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# Research on Simulation Evaluation of Tactical Internet Network under Dynamic View

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## Abstract

**Aiming at the highly complex and dynamically changing characteristics of the battlefield during the implementation of the tactical Internet, the network effectiveness of the tactical Internet is studied from the perspective of the dynamic field of view. Based on the OPNET simulation tool, the typical tactical Internet is networked. The model has been studied, and a tactical Internet network simulation model has been constructed from the perspective of business performance. Finally, the simulation scenario is designed and simulated according to the operational requirements. The results show that the constructed simulation model can solve the problem of dynamic evaluation of the network effectiveness of the tactical Internet in the combat implementation phase.**

## Keywords

**Tactical Internet; Dynamic Field of View; Network Simulation.**

## 1. Introduction

The tactical Internet is an important part of our military's command information system, and is a communication platform that realizes the interconnection of systems such as command and control, intelligence reconnaissance, fire strike, field air defense, electronic countermeasures, and after-installation support. Because of its diverse equipment systems, flexible networking methods, cumbersome organization and application, and extremely high test costs, the use of test exercises to test and evaluate the effectiveness of tactical Internet networking can no longer adapt to the timeliness of joint combat communications support based on information systems. Issues such as sex and flexibility. Therefore, it is urgent to use an advanced simulation platform to model and simulate the tactical Internet so that the network effectiveness of the tactical Internet can be evaluated scientifically, accurately and quickly.

## 2. Tactical Internet Network Effectiveness Dynamic Evaluation Process

The dynamic evaluation of the effectiveness of the tactical Internet network refers to the use of various technical tools, methods and methods by the information security department (troops) to analyze and make decisions on the performance of the battlefield network by focusing on the command and control activity process and centering on the commander’s key information requirements, thereby monitoring The quality of the real-time communication network on the battlefield. It is based on the actual dynamic changes of the battlefield and the operational needs of our commanders for key information during the operational implementation phase, and through the time sequence analysis of the performance of the tactical Internet network, the entire process and full cycle evaluation method of the network planning program is realized.

In the operational planning stage, the commander first selects the optimal tactical Internet network planning plan through static evaluation of the tactical Internet network planning plan, and then

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formulates the combat information communication plan, instructions and other documents based on this to the information communication support unit, and then information According to the plan, the communications support team began to build a tactical Internet network system. During the combat implementation phase, due to the continuous changes in support conditions (such as the adjustment of higher-level instructions, the development of the battle situation, and changes in user needs), the information obtained through situation monitoring is dynamically evaluated on the basis of the original network planning plan to evaluate whether the effect is effective Deviation, whether there is a difference in the task and whether the position is offset and other factors. According to the evaluation results, the network planning plan is dynamically adjusted to meet the needs of the commander. Finally, an adjusted information and communication support plan is formulated based on the evaluation results, and finally the plan is issued to the information and communication support unit, and the information and communication support unit adjusts the tactical Internet network system according to the plan. The dynamic evaluation workflow is shown in Figure 1:

