PACE Award Finalist
Dual Role Hub

January 27, 2016
Delphi Data Connectivity
Auburn Hills, MI



EX.
18
C.A. No.17-1194-JDW

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Innovation for the Real World

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Agenda

ITEM	Start Time	End Time
• Welcome & Introductions	9:00	9:10
• Delphi Data Connectivity / Delphi E/EA Overview	9:10	9:30
• Delphi Data Connectivity Site Tour	9:30	10:00
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• Reserved Time (may finish early)	3:00	4:00

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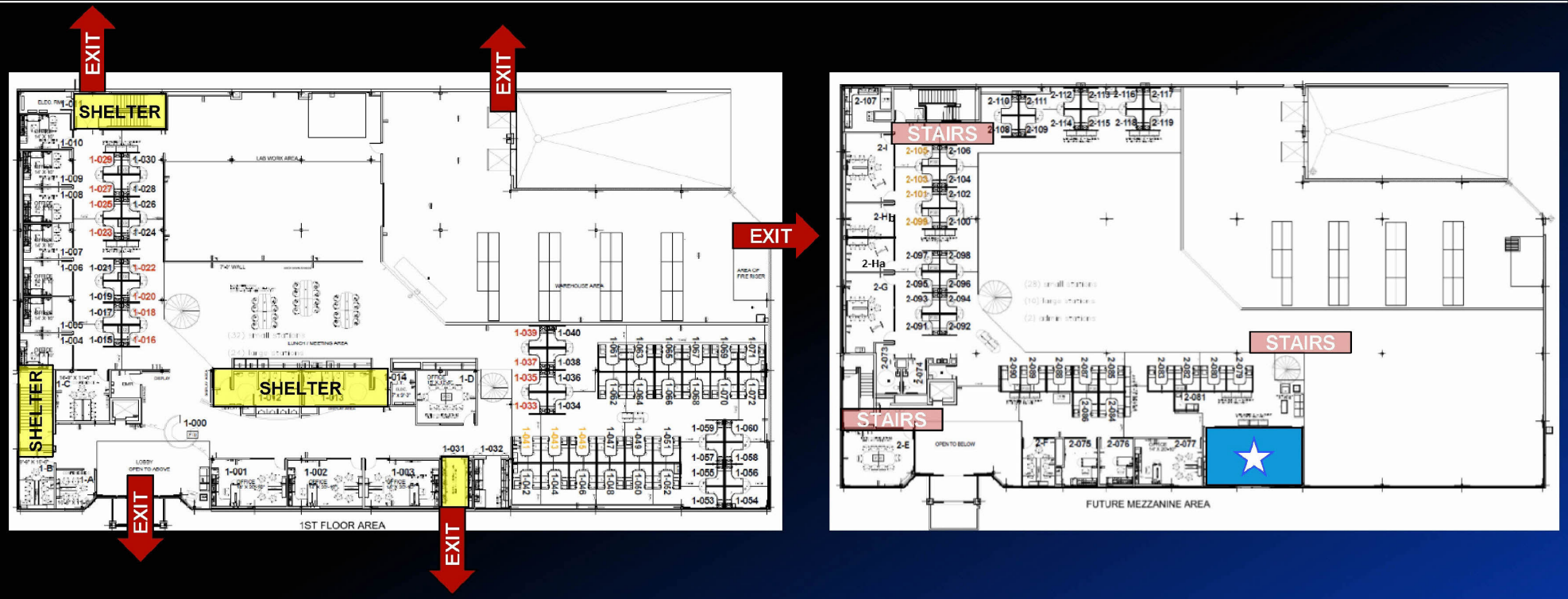
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Delphi Data Connectivity – Visitor Protocol



★ Evacuation meeting area is across parking lot in front of building

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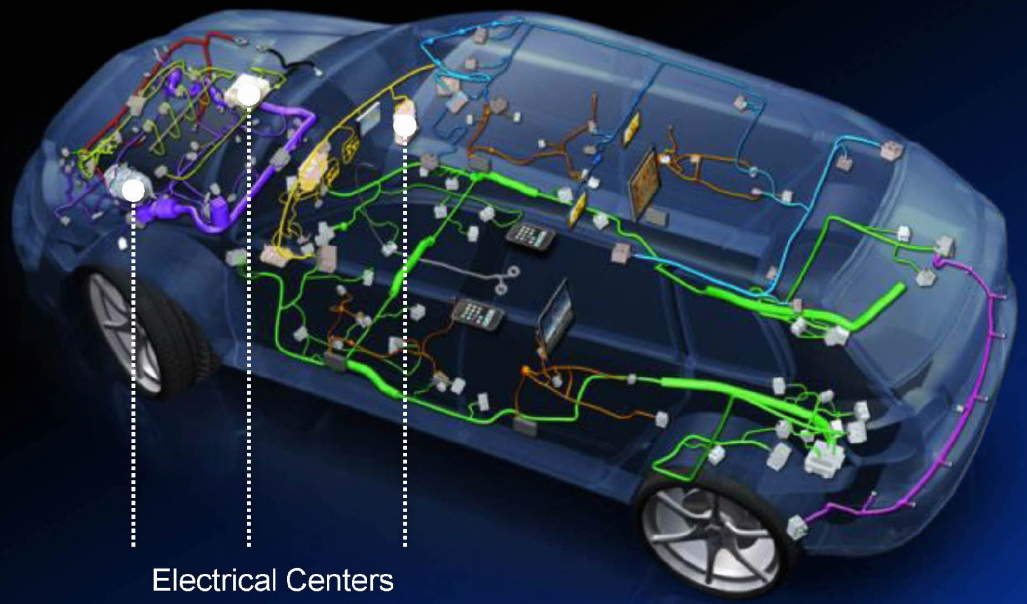
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The Delphi Packard E/EA Inside

Connects | **Protects** | **Activates**

- Main Body Harness
- Battery Cable
- Engine Compartment Harnesses
- Interior Harness
- Door Harness
- Headliner Harness
- Rear Harness
- Electrical Connectors



Bringing the vehicle to life

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A complete system approach

Supported by two strong product business units

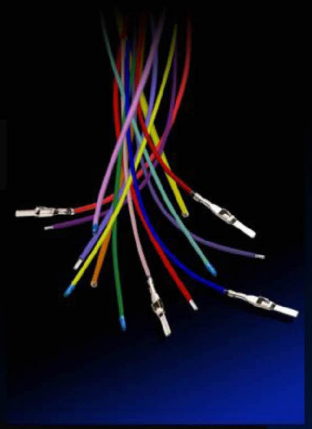
Electrical & Electronic Distribution Systems



Wiring Assemblies



Hybrid



Cables

Connection Systems



Electrical Centers



Data Connectivity



SRS



High Power

Standard Auto Connection Systems

- Housings
- Terminals
- Non Circuit Bearing
- Mechatronics Packaging (MEPA)
- Pin Headers

