A11 — Decision Layer Specification

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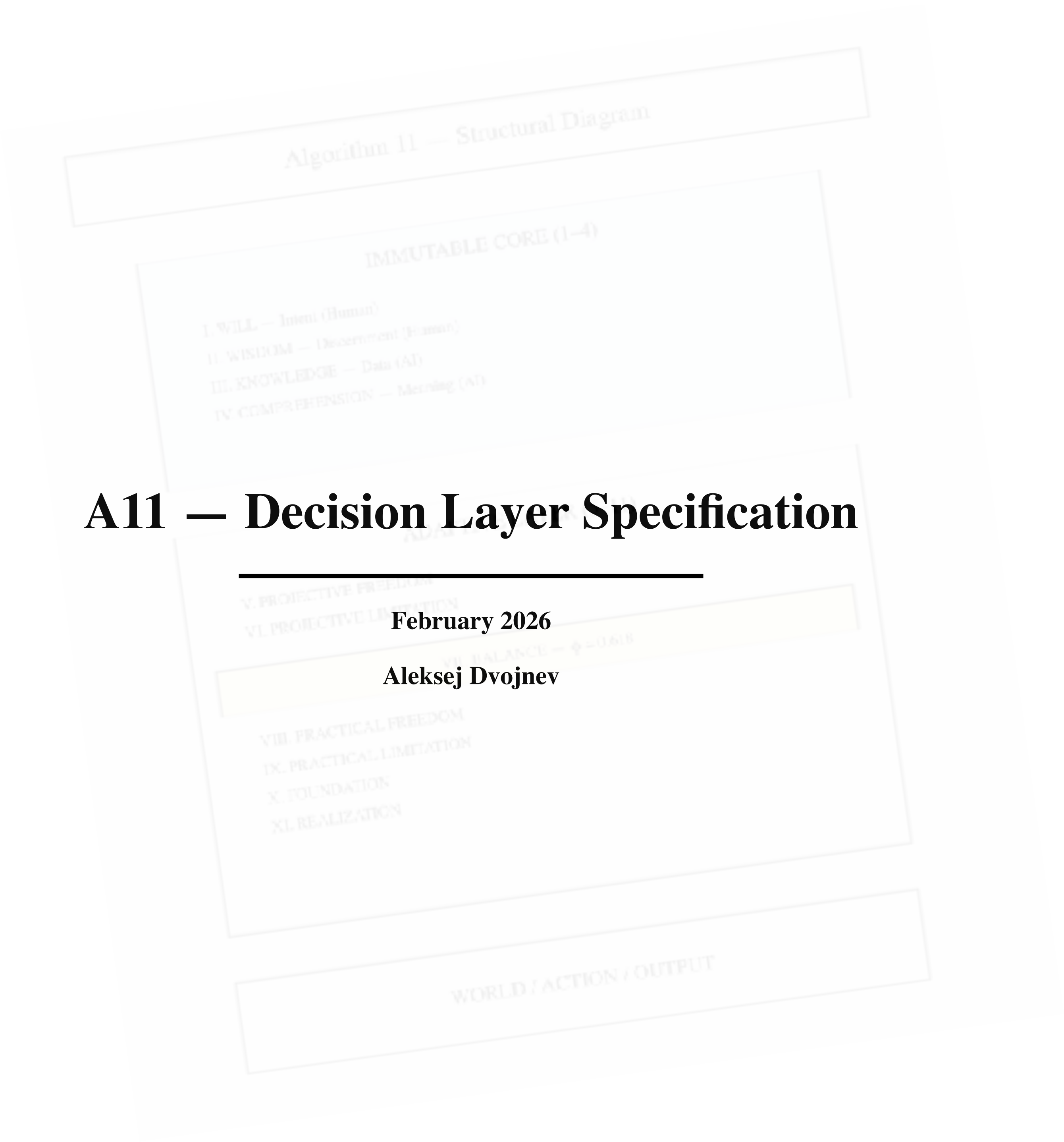

A11 — Decision Layer Specification

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Abstract

This document defines **A11 as a universal decision-making layer** for autonomous systems, robotics, and hybrid human–AI reasoning.

The specification formalizes the interfaces, structure, operational cycle, safety properties, and integration requirements that enable A11 to function as a predictable, interpretable, and domain-agnostic decision layer.

A11 provides a structured cognitive process that separates intention from computation, ensures deterministic behavior under uncertainty, and enables scalable coordination across heterogeneous agents.

This specification serves as the foundational standard for integrating A11 into autonomous vehicles, multi-agent robotic systems, off-Earth construction platforms, aerospace docking systems, and large-scale reasoning architectures.

1. Introduction

1.1 Purpose of the Decision Layer

Modern autonomous systems require a **predictable, interpretable, and certifiable** decision-making module.

Existing approaches—LLM-based reasoning, heuristic planners, or domain-specific controllers—lack:

- consistent structure
- deterministic behavior
- cross-domain applicability
- interpretable decision traces
- modularity
- safety guarantees

A11 addresses these gaps by defining a **universal decision layer** that can be embedded into any autonomous or reasoning system.

