COMMERCIAL WHITE PAPER · v1.1

LAKANA Sovereign Structural Intelligence

Structural safety without unauthorized biometric replication.

A privacy-preserving safety infrastructure for athletics and load-bearing workforces that prevents raw biometric, workload, recovery, gait, medical-adjacent, and environmental signals from becoming uncontrolled digital replicas of the people they are meant to protect.

UNAUTHORIZED BIOMETRIC REPLICATION
The creation of usable biological or performance proxies from data the person cannot inspect, limit, correct, or revoke.

33M	**5**	**77.7%**	**0**
athlete-arm records across accepted 90/365 true-horizon simulation evidence	sport profiles including female soccer and fastpitch softball	mean ACL-family burden reduction at accepted horizons	modeled adverse-leak events under COMP-SOV v2 ABM condition

ACCESS POSTURE

User-owned raw signal custody

Medical Lease for licensed clinical devices

Coach envelope aggregate safety only

NICOLE audit and revocation

MarTaize K. Fails · Founder, LAKANA Sovereign Systems · Norman, Oklahoma · May 2026

Companion technical record: SSI v8.5 accepted Monte Carlo artifact bundle (SHA-256 preserved).

Structural safety should not require uncontrolled biological copying. SSI makes safety intelligence usable while keeping the human being sovereign over the signals that recreate them.

PART I **EXECUTIVE THESIS AND MARKET RISK**

1 Executive thesis

SSI is a local-first structural-safety infrastructure layer for high-load human environments. It is not a scouting product, a coach-surveillance platform, a clinical diagnostic device, or a return-to-play authority. Its commercial value is architectural: it separates raw clinical telemetry, licensed medical review, coach-facing operating signals, vendor assertions, research outputs, and audit evidence into different governed lanes.

Modern athlete and workforce monitoring creates a direct conflict. Institutions need earlier recognition of structural load, heat strain, recovery collapse, gait deviation, and other safety-relevant states. At the same time, the raw signals needed to observe those states can reconstruct the person who produced them. Sleep debt, hydration patterns, gait changes, workload history, impact accumulation, thermal stress, recovery markers, and medical-adjacent context can combine into a usable biological proxy. That proxy may reveal not only that a person is unavailable, but why the body is vulnerable.

SSI is built for that world. Raw signals remain athlete or user governed by default. Licensed medical staff may receive governed raw telemetry through Medical Lease access when clinically authorized. Coaches and front-office users receive aggregate safety envelopes, not individual physiological drill-down. Vendor models may contribute signed assertions, but those assertions are checked against deterministic safety boundaries and logged. Institutional decisions become reviewable without making raw human state the ordinary object of institutional custody.

The current SSI evidence stack supports controlled pilot diligence: pass-gated Monte Carlo simulation across five sport profiles, accepted true-horizon outputs, active comparator-policy abstractions, sport-specific heterogeneity, and custody-policy stress testing. These artifacts do not establish clinical validation, field effectiveness, regulatory clearance, injury-prevention guarantee, or return-to-play authority. They establish that SSI is a serious, testable architecture for privacy-preserving structural-safety decision support.

+0.1943 yr mean 365-day modeled retained-year delta across sport profiles	**+12.44 pp** mean 365-day recognition advantage	**40.97%** mean 365-day total modeled burden reduction	**5 / 5** sport profiles positive across accepted horizons

Institutional thesis

SSI gives responsible institutions usable structural-safety awareness while reducing the need to own, centralize, or repurpose the raw biometric signals that can recreate the person being protected.

Who should read this first

Reader	Start here	Decision value
General counsel / risk officer	§3–5, §15, §20, §23	Custody, consent, discovery, CBA, regulatory boundary, audit posture.
Medical director / athletic trainer	§6–10, §12–14	Medical Lease, evidence boundary, stability, N-of-1 baseline, NNR, false-recovery protection.
Athlete / player association	§2, §4, §6, §15–16, §19	Raw-signal custody, anti-profiling, revocation, women-sport parity, prohibited data use.
GM / AD / owner / funder	§1, §8–15, §21–22	Pilot readiness, retained-time signature, availability risk budget, partner value.
Security / privacy engineer	§5–6, §18–20, §23	Role-separated access, VAS, NICOLE audit, COMP-SOV custody stress, claim boundary.

2 Safety analytics are drifting toward surveillance

High-performance sport and load-bearing work now sit inside a growing sensor ecosystem: wearables, optical tracking, force and load estimates, sleep and recovery platforms, environmental models, medical-adjacent measurements, app telemetry, video systems, and team analytics. Each system can be justified as a safety or performance tool. Taken together, they create a persistent record of human vulnerability.

The surveillance problem is deeper than a public report that an athlete is out because of a hamstring strain, sore lower back, illness, or fatigue. Raw and near-raw telemetry can expose the hidden causes of vulnerability: sleep debt, dehydration, altered gait, recovery collapse, heat strain, impact accumulation, movement asymmetry, unresolved structural load, or glycemic instability where such signals are collected. Those details are exactly the kinds of signals that should remain with the person and trusted medical staff unless a specific, governed safety purpose justifies access.

When enough signals are collected over time, the person can be reconstructed as an operational profile. The profile may live across vendors, team systems, research environments, betting-adjacent analytics, recruiting files, insurance models, or unauthorized datasets. It does not need a visible name tag to be harmful. A sufficiently rich behavioral, biometric, location, workload, recovery, and performance structure can reveal competitive and medical-adjacent state even when obvious identifiers are removed.

Raw / near-raw signals
sleep, gait, hydration, load, heat, recovery

Merged datasets
team, vendor, optical, medical-adjacent, environment

Shadow profile risk
biological / performance proxy beyond user control

SSI boundary
local custody, Medical Lease, aggregate outputs

Safety should not require biological surrender

SSI exists because earlier recognition of structural risk should not require a permanent raw biometric warehouse. The architecture separates medical usefulness from institutional surveillance: medical review can be deep where authorized; coach and vendor access stays bounded.

3 Legal pressure is becoming buyer risk

Athlete and worker telemetry is no longer a technical procurement detail. It is a legal, labor, regulatory, and reputational risk surface. The cases and regulatory signals below are not presented as findings of liability unless a source reports a final ruling. They are market-risk signals: they show the categories of exposure that appear when systems centralize raw human data first and design governance later.

Project Red Card: athlete performance data as traded commodity

In October 2021, The Guardian reported that more than 850 professional footballers were involved in an action over the alleged use and commercial trading of their personal information and performance statistics. Letters before action were reportedly sent to major firms across the betting, gaming, entertainment, and data industries [S1].

The allegation at the center of Project Red Card is not that data was physically stolen. The allegation is that it was treated as a commercial asset without the athletes' meaningful knowledge or control. Detailed performance data, combined with conditioning, training load, recovery trends, and physical output metrics across a season, begins to approximate the athlete's underlying health and vulnerability state without ever accessing a formal medical record. If performance infrastructure connects, through vendor relationships, analytics partnerships, or data-broker intermediaries, to parties with downstream commercial interests, the institution has created an asset whose destination it does not fully control.

WHOOP litigation: the consent gap in health wearables

Lomeli v. Whoop alleges that sensitive wearable and app data were disclosed to a third-party tracker without user knowledge or consent [S2][S3]. The case is pending and the allegations may be contested. The structural lesson is clear: a consent form for a device or training use case is not the same thing as consent to every SDK, analytics integration, future vendor change, or secondary routing path. Device signals such as recovery state, sleep architecture, daily strain, heart-rate-variability trends, and readiness scores are commercially valuable to parties whose interests may diverge from the athlete's. Consent to use the device is not consent to every commercial relationship the device maker has established or may establish later.

FDA warning letter: the wellness-to-medical boundary is enforceable

In July 2025, FDA issued a warning letter stating that WHOOP Blood Pressure Insights was being marketed and distributed without marketing authorization and that the blood-pressure estimation function was not within the cited general wellness posture [S4]. Rowe v. Whoop later alleged that medical-grade blood pressure insights were falsely advertised [S5]. These are cited as market signals, not as final findings of liability. The regulatory lesson is that the wellness-to-medical boundary is not decided by marketing language alone. If an institution incorporates device outputs into training workflow, it extends institutional credibility to the vendor's regulatory posture.

