ADB SAFEGATE | AIRFIELD

CORTEX ALCMS

System Preliminary Description

ADB SAFEGATE

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2 Glossary

Abbreviation	Description
ADBSG	ADB Safegate
AGL	Airfield Ground Lighting
AGL – function	A group of AGL Lighting circuits that are always controlled simultaneously.
ALCMS	Airfield Lighting Control and Monitoring System
ATC	Air Traffic Control (tower).
Auxiliaries	All AGL Devices excepting those belonging to the series circuits.
AUX	Auxiliary
CCR	Constant Current Regulator.
DOV	Detailed Object View of an AGL equipment. This view regroups the status, alarm messages and individual control of this particular equipment.
EFD	Earth Fault Detection
Ethernet	Network protocol developed jointly by Xerox, Intel and Digital Equipment Corporation. Ethernet networks use CSMA/CD and run over a variety of cable types at 100 Mbps (megabits per second), or 1Gbps (Gigabit per second).
HMI	Human/Machine Interface
Node	Single location where ALCMS components are installed (e.g.: ATC, Substation, Maintenance center).
PLC	Programmable Logic Controller
RVR	Runway Visual Range (here used as prevailing Visibility measurement)
SAT	Site Acceptance Test.
SUB	AGL Substation
TCP/IP	Transmission Control Protocol Internetwork Protocol
UPS	Uninterruptible Power Supply

3 Introduction

3.1 Objective of this document

This document provides a Technical Description of ADB SAFEGATE's Airfield Lighting Control and Monitoring System (ALCMS).

This document is, for the purpose of this submission, to be considered as a clarification outline paper to identify and assess the development of the design definition requirements.

3.2 Proprietary Information

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3.3 Trademarks and Patent Rights

General notice: other product names used here are for identification purposes only and may be trademarks of their respective companies. The Man Machine Interface for Airport Traffic Control representation is protected for ADBSG, by patent US 6,246,342 B1 dated June 12, 2001.

3.4 About ADB Safegate

Being market leader in the field of Airfield Ground Lighting, ADBSG provides products, airside solutions and services for airports worldwide. Operating in over 150 countries, ADBSG strives to continue to set the standard in innovation and technology, while offering optimal solutions for ground traffic management at airports, through visual aids. By doing so, we support airports around the world in enhancing their airside safety, efficiency, availability and maintainability.

Quality of our products, solutions and services is of outmost importance – seeing the environment that they operate in, and the operational requirements on safety and reliability that they must sustain. Therefore high levels of quality management during design, engineering, manufacturing and shipping processes are continuously maintained, in accordance with our ISO 9001 procedures.

3.5 Applicable Documents

The most recent revision of the following documents form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of the program contractual documents shall be considered the superseding requirement followed by the contents of this system specification.

Reference	Title
[ICAO]	ICAO Annex 14, Volume 1 (Aerodromes)
[ICAO]	ICAO Manual of Surface Movement Guidance and Control System, Doc 9476-AN/927
[ICAO]	ICAO European Manual on Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Doc 9830 – AN/452 first edition 2004.
[ICAO]	Eurocae, WG 41: Minimum Aviation System Performance Standards for Advanced Surface Movement Guidance and Control Systems (A-SMGCS)
[ISO 9001]	Quality systems – Model for quality assurance in design, development, production, installation and servicing
[FAA]	FAA AC 150_5345_56b
[EASA]	CS-ADR-DSN

4 ADB Safegate's ALCMS philosophy

4.1 General purpose of an ALCMS

The primary goal of an Airfield Ground Lighting Control & Monitoring System (ALCMS) is to provide control and monitoring functionalities for visual aids to enhance safety, efficiency, maintainability, and reliability of airside operations.

Practically, this means that the ALCMS is used to control and monitor all Airfield Ground Lighting (AGL) equipment installed on the airfield, and as such supports the efficient and safe maneuvering of all ground traffic at an airfield. This is achieved by using a series of Computers and/or Programmable Logical Controllers (PLCs) that will transfer the ATC operator's commands to the various devices in the field; monitor their status and provide the appropriate feedback to the operator and maintenance staff.

The ALCMS is part of a modular and scalable system platform – for both hardware and software. The purpose of this modular approach is to be capable of growing with the airport needs; as and when changes are required in the future, options may be added to extend the functionality.

4.2 Safety

Safety is of crucial importance in airside operations. This is also valid for any ALCMS being implemented at a live airport. Safety requirements are to be taken into consideration in the ALCMS design, development, installation, commissioning and training that comes along.

The general guidelines used are provided here:

- Competent development management: the ALCMS concept is based on ADBSG many years of experience in AGL products and systems development. Being an active member of several international regulatory organizations that define new standards for the AGL industry, ADBSG possesses long experience and thorough understanding of airside processes, their impact on AGL requirements, and the relevance of safety to that. This is reflected in safety being an integral part of the design process of ADBSG products and standards. Defining the concept of safety in individual designs, considering relevant fail-safe modes of operation, supporting the development of safety cases are important instruments in this respect.
- Selection of Hardware components and architecture design, in order to safeguard the availability of the ALCMS, the proposed architecture considers using high available components, typically industrial equipment, for the crucial parts of the system.
  Depending the level of availability required to ensure safe operations at the airport, the ALCMS design may consider redundancy for the most critical ALCMS components, ensuring the failure of one component will not compromise the operations.
- Ease of use, intuitive design, it is key to safety to have systems which are developed to be easily comprehensible by the end users without requiring extensive training, the ADBSG delivered systems are developed over many years using feedback received by the wide range of Air Traffic Controllers and Maintenance team users that helped us make the ALCMS easy to take up by airports.
- The use of logging mechanisms in the ALCMS is another safety-supporting functionality. This covers both the logging of operational events in the ALCMS, as well as a detailed logging of a range of technical parameters.

- Scalable Cyber Security to protect the ALCMS against major threats that could affect Airport Operations is key to prevent disruption of the operations where the measures taken are adapted to the need and applied to several levels of the architecture such as protecting the end points with physical access control, log-in mechanisms, firewalls, antivirus, encryption of communication that can be applied depending on the safety requirements defined during the design of the Solution.

4.3 Design Philosophy

The ADBSG proposed solution for the new Airfield Ground Lighting Control & Monitoring System (ALCMS) will be designed to ensure a safe and user friendly method for the ATC operator interface fully in accordance with ICAO regulations and recommendations; and customer specified requirements.

The design for the ALCMS, gives due consideration to the relevant internationally accepted standards, ICAO Annexe 14, Aerodrome Design Manual Part-4 and Part-5, EASA CS-ADR-CSN or FAA AC150 L-890.

The architecture of the ALCMS is carefully chosen, with particular attention being paid to the following requirements:

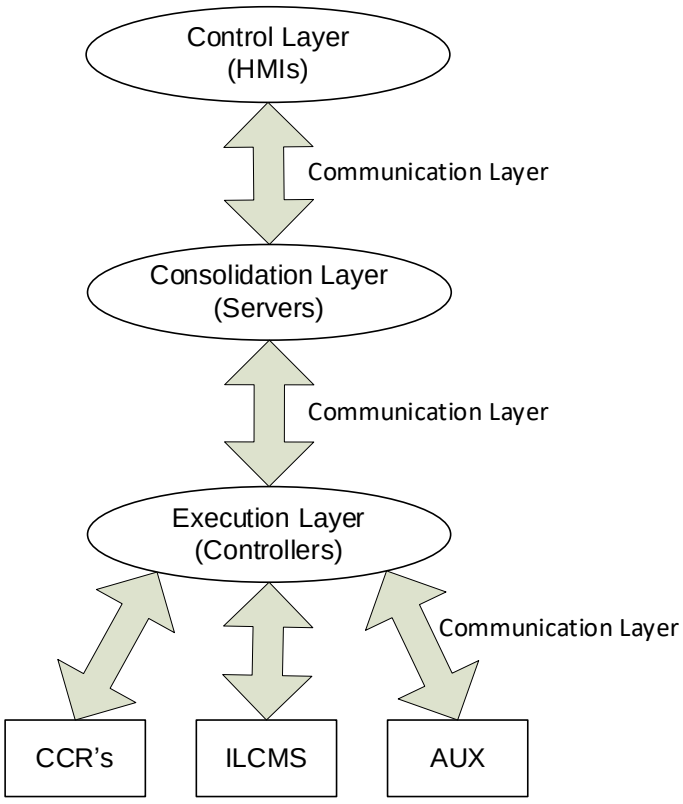
- System Reliability, Availability, Maintainability and Sustainability.
- Smooth transition of operation from the Design team to the airport facility operator.
- Provision of a modular design to facilitate "*ease of realization*" of any future "extensions" or "enhancements" of the system.
- Ease of maintaining the system.
- ATC HMI – visualization screens: developed with the benefit of end-user operator input.
- HMI realization using proven and reliable latest version tools and products.
- Industrial grade-based components for stability and robustness.
- Utilization of latest versions of software and hardware already in-use and proven in airports.
- System enhancement support.
- Integration with other 3rd party systems.

