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Providing Global Awareness in Distributed Dynamic Systems

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The paper investigates applicability of the developed high-level model and technology for solution of diverse problems in large distributed dynamic systems which can provide sufficient awareness of their structures, organization, and functionalities. After the review of meanings of awareness and existing approaches for its expression and support, the paper shows application of the Spatial Grasp Model and Technology (SGT) and its basic Spatial Grasp Language (SGL) for very practical awareness solutions in large distributed dynamic systems, with obtaining any knowledge from any point inside or outside the system. The self-evolving, self-replicating, and self-recovering scenario code in SGL can effectively supervise distributed systems under any circumstances including rapidly changing number of their elements. Examples are provided in SGL for distributed networked systems showing how in any node any information about other nodes and links, including the whole system, can be obtained by using network requesting patterns based on recursive scenarios combining forward and backward network matching and coverage. The returned results may be automatically organized in networked patterns too. The presented exemplary solutions are parallel and fully distributed, without the need of using vulnerable centralized resources, also very compact. This can be explained by fundamentally different philosophy and ideology of SGT which is not based on traditional partitioned systems representation and multiple agent communications. On the contrary, SGT and its basic language supervise and control distributed systems by holistic self-spreading recursive code in wavelike, virus-like, and even “soul-like” mode.

Keywords: awareness, distributed awareness, situational awareness, real world awareness, global awareness, distributed systems, Spatial Grasp Technology, Spatial Grasp Language, networked implementation, self-evolving scenarios, spatial pattern-matching, higher-level knowledge

1. Introduction

Awareness, especially its global capabilities, is extremely important in our everyday life. In most general terms, global awareness is considered as a capacity that incorporates attitudes, knowledge, and skills necessary to navigate the challenges and opportunities of a globalized world. It provides understanding of values and beliefs of different cultures, analyzes solutions to international problems, and makes recommendations that contribute to the global common good. The aim of this paper is to investigate application of the developed high-level model and technology for solving diverse problems in large distributed dynamic systems which can provide, from any inside or outside point, sufficient awareness of their coverage, structures, and functionalities. The rest of the paper is organized as follows.

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Section 2 provides a review of the meaning of awareness and existing approaches for its expression and support, which include distributed and situation awareness, its practical, theoretic and technological issues, also awareness and control of real systems and networks. Emphasizing complexity of real distributed systems, it stresses the necessity of new management approaches with high system awareness. Section 3 briefs the developed, patented, and extensively published Spatial Grasp Model and Technology (SGT) providing distributed holistic vision, comprehension, and management of large dynamic systems by self-spreading recursive code. This includes general issues, basic Spatial Grasp Language (SGL), and distributed networked implementation. Section 4 provides a hypothetical distributed system example with hundreds of different nodes interlinked by various relations, with nodes and links having physical and virtual properties, which is analyzed in detail in the following sections. Elementary awareness queries are considered in Section 5 which include names of all global communication nodes, all working nodes, combined communication-working nodes, top management nodes, and nodes with links to other businesses. Finding paths in the whole network is in Section 6 which include a single path from start to end nodes, also with using only certain link types, shortest path tree (SPT) from start to all other nodes, and finding shortest paths from start to end nodes on the basis of SPT created. Section 7 considers finding some peculiar structures in the system network which may reflect its diversity and complexity. These include all articulation points in the communication network, discovery and exhibition of all maximum cliques inside working collectives, and maximum cliques in the communication network.

Section 8 provides some higher-level knowledge about the distributed system which includes evaluating total length of global communication network, listing all working collectives, determining which collective has maximum number of offices, outlining X_Y area occupied by the whole distributed system, also inferring business cooperation network between different organizations as a whole. Section 9 concludes the paper with the hope that any imaginable and even so far unimaginable awareness queries and solutions in distributed systems can be obtained by recursive scenarios in SGL. References provide review on existing awareness publications and the chosen investigative technology.

2. Awareness and Its Existing Approaches

This provides a review of the meaning of awareness and its different options, and also analyses existing approaches for its expression and support.

Awareness Definitions

Awareness (Wikipedia, 2023a) is a concept about knowing, perceiving, and being cognizant of events. The concept is often synonymous to consciousness and is also understood as being consciousness itself. The states of awareness are also associated with the states of experience so that the structure represented in awareness is mirrored in the structure of experience.

In spatial awareness (Alberta Regional Professional Development Consortia, 2023), the definition of visual-spatial relations is the ability to visually perceive two or more objects in relation to each other and yourself. Spatial reasoning is how we understand how things (including ourselves) move and interact in relation to the physical space around them. It also involves understanding the relationships of objects as they change position.

