Crestron Linn Driver

for SIMPL Windows

Installation Guide

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Introduction

This document aims to provide guidance in setting up a Crestron project that utilises the Crestron Linn Driver for SIMPL Windows. This set of SIMPL modules offers an interface for network control over several Linn DS/DSM devices including the Linn Kustom DSM. The driver operates by utilizing Linn's custom-install **Gateway API*** software. Rather than handling one-to-one communication between Crestron processor and (potentially several) Linn devices the gateway API arranges all Linn products on a local network into a **house topology** and manages control. By default, the maximum number of **rooms** allowed by this driver in a setup is 20. This gateway API is available on any **Core4** Linn device (see https://docs.linn.co.uk/wiki/index.php/Category:CORE4) or by having a device running Kazoo Server. Only one instance of the gateway is required. The Gateway API is enabled on Linn devices through the advanced settings in Linn's 'manage systems' web configuration. The Gateway API will be automatically discovered on the local network on start-up. Control over the devices is then accessed through a **Crestron control point** (CCP). A list of available features is given below:

- Room selection - each CCP has an actively selected room within the house topology that can be changed via the CCP itself.
- Grouping - the current **grouping** of rooms set via Kazoo/LinnApp will be reflected in the room selection menu and automatically update whenever a change in grouping occurs.
- For each room/device in the house, the user has control over the following DS functionalities:
    - Standby control - each room can be individually toggled between standby states.
    - Volume control - step up/down, set to absolute value, and toggle mute.
    - Toggle shuffle and repeat states for appropriate sources.
    - Transport control over any active playlist - play, pause, play/pause toggle, skip previous, skip next.
    - Source selection - capable of selecting external sources on a DS.
    - Metadata – view metadata for the currently playing item including artwork.
    - Seeking – view the time elapsed, time remaining, and the time progress on a gauge bar for the active track. Input to move to a new time position within the active track.
    - Pin selection - as on physical Linn DSM devices, customizable buttons can be set up using a Linn control point (Kazoo/LinnApp) to provide easy access to favourite radio stations, playlists, or external sources. The name and associated artwork for each pin can also be accessed via the module and displayed on a CCP interface.
- Standby states of all rooms within the house can be changed quickly and directly from a room selection menu without having to select the room as the active room of a CCP first
- Through SIMPL Windows, a CCP can be set to lock onto a certain room if that room is found through the gateway API. Useful for systems where perhaps only 1 Linn DS is in use and allows room selection to be omitted from the CCP.
- For more advanced macro functionality, a serial input optionally allows programmers to run **LPEC** commands directly to devices in the house from the Crestron processor.

This driver is built in a modular format to allow for different third-party streaming services to be added in separate modules which can be added/omitted from the setup as per the customer's requirements. The currently available modules:

*definitions/explanations of terms given in bold font are provided in the glossary section

- Airable radio – browsing of airable radio stations with a search feature. Once found stations can be selected for playback, favourited/unfavourited, or assigned to pins on the DS of the active room.

This list of services will be expanded in the future with Tidal and Qobuz being the next two scheduled for development.

Note: this driver is designed for use in SIMPL Windows and is not a *Crestron Driver* designed for use with the Crestron Home OS.

Requirements

Access to Crestron's pool of software (SIMPL Windows, Toolbox, Vision Tool Pro-e, etc) is required for setting up a system. A Crestron 4-series control processor is also required. Earlier Crestron control processors (3-series and before) are not compatible for use with this driver.

An intermediate level of Crestron installation experience is required for the setup and integration of this module into a project; particularly in working with SIMPL Windows and Vision Tools Pro-e (or HTML5). No SIMPL+ or SIMPL# programming experience is required for a basic installation.

An understanding of Linn DS/DSM product functionality is also assumed including the Kustom DSM with its stream and zone architecture. The Kustom DSM is a product by Linn designed for use within custom installs and will therefore commonly be used in conjunction with this driver (for further information see: https://docs.linn.co.uk/wiki/index.php/Kustom_DSM)

Driver Overview

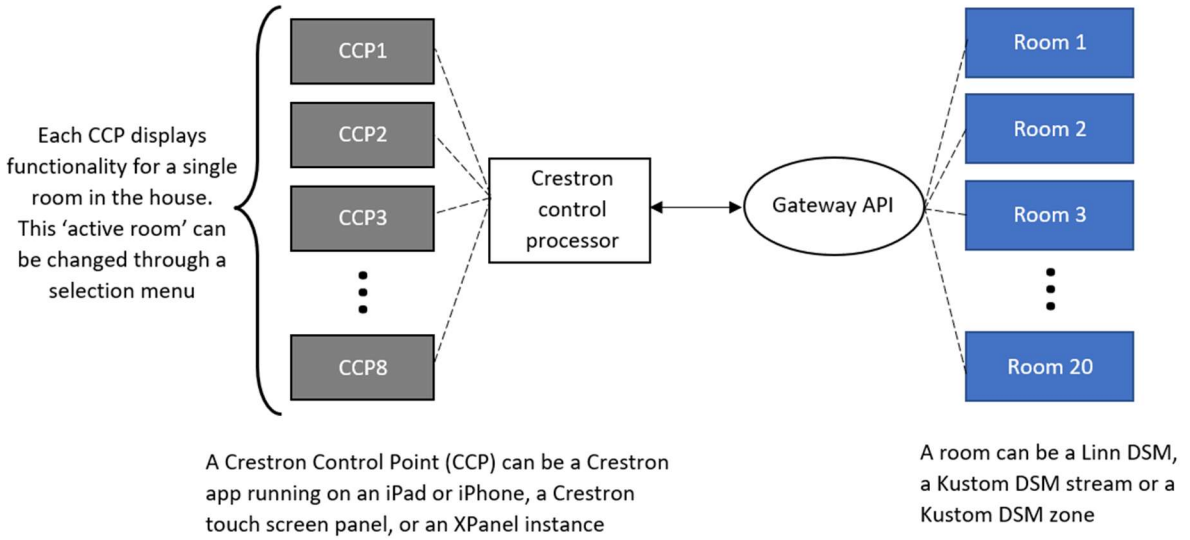

Fig. 1 – Overview of a setup using the Crestron Linn Driver for SIMPL Windows. By default, there can be up to 20 Linn 'rooms' on the local network that the Gateway API will organise and communicate with. The Crestron control processor will communicate and receive any changes that occur with these devices. You can add as many Crestron control points (CCP) as needed for the devices you have available (Touch panels, iPads etc). These will be located around the house and are used to control the functionality of these rooms. Each CCP will have one active room selected at any time that can be changed through the room selection menu.