1.2 Scope

This specification defines:

- the architecture of the A11 decision layer
- its operational cycle
- input/output interfaces
- safety and predictability requirements
- integration patterns
- domain-agnostic design principles

It does **not** define:

- perception systems
- low-level control systems
- hardware-specific implementations
- domain-specific optimizations

1.3 Design Philosophy

A11 is built on three principles:

1. **Interpretability** — every decision must be explainable.
2. **Determinism** — the same inputs must produce the same outputs.
3. **Universality** — the architecture must work across all domains.

2. A11 as a Decision Layer

2.1 Definition

A11 is a structured cognitive architecture that functions as a universal decision-making layer between perception and control.

It transforms:

- raw or processed sensory data
- contextual information
- goals and constraints
- human or system-level intentions

into:

- deterministic decisions
- interpretable reasoning traces
- conflict-free coordination actions
- stable behavioral outputs

2.2 Key Properties

A11 provides:

- **Predictability** — deterministic decision cycle
- **Interpretability** — structured reasoning trace
- **Modularity** — domain-agnostic interfaces
- **Scalability** — works for single agents and multi-agent systems
- **Safety** — stable behavior under uncertainty

- **Hybrid compatibility** — works with humans and AI agents

2.3 Position in the Autonomy Stack

A11 sits between:

Perception Layer

- sensors
- vision models
- mapping
- state estimation

A11 Decision Layer (this document)

- reasoning
- conflict resolution
- prioritization
- intention alignment
- action selection

Control Layer

- motion planning
- actuation
- low-level controllers

3. Architecture Overview

3.1 Inputs

A11 receives:

1. State Inputs

- environment state
- agent state
- uncertainty estimates

2. Context Inputs

- mission goals
- constraints
- rules
- safety boundaries

3. Communication Inputs

- messages from other agents
- human instructions
- system-level directives

4. Historical Inputs

- previous decisions
- memory frames
- temporal context

3.2 Outputs

A11 produces:

1. Decision Output

- selected action
- priority
- justification

2. Reasoning Trace

- structured explanation
- decision path
- conflict resolution steps

3. Coordination Output

- messages to other agents
- negotiation signals

- synchronization markers

3.3 Internal Structure

A11 consists of:

1. **Intention Layer**
2. **Context Layer**
3. **Evaluation Layer**
4. **Balance Layer**
5. **Decision Layer**
6. **Rollback & Stability Layer**

Each layer is deterministic and interpretable.

4. Decision Cycle

A11 operates in an **11-step deterministic cycle**:

1. **Receive Inputs**
2. **Validate Inputs**
3. **Construct Context**
4. **Identify Intentions**
5. **Generate Options**
6. **Evaluate Options**
7. **Apply Constraints**
8. **Resolve Conflicts**
9. **Apply Balance Mechanism**
10. **Select Decision**
11. **Generate Reasoning Trace**

This cycle ensures:

- stability
- predictability

- reproducibility
- safety

5. Safety & Predictability

5.1 Deterministic Behavior

A11 guarantees:

- identical inputs → identical outputs
- no stochastic decision paths
- no hidden internal states

5.2 Interpretability

Every decision includes:

- reasoning trace
- conflict resolution steps
- applied constraints
- evaluation metrics

5.3 Rollback Mechanism

If the system detects:

- contradiction
- instability
- unsafe decision
- incomplete context

A11 performs:

- rollback to previous stable state
- re-evaluation
- re-balancing

5.4 Safety Boundaries

A11 enforces:

- hard constraints
- soft constraints
- domain-specific safety envelopes

6. Implementation Requirements

6.1 Minimal Requirements

A system implementing A11 must support:

- structured input format
- deterministic evaluation
- reasoning trace generation
- rollback mechanism
- context persistence

6.2 Message Format

Messages must include:

- type
- timestamp
- agent ID
- context frame
- decision frame
- justification

6.3 Integration Requirements

A11 must be integrated:

- after perception
- before control
- with access to context

- with access to communication channels

7. Domain-Agnostic Design

A11 is designed to work across:

- autonomous vehicles
- multi-agent robotics
- off-Earth construction
- aerospace docking
- industrial automation
- LLM-based reasoning systems

The architecture does not assume:

- specific sensors
- specific actuators
- specific environments
- specific communication protocols

8. References to Applied Models

This specification is complemented by:

- **A11 for Autonomous Vehicles — Conflict Resolution Model**
- **A11 for Multi-Agent Robotics — Coordination Framework**
- **A11 for Off-Earth Construction — Autonomous Base Building**
- **A11 for Aerospace Docking — Autonomous Maneuvering** (upcoming)

These documents demonstrate domain-specific applications of the A11 decision layer.

9. Conclusion

A11 provides a **universal, interpretable, deterministic, and modular** decision-making architecture suitable for any autonomous or reasoning system.

This specification defines the standard required to implement A11 as a decision layer across diverse domains.

A11 transforms autonomy from a collection of heuristics into a **structured cognitive system** capable of predictable and safe operation in complex environments.

Appendix A — Glossary

Decision Layer — module responsible for selecting actions.

Reasoning Trace — structured explanation of a decision.

Rollback — mechanism for restoring a stable state.

Context Frame — structured representation of goals and constraints.

Balance Mechanism — stability operator ensuring non-extreme decisions.

Appendix B — Compliance Checklist

A system is A11-compliant if it:

- implements the 11-step decision cycle
- generates reasoning traces
- supports rollback
- enforces constraints
- maintains deterministic behavior
- integrates with perception and control layers