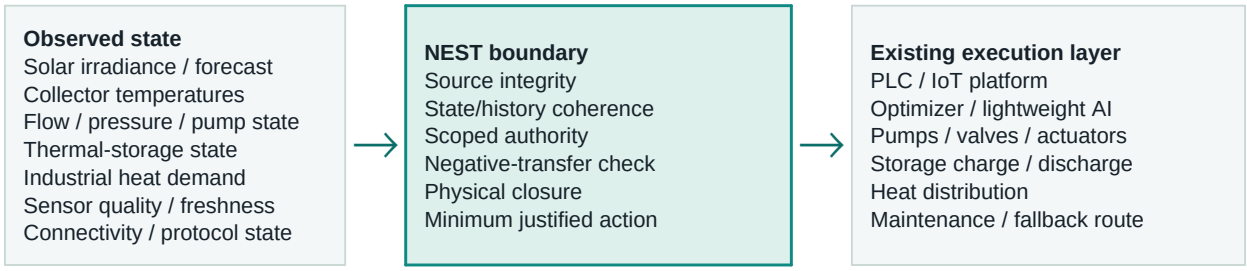
NEST for Smart Control of Industrial Solar-Thermal Systems

A deterministic pre-consequence assurance and control layer for the CRES / SAMMLER adaptive-control challenge

Challenge fit. SAMMLER seeks intelligent, adaptive real-time control of solar heat generation, storage and distribution under fluctuating solar input, variable industrial heat demand, sensor degradation, connectivity limitations and retrofit constraints. **NEST fits as a deterministic boundary around the existing PLC, IoT, optimisation or lightweight-AI control stack.** It evaluates whether a proposed control action remains admissible in the current whole-system state before that action becomes a thermal, reliability or energy consequence.

1. Where NEST sits in the SAMMLER control loop



PRESERVE	HOLD	REPAIR	REROUTE	ISOLATE / DENY
valid control proceeds	evidence not sufficient	recoverable proposal corrected	safe alternative path	inadmissible consequence contained

Why this is a natural NEST test

Degraded sensing	A temperature, flow or storage signal can be individually plausible yet stale, drifting or inconsistent with the rest of the plant. NEST can reduce authority rather than blindly propagate the command.
Variable generation + demand	A control action that is valid under one solar or process state can become inadmissible after demand, storage or collector conditions change.
Retrofit without replacement	NEST can sit around the existing PLC / IoT / optimisation path in shadow first; it does not require SAMMLER to replace its core control technology.
Minimum justified intervention	The objective is not blanket shutdown. Preserve valid operation; hold uncertainty; repair or reroute recoverable actions; isolate or deny only when the bounded consequence is inadmissible.
Deterministic proof	Each decision can be bound to the input state, proposed action, admitted route and observed result for replay and comparison.

2. Proposed CRES / SAMMLER validation

Objective: test whether NEST improves control admissibility and resilience under realistic solar-thermal disturbances while preserving useful heat delivery and avoiding unnecessary intervention.

Test condition	Challenge to the control stack	NEST behaviour / metric
Sensor drift or degradation	Temperature / flow / storage values remain syntactically valid but become inconsistent with plant state.	Source integrity + coherence; preserve, hold, isolate or reroute according to evidence.
Connectivity loss / stale state	IoT or remote data stop updating while automation continues.	Bound authority to freshness; HOLD rather than extrapolate unjustified control.
Rapid solar fluctuation	A previously valid pump / valve / storage action becomes unsafe or wasteful after solar input changes.	Re-evaluate current consequence before execution; preserve or repair/reroute.
Heat-demand transition	Industrial demand changes faster than fixed schedules or local control assumptions.	Whole-state closure across generation, storage, distribution and demand.
Conflicting objectives	Thermal utilisation, storage limits, equipment protection and process demand pull in different directions.	Minimum justified action; avoid local optimisation that creates a worse system consequence.

Validation sequence

• **1. Freeze:** CRES/SAMMLER defines interfaces, physical limits, baseline control behaviour, disturbance scenarios and success metrics before the test.

• **2. Shadow:** NEST observes the same proposed actions without modifying the plant.

• **3. Independent challenge:** CRES supplies unseen sensor, connectivity, solar and heat-demand conditions; all wins, ties, misses and false interventions are retained.

• **4. Compare:** baseline vs NEST on valid-operation preservation, inadmissible-action prevention, HOLD correctness, repair/reroute success, latency and deterministic replay.

• **5. Bounded pilot:** only if shadow performance meets pre-agreed thresholds, activate one narrow reversible control lane.

Minimal integration - not a new controller

The NEST core remains the same. The SAMMLER-specific work is a thin adapter that maps approved plant signals and proposed actions into a bounded state: temperatures, flows, storage state, industrial heat demand, sensor confidence/freshness, connectivity and actuator constraints. NEST can then sit around the existing PLC, IoT and lightweight-AI/optimisation components. The goal is to bound their authority before physical consequence, not to replace their forecasting or control logic.

Existing maturity and evidence boundary

Implemented architecture	Deterministic pre-consequence control with state/history handling, bounded actions, receipts and replay. Public proof: boundedsystem.com/demo/proof-pack
10,000-case blind internal evaluation	9,128 valid cases preserved; 872 predefined inadmissible cases identified; zero false accepts and zero false rejects in that controlled water-sector evaluation.
20,000-case local API harness	10,000 ALLOW / 10,000 BLOCK; zero routing mismatches; 20,000 receipts; zero blocked backend arrivals.
Claim boundary	These are internal/local controlled results, not solar-thermal validation. The SAMMLER collaboration is intended to provide independent physical-system testing under CRES-defined conditions. A positive result can progress to a bounded retrofit demonstration; negative or null results remain part of the evidence.