Meaningful access: policy, management and orchestration

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Abstract: Access management for learning communities requires a unified theory, sustaining the implementation of instructional policies, for 'social networks'. The management method we have reached is based on the integration of content-rich resources in 'operations' that model/control the access of those seeking to learn something by using them, with or without assistance. Activities may be sequenced emergently or planned, using scenarios (or 'functions' – a biological metaphor). The proposed formula offers multiple facilitations: guiding, sequencing, coordination, matching, tracing etc. The gradual concretisation of operational elements (human and machine interprets/executors) can rely on technical, semantic and administrative indexing and on the 'metafunctions' mechanism.

Keywords: meaningful access; policy management; interfaced operations; orchestrating functions; procedural aggregation; coordination tools; component concretisation rules; evolving scenarios; explanatory cooperation; software engineering.

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Bibliographical notes: Ioan Rosca is an interdisciplinary researcher (mathematics, electronics and telecommunications, computer and information science, politics and sociology, communication and education) and a socio-technical systems engineer. He has dedicated his PhD study to the explanation phenomenon. Later, he has investigated the problem of equipping remote and distributed instruction, participating in the projects of LICEF (a research institute of the Montreal Teleuniversity). The related work is exposed in some papers, signalled in the bibliography. As conceptual architect of the TELOS system (in the LORNET project), he has intensely used the exploratory research, based on developing illustrative prototypes.

Val Rosca is the young developer of these prototypes, participating continuously in the refinement of the behavioural specifications. He designed a sophisticated 'function' manager – for the orchestration of cooperative

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activities. His multidisciplinary studies (economy-management, computer science) have led him to the multidimensional problem of access policy and management, for services distributed on computer networks. Participating in the design of the Amazon 'community tags' system, he has also encountered the 'augmented social networks' problem.

1 Introducing the issue of 'meaningful access'

In his online blog, a pioneer of online resource sharing (Downes, 2007) goes from frustration to scepticism: "*The Semantic Web will never work because it depends on businesses working together, on them cooperating*". In today's world, it is often more important to block access to information than to facilitate it. Walls pierced by the doors of technical inter-operability are … administratively bricked up, especially if no secure locks can be found. The gates opened for external access must at least be under some form of control (Sessions, 2003).

There are cases, however, where information accessibility (and even promotion) is encouraged, as a social–intellectual necessity, relying on easily reproducible goods: spreading material-spiritual well-being, social equity, personal emancipation, civic watch. Special motivations and situations can be invoked to restrain access to information, for personal (private) or governmental (classified) interests: defending intimacy and honour, copyright, property rights, personal and social risks.

The principles forming the vision of the LORNET project (Paquette et al., 2006) relied on the aspiration for sharing and cooperation. The attitude of the community members interconnected by TELOS will depend on the strategy (policy) of stimulating cooperation (incentives). Studies (like Greer et al., 2001) show natural limits to stimulating fraternity. The coexistence, within the same informational network, of situations, when accessibility is favoured over protection and vice-versa, calls for a means to adapt the access level and thus for a coherent access management system, allowing the rights negotiation, conforming to an evolving policy.

Our position regarding Downes's alarm call covers two complementary aspects. On the one hand, along the line of currents such as 'social/distributed/situated cognition' (see an example in Payne et al., 2001) or 'community computing', we are interested in the consolidation of the 'collective brain', with the help of computer-networked synapses. We envision a future in which participants ask the global system to be connected with optimal support resources (objects, services or persons) for solving a given problem. We imagine new forms of knowledge propagation in this milieu (through 'semantic waves'), along with new approaches to collective projects (through emergent formation of distributed teams).

On the other hand, we are aware of the risks engendered by major modifications of our collective intellectual physiology. Social systems, equipped with revolutionary technical instruments, form new socio-technical systems that could also evolve in harmful directions, for society or individuals (also see Rosca, 2006a).

Therefore, to defend individual or group interests (privacy, autonomy, etc.), members of large communities need appropriate 'synapses', with adjustable and observable accessibility. It is, we believe, a necessity, for initiatives such as the Augmented Social Network (ASN) (Jordan et al., 2003)

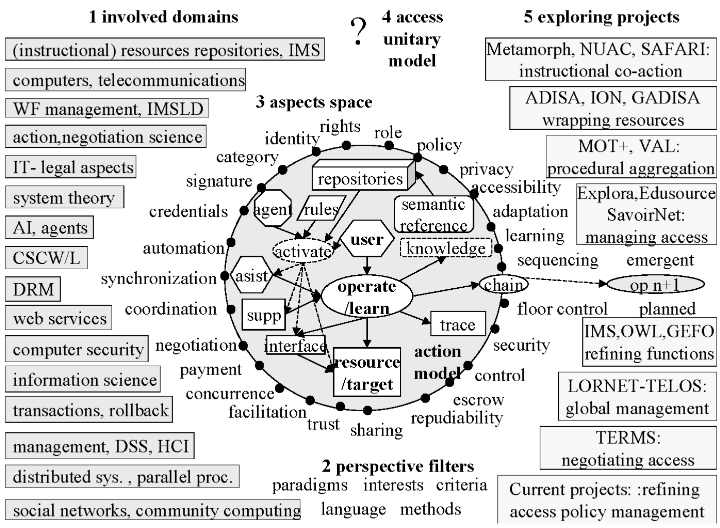
> "that would build identity and trust into the architecture of the internet, in the public interest, in order to facilitate introductions between people who share affinities or complimentary capabilities across social networks."

Hence, the interest for a 'policy aware infrastructure' as in Weitzner et al., (2004) that proposes "a rule-based policy management system that can be deployed in the open and distributed milieu of the World Wide Web". A gateway layer – with explicit, adaptable and negotiable penetrability, should therefore be available at several levels (entering a system, accessing a resource, calling a service, etc.).

A variety of efforts from different fields have been made in this direction (see examples in Bauer, 2003; Kaviani et al., 2007; Weiss, 2004; Anwar and Greer, 2006; Desmarais et al., 2007) leading to multiple attempted standards for expressing policy in information systems. Here is a short list (see a synthesis in Anderson, 2006): *ITU-T X.812 Recommendation (1995): Access control framework; ISO MPEG 21 Rights Expression Language, Rights Data Dictionary (2004); ANSI/INCITS 359: Information Technology -- Role-Based Access Control (RBAC) 2004 (see* Sandhu, et al., 2000); *IETF RFC2748: The Common Open Policy Service (COPS) Protocol; ETF RFC3460: Policy Core Information Model (PCIM) and IETF RFC4011: Policy-Based Management (MIB*)*; W3C Web Services Architecture; W3C Web Services Policy 1.5 – Framework; OASIS Extensible Access Control Markup Language (XACML); OASIS WSPL* (Anderson, 2004); *W3C Open Digital Rights Language (ODRL)*;etc. Beyond differences between norms, the problem of managing a 'resource repository' is usually solved by attaching a set of administrative rules onto a resource – or an entire group of resources.

