**HDB Smart Lighting Platform**

**Technical Specification**

**Date: 07-Aug-2020**

**Table of Contents**

[1 General 4](#_Toc47623653)

[1.1 Objective 4](#_Toc47623654)

[1.2 Scope of Work 4](#_Toc47623655)

[1.3 Business Model 5](#_Toc47623656)

[2 HDB-SLP Platform Requirements 6](#_Toc47623657)

[2.1 Overview 6](#_Toc47623658)

[2.2 General Requirements 8](#_Toc47623659)

[2.3 Operational Scenarios 9](#_Toc47623660)

[2.4 Post-Award Mock-up 12](#_Toc47623661)

[2.5 Hosting Requirements 12](#_Toc47623662)

[2.6 System Design & Considerations 13](#_Toc47623663)

[2.7 Human Machine Interface 14](#_Toc47623664)

[2.8 System Backup & Housekeeping 15](#_Toc47623665)

[3 HDB-SLP Functional Requirements 17](#_Toc47623666)

[3.1 Multi-Vendor Smart Lighting Systems 17](#_Toc47623667)

[3.2 Multi-Tenant Architecture 17](#_Toc47623668)

[3.3 Communication Interface with Smart Lighting Systems 17](#_Toc47623669)

[3.4 Data Ingestion to HDB Smart Hub 17](#_Toc47623670)

[3.5 Data Ingestion to DECADA Cloud 17](#_Toc47623671)

[3.6 User Activities Log 17](#_Toc47623672)

[3.7 Site Management 18](#_Toc47623673)

[3.8 Site Overview 18](#_Toc47623674)

[3.9 Site Summary 18](#_Toc47623675)

[3.10 User Interface 19](#_Toc47623676)

[3.11 Dashboard 19](#_Toc47623677)

[3.12 Device Configuration 21](#_Toc47623678)

[3.13 Lighting Schemes 23](#_Toc47623679)

[3.14 Lighting Profiles 25](#_Toc47623680)

[3.15 Fault Management 29](#_Toc47623681)

[3.16 Environmental Monitoring 30](#_Toc47623682)

[3.17 Motion Traffic 31](#_Toc47623683)

[3.18 Energy Usage 33](#_Toc47623684)

[3.19 Maintenance 33](#_Toc47623685)

[3.20 Normal Light Automatics Testing 36](#_Toc47623686)

[3.21 Emergency Light Automatics Testing 36](#_Toc47623687)

[4 IT Security 40](#_Toc47623688)

[4.1 General Requirements 40](#_Toc47623689)

[4.2 Software Security 42](#_Toc47623690)

[4.3 Anti-Malware Measures 42](#_Toc47623691)

[4.4 Security Incident Reports 44](#_Toc47623692)

[4.5 Hardening Requirements 45](#_Toc47623693)

[4.6 Patch and Vulnerability Management 45](#_Toc47623694)

[4.7 Access Control 46](#_Toc47623695)

[4.8 Vulnerability Assessment and Penetration Tests 47](#_Toc47623696)

[4.9 System Security 48](#_Toc47623697)

[5 System Delivery and Acceptance 50](#_Toc47623698)

[5.1 System Testing 50](#_Toc47623699)

[5.2 System Acceptance 50](#_Toc47623700)

[6 System Support and Maintenance 52](#_Toc47623701)

[6.1 General Requirements 52](#_Toc47623702)

[6.2 Software Maintenance 52](#_Toc47623703)

[6.3 Problem Analysis and Classification 53](#_Toc47623704)

[6.4 Problem Resolution Timeframe 54](#_Toc47623705)

[7 Other Requirements 55](#_Toc47623706)

[7.1 Connectivity Requirements 55](#_Toc47623707)

[7.2 Exit Management 55](#_Toc47623708)

# General

## Objective

### The aim of this Contract is to implement a Smart Lighting Platform for the following purposes:

1. Provide a centralised web portal for HDB and Town Councils to manage smart lighting systems from different vendors.
2. Allow authorised personnel tiered access to HDB-SLP portal for management and control;
3. Facilitate configuration of smart lighting systems by authorised personnel/administrator;
4. Facilitate on-demand zoning and re-zoning of smart lighting systems with respect to Town Council setup;
5. Facilitate easy access to smart lighting dashboard information such as system health status, utilisation and maintenance metrics of smart lighting systems;
6. Facilitate logical organisation of smart lighting devices in accordance to its physical location and purpose (e.g. Blk 123 basketball court, Blk 789 MSCP Lift Lobby).
7. Facilitate use of smart lighting motion traffic statistics/heat map metrics to assist and support TC operators to optimize resource utilisation for maintenance task duty roster planning.
8. Collate and ingest health status parameters of managed smart lighting systems of approved vendors to HDB Smart Hub for analysis and analytics.

## Scope of Work

This Contract covers two phases: development and maintenance phase:

1. The scope of development phase is to implement a Smart Lighting Platform for multi-vendor smart lighting management.
2. The scope of maintenance phase is to manage and maintain the Smart Lighting Platform throughout the contractual period.

As such, the bidding price shall consist of two parts: one for development phase and one for maintenance phase.

## Business Model

**Key Features**

* HDB will pay upfront for development, configure, test & commission of SLP and cloud infrastructure & setup.
* HDB will own the SLP upon commissioning.
* TCs will pay a recurring monthly fee per light node to the Contractor for support and maintenance of SLP and 3rd-party software licenses upon commissioning.
* HDB will provide the estimated projected number of nodes over contract period.

**Development Phase**

Year 1

onwards

**Maintenance Phase**

Year 0

Paid by HDB

SLP Software Development

Cloud Infra & Set-up

SLP Software Maintenance

COTS Software Licences

Configure, Test & Commissioning

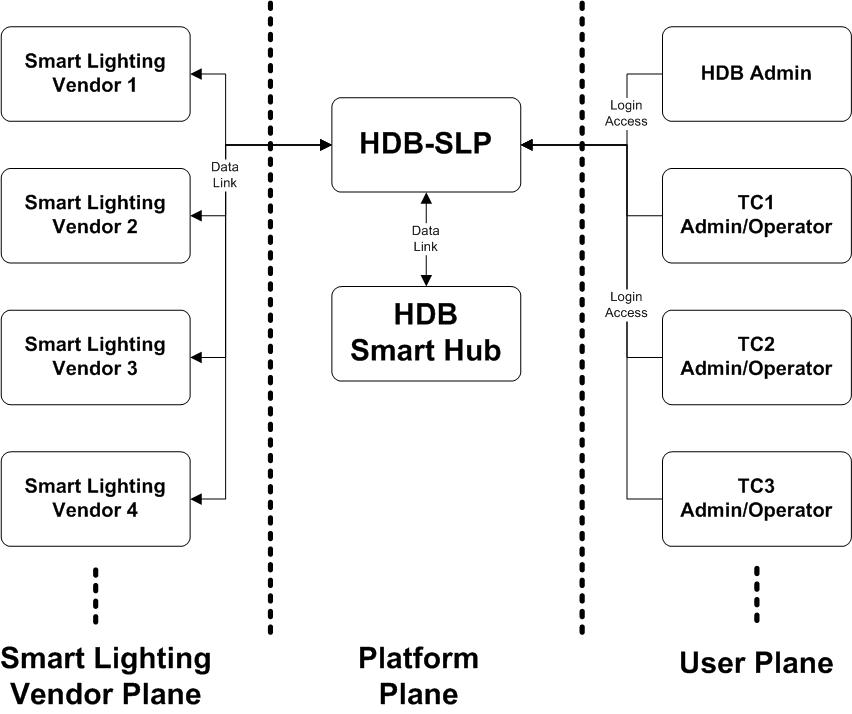
Paid by TCs via Subscription (per light node per month)

Paid by HDB

# HDB-SLP Platform Requirements

## Overview

### A simplified diagram depicting the HDB-SLP setup is shown below. The Contractor is to provide the final detailed setup and the design for HDB’s approval within three (3) months from date of award.



### The Contractor shall complete this project within fifteen (15) months from the Contract Commencement Date, followed by mandatory software application and infrastructure maintenance support for ten (10) years upon Acceptance Date of HDB-SLP.

### The Contractor shall be responsible of the upgrading of existing smart lighting systems backend software to interface with HDB-SLP. Please refer to Appendix X for the listing of existing smart lighting system and the indicative upgrading cost.