Cothron v. White Castle: compounding liability in repeated biometric transmission

The Illinois Supreme Court's decision in Cothron v. White Castle System, Inc. gives the biometric-custody problem a concrete enterprise-liability shape. The court held that a separate claim accrues under the Illinois Biometric Information Privacy Act each time a private entity scans or transmits an individual's biometric identifier or biometric information in violation of the Act's consent and disclosure provisions [S16]. The decision addressed claim accrual, not a final liability finding against every biometric system, but it made the boardroom issue unmistakable: repeated biometric capture or transmission can turn ordinary operations into repeated compliance exposure when the consent and disclosure architecture is defective.

White Castle argued that a per-scan or per-transmission interpretation could create ruinous damages exposure. Illinois later amended BIPA in 2024, changing the damages mechanics for repeated collections or disclosures involving the same person in certain circumstances [S17]. That later amendment keeps the case from being overstated as a current damages formula. It does not erase the procurement lesson. A system that continuously routes raw human identifiers or biometric information to external infrastructure remains a compounding legal-risk surface unless collection, transmission, consent, retention, and third-party access are controlled by design.

For SSI, the architectural lesson is direct. Continuous export of raw biometric signals to institutional or vendor clouds should not be the default cost of safety monitoring. A local-first safety architecture, governed Medical Lease access, role-bounded outputs, revocation, key rotation, and NICOLE-style audit reduce the need for continuous raw-biometric transmission. The claim is not that SSI eliminates BIPA or privacy-law exposure. The claim is that SSI attacks the root procurement risk Cothron makes visible: repeated raw human-data routing without a custody architecture strong enough

to survive adversarial review.

Catapult and the NCAA inquiry: performance infrastructure as a high-value target

In December 2023, the Associated Press reported that Catapult was aware of an NCAA investigation into alleged unauthorized access to college football video footage, and that Catapult stated it had not found a security breach in its own systems while cooperating with authorities [S6]. The example is not treated as a conclusion against Catapult. Sports performance infrastructure can include video, practice materials, scheme information, availability context, and, in many platforms, adjacent performance or workload data. Even where a specific inquiry concerns video access rather than raw physiological telemetry, the procurement lesson is the same: centralized performance infrastructure can become a high-value target. When that infrastructure becomes the subject of an unauthorized-access inquiry, the institution faces questions it cannot fully answer from a remote architecture.

Legal and evidentiary boundary

Named companies and cases are cited as market-risk signals. Allegations, complaints, investigations, warning letters, and media reports are not treated as findings of liability unless a source reports a final ruling. This document is not legal advice.

4 Five signals, one root architectural failure

The same legal-market pattern becomes an architecture requirement. Once athlete data leaves athlete control, it can be copied, modeled, merged, sold, litigated, breached, repurposed, or used to infer value. The risk is not only who sees the data today. The risk is how many future systems can rebuild the athlete from the data tomorrow.

For athletes, the exposure is personal and economic. A training sensor may reveal recovery collapse before a contract negotiation; a sleep or strain record may reveal why a player is vulnerable; a gait or impact pattern may become a durable weakness label; a recruiting, NIL, insurance, betting, or roster model may draw conclusions from data the athlete cannot inspect or challenge. Data collected for safety can become data used for profiling.

For institutions, the exposure becomes a buyer problem. A vendor's raw-data custody architecture becomes the institution's procurement, litigation, labor, and reputational risk surface. The institution may not intend to monetize athlete vulnerability. But if the system it deploys creates a persistent, transferable, third-party-accessible biometric asset, the institution must explain why that asset was necessary and how it was bounded.

Risk category	Institutional question	SSI design answer
Raw custody	Why does the institution need raw biometric possession?	Raw signals remain athlete or user governed by default; medical raw access is leased through governed clinical channels.
Consent gap	Can the athlete see, limit, correct, or revoke data use?	NICOLE-style audit, purpose-limited release, revocation, and key rotation make access governance inspectable.
Coach surveillance	Can coaches query individual physiology?	Coach-facing outputs are aggregate, non-queryable safety envelopes, not individual medical telemetry.
Vendor drift	Can vendor models route or reuse data beyond the original purpose?	VAS supports signed assertions and deterministic boundary checks without default raw telemetry transfer.
Discovery risk	What happens when alerts or overrides are reviewed later?	DCL preserves decision context without promising legal immunity; the record is neutral.

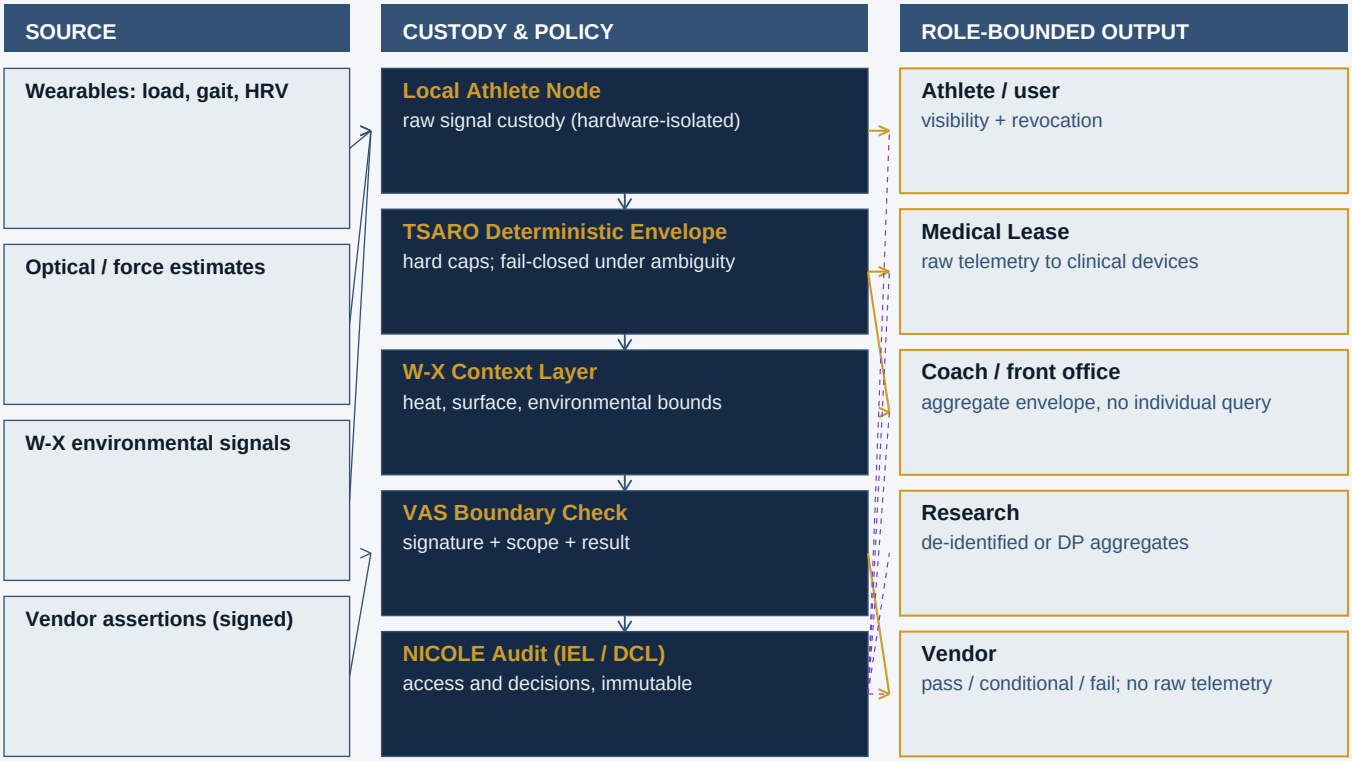
PART II ARCHITECTURE AND ACCESS CONTROL

5 Architecture response: custody, consent, purpose, audit

SSI converts the legal and ethical problem into a systems problem. The answer is not to hide data use inside terms of service. The answer is to make data roles structurally different. Athletes, medical personnel, coaches, vendors, researchers, unions, and institutions cannot all sit inside the same access class.

