System and Method for Adaptive Temporal Detection of Persistent Objects Using Dynamic Baseline Management

Adaptive Temporal Package Detection Engine (ATPDE)

Engineering Specification Supporting a United States Provisional Patent Application

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Notice

This document describes the design, operation, preferred embodiment, and alternative embodiments of the Adaptive Temporal Package Detection Engine (ATPDE). The information contained herein is intended to provide a complete technical disclosure of the invention and to serve as the engineering foundation for a United States Provisional Patent Application.

This document is written from an engineering perspective. Descriptions are intended to enable a person having ordinary skill in the fields of computer vision, software engineering, and digital image processing to understand, implement, and evaluate the disclosed invention.

Unless expressly stated otherwise, references to specific programming languages, operating systems, software libraries, hardware platforms, camera manufacturers, communication protocols, or commercial products are presented solely for purposes of describing the preferred embodiment and should not be interpreted as limiting the scope of the invention.

Throughout this specification, the term “package” represents the preferred application of the invention. The underlying architecture is equally applicable to other forms of persistent object detection and should not be construed as being limited to residential package monitoring.

Table of Contents

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1. Field of the Invention

The present invention relates generally to computer vision systems, digital image processing, automated surveillance, and persistent object detection.

More particularly, the invention relates to systems and methods for detecting the appearance, continued presence, and removal of stationary objects through adaptive temporal analysis using dynamic baseline management.

The preferred embodiment is implemented as the **Adaptive Temporal Package Detection Engine (ATPDE)**, a computer-implemented framework that evaluates monitored scenes over time rather than relying upon isolated observations. ATPDE integrates adaptive baseline management, environmental stability evaluation, candidate object analysis, temporal confidence accumulation, lifecycle state management, and configurable notification processing into a unified detection architecture.

Although the preferred embodiment is directed toward residential package delivery monitoring, the invention is not limited to package detection and may be employed in commercial, industrial, healthcare, logistics, retail, security, and other applications requiring reliable detection of persistent objects.

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2. Background of the Invention

The widespread adoption of electronic commerce has resulted in a substantial increase in residential and commercial package deliveries. As package volumes have increased, so too has the need for reliable automated monitoring systems capable of notifying property owners when deliveries occur.

Existing surveillance solutions generally employ one or more of the following techniques:

- Motion detection.
- Pixel-based change detection.
- Background subtraction.
- Object classification using artificial intelligence.
- Event triggering based upon video analytics.

Although these approaches have achieved varying degrees of success, each exhibits practical limitations when deployed in uncontrolled outdoor environments.

Motion detection systems frequently respond to environmental activity unrelated to package placement, including moving shadows, changing sunlight, wind-driven vegetation, insects, precipitation, reflections, and camera exposure adjustments. These events often produce nuisance notifications that reduce user confidence and increase unnecessary alert fatigue.

Artificial intelligence object recognition systems provide improved semantic understanding of individual images; however, many commercially available implementations continue to evaluate observations on a frame-by-frame basis. Temporary classification failures may therefore cause a persistent object to appear and disappear repeatedly despite remaining physically stationary within the monitored region.

Traditional background subtraction systems similarly encounter challenges when operating continuously over extended periods. If a newly introduced object remains visible while the background model continues to adapt, that object may eventually become incorporated into the reference image. Once this occurs, the monitoring system may lose awareness of the object's continued presence.

Outdoor surveillance environments introduce additional complexity through continually changing illumination, weather conditions, seasonal variation, camera operating characteristics, and other environmental influences. Collectively, these factors make reliable persistent object detection significantly more difficult than detecting simple motion.

Accordingly, there exists a need for an improved computer vision framework capable of distinguishing genuine object placement from temporary environmental disturbances while maintaining accurate awareness of object persistence throughout the object's lifecycle.

There further exists a need for a system capable of autonomously maintaining an accurate reference representation of the monitored environment without incorporating newly introduced persistent objects into that reference representation.

The present invention satisfies these needs through a coordinated architecture that combines adaptive baseline management, environmental stability evaluation, temporal confidence accumulation, lifecycle state management, and configurable notification processing into a unified persistent object detection framework.

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3. Summary of the Invention

The present invention provides a computer-implemented system and method for adaptive temporal detection of persistent objects using dynamic baseline management.

In the preferred embodiment, the invention is implemented as the Adaptive Temporal Package Detection Engine (ATPDE), which continuously evaluates one or more monitored regions using sequential digital images acquired from one or more imaging devices.

Unlike conventional systems that attempt to determine object existence from individual observations, ATPDE evaluates observations collected over time. Each observation contributes evidence regarding the existence, persistence, stability, and eventual removal of an object.

The disclosed architecture separates environmental analysis from object evaluation. Before confidence may be accumulated, ATPDE first determines whether environmental conditions are sufficiently stable to support reliable interpretation of observed image changes. Environmental instability may delay confidence accumulation, suspend baseline updates, reduce confidence growth, or otherwise influence system behavior.

The invention further employs Dynamic Baseline Management, which selectively updates the reference representation of the monitored scene only when predefined safety conditions indicate that baseline modification may occur without compromising future object detection. This selective update strategy reduces the likelihood that persistent objects become incorporated into the baseline while permitting long-term autonomous operation.

Object detection within ATPDE is modeled as a progressive lifecycle rather than a binary decision. Candidate objects advance through configurable lifecycle states according to accumulated confidence, environmental stability, persistence, and historical observation consistency. Similarly, detected objects may transition through removal and recovery states before the monitoring system returns to its normal operating condition.

The invention further provides configurable notification processing that may communicate significant lifecycle events through one or more notification mechanisms, including mobile applications, electronic mail, text messaging, application programming interfaces, web services, automation platforms, and additional communication systems.

The architecture described herein is intentionally modular. Individual subsystems may be modified, replaced, distributed, or expanded without departing from the principles of the invention provided that the coordinated temporal evaluation framework remains substantially intact.

The combination of adaptive baseline management, environmental stability evaluation, temporal confidence accumulation, lifecycle state management, and modular notification processing provides significant improvements in reliability over conventional motion detection and frame-by-frame object recognition systems operating within uncontrolled environments.

4. Definitions and Terminology

4.1 Purpose

The following definitions establish the terminology used throughout this specification. Unless specifically indicated otherwise, these definitions shall apply consistently throughout all subsequent sections of this document.

The definitions contained herein describe functional engineering concepts and are not intended to limit the invention to any particular hardware platform, programming language, software library, operating system, artificial intelligence framework, communication protocol, or commercial implementation.

Throughout this specification, terminology has been selected to distinguish ATPDE from conventional motion detection and image classification systems by emphasizing temporal analysis, persistent object evaluation, adaptive baseline management, and coordinated subsystem interaction.

4.2 Adaptive

The term **Adaptive** refers to the capability of ATPDE to modify operational behavior in response to observed environmental conditions, accumulated historical evidence, system configuration, operational state, or measured performance characteristics.

Adaptive behavior may include, but is not limited to:

- Baseline update decisions.
- Confidence adjustment.
- Environmental compensation.
- Detection timing.
- Notification timing.
- Recovery behavior.
- Processing thresholds.

Adaptation may be achieved through deterministic algorithms, statistical analysis, configurable rules, artificial intelligence techniques, heuristic evaluation, or combinations thereof.

4.3 Temporal Analysis

The term **Temporal Analysis** refers to evaluation performed across multiple observations collected over time.

Unlike conventional frame-by-frame processing, temporal analysis considers the historical consistency of observations when determining whether an object has appeared, remains present, or has been removed.

Temporal analysis may evaluate:

- Observation duration.
- Observation frequency.
- Spatial consistency.
- Historical confidence.
- Environmental stability.
- Observation persistence.
- Confidence trends.

Within ATPDE, time is treated as an engineering input rather than merely the interval between captured images.

4.4 Persistent Object

A **Persistent Object** is any object that remains within a monitored region for a duration sufficient to satisfy configurable temporal and confidence requirements.

Persistence is determined by accumulated evidence rather than instantaneous observation.

Examples include:

- Delivered packages.
- Storage containers.
- Equipment.
- Inventory.
- Medical devices.
- Pallets.
- Safety equipment.
- Construction materials.

The invention is not limited to any particular object category.

4.5 Package

Within the preferred embodiment, a **Package** refers to any delivered parcel, envelope, shipment, container, or similar article deposited within a monitored delivery area.

Throughout this specification, package detection is presented as the preferred commercial implementation of ATPDE.

References to packages shall not be interpreted as limiting the invention to residential delivery monitoring.

4.6 Monitoring Zone

The **Monitoring Zone** is the user-defined region within which ATPDE evaluates the presence and persistence of objects.

The monitoring zone may be represented using one or more of the following techniques:

- Polygonal regions.
- Rectangular regions.
- Pixel masks.
- Binary masks.
- Vector descriptions.

- Multiple independent regions.
- Dynamically generated regions.

Alternative embodiments may employ one or more monitoring zones simultaneously.

Monitoring zones may overlap, remain independent, or cooperate as part of a larger detection strategy.

4.7 Baseline

The **Baseline** is the reference representation of the monitored environment against which newly acquired observations are compared.

The baseline may consist of:

- A single reference image.
- Multiple reference images.
- Statistical scene models.
- Feature representations.
- Composite reference data.
- Equivalent representations describing the monitored environment.

Unlike continuously adapting background subtraction systems, ATPDE treats the baseline as a protected engineering asset.

Baseline modification occurs only when predefined safety conditions indicate that updates may occur without compromising future object detection.

4.8 Dynamic Baseline Management

Dynamic Baseline Management is the coordinated process responsible for creating, validating, protecting, updating, invalidating, restoring, and replacing the baseline representation used by ATPDE.

Baseline management decisions may consider:

- Existing object state.
- Environmental stability.
- Historical observations.
- Confidence values.
- Candidate object activity.
- Baseline age.
- System configuration.

Dynamic Baseline Management is one of the primary architectural components of ATPDE.

4.9 Candidate Object

A **Candidate Object** is a region that exhibits measurable differences from the current baseline and therefore warrants additional analysis.

Candidate identification does not indicate that an object has been detected.

Instead, candidate status represents preliminary engineering evidence that may contribute to future confidence accumulation.

Candidate evaluation may include:

- Area measurement.
- Contour analysis.
- Shape consistency.
- Zone overlap.
- Spatial stability.
- Edge density.
- Historical persistence.
- Additional engineering metrics.

4.10 Confidence

Within ATPDE, **Confidence** represents the accumulated engineering evidence supporting the existence of a persistent object.

Confidence is intentionally distinguished from artificial intelligence probability scores.

Confidence may be influenced by:

- Temporal persistence.
- Environmental stability.
- Candidate quality.
- Historical consistency.
- Baseline agreement.
- Spatial stability.
- Observation history.

Confidence values may increase, decrease, remain constant, or decay according to observed conditions.

Confidence is continuously reevaluated throughout the object lifecycle.

4.11 Environmental Stability

Environmental Stability is a quantitative assessment of whether observed changes within the monitored scene are likely attributable to legitimate object placement or to transient environmental disturbances.

Environmental stability evaluation may consider:

- Illumination.
- Shadow movement.
- Camera exposure adjustment.
- White balance variation.
- Weather.
- Wind.
- Reflections.
- Sensor noise.
- Compression artifacts.
- Other environmental influences.

Environmental stability serves as an independent engineering input to ATPDE’s decision-making process.

4.12 Object Lifecycle

The **Object Lifecycle** describes the progression of a detected object through successive operational states.

In the preferred embodiment, lifecycle states include:

- No Object
- Possible Object
- Confirmed Object
- Persistent Object
- Reminder Active
- Object Removed
- Baseline Recovery

Alternative embodiments may define additional states, combine states, or omit states without departing from the principles of the invention.

4.13 Notification Event

A **Notification Event** is a system-generated indication that a configurable condition has occurred and should be communicated to one or more external systems or users.

Notification events may include:

- Possible object detected.
- Object confirmed.
- Object remains present.
- Object removed.
- Camera unavailable.
- Camera restored.
- Baseline updated.
- System fault.

Notification delivery mechanisms are independent of the underlying detection architecture.

4.14 Preferred Embodiment

The **Preferred Embodiment** represents the implementation currently regarded by the inventor as the best known mode of practicing the invention at the time this specification was prepared.

Descriptions of the preferred embodiment are intended to enable implementation of ATPDE while illustrating the engineering concepts described herein.

Alternative embodiments described elsewhere in this specification demonstrate that the invention is not limited to a single implementation.

4.15 Engineering Framework

The term **Engineering Framework** refers to the coordinated interaction of independent software components that collectively implement ATPDE.

No individual subsystem alone constitutes the invention.

Rather, ATPDE derives its capabilities from the coordinated interaction of image acquisition, environmental analysis, dynamic baseline management, candidate object evaluation, temporal confidence accumulation, lifecycle management, notification processing, and system configuration operating together as a unified architecture.

Unless otherwise indicated, references to ATPDE throughout this specification refer to this integrated engineering framework.

5. Brief Description of the Drawings

The accompanying drawings illustrate preferred embodiments of the Adaptive Temporal Package Detection Engine (ATPDE) and are intended to assist in understanding the principles of the invention. The drawings are provided for purposes of explanation and should not be interpreted as limiting the scope of the invention. The relative arrangement, number, appearance, and organization of components shown in the drawings may vary in alternative embodiments while remaining within the scope of the disclosed invention.

Figure 1 illustrates a high-level architectural overview of the Adaptive Temporal Package Detection Engine (ATPDE), showing the principal software subsystems and the flow of information between image acquisition, environmental analysis, baseline management, candidate evaluation, temporal confidence accumulation, lifecycle management, notification processing, event history management, and configuration management.

Figure 2 illustrates the preferred operational processing pipeline used by ATPDE, beginning with image acquisition and progressing through validation, environmental analysis, baseline comparison, candidate generation, temporal confidence accumulation, lifecycle evaluation, notification processing, baseline management, and preparation for the next observation cycle.

Figure 3 illustrates an example monitoring environment showing an imaging device observing a user-defined monitoring zone in which persistent objects may be detected.

Figure 4 illustrates an example monitoring zone definition, including one or more polygonal regions used to identify the portion of the acquired image that participates in object evaluation.

Figure 5 illustrates the Environmental Analysis Engine and its evaluation of environmental stability, including representative inputs such as illumination variation, shadow movement, weather effects, camera exposure changes, reflections, and transient environmental disturbances.

Figure 6 illustrates the Dynamic Baseline Manager, including baseline creation, baseline protection, baseline validation, deferred updates, controlled recovery, and baseline replacement following confirmation that a monitored region has returned to a stable condition.

Figure 7 illustrates the Candidate Object Engine, including comparison of the current observation against the protected baseline, identification of changed regions, candidate qualification, candidate characterization, and preparation of engineering evidence for downstream temporal analysis.

Figure 8 illustrates the Temporal Confidence Engine, including progressive confidence accumulation, confidence growth, confidence decay, confidence suspension, confidence reset, and multi-factor evidence integration over successive observations.

Figure 9 illustrates the Object Lifecycle Manager and representative lifecycle transitions, including No Object, Possible Object, Confirmed Object, Persistent Object, Reminder Active, Removal Evaluation, Object Removed, and Baseline Recovery.

Figure 10 illustrates the Notification Decision Engine and representative notification pathways used to determine when lifecycle events should be communicated to users, external applications, or automation systems.

Figure 11 illustrates the Event History Manager and an example chronological recording of significant operational events, including candidate creation, confidence updates, lifecycle transitions, baseline operations, and notification activity.

Figure 12 illustrates the Configuration Manager and representative configurable operating parameters, including monitoring zones, confidence thresholds, timing values, notification schedules, environmental sensitivity, and baseline management policies.

Figure 13 illustrates an example sequence of observations demonstrating temporal confidence accumulation as a persistent object remains within the monitored region over multiple image acquisition cycles.

Figure 14 illustrates an example sequence showing confirmation of object removal followed by controlled baseline recovery and protected baseline replacement.

Figure 15 illustrates a representative end-to-end operational example beginning with an empty monitored region, followed by object introduction, confidence accumulation, object confirmation, reminder processing, object removal, and restoration of the protected baseline.

Figure 16 illustrates representative interactions among the principal ATPDE subsystems, demonstrating the coordinated exchange of engineering evidence throughout the detection process.

The drawings described herein are intended to illustrate the preferred embodiment of the invention and selected examples of its operation. Additional drawings, modified component arrangements, alternative processing sequences, or other illustrative representations may be employed without departing from the principles disclosed in this specification.

6. Detailed Description of the Preferred Embodiment

6.1 Overview

The following detailed description presents the presently preferred embodiment of the Adaptive Temporal Package Detection Engine (ATPDE). The preferred embodiment represents the best mode presently contemplated by the inventor for implementing the disclosed invention. It is provided to enable a person having ordinary skill in the fields of computer vision, digital image processing, software engineering, and automated monitoring systems to make and use the invention.

The preferred embodiment describes a computer-implemented framework that detects the appearance, continued presence, and removal of persistent objects through coordinated temporal analysis rather than isolated image evaluation. ATPDE continuously evaluates observations collected from one or more imaging devices while maintaining a protected understanding of the monitored environment through Dynamic Baseline Management.

Unlike conventional surveillance systems that rely primarily upon motion detection or frame-by-frame object recognition, ATPDE combines multiple independent engineering subsystems that cooperate to evaluate accumulated evidence over time. These subsystems include environmental stability analysis, protected baseline management, candidate object evaluation, temporal confidence accumulation, lifecycle state management, notification processing, event history management, and centralized configuration management.

Each subsystem contributes engineering evidence to the overall decision-making process. No individual subsystem independently determines whether a persistent object exists. Instead, ATPDE reaches detection decisions through the coordinated interaction of all participating components.

Throughout the preferred embodiment, references to packages represent the preferred commercial implementation of the invention. The underlying architecture is equally applicable to detecting other forms of persistent objects and should not be interpreted as limiting the invention to residential package monitoring.

Referring now to **Figure 1**, the overall ATPDE architecture comprises an Image Acquisition Layer, Environmental Analysis Engine, Dynamic Baseline Manager, Candidate Object Engine, Temporal Confidence Engine, Object Lifecycle Manager, Notification Decision Engine, Event History Manager, and Configuration Manager operating together as an integrated engineering framework.

Referring additionally to **Figure 2**, observations proceed through a preferred processing sequence beginning with image acquisition and validation, followed by environmental evaluation, comparison against the protected baseline, candidate object generation, temporal confidence accumulation, lifecycle evaluation, notification processing, historical event recording, baseline management, and preparation for the next observation cycle.

Although the preferred embodiment describes a sequential processing pipeline for purposes of explanation, the invention is not limited to sequential execution. Alternative embodiments may execute one or more processing stages concurrently, distribute processing across multiple computing devices, reorder selected operations, or combine individual subsystems while preserving the coordinated temporal evaluation principles disclosed herein.

The following sections describe each principal subsystem of ATPDE in greater technical detail.

6.2 Overall System Architecture

The Adaptive Temporal Package Detection Engine (ATPDE) comprises a coordinated collection of cooperating software components that collectively evaluate the appearance, continued presence, and removal of persistent objects within one or more monitored environments.

Unlike conventional surveillance systems in which a single algorithm determines whether an object exists, ATPDE distributes engineering responsibility across multiple independent subsystems. Each subsystem performs a specialized function while simultaneously contributing engineering evidence to the overall detection process. The resulting determination of object existence is therefore based upon the coordinated interaction of these subsystems rather than upon any individual computational technique.

Referring to Figure 1, the preferred embodiment comprises an Image Acquisition Layer, an Environmental Analysis Engine, a Dynamic Baseline Manager, a Candidate Object Engine, a Temporal Confidence Engine, an Object Lifecycle Manager, a Notification Decision Engine, an Event History Manager, and a Configuration Manager.

The Image Acquisition Layer serves as the interface between ATPDE and one or more image-producing devices. In the preferred embodiment, observations are acquired from one or more digital imaging devices at configurable intervals. Alternative embodiments may obtain observations from recorded image sequences, video streams, network cameras, mobile imaging devices, industrial vision systems, or other image-producing technologies.

Each acquired observation is validated before participating in downstream processing. Validation may include verification of image availability, communication integrity, image dimensions, timing consistency, or other engineering criteria appropriate to the selected implementation.

Validated observations are forwarded to the Environmental Analysis Engine.

The Environmental Analysis Engine evaluates the overall reliability of the observed scene before candidate object analysis begins. Environmental analysis is intentionally separated from object evaluation because changes affecting an entire scene frequently result from environmental conditions rather than object placement.

Representative environmental conditions include changes in illumination, cloud movement, precipitation, reflections, wind-driven vegetation, camera exposure adjustment, white balance variation, sensor noise, image compression artifacts, and similar transient influences.

Rather than determining whether an object exists, the Environmental Analysis Engine produces an engineering assessment describing whether current environmental conditions are sufficiently stable to support reliable candidate evaluation and confidence accumulation.

Following environmental evaluation, observations are compared against the protected baseline maintained by the Dynamic Baseline Manager.

The Dynamic Baseline Manager maintains a trusted engineering representation of the monitored environment. Unlike continuously adapting background subtraction systems, ATPDE intentionally prevents unrestricted modification of the baseline. Baseline replacement occurs only after predetermined engineering conditions demonstrate that modification may occur without compromising future object detection.

Comparison between the validated observation and the protected baseline produces one or more candidate regions representing meaningful differences within the monitored environment.

These candidate regions are evaluated by the Candidate Object Engine.

The Candidate Object Engine performs engineering analysis intended to distinguish meaningful candidate objects from insignificant scene variation. Candidate evaluation may include measurement of area, spatial consistency, monitoring zone occupancy, contour characteristics, edge information, persistence, geometric properties, historical consistency, or other engineering measurements.

Qualified candidates are subsequently forwarded to the Temporal Confidence Engine.

The Temporal Confidence Engine performs one of the distinguishing functions of ATPDE.

Rather than producing a binary detection result from a single observation, ATPDE accumulates engineering evidence over multiple observations acquired throughout time. Confidence may increase, decrease, remain constant, decay, or be temporarily suspended according to environmental stability, candidate quality, historical consistency, baseline integrity, and other engineering measurements.

Confidence therefore represents accumulated engineering evidence rather than an instantaneous classification result.

The Object Lifecycle Manager continuously evaluates accumulated confidence together with historical system behavior to determine the operational state of each candidate object.

Representative lifecycle states include No Object, Possible Object, Confirmed Object, Persistent Object, Reminder Active, Removal Evaluation, Object Removed, and Baseline Recovery. Alternative embodiments may employ additional lifecycle states or simplified lifecycle models without departing from the inventive principles disclosed herein.

Lifecycle transitions do not occur solely because of a single observation. Instead, transitions are governed by accumulated engineering evidence generated through the coordinated interaction of the preceding subsystems.

Whenever significant lifecycle events occur, responsibility passes to the Notification Decision Engine.

The Notification Decision Engine evaluates whether one or more lifecycle events satisfy user-defined notification policies. Notification decisions may consider delivery schedules, reminder intervals, duplicate suppression rules, communication availability, notification priority, user preferences, and additional engineering criteria.

Notification processing is intentionally separated from object detection so that communication policies may be modified independently of the underlying detection architecture.

Throughout system operation, the Event History Manager maintains a chronological engineering record describing significant operational events.

Representative historical information includes observation timestamps, environmental conditions, candidate evaluations, confidence progression, lifecycle transitions, baseline operations, notification events, system faults, communication interruptions, and other diagnostic information useful for engineering evaluation, auditing, or future system optimization.

Operational behavior of each subsystem is governed by the Configuration Manager.

