

Smart Building Project - Phase 2

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Software Requirements Specification

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Assumptions

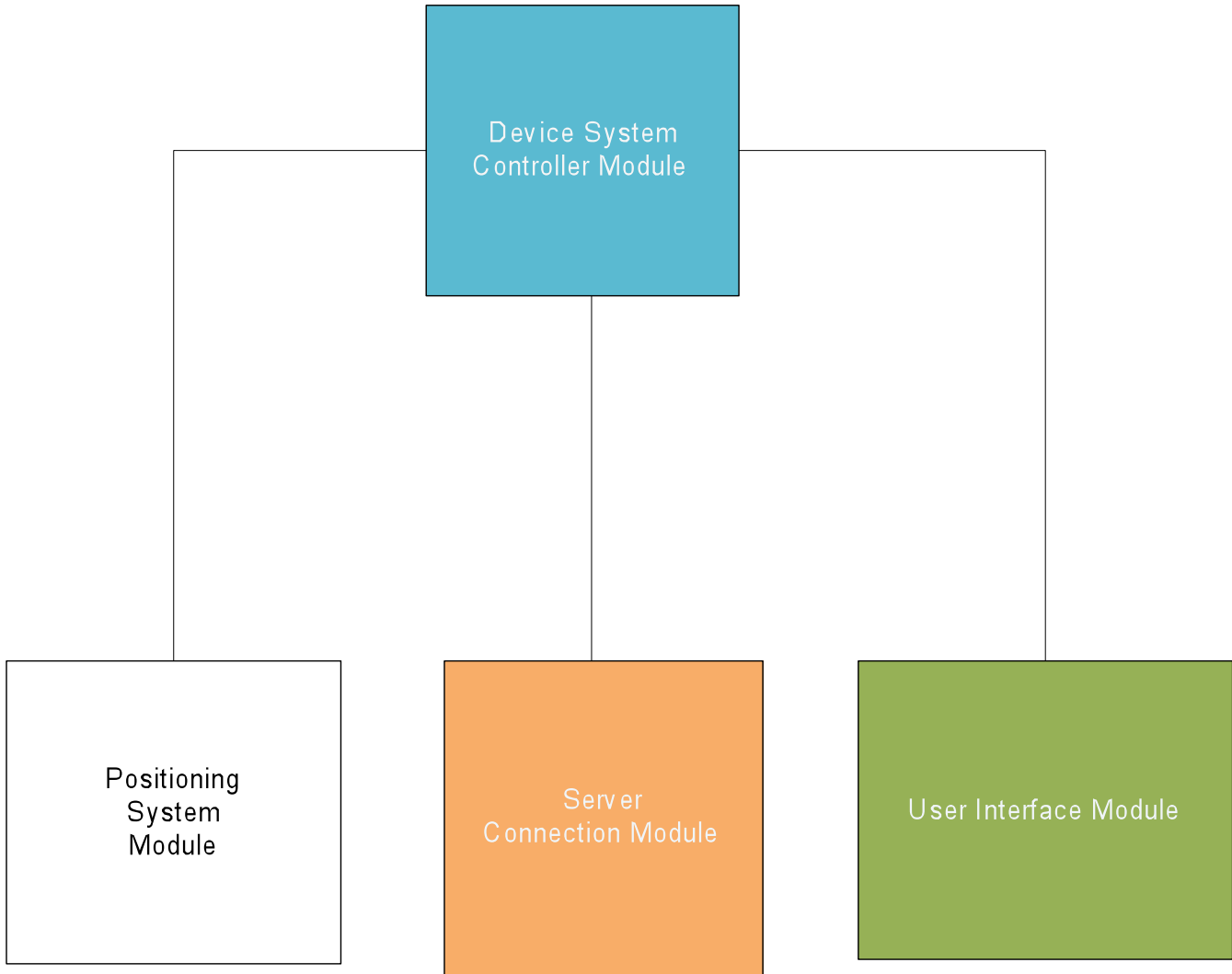
The following is a list of assumptions regarding the functionality of the Smart Building System.

- It is assumed that the user is able to hear, understand and speak English, in order to interact with the handheld navigation device. Users are visually impaired, but are able to hear and react to auditory navigational cues delivered by the device. These audio cues and voice recordings are the primary mechanism by which the device will convey routing and point-of-interest and safe travel routing information to the user. The device interprets and reacts to commands and requests spoken by the user.
- The device will provide navigational instructions, which are intended to guide the user along safe travel paths, between “points of interest” throughout the SmartBuilding. Routing data for the points of interest are stored in the system, and must remain accurate and up to date.
- The navigation system does not provide real-time obstacle avoidance. Moveable objects such as furniture are not tracked by the system. As such, it is necessary for users to be able to detect, avoid, and navigate past moveable obstacles in a manner that is independent of the device.
- The SmartBuilding system will be installed, configured, and maintained by (or with the knowledge of) SmartBuilding technicians. As part of the installation process, the building is mapped, points of interest are identified, and safe travel paths are established. Additions and modifications to the navigation data can be made at any time. SmartBuilding technicians will be responsible for overseeing and/or performing any post-installation modifications to the physical system or supporting software.
- A local server, running the SmartBuilding software, must be present to support the SmartBuilding system. The server must remain operational and responsive at all times, when devices are in use.

