



# Driveline Control Development

Off-road Automotive

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AG&CE PD – HYDRAULIC CONTROLS EU DESIGN

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# CNH Industrial

## Company Overview

**CNH Industrial is a global leader in capital goods that implements design, manufacturing, distribution, commercial and financial activities in international markets.**

- We employ more than **64,000** people in 64 manufacturing plants and **50 research and development centers** in **180 countries**.
- Our global presence and broad reach mean that we can capitalize on opportunities for growth and pursue our ambition to become a leader in our sectors.
- Through our 12 brands we make the vehicles that keep agriculture and industry growing. From tractors and combines to trucks and buses, as well as powertrain solutions for on-road and off-road and marine vehicles, we design, produce and sell machines for work.



PRODOTTI

AGRICOLTURA DI PRECISIONE (PLM®)

GAMME APPLICAZIONI

GAMME APPLICAZIONI

SERVIZI E VENDITA NEWS E MEDIA NEW HOLLAND

TRATTORI

SOLLEVATORI TELESCOPICI

MIETITREBBIE

FIENAGIONE

PRESSE

TRINCIACARICATRICI

VENDEMMIATRICI

ARATRI

LAVORAZIONE DEL TERRENO

CONSTRUCTION



T9



T8



T7 HEAVY DUTY



T7 PASSO LUNGO



T7 PASSO STANDARD



T7S



T6



T5 AUTO COMMAND™



T5 ELECTRO COMMAND



T5 UTILITY



TD5



T4F/NV



T4F BASSOTTO



TK4



T4 LP



T4FB



TD4F



TI4



T4S



T4



T3F



T3.50F



TD3.50



BOOMER



- A** Vano portaoggetti sul lato sinistro cabina.
- B** Comodo sedile per il passeggero
- C** Lussuoso pavimento con moquette per ridurre il rumore degli organi di trasmissione
- D** Sedile in pelle riscaldato e ventilato con cuscino di seduta estensibile/retraibile
- E** Monitor AFS PRO 700™ con schermo touch screen
- F** Bracciolo Multicontroller
- G** Climatizzatore automatico

