1. PREAMBLE TO IT ALL

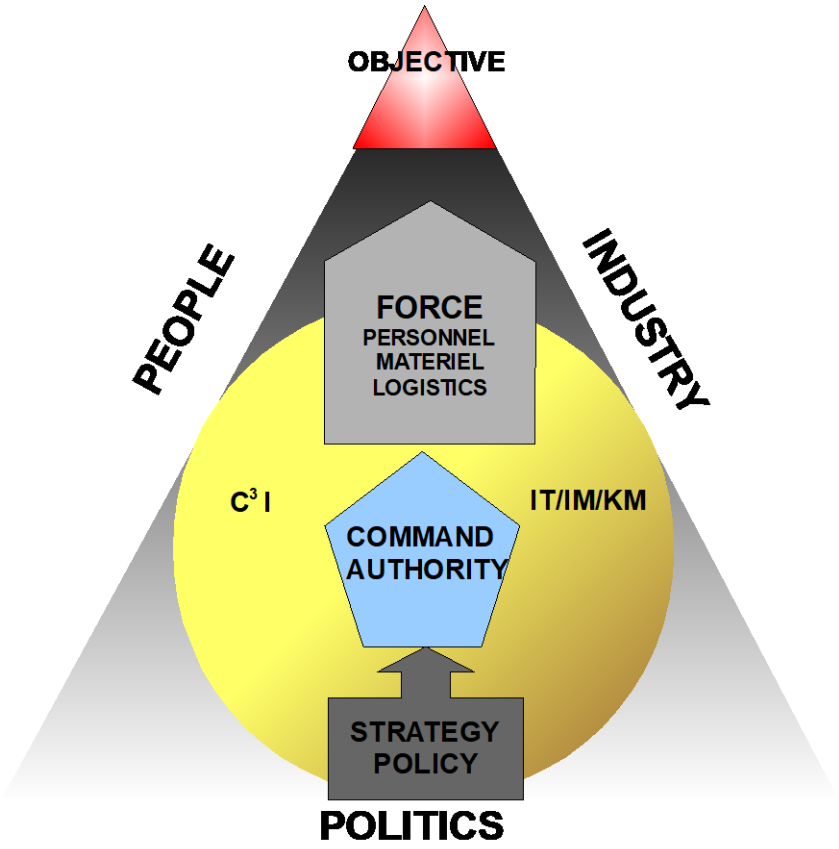

FIGURE 1: THE IDEAL ENVIRONMENT AND ACTIVITIES OF A PANDEMIC MITIGATION FORCE. Interactions of people (healthcare recipients, general public), industry, and politics result in policies and strategies leading to the deployment of force (people, materiel, and the support elements) to the theatre of operations (triangle) – either a physical region or a "virtual theatre" such as a major issue (e.g., worldwide reduction of mortality; global containment of a pathogen; sustainment of supply chains). Theater command authority enacts the strategy by committing the force to a series of actions aimed at the attainment of the strategic/political objective. In widely dispersed operations of global healthcare Command, Control, Communications, and Intelligence (C^3I) are based on the extensive, orchestrated use of the entire range of IT/IM/KM platforms and media. The presence of a clearly defined strategy and unified command authority supported by the pervasive use of technology and e-tools assures

coherence and unity of effort. In the real world, particularly during national, international, and multinational activities such as those created by COVID 19, clearly defined strategies are often missing. Unified command authority is either nonexistent, endowed with limited authority, or restricted to individual sectors of the overall effort. Problems are magnified by the lack of appropriate training in collaborative whole-of-government/international/multinational command and the employment of mission-inadequate or inappropriate ICT support technologies leading to chaos, discord among the actors, minimal ground effect, or even abandonment of the initiative.

2. "DON'T GET STUCK ON STUPID" (LT. GEN. RUSS HONORÉ)

Arguably, short of an asteroid collision with Earth or the explosion of the supervolcano under Yellowstone National Park, no other disaster but a pandemic can have consequences that will affect humanity across the entire globe, impact practically every aspect of its activity, and have the potential to irrevocably alter the post-calamity course of human civilization. With the span of dangers posed by biodisasters and their near first- and higher-level consequences, the intensity of attention devoted to their prevention, mitigation, and sequelae does not surprise: the "bioterror or bio-error" bet struck between Rees and Pinker[1] is not the outward sign of wry amusement of two scientists confronting a figment of intellectual imagination, but the exponent of grave concern among scientific, medical, and public health communities about the cataclysmic impact that an uncontrollable bioevent is more than likely to have.