Total information awareness (Wikipedia, 2023b) was a mass detection program by the United States Information Awareness Office. It operated under this title from February to May 2003 before being renamed Terrorism Information Awareness.

Distributed Situation Awareness

Distributed computing (Mohanan, 2022) is defined as a system consisting of software components spreading over different computers but running as a single entity. A distributed system can be an arrangement of different configurations, such as mainframes, computers, workstations, and minicomputers. Distributed systems are the most significant benefactor behind modern computing systems due to their capability of providing scalable and improved performance.

Distributed situation awareness (Salmon & Plant, 2022) is focused on situation awareness in domains such as defense, transport, and process control. A significant contribution has been to initiate a shift from considering individual human operator situation awareness to considering the situation awareness of human and non-human teams, organizations, and even socio-technical systems. The distributed situation awareness model has become increasingly relevant for modern day systems and problems.

Contemporary thinking on Distributed Situation Awareness (DSA) (Stanton, 2016) has been developed over the past decade from a concept into a testable theory with associated methodology. Early forays into understanding the nature of DSA are presented together with examples of case applications, where DSA is based on the original ideas from Distributed Cognition.

Practical and Theoretic Issues on Distributed Situation Awareness

Seven issues on distributed situation awareness measurement (Chatzimichailidou, Protopapas, & Dokas, 2015) consider Situation Awareness (SA) as an emergent property of a complex socio-technical system rather than an individual endeavor. This work collects some of the most crucial issues surrounding the existing SA measurements techniques that arose under the complex socio-technical systems settings, moving beyond the existing network-based approaches.

Real world awareness in distributed organizations (Sultanov & Weber, 2011) marks the state of being informed incorporated with an understanding of project-related activities, states or relationships of each individual employee within a given group as a whole. Awareness becomes a concurrent process which amplifies the exigency of easy routes for staff to be able to access this information, deferred or decentralized, in a formalized and problem-oriented way.

In *distributed situation awareness theory, measurement and application* (Salmon, Stanton, & Jenkins, 2017)) situation awareness is the term that is used within human factors circles to describe the level of awareness that operators have of the situation. It focuses on how operators develop and maintain a sufficient understanding of what is going on in order to achieve success in task performance. This construct has become a fundamental theme in system design and evaluation and has received considerable attention from the research community.

Technological Issues of Distributed Awareness

Distributed situation awareness is becoming a "middleware" between the new economic sociology and embedded open innovation (Chatzimichailidou, Freund, & Dokas, 2014). Modern societies are comprised of open systems where their internal elements interact with their environment. These diverse elements are integrated in multi-agent socio-technical systems exhibiting an open process of information fusion. Combination of Distributed Situation Awareness and Embedded Open Innovation can contribute to change our view of collaboration, develop a holistic and systemic culture, along with models based on the socio-technical perspective.

Context awareness in distributed computing systems is considered by Preden and Helander (2009). Creating robust systems that deal with and consist of both the physical world and networked computing nodes is relevant to a large class of applications. Due to the importance of such cyber-physical systems to our everyday lives and economies, it is important to investigate and develop new methodologies for programming such systems. Context information in the computation may be part of the answer to dealing with the emergent behavior and dynamicity of cyber-physical systems.

Distributed Situational Awareness and Control of Real Systems and Networks

Distributed situational awareness in robot swarms is considered by Jones, Milner, Sooriyabandara, and Hauert (2020). Many robot systems are becoming a reality for large companies that can invest in bespoke solutions. These systems often require carefully engineered infrastructure and a central planner to coordinate the robots. Distributed situational awareness allows swarms of low-cost robots to rapidly and accurately capture the state of an environment and act accordingly, with no central data storage, modeling, or control.

Distributed situational awareness and control are discussed by Gan, Xu, and Sukkarieh (2016), which describes the benefits of applying distributed unmanned aerial vehicle (UAV) teams to situational awareness problems. The situational awareness problem is decomposed into two components: decentralized data fusion and team decision making to maximize information gain. The work outlines mathematical formulation of the general team decision-making problem and how to yield tractable, online solutions.

A review of network situation awareness for operation and maintenance is discussed by Ge, Li, Yan, and Sun (2022). In order to meet the requirements of high-tech enterprises for high power quality, high-quality operation and maintenance in smart distribution networks (SDN) is becoming increasingly important, and situation awareness (SA) begins to excite the significant interest of scholars and managers, especially after the integration of renewable energy into SDN. The paper decomposes SA into three stages: detection, comprehension, and projection.

