

**Research & Vehicle Technology**

**“Infotainment Systems Product Development”**

**Feature – Cloud Enhanced DTE**

**APIM Infotainment Subsystem Part Specific Specification (SPSS)**

Version 1.2

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**FORD CONFIDENTIALF**

**Revision History**

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|  | CDTE-REQ-353817/D-Utilization of IP Pass-Through Framework+ | | ndecia: updated to clarify token storage for future use |
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|  | CDTE-REQ-353598/B-Lost Connectivity with Cloud Enhanced DTE Off-Board Server2 | | ndecia: corrected typo in server name reference |
|  | CDTE-REQ-353800/C-Checking CE-DTE Subscription Status | | ndecia: updated to state that enrollment check should occur at network wake-up |
|  | CDTE-REQ-357726/B-Feature HMI Notifications | | ndecia: updated to reduce scope of the Interface Client's role in displaying information to the user |
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|  | STR-673170/B-Appendix: Reference Documents | | ndecia: updates not-applicable to APIM SPSS |

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# Overview

Cloud-Enhanced Distance to Empty (CE-DTE) is a cloud microservice to help Electric Vehicles determine the most accurate range of their vehicles. The CE-DTE microservice can be called by the vehicle or a third party navigation provider. It incorporates driving history, weather, traffic, elevation and vehicle status (as available) to return an estimated energy use for other services to more accurately calculate the Distance to Empty value.

## Feature Operation

A driver of an Electric Vehicle is presented with an HMI that displays the currently calculated Distance to Empty. This calculation can be improved by leveraging other data sources in conjunction with the on-board vehicle data that is already used to make the calculation for a resultant DTE with improved accuracy. This is done in a manner that is mostly transparent to the driver as the data is sent automatically during each drive cycle and an enhanced DTE is generated as part of this process. This can occur when a user plans a trip to generate a new route, or even when no route is active.

## Feature Assumptions

This feature is currently intended to be only available on Electric Vehicles and can only be supported on FNV2 architectures. Future versions of the feature may cover non-electric vehicles but may also require changes to this or other specifications.

The feature also requires a backend enrollment process that does not impact the vehicle ECUs. The vehicle must be authorized by the user to send data off-board.

## Logical Block Diagram

## Terminology and Abbreviations

The following table lists terminologies that are used in this document along with a brief description.

| **Term** | **Description** |
| --- | --- |
| CE-DTE | Cloud Enhanced Distance to Empty |
| FTCP | Ford Telematics Communication Protocol |
| IPPT | Internet Protocol Pass-through |
| HMI | Human Machine Interface |
| VSDN | Vehicle Service Delivery Network |
| ECG | Enhanced Central Gateway |
| APIM | Accessory Protocol Interface Module |
| FCI | Ford Cloud Interface |
| EV | Electric Vehicle |
| TCU | Telematics Control Unit |
| HPCM | Hybrid Powertrain Control Module |

# Architectural Design

## Physical Mapping of Classes

The table below shows an example of how the logical classes that make up the Cloud Enhanced DTE feature may be mapped into physical modules. This mapping example is specific to the FNV2 architecture and does not necessarily carryover to other carlines or vehicle architectures.

|  |  |
| --- | --- |
| **Logical Class** | **Physical Module (ECU)** |
| Cloud Enhanced DTE Client | ECG |
| Cloud Enhanced DTE Interface Client | APIM |
| Cloud Enhanced DTE Status Client | IPC |
| Cloud Enhanced DTE Off-Board Server1 | VSDN/TMS/VPOI |
| Cloud Enhanced DTE Off-Board Server2 | CE-DTE Service |
| Cloud Enhanced DTE Off-Board Server3 | Nav Cloud |
| Cloud Enhanced DTE Vehicle Data Server | HPCM |

## CDTE-CLD-REQ-353223/A-Cloud Enhanced DTE Client

The Cloud Enhanced DTE Client is responsible for requesting tokens as an IPPT client, issuing CE DTE requests, unpacking and distributing off-board generated data payloads to the vehicle, packing and transmitting on-board generated data payloads to the Cloud Enhanced DTE Server, and initiating the process of updating the on-board DTE value accordingly.