# Commands

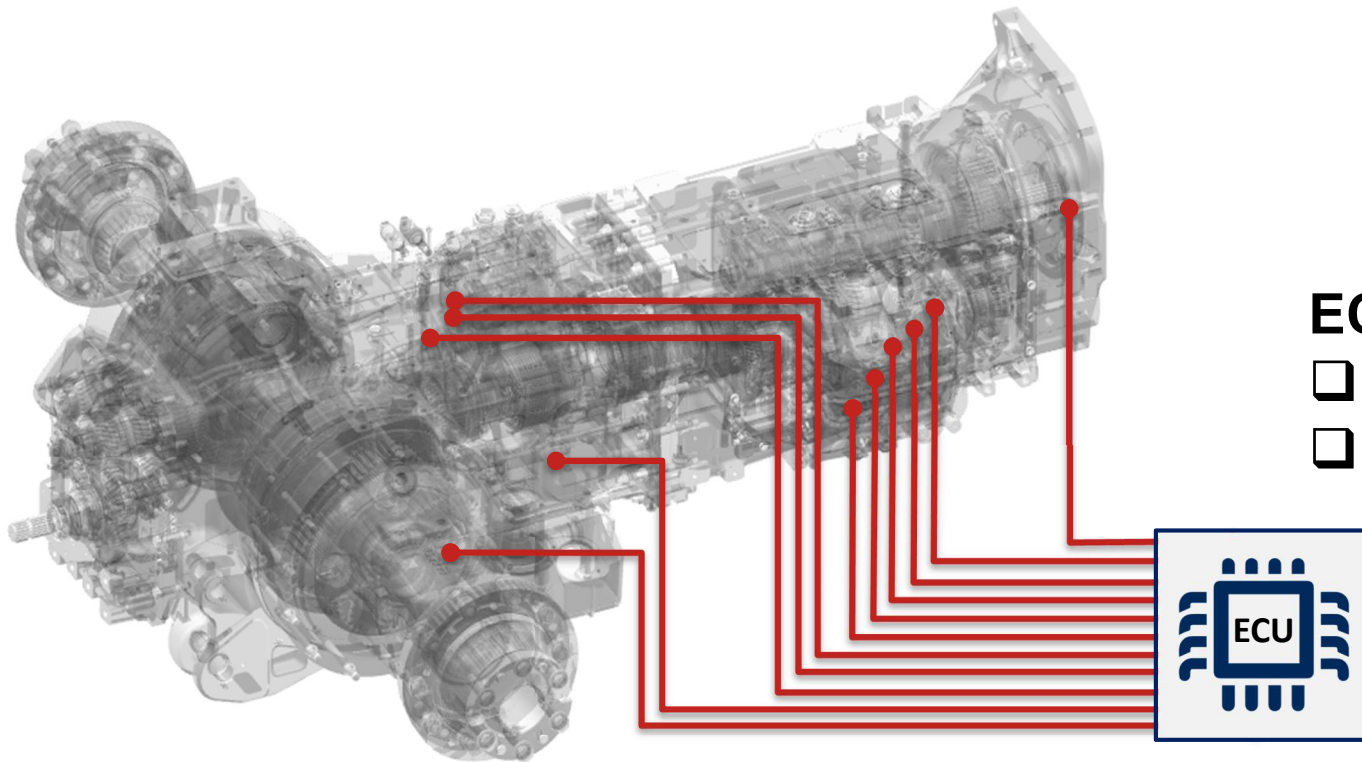
## Puma CVX






# Deep into the Control

# The ECU (Electronic Control Unit)

The Brain of the Vehicle



