C-V2I LITE in SYNC+ – Phase x.x

Product Requirements Document (PRD)

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1 Introduction

1.1 Purpose

The purpose of the document is to describe and specify each “V2I/ Vehicle to infrastructure” features, which will be deployed in SYNC+ system.

1.2 Scope

For a vehicle to support the feature, the vehicle must have all of the following capabilities but not limited to

- SYNC+
- GPS Antenna
- Embedded Navigation (Map data)
- TCU / Embedded Moden

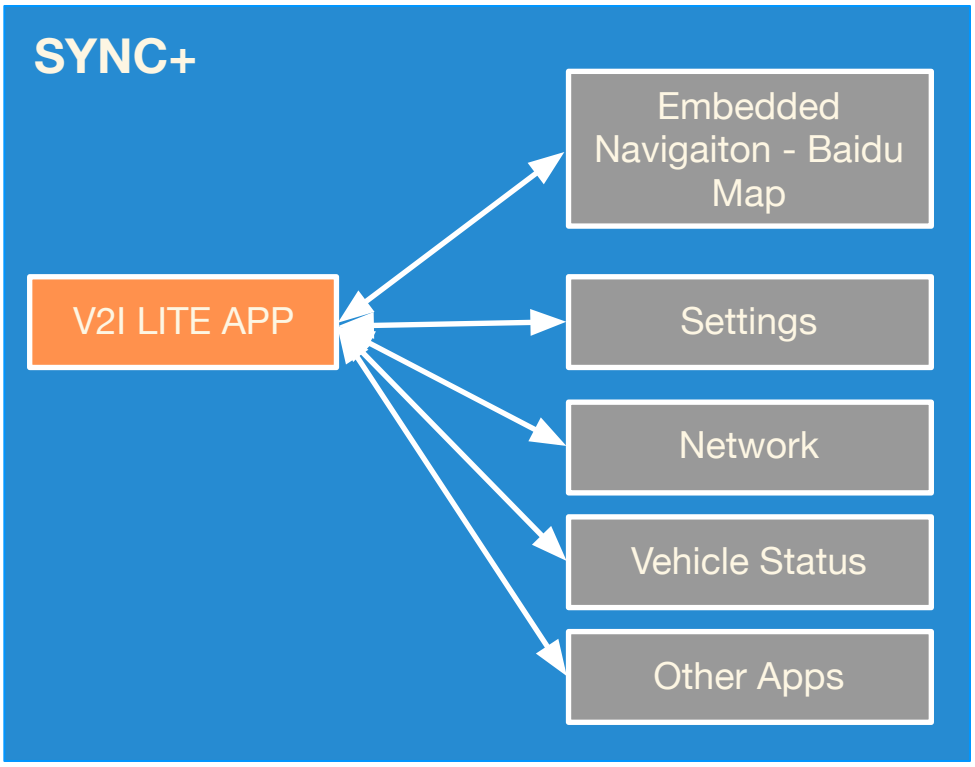
1.3 Audience

- Ford
  - Feature team
  - Function componment team
  - Testing team
- SYNC+ integration
  - Embedded Navigtaion, Settings, Voice Assistant
  - UX/UI designer
  - System Level engineer
  - IntegrationTester
- Nominated HMI supplier
  - UX/UI designer
  - Tester
  - Inteviewer designer

1.4 Terms, Acronyms and Definitions

Term or Acronym	Definition
SYNC+	The new generation of SYNC android based system for China market.
V2I	Vehicle to Infrastructure
TLI	Traffic Light Information
GLN	Green Light Notification
GLOSA	Green Light Optimal Speed Advisory
RLVW	Red Light Violation Warning
RSI	Road Side Information
OASS	Optimization of Automatic Start-stop Engine
V2I LITE APP	Ford in-house development V2I application
Embedded Navigation	Baidu Map on SYNC+

1.5 Components



- V2I LITE APP is a standalone application installed in SYNC+ to provide V2I series function to driver.
  - Act as a host to monitor the conditions from other moduels.
  - Act as a host to send command under certain circumstance.
- V2I LITE APP need to set up some data/command channels with Embedded Navigation, Settings, Network, Vehicle status, etc.. , which will detailed defined from each following sections.

2 Feature Requirement

2.1 TLI

2.1.1 Description

This feature enables the Driver to be informed the most relative Traffic Light information from his/her intention, for example the current light status, phase, duration/countdown, types etc. The computed result will be displayed via HMI system, where would be specified on vehicle basis.

This features provides an in-vehicle display of the status of the traffic signal that the vehicle is approaching to the signalized intersection.

2.1.2 Assumptions

- The system works in those cities that have granted the access to their traffic control data.
- The Embedded Navigation may receive the command from V2I LITE APP.(defined in ***3.Function Interface.)***
- The system receives real-time signal information from traffic management system.

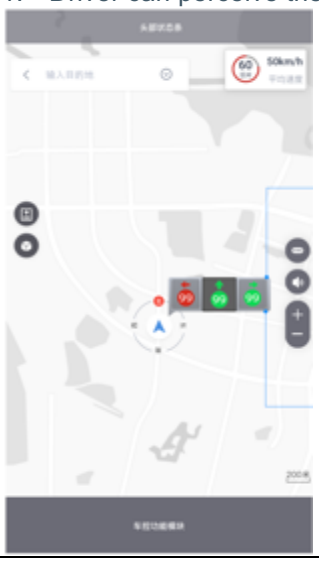
2.1.3 User Stories

User Story ID	User Story
2.1.3.1	As a driver, I would like to be provided an in-vehicle display of the status of traffic signal that the vehicle is approaching to signalized intersection.

2.1.4 Requirements

Requirement ID	Title	Description
2.1.4.1	Receive command from V2I LITE APP	V2I LITE App will use the determined API interface (defined in ***3. Function Interface***) to send and trigger the events, in different scenarios, for example, Navigtion mode, Cruise mode, others.
2.1.4.2	Privilege	V2I LITE APP can be granted with necessary privilege while daily using.

2.1.5 Use Cases

Use Case ID	2.1.5.1
Use Case	The traffic light info can be presented in Embedded Navigation in Cruise mode.
User Stories	2.1.3.1
Requirements	2.1.4.1
Pre-Conditions	1. The signalized intersection is active. 2. The host vehicle radio connection is enabled. 3. Embedded Navigation is equipped. 4. V2I LITE APP is active.
Trigger	1. V2I LITE App send the command.
Expected Behavior	1. Driver can perceive the traffic light information from the display. 
Post Conditions	
Exceptions	<Embedde Navigation failed receive the command sent from V2I LITE APP>

Use Case ID	2.1.5.2
Use Case	The traffic light info can be presented in Navigation mode.
User Stories	2.1.3.1
Requirements	2.1.4.1, 2.1.4.2
Pre-Conditions	1. The signalized intersection is active. 2. The host vehicle radio connection is enabled. 3. Embedded Navigation is equipped. 4. V2I LITE APP is active.
Trigger	1. V2I LITE App send the command periodically.
Expected Behavior	1. Driver can perceive the traffic light information from the display. 
Post Conditions	
Exceptions	<Embedde Navigation failed receive the command sent from V2I LITE APP>

Use Case ID	2.1.5.3
Use Case	The traffic light info can be presented in other pages with the necessary privilege.
User Stories	2.1.3.1
Requirements	2.1.4.1
Pre-Conditions	1. The signalized intersection is active. 2. The host vehicle radio connection is enabled. 3. V2I LITE APP is active.
Trigger	1. V2I LITE App send the command periodically.
Expected Behavior	1. Driver can perceive the traffic light information from the display. 
Post Conditions	
Exceptions	<V2I LITE APP failed launch by itself.>

2.2 GLN

2.2.1 Description

This feature enables the Driver to be notified the most relative Traffic Light shifting from Red to Green within the very last seconds (eg. 5 seconds). The computed result will be prompted via recognized audible sound and visualized HMI. The feature can help assit Driver to prepare moving in ahead and the traffic efficiency can be improved, especially for congested intersection.

2.2.2 Assumptions

- The system works in those cities that have granted the access to their traffic control data.
- The Embedded Navigation may receive the command from V2I LITE APP.(defined in ***3.Function Interface.)***
- The system receives real-time signal information from traffic management system.

2.2.3 User Stories

User Story ID	User Story
2.2.3.1	As a driver, I would like to be notified when the phase shifting of traffic light is impending.

2.2.4 Requirements

Requirement ID	Title	Description
2.2.4.1	Receive command from V2I LITE APP.	V2I LITE APP will use the determined API (defined in ***3. Function Interface***) to send and trigger the events, under different scenarios, for exmpale, navigation mode, crusie mode, others.
2.2.4.2	Privilege	V2I LITE APP can be granted with necessary privilege while daily using.