An overview of the basic structure of a setup incorporating this driver can be seen in Fig. 1. The driver itself has two core SIMPL modules/symbols that need to be incorporated in a SIMPL Windows project:

- **LinnDriver**
  - This is the 'brain' of the driver that is responsible for establishing communication with the Gateway API and managing information received from it to update CCPs accordingly.
  - The SIMPL symbol's interface is shown in Fig. 2. The module is headed by essential inputs and outputs. The macro command input that allows for more advanced scripting of macros also appears here.
  - The following section, minimized in Fig. 2, contains information shared across all CCPs about the rooms within the house. This information is used by the room selection menu which contain the names of every room and individual, toggleable standby control buttons.
  - The module/symbol contains several parameters. Some of these are optional such as overriding the discovery mechanism by entering the gateway API IP/port manually. The processor IP and image paths are required for the image files of source types. All these are explained in greater detail in the section 'Module Parameters'.

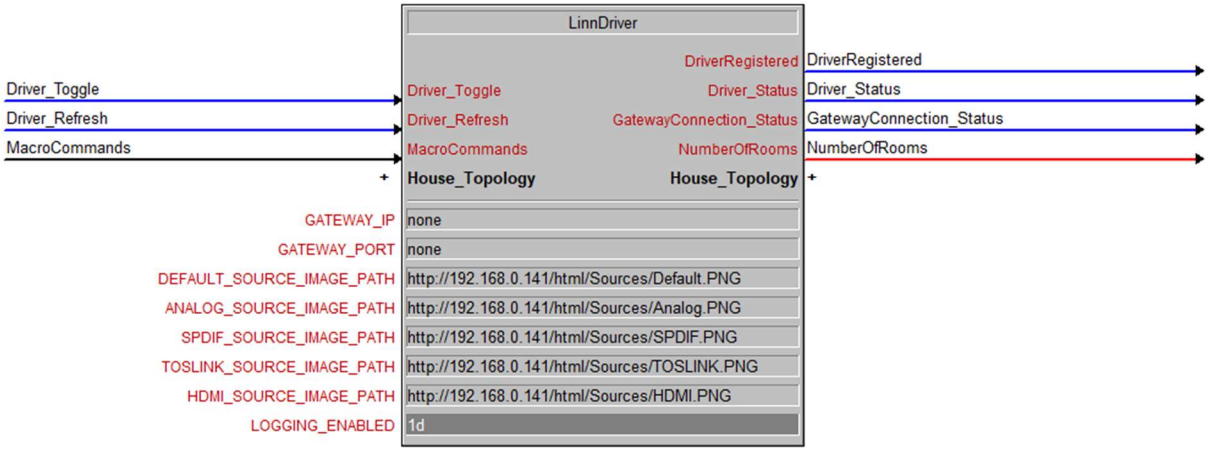

Fig. 2 – Overview of the LinnDriver SIMPL module. Some basic information about program and gateway connection state as well as the macro command input and the number of rooms in the active topology are given at the top. This is followed by a section containing shared information about each room in the house. At the bottom, a number of parameter fields are also visible which will be explained in detail.

- **LinnControlPoint**
  - This SIMPL modules provides all the unique input and output signals required within a CCPs GUI. One of these must be added for each CCP used in the house setup, as shown in Fig. 3, and given a unique name in the module parameter. Each CCP is able to select an active room from the list of devices on the local network.
  - On start-up of the program these modules will automatically register themselves with the main driver module. No connection of signals between the *LinnDriver* module and the *LinnControlPoint* module is required.
  - The list of input and output signals contained in the module covers all the basic functionality outlined in the introduction. A description of all these input and output signals is given in Section '*LinnControlPoint* Signal List'.

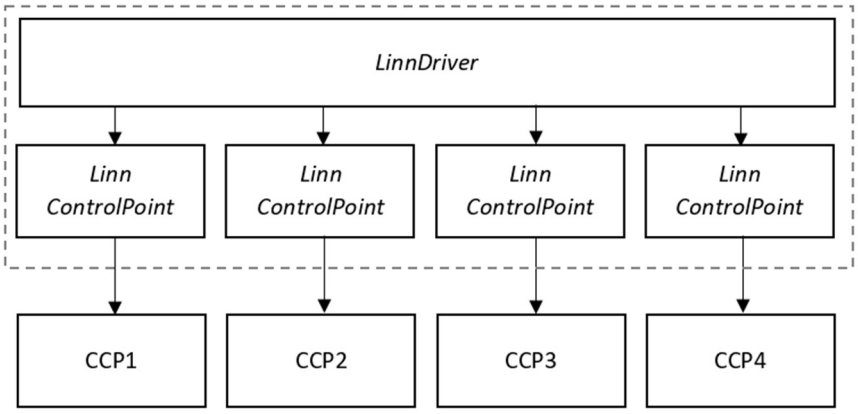

Fig. 3 – Structure and connection between the two core modules that make up the program. Control Point modules only need to be added if they are necessary in the project setup: for example, the above setup only contains 4 CCPs and therefore only uses 4 instances of the *LinnControlPoint* module.

Demo Project

A demo project is provided alongside this driver's basic components. The example GUI design .vtp file is not intended to be used in a Crestron customer setup but rather to be a point of reference and for helping understand how to implement this driver in a project. It is expected that other home automation aspects unique to the customer will also be included in the project and controlling Linn products will not be the sole function of the Crestron system (although it is certainly possible). The Linn driver is designed to work alongside these other features.

One particular facet of the demo project that it is highly recommended to follow is the use of digital, analog, and serial joins from the VisionTools Pro-e project. A non-exhaustive list of examples where following the demo project signal joins becomes useful:

1. Transport controls will become greyed out when not applicable to the active source.
2. Standby buttons on the room selection menu will be hidden where they are irrelevant.
3. Loading processes will be made visually cleaner.

The demo contains a setup that includes 2 CCPs under ethernet devices: the first being an XPanel instance and the second being an iPad. These both utilise identical GUI projects (*Linn_Demo_XPanel.vtp* and *Linn_Demo_iPad.vtp* for respective device types) however this does not have to be the case in a customer project.

Control Point GUI Setup

A GUI will have to be designed for use with this driver. This is completely customisable and should be tailored to the Crestron customers unique requirements but will generally feature a similar structure. The functionality in the demo project is split into some basic pages:

- Home page
- Now playing page
- Room selection page
- Source selection page
- Pin selection page
- Pages for any added services (explained further in dedication sections)
- Settings page

The home page contains *page flip* references to the other pages and can be returned to at any point by pressing the home button. In a customer's project this is fully flexible and be changed to the designers liking. Some tips towards building a GUI project that includes this driver are detailed later in this document.

Making Modifications to the Driver

The SIMPL# code is precompiled, and it is not possible to make changes. Uninformed changes to the SIMPL+ source code files will likely cause serious problems in the user experience. However, some aspects such as the maximum room count can be modified with some Crestron programming experience. To increase the maximum number of rooms, open the SIMPL+ files for *LinnDriver.usp* and *LinnControlPoint.usp* and change the value for the #DEFINE_CONSTANT MAX_ROOMS. After recompiling the SIMPL+ source files, the accompanying SIMPL Windows modules will have to be adjusted to accommodate the extra signals. For further information, advice or to request modifications, please contact: helpline@linn.co.uk.

Signal Suffix Types

Some general conventions for suffixes are used in the naming of module inputs and outputs and are outlined below.