### The mandatory items to be delivered in this Contract include:

1. Infrastructure design for the System
2. Application development for HDB-SLP
3. Project Management Plan for the commissioning of the system
4. Supply, delivery and installation of System’s software
5. Supply, delivery and installation of System’s hardware
6. Supply and delivery of comprehensive System documentation to facilitate ease of maintenance.
7. Network security and penetration test reports for the system by accredited 3rd party test house.
8. Ten (10) years of maintenance support services for the system (inclusive of one (1) year system warranty period)

### The Contractor shall provision and deploy the proposed System at HDB’s approved datacentre with user accounts setup for:

### a. HDB Administrator b. Town Council Administrator c. Town Council Operator

### d. Other Agency Administrator (Smart lighting Systems not belonging to HDB)

### e. Other Agency Operator

### f. Other Agency User

g. SLS Supplier

## General Requirements

### The Contractor shall propose a technology platform based on

1. Customised (Custom Built) Solution(s)
2. Commercial-Off-The-Shelf (COTS) Software

### The Contractor shall ensure that software support is available for all software products used in the HDB-SLP system for the minimum life span of 10 years of the System. The software support shall include security updates, patches, fixes and access to technical knowledge base/documentation.

### The Contractor shall provide detailed solution, system architecture and technology roadmap of the proposed platform with the objective of illustrating its maintainability over the next ten (10) years after the year one Defect Liability Period.

### The Contractor shall ensure that support is available from the principal software vendor for all COTS software proposed for the design, architecture, customisation, implementation, testing and maintenance of the System.

### The Contractor shall propose both Cloud and Web-based solution to handle the requirements with 99.9 % High Availability (HA).

### The Contractor shall put in place a development and testing phase, before cutover to production to verify application and Database Active-Standby testing setup via automated means.

### The Contractor shall work with HDB appointed IT department/partner to deploy the HDB-SLP on Government Commercial Cloud (GCC).

## Operational Scenarios

### The Contractor upon contract award shall work with HDB to ensure that the system fulfils their operational needs and standard operating procedures.

### There are Five (5) types of users accessing the HDB-SLP system:

1. **HDB Root Administrator** is authorised and responsible to zone and re-zone smart lighting systems in accordance to Singapore’s Town Council boundary map. The root administrator is also authorised to create and delete accounts for TC administrators and users. The root administrator account is created and handed over to HDB at system delivery. This role is to be carried out by SLP operator. An authorised request form needs to be put up by HDB to effect such changes before SLP operator can proceed to do the changes.
2. **TC Administrator** of each TC are authorised to manage smart lighting systems to perform device configuration changes and user account management. This role is to be carried out by SLP operator. An authorised request form needs to be put up by HDB to effect such changes before SLP operator can proceed to do the changes.
3. **TC Operators** are authorised to access the HDB-SLP system to manage smart lighting systems for TC smart lighting operation and maintenance tasks. The operators shall utilise HDB-SLP’s health management feature to handle smart lighting alerts and faults on a day-to-day basis.
4. **Other Agency Administrator** is authorised to manage smart lighting systems to perform device configuration changes and user account management. This role is to be carried out by SLP operator. An authorised request form needs to be put up by Other Agency to effect such changes before SLP operator can proceed to do the changes.
5. **Other Agency Operators** are authorised to access the HDB-SLP system to manage smart lighting systems for smart lighting operation and maintenance tasks. The operators shall utilise HDB-SLP’s health management feature to handle smart lighting alerts and faults on a day-to-day basis.
6. **Other Agency User** are authorised to only view the smart lighting devices status. They are not allowed to make any configuration changes.
7. **SLS Suppliers** are authorised to acknowledge alarm and view only the smart lighting devices under SLS Supplier. The SLS Supplier will not be able to make any changes or do any configuration of the devices on HDB-SLP

**Operation Scenario 1:** Add New Smart Lighting Vendor to HDB-SLP

### The HDB **Root Administrator** is responsible to profile newly certified smart lighting system vendor as part of the HDB-SLP by adding the new smart lighting devices to its’ appointed town council. A copy of the lighting network master data configuration file furnished by the newly certified smart lighting system vendor shall be used to perform the import using the HDB-SLP network administration feature.

**Operation Scenario 2:** Assign Smart Lighting devices to a new TC

### The HDB **Root Administrator** is responsible to assign lighting devices for a new TC setup via the HDB-SLP network administration feature.

**Operation Scenario 3:** Un-assign Smart Lighting devices from existing TC and assign Smart Lighting devices to a new TC

### The HDB **Root Administrator** is responsible to support TC re-zoning by un-assigning lighting devices from TC 1 and re-assigning the lighting devices to TC 2 via the HDB-SLP network administration feature.

**Operation Scenario 4:** Add/Delete Town Council Administrator to HDB-SLP

### The HDB **Root Administrator** upon successful setup of the newly zoned smart lighting devices shall proceed to create and appoint administrator account for the designated TC to manage the smart lighting system via the HDB-SLP user account administration feature.

### The HDB **Root Administrator** where required shall remove Administrator from HDB-SLP via the HDB-SLP user account administration feature.

### The HDB **Root Administrator** where required shall support add and delete feature of Operator user accounts from HDB-SLP via the HDB-SLP user account administration feature.

**Operation Scenario 5:** Add/Delete Town Council Operators to HDB-SLP

### The **TC** **Administrator** upon successful appointment by the root administrator will proceed to create operator accounts for his/her TC. The **TC** **Administrator** is also responsible to remove operator accounts from HDB-SLP where necessary.

### The **TC Administrator** shall be authorised to view only the smart lighting devices designated to his/her TC.

**Operation Scenario 6:** Configure and/or change Smart Lighting system settings

### The **TC Administrator** is responsible to configure or reconfigure smart lighting system changes for his TC, such as lighting profile, lighting schemes to fine tune light-on duration and brightness calibration where necessary, using the HDB-SLP light configuration feature post commissioning. Smart lighting system configuration changes requested by Administrator shall be 2FA authenticated by the HDB-SLP access control feature prior to change.

**Operation Scenario 7:** Manage Smart Lighting assets

### The **TC Administrator** is responsible to manage all lighting assets (driver make, driver model, date of installation, etc) designated to his TC via the HDB-SLP Inventory Management feature.

**Operation Scenario 8:** Apply TC logo, web themes to customise look and feel of HDB-SLP client account

### The **TC Administrator** is responsible to apply custom TC logo and web themes to create a unique identity and branding for his/her TC on the HDB-SLP’s client interface.

**Operation Scenario 9:** Smart Lighting Device Management by Town Council Operators

### The **TC** **Operator** is responsible to manage smart lighting systems designated to their TC for day-to-day operation and maintenance using the HDB-SLP dashboard and the HDB-SLP warning and fault alert feature.

### The **TC** **Operator** shall be guided on the follow-up actions as part of the HDB-SLP lighting events and faults notification report.

### The **TC Operator** shall be authorised to view only the smart lighting devices designated to his/her TC

**Operation Scenario 10:** Smart Lighting Device Viewing by SLS Suppliers

### . The SLS Operator shall be authorised to acknowledge alarm and view only the smart lighting devices under SLS Operator. The SLS Operator will not be able to make any changes or do any configuration of the devices on HDB-SLP.

## Post-Award Mock-up

### Three (3) months post contract award, the Contractor shall mock-up the HDB-SLP client interface to demonstrate selected operational scenarios as detailed in Section 1.5.

### Post-Award mock-up shall be jointly conducted together with HDB and TC administrator and operator to ensure the interfaces designed are in-line with the end-user’s day-to-day usage and operational workflows.

## Hosting Requirements

### The Tenderer shall be responsible for the design, architecture and implementation of the solution comprising all necessary computational, storage, software services that are required for the HDB-SLP system during the development period of fifteen (15) months and for ten (10) years after commissioning of the System.

### The Tenderer shall only propose to host the System in one of 3 Singapore Government Appointed Commercial Cloud Service Providers (CSPs). Government on Commercial Cloud (GCC) provides Cloud Services from the following THREE (3) Cloud Service Providers (CSP). All services from GCC must be subscribed using HDB’s name.

