Decision and Visualization for Negotiation

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Abstract

We present a new strategic model for solving large scale negotiation problems involving numerous actors and issues. It merges previous multi-issues and actors methods based on power relationship between stakeholders and their ability to bargain in order to increase their utility. We apply new Visualization techniques to analyse its outputs: Dissatisfaction analsys, Proximity map, Passive Influences and Power repartition on issues. We simultaneously describe the implemented system on an assessment in the Wireless Internet Service Provider scenario.

1 Introduction

It is widely recognized that decision makers who intend to make sound decisions must base themselves on a thorough and comprehensive understanding of the current situation and its future perspectives. This task is becoming more and more difficult, as society is being characterized by a greater than ever complexity, uncertainty and fast pace of development. As a result, tools and decision support systems are increasingly required to give support to negotiators, especially when they cope with the study of complex social systems. Multi-issues and actors methods help analyzing large scale and long term negotiations between stakeholders on some issues. They root into two fundamental inputs: actors and issues.

- an *actor* is an entity which has objectives in the current situation and takes part in its outcome, either by influencing the issues directly, or influencing the other actors.
- an *issue* is something that is open to debate, or has been agreed upon.

The hypothesis that rules actor models is that actors have opinions about the different issues that characterize a studied problems, and they will use their power in order to influence the outcome towards their will. Their means include pressure, direct power, bargaining and lobbying. Actor models help negotiators identify advantages and opportunities. They can also predict a particular environment's evolution or the actor's behaviors and strategic alliances.

The goal of this paper is to present a complete tool for strategic decision making in negotiations with MASAM, a new multi-issue actor model, and OMEN, the corresponding visualization module. We are first going to discuss how MASAM works and compare it to previous similar methods. Before presenting OMEN, we will make a brief state of the art of visualization applied to strategic decision making problems (section 3) and continue with a short explanation of the illustrative scenario (WISP assessment in section 4) and its actors and issues. This will provide concrete examples for the in-depth description of OMEN, the visualization module, in section 5, before concluding.

2 MASAM: a model for negotiation

Numerous multi-issue actor models have already been developed, either based on intuitive evaluation of the situation ([1], [5]) or more complicated, using mathematical or economical concepts, like game theory ([2]). While the more simplistic methods have the advantage of being more straightforward, they fail to use at best the hard collected data that is needed to run them.

We designed a proposition which integrates all the possibilities of two models, the MACTOR method [5] and a model developed by Allas [1]. Our proposal called MASAM (Multi-issue Actor Strategic Analysis Model) also goes farther as far as data transformation and output options are concerned. This section firsts present the required inputs (section 2.1), then briefly explains the way it computes the data and gives a theoretical interpretation of its outputs (section 2.2).

2.1 MASAM's Inputs

Apart from the two standard inputs, a list of actors and issues (Godet have developed formal methodologies to find pertinent issues [5]), the model needs four input matrices that should be collected through expertise. The matrices' cells represent a link between two actors, or between an actor and an issue. The hypothesis is that actors have opinions on issues, and grand a particular importance to its outcome. They can use their power to influence the issues' outcomes or to influence actors directly by different means.

The *position matrix* represents the opinions of actors on all issues, expressed in a linear continuum. For instance, the price of an item might range from 30$ to 90$. The model then uses a linear standardization process so that all the values within the matrix range from 0 to 100.

The *salience matrix* shows the importance that actors attribute to issues, ranging from 0 (the actor is not concerned by the issue's outcome) to 100 (the issue is primordial for the actor). The numeric value corresponds to the utility that the stakeholder gains if the outcome gets closer to its position.

The *clout matrix* represents the power that actors can exert on each issue. The issues are supposed to be controlled by the studied actors, each of them detaining a part of the issue's outcome in its hands. The total clout of 100% (for each issue) is divided among the actors so that the repartition shows at best the power distribution.

The *influence matrix* represents the different relationships of power between actors. Since actors can use their power not only by controlling issues directly, but also by influencing other actors through lobbying or other pressures, this actor $\times$ actor matrix specifies for each actor, who has control on it. Influence matrix works like the clout matrix: actors are 100% controlled. Some of this control is actually exerted directly by the actor himself. This part of auto-determination lies in the diagonal part of the matrix. The rest of the non self-controlled influence is exerted by other actors, and divided among them according to the power repartition.

2.2 The model's processes and outputs

The model proposes four analyses that generate their particular output, but it also has the advantage of being compatible with the two models which inspired its creation (Godet and Allas). This adaptability allows anyone to use all of these models' tools, in addition to the ones MASAM proposes. The four analyses provided by the new model deals with indirect influences, issue outcome and dissatisfaction, actor power repartition and strategic alliances.