Suffix	Type	Description
_Toggle	Digital Input	An input which will toggle a functionality.
_Select	Analog Input	An input to the module used to select an item in a list.
_Status	Output (Any type)	An output which gives feedback of the current state of a GUI feature. For example, the digital high or low state of a mute button, or a string containing track metadata.
_Available	Digital Output	Output signals used to make buttons controlling corresponding inputs unavailable. For example, depending on the current source of a DS features like shuffle and repeat may not be relevant and hence should not be available for selection in the CCP.
_Visible	Digital Output	Output signals used to make buttons controlling corresponding inputs invisible in certain situations.

LinnDriver Signal List

Beginning at the top of the LinnDriver symbol, previously shown in Fig. 2, there are signals for the general operation of the driver.

Inputs

Name	Type	Description
Driver_Toggle	Digital	Toggles the driver between being in a disabled or active state. Defaults to the enabled state on loading to the Crestron processor.
Driver_Refresh	Digital	If program is active, this will refresh the program. All known data about Linn devices and their states will be reset and the current Gateway API session will be closed and re-established.
MacroCommands	Serial	Used for sending LPEC commands directly to rooms within the house. Optional advanced feature, explained in greater detail in *Macro Commands* section.

Outputs

Name	Type	Description
DriverRegistered	Digital	On loading the program, the driver will register itself. If not high, then an error has occurred.
ProgramActive_Status	Digital	Indicates the current active state of the driver. If active this will be high in value, else it will be low.
GatewayConnection_Status	Digital	Indicates the current state of the connection with the gateway API. If a connection is open this will be high in value, else it will be low.
NumberOfRooms	Analog	Once a connection to the gateway API is established this signal will output the number of rooms (more specifically, the number of lines required in a list of rooms within the house).

Room Section

The following sets of signals provide information about the rooms within the house. This information is shared across all CCPs and will be used in the room selection menu of every CCP.

Inputs

Name	Type	Description
Room[1-20]_Standby_Toggle	Digital	Directly toggle the standby state of the corresponding room.

Outputs

Name	Type	Description
Room[1-20]_Standby_Status	Digital	Give the standby state of the rooms in the current house setup. Note: Digital signal high for standby off (i.e., room turned on), low for standby on.
Room[1-20]_Standby_Visible	Digital	Must be used to set the visibility of the room standby buttons. In some cases, with the Kustom DSM, a standby button should not be visible.
Room[1-20]_Text	Serial	The names of the rooms in the current house setup.

Module Parameters

Name	Description
GATEWAY_IP	Optional: By entering a valid IPv4 address into this field, the automatic discovery mechanism will be overridden, and this address will be used instead.
GATEWAY_PORT	Optional: By entering a valid port number (integer 1025-65536) into this field, the default gateway port number of 4100 will be overridden.
DEFAULT_SOURCE_IMAGE_PATH	Enter the local path for the image that will be used for source that don't conform to any of the following types.
ANALOG_SOURCE_IMAGE_PATH	Enter the local path for the image that will be used for external sources of the analog type.
SPDIF_SOURCE_IMAGE_PATH	Enter the local path for the image that will be used for external sources of the SPDIF type.
TOSLINK_SOURCE_IMAGE_PATH	Enter the local path for the image that will be used for external sources of the TOSLINK type.
HDMI_SOURCE_IMAGE_PATH	Enter the local path for the image that will be used for external sources of the HDMI type.
LOGGING_ENABLED	Use to enable logging on the Crestron console for debugging purposes. *0d* for disabled *1d* for enabled.

The set of parameters for source image paths are used to provide appropriate images on-screen for the various external source categories. For the external sources of a Linn DSM there is no standard metadata artwork image that is used. This is left up to the installer to choose with the aim that images are chosen that fit with the theme of the Crestron project GUI.

The first step is to take the image files and host them locally on the Crestron processor using FTP or Crestron Toolbox. Once transferred the paths for these image files can be obtained. These will take the form of "*http://192.168.0.141/html/Sources/Analog.PNG*" depending on their location. These paths can now be inserted in the parameter fields.

LinnControlPoint Signal List

This module acts to modularise the functionality that is common across CCPs, keeping the *LinnDriver* module's interface clean. All inputs from buttons and feedback to the GUI for basic functionality is made available through this SIMPL module. One of these should be added for each CCP that is used in the project configuration. The signal list will be detailed in full here.

Section A – CCP Information, Room/Source Information & Standby

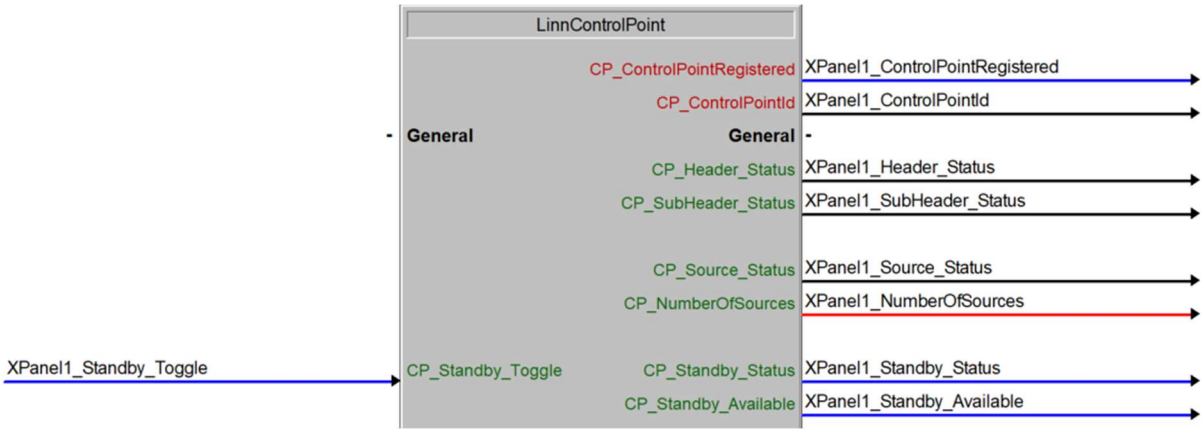

Fig. 4 – Screenshot of the first portion of signals in the *LinnControlPoint* SIMPL module

Inputs

Name	Type	Description
CP_Standby_Toggle	Digital	Toggle the standby state of the room currently selected by the CCP.

Outputs

Name	Type	Description
CP_ControlPointRegistered	Digital	On loading the program, the control point will register itself. If not high, then an error has occurred.
CP_ControlPointId	Serial	The name of the control point as set through the CONTROL_POINT_NAME parameter.
CP_Header_Status	Serial	This text output will give primary information about the current state of the CCP. It will display text when searching for the gateway connection or loading and give information about which room within the house topology is currently selected by the CCP.
CP_SubHeader_Status	Serial	This text output is used for secondary information about the current state of the CCP. Used when a **listening room** is selected, the listening room's name will be output through this signal.
CP_Source_Status	Serial	This text output shows the current source selected by the active room of the CCP.
CP_NumberOfSources	Analog	Updated with the number of sources for the room currently selected by the CCP. Used by the source selection menu subpage to determine the number of items in a list.

