DNAOS for KREMMS: A Distributed Platform for Knowledge Resource Entitlement, Modeling, Management, and Sharing

André CUSSON*

01 Communications Inc.

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Abstract

This article is a knowledge technology case study of DNAOS, a distributed platform for Knowledge Resource Entitlement, Modeling, Management, and Sharing (KREMMS). Some historical aspects of its design, development, and release are briefly discussed, after which the DNAOS technology is commented upon from the specific viewpoint of KREMMS. At the core of this platform is the conception of knowledge as a natural phenomenon, which conception is reflected in the ontology of this technology: Fundamental knowledge structures and structuring principles, believed to be "natural," including qualification, resources, and relationships, are considered theoretically and modeled computationally. Finally, with the help of images, the reader is briefly introduced to some DNAOS capabilities, touching on transaction, application, data, model, and interface.

Key words: Knowledge as a natural phenomenon; Knowledge resources; Knowledge management; Knowledge modeling; Knowledge sharing; Knowledge entitlement

1 Introduction

Understanding, both intellectually and scientifically, the intuitive nature, structure, and operation of knowledge is a crucially important and determining task in *knowledge management*; this, like our own human thinking and operation, and as the very

*✉ acusson@01communications.com

label conveys, is deeply rooted in knowledge. Armed with this understanding, faced with complex security, authorization, and classification issues a team of industrial collaboration portal design (01 COMMUNICATIONS INC.; see [1]), along with a team of natural phenomena research (Cosmos Square Inc.) collaborated to better understand the fundamental principles of knowledge, as well as the related implications in computing, data sharing, and entitlement security. This work led to enabling major new possibilities in knowledge management and ontology grounding, in designing computing systems that dynamically recognize and manage massive amounts of knowledge resources, as well as in effectively enabling entitlement security where unlimited granularity authorizations, classification, and contexts are analyzed, correlated, and tracked in real time. Hence, this research work led to the design, development and initial release in 2004 of the DNAOS technology ([2], [3]), a distributed platform for *Knowledge Resource Entitlement, Modeling, Management, and Sharing* (henceforth abbreviated as KREMMS).

As a knowledge technology case study, this article is not the place to enter a full-fledged discussion on knowledge, nor on related technology; for this reason, I provide only some general aspects hinting on how knowledge technology and management benefit from better understanding some of the fundamental structuring principles of this natural phenomenon that is knowledge. Suffice it to say here that my view is not dissimilar from that of the Kantian epistemology, in which we can only know objects existing in time and space (see Kant, 1781/2007), a view that is widely accepted in today's cognitive science. As a matter of fact, I could go as far as the German idealists and claim that knowledge is reality itself–or reality is the phenomenon of knowing (a possible interpretation, of course). Some contemporary discussions in knowledge as a natural phenomenon are, for instance, Bermúdez (2006), Kornblith (2002), and Stephens (2012).

The DNAOS knowledge technology implements a wholly orthodox ontology, if with a few idiosyncratic elements. Readers with a background in philosophy will find that many passages below contain elements that are to be found in some well-known lists or tables of *categories*, or the constituting elements of reality and/or of the possibility of knowing what exists (e.g., Aristotle [see Ackrill, 1963]; Kant, 1781/2007). This only shows that the contemporary effort of producing *ontologies* in computing in general and knowledge technology in particular is a continuation of the century-long task of producing an *ontology* in the larger field of metaphysics (see, e.g., Guarino, 1995; Poli & Seibt, 2010; Poli et al., 2010).

Like all work in knowledge technology, this article also uses profusely the terms "knowledge," "information," and "data." Distinguishing them is a well-known difficult task that is ongoing in literature as diverse as high-school textbooks / examination guides (e.g., Cambridge International, 2015) and papers in the largely mathematical field of formal epistemology (e.g., Augusto, 2020; this issue). In this article, *data* is considered simply as being any computer representation, while *information* is interpreted as a projected element of some knowledge resource aspect; as for *knowledge*, my view has already been briefly discussed above and I shall elaborate on it below in different passages. This elaboration is meant to be put into relation with the characteristics of the DNAOS technology, and it, together with the images provided, are hopefully sufficient for readers to judge for themselves on how this technology implements this–perhaps idiosyncratic–view of knowledge.

2 Challenges and Solutions

Before considering a few of the many issues facing the business environment, as well as to try to better understand the context, I first briefly consider how the solutions presented here emerged.

At the start of the millennium, 01 COMMUNICATIONS INC. set up an R&D endeavor in which its top designers and architects joined with a natural phenomena research team from the Consonance division of Cosmos Square Inc. to try better to understand and resolve related issues. The motivating factors were:

- Decade-long experience in designing and developing industrial collaboration portals, for various industries, where users are typically competing, and sometimes collaborating, organizations;
- The realization that sharing complex services has real value, but that no organization would like its data in front of a competitor's eye;
- The understanding that, though competitors, organizations can effectively share different kinds of resources with others to mutual advantages, introducing the need for shared and controlled management of the shared resources;
- The realization that as the shared resources can vary dynamically, all data can potentially be shared, each with its own set of rules, conditions, as well as rights and privacy protection and management;
- The awareness that while current security can protect systems from some access, the control granularity is coarse, at best, and data security remains a very open issue.