## CDTE-CLD-REQ-353783/C-Cloud Enhanced DTE Interface Client

The Cloud Enhanced DTE Interface Client is only responsible for providing route status to the Cloud Enhanced DTE Client.

## CDTE-CLD-REQ-353784/B-Cloud Enhanced DTE Status Client

The Cloud Enhanced DTE Status Client is responsible for displaying the DTE status and display additional DTE-related information to the user.

## CDTE-CLD-REQ-353224/A-Cloud Enhanced DTE Off-Board Server1

The Cloud Enhanced DTE Server represents backend services which are responsible for providing Enrollment Status updates, generating IP Pass-through tokens, and receiving CE-DTE related vehicle data updates.

## CDTE-CLD-REQ-353785/A-Cloud Enhanced DTE Off-Board Server2

The Cloud Enhanced DTE Server represents CE-DTE cloud service which will generate CE-DTE powertrain update payloads.

## CDTE-CLD-REQ-357379/A-Cloud Enhanced DTE Off-Board Server3

The Cloud Enhanced DTE Off-Board Server3 represents the Nav cloud service which will respond to navigation route requests.

## CDTE-CLD-REQ-353786/A-Cloud Enhanced DTE Vehicle Data Server

The Cloud Enhanced DTE Vehicle Data Server is responsible for the on-board calculation and updating of DTE and providing this to the Cloud Enhanced DTE Status Client. This Cloud Enhanced DTE Vehicle Data Server is also the primary source of the DTE vehicle data that is uploaded to the Cloud Enhanced DTE Off-Board Server1.

## CDTE-IIR-REQ-354139/C-CloudEnhancedDTEInterfaceClient\_Tx

### MD-REQ-354138/C-TripInfoStructure

This is a logical SOA interface containing the Trip Structure as described in the Trip Data protobuf.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | |
| **Method Type** | | On-Change | | | | |
| **QoS Level** | | Default | | | | |
| **Retained** | | No | | | | |
|  | | | | | | |
| **R/O** | **Name** | | **Type** | **Literals** | **Value** | **Description** |
| **Response (\_Rsp)** | | | | | | |
| R | TripInfoStructure | | bytes | Refer to Trip Data protobuf | - | This API contains the trip information of the active route |

### MD-REQ-364361/B-TripStatus

This is a logical SOA interface containing the Trip Status as described in the Trip Data protobuf.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | |
| **Method Type** | | On-Change | | | | |
| **QoS Level** | | Default | | | | |
| **Retained** | | No | | | | |
|  | | | | | | |
| **R/O** | **Name** | | **Type** | **Literals** | **Value** | **Description** |
| **Response (\_Rsp)** | | | | | | |
| R | TripStatus | | bytes | Refer to Trip Data protobuf | - | This API contains the status of any active or inactive trips |

# General Requirements

## REQ-333280/A-FTCP Specification References

The following FTCP specifications define the FTCP alerts/commands mentioned in this SPSS, as well as the protocol used to transmit them via the OffBoardGateway (for FNV2):

* Ford Telematics Communication Protocol Specification
* FNV2-FCI Protocol SPSS

## CDTE-REQ-353787/B-Utilization of Wireless Interface Router framework

The Cloud Enhanced DTE Client shall utilize the Wireless Interface Router framework to facilitate the establishment of connectivity with any off-board services. Please see the Wireless Interface Router SPSS for further details on this framework.

## CDTE-REQ-353817/E-Utilization of IP Pass-Through Framework

At network wake-up, the Cloud Enhanced DTE Client shall leverage the IP Pass-Through framework to issue a token request and facilitate communication with the Cloud Enhanced DTE Off-Board Servers. These tokens shall be stored internally for future use of this feature. If an error code of IPPT\_CLOUD\_SYSTEM\_DOWN is received in response to a token request, the Cloud Enhanced DTE Client shall not reattempt a token request until the next key cycle. Refer to the latest IP Pass-Through SPSS for further details on this framework.

