KAPITEL 8 / CHAPTER 8 [8]
ACOUSTIC EFFECTS OF WAR AS AN EXAMPLE OF A HYPOTHETICAL LAW OF INFORMATION CONSERVATION

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Introduction: Is an analogy possible?

In physics, there are fundamental laws of conservation – energy, mass, momentum. They argue that certain quantities do not disappear, but only pass from one form to another. Is it possible to formulate the law of information preservation in the same way?

This was done by us back in 2007-2008. [1 – 3]. It is clear that over the years our concept has been revised and self-improved many times.

The initial data for our modern research, described in this work, was the formulation of a hypothetical law of information conservation, discovered by us personally and described by us earlier in our works [1 – 3].

Let us recall the wording we proposed.

The hypothetical Law of Conservation of Information [1 – 3] can be stated by us as follows: *"In a closed system, information does not disappear, but only passes from one form to another, being stored in the structure, traces or interrelations of elements."*

This is a study on the possibility of formulating the law of conservation of information by analogy with the physical laws of conservation of energy, mass and matter. This includes analyzing scientific theories, concepts in physics, computer science, and philosophy that support or deny the existence of such a law.

Now there is a war against Russian aggression in Ukraine. We would like to supplement our theory with a number of other examples, including, in particular, an example of the acoustic impact of a shock wave from explosions on the population of our long-suffering state.

In this sense, the model of transformation and preservation of information will look like: from an event (explosion) → through sensors and physical consequences →

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to people's memory and digital archives (Fig. 1).

