DIAL

DIscovery **A**nd **L**aunch protocol specification
Version 2.0.1

1 Introduction

This document describes **DIAL**, a simple protocol for **DI**scovery **A**nd **L**aunch that enables second-screen applications to discover and launch first-screen applications on first-screen devices.

The goal of this protocol is to enable CE device owners to enjoy seamless integration of phone and tablet applications with their TV-based entertainment experience.

2 Terminology

First-screen: a TV, Blu-ray player, set-top-box, or similar device
Second-screen: a smartphone, tablet, or similar device
DIAL Server: a device implementing the server side of the DIAL protocol, usually a first-screen device.
DIAL Client: a device that can discover and launch applications on a DIAL server, usually a second-screen device.

3 Example use cases

Four different methods are suggested for using DIAL and for establishing communication between second-screen and first-screen applications:

- First-screen service
- Second-screen service
- Cloud service
- Connecting a second-screen application to a running first-screen application

The first three of these methods are compatible with the process described in section 7 for using Wake-on-LAN (WoL) or Wake on Wireless LAN (WoWLAN) to power up a first-screen device. The fourth method presumes that the first-screen device is already running, so WoL and WoWLAN are not relevant to that use case.

3.1 First-screen service

A Netflix application on an iPhone discovers a Netflix-enabled TV and then launches the Netflix application on the TV to watch a movie. Steps (a), (b), and (c) are covered by DIAL, steps (d) and (e) are Netflix-specific and outside the scope of this document:

(a) Netflix application on iPhone discovers the DIAL service on the networked TV.
(b) Netflix application on iPhone uses DIAL to ask TV to launch the Netflix application. The DIAL server MAY pass a URL to the Netflix application, which the application could use to relay information to the DIAL server.
(c) Netflix application on TV optionally returns additional information to the DIAL server.
(d) Netflix application on iPhone discovers the Netflix application on TV.
(e) Netflix application on iPhone and the Netflix application on TV communicate to show the movie.

3.2 Second-screen service

A YouTube application on an Android tablet discovers a YouTube-enabled TV and then launches the YouTube application on the TV to play a video. After the video ends, the TV returns to the previously playing TV show. Steps (a), (b), and (c) are covered by DIAL, step (d) is YouTube-specific and outside the scope of this document:

(a) YouTube application on tablet discovers DIAL service on the networked TV.
(b) YouTube application on tablet uses DIAL to ask TV to launch the YouTube application, passing an IP/port corresponding to the YouTube application on the tablet. In addition to the IP/port, the DIAL server MAY also pass a URL to the YouTube application, which the first-screen application could use to relay information to the DIAL server.
(c) YouTube application on TV optionally returns additional information to the DIAL server.
(d) YouTube application on TV communicates with the YouTube application on tablet to show the video, then exits back to normal TV UI.

3.3 Cloud service

A (fictitious) WebcamX application on an Android phone discovers a WebcamX-enabled TV and then launches the browser-based HTML5 WebcamX application on the TV to display a webcam stream. Steps (a), (b), and (d) are covered by DIAL, steps (c) and (e) are WebcamX-specific and outside the scope of this document:

(a) WebcamX application on phone discovers DIAL service on the networked TV.
(b) WebcamX application on phone uses DIAL to ask TV to launch an HTML5-based browser starting with the URL for the WebcamX application, passing a unique token based on a random number. In addition to the random number, the DIAL server MAY also pass a URL to the WebcamX application, which the application could use to relay information to the DIAL server.
(c) WebcamX application on TV communicates with a cloud-based WebcamX server, making the server aware of the unique token created in step (b).
(d) WebcamX application on TV optionally returns additional information to the DIAL server.
(e) WebcamX application on phone communicates with the WebcamX application on TV via a cloud-based WebcamX server, using the unique token to enable the server to correctly route traffic between the two applications.

3.4 Connecting a second-screen application to a running first-screen application

A second-screen device discovers a DIAL service on a networked TV. The device sends a request to determine whether a YouTube application is available on the TV, and the DIAL server response indicates that the application is, in fact, already running. The DIAL response – see step (c) – includes the data from step (c) in section 3.2. (Such data is also communicated in step (c) of sections 3.1 and 3.3.) That information enables the device to connect directly to the YouTube application on the TV. Steps (a), (b), and (c) are covered by DIAL; step (d) is YouTube-specific and outside the scope of this document.

(a) YouTube application on Android phone discovers DIAL service on the networked TV.
(b) YouTube application on Android phone uses DIAL to request information about the status of the YouTube application on the TV, such as whether the application is installed on the TV and, if so, if it is stopped or running.
(c) The DIAL server response indicates that the application is already running. The response also contains additional data that enables the YouTube application on the Android phone to communicate with the running instance of the YouTube TV application.
(d) YouTube application on Android phone connects directly to running instance of the YouTube TV application.

4 Protocol overview

The DIAL protocol has two components: **DIAL Service Discovery** and the **DIAL REST Service**.

DIAL Service Discovery enables a DIAL client device to discover DIAL servers on its local network segment and obtain access to the DIAL REST Service on those devices.

The *DIAL REST Service* enables a DIAL client to query, launch, and optionally stop applications on a DIAL server device.

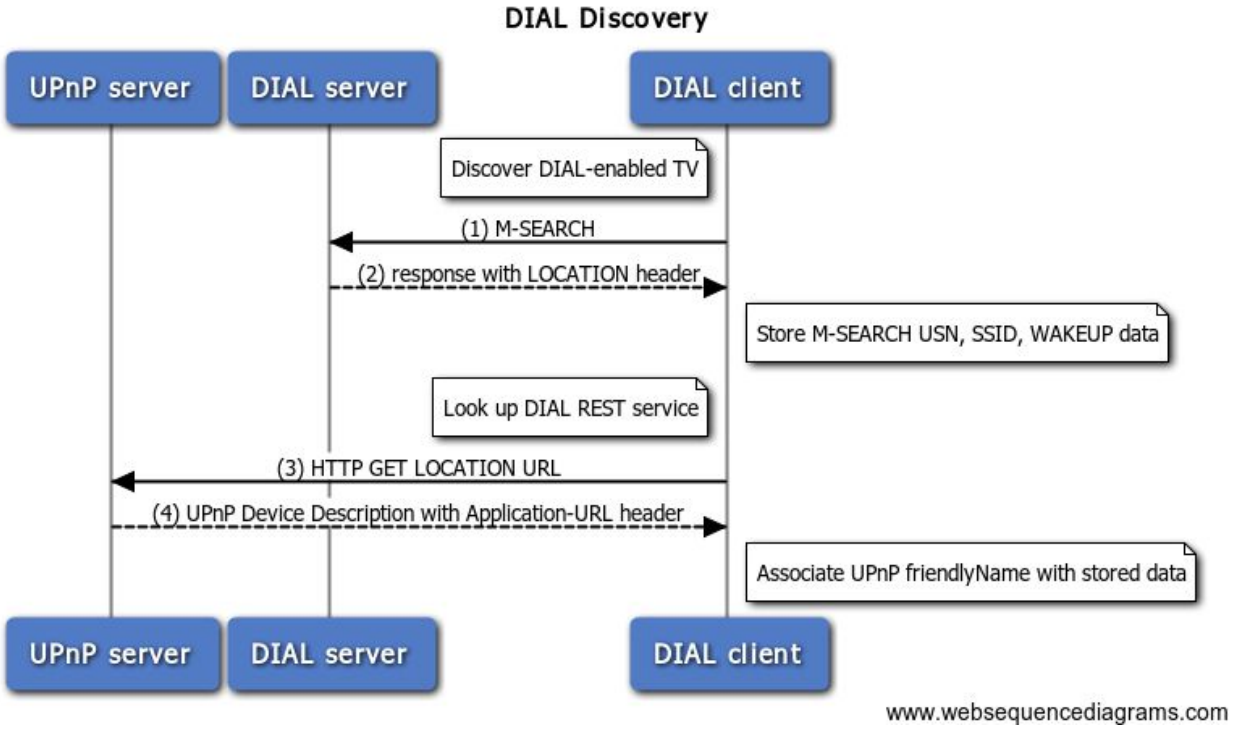
DIAL Service Discovery is achieved using a new Search Target within the SSDP protocol defined by UPnP [1] and an additional header in the response to an HTTP request for the UPnP device description.

