WELTWERT INSIGHTS

Precision Mass: From Warfare to Economics and Policymaking
How a Military Concept Reshapes Global Strategy
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1. Introduction

Inspired by an article on "Precise Mass", published in media outlet Foreign Affairs, we reflected on whether this concept could also be extended to other areas, such as economics, competition, politics, and policymaking. The application scenarios we describe here are not fundamentally new in substance. But the concept we refer to as "***precision mass***" in reference to the article cited offers new perspectives on how a military concept, that combines the scale of a WW1 artillery barrage with the precision of a cruise missile, reshapes global strategy in other areas like economy or policy making.

2. Executive Summary

2.1. *Precision Mass* – From Warfare to Economics, Competition, and Policymaking

Definition: *Precision Mass* is a concept combining the deployment of large-scale resources or assets with surgical precision to achieve a military, economic or political objective. The goal is to maximize impact while minimizing the side-effects of a blanket approach that lacks a clear definition.

The concept[1] of ***Precision Mass***, has its origin in the military domain, where AI-driven systems (e.g., drones, hypersonic missiles, big data, satellite communication, etc.) redefine military power. By combining **large-scale mobilization** with **surgical precision**, *Precision Mass* redefines strategy across warfare, economic competition, and policymaking. Surgical precision in this day and time is increasingly enabled by artificial intelligence (AI), advanced analytics, and real-time data. This essay traces the development of Precision Mass from its military roots to its applications in economic conflicts and policymaking, using examples like the US's Greenland strategy or the Venezuela example to illustrate cross-domain synergies. It explores how the logic of this concept translates beyond the battlefield, offering new frameworks for understanding and addressing contemporary global challenges.

The true power of the **combination of mass and precision** only becomes apparent when its **adaptability is fully harnessed**. Adaptability increases dramatically when AI is used to select

[1] We view "Precision Mass" as a concept (i.e., a theoretical, analytical construct) that can be applied in various fields. In our view, it is neither a framework, that is, an operational approach (operational), nor a purely phenomenological concept. The latter would be too simplistic.

priority targets from a wide range of options, while simultaneously providing a large number of operational options for engaging those targets.

With the increased scale and frequency of hybrid attacks the new era of warfare is also characterized by a general state of “non-peace”. This has been described as ‘hybrid or shadow war’ or ‘grey zone’ conflict. In this case, the number of incidents and the broad range of targets and methods represent the element of mass, while the element of ‘precision’ lies in the exact targeting of a societal, infrastructural or technical vulnerability, or the precise targeting of misinformation or disinformation.

2.2. *Precision Mass* in biological systems

When we think about Precision Mass in a broader context, as a combination of size or mass and surgical precision, and look at biological systems or, more generally, nature from this perspective, fascinating parallels become apparent. Nature provides compelling examples for Precision Mass, demonstrating how scalable, decentralized systems achieve precision through adaptive feedback, local rules, and emergent intelligence. These biological systems offer blueprints for man-made systems, from AI-driven warfare to adaptive policymaking, highlighting the tremendous power of combining mass and precision. These aspects are described in more detail in the Annex.

3. Precision Mass in Modern Warfare

Core Definition:

- **Mass:** Traditional military scale deployment of troops and weaponry (e.g., large armies, strategic nuclear arsenals, carpet bombing, etc.).
- **Precision:** AI-enabled targeting (e.g., drones, cyber warfare, big data, predictive analytics).
- **Precision Mass:** Merging Mass and Precision to **scalable, AI-driven systems** that adapt in real time, such as:
    - Swarms of autonomous drones.
    - Hypersonic missiles with real-time targeting.
    - AI-driven logistics and battlefield analytics.

The most recent telling example is the "decapitation strike" against Iran's political and military leadership on 28 February 2026.[2]

Further Examples:

- **Ukraine War:** AI-guided artillery and drone swarms.[3]
- **US-China Military/Tech Rivalry:** AI-driven hypersonic missiles and cyber operations.[4]
- **Hybrid Warfare:** Russia's blend of cyberattacks, disinformation, and conventional forces.[5]

[2] The militarily successful precision bombing of the Iranian leadership with a special type of missile called Sparrow was prepared and enabled by a complex cyber operation. According to an article in the FT, a years-long intelligence campaign that helped pave the way for the ayatollah's assassination. This source of real-time data, one of hundreds of different streams of intelligence, was not the only way Israel and the CIA were able to determine exactly what time Khamenei would be in his offices this fateful Saturday morning (28 Feb) and who would be joining him. Nor was the fact that Israel was also able to disrupt single components of roughly a dozen or so mobile phone towers near Pasteur Street, making the phones seem as if they were busy when called and stopping Khamenei's protection detail from receiving possible warnings. The information in this footnote refers to a remarkable effort of coordination facilitated by AI, leading to a precision strike. The precision-*mass* effect of the US and ISR efforts is illustrated in this article, referring inter alia to Project Maven.