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Delphi Acquisition of Unwired Technology

Delphi Acquired Unwired Technology in October 2014

Key Acquisition Advantages

- Expanded Delphi's technical capability for connected infotainment modules
- Made Delphi the largest Rear Seat Entertainment (RSE) peripheral & USB connectivity supplier globally
- Provided Delphi customers access to advanced smart-device connectivity technologies enabling improved competitiveness as consumer electronic device megatrends continue to proliferate
- Along with wireless charging, created a new, focused business unit chartered with advancing the development of in-vehicle consumer connectivity modules

Major Product Additions

- Advanced USB connectivity solutions (leading market share)
  - USB 3.0 Super Speed
  - HDMI, MHL & SIM Card
  - Host-to-Host Bridge for USB hubs **to uniquely support Apple CarPlay™**
- Rear Seat Entertainment Peripherals (~90% global market share)
  - Wireless headphones, transmitters & remote controls
  - Started RSE headphone segment in 1997
  - Supply key multi-mode transmitter IC to RSE system integrators

Key Customers

- GM, Ford, Chrysler, Nissan, Honda, Jaguar-Land Rover & BMW

UNWIRED® TECHNOLOGY LLC

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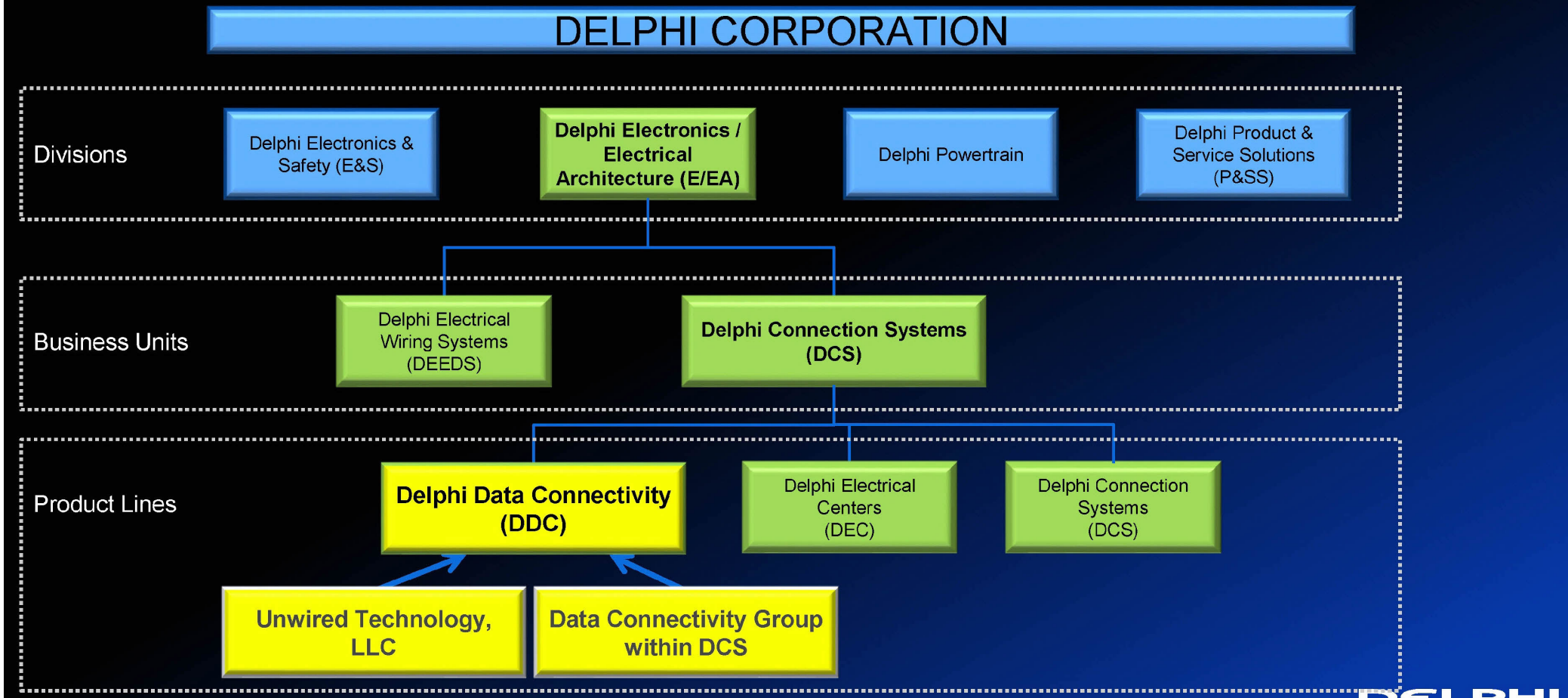
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Delphi Data Connectivity Formation



Delphi Data Connectivity

23,000 ft² (Auburn Hills, occupied in 2014)

45+ engineers located in Auburn Hills, MI, Champion, OH and Anting, China

145 total employees growing to 175+ in 2016

Manufacturing in China, both contract and in-house (Anting)

Innovation

- Electronics, Mechanical and Software Product Development
- Process Development
- Prototyping
  - Rapid Prototyping (Mechanical (SLA, FDM, 3DP) and Electrical)
- TALC (Trim, Appearance, Lighting, Color)

Validation & Evaluation

- Test Laboratories
  - Utilize internal and external lab
  - Labs located in Michigan, Ohio and China
  - Electrical, Mechanical, Environmental
  - USB & Apple Qualification
- Innovation Tools
  - Multi-Cad Software (UG-NX, Catia, Pro/E)
  - Mechanical Simulation (FEA (Ansys, Abaqus), Moldflow, Lighting)
  - Reversed Technology (CT scan, remodeling)
  - Schematic Design (DxDesigner, Altium, OrCAD)
  - Layout (Expedition, Altium)
  - Electrical Simulation (Saber, Multisim, HyperLynx)
  - USB Specific (Eye pattern testing, USB Certification testing)



Auburn Hills



Champion Technical Center



Anting China

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Delphi E/EA
Global Innovation Footprint



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Delphi Dual Role Hub Overview