It was clear from the start that rather than building custom applications that operated on data, data should be the driver, hence data-driven applications where security, including authorizations, dynamic classification, encryption, cryptography key, as well as steganography and tracking, are also data-driven. These requirements are quite high and imply a high level of governance and administration, also driven by a massive amount of data. More so, a solution should also support scaling to a global level. The challenge was important enough to warrant going over all concepts and issues, inside and outside of the box. It was the team's experience with understanding the nature, structure, and operation of natural phenomena in terms of fundamental principles that led to the realization that knowledge is a natural phenomenon, with its own structured logic and principles. I next approach this topic.

3 Knowledge as a Natural Phenomenon

3.1 Knowledge, Ontology, and Other Considerations

The cornerstone of the viewpoint of knowledge as a natural phenomenon is the belief that evolution is not possible without knowledge and its natural memorization. More specifically, knowledge can be considered a natural phenomenon in the following sense: when one learns and gathers knowledge about something, one is actually studying the structure of the part of reality that this something *is*, a skill or activity technically called *metaphysics* (less generally: *ontology*). Hence, knowledge can be seen as capturing the structure of reality–or as being reality itself, from a more essentialist perspective, as mentioned in the Introduction.

Of course, knowledge is also the coherently integrated collection of all fully qualified information, meta-information and relationships, including all qualified relationships between all information, and meta-information, repeatedly and recursively. The implications of this are far reaching and only a few can be briefly addressed here, starting with a small example, considering the effective meaning of a short sentence like "the keys are on the table."

Let it be given a context where one needs to drive to the airport to meet a returning spouse, yet the car will not start. One runs to a friendly neighbor's place and, as one is greeted, one asks: "May I borrow your car to pick up my returning spouse at the airport? My car won't start." The neighbor's reply might be: "The keys are on the table." At first, and quite rightly, one may interpret this sentence as simply and explicitly meaning that the car keys are lying on some table that both parties know about, but, in fact, there is much more knowledge associated with the sentence, including things like:

"I know (that)

- you are my neighbor friend whom I have known for many years
- where you live
- you have a valid driver permit
- we both have adequate insurances
- indeed your spouse is returning today
- you need my car to go to the airport to pick her up
- the weather is nice and traffic should not be too bad
- you understand that the car is mine
- you will return it right
- you are responsible for everything that happens to it and with it
- you know that, should you act irresponsibly with my car, I can have much recourse, including use of GPS and video evidence, as well, under pertinent and well recognized laws, I could sue the pants off your back
- we expect that when you return, we will have a BBQ and listen to your spouse about her trip."

All considered, "you can borrow my car and the keys are on the table!"

The above can be seen as an illustration of what can be called *(background) knowledge*. Three considerations may emerge from it that have to do with properties of this kind of knowledge:

1. The *exchanged* knowledge substantially exceeds the limits of shared words.
2. Typically intuitive, knowledge *sharing* is a powerful and complex multi-layered process.
3. *Security* is naturally built into knowledge, quite unlike information.

The first consideration is believed to confirm the view that knowledge is indeed "the coherently integrated collection of all fully qualified information, meta-information and relationships, including all qualified relationships between all information, and meta-information, repeatedly and recursively." The second consideration suggests that knowledge architecture, management, and operation is highly, even mostly, intuitive; nonetheless, as with every natural phenomenon at the foundation of intuition, knowledge also relies on strict logical principles and processes, and the key to more effective and durable knowledge lies in the detailed intellectual understanding of these natural principles and processes. The third consideration above also indicates that all security controls are naturally integrated into knowledge, which is not the case for information. (Of course, in many cases, such as the industrial collaboration portals mentioned above, this becomes a determining factor, and especially so in the scenario of an even wider reaching data-sharing platform over the Internet, and ultimately all data shared thereon; see Fig.s 3 and 7 below).

3.2 Properties of Knowledge

While knowledge seems to be, and may well be, unlimited, we manage it in chunks that we refer to as "resources." In fact, there is nothing but knowledge resources. A knowledge resource is anything we consider or manage. Resources can have many properties that each, simple or complex, qualify some aspect of the resource and each property is referred to as a "quality."

Fundamental resource types can be referred to as "archetypes." Archetypes define the underlying ontology foundation, as well as support various generic qualification sets and processing. Common knowledge resource archetypes include: Metadata; Thing, Place, Party; Relation, Role, Schedule; Access, Rule, Process; Artifact, Description. The DNAOS technology for KREMMS is based on a metamodel that takes these into consideration (see Fig. 1).

