



## Economic Analysis Tools Implementation in Resource Management Process

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### Introduction

A characteristic common feature of economic resources including financial capital, is their scarcity that determines the need to seek maximum utility and return to their management. On the other hand is the well known and generally accepted idea of unlimited amounts of human needs, which among other things have a tendency to reproduce at a higher level when they reach a certain degree of saturation or satisfaction. Summed effects of both economic and social phenomenon give the necessity of choice and make rational, informed and effective solutions to meet existing needs with available resources and in a way as to maximize the utility of the resources used.

The above-described theoretical concept holds true for issues related to financial resources management in the defense sector. The amount of these resources is limited by various factors, among which the most significant influence have the size of gross domestic product, state of the economy as a whole, the amount of funds allocated from the state budget in the interest of building and maintaining defensive capabilities, the allocation of earmarked funds for security in areas which include personnel, maintenance, training, participation in operations, investments, etc. The limited scope and significant amounts of financial resources for security on the one hand and on the other hand the need for security, which is one of the existential needs of people demanding to impose decisions on the use of resources and tools to their justification and support.

### Current Situation Description

In modern conditions the Analysis of Alternatives (AoA) is used in practice as a tool for decision support in the planning process of the forces on the basis of capabilities, in determining the structure of the Armed Forces in support for analysis and selection of options for action related to the size defense spending, risk management, etc. In this type of analysis the focus is on life-cycle cost and operational effectiveness of alternatives without paying explicit attention to whether alternatives are acceptable (affordable) in terms of current budgetary constraints. The analysis of alternatives seek to assess costs and effectiveness of competing alternatives and how far they are eligible in terms of financial constraints is considered as a separate issue and therefore remains in the background. In the analysis of alternatives is carried out modeling of the decision by comparing the

alternatives presented as points in the field of coordinate system with axes measuring costs and effects.

In assessing the defense investment criteria “costs” and “effects” can not easily be combined into an integrated criterion by which to assess and rank the importance of investigated alternatives and decide on choosing a preferred alternative. Using criteria to evaluate the effectiveness (Measures of Effectiveness, MoE) and the cost of the life cycle of alternatives does not solve the problem of combining these two private evaluations in a summary that gives rise to the final worthwhile. Criteria for assessing performance (Measures of Performance, MoP) in turn are usually quantitative systemic in nature, selected for their help with measurements to be one or several criteria for assessing effectiveness. According to Hitch and Makiyn, criterion is a test by which to elect an alternative to other, competing with her. Choosing the appropriate criterion is a central problem in defining and implementing the cost-effectiveness analysis. The two most popular criteria used in making decisions based on the AoA include: benefit / cost ratio; determining the weighting of costs and effects.

Using both criteria is associated with some problems. The first criterion is being implemented smoothly if there is a scenario that sets budgetary constraints or the level of desired effects. Benefit/cost or effects/costs ratio are used in AoA when neither costs nor benefits/effects of the compared alternatives can be fixed and leveled.

Figure 1 presents two alternatives A and B, the realization of each would bring different effects and needs different costs. Alternative B has a higher evaluation of the effects to alternative A, which is valid with respect to estimates of the costs. As a criterion for comparing the two alternatives is selected ratio cost/effects. Consider that:

$$\frac{\text{Effects A}}{\text{Cost A}} > \frac{\text{Effects B}}{\text{Cost B}} \quad (1)$$

Remains an open question actually an alternative A is better than alternative B and if it is affordable and realistic in terms of resource constraints. Let's look at an example evaluating the effects and costs of both alternatives, the values of which are given in Table 1.

Based on data from Table 1, effects/costs ratio of both alternatives is respectively equal to 1 and 0.9, the choice of a preferred alternative is directed to alternative A. It is possible, however, another case in which estimates of the effects and costs for two alternatives to be as it is shown in Table 2.

Under these conditions the value of the effects/costs ratio of alternative A is 1 and for alternative B is 1.1, hence the preference

Table 1: Evaluating the effects and costs of both alternatives.

Alternatives	Cost estimates, In mln levs	Effect estimates, In utility
A	10	10
B	1 000	900

Table 2: Estimation of the effects and costs for two alternatives.

