Firepower Allocation of Continuous Multiple Incoming Targets

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Abstract. Aiming at the problem of firepower allocation under continuous multi-target attack during the course of anti-ballistic missile operations, the time factor is added to the performance function of the evaluation scheme index. A dynamic firepower allocation model under continuous multi-target attack is established. The efficiency changes of the same weapon target matching scheme at different times are fully considered. The problem of target priority is optimized by using the method of generalized difference and rescheduling to solve the dynamic firepower Allocation scheme, which can determine the matching scheme of the target and weapons and the launching time of the interceptor. Thus, make the firepower allocation plan more time-efficient, closer to actual combat. The validity of this method is verified by a specific example. The research results have certain reference value for the application of mid-stage missile defence.

1. Introduction

The purpose of firepower allocation is to determine which positions and which time an interceptor should be reached in to respond to the incoming missile targets in one or more times of anti-missile operations, in order to achieve operational effectiveness with the minimum number of weapons. It can be seen that the firepower allocation includes the matching of weapons targets and the timing of interceptor launching.

At present, the content of firepower allocation focuses on the issue of intercepting missiles allocated to missiles [1-3], and belongs to the Weapon Target Assignment (WTA) issue. The launch timing of an interceptor is determined by the particular operational scenario. Literature [4] studied the firepower allocation in air defence and determined the required number of weapons. The weapon assigned to the target was determined based on the shortest combat time. However, the article did not conduct an in-depth study on the shooting opportunity but conducted a qualitative analysis and did not give an analytical mathematical model. In the paper[5], the concept of "pre-emptive damage" and "firing advancement factor" was used to allocate anti-aircraft firepower to the combined guns. Weapons that meet the expected probability of destruction were assigned to each incoming target, and an appropriate timing of warfare was planned. In the repeatedly attack, the ABM decision-making plan should be adjusted according to real-time operational situations, which increasing the difficulty of choosing the best solution.
In this paper, the time factor is added to the performance function of the evaluation scheme index, a dynamic model of fire Allocation scheme is established, and the model is solved by generalized differential method and rescheduling method. Because time elements are added to the model, the fire allocation scheme is timelier and more practical combat.

2. Analysis of Continuous Multi-target Missile Defence Problem
The text of your paper should be formatted as follows: In actual combat operations, the missile strike is often uncertain. During the entire anti-missile battle, at most one battlefield for each incoming missile is generated for each combat period corresponding thereto. The missile strike is attacking the ground assets with multiple missiles in a very short period of time or a single incoming missile random, offensive position and time are not sure. The firepower allocation plan in actual combat should not only determine the match strategy of the weapon target, but also determine the launch time of the interceptor against the target.

The generalized differential method can solve the problem that the total efficiency of the firepower allocation scheme and the effect of time factor on the quality of the solution when the number of interceptors in firepower allocation scheme is gradually increased. The rescheduling algorithm can maximize the improvement under the condition of shortage of combat resources Combat effectiveness, increase the use of resources.

2.1. Firepower Allocation based on improved generalized difference method
Theorem[6]: The number of incoming missile targets is $n$. The optimal solution for intercepting all targets using $m$ interceptors can be written as $(m_1, m_2, \ldots, m_n)$, $m_1 + m_2 + \ldots + m_n = m$, $m_i (i = 1, 2, \ldots, n)$ indicates the number of interceptors assigned to the target $i$. Then, when the number of interceptors increases by 1, there exists the optimal solution $k$ $(m^1_1, m^2_2, \ldots, m^k_k)$ in the $m + 1$ optimal interception schemes when the number of interceptors is equal $0, 1, \ldots, m$, so that exists the target $k$ in the scheme that makes the final scheme $(m^1_1, m^2_2, \ldots, m^k_k)$ the optimal scheme, when the number of interceptors is $m + 1$.

The principle of generalized differential method is adding an interceptor and find out the optimal firepower Allocation plan when the number of interceptors is $m + 1$, based on the optimal firepower Allocation of allocating $m$ interceptors to $n$ targets.

Suppose the attack target set is $N_q$ in the period $q$, When using the improved generalized differential method to solve the fire Allocation, the combat time is taken as a factor to evaluate the quality of the Allocation effect[7]. The remaining interception time of the missile is the time from the earliest moment when the missile intercepts within the interception time window to the latest moment of the interception window from the moment when the information of the incoming missile is transmitted from the early warning system to the accusation system, which characterizes the urgency of anti-missile operations. If the current moment is before the earliest moment of the interception window, the remaining interception time is the entire interception window time period.