3.2.1 Quality

The most fundamental quality is *identification*, which can take many forms, but is indispensable since if it cannot be identified, it cannot be managed. However, there are many more qualities, or quality types, of which some are fundamental:

IDENTIFICATION, including: labeling, typing, categorizing, referencing

CLASSIFICATION, including: basic, intrinsic, relative, dynamic

DURATION, including: period, date, time, cycle, repeat, event

LOCATION, including: physical, logical, address, area, volume, place

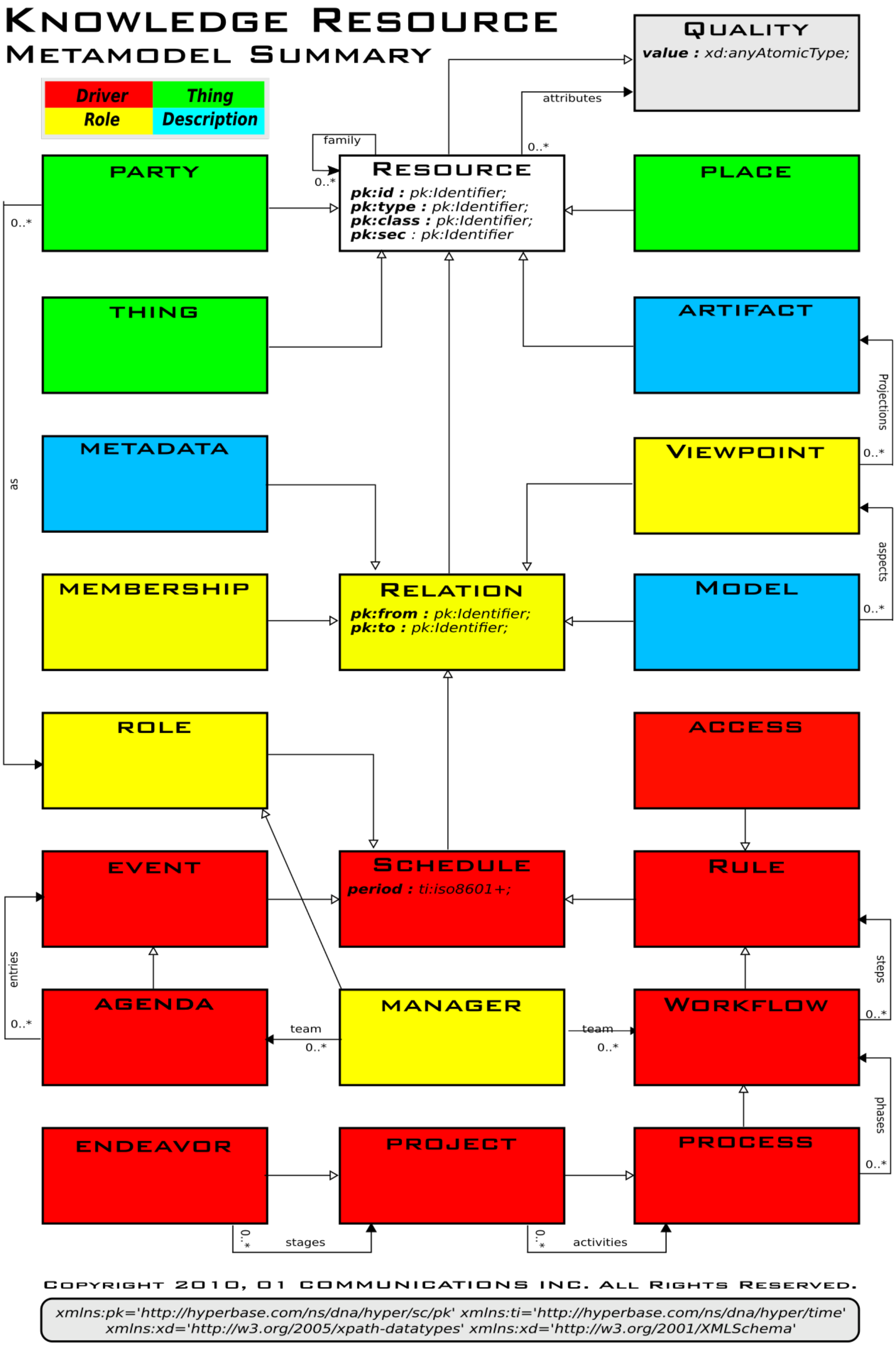

Figure 1: Knowledge resource metamodel summary.

DESCRIPTION, including: text, sound, image, video, model, animation, simulation

REFERENCE, including: parent, child, component, sibling

PERSISTENCE, including: storage, credential, backup

COLLECTION, including: list, sequence, array, map, set

RULE, including: condition, binding, access, window, behavior

INDICATOR, including: static, dynamic, Key Performance Indicators (KPIs)

Figure 1 above shows a complete ontology of quality types and their relations in the metamodel for the DNAOS technology for KREMMS.

3.2.2 Relationships

While many resources are like leaves of a tree, others, even more numerous, are like branches and define or qualify the relationships between other resources (leaves or branches). These are referred to as "relationships." Relationship types are unlimited. Relationships are resources and have the additional characteristics of providing specific references to their source and destination resources, while fully qualifying the relationship and its associated behavior. Figure 2, for example, shows some of a company's related entities.

3.2.3 Modeling Knowledge Computationally

As said above, humans handle knowledge in a very intuitive way in their personal and social relations, for example. The aim of any knowledge management technology, which is essentially implemented in a computer, should be to provide to users the same ease. In order to achieve this some aspects are crucial: *Representation*, *Processing*, *Managing*, *Governance*, and *Classification*. I next briefly discuss these.

REPRESENTATION: Resources can be modeled into graphs or logical networks, as well as mapped to structured representations (in XML, for example), but representations like RDF can have (arbitrary) built-in semantics that conflict with the natural structure of knowledge. In RDF, for example, relations are links, not qualified relationships. (Of course, one could try to fully represent a knowledge resource or even a qualified relationship, or behavior, or classification in RDF, given enough time, but it is not naturally supported and some semantic bias needs to be convoluted around. Default queries would be extremely complex or would not work; typically, complexity will grow exponentially as more resources are considered, changing anything could be catastrophic, and adequate performance becomes unachievable.)

