A Systemic Theory of Escalation and the Loss-of-Control Threshold in Networked Conflict

Author: Shaoyuan Wu

ORCID: https://orcid.org/0009-0008-0660-8232

Affiliation: Global AI Governance and Policy Research Center, EPINOVA LLC

Date: March 20, 2026

Working Paper

F-Series Information:
The WP-F series explores AI governance and strategic risk through comparative and historical diagnostics, examining how inherited strategic and regulatory logics break down when transferred into AI-mediated contexts.

Recommended Citation:
Wu, Shaoyuan. (2026). *A Systemic Theory of Escalation and the Loss-of-Control Threshold in Networked Conflict* (EPINOVA Working Paper No. EPINOVA–WP–F–2026–09). Global AI Governance and Policy Research Center, EPINOVA LLC. https://doi.org/10.5281/zenodo.19139977.

Disclaimer:
This working paper presents diagnostic and exploratory analysis intended to examine inherited strategic and governance logics under AI-mediated conditions. It does not constitute policy recommendations, predictive assessments, or official positions of any institution.

Abstract

Contemporary escalation increasingly unfolds not as a sequence of discrete strategic decisions, but as an endogenous process generated by interactions among interconnected military, political, economic, and informational systems. Existing approaches remain largely event-centered or outcome-oriented, focusing on escalation choices or on which actor is most likely to lose control first. This article advances a different perspective by theorizing how loss of control emerges.

It conceptualizes the loss-of-control threshold (LoCT) as a dynamic state-transition condition arising when cumulative systemic pressure exceeds an actor's capacity to regulate escalation. To formalize this process, the article develops an integrated framework linking three dynamically coupled components: the Systemic Pressure Index (SPI) as a time-varying measure of multi-domain stress accumulation; the Operational Node Criticality Score (ONCS) as a structural mechanism through which localized disruptions generate disproportionate system-level effects; and a perception layer that mediates escalation through information distortion, amplification, and recursive feedback. The framework further captures how operational constraints and access conditions shape the propagation of systemic pressure.

The analysis shows that escalation in networked conflict is driven by nonlinear accumulation, cross-domain propagation, and perception-mediated interaction rather than by isolated decisions. Loss of control emerges not as an *ex post* outcome, but as an endogenous threshold condition produced by the joint dynamics of rising systemic pressure, declining control capacity, and deteriorating sustainment capacity.

By shifting the analytical focus from discrete events and decision points to the dynamic conditions under which control becomes structurally unsustainable, the article contributes a generalizable framework for explaining escalation in contemporary networked conflict.

Keywords: loss-of-control threshold (LoCT); systemic escalation; networked conflict; Systemic Pressure Index (SPI); Operational Node Criticality Score (ONCS); nonlinear dynamics; information feedback; escalation theory

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1. Introduction

Existing escalation theory has provided powerful tools for understanding coercion, signaling, and strategic interaction (Kahn, 1965; Schelling, 1966; Jervis, 1976). Yet much of this literature remains anchored in an event-centered view of conflict, conceptualizing escalation as a sequence of discrete moves, ladders, or bargaining choices (Kahn, 1965; Schelling, 1966). Even when contemporary analyses acknowledge uncertainty, feedback, or threshold effects, they often remain oriented toward an outcome-based question: which actor is most likely to lose control first (Wu, 2026e)?

This article starts from a different premise. The central analytical task is not to identify the most vulnerable actor ex ante, but to explain how loss of control emerges as a systemic process under conditions of networked interdependence, cumulative pressure, and perception-mediated interaction (Farrell & Newman, 2019; Helbing, 2013; Jervis, 1976).

This shift is necessary because contemporary conflict increasingly unfolds in environments defined by tightly coupled operational systems, distributed infrastructures, and high-velocity information flows (Cebrowski & Garstka, 1998; Alberts et al., 2000; Rinaldi et al., 2001; Helbing, 2013). Under these conditions, escalation is no longer governed solely by intentional choice or centralized command. Military operations generate pressures that spill across domains; disruptions propagate through interdependent networks; and information environments reshape how events are perceived, interpreted, and acted upon. The result is a form of escalation that is not simply chosen, but progressively produced by the interaction of structural and dynamic forces (Rinaldi et al., 2001; Hoskins & O'Loughlin, 2015; Wu, 2026b).

In such settings, control cannot be treated as a fixed attribute of leadership, doctrine, or political will (Helbing, 2013; Farrell & Newman, 2019). It is better understood as a contingent property of the system itself: a function of resilience, absorptive capacity, adaptive flexibility, and the integrity of operational and informational networks. Actors may therefore retain material capability while simultaneously losing control over escalation dynamics. What matters is not only whether they can continue to act, but whether their systems can still absorb pressure, maintain coordination, and prevent reinforcing feedback loops from driving conflict beyond manageable bounds (Jervis, 1976; Helbing, 2013).

To capture this problem, the article develops the concept of the loss-of-control threshold (LoCT) (Wu, 2026e). LoCT is defined not as a static tipping point or a retrospective label for strategic failure, but as a dynamic state-transition condition (Wu, 2026e; Helbing, 2013). It is reached when accumulated systemic pressure exceeds an actor's capacity to regulate escalation. In this formulation, the critical issue is not a single decision, strike, or miscalculation in isolation, but the convergence of multiple processes that together make control structurally unsustainable (Wu, 2026e).

The argument proceeds in three steps. First, the article reconceptualizes escalation as a systemic process generated through the interaction of accumulation, coupling, and information amplification. Second, it formalizes the relationship between systemic pressure and control capacity through a threshold framework centered on LoCT. Third, it introduces two analytical constructs—the Systemic Pressure Index (SPI) and the Operational Node Criticality Score (ONCS) together with a perception layer, in order to explain how localized shocks can be amplified into system-level instability (Wu, 2026a, 2026b, 2026c).

The article makes three contributions. First, it reconceptualizes escalation as a state-dependent process unfolding across military, economic, political, and informational domains rather than as a sequence of discrete decisions. Second, it formalizes the relationship between rising systemic pressure and shifting control capacity through a dynamic threshold framework. Third, it provides a generalizable analytic language linking cumulative pressure, network structure, and informational distortion in networked conflict environments.

The broader claim is straightforward but consequential: in contemporary networked conflict, escalation is best understood not as a ladder to be climbed, but as a system trajectory approaching a critical boundary. The central question is therefore not simply whether actors choose to escalate, but whether their systems can continue to sustain control as pressure accumulates and propagates across interconnected domains (Wu, 2026e).

2. Systemic Escalation as a Dynamic Process

Escalation in contemporary conflict is increasingly generated by interacting system-level dynamics rather than by discrete strategic decisions. While traditional models conceptualize escalation as a sequence of intentional moves, this perspective becomes insufficient in environments characterized by high interdependence, multi-domain interaction, and rapid information feedback (Rinaldi et al., 2001; Helbing, 2013; Hoskins & O'Loughlin, 2015).

This article conceptualizes escalation as an endogenous system trajectory—a process produced by the interaction of underlying mechanisms that operate continuously over time. Specifically, escalation is driven by three mutually reinforcing dynamics: **pressure accumulation, system coupling, and information amplification** (Helbing, 2013; Wu, 2026b).

These mechanisms do not operate sequentially but simultaneously. Their interaction determines whether localized disruptions remain contained or evolve into system-level instability (Helbing, 2013; Wu, 2026b). Formally, escalation can be expressed as:

$$\boldsymbol{Escalation}(\boldsymbol{t}) = \boldsymbol{f}(\boldsymbol{A}(\boldsymbol{t}), \boldsymbol{C}(\boldsymbol{t}), \boldsymbol{I}(\boldsymbol{t})) \tag{2.1}$$

where, $A(t)$ denotes accumulated systemic pressure; $C(t)$ captures the degree of system coupling; and, $I(t)$ represents the intensity of information-mediated amplification.

2.1 Pressure Accumulation

Operational activity generates cumulative and path-dependent stress across multiple domains, including military, economic, political, and informational systems (Helbing, 2013; Wu, 2026b).

