Truck Partial Automation – Integrated ACC and CACC

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Background

- **Funded under Federal Highway Administration (FHWA) Exploratory Advanced Research Program solicitation, Spring 2013**
- **Cooperative Adaptive Cruise Control (CACC) with V2V to achieve:**
  - **Shorter following distances**
  - **Enhanced string stability and safety**
  - **Increased traffic throughput, while reducing fuel use and emissions**
- **Adaptive Cruise Control (ACC) cannot achieve those objectives due to cumulative delays from downstream to upstream in the string**

CACC versus Platooning

CACC	Platooning
Constant time gap following strategy	Constant distance/clearance following strategy
Decentralized control with no special responsibilities for the string leader	Hierarchical control with special responsibilities for platoon leader
Ad hoc string membership	Coordinated platoon membership

ACC and CACC Modes in the Trucks

- **ALL trucks –** manual or assisted driving modes chosen by drivers on-the-fly
- **LEAD truck –** generally in ACC mode during testing
- **FOLLOWING trucks –** in CACC mode when
  - o V2V messages received from preceding and lead truck
  - o Cut-in duration < 30 sec
  - o Distance from the preceding truck not too large after vehicle cut-out
- **FOLLOWING trucks –** not in CACC mode if any of the aforementioned conditions are not met

Modeling and Controller Implementation Challenges

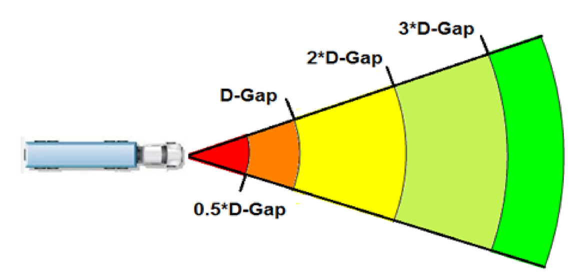
- **Different vehicle types: models & dynamical capabilities vary a lot**
- **Manually driven vehicles: significant driver behavior differences**
- **Reliability in detection and communication is critical for control**
- **Delays in dynamics, detection and actuation harm string stability**
- **Cut-in & cut-out by manually driven vehicles at different locations and speeds**
- **Flexibility in maneuverability and transition between modes**
- **More reliable control for safety:**
  - o **needs control to be more stiff**
  - o **quick response**
- **Driver comfort, fuel economy & flexibility in maneuverability**
  - o **wants control to be softer**
- **Conflict in control: minimizing distance error and speed error**