PROCESSING: As knowledge can be represented in "computer" format and "data" refers to a "computer" representation, it can be referred to as *knowledge data* rather than *information data*. While information data is "flat & square," knowledge data is live, dynamic, correlated, and highly structured, allowing new knowledge processing applications. Such applications dynamically figure out data structure, purpose, and processing. They are generic applications. These applications operate on knowledge quite like humans do intuitively. Hence they are closer to humans, supporting more

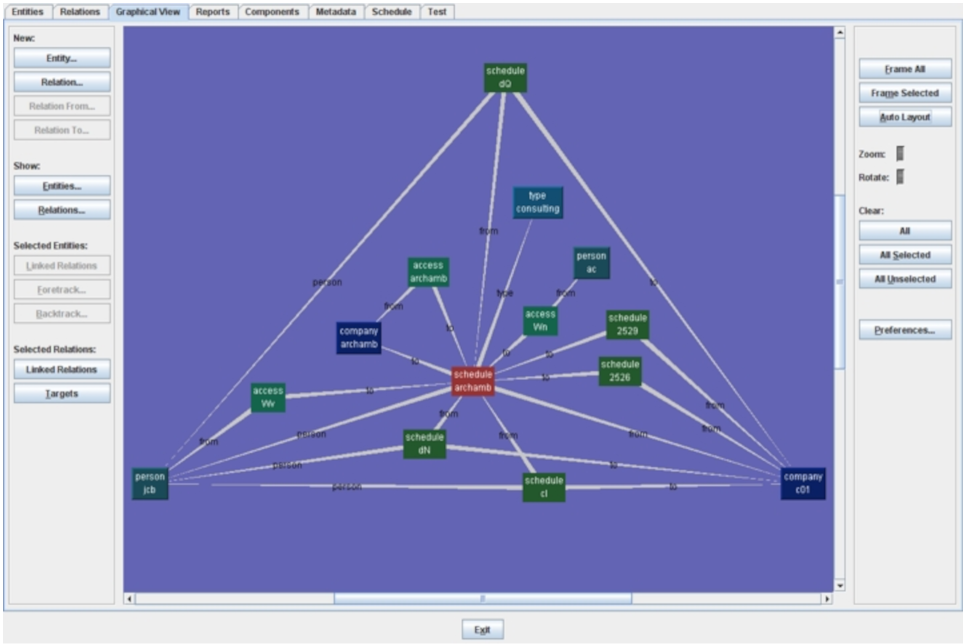

Figure 2: Relationship modeling in DNAOS for KREMMS. (For a higher-definition image, go to: http://knowledgearchitect.org/asset/image/relmod.png)

naturally understood and executed interfaces between humans and systems, and at a much deeper level.

MANAGEMENT: In current knowledge management environments, humans tend to try to gather knowledge from other humans, the implied workers. The process condenses and stores it as information data in a database or repository, again for humans to query and retrieve to try to map back to effective knowledge, when required. At each step and transformation, some knowledge is lost, while the information remains relatively static (e.g. not real-time nor run-time), and while updating the information at any time can be a serious process including mapping back and forth to/from knowledge. Modeling knowledge implies querying, selecting, and structuring this knowledge.

Ontology is a key knowledge structuring foundation. It is therefore key that insufficiently grounded ontology can be a serious limitation. It can seem adventurous to try to model and structure knowledge without grounding the “enterprise” ontology, in other words without considering and clearly understanding what knowledge is, especially given that natural phenomena are articulated by structured natural and logical principles. While that is where ontology should root, in most cases today ontology foundations–some may say “root classes”–are defined arbitrarily, typically based on the semantics of the representation (e.g. RDF), as well as by arbitrary convention. It may be surprising to note that up to now, nowhere is natural knowledge architecture even considered.

GOVERNANCE: Knowledge management and governance have a bi-lateral relationship since knowledge is required for governance, and good governance applies to knowledge and to its management. While this seems natural when systems manage effectively knowledge resources, this is not so where knowledge is reserved to humans, rendering the process complex and cumbersome, even often infeasible, and governance complexity grows rapidly when relying exclusively on human activity, or its effectiveness is sacrificed. Knowledge resource management provides additional essential knowledge management advantages, especially through computerized management of fully qualified relationships and behavior, by using dynamic key performance indicators (KPIs), as well as by inherently supporting classification and authorization management. (See Fig. 4.)

CLASSIFICATION: Classification presents an especially interesting case as one may try to classify, say, phone numbers for some privacy level globally. This value is arbitrarily set by some humans trying to consider the implications, from their experience, at this point in time. Yet, the sensitivity of an element (phone numbers, in this example) really mostly depend on what the phone number is effectively associated to at the request time. A phone number by itself may not be very sensitive, but it seems quite different when it is associated with the customer identification and the list of his transactions as, for example, the video he has been viewing during a lockdown. Classification is a dynamic relationship-based run-time evaluation, something humans cannot practically do, especially in large environments. Nonetheless, these fully qualified relationships need to be dynamically processed, at run time, something that information processing does not support, contrary to knowledge-based governance elaborated in this article. Finally, classification is crucial to content security and privacy. In fact, effective data and sharing security should be based on evaluating the intersection of applicable authorizations, dynamic classifications, and applicable context, conditions and rules, in order to determine decryption, tracking, and access. Classification is also determinant for various other processes, including knowledge management, modeling, and structuring.

