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MAPPING CRIMINOGENIC FINANCIAL FLOWS: TYPOLOGY, NODES AND SECURITY THREATS

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MAPPING CRIMINOGENIC FINANCIAL FLOWS: TYPOLOGY, NODES AND SECURITY THREATS

Abstract: This article proposes an operational cartography of criminogenic financial flows, structured through a topological, multiscalar, and geo-legal framework. The central hypothesis asserts that capital circulation is neither neutral nor random, but rather a strategic architecture assembled through physical infrastructures, legal structures, and digital devices. Based on an expanded taxonomy, the study develops a classification of twelve types of financial flows according to their geometry (binary, triangular, circular, multiple, hybrid) and their impact on national and international security.

The analysis reveals that these flows configure specific morphologies of structural vulnerability. Some follow well-established patterns: binary flows operate as preferred structures in scenarios of interstate financial coercion; triangular flows function as surgical vectors of strategic legalization; and round-trip flows simulate foreign investment through circular capital circuits. Others adopt more disruptive forms: fractal flows act as amplifiers of systemic risk via nested leverage structures, while mirror flows are engineered as algorithms of transnational legal subjugation, designed to shield extraterritorial control under contractual disguise.

Moreover, the study argues that conventional financial monitoring techniques are insufficient when confronted with multi-jurisdictional contractual assemblages, crypto-legal algorithms, and opaque risk nodes.

Methodologically, the research integrates network theory, geographic infrastructure analysis, and contractual engineering. The conclusion advocates for a doctrine of financial sovereignty grounded in strategic traceability, nodal cartography, and adversarial intelligence. Without maps, there is no control; without control, there is no sovereignty. Mastering the trajectory of capital becomes a critical prerequisite for geopolitical survival in the twenty-first century.

Resumen: Este artículo propone una cartografía operativa de los flujos financieros criminógenos, estructurada desde una lógica topológica, multiescalar y geojurídica. La hipótesis central sostiene que la circulación del capital no es neutra ni aleatoria, sino una arquitectura estratégica ensamblada mediante infraestructuras físicas, estructuras jurídicas y dispositivos digitales. A partir de una taxonomía expandida, se propone una clasificación de doce flujos financieros según su geometría (binaria, triangular, circular, múltiple, híbrida) y su impacto sobre la seguridad nacional e internacional.

El análisis revela que estos flujos configuran morfologías específicas de vulnerabilidad estructural. Algunos responden a patrones muy conocidos: los flujos binarios actúan como estructuras preferentes en operaciones de coacción financiera interestatal; los triangulares funcionan como vectores quirúrgicos de legalización estratégica; los *round-trip* simulan inversión extranjera mediante montajes circulares de capital. Otros adoptan formas más disruptivas: los fractales operan como amplificadores

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de riesgo sistémico mediante estructuras de apalancamiento anidado, mientras que los flujos espejo se ensamblan como algoritmos de sometimiento jurídico transnacional, diseñados para blindar el control extraterritorial bajo apariencia contractual. Además, sugiere que las técnicas convencionales de monitorización financiera resultan insuficientes ante ensamblajes contractuales multijurisdiccionales, algoritmos criptojurídicos y nodos opacos de riesgo.

Metodológicamente, el estudio integra teoría de redes, análisis geográfico de infraestructuras e ingeniería contractual. La conclusión aboga por una doctrina de soberanía financiera basada en trazabilidad estratégica, cartografía nodal e inteligencia adversarial. Sin mapas, no hay control; sin control, no hay soberanía. Dominar la trayectoria del capital se convierte en requisito clave para la supervivencia geopolítica en el siglo XXI.

Keywords: financial geography, illicit financial flows, critical financial infrastructure, jurisdictional arbitrage, topological architecture of capital flows.

Palabras clave: geografía de las finanzas, flujos financieros ilícitos, infraestructura crítica financiera, arbitraje jurisdiccional, topología de los flujos de capital.

ABBREVIATIONS

ABS: Asset-Backed Securities

AML: Anti-Money Laundering

AMLD: Anti-Money Laundering Directive

API: Application Programming Interface

ECB: European Central Bank

BEPS: Base Erosion and Profit Shifting

BIS: Bank for International Settlements

FSB: Financial Stability Board

CDB: China Development Bank

CDS: Credit Default Swap

CEX: Centralized Exchange

CIMA: Cayman Islands Monetary Authority

CIPS: Cross-Border Interbank Payment System CLS: Continuous Linked Settlement
CLS: Continuous Linked Settlement

CLS: Continuous Linked Settlement

CMOR: Master Agreements on Financial Transactions

CRM: Customer Relationship Management

CRS: Common Reporting Standard

CFTC Commodity Futures Trading Commission

DTCC: Depository Trust & Clearing Corporation

FATCA: Foreign Account Tax Compliance Act

FATF: Financial Action Task Force

FIX: Financial Information Exchange

FSB: Financial Stability Board

G7: Group of Seven

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G20: Group of Twenty

FATF: Financial Action Task Force

AI: Artificial Intelligence

FDI: Foreign Direct Investment

IMF: International Monetary Fund

ISDA: International Swaps and Derivatives Association

OTC: Over The Counter

PSD2: Payment Services Directive 2

RDL: Royal Legislative Decree

SIGINT: Signals Intelligence

SPV: Special Purpose Vehicle

SEC: Securities and Exchange Commission

SWIFT: Society for Worldwide Interbank Financial Telecommunication

TRS: Total Return Swaps

FIU: Financial Intelligence Unit

INTRODUCTION

The exponential expansion of international financial flows in the 21st century has destabilised canonical notions of sovereignty, national security and conflict. Far from constituting simple economic transactions, these flows shape functional power structures that overstep the institutional competences of states and erode their capacities for territorial intervention (Bryan et al., 2017). The circulation of capital does not only follow a productive or fiscal logic: it unfolds through legal trajectories, digital protocols and material supports that transform space into an operational field of geopolitical contestation. Under the guise of abstract fluidity, the architecture of money is anchored to strategic nodes: undersea cables, data centres, extraterritorial legal contracts and enclaves of delegated fiscal sovereignty (Cannon, 2025).

This new regime of financial mobility operates in an environment of structural liberalisation, technical opacity and systemic deregulation, where fiscal engineering, the multiplication of derivative instruments and decentralised technologies have turned the topology of capital into a web of difficult traceability. The apparent dematerialisation of money hides a hyper-localised spatial device, whose morphology responds to the interests of accumulation, evasion and legal shielding. Finance has ceased to be a technical matter for experts and has become a vector of global instability and an instrument of territorial capture by military and civilian means. Indeed, part of national and international security is increasingly at stake in the mastery or loss of these circulation routes.

In this context, capital behaves as a force operating simultaneously on multiple scales. There are differentiated topological patterns of financial circulation that not only optimise fiscal profitability or regulatory arbitrage, but also design corridors of legal immunity, shield strategic actors from state regulation and configure functional territories disconnected from the traditional sovereign framework. These mobile capital architectures generate power asymmetries, regulatory grey zones and structural risk nodes that defy classical supervisory tools.

In the face of this threat, it is imperative to build spatial financial intelligence capable of identifying complex contractual assemblages, mapping critical infrastructures and anticipating asset shifting dynamics. Security in the 21st century requires, more than ever, a doctrine of strategic traceability and adversarial mapping of capital in motion.

Methodologically, the study integrates three complementary approaches: network theory, geographical analysis of infrastructures and contractual engineering. Network theory is used to identify the connection architectures that structure criminogenic financial flows - bidirectional, triangular, circular, multidirectional or hybrid - with each node understood as a financial entity, jurisdiction or intermediation instrument, and each link as a functional flow or hedging relationship. This approach derives from previous work on the spatial morphology of international financial transactions (Fernández Cela, 2015; 2021), where topological typologies of capital circulation applicable to risk scenarios were developed.

The geographical analysis of infrastructures addresses the territorial dimension of capital and its material supports - submarine cables, data centres, clearing houses or tax enclaves - linking patterns of financial mobility with the spaces where they are located. This method, already used in previous studies on tax havens and offshore financial centres

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(Fernández Cela, 2018; 2019), makes it possible to identify critical corridors and jurisdictional discontinuities based on open institutional sources such as SWIFT, the BIS and the CEF.

Contractual engineering is applied to the study of the legal assemblages that underpin transnational flows. By examining international framework contracts and fiduciary structures, we analyse the mechanisms of opacity and the strategies of legal shielding that shape the architecture of global capital. This methodological component extends the line of research developed in recent analyses of financial contagion and legal traceability (Fernández Cela, 2023; 2025), where the notion of "contractual engineering" as a legal infrastructure of power is formalised.

The combination of these three approaches configures an operational methodology oriented towards the detection of critical nodes and the analysis of risk morphologies. More than a descriptive technique, it constitutes a strategic tool for understanding the functional geography of money and its capacity to alter balances of security and sovereignty.

2. FINANCIAL SPATIALITY AND JURISDICTIONAL RISK

For decades, the global economy has been described as a process of increasing integration, where capital flows frictionlessly between spaces. This narrative of "free" capital is a myth. Recent research shows that capital operates within an asymmetric legal, digital and geopolitical infrastructure. It is a contract codified by legal architectures, accelerated by algorithmic infrastructures and shielded by opaque jurisdictions (Zucman, 2015). This logic generates topological patterns of circulation and strategic vulnerabilities.