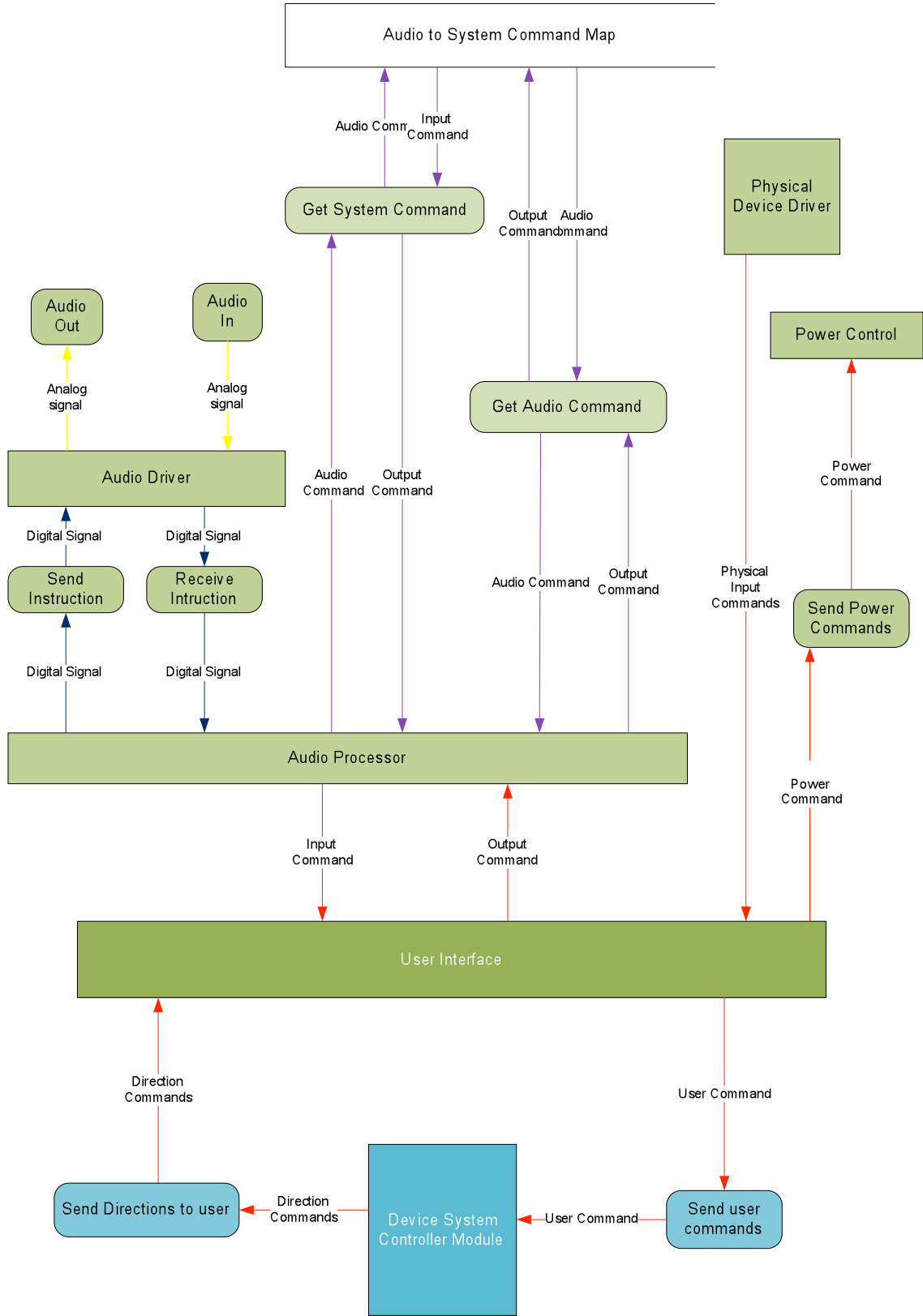
Limitations and Constraints

- A battery similar to that of a cellular phone will power the handheld device. Limited battery life may pose a limit to the reliability of the device.
- Due to the nature of wireless networking and navigational technology, there is no way to guarantee 100% accuracy or reliability. System or service outages due to power failure, hardware malfunction, loss of signal strength, etc. can potentially result in unreliable service.
- The network components will be installed indoors, and navigational assistance is limited to the inside of the building. Users who leave the building can no longer be guided by the system.
- There is a practical limit to the number of concurrent network connections the server can support, and the number of transmitters that can make up a navigational network. These limits have yet to be conclusively determined, but are expected to be high enough to be practically unrestrictive.

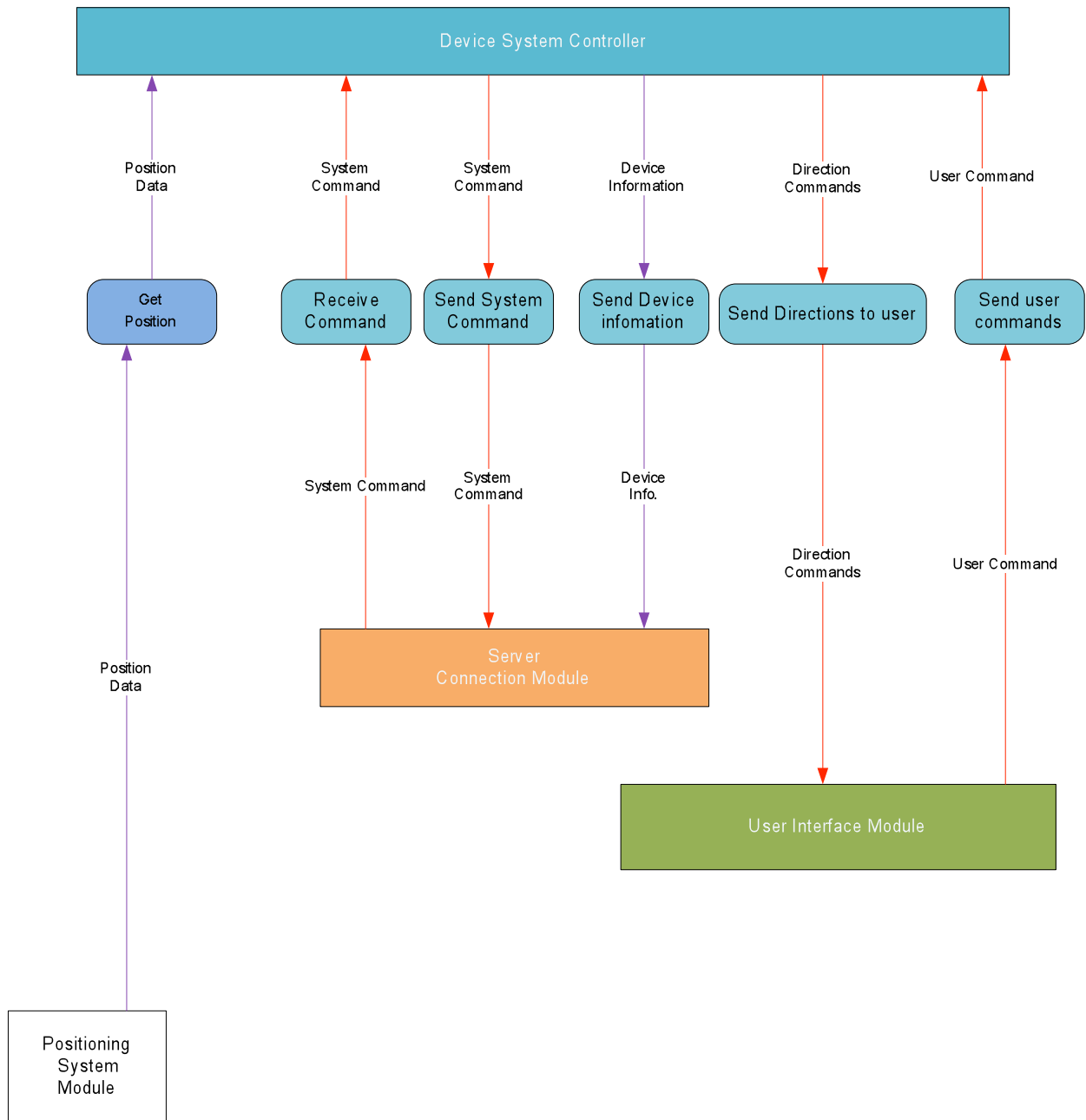
Functional Requirements: Device Information and Command Flow