CP_Standby_Status	Digital	Gives feedback for the standby state of the room currently selected by the CCP. Note: Digital signal high for standby off (i.e., room turned on), low for standby on.
CP_Standby_Available	Digital	Must be used to define the availability of the standby control button. For cases where no room is actively selected the standby button in the CCP should become unavailable.

Section B – Volume & Transport Control

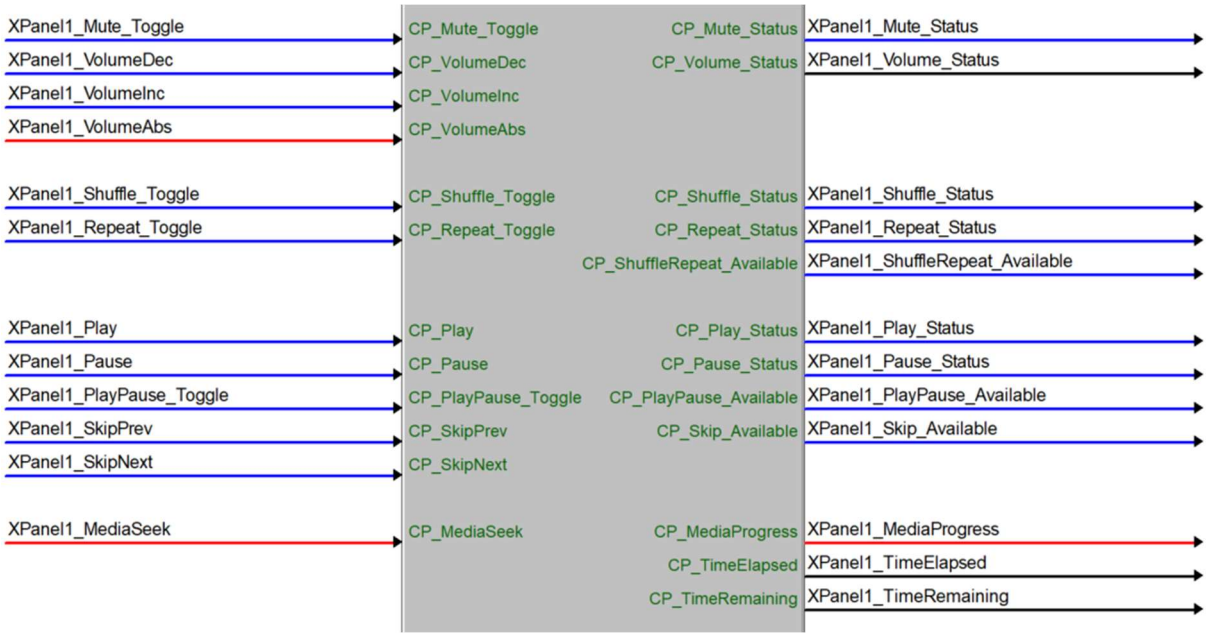

Fig. 5 – Screenshot of the second portion of signals in the *LinnControlPoint* symbol

Inputs

Name	Type	Description
CP_Mute_Toggle	Digital	Toggle the mute state of the room currently selected by the CCP.
CP_VolumeDec	Digital	Decrease the volume of the room currently selected by the CCP by 1. Held presses will cause the volume to ramp at a rate of 4/second.
CP_VolumeInc	Digital	Increase the volume of the room currently selected by the CCP by 1. Held presses will cause the volume to ramp at a rate of 4/second.
CP_VolumeAbs	Analog	Sets the volume using the absolute value of the analog input. Any time a change is made to this signal the room's volume will be set to that value.
CP_Shuffle_Toggle	Digital	Toggle the shuffle state of the room currently selected by the CCP.
CP_Repeat_Toggle	Digital	Toggle the repeat state of the room currently selected by the CCP.
CP_Play	Digital	Set the transport state of the room currently selected by the CCP to play.

CP_Pause	Digital	Set the transport state of the room currently selected by the CCP to pause.
CP_PlayPause_Toggle	Digital	Toggle the transport state of the room currently selected by the CCP between play and pause. Alternative to individual play and pause buttons.
CP_SkipPrev	Digital	Skip backward to the previous item in the active playlist.
CP_SkipNext	Digital	Skip forward to the next item in the active playlist.

Outputs

Name	Type	Description
CP_Mute_Status	Digital	Gives feedback for the mute state of the room currently selected by the CCP.
CP_Volume_Status	Serial	This text output shows the current volume level of the active room of the CCP.
CP_Shuffle_Status	Digital	Gives feedback for the shuffle state of the room currently selected by the CCP.
CP_Repeat_Status	Digital	Gives feedback for the repeat state of the room currently selected by the CCP.
CP_ShuffleRepeat_Available	Digital	Must be used to define the availability of the shuffle and repeat toggle buttons. For cases where these buttons are irrelevant for the actively selected room's source these will become unavailable in the CCP.
CP_Play_Status	Digital	Gives feedback for the play state of the room currently selected by the CCP.
CP_Pause_Status	Digital	Gives feedback for the pause state of the room currently selected by the CCP.
CP_PlayPause_Available	Digital	Must be used to define the availability of the play and pause buttons. For cases where these buttons are irrelevant for the actively selected room's source these will become unavailable in the CCP.
CP_Skip_Available	Digital	Must be used to define the availability of the skip prev and skip next buttons. For cases where these buttons are irrelevant for the actively selected room's source these will become unavailable in the CCP.

Section C – Seeking & Metadata

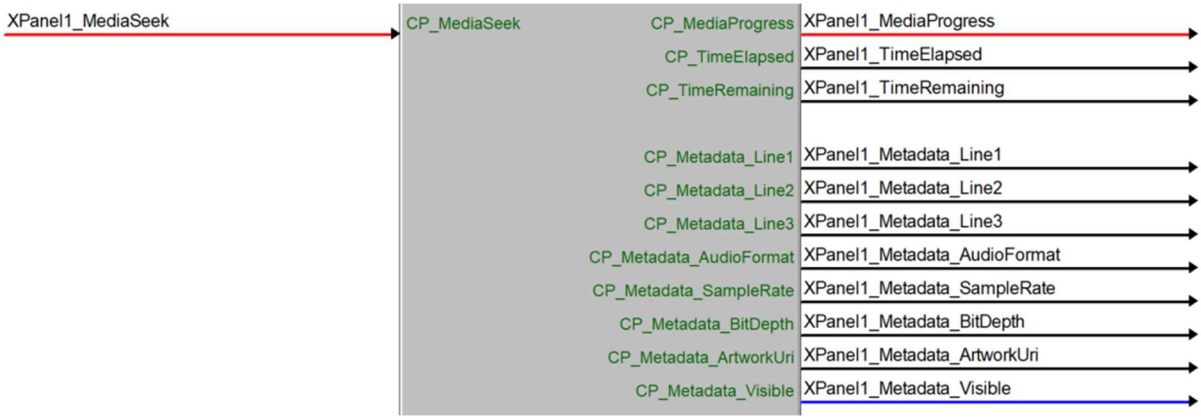

Fig. 6 – Screenshot of the third portion of signals in the *LinnControlPoint* SIMPL module

Inputs

Name	Type	Description
CP_MediaSeek	Analog	For relevant sources, move to a new position in the currently playing track. Use an integer value in the range 0-255, this will be mapped as a percentage.

