
Car Connectivity Consortium

MirrorLink[®]

Core Architecture

Version 1.2.2
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Approved

TERMS AND ABBREVIATIONS

A2DP	Bluetooth Advanced Audio Distribution Profile
ARP	Address Resolution Protocol
BT	Bluetooth
CDB	Common Data Bus
CDC	Communications Device Class; specified from USB Device Working Group
CE	Consumer Electronics; CE devices are referred to as mobile devices within this specification
DAP	Device Attestation Protocol
DHCP	Dynamic Host Configuration Protocol
ECM	Ethernet Control Model; part of the CDC device class
HFP	Bluetooth Hands-free Profile
HSP	Bluetooth Headset Profile
HMI	Human Machine Interface
HU	Head-unit (this term is used interchangeably with the MirrorLink client)
HS	Head-set
IP	Internet Protocol
NCM	Network Control Model; part of the CDC device class
Pointer Event	Pointer events are used to describe touch screen action in which the user touches the screen with one (virtual) finger only at a single location.
RFB	Remote Framebuffer
RTP	Real-time Transport Protocol
SBP	Service Binary Protocol
TCP	Transmission Control Protocol
Touch Event	Touch events are used to describe touch screen action in which the user touches the screen with two or more separate fingers at different locations. Touch events are used to describe more complex touch action, like pinch-open or pinch-close.
UDP	User Datagram Protocol
UI	User Interface
UPnP	Universal Plug and Play
USB	Universal Serial Bus
VNC	Virtual Network Computing

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1 ABOUT

This document specifies an interface for enabling remote user interaction of a mobile device via another device. This specification is written having a car head-unit to interact with the mobile device in mind, but it will similarly apply for other devices, which do provide a colored display, audio input/output and user input mechanisms.

This document is aimed at people going to design and develop compliant solutions. This set of documents will provide all necessary interface functionality and requirements to implement a fully compliant device, on both the mobile device and the head-unit side.

The specification lists a series of requirements, either explicitly or within the text, which are mandatory elements for a compliant solutions. Recommendations are given, to ensure optimal usage and to provide suitable performance. All recommendations are optional.

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are following the notation as described in RFC 2119 [19].

1. MUST: This word, or the terms "REQUIRED" or "SHALL", mean that the definition is an absolute requirement of the specification.
2. MUST NOT: This phrase, or the phrase "SHALL NOT", mean that the definition is an absolute prohibition of the specification.
3. SHOULD: This word, or the adjective "RECOMMENDED", mean that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course.
4. SHOULD NOT: This phrase, or the phrase "NOT RECOMMENDED" mean that there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
5. MAY: This word, or the adjective "OPTIONAL", means that an item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product while another vendor may omit the same item. An implementation which does not include a particular option MUST be prepared to interoperate with another implementation which does include the option, though perhaps with reduced functionality. In the same vein an implementation which does include a particular option MUST be prepared to interoperate with another implementation which does not include the option (except, of course, for the feature the option provides.)

The document will focus on the interface functionality, its parameters and protocols only. It does not provide any guidelines for implementing the protocol. If there is a reference towards an implementation, this is of informative nature only.

2 INTRODUCTION TO MIRRORLINK

MirrorLink provides a concept for integrating the mobile device (hereinafter referred to as the “MirrorLink server”) and the vehicle head-unit (hereinafter referred to as the “MirrorLink client”). In a MirrorLink context, the control and interaction of applications and services running on the mobile device will be replicated into the car environment. Diverting display and audio output to the car head-unit come together with receiving key and voice control input from it are the main interaction streams, as shown in the following figure.