As signalled in the left side of Figure 1, the problem of access modelling and management is tackled by many domains, having their own perspective filters and concentrating on various elements of the involved aspect space.

Figure 1 Modelling the meaningful access – quest for refining a management formula



One sometimes refers to rights and obligations (administrative nuance/flavour /dimension), privacy and transparency (civic nuance), chaining and synchronisation (coordinative nuance), supervision and security (control nuance), facilitation and assistance (support nuance), decision and negotiation (managerial nuance), etc. Considerations from different communication levels (society, software, hardware) are intricate, the apparition of 'computer agents' further blurring the boundaries.

Domains interested in facilitating complex cooperative human activities, (workflow management, CSCW, DSS, HCI, etc.) have confronted the problem of managing concurrent (shared) access to resources, required for task fulfilment, by establishing their own models, norms, methods and instruments for the coordination (synchronisation) of processes driven by multiple human wills (see examples in Isenhour et al., 2001; Dommel and Garcia-Luna-Aceves, 1997; Liu et al., 2005; Raghunathan, 1996).

On the other hand, the intervention of mechanical entities that observe, control and execute (computers, machine agents) has triggered research on their access to resources (objects, services) – as manipulation handlers. Orchestrating machine access (flowchart sequencing, parallel thread synchronisation, remote connection, service choreography, transaction management, etc.) is intensively studied in computer science.

The practical solutions arising from so many directions are very diverse; each system has to harmonise its access policy (rules) editors with its rules interpreters/executors. Furthermore, inter-system administrative interoperability requires efforts for coupling or adopting shared norms. This also leads to the organisation of an intervention (mediation) layer (space) that can be found in the context: of a shared target (resource, service, repository), of the beneficiary (caller), or on a separate tier, dedicated to the orchestration of concurrent access. An adaptable (programmable) interface (gateway) can intervene in: identification, verification or evaluation, personalisation, adaptation, protection, control, supervision, tracing (and reputability), retrieval, matching, assistance, facilitation, automation, translation, chaining within a task, transaction (rollback), integration, sharing and co-piloting, concurrency solving (semaphore, floor control), group (team, community) coordination, access negotiation, payment, etc.

In distributed instructional systems, we encounter aspects related to accessing (pedagogical) resource repositories, instruction process choreography (learnflow), administration of various activities, adoption of interoperation norms. These problems can be studied within the framework of domains mentioned earlier and the instruments they elaborate can be valorised, with appropriate adaptations. However, our focus was on the issue of *access specific to systems dedicated to knowledge propagation* (instruction). Therefore, we have scrutinised the pedagogical use of resource repositories along with the use of repositories of pedagogical resources, the pedagogical management of workflows along with the management of pedagogical workflows.

In our model, we have sought to coagulate the administrative aspects (like rights and obligations) and the coordinative aspects (like intervention roles) around the instructional goal: *the use of a target resource by someone who wishes to act meaningfully, operating directly or calling a service by an interface, understanding something and possibly producing traces, with the possible help of support objects and human assistants*. The 'activation' (retrieving, obtaining, installing, adapting, launching, accessing, etc.) of a resource (placed in a repository space, and indexed semantically) or of some appropriate support elements may be governed by rules, implemented with the aid of an agent, and complying with an access policy. The concatenation of the current operation

(On) to the subsequent one (On + 1) may be done freely (emergently) or conforming to a procedural plan.

2 Quest for refining a management formula

It is difficult to presume that convergence towards a universal 'ontology of access' will easily succeed, considering the multitude of directions from which come the concepts it should collect. Therefore, to introduce the formula we propose for access management, we will resort to a succinct narration of the modality through which we have established it in a series of projects of illustrative-exploratory nature (signalled in the right side of Figure 1). This explanation completes the presentation of our research in Rosca (2006b) – a progressive quest towards a formula calibration (see Section 4).

The complexity of managing socio-technical interactions showed up during the study of pedagogically aimed cooperation ('learning by co-doing') in expert–computer–novice triangles (in the Metamorph, SAFARI and NUAC projects, research exposed in a PhD thesis – Rosca, 1999). In each node of the collaborative-instructive operation chain, we may encounter a fructuous intersection between the interventions of the assisting expert, the beneficiary novice and the supporting computer. The *issue of pedagogically exploiting concurrency* is, therefore, formulated in different terms than when tasks are shared only for practical reasons. The actual interventions during a 'co-action' type instructional session, creatively exploit the access rights established (through negotiation) for each operation. The local interaction protocol can be integrated into a 'collaboration mode', valid along an entire chain that determines the posture of the protagonists: student executing freely or under human supervision, expert demonstrating an execution, formative work in pair, machine demonstrator, etc. To pertinently intervene in the process of instructive cooperation, the computer action must be based on an appropriate model of the collaboration phenomenon, a sort of '*microscopy of management*' (negotiation atomics).

The necessity for bi-controlling applications has led to the model of the 'bi-computer' (conceived for two correlated users) and to the principle of a 'glass window': a transparent layer, through which all the executor's orders are sent to the application, so that it is possible to intercept and communicate actions to the remote partner; his feedback reactions (signalling, blocking, explaining, etc.) may be mixed with the executor's actions. It was the start of the idea to 'wrap' resources with a layer (interface) that can intermediate actions on them.