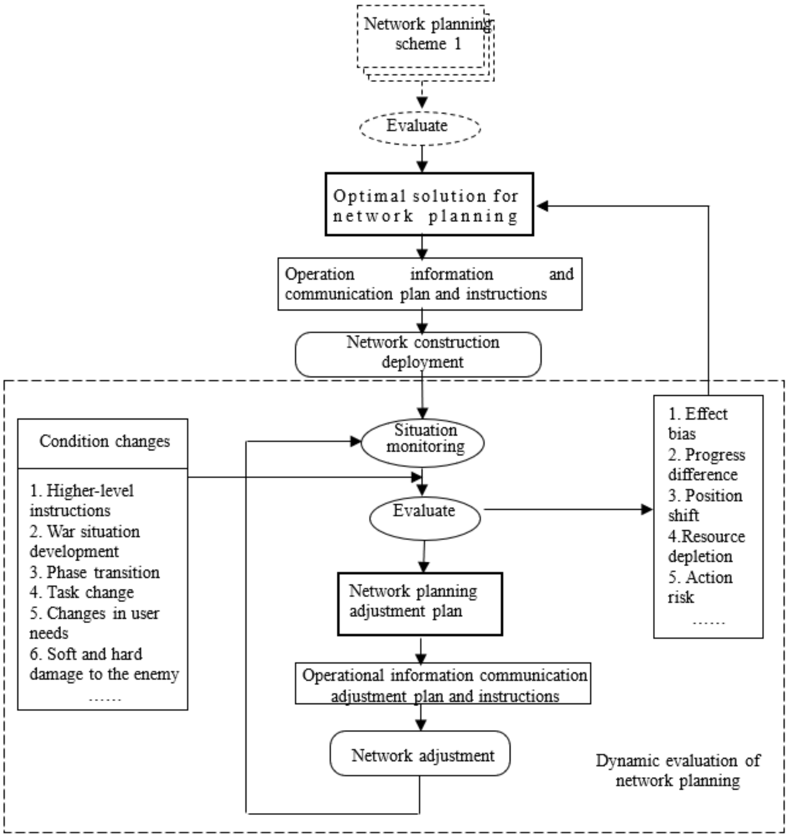


**Figure 1.** Workflow of the dynamic assessment of Zhan Internet network planning

According to the dynamic evaluation process of the tactical Internet, it can be seen that the tactical Internet is not fixed after the construction of the network system, but is a process of continuous adjustment, continuous evaluation, and repeated iteration. The tactical Internet has dynamic performance during use, and the commander's requirements for military information are complex and changeable. Therefore, it is difficult to conduct a comprehensive analysis of the overall performance of the tactical Internet network. However, the performance of the tactical Internet network and communication nodes end up The end performance is closely related, so it is possible to analyze the factors that affect the overall performance of the tactical Internet system by analyzing the end-to-end performance of the node. Through the analysis of the three levels of node, link and network, a dynamic simulation model is established, and the behavioral elements in the dynamic process of the

 Volume 8 Issue 11, 2022
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network are simulated according to military information requirements and specific services, so as to obtain the local service performance characteristics of the network.

In order to build a tactical Internet simulation model to study the business performance of the basic network, it is necessary to conduct node-to-node and end-to-end business performance analysis. The network performance of various tactical Internet services can generally be measured by performance indicators such as throughput R(P), delay D(P), and packet loss rate L(P). When analyzing tactical Internet networks, the key is to obtain the relationship function between nodes and links (edges) in the network. Bring these relational functions into the tactical Internet simulation network model, and use the characteristic parameters of the service flow to simulate and analyze the key parameters such as the throughput, delay and packet loss rate of the network service flow. Therefore, the nodes and links in the network must be mapped and abstractly described, so as to lay the foundation for the next step of modeling and simulation.

## 3. Tactical Internet Simulation Modeling Method

### 3.1 Typical Networking Mode of Tactical Internet

The tactical Internet is based on node switches and uses microwave relay and tactical radio as the main transmission methods. It provides voice, fax, data, and video services to build an information communication platform for land mobile operations. The main communication nodes include: trunk nodes and radio access nodes. Among them, the backbone node is used to construct a backbone transmission network covering the range of the battlefield, and the radio access node is used to construct an access network of all levels and various tactical radio subnets. The typical networking mode of the tactical Internet adopts the network architecture of "backbone network + access network", and its typical networking mode is shown in Figure 2:

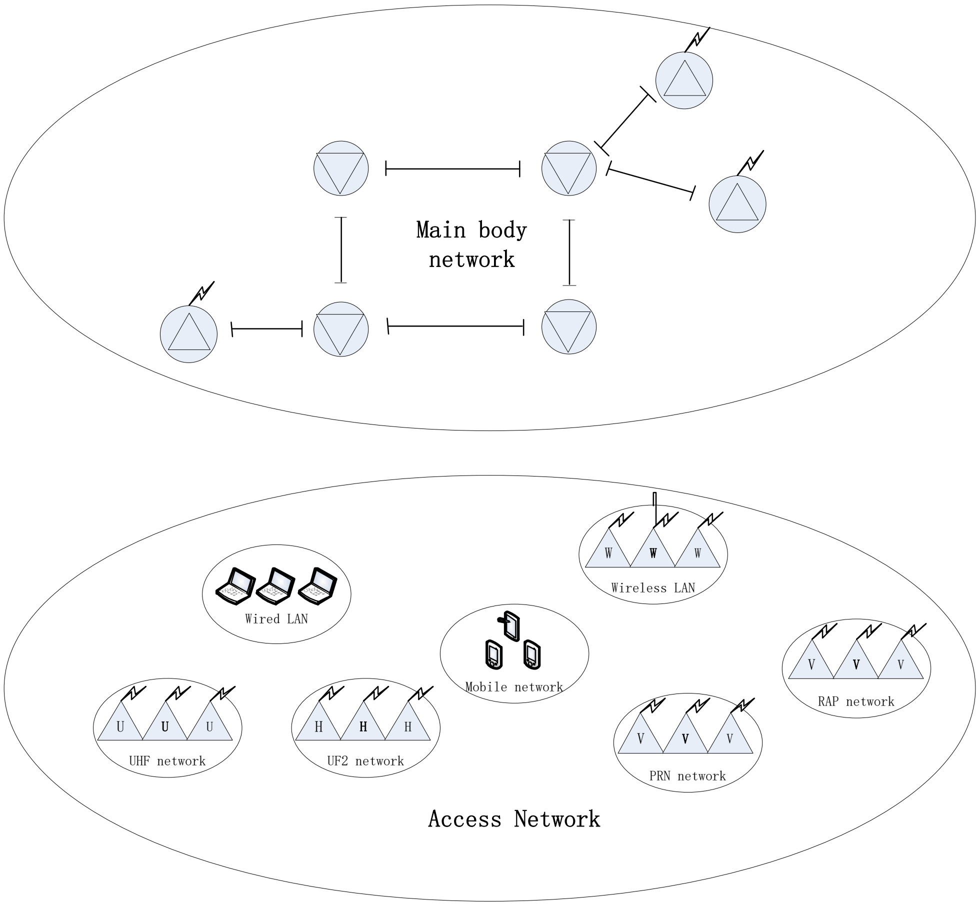


**Figure 2.** Typical networking mode of the tactical Internet

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## 3.2 Simulation Model Mapping Strategy

The tactical Internet has flexible networking methods, a large number of users, a complex topology, and its simulation nodes have physical characteristics such as bandwidth and delay. When the simulation system is mapped from the physical network to the simulated network, node mapping, link mapping, and network mapping must be considered at the same time. The quality of the mapping strategy directly affects whether the response of the simulated network and the real network is consistent.

### 3.2.1 Node Mapping

Tactical Internet node equipment mainly includes trunk nodes and radio access nodes. The trunk nodes use ATM switches as the core to realize the interconnection of various elements of the network. They mainly include 1 node switch, 4 5G microwave relay machines, and 1 ultrashort wave radio station. , 125w shortwave radio and other equipment, considering the actual use of tactical Internet, the work process is simply abstracted as shown in Figure 3:

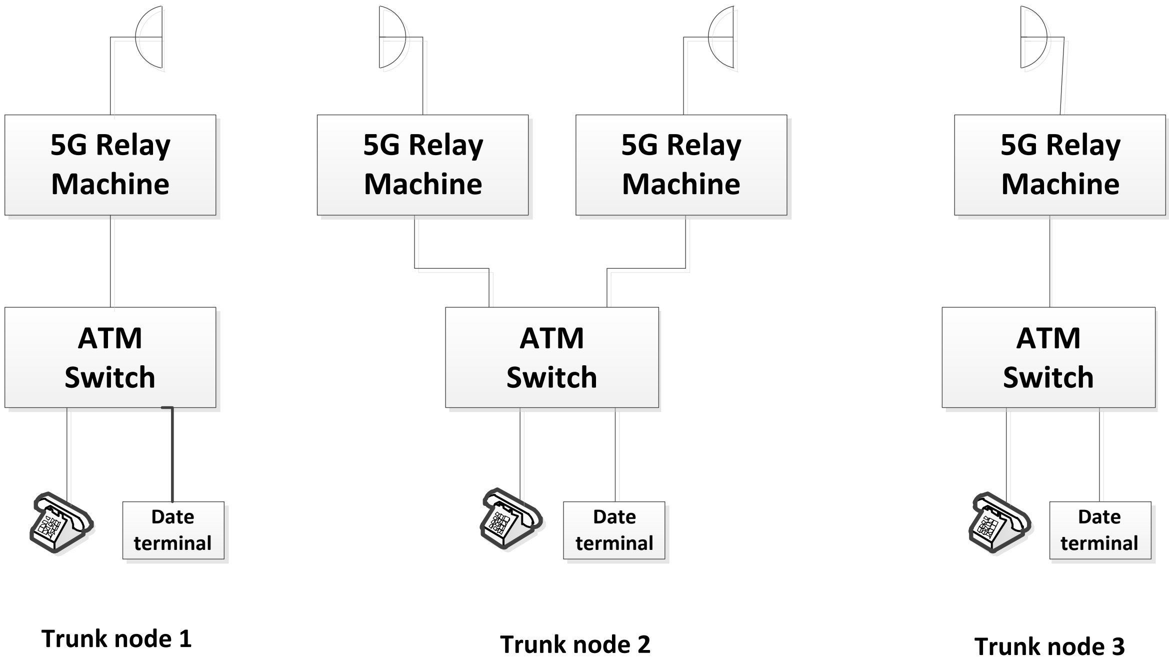


**Figure 3.** Working principle diagram of unconnected car and trunk line node

Map the ATM switch and 5G relay in the trunk node to OPNET Modeler respectively. When designing the trunk node model, map the trunk node from the five-layer computer network architecture. Its application layer and transport layer mainly include data source modules to generate data packets and process data transmitted by the network layer. The network layer includes an ip packet module, an ip routing module and an ip_arp module, which mainly complete the encapsulation and decapsulation of ip data packets, as well as the routing function and address resolution function of the data packets. The data link layer includes ATM call control module, ATM signaling module, AAL module, ATM layer module, distribution module and translation module for the core switch, which mainly realizes the integrated access and exchange of voice, data, image and other services. The layer mainly includes receiving/sending information module and antenna module. The mapping relationship is shown in the table1:

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**Table 1.** Corresponding module relationship table of each layer of trunk node mapping

| Network architecture | Modules of each layer | Function of each layer |
|---|---|---|
| Application layer | Application module | Provide services for the user's application process |
| Transport layer | TCP module | Responsible for the communication between the two processes |
| Network layer | Ip grouping module、Ip routing module、Ip address module | Responsible for routing so that the packets from the transport layer can be exchanged to the destination host |
| Date link layer | ATM signaling module、ATM call control module、AAL module 、Distribution module、Translation module | Responsible for assembling the ip datagrams of the network layer into frames and providing necessary control information |
| Physical layer | Receiver/sender module、Antenna module | Responsible for transmitting bit date stream |

The radio access node is used to set up a radio access node to realize the seamless connection between the tactical radio subnet and the backbone network. It mainly includes 1 node switch, 3 ultrashort wave radio stations, 1 high-speed data radio station, and 1 5G microwave relay machine. When designing the car-free node model, refer to the trunk node model. Compared with the trunk node, the radio access node has more voice processing modules and data processing modules at the application layer, and 5 microwave receiving/sending information at the physical layer. The module has 3 more ultrashort wave receiving/sending information modules, and the antenna modules have certain differences. The network layer and data link layer modules are almost the same.