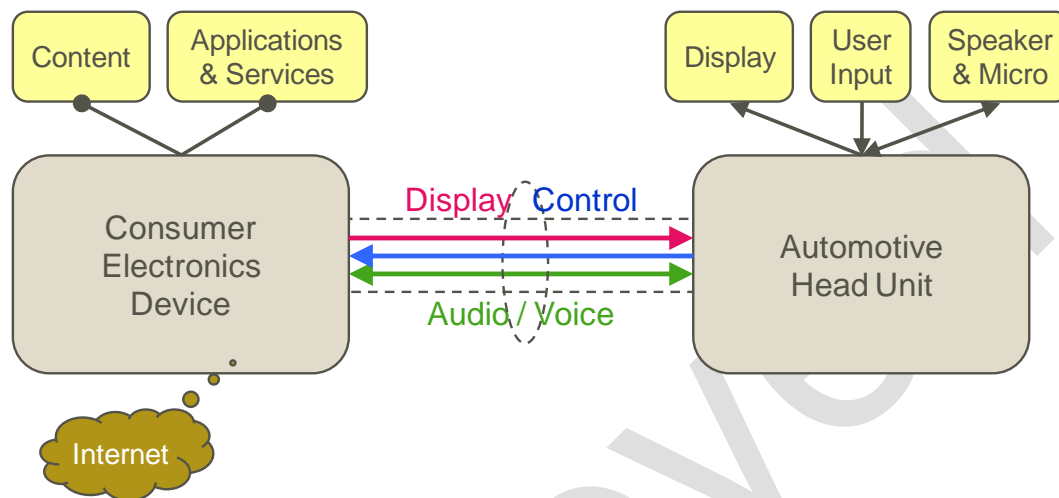


Figure 1: MirrorLink Concept

The result is a concept somewhere between running the applications natively in the mobile phone or in the car unit. From the user experience point of view it can offer "the best of the both worlds" where the large variety of mobile phone applications is complemented and enhanced by the car system providing convenient and safe means for using (i.e. controlling) these applications.

It is easier to add new consumer electronic functionalities into the vehicle environment via a mobile device than integrating them into the car infotainment system. In any case, the usage of those applications will become more convenient if the same device with the same content stored in it can be used in all the different environments from home to car, and providing Internet connectivity at the same time. On the other hand, the large displays of the car units can enhance the user experience from what the mobile device can offer by itself.

In addition the mobile device typically provides the latest technologies, from radio connectivity, to multimedia codecs. At the same time, the openness of the platforms, allows delivery of new applications and services at any time.

There are no standard methods currently defined for MirrorLink connectivity. However, when creating the required solutions, technologies provided by existing open, non-proprietary standards - like USB, TCP/IP, VNC, UPnP etc. - SHOULD be used as the basis. The needed additional elements SHOULD then be developed and agreed in cooperation between the related industry sectors.

The car systems comprise of several different methods for user interaction, like individual keys, rotating knobs, touch screen and even voice-activated control. For proper interoperability, the control method towards the mobile device SHOULD be the same regardless of the actual input mechanism on the car side. Furthermore, to ensure that MirrorLink does provide interoperability independent of any application, even legacy ones, it hooks into low-level abstraction.

3 MIRRORLINK ARCHITECTURE

The MirrorLink high-level architecture is shown in the following figure.

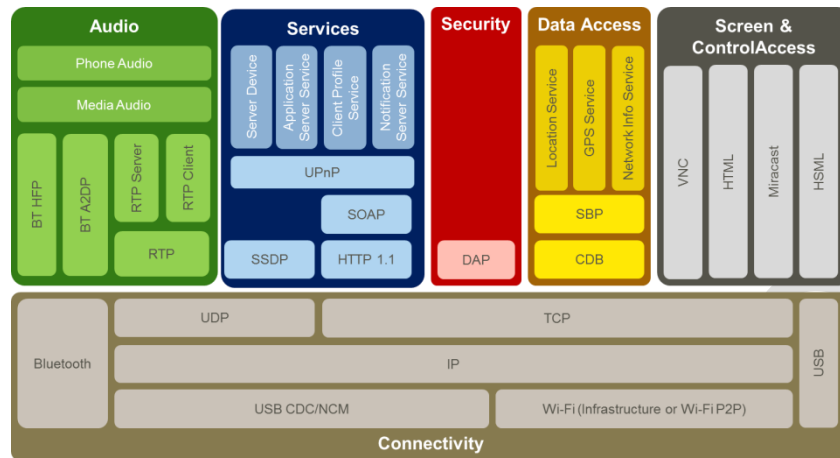


Figure 2: MirrorLink Architecture

MirrorLink 1.1 Architecture consists of a set of protocols, providing the following features:

1. Connectivity, as specified in [1], providing
 - a. Wired and wireless IP based connection-oriented and connection-less connectivity, and
 - b. Dedicated Bluetooth connectivity
2. UPnP based Services, providing
 - a. Mechanisms for advertisement of MirrorLink enabled Server devices as specified in [12]
 - b. Mechanisms for application notifications, as specified in [11],
 - c. Mechanisms for MirrorLink client profiles, as specified in [10], and
 - d. Mechanisms for advertisement and control of MirrorLink server based applications and their certification information, as specified in [9]
3. Access to Screen and Control, as specified in [2], providing
 - a. Replication of the MirrorLink Server's display content to the MirrorLink Client using VNC,
 - b. Control Channel of Key, Pointer and Touch events back to the MirrorLink Client, and
 - c. Exchanging display and event related information and notifications
4. Audio, as specified in [3], providing
 - a. RTP audio streaming, for different payload types, outputting the MirrorLink Server
 - b. RTP audio streaming, for different payload types, inputting the MirrorLink Server
 - c. BT HFP based legacy phone audio
 - d. BT A2DP based legacy media audio
5. Access to Data Services, providing
 - a. Simple multiplexed, shared bus, hosting services, as specified in [5],
 - b. Binary protocol framework for implementing various services, as specified in [6],
 - c. GPS data service using the binary protocol framework, as specified in [7], and
 - d. Location data service, using the binary protocol framework, as specified in [8]
6. Security mechanisms, as specified in [4], providing
 - a. Attestation of MirrorLink Server devices and their main MirrorLink protocol components

MirrorLink 1.2 Architecture is adding the following additional features:

1. Connectivity
 - a. CCC specific IEEE 802.11 Information Element (OUI) as specified in [13].
 - b. Internet Accessibility supporting Group Ownership negotiation in Wi-Fi P2P networks, as specified in [17].
2. UPnP based Services

- 1 a. No additional services; some smaller additions to some of the services, as highlighted in
- 2 [9], [10], and [12]
- 3 3. Access to Screen and Control, providing
- 4 a. Replication of HTML based user interfaces (Web Applications), as specified in [13]
- 5 b. Replication of MirrorLink Server's display contents to the MirrorLink Client using HSML
- 6 as specified in [18].
- 7 c. Replication of MirrorLink Server's display contents to the MirrorLink Client using Wi-Fi
- 8 Display, as specified in [14].
- 9 4. Audio
- 10 a. No additions
- 11 5. Data Services
- 12 a. Network Management Data Service, providing dynamic information on network status, as
- 13 specified in [16]
- 14 6. Security mechanisms
- 15 a. Added WFD and HSML elements as highlighted in [4].
- 16

4 MIRRORLINK FEATURES

The following table specifies the requirements for the different MirrorLink features for the MirrorLink Server and Client and for which version the feature has been introduced.

The version number given for a specific feature, highlights the MirrorLink version in which the feature has been introduced. The feature is available with the same given obligation for the MirrorLink Server and Client from that version onward. In case the obligation changes between versions, an additional entry is made, defining the new feature obligation.

Feature			Version	MirrorLink Server	MirrorLink Client
Connectivity	USB	USB Host	1.0	N/A	MUST
		USB Device	1.0	MUST	N/A
		CDC/NCM Device Class	1.0	MUST	MUST
		HSML Device Class	1.2	SHOULD	SHOULD
	WLAN	Wi-Fi Access Point	1.0	SHOULD	SHOULD
		Wi-Fi Device	1.0	SHOULD	SHOULD
		IEEE 802.11 CCC IE	1.2	COND.	COND.
		Wi-Fi-Direct P2P	1.1	SHOULD	SHOULD
	Bluetooth		1.0	MAY	MAY
UPnP based Services MirrorLink implements 2-Box pull model	UPnP Server Services Provided	Server Device	1.0	MUST	N/A
		Application Server Service	1.0	MUST	N/A
		Client Profile Service	1.0	MUST	N/A
		Notification Server Service	1.1	SHOULD	N/A
	UPnP Control Point Services Supported	Server Device	1.0	N/A	MUST
		Application Server Service	1.0	N/A	MUST
		Client Profile Service	1.0	N/A	SHOULD
			1.2	N/A	MUST
		Notification Server Service	1.1	N/A	SHOULD
Screen & Control	VNC	VNC over USB	1.0	MUST	MUST
		VNC over Wi-Fi	1.0	MAY	MAY
	HSML		1.2	SHOULD	SHOULD
	Wi-Fi Display		1.2	SHOULD	SHOULD
	HTTP		1.2	MAY	MAY
Audio	RTP	RTP Server	1.0	MUST	SHOULD
		RTP Client	1.0	SHOULD	MUST
	BT	BT HFP	1.0	SHOULD	SHOULD
		BT A2DP	1.0	MAY	MAY
Access to Data	Common Data Bus	Server Endpoint	1.1	SHOULD	N/A
		Client Endpoint	1.1	N/A	SHOULD
	Service Binary Protocol		1.1	COND.	COND.