The *influence analysis* enlarges the concept of indirect influence, which was also proposed in the MACTOR method, but in a different way. The hypothesis is that actors can exert their part of control on other actors, not only to take advantage of their clout, but also of their influences on third actors. The so-called bridge actor loses some of its influence to the profit of the actors that control it. The user can specify up to which point this theory makes sense: how many bridge actors can there be? The answer is of course contingent to the situation. In a negotiation, the parameters that will set the depth of the influence matrix will be the time left and the accessibility of the parties. If there are still many negotiation sessions, the actors will have the opportunity to use a wider spread of influence than if there is less time. Although the model allows to get to a nth order influence matrix, actors will probably not have the time and forces to use the influence through more than two or three bridge stakeholders. By including the concept, the influence give a better representation of reality and can be used in order to know better the most dominant or dominated actors, in a relationship point of view.

The *issue analysis* actually shows two concepts: the expected outcome and the actors' satisfaction. By taking account of the actor's power, be it through influence or clout, the model evaluates the situation's outcome for each issue, supposing that all stakeholders will use their means so that the issues end as near as possible from their position. This result is the base on which negotiators can start: it is the probable outcome if no actors bargain or negotiate, but instead only use their power to accomplish their wishes. The second part of the issue analysis actually opens the discussion about this outcome's stability. Indeed, many of the actors may be dissatisfied with the outcome, especially if the most salient actors are not the ones that hold the power. A dissatisfaction coefficient is calculated for each actor, depending on their position and their salience. The farther their opinion from the outcome and the most salient they are about the issue, the more dissatisfied they will be. Actors that are dissatisfied in the same way, which means which want to change the issue's result in the same direction, are likely to destabilize the situation and to bargain in order to obtain satisfaction. For each issue, an aggregated dissatisfaction coefficient shows how controversial it is. A first step for negotiators would be to locate dissatisfied actors on issues on which they don't have control: their needs and wishes can be evaluated and used to gain utilities on other salient issues. As well, a satisfied actor on a controversial issue has to do its best to cement the less likely outcome.

The *actor analysis* then focuses on the true power repartition of actors. At first, a few aggregated values can show the actors that have the most clout on important issues (the ones on which actors are the most salient). As well, the model can take the influences (direct and indirect) into account, and give a representation of their true clout, which is the real part of control they have on issues, including all the parameters that were entered. The new power repartition, still being stored in a matrix that shows how each issue is controlled, can be used by negotiators to spot the most powerful stakeholders. Powerful but non-salient actors, for example, are going to be important allies, since they can modify or strengthen their position at a low cost for them, in exchange for support on other issues. Of course, a global coefficient which represents the overall true clout is also assigned to all actors, and can give an idea of the actor's importance and implication in the studied situation.

The *alliance analysis*, at last, attempts to match actors and to determine the most straightforward strategic alliances. The model supposes that actors that share similar points of view on issues they are salient on are more likely to be interested in a strategic alliances. On the other hand, if actors are divergent on salient issues, they also tend to be divergent globally, to fight each other and to belong to different strategic coalitions. For each couple of actors, an alliance coefficient which depends on their convergent and divergent opinions is calculated, and actually used to esteem their proximity. The coefficient ranges from 0 to 1, and actors which have a very low proximity are supposed to be strong allies, while the most divergent will be assigned a high value. The goal of this part of the model is to identify groups which have low proximity between each other, and thus show that these groups have strong changes of making successful strategic coalitions.

3 Strategic visualization: a state of the art

Model proposed to solve multi-issues and actors problems deal with a lot of different parameters (e.g. salience, clout, power...) When it comes to decision making and analysis of results, one quickly feels that it is indeed very difficult to compare data sets in numeric or in tables form. More precisely, research in the specific case of multi-issues and actors models mainly focused on methods but only provided few visualization paradigms. This motivated us to propose graphical tools to help decision making in this specific case. We will first discuss some general approaches in Strategic Visualization and then focus on their applications to multi-issue actor models.

3.1 Research in Strategic Visualization

Visualization of data is not a recent topic: from cartography to subway maps or common presentation pie charts, men have always deployed a lot of efforts in representing graphically some abstract concepts. Our goal is not to list every contribution of the Visualization literature: interested readers could wisely check out the work of Tufte [10] or Spence [9] for a good introduction. Strategic visualization is the application of visualization techniques to decision making. Put in a simple way: how can machines present data so that people can take decisions based on quantitative and qualitative information? When considering large amount of information, it quickly becomes difficult to only use text or tables: in his article [4], Dürsteler states that while sentences are relevant for comparing two or three values (at most), tables are better for considering up to twenty elements simultaneously. However, when one goes beyond this limit, it becomes too complicated to use these methods – hence, the need of graphic representations.

What do we expect from these representations? The simultaneous views of multiple elements should help us to compare them and perceive patterns or hidden relationships. It is interesting to note that in the jungle of available graphic representations (see Harris [8]) there is never one perfect approach, but multiple ones. Depending on the problem, it is up to the user to select one that matches his/her expectation and helps comparing elements.

