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# Publicly Available Specification (PAS); Intelligent Transport Systems (ITS); MirrorLink®; Part 1: Connectivity

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# Contents

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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 1 of a multi-part deliverable for the Mirrorlink® Specifications:

**Part 1: "Connectivity";**

Part 2: "Virtual Network Computing (VNC) based Display and Control";

Part 3: "Audio";

Part 4: "Device Attestation Protocol (DAP)";

Part 5: "Common Data Bus (CDB)";

Part 6: "Service Binary Protocol (SBP)";

Part 7: "GPS Data Service";

Part 8: "Location Data Service";

Part 9: "UPnP Application Server Service";

Part 10: "UPnP Client Profile Service";

Part 11: "UPnP Notification Server Service";

Part 12: "UPnP Server Device";

Part 13: "Core Architecture";

Part 14: "Application Certificates";

Part 15: "Application Programming Interface (API) Level 1 & 2";

Part 16: "Application Developer Certificates";

Part 17: "MirrorLink over Wi-Fi Display (WFD)";

Part 18: "IEEE 802.11™ Car Connectivity Consortium (CCC) Information Element";

Part 19: "Network Information Data Service";

Part 20: "Internet Accessibility";

Part 21: "High Speed Media Link (HSML)";

Part 22: "Android-Specific Specifications";

Part 23: "Bluetooth® Out-of-Band Pairing Data Service";

Part 24: "Media Meta Data Service";

Part 25: "Navigation Meta Data Service";

Part 26: "Consumer Experience Principles and Basic Features";

Part 27: "Basic Meta Data Service";

Part 28: "Weather Data Service";

Part 29: "Schedule Data Service".

# 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 colour display, audio input/output and user input mechanisms.

The connectivity between the MirrorLink Server and Client is the basis to provide interoperability between both. The Connectivity stack is specified in the following, starting from the low layer and going up the protocol stack.

It is not the objective of the present document to provide a detailed overview of the different protocols. Instead the present document highlights the components and parameters required to ensure proper connectivity. The connectivity solution is built purely on existing wireless and wired standards. Therefore, detailed information is available in the respective documents.

# 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.

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 necessary for the application of the present document.

[1] USB 2.0: "Universal Serial Bus Specification", Revision 2.0, April 27, 2000.

[2] USB-IF: "Universal Serial Bus Communications Class Subclass Specifications for Network Control Model Devices", Revision 1.0 April 30, 2009. http://www.usb.org/developers/docs/devclass_docs/.

[3] Wi-Fi Alliance Technical Committee, P2P Task Group: "Wi-Fi Peer-to-Peer (P2P) Technical Specification", Revision 1.1, October 4, 2010.

[4] IETF RFC 791: "Internet Protocol - DARPA Internet Program Protocol Specification", September 1981, https://tools.ietf.org/html/rfc791.

[5] IETF RFC 2131: "Dynamic Host Configuration Protocol", May 1997, https://tools.ietf.org/html/rfc2131 .

[6] IETF RFC 826: "An Ethernet Address Resolution Protocol -- or -- Converting Network Protocol Addresses to 48.bit Ethernet Address for Transmission on Ethernet Hardware", November 1982. https://tools.ietf.org/html/rfc826 .

[7] IETF RFC 5227: "IPv4 Address Conflict Detection", July 2008, https://tools.ietf.org/html/rfc5227.

## 2.2 Informative references

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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.