An overview of reinforcement learning algorithms for handover management in ultra-dense small cell networks, which may be used for distributed awareness, is considered by Tanveer, Haider, Ali, and Kim (2022). The fifth generation (5G) wireless technology emerged with marvelous effort in design, deployment, and standardization of the upcoming wireless network generation. Artificial intelligence and machine learning techniques are well capable to support 5G latest technologies that are expected to deliver high data rate to massive machine type communications.

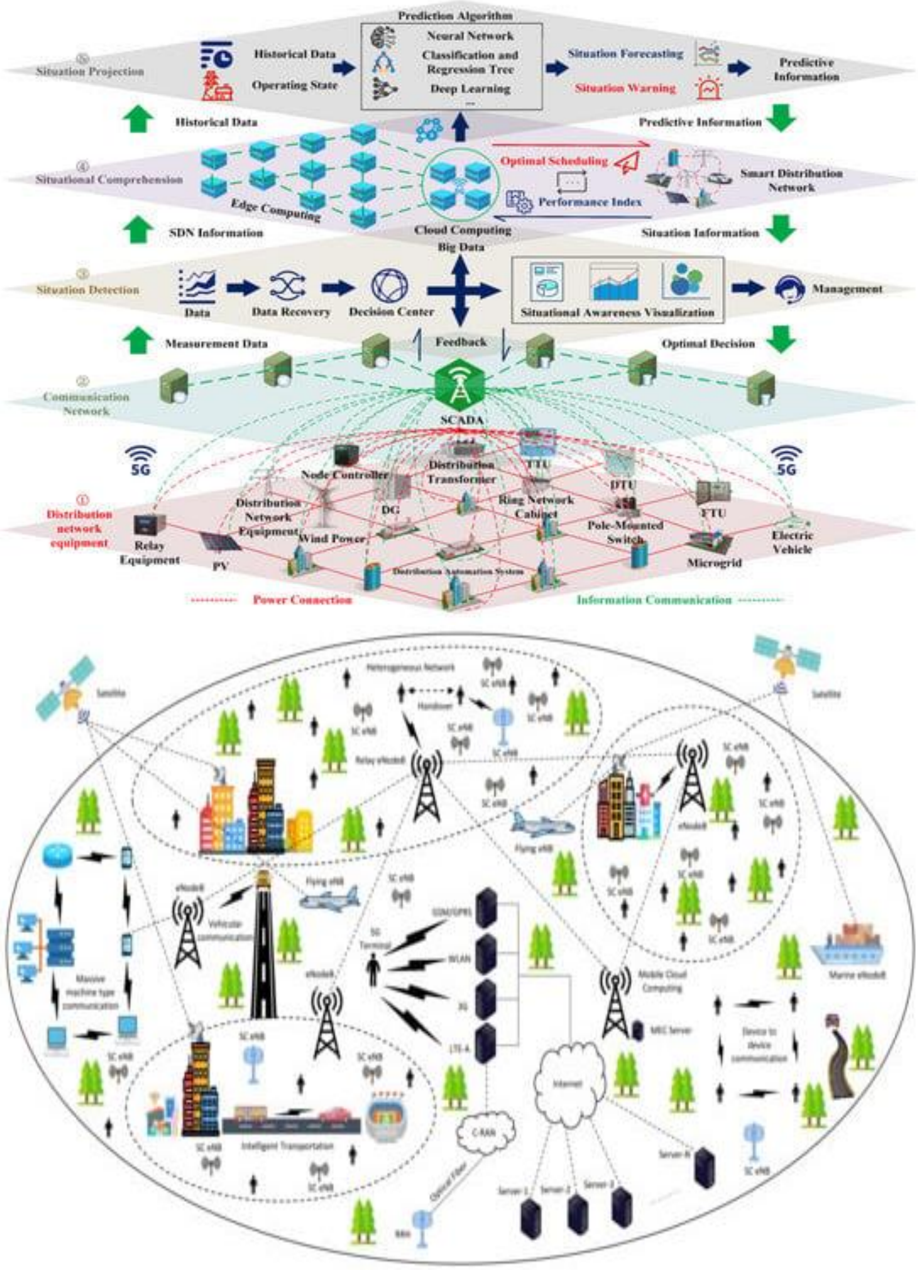

Figure 1. Examples of complex distributed systems.

Complexity of Distributed Systems With New Management Approaches Needed

This brief review confirms enormous complexity of real distributed dynamic systems and how to deal with them properly, with two related pictures shown in Figure 1 (borrowed from Ge et al. (2022) and Tanveer et al. (2022)) without explanation, just to give impression of their diversity and complexity).