The DIAL REST Service is accessed using HTTP [2].

DIAL clients and servers SHALL support the requirements of Section 2.1 of [1]. In particular, HTTP 1.0 SHALL be supported and support of HTTP 1.1 is RECOMMENDED.

5 DIAL Service Discovery

The DIAL Service Discovery protocol is based on SSDP (Simple Service Discovery Protocol) version 1.1 as defined in UPnP [1] and HTTP [2] and is illustrated in the following figure:



A DIAL client SHOULD support connections to the collection of:

- Active DIAL servers discovered during this process
  and
- WoL- and WoWLAN-capable DIAL servers that the DIAL client previously discovered while the client was connected to the same wireless network SSID. (Note that WoL-capable servers do not need to connect to a wireless network SSID and WoWLAN-capable servers might connect to a different wireless network SSID than the DIAL client.)

Implementation Note:

- *If the DIAL client is not connected to a WiFi network, it will not be able to connect to devices using WoL or WoWLAN. In that case, the client would only support connections to active DIAL servers discovered during the DIAL Service Discovery process.*

5.1 M-SEARCH request

A DIAL client that wishes to discover DIAL servers SHALL send an `M-SEARCH` request as defined in Section 1.3.2 of [1] over UDP to the IPv4 multicast address 239.255.255.250 and UDP port

1900 including the Search Target header (`ST`) with the following value defined by this specification:

```
urn:dial-multiscreen-org:service:dial:1
```

5.2 M-SEARCH response

An SSDP/UPnP server receiving an `M-SEARCH` request with the Search Target defined above shall respond as defined in Section 1.3.3 of [1].

5.2.1 Processing an M-SEARCH response

The `M-SEARCH` response SHALL contain the following information:

- The `LOCATION` header SHALL contain an absolute HTTP URL for the UPnP description of the root device. The host portion of the URL SHALL either resolve to an IPv4 address or be an IPv4 address.
- The Search Target header (`ST`) of the response SHALL contain the identifier defined in Section 5.1.
- The `WAKEUP` SSDP header SHALL NOT be present unless both of the following conditions are true, and it SHALL be present when these conditions are true:

    - The DIAL-enabled device supports WoL or WoWLAN.
    - WoL or WoWLAN is currently enabled for the device.

    The header value contains two parameters. An equals sign (=) separates each parameter from its value, and a semicolon separates the two parameters in the header value.

    - `MAC`: The MAC address of the first-screen device's wired or wireless network interface that is currently in use.
    - `Timeout`: The estimated upper bound of the duration, measured in seconds, of the time needed to wake the DIAL server device and then start its DIAL server. This value measures the time starting when the WoL magic packet is sent to the time that the DIAL server is running and able to respond to DIAL Discovery Service requests.

Note that it is possible for a DIAL client to discover the same DIAL server over different interfaces. The DIAL client SHALL use the `M-SEARCH` response's `USN` (Unique Service Name) header value to deduplicate the list of discovered DIAL servers.

Annex B (example B.2) shows a sample `M-SEARCH` response.

5.2.2 Storing data about DIAL-enabled devices that support DIAL Wake-up

The DIAL client device SHALL persist certain information about discovered DIAL server devices that support WoL or WoWLAN. This information enables the client to use DIAL Wake-up, as discussed in section 7.3, to power on a DIAL server device at later times if that device is inactive.

If the `M-SEARCH` response discussed in section 5.2 contains the `WAKEUP` header, the client device SHALL persist the following information:

- The `USN` from the `M-SEARCH` response.

- The wireless SSID it is using. This value will help the DIAL client device avoid future attempts to wake devices that are unavailable on a given network. If the SSID is not defined and the BSSID is available, that value can be used instead.
- The `MAC` parameter value from the `WAKEUP` header.
- The `Timeout` parameter value from the `WAKEUP` header.

Implementation Notes:

- *The UPnP `friendlyName` field of the device description response, which is discussed in section 5.4, may also be a useful value to store. For example, this value is helpful when giving users a choice of DIAL server devices to interact with.*
- *Even if the `M-SEARCH` response does not contain the `WAKEUP` header, it may be useful to store information that could be used to list DIAL servers that had previously been found on the same SSID that the DIAL client is using but that have not yet responded to the `M-SEARCH` request.*

5.3 Device description request

On receipt of the `M-SEARCH` response, the DIAL client MAY issue an HTTP GET request to the URL received in the `LOCATION` header of the `M-SEARCH` response. Generally, a DIAL client uses the `M-SEARCH` request and response to verify that the DIAL server device is still available and does not need to repeat requests for the device description. (*Note that matching of SSDP header field names is case-insensitive.*)

5.4 Device description response

On receipt of a valid HTTP GET for the device description, a DIAL server SHALL respond with an HTTP response containing the UPnP device description as defined in Section 2 of [1].

In addition to the requirements of [1], the request SHALL NOT be redirected.

If the request is successful, the HTTP response SHALL contain an additional header field, `Application-URL`, the value of which SHALL be an absolute HTTP URL. This URL, minus any trailing slash ('/') character, identifies the DIAL REST Service and is referred to as the *DIAL REST Service URL*. The host portion of the URL SHALL either resolve to an IPv4 address or be an IPv4 address.

The format of the Application-URL header field is defined as follows, following the ABNF notation of [2]:

```
Application-URL = "Application-URL" ":" absoluteURI
```

A DIAL client receiving this response SHALL use the provided URL to access the DIAL REST service defined below. (*Note that matching of HTTP header names is case-insensitive*)

6 DIAL REST Service

The DIAL REST service represents applications (for example Netflix, YouTube, etc.) as resources identified by URLs. Operations related to an application are performed by issuing HTTP requests against the URL for that application. This URL is known as an *Application Resource URL*.

