



**Publicly Available Specification (PAS);  
Intelligent Transport Systems (ITS);  
MirrorLink<sup>®</sup>;  
Part 13: Core Architecture**

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 Reference
 

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## Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Intelligent Transport Systems (ITS).

The present document is part 13 of a multi-part deliverable. Full details of the entire series can be found in part 1 [1].

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## Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

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# 1 Scope

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

The present document defines the core MirrorLink architecture, linking the different MirrorLink related protocols together, and providing MirrorLink session management related information.

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## 2 References

### 2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at <https://docbox.etsi.org/Reference>.

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The following referenced documents are necessary for the application of the present document.

- [1] ETSI TS 103 544-1 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 1: Connectivity".
- [2] ETSI TS 103 544-2 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 2: Virtual Network Computing (VNC) based Display and Control".
- [3] ETSI TS 103 544-3 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 3: Audio".
- [4] ETSI TS 103 544-4 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 4: Device Attestation Protocol (DAP)".
- [5] ETSI TS 103 544-5 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 5: Common Data Bus (CDB)".
- [6] ETSI TS 103 544-6 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 6: Service Binary Protocol (SBP)".
- [7] ETSI TS 103 544-7 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 7: GPS Data Service".
- [8] ETSI TS 103 544-8 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 8: Location Data Service".
- [9] ETSI TS 103 544-9 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 9: UPnP Application Server Service".
- [10] ETSI TS 103 544-10 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 10: UPnP Client Profile Service".
- [11] ETSI TS 103 544-11 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 11: UPnP Notification Server Service".

- [12] ETSI TS 103 544-12 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 12: UPnP Server Device".
- [13] ETSI TS 103 544-14 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 14: Application Certificates".
- [14] ETSI TS 103 544-15 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink® ; Part 15: Application Programming Interface (API) Level 1 & 2".
- [15] ETSI TS 103 544-16 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 16: Application Developer Certificates".
- [16] ETSI TS 103 544-17 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink® ; Part 17: MirrorLink® over Wi-Fi Display (WFD)".
- [17] ETSI TS 103 544-18 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink® ; Part 18: IEEE 802.11™ Car Connectivity Consortium (CCC) Information Element".
- [18] ETSI TS 103 544-19 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 19: Network Information Data Service".
- [19] ETSI TS 103 544-20 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 20: Internet Accessibility".
- [20] ETSI TS 103 544-21 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink® ; Part 21: High Speed Media Link (HSML)".
- [21] ETSI TS 103 544-22 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 22: Android Specific Specifications enabling AIDL-based MirrorLink® Applications".
- [22] ETSI TS 103 544-23 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 23: Bluetooth® out-of-Band Pairing Data Service".
- [23] ETSI TS 103 544-24 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 24: Media Meta Data Service".
- [24] ETSI TS 103 544-25 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 25: Navigation Meta Data Service".
- [25] ETSI TS 103 544-26 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 26: Consumer Experience Principles and Basic Features".
- [26] ETSI TS 103 544-27 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 27: Basic Meta Data Service".
- [27] ETSI TS 103 544-28 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 28: Weather Data Service".
- [28] ETSI TS 103 544-29 (V1.3.0): "Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 29: Schedule Data Service".
- [29] UPnP™ Forum, "UPnP™ Device Architecture 1.1", 15 October 2008.

NOTE: Available at <http://www.upnp.org>.

## 2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long-term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

Not applicable.

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## 3 Definitions and abbreviations

### 3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

**pointer event:** touch screen action in which the user touches the screen with one (virtual) finger only at a single location

**touch event:** touch screen action in which the user touches the screen with two or more separate fingers at different locations

NOTE: Touch events are used to describe more complex touch action, like pinch-open or pinch-close.

