COMPLEXITY IN INTERNATIONAL SECURITY

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COMPLEXITY IN INTERNATIONAL SECURITY: A HOLISTIC SPATIAL APPROACH

BY

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INVESTOR IN PEOPLE

To my beloved wife Lilia as the chief inspiration and security during this and previous book's writing.

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About the Author

Peter Simon Sapaty, Chief Research Scientist at the Ukrainian Academy of Sciences, has been researching networked systems for five decades. Outside of Ukraine, he has worked in former Czechoslovakia (now the Slovak Republic), Germany, the UK, Canada and Japan as a Group Leader, Alexander von Humboldt Researcher, and invited and Visiting Professor. He launched and chaired the SIG on Mobile Cooperative Technologies in Distributed Interactive Simulation project in the US, and he invented a distributed control technology that resulted in a European patent. Dr Sapaty has published several books and over 200 papers, and he has worked with several international scientific journals, including in the role of Editor-in-Chief.

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Preface

The current book reflects our decades of dealing with large distributed networked systems, with the gained practical and theoretical experience allowing for their effective seeing, comprehending and impacting as a whole, from above rather than inside, with capabilities for the latter too. And this experience appeared to be close to the gestalt psychology and theory highlighting the unique quality of human (and may not only) brain to directly grasp the wholeness of different phenomena while treating parts, which may not be complete, in the context of this whole, rather than vice versa.

We have strengthened this holistic vision by a special, constantly evolving, distributed programming model and technology, operating not so inside system components but rather above and between them. This resulted in a possibility of extrapolating holistic qualities of a concentrated brain to dynamic distributed systems while providing their integral goal-driven management and behaviour in real-time and often ahead of it. The current, fifth, book on this paradigm and resultant networking technology is examining the application of the accumulated experience to analysis and management of national and international security problems, especially those caused by the world's growing human and environmental dynamics and unpredictability in the twenty-first century.

These security problems may be massive, distributed and spatial in nature, potentially appearing any time in any world points, simultaneously covering large territories, also involving different cultures, religions, traditions and legislation. They can be caused by complex patterns of international relations, may need continuous monitoring of world dynamics with numerous moving objects, whether technical or human, in terrestrial and celestial spaces. The existing security bodies, with often outdated world information collected in a centralized way, also capable of becoming dysfunctional, may even happen to represent part of the security problems rather than their solutions. We will be addressing many such security problems while offering exemplary solutions based on the spatial grasp technology (SGT) described in the current and previous books.

The growing world dynamics and international instability and insecurity inspired the urgent search for radically new models guaranteeing not only prosperity and safety but even survivability in rapidly changing environments, with the use of all available, scattered, casual, even not perfect resources, which should work together as one system. And, this is just in line with the ideology and methodology of SGT being developed for the last decades and in different countries. Another related example is the latest DARPA Mosaic Warfare concept, discussed as a special chapter in this book, which may have an important influence on global security too.

Peter Simon Sapaty

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Chapter 1

Introduction

1.1. The Growing World Dynamics and Post-liberal Security Problems

For several generations, the world has been governed by what today is usually called "the global liberal order" [1]. Though having many faults and problems, it has proved superior to all alternatives. The liberal world of the early twenty-first century has become more prosperous, healthy and peaceful than ever before. Nevertheless, people all over the world are now losing faith in the liberal order. Nationalist and religious views are back in vogue. Governments are increasingly restricting the flow of ideas, goods, money and people. Walls are popping up everywhere, both on the ground and in cyberspace. Immigration is out, tariffs are in.

In order to survive and flourish in the twenty-first century, humankind needs effective global cooperation, greater trust between countries, and such trust should be global. We need to create a global safety-net to protect humans against different shocks. Viable blueprint for such cooperation is offered by liberalism. Nevertheless, governments all over the world are undermining the foundations of the liberal order, and the world may be turning into a network of fortresses.

Humankind now faces the triple crisis of *nuclear war*, *climate change* and *technological disruption*. In the twenty-first century, we face global problems that even large nations cannot solve by themselves. This "multiplex world" [2] carries both risks and opportunities for managing international stability, and the world should accept the new realities and search for new ways to ensure peace and stability. There is growing number of investigations, new ideas and other publications in this emerging area [3–5].

During this transitional period from liberal to post-liberal organization, we are witnessing a rapidly growing world dynamics with such words as *disaster*, *crisis* and *emergency* being frequently used in everyday life and in different points throughout the globe, with detailed clarification and comparison of such terminology found in [6]. Emergency response and crisis management are already vital activities and essential part of infrastructures in different organizations [7].

