Effective Model Operation by Joining and-Separating Technique in Smart Grids

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Abstract—At present, cost is considering a serious factor in world of electricity. Finding ways to reduce overhead and shorten time factor as much as possible is now vital, when combined with finding best ways for transfer power. The Energy Service Providers (ESPs) have resorted to managing the coordination of each party's requirements by unifying units (the coalition) in utilizing way to deal with other unit's needs. The concept of coalition strategy based on using of the unified Micro Grids (MGs) units primarily on the GT-CFS strategy to get over high-speed routing requirements of smart grid, increasing revenues and maximizing the profit for all MGs networks. In paperwork, an explanation and comparison of how to make additional profit by applying two different ways "Shapley and Equal Sharing Role". The results also illustrating the mechanism produces a stable model that generates high profits with MGs.

Index Terms—Energy service providers, micro grids, game coalition formulation strategy, shapley value, equal sharing role.

I. Introduction

In recent years, increasing demands and high volume of electricity consumption, super-need to develop substitutes, other systems, and methods have been imposed to better satisfy these increases. Serious study and substantive work have been done as above gap which has creating a search orientation to find methods to meet daily demands and address issue of shortfalls and inadequacy to overcome their obligations. Consequently, persistent and persistent efforts have produced alternative methods and systems. among of them, partitioning today into parts: Peak periods [1], [2]. Within one day, the peak demand consists of demand congestion (ie, the heaviest consumption and demands of electricity), while the remaining time is implied to as a period outside peak period. Moreover, peaks period varies with different seasons for years. It is difficult for traditional power plants to overcome effectively to the difference. therefore, need other energy sources needed, and this leads us to the wonderful world of renewable resources (ie, smart grid), which can help power plants meet peak and off peak requirements effectively avoiding unnecessary generated power and / or loss of distribution.

Network systems collaborating with researchers effectively to provide basic support. These systems composing of geographical distribution for resources (computers, storage, etc.) had by independent organizations. Managing resources in such open distributed environments is very complex problem if solved, resources using efficiently and faster implementation of applications. Existing network resource management systems [3-6] clearly do not address the formation and management of effective model [7]. Good planning for a better performance network system providing high efficiency for multi-purpose coverage and purposes. Due to complexity of resource management, it be appropriated if we go to above plan. Note that profit is key factor for shaping effective models in networks, therefore it should be considered at designing and shaping mechanisms for providing better performance and increasing efficiency. it should be developing Mechanisms to form effective model consider participants' attitude and presentation with a stimulating contribution to resources.

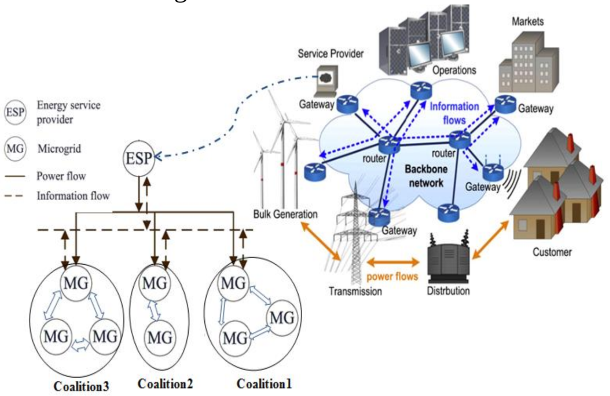

Fig. 1. ESP construction model

To achieve higher efficiency and performance of each unit, we must divide this model into three stages: identification, structural configuration function and operation. To begin a consummate understanding for each unit's identification, it is strongly suggested that effective models at (the configuration stage, negotiate potential partners on the specific terms, objective, and duration of cooperation). Once the effective model is formed, it enters the operating stage in which members of effective model (EM) collaborate in solving a significant task. This paper attends to construction and specifications of EMs (Phase II). This depends mainly on the game coalition where MGs decide to form EMs in a way that makes every MG work for raising its profits. EMs provides the complex resources needs to complete tasks. EM is traditionally designed to share resources but can also represent an economic model [7]. The model

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discussing, consists of MGs sets and a network user who apply for the required amount of power. A subset of the MG group will be formed to exchange the required power with the highest individual profit. The ESP construction model as Fig. 1. Fig. 1 show that many management systems suggested to regulate Micro-Grid networks (identified as distribution network subsystem interconnected at the electrical and information levels). Regardless of this approach which aims to impose architectural control whether centrally or not already existing microwave networks.