The Configuration Manager maintains configurable engineering parameters including monitoring zones, environmental thresholds, temporal confidence parameters, lifecycle timing, notification policies, baseline management rules, and other operating characteristics. These parameters permit ATPDE to be adapted to different monitoring environments without altering the underlying engineering architecture.

Although the preferred embodiment describes these subsystems as logically distinct components, the invention is not limited to any particular software architecture. Alternative embodiments may combine individual subsystems, subdivide selected responsibilities, execute components concurrently, distribute processing across multiple computing devices, or employ future computational architectures while preserving the coordinated temporal evaluation framework disclosed throughout this specification.

A distinguishing characteristic of ATPDE is that no individual subsystem independently determines the existence of a persistent object. Instead, object detection results from the cooperative interaction of image acquisition, environmental analysis, protected baseline management, candidate evaluation, temporal confidence accumulation, lifecycle management, notification processing, event history recording, and centralized configuration operating together as a unified engineering framework.

Accordingly, the invention resides not in any individual algorithm or processing stage, but in the coordinated architecture through which multiple independent engineering subsystems cooperate to evaluate persistent objects over time while maintaining a protected understanding of the monitored environment.

6.3 Image Acquisition Layer

The Image Acquisition Layer provides the interface between the Adaptive Temporal Package Detection Engine (ATPDE) and one or more image-producing devices from which observations of the monitored environment are obtained.

The purpose of the Image Acquisition Layer is to provide reliable, sequential observations suitable for temporal evaluation while isolating downstream processing components from hardware-specific implementation details. By separating image acquisition from the remaining engineering subsystems, ATPDE may operate with numerous imaging technologies without modification of the underlying detection architecture.

In the preferred embodiment, observations are acquired from one or more digital surveillance cameras positioned to monitor a predefined region of interest. Images may be obtained at configurable time intervals or continuously from a video stream, depending upon system configuration and operational requirements.

The invention is not limited to any particular image acquisition methodology. Alternative embodiments may acquire observations from Internet Protocol (IP) cameras, Universal Serial Bus (USB) cameras, embedded imaging devices, industrial machine vision systems, mobile device cameras, network video recorders, cloud-hosted image services, prerecorded image sequences, video files, or future imaging technologies capable of producing sequential visual observations.

Likewise, the invention is independent of image resolution, frame rate, color depth, compression method, communication protocol, image encoding format, or camera manufacturer.

Each observation received by the Image Acquisition Layer is subjected to preliminary validation before participating in downstream processing. Validation ensures that only observations meeting minimum engineering requirements are introduced into the ATPDE processing pipeline.

Representative validation operations may include verification of image availability, confirmation that the acquired observation contains valid image data, verification of expected image dimensions, detection of communication failures, timing verification, image integrity assessment, and confirmation that the observation is compatible with the currently maintained protected baseline.

Should one or more validation criteria fail, the observation may be rejected, processing temporarily suspended, or recovery procedures initiated. Such actions are implementation dependent and may vary among alternative embodiments.

The Image Acquisition Layer may further monitor the operational status of the imaging device throughout normal system operation. Representative operational conditions include communication interruption, delayed image acquisition, corrupted observations, unavailable image streams, device restart, network failure, or camera replacement.

When abnormal operating conditions are detected, ATPDE may temporarily suspend confidence accumulation, delay baseline updates, generate engineering diagnostic events, notify external systems, or initiate recovery procedures. These actions reduce the likelihood that temporary imaging faults will produce erroneous object detections.

In one preferred embodiment, ATPDE maintains awareness of image timing to ensure that observations are processed in their intended chronological sequence. Sequential observations form the foundation upon which temporal confidence accumulation operates. Missing observations, delayed observations, duplicated observations, or observations arriving outside acceptable timing tolerances may therefore be identified and handled according to configurable engineering policies.

The Image Acquisition Layer may additionally perform preprocessing operations that prepare observations for downstream analysis. Representative preprocessing operations may include image resizing, geometric normalization, color space conversion, orientation correction, cropping, masking, metadata extraction, timestamp association, or equivalent engineering operations. Such preprocessing serves only to standardize observations and does not itself determine whether a persistent object exists.

The Image Acquisition Layer intentionally avoids making object detection decisions. No determination regarding package placement, object persistence, confidence accumulation, lifecycle progression, or notification generation is performed within this subsystem.

Instead, the Image Acquisition Layer supplies validated and normalized observations to the Environmental Analysis Engine, which performs the first stage of engineering evaluation within the ATPDE architecture.

This separation of responsibilities provides several engineering advantages. Imaging hardware may be replaced without modification of downstream processing components. Alternative acquisition technologies may be introduced without altering temporal confidence accumulation or lifecycle management. Camera-specific characteristics remain isolated from the coordinated detection framework, thereby improving portability, maintainability, and long-term adaptability of the invention.

Although the preferred embodiment illustrates acquisition from a single imaging device, the invention is not limited to a single source. Alternative embodiments may simultaneously acquire observations from multiple cameras positioned to monitor different viewpoints, overlapping monitoring zones, or geographically distributed locations. In such embodiments, observations may be processed independently, cooperatively, or through distributed engineering architectures while preserving the coordinated temporal evaluation principles disclosed throughout this specification.

Accordingly, the Image Acquisition Layer functions as the controlled entry point into ATPDE, ensuring that downstream engineering subsystems receive reliable observations suitable for environmental analysis, protected baseline comparison, candidate object evaluation, temporal confidence accumulation, and lifecycle management. By isolating hardware-specific acquisition details from the remainder of the architecture, the Image Acquisition Layer contributes to the modular, technology-independent design that characterizes the Adaptive Temporal Package Detection Engine.

6.4 Environmental Analysis Engine

The Environmental Analysis Engine performs an independent engineering evaluation of the monitored scene to determine whether current environmental conditions are suitable for reliable persistent object analysis.

Unlike conventional object detection systems that immediately evaluate image differences as potential objects, ATPDE first determines whether observed scene changes are more likely attributable to environmental influences than to the appearance of a persistent object.

This separation of environmental evaluation from object evaluation represents one of the distinguishing characteristics of the Adaptive Temporal Package Detection Engine.

Referring generally to Figure 5, the Environmental Analysis Engine receives validated observations from the Image Acquisition Layer and performs a comprehensive assessment of scene stability before candidate object evaluation begins.

The Environmental Analysis Engine is intentionally independent of the Candidate Object Engine. Rather than determining whether an object exists, its responsibility is to determine whether the observed environment is sufficiently stable to permit reliable engineering interpretation of subsequent image changes.

Outdoor monitoring environments are subject to continual visual variation that frequently produces image differences unrelated to the placement or removal of persistent objects.

Representative environmental influences include changing sunlight, cloud movement, moving shadows, precipitation, wind-driven vegetation, reflections, seasonal lighting variation, camera exposure adjustment, automatic white balance correction, sensor noise, image compression artifacts, temporary obstructions, insects, airborne debris, and numerous additional environmental phenomena.

Many conventional monitoring systems interpret these transient changes as evidence of object placement because they evaluate image differences without first determining whether the surrounding environment remains stable.

ATPDE instead evaluates environmental stability before confidence accumulation is permitted.

In one preferred embodiment, the Environmental Analysis Engine performs one or more engineering measurements describing the current operating condition of the monitored scene.

Representative engineering measurements may include overall brightness variation, localized illumination change, global contrast variation, spatial distribution of image differences, temporal consistency between successive observations, scene-wide variation, localized disturbance measurements, edge stability, texture consistency, image noise characteristics, or equivalent engineering indicators of environmental stability.

The invention is not limited to any particular environmental measurement methodology.

Alternative embodiments may employ deterministic algorithms, statistical analysis, heuristic evaluation, adaptive thresholding, artificial intelligence, neural network models, Bayesian inference, fuzzy logic, machine learning, sensor fusion, or future computational techniques capable of estimating environmental stability.

Regardless of implementation methodology, the engineering objective remains consistent.

The Environmental Analysis Engine produces an engineering assessment describing the reliability of the current scene rather than determining whether a persistent object exists.

The resulting environmental assessment is subsequently utilized by downstream ATPDE subsystems.

For example, when environmental stability satisfies predetermined engineering criteria, qualified candidates may contribute fully toward temporal confidence accumulation.

Conversely, when environmental instability is detected, ATPDE may reduce confidence growth, suspend confidence accumulation, delay lifecycle progression, postpone baseline replacement, reject candidate observations, or otherwise modify system behavior according to configurable engineering policies.

Environmental analysis therefore influences object detection without directly performing object detection.

This separation provides significant engineering advantages.

Transient environmental disturbances frequently affect a large percentage of the monitored scene simultaneously. Examples include rapid cloud movement producing broad shadow displacement, sudden camera exposure adjustments affecting overall image brightness, or precipitation temporarily obscuring substantial portions of the observation.

Such events often generate image differences considerably larger than those produced by a delivered package.

Rather than immediately interpreting these differences as evidence of object placement, ATPDE evaluates the characteristics of the observed variation.

Representative engineering characteristics considered during environmental evaluation may include the geographic distribution of image change throughout the observation, the relationship between localized and scene-wide variation, the temporal persistence of observed changes, the consistency of successive observations, and the relationship between current observations and previously established environmental conditions.

By evaluating these characteristics independently from candidate object analysis, ATPDE substantially reduces the likelihood that transient environmental disturbances will initiate erroneous lifecycle transitions.

The Environmental Analysis Engine additionally contributes to long-term autonomous operation of ATPDE.

Outdoor environments naturally experience gradual changes throughout daily operation, including sunrise, sunset, seasonal lighting variation, weather changes, and camera operating characteristics.

Rather than treating every visual difference as an object candidate, ATPDE continuously evaluates the overall environmental condition and adapts downstream processing accordingly.

This capability allows the system to operate reliably for extended periods without continual operator intervention or manual recalibration.

Environmental analysis also serves an important role in protecting the integrity of the Dynamic Baseline Manager.

Because baseline replacement occurs only when environmental conditions satisfy predetermined engineering requirements, the Environmental Analysis Engine provides one of the principal engineering inputs governing baseline update authorization.

Consequently, environmental evaluation not only influences confidence accumulation but also contributes to preservation of the trusted baseline representation maintained throughout ATPDE operation.

Although the preferred embodiment describes a centralized Environmental Analysis Engine, the invention is not limited to a single implementation.

Alternative embodiments may perform environmental evaluation independently for multiple monitoring zones, multiple imaging devices, distributed processing nodes, cloud-based processing systems, edge computing devices, or combinations thereof.

Likewise, environmental stability may be represented as one or more quantitative values, qualitative classifications, confidence measurements, engineering scores, probabilistic estimates, or equivalent representations suitable for influencing downstream processing.

Regardless of implementation methodology, the Environmental Analysis Engine remains responsible for evaluating whether current operating conditions support reliable interpretation of observed scene changes before persistent object evaluation proceeds.

Accordingly, the Environmental Analysis Engine provides an independent engineering assessment of scene stability that serves as a foundational input to candidate object evaluation, temporal confidence accumulation, lifecycle management, protected baseline maintenance, and long-term autonomous operation.

By separating environmental evaluation from object confirmation, ATPDE achieves improved detection reliability, reduced false positive detections, enhanced baseline protection, and greater resilience within continuously changing operating environments.

6.5 Dynamic Baseline Manager

The Dynamic Baseline Manager is responsible for creating, maintaining, protecting, validating, updating, recovering, and replacing the baseline representation utilized throughout the Adaptive Temporal Package Detection Engine (ATPDE).

The baseline represents ATPDE's trusted engineering reference of the monitored environment against which newly acquired observations are compared. Unlike conventional background subtraction systems that continuously adapt their reference image, ATPDE treats the baseline as a protected engineering asset whose integrity is essential to reliable persistent object detection.

Referring generally to Figure 6, the Dynamic Baseline Manager cooperates with the Environmental Analysis Engine, Candidate Object Engine, Temporal Confidence Engine, Object Lifecycle Manager, Event History Manager, and Configuration Manager to determine when baseline modification may safely occur.

One of the distinguishing characteristics of the disclosed invention is that baseline management is performed as an active engineering process rather than as an automatic background adaptation mechanism.

In many conventional surveillance systems, the background model continuously incorporates newly acquired observations. Although such approaches compensate for gradual environmental change, they may also incorporate newly introduced stationary objects into the reference image. Once incorporated, those objects are no longer distinguishable from the surrounding environment, causing the monitoring system to lose awareness of their continued presence.

ATPDE intentionally avoids this behavior.

Instead of continuously adapting the baseline, ATPDE protects the reference representation whenever engineering evidence indicates that modification could compromise future object detection.

In the preferred embodiment, baseline protection begins immediately upon identification of conditions suggesting the possible introduction of a persistent object. Protection may continue throughout candidate evaluation, temporal confidence accumulation, lifecycle progression, reminder processing, removal evaluation, and controlled recovery.

During this protected interval, newly acquired observations continue to be evaluated against the existing baseline while baseline replacement remains prohibited.

As a result, the monitored object remains distinguishable regardless of how long it remains within the monitored region.

This protected baseline methodology enables ATPDE to maintain awareness of persistent objects for extended durations without allowing those objects to become incorporated into the engineering reference representation.

The Dynamic Baseline Manager evaluates multiple engineering conditions before authorizing baseline replacement.

Representative engineering conditions include confirmation that no candidate object is actively accumulating confidence, no confirmed object currently exists, no object remains in a removal evaluation state, environmental stability satisfies predetermined engineering criteria, imaging devices are operating normally, observation quality remains acceptable, and other configurable engineering policies established by the Configuration Manager.

Only after all required engineering conditions have been satisfied may baseline replacement be authorized.

The decision to replace the baseline is therefore the result of accumulated engineering evidence rather than elapsed time alone.

In one preferred embodiment, ATPDE additionally supports scheduled baseline evaluation.

Scheduled evaluations permit the system to determine whether gradual environmental changes justify creation of an updated protected baseline. Representative scheduling policies may include predetermined times of day, elapsed operational duration, seasonal adjustment intervals, administrative requests, or equivalent engineering triggers.

Importantly, scheduled evaluation does not guarantee that baseline replacement will occur.

Instead, scheduled evaluation merely initiates an engineering review during which the Dynamic Baseline Manager determines whether all baseline replacement criteria have been satisfied.

If any condition indicates that baseline modification could compromise object detection, the existing protected baseline remains active.

This distinction between evaluating baseline replacement and performing baseline replacement is an important characteristic of ATPDE.

The Dynamic Baseline Manager further performs baseline recovery following confirmed object removal.

When the Object Lifecycle Manager determines that a previously confirmed object has been removed, ATPDE does not immediately establish a new baseline.

Instead, the system enters a controlled recovery period during which successive observations continue to be evaluated.

This recovery interval allows temporary disturbances associated with object removal, including residual motion, changing shadows, operator activity, camera stabilization, or environmental variation, to dissipate before a replacement baseline is created.

Only after the monitored environment has returned to an acceptable level of stability does the Dynamic Baseline Manager authorize creation of a new protected baseline representing the restored scene.

This controlled recovery process substantially reduces the likelihood that temporary disturbances become incorporated into the engineering reference representation.

The Dynamic Baseline Manager may additionally invalidate a baseline whenever engineering evidence indicates that the current reference representation can no longer be trusted.

Representative conditions leading to baseline invalidation may include significant camera repositioning, persistent communication failures, substantial environmental changes, administrative intervention, imaging device replacement, or equivalent engineering events affecting baseline integrity.

Following invalidation, ATPDE may suspend normal monitoring until a replacement protected baseline has been successfully established.

Throughout normal operation, the Dynamic Baseline Manager cooperates continuously with the Environmental Analysis Engine.

Environmental stability serves as one of the principal engineering inputs governing baseline replacement authorization. Likewise, baseline integrity influences downstream candidate evaluation and temporal confidence accumulation.

This bidirectional interaction allows ATPDE to maintain a stable understanding of the monitored environment while adapting to gradual environmental evolution without sacrificing reliable persistent object detection.

Although the preferred embodiment utilizes a single protected baseline representing one monitored environment, the invention is not limited to a single baseline.

Alternative embodiments may maintain multiple protected baselines associated with multiple monitoring zones, multiple imaging devices, varying environmental conditions, different operating schedules, or distributed processing architectures.

Similarly, baseline representations may consist of one or more reference images, statistical scene models, feature representations, composite scene descriptions, learned environmental models, three-dimensional representations, or equivalent engineering constructs capable of describing the monitored environment.

Regardless of the selected representation, ATPDE continues to govern baseline modification through coordinated engineering evaluation rather than unrestricted automatic adaptation.

Another distinguishing aspect of the Dynamic Baseline Manager is its cooperative relationship with every principal subsystem comprising ATPDE.

The Image Acquisition Layer supplies validated observations suitable for baseline comparison.

The Environmental Analysis Engine determines whether current operating conditions permit baseline replacement.

The Candidate Object Engine identifies engineering evidence suggesting that baseline protection should continue.

The Temporal Confidence Engine provides accumulated evidence regarding object persistence.

The Object Lifecycle Manager determines when lifecycle transitions authorize baseline recovery.

The Event History Manager records baseline creation, protection, recovery, replacement, and invalidation events for engineering analysis and diagnostic purposes.

The Configuration Manager governs baseline policies, scheduling rules, protection criteria, recovery timing, and administrative controls.

Accordingly, the Dynamic Baseline Manager does not operate as an isolated software component.

Rather, it functions as a coordinating engineering subsystem whose decisions are derived from the combined evidence supplied by the remaining ATPDE architecture.

The protected baseline methodology described herein distinguishes the Adaptive Temporal Package Detection Engine from conventional continuously adapting background subtraction systems by preserving a trusted engineering representation of the monitored environment throughout the complete lifecycle of a persistent object.

Through coordinated baseline protection, controlled recovery, evidence-based replacement, and continuous cooperation with the remaining ATPDE subsystems, the Dynamic Baseline Manager enables long-term autonomous operation while substantially reducing false object removal, minimizing baseline contamination, preserving persistent object awareness, and improving overall detection reliability.

6.6 Candidate Object Engine

The Candidate Object Engine is responsible for identifying, qualifying, characterizing, and managing regions of interest that exhibit meaningful differences between the current observation and the protected baseline maintained by the Dynamic Baseline Manager.

The Candidate Object Engine serves as the intermediate engineering subsystem between baseline comparison and temporal confidence accumulation. Its purpose is not to determine whether a persistent object exists, but rather to identify potential object candidates that warrant additional engineering evaluation.

Unlike conventional motion detection systems that frequently interpret every measurable image difference as a detection event, ATPDE distinguishes preliminary candidate generation from actual object confirmation.

Referring generally to Figure 7, the Candidate Object Engine receives two principal engineering inputs: the validated current observation supplied by the Image Acquisition Layer and the protected baseline maintained by the Dynamic Baseline Manager.

The Candidate Object Engine compares the current observation against the protected baseline to identify regions exhibiting measurable visual differences.

The invention is not limited to any particular comparison methodology.

Representative comparison techniques may include pixel differencing, feature comparison, edge analysis, region comparison, texture analysis, contour extraction, artificial intelligence feature extraction, statistical image analysis, learned representations, or other computational methodologies capable of identifying meaningful differences between sequential observations.

The resulting differences are organized into one or more candidate regions representing areas that may contain newly introduced or removed persistent objects.

Generation of a candidate region does not indicate that an object has been detected.

Instead, candidate generation represents preliminary engineering evidence that additional evaluation is warranted.

Each candidate region is subsequently evaluated using one or more engineering characteristics intended to distinguish meaningful object candidates from insignificant scene variation.

Representative engineering characteristics may include candidate area, contour geometry, spatial consistency, monitoring zone overlap, aspect ratio, compactness, edge density, texture characteristics, position stability, historical persistence, motion characteristics, localized contrast, boundary definition, or equivalent engineering measurements.

The invention is not limited to any particular qualification methodology.

Alternative embodiments may employ deterministic algorithms, statistical evaluation, heuristic analysis, artificial intelligence, machine learning, neural network models, Bayesian inference, fuzzy logic, hybrid computational techniques, or future engineering methodologies suitable for candidate qualification.

Candidate qualification may additionally consider the relationship between the candidate region and one or more predefined monitoring zones.

In one preferred embodiment, ATPDE evaluates whether a sufficient portion of the candidate occupies the designated monitoring region before forwarding the candidate for temporal evaluation.

Candidates exhibiting insufficient interaction with the monitoring zone may be rejected without further processing.

Alternative embodiments may employ multiple monitoring zones simultaneously.

Candidates may be evaluated independently within each monitoring region, shared among multiple regions, or associated with different engineering policies according to system configuration.

The Candidate Object Engine further evaluates the spatial stability of each candidate across successive observations.

Transient image differences frequently appear briefly before disappearing during subsequent observation cycles.

Examples include moving leaves, insects, rain, snow, rapidly changing shadows, reflections, temporary glare, airborne debris, or image compression artifacts.

Such disturbances commonly generate measurable image differences but generally lack the consistency expected of a persistent object.

Accordingly, the Candidate Object Engine may reject candidates exhibiting excessive movement, inconsistent geometry, rapidly changing area, unstable position, or other characteristics inconsistent with persistent object placement.

Candidate evaluation therefore serves as an engineering filter positioned between baseline comparison and temporal confidence accumulation.

This filtering process substantially reduces the amount of insignificant engineering evidence introduced into downstream processing.

Importantly, rejection of a candidate does not imply that ATPDE has concluded that no object exists.

Likewise, acceptance of a candidate does not imply that ATPDE has determined that an object has been detected.

Rather, acceptance simply indicates that the observed region satisfies preliminary engineering criteria necessary for temporal evaluation.

Only after candidate qualification does responsibility pass to the Temporal Confidence Engine.

The Candidate Object Engine intentionally avoids maintaining long-term object state.

Responsibilities such as confidence accumulation, lifecycle progression, notification generation, and baseline management remain assigned to their respective engineering subsystems.

This separation of responsibilities contributes significantly to the modular architecture of ATPDE.

The Candidate Object Engine also cooperates continuously with the Environmental Analysis Engine.

Environmental stability measurements may influence candidate qualification by modifying engineering thresholds, delaying candidate acceptance, reducing engineering weighting, suspending evaluation, or otherwise adapting candidate processing according to current operating conditions.

Similarly, the Candidate Object Engine cooperates with the Dynamic Baseline Manager by providing engineering evidence indicating that baseline protection should continue while meaningful candidates remain under evaluation.

The Candidate Object Engine may additionally support simultaneous evaluation of multiple independent candidates.

Each candidate may maintain its own engineering measurements, spatial characteristics, qualification history, and downstream confidence accumulation while sharing common environmental analysis and protected baseline management.

Alternative embodiments may further associate candidate regions with unique identifiers permitting continuous tracking across multiple observations.

Such identifiers may support engineering analysis, historical evaluation, object correlation, distributed processing, or additional lifecycle management functions without departing from the principles disclosed herein.

The Candidate Object Engine may also characterize engineering properties beyond simple object presence.

Representative properties include estimated object size, occupied monitoring area, boundary characteristics, geometric consistency, persistence measurements, engineering quality metrics, and other descriptive information useful for downstream temporal evaluation.

These engineering characteristics may contribute to confidence accumulation without independently determining object existence.

Although the preferred embodiment describes sequential candidate qualification, the invention is not limited to sequential processing.

Alternative embodiments may evaluate multiple candidates concurrently, distribute candidate processing across multiple computing devices, employ parallel computational architectures, or utilize future processing technologies while preserving the coordinated temporal evaluation framework disclosed herein.

A distinguishing characteristic of the Candidate Object Engine is that it functions as a provider of engineering evidence rather than as an object detector.