The architecture begins from data minimization. Raw signals remain local and athlete or user governed by default. Medical users obtain raw telemetry through a bounded clinical pathway. Coaches and operational leaders receive aggregate safety envelopes, not individual physiological drill-down. Vendors can submit signed readiness or load assertions without receiving raw athlete telemetry. Researchers receive de-identified or differentially private aggregate outputs unless a separate governed protocol exists.

The result is not anti-institutional. It is institutionally safer. A school, club, or workforce-safety partner can support earlier safety awareness while holding less raw human data. The strongest legal and commercial argument for SSI is that it preserves medical utility while reducing unnecessary institutional custody of the very data that creates downstream liability.



Solid arrows: governed flow. Gold: deterministic boundary. Iris dashed: NICOLE audit visibility (read-only).

Figure 1. *SSI lane separation. Raw signals enter under user custody; deterministic policy and NICOLE audit govern role-bounded outputs. No lane inherits the permissions of another.*

Research calibration is not operational custody

SSI simulation evidence may use empirical, public, licensed, de-identified, aggregate, or third-party research datasets for calibration and stress testing. That research use does not create a right to operationally profile, identify, recreate, or govern a living athlete without consent. Deployment requires athlete or user custody, Medical Lease controls, role separation, auditability, revocation, and pilot-specific consent.

6 Medical Lease: medical utility without coach surveillance

Medical access must be a first-class architecture, not an exception hidden behind a consent form. Licensed medical staff may need raw traces, continuous trends, load histories, signal-quality context, environmental exposure, and event chronology. SSI supports that need through Medical Lease access: role-bound, device-bound, time-bound, purpose-bound, logged, revocable access to authorized clinical devices.

Medical Lease is not a coach portal. It is a clinical access channel. It allows authorized athletic trainers, physicians, or care-team personnel acting within scope of practice to review raw telemetry where protocol and consent allow it, while preventing the same data from becoming a coach-facing performance feed or a front-office vulnerability record.

A functioning Medical Lease includes a defined clinical role, registered device, authorized purpose, access duration, athlete visibility, NICOLE access entry, emergency or break-glass rules, and revocation process. Revocation triggers key rotation, access expiration, and audit logging. The medical team can see what the medical team needs. The coach cannot quietly become a biometric observer.

Medical Lease property	Meaning
Role-bound	Access limited to authorized clinical users acting under defined clinical protocol.
Device-bound	Raw telemetry released only to registered clinical devices, not ordinary institutional dashboards.
Time-bound	Access expires according to the lease condition and does not become a permanent data lake.
Purpose-bound	Use is limited to safety, clinical review, and care-team context, not scouting or contract evaluation.
Logged and revocable	Every lease event is recorded; revocation rotates keys and invalidates future access.

Clinical boundary

SSI is not anti-medicine. SSI is anti-unbounded-custody. Medical review can be deep; coaching and vendor access remains bounded.

Cryptographic posture

Medical Lease, NICOLE audit, IEL/DCL ledger integrity, and revocation mechanics are implemented through hardware-anchored key separation, device-bound credential issuance, signed access-event logging, and seasonal key rotation. Raw telemetry custody is hardware-isolated at the Local Athlete Node. Specific primitive families, key-rotation schedules, and ledger-chain construction details are addressed at formal-specification level in the LAKANA doctrine preprint and patent application, which are the authoritative sources for cryptographic review. This white paper makes no cryptographic-strength claim beyond what those documents support, and no quantum-resistance claim. Post-quantum migration is a tracked design item and not a current architectural guarantee.

PART III **EVIDENCE, RESULTS, AND STABILITY**

7 Product definition and evidence boundary

SSI is a safety-boundary product, not a performance-optimization product. It does not diagnose injury, clear athletes, replace medical staff, or promise injury prevention. It constrains unsafe claim expansion, preserves auditability, and surfaces bounded structural-load state earlier than purely manual workflow can reliably do at scale.

Capability	Meaning
Deterministic safety envelope	Constrains load, thermoregulation, recovery, and structural strain claims through bounded safety envelopes rather than opaque live-session learning.
Fail-closed ambiguity	When sensor quality, environmental context, or model confidence is too weak, SSI reduces claims or becomes silent rather than inventing precision.
Post-session learning only	Updates occur outside live sessions and are bounded by cohort privacy gates, preventing the system from self-relaxing during acute risk.
Evidence-grade custody	NICOLE-style logging supports integrity, access accountability, and reviewer-facing audit packages without exposing trade-secret response functions.
W-X environmental context	Heat, storm, field, and local environmental state condition structural safety interpretation; a fatigue signal under extreme heat is not equivalent to the same signal under cool conditions.

Evidence tier by claim class

Tier	Definition	Examples in this document
Architecture	Specification-grade claim about how SSI is designed and what it can do by construction. Does not depend on simulation evidence.	Local-first custody; Medical Lease protocol; NICOLE audit; TSARO deterministic envelope; W-X context layer; VAS pass/conditional/fail logic; DCL neutrality; lane separation in Figure 1.
Simulation-bound	Numerical claim derived from the v8.5 pass-gated Monte Carlo evidence stack. Holds inside the simulator under stated assumptions; does not establish field effectiveness.	33M athlete-arm records; +0.1943 yr mean 365-day retained-year delta; 40.97% mean 365-day burden reduction; 77.7% ACL-family burden reduction; per-sport retained-time deltas; COMP-SOV v2 ABM results; football LT post-stack NNRday = 0.225.
External public source	Claim sourced from named external public material. Cited and access-date documented.	All external legal-market signals; FDA, NIOSH, BIPA, FERPA, OSHA, NFL CBA, Cothron, EEOC wearable-workplace references; FIFPRO and Project ACL references.

Evidence boundary

All numerical performance claims in this document are simulation-bound unless explicitly described otherwise. They support controlled pilot readiness and partner diligence. They do not establish clinical validation, diagnosis, injury-prevention guarantee, regulatory clearance, field effectiveness, or return-to-play authority.

8 Evidence stack: stronger than a concept proposal

The commercial argument does not rest on aspirational architecture alone. SSI has a pass-gated simulation evidence base that can be reviewed without burying the reader in manuscript-level mathematics.

Evidence component	Status	Role
Strict empirical hard gate	Passed	Major empirical lanes were staged, parsed, and accepted before final sensitivity analysis.
14-day comparator branch	Completed	Tests SSI against active policy abstractions rather than a single weak no-action baseline. Comparator arms are modeled policy abstractions and ablation families, not head-to-head field trials against named commercial vendors.
90-day accepted audit	Accepted	Shows positive true-horizon support before the full-year window.
365-day accepted audit	Accepted	Longest accepted true-horizon sport-level evidence used for commercial results.
SHA-256 artifact preservation	Completed	Supports reviewer diligence and reproducibility posture.

Definition: athlete-arm record

An athlete-arm record is one simulated athlete instance under one policy arm within the Monte Carlo design. The 33M figure refers to accepted simulation evidence across five sport profiles and accepted 90/365-day true-horizon artifacts; it is not field deployment data.

Comparator classes used in the simulation evidence

The 14-day comparator branch and the COMP-SOV v2 custody-policy stress test do not compare SSI against a single weak no-action baseline. Both branches evaluate SSI against five distinct policy abstractions drawn from active monitoring practice: a Hybrid State-of-the-Art class that combines internal and external load logic, an ACWR-style acute-to-chronic workload ratio class, an internal-recovery-monitoring class, an external-load-monitoring class, and a centralized industry-ablation class. Sport-level retained-time, recognition, burden, and ACL-family results are evaluated against this comparator family rather than against a single straw policy. The classes are simulator-bound abstractions of representative monitoring postures observed in the public literature and current commercial practice; they are not named-vendor reproductions, and no claim is made that any specific commercial product implements one of the classes verbatim.

9 Results: retained time, recognition, burden, ACL-family

SSI's evidence base is a multi-metric safety signature. The system is not only modeled to increase retained time. It also increases recognition and reduces total modeled burden and ACL-family burden across sport profiles. No single headline statistic captures the full pattern.