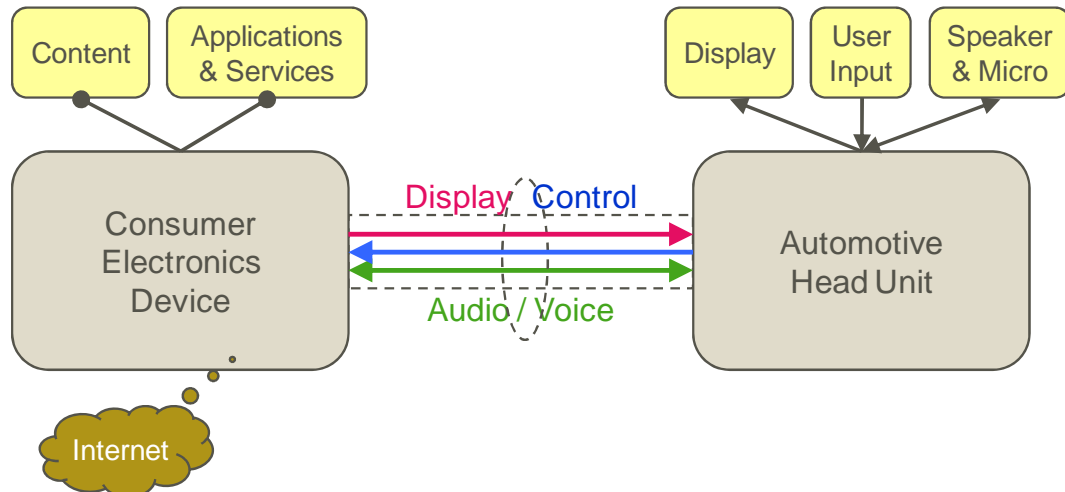
### 3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

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 the present document
DAP	Device Attestation Protocol
DHCP	Dynamic Host Configuration Protocol
ECM	Ethernet Control Model; part of the CDC device class
HFP	Bluetooth Hands-free Profile
HMI	Human Machine Interface
HS	Head-Set
HSML	High-Speed Media Link
HSP	Bluetooth Headset Profile
HU	Head-Unit (this term is used interchangeably with the MirrorLink client)
IP	Internet Protocol
NCM	Network Control Model; part of the CDC device class
RFB	Remote Framebuffer
RLE	(Scan-line based) Run Length Encoding
RTP	Real-time Transport Protocol
SBP	Service Binary Protocol
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
UI	User Interface
UPnP	Universal Plug and Play
USB	Universal Serial Bus
VNC	Virtual Network Computing

## 4 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 Figure 1.



**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.

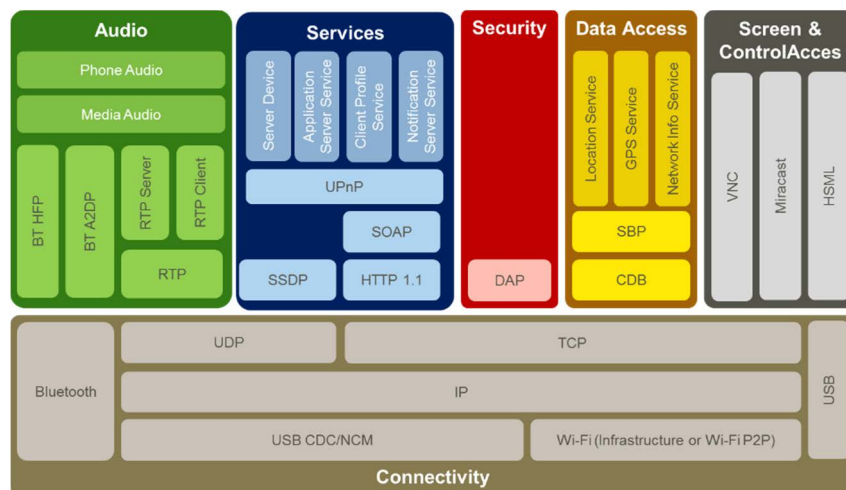
The car systems comprise of several different methods for user interaction, like individual keys, rotating knobs, touch screen and even voice-activated control. For proper interoperability, the control method towards the mobile device should be the same regardless of the actual input mechanism on the car side.

