Toward a Science of Cyber-Physical System Integration

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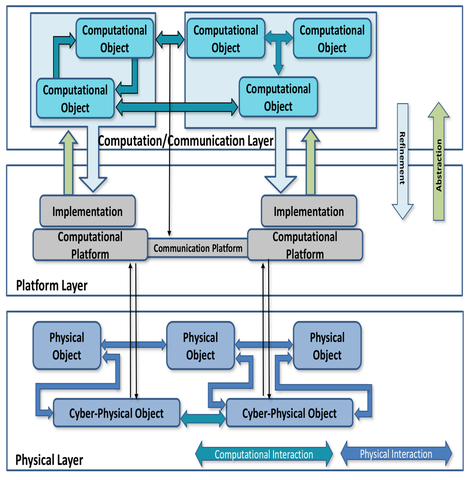
System integration

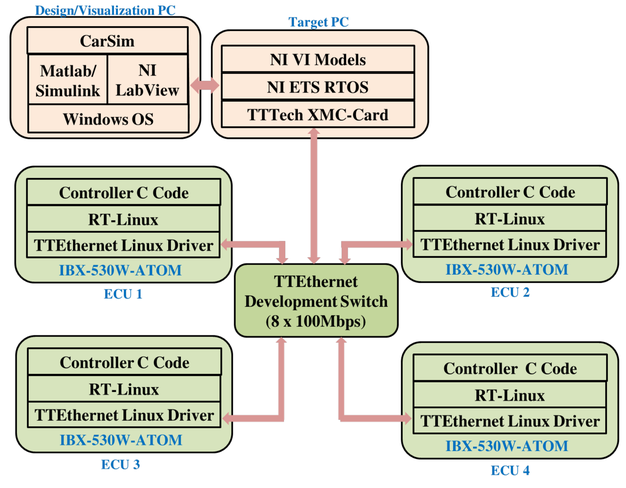
- System integration today relies on ad-hoc methods simply aiming at "making work somehow"
- System integration is challenging in CPS where fundamentally different physical and computational design concerns interact
- Transforming system integration from a high-risk management practice into a science-based engineering discipline is a significant challenge

CPS are inherently heterogeneous

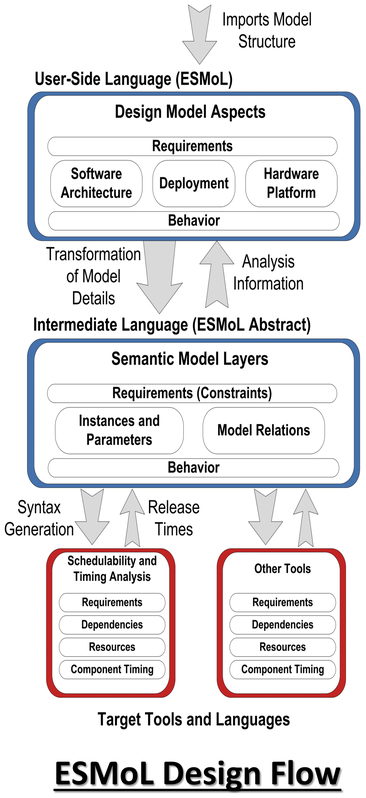
Physical Dynamics | Computational Dynamics (ECUs) | Communication Networks (TTEthernet)



Automotive experimental platform (AEP)

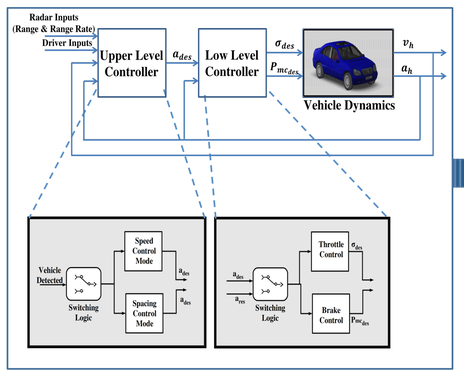


Decoupling embedded control software design from platform uncertainties



ESMoL Design Flow

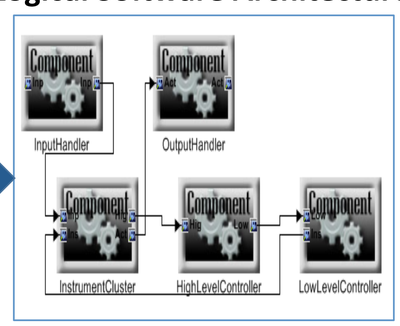
Simulink Control System Model



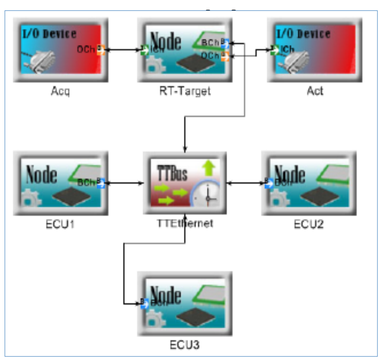
Component Name	WCET
Instrument Cluster	1100 ns
High Level Controller	300 ns
Low level Controller	1700 ns
Rear View Monitoring	200 ns