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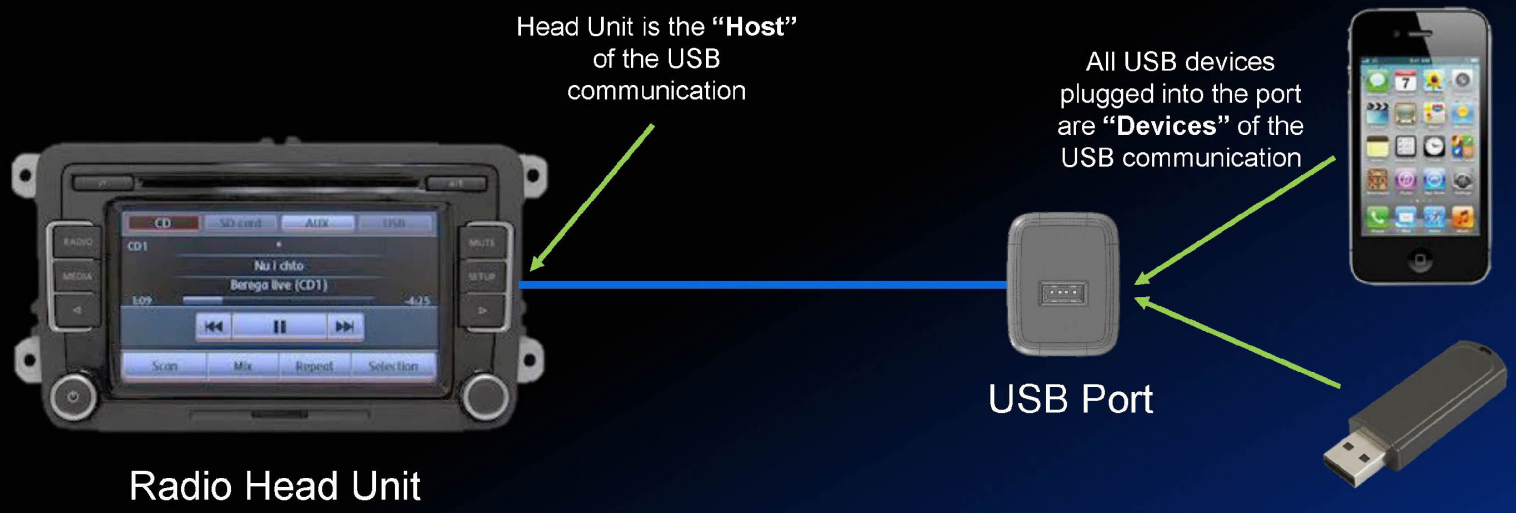
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Delphi Dual Role Hub Summary

- When Apple announced CarPlay™ in 2012, iPhone users couldn't wait to buy a car with an infotainment interface that was intuitive and mirrored how their phone worked. There was only one problem. The OEMs couldn't make it work without driving up the cost, limiting the functionality or taking up all the space in the head unit.
- The problem with the CarPlay™ integration came when a driver wanted to access music on another device, play video on a passenger's tablet or listen to music on a passenger's Android phone. The iPhone running CarPlay™ wanted to operate as the sole "host" device taking control from the car radio and denying access to other devices.
- Delphi solved it – at a lower cost, in a smaller package and with all functionality - by developing a custom USB ASIC (patent pending) allowing the iPhone and car radio to be recognized as "host" devices simultaneously.
- As a result, Delphi is the sole source of media module hubs in every mid- and high-level infotainment system GM globally for MY 2015. Next year, Delphi will capture 40 percent of GM, Ford, and Chrysler products globally, representing 10 million units annually with the potential to reach all OEMs globally.

USB Connectivity
Conventional Design – Single USB Connection



Single USB Connection

USB Connectivity
Conventional Design – Single USB Connection with Apple CarPlay™

Head Unit is the **"Device"** of the USB communication during CarPlay™. This is done by having a USB "On The Go" (OTG) port on the Head Unit.

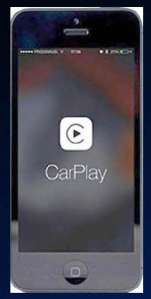
The iPhone is the **"Host"** of the USB communication during CarPlay™



Radio Head Unit



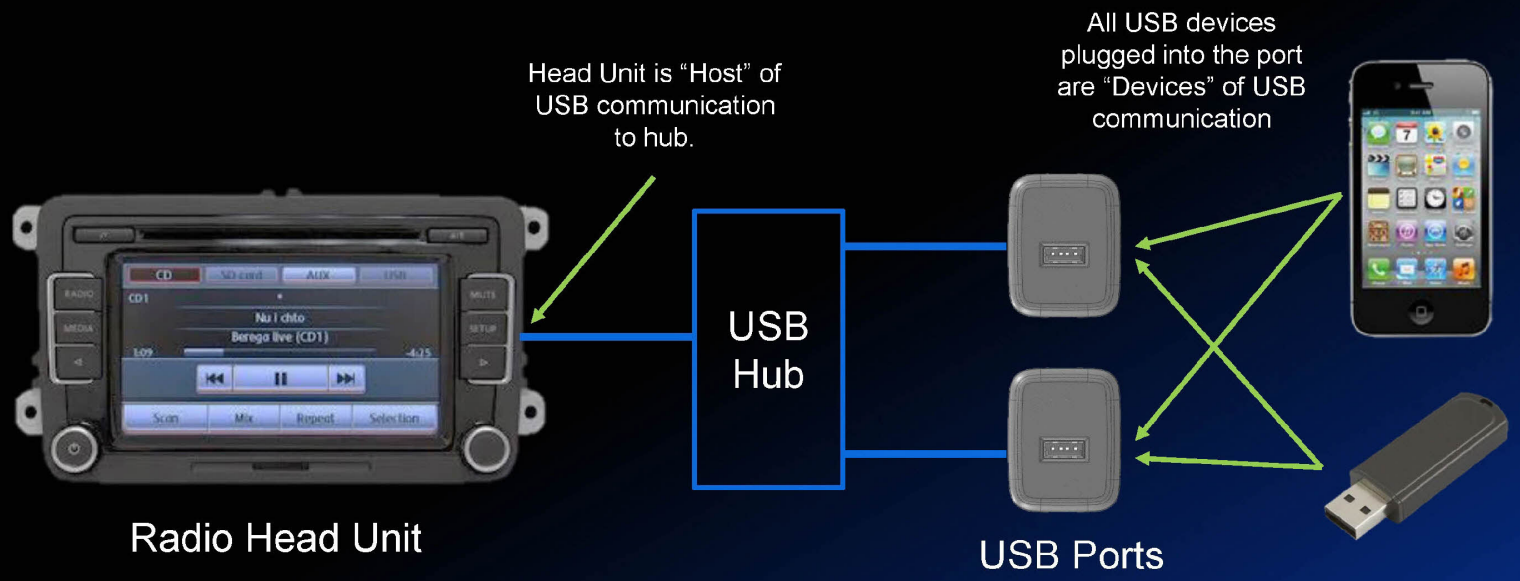
USB Port



Single USB Connection with Apple CarPlay™

- Apple CarPlay™ requires that the iPhone is the "Host" of the USB communication.
- The Head Unit needs to have an OTG USB port that switches from "Host" to "Device" to support Apple CarPlay™ or a dedicated "Device" port for only CarPlay™.

