TLTE Resilient Agent Architecture for JIATF-401

A proposed resilient communications, distributed PNT/TSPI, data-transport and self-healing Agent layer for the cross-domain counter-UAS common operating picture

Prepared for discussion with JIATF-401 and U.S. Government counter-UAS stakeholders

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Purpose. Translate JIATF-401's stated goals - common air-domain awareness, information sharing, interoperability, testing/standards, capability access and transition to operational employment - into a specific, measurable TLTE integration concept.

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Important status statement. This paper is an industry proposal, not a JIATF-401 endorsement, selection, award, validated performance report, or statement that TLTE is currently part of the JIATF-401 marketplace. Government goals are cited to public sources. TLTE capabilities beyond the granted patent baseline are presented as proposed architecture and must be verified through government-observed testing.

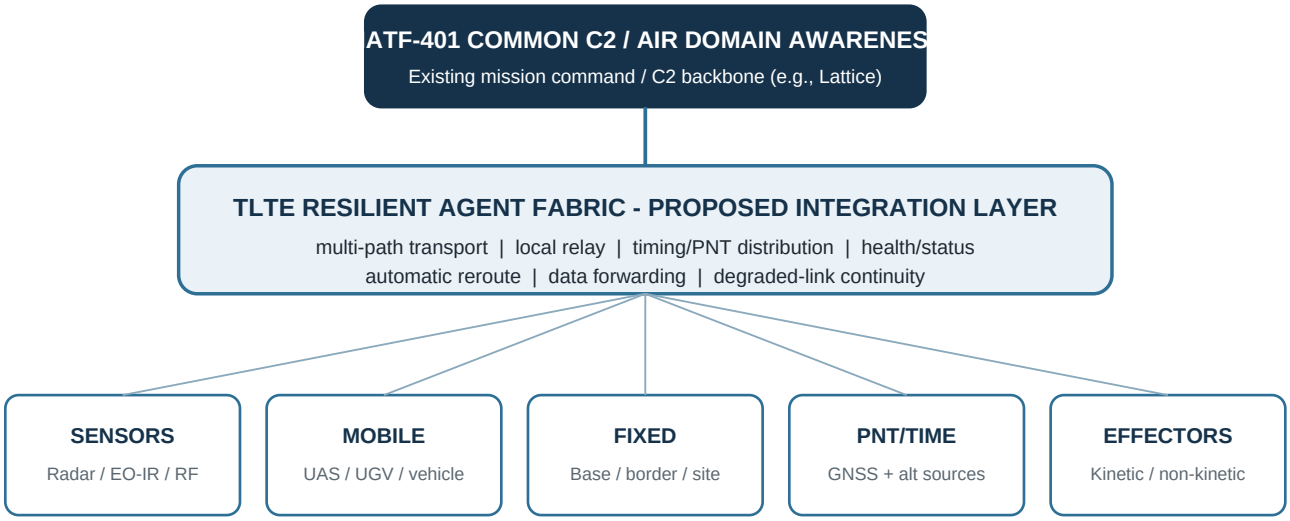
Executive Summary

JIATF-401's public direction is increasingly explicit: counter-UAS must function as an integrated, interoperable enterprise rather than a collection of isolated sensors and effectors. The September 2026 interagency summit centered on a unified, cross-domain common operating picture for air traffic in national-security-critical areas, while its breakout work addressed information sharing, capability access, testing, standards and integration. Earlier JIATF-401 actions established a common C2 backbone, standardized test criteria, a marketplace for validated systems/components, and rapid operational procurement pathways. [1]-[8]

TLTE proposes to contribute a **resilient Agent fabric** beneath and alongside the government's selected mission-command/C2 environment. The concept is not another radar, interceptor, jammer or replacement C2. It is a distributed communications and PNT/TSPI support layer intended to keep sensor, track, status, timing and command data moving when a primary path, relay, platform or GNSS source becomes degraded.

