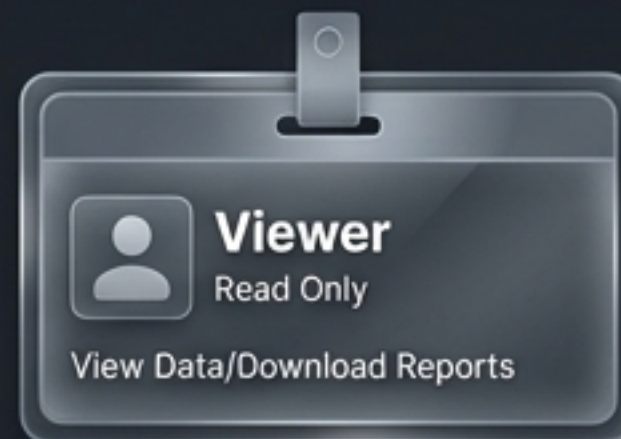
Inter Regular

Integrity: Includes automated checksum calculation and memory segment validation.

Inter Regular

Governance: Audit Trail & RBAC

Role-Based Access Control (RBAC)



Security: Granular permissions ensure junior engineers cannot alter Master branches without approval.

Parameter History: `Map_Fuel_Inj`

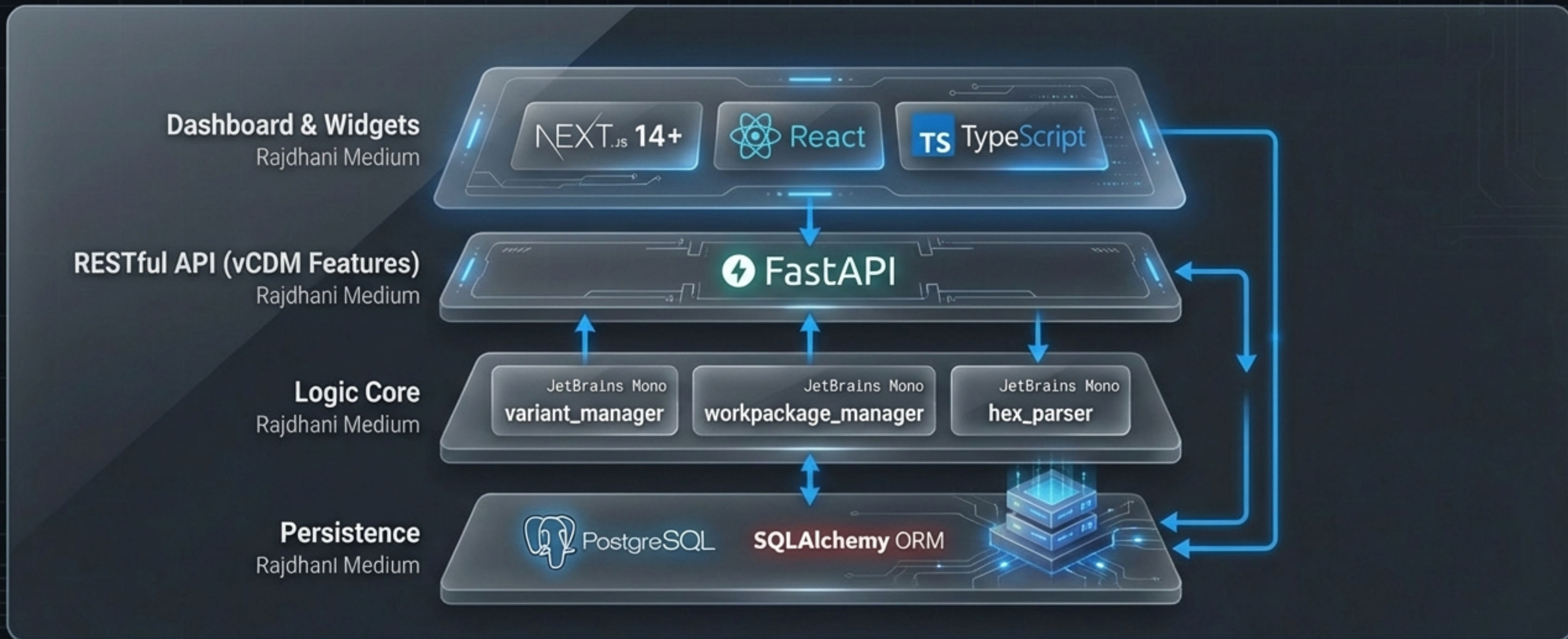
Feb 01 JetBrains Mono
User A changed to 1.2
Comment: "Base tune"

Feb 03 JetBrains Mono
User B changed to 1.4
Comment: "Cold start fix"

Feb 04 JetBrains Mono
Admin Reverted to 1.2
Reason: "Failed validation" ⚠️

Accountability: Who changed what, when, and why? Full history log for every parameter.

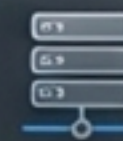
Technical Architecture: The Engine Room



Modern Stack: Rajdhani Medium
Built on a cloud-native, scalable Python/React stack.
Inter Regular



Scalability: Rajdhani Medium
Designed to handle massive variant trees and extensive history logs without performance degradation.



HELIX

Summary: The HELIX Advantage

STRUCTURE

Hierarchical
Command Center
(OEM -> Project
-> Vehicle)

CONTROL

Rigorous State
Machines and
Conflict
Resolution

TRUTH

Single Source of
Truth with deep
Audit Trails

A complete ecosystem for the lifecycle of calibration data—from ingestion to release.