Reading the per-athlete and per-roster scale

Per-athlete modeled retained-time deltas range from 0.113 years (softball, about 41 days) to 0.255 years (basketball, about 93 days) at the 365-day accepted horizon. At the per-athlete scale, these are modest individual deltas. At the roster, program, or league aggregate scale, the same per-athlete deltas compound: an NFL roster of 53 active players at a mean 81.9-day football delta represents on the order of 11.9 modeled retained-athlete-years per roster-year inside the simulator; a 24-player women-soccer roster at the female-soccer delta represents on the order of 5.0 modeled retained-athlete-years per roster-year. These are simulator aggregates, not field projections. The field test is the pilot.

365-day accepted: retained-year delta by sport profile

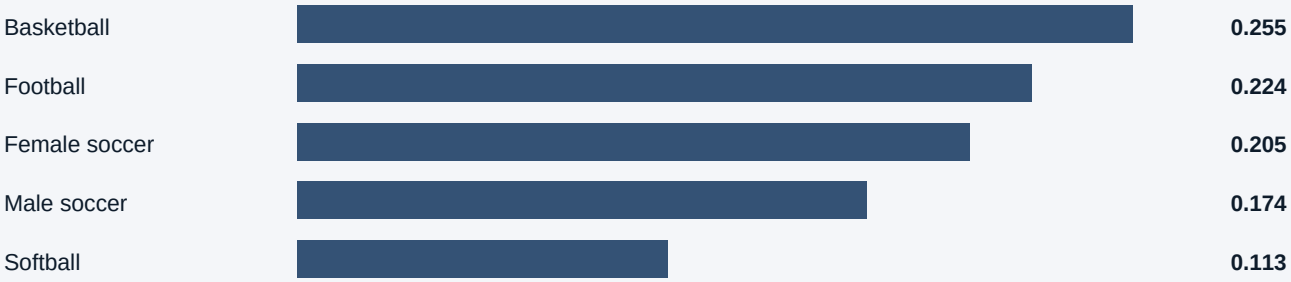


Figure 2. *Modeled retained-year delta (SSI minus comparator) at the 365-day accepted horizon. Simulation-bound.*

Sport	SSI yrs	Comp. yrs	Delta yrs	Days eq.	Recog. adv.	Burden red.	ACL-fam. red.
Basketball	0.4489	0.1938	0.2550	93.1	17.903 pp	46.061%	68.300%
Football	0.4970	0.2727	0.2242	81.9	17.961 pp	43.833%	72.717%
Female soccer	0.5102	0.3048	0.2054	75.0	9.200 pp	44.539%	73.715%
Male soccer	0.5434	0.3697	0.1737	63.4	11.581 pp	45.290%	83.535%
Softball	0.5981	0.4851	0.1130	41.2	5.576 pp	25.150%	90.161%

Composite vs. decomposed burden

The 40.97% mean 365-day burden reduction figure is a composite over the modeled burden basket: acute-event burden, soft-tissue burden, ACL-family burden, heat-illness burden, and managed-restriction burden. The composite is favorable, and the ACL-family component is the largest driver. The composite is not uniform across components. The Deterministic Ratchet converts unresolved structural load into managed restriction days inside the simulator. In categories that count managed restriction as a burden line, SSI shows higher modeled restriction burden than the comparator family while showing lower acute and ACL-family burden. The composite reduction is the net effect after both directions are summed. This trade is intentional: the simulator represents the architectural choice to convert acute structural failures into bounded, audit-preserved managed-restriction events. The full decomposition by component and by sport is documented in the companion manuscript.

10 Stability and mechanism

Horizon stability matters because a safety architecture can look promising at one window and collapse when the outcome horizon changes. The accepted 90-day and 365-day outputs address that concern directly. Every sport profile remains positive at both horizons for retained-year delta. The mean retained-year delta rises from +0.1851 years at 90 days to +0.1943 years at 365 days. Mean recognition advantage remains large at both horizons, and mean ACL-family burden reduction stays essentially stable at approximately 77.7%.

The stability does not mean every sport behaves the same way. A credible structural-load model should not produce identical effects in basketball, football, female soccer, male soccer, and softball. Those sports differ in contact density, cutting and landing frequency, sprint load, recovery rhythm, throwing workload, environmental exposure, and position-specific strain. The sport heterogeneity in the v8.5 results suggests the simulator is responding to exposure structure rather than applying one uniform benefit across every profile.

The mechanism is recognition-targeting, not blanket suppression. A crude system can reduce injury proxies by simply restricting more athletes. SSI's stronger claim is different: modeled retained time improves while recognition increases and burden decreases. That pattern is consistent with earlier identification of high-load or unstable states, redistribution away from severe burden pathways, and managed recovery before unresolved structural load becomes terminal or season-altering burden. The deterministic ratchet and fail-closed ambiguity explain why this mechanism is plausible. Short-term high output does not erase unresolved structural load. When hazard history is active, the safety envelope

does not expand because the athlete looks good on a given day. When sensor quality or environmental context is uncertain, SSI reduces its claims rather than issuing a false-safe signal.

Stability supports controlled pilot diligence. It does not establish clinical proof. The correct interpretation is that the simulation signature is coherent enough to justify prospectively defined, consented pilot work with clear endpoints, independent review, and strict access boundaries.

Sport	90-day delta	365-day delta	Direction
Basketball	0.2476	0.2550	Positive at both horizons
Football	0.2142	0.2242	Positive at both horizons
Female soccer	0.1948	0.2054	Positive at both horizons
Male soccer	0.1646	0.1737	Positive at both horizons
Softball	0.1044	0.1130	Positive at both horizons

Why the ACL-family stability matters

Mean ACL-family burden reduction remains nearly unchanged across accepted horizons. That does not prove field injury prevention; it shows internal coherence in the modeled structural-load pathway, making the result suitable for controlled pilot diligence.

11 Sport-specific interpretation: heterogeneity is credibility

The sport-specific pattern matters because a structural-safety system should reflect the demands of the sport. Basketball shows the largest retained-time effect, consistent with high-frequency cutting, landing, acceleration, and deceleration. Football operates as a multi-hazard stress case because contact, heat, neuro-impact, and lower-limb load must remain coherent at the same time.

Female soccer is a primary evidence lane, not a downstream generalization from male data. The accepted outputs show strong retained-time and ACL-family burden support in a domain where workload, travel, rest, and structural injury concerns are central to player safety. Male soccer shows moderate retained-time gain with strong ACL-family reduction, useful for lower-limb structural-risk and fixture-load discussions. Softball shows the smallest retained-year delta but the strongest ACL-family burden reduction, making it a narrow-pathway structural-risk result rather than a generic survival headline.

Workforce translation follows the same structural logic. Construction, logistics, first response, tactical training, industrial labor, and similar load-bearing environments have distinct exposure signatures. SSI's architecture can be adapted to role-specific load, heat, fatigue, recovery, and environmental envelopes, but workforce claims require separate calibration and pilot evidence, addressed in Section 17.

Profile	Commercial interpretation
Basketball	Largest retained-time effect; high-frequency cutting, jumping, deceleration, landing, and short-cycle load accumulation.
Football	Strong multi-hazard stress case; contact, lower-limb load, heat, and neuro-impact lanes must stay coherent.
Female soccer	Central women-sport lane with strong retained-time and ACL-family burden results.
Male soccer	Moderate retained-time gain with strong ACL-family reduction for lower-limb structural-risk discussions.
Softball	Smallest retained-year delta but strongest ACL-family reduction; narrow-pathway structural-risk value.

Pilot targeting insight

The first SSI pilots should target a profile with high structural-load burden, clear medical workflow, trusted participant consent, and a partner willing to evaluate aggregate-bounded safety outputs rather than raw biometric possession.

PART IV

STRATEGIC DIFFERENTIATORS

12 Sovereign Baseline: N-of-1 outlier protection

Elite athletes are not population averages. The immediate front-office objection to any workload model is whether a rare outlier will be governed by a generic distribution. A star quarterback, elite goalkeeper, WNBA guard, Olympic sprinter, or collegiate softball pitcher cannot be treated as the mean of a cohort and still be protected with precision. Population thresholds that work for the middle of a distribution can signal false safety for the outlier whose body operates at a different structural equilibrium than the cohort was trained on.