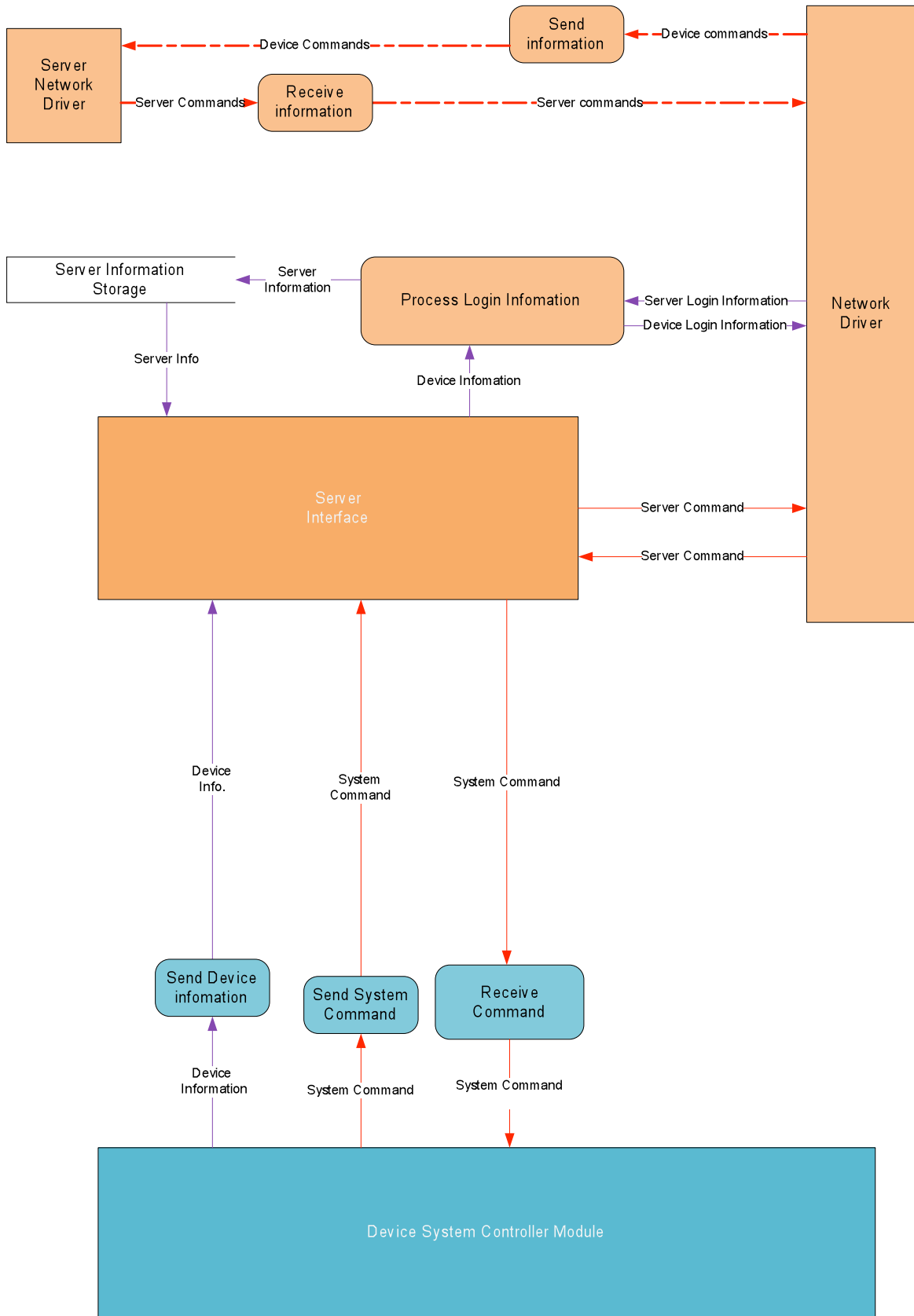
Functional Requirements: Device - User Interface Module