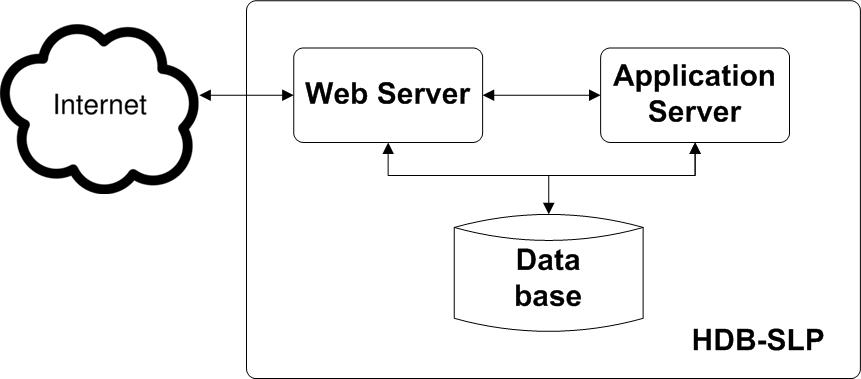
1. Amazon Web Services (AWS)
2. Google Cloud Platform (GCP)
3. Microsoft Azure Cloud (Azure)

### The Tenderer shall detail in the proposal, based on the solution design and architecture, compute the total resources and estimate the usage fees. All assumptions made shall be clearly stated in the proposal.

## System Design & Considerations

### The HDB-SLP Software Architecture shall comprise three (3) tier architecture as listed below:

1. Web Server
2. Application
3. Database



### The Contractor shall describe the logical components used, the relationship across the various components and how the components are deployed in the System. The logical components shall include hardware, software, and interfaces with existing system.

### The Contractor shall propose the System Architecture based on the following considerations:

1. Performance, Scalability and Availability
2. Maintainability – Modularity and design flexibility for future upgrade and enhancements.

### The Contractor shall adopt industry best practices and available open standards in the proposed System, so as to optimize the in-built system capabilities and to minimize customisation, system deployment time and cost.

### The System Architecture shall be subjected to HDB’s approval and shall be designed to have the capacity to support between fifty thousand to three million smart lighting devices.

### The Contractor shall carry out the System Capacity Sizing for the system infrastructure based on current and projected growth in the future. The initial capability shall be based on one hundred thousand lights. The projected growth is estimated to be one million lights by 2023, 1.5 million lights by 2024 and 2 million lights by 2026. Note that the actual figures may vary.

### The Contractor shall provide detailed illustrations on how the configuration meets the requirements specified for system availability, response time (to be determined by HDB) and system performance.

### The Contractor shall list all licenses required to implement the proposed solution. Licenses should include, where applicable, database license, server license, license for application development tools, application solution runtime license, any end-user licenses for using the System, and recurrence cost, if any.

## Human Machine Interface

### The HDB-SLP system shall provide user-friendly and intuitive Graphical User interfaces (GUI) for:

1. Consistency of object and phrases
2. Flexibility and efficiency of use
3. Effective error handling
4. Optimized user experience

### The HDB-SLP system shall be designed with the following criteria:

1. Minimum steps/inputs clicks required;
2. Minimum opening of pop-up windows;
3. User-friendly steps with online help;
4. Optimised for screen resolution of minimally 1024 x 768 pixels for website for 4:3, 5:4 and 16:9 computer displays;
5. Menu shall be structurally arranged, and each option in the menu shall be easily accessible;
6. Descriptive labels and control button names shall clearly convey their intended behaviour;
7. Error messages shall be descriptive with corrective actions furnished to operators without the need to resort to online help;
8. All TC users shall see a common and seamless user-interface;
9. The System shall provide tool-tip capability for quick access to meaning/purpose of the selected field, or feature.
10. Web-interface shall be mobile friendly.

## System Backup & Housekeeping

### The Contractor shall be responsible to make and secure backups of vital system software, applications and data for use, if System becomes corrupted or destroyed.

### All backup, recovery and archival must be fully automated, requiring minimal manual actions and resources or manpower.

### Retention period for data file, reports and attachments in the proposed solution shall be a minimum of one (1) year.

### The Contractor shall propose and implement mechanisms with supporting processes and defined Disaster Recovery procedures to allow the system to be recovered and reset to the system’s original state after a disruption or failure.

### The Contractor shall propose archival method to offload non-essential data.

### The Contractor shall provide an offsite solution to store, audit, backup and archival of information.

# HDB-SLP Functional Requirements

The HDB-SLP functional requirements shall include but not limited to the following:

## Multi-Vendor Smart Lighting Systems

System shall communicate with smart lighting systems from different vendors using HDB defined MQTT protocols for Smart Lighting and provide a unified GUI for lighting management and control.

## Multi-Tenant Architecture

System shall adopt a multi-tenant architecture to provide a central web portal to serve multiple town councils for lighting management and control.

## Communication Interface with Smart Lighting Systems

System shall provide MQTT broker and interface with smart lighting systems for event, alarm, configuration and control via MQTT interface. Please refer to the Smart Hub Interface Control Document for details.

## Data Ingestion to HDB Smart Hub

System shall route events and alarms from smart lighting systems to Smart Hub via the MQTT interface. Please refer to Appendix X : Smart Hub Interface Control Document for details.

## Data Ingestion to DECADA Cloud

System shall route events and alarms from smart lighting systems to DECADA Cloud via the MQTT interface. Please refer to Appendix X : Smart Hub Interface Control Document for details

## User Activities Log

System shall store user events and provide the following functions to generate user activities report. Only the Administrator is allowed to view and generate activities report. The user events includes user login / logout and configuration change.

* Select user name
* Select start and end date
* Display a table to show user events
* Export report in PDF and CSV format
* The report shall include the following information:
  + User name
  + Date and Time
  + User event

## Site Management

A site is defined as a town council that consists of a number of residential blocks and car parks. System shall provide the following functions for site management, which is only available to the Administrator:

* Create a site that ties to a town council.
* Input residential blocks and car parks that belong to the town council.
* Rearrange individual residential block and car park from one town council to another town council.

## Site Overview

System shall provide a MAP view to show the health status of individual residential block and car park within the town council based on colour-coded scheme. The residential block and car park can be displayed as icons on the MAP.

* Green : Lighting system OK, no fault found
* Red : Major faults (e.g. lighting system not responding, gateway offline)
* Amber : Minor faults (e.g. light fault, sensor fault, node lost)

## Site Summary

System shall provide a table to show the summary of individual residential block and car park within the town council:

* Block number
* System vendor name
* Connection status (e.g. online / offline)
* Health status (e.g. OK / fault detected)
* Average burn time
* Average energy saving

## User Interface

System shall provide a graphical user interface that is convenient for user to monitor faults and configure system parameters for each residential block and car park within the town council.

* Table view
* Floor plan
* Combination of table view and floor plan

Start with map, select building, bring to dashboard (left side of dashboard is a menu selection, device configuration lead to table view)

## Dashboard

System shall provide a dashboard to show the following information for individual residential block and car park.

* Equipment List
* Configuration
* Maintenance
* Health Status
* Motion traffic
* Motion heatmap
* Burn time
* Energy consumption

### Equipment List

System shall display the following information:

* Luminaire quantity
* Sensor quantity
* Gateway quantity

### Configuration

System shall display the following information:

* + Predictive lighting (enable / disable)
  + Lighting Profiles (enable / disable)
  + Fault Reporting (enable / disable)
  + Burn Time (%)
  + Energy Saving (%)

### Maintenance

System shall display the luminaire quantity according to the following burn time bands:

* Less than 30% usage
* Between 30% and 50% usage
* Between 50% and 70% usage
* Between 70% and 90% usage
* Between 90% and 100% usage
* More than 100% usage

### Health Status

System shall display the following information:

* Quantity of light failure
* Quantity of sensor failure
* Quantity of communication failure (sensor offline)

### Motion Traffic

System shall display the previous day’s motion traffic per user selection as follows:

* Motion count versus time
* Motion count versus sensor node
* Motion count versus location (e.g. level 1, level 2, etc.)

### Motion Heatmap

System shall display the previous day’s motion heatmap per user selection as follows:

* Time versus sensor node
* Time versus location (e.g. level 1, level 2, etc.)

### Burn Time

System shall display a chart to show the burn time for each luminaire (burn time vs. sensor node). This chart shall automatically refresh on a daily basis.

### Energy Consumption

System shall display a chart to show the energy consumption for the last 7 days (energy consumption vs. date). This chart shall automatically refresh on a daily basis.

## Device Configuration

System shall provide device configuration for sensor and lighting parameters.

### Sensor Parameters

System shall provide functions to configure the following sensors:

* Motion Sensor
* Photo Sensor
* Rain Sensor

#### Motion Sensor

Motion sensor is used to detect movement and turn on lights in advance.