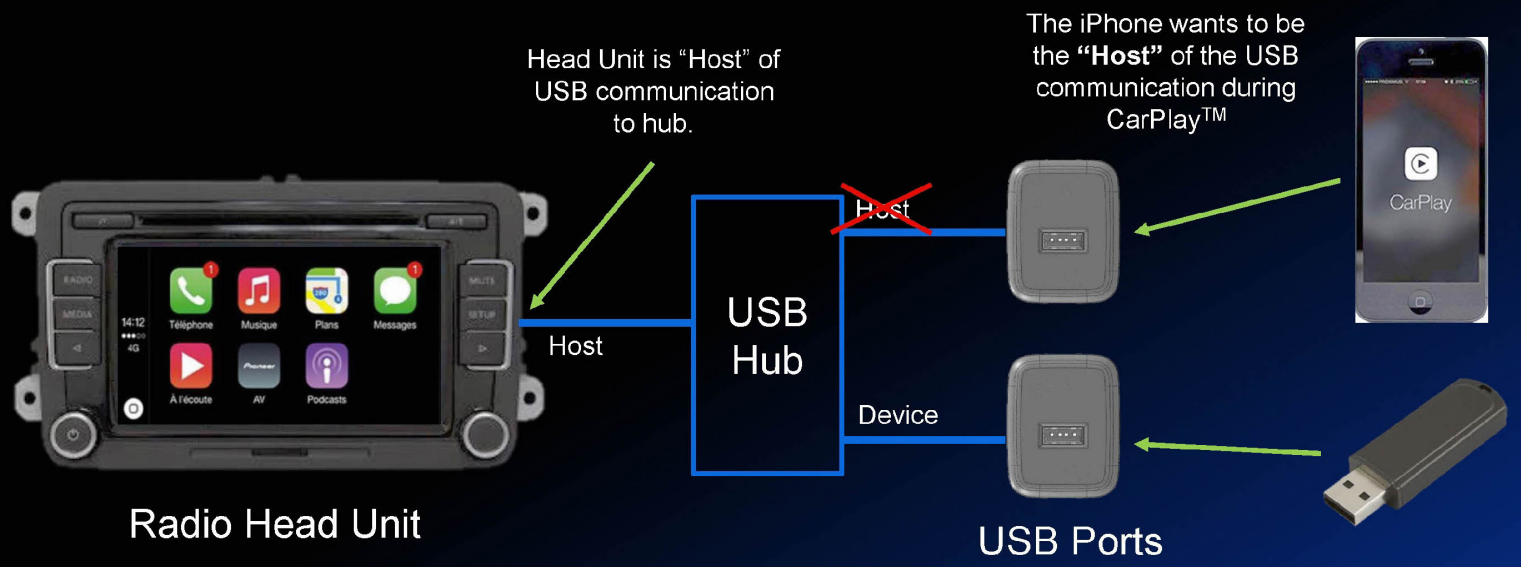
USB Connectivity
Conventional Design – Multiple USB Connections



Multiple USB Connections

- Multiple USB connections are desired by OEMs to add more USB ports to their vehicles for greater connectivity and convenience to the drivers and passengers!
- USB hubs are more efficient from a system perspective since additional ports aren't required on the Head Unit.

USB Connectivity
System Challenge – Multiple USB Connections with Apple CarPlay™



Multiple USB Connections

- A standard USB hub cannot have multiple USB "Hosts" connected to it.
- The Head Unit cannot simply utilize OTG to switch to "Device" because it connected to a hub!
- **This was the initial problem that the OEMs encountered!**

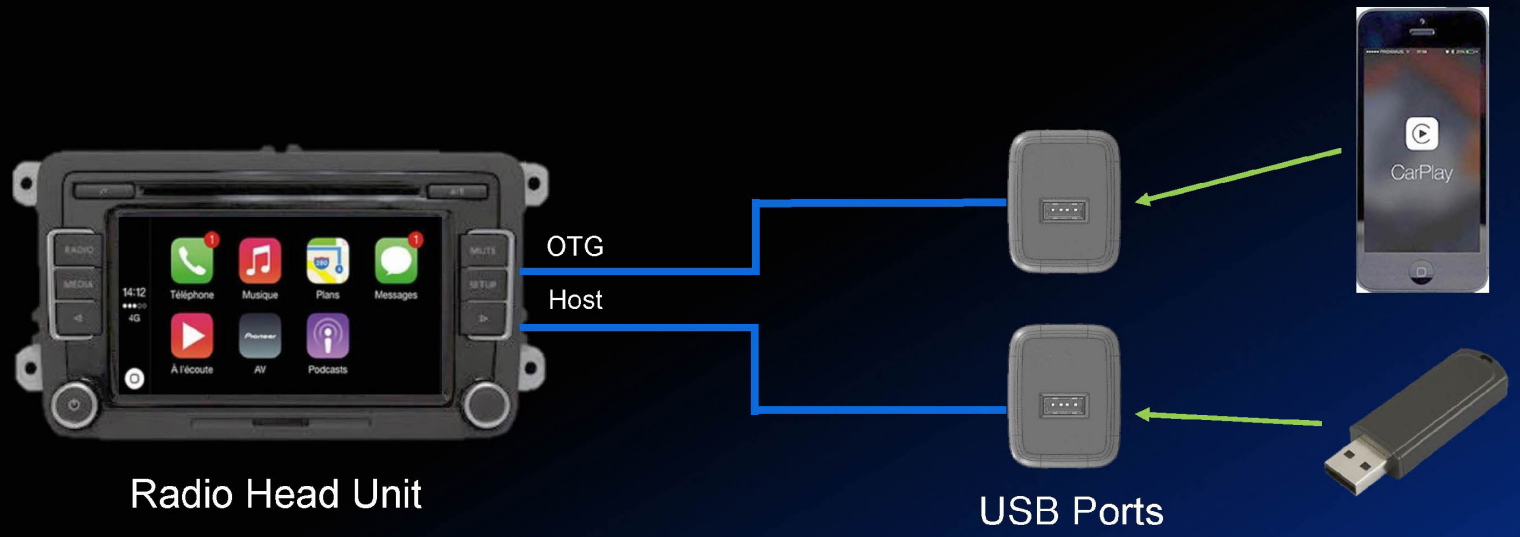
USB Connectivity
Potential Options for Multiple USB Connections with Apple CarPlay™

1. Add multiple USB paths back to the Head Unit
2. Utilize a “Port Reverse” hub developed by another IC Mfg.
3. Delphi’s Dual Role Hub

- The benefits of the Delphi Dual Role Hub are understood by studying the drawbacks of the competing solutions.