4 The DNAOS Platform

It is from these realizations, as well as others, that Montreal-based 01 COMMUNICATIONS INC. started its DNAOS platform project at the turn of the millennium, initially putting it online in 2004. The DNAOS platform is a standards-based, platform-independent, optimized performance, highly secure, scalable, distributed, hybrid-cloud, parallel-transformation streaming-pipeline powered platform for rich-content knowledge-resource entitlement, modeling, management, and sharing, in virtual profile, mixed-reality, and collaboration portals and solutions.

Designed to manage knowledge resources, the DNAOS platform manages all data, dynamically transforming "raw" information like system events, signals, alarms, legacy datasets, into corresponding knowledge resources, streaming them with all other knowledge resources through the parallel transformation pipeline engine where they are dynamically analyzed, processed, and transformed as required (see Fig. 4).

For every detected request through SOA, ROA, J2EE and .NET protocols, DNAOS analyses and crosses four (4) main unlimited granularity graphs or logical networks:

REQUEST: requester, type, purpose, sequence, targets, etc.

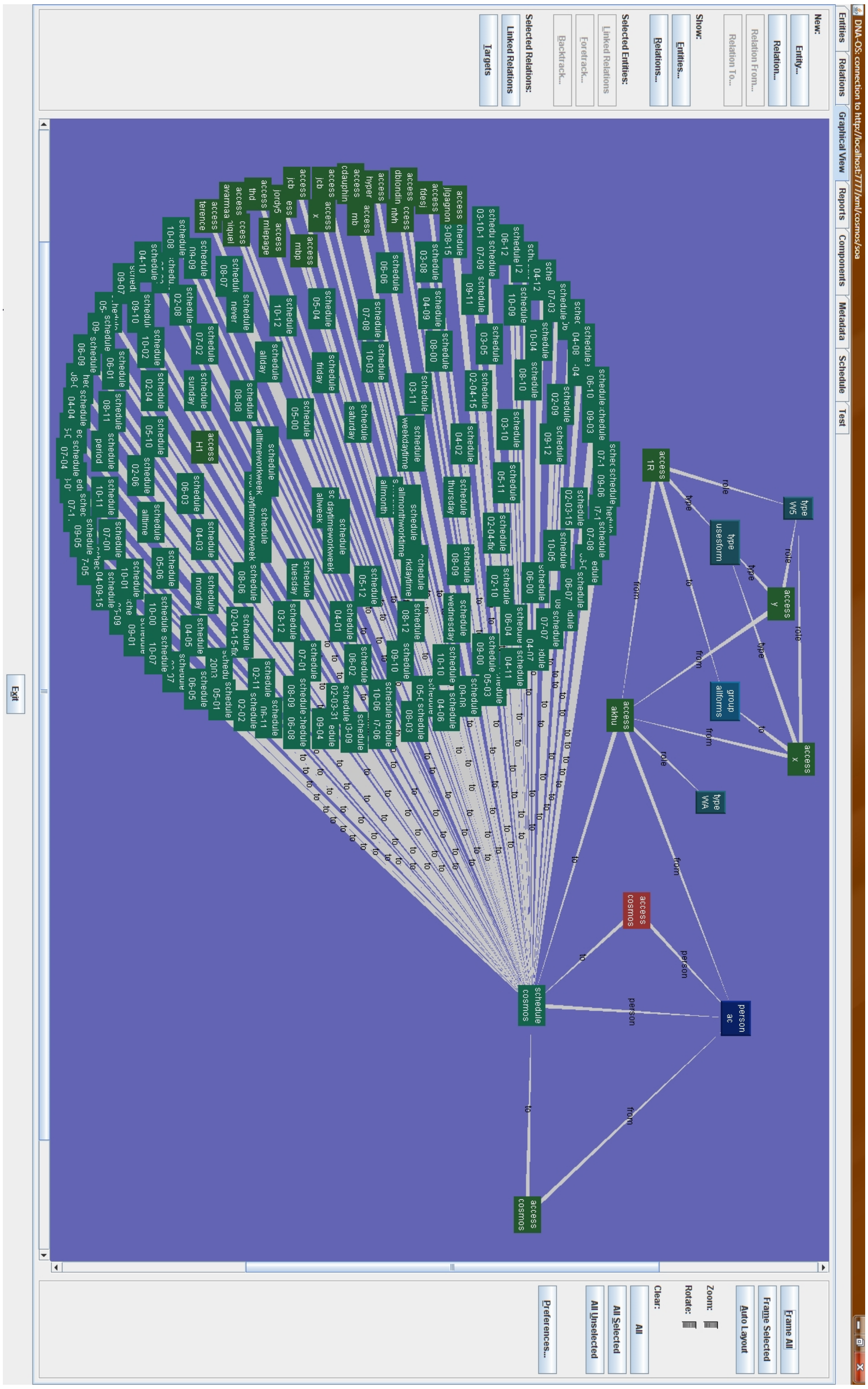

Figure 3: Entitlement modeling in the DNAOS technology.
(Go to http://knowledgearchitect.org/asset/image/project-access.png for a higher-definition image.)