Such systems need for their observation, understanding, management, and control most advanced theoretical and practical approaches, mechanisms, and technologies providing local and global awareness of their structures and organizations, which may be needed to be available from any their points, and to which this paper is devoted.

3. The Model and Technology of Spatial Vision and Comprehension

Only most general features of the developed paradigm are included, with availability of existing extended publications on its philosophy, features, organization, and numerous applications.

General Issues

Within Spatial Grasp Model and Technology (Sapaty, 1990; 1999; 2005; 2017; 2018; 2019; 2021; 2022a; 2022b; 2022c; 2022d; 2023a; 2023b) a high-level operational scenario expressed in recursive Spatial Grasp Language (SGL), starting in any world point as in Figure 2, propagates, covers, and matches the distributed environment in parallel wave-like mode. Such propagation can result in echoing of the reached states and data, which may be arbitrarily remote, to be represented as the final result, or used for higher level decisions and launching other waves. These capabilities altogether provide holistic spatial solutions unachievable by any other models and systems.

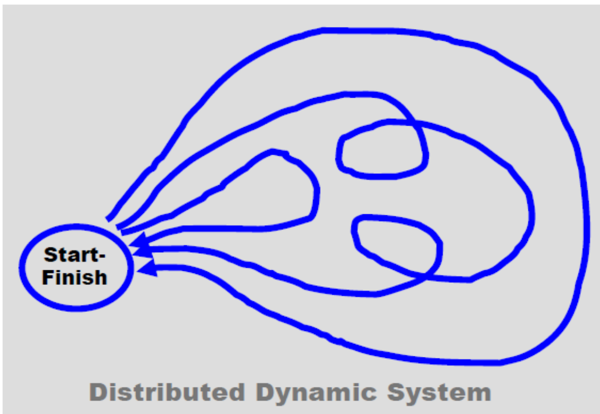

Figure 2. Collecting and returning any knowledge into any point with Spatial Grasp Model.

Spatial Grasp Language (SGL)

The SGL (with many details in Sapaty (2017; 2018; 2019; 2021; 2022a)) allows for expressing direct space presence and operations with unlimited powers and parallelism. Its universal recursive organization with operational scenarios called *grasp* can be expressed just by a single formula:

grasp → *constant* | *variable* | *rule* ({ *grasp*, })

where SGL *rule* expresses certain action, control, description, or context accompanied with operands, which can themselves be any *grasps* too. Top SGL details can be expressed as:

constant → *information* | *matter* | *custom* | *special*
variable → *global* | *heritable* | *frontal* | *nodal* | *environmental*
rule → *type* | *usage* | *movement* | *creation* | *echoing* |
verification | *assignment* | *advancement* | *branching* |
transference | *exchange* | *timing* | *qualifying*

The rules, starting in some world points, can organize navigation of the world sequentially, in parallel or any combinations thereof. They can result in staying in the same application point or can cause movement to other world points with obtained results to be left there, as in the rule's final points. Such results can also be collected, processed, and returned to the rule's starting point, the latter serving as the final one on this rule. The final world points reached after the rule invocation can themselves become starting ones for other rules. The rules, due to recursive language organization, can form arbitrary operational and control infrastructures expressing any sequential, parallel, hierarchical, centralized, localized, mixed, and up to fully decentralized and distributed algorithms.

Networked SGL Implementation

Each SGL interpreter copy can handle and process multiple active SGL scenario code propagating in space and between the interpreters. Integrated with any distributed systems and networks, the SGL interpretation network can form a spatial computer with unlimited power for processing, simulation, and management of distributed systems and worlds. Having recursive self-spreading, self-controlled, and super-virus nature, this paradigm can dynamically establish and keep superior power over any systems (including creating them from scratch and providing local and global awareness from any point to the same or other points, whether inside or outside of the system).

4. Hypothetical Distributed System Example

In order to analyze and show practical SGT and SGL capabilities for providing local and global awareness of any distributed systems, we will be using their formal (also rather hypothetical) representation as a large heterogeneous distributed network (of exactly 100 nodes), with different kinds of nodes having both names and physical coordinates, which are interconnected by different types of links, as in Figure 3 and Figure 4.