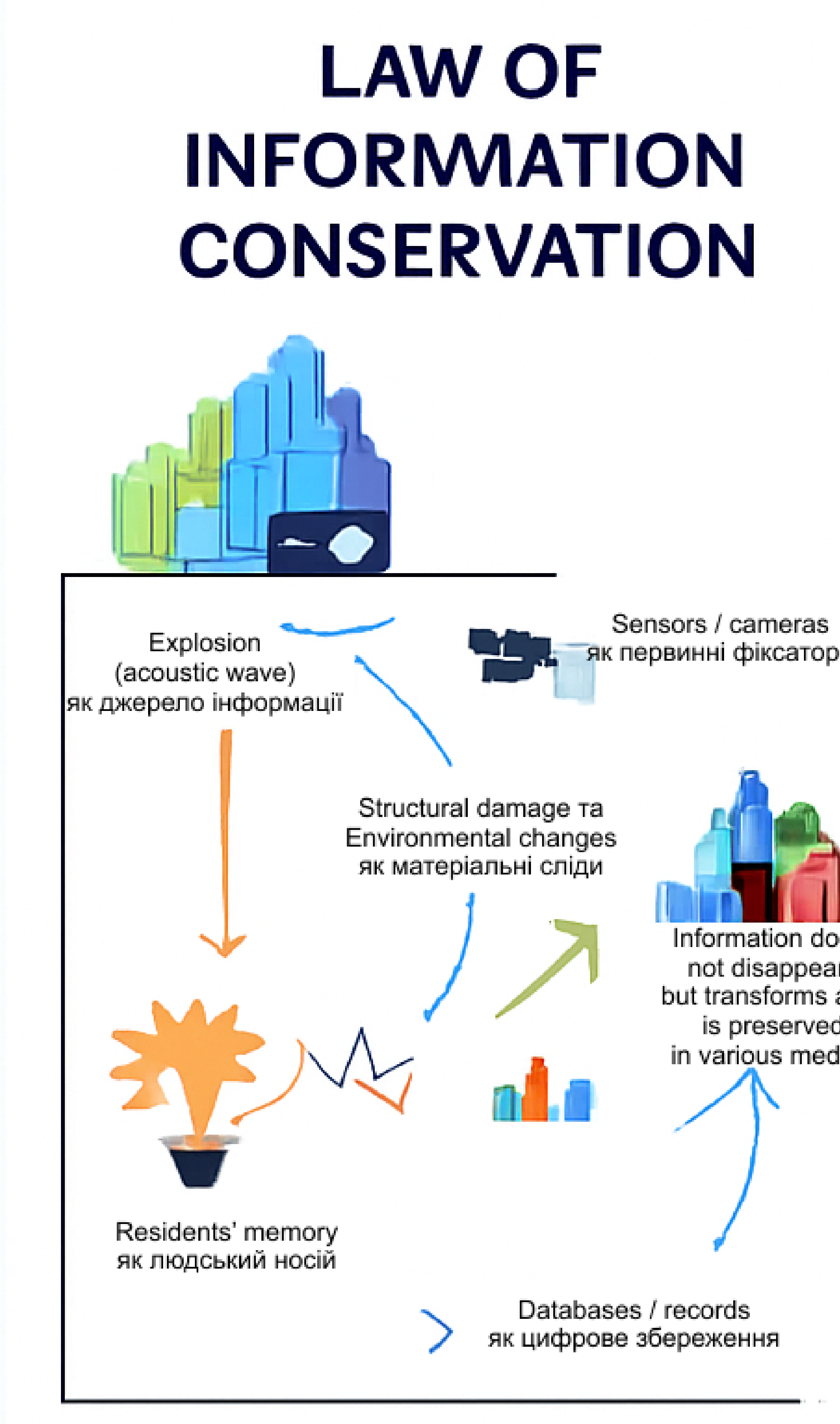

Figure 1 – Information does not disappear, but is transformed and stored in various media (including human memory) according to the Law of Information Conservation invented by us

8.1 Historical context as a prerequisite for our research

Thus, Claude Shannon back in 1948 initiated the theory of information precisely as a quantitative measure of messages.

Norbert Wiener, (as if in addition to this), considered information as the opposite of entropy.

John Archibald Wheeler expressed the idea of "It from Bit" – that physical reality arises from information.

8.2 Physical aspects as prerequisites for the law of information conservation

Here we should talk about some aspects that can theoretically justify the existence of a hypothetical law of conservation of information proposed by us. Let's remind them.

This is the so-called Landauer principle: erasing one bit of information requires minimal energy, which connects the information to thermodynamics.

Quantum mechanics says that the evolution of the wave function is reversible – that is, information does not disappear, but dissipates.

It is worth mentioning the scientific idea of the so-called Black Holes, remembering that the Hawking paradox about the loss of information led to the hypothesis that information is stored on the event horizon (i.e. the holographic principle).

Moving on to such a science as computer science, it should be said that in digital systems, information can be lost, but often only for the observer. At the carrier level, it is stored in the form of state changes. Backup, logging, tracing are technical ways to preserve information even after it has been "deleted".

In addition, some philosophical considerations should be given. Information is not only data, but also structure, connections, context. In the philosophy of science, information is considered as an ontological entity – that is, one that exists independently of the observer.

All this will be told in the future, with significant dissemination and deepening.

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8.3 Imagination about closed systems

Speaking about our scientific hypothesis: ("*In a closed system, information does not disappear, but only passes from one form to another, being preserved in the structure, traces or relationships of elements.")*, – it is necessary to provide a definition of what exactly is meant by the term "closed system" in the context of information storage. This covers the following issues:

– How is "closedness" defined in physics, computer science, and philosophy?

– What criteria allow us to consider the system closed in terms of information exchange?

– Examples of real or theoretical systems where information is stored losslessly.

– How is information transformed, but does not disappear, in such systems?

We begin to answer these questions.

In general, what is a "closed system"? A lot of attention is paid to this issue in our works [1 – 3]. The work should be highlighted separately [4]. In addition to this, we give the following.

In different sciences, the term has a specific meaning:

– In physics: a closed system is one that does not exchange energy or matter with the environment. (An example is: a perfect thermos, or a model of the universe in cosmology).

– In computer science: a system that does not receive new data from the outside and does not transmit it to the outside. (For example, an autonomous server without Internet access).

– In philosophy and information theory: closure can mean logical completeness – when all the elements of the system are interconnected, and changes occur only internally.

In a modern digital system: data → log → backup copy → database → analytics - all this happens without external intervention.

Turning to our question: (negative impact of the consequences of Russian aggression), it should be said that in the context of information storage, it looks like this:

In urban environments: explosion → sound → sensors → recordings → memory → archives – all this happens within the same information ecosystem.