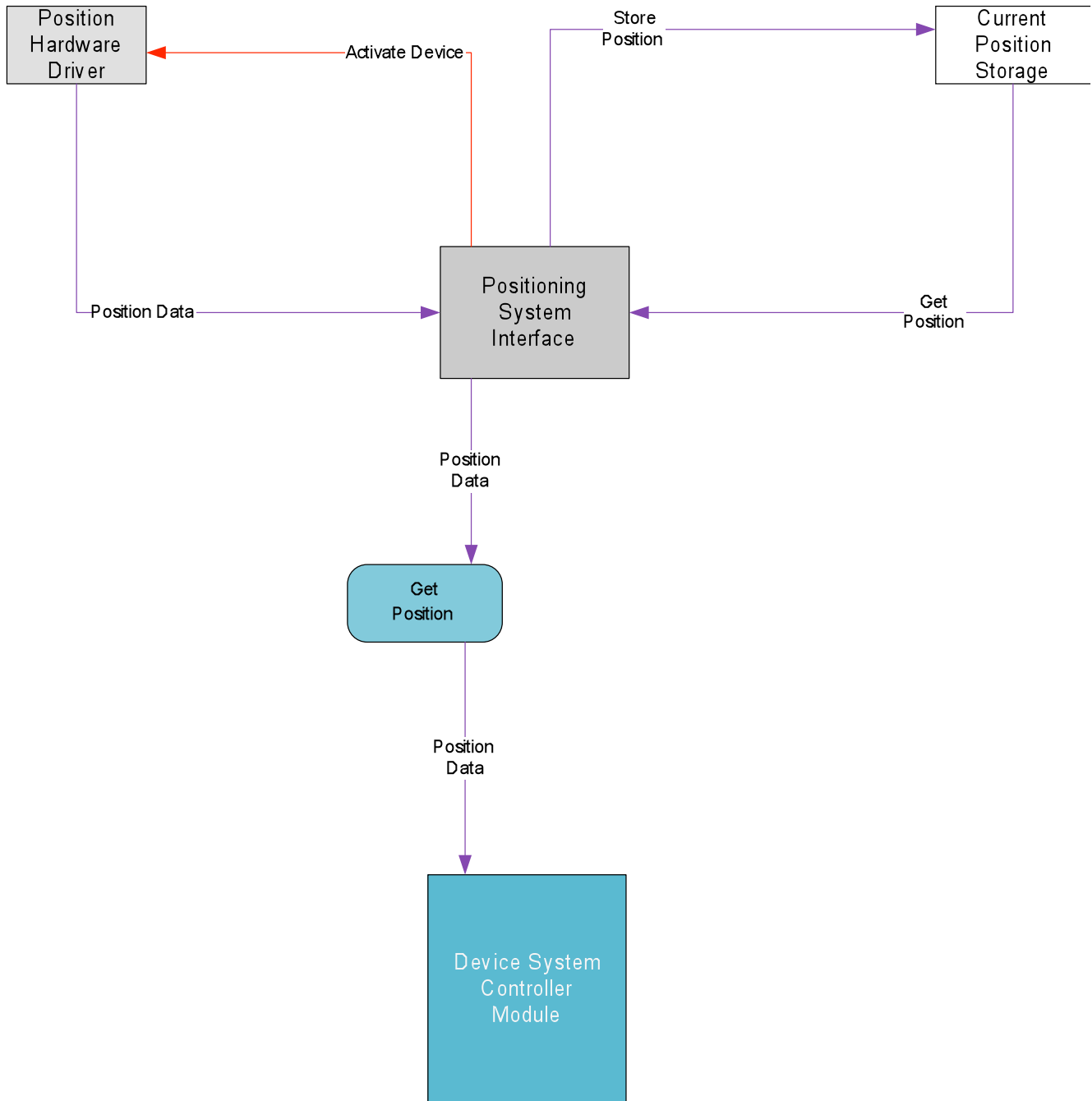
Functional Requirements: Device - System Control Module



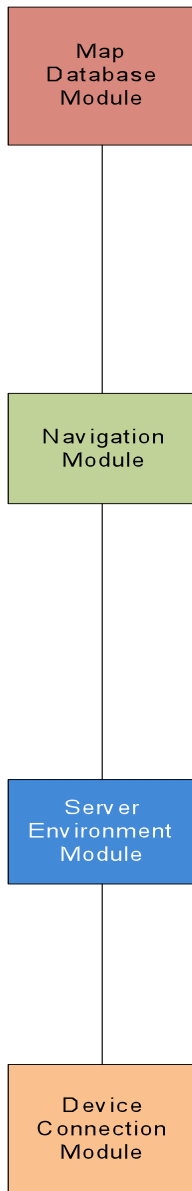
Functional Requirements: Device - Server Connection Module