Alternatives	Cost estimates, In mln levs	Effect estimates, In utility
A	10	10
B	1 000	1100

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to be directed to alternative B. Comparing the absolute cost of the two alternatives shows that alternative B is hundred times more expensive than alternative A, which automatically raises the question of the possibility of financing more expensive alternative within the existing budgetary constraints. It is obviously the necessity of performing analysis and assessment of the utility to receive an additional 1090 units from the effects of alternative B, whose value is 990 million or preferred alternative with lower costs as in this case is an alternative A.

When using a effects/cost ratio an effective approach is a gradual narrowing of the limitations of comparing alternatives in terms of costs or effects to reach the same levels of costs or effects, then choose their preferred. An example of applying a similar approach could include the choice of several home evaluations for the budget available. If during the analysis found that the same alternative is preferred in all dimensions of the budget, then obviously it can with high confidence to be accepted as the preferred overall. In the event that none of the studied alternatives is best for all measured values of the budget, it is also useful information for decision makers.

The second criterion used in the AoA is associated with determining the weighting of the effects and costs. In response to the observed lack of capabilities (capability gap), defined on the basis of scenario planning in response to a threat should be defined the requirements for weapons systems, doctrine, training, readiness, etc., by which this gap will overcome. Based on these requirements to determine criteria for assessing effectiveness, which most often constructed as a hierarchical structure in a manner shown in Figure 2.

The characteristics of the lowest fourth level - speed, range, weight, load capacity - can be measured and defined quantitatively.

Using the names in this example, the utility function can be written as:

$$U = U(M, T) = \phi_1 [\phi_2 (S, R), \phi_3 (P, W)] \quad U = U_{\max} \quad (2)$$

Task using the utility function is to determine the alternative, giving maximum impact per unit cost of resources.

More widely used, similar but more elementary approach to the analysis of alternatives is to determine the weighting of the costs and effects of the studied alternatives and replacing them in function of the utility. The European Union has approved a legislative package to simplify and modernize existing in individual states laws on public procurement. The package retain the two criteria for evaluating and comparing alternatives - the lowest cost and highest economic value. Requirements to member states related to publication of the values of the weightings for each of the criteria applied in determining the highest economic value.

Using the weighting -  $w_1$  and  $w_2$ , and assessments of the effects and costs are determined value of utility function for each of the studied alternatives, based on which choose their preferred.

$$V = w_1 \text{Effects} - w_2 \text{Cost} \quad (3)$$

The preferred alternative is that with the highest value of the utility function.

$$V = (\text{Effects}, \text{Cost}) = \max \quad (4)$$

Applying the described approach is related to solving two major problems:

modeling the effects and costs of alternatives and determine the weighting.

In the second problem, should answer the question how important are the effects, costs, respectively, analyzed in the present case. An example analysis is used to select plants for water treatment, where should decide what is more important: minimizing the cost of funds or maximizing the degree of water purification and what proportion is the importance of both parameters.

Using the example shown in Figure 3, depending on the values of the two weighting -  $w_1$  and  $w_2$  two extreme cases are possible:

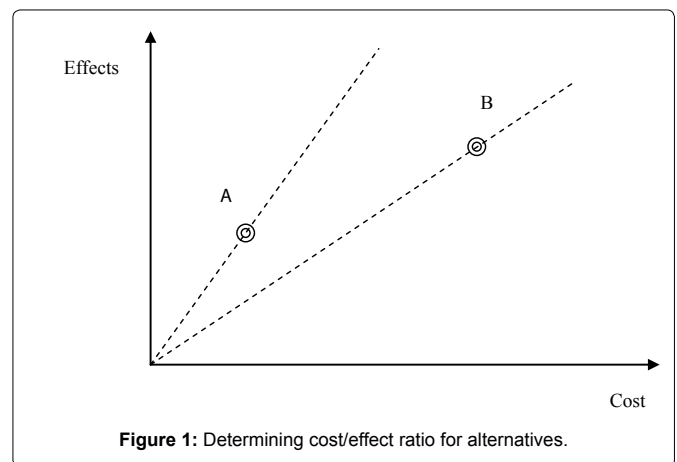


Figure 1: Determining cost/effect ratio for alternatives.