Worst Case Execution Time Analysis

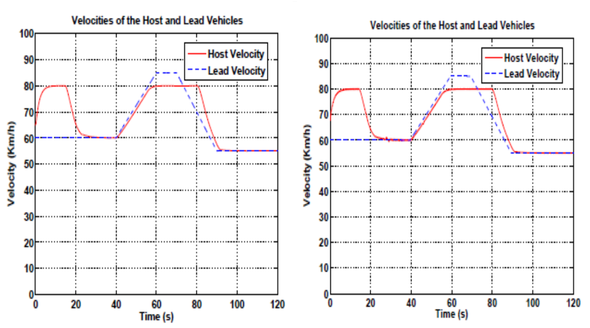
Logical Software Architecture



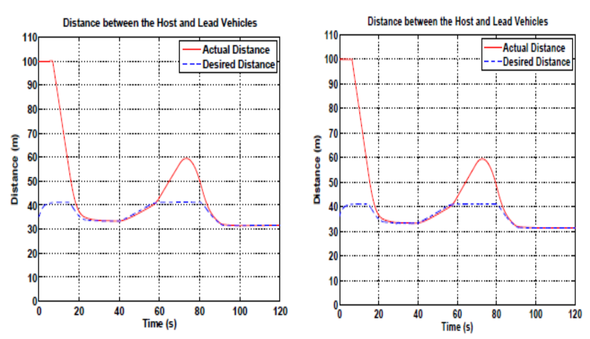
Hardware Platform



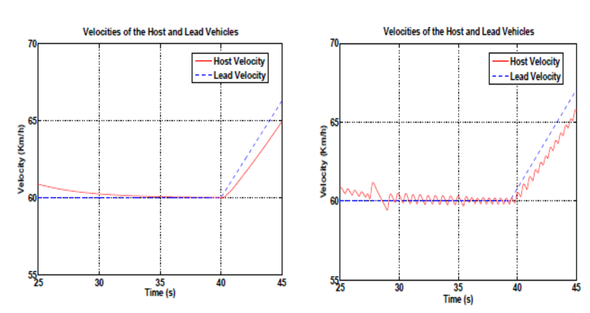
Simulation and Experimental Results



(a) Velocity Profile

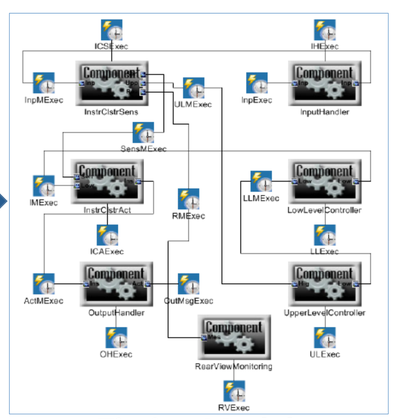


(b) Gap Distance

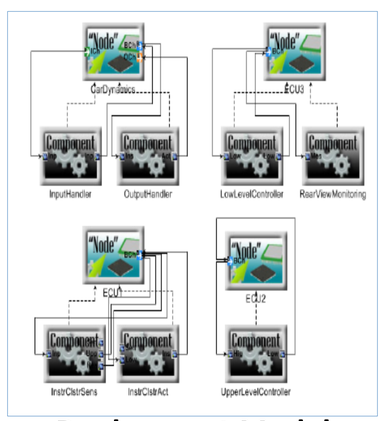


(c) Platform Effects

Timing Model



Deployment Model



Static Schedule

```
Hyperperiod 10 ms

TTEthernetSync 0
CarDynamics/Acq_0 3.436
CarDynamics/InputHandler_0 5.624
CarDynamics/OutputHandler_0 7.811
CarDynamics/Act_0 8.905

TTEthernetSync 0
HighLevelController/HighLevelController_0 5.624

TTEthernetSync 0
InstrumentCluster/InstrumentCluster_0 5.621

TTEthernetSync 0
LowLevelController/LowLevelController_0 5.624

TTEthernetSync 0
TTEthernet/InstrumentCluster.HighLevelMsg_0 5.607
```

Embedded Software

Adaptive Cruise Control (ACC) Case Study

Time-Triggered Execution Layer

Matlab/Simulink | **AEP**

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