[3] **Source:** "How Ukraine Is Using AI to Fight Russia" (Wired, 2023) https://www.wired.com/story/fast-forward-ukraines-quest-for-homegrown-ai-drones-to-take-on-russia/, **Academic**: Simmons-Edler et al. (2025) analyze the application of artificial intelligence in modern weapon systems https://www.researchgate.net/publication/392105341_Military_AI_Needs_Technically-Informed_Regulation_to_Safeguard_AI_Research_and_its_Applications/citations

[4] **Source:** https://www.cnas.org/publications/reports/u-s-china-competition-and-military-ai, **Academic**: Digital titans at war: US–China tech rivalry and the rise of Chinese military aid https://www.cnas.org/publications/reports/u-s-china-competition-and-military-ai

[5] **Source:** Eroding Global Stability: The Cybersecurity Strategies of China, Russia, North Korea, and Iran (2025) https://smallwarsjournal.com/2025/11/26/cybersecurity-strategies-china-russia-north-korea-iran/, **Academic:** A Global Analysis of Cyber Threats to the Energy Sector: Currents of Conflict from a geopolitical perspective (2025) https://arxiv.org/html/2509.22280v1

In military terms, *Precision Mass* merges the overwhelming scale of traditional warfare instruments – i.e. weaponry - with the accuracy of precision strikes. AI-driven systems, such as drones (loitering, swarming or sitting, aerial, sea), autonomous vehicles, and predictive analytics, enable real-time target identification, adaptive coordination, and scalable deployment. This approach lowers barriers to entry for smaller actors, The result is a **new era of warfare**, where mass and precision are no longer trade-offs but complementary forces, reshaping deterrence, escalation risks, and global security norms. For more detail, see Appendix 1 (Section 9).

4. Spill-over to Economic Conflicts

Economic conflicts are increasingly characterized by a similar *Precision Mass* dynamic. Here, "mass" refers to the scale of resources, market access, or financial power, while "precision" involves targeting specific vulnerabilities, such as supply chains, financial systems, or data flows, including as identified with AI-driven tools.

Spill-over Mechanisms include **(1) Technology Transfer**: Military AI (e.g., predictive analytics, autonomous systems) is repurposed for economic and political goals. **(2) Strategic Culture**: The logic of Precision Mass, scalability + precision, becomes a template for the deployment of economic conflict tools.

Key manifestations include:

- **Targeted Sanctions and Trade Wars:** AI is deployed to analyze global trade flows to impose surgical sanctions (e.g., U.S. restrictions on semiconductor exports to China or Chinese squeeze of selected rare earths) or counter adversarial economic strategies. Sanctions against specific individuals fall also in this category.
- **Financial Warfare:** Algorithmic trading and AI-powered financial tools can disrupt markets or freeze assets with the utmost precision, as can be seen in the case of sanctions against specific individuals.
- **Massive Amount of Data as a Weapon:** AI can be used to manipulate vast information flows, from disinformation campaigns to cyberattacks on critical infrastructure, exemplified by China's use of social media bots and Russia's hybrid tactics in Europe.
- **Supply Chain Disruptions:** AI systems are trained with large-scale data maps, facilitating the stressing of global supply chains and allowing state and non-state actors to exploit chokepoints (e.g., semiconductor fabs, rare earth mining) for strategic leverage.
- **Focused selectively restricted access to or investment in a massive market:** the large USA market, including military, can be leveraged by imposing market access restrictions unless the access seeker massively invests in selective priorities such as fabs, or disinvestment such as wind energy parks.

This dynamic creates **asymmetric advantages. O**n the one hand smaller actors can disrupt larger economies for lower costs, and benefit from **plausible deniability**, as economic attacks often occur in the "gray zone" between war and peace. On the other hand, great powers can highly selectively inflict massive trade damage on each other or put a smaller adversary in a stranglehold. The result is an **AI-driven arms race in economic statecraft**, fragmenting global markets into rival blocs and demanding new norms for data sovereignty, cybersecurity, and AI ethics.