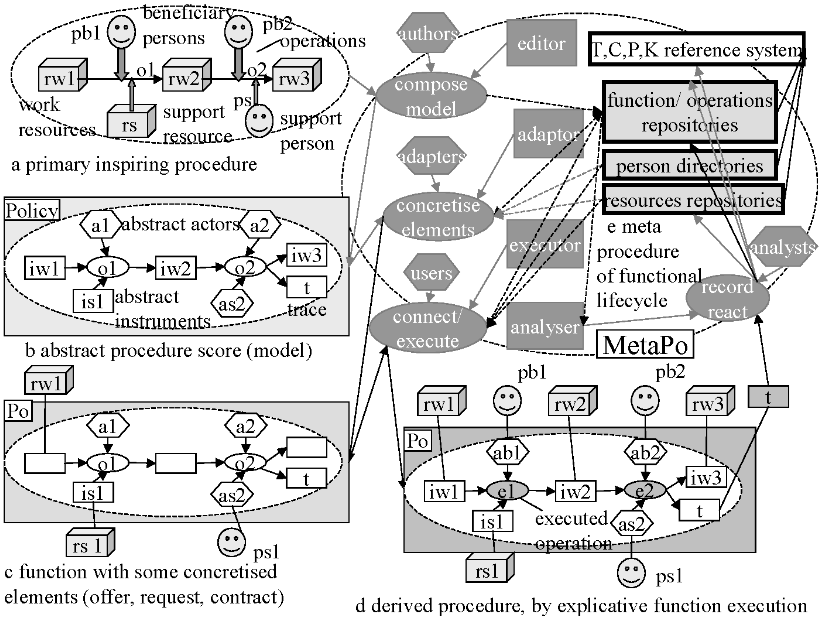
Enriching primary resources (applications, documents) with layers (declarations and executors) facilitating their use (retrieval, usage, aggregation, automation, etc.), we have obtained (in the ION project) 'secondary resources' capable of being manipulated through an intermediary logic, with the help of a 'resource controller'. A 'command batch' formulated in the intermediary language of a secondary resource forms a 'tertiary resource' – enacted as an operational cascade. Observing the graphical editor and executor of those cascades, we realised that they behaved as procedural aggregations of the chained (automated) operations.

Facilitating the composition of a new resource from the existing ones, used as components, is of special interest for the support of pedagogical design, pursued in LICEF projects (ADISA, Explora, etc.). We have tried to overcome the technical difficulties of the composition (interoperability, dependencies, etc.) by using the facilities of secondary resources. The calibration of the ION aggregator through the exercise of decomposing–recomposing the ADISA system (in the GADISA project) has revealed the problems and limits of structural ('fusion type') aggregation (Rosca, 2006a; Rosca and Paquette, 2002). The access policy for the system resulting from an aggregation must be defined, as it depends on (but not automatically result from) the policies attached to the components (governed by the will of their constructor/owner).

All these have driven our attention towards the procedural aggregation. Inspired by the LICEF work on workflow modelling (MOT and MOT + projects), we have attempted to pass from passive (descriptive) procedure model editors to active orchestration managers. We have realised that by interfacing resources with procedural management filters, one prepares their integration for various use contexts. From here came (in the VAL project – see Rosca and Rosca, 2004) the idea of 'function' type aggregation – able to orchestrate a group of resources and persons, by sequencing a series of 'operations'.

To systemically integrate the objects, actors and rules involved in an instructional process, the 'operation' models the procedural topology and physiology. It may become an active tool, an 'orchestration score' for both human and machine interprets/executors. This orientation allows us to approach 'organically' the issue of aggregating composed resources (see Paquette and Rosca, 2002). Instead of structural concatenation, we manage the chaining of operations (processes/contexts) with 'functions'.

Figure 2 Procedure orchestration with evolving functions



Our procedure management method focuses (pragmatically) on the facilities created by the functional model that reflects and accompanies a procedural reality, allowing its reproduction (derivation), more or less accurate, in execution instances:

Description (for understanding and inspiration). The operation (function) is used for explaining a phenomenon or as a guide for the orientation of the actors involved in actions. The model's interpret observes the operation (chain), follows the instructions and the criteria that influence the decisions, reads the support documents connected to some nodes, etc.

Interception and declaration (for memory, control, evaluation, local help, general feedback). The user produces traces, annotates the execution (announcing and commenting his progress) and may answer to certain verification questions. The execution data (traces, annotations, answers) may be observed by some partner or supervisor, steer automatic assistance, or be recorded, for later evaluation or ameliorating feedback.

Facilitation The function eases the resources' retrieval, launch and manipulation, aggregating them dynamically. It can also launch batches of automatic operation.

Coordination. Acting as a synchronisation whiteboard (orchestration score), the function facilitates the coordination of the team formed by human participants and machine agents (via communication, co-action and sharing).

Connection and matching. The function can provide filtering, advising, matching and alerting services, sustaining the selection of the connected resources. These services are possible when the human and material components are indexed, on technical-T, communicational-C, policy-P, and knowledge-K reference systems:

As we can see in Figure 2, to be used in the ways described above, a 'function' must have been prepared during the edition phase. After the definition of a generic model (using abstract 'instruments' for resources, and 'actors' for participants) and the particularisation of 'derivate models' through the concretisation of appropriate elements (found in the person directories or resource repositories), these models can be indexed and published in a function/operation repository, becoming retrievable, as any resource. The users of such 'procedural aggregates' take advantage of the facilities prepared during edition. The transformation cascades of a functional or operational life-cycle, involving the model and the procedural reality that it mirrors and influence (as the one presented in grey-up right side in Figure 2) can be managed with *meta-functions* (Rosca, 2006c).

Functions and the operations that can be broken up into can be seen as a wrapper for intermediating access to procedurally aggregated/encapsulated resources. In the general schema of the Explora2 tele-instruction system (Paquette and Rosca, 2002), the Resource Manager/Controller is empowered with a module for the management (edition and execution) of wrapped operations. We have also considered the possibility of declaring access conditions for person participation, as a definition layer for 'secondary human resources' handled with the Participants Manager. What was left to decide was the way in which concurrency rules were to be defined and handled (the repartition of access rights, negotiated) establishing the equilibrium between the intervention mandates of: operations, participants and resources. Inspired by the collaboration between the Explora2 (Paquette and Rosca, 2002) and iHelp (Vassileva et al., 2003) projects and by other works on using agents to coordinate communities, we have proposed, in the Explora2 specifications, that secondary resources (objects, operations, persons) be backed by 'mediation agents'. The implementation of this solution in Explora2 was, however, delayed, owing to the transition to the SavoirNet context, where the Explore management system became an intermediary, facilitating the inter-operation of connected tele-instruction systems. Services found in various technical and administrative contexts had to be aggregated, using resource description, inter-operation and orchestration norms-insufficiently stabilised. The eduSource project revealed the complications of the access rights issue, created by the wish to federalise pedagogical resource repositories. The solutions proposed by our colleagues (McGreal et al., 2004) were axed on equipping repositories of resources described in LOM, with DRM mandates, implemented by mediation agents (brokers).