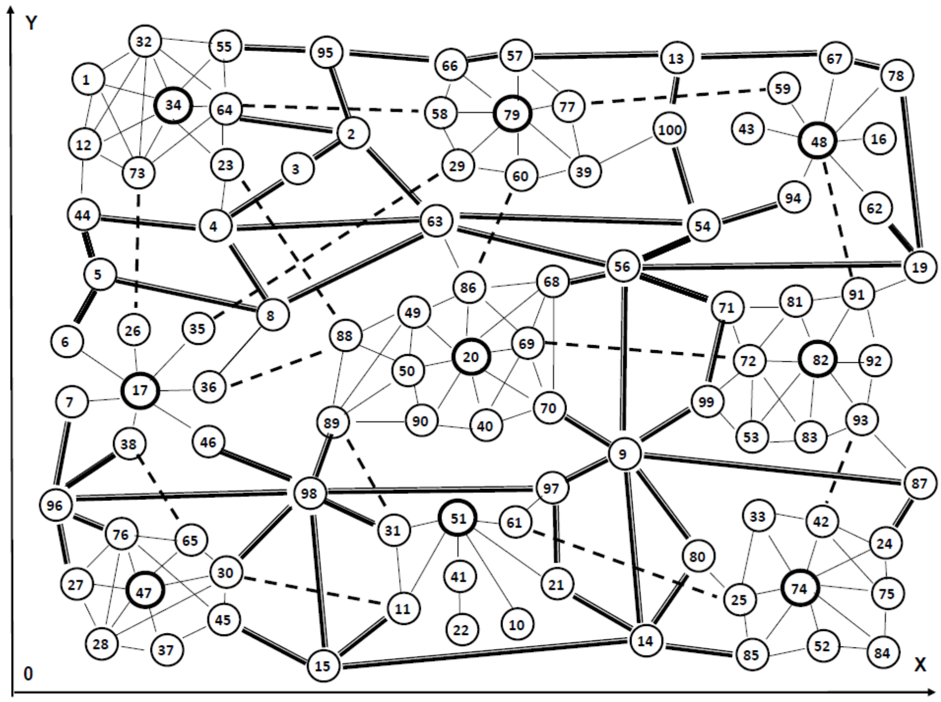

Figure 3. Hypothetical networked image of large distributed heterogeneous system.

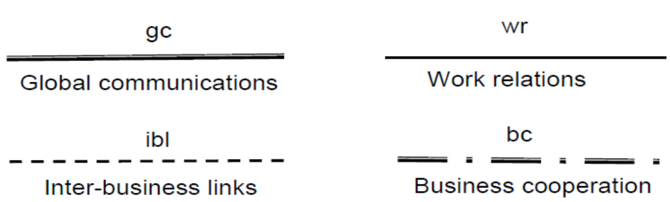

Figure 4. Different types of network inter-node links.

This system example reflects different working organizations as collectives (having hardened top management nodes), which may have hierarchical or more complex organizations, with working relations (wr) between nodes-departments. These organizations are interconnected by global communication network (having gc links) which may reflect power and resources supplies and exchanges, electronic links, physical road connections, etc. This global communication network has its own communication nodes (with only gc links) to keep global coverage, while some of its nodes are common with working nodes (these having both wr and gc links) via which different organizations are supplied with global system communication and transportation resources. Different organizations may also have peculiar cooperation (with inter-business links, or ibl) between their special departments (which, say, may reflect additional phone or internet connections, or just personal friendship and interests). By these local links the organizations may be generally considered as having global cooperation with each other (it will be shown later how these bc links can be inferred between the whole organizations).

In the following sections we will be showing practical solutions in SGL of useful system observation tasks (actually any imaginable and may even be so far unimaginable) which provide awareness about different points, parts, and the whole of the system of Figure 3, which may be detailed, summarized, or generalized. And the request for such knowledge can be issued any time and from any points inside or outside the system and returned to same or other points, thus providing global and mutual awareness of its contents, structures, and organizations for everybody and any institutions.

5. Elementary Awareness Queries

These requests are providing most general knowledge about the network components.

Listing Names of All Global Communication Nodes

output(hop_nodes(all); TYPE = global; NAME) or

output(hop_nodes(all); true(hop_links(gc)); NAME)

Result: (55, 95, 66, 37, ..., 9, 14, 85)—about half of all nodes, which may include some working nodes which are having double functionality.

Listing All Working Nodes (Top Managers Including)

output(hop_nodes(all); true(hop_links(wr)); NAME)

Result: (1, 32, 55, ..., 85, 52, 24)—almost half of all nodes too. These may also include some global communication nodes with double functionality.

Naming Combined Communication-Working Nodes

output(hop_nodes(all); true(and(hop_links(wr), hop_links(gc))); NAME)

Result: (55, 64, 44, 4, 66, 57, 100, 67, 78, 94, 62, 6, 7, 8, 38, 46, 89, 68, 70, 71, 99, 19, 87, 27, 76, 30, 31, 11, 97, 21, 80, 24, 85).