Examples:

- The **recent Venezuela example:**
  - **Military-Economic Link:** Massive military power was used to establish a naval blockade for political/military and economic coercion. In an earlier phase the deployment of military presence was, disguised as the "fight against drug smuggling".
  - **Precision Mass in Action:** The targeted, precise abduction of Venezuelan President Maduro was prepared and enabled by extensive intelligence and cyber operations. This could serve as an example for similar events in the future.
- **US Greenland Ambitions:**
  - **Military-Economic Link:** The US updated its Arctic strategy (e.g., modernized Greenland bases) to counter China/Russia, blending **military presence (mass)** with **targeted economic investments (precision)**, e.g., rare earth mining deals to secure critical material supply chains.
  - **Precision Mass in Action:** Using AI to map Arctic resources and disrupt adversaries' access (e.g., restricting Chinese mining bids).
- **US-China Military/Tech Rivalry:**
  - **Mass:** Global semiconductor supply chains.
  - **Precision:** AI-driven export controls (e.g., banning ASML chip machines to China) and cyberespionage targeting specific firms (e.g., Huawei).
- **Russia's Energy Cyber Tactics:**
  - **Mass:** Gas exports to Europe.
  - **Precision:** Cyberattacks on European energy systems and disinformation campaigns to create and exploit political divisions.

Key Dynamics:

- **Asymmetric Advantages:** Smaller actors (e.g., Taiwan, Estonia) use AI to punch above their weight.
- **Plausible Deniability:** Economic attacks (e.g., sanctions, cyberattacks) blur the line between war and peace (a state of "non-peace").

5. Precision Mass in policymaking and policy application

In policymaking and policy application, *Precision Mass* translates to **scalable, yet targeted interventions** that leverage factors like social sentiment, market sizes, data and technology to maximize impact while minimizing waste through a blanket approach. Possible applications include:

- **Economic Policy:** AI-driven "precision stimulus" is used to target interventions where they are most needed (e.g., financial or fiscal stimuli for struggling or strategically important industries), while adaptive regulation is being adjusted to real-time economic indicators, based on extensive analysis of economic ecosystems.
- **Social Policy:** Combining a broad range of socio-economic data from the entire population to create personalized welfare systems with AI to tailor services (e.g., healthcare, education) to individual needs, ensuring broad coverage without sacrificing relevance.
- **Geopolitical Strategy:** The deployment of targeted diplomacy aiming to achieve a strategic objective in a broad geographical area. This could be built on data-driven assessments of shared interests, mirroring how military alliances are formed for strategic advantage. See also the Venezuela example.

How the concept of Military Precision Mass Translates to Policy:

- **Mass:** Broad policy reach (e.g., universal healthcare, climate goals, digital policy and sovereignty).
- **Precision:** AI-driven customization (e.g., personalized welfare, adaptive regulations).

5.1. Global Examples for Precision Mass in policymaking and policy application

5.1.1. The EU's Digital Decade Policy Program (2030)

Why it fits *Precision Mass*:

- **Mass:** A continent-wide digital transformation strategy, aiming to make the EU a global leader in digital innovation by 2030.
- **Precision:** Uses AI, data analytics, and real-time monitoring to tailor digital policies (e.g., cloud computing, semiconductors, cybersecurity) to specific member states' needs and vulnerabilities and provide a clear picture of progress towards the 2030 objectives.

Key Features:

- **Digital Targets:** Sets binding targets for digital infrastructure (e.g., gigabit connectivity for all households, 10,000 climate-neutral edge nodes for data processing).
- **AI Act:** Regulates AI based on risk levels, applying stricter rules to high-risk applications (e.g., biometric surveillance, critical infrastructure).

- **Digital Markets Act (DMA) and Digital Services Act (DSA):** Targets "gatekeeper" platforms (e.g., Google, Meta) with precise obligations to ensure fair competition and user safety.

Sources:

- EU Digital Decade Policy Program 2030
- DMA and DSA: European Parliament
- AI Act: European Commission

5.1.2. U.S. Inflation Reduction Act (IRA, 2022)

Why it fits *Precision Mass*:

- **Mass:** A $369 billion investment in clean energy, the largest climate change related legislation in U.S. history, designed to reshape the national economy.
- **Precision:** Uses tax incentives, grants, and loans to **target specific industries** (e.g., electric vehicles, solar manufacturing, battery production) and **geographic regions** (e.g., "energy communities" in coal-dependent states).

Key Features:

- **Industrial Policy:** Directs funds to domestic manufacturing of clean energy technologies, reducing reliance on China.
- **Localized Impact:** Prioritizes investments in disadvantaged communities, using data to identify areas with the highest need.
- **Adaptive Implementation:**[6] Continuously adjusted based on market responses and technological advancements.

Sources:

- US Inflation Reduction Act (IRA) (White House)
- IRA's Impact on Clean Energy (Brookings, 2023)
- The Inflation Reduction Act: A Place-Based Analysis (DoT)

5.1.3. China's Social Credit System

Why it fits *Precision Mass*:

[6] The role of adaptability to exploit the full potential of the combination of mass and precision is explained in more detail in section 2.1.