Like all other disasters, pandemics can be prevented through unceasing national and international surveillance, rapid and truthful exchange of information among all involved authorities, and rapid marshaling of all relevant resources needed to identify and isolate suspicious event foci before the disease has a chance to transform into an epidemic. Two elements have fundamental importance in the implementation and operational execution of these functions: preparedness and readiness.

[1] Rees, M. (2021, June 16). Martin Rees and Steven Pinker: Wagering on catastrophe. *The New Statesman*. "Four years ago these two eminent scientists bet on the likelihood of a man-made global biological disaster. Is it time to decide a winner?" Available at https://www.newstatesman.com/politics/uk-politics/2021/06/martin-rees-and-steven-pinker-wagering-catastrophe

Preparedness (von Lubitz & Wickramasinghe, 2006[2]; von Lubitz, Patricelli, & Beakley, 2008[3]) is nothing else but a clear understanding of the who/what/where/when/and how established *prior* to the targeted event. All response constituents are anticipatory, hopefully well understood, in an easily identifiable and accessible place, and are continuously improved to accommodate new methods and techniques assuring maximum efficiency of counteraction once a critical (bio)event is detected. The process of preparedness is fractal in nature, and the entire system of developing pandemic preparedness is typical of procedures utilized by fractal organizations: the same process is continuously repeated at all levels cumulatively resulting in both enhancement of the efficacy and quality of the organizational output. In practical terms, fractal operations translate into pan-organizational adaptation and practice of Boyd's OODA Loop (Observe-Orient-Determine-Act)[4] whose consecutive revolutions maximize the overall output. Preparedness is therefore not a static element and the commonly heard statement that "we are prepared" is, equally commonly, nothing but wishful thinking. Preparedness plans once developed rest peacefully in colorful binders collecting dust on the shelves of organizations that are expected to implement them whenever the need arises. And when it does, we are short of everything and hear the usual mantra of "this time we were not prepared but the next time…." And when the next time arrives, the apocryphal statement of the most decorated French soldier, General Bigeard[5] becomes starkly pertinent: "In 1914 we were not prepared. In 1940 we were fully prepared. For 1914." And thus, quite inevitably, one calamity is bound to follow the other. Since the worldwide Spanish flu in 1918-1920 that killed millions and rocked a world that had just been decimated by the first world war, scientists, epidemiologists, and public health experts have been waiting for the "coming plague" – the elegant term coined by Laurie Garrett in her Pulitzer Prize-winning book[6].

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[2] von Lubitz, D. & Wickramasinghe, N. (2006). Dynamic leadership in unstable and unpredictable environments. *International Journal of Management and Enterprise Development, 3 (*4), 339 – 350.

[3] von Lubitz, D. K., Beakley, J. E., & Patricelli, F. (2008). 'All hazards approach' to disaster management: the role of information and knowledge management, Boyd's OODA Loop, and network-centricity. *Disasters, 32*(4), 561–585. https://doi.org/10.1111/j.1467-7717.2008.01055.x

[4] Richards, C. (2004). *Certain to Win: The Strategy of John Boyd Applied to Business*. Xlibris: St. Paul (MN).

[5]Wikipedia: Marcel Bigeard (2021). See https://en.wikipedia.org/wiki/Marcel_Bigeard

[6] Garrett, L. (1994). *The Coming Plague: Newly Emerging Diseases in a World Out of Balance*. Farrar Straus & Giroux: New York.

Several warnings, such as the influenza of 1957, HIV/AIDS, SARS, MERS, H1N1, and Ebola shook the world badly, but, euphemistically, "we dodged the bullet." But "dodging" is the combination of sheer luck and the doggedly determined and extremely gallant effort of all those who, often in desperate circumstances and at the risk to their own lives, fought to contain the spread and quell the lethal danger. The "frontline soldiers" uniformly fought bravely; the "generals" failed miserably too often. Time and time again the truth articulated in the eighteenth century by Field Marshal Maurice de Saxe that generals, when coming to the front, do what they know instead of knowing what they should be doing was (and is) glaringly evident. In part, the failures related to the near-complete lack of *readiness* among those in strategic and operational command who were expected to implement preparedness plans and direct their execution. Readiness is thus NOT the ability to execute pre-planned actions but the ability to respond to the threat by containing it by any and all means at the immediate disposal of those facing that threat, without waiting for approvals, directives, authorizations, and/or agreements[7]. The concept of readiness is embodied in the motto of the U.S. Marines, "adopt, improvise, overcome."
In his poignantly painful book "*Doom: The Politics of Catastrophe*", Niall Ferguson[8] identified the principal sources of failure in responding to any major disaster:

- Failure to learn from history
- Failure of imagination
- Tendency to "fight the last war"
- Underestimation of the threat
- Belief the threat would never come and subsequent procrastination

COVID-19 introduced new elements or revealed pre-existing fault-lines:

- The politicization of the initial response
- A search for scapegoats
- Indecisive national and international authorities failing to *lead* the response
- A sensation-seeking media

[7] von Lubitz, D. & Wickramasinghe, N. (2006). Dynamic leadership in unstable and unpredictable environments. International Journal of Management and Enterprise Development, 3 (4), 339 – 350.

[8] Ferguson, N. (2021). *Doom: The Politics of Catastrophe*. Penguin Press: New York.

- Misleading information disseminated through social networks and purposeful spread of misinformation/disinformation
- Inadequately educated population
- Re-emergence of national/international disparities in healthcare access and operations

Pandemics are exceedingly complex, multilayered, and multifaceted events that historically have been viewed by many as nothing but large-scale infectious disease crises and thus the exclusive domain of scientific and clinical medicine and public health. It is a relatively recent realization that the rapidly growing invasion of natural habitats through excessive deforestation, urbanization, and industrialization has thrown animals and humans together into new conjunctions and configurations that are conducive to the emergence and unprecedentedly rapid spread of highly infectious zoonotic diseases. With up to 70% of emerging infectious diseases having an animal origin, the One Health concept aimed at a better understanding of the interactions between humans, animals, and the environment, in general, was born.

The COVID-19 pandemic turned out to be a brutal test revealing all weaknesses of the preceding thinking and planning. Was then the reason for the COVID-19 calamity, not the virus itself but "The Nature of Pandemics" – i.e., everything that accompanies a major pandemic, everything either barely recognized or not recognized at all? Everything that hitherto has been known and accepted as the inherent companions of every non-bio disaster and its aftermath but, due to the seemingly "unique" nature of a pandemic, hardly ever associated with it?

Increasingly, the utilization of advanced technologies plays a very significant role in interactions within the pandemic environment. Modern information technology was (and is) responsible for much of the infodemic that "contaminated" the COVID-19 pandemic. However, visualization technology can be also instrumental in the very advanced training of individuals in pandemic preparedness/readiness stretching from an ICU bay to international level command and control of counter-pandemic interventions. The combination of advanced technology and new forms of training and subsequent practice of transdisciplinary and transboundary decision making is based on Teams of Leaders (ToL) and OODA Loop concepts. Such training, particularly at the senior executive command levels, is essential as the foundation for the management of critical events

characterized by a high degree of geographical extent, the number of disparate organizations involved, uncertainty, and the speed of spread and lethality. It also promotes employment at full utilization of networkcentric methodologies hitherto almost studiously bypassed in pandemic management. With the development of electronic health records across North America and Europe - and now most of the world - data acquisition and management and understanding of what is being encountered within a facility, a city, county, region, country, and globally, can be captured, and the analysis can be facilitated then disseminated within mitigation networks as never before, enhancing the effect of ToL and OODA Loop-based operations.

COVID 19 was the first event that stressed the intersection of multiple disciplines and agencies needed to recognize, understand, and control a biodisaster. It also brutally revealed the incompetence and indecisiveness of the authorities upon which the success of anti-pandemic operations depended, showing the painful ignorance of basic issues of biology, healthcare, and public health among political leaders whose misguided or utterly misinformed actions and postulates led to the explosion of conspiracy theories. Ultimately, the pandemic-related showed a terrifying truth: we are NOT ready, we are NOT prepared, and our collective behaviour in face of a pandemic is akin to what a Russian political leader described as that of a monkey playing with a hand grenade.

The intent of the response to the Challenge is to provide a globally distributed AR/VR training environment based on network-centric principles, and the combined Teams of Leaders (ToL) and OODA Loop principles. Participation in the described training will eliminate cognitive deficiencies in the development of readiness skills and capacity for unfettered response to emerging biocrises.

3. CONCEPTUAL FOUNDATIONS: ToL and OODA Loop

In similarity to all other catastrophes and disasters, bioevents follow a relatively constant pattern, each with its own characteristics and each with specific requirements for mitigation and containment.