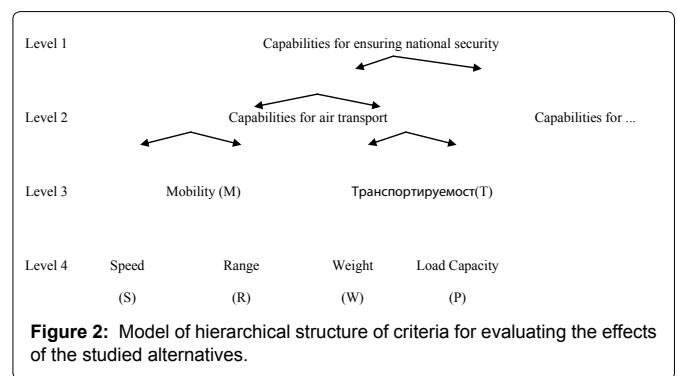


Figure 2: Model of hierarchical structure of criteria for evaluating the effects of the studied alternatives.

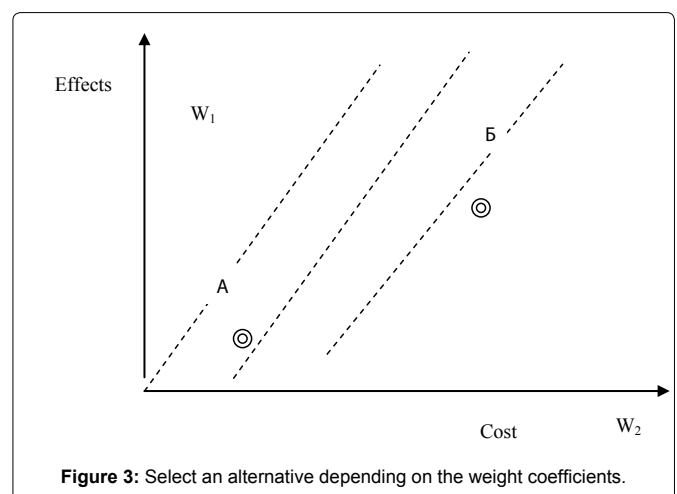


Figure 3: Select an alternative depending on the weight coefficients.

- When the effects were evaluated as significantly more important than cost, i.e.  $w_1 \gg w_2$ , the preferred alternative will be B;
- Where costs are assessed as significantly more important than the effects, i.e.  $w_1 \ll w_2$ , the preferred alternative will be A.

In analyzing extreme cases are usually ignored, so the question arises of how to set the values of the two weighting -  $w_1$  and  $w_2$ . If not considered the affordability of the alternatives in terms of resource constraints, i.e. if the budget is unlimited, it can be assumed that  $w_2 = 0$ , in which alternatives are compared only to their effects.

To determine the appropriate weighting factors need to be aware of resource constraints in terms of budget. For a high level of uncertainty of the analysis tends to underestimate the costs, i.e. down the optimistic assessments of the amount of resources needed to implement the program/project. As a result of this trend is disturbing the balance between resources for the consumer portfolio of programs/projects in the defense and the availability of such handle is committed to feasible programs/projects, reduces the probability of success and increased risk for programs/projects and as an endpoint reaches the failure to build the desired defense capabilities in quantitative, qualitative and temporal aspects.

### Development of Economic Analysis Tools and Their Application in Resource Management Process

One of the main challenges facing strategic management of defence is to achieve a balanced combination (portfolio) of acquisition projects among others are eligible in terms of budgetary constraints. Addressing this challenge is possible at the expense of implementing effective methods of analysis, definition and maintenance of managerial decisions related to defense resource management, as is the method EEoA. In this method clearly distinguishes three variables: life cycle cost or cost of alternative operational efficiency, resources are expected to be available to finance the program/project (financial scenario).

One of the ideas of EEoA is to improve networking and coordination between the force planning processes based on capabilities, defense resources program management and defense acquisition. Another innovative idea of EEoA is to use different budget scenarios to meet forecasts for the future six-year programming period. Thus the analysis includes an explicit optimization approach for making acquisition decisions within resource constraints. This approach is parallel with the optimization approach of PPBS, manifested in search of an optimal set of forces, equipment and maintenance, which maximizes the product national security within the financial budgetary constraints.

