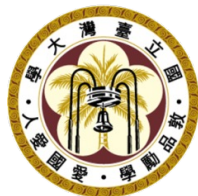


Design Automation Challenges for Automotive Systems

Chung-Wei Lin

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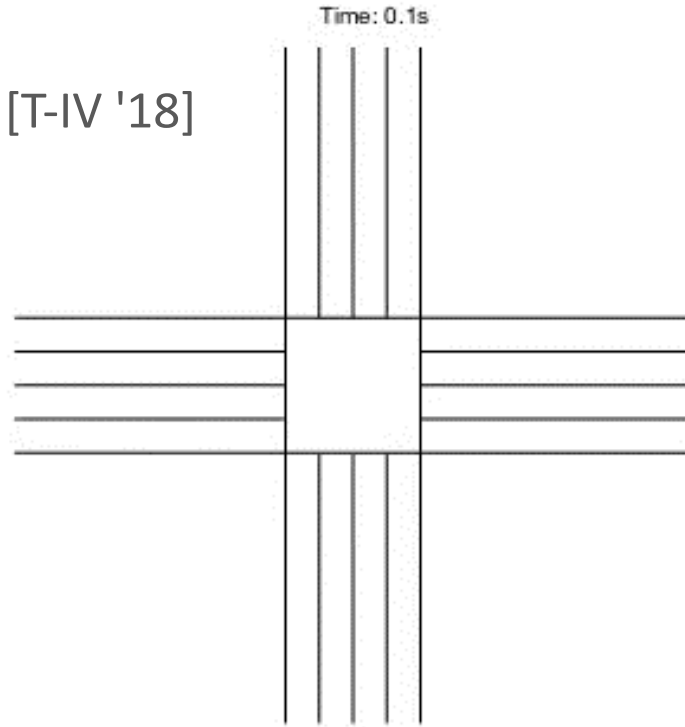


臺灣大學

National Taiwan University

Connected and Autonomous Vehicles

- ❑ A good application may need both of "connectivity" and "autonomy"
 - Intersection Management [T-IV '18]



Design Complexity

❑ Software

- Various functions for sensing, perception, planning, decision, control, etc.
- Number of lines of code
 - 1 → 10+ → 100 million from 2000 → 2010 → 2020
- Values to vehicle's total value
 - Embedded software: 2% → 13% from 2000 to 2010
 - Electronics system: expected to be 50% in 2030

❑ Hardware

- Number of Electronic Control Units (ECUs)
 - 20 → 50+ → more in the past decade
- New computational components and communication protocols

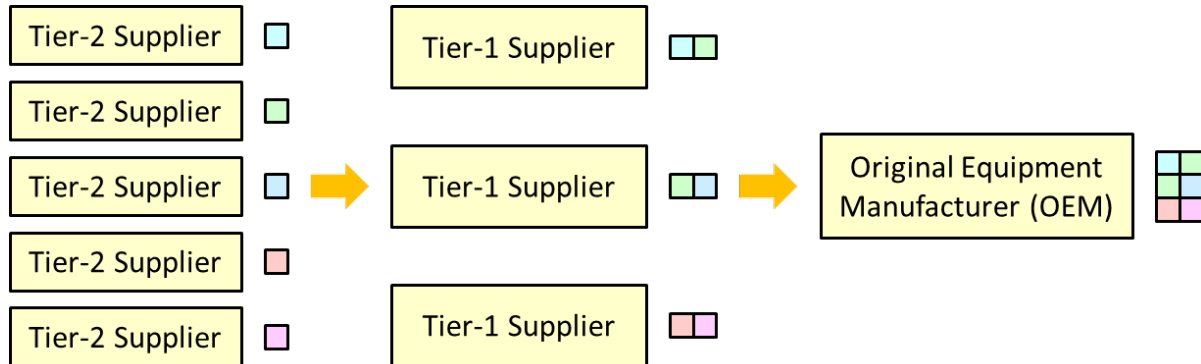
Fundamental Challenges

❑ How do you know

- Your design is correct, i.e., satisfying its requirements?
- Your implementation is correct, i.e., satisfying its specification?

