SARA: A tool for service levels – aware contracts

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Abstract—**The evolution of IT management towards a more customer–centric approach has shifted IT managers perspective from the IT department's traditional point of view to the final user perception. We can state that IT department horizon line has been shifted from the business border to the end user frontier. Therefore IT managers are more and more focused on services seen in the end-to-end perspective. In order to support IT managers in designing services that can be guaranteed at the end users, we propose SARA, a tool for mapping contracts over end-to-end service chains. SARA aims to support IT managers for assessing the actual coverage of obligations with respect to the service they must provide to final users. In this way IT managers are allowed to calculate SLAs they can guarantee, given a set of already signed service contracts, and to evaluate the impact of contract variations on the service levels deployed to the final users.**

Keywords- Service levels, Contract management, ITIL, service composition

I. INTRODUCTION

The context. Business Process Outsourcing (BPO) and cloud computing are some examples of the recent acceleration in the evolution of the Internet as the technological vehicle underpinning the expansion of service provision and inter-/intra-enterprise integration in all market sectors. These paradigms push to a new vision of IT management, not limited to technology and more oriented towards final users. If we focus on the delivery of IT services (especially software as a service) to final customers, this requires to describe the service in end-to-end perspective, which means that IT manager should be able to map and monitor the whole IT service chain from the data center to the final user.

Actually, in scenarios like BPO or cloud computing, the IT manager must monitor the service levels as agreed in the signed contract with his service provider. In these scenarios, based on Service Oriented Architecture (SOA), usually the IT manager signs several contracts with service providers on the basis of a proper trade-off between cost and quality of service. Then the IT department owns the task to compose these services to generate new services to the final user.

The service levels of these composed services are (partially) constrained by the obligations included in the underpinning contracts, so that to guarantee a certain service level to the final users, IT managers have to negotiate the appropriate service level to the corresponding service provider. This is the reason why we state that in BPO and in cloud computing the management of service contracts is strictly related to the service levels design and enforcement.

Managing contracts from a service-oriented point of view means to define contract terms and conditions starting both from the service definition and from the service levels definetion. As ITIL's Continual Service Improvement (CSI) ([1], [2]) states, service terms, or provider's obligations and penalties, can be defined after a monitoring phase when real values of SLAs 'KPIs are available and monitoring procedures have been agreed between service providers and service client. Like service level monitoring and management, contract owner must be able to manage all phases of the contract life cycle with the support of service levels information, from the initial definition of terms and conditions, till the conclusion.

Moreover usually in SOAs new services can be generated by composing elementary services, which are guaranteed through respective contracts. Like services are composed, we state that it is necessary to compose corresponding service contracts (and their obligations) in order to be aware of the boundaries and constraints the composed service is subjected to.

We define the contract composition as the process of derivation of a contract, obtained from the composition of other contracts, signed with different providers.

Applying this definition the obligation of an IT manager about the service level guarantee to the final user can be seen as the result of the composition of contracts, and contract specifications. Starting from these low level contracts, and from the related specifications, the final provider's goal is to automatically obtain the terms of the overall contract, through defining some composition rules. A service-based approach of this problem allows deriving the final contract from service composition rules, and contract specifications from the application of these rules on the parameters of each low level contract, and service. It also must be considered the reverse process: starting from the final contract and from its terms and conditions, a provider can be interested in obtaining the specification of each low level contract.

The main issues. In contract composition we notice a lack of tools aided to support who must guarantee service levels. Given a service chain governed by several contracts, our purpose is to answer the following questions:

- Can an IT manager guarantee a certain service level to the final user?

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- Given a number of contracts and related SLAs, what target can be guaranteed to the final users?
- What impact has the variation of a certain contract on the service level guaranteed to the finale user ?
- What service level target has IT manager to negotiate with providers in order to guarantee a predefined service level?
- How service contracts are related to enterprise resources (i.e. human resources, IT resources, etc.) and IT service chains?