Crisis and security management are also considered in a global scale like dealing with disasters that could break global communications and the internet [8], associated with missile defence [9] and even moving to outer space [10]. Global terrorism [11], cyber attacks [12], natural disasters with their social and political impact [13,14], religious conflicts [15], as well as many others with relation to international security [16] are the areas were disasters, crises and emergency are common, with urgent need of their effective prevention, alleviation and management.

International security, also called *global security*, refers to the amalgamation of measures taken by states and international organizations to ensure mutual survival and safety [17]. These measures may include military actions and diplomatic agreements such as treaties and conventions. Security policy is more than defence policy, more than military policy, more than a policy aimed at being prepared for war; security policy is also *aimed at avoiding war* [18].

Security policy embraces domestic security, economic development policy and policy for influencing the international system so as to create a peaceful environment, regionally as well as globally. The world is entering its most dangerous chapter in decades [19], where the sharp uptick in war over recent years is outstripping the ability to cope with consequences. From global refugee crisis to the spread of terrorism, the collective failure to resolve conflict is giving birth to new threats and emergencies. Even in peaceful societies, the politics of fear is leading to dangerous polarization.

Nuclear weapons are important for a number of reasons, including their role in deterrence, national prestige and military budgets [20]. But underlying all this is the possibility that they could be used in war, and a nuclear war would be catastrophic and even suicidal. Avoiding nuclear war is thus a topmost priority for the international community. In [21], after analysing the years after WW2, three pathways to nuclear war were explored: an international crisis leading directly to nuclear war, an accident or misperception leading to nuclear escalation or nuclear retaliation against an imaginary attack and a general conventional war leading to nuclear war. The detailed assessment has found that the expected probability of nuclear war during this historical period was greater than 50 percent! This level of risk is extremely high. It is therefore urgent that effective measures be taken to substantially reduce the risk of nuclear war.

Conflicts are often spreading from local no non-local to international to global, covering large distributed spaces, and it is becoming more and more difficult to prevent, control and stop them by traditional centralized agencies and resources, also existing measures and technologies. Something in a much broader and more powerful scale is needed for maintaining national, international and global security, which could operate holistically, globally and spatially. And this is the aim and main contents of the current book.

1.2. New Organizational and Management Models and Technologies

Of particular interest and effectiveness, may be, radically new models guarantee not only prosperity and safety but even survivability in rapidly changing environments, national as well international, with the use of all available, scattered, casual, even not perfect resources, which should work together as one holistic system. These models should also allow for seamless embedment of massive robotics into human organizations, with robots taking care of dangerous and critical situations while acting cooperatively with humans and among themselves under global goals and unified control. Examples of related approaches, discussed in detail later in this book, are mentioned in this section.

1.2.1. DARPA Mosaics Concept

The latest US Defense Advanced Research Projects Agency (DARPA) Mosaic Warfare concept [22–28] may be particularly important for organizing solutions of complex national and international defence and security problems in highly dynamic and unpredictable situations. This new Strategic Technology Office's (STO) strategy seeks harnessing the power of dynamic, coordinated and highly autonomous systems, turning complexity into a powerful new asymmetric capability via rapidly composable networks of low-cost sensors, multi-domain command and control nodes and cooperative manned and unmanned systems.

This DARPA move was actually triggered by the fact that traditional US asymmetric technology advantage, such as highly advanced satellites, stealth aircraft, or precision munitions, is lower than it once was, offering a reduced strategic value due to increased global access to comparable high-tech systems and components, many of which are now commercially available. Within mosaic concept, lower-cost, less complex systems may be linked together in a vast number of ways to create desired, interwoven effects tailored to any scenario. The individual parts of a mosaic may be trading reliability and maintenance for their low-cost and quick availability but together may be invaluable for their contribution to the whole. This also means that even if a number of pieces of the mosaic are neutralized, the collective can instantly respond as needed to still achieve the desired, overall effect.

The mosaic concept fundamentally differs from the traditional "system of systems" model, where each part is uniquely designed and integrated to fill a specific role. It envisions a bottom–up composition capability where individual elements like individual tiles in a mosaic are combined to create an effect in ways not previously contemplated, potentially dynamically, with parts not originally dedicated to this particular task, being rather amorphous, universal and multifunctional. Unlike today's monolithic systems and rigid architectures that take decades to develop, Mosaic Warfare is oriented on utilization of rapid machine-to-machine interoperability and Artificial Intelligence to network manned and unmanned systems together, creating resilient and distributed architectures at campaign, and eventually, mission speeds.

The mosaic concept focuses on speed and adaptation, networking sensors, command and control, and effects together across domains to form solutions that adapt to dynamic threats and environments.