In general there are six ways to structure the analysis of the type EEoA presented by the model in Figure 4<sup>1</sup>. More detailed examination of the six options for structuring EEoA warrants define the following aggregate characteristics:

- In the first five approach to analyze the costs and effects of the program/project regardless of other programs/projects from the portfolio of the organization in case of system defense. In the latter approach analyzes the costs and effects are made in terms of all programs/projects included in the portfolio of defense systems.

- Through the first three approaches is an analysis of alternatives created by the analysts (endogenous alternatives), for example, comparing alternatives for defense programs generated by experts and the programming team. The last approach gives opportunity to compare already established alternatives (exogenous alternatives), for example when assessing the bids of other participants in the process of selecting a contractor of the contract.

Each of the six approaches to structuring EEoA can be described in more detail in the following way:

#### Approach 1: fixed budget approach

This applies in cases where there is fixing the cost of program/project and alternatives to be compared solely on the basis of effects. The preferred alternative is one that provides the largest effect.

Figure 5 is an example for implementing the approach for the analysis of alternatives to the standard level of expenditure. Obviously, at a fixed level of expenditure alternative A provides the highest level of effects so that in this case it may be chosen as the preferred alternative.

#### Approach 2: fixed effectiveness approach

This applies in cases where there is a fixing of the effects of program/project and alternatives are compared only in relation to their costs. The preferred alternative is the one whose costs are lowest.

Figure 6 presents an example of applying the approach to analysis of alternatives to the standard level of effects. It is obvious that alternative A is the lowest cost estimates so that in this case, at the same level of effects that can be chosen as the preferred alternative.

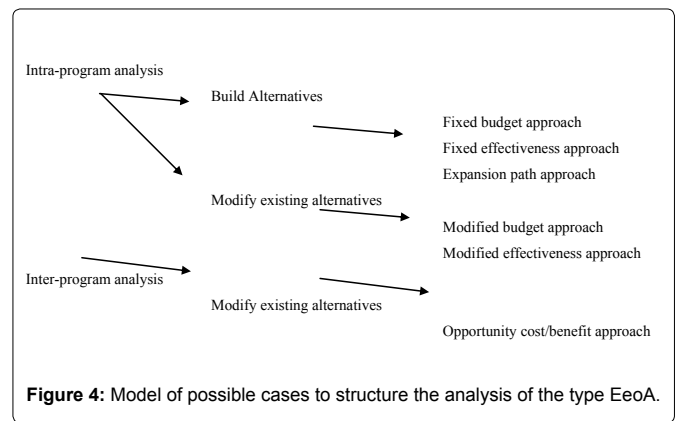


Figure 4: Model of possible cases to structure the analysis of the type EeoA.

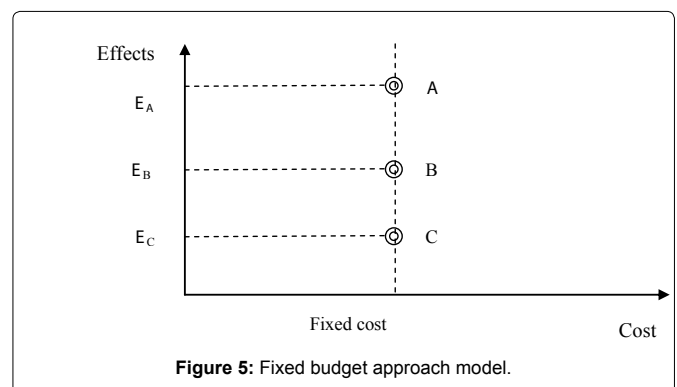


Figure 5: Fixed budget approach model.

<sup>1</sup>F. Melese. Economic Evaluation of Alternatives

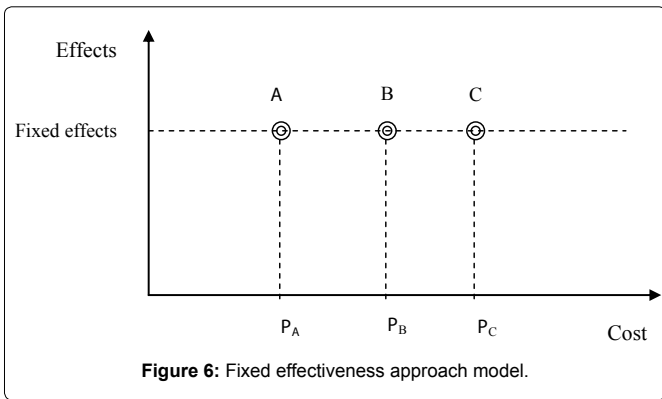


Figure 6: Fixed effectiveness approach model.