To consider a system closed from the point of view of information exchange, it is necessary to determine a set of criteria that distinguish it from the external environment. Here are the key: criteria for the closure of the information system:

1. No external I/O:

– the system does not receive new data from the outside and does not transmit it to the outside;

– all information processes take place only inside.

2. Preservation of information balance:

– information does not disappear, but only transforms between different media (data → signals → structures → memory);

– losses are possible only in the form of "entropy for the observer", but not for the system itself.

3. Internal closure of channels:

– all channels of information exchange are closed to the elements of the system. (For example: sensor → database → analytics → archive → user's memory – without going outside).

4. Autonomy of functioning:

– the system can exist and reproduce information processes without external sources. (An example is a standalone server that operates without the Internet, but stores and converts data).

5. Defined limits:

– clearly defined boundaries separating the system from the environment;

– in physics, these are spatial or energy limits;

– In digital systems, these are network or software barriers.

Let's give another example (in an urban context).

The closed system here is a network of sensors in the city that collects noise data, stores it in a local database, and analyzes it without access to external servers.

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Open system: same network but with data transfer to the cloud or external think tanks. (Fig. 2)

Thus, closure means that information circulates only within the system, changing shape but not going beyond it (Table 1).

Table 1 – Visualization of Comparison of Closed and Open Systems in Three Areas – Physics, Computer Science and Urban Studies

	CLOSED SYSTEM	OPEN SYSTEM
Physics	System without exchange of energy or matter with the medium	System open to environment, with exchange of energy, matter or information
infomatics	Autonomous server without access to external networks, whore information transforms but is not lost	Server connected to the global internet and communicating with external nodes
Urbanistics	Network of city sensors that analyze and store noise level data internally, or in a local data center	System of sensors that transmits information to external servers or clouds

Thus, closedness means that information circulates only within the system, and openness means that there is an exchange with the external environment.

Let's show a "hybrid" scheme that will show semi-closed systems (for example, a local area network with a controlled exchange channel)?

It has such elements as (Fig. 2):

– city sensor network (data source, e.g. noise or vibrations);

– local processing center (data is stored and analyzed within the system);

– controlled external channel (limited exchange with the cloud or external servers, only when necessary).

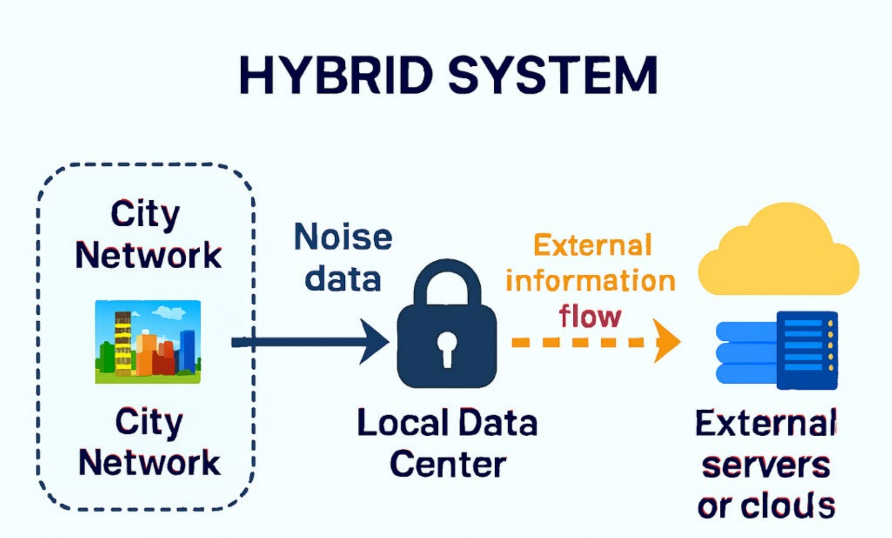

Figure 2 is a diagram of a semi-closed (hybrid) information system

Thus, the system works as a closed in most processes, but has a managed output, which allows integration with wider networks without full openness.

This is very convenient for urban security systems or critical infrastructure: most of the data remains locally, and only aggregated or encrypted information is transmitted to the outside.