2.2.5 Use Cases

Use Case ID	2.2.5.1
Use Case	Auditory notification prompt to driver when the phase shifting of the light is impending.
User Stories	2.2.3.1
Requirements	2.2.4.1, 2.2.4.2
Pre-Conditions	1. The signalized intersection is active. 2. The host vehicle radio connection is enabled. 3. V2I LITE APP is active.
Trigger	1. V2I LITE APP send the command.
Expected Behavior	1. Driver may perceive the auditory notification from SYNC+.
Post Conditions	
Exceptions	<V2I LITE APP failed to send the command.>

2.3 GLOSA

2.3.1 Description

This feature enables the Driver to be recommened a speed range to pass through the intersection clearly that can optimize the fuel economy and improve the traffic efficiency. The computed result will be displayed in HMI, where would be specified on vehicle basis.

Vehicle approaching signalized intersctions would continused receive SPaT messages from the intersections, and they would receive advisories to allow progress with minimum fuel consumption and environmental impact.

2.3.2 Assumptions

- The system works in those cities that have granted the access to their traffic control data.
- The Embedded Navigation may receive the command from V2I LITE APP.(defined in ***3.Function Interface.)***
- The system receives real-time signal information from traffic management system.

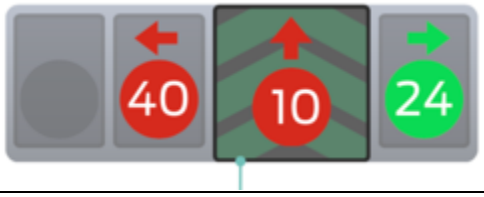
2.3.3 User Stories

User Story ID	User Story
2.3.3.1	As a driver, I would like to be recommended if I can pass through the signalized intersection under current speed.

2.3.4 Requirements

Requirement ID	Title	Description
2.3.4.1	Receive command from V2I LITE APP.	V2I LITE APP will use the determined API (defined in ***3. Function Interface***) to send and trigger the events, under different scenarios, for exmpale, navigation mode, crusie mode, others.
2.3.4.2	Privilege	V2I LITE APP can be granted with necessary privilege while daily using.

2.3.5 Use Cases

Use Case ID	2.3.5.1
Use Case	Recommended Speed rang or Visulaized clearly indicator on passing through signalized intersection.
User Stories	2.3.3.1
Requirements	2.3.4.1, 2.3.4.2
Pre-Conditions	1. The signalized intersection is active. 2. The host vehicle radio connection is enabled. 3. V2I LITE APP is active.
Trigger	1. V2I LITE APP send the command.
Expected Behavior	1. If the recommended speed is applicable, the relative/determined traffic light will turn translucent green with the pattern of directional arrows. 
Post Conditions	
Exceptions	<V2I LITE APP failed to send the command.>

2.4 RLVW

2.4.1 Description

This feature enables the Driver to be notified an emergency warning under the situation. When the vehicle comes to a Green or Yellow light, it will give a warning for the driver to decelerate before the light changes and avoide the unintentionally violate the traffic rule.

Vehicle approaching a signalized intersection are continuously receiving SPaT messages from the intersections, which are used by the vehicle to estimate whether it is on a trajectory that would cause it to cross the stop line after the onset of red phase. If indeed it is on track to cross the stop line in red, the system issue an auditory alert to the driver urging him or her to stop. This is intended to reduce red light violations and the crashes associated with them.

2.4.2 Assumptions

- The system works in those cities that have granted the access to their traffic control data.
- The Embedded Navigation may receive the command from V2I LITE APP.(defined in ***3.Function Interface.)***
- The system receives real-time signal information from traffic management system.User Stories

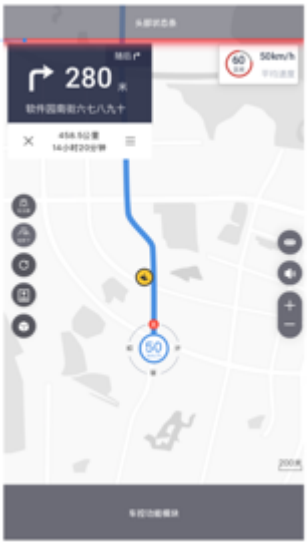
2.4.3 User Stories

User Story ID	User Story
2.4.3.1	As a driver, I would like to be notified by a warning/alert if the situation is critical and will run red light.

2.4.4 Requirements

Requirement ID	Title	Description
2.4.4.1	Receive command from V2I LITE APP.	V2I LITE APP will use the determined API (defined in ***3. Function Interface***) to send and trigger the events, under different scenarios, for exmpale, navigation mode, crusie mode, others.
2.4.4.2	Privilege	V2I LITE APP can be granted with necessary privilege while daily using.

2.4.5 Use Cases

Use Case ID	2.4.5.1
Use Case	Visual and Auditory alert if it is predeicted to reach stop line after the red onset.
User Stories	2.4.3.1
Requirements	2.4.4.1, 2.4.4.2
Pre-Conditions	1. The signalized intersection is active. 2. The host vehicle radio connection is enabled. 3. Red light will onset. 4. V2I LITE APP is active.
Trigger	1. VI2 LITE APP send the command.
Expected Behavior	1. Visual and auditory alert will be promt to dirver it is predeicted to reach stop line after the red onset. 
Post Conditions	
Exceptions	<V2I LITE APP failed to send command.>

2.5 RSI

2.5.1 Description

This feature enables the Driver to be broadcasted with the nearby road information, for example, hazardous wanring, emergency vehicle upcoming warning, construction zones, black-ice road, slippery road etc. The computed result will be prompted with audible TTS and visualized HMI, which would be specified on vehicle basis.

2.5.2 Assumptions

- The system works in those cities that have granted the access to their traffic control data.
- The system may receive the command from V2I LITE APP.(defined in ***3.Function Interface.)***
- The system receives real-time signal information from traffic management system.User Stories

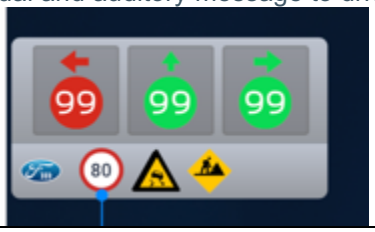
2.5.3 User Stories

User Story ID	User Story
2.5.3.1	As a driver, I would like to be broadcasted the near by latest Traffic information in vehicle from Road Side Unit.

2.5.4 Requirements

Requirement ID	Title	Description
2.5.4.1	Receive command from V2I LITE APP.	V2I LITE APP will use the determined API (defined in ***3. Function Interface***) to send and trigger the events, under different scenarios, for exmpale, navigation mode, crusie mode, others.
2.5.4.2	Privilege	V2I LITE APP can be granted with necessary privilege while daily using.

2.5.5 Use Cases

Use Case ID	2.5.5.1
Use Case	Driver receive the near by Traffic information from Road Side Unit.
User Stories	2.5.3.1
Requirements	2.5.4.1, 2.5.4.2
Pre-Conditions	1. The signalized intersection is active. 2. The host vehicle radio connection is enabled. 3. Red light will onset. 4. V2I LITE APP is active.
Trigger	1. V2I LITE APP send the command.
Expected Behavior	1. Visual and auditory message to driver from the imcoming message. 
Post Conditions	
Exceptions	<V2I LITE failed send the command.>

2.6 OASS

2.6.1 Description

This feature enables the Dirver to be recommended manually disable the Automatic Start-Stop engine under certain condition. The purpose of automatic start/stop engine is to reduce the amount of time the engine spends idling, thereby reduce fuel consumption and emission for internal combustion engine. With

the traffic light countnumber of Red light, it may help to predict the idling time and avoide the annoying Start-Stop engine under too short period.

2.6.2 Assumptions

- The system works in those cities that have granted the access to their traffic control data.
- The system may receive the command from V2I LITE APP.(defined in ***3.Function Interface.)***
- The system receives real-time signal information from traffic management system.User Stories.

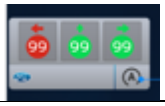
2.6.3 User Stories

User Story ID	User Story
2.6.3.1	From those vehicle equipped Engine Start/Stop, as a driver, I would like to the system automatically disable the Engine Start/Stop that may avoide the annoying under too short idling period.

2.6.4 Requirements

Requirement ID	Title	Description
2.6.4.1	Receive command from V2I LITE APP.	V2I LITE APP will use the determined API (defined in ***3. Function Interface***) to send and trigger the events, under different scenarios, for exmpale, navigation mode, crusie mode, others.
2.6.4.2	Privilege	V2I LITE APP can be granted with necessary privilege while daily using.