Outputs

Name	Type	Description
CP_MediaProgress	Analog	For relevant sources, gives feedback for the progress of the currently playing track. Progress is mapped as an integer value between 0-255.
CP_TimeElapsed	Serial	This text output shows the time elapsed for the currently playing item (uses format hh:mm:ss).
CP_TimeRemaining	Serial	This text output shows the time remaining for the currently playing item (uses format hh:mm:ss).
CP_Metadata_Line1	Serial	This text output contains the first line of metadata for the active room of the CCP. Commonly, a track title, radio station name, or external source name.
CP_Metadata_Line2	Serial	This text output contains the second line of metadata for the active room of the CCP. Commonly, an artist name or radio metatext.
CP_Metadata_Line3	Serial	This text output contains the third line of metadata for the active room of the CCP. Commonly an album name.
CP_Metadata_AudioFormat	Serial	This text output contains the audio format for the active room of the CCP.
CP_Metadata_SampleRate	Serial	This text output contains the sample rate for the active room of the CCP.
CP_Metadata_BitDepth	Serial	This text output contains the bit depth for the active room of the CCP.
CP_Metadata_ArtworkUri	Serial	This text output contains the artwork URI for the active room of the CCP.
CP_Metadata_Visible	Digital	Used to define the visibility of the metadata. Hides metadata during standby and loading processes.

Section D – Pins

Inputs

Name	Type	Description
CP_Pin[1-6]	Digital	Select the corresponding pin for playback for the room currently selected by the CCP

Outputs

Name	Type	Description
CP_Pin[1-6]_Available	Digital	Used to define the availability of the corresponding pin buttons. For cases when a pin is empty, loading or no room is currently selected
CP_Pin[1-6]_Name	Serial	This text output contains the name of the item the pin contains for the active room of the CCP.
CP_Pin[1-6]_ArtworkUri	Serial	This text output contains the artwork URI of the item the pin contains for the active room of the CCP.

Section E – Room & Source Selection

These final sets of signals are related to the room and source selection pages.

Inputs

Name	Type	Description
CP_Room[1-20]_Select	Digital	Select a room from the corresponding list to become the new active room of the CCP.
CP_Source[1-20]_Select	Digital	Select a source from the source list of the active room to become active.

Outputs

Name	Type	Description
CP_AnyRoom_Selected	Digital	Used to indicate if any room is actively selected on the CCP. Digital high if so, low if not.
CP_Room[1-20]_Selected	Digital	Whichever room in the topology is currently active on the CCP will be shown in this set of digital outputs. Gives feedback for the room selection list by allowing it to highlight the active room.
CP_Source[1-20]_Selected	Digital	Whichever source is currently selected for the active room of the CCP will be shown in this set of digital outputs. Gives feedback for the source selection list by allowing it to highlight the active source.
CP_Source[1-20]_Text	Serial	A set of serial signals which are populated with the names of the sources for the currently active room on the CCP. Used by the source selection list.

Module Parameters

Name	Description
CONTROL_POINT_NAME	A name that describes the control point (eg. Hallway TP, Living Room iPad). Must be unique from other control point module instances. Used for debugging purposes and for associating additional service modules.
DEVICE_LOCK	Optional: By entering a name (or **UDN**) of a device/room the control point will automatically select that room if it is present in the house. **If no device lock is in use enter "none" as the parameter value.**

Design Tips

Room Selection Page

The room selection page from the demo project is shown in Fig. 7. This page was built in VisionTools Pro-e and uses a 'Crestron Subpage Reference List' item. This object takes in a reference to another subpage (a list item) and forms a list of these. This is to allow for standby buttons for each room in the house topology to be present next to the room names. Care must be taken when designing a similarly presented room selection feature for a customer's project. Pay specific attention to the way that digital join increments are used and how the formatted text labels contain the serial joins.

It can also be seen in Fig. 7 that rooms are presented in a list with any existing groupings shown via use of indentation. Rooms within the house are ordered automatically and these indentations are prepended to the output strings. Also note the invisibility of standby buttons for Kustom streams within a group led by itself. This is simply to avoid multiple buttons which serve identical functionality.

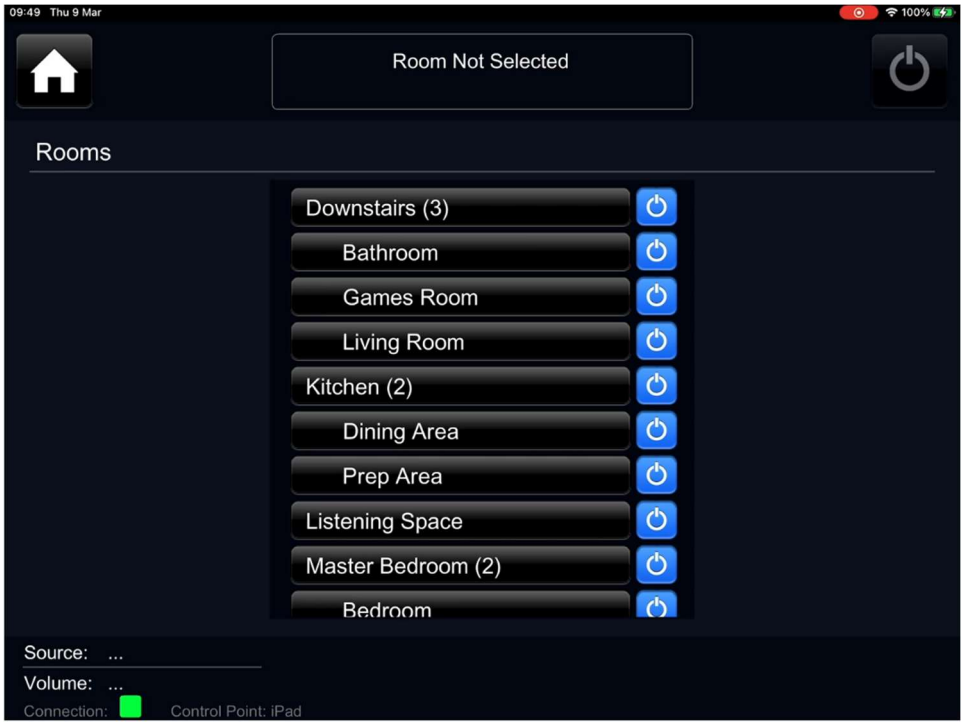

Fig. 7 – Screenshot of the room selection menu/sub-page for the demo project with an example house setup. The first group is a Kustom DSM stream with 3 listening zones. Further down a standalone DSM named *Listening Space* can be seen.