The basic MirrorLink consumer experience principles and features are specified in [27].

## 5 MirrorLink Architecture

The MirrorLink high-level architecture is shown in Figure 2.





**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.
- 7) MirrorLink API:
  - a) Introduced application certificates, as specified in [13].
  - b) Introduced application developer certificates, as specified in [15].
  - c) Introduced MirrorLink API Level 1, as specified in [14].

MirrorLink 1.2 Architecture is adding the following additional features:

- 1) Connectivity:
  - a) CCC specific IEEE 802.11 Information Element (OUI) as specified in [17].
  - b) Internet Accessibility supporting Group Ownership negotiation in Wi-Fi P2P networks, as specified in [19].
- 2) UPnP based Services:
  - a) No additional services; some smaller additions to some of the services, as highlighted in [9], [10] and [12].
- 3) Access to Screen and Control, providing:
  - a) Replication of MirrorLink Server's display contents to the MirrorLink Client using HSML as specified in [20].
  - b) Replication of MirrorLink Server's display contents to the MirrorLink Client using Wi-Fi Display, as specified in [16].
- 4) Audio:
  - a) No additions.
- 5) Data Services:
  - a) Network Management Data Service, providing dynamic information on network status, as specified in [18].
- 6) Security mechanisms:
  - a) Added WFD and HSML elements as highlighted in [4].
- 7) Mirrorlink API:
  - a) No additions.

MirrorLink 1.3 Architecture is adding the following additional features:

- 1) Connectivity:
  - a) No additions.
- 2) UPnP based Services:
  - a) Deprecation of element in UPnP A\_ARG\_TYPE\_AppList, as specified in [9].
  - b) Deprecation of elements in UPnP A\_ARG\_TYPE\_ClientProfile as specified in [10].
- 3) Access to Screen and Control:
  - a) Deprecation of VNC protocol features, as specified in [2].
  - b) Addition of VA H.264 encoding, as specified in [2].

- 4) Audio:
  - a) Added RTP payload 100, as specified in [3].
- 5) Data Services:
  - a) Bluetooth out-of-Band Pairing Data Service, as specified in [22].
  - b) Media Meta Data Service, as specified in [23].
  - c) Navigation Meta Data Service, as specified in [24].
  - d) Basic Meta Data Service, as specified in [26].
  - e) Weather Data Service, as specified in [27].
  - f) Schedule Data Service, as specified in [28].
- 6) Security mechanisms:
  - a) No additions.
- 7) MirrorLink API:
  - a) Introduced MirrorLink API Level 2, as specified in [14].

MirrorLink is platform agnostic; but Android specific requirements are captured in [22].

## 6 MirrorLink Features

Table 1 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.

**Table 1: MirrorLink Feature Requirements**

Feature			Version	MirrorLink Server	MirrorLink Client
Connectivity	USB	USB Host	1.0	N/A	Shall
		USB Device	1.0	Shall	N/A
		CDC/NCM Device Class	1.0	Shall	Shall
		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
UPnP based Services	UPnP Server Services Provided	Server Device	1.0	Shall	N/A
		Application Server Service	1.0	Shall	N/A
		Client Profile Service	1.0	Shall	N/A
		Notification Server Service	1.1	Should	N/A
		1.3	Shall		
MirrorLink implements		Server Device	1.0	N/A	Shall