2.6.5 Use Cases

Use Case ID	2.6.5.1
Use Case	Mannually / Automatically alter the Engine Start/Stop function.
User Stories	2.6.3.1
Requirements	2.6.4.1, 2.6.4.2
Pre-Conditions	1. The signalized intersection is active. 2. The host vehicle radio connection is enabled. 3. Red light will onset. 4. V2I LITE APP is active.
Trigger	1. V2I LITE APP send the command.
Expected Behavior	1. For those vehicle need to manually disable the Engine Start/stop, an indicator will be presented accompany with Text-to-Speech. 2. For those vehicle can automatically temporarly disable the Engine Start/stop, an indicator will be presented the result. 
Post Conditions	
Exceptions	<V2I LITE App failed to send command.>

2.7 Turn-by-turn information

2.7.1 Description

The embedded navigation shall sync up the turn-by-turn information to V2I LITE APP, for example, direction (left, right, straight), how much distance to the turn.

Details interface requirements may refer to - 3.5 已规划路线信息 / Turn-by-turn information

2.8 Settings

2.8.1 Description

Driver may easily tune their preferences (visual, auditory) for each sub-functions from the Settings page. The exact combination/preferences can be found at 2.8.2 Preferences.

The design will reuse as much as exsiting UI components from SYNC+/Settings. While some item contain a separate info page to elaborate the functions. More details mockup, UI maker can be fond at [Ford-V2I]Settings_UI_Design-V1.0-20200325.pdf, [Ford-V2I]_Settings_markup_20200325.pdf

The visual assets can be found at [Ford-V2I]_Settings UI Design-V1.0-20200325_assets.zip.

- Toggle button
- Swtich
- Choice box

2.8.2 Preferences

Function Name	Description
V2I Setting 接收 V2I 通知	开启后，将按照设定，显示 V2I 各类信息的提示和告警，如：红绿灯信号、绿波车速、绿灯起步…等提醒。
红绿灯信号	根据设置的灵敏度，显示前方路口的红绿灯信号。
绿波车速	开启后，若以当前车速行进，将在到达前方路口时，能在绿灯状态下通过路口，该功能将以图示中的符号给出提示。
绿灯起步提醒	开启后，在停车等待红灯的状态下，根据设置的灵敏度，在红灯即将变绿灯时，将呈现图像和声音的提醒。
闯红灯预警	根据设置的灵敏度，当存在有闯红灯风险时，给出图像和声音的提醒。
最优自动起停	开启后，在需停车且等待红灯的时间不长的情况下，将会显示建议关闭自动启停功能的提醒。
道路信息广播	开启后，将接收到的前方实时道路状况，显示在 V2I 信息条中。
声音设置	根据设定的模式，关闭或开启部分声音的提示。
全局浮窗 APP（Baidu）	开启后，将在非地图应用的画面，显示 V2I 相关信息，且可上下拖拽或收起、展开。

2.9 Audio Arbitration

2.9.1 Description

Two or more TTS / Audio can be played to the same output stream simultaneously. One of the option is to mix everything together. While this is the technicaly impressive, it can be very aggravating to user. To avoid every media source playing at the same time, V2I LITE APP will follow the exisiting IVI - Audio Arbitation strategy as much as possible and self-management **Audio Focus** to be cooperative with other sync-apps and offer a better experience with Navigation.

2.9.2 Arbitration Flow Chart

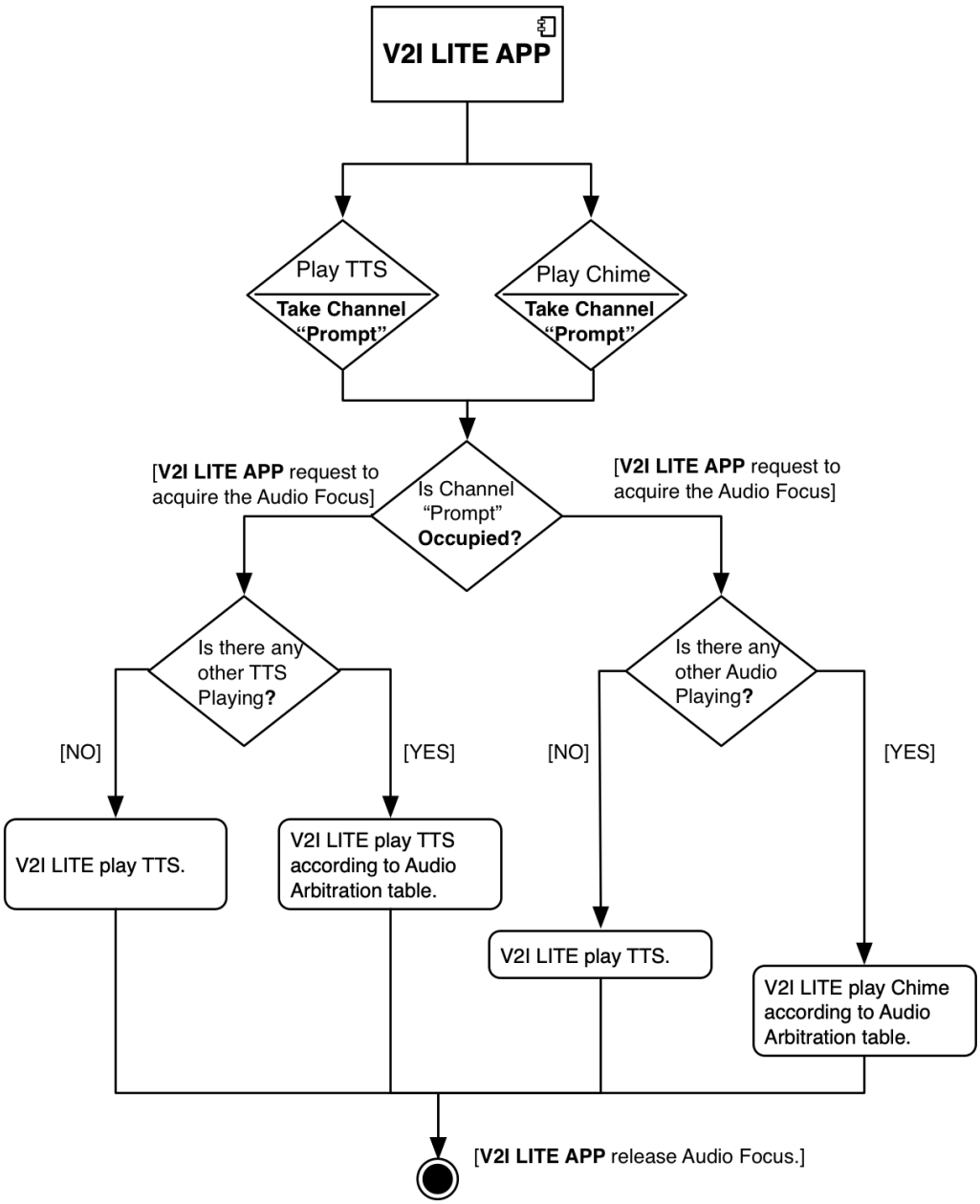


Table 2.9.2.1 SYNC+音频管理补充需求_Ver1.11

Current / New	Media/Radio	Telephone	Prompt - Navi.User	Prompt & V2I	PTT & VR	Mute	Standby
Media/Radio	Granted	Delay	Mix	Mix	Reject	Granted	Reject
Telephone	Granted	Granted 注 1	Mix 注 13	Granted	Granted	Granted	Reject
Prompt - Navi.User	Mix 注 12	Mix	Granted	Granted	Granted	Granted	Reject
Prompt & V2I	Mix	Reject	Reject	Granted	Reject	Granted	Reject
PTT & VR	Granted	Reject	Granted	Granted	Granted 注 2	Granted	Reject
Mute	mute	Reject	Reject	Reject	Reject	Granted 注 5	Reject
Standby	Granted	Granted	Granted	Granted	Granted	Granted 注 10	Granted

Please refers to - 3.7 音频资源仲裁 / Audio Arbitration （Baidu&YFV）

2.10 Abnormal & misbehavior Information

2.10.1 Description

Pleae refers to - 3.9 系统异常状态提醒 / System Abnormal & misbehavior Notification

3 Function Interface

3.1 Ford V2I APP 提供地图显示所需数据

3.1.1 Functions

Ford V2I Lite APP 会定时发送红绿灯等相关显示数据给 Baidu MAP APP，百度地图需要按照需求显示对应图标及播放 TTS。

3.1.2 Communication Method

Content Provider

3.1.3 Transmit frequency

N/A

3.1.4 Data Sending

Sending parameters as below.