Research and previous works can clearly be divided into two categories, and both are successfully applied to Strategic Visualization:

- generic Visualization Systems, offering a broad range of graphic representations that one can pick up depending on the problem (toolkit approach)
- the development of specific Visualization Systems linked to a particular application

Recent research in Strategic Visualization is often related to data mining of huge data sets extracted from various sources and loaded into data warehouses. Typical problems are monitoring of telecom switch data or World Wide Web traffic, large company organization problems and so forth (check out *The Atlas of Cyberspaces* for an introduction [3]). Hao *et al.* from HP labs [7] propose for instance an open framework with a set of general visualization tools and apply it to numerous Business Intelligence problems.

3.2 Visualization in multi-issues and actors models

Visualization in multi-issues and actors models is of course very specific as compared to general Strategic Visualization. Narrowing the class of problems is indeed an advantage as graphics might be enriched with many context-dependent elements encoded into different attributes of the same object. We will discuss later on how we use hue, size and transparency of symbols to simultaneously present multiple dimensions and parameters on the same graph.

As remarked previously, more effort could be spent in proposing new visualization metaphors for multi-issues and actors problems. As a starting point, we are now going to consider available graphical representations proposed by authors of the MACTOR and McKinsey methods.

3.2.1 Godet (MACTOR) graphs

Godet [5] introduced with MACTOR a method to represent on two graphs the convergences and divergences between actors. On each graph, actors (represented by nodes) are linked whenever they agree (respectively, disagree). Links' size (and/or labels over them) indicate the respective importance of the convergence or divergence.

The second graph is a distribution of issues in a 2D plane. Issues are closer whenever actors' positions on them are similar.

Finally, Godet merges on a third graph the correspondences between all actors and issues: issues and actors are positioned on a 2D plane so that actors willing to hardly defend an issue are close to it.

3.2.2 Allas (McKinsey) graphs

Allas's [1] analysis introduces numerous similar graphs for comparing actors' parameters arranged into 2 by 2 matrices by placing actors (or issues) in a 2D plane. He sets up a two axis system to compare elements such as salience vs clout, actors' saliences, and so forth. Symbols placed at actors' locations might be enriched by another parameter (for instance, is the actor an ally or an enemy) encoded in the color of the symbol. It could be called somewhat a "parameter versus parameter" approach, where actors coordinates in the plane correspond to the value of the parameter represented on each axis. The quality of Allas's work is his pertinent analysis of the space composed by the division of the 2D space: by separating the plane into four areas (top-left, top-right, bottom-left and bottom-right), it is easy to categorize actors or issues. For example, when comparing salience vs clout: 1. if salience is high and clout is low, actor is a follower (bring into coalition if little effort is required) 2. actors will either be allies or enemies if salience and clout are high 3. if both parameters are low, actors can be ignored and 4. if clout is high and salience is low, actors are influencers that one should try to lobby in order to win.

3.3 Limitations of current visualization in multi-issues and actors models

While Godet and Allas proposed some graphs to help decision making, there are still some relationships and parameters that were not represented on them. For instance, Godet takes into account the active and passive influences, but represents them in a table, which is not easy to read. The visualization of the power repartition on issues (partly supported by MACTOR and enhanced in MASAM) is also another class of graph to address. One can also remark that comparing the convergences and divergences between actors onto two different graphs as proposed in MACTOR is somewhat strange as both are tightly linked.

These limitations motivated us to introduce more visual paradigms to help multi-issues and actors negotiators. They will be presented with our developed system in the section 5.

4 Application to the WISP scenario

In order to demonstrate the MASAM method and give the reader a more concrete understanding of what kind of analysis are supported by the model, we present in this section its applications to the analysis of the Wireless Internet Service Provider (WISP) industry, viewed from the perspective of the current Swiss market situation. This scenario will illustrate the graphs introduced in section 5.

The WISP industry has been chosen to illustrate the model because of the general interest that surrounds it and the number of open questions that have not yet been answered. This uncertainty is one of the reasons of conducting a study using multi-issue actor models. In order to do so, a number of preparatory steps must be made: firstly, the relevant issues and their measuring scales must be defined. Then, the involved actors must be identified and finally, input on the position, salience, clout and influence must be gathered through expert interviews. It is worth noting that in order to present a relatively simple example, we focused ourselves on a very limited number of issues and actors.

We are now going to list the WISP issues and actors (see also Fig.1).

Figure 1. Actors and Issues (WISP scenario)

4.1 Issues

This study focuses on five principal issues: mobility, device, wide area WLAN, free network emergence and regulation.

- **Mobility** describes how much mobile WLAN will be. It can be measured on a scale ranging from stationary use (wireless connectivity within a private and limited local area) to mobile use (continuous Internet connection while on the move).

- **Device** shows which device will access WISP services. It can be evaluated on a scale ranging from predominance of notebook-type to a predominance of mobile phone-type devices, with PDAs counting as an intermediate between the two.

