ADAS validation using Model-In-Vehicle

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Introduction to Organization and Business

Cognizant (NASDAQ-100: CTSH) is one of the world's leading professional services companies, transforming clients' business, operating and technology models for the digital era. Our unique industry-based, consultative approach helps clients envision, build and run more innovative and efficient businesses. Headquartered in the U.S., Cognizant is ranked 195 on the Fortune 200 and is consistently listed among the most admired companies in the world.

Cognizant Digital Business

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For More details:
https://investors.cognizant.com/2019-04-18-Cognizant-Schedules-First-Quarter-2019-Earnings-Release-and-Conference-Call

OUR OVERVIEW

Founded
in 1994 (CTSH, Nasdaq)

Headquarters
Teaneck, NJ

Revenue Mix Q4 2018
NA: 76.14%
Europe: 17.92%
RoW: 5.93%

100+ Global
Delivery Centers

~281,600
Employees

Revenue Q4 2018
$4.13 B (up 7.9% YoY)

ACCOLADES

- **10** — **Fortune** Most Admired Companies Years in a Row
- **195** — **Fortune** 500
- **16** — **Barron** 100 Most Sustainable Companies 2018
- **281** — **Financial Times** Global 500
- **87** — **Forbes** Top 100 digital Companies
- **573** — **Forbes** Global 2000

Key Takeaways

Verification of algorithm at early stages of development

Easy model level revision

Less repetition in development process

Balanced plant model development and environment model development

Reduced effort for simulation

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Stages in Model based development

Verifies Algorithm

Validate the code (auto / hand generated)

Validate real time behavior

Multi ECU, vehicle like environment

Finally, testing on vehicle.

New methods and tools are required to deal with the software complexity explosion, reduce iteration, promote reusability of test cases and be time efficient.

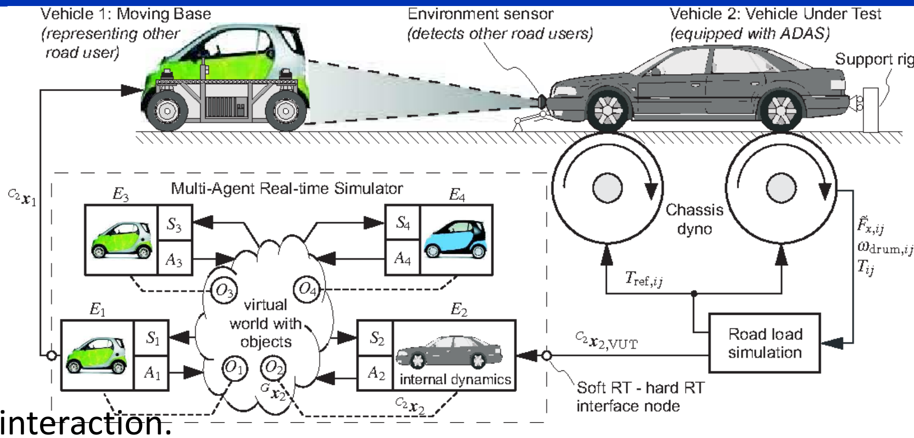
Advanced techniques of simulation

Vehicle-in-the-loop Simulation

- Validates vehicle behavior against test scenarios created in the virtual world.

e.g. Emergency braking systems

Too late in development cycle, require ECU



Driver-in-the-Loop Simulation

- Validates working of systems which depend on human interaction.

e.g. Lane keeping assistants, adaptive headlamp control.

Too late in development cycle, require at least RCP ECU

Classic Methodology

DUT	Goal	Plant Model	Environment	Suitability
EMS / ESP / EPS	Optimizing the performance of vehicular sub system to meet certain performance norms like emission , drivability , economy etc	Detailed Mathematical / Statistical / Data driven representation of a vehicular subsystem(s)	Simulated environment is basically a predictive (for traffic) visual recreation (for camera) of surroundings and lacks the inherent randomness set forth by real environment	More Suitable for testing of sub systems within vehicle rather than vehicle behavior itself within its environment

Dynamic Environment Model

Generating dynamic real world scenarios is **nearly impossible** using tool chains available and by using conventional methodologies