Crucially, systemic pressure is non-resetting (Helbing, 2013). Actions do not dissipate prior stress but instead build upon an evolving baseline. As a result, escalation dynamics are inherently path-dependent: the effect of any given action depends on the level of accumulated pressure at the moment it occurs.

This cumulative structure produces two key effects. First, pressure accumulation is nonlinear. Identical actions may generate different outcomes depending on the system's prior stress level. Second, accumulation progressively reduces the system's tolerance for additional shocks, increasing sensitivity to marginal perturbations (Wu, 2026b).

The implication is that escalation does not require large discrete shocks. Even low-intensity, sustained inputs can gradually push the system toward instability.

Proposition 1 (Accumulation Effect). The marginal impact of any action on escalation increases as accumulated systemic pressure rises.

2.2 System Coupling

Contemporary conflict systems are characterized by dense interdependence across domains and infrastructures, including logistics, energy, communications, and command systems (Rinaldi et al., 2001; Farrell & Newman, 2019).

Under conditions of high coupling, disruptions do not remain localized. Instead, they propagate across interconnected nodes and domains, producing cascading effects whose magnitude depends on network structure rather than initial shock size (Rinaldi et al., 2001; Helbing, 2013).

Two structural features are particularly important. First, connectivity determines the number of pathways through which disruptions can spread. Second, dependency relationships determine how strongly system components rely on one another. Systems that combine high connectivity with strong dependencies are especially prone to cascade dynamics.

As a result, escalation becomes a function of network topology. Localized actions can generate disproportionate system-level effects when they occur within highly interconnected structures (Farrell & Newman, 2019; Wu, 2026a).

Proposition 2 (Coupling Effect). The systemic impact of localized disruption increases with the degree of interdependence across networked systems.

2.3 Information Amplification

Escalation is not driven solely by material conditions (Jervis, 1976; Hoskins & O’Loughlin, 2015; Nye, 2010). It is mediated by information environments that shape perception, interpretation, and response.

This mediation produces a structural divergence between actual system conditions and their perceived representations:

$$\boldsymbol{State_{perceived} \neq State_{actual}} \tag{2.2}$$

This divergence arises from mechanisms such as selective amplification, narrative framing, strategic signaling, and information distortion. These processes are endogenous to modern information environments rather than exogenous noise (Jervis, 1976; Hoskins & O’Loughlin, 2015).

The consequences are significant. First, perception can compress decision timelines by generating urgency independent of material conditions. Second, it can amplify perceived threats, leading actors to respond to interpreted rather than actual system states. Third, it can destabilize signaling, increasing the risk of miscalculation and escalation.

As a result, escalation becomes partially decoupled from objective conditions and increasingly driven by perception-mediated dynamics (Jervis, 1976; Wu, 2026c).

Proposition 3 (Perception Effect). Escalation dynamics are shaped by perceived system conditions, which may diverge systematically from underlying material states.

2.4 Interaction and System Trajectory

The three mechanisms: accumulation, coupling, and information amplification interact recursively rather than independently (Helbing, 2013; Wu, 2026b). Accumulation raises baseline systemic pressure, coupling increases the propagation of disruptions, and information amplification accelerates interpretation and response.

Together, these interactions produce nonlinear escalation trajectories. Systems may appear stable under repeated shocks until structural conditions align, at which point escalation accelerates rapidly. Escalation is therefore not determined by any single mechanism in isolation, but emerges from their interaction over time (Helbing, 2013).

Proposition 4 (Interaction Effect). Escalation emerges from the interaction of accumulation, coupling, and information amplification, producing nonlinear and path-dependent system trajectories.

2.5 Implication: From Decisions to Dynamics

Taken together, these mechanisms imply that escalation is better understood as a continuous process of system evolution than as a sequence of discrete decisions. Individual actions matter not only because of their immediate effects, but because of how they interact with accumulated pressure, network structure, and perception-mediated feedback. The analytical task is therefore not simply to identify decision points, but to explain how interacting system dynamics generate trajectories that approach instability (Helbing, 2013; Wu, 2026e).

3. The LoCT Framework as a State Transition Model

The concept of a threshold is central to understanding escalation, yet it is often treated as a static tipping point or an *ex post* label for failure (Kahn, 1965; Schelling, 1966). This article reconceptualizes LoCT as a dynamic state-transition condition within an evolving system (Wu, 2026e).

Rather than marking a discrete event, LoCT defines the boundary at which an actor’s system shifts from controlled adaptation to endogenous instability. Control, in this formulation, is not binary but continuous and state-dependent: systems can absorb, redistribute, and regulate pressure up to a point, beyond which regulatory capacity degrades and escalation dynamics become self-reinforcing.

This transition is not triggered by a single shock. It emerges from the interaction of cumulative pressure, structural coupling, and perception-mediated feedback. LoCT therefore captures a system-level regime change, not an isolated decision or event (Wu, 2026e; Helbing, 2013).

3.1 State Space and System Regimes

At any time t, an actor's system can be represented as occupying one of four dynamic states:

$$\boldsymbol{State_i(t)} \in \{\boldsymbol{Stable}, \boldsymbol{Strained}, \boldsymbol{Critical}, \boldsymbol{Uncontrolled}\}$$

(3.1)

These states correspond to qualitatively distinct regimes defined by the relationship between systemic pressure and adaptive capacity (Helbing, 2013).

- **Stable:** Pressure remains well within absorptive capacity; disturbances are dampened.
- **Strained:** Pressure accumulates but remains manageable through adaptation.
- **Critical:** The system operates near its capacity limit; sensitivity to shocks is high.
- **Uncontrolled:** Regulatory mechanisms break down; escalation becomes self-reinforcing.

Transitions between these states are nonlinear and path-dependent. Movement is not necessarily gradual; small perturbations may trigger abrupt shifts when the system approaches its critical boundary.

The transition from **Critical** to **Uncontrolled** defines the crossing of the loss-of-control threshold (Wu, 2026e).

3.2 Formal Definition of LoCT

The loss-of-control threshold is defined as:

$$\boldsymbol{LoCT_i}\text{: } \boldsymbol{SPI_i(t)} \geq \boldsymbol{\theta_i(t)}$$

(3.2)

where, $SPI_i(t)$: denotes the Systemic Pressure Index; and, $\theta_i(t)$ denotes time-varying control capacity.

This condition specifies the point at which systemic pressure exceeds the system's ability to regulate escalation.

3.3 The Moving Boundary: Dynamic Threshold Capacity

A central feature of LoCT is that the threshold $\theta_i(t)$is dynamic and endogenous, not fixed (Wu, 2026e). Control capacity evolves over time as a function of resource availability and depletion, infrastructure resilience and redundancy, institutional coherence and decision capacity, and information integrity and signaling credibility.

Under sustained stress, these factors tend to degrade, causing $\theta_i(t)$to decline. At the same time, adaptive responses, such as resource mobilization or external support, may temporarily stabilize or increase capacity.

As a result, LoCT is best understood as a moving boundary defined by the interaction between rising pressure and shifting capacity:

$$\boldsymbol{Escalation\ Risk} \sim \boldsymbol{SPI_i(t)} \uparrow \ \textbf{and/or}\ \boldsymbol{\theta_i(t)} \downarrow \qquad \textbf{(3.3)}$$

This formulation implies that systems may cross LoCT not only through increasing pressure, but also through declining control capacity (Wu, 2026e).

Proposition 5 (Moving Boundary Effect). The likelihood of crossing the loss-of-control threshold increases with either rising systemic pressure or declining adaptive capacity, reflecting a dynamically shifting boundary.

3.4 Multi-Domain Aggregation

LoCT is inherently multi-domain (Rinaldi et al., 2001; Wu, 2026b). Systemic pressure is not confined to a single domain but emerges from the aggregation of stress across military systems (attrition, operational tempo), economic systems (resource depletion, infrastructure disruption), political systems (legitimacy, decision coherence), and informational systems (narrative pressure, signaling distortion).

Because these domains are structurally coupled, pressure propagates across them, amplifying total system stress. This implies that threshold proximity cannot be inferred from any single domain. A system may appear stable militarily while approaching LoCT through economic or political strain (Rinaldi et al., 2001).

