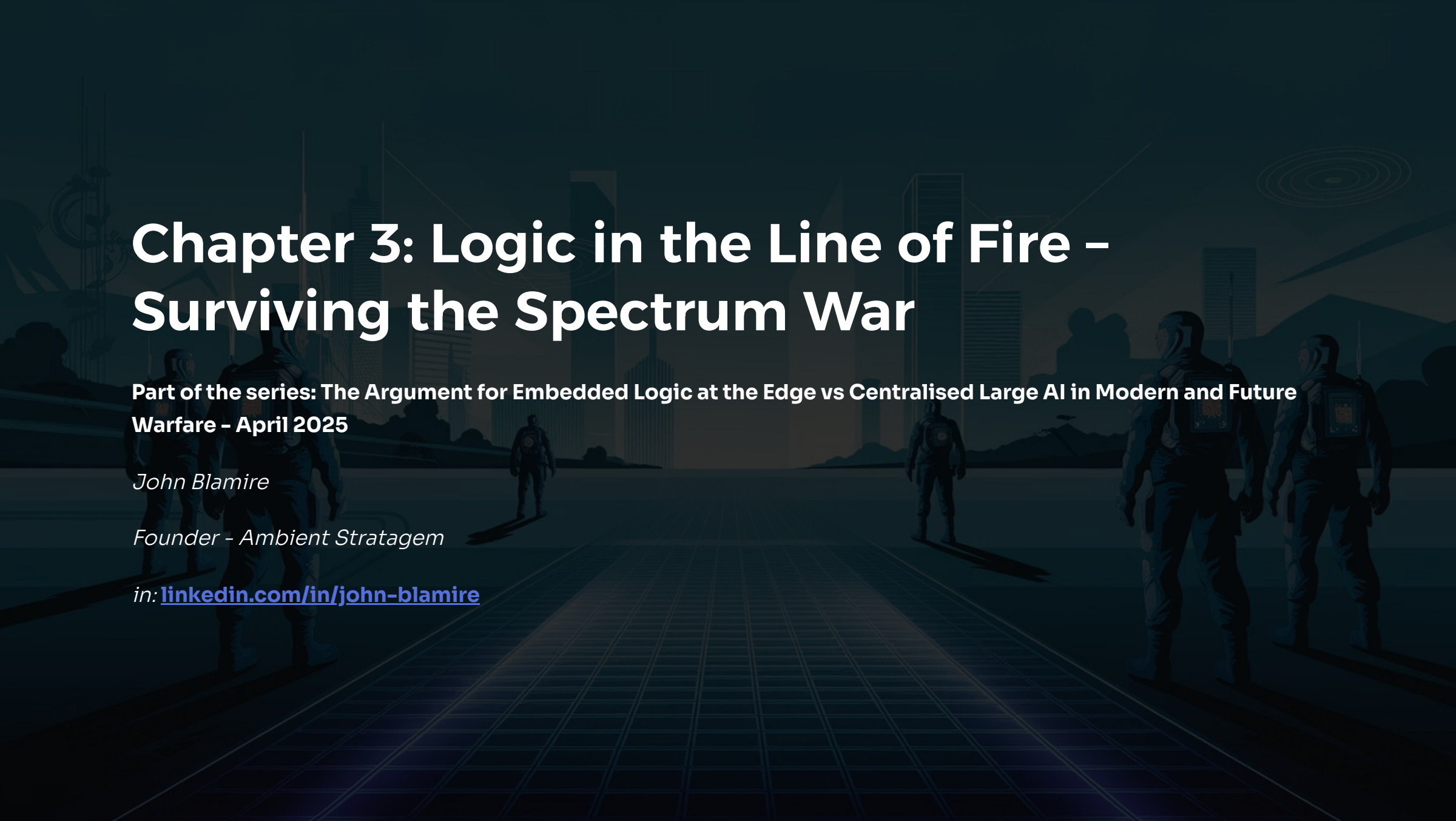

Chapter 3: Logic in the Line of Fire – Surviving the Spectrum War

Part of the series: The Argument for Embedded Logic at the Edge vs Centralised Large AI in Modern and Future Warfare – April 2025

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The Electromagnetic Battlefield

> "The side that dominates the electromagnetic spectrum will own the decision space."
> — General David Petraeus, Former Commander, US Central Command

Today's battlefield is shaped less by terrain and more by signals, noise, and silence. Victory increasingly depends not on how far or fast a weapon can fire—but on whether it can function at all when its signals are jammed, its GPS is spoofed, or its data stream is cut mid-mission.

This chapter examines how modern warfare has become a spectrum war, and why AI must be designed to operate as if connectivity is optional. Logic must survive contact with the enemy. And that means logic must live at the edge.

