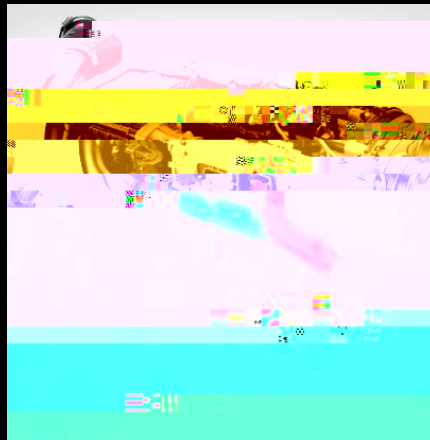


PROPULSION SiL IN CI

Continuous Integration and Validation Using Closed-Loop SiL Simulation for Propulsion Control and Calibration



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Volvo Cars, Göteborg, Sweden

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IN THE BEGINNING

- Started 2002
- 10 model developers
- SourceSafe/Vault
 - Used as a network storage
- Manual starting bat files for code gen and building

HISTORY

- Prior to the current engine generation, most tests done in car
- During the development of the current engine generation, automatic unit and system tests were introduced.
 - Aftertreatment SW solely developed in SIL platform.
 - One senior SW developer said: *now I know it will work when we test in the car...*

CAE Engineers
use Silver to
run plantmodels

SOFTWARE IN THE ENGINE CONTROL MODULE



- The Software in current generation ECMs is structured into around 500 modules
- A small part of the application code is still made by the HW suppliers

CI/CD SYSTEM

-

CI/CD SYSTEM

Build dll, unit tests, Merge tests
and Exploratory tests executed by
Silver and TestWeaver



CI/CD SYSTEM

```
MINGW64/c/git/pt_pcc
jFouFas18G0TCND7163LJN MINGW64 /c/git/pt_pcc (master)
$ git pull --rebase
remote: Counting objects: 10734, done
remote: Finding sources: 100% (202/202)
remote: Total 202 (delta 89), reused 202 (delta 89)
```

CI/CD SYSTEM



CI/CD SYSTEM

7

Start Jenkins Job

Integrations
RENDER BY THE

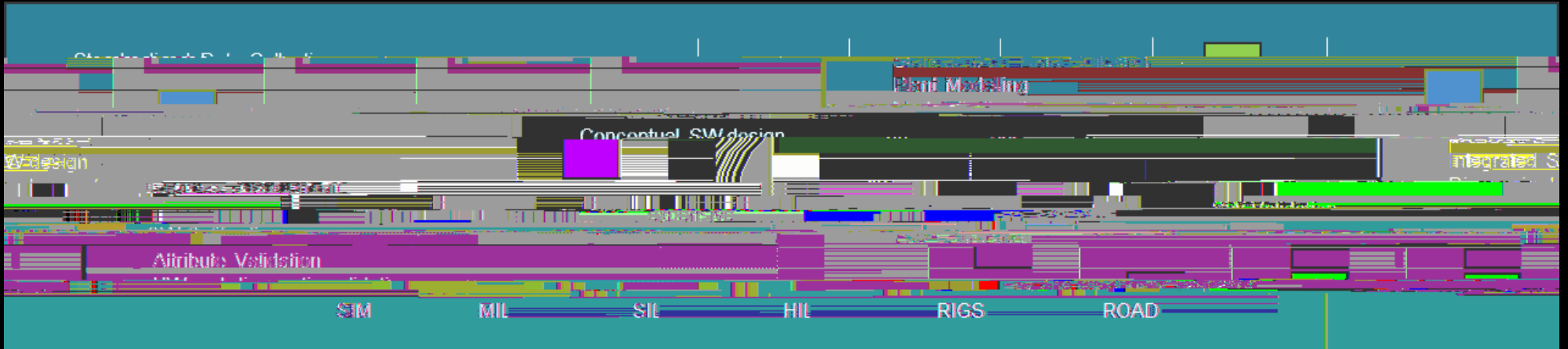
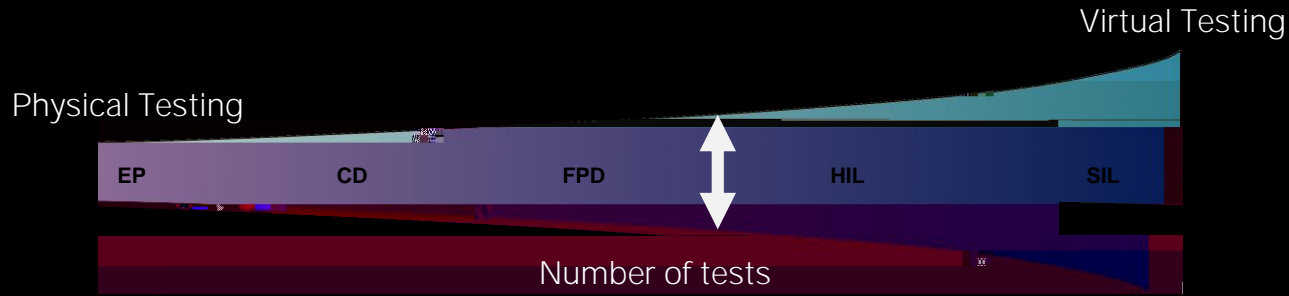
my call ID