## CDTE-REQ-353810/A-Utilizing Existing Location Services Functions

For the purposes of this feature, the Cloud Enhanced DTE Client is utilizing existing functions from the Location Service SPSS to collect data on the vehicle’s location and current time. Refer to the Location Service SPSS for further details on how this data is can be collected.

## CDTE-REQ-353788/B-Delete Token and CE DTE Data Upon Being Unsubscribed

Upon being unsubscribed via CCS, the Cloud Enhanced DTE Client shall delete any stored IPPT tokens and Cloud Enhanced DTE related data.

## CDTE-REQ-353692/A-Cloud Enhanced DTE CCS Requirement

The Cloud Enhanced DTE feature is impacted by Customer Connectivity Settings. For details on how this is impacted, please refer to the Customer Connectivity Settings Manager SPSS for further detail.

## CDTE-REQ-354175/A-Signal to Represent Ignition On and Ignition Off Events

For the purposes of this document, the Powerpack\_St signal shall be used to represent Ignition Events. The Powerpack\_St signal being set to 0x0 (PwPckOff\_TqNotAvailable) shall be treated as an Ignition Off event and the Powerpack\_St signal being set to 0x1(PwPckOn\_TqNotAvailable), 0x2(StartInPrgrss\_TqNotAvail), or 0x3(PwPckOn\_TqAvailable) shall be treated as an Ignition On event.

## CDTE-REQ-354177/C-Lost Connectivity with Cloud Enhanced DTE Off-Board Server1

If vehicle connectivity is lost or if there is a malfunction with the Cloud Enhanced DTE Off-Board Server1, the Cloud Enhanced DTE Client shall utilize any existing FTCP retry strategies when attempting to re-establish a connection.

## CDTE-REQ-353598/B-Lost Connectivity with Cloud Enhanced DTE Off-Board Server2

If vehicle connectivity is lost or if there is a malfunction with the Cloud Enhanced DTE Off-Board Server2, the Cloud Enhanced DTE Client shall try to reestablish a connection every 5 minutes for data sent via IPPT protocols until a connection is reestablished or the vehicle is turned off.

## CDTE-REQ-353800/C-Checking CE-DTE Subscription Status

The Cloud Enhanced DTE Client shall always verify the feature enrollment/subscription status via CCS at network wake-up and prior to executing any other CE-DTE related functions.

## CDTE-REQ-357726/B-Feature HMI Notifications

The Cloud Enhanced DTE HMI has message notifications/pop-ups which can occur when the HMI has to indicate additional information to the user such as a reason for why the DTE value has been updated. These notifications are presented to the User by the Cloud Enhanced DTE Status Client.

## CDTE-REQ-359198/B-Reporting Application Version

The Cloud Enhanced DTE Client shall report its Cloud Enhanced DTE Application version when sending either of the CEDTENoRouteAPI\_Rq or CEDTENewRouteAPI\_Rq requests.

## CDTE-REQ-403289/A-Capturing Timestamp for Key-On Events

The Cloud Enhanced DTE Client shall capture and store the timestamp at every Key-On Event to be later used for identifying each key cycle.

## CDTE-REQ-403677/A-Compiling Vehicle Payload History

While the GearPosition\_St is set to Park, the Cloud Enhanced DTE Client shall monitor the value VehiclePayloadEstimated\_St for any changes. If any changes are detected, the updated value shall be stored and timestamped to create a table of vehicle payload history, including the value from when GearPosition\_St first transitioned to Park, and this table shall be used in other functions later in this document.

## CDTE-REQ-403679/A-Determining a Change in Vehicle Payload

Upon detecting a transition in GearPosition\_St to Park from any other value, the Cloud Enhanced DTE Client shall capture a snapshot of the values of VehiclePayloadEstimated\_St and store it. Since the value of VehiclePayloadEstimated\_St is set to NoDataExists or 0 upon GearPosition\_St transitioning from Park to any other value, the last non-zero valid value of VehiclePayloadEstimated\_St shall be persisted and stored for comparison purposes.