- **Wide Area WLAN development** relates to the extent of coverage offered by WLAN networks, ranging from a very limited coverage to a truly ubiquitous coverage through integration of WLANs with cellular networks.

- **Free networks emergence** reflects the extent to which free community networks arise. Community networks are groups of end users willing to share their private hotspots with each other and eventually providing free wireless Internet access to the public.

- **Regulation** represents the tightness of the national WLAN frequency allocation and related regulation policy.

4.2 Actors

The study comprises seven main categories of actors:

- **Mobile network operators (MNO)** essentially include operators of GSM, GPRS and UMTS networks.

- **Internet service providers (ISP)** and other network operators, include operators of fixed telephony networks, fixed packet-based data networks) and wireless Internet access networks.

- **Venues** represent a variety of property owners which provide the place where the access points composing the network are installed (e.g. airports, hotels, public buildings and so forth).

- **Communities** are free networks, built by clustering members' private hotspots together to provide access to the community members, often operated by loose federations of technology enthusiasts.

- **Informatics-related enterprises** include companies active on the informatics industry, whether by selling hardware, software or network equipment.

- **Telephony-related enterprises** are companies active on the telephony industry, like phone manufacturers.

- **Regulation** are the local regulation authorities, mainly controlling the WLAN frequency allocation.

The purpose of this study is not only to obtain a comprehensive overview of the current situation of the WISP market, but also to gain insight into its possible future evolution. Indeed, by taking into account the effects of the actors on the evolution determinants of the system (i.e. the issues), more realistic future scenarios can be designed.

This basic presentation of the WISP scenario will give us some sample cases in the following in-depth discussion of the Visualization module.

5 A proposal for visualization

5.1 Presentation of the OMEN system

OMEN is a new tool for Strategic Visualization of the MASAM method. Dataflow is decomposed into data acquisition, computation and prediction through the MASAM model, and strategic visualization (Fig.2). A Microsoft Excel prototype was retained for acquisition and computation, both for ease of use when creating the dataset and functionalities. Results are then exported into an XML file, which, in turn, is read by the OMEN module. This latest application was coded into Macromedia Flash which supports a lot of interesting features: vector animation primitives (allowing scalable windows without any loss of quality), native facilities for designing custom user interfaces and controls (a key element in our case), reusability of created visualization components, event-based synchronization of UI components and data import through XML.

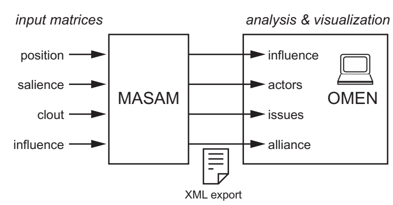

Figure 2. Connecting MASAM and OMEN

5.2 Overview of the system

OMEN screen is decomposed into numerous windows, allowing concurrent visualization and manipulation of data. The interface is highly configurable, so that the user can dynamically select and filter pertinent problems. We believe that simultaneously displayed charts are fundamental for comparing actors and issues: for quick identification, an icon is associated to issues and actors. Each of these symbols reacts whenever the mouse rolls over it. It is then easier for the user to simultaneously consider all concurrent representations of the actor and take decisions accordingly. Other symbols are proposed, such as smileys pointing out which actor is an ally or an enemy of the main actor (see bellow for a definition of this specific actor).

On the application screenshot (Fig.3), the current subject of study (what we call the main actor) is the Regulator. The actor's passive influence are displayed in a pie chart, were the self passive influence is green, whereas all exterior influences are red. Slices of the chart artificially grow when the user moves the mouse over then and every representation of the focused actor is similarly highlighted, so that one can compare the main actor with it. On the figure, the mouse is over the MNO slice and the MNO symbol consequently grows on the Proximity map. Lines representing passive influences of this actor are also highlighted on the corresponding graph and a tool-tip displays the current focused value next to the mouse.

This simultaneous highlighting is one of the great features of the User Interface – without it, it is more difficult to locate all concurrent instances of the same actor all over the screen. Internally, it is implemented as an event-based model with listeners: as the OMEN module is loaded, User Interface components subscribe to the XML loaded simulation. Whenever focus change, an actor loses focus and another gain it: a corresponding event is triggered into each listener, which in turn refreshes its display. This powerful mechanism ensures a synchronous coherent display of data. For further information, refer to Hall and Wan's work [6].

The next section lists the various windows of the user interface.

5.3 Windows and Diagrams

OMEN is split into numerous windows: three are basic data selectors (list of actors, list of issues, main actor) and five handle the more complex data visualization (proximity map, actors details, passive influences, power repartition). We are going to discuss their design and provide an example of their analysis in the case of the WISP scenario introduced in section 4.

