**logo NM-A-2020-02-VAL-01**

**Nullmax**

**Pioneer Software Qualification Test Plan**

**V0 .0.3**

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|  | 2020/04/19 | 2020/04/19 |

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# General Information

## Purpose

This document is used to identify the test plan and to standardize the test process. The audience for this document includes test engineers, program development engineers, and project managers.

## Scope

This document applies to the Nullmax Pioneer project.

## Reference Document

The following documents are referred to in this text in such a way that some or all of their content constitutes requirements of this document.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No.** | **Reference Document** | **File No.** | **Version No.** | **Location** |
| 1 | Pioneer\_Software\_Requirements\_Documentation.V0.4.docx |  |  | https://git.nullmax.net/dynamic\_library/nm-a-2019-02/v1.0.0/swe.1\_software\_requirements\_analysis/tree/master/Work\_Products |
| 2 | Project\_Management\_Plan.xlsx |  | V0.1 | https://git.nullmax.net/dynamic\_library/nm-a-2019-02/v1.0.0/man.3\_project\_management/blob/master/Project\_Management\_Plan.xlsx |
| 3 | Milestones\_Plan.xlsx |  | V0.1 | https://git.nullmax.net/dynamic\_library/nm-a-2019-02/v1.0.0/man.3\_project\_management/blob/master/Milestones\_Plan.xlsx |
| 4 | 纽劢故障管理 |  | V1.0 | https://git.nullmax.net/dynamic\_library/nm-a-2019-02/v1.0.0/swe.6\_software\_qualification\_test/blob/master/Work\_Products/%E7%BA%BD%E5%8A%A2%E8%BD%AF%E4%BB%B6%E6%95%85%E9%9A%9C%E7%AE%A1%E7%90%86V1.0.docx |
| 5 | 软件鉴定测试指南 |  | V1.0 | https://git.nullmax.net/dynamic\_library/nm-a-2019-02/v1.0.0/swe.6\_software\_qualification\_test/blob/master/Work\_Products/Test\_case%20and%20test\_plan/%E8%BD%AF%E4%BB%B6%E9%89%B4%E5%AE%9A%E6%B5%8B%E8%AF%95%E6%8C%87%E5%8D%97v1.0.doc |

## Project Background

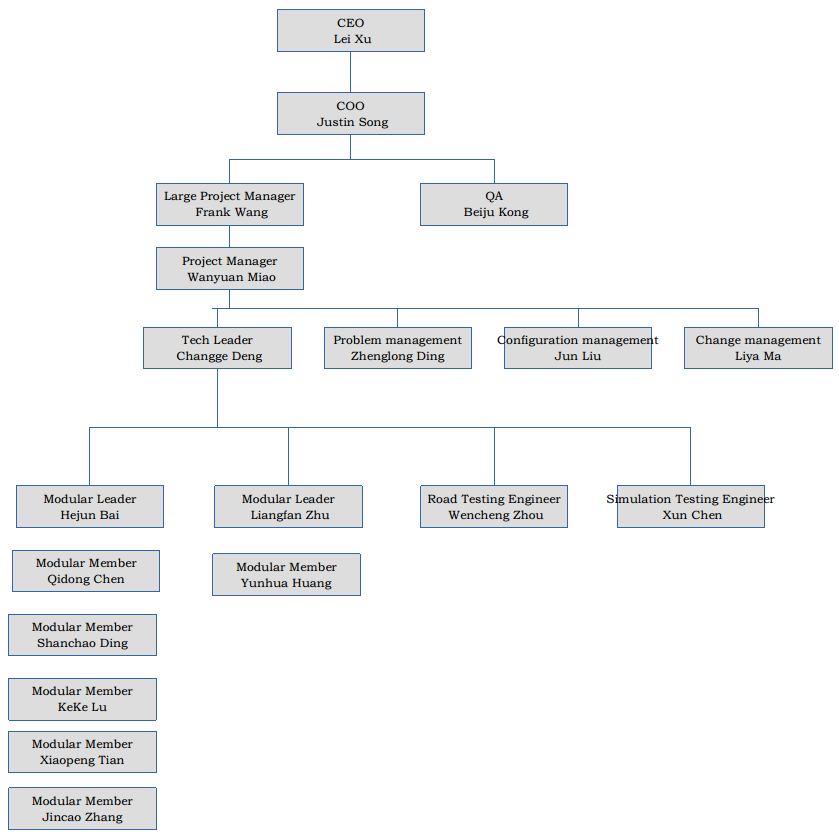
The RHP project developed by Desay meets the development requirements of driving function in rush hours. Desay is responsible for the development of domain controller ECU module, and nullmax is responsible for the development of "perception and fusion" in the software system framework. Based on this customer demand, Nullmax established the Pioneer project to complete this development task.