❑ The compatibility is also one challenge

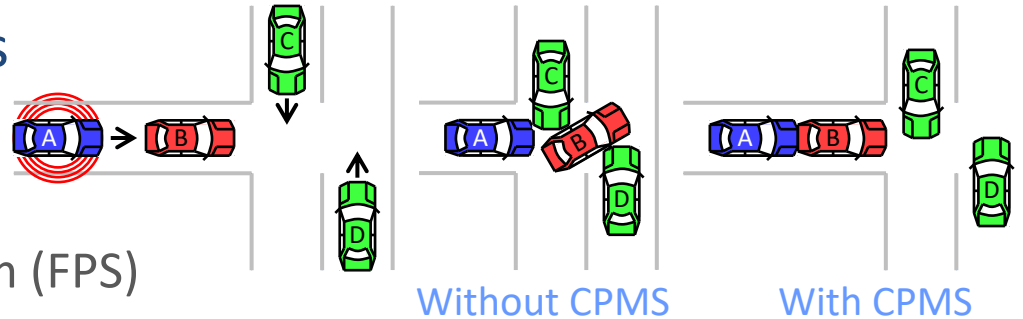
- Different components, systems, and vehicles are designed and implemented by different companies



Compatibility of Systems [DAC '18]

Integration of two systems

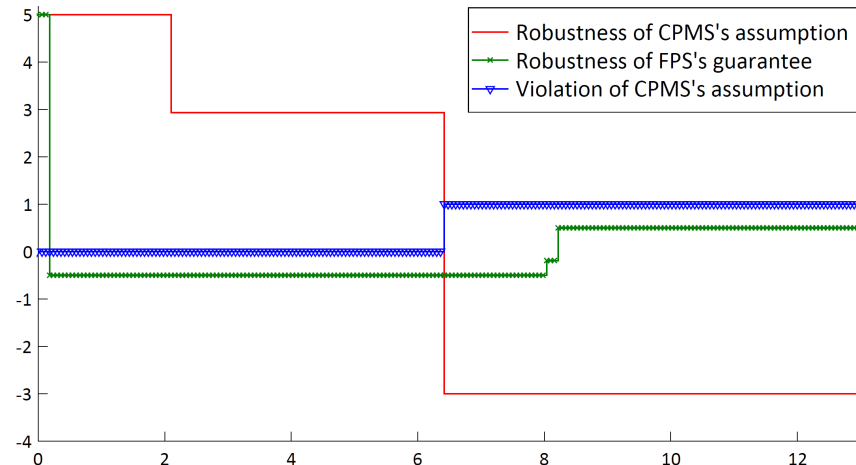
- Cooperative Pile-up Mitigation System (CPMS)
- False-start Prevention System (FPS)



Property specification language and automation tool

- Signal Temporal Logic (STL)
- Breach [Donze '10]

A violation can be detected



Compatibility of Vehicles [DATE '22]

❑ An incompatible example of lane-changing

- Two autonomous vehicles always accelerate or decelerate together
 - Different automotive makers develop different types of systems by their own
- They always keep the same longitude along a road segment
- They fail to exchange their lanes before the end of the road segment

❑ A methodology to verify if lane-changing systems (finite-state machines or hybrid systems) are compatible

- If not, we will need requirements engineering or runtime monitoring

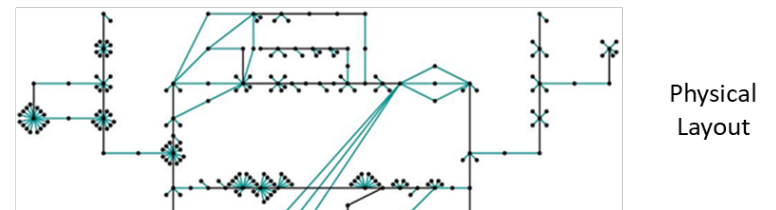
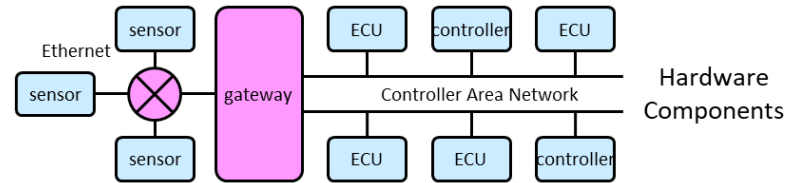
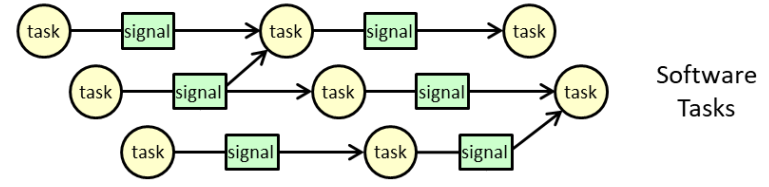
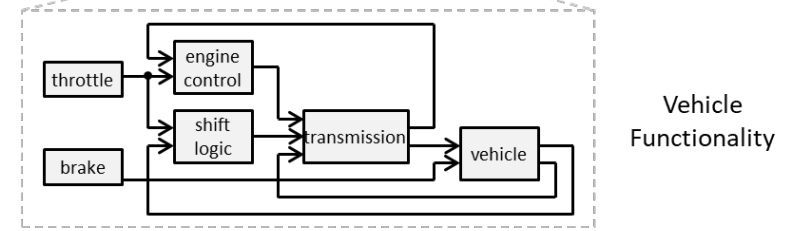
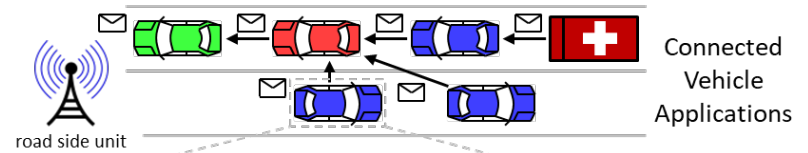
More Viewpoints