We propose SARA, a tool for mapping contracts over end-to-end service chains, in order to support IT managers to assess the actual coverage of obligations with respect to the service he must provide to the final user. Moreover SARA allows to calculate the SLA he can guarantee, given a set of already signed service contracts, and to evaluate the impact of contract variations on the final service level. The tool is based on a visual model, since it is well known that the use of visual models makes easier the perception of knowledge and, in this way, the intuitive understanding, reading and maintenance of complex systems ([3], [4]).

The contribution of this paper is twofold. First we present the tool for representing IT service chains as hierarchical or network diagrams and contracts specifications as polygons over IT chains. Second, a preliminary evaluation of the model is presented, based on user-based tests and the principles defined in [5].

Paper organization. The next sections of this paper offer a discussion of related work, the description of the tool, its validation and conclusions.

II. RELATED WORKS

The topic of modeling and visualizing service contracts is not new in the research literature.

Several works about the formal specification contracts have been published in the literature ([8]-[10]). They aim at defining meta-models for the specification of contracts whose purpose is their enactment or their enforcement. For instance, in [8] Chiu et al. present a meta-model for e-contract templates written in UML, where a template consists of a set of contract clauses of three different types: obligations, permissions and prohibitions. These clauses are later mapped into event-condition-action (ECA) rules for contract enforcement purposes, but the templates do not include any kind of reparation or recovery associated to the clauses, and the way of specifying the different possible relationships between clauses is not clear. In [9] Krishna et al. propose another meta-model of e-contracts based on entity-relationship diagrams that they use to generate workflows supporting e-contract enactment. This meta-model includes clauses, activities, parties and the possibility of specifying exceptional behavior. Another approach can be found in [10], where Rouached et al. propose a contract layered model for modeling and monitoring e-contracts. This model consists of a business entities layer, a business actions layer, and a business rules layer. These three layers specify the parties, the actions and the clauses of the contract respectively, including the conditions under which these clauses are executed.

To the best of our knowledge, we only found a few contributions about visual models for the definition of contracts ([6], [7]). They provide notations that are more suited to the needs of business process developers than the formal approaches.

None of these approaches consider the perspective of tools for service contract composition which show the relationship among contract signed with providers and with clients, the enabling IT infrastructure and the delivered services. Moreover none of these approaches consider the relationship between resources necessary to deploy a service and the contract.

Actually several industrial and open source tools already exist for managing contracts and obligations, which support the traditional contract terms, costs and life cycle management. In addition to these tools, there are CA Business Insight, Digital Fuel and iContract tools, representing the so-called 'Obligation Management Tools', as they deal with customers and providers accountability in IT services contracts. However, research has shown the lack of tools which support the service-oriented Contract Management idea, or which support the relationship of contracts with services and resources. Some authors ([11]) deal with this issue of mapping contracts on IT service chains, but they do not provide tools to support the model. We will start from their work in the development of SARA, with a specific attention to the dynamic resources representation, and to contracts mapping on IT services and technical resources.

III. SARA: A TOOLS FOR SERVICE CONTRACT COMPOSITION

SARA is aimed primarily at business executives with the intent of handling the services described in the respective contracts, and the resources (human, hardware and software) necessary for the provision of those services.

The main objectives of the tool are to represent resources allowing operations on them, and to map contracts on represented resources.

Therefore Sara's stakeholders include:

- The general manager and any technical and business managers, who coordinates and optimizes business activities;
- The department managers the company is organizationally split in, who are in charge to achieve the objectives and who are accountable for the efficiency and results of the work;
- Human resources managers, who are involved in the selection, training and remuneration of employees;
- The service managers, who manage the entire service life cycle until delivery to the final customer;
- The contract managers, responsible for the management of contracts and the definition of terms and conditions that the enterprise is able to meet;