# Abbreviation and Terminology

OS -- Operating system

SIL -- Software in the Loop

# Organization Chart



# Role, Responsibility & Authority

|  |  |  |
| --- | --- | --- |
| **Role** | **Responsibility** | **Authority** |
| Test Manager | Review test cases developed by test engineers and confirm test result | Mingchao Zhang |
| Field Test Engineer | Develop field test cases and test plan, implement field test and submit test result | Wencheng Zhou |
| Simulation Test Engineer | Develop simulation test cases and test plan, implement simulation test and submit test result | Xun Chen |
| Development Engineer | Review test cases and test plan, optimize algorithm based on test result | Liangfan Zhu |
| Project Manager | Review test cases and test plan, and manage test result | Wanyuan Miao |

# Task Overview

## Test environment

Simulation test environment:

OS: Ubuntu

Simulation software: Carmaker, Simulator interface adapter

Field test environment:

OS: Ubuntu

Test instruments: PX2, Stereo Camera, ESR, Conner Radar, Ublox device, Object vehicles

## Tools

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tool Name** | **Purpose** | **Version** | **License** | **Guideline Name** | **Guideline Location** |
| Carmaker | Used for setting up the simulation scenarios and vehicle dynamic simulation | 8.1 |  |  |  |
| UBlox device | Obtain GPS data of vehicles | NA |  |  |  |
| Qianxun positioning service | Obtain high accuracy differential positioning information | NA |  |  |  |
| Object vehicles | Used in proving ground test and filed operational test | NA |  |  |  |

## Overview of the test content

Test the function of lane change，and the performance of the related modules, such as object detection, lane change, lateral control, longitude control and so on.

Software requirement specification: Pioneer\_Software\_Requirements\_Documentation.V0.4.docx

Version: 0.4

## Conditions and Restrictions

1. Software released on time every week
2. The test vehicles and test equipment are ready;
3. The Carmaker dongle is available;
4. The Qianxun positioning service can work properly.

### Entry Condition

1. The new version software is released, and the release note should be provided;
2. The integration test report is complete, and there is no level P0 or P1 errors
3. Test engineer should be acquainted with the integration objectives, test priorities and test scope of the current version.

### Exit Condition

Test termination criteria of the weekly release version

1. All selected test cases have been executed;
2. All test reports have been filed;
3. All test data have been backed up;
4. All bugs have been submitted to the problem management system;
5. No level P0 or P1 errors are found.

Test termination criteria of the final delivery version

1. The design of test cases has been reviewed and delivered;
2. Test plan has been determined and project node has been checked;
3. Test coverage requirement specified in test plan has been met；
4. All the requirements in the project requirements specification has been completed;
5. Bugs approved have been fixed, and the software maturity meets the project requirements, or be approved by the customer

### Suspension Condition

1. P0 and P1 level errors occur when testing
2. The stability of software is poor. Test work cannot be carried out smoothly
3. If the project needs to be temporarily adjusted, suspend the test, and backup the test data of the suspending point

### Resumption Condition

1. The bugs causing the suspension has been fixed
2. Restart after the priority is adjusted if the project was suspended due to the change of priority of the project,