The core design objective is straightforward: preserve the information chain from detect -> track -> decide -> coordinate -> engage -> assess, even while parts of the network fail. TLTE's proposed Agent architecture uses transceiver/repeater Agents, multiple routes, local forwarding, distributed timing/PNT inputs, automatic rerouting and machine-to-machine exchange to reduce dependence on any single communications path.

The government should evaluate the concept through measurable evidence rather than assertion. This paper therefore defines a bounded 10-20 Agent demonstration with explicit failure injection and performance measures.



Conceptual integration: TLTE augments transport/PNT resilience; it does not replace sensors, effectors, or the government's selected C2.

1. JIATF-401 Mission Context

The following requirements are taken directly from, or tightly derived from, JIATF-401's public actions. The right-hand column defines the proposed TLTE response without implying government acceptance.

JIATF-401 stated direction	Operational implication	Proposed TLTE contribution
Unified, cross-domain common operating picture [1]	Track and status data must cross organizational, classification, sensor and network boundaries with predictable delivery.	Resilient Agent transport paths; local relay; route diversity; time/PNT metadata distribution; health/status reporting.
Information sharing and integration [1]	Sensor observations, tracks, alerts and system state must reach authorized decision points.	Machine-to-machine forwarding and addressable Agent endpoints; interface adapters at system boundaries.
Responsive, interoperable sen sor/effector/mission-command network [2]	The network must connect heterogeneous systems without forcing a single vendor at every layer.	Vendor-agnostic transport concept using published/approved interfaces; TLTE positioned as an enabling layer, not a proprietary replacement for every subsystem.
Common C2 / air-domain awareness [4]	C2 needs dependable data from distributed sensors and needs to return commands/status to fielded systems.	Transport/PNT resilience underneath the selected C2; redundant routes and local continuity when upstream connectivity is impaired.
Standardized test and evaluation [3], [7]	Claims must be supported by repeatable, comparable data.	Government-observed failure-injection test plan with latency, delivery, recovery, continuity and availability measures.
Marketplace and rapid acquisition [2], [6]	Validated components need a transition path to procurement and deployment.	Package Agent hardware/software as a testable component set with documented interfaces, configuration baseline, BOM and evidence package.
Integrated architecture for border/homeland missions [5]	Fixed and mobile systems must operate over geographically distributed sites.	Mixed fixed/mobile Agents for installations, corridors, vehicles, UAS/UGV and temporary mission nodes.

Key positioning decision

JIATF-401 has already publicly described an enterprise common C2 action using Anduril Lattice. [4] Accordingly, TLTE should not present this concept as a replacement for the government's selected C2. The stronger integration position is to provide communications-path resilience, distributed PNT/TSPI support, edge relay and continuity services that feed the common C2 and connected mission systems.

2. TLTE Technology Elements Relevant to the Mission

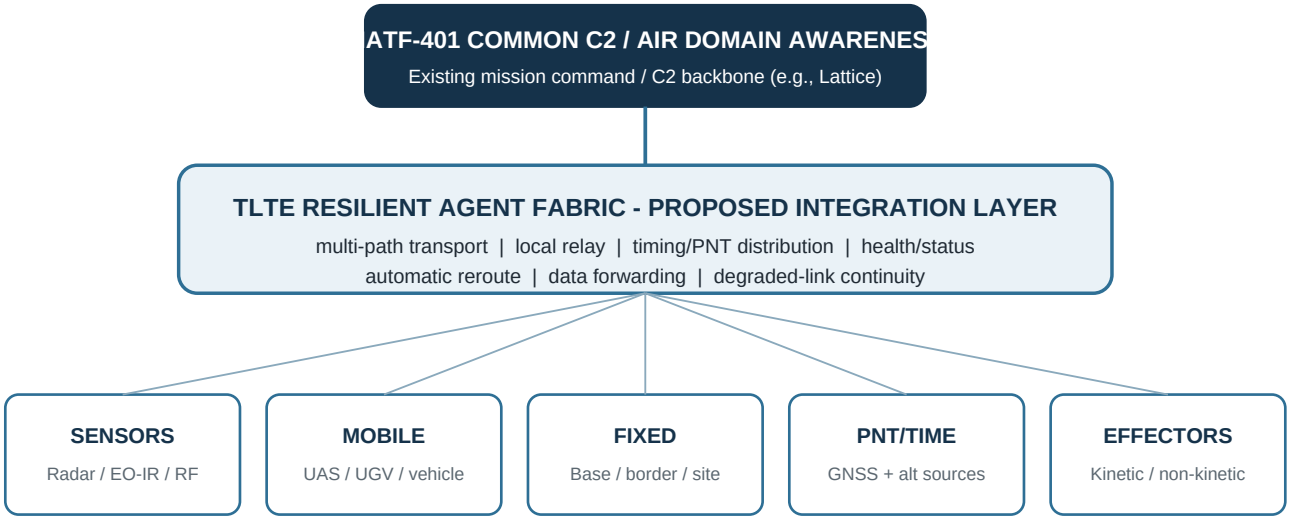
TLTE's relevant portfolio can be organized into six mission functions. Patent-supported baseline concepts are distinguished from proposed extensions that require demonstration.