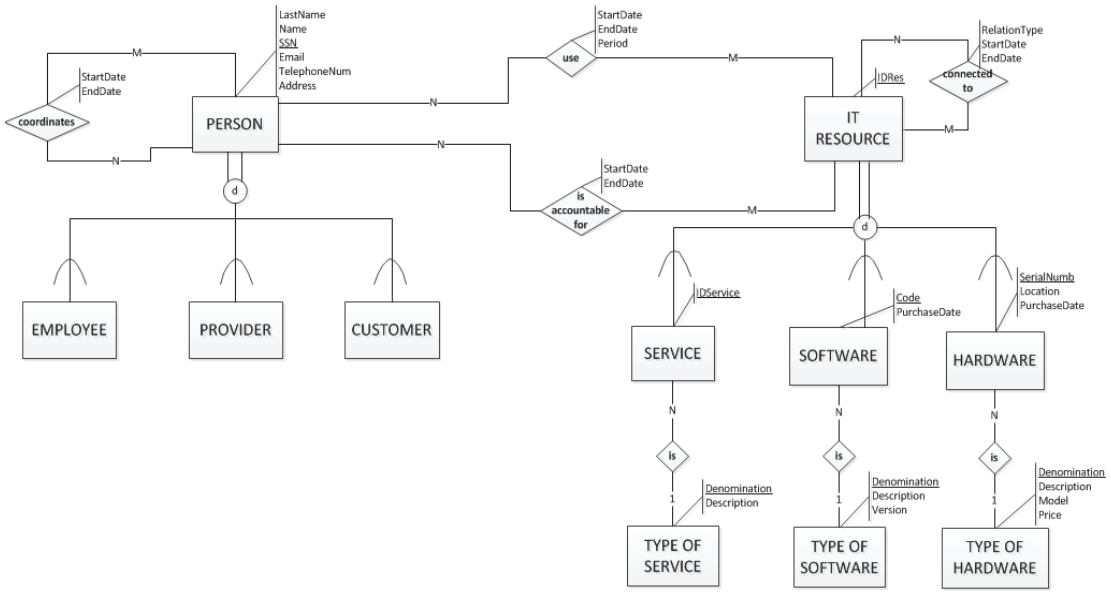

Figure 1: Enterprise Resources Entity-Relationship Diagram

- Administration, which manages the company balance sheet, including receipts and payments, and the fiscal and social security;

SARA aims at managing contracts in the sense that it supports the contract mapping on services and resources and the visualization of SLA and accountability features at the monitoring points [12], which correspond to the check points described in [11]. The tool allows resources and services visual representation together with their relationships with contracts; in particular, through the tool users are able to:

- Automatically generate different types of diagrams (organization charts, network diagrams and services graphs) from data loaded from a database;
- Access through diagram shapes to detailed information stored into CMDB (Configuration Management DataBase) or SMDB (Service Management DataBase);
- Save on database changes, structural or on individual items data, made on diagrams;
- Allow the definition of different levels of detail for complex diagrams;
- Graphically manage contracts mapping on services and resources.

In the first version, aiming to test the approach, the tool has been developed in Visual Basic for Application language on Microsoft Visio.

A. Data models

To design software that allows users to get a graphical representation of company resources, and respective contracts for services provision, one of the most important issues is data sources modeling. Given the scope vastness, and in order to take into account all the aspects, business resources modeling is distinguished from contractual information modeling.

1) Resource modeling

To perform the enterprise resources modeling it's necessary to consider the company point of view, and the managers' need to have available all information related to resources and to relations between them. So the term resources can include both human resources, and systems, organized into services, software and hardware, according to the scheme shown in Figure 1.

In addition to individual resources information, the user needs to know relationships between homogeneous resources, and between resources that belong to different categories; these relations may provide a lot of information, such as employees responsibilities on systems, software or hardware that supports service provision, or company organization chart, and connection of all company hardware devices.