We have given a comparative scheme of three types of information systems – closed, hybrid and open (Fig. 3)

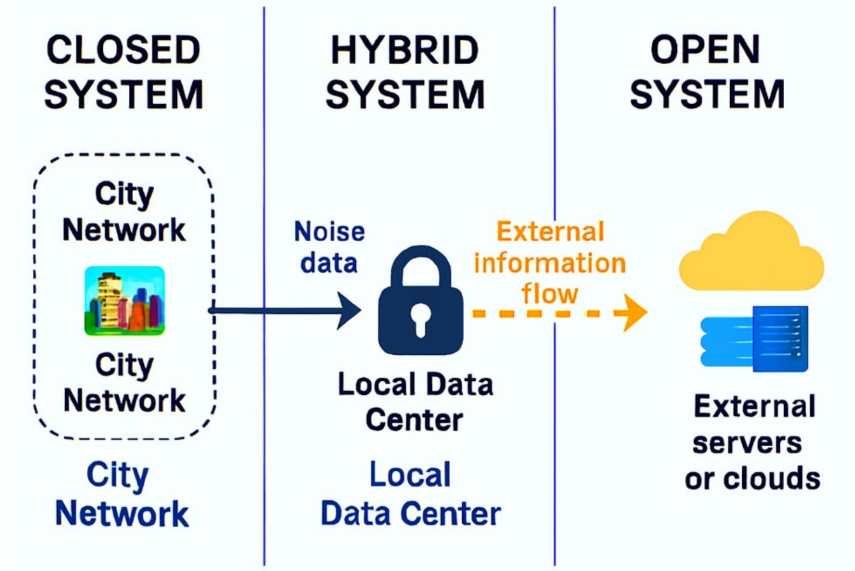

Figure 3 – Closed, semi-closed and open systems (different levels of information security and autonomy are illustrated)

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Closed system: data (e.g. city noise) remains inside the LAN and processing center. No way out.

In a Hybrid system, most data is stored locally, but there is a controlled channel for sharing with external servers or the cloud.

In the Open System, data is immediately transmitted to the outside, without an internal barrier.

This allows historical versions of data to be stored, which is a form of information memory.

8.4 Examples of application of the proposed (hypothetical) Law of Information Retention

Any theory is unfounded without examples of its application. Where can you see the manifestations of the Law of Information Conservation? We have tried to find more and more evidence of the existence of our Law.

Let's consider these or other examples in more detail. For the sake of convenience, we will divide them into various fields: physics; informatics; right; philosophy; biology; ecology; Education; culture and the most modern trends, i.e. artificial intelligence. Thus, the validity of the law of information preservation invented by us is asserted by the following facts.

1. Physics and Theory of Information [5 – 8]:

– *Black holes and the Hawking conjecture*. Stephen Hawking suggested that information could disappear in a black hole, but later theorists (including Leonard Susskind) proved that information does not disappear, but is stored on the event horizon - this became the basis of the principle of holography.

– *Quantum mechanics*. The law of conservation of information in quantum theory states that the evolution of a quantum system is unitary – that is, information about the initial state is not lost, even if it looks "blurry".

– *Liouville's theorem* (classical mechanics). In classical mechanics, Liouville's theorem states that the density of points in phase space is conserved during the

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evolution of the system.

– *Quantum decoherence.* Although quantum systems can lose coherence due to interaction with the medium, all information about the system and the medium together is stored in a unitary description – that is, in a global sense, the information does not disappear.

– *Entropy and information.* In thermodynamics, entropy is often interpreted as a measure of the loss of information about the microscopic state of a system. However, in statistical mechanics, all information about a system is stored at the level of microstates, even if it is not accessible to an observer.

– *The principle of determinism*. In classical physics, determinism means that knowing the exact state of a system at a given point in time can accurately predict its future. This implies the complete storage of information about the evolution of the system.

– *Holographic principle*. In string theory and quantum gravity, the holographic principle states that all information about the volume of space can be encoded at its boundary. It is a radical form of information conservation that has profound implications for understanding space, time, and matter.

2. Computer Science and Cybersecurity:

– *Data retention laws*. In many countries, there are regulations that oblige companies to store certain types of data (telecommunications logs, financial transactions, Internet activity) for a certain time – for example, for investigative or regulatory purposes [9].