# 3 Definitions and abbreviations

## 3.1 Definitions

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

**pointer event:** used to describe 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:

| | |
|---|---|
| AP | Access Point |
| ARP | Address Resolution Protocol |
| CDC | Communications Device Class |

NOTE: Specified from USB Device Working Group.

| | |
|---|---|
| CE | Consumer Electronics |

NOTE: CE devices are referred to as mobile devices within the present document.

| | |
|---|---|
| DHCP | Dynamic Host Configuration Protocol |
| HMI | Human Machine Interface |
| HU | Head-unit |

NOTE: This term is used interchangeably with the MirrorLink Client.

| | |
|---|---|
| HS | Head-Set |
| IP | Internet Protocol |
| NCM | Network Control Model |

NOTE: Part of the CDC device class.

| | |
|---|---|
| RFB | Remote Framebuffer |
| RTP | Real-time Transport 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 Physical & Link Layer

## 4.1 General

In principle, the present document does not intend to limit the use of any wireless and wired technology. Nevertheless, the connectivity solution should provide reasonable high bandwidth. Minimum bandwidth on link layer cannot be given, as the user experience depends on the networking & transport layer performance, as well as on the parameters of the display (resolution and colour format).

Table 1 gives some indication of the required bandwidth on the display level, i.e. on top of any transport mechanism. These values assume non-incremental, uncompressed updates.

**Table 1: Example Bandwidth Requirements vs. Display Update Rate**

| Full Display Update / s | WVGA 800 x 480 x 2 | WVGA 800 x 480 x 4 | WSVGA 1024 x 600 x 2 | WSVGA 1024 x 600 x 4 |
|---|---|---|---|---|
| 10 | 7 680 000 Byte/s | 15 360 000 Byte/s | 12 288 000 Byte/s | 24 576 000 Byte/s |
| 20 | 15 360 000 Byte/s | 30 720 000 Byte/s | 24 576 000 Byte/s | 49 152 000 Byte/s |

Wired technologies have advantages with regards to achievable bandwidth and security over wireless technologies. In addition, wired USB provides charging capabilities and is the preferred charging interface in the mobile industry.

## 4.2 Universal Serial Bus (USB)

### 4.2.1 General Requirements

USB provides a high-bandwidth connection while allowing charging of the mobile device at the same time. The MirrorLink Client shall provide a USB host. The MirrorLink Server shall provide USB device functionality.

The USB host and device shall at least support USB 2.0 high-speed.

### 4.2.2 MirrorLink USB Command

To simplify the user intervention on the MirrorLink Server, it can set the right USB personality automatically, once connected to the MirrorLink Client.

NOTE: A USB personality can include multiple USB device classes, which can be then used from the USB host simultaneously.

To inform the MirrorLink Server about the Client's MirrorLink support, the USB host sends a specific identification message to the USB device, prior to configuring the device.

This MirrorLink USB Command shall be according the following format.

```
bmRequestType = 0x40
bRequest      = 0xF0
wValue[1]     = MirrorLink major version
wValue[2]     = MirrorLink minor version
wIndex        = USB Host vendorID
wLength       = 0
Data          = None
```

USB uses little endian. Therefore, the MirrorLink minor version is in the high byte and the MirrorLink major version in the low byte of *wValue*.

```
MirrorLink 1.0: wValue = 0x0001 (0x01, 0x00)
MirrorLink 1.1: wValue = 0x0101 (0x01, 0x01)
MirrorLink 1.2: wValue = 0x0201 (0x01, 0x02)
MirrorLink 1.3: wValue = 0x0301 (0x01, 0x03)
```

A MirrorLink Server should apply a received MirrorLink version 0.1 as a 1.0 version (for backward compatibility reasons).

The MirrorLink Client, implementing the USB host, shall send the MirrorLink USB command every time, the user intends to start MirrorLink, independent of whether CDC/NCM is enumerated, unless the MirrorLink Server is already advertising itself via *SSDP:alive* messages.

The MirrorLink Server, implementing the USB device, shall enable CDC/NCM and start advertising itself via *SSDP:alive* messages, when receiving the MirrorLink USB command, unless

a) the consumer has set a different preference; or

b) the MirrorLink Server manufacturer has set a different default preference.

In latter case, the consumer shall be able to change that preference. The USB device shall allow for manual or semi-manual selection of the USB CDC/NCM profile and start of the *SSDP:alive* advertisements.