Our vision is to propose a way to bring together smart grid actors to dynamically round up the optimal responses of the small network. Consequently, the main concern is developing of techniques aimed to creating an appropriated regulatory structure. ESP is sets of MG that are connected through the IT infrastructure and behave in a coordinated automated way. The most difficult problem in implementing EM is ESPs where ESPs are the main controller in all MGs interrelated and coordinated MGs based on coalition games. Therefore, we seek a dynamic estimate for best standards of the alliance where it is more effective for ensuring continuity and power in systems. ESPs will also enable increased overall revenue and increased revenue for each of Micro Grids (MGs). For additional profit achieving, we use two different methods "Equal Sharing and Shapley value Role", for enhancing values of contribution or the requirements in satisfactory manner. The results clearly showing that the mechanism has also produced a stable model that automatically leads to increase revenue with using of MG. We analyze the proposed EM construction characteristics mechanism and how to achieving highest profit for each MG using the two different methods and conduct the simulation experiments to investigate its characteristics by comparing these methods that were applied for measuring execution time desired for implementing coalition as the contribution value.

II. Background and Related Works

Network computing systems enable researchers to collaborate effectively basic support for advanced scientific and engineering research procedures. This is systems consisting of geographically distributed resources, where the management of these resources it is one of the most complex problems and its solution is to reach us to efficiency use all resources and perform faster applications. for existing network resource management systems do not explicitly address configuration and management actual strategies for existing network resource management systems [8], [9]. Where the resource management systems that include multiple administrative domains organizations have been extensively studied. Several mechanisms have been developed to manage these resource systems [10], [11]. These Mechanisms and regulations do not explicitly take into account the independence and incentives of resource owners to contribute resources. Many models are based on economy and systems for managing resources in open distributed systems which has been addressed in [12], [13].

A simple tightly controlled for connecting and operating power resources in small networks M.V. Kirthiga *et al*. proposed a detailed methodology for developing a small independent network to address energy loss in [14]. In addition, some researchers have upgraded networks distribution to a smarter network and applying solutions with distribution network and power conversion in business. At present, the theoretical approaches of games are considerable tool in intelligent network research. Chun Zhang. proposed a model for allocating fair energy resources using a minority game algorithm of smart buildings as described in [15]. W. Saad. presented an algorithm build on collaborative gaming theory was introduced to study new collaborative strategies between micro networks with distribution network . It does not explicitly address the problem unity for Building and Management Alliance which one of key issues to be solving in large-scale computing systems to simplify collaboration between participating parts to overcome all MG requirements. Requirements for dynamic interactive crisis creation and management with smart networks are discussed in [16].

Most important requirement is the interoperability of the environment. Typically, this is satisfied with existing networks through common protocols for creating and managing participation and contribution relationships. The EMS management and operation function is supported by providing the basic concept of EM policy specification, security resource management, flexibility and disclosure. The toolkit provides mechanisms for building EM and EM analysis and management tools. The Dynamic Construction Structure of (EM) is examined between the independent factors and the computer management factor of EMs as in [17].The problem for forming an EM model can see as coalitional problem formation. Researches that conducted on formation of an alliance in the multi-factor systems community for problems as assignment and service creation . Our earliest work is presented where we present search methods for scheduling applications of parameter scanning in network environments and a structure for management resources system and scheduling in global network ,while our proposed mechanism relies on models and game alliance techniques. We believe Game Theory is powerful tool for building an EM model and providing more efficient and scalable mechanisms. SP techniques does not simplify the stability and robust analyses of EM configuration process, while this is important and represents strengths of games theory for alliance [18], [19].