System shall provide a function to set detection range with the following parameters: level 1, level 2 and level 3. Level 1 has the least detection range and level 3 has the largest detection range. The detection range may vary according to different sensor types (e.g. indoor motion sensor versus outdoor motion sensor).

#### Photo Sensor

Photo sensor is used to measure ambient daylight for lighting control in daylight profile and daylight harvesting profile.

System shall provide a function to configure photo sensor with the following parameters:

* Lower threshold (10 to 60,000 lux) to detect dim daylight, typical value is 200 lux.
* Upper threshold (10 to 60,000 lux) to detect bright daylight, typical value is 400 lux.
* Monitoring interval (5 to 255 sec) to measure daylight, typical value is 30 sec.

#### Rain Sensor

Rain sensor is used to measure rainfall for lighting control in rain profile.

System shall provide a function to configure rain sensor with the following parameters:

* Lower threshold (5 to 255 pulses) to detect light rain, typical value is 5 pulses.
* Upper threshold (5 to 255 pulses) to detect heavy rain, typical value is 30 pulses.
* Monitoring interval (5 to 255 sec) to measure precipitation rate, typical value is 60 sec.

Each pulse is corresponding to 0.01 mm of rainfall.

### Lighting Parameters

System shall provide the following features for lighting configuration and control:

* Lighting Override
* Software Dimming
* Light Intensity
* Time Delay
* Lighting Zone
* Trigger Zone

#### Lighting Override

Lighting override option is used to control lighting operation mode so that light can be configured to operate in auto, always on or always off mode.

System shall provide a function to set lighting override with the following parameters: auto mode, force on, force off.

* Auto mode is on-demand lighting based on motion detection.
* Force on is to turn on light and maintain light on.
* Force off is to turn off light and maintain light off.

#### Soft Dimming

#### Soft dimming option is used to provide smooth visual effect during the process of brightening up and dimming down.

System shall provide a function to set soft dimming with the following parameters: ramp up time, ramp down time. The range of ramp-up and ramp-down time is from 1 to 3 seconds, with a step of 1 second. The typical ramp-up and ramp-down time is 1 and 2 seconds, respectively.

#### Light Intensity

Light intensity option is used to control dim and bright level. When motion is detected, light will brighten up to the bright level, once motion is passed, light will dim down to the dim level to save energy.

System shall provide a function to set light intensity with the following parameters: dim level, bright level. Dim level is from 0% to 50% whereas bright level is from 50% to 100%. The typical dim and bright level is 20% and 100%, respectively.

#### Time Delay

Time delay option is used to control the hold time for light to remain on for a period of time when motion is detected.

System shall provide a function to set time delay. The range of time delay is from 10 to 3600 seconds. The typical time delay is 30 seconds.

#### Lighting Zone

Lighting zone consists of a group of sensors and is typically used for device configuration and lighting control (e.g. predictive lighting, dimming profile, etc).

System shall provide a function to assign up to 8 lighting zones to a sensor. Total 60 lighting zones (1 to 60) are supported per gateway.

#### Trigger Zone

Trigger zone is typically used by predictive lighting to turn on lights in multiple paths. When a sensor is assigned with trigger zones, it is considered as a trigger node. When the sensor detects movement, the lights in the corresponding trigger zones (or lighting zones) will be turned on.

System shall provide a function to assign up to 8 trigger zones to a sensor. Total 60 trigger zones (1 to 60) are supported per gateway.

## Lighting Schemes

System shall provide the following lighting schemes to turn on lights in advance with respond to pedestrian and vehicle movement.

* Proximity Lighting
* Predictive Lighting

### Proximity Lighting

Proximity lighting is used to turn on lights in advance in a straight path that the pedestrian is heading. This is achieved by listening to the neighbour nodes and turning on light whenever neighbour nodes detect motion. It can be applied to common corridor, covered linkway, stairwell, etc.

System shall provide the following functions to configure the proximity lighting scheme of a motion sensor:

* Enable / disable proximity lighting.
* Select up to three immediate left and right neighbour motion sensors.
* Movement detected by any of the selected neighbour motion sensors will trigger the motion sensor to turn on light.

For example, assuming there are 7 sensors in a row which are configured to listen to 2 immediate neighbours. If motion is detected by say sensor 4, which will turn on its own light and lights in sensor 2, 3, 5, and 6 will be tuned on as well by the respective sensors.



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### Predictive Lighting

Predictive lighting is used to turn on lights in open areas and multiple paths such that when motion is detected by a sensor (trigger node), the lights in the corresponding trigger zones will be turned on. It can be applied to void deck, lift lobby, junction, driveway, etc.

System shall provide the following functions to configure the predictive lighting scheme for individual residential block and car park:

* Enable / disable predictive lighting.
* Assign up to 8 trigger zones to a motion sensor.
* When movement is detected by the motion sensor, the lights in the corresponding trigger zones will be turned on.
* Total of 60 zones must be supported (zone 1 to 60).

For example, assuming there are 9 sensors deployed at the T-junction. Sensor 2, 3, 5, 6, 7 and 8 are configured as lighting zone 1 and these sensors are also configured as the trigger nodes that have zone 1 as the trigger zone. In this case, any motion detected by these sensors will turn on the lights in zone 1.



Zone 1

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## Lighting Profiles

System shall provide the following time-based and ambient profiles for lighting control to save energy.

* Timer Profiles
* Dimming Profiles
* Luminance Profiles
* Daylight Profile
* Rain Profile

### Timer Profiles

Timer profile is used to control lighting operation mode per zone based on time of the day. For example, an event can be setup to perform auto lighting control as follows:

* On-demand lighting during night time from 7pm to 7am.
* Force off lights during day time from 7am to 7pm.

System shall provide 10 timer profiles with the following functions:

* 1. Activate / deactivate profiles.
  2. Select number of profiles.
  3. For each profile,
* Set start and end time for event to take effect.
* Select day of week for event to take effect. The day of week includes weekday, weekend, everyday and holiday.
* Select a lighting zone for action to take effect (zone 1 to 60).
* Select a desired action when event occurs. The list of actions includes auto mode, force on light, force off light. Auto mode is on-demand lighting based on motion detection.

### Dimming Profiles

Dimming profile is used to control dim intensity per zone based on time of the day. For example, an event can be setup to have dim intensity of 30% during night time and subsequently change to 15% during midnight to further reduce energy consumption.

System shall provide 10 dimming profiles with the following functions:

1. Activate / deactivate profiles.
2. Select number of profiles.
3. For each profile,

* Set start and end time for event to take effect.
* Select day of week for event to take effect. The day of week includes weekday, weekend, everyday and holiday.
* Select a lighting zone for action to take effect (zone 1 to 60).
* Set a desired dim intensity (e.g. 30%) as the action when event occurs.

### Luminance Profiles (brightness profile)

Luminance profile is used to set the bright intensity of lights per zone based on predefined schedule. For example, events can be setup to have 80% brightness for new lights and subsequently increase the brightness level to compensate LED decay overtime.

System shall provide 10 luminance profiles with the following functions:

1. Activate / deactivate profiles.
2. Select number of profiles.
3. For each profile,

* Set start and end date for event to take effect.
* Select a lighting zone for action to take effect (zone 1 to 60).
* Set a desired bright intensity (e.g. 80%) as the action when event occurs.

### Daylight Profile

Daylight profile is used to control lighting operation mode for residential block or car park based on ambient daylight. For example, an event can be setup to monitor daylight and perform auto lighting control as follows:

* On-demand lighting under dim daylight (e.g. cloudy day).
* Force off lights under bright daylight to save energy.

System shall provide one daylight profile with the following functions:

* Activate / deactivate profile.
* Set start and end time for event to take effect.
* Select a photo sensor to measure ambient daylight.
* Set lower and upper threshold to detect dim and bright daylight.
* Select a lighting zone for action to take effect (zone 1 to 60).
* Select desired actions corresponding to dim and bright daylight. The list of actions includes auto mode, force on light, force off light. Auto mode is on-demand lighting based on motion detection.

### Rain Profile

Rain profile is typically used to control lighting operation mode for surface car park based on rainfall. For example, an event can be setup to monitor rainfall and perform auto lighting control as follows:

* On-demand lighting during light rain (or no rain).
* Force on lights during heavy rain for better visibility.