Feature			Version	MirrorLink Server	MirrorLink Client
2-Box pull model	UPnP Control Point	Application Server Service	1.0	N/A	Shall
		Client Profile Service	1.0	N/A	Should
	Services Supported	Notification Server Service	1.2		Shall
			1.1	Should	
			1.3	Shall	
Screen & Control	VNC	VNC over USB	1.0	Shall	Shall
		VNC over Wi-Fi	1.0	May	May
	HSML		1.2	Should	Should
	Wi-Fi Display		1.2	Should	Should
Audio	RTP	RTP Server	1.0	Shall	Should
			1.3	Shall	Conditional <sup>(6)</sup>
		RTP Client	1.0	Should	Shall
			1.3	Shall	Shall
	BT	BT HFP	1.0	Should	Should
			1.3	Conditional <sup>(7)</sup>	Conditional <sup>(6)</sup>
BT A2DP	1.0	May	May		
Access to Data	CDB/SBP	Sink Endpoint	1.1	Should	N/A
			1.3	Shall	Should
		Source Endpoint	1.1	N/A	Should
			1.3	Shall	Shall <sup>(1)</sup>
	GPS Data Service		1.1	Should <sup>(4)</sup>	Should <sup>(3)</sup>
	Location Data Service		1.1	Should <sup>(4) (5)</sup>	Should <sup>(3) (5)</sup>
			1.3	Shall <sup>(4) (5)</sup>	Shall <sup>(2) (3) (5)</sup>
	Network Management Data Service		1.2	May <sup>(3)</sup>	May <sup>(4)</sup>
	Media Meta Data Service		1.3	Shall <sup>(3) (5)</sup>	Should <sup>(4) (5)</sup>
	Navigation Meta Data Service		1.3	Shall <sup>(3) (5)</sup>	Should <sup>(4) (5)</sup>
	Weather Data Service		1.3	Shall <sup>(3)</sup>	Should <sup>(4)</sup>
	Schedule Data Service		1.3	Shall <sup>(3)</sup>	Should <sup>(4)</sup>
Bluetooth out-of-band Pairing Data Service		1.3	Should <sup>(4)</sup>	Should <sup>(3)</sup>	
Security	DAP	Server Endpoint	1.0	Should	N/A
			1.1	Shall	
		Client Endpoint	1.0	N/A	Should
			1.3		Shall
<p>(1) Shall be implemented, unless the MirrorLink Client does not implement any source data service.  (2) Shall be implemented, unless the MirrorLink Client does not have access to GPS information.  (3) Data Service Source.  (4) Data Service Sink.  (5) Reverse operation of the data service may be supported as well.  (6) Shall be implemented, if MirrorLink Client has microphone support.  (7) Shall be implemented, if MirrorLink Server has phone call capabilities.</p>					

A MirrorLink device shall implement the Service Binary Protocol if any of the Data Services are implemented.

A MirrorLink device shall implement the IEEE 802.11 CCC Information Element, defined in [17], if it makes Wi-Fi Display available through MirrorLink.

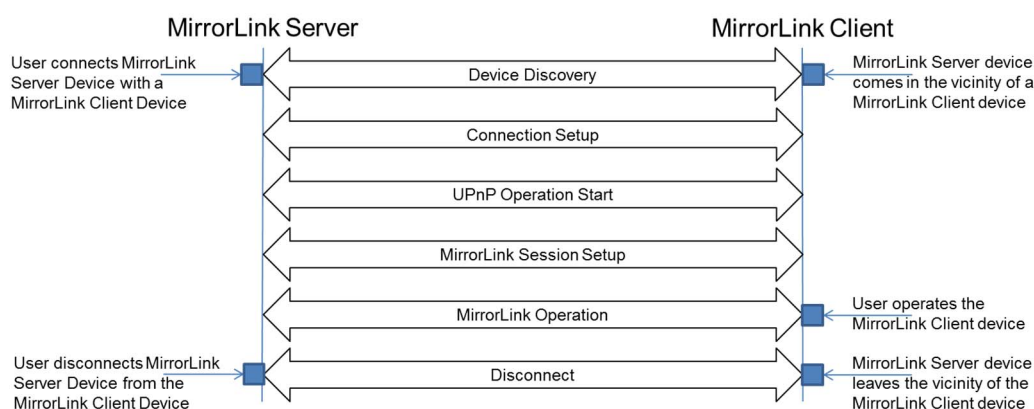
A MirrorLink Client shall implement a CDB/SBP Source endpoint and the Location Data Service source, in case it has access to a location information, e.g. via a GPS module.