TLTE element	Role in C-UAS enterprise	Evidence/status framing
Transceiver/Repeater Agent	Addressable communications endpoint and relay that receives, forwards and redistributes mission data across available links.	The granted patent supports device-to-device communications, digital addressing, shared sensor/alert data and situational awareness. The broader military Agent implementation is a proposed engineering extension requiring test. [10]
RGMN / Tedford Global Mesh	Self-healing multi-path topology intended to maintain connectivity as links or Agents are removed or degraded.	Proposed TLTE architecture. Route-recovery behavior, scale, throughput and cyber resilience should be demonstrated under controlled conditions.
Distributed PNT / TSPI support	Distribute position, navigation, timing and track metadata; fuse or hand off among available sources; support continuity during GNSS degradation.	Patent baseline includes GPS positioning and local continuity concepts. Claims of GPS-independent or centimeter-class performance are not treated as proven here and require independent test. [10]
TMOA defense alerting layer	Translate local sensor/track information into mission alerts and shared situational awareness for military users.	Company operational concept; should be evaluated as software logic and data products rather than assumed capability.
Autonomous-system connectivity	Support UAS, UGV and vehicle endpoints that need low-latency state/track exchange and coordinated routing.	Patent contemplates military vehicles and real-time data sharing; autonomous swarm-scale performance remains a test objective. [10]
Ground/fixed/mobile deployment options	Create persistent installation/border infrastructure plus rapidly deployable mobile relay points.	Deployment concept; environmental, RF, power, mobility and maintainability characteristics require configuration-specific verification.

Patent baseline - what can be stated firmly

US 12,142,143 B1, granted November 12, 2024, describes a vehicle alert system with a control module, digital addressing for communication with another device, GPS positioning, sensor-data sharing, alerts, situational awareness, and use in groups that may include military personnel/vehicles. It also describes continuity through local GPS when satellite connection is lost. [10] This is a useful technical foundation, but the patent itself does not prove every performance characteristic of the broader TLTE Agent/global-mesh concept.

3. Proposed System Architecture



Conceptual integration: TLTE augments transport/PNT resilience; it does not replace sensors, effectors, or the government's selected C2.

3.1 Agent functions

- **Addressable endpoint:** each Agent has a unique logical identity and exposes status, link health, timing state and mission-data interfaces.
- **Store/forward/relay:** mission data can traverse intermediate Agents rather than depending on a direct endpoint-to-C2 path.
- **Multi-path routing:** the Agent fabric maintains more than one candidate route when topology and spectrum permit.
- **Automatic reroute:** a lost or degraded link triggers route recomputation and forwarding over an alternate path.
- **Local continuity:** nearby Agents can continue exchanging mission data during upstream disruption, preserving local awareness until higher-level connectivity returns.
- **PNT/time distribution:** Agents carry source quality, time, position and uncertainty metadata so consuming systems can make informed decisions under degraded conditions.
- **Interface gateway:** edge adapters translate approved sensor/C2 messages into transportable data objects without changing the sensor or effector's native mission function.