System shall provide one rain profile with the following functions:

* Activate / deactivate profile.
* Set start and end time for event to take effect.
* Select a rain sensor to measure rainfall.
* Set lower and upper threshold to detect light and heavy rain.
* Select a lighting zone for action to take effect (zone 1 to 60).
* Select desired actions corresponding to light and heavy rain. The list of actions includes auto mode, force on light, force off light. Auto mode is on-demand lighting based on motion detection.

### Daylight Harvesting Profile

Daylight harvesting profile is used to adjust luminance level of each group of lights according to the ambient daylight measured using photocell sensor(s). For example, an event can be setup to adjust luminance level of the lights near the entrance / exit of a basement car park.

System shall provide one daylight harvesting profile with the following functions:

* Activate / deactivate profile.
* Set start and end time for event to take effect.
* Select day of week for event to take effect. The day of week includes weekday, weekend, every day and holiday.
* Set daylight threshold to generate multiple daylight levels.
* Set minimum and maximum luminance level to generate multiple luminance levels.
* Select an overall daylight harvesting zone for event to take effect (zone 1 to 60). The overall daylight harvesting zone consists of the sensor nodes in all the daylight harvesting zones.

Band 1

(10% light level)

Band 2

(30% light level)

Band 3

(50% light level)

Band 4

(70% light level)

Band 5

(90% light level)

1000 lux

750 lux

500 lux

250 lux

Min: 10%, Max: 90%

Band 1

(0% light level)

Band 2

(25% light level)

Band 3

(50% light level)

Band 4

(75% light level)

Band 5

(100% light level)

1000 lux

750 lux

500 lux

250 lux

Min: 0%, Max: 100%

The daylight threshold and min/max luminance level are used to generate 5 light bands for luminance adjustment based on measured ambient daylight. The daylight threshold is divided by 4 to generate 4 daylight levels whereas the difference of minimum and maximum luminance is divided by 4 to generate 4 luminance levels. For example:

## Fault Management

System shall provide fault management per town council.

### Health Monitoring

System shall provide the following functions for user to monitor lights which show signs of failure:

* Query light power and blink intensity from smart lighting systems and predict failure of individual light point before it occurs.
* Display a list of active alarms with the following fields: block number, sensor ID, fault report time, fault description, acknowledged by, acknowledgement time, remarks.

### Alarm Monitoring

System shall provide the following functions for user to monitor faulty lights and sensors:

* Receive fault indication from smart lighting systems.
* Display a list of active alarms with the following fields: block number, sensor ID, fault report time, fault description, acknowledged by, acknowledgement time, remarks.
* Provide options for user to acknowledge and enter remarks of the alarm.

### Fault Notification

System shall provide the following functions for fault notification and build in a mechanism to ensure that user has received the notification (e.g. user acknowledgement).

* Enable / disable fault notification
* Automatic send fault reminder every hourly if no user acknowledgement
* Alarm message shall include the following information:
  + Block number
  + Sensor ID
  + Date and time
  + Fault description
  + Sensor location

### Fault Report

System shall provide the following functions to generate fault report for individual residential block and car park:

* Select report type (light fault, sensor fault, network lost, all fault).
* Select start and end date.
* Display chart per user selection.
* Export report in PDF and CSV format.
* Provide options to automatic generate report and send to user: none, daily, weekly, monthly.
* Fault report shall include the following information:
  + Block number
  + Sensor ID
  + Fault report time
  + Fault description
  + Acknowledged by
  + Acknowledgement time

## Environmental Monitoring

### Environmental Data

System shall receive environment data on a regular basis from environmental sensors and store into database. Please refer to the Smart Hub Interface Control Document for the update interval. Typical update interval for environmental sensor is 15 minutes.

### Environmental Report

System shall provide the following functions to generate environmental report:

* Select report type (daylight, temperature, humidity, rainfall).
* Select any date.
* Display chart per user selection.
* Export report in PDF and CSV format.
* Provide options to automatic generate report and send to user: none, daily, weekly, monthly.
* The report shall include the following information:
  + Date and time
  + Sensor ID
  + Sensor reading

## Motion Traffic

### Motion Data

System shall receive motion data on a regular basis from motion sensors and store into database. Please refer to the Smart Hub Interface Control Document for the update interval. Typical update interval for motion sensor is 15 minutes.

### Motion Report

System shall provide motion traffic and motion heatmap report for individual residential block and car park.

#### Motion Traffic

System shall provide the following functions to generate motion traffic report:

* Select report type (motion vs. time, motion vs. sensor node, motion vs. location).
* Select any date.
* Display chart per user selection.
* Export report in PDF and CSV format.
* Provide options to automatic generate report and send to user: none, daily, weekly, monthly.
* The report shall include the following information:
  + Time / Sensor ID / Location (e.g. void deck, linkway)
  + Motion volume (accumulated detection counts per hour / node / location)

#### Motion Heatmap

System shall provide the following functions to generate motion heatmap report:

* Select report type (time vs. sensor node, time vs. location, floor plan).
* Select any date.
* Select floor for floor plan heatmap.
* Display chart per user selection.
* Export report in PDF and CSV format.
* The report shall include the following information:
  + Sensor ID / Location (e.g. void deck, limkway)
  + Motion volume (accumulated detection counts per node / location)

#### On-Demand Cleaning

System shall provide the following functions for on-demand area cleaning:

* Monitor the motion activity of every floor in residential block and every deck in MSCP.
* Alert the relevant personnel for cleaning if motion activity of a particular area exceeds predefined threshold.

#### Security Monitoring

System shall provide the following functions for security monitoring:

* Monitor the motion profile of void deck, lift lobby, staircase, corridor, driveway and parking lots in HDB estate.
* Alert the relevant personnel if there is a change in motion profile especially in midnight which may imply suspicious activities on site.

## Energy Usage

### Energy Data

System shall receive energy information (per luminaire) on a regular basis from smart lighting systems and store into database. Please refer to the Smart Hub Interface Control Document for the update interval. Typical update interval for energy usage is 12 hours.

### Energy Report

System shall provide the following functions to generate energy report for individual residential block and car park:

* Select report type (energy consumption, energy saving, CO2 saving, financial saving).
* Select start and end date (daily, monthly, yearly).
* Display chart per user selection.
* Export report in PDF and CSV format.
* Provide options to automatic generate report and send to user: none, daily, weekly, monthly.
* The report shall include the following information:
  + Period of Time
  + Energy consumption / energy saving / CO2 saving / financial saving.

### Energy Performance

System shall compare the energy usage of similar blocks and alert the respective smart lighting vendor to optimize lighting schemes to reduce energy consumption if the energy usage is excessive.

## Maintenance

### Burn Time

#### Burn Time Data

System shall receive burn time information (per luminaire) on a regular basis from smart lighting systems and store into database. Please refer to the Smart Hub Interface Control Document for the update interval. Typical update interval for luminaire burn time is 12 hours.

#### Burn Time Report

System shall provide the following functions to generate burn time report for individual residential block and car park:

* Select report type (burn time, burn time percentage, burn time with reference to 50,000 hours).
* Display chart per user selection.
* Export report in PDF and CSV format.
* Provide options to automatic generate report and send to user: none, daily, weekly, monthly.
* The report shall include the following information:
  + Sensor ID
  + Burn time (hours or percentage)

### Predictive Maintenance

System shall provide the following functions to trigger alert for lights replacement and build in a mechanism to ensure that user has received the notification (e.g. user acknowledgement).

* Enable / disable alert notification
* Set quantity of luminaires (10% to 100%), default is 10%
* Set percentage of life time (10% to 100%), default is 90%
* Send out alert message when the predefined quantity of luminaires has reached the percentage of life time per user selection.
* Alert message shall include the following information:
  + Block number
  + Date and time
  + Alert description

### Inventory

System shall provide inventory with the following fields for individual residential block and car park:

* Sensor ID
* Luminaire description
* Luminaire model
* Driver model
* Location
* Remark

System shall provide the following functions to manage inventory:

* Create inventory.
* Modify inventory (add, edit, delete).
* Export inventory in PDF and CSV format.

### Luminaire Model

System shall provide luminaire models with the following fields for individual residential block and car park:

* Luminaire Model
* Description
* Rated Watt
* Manufacturer
* Expected Life Time
* Picture
* Remark

System shall provide the following functions to manage luminaire model:

* Create luminaire model.
* Modify luminaire model (add, edit, delete).
* Export luminaire model in PDF and CSV format.