## ECU INPUTS:

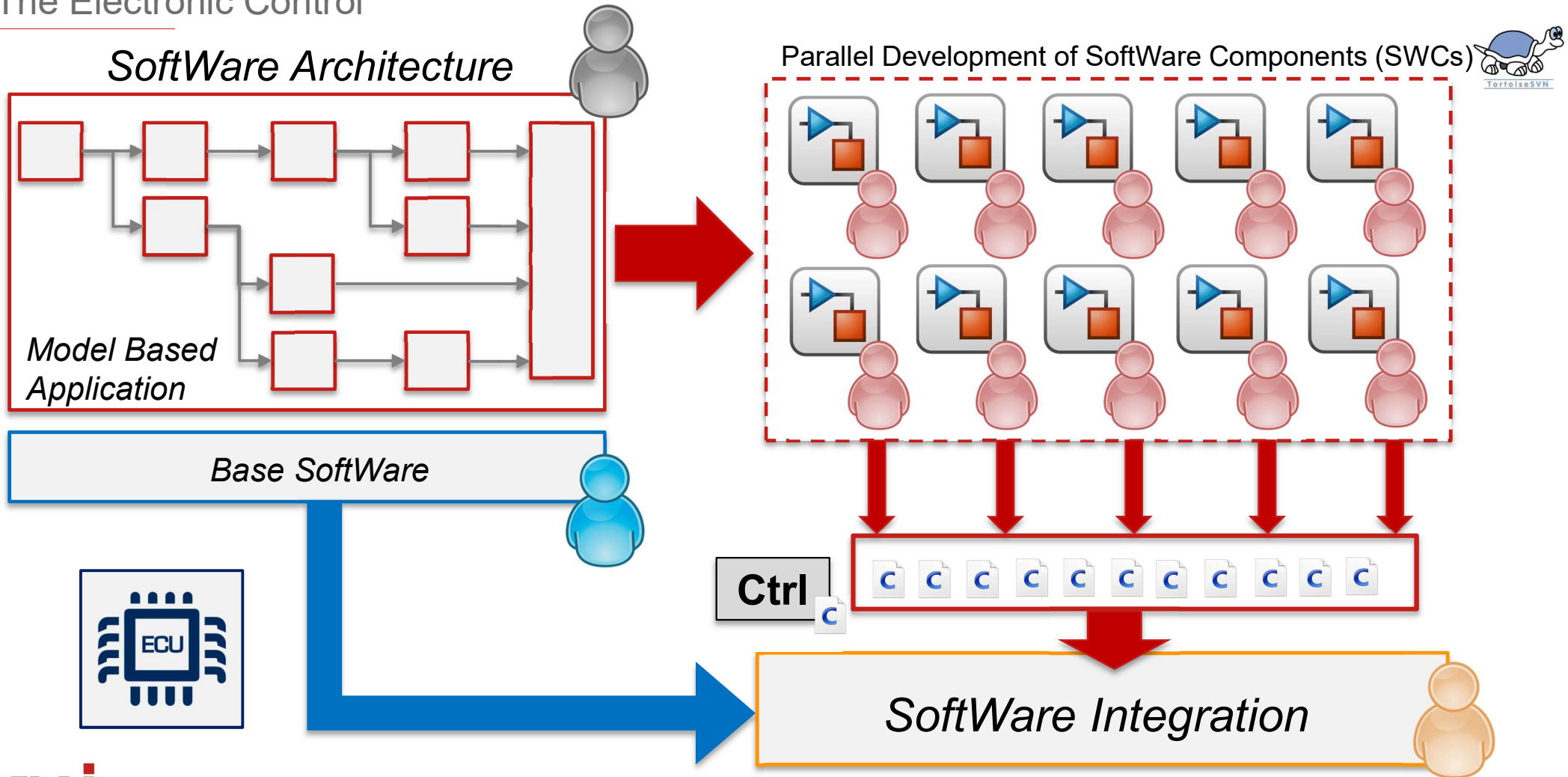
- CAN
- Sensors
  - Temperature 
  - Pressure 
  - Position
  - Speed 
  - Torque