Proposition 6 (Multi-Domain Effect). The probability of loss of control increases with aggregated cross-domain pressure rather than domain-specific stress alone.

3.5 Phase Transition Dynamics

LoCT can be interpreted as a nonlinear phase transition in system behavior (Helbing, 2013).

- **Below threshold:** feedback mechanisms are predominantly dampening.
- **Near threshold:** the system enters a critical regime; sensitivity increases sharply.
- **Above threshold:** feedback loops become self-reinforcing; escalation accelerates.

This transition exhibits classic features of critical systems: nonlinearity, disproportionate response to small perturbations, and rapid regime shift. Escalation may therefore appear stable until the system approaches its critical boundary, after which it accelerates rapidly (Helbing, 2013).

Proposition 7 (Criticality Effect). As systemic pressure approaches control capacity, the system becomes increasingly sensitive to marginal perturbations, increasing the likelihood of abrupt escalation.

3.6 Interpretation: From Event to Condition

LoCT is best understood as a condition rather than an event. Loss of control emerges when system dynamics produce a configuration in which regulatory capacity becomes structurally insufficient. The key implication is that escalation is driven not only by shocks themselves, but by the evolving relationship between pressure, capacity, and feedback near the threshold (Wu, 2026e; Helbing, 2013).

Figure 1 illustrates the LoCT framework as the interaction between systemic pressure accumulation $SPI_i(t)$and dynamically evolving control capacity $\theta_i(t)$, highlighting the nonlinear boundary separating controlled and uncontrolled regimes.

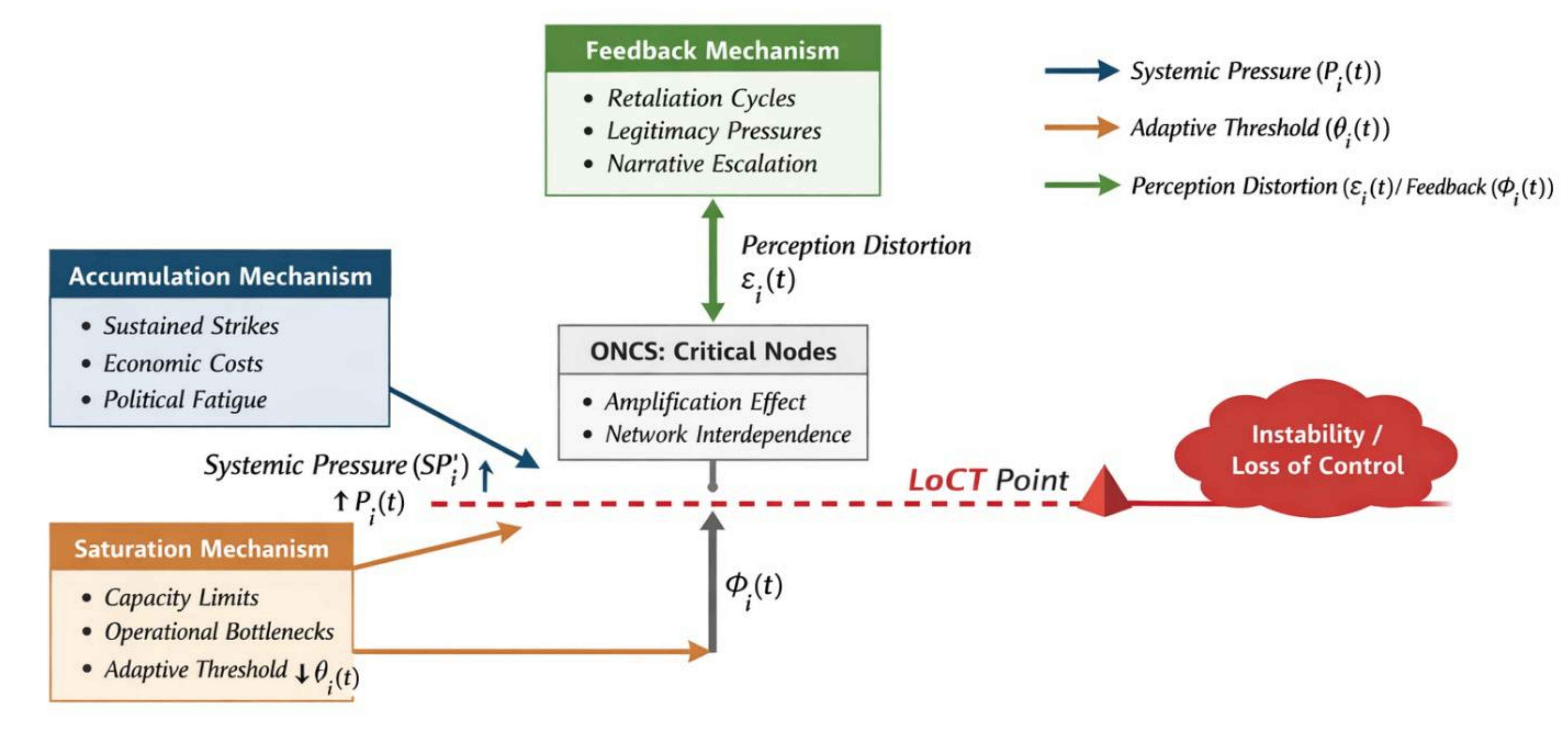

Figure 1. The Loss-of-Control Threshold (LoCT) Framework

4. Modeling Systemic Pressure (SPI) as a Dynamic Variable

The Systemic Pressure Index (SPI) is conceptualized as a time-dependent flow variable that captures the evolving level of stress within an actor's interconnected operational system (Wu, 2026b). Rather than representing a static accumulation of damage, SPI reflects the dynamic processes through which pressure is generated, propagated, and amplified across interdependent domains.

Formally, the evolution of systemic pressure can be expressed as:

$$\boldsymbol{\frac{dSPI_i(t)}{dt}} = \boldsymbol{f(S_i(t), ONCS_j(t), C_i(t), I_i(t))} \tag{4.1}$$

where, $S_i(t)$denotes the intensity of operational shocks; $ONCS_j(t)$captures the structural criticality of targeted nodes; $C_i(t)$reflects the degree of system coupling; and, $I_i(t)$represents information-driven amplification effects.

In this formulation, systemic pressure emerges from the interaction of structural and informational dynamics that govern how localized disruptions propagate through the system. Shocks applied to structurally critical nodes generate disproportionate effects, while higher levels of system coupling enable disturbances to diffuse across domains. At the same time, information environments transform operational events into perceived system states, reinforcing feedback loops and compressing response timelines.

Importantly, the propagation of systemic pressure is conditioned by operational constraints and access limitations, which shape the persistence and effectiveness of system activity under contested conditions. As these constraints intensify, propagation pathways may be altered and pressure accumulation accelerated, even in the absence of increased shock intensity. Under conditions of high connectivity and amplification, these interacting mechanisms produce nonlinear escalation dynamics (Rinaldi et al., 2001; Helbing, 2013; Wu, 2026b).

4.1 Dynamic Properties

The evolution of SPI is characterized by nonlinearity, path dependency, and acceleration under stress, which together define its behavior as a dynamic process (Helbing, 2013).

First, pressure accumulation is inherently nonlinear. The effects of operational shocks are mediated by system structure and information dynamics, such that identical inputs may generate vastly different outcomes depending on node criticality, coupling intensity, and feedback conditions. SPI therefore evolves as an interaction-driven process rather than a simple additive function (Helbing, 2013).

Second, SPI exhibits strong path dependency. Early disruptions reshape system structure by degrading resilience, altering coupling relationships, and weakening coordination capacity. These structural changes modify the system's response function, increasing its sensitivity to subsequent shocks. As a result, later inputs may produce amplified effects even when their magnitude remains constant (Helbing, 2013).

Third, the rate of pressure accumulation accelerates as the system approaches its adaptive limits. This can be expressed as:

$$\frac{d^2 SPI_i(t)}{dt^2} > 0 \text{as} SPI_i(t) \rightarrow \theta_i(t) \tag{4.2}$$

This acceleration reflects the saturation of buffering mechanisms and the increasing efficiency of propagation across tightly coupled domains. Under such conditions, marginal increases in shocks or feedback can produce disproportionately large increments in systemic pressure, rapidly pushing the system toward instability (Helbing, 2013; Wu, 2026b).