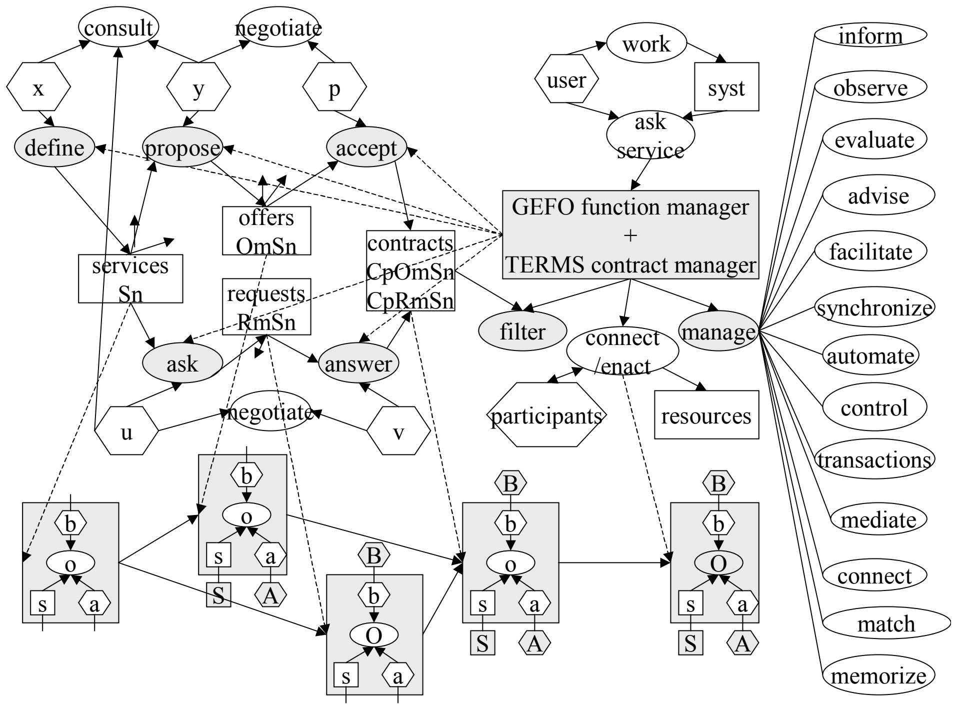
We followed the trends on managing metadata descriptors for resources, chains and services (from LOM and WSDL towards ontologies and semantic web), participating in the reengineering of the MOT+ graphical knowledge editor (to support graphical ontology edition). On this occasion, we resumed the study of content management, observing that explicating knowledge evolution is essential for instructional systems. To retrieve, with a unique query, the documents, persons and operations pertinent as support, a common semantic (knowledge) reference system is appropriate, for indexing resources, participants and operations (Paquette and Rosca, 2004). On the other hand, we have refined the study of planned procedures, observing the adaptation of MOT+ editor so that it can define IMS-LD scenarios (Marino et al., 2004).

Perfecting the mechanisms of meaningful process orchestration (functional model enactment) has led us to an advanced prototype of operation/function management (GEFO, Rosca and Rosca, 2004). With the help of a ‘metafunction’, we can manage the chain of states that leads from the abstract definition of a function to the concretisation of the involved elements, and finally to execution instances. Throughout this process, the operation can work as a synapse, employing semantic matching strategies (resolving ‘competence equations’) or administrative conformance strategies (solving policy mandate equations). This connective facility (see Rosca, 2005) supposes that the elements be indexed semantically (administratively) on the basis of appropriate reference systems (knowledge, rights). The presence of a K layer (knowledge: detained, necessary or acquired) reveals the evolution of competences, enforcing the operation’s instructive aspect. In the same direction goes the introduction of ‘interaction modes’ (that characterise a protagonist’s position in a functional chain: who learns by observing or doing, who teaches by doing and showing, etc.). This longitudinal view allows us to approach the global policy for managing the local access policies, giving to a knowledge community a better control over its informational physiology.

All these efforts have been collected in the LORNET project, which aims to support technical and semantic inter-operation between educational service providers and resource repositories, accessible through the internet. The conceptual architecture of the TELOS middleware (Paquette et al., 2006; Rosca, 2006b, 2006c) combines the emergent aggregation of the objects and processes extracted from the primary and secondary resource repositories with the orchestration of (cooperative) operations, through ‘functions’. When the execution of an operation sequence is accomplished by enacting a functional model, the management of the intervention rights may be tuned, in each operation, according to the access mandates (for processes, actors, instruments), using the data from the current session (resulting from previous operations) and considering the chosen working mode. It remains to establish the way to declare mandates and to use them in the dialogue between the broker-agents – coordinated by the global operational logic, surpassing the difficulty of coordinating man–machine orchestras, combining ideas of human team management (workflow, CSCW, DSS) and technical synchronisation (service choreography, flowchart, concurrent and parallel processing, etc.).

A first attempt, presented at the LORNET’06 congress (Rosca, 2006b), was the combination of GEFO’s capabilities (editing operational topologies, concretising them with elements extracted from repositories, controlling the enactment of operation chains) with the possibilities of managing service contracts explored in the TERMS prototype, developed in another project.

