# FNV2 Ford Cloud Interface Architecture (FNV2-FCI)

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| **Owner** | Park, Terry (T.) |
| **Reviewer** | D'Souza, Stephen (S.) |
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## 1. Glossary

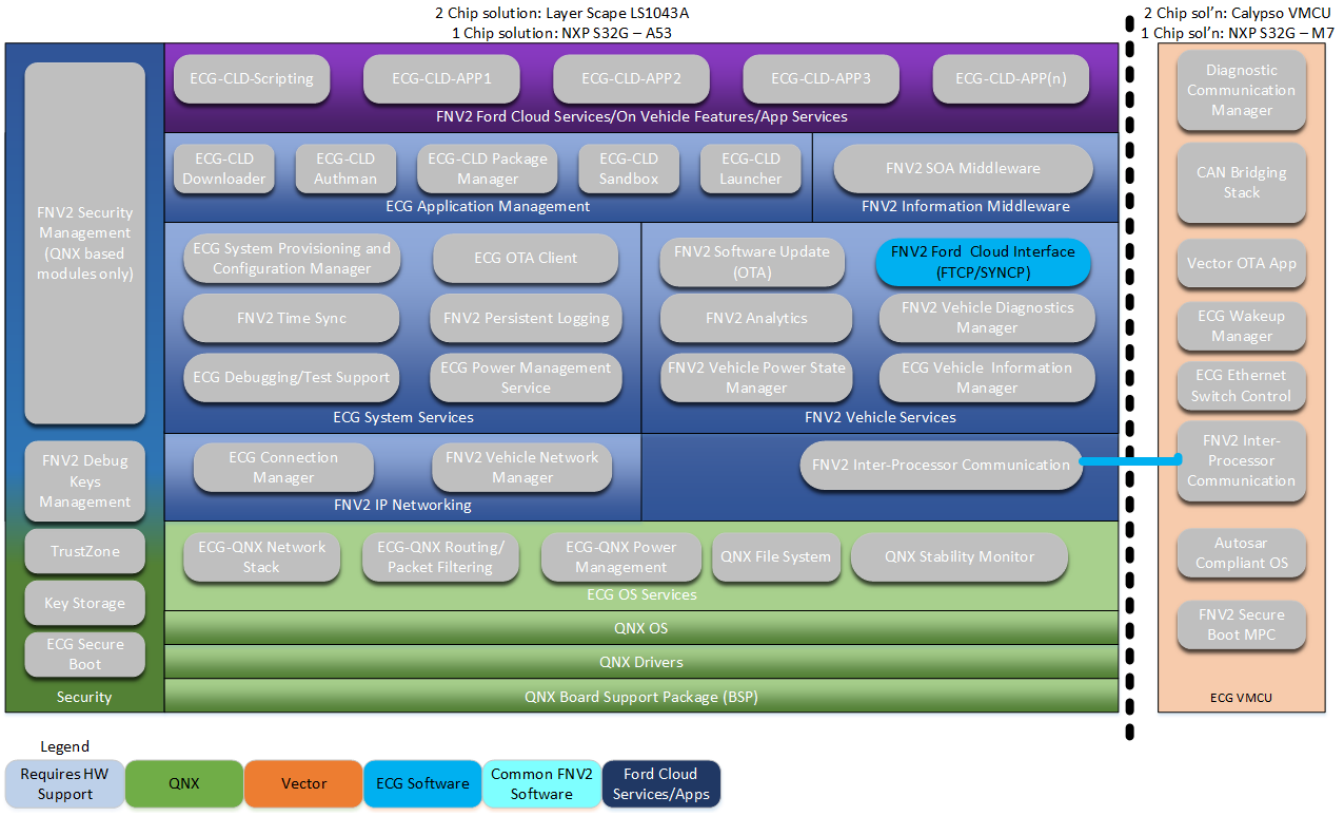
| Term | Definition |
|---|---|

| | |
|---|---|
| FNV2-FCI | FNV2 Ford Cloud Interface |
| SDN | Service Delivery Network |
| MQTT | Message Queue Telemetry Transport |
| FTCP | Ford Telematics Communication Protocol |
| GPB | Google Proto Buffer |
| GIVIS | Azure Cloud |
| CCS | Customer Connectivity Settings |
| OLT | On Line Traffic |
| RTT | Real Time Traffic |
| LWT | Last Will and Testament |
| PARSED | TCU feature enabler that gathers vehicle data from any ECU on the vehicle. SDN requests PARSED Data from vehicle, TCU PARSED client queries ECUs |

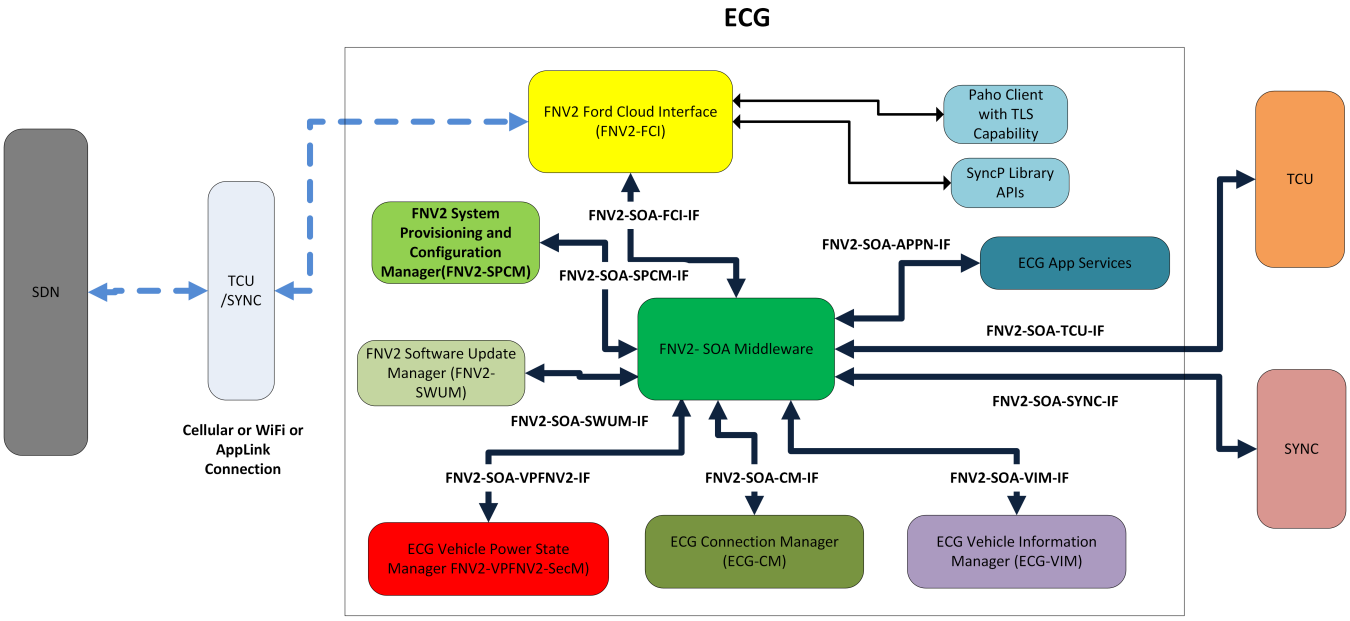
# 2. Summary

The page describes the high level design for FNV2-FCI. The following sections describe the start-up, connect/disconnect procedure, the message exchange patterns between the Ford SDN and FNV2-FCI, and the interactions between FNV2-FCI and other modules in vehicle.

The Ford Cloud Interface serves as the interface between the Ford SDN and ECG. This is responsible for the data communication between the Ford SDN and the modules in vehicle. The Ford Cloud Interface establishes and manages a connection to the Ford SDN. FTCP is used with MQTT to exchange messages between the Ford SDN and FNV2-FCI. The message is encrypted with SyncP which is Ford proprietary security protocol, and the payload is defined using Google Protocol Buffers. FNV2-SOA middleware is used to exchange messages between FNV2-FCI and the modules in ECG, SYNC or TCU. FNV2-FCI converts a FTCP message into a FNV2-SOA message or vice-versa before passing a message between the SDN and the vehicle modules.



# 3. Interfaces




Visio File: FCI_blockDiagramNew.vsd

Note: here the thick solid arrow lines indicates the SOA connections between different components, the thin solid arrow lines indicates API calls to prebuilt libraries, and the dotted arrow lines indicate the actual network connection to/from SDN through different transport interfaces. The interface can be one of the follows: cellular interface from TCU, WiFi interface from TCU through hotspot, WiFi interface from SYNC through hotspot, and App link interface from user's smart phone through SYNC. The App link interface is implemented by TUN device driver in Sync (refer section 4.2.5 IVDCM SDL Integration in IVDCM.SAD-V.60_Draft.pdf).

## 3.1. FNV2 Vehicle Power State Manager Interface

FNV2-VPSM shall provide interface APIs to FNV2-SOA framework for service or apps to vote for ECG Sleep and TCU PS/CS. FCI votes for TCU PS and CS when FCI changes vehicle power state.

More info can be found from the Power Management Architecture doc: ECG Power Management Architecture.