In the light of previous considerations, resources modeling, which is based on Entity-Relationship (ER) models, considers:

- People, divided into Employees, Suppliers and Customers;
- IT resources, which can be Services, Software or Hardware;
- Relationships between people, which allow to derive the corporate hierarchy;
- Relationships between IT resources, homogeneous or heterogeneous;
- Relationships between people and resources, to obtain information about responsibilities and use.

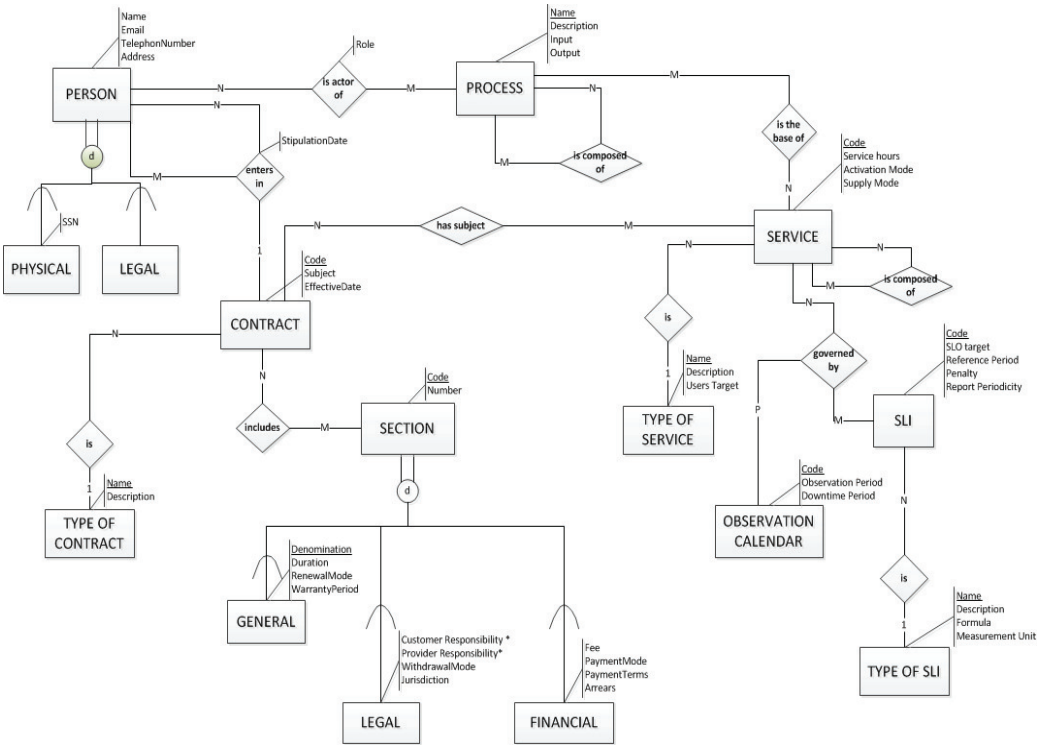

Figure 2: Contracts Entity-Relationship Diagram

2) Contracts Modeling

Contracts domain modeling is the first step towards a graphical representation of contracts coverage on resources and services diagrams. The main concepts to be considered in modeling are the Contract, the Service Level Indicator and the Service: each Contract involves people who enter into it, and includes some general, legal and financial information, which describe its terms and conditions. Contracts related to services provision also include one or more Service Level Indicators (SLIs) that define how to measure service levels, and guaranteed by contract performance. Service is inevitably connected to SLI and Contract concepts: service is contract subject, and it is regulated by some SLIs; each service is described by some general and technical information, and is the result of one or more business processes implementation. A proper ER modeling (Figure 2) for contracts context must include described concepts and express relationships between them.