1.2.2. Spatial Grasp Paradigm

Spatial grasp paradigm, model, technology and their existing applications (named together as spatial grasp technology (SGT)) for high-level management of large distributed systems ([29−47] from about 200 publications) have similar capabilities to those planned for the DARPA mosaics, capable of serving as a basic ideology, model and technology for it (related project proposals for DARPA are under way). SGT allows arbitrarily scattered, distributed, heterogeneous and casual units to be holistically integrated at runtime into a powerful force capable of pursuing local and global goals which may be constantly changing on a dynamic operational field.

SGT operates in the form of active recursive patterns spatially covering and matching distributed environments, radically differing from traditional parts-to-whole models and approaches like interoperability and federation of forces. Its key element is high-level recursive spatial grasp language (SGL), which can express distributed spaces and operations in them in a way understandable to both manned and unmanned system components, allowing them seamlessly integrate with each other.

The operational spatial scenarios in SGL are usually hundreds of times simpler and shorter than in other languages as the approach effectively hides most of traditional and standard system management routines into intelligent interpreters of SGL, which can be networked, thus avoiding their explicit programming and repetition. This allows us to grasp top semantics of what to be done in distributed operational fields, with virus-like SGL scenarios freely moving, modifying and replicating in distributed spaces while creating active distributed task-oriented infrastructures and keeping full control over distributed physical, virtual or combined resources and spaces. Communicating SGL interpreters can be installed in great numbers and integrated with existing local command and control systems, effectively converting the whole operational field into an intelligent spatial computer self-analyzing, controlling and managing the operational theatre, also collectively recovering from failures and damages.

Different distributed scenarios have been investigated under SGT confirming is applicability and power for effective operation in dynamic and unknown environments, which may relate to world complex security and defence problems. Such scenarios under SGT and its previous variants called WAVE, for example, included or may be: (1) protecting a fleet of sea vessels distributed over certain area against multiple aerial objects using automatically created C2 infrastructures which may be hierarchical or peripheral; (2) collective tracing, analysis and elimination of multiple moving objects with tricky routes like torpedoes or cruise missiles, using cheap networked sensors installed in multiple vehicles; (3) using unmanned maritime swarm to attack adversary's fleet where SGL describes goal-driven behaviour of the robotic swarm operating without any central control; (4) realistic battle strategy & tactics of unmanned swarm against another manned, unmanned or mixed group/swarm with fully autonomous swarm organization; (5) fully distributed simulation, analysis and tracing of multiple objects in outer space which may relate to civil satellites, special military units or numerous debris; and (6) as well as in many other areas [30−47].

SGT is also offering a new and quite unusual approach for human-robot integration which is not pursuing and developing traditional and overwhelmingly praised and used "interoperability" ideology and practice, but rather creating a much higher "over-operability" layer in the form of supreme (i.e., standing above humans and robots) spatial intelligence. This layer expresses top contents of what should be done in distributed spaces and main decisions to be taken in complex situations, making it easy to assemble any teams with any ratio between humans and robots that can substitute each other at runtime without interrupting system missions, while always preserving goal orientation and mission capabilities.

The technology in its previous variants was successfully prototyped, tested and used in different countries (including Germany, UK, Canada and US, also researched for collective robotics in Japan), and its latest version can be quickly installed on an agreement on any platforms needed.

1.3. How the Book Is Organized

The rest of the book is organized as follows:

Chapter 2 explains the notion and meaning of international security, also global security, as an amalgamation of measures taken by states and international organizations to ensure mutual survival and safety. It provides description of different world areas with existing security problems which include disease epidemics, world religious diversity with emerging tensions, environmental dangers, refugee crises, armed conflicts, terrorism, etc. Also briefs some existing international security bodies and measures like UN, Security Networks and security oriented technologies. An urgent need of radically new approaches for effective analysis, management and support of world security is also explained.

Chapter 3 describes the basics of the developed high-level SGT and of its SGL allowing us to create and manage very large distributed systems in physical, virtual and executive domains, in highly parallel manner and without any centralized resources. Main features of SGT with its self-evolving and self-spreading spatial intelligence, recursive nature of SGL and organization of its networked interpreter will be briefed. Numerous interpreter copies can be installed worldwide and integrated with other systems or operate autonomously and collectively in critical situations. Relation of SGT, with its capability of providing holistic solutions in distributed systems, to the gestalt psychology and theory highlighting unique qualities of human mind and brain to directly grasp the whole of images and events will be explained too, with SGT serving as believably the first attempt to formalize and implement the notion of gestalt for distributed solutions.

Chapter 4 offers complete details of the latest SGL version particularly suitable for dealing with very large security systems and emerging crisis situations.

It describes main types of constants representing information, physical matter or both, and four very different and specific types of variables, called “spatial”, as operating in fully distributed spaces and even being mobile themselves when serving spreading algorithms. Also given full repertoire of the language operations, called “rules”, which can be arbitrarily nested and carry different navigation, creation, processing, assignment, control, verification, context, exchange, transference, echoing, timing and other loads. The rules equally operate with local and remote values, readily process physical matter/objects and distributed networked knowledge and can be used for creation of active graph-based spatial patterns navigating, invading, matching, processing, conquering and changing distributed environments. Elementary programming examples in SGL are also provided.