Item 1	Item 2	Type	Descriptopn
highlightView	Base64Icon	String	Base64 picture data
bubbleView	Base64Icon	String	Base64 picture data
	lon	Double	Lontitude of vehicle
	lat	Double	Latitude of vehicle

3.1.5 Response

N/A

3.2 从百度获取地图数据

3.2.1 Functions

根据 request 的经纬度返回最近一个路口多个进口方向道路坐标点（GJC02 坐标系）等数据。

3.2.2 Communication Method

AIDL

3.2.3 Data Sending

Parameters	Required	Type	Description
Lon.	Yes	Double	The longitude of intersection
Lat.	Yes	Double	The latitude of intersection

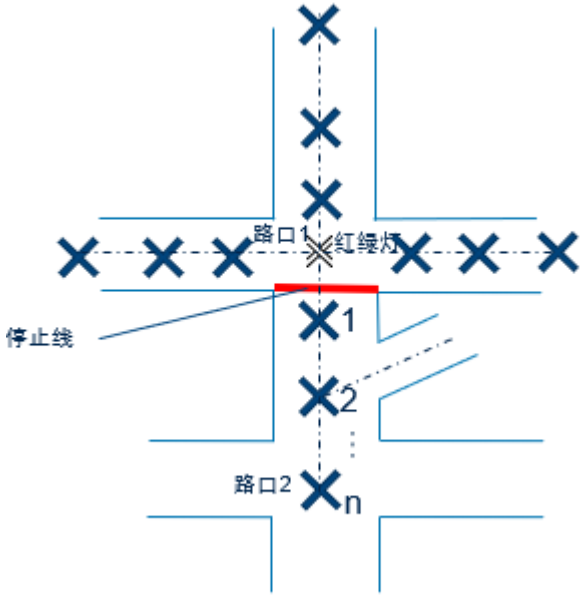
3.2.4 Response

Parameters	Type			Description
Lon.			Double	The longitude of intersection
Lat.			Double	The latitude of intersection
roads			List	道路级别数据，路口进口方向路网数据集合①
-	points		List	组成当前道路的几何位置点坐标，此集合的**最后一个坐标点必须为停止线位置坐标**②
-	-	Lon.	Double	道路点的经度
-	-	Lat.	Double	道路点的纬度
-	limit_speed		Double	道路限速
-	is_left_allowed		Boolean	道路是否允许左转
-	is_straight_allowed		Boolean	道路是否允许直行
-	is_right_allowed		Boolean	道路是否允许右转

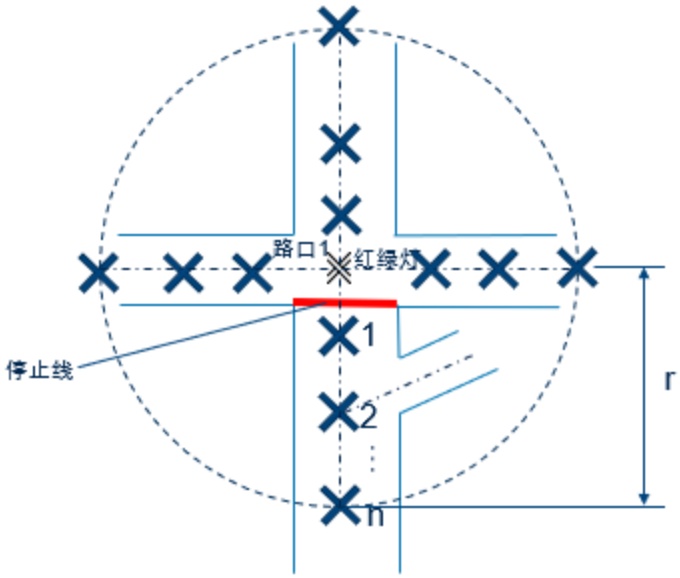
备注：

① 根据 request 的经纬度返回最近一个路口多个进口方向道路坐标点（GJC02 坐标系）等数据，根据有无连续路口，分为两种情况。

第一种情况：存在连续路口。如图，路口 1 和 2,那么第 n 个坐标为路口 2 的中心点坐标。

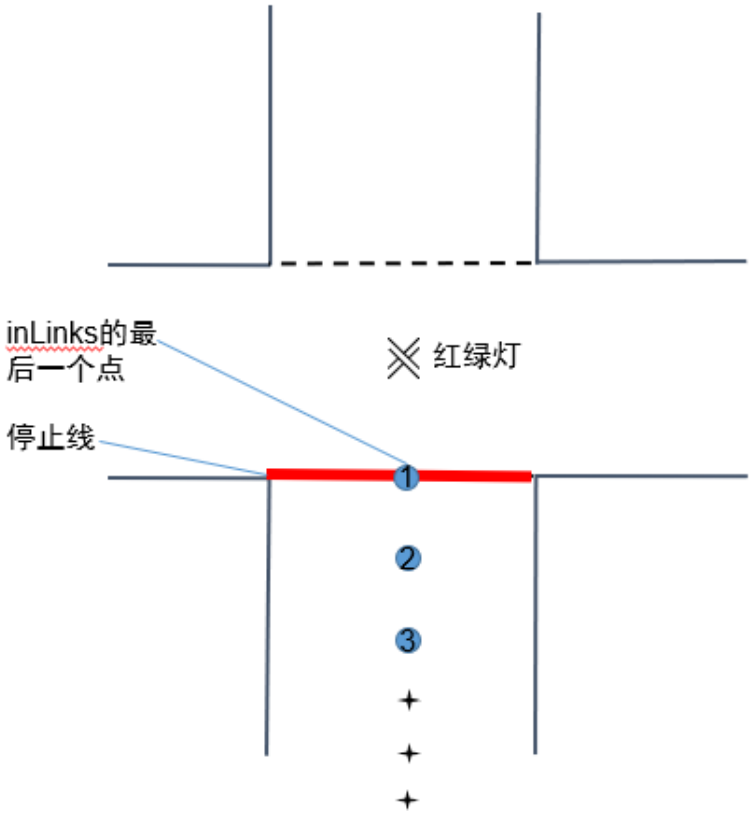


第二种情况：不存在连续路口。如图，那么第 n 个坐标是以红绿灯为圆点，半径为 r 的位置坐标。r 为 1000 米。



② Ford 希望“停止线的位置”以“组成当前道路的几何位置点坐标”形式提供。如下图所示，若一条路由坐标点 1、2、3…的集合构成，填充在 inlinks 消息中的坐标点必然包含点 2 和点 3，除此之外 Ford

要求填充在 inlinks 消息中的最后一个坐标点必须是停止线的位置坐标点 1。最后百度提供的 inlinks 消息集中实际上包含了坐标点 1、2、3。



Sample:

```
{
  // 1. 交叉路口中心点坐标
  "lon": 120.3114752,
  "lat": 31.4907072",
  // 2. 能够组成路口进口方向路网的道路位置点集合
  "roads": [{
          // 2.1 （例：南向北方向）组成道路几何形状的坐标点，最后一个坐标点为停止线
          "points": [{
              "lon": 120.318137,
              "lat": 31.486645
              }, ... , {
              "lon": 120.316067, // 最后一个坐标点为道路停止线坐标点
              "lat": 31.488676
              }],
          // 2.2 当前道路限速
```

```
            "limit_speed": 60,
            // 2.3 当前路口是否允许左转
            "left_turn": true,
            // 2.4 当前路口是否允许直行
            "straight": true,
            // 2.5 当前路口是否允许左转
            "right_turn": true
        }, {
            // 2.1 （例：北向南方向）组成道路几何形状的坐标点，最后一个坐标点为停止线
            "points": [{
                "lon": 120.318137,
                "lat": 31.486645
                }, ... , {
                "lon": 120.316067, // 最后一个坐标点为道路停止线坐标点
                "lat": 31.488676
                }],
            // 2.2 当前道路限速
            "limit_speed": 60,
            // 2.3 当前路口是否允许左转
            "left_turn": true,
            // 2.4 当前路口是否允许直行
            "straight": true,
            // 2.5 当前路口是否允许左转

            "right_turn": true
        },{
            // 2.1 （例：西向东方向）组成道路几何形状的坐标点，最后一个坐标点为停止线
            "points": [{
                "lon": 120.318137,
                "lat": 31.486645
                }, ... , {
                "lon": 120.316067, // 最后一个坐标点为道路停止线坐标点
                "lat": 31.488676
                }],
            // 2.2 当前道路限速
            "limit_speed": 60,
            // 2.3 当前路口是否允许左转
            "left_turn": true,
            // 2.4 当前路口是否允许直行
            "straight": true,
            // 2.5 当前路口是否允许左转
            "right_turn": true
        },{
```

```
            // 2.1 （例：东向西方向）组成道路几何形状的坐标点，最后一个坐标点为停止线
            "points": [{
                "lon": 120.318137,
                "lat": 31.486645
                }, ... , {
                "lon": 120.316067, // 最后一个坐标点为道路停止线坐标点
                "lat": 31.488676
                }],
            // 2.2 当前道路限速
            "limit_speed": 60,
            // 2.3 当前路口是否允许左转
            "left_turn": true,
            // 2.4 当前路口是否允许直行
            "straight": true,
            // 2.5 当前路口是否允许左转
            "right_turn": true
        }

    ]}
}
```