The spatial structure of financial flows reveals the fragility of operational efficiency. A single transaction (A → B) hides multiple critical layers: undersea cables, satellites, digital platforms. These accelerate transfers, but also concentrate risks, becoming strategic targets (Appert, 2024).

Their genesis stems from asymmetric encryption scenarios. International circulation is not a simple allocation of resources: it is an architecture of power. It obeys principles of legal engineering, invisible technology and geopolitical decisions. As Pistor (2019) has shown, capital does not circulate: it is legally constructed. Its anatomy reveals more about the world order than any sovereignty treaty.

Every flow arises from an asymmetry: regulatory gap, macroeconomic inequality or technological window. The choice of channels (correspondents, *crypto-mixers*, OTC contracts) does not respond to technical neutrality, but to a strategy of sovereignty arbitrage (Sharman, 2010): the path that maximises advantages and reduces state interference is chosen.

Capital traverses simultaneous layers. At the physical layer: MAREA cables, Chicago-NY microwave towers, or cash transport trucks (Tooze, 2021). At the digital layer: *blockchains* like Monero, high-frequency servers like LD4. At the legal layer: *common law* contracts or arbitration in Singapore. These are not just supports, but choke points where control is exercised (Cowen, 2014).

Capital does not just move, it mutates. It changes legal form (from illicit to investment), technology (cash → Monero → *token*), and risk (*subprime* → CDOs). This transmutation is ontological: it turns the illegitimate into legitimate, the opaque into auditable, the speculative into institutional. It is an alchemy operated by technologists, lawyers and algorithms that renders legal language porous. This logic is symbolic and parasitic. It embeds itself as a symbiotic organism in formal structures. When cartels infiltrate logistical networks, off-balance sheet repos are counted in the trillions, or mortgages are repackaged until they become unknowable, capital acts as a self-replicating virus (Christensen, 2011).

And when it anchors, it reconfigures territory. It materialises as assets: flats in Knightsbridge, ports in Angola, debt in Greece. It does not flee space: it shapes it. As Sassen (2015) explains, capital does not deterritorialise, but reconfigures to serve its logics. The resulting topography is a geometry of power: enclaves of accumulation and zones of financial exclusion.

The cycle feeds back on itself. Profits from one circuit feed the next. They are automated by AI that optimises evasion and opacity; they are shielded by the institutional capture of the Big Four; they are legitimised by a discourse that turns complexity into technicality. Although illicit flows represent at least 2.7% of global GDP, less than 0.1% is seized (UNODC and FATF, 2009). This is not a failure: the system is designed to recycle.

Financial circulation must be thought of in terms of hydrodynamics. The pressure comes from asymmetries; the pipes are physical, digital and legal infrastructures; the filters, techno-legal devices; the reservoirs, assets where the flow is anchored as power. As the Bank for International Settlements (2024) warns, without route maps and exposures, states are passive observers.

3. SPATIAL TOPOLOGY OF CRIMINOGENIC FINANCIAL FLOWS

The architecture of illicit financial capital transactions does not respond to a uniform logic, but to a plurality of topological configurations that structure the circulation of capital according to its function, purpose and legality. Each flow is a dynamic assemblage of functional nodes - origin, legalisation, destination, consolidation, custody, arbitration - which act as intermediate stations where capital is transformed, disguised or accelerated. These nodes can materialise as opaque jurisdictions, data centres, algorithmic *trading* infrastructures, fiduciary entities, tolerant exchanges or arbitral tribunals, configuring a mesh of geo-economic and geo-legal vectors.

Its classification cannot be restricted to binary categories such as licit or illicit, nor to static taxonomies of products or jurisdictions. It requires a multidimensional analytical framework that integrates three key capabilities: (i) its spatial geometry, understood as the arrangement of physical (cables, nodes, data centres) and digital (execution platforms, decentralised networks) routes; (ii) its legal architecture, where layers of fiduciary, contractual and regulatory intermediation operate; and (iii) its temporal dynamics, which incorporate factors such as speed of circulation, structural latency and the cyclical recursiveness of capital (Fernández Cela, 2025).

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On this three-dimensional basis, transnational financial flows are articulated through several simultaneous layers of infrastructure that enable and condition their movement: a physical layer, made up of submarine cables, microwave links, geostationary satellites and hyperconnected data centres. A digital layer, where transactions are executed through protocols, and assets circulate in DeFi networks, *stablecoins* without verifiable backing and opaque smart contracts. And a legal layer, underpinned by contractual assemblages, hybrid regimes of law and jurisdictions designed to shield assets from institutional control. This layering creates a complex, opaque and asymmetric financial topology that requires operational approaches beyond simple banking regulation. These infrastructures condition the movement of capital by determining its routes, speed and accessibility between nodes; their influence will be realised in the twelve types of flows discussed below.

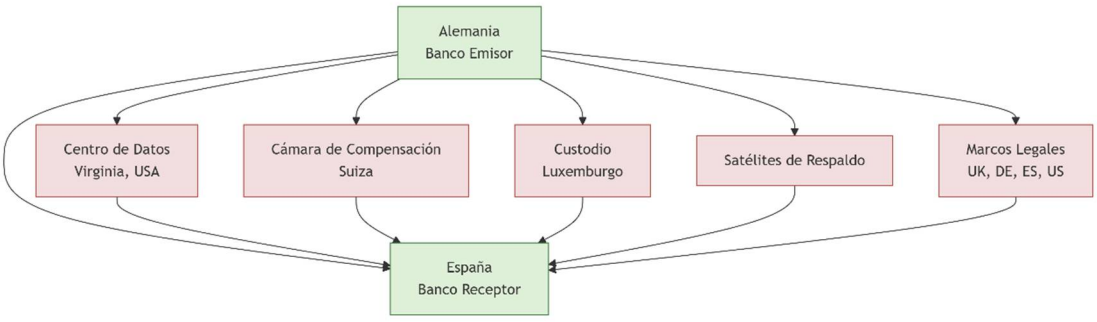
3.1. BIDIRECTIONAL FLOWS

3.1.1. Binary flows: lethal efficiency and strategic simplicity

These are direct transfer structures between two financial nodes that constitute the topological form of minimum entropy in the global financial system: they are fast, efficient and direct. Beneath their apparent operational neutrality (A → B) lies a critical architecture of risk concentration and systemic vulnerability. In such flows, efficiency becomes fragility, and transparency is only a functional illusion.

Far from being secondary channels, binary flows represent the standard circuit of wholesale payments, foreign trade, institutional *clearing* or international transfers in real time. Their hyperlinear nature implies a deliberate reduction of nodes, redundancies and *buffers*, making them vectors of strategic dependence (Clark, 2016). Examples such as the Germany-China payments relationship, where T2 and SWIFT structure a high-volume direct channel, illustrate their operation. However, minimal redundancy makes them highly sabotagable channels: a technical failure, political intervention or legal blockage is enough to collapse the entire flow.

Diagram 1.- Organisational structure of binary flows



Source: own elaboration

From a financial intelligence perspective, this linearity is a structural weakness. A detailed analysis reveals a multi-scale functional trajectory that crosses 5 to 7 different jurisdictions in each binary transaction. Thus, a transfer A → B between a German and a

Chinese bank involves: i) digital infrastructure; ii) physical infrastructure; iii) satellite back-up layers; iv) data centres in transit; and v) fragmented legal frameworks (Scheme 1). Thus, an apparent straight line hides a legal, digital and physical operating framework that makes it a highly vulnerable target (Egmont Group, 2024).

Moreover, low-definition opacity is one of its most lethal characteristics: binary flows condense the entire operation into a single transfer line. This allows geopolitical traceability to be hidden behind technical simplicity. A contract can be domiciled in London, the custodian in Hong Kong, the server in Virginia, and the payment system managed from Switzerland. The result: operational visibility without geo-economic control (Vitali et al., 2011).

In contexts of hybrid warfare or economic coercion, binary flows are the easiest critical infrastructure to exploit. *Ghost injection* techniques, latency manipulation, physical sabotage or capture of intermediate nodes are feasible and modellable scenarios (Govella, 2025). Contemporary financial warfare doctrine, based on flow interdiction, has binary transfers as its most visible target.