Pin Usage

Pins can play an important role in a Crestron project utilising this driver. The digital inputs exposed through the module work in the same manner as the physical pins on Linn Majik/Selekt/Klimax DSM devices and causes them to load a media item set through a Linn control point (Linn Kazoo, Linn App) or through the driver itself.

These can be set to be external sources, radio stations, playlists, or albums. This allows the customer to quickly select from a set of favourite media items directly through a CCP. These pins should be configured during the setup process however a customer is free to reconfigure these themselves if they wish to and they will be automatically updated for the Crestron system.

External Source Invisibility

Linn DS/DSM devices have a range of external inputs available however not all may actually be in use. It is recommended that unused ports are hidden via the configuration settings in the Manage Systems of the customer's Linn account. Ports can also be given more relevant names as to what they contain (i.e., 'HDMI1' could be renamed to 'PS5'). These settings will be reflected in the source selection menu of the CCP using the Linn driver and keep the interface tidy.

Multi-Byte and International Fonts

Working with metadata for music from streaming services will mean the occasional encountering of text which contains characters outside the ASCII character set (for example Chinese, Russian or Korean characters). There is support built into the driver to allow for these to be displayed. For this to work the theme "Standard Theme International.xml" must be used in a VisionTools Pro-e project. The font "Arial Unicode MS" must also be used for the text labels where this is relevant. This is demonstrated in the demo project included with this driver. For more information see the official Crestron guide: https://support.crestron.com/app/answers/detail/a_id/5264/kw/utf-8.

Driver Enable and Refresh Buttons

The *Driver_Toggle* and *Driver_Refresh* digital inputs do not need to be placed in obvious locations of the project interface as the driver is automatically enabled on start-up and will automatically attempt to reconnect when required. It is recommended that they are attached to a button somewhere on the CCP though. If your project contains a generic settings page, it could prove useful to include these buttons as an easy method for resetting the driver in the case of unexpected problems.

Single Room Setups

For Crestron projects that implement this driver where there is only one Linn device in the setup there are additional advisory steps. For these setups there is no reason to utilise room selection and it is recommended that the device lock parameter for all CCPs is set to the single room's name (or UDN). The result of this is that the device will be automatically selected on start up.

Macro Commands

The serial input *MacroCommands*, is included as a simple way to allow for more direct control of DS functionality. This input utilises the LPEC protocol that can be used to control Linn DSMs over a Telnet connection. Upon loading the driver, telnet sessions are automatically opened and setup for all available rooms and can then be used at any point to send LPEC commands. The format of messages sent to this serial input should be of the form:

> *<Room Name> LPEC Command*

For example, to set the volume of a DS:

> <Living Room> Action Ds/Volume 2 SetVolume “45”

The driver will search for room that matches the name in the chevrons (angle brackets). If the room is found the LPEC command will be forwarded to that device, else it will be discarded.

The protocol does included scope for eventing (ie. service’s events can be subscribed to and subsequent changes in the evented variables will cause unsolicited event messages to be sent from the device). This should not be used however as there is no handling of responses over the socket connection. Any changes caused by actions will cause a response from the gateway API that will correctly update the values within the setup. **Note: the LPEC protocol is not compatible for use with Kustom zones.** For further information about this protocol see: https://docs.linn.co.uk/wiki/index.php/Developer:LPEC

A SIMPL+ module could be written to allow for macro a series of commands to be sent out from a single button press. A single button press could result in a series of commands being sent out to multiple devices. If doing so it is recommended that a small DELAY is placed between each setting of the serial input. For example:

```
soMacroCommands = "<Living Room> Action Ds/Volume 2 SetVolume \"45\"";
DELAY(5);     // a 50ms delay
soMacroCommands = "<Dining Room> Action Ds/Volume 2 SetVolume \"65\"";
```

Services

With this new Crestron driver comes new support for the browsing of streaming services. Currently only Airable radio is supported but this list will be added to in the future. It is planned that the next major release will include support for Tidal and Qobuz streaming services. This support is optionally added to a project through a modular technique. In Fig. 8 a program view containing the logic of the demo project is shown. The services are added to each control point as an optional "bolt-on" SIMPL module containing all the necessary signals for browsing.

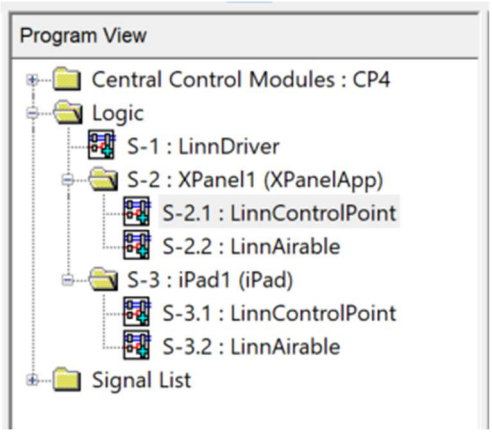

Fig. 8 – Screenshot of the program view for the demo project with a setup of two control points named "XPanelApp" and "iPad". Alongside each control point module there is also an optional "LinnAirable" module which contains all the signals required for browsing of the Airable radio service

This modular technique means that, in the future, when several services are available an installer need only set up the ones required by the customer. To associate a *LinnControlPoint* module with a service module (eg. *LinnAirable*) simply ensure that the CONTROL_POINT_NAME parameter of both modules is identical. The driver will handle the rest! In this section, instructions will be given on how to setup these service modules.

Airable Radio

Airable radio is a popular internet streaming platform that grants customers live access to radio stations around the world. It's inclusion in this driver allows for browsing of several categories and a search feature to quickly find a desired radio station. Once found, a station can be selected for playback, favourited/unfavourited, or added to one of the active room's pins. There is a set structure for how this service will be set up in a project that should be followed.

On start up the module will register the service module and find the control point that it will be associated with by looking for the matching control point name defined in the module parameters. Some key signals regarding the status of the service module are given at the top of the module as shown in Fig. 9.

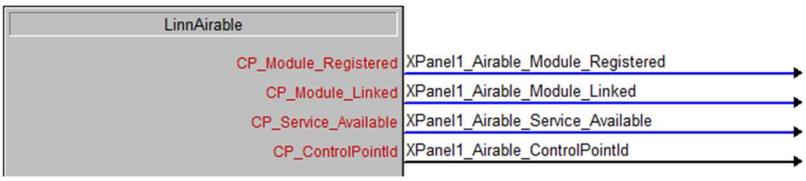

Fig. 9 – Screenshot of the first portion of signals in the *LinnAirable* SIMPL module

Outputs

Name	Type	Description
CP_Module_Registered	Digital	On loading the program, the service module will register itself. If not high, then an error has occurred.
CP_Module_Linked	Digital	After registering, the service module will search for a control point to associate itself with. If this step fails, this signal will remain low and indicates an error has occurred. Ensure that the CONTROL_POINT_NAME parameters are identical and unique from other CCPs.
CP_Service_Available	Digital	Used to indicate if the airable service is available for the actively selected room on the CCP. Digital high if so, low if not. Should always be available as long as your Linn DS device is registered with a Linn account.
CP_ControlPointId	Digital	The name of the control point as set through the CONTROL_POINT_NAME parameter.