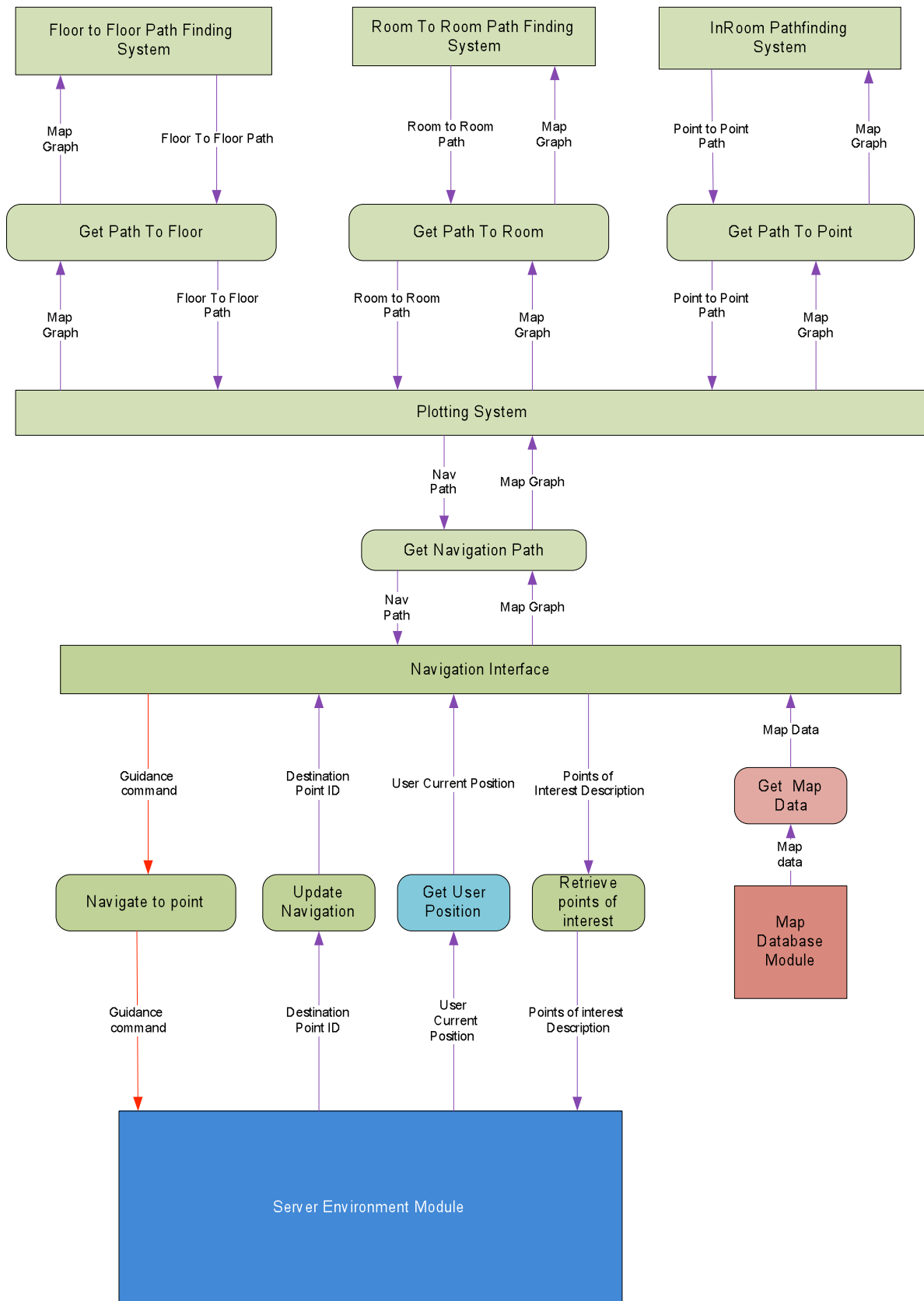
Functional Requirements: Device - Positioning System Module



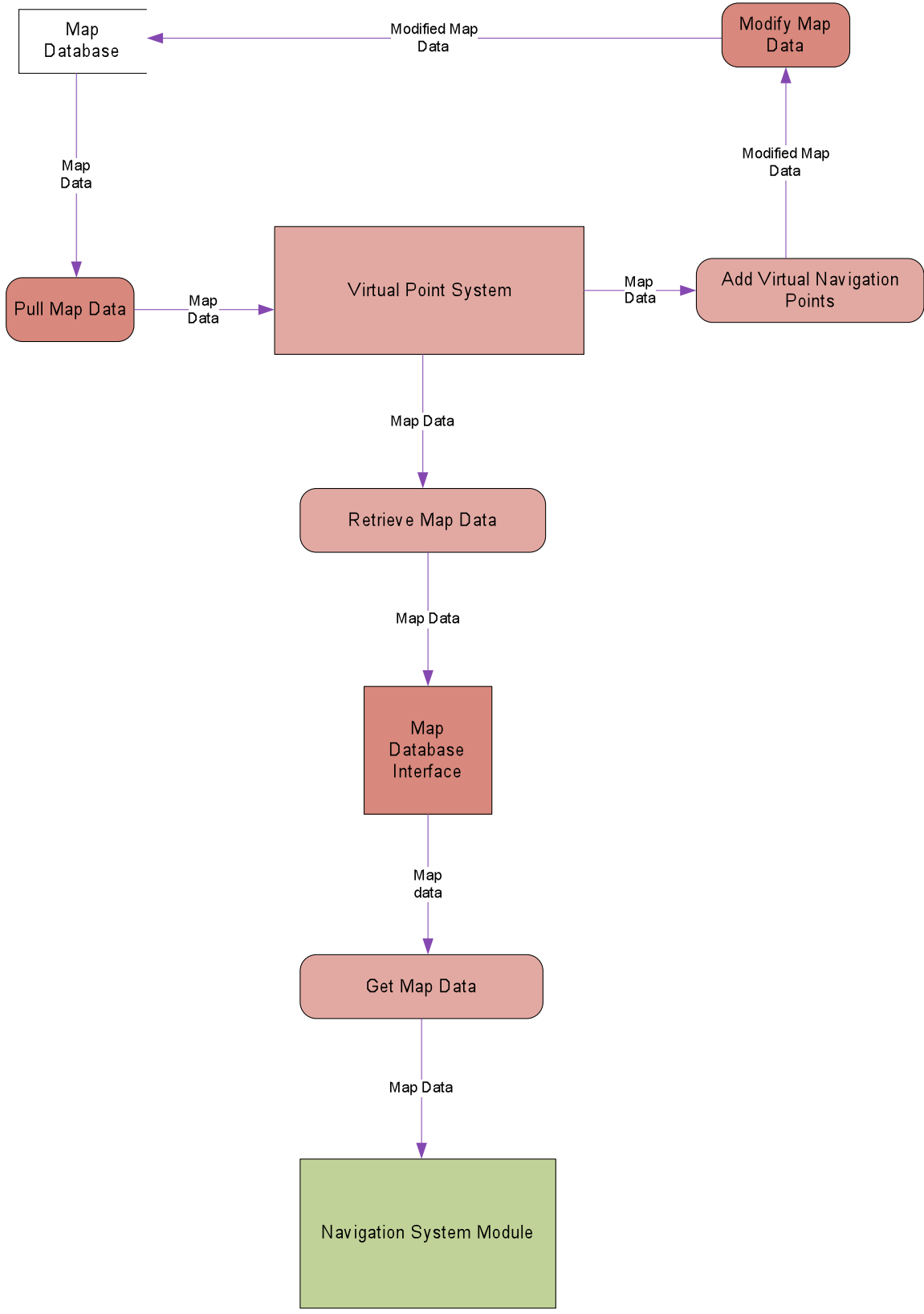
Functional Requirements: Server Module Coupling