The data exchanged via the CDB/SBP can be subject to user privacy and/or other regulatory requirements. It is expected that the data sink will not permanently store such data, unless this is part of the service's functionality and/or respective consent has been provided. The fulfilment of these requirements is outside the scope of the MirrorLink specifications.

## 7 MirrorLink Session

### 7.1 General

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**

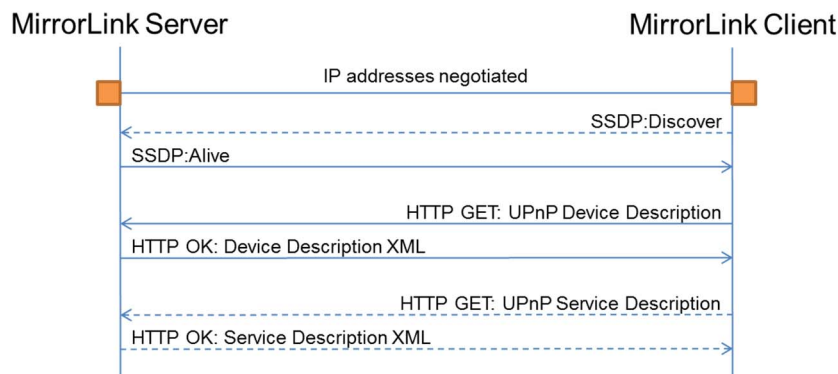
During the Device Discovery phase, devices detect each other as MirrorLink enabled devices, using the mechanisms described in [1] or [17]. In the connection setup phase the physical connection is established, including negotiation of the group ownership in Wi-Fi P2P networks, setting up the USB CDC/NCM connection and the IP address setup. The IP interface shall 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.

### 7.2 UPnP Operation Start

The sequence diagram of the UPnP operation start is given in the following Figure 4. The sequence shall follow UPnP device architecture specification as given in [29].



**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 shall be visible over each interface, using *SSDP:Alive* broadcast messages.

The MirrorLink Client should use *SSDP:discover* to avoid waiting for the MirrorLink Server's *SSDP:alive* messages for a long time. For MirrorLink over WFD [16] MirrorLink Clients and Servers shall either use *SSDP:discover* or the CCC's Information Element, as specified in [17].

Immediately after locating the MirrorLink Server's device description, the MirrorLink Client shall 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 shall 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. The remote user interface mechanism requires additional link-layer protocols:

- `vncu`    USB    CDC/NCM                    VNC over USB
- `vncw`    Wi-Fi    AP Mode or P2P                VNC over Wi-Fi
- `wfd`     Wi-Fi    P2P                                Wi-Fi Display
- `hsm1`    USB    CDC/NCM and Proprietary    High-Speed Media Link