### LED Driver Model

System shall provide LED driver models with the following fields for individual residential block and car park:

* LED Driver Model
* Description
* Rated Watt
* Manufacturer
* Expected Life Time
* Picture
* Remark

System shall provide the following functions to manage LED driver model:

* Create LED driver model.
* Modify LED driver model (add, edit, delete).
* Export LED driver model in PDF and CSV format.

## Normal Light Automatics Testing

System shall provide the following functions for normal light automatics testing:

### Manual Test

System shall provide the following functions for manual test:

* Select a light, a group of lights (per zone) or all lights (per postal code).
* Activate test.
* Get test results after 10 seconds has elapsed.

### Auto Test

System shall provide the following functions for auto test:

* Setup a time schedule to perform auto test.
* Activate test when the schedule is due.
* Get test results after 10 seconds has elapsed.
* Notify user if a failure is observed.

## Emergency Light Automatics Testing

System shall provide the following functions for emergency light automatic testing:

### System shall schedule (during silent hours) and carry out automatic testing (i.e. without any manual intervention once the system is configured) for all emergency lightings (maintained and non-maintained emergency luminaires and EXIT signs) installed, in accordance with SCDF Fire Safety Regulation SS 563. This includes

* Monthly functional test, the emergency lights shall undergo a discharge test for at least 30 seconds and during which, the emergency light is turned on by the back-up battery.
* Annual duration test, the emergency lights shall undergo a discharge test for at least the rated duration that the emergency light is designed for. During which, the emergency light is turned on by the back-up battery.
* Maintain a log file (including timestamp of test, results OK/NOK, any faulty item detected) of all tests conducted at a backend system for audit trail.

### The Automatic Test System shall be designed to allow grouping and testing of emergency lights in an alternate manner whenever possible. The test duration of the next alternate group shall not overlap with the recharging period of the previous group. This is to ensure sufficient luminaires remain in operation in times of emergency.

### System shall allow user to initiate a commission test each time a new luminaire is installed or a battery is replaced.

-        Commission test, the emergency lights shall undergo a discharge test duration as such:

|  |  |
| --- | --- |
| **Luminaire Rated Duration** | **Commission Test Duration** |
| 1-hour | 1.5 hours |
| 2-hour | 2 hours |
| 3-hour | 3 hours |

During which, the emergency light is turned on by the back-up battery.

### Manual Test

System shall provide the following functions for manual test:

* Select test type (functional, duration, commissioning test).
* Select a light or a zone for testing.
* Activate test, allow user to cancel the test while test is in progress.
* Get the test results after test duration has elapsed.

### Automatics Functional Test

System shall provide the following functions for automatics functional test:

* Select a zone for auto test.
* Setup a time schedule to perform the test in monthly basis.
* Activate functional test when the schedule is due.
* Collate the test results after test duration has elapsed.
* Postpone test for the emergency lights that cannot complete automatic test (e.g. battery not fully charged).
* Notify user if any emergency light failed the test.

### Automatics Duration Test

System shall provide the following functions for automatics duration test:

* Select a zone for auto test.
* Setup a time schedule to perform the test in yearly basis.
* Activate duration test when the schedule is due.
* Collate the test results after test duration has elapsed.
* Postpone test for the emergency lights that cannot complete automatic test (e.g. battery not fully charged).
* Notify user if any emergency light failed the test.

### Fault Notification

System shall provide the following functions for fault notification and build in a mechanism to ensure that user has received the notification (e.g. user acknowledgement).

* Enable / disable fault notification
* Alarm message shall include the following information:
  + Block number
  + Sensor ID
  + Light type
  + Test date
  + Test type
  + Fault description
  + Sensor location

### Test Report

System shall provide the following functions to generate test report for each emergency light:

* Select one emergency light or all emergency lights.
* Select start and end date.
* Display a table to show sensor ID, test date, test type, test result and failure description.
* Export test report in PDF and CSV format.
* Provide options to automatic generate report and send to user: none, daily, weekly, monthly.
* Test report shall include the following information:
  + Block number
  + Sensor ID
  + Light type
  + Test date
  + Test type
  + Test result
  + Fault description

### Fault Report

System shall provide the following functions to generate fault report for individual residential block and car park:

* Select report type (light fault, battery fault, charger fault, all faults).
* Select start and end date.
* Display a chart to show test date, test type and number of failures.
* Export report in PDF and CSV format.
* Provide options to automatic generate report and send to user: none, daily, weekly, monthly.
* Fault report shall include the following information:
  + Block number
  + Sensor ID
  + Light type
  + Test date
  + Test type
  + Fault description
  + Acknowledged by
  + Acknowledgement time

# IT Security

## 

## General Requirements

### The Tenderer shall ensure the network infrastructure is sufficiently protected and is governed by one or more of the following;

1. VPN or leased lines
2. Private mobile APNs
3. DNS pinning
4. Traffic filtering by type, port and source
5. Use of certificate
6. Lock down of un-used ports
7. Allow only white listed source to establish connections, to prevent connections from non-trusted source

### The Tenderer shall engage approved contractor to carry out Vulnerability Assessment (VA) to identify security vulnerabilities and configuration non-compliances (NC) on all identified systems prior to System Acceptance.

### The Tenderer shall produce VA report within five (5) days upon completion of the VA for HDB’s review and acceptance. The VA report shall include the following;

1. Description of the system, network architecture and the components assessed
2. Description of all security threats and vulnerabilities identified.
3. Assessment of the risk level of each security threat and vulnerability
4. Description of the countermeasures to address each of the security threats and vulnerabilities
5. Description of the residual risk (if any) after the countermeasures are implemented
6. Security risk register listing the security threats/vulnerabilities, their likelihood of occurrence, their severity/impact to HDB’s environment, their assessed risk level, the mitigation actions, and their residual risks.

### The scope of VA shall include but not limited to the following:

1. Latest patches and updates are applied to the HDB-SLP system
2. Latest anti-malware signatures are applied to the HDB-SLP system
3. Hardening policies are applied to the HDB-SLP system

### In the event of non-compliances from the result of the VA, the Tenderer shall take immediate corrective actions to ensure strict compliance and provide objective evidence that the corrective action taken is effective in rectifying the non-compliance before System Acceptance.

### The Tenderer shall conduct a security posture review of the system once every two (2) years till the end of software system support.

### The Tenderer shall ensure full protection against cyber-attacks not limited to the following:

1. Man-in-Middle attacks;
2. Brute Force attacks;
3. OWASP Web Application Risk;
4. Denial of Service (“DOS”);
5. Malware

## Software Security

### The Tenderer shall perform a threat modelling and analysis, and assess the need to conduct the Software Security Test to ensure that the software is implemented securely and is not subjected to any known vulnerabilities.

### The Tenderer shall submit the Software Security Test Plan to HDB for review and acceptance, at least one (1) month before the conduct of Design Review under the Contract. The Software Security Test shall cover all aspects of the software delivered, including custom codes, components, products and system configuration.

### HDB reserves the rights to conduct ad-hoc audits, reviews and software security assessments on the system.

### The Tenderer shall rectify all vulnerabilities identified in the Software Security Tests, as well as any audits, reviews or security assessments that have been conducted.

### The Tenderer shall submit the Software Security Test Report to HDB one (1) month prior to System Acceptance.

### Where the HDB exercises its rights to conduct inspections, audits and vulnerability assessments on the system to be delivered, the Tenderer shall grant, at its own cost and expense, all access, tools, materials and such other assistance as may be required by HDB.

### If the inspections, audits and vulnerability assessments on the system to be delivered show that the Tenderer is not complying with the IT Security Requirements, HDB shall inform the Tenderer forthwith and the Tenderer shall, at its own cost and expense, take immediate corrective actions to ensure strict compliance, and provide objective evidence that the corrective actions taken are effective in rectifying the non-compliance.

## Anti-Malware Measures

### The Tenderer shall ensure that the anti-malware solution approved by HDB is installed on all computers, including but not restricted to systems under development and platform systems, and that the malware definition files are kept up-to-date in these computers.

### The Tenderer shall ensure that the anti-malware solution is compatible with the proposed system, and that there is no impact to the stability, functionality, safety and performance as dictated in the specifications.