SSI answers that objection through Sovereign Baseline Initialization. The athlete is initialized as an individual structural system before deterministic safety-envelope logic is applied. The baseline is not a diagnosis and not a guarantee of injury prediction. It is an architecture for avoiding the most common failure of population-mean systems: forcing the outlier to adapt to the algorithm instead of forcing the algorithm to respect the individual baseline.

Commercially, Sovereign Baseline turns safety from a generic restriction tool into individualized safety governance. Ownership gets protection for high-value roster assets without creating a blanket benching machine. Athletes avoid population-normal labels that ignore training history, position demand, morphology, recovery rhythm, and lived load. Medical staff review a baseline-aware safety envelope instead of a black-box risk percentage. Unions gain individualized safety without giving management an unrestricted biometric profile of the athlete's vulnerabilities.

Evidence boundary

The N-of-1 baseline is an architecture and simulator claim. It is not a diagnosis, return-to-play authority, or medical-device performance claim.

13 NNR: the executive risk budget

Sports organizations do not need another alert system that only declares risk high. They need a way to budget risk. SSI translates restriction decisions into a Number Needed to Restrict style operating metric: how many managed restriction or recovery days are required, under a specified simulator or pilot protocol, to avert one severe structural-burden event.

The power of NNR is that it gives the general manager, medical director, athlete representative, and risk officer a shared language. A restriction day has a cost: lost practice time, availability tradeoff, competitive planning, and athlete frustration. A severe structural event has a larger cost: lost player availability, replacement spending, dead-cap exposure, lost development time, insurance exposure, and discovery risk. NNR makes the tradeoff explicit rather than emotional.

SSI does not present NNR as a universal constant. It is computed under stated simulator, sport, cohort, and pilot assumptions. It also requires symmetric burden accounting. Comparator rest, load moderation, and SSI restriction must be counted against the same availability denominator. A system cannot claim superiority by hiding its own restriction cost.

NNR_{day} worked example — football LT post-stack extract

14.85 extra modeled restriction days / 66.12 modeled burden days avoided = NNR_{day} = 0.225. Terminal-event NNR is undefined in this extract because the terminal-rate reduction denominator is zero. This is a burden-day operating example, not a universal terminal-event NNR.

Term	Operational meaning
Restriction days	Short-term managed availability cost.
Severe event	Catastrophic or season-altering structural-burden proxy.

Term	Operational meaning
NNR	Managed restriction days per avoided severe event under specified conditions.
Risk budget	Front-office and medical decision language for whether protective restriction is rational.

14 Deterministic Ratchet: false-recovery protection

The most dangerous failure mode in high-load sport is not always obvious fatigue. It is false recovery: the athlete looks good in practice, produces a high short-term output, and a permissive system expands their safe envelope while unresolved structural load is still accumulating. SSI treats false recovery as a safety-engineering failure, not an edge case.

The deterministic ratchet means short-term performance cannot erase hazard memory. When unresolved structural load accumulates, the permitted envelope tightens or holds. It does not expand because an athlete feels better on Thursday, hits a speed number, or clears a generic readiness threshold. Re-expansion requires recovery or remodeling evidence under audited conditions.

This is how SSI avoids both blanket suppression and false clearance. It does not need to treat every athlete as fragile. It also refuses to treat a temporary performance spike as proof of structural readiness. The ratchet separates what the athlete can produce right now from what the unresolved load history permits responsibly.

Legacy risk-score posture	SSI deterministic ratchet posture
Athlete looks good today; risk score may relax.	Acute performance does not erase unresolved hazard memory.
Sensor confidence can become permission.	Unsafe or ambiguous state reduces claims rather than expanding them.
Coach interprets a probability.	Medical staff reviews a bounded restriction state and audit trail.
Recovery may be inferred from output.	Recovery or remodeling must be evidenced before envelope re-expansion.

15 Raw biometric custody as a high-risk institutional asset

Raw biometric telemetry is not ordinary operational data. It is a discoverable, regulated, contract-sensitive, identity-adjacent asset that can reveal body state, vulnerability, trend direction, and future availability. In high-stakes sport, that information can affect scouting, contracts, roster movement, NIL valuation, betting markets, insurance, recruiting, and bargaining leverage.

The phrase high-risk asset is not rhetorical. It describes a procurement reality. If an institution authorizes a vendor to collect raw athlete telemetry, the institution must be prepared to explain the necessity of that custody, the scope of consent, the vendor's third-party data flows, security posture, retention schedule, acquisition pathway, and use restrictions. The institution cannot fully outsource the ethical and legal consequences of data gathered under its authority. The BIPA/Cothron discussion in Section 3 is the legal version of the same architecture problem.

Risk surface	SSI mitigation posture
GDPR / player-data claims	Local-first custody, consent-gated release, aggregate-bounded institutional outputs.
CBA / player-union exposure	No coach-level individual biometric query; explicit data-use prohibitions and audit visibility.
BIPA-style biometric privacy	Minimized institutional raw custody; governed Medical Lease when raw data is clinically authorized.
Duty-of-care discovery	Fail-closed deterministic states, override logging, and NICOLE-style audit trail.

Risk surface	SSI mitigation posture
Continuous biometric routing	Raw identifier export to institutional or vendor clouds is not the default operating model.

Explicit data-use prohibitions

SSI data and derived outputs may not be used for contract negotiation, trade valuation, free-agency assessment, scholarship decisions, recruiting profiling, roster discipline, insurance underwriting, NIL commercial valuation, or employment decisions without explicit per-purpose consent and applicable legal and collective-bargaining review. These prohibitions apply to all access lanes and are not waivable by institutional policy alone.

16 Women's sports and the biometric data gap

Biological accuracy is not politics. It is safety engineering. A system that misreads female athletes, athletes of color, outlier bodies, or degraded sensor signals is not merely unfair; it is structurally unsafe. The safe posture is not to claim bias is solved. The safe posture is to build systems that make population blind spots, sensor quality, and access misuse visible, bounded, and fail-closed.

Female soccer and fastpitch softball are primary SSI simulation lanes, not addenda. The accepted v8.5 outputs report strong ACL-family burden reductions in both profiles. That matters because the broader sports world is confronting a visible ACL crisis in women's football. FIFPRO's Project ACL aims to accelerate research into ACL injuries and player availability, and FIFPRO has reported links between increased workload, travel, insufficient rest, and lower-limb injury susceptibility in women's football [S7][S8]. Reuters has reported that the NWSL and NWSLPA joined Project ACL, noting limited evidence on how to reduce ACL injuries at the professional level and that women make up as little as 8 percent of sports science research [S9].

The biometric data gap also includes sensor fidelity. The FDA has stated that current scientific evidence suggests accuracy differences in pulse oximeter performance between individuals with lighter and darker skin pigmentation, and its 2025 draft guidance is aimed at improving device performance across the range of skin pigmentation [S10][S11]. SSI does not claim that every wearable issue is identical to medical pulse oximetry. It treats the principle as operationally important: sensor quality, signal provenance, and individualized baselines must be first-class safety variables, not footnotes.

SSI's response is Sovereign Baseline initialization, sensor-quality awareness, fail-closed ambiguity, and access and custody discipline. A degraded or contradictory signal should not authorize a false-safe output. An athlete should not be governed against a population threshold built from data that does not represent her sport, sex, position, recovery rhythm, or individual structural history.

Biometric data gap	Why it matters	SSI response
Female structural load	Women athletes face visible ACL/workload concerns and research gaps.	Female soccer and fastpitch softball are primary modeled lanes; N-of-1 baseline and structural-load envelopes.
Male-default algorithms	Generic thresholds can misfit sex, sport, position, recovery rhythm, and individual morphology.	Sovereign Baseline Initialization avoids generic population-mean governance.
Sensor fidelity	Skin pigmentation and other factors can affect device performance in certain technologies.	Fail-closed ambiguity reduces claims when sensor fidelity degrades rather than authorizing false-safe output.
Outlier protection	Population-trained systems can confuse under-measurement with readiness.	Signal quality, provenance, and individualized baselines are first-class variables.