Candidate qualification represents the beginning of ATPDE’s decision-making process, not its conclusion.

Object confirmation remains the responsibility of the coordinated interaction between the Candidate Object Engine, Environmental Analysis Engine, Temporal Confidence Engine, Object Lifecycle Manager, and Dynamic Baseline Manager.

Accordingly, the Candidate Object Engine transforms raw image differences into qualified engineering candidates suitable for temporal evaluation while filtering insignificant scene variation that might otherwise produce erroneous detections.

By separating candidate qualification from confidence accumulation and lifecycle management, ATPDE achieves improved detection reliability, reduced false positive detections, enhanced modularity, and greater flexibility than conventional systems that attempt to determine object existence directly from isolated image differences.

6.7 Temporal Confidence Engine

The Temporal Confidence Engine is responsible for accumulating, maintaining, modifying, suspending, decaying, and evaluating engineering evidence associated with one or more qualified candidate objects over successive observations.

The Temporal Confidence Engine represents one of the principal distinguishing features of the Adaptive Temporal Package Detection Engine (ATPDE). Unlike conventional surveillance systems that attempt to determine object existence from an individual image or isolated observation, ATPDE evaluates engineering evidence collected across time.

Accordingly, ATPDE treats time as an active engineering input rather than merely the interval separating acquired observations.

Referring generally to Figure 8, the Temporal Confidence Engine receives qualified engineering candidates from the Candidate Object Engine together with supporting information generated by the Environmental Analysis Engine, Dynamic Baseline Manager, Configuration Manager, and other cooperating ATPDE subsystems.

Rather than immediately declaring that an object exists, the Temporal Confidence Engine evaluates whether newly acquired engineering evidence is consistent with the continued presence of a persistent object.

Each qualified observation contributes to an accumulated confidence value representing the likelihood that a candidate corresponds to a genuine persistent object.

The confidence maintained by ATPDE is intentionally distinguished from an artificial intelligence confidence score or classification probability.

Artificial intelligence confidence typically represents the probability that a single observation belongs to a particular object class.

In contrast, ATPDE confidence represents accumulated engineering evidence derived from multiple independent observations evaluated over time.

Consequently, confidence within ATPDE may continue to evolve even when individual observations vary slightly due to changing environmental conditions.

In the preferred embodiment, confidence is neither fixed nor static.

Instead, confidence continuously evolves throughout the lifecycle of each qualified candidate.

Engineering evidence may cause confidence to increase, decrease, remain unchanged, decay, suspend, or reset according to observed operating conditions.

Representative engineering factors influencing confidence include:

- Candidate persistence.
- Environmental stability.
- Spatial consistency.
- Historical observation consistency.
- Baseline integrity.
- Monitoring zone occupancy.
- Candidate quality.
- Observation continuity.
- Previous confidence history.
- Additional engineering evidence.

The invention is not limited to any particular confidence equation, weighting methodology, or computational model.

Alternative embodiments may utilize deterministic scoring systems, weighted accumulators, statistical models, Bayesian inference, fuzzy logic, Hidden Markov Models, reinforcement learning, neural networks, adaptive mathematical models, artificial intelligence, machine learning, or future computational techniques.

Regardless of implementation methodology, ATPDE maintains the principle that confidence represents accumulated engineering evidence collected over multiple observations.

One of the primary engineering responsibilities of the Temporal Confidence Engine is distinguishing temporary scene variation from persistent object placement.

For example, a transient environmental disturbance may generate one or more qualified candidates during a brief observation interval.

Although these candidates satisfy preliminary engineering requirements established by the Candidate Object Engine, their limited persistence causes only minimal confidence accumulation.

When subsequent observations fail to demonstrate continued consistency, confidence may remain unchanged, decay, or return to an initial state.

Consequently, transient events generally fail to progress beyond preliminary evaluation.

Conversely, when successive observations consistently demonstrate that a candidate remains present within the monitored region while environmental conditions remain sufficiently stable, engineering evidence accumulates progressively.

As confidence continues to increase across multiple observation cycles, the probability that the candidate represents a genuine persistent object likewise increases.

The Object Lifecycle Manager subsequently utilizes accumulated confidence when determining lifecycle transitions.

Importantly, the Temporal Confidence Engine does not itself declare object confirmation.

Instead, it provides continuously updated engineering evidence upon which lifecycle decisions are based.

This separation of responsibilities contributes significantly to ATPDE’s modular architecture.

The Temporal Confidence Engine further supports confidence suspension during periods of environmental instability.

When the Environmental Analysis Engine determines that observed scene changes cannot be reliably interpreted due to changing illumination, precipitation, camera exposure adjustment, or other environmental influences, ATPDE may temporarily suspend confidence accumulation.

During suspension, confidence may remain unchanged until reliable operating conditions return.

Alternative embodiments may instead reduce confidence growth, apply engineering weighting factors, temporarily decay confidence, or otherwise modify accumulation according to configurable engineering policies.

Likewise, ATPDE supports confidence decay when accumulated engineering evidence weakens.

For example, if a previously qualified candidate gradually loses consistency across successive observations, confidence may decrease according to predetermined engineering rules.

Confidence decay permits ATPDE to adapt naturally to changing scene conditions while avoiding abrupt transitions caused by isolated observations.

In one preferred embodiment, confidence is maintained independently for each qualified candidate.

Multiple candidates may therefore accumulate engineering evidence simultaneously without interfering with one another.

Each candidate progresses independently according to its own observation history, environmental conditions, engineering measurements, and accumulated confidence.

The Temporal Confidence Engine additionally maintains historical continuity across successive observations.

Rather than evaluating each observation independently, ATPDE associates newly acquired engineering evidence with previously accumulated evidence whenever sufficient spatial and temporal consistency exists.

This historical continuity enables ATPDE to recognize persistent objects despite minor variations in appearance, illumination, or environmental conditions.

The Configuration Manager governs numerous engineering parameters affecting confidence accumulation.

Representative configurable parameters include confidence growth rate, decay rate, suspension policy, weighting factors, lifecycle thresholds, persistence requirements, engineering limits, and additional operational characteristics.

Adjustment of these parameters permits ATPDE to be optimized for diverse monitoring environments while preserving the coordinated temporal evaluation framework disclosed throughout this specification.

The Temporal Confidence Engine cooperates extensively with the remaining ATPDE subsystems.

The Candidate Object Engine supplies qualified engineering candidates.

The Environmental Analysis Engine influences confidence through environmental stability assessment.

The Dynamic Baseline Manager provides the protected reference representation upon which confidence evaluation depends.

The Object Lifecycle Manager interprets accumulated confidence to govern lifecycle progression.

The Event History Manager records confidence evolution for engineering diagnostics, historical analysis, auditing, and future optimization.

The Configuration Manager defines engineering policies governing confidence behavior.

Accordingly, the Temporal Confidence Engine does not function as an isolated scoring algorithm.

Instead, it serves as a cooperative engineering subsystem whose purpose is to transform successive observations into accumulated engineering evidence suitable for lifecycle management.

Although the preferred embodiment illustrates confidence accumulation as a progressive increase over time, the invention is not limited to monotonic growth.

Alternative embodiments may permit nonlinear accumulation, weighted accumulation, probabilistic estimation, confidence normalization, adaptive scaling, confidence averaging, distributed confidence models, hierarchical confidence structures, or equivalent engineering methodologies while preserving the principles disclosed herein.

The defining characteristic of the Temporal Confidence Engine is therefore not the mathematical method used to calculate confidence, but rather the coordinated accumulation of engineering evidence across multiple observations before object confirmation is permitted.

By evaluating persistence instead of isolated image differences, ATPDE substantially reduces false detections caused by transient environmental disturbances while providing a more reliable representation of persistent object existence.

Accordingly, the Temporal Confidence Engine forms the central decision-support subsystem within ATPDE by continuously transforming qualified observations into accumulated engineering evidence that supports reliable lifecycle progression, protected baseline management, notification processing, and long-term autonomous operation.

Through progressive evidence accumulation, adaptive confidence management, and continuous cooperation with the remaining ATPDE subsystems, the Temporal Confidence Engine distinguishes ATPDE from conventional frame-by-frame detection systems and enables reliable persistent object detection within continuously changing environments.

6.8 Object Lifecycle Manager

The Object Lifecycle Manager is responsible for governing the progression of each qualified candidate through a series of engineering lifecycle states representing the complete existence of a persistent object within the monitored environment.

Unlike conventional object detection systems that produce isolated detection events without maintaining object state, the Adaptive Temporal Package Detection Engine (ATPDE) manages each candidate as an evolving engineering entity whose condition changes over time in response to accumulated evidence supplied by cooperating subsystems.

Referring generally to Figure 9, the Object Lifecycle Manager receives engineering evidence from the Temporal Confidence Engine together with supporting information provided by the Candidate Object Engine, Environmental Analysis Engine, Dynamic Baseline Manager, Event History Manager, and Configuration Manager.

Using this accumulated engineering evidence, the Object Lifecycle Manager determines when lifecycle transitions should occur.

The Object Lifecycle Manager intentionally separates lifecycle management from candidate qualification and confidence accumulation.

The Candidate Object Engine determines whether meaningful engineering candidates exist.

The Temporal Confidence Engine accumulates engineering evidence regarding those candidates.

The Object Lifecycle Manager interprets that accumulated evidence to determine the operational state of each candidate throughout its existence.

In the preferred embodiment, ATPDE defines multiple lifecycle states representing the progressive evolution of a persistent object.

Representative lifecycle states may include:

- No Object Present
- Candidate Under Evaluation
- Possible Persistent Object
- Confirmed Persistent Object
- Persistent Object Present
- Removal Evaluation
- Object Cleared
- Baseline Recovery
- Monitoring Restored

The invention is not limited to any particular number, order, naming convention, or implementation of lifecycle states.

Alternative embodiments may utilize fewer states, additional intermediate states, hierarchical state models, probabilistic state representations, finite state machines, adaptive state transitions, distributed lifecycle management, or equivalent engineering methodologies while preserving the coordinated lifecycle principles disclosed herein.

Each lifecycle transition is governed by accumulated engineering evidence rather than a single observation.

For example, identification of a qualified candidate by the Candidate Object Engine does not immediately cause ATPDE to declare object placement.

Instead, the candidate enters an evaluation state during which the Temporal Confidence Engine accumulates engineering evidence across successive observations.

Only when accumulated evidence satisfies predetermined engineering criteria does the Object Lifecycle Manager authorize transition to a more advanced lifecycle state.

Similarly, transition from a possible persistent object to a confirmed persistent object requires continued accumulation of engineering evidence demonstrating that the observed candidate exhibits the consistency, persistence, and stability expected of a genuine persistent object.

The Object Lifecycle Manager therefore ensures that lifecycle progression reflects engineering confidence rather than isolated visual events.

Once an object reaches a confirmed lifecycle state, ATPDE maintains awareness of that object throughout its continued presence within the monitored region.

Unlike systems that repeatedly report identical detections for the same stationary object, the Object Lifecycle Manager recognizes that a confirmed object remains the same engineering entity until sufficient evidence demonstrates otherwise.

This persistent object awareness substantially reduces redundant notifications while preserving continuous knowledge of object presence.

The Object Lifecycle Manager additionally governs engineering behavior associated with long-duration object presence.

Representative lifecycle activities may include duration tracking, reminder scheduling, engineering event generation, object aging, historical recording, administrative reporting, or other operational functions appropriate for confirmed persistent objects.

These activities are performed without requiring repeated object confirmation, thereby reducing unnecessary processing while preserving accurate object history.

Removal of a persistent object is likewise managed as a lifecycle transition rather than an instantaneous event.

When observations indicate that a previously confirmed object may no longer be present, ATPDE does not immediately declare object removal.

Instead, the Object Lifecycle Manager initiates a removal evaluation state during which additional engineering evidence is collected.

This evaluation period allows ATPDE to distinguish genuine object removal from temporary disturbances such as partial occlusion, environmental variation, brief camera interruption, changing illumination, or transient scene activity.

Only after accumulated engineering evidence consistently demonstrates that the previously confirmed object no longer exists does the Object Lifecycle Manager authorize transition to the Object Cleared state.

Following successful removal confirmation, the Object Lifecycle Manager cooperates with the Dynamic Baseline Manager to initiate controlled baseline recovery.

This coordinated interaction ensures that baseline replacement occurs only after object removal has been reliably verified and environmental stability has been restored.

The Object Lifecycle Manager also coordinates closely with the Notification Decision Engine.

Lifecycle transitions may authorize, suppress, delay, or terminate notification activities according to configurable engineering policies.

For example, transition into a confirmed persistent object state may authorize initial notification delivery, while continued occupancy of the same lifecycle state may instead authorize periodic reminder notifications without generating duplicate detection events.

Similarly, transition to the Object Cleared state may authorize removal notifications while simultaneously terminating reminder generation.

The Object Lifecycle Manager maintains historical continuity throughout each object's existence.

Engineering information associated with a lifecycle entity may include timestamps, duration measurements, accumulated confidence history, engineering measurements, lifecycle transition history, notification status, baseline interactions, environmental conditions, and additional operational metadata useful for engineering analysis and system diagnostics.

This historical continuity supports long-term autonomous operation while providing a complete engineering record describing the object's lifecycle.

The Configuration Manager governs numerous engineering parameters associated with lifecycle progression.

Representative configurable parameters include confidence thresholds, persistence requirements, removal evaluation duration, reminder intervals, lifecycle timeout values, recovery timing, notification policies, and additional operational characteristics.

Adjustment of these parameters permits ATPDE to accommodate diverse monitoring environments while preserving the coordinated engineering architecture disclosed throughout this specification.

Although the preferred embodiment illustrates management of a single persistent object, the invention is not limited to one lifecycle entity.

Alternative embodiments may simultaneously manage multiple independent objects, each maintaining separate engineering evidence, confidence accumulation, lifecycle history, notification state, and baseline interactions.

Likewise, lifecycle management may be performed by centralized processing, distributed computing systems, cloud-based architectures, edge computing devices, or future computational platforms without departing from the principles disclosed herein.

A distinguishing characteristic of the Object Lifecycle Manager is that lifecycle transitions are driven by coordinated engineering evidence produced by multiple cooperating ATPDE subsystems.

No individual subsystem independently determines that an object has appeared, persisted, or been removed.

Instead, lifecycle progression results from the combined interpretation of candidate qualification, environmental stability, protected baseline management, temporal confidence accumulation, and configurable engineering policies.

Accordingly, the Object Lifecycle Manager transforms accumulated engineering evidence into an organized sequence of lifecycle states representing the complete existence of a persistent object within the monitored environment.

Through coordinated lifecycle progression, controlled state transitions, historical continuity, and continuous cooperation with the remaining ATPDE subsystems, the

Object Lifecycle Manager enables ATPDE to distinguish meaningful persistent object events from transient environmental variation while supporting reliable notification processing, protected baseline management, comprehensive event history, and long-term autonomous monitoring.

6.9 Notification Decision Engine

The Notification Decision Engine is responsible for determining when, how, and under what engineering conditions information regarding persistent object lifecycle events should be communicated to users, external systems, monitoring services, automation platforms, or other recipients.

Unlike conventional monitoring systems that immediately generate alerts whenever an object is detected, the Adaptive Temporal Package Detection Engine (ATPDE) separates object detection from notification authorization.

This separation represents a significant architectural characteristic of the invention.

The existence of a confirmed persistent object does not necessarily require immediate notification.

Instead, notification decisions are based upon accumulated engineering evidence, object lifecycle state, environmental conditions, configurable operational policies, and other engineering criteria evaluated cooperatively throughout ATPDE.

Referring generally to Figure 10, the Notification Decision Engine receives engineering information from the Object Lifecycle Manager together with supporting information supplied by the Temporal Confidence Engine, Environmental Analysis Engine, Dynamic Baseline Manager, Event History Manager, Configuration Manager, and other cooperating ATPDE subsystems.

Using this accumulated engineering information, the Notification Decision Engine determines whether notification should be authorized, delayed, suppressed, repeated, modified, or terminated.

The Notification Decision Engine intentionally does not participate in object detection.

Responsibilities such as candidate qualification, confidence accumulation, lifecycle progression, and baseline management remain assigned to their respective engineering subsystems.

Instead, the Notification Decision Engine evaluates whether a particular lifecycle event warrants communication outside ATPDE.

This architectural separation allows detection reliability and notification behavior to evolve independently.

In one preferred embodiment, notification authorization may occur in response to one or more lifecycle transitions.

Representative notification events include:

- Possible persistent object identified.
- Persistent object confirmed.
- Persistent object remains present.
- Persistent object removed.
- Baseline successfully restored.
- Engineering fault detected.
- Monitoring suspended.
- Monitoring resumed.
- Administrative events.
- Diagnostic events.

The invention is not limited to any particular collection of notification events.

Alternative embodiments may generate notifications for additional lifecycle transitions, engineering conditions, maintenance activities, security events, statistical summaries, predictive analysis, or future operational requirements.

Notification authorization is governed by configurable engineering policies rather than fixed operational rules.

Representative engineering policies may include minimum confidence requirements, lifecycle state requirements, environmental stability, notification schedules, quiet periods, operating hours, user preferences, notification priorities, object duration, reminder intervals, escalation policies, recipient availability, engineering diagnostics, or equivalent operational criteria.

Only after the required engineering policies have been satisfied does the Notification Decision Engine authorize communication.

The Notification Decision Engine further supports notification suppression.

Repeated observations of the same confirmed persistent object do not necessarily require repeated notification.

Instead, ATPDE may recognize that the object remains within an unchanged lifecycle state and suppress redundant communications while maintaining complete engineering awareness internally.

Suppression substantially reduces unnecessary notifications without reducing detection reliability.

The Notification Decision Engine additionally supports reminder notification.

When a confirmed persistent object remains present beyond a configurable engineering interval, ATPDE may authorize one or more reminder notifications indicating continued object presence.

Reminder generation is governed independently from initial notification authorization and may utilize different engineering policies, priorities, schedules, recipients, or communication methods.

Similarly, reminder generation may terminate automatically following object removal or lifecycle transition.

Escalation policies may also be implemented.

For example, continued object presence beyond one or more configurable engineering thresholds may authorize progressively different notification behavior.

Representative escalation actions include communication with additional recipients, increased notification priority, alternative communication channels, repeated delivery intervals, engineering reporting, workflow initiation, or equivalent operational responses.

Alternative embodiments may omit escalation entirely without departing from the principles disclosed herein.

The Notification Decision Engine may additionally evaluate notification timing.

Engineering policies may specify operating schedules during which notification is permitted, restricted, delayed, or prohibited.

For example, notifications may be authorized only during designated operating hours, suspended during maintenance periods, delayed until predetermined schedules, or redirected according to administrative policies.

The invention is not limited to any particular scheduling methodology.

The Notification Decision Engine further supports multiple communication mechanisms.

Representative communication methods include electronic mail, text messaging, mobile application notification, push notification, audible alarms, visual indicators, network messaging, industrial automation protocols, workflow management systems, cloud services, application programming interfaces (APIs), supervisory monitoring systems, building automation systems, Internet of Things (IoT) platforms, security management systems, or equivalent communication technologies.

The invention remains independent of any particular communication protocol or notification provider.

Alternative embodiments may employ future communication technologies without altering the coordinated engineering architecture disclosed herein.

The Notification Decision Engine may also determine the engineering content included within authorized notifications.

Representative notification content may include object identification, lifecycle state, timestamps, duration measurements, confidence information, engineering diagnostics, environmental conditions, monitoring zone identification, captured observations, historical summaries, baseline status, administrative information, or other engineering data useful to the recipient.

The Event History Manager cooperates with the Notification Decision Engine by recording notification authorization, suppression, delivery attempts, reminder generation, escalation activity, communication failures, recipient acknowledgments, and related engineering events.

These historical records support engineering diagnostics, auditing, statistical analysis, system optimization, and long-term operational reporting.

The Configuration Manager governs notification behavior through configurable engineering policies.

Representative configuration parameters include notification enablement, recipient selection, delivery schedules, reminder intervals, escalation thresholds, engineering priorities, communication methods, suppression rules, retry policies, timeout intervals, and other operational characteristics.

Modification of these parameters allows ATPDE to satisfy diverse operational requirements without altering the underlying detection architecture.

Although the preferred embodiment illustrates notification processing performed locally within ATPDE, the invention is not limited to local implementation.

Alternative embodiments may distribute notification decision processing across cloud computing environments, edge computing devices, enterprise monitoring systems, distributed security architectures, or combinations thereof while preserving the cooperative engineering principles described herein.

A distinguishing characteristic of the Notification Decision Engine is that notification represents the final consequence of accumulated engineering evidence rather than the direct result of image analysis.

No individual observation, candidate, or isolated subsystem independently authorizes communication.

Instead, notification occurs only after coordinated engineering evaluation performed throughout ATPDE has produced sufficient evidence to justify external action.

Accordingly, the Notification Decision Engine transforms validated lifecycle events into controlled external communication through configurable engineering policies, coordinated subsystem interaction, and evidence-based authorization.

By separating notification processing from object detection, ATPDE provides improved operational flexibility, substantially reduces unnecessary alerts, supports sophisticated reminder and escalation strategies, accommodates diverse communication technologies, and enables reliable long-term autonomous monitoring without compromising the integrity of the underlying detection process.

6.10 Event History Manager

The Event History Manager is responsible for recording, organizing, maintaining, and providing access to engineering events generated throughout operation of the Adaptive Temporal Package Detection Engine (ATPDE).

Unlike conventional monitoring systems that record only final detection results or notification activity, ATPDE maintains a comprehensive engineering history describing the progression of subsystem interactions, lifecycle transitions, confidence evolution, baseline management, environmental conditions, and other operational events.

This persistent engineering history supports diagnostics, auditing, system optimization, statistical analysis, and long-term autonomous operation.

Referring generally to Figure 11, the Event History Manager receives engineering events from the Image Acquisition Layer, Environmental Analysis Engine, Dynamic Baseline Manager, Candidate Object Engine, Temporal Confidence Engine, Object Lifecycle Manager, Notification Decision Engine, Configuration Manager, and other cooperating ATPDE subsystems.

Each subsystem may contribute engineering events independently while the Event History Manager maintains a unified chronological record representing overall system operation.

The Event History Manager intentionally functions independently from object detection.

Recording an engineering event neither influences candidate qualification nor directly alters confidence accumulation, lifecycle progression, or baseline management.

Instead, the Event History Manager preserves an accurate engineering record describing how ATPDE reached its operational decisions.

This architectural separation ensures that engineering diagnostics remain available without affecting detection reliability.

In one preferred embodiment, engineering events may include, but are not limited to:

- Observation acquisition.
- Environmental stability evaluation.
- Candidate object qualification.
- Confidence accumulation.
- Lifecycle state transitions.
- Baseline creation.
- Baseline protection.
- Baseline recovery.
- Baseline replacement.
- Baseline invalidation.
- Notification authorization.

- Notification suppression.
- Reminder generation.
- Escalation activity.
- Object removal confirmation.
- Configuration modification.
- Administrative actions.
- Engineering diagnostics.
- Communication failures.
- Monitoring suspension.
- Monitoring restoration.

The invention is not limited to any particular collection of engineering events.

Alternative embodiments may record additional operational information according to system requirements while preserving the coordinated engineering principles disclosed herein.

Each engineering event may contain one or more descriptive attributes.

Representative attributes include timestamps, event type, subsystem identifier, lifecycle state, engineering measurements, confidence values, environmental assessments, monitoring zone information, baseline status, notification status, configuration values, object identifiers, processing duration, diagnostic information, administrative annotations, or equivalent engineering metadata.