□ Levels of "contracts"

- Interfaces of components
- Preconditions and post-conditions of components
 - Functional behavior
- Timing to the dependency between components
- Performance of components

□ Decomposition and composition

- Horizontal or vertical (right figure)



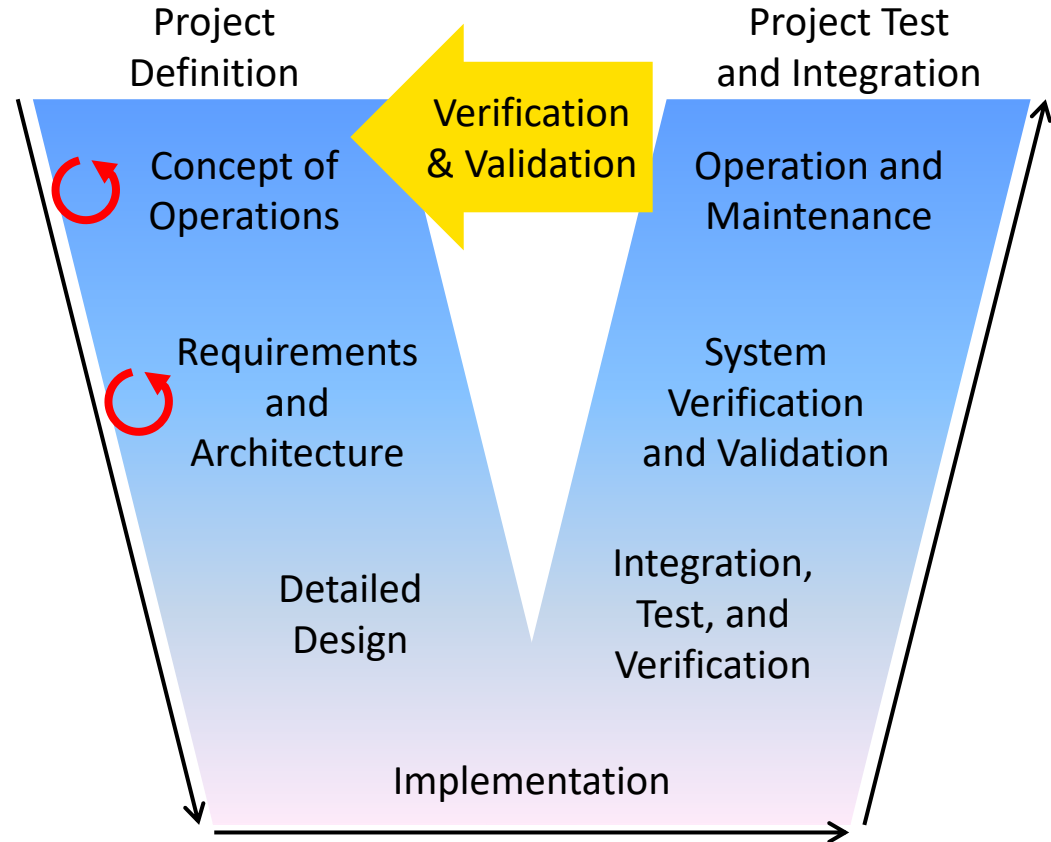