3.1.2. High latency flows: geopolitics of microseconds

They constitute the most sophisticated technological dimension of today's financial capitalism. Their logic is not fiscal or accounting, but temporal: controlling the microseconds that separate two financial operations in order to capture value before the market perceives it. In these environments, time is added to space as a critical vector of power (Diagram 2)**.**

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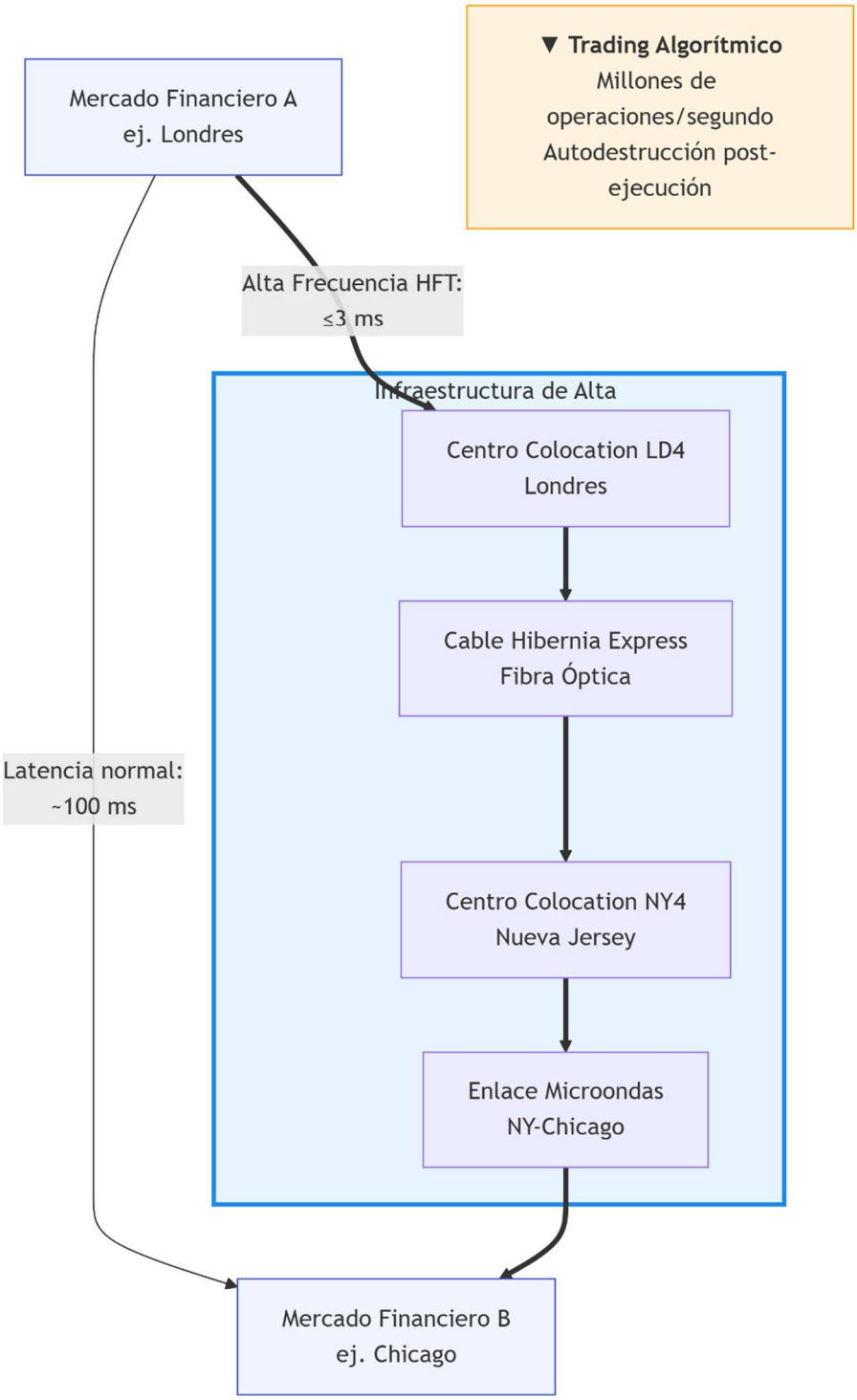
Diagram 2.- Organisational structure of high latency flows



Source: own elaboration

They operate mainly on high-frequency algorithmic *trading* (HFT) platforms, where millions of trades per second are executed from *colocation* centres such as LD4 (London), NY4 (New Jersey) or Equinix ZH4 (Zurich). These infrastructures are physically located next to the exchanges to minimise latency. Dedicated fibre optic cables (C-Lion1, Hibernia Express) and microwave links between New York and Chicago allow latency to be reduced to less than 3 milliseconds (Laughlin et al., 2013).

This time control is not neutral: it shapes an ecosystem where technologically powerful actors capture informational rents invisible to the regulator. The difference between making or losing millions lies in who receives a quote or a regulatory change first.

From a security perspective, high latency flows are extremely difficult to track: there is no identifiable beneficial owner, the duration of exposure is shorter than the audit cycle and contracts are programmatic. Trades self-destruct after execution (Linton and Mahmoodzadeh, 2018). They require real-time algorithmic monitoring systems, correlation of network *logs* and direct access to physical infrastructure (Westermeier, 2023). These flows are not anomalies: they form operational frontiers where financial power is redefined. Time dominance becomes functional sovereignty. Whoever controls latency imposes the rhythm of the market.

3.2. TRIANGULAR FLOWS

3.2.1. Tri-polar financial flows: a magic number of impunity

They represent a deliberate legal architecture designed to fragment responsibilities, dissolve traceability and shield assets of opaque origin. They are not exceptions or anomalies of the global financial system: they are its most perfected functional expression. Their geometry A → B → C is the spatial codification of a structured strategy of capital legalisation, designed to operate outside fiscal control, financial supervision or criminal prosecution. Its utility is not technical, but political: to guarantee the multi-scale impunity of capital in motion.

The basic structure is composed of three functional nodes: (i) the origin or extraction node (A), where capital is generated; (ii) the intermediate or legalisation node (B), a jurisdiction with structural opacity, flexible fiduciary legislation and favourable bilateral treaties; and (iii) the consolidation node (C), a global financial centre where capital is banked, invested or patrimonialised (Garcia-Bernardo et al., 2017). This sequence allows critical functions to be segmented: extracting capital in Madrid or Luanda, reorganising in Luxembourg or Jersey, and consolidating in London or Dubai. Each jurisdiction, separately, formally complies with the law. It is the assembly that produces impunity.

The operational key lies in legal dispersion. Triangular flows employ legal camouflage technologies: chain trusts, *special purpose vehicles* (SPVs), simulated intra-group loans, mirror contracts, *blockchain* double counting, use of hybrid structures and multi-layered evasion (Judijanto et al., 2024). These devices not only reduce the visibility of beneficial ownership, but also allow the creation of redundant structures capable of instant migration in the face of sanctions or blockchain. The case of *mirror loans* between

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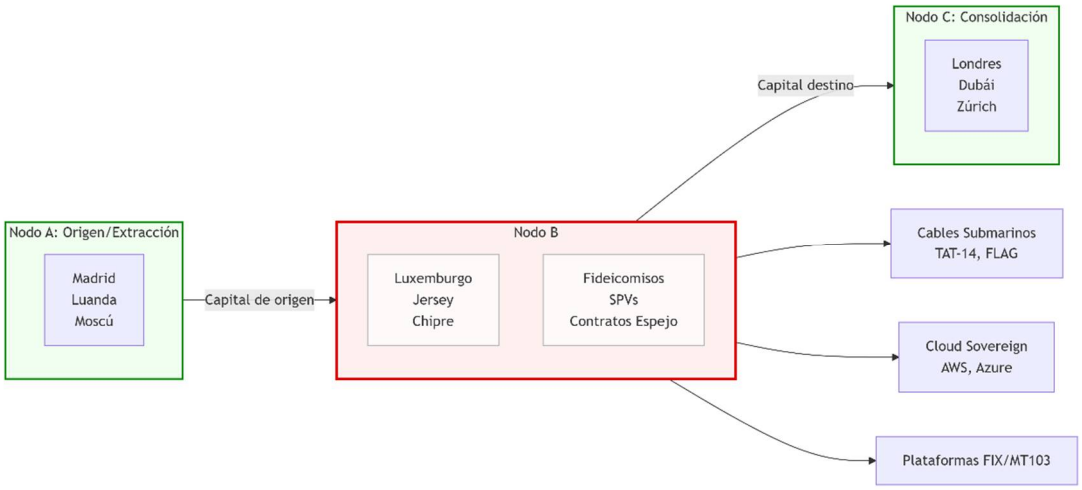
Russia and Cyprus, or Arab funds in Jersey *trusts* during international sanctions, demonstrate this (Diagram 3).

Diagram 3.- Organisational structure of tripolar financial flows



Source: own elaboration

Topologically, triangulation is a vector of jurisdictional capture. Submarine cables, sovereign cloud data centres, geostationary satellites and decentralised banking networks cross over. An operational example: from Moscow, capital travels via TAT-14 to Bude or Marseille, crosses to Cyprus where it is reconfigured via *trusts* or shell foundations, and from there is transferred via FLAG or C-Lion1 to London or Dubai. All recorded via FIX platforms, MT103 or cryptographic APIs, with fragmented copies in AWS GovCloud, Oracle EU Sovereign Cloud or Azure Gibraltar. It is a simultaneous physical, legal and semantic flow.

From an intelligence perspective, the main threat is not just money laundering or tax evasion, but the systematisation of opacity as an operational norm. Each vertex of the triangle represents a layer of institutional shielding (Akartuna et al., 2024). Adversarial analysis requires detection of artificial chronologies, simulation of latencies, correlation of *proxies*, or parsing of trust contracts using legal AI (Surden, 2019). Conventional traceability is useless: discontinuous legal mapping and forensic semantic mining are required.