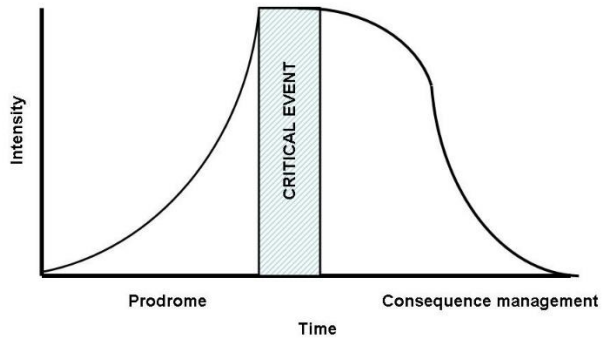

FIGURE 2: STAGES OF CRISIS DEVELOPMENT. During the prodromic stage, e.g., seemingly inconsequential observations of changes in the normal characteristic of the biotope, begin to intensify until the watershed stage is reached, and full-blown crisis results. Ultimately, the intensity abates, consequence management becomes increasingly effective, first slowly then very rapidly, until the trailing stage is reached. Each stage requires different skills, methods, and approaches. Most personnel at the executive levels are experts within their own fields, but in transboundary environments (such as pandemics) are incapable of generating a broad concept of operations, forgetting that pandemics are only partially purely biological/medical events. In reality, they involve practically every aspect of human activity and demand a very broad expertise of many individuals, agencies, and even nations. Severe friction is an unavoidable companion in such situations, yet extremely few executive commanders are trained in the art of collaborative command and leadership in such environments.

The Teams of Leaders (ToL) collaboration training philosophy is the product of a US Army effort to incorporate former Warsaw Pact countries into the formal structure of the European Union and NATO. For the first time, a practical concept emerged that intimately bound technology and people and multiplied the power of both by maximally utilizing the fused capacity of each. The foundations of ToL consist of Information Management (IM), Knowledge Management (KM), and high performing team building. The unprecedented power of ToL results from the collaboratively functional combination of these three hitherto separate

disciplines that permits/stimulates development of transboundary shared skills, knowledge, and attitudes (SKAs) both horizontally - across disciplines, organizations, functions**,** and cultures, and vertically – throughout organizational hierarchies and even national bureaucracies.

Shared trust and confidence are the natural consequence of the process whose principal social outcome is the generation of High Performing Leader Teams (HPLTs). Transboundary interaction and collaboration among the latter across formal structures of organizations, function**s,** levels, and cultures fosters the most fundamental aspect of any collaborative effort – the condition and state of ***actionable understanding***.

Implementation of the ToL concept has been shown to engender Mission Command attitudes, i.e., increased mission-focused collaboration, mission understanding, enhanced mission focus, and reduction of inter-organizational friction and bureaucratic parochialism. Invariably, the overall outcome is a prominent reduction of output variability, maximized utility of effort, and operational focus centered on strategic rather than subordinate goals.

Extensive use of web-based IT/IM/KM, social networking technologies, video conferencing, VR, etc., facilitates all processes taking place within the ToL-focused environment. "Time = Zero; Distance = Zero" is one of the cardinal attributes of ToL-based operations: all collaborative exchanges are multidimensional and simultaneously executed horizontally (peer-to-peer), vertically (down-up and up-down within hierarchies), regardless of time, and independently of space. They become temporally confluent, all-inclusive, and self-expanding through viral social spread.

While the ToL concept offers several cardinal advantages over other methodologies, its principal attribute is to serve as the most effective High Performing Leader Team builder; to foster transboundary HPLT collaboration; and to create the universe of cooperating Teams of Leaders unified by shared, mission-oriented actionable understanding. The latter is critical for the development of effective crisis and disaster preparedness *at all levels.* During operations, ToL-based practices allow near-immediate generation of task-oriented "action swarms" and task-focused implementation of "just-in-time" solutions. Finally, ToL serves as a force multiplier in

the development of organizational, multi-organizational, and community resilience. Thus, in contrast to traditional emergency response organizations, ToL-based entities are always both anticipating and making sense of the chaotic environment: ToL-based units on the ground collaborate across former boundaries rather than fight for resources and operational influence. While ToL does not impose order upon chaos, it reduces chaos by developing means of its containment (and even elimination) based on ToL-contingent presence and operational implementation of actionable understanding.

Applicable to all circumstances, the OODA Loop (also known as Boyd's Loop) provides the essential framework for knowledge-based, multidimensional critical thinking, and rapid decision-making in complex, rapidly, and unpredictably changing environments. To operate successfully in such environments demands real-time decisions and precise, focused actions, whose execution determines both the operational tempo and direction (future) of the entire operating environment. Hence, the quality of decisions on which the subsequent activity is based has paramount importance.