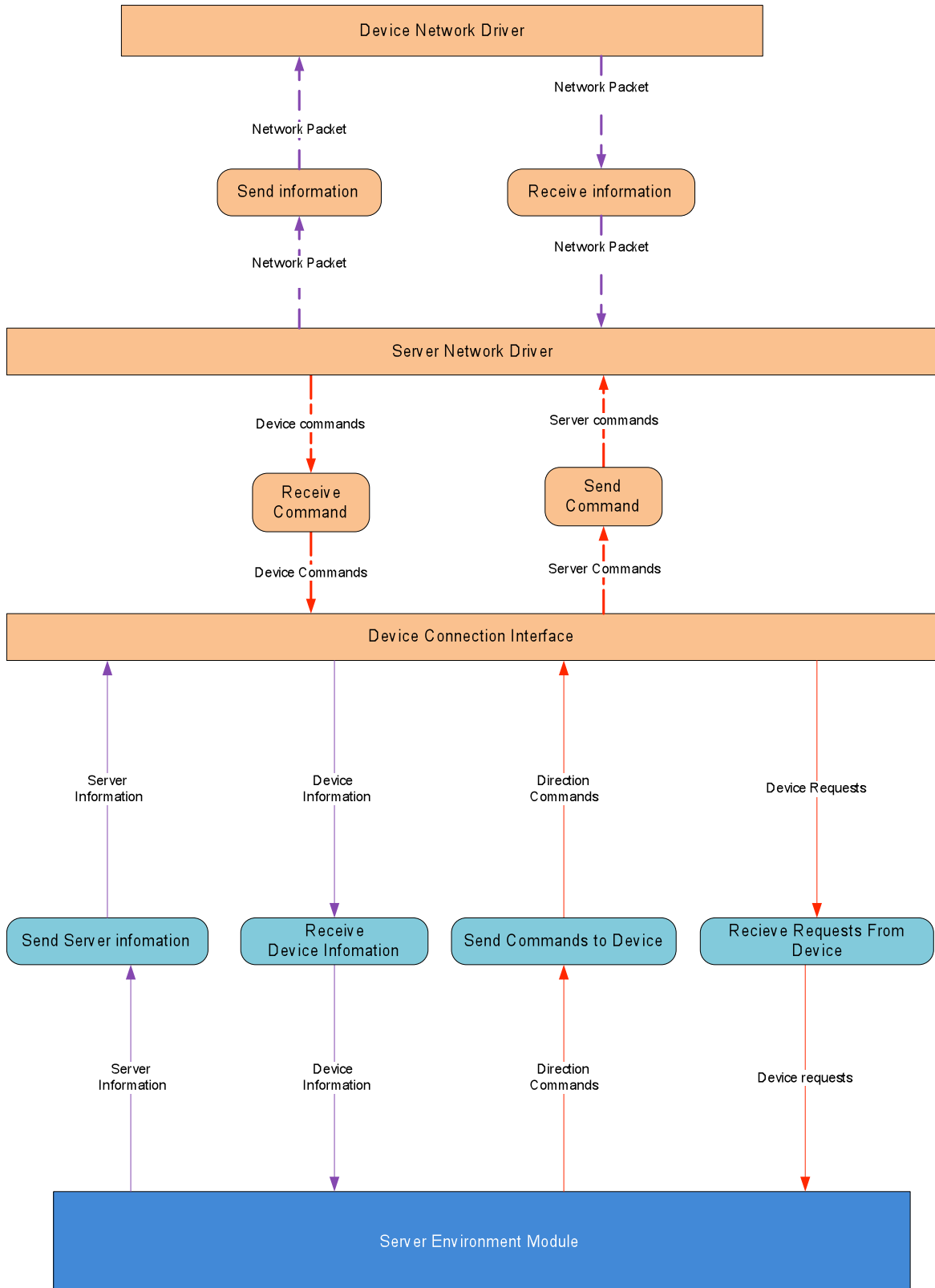
Functional Requirements: Navigation Module