The Electromagnetic Spectrum Is Now a Weapon

Military strategists have long regarded the spectrum as a domain—but today, it is an actively contested battlespace. Adversaries now possess the ability to:

- Jam communications across tactical and strategic frequencies.
- Spoof GPS signals, redirecting drones or confusing navigation systems.
- Deny access to satellite links and target emitting systems with EW-enabled kinetic strikes.
- Hack or disrupt commercial satellites supporting military systems.

This is not theoretical. It is already shaping operations in Ukraine, Gaza, the Red Sea, and the Indo-Pacific.

> "The kill chain is only as strong as your weakest signal." — NATO Cyber Defence Planner, 2025

Case Study: Gaza, October 2024

During a major escalation in the Israel-Gaza conflict, Israel's border-monitoring AI—heavily reliant on centralised visual pattern recognition—collapsed under coordinated cyber and electromagnetic assault.

Disrupted Surveillance

Disruption to uplinks rendered border cameras ineffective.

Cloud Failure

Cloud-based logic models failed to update or respond to real-time events.

Legacy Fallback

Edge-based legacy systems were reactivated as a stopgap.

The lesson: even the most sophisticated AI systems are vulnerable if they require a functioning digital ecosystem. The battlefield is not an ecosystem. It is a desert of disrupted signals and adversarial intent.

Embedded Logic: Built for Degradation

Resilient AI must be:

Silent when needed

Able to operate without emitting detectable signals.

Autonomous under duress

Able to function without external guidance.

Modular and mission-specific

Able to adapt logic for different threat environments.

This approach mirrors the design logic of hardened military systems:

- Stealth aircraft operate with strict EMCON protocols.
- Submarines function without communication for days or weeks.
- Forward units often operate under radio silence.

AI must follow suit.

> "In a spectrum-denied zone, your only friend is the logic you brought with you."
> — British Army Signals Officer, 2024

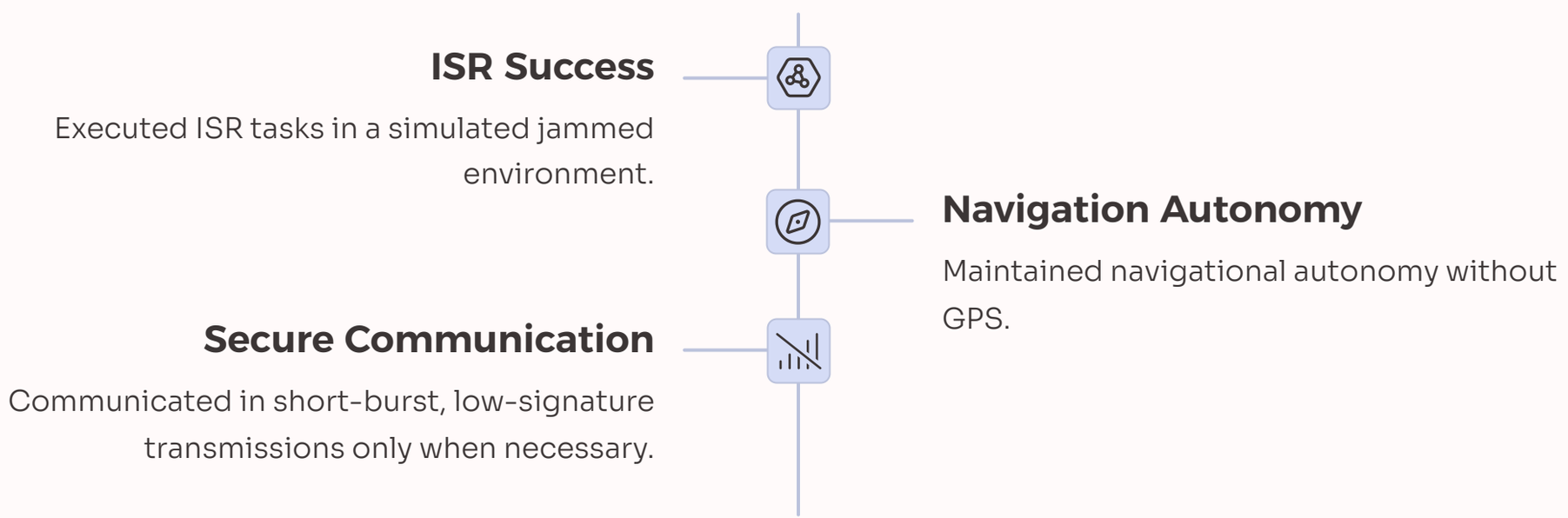
Design Principles for AI Survivability

To survive in contested EM environments, logic systems must:

- Pre-load mission-relevant decision trees and classifiers before deployment.
- Use low-power, low-emission chipsets to reduce detection risk.
- Rely on deterministic, state-aware processing, not constant data retrieval.

One emerging methodology is the use of Stateful Data Flow Graphs (SDFGs) to build logic that behaves more like hardware than software—predictable, fast, and self-contained.

