



SYSTEM 2 · PREDICTIVE
world models · cortex · deliberative

CORTEX //
PREDICTIVE WORLD MODEL
• Intent Prediction
• Scenario Planning
• Long Horizon Reasoning
• World State Simulation

COMMONS //
V2X · UTM · TWIN
• Shared Perception
• Data Fusion
• Digital Twin
• Infrastructure Context

COOPERATIVE PERCEPTION · COMMONS
shared sensing — feeds BOTH systems

SPINAL //
SENSOR FUSION
+ COOP PERC
• Multi-Modal Fusion
• Object Tracking
• Event Detection
• Semantic Understanding

REACTIVE EDGE //
<100ms
• Closed-Loop Control
• Real-Time Planning
• Safety Enforcement
• Immediate Response

SYSTEM 1 · REACTIVE
spinal · closed-loop · <100ms

Full Autonomous Mobility — Beyond the Single Stack

SDV · Robotics · AAM // Reactive · Predictive · Cooperative Perception Commons

System 1, System 2, and the cooperative path across cars, robots, and aircraft.

- 🚗 SDV → AIDV
- 🤖 ROBOTICS · industrial + domestic
- ✈️ AAM → AIDA

INSIDE THIS BRIEF

- I** SOFTWARE-DEFINED → AI-DEFINED ERA
L1-L3 was sensor fusion. L4-L5 is cooperative perception. Why the architecture has to change.
- II** THREE ARCHITECTURAL SCHOOLS
Scale the recipe · Predictive world models · Modular + cooperative. The honest answer isn't pick-one.
- III** SYSTEM 1 + SYSTEM 2 + COOP PERCEPTION
Reactive spinal · predictive cortex · shared sensing commons — the topology answer, diagrammed.
- IV** THREE VERTICALS · ONE ARCHITECTURE
SDV · Robotics (industrial + domestic) · AAM — same topology, different infrastructure.
- V** REGIONAL SPOTLIGHT · HOUSTON
The one US metro overlapping all three lanes — spaceport + V2X corridor + UAS test site + robotics pilots.
- VI** SIX PATHS FORWARD
Vertical-agnostic — applies to cars, robots, and aircraft alike. Validation as infrastructure.
- VII** ENGAGE · THE PRACTICE
Four engagement formats — executive briefing, diagnostic sprint, build sprint, fractional advisory. From brief to build.

Full Autonomous Mobility — Beyond the Single Stack

System 1, System 2, and the cooperative path across cars, robots, and aircraft.

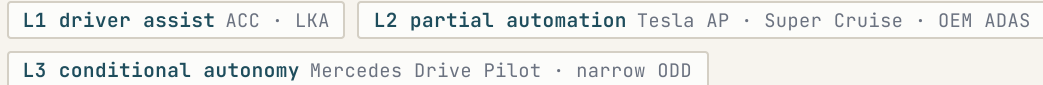
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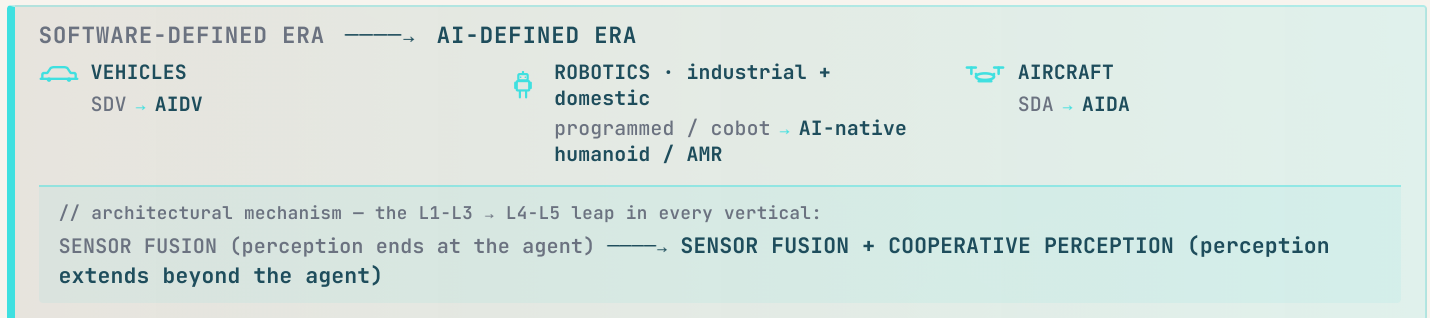
circulation permitted with attribution