Taken together, these properties imply that escalation dynamics may appear gradual in early stages but can shift abruptly as structural conditions evolve. Such transitions reflect endogenous system dynamics rather than discrete changes in input intensity.

4.2 Structural Interpretation

From a broader theoretical perspective, SPI can be understood as a generalized stress function governing system stability (Helbing, 2013; Rinaldi et al., 2001). Its behavior exhibits strong parallels with established models of complex systems, including cascading failure processes, epidemic diffusion models, and stress accumulation systems.

Across these domains, a common structural logic emerges: system-level instability is not primarily driven by isolated shocks, but by the interaction between accumulation, connectivity, and feedback mechanisms. Within the SPI framework, these correspond respectively to the buildup of systemic pressure, the degree of interdependence across system components, and the amplification effects generated through information environments.

This interpretation suggests that escalation dynamics are fundamentally emergent properties of system organization. The critical variable is not the magnitude of individual disruptions, but how they interact with network structure and feedback processes to produce cumulative systemic stress.

As a result, systems may exhibit apparent stability under repeated shocks until structural conditions align, at which point pressure accumulation can trigger rapid phase transitions toward instability (Helbing, 2013).

4.3 Link to Threshold Dynamics

The analytical significance of SPI lies in its relationship to the loss-of-control threshold $\theta_i(t)$. As systemic pressure approaches this threshold, the system enters a regime of heightened sensitivity in which marginal perturbations can produce disproportionate effects.

In this near-threshold regime, system response becomes increasingly nonlinear. Small increases in shock intensity, minor changes in node targeting, incremental shifts in coupling, or amplified information feedback may all accelerate the growth of systemic pressure.

Once the condition $\boldsymbol{SPI_i(t) \geq \theta_i(t)}$ is satisfied, the system crosses the loss-of-control threshold and transitions from critical stability to uncontrolled escalation.

At this point, feedback mechanisms shift from dampening to reinforcing; cross-domain propagation intensifies; and coordination capacity deteriorates.

Escalation dynamics become increasingly endogenous and self-reinforcing, reducing the effectiveness of deliberate control efforts.

Importantly, threshold crossing does not require large discrete shocks. It may emerge through either rapid accumulation of systemic pressure or gradual erosion of control capacity. In many cases, these processes interact, accelerating convergence between $SPI_i(t)$ and $\theta_i(t)$.

This relationship implies that escalation risk is determined not solely by the magnitude of incoming shocks, but by the system's proximity to its threshold. Systems operating near $\theta_i(t)$may appear stable while remaining highly vulnerable to abrupt transition.

Accordingly, the central strategic challenge in contemporary conflict is not the avoidance of shocks, but the ability to delay or prevent convergence between systemic pressure and control capacity (Wu, 2026e).

4.4 Toward an Operational Formulation of SPI

To bridge the gap between theoretical abstraction and empirical application, the **Systemic Pressure Index (SPI)** can be reformulated in a semi-operational integral form that captures cumulative pressure over time (Wu, 2026b):

$$\boldsymbol{SPI_i(t) = \int_0^t \alpha \cdot S_i(\tau) \cdot ONCS_j(\tau) \cdot C_i(\tau) \cdot I_i(\tau)\, d\tau} \tag{4.4}$$

where, α is a scaling coefficient capturing baseline system sensitivity; τ denotes continuous time; and, all other variables retain their definitions as previously specified.

This formulation makes three analytical advances.

First, it formalizes systemic pressure as a cumulative flow process rather than a discrete or event-based variable. Pressure is continuously generated and integrated over time, reflecting the persistent nature of modern conflict environments.

Second, it introduces multiplicative interaction effects between variables. Rather than contributing independently, operational shocks, node criticality, system coupling, and information amplification jointly determine the marginal contribution to systemic pressure. This structure captures the intuition that identical shocks may produce vastly different outcomes depending on system configuration.

Third, it provides a pathway toward empirical estimation and simulation. Each component can be approximated using observable or model-derived proxies:

- $S_i(t)$: strike frequency, intensity, or resource expenditure (e.g., missile salvos, ISR tempo)；
- $ONCS_j(t)$: infrastructure criticality scores (energy nodes, command hubs, logistics corridors)；
- $C_i(t)$: interdependence metrics (grid connectivity, supply chain coupling, network density)；
- $I_i(t)$: information amplification indicators (media volume, narrative convergence, sentiment volatility).

Under this formulation, SPI becomes compatible with data-driven frameworks, enabling integration with real-time monitoring systems and simulation environments.

Importantly, this structure allows for threshold forecasting. By estimating both $SPI_i(t)$and the dynamic threshold $\theta_i(t)$, analysts can model the likelihood and timing of convergence, providing early warning of potential loss-of-control conditions.

4.5 Broader Analytical Integration

The SPI model is not intended as a standalone construct, but as a core dynamic variable within a broader systemic analytical architecture. It can be linked to related monitoring and analytical frameworks to form a unified model of contemporary conflict.

(1) SPI and cost-monitoring frameworks

Within conflict cost-monitoring frameworks, cumulative financial and material costs can be interpreted as observable manifestations of systemic pressure accumulation. While such systems track direct expenditure and broader economic shock, SPI captures the underlying system stress dynamics driving these costs.

This relationship can be conceptualized as:

- cost-monitoring framework → observable cost layer.
- SPI → latent stress accumulation layer.

In this sense, rising costs are not merely consequences of conflict intensity, but indicators of increasing systemic pressure. Divergence between cost accumulation and SPI trajectories may also reveal hidden resilience or emerging fragility within the system (Wu, 2026b).

(2) SPI and information ecosystem warfare

SPI explicitly incorporates information dynamics through the variable $I_i(t)$, linking it to broader frameworks of information ecosystem warfare.

In this context, information systems perform three critical functions:

- **Amplification:** magnifying the perceived impact of operational events.
- **Synchronization:** aligning perceptions across audiences and decision-makers.
- **Acceleration:** compressing response cycles and reducing deliberation time.

This implies that information competition is not merely a parallel domain of conflict, but a force multiplier within systemic pressure accumulation. High-intensity information environments effectively increase the gain of the SPI system, accelerating convergence toward threshold conditions (Hoskins & O'Loughlin, 2015; Nye, 2010; Wu, 2026c).

(3) SPI and Loss-of-Control Threshold (LoCT)

SPI serves as the dynamic driver, while the loss-of-control threshold $\theta_i(t)$defines the system's adaptive capacity. Their interaction forms the core condition of escalation:

$$\boldsymbol{SPI_i(t) \rightarrow \theta_i(t)} \tag{4.5}$$

This formulation unifies the model:

- **SPI** → how pressure accumulates;
- **LoCT** → when control fails.

Crucially, both variables are dynamic. While SPI tends to increase under sustained stress, the threshold $\theta_i(t)$ may decrease over time due to resource depletion, institutional fatigue, coordination breakdown, and legitimacy erosion. This creates a dual convergence dynamic: escalation is driven not only by rising pressure, but also by declining control capacity (Wu, 2026e).

(4) Toward a unified systemic warfare model

Taken together, these linkages position SPI as a central state variable within a broader systemic warfare model:

- Operational layer (OSW) → generates shocks $S_i(t)$;
- Structural layer (ONCS + coupling) → shapes propagation;
- Information layer → amplifies and accelerates;
- SPI → accumulates system stress;
- LoCT → defines system limits.

This architecture reframes modern conflict as a dynamic system of interacting processes rather than a sequence of discrete engagements (Wu, 2026a, 2026b, Wu, 2026d).

Escalation is governed by a dual dynamic: the acceleration of systemic pressure and the degradation of control capacity, both of which can be abruptly altered by information shocks and structural disruptions.