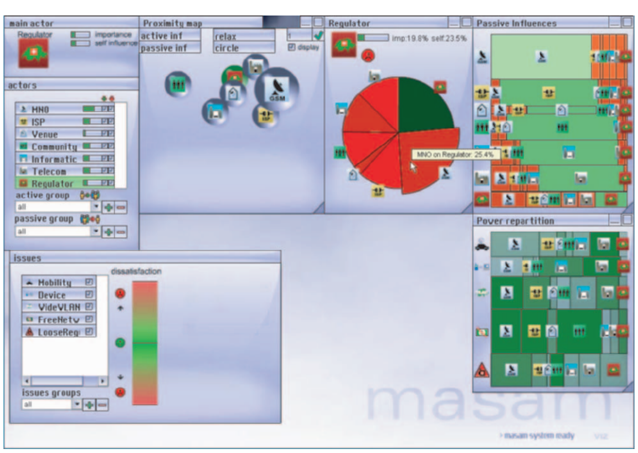

Figure 3. A global snapshot of OMEN.

5.3.1 List of actors and issues

All actors are displayed in the List of actors, where the main actor is highlighted in green (Fig.4). Rather than using a classical combobox, we have added on each actor's line more information: a bar represents the importance of the actor, and two checkboxes indicate whenever or not the actor belongs to the group filtering displayed influences. The reason for this is that when the number of actors grows, it can be difficult to read everything on the same graph. Groups are an elegant way of filtering information, by only considering a subset of actors. We will discuss the groups and filters later on. The user creates and deletes groups with the corresponding input boxes. On this screenshot, there is no group and all actors are selected.

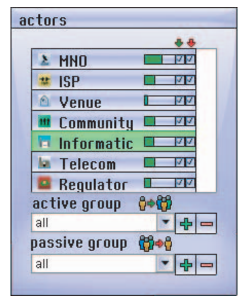

Figure 4. The list of all actors.

The Main Actor is the simplest window, yet, it clearly specifies who is the subject of the analysis, i.e., the party for which we will adopt strategic recommendations. If the user belongs for instance to the Telephony group, an interesting main actor could be his/her main competitor: Informatics. By selecting this main actor, the user could take change his/her role and consider the situation from the competitor's point of view. The window simply summarizes the name of the main actor, its symbol, importance and self influence.

The list of issues is pretty similar to the list of actors. Groups are also possible with issues, so that one can filter certain categories.

5.3.2 Actor details

Actor details offers a fast overview of actors influencing the main actor (Fig.5). Theses passive influences are arranged on a pie chart: one slice shows the self influence of the actor on itself. We chose to paint it in green, as opposed to other influences undertaken by the actor which are painted in red. The size of their slice is proportional to the influence of the other actor. Pie chart was a natural choice since all influences sum up to 100% and people are used to pie charts for this kind of representations. It is interesting to note that if we had considered only some of the influences (thus, not

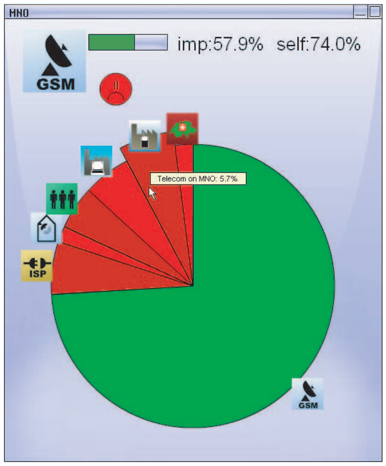

Figure 5. Actor details.

summing up to 100%), we should have avoided a pie chart as it is a misleading choice in this case.

Whenever the mouse rolls over slices (as explained previously), they gain focus and corresponding occurrences of the same actor all over the screen are highlighted to help concurrent reading of information.

The importance and self-influence of the main actor are also summarized on top of the window so that one can distinguish if the actor is important or not.

For instance, the MNO is a powerful actor, and its self influence is quite big (green slice). Other influences occupy the remaining slices: details are displayed as the user moves the mouse over them (Fig.5).

5.3.3 Influence analysis

It might be tempting to adopt pie charts in order to simultaneously represent the influences of all actors. However, while it is a nice representation for one actor, is becomes more difficult to compare pie charts altogether. Furthermore, a rectangle chart could better take advantage of the limited space available for display.

We retained a mosaic graph (Fig.6), inspired by the Map of the Market on smartmoney.com [11] website. The graph has the advantage of being able to display simultaneously many actors and more information about them. It indeed allows to visualize all actor's influence on each other in a matrix-like graph, and each cell gathers three indications, represented by its width, height an color.

The window is divided into rectangular horizontal bands, on per each actor. The height of this band is proportional to the importance of the actor. Each band is then segmented according to the influences on this actor – the symbol of the actor occupies the corresponding rectangle. This distribution makes sense as influences per actor sum up to 100%. The resulting mosaic graph is a powerful and easy to read tool: surface comparison does not only show influences, but also important influences, as height is proportional to actors' importance.