The invention is independent of any particular event structure or storage format.

The Event History Manager maintains the chronological relationship between engineering events.

Rather than storing isolated records, ATPDE preserves the sequence in which engineering activities occur.

This chronological organization enables reconstruction of the complete engineering pathway leading to object confirmation, notification authorization, object removal, baseline replacement, or other significant operational outcomes.

Historical continuity provides significant engineering advantages.

For example, an operator may review the complete progression of a persistent object from initial candidate qualification through confidence accumulation, lifecycle advancement, notification delivery, continued object presence, removal confirmation, baseline recovery, and restoration of normal monitoring.

Likewise, engineering personnel may reconstruct the exact operational conditions existing at any point during ATPDE operation.

The Event History Manager further supports engineering diagnostics.

When unexpected system behavior occurs, historical engineering events may be examined to determine the sequence of subsystem interactions contributing to the observed outcome.

Representative diagnostic activities include evaluation of confidence progression, environmental stability assessment, baseline management decisions, lifecycle transitions, notification authorization, configuration changes, communication failures, and administrative actions.

Historical engineering analysis therefore facilitates troubleshooting without requiring reproduction of the original operating conditions.

The Event History Manager additionally supports statistical analysis and long-term system optimization.

Representative statistical information may include detection frequency, object duration, notification counts, baseline replacement frequency, environmental stability trends, candidate rejection rates, confidence accumulation characteristics, subsystem utilization, engineering performance metrics, and equivalent operational summaries.

Such information may be utilized to improve future system configuration, engineering policies, or operational performance.

The Event History Manager may also support engineering auditing.

Historical records provide verifiable documentation demonstrating the operational decisions made by ATPDE throughout system operation.

Such audit records may be utilized for administrative review, regulatory compliance, engineering validation, performance verification, security investigations, operational reporting, or equivalent organizational purposes.

The invention is not limited to any particular storage methodology.

Alternative embodiments may maintain engineering history within volatile memory, non-volatile memory, relational databases, object-oriented databases, distributed storage systems, cloud storage services, append-only logs, event streaming platforms, industrial historians, blockchain-based storage, or future data management technologies.

Similarly, engineering history may be retained indefinitely or managed according to configurable retention policies.

Representative retention methodologies include time-based retention, capacity-based retention, event prioritization, archival storage, compression, summarization, selective deletion, or equivalent engineering approaches.

The Configuration Manager governs historical recording policies through configurable engineering parameters.

Representative parameters include event categories, diagnostic detail level, retention duration, storage location, archival policies, engineering reporting intervals, export formats, administrative controls, and additional operational characteristics.

These configurable policies permit ATPDE to satisfy diverse operational requirements while preserving complete engineering traceability.

The Event History Manager cooperates closely with all principal ATPDE subsystems.

Every subsystem contributes engineering evidence describing its operational responsibilities, while the Event History Manager preserves those contributions as a unified engineering record.

Consequently, ATPDE maintains a complete operational history extending beyond simple object detection to encompass the coordinated interaction of every engineering subsystem comprising the invention.

Although the preferred embodiment illustrates centralized event history management, the invention is not limited to centralized implementation.

Alternative embodiments may distribute engineering history across multiple processing devices, synchronize historical records among geographically separated monitoring systems, aggregate engineering events within enterprise analytics platforms, or maintain independent histories for multiple monitoring locations while preserving the coordinated historical framework disclosed herein.

A distinguishing characteristic of the Event History Manager is that it records the engineering reasoning underlying ATPDE operation rather than merely recording final outcomes.

Instead of documenting only that an object was detected, ATPDE preserves the sequence of engineering events explaining why that determination was reached.

This comprehensive historical record supports transparency, repeatability, diagnostics, system improvement, and engineering accountability.

Accordingly, the Event History Manager provides ATPDE with a persistent chronological engineering record describing subsystem cooperation, confidence evolution, lifecycle progression, baseline management, environmental evaluation, notification activity, and operational decision making.

Through comprehensive engineering history, chronological event preservation, subsystem integration, and configurable historical management, the Event History Manager enhances the reliability, maintainability, transparency, and long-term autonomous operation of the Adaptive Temporal Package Detection Engine.

6.11 Configuration Manager

The Configuration Manager is responsible for defining, maintaining, validating, protecting, and applying the operational parameters governing the behavior of the Adaptive Temporal Package Detection Engine (ATPDE).

Unlike conventional monitoring systems in which detection behavior is permanently defined by fixed software logic, ATPDE separates engineering policy from engineering implementation through a configurable management subsystem.

This architectural separation enables ATPDE to adapt to diverse monitoring environments without altering the underlying coordinated detection architecture.

Referring generally to Figure 12, the Configuration Manager cooperates with every principal subsystem comprising ATPDE.

Configuration information influences operation of the Image Acquisition Layer, Environmental Analysis Engine, Dynamic Baseline Manager, Candidate Object Engine, Temporal Confidence Engine, Object Lifecycle Manager, Notification Decision Engine, and Event History Manager.

Rather than independently performing object detection, the Configuration Manager provides the engineering policies under which those subsystems operate.

The Configuration Manager intentionally remains separate from operational decision making.

Individual subsystems continue to evaluate engineering evidence according to their assigned responsibilities.

The Configuration Manager instead establishes the configurable criteria governing those evaluations.

This separation allows ATPDE to preserve a consistent architectural framework while accommodating different operational requirements.

In one preferred embodiment, configurable engineering parameters may include, but are not limited to:

- Observation acquisition intervals.
- Monitoring zone definitions.
- Environmental stability thresholds.
- Candidate qualification criteria.
- Minimum candidate size.
- Monitoring zone overlap requirements.
- Temporal confidence accumulation policies.
- Confidence thresholds.
- Confidence decay characteristics.
- Lifecycle transition requirements.
- Baseline protection policies.
- Baseline recovery timing.
- Baseline replacement schedules.
- Notification authorization policies.

- Reminder intervals.
- Escalation criteria.
- Operating schedules.
- Event history retention policies.
- Diagnostic recording options.
- Administrative preferences.
- System maintenance parameters.

The invention is not limited to any particular collection of configurable parameters.

Alternative embodiments may expose additional engineering policies while preserving the coordinated subsystem architecture disclosed herein.

Configuration values may be established through numerous engineering mechanisms.

Representative mechanisms include administrative interfaces, graphical user interfaces, command-line utilities, configuration files, structured data formats, application programming interfaces (APIs), enterprise management platforms, cloud-based configuration services, remote administration systems, automated provisioning systems, or equivalent configuration methodologies.

The invention is independent of any particular configuration technology.

The Configuration Manager further validates engineering parameters before permitting their use.

Representative validation activities include verification of allowable value ranges, consistency between related parameters, dependency validation, required parameter verification, format validation, conflict detection, completeness evaluation, and equivalent engineering checks intended to prevent invalid system operation.

Should invalid configuration information be detected, ATPDE may reject the modification, restore previously validated values, notify administrative personnel, record engineering diagnostics, or initiate other recovery procedures according to configurable engineering policies.

This validation process substantially reduces the likelihood that administrative errors compromise detection reliability.

The Configuration Manager additionally supports dynamic modification of operational policies.

Certain engineering parameters may be modified during normal ATPDE operation without requiring interruption of monitoring activities.

Alternative embodiments may instead require administrative authorization, scheduled maintenance intervals, subsystem restart, staged deployment, or other engineering procedures before configuration changes become effective.

The invention is not limited to any particular configuration update methodology.

The Configuration Manager also maintains relationships among cooperating engineering parameters.

Adjustment of one engineering policy may influence the interpretation of additional parameters governing other ATPDE subsystems.

For example, modification of lifecycle thresholds may affect notification authorization, baseline protection duration, confidence accumulation requirements, historical recording policies, or equivalent engineering behaviors.

Accordingly, the Configuration Manager coordinates parameter consistency across the complete ATPDE architecture rather than treating individual settings as isolated values.

The Configuration Manager may further support multiple configuration profiles.

Representative profiles may correspond to different monitored environments, camera installations, customer requirements, seasonal operating conditions, administrative preferences, security policies, or other operational scenarios.

Selection of an alternate profile allows ATPDE to adapt rapidly to changing deployment requirements while preserving the underlying engineering architecture.

Alternative embodiments may automatically select configuration profiles according to environmental conditions, time schedules, administrative policies, detected operating characteristics, or equivalent engineering criteria.

The Configuration Manager additionally supports configuration persistence.

Validated engineering parameters may be retained across system restarts, maintenance operations, software upgrades, equipment replacement, or equivalent operational events.

Configuration persistence ensures that ATPDE resumes operation according to previously established engineering policies without requiring repeated administrative intervention.

The Configuration Manager cooperates closely with the Event History Manager.

Administrative modifications, validation failures, configuration activation, parameter changes, profile selection, restoration operations, and other engineering activities may be recorded as historical events supporting diagnostics, auditing, engineering traceability, and operational accountability.

The Configuration Manager may also provide controlled administrative access.

Representative administrative capabilities include parameter modification, profile management, engineering diagnostics, configuration export, configuration import, policy verification, access control, user authorization, audit logging, and equivalent management functions.

The invention is not limited to any particular administrative security methodology.

Although the preferred embodiment illustrates centralized configuration management, the invention is not limited to centralized implementation.

Alternative embodiments may distribute configuration information among multiple monitoring devices, synchronize engineering policies across enterprise deployments, obtain configuration from cloud-based management services, inherit policies from supervisory management systems, or employ future configuration technologies while preserving the coordinated engineering principles disclosed herein.

A distinguishing characteristic of the Configuration Manager is that operational behavior is governed through configurable engineering policies rather than modifications to the underlying detection architecture.

The cooperating ATPDE subsystems continue to perform their assigned engineering responsibilities regardless of the selected operational configuration.

Only the governing engineering policies change.

This separation substantially improves adaptability while preserving architectural integrity.

Accordingly, the Configuration Manager provides ATPDE with a centralized engineering policy framework through which operational behavior may be validated, coordinated, persisted, and administered across all cooperating subsystems.

Through comprehensive parameter management, policy validation, subsystem coordination, administrative control, and configuration persistence, the Configuration Manager enables ATPDE to operate reliably within diverse deployment environments while preserving the coordinated engineering architecture that distinguishes the Adaptive Temporal Package Detection Engine.

6.12 Cooperative Operation of the Adaptive Temporal Package Detection Engine

The Adaptive Temporal Package Detection Engine (ATPDE) derives its capabilities from the coordinated interaction of multiple engineering subsystems operating as an integrated architecture.

Unlike conventional monitoring systems in which a single algorithm or isolated software component determines object detection, ATPDE distributes engineering responsibilities among specialized subsystems that continuously exchange engineering evidence while maintaining independent operational responsibilities.

Accordingly, the invention resides not in any individual subsystem, computational technique, or image processing algorithm, but in the coordinated engineering framework through which the cooperating subsystems collectively evaluate persistent object existence.

Referring generally to Figures 1 through 12, ATPDE performs persistent object detection through a progressive sequence of coordinated engineering operations.

The Image Acquisition Layer acquires validated observations suitable for analysis.

The Environmental Analysis Engine evaluates scene stability independently of object detection.

The Dynamic Baseline Manager maintains a protected engineering reference representation of the monitored environment.

The Candidate Object Engine transforms meaningful scene differences into qualified engineering candidates.

The Temporal Confidence Engine accumulates engineering evidence across successive observations.

The Object Lifecycle Manager governs progression through successive lifecycle states.

The Notification Decision Engine determines when external communication is warranted.

The Event History Manager preserves a comprehensive engineering record describing subsystem activity.

The Configuration Manager establishes the engineering policies governing subsystem operation.

Each subsystem performs a distinct engineering responsibility while contributing evidence utilized by one or more cooperating subsystems.

No subsystem independently determines that a persistent object has been placed, remains present, or has been removed.

Instead, engineering decisions emerge from the cumulative interaction of multiple cooperating subsystems operating over time.

This coordinated engineering architecture provides several significant advantages.

First, subsystem specialization allows each engineering component to focus upon a narrowly defined responsibility.

For example, the Environmental Analysis Engine evaluates environmental stability without performing object confirmation, while the Candidate Object Engine evaluates meaningful scene differences without determining object persistence.

Likewise, the Temporal Confidence Engine accumulates engineering evidence without authorizing lifecycle transitions, and the Notification Decision Engine governs communication without participating in object detection.

This separation of responsibilities improves maintainability, adaptability, reliability, and engineering transparency.

Second, subsystem cooperation permits engineering evidence produced by one subsystem to influence the behavior of multiple additional subsystems.

Environmental stability may influence candidate qualification, confidence accumulation, lifecycle progression, baseline replacement, and notification authorization.

Likewise, accumulated confidence may influence lifecycle transitions, reminder generation, baseline recovery, engineering history, and administrative reporting.

Protected baseline management influences candidate comparison while simultaneously preserving object persistence throughout extended monitoring periods.

Consequently, engineering evidence produced within ATPDE is continuously shared among cooperating subsystems rather than consumed by a single processing stage.

Third, coordinated subsystem interaction substantially improves resilience against transient environmental disturbances.

Temporary lighting changes, moving shadows, precipitation, vegetation movement, image noise, communication interruptions, and comparable environmental phenomena are independently evaluated before influencing downstream engineering decisions.

Because engineering evidence must remain consistent across multiple cooperating subsystems before lifecycle progression is authorized, transient disturbances rarely produce erroneous persistent object detections.

Similarly, isolated subsystem anomalies generally do not compromise overall system reliability because engineering decisions require corroborating evidence supplied by additional cooperating subsystems.

The cooperative architecture further supports long-term autonomous monitoring.

Gradual environmental evolution, changing seasonal conditions, camera maintenance, administrative configuration changes, and prolonged object presence are managed through coordinated subsystem interaction rather than isolated engineering rules.

This allows ATPDE to operate continuously for extended durations while preserving reliable detection performance without frequent manual recalibration.

The coordinated architecture additionally enables modular implementation.

Each engineering subsystem may be implemented as an independent software component, shared processing module, distributed service, cloud-based function, embedded firmware component, hardware accelerator, virtualized service, or equivalent computational element.

Subsystem boundaries may be combined, subdivided, replicated, distributed, parallelized, or otherwise reorganized according to implementation requirements without departing from the coordinated engineering principles disclosed herein.

Likewise, communication among subsystems may occur synchronously, asynchronously, through shared memory, message queues, event streams, service interfaces, network protocols, publish-subscribe architectures, application programming interfaces (APIs), distributed messaging systems, or equivalent communication methodologies.

The invention remains independent of any particular implementation architecture.

The cooperative architecture also accommodates future technological advancement.

Individual computational techniques employed within one subsystem may be replaced by improved algorithms, artificial intelligence models, machine learning techniques, image processing methods, hardware technologies, or future computational methodologies without requiring modification of the overall engineering framework.

For example, improvements to environmental analysis, candidate qualification, confidence accumulation, or notification processing may be introduced independently while preserving the coordinated interaction among the remaining ATPDE subsystems.

Consequently, ATPDE remains adaptable to future technological developments without altering the fundamental engineering architecture comprising the invention.

Another distinguishing characteristic of ATPDE is that engineering decisions are evidence-driven rather than event-driven.

Conventional monitoring systems frequently initiate object detection immediately following observation of a single image difference or classification result.

In contrast, ATPDE continuously accumulates, validates, and correlates engineering evidence generated by multiple cooperating subsystems before authorizing significant operational actions.

Object confirmation, lifecycle progression, notification delivery, baseline replacement, and removal confirmation therefore represent the culmination of coordinated engineering reasoning rather than isolated computational events.

This evidence-driven architecture substantially improves operational reliability while reducing erroneous detections caused by transient environmental variation.

The cooperative operation of ATPDE further provides comprehensive engineering traceability.

Every significant operational decision may be reconstructed from the historical interaction of cooperating subsystems preserved by the Event History Manager.

Engineering personnel may therefore determine not only what operational decision was reached, but also the engineering evidence and subsystem interactions responsible for that decision.

This capability supports diagnostics, auditing, validation, regulatory compliance, performance optimization, and long-term system improvement.

Although the preferred embodiment describes cooperation among the engineering subsystems identified throughout this specification, the invention is not limited to the precise subsystem organization illustrated herein.

Alternative embodiments may introduce additional cooperating subsystems, consolidate multiple responsibilities into fewer processing components, distribute responsibilities across enterprise computing environments, or reorganize subsystem interaction while preserving the coordinated engineering principles disclosed throughout this specification.

Accordingly, the Adaptive Temporal Package Detection Engine is fundamentally characterized by the coordinated interaction of specialized engineering subsystems that collectively evaluate persistent object existence through accumulated engineering evidence, protected baseline management, environmental analysis, lifecycle progression, and evidence-based operational decision making.

The invention therefore resides in the cooperative engineering architecture itself rather than in any individual software algorithm, image processing technique, artificial intelligence model, hardware platform, programming language, operating system, communication protocol, or implementation technology.

Through coordinated subsystem interaction, ATPDE provides a robust, modular, adaptable, explainable, and technology-independent framework for reliable persistent object detection capable of long-term autonomous operation within continuously changing monitoring environments.

6.13 Summary of the Preferred Embodiment

The foregoing description presents one preferred embodiment of the Adaptive Temporal Package Detection Engine (ATPDE) as a coordinated engineering architecture for detecting, tracking, managing, and reporting persistent objects within a monitored environment.

As described throughout this specification, ATPDE differs fundamentally from conventional motion detection systems, background subtraction systems, and frame-by-frame object classification techniques by employing multiple cooperating engineering subsystems that collectively evaluate accumulated evidence over time.

In the preferred embodiment, the Image Acquisition Layer acquires validated sequential observations of the monitored environment.

The Environmental Analysis Engine independently evaluates scene stability to determine whether environmental conditions support reliable interpretation of observed changes.

The Dynamic Baseline Manager maintains a protected engineering reference representation of the monitored environment and governs evidence-based baseline replacement.

The Candidate Object Engine transforms meaningful scene differences into qualified engineering candidates suitable for additional evaluation.

The Temporal Confidence Engine progressively accumulates engineering evidence describing object persistence across successive observations.

The Object Lifecycle Manager governs the complete progression of each object through coordinated lifecycle states representing appearance, evaluation, confirmation, continued presence, removal, recovery, and restoration of normal monitoring.

The Notification Decision Engine determines whether engineering evidence justifies communication with external recipients according to configurable operational policies.

The Event History Manager preserves a comprehensive chronological engineering record describing subsystem interactions, operational decisions, lifecycle progression, confidence evolution, baseline management, and notification activity.

The Configuration Manager provides centralized administration of engineering policies governing operation of all cooperating subsystems.

Together, these cooperating engineering subsystems form an integrated architecture in which no individual subsystem independently determines persistent object existence.

Instead, ATPDE reaches operational decisions through the coordinated accumulation and interpretation of engineering evidence produced by multiple specialized subsystems operating cooperatively over time.

This coordinated evidence-based architecture provides significant engineering advantages over conventional monitoring approaches.

By separating environmental evaluation from object qualification, ATPDE substantially reduces false detections caused by transient environmental disturbances.

By protecting the baseline throughout object presence and authorizing replacement only after coordinated engineering evaluation, ATPDE preserves awareness of persistent objects regardless of how long they remain within the monitored environment.

By accumulating engineering evidence across successive observations rather than relying upon isolated image analysis, ATPDE distinguishes genuine persistent objects from temporary scene variation.

By managing complete object lifecycles, ATPDE supports reliable confirmation, reminder generation, removal verification, baseline recovery, and restoration of normal monitoring without repeated object detection.

By separating notification policy from detection logic, ATPDE provides flexible communication behavior independent of engineering evaluation.

By preserving comprehensive engineering history, ATPDE enables explainable operation, diagnostics, auditing, and long-term system optimization.

By centralizing engineering policies within the Configuration Manager, ATPDE accommodates diverse deployment environments while preserving a consistent architectural framework.

The preferred embodiment further demonstrates that the disclosed invention is independent of any specific computational methodology.

The engineering principles described herein may be implemented using deterministic algorithms, statistical analysis, heuristic evaluation, artificial intelligence, machine learning, neural networks, sensor fusion, cloud computing, edge computing, distributed processing, embedded systems, future computational technologies, or combinations thereof without departing from the coordinated engineering architecture comprising the invention.

Similarly, ATPDE is independent of any particular programming language, operating system, imaging device, communication protocol, database technology, hardware platform, software framework, or user interface implementation.

The engineering concepts disclosed herein remain applicable regardless of implementation technology.

Although the preferred embodiment has been described primarily in connection with monitoring package deliveries, the invention is not limited to package detection.

The coordinated engineering architecture disclosed herein may be applied to monitoring any persistent object whose appearance, continued presence, relocation, or removal is significant within a monitored environment.

Representative applications include security monitoring, industrial process monitoring, inventory management, equipment supervision, asset tracking, logistics operations, manufacturing automation, facility management, healthcare environments, transportation systems, agricultural monitoring, scientific observation, environmental monitoring, and numerous additional applications requiring reliable persistent object detection.

Likewise, the preferred embodiment represents only one implementation of the disclosed engineering principles.

Alternative embodiments may modify subsystem organization, engineering methodologies, communication mechanisms, confidence models, lifecycle structures, baseline representations, notification strategies, administrative policies, computational techniques, or implementation technologies while preserving the coordinated subsystem interaction described throughout this specification.

Accordingly, the invention should not be interpreted as being limited to the precise embodiment disclosed herein.

Rather, the scope of the invention encompasses all embodiments employing the coordinated engineering principles described throughout this specification together with equivalent structures, methods, computational techniques, subsystem organizations, and engineering variations that perform substantially the same functions in substantially the same manner to achieve substantially the same results.

It is therefore intended that the accompanying claims define the scope of the invention and that all modifications, equivalents, and alternative embodiments falling within the spirit and scope of those claims be embraced thereby.

7. Alternative Embodiments

7.1 Purpose

The preceding chapters describe the presently preferred embodiment of the Adaptive Temporal Package Detection Engine (ATPDE). The preferred embodiment represents the implementation presently regarded by the inventor as the best known mode for practicing the invention.

The invention, however, is not limited to the specific implementation described herein. Numerous modifications, substitutions, extensions, and alternative implementations may be employed while preserving the fundamental principles of adaptive temporal detection through coordinated environmental analysis, protected baseline management, candidate object evaluation, temporal confidence accumulation, and lifecycle state management.

The following embodiments are intended to illustrate the flexibility of the disclosed architecture and should not be interpreted as limiting the scope of the invention.

7.2 Alternative Imaging Devices

Although the preferred embodiment utilizes one or more digital surveillance cameras, ATPDE may operate with virtually any imaging device capable of providing sequential visual observations.

Examples include:

- Internet Protocol (IP) cameras.
- USB cameras.
- Embedded system cameras.
- Mobile device cameras.
- Industrial machine vision cameras.
- Network Video Recorders (NVRs).
- Digital still-image sources.
- Recorded video files.
- Future imaging technologies.

The invention does not depend upon any particular camera manufacturer, communication protocol, image resolution, or acquisition method.

7.3 Alternative Monitoring Environments

While the preferred commercial implementation monitors residential package deliveries, ATPDE is equally applicable to numerous environments requiring persistent object detection.

Representative applications include:

- Commercial loading docks.
- Warehouse inventory monitoring.
- Manufacturing workstations.
- Hospital equipment tracking.
- Pharmaceutical storage.
- Retail displays.
- Construction site monitoring.
- Vehicle parking areas.
- Airport baggage handling.
- Secure storage facilities.
- Utility infrastructure.
- Agricultural monitoring.
- Laboratory environments.
- Public safety installations.