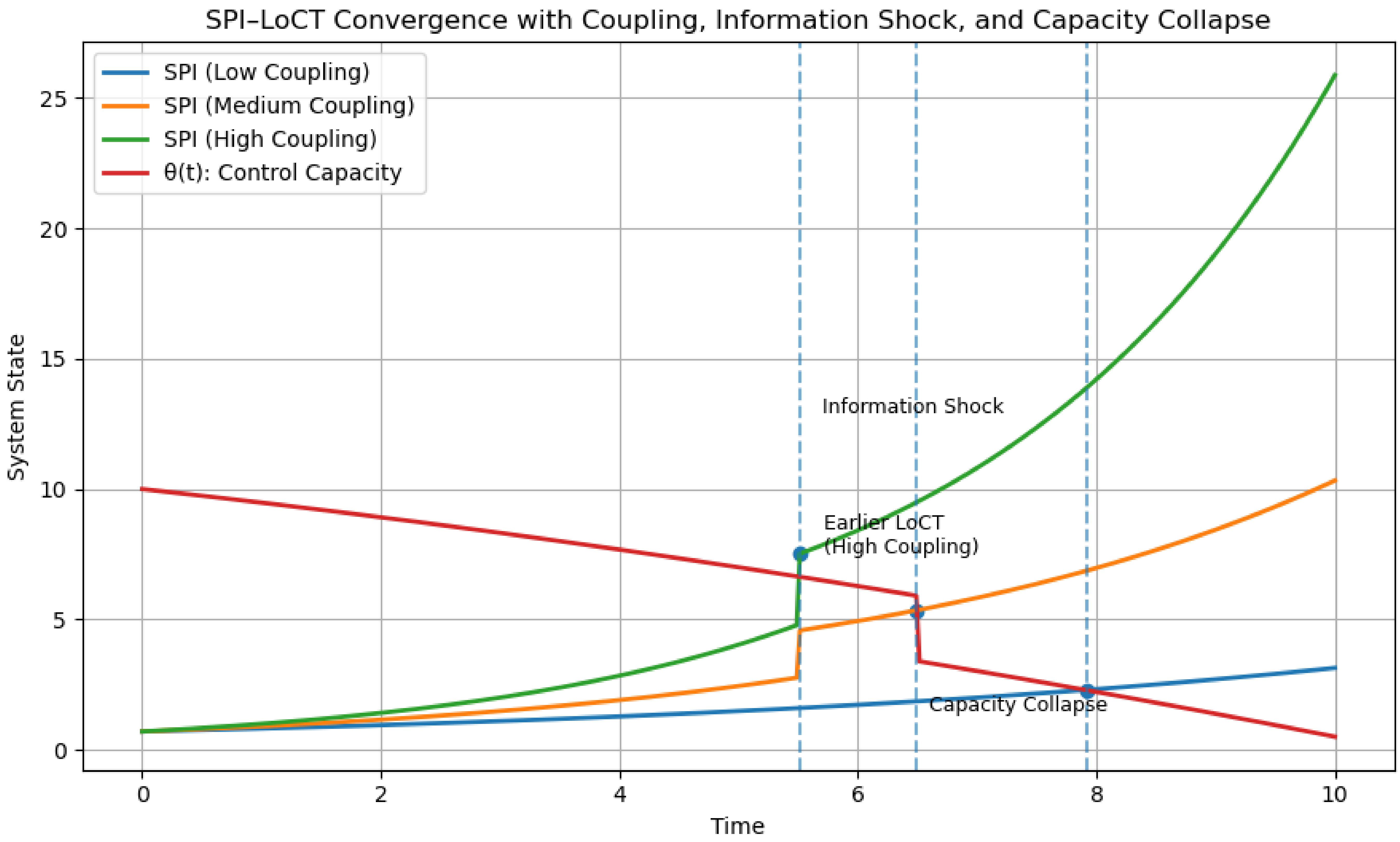

Figure 2. Dynamic Interaction of Systemic Pressure and Control Capacity under System Coupling and Capacity Degradation

Figure 2 illustrates the dynamic interaction between systemic pressure (SPI) and control capacity $\theta(t)$over time under varying conditions of system coupling and information-driven amplification.

SPI trajectories evolve as a function of system coupling, with higher interdependence increasing both the rate and nonlinearity of pressure accumulation. Control capacity $\theta(t)$declines endogenously under sustained stress and may exhibit discontinuous degradation when critical system components are disrupted.

The propagation of systemic pressure is further conditioned by operational constraints and access limitations, which shape the persistence and effectiveness of system activity in contested environments. As these constraints intensify, pressure accumulation may accelerate even in the absence of increased shock intensity.

LoCT events occur at the intersection where $SPI(t) \geq \theta(t)$ .The model shows that escalation outcomes are jointly determined by system coupling, information-driven amplification, and the dynamic interaction between pressure accumulation and capacity degradation, rather than by shock magnitude alone.

5. Node Criticality and Nonlinear Escalation Effects

The **Operational Node Criticality Score (ONCS)** captures the structural importance of individual nodes within an actor's operational system and determines how localized disruptions are translated into system-level effects (Rinaldi et al., 2001; Wu, 2026a, 2026b). Within the broader dynamics of systemic pressure, ONCS functions as a primary amplification mechanism, linking micro-level shocks to macro-level outcomes.

Not all disruptions are equivalent. While some remain localized and dissipate, others propagate across interconnected domains, generating disproportionate systemic effects. This differentiation introduces structural asymmetry into escalation dynamics, such that escalation outcomes depend not only on the magnitude of shocks, but on their position within the network topology (Farrell & Newman, 2019; Rinaldi et al., 2001).

5.1 Structural Basis of Node Criticality

High-criticality nodes are characterized by three interrelated properties:

- **Network centrality:** nodes occupying key positions within connectivity structures
- **Interdependence:** nodes embedded within tightly coupled functional relationships
- **Irreplaceability:** nodes with limited redundancy or substitution capacity

Such nodes often operate at the intersection of multiple operational flows, including energy distribution systems, logistics and supply chain coordination, command control, and communication (C3) networks, and information and perception infrastructures.

In addition to their functional role, some nodes possess symbolic or political significance, which extends their impact into the information domain (Wu, 2026d). As a result, these nodes act as cross-domain convergence points, where disruption in one layer can propagate into others (Rinaldi et al., 2001; Farrell & Newman, 2019).

5.2 Amplification Mechanism

The amplification effect of node disruption can be expressed in simplified form as:

$$\boldsymbol{\Delta SPI_i(t) \propto ONCS_j(t) \cdot Impact_j(t)} \tag{5.1}$$

where, $\Delta SPI_i(t)$ is the incremental increase in systemic pressure; $ONCS_j(t)$ represents the structural criticality of node j; and, $Impact_j(t)$ captures the magnitude of disruption at that node.

This relationship formalizes a key principle: systemic pressure is shaped not only by the magnitude of disruption, but by the structural position of the targeted node (Wu, 2026a).

Consequently, identical levels of physical damage may produce radically different systemic outcomes depending on whether they affect peripheral nodes or structurally central ones. In highly interconnected systems, high-ONCS nodes function as pressure multipliers, converting localized shocks into distributed stress signals that propagate across domains (Rinaldi et al., 2001; Wu, 2026b).

5.3 Cascading Failure and Feedback Dynamics

When system interdependence reaches a critical level, disruptions to high-ONCS nodes can initiate cascading dynamics (Rinaldi et al., 2001; Helbing, 2013).

An initial disruption generates localized system stress, which exposes latent vulnerabilities within the network. These vulnerabilities—whether infrastructural, organizational, or informational—create new points of fragility that are increasingly susceptible to subsequent shocks.

This process can be conceptualized as a feedback loop:

Disruption → Vulnerability Exposure → Increased Sensitivity → Further Disruption

As this loop unfolds, the system transitions from localized disturbance to self-reinforcing systemic stress accumulation, accelerating the growth of $SPI_i(t)$.

Importantly, this dynamic is not linear. Once cascading processes are activated, marginal disruptions may produce disproportionately large effects, reflecting the system's shift from buffered resilience to propagation-dominated behavior (Helbing, 2013).