MiV - Model-in-Vehicle testing methodology

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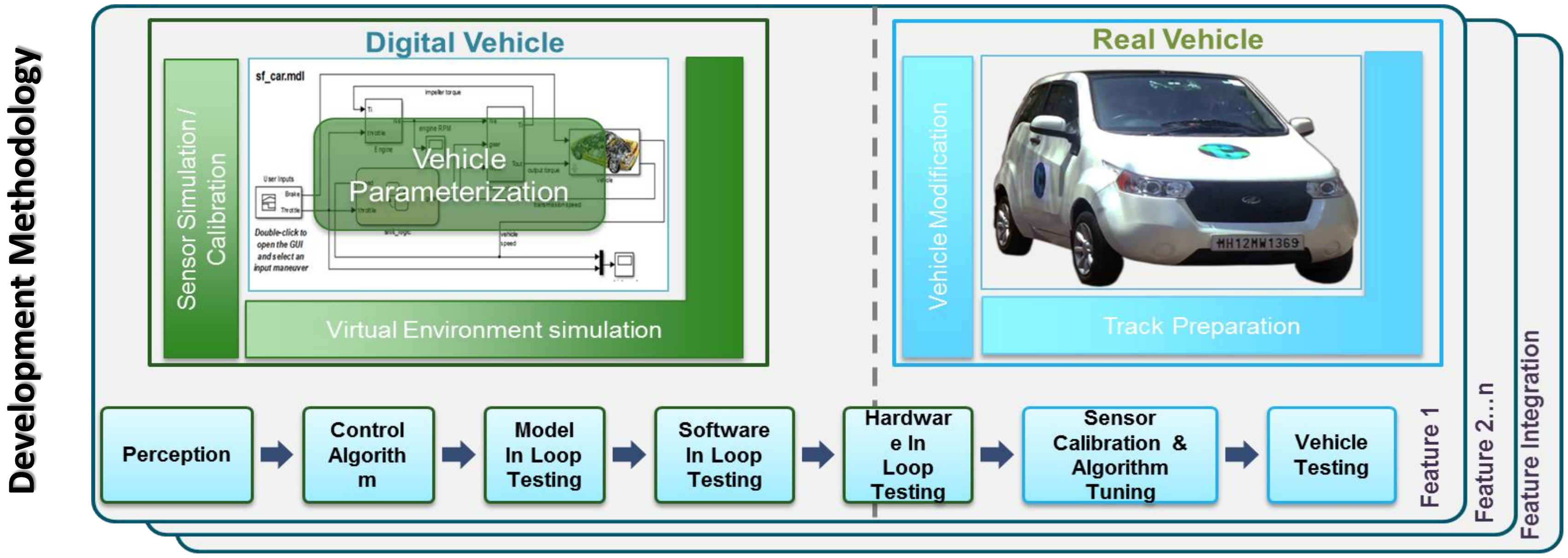
Autonomous Vehicle @ Cognizant

Cognizant Autonomous Vehicle



500+ miles for testing and data collection

Connected App | LANE Keep | COLLISION Detection | PEDESTRIAN Detection | VEHICLE Control | U Turn

225 meter VIRTUAL AND REAL TEST TRACKS

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MIV(Model-In-Vehicle) Approach for AV

Vehicle Network Toolbox
Establishes communication between Model and Control Interface via CAN messages, making Model-In-Vehicle real-time.

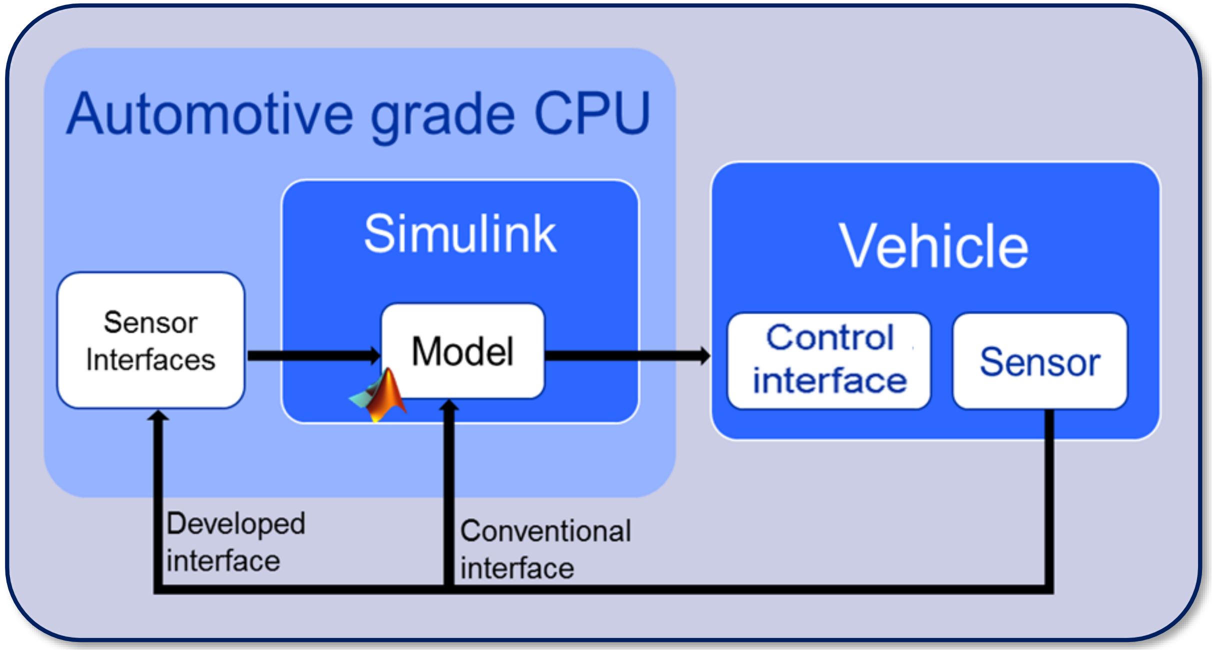
Instrument Controller Toolbox
Lets you connect MATLAB® directly to vehicle sensors using communication protocols such as UDP, TCP, serial etc.