Naming All Top Management Nodes

output(hop_nodes(all); TYPE = top; NAME)

Result: (34, 79, 48, 17, 20, 82, 47, 51, 74).

Listing Nodes Having Links to Other Businesses (Which May Include Working, Top Management, and Combined Working-Communicating Nodes)

output(hop_nodes(all); true(hop_links(ibl)); NAME)

Result: (64, 58, 77, 59, 35, 29, 36, 23, 88, 69, 72, 38, 65, 30, 11, 61, 25, 42, 93, 48, 91).

6. Discovering Different Paths Between Nodes in the System Networks

Finding Any Single Path (i.e. Without Node Repetitions) From Start to End Nodes

```
nodal(Start = ...); frontal(End = ..., Path);
output(hop_first(Start); Path = NAME;
    repeat(hop_first_links(all); Path &= NAME;
        if(NAME == End, terminate_blind(Path))))
```

If for example, Start = 23, End = 72, the path found may be: (23, 88, 50, 20, 69, 72), with accidentally used links ibl and wr.

Finding Any Single Path (Without Repetitions) From Start to End Nodes Using Only Certain Link Types

```
nodal(Start = 23); frontal(End = 72, Links = (wr, gc), Path);
output(hop_first(Start); Path = NAME;
    repeat(hop_first_links(Links); Path &= NAME;
        if(NAME == End, terminate_blind(Path))))
```

If only wr and gc links allowed with same Start and End nodes, as above, the path found may be as: (23, 4, 63, 56, 71, 72).

Shortest Path Tree (SPT) From Start Node to All Other Nodes (Assuming All Links With Length 1)

```
nodal(Start = ..., Parent, Distance); frontal(Length);
hop_node(Start); Distance = 0;
repeat(hop_links(all); increment(Length, 1);
    or(Distance == nil, Distance > Length);
    Distance = Length; Parent = PREVIOUS)
```

This SPT covering all network nodes, beginning from Start, will be recorded in the network structure rather than output, where in each node reference to its above tree node is fixed in the nodal variable Parent.

Shortest Path Tree (SPT) From Start Node to All Other Nodes With Taking Into Account Physical Distances Between Nodes

For this, we should change incrementing length in the above scenario to (which can result in a different SPT): increment(Length, far(BERORE, WHERE)).

Finding Shortest Path (SP) From Start to Final Nodes on the Basis of SPT Found

(a) *Starting in the final node and issuing the path in the starting node*. The following scenario for the path from Start to Final starts in the final node and then moves upwards the SPT while collecting the passed path in reverse order (using names recorded in variable Parent), until reaches Start node, issuing it from there.

```
nodal(Final = ...); frontal(Path, Start);
hop_node(Final);
output(repeat(Path = NAME && Path; hop(Parent);
        if(NAME == Start, quit(Path)))
```

(b) *Beginning from Start and moving downward the tree*. This will be accumulating all paths passed down the tree, which may be done in parallel, while terminating in Final and issuing collected Path there.

```
nodal(Start = ...); frontal(Final = ..., Path);
hop_node(Start);
output(repeat(Path = append(Path, NAME);
            if(NAME == Final, terminate(Path));
            hop_links(all); Parent == PREVIOUS))
```

With Start = 60 and End = 28, such path may be: (60, 86, 49, 89, 98, 30, 28).

7. Finding Peculiar Structures

Different parts of the system in Figure 3 may have different, often complex, networking structures which may reflect their purpose, functionality, and general capabilities. Among these, articulation points (reflecting network weakest points) and cliques (as most powerful structures) may be of particular interest and importance.

Finding Articulation Points (AP)

These are the network nodes which when deleted split the network into disconnected parts. The following scenario will be finding all AP in parallel in the communications network with gc type of links.

```
hop_nodes(all); true(hop_links(gc)); COLOR = NAME; hop_first(stay);
output(
  and_seq((hop_first_link(any, gc); repeat(hop_first_links(all, gc))),
          hop_first_links(all, gc),
          done(NAME)))
```

Result: (56, 9, 87, 14, 98, 96, 5, 15, 19, 95, 2, 87).

This scenario, starting in all gc-connected nodes, first goes by any single gc link to a neighboring node and marks the whole part of the network starting from it with a special COLOR (the starting node including). After this, it tries to move via all other gc links from the same starting node and see if at least a single unmarked node reached. That will indicate that this starting node separates the whole network into disconnected parts, and its name will be printed together with other such nodes.