USB Connectivity
Option 1 – Multiple USB Connections with Apple CarPlay™

Add multiple USB paths back to the Head Unit

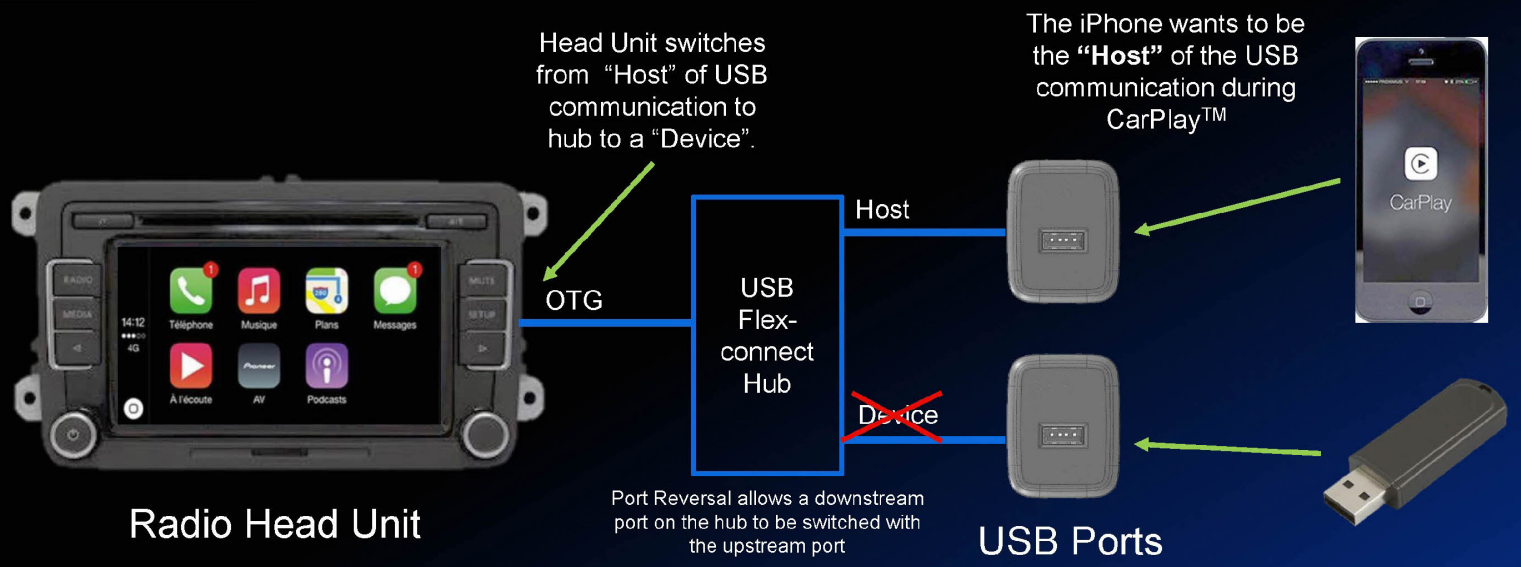


Multiple USB Connections

- Requires additional USB ports on Head Unit (added $, program delays, room in Head Unit)
- Only one of the ports (the OTG port)will support Apple CarPlay™
- Long cables may be needed to the port which would degrade integrity of USB signal

USB Connectivity
Option 2 – Multiple USB Connections with Apple CarPlay™

Utilize a "Port Reversal" hub

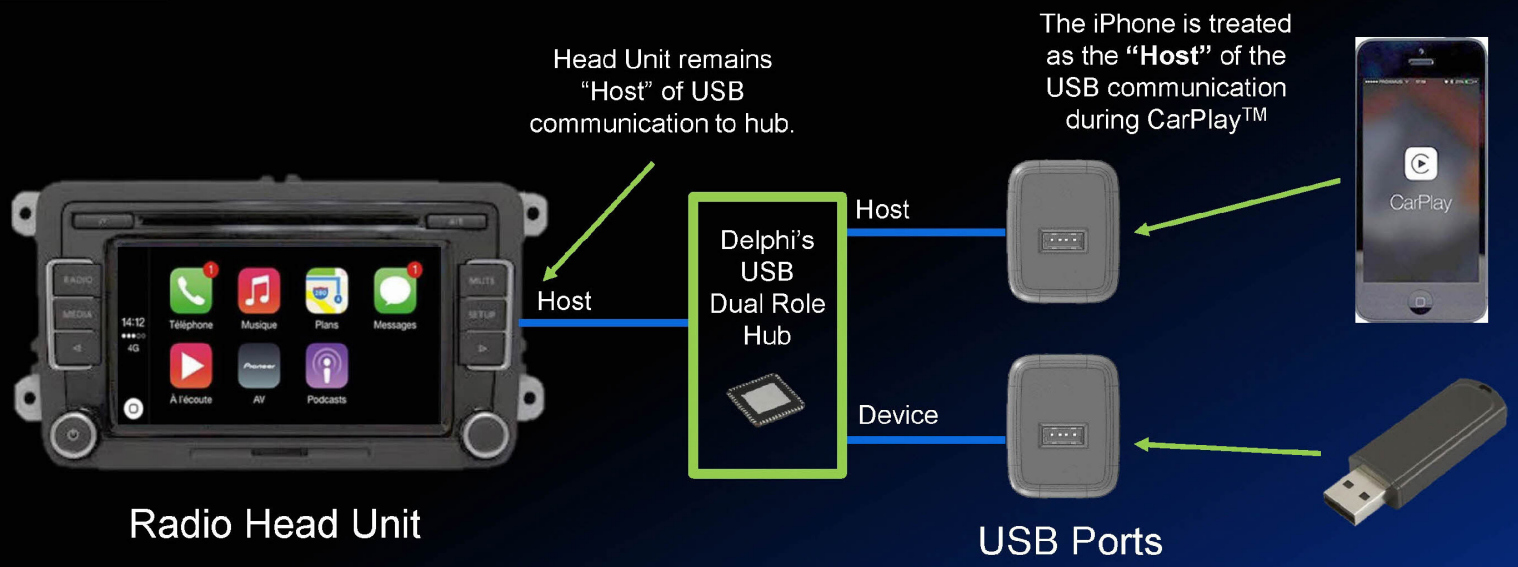


Multiple USB Connections

- Requires OTG port on Head Unit (added $, program delays)
- When one of the ports is used for CarPlay™, the other port cannot transfer data to the head unit→ the port is charge-only
- Due to switching inside the Port Reversal Hub, some signal degradation occurs

USB Connectivity
Option 3 – Multiple USB Connections with Apple CarPlay™

Delphi's Dual Role Hub



Multiple USB Connections

- Does not requires OTG port on Head Unit → no hardware change to Head Unit
- When one of the ports is used for CarPlay™, the other ports ARE ABLE to transfer data to the Head Unit!
- Robust USB signal integrity

USB Connectivity
Option Comparison of Multiple USB Connections with Apple CarPlay™

Key System Considerations	Two USB Paths	Port Reversal Hub	Delphi Dual Role Hub
Head Unit used "Host" port (OTG not required)	No	No	Yes
CarPlay™ available on any USB port	No	Yes	Yes
Other hub ports work during CarPlay™	Yes	No	Yes
Impact to USB signal integrity	Severe	Some	None
Vehicle System Cost	Highest	Moderate	Lowest
Head Unit Software Drivers Required	No	Yes	Yes

- Delphi's Dual Role Hub addresses all of the key system considerations to offer the OEMs a solution to their iPhone integration challenges
- Delphi's solution does require that a software driver be installed into the Head Unit. Delphi provides the driver AND integration support to make the installation efficient.