## ECU OUTPUTS:

- CAN
- Actuators
  - Proportional electro-valves
  - On-Off electro-valves

# Inside the ECU

The Electronic Control



# Inside the Control

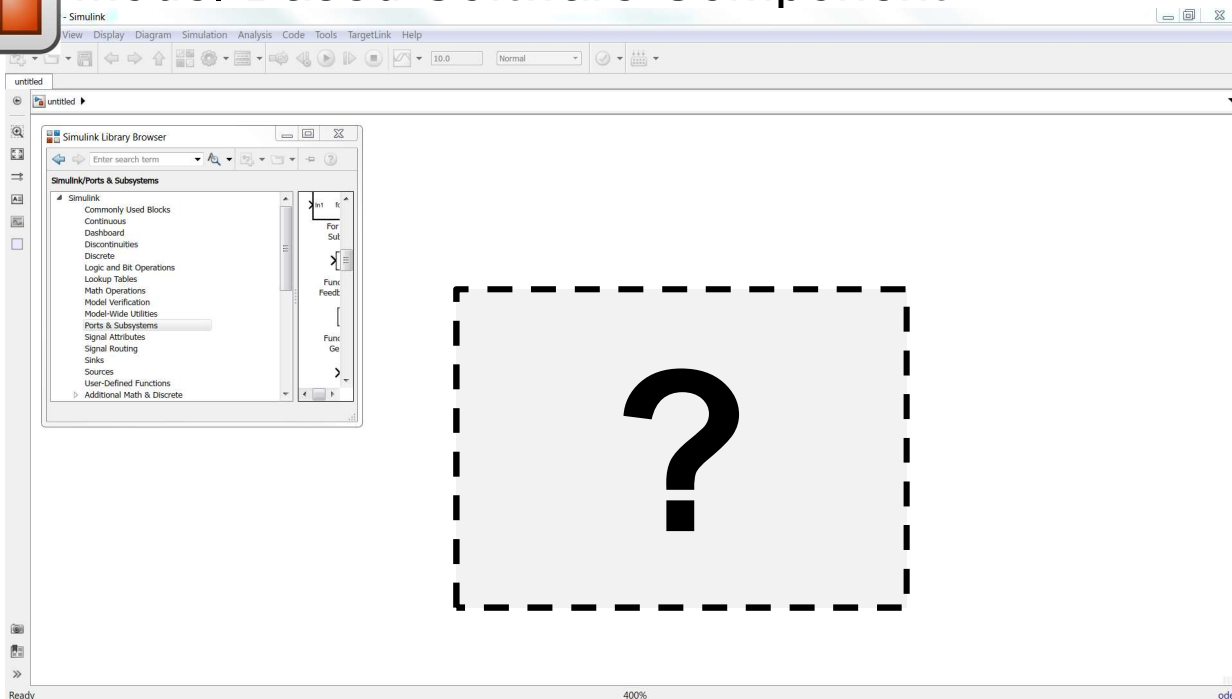
## Model-Based Design (MBD)