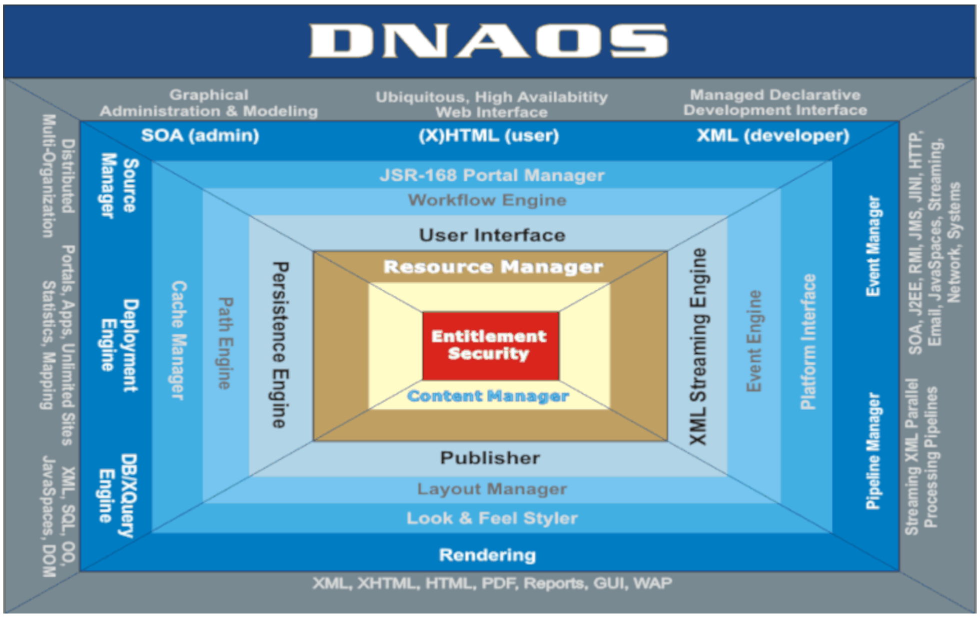

Figure 4: DNAOS architecture overview.

Context: conditions, rules, restrictions on time, location, operation, etc.

Authorization: Direct or indirect, on all target resources, for the given requester(s).

Classification: Dynamically computed classification of each implied resource.

I next briefly discuss the DNAOS technology for KREMMS from the viewpoint of some crucial aspects and refer the reader to the Figures for details.

Transaction – DNAOS determines and effectively returns all and only the properly entitled target resources. All operations are logged in detail and DNAOS uses advanced digital steganography to enable resource instance tracking as required. All data can be encrypted and returned entitled resources are dynamically decrypted on effective access, just as required.

Application – Any application can be built on the DNAOS platform. Since the data is *knowledge data*, all relationships involved, including metadata, are processed and applied as required (see Fig. 5). Applications are data-driven and are dynamically invoked as content streams through the pipelines.

Data – For DNAOS, data is key, as it is knowledge, and this data constitutes the direct instancing of a Master Data Model (MDM), that of those knowledge resources. The MDM is the effective operational model even when only subsets of some knowledge resources are used. This MDM also defines the ontology referenced. Persistence is decoupled and each resource or sub-resource can be associated with different systems or repositories, each with its own location, access, rules, conditions, credentials, etc.

Modeling – Modeling knowledge resources is also key, as it eases complexity management. There is much to say about knowledge resource modeling and it is notable that not only does DNAOS support the creation of resources through modeling, it also reverse-models existing resources into models for further management (see Fig.s 5, 6).

Interface – In addition to its built-in system interfaces and protocols, connecting it to anything, DNAOS supports various human interface types, including smart forms for common web and application interface, as well as SOA connected rich client applications for resource modeling, environment administration, and advanced queries.

5 Conclusion

Developing and operating DNAOS technology for a few decades, and realizing the potential of generalizing KREMMS (Knowledge Resource Modeling, Management, and Sharing), so that everyone can benefit from effective knowledge resource data processing, and everyone can share and collaborate, enabling an effective knowledge economy, the company believes to have defined KREMMS standards proposals ([4]) for the great standardization organizations, among which ISO stands high on the list ([5]-[9]).

I hope the above introduction to the DNAOS technology for KREMMS will convince readers that it can be used to entitle, model, manage, and share knowledge resources, while providing secure collaboration and content for its users.

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Conflicts of Interest

The author is knowledge architect of 01 COMMUNICATIONS INC., a Montreal-based company.