## 3.2. ECG Connection Manager Interface

The ECG-CM controls and manages the IP data transport interfaces between the vehicle and external networks. The FNV2-FCI is responsible for prioritizing and queuing of commands to Ford SDN, based on the nature of the FTCP request and application intent specified by the apps. The intents specify the priority, time sensitivity and possible selection of an interface, cellular, ECG WiFi, SYNC Wifi or AppLink. Based on those application intents, FNV2-FCI will request the ECG-CM to establish the appropriate connection to SDN.

More info can be found from the Connection Manager Architecture doc: ECG Connection Manager Architecture.

## 3.3. ECG Application Services

The ECG-App services are responsible for processing FTCP commands/responses and triggering FTCP alerts. When FNV2-FCI receives the FTCP message from SDN, FNV2-FCI will pass the message to the application service which is registered to handle it. The app service should be aware of the expected behaviour and payload format for the command before it registers the command to the service directory.

## 3.4. ECG System Provisioning and Configuration Manager Interface

The ECG-SPCM is responsible for provisioning of ECG, TCU and managing the system configuration as required by manufacturing EOL and dealers. The ECG-SPCM will provide the SDN url to the FNV2-FCI and request to connect during provisioning process.

Here are what the ECG-SPCM is responsible for:

- Provisioning of ECG and TCU modules in FNV2
- Storing configuration items (DID's) and providing API's for other modules to access
- Propagating configuration update to other modules
- Participating in DIL update during software update process
- Managing Master Reset process

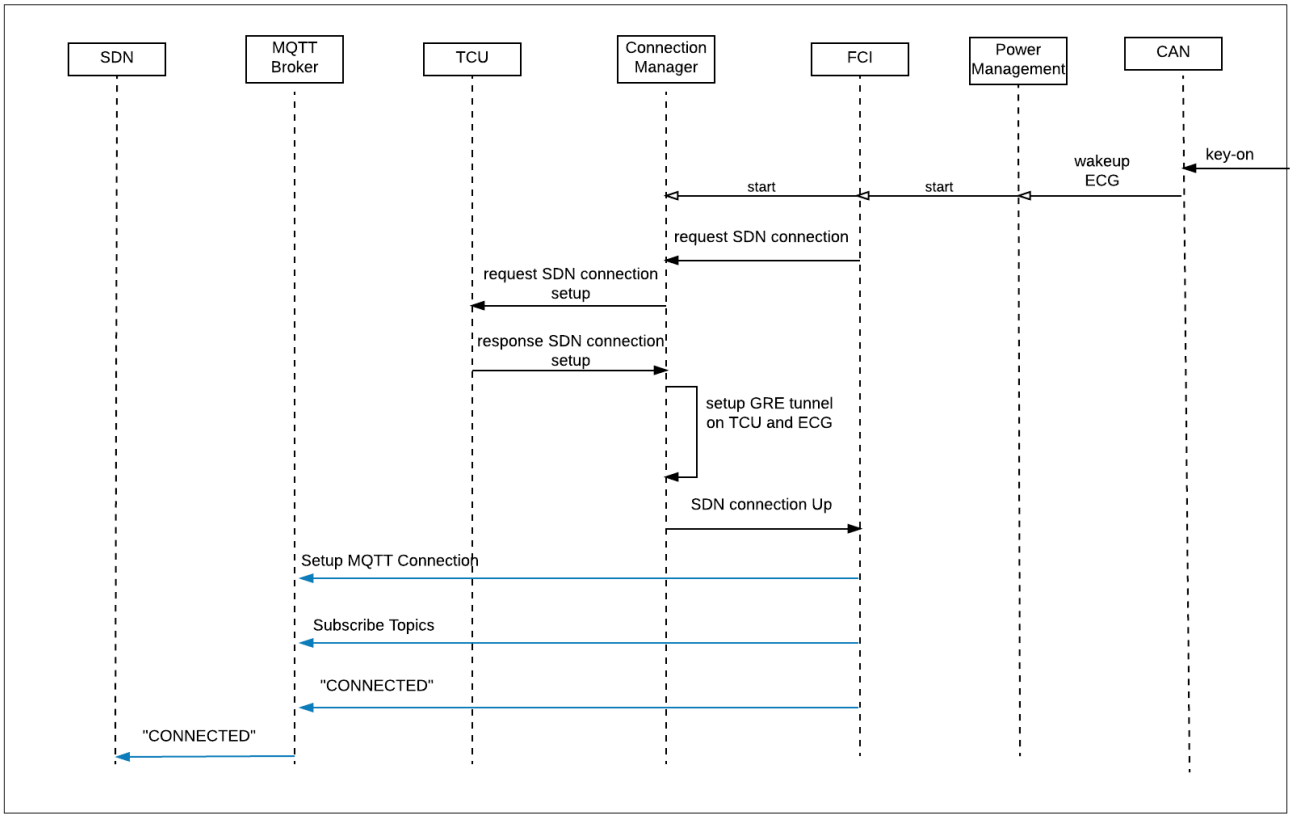
More info can be found from the System Provisioning and Configuration Manager Architecture doc: ECG System Provisioning and Configuration Manager.

# 4. High Level Design

## 4.1. FNV2-FCI connection to SDN

### 4.1.1. Start-up (key-on) and CONNECTED

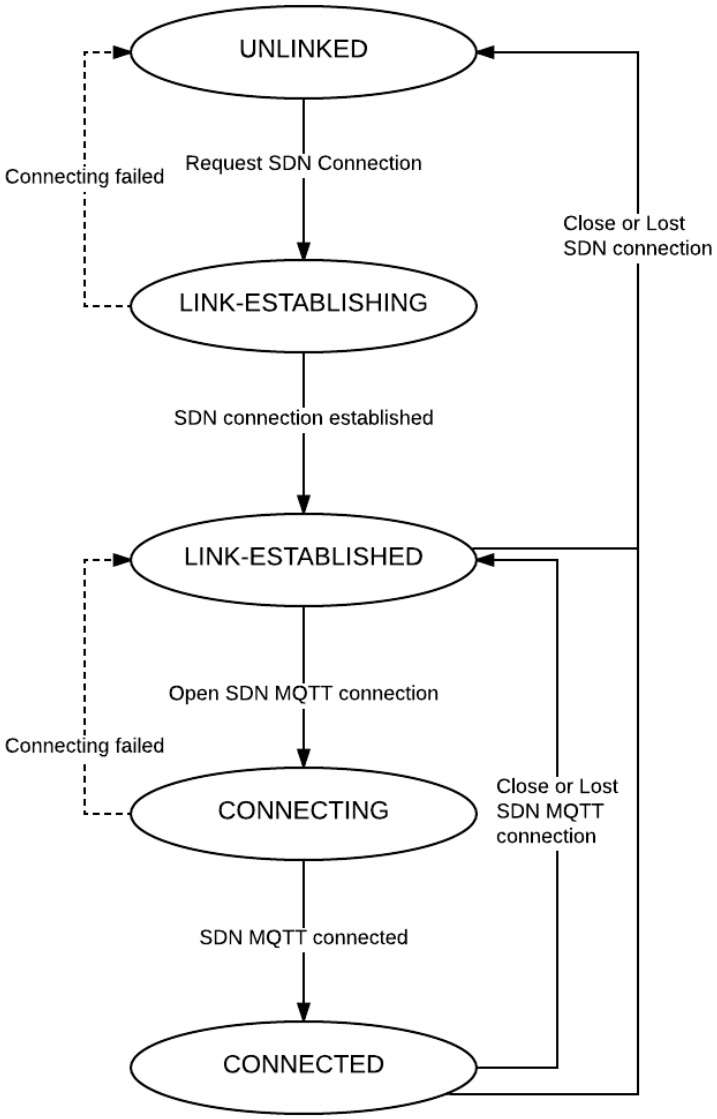
The FNV2-FCI sends the connection status ("Connected") alert when a new MQTT session is established.




### 4.1.2. DISCONNECTED

The FNV2-FCI sends the connection status("Disconnected") alert when disconnected gracefully or MQTT broker sends LWT to SDN when disconnected unexpectedly.

### 4.1.3. Connection state transition




## 4.2. FTCP Message Exchange Pattern

This section identifies the message flows that take place between the cloud and the ECG by using FTCP protocol.