### 3.2.2 Link Mapping

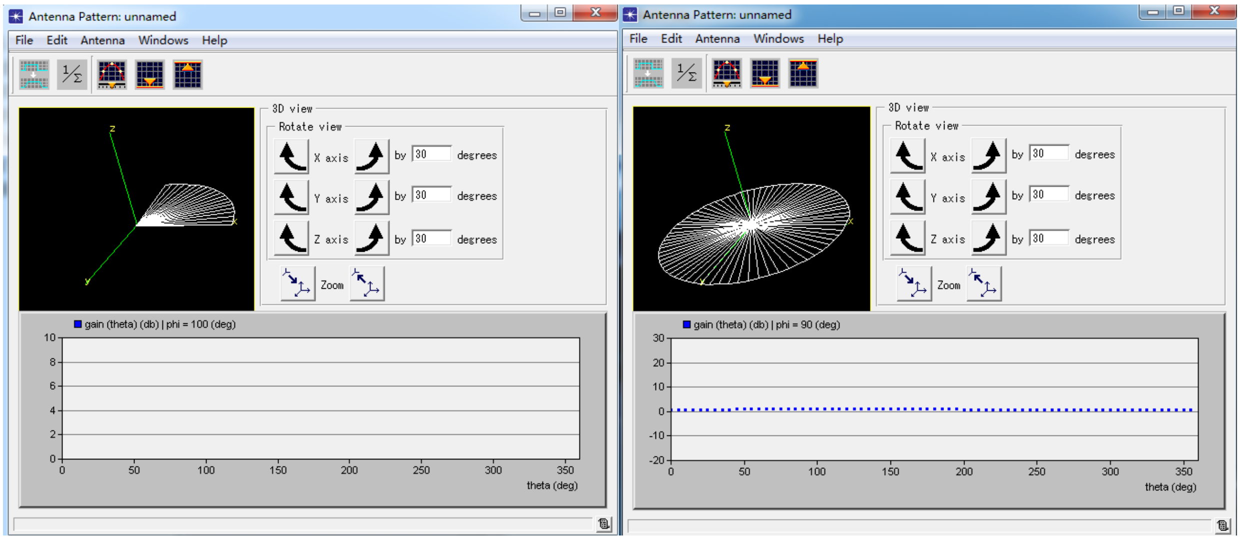


**Figure 4.** (a)Directional antenna model (b)Omnidirectional antenna model

The tactical Internet link can be divided into two types from the transmission medium: wired link and wireless link. Wired links mainly use optical fiber, covered wire and 2M remote transmission to connect within nodes or between command post subnets; wireless; The link mainly uses microwave, ultrashort wave and other means to construct backbone network and tactical radio subnet. The wired link has a corresponding standard library in Modeler, which can be directly called from the model

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library, so I won't repeat it here. Mainly analyze the mapping method of wireless link in Modeler. In the backbone network of the Internet of War, microwave relay is the main means of its transmission, and its links are directional. In the modeler, the directional microwave transmission mode can be mapped to the directional setting of its antenna module. The tactical radio subnet mainly relies on ultrashort wave communication, and its transmission range is a circle centered on itself, and its antenna module can be set as an omnidirectional antenna. The antenna model is shown in Figure 4:

In addition to the difference in the directivity of the antenna, the wireless link model differs in the working frequency, working mode, maximum transmission rate, and modulation mode of the microwave relay and ultrashort wave radio on the wireless link. The specific parameters are shown in Table 2. Therefore, it is necessary to fully consider the configuration of the above parameters when modeling the wireless link.

**Table 2.** Wireless link parameter configuration

| | Working frequency | Way of working | Maximum transmission rate | modulation |
|---|---|---|---|---|
| microwave | 4400MHZ~5000MHZ | Inter-frequency duplex | 34368kb/s | TFM、8PSK |
| Ultrashort wave | 30MHZ~87MHZ | Medium and high speed frequency hopping | 38.4kb/s | FM、CPM |

### 3.2.3 Network Topology Mapping

Tactical Internet network topology mapping can adopt the idea of hierarchical construction. Modeling is carried out in the modeler according to the 3-layer network architecture of backbone network, tactical radio network and access network. The backbone network is deployed by backbone nodes in the form of microwave relay transmission, the tactical radio network is interconnected by ultrashort wave radio stations, and the access network is interconnected by radio access nodes through the RAP base station mode to achieve the interconnection between the tactical radio network and the backbone network. Intercommunication. Its construction network model is shown in Figure 5:

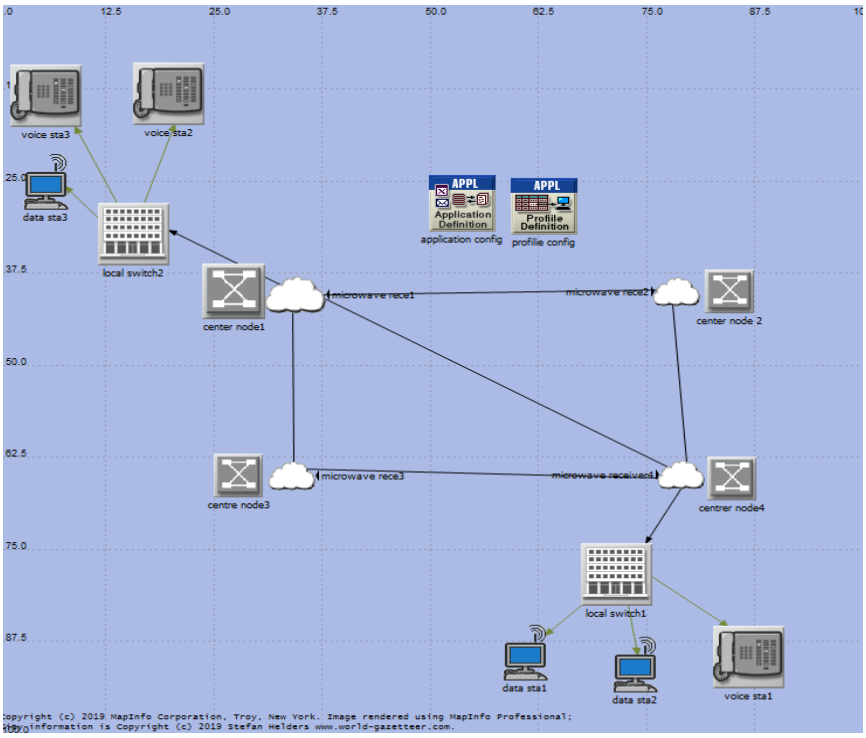


**Figure 5.** Network topology model diagram of the Internet

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## 4. Simulation Design and Implementation

Tactical Internet simulation simulates a large amount of network statistics data, and it must be driven by simulation according to network requirements when performing network simulation. Two scenarios are designed for simulation and simulation according to the combat background.

Scenario 1: The jamming unit of our face-to-face enemy tries to repressive interfere with our command information system. It uses the "drone + jammer" mode to try to s repressive interfere with our communication network system based on a fixed track. The jammer parameters are shown in Table 3:

**Table 3.** Jammer parameter configuration

| Jammer parameters | Numerical value |
|---|---|
| Jammer transmit power | 40w |
| Jammer flying height | 1200m |
| Jammer flying speed | 400km/h |
| Jammer's trajectory | from（xx）to（xx） |

Run the simulation to analyze the anti-interference ability of our command information system by analyzing the receiving curve of our voice and data services.