Matlab Real-time Pacer block
Achieved real time simulation with fixed time interval using Matlab Real-time Pacer block. Able to generate real-time control of pedals.

Flexible Sensor interface
Created intermediate communication for sensors unsupported by Simulink.

Matlab Simulink Model
The model uses these feedback from vehicle and information about environment from sensors to make the vehicle take the desired action.

Time Monitoring and feedback
We managed to read time for execution for each simulation step and the actual step time. Using this time in all calculations in which time is a factor helps us achieve accurate values.



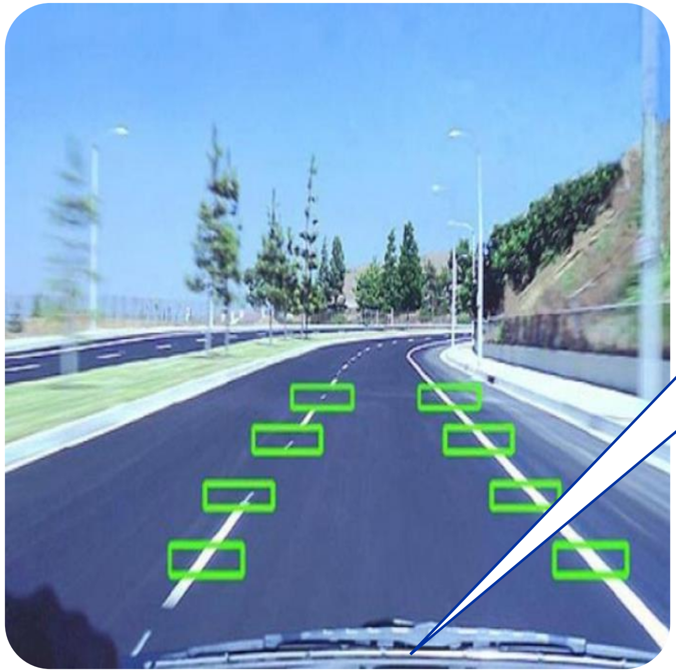
Sample scenario for Model-In-Vehicle

Lane keeping:

- Model-In-Vehicle allows in vehicle tuning of algorithm as per vehicle behavior which is very difficult to replicate in conventional testing methodology.
- Ability to achieve environment randomness which can cause sensor to saturate or misbehave. This helps in tuning the module for such randomness as well.
- Better robust designing can be achieved in using such methodology.
- Allows runtime monitoring of parameters to understand model functionality.