- **Mass:** A nationwide system integrating data from financial, legal, and social behaviors to monitor and influence 1.4 billion citizens.
- **Precision:** Uses AI to **target individuals and businesses** with rewards or penalties based on compliance with state priorities (e.g., environmental regulations, debt repayment).

Key Features:

- **Behavioral Control:** AI-driven scoring allows the political level (CCP) to control access to loans, jobs, and travel, creating a scalable yet individualized system of governance.
- **Regional Adaptation:** Local governments can customize the system to address specific challenges (e.g., pollution in industrial cities, financial stability in rural areas).
- **Real-Time Adjustments:** Continuously updated based on new data and policy goals.

Sources:

- China's Social Credit System (Mercator Institute for China Studies, 2022)
- China's Social Credit System in 2021: From fragmentation towards integration (Mercator Institute for China Studies, 2022)
- Shaping AI's Future? China in Global AI Governance (Journal of Contemporary China, 2022)

5.1.4. India's Aadhaar Biometric ID System

Why it fits *Precision Mass*:

- **Mass:** The world's largest biometric ID system, covering 1.3 billion people.
- **Precision:** Uses AI and data analytics to **target social welfare programs** (e.g., food subsidies, pension payments) directly to individuals, reducing leakage and corruption.

Key Features:

- **Direct Benefit Transfers:** AI verifies identities and routes payments to bank accounts, ensuring precision in resource allocation.
- **Scalable Infrastructure:** Integrates with healthcare, education, and financial services, creating a unified platform for governance.
- **Adaptive Policies:** Continuously refined based on feedback and technological upgrades.

Sources:

- AI in India's Governance (NITI Aayog, 2021)
- The Aadhaar Mirage. A Second [critical] Look at the World Bank's 'Model' for Digital ID Systems (2022)
- India's Aadhaar scheme and the promise of inclusive social protection (2017)

5.1.5. South Korea's Digital New Deal

Why it fits *Precision Mass*:

- **Mass:** A national digital transformation plan to create a data-driven economy, with investments in AI, 5G, and other digital infrastructure.
- **Precision:** Focuses on **specific sectors** (e.g., smart cities, healthcare, education) and **vulnerable groups** (e.g., elderly, low-income households) to maximize impact.

Key Features:

- **Smart Cities:** Uses AI to optimize traffic, energy, and public services in urban areas.
- **Digital Education:** Targets digital literacy programs to regions with low connectivity.
- **Healthcare Innovation:** AI-driven diagnostics and telemedicine for rural communities.

Sources:

- South Korea's Digital New Deal (Ministry of Economy and Finance, 2022)
- AI in South Korea's Smart Cities (IEEE, 2023)
- Digital Inclusion Policies (OECD, 2021)

5.2. Why These Examples Work

- **Current and Active:** All examples are either recently implemented or actively evolving (e.g., EU Digital Decade, U.S. IRA).
- **Clear *Precision Mass* Logic:** Each combines **large-scale resources** with **targeted, data-driven interventions**.
- **Diverse Geographic Focus:** Covers the EU, U.S., China, India, and South Korea, showing global applicability.
- **Documented Impact:** Supported by official reports, academic analyses, and media coverage.

Challenges:

- **Data Dependency:** Risks of surveillance and bias.
- **Ethical Dilemmas:** Who decides policy "targets"?
- **Algorithmic failures:** targeting the wrong subjects.[7]

6. Cross-Domain Synergies

6.1. How Domains Reinforce Each Other

- **Military → Economics:** AI developed for warfare (e.g., predictive analytics) is repurposed for economic statecraft (e.g., sanctions, supply chain mapping).
- **Economics → Policy:** Economic *Precision Mass* (e.g., targeted sanctions) stimulates the development of policy tools (e.g., adaptive trade regulations).
- **Policy → Military**: Policy measures such as the EU AI Act aim to influence the global development of military AI (e.g., ethical guidelines for autonomous weapons). However, given developments in the U.S. (not to mention China), there is considerable grounds for skepticism at this point. Not only might the EU AI Act fail to have the intended global brake effect on autonomous weapons, but it could even have the opposite effect: EU drone manufacturers might decide to relocate their production to the U.S. so as not to fall behind in the race.

6.2. Case Study: mutually reinforcing components of the US Greenland Strategy

- **Military:** Expanding Arctic bases to counter Russia/China.
- **Economic:** Securing rare earth supplies via Greenlandic partnerships.
- **Policy:** Using AI to monitor Arctic shipping routes and enforce sanctions.

7. Implications and Future Directions

The *Precision Mass* concept offers a powerful lens for rethinking strategy across domains. However, this approach raises challenges, including data dependency, implementation complexity, and ethical dilemmas around fairness and transparency:

- **New Arms Race:** AI-driven *Precision Mass* in economics/policy mirrors military competition.
- **Fragmentation Risks:** Rival blocs (U.S. vs. China) create fragmented markets.
- **Governance Gaps:** Need for norms on AI, data sovereignty, and cybersecurity.