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

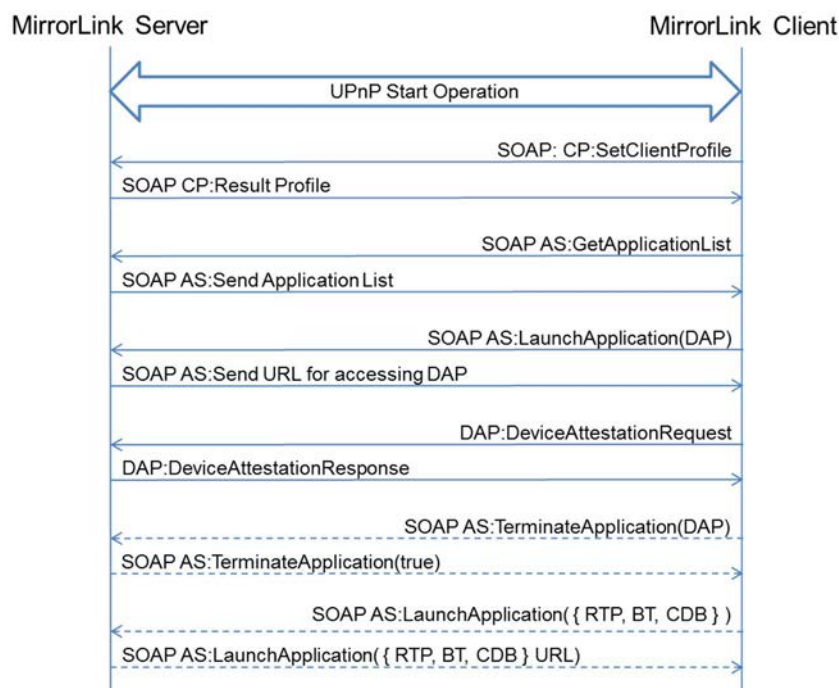
#### **Performance Requirements:**

The MirrorLink Server shall have the Device XML accessible not later than 10s after IP address assignment, at the same location provided via the CCC Information Element and via the response to a *SSDP:discover* message.

## 7.3 MirrorLink Session Setup

### 7.3.1 General

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



**Figure 5: MirrorLink Session Setup Sequence Diagram**

The MirrorLink Client shall setup the MirrorLink session, when a MirrorLink Server device is advertising MirrorLink support using *SSDP:alive* messages, unless the consumer has set a different MirrorLink Client preference. A MirrorLink Client intending to use MirrorLink over USB, shall request the start of MirrorLink operation from the MirrorLink Server using the MirrorLink USB command, as defined in [1].

### 7.3.2 Physical Interface Selection

The MirrorLink Client shall list all available alternative remote user interface mechanisms into the *presentations* list of *A\_ARG\_TYPE\_ClientProfile* as defined in [10]. The list is independent of whether a particular mechanism is currently available due to the established physical connections. The MirrorLink Client shall send the *SetClientProfile* action including the *A\_ARG\_TYPE\_ClientProfile* at the start of the MirrorLink session, prior using any other UPnP service's action.

Depending on the MirrorLink Server and Client capabilities, and currently established physical connections, multiple remote user interface mechanisms are available to stream the MirrorLink Server's screen to the MirrorLink Client. Table 2 shows the possible physical and logical interfaces of the remote user interfaces and the used remote protocol. It is possible for the MirrorLink Client to choose between two physical and/or logical interfaces.

**Table 2: Allowed Remote User Interfaces**

Remote User Interface Mechanisms	Physical Interface	Logical Interface	Remote Protocol
vncu	USB	CDC/NCM	VNC over USB (framebuffer encoding agreed within VNC)
vncw	Wi-Fi	AP Mode or P2P	VNC over Wi-Fi
wfd	Wi-Fi	P2P	Wi-Fi Display
hsm1	USB	CDC/NCM & Proprietary	VNC with HSML over USB

The MirrorLink Server and Client shall use the preferred Remote User Interface mechanism, if only one preference is given in Table 2 for the respective combination.

Selection of the interface, and therefore selection of the Remote UI Mechanisms is done by sending the initial UPnP *SetClientProfile* message over the selected physical interface:

- The MirrorLink Server shall use the physical interface, over which the *SetClientProfile* action is received.
- For a Wi-Fi physical interface, the MirrorLink Server and Client shall:
  - Use Wi-Fi Display, if *wfd* is supported from both devices and a Wi-Fi P2P connection has been established.
  - Otherwise, use VNC over Wi-Fi, if *vncw* is supported from both devices.
  - Otherwise, no connection is possible and devices will need to fall back to a USB connection.
- For a USB physical interface, the MirrorLink Server and Client shall:
  - Use VNC over USB.
  - Select the framebuffer encoding, e.g. RAW, RLE, HSML or VA H.264 within the VNC protocol, as specified in [2]. The MirrorLink Server and Client shall enable the use HSML or VA H.264 if supported from both devices.