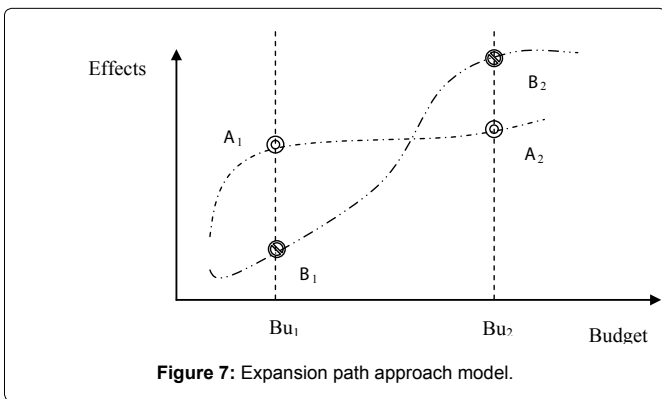


Figure 7: Expansion path approach model.

**Approach 3: expansion path approach**

The application of this approach include the implementation of three consecutive steps (Figure 7). In beginning to define and declare all of the desired quality characteristics of the site, which will be evaluated during the analysis under the pessimistic, optimistic and most likely scenario of funding.

Not declaring the utility function, in which alternatives will be compared. In the second step is to build competing alternatives based on different cost and production functions. Each of the alternatives to maximize on the defined characteristics of the object of analysis and scenarios for funding. In the third step, based on current estimates of funding alternative is chosen which maximizes the effects within budgetary constraints. For each of the alternatives tested is plotted graph showing the climate effects provided for each of the funding scenarios - B1 and B2. Decision to select a preferred alternative to reflect the choice of scenarios for funding:

- When selecting a pessimistic variant B1 as the preferred financing alternative is selected A1;
- In an optimistic variant of funding B2 as the preferred alternative is selected B2.

With a similar approach overcomes one of the weaknesses in the evaluation of alternatives, expressed in obtaining and providing decision makers point assessment of alternatives to the most probable amount of budgetary constraints without taking into account associated risks and their possible impact on the studied alternatives.

**Approach 4: modified budget approach**

A similar approach applies in cases where the studied alternatives

were developed based on some preliminary limitations - such as restrictions on the amount of staff, number of organizational units, etc. (Example providing one computer for each staff; exact number of aircraft in one squadron aviation).

The first step in the analysis of such alternatives is the same to modify it so that all may be the same cost. Obviously, alternatives A and B have different estimates of costs and effects (Figure 8). If the estimated cost of alternative B is accepted as basic or standard, then alternative A is modified in alternative A1 in a manner so that its cost to reach the level of basic or already fixed costs. At the same time be amended and evaluation of the effects of the modified alternative A1. As a second step in implementing the approach is carried out a comparison between alternatives, the basis of which are fixed costs in the case of alternative B, alternative and modified in the case A1. The preferred alternative is that a higher assessment of the effects in case A1.

**Approach 5: modified effectiveness approach**

In applying this approach gradually through the modification of the studied alternatives to the alignment of their effects and a selection of the preferred alternative among modified, which has the lowest cost estimates.

The graph in Figure 9 alternatives A and B have different estimates of the costs and effects. In this case, the effects provided by alternative B is accepted as a border or fixed effects. Alternative A is transformed into an alternative A1 to reach the level of fixed effects. Of the two alternatives with equal effects - A1 and B - apparently the first has

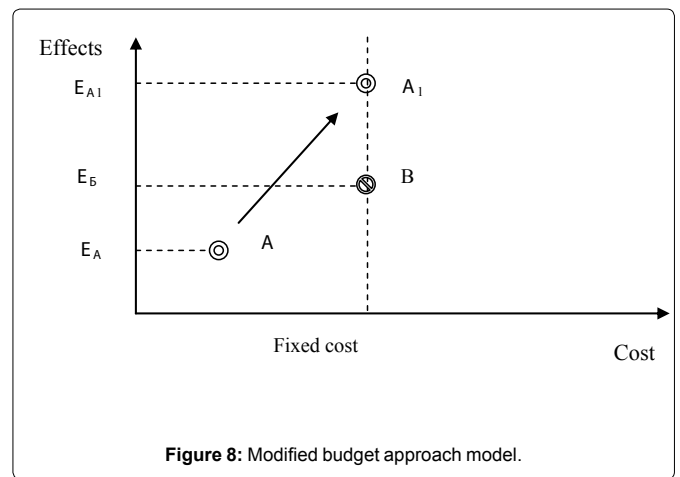


Figure 8: Modified budget approach model.