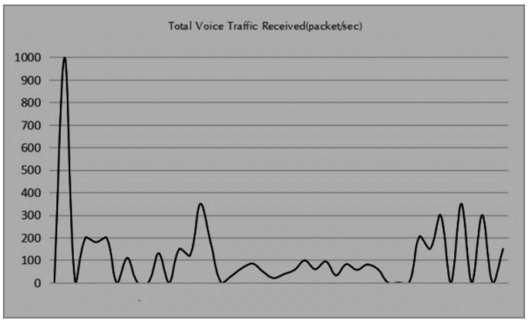


**Figure 6.** a. Voice service receiving and sending curve diagram

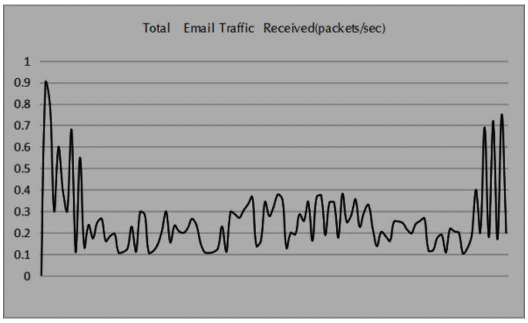


**Figure 6.** b. Data service receiving and sending curve diagram

It can be analyzed from the simulation results that: in the context of this scenario and simulation parameters, the global statistics of the voice data service of the jammer has some interference, but the interference effect is not obvious; while the data service is greatly affected by the jammer, and the packet loss rate Higher, its interference effect is more obvious.

Scenario 2: Our Tactical Internet Route No. 4 node is hit by enemy fire, Route No. 4 node cannot work, its No. 3 and No. 4 microwave links fail, run a simulation, and analyze the throughput of our No. 1 microwave link through comparison Analyze the survivability of our communication network based on the quantity and the packet loss rate of user terminal No. 1.

According to the current unfavorable situation that some nodes of our information communication network are destroyed by enemy fire, and based on the constructed tactical Internet simulation entity model, the tactical Internet network is simulated in the absence of No. 4 node. The network throughput and packet loss rate of node 1 (basic command post) are analyzed to monitor and evaluate the operation of the entire network system. The simulation results are shown in the figure.

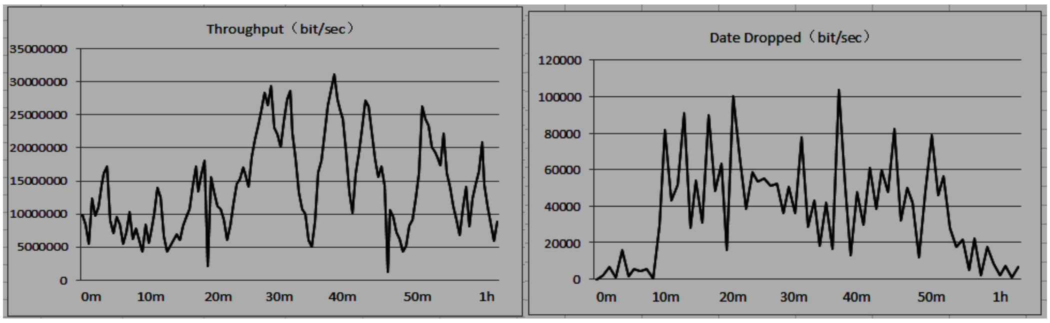


**Figure 7.** a. Network throughput b. Network packet loss rate

Simulation result analysis:

(1) When node 4 of this combat scenario is hit by enemy fire, our command information system can still communicate with each other, proving that the grid-based tactical Internet network structure has a certain degree of resilience.

(2) Through the simulation analysis of the network throughput of the No. 1 node, it can be concluded that the maximum peak value of the network throughput of the scheme 4 is about 36 Mbit/sec, and the maximum peak value of the network throughput of the scheme 1 is about 31 Mbit/sec, and the scheme The average network throughput of 4 is greater than that of Option 1.

(3) The network packet loss rate simulated from the No. 4 trunk node is also different in plan 1 and plan 4. The network packet loss rate of plan 4 is obviously lower than that of plan 1, and the network loss rate of plan 1 is significantly lower than that of plan 1. The packet rate has been fluctuating around the peak and the average packet loss rate is relatively high.

## 5. Conclusion

Based on the dynamic changes of the battlefield environment, this article starts from the operational needs of operations, and uses OPNET simulation tools to map key components of the tactical Internet from nodes, links and networks, and analyzes typical tactical Internet networking models from the perspective of dynamic evaluation. Facing the battlefield "soft and hard" damages, network business performance simulations are carried out. The network simulation results show that the constructed model can reflect the network business performance of the battlefield communication network and can provide a scientific basis for the commander's network planning.

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