Delphi Dual Role Hub
Apple Approval

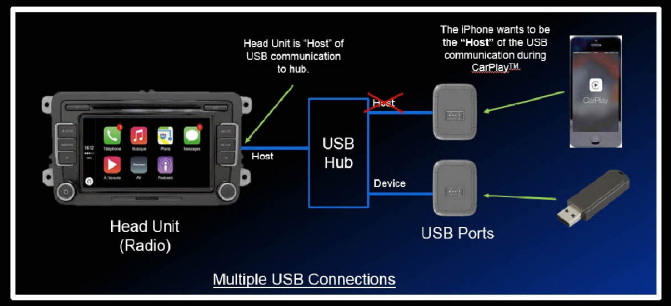
- Delphi system has passed Apple certification process at 3 OEMs
- Delphi's Dual Role Hub has been demonstrated and reviewed with Apple
- Delphi has in house capability of running Apple MFi compliance tests to ensure compliance to Apple specifications



Apple CarPlay

Delphi Dual Role Hub Innovation Approach

Identified industry relevant issues with integrating iPhone into vehicle architectures



1

Utilized expertise to identify a creative solution that addressed key considerations

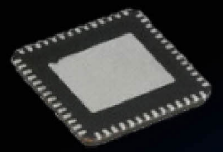
Key know-how required to solve the problem

- ✓ Automotive Systems
- ✓ USB Connectivity
- ✓ Apple Requirements
- ✓ Head Unit Software & Programming

Delphi has a "Patent Pending" for the Dual Role Hub innovation (Patent Number US 20150089092 A1)

2

Developed custom IC to offer packaging optimization AND a competitive advantage



56 pin
Integrated Circuit

Lower Cost
Small Packaging
Hard to Replicate

This required A LARGE INVESTMENT

3

Introduce Delphi's Dual Role Hub as a solution to customers CarPlay™ integration

4

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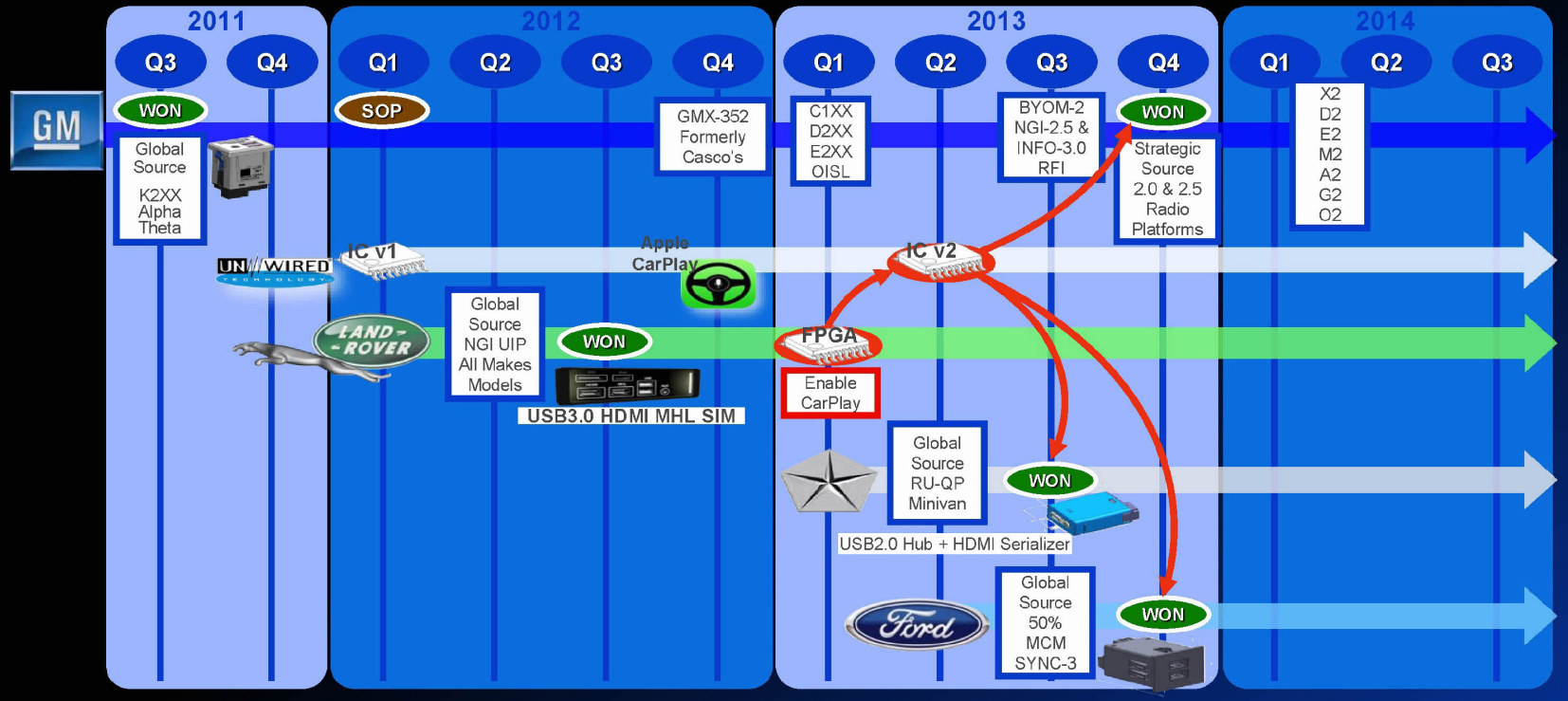
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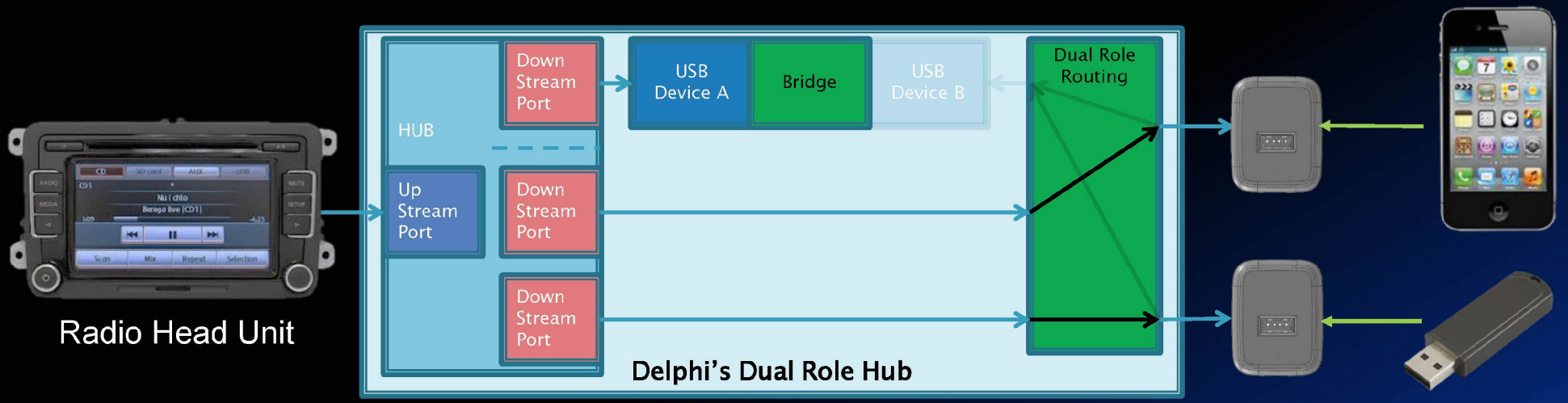
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Delphi Dual Role Hub Innovation Timeline