4.4 System Topology

The typical architecture of the complete ALCMS can be divided into three levels:

- Control layer: Human-Machine Interface (HMI) computers for ATC operators and maintenance staff: the top-level HMIs for command and visualization provide control and monitoring functionality to the ATC operators and detailed graphical feedback of the airport's AGL equipment to the maintenance staff.
- Consolidation layer: on separate computers acting as server or distributed over the HMIs and Substation Controllers, this layer is consolidating the data from the different other layers, translating the information to be consistent to the receiver and log all events and data that is used by the other layers to present information.
- Communication layer: Dedicated communication network as a connecting intermediate between substation cabinets on all locations, HMI computers, I/O modules and actuators.
- Execution layer: Substation controllers to which the field equipment is connected. It is this layer that will execute the commands from the control layer through the field.
- Field layer: the Actuators and Sensors, typically the CCRs, ILCMS, Sensors, Auxiliaries that are controlled and monitored by the ALCMS.

At each of these layers, dedicated components are used to perform the layer-specific tasks and achieve the required degree of performance.



4.5 Hardware Selection

To guarantee the availability of the system care is taken in the selection of the hardware components used within the Cortex ALCMS Product suite, selecting appropriately commercial and industrial off-the-shelf components to compose the Solution.

The selection of the hardware is also influenced by the customer requirements, e.g., while the proposed standard offering for HMI is standard commercial computers, to be installed in ATC Consoles, it is possible to use Industrial grade computers installed in racks when required by the airport.

All proposed cabinets are of industrial type and can be wall mounted or self-standing depending on the needs.
The manufacturing and cabling of the cabinets ensure a high level of quality and is delivered with its complete set of documentation to ease maintenance and troubleshooting.

The selection of the hardware is achieved by following a validation process where several considerations are taken regarding the usage of the components for the whole Solution:

- Hardware requirements related to Software needs to ensure the best performance.
- Lifetime of the hardware, MTBF as well as MTTR values are key to provide a solution that will continue working for a long time and that is easy to maintain or to replace in case of failure.
- Energy consumption to reduce the environmental impact of the selected hardware.
- Worldwide availability to ease spare parts management.

5 Functional description of the ALCMS HMI

5.1 Introduction

The operational HMI is based on a Graphical User Interface (GUI) with easy-access menus and screens displaying all the relevant information. This HMI is designed with intuitive look-and-feel and use of icons to facilitate operation. Care was taken during the design to always provide clear and unambiguous information to the operator and to facilitate the integration of the system in the tower, all the screens relevant to the ATC are specifically designed to be easily operable with a touch screen.

5.2 User management

As for any control and monitoring system, the volume of information presented to each user must be carefully controlled to avoid overloading the operator with irrelevant information. Therefore, different user groups have been created, each of them having clearly defined access rights.

The system has 4 main user groups.

- ATC controller:
  The lighting control part is dedicated to the tower operations, containing all means related to the sending of command to the airfield ground lighting. This section can be split into Air Traffic Control (Runway, Approach, Papi lights…) and Surface Guidance Management (Taxiway, Lead-on and Stopbars lights control).

- Maintenance:
  The AGL monitoring and troubleshooting part is dedicated to the maintenance service team.

- Supervisor ATC:
  The Supervisor role is having the same capabilities as any ATC controller user with the additional responsibility to modify the configuration of the ATC related functionalities, such as changing Stopbar timers, adapting the automatic brightness table, or other related configuration settings.

- Supervisor MAINT:
  The Supervisor Maintenance is having the same capabilities as the Maintenance user with the additional responsibility to adapt the System settings, being able to access the OS environment, changing alarm settings, or other related configuration settings.

The system provided functionality depends on the login name and password of the user; this will grant access to certain functions while other functions will be blocked. When no user is logged in, the System will continue to provide view only functions.

The access to the ALCMS and thus the selection of a user group is restricted by log-in and password.

5.3 Control of operations

As indicated in the previous chapters, the overall ALCMS may comprise multiple computers, which result in the necessity to control the access to the airfield lighting equipment.

Indeed, controlling the equipment from two locations simultaneously could result in unexpected behavior for the operators if no clear control mechanisms are set in place.

The ALCMS system is configured in such a way that only one of the system computers is allowed to enter commands into the system at a specific point in time and for a specific area of responsibility.

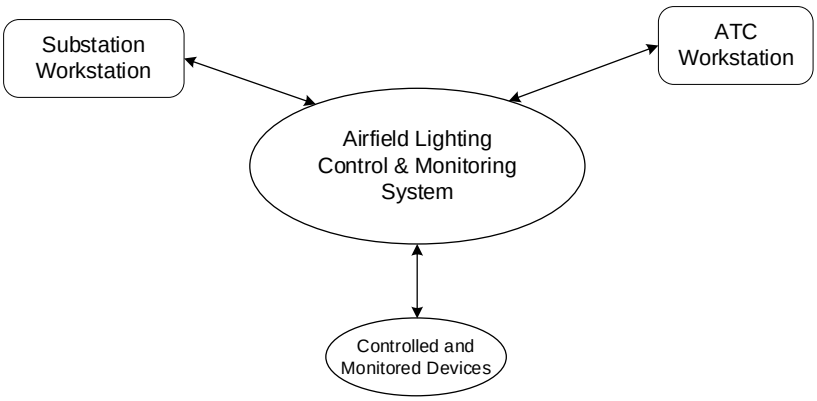
Mostly, the control will be granted to the ATC-HMI, used by the ATC operators, when multiple HMIs are available, a user having the required privileges will be allowed to request the control of the operations on any of those HMIs to become the unique user controlling the AGL infrastructure.

In case of need, this same control can be taken from a Maintenance HMI located in the Maintenance facility or in any substation.

Remark: It should be noted that a locally formalized procedure should be put in place at the airport for this purpose.

5.3.1 Context Diagram

The following diagram depicts the context of the Airfield Lighting Control and Monitoring system (ALCMS). It is foreseen that the interfaces mentioned in the diagram shall provide all necessary information for ensuring the system's performance.



All the systems requiring data exchange at the Airport shall be interconnected using the visual aids dedicated network, called the Common Data Network (CDN). Interfaces with other systems are made available via a secured connection via separate and dedicated router/switch.

5.3.2 AGL control philosophy

The ALCMS is used by different type of users, therefore it includes the required functionalities allowing each user to operate according to his role. The ALCMS foresees functionalities for the Air Traffic Controllers and for the Maintenance staff of the airport.

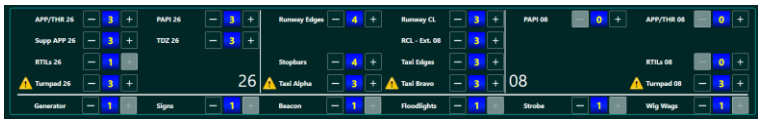
The ALCMS is designed to ease the ATC operator activities by grouping the AGL commands in a functional way where CCRs are grouped in AGL functions (e.g. Approach lighting) and in compliance with the ICAO recommendations while on the other hand allowing the maintenance staff to isolate one particular CCR providing the capability to control and monitor that circuit individually.

To permit this, the ALCMS foresees a mechanism which allows the Maintenance user to disconnect an equipment for maintenance purpose which allows him to control and monitor that equipment.

Three levels of control are provided to operate the AGL infrastructure:

Automatic Selection of Individual Aids

Individual Brightness Selection



Maintenance Mode

The usage of these controls is further explained in the following chapters.

5.4 The different HMI windows.

The following chapters provide a high-level description of the different screens the HMI will provide as well as the options that can enhance the solution and better fit the operational expectations.

Remark: the several screens shown in the following chapters are generic examples, the final layout may differ depending on the Airport specific situation.