3.3 获取当前状态（地图、小地图、非地图）

3.3.1 Functions

当用户不在百度地图页的时候，Ford V2I Lite APP 会浮窗显示红绿灯等信息。需要进入百度地图和退出地图 APP 的时候发出相应广播通知 Ford APP，然后 Ford APP 决定是否显示浮窗。百度地图 APP 不可见，则显示 Ford V2I Lite 自身浮窗；百度地图 APP 可见，则 Ford APP 发送数据给百度地图并显示。

3.3.2 Communication Method

Broadcast(TBD)

3.3.3 Transmit frequency7

当地图可见状态发生变化时发出对应广播

3.3.4 Data Sending

Sending parameters as below.

广播名称	说明
android.intent.action.BD_MAP_RUNNING_VISIBLE	百度地图(运行中)可见广播
android.intent.action.BD_MAP_RUNNING_NOTVISIBLE	百度地图(运行中)退到后台（不可见）广播

3.3.5 Response

N/A

3.4 获取车辆经纬度

3.4.1 Functions

Ford V2I Lite APP 需要获取车辆经纬度（GCJ02）。

3.4.2 Communication Method
AIDL

3.4.3 Transmit frequency
N/A

3.4.4 Data Sending
Sending parameters as below.

信号	信号说明
车辆经度	新添加（GCJ02 坐标系）
车辆纬度	新添加（GCJ02 坐标系）

3.4.5 Response
N/A

3.5 已规划路线信息 / Turn-by-turn information

3.5.1 Functions
Ford V2I Lite APP 中的应用场景需要获取导航模式下前方路口导航方向（左转、直行、右转）。

3.5.2 Communication Method

AIDL

3.5.3 Transmit frequency

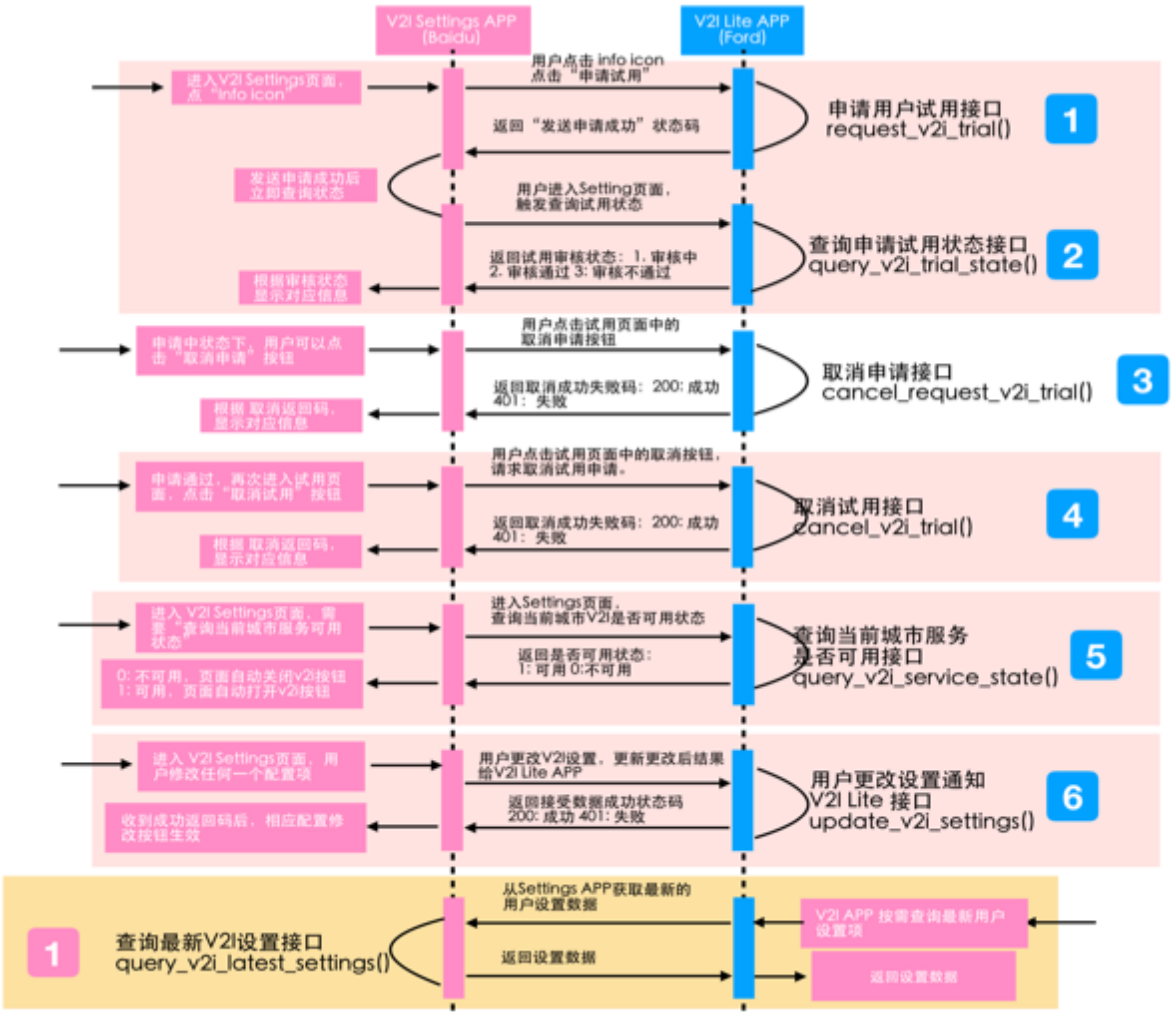
Event driven.

3.5.4 Data Sending

信号	信号说明
导航方向	导航模式下，车辆即将进入前方路口的导航行进方向（左转、直行、右转）
经度	导航模式下，车辆即将进入前方路口的经度
纬度	导航模式下，车辆即将进入前方路口的纬度

3.6 功能设置 / Settings

3.6.1 Sequence Diagram



3.6.2 Communication Method

AIDL

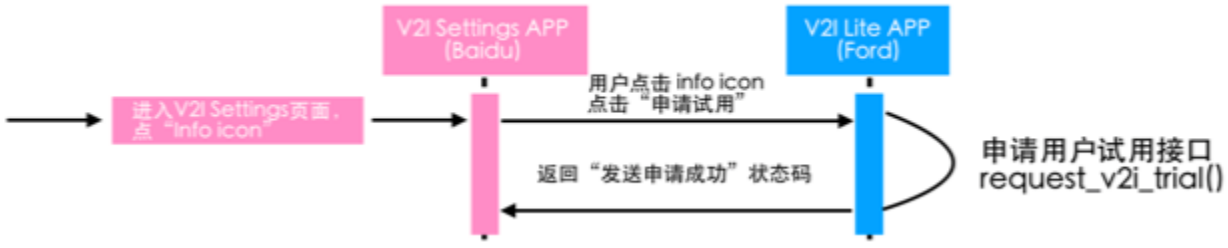
3.6.3 Transmit frequency

Event driven.