In case a MirrorLink 1.3 Server and Client is connected to a MirrorLink 1.1 or 1.0 device, which do not recognize or set the *presentation* element, the following rules shall apply to determine the remote user interface mechanism:

- Use the physical interface, over which the *SetClientProfile* action is received.
- For a Wi-Fi physical interface, the MirrorLink Server and Client shall:
  - Use VNC over Wi-Fi.
  - Otherwise, no connection is possible and devices will need to fall back to a USB connection.
- For a USB physical interface, the MirrorLink Server and Client shall:
  - Use VNC over USB.

The MirrorLink Server shall set the *protocolID* within *A\_ARG\_Type\_AppList* (as specified in [9]) dependent on the selected remote user interface mechanism:

- "VNC" , if *vncu*, *vncw* or *hsml* is the preferred remote user interface mechanism.
- "WFD" , if *wfd* is the preferred remote user interface mechanism.
- No remote user interface mechanism is available if no shared mechanism is available. No "VNC" or "WFD" application shall be listed then.

Whether a remote user interface mechanism is available from the MirrorLink Server shall 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.



### 7.3.3 Setting the Client Profile

The MirrorLink Client shall set the respective Client Profile prior to using any other MirrorLink specific UPnP actions.

The MirrorLink Client shall 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 clause 7.2.

Setting the Client Profile defines the start of the MirrorLink session.

### 7.3.4 Executing Device Attestation Protocol

The MirrorLink Client shall retrieve the Application Listing from the MirrorLink Server to identify and to launch the Server's DAP endpoint. The MirrorLink Client shall execute the Device Attestation Protocol as specified in [4]. The MirrorLink Client shall 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.

The MirrorLink Client may defer the execution of the Device Attestation Protocol to fulfill performance requirements with respect to MirrorLink session establishment, the providing initial access to application. But DAP shall be executed as soon as those requirements have been met.

### 7.3.5 Establishing other Connections

The MirrorLink Client shall establish all necessary Audio (like RTP or Bluetooth) connections as well as the Common Data Bus connection, at the start of the MirrorLink session.

The MirrorLink Server shall turn on Bluetooth and Bluetooth pairing shall be executed. The MirrorLink Server shall use the Bluetooth MAC address of the MirrorLink Client, as provided in the UPnP Client Profile. The MirrorLink Server shall display the necessary UI for Bluetooth pairing on the MirrorLink Server screen or shall use Bluetooth out-of-band pairing. User interaction for this is allowed.

## 7.4 MirrorLink Operation

### 7.4.1 Updating the Client Profile

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

### 7.4.2 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 shall immediately terminate any previously established connection, after receiving a successful response to the Set Client Profile action.

NOTE: Updates to the physical transport may result in a different `protocolID` within `A_ARG_Type_AppList` dependent on the new physical transport and the derived available preferred remote user interface.

A change of the physical interface shall 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 shall 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).

### 7.4.3 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.

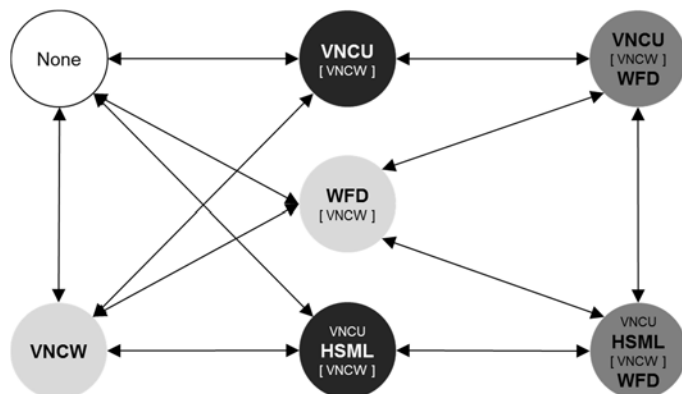


Figure 6: Remote User Interface Transition Diagram

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.