In addition, it is not handle application scheduling problems within EM, while our proposed framework addresses this problem and provides a mechanism for scheduling applications within EMs. The approach used here depends on the coalition games, with using mergers and divisions process in [19], The conception of visualization must impose a strategy in utilizing the MGs function used for the GT-CFS strategy. in our work, EM is an alliance of MGs who wish to maximize their individual abilities profits are largely indifferent to global welfare. The model we consider to be composed for a sets of MG_S that offers all data reports with specifications consist of deadline and payment. A subset of MG_S will configure EM in order to execute the process of exchange power (tasks) by the target deadline. The goal of each ESP is to form EM so produces the highest subjective profit. This approach will enable the MGs to achieve results by using two methods " Equal Sharing and Shapley Value Role ", that will improve rating of profit, and the production mechanism will become a consistent model mainly to increase revenues with using MGs. When some details are needed to enhance productivity and improve performance during operations. The best management methods must be implemented for achieving best results and higher profits.

In fact, the contribution of a MG to the coalition depend on the order. Therefore, it is necessary to calculate the average of payoffs in all conditions. A solution concept for coalitional games as a payoff vector which allocated each payoff among MGs in fair manner. The primary concern for any coalition game is the stability [20]. y. One of concepts solution concepts used to assess the stability of coalitions is the core.

When the result appears to be unfair, MGs with same coalition distribute the extra payoff based on an envisioned strategy for objective selection and concept of Shapely value or Equal Sharing Role for extra profit distribution in a coalition, we suggest an algorithm to formulate the optimal coalition structure. In which each MG prefers to attend in the coalition, which will bring most profits to it, while not the total coalition value. At the end, the comparison relation that is called 'Pareto order' based on an individual payoff is introduced [21].

our paper indexed as follows. In second section, background of related EM structural work description, system model we see in third section, that describe the theoretical game used to design the proposed system mechanism. The proposed mechanism and characterize its features presented in section IV. In Section V, we will evaluate the mechanism by large-scale simulation experiments. Finally, in section VI, summarize findings and conclusion to our work.

III. The Model AS A Coalition Approach

In this section, we are describing the structural form of EM model in smart networks as a coalition game. The first system describes the emerging timetable issue in managing the rapid response to demand in the smart grid. Many MG send different power massages simultaneously required to the network controllers (ESP) with a flexible time period during which their requests can be performed when receiving these massages, and each controller's schedules form a request on their own. Each MG application form is a separate task. The purpose of scheduling all orders is reducing the total expenditure of electricity, Speed response and response to power transmission [22], requests required in smart networks in less time and reduce loss. ESPs are the required massages as basis of the MG request form F (each consisting of an independent task $\{T_1, T_2, .., T_n\}$ such as (distance, required power, each T_F task considered as function of applications that characterized by workload of w (T), which defined as mounting of instructions for tasks F that is not provided by one MG, Thus, several MG_S combine their resources together to implement the desired demand.

We consider sets of m MG_s, $G = \{g_1, g_2, . . ., g_m \}$ is available and ready to assemble to suit the required power. Here we assuming that each Energy service provider have many computing resources with s (G) speed. The speed of s (G) gives the number of instructions per second that performed by ESP that contains G, therefore, the time wished for executing task T at ESP_G Through the execution time equation. t: $F \times G \to R$, where $t(T, G) = w(T)/s(G)$. all ESPs deal with cost for executing a task. The rate incurred by ESP $g \in G$ when executing task $T \in F$ is given by cost function, c: $F \times G \to R$. Furthermore, we assuming that MG has the incentive to working collaboratively to reduce power transfer between each other. To improve economic efficiency in a cooperative manner, assuming that the MG has zero fixed costs and that its variable costs are provided by function c. MGs are prepared for paying cost P less than its available budget which indicates completion of implementation by the deadline d. If operation of processing exceeds d, the MG is not willing pay any amount, $P = 0$. MGs unite to assemble to form in an imaginary manner to perform tasks and exchange power to cover their needs and most importantly for maximizing their profits (profit: is difference between costs of payment and treatment of the labor force through formatting of coalitions). If the profit is negative (as loss), ESP will not prefer the participation. We describe the EM formation problem as coalition approach [22]. Principally, cooperative coalitional approach is defined by the pair (N, v), where N= {1, 2,..., N} is sets of finite players, v is a real-value function called characteristic function defined as $S \subseteq N$, $v : 2^N \setminus \{\emptyset\}$ *and* $S \to R$. The utility function per coalition $S \subseteq N$ that defines the total payoff achieved by S. with our model, players are MGS (ie, N = G) that form the EMs model (we use EM terms and the coalition interchangeably).