Feature			Version	MirrorLink Server	MirrorLink Client
	GPS Data Service		1.1	SHOULD	SHOULD
	Location Data Service		1.1	SHOULD	SHOULD
	Network Management Data Service		1.2	MAY	MAY
Security	DAP	Server Endpoint	1.0	SHOULD	N/A
			1.1	MUST	N/A
		Client Endpoint	1.0	N/A	SHOULD

Table 1: MirrorLink Feature Requirements

- 1
- 2 A MirrorLink device MUST implement the Service Binary Protocol if any of the Data Services are imple-
- 3 mented.
- 4 A MirrorLink device MUST implement the IEEE 802.11 CCC Information Element, if it makes Wi-Fi Dis-
- 5 play available through MirrorLink.

5 MIRRORLINK SESSION

The high-level MirrorLink session diagram is shown in the following Figure 3. The MirrorLink flow starts with the user either actively connecting the MirrorLink Server device with a MirrorLink Client device, or by automatic connection, when coming into the vicinity of a MirrorLink Client device.

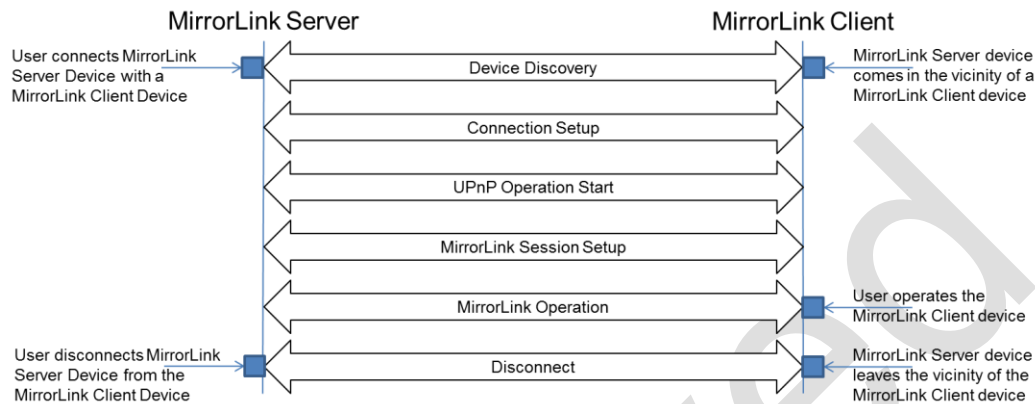


Figure 3: High-level MirrorLink Session Sequence Diagram

During the Device Discovery phase, devices detect each other as MirrorLink enabled devices, using the mechanisms described in [1] or [15]. In the connection setup phase the physical connection is established, including negotiation of the group ownership in Wi-Fi P2P networks, setting up the USB CDC/NCM connection and the IP address setup. The IP interface MUST be operational within 3s after the IP address has been negotiated.

After IP addresses have been assigned, the UPnP Operation starts, leading to the establishment of setup of the MirrorLink Session. On successful MirrorLink session setup, the regular MirrorLink operation starts, where the user is operating the MirrorLink Client device in order to access and control applications on the MirrorLink Server device.

The MirrorLink session ends when the user disconnects the physical connection, leaves the vicinity of the MirrorLink Client device, or terminates the MirrorLink functionality on either device.

5.1 UPnP Operation Start

The sequence diagram of the UPnP operation start is given in the following Figure 4. The sequence MUST follow UPnP device architecture specification as given in [20].

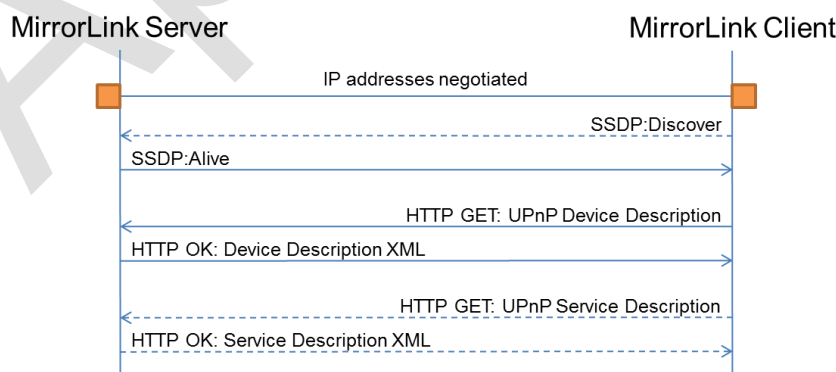


Figure 4: UPnP Operation Start Sequence Diagram

In case the MirrorLink Server is connected via multiple interfaces (like Wi-Fi, USB), the UPnP Server Device MUST be visible over each interface, using SSDP:Alive broadcast messages.