3.6.4 Data sending/Response

3.6.4.1 interface No.1

- Diagram



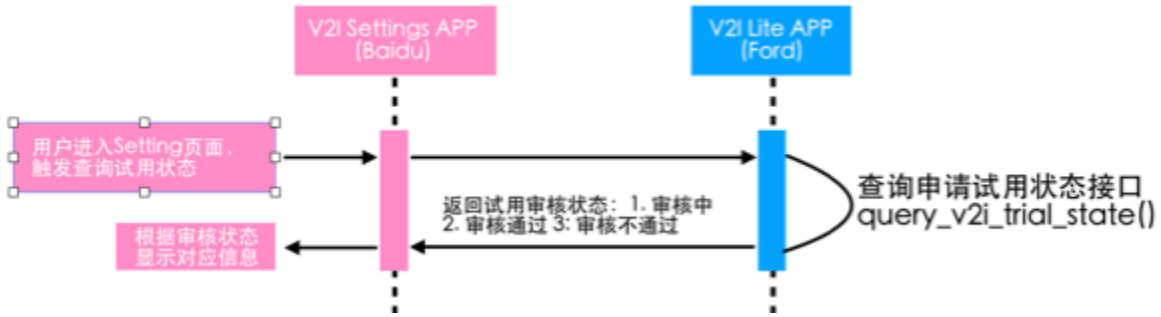
- Parameter

V2I Lite APP 提供提交申请用户试用接口，参数如下：

信号_请求方	请求参数	参数说明
V2I Settings APP（Baidu）	NA	NA
信号_应答方	**响应参数**	**参数说明**
V2I Lite APP（Ford）	成功响应（JSON or Object）	
	Code（例：200）	申请试用提交成功状态返回码
	错误响应	
	401	提交失败

3.6.4.2 interface No.2

- Diagram



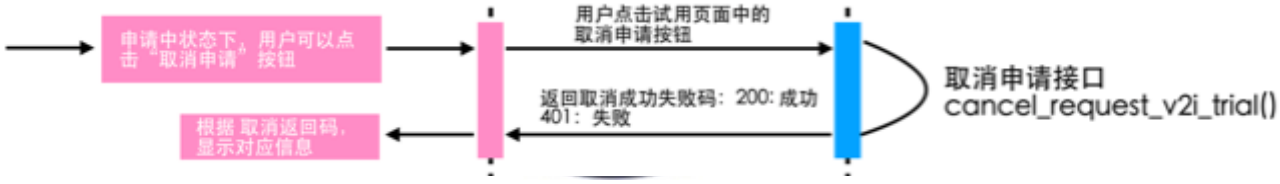
- Parameter

V2I Lite APP 提供查询申请试用状态接口，参数如下：

信号_请求方	请求参数	参数说明
V2I Settings APP（Baidu）	NA	NA
信号_应答方	**响应参数**	**参数说明**
V2I Lite APP（Ford）	成功响应（JSON or Object）	
	Code（例：200）	查询申请试用状态返回码
	trial_state（例：2）	1: 审核中 2: 审核通过 0: 审核不通过
	错误响应	
	401	查询失败

3.6.4.3 interface No.3

- Diagram



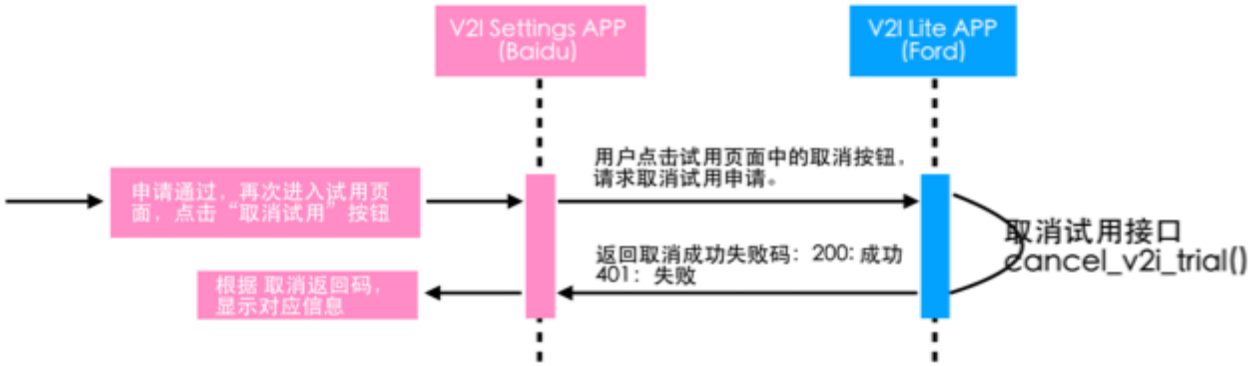
- Parameter

V2I Lite APP 提供取消申请用户试用接口，参数如下：

信号_请求方	请求参数	参数说明
V2I Settings APP（Baidu）	NA	NA
信号_应答方	**响应参数**	**参数说明**
V2I Lite APP（Ford）	成功响应（JSON or Object）	
	Code（例：200）	取消申请状态返回码
	错误响应	
	401	取消失败

3.6.4.4 interface No.4

- Diagram



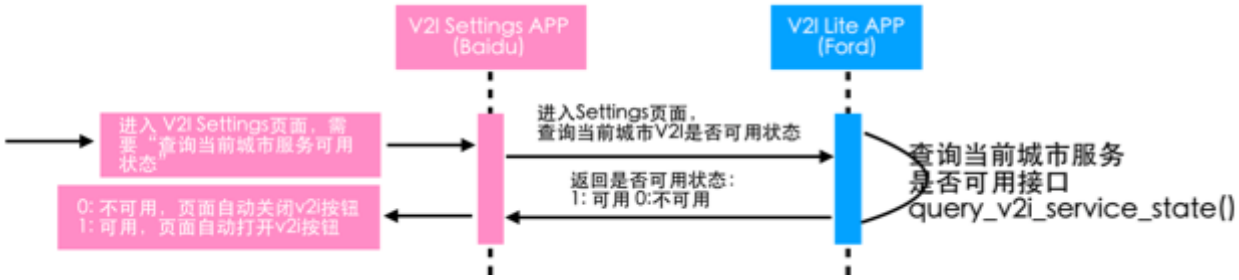
- Parameter

V2I Lite APP 提供取消试用接口，参数如下：

信号_请求方	请求参数	参数说明
V2I Settings APP（Baidu）	NA	NA
信号_应答方	**响应参数**	**参数说明**
V2I Lite APP（Ford）	成功响应（JSON or Object）	
	Code（例：200）	取消试用状态返回码
	错误响应	
	401	取消失败

3.6.4.5 interface No.5

- Diagram



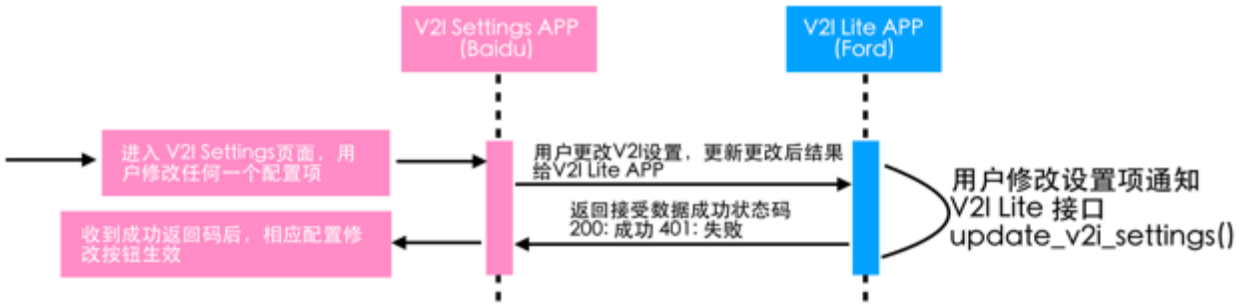
- Parameter

V2I Lite APP 提供查询 V2I 服务可用状态接口，参数如下：

信号_请求方	请求参数	参数说明
V2I Settings APP（Baidu）	NA	NA
信号_应答方	**响应参数**	**参数说明**
V2I Lite APP（Ford）	成功响应（JSON or Object）	
	Code（例：200）	查询 V2I 服务状态状态返回码
	service_flag（例：1）	1: 可用 0: 不可用
	错误响应	
	401	查询失败

3.6.4.6 interface No.6

- Diagram



- Parameter

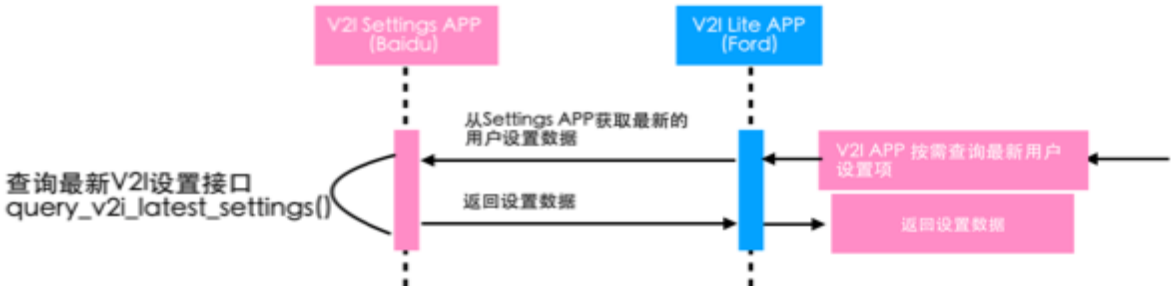
V2I Lite APP 提供用户修改设置项通知接口，参数如下：

信号_请求方	请求参数		参数说明		
V2I Settings APP（Baidu）	参数名 1	参数名 2	功能名称	所有选项	默认设置
	data	v2i_on_off	接收 V2I 通知	1: 开启/ 0: 关闭	开启
	-	tli_sensitivity	红绿灯信号	2:灵敏度高/1:灵敏度低/0:关闭	灵敏度高

