

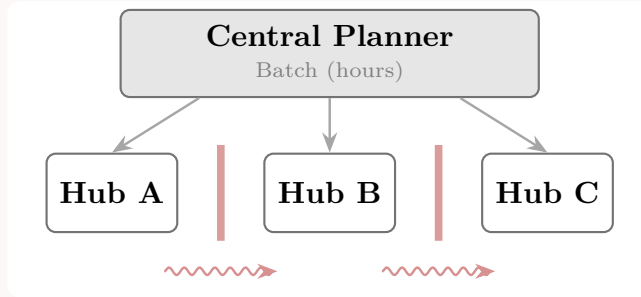
Agentic AI for Adaptive and Resilient Middle-Mile Freight Operations

\$2.3–\$2.6M | 36 mo

Lacy Greening (Team Lead, ASU) | Reem Khir (Purdue) | Optimization

“Transform the middle mile into an adaptive AI-driven network”

THE PROBLEM



Isolated • Cascading • No visibility

Plans generated days and hours ahead. Facilities adjust alone. No cross-hub coordination—delays cascade, capacity idles.

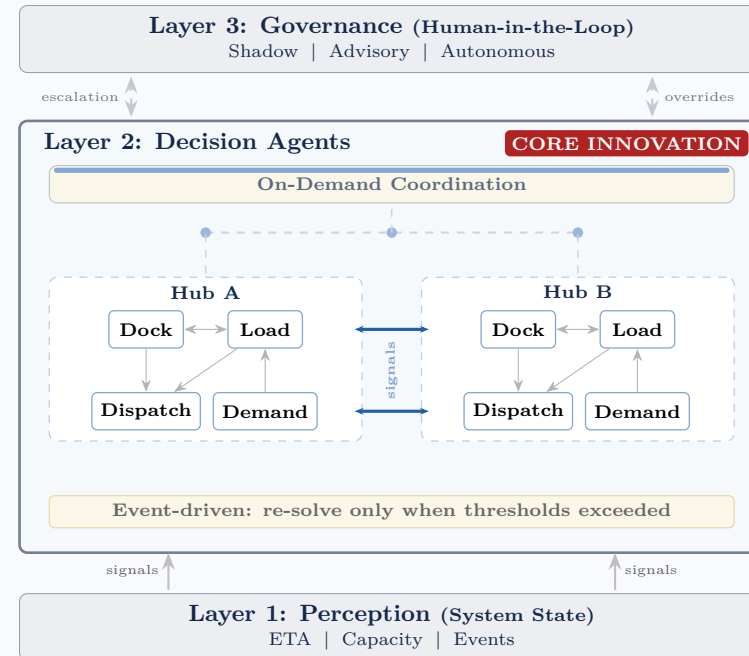
\$2T+
annual U.S. freight

20–35% empty miles
~57% load factor
2–4 hour response

Better algorithms alone won't solve this.

The missing piece is an architecture that enables facilities to coordinate decisions across the network in real time.

THE ARCHITECTURE



Key Innovations

- Distributed coordination via structured signals
- Scoped incremental re-solves, not full replanning
- Hybrid optimization–learning agents
- Human-in-the-loop governance

Team Experience

Greening (ASU): Middle-mile network design and optimization; prior work with Amazon and The Home Depot on freight planning.

Khir (Purdue): Real-time hub scheduling and learn-to-optimize methods; prior work with UPS, Cummins, and Toyota Material Handling – Raymond.

TARGETS & PLAN

>10× faster
No cascade | No manual replan
All hubs consistent within minutes

	Current	Target
Response	2–4 hr	<15 min
Utilization	~65%	80–90%
Reliability	85–90%	97–98%
Empty miles	20–35%	10–20%

R&D Plan (36 months)

- Phase 1** Mo 0–10: Single-hub agents + event-driven coordination
- Phase 2** Mo 9–24: Multi-hub signals + network-level validation
- Phase 3** Mo 23–36: System integration + shadow/advisory pilot

Deployment

Modular: operators deploy individual agents first, expand to full coordination. Shadow → advisory → autonomous. Integrates with existing TMS/WMS.

Commercialization

Target users: carriers, parcel networks, 3PLs. Individual agent modules for small operators; full coordination stack for large multi-hub networks.

Broader Impact

FHWA • FMCSA • FRA • MARAD

Anchors a broader ARPA-I program extending to rail yards (FRA), port terminals (MARAD), and cross-modal coordination. Energy grids, AV fleets, and manufacturing are actively pursuing **distributed autonomous**

coordination—freight is next.