Submitted by the FRAV task pilot

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Functions That Comprise the Dynamic Driving Task:

For Consideration by FRAV

Task: Recommend a description of the subtasks/functions that comprise the Dynamic Driving Task (DDT).

Purpose: FRAV is developing functional requirements for the safe performance of the DDT by an automated driving system (ADS). Having a common understanding of the functions that comprise the DDT will facilitate development of requirements relevant to performance of those functions.

Guiding principle: Rather than describing each DDT function in the minutest detail by listing each possible subdivision of the function, our goal is to include functions at the most general level that will serve the purpose of identifying functions that should be the subject of functional requirements.

Starting point: SAE J3016 (as revised in April 2021) provides a definition of DDT that includes several basic functions but is not intended to be all-inclusive.

Suggested FRAV approach

- Start with the J3016 DDT definition
- Add some additional functions for possible inclusion (shown below as "added")
- Include China's recommended three categories of functions (perception, decision, control), which track the "sense→plan→act" concept
- Suggested approach does not include HMI aspects mentioned in the Chinese proposal (see discussion in Background section)

Suggested definition

"Dynamic driving task" (DDT) means all of the real-time operational and tactical functions required to operate a vehicle in on-road traffic, excluding the strategic functions such as trip scheduling and selection of destinations and waypoints, and including the following subtasks:

<u>Perception</u>

- Monitoring the driving environment via object and event detection, recognition, and classification, which includes:
  - Perceiving other vehicles and road users, the roadway and its fixtures, objects in path, relevant environmental conditions (added)
- Sensing the ODD boundaries of the ADS feature (added)
- Positional awareness (added)

<u>Decision and Planning</u>

- Prediction of actions of other road users (added)
- Response preparation
- Maneuver planning

Control

- Response execution
- Lateral vehicle motion control (deleted “via steering”)

  NOTE 1: Lateral control may be effectuated by changes to the steering angle of one or more wheels and/or braking of individual wheels

- Longitudinal vehicle motion control (deleted “via acceleration and deceleration”)
- Enhancing conspicuity via lighting, signaling and/or gesturing, etc. (added “/or”)

Background Information

Excerpts from SAE J3016 (April 2021)

"3.10 DYNAMIC DRIVING TASK (DDT)

All of the real-time operational and tactical functions required to operate a vehicle in on-road traffic, excluding the strategic functions such as trip scheduling and selection of destinations and waypoints, and including, without limitation, the following subtasks:

1. Lateral vehicle motion control via steering (operational).

2. Longitudinal vehicle motion control via acceleration and deceleration (operational).

3. Monitoring the driving environment via object and event detection, recognition, classification, and response preparation (operational and tactical).

4. Object and event response execution (operational and tactical).

5. Maneuver planning (tactical).

6. Enhancing conspicuity via lighting, sounding the horn, signaling, gesturing, etc. (tactical).

NOTE 1: Some driving automation systems (or the vehicles equipped with them) may have a means to change longitudinal vehicle motion control between forward and reverse.

NOTE 2: For simplification and to provide a useful shorthand term, subtasks (3) and (4) are referred to collectively as object and event detection and response (OEDR) (see 3.19).

NOTE 3: In this document, reference is made to "complete(ing) the DDT." This means fully performing all of the subtasks of the DDT, whether that role is fulfilled by the (human) driver, by the driving automation system, or by a combination of both.

NOTE 4: Figure 2 displays a schematic view of the driving task. For more information on the differences between operational, tactical, and strategic functions of driving, see 8.11.