Figure 3 Service definition, negotiation and execution with GEFO+TERMS



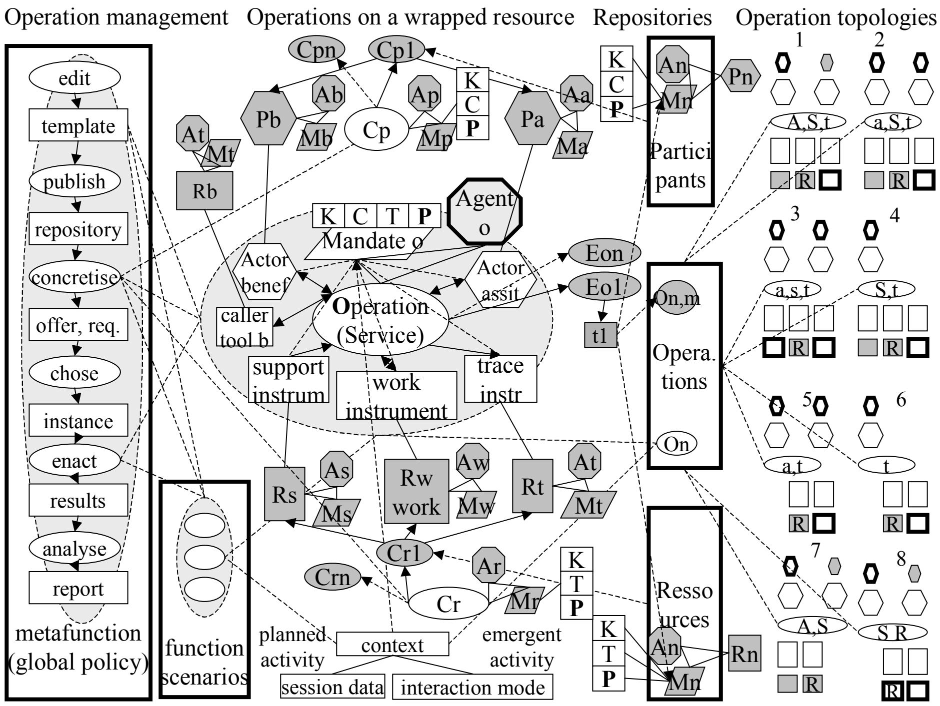
The *Sn* template of a collaborative operation, (with abstract beneficiary *b*, assistant actors *a* and support instruments *s*) is edited with GEFO, and placed in a 'service database'. Using instruments of service particularisation for a local administrative context (institution, community, project), the TERMS editor drives the process of negotiating the *Om* concretisation of support resources *S* and assistant participants *A* – fuelling an 'offer database' (*OmSn*). Starting from it, the final concretisation of the beneficiary *B* can be done, leading to a *CpOmSn* contract. Other advancement tracks in the state machine that leads from an *Sn* service to a *Cp* contract are also possible; for instance – first, the concretisation of the beneficiary *B*, placed in a 'request database' *RmSn*, and then the selection of the assistants (*A* and *S*) lead to the contract *CpRmSn*. A user may ask to participate in a contracted procedure, acting directly or mediated by an intermediary system. The filtering of the appropriate function and the connection of appropriate instance elements is done. Managing contract execution (by the enactment of the actual operation *O*) in the GEFO-TERMS prototype (solving concurrency, rollback, chaining, verification, tracing and other problems) combines the GEFO capabilities of machine control and human expressiveness with the TERMS orientation towards tracking human responsibility in contract fulfilment.

In the actual stage of our research (see examples in Section 4), we reorganise the elements from GEFO and TERMS, in a unique but modularised system that would allow the unitary management of rights, competences and technical conditions.

3 The 'operation': topology, aggregation, aspects, concretisation, management

Figure 4 models the behavioural physiology of access management in mixed (man–machine) distributed systems, a solution attained while pursuing the objectives mentioned in Section 1, following the experiences related in Section 2 and upon which the specifications of the systems we are implementing rely on (Section 4).

Figure 4 A formula for the management of access policies



A distributed system contains 'primary resource' and 'secondary resource' repositories (prepared by adding metadata descriptors *M* – depicted with lozenges, manipulation layers, and possibly representation agents *A* – brokers, depicted with octagons). Among the elements of the indexation (description) of material resources (applications, documents), apart from the 'semantic' area *K* (describing the resource's content) and the technical area *T* (the technical conditions for its operation), an *Mn* access mandate contains, in the *P* area, the administrative rules for access (policies). The *P* mandate definition is based on a dictionary/ontology specific to the access problem space (and to the means used for orchestrating access: semaphores, blackboards, functions, etc.), and can be used by the human participants or by some orchestration agents.

A person *Pn* participating in the community life may also be indexed semantically (K area competences linked to various knowledge), communicationally (C area – communication modes, preferences, language, etc.) and administratively (identity, credentials, authority, membership to categories and groups, personal portfolios, rights and obligations, tasks and roles, etc.). In the case of 'secondary human resources' also, the policy area *P* of an *Mn* mandate (correlated with the intervention of potential orchestrators) may rely on a specific ontology, built progressively by the community, and may be sustained by a specialised broker *An* (octagon in Figure) that accompanies (supports, controls, etc.) the person in his actions (online case) or represents him in his absence (offline case).

The key instrument for the coordination of system activities is the operation *O*, which regulates (orchestrates) the service of using a certain resource, by the community. We will not go into the technical or content issues of coordination (the pursuit of the optimal equilibrium for the K, T and C is exposed in other contexts, as Rosca, 2005), focusing instead on managing the administrative (access policy) aspects (*P* area of Mn mandates).

An operation's template contains, as key abstract elements:

- The working 'instrument' (empty rectangle) – *Iw* (that will be materialised with concrete resources *Rw* – filled rectangle, during the resource concretisation phase *Crn*). It can be indexed semantically, technically or administratively – if restrictions (conditions) imposed to the concretisation process are declared. These policy restrictions can be defined extensively (list of admitted/required resources) through access rules belonging to a specific dictionary or as a 'selective filter' (SQL-like) based on the resources' metadata administrative characterisation fields (in the *P* area).
- The operation *O* (empty oval) (that will be concretised/'enacted' in various execution instances – filled oval *Eon*). The declarations of abstract elements composing the operation (*Iw*, *Ab*, etc.) may be integrated in the operational mandate *Mo*, or treated separately.
- The beneficiary actor (user) *Ab* (empty hexagon – a role that will be concretised by a human participant *Pb*). The semantic indexing K defines the conditions imposed to the potential executor/learner (competences required or gained playing the role). The administrative indexing P may impose extra-semantic restrictions (conditions) to the participants who will concretise the actor. These restrictions can be declared extensively (list of admitted/required persons or categories), through rules belonging to a specific dictionary or as a 'selective filter' (SQL-like) defined based on the persons' metadata characterisation (rights and responsibilities).

Apart from these components, the operation may also involve:

- One (or several) support instrument *Is* (materialised by the support resource *Rs*). It may be a document or a content-less support tool, used in parallel to the main resource.
- One (or several) human assistant *Aa* (materialised by the person *Pa*, during the concretisation Cp-piloted by *K*, *C*, *P* criteria). The cooperation rapport (interaction mode) between the beneficiary executor *b* and his assistant *a*, determines their pedagogical posture.