[7] An illustrative example was the **Child Benefit Scandal (The Netherlands, 2005-2019)**: In its aggressive crackdown on fraud, the government employed socially discriminatory algorithms, which had serious financial consequences for a large number of affected families.

For anticipatory policymaking, Precision Mass enables future-proofing policies and scenario-based planning, using predictive tools to model and prepare for multiple futures.It highlights the need for:

- **New Governance Models:** Institutions must develop capacities to harness AI and data for scalable yet precise policymaking.
- **Ethical and Legal Safeguards:** Rules are needed to govern AI's dual-use potential in economic and political conflicts, ensuring accountability and minimizing unintended consequences.
- **Global Cooperation:** Fragmentation risks demand international dialogue on norms for AI, data sovereignty, and cybersecurity.

By embracing *Precision Mass*, policymakers, economists, and strategists can design interventions that are **both broad and bespoke**, leveraging technology to address complex challenges, from climate change to geopolitical rivalry, with unprecedented agility and impact.

To conclude, *Precision Mass* is more than a military concept; it is a **strategic blueprint** for the 21st century, offering a roadmap for navigating the intersection of scale and specificity in an AI-driven world. Given all the potential benefits of Precision Mass, in which AI plays a central role, we should also mention that there is a downside: the advantages of "big numbers, precise impact" can be undone by AI failures. This should not be treated as a footnote in the race for GenAI and warrants further research.

8. General References (non-exhaustive examples)

Hossin, M. A., Du, J., Mu, L., & Asante, I. O. (2023). Big Data-Driven Public Policy Decisions: Transformation Toward Smart Governance. *SAGE Open*. https://doi.org/10.1177/21582440231215123

Janssen, M., & Van der Voort, H. (2015). Adaptive governance: Towards a stable, accountable and responsive government. *Government Information Quarterly*, *33*(1), 1-5. https://doi.org/10.1016/j.giq.2016.02.003

Bali, A. S., Capano, G., & Ramesh, M. (2019). Anticipating and designing for policy effectiveness. *Policy and Society*, *38*(1), 1-13. https://doi.org/10.1080/14494035.2019.1579502

Evans, A., April 25th, 2024, Anticipatory policymaking for a thriving future https://blogs.lse.ac.uk/politicsandpolicy/anticipatory-policymaking-80610-2/

9. Appendix 1: Outline of the term *Precision Mass* in the Military Context

The phrase **era of *precision mass* in warfare** refers to a fundamental shift in how military power is deployed, combining **massive scale** with **unprecedented precision,** a transformation largely enabled by artificial intelligence (AI) and advanced weapons:

9.1. What is *Precision Mass*?

Applying the definition given above:

- **Mass:** Traditionally, military power relied on sheer quantity, large armies, vast arsenals, and overwhelming firepower. Think of World War II's carpet bombing or Cold War-era stockpiles of nuclear weapons.
- **Precision:** In recent decades, precision-guided munitions (PGMs) like GPS-guided bombs or drones and initiatives like Project Maven[8] have allowed militaries to strike specific targets with high speed and accuracy, reducing collateral damage and improving efficiency.
- **Precision Mass:** merges the two concepts. It's not just about having a few precise weapons; it's about deploying **large numbers of highly precise, AI-enabled systems,** drones, hypersonic missiles, autonomous vehicles, and swarming robots, that can operate in coordinated, adaptive ways. AI allows these systems to analyze vast amounts of data in real time, identify and prioritize targets, and even make autonomous decisions on the battlefield.

9.2. How AI Enables *Precision Mass*

- **Real-Time Data Processing:** AI systems can process data from satellites, drones, sensors, and intelligence feeds faster than humans, enabling rapid target identification and engagement.
- **Autonomous Coordination:** AI allows swarms of drones or robots to act as a unified force, adapting to changing conditions without constant human input. For example, a swarm of drones could autonomously search, identify, and engage enemy targets across a wide area.
- **Predictive Analytics:** AI can predict enemy movements, supply routes, or vulnerabilities, allowing preemptive strikes or the disruption of adversary operations before they fully materialize.

[8] **Project Maven** (officially **Algorithmic Warfare Cross Functional Team**) is a Department of Defense initiative launched in April 2017 to accelerate the adoption of machine learning and data integration across U.S. military intelligence workflows, initially focused on applying computer vision for processing images and videos for intelligence purposes. Currently, the program operates under the National Geospatial-Intelligence Agency (NGA) and encompasses multiple applications across the Department of Defense spanning military operation targeting support, data integration and visualization for analysts, and training machine learning models on labeled datasets of military assets and infrastructure. It integrates data from drones, satellites, and other sensors to flag potential targets, present findings to human analysts, and relay their decisions to operational systems.