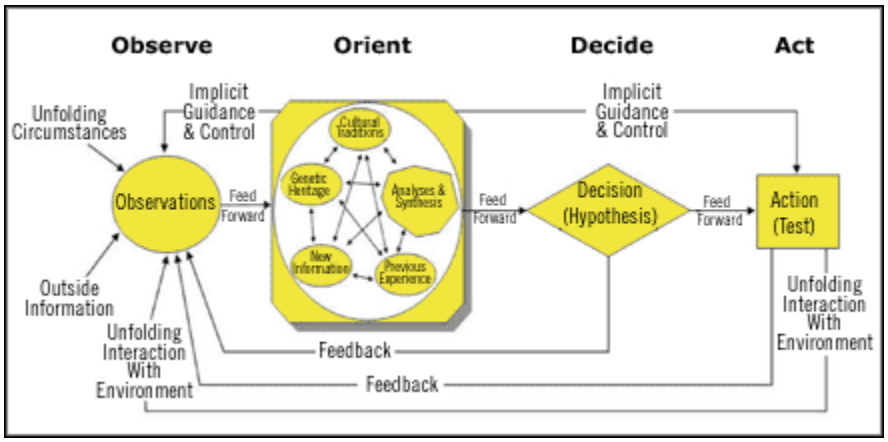

FIGURE 3: THE OODA LOOP: Four stages of the OODA Loop with their inputs, outputs and interdependencies.

The concept of the OODA Loop is based on a cycle of four consecutive stages of Observation, Orientation, Decision, and Action and its prominent applications dominate:

- Rapid development of situation awareness
- Accelerated development of competitive advantage
- Decision-making processes among collaborating teams
- Activities performed in novel and/or unstable environments
- Implementation and monitoring of change and
- In activities performed in hostile/acutely competitive settings.

The global environment of politics, business, healthcare, and social interactions demands an increasing level of swiftness and agility in addressing complex problems that often arise without warning and may rapidly transform from local issues into international or even global dilemmas. By necessity, solutions to such problems must be transboundary, rapid, and contain a high degree of flexibility to accommodate the vagaries of the ever-changing mosaic of the environment in which they are to be implemented. The impact of these solutions must be monitored closely, and the "ground effect" adjusted without delay. What is needed, then, is a simple, effective, collaborative approach based on two principal elements: action based on actionable understanding combined with agility of action where the latter must be based on instantaneous situation awareness and be commensurate with both current and future demands of the unfolding circumstances in which all activities are performed. The combination of ToL and OODA concepts enhances not only collaboration among teams working in complex environments but also develops a heightened ability to:

- Identify critical core issues
- Form teams capable of addressing those issues
- Communicate effectively and clearly among collaborating teams
- Respond to sudden and unforeseen changes in the operating environment
- Incorporate then transform change into a steady-state operating environment
- Act based on process rather than concept learning
- Develop trust and confidence among all participating actors
- Develop and practice operational readiness, i.e., decisive action rather than fallback on pre-existing plans

- Build and use actionable understanding as the foundation of all collaboration

The ToL concept is built on – developing people: the skills, knowledge, and attitudes for High Performing Leader Teams; the application of Information Management tools to connect and collaborate; and deliberate Knowledge Management processes required to improve the way we organize and share information, operate and decide. The OODA concept focuses, on the other hand, on how the ToL methodology is applied to actions in the "swift and severe world" (Bruce Piasecki, personal communication) fitting it into a cycle of sequential steps that facilitate rapid development of situational awareness, enhance sensitivity to indicators of the forthcoming changes in the operating environment, and promote the near-instantaneous adjustment of action in response to sudden operational shifts and upheavals.

4. NETWORKCENTRIC VR/AVR TRAINING PLATFORM

a. Virtual Reality (VR)

In VR, headsets immerse users in a 3-D computer-generated environment where spatial data, such as the data that produces a rendering of a building or a house, become more real and more actionable. While VR is often associated with gaming and entertainment, VR applications for business are expanding strongly, they are used in various sectors including health care.

b. Augmented VR (A/VR) the Mojo Lens

Devices or wearables provide information tailored to the context and space in which a user works. The information appears as visual or audio supplements that help an operator, technician, or surgeon more efficiently undertake a task. For example, the Mojo Lens, a smart contact lens with a built-in display, is a potent facilitator of AR operations. It provides on-demand information inputs without interrupting the user's focus and expands the perception of the physical world by adding layers of digital information on top of it. The current display can squeeze 70,000 pixels into a space smaller than half a millimeter across, making it the smallest and densest dynamic display ever made.

c. Mixed Reality (MR) or Merged Reality is a superset of AR; mixed reality adds digital objects to physical ones, anchoring them to points in the real world. Users can then perceive physical and digital objects in the same space. It is often used for training purposes.

d. Extended reality (XR)

The term "extended reality" is used to talk about all-immersive techniques, that is to say, VR, AR, and MR. It gathers all current and future technologies related to real and virtual environments and human-machine interactions.