If the MirrorLink Client does not have any pre-existing knowledge about the URL of the MirrorLink Server's Device Description, it **MUST** use SSDP mechanisms to discover and locate it. The MirrorLink Client **SHOULD** use `SSDP:Discover` to avoid waiting for the MirrorLink Server's `SSDP:Alive` messages for a long time. MirrorLink over WFD specification [14] **REQUIRES** MirrorLink Clients and Servers to skip this phase, and to use the CCC's Information Element, as specified in [15]. However, the MirrorLink Server is not prohibited to send SSDP messages according to the UPnP procedure specified in [20].

Immediately after locating the MirrorLink Server's device description, the MirrorLink Client **MUST** retrieve the device description using `HTTP-GET`. The MirrorLink Client **MAY** retrieve the MirrorLink Server's service description as well using `HTTP-GET`; but all necessary information for the MirrorLink Client's UPnP Control Point operation are available in the Service section of the device description.

The MirrorLink Server **MUST** list all available alternative remote user interface mechanisms into the `X_presentations` list within the UPnP Server Device XML, defined in [12]. The list is independent of whether a particular mechanism is currently available due to the established physical connections.

Allowed remote user interface mechanisms and the associated physical interface are listed below:

• <code>vncu</code>	USB	VNC over USB
• <code>vncw</code>	Wi-Fi	VNC over Wi-Fi
• <code>wfd</code>	Wi-Fi	Wi-Fi Display
• <code>hsm1</code>	USB	High-Speed Media Link
• <code>html</code>	USB/Wi-Fi	HTML based Web Application

`hsm1`, `wfd` and `html` are not available in MirrorLink 1.0 and 1.1.

5.2 MirrorLink Session Setup

The sequence diagram of the MirrorLink session setup is given in the following Figure 5. The MirrorLink session **MUST** start immediately after the UPnP Operation Start has been completed.

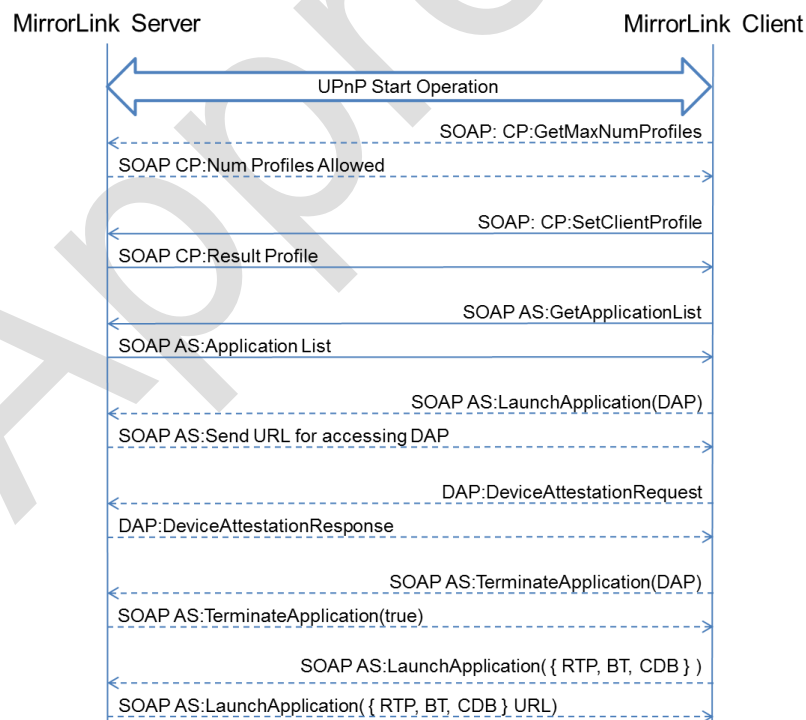


Figure 5: MirrorLink Session Setup Sequence Diagram

The MirrorLink Client SHOULD use the `UnusedProfileIDs` evented variable, within the UPnP Client Profile service, to retrieve the Client Profile Identifiers, which are available for the MirrorLink Client.