An update to the preferred remote user interface may result in a different *protocolID* within *A\_ARG\_Type\_AppList*. In that case, the MirrorLink Server shall send an UPnP *AppListUpdate* event.

In case the MirrorLink Client wants or needs to switch the physical interface, it shall use the mechanism described in clause 7.4.2.

### 7.4.4 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, Figure 7 shows the resulting allowed transitions.

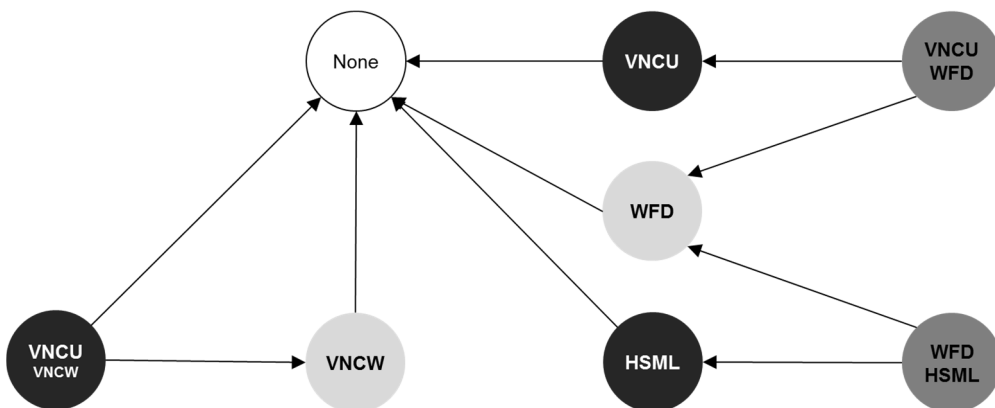


Figure 7: Disappearing Physical Connection Transition Diagram

An update to the preferred remote user interface may result in a different *protocolID* within *A\_ARG\_Type\_AppList*. In that case, the MirrorLink Server shall send an UPnP *AppListUpdate* event.

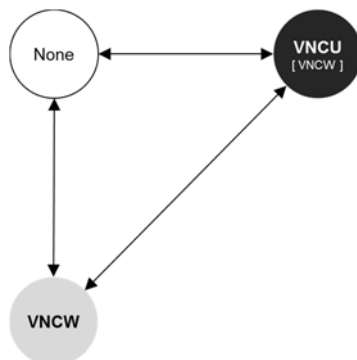
The MirrorLink Client shall switch to the remaining physical interface using the mechanism described in clause 7.4.2.

Whenever a physical interface disappears, the interface shall not be locked to a specific client, when it becomes available again.

### 7.4.5 Legacy MirrorLink Mode

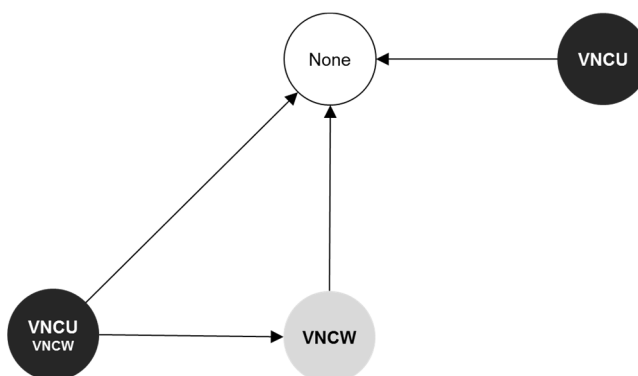
In case either the MirrorLink Client or the MirrorLink Server devices are MirrorLink 1.1 or MirrorLink 1.0 devices, HSML or WFD are not available for MirrorLink use.

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)**

## 7.5 MirrorLink Session Termination

The MirrorLink Server shall 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 shall 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.

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## Annex A (informative): Authors and Contributors

The following people have contributed to the present document:

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## History

<b>Document history</b>		
V1.3.0	October 2017	Publication