The MirrorLink specification does not specify, whether USB CDC/NCM is provided as an individual device class or within a USB personality. In latter case, it is up to the USB device implementation, which other USB device classes may be available under the same personality, where USB CDC/NCM is provided. The USB Host shall support CDC/NCM within a USB personality and as an individual device class.

### 4.2.3 Managing USB Personalities using the MirrorLink USB Command

If a MirrorLink Client wants to use MirrorLink immediately upon physical connection of the USB port, the client should send the MirrorLink USB command before the end of the USB enumeration, to ask the MirrorLink Server to provide a USB personality supporting MirrorLink (i.e. allowing a USB-CDC/NCM).

If a MirrorLink Client wants to change to MirrorLink from other USB personalities later, the MirrorLink Client should send the MirrorLink USB command at a later time. Alternatively, the MirrorLink Client may reset the USB connection.

NOTE: Resetting the USB connection does not inform the MirrorLink Server, that the MirrorLink Client supports MirrorLink.

If the MirrorLink Server is not able to switch to USB CDC/NCM functionality in response to the MirrorLink USB command, e.g. as the user has a different preference, the USB device shall respond with a STALL PID. If the MirrorLink Server responds with a STALL PID (refer to [1], clause 9.2.7), it shall provide a mechanism for the user to switch to MirrorLink.

Using the MirrorLink USB command, the MirrorLink Client can detect an operating MirrorLink Server connected to it, if all the following conditions are true:

1) The MirrorLink USB command does not return with STALL PID;

2) The USB device descriptor has USB CDC/NCM; and

3) A MirrorLink device is advertised over UPnP.

If the MirrorLink Client wants to switch from MirrorLink to another USB personality or device class, it shall reset the USB connection. It will be up to the MirrorLink Server to select a different USB personality; therefore, the MirrorLink Server may still provide MirrorLink functionality.

If the MirrorLink Server wants to switch from MirrorLink to another USB personality or device class, it shall reset the USB connection and provide a new USB personality or device class.

### 4.2.4 Interoperability Issues using the MirrorLink USB Command

USB devices, not supporting MirrorLink USB command, will return STALL PID in compliance with USB 2.0 core specification [1].

Nevertheless, the MirrorLink Client may recognize that a connected USB device is not working, after sending the MirrorLink USB command, e.g. the USB host is not able to read the USB device descriptor. This might be the case, if the connected USB device has not been certified from USB-IF. To resolve this issue, the MirrorLink Client should reset the USB connection and should not send the MirrorLink USB command again after reset.

## 4.3 Wireless Local Area Networks (WLAN)

### 4.3.1 General

Support for Wireless LAN is optional.

MirrorLink WLAN connectivity shall be implemented using Wi-Fi Alliance's Wi-Fi technology. The physical IEEE 802.11x transport layer should be selected to meet the bandwidth needs of the framebuffer transfer as described in Table 1.

### 4.3.2 Wi-Fi Access Point based Connection

Both, MirrorLink Server and MirrorLink Client can be Access Point (AP) and Client. Which entity is taking which role, depends on the configuration of the MirrorLink Client and Server. The decision making is out of scope of MirrorLink. It is strongly recommended though, that the MirrorLink Client should be the Wi-Fi access point.

Link-Layer authentication mechanisms, like WPA, shall be used, if mandated from the MirrorLink Server or from the MirrorLink Client.

If a MirrorLink Server is connected to a MirrorLink Client's Wi-Fi access point, it should reset routing tables, to maintain data connectivity via its cellular interface, as the MirrorLink Client need not offer any own connectivity to the MirrorLink Server. The MirrorLink Server should keep state, which Wi-Fi network (SSID) is supporting MirrorLink.

### 4.3.3 Wi-Fi P2P based Connection

If a MirrorLink Server and Client want Wi-Fi P2P connection, it shall proceed Wi-Fi connection setup as defined at Wi-Fi P2P specification [3].