5.2.1 Physical Interface Selection

Depending on the MirrorLink Server and Device capabilities, and currently established physical connections, multiple remote user interface mechanisms are available to stream the MirrorLink Server's screen to the MirrorLink Client. The following Table 2 shows the available remote user interface combinations and the preferred mechanism(s). The table takes into account, that some interfaces Remote UI mechanisms MAY NOT be available, even if the devices would support it, e.g. user has not connected the USB cable.

Combination	Preferred Physical Interface	Preferred Remote User Interface Mechanism
None	N/A	N/A
vncu	USB	vncu
vncw	Wi-Fi	vncw
wfd	Wi-Fi	wfd
vncu, vncw	USB	vncu
vncu, hsml	USB	hsml
vncu, wfd	USB or Wi-Fi	vncu or wfd
vncw, wfd	Wi-Fi	wfd
vncu, vncw, hsml	USB	hsml
vncu, vncw, wfd	USB or Wi-Fi	vncu or wfd
vncu, hsml, wfd	USB or Wi-Fi	hsml or wfd
vncu, vncw, hsml, wfd	USB or Wi-Fi	hsml or wfd

Table 2: Allowed Remote User Interface Combinations

The MirrorLink Server and Client SHOULD use the preferred Remote User Interface mechanism, if only one preference is given in Table 2 for the respective combination. Note: `html` does not play any role in defining the preferred Remote User Interface mechanism.

The MirrorLink Client MUST select one of the two given preferences in Table 2, if two preferences are given. If two preferences are given, one is associated with the USB, the other with the Wi-Fi interface. Selection of the interface, and therefore selection of the Remote UI Mechanisms is done by sending the initial UPnP Set Client Profile message over the selected interface, binding that interface to the given client profile.

Whether or not a remote user interface mechanism is available from the MirrorLink Server MUST be derived from the MirrorLink Client based on the following indications:

- vncu:** USB connection established and USB CDC/NCM is available
- hsml:** USB connection established, USB CDC/NCM is available and MirrorLink Server has included HSML into the Server Device XML
- vncw:** Wi-Fi connection established and MirrorLink Server has included VNCW into the Server Device XML
- wfd:** Wi-Fi P2P connection established and CCC and WFD Information Element available and MirrorLink Server has included WFD into the Server Device XML

5.2.2 Setting the Client Profile

The MirrorLink Client MUST set the respective Client Profile prior to using any other MirrorLink specific UPnP actions. It MAY check the maximum number of supported client profiles from the MirrorLink Server prior to setting the initial client profile though.

The MirrorLink Client MUST include all available remote user interface mechanisms into the presentations list within the UPnP A_ARG_TYPE_ClientProfile, as specified in [10]. The list is independent of whether a particular mechanism is currently available due to the established physical connections.

The list of possible remote user interface mechanisms is the same as listed in section 5.1.

5.2.3 Executing Device Attestation Protocol

The MirrorLink Client SHOULD retrieve the Application Listing from the MirrorLink Server to identify and to launch the Server's DAP endpoint. The MirrorLink Client SHOULD execute the Device Attestation Protocol as specified in [4]. The MirrorLink Client MAY omit the DAP parts, if it never enables Drive Mode operation. The MirrorLink Client MUST immediately terminate any later established connection, if the attested component's URL is not identical to the established connection. The MirrorLink Client SHOULD terminate the DAP endpoint on the MirrorLink Server after completion of the DAP sequence.

5.2.4 Establishing other Connections

The MirrorLink Client SHOULD establish all necessary Audio (like RTP or Bluetooth) connections as well as the Common Data Bus connection, after the successful completion of the DAP sequence.

5.3 MirrorLink Operation

5.3.1 Updating the Client Profile

Subsequent setting of the UPnP Client Profile by the MirrorLink Client MUST overwrite any previous client profile setting for the same profile identifier, if the ClientID value in the Client Profile is identical to the original one.

Subsequent setting of the UPnP Client Profile by the MirrorLink Client MUST be denied, using Error Code 701 – Operation Rejected, if the ClientID value in the Client Profile is not identical to the original one.

5.3.2 Changing the Physical Interface

In case the client profile is updated using another physical interface (e.g. Wi-Fi rather than USB), the MirrorLink Client MUST immediately terminate any previously established connection, after receiving a successful response to the Set Client Profile action.

A change of the physical interface MUST be denied, using "Error Code 701 – Operation Rejected", if the ClientID value in the Client Profile is not identical to the original one.