Using adaptive optimization criteria, combined with the remaining interception time and interception probability, the definition of the total performance function is:

$$E = \sum_{j=1}^{n} \varepsilon \cdot p_j + \mu \cdot t_j$$

$\varepsilon$, $\mu$ are the weight coefficients. $p_j$ is the intercept probability of target $j$, $t_j$ is the time cost function, the formula is:

$$t_j = \frac{t_j^l - t_j^r}{\Delta t_j}$$

$t_j^l$ is the last Interceptor launch time on the target $j$, $t_j^r$ is the moment when the last interceptor launched on the target $j$ in the Allocation plan, $\Delta t_j$ is the length of launch time window of target $j$. 


When the objective function incorporates the time factor, the higher the interception time is, the higher the quality of the prior Allocation plan is. On the contrary, the closer the interception time is to the deadline, the lower the quality of the Allocation plan is.

Steps of generalized differential method are:

1) First, find the number of basic interceptors that satisfy the probability of destroying damage. The minimum number of interception interceptors per target is \((m_1, m_2, \ldots, m_n)\). Find a target to make the number of the interceptors assigned to the target is \(m_0\), the optimization plan is \((0, 0, \ldots, m_0, \ldots, 0)\), when the launch time is \((t_1, t_2, \ldots, t_m)\). The set target is allocated according to the expected damage value, the expected damage probability for each incoming missile target is \(p^*\), in the period of time \(t_0\). So that the minimum projectiles \(m_0\) can be solved:

\[
m_0 = \min\{\log_{1-p^*}(1-p')\}, \quad j = 1, 2, \ldots, n
\]

2) Add an interceptor on \(m_0\). There are two cases, in the first case, each target of the current time is assigned to \(m_0 + 1\) interceptors, and the intercept performance is calculated and the maximum value is \(\Sigma_0\). In the second case, on the basis of (1), an interceptor is added to one of the targets to calculate the intercept effectiveness, and the maximum value is \(\Sigma_0\). To compare \(\Sigma_0\) and \(\Sigma_0\), the corresponding solution for the largest is the optimal solution for \(m_0 + 1\) interceptors.

3) Add two interceptors on \(m_0\). There are three cases, in the first case, each target of the current time is assigned to \(m_0 + 2\) interceptors, and the intercept performance is calculated and the maximum value is \(\Sigma_0\). In the second case, on the basis of (1), two interceptors are added to one of the targets to calculate the intercept effectiveness, and the maximum value is \(\Sigma_0\). In the third case, on the basis of \(m_0 + 1\), find the optimal solution according to Step 2, and the maximum value is \(\Sigma_0\). To compare \(\Sigma_0\), \(\Sigma_0\), and \(\Sigma_0\), the corresponding solution for the largest is the optimal solution for \(m_0 + 2\) interceptors.

Similarly when \(m\) interceptors are added on \(m_0\), it needs to be divided into \(m + 1\) steps.

According to the traditional generalized difference method, when the firepower Allocation is solved, only the number of intercepting bombs is considered, and the type of interceptor bombs is not distinguished. For incoming missile targets, intercepting bombs of different launching positions can be distinguished as different types. Therefore, the use of generalized differential method assigned to the target interceptor, it should also consider the choice of launch position. In each step, there are two levels. The first level is the decision plan \((m_1, m_2, \ldots, m_n)\) of \(m\) interceptors assigned to \(n\) incoming targets. The second level is making \(m_i\) interceptors assigned to the target \(i\). The allocation plan assigned to \(s\) positions is \((m'_1, m'_2, \ldots, m'_s)\). According to the generalized differential method, the estimated initial consumption of interceptors of the target \(i\) is \(m'_i\), and the \(m_i\) interceptors are allocated in \(s\) positions to find the optimal allocation scheme.

2.2. Firepower allocation based on rescheduling

Establish a fire allocation model of continuous multiple incoming objects. Rescheduling[8] refers to when occur new incoming target, updates the program according to the current situation. When the previous decision-making program has not yet been implemented and can’t meet the optimal decision-making under the current situation, it is necessary to release the previous decision-making resources to release the occupied resources and regenerate an optimized solution to the current situation.