The main concept is obviously the contract, described by the Type of Contract entity, and characterized through the Section entity, specialized with different entities, to represent general, legal and financial information. The contract is defined as an agreement signed by two subjects, whether physical or legal ones; this justifies the ternary relationship *enters into*, and the Person entity, specialized with Physic and Legal entities. Contact point between information directly related to the contract, and those which concern services, is the *has subject* relationship. Service characterization is made by entering the appropriate description attributes and by distinguishing Service from Type of Service entities, similarly to what explained for contracts. The relationship between services and indicators used to monitor services levels is represented by the ternary *governed by* relation, which links the service to SLI (Service Level Indicator) and Observation Calendar entities: each service is regulated by some indicators, and for each of them an observation calendar can be defined. Each SLI is characterized by attributes such as name, description, metric, measurement formula, measurement unit and the corresponding Service Level Objective (SLO) target, suitably inserted within SLI and Type of SLI entities. The Service, already inserted into resources ER diagram, is connected to Process entity, to track processes that underpin service delivery. Moreover, the *is composed of* relation, recursive on Service, models service composition, and in particular makes explicit the existing relationship between basic and composite services.

IV. VALIDATION SCENARIOS

In order to test the system we have defined two specific scenarios: the service chain management and the contract management.

A. Service Chain Management

Service Level Management can be considered the primary management of IT services, ensuring that agreed services are delivered when and where they are supposed to be delivered. The Service Level Manager is dependent upon all the other areas of Service Delivery providing the necessary support that

ensures the agreed services are provided in a secure, efficient and cost effective manner.

In the depicted scenario a support for ITSM and SLM activities can be a graphical representation of services, with the relevant detailed information, and relationships between them; we chose the representation mode of the graph, described in the following section.

1) Service Graph

A service graph is used to present the service chain. The graph is made up of nodes, representing a service, and each arc represents a relationship between two services. Through service graphs users are able to represent, in addition to services relationships, also services composition, provided that some representation rules have to be defined, for the main types of relations that may exist between services:

- Sequence: services must be provided in sequential order, and the first service output becomes input for the second service;
- Parallel: service output can lead to use only one among different services, or all at once;
- Condition: service provision is restricted to the test for a condition on the previous output;
- Loop: a service is repeatedly provided, for a well-defined number of times.

Figure 3 shows the service graph representing a specific service chain. Sara expose different icons according to the specific represented service: wireless network service has a different icon respect to the wired one and application service is represented by a server icon, while the laptop icon represent the final user.

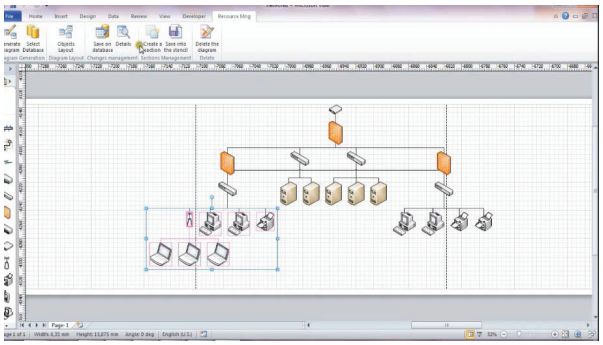

Figure 3: Service Graph with SARA

An IT service is specified by the following aspects:

- General Information: include name, description, service type, and additional information, such as service hours, users target, criticality level and business impact;
- Technical specifications: service components, internal processes and provision support structures, alerting procedures;
- Security: includes personal, sensitive and juridical data, and specifies the owner of data processing;
- Contacts: actors involved in services provision, such as Service Manager, Business Units, Business Processes Manager and reference contacts for incidents escalation;
- Indicators and SLAs: aspects that have to be taken into account for service levels assessment, such as KPI (Key Performance Indicator), indicator type and description, sample frequency, formula, expected service level, obligation calendar, tracking period.

The service properties are visible in a specific window, accessible by clicking on the specific service, as shown in Figure 4.