# Software qualification test scheme

## Test Range

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **SYS REQ ID** | **SW REQ ID** | **Function** | **Function Description** | **Milestone** |
| 1 | RHP-7 | DRSR-1 | Support confirmed lane change | Describes the process of confirmed lane change in the auto-driving mode. | 2020/7/25 |
| 2 | RHP-2 | DRSR-2 | Detect lane change necessity | Describes the process of detecting lane change necessity. | 2020/7/25 |
| 3 |  | DRSR-16 | Detect lane change necessity considering slow moving front vehicle | The lane change necessity shall be judged based on the speed of the front vehicle and the expected speed of ego car. After meeting the judgment conditions, the system considers it is necessary to perform confirmed lane change. | 2020/7/25 |
| 4 | RHP-10 | DRSR-20 | Compute ego car's expected speed | Calculate the expected speed of the vehicle. | 2020/7/25 |
| 5 | RHP-25 | DRSR-21 | Acquire ego car's expected speed | Obtain the expected vehicle speed set by the user | 2020/7/25 |
| 6 | RHP-5 | DRSR-17 | Detecting lane change necessity considering adjacent lane flow speed | In the case of fast traffic flow in the adjacent lane, after meeting the judgment conditions, the system considers it necessary to change lanes | 2020/7/25 |
| 7 |  | DRSR-18 | Detecting lane change necessity considering adjacent lane speed limit | The system judge lane change necessity according to the speed limit of adjacent lane and expected speed. After meeting the judgment conditions, the system considers it necessary to confirm the lane change | 2020/7/25 |
| 8 | RHP-8  RHP-24 | DRSR-19 | Detecting lane change necessity considering ego car following state | The system judge lane change necessity according to the following status of ego car. After meeting the judgment conditions, the system considers it necessary to confirm the lane change | 2020/7/25 |
| 9 | RHP-3  RHP-32 | DRSR-3 | Detect confirm lane change possibility | Describes the process that the system judges the possibility of lane change according to the information of ODD area, collision risk and ego car's status | 2020/7/25 |
| 10 | RHP-12 | DRSR-22 | Detect lane change possibility considering collision risk | The system determines lane change possibility considering collision risk by obtaining the safety distance information of surrounding vehicles and ego car, and the information of obstacles in front. | 2020/7/25 |
| 11 | RHP-28 | DRSR-25 | Compute safety distance with surrounding vehicle | Calculate the safety distance of vehicles in front of left, rear left, front right and rear right of ego car through the surrounding vehicle information and vehicle speed | 2020/7/25 |
| 12 | RHP-13 | DRSR-23 | Detect lane change possibility considering ego car status | Detect lane change possibility considering ego car status | 2020/7/25 |
| 13 | RHP-31  RHP-33 | DRSR-26 | Detect driver status | Detect driver status | 2020/7/25 |
| 14 |  | DRSR-24 | Detect lane change possibility considering ODD area | The system judge whether it is in the odd area to judge the possibility of lane change | 2020/7/25 |
| 15 | RHP-6 | DRSR-4 | Lane change request and confirmation | After judging the lane change possibility, the system sends out lane change request information and receives and processes driver confirmation information | 2020/7/25 |
| 16 |  | DRSR-27 | Send out lane change request indication | Describes the process of sending lane change request information | 2020/7/25 |
| 17 |  | DRSR-28 | Send out lane change button indication of direction | Send out lane change button indication of direction for display | 2020/7/25 |
| 18 |  | DRSR-29 | Send out lane change direction text indication | Send out lane change direction text indication for display | 2020/7/25 |
| 19 |  | DRSR-30 | Send out lane change request signal light flashing | Send out lane change request signal light flashing | 2020/7/25 |
| 20 | RHP-14 | DRSR-31 | Receive and process lane change confirmation | Describes the process of receiving and processing lane change confirmation message | 2020/7/25 |