The division of the time period follows the target incoming process, dividing the entire operation time process into several time periods according to the events, and the time required to generate the solution is \(\Delta T\). Suppose that make the moment \(\Delta T\) when the first target is discovered as the starting time of phase \(q\), \(\Delta T\) before the moment is the end of the previous period. In this stage the incoming missile collection is \(N\). If a target is not successfully intercepted in a phase, and the target's remaining interception time meets the constraint of the second interception, the target is added as a new target to
the target of the next phase to redistribute the allocation scheme. Suppose the current moment is \( t \),
then at this moment belonging to \( q(t) \), the target of the incoming missile collection is \( N(t) \). The
current collection of weapons resources \( M(t) \) is solved by:
\[
M(t) = M(0) - \sum_{q=1}^{q(t)-1} d(t^q)
\]
(4)

\( N_{ap}(q) \) represent the set of new targets that appear during the period \( q \). \( N_{ap}(q) \) represents the set
of targets that have vanished during the period \( q \), including targets that were successfully intercepted
and those that were not successfully intercepted but could not be intercepted for the second time. Then
the target set \( N(t) \) within the current time as:
\[
N(t) = N(0) + \sum_{q=1}^{q(t)-1} N_{ap}(q) - \sum_{q=1}^{q(t)-1} N_{die}(q)
\]
(5)

There are \( b_i \) launchers at the \( i \) position, so the maximum number of interceptor launches that can
be fired at the same position is \( b_i \). For the same target, in order to prevent interference with each other,
the interception launch interval of each position on the same target is \( \Delta t_i \), the adjacent minimum firing
interval for each launch frame on the same target is \( \Delta t_r \). The position \( i \) of the interceptor’s maximum
launch volume in the period \( q \) is:
\[
M_i^q = \left( 1 + \frac{\Delta t_i}{\Delta t_q} \right) b_i
\]
(6)
The number of missiles launched during the period \( q \) should satisfy:
\[
\sum_{j=1}^{m} \sum_{i=1}^{n} x_{ij}^q \leq \sum_{i=1}^{n} M_i^q
\]
(7)

\( x_{ij}^q \) represents the position \( i \) assigned to target \( j \) during period \( q \). The matching decision value
\( x_{ij}(t) \) of weapon and target at any time meet the 0-1 constraints over time, that is \( x_{ij}(t) = \{0, 1\} \).
Thus it can be seen that the entire matrix of fire allocation decision-making also changes over time,
indicating whether weapons \( i \) are assigned to the target \( j \) at time \( t \)[9], in the course of the anti-missile
operations, the same allocation plan was put in place at different times to represent different interception strategies.

Applying a combination of on-line scheduling and re-scheduling to avoid the phenomenon of "short-sightedness" in the allocation plan due to the appearance of a random target, and to make the second interception of the target that is not successfully intercepted in the first interception solution[10].

3. Steps of continuous multi-target fire allocation

Text Steps of continuous multi-target incoming missile defense firepower allocation are as follows:

1) First, the target set \( N_i \) of the first phase is used to estimate the initial consumption of the
interceptor of the current phase. For the type of incoming target, the probability of the expected
damage to the target is determined. By combining the hit probability of the missile with
different positions ,the initial consumption \( N_o \) of the current time is obtained:
\[
M_o = \sum_{j=1}^{n} \min(\log_{1/(1-p_j)}(1-p^*)), \quad i = 1, 2 \cdots m
\]
(8)
2) The generalized differential method is used to assign \( M_o \) interceptors to the current wave target,
and the optimal firepower allocation scheme is selected according to the interception efficiency.
3) Calculate the probability of damage to each incoming target, that is \([p_1, p_2, \cdots p_n]\).
4) If \( p_j \geq p^* \), \( j = 1, 2 \cdots n \), indicates that the desired damage value can be achieved under
the current energy consumption, and the amount of ammunition will be reduced by one. Repeat
Target allocation scenario, new target. In the first case, the current number of interceptors meets the requirements of the new target allocation plan. However, part of the plan for the previous target allocation scheme is not finalized, all interceptor missiles and firepower allocation plan are finalized, all interceptor missile launches will be ready for launching and waiting for the launching moment to come.

5) If \( p_j < p^* \), \( j = 1, 2, \ldots, n \), indicates that the desired damage value can’t be achieved under the current energy consumption, and the amount of ammunition will be increased by one. Repeat steps (2) and (3) until \( p_j \geq p^* \), \( j = 1, 2, \ldots, n \) always meet, increase the amount of ammunition by 1 again. Repeat steps (2) and (3) until the probability of intercepting any target meet \( p_j \geq p^* \), \( j = 1, 2, \ldots, n \).