FIGURE 4: NETWORKCENTRIC TRAINING SIMULATION. Scenario: global pandemic that starts in city A; infection foci begin to be detected worldwide. The task: identify the pathogen, control its spread, design appropriate population support measures, preserve the integrity of supply chains, maintain law and order, and assure the maximum level of international/global collaboration within the conceptual JIIM framework. The trainees are located in distributed VR hubs around the world and interact using (A)VR – the Mojo Lens. The interactions can be both synchronous and asynchronous, and involve local interactions within individual hubs, among hubs, and with the globally distributed

information sensors, augmenters, and compiling nodes off the network (Fig. 5). The number of trainees, the extent of geographical distribution and agencies involved, and the training rules and principles can be flexibly adjusted depending on the used scenario (war, social unrest, economic collapse, disaster, etc.).

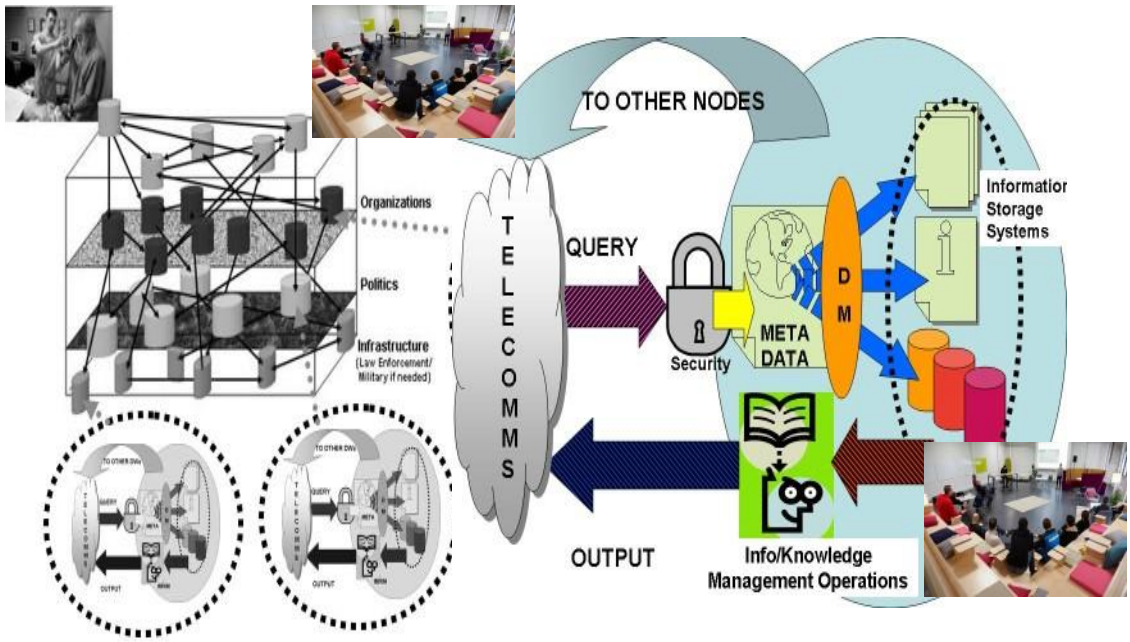

FIGURE 5: NETWORK-CENTRIC GLOBALLY DISTRIBUTED TRAINING SYSTEM. The network consists of information sensors, information aggregators and compilers, data/information/knowledge management and storage systems located within network nodes, the latter distributed in a multidimensional/multilevel interconnected grid that communicates with the users via synchronous/asynchronous input/output AVR devices. The entire cloud-based system assures maximum flexibility of operations, provides users with on-demand scenario manipulation, situational realism, and permits the introduction of situational fluidity and stressors at the intensity level unattainable in all other training situations and systems. Importantly, the system allows full operational use whenever global disaster management at JIIM level of complexity is required.