Each subset $S \subseteq G$ is a *coalition*. If all the players (MGs) form a coalition, it is called *overall coalition*. A coalition has a *value* given by characteristic function $v(S)$ manifesting the profits earned when members of coalition act as a group. Each coalition of MGs $S \subseteq G$, there exists a hunting factor for implementation coalition process μ_S: $F \to S$, the costs incurred for executing the tasks F on S under searching μ_S is given by

$$C(F.S) = \sum_{T\in F}\sum_{G\in S}\psi_S(T.G)C\,(T.G) \quad (1)$$

where

$$\psi_s(T.G) = \begin{cases}1 & if\ \mu_S\ (T) = G \\ 0 & if\ \mu_S\ (T) \neq G\end{cases} \quad (2)$$

The time execution is given by completing time as induced by its working period μ_S. The time execution is given

$$E(F.S) = \max_{G\in S}\sum_{T\in F}\psi_s(T.G)\,t(|S|) \quad (3)$$

where

$$t(|S|) = w(T)\,/s(G) \quad (4)$$

If productivity per coalition $S \in 2^N \setminus \{\emptyset\}$, $t(|S|) * \sum_{j\,\in\,S}\alpha_j$ where $t : N \to R$, with contribution list $\alpha_{i\,.i\,\in\,N}$. We define the following characteristic function of our proposed EM formation game.

$$v(S) = \begin{cases}\mathcal{E} & if\ |S| > 0\ \ and\ \ E(F.S) \le d \\ 0 & if\ |S| = 0\ \ or\ \ E(F.S) > d\end{cases} \quad (5)$$

where $\mathcal{E} = P - C(F.S) * t(|\boldsymbol{S}|) * \sum_{j\,\in\,S}\alpha_j$ and $v(S)$ contents the constraint $v(\emptyset) = 0$.

The objective of each ESP is to determine membership in a coalition that gives the highest share of profits. There are different ways for dividing the profit *v(S)* achieved by coalition *S* among its members in MG. The first method will use *Shapley value* but *Shapley value* calculation requires repetition on each division of the coalition, an exponential time for attempts. Another rule for dividing profit is *Equal Sharing* of profits among members. Equal sharing provides equal sharing attribution that provides a traceable way to successfully identify and use shares as a rule of customization in other systems where traceability is crucial (eg, [23], [24]). For this reason, we are discussing equal participation in profit as basis of profit splitting. Given their behavior that maximizes well-being, ESPs prefer a low-profit coalition if their profit margins are higher than those they have gained by participating in a very lucrative coalition. Therefore, ESPs can choose preferred *S* coalition.

$$max_S\ \frac{v(S)}{|S|} = \max_{S}\ \frac{P - C(F.S) * t(|\boldsymbol{S}|) * \sum_{j\,\in\,S}\alpha_j}{|S|} \quad (6)$$

some restrictions need for solving in our model, First, the tasks should be complete before deadline, while the second (overall Coalition G) is members of coalition. When an *S* coalition is formed, its production is equally shared among its members and then profits are referred for each member by

$$\varphi(S) = \frac{v(S)}{|S|} \quad (7)$$

Through the formation of a comprehensive coalition of profits obtained by each member Participation in the overall coalition is not less than one get it when you work alone, so the full profit of the overall coalition must be divided among its members.

$$\sum_{G\in S}\varphi_g(G) \ge v(g)\ \ .\forall\, S \subseteq G$$

The result of that conception solution of coalitional game is a profit carrier that distributes profits between players with a fair manner. with case of revenue of any coalition not exceed of total revenue of its members in the overall coalition, in addition, if no player has an inducement for leaving overall coalition to join another coalition (for higher profit), the vector in the EM configuration game may be empty, If a comprehensive coalition not formed, it will form independent and separate coalitions.

Assume that if MG_S is not involved to perform a task, it should get zero payoff. If there is some groups do not participate in any task, there should not be considered members of EM.

