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Interoperability Testing: comprehensive, global, and streamlined solutions for next generation in-vehicle experiences

Challenge

A major Japanese Original Equipment Manufacturer (OEM), preparing to launch its infotainment products globally, aimed to enhance product quality by conducting connectivity interoperability (IOP) testing across various regions. This testing was essential to ensure compatibility with a broad range of phone manufacturers and cellular carriers, thereby improving the user experience across numerous vehicle models. Leveraging its global reach and proven expertise, EagleTC was awarded a multi-year contract to perform these tests in North America (including the USA, Canada, and Mexico) and the Middle East (i.e., Jordan).

Solution

EagleTC worked hand and hand with the automaker to develop a testing plan that would execute IOP testing for multiple vehicle platforms. Many elements of the testing had to be addressed prior to the start of testing – Test Case Development, Phone Selection/Procurement, Test Bench Setup, Guideline Document, and Test Execution.

Test Case Development

EagleTC's engineers began by focusing on the development of detailed test cases. Test cases were developed using technology standards, the automaker's requirements and EagleTC's engineering expertise and experience. Working together, EagleTC and the automaker went through a series of reviews to finalize a comprehensive list of test cases for each platform. Figure (1) depicts the process of test case development, while Table (1) summarizes the technologies and features that were tested.

Phone Selection/Procurement

In parallel with test cases development, EagleTC was responsible for securing the phones required for testing. EagleTC performed market research to determine and select a wide variety of phones and cellular carriers for the IOP testing. Since it's not feasible to test all available options in the market, the following measures were used to generate the most complete sample – market research, customer request, and availability in the selected region. Over 200 phones from 15 different manufacturers

were selected, with model years ranging from 2017 to 2024. Table (2) shows the distribution of phone manufacturers and cellular carriers used.

Once the phone list was finalized, the phones were prepared for testing. This included updating phones and applications to the latest software versions, downloading music, creating contacts with multiple numbers and photo formats, and preparing the phones for generating logs.

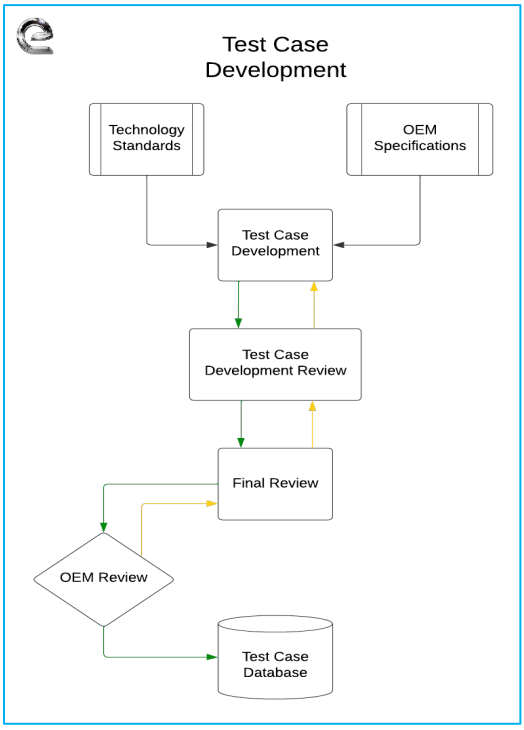

Figure (1) – Test Case Development Workflow.

Technology	Features
Bluetooth	Pairing/Connectivity Hands Free Profile (HFP) Phonebook Access Profile (PBAP) Advanced Audio Distribution Profile (A2DP) Audio Video Remote Control Profile (AVRCP) Message Access Profile (MAP)
Multi-Profile	Multiple features active simultaneously
Coexistence	Bluetooth + WIFI
Wi-Fi	Access Points/Hotspots
Phone Projection	CarPlay and Android Auto (Wired/Wireless)

Table (1) – List of Technologies and Features Tested.