The Application Resource URL for an application is constructed by concatenating the *DIAL REST Service URL,* a single slash character *('/')* and the *Application Name*.

The Application Name for each application is defined by the application provider. Application Names MUST be registered in the DIAL Registry (See Section 8).

6.1 Querying for application information

6.1.1 Client request

A DIAL client that wishes to discover information about an application SHALL send an HTTP `GET` request to the Application Resource URL.

6.1.2 Server response

On receipt of a `GET` request, the DIAL server SHALL first extract the Application Name from the request URL. If the `GET` request is invalid or cannot be processed to extract the Application Name, the server SHALL return the appropriate HTTP response code as defined in [2].

If the Application Name is not recognized, the server SHALL return an HTTP response with response code `404 Not Found`.

Otherwise the DIAL server SHALL return an HTTP response with response code `200 OK`. The MIME type of the response SHALL be `text/xml` and the character encoding SHALL be UTF-8 and SHALL be explicitly indicated with the `charset` MIME parameter.

The XML document SHALL conform to the schema defined in Annex A except that unrecognized XML elements and attributes MUST be ignored by the client.. The semantics of this document are described in the following table:

Element or @attribute	Definition
`service`	Encapsulates the DIAL server response.
`@xmlns`	Identifies the XML namespace for the response. The value will be `urn:dial-multiscreen-org:schemas:dial`
`@dialVer`	Identifies the DIAL protocol version associated with the response.
`name`	Contains the Application Name
`options`	
`@allowStop`	Valid values are: • `true`: Indicates that the `DELETE` operation described in

	Section 6.4.2 is supported. This is the default value. • `false`: Indicates that the `DELETE` operation described in Section 6.4.2 is not supported.
`state`	Valid values are: • `running`: Indicates that the application is installed and either starting or running. • `stopped`: Indicates that the application is installed and not running. • `installable=<URL>`: Indicates that the application is not installed but is available for installation. The `<URL>` in the value MUST contain an absolute HTTP URL. The host portion of the URL SHALL either resolve to an IPv4 address or be an IPv4 address. A DIAL client may initiate installation of the application on the DIAL server by sending an HTTP GET request to the provided URL. Any other value is invalid and SHOULD be ignored.
`link`	This optional element SHOULD be included when an application is running *and* the DIAL server supports `DELETE` requests as described in section 6.4.2.
`@rel`	The attribute value MUST be "`run`" .
`@href`	The `href` attribute contains the resource name of the running application, e.g. "**run**" or "**pid-25352**". This name SHOULD match the last portion of the name returned in the 201 CREATED response (e.g. http://192.168.1.200:2342/apps/YouTube/**run**).
`additionalData`	Contains zero or more elements that the specified application posted, upon being launched, to the DIAL server. With the exception of names registered in the DIAL Additional Data Reserved Names registry, the names and values of those elements are selected by the first-screen application developer and are outside the scope of this document.

DIAL servers MAY support client triggering of application installation for specific applications that are not currently installed.

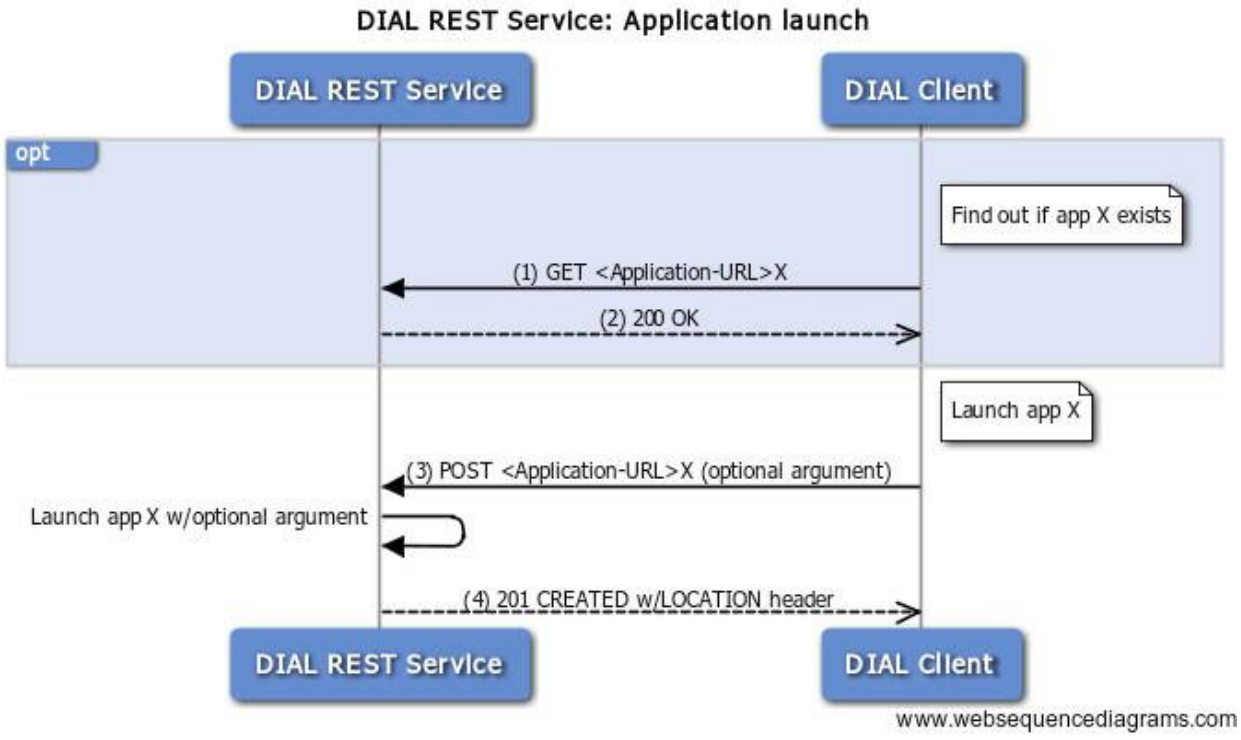
If the Application Name is recognized, the application is not installed, and the DIAL server supports client triggering of application installation for this application, then the DIAL server SHALL return a `state` element the value of which begins with the string `installable=` as described in the table above.

On receipt of such a request at the DIAL server, if the Application Name is recognized, the application is not installed, and the DIAL server does not support triggering of application installation for this Application Name, then the DIAL server SHALL return an HTTP response with response code `404 Not Found`.

Implementation note:

- *If an application is installable, the client can choose whether or not to GET the installable URL provided. For example, the client (second-screen application) can present a choice to the user: "Application is not installed. Would you like to install it now?". The way the first-screen device handles the installation request is OEM-defined; options include immediate installation of the application, presentation of the application in a marketplace or similar application store, etc.*

6.2 Launching an application



6.2.1 Client request

A DIAL client that wishes to launch an application on a DIAL server SHALL send an HTTP `POST` request to the Application Resource URL for the desired application.