Union-facing principle

Safety inference should not require male-default population models, unbounded third-party telemetry custody, or fail-open sensor assumptions. It should learn the athlete, protect the athlete, and document every institutional use of biological truth.

PART V

WORKFORCE, VENDOR COMPATIBILITY, SOVEREIGNTY

17 Workforce extension boundary

SSI's structural-load logic is architecturally extensible to load-bearing workforce environments: construction, logistics, first response, tactical training, industrial labor, and related high-load settings. That extension is a design pathway and future pilot target, not a completed workforce validation claim. Current SSI evidence is sport-domain simulation evidence. Workforce deployment requires separate calibration, labor review, legal review, and occupational safety alignment.

Workforce deployments may not use SSI outputs for hiring, firing, promotion, discipline, productivity scoring, compensation, scheduling priority, or employment-condition decisions without separate legal, labor, collective-bargaining, and regulatory review. Supervisory access must remain aggregate by default. Individual raw telemetry belongs in worker custody or governed clinical and safety review, not ordinary management dashboards.

A workforce pilot must sit inside OSHA/NIOSH hierarchy-of-controls discipline. SSI can support administrative control, early recognition, heat/load awareness, and auditability. It does not replace engineering controls, hazard elimination, protective equipment, staffing, breaks, wage-and-hour compliance, or workers' compensation procedures. NIOSH describes the hierarchy of controls as prioritizing elimination, substitution, engineering controls, administrative controls, and personal protective equipment [S12].

The workplace wearable risk is also civil-rights risk. Reuters reported that the EEOC warned in December 2024 that employer-mandated wearables collecting biometric information and vital signs may amount to a medical examination under the ADA unless job-related and necessary, and that employment decisions based on wearable data can create discrimination risk [S18][S19]. That is why SSI's workforce posture requires aggregate supervisor outputs, no HRIS integration by default, and separate legal and labor review before any employment-impacting use.

Workforce deployment status

Design extension and future pilot pathway only. No workforce efficacy, injury-prevention, or load-management claims are made from current sport-domain artifacts.

Required condition	Meaning
Voluntary participation	No retaliation for refusal or revocation; refusal may not affect shift assignment, scheduling, discipline, or compensation.
No individual supervisor query	Aggregate safety envelope only by default; supervisors do not see individual physiology.
No HRIS integration by default	No productivity, discipline, scheduling, or compensation use without separate review and consent.
Collective-bargaining review	Union or works-council participation where applicable; bargaining-unit access to deployment protocol.
OSHA/NIOSH alignment	Administrative-control framing; not a replacement for engineering controls, hazard elimination, or PPE.

18 Vendor Assertion Signing and competitor compatibility

SSI operates as a vendor-neutral deterministic boundary layer. Existing third-party readiness, load, recovery, or performance models may continue to operate within their probabilistic domain. Their clearance assertions can be signed, bounded, and checked against deterministic physiological and environmental constraints before institutional authorization.

Vendor Assertion Signing lets a vendor sign a readiness or load recommendation. SSI verifies the signature, model identity, timestamp, and assertion scope, then checks the recommendation against tissue tolerance, thermoregulation ceiling, cumulative strain budget, TSARO hard caps, and W-X environmental load. PASS, CONDITIONAL, or FAIL is logged without exposing raw athlete telemetry to the vendor. The result gives institutions a deterministic safety backstop without requiring a rip-and-replace procurement decision.

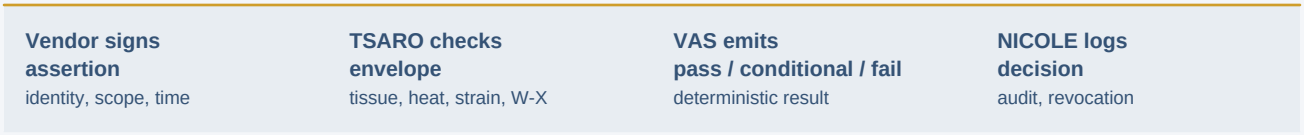


Figure 3. *VAS decision flow. Vendor assertions are bounded by deterministic envelope and audited; raw telemetry is not exposed to the vendor.*

Vendor concern	SSI response
Are you saying our model is unsafe?	No. Vendor models may estimate probabilistic readiness. SSI checks deterministic boundary compliance.
Does this add workflow friction?	Assertions pass automatically when inside the deterministic envelope; boundary violations escalate.
Does this shift liability?	It clarifies decision flow by logging assertion, deterministic result, and override status.
Why deterministic if ML works?	Probabilistic models estimate likelihood. Deterministic envelopes define what the institution refuses to authorize under bounded physical constraints.

19 Sovereignty as measurable custody architecture

The sovereignty question is measured as custody architecture, not slogan. Under COMP-SOV v2 ABM simulation conditions, SSI deterministic policy class produced zero observed and modeled adverse-leak events. That is a simulation-bound custody-stress result, not a real-world guarantee of zero legal or operational risk.

COMP-SOV v2 ABM custody stress test by policy class

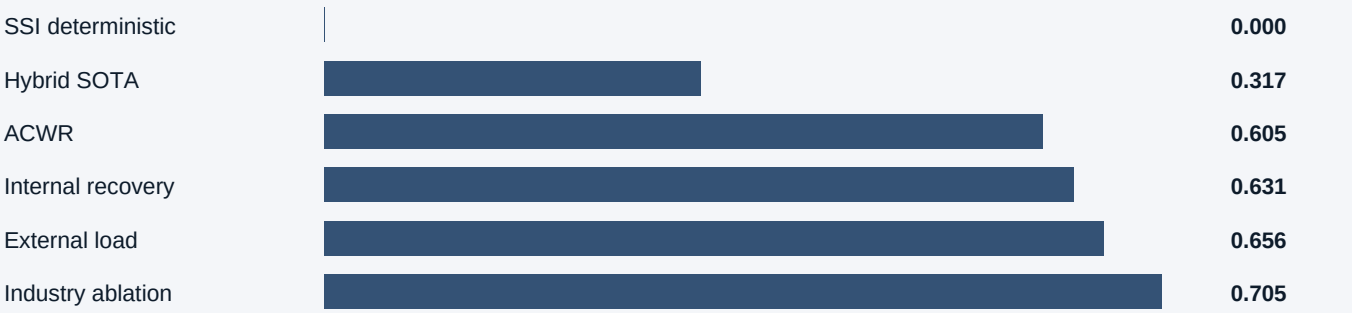


Figure 4. *COMP-SOV v2 modeled adverse-leak rate by policy class. Lower is safer. Simulation-bound; not a real-world vendor leak-rate claim.*

COMP-SOV boundary

The COMP-SOV result is not a real-world vendor leak-rate claim. It is an ABM custody-stress comparison. Under the deterministic SSI policy class and simulation condition, the model observed zero adverse-leak events. Centralized or third-party-exposed abstractions produced nonzero modeled adverse custody risk under the same simulation framing.

20 Legal proof posture and DCL neutrality

Institutions do not only need safer technology. They need to demonstrate that they took reasonable steps, separated roles, honored consent, avoided unnecessary raw-data possession, and created a reviewable decision trail. SSI functions as both a structural-safety layer and a legal-defensibility architecture serving that evidentiary requirement.

The Decision Causality Ledger does not favor the institution or the athlete by design; it favors the record. A documented adherence to safety workflow and an undocumented override are both preserved for review. The DCL improves accountability, but it does not create legal immunity. Athlete or user access, institutional chain-of-custody records, medical access logs, and third-party legal discovery requests must each be governed by explicit protocol, informed consent, applicable law, and counsel.

A system that records uncomfortable facts is more credible than a system that hides them. If an institution follows safety workflow, the audit trail helps demonstrate that. If an institution overrides or ignores safety state without process, the same audit trail exposes it. SSI's accountability value comes from neutrality.

Moment	Defensible artifact
Before event	Protocol, consent, role matrix, Medical Lease boundaries, data-minimization map, pre-registered pilot endpoints.
During event	TSARO state, W-X context, Medical Lease state, coach envelope output, warning, and override status.
After event	NICOLE IAL/DCL package showing who accessed what, when, for what role, and what action followed.
For athlete	Access visibility, revocation, anti-profiling protections.
For institution	Evidence that safety checks were role-bounded and not quietly bypassed.