5.4.1 Navigation Bar

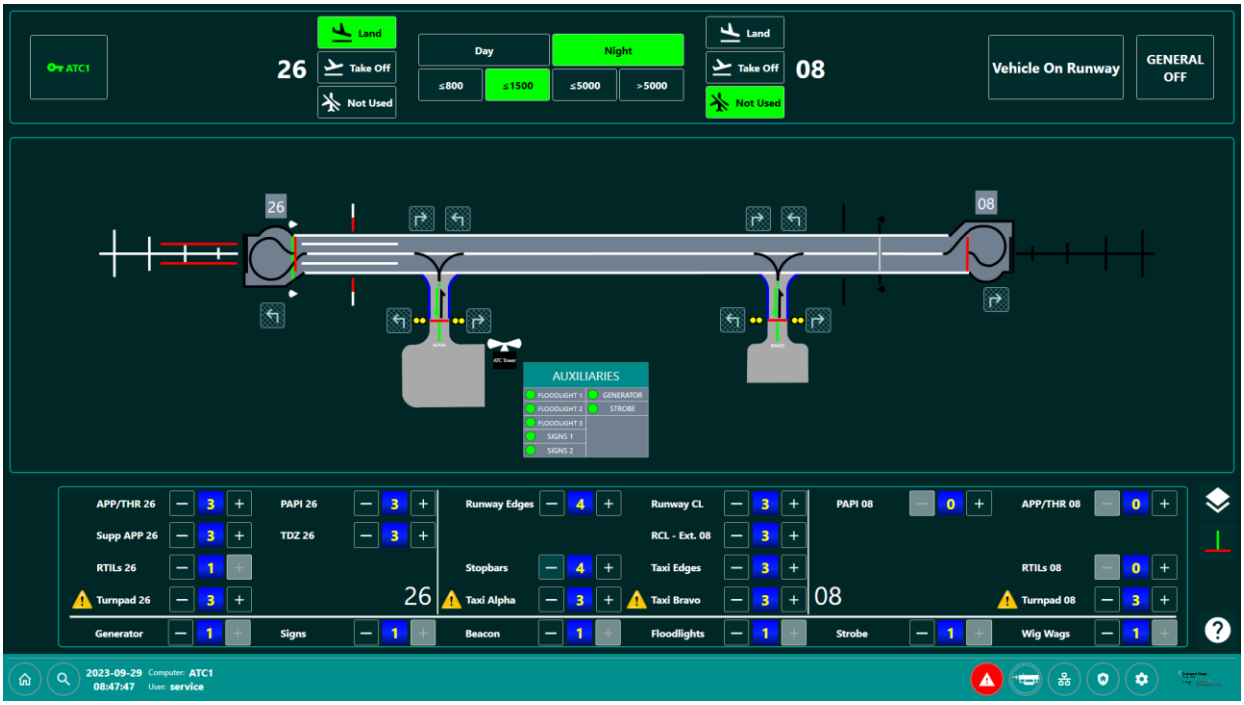
To navigate through the various HMI windows, a Common "Navigation" bar is always present at the bottom of the HMI. The accessible HMI windows will depend on the user level.

This Navigation bar provides several buttons to navigate between the HMI windows, a menu button providing additional settings such as login, select the HMI themes, access the user manuals and a set of displays showing the actual date and time, the name of this HMI, and the user that is logged into the system.

5.4.2 Airport Overview Window

The ATC operators primarily use this window for the control and monitoring of the approach, runway and taxiway lighting while the Maintenance user can get an immediate status of the AGL conditions that could affect the operations.

The Airport Overview Window contains several sections as described below.



5.4.2.1 *AGL ATC Control Section*

The Control part is divided in 2 main group of functionaliies used by the ATC Controller to set the Runway configuration and allowing to fine tune the individual AGL functions intensities.

The global settings section provides functionalities to take the control of the operations and set the Runway configuration:

- Take Control of the operations.
- Landing Direction and Configuration.
- Background luminance and Visibility condition.
- Advising all users that a vehicle is on the Runway making it unsafe to be used.
- General Off button providing a mean to switch all AGL off in one operation e.g. at the closure of the Airport.

By setting the Landing Direction and the Luminance level, the ALCMS will operate the different AGL visual aids at the intensity level defined in the automatic brightness table.

The Individual AGL Functions controls section:

The Individual Function control section will be used when the operator wants to deviate from the default configuration set by using the global control section to meet the immediate requirement of a pilot or sudden variation of weather. It will allow the user to control individually each of the available AGL Visual Aids.

For each function:

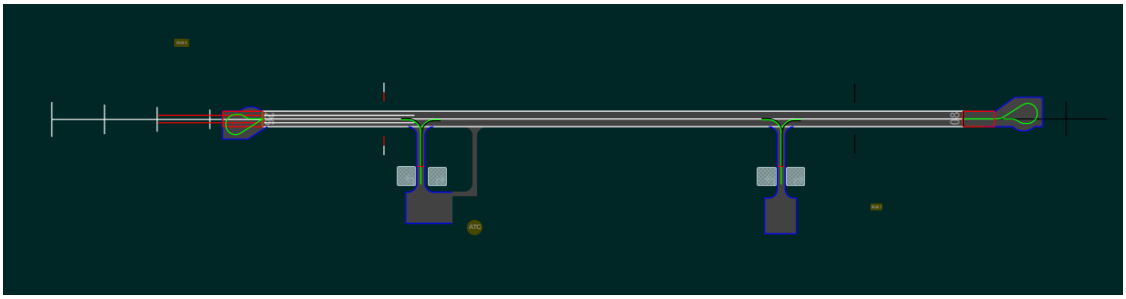
- A [+] and [-] buttons are available to increase/decrease the brightness of each equipment by one step. When doing so, a yellow rectangle will appear to show the newly requested intensity of functions, while the blue rectangle shows the status of the functions. The user must then validate the new request before it is executed.

- If the function CCRs are partially in maintenance, local or unserviceable, a yellow warning sign will appear on the button. This means that the ATC operator can continue controlling the remaining CCRs addressed by this function.

- A red warning sign will appear on the button if all corresponding CCRs are non-operational or in maintenance/local mode. While in this situation, the ATC operator has no control over this function.

5.4.2.2 *Graphical Feedback Section*

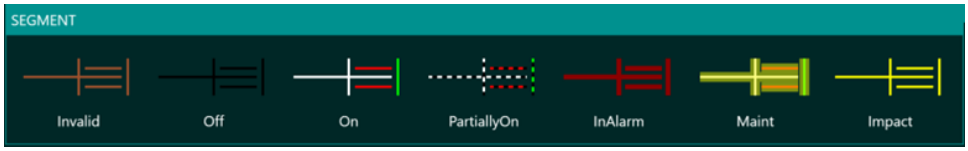
The "Graphical Feedback" section presents a "live" picture of the Runway providing immediate true status of the AGL visual aids by using colors and graphical behaviors.



Since this feedback is generated on AGL-function level (could be a group of regulators), it may be difficult to determine from this window which AFL-equipment has an error.

Therefore, the Equipment Overview window is available to get the additional details that the Maintenance team would need to maintain the AGL infrastructure.

The "Graphical Feedback" section depicts the airfield current situation through dynamic objects that represent true status feedback. This means that each object (represented lighting) can be represented in seven different states:



- Invalid: the system is loading and establishing connection with this set of segments.
- Off: the segment is turned Off.
- On: the segment is turned on; the actual color is shown.
- Partially On: the segment is partially on thanks to interleaving. Part of the CCRs powering the segments is unavailable.
- In Alarm: an alarm exists at the segment level.
- Maint: the segment is set in maintenance (at the segment level).
- Impact: the segment will be impacted by the current ATC requested commands.

A legend is always available using the [?] button on the lower right part of the screen.

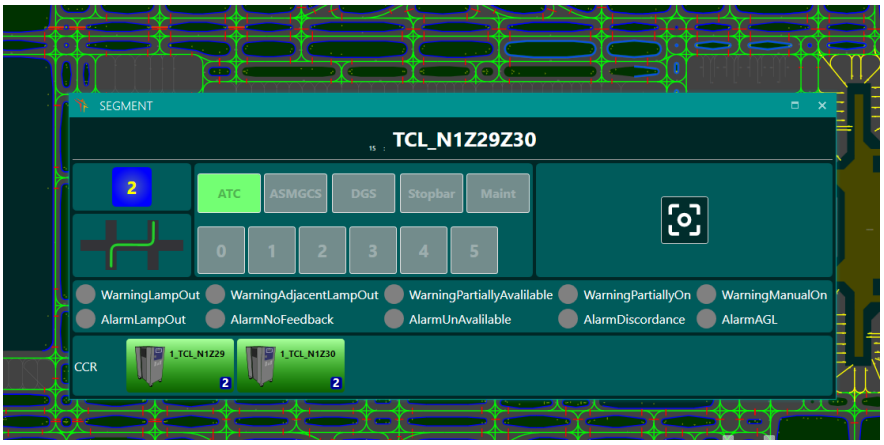
Graphical Feedback Interactive Navigation

To allow the user to navigate freely on the mimic and through the various AGL functions of the airfield, the mimic is zoomable, translatable, and rotatable. Displayed lighting functions are also selectable.