Implementation Note:

- *Which applications are available to launch using DIAL is entirely at the discretion of the DIAL server implementer.*

The message body of the POST request MAY be empty or MAY contain an argument string to be passed to the application on launch.

If the message body of the POST request is empty, a "`Content-Length: 0`" header SHOULD be sent to avoid receiving a possible "`411 Length Required`" error.

If the message body of the POST request is non-empty, the MIME type SHALL be `text/plain`, the character encoding SHALL be UTF-8, and the character encoding SHALL be indicated explicitly by including the `charset` MIME parameter.

Implementation Notes:

- *How the argument is passed to the application may be platform- and application-specific and is outside the scope of this document.*
- *The format of the argument should match the requirements of the application being launched. Key-value pairs, JSON, XML, etc. are all possible and the choice is outside the scope of this document.*
- *DIAL servers MUST support argument strings up to 4KB in length. The DIAL server implementer MAY choose to support larger argument strings.*
- *A DIAL server MAY pass the argument string directly to the application: Applications MUST NOT assume that any security checks (such as character-encoding checks) have been performed and therefore MUST perform their own security checks on the argument data.*
- *The DIAL payload MUST be passed to the launched application in a way that ensures it **cannot be used to circumvent fundamental security or integrity of the platform**. For example, the DIAL payload SHOULD NOT be used to*
  - *directly define arbitrary command-line parameters when running a native application unless adequate protections are taken.*
  - *provide the actual executable name.*
  - *control process attributes like priority or ownership.*

6.2.2 Server response

On receipt of a valid `POST` request, the DIAL server SHALL first extract the Application Name from the `POST` URL. If the `POST` request is invalid or cannot be processed to extract the Application Name, the server SHALL return the appropriate HTTP response code as defined in [2].

The server SHALL respond, as indicated in the table below, depending on:

- whether the Application Name is not recognized.
- whether the content length of the message body exceeds the maximum size supported by the server.
- the current application state:
  - not started: the application is not running.
  - starting: the application is being started due to another DIAL REST Service request or for another reason.
  - running: the application is running.
- whether the message body is empty or non-empty.

DIAL servers MUST support any message body in a POST request with content length of 4KB or less.

In the table below, earlier rows take precedence over later ones. If the Action indicates a HTTP response code the server SHALL return an HTTP response with the indicated response code.

Application recognized	**Message body**	**Application state**	**Action**
No	any	n/a	`404 Not Found`
Yes	too long	n/a	`413 Request Entity Too Large`
Yes	empty	Not running	`201 Created` * Start application
Yes	non-empty	Not running	`201 Created` * Start application with provided argument, if any
Yes	empty	Starting[1]	`200 OK`
Yes	non-empty	Starting[2]	`200 OK`
Yes	empty	Running	`200 OK`
Yes	non-empty	Running	Provide new argument to application

[1] Started by DIAL or by any other means, e.g. built-in menu, etc.

[2] Started by DIAL or by any other means, e.g. built-in menu, etc.

If the application is running after the action specified above, the DIAL server SHALL return an HTTP response with response code `201 Created`. In this case, the `LOCATION` header of the response shall contain an absolute HTTP URL identifying the running instance of the application, known as the *Application Instance URL*. The host portion of the URL SHALL either resolve to an IPv4 address or be an IPv4 address. No response body shall be returned.

Otherwise, if the application cannot be successfully started or re-started for any reason, the DIAL server SHALL return an HTTP response with response code `503 Service Unavailable`.

Implementation Note:

- *If the application is already running and an argument is provided and the platform does not support providing new arguments to running applications, then the application should not be restarted with the new argument unless allowed by the application provider.*
- *To run the application, the host system should use a non-blocking form of "fork", "exec", "spawn", or equivalent that will catch any immediate error (like ENOMEM or EAGAIN) and map it to a 503 "Service Unavailable" error. If there is no error and the system command to run the application succeeds, then the application is running for the purposes of this specification.*

The Application Instance URL may be used to stop the running instance of the application, as described in section 6.4.

6.2.2.1 HDMI-CEC Integration

If a DIAL-enabled device connects to a display using HDMI and HDMI-CEC is available, then the device MUST emit the following HDMI-CEC commands in sequence every time a DIAL client successfully launches an application on that device:

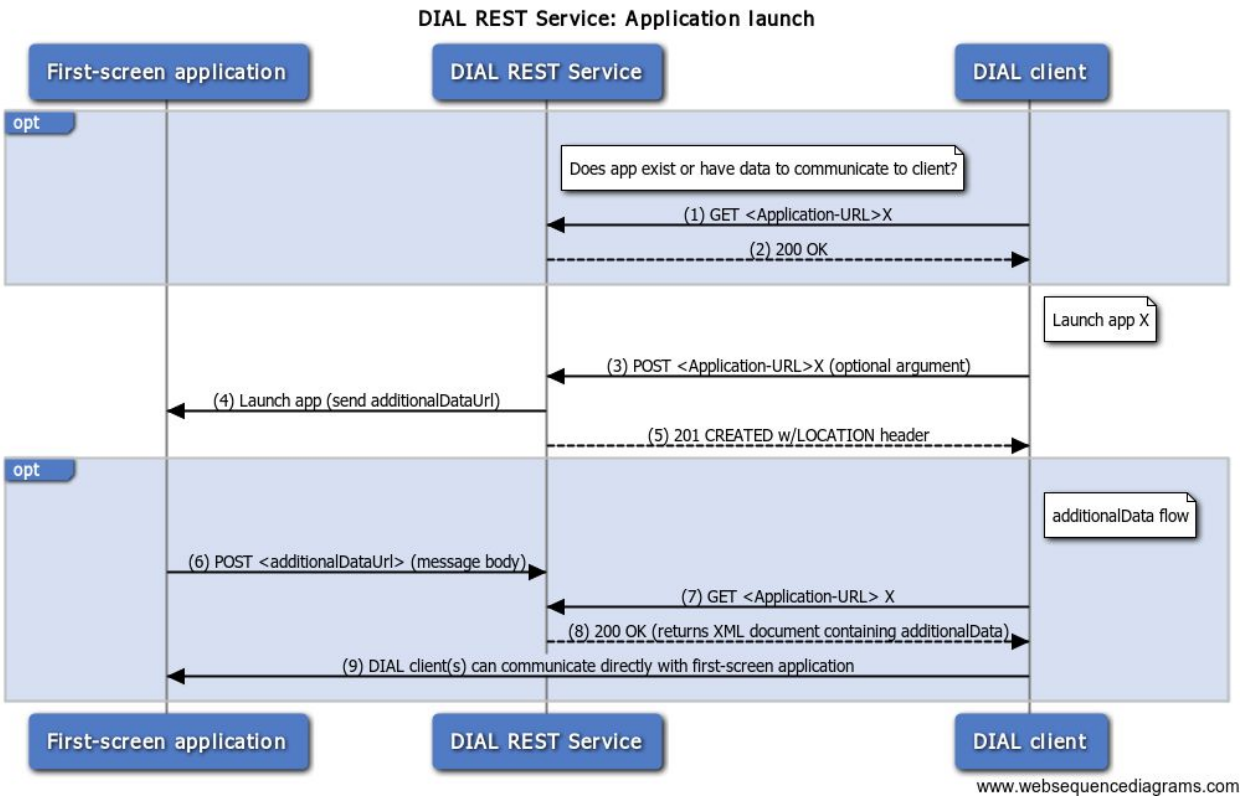
1. `<Image View On>`
2. `<Active Source>`

These commands enable the first-screen device to be played and become the active source for the display with a single button press. See the "One Touch Play" feature, which is described in Supplement 1 (Consumer Electronics Control) of the HDMI specification.