Careful legal language

SSI clarifies decision pathways, reduces unnecessary raw-data custody, and makes safety-state handling auditable. It does not eliminate liability, guarantee compliance, or replace independent legal counsel.

PART VI **PILOT PATH, CLAIMS, AND CLOSE**

21 Pilot package: test SSI without taking surveillance risk

The immediate commercial product is a controlled pilot package, not broad deployment. A strong pilot converts simulation evidence into field evidence while preserving consent, medical access, aggregation, non-diagnostic boundaries, and role separation.

A first pilot targets one sport or workforce profile with high structural-load burden, trusted medical participation, operational workflow clarity, environmental context, and a partner willing to evaluate aggregate-bounded safety outputs. The pilot must not begin with a raw data lake. It begins with protocol, access map, Medical Lease rules, endpoint registration, and a defined go/no-go decision path.

Phase	Timeframe	Work package	Success evidence
Pre-pilot design	Weeks 0–4	Profile selection, sensor inventory, consent model, Medical Lease boundaries, endpoint registration.	Approved protocol and access matrix.
Simulation customization	Weeks 4–8	Monte Carlo safe-set analysis for chosen profile and W-X context integration.	Simulation packet and claim-boundary memo.
Controlled pilot	Weeks 8–20	Consented field evaluation with clinical raw telemetry lease and aggregate coach outputs.	Pilot dataset, audit bundle, decision memo.
Scale decision	Weeks 20–24	Independent review and operational refinements.	Scale/no-scale recommendation.

Pre-registered pilot decision criteria

A pilot that cannot fail is not a pilot. SSI pilot packages commit to pre-registered success, failure, and null criteria before participant consent. The criteria below commit to the structure of evaluation, not to a universal numerical pass threshold; per-pilot thresholds are negotiated during pre-pilot design with the partner medical director, partner general counsel, and, where applicable, the bargaining unit.

Outcome class	Criterion structure
Success	(i) Direction of modeled retained-time and ACL-family burden reduction reproduces in the pilot population at a partner-agreed minimum effect floor. (ii) Medical Lease access events occur as designed with audit completeness at or above threshold. (iii) Coach-tier outputs remain aggregate-bounded with zero individual-raw-query incidents. (iv) Revocation events are honored within the partner-agreed time window. (v) No serious adverse event causally attributed to SSI advisory output.
Failure	(i) Direction of effect reverses or is statistically indistinguishable from comparator at the partner-agreed minimum effect floor. (ii) Audit completeness falls below threshold. (iii) Coach-tier outputs are operationally indistinguishable from individual physiology drill-down. (iv) Revocation is not honored. (v) Any serious adverse event causally attributed to SSI advisory output.
Null	The pilot completes per protocol but the data are inconclusive on the primary endpoint. The system proceeds to structured pilot extension, protocol revision, or no-scale decision with the partner. Null is a valid outcome, not a failed outcome.

Youth and school boundary

Youth or school-based deployments require parent or guardian consent, district legal review, minor-specific data minimization, FERPA and student-record assessment before any pilot, no recruiting or athletic-eligibility use of SSI outputs, and no coach-level individual raw biometric access. These requirements are not waivable by institutional policy.

22 Buyer value and implementation roadmap

Each institutional buyer faces a distinct operational risk surface. SSI addresses all of them through the same architectural mechanism: reduced raw-data custody, governed access lanes, and a complete audit record.

Buyer	Value
Athletic department	Reduce unstructured safety decisions, support medical review, protect athletes from profiling, preserve coach usability.
School district / youth sport	Build a consented safety layer without a child-athlete biometric warehouse or opaque third-party profiling.
Athlete / player association	Preserve access visibility, revocation, anti-profiling boundaries, and protection from contract-sensitive data misuse.
Medical director	Receive clinically governed raw telemetry where authorized while preserving audit, scope, and purpose boundaries.
General counsel / risk officer	Reduce custody, consent-gap, vendor-access, CBA, discovery, and regulatory ambiguity surfaces.
Workforce safety operation	Monitor heat, load, and recovery stress with aggregate-bounded outputs and full labor safeguards in place.
Insurer / risk partner	Document what was known, when it was known, who saw it, and whether an override occurred.
Research institution	Study deterministic safety inference and privacy-preserving telemetry under clear artifact custody.
Grant / funder reviewer	Bridge from simulation evidence to controlled pilot evidence with non-surveillance built into the design.

Partner ask

Fund a controlled SSI pilot that tests whether deterministic, privacy-preserving structural safety can deliver useful medical and institution-level action signals without turning raw biometric ownership into the default operating model.

23 Claim boundary, regulatory crosswalk, limitations

SSI's claim boundary protects participants, institutions, and LAKANA at the same time. Each assertion is separated into architecture, simulation evidence, pilot planning, and excluded claims so that no reader confuses controlled simulation support with clinical validation, field effectiveness, or legal immunity.

Claim class	Supported now	Not claimed now
Architecture	Local-first, deterministic, Medical-Lease-capable, aggregate-bounded, fail-closed structural-safety design.	Full production certification or medical-device status.
Simulation evidence	Pass-gated Monte Carlo evidence across five sport profiles, active comparators, and accepted true horizons.	Field effectiveness or clinical validation.
Privacy / sovereignty	Modeled custody separation and ABM stress-test evidence for local-first deterministic policy class.	Legal guarantee of zero risk.
Medical access	Governed raw telemetry access to authorized clinical devices under Medical Lease.	Unrestricted coach access or automatic return-to-play authority.

Claim class	Supported now	Not claimed now
Operational readiness	Pilot-ready protocol, safety-envelope outputs, audit artifacts, and defined next endpoints.	Replacement of medical staff or institutional safety procedures.

Regulatory crosswalk

Domain	Compliance surface	SSI response
BIPA and analogous biometric laws	Collection, retention, sale or profit, disclosure, and consent.	Minimized institutional raw custody; NICOLE access logs; purpose limitation and revocation.
GDPR Article 9	Health and biometric special-category data.	Consent-gated release, data minimization, athlete visibility, erasure by key or ciphertext invalidation.
League CBA wearable clauses	Contract, discipline, commercial use, and data-rights restrictions.	Data-use prohibitions; coach aggregate envelope; no individual raw query.
FDA general wellness boundary	Medical-device claims and wellness-to-medical line.	Non-diagnostic claim boundary; fail-closed ambiguity; no return-to-play authority.
OSHA / NIOSH	Workplace hazard controls and occupational safety.	Administrative-control framing; separate workforce calibration required.
FERPA / student privacy	Student records and guardian or eligible-student consent.	Youth boundary, minor-specific minimization, no recruiting or eligibility use.

Standing limitations register

The following limitations are inherent to the current evidence and design posture and are stated explicitly so they do not need to be inferred from text scattered across the document. Any of these will be re-evaluated as the pilot evidence base develops.

Limitation	Posture
No field-effectiveness evidence	All performance numbers are simulator-bound. The pilot is the field-evidence pathway.
No clinical validation	SSI does not diagnose, treat, prognose, or authorize return to play. Clinical authority is preserved with licensed medical staff.
No regulatory clearance	SSI is not a cleared medical device. The current posture is non-diagnostic structural-safety infrastructure under General Wellness alignment.
No quantum-resistance claim	Cryptographic posture is hardware-anchored and key-separated; post-quantum migration is a tracked design item, not a current guarantee.
Comparator is simulator-bound	The five comparator classes are policy abstractions, not named-vendor reproductions.
Workforce-track validation is future work	Sport-domain simulation evidence does not transfer to industrial recordables without separate calibration.
Sensor fidelity is bounded by hardware	Architecture mitigates degraded-signal risk via fail-closed ambiguity and N-of-1 baseline, but does not solve sensor bias at the physics layer.
Subgroup heterogeneity is unknown in pilots	Sport profiles model average-cohort exposure structure; per-team, per-position, and per-athlete heterogeneity in real cohorts is a pilot question.
External calibration is incomplete	Hazard rates are internally consistent inside the simulation evidence stack. External calibration to a named prospective field cohort is future work.