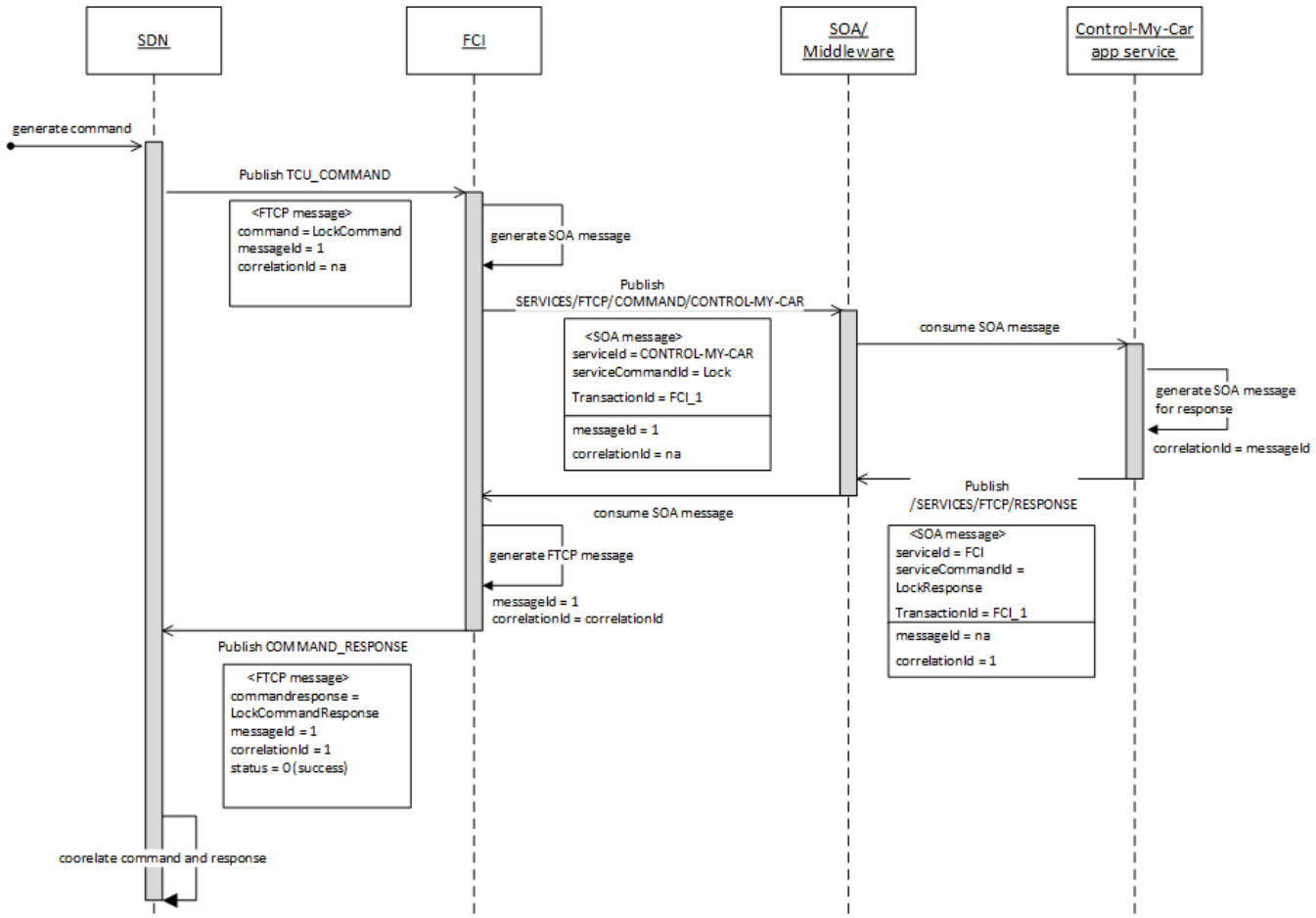
To facilitate message tracking, messages can contain a MessageID, a CorrelationID, or both. MessageID is a token in the Command or Alert that uniquely identified a message sent by the message originator. This ID is a rolling counter. CorrelationID is a token in the Command Response and Query Response or in the Correlated Alert and it has the same value as the MessageID of the Command or Query that originated from the cloud or ECG.

- For all messages, the originator of the message shall use 32 bit rolling counter to generate the MessageID. This counter will roll once the max value of the counter has been reached.
- For non-correlated alerts, the ECG shall always send a MessageID and only a MessageID.
- Commands from the SDN shall always contain MessageID and the CorrelationID will not be populated
- The ECG shall respond to a Command from the cloud with a Command Response containing a CorrelationID and MessageID. The ECG shall populate the CorrelationID with the exact value it received in the MessageID of the Command; thus allowing ease in knowing which Command is associated with which Command Response.
- For Correlated alerts, the ECG shall populate the CorrelationID with the exact value it received in the MessageID of the Command from the cloud.

### 4.2.1. Command + Response

The SDN follows a request-response model to exchange the Commands and Command Response messages with the vehicle; every Command Response is correlated with its SDN Command by applying the above defined CorrelationID pattern.

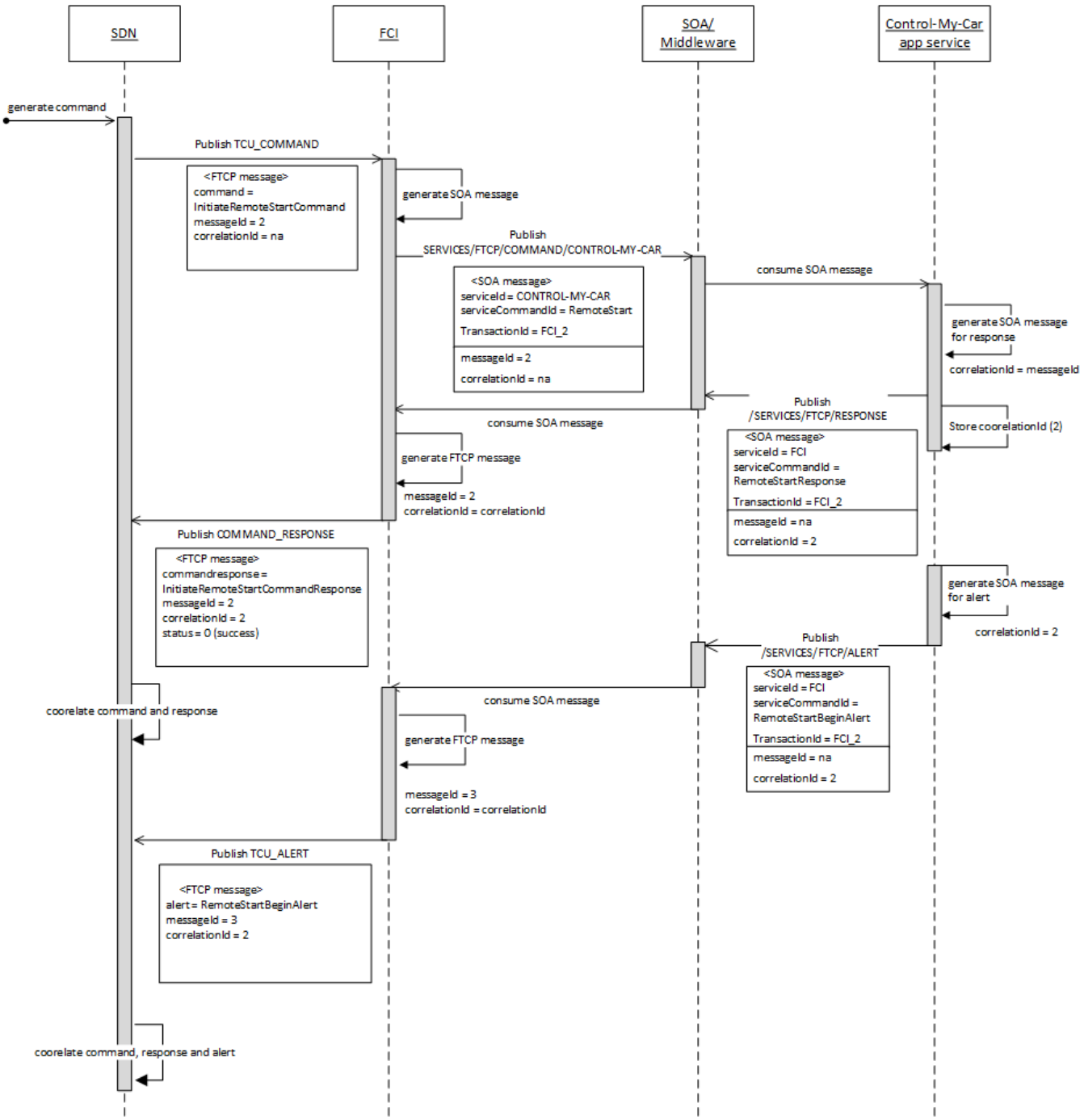
The following diagram explains how the SDN correlates the Command and it Command Response with a MessageID and CorrelationID:




## 4.2.2. Command + Response + Alert

The ECG follows a unique message model to publish the Alerts (correlated alerts) by correlating the SDN commands. The SDN correlates the Commands, Command Responses and Alerts with a MessageID and CorrelationID.