In each case, ATPDE evaluates the appearance, persistence, and removal of stationary objects using coordinated temporal analysis.

7.4 Alternative Baseline Representations

The preferred embodiment employs a protected reference image representing the monitored scene.

Alternative embodiments may instead utilize:

- Multiple reference images.
- Composite scene representations.
- Statistical background models.
- Feature-based scene descriptions.
- Learned reference models.
- Three-dimensional scene models.
- Hybrid baseline representations.

Regardless of implementation, baseline modification remains governed by controlled engineering decisions intended to preserve reliable persistent object detection.

7.5 Alternative Environmental Analysis

Environmental stability may be evaluated using various computational techniques.

Examples include:

- Statistical analysis.
- Rule-based evaluation.
- Heuristic scoring.
- Machine learning.
- Neural network models.
- Bayesian inference.
- Sensor fusion.
- Future computational methodologies.

Environmental evaluation remains separate from object confirmation, preserving ATPDE's coordinated decision-making architecture.

7.6 Alternative Candidate Evaluation

Candidate generation and qualification may employ numerous image analysis techniques, including:

- Pixel differencing.
- Edge detection.
- Feature extraction.
- Texture comparison.
- Contour analysis.
- Region segmentation.
- Artificial intelligence feature extraction.
- Learned object proposals.
- Hybrid computer vision methods.

The invention is not limited to any specific candidate generation algorithm.

7.7 Alternative Confidence Models

Temporal confidence accumulation may be implemented using a variety of computational approaches.

Examples include:

- Linear accumulation.
- Weighted scoring.
- Probabilistic models.
- Bayesian confidence estimation.
- Hidden Markov Models.
- Fuzzy logic.
- Reinforcement learning.
- Adaptive confidence scaling.
- Future temporal reasoning techniques.

Regardless of methodology, confidence remains an accumulated measure of engineering evidence collected across multiple observations rather than a decision derived from a single image.

7.8 Alternative Lifecycle Models

Alternative embodiments may define different lifecycle structures depending upon application requirements.

Examples include:

- Simplified three-state models.
- Expanded multi-state workflows.
- Hierarchical lifecycle models.
- Parallel lifecycle management for multiple objects.
- Distributed lifecycle coordination across multiple monitoring systems.

Lifecycle transitions continue to be governed by accumulated engineering evidence rather than isolated observations.

7.9 Alternative Notification Mechanisms

Lifecycle events may be communicated through numerous notification technologies, including:

- Mobile push notifications.
- Electronic mail.
- SMS or MMS messaging.
- Desktop notifications.
- RESTful web services.
- Message queues.
- Home automation platforms.

- Industrial control systems.
- Cloud-based event services.
- Future communication technologies.

Notification delivery remains independent of the detection process itself.

7.10 Alternative Software Implementations

ATPDE may be implemented using numerous programming languages, operating systems, and software frameworks.

Representative examples include:

- C#
- Visual Basic .NET
- C++
- Python
- Java
- Go
- Rust
- JavaScript
- Embedded firmware
- Cloud-native microservices

Similarly, the invention may utilize a variety of computer vision libraries, image processing frameworks, and operating environments without departing from the disclosed architecture.

7.11 Alternative Hardware Platforms

The invention may execute on a wide range of computing devices including:

- Desktop computers.
- Laptop computers.
- Embedded controllers.
- Industrial computers.
- Single-board computers.
- Network appliances.
- Edge AI devices.
- Virtual machines.
- Cloud computing environments.
- Distributed processing systems.

No particular hardware architecture is required.

7.12 Alternative System Architectures

Although the preferred embodiment employs cooperating software modules within a single application, alternative implementations may distribute functionality across multiple processing nodes.

Examples include:

- Client-server architectures.
- Edge and cloud processing.
- Distributed microservices.
- Containerized deployments.
- Hybrid local and cloud systems.

The coordinated exchange of engineering evidence among the participating subsystems remains the defining characteristic of ATPDE.

7.13 Engineering Consistency

Regardless of the implementation selected, preferred embodiments preserve the coordinated operation of:

- Environmental stability evaluation.
- Protected baseline management.
- Candidate object evaluation.
- Temporal confidence accumulation.
- Lifecycle state management.

These cooperating functions collectively distinguish ATPDE from conventional frame-by-frame detection systems.

7.14 Chapter Summary

The embodiments described in this chapter demonstrate that the Adaptive Temporal Package Detection Engine is not limited to a particular programming language, operating system, camera manufacturer, image processing library, computing platform, or deployment architecture.

Rather, the invention resides in the coordinated temporal evaluation of persistent objects through the interaction of environmental analysis, protected baseline management, candidate object evaluation, temporal confidence accumulation, and lifecycle management.

Numerous modifications and alternative implementations may be employed without departing from the principles and spirit of the invention disclosed throughout this specification.

8. Operational Examples

8.1 Purpose

The following operational examples illustrate representative implementations of the Adaptive Temporal Package Detection Engine (ATPDE). These examples are provided solely to explain the operation of the preferred embodiment and should not be interpreted as limiting the scope of the invention.

Each example demonstrates how the coordinated interaction of the Environmental Analysis Engine, Dynamic Baseline Manager, Candidate Object Engine, Temporal Confidence Engine, Object Lifecycle Manager, Notification Decision Engine, Event History Manager, and Configuration Manager collectively determine the existence, persistence, and removal of monitored objects.

Although the examples describe package detection, the same operational principles apply to numerous other persistent object detection applications.

8.2 Example 1 – Normal Package Delivery

Initially, the monitored delivery area contains no persistent object. ATPDE has previously established a protected baseline representing the empty scene.

A delivery person places a package within the predefined monitoring zone.

During the next observation cycle, ATPDE detects differences between the newly acquired image and the protected baseline. The Candidate Object Engine identifies a qualified candidate region while the Environmental Analysis Engine determines that environmental conditions remain stable.

The candidate contributes engineering evidence to the Temporal Confidence Engine. As successive observations continue to show the package in a stable position, confidence progressively increases.

Once the configured confidence criteria have been satisfied, the Object Lifecycle Manager transitions from **No Object** to **Possible Object**, and subsequently to **Confirmed Object**.

The Notification Decision Engine determines that notification requirements have been satisfied and transmits a package arrival notification.

The Dynamic Baseline Manager continues protecting the baseline throughout the object's presence, preventing incorporation of the package into the reference representation.

8.3 Example 2 – Temporary Shadow Movement

The monitored scene experiences rapidly changing cloud cover that produces moving shadows across the monitoring zone.

Image comparison identifies substantial visual differences; however, the Environmental Analysis Engine determines that the changes affect a broad portion of the monitored scene and exhibit characteristics consistent with illumination variation rather than localized object placement.

Environmental stability is reduced.

Although temporary candidate regions may be generated, confidence accumulation is delayed or suspended until stable operating conditions return.

No object confirmation occurs.

The protected baseline remains unchanged.

Once environmental stability returns, normal operation resumes without generating unnecessary notifications.

8.4 Example 3 – Camera Exposure Adjustment

Automatic exposure control within the imaging device causes a sudden change in image brightness.

The Environmental Analysis Engine recognizes the scene-wide brightness variation as an environmental event rather than localized object placement.

Confidence accumulation is temporarily suspended.

Candidate observations collected during the transition contribute little or no additional engineering evidence.

Following stabilization of camera exposure, ATPDE resumes normal processing using the existing protected baseline.

8.5 Example 4 – Persistent Object Remaining for an Extended Period

Following confirmation of package delivery, the package remains within the monitoring zone for several hours.

Successive observations continue to confirm the object's presence.

The Object Lifecycle Manager transitions into the **Persistent Object** state.

Depending upon system configuration, the Notification Decision Engine may generate reminder notifications at predefined intervals while suppressing duplicate delivery notifications.

Throughout this period, the Dynamic Baseline Manager continues protecting the reference representation.

The package therefore remains detectable regardless of how long it occupies the monitored region.

8.6 Example 5 – Package Removal

The package is removed from the monitored region.

The Candidate Object Engine observes the disappearance of the previously confirmed object.

Rather than immediately declaring object removal, ATPDE enters the **Removal Evaluation** state.

Multiple subsequent observations confirm that the package has not reappeared and that environmental conditions remain stable.

Temporal confidence associated with the package decays according to the configured engineering rules.

Once sufficient engineering evidence has accumulated, the Object Lifecycle Manager declares **Object Removed**.

Only after confirmation of stable environmental conditions does the Dynamic Baseline Manager authorize creation of a new protected baseline representing the restored empty scene.

8.7 Example 6 – Camera Communication Interruption

Communication with the imaging device is temporarily lost.

The Image Acquisition Layer reports the communication failure.

The Event History Manager records the interruption.

Confidence accumulation is suspended while image acquisition is unavailable.

Following restoration of communication, ATPDE validates the received observations before resuming normal operation.

Baseline updates remain prohibited until stable operating conditions have been verified.

This controlled recovery process reduces erroneous detections immediately following camera reconnection.

8.8 Example 7 – Multiple Candidate Objects

Two independent objects appear within the monitored scene during the same observation sequence.

The Candidate Object Engine segments each candidate independently.

Each candidate accumulates engineering evidence separately.

One candidate satisfies the configured confidence requirements and progresses through the object lifecycle.

The second candidate fails to accumulate sufficient engineering evidence and is rejected without generating notifications.

This example illustrates that ATPDE evaluates each candidate independently while maintaining coordinated system behavior.

8.9 Example 8 – Scheduled Baseline Renewal

ATPDE is configured to evaluate baseline renewal during predetermined operating periods.

At the scheduled evaluation time, the Dynamic Baseline Manager confirms:

- No confirmed object exists.
- No candidate object is accumulating confidence.
- Environmental stability is acceptable.
- Camera operation is normal.

Having satisfied all required engineering conditions, ATPDE replaces the protected baseline with an updated reference representation.

Normal monitoring resumes immediately using the new baseline.

8.10 Example 9 – False Candidate Rejection

Wind causes nearby vegetation to briefly extend into the monitored region.

A candidate region is generated.

Subsequent observations reveal rapid changes in position, shape, and occupied area.

Environmental stability measurements indicate transient scene activity.

Because the observed characteristics remain inconsistent with a persistent object, confidence fails to accumulate sufficiently for lifecycle progression.

The candidate is discarded without generating notifications.

8.11 Example 10 – Long-Term Autonomous Operation

ATPDE operates continuously for an extended period while monitoring a residential delivery area.

Throughout operation, the system repeatedly performs image acquisition, environmental evaluation, candidate analysis, temporal confidence accumulation, lifecycle management, event logging, notification processing, and controlled baseline maintenance.

Environmental conditions change throughout the day due to sunrise, cloud cover, weather, and nighttime illumination.

Despite these changes, ATPDE continues maintaining a protected understanding of the monitored scene while reliably distinguishing persistent object placement from transient environmental disturbances.

This example demonstrates the suitability of ATPDE for long-term autonomous monitoring requiring minimal operator intervention.

8.12 Chapter Summary

The operational examples presented in this chapter demonstrate the practical application of the Adaptive Temporal Package Detection Engine under representative operating conditions.

Although the individual examples describe package monitoring, they illustrate general engineering principles applicable to a broad range of persistent object detection environments.

Collectively, these examples demonstrate how the coordinated interaction of ATPDE's principal subsystems enables reliable detection, confirmation, persistence monitoring, object removal, and controlled baseline recovery while minimizing false detections caused by changing environmental conditions.

9. Advantages of the Invention

9.1 Purpose

The Adaptive Temporal Package Detection Engine (ATPDE) provides a coordinated computer-implemented framework for detecting the appearance, continued presence, and removal of persistent objects within monitored environments.

The advantages described in this chapter arise from the coordinated interaction of the subsystems disclosed throughout this specification rather than from any single algorithm, software component, or hardware device.

The following discussion summarizes representative engineering advantages achieved by the preferred embodiment. Additional advantages may become apparent to those skilled in the art upon implementation of the disclosed invention.

9.2 Improved Detection Reliability

Unlike conventional systems that evaluate individual images independently, ATPDE accumulates engineering evidence over multiple observations.

By treating time as an active engineering variable, ATPDE is able to distinguish persistent objects from temporary visual disturbances more reliably than systems relying solely upon instantaneous image evaluation.

This progressive evaluation significantly improves overall detection consistency.

9.3 Reduced False Positive Detections

Conventional outdoor surveillance systems frequently generate false alerts caused by environmental influences such as moving shadows, changing illumination, precipitation, wind-driven vegetation, or camera exposure adjustments.

ATPDE evaluates environmental stability independently from object analysis and permits confidence accumulation only when engineering conditions support reliable interpretation.

As a result, transient environmental disturbances are less likely to generate erroneous object detections.

9.4 Reduced False Object Removal

Many conventional background subtraction systems gradually incorporate stationary objects into the reference scene, eventually causing the system to lose awareness of the object's continued presence.

ATPDE avoids this behavior by protecting the baseline while object evaluation remains active.

Controlled baseline recovery occurs only after accumulated engineering evidence confirms that a previously detected object has been removed and that the monitored environment has returned to a stable condition.

This approach substantially reduces premature object removal events.

9.5 Long-Term Autonomous Operation

The coordinated interaction of environmental analysis, protected baseline management, temporal confidence accumulation, and lifecycle management enables ATPDE to operate autonomously for extended periods without requiring continual manual recalibration.

Controlled baseline maintenance allows the system to adapt to gradual environmental changes while preserving reliable object detection.

This capability is particularly advantageous in continuously operating surveillance environments.

9.6 Explainable Engineering Decisions

ATPDE produces detection decisions based upon measurable engineering evidence accumulated throughout multiple cooperating subsystems.

Representative evidence includes:

- Environmental stability.
- Candidate qualification.
- Monitoring zone occupancy.
- Historical consistency.
- Baseline integrity.
- Temporal confidence.
- Lifecycle state.

Because each decision is supported by observable engineering measurements, ATPDE provides greater diagnostic transparency than systems relying solely upon opaque classification results.

9.7 Modular Architecture

The disclosed architecture intentionally separates major processing responsibilities into independent cooperating subsystems.

Examples include:

- Image Acquisition.
- Environmental Analysis.
- Dynamic Baseline Management.
- Candidate Object Evaluation.
- Temporal Confidence Accumulation.
- Object Lifecycle Management.
- Notification Processing.
- Event History Management.
- Configuration Management.

This modular organization simplifies maintenance, testing, future enhancement, and adaptation to new hardware and software technologies.

9.8 Technology Independence

ATPDE is independent of any particular:

- Programming language.
- Operating system.
- Camera manufacturer.
- Image processing library.
- Artificial intelligence framework.
- Communication protocol.
- Hardware platform.
- Deployment architecture.

Alternative implementations may utilize different technologies while preserving the coordinated temporal evaluation framework disclosed herein.

9.9 Scalability

Although the preferred embodiment describes monitoring a single delivery area, ATPDE is readily adaptable to larger deployments.

Alternative implementations may monitor:

- Multiple independent monitoring zones.
- Multiple imaging devices.
- Multiple facilities.
- Distributed monitoring systems.
- Cloud-based processing environments.
- Industrial automation platforms.

The underlying engineering principles remain unchanged regardless of deployment scale.

9.10 Broad Applicability

While package detection represents the preferred commercial implementation, ATPDE is applicable wherever reliable persistent object detection is required.

Representative applications include:

- Residential monitoring.
- Commercial logistics.
- Warehousing.
- Manufacturing.
- Healthcare.
- Retail.
- Construction.
- Transportation.
- Public infrastructure.
- Security monitoring.

The invention therefore extends well beyond package delivery applications.

9.11 Cooperative Decision Architecture

A distinguishing characteristic of ATPDE is that no individual subsystem independently determines whether a persistent object exists.

Instead, detection results from the coordinated interaction of multiple engineering subsystems operating together.

Environmental analysis evaluates scene stability.

The Dynamic Baseline Manager preserves a trusted reference representation.

The Candidate Object Engine identifies meaningful scene changes.

The Temporal Confidence Engine accumulates engineering evidence across time.

The Object Lifecycle Manager governs operational state transitions.

Notification processing communicates significant events only after appropriate lifecycle conditions have been satisfied.

This cooperative decision architecture provides substantially greater reliability than approaches relying upon any single detection technique.

9.12 Engineering Summary

The Adaptive Temporal Package Detection Engine introduces a coordinated framework for persistent object detection that combines adaptive baseline management, environmental stability evaluation, candidate object analysis, temporal confidence accumulation, lifecycle state management, and configurable notification processing into a unified computer-implemented architecture.

By evaluating observations over time rather than relying upon isolated image analysis, ATPDE provides improved detection reliability, reduced false detections, enhanced baseline protection, greater explainability, long-term autonomous operation, and broad adaptability across diverse monitoring environments.

These advantages collectively distinguish the disclosed invention from conventional motion detection, background subtraction, and frame-by-frame object recognition systems.

10. Conclusion

The Adaptive Temporal Package Detection Engine (ATPDE) provides a computer-implemented system and method for detecting the appearance, continued presence, and removal of persistent objects through coordinated temporal analysis using dynamic baseline management.

Unlike conventional surveillance systems that rely primarily upon motion detection, continuously adapting background models, or frame-by-frame object recognition, ATPDE evaluates observations collected over time and integrates multiple independent sources of engineering evidence before determining that a persistent object exists.

Throughout this specification, the invention has been described as a coordinated engineering framework comprising an Image Acquisition Layer, Environmental Analysis Engine, Dynamic Baseline Manager, Candidate Object Engine, Temporal Confidence Engine, Object Lifecycle Manager, Notification Decision Engine, Event History Manager, and Configuration Manager. These subsystems cooperate to evaluate the monitored environment while preserving a protected baseline representation and maintaining a continuous understanding of object persistence.

A distinguishing characteristic of the disclosed invention is that no individual observation, algorithm, subsystem, or measurement independently determines whether a persistent object exists. Rather, ATPDE accumulates engineering evidence across successive observations, evaluates environmental stability, protects the integrity of the baseline, manages object lifecycle transitions, and generates notifications only after predefined engineering criteria have been satisfied.

The disclosed architecture enables reliable long-term autonomous operation within uncontrolled environments by reducing false detections caused by transient environmental disturbances while minimizing the likelihood that persistent objects become incorporated into the protected baseline. Through coordinated temporal evaluation, ATPDE maintains an accurate representation of the monitored scene while adapting to changing operating conditions without sacrificing detection reliability.

Although the preferred embodiment has been described primarily with respect to residential package monitoring, the invention is not limited to package detection. The principles disclosed herein are applicable to numerous applications requiring reliable detection, monitoring, persistence evaluation, and removal confirmation of stationary or substantially stationary objects, including commercial, industrial, healthcare, logistics, retail, transportation, infrastructure, security, and other monitoring environments.

The preferred embodiment presented throughout this specification represents the best mode presently contemplated by the inventor for practicing the invention. Those skilled in the art will recognize that numerous modifications, substitutions, additions, and alternative implementations may be made without departing from the spirit and underlying principles of the disclosed invention. Variations in hardware, software, image processing techniques, communication methods, deployment architectures, computational methodologies, or subsystem implementation details may be employed while preserving the coordinated temporal evaluation framework described herein.

Accordingly, the scope of the invention should not be interpreted as being limited to the specific embodiments described in this specification, but rather should encompass all implementations that embody the principles of adaptive temporal detection through coordinated environmental analysis, protected dynamic baseline management, candidate object evaluation, temporal confidence accumulation, and lifecycle state management as disclosed herein.

This specification is intended to provide a complete technical disclosure sufficient to enable one skilled in the relevant arts to make and use the invention and to serve as the engineering foundation supporting a United States Provisional Patent Application and any subsequently filed non-provisional patent applications based upon the inventive concepts disclosed herein.

Appendix A – Representative Algorithms

A.1 Purpose

This appendix describes representative algorithms employed by the Adaptive Temporal Package Detection Engine (ATPDE). The algorithms are presented in a technology-independent form to illustrate the operational principles of the invention.

The examples contained herein are intended to enable implementation of the preferred embodiment and should not be interpreted as limiting the invention to any particular programming language, software library, operating system, image processing framework, or computational methodology.

Alternative algorithms that perform substantially equivalent engineering functions remain within the scope of the invention.

A.2 Overall Processing Algorithm

The preferred embodiment performs a repeating sequence of operations for each acquired observation.

Representative processing sequence:

```
Acquire Observation

Validate Observation

Evaluate Environmental Stability

Retrieve Protected Baseline

Compare Observation to Baseline

Generate Candidate Objects

Qualify Candidate Objects

Update Temporal Confidence

Evaluate Lifecycle State

Generate Notifications
```

```
Record Event History

Evaluate Baseline Update Eligibility

Repeat
```

Although illustrated sequentially, alternative embodiments may perform one or more operations concurrently or in a different order.

A.3 Environmental Stability Algorithm

Representative processing logic:

```
Measure Overall Brightness

Measure Brightness Change

Evaluate Spatial Distribution

Measure Image Contrast

Evaluate Environmental Indicators

Calculate Environmental Stability Score

IF Stability Score >= Threshold

    Permit Candidate Evaluation

ELSE

    Suspend or Reduce Confidence Accumulation

END IF
```

Environmental evaluation may utilize statistical analysis, heuristic methods, artificial intelligence, sensor fusion, or equivalent computational techniques.

A.4 Candidate Generation Algorithm

Representative processing sequence:

```
Compare Current Observation to Protected Baseline
```

```
Identify Changed Regions

Segment Independent Regions

Measure Candidate Characteristics

Evaluate Monitoring Zone Overlap

Reject Invalid Candidates

Forward Qualified Candidates
```

Candidate characteristics may include area, shape, aspect ratio, edge density, spatial stability, historical consistency, and other engineering measurements.

A.5 Temporal Confidence Algorithm

Representative confidence update:

```
FOR each Qualified Candidate

    Evaluate Historical Consistency

    Evaluate Environmental Stability

    Evaluate Candidate Persistence

    Evaluate Baseline Integrity

    Update Confidence

NEXT
```

Confidence may increase, decrease, remain unchanged, decay, or be suspended according to accumulated engineering evidence.

The invention is not limited to any specific confidence equation.

A.6 Lifecycle Management Algorithm

Representative lifecycle evaluation:

```
IF Confidence < Possible Threshold

    State = No Object
```

```
ELSE IF Confidence >= Possible Threshold

    State = Possible Object

ELSE IF Confidence >= Confirmed Threshold

    State = Confirmed Object

ELSE IF Object Persists

    State = Persistent Object

END IF
```

Additional states including Reminder Active, Removal Evaluation, Object Removed, and Baseline Recovery are evaluated according to accumulated engineering evidence.

Alternative embodiments may employ additional or fewer lifecycle states.

A.7 Baseline Protection Algorithm

Representative processing:

```
IF Candidate Active

    Protect Baseline

ELSE IF Confirmed Object Exists

    Protect Baseline

ELSE IF Environmental Stability Poor

    Protect Baseline

ELSE IF Recovery Incomplete

    Protect Baseline

ELSE

    Permit Baseline Update

END IF
```

This protected baseline methodology distinguishes ATPDE from continuously adapting background subtraction systems.

A.8 Object Removal Algorithm

Representative processing:

```
IF Confirmed Object Disappears

    Begin Removal Evaluation

    Continue Monitoring

    IF Multiple Stable Observations Confirm Removal

        Declare Object Removed

        Begin Baseline Recovery

    END IF

END IF
```

Removal is intentionally delayed until sufficient engineering evidence has accumulated.

A.9 Notification Algorithm

Representative processing:

```
IF Lifecycle Transition Occurs

    Evaluate Notification Policy

    Evaluate User Schedule

    Evaluate Reminder Timing

    Generate Notification

END IF
```

Notification mechanisms remain independent of the underlying detection architecture.