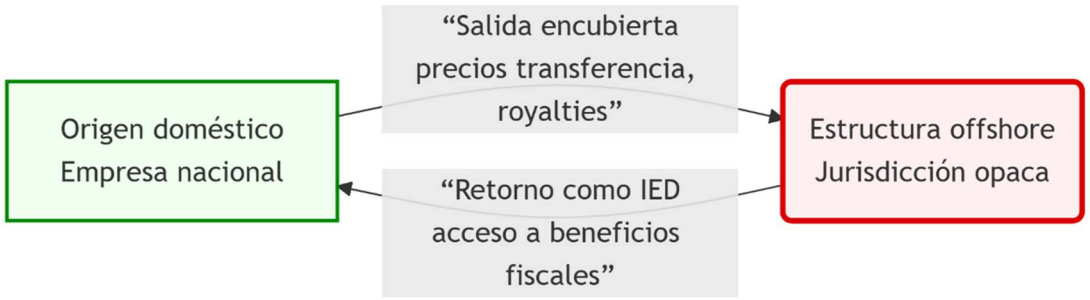
3.2.2. *Round-trip* return flows: simulating internationalisation and wealth re-appropriation

These financial flows are one of the most perverse and effective ways of simulating Foreign Direct Investment (FDI). On the surface, they appear to be a legitimate injection of transnational capital. In practice, they conceal the recycling of national wealth by domestic elites who, using *offshore* architectures, return their own capital disguised as international investment, accessing tax benefits, regulatory incentives or contracts reserved for foreign investors (Aykut et al., 2017).

Their operational architecture is based on a functional path A → B → A′. At the point of origin (A), capital usually flows out through creative accounting techniques: transfer pricing, inflated *royalty*, false invoicing. At the intermediate node (B), the instrumental entity acts as a "structural legalisation": no beneficial owner, no real economic risk, but legal formality. In the return (A′), the State receives the capital as foreign investment without the capacity to verify its traceability. It is an engineering of legalised impunity (Sikka and Willmott, 2010).

Topologically, these flows do not respond to a logic of productive displacement, but of institutional feedback. They are simulated loops that create a fictitious internationalisation, where capital does not change control, only legal form (Garcia-Bernardo et al., 2017). They operate on a highly fragmented digital infrastructure: wired SWIFT networks; storage of corporate and fiduciary documents in encrypted sovereign clouds (Oracle Cloud, AWS GovCloud); and bank custody in entities with low AML integration.

Diagram 4.- Organisational structure of *round-trip* financial return flows



Source: own elaboration

From a financial intelligence perspective, return flows require techniques of reverse traceability of beneficial ownership, semantic analysis of fiduciary clauses, and modelling of patterns of asset recycling. They are mechanisms of private appropriation of public benefits. They simulate globalisation, but institutionalise capture. Behind each "international investor" may hide a local oligarch who has learned to circumvent the democratic control of capital (Diagram 4).

3.3. CIRCULAR FLOWS

3.3.1. flows in a self-destructive loop : geometry of programmed collapse

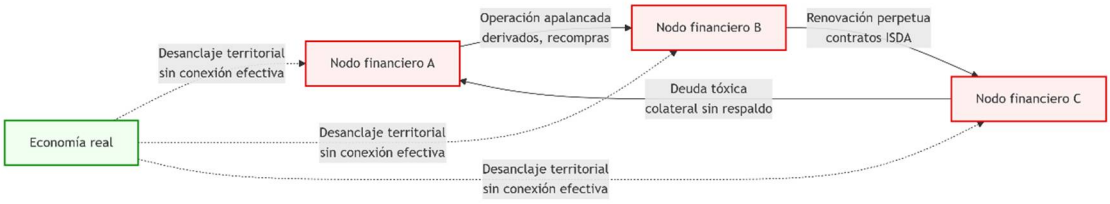
They represent a pathological form of capital circulation, in which the same transactional economic resource between closed nodes reinforces, at each iteration, the fragility of the system that sustains it. Their topology is not based on efficiency or redistribution, but on the feedback of risk, debt or the illusion of solvency, generating a functional architecture whose purpose is to prolong collapse, not to avoid it (Bardoscia et al., 2017).

These flows manifest themselves in three distinct topological forms. First, concentrated speculative loops: closed loops between high-density financial nodes (Chicago → Cayman → Delaware → Chicago) where capital revolves around itself through derivatives, leverage or share buybacks, with no connection to the real economy

and no value creation (Battiston et al., 2016). Second, peripheral institutional loops, typical of economies in crisis (Athens → Brussels → ECB → Athens), where debt issuance fuels bailout and adjustment cycles that aggravate contraction, generating structural dependence (Brunnermeier et al., 2016). Third, decentralised digital loops, typical of blockchain environments: unbacked tokens are used as collateral to create new assets from the same ecosystem, generating liquidity expansion without real anchoring, exposed to instantaneous collapse, as evidenced by the Terra/Luna case in 2022 (Briola et al., 2022). Each represents an autonomous geometry of risk replication.

The dominant topology is that of the self-referential ring: a cycle A → B → A, where capital returns transformed, more leveraged, more toxic, more dependent on its own continuity. This morphology generates three critical spatial effects. The first is a territorial de-anchoring where flows do not pass through the real economy. They are located in abstract nodes of financial decision-making, and do not translate into improvements in employment, production or investment. The second corresponds to a functional polarisation: the benefits are concentrated in issuing centres, while the social costs (adjustment, debt, unemployment) are borne by the peripheral areas. Finally, operational encapsulation develops: here the system becomes blind to its environment. Financial valorisation is carried out internally, ignoring the material consequences on its territorial environment (diagram 5).

Diagram 5.- Organisational structure of flows in a self-destructive loop



Source: own elaboration

The infrastructure of these loops includes payment networks such as T2, Euroclear or CLS, transatlantic cable transmissions (TGN-Atlantic, AEConnect), ISDA contracts allowing perpetual renewals, and centralised data platforms where memoranda of understanding, redemption agreements and syndicated issues are stored as part of an invisible contractual legitimacy.

From a financial intelligence perspective, the self-destructive loop must be treated not as a conjunctural anomaly but as a structural device. It requires detection of contractual circularities, non-linear simulations of sustainability, and adversarial mapping of toxic collateral (Capozzi et al., 2025). These structures do not seek to generate development: they seek to postpone insolvency without redistributing power or reforming the system. They are technologies of collapse management. Where there is a loop, there is closure; and where there is closure, there is circular domination. The only viable way out is not refinancing: it is the strategic breaking of the loop, the structural audit of collateral and the spatial reconfiguration of flows towards open, productive and sovereign trajectories that use assets for social improvement.

3.4. MULTIDIRECTIONAL FLOWS

3.4.1. Synthetic pentagonal flows: mapping jurisdictional complexity and codified risk

Together with cryptographic networks, they constitute the most sophisticated, opaque and dangerous geometry of the contemporary financial system. Unlike binary or triangular flows, pentagonals not only disperse nodes, jurisdictions and custodians, but actively assemble legal vulnerabilities, regulatory asymmetries and chains of leveraged risk. They are not system failures or gaps in the system: they are the system at its most optimised to evade oversight and maximise returns at the expense of global stability.

A pentagonal flow is a multidirectional financial structure with differentiated tasks (Fernández Cela, 2025): a risk issuer, usually a fund or bank domiciled in Delaware or London; an unconsolidated SPV in Ireland or the Virgin Islands; a collateral guarantor - insurers with *non-recourse* clauses in Guernsey or Bermuda; a custodian such as Euroclear, Clearstream or DTCC; and a hybrid arbitral jurisdiction - Singapore, London, Vienna - that resolves disputes. This architecture decouples risk, ownership and collateral across jurisdictions, making integrated oversight difficult and facilitating opaque structures immune to state intervention or ex ante scrutiny.

Each node fragments risk, dissociates ownership and hinders traceability. This assembly logic seeks to separate operational risk from legal and collateral risk, making the structure immune to state intervention or regulatory oversight. They are built with highly customised OTC derivatives: TRS, CDS, synthetic options, ISDA contracts with mirror clauses or forwards linked to invisible assets (Kiff et al., 2009). Everything is stored in distributed legal clouds, with attachments spread across contradictory jurisdictions. The key is not in the financial content, but in its deliberately unintelligible topological coding.

The impact of pentagonal flows is systemic: they break multiple risk containment mechanisms. A contagious cross-default clause can trigger chain margin calls on a single default, amplifying liquidity pressure (Markose et al., 2010). This dynamic is exacerbated by the lack of harmonisation between regimes such as EMIR, Dodd-Frank or Solvency II, which allows regulatory arbitrage where risk accumulates undetected. In addition, synthetic leverage and the absence of netting mechanisms prevent a clear assessment of net exposure, hiding critical vulnerabilities under misleading gross figures (Scheme 6).

Collateral fragmentation is the last critical link. Re-hypothecation - reuse of the same asset as collateral in multiple transactions - means that when a margin call is triggered, the collateral is no longer available (Luu et al., 2018). This opaque and untraceable network design transforms one-off stresses into systemic collapses. This was the case with Lehman Brothers, which accumulated more than 900,000 OTC contracts without netting (Manzano, 2017); Archegos Capital, which replicated leveraged positions via hidden swaps; and Credit Suisse, whose exposure to cross-jurisdictional swaps without collateral precipitated its collapse in 2023.