In a NATO trial (Black Sea, March 2025), a prototype system based on this model successfully:



The cloud-based alternative failed after 12 minutes of denial conditions.

The New Role of Embedded AI in Spectrum War

The battlefield has moved beyond full-spectrum dominance. It has entered a phase of spectrum survival. Systems must be able to:

Think locally

Not wait for server permission.

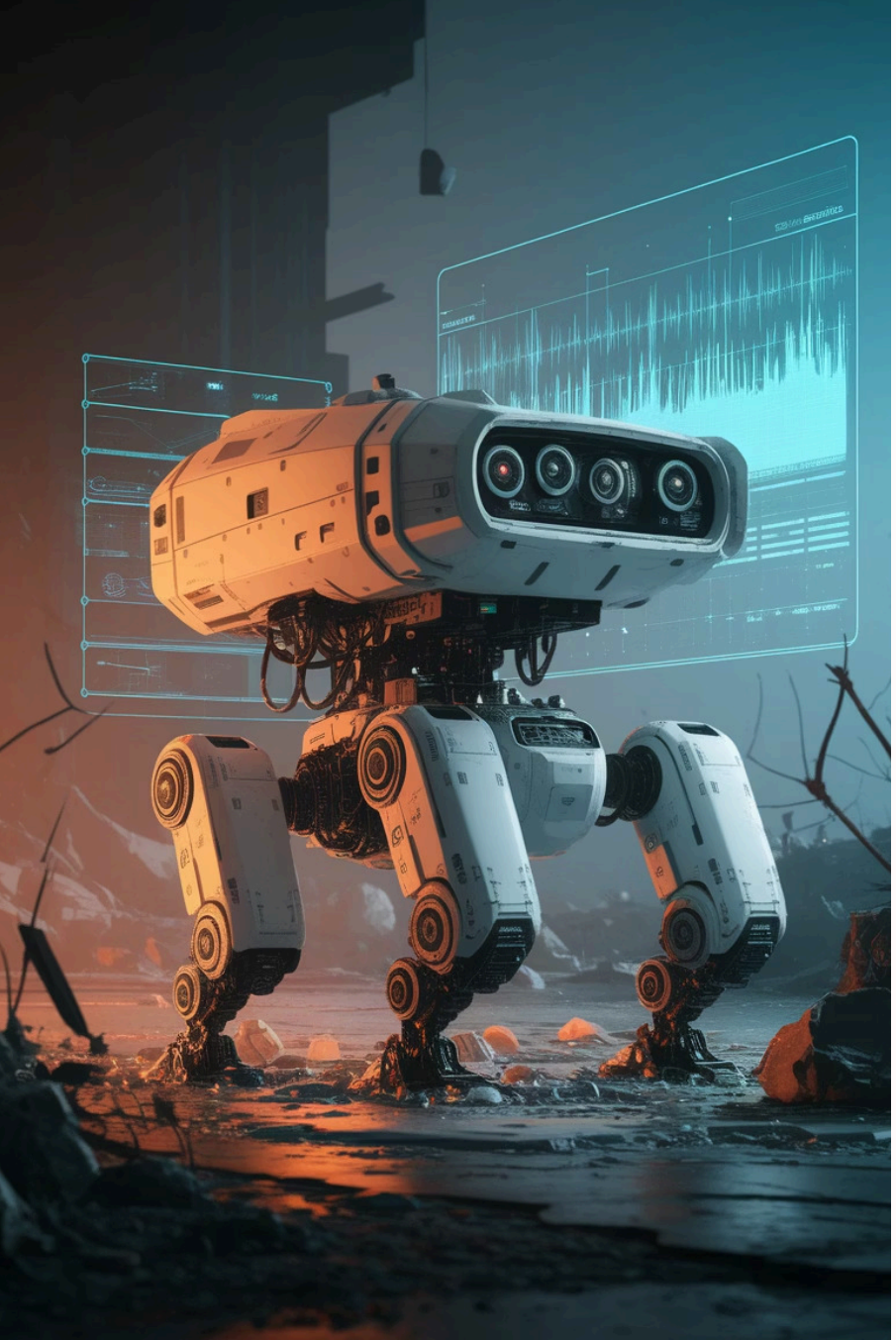
Degrade intelligently

Choosing next-best actions based on available data.

Continue functioning

Even when everything else goes dark.

This makes embedded logic not a luxury—but a requirement for operational continuity.



Conclusion

The logic we embed is now as important as the steel we armour or the stealth we shape. In spectrum warfare, only embedded logic will keep fighting when the rest of the system collapses.

AI that survives must be AI that does not assume it will be connected, supported, or safe. It must assume it is alone—and be good enough to win anyway.

NEXT - Chapter 4: Sovereign by Design – The Geopolitical Imperative of Embedded AI

Continue reading to explore how embedded AI systems impact national security and sovereignty in modern warfare.