Finding Maximum Cliques (MC) Inside All Working Collectives

Cliques are the strongest network parts represented as full graphs with any node connected to any other one. The scenario below is finding all maximum cliques in the networks of working collectives, having number of their nodes with equal or higher than the given Threshold (chosen to be four for obtaining more interesting cases).

```
output(
  hop_first_nodes(all, TYPE = top);
  fringe(repeat(done(stay), hop_first_links(wr)));
  contain(
    frontal(Clique = NAME, Threshold = 4);
    repeat(
      or_seq((hop_links(all, wr); notbelong(NAME, Clique);
             true(and_parallel(hop(link_any(wr), nodes_all(Clique))));
             if(PREDECESSOR > NAME, append(Clique, NAME), abort)),
            (count(Clique) >= Threshold; done_unit(Clique))))))
```

Starting from all working nodes (accessed from top managers) it spreads via links to other working nodes and adds each new node to the frontal variable Clique if this node has connection with all previous clique nodes, until this becomes possible, then outputs the obtained clique in Clique. To avoid duplicates, which can appear as any clique can be independently forming from all its nodes, the clique formation should only be continued in a unique order by comparing the value of new node in NAME with the value of previous node in environmental variable PREDECESSOR (using for comparison just node names), immediately terminating otherwise.

The resultant cliques will be as follows: (73, 34, 32, 12, 1), (76, 47, 28, 27), (86, 69, 68, 20), (70, 69, 40, 20), (83, 82, 72, 53), (75, 74, 42, 24), see also their graphical images in Figure 5.

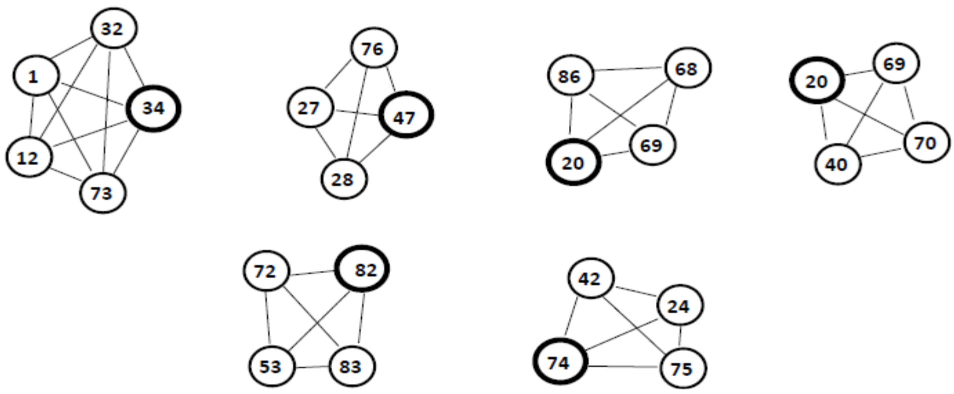

Figure 5. Resultant maximum cliques in the working collectives.

To show possible cliques in particular working collectives, not all as above, we should start only from their top management nodes (shown as heavier ones in Figure 3 and Figure 5), where, say, collective with top manager 20 has two cliques (86, 69, 68, 20) and (70, 69, 40, 20), while others only one or none.

Finding MC in the Whole Communication Network

To do this, we should change the following parameters in the above scenario, as follows, including a lower Threshold as communication network has a less complex structure, see also Figure 3:

TYPE = global, Threshold = 3

The result will be: (63, 8, 4), (63, 56, 54) and (80, 14, 9), with only three-node cliques found, see also Figure 6 for their graphical copies.

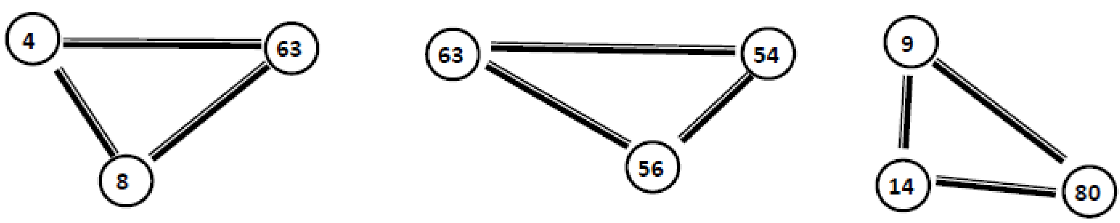

Figure 6. Resultant cliques in global communication network.

8. Providing Awareness by Higher-Level Knowledge on the Distributed System

In this section we will be considering some more diverse knowledge on the network of Figure 3, which may be grouped, averaged, summarized, or even effectively inferred in order to obtain higher-level awareness and assessment of the distributed system or its parts.