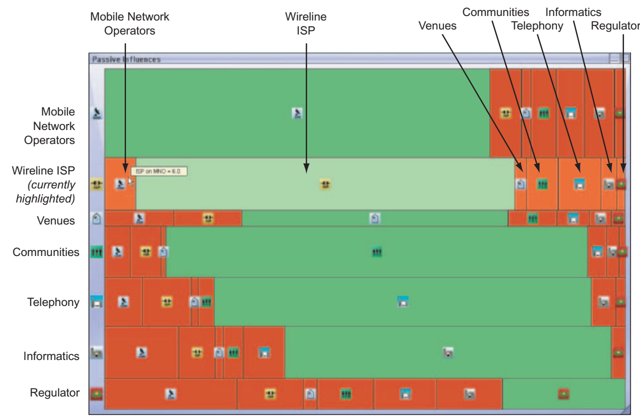

Figure 6. The mosaic graph of passive influences

As in the Actor Detail's pie chart, we colored the Passive Influences graph boxes in green for the self passive influences of actors, and in red otherwise (Fig.6). These green and red surfaces are indeed worth distinguishing: they help spotting each actor's independence, autonomy and ability to enforce its will.

Analysis of the Passive influences in the WISP scenario: In the context of the WISP industry example, figure 6 suggests that Mobile Network Operators are by far the most important actors, since they cover the largest surface on the graph (thus being both a powerful and influent actor). They also have a sizeable coefficient of auto-determination and therefore bear little influence from other actors. On the contrary, Venues are much less important (little overall clout power coefficient) and have a smaller auto-determination. A particular case is the regulator, which is moderately important but, because of its role as a conciliatory actor, has the lowest auto-determination coefficient and has relatively low influence on other actors. This graph will also become useful later, when the different actors design their negotiation strategies: for example network operators might exploit their large influence on regulation authorities to change the expected outcome of certain issues.

5.3.4 Issue analysis: Dissatisfaction

The *dissatisfaction graph* (Fig.7) represents for each issue a vertical scale on which each of the actors are positioned. The scale represents the actors' dissatisfaction towards the expected outcome of the situation. A position in or near of the middle of the bar mean low dissatisfaction, either because the actor is not salient on the studied issue, or because the outcome is expected to be near of our subject's position. Dissatisfied actors, i.e. actors that have a high salience and a position highly diverging from expected outcome, will be placed on the exterme sides of the bars: on the top if their position is higher than the expected outcome and on the bottom in the opposite case.

Application to WISP: on the Free Networks issue, the corresponding dissatisfaction scale shows how actors are positioned respectively to the expected outcome: Communities (on the top) and MNO/ISP (on the bottom) are the most unsatisfied actors. According to that issue's imporance, and to the high dissatisfaction the three actors have, the other unsalient stakeholders will be in strong position to give their support to one of the parties.

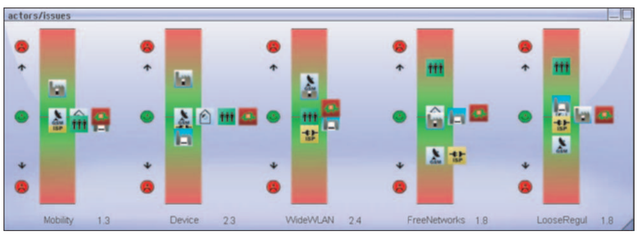

Figure 7. Dissatisfaction analysis.

5.3.5 Actor analysis: Power repartition on issues

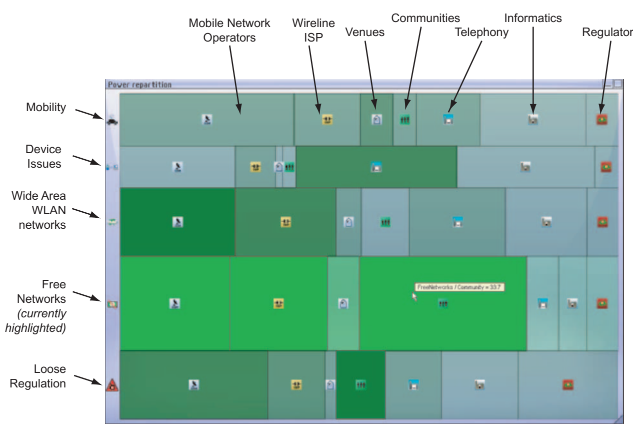

Figure 8. Power repartition on issues.

The graph of Power repartition of actors on issues is quite similar to the previous ones (Fig.8). Similar considerations leaded us to integrate another mosaic graph in the system. Issues occupy horizontal bands which are in turn divided proportionally to each the power of actors of this issue. The height of bands also relies on the importance of the issue, so that more important issues take up more space. Into each division rectangle, the symbol of the actor recalls its owner. As MASAM introduces a salience of actors on issue, it is worth to represent how actors are interested by the issues: a rectangle might be large, but if the corresponding actor does not really care what will go on, one should pay less attention to it. Rather than using color, we propose to represent this notion with transparency: the less important the issue is, the more translucent the rectangle will be.