A.10 Event History Algorithm

Representative processing:

```
Record Timestamp

Record Lifecycle State

Record Confidence

Record Environmental Stability

Record Candidate Information

Record Baseline Activity

Store Historical Event
```

Historical information may support diagnostics, analytics, engineering evaluation, auditing, or future optimization.

A.11 Configuration Processing

Representative processing:

```
Load Configuration

Validate Configuration

Apply Parameters

Monitor Runtime Changes

Update Processing Rules
```

Configuration parameters may include thresholds, timing values, monitoring zones, notification policies, baseline management rules, and environmental sensitivity.

A.12 Multi-Object Processing

Alternative embodiments may evaluate multiple independent candidates simultaneously.

Representative processing:

```
FOR each Candidate

    Evaluate Candidate

    Update Confidence

    Update Lifecycle

NEXT
```

Each candidate maintains an independent engineering history while sharing common environmental analysis and baseline management.

A.13 Alternative Computational Methods

The representative algorithms described throughout this appendix may be implemented using numerous computational methodologies including, but not limited to:

- Deterministic algorithms.
- Statistical analysis.
- Rule-based systems.
- Bayesian inference.
- Artificial intelligence.
- Machine learning.
- Neural networks.
- Fuzzy logic.
- Reinforcement learning.
- Hybrid computational frameworks.
- Future computational methodologies.

Regardless of implementation, the defining characteristic of ATPDE remains the coordinated temporal evaluation of persistent objects using environmental analysis, protected baseline management, candidate evaluation, temporal confidence accumulation, and lifecycle management.

A.14 Appendix Summary

The algorithms presented in this appendix illustrate representative implementations of the Adaptive Temporal Package Detection Engine and demonstrate the coordinated interaction of its principal engineering subsystems.

The algorithms are intended to describe functional behavior rather than prescribe specific software implementations. Numerous variations, optimizations, substitutions, and computational techniques may be employed while preserving the engineering principles disclosed throughout this specification.

Appendix B – Representative Configuration Parameters

B.1 Purpose

This appendix describes representative configuration parameters that may be employed by the Adaptive Temporal Package Detection Engine (ATPDE).

The parameters presented herein are illustrative of the preferred embodiment and demonstrate one method of configuring the disclosed invention. The invention is not limited to any particular parameter, numerical value, threshold, timing interval, or operating range.

Alternative embodiments may employ additional parameters, omit selected parameters, or utilize different default values while preserving the engineering principles disclosed throughout this specification.

B.2 Image Acquisition Parameters

Representative image acquisition parameters include:

Parameter	Purpose
Image Source	Identifies the image-producing device or stream.
Acquisition Interval	Defines the time between successive observations.
Image Resolution	Specifies the preferred observation resolution.
Frame Rate	Controls image acquisition frequency for continuous video.
Communication Timeout	Determines acceptable response time from the imaging device.
Camera Recovery Delay	Defines the delay before processing resumes following communication restoration.

B.3 Monitoring Zone Parameters

Representative monitoring zone parameters include:

Parameter	Purpose
Monitoring Zone Definition	Defines one or more regions evaluated for persistent objects.
Polygon Coordinates	Specifies the boundaries of polygonal monitoring regions.
Minimum Zone Overlap	Minimum candidate overlap required for evaluation.
Multiple Zone Support	Enables simultaneous evaluation of multiple monitoring areas.
Zone Enable/Disable	Allows individual monitoring regions to be activated or deactivated.

B.4 Environmental Analysis Parameters

Representative environmental configuration includes:

Parameter	Purpose
Environmental Stability Threshold	Minimum acceptable stability required for normal evaluation.
Brightness Variation Threshold	Permitted change in scene illumination.
Contrast Threshold	Acceptable contrast variation between observations.
Scene Change Threshold	Maximum allowable scene-wide variation before environmental instability is assumed.
Environmental Delay	Delay before processing resumes after unstable conditions.

B.5 Candidate Object Parameters

Representative candidate evaluation parameters include:

Parameter	Purpose
Minimum Candidate Area	Rejects insignificant image changes.
Maximum Candidate Area	Rejects excessively large scene

Parameter	Purpose
	changes.
Minimum Zone Occupancy	Minimum percentage of monitoring zone occupied by a candidate.
Shape Qualification	Optional engineering limits on candidate geometry.
Candidate Persistence	Number of observations required before confidence accumulation.

B.6 Temporal Confidence Parameters

Representative confidence parameters include:

Parameter	Purpose
Initial Confidence	Starting confidence assigned to a new candidate.
Confidence Increment	Amount confidence increases following qualified observations.
Confidence Decay Rate	Reduction applied when engineering evidence weakens.
Confidence Suspension Policy	Governs behavior during unstable environmental conditions.
Maximum Confidence	Upper limit for accumulated confidence.

B.7 Lifecycle Parameters

Representative lifecycle parameters include:

Parameter	Purpose
Possible Object Threshold	Confidence required to enter the Possible Object state.
Confirmed Object Threshold	Confidence required for object confirmation.
Persistent Object Threshold	Criteria for long-term object persistence.
Removal Evaluation Duration	Observation period before object removal is confirmed.
Baseline Recovery Delay	Minimum delay before baseline replacement following removal.

B.8 Baseline Management Parameters

Representative baseline management parameters include:

Parameter	Purpose
Automatic Baseline Updates	Enables or disables autonomous baseline replacement.
Baseline Protection Policy	Prevents modification while object evaluation remains active.
Baseline Age Limit	Maximum preferred age of a protected baseline.
Scheduled Renewal Interval	Optional schedule for baseline evaluation.
Manual Override	Allows administrative baseline replacement.

B.9 Notification Parameters

Representative notification parameters include:

Parameter	Purpose
Initial Notification Enable	Enables notification following object confirmation.
Reminder Interval	Time between reminder notifications.
Notification Schedule	Permitted delivery times.
Delivery Mechanisms	Supported communication methods.
Duplicate Notification Policy	Controls suppression of repeated notifications.

B.10 Event History Parameters

Representative event logging parameters include:

Parameter	Purpose
Logging Enable	Enables operational history recording.
Diagnostic Detail	Controls amount of recorded

Parameter	Purpose
	engineering information.
History Retention	Specifies event storage duration.
Timestamp Resolution	Defines timestamp precision.
Export Options	Permits historical event export for diagnostics.

B.11 System Configuration Parameters

Representative system-wide configuration includes:

Parameter	Purpose
Operating Mode	Defines the selected monitoring behavior.
Processing Priority	Controls allocation of processing resources.
Diagnostic Mode	Enables engineering diagnostics.
User Permissions	Defines administrative configuration rights.
Default Operating Profile	Specifies preferred startup configuration.

B.12 Representative Preferred Embodiment

In one preferred embodiment of ATPDE, representative configuration values include engineering parameters governing:

- Environmental stability sensitivity.
- Candidate object qualification.
- Temporal confidence accumulation.
- Lifecycle transition thresholds.
- Protected baseline management.
- Monitoring zone definition.
- Notification timing.
- Event history retention.

The specific numerical values selected for these parameters are dependent upon the monitored environment, imaging device, object characteristics, user preferences, and operational requirements. Accordingly, the preferred embodiment should not be interpreted as limiting the invention to any particular configuration values.

B.13 Configuration Flexibility

One of the engineering advantages of ATPDE is that operational behavior may be adapted through configuration rather than modification of the underlying detection architecture.

Individual parameters may be adjusted independently or collectively to optimize performance for different environments, imaging systems, monitored objects, or operational objectives while preserving the coordinated temporal evaluation framework disclosed throughout this specification.

B.14 Appendix Summary

The representative configuration parameters described in this appendix illustrate one method of adapting the Adaptive Temporal Package Detection Engine to different operating environments.

The invention is not limited to the parameters or representative values presented herein. Numerous additional configuration options, operating policies, threshold values, timing intervals, and engineering controls may be employed without departing from the principles of adaptive temporal detection using coordinated environmental analysis, protected baseline management, candidate object evaluation, temporal confidence accumulation, and lifecycle state management.

Appendix C – Representative State Diagrams

C.1 Purpose

This appendix describes representative state diagrams illustrating the operational behavior of the Adaptive Temporal Package Detection Engine (ATPDE).

The diagrams described herein are intended to demonstrate the coordinated interaction of the principal ATPDE subsystems during normal operation. The state models are representative of the preferred embodiment and should not be interpreted as limiting the invention to any particular number of states, transition sequence, or implementation methodology.

Alternative embodiments may add, remove, combine, subdivide, or reorder individual states while preserving the engineering principles disclosed throughout this specification.

C.2 Overall System Operational State Diagram

The overall ATPDE framework progresses through a continuous sequence of operational states.

Representative system states include:

```
System Startup
        │
        ▼
Initialize Configuration
        │
        ▼
Initialize Camera
        │
        ▼
Acquire Initial Baseline
        │
        ▼
Monitoring Active
        │
        ├─────────────┐
        │             │
        ▼             │
Process Observation   │
        │             │
        ▼             │
Update System State ──┘
        │
        ▼
Shutdown
```

The preferred embodiment continuously repeats the observation-processing cycle while monitoring remains active.

C.3 Object Lifecycle State Diagram

The preferred embodiment models persistent object detection as a managed lifecycle.

Representative lifecycle states include:

```
No Object
     │
     ▼
Possible Object
     │
     ▼
Confirmed Object
```

```
      │
      ▼
Persistent Object
      │
      ▼
Reminder Active
      │
      ▼
Removal Evaluation
      │
      ▼
Object Removed
      │
      ▼
Baseline Recovery
      │
      ▼
No Object
```

Transitions occur only after sufficient engineering evidence has accumulated.

Transient disturbances commonly return directly to the **No Object** state without progressing further.

C.4 Temporal Confidence State Diagram

Confidence is managed as a continuously evolving engineering measurement.

Representative confidence states include:

```
Initialize
      │
      ▼
Accumulate
      │
    ┌─┼─────────────┐
    ▼ ▼             ▼
Grow Suspend     Decay
    │   │           │
    └───┼───────────┘
        ▼
Evaluate
        │
        ▼
Reset
        │
        ▼
Initialize
```

Confidence progression depends upon accumulated engineering evidence rather than any individual observation.

C.5 Baseline Management State Diagram

The Dynamic Baseline Manager governs the protected baseline throughout its operational lifecycle.

Representative states include:

```
Create Baseline
       │
       ▼
Protected Baseline
       │
       ▼
Evaluate Update Eligibility
       │
 ┌─────┴────────────────┐
 │                      │
 ▼                      ▼
Protect          Update Authorized
 │                      │
 └──────────┬───────────┘
            │
            ▼
Baseline Recovery
            │
            ▼
Protected Baseline
```

Baseline replacement occurs only after predefined engineering conditions have been satisfied.

C.6 Environmental Stability State Diagram

Environmental analysis continuously evaluates the reliability of the monitored scene.

Representative states include:

```
Stable
   │
   ▼
Minor Variation
   │
   ▼
```

```
Unstable
   │
   ▼
Suspend Confidence
   │
   ▼
Recover Stability
   │
   ▼
Stable
```

Environmental instability influences downstream processing but does not itself constitute object detection.

C.7 Candidate Object State Diagram

Each candidate progresses through a structured evaluation sequence.

Representative states include:

```
Image Difference
        │
        ▼
Candidate Generated
        │
        ▼
Qualified
   ┌────┴─────┐
   ▼          ▼
Rejected   Accepted
              │
              ▼
Temporal Confidence
```

Candidate qualification represents preliminary engineering evidence rather than object confirmation.

C.8 Notification State Diagram

Notification processing is governed independently from object detection.

Representative states include:

```
No Event
    │
    ▼
```

```
Lifecycle Change
    │
    ▼
Evaluate Policy
    │
 ┌──┴──────────────┐
 ▼                 ▼
Suppress      Notify User
                   │
                   ▼
Reminder Timer
                   │
                   ▼
Evaluate Again
```

Notification decisions depend upon lifecycle state, timing policies, and user configuration.

C.9 Camera Availability State Diagram

The preferred embodiment continuously evaluates communication with image-producing devices.

Representative states include:

```
Camera Available
        │
        ▼
Communication Failure
        │
        ▼
Recovery Attempt
        │
 ┌──────┴──────────┐
 ▼                 ▼
Retry         Connection Restored
                    │
                    ▼
Validate Observation
                    │
                    ▼
Camera Available
```

Camera availability is managed independently from object evaluation.

C.10 Event History State Diagram

Operational history is maintained throughout ATPDE operation.

Representative event flow includes:

```
System Event
      │
      ▼
Record Timestamp
      │
      ▼
Record Event Details
      │
      ▼
Store History
      │
      ▼
Await Next Event
```

Historical information supports diagnostics, auditing, and engineering analysis.

C.11 Configuration State Diagram

Configuration management governs operating parameters throughout the system lifecycle.

Representative states include:

```
Load Configuration
        │
        ▼
Validate Parameters
        │
        ▼
Apply Configuration
        │
        ▼
Monitoring Active
        │
        ▼
Configuration Changed
        │
        ▼
Validate Changes
        │
        ▼
Apply Updated Configuration
```

Configuration changes may take effect immediately or according to predefined operational policies.

C.12 Alternative State Models

Alternative embodiments may employ additional or modified state models, including:

- Hierarchical state machines.
- Parallel state machines.
- Distributed state management.
- Multi-object state tracking.
- Event-driven architectures.
- Artificial intelligence assisted state transitions.
- Future computational state management techniques.

Regardless of implementation, ATPDE maintains the principle that operational behavior is governed by coordinated state transitions derived from accumulated engineering evidence.

C.13 Appendix Summary

The representative state diagrams presented in this appendix illustrate how the principal subsystems of the Adaptive Temporal Package Detection Engine cooperate to provide reliable persistent object detection.

These state models demonstrate that ATPDE operates as a coordinated engineering framework in which environmental evaluation, protected baseline management, candidate analysis, temporal confidence accumulation, lifecycle management, notification processing, and configuration management interact through well-defined operational states.

The diagrams are representative only and should not be interpreted as limiting the invention to any particular state structure or transition sequence. Numerous equivalent state models may be employed while preserving the engineering principles disclosed throughout this specification.

Appendix D – Representative Process Flowcharts

D.1 Purpose

This appendix presents representative process flowcharts illustrating the operational workflow of the Adaptive Temporal Package Detection Engine (ATPDE).

The flowcharts describe one preferred embodiment of the disclosed invention and are intended to demonstrate the interaction of the principal engineering subsystems described throughout this specification.

The process flows presented herein are representative only. Alternative embodiments may perform operations in different sequences, combine individual steps, execute multiple operations concurrently, omit selected operations, or introduce additional processing while preserving the engineering principles disclosed herein.

D.2 Overall System Processing Flow

The preferred embodiment continuously performs the following processing cycle.

```
text id="4q5bzs" System Startup       │       ▼ Load Configuration      │
▼ Initialize Camera         │       ▼ Acquire Observation        │       ▼
Environmental Analysis        │       ▼ Retrieve Protected Baseline       │
▼ Generate Candidate Objects      │       ▼ Temporal Confidence Evaluation
│       ▼ Lifecycle Management       │       ▼ Notification Processing
│       ▼ Event Logging        │       ▼ Baseline Evaluation       │       ▼
Repeat Monitoring Cycle
```

This processing sequence repeats continuously while monitoring remains active.

D.3 Image Acquisition Flowchart

Representative processing:

```
text id="lqbnl8" Request Observation         │         ▼ Image Received?
┌────┴────┐    │         │   Yes       No   │         │   ▼         ▼
Validate   Retry Image      Acquisition    │         │    └────┬────┘
▼ Forward Observation
```

Alternative embodiments may obtain observations from still images, video streams, image sequences, or other imaging technologies.

D.4 Environmental Analysis Flowchart

Representative processing:

```
text id="vjglcz" Acquire Observation         │         ▼ Measure Brightness
│         ▼ Measure Contrast         │       ▼ Evaluate Scene Stability
          ▼ Stable Environment?     ┌────┴────┐   │         │  Yes        No
│         │    ▼         ▼ Continue  Suspend or Processing Reduce Confidence
```

Environmental evaluation occurs before candidate confirmation.

D.5 Candidate Object Evaluation Flowchart

Representative processing:

```
text id="hlgcw0" Compare Observation to Baseline       │       ▼ Generate
Difference Regions        │       ▼ Segment Candidates       │       ▼
Evaluate Candidate Size        │       ▼ Evaluate Zone Overlap       │       ▼
Qualified Candidate?    ┌────┴────┐    │          │  Yes        No     │
│    ▼          ▼ Confidence   Reject Engine      Candidate
```

Candidate qualification does not itself confirm object existence.

D.6 Temporal Confidence Flowchart

Representative processing:

```
text id="gcgb8g" Qualified Candidate         │        ▼ Evaluate Persistence
│        ▼ Evaluate Historical Consistency        │        ▼ Evaluate
Environmental Stability         │       ▼ Update Confidence        │
▼ Confidence Threshold Met?    ┌────┴────┐     │         │    Yes       No
│         │     ▼         ▼ Lifecycle   Continue Transition  Monitoring
```

Confidence represents accumulated engineering evidence rather than instantaneous detection.

D.7 Object Lifecycle Flowchart

Representative processing:

```
text id="3b2mhj" No Object      │      ▼ Possible Object      │      ▼
Confirmed Object      │      ▼ Persistent Object      │      ▼ Object
Removed?  ┌───┴────┐  │        │ No        Yes  │        │  ▼         ▼
Continue Baseline Recovery Monitoring
```

Lifecycle progression depends upon accumulated evidence collected across multiple observations.

D.8 Baseline Management Flowchart

Representative processing:

```
text id="l5lhga" Evaluate Baseline        │         ▼ Object Active?
┌────┴─────┐     │          │  Yes          No     │          │    ▼          ▼
Protect    Evaluate Stability Baseline         │                  ▼
Stable Environment?               ┌────┴────┐       │         │
Yes       No           │         │             ▼         ▼ Update    Continue
Baseline  Protection
```

The preferred embodiment protects baseline integrity throughout active object evaluation.

D.9 Notification Processing Flowchart

Representative processing:

```
text id="43mewr" Lifecycle Event        │       ▼ Notification Enabled?
┌────┴─────┐     │         │  Yes        No     │         │    ▼         ▼
Evaluate   Suppress Schedule    │     ▼ Generate Notification    │    ▼
Schedule Reminder
```

Notification generation remains independent from object detection.

D.10 Event History Flowchart

Representative processing:

```
text id="5d7q5s" System Event       │       ▼ Collect Engineering Data
│       ▼ Timestamp Event       │       ▼ Record Lifecycle State       │
▼ Store Historical Record
```

Historical records support engineering diagnostics, auditing, and performance evaluation.

D.11 Baseline Recovery Flowchart

Representative processing:

```
text id="kbrr5i" Object Removed       │       ▼ Continue Monitoring       │
▼ Environment Stable?      ┌────┴────┐    │         │  Yes        No     │
```

```
│    ▼          ▼ Create New Continue Protected  Monitoring Baseline        │
▼ Resume Normal Operation
```

Baseline replacement occurs only after sufficient engineering evidence confirms scene stability.

D.12 Continuous Monitoring Flowchart

Representative processing:

```
text id="xb5ggz" Start Monitoring        │         ▼ Acquire Observation
│        ▼ Analyze Scene         │         ▼ Update Confidence        │
▼ Manage Lifecycle        │         ▼ Evaluate Baseline        │         ▼ Log
Events        │         ▼ Repeat
```

Continuous repetition enables long-term autonomous monitoring.

D.13 Alternative Process Flows

Alternative embodiments may utilize:

- Parallel processing pipelines.
- Multi-threaded processing.
- Distributed computing architectures.
- Cloud-based processing.
- Edge computing devices.
- Artificial intelligence accelerators.
- Event-driven processing.
- Hardware-assisted image analysis.
- Future computational architectures.

Regardless of implementation, the invention remains directed to the coordinated temporal evaluation framework disclosed throughout this specification.

D.14 Appendix Summary

The representative process flowcharts presented in this appendix illustrate one preferred operational implementation of the Adaptive Temporal Package Detection Engine.

The flowcharts demonstrate how image acquisition, environmental analysis, protected baseline management, candidate object evaluation, temporal confidence accumulation, lifecycle management, notification processing, and event history recording cooperate to provide reliable persistent object detection.

The specific processing sequences illustrated herein are representative only and should not be interpreted as limiting the invention. Numerous equivalent workflows, processing orders, computational techniques, and implementation methodologies may be employed while preserving the inventive principles disclosed throughout this specification.

Appendix E – Representative Engineering Figures

E.1 Purpose

This appendix identifies the representative engineering figures referenced throughout this specification and describes the technical purpose of each illustration.

The figures described herein are intended to aid in understanding the preferred embodiment of the Adaptive Temporal Package Detection Engine (ATPDE). The figures are illustrative rather than limiting and may be modified, expanded, consolidated, or replaced by equivalent engineering illustrations without departing from the disclosed invention.

The figures are not intended to represent actual software screens, programming code, or implementation-specific diagrams. Instead, they communicate the functional relationships among the principal engineering subsystems comprising ATPDE.

E.2 Figure 1 – Overall ATPDE System Architecture

Title

Adaptive Temporal Package Detection Engine Architecture

Purpose

Illustrates the major subsystems comprising ATPDE and the flow of engineering information between them.

Representative Components:

- Image Acquisition Layer
- Environmental Analysis Engine
- Dynamic Baseline Manager
- Candidate Object Engine
- Temporal Confidence Engine

- Object Lifecycle Manager
- Notification Decision Engine
- Event History Manager
- Configuration Manager

This figure provides the highest-level overview of the invention.

E.3 Figure 2 – Overall Processing Pipeline

Title

End-to-End Processing Pipeline

Purpose

Illustrates the sequential processing of observations from acquisition through notification and baseline management.

Representative stages include:

- Image Acquisition
- Environmental Evaluation
- Baseline Comparison
- Candidate Evaluation
- Confidence Accumulation
- Lifecycle Management
- Notification
- Event Logging
- Baseline Evaluation

E.4 Figure 3 – Monitoring Environment

Title

Representative Monitoring Environment

Purpose

Illustrates a typical monitored location containing:

- Imaging device
- Monitoring zone
- Protected delivery area

- Candidate object location

The figure demonstrates one example deployment only.

E.5 Figure 4 – Monitoring Zone Definition

Title

Representative Monitoring Zone

Purpose

Illustrates polygonal monitoring regions evaluated by ATPDE.

The figure demonstrates:

- Polygon boundaries
- Zone overlap
- Candidate intersection
- Ignored background areas

Alternative embodiments may utilize different monitoring geometries.

E.6 Figure 5 – Environmental Analysis Engine

Title

Environmental Analysis Architecture

Purpose

Illustrates representative engineering inputs used to determine environmental stability.

Representative inputs include:

- Brightness
- Contrast
- Scene variation
- Exposure variation
- Environmental indicators

The figure illustrates generation of an environmental stability assessment.

E.7 Figure 6 – Dynamic Baseline Manager

Title

Protected Baseline Management

Purpose

Illustrates how ATPDE protects, evaluates, updates, and recovers baseline representations.

Representative stages include:

- Protected baseline
- Candidate present
- Update prohibited
- Removal confirmed
- Recovery complete
- New baseline established

E.8 Figure 7 – Candidate Object Evaluation

Title

Candidate Evaluation Pipeline

Purpose

Illustrates the transformation from image differences into qualified engineering candidates.