6) After the current missiles and firepower allocation plan are finalized, all interceptor missile launches will be ready for launching and waiting for the launching moment to come.

7) When the new goal appears, there are three situations. First, follow steps (1) - (5) to calculate the allocation plan for the new target. In the first case, the current number of interceptors meets the requirements for a new target allocation scenario, so continue to implement the program. In the second case, the current number of interception shells does not meet the requirements for a new target allocation scheme. If the previous time of fire allocation plan has been executed or the rescheduling has not been implemented, the existing quantity of combat resources will be used as the amount of consumption, and the project will continue to be implemented according to steps (1) and (2). In the third case, the current number of interception missiles can’t meet the requirements of the new target allocation plan. However, part of the plan for the previous time of missiles has not yet been implemented, and then the firepower allocation is carried out according to the re-scheduling to generate a new allocation plan.

8) Proceed to step (7) when a new target appears, until the entire battle is over.

4. Instance simulation analysis

To defend against a target as the background of the anti-missile operation, assume that there are four interception positions around the point, its location is shown in Table 1.

| Table 1. Intercept position coordinates. |
|----------------------------------------|
| position | Coordinates in the geocentric coordinate system.(km) |
|---------|------------------------------------------------------|
| A | (-4583.21 1616.73 4130.31) |
| B | (-4676.21 1633.02 4018.12) |
| C | (-4633.64 1746.35 4019.85) |

Assuming the incoming missile targets landed near the ground. The initial time of the simulated scenario is 0. The parameters are as shown in Table 2:

| Table 2. The first incoming missile information. |
|-----------------------------------------------|
| Target | Discovery time/s | The position in geocentric coordinate system.(km) | The velocity in geocentric coordinate system(km/s) |
|--------|-----------------|-------------------------------------------------|-------------------------------------------------|
| \( T_{01} \) | 340 | (-4373.71 4243.42 3928.88) | (-1.81 -2.71 1.72) |
| \( T_{02} \) | 259 | (-6109.63 1020.23 3051.44) | (0.41 1.64 2.99) |
| \( T_{03} \) | 302 | (-4521.52 -1365.51 5222.33) | (-2.39 3.75 0.69) |
On the first incoming missiles, consider the moment of the missile as the starting moment of the interception window to judge. Four interception positions can be obtained for each incoming missile interception window. Using a certain type of interceptor to intercept the incoming targets, the launch time window of the target in the first period is as shown in Table 3:

### Table 3. Launch time window of interceptor.

| Position | $T_{01}$  | $T_{02}$  | $T_{03}$  | $T_{04}$  |
|-----------|-----------|-----------|-----------|-----------|
| A         | [675  1047] | [367  759] | [563  938] | [240  646] |
| B         | [680  1055] | [415  656] | [579  867] | [256  613] |
| C         | [716  994]  | [398  703] | [620  683] | [209  621] |

Assuming there are three interceptor launchers, the number of interceptors available at each position at the initial moment expressed as $Q = [3 4 3]$. The average intercept probability of interceptor missiles on incoming missiles at different positions is shown in Table 4:

### Table 4. The intercept probability for the first incoming missiles.

| Position | $T_{01}$  | $T_{02}$  | $T_{03}$  | $T_{04}$  |
|-----------|-----------|-----------|-----------|-----------|
| A         | 0.81      | 0.79      | 0.81      | 0.71      |
| B         | 0.82      | 0.64      | 0.87      | 0.79      |
| C         | 0.69      | 0.72      | 0.86      | 0.85      |

Suppose the threat value of current incoming missiles is $c = [0.217 0.185 0.344 0.253]$. Suppose that for the incoming missile target, the expected probability $P^*$ of damage for each target is 0.95. The minimum interval launch time of the same position on the same target is $\Delta T = 20s$. Then according to the formula (8) the required number of missiles can be obtained. The target's initial consumption of interceptor is $M_0 = 8$. The number $m_0$ of minimum consumption of interceptor for each target is 2.