Chapter 5 provides some exemplary security-oriented applications in SGL, as follows: (1) finding suspects belonging to some group with trying to discover detailed information of their current whereabouts, by checking different databases and tracing their spatial movement around the globe; (2) controlling and impacting the distribution of a conflict, which is evolving and spreading in some region, where we want, beginning from some position inside it, to spread our parallel search through the conflict area and trying to extinguish it; (3) distributed simulation of complex territorial conquest with different (more than two) opposing forces, each having individual strength and trying to conquer and cover the whole area itself while competing with other forces on the same territory; and (4) collective evacuation from a disaster zone, where in case of major disasters (like earthquakes, flooding, etc.) many people, especially elderly and handicapped, may need a special help to relocate even escape.

In *Chapter 6* different network operations will be described in SGL, which may be useful for security applications. Basic network management mechanisms are expressed in SGL capable of working on their own even if traditional communications and internet includings are damaged in conflicts. These include network creation from scratch, finding proper paths between nodes and creating routing tables allowing for shortest communications. Also shown is the use of SGT for analysing distributed networks with social flavour by finding strong and weak components in them and changing their topology if needed in crisis situations. Another example is how to outline different communities in a distributed social network, find their topographical centres and evaluate physical distances between them for preventing possible social conflicts, while doing this repeatedly together with simulation of spatial mobility of individuals in time.

In *Chapter 7* different security-related examples will be shown in SGL dealing with discovery, tracing and analysis of multiple mobile objects, whether technical or human, in distributed environments. Starting from how overall command and control of a hypothetical missile defence can be automatically updated and managed in SGL by individually tracing and supervising of movement of multiple ballistic missiles on their full path from discovery to elimination. Other case will be dealing with fully distributed tracing of cruise missiles with complex and tricky routes, which can be effectively followed, analysed and controlled by mobile spatial intelligence spreading through intelligent sensor network, not allowing their escape. Another is high-level simulation and tracing of movement of multiple objects in outer space assisting to avoid collisions with them for new vehicles launched, with engagement of scattered space observation sensors that can be integrated worldwide under SGT. The chapter also shows how to organize distributed simulation and assistance of flows of refugees through international borders, which may be caused by conflicts, disasters or climate change.

Chapter 8 aims at finding in a multitude, diversity and high dynamics of international relations the worldwide appearance of particular spatial patterns that could potentially lead to a nuclear war. It demonstrates how complex international relations might be be, and how important is to predict and prevent global conflicts with nuclear weapons owned by different countries, also providing the latest data on worldwide distribution of nuclear weapons. The chapter demonstrates how different patterns of relations between countries, which can potentially lead to nuclear conflicts, can be converted into high-level active patterns-scenarios in SGL. These scenarios are then regularly self-spreading and self-matching in parallel and fully distributed mode with worldwide international structures, in order to find the related emerging threats. SGT can also be effectively used for distributed simulation of appearance, evolution and spreading of possible world conflicts and nuclear ones including.

Chapter 9 relates to advanced management of large distributed dynamic systems in unpredictable and crisis situations. It briefs the DARPA Mosaic Warfare concept and shows its possible expression under SGT together with exemplary solutions for such tasks as grouping of scattered elements into more powerful forces with unified control and supervision and elimination of dangerous elements by collective operation of causal forces around them. Of practical importance may be mosaics-related approaches using massive robotics. It is shown in SGL how easy to assemble teams of unmanned combat aerial vehicles (UCAV) for intelligent swarming, self-restructuring and observing territory with collection, distribution and impacting of targets discovered. Another SGL scenario organizes automatic fight of an aerial swarm with other unmanned or manned group/swarm, autonomously and without external control. Also shown is how broken into pieces platoon of manned or unmanned vehicles, due to unpredictable situations on roads, is self-recomposing into a normal platoon chain again, with vehicles symbolically considered as mosaic tiles.

Chapter 10 concludes the book, summarizing the investigated main features of world security problems with explanation of their possible solutions under SGT. The developed ideology and technology allow us to convert the whole world into intelligent self-organized supercomputer constantly investigating and adequately reacting on numerous crises and security situations which may emerge any time and in/from any world points. Future plans of this work include: (1) international teaming on the described mosaic concept; (2) distributed interactive simulation of world security problems and situations; (3) reimplementation of SGT on modern platforms; (4) possible SGT embedment in existing and new world security organizations; (5) further investigation and development of distributed holistic management related to gestalt theory; and (6) new international publications and patenting.