The user may change the view of the mimic using click & drag for translation, scrolling for zoom, and the compass for rotation.

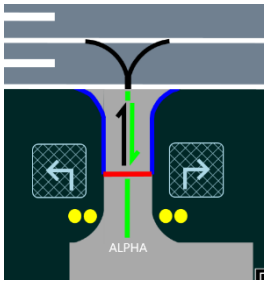
Maintenance control and monitoring.

For the Maintenance users, the Graphical Feedback section provides additional features allowing them to click on any object of the screen to get a detailed view providing the current state of the object as well as a mean to operate the object in maintenance mode.



5.4.2.3 *Stopbar Control*

Stopbars are controlled from the graphical mimic area of the window, each stopbar is surrounded by a set of buttons allowing for a direction control of the lead-on when available:



In this example, those LEFT and RIGHT buttons allow the ATC operator to activate the stopbar cycling sequence in the chosen lead-on direction.

The cycling sequence is composed of various phases, aligned with the progression of the aircraft on the taxiway:

- ENTER

  The *enter* phase is the time during which the aircraft is allowed to run over the stopbar. Hence, the stopbar is turned off during that phase. All the lead-ons are turned on during that phase.

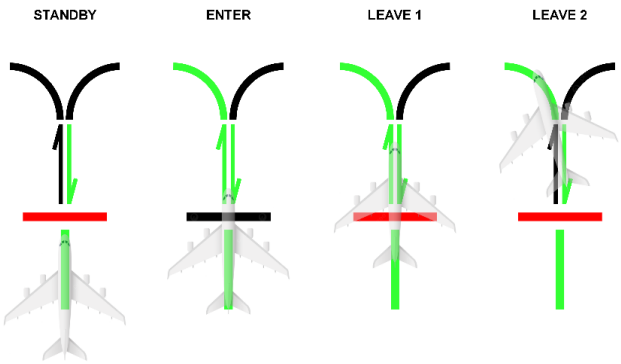
- LEAVE 1

  The *leave (1)* phase is meant to start when the aircraft has finished running over the stopbar. During that phase, the stopbar turns on again to protect the runway. The lead-ons however remain ON for a configurable period to support the line up of the Aircraft while the Stopbar is already closed to protect the runway.

- LEAVE 2 (optional)

  The *leave 2* phase is optional, meaning all the lead-ons can either be switched off at the same time when *leave 1* phase is finished. Or they can progressively be switched off. In case a *leave 2* lead-on is present, the first lead-on segment (right after the stopbar) will be switched off, while the second lead-on (left or right turn onto the runway) will remain on allowing the aircraft to finalizing its line up.

The figure below shows the sequenced phases of a stopbar cycling procedure:

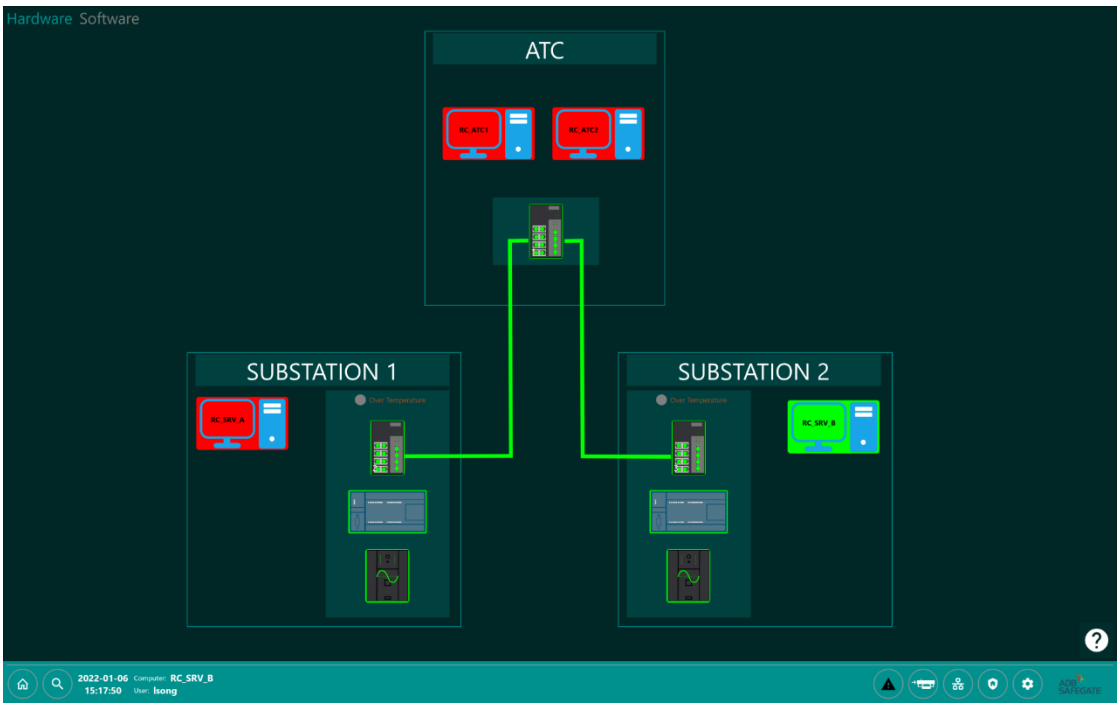


Each phase has a configurable timeout. When the stopbar cycling is started, the *enter* phase will be launched and a countdown will start. When the latter gets to 0, the next phase will be started.

5.4.3 System Status Window

The System Status Window provides a graphical representation of the different components of the ALCMS giving its actual status using colors.

This window is the starting point of maintenance and troubleshooting activity. It will typically display the status of HMIs, Servers, PLCs, network equipment and UPS.



A Maintenance user can click on any object on the screen to open a detailed view providing the actual state and all information available for that object.

A set of icons and color code will be used to provide direct feedback on the actual status of the equipment ensuring a fast understanding of the situation.

5.4.4 Equipment Status Window

The Equipment status window provides a complete and comprehensive overview on the several equipment connected to the ALCMS, providing the status of the individual CCRs, ILCMS and Auxiliaries. The Maintenance team has the ability to view this information in different formats either in a graphical way or in a tabular form allowing printing reports of filtered information. Below is a high level description of both views:

5.4.4.1 *Substation Window*

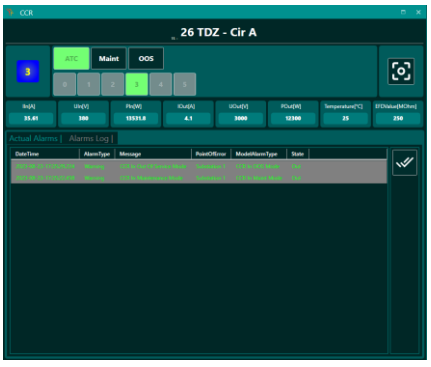
The ALCMS provide a Substation View to be used for maintenance purposes and providing a graphical representation of the different components controlled and monitored by the ALCMS and distributed in the several substations. A window is provided per Substation to ease the navigation.

Each piece of equipment is represented by a graphical object which provides immediate status of the equipment using colors (ON/OFF) and icons (Step, Local, Alarm, Warning).

By clicking on the graphical object, the Equipment detailed view pops-up, displaying detailed information e.g., operational status, alarms, output current, voltage, power, earth fault measurements, operational times, several trends providing historical data. It also provides the Maintenance user with tools to change the operational status of the equipment such as:

- Maintenance mode allows operation of the equipment without the need of taking over the operations from ATC but only getting the control of this equipment for testing purposes.
- Out of Service mode disables the equipment from ATC control while stopping all alarms and events during the maintenance activities.

The Detailed View also provides a locator function that allows a quick finding of the light, circuit or area linked to the object, bringing, and highlighting the affected area to the user on the Airport mimic.