- Instruments *It* (materialised, in each instance, by an object *Rt*) for recording and managing the execution's results (*t1* – lozenge): traces, annotation, products, etc. These allow us to observe and evaluate (control aspect) the execution process (planned or emergent) and steers potential modifications (reactive aspect).
  The execution data *t1*, fuelling the data set of the instance execution *Eo1*, may also enrich the participant model or the metadata characterisation of the used resource (global feedback). The trace facility may be included in the function manager or be external, if we wish to use an 'epiphyte' assistance tool (Dufresne et al., 2004).
- One (or several) beneficiary tool *Tb* (materialised by a calling system/process *Rb*). This case arises when, instead of a participant acting directly, the operation is stirred by a machine element (application, system, agent) working for a human beneficiary.

An operation can have various topologies, tailored to the necessities (right side of the Figure). We can, by example, have:

- situations when the human support *a* and the material support *s* are already concretised (as *A* and *S*), the only things left to be established during the execution being the actual user and the resulted trace
- the human assistant *a* is established only during the execution phase (with possibilities of optimisation, through matching)
- the concretisation of both support forms *a* and *s* is done during the execution phase
- only a support document S is (already) connected
- only a human assistant *a* is proposed, but not yet concretised
- working without support
- without trace
- the work resource *R* is only abstractly specified, being chosen at execution time, depending on availabilities, etc.

To solve the concurrency between the intervention mandates (with Knowledge, Communication, Technical and Policy areas) of the various entities (*Ma, Mb, Mt, Mw, Ms*, etc.), which concretise actors and instruments, the operation is provided with *a mandate Mo for the coordination of global (parallel) processes, expressed in an appropriate language, comprehended by all involved interpreters.* The experimental versions attempted in our prototypes have confirmed the difficulty of synthesising this hybrid language. Editing such a global mandate (like an orchestra score) must take into account the distribution (topology) of participation, the semiotic and ergonomic requirements related to the interpretation of human participants, the characteristics of machine interpreters, the methods for realising a convergent negotiation.

'Semaphorisation' is the responsibility of the conducting agent of the operation, *Ao*. It will attempt to optimally accommodate the mandates of the passive components, the will of the human participants and the intervention of the representation agents (brokers). The specification of this orchestration mechanism (language, processes, tools) proves to be extremely challenging and remains our main research track.

The operation *On* can be executed in the *context* of an *emergent* activity, with participants choosing freely their procedural-type resources, from the operation repository. Compared with a direct action on the primary resources, the users will dispose now of the orchestrating facilities prepared in the operation's wrapper. They may chain freely a sequence of operations, seeking a given objective. The system could offer post-factum reflection (modelling) possibilities for observing expressive sequencings (demonstrations, expertise eliciting, behavioural studies, etc.), taking advantage of the possibility to intercept actions at the operational interface level. In this case, the orchestration logic conducted by *Ao* will be relatively autonomous (although it can consider the working '*mode*' fixed at the operation catalogue level, or use some resources or data coming from preceding operations – if the resource controller offers the possibility of propagating 'system variables').

When *planned* operations' sequencing is required, the inclusion of operations in 'functions' is recommended. In this context, the activity of any individual operational conductor *Aon* may strongly depend on the function chaining logic (manifested through the elements shared between two operations or trough the propagation of *session data*). The '*interaction mode*', specified for an entire function, can homogenise the way concurrency is resolved, along with an operational cascade.

Therefore, the blended community of people and tools forming 'augmented social networks' may be provided with orchestrators (synapses, semaphores) of operation-type procedural resources, preparing the machine and human interpretation and action, adapting the system to various access management modes, capacities and needs.

The concretisation of the elements (persons, resources) of an orchestrator (operation, function) can become the object of a negotiation, piloted by a meta-semaphore. But, editing (adapting) an operation (function) is also a socio-collaborative process; to facilitate it (allowing authoring – more accessible – instead of programming – too specialised), the administrative facilities may belong to a dictionary (ontology) of specific concepts – negotiated by the community. Citizens will be able to participate in activities, according to the posture they have in a project, based on clear and controllable intervention protocols.

To ensure the public control at the level of the global management policy for the community's collaborative activities, one can process, through the meta-function mechanism, the organisation chain of an orchestrated activity: editing operation (function) templates, publishing them in a repository; concretising beneficiaries (obtaining 'request-functions') or assistants ('offer-functions') or all elements ('contract-functions'); choosing and approaching an execution instance (by one or more persons, in one or more work sessions); enacting operations (while respecting the prepared rules, solving conflicts by the conductor and recording the results); analysing the data resulted from one or more instances and proposing reports (as feedback upon which the process can be resumed). These 'meta-functions' will reflect (sustain) the community's administrative policy, being modified through the same collaboration mechanisms as those they regulate.

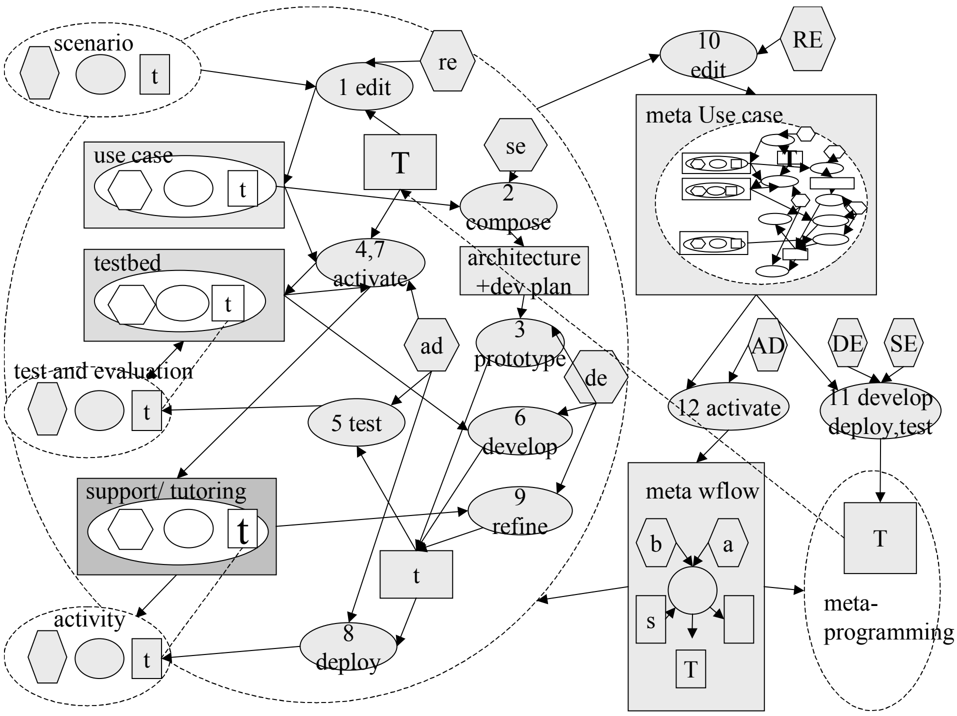
4 In guise of conclusion: new exploratory applications

We are aware that too many un-tackled problems or ambiguous aspects remain to be studied. Being adepts of behavioural exploration applied in concrete projects, we intend to integrate function-based policy management in a few pilot-applications. We will expose, in future papers, the findings of these prototypal implementations and the consequences for the refinement of the above specifications.