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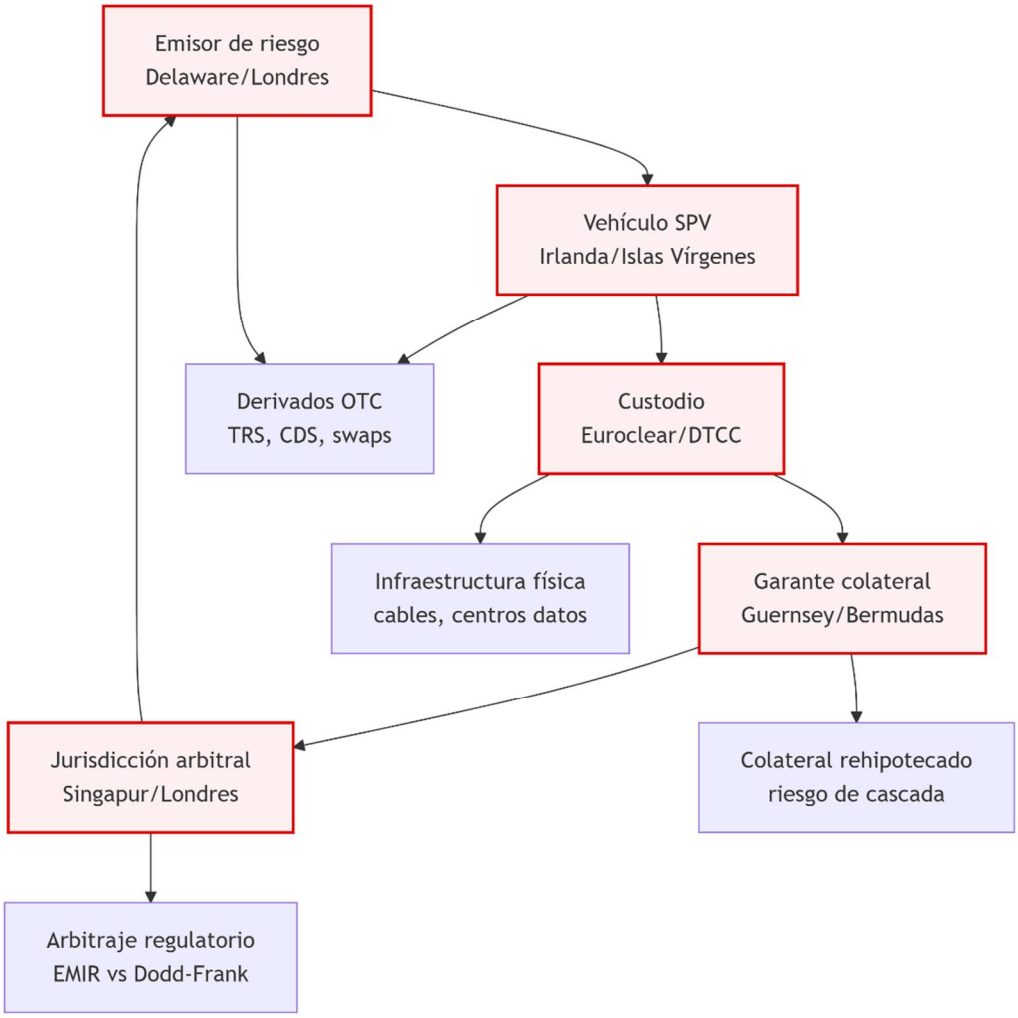
Diagram 6.- Organisational structure of synthetic pentagonal flows



Source: own elaboration

Spatially, these flows form a global hypergeometric graph that crosses physical infrastructures (LD4, NY4, FLAG), submarine cables, contingency satellites (SES, Kuiper), data centres and low-latency servers (Equinix, AWS, Azure). Nowhere is there a complete overlap between collateral, incumbent, custodian and contract. This radical decoupling is its greatest strength for the system, and its greatest threat to stability.

Neutralising pentagonal flows requires unconventional capabilities. Traditional regulation centred on national entities or registries is insufficient. Strategies such as: contractual mapping using forensic AI to track hidden clauses; adversarial simulation of cascading nodal failures; physical-legal verification of assets at custodian nodes; reverse legal penetration in private arbitration; resilience testing for SWIFT *blackout* or digital outages; structural interception correlating margins, risk and contractual servers; and pre-syntactic analysis of derivatives to detect critical clauses are required. These measures

would help to dismantle opaque architectures designed to evade any form of integrated oversight.

Their threat is not only in their volume, but also in their design. They are legal instruments that result in spatial structures with a high criminogenic component. Their function is not to invest, but to dematerialise control, dilute accountability and extract profitability from systemic disinformation. As long as the system allows multi-jurisdictional contractual assemblages without integrated oversight, pentagonal flows will remain a vector of the next crisis.

3.4.2. Fractal flows: nested architecture of systemic opacity

They are the operational core of the 2008 financial crisis and the most perfected expression of the engineering of financial opacity. Their essence lies not in the movement of capital in the classical sense, but in the structural replication of contractual instruments over successive layers of packaged risk. They are flows with no linear path, no single point of origin and no discernible destination: what flows is risk itself, transformed, repackaged and redistributed in the form of "safe" assets through multiple layers of nested securitisation.

In operational terms, a fractal flow starts from a real asset: mortgages, student loans, lines of credit, expected rents. These assets make up Layer 1, which is aggregated and transformed into MBS/ABS securities (Layer 2), structured in turn into CDOs (Layer 3), which can be repackaged as CDOs² (Layer 4), and artificially replicated in *Synthetic* CDOs (Layer 5), where there is no longer a real asset, but only contractual references (CDS, options, synthetic index derivations). Each layer adds a greater distance from the real risk, while multiplying its apparent profitability (Barnett-Hart, 2009).

The logic of these flows is not to finance the economy, but to monetise risk. Their architecture is deliberately opaque: contracts are written in hyper-complex legal language, encoded in proprietary formats, midnight clauses, stored in distributed clouds (AWS, Equinix, Azure), with no cross-visibility between custodians (Stenzel, 2021). The key is that no one entity sees the whole map. Regulators, rating agencies and end-holders (pension funds, insurers, sovereign wealth funds) are faced with structures of which they know a part, but not the whole.

From a topological point of view, fractal flows do not move as trajectories A → B → C, but replicate as a layered network, without symmetry or linearity. A *subprime* mortgage default in Nevada can generate contagion effects in German insurers or Norwegian funds that never knew they had exposure. Key nodes include issuers in the US, SPVs in Ireland or Cayman, insurers in Bermuda and holders in Tokyo or Frankfurt. This dispersion generated a total dissociation between ownership, risk and custody, making any coherent oversight of the system difficult (Diagram 7).

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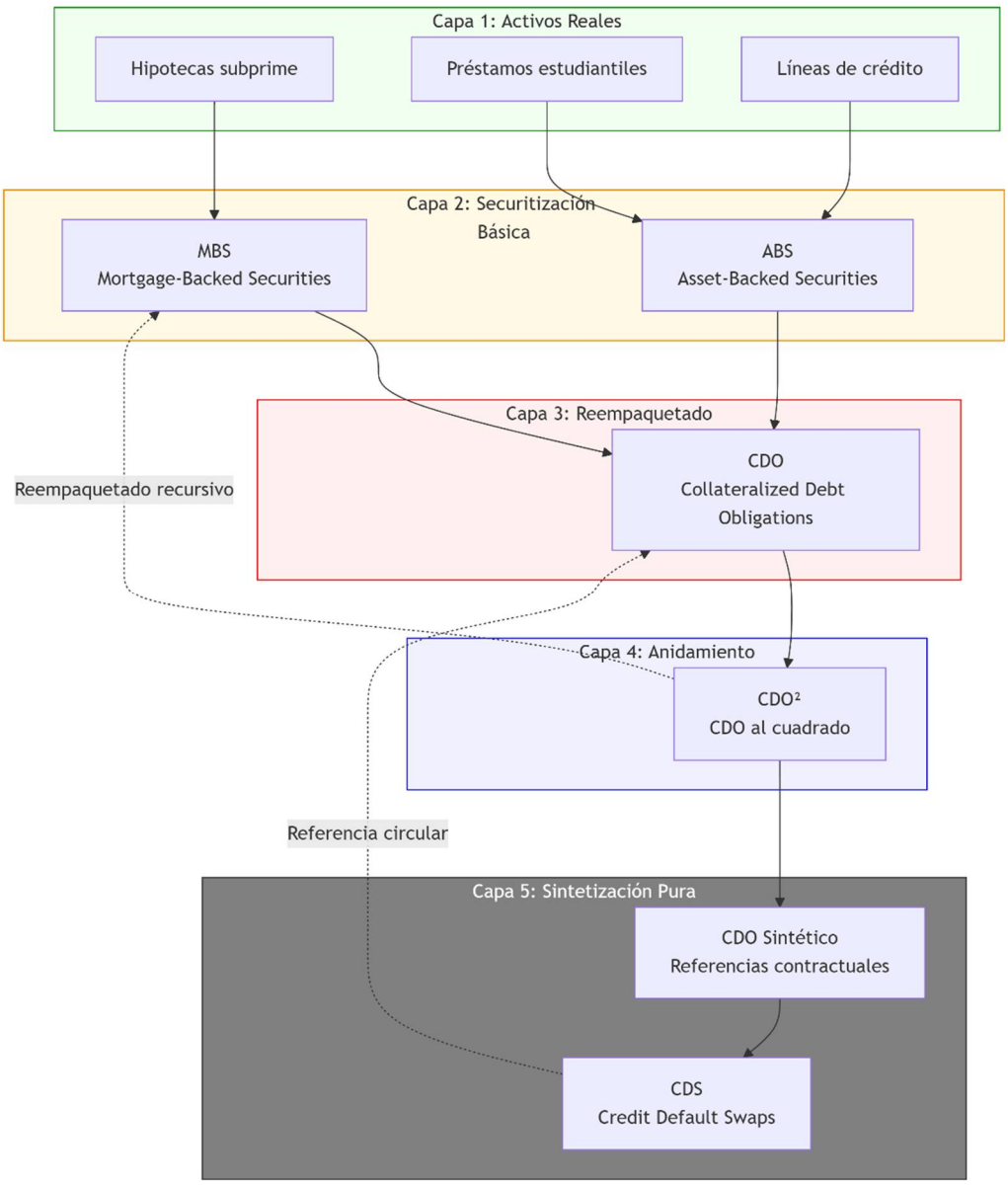
Diagram 7.- Organisational structure of fractal flows