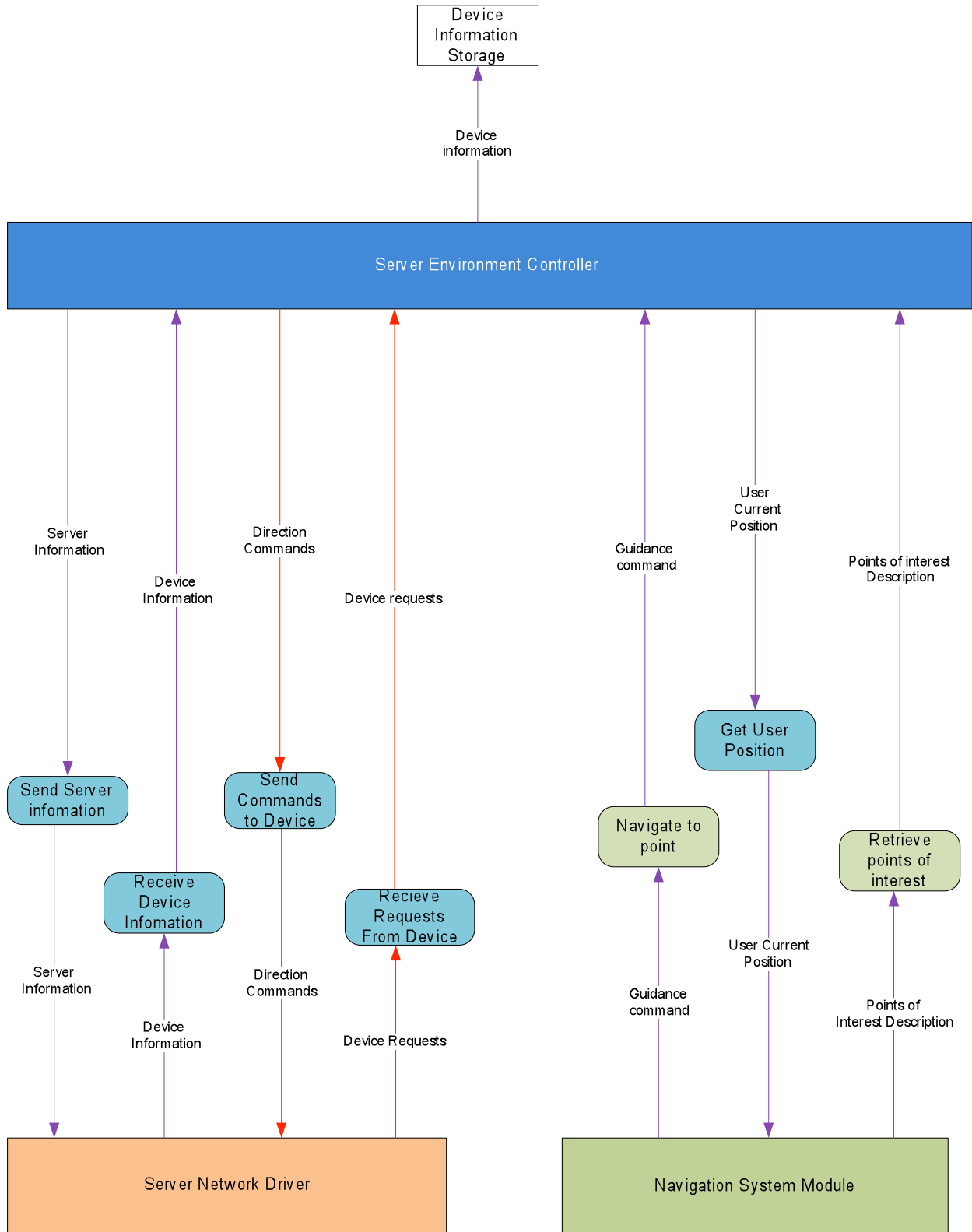
Functional Requirements: Map Database Module



Functional Requirements: Device Connection Module



Functional Requirements: Server Environment Module



Functional Requirements: System Narrative

High Level System Description

There are two significant components on this project, a user device, and central server. These two components communicate with each other over a wireless Zigbee network.

The device is capable of translating human speech into system commands which are sent to the server, and is also capable of calculating its current position as an XYZ coordinate using a Texas Instruments hardware system on a chip, which uses a proprietary algorithm to quickly calculate position based on known static points of Zigbee radio transmitters. It will also have some physical button inputs for vital system functions, such as power and emergency calls.

The server system instantiates a new environment for each device that connects to it, and using a central map database informs the user of local points of interest within the building at any level of detail requested (via voice commands from the device) and then navigating the user along a safe and expedient path to any point requested.

The server and device communicate through network drivers on each system, over the same Zigbee network used to determine the devices position.

User Device System

This is the system will be installed on the handheld device which the user will carry with them.

1. Device Controller module

- 1.1. Device system controller: The device controller is a top level supervisory module on the device. The device controller responds to the commands from the user, through the user interface in the user interface module, and from the server connection module, from the server interface within the server connection module. Commands are then routed to their destination with power commands sent to the power controller module, navigation requests from the user to the server, and navigation and POI information from the server to the user, as well as position information sent to the server. It utilizes the Power Control Interface, User Interface, and Server Interface to accomplish these tasks, thus decoupling the Device System Controller from the sub-systems of any other modules.

2. User Interface module

- 2.1. User Interface: User Interface takes decouples the User Interface Module from the rest of the system, allowing the actual external device interfaces to arbitrarily change without affecting the rest of the system. This allows us to test and develop without actually needing true user input and output immediately.
- 2.2. Physical Device Driver: The physical device driver will be anything other than audio input. For example, reset button, quick buttons, and volume dial will all be handled by this.
- 2.3. Power Controller: The power controller of the device is capable of adjusting the power of the device as necessary, be it on/off/sleep.
- 2.4. Audio Processor: The audio processor acts as a translator, converting audio data to system commands, and system commands to audio, by analyzing the audio data and utilizing the data stored in the audio to system command map.
- 2.5. Audio driver: This acts as an interface to the physical audio hardware, and will interpret hardware input as audio data usable by the audio processor. It will also convert audio data from the audio processor into hardware commands to produce the proper sound.
- 2.6. Audio to System command map: This is a physical memory storage area, possibly flash memory, which is used to store mapping of audio commands to system commands.

3. Server Connection Module

- 3.1. Device Network Driver: This driver controls the device network hardware, and is meant to deal with sending and receiving information over the network.
- 3.2. Server Interface: This acts as a virtual server which will translate all of the commands it receives from the device to be sent over the network driver, and interpret all incoming data from the network drivers as device commands (or rejecting bad data if it is received).
- 3.3. Server Information Storage: This is a memory storage used for storing any connection information necessary for the system to communicate with the server once it has established a connection.

4. Positioning System Module

- 4.1. Positioning System Interface: Interface for decoupling the positioning system module. All requests for the devices position must be made through this interface.

- 4.2. Position Hardware Driver: The position hardware driver controls the Texas Instruments position tracking chip, retrieving position data when requested.
- 4.3. Current Position Storage: This is simply a small memory space. It stores the current location of user. It makes for fast retrieval of the users last known position.

Server System

A central building server is connected to the Zigbee network, preferably through direct wiring to the propagator of the Zigbee network to ensure maximum reliability of the connection to the network. This system is the one which will be installed on the server to host environment for the devices to interact with.

5. Device Connection module

- 5.1. Server Network Driver: This driver controls the server network hardware, and is meant to deal with sending and receiving information over the network.
- 5.2. Device Connection Interface: This acts as a virtual device which will translate all of the commands it receives from the server to be sent over the network driver, and interpret all incoming data from the network drivers as server commands (or rejecting bad data if it is received).