If a MirrorLink Client is setup to connect in this mode and the MirrorLink Server is set to operate in same mode, the two devices find each other over Wi-Fi technology and negotiate the AP and client role in autonomous way by exchanging Group Owner negotiation procedure defined in the Wi-Fi P2P specification.

The AP role negotiation is performed as following, as defined in [3]:

1) The Wi-Fi interface turns on at both of MirrorLink Server and Client.
2) If the Wi-Fi mode is set to P2P mode, it proceeds to Wi-Fi Device discovery as defined in [3].
3) After Wi-Fi Device discovery, both sides may perform Wi-Fi Service discovery to find each other.
4) The MirrorLink Server and Client exchange Group Owner negotiation messages to negotiate AP role by checking GO Intent value in the message.
5) The device sends higher value of GO Intent value field takes Group Ownership and starts AP mode.

# 5 Networking and Transport Layer

## 5.1 General

Networking mechanisms are used to abstract the different physical transport mechanisms. The Internet Protocol is a well-established and known networking solution.


**Figure 1: MirrorLink Networking and Transport Stack**

The present document anticipates only USB and WLAN networking, as shown in Figure 1. Other wired or wireless links may be supported, if they carry IP packets.

## 5.2 USB Networking

USB Networking shall be always supported.

The USB networking shall follow CDC/NCM device class, as specified in [2]. According to [2], the device and host shall support 16-bit NTB structures (NTB-16) and may also support 32-bit NTB structures (NTB-32). The host and client should support a Maximum Transmission Unit (MTU) size bigger than 1 500 Bytes. It is recommended they support MTU sizes up to 9 000 Byte. The USB host shall follow the maximum Ethernet frame size supported from the USB device as discovered from the value *wMaxSegmentSize* in the Ethernet Networking Functional Descriptor (For details refer to [1]) and supported from the host.

The USB CDC/NCM specification does not define the position of the NDP element within NCM Transfer Blocks. Therefore, the MirrorLink Client's CDC/NCM driver shall not make any assumption on the position of the NDP within the NTB.

CDC/NCM endpoints may validate NTH and NDP packets and check for the presence for the header signature of the NTH (NCMH) and NDP (NCMx) Blocks and reject packets where they are not conforming. Therefore, CDC/NCM drivers shall not leave the signature blank.

**Implementation Note:**

> Different operating systems can select different names for the CDC/NCM network interface, and not only `"usbX"`, `"ncmX"` or `"wwanX"` are amongst the possibilities, depending on the NCM function configuration. Therefore, MirrorLink Client vendors should not hardcode the network interface name where to look for a MirrorLink Server. The purpose of UPnP is to enable discovery on all interfaces.

## 5.3 WLAN Networking

Support for Wireless Local Area Network (WLAN) is OPTIONAL. IP packets are carried over WLAN connections, using the Ethernet LLC/SNAP framing. On network types, other than Ethernet, LLC and SNAP headers are shall be used to multiplex different protocols on the link layer.

## 5.4 IP Configuration

### 5.4.1 IPv4 Configuration

The networking layer shall support IPv4, as specified in [4]. For IP connection IP addressing is a fundamental functionality of both side devices.

For IP addressing, MirrorLink Server and MirrorLink Client shall support Dynamic Host Configuration Protocol (DHCP) which is standardized as in [5] and the role of DHCP server and DHCP client is decided by each connectivity technology and use cases:

- The Wi-Fi AP shall have a DHCP server.
- A MirrorLink Server providing USB Device functionality shall have a DHCP server.

DHCP use UDP as transport protocol and well known port numbers are used for the communication:

- Packets sent from the client have source port 68 and destination port 67.
- Packets sent from the server have source port 67 and destination port 68.