- **Target selection:** AI increased analysis, identification and priorization of targets allows a sizeable reduction in the time between the decision to engage and the actual strike.
- **Scalability:** AI-driven systems can be deployed at scale. Instead of a handful of expensive precision missiles, militaries can now field thousands of lower-cost, AI-guided drones or loitering munitions, overwhelming defenses through sheer numbers and precision.

9.3. Why This Reshapes Warfare and International Security

- **Lower Barriers to Entry:** Smaller states or non-state actors (like terrorist groups) can now access precision capabilities that were once the domain of superpowers. For example, commercially available drones, combined with AI, can be weaponized for targeted attacks.
- **Speed and Unpredictability:** The speed of AI-driven decision-making and the unpredictability of autonomous systems make traditional defense strategies, like air defense or cybersecurity, less effective. Adversaries may struggle to counter swarms of AI-guided weapons or adaptive cyberattacks. It should be noted, however, that while unpredictability offers certain advantages, it also entails an increased risk for users of the autonomous system should the system lose control.
- **Blurring Lines Between War and Peace:** AI-enabled systems can conduct operations below the threshold of traditional warfare, aimed at disruption such as sabotage, disinformation, or targeted assassinations, making it harder to attribute attacks or define what constitutes an act of war and enhances deniability
- **Escalation Risks:** The ability to strike with precision at scale and at low cost could lower the threshold for conflict, as states might perceive limited strikes as "low risk." However, miscalculations or AI errors could spiral into larger conflicts.

9.4. Examples in Practice

- **Ukraine War:** Both Ukraine and Russia have used AI-enabled drones and loitering munitions to strike targets with precision, often in large numbers. Ukraine's use of AI to analyze satellite imagery and direct artillery strikes is a real-world example of *precision mass*.
- **Swarming Drones:** The US, China, and Israel are developing drone swarms that can overwhelm air defenses by sheer numbers, creating a "saturation effect" while maintaining precision targeting.
- **Autonomous Vehicles:** AI-driven armored vehicles, tanks, ships, and submarines are being tested for their ability to operate in coordinated groups, reducing the need for human soldiers in high-risk environments. These are also developed in smaller sizes and referred to as land and sea or submarine drones.

9.5. Implications for International Security

- **Arms Race:** The pursuit of *precision mass* capabilities is driving a new arms race, particularly between the U.S., China, and Russia, as each seeks to outpace the others in AI and autonomous systems.
- **Deterrence Challenges:** Traditional deterrence strategies (like nuclear deterrence) may, notwithstanding their general strategic importance not apply to AI-driven conflicts, where attacks can be deniable, rapid, and conducted by non-state actors or proxies.
- **Norms and Governance:** There is an urgent need for international norms and agreements to regulate the use of AI in warfare, but geopolitical rivalries make consensus difficult. While a first step has been made with the "Political Declaration on Responsible Military Use of Artificial Intelligence and Autonomy" the actual effect of this initiative, for example in the light of the US-Israeli operation 'Epic Fury' on Iran is an object for further study

9.6. Takeaways

The *era of precision mass* represents a paradigm shift in warfare, where **AI and precision weapons allow militaries to combine the overwhelming scale of traditional mass warfare with the surgical accuracy of modern precision strikes**. This transformation is reshaping not only how wars are fought but also the very nature of international security, creating both opportunities and profound risks for global stability.

10. Appendix 2: Expanding Precision Mass to Biology

After further reflection, we wondered whether the ***Precision Mass*** concept, **i.e., the combination of size and surgical precision**, can be found in **biological systems** or, **more generally, in nature**. Nature provides compelling examples for *Precision Mass*, demonstrating how scalable, decentralized systems achieve precision through adaptive feedback, local rules, and emergent intelligence. These biological systems offer blueprints for man-made systems, from AI-driven warfare to adaptive policymaking, highlighting the tremendous power of combining mass and precision. This reflection leads to **further research questions**: Could specific biological systems and behavior directly inspire human-made *Precision Mass* strategies in a particular domain, like cybersecurity or economics?

The examples cited below are meant as inspiration for further study. They are based on an AI-supported online search for relevant examples of *Precision Mass* in nature. These examples are illustrative and were checked for plausibility, but without specific expertise in these fields. In addition, it is suggested that examples from nature[9] be examined in terms of their potential applicability in technology and economics for future research questions.

