TECHNICAL WHITE PAPER / INDOOR SURVEILLANCE

Autonomous surveillance robot

Every route. A clearer picture.

A mobile observation platform for mapped indoor spaces. Connect a robot chassis, site-aware navigation and an operator workflow to turn patrol rounds into reviewable evidence.



Product visualization. Illustrative application; not a verified deployment photograph.

Executive summary

Fixed cameras provide a consistent view of selected locations. A mobile robot adds a changing viewpoint along a planned route. This reference design focuses on repeatable indoor inspection, recording where an observation occurred and routing it to an operator. It does not determine a person's identity or grant access to a controlled area.

Design status

These technical white papers describe proposed system architectures for Xcugas surveillance applications. Hardware, software integrations and operating limits are selected and validated for each project. Diagrams and interactive missions are illustrative; they are not live telemetry or evidence of tested product performance.

01 / TECHNICAL REFERENCE

Purpose and operating context

Repeatable rounds

Visit agreed checkpoints and record missed locations rather than treating an incomplete route as a successful patrol.

Context for operators

Pair an observation with the mission, map location and capture time so a team can decide what to do next.

A platform to build on

Choose the body, cameras and application workflow around the site, using the chassis and software interfaces as a foundation.

Application environments

Environment	Potential use
Data-center corridors	Observe agreed equipment-room approaches and route potential restricted-zone events for review.
Managed facilities	Check accessible corridors, doors and selected assets during scheduled rounds.
Indoor campuses	Repeat patrols through mapped, controlled spaces where pedestrian interaction can be assessed.

The observation-to-action boundary

The platform collects observations and presents evidence. A candidate event is not an established incident. An assigned operator reviews the context, records the outcome and follows the site response process.

02 / TECHNICAL REFERENCE

The mission, step by step

The following sequence describes a normal mission. Each transition should have an explicit acknowledgement or readiness condition; completion cannot be inferred from a command being sent.

Step	What happens
01. Define the patrol	An operator selects the approved map, checkpoints and observation rules. The mission receives an identifier so every later event can be traced to its route.
02. Check readiness	Check sensor freshness, map alignment, available energy and the local stop system. A readiness failure prevents a mission from starting.
03. Navigate the corridor	Estimate position from available sensing, plan a traversable path and follow it while checking the space ahead. The application should pause if the route cannot be validated.
04. Observe a checkpoint	Capture a view at the designated location. A configured rule can flag an observation for review; a visual detection alone is not proof of unauthorized access.
05. Send for review	Package the event with its capture time, map pose and evidence reference. The operator acknowledges or dismisses the event; delivery and acknowledgement are separate states.
06. Return and reconcile	Return to the assigned home or charging position when conditions allow. Mark completed, missed and interrupted checkpoints in the mission record.

The route is blocked

The proposed response is to stop before the obstruction, evaluate a permitted alternate route and request assistance if no validated route remains. In this example the mission stays paused; the robot does not squeeze through an unknown gap.

Connection lost

This example pauses the mission locally and queues the event. The operator panel must show stale telemetry, and no delivered-alert claim is made until connectivity and acknowledgement are restored.

03 / TECHNICAL REFERENCE

Architecture and technology

Proposed allocation of responsibilities. Final components, software versions and interfaces are selected during project engineering.

01 / PROPOSED LAYER

Sense

LiDAR, camera, wheel feedback

02 / PROPOSED LAYER

Estimate & plan

Onboard computer / ROS 2 candidate

03 / PROPOSED LAYER

Move & protect

Drive controller + local stop chain

04 / PROPOSED LAYER

Observe & review

Event service + operator panel

Mapping is not the same as localization

SLAM builds or updates a map while estimating motion. A routine patrol may instead localize against an approved map. Door changes, moved equipment and reflective surfaces can reduce confidence; commissioning must define when to stop and relocalize.

Global route, local decisions

A candidate ROS 2/Nav2 integration separates route planning from the controller that follows it. Define the robot footprint, clearance and permitted zones using the actual body and payload. A camera-based alert should not override motion constraints.

Observation needs context

An event rule should consider zone, time and repeated observations. Keep evidence and operator decisions together. Tune thresholds against representative lighting and traffic, and record both false alerts and missed examples.

Local control boundary

The local platform must have an assessed response when connectivity or mission logic fails. A web dashboard or language model does not replace the local control and stop / recovery systems.

04 / TECHNICAL REFERENCE

Hardware and configuration

Configure each subsystem against the actual site and payload. The following describes candidate roles, not a fixed bill of materials or a claim that all options are supplied together.

Subsystem	Candidate configuration	What to verify
Mobile base	Drive motors, encoders and chassis	Footprint, turning space, floor transitions, braking and payload stability.
Range sensing	2D LiDAR and optional depth sensing	Coverage near glass, dark surfaces, overhangs and low obstacles.
Observation	RGB camera; other payloads by scope	Field of view, low-light quality, privacy masks and camera placement.
Compute & control	Onboard computer and drive controller	Processing load, thermal limits, watchdogs and sensor time alignment.
Power & docking	Battery management and charging interface	Usable mission energy, reserve policy, contact alignment and charging verification.
Connectivity	Site Wi-Fi or scoped network link	Coverage gaps, roaming behavior, buffering and reconnection handling.

Specifications to establish

Document dimensions, mass, payload, operating speed, usable energy, runtime, environmental limits, connectivity and service intervals for the selected configuration. No numerical performance, ingress rating, certification or endurance claim is made in this paper.

