



# Optimal Algorithm for Shared Network Communication Bandwidth in IoT Applications

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## Abstract:

In recent years, a variety of wired and wireless network communication protocols in the field of industrial control have become increasingly mature. The purpose of this paper is to provide a Shared network communication bandwidth optimization management algorithm for large-scale industrial networked control systems in Internet of things applications. This algorithm is based on the generalized geometric convex optimization method and can realize the optimal allocation of Shared network communication bandwidth resources. L2 networked control systems is used in this paper for the establishment of various numerical relations between the control performance and the communication network parameters. Based on the generalized geometric convex optimization method for the numerical relationship between convex analysis and fitting, convexity, and with the convex analysis and the numerical relationship between convexity fitting as constraint conditions, the results of integrity for networked control systems with large-scale resource allocation target will share the optimal management of network resources as a generalized geometric convex optimization problem. Using convex optimization software package for optimizing the optimal global solution of management problem, i. e. the optimal allocation of resources, the algorithm realizes the stability of each networked control system and achieve optimal L2 control performance. It is concluded that the predetermined transmission rate between the network node one and network node two, the data flow information sent by the network node two to the network node one is read, the delay time and packet loss rate between the two nodes are determined, the delay time is reduced by about 8 seconds, and the packet loss rate is greatly reduced by 78%.

**Keywords:** Shared Network; Communication Bandwidth Optimization; Internet of Things Environment; Sensor Nodes; Management Algorithm

## 1. Introduction

In recent years, a variety of wired and wireless network communication protocols in the field of industrial control have become increasingly mature. The popularization of micro-control units, sensors and actuators based on standard network interfaces and the improvement of embedded operating system software standards have laid a foundation for the large-scale application of the Internet of things in industrial control. Is the Internet of things based on Shared communication network under the environment of large-scale industrial networked control systems, with

a Shared focus controller has high computing power, which makes possible all kinds of advanced control algorithm is applied to the engineering practice, so as to further improve the control precision of the closed loop control system, it is charged with closed loop control system modeling, control algorithm simulation, system, system status monitoring and sharing resource management integration of computing platform. When joining a new controlled system, the sensors, actuators available standard interface easily connected to share the communication network, as long as the operation of embedded operating system focused on the controller to join a computing task, the task was time scheduling, sampling was used to control system's output signal, calculation and send control signal, to realize the network closed loop control of the controlled system, such a big cut the cost control system hardware and software implementation and investment cost, and improve the control performance. As a result, the Internet of things environment of large-scale industrial networked control system based on Shared communication network has the building cost is low, the construction speed is quick, easy to debug, flexible connection, plug and play the advantages of easy maintenance, significantly superior to the traditional distributed control system (DCS) and fieldbus control system (FOS), represents the iot environment to build large-scale industrial development trend of the networked control systems.

With the application of the Internet of things, a large number of wireless communication technology of the Internet of things has been developed. Its chip is cheap, stable and reliable. Meanwhile, the convenient development environment and simple development tools are easy to develop its communication software and train its personnel. In most practical Internet of things application systems, the information layer has the need to access TCP/IP network, how to integrate the wireless communication network technology into the Ethernet standard based on TCP/IP protocol, this is one of the worthy research topics in the Internet of things application field.

Tim Roughgarden considers a network-cost Shared game with a non-anonymous cost function, where the cost of each edge is a submodule function of its user, Shared using a Shapley value. Non-anonymous cost functions model asymmetries between participants that can be caused by different bandwidth requirements, usage times, service requirements, and so on. These games can have Nash equilibria of different qualities. The goal of Tim Roughgarden is to determine well-motivated equilibrium refinement that allows for good worst-case approximation of boundaries. The main result is that the strict bounds of the costs of strong Nash equilibrium and the potential functions of the network cost sharing game with non-anonymous cost functions are minimized, and these cost functions are parameterized by the allowed set of submodular cost functions  $C$ . The two worst-case boundaries overlap for each set  $C$  and are equal to the summability parameters introduced by Roughgarden and Sundararajan to describe efficiency losses in the family of cost-sharing mechanisms. Thus, a single parameter determines both the worst-case efficiency of the network cost-sharing game (in two unmatched senses) and the cost-sharing mechanism [1]. Kee-young Kwahk studies the impact of third-generation iungens orientation on knowledge sharing activities and individual work performance in corporate social media environments. Kee-young Kwahk found that knowledge self-efficacy, social interaction and reciprocity norms positively affected the positioning and knowledge sharing activities of the third generation of iungens in social media, while the fun of helping had no significant impact. In addition, the orientation of 3us yunghens has a significant impact on knowledge sharing activities in social media, which further affects individual work performance. Based on the above analysis results, kee-young Kwahk discussed the research results and proposed the theoretical and practical significance of the study as well as the limitations of the study [2]. Mobile virtual network operators (MVNOs) are mobile operators that do not have their own infrastructure or government-issued spectrum licenses. They buy spectrum from the major mobile network operators (MNOs) to provide their own branded communications services. MVNOs are expected to play an important role in the mobile network market as it will increase competition in the retail market and help meet the needs of niche markets. However, with the rapid growth of mobile data flow demand, the efficient utilization of limited spectrum resources of MVNOs has become an important issue. Here, Wei LIU proposed a resource sharing mechanism between MVNOs in the context of network function virtualization (NFV). This mechanism enables MVNOs to improve quality of service (QoS) by sharing spectrum resources. In order to ensure the fairness of resource sharing, a decision-making strategy based on Nash bargaining is designed. A large number of numerical evaluation results verify the effectiveness of the model [3].