4.1 Use cases evolving to support tools (refining global management of local access)

A major orientation in software engineering (generalised in system engineering) is the employment of use cases for eliciting behavioural specifications. The architecture can be defined onto them, and then, the system can be built. The growing attention for the use of ‘scenarios’ in ‘requirements engineering’ (Caroll, 2000) enhances the interest for the rocedural modelling (descriptive aspect) of a software-equipped system’s physiology (treatable as a function model). The necessity to develop instruments for systems in continuous evolution raises the challenge of the evolutionary engineering of instruments, architecture and specifications (Lehmann et al., 2002). New use cases (taking also the access conditions into account) can be created to deal with changes in requirements. Another way is to progressively modify existing ones. Such an evolutionary model will less and less express the ‘scenario’ (showing what instruments ought to be built) and more and more how the developed instruments can be used.

Figure 5 Use cases evolving to support tools



As suggested on the left of Figure 5, a use-case enriched as an active policy-aware ‘function’ can evolve towards a testbed tool and finally as a support tool. A meta-tool *T* (of a function-manager type) may be initially used by a requirements engineer *re* for editing the use case, reflecting the physiologic scenario envisioned for the target object *t* (that may be, among others … an instrument for access management). Observing the use case, a software engineer elaborates the architecture and the development plan, used by the developers *de* to conceive a prototype of the *t* target. A first use-case activation by the *ad* administrator (concretising the function) leads to an orchestrating testbed, allowing the evaluation of the prototype in the testing process. The observations collected by the testbed-function orientates the developing of *t*. Its deployment (into the exploitation context) may use again the function model, adapted (by a second activation) for the use as an instrument for supporting, tutoring or gathering use observations, for ulterior refinements of *t*.

The entire process may be, at its turn (see the Figure's right side), modelled by a requirement engineer *RE*, in a 'meta-use-case', reflecting the intended employment of the 'evolving use cases manager' *T*; a passive model that may orient the process of developing *T*, by software engineers *SE* and developers *DE*. The activation of this meta-use-case will lead to a meta-workflow that may pilot the process of producing *T* or of its application, in constructing *t targets*. Hence, the meta-functions may be valorised to govern the management of the evolving and orchestrating use cases as a sophisticated instrument for the global management of software projects.

4.2 Instructive cooperation in software production (refining the orchestration for explanative co-action)

Managing the global evolution of software projects requires solutions for the inevitable modifications that occur in the design team (the departure and arrival of members, knowledge modification for those remaining, etc.). The use of content-aware and policy-aware 'functions' (see Figure 2) for managing cooperative programming activities (active aspect), including task sharing in novice-expert pairs (instruction aspect), would allow, apart from the coordination of production flows according to given SE policies, protocols and methodologies, to form interns through "learning by doing inside the team". Such a flexible training solution would correspond to the needs of the industry and to the interest of pioneer learning institutions (like CMU, see http://west.cmu.edu/prospective_students/unique_features) that practise software engineering instruction through involvement in pedagogically prepared projects. Control over each actor's intervention could also sustain the formation of distributed programming teams – for projects emerging in large programmer communities.

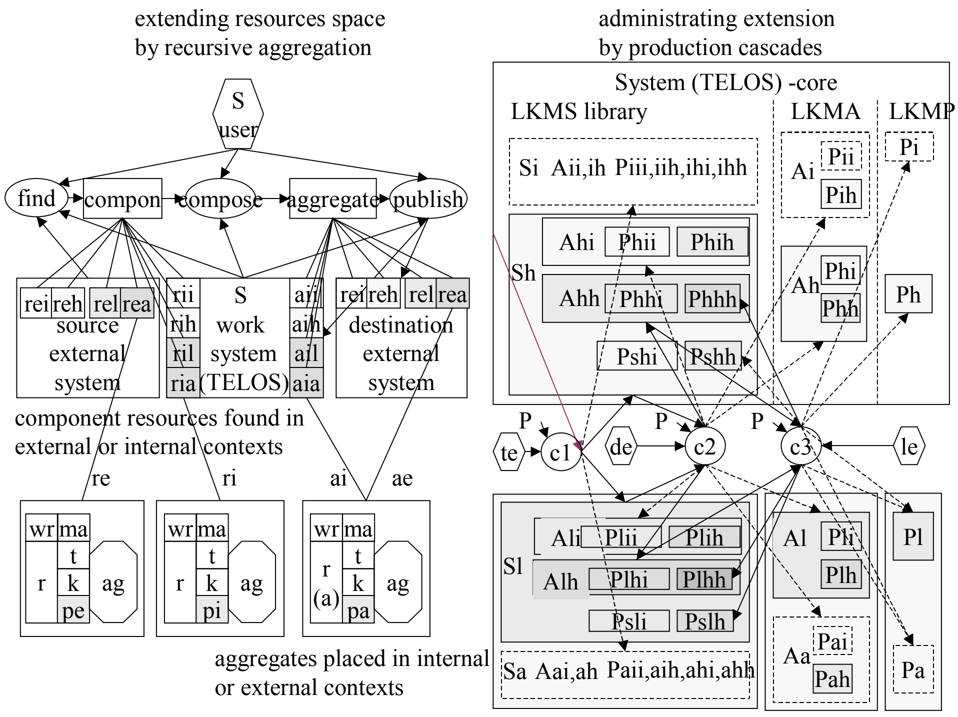
4.3 Managing extension cascades for TELOS-like systems (refining the administration of operation chains)

The extension of the TELOS space through recursive aggregation (see Paquette et al., 2006; Rosca, 2006a, 2006b) even facilitated technically by means to support composition and inter-operability is confronted to administrative problems.