Note that a successful launch is considered to be any attempt to launch an application that results in a `2xx` HTTP response code.

6.3 Sending additional data from a first-screen application to a DIAL server

An application launched or running on the first-screen device can send a small amount of data to the DIAL server. The DIAL server can then communicate that information to DIAL clients that connect to the DIAL server. The additional data could, for example, permit multiple second-screen devices to simultaneously connect to and interact with the first-screen application.



The process diagram above illustrates the process by which a first-screen application can send data back to the DIAL server. The DIAL server can subsequently communicate to any second-screen device that contacts it. The following notes explain the image in more detail:

- Steps 1 through 5 show the same process as the image in section 6.2.
- Steps 1 and 7 represent the same type of request.
- Steps 2 and 8 represent the same type of response. Step 8 illustrates a situation in which the DIAL server's response contains an `<additionalData>` element.
- A DIAL server must support CORS to support the request made in step 6.
- Any process or mechanism that launches a first-screen application (step 4), such as a menu on the first-screen device, MUST send the `additionalDataUrl` shown in step 4 when launching the application. The `additionalDataUrl` enables steps 6 through 9 to occur regardless of which process launches the first-screen application.
- A second-screen application running on a DIAL client MAY be designed to check the <state> element in the response sent in steps 2 and 8 and follow a different flow if the application is already running. A second-screen application that does follow a different process depending on an application's state MUST implement steps 1 and 2 even though they are marked as optional.

  For example, if a first-screen application supports multiple second-screen clients simultaneously, then a second-screen client must send the request in step 1 to determine whether the first-screen application is running. If the application is not running, the second-screen client launches the application (step 3). However, if the application is

running, the second-screen client follows a different process (step 9)

6.3.1 Request to POST additional data from first-screen application to DIAL server

When a first-screen application is launched, the launching service (DIAL server, TV menu, etc.) can send an `additionalDataUrl` to the application. The `additionalDataUrl` can be sent as a parameter, property, key, etc. The decision of how to send the `additionalDataUrl` is left to the DIAL server implementer.

If present, that parameter SHALL specify a URL that the first-screen application can use to POST additional data, structured as key-value pairs, to the DIAL server. (The DIAL server can subsequently relay that information to other DIAL clients that connect to the server as discussed in section 6.1.2.)

- If the `additionalDataUrl` is specified, that value MUST be sent to the first-screen application every time it is launched, even when the first-screen application is not started by the DIAL server. This ensures that the first-screen application can always communicate the additional data to the DIAL server.
- The URL MUST be unique for each application.
- The `additionalDataUrl` value MUST be URL-encoded using the rules defined in [5] for MIME type `application/x-www-form-urlencoded`.
- The URL host MUST be `localhost`. This value SHALL be checked in the application.
- Using an `additionalDataUrl` of the form `/apps/<app_name>/dial_data` is RECOMMENDED. If the URL contains the application name, the DIAL server can easily identify the application to which data is being sent.
- For the key-value pairs that the first-screen application sends to the DIAL server, the key names and their corresponding values are selected by the application provider and are outside the scope of this document. However, key names MUST be within the US-ASCII character range [0-9a-zA-Z]. Key names that fall outside of this range MUST be rejected with HTTP response code `400 Bad Request`.

If a first-screen application receives an `additionalDataUrl`, the application should POST a request to that URL as soon as the additional data is available. The size of the POST request MUST be smaller than 4KB.

Security considerations:

A first-screen application running on the application provider's domain needs to be able to call the `additionalDataUrl` that the DIAL server provides. To support this capability, the DIAL server MUST support Cross-Origin Resource Sharing (CORS) requests as defined in [4].

For example, the YouTube TV application running on www.youtube.com needs to call the DIAL server's `additionalDataUrl`. To provide this support, the DIAL server needs to add the following response header when handling requests to the application's `additionalDataUrl` (`/apps/youtube/dial_data`):

```
Access-Control-Allow-Origin: https://www.youtube.com
```

Implementation Note:

- *Each application MUST have a way to communicate its authorized domain to the DIAL server. This communication could occur at build time or by updating stored metadata. A hardcoded list of authorized domains MAY only be used for systems that cannot download applications dynamically.*

6.3.2 Process for handling additionalData on a DIAL server

The key-value pairs that a first-screen application sends to the `additionalDataUrl` MUST be in the `x-www-form-urlencoded` body of a POST request to that URL. The DIAL server MUST decode the POST body according to the rules defined in the "application/x-www-form-urlencoded" section of [5] and MUST then store the decoded key-value pairs. (In [5], the key in a key-value pair is referred to as the "control name," and the value is referred to as the "control value.")

The DIAL server MUST include those key-value pairs, formatted as XML elements and element values, in responses (section 6.1.2) to all subsequent DIAL Application Information requests (section 6.1.1) pertaining to the same application. Each key-value pair is returned as a separate XML element nested inside the `additionalData` element as defined below:

- The element name is set to be the key in the key-value pair.
- The element value is set to be the value in the key-value pair. Note: You MUST apply the appropriate XML encoding for the element value as defined in section 2.4 of [6]. For example, if the value is "me & you", the correct encoded value is "me & you".

Each time a DIAL server receives a POST request sent to an `additionalDataUrl`, the server MUST replace all stored key-value pairs for the sending application with the key-value pairs in the request. For example, an application could clear a value by sending a request that omits a key-value pair sent in a previous request.

The key-value pairs stored for an application MUST always be returned in a DIAL Application Information response, even if the application is not currently running.

6.4 Stopping an application

6.4.1 Client request

A DIAL client that wishes to stop a running instance of an application on a DIAL server SHALL send an HTTP `DELETE` request to the Application Instance URL.

6.4.2 Server response

Support of the `DELETE` request is RECOMMENDED for DIAL servers.

If the `DELETE` request is not supported the DIAL server SHALL return an HTTP response with response code `501 NOT IMPLEMENTED`.

If supported, then on receipt of a `DELETE` request, the DIAL server SHALL first determine whether the provided URL corresponds to a running application. If the `DELETE` request is invalid or cannot be processed to determine whether the provided URL corresponds to a running application, the server SHALL return the appropriate HTTP response code as defined in [2].