Model-Based Software Developer



Model-Based Software Component



- Requirements
  - Physical System Configuration
  - Functional Spec
- Input
  - Physical (sensors)
  - Virtual (commands, status)
- Output
  - Physical (current)
  - Virtual (commands, status)



- Control Strategy
- MBD Implementation

# Inside the Control

## Hydrostat Control



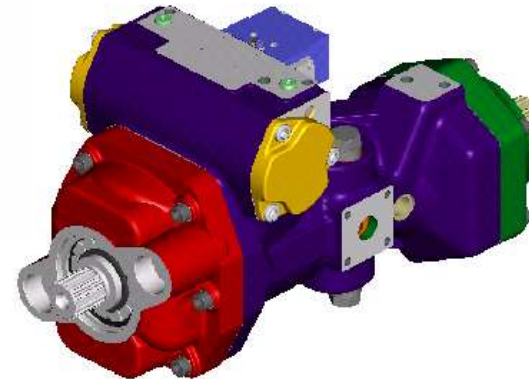
### Optum CVXDrive

- 10500 – 16000 kg
- 6 CYL Engine (6728 cm<sup>3</sup>) 300 Hp
- **CVT Transmission**



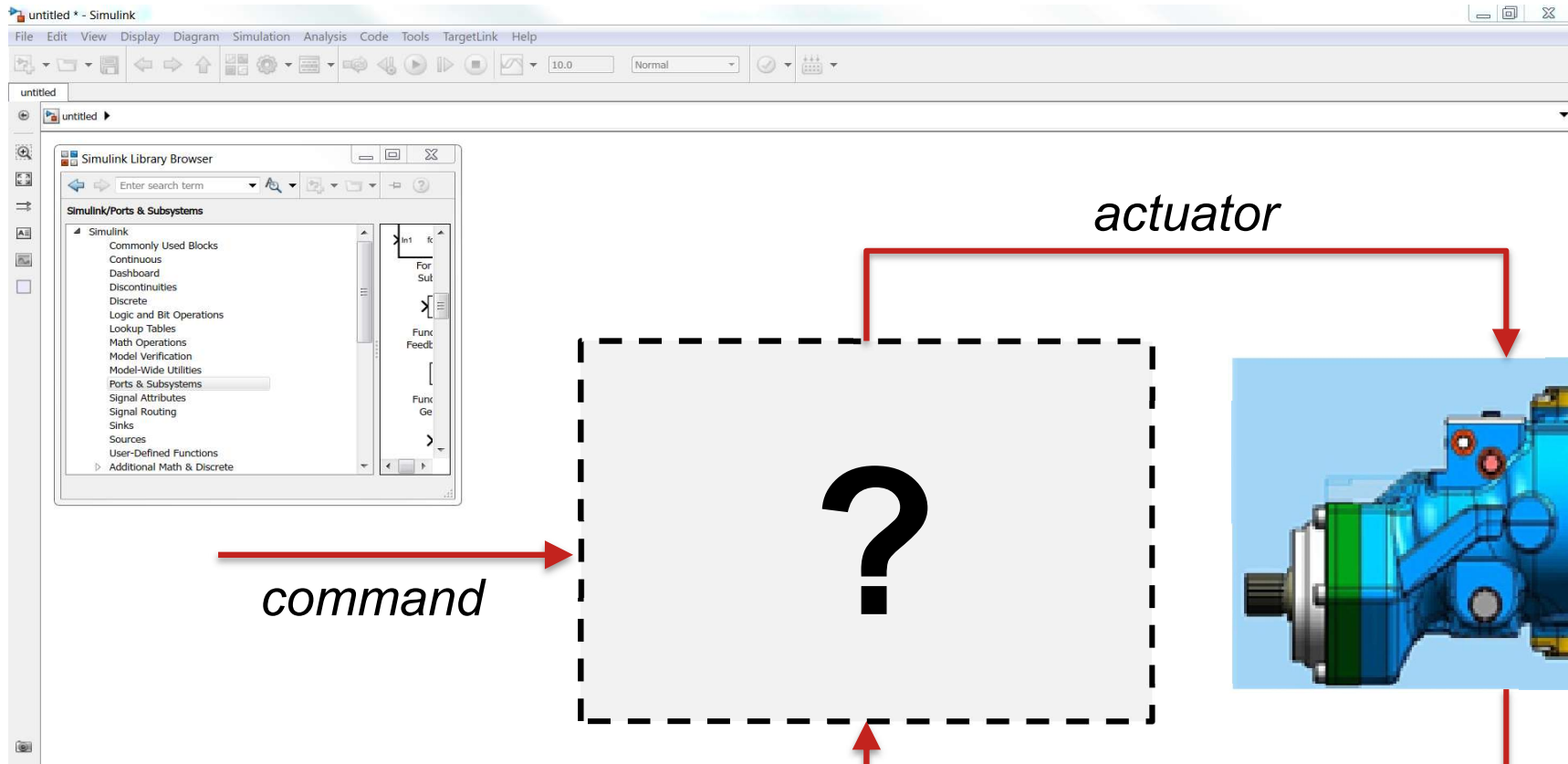
### Hydrostatic Unit:

Variable Displacement Pump + Hydraulic Motor



# Inside the Control

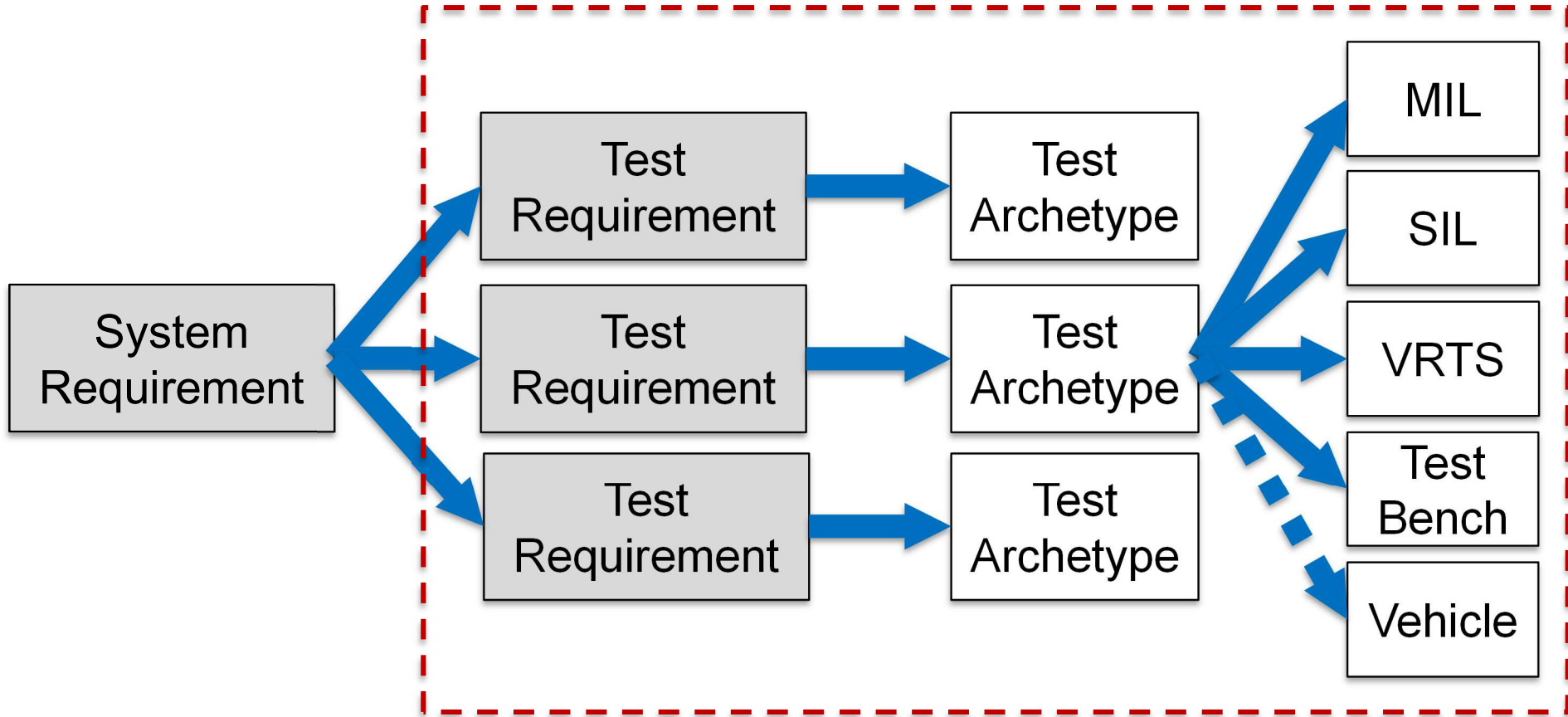
## Control Architecture



# Software Validation

# Software Validation

## Multi Environment Tests



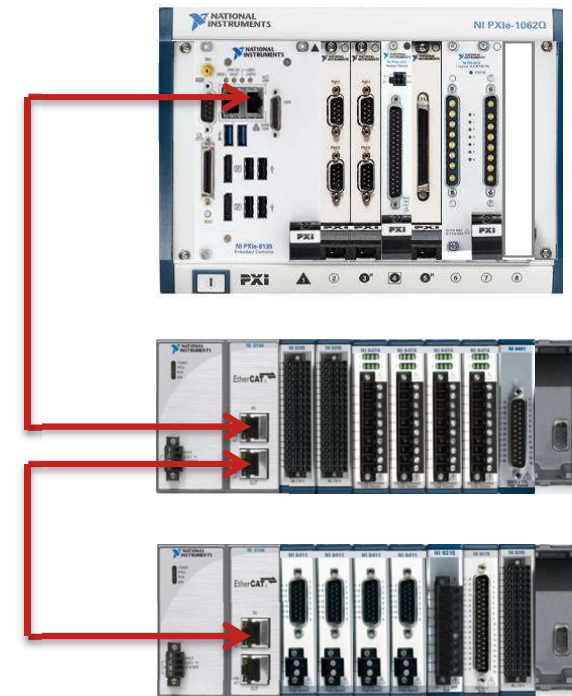
**METG - MULTI ENVIRONMENT TEST GENERATION**

# Software Validation

Hardware-In-the-Loop (HIL)

## VeriStand Real Time Simulator (VRTS)

- Model Validation
- Electrical Test
- Functional Test
- Hardware Debugging
- Software Debugging
- Diagnostic Test
- Pre-Calibration



# Software Validation

## Test Bench

- Automated Tests (METG)
- Control Validation
- Control Tuning
- Optimized Control AutoCalibration (NSGA-II Optimization Algorithm)



# Backup