Region	Phone Manufacturer	Cellular Carrier
USA	Apple, Samsung, Motorola, Nokia, T-Mobile, OnePlus, Google, LG, Alcatel, BLU	Verizon, AT&T, and T-Mobile.
Canada	Apple, Samsung, Motorola, Google, TCL, ZTE	Rogers, Bell, and Telus.
Mexico	Apple, Huawei, Motorola, OPPO, Samsung, Vivo, Xiaomi, ZTE	Telcel, and Movistar.
Jordan	Apple, Huawei, Infinix, OnePlus, OPPO, Samsung, TECNO, Vivo, Xiaomi	Zain, Orange, and Umniah.

Table (2) – Distribution of Phone Manufacturers and Cellular Carriers.

Test Bench Setup

A predefined number of test benches were shipped to each region based on the vehicle platform and testing timeline. Before starting each testing session, the engineers verified that the benches in every region were operating correctly and running the appropriate software version as specified by the OEM.

Guideline Document

Maintaining consistency across four countries and numerous testing cycles was paramount. To achieve this, EagleTC generated and followed a common set of testing guidelines for both the infotainment systems and the phones for each of the four countries. The guidelines included pre-test preparation for the infotainment system and phone, instructions for generating all logs, performing infotainment system software updates, and conducting all IOP test cases. They also outlined the format in which test results should be submitted to the OEM, ensuring clear and uniform reporting.

Test Execution

With the guidelines in place, EagleTC's engineers conducted the IOP testing and provided videos and system logs for the phone and infotainment system, for all identified issues. These logs included a Gal Monitor log, Bug Reports, and an infotainment system log enabling the OEM to review and resolve issues as necessary. Figure (2) illustrates the complete IOP testing process.

All issues identified were tracked through EagleTC's defect database, allowing team members in the different regions to collaborate efficiently, especially when identifying the same issues across the different regions. After reviewing internally, EagleTC entered

the identified issues into the OEM's defect database for review and resolution. In addition, EagleTC mapped the tested features and their results to coordinate with the customer's website. Table (3) is an example of test result mapping.