Upon a transition in GearPosition\_St from Park to any other value, if the persisted last known valid value of VehiclePayloadEstimated\_St differs by at least +/-250kg from the initial value of VehiclePayloadEstimated\_St first captured when entering Park, then the Cloud Enhanced DTE Client shall consider this a large enough change in VehiclePayloadEstimated\_St to be used as described in other functions later in this document.

# Functional Definition

## CDTE-FUN-REQ-353231/A-Request CE DTE Calculation When No Route is Active

### Requirements

#### CDTE-REQ-353232/B-IPPT Token Requests

The Cloud Enhanced DTE Client shall request for any IPPT tokens, if no valid tokens exist already, to initiate communication with the Cloud Enhanced DTE Off-Board Server2.

#### CDTE-REQ-353235/E-Generating and Transmitting CE-DTE No Route Request

After a transition to Ignition On, the Cloud Enhanced DTE Client shall assess the stored value of the TripStatus interface. If the stored TripStatus value is a value other than “Ongoing”, the Cloud Enhanced DTE Client shall then wait for a valid value (0x0 – 0xFFD) to be reported in the TracBatteryAvailable\_St signal before proceeding with the assessment of TrailerConnected\_St.

If the value of TrailerConnected\_St is Yes, then the Cloud Enhanced DTE Client wait until TrailerID\_St is set to a non-zero value OR until the GearPosition\_St is set to a value other than Park, before proceeding with generating the CE-DTE request as described further below.

If the value of TrailerConnected\_St is No, then the Cloud Enhanced DTE Client shall immediately proceed with generating the CE-DTE request as described below.

Once either of the above conditions have been satisfied, the Cloud Enhanced DTE Client shall then generate and transmit a CE-DTE request (CEDTENoRouteAPI\_Rq) to the Cloud Enhanced DTE Off-Board Server2 which contains the data elements CabinAirTemp\_St, TracBatteryAvailable\_St, TrailerID\_St, TrailerConnected\_St, Location1, and Vehicle Payload History if available (as defined in CEDTE-REQ-403677-Compiling Vehicle Payload History.)

Note: If TripStatus is again reported as a value other than “Ongoing”, later in the drive cycle, the Cloud Enhanced DTE Client shall not transmit another CE-DTE request (CEDTENoRouteAPI\_Rq) to the Cloud Enhanced DTE Off-Board Server2.

#### CDTE-REQ-353693/A-Distributing CE-DTE Data Payload

Upon receiving a response payload (CEDTENoRouteAPI\_Rsp) which contains the Cloud Enhanced DTE Powertrain Update data payload, the Cloud Enhanced DTE Client shall unpack and parse this payload to be sent to the Cloud Enhanced DTE Vehicle Data Server.

#### CDTE-REQ-379533/A-Detecting a Change in Trailer Status or Payload History for No Route Request

If at any point during the key cycle, the Cloud Enhanced DTE Client detects a change in the TrailerConnected\_St or a large enough change in the VehiclePayload\_St (according to the criteria defined in CEDTE-REQ-403679-Determining a Change in Vehicle Payload) then it shall generate and transmit a CE-DTE request (CEDTENoRouteAPI\_Rq) to the Cloud Enhanced DTE Off-Board Server2 which contains the data elements CabinAirTemp\_St, TracBatteryAvailable\_St, TrailerID\_St, TrailerConnected\_St, Location1, and Vehicle Payload History if available (as defined in CEDTE-REQ-403677-Compiling Vehicle Payload History.)