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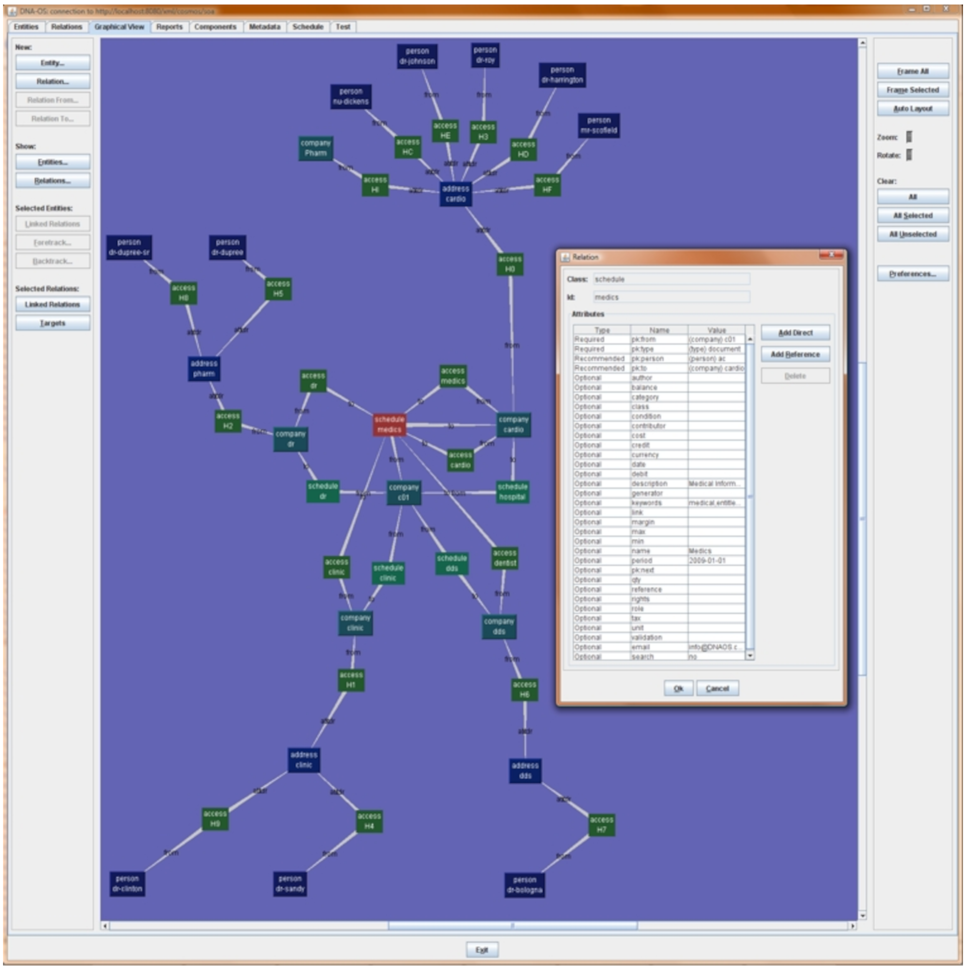

Figure 5: Managing relationships in the DNAOS technology.
(For a higher-definition image, go to:
http://knowledgearchitect.org/asset/image/medimodrunner.png)