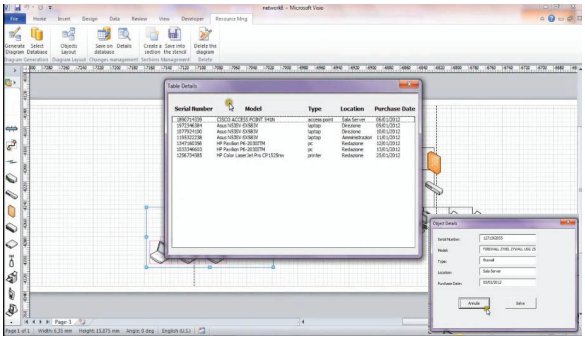

Figure 4: SARA - Service properties

2) Tool Functionalities

The tool is inserted in ITSM and SLM context as a support for IT services management. In particular, services representation by a graph, which is also automatically generated from SMDB (Service Management DataBase), allows the user to have a clear view of services and of relationships between them. In addition, the direct connection graph elements and the information stored in SMDB allows to access services detailed data from their graphical representation. The tool also offers the possibility to make changes on graph or on individual elements details, and to store them into the database.

In services composition context, the tool potentials are significant, ranging from simple graphical representation, to composite service information management, derivable from individual services that compose it.

From a graphical point of view, managing services composition means to associate a cluster with a node of the graph, which represents a composite service, its characterization in terms of services components and relations between them as shown in Figure 5. The cluster is saved as a new shape, presented as a small window full of icons in the palette and it can be reused.

So the user owns a dual representation, based on different granularity levels, which can be used according to the graph contexts. Then the tool should be able to provide the user with the ability to create composite services and to define the related characterization. On the other hand, composite service details are closely related to, and in some cases can be derived from those of services that constitute it. Therefore the tool can be used to derive information about composed services, as well as to manage the graphical composition representation, once

composition rules derive information from components service. In addition, the tool offers the possibility of adopting an inverse approach, which starts from composed services data and from some components information, and extracts the missing ones.

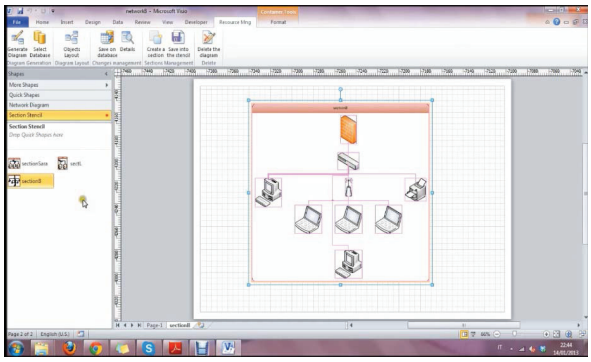

Figure 5: Service Composition in a cluster

B. *Contract Management*

The previous scenario is part of the most complex one related to contract management, in which managers need to know contracts coverage on services and resources in order to relate contracts terms and conditions to service levels and hardware performance. The tool is proposed as a solution for contracts coverage representation, and for the management of contract composition.

1) *Scenario Description*

Contract is defined as "an agreement between two or more parties to establish, regulate or terminate a legal relationship between them". Contract unavoidable requirements are: the agreement between parties, the cause, the subject, and the contract structure, if required by law. The considered scenario restricts the scope to contracts which have as their subject one or more IT services; for these contracts another fundamental element is the SLA, in which services levels specifications are inserted.

Contract handling throughout its life cycle is the goal of Contract Management, the process by which the enterprise ensures the product/service delivery, within standards defined by contract between parties. Contract management includes negotiating the terms and conditions in contracts and ensuring compliance with them, as well as documenting and agreeing on any changes or amendments that may arise during its implementation or execution. It can be summarized as the process of systematically and efficiently managing contract creation, execution, and analysis for the purpose of maximizing financial and operational performance and minimizing risk. So the main contract management objective is not only to ensure the service delivery according to what set by contract conditions and standards, but also to enable the company to achieve the best value for money, defined as the best result obtainable in terms of economy, efficiency and effectiveness, by balancing contract costs, benefits and risks.