If the provided URL does not correspond to an application running in the foreground, the server SHALL return an HTTP response with response code `404 Not Found`.

Otherwise, the server SHALL send an HTTP response with response code `200 OK` and attempt to stop the running application. These two operations SHOULD be carried out asynchronously.

6.5 CORS Requirements and CORS Access Control Policy

In addition to the CORS check made on `additionalDataUrl`, all Application Resource URLs are subject to the following policy:

Whenever an HTTP request is made against an Application Resource, the DIAL server should run the following checks:

1. If the `ORIGIN` header is absent in the request, the CORS check is not applicable and the request is allowed.
2. If the `ORIGIN` header is present in the request:
    a. `ORIGIN` headers that don't start with 'http', 'https', or 'file' are automatically accepted.
    b. The `ORIGIN` header must match one of the authorized domains provided by the DIAL application.

Implementation Note:

- *Each application MUST have a way to communicate its authorized domain to the DIAL server. This communication could occur at build time or by updating stored metadata. A hardcoded list of authorized domains MAY only be used for systems that cannot download applications dynamically.*

7 DIAL and Wake-on-LAN or Wake on Wireless LAN

This section explains how a second-screen device can use Wake-on-LAN (WoL) or Wake on Wireless LAN (WoWLAN) to power on a previously discovered first-screen device. This enables the second-screen device to subsequently start and interact with applications on the first-screen device as described in section 6.

7.1 Background

Wake-on-LAN (WoL) is an Ethernet networking standard that allows a device to be turned on or awakened by a network message. WoWLAN is similar but applies to a device that can be reached over an 802.11 connection. In this document, the term *DIAL Wake-up* refers to both WoL and WoWLAN implementations.

7.2 Implementation details

- If the first-screen device is wake-on compliant and the DIAL server operates over a particular interface, then the waking functionality SHALL also work on that interface.
- The first-screen device SHALL implement DIAL Wake-up functionality for wired connections and for both secure and insecure wireless connections.
    - To wake a first-screen device, the second-screen device must know the MAC address of the first-screen device's network interface.
- If Wake-on-Wireless is supported on a device that supports WPA2, the Group Temporal Key renewal handshake MUST be supported while a device is in sleep mode. If this was not the case, over time it would be impossible to wake up the device due to the inability of the device to decrypt the broadcast magic packet.

7.3 Using DIAL Wake-up

During the DIAL Service Discovery process, defined in section 5, a DIAL client sends an `M-SEARCH` request to discover DIAL servers and receives an `M-SEARCH` response in response. The client SHOULD then support connections to the collection of:

- Active DIAL servers discovered during this process
  and
- Previously discovered WoL-capable DIAL servers on the same SSID as the DIAL client

As explained in section 5.2, the first-screen device running the DIAL server SHALL return a `WAKEUP` SSDP header in the `M-SEARCH` response if the device supports DIAL Wake-up. In addition, if the `M-SEARCH` response contains the `WAKEUP` header, the second-screen device SHALL store certain values, including the `MAC` and `Timeout` values from that header, so that the second-screen device can use DIAL Wake-up to power on the first-screen device in the future.

If the user chooses to connect to a first-screen device that supports DIAL Wake-up, and that

device is not responding to the DIAL discovery process explained in section 5, then the DIAL client SHALL:

1. Broadcast a Wake-on-LAN magic packet containing the first-screen device's MAC address. Because the DIAL client sends the magic packet over an unreliable transport layer, the client SHALL send the packet once every 50ms until either of the following occurs:
    a. The DIAL server starts responding to DIAL discovery service requests as defined in section 5.
    b. The launch attempt times out. It is RECOMMENDED that the DIAL client use the `Timeout` value from the `M-SEARCH` response discussed in section 5.2, to estimate the amount of time to allow before the attempt is deemed to time out. The DIAL client is RECOMMENDED to wait two times the `Timeout` value before considering a launch attempt to have timed out. If that time is greater than two seconds, the client is RECOMMENDED to display a visual progress signal to the user.
2. If the DIAL server begins responding to DIAL discovery service requests as explained in option (a) above, the DIAL client SHALL continue with normal DIAL requests.

8 DIAL Registry

To ensure that the correct name for each application is well-defined and to avoid naming conflicts, Application Names must be registered in the DIAL Registry. The DIAL specification maintainer will maintain this registry and make it available to anyone implementing or using the DIAL protocol.

Application Names may be registered explicitly, or a set of Application Names with a common prefix may be registered by registering an *Application Prefix*.

Application Names and Prefixes MUST consist of a sequence of characters matching the `pchar` production of RFC3986 [3]. Matching of Application Names and Prefixes is case-sensitive and SHALL be performed after decoding percent-encoded characters (i.e. the three-character sequence '%30' matches the single character '0'.)

An Application Prefix MUST be at least four (4) characters in length (after decoding percent-encoded characters) and must include a recognizable company name. For example: "Acme-", "com.acme".

Application names can be registered if the application is actually available in the market and there is no conflict with previously registered names or prefixes. Application prefixes can be registered if the company name in the prefix is actively delivering applications or devices that run them to the market. Names or prefixes that may be confused with previous registrations (e.g. "netflix", "youtube", "Y0uTube", etc.), or are not intended for use with DIAL, may not be registered.

9 Out-of-box experience

The default out-of-box experience (OOBE) for a first-screen device SHOULD set up the features and functions required for a successful DIAL experience, including:

- networking – Users should be encouraged to connect their device to the Internet.
- application store/portal – During the OOBE, the user should have the opportunity to configure any store, portal, or application that could prevent a successful DIAL application launch or installation.
- Wake-on-LAN feature – If the first-screen device supports Wake-on-LAN, that feature should be enabled.

After a user completes the first-screen device OOBE, a DIAL client SHOULD be able to discover and launch an application on that first-screen device.

Implementors are strongly encouraged to support the "installable" status for applications available through an application store. Alternately, an implementation can hide the fact that an application is not installed and silently install an application that is launched through DIAL.

10 References

[1] UPnP™ Device Architecture 1.1 , 15 October 2008, http://upnp.org/sdcps-and-certification/standards/device-architecture-documents/
[2] RFC2616 (http://www.ietf.org/rfc/rfc2616.txt)
[3] RFC3986 (http://tools.ietf.org/html/rfc3986)
[4] Cross-Origin Resource Sharing - W3C Recommendation, http://www.w3.org/TR/cors/
[5] HTML 4.01 Specification (http://www.w3.org/TR/html401/)
[6] XML 1.0 5th Edition (http://www.w3.org/TR/2008/REC-xml-20081126/)

11 Acknowledgements

This document greatly benefited from review, feedback, and suggestions from several CE manufacturers and content providers. The document authors appreciate their help and support.

Notably, Samsung and Sony provided significant guidance to ensure that DIAL would be a compatible and effective solution for first-screen devices and also meet their goals for great second-screen user experiences. The document authors especially thank our colleagues at these companies for their efforts on behalf of DIAL.