Environmental randomness

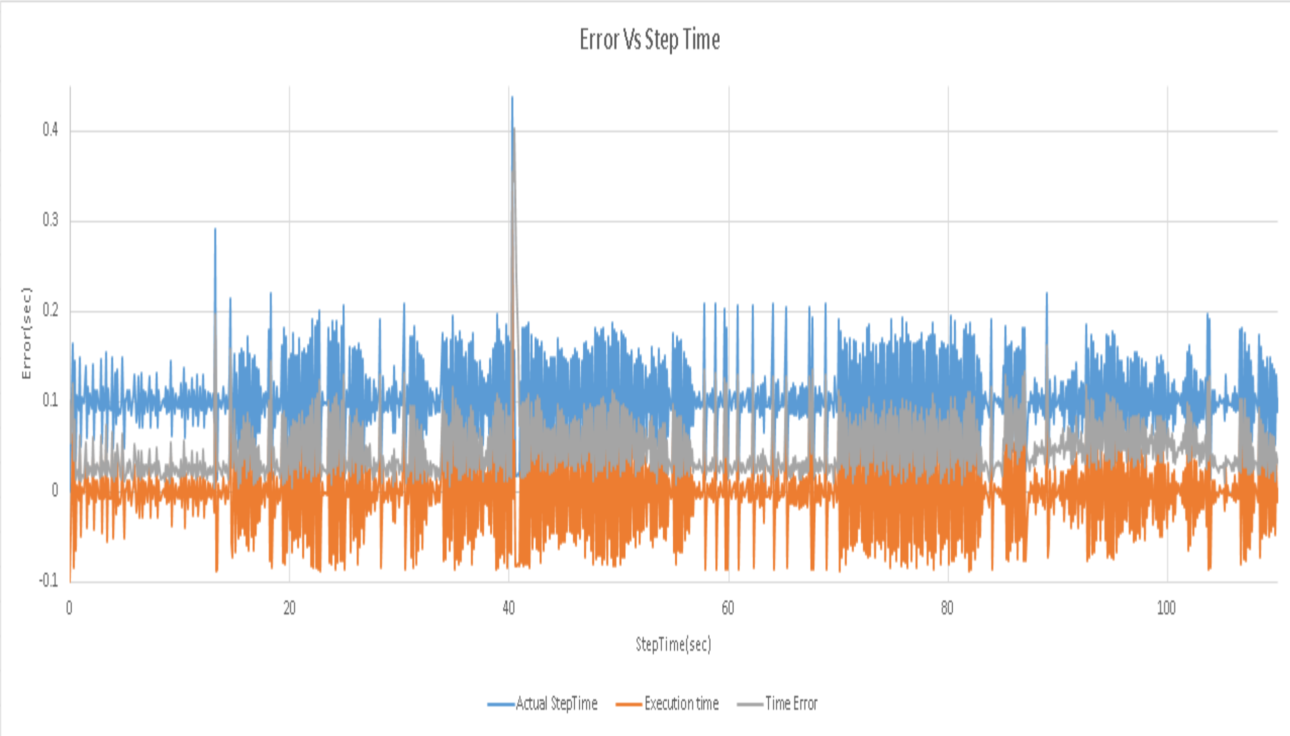
- Sun glare
- Shadows
- Pedestrians
- Lane abnormalities