5.4 Network Topology and Cross-Domain Propagation

From a network perspective, ONCS reflects a node's position within a multi-layered system-of-systems, in which operational, infrastructural, and informational networks are tightly coupled (Rinaldi et al., 2001).

Two structural properties are particularly important:

- **Connectivity density:** determines the number of pathways through which disruptions can propagate.
- **Dependency structure:** determines the system's sensitivity to node failure.

Nodes that bridge multiple domains are especially critical. These inter-layer connectors enable pressure generated in one domain (e.g., physical infrastructure) to propagate into others (e.g., information systems or political legitimacy), thereby amplifying total system stress.

This cross-domain propagation is a key driver of nonlinear escalation, as it transforms localized disruptions into multi-domain systemic effects (Farrell & Newman, 2019; Wu, 2026a).

5.5 Implications for Escalation Dynamics

Within this framework, escalation cannot be understood solely in terms of the scale or frequency of attacks (Wu, 2026a). Instead, it is fundamentally shaped by the topology of the targeted network (Wu, 2026a, 2026b).

ONCS provides the analytical mechanism through which network structure is translated into escalation dynamics. It explains why some disruptions dissipate with limited impact, while others generate nonlinear effects that rapidly accelerate systemic pressure accumulation.

As a result, escalation is best understood as a function of where disruption occurs rather than simply how much damage is inflicted. Crucially, high-ONCS targeting can significantly accelerate convergence toward the loss-of-control threshold:

$$\boldsymbol{\Delta SPI_i(t)} \uparrow \Rightarrow \boldsymbol{SPI_i(t)} \to \boldsymbol{\theta_i(t)} \tag{5.2}$$

This establishes a direct linkage between node-level targeting decisions and system-level escalation outcomes.

6. The Perception Layer: Real vs. Perceived Systems

A defining feature of contemporary networked conflict is the systematic divergence between real and perceived system states (Jervis, 1976; Hoskins & O'Loughlin, 2015). Actors do not respond directly to objective system conditions, but to their interpreted representations, which are shaped by information environments, signaling strategies, and structural uncertainty (Jervis, 1976; Nye, 2010).

As a result, escalation dynamics unfold across a dual-layer system:

- a material layer, defined by real systemic stress, and
- a cognitive layer, defined by perceived instability.

6.1 Formalizing Perception Distortion

This relationship can be expressed as:

$$\boldsymbol{SPI_i^{perceived}(t)} = \boldsymbol{SPI_i^{real}(t)} + \boldsymbol{\epsilon_i(t)} \tag{6.1}$$

where, $SPI_i^{real}(t)$ denotes the actual level of systemic pressure; $SPI_i^{perceived}(t)$denotes the actor's perceived pressure; and, $\epsilon_i(t)$captures the distortion between reality and perception.

Crucially, $\epsilon_i(t)$is not random noise. It is a structured, endogenous, and dynamically generated variable arising from the information environment (Jervis, 1976; Hoskins & O'Loughlin, 2015).

6.2 Sources of Structured Distortion

Perception distortion emerges from the interaction of multiple mechanisms:

- **Media amplification:** selective framing and rapid dissemination transform localized events into signals of systemic instability
- **Misinformation and disinformation:** introduction of false or strategically manipulated content reshapes perceived system states
- **Strategic signaling:** actors deliberately exaggerate or conceal conditions to influence adversary expectations
- **Uncertainty and incomplete information:** decision-makers rely on inference under ambiguity, often biased toward worst-case interpretations

These mechanisms generate persistent and directional deviations, rather than random fluctuations, between real and perceived system conditions (Jervis, 1976; Hoskins & O'Loughlin, 2015; Nye, 2010).

6.3 Decision-Making under Perceived Pressure

The divergence between material conditions and perceived reality has direct implications for decision-making.

When

$$\boldsymbol{SPI_i^{perceived}(t) > SPI_i^{real}(t)} \tag{6.2}$$

actors may overestimate system instability, triggering escalation responses to threats that are amplified rather than material (Jervis, 1976).

More critically, decisions are conditioned not on actual system thresholds, but on perceived proximity to instability. This creates the possibility of premature threshold crossing, in which escalation is initiated even though the underlying system remains within manageable bounds.

Over time, persistent distortion also erodes signaling credibility, weakening deterrence and reducing the capacity for coordinated de-escalation (Jervis, 1976; Hoskins & O'Loughlin, 2015).

6.4 Perception–Threshold Interaction

The perception layer interacts directly with threshold dynamics:

$$\boldsymbol{SPI_i^{perceived}(t) \rightarrow \theta_i(t)} \tag{6.3}$$

When perceived systemic pressure approaches or exceeds the loss-of-control threshold $\theta_i(t)$, actors may initiate escalation independent of real system conditions.

6.5 Recursive Feedback Dynamics

The relationship between perception and material reality is bidirectional (Hoskins & O'Loughlin, 2015).

Perception-driven escalation generates new operational shocks, which feed back into the material layer:

$$\boldsymbol{SPI_i^{perceived}(t)} \uparrow \Rightarrow \textbf{Action} \Rightarrow \boldsymbol{S_i(t)} \uparrow \Rightarrow \boldsymbol{SPI_i^{real}(t)} \uparrow \tag{6.4}$$

This establishes a recursive feedback loop:

Perception → Action → Material Change → Updated Perception

Within this loop, the perception layer functions not only as an amplifier of systemic pressure, but also as an independent generator of escalation dynamics (Wu, 2026c).

6.6 Implications for Escalation Control

The perception layer is therefore not merely an interpretive overlay, but an active component of system dynamics.

Its inclusion fundamentally alters the logic of escalation control. Managing conflict is no longer limited to regulating material variables (e.g., force deployment, infrastructure resilience), but also requires stabilizing perception across actors, reducing informational distortion, and maintaining credible signaling environments.

Absent these conditions, even structurally stable systems may be driven toward instability through perception-induced escalation pathways (Jervis, 1976; Hoskins & O'Loughlin, 2015).

7. Mechanisms of Loss of Control: A Unified Model

Loss of control in networked conflict does not arise from a single decisive trigger, but from the interaction of multiple dynamic mechanisms operating across both material and cognitive domains (Helbing, 2013; Wu, 2026e). These mechanisms jointly shape the evolution of systemic pressure and determine whether and when an actor's system crosses the loss-of-control threshold $\theta_i(t)$ (Wu, 2026e).

Taken individually, the preceding sections specify distinct drivers of escalation. Taken together, they reveal a tightly coupled dynamic system in which pressure accumulation, capacity constraints, and recursive feedback interact to produce nonlinear escalation trajectories (Helbing, 2013; Wu, 2026b).

This introduces a critical asymmetry: threshold crossing may occur first in the cognitive domain and only subsequently in the material domain. In such cases, escalation becomes self-fulfilling, as perception-driven actions generate the very conditions they were intended to prevent (Jervis, 1976; Wu, 2026c).

7.1 Accumulation: The Growth of Systemic Pressure

The first mechanism is accumulation, which captures the gradual buildup of systemic pressure over time (Helbing, 2013; Wu, 2026b).

In contemporary conflict environments, pressure is generated not only through kinetic operations, but also through sustained economic strain, political and institutional fatigue, and informational contestation.

These inputs do not accumulate linearly. Instead, accumulation is path-dependent, such that early disruptions reshape system structure, degrade resilience, and increase sensitivity to subsequent shocks.

Formally, this dynamic is reflected in the evolution of systemic pressure:

$$\boldsymbol{SPI_i(t)} \uparrow \Rightarrow \boldsymbol{SPI_i(t)} \rightarrow \boldsymbol{\theta_i(t)} \tag{7.1}$$

Even prolonged low-intensity inputs can therefore progressively push the system toward its threshold, as structural adaptation reduces buffering capacity over time (Wu, 2026b).

7.2 Saturation: The Contraction of Control Capacity

The second mechanism is saturation, which reflects the finite capacity of critical subsystems to absorb and process stress (Rinaldi et al., 2001; Wu, 2026a).

Operational systems, including air defense networks, logistics chains, and command structures, possess inherent throughput limits. As these limits are approached, system behavior shifts from adaptive absorption to constraint-driven degradation.