Autonomous mobility is on a two-regime path. Levels 1–3 are the **Software-Defined era**—sensor fusion inside a bounded ODD, shipping at scale today across **SDV** (vehicles), **SDA** (aircraft), and programmed / cobot robotics. Levels 4–5 are the **AI-Defined era**—sensor fusion **plus cooperative perception**, emergent phenomena, causal reasoning, and validation no single OEM can field alone. The leap is not "a better model." It is an architectural shift to **Physical AI**, a hybrid **reactive + predictive** topology, and a cooperative-perception commons.

where_we_are.l1_l3 // Software-Defined era — sensor fusion alone, bounded ODD



The boundary of perception ends at the agent. On-platform **sensor fusion** (camera · radar · LiDAR · IMU · GNSS) scales beautifully inside a bounded ODD: more data and compute compound, the long tail is manageable, and validation is per-scenario regression testing. The same logic governs **SDV** on supervised lanes, **SDA** under VFR in charted corridors, and programmed / cobot robotics in structured cells, lines, and homes. **This regime is shipping.**

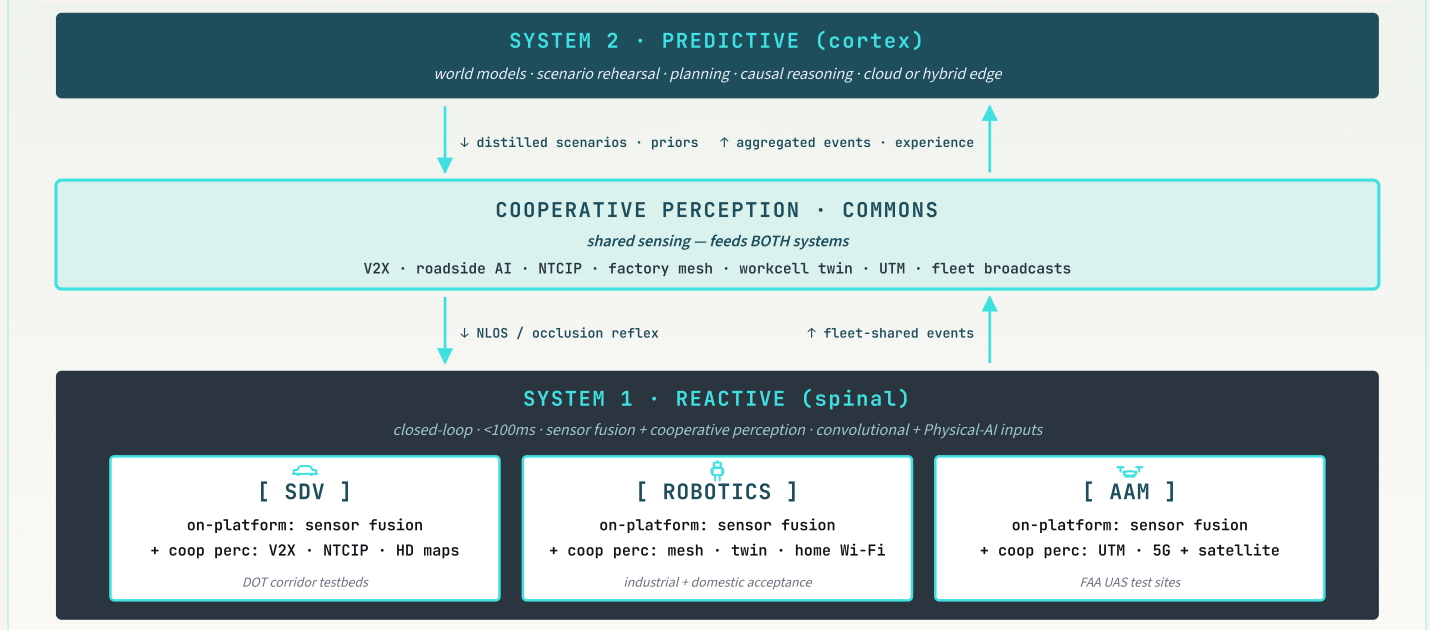


the_l4_l5_gap // AI-Defined era — perception extends beyond the agent

Beyond L3, the long tail becomes **emergent and causal**: occluded pedestrians, intent, physics, novel scenes, counterfactuals. The architectural mechanism is the **expansion of the perception boundary**: sensor fusion alone is the L1-L3 substrate; sensor fusion **plus cooperative perception** is the L4-L5 substrate. The gap is no longer parameters or data — it is what no single agent can perceive alone. This is where **SDV → AIDV**, **SDA → AIDA**, and programmed robotics → **AI-native** all converge on the same need: **Physical AI** that **predicts how the world evolves**, fed by a shared sensing commons.

Physical AI — multi-modal, real-time, safety-critical AI that reasons about and acts in the physical world; spans autonomous driving, mobile robotics (industrial + domestic), advanced air mobility, and smart infrastructure.

what_it_takes.hybrid_architecture // reactive (System 1) · predictive (System 2) · cooperative perception commons
// fig.01 · hybrid architecture · System 2 predictive (cortex) · Cooperative Perception commons · System 1 reactive (spinal)