Source: own elaboration

The vulnerabilities are multiple: misalignment of incentives (structurers charge for volume, not sustainability), flawed mathematical models (Gaussian copula with unrealistic assumptions), inefficient audits (unreadable prospectuses), and regulatory fragmentation that prevents any supervisor from having a complete overview. Fractal securitisation transforms a decentralised financial system into a self-referential hierarchical opacity machine (Awrey, 2012; Brigo et al., 2009).

From a financial intelligence perspective, neutralising complex flows requires advanced technological and regulatory tools. First, reverse tracing through legal AI would allow reconstructing hidden fiduciary routes by training neural networks with ISDA

contracts, prospectuses and annexes (Capozzi et al., 2025). Second, a regulatory limit should be set to prohibit more than two levels of nesting in structured derivatives, blocking synthetic architectures that impede oversight. This approach aligns with reforms such as SEC Rule 18f-4, which seeks to contain the risk of excessive leverage. Third, there is an urgent need to develop synthetic exposure mapping that identifies nodes where derivatives with no net collateral are concentrated, potential hotspots of systemic risk (Markose, 2012). Fourth, semantic reform is required to standardise the readability of prospectuses and incorporate automated analysis to detect opaque clauses (ESMA, 2022). These combined actions not only address the current opacity, but also redesign the regulatory environment to make it incompatible with opaque financial engineering.

3.4.3. Flows of accounting concealment: a parallel global capital register

Their function is to constitute an invisible accounting network on which part of the global financial system operates. They do not necessarily involve physical transfers of capital, but semantic-accounting movements, where it is ownership, risk or income that is shifted, but not the underlying asset. They are designed to operate outside the regulatory radar without abandoning formal legality.

Their strategic ontology is clear: separate legal form from economic substance. A regulated entity (bank, fund, insurer) registers part of its accounting, profits or risk in an unregulated entity located in an *offshore* jurisdiction. Thus, the risk or income "disappears" from the supervisory perimeter of the primary regulator, without relinquishing effective control of the group (Gorton and Souleles, 2007).

These structures are not marginal. They constitute the operational architecture of the shadow financial system, and their existence is a necessary condition for the viability of the other opaque flows: triangular, pentagonal or fractal. They act as "accounting neutralisation nodes", where capital is relabelled, relocated or temporarily invisible.

In spatial terms, they are supported by a highly fragmented physical and digital infrastructure across multiple jurisdictions. Contracts and records are stored in hybrid clouds with partial encryption, decoupling physical location and legal jurisdiction. Records are updated through banking APIs without AML integration, and flows are channelled through SWIFT or FIX networks without verifiable territorial correspondence.

From a financial security perspective, the risks are serious: structural deconsolidation prevents balance sheets from reflecting real exposures, hiding key links between entities. There is illusory transparency, where firms formally comply with local regulations while operating parallel structures out of audit. In addition, there is accounting capture, shifting risks and outcomes to vehicles without effective oversight, weakening institutional control (Gorton, 2007; IMF, 2014). The response requires forensic semantic penetration, cross-auditing of fiduciary networks and reverse topological analysis of hidden consolidations. Accounting concealment flows are not just mechanisms of circumvention, they constitute a key parallel structure in the architecture of 21st century capital (Figure 8).

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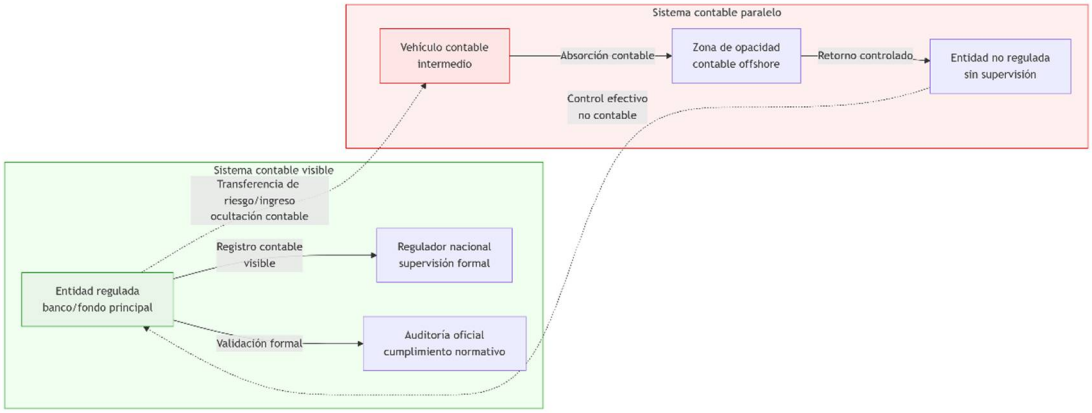
Diagram 8.- Organisational structure of accounting hiding flows



Source: own elaboration

3.4.4. Parasitic flows: the criminal symbiosis of the formal financial system

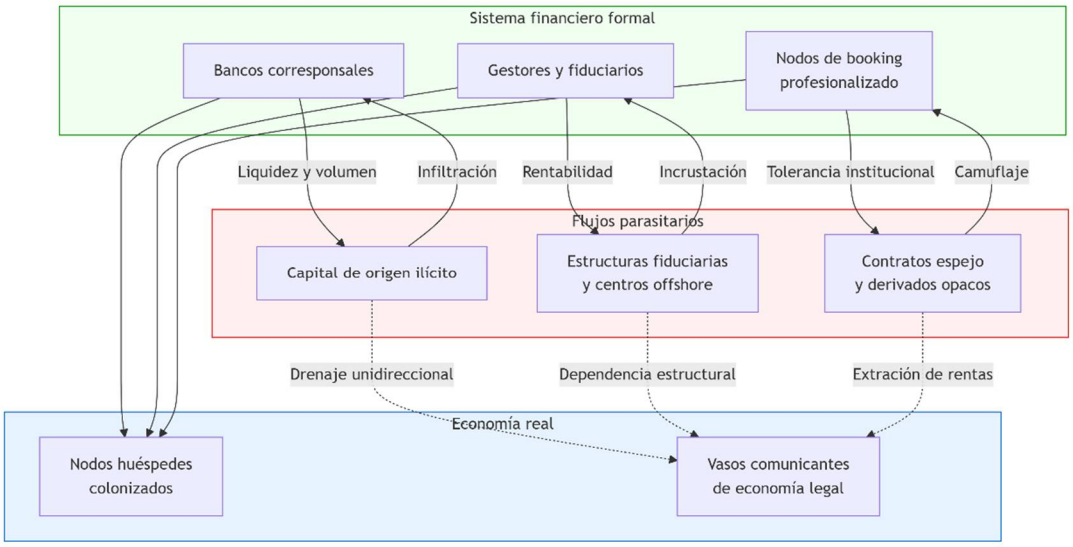
They represent an operational interface between the formal financial system and illicit accumulation networks. Unlike traditional criminal flows, parasitic flows do not exist outside the traditional banking system: they colonise, use and deform it from within. They are a systemic embedding mechanism, in which capital of illicit origin is integrated into the upper layers of the financial system with the functional complicity of managers, trustees, correspondent banks or professionalised booking nodes (Levi, 2012; Sharman, 2010).

Their logic is that of operational symbiosis: criminal capital needs financial structures to circulate and legitimise itself; financial capital tolerates this infiltration in exchange for liquidity, volume and profitability. The boundary between legality and illegality becomes blurred, not so much by direct fraud, but by institutional design. Trust structures, offshore centres, mirror contracts or derivative instruments allow layers of formal legality to be superimposed on capital whose origin is segmented, dissolved or deliberately obscured.

These trajectories exploit structural vulnerabilities: ambiguous fiduciary legislation, banks with low levels of *compliance*, opaque jurisdictions without CRS and stock exchanges that authorise non-transparent vehicles. The fragmentation between economic and legal ownership allows the financial parasite to exist. From a financial intelligence perspective, their detection requires a hybrid approach: mapping of fiduciary genealogies, simulation of dynamic *layering* with forensic AI, and mapping of institutional tolerance vectors to locate banking or judicial nodes that facilitate their operational embedding and permanence.