A change of the physical interface MUST be denied as well, using the same Error Code, if the interface is not consistent with the provided Client Profile (e.g. the MirrorLink Client uses the Wi-Fi interface, but only vncu is listed in the available remote user interface mechanisms).

5.3.3 Changing the Remote UI Mechanism

In case Remote UI Mechanisms become available or disappear during a MirrorLink session, after the initial interface has been selected, the MirrorLink Client SHOULD follow the state transition diagram shown in Figure 6.

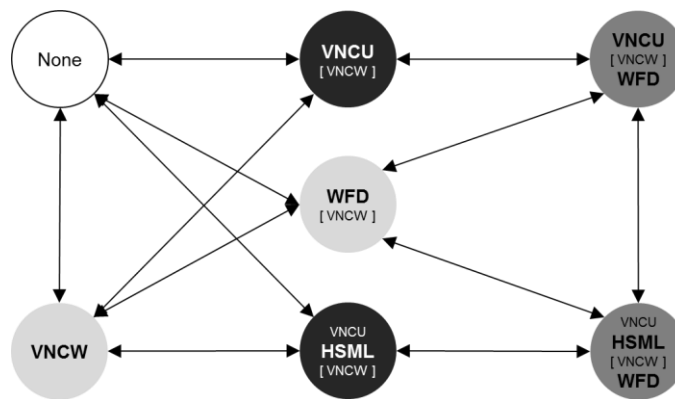


Figure 6: Remote User Interface Transition Diagram

The remote UI mechanism, highlighted with a bold and bigger font, is the preferred one, according to Table 2. The states with **wireless** preferred Remote User Interface mechanism are shown in light grey color, whereas **wired** ones are shown in black color. States using medium grey indicate two preferences. In that case a preference is given for each physical interface. States containing a "[VNCW]" entry do not change whether or not a VNC over Wi-Fi based remote UI mechanism is available.

In case the MirrorLink Client wants or needs to switch the physical interface, it **MUST** use the mechanism described in section 5.3.2.

5.3.4 Disappearing Physical Interfaces

In case any of the physical connection suddenly disappear, e.g. as the user disconnects a wired connection, switches off a wireless radio, the following Figure 7 shows the resulting allowed transitions.

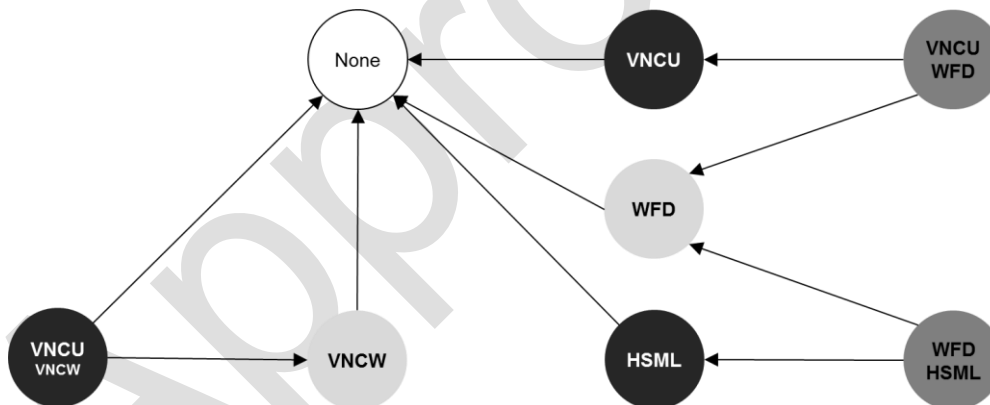


Figure 7: Disappearing Physical Connection Transition Diagram

The MirrorLink Client **MUST** switch to the remaining physical interface using the mechanism described in section 5.3.2.

Whenever a physical interface disappears, the interface **MUST NOT** be locked to a specific client, when it becomes available again.

5.3.5 Support for Web Applications

The MirrorLink Server **MUST** include HTTP applications into its application listings, if both the MirrorLink Server and Client include `http` as a remote user interface mechanism.

5.3.6 Legacy MirrorLink Mode

In case either the MirrorLink Client or the MirrorLink Server devices are MirrorLink 1.1 or MirrorLink 1.0 devices, HSML or WFD are not available for MirrorLink use.

In that case, the Remote User Interface Transition diagram simplifies to the diagram shown in Figure 8.