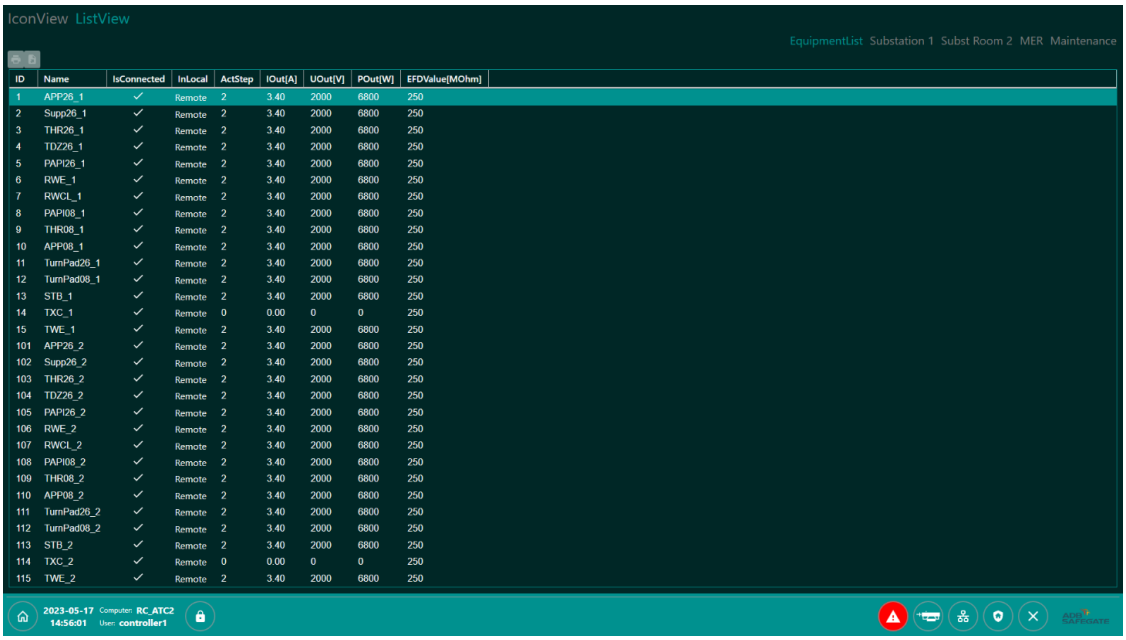


5.4.4.2 *Equipment Status List View*

The Equipment Status Window provides a complete overview of the AGL equipment controlled and monitored by the ALCMS in a tabular form.

For each equipment, the System displays its current operational state (ON, OFF, Step, Remote, Local, Alarm) and the analogue information it provides, such as Output Current, Voltage, Power, and/or Isolation value.

It provides means to filter the data as well as printing the outcome in a report.



ID	Name	IsConnected	InLocal	ActStep	IOut[A]	UOut[V]	POut[W]	EFDValue[MOhm]
1	APP26_1	✓	Remote	2	3.40	2000	6800	250
2	Supp26_1	✓	Remote	2	3.40	2000	6800	250
3	THR26_1	✓	Remote	2	3.40	2000	6800	250
4	TDZ26_1	✓	Remote	2	3.40	2000	6800	250
5	PAPI26_1	✓	Remote	2	3.40	2000	6800	250
6	RWE_1	✓	Remote	2	3.40	2000	6800	250
7	RWCL_1	✓	Remote	2	3.40	2000	6800	250
8	PAPI08_1	✓	Remote	2	3.40	2000	6800	250
9	THR08_1	✓	Remote	2	3.40	2000	6800	250
10	APP08_1	✓	Remote	2	3.40	2000	6800	250
11	TurnPad26_1	✓	Remote	2	3.40	2000	6800	250
12	TurnPad08_1	✓	Remote	2	3.40	2000	6800	250
13	STB_1	✓	Remote	2	3.40	2000	6800	250
14	TXC_1	✓	Remote	0	0.00	0	0	250
15	TWE_1	✓	Remote	2	3.40	2000	6800	250
101	APP26_2	✓	Remote	2	3.40	2000	6800	250
102	Supp26_2	✓	Remote	2	3.40	2000	6800	250
103	THR26_2	✓	Remote	2	3.40	2000	6800	250
104	TDZ26_2	✓	Remote	2	3.40	2000	6800	250
105	PAPI26_2	✓	Remote	2	3.40	2000	6800	250
106	RWE_2	✓	Remote	2	3.40	2000	6800	250
107	RWCL_2	✓	Remote	2	3.40	2000	6800	250
108	PAPI08_2	✓	Remote	2	3.40	2000	6800	250
109	THR08_2	✓	Remote	2	3.40	2000	6800	250
110	APP08_2	✓	Remote	2	3.40	2000	6800	250
111	TurnPad26_2	✓	Remote	2	3.40	2000	6800	250
112	TurnPad08_2	✓	Remote	2	3.40	2000	6800	250
113	STB_2	✓	Remote	2	3.40	2000	6800	250
114	TXC_2	✓	Remote	0	0.00	0	0	250
115	TWE_2	✓	Remote	2	3.40	2000	6800	250

5.4.5 Alarms Window

When the Alarm Window menu button is selected from the navigation section, the Alarm Window can be viewed. This page displays information about all the alarms currently active in the system and is a valuable tool for troubleshooting the system. Messages can be sorted, filtered, and printed and a clear color code is used to show the severity of the problems.

The handling of alarms is based on a defined workflow that ensures that all the alarms must be acknowledged by the users before they are cleared from the alarm browser.

Also, as several levels of alarms (and warnings) are available, the contents of the alarm window will be adapted to the currently logged-in user. This ensures that ATC users are presented with information directly relevant to them.

Note also that alarms are accompanied by an audible sound to attract the user's attention.

ID	ModelID	DateTime	AlarmType	Message	PointOfError	ModelType	EquipmentName	ModelAlarmType	State
3096512506626049	1	2022-01-07-16:55:11.888	Warning	Segment Warning Partially Availlable	System	Segment	BANA	Segment Warning Partially Availlable	InAck
3096516801593345	1	2022-01-07-17:00:23.311	Warning	Segment Warning Partially On	System	Segment	BANA	Segment Warning Partially On	In
3378017548107777	1	2022-01-07-17:00:23.311	Warning	Function Warning Partially On	System	Function	BANA	Function Warning Partially On	In
2814771241943141	101	2022-01-07-17:00:17.898	Warning	CCR In OOS Mode	Sub1	CCR	BANA 14	CCR In OOS Mode	In
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3378021843075081	9	2022-01-07-16:09:20.745	Warning	Function Warning Deviation	System	Function	GLIDBANA 32	Function Warning Deviation	In
3378021843075080	8	2022-01-07-16:09:20.745	Warning	Function Warning Deviation	System	Function	INFLYGNING Li 32	Function Warning Deviation	In
3378021843075079	7	2022-01-07-16:09:20.745	Warning	Function Warning Deviation	System	Function	INFLYGNING Hi 32	Function Warning Deviation	In
3378021843075078	6	2022-01-07-16:09:20.745	Warning	Function Warning Deviation	System	Function	RGL	Function Warning Deviation	In
3378021843075077	5	2022-01-07-16:09:20.745	Warning	Function Warning Deviation	System	Function	TAXI	Function Warning Deviation	In
3378021843075076	4	2022-01-07-16:09:20.745	Warning	Function Warning Deviation	System	Function	GLIDBANA 14	Function Warning Deviation	In
3378021843075074	2	2022-01-07-16:09:20.745	Warning	Function Warning Deviation	System	Function	INFLYGNING Hi 14	Function Warning Deviation	In
17170896997318757	101	2022-01-07-16:09:20.745	Alarm	Cabinet DisConnected	Sub1	Cabinet	1_Cabinet	Cabinet DisConnected	In
3378021843075073	1	2022-01-07-16:09:20.745	Warning	Function Warning Deviation	System	Function	BANA	Function Warning Deviation	In
6755670023995423	31	2022-01-07-16:09:20.745	Alarm	Computer DisConnected	Sub1	Computer	RC_SRV_A	Computer DisConnected	In
6755670023995394	2	2022-01-07-16:09:20.745	Alarm	Computer DisConnected	ATC	Computer	RC_ATC2	Computer DisConnected	In
6755670023995393	1	2022-01-07-16:09:20.745	Alarm	Computer DisConnected	ATC	Computer	RC_ATC1	Computer DisConnected	In
3378021843075075	3	2022-01-07-16:09:20.745	Warning	Function Warning Deviation	System	Function	INFLYGNING Li 14	Function Warning Deviation	In
17170896997318857	201	2022-01-07-16:09:20.745	Alarm	Cabinet DisConnected	Sub2	Cabinet	2_Cabinet	Cabinet DisConnected	In