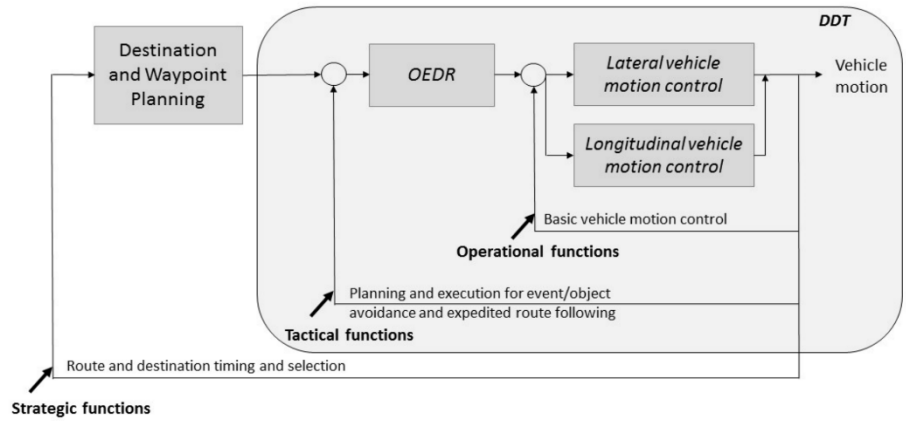


Figure 2 - Schematic (not a control diagram) view of driving task showing DDT portion

For purposes of DDT performance, Level 1 driving automation encompasses automation of part of the innermost loop (i.e., either lateral vehicle motion control functionality or longitudinal vehicle motion control functionality and limited OEDR associated with the given axis of vehicle motion control); Level 2 driving automation encompasses automation of the innermost loop (lateral and longitudinal vehicle motion control and limited OEDR associated with vehicle motion control), and Level 3 to 5 driving automation encompasses automation of both inner loops (lateral and longitudinal vehicle motion control and complete OEDR). Note that DDT performance does not include strategic aspects of driving (e.g., determining whether, when, and where to travel)."

Note: The above definition says "including without limitation," indicating that the list of DDT subtasks is not intended to be all-inclusive.

The SAE definition draws heavily from Michon, J.A., 1985. A CRITICAL VIEW OF DRIVER BEHAVIOR MODELS: WHAT DO WE KNOW, WHAT SHOULD WE DO? In L. Evans & R. C. Schwing (Eds.). Human behavior and traffic safety (pp. 485-520). New York: Plenum Press, 1985. Important to an understanding of the SAE definition is this additional language from SAE J3016 (emphasis added):

"8.11 Driving versus DDT

Driving entails a variety of decisions and actions, which may or may not involve a vehicle being in motion, or even being in an active lane of traffic. The overall act of driving can be divided into three types of driver effort: strategic, tactical, and operational (Michon, 1985). **Strategic effort** involves trip planning, such as deciding whether, when and where to go, how to travel, best routes to take, etc. **Tactical effort** involves maneuvering the vehicle in traffic during a trip, including deciding whether and when to overtake another vehicle or change lanes, selecting an appropriate speed, checking mirrors, etc. **Operational effort** involves split-second reactions that can be considered pre-cognitive or innate, such as making micro-corrections to steering, braking and accelerating to maintain lane position in traffic or to avoid a sudden obstacle or hazardous event in the vehicle's pathway.

> **The definition of DDT provided above (3.10) includes tactical and operational effort but excludes strategic effort.** It is that portion of driving that specifically entails operating a vehicle in an active lane of traffic when the vehicle is either in motion or imminently so. (It should be noted that these terms—strategic, tactical and operational—may have different meanings in other contexts but are defined as above for the purposes of this document.) Indeed, this Recommended Practice defines "operate" to include both operational and tactical efforts.
>
> Object and event detection, recognition, classification, and response (aka, OEDR) form a continuum of activities often cited in the driver workload literature. **In the case of driving automation systems, OEDR also includes events associated with system actions or outcomes, such as undiagnosed driving automation system errors or state changes."**

Although the J3016 definition of DDT excludes strategic functions, J3016 recognizes that some of the strategic aspects of driving may also be automated:

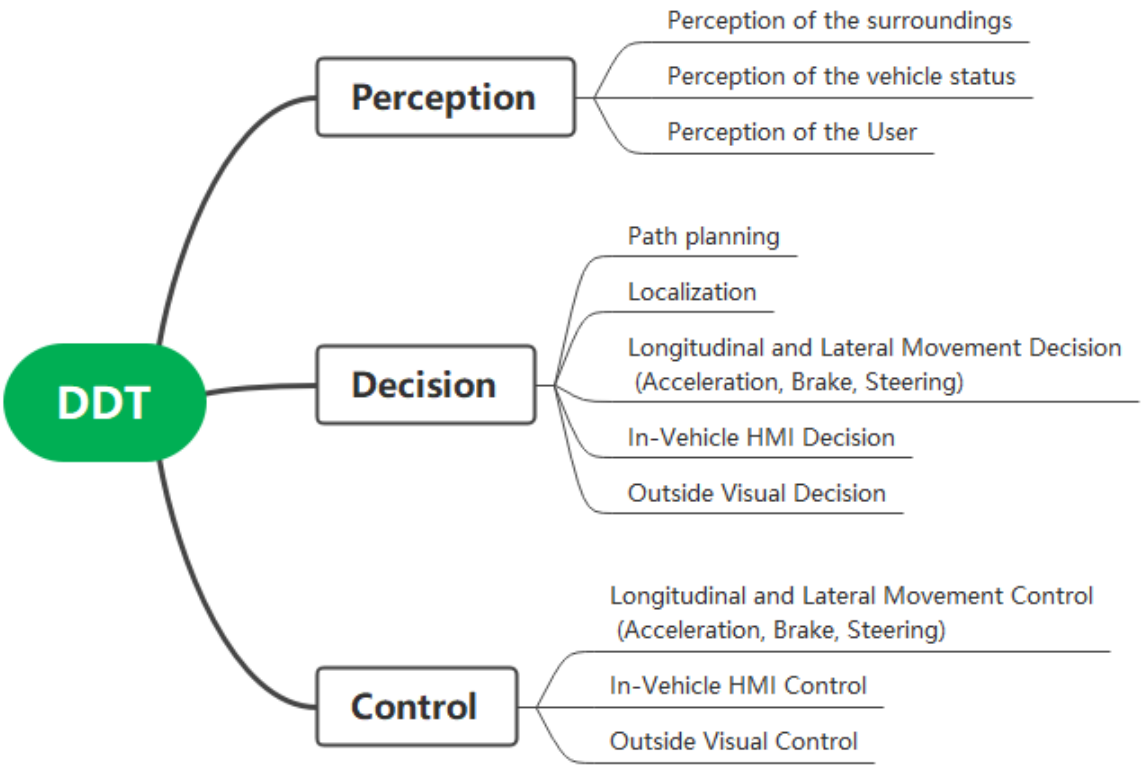
> **"8.10 Possible Automation of Some Strategic Aspects of Driving**
>
> Strategic aspects of vehicle operation (decisions regarding whether, when, and where to go, as well as how to get there) are excluded from the definition of DDT, because they are considered user-determined aspects of the broader driving task, even when partially automated, such as through route navigation software. However, for certain advanced ADS features, such as ADS-dedicated vehicles that are operated as a ride-hailing or delivery service fleet, timing, route planning and even destination selection may also be automated in accordance with purposes defined by the user, namely, a driverless operation dispatcher or a dispatching entity."

Other SAE J3016 definitions that are relevant to DDT

> "3.19 OBJECT AND EVENT DETECTION AND RESPONSE (OEDR) The subtasks of the DDT that include monitoring the driving environment (detecting, recognizing, and classifying objects and events and preparing to respond as needed) and executing an appropriate response to such objects and events (i.e., as needed to complete the DDT and/or DDT fallback).
>
> 3.20 OPERATE [A MOTOR VEHICLE] Collectively, the activities performed by a (human) driver (with or without support from one or more Level 1 or 2 driving automation features) or by an ADS (Level 3 to 5) to perform the entire DDT for a given vehicle."

China's proposal on DDT functions (taken from FRAV-12-07)

What functions make up the DDT?



Considerations related to suggestions from China

- DDT is intended to cover functions required to operate a vehicle by an ADS or human, not decisions about whether a human or ADS performs those functions
- HMI issues can be addressed by specific functional requirements concerning transition to human driver in vehicles where transition is expected (i.e., SAE Level 3) instead of adding this as an element of the DDT definition