### The Tenderer shall include a plan for Anti-Malware Management to HDB for review and acceptance within thirty(30) working days after contract is awarded. This plan shall articulate measures to reduce the risk of infection by any Unauthorised Code to the system during the course of the Tenderer’s work. The Tenderer shall be responsible to ensure that its staff comply with the measures stated in the plan and the Tenderer shall bear full responsibility for any delays or damages due to any infection by any Unauthorised Code caused by its staff.

### For updating the anti-malware definition, the Tenderer must obtain the definition only from verifiable and trusted sources. When the system is in use but have yet to be delivered to the end-user, the Tenderer shall update the anti-malware signature at least once a week.

### The Tenderer shall conduct a full anti-malware scan on the system every month. In the event that any Unauthorised Code is found, the Tenderer must immediately isolate the system from the source of infection and inform HDB.

### The Tenderer shall ensure that the system is delivered free of any Unauthorised Code.

### A full system malware scan shall be performed by the Tenderer prior to handover of the system. The Tenderer shall submit documentation of the scan performed, date of the scan, the scan results and the date/version of the anti-malware software and definition.

### For the purpose of this Paragraph 3.3, “Unauthorised Code” shall include viruses, Trojan Horses, worms, back doors, ransomware, debugging code, or other software routine such as Easter eggs or all other forms of malware, firmware or hardware components designed to permit unauthorised access, operation, monitor, retrieve, copy, disable, erase, or otherwise harm or disrupt software, hardware, system or data, or to perform any such actions.

## Security Incident Reports

### The Tenderer shall identify all activities that are to be logged. These shall include access and changes to key or critical components of the system, exceptions or abnormal activities but not limited to the following:

1. Privileged accounts and accesses;
2. Login failures;
3. Component failures;
4. Change of configurations such as system settings, firewall rules, registry files etc.;
5. Change of network configurations;
6. Connection of unauthorised devices or components;
7. Use of unauthorised services;
8. Activation of unknown or unauthorised ports;
9. Remote accesses;
10. Key operational events and security configuration changes.

### Logs for key operational events and security configuration changes shall be saved in a secured location to support monitoring and incident investigation. The integrity of these logs shall be maintained at all times for accurate and complete event reconstruction. The Tenderer shall ensure that the logs are stored for a minimum of one (1) year.

### The Tenderer shall ensure that proper measures are implemented to disallow log access and detect tampering of logs, especially logs captured from the deployed component. Where practicable, log collection shall be centralized to ensure timely detection of cybersecurity incidents.

### The malware detection solution/system shall support logging of all critical parameters but not limited to the following:

1. Timestamp
2. Source IP
3. Destination IP
4. Ports
5. Protocol
6. Domain

## Hardening Requirements

### The Tenderer shall implement hardening of the system to minimize the risk of likelihood of successful attack. The Tenderer shall ensure that the software application is hardened and only executes services that are required by HDB.

### The Tenderer shall conduct Vulnerability Assessment, Penetration Test, Code Scanning and Security Review of all software provided for proper functioning of Network components. The Tenderer shall make sure all discovered security findings are successfully remedied before commissioning.

### Prior to deployment on site or go-live, the Tenderer shall ensure that the hardened components are based on recommended security settings, conduct vulnerability assessments and penetration testing, where applicable. Test cases should validate the security configuration of the sensor systems and their components. The Tenderer shall clearly state the details, such as deviation, proposed workaround(s), mitigation measures, in the event the hardening controls required is deemed infeasible.

## Patch and Vulnerability Management

### The Tenderer shall constantly review security threats, vulnerabilities, patches and fixes announced by the suppliers. The Tenderer shall advise HDB on possible impact and solutions. The Tenderer shall be responsible for keeping the system up-to-date as well as for reporting and patching all known vulnerabilities. In the event that The Tenderer is not able to provide a patch in a timely manner or where a patch is not feasible, the Tenderer shall expediently identify and provide workaround(s) to prevent the vulnerabilities from being exploited. All security incidents shall be reported to HDB.

### The Tenderer shall implement a patch management process that covers regular patches and tracking of asset inventory. The Tenderer shall ensure that the system is regularly checked and patched for vulnerabilities:

1. When informed by HDB or product principal;
2. Every six (6) months or earlier, should there be a major version release or change in the initial security assumptions;
3. Leverage on product principal to obtain updates on the upcoming product/software releases, as well as the latest available or upcoming security patches/updates, where possible.

### The Tenderer shall apply security patches in the time-frame according to the criticality of the vulnerability stated, unless otherwise agreed by HDB:

|  |  |
| --- | --- |
| Types of Patches | Deployment of Patch Upon Availability |
| Emergency | Twenty-four (24) hours |
| High | Four (4) weeks |
| Medium/Low | Eight (8) weeks |

## Access Control

### The System shall have an access control module for the management of user access rights. The access control module shall allow management of user rights at the individual or group levels.

### The System shall allow authorization and access control mechanism based on permissions and privileges granted depending on the user’s role and groups.

### The System shall provide an administrator module to carry out user account management, user roles management and audit report generation.

### The Contractor shall provide audit trail services, two factor authentication (2FA) and access controls for all Cloud Service Provider’s management accounts, in accordance with the security requirements for privileged access.

## Vulnerability Assessment and Penetration Tests

### The scope of vulnerability shall include, as a minimum:

1. Identify known technical vulnerabilities
2. Determine the extent to which they are exposed to threats
3. Identify what could be affected by specific vulnerabilities.

### The scope of penetration testing of the application shall include, as a minimum:

1. Injection;
2. Broken authentication;
3. Data exposure;
4. XML external entities (XXE);
5. Broken access controls;
6. Security misconfigurations;
7. Cross Site Scripting (XSS)
8. Insecure deserialization;
9. Using components with known vulnerabilities; and
10. Insufficient logging and monitoring.

### Penetration methodology (e.g. Open Source Security Testing Methodology Manual (OSSTMM), Open Web Application Security Project (OWASP) Testing Guide, Penetration Testing Execution Standard (PTES)) shall be used to test the HDB-SLP systems:

* Before HDB-SLP systems are deployed to the production environment;
* Upon major changes to HDB-SLP system; and
* Annually for Internet-accessible ICT systems.

### External parties conducting penetration testing shall be independent and competent with relevant and recognized certifications. For companies, they shall be accredited with CREST Certified Penetration Testing. For individuals conducting the penetration testing on behalf of their companies, they shall be certified with recognised certifications such as OSCP and/or CREST (CRT & above), as a minimum.

### The security test results shall include:

* Recording details of security weaknesses;
* Assessing the associated risks;
* Implementation actions to address these risks; and
* Repeating tests of the systems following corrective actions; and
* Risk accepted is approved by the system owner, if applicable.

## System Security

### The System shall have a timeout and automatic logout feature for non-active sessions. Users shall be logged out if there has been no activity for a pre-defined period. The pre-defined period shall be configurable by Root Administrator.

### The Tenderer shall provide detailed description of the measures for preventing single point of failure that could disrupt the entire System.

### Design and security configuration of critical IT resources, such as network appliances, operating systems, databases and web servers, shall be hardened and reviewed before the System becomes operational. The Contractor shall work with the relevant principals or certified third-parties for the review and rectify all findings before the Security Audit/Review conducted by HDB takes place.

### The Tenderer shall provide detailed descriptions of the system hardening and secure configuration checklists for the System, from Applications down to the Operating System level.

### The Tenderer shall ensure that any changes to the original design, implementation and setup of the System are approved by HDB before implementing the change.

### The Tenderer shall provide detailed description of the proposed change and security risk assessment for approval by HDB before deployment. The Contractor shall include the detailed description of this process as part of the change control process.

### The Tenderer shall ensure all test data, test accounts and test credentials are removed from the production System before commissioning.

# System Delivery and Acceptance

## System Testing

### The Contractor shall perform at least 1 round of system tests before delivery and prior to commissioning of the HDB-SLP:

1. Functional Tests
2. Vulnerability Tests
3. Load Tests
4. Stress Tests
5. Penetration Tests
6. System Integration and Tests

### The Tenderer shall provide detailed information/algorithm to demonstrate how the system capacity sizing is derived in the tender proposal.

### The Tenderer shall provide and execute the necessary test programs to verify that the specified response time is met. The Tenderer shall submit the reports from the tests and explain the findings to HDB for comment and fine-tuning, if required.

## System Acceptance

### Should any test/demonstration fail to meet requirements(s), the Contractor shall perform a re-test on another suitable date/time. Contractor shall carry out rectification works to fulfil functionality of the system, with all cost to be borne by Contractor. This process shall be repeated until the system performs/functions, in accordance with all requirements stipulated in this document, or upon acceptance of the system by HDB.