5.4.5.1 *Alarm and Event Log Window*

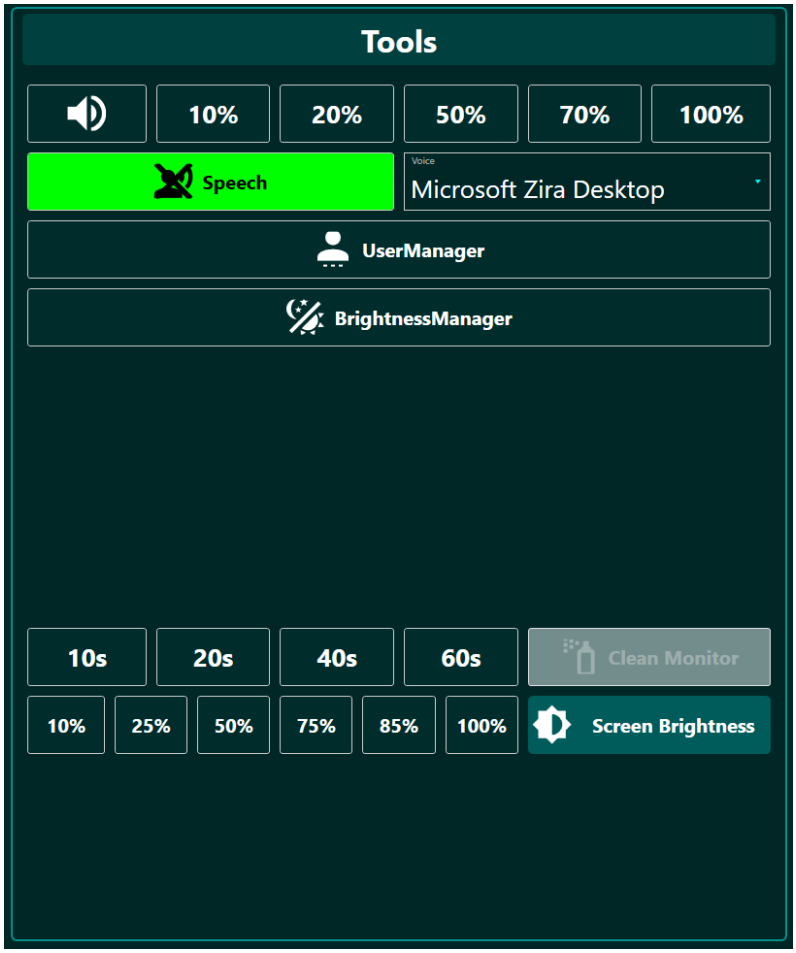
This window records the history of the alarms and events (operator major controls e.g., changing Landing Direction) that appeared on this machine and the system.

An advanced filter tool is provided by ADB SAFEGATE to select the required data. It is possible to sort and filter the alarm messages following several different rules.

5.4.6 Utility screens

The ALCMS provides several utilities for maintenance operators and system administrators:

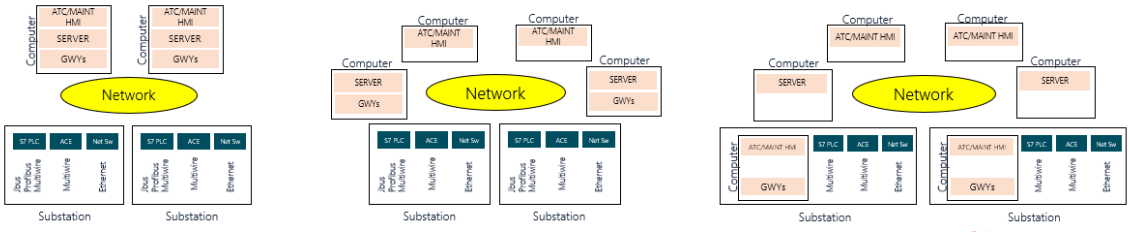
- The User Configuration of the System restricted to power users.
- The ICAO Table screen from which the system administrator can modify the default conditions settings defined according to the requirement per ICAO Annex 14.
- The Manuals screen provides access to on-line documentation such as, ADB SAFEGATE's manuals for installation of AGL fixtures or AGL equipment.
- The Tools allowing the user to to set volume, screen brightness settings and cleaning the touchscreen..



5.4.7 Optional features

The CORTEX ALCMS is a platform that is meant to support the growing Airport operational needs and can therefore be expanded as the Airport is.

The expansion could be structural, implying the growth of the System architecture by adding additional AGL Equipment, HMIs, electrical substations, ATC towers, Maintenance centers or any other location that the Airport would like to have capabilities in controlling or maintaining the AGL infrastructure. The CORTEX ALCMS was developed to ensure no limitations of the System Architecture, adding additional components is always possible.



Besides the structural growth, the operational needs may also demand additional functionalities to support the stakeholders in their daily activities, these functionalities may not be needed in first instance, but come with the expansions of the Airport. Therefore, the CORTEX ALCMS can be enhanced with features that would ease the operations of the Maintenance teams or Air Ground Traffic controllers while the Airport complexity grows.

The following chapters give a description of the additional features the Cortex ALCMS solution can provide to support this growth. These additional features can be installed at any time to the existing solution.

5.4.7.1 *Multiple Runways and Areas of Responsibilities*

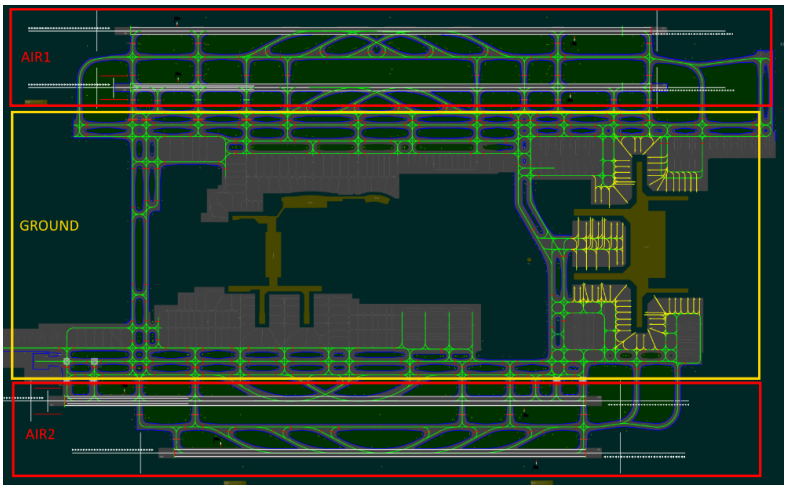
When the Airport complexity grows with additional Runways or complex taxiway layout, the airport operators may need to divide the load and segregate the operations in different Areas of Responsibilities where multiple ATC controllers would control and monitor different areas of the Airport.

It could be decided that one AIR controller would control the first runway, while a second AIR controller would oversee the second runway and a third Apron controller would take care of the Ground traffic.

This optional feature would provide the users with this capability, during the design of the Solution the transfer points would be defined and the ALCMS would be configured in a way to allow this segregation of authority.

Each Controller could therefore control and monitor the AGL infrastructure related to his Area of Responsibility.

As Airports have their high and low traffic periods, this functionality also allows one operator to take control of multiple areas of responsibility allowing as an example the same operator to control the whole Airport during night when the traffic is low and distribute the load during day traffic peaks.



5.4.7.2 *ILCMS integration*

The ADB SAFEGATE – LINC360 system controls and monitors individual lamps. It reacts to higher level commands from the ALCMS system to which it reports the status of the units and fixtures installed in the field.

The LINC360 system uses the serial circuit powering the fixtures as the communication carrier, requiring no extra cable. The LINC360 remotes and Intelligent lights are addressable units having a unique address allowing the control of the fixtures they are connected with. This control can be individually or in a group. Each LINC360 field unit reports back its status and the connected fixtures' status.

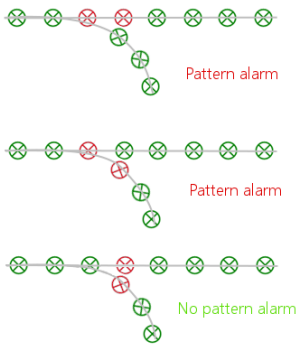
The LINC360 system is mainly composed of 2 types of components:

- The LINC360 controller's key role is to relay the commands coming from the LINC360 Server to the LINC360 Remotes installed in the field by sending them through the Series circuit using the Power line communication. On the other hand, it retrieves the status of each individual LINC360 Remote permitting the monitoring of each individual fixture.

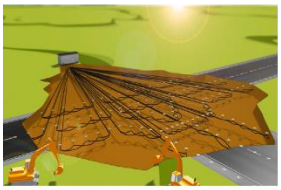
- The LINC360 Remotes and Intelligent lights will be of the type of fixture. The remotes will be installed between the transformer and the lights and will permit the individual control and monitoring of the connected fixture while the Intelligent light (EQ fixture) has the communication driver directly integrated in the fixture.