3.2 Data classes

Data class	Examples	Transport treatment
Track/observation	Position, velocity, classification, confidence, source	Priority; timestamped; sequence-aware; stale-data rejection.
PNT/TSPI	Time, position, source quality, uncertainty, track state	High integrity; provenance retained; quality flags exposed.
Command/status	Tasking, cueing, readiness, engagement state	Authenticated; priority; positive acknowledgement where required.
Network health	Link quality, Agent availability, route state, clock health	Continuous/periodic telemetry for orchestration and operator awareness.
Bulk/noncritical	Logs, maintenance data, software/configuration artifacts	Lower priority; rate-limited during congestion.

4. How the TLTE Concept Addresses the JIATF-401 Task

The mission value is best expressed as operational threads rather than isolated technology features.

Thread A - Common operating picture continuity

A radar, RF detector or EO/IR sensor produces an observation. The local Agent timestamps and forwards the data. If the preferred backhaul is available, the observation reaches the common C2 normally. If that path fails, the Agent fabric selects an alternate route through another fixed or mobile Agent. The objective is that the C2 sees a temporary path change rather than a complete loss of the sensor feed.

Thread B - Cross-domain information movement

Where policy and security architecture permit, gateway Agents can sit at approved boundaries and move only authorized data products between networks. The design goal is not to bypass classification controls; it is to provide a resilient transport substrate to approved cross-domain solutions and data guards.

Thread C - GNSS-degraded operation

Agents distribute timing/PNT source quality and uncertainty, allowing mission systems to recognize when GNSS is degraded and to consume approved alternative/local sources where available. A credible demonstration should deliberately degrade GNSS and measure whether local track continuity, time coherence and data delivery remain usable. This paper does not claim that the current TLTE implementation has already achieved a government-certified GPS replacement.

Thread D - Mobile autonomous systems

Vehicle-, UAS- or UGV-mounted Agents can extend the topology as platforms move. The relevant government question is not whether the mesh is theoretically global; it is whether moving endpoints can join, leave and reroute without unacceptable loss of track or command data. That behavior is directly measurable.

Thread E - Sensor-to-effector chain

TLTE does not need to own the sensor or effector to contribute. The Agent layer can transport observations to C2 and return authorized tasking/status to connected systems. Engagement authority, target identification and weapons release remain in government-approved C2 and operator workflows.

5. Resilience Engineering

Failure / attack condition	Desired Agent behavior	Evidence to collect
Primary communications link lost	Detect degradation; switch to alternate route; report event.	Detection time, route-recovery time, packet loss, operator visibility.
Single Agent removed	Neighboring Agents reconverge around missing relay.	Convergence time, path stretch, delivery ratio, track continuity.
Multiple links degraded	Prioritize critical data; use remaining paths; shed noncritical traffic.	Latency by priority, queue depth, drop rate, critical-message success.
GNSS degraded/spoofed	Flag source quality; preserve source provenance; use approved alternate/local source if configured.	PNT availability, time error, position error, integrity flags, recovery.
Network partition	Maintain local exchange inside surviving partition; reconcile when connectivity returns.	Local mission continuity, data age, reconciliation behavior.
High track density	Scale routing/processing while preserving critical flows.	Tracks/sec, CPU/memory, bandwidth, latency percentile, dropped updates.
Cyber/identity anomaly	Reject unauthenticated endpoint/data; log event; preserve trusted routes.	Authentication failures, alerting, containment, recovery.

Security architecture principles

- Zero-trust assumption at interfaces: authenticate devices, services and data producers before accepting mission traffic.
- Cryptographic protection appropriate to the target security domain; algorithms and key management selected with the government security authority.
- Signed configuration and software artifacts; controlled update process; rollback and audit capability.
- Data provenance retained so the common operating picture can distinguish source, age, confidence and transformation history.
- Least-privilege routing and segmentation; an Agent should not become an uncontrolled bridge between security domains.
- Observable failure: degraded states must be reported to operators and logs rather than hidden by automatic routing.