### All procedures/labour/materials and other costs incurred, for successful completion of Testing and Commissioning procedures shall be borne by The Contractor.

### User acceptance test results shall be signed off by both Tenderer and HDB, and submitted to HDB upon completion.

### User manual(s) for all devices/equipment supplied/operating procedures and others included in the contract shall be provided in soft copies and submitted to HDB within two (2) weeks after successful completion of Testing and Commissioning procedures.

### The Contractor shall conduct at least one (1) training session each for HDB and each TC upon successful testing and commissioning.

# System Support and Maintenance

## General Requirements

### The Contractor shall manage and maintain the Smart Lighting Platform for 10 years inclusive of 1 year DLP. The payment by TC is based on per node per month basis.

### The Contractor shall designate a Service Manager for the Support and Maintenance Services. The Project Manager shall be the single point of contact and to ensure that all performance indicators in the Contract are met.

### The Contractor shall submit a schedule for preventive/routine maintenance to be performed at times approved by HDB.

### Upgrading and maintenance of all software shall be conducted in a modular approach and shall not require a complete shutdown of the System. Upgrading and maintenance activities shall have minimal impact on normal operations.

### The Contractor shall describe the support infrastructure to deliver excellent support and services to TC. The following support structure shall be available locally:

1. Local support centre;
2. Local help desk support; and
3. Assistance in problem resolution and determination

### The Contractor shall train the ITD Helpdesk and Operation staff to provide first (1st) level support for the backend system and provide them with clear documentation including Frequently Asked Questions (FAQ) on carrying out the first (1st) level support. The Contractor shall provide second (2nd) level support for the backend system.

## Software Maintenance

### The Contractor shall be responsible to maintain the System, inclusive of the following responsibilities (but not limited to):

1. Upgrade/Patches
2. Version Upgrade (if required)
3. Preventive and Corrective Maintenance
4. Backup and Recovery
5. Log Management
6. Device Management
7. Antivirus Software and Updates

### The Contractor shall indicate the level of support provided for software products (both customised and off-the-shelf) provided by third-party vendors. In addition, the Contractor shall state how they plan to handle updates or upgrades to such software as and when they become available both from the System operations continuity and cost perspectives.

### The Contractor shall deliver and install all future updates of its own software and documentations to HDB at no cost.

### The maintenance cost shall include the cost of upgrade, enhancement and support of the third-party software proposed to HDB. This shall also include any additional costs associated with supporting an earlier version should HDB decide against proceeding with the upgrade. The Contractor shall ensure that there is proper version control for all changes in the System components.

### If any Severity 2 or 3 software errors cannot be corrected within forty-eight (48) hours from the time of fault notification, the Contractor shall devise a way to bypass the error to allow normal System operations within the next twenty-four (24) hours. Refer to the definition of severity level.

## Problem Analysis and Classification

### The Contractor shall analyse all problems reported. Such problem analysis shall include the identification of the cause of the problem, the programs and Systems affected, the data or any loss suffered and the recommended solutions.

### The Contractor shall classify all problems encountered, subject to HDB’s approval based on the following severity level.

1. Severity 1: These problems have a major impact on the System such that operational users are unable to perform the critical business functions. Problems classified as Severity 1 include hardware failure, service failure, network failure, storage System failure, intrusion, hacking etc. in the Production Environment;
2. Severity 2: These are problems that affect a small group of users, a single user, a particular process or function for which there are acceptable alternatives for bypassing the problems. For instance, failure that is made transparent to the users due to high availability configurations using clustering, fail-over or load-balancing solutions; or
3. Severity 3: The problem has minimal or no effect on TC’s ability to perform its functions.

## Problem Resolution Timeframe

### The supporting standard shall be: Contractor must be contactable via a 24/7 hotline and respond to client according to the response time set in the tender specifications.

### The Response Time is the period of the time **commencement** when a fault condition has been reported to the Contractor and **end** when suitably qualified maintenance personnel arrives at the site to start repair / maintenance.

### The following service levels for problem analysis and resolution are applicable to all maintenance support services which are managed and delivered by the Contractor:

|  |  |  |
| --- | --- | --- |
| **Severity** | **Response Time** | **Resolution Time** |
| 1 | 2 hour | 6 hours |
| 2 | 6 hours | 3 calendar days |
| 3 | Next working day | 7 calendar days |

### The Contractor shall provide progress updates according to the following schedule for hardware and / or software problems:

1. Severity 1: Hourly updates;
2. Severity 2: Updates to be provided every 12 hours; and
3. Severity 3: Updates to be provided every 24 hours.

### The response time refers to the time taken by the Contractor to reply to the person who reported the problem with the initial assessment of the problem. The response time shall start at the time when the problem is first reported by user or any means of communication.

### Problem resolution refers to fixes applied to the system in order to resume normal service. The problem resolution time applies to all problems reported by the users as well as all alerts and errors reported by the network and system.

### The problem resolution time shall start at the time when the problem is reported via the Helpdesk / Operations staff or detected by any network and system and ends when the problem has been resolved and closed. All Severity 1 and Severity 2 problems shall only be closed by TC. Severity 3 problems may be closed by the Contractor. However, TC reserves the right to re-open a Severity 3 problem if the problem is not satisfactorily resolved.

# Other Requirements

## Connectivity Requirements

This section covers the requirements for data transmission from the System to GCC and HDB Smart Hub.

The Contractor shall propose the connectivity plan from Smart Lighting Systems to HDB SLP in GCC and HDB Smart Hub for approval by HDB within three (3) months from date of Award.

### The connectivity between the edge devices and the HDB SLP system shall use 4G for data transmission. An approved private APN shall be used.

### Cost of edge gateways and any others required for the successful integration and transmission of data from existing Smart Lighting Systems to HDB SLP and HDB Smart Hub shall be excluded from the tender proposal.

## Exit Management

### In the contract: “Exit Plan” means the exit plan approved by HDB for the orderly transition of the performance of the Contract from the Contractor to the Incoming Contractor, HDB or such other person appointed by HDB, and “Transition Services” means the services required to be provided by Contractor to HDB in accordance with the Exit Plan and other services required by HDB to ensure the orderly transition of the Contract.

### In the event of the expiry or termination of the Contract, the Contractor shall ensure that: a. The services to HDB shall not be disrupted. b. A smooth hand-over of services, including the transfer of all the security certificates used, to the new service provider appointed by HDB shall be achieved. c. The entire transition phase si as transparent as possible to HDB. d. All data shall be handed over to HDB.

### The Contractor shall provide HDB with the draft Exit Plan for approval within three (3) months from the date of commencement of the Contract. The Exit Plan shall cover the areas specified in the Technical specifications and shall be reviewed regularly and kept up to date.

### In the event of the impending expiry of the Contract or where notice of the termination of the Contract has been issued by either Party, HDB may require the Contractor to provide Transition Services in accordance with the Contract and Exit Plan. As part of Transition Services, the Contractor shall also make available to HDB and any third party succeeding the Contractor appointed by HDB (“Incoming Contractor”) such documentation and provide assistance (including briefings and training) as HDB or the Incoming Contractor may reasonably require to allow an orderly transition to the Incoming Contractor with minimal disruption.

### The Contractor shall commence the Transition Services on the earlier date of the following: a. the date set out by HDB in the notice of Transition Services. b. in the event that the Contract is terminated for any reason whatsoever, the date of the termination notice.

### In the event that HDB requires the Contractor to provide Transition Services beyond six (6) months from the expiry or termination of the Contract, the Contractor shall provide such Transition Services at the rates established under the Contract save that the Contractor is not required to provide Transition Services beyond (6) months from the expiry or termination of the Contract.

### The following shall be covered in the decommissioning process, but not limited to:

1. Appointment of a decommissioning project manager;
2. Schedule for various decommissioning milestones such as obtaining HDB’s approval, taking the HDB-SLP system offline, backing up and removing the data, removing the credentials etc.;
3. Data archival and removal process;
4. Communication to affected users;
5. Removal or revocation of credentials such as service accounts and certificates;
6. Asset inventory (Hardware, software, equipment, appliance etc.);
7. Asset for redeployment (if necessary);
8. Disposal; and
9. Proper management sign-off upon completion.

### The Contractor shall ensure that the data stored on the HDB-SLP system are securely backed-up and removed from HDB-SLP system upon decommissioning.