- Delphi/Unwired identified the problem and integrated the solution into the custom IC plans in 9 months.
- First production launch was in May of 2015
- We are currently in production with 2 OEMs with our custom IC, with several more to come!

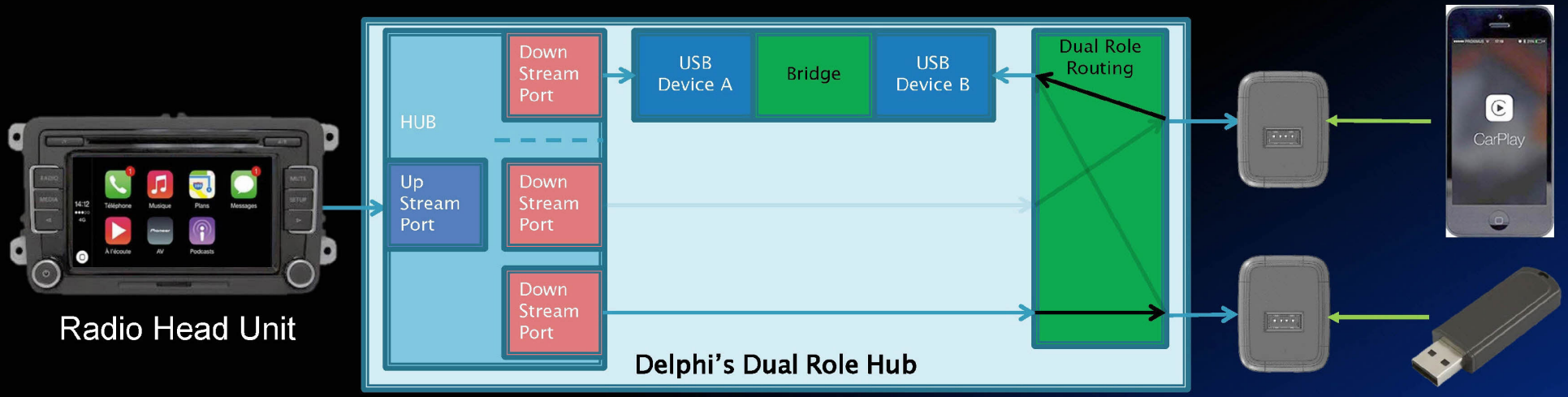
Delphi Dual Role Hub Innovation Solution



Description :

- At power up Head Unit detects a USB hub and a custom device (Bridge)
- Head Unit will load custom driver for the Bridge device supplied by Unwired
- Bridge driver has ability to control routing of any downstream port of the hub to either the Bridge or straight to the hub
- USB port routing is direct to the Hub for initial connection as a normal USB device.

Delphi Dual Role Hub Innovation Solution

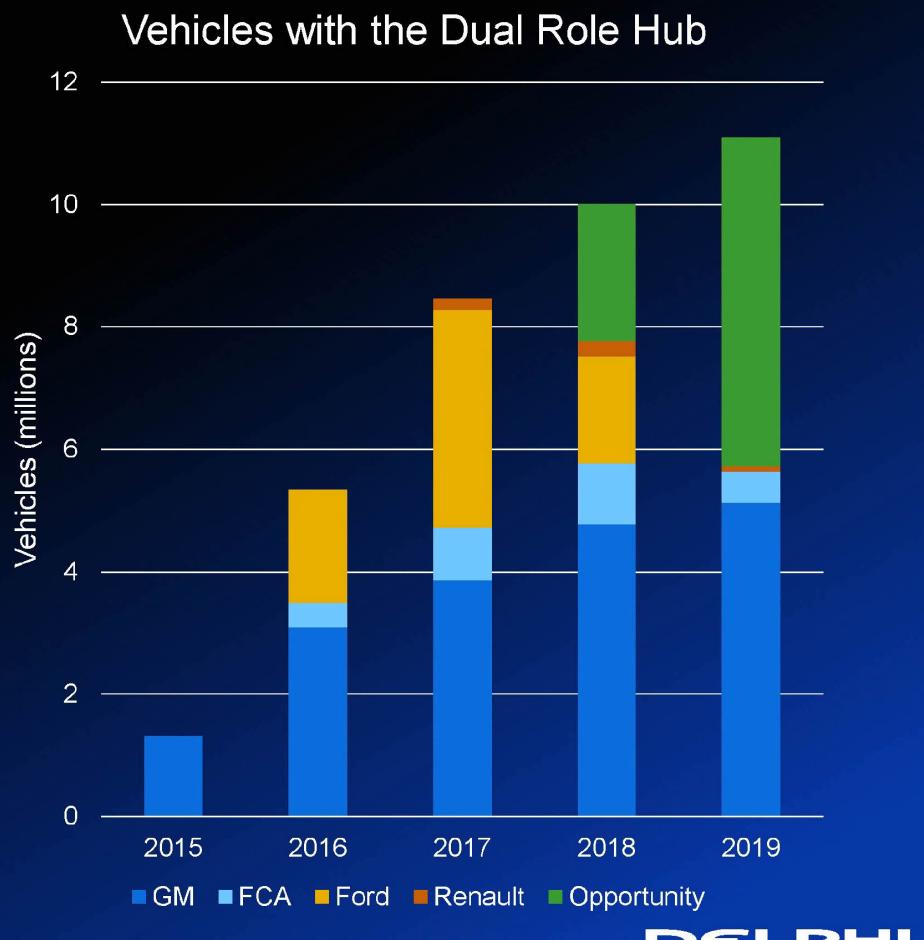


Description :

- Upon connection to Apple device the head unit will authenticate and then command the Bridge driver to role reverse resulting in the Apple device to be routed to the Bridge
  - Module contains a single Bridge
  - Either user accessible port may be role reversed and connected to the bridge
- When the iOS device is in host mode it will transfer data to Device B and Device B will transfer it to Device A.
- The Bridge driver in the head unit will read the data from endpoints in device A and pass it to a gadget driver

Delphi Dual Role Hub
OEM Acceptance

- Delphi has awarded business with 4 Global OEMs that utilizes the Dual Role Hub
  - GM: SOP May 2015
  - FCA: SOP October 2015
  - Ford: SOP March 2016
  - Renault: SOP February 2017
- Since the USB hub is part of the infotainment system, the programs are awarded across platform and globally (e.g. not just for a single vehicle platform in a specific region)
  - GM and Ford awards cover infotainment systems for the majority of their vehicles (including Opel, SGM, Ford Global)
- By 2018, 10% of all cars built globally will have a Delphi Dual Role Hub!
- We are pursuing business with VW group, Daimler, PSA, Volvo, Nissan and Hyundai that would utilize our Dual Role Hub.