3

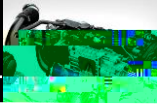


Start Jenkins Job

SIL, THE CORE OF THE CI SYSTEM

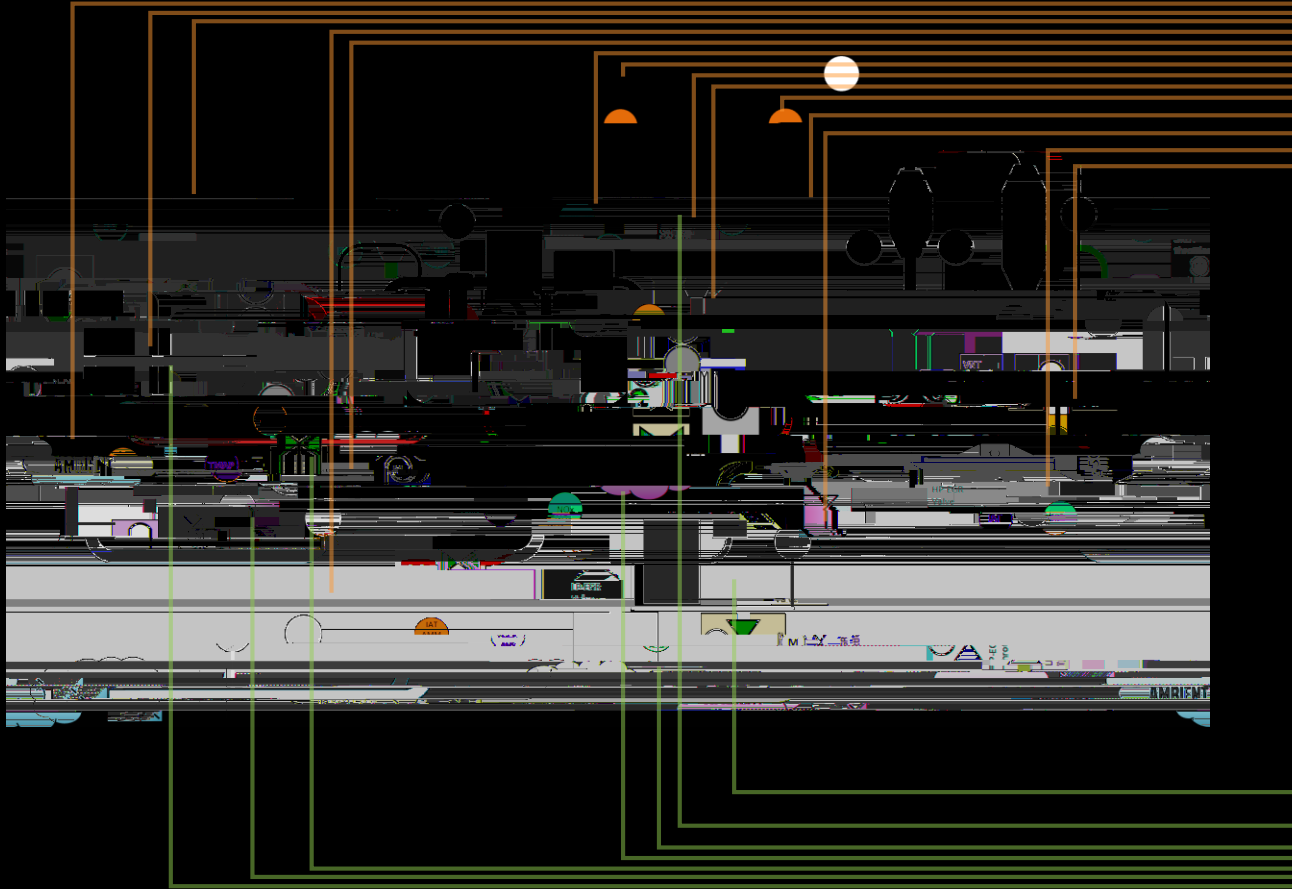


TEST EXECUTION FRAMEWORK



ECM SIL - ENGINE PLANT MODEL

sensors



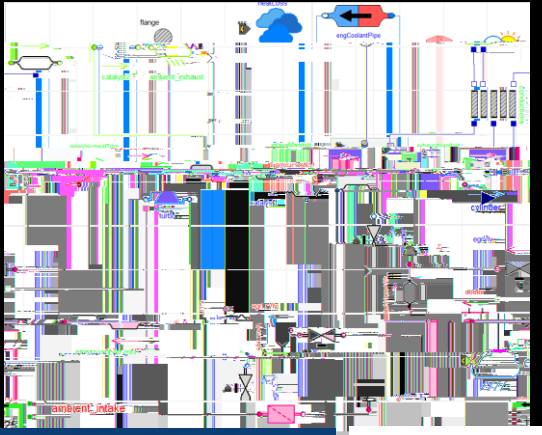
Engine Control Module

SIL dll

actuators

ENGINE PLANT MODEL - PARTS

- In-house developed Dymola model for torque, air-charge and cooling systems
- Supplier catalyst models, blackbox
- Data-driven emission models
ETAS ASCMO, Neural networks