Main Page

The main page of the airable service is shown in Fig. 10. It can be seen that there is a list of categories, or *containers*, in a list down the left-hand side. These contain collections of radio stations made by Airable. The favourites container has the stations favourited by the user on the Airable account associated with the Linn DS. The favourites container is selected automatically on start-up and will populate the item list on the right. Selecting a different container from the list will select it as the new *active container*. This will load a new page of items on the right-hand side. Up to 20 items are viewable in the page. If the container has more than 20 items in it, the page previous/next buttons will become available, and you will be able to move forward and backwards through pages to view more items.

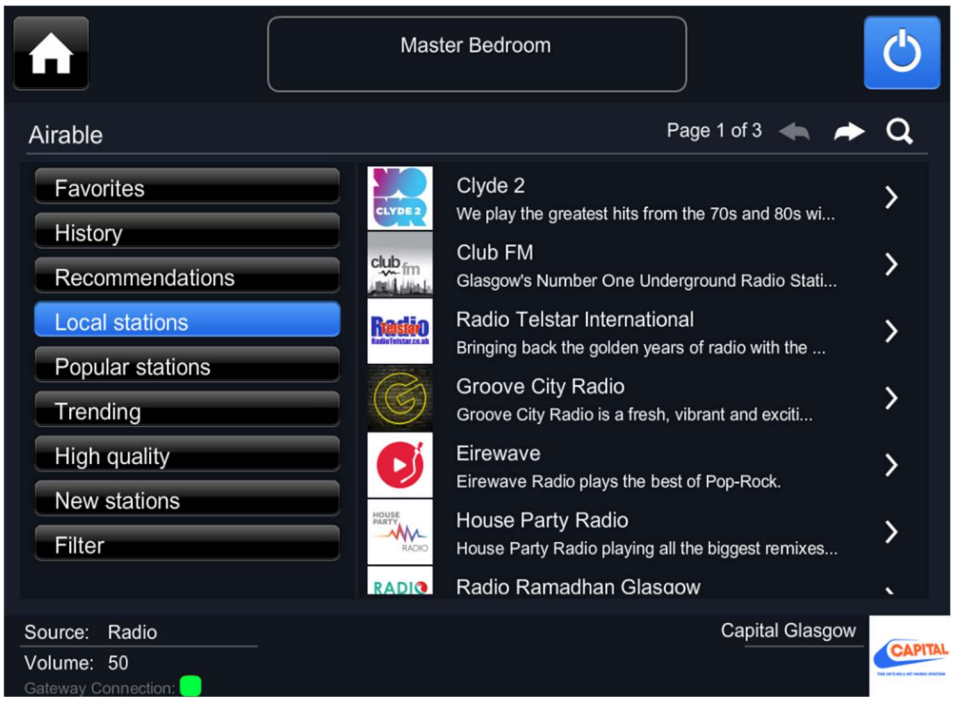

Fig. 10 – Screenshot of the main page for Airable in the demo project. Down the left-hand side of the page are the containers – i.e., some useful categories for browsing and exploring radio stations. Once a container is selected the lists of items on the right side will populate. A maximum of 20 items is viewable. A pagination system is used when more than 20 items are available, and the user can move back and forward through pages using the buttons at the top. The right arrow visible next to each item opens up the "action page" which will be explained shortly.

Inputs

Name	Type	Description
CP_PrevPage	Digital	If possible, change to previous page in the currently selected container.
CP_NextPage	Digital	If possible, change to the next page in the currently selected container.
CP_Container[1-20]_Select	Digital	Used to select a container for browsing its contents.
CP_Item[1-20]_Select	Digital	Used to select an item within the active container for playback.
CP_Item[1-20]_Action	Digital	Used to select an item within the active container for use by the action page.

Outputs

Name	Type	Description
CP_PrevPage_Available	Digital	Used to define the availability of the previous page button. For example, when on the first page the previous page button will be unavailable.
CP_NextPage_Available	Digital	Used to define the availability of the next page button. For example, when on the last page the next page button will be unavailable.
CP_CurrentPage	Analog	Numeric value of the current page number for the active container. Will display zero if no container is selected.
CP_MaxPage	Analog	Numeric value of the maximum page number for the active container. Will display zero if no container is selected.
CP_PageInfo	Serial	A string containing info about the current page for the active container. Eg. “Page 1 of 5”.
CP_NumberOfContainers	Analog	Numeric value of the number of containers found for the service.
CP_AnyContainer_Selected	Digital	Used to indicate if any Airable container is actively selected. Digital high if so, low if not.
CP_Container[1-20]_Selected	Digital	Whichever container is currently selected will be shown in this set of digital outputs. Gives feedback for the container list by allowing it to highlight the active container.
CP_Container[1-20]_Name	Serial	Contains the names of the available containers for the Airable service.
CP_NumberOfItems	Analog	Numeric value of the number of items in the current page for the active Airable container.
CP_Item[1-20]_Name	Serial	Contains the names of the items for the current page of the active Airable container.
CP_Item[1-20]_Description	Serial	Contains the descriptions of the items for the current page of the active Airable container.
CP_Item[1-20]_ArtworkUri	Serial	Contains the artwork URIs of the items for the current page of the active Airable container.
CP_Item[1-20]_Action_Visible	Digital	Used to define the visibility of the action buttons. Used to hide the action buttons for the *By Location/Language/Genre* filter items.

Search Page

For finding a specific station from Airable's library, a search function is available. In the demo project a page is dedicated to this functionality that is brought up by pressing the magnifying glass button seen in Fig. 10. From the search page, shown in Fig. 11, the user can enter a search argument in the text entry box and, after hitting enter, the list below will populate with results. There is no pagination available for search results so there is a maximum of 20 results displayed. If the user does not find the desired result in the top 20 results, they will need to refine their search. The top 3 items in the search results are filters that can also be used to refine the search. Here again, each item can be selected directly for playback, or the right arrow button can be pressed to load the item into the *action page*.