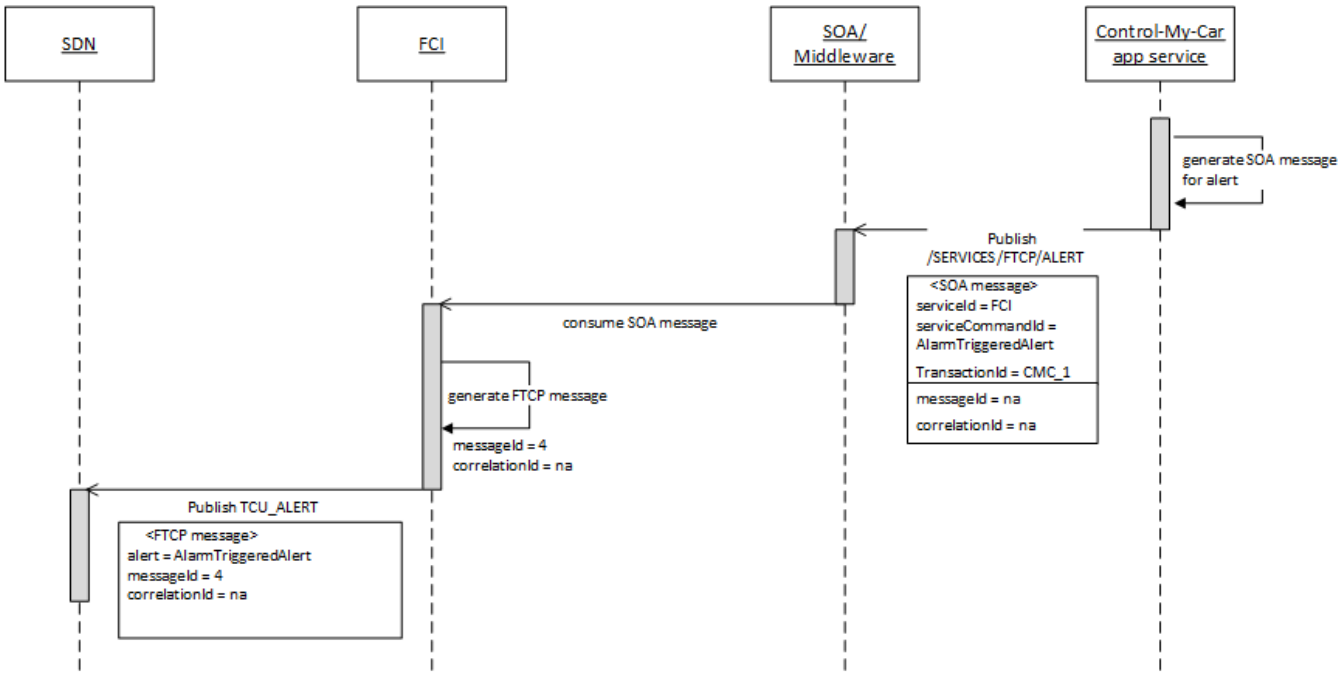
The following diagram explains how the Commands, Command Responses and Alerts are exchanged and correlated:




### 4.2.3. Alert

The ECG follows a one-way message exchange model to publish vehicle generated Alerts (non-correlated alerts) to the SDN; the SDN processes the message without correlation of command messages.

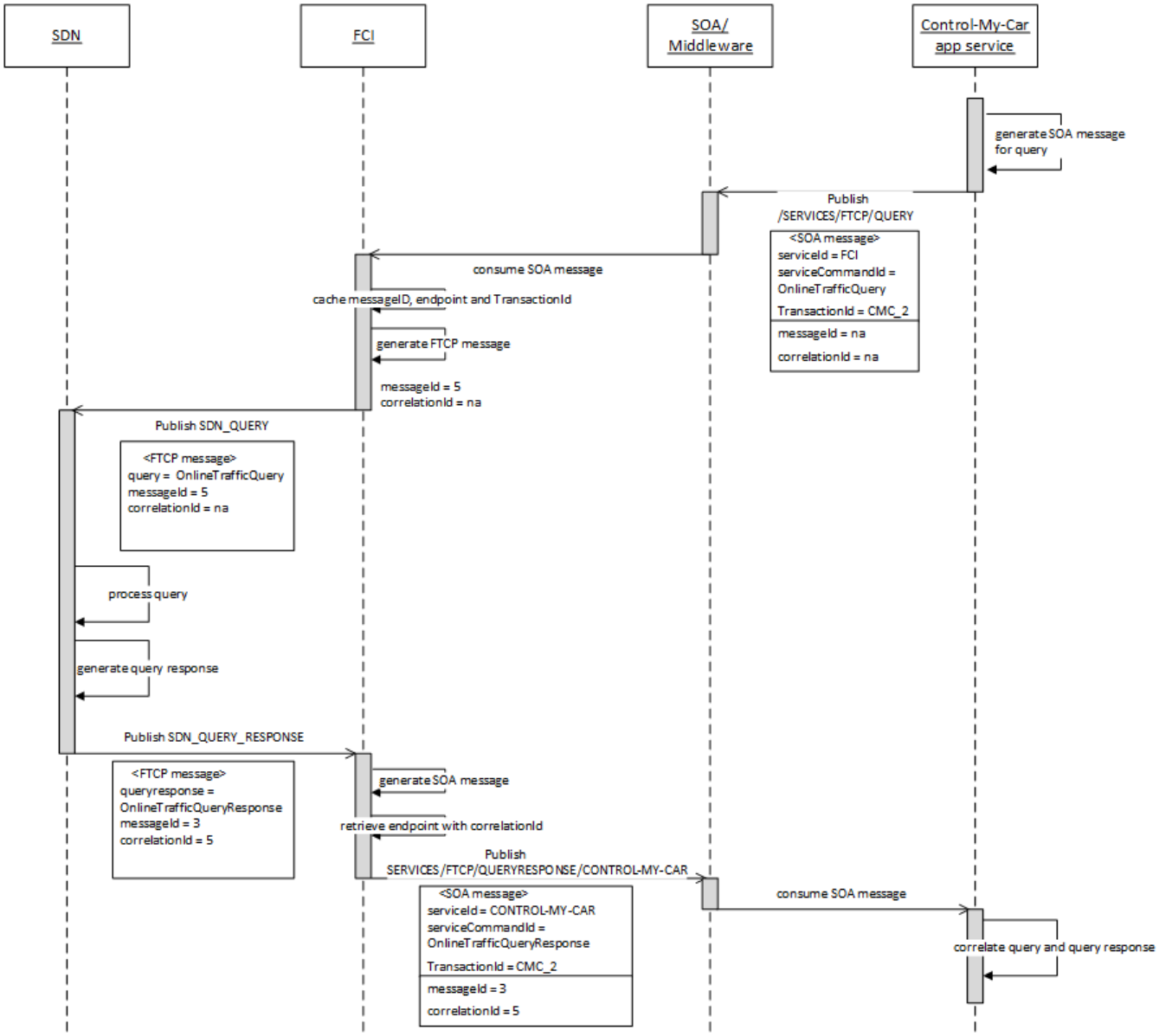
The following diagram explains how the Alerts are exchanged between the vehicle and SDN with a MessageID:




### 4.2.4. Query + Response

The ECG follows a request-response model to exchange the ECG Queries and Query Response messages with the SDN/cloud; every SDN Query Response is correlated with its ECG Qurey by applying the defined CorrelationID pattern.

The following diagram explains how the SDN and the ECG correlate the Query and Query Response messages with a MessageID and CorrelationID:

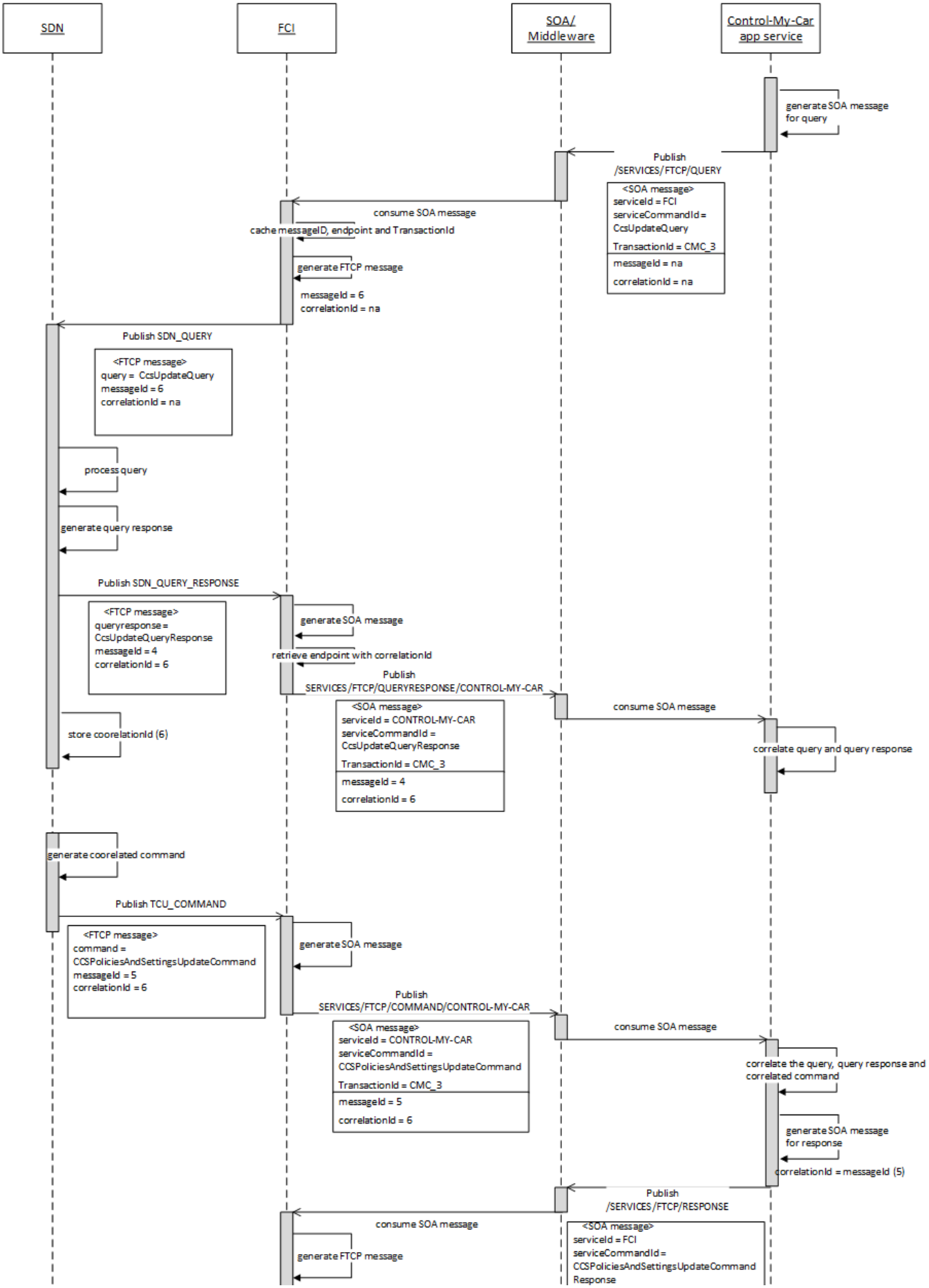


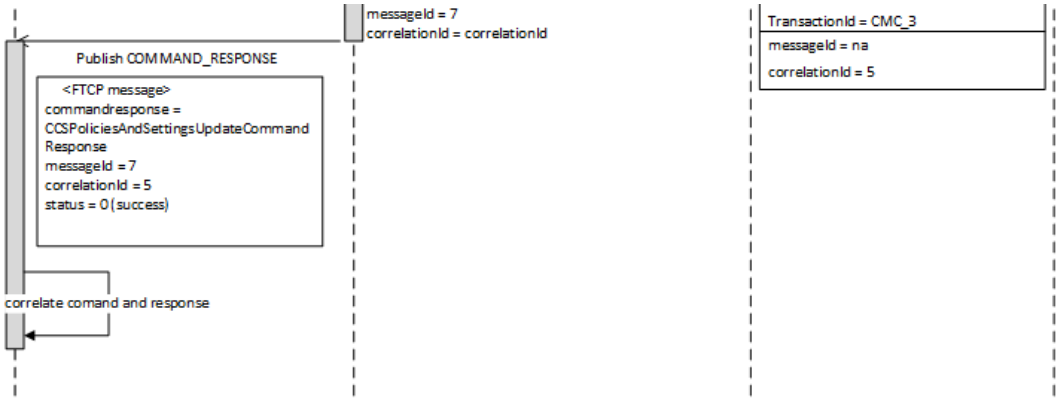

## 4.2.5. Query + Response + Command + Response

The ECG and SDN follow a unique model to exchange the ECG Query and Query Response, Command and Command Response messages. SDN Query Response and Correlated Command are correlated with it ECG Query by defined CorrelationID pattern. ECG Command Response is correlated with its ECG Query, Query Response and Correlated Command.

SDN Command followed by Query Response will get triggered or initiated conditionally based on query specific use case scenarios or functionality.

The following diagram explains how the SDN and ECG correlate the Query, Query Response, Command and Command Response messages with MessageID and CorrelationID:

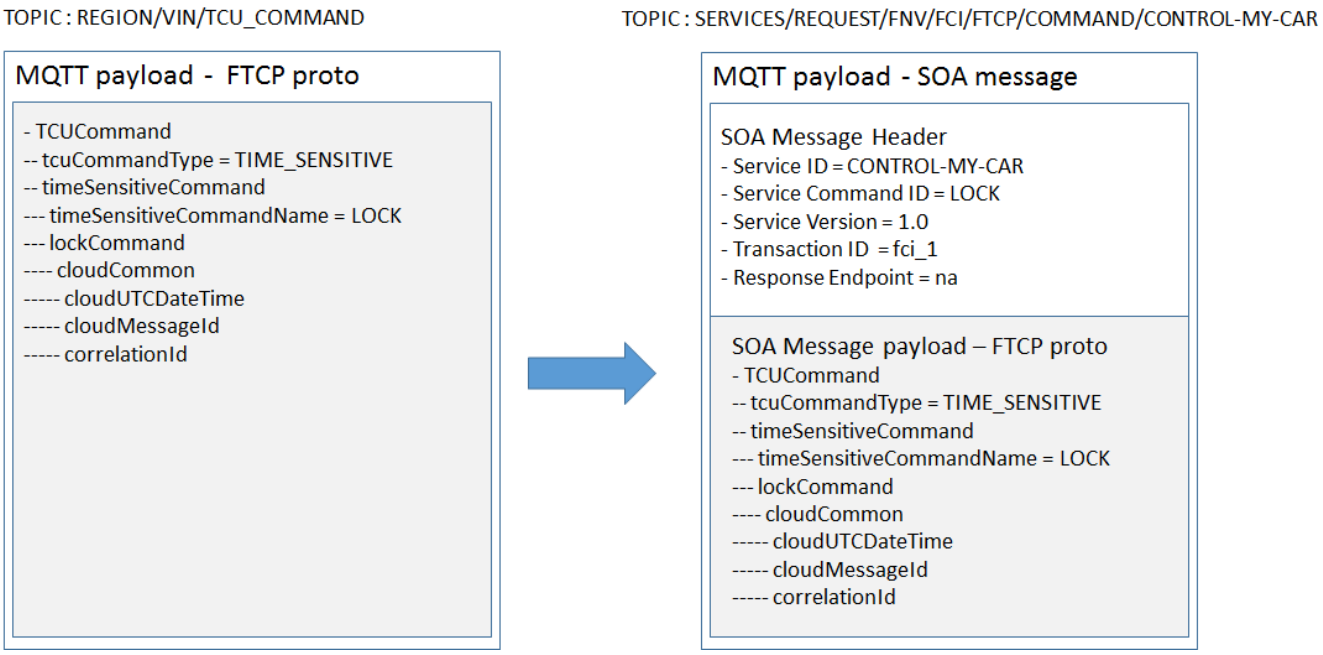

SDN
FCI
SOA/ Middleware
Control-My-Car app service
generate SOA message for query
Publish /SERVICES/FTCP/QUERY
<SOA message>
serviceId = FCI
serviceCommandId = CcsUpdateQuery
TransactionId = CMC_3
messageId = na
correlationId = na
consume SOA message
cache messageID, endpoint and TransactionId
generate FTCP message
messageId = 6
correlationId = na
Publish SDN_QUERY
<FTCP message>
query = CcsUpdateQuery
messageId = 6
correlationId = na
process query
generate query response
Publish SDN_QUERY_RESPONSE
<FTCP message>
queryresponse = CcsUpdateQueryResponse
messageId = 4
correlationId = 6
generate SOA message
retrieve endpoint with correlationId
Publish SERVICES/FTCP/QUERYRESPONSE/CONTROL-MY-CAR
<SOA message>
serviceId = CONTROL-MY-CAR
serviceCommandId = CcsUpdateQueryResponse
TransactionId = CMC_3
messageId = 4
correlationId = 6
consume SOA message
correlate query and query response
store coorelationId (6)
generate coorelated command
Publish TCU_COMMAND
<FTCP message>
command = CCSPoliciesAndSettingsUpdateCommand
messageId = 5
correlationId = 6
generate SOA message
Publish SERVICES/FTCP/COMMAND/CONTROL-MY-CAR
<SOA message>
serviceId = CONTROL-MY-CAR
serviceCommandId = CCSPoliciesAndSettingsUpdateCommand
TransactionId = CMC_3
messageId = 5
correlationId = 6
consume SOA message
correlate the query, query response and correlated command
generate SOA message for response
correlationId = messageId (5)
Publish /SERVICES/FTCP/RESPONSE
<SOA message>
serviceId = FCI
serviceCommandId = CCSPoliciesAndSettingsUpdateCommand Response
consume SOA message
generate FTCP message