| 21 |  | DRSR-32 | Receive paddle message |  | 2020/7/25 |
| 22 |  | DRSR-33 | Receive button message of lane change confirmation |  | 2020/7/25 |
| 23 |  | DRSR-34 | Receive driver's head swing confirmation message |  | 2020/7/25 |
| 24 |  | DRSR-35 | Support detecting termination when waiting lane change confirmation message | Describes the process of detection and processing of lane change termination while waiting for driver's confirmation | 2020/7/25 |
| 25 |  | DRSR-36 | Support timeout process of confirmation message | Describes the process after the system waits for the driver to confirm the message timeout | 2020/7/25 |
| 26 |  | DRSR-37 | Send lane change cancellation indication | Send lane change cancellation indication for display | 2020/7/25 |
| 27 |  | DRSR-38 | Send lane change stopping flashing indication of request signal light | Send lane change stopping flashing indication of request signal light | 2020/7/25 |
| 28 | RHP-15 | DRSR-5 | Perform lane change | After receiving the driver's confirmation, the system begins to plan the lane change trajectory and speed, and carries out the process of lane change | 2020/7/25 |
| 29 | RHP-21 | DRSR-6 | Send indication message of lane change started | The system send indication message to display once starts to performing lane change | 2020/7/25 |
| 30 | RHP-19 | DRSR-7 | Planning lane change trajectory | Describes the process of planning trajectory | 2020/7/25 |
| 31 |  | DRSR-11 | Planning lane change trajectory supporting 2.8m lane width standard | Describes the process of planning trajectory | 2020/7/25 |
| 32 |  | DRSR-12 | Planning lane change trajectory supporting 3.0m lane width standard | Describes the process of planning trajectory | 2020/7/25 |
| 33 |  | DRSR-13 | Planning lane change trajectory supporting 3.25m lane width standard | Describes the process of planning trajectory | 2020/7/25 |
| 34 |  | DRSR-14 | Planning lane change trajectory supporting 3.5m lane width standard | Describes the process of planning trajectory | 2020/7/25 |
| 35 |  | DRSR-15 | Planning lane change trajectory supporting 3.75m lane width standard | Describes the process of planning trajectory | 2020/7/25 |
| 36 |  | DRSR-39 | Send trajectory information to display | Send trajectory information to display in real time | 2020/7/25 |
| 37 | RHP-20 | DRSR-8 | Planning lane change speed | The system plans the lane changing speed | 2020/7/25 |
| 38 | RHP-22 | DRSR-9 | Lateral control | Describes the process of outputting lateral control vehicle actuator according to the speed planning information of lane change | 2020/7/25 |
| 39 | RHP-23 | DRSR-10 | Longitudinal control | Describes the process that the system outputs the longitudinal control vehicle actuator according to the speed planning information of lane change | 2020/7/25 |
| 40 |  | DRSR-40 | Complete lane change | The system judges whether the lane change is completed and the process after it is completed | 2020/7/25 |
| 41 | RHP-34 | DRSR-41 | Detect lane change over distance | The system calculates lane change over-line state by comparing the lateral moving distance of the lane change with the width of the vehicle body | 2020/7/25 |
| 42 |  | DRSR-42 | Send out indication of completion of lane change | Send out indication of completion of lane change | 2020/7/25 |
| 43 |  | DRSR-43 | Timeout process of performing lane change | Describes the processing after lane change timeout | 2020/7/25 |
| 44 | RHP-16  RHP-17 | DRSR-44 | Termination process during performing lane change | Describes the system's real-time detection of lane changing conditions and the process after detecting the termination of lane changing events | 2020/7/25 |
| 45 | RHP-35 | DRSR-45 | Detect possibility of returning to original lane | Describes the possibility of the system to return to the original lane after detecting the termination of lane change event | 2020/7/25 |
| 46 | RHP-18 | DRSR-46 | Action of lane change under critical situation | Action of lane change under critical situation | 2020/7/25 |