6. Server Environment Module

- 6.1. Server Environment Controller: This controls the server, and provides a unique server “environment” for each device to interact with, so that multiple devices can operate simultaneously and independently on the same server.
- 6.2. Device Information Storage: This stores all of the information necessary to keep each of the devices uniquely identified, tracked and guided.

7. Navigation module

- 7.1. Navigation System Interface: This decouples the Navigation Module’s sub-systems from the rest of the server system. So long as this interfaces function calls remain unchanged, exterior modules will not need to be changed if the inner workings of the Navigation Module are modified.
- 7.2. Plotting System: Based upon the pre-calculation algorithm, which all map point stores the shortest path; the plotting system will be able to return a path between the user and the point of interest. By using a shortest path algorithm, it chooses the smallest weighted path between current positions and destination. In this case, a map must be preloaded into the system.
- 7.3. Floor to Floor path finding system: This system takes building map data, user current position and desired destination and returns a floor by floor path to the destination.
- 7.4. Room to Room path finding system: This system takes floor map data, start position and desired destination and returns a room by room path to the destination.
- 7.5. Point to Point path finding system: This system takes room map data, start position and desired destination and returns a point to point path to the destination.

8. Map Database Module

- 8.1. Map Database Interface: This decouples the Map Databases other sub-systems from the rest of the server system. So long as this interfaces function calls remain unchanged, exterior modules will not need to be changed if the inner workings of the Map Database Module are modified.
- 8.2. Virtual Point System: The virtual point system manages the map data, and ensures that every time the map data is to be retrieved by the system that the data is properly passed. It does this by interpreting the file stored in the Map Database and converting it to a graph of the points of interest. Each point of interest must be reachable and each path between points must be as

expedient as possible. To accomplish this it will also add “virtual points” in the graph for navigation purposes if it determines that they are necessary through a navigation efficiency algorithm.

8.3. Map Database: A database storage area, most likely kept on a long term storage device such as a hard drive. The map data is stored here as a formatted file.

Configurability/Flexibility

Handheld Device

- The device will be equipped with a headphone jack for audio output. The user will have control over audio volume, as well as frequency and intensity of audio cues. The device can be configured to deliver constant audio navigation cues to help guide the user along a path, the user may choose to limit audio output to receive only on-demand assistance, with a range of intermediate settings between the two extremes.

Building

- The physical network structure is expected to remain stationary under normal circumstances. Points of interest and safe travel paths can be added, removed, and altered at any time, through the server software interface.

Risks

Operation

- System installation and configuration must be performed correctly and accurately, and the system must be tested thoroughly before deployment. Failure to identify dangerous obstacles within the system, or failure to produce an accurate building map can result in catastrophe for the user.
- Navigational system components must remain stationary, and building map data must remain accurate and up to date. The local server must remain operational at all times. Failure to meet these requirements will expose risks to the safety of the users, who rely on the functionality provided by the device.

Schedule

- The time required for physical system installation is expected to be insignificant compared to the time required to produce accurate mapping data for the building. Installation technicians work with building owners and designers to generate Point of Interest and safe navigation data. The mapped routes must be thoroughly tested. This process will vary in length depending on the size of the target building, but is likely to consume the majority of the time spent during the installation phase.

Security

- The privacy of all users must be maintained. No data will be collected and stored on the server that could be used to personally identify any user of the navigation device. If logging information is gathered by the system, it must not collect any personally identifying information about the users.
- In order to insure safe, reliable and trustworthy operation of the system, the integrity and security of all network components must be maintained. Any data kept on the local server must be kept secure in order to prevent tampering by unauthorized persons.
- The local servers must undergo periodic maintenance. Building map data should be periodically backed up to an offsite location. SmartBuilding software and operating system software running on local servers should be kept up to date, and any critical security patches should be applied during maintenance periods.

Requirements Change Form

To make a change to the terms of the Software Requirements Specification, complete and submit this form.

Contact Information	
Organization:	
Name:	
Phone:	
Email:	

Requirement Change Details		
Affected Components: (check all that apply)	Software:	Hardware:
	Device	Device
	Server	Server
	Network	Network
Description:		

For Official Use Only		
Comments:		
<input type="checkbox"/>	Accepted	<input type="checkbox"/> Declined
Signatures:		Dates:
1.		
2.		
3.		

Module / Requirement Cross Reference

Functional Requirements	Module	Module Description Number	Module Operation	
User Device System (Page 5)	Device Controller Module	1.1	Device System Controller	
	User Interface Module	2.1	User Interface	
		2.2	Physical Device Driver	
		2.3	Power Controller	
		2.4	Audio Processor	
		2.5	Audio Driver	
		2.6	Audio to System Command Map	
	Server Connection Module	3.1	Device Network Driver	
		3.2	Server Interface	
		3.3	Server Information Storage	
	Positioning System Module	4.1	Positioning System Interface	
		4.2	Position Hardware Driver	
		4.3	Current Position Storage	
	Server System (Page 6)	Device Connection Module	5.1	Server Network Driver
			5.2	Device Connection Interface
Server Environment Module		6.1	Server Environment Controller	
		6.2	Device Information Storage	
Navigation Module		7.1	Navigation System Interface	
		7.2	Plotting System	
		7.3	Floor to Floor Path Finding System	
		7.4	Room to Room Path Finding System	
		7.5	Point to Point Path Finding System	
Map Database Module		8.1	Map Database Interface	
		8.2	Virtual Point System	
		8.3	Map Database	

Integration Thread

The integration thread, which represents a core system to which additional modules can be added to, will allow the user to input an end destination and receive directions from their current location to the chosen destination. This allows a user to enter any building the system is installed in to navigate freely without additional help.

Modules shown in the integration thread should be the bare necessities and allow for possible requirement changes proposed by the customers. As it can be seen the integration thread and the full design shown prior are similar. This is because the full design of the system was created in order to be as simplistic as it could. Also by doing this any additional features that the customer may request can be integrated without greatly augmenting the main system.

Future changes to systems should not alter the integration thread greatly. This will allow those changes to be easily integrated as there will not be multiple versions of the integration thread to work with.