Analysis in the WISP scenario: In the context of the WISP industry example, the Power repartition graph suggests that the relatively most important issue is the emergence of Free Networks, due to the high number of salient actors on this issue. As seen in the dissatisfaction chart above, it is possible to recognize two groups – MNOs and ISPs – which are against Free Network emergence on the one side, and Communities which are in favour on the other side. The former controls approximately 50% of the clout, compared with nearly 35% of communities. These groups seems to have the possibility to obtain some support from the other players, in particular those which are not much salient: MNOs should be able to easily obtain support from Telecom firms, while Communities might have an harder time to convince Informatics firms. For negotiation, this graph is one of the most important: it allows to directly spot the most controversial issues and find the agreements a subject will need to find. On issues the subject is salient on, actors can easily find the surfaces controlled by uninterested stakeholders, and thus find easy to earn support. On the other hand, the subject can find which kind of support will be the best exchange "currency".

Other issues almost have the same importance, with Device issue being the least important, since it basically concerns only Telecom and Informatics manufacturers. For this reason, this issue could be an important object of negotiation for players wanting to gain the manufacturers' support. For example, MNO seems ideally placed to favorably conduct such exchanges, since they have an important clout on the Device issue: still they seem more inclined to conduct such exchanges with Telecom firms, as they have high influence over them, existing relationships and share a common position on many issues.

5.3.6 Alliance analysis: the Proximity map

A powerful tool to quickly analyze the relationships between actors is the Proximity map, on which actors of similar interests are regrouped (Fig.9). MASAM defines the expected distance between two actors as a composition of their difference of positions and saliences. However, it is not possible to find a situation were all expected distances are matched, since the problem has too many constraints to fulfill. Thus, a compromise must be chosen. We retained a dynamic method to do so: actors are first arranged in a circle in the proximity map, before we start the relaxation process. When relaxation takes place, actors try to progressively move toward each other in order to fulfill most of their constraints. After some time (the system evolves dynamically on the screen), an equilibrium is found. OMEN then fits the actors' positions to fill the window, in order to maximize the useful area.

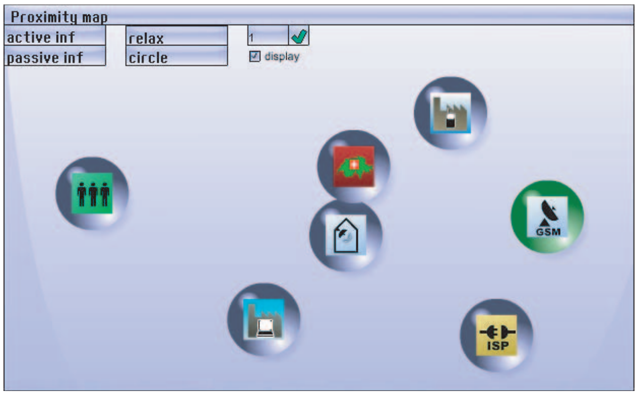

Figure 9. Actors are arranged into groups in the Proximity map (after relaxation).

While the idea of a Proximity map is not new, the way expected distances are computed by MASAM and the dynamic display of the system is an original method. Various equilibrium states might exist since not all constraints can generally be simultaneously fulfilled. In OMEN, the user can try other configurations: while dragging an actor in the map with the mouse, the relaxation process will move all other actors accordingly. By playing around and trying to put the dragged actor closer to others, it is easy to notice how attracted or repulsed actors are. Allies actors stay close to the main actor, while other enemies promptly move away.

It is also possible to display on the final graph the error between expected and actual actors' distances (Fig.10). An adjustable threshold limits the display to either all or only the most important errors. Problematic distances are depicted as links joining actors and dots on them represent the expected actors' locations. If the distance between actors should be smaller, dots are placed on the link to figure were the actors should be. Similarly, if the expected distance is greater than the actual one, the link goes toward the two actors and dots at each extremity show the expected locations.

This display is indeed a very convenient way to visually measure errors: when the actor location is correct all error dots are very close. A cluttered cloud of error dots points out actors' locations that should be treated more carefully, as they only are a compromise of the constraints system.

To sum up the contribution of this graph, it is clear that representing abstract "distances" between actors by real distances on a 2D plane is a very straightforward and easy to read interpretation. We especially take care for instance that whenever resizing the window, its aspect ratio of the height/width maintained so that no distortion appears in the reading of the distances. We believe that the dynamic manipulation of actors and the corresponding real-time relaxation are great intuitive tools to evaluate how they behave one to another.

Analysis in the WISP scenario: on figure 9, Communities seems not surprisingly to be quite isolated on the Proximity map, as their interests are very different than for the other users. Its nearest potential allies are Venues and Informatics. They could try to create alliances with them against their enemies, MNO's and ISP's, which are as far as Communities from the central actors. The Regulator also has a "center" expected location, close to Venues (a not really powerful actor). A large gap separates Informatics- and Telephony-related enterprises (strong competitors) and each one is close to the corresponding network operator (Mobile and Wireline Network Operators).