In the left side of Figure 6, we resume the recursive vision on the extension of a system as TELOS (presented in Rosca, 2006b). TELOS allows the users to continuously extend a resource base, supporting them in the research of the necessary components (in the TELOS or an external space), then in their use for various purposes, among which the aggregation of new resources, followed by the publication of the aggregated resources in TELOS or external system repositories. The input resources *r* or the output aggregates *a*, (internal: *ri*, *ai* or external: *re*, *ae)* may work immersed (i – functionally inseparable from the keeping context) hosted (h – kept in-house, but functionally separable) linkable (l – functioning remotely, but in connection with the source context), autonomous (working remotely and independently), etc. To facilitate the manipulation and the aggregation, the primary resources *r* are wrapped in secondary ones, which may imply the intervention of an agent, observing some technical-T, knowledge-K and policy-P mandates. Our central problem is the procedure of the derivation of the aggregate policy *pa*, depending on the policies *pn* of the components, and on their localisation.

The right side of Figure 6 resumes the vision of the extension of a TELOS-like system, by ‘production cascades’, segmented by administrative ‘discontinuity’. Starting from core modules *te* technologists fabricate (phase *c1*) “Learning And Knowledge Management Systems” (LKMS) immersed (*Si*) or hosted (*Sh*) in the core library, or placed in the context of external beneficiaries: autonomous (*Sa*) or linked (*Sl*). Using LKMS, designers *de* can build (*c2* phase) “learning and knowledge management applications” (LKMA) placed in the LKMA library of the core (*Ai*, *Ah*) or of an external system (*Al*, *Aa*) or in the library of the constructor LKMS (*Ahi*, *Ahh*, *etc.*). The use of an LKMA by learners *le* modifies their competences and can produce “Learning and Knowledge Management Products” (LKMP) deployable in various contexts: core and external LKMP libraries (*Pi*, *Ph*, *Pl*, *Pa*), LKMA product libraries (*Pii*, *Pih*, *Phi*,*Phh*, *Pli*, *Plh*, *Pai*, *Pah*), LKMS product libraries (*Pshi*, *Pshh*,*Psli*,*Pslh*), etc.

Figure 6 Managing extension cascades for TELOS-like systems



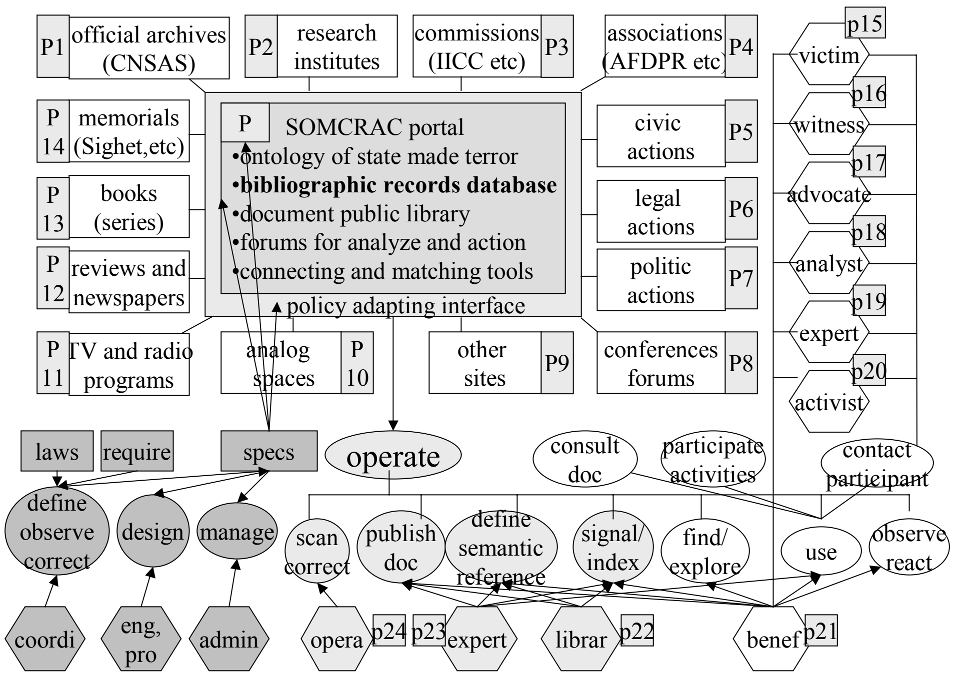
The core-LKMS-LKMA-LKMP cascades raise 'political' questions: to whom do the components and the aggregation instruments used to compose a new system belong? Will an embedded (immersed or hosted) or a remote (linked and autonomous) system depend administratively on some core services? On those of the LKMS or LKMA that built it? Or will it be administratively independent? If TELOS should sustain a "social augmented network", the solution to these macro-organisation problems must be handled explicitly. Global policy management facilities are required, like those of 'system metafunctions'.

4.4 Public management of civic research (refining emergent operation chains)

To exploit distributed resources in a given informational space (p2p, institution repositories, etc.), keeping an optimal compromise between privacy and transparency, by filtering access with policy-aware operations can be decisive.

The SOMCRAC project (see Figure 7) is dedicated to organising the collective memory about the communist regime's crimes in Romania (see explanations in Rosca, 2006d).

Figure 7 Public management of civic research



The portal will contain its own electronic library (developed by scanning and publishing accessible documents) but its main part is *the bibliographic records database*. The source descriptors of these indexed records point to various information spaces (SOMCRAC library, similar sites, printed and internet journals, newspapers and books, TV programmes, archives of official institutions, research centres, investigation commissions, involved associations, etc.) having their own access policies *pn*.

Domain experts and librarians, proceed to the indexation of every record, in various ways (to increase the retrieval possibilities). One of the possible semantic reference systems is an ontology of state terror, seen also as a synthetic form of structuring the domain.

The clients (victims, witness, analysts, activists, researchers, etc.) locate the pertinent records and then use the corresponding (attached, signalled) resources: consulting documents, participating in activities or contacting other participants.

To design the system (defining specifications for the developers and administrators), the project coordinators must consider a complex and labile ensemble of laws and critical requirements. Designing public controllable mechanisms for managing the access policy to bookmarks, documents, testimonies, proofs and pleadings placed in various contexts should help us to surpass the obstacles (raised by the problem complexity, but also by the culprits and their accomplices) and the inertia of a malevolent bureaucracy (paralysed by the giant mass of disorganised information).

The biggest civic, and research challenge, is to establish a global policy *P* for managing the conciliation of local access policies *Pn*.

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