	-	glosa_on_off	绿波车速	1:开启/0:关闭	开启
	-	gln_sensitivity	绿灯起步提醒	3:灵敏度 8 秒/2:灵敏度 5 秒/1:灵敏度 3 秒/0:关闭	灵敏度 3 秒
	-	rlvw_sensitivity	闯红灯预警	2:灵敏度高/1:灵敏度低/0:关闭	灵敏度高
	-	oass_on_off	最优自动起停	1:开启/0:关闭	开启
	-	rsi_on_off	道路信息广播	1:开启/0:关闭	开启
	-	voice_setting	声音设置	2:详细/1:简洁/0:关闭	简洁
	-	global_overlay_on_off	全局浮窗	1:开启/0:关闭	开启
信号_应答方	**响应参数**		**参数说明**		
V2I Lite APP（Ford）	成功响应（JSON or Object）				
	Code（例：200）		更新用户最新设置成功码		
	错误响应				
	401		更新失败		

3.6.4.7 interface No.7

- Diagram



- Parameter

Baidu Setting 提供查询最新 V2I 设置项，参数如下：

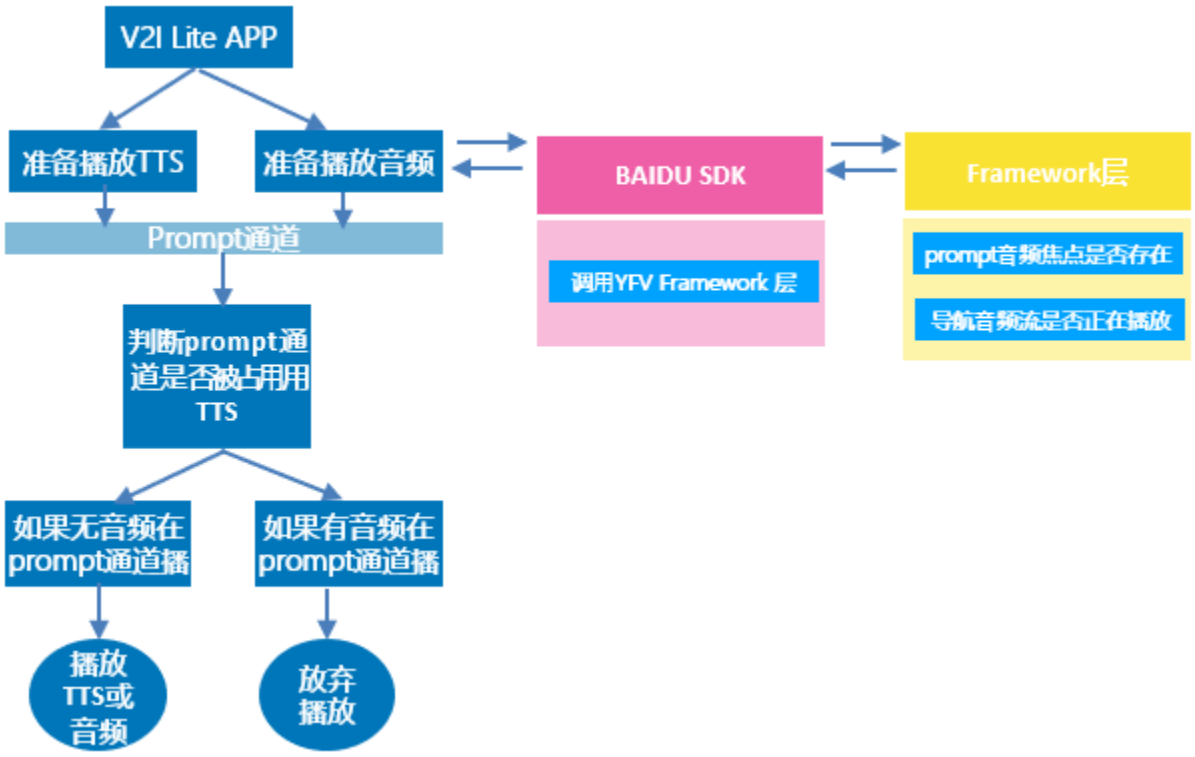
信号请求方	**请求参数**		**参数说明**		
V2I Lite APP（Ford）	NA		NA		
信号_应答方	**响应参数**		**参数说明**		
V2I Settings APP（Baidu）	成功响应（JSON or Object）				
	参数名 1	参数名 2	功能名称	所有选项	默认设置
	code	200	-	-	-

	data	v2i_on_off	接收 V2I 通知	1: 开启/ 0: 关闭	开启
	-	tli_sensitivity	红绿灯信号	2:灵敏度高/1:灵敏度低/0:关闭	灵敏度高
	-	glosa_on_off	绿波车速	1:开启/0:关闭	开启
	-	gln_sensitivity	绿灯起步提醒	3:灵敏度 8 秒/2:灵敏度 5 秒/1:灵敏度 3 秒/0:关闭	灵敏度 3 秒
	-	rlvw_sensitivity	闯红灯预警	2:灵敏度高/1:灵敏度低/0:关闭	灵敏度高
	-	oass_on_off	最优自动起停	1:开启/0:关闭	开启
	-	rsi_on_off	道路信息广播	1:开启/0:关闭	开启
	-	voice_setting	声音设置	2:详细/1:简洁/0:关闭	简洁
	-	global_overlay_on_off	全局浮窗	1:开启/0:关闭	开启
	错误响应				
	401		查询失败		

3.7 音频资源仲裁 / Audio Arbitration （Baidu&YFV）

3.7.1 Functions

V2I 信息播报分为 TTS 播报和音频（MP3）播报，都走 prompt 通道进行播报，但是在播报前需要判断当前通道是否被占用，具体流程如下：



所以，对于 V2I TTS 播报来说：

- 导航在播，则 V2I 的 TTS 不不播
- V2I 的 TTS 在播，导航 TTS 来了了会打断 V2I 的 TTS
- 音音乐在播放，V2I 的 TTS 也播放，会和音音乐混音音

对于 V2I 音频（MP3）播报来说：

- V2I 音音频正在播放，如果这时用用户打开音乐混音（media 降到 5，Prompt 按照调音音大大小小，不不论先后只要混就是这样）
- 如果当前音音乐正在播放，V2I 音频会混音音（不不论先后，同上）
- 如果导航在播，V2I 音频准备播，导航被抢占
- V2I 音频在播，导航准备播，则导航抢占 V2I 音频

因此，需要准备三个接口：

- 接口 1:(YFV) prompt 是否被占用用（发生生变化需要通知）
- 接口 2:(百度) 在 prompt 通道播放 TTS
- 接口 3:(百度) 在 prompt 通道播放短促音音频

3.7.2 Communication Method

SDK update.

3.8 获取城市名称

3.8.1 Functions

获取车辆当前位置所在的城市名称。

3.8.2 Communication Method

AIDL

3.9 系统异常状态提醒 / System Abnormal & misbehavior Notification

3.9.1 Functions

依据 SYNC+ 系统对状态定义的形式处理 。

3.9.2 Communication Method

TOAST

3.10 通过 Carservice 获取车辆数据（ YFV ）

3.10.1 Functions

Ford V2I Lite APP 需要获取车辆车速，左右转信号灯等数据，通过 Car Service 来获取，需要 YFV 提供对应的接口。

3.10.2 Communication Method

通过 Car Service SDK 获取，需要 YFV 提供 SDK 并提供相应 MCU 版本

3.10.3 Transmit frequency

N/A

3.10.4 Data Requirement

Sending parameters as below.