EMP / environmental resilience: TLTE has discussed EMP-robust deployment concepts. For a government paper, that should be treated as a design objective until the selected Agent hardware, enclosure, power subsystem and interfaces are tested against an agreed standard. The same evidence-first rule applies to temperature, water ingress, shock, vibration and electromagnetic compatibility.

6. PNT / TSPI Role in the Counter-UAS Architecture

Counter-UAS is fundamentally a time-and-position problem as well as a sensing and defeat problem. Tracks from different sensors cannot be fused reliably if their timestamps, coordinate frames or uncertainty are inconsistent. JIATF-401's FY2027 budget material also emphasizes open-architecture interfaces, decision-support tools and system integration around a common C2. [9]

PNT/TSPI function	TLTE proposed mechanism	Government value
Time distribution	Agents distribute time plus source/quality metadata.	Consistent timestamping for multi-sensor correlation and track fusion.
Position distribution	Agents carry endpoint position and uncertainty.	Supports mobile sensor/effector registration and track geometry.
Source diversity	Allow configured GNSS, local, inertial, network or other approved sources.	Reduces single-source dependence; enables graceful degradation.
Integrity awareness	Propagate source health, age and confidence rather than only a coordinate.	Lets C2 reject or de-weight suspect data.
TSPI continuity	Maintain time-space-position information exchange across alternate network paths.	Preserves a coherent operational picture during communications disruption.

What should be demonstrated before making stronger PNT claims

- Absolute and relative time error against a traceable reference.
- Absolute and relative position error for fixed and mobile Agents.
- Holdover performance after loss of primary time/PNT source.
- Spoof/jam detection behavior and integrity flagging.
- Time-to-recover after source restoration or handoff.
- Effect of PNT degradation on track correlation, route selection and sensor-to-effector latency.

7. Interoperability with Existing JIATF-401 C2

JIATF-401's March 2026 enterprise action established Lattice as a common C2 path for air-domain awareness and interoperability. [4] The TLTE concept should therefore enter through open, documented interfaces and prove that it improves resilience without forcing the government to replace its selected mission-command environment.

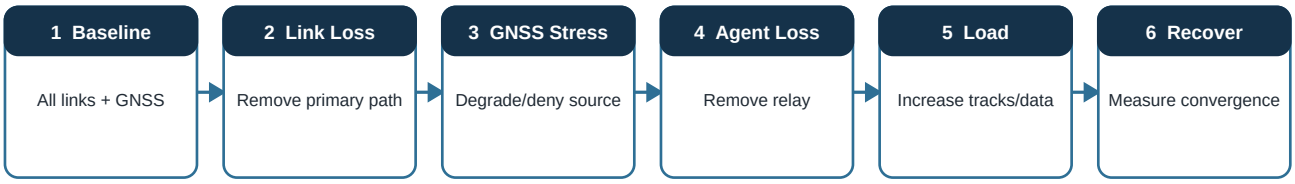
Recommended interface posture

- **Northbound:** publish sensor/track/network-health/PNT products to the common C2 through government-approved APIs or message buses.
- **Southbound:** ingest observations/status from radar, RF, EO/IR, passive sensors, mobile platforms and other approved sources.
- **East-west:** Agent-to-Agent transport for redundant routing and local continuity.
- **Effector side:** carry authorized cueing/tasking/status messages; do not embed autonomous lethal authority in the transport layer.
- **Data model:** preserve timestamps, coordinate reference, confidence, source identity and uncertainty so the receiving C2 can reason about data quality.

Open-architecture principle

A successful TLTE integration should be replaceable at the interface boundary. That is a strength, not a weakness: government buyers can evaluate the Agent fabric as a modular component while retaining competition among sensors, effectors, C2 applications and communications bearers. The value proposition is resilience and continuity across heterogeneous components.

8. Proposed 10-20 Agent Government-Observed Demonstration



Primary measures: end-to-end latency | packet delivery | route recovery | track continuity | PNT availability | operator-visible faults

All performance thresholds should be government-approved before test; no unverified TLTE performance number is treated as proven in this paper.