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Delphi Dual Role Hub
GM Vehicle Roll-out

- Awarded GM media hub business for non-Dual Role Hub in Q3 of 2011
- Awarded GM media hub business with Dual Role Hub in Q4 of 2014
- Delphi's Dual Role Hub is on these 2016 MY GM Programs:
  - Silverado/Sierra
  - Tahoe/Yukon
  - Suburban
  - Malibu (NA, China, Korea)
  - Impala
  - Lacross
  - Regal
  - Captiva (Europe, China)
  - CTS
  - ATS (NA, China)
  - Camaro
  - CT6 (NA, China)
  - SRX
  - Corvette

Delphi Dual Role Hub
Ford Vehicle Roll-out

- Awarded Ford media hub business for non-Dual Role Hub in Q4 of 2013
- Awarded Ford media hub business with Dual Role Hub in Q2 of 2015
- Delphi's Dual Role Hub will be on these 2017 MY Ford Programs:
  - Lincoln MKC
  - Lincoln MKZ
  - Lincoln MKT
  - Lincoln MKS
  - Kuga
  - Fusion
  - Focus
  - F150/250/350/450
  - Edge
  - Galaxy
  - Fiesta
  - C Max
  - Flex
  - Taurus
  - Ecosport
  - Mondeo
- We are currently pursuing award of the 2019+ MY programs

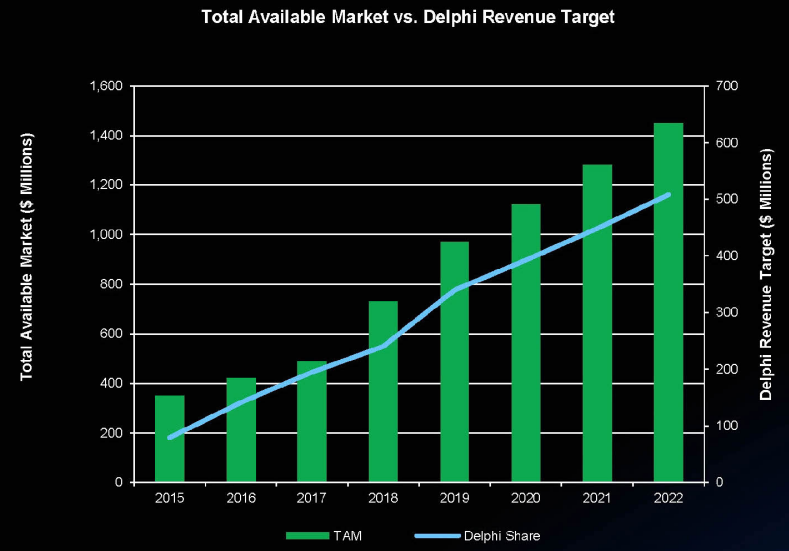
Delphi Dual Role Hub
FCA Vehicle Roll-out

- Awarded FCA media hub business for RU Platform in Q3 of 2013
- FCA is transitioning all of the prior Delphi non-Dual Role Hub modules to the Dual Role hubs in 2017 MY
- Delphi's Dual Role Hub will be on these 2016 & 2017 MY FCA Programs:
  - MP (2016 MY Brazil)
  - Pacifica (new minivan)
  - 200
  - 300
  - Charger
  - Challenger
  - Jeep Cherokee
  - Mazerati Quattroporte
- We are pursuing many other platforms with FCA (including several with Fiat, Mazerati and Alfa Romeo).

FCA
FIAT CHRYSLER AUTOMOBILES

Delphi Dual Role Hub
Market Size and Potential Revenue

Total USB Module Market Size



USB Module Market will be worth $1.4B by 2022

- Delphi currently has about 23% of the USB market globally with $150M in revenue (2015)
- The Dual Role Hub is a key enabler to Delphi conquesting additional market share
- Delphi will have 35% of the USB market globally by 2022 with an estimated $500M in revenue

Delphi Dual Role Hub Summary

- Delphi's patented Dual Role Hub provides unmatched functionality for the integration of Apple CarPlay™ into vehicles

- Functional Benefits to the OEM are:
  - Head Unit only requires "Host" USB port (lower cost and smaller than OTG port)
  - Any port on the USB hub can be used for CarPlay™
  - Other hub ports are able to transfer data to the Head Unit, when one of the ports is used for CarPlay™
  - USB signal integrity is not deteriorated

- Delphi's Dual Role Hub is being adopted by OEMs Globally

- Key enabler for Delphi Data Connectivity to grow to $500M+

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Customer Reference Calls

Tanmoy Joshi

12:30 – 1:00 PM

Supervisor Infotainment
Ford Engineering Building 5
tjoshi@ford.com
(313) 805-6710

Marvin A. Lewis

1:00 – 1:30 PM

BOM Family Owner – USB
General Motors Technical Center
marvin.lewis@gm.com
(248) 866-9016

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Backup

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USB Connectivity
Connecting an Apple Device to Anything

- Apple has specific requirements whenever an OEM (or any other consumer device maker) wants to connect to one of their iPhones
- Apple enforces these requirements in order to control the user experience of their phone … if the connection doesn't work, they don't want the consumer to dissatisfied!
- Apple Requirements:
  - Must have an Apple Authentication IC integrated in the product
  - System must receive Apple Certification
    - All system components must pass independent USB certification (electrical and communications tests)
    - Overall system must pass independent Apple testing (additional system integrity checks)

- Meeting the electrical and signal integrity checks for Apple are NOT trivial and need to be considered in the overall design of the system.
- Long lengths of cable and multiple interfaces DEGRADE the performance of the system and should be minimized.

Delphi Dual Role Hub Requires a Delphi Provided USB Device Driver in Head Unit

- Head Unit Device Driver has been implemented in Linux and QNX head units.
- Successful CarPlay™ system implementations have been made by multiple head unit suppliers using Linux, QNX, and Android with the Delphi Dual Role Hub and Driver.
- Delphi in house software resources available to assist OS and head unit providers in their implementation of the head unit Driver.
- Reference driver available from Unwired
  - Provided as GPLv2 Source code
  - Uses Gadget API
  - Tested with Kernels 3.8 and above
  - Uses multiple Vendor Specific Messages to role reverse the hub and encapsulate data