IV. EM Configuration Mechanism

this section presented the conception of the game theory of coalitions needed to describe the proposed mechanism and then providing the mechanism. *coalition formation* [25] is divide the players into separate groups. Coalition $S = \{S1, S2\ ,.\ .\ .\ , Sn\}$ is a separate coalitions where each player is membering of a single coalition, *i.e.*, $S_i \cap S_j = \emptyset$ for *all i and j where* $i \neq j$ and $\cup_{S_i\in S} S_i = N$. In the EM configuration game specified in the section above, only one coalition is selected in coalition structure to implement the application form, where coalition chosen produces the highest individual reward for all its members. Coalitions that cannot complete the program at the deadline it should be consider financial returns of coalitions are zero. The following concept used in designing an EM forming mechanism. Therefore, when forming optimal structure of coalitions, each element of coalition preferred to participating with coalition that would benefit most from the gains, while not representing the total coalition value. To this end, the comparative relationship "Pareto system" is called on basis of individual reward.

Assume two sets of separate coalitions $A = \{A_1, ..., A_i\}$ and $B = \{B_1, ...,B_j\}$ formed from the same players. For one collection $A = \{A_1, ..., A_i\}$, the payoff of a player k in a coalition $A_k \in A$ is $\Phi_k(A) = \Phi_k(A_k)$ *where* $\Phi_k(A_k)$ is given by eq. (6) for coalition A_k. Collection *A* preferring to *B* by Pareto order, i.e.

$$A \rhd B \Leftrightarrow \Phi_j(A) \ge \Phi_j(B). \quad \forall\, j \in A.B$$

And

$$\Phi_k(A) > \Phi_k(B).\ \ \exists\, k \in A.B \quad (8)$$

Pareto rule means, set of players prefer to join Group *A* instead of *B*, if one player can have improved his profit at least when the structure is changed from *B to A* without reducing anyone else's bonuses. In forming an ideal coalition structure, each MG group preferred to participating in coalition that will bring the most profit to it, while total values of alliance will not be. To this end, the comparison relationship [26], [28], called Pareto Order, is introduced on basis of individual reward. in Equation (8), Group *A* preferred structure of *B*. If one player is able for getting a better reward at least without diminishing other players' profits, based on an individual comparison relationship, we suggest an algorithm by ESP in a central way,

Join and Separate (or merge and split).

Join: Join any sets of coalitions $\{S_1, ..., S_l\}$ where $\{\cup^{L}_{i=1} S_i\} \triangleright \{S_1, ..., S_l\}$, hence, $\{S_1, ..., S_l\} \rightarrow \{\cup^{L}_{i=1} S_i\}$

Separate: divide any coalition $\{\cup^{L}_{i=1} S_i\}$ where $\{\{S_1, ..., S_l\} \triangleright \{\cup^{L}_{i=1} S_i\}$ hence, $\{\cup^{L}_{i=1} S_i\} \rightarrow \{S_1, ..., S_l\}$.

From the definitions of Join and Separate, we using the defined comparison relations, [24], [27]:

Coalitions decide to join only if at least only one can improve their individual profits strictly through the consolidation rule without minimizing other electronic support transactions. Therefore, the individual merger rule is an agreement between MG working together if it is beneficial to them. [29] As we mentioned earlier, once coalitions formed coalitions, the final coalition, is implementing the program, so forming rest of coalitions is unimportant. The reason of resting of the MG is not in the final coalition can be involved again in the process of forming another coalition to perform another custom application. Therefore, the coalition has decided to split only if there is only one sub-alliance that strictly improves the individual rewards of its constituent group. Under the split rule, individual profits can be reduced to other sub-coalitions. The rule of division seen as not implementing a selfish decision by coalition and without considering impact of division on other coalitions. S_i *and* S_j coalitions decide to merge based on complement comparison specified by the eq. (8) where all MGs in S_i, S_j able to maintain or improve their individual profits. The individual profit of the MG calculated by eq. (6) finish with final input. As a result, the merge occurs if two following differences are satisfied.