// fig.01 is the thesis · reactive + predictive + a shared commons · same topology in every lane

– continued page 3 : which architecture wins? · the topology answer · per-lane specifics · paths forward

three_schools.l4_plus_debate // which architecture wins?

01 SCALE THE SAME RECIPE

TODAY

End-to-end nets, more parameters, more fleet data. **Has shipped L4 inside heavily geofenced ODDs** (Waymo · 10 US cities · ~3,000 vehicles · 2026) — but the same recipe **has not generalized outside that envelope**. Bets the next leap to geographically open L5 is a quantitative continuation of the current curve.

02 PREDICTIVE WORLD MODELS

EMERGING

Self-supervised, generative, scenario-aware (**Meta V-JEPA 2 · Wayve GAIA-1 · NVIDIA Cosmos**, adjacent research). Designed for the causal reasoning L4+ demands. Earlier in the curve—and the most likely architectural unlock for the open-ODD, geographically-general L5 regime.

03 MODULAR + COOPERATIVE

SHIPPING · ODD-BOUNDED

Explicit perception / prediction / planning paired with **HD maps, factory twins, aeronautical charts, V2X, UTM**. Operates today inside ODDs. Scales slowly geographically but produces real revenue and real safety cases.

> THE TOPOLOGY ANSWER · REACTIVE + PREDICTIVE + A SHARED COMMONS

SYSTEM 1 + SYSTEM 2 + COOPERATIVE PERCEPTION

System 1 — reactive (spinal): *closed-loop, <100ms, sensor fusion + cooperative perception integrated as one nervous system.* **System 2 — predictive (cortex):** *world models, scenario rehearsal, planning — cloud or hybrid edge.* **Cooperative perception — commons:** *shared sensing that feeds both tiers. The L4+ unlock is the coupling of all three—across cars, robots, and aircraft.*

Borrowing Kahneman's System 1/2 framing as inspiration, not a literal mapping — the engineering reality is reactive vs. predictive, with a third commons layer that has no analog in pure cognitive theory.

three_verticals.one_architecture // same topology · different infrastructure per lane

[SDV]

Software-Defined Vehicles

ODD: geofence · weather envelope · sensor stack **Infrastructure:** V2X (C-V2X; DSRC spectrum sunset) · HD maps · NTCIP traffic controllers **Validation:** DOT corridor testbeds · Mcity · 5GAA · FHWA **Standards:** SAE J3016.