Configuration

- 10-20 mixed Agents: fixed, vehicle/mobile and at least one moving aerial/robotic endpoint if permitted.
- At least two independent communications paths/bearers so rerouting is physically meaningful.
- One or more representative sensor feeds or recorded/replayed track sources.
- A government-selected C2 endpoint or surrogate interface that consumes tracks/status.
- Primary GNSS/time source plus at least one approved alternate/local timing or positioning source if available.
- Instrumentation independent of the TLTE application for latency, packet capture, time reference and event logging.

Test events and measures

Event	Action	Primary measures
Baseline	Run nominal topology and representative track load.	Latency distribution, delivery ratio, bandwidth, CPU/memory, PNT error.
Primary-path loss	Physically disable or isolate the preferred route.	Detection time, route recovery, packets lost, track gap duration.
Agent removal	Power down/remove one then multiple relay Agents.	Convergence, alternate path formation, service continuity.
GNSS degradation	Use approved lab/range method to deny/degrade source.	Integrity indication, holdover, alternate-source behavior, track impact.
Load increase	Increase track/update rate and noncritical traffic.	Critical-flow latency, queue/drop behavior, saturation point.
Partition/rejoin	Split network, operate locally, restore connection.	Local continuity, data age, reconciliation, duplicate/stale handling.

Acceptance thresholds: TLTE should not invent them. JIATF-401 or the sponsoring test organization should approve mission-relevant thresholds before execution. TLTE can propose targets, but the final pass/fail criteria should be government-owned and traceable to the use case.

9. Evidence Package for JIATF-401 Evaluation

To align with JIATF-401's standardized evaluation approach, the demonstration should produce a reusable evidence package rather than a marketing-only report. [3], [7]

Artifact	Contents
System description	Hardware/software baseline, Agent roles, topology, interfaces, data flows, dependencies.
Test plan	Use cases, threat/failure conditions, instrumentation, procedures, thresholds, safety constraints.
Raw data	Packet/event logs, timing traces, PNT truth/reference data, resource utilization, configuration snapshots.
Results report	Measured values with distributions, not only averages; anomalies and failed runs retained.
Cyber package	Architecture, identity/authentication approach, software provenance, SBOM where applicable, vulnerability handling.
Interface control document	Northbound/southbound/east-west messages, schemas, timing, error handling and versioning.
Transition package	BOM, manufacturing path, installation, training, sustainment, spares, software update and licensing assumptions.

Recommended decision gates

Gate	Decision
G0 - Paper review	Is the concept relevant enough to sponsor an integration/test planning session?
G1 - Bench integration	Can Agents exchange representative mission data through approved interfaces?
G2 - Resilience demo	Does the network recover from injected link/Agent/PNT failures within approved thresholds?
G3 - Operational assessment	Does the capability improve mission continuity in a representative field environment?
G4 - Transition	Is the evidence sufficient for marketplace/component inclusion, prototype follow-on, contract vehicle, or other acquisition path?

10. Acquisition and Transition Fit

JIATF-401 has demonstrated that it can move validated technology into operational procurement through the counter-UAS marketplace, existing contract vehicles, prototype purchases and other rapid actions. The marketplace is designed around validated systems and components and is being expanded as new technologies are developed and companies request inclusion. [2], [6]

A disciplined TLTE transition sequence

Step	TLTE action	Government outcome sought
1. Technical interchange	Present this architecture and identify one bounded mission gap.	Sponsor/technical owner agrees on testable problem.
2. Interface definition	Map Agent interfaces to selected C2/sensor environment.	Integration plan and data-rights/security boundaries.
3. Prototype configuration	Build/assemble a controlled 10-20 Agent baseline.	Configuration ready for independent observation.
4. Standardized test	Execute agreed failure-injection and interoperability events.	Comparable evidence aligned to JIATF-401 T&E; principles.
5. Operational assessment	Place Agents in representative installation/border/field scenario.	User feedback and mission-effect evidence.
6. Acquisition decision	Package validated component and sustainment data.	Marketplace, contract, prototype follow-on, or other authorized transition route.