– *Archiving and backup*. In corporate systems, information is stored through multi-level backups to avoid loss in case of failures – this is a practical embodiment of the principle of information preservation. Backup systems ensure the safety of information in the event of a failure, loss or attack. Archives allow you to store historical versions of data, which is a form of information memory [10].

– *Blockchain*. Blockchain technology guarantees the immutability of records: each transaction is stored in a chain of blocks, and it cannot be changed without violating the integrity of the entire system.

– *Event logs (log files).* Operating systems, servers, and applications keep event logs that record all user and system actions. This allows you to restore the history of events and is critical for auditing and security [12].

– *Data transfer protocols.* TCP/IP protocols ensure reliable transmission of information with integrity checking. If the data is corrupted, it is resent – that is, the system seeks to preserve complete information [13].

– *Version control systems.* Git, SVN, and other systems allow you to store all changes in code or documents. This allows you to return to previous states and track the evolution of information [14].

– *Disaster Recovery*. IT infrastructures have recovery plans that include data duplication, geographically distributed servers, and automatic switching – all aimed at preserving information even in critical situations [15].

– *Metadata*. Information about information – metadata – is stored together with files, databases, images. It allows you to identify, classify and restore context [16].

3. Legal aspects:

– The Law of Ukraine "On Information" defines the *principles of objectivity, completeness, accuracy and legality of information storage*. The state undertakes to create systems for the protection and preservation of national information resources. [17].

– *Information sovereignty:* The idea that the state has the right to control and store information that relates to its citizens, culture and security.

4. Philosophy [18 – 20]:

– Information realism is a philosophical position that information is the fundamental essence of being.

– Epistemology – knowledge as a form of stored information transmitted through language, texts, culture.

– Philosophy of science – scientific theories preserve information about nature, even if paradigms change.

– Memetics – ideas (memes) as units of cultural information stored and transmitted.

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5. Biology and evolution [21 – 23]:

– *Genetic information.* DNA is a carrier of information that is passed down from generation to generation. Mutations change it, but fundamentally the information does not disappear, but transforms.

– *Epigenetics* – changes in gene expression that persist without changing the DNA itself.

– *Biological memory* – the brain's neural networks store information about experiences.

Evolution – natural selection stores adaptive information in genomes.

6. Ecology. Let's fill this paragraph with examples of how information is stored in natural systems [24 – 27]. They show that nature itself is a carrier of information that can be "read" through scientific methods:

– *Ecosystem memory.* Forests, swamps, coral reefs retain traces of climate change, fires, pollution – this allows scientists to reconstruct ecological history [24].

– *Bioindicators*. Species sensitive to environmental changes (lichens, amphibians) signal the quality of air, water, and soil [25].

– *Annual tree rings* contain data on temperature, precipitation, pollution – a natural archive of climate [26].

Soil layers. Sedimentary deposits store information about erosion, chemicals, anthropogenic impact [27].

7. Education:

– *Pedagogical heritage.* Teaching methods developed by outstanding teachers (for example, Sukhomlynsky, Montessori) are passed down through generations, forming educational systems.

– *Archives of knowledge.* Libraries, digital repositories, educational platforms (Coursera, Prometheus) are the collective memory of humanity available for learning.

– *Educational environment.* Schools and universities preserve cultural and academic traditions that influence the formation of personality.

– *Student diaries and portfolios.* Reflect individual progress, interests, skills – personalized educational memory.

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– *Scientific publications and dissertations.* They preserve research results, form academic discourse.

– *Language environment.* Schooling a language creates cognitive structures that last a lifetime.

– *Pedagogical traditions.* For example, the Ukrainian assessment system, the class-lesson model is the institutional memory of education.

8. Artificial Intelligence:

– *Machine learning models*. Algorithms store information from training data – this is a form of memory that allows you to predict, classify, and recognize.

– *Neural networks.* Deep models (GPT, BERT) have billions of parameters that encode knowledge from texts, images, languages – this is the digital memory of human experience.

– *Recommendation systems.* Remembering user preferences, adapting content (music, movies, news) is an example of personalized information memory.

– *Knowledge bases and ontology.* Structured systems of concepts that allow you to understand the context and logic of the subject area.

– *Log files and request history.* They preserve the user's interaction with the system – the source of adaptation and learning.

– *Simulations and digital twins.* Models of real objects that "remember" the state, behavior, history of changes.