Configuration baseline

Retain the hardware revision, sensor calibration, software versions, map or route revision and acceptance-test record together. Repeat relevant tests after changing the payload, drive system, sensors, controller parameters or mission logic.

05 / TECHNICAL REFERENCE

Interfaces and evidence lifecycle

Interface	Information exchanged	Integration requirement
Sensor > autonomy	Time-stamped scans, images and odometry	Define frames, units, update expectations and stale-data behavior.
Mission > motion	Approved waypoints and navigation goals	Require preconditions, cancellation handling and state feedback.
Robot > dashboard	Health, mission state and observations	Include capture time, receive time and a visible freshness indicator.
Dashboard > robot	Authorized mission / pause / resume requests	Validate ownership, expiry and acknowledgement before changing state.

Capture – **Queue** – **Receive** – **Acknowledge** – **Resolve**

Capture time, receipt time and operator acknowledgement are different facts. Preserve event identifiers across retries, retain original timestamps and make stale data visible.

Illustrative event contract

```
{
  "event_id": "robot-example-001",
  "mission_id": "patrol-example",
  "platform": "robot",
  "captured_at": "2026-11-01T10:00:00Z",
  "location": {
    "frame": "site_map",
    "checkpoint": "review-zone"
  },
  "type": "observation_for_review",
  "evidence_ref": "access-controlled-reference",
  "delivery_state": "queued",
  "review_state": "unreviewed"
}
```

Example fields only. This is not a published API or a live event. Select authentication, transport, retention and access rules for the deployment.

06 / TECHNICAL REFERENCE

Operating limits and failure responses

Changing indoor geometry

A map is not a guarantee that a corridor remains clear. Reassess routes after layout changes.

Steps and inaccessible areas

Stairs, lifts and automatic doors require separate integration and validation; do not assume they are supported.

Shared spaces

Pedestrian behavior, visibility and stopping distance must be evaluated for the specific installation.

Unspecified capacity

Runtime, speed, payload, dimensions, detection accuracy and charging time remain configuration-specific.

Condition	Proposed response	Acceptance evidence
Obstacle blocks the route	Stop, attempt only an allowed replan, then pause for assistance.	No contact; an interrupted mission remains visibly incomplete.
Position confidence drops	Suspend motion and require a validated recovery or operator intervention.	The robot does not continue along a pose estimate known to be unreliable.
Network connection drops	Apply the configured local pause policy and buffer events with original timestamps.	Dashboard shows stale data; queued and delivered events remain distinct.
Energy reaches reserve	End the patrol and attempt the validated return procedure if feasible.	Reserve is tested under the configured load; charging is confirmed separately.

07 / TECHNICAL REFERENCE

Deployment and acceptance testing

Set thresholds and test conditions before the pilot. Retain incomplete missions, false alerts and interventions in the record instead of reporting only successful runs.

Phase	Required outcome
1. Scope	Define the site, task, operating area, users and intervention responsibilities.
2. Integrate	Select hardware and software, calibrate sensors and document the interfaces and exception policies.
3. Pilot	Exercise normal missions and failure cases under controlled conditions. Retain logs and operator observations.
4. Accept	Review measured results, train operators and agree maintenance and revalidation procedures.

Measure	How to evaluate	Test conditions
Route completion	Completed checkpoints / scheduled checkpoints	Include blocked and interrupted runs in the report.
Obstacle response	Stop clearance and intervention count	Test representative people, objects and floor conditions.
Observation quality	Precision and recall on a labelled test set	Include day/night scenes and difficult negative examples.
Alert lifecycle	Capture-to-receipt and receipt-to-acknowledgement time	Report tail latency and connectivity failures, not just averages.
Return & charge	Successful docking and verified charge sessions / attempts	Include low-energy and alignment-error cases.

Before the scoping discussion

Provide floor plans, permitted routes, clearance constraints, observation examples, privacy zones, network coverage and a charging location. Define who reviews events and who can recover a paused robot.

08 / TECHNICAL REFERENCE

Governance, sources and next steps

Access and retention

Define device identity, operator roles, authenticated connections, evidence access and a retention schedule. Limit capture to the agreed task; use restricted zones and masking where required by the site.

Human decision ownership

Assign who reviews candidate observations, acknowledges incidents, authorizes privileged commands and recovers interrupted missions. Detection output should not be treated as a conclusion about identity, intent or wrongdoing.

Optional language interface

An LLM connector may propose a structured task. The mission service must validate it against permitted actions and site constraints; it must not bypass control limits or replace operator review.

Technical sources

1. Nav2: navigation servers
Explains the separation of planning, control and recovery in a ROS-based navigation system.
https://docs.nav2.org/jazzy/getting_started/navigation_concepts/navigation_servers/

2. ROS 2: quality of service
Describes message delivery policies and publisher/subscriber compatibility.
https://github.com/ros2/ros2_documentation/blob/jazzy/source/Concepts/Intermediate/About-Quality-of-Service-Settings.rst

Sources reviewed 1 November 2026. External documentation explains candidate components, not Xcugas implementation status. Pin supported versions and verify integrations during the project.

Terms used in this paper

Term	Meaning
Pose	Position and orientation in a defined coordinate frame.
Telemetry	Reported platform state, health and mission information.
Acceptance test	A measured check against criteria agreed before deployment.
SLAM	Simultaneous localization and mapping; estimating motion while constructing a map.

Discuss your configuration: hello@xcugas.com

Online technical showcase and interactive mission