Representative processing includes:

- Difference detection
- Segmentation
- Area measurement
- Zone overlap
- Candidate qualification

E.9 Figure 8 – Temporal Confidence Engine

Title

Temporal Confidence Accumulation

Purpose

Illustrates how engineering evidence accumulates over multiple observations.

Representative concepts include:

- Confidence growth
- Confidence decay
- Stability weighting
- Historical consistency
- Threshold evaluation

The figure emphasizes that confidence is accumulated across time rather than derived from a single observation.

E.10 Figure 9 – Object Lifecycle Manager

Title

Persistent Object Lifecycle

Purpose

Illustrates lifecycle progression including:

- No Object
- Possible Object
- Confirmed Object
- Persistent Object
- Removal Evaluation
- Object Removed
- Baseline Recovery

E.11 Figure 10 – Notification Decision Engine

Title

Notification Decision Workflow

Purpose

Illustrates how lifecycle events interact with notification policies before generating user notifications.

Representative decisions include:

- Schedule validation
- Reminder timing
- Duplicate suppression
- Notification delivery

E.12 Figure 11 – Event History Manager

Title

Operational Event History

Purpose

Illustrates representative historical information recorded by ATPDE.

Representative information includes:

- Timestamp
- Lifecycle state
- Confidence
- Environmental status
- Baseline activity
- Notification events

E.13 Figure 12 – Configuration Manager

Title

Representative Configuration Architecture

Purpose

Illustrates configurable engineering parameters including:

- Detection thresholds
- Confidence parameters
- Timing controls
- Notification policies
- Baseline settings
- Monitoring zones

E.14 Figure 13 – Temporal Confidence Example

Title

Representative Confidence Accumulation

Purpose

Illustrates confidence increasing over successive observations until lifecycle transition occurs.

The figure may include a representative graph demonstrating:

- Observation number
- Confidence level
- Possible threshold
- Confirmed threshold

E.15 Figure 14 – Baseline Recovery Example

Title

Protected Baseline Recovery

Purpose

Illustrates baseline protection during object presence followed by controlled baseline replacement after confirmed removal.

Representative stages include:

- Empty scene
- Package placement
- Protected baseline
- Package removal
- Stable environment
- New baseline

E.16 Figure 15 – Complete Operational Workflow

Title

Complete ATPDE Operational Sequence

Purpose

Illustrates end-to-end operation beginning with image acquisition and ending with baseline recovery.

The figure combines the principal engineering subsystems into a single operational workflow.

E.17 Figure 16 – Subsystem Interaction Diagram

Title

ATPDE Cooperative Architecture

Purpose

Illustrates the engineering relationships among all ATPDE subsystems.

Unlike a processing flowchart, this figure emphasizes subsystem communication and cooperative decision making.

Representative interactions include:

- Environmental Analysis ↔ Temporal Confidence
- Candidate Evaluation ↔ Lifecycle Manager
- Lifecycle Manager ↔ Notification Engine
- Baseline Manager ↔ Environmental Analysis
- Configuration Manager ↔ All Subsystems
- Event History Manager ↔ All Operational Components

This figure emphasizes that ATPDE functions as an integrated engineering framework rather than a collection of independent algorithms.

E.18 Alternative Figures

Alternative embodiments may include additional engineering figures illustrating:

- Multi-camera deployments
- Multiple monitoring zones
- Distributed processing architectures
- Cloud implementations
- Edge computing implementations
- Artificial intelligence assisted embodiments
- Industrial monitoring systems
- Commercial logistics systems

- Healthcare monitoring systems
- Transportation monitoring systems

Such figures remain within the scope of the disclosed invention.

E.19 Appendix Summary

The representative engineering figures described throughout this appendix provide a visual understanding of the Adaptive Temporal Package Detection Engine and its principal engineering subsystems.

Collectively, the figures illustrate the coordinated interaction of image acquisition, environmental analysis, protected baseline management, candidate object evaluation, temporal confidence accumulation, lifecycle management, notification processing, event history recording, and configuration management.

The figures are representative only and are intended to facilitate understanding of the invention. Alternative diagrams, layouts, engineering illustrations, and visual representations may be employed while preserving the inventive concepts disclosed throughout this specification.

Adaptive Temporal Package Detection Engine (ATPDE)