### Use Cases

#### CDTE-UC-REQ-353236/A-Request CE DTE Calculation When No Route is Active

|  |  |
| --- | --- |
| **Actors** | Cloud Enhanced DTE Interface Client, Cloud Enhanced DTE Client, Cloud Enhanced Off-Board Server2 |
| **Pre-conditions** | No navigation route is planned or active |
| **Scenario Description** | The Cloud Enhanced DTE Client requests a CE DTE update from Cloud Enhanced DTE Off-Board Server2. |
| **Post-conditions** | The on-board DTE value is updated. |
| **List of Exception Use Cases** | Lost Connectivity with Cloud Enhanced DTE Off-Board Server |
| **Interfaces** |  |

#### CDTE-UC-REQ-354180/B-Lost Connectivity with Cloud Enhanced DTE Off-Board Server

|  |  |
| --- | --- |
| **Actors** | Cloud Enhanced DTE Client, Cloud Enhanced Off-Board Server1/2 |
| **Pre-conditions** | A connection is attempting to be established with the Cloud Enhanced DTE Off-Board Server1/2 |
| **Scenario Description** | The Cloud Enhanced DTE Client determines that connectivity has been lost with the Cloud Enhanced DTE Off-Board Server1/2 |
| **Post-conditions** | The Cloud Enhanced DTE Client attempts to reestablish the connection per the defined retry strategies. The Cloud Enhanced DTE Vehicle Data Server filters back to using the on-board DTE value until a connection is reestablished. |
| **List of Exception Use Cases** |  |
| **Interfaces** |  |

### White Box View

#### CDTE-ACT-REQ-353237/C-Request CE-DTE Calculation When No Route is Active

Activity Diagram



#### CDTE-SD-REQ-353238/C-Request CE DTE Calculation When No Route is Active

Scenarios

Normal Usage

The Cloud Enhanced DTE Client requests a CE DTE update from Cloud Enhanced DTE Off-Board Server2

Constraints

Pre-condition

No navigation route is planned or active

Post-condition

The on-board DTE value is updated

Sequence Diagram



## CDTE-FUN-REQ-357811/B-Request a Navigation Route CE-DTE Calculation

### Requirements

#### CDTE-REQ-357812/A-IPPT Token Requests

The Cloud Enhanced DTE Client shall request for any IPPT tokens to initiate communication with the Cloud Enhanced DTE Off-Board Server2.

#### CDTE-REQ-353233/F-Reporting Trip Status

The Cloud Enhanced DTE Interface Client shall report the status of the trip via the TripStatus interface, both on-change and at start-up. This includes the status of when a route is active as well as not active. This interface shall be timestamped by the Cloud Enhanced DTE Interface Client and sent for all trips of any type.

#### CDTE-REQ-366609/A-Generating and Reporting the TripInfoStructure Payload

The Cloud Enhanced DTE Interface Client shall generate and send the TripInfoStructure payload to the Cloud Enhanced DTE Client via the TripInfoStructure interface. This TripInfoStructure payload shall be generated and sent to the Cloud Enhanced DTE Client for all trips of any type. This interface shall be timestamped by the Cloud Enhanced DTE Interface Client.

#### CDTE-REQ-353811/B-Passing-through the Trip Info to the CE-DTE Off-Board Server2

Upon receiving the TripInfoStructure payload from the Cloud Enhanced DTE Interface Client, the Cloud Enhanced DTE Client shall pass through the TripInfoStructure payload as part of CEDTENewRouteAPI\_Rq to the Cloud Enhanced DTE Off-Board Server2.

#### CDTE-REQ-388939/B-Assessing Trip Status

After a transition to Ignition On, the Cloud Enhanced DTE Client shall assess the stored value of the TripStatus interface. If the stored TripStatus value is “Ongoing”, the Cloud Enhanced DTE Client shall immediately generate and transmit a CE-DTE request via CEDTENewRouteAPI\_Rq to the Cloud Enhanced DTE Off-Board Server2 as described in CDTE-REQ-357813/B-Generating and Transmitting a New Route API Request.

If the updated value of TripStatus is a value other than “Ongoing,” the Cloud Enhanced DTE Client shall proceed with the No Route Request (per CDTE-REQ-353235/D-Generating and Transmitting CE-DTE No Route Request.)

#### CDTE-REQ-357813/D-Generating and Transmitting a New Route API Request

Upon receiving an update with TripStatus set to “Ongoing” anytime during the drive cycle, the Cloud Enhanced DTE Client shall assess the value of TrailerConnected\_St.

If the value of TrailerConnected\_St is Yes, then the Cloud Enhanced DTE Client wait until TrailerID\_St is set to a non-zero value OR until the GearPosition\_St is set to a value other than Park, before proceeding with generating the CE-DTE request as described further below.