DYMOLA

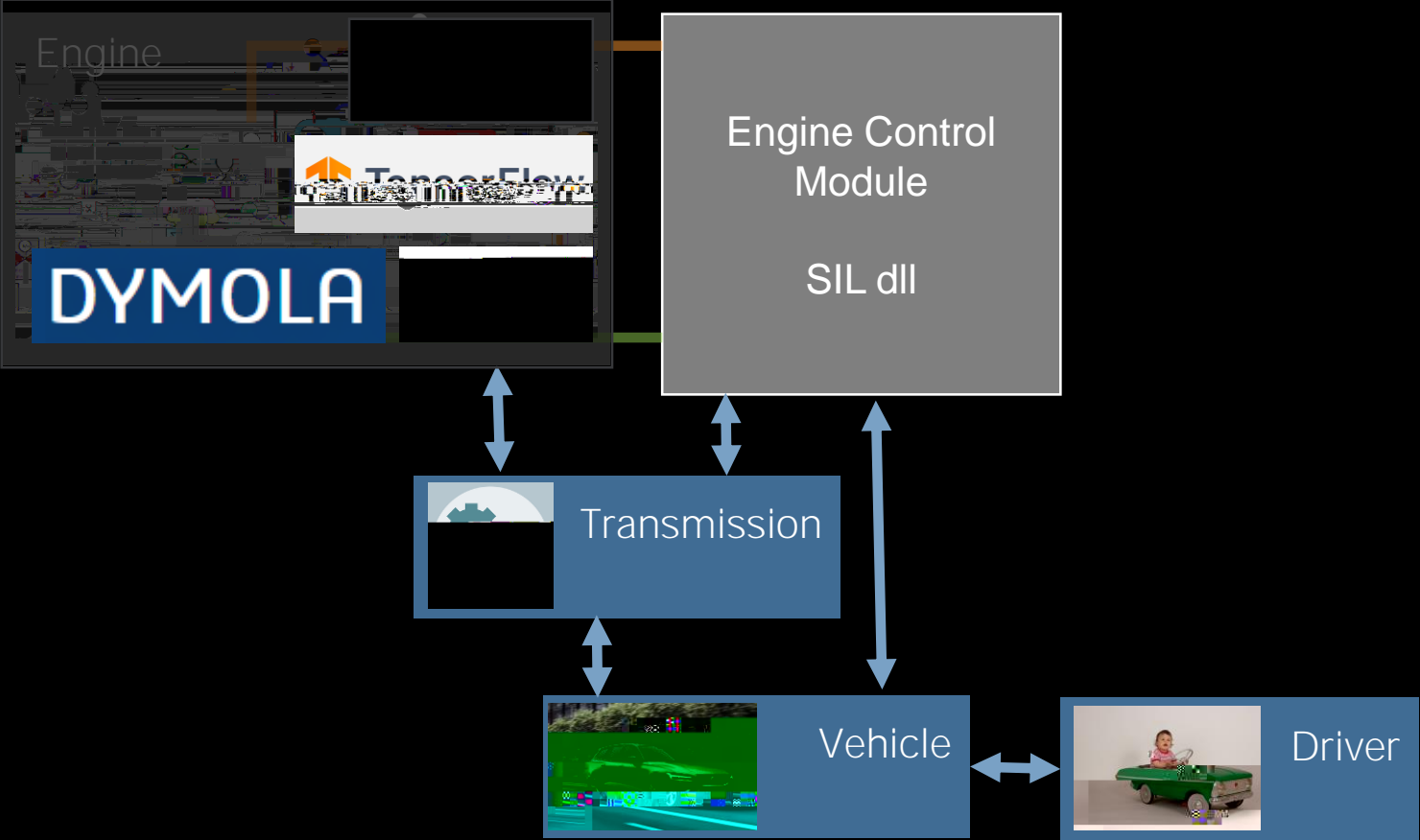


ASCMO

TensorFlow

Fortran

ECM SIL - THE FULL SYSTEM

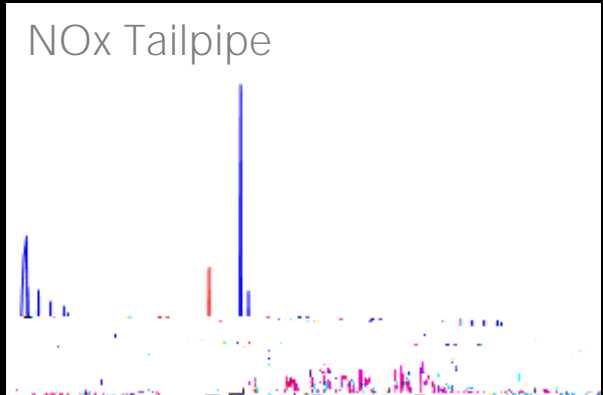
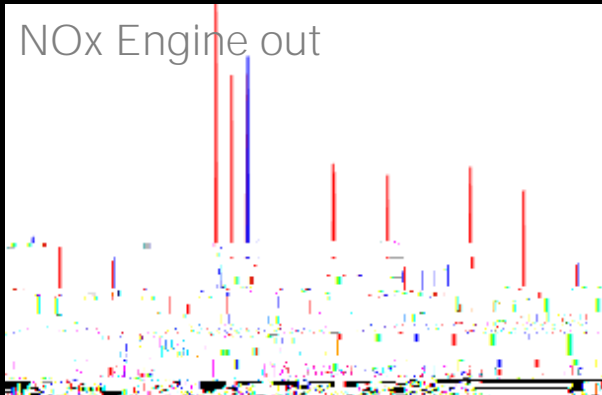
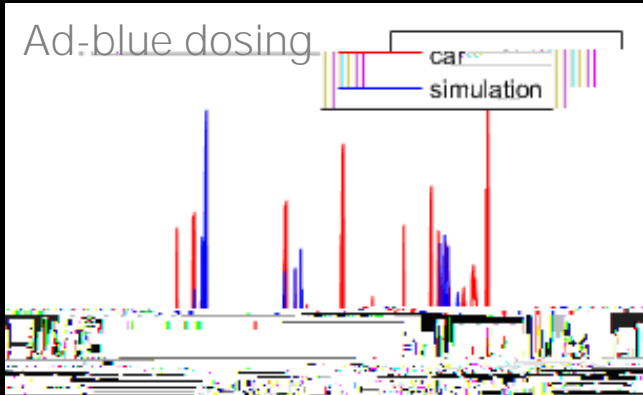
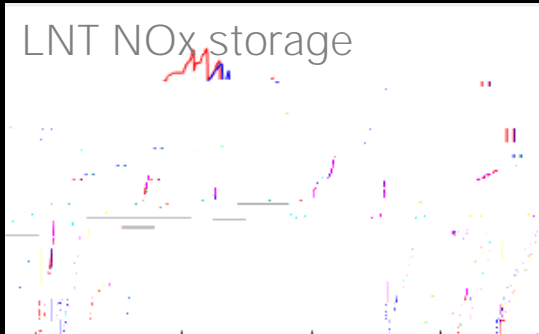
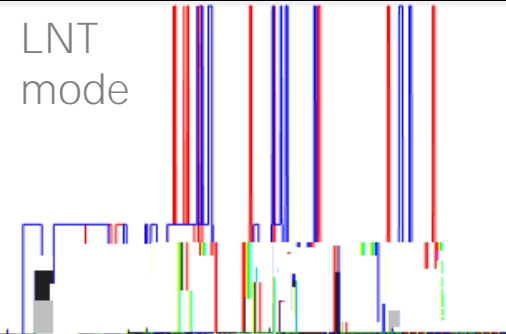
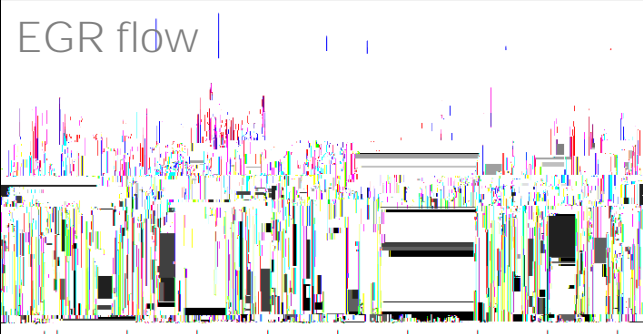


RESULTS, WLTC

- WLTC cycle comparison
- ECM SIL vs. Prototype vehicle rig measurement
- Input: WLTC velocity profile
- Including emissions
- Focus on triggering software functionality, not absolute quantities



RESULTS, WLTC



THANK YOU!