![Figure 1. Interception probability on different number of interceptors for single target](image1)

![Figure 2. Interception efficiency on different number of interceptors for single target](image2)
Figure 1 shows the change in the probability that the target is successfully intercepted according to the number of interceptors increase from 1 to 8 in the current scenario. The results show that when the number of interceptors allocated to each target is 2, the expected damage probability can be met. Figure 2 shows the trend of the maximum interception efficiency when the number of interceptors assigned to a single target is 1 to 8. The results show that for the 4 incoming missile targets in the current time, the interception performance basically does not change while the number of intercepting missiles assigned to each target is 2 or more. We can also see that there is a downward trend in the increase again, reflecting that the probability of damage does not increase any more, and the quality of the program decreases due to the time factor, when the increase of interceptors to a special target.

Table 5 shows that the allocation of interceptors in different positions, while the number of interceptors assigned to each target to meet the maximum interception performance change from 1 to 8. According to the generalized differential method, it is allocated according to the target level, and the minimum amount of ammunition for each target is 2. According to step 1, the optimal allocation scheme is \((0,0,2,0)\) for the firing of 2 interceptors as shown in Figure 2. The corresponding interceptor allocation scheme is \((0,2,0)\) as shown in table 5.

| Number | Target 1 | Target 2 | Target 3 | Target 4 |
|--------|----------|----------|----------|----------|
|        | Position 1 | Position 2 | Position 3 | Position 1 | Position 2 | Position 3 | Position 1 | Position 2 | Position 3 |
| 2      | 0         | 2         | 0         | 0         | 2         | 0         | 0         | 0         | 2         |
| 3      | 1         | 2         | 0         | 0         | 0         | 3         | 0         | 0         | 3         |
| 4      | 2         | 2         | 0         | 3         | 1         | 0         | 1         | 3         | 0         |
| 5      | 3         | 2         | 0         | 3         | 1         | 1         | 1         | 3         | 1         |
| 6      | 3         | 2         | 1         | 3         | 1         | 2         | 2         | 3         | 1         |
| 7      | 3         | 3         | 1         | 4         | 2         | 2         | 3         | 3         | 1         |
| 8      | 4         | 3         | 1         | 4         | 2         | 2         | 4         | 3         | 1         |

The effect of the program for each step of increasing the amount of interceptors from 2 to 8 is as shown in Table 6:

| Interceptors number | The optimal interception efficiency in single step of generalized differential method |
|---------------------|---------------------------------|
|                     | \(\sum_1\) | \(\sum_2\) | \(\sum_3\) | \(\sum_4\) | \(\sum_5\) | \(\sum_6\) | \(\sum_7\) |
| 2       | 0.3242           |               |               |               |               |               |               |
| 3       | 0.3278           | 0.6485        |               |               |               |               |               |
| 4       | 0.3283           | 0.7737        | 0.6716        |               |               |               |               |
| 5       | 0.3283           | 0.8769        | 0.7957        | 0.6752        |               |               |               |
| 6       | 0.3284           | 0.9000        | 0.8978        | 0.7995        | 0.6755        |               |               |
| 7       | 0.3284           | 0.9220        | 0.9035        | 0.9021        | 0.8003        | 0.6755        |               |
| 8       | 0.3275           | 0.9430        | 0.9259        | 0.9039        | 0.9028        | 0.8003        | 0.6755        |

Figure 3 shows the comprehensive interception efficiency of the 4 incoming missile targets according to the generalized difference method and the total number of interceptor from 2 to 8. When the number of interceptor is 8, the comprehensive interception effectiveness is 0.9429.
Figure 3. The interception efficiency of different number of interceptors in the optimal allocation strategy.

Corresponding to Figure 3, the allocation of interceptors for each particular number of interceptors is shown in Table 7. If \( p_j > p^* \), reduce the number of interceptors by one to count according to the generalized differential method to set the desired damage probability for each target. When the number of interceptors is 8, the probability of damage is solved according to the optimal strategy, the result is \( (0.9689, 0.9589, 0.9829, 0.9763) \).

| Number | Target 1 | Target 2 | Target 3 | Target 4 |
|--------|----------|----------|----------|----------|
| 2      | 0 0 0    | 2 0      | 0 0      | 0 0      |
| 3      | 0 0 0    | 0 0      | 0 0      | 0 0      |
| 4      | 0 1 0    | 0 0      | 0 0      | 0 0      |
| 5      | 0 1 0    | 1 0      | 0 0      | 0 0      |
| 6      | 0 1 0    | 1 0      | 0 0      | 0 0      |
| 7      | 0 2 0    | 1 0      | 0 0      | 0 0      |
| 8      | 0 2 0    | 2 0      | 0 0      | 0 0      |

When the number of interceptors is 7, the probability of damage is solved according to the optimal allocation strategy, the result is \( (0.9689, 0.9793, 0.9829, 0.9763) \). We can see that \( p_j < p^* \) exists, so the corresponding scheme is the final allocation scheme when the number of interceptors is 8.