A few illustrative examples of how *Precision Mass* manifests itself in nature, along with insights and implications for understanding complex natural systems.:

10.1. Precision Mass in Biological Systems: Core Concepts

In nature, *Precision Mass* can be observed in systems where **large-scale, distributed actions** (mass) are combined with **highly targeted, adaptive responses** (precision) to achieve efficiency, resilience, or competitive advantage. These systems often rely on **decentralized coordination**, **feedback loops**, and **emergent behaviors,** analogous to AI-driven coordination in human-made systems.

Key Characteristics:

- **Mass:** Large numbers of individuals, cells, or organisms acting collectively (e.g., swarms, colonies, immune systems).
- **Precision:** Targeted, adaptive responses to specific stimuli or threats (e.g., predator avoidance, resource allocation, immune targeting).
- **Emergent Intelligence:** Decentralized, self-organizing systems that achieve precision through simple rules and feedback (e.g., ant colonies, neural networks).

[9] A recent article describes the implant of a digitized fruit fly brain into a simulated (robotic) body. Imagine, what this means for the adaptability of a swarm of drones that behave like they would have the brain power of a living organism, like a hawk.

10.2. Examples of Precision Mass in Nature

10.2.1. Ant Colonies: Swarm Intelligence

- **Mass:** Colonies of thousands or millions of ants, acting as a single "superorganism."
- **Precision:**
  - **Foraging:** Ants use pheromone trails to **dynamically optimize paths** to food sources, adapting in real time to environmental changes (e.g., obstacles, predator threats).
  - **Division of Labor:** Tasks (e.g., nursing, foraging, defense) are allocated based on **local interactions and feedback**, not centralized control.
  - **Nest Construction:** Ants build complex, climate-controlled nests by following simple rules, achieving **scalable precision** without a blueprint.
- **Parallel to Human Systems:** Mimics AI-driven swarm robotics (e.g., drone swarms) or adaptive logistics in military/economic domains.
- **Sources:**
  - Decentralized decision making by an ant colony: drift-diffusion model of individual choice, quorum and collective decision (May 2021)
  - Experiments on collective decision-making during food recruitment make no (ecological) sense (June 2018)

10.2.2. Immune System: Adaptive Defense

- **Mass:** Billions of immune cells (e.g., T-cells, B-cells, macrophages) patrolling the body.
- **Precision:**
  - **Targeted Responses:** The immune system **identifies and attacks specific pathogens** (e.g., viruses, bacteria) while sparing healthy cells, using molecular "signatures" (antigens).
  - **Memory and Adaptation:** Vaccines and prior infections create **adaptive immunity**, allowing faster, more precise responses to repeat threats (e.g., COVID-19 mRNA vaccines).
  - **Scalable Deployment:** Cytokine signaling recruits cells to infection sites, balancing **broad mobilization** with **localized action**.
- **Parallel to Human Systems:** Analogous to **AI-driven cybersecurity** (e.g., detecting and neutralizing specific threats in a network) or **precision medicine** (targeted therapies).
- **Sources:**
  - The Immune System Computes the State of the Body: Crowd Wisdom, Machine Learning, and Immune Cell Reference Repertoires Help Manage Inflammation (Front. Immunol., 2019)
  - Adaptive immunity (JACI, 2010)

10.2.3. Schooling Fish and Flocking Birds: Collective Motion

- **Mass:** Thousands of individuals moving in unison (e.g., herring schools, starling murmurations).
- **Precision:**
  - **Predator Evasion:** Rapid, coordinated movements confuse predators, achieved through **local rules** (e.g., align with neighbors, avoid collisions).
  - **Efficient Foraging:** Schools of fish **optimize energy use** by drafting off one another, dynamically adjusting formation.
  - **Scalable Adaptation:** No leader; precision emerges from **individual responses to immediate neighbors**.
- **Parallel to Human Systems:** Inspires **swarm robotics** (e.g., drone swarms) and **adaptive logistics** (e.g., real-time routing in delivery networks).
- **Sources:**
  - The physics of flocking: Correlation as a compass from experiments to theory (Physics Reports, 2018)
  - A common rule for decision making in animal collectives across species (PNAS, 2012)

10.2.4. Fungal Networks: Resource Distribution

- **Mass:** Vast mycelial networks (e.g., *Armillaria ostoyae*, the "humongous fungus") spanning kilometers.
- **Precision:**
  - **Nutrient Exchange:** Fungi **selectively allocate resources** to plants in need (e.g., carbon to shaded trees, phosphorus to seedlings) via underground "Wood Wide Web."
  - **Adaptive Growth:** Networks **rewire dynamically** to bypass damaged areas or exploit new resources.
  - **Symbiosis:** Precision in **partner selection** (e.g., favoring beneficial plants, avoiding parasites).
- **Parallel to Human Systems:** Mirrors **adaptive supply chains** (e.g., rerouting goods during crises) or **smart grids** (balancing energy distribution).
- **Sources:**
  - Evidence for common fungal networks among plants formed by a Dark Septate Endophyte in *Sorghum bicolor* (communications biology, 2025)
  - How mycorrhizal associations drive plant population and community biology (Science, 2020)