## Software test strategy

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **SW REQ ID** | **Function** | **TC ID** | **Test Methods** | **Test Case Design Method** |
| 1 | DRSR-1 | Support confirmed lane change |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value,  Error inference |
| 2 | DRSR-2 | Detect lane change necessity |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value,  Error inference |
| 3 | DRSR-16 | Detect lane change necessity considering slow moving front vehicle |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value,  Error inference |
| 4 | DRSR-20 | Compute ego car's expected speed |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value, Error inference |
| 5 | DRSR-21 | Acquire ego car's expected speed |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value, |
| 6 | DRSR-17 | Detecting lane change necessity considering adjacent lane flow speed |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value, Error inference |
| 7 | DRSR-18 | Detecting lane change necessity considering adjacent lane speed limit |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value, Error inference |
| 8 | DRSR-19 | Detecting lane change necessity considering ego car following state |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value, Error inference |
| 9 | DRSR-3 | Detect confirm lane change possibility |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value, Error inference |
| 10 | DRSR-22 | Detect lane change possibility considering collision risk |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value, Error inference |
| 11 | DRSR-25 | Compute safety distance with surrounding vehicle |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 12 | DRSR-23 | Detect lane change possibility considering ego car status |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value, Error inference |
| 13 | DRSR-26 | Detect driver status |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 14 | DRSR-24 | Detect lane change possibility considering ODD area |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 15 | DRSR-4 | Lane change request and confirmation |  | Proving Ground, Field operational | boundary value |
| 16 | DRSR-27 | Send out lane change request indication |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 17 | DRSR-28 | Send out lane change button indication of direction |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 18 | DRSR-29 | Send out lane change direction text indication |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 19 | DRSR-30 | Send out lane change request signal light flashing |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 20 | DRSR-31 | Receive and process lane change confirmation |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 21 | DRSR-32 | Receive paddle message |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 22 | DRSR-33 | Receive button message of lane change confirmation |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 23 | DRSR-34 | Receive driver's head swing confirmation message |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 24 | DRSR-35 | Support detecting termination when waiting lane change confirmation message |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 25 | DRSR-36 | Support timeout process of confirmation message |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 26 | DRSR-37 | Send lane change cancellation indication |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 27 | DRSR-38 | Send lane change stopping flashing indication of request signal light |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 28 | DRSR-5 | Perform lane change |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 29 | DRSR-6 | Send indication message of lane change started |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 30 | DRSR-7 | Planning lane change trajectory |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 31 | DRSR-11 | Planning lane change trajectory supporting 2.8m lane width standard | QT\_LC\_0001  QT\_LC\_0002  QT\_LC\_0003  QT\_LC\_0004  QT\_LC\_0005  QT\_LC\_0006  QT\_LC\_0007  QT\_LC\_0008  QT\_LC\_0009  QT\_LC\_0010 | SIL simulation, Proving Ground, Field operational | boundary value |
| 32 | DRSR-12 | Planning lane change trajectory supporting 3.0m lane width standard | QT\_LC\_0011  QT\_LC\_0012  QT\_LC\_0013  QT\_LC\_0014  QT\_LC\_0015  QT\_LC\_0016  QT\_LC\_0017  QT\_LC\_0018  QT\_LC\_0019  QT\_LC\_0020 | SIL simulation, Proving Ground, Field operational | boundary value |
| 33 | DRSR-13 | Planning lane change trajectory supporting 3.25m lane width standard | QT\_LC\_0021  QT\_LC\_0022  QT\_LC\_0023  QT\_LC\_0024  QT\_LC\_0025  QT\_LC\_0026  QT\_LC\_0027  QT\_LC\_0028  QT\_LC\_0029  QT\_LC\_0030 | SIL simulation, Proving Ground, Field operational | boundary value |
| 34 | DRSR-14 | Planning lane change trajectory supporting 3.5m lane width standard | QT\_LC\_0031  QT\_LC\_0032  QT\_LC\_0033  QT\_LC\_0034  QT\_LC\_0035  QT\_LC\_0036  QT\_LC\_0037  QT\_LC\_0038  QT\_LC\_0039  QT\_LC\_0040 | SIL simulation, Proving Ground, Field operational | boundary value |
| 35 | DRSR-15 | Planning lane change trajectory supporting 3.75m lane width standard | QT\_LC\_0041  QT\_LC\_0042  QT\_LC\_0043  QT\_LC\_0044  QT\_LC\_0045  QT\_LC\_0046  QT\_LC\_0047  QT\_LC\_0048  QT\_LC\_0049  QT\_LC\_0050 | SIL simulation, Proving Ground, Field operational | boundary value |
| 36 | DRSR-39 | Send trajectory information to display |  | SIL simulation, Proving Ground, Field operational | boundary value |
| 37 | DRSR-8 | Planning lane change speed |  | SIL simulation, Proving Ground, Field operational | boundary value |
| 38 | DRSR-9 | Lateral control |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 39 | DRSR-10 | Longitudinal control |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 40 | DRSR-40 | Complete lane change |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 41 | DRSR-41 | Detect lane change over distance |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 42 | DRSR-42 | Send out indication of completion of lane change |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 43 | DRSR-43 | Timeout process of performing lane change |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 44 | DRSR-44 | Termination process during performing lane change |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 45 | DRSR-45 | Detect possibility of returning to original lane |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |
| 46 | DRSR-46 | Action of lane change under critical situation |  | SIL simulation, Proving Ground, Field operational | Equivalence class, boundary value |