Patent Figures

Inventor: James Kevin Brown

Figure 1 – Overall ATPDE System Architecture

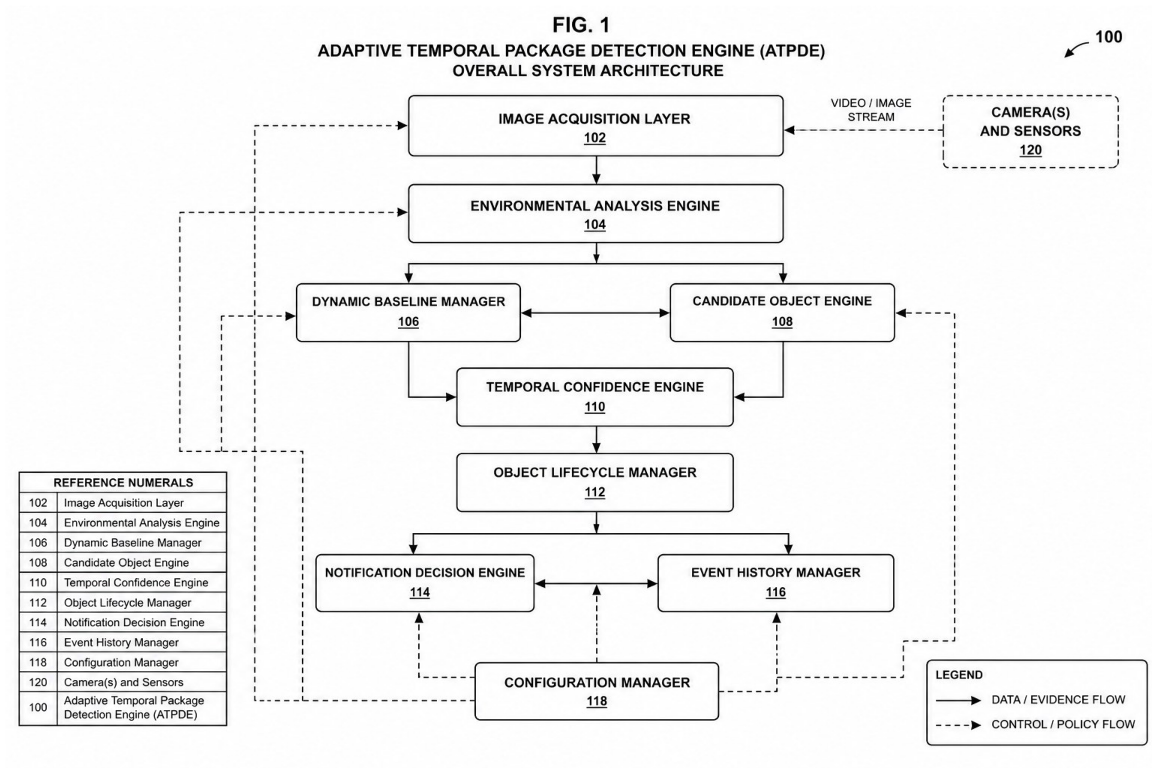


Figure 2 – Image Acquisition Layer

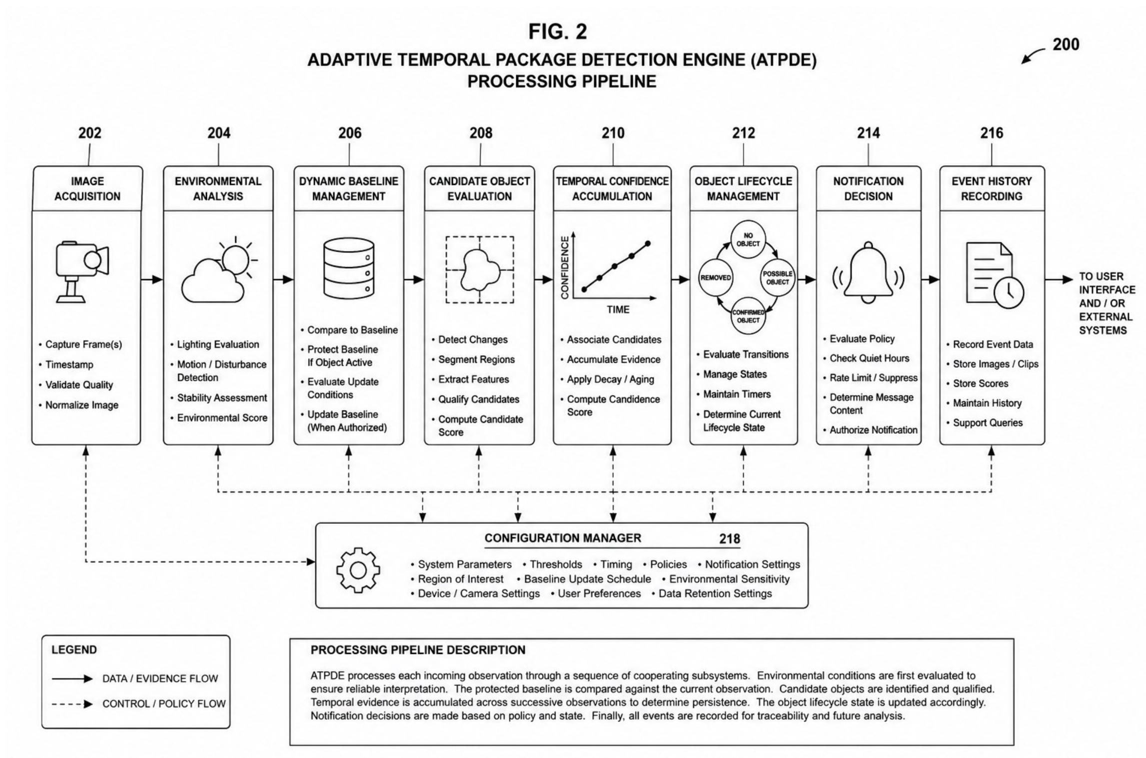


Figure 3 – Environmental Analysis Engine

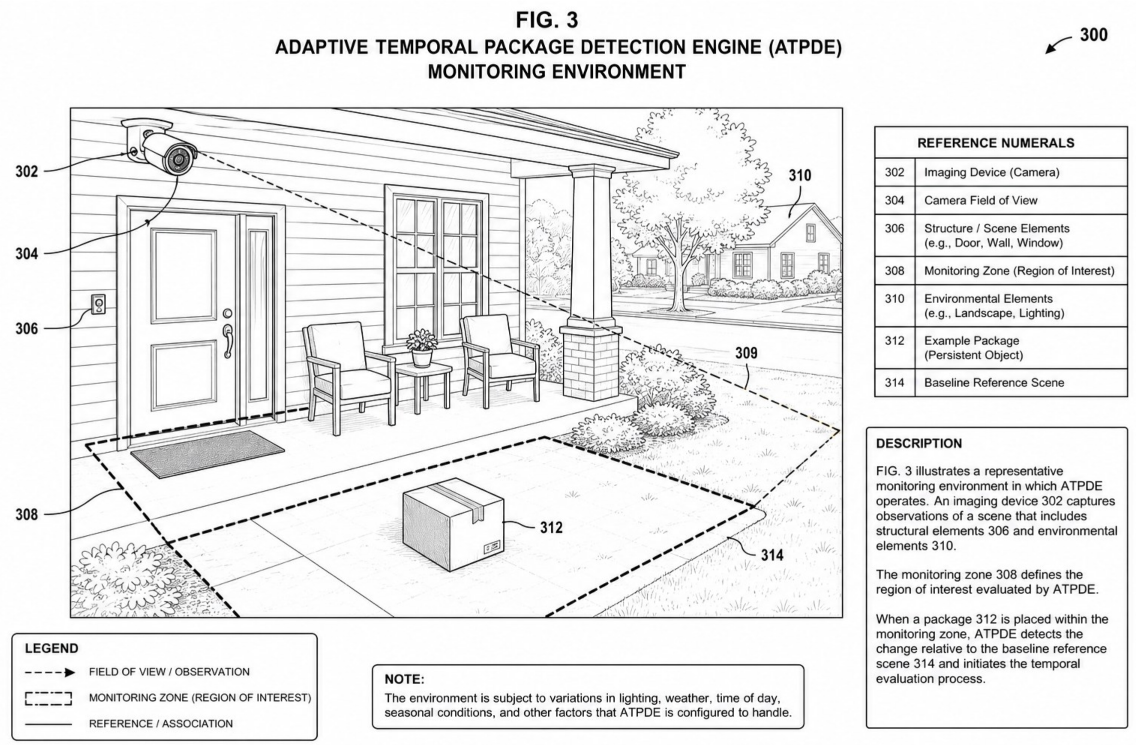


Figure 4 – Dynamic Baseline Manager

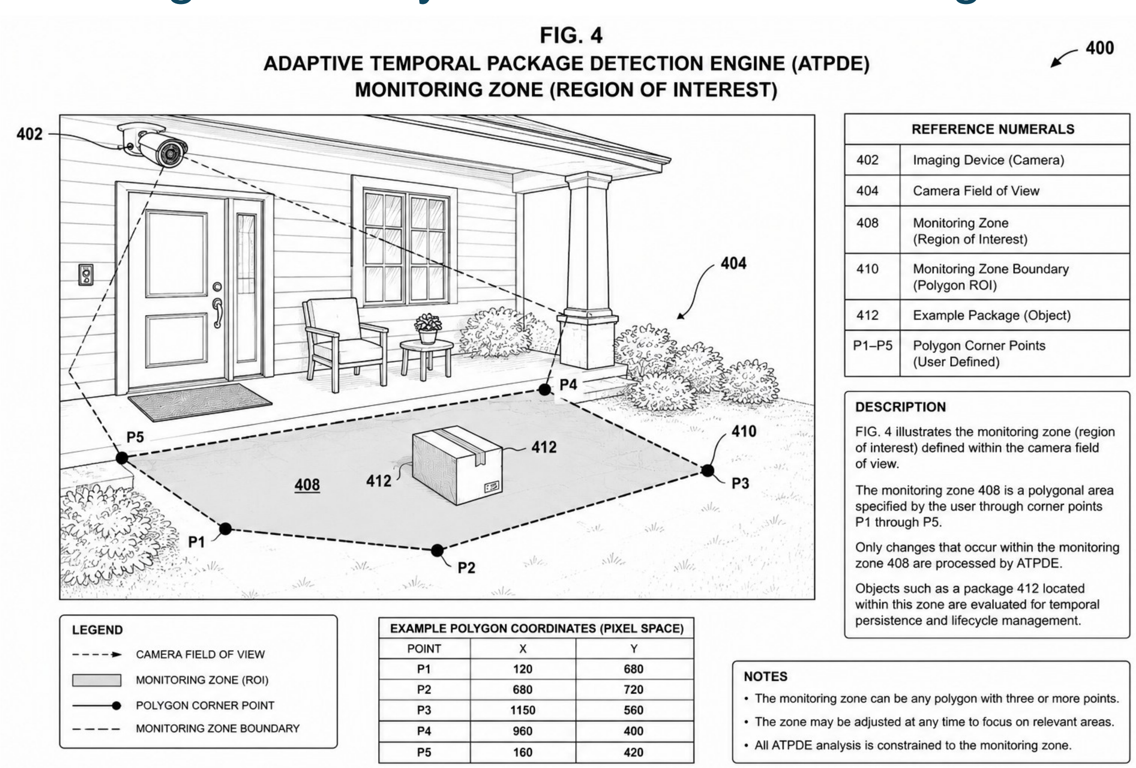


Figure 5 – Candidate Object Engine

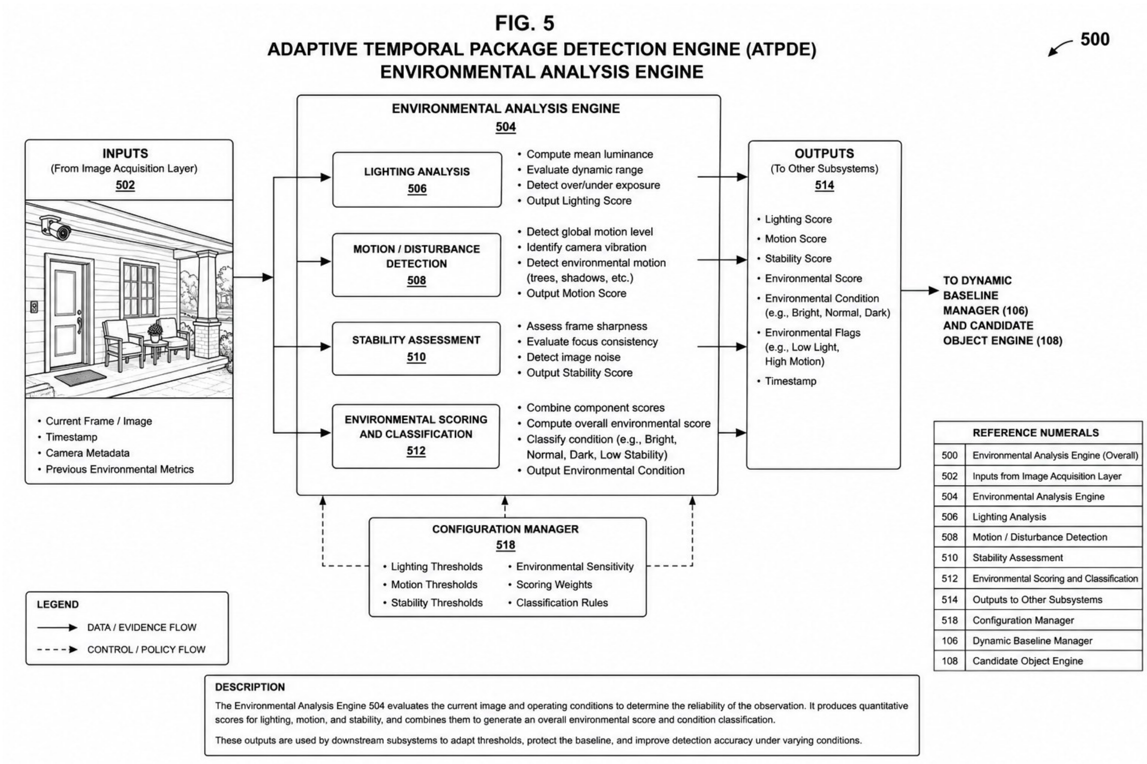


Figure 6 – Temporal Confidence Engine

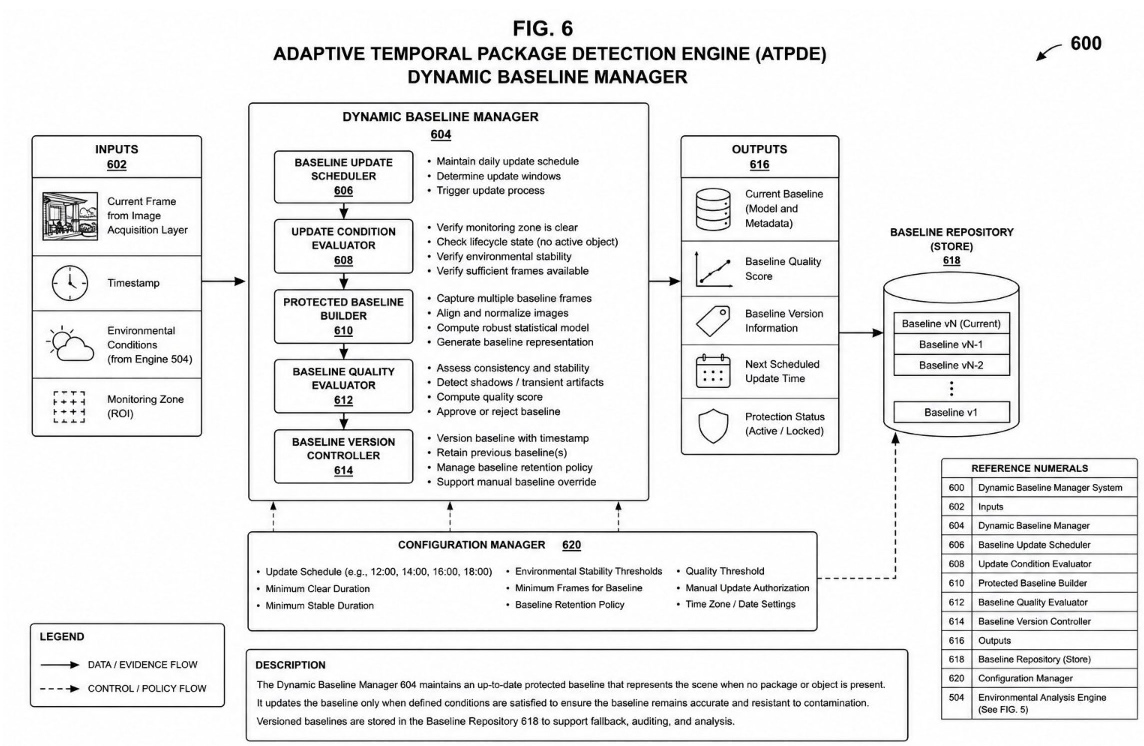


Figure 7 – Object Lifecycle Manager

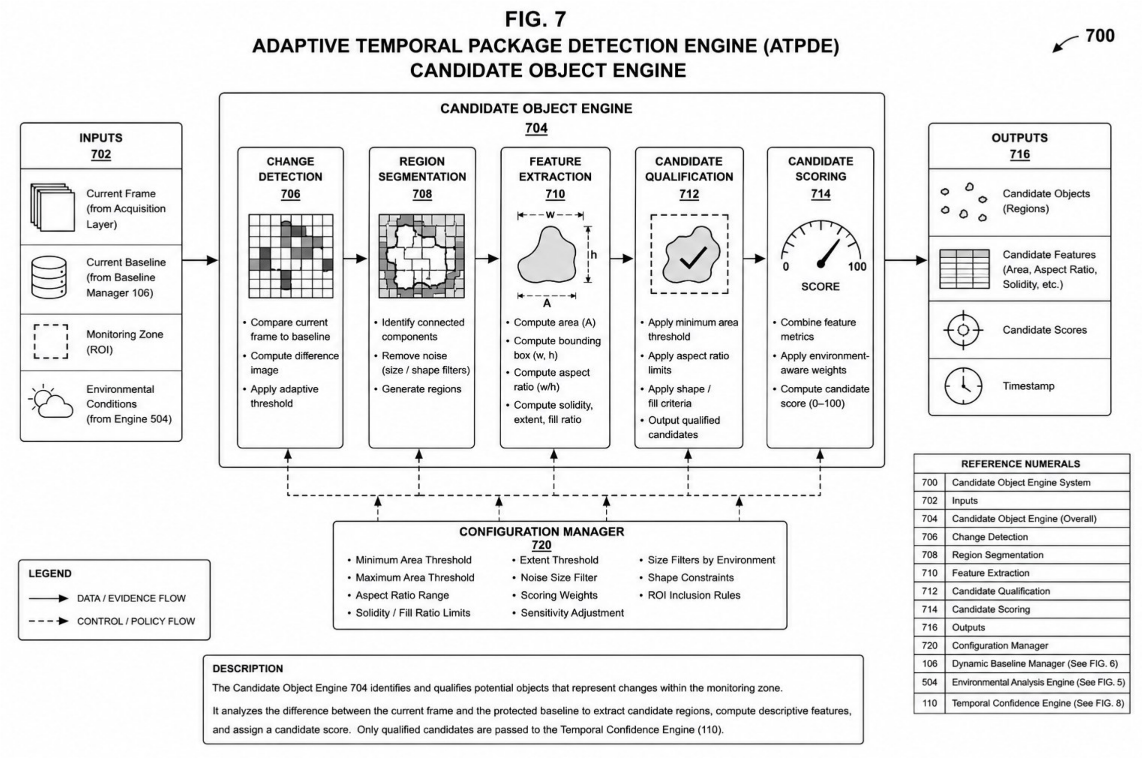


Figure 8 – Notification Decision Engine

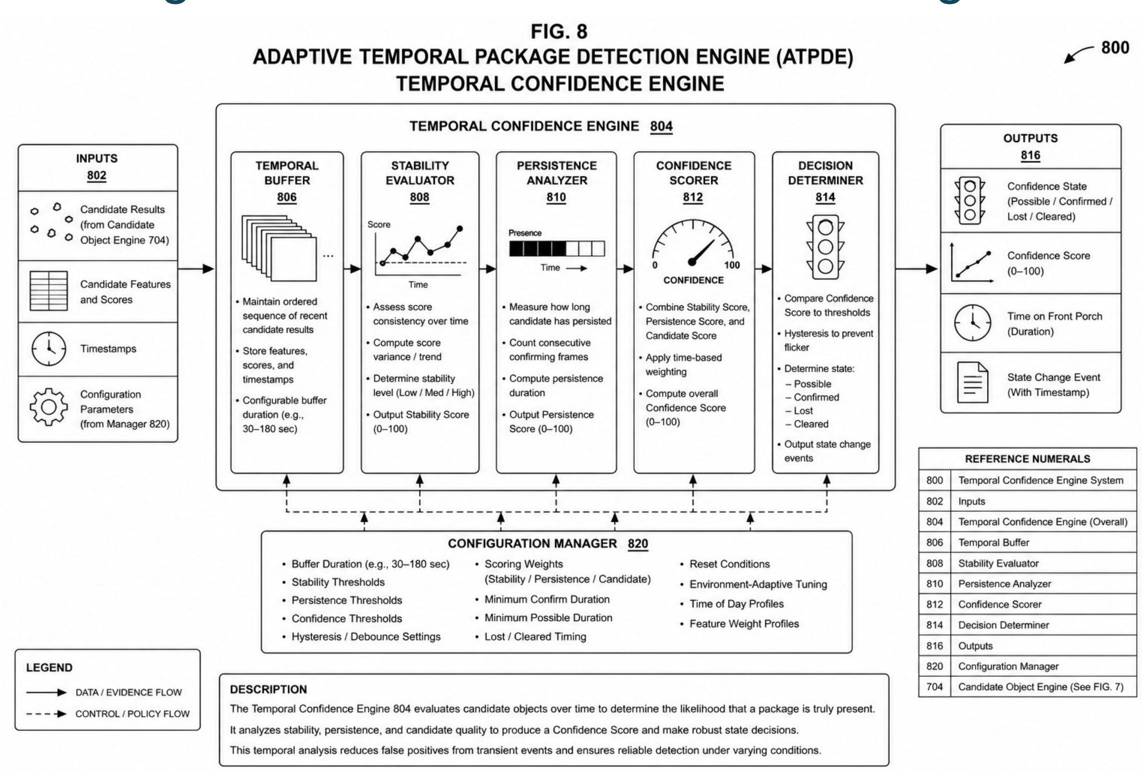


Figure 9 – Event History Manager

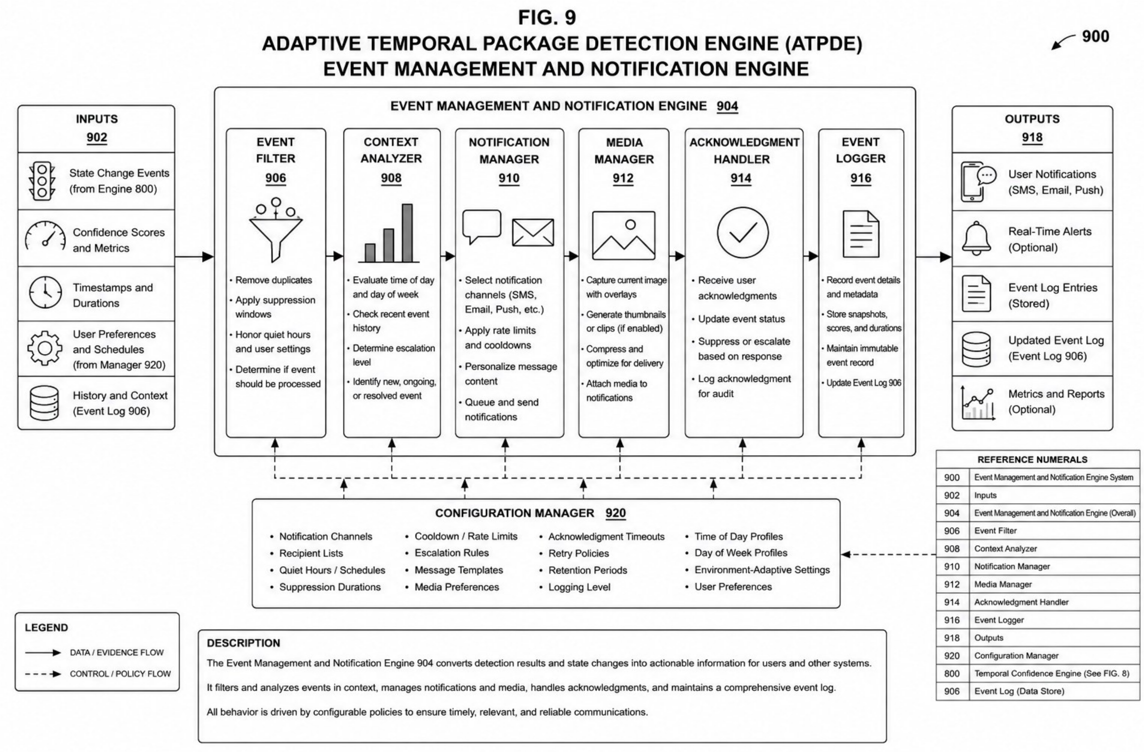


Figure 10 – Configuration Manager

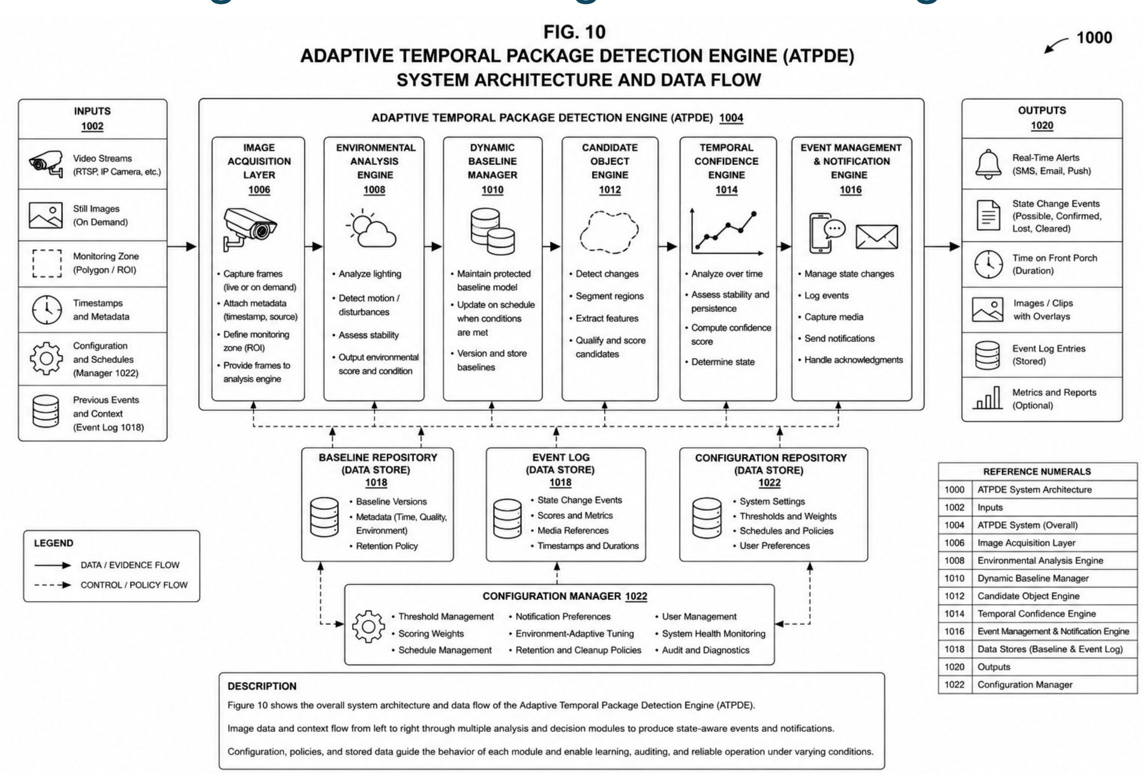
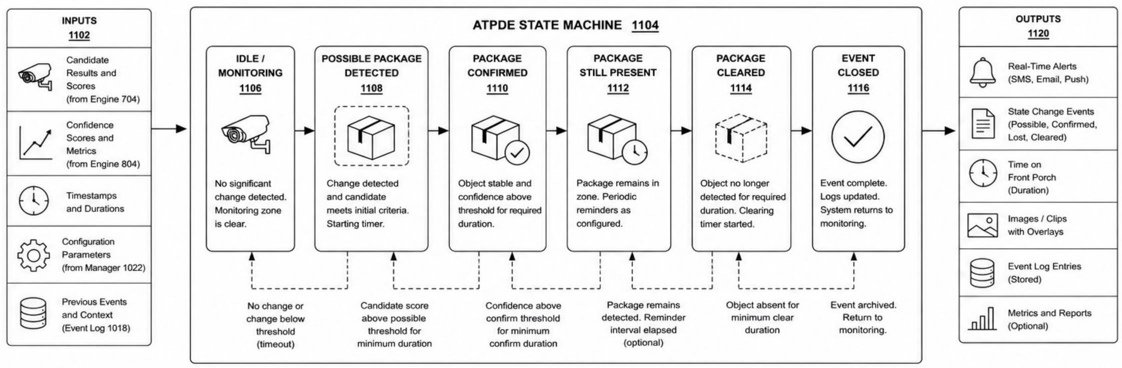


Figure 11 – Cooperative Operation of ATPDE

FIG. 11
ADAPTIVE TEMPORAL PACKAGE DETECTION ENGINE (ATPDE)
STATE MACHINE AND EVENT LIFECYCLE

1100



STATE TRANSITIONS AND TRIGGERS

FROM STATE	TO STATE	TRIGGER / CONDITION	REQUIRED DURATION (CONFIGURABLE)
IDLE / MONITORING (1106)	POSSIBLE PACKAGE DETECTED (1108)	Candidate score ≥ Possible Threshold	Minimum Possible Duration
POSSIBLE PACKAGE DETECTED (1108)	PACKAGE CONFIRMED (1110)	Confidence score ≥ Confirm Threshold	Minimum Confirm Duration
PACKAGE CONFIRMED (1110)	PACKAGE STILL PRESENT (1112)	Package remains detected in zone	— (continuous)
PACKAGE STILL PRESENT (1112)	PACKAGE CLEARED (1114)	No object detected in zone	Minimum Clear Duration
PACKAGE CLEARED (1114)	EVENT CLOSED (1116)	Clearing duration satisfied	— (immediate)
Any State	IDLE / MONITORING (1106)	System reset / manual reset / error recovery	— (immediate)

REFERENCE NUMERALS

1100	State Machine and Event Lifecycle (Overall)
1102	Inputs
1104	ATPDE State Machine
1106	Idle / Monitoring State
1108	Possible Package Detected State
1110	Package Confirmed State
1112	Package Still Present State
1114	Package Cleared State
1116	Event Closed State
1120	Outputs
704	Candidate Object Engine (See FIG. 7)
804	Temporal Confidence Engine (See FIG. 8)
1018	Event Log (Data Store) (See FIG. 10)
1022	Configuration Manager (See FIG. 10)

LEGEND

- DATA / EVIDENCE FLOW
- CONTROL / STATE TRANSITION

DESCRIPTION

Figure 11 illustrates the state machine and lifecycle for package detection events.

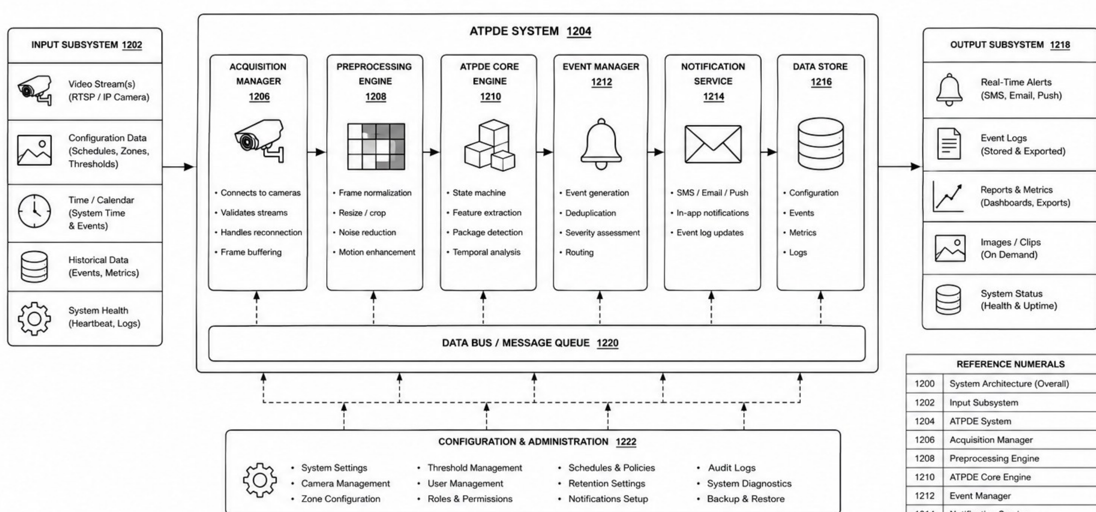
Events progress through a sequence of states from initial detection to final closure based on configurable thresholds and time durations.

This state machine ensures consistent behavior, reduces false positives, and provides clear event tracking and reporting.

Figure 12 – Persistent Object Lifecycle

FIG. 12
ADAPTIVE TEMPORAL PACKAGE DETECTION ENGINE (ATPDE)
SYSTEM ARCHITECTURE – COMPONENT INTERACTION

1200



REFERENCE NUMERALS

1200	System Architecture (Overall)
1202	Input Subsystem
1204	ATPDE System
1206	Acquisition Manager
1208	Preprocessing Engine
1210	ATPDE Core Engine
1212	Event Manager
1214	Notification Service
1216	Data Store
1218	Output Subsystem
1220	Data Bus / Message Queue
1222	Configuration & Administration

LEGEND

- DATA FLOW
- CONTROL / CONFIGURATION FLOW

DESCRIPTION

Figure 12 illustrates the internal architecture of the ATPDE system and the interaction between major components.

Data flows from the input subsystem through the processing pipeline to the event management and notification services.

Configuration and administrative functions support system operation, monitoring, and maintenance.

Figure 13 – Temporal Confidence Accumulation

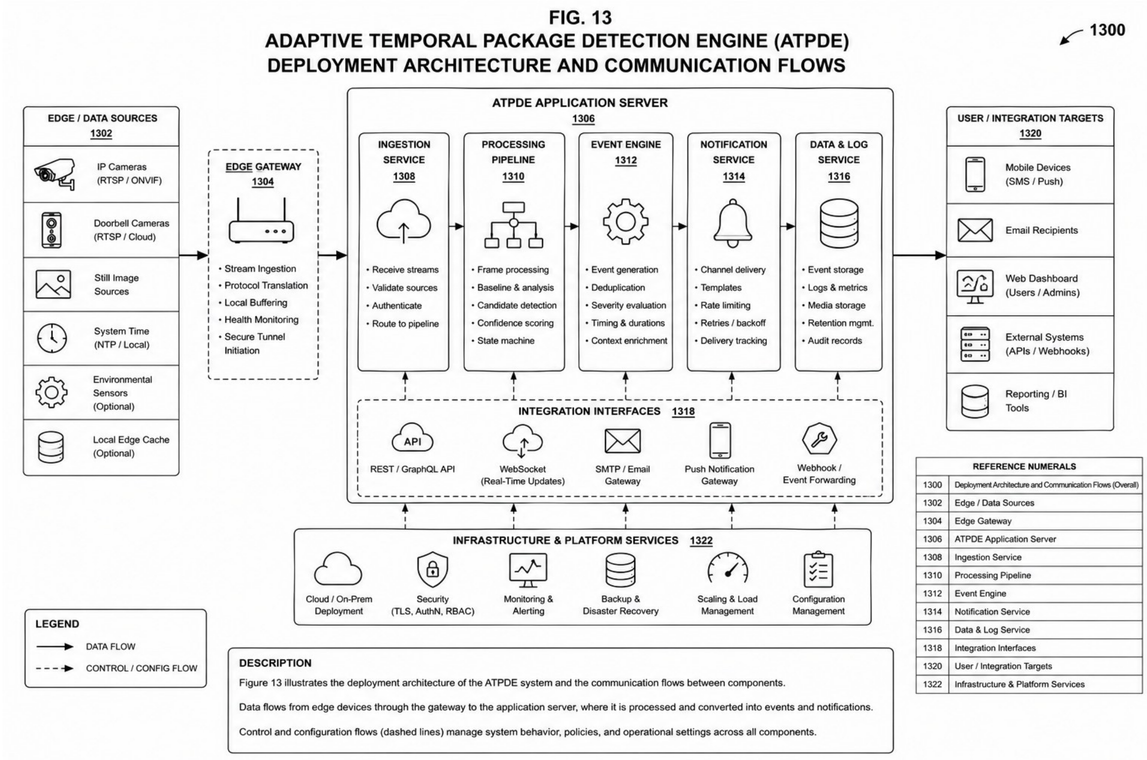


Figure 14 – Baseline Recovery Process

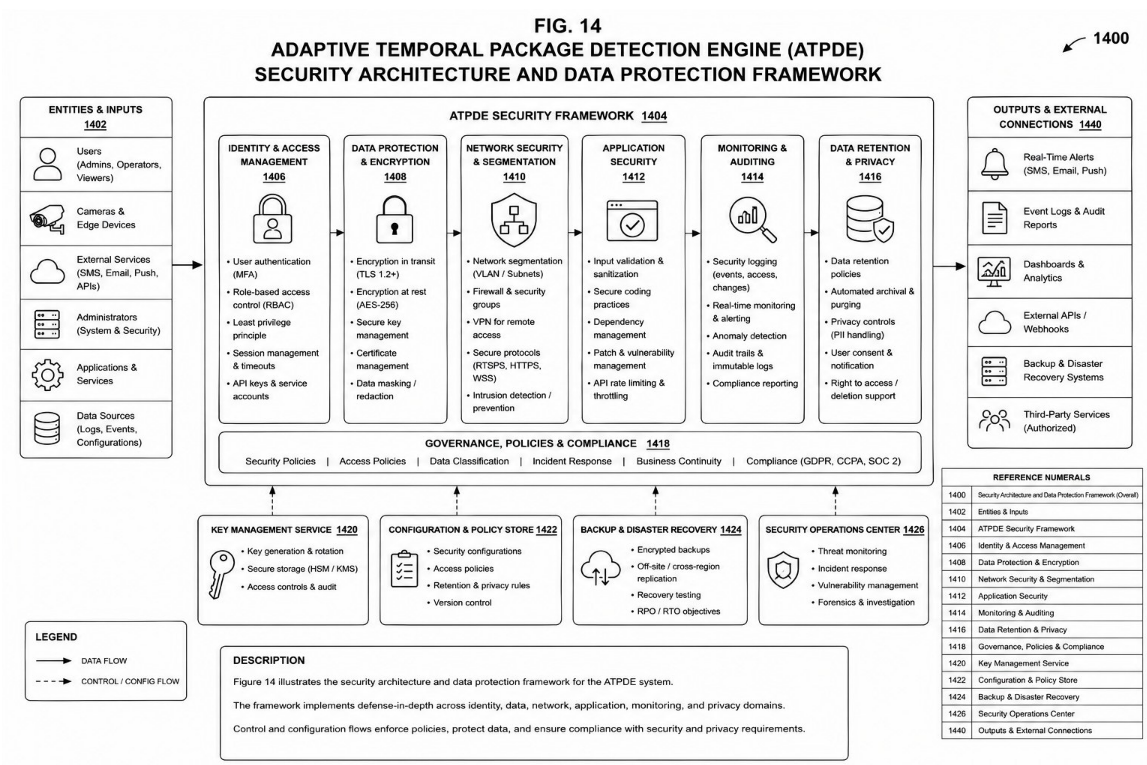


Figure 15 – End-to-End Detection Workflow

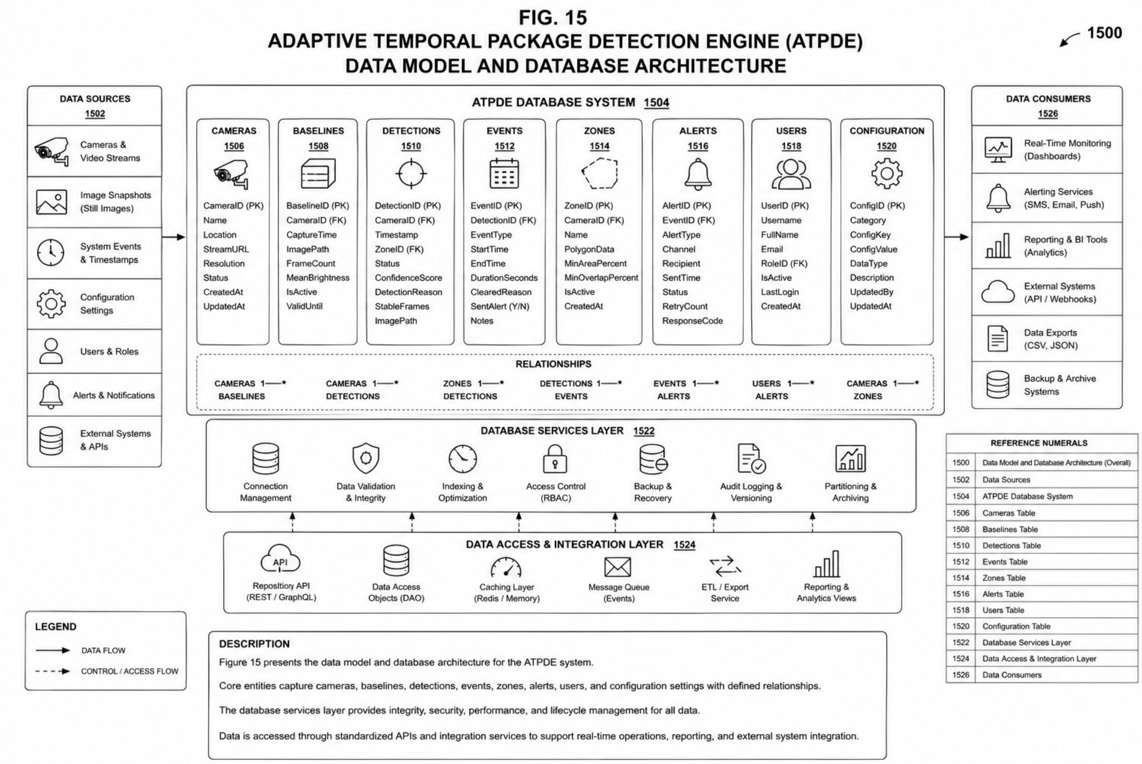


Figure 16 – Cooperative Subsystem Interaction