Parasitic flows are one of the most dangerous forms of capture: the one that is not perceived as criminal, but colonises the communicating vessels of the legal economy from within. Combating them requires maps, not lists; structural intelligence, not just formal compliance (Diagram 9).

Diagram 9.- Organisational structure of parasitic flows



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3.4.5. Mirror debt flows: contractual engineering of geo-financial subjugation

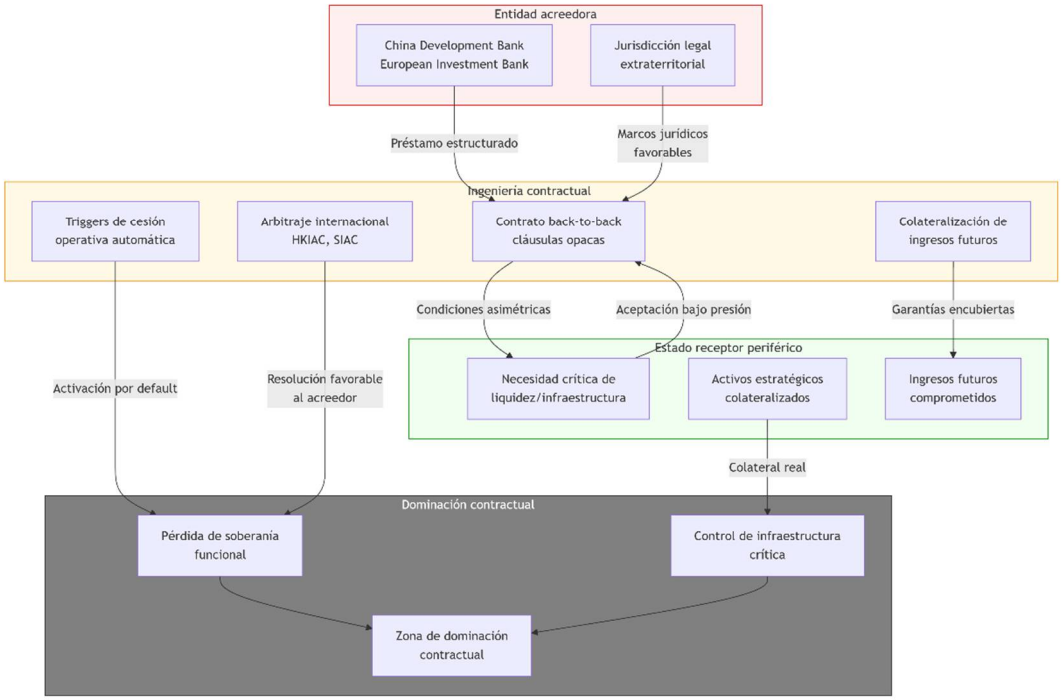
Mirror debt flows are a central tool in the architecture of contemporary financial diplomacy. Although they are presented as development finance or bilateral cooperation agreements, they conceal highly structured mechanisms of strategic subordination. Their contractual design responds to a logic of deliberate asymmetry: the debtor state, generally peripheral and with little bargaining power, is induced to accept opaque conditions under extraterritorial legal frameworks, issued by parastatal creditor entities such as the European Investment Bank or the China Development Bank. These operations not only impose financial dependency, but also reconfigure functional sovereignties by progressively transferring control over key assets and flows without the need for visible military or political intervention (Parker and Chefitz 2018).

The operational structure of these flows is based on an extra-accounting legal set-up: the actual collateral of the loan is not the financed asset, but future state revenues (hydrocarbon royalties, port fees, customs duties), which guarantees a more stable source of repayment for the recipient country's economic infrastructure. These mirror clauses, which are not publicly disclosed, contain contractual *triggers* that make it possible to activate mechanisms of operational cession, forced leasing or the transfer of functional sovereignty in the event of a technical default. The paradigmatic case is the Hambantota port in Sri Lanka, where debt default with China led to the cession of control for 99 years. These schemes represent a sophisticated form of geo-economic domination that combines financial engineering, legal opacity and deferred territorial capture.

The operational scheme starts with a creditor node offering a structured loan under a legal jurisdiction favourable to the creditor. The debtor node, with low bargaining power and critical liquidity or infrastructure needs, accepts opaque contractual terms with asymmetric trigger clauses and disguised guarantees. Unlike standardised multilateral

loans, these bilateralised contracts are not subject to parliamentary transparency, international oversight or ex ante auditing (Scheme 10).

Diagram 10.- Organisational structure of mirror debt flows



Source: own elaboration

The technical key to the mirror flow lies in the non-formal collateralisation. Instead of backing the loan with the financed asset, it is linked to future flows of sovereign revenues (hydrocarbon exports, port taxes, customs duties), allowing that, in the event of default, a clause of operational assignment or forced leasing of strategic assets is automatically activated. These contracts often include *non-recourse enforcement* clauses that shield the creditor from any restructuring or public dispute (Mihalyi et al., 2022).

Topologically, the flow is consolidated through distributed legal networks: the contract is signed in one jurisdiction, arbitration is submitted to creditor-friendly international courts (HKIAC, SIAC), enforcement is formalised in supranational courts, and collateralised assets may be fragmented in different national registries or even in legal clouds with delegated functional sovereignty.

From a financial intelligence perspective, this type of flow requires contractual counter-engineering and early intervention. It is essential to identify trigger clauses (*event of default*), map the committed *off-ledger* flows as collateral (*off-ledger mapping*) and map the jurisdictions involved to anticipate transfer of control scenarios. In addition, financial defence doctrines should be deployed that include capabilities for sovereign renegotiation, legal reconfiguration of the contract and operational resistance to offshore takeover (IMF, 2021).

Mirror debt flows do not seek financial return: they seek control. They are legal algorithms of programmed dispossession, assembled to transform debt into domination. This is done through contractual clauses that reconfigure the sovereignty of the debtor, shifting economic decision-making power to the creditor. Its neutralisation does not lie in economic solvency, but in legal sovereignty, tactical anticipation and strategic mapping of contractually codified risk.

3.5. HYBRID FLOWS

3.5.1. Crypto-opaque flows: the new geography of cryptojurisdictional laundering

They represent a post-jurisdictional evolution of money laundering: a set of decentralised, semi-anonymous and structurally evasive capital trajectories, articulated through crypto platforms, mixers, bridges and stablecoins without verifiable backing. They do not respond to traditional fiscal or banking logics: they move on P2P networks, DeFi infrastructures and obfuscated smart contracts (Zola et al., 2025; Elliptic, 2024).

Digital smuggling flows operate through a three-layered functional architecture that ensures their structural resistance to traditional traceability. In the first stage, opaque capital is converted into cryptoassets through permissive entry ramps that minimise institutional control (Gabbiadini et al., 2024). Centralised *exchanges* with weak identity verification, unregulated cryptocurrency ATMs and NFT exchange platforms used as speculative hedging instruments allow the insertion of money into the crypto ecosystem without raising formal alerts. This initial fragmentation of the origin is key to decoupling the digital asset from the illicit wealth that originates it.

In the intermediate phase, digital assets undergo an obfuscated transition through the use of tools specifically designed to destroy the continuity of the transactional trail. *Mixers* such as Tornado Cash, inter-chain exchange protocols (RenBridge) and second-layer networks (Arbitrum, zkSync) allow assets to be recomposed, subdivided and forwarded without the authorities being able to reconstruct a verifiable timeline (Nadler and Schär, 2023). This stage exploits the legal and technical vulnerabilities of *multichain* structures and custodianless smart contracts to dilute attribution.

Finally, the reconfigured funds are reconverted into fiat currency or put into operational circulation through low-control over-the-counter channels. OTC *brokers*, prepaid crypto debit cards or the use of *stablecoins* without transparent backing make it possible to close the cycle in crypto-permissive jurisdictions such as the United Arab Emirates, Georgia, Nigeria or El Salvador (Diagram 11).

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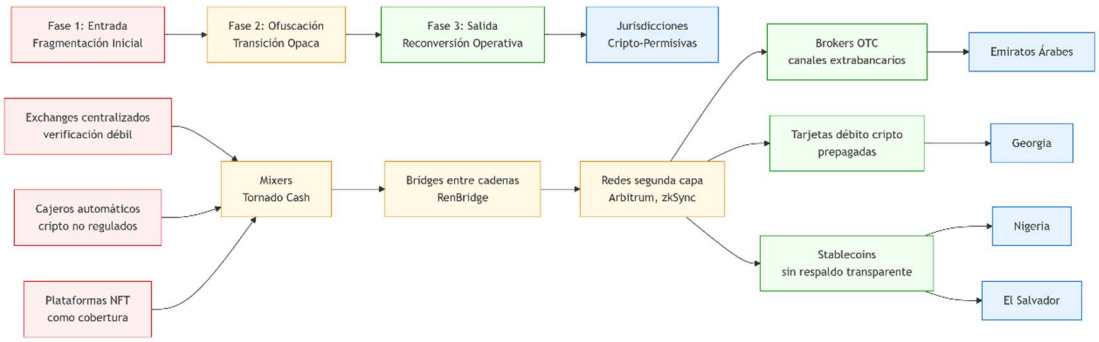
Diagram 11.- Organisational structure of crypto-opaque flows



Source: own elaboration

These trajectories are highly resistant to traditional traceability. AML tools do not cover multichain structures, and state FIUs lack the technical and legal jurisdiction to intervene in decentralised *smart contracts* or non-custodian *wallets*. From a financial intelligence perspective, these flows demand a new approach: *blockchain* forensic AI, analysis of *wallet-to-wallet* behavioural patterns, monitoring of opaque *bridges*, and geographic correlation of nodes and validators. The threat is not just criminal: it is structural. These networks are generating a parallel monetary sovereignty that is difficult to tap and even more difficult to map.