When the rate of each coalition divided among its members on basis of the proportional rule of some of specific participation(contribution) lists $\alpha_{i\,.i \in N}$ [30]

$$u_i\,(S) = \frac{\alpha_i}{\sum_{j \in S} \alpha_j} * v(S) \tag{9}$$

$$A \succcurlyeq_i B \Leftrightarrow \frac{\alpha_i}{\sum_{j \in A} \alpha_j} * v(A) \geq \frac{\alpha_i}{\sum_{j \in B} \alpha_j} * v(B)$$
$$\Leftrightarrow \frac{v(A)}{\sum_{j \in A} \alpha_j} \geq \frac{v(B)}{\sum_{j \in B} \alpha_j} \tag{10}$$

Define $\varphi(A) = \frac{v(A)}{\sum_{j \in A} \alpha_j}$ any i $\in N$ and A, $B \in S$, $A \succcurlyeq_i B$ if $\Phi_k(A) > \Phi_k(B)$

For the partition rule, a coalition decides to splitting into two coalitions S_i *and* S_j based on divided comparison set by eq. (8) where all MGs in C, SG, or both able to maintain or improve their individual payoffs. Thus, splits if only one for following inequalities is satisfied.

$$B \succcurlyeq_i A \Leftrightarrow \frac{\alpha_i}{\sum_{j \in B} \alpha_j} * v(B) \geq \frac{\alpha_i}{\sum_{j \in A} \alpha_j} * v(A)$$
$$\Leftrightarrow \frac{v(B)}{\sum_{j \in B} \alpha_j} \geq \frac{v(A)}{\sum_{j \in A} \alpha_j} \tag{11}$$

$B \succcurlyeq_i A$ if $\Phi_k(B) > \Phi_k(A)$

After determining the maximum full benefit for the coalition forces (indicating contribution factor or rate of each MG in each coalition for maximum profit), we applied the "Equal Sharing Role" to appropriately distribute the profits in coalitions when $\alpha_j = (1.1. \ldots 1)$. From above we note that the individual reward of each MG only one from divided coalitions, S_i *or* S_j, should be higher than or equal the sum of its total profits. coalitional structure stability characterized by conception of *Stability Function S* [20], [31].

The rule applied is "Shapley value" that widely using in the fair distribution of coalitional games [30], [32]. The "Shapley value" can be taken as a measure of contribution for each MG. For our coalitional game *(N, v)*, Shapley value for each MG is denoted as $\boldsymbol{\varphi_G(S)}$ that calculated as:

$$\boldsymbol{\varphi_G(S)} = \sum_{s \subseteq N \setminus \{i\}} \binom{|S|-1}{|N|}^{-1} \left(\boldsymbol{v}(\boldsymbol{S} \cup \{\boldsymbol{i}\}) - \left(\boldsymbol{v}(\boldsymbol{S})\right)\right) \tag{12}$$

where each subset of S coalition is added without the i player, and the corresponding profit *v (S < {i})) − v(S))* acquired by player i under the different join order, the average value is all that is possible Conditions are calculated. Shapley value calculated for each MG_i is obtained after distribution [33].

V. Simulation Results

We consider 30 MGS. Since each MG sends a message to ESP contains all the required energy information, keeping in mind that this number of MG is reasonable. We ran 10 different application workloads, range from 1 to 10 tasks. Simulation parameters. The deadline is 3,00 seconds and the payment equal 20 units maintained on all tests. The deadline and payment values are large enough to ensure a practical solution in each experiment. The speed bus is created for the fastest current Intel processor, where we assume to be 100 IPS. Each task has a workload expressed in the instructions, randomly selected from [10, 100]. The load vector, w, contains the workload of each task per massage. Basing on the velocity vector and load vector, the time execution for each T_j task for each MG g_i obtained by ESP using equation (4). the time execution matrix is consistent if a MG g_i its task execution T_j faster than MG g_k , executes all tasks faster than MG g_k [26]. The generated time matrix is consistent due the fact that $w(T_j)$ is fixed for $T_j \in F$, thus, for any task T_j if $t(T_j,G_i) < t(T_j,G_k)$ is true, then we have $s(G_i) > s(G_k)$ which means G_i Respond to the request is faster than G_k. As a result, $t\,(T_q,G_k) > t\,(T_q,G_i)$ is satisfied for all tasks $T_q \in F$. Each overhead matrix c is generated using method described in [26]. For each coalition formation, two different methods of **"Equal Sharing and Shapley value Role"** applied for profits distribution between MGs to distribute profits between the MG in a fair manner.