## Software qualification test methods

Software qualification test methods include 3 methods

1. SIL simulation test

In SIL simulation test, scenarios and vehicle models are built with Carmaker on the test computer, which is used to test planning and control function and performance;

1. Proving ground test

In proving ground test, software is running on the test vehicle, and all test cases are executed in a completely enclosed test field with test instruments and tools;

1. Field operational test

Field operational test is executed on the open road. Like proving ground test, the software is running on the test vehicle too, while the test scenarios are all the real traffic scenarios.

## Software qualification test requirements and coverage

1. Function coverage should be 100%
2. System requirement coverage should be 100%

## Software qualification test case design methods

Strategy of test case design methods:

1. For the logical function, scenario analysis method is adopted to the analyze the basic flow and alternate flow of the logical scenario firstly;
2. Then equivalence class method is used to divide the test input criterion;
3. Boundary value analysis method is used to analyze the input value and design the test cases;
4. If necessary, error inference method can be used to append more test cases;
5. Check coverage of the test cases against the requirements. If the required coverage standards are not met, sufficient test cases should be added.

## Regression test strategy

1. Execute partial regression testing for the problems and modifications and their influence scope found when testing
2. Execute full regression test for the modification of basic functions

# Test plan

The software version iterates weekly. After each version is released, the following test is performed according to release note

1. Execute regression test for the problems fixed in current version
2. For the newly added features, execute the simulation test first. After the test passes, then execute road test

## Testing the time plan

1. Weekly test
2. Regression test
3. New feature test

Weekly test will be executed every week when the weekly version is released

1. System test

System test will be executed from July 25th to August 1st.

# Risk control

## Risk analysis and response measures

|  |  |  |
| --- | --- | --- |
| **No.** | **Risk Specification** | **Response Measure** |
| 1 | The test vehicle fault makes test impossible | Check the test vehicle status weekly;  Prepare one more spare vehicle and check its status weekly |
| 2 | Something wrong with Carmaker dongle | A dedicated and a spare dongle is provided for this project, if one dongle invalid, then contact supplier to solve the problem immediately. |
| 3 | Delivery delayed due to the progress of development or too many bugs | Tracking the integration test status 2 days before release date, conform the state of release version is regular. |
| 4 | Qianxun positioning service cannot work properly | Contact Qianxun service immediately when the service has problem. |

# Training Requirements

NA

# Manage Defects

Refer to ’纽劢软件故障管理V1.0’

# Test submission results

1. Software test plan
2. Software test plan review checklist
3. Software test case
4. Software test case review checklist
5. Software test execution results
6. Software test report
7. Software test process completion checklist
8. Software traceability matrix
9. Software traceability matrix review checklist (identification test part)