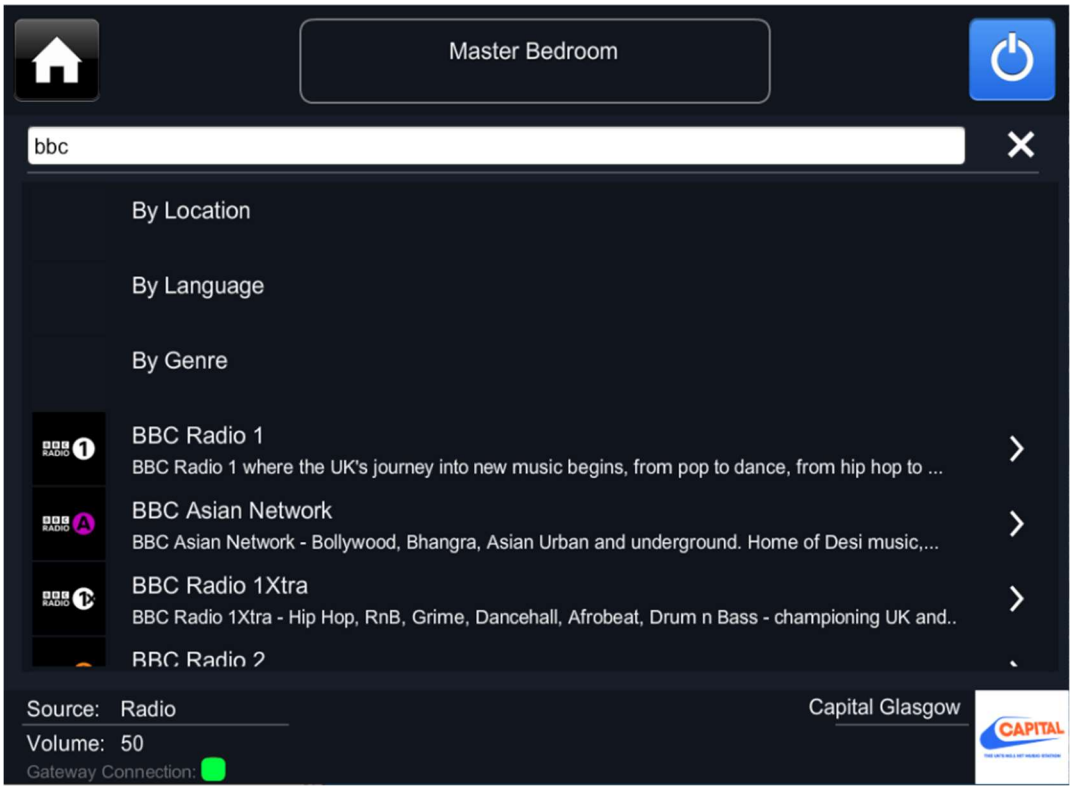

Fig. 11 – Screenshot of the search page for Airable in the demo project. The search entry bar at the top is used to enter a search argument and, after pressing enter, 20 search results will load. The *By Location/Language/Genre* items can be used to apply filters on the results. The right arrow on the result items is used to load the item the action page. In this demo project, pressing the 'X' button will return the user to the Airable main page.

Inputs

Name	Type	Description
CP_SearchTextEntry	Serial	Use for the enter text for the search of the Airable service. Search is not begun until the digital signal below is made high.
CP_Search	Digital	Begin the search process using the string value entered in the serial signal above.
CP_Search[1-20]_Select	Digital	Used to select an item from the search results for further browsing or playback.
CP_Search[1-20]_Action	Digital	Used to select an item from the search results for use by the action page.

Outputs

Name	Type	Description
CP_NumberOfSearchResults	Analog	Numeric value of the number of items in the active search result.
CP_Search[1-20]_Name	Serial	Contains the names of the items in the active search results
CP_Search[1-20]_Description	Serial	Contains the descriptions of the items in the active search result.
CP_Search[1-20]_ArtworkUri	Serial	Contains the artwork URIs of the items in the active search.
CP_Search[1-20]_Action_Visible	Digital	Used to define the visibility of the action buttons. Used to hide the action buttons for the *By Location/Language/Genre* filter items.

Action Page

A dedicated button is given to directly select stations for playback in the main page and search page. Additional options for what to do with the station are made possible through the action page. When the action input signal is used for an item, it will be loaded to the action page. In the demo project, pressing one of these buttons will also do a page flip to the Airable action page. This page, shown in Fig. 12, gives option to play now, toggle the favourite status or set the station to a pin. The item currently selected to perform an action on is displayed at the top of the page.

Fig. 12 – Screenshot of the action page for Airable in the demo project. The name, description and artwork for the active action item are shown at the top. Dedicated buttons to play now, and favourite/unfavourite are seen below. The item can also be set any of the pins for the active room. The artwork URI signals from the control point module are used to show the items currently occupying the six pins. The 'X' button returns the user to the previous page.

Inputs

Name	Type	Description
CP_Action_PlayNow	Digital	Selects the current Airable action item for playback on the CCPs active room
CP_Action_Favourite_Toggle	Digital	Toggles the favourite status of the current Airable action item.
CP_Action_SetToPin[1-6]	Digital	Sets the current Airable action item to a pin on the CCPs active room

Outputs

Name	Type	Description
CP_Action_Favourite_Status	Digital	Indicates if the current Airable action item is favourited.
CP_Action_ItemName	Serial	Contains the name of the current Airable action item.
CP_Action_ItemDescription	Serial	Contains the description of the current Airable action item.
CP_Action_ItemArtworkUri	Serial	Contains the artwork URI of the current Airable action item.

The only parameter for the Airable module is the CONTROL_POINT_NAME:

Name	Description
CONTROL_POINT_NAME	A name that matches the name of the associated control point module.

Glossary

Core4 – A category of Linn DS products. A list of these devices, which are capable of running the Gateway API, can be found here: https://docs.linn.co.uk/wiki/index.php/Category:CORE4

Crestron control point (CCP) – A device through which the Crestron system is controlled (eg. Touch panel, iPad, Phone, XPanel application) with a GUI designed through Crestron's software tools.

Gateway API – Linn's own API for managing Linn devices across a local network. A WebSockets connection is established between the Crestron control processor and the gateway API and is used to learn about the devices within the network and control features on them. Comes included with Kazoo server software and on Core4 Linn DSM products.

Grouping – Linn devices are capable of being grouped together to allow two or more systems to play the same music in synchronisation. One device will lead the group and all listening devices will play the same output audio.

House Topology – The topology of Linn devices found by the Gateway API within a local network. Contained within this will also be information about groupings of devices, i.e., if there are devices on the local network that are listening to other devices. For the Kustom DSM there will be additional information about the arrangement of streams and zones.

Listening Room – When Linn DS devices are grouped to play the same audio, there will be one room that leads the group. The other devices are referred to as listeners or listening rooms.

LPEC – Linn Protocol for Eventing and Control, an existing protocol for direct control over Linn devices: https://docs.linn.co.uk/wiki/index.php/Developer:LPEC

Room – A room in Linn DS/DSM products refers to a single playable device. The majority of products Majik/Selekt/Klimax are equivalent to a single room. This is not as simple in the case of Kustom DSM where there are multiple devices contained within the one box. For more info on how streams and zones operate see https://docs.linn.co.uk/wiki/index.php/Kustom_DSM. More specifically, in this driver, a room refers to anything that could occupy a line on the room selection menu which could be a standalone Linn DS or a Kustom stream or zone.

UDN –A fixed device identifier for Linn DS devices. Can be used to ensure that rooms for device locking can be found even if their visible name is changed through system configuration. Can be found by looking through the Crestron control processor logs on start-up and looking for the */V2/topology/status* response.