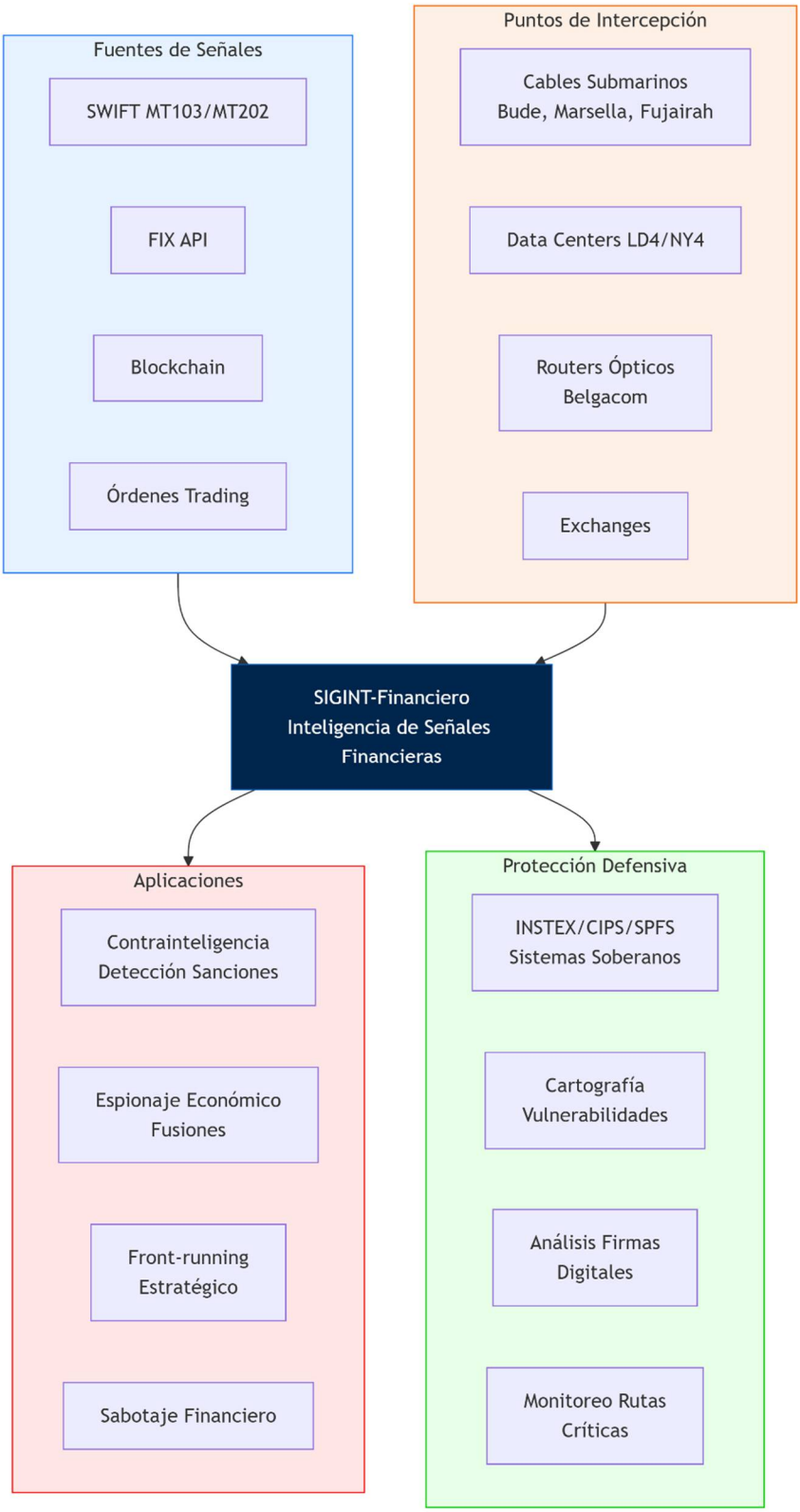
3.5.2. SIGINT-Financial: the strategic capture of capital flows

Signals intelligence applied to financial networks constitutes a new operational field where electronic surveillance, economic espionage and the technical architecture of the global financial system come together. Unlike traditional intelligence based on people (*HUMINT*) or open sources (*OSINT*), financial SIGINT exploits the physical-digital infrastructure through which payment orders, contracts and asset transfers circulate.

As we have seen, its operational logic starts from the premise that every financial flow leaves a digital footprint, be it a SWIFT message (MT103, MT202), a FIX API connection, a blockchain execution, or a margining order between counterparties (Markose, 2012, op. cit.; Weinbaum et al., 2018). These signals can be intercepted, correlated and exploited by state or private actors with privileged access to technical nodes (*data centres*, *landing stations, exchanges*, custody).

Documented cases such as the ECHELON/GCHQ-NSA agreement to intercept SWIFT traffic from Bude in the UK, or the cross access to optical *routers* of Belgacom or Submarine Cable Maps (Marseille, Fujairah), show that the financial system can become a theatre of covert operations (Ball, 2013). Not only for counter-intelligence purposes (detection of sanctions violations, flow to designated entities), but also as a tool for geo-economic advantage such as merger espionage, strategic *front-running* or financial sabotage (Diagram 12).

Diagram 12.- Organisational structure of SIGINT-Financial flows



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From a defensive perspective, states require SIGINT vulnerability mapping capabilities, monitoring of transmission routes (cables, satellites, IXPs), digital signature analysis of flows and deployment of sovereign financial messaging systems.

In the 21st century, he who dominates latency controls the market. But he who dominates the signal, controls the financial power map. Financial SIGINT is not the future: it is already operational.

4. CONCLUSIONS AND PROPOSALS

The main flows of global financial capital have been mapped through a topological and scalar classification. Far from considering transactions as mere accounting transfers, I suggest considering them as functional structures of power, articulated through digital, legal and geo-economic infrastructures that configure the financial system as a field of strategic conflict. Organising the analysis by spatial scales allows us to understand that capital does not flow in a vacuum: it circulates through structured territories, through assembled legal layers and through infrastructural networks designed to favour certain actors and neutralise others.

The twelve flows analysed are not marginal exceptions, but functional expressions of a global architecture that is both decentralised and hierarchical. Each of them materialises a technique of opacity, simulation or domination. Some through speed (HFT), others through silence (accounting concealment), others through legal manipulation (mirror debt), others through contagion (fractals), others through mimicry (parasitic flows).

Faced with this map, financial intelligence cannot be limited to regulatory compliance or statistical analysis. It requires a doctrine of structural financial sovereignty, based on three pillars. First, critical mapping that builds functional maps of capital, focusing on trajectories, nodes and legal assemblages, not abstract national aggregates. Second, improved adversarial modelling, developing tools for systemic risk simulation and nodal exploitation, not only to anticipate collapses, but also to dismantle capture circuits. Third, expanding strategic traceability: establishing regulatory, technological and diplomatic mechanisms to ensure the tracking of each relevant flow, from its origin to its destination, including collateral, contracts, beneficiaries and jurisdictions.

Consistent with proactive action and financial defence doctrines, an IA-ADF (Alert and Detection of Flows) system is proposed that integrates: (i) dynamic mapping of relationships between entities/jurisdictions to identify the 12 morphologies described (including round-trip, mirror and self-destructive loops); (ii) contractual NLP to locate covert dominance clauses (event of default, cross-default, operational assignments, non-recourse); (iii) routing, latency and collateral anomaly detection (rehypothecation, insufficient netting, sovereign jumps); and (iv) adversarial simulation (what-if) to test for contagion and trigger early warnings and pre-emptive blocking. AI does not replace compliance, it precedes it: it transforms reactive supervision into structural prevention of risk scenarios in the twelve proposed flows.

Contemporary sovereignty is not only at stake in the control of territory, but in the mastery of the diagram: of financial graphs, transfer infrastructures, interstate contracts

and digital platforms that allow or block the passage of capital. Whoever controls the path conditions the power relations.

High-resolution financial geo-intelligence is proposed, capable of reading the architecture of globalisation not as a diffuse spider's web, but as a set of tunnels, valves, mirrors and channels whose logic is decipherable and therefore governable. It is a complex and onerous challenge, but what is at stake is not just transparency or efficiency: it is the reconstruction of economic sovereignty on geometric, legal and topological foundations.

In times of structural instability and latent financial warfare, mapping is not describing: it is preparing. Financial security in the 21st century will be proportional to the state's ability to read and redesign its own flows. And this requires forward thinking, doctrine and action. This is where that task begins.

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