Canonical field examples: Mcity Test Facility (Ann Arbor) · 5GAA corridor demos · THEA Tampa CV Pilot · Texas TRUST V2X corridor (Greater Houston + College Station · TTI-led).

[ROBOTICS]

Industrial + Domestic · Humanoid · AMR · Cobot

ODD: cell · line · warehouse aisle (*industrial*) · home · care environment (*domestic*) **Infrastructure:** factory mesh · private 5G · digital twin of the workcell (*industrial*) · home Wi-Fi · consumer edge AI (*domestic*) **Validation:** ISO 10218 + ISO/TS 15066 (*industrial*) · emerging humanoid + consumer-product safety regimes (*domestic*) **Players:** Aptronik · Figure · 1X · Boston Dynamics · Tesla Optimus.

Canonical field examples: Aptronik–Mercedes-Benz industrial pilots · Figure–BMW · 1X · Boston Dynamics–Hyundai · Tesla Optimus consumer + industrial trials.

[AAM]

Advanced Air Mobility · eVTOL

ODD: vertiport · corridor · weather + visibility envelope **Infrastructure:** UTM (Unmanned Traffic Management) · 5G + satellite redundancy · vertiport ground systems **Validation:** FAA UAS test sites · NASA UTM partner programs **Standards:** ASTM F38 · FAA Part 135 · JARUS.

Canonical field examples: FAA UAS Test Site program (7 federally designated sites) — NUAIR (NY) · Nevada · Alaska / Pan-Pacific (UAF) · Northern Plains (ND) · Virginia Tech (MAAP) · TAMU-CC Autonomy Research Institute (formerly Lone Star UAS Center, TX) · Choctaw Nation (OK). Plus the Houston Spaceport — FAA-licensed commercial spaceport at Ellington — as a vertiport / UAM corridor anchor.

> REGIONAL SPOTLIGHT · HOUSTON One US metro overlaps **all three lanes** in the same geography: an FAA-licensed commercial spaceport at Ellington (vertiport + UAM corridor anchor), the TAMU-CC Autonomy Research Institute (FAA UAS test site, formerly Lone Star UAS Center), the Texas TRUST V2X corridor (TTI-led, Greater Houston + College Station), plus active logistics-robotics field pilots and emerging industrial-humanoid program engagement across the Gulf manufacturing corridor. A natural canvas for a federated, cross-mode validation commons.

Different infrastructure. Same topology. The commons the sector still has to build is shared across all three lanes.

system_of_systems.validation_commons // the boundary work no single vendor can field alone

SoS — coupled subsystems with explicit interface contracts; strength at each boundary lifts the corridor, the line, or the airspace. **Validation commons** — federated testbeds, shared scenario libraries, and cross-domain attestation that no single OEM, robotics maker, or eVTOL builder can field alone.

The federated testbed plays the role for Physical AI that ImageNet played for vision: shared scaffolding the whole ecosystem can train and validate against. The difference is that Physical AI testbeds must include **infrastructure-side observations**—V2X feeds, factory mesh telemetry, UTM tracks—not just curated datasets. The commons is operational, not static.

six_paths_forward // vertical-agnostic — applies to SDV, Robotics, AAM

1. Fund **corridor-scale federated testbeds**—cross-state, cross-OEM, cross-mode where possible (road + factory + sky).
2. Couple **foundation / world models in the cloud** with **distilled specialized edge models**—scale *and* specialize, not one or the other.
3. Standardize **cooperative-perception interface contracts**: V2X for ground, mesh + twin for factory, UTM for air.

From Brief to Build – The Ronna-X practice.

The same architecture-first lens applied above — now deployed inside your team.