Importantly, saturation does not merely increase effective pressure; it reduces the system's tolerance for pressure. In analytical terms, this corresponds to a dynamic contraction of the threshold: $\theta_i(t)$.

This mechanism explains why systems may transition abruptly from controlled adaptation to breakdown, even in the absence of large increases in external inputs. The boundary between stability and instability is not fixed, but endogenously shaped by system capacity (Helbing, 2013).

7.3 Feedback: Recursive Amplification across Domains

The third mechanism is feedback, which captures the recursive interaction between action, perception, and response (Jervis, 1976; Hoskins & O'Loughlin, 2015).

Feedback processes are particularly pronounced in the political and informational domains, where retaliation cycles, legitimacy pressures, and narrative escalation reinforce one another.

These dynamics operate through the perception layer, where systemic pressure is both experienced materially and interpreted cognitively:

$$\boldsymbol{SPI_i^{perceived}(t) = SPI_i^{real}(t) + \epsilon_i(t)} \tag{7.2}$$

where, $\epsilon_i(t)$represents structured perception distortion. Feedback loops act as multipliers, simultaneously increasing real pressure through continued interaction, and amplifying perceived pressure through informational dynamics.

In extreme cases, escalation becomes perception-driven, with cognitive dynamics outpacing material conditions (Jervis, 1976; Wu, 2026c).

7.4 Unified Condition for Loss of Control

Equation (7.3) generalizes the LoCT condition defined in Equation (3.2) by incorporating perception distortion and feedback dynamics into the threshold condition. The unified condition emerges from the interaction of three coupled mechanisms: accumulation, saturation, and feedback.

This generalized condition can be expressed as:

$$\boldsymbol{LoCT_i} \Leftarrow \boldsymbol{F}(\boldsymbol{SPI_i}(\boldsymbol{t}), \boldsymbol{\theta_i}(\boldsymbol{t}), \boldsymbol{\epsilon_i}(\boldsymbol{t}), \boldsymbol{\Phi_i}(\boldsymbol{t})) \tag{7.3}$$

where $SPI_i(t)$ represents accumulated systemic pressure; $\theta_i(t)$ denotes adaptive control capacity; $\epsilon_i(t)$ captures perception distortion; and $\Phi_i(t)$ reflects the intensity of feedback processes across domains.

Loss of control occurs not when any single variable reaches an extreme value, but when their interaction produces a critical configuration in which pressure is elevated, capacity is constrained, and feedback is self-reinforcing (Wu, 2026e).

7.5 Recursive Coupling and Escalation Acceleration

These mechanisms do not operate sequentially, but recursively and in mutually reinforcing fashion.

Accumulation increases baseline pressure, accelerating saturation by pushing subsystems toward capacity limits.

Saturation reduces adaptive capacity, increasing system sensitivity to further shocks.

Feedback generates new inputs, both material and perceptual, that further accelerate accumulation.

This produces a closed-loop dynamic:

Accumulation → Saturation → Feedback → Further Accumulation

The result is a self-reinforcing escalation process in which $SPI_i(t)$ ↑, $\theta_i(t)$ ↓, and $\epsilon_i(t), \Phi_i(t)$ ↑ evolve simultaneously (Helbing, 2013; Wu, 2026b).

7.6 Loss of Control as a Synchronization Problem

The central implication is that loss of control is best understood not as a single threshold event, but as a synchronization problem across interacting system variables (Helbing, 2013; Wu, 2026e).

Escalation becomes most dangerous not when systemic pressure is at its highest, but when the system approaches a configuration in which control capacity is constrained, perception is significantly distorted, and feedback loops are fully activated.

Under these conditions, even marginal perturbations can trigger discontinuous transitions, pushing the system irreversibly across the loss-of-control threshold (Wu, 2026e).

8. Illustrative Application: Early Phase of the 2026 U.S.–Israel–Iran Conflict

This section provides a mechanism-oriented illustration of the proposed framework rather than a full empirical or comparative analysis. Its purpose is not to establish causal claims, but to demonstrate how the model captures observable interaction patterns during the early phase of the 2026 U.S.–Israel–Iran conflict (Reuters, 2026a, 2026b, 2026c; Associated Press, 2026; Atlantic Council, 2026).

Accordingly, the analysis interprets observed dynamics through the lens of systemic pressure (SPI), node criticality ($ONCS$), perception distortion ($\epsilon_i(t)$), and feedback intensity ($\Phi_i(t)$) (Wu, 2026a, 2026b, 2026c, 2026e).

8.1 Node-Based Amplification in Early Strikes

Observed developments during the initial phase of the conflict exhibit patterns consistent with node-based amplification.

Several targeted strikes produced effects that exceeded their immediate physical damage, indicating that their impact was mediated by structural position rather than scale alone (Reuters, 2026c; Associated Press, 2026; Wu, 2026a). Such outcomes are consistent with high values of $ONCS_j(t)$, where disruption to structurally central nodes generates cross-domain propagation effects.

These dynamics suggest that:

$$\boldsymbol{\Delta SPI_i(t) \propto ONCS_j(t) \cdot Impact_j(t)} \tag{8.1}$$

In this context, escalation is driven less by the magnitude of individual actions than by where disruption occurs within the system topology. Early-phase interactions thus reveal the presence of structurally asymmetric escalation pathways (Wu, 2026a).

8.2 Accumulation under Sustained Interaction

In parallel, repeated cycles of action and response contributed to a gradual increase in baseline systemic pressure (Reuters, 2026a, 2026b; Wu, 2026b).

Even in the absence of large-scale escalation events, sustained interaction across military, economic, and political domains generated cumulative system stress, reflected in $SPI_i(t)$.

This pattern is consistent with the accumulation mechanism described in Section 7. Early disruptions altered system structure, degraded buffering capacity, and increased sensitivity to subsequent shocks. As a result, the system became progressively more responsive to marginal inputs, indicating path-dependent pressure growth.

8.3 Perception Distortion and Informational Amplification

The informational environment played a central role in shaping escalation dynamics during this phase (Atlantic Council, 2026; Wu, 2026c).

Rapid dissemination, selective framing, and narrative amplification increased perceived instability beyond what would be expected from material conditions alone. This divergence is captured by the distortion term:

$$\boldsymbol{\epsilon_i(t) = SPI_i^{perceived}(t) - SPI_i^{real}(t)}$$

(8.2)

Rather than functioning as random noise, $\epsilon_i(t)$reflects structured amplification within the information environment, transforming localized events into signals of broader systemic vulnerability.

As a result, $SPI_i^{perceived}(t) > SPI_i^{real}(t)$ in key moments, indicating that escalation pressures were partially driven by cognitive amplification rather than material change alone (Wu, 2026c).

8.4 Feedback Loops and Escalation Reinforcement

Perception dynamics interacted with operational behavior to generate recursive feedback loops, captured by the feedback term $\Phi_i(t)$ (Reuters, 2026b; Atlantic Council, 2026; Wu, 2026c).

Cycles of action and response driven by deterrence signaling, retaliation pressures, and narrative competition produced a reinforcing process in which:

$$\textbf{Perception} \rightarrow \textbf{Action} \rightarrow \boldsymbol{SPI_i^{real}(t)} \uparrow\rightarrow \textbf{Updated Perception}$$

(8.3)

This dynamic illustrates how feedback processes simultaneously increase real systemic pressure through continued interaction, and perceived pressure through informational amplification.

In this sense, escalation during the early phase was not solely event-driven, but process-driven, shaped by recursive interaction across material and cognitive domains (Wu, 2026c).

8.5 State-Dependent Impact and Threshold Proximity

A central implication of the framework is that the significance of any given action is state-dependent (Wu, 2026e).

The impact of an action must be evaluated relative to the system's position vis-à-vis the loss-of-control threshold $\theta_i(t)$. As systemic pressure approaches this threshold,

$$\boldsymbol{SPI_i(t) \rightarrow \theta_i(t)}$$

(8.4)

the system becomes increasingly sensitive to marginal shocks, and the relationship between action and outcome becomes highly nonlinear.