When integrating LINC360 to the ALCMS, it is possible to:

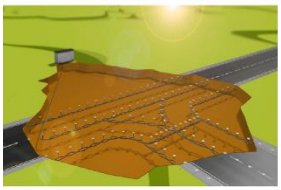
- Monitor the status of the several circuits, quantity of burnt lamps, adjacent lamps out that contribute to the serviceability calculation of a particular AGL function.



- Segment the primary circuit by grouping logically the lights allowing for group control, such as stopbars and lead on segments heavily reducing the amount of primary cabling.



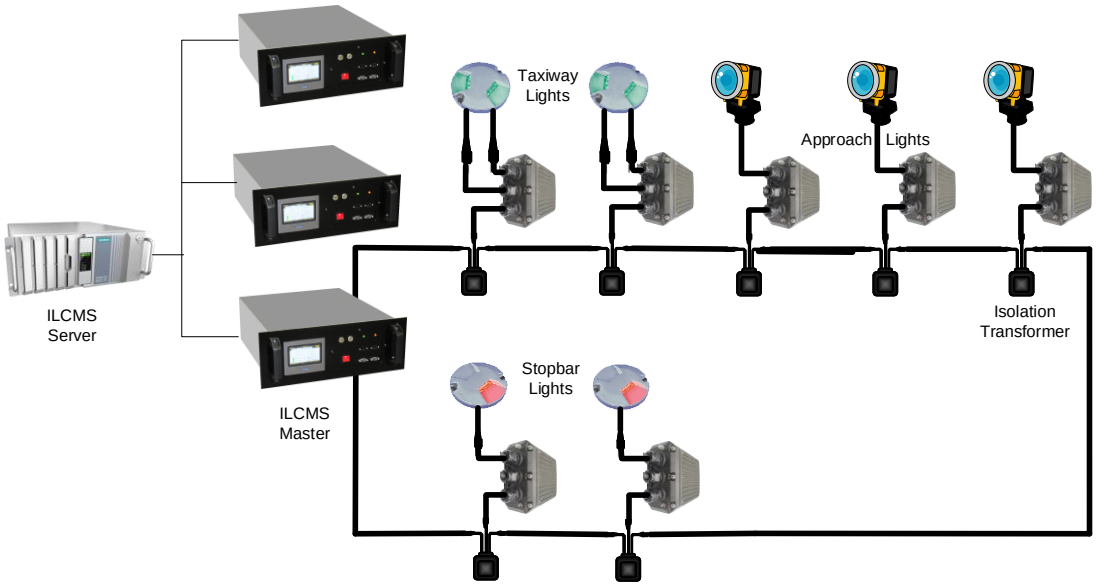
Cabling in traditional AGL system
(Hardware defined segments)



Cabling in ILCMS System
(Software defined segments)

- Monitor each individual light, provide the maintenance team with the details of the light to be serviced easing the maintenance activities planning.

The following sketch provides an overview of the installation of the LINC360 Components

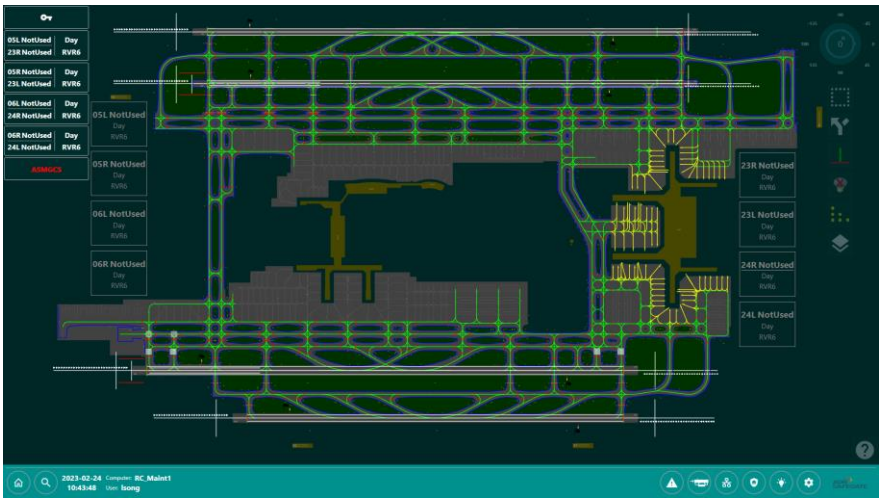


5.4.7.3 *On Scale Overview with Individual Light monitoring*

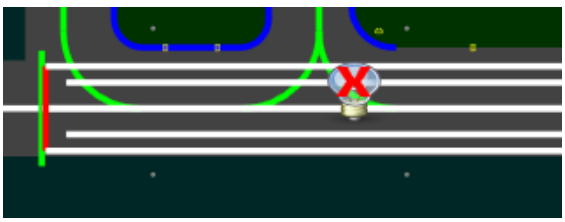
When the Airport AGL infrastructure grows, having a geographically accurate representation of the Airfield and detailed AGL information becomes crucial to support the operations and ease the maintenance activities.

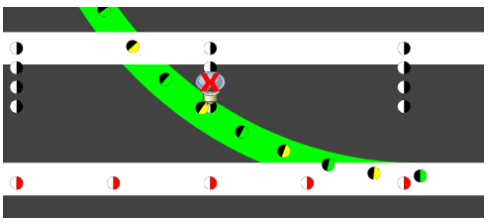
The On Scale Airport Overview functionality provides this granularity and in combination with ADBSG's ILCMS LINC360 solution will support the maintenance team in the planning of the corrective actions regarding burnt lamp replacement.

The On Scale Airport Overview is built using an AutoCAD drawing which is imported into the Cortex ALCMS making the AutoCAD drawing the unique source of truth for the AGL infrastructure.



It also provides monitoring of burnt lamps directly on the map, providing the exact position to the Maintenance staff and reducing the time needed in locating the problem, hence improving the response time of the team to ensure corrective actions.





Clicking on the lamp error icon opens a detailed view providing all information about this particular fixture.

5.4.7.4 *Routing and Guidance*

When the AGL infrastructure related to the ground movements becomes complex it may become interesting to have a fine graded control of the routes provided to pilots to reduce risks of confusion.

The Cortex ALCMS when supplemented by a LINC360 ILCMS solution provides a solution to support those operations by e.g.:

- Setting Landing and Take off routes automatically with the selection of the Landing Direction or Visibility conditions.
- Pre-programming routes that the ATC operator can select based on needs.
- Providing segment granularity by reducing segment size, to support advanced routing and guidance features provided by an A-SMGCS.

5.4.7.5 *Stopbar monitoring and reactivation with Sensors*

Stopbars are typically operated using a timer that will relight the Stopbar and switch off the Lead-on after a configured time, this operation can be enhanced by adding a set of Presence Sensors around the Stopbar and after the Lead-on that will capture the passage of the Aircraft and immediately reactive the Stopbar and switch off the Lead-on as soon as the Aircraft finishes its line up to the Runway.

The technologies typically used to achieve this functionality are:

- Microwave Sensors, or Microwave barriers, where a transceiver and receiver are installed on poles on both sides of the taxiway. They generate an invisible microwave barrier that will produce a detection when the Aircraft “interrupt” the beam.
- Induction Loops installed in the pavement and based on electromagnetic induction will generate a detection when an Aircraft passes over the loop. Then the metal parts induce a current that causes a change in the loop’s inductance which in turn generates a detection signal.

The additional feature that adding Sensors could provide is more related to the safety aspect of the Stopbar operation by providing an alert to the ATC operator if an Aircraft or a vehicle would cross the lit stopbar and therefore perform an unauthorized crossing of the Stopbar.

Depending on the expected functionality the sensors can be placed at distinct locations:

- Before the stopbar to provide a “presence” signal to the ATC operator informing that an Aircraft or vehicle is waiting in front of the Stopbar
- Right After the stopbar to relight the Stopbar after the passage of the Aircraft or vehicle, protecting immediately the runway entrance to avoid that another Aircraft or vehicle could consider the passage to be granted while the timer is still running. This same Stopbar Sensor in combination with the Presence sensor would provide an “unauthorized Stopbar crossing” alert when an Aircraft is going in the direction of the Runway and passing the lit Stopbar.
- After the 90m Lead-on to extinguish the 90m Lead-on taxiway lights when the Aircraft finishes its line-up to or crossing of the Runway.