– *Ethical frameworks.* Built-in rules (for example, restrictions on content generation) are a form of normative memory.

9. Culture

– *Myths and legends.* Oral tradition preserves historical events, moral lessons, worldview is a form of collective memory.

–*Art.* Paintings, music, literature are visual and emotional archives of epochs that convey experiences, values, experiences.

– *Rituals and holidays.* Cultural practices (Kupala, Christmas, Independence Day) preserve the identity and historical memory of the people.

– *Museum exhibits and archives.* Material memory carriers – objects, documents, artifacts.

– *Cinema and television.* They reflect the era, social moods, historical events - the visual memory of generations.

– *Language and phraseological units.* They preserve cultural codes, metaphors, historical allusions.

– *Traditional crafts.* For example, pottery, embroidery – transmit knowledge through practice, gesture, material.

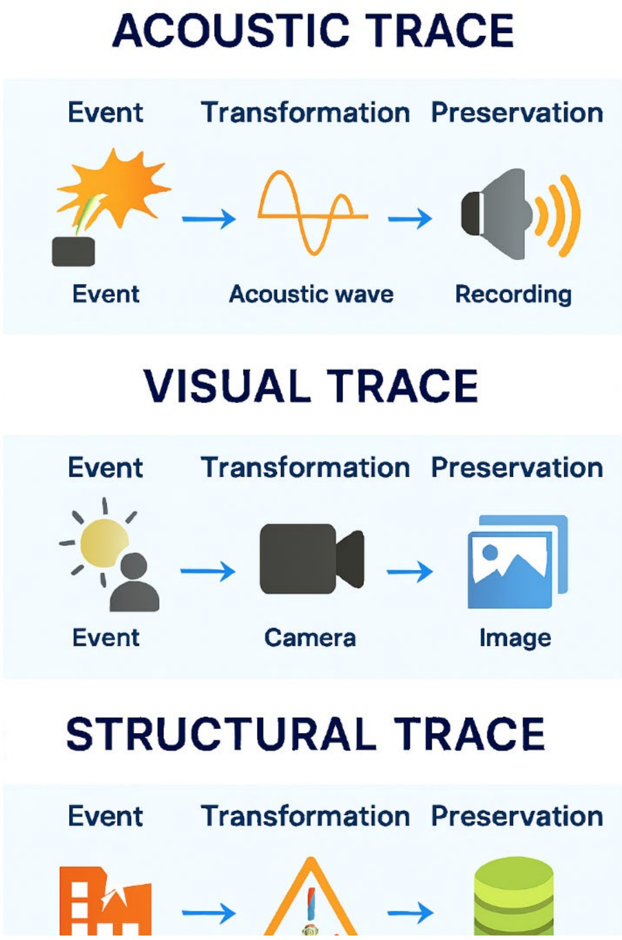

Figure 4 – A series of diagrams where each type of information trace is shown separately – acoustic, visual and structural.

The above-mentioned examples of the proposed Law of Information Preservation [5 – 27] have been collected by us through the analysis of literature sources. Let us supplement this list with our own example: *Acoustic effects of war:*

– in our study of sound waves in Kharkiv, each explosion is not only energy, but also an information trace;

– even after wave scattering, recordings, structural damage, changes in the environment are forms of stored information;

– sensory systems, urban maps, even residents' memory – store information about the event.

All this is graphically shown in Fig. 4, where:

The acoustic footprint implies: "Event: explosion → Transformation: acoustic wave → Storage: recording (microphone, sensor, audio archive)."

The visual footprint includes: "Event: phenomenon or action → Transformation: camera capture → Save: image, video, photo."

The structural footprint has the following components: "Event: Destruction, Impact, → Transformation: Material Damage → Preservation: Cracks, Debris, Object Condition Database."

These three schemes together form a single system of information storage, where different channels (sound, light, material) record and transform the event into their own "trace".

Thus, we supplemented the hypothetical Law of Information Preservation with examples taken directly from the experience of hostilities in Ukraine during the repulsion of Russian aggression against our country.

Conclusions

Such a law is not formalized in physics, but has interdisciplinary power. It can become the basis for new models in urban security, information ecology, cryptography, and artificial intelligence.