This paper discloses a common word network communication bandwidth optimization management algorithm for large-scale networked industrial control system in the context of the Internet of things. This algorithm can

balance and coordinate the control accuracy requirements of each control system on the whole, and realize the overall optimal energy-saving and efficient operation of large-scale networked control system. Algorithm implementation plan: setting the L2 control performance of networked control system with the numerical relations between the communication network parameters, based on the generalized geometric convex optimization method for the numerical relationship between convex analysis and fitting, convexity as constraint conditions, and thus results in large networked control system integrity for the allocation of resources, the above problem statement for generalized geometric convex optimization problem, using convex optimization software package for the global optimal solution, namely the optimal resource allocation scheme is given, and implement each of the stability of networked control systems and to optimize L2 control performance.

## **2. Proposed Method**

### *2.1 Overview of the Internet of Things*

#### (1) Definition and significance of Internet of things

IoT status and research progress of analysis: the Internet of things from the world development process, the United States in the world's leading research and development strength, adopted from basic research, applied research to market development mode of "long-term" information technology development, not only has grabbed the development of information technology, and also constantly new technology leap, leading the tide of information technology revolution and the development direction, control the information technology to international standards. This can be used as a reference for the development of the Internet of things in China. First, while increasing the application of the Internet of things, basic research on the Internet of things should not be relaxed at all. Second, seize the first-mover advantage of a new round of emerging technologies and participate in the formulation of international standards. Europe has been unwilling to lag behind the United States in the construction of information technology and economic development. Although the European region is facing the overall economic recession, serious aging population, climate warming and many other problems recently, the eu has been committed to promoting the unified development of the European Community [4-5].

#### (2) Internet of things technology

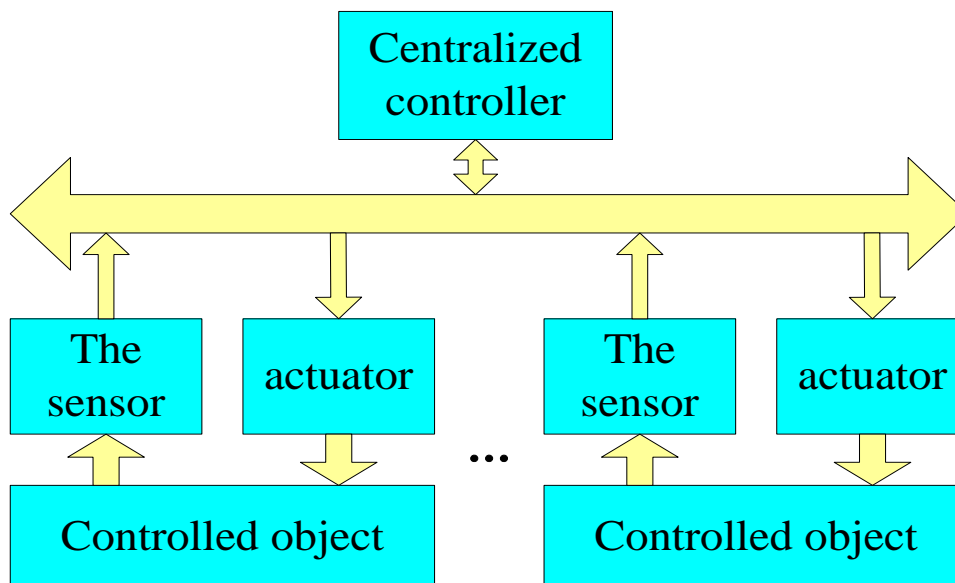
Earlier scholars put forward the definition of the Internet of things is, through the radio frequency identification (rfid), infrared sensors, global positioning system (GPS), laser scanners, such as information sensing device, according to the contract, will any goods to connect to the Internet, information