Consequently, identical actions may produce minimal effects in early stages but trigger disproportionate consequences when the system is near instability. This explains the observed variation in escalation effects across seemingly similar events(Wu, 2026e).

8.6 From Event Sequences to System Dynamics

This perspective challenges event-centric interpretations of escalation. Rather than viewing conflict as a sequence of discrete actions, the framework conceptualizes escalation as a dynamic process governed by evolving system states. Localized actions acquire strategic significance only through their interaction with accumulated systemic pressure $SPI_i(t)$, structural amplification $ONCS_j(t)$, perception distortion $\epsilon_i(t)$, and proximity to threshold conditions $\theta_i(t)$.

8.7 System Approaching Critical Transition

Taken together, the early-phase dynamics of the 2026 conflict are best understood not as isolated events, but as manifestations of an underlying system approaching a critical transition.

Accumulation, structural amplification, and perception-mediated feedback do not merely coexist; they mutually reinforce one another, producing a trajectory in which:

$$\boldsymbol{SPI_i(t) \uparrow + \epsilon_i(t) \uparrow + \Phi_i(t) \uparrow \Rightarrow SPI_i(t) \rightarrow \theta_i(t)} \tag{8.5}$$

The framework thus provides a coherent analytical lens for understanding how seemingly limited interactions can generate increasingly unstable outcomes over time, even in the absence of large-scale escalation events (Wu, 2026b, 2026c, 2026e).

The actor-specific logic of convergence between systemic pressure and control capacity can be summarized as follows.

Table 1. Actor-Specific Systemic Pressure (SPI) and Control Capacity (θ) Dynamics in the U.S.–Israel–Iran Conflict

Actor	SPI Dynamics	(θ) Dynamics	Risk
United States	Gradual but cumulative pressure accumulation across globally distributed operational systems	Progressive decline driven by fiscal strain, force dispersion, and strategic overextension	Delayed but systemic LoCT risk (high inertia, low reversibility once approached)
Israel	Rapid pressure accumulation under high system coupling and continuous high-intensity operations	Accelerated erosion due to resource depletion, operational fatigue, and escalation lock-in	Early LoCT risk (fast convergence under sustained engagement)
Iran	Moderate but adaptive pressure accumulation shaped by asymmetric and distributed response strategies	Structurally unstable, driven by legitimacy–retaliation feedback loops and internal–external coupling	Nonlinear LoCT risk (threshold may shift abruptly under political or symbolic shocks)

Note: The table does not predict which actor will cross LoCT first in a deterministic sense. Rather, it clarifies that different actors approach instability through distinct structural pathways (Wu, 2026e).

9. Theoretical Implications

The framework developed in this study implies a fundamental reconceptualization of escalation, control, and strategic outcomes in contemporary conflict.

Rather than treating escalation as a sequence of discrete, intentional moves, it is more accurately understood as a dynamic trajectory within a complex adaptive system (Kahn, 1965; Schelling, 1966; Helbing, 2013). Traditional escalation models, which are often represented as stepwise ladders, assume that actors progress through identifiable stages based on deliberate choice. By contrast, the analysis presented here suggests that escalation emerges from the continuous interaction of systemic pressure accumulation (SPI), structural amplification ($ONCS$), and recursive feedback processes (Φ).

In this sense, escalation is not a sequence of decisions, but a state-dependent evolution of the system itself (Wu, 2026b).

9.1 Control as an Emergent System Property

This reconceptualization carries important implications for how control is understood (Helbing, 2013).

Control in conflict cannot be reduced to leadership intent or centralized decision-making authority. Instead, it emerges from the underlying properties of the system, including resilience to absorb shocks, adaptability under stress, and integrity of interconnected networks.

These factors jointly determine whether a system can maintain stability under pressure.

As a result, even highly capable decision-makers may be unable to prevent escalation when systemic conditions deteriorate, while systems with sufficient resilience may sustain stability despite suboptimal decisions. Control is therefore best understood as an emergent system property rather than a purely agent-driven outcome (Rinaldi et al., 2001; Helbing, 2013).

9.2 Endogenous Instability

A further implication concerns the nature of instability (Helbing, 2013).

Within this framework, instability is not primarily the result of exogenous shocks or random disruptions, but is generated endogenously through system structure and dynamics. High levels of interdependence, nonlinear accumulation of pressure, and feedback loops between perception and action create conditions under which instability becomes an inherent feature of the system.

Formally, instability emerges when $SPI_i(t)\uparrow + \theta_i(t)\downarrow + \epsilon_i(t), \Phi_i(t)\uparrow$ produce convergence toward the loss-of-control threshold.

Escalation risk is thus embedded within the system itself, arising from its configuration and internal interactions rather than from isolated triggering events (Helbing, 2013; Wu, 2026e).

9.3 Strategic Success as Temporal Control

These insights lead to a redefinition of strategic success.

In traditional frameworks, success is often equated with battlefield dominance, decisive victory, or rapid coercive effect (Schelling, 1966; Wu, 2026e). However, in a system characterized by cumulative pressure and nonlinear thresholds, success is more accurately defined as the ability to delay or avoid crossing the loss-of-control threshold.

This can be expressed as:

$$\boldsymbol{Success_i \approx max\, T} \text{ such that } \boldsymbol{SPI_i(t) < \theta_i(t)} \tag{9.1}$$

Under this formulation, the central strategic objective becomes the preservation of system stability over time. Strategic success is therefore equivalent to maximizing time under controllability constraints.

Maintaining control takes precedence over achieving immediate operational gains, and endurance replaces decisiveness as the primary metric of effectiveness. Conflict becomes a competition not over who wins first, but over who remains controllable the longest (Wu, 2026e).

9.4 From Event-Centric to System-Centric Conflict

Taken together, these implications point toward a broader theoretical shift from event-centric to system-centric understandings of conflict (Kahn, 1965; Helbing, 2013).

Within this framework, escalation is a function of system dynamics, not discrete actions; control is a function of system properties, not individual decisions; instability is a function of structural conditions, not external shocks; and success is a function of temporal endurance, not immediate outcomes.

This reframing aligns with the transformation of warfare into a persistent, networked, and data-intensive process, in which outcomes are determined by the management of cumulative systemic pressure across interconnected domains.

More broadly, this framework redefines modern conflict as a problem of dynamic system regulation under conditions of cumulative pressure, structural interdependence, and perception-driven feedback (Wu, 2026b, 2026c).

Conclusion

This article develops a systemic theory of escalation centered on the loss-of-control threshold (LoCT) as a dynamic condition of state transition. It argues that contemporary conflict is not governed primarily by isolated decisions or discrete events, but by the interaction of cumulative systemic pressure, nonlinear propagation across interconnected systems, and perception-driven feedback within contested information environments. Escalation, in this sense, is not a ladder to be climbed, but a trajectory unfolding within a complex adaptive system.

This perspective shifts the analytical focus from outcomes to conditions. The central strategic question is no longer which actor will achieve decisive victory, but how long each can sustain control under mounting and compounding pressure. Control is not reducible to leadership intent or centralized authority; it emerges from system-level properties such as resilience, adaptability, and network integrity. As these properties degrade, the capacity to regulate escalation erodes in nonlinear and often difficult-to-reverse ways.

More specifically, escalation dynamics can be understood as the interaction of three coupled processes: the accumulation of systemic pressure (SPI), the structural amplification of localized disruptions through critical nodes (ONCS), and the mediation of action through perception and information feedback. The convergence of these mechanisms produces threshold conditions under which control becomes structurally unsustainable.

Within this framework, conflict outcomes depend less on battlefield superiority than on the ability to maintain systemic stability over time. Strategic success is therefore redefined not as rapid dominance, but as temporal endurance under stress. In networked and data-intensive warfare, the decisive variable is not victory in the traditional sense, but the capacity to delay systemic breakdown.

Loss of control emerges not as a discrete outcome, but as a systemic transition condition produced by the coupled dynamics of pressure accumulation, structural amplification, and perception-mediated feedback. Strategic advantage therefore lies not in achieving decisive victory, but in sustaining controllability for longer than one’s adversary under conditions of cumulative systemic pressure.

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