Figure 4 shows the launching times of each position interceptor under the optimal allocation scheme. Position A assigns two interceptors to target 2, and the launching times are [367s, 387s]; Position B assigns two interceptors to target 3, and the launching times are [579s, 599s]; Position B assigns two interceptors to target 1, and the launching times are [680s, 700s]; Position C assigns two interceptors to target 4, and the launching times are [409s, 429s].

The target of the first phase has been assigned according to the expected damage probability and the maximum interception efficiency. When the first phase of the program has not yet been fully implemented, the new target appears, the new target information is shown in Table 8.
Table 8. The second incoming missile information.

| Target | Discovery time/s | The position in geocentric coordinate system (km) | The velocity in geocentric coordinate system (km/s) |
|--------|-----------------|-----------------------------------------------|-----------------------------------------------|
| $T_{05}^1$ | 536             | (-5480.41, 4417.52, 2266.81)                  | (-1.85, -0.61, 3.27)                           |
| $T_{06}^1$ | 572             | (-5661.01, 373.31, 4573.15)                    | (-0.45, 2.25, 0.96)                            |

The parameter information of the new target is shown in Table 9:

Table 9. Launch window and intercept probability in period two.

| Position | Launch time window $T_{03}^1$ | $T_{04}^1$ | Intercept probability $T_{03}$ | $T_{04}$ |
|----------|-------------------------------|------------|-------------------------------|---------|
| A        | [1226,1545]                  | [888,1068] | 0.76                          | 0.83    |
| B        | [1271,1484]                  | [911,1033] | 0.70                          | 0.84    |
| C        | [1280,1427]                  | [884,1120] | 0.62                          | 0.75    |

The number of the threat of target 5 and target 6 are $c_5 = [0.3020, 0.4972]$. It can be seen from Figure 4 that when the scene time is 572s, the interceptors against $T_{05}$ and $T_{06}$ at position B has not been launched. The minimum consumption of interceptors against $T_{05}$ and $T_{06}$ is 4 according to expectation interception probability of the targets. The rank of the threat at this time is $c_6 > c_4 > c_5 > c_1$. At this moment, the number set of interceptor remaining in all positions are $M_2 = (1, 0, 1)$ so that the weapons resources allocated to $T_{05}$ and $T_{06}$ will be released, and the number set of released weapons resources are $M_2 = (1, 4, 1)$. So the second set targets period are $N_2 = (T_{01}, T_{03}, T_{05}, T_{06})$, then using the generalized differential method to allocate the interceptors of $N_2$ again.

Figure 5 is a comparison diagram of the interception efficiency of the target before and after rescheduling with the generalized differential method. It is shown that the rescheduling method is better than the non-rescheduling method in the case of resource shortage.

Figure 5. The interception performance after e-scheduling

The allocation scheme and launch time after e-scheduling are as shown in Table 10:
Table 10. The allocation scheme after e-scheduling.

| Position | Allocation scheme | Launch time |
|----------|-------------------|-------------|
|          | $T_{01}$  | $T_{02}$  | $T_{03}$  | $T_{04}$  | $T_{01}$  | $T_{02}$  | $T_{03}$  | $T_{04}$  |
| A        | 1       |           |           |           |           | 1226      |           |           |
| B        | 1       | 1         | 1         | 1         | 680       | 579       | 1271      | 911       |
| C        | 1       |           |           |           |           |           | 620       |           |

5. Conclusions
In this paper, the time factor is added to the performance function of the evaluation scheme index, a dynamic firepower allocation scheme model under continuous multi-target attack is established, the dynamic fire allocation scheme is solved by the generalized differential method and the rescheduling method. The differential method can solve the effect of the firepower allocation scheme on the quality of solution when the number of interceptor in the firepower system is gradually increased, and compares the operational effectiveness before and after heavy scheduling. It shows that the rescheduling algorithm can be used in a situation that the combat resources is of shortage, in this way the operational effectiveness is maximized and the use of resources is increased.

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