Appendix A: Designing a DIAL client device UI

A DIAL client device is likely to display a list of DIAL servers to which the device can connect. The following list contains recommendations for that list:

- The UPnP `friendlyName` field of the device description response, which is discussed in section 5.4, is a useful value to display when giving users a choice of DIAL server devices to interact with or when identifying the device to which the client is connecting.

- Even if an `M-SEARCH` response, discussed in section 5.2, does not contain the `WAKEUP` header, it could be useful to store information about the identified device. That information would let the DIAL client list non-WoL-capable DIAL servers that have not yet responded to the `M-SEARCH` request but had previously been found on the same SSID that the DIAL client is using. For example, those devices could be listed but not available for selection.

- A client device could store a list of preferred DIAL server devices and use that list to select a DIAL server rather than require the user to explicitly select a server device. Similarly, a client device could allow the user to specify that a discovered DIAL server should no longer be presented as an option to interact with.

  Note that providing the ability to identify a preferred device could eliminate the need for a user to always select a device on a network on which multiple devices are present. However, the selection of a preferred device could also result in that device being powered on rather than connecting to another available, powered-on device.

- A client device could allow a user to connect to multiple DIAL servers simultaneously, thereby sharing content from a single second-screen device to multiple first-screen devices.

Annex A: Application resource XML Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:dial-multiscreen-org:schemas:dial"
        attributeFormDefault="unqualified"
        elementFormDefault="qualified"
        xmlns:xs="http://www.w3.org/2001/XMLSchema"
        xmlns="urn:dial-multiscreen-org:schemas:dial">
   <xs:import namespace="http://www.w3.org/2005/Atom" schemaLocation="atom.xsd"/>
   <xs:element name="service" type="ServiceType"/>

   <xs:complexType name="ServiceType">
      <xs:sequence>
         <xs:element name="name" type="xs:string" minOccurs="1" maxOccurs="1"/>
         <xs:element name="options" type="optionsType" minOccurs="0" maxOccurs="1"/>
         <xs:element name="state" type="xs:string" minOccurs="1" maxOccurs="1"/>
         <xs:element name="link" type="linkType" minOccurs="0" maxOccurs="1"/>
         <xs:element name="additionalData" minOccurs="0" maxOccurs="1">
            <xs:complexType>
```

```
            <xs:sequence>
               <xs:any minOccurs="0" maxOccurs="unbounded" processContents="lax"/>
            </xs:sequence>
         </xs:complexType>
      </xs:element>
   </xs:sequence>
   <xs:attribute name="dialVer" type="xs:string" use="optional"/>
</xs:complexType>

<xs:complexType name="optionsType">
   <xs:attribute name="allowStop" type="xs:boolean" use="optional"/>
</xs:complexType>

<xs:complexType name="linkType" mixed="true">
   <xs:attribute name="href" use="required" type="xs:anyURI"/>
   <xs:attribute name="rel" type="xs:string" use="optional"/>
</xs:complexType>
</xs:schema>
```

Annex B: Message Examples

B.1 M-SEARCH

```
M-SEARCH * HTTP/1.1
HOST: 239.255.255.250:1900
MAN: "ssdp:discover"
MX: seconds to delay response
ST: urn:dial-multiscreen-org:service:dial:1
USER-AGENT: OS/version product/version
```

B.2 M-SEARCH response

```
HTTP/1.1 200 OK
LOCATION: http://192.168.1.1:52235/dd.xml
CACHE-CONTROL: max-age=1800
EXT:
BOOTID.UPNP.ORG: 1
SERVER: OS/version UPnP/1.1 product/version
USN: device UUID
ST: urn:dial-multiscreen-org:service:dial:1
WAKEUP: MAC=10:dd:b1:c9:00:e4;Timeout=10
```

B.3 Device description request

This message is sent from the DIAL client to the DIAL server:

```
GET /dd.xml HTTP/1.1
...
```

B.4 Device description response

```
HTTP/1.1 200 OK
Application-URL: http://192.168.1.1:12345/apps
...

<UPnP device description in message body>
```

B.5 Application information request

This message is sent from the DIAL client to the DIAL server:

```
GET /apps/YouTube
...
```

B.6 Application information response

```
HTTP/1.1 200 OK
…

<?xml version="1.0" encoding="UTF-8"?>
<service xmlns="urn:dial-multiscreen-org:schemas:dial" dialVer="1.7">
    <name>YouTube</name>
    <options allowStop="true"/>
    <state>running</state>
    <link rel="run" href="run"/>
</service>
```

B.7 Application information response for application that allows multiple connected users

```
HTTP/1.1 200 OK
…

<?xml version="1.0" encoding="UTF-8"?>
<service xmlns="urn:dial-multiscreen-org:schemas:dial" dialVer="1.7">
    <name>YouTube</name>
    <options allowStop="true"/>
    <state>running</state>
    <link rel="run" href="run"/>
    <additionalData>
        <screenId>screen123</screenId>
        <sessionId>token123</sessionId>
    </additionalData>
</service>
```

Note: The <screenId> element is provided as an example. In fact, the <additionalData> element can contain one or more elements. The names and values of those elements are outside the scope of this document and are selected by the first-screen application developer.

B.8 Application launch request

This message is sent from the DIAL client to the DIAL server:

```
POST /apps/YouTube
Content-Type: text/plain; charset="utf-8"
```

```
...

param1=value1&param2=value2
```

B.9 Application launch request with additionalDataUrl

This message is sent from the DIAL client to the DIAL server:

```
POST /apps/YouTube
Content-Type: text/plain; charset="utf-8"
...

param1=value1&param2=value2
```

The DIAL server launches the first-screen application and passes the `additionalDataUrl` argument to that application in an implementation-specific manner.

For browser-based applications, the `additionalDataUrl` should be appended to the launch URL as an additional query-string argument separate from the DIAL payload.

For example, the URL used to launch the first-screen application might look like this:

```
https://example.com/tv?dialpayload=<URL-Encoded DIAL
payload>&additionalDataUrl=<URL-Encoded URL>
```

B.10 Application launch response

```
HTTP/1.1 201 CREATED
LOCATION: http://192.168.1.1:12345/apps/YouTube/run
...
```

B.11 Application request sending additional data to DIAL server

```
POST /apps/YouTube/dial_data
Host: localhost:8080
Content-Type: application/x-www-form-urlencoded; charset="utf-8"
screenId=screen123&sessionId=token123
```

Annex C: Sequence diagram source