Evaluating Total Length of the Global Communication Network

This will be taking into account physical distances between its nodes on both sides of the existing links.

```
output_sum(hop_nodes(all, TYPE = global); hop_links_all(gc);
           PREDECESSOR < NAME; far(BEFORE, WHERE))
```

List All Working Collectives With the Nodes Each of Them Includes

This starting from top manager nodes and colleting all nodes-departments under their control.

```
output(
  hop_first_nodes(TYPE = global);
  unit(repeat(done(NAME), hop_first_links(wr))))
```

Result: (34, 1, 32, ...), (79, 58, 77, ...), (48, 43, 16, ...), (17, 7, 35, ...), (20, 50, 69, ...), (82, 72, 83, ...), (47, 27, 30, ...), (51, 11, 21, ...), (74, 25, 75, ...).

Which Working Collective Has Maximum Number of Offices

```
output_max(
  hop_nodes(all, Type = top);
  append(count(repeat(done(stay), hop_first_links(wr))), NAME))
```

The result using top manager's name as the name of the whole collective will be: 20 or 82, as both having 12 constituent nodes.

Outline X_Y Area Occupied by the Whole Distributed System

```
output(extend((Xmin, Xmax, Ymin, Ymax), (hop_nodes(all); WHERE)))
```

The result is based on a very simple procedure (easily written when needed) extending all collected individual node addresses into the whole area minimally covering them all.

The returned result on the whole area will be represented as: Xmin = ..., Xmax = ..., Ymin = ..., Ymax = ...

Showing Top Business Cooperation Network Between Different Organizations as a Whole

This will be inferred from existing inter-business links (ibl) between some departments of different organizations. The resultant network may be represented by new business cooperation links bc (see Figure 4) between these organizations which are symbolically represented by their top management nodes.

```
output(hop_nodes(all); TYPE = top; COLOR = NAME; hop_first(stay);
      unit(NAME, (fringe(repeat(done(stay), hop_first_links(wr)));
                  hop_first_links(all, ibl);
                  repeat(if((TYPE == top; done(NAME)),
                            hop_first_links(wr))))))
```

The textual result will be as follows, where each bracketed group starts with the organization name as its top manager followed by other organizations (also named by top managers) directly linked to the start by new links: (34, 79, 17, 20), (79, 34, 17, 48, 20), (48, 79, 82), (17, 34, 79, 20, 47), (20, 34, 17, 79, 82, 51), (82, 48, 20, 74), (47, 17, 51), (51, 20, 47, 74), (74, 51, 82).

From this textual notation its graphical representation can be easily obtained, as shown in Figure 7.

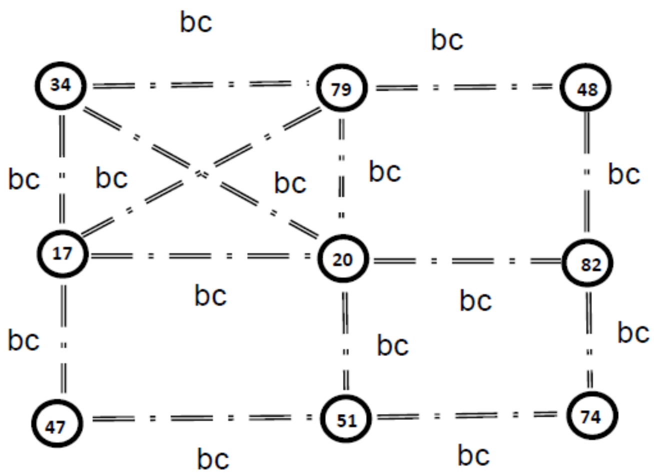

Figure 7. Resultant top business cooperation network.

9. Conclusions

Having provided a review of different meanings of awareness and existing approaches for its expression and support, the paper investigated application of the developed Spatial Grasp Model and Technology (SGT) for providing very practical awareness solutions in large distributed dynamic systems, with obtaining any knowledge needed from any point inside or outside the system. All presented exemplary solutions are very compact, highly parallel and fully distributed, without the need of using vulnerable centralized resources. This may be explained by the completely different philosophy and ideology of SGT which is not based on traditional systems partitioning and multiple agents communications (the latter essentially stemming from the "Society of Mind" approach (Minsky, 1988)). On the contrary, SGT and its basic language supervise and control distributed systems by self-spreading and self-matching holistic recursive code in wavelike mode, which accumulates ultimate power in itself rather in the system its supervises. This may be conceptually closer even to some existing ideas of "soul" (for example, as in Hodgkinson (2020)), with obtained solutions much stronger, clearer, and more compact than with any other approaches.

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