The definition and management of IT services contracts cannot disregard services and hardware used for their provision, and is inevitably affected by problems the described above, related to services management, composition and hardware resources. Therefore the main issue addressed in this context is the definition and representation of contracts relationships with services and hardware.

2) *Tool functionalities*

To represent contract coverage on services and resources means to identify and indicate elements that are directly related to the contract, starting from a network diagram or a services graph. Potentialities of this representation are numerous, and in particular it allows to:

- Obtain contractual terms and conditions to be imposed based on related service levels information;
- Check effects on contract of any service levels changes;
- Link contract conditions with performance of the hardware involved in services provision;
- Test the possible insertion, relocation, or elimination of one or more devices by assessing their effects on contract conditions.

Unlike the other scenario, for which it has been possible to identify a representation mode considered de facto standard, a univocal representation of contracts coverage on resources and services doesn't exist. The chosen representation procedure consists of assigning a color to each contract and indicating its coverage by painting the appropriate diagram sections. So the user, starting from a network diagram or a services graph, can select the contract of which he is intended to represent the coverage, and hence the related color. Subsequently, through the selection of a portion or of all diagram elements directly related to the contract, the selected area will be highlighted with the chosen color.

The chosen graphical representation procedure lends itself to indicate contracts composition, or the presence of any diagram elements or sections covered by more contracts. These situations may indeed be represented through the overlap or the intersection of colored areas corresponding to different contracts. Figure 6 shows how contracts are overlapped on service graph. Each rectangle defines a contract boundary with its own SLAs and accountability features.

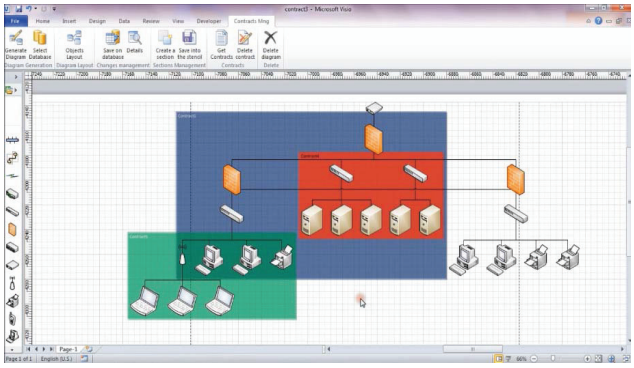

Figure 6: Contract visualization over a network graph

C. Model evaluation

In this section we present a qualitative evaluation of the visual tool described above. We discuss how the tool fits some of the most important principles for designing effective visual notations defined [5]. First, the principle of semiotic clarity is accomplished by the tool, as there is only one graphical structure corresponding to each semantic concept and vice versa. Second, the principle of perceptual discriminability is taken into account to differentiate between refinements, having each kind of refinement a clearly distinct shape and using the text with the name of the refinement to complement the graphics (principle of dual coding). We also have that the number of different graphical symbols in the model is under the upper limit of six categories for graphics complexity, so the principle of graphic economy is accomplished. Finally, the principle of complexity management is covered by the cluster functionality in the tool. As we have seen in the previous section, modules are combined by having the same box appearing in several diagrams (principle of cognitive integration).

V. Conclusions and future works

The paper describes a visualization tool of service level aware contract composition, we named SARA. The tool is based on a model described in [11], which has already tested in an industrial pilot project.

Using SARA, check points model previously designed by hand in Visio are now supported with primitives and macros. Graphical visualization of service and contract composition is also derived by data stored in databases or CMDB. Thus the management of contracts and composition is simplified and made more effective.

The tool aims at helping managers to tame the complexity of IT scenarios and to understand the relationships between IT service architecture, contracting and (reachable) SLAs target objectives.

The link between the systems for managing resources and contracts terms and conditions improves service levels and helps in shaping clearer contracts.

Next steps include porting the tool on the Web, adding models and features also to manage contract's administrative aspects.

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