10.2.5. Bacteria Quorum Sensing: Coordinated Attacks

- **Mass:** Billions of bacteria in a colony (e.g., *Pseudomonas aeruginosa*).
- **Precision:**
  - **Quorum Sensing:** Bacteria **release signaling molecules** to coordinate attacks (e.g., biofilm formation, toxin release) only when their numbers reach a critical mass.
  - **Targeted Virulence:** Precision in **timing and location** of infections (e.g., lung infections in cystic fibrosis patients).
  - **Adaptive Resistance:** Colonies **develop resistance** to antibiotics through coordinated genetic changes.
- **Parallel to Human Systems:** Analogous to **cyberattacks** (e.g., botnets coordinating DDoS attacks) or **economic sanctions** (triggered by thresholds).
- **Sources:**
  - Quorum Sensing: Not Just a Bridge Between Bacteria (Microbiology open, 2025)
  - Mechanisms of bacterial immunity, protection, and survival during interbacterial warfare (Cell Host & Microbe, 2024)

10.3. Implications for Human Systems

The biological examples above reveal **universal principles of *Precision Mass*** that can inform human strategies:

Biological System	Mass	Precision	Lesson for Human Systems
Ant Colonies	Millions of ants	Dynamic path optimization	**Swarm robotics, adaptive logistics**
Immune System	Billions of cells	Targeted pathogen responses	**Cybersecurity, precision medicine**
Schooling Fish	Thousands of individuals	Predator evasion via local rules	**Autonomous drones, real-time routing**
Fungal Networks	Kilometers of mycelium	Selective resource allocation	**Smart grids, adaptive supply chains**
Bacterial Quorum Sensing	Billions of bacteria	Coordinated attacks at thresholds	**Cyberattacks, economic sanctions**

10.4. Cross-Domain Insights

10.4.1. Decentralized Coordination

- Nature achieves *Precision Mass* **without central control**, relying on **simple rules + feedback** (e.g., pheromones, quorum sensing).
- **Human parallel:** Blockchain, swarm robotics, and AI-driven systems mimic this decentralization.

10.4.2. Adaptive Resilience

- Biological systems **rewire dynamically** (e.g., fungal networks, immune responses) to handle disruptions.
- **Human parallel:** Adaptive governance (e.g., EU's Green Deal adjustments) or resilient supply chains.

10.4.3. Threshold-Driven Action

- Precision is often **triggered by scale** (e.g., quorum sensing, ant trails).
- **Human parallel:** Economic sanctions (e.g., triggered by human rights violations) or military escalation thresholds.

10.4.4. Emergent Intelligence

- Complex precision arises from **local interactions**, not top-down design.
- **Human parallel:** AI-driven systems (e.g., traffic optimization, fraud detection) learn from distributed data.

10.5. Future Research Directions

- **Bio-Inspired AI:** Can algorithms mimic **ant foraging** or **immune system adaptability** for better *Precision Mass* in human systems?
- **Resilience Engineering:** How can **fungal networks' adaptive rewiring** inform infrastructure design (e.g., power grids, internet)?
- **Ethical Frameworks:** Biological systems prioritize **survival and efficiency**—how should human systems balance these with **equity and transparency**?
- **Further research questions:** How specific biological systems and behavior (e.g., ant colonies, immune responses) could directly inspire **human-made *Precision Mass* strategies** in a particular domain (e.g., cybersecurity, economics, policy making)?

10.6. Putting the Biological Analogy to Test

At the first glance, looking at biological systems through the lens of Precision Mass is a fruitful, inspiring analogy. However, it would be useful to examine the limits of this analogy by

- Asking where it no longer applies or where it could potentially be misleading.
- Going from analogy to operations: what would it take to operationalise it in most realistic cases.
- Discussing potential downsides (the individual does not count, collateral damage, implements only one objective namely survival, bio-ecosystems can be destroyed, etc.…), especially given our geopolitical interest.

10.7. Concluding Remarks

Nature provides **compelling examples** for *Precision Mass*, demonstrating how **scalable, decentralized systems** achieve precision through **adaptive feedback, local rules, and emergent intelligence**. These biological systems might offer **blueprints for man-made systems,** from AI-driven systems to adaptive policymaking, highlighting the tremendous power of combining **mass and precision**.

11. About the Authors

This essay is the result of a collaboration by the WeltWert® team, based on a concept by Georg Serentschy with significant contributions from Derk Oldenburg and Paul Timmers.

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