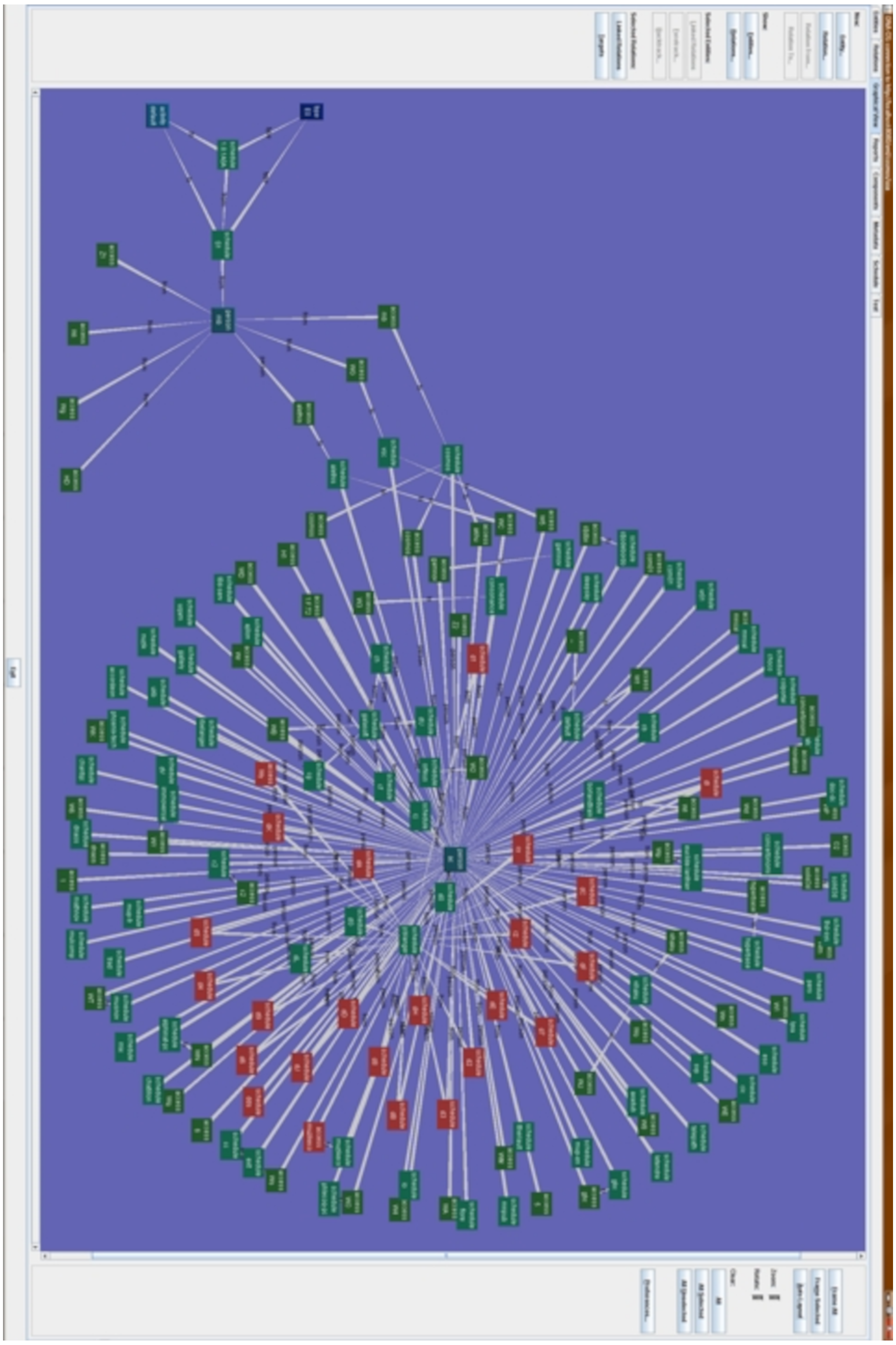

Figure 6: Managing knowledge resources in DNAOS.
(Go to http://knowledgearchitect.org/asset/image/maneng.png for a higher-definition image.)

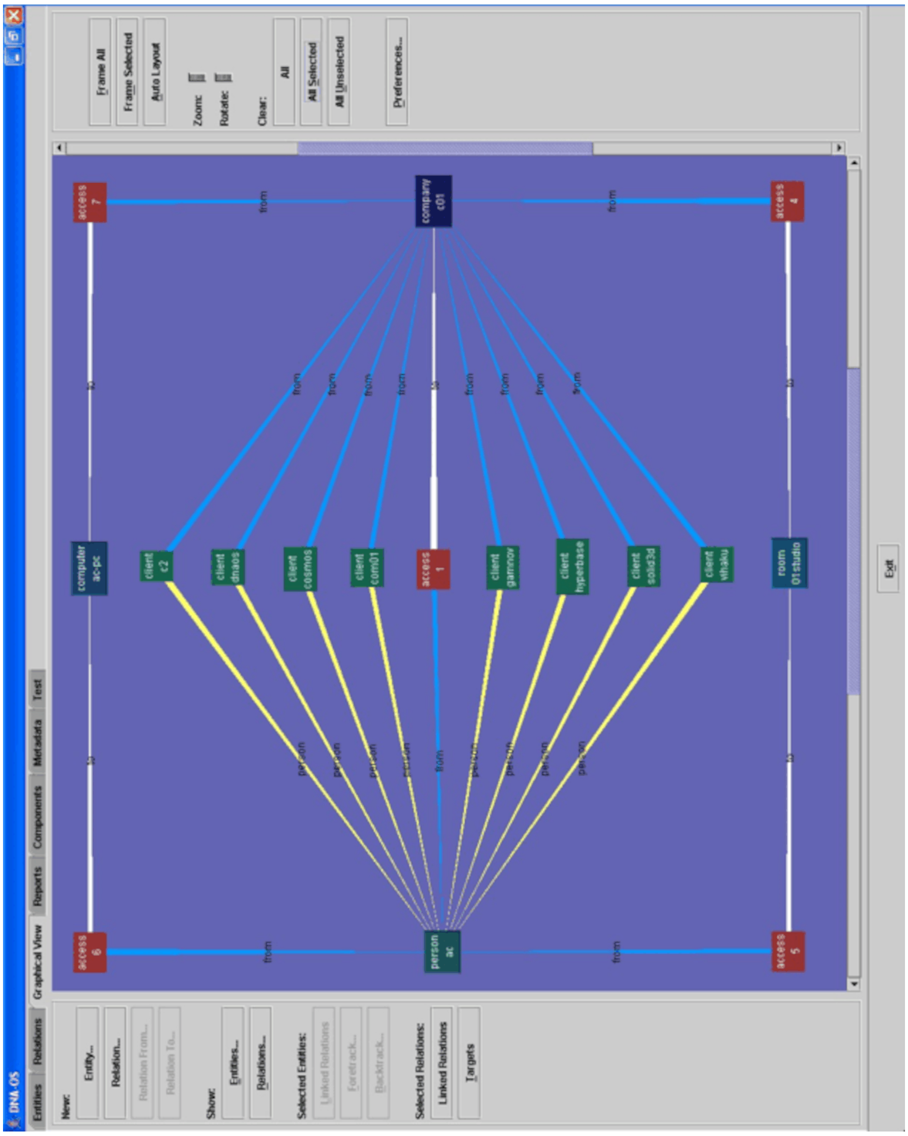

Figure 7: Access control management in the DNAOS technology.
(Go to http://knowledgearchitect.org/asset/image/access.png for a higher-definition image.)

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Online Resources

[1] htpp://www.01communications.com

[2] http://dnaos.com

[3] http://stratml.hyperbase.com/stratml.html

[4] http://entitlementstandards.org

[5] https://www.iso.org/home.html

[6] https://www.oasis-open.org/

[7] https://www.omg.org/

[8] https://www.opengroup.org/

[9] https://www.w3.org/

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