Why limitations are listed

A document that names its limitations is more useful than one that does not. None of the limitations above are blockers to controlled pilot evaluation; they are the things the pilot will resolve, refine, or rule on.

24 Closing position

The public value of SSI is not that it collects more about the human body. The value is that it refuses to make raw human state the default price of safety. The same signals that can protect a person can also be used to profile, price, trade, recruit, discipline, insure, exploit, or reconstruct that person. A serious safety infrastructure must address both sides of that fact.

SSI gives institutions a disciplined way to pursue structural-safety awareness without converting the person into an uncontrolled dataset. It learns the individual baseline, fails closed under uncertainty, gives medical staff governed raw telemetry when clinically needed, gives coaches only bounded aggregate safety state, permits vendor compatibility through signed assertions, and preserves the decision record through audit and revocation.

The strongest partner path is a controlled pilot: consented participants, defined access roles, Medical Lease governance, aggregate institutional outputs, W-X environmental context, pre-registered endpoints, and audit-preserved decisions. That path respects the participant, protects the institution, and turns simulation-bound evidence into accountable operational learning.

Final thesis

LAKANA SSI is privacy-preserving structural safety infrastructure: it prevents unauthorized biometric replication while preserving the medical and institutional safety signals needed to protect high-load humans.

25 References and legal-market source notes

Sources are used for legal-market and scientific context. Allegations, complaints, investigations, warning letters, and reports are cited as risk signals unless a source reports a final ruling. This document is not legal advice, clinical validation, medical-device clearance, or an assertion of wrongdoing by named vendors, leagues, venues, or data providers.

[S1] Ben Fisher, "Hundreds of professional footballers threaten legal action over use of data," The Guardian, Oct. 12, 2021. URL: https://www.theguardian.com/football/2021/oct/12/hundreds-of-professional-footballers-threaten-action-against-betting-companies. Accessed May 11, 2026.

[S2] Kelsey McCroskey, "Whoop Facing Class Action Lawsuit for Allegedly Sharing Users' Fitness Tracker Data Without Permission," ClassAction.org, Aug. 18, 2025. URL: https://www.classaction.org/news/whoop-facing-class-action-lawsuit-for-allegedly-sharing-users-fitness-tracker-data-without-permission. Accessed May 11, 2026.

[S3] Lomeli v. Whoop, Inc., Complaint, No. 3:25-cv-06828, N.D. Cal., filed Aug. 13, 2025. URL: https://www.classaction.org/media/lomeli-v-whoop-inc.pdf. Accessed May 11, 2026.

[S4] U.S. Food and Drug Administration, "WHOOP, Inc. - 709755 - 07/14/2025," Warning Letter, July 14, 2025. URL: https://www.fda.gov/inspections-compliance-enforcement-and-criminal-investigations/warning-letters/whoop-inc-709755-07142025. Accessed May 11, 2026.

[S5] "Whoop Lawsuit Claims Blood Pressure Monitors Are Falsely Advertised as Medical-Grade," ClassAction.org, Nov. 21, 2025; discusses Rowe v. Whoop, Inc., No. 3:25-cv-09910. URL: https://www.classaction.org/news/whoop-lawsuit-claims-blood-pressure-monitors-are-falsely-advertised-as-medical-grade. Accessed May 11, 2026.

[S6] Associated Press, "Tech company says NCAA looking into possible unauthorized access to football video," AP News, Dec. 29, 2023. URL: https://apnews.com/article/ncaa-video-investigation-6904fcc035a125831ecafbc4f3048c91. Accessed May 11, 2026.

[S7] FIFPRO, "Project ACL: Research on ACL Injuries in Women's Football." URL: https://www.fifpro.org/en/what-we-do/health-initiatives/project-acl. Accessed May 11, 2026.

[S8] FIFPRO, "New FIFPRO report shows increased workload, travel and insufficient rest in women's football is making players more susceptible to injuries — including ACL injuries," Dec. 15, 2023. URL: https://www.fifpro.org/en/articles/2023/12/new-fifpro-report-shows-increased-workload-travel-and-insufficient-rest-in-women-s-football-is-making-players-more-susceptible-to-injuries-including-acl-injuries. Accessed May 11,

2026.

[S9] Lori Ewing, "US women's soccer league joins global project to cut ACL injuries," Reuters, Apr. 22, 2026. URL: https://www.reuters.com/sports/soccer/us-womens-soccer-league-joins-global-project-cut-acl-injuries-2026-04-22/. Accessed May 11, 2026.

[S10] U.S. Food and Drug Administration, "FDA Proposes Updated Recommendations to Help Improve Performance of Pulse Oximeters Across Skin Tones," Jan. 6, 2025. URL: https://www.fda.gov/news-events/press-announcements/fda-proposes-updated-recommendations-help-improve-performance-pulse-oximeters-across-skin-tones. Accessed May 11, 2026.

[S11] U.S. Food and Drug Administration, "Pulse Oximeters for Medical Purposes — Non-Clinical and Clinical Performance Testing, Labeling, and Premarket Submission Recommendations," Draft Guidance, Jan. 2025. URL: https://www.fda.gov/regulatory-information/search-fda-guidance-documents/pulse-oximeters-medical-purposes-non-clinical-and-clinical-performance-testing-labeling-and. Accessed May 11, 2026.

[S12] Centers for Disease Control and Prevention / NIOSH, "Hierarchy of Controls," Apr. 10, 2024. URL: https://www.cdc.gov/niosh/hierarchy-of-controls/about/index.html. Accessed May 11, 2026.

[S13] NFL Collective Bargaining Agreement, Article 51, Section 14, Over The Cap CBA viewer. URL: https://overthecap.com/collective-bargaining-agreement/article/51/section/14. Accessed May 11, 2026.

[S14] Illinois General Assembly, 740 ILCS 14, Biometric Information Privacy Act. URL: https://www.ilga.gov/Legislation/ILCS/Articles?ActID=3004&ChapterID=57&Print=True. Accessed May 11, 2026.

[S15] Legal Information Institute, Cornell Law School, 29 U.S. Code Sec. 654 — Duties of employers and employees. URL: https://www.law.cornell.edu/uscode/text/29/654. Accessed May 11, 2026.

[S16] Cothron v. White Castle System, Inc., 2023 IL 128004, Illinois Supreme Court, Feb. 17, 2023; Justia summary and opinion text. URL: https://law.justia.com/cases/illinois/supreme-court/2023/128004.html. Accessed May 11, 2026.

[S17] Daniel Wiessner, "Illinois governor approves business-friendly overhaul of biometric privacy law," Reuters, Aug. 5, 2024. URL: https://www.reuters.com/legal/government/illinois-governor-approves-business-friendly-overhaul-biometric-privacy-law-2024-08-05/. Accessed May 11, 2026.

[S18] Daniel Wiessner, "EEOC says wearable devices could lead to workplace discrimination," Reuters, Dec. 19, 2024. URL: https://www.reuters.com/legal/government/eeoc-says-wearable-devices-could-lead-workplace-discrimination-2024-12-19/. Accessed May 11, 2026.

[S19] U.S. Equal Employment Opportunity Commission, "Wearables in the Workplace: Using Wearable Technologies Under Federal Employment Discrimination Laws," listed under EEOC Publications, 2024. URL: https://www.eeoc.gov/eeoc-publications. Accessed May 11, 2026.

[S20] U.S. Department of Education, "FERPA," Protecting Student Privacy. URL: https://studentprivacy.ed.gov/ferpa. Accessed May 11, 2026.

[S21] SSI v8.5 accepted Monte Carlo artifacts and LAKANA internal evidence package: accepted 90-day and 365-day true-horizon outputs, 14-day comparator-policy branch, strict empirical hard-gate proof, COMP-SOV v2 ABM custody-policy sensitivity, and SHA-256-preserved release packages. Numerical claims are simulation-bound.

Legal and scientific boundary

This white paper is not legal advice, clinical validation, medical-device clearance, or an assertion of wrongdoing by named vendors, leagues, venues, or data providers. It is a commercial, architectural, and simulation-evidence package for controlled pilot diligence.