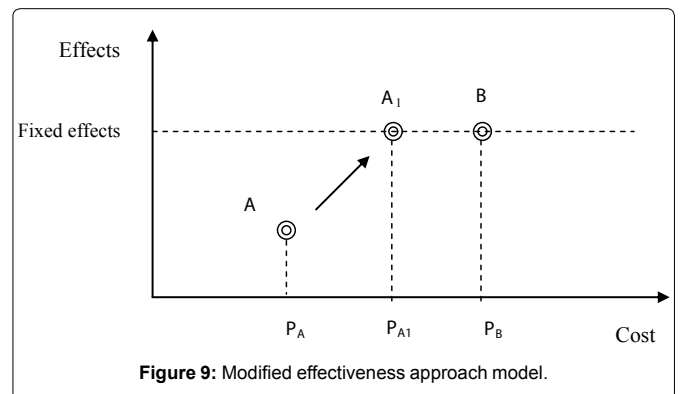


Figure 9: Modified effectiveness approach model.

a lower cost estimates and therefore can be offered and selected a preferred alternative.

### Approach 6: opportunity cost/benefit approach

This applies in cases of analysis of alternatives when comparing alternatives can not be modified, can not be fixed desired level of effects of alternatives, the amount of future funding is unknown.

In these cases it is obvious that there will be alternatives that provide more effects, but with higher cost estimates and alternatives that are cheaper, but providing fewer effects. Under these conditions approach is used to compare alternatives in terms of overall portfolio of programs/projects of the organization (Inter-program analysis). There are two main issues to resolve:

- Where it will provide additional funds if necessary to choose the more expensive alternative;
- How will be redeployed and used the funds if they choose the cheaper alternative.

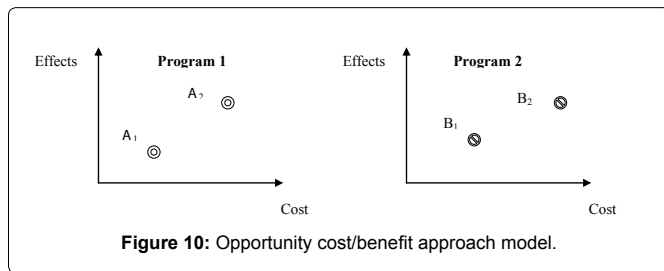


Figure 10: Opportunity cost/benefit approach model.

With this approach it is possible to compare projects of different programs from the portfolio of defence. The analysis should be reported loss effects of the programs in case you choose options on its behalf to fund the shortfall of funds under another program under which selected a more expensive alternative. From the example shown in Figure 10, if an alternative is preferred A2 to A1, the program 1 will receive more effects, but will require additional funding from the program 2, which is imperative in choosing the cheapest alternative B1 and loss effects which would provide an alternative B2. On the other hand can analyze the benefits of choosing an alternative B2 from program 2, which should additional financing of a program 1 and selection of alternative A1.

### Conclusion


Presented an advanced tool for conducting economic analysis in defining and maintaining solutions for the use of limited financial resources for the defense to meet the needs of security and its undoubted advantages are only a necessary condition for increasing the effectiveness of strategic management in defence. Sufficient condition is expressed in preparedness, ability, willingness and readiness of leaders and experts in the defense to apply such instruments in the form of methods and models to define, claim and justify its decisions to be in reality their actions understood by the public, and plans to modernize the Armed Forces realistic, affordable, low risk and resources provided. Only when necessary and sufficient condition exist and meet each other we can expect that the limited financial resources for the defense will actually be spent on addressing the needs of society for security in a manner that ensures maximization of utility received and disbursement of funds from taxes on citizens will ensure getting the greatest effect on them.

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