The strongest near-term ask is therefore not a claim that TLTE should immediately receive enterprise deployment funding. It is a request for a technical interchange and government-observed integration/resilience demonstration tied to JIATF-401's common-operating-picture and interoperability objectives.

11. Risks, Boundaries and Mitigations

Risk / boundary	Why it matters	Mitigation
Unverified performance claims	Unsupported latency, range, PNT accuracy or survivability claims weaken credibility.	Use measured values only; pre-register instrumentation and thresholds.
Existing common C2 already selected	A replacement-C2 pitch conflicts with current enterprise direction.	Integrate under/alongside selected C2; prove transport/PNT resilience.
Spectrum / RF constraints	Mesh performance depends on bearers, power, terrain, congestion and policy.	Define bearer-specific configurations and test in representative spectrum conditions.
Cyber accreditation	A new relay fabric increases attack surface if identity and software assurance are weak.	Zero-trust identity, signed software/config, SBOM, logging, segmentation and government security review.
Cross-domain security	Moving data between domains is tightly controlled.	Use approved guards/CDS; TLTE provides transport to the boundary, not policy bypass.
PNT overclaim	Alternative PNT is a high-consequence claim.	Characterize source quality, uncertainty, holdover and integrity; independent truth reference.
Scale extrapolation	10-20 Agent success does not automatically prove theater/global scale.	Progressive scaling tests and modeling calibrated with measured data.
Environmental survivability	Fielded Agents may face heat, water, shock, vibration, EMI/EMC and power interruption.	Configuration-specific qualification against government-selected standards.

12. Proposed Government Discussion Questions

A productive first technical interchange should answer the following:

- Which JIATF-401 mission thread has the highest unmet resilience need: installation defense, border operations, major-event security, expeditionary operations, or another use case?
- Which common C2 interface and representative sensor/effector interfaces should be used for the first demonstration?
- What data types and security domains must the Agent fabric carry, and what cross-domain boundaries are in scope?
- What are the government-owned thresholds for route recovery, track continuity, latency, delivery, PNT availability and operator-visible fault reporting?
- Which communications bearers should be represented so that multi-path recovery is operationally meaningful?
- What PNT/time sources and truth references should be used for GNSS-degraded testing?
- Which JIATF-401 standardized T&E; data fields and evidence formats must be captured?
- What transition mechanism is appropriate if the component meets thresholds: marketplace inclusion, prototype action, existing contract vehicle, or another authorized path?

Requested next action

TLTE requests consideration for a technical interchange focused on a bounded resilience demonstration. The proposed objective is to determine, through government-observed measurements, whether a 10-20 Agent TLTE fabric can maintain mission-data and PNT/TSPI continuity across injected communications, Agent and GNSS-source failures while interfacing with the government's selected counter-UAS C2 environment.

Conclusion

JIATF-401's stated mission is moving toward an integrated counter-UAS enterprise: shared air-domain awareness, interoperable sensors/effectors/mission command, standardized evidence, rapid acquisition and operational employment. [1]-[8] That direction creates a specific technical question for TLTE: can its distributed Agent concept keep the information and PNT/TSPI layer functioning when the normal path is degraded?

TLTE's granted patent provides a documented baseline in device-to-device communication, digital addressing, sensor-data sharing, positioning and situational awareness. [10] The broader self-healing mesh, autonomous-system, alternative-PNT and contested-environment claims should now be converted into measurable engineering evidence. That is the central recommendation of this paper.

Strategic proposition: TLTE should be evaluated as a resilient enabling layer - connecting and sustaining the flow of trusted sensor, track, command, status and PNT/TSPI information across heterogeneous counter-UAS systems - rather than as a replacement for the government's selected sensors, effectors or common C2.

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Source note. Government mission statements and acquisition facts in this paper are based on the cited public sources. TLTE architectural descriptions are company-proposed concepts unless explicitly tied to the granted patent. No government source cited here states that TLTE has been selected, funded, validated, or placed in the JIATF-401 marketplace.

Authorized Signatories

This edition contains the same technical content as the companion edition. Only the order of the two authorized signatories is reversed for the originating contact.

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