The DHCP server on the MirrorLink Server shall provide an IP address within the `192.168.`*x*`.`*y* with *x* in the range of 2 to 127 and *y* in the range of 0 to 254. The netmask shall be `255.255.255.`*z* with *z* in the range of 0 to 254. In case the DHCP server provides an IP address for a wired network interface it shall ensure, that the provided IP address is not already assigned on the MirrorLink Server's internal network.

The DHCP server on the MirrorLink Client shall provide an IP address within the `192.168.x.y` with *x* in the range of 2 to 254 and *y* in the range of 0 to 254. The netmask shall be `255.255.255.`*z* with *z* in the range of 0 to 254.

The DHCP client should use ARP to resolve potential IP conflicts on the MirrorLink interface, as defined in [7], when connected via a wireless network interface. Otherwise it should use ARP to only send a gratuitous ARP message, as defined in [6]; this will reduce networking induced latency.

If the DHCP client has multiple interfaces via different networks (i.e. Wi-Fi Interface and USB Interface), the DHCP client should be able to detect IP conflicts between the interfaces. If the DHCP client indicates that an IP conflict occurred, sending a DHCPDECLINE message, the DHCP server shall offer a new IP address `192.168.`$x_{new}$`.`$y_{new}$, where at least $x_{new}$ is different from the previous offered address or it shall provide a manual mechanism to change the provided IP address to achieve the same IP address change.

The DHCP server may provide a default gateway address for the DHCP client. Provisioning of the default gateway address should not be interpreted as if the DHCP server provides Internet connectivity. The present document does not intend to specify the setup of IP routing functionality on the DHCP server.

### 5.4.2 IPv6 Configuration

The networking layer should not use IPv6, as the UPnP related mechanisms in MirrorLink have not been specified for IPv6 addresses.

## 5.5 Transport Layer

The IP protocol enables two transport mechanisms:

- User Datagram Protocol (UDP) to provide connectionless communication, used for service advertising, multi-casting, and most real-time streaming protocols.
- Transmission Control Protocol (TCP) to provide connection-oriented communication.

The transport layer shall support UDP and TCP transport protocols on top of IP.

# 6 Session & Application Layer

The MirrorLink application layer consists of three basic session layer components using either UDP or TCP sockets to interact as shown in figure 2:

- Audio, responsible for providing and exchanging audio content, using UDP sockets.
- VNC, responsible for exchanging display and control information, using TCP sockets.
- UPnP, responsible for service negotiation and remote application control, using UDP broadcasting and TCP sockets.
- Device attestation, responsible for confirming the compliancy of the MirrorLink Server software and hardware using the Device Attestation Protocol (DAP) over a TCP socket.
- Data Exchange, responsible for exchange data using the Common Data Bus (CDB) protocol over a TCP socket.

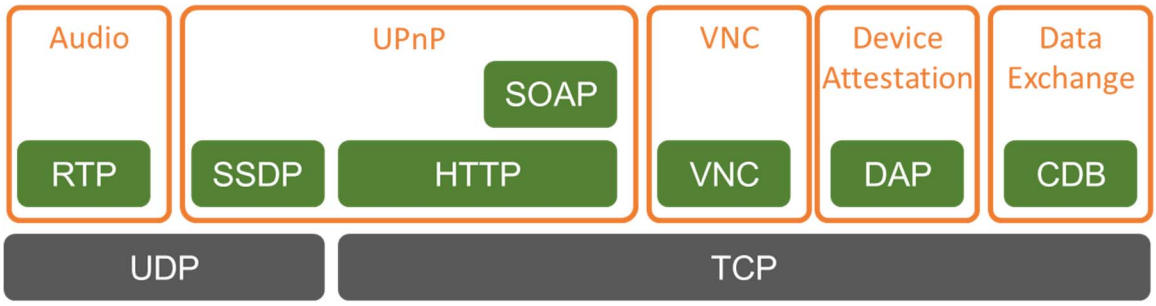


**Figure 2: Session Layer**

# Annex A (informative): Authors and Contributors

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# History

| Document history | | |
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