信号	信号名称	上报周期	备注
车辆识别码	VehicleGGCCData	状态读取	
车速	Veh_V_ActlEng	差分上报/状态读取	
左转信号	TurnLghtLeft_D_Rq	差分上报/状态读取	
右转信号	TurnLghtRight_D_Rq	差分上报/状态读取	
档位信号	GearLvrPos_D_Actl		
	GearLvrPos_D_Actl_UB	差分上报/状态读取	
刹车踏板信号&刹车灯信号	BpedDrvAppl_D_Actl	差分上报/状态读取	刹车踏板信号&刹车灯信号共用信号
	BpedDrvAppl_D_Actl_UB	差分上报/状态读取	
后轮转数	WhlRotatRl_No_Cnt	差分上报/状态读取	
	WhlRotatRr_No_Cnt		
自动启停状态	StopStrtDrvMde_D_Indic	差分上报/状态读取	
	StopStrtStdby_D_Indic	差分上报/状态读取	
方向盘方向转角	StePinComp_An_Est	差分上报/状态读取	
	StePinComp_An_Est_UB	差分上报/状态读取	
	StePinCompAnEst_D_Qf	差分上报/状态读取	
加速踏板信号	ApedPos_Pc_ActlArb	差分上报/状态读取	
~~车头方向~~	~~GPS_Heading(Event)~~	~~差分上报/状态读取~~	IVI send out, no need CAN
双闪灯状态	~~HazrdLght_B_Stat~~		HS4 可以收到，但是 HS4 DBC 是由北美 Own，更新周期较长
	TurnLghtLeftOn_B_Stat	差分上报/状态读取	
	TurnLghtRightOn_B_Stat	差分上报/状态读取	
失控状态信号	LaActvStats_D_Dsply(LKA/LDW telltale)	差分上报/状态读取	
	StabCtlBrkActv_B_Actl(ESC activate status)	差分上报/状态读取	

	DrvSlipCtlLamp_D_Rq(ESC telltale)	差分上报/状态读取	
	DrvAntiLckLamp_D_Rq(ABS malfunction telltale)	差分上报/状态读取	
	DrvSlipCtlOffLamp_D_Rq(TCS OFF telltale)	差分上报/状态读取	
	DrvSlipCtlOffLamp_D_Rq_UB(TCS OFF telltale update-bit)	差分上报/状态读取	

4 Acceptance Criteria

4.1 External SDK, APIs

The external SDK, APIs defined in Chapter 3. shall be fully conducted functional testing and submit the cooresponding testing reports/results to Ford team.

Functional Testing comprise Unit Testing, Integration Testing, System Testing, Smoke Testing, GUI Testing, Sanity Testing, Regression Testing and Acceptance Testing.

4.1.1 Unit Testing

Each individual component or module shall be tested by the Baidu(development team or tester). It guarantee the software component or module meet the requirement and functional works as expected.

4.1.2 Integation Testing

Baidu team shall cooperate with Ford team on all of the integrated external modules to verify the combined functionality after integration.

4.1.3 Smoke Testing

Whenever a new build is provided by the Baidu development team, Ford team shall validate the software build and ensures that no major issue exists.

Baidu team shall ensure that the software build is stalbe. The Smoke Testing shall be checked that no show stopper defect exists in the new build which will prevent the integration and testing the application in detail.

4.1.4 Sanity Testing

The sanity testing shall be performed to determine if a new build is performing well enough to accept it for a major testing effort or not. For example, if a new build is crashing for the initial use, then the build is not stable enough for further testing. Hence another build is assigned to fix it immediately.

4.1.5 Graphic User Interface Testing

The expected GUIs of the application are defined in the Chapter 2. Feature Requirement and the series mock up screens are recored with separate files. The GUI testing comprise the size of the buttons, input filed present on the screen, alignment of the text/layout, and content in the tables, etc..

4.1.6 Acceptance Testing

Ford team shall perform the Acceptance Testing and verify whether the end to end flow of the whole system is as per business requirements or not and if it is as per the needs of the end-user. Ford team accepts the software only when all the features and functionalities work as expected. It is the last phase of the testing, after which the software goes into the production. Baidu team shall provide technical collabroation with Ford dev team on any changes happened from **Go/No-Go decision** for the V2I product.

4.2 Beta Program Testing

Ford will initate a formal type of pre-market V2I product testing in Real Environment, which is carried out by the customer. It will be released to a certain number of real customers in a specific area.

Baidu team shall keep on and ensure providing technical support on major defects/failures in the V2I product during the Beta testing arised from external components/modules. It is successful when the customer accepts the product.

4.3 Metadata

4.3.1 Direction of Road Link

Road link describes the road segment between two intersections. For the V2I product, the directional "inbound" from Intersection A to Interseciton B (*Fig 4.3.0*) is taken into account.

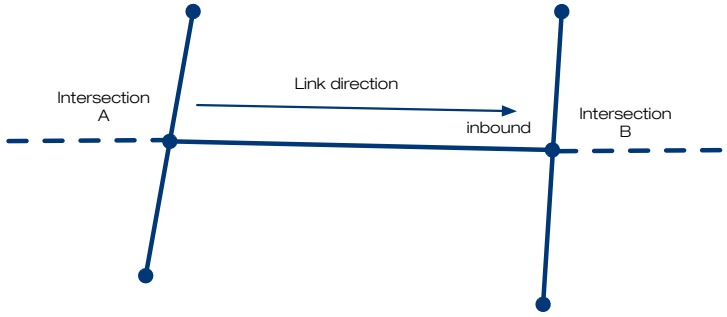


Fig 4.3.0 Link direction

4.3.2 Points of Intersection Geometry

The usage of points are defined in Chapter 3.2 从百度获取地图数据. The points data output from Baidu interface shall be well organized and can be used to describe the intersection as *Fig 4.3.2.1.*

No.	Symbol	Description
1		Road shape points to connect the Road links.
2		The first points of next inbound from Road Link.
3		STOP LINE representation.
4		Road Link direction. Maximum length is 1000 metere.

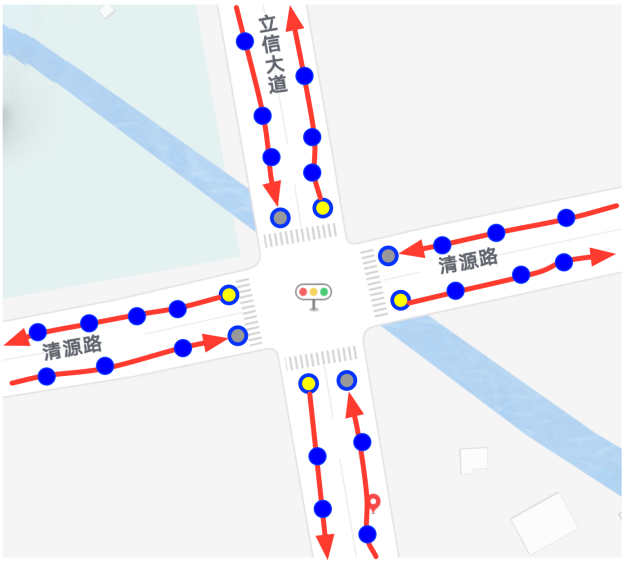


Fig 4.3.2.1 Points of Road geometry

5 Classification Key

Classification	Notes
Proprietary	Information created or obtained in the normal course of business and not classified as Secret or Confidential
Confidential	Information that provides the Company with a competitive advantage, that supports its technical or financial position, and which, if disclosed without authorization, could cause damage to the Company.
Secret	Information of a strategic or highly sensitive nature that, if disclosed without authorization, would cause substantial, severe, or irreparable damage to the Company or its relationships.

6 Document Status Key

Status	Notes
DRAFT	Document currently being worked on. Shall not be used as a solid reference to information included in this document.
AFR	Available For Review. Document information is not eligible for changes. Approving manager will revise this document and if all the information is found to be completely valid, then the document will change to REL status. If the document is found to have errors, the document will change to DRAFT status.
REL	Released. Document is completely valid at time of review, and is now available to be used as a solid reference of information.

7 Changes

Author	Date (YYYY/MM/DD)	Status	Notes
Henry Fan &Yifei Li	2019/12/05	DRAFT	Version 0.1 – Initial the document. Add Chapter “Feature Requirment”
Yuanyan Zhang & Gong hang	2019/12/06	DRAFT	Version 0.1 – Add chapter “Function Interface”
Yifei Li & Yuanyan Zhang& Gong hang	2020/01/21	DRAFT	Version 0.2 – Add chapter “2.7 / 2.8 / 2.9 / 2.10 / 3.5 / 3.6 / 3.7 / 3.8”
Gong Hang	2020/01/21	DRAFT	Version 0.3 – Update “Function Interface”
Gong Hang	2020/02/28	DRAFT	Version 0.4 – Update “3.5 Settings”； Add chapter 3.10； Update chapter 3.7
Yifei Li	2020/03/04	DRAFT	ISSUE Version 0.4 . initiate “4. Acceptance Criteria”
Yifei Li	2020/03/24	DRAFT	Compose “4. Acceptance Criteria”
Yifei Li	2020/03/24	DRAFT	ISSUE Version 0.5

8 Contacts

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