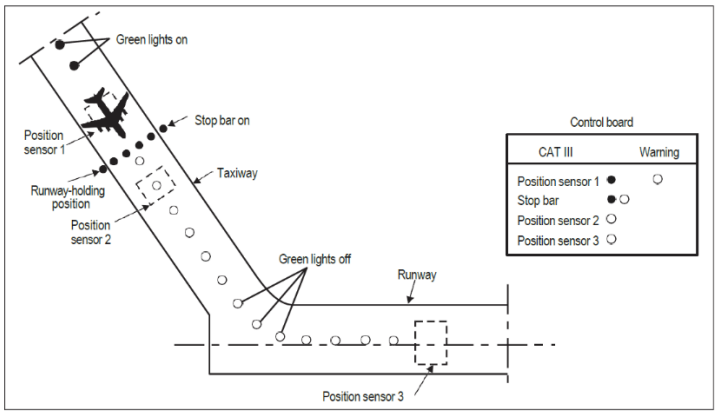
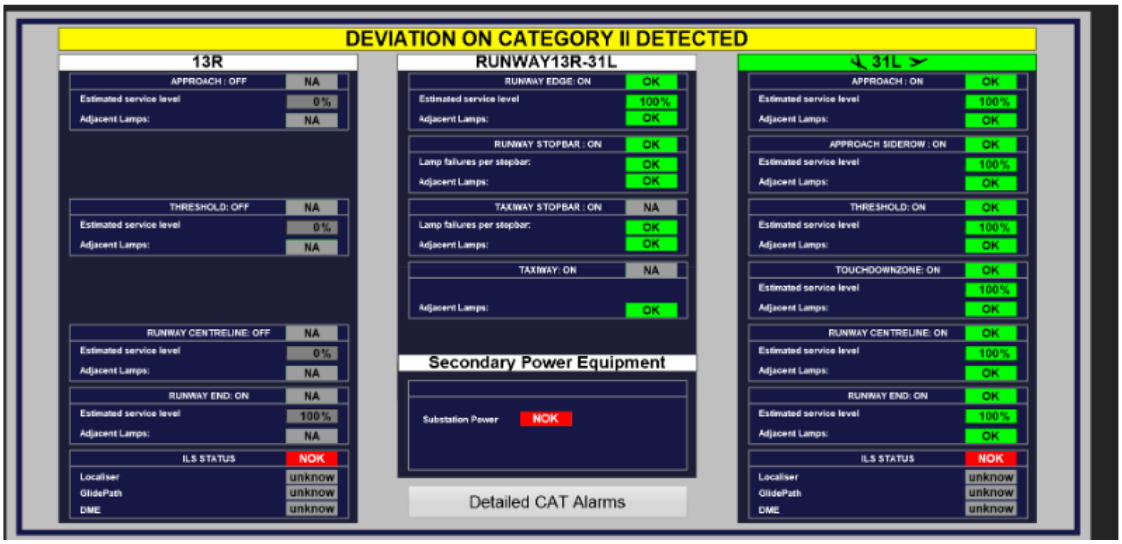


Figure 10-2. Control of stop bar through position sensors — Aircraft approaching the stop bar

5.4.7.6 *Serviceability monitoring*

Airports operating in different Category conditions need to maintain a certain level of Serviceability for the several AGL functions as well as ensure the proper operation of other supporting Systems such as ILS, Glide path or power generators to be compliant with regulation body expectations.

The Serviceability monitoring module will constantly monitor the state of these several sub systems to provide a comprehensive dashboard their status, serviceability percentage, adjacent lamps out, etc. This helps users know the actual conditions the Airport can operate at for each landing direction and allows early identification of the critical assets to be serviced to ensure the operations in a particular Condition.



5.4.7.7 *Weather interface*

The Weather interface is meant to provide the Weather System with the actual status of the Runway Lights intensity to determine the visibility conditions of the Airport.

This option is made possible by a PLC located in the Tower which will have the following outputs:

- 5 outputs providing the actual Runway Edge intensity.
- 5 outputs providing the actual the Runway Centerline intensity.

- 2 outputs providing the actual Landing Direction in operation.

5.4.7.8 *A-VDGS interface*

The A-VDGCS will give pilots guidance towards the parking gate, ensuring it is parked at the correct place to facilitate the passenger bridge deployment.

To smooth the operations and ensure the Aircraft are properly driven to the correct parking gate when driving on the Apron, an interface between the A-VDGS system and the ALCMS is possible. This interface will provide the A-VDGS system with the capability to control the gate Lead-in lights, providing the pilot with a unique and clear direction path to the assigned gate until the A-VDGCS solution starts the tracking sequence.

This interface is based on an open interface protocol that can be adopted by any A-VDGS manufacturer easing the integration.

5.4.7.9 *3rd party AGL open interface*

This additional function of the Cortex ALCMS is for those Airports having or willing to invest in an A-SMGCS solution providing the Guidance Service or having an ICWP to group several subsystems within the same HMI. They also must be willing to replicate the ALCMS AGL control and monitoring functionalities to integrate the AGL infrastructure into their Solution.

The Cortex ALCMS provides an open interface allowing such high-level Systems to control and monitor the AGL infrastructure. The interface exposes the different controllable AGL elements such as AGL Functions, AGL Segments and Stopbars allowing such 3rd party solutions to easily integrate the AGL infrastructure in their Solution.

5.4.7.10 *Cyber Security*

Cyber Security could be of importance for an Airport and therefore the Cortex ALCMS can be provided with a wide set of measures to protect the system against the identified threats.

These measures can be applied to the different layers of the ALCMS.
Operating System, Network, hardware, communication hardening methods could be applied depending on the mitigation methods resulting of the risk analysis.

Cyber Security is not offered standardly because it comes with a certain cost and therefore offered on demand and based on an initial risk assessment provided by the Airport IT department.

If Cyber Security is of concern, please contact your Sales representative.

6 Cortex ALCMS Project Process description

ADB Safegate is worldwide leader in the delivery of AGL products and deployment of ALCMS solutions easing the operations at airports. ADB Safegate has 50+ Engineers exclusively working on delivering Solutions to all airports in the world, these teams are in several geographical regions to better support our customers.

All teams and Engineers work following the same process to ensure that the quality of our Solutions is the same regardless of the Region they are deployed.

The Cortex ALCMS process follows this approach while simultaneously being lean enough to ensure cost effective Solutions can be provided to our Customers and maintaining high-quality and will therefore consist of the following main activities:

- Scope definition: this is the very first step in the realization of the Solution and consists of gathering the required information that is needed to configure the ALCMS, specifically for the Airport, during this step a questionnaire is to be compiled to gather the requirements in term of System Architecture and AGL infrastructure.

- With the provided information and the Functional set bought, a System Subsystem Design Document is generated providing definition on the Solution that will be produced. The document will detail the solution hardware architecture, the network configuration and the functionalities included in the Solution, providing customized views to show the graphical layout of the HMI and explaining the features provided within the Solution.

  This document is the main one that will be used during the production of the Solution and therefore requires a thorough verification by all stakeholders, a process shall be in place to formalize the submission, collecting the remarks and acknowledging its approval.

- The Solution is produced, the hardware is manufactured, and the software is configured for the Airport based on the received information.

  The complete setup is made in our premise, simulating as much as possible the real world, all cabinets are setup, interconnected using the same type of media that will be used on site, all computers, PLCs, network switches and UPS are connected to their respective end points and loaded with their respective software, finally simulators are used to verify the communication with the AGL equipment that will be available on site.

- A remote demonstration is planned with the Customer to show the resulting Solution and verify the correctness of the functionalities and graphical views.

- The Solution is validated following our internal Formal Qualification Testing (FQT) procedure to verify that all requirements are achieved, and that the Solution is in accordance with the expectations.

- As an option, a Factory Acceptance Test can be ensured, during this test, the customer representatives are invited in ADB Safegate's premise to formerly perform a set of pre-defined tests and witness the conformity of the provided solution against the System Subsystem Design Document.

  Remarks gathered during the FAT are analyzed and corrected before the delivery of the Solution.

- The user documentation is generated and comprises:
    - Installation Manual that will help the local team to install the several components of the Solution in the various locations.
    - Architecture Manual describes the solution's architecture, its components, the equipment that are connected and how they are connected.
    - User Manual that describes the several functionalities and the way to operate them.
    - Maintenance Manual that describes the preventive and corrective maintenance procedures.
    - Shop drawings of the cabinets to support the Maintenance troubleshooting.
- The Solution is delivered to the site and physically installed by the installation company.
- The Solution is commissioned by an ADBSG expert that will verify and test:
    - The physical and electrical installation is in accordance with expectations.
    - Communication with all the equipment.
    - The network linking the distinct locations.
    - The different functionalities of the ALCMS in accordance with the System Description.
- A Site Acceptance Test is performed with the customer to validate the Solution.
- Hands on training for ATC and Maintenance personnel.
- Release of the Solution to the customer and start of warranty period following terms of contract.