Ronna-X is a Houston-anchored research-and-build practice for full-autonomous-mobility programs. We help SDV, robotics, AAM, and infrastructure-side teams turn architectural complexity into shippable strategy: **federated testbed design · cooperative-perception roadmaps · partner ecosystem maps · GTM playbooks · pilot architectures**. Independent of any vendor stack. Operator-side voice. Engagements are sprint-based with the option to extend into fractional advisory.

engagement_formats // four standard scopes · price bands indicative · all scoped per engagement

▸ 01 · ENTRY 1 day · on-site or remote

EXECUTIVE BRIEFING

A one-day intensive for an exec or program team that wants the cross-vertical architecture made *actionable* in their context. Structured Q&A, scenario walk-through, ecosystem orientation.

DELIVERABLES

- 1-day workshop (½ day intro + ½ day deep-dive)
- Tailored 8–12 page readout PDF
- 2 follow-up office-hours sessions (30 min each)

USD 6K – 12K FLAT · TRAVEL SEPARATE

▸ 02 · DIAGNOSTIC 2–3 weeks

DIAGNOSTIC SPRINT

A focused architecture-and-GTM review for a specific program (SDV pilot, V2X corridor, vertiport operator stack, humanoid deployment). Where are the moats? Where is the topology debt? Who should you partner with?

DELIVERABLES

- Architecture & topology gap analysis (~20 pages)
- Partner ecosystem map + named shortlist
- GTM readiness scorecard with 90-day actions
- Final readout to leadership (60–90 min)

USD 20K – 35K FIXED-FEE · 2 WORK-STREAMS

▸ 03 · BUILD 6–8 weeks

BUILD SPRINT

Full GTM-to-pilot scope — the end-to-end output a program team can take to commit. Strategy, playbook, partner contracts framework, pilot architecture, validation plan, KPI framework. Where Ronna-X most directly bridges thesis to deployment.

DELIVERABLES

- Complete GTM playbook + ecosystem map + value-prop matrix
- Pilot architecture + cooperative-perception interface spec
- Named partner contact list + warm-intro execution
- KPI framework + 12-month operating cadence
- Weekly 90-min working sessions throughout

USD 60K – 120K MILESTONE-BASED · 3 WORK-STREAMS

▸ 04 · EMBEDDED monthly retainer · 3-month minimum

FRACTIONAL ADVISORY

Embedded at ~1 day/week with the product, strategy, or program-management team. On-call for exec working sessions, deal reviews, partner conversations, board-prep memos. Best for programs already in motion needing senior architectural judgment continuously.

DELIVERABLES

- ~1 day/week embedded + on-call slack/email
- Monthly board-ready memo on program posture
- Co-author of strategy docs, partner pitches, RFP responses
- Quarterly off-site facilitation

USD 10K – 18K / month 3 MO. MIN

▸ WHERE CLIENTS HIRE RONNA-X

SDV · V2X corridor strategy	Cooperative-perception roadmaps	Federated testbed design	AAM · vertiport ecosystem
UTM partner architecture	Industrial humanoid pilot framing	5G + edge-AI program management	
Houston / Gulf market entry			

▸ HOW A CONVERSATION STARTS

<p>01 DISCOVER</p> <p>30-min intro call. We map your program against the System 1 / 2 / commons frame and identify whether there's a real engagement fit.</p> <p>no charge · no slides</p>	→	<p>02 SCOPE</p> <p>Within 48h: a written 1-page Statement of Work — outcome, timeline, deliverables, milestones, price. You decide. No follow-up pressure.</p> <p>48h SLA</p>	→	<p>03 SHIP</p> <p>Sprint or retainer kicks off. Weekly checkpoints. Working sessions with your team. Concrete artifacts at every milestone.</p> <p>milestone-based</p>
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```
$ ./initiate-engagement.sh
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If this brief mapped to a real program on your side – let's talk for 30 minutes.

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// 48h response · NDA-friendly · no sales sequence · no pitch deck · 15+ years operator-side · Test & Measurement · Digital Twins · Cyber-Physical · 5G · V2X · Mcity ITS PoC · 5GAA · smart-grid GTM · Houston metro