## 4.2.6. Message transformation between FTCP and SOA

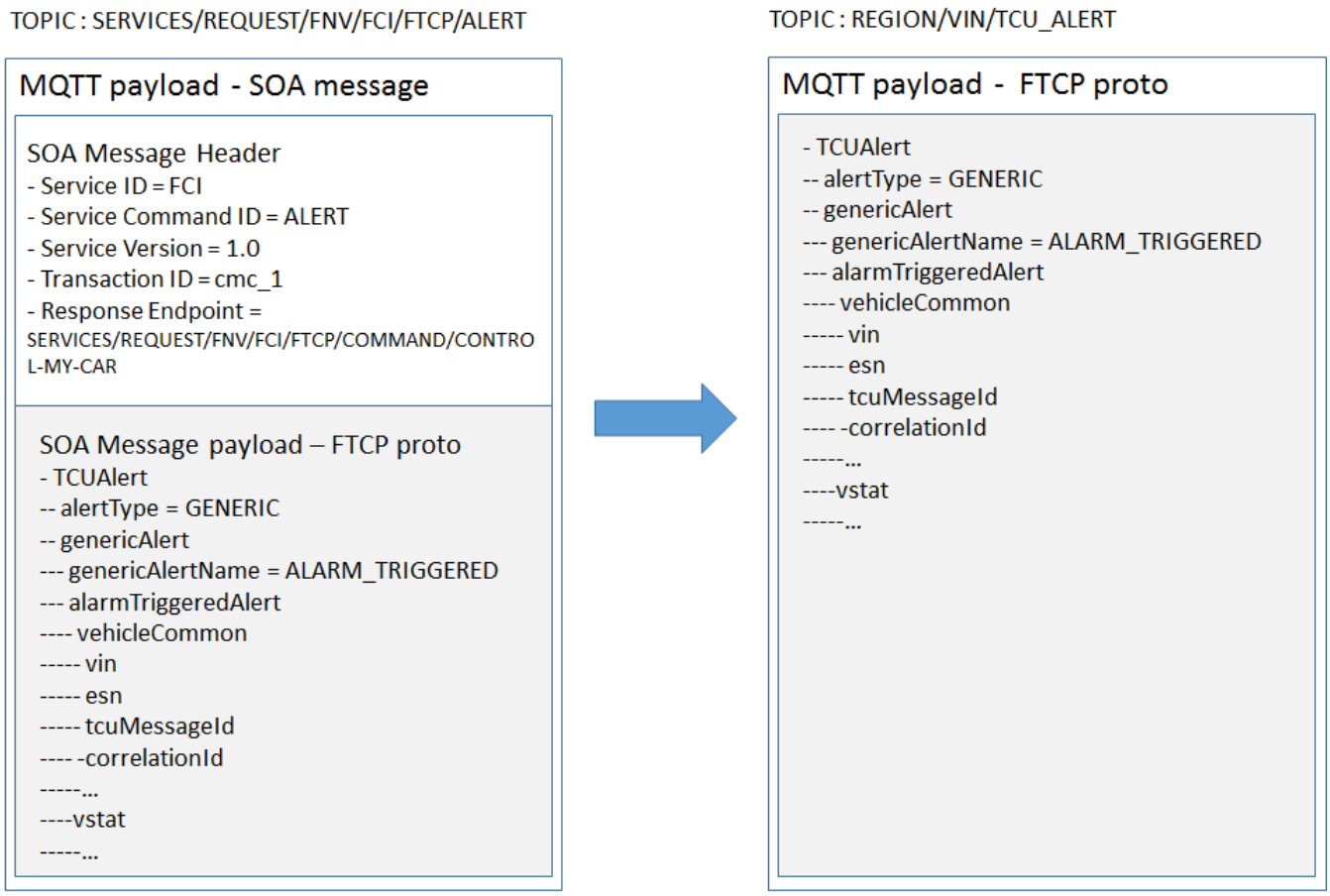
### 4.2.6.1. FTCP to SOA

This diagram shows FTCP to SOA message conversion for TCU_COMMAND (LOCK).




### 4.2.6.2. SOA to FTCP

This diagram shows SOA to FCP message conversion for TCU_ALERT (ALERM_TRIGGERED)




### 4.2.7. TOPICS used for passing FTCP message through SOA

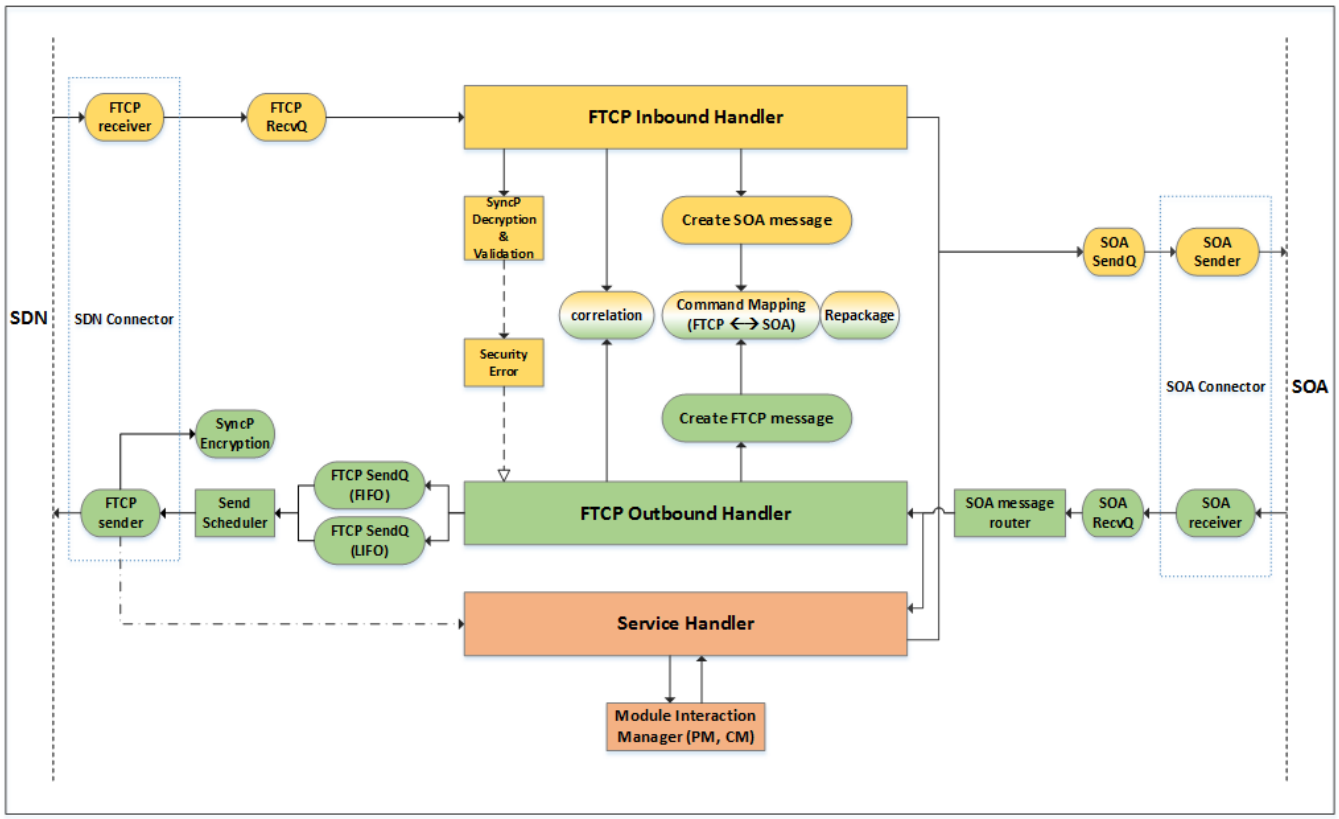
The following topics will be used to pass FTCP messages between FCI and other modules through SOA.

- TCU_COMMAND
  "SERVICES/REQUEST/FNV/FCI/FTCP/COMMAND/<svc-id>"
- COMMAND_RESPONSE
  "SERVICES/REQUEST/FNV/FCI/FTCP/RESPONSE"
- TCU_ALERT
  "SERVICES/REQUEST/FNV/FCI/FTCP/ALERT"
- SDN_QUERY
  "SERVICES/REQUEST/FNV/FCI/FTCP/QUERY"
- SDN_QUERY_RESPONSE
  "SERVICES/REQUEST/FNV/FCI/FTCP/QUERY_RESPONSE/<svc-id>"

## 4.3. FNV2-FCI Components

### 4.3.1. components and interaction diagram

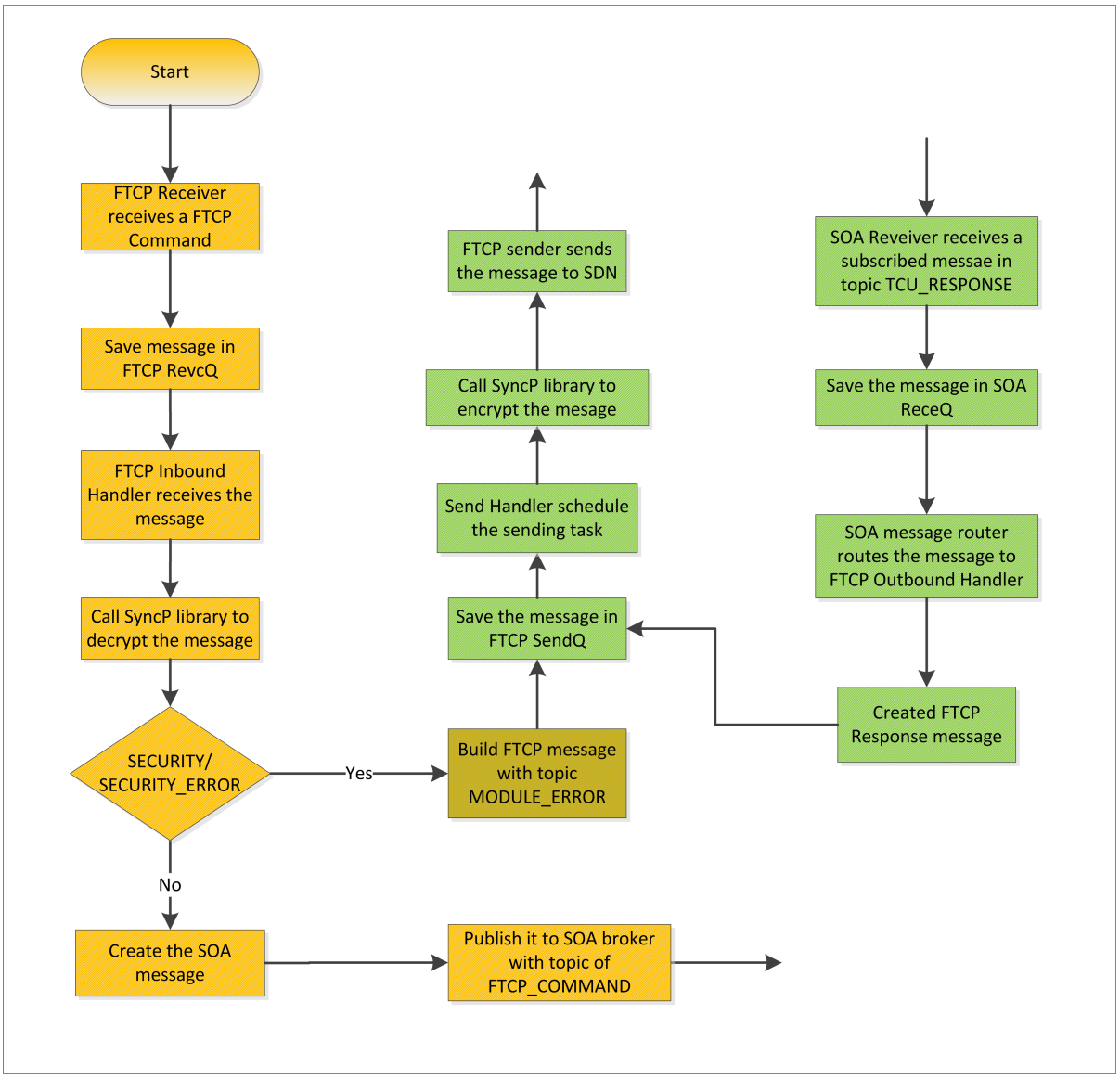
This diagram illustrates FTCP and FNV2-SOA message flow within FNV2-FCI components.