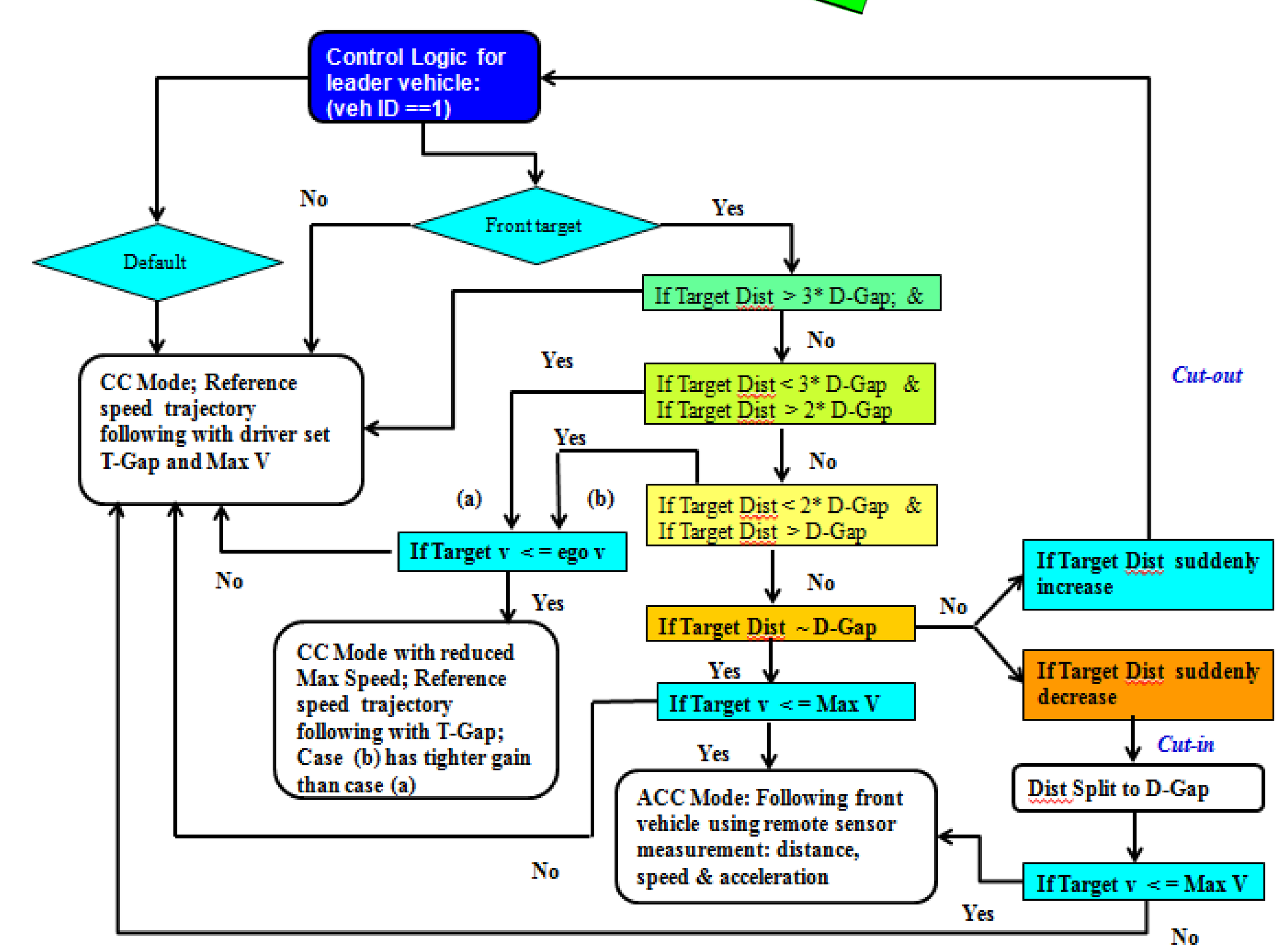
ACC Controller Flowchart

Inputs: preceding vehicle speed, acceleration, and target distance

Outputs: desired engine or braking torque

ACC progressive coupling range with respect to Clearance Gap

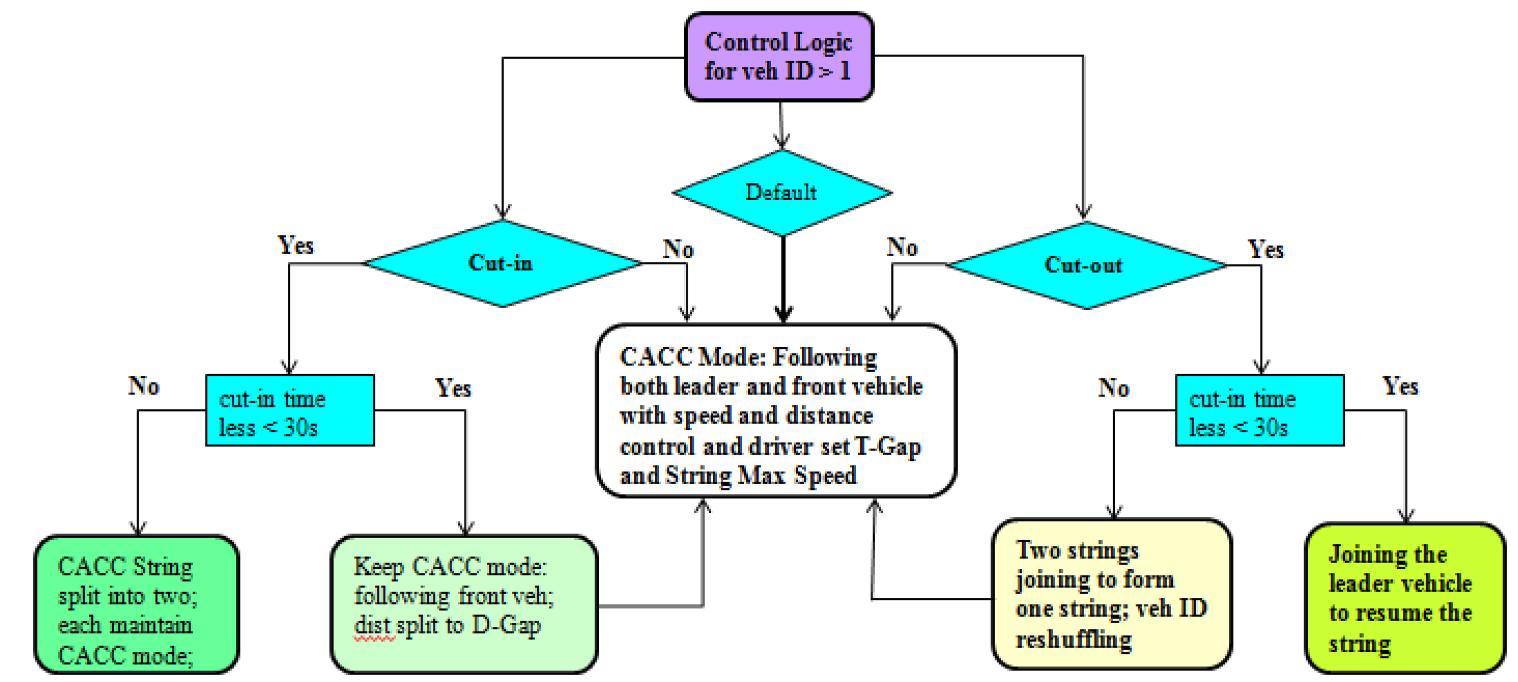




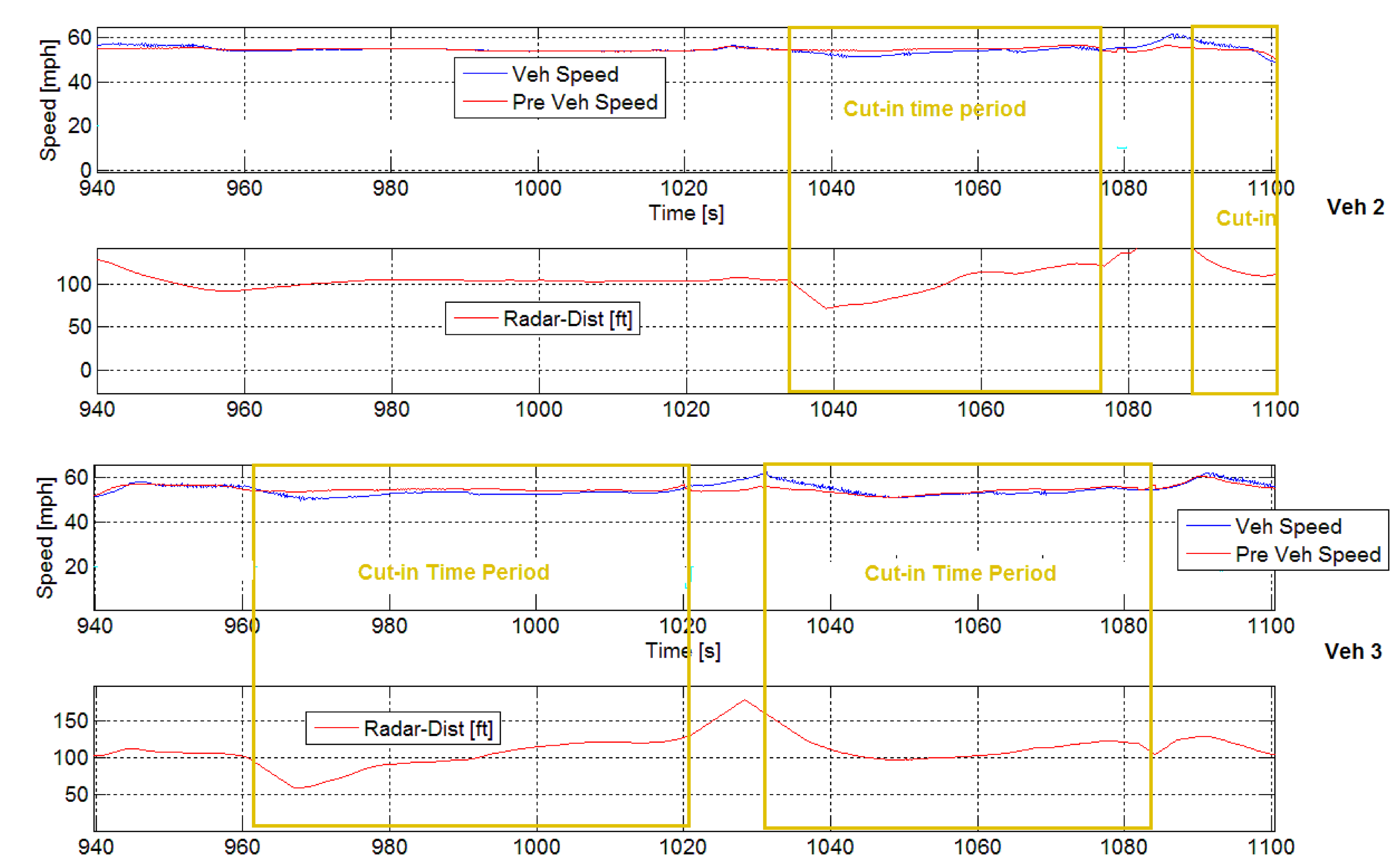
CACC Controller Flowchart

Inputs: preceding and lead vehicle speeds, accelerations, and target distances

Outputs: desired engine torque or engine retarder torque



3-Truck Tests at 55 mph on I-580



Next Steps

- **Refine CACC controller implementation**
- **Integrate supplementary Driver-Vehicle Interface for CACC-specific information**
- **Driver acceptance tests for different gap settings on highways**
- **Controlled fuel consumption experiments**
- **Demonstration in LA and Washington DC**