Therefore, although Communities are not the most powerful in this case, they can get support from Informatics due to their proximity, and from Telecom thanks to their different salience on relevant issues, in order to move the outcome towards their wishes.

A closer analysis reveals two main dimensions of divergence on figure 11. On the horizontal dimension, a clear differentiation separates the Communities (supporting free networks) and commercial providers (supporting commercial networks). On the vertical dimension, there is a disagree related to the mobility usage of WLAN, going from mobile use (favored by Telecom and MNO) to stationary use (favored by ISP, Informatics and Communities): the regulation of free networks seems to be the main issue..

Overall, it is possible to distinguish three major groups, which seem to focus on three different possible usages of

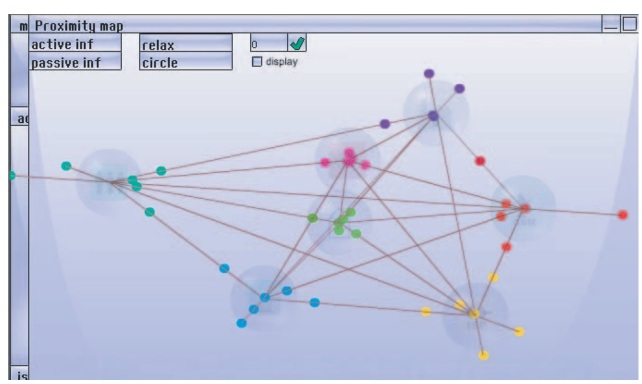

Figure 10. Proximity map: expected locations and actual locations of actors.

WLAN technologies. The first group concentrates on Free networks: these are the Communities, which are clearly marginalized from the other players although they may get some support from some Informatics-related enterprises and Venues. The second group focuses more on commercial public hotspot networks, and comprises principally Mobile Network Operators and Telecom-related firms. The third group pushes for private WLAN with ISPs and informatics-related enterprises. The Regulator and Venues are somewhat in the middle of the different groups, which suggests that they could be interesting allies to use as to alter the overall direction of the industry.

5.4 Filtering data

As pointed out by Hao [7], one interest of visualization is to discover patterns in the data and to select the subsets on which to focus further detailed analysis. The Proximity map is for example a great tool to perceive actors' alliances. However, some of the proposed representations become difficult to read if numerous actors and issues are involved (more than ten) as we tried to gather multiple dimensions on the same graphs. Graphs such as Passive Influences and the Power repartition on issues are a typical bottleneck in this case. We consequently propose to filter them. The user can dynamically create subsets of actors: when applying them to the lists of passive actors, the system displays a filtered graph, where rectangles are proportionally maximized to fit the window. It is similarly possible to filter the Power repartition graph by groups of issues.

Apart from preventing visual occlusion, data filtering is also an easy way to inspect some scenarios and to answer questions such as: "What can we expect from this class of actors?". For instance, if one makes groups matching actors that are close on the Proximity map, it is easy to filter the situation from this group's point of view. The Proximity map also adapts to filtering: transparent symbols replace actors not belonging to the current filtering group.

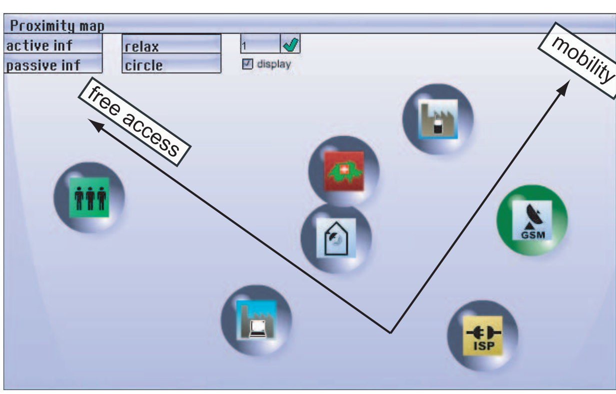

Figure 11. The Proximity map helps isolating two dimensions in the WISP scenario

6 Conclusion and future works

We believe that the MASAM method and its OMEN module address more precisely the multi-issues and actors problems: MASAM mixes in a coherent framework parameters and separated methodologies as implemented in Godet and Allas's methods. The OMEN module introduces new graphs: actors' groups of interests and possible alliances are easy to interpret from the Proximity map. Influences and Power repartition graphs are also much better than tables for comparing instantaneously the most interesting elements.

The proposed system is still under development. Further extensions include:

1. Better interaction: a tighter integration of the MASAM and OMEN modules would make it easier to change the input data of MASAM based on OMEN analysis and run the simulation again.

2. AI interpretation of the results: for instance, the program could automatically suggest groups of actors based on the Proximity map.

3. A better visualization of all actors' dissatisfactions on issues' expected outcomes is under development.

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