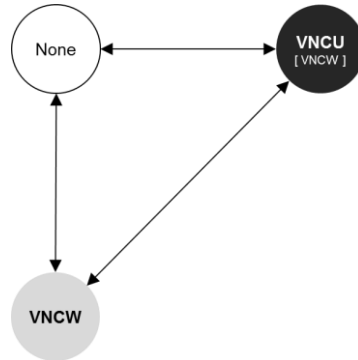


Figure 8: Remote User Interface Transition Diagram (Legacy Mode)

In case any of the physical connection suddenly disappears in legacy mode, Figure 9 shows the resulting allowed transitions.

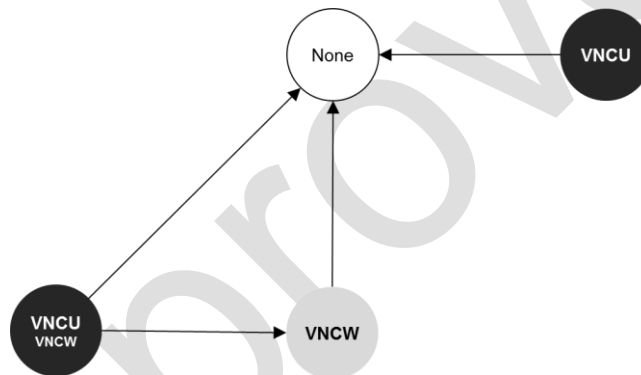


Figure 9: Disappearing Physical Connection Transition Diagram (Legacy Mode)

5.4 MirrorLink Session Termination

The MirrorLink Server MUST terminate an ongoing MirrorLink session, if the MirrorLink Client set the UPnP Client Profile to an empty String, i.e. `ClientProfile` equals `""`.

Attempts to terminate the MirrorLink session MUST be rejected from the MirrorLink Server, using "Error Code 701 – Operation Rejected", if the MirrorLink Server cannot identify the MirrorLink Client, e.g. via its IP address, as being the one, which initially setup and/or subsequently defined the MirrorLink session.

6 REFERENCES

- [1] Car Connectivity Consortium, "MirrorLink – Connectivity", Version 1.1, CCC-TS-008.
- [2] Car Connectivity Consortium, "MirrorLink – VNC based Display and Control", Version 1.1, CCC-TS-010.
- [3] Car Connectivity Consortium, "MirrorLink – Audio", Version 1.1, CCC-TS-012.
- [4] Car Connectivity Consortium, "MirrorLink – Device Attestation Protocol ", Version 1.2, CCC-TS-059.
- [5] Car Connectivity Consortium, "MirrorLink – Common Data Bus", Version 1.1, CCC-TS-016.
- [6] Car Connectivity Consortium, "MirrorLink – Service Binary Protocol", Version 1.1, CCC-TS-018.
- [7] Car Connectivity Consortium, "MirrorLink – GPS Data Service", Version 1.1, CCC-TS-020.
- [8] Car Connectivity Consortium, "MirrorLink – Location Data Service", Version 1.1, CCC-TS-022.
- [9] Car Connectivity Consortium, "MirrorLink – UPnP Application Server Service", Version 1.2, CCC-TS-060.
- [10] Car Connectivity Consortium, "MirrorLink – UPnP Client Profile Service ", Version 1.2, CCC-TS-061.
- [11] Car Connectivity Consortium, "MirrorLink – UPnP Notification Server Service", Version 1.1, CCC-TS-028.
- [12] Car Connectivity Consortium, "MirrorLink – UPnP Server Device", Version 1.2. CCC-TS-062.
- [13] Car Connectivity Consortium, "MirrorLink – Web Applications", Version 1.2, CCC-TS-048
- [14] Car Connectivity Consortium, "MirrorLink – MirrorLink over Wi-Fi Display", Version 1.2, CCC-TS-049
- [15] Car Connectivity Consortium, "MirrorLink – IEEE 802.11 CCC Information Element", Version 1.2, CCC-TS-050
- [16] Car Connectivity Consortium, "MirrorLink – Network Information Data Service", Version 1.2, CCC-TS-051
- [17] Car Connectivity Consortium, "MirrorLink – Internet Accessibility", Version 1.2, CCC-TS-053
- [18] Car Connectivity Consortium, "MirrorLink – High Speed Media Link (HSML)", Version 1.2, CCC-TS-054
- [19] IETF, RFC 2119, Keys words for use in RFCs to Indicate Requirement Levels, March 1997.
<http://www.ietf.org/rfc/rfc2119.txt>
- [20] UPnP Forum, "UPnP Device Architecture 1.0", 24 April 2008, <http://www.upnp.org>