```
title DIAL Discovery
participant "UPnP server" as U
participant "DIAL server" as S
participant "DIAL client" as C
note left of C: Discover DIAL-enabled TV
C->S: (1) M-SEARCH
S-->C: (2) response with LOCATION header
note right of C: Store M-SEARCH USN, SSID, WAKEUP data
note left of C: Look up DIAL REST service
C->U: (3) HTTP GET LOCATION URL
U-->C: (4) UPnP Device Description with Application-URL header
note right of C: Associate UPnP friendlyName with stored data

title DIAL REST Service: Application launch
participant "DIAL REST Service" as S
participant "DIAL client" as C
opt
note right of C: Find out if app X exists
C->S: (1) GET <Application-URL>X
S-->C: (2) 200 OK
end
note right of C: Launch app X
C->S: (3) POST <Application-URL>X (optional argument)
S->S: Launch app X w/optional argument
S-->C: (4) 201 CREATED w/LOCATION header

title DIAL REST Service: Application launch
participant "First-screen application" as F
participant "DIAL REST Service" as S
participant "DIAL client" as C
opt
note right of S: Does app exist or have data to communicate to client?
C->S: (1) GET <Application-URL>X
S-->C: (2) 200 OK
end
note right of C: Launch app X
C->S: (3) POST <Application-URL>X (optional argument)
S->F: (4) Launch app (send additionalDataUrl)
S-->C: (5) 201 CREATED w/LOCATION header
opt
note right of C: additionalData flow
F->S: (6) POST <additionalDataUrl> (message body)
C->S: (7) GET <Application-URL> X
S-->C: (8) 200 OK (returns XML document containing additionalData)
C->F: (9) DIAL client(s) can communicate directly with first-screen application
end
```

CHANGE HISTORY

Version 2.0.1

1. 7.3: Recommending a more aggressive Wake-on-LAN magic packet emission to increase odds of first screen seeing packet.
2. Annex A: Clarified that the number of `additionalData` child elements is unbounded by adding a `maxOccurs` attribute.

Version 2.0

1. Modified the protocol to explain how a second-screen device can use Wake-on-LAN (WoL) or Wake-on-Wireless-LAN (WoWLAN) to power on a first-screen device, thereby enabling the second-screen device to start and interact with applications on the first-screen device.
    a. 5: Updated the sequence diagram to reflect the storage of device data.
    b. 5.2: Added instructions for including a `WAKEUP` SSDP header in an `M-SEARCH` response if the first-screen device sending that response supports WoL. This section also provides guidance for storing data about known DIAL servers.
    c. 7: Added section that explains process of waking a device using DIAL. The section includes background information about WoL and WoWLAN, implementation details, instructions for discovering first-screen devices that support DIAL Wake-up, and instructions for waking a device using DIAL. Renumbered remaining sections accordingly.
    d. Annex B: Updated sample M-SEARCH response in section B.2.
2. 5: Added explanation that a DIAL client SHOULD support connections to the collection of:
    a. Active DIAL servers discovered during this process
    and
    b. Previously discovered WoL-capable DIAL servers on the same SSID as the DIAL client.
3. 5.3: Modified content to note that a DIAL client MAY, rather than SHALL, issue a device description request by sending an HTTP GET request to the URL received in the `LOCATION` header of the `M-SEARCH` response described in section 5.2. Generally, a DIAL client uses the `M-SEARCH` request and response to verify that the DIAL server device is still available and does not need to repeat requests for the device description.
4. 6.1.2: Added `<service>` element and its attributes to table that lists elements of a DIAL server response. This update does not reflect a change to the actual format of a DIAL server response.
5. 6.1.2: Clarification of `additionalData` element definition.
6. Added section 6.2.2.1: 'HDMI-CEC Integration'.
7. 6.3.1: Note restriction that key names sent in `additionalDataUrl` must be within US-ASCII range [0-9a-zA-Z] and that key name must be rejected with an HTTP `400` response if it contains characters outside of the supported range.
8. 6.3.2: Additional information on how DIAL server decodes values in the POST body and that the POST body must have content type `x-www-form-urlencoded`.

9. Added section 9: 'Out-of-box experience'
10. Added *Appendix A: Designing a client device UI*. This section provides guidance for a DIAL client that lists DIAL servers to which the client device can connect.
11. Annex B.6, B.7: `href` attribute value correction.
12. Annex B.9: Request body correction.
13. Annex B.11: Content-type correction.

Version 1.7.2

1. Added section 6.5: 'CORS Requirements and CORS Access Control Policy'.

Version 1.7.1

1. Modified Annex B.9 to clarify the use of `additionalDataUrl`.
2. Modified Annex B.3, B.5, B.8, B.9 to clarify what sends and receives the message examples.

Version 1.7

1. Modified the protocol to explain how a first-screen application can send data back to the DIAL server, which the DIAL server can communicate to any second-screen device that contacts it.
    a. Added steps to sections 3.1, 3.2, and 3.3.
    b. Added section 3.4, which explains use case of a second-screen application connecting to an already running first-screen application.
    c. 6.1.2: Added `<additionalData>` element to table.
    d. 6.3.1: Added instructions for including `additionalDataUrl` in request to launch first-screen application. Note that the `additionalDataUrl` MUST be sent to the first-screen application every time it is launched, even when the first-screen application is not started by the DIAL server.
    e. 6.3.2: Added section explaining how to send additional data from a first-screen application to a DIAL server and how to relay that information from the DIAL server to DIAL clients that try to launch or retrieve information about that application.
    f. Annex A:
        i. Modified XML schema to contain `<additionalData>` element.
        ii. Modified XML schema to add an optional DIAL version attribute to the `<service>` element of the Application Information response.
    g. Annex B: Reordered sample messages and added messages:
        i. B.7 (Application Information response for application that allows multiple connected users)
        ii. B.9 (Application launch request with additionalDataUrl)
        iii. B.11 (Application request sending additional data to DIAL server)
2. Reordered subsections of 6.1 as follows:
    - 6.1: Querying for application information
    - 6.2: Launching an application
    - 6.3: Sending additional data from a first-screen application to a DIAL server

- 6.4: Stopping an application

3. 6.1.2: Cleaned up element and attribute definitions. Moved details about installable applications to the description of the `installable=` value in the `<state>` element's definition.

Version 1.6.5

1. Modified section to 6.1.3.2 to break down the `rel` and `href` attributes in separate rows. Updated the schema in Annex A to no longer reference the Atom schema's definition of LinkType. LinkType is now entirely defined in this spec.
2. In section 6.1.1.2 clarified that the Application Instance URL may only be used to **stop** the running instance of the application and not to request information.
3. Replaced 'backslash' with 'slash' in paragraphs 5.4 and 6.1 to describe the '/' character in a URL.
4. Specified that the default value for the `@allowStop` attribute is true in section 6.1.3.2

Version 1.6.4

1. Title: Cleaned up title page.
2. 6.1.1.1: Added recommendation to send a "Content-Length: 0" header when POST is empty to avoid receiving a possible "411 Length Required" error.

Version 1.6.3

1. 6.1: Simplified the explanations of the concatenation rules for the application name with Application-URL.
2. 6.1.1.1: Added emphasis on security measures when handing off DIAL payload to application in implementation notes.
3. 6.1.1.2: Clarified we are talking about the LOCATION header.
4. 6.1.1.2: Implementation notes: Clarified that restarting an application due to a modified DIAL payload is only allowed if an application provider allows it.
5. 6.1.3.2: Clarified that an application that has just launched (is starting) should be reported as "running".
6. Added CHANGE HISTORY section to document.