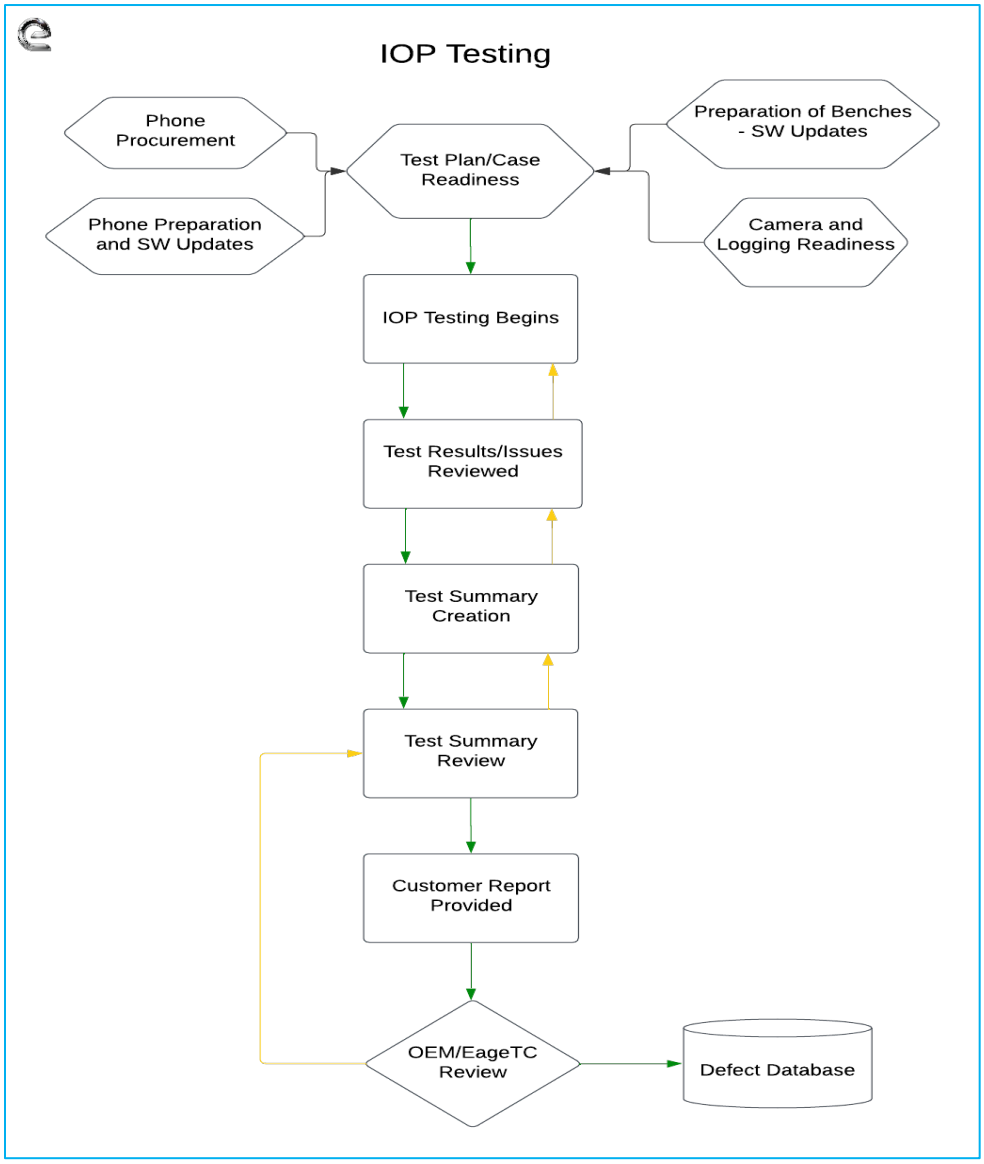

Figure (2) – IOP Testing workflow.

Test Result Mapping		Phone X Carrier 1	Phone X Carrier 2	Phone Y Carrier 3
Basic Features	Phone Pairing-Passive	✓	✓	✓
	Phone Pairing-Active	✓	✓	✓
	Handsfree Calling	✓	✓	✓
	Incoming Call	X	✓	✓
	Call Transfer	✓	✓	✓
Advanced Features	Call Waiting	✓	✓	✓
	Phonebook Import	✓	✓	✓
	Call History	✓	✓	X
Bluetooth Audio	Bluetooth Audio	✓	✓	✓
Indicators	Battery Levels	✓	✓	✓
	Caller ID	✓	✓	✓
	Signal Strength	✓	X	✓
SMS/Text Messaging	Receive Message	✓	✓	✓
	Notification	✓	✓	✓
	Send Message	✓	✓	✓
Phone Projection	Car Play	✓	✓	X
	Android Auto	X	X	✓
Wi-Fi	Client	✓	✓	✓
	Access Point	X	✓	✓

Table (3) * – Example of Test Result Mapping.

* This list is a sample and is not all inclusive.

Results

EagleTC continued to deliver excellence with quality and agility to the OEM during all the testing cycles. The following highlights EagleTC's competence in providing this service to the customer:

- **Test Cases:** Over 350 test cases were executed per phone, validating interoperability between key technologies and features.
- **Testing Guidelines:** Guidelines were created to ensure consistency and reliability across all regions for each testing cycle.
- **Phones:** A total of 250 phones were tested across all regions, reflecting a wide variety of manufacturers, carriers, and model years.
- **Timely Project Delivery:** EagleTC delivered results ahead of schedule for all testing cycles, maintaining integrity, efficiency and cost-effectiveness.

In summary, EagleTC provided comprehensive IOP testing results to the automaker, enabling them to deliver the highest quality and experiences on a global scale.

As with all projects, EagleTC continues to show its excellence through:

- Deploying teams on short notice without compromising expertise or quality.
- Delivering completed projects with excellence, on time or ahead of schedule.
- Adapting seamlessly to changing conditions while maintaining consistent and accurate results.
- Maintaining open lines of communication with our customers, allowing real-time reporting and resolutions.

By combining global resources with deep automotive expertise, EagleTC ensures its customers receive world-class solutions—every single time.