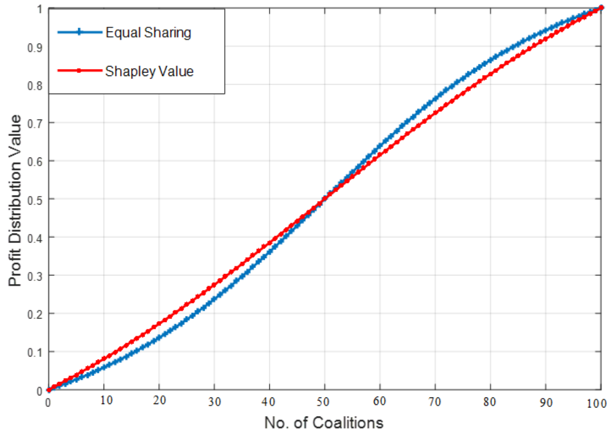

Fig. 2. Profit distribution value of shapley and equal sharing roles

In Fig. 2, presented the comparison of contribution between Shapley and Equal share roles" , which result from coalitions of all members. Once coalitions are formed, the MGs of the same coalitions face problem of how to appropriately distribute additional profits in the coalitions. The profit distributed depends entirely on rating of the MGs contribution from each MG in the coalitions. By applying two methods, they are relatively close to the value of profits distribution between the MGs with different number of coalitions.

From Fig. 3 The time execution is shown if two Shapley and Equal Share Role methods are applied, execution time is reasonable to indicate the appropriate coalition to incorporate any MG and after profits distribution. From the way we observe, the times of implementation of Shapley value method are greater than comparing role of Equal Share with increasing number of tasks (coalitions) because they require repetition of each part of the coalition.

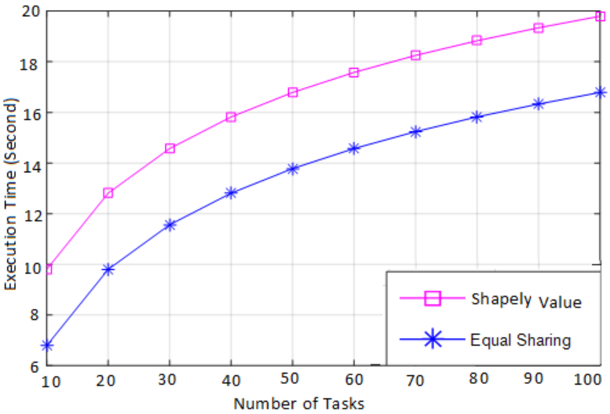

Fig. 3. Execution time comparison between shapley and equal share roles

Fig. 4 Show the profit value for each one of the two method " Equal Sharing and Shapley Value Role " where by increasing no. of coalition the payoff value distributed over all members of coalition. after applying the two methods we are noting that Equal Sharing Role Provide higher payoff value than Shapley Role"

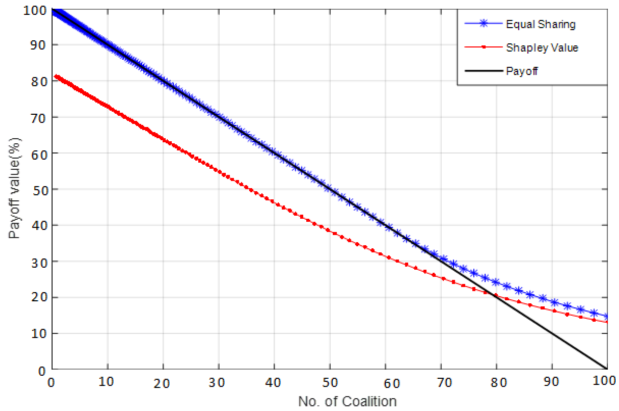

Fig. 4. Payoff value comparison between shapley and equal sharing roles

VI. Conclusion

We conduct sets of simulation attempts that allows of comparing the two methods to enable ESP to determine memberships in a coalition giving the highest percentage of profit. The different methods divide the profit earned by coalition among members. The first one is Shapley value, but Shapley value calculation requires the repetition of each division of the coalition, an exponential time endeavor. Another rule for payoff division is equal sharing of the profit among members. Equal sharing provides a tractable way to determine shares that successfully used as an allocation rule in other systems where tractability is critical. For this reason, we rely on equal participation program as basis of profit splitting.

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