System Design: V-Model

❑ Consider design metrics

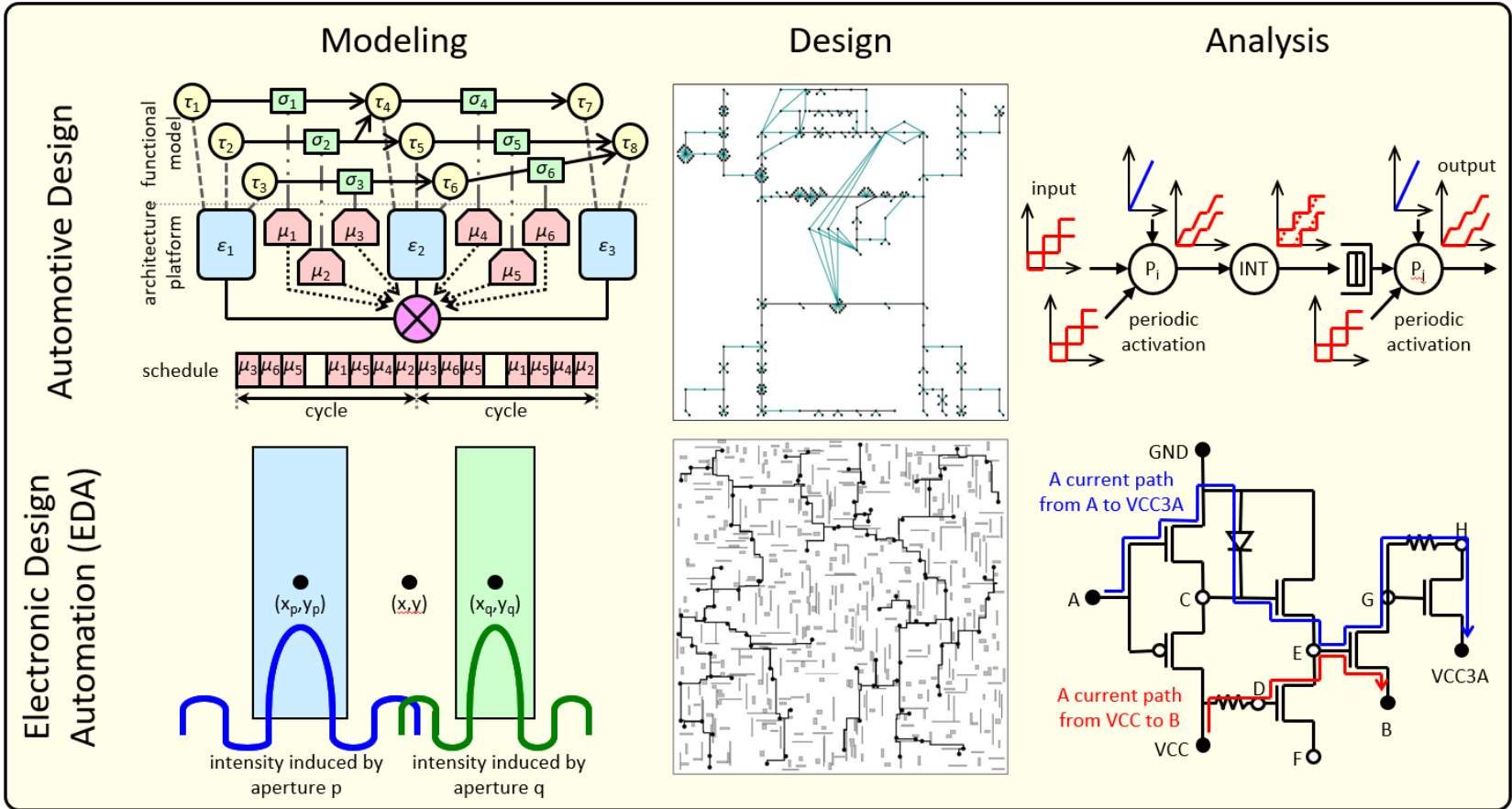
- Safety
- Reliability
- Robustness
- Power
- Performance
- Security

❑ Assist system designers for early design decisions

- More efficient process



EDA vs. Automotive Design Automation



Q&A

Thank You!