In Vehicle tuning of lane keep algorithm as per scenarios encountered

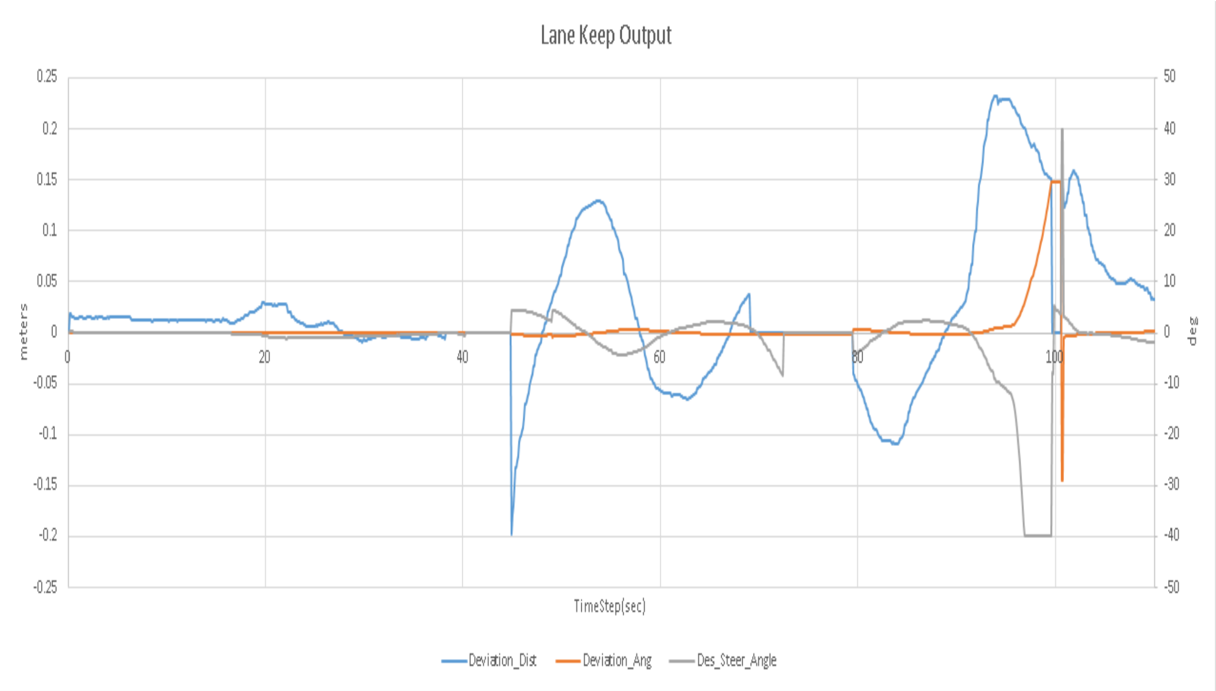
Results

Time Error



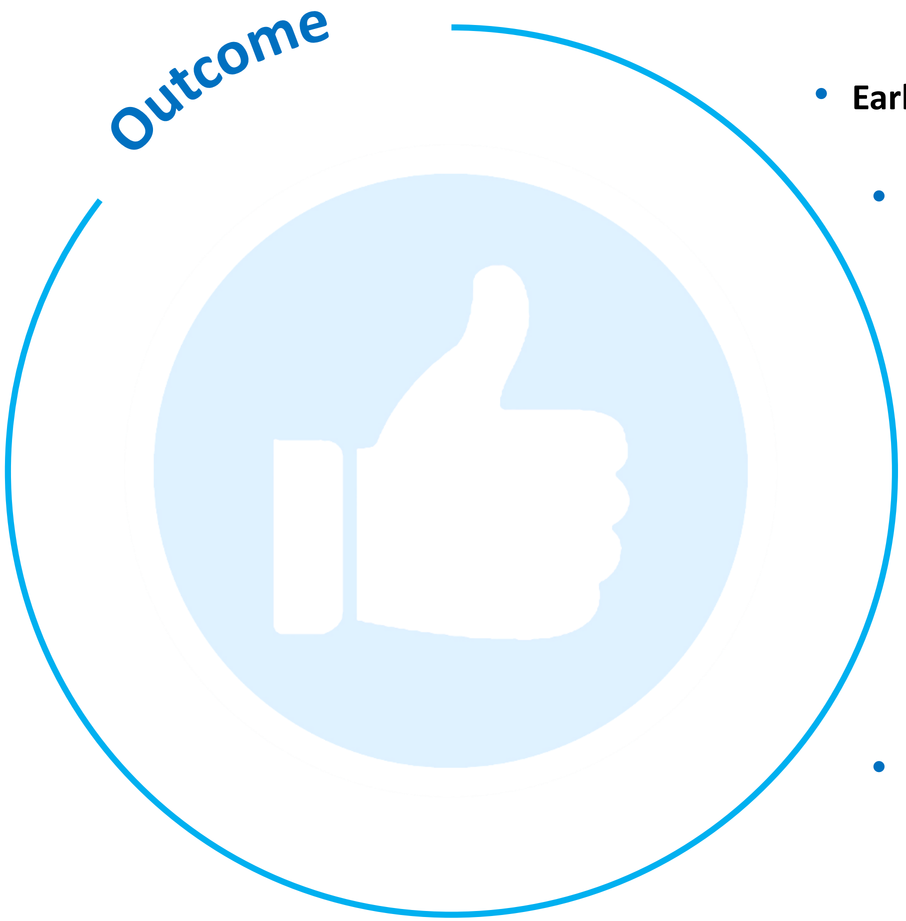
- Able to account for loss in execution time.
- Time adaptive simulation to overcome calculation errors for time curtail measurements.

Sample Scenario



- Able to achieve deviation error of less than 0.2 meters.
- Able to navigate vehicle in the center of the lane with minimum error even on turns and curved roads

Concluding Remarks



- **Early Validation & Verification of algorithms** for difficult to replicate scenarios in virtual world
- **Model Revisions Instantaneously** as validation of model takes place in real time.
- **Non sequential and non repetitive,** MIV a time saving option.
- **Reduced dependency on hardware** because of the developed interfaces
- **Overcomes Sensor replication challenge** as compare to Virtual Environment.
- **Helps Model tuning** as per Sensor Calibration
- **Real-time vehicle communication** using a high end automotive grade CPU.

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Thank You