Dependable Cyber-Physical Systems | Junsung Kim

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Overview

- CPS perceive their surroundings using sensors, monitor dynamic processes, and control actuators.
- Societal potential
- Economic potential up to $82 trillion by 2025 [NIST 2013]
- Challenges in recent CPS

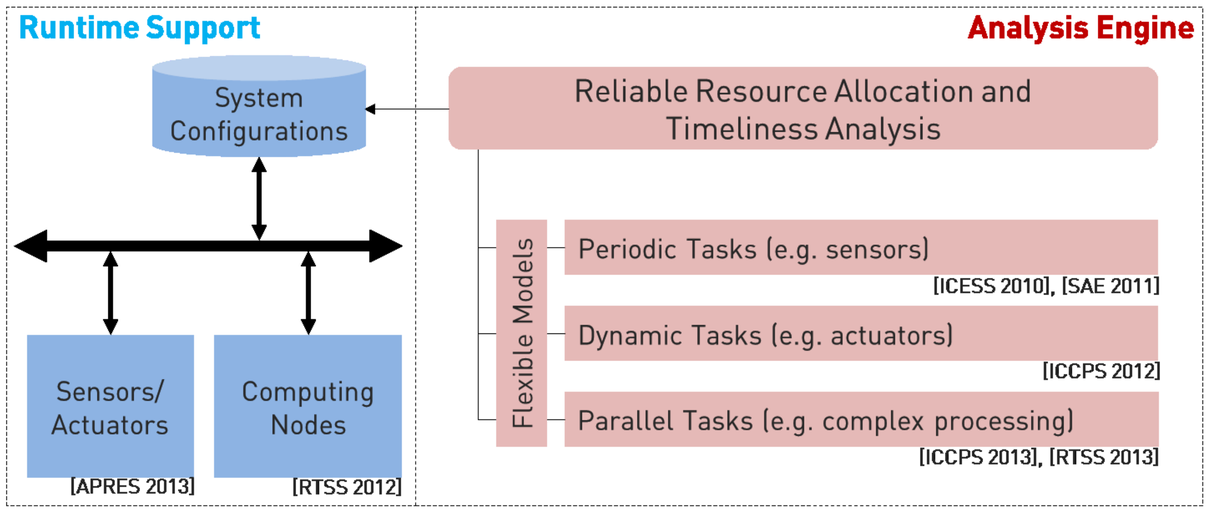
Safety-critical → **Dependability constraints** → **Reliability constraints**, **Timing constraints**