If the value of TrailerConnected\_St is No, then the Cloud Enhanced DTE Client shall immediately proceed with generating the CE-DTE request as described below.

Once either of the above conditions have been satisfied, the Cloud Enhanced DTE Client shall then generate and transmit a CE-DTE request via CEDTENewRouteAPI\_Rq to the Cloud Enhanced DTE Off-Board Server2 which contains the data elements TripInfoStructure payload (if available), TripStatus, CabinAirTemp\_St, TracBatteryAvailable\_St, TracBatteryMaximum\_St, DistanceToEmpty\_St, AverageRangePerCharge\_St, Odometer\_St, TrailerID\_St, TrailerConnected\_St, Location1, and Vehicle Payload History if available (as defined in CEDTE-REQ-403677-Compiling Vehicle Payload History.)

#### CDTE-REQ-357815/A-Distributing New Route CE-DTE Data Payload

Upon receiving a response payload (CEDTENewRouteAPI \_Rsp) which contains the Cloud Enhanced DTE Powertrain Update data payload, the Cloud Enhanced DTE Client shall unpack and parse this payload to be sent to the Cloud Enhanced DTE Vehicle Data Server.

#### CDTE-REQ-403319/A-Detecting a Change in Trailer Status or Payload History for New Route Request

If at any point during the key cycle, the Cloud Enhanced DTE Client detects a change in the TrailerConnected\_St or a large enough change in the VehiclePayload\_St (according to the criteria defined in CEDTE-REQ-403679-Determining a Change in Vehicle Payload) then it shall generate and transmit a CE-DTE request (CEDTENewRouteAPI\_Rq) to the Cloud Enhanced DTE Off-Board Server2 which contains the data elements TripInfoStructure payload (if available), TripStatus, CabinAirTemp\_St, TracBatteryAvailable\_St, TracBatteryMaximum\_St, DistanceToEmpty\_St, AverageRangePerCharge\_St, Odometer\_St, TrailerID\_St, TrailerConnected\_St, Location1, and Vehicle Payload History if available (as defined in CEDTE-REQ-403677-Compiling Vehicle Payload History.)

### Use Cases

#### CDTE-UC-REQ-357816/A-Request a Nav Route CE-DTE Calculation

|  |  |
| --- | --- |
| **Actors** | Cloud Enhanced DTE Interface Client, Cloud Enhanced DTE Client, Cloud Enhanced Off-Board Server2 |
| **Pre-conditions** | A navigation route is planned but not active |
| **Scenario Description** | User starts the active route. The Cloud Enhanced DTE Interface Client indicates that a route is currently active. The Cloud Enhanced DTE Client transmits the CEDTENewRouteAPI\_Rq to the Enhanced Off-Board Server2. |
| **Post-conditions** | The result is returned to the Cloud Enhanced Client which extracts the CE-DTE Payload and parses it. |
| **List of Exception Use Cases** |  |
| **Interfaces** |  |

### White Box View

#### CDTE-ACT-REQ-357817/B-Request a Nav Route CE-DTE Calculation

Activity Diagram



#### CDTE-SD-REQ-357818/B-Request a Nav Route CE-DTE Calculation

Scenarios

Normal Usage

User starts the active route. The Cloud Enhanced DTE Interface Client indicates that a route is currently active. The Cloud Enhanced DTE Client transmits the CEDTENewRouteAPI\_Rq to the Enhanced Off-Board Server2.

Constraints

Pre-condition

A navigation route is planned but not active

Post-condition

The on-board DTE value is updated

Sequence Diagram



# Appendix: Reference Documents

|  |  |
| --- | --- |
| Reference # | Document Title |
| 1 | IP Passthrough Client SPSS |
| 2 | Customer Connectivity Settings SPSS |
| 3 | Ford Telematics Communications Protocol Specification |
| 4 |  |
| 5 |  |
| 6 |  |
| 7 |  |
| 8 |  |
| 9 |  |
| 10 |  |