## 4.3.2. Flow Chart Diagram

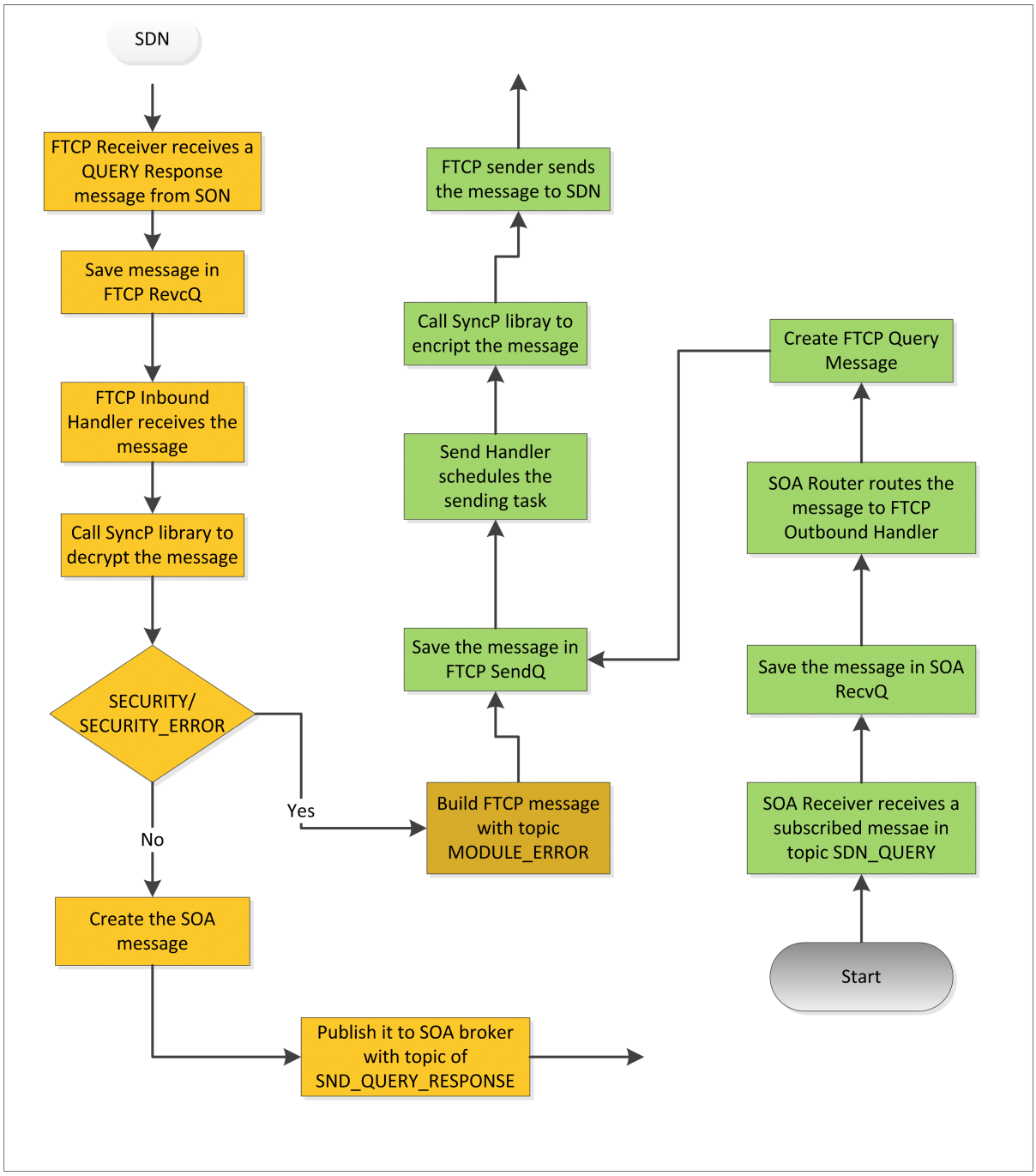
### 4.3.2.1. Receives a TCU Command from SDN

This flow chart diagram describes the component interactions in FCI when a FTCP TCU Command is received by FCI.



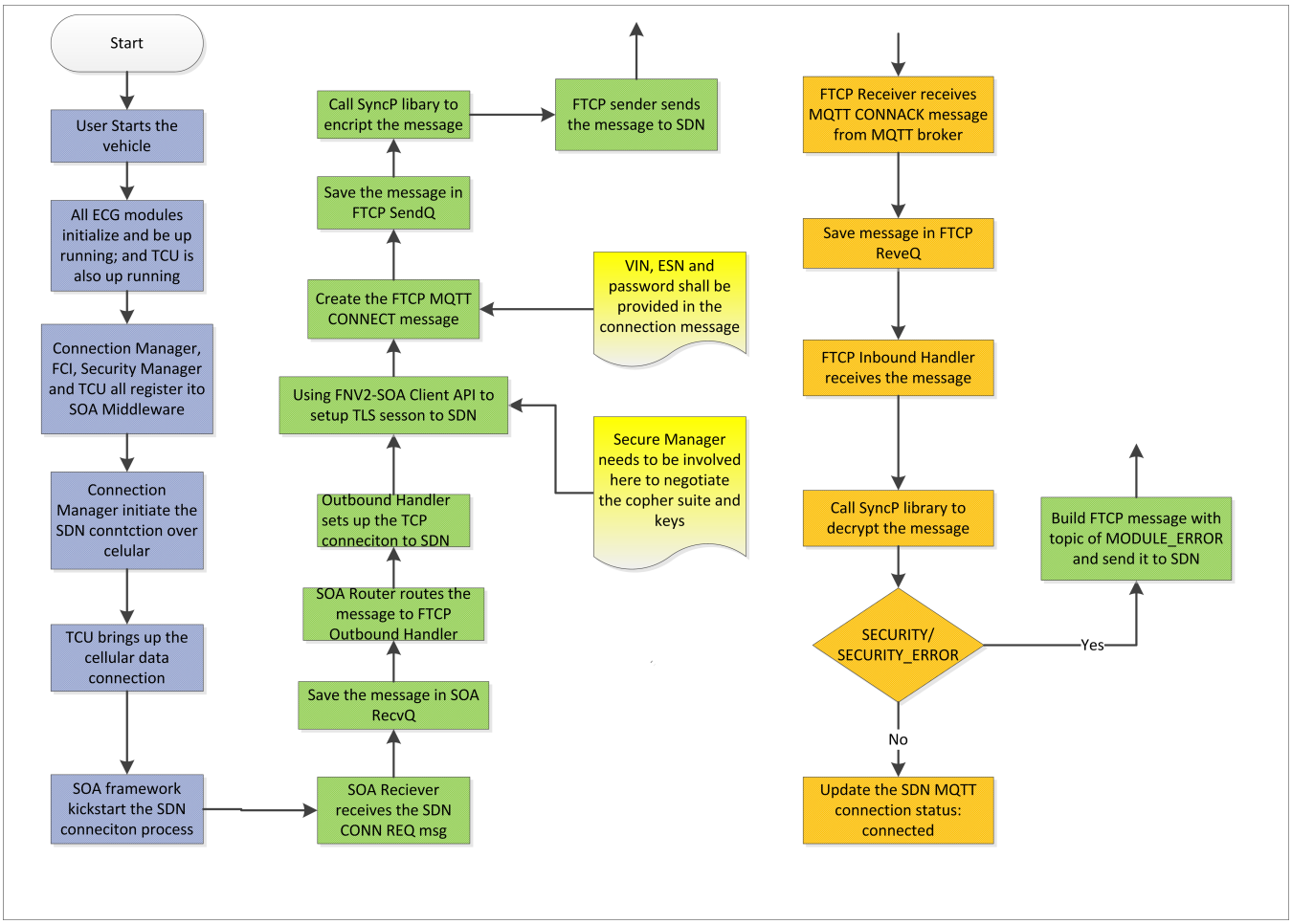

#### 4.3.2.2. Sends a Query Message to SDN

This flow chart diagram describes the component interactions in FCI when FCI receives a Query Request message from the vehicle.

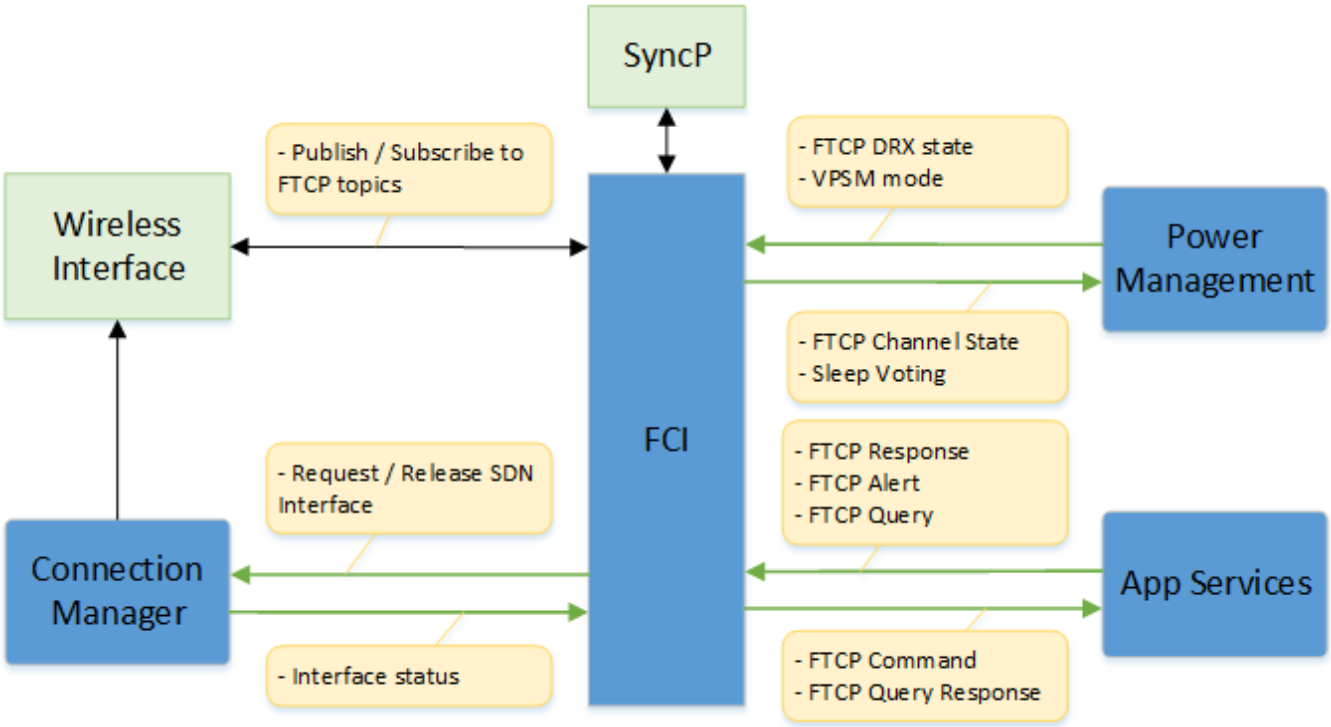



#### 4.3.2.3. Driver starts the car and ECG connects to SDN

This flow chart diagram illustrates the FCI code running sequence when user starts the car, such as how a secure MQTT session is established between ECG and SDN.

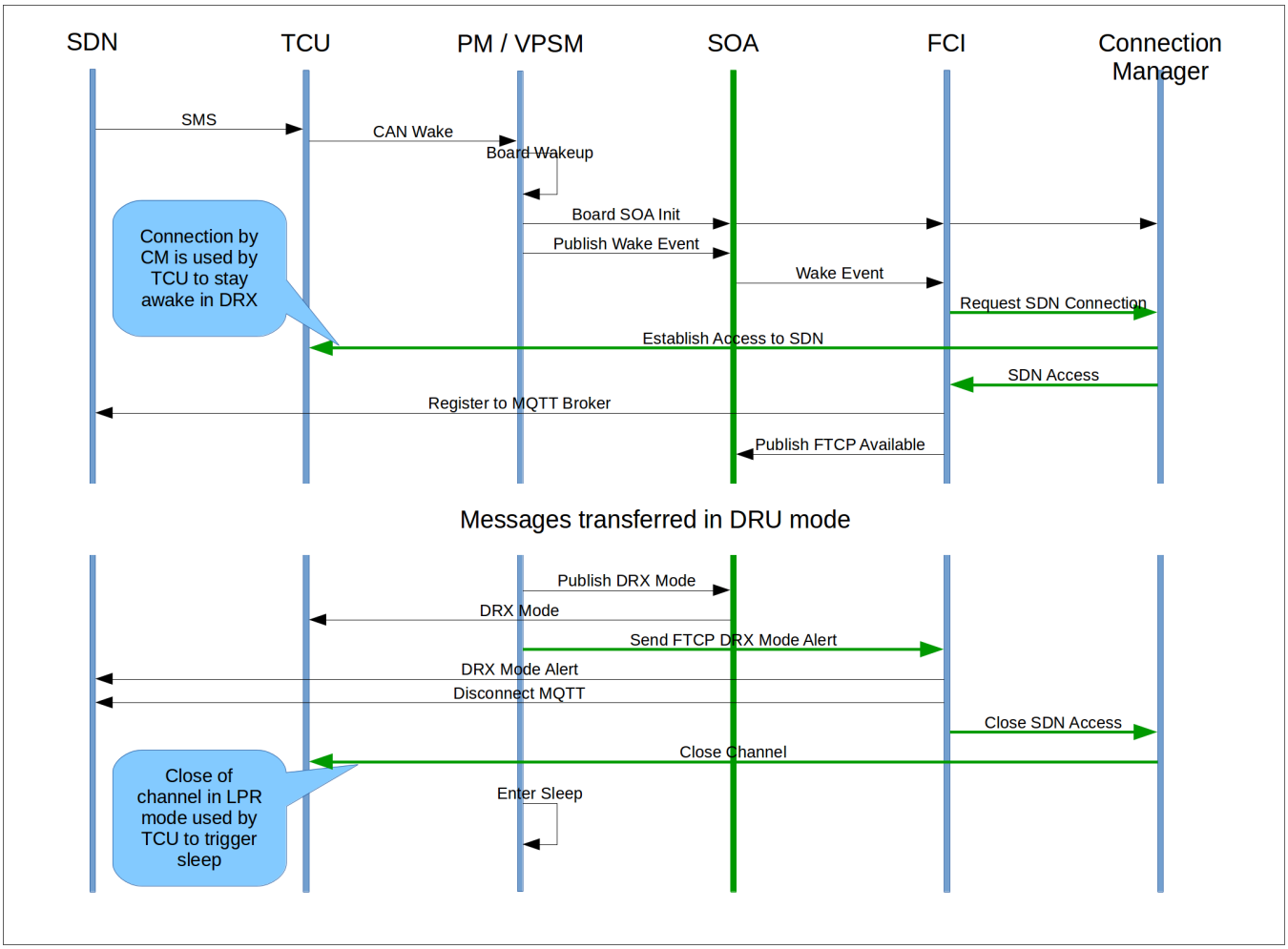



## 4.4. Module Interaction




### 4.4.1. Power Management

The following diagram represents the exchanges that occur when we are in LPR mode and receive an SMS to wake, process commands and then return to LPR mode.




## 4.5. Power State Transition

Power State Handling for Cloud Connectivity

## 4.6. FNV2-FCI Message Transform

### 4.6.1. flow chart diagram

**FNV2-FCI Message Transform**

# 5. Use Cases

All the use cases of FNV2-FCI which are based on the FNV2-FCI requirements are available from here: FNV2 Ford Cloud Interface HLD Use Cases.

All the other use cases of FNV2-FCI are available from here: FNV2-FCI HLD Connection Loss Use Cases.

# 6. Use of Data Partition

| Directory | Contents | Frequency of Write | Frequency of Read | Data Partition Wipe Recovery | Corruption Recovery | Master Reset Behaviour |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| /data/tmp/fci /correlationtable.db | Unsent FTCP responses | When FCI shuts down gracefully<br><br>and there are unsent FTCP responses | When FCI is started | No action | Discard when corrupted | No action / not required |
| /data/tmp/fci /unsentftcpalerts.db | Unsent FTCP messages | When FCI shuts down gracefully<br><br>and there are unsent FTCP messages | | | | |
| /data/tmp/fci/states.xml | ECG power state | Every time when power state update<br><br>and when FCI leaves DWU mode | | | | |

# 7. Questions

| No. | Description | Owner | Status |
|---|---|---|---|
| | *Question description here* | *Current owner, if assigned* | Current status |
| | | | |
| | | | |

# 8. References

| Documents |
|---|
| Ford Telematics Communication Protocol Specification.pdf |
| FTCP Message Sequence Reference Document |
| IVDCM.SAD-V.60_Draft.pdf |