Cost-effective → **Cost constraints**

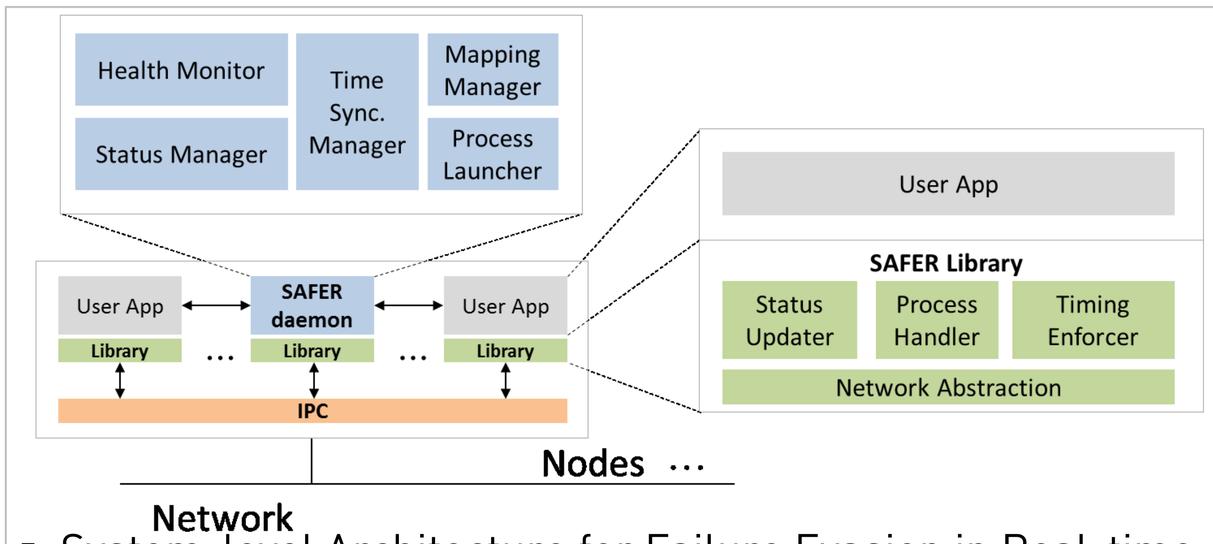
Aesthetic → **Space constraints**

Flexibility constraints

My Approach



SAFER

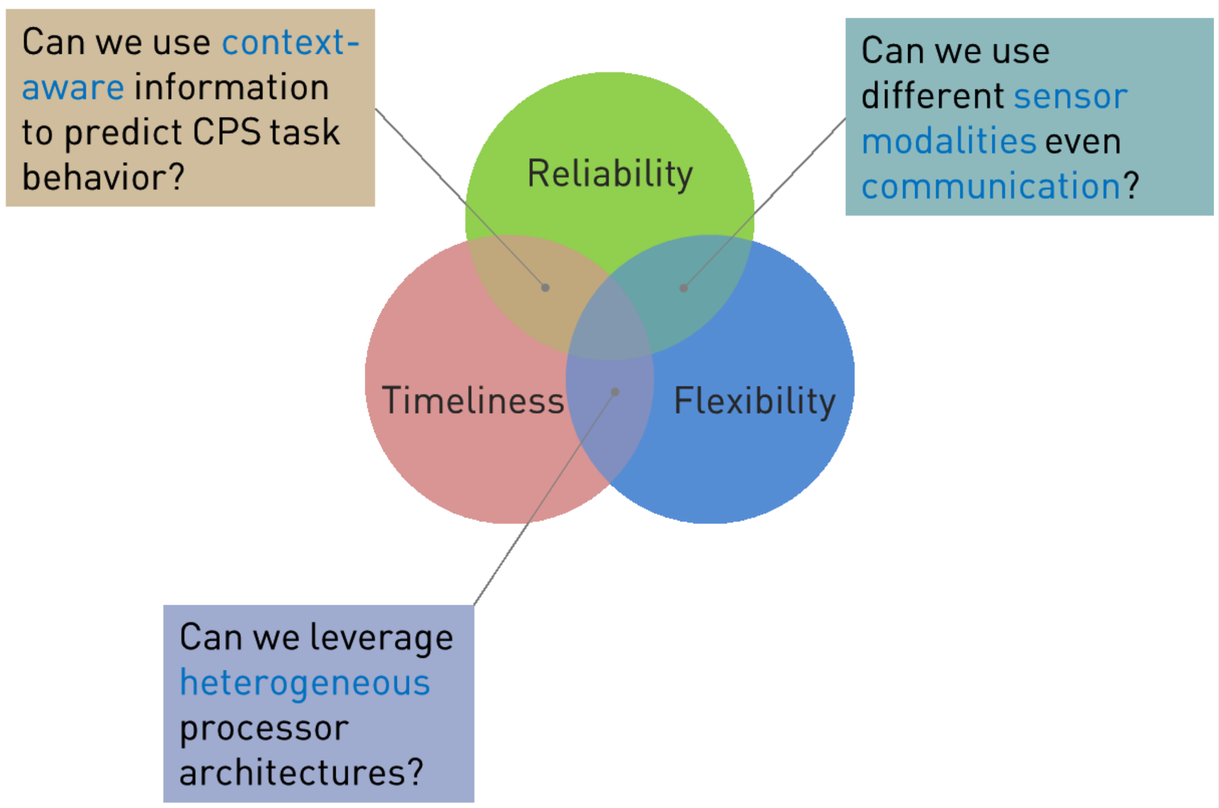


- System-level Architecture for Failure Evasion in Real-time Applications
  - **Software-level** redundancy
  - **Timely** recovery guarantee
  - Running on an autonomous vehicle

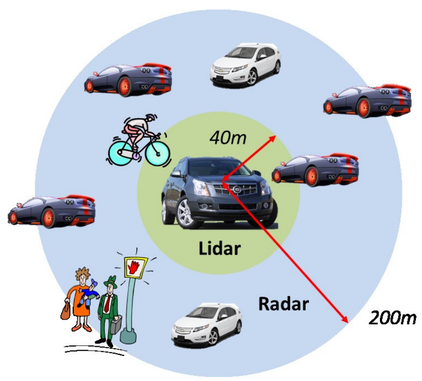
New CPS Computation Models

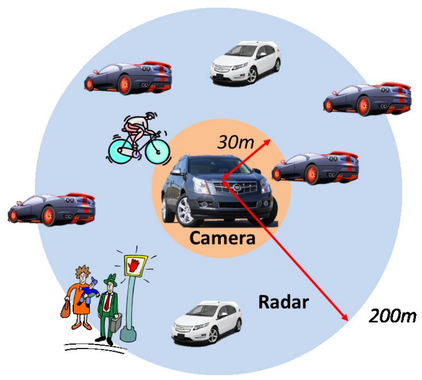
- Real-time scheduling for CPS
  - **Periodic** task model
    - Represented by period and execution time
  - **Priority**-driven scheduling
  - **Schedulability** test to see if each task meets its deadline
- **Dynamic** task model
  - Dealing with tasks that have varying period and execution time
  - Applicable to engine control module analysis
- **Parallel** task model
  - Dealing with tasks that have multi-threads
  - Applicable to planning and perception subsystems of an autonomous vehicle

Future Research



Towards Safer Autonomous Vehicles





- When LIDAR fails…
- Try to recover using a camera
- Challenges:
  - Predict the utilization of a vision algorithm
  - Leverage heterogeneous processor (e.g. GPU) if possible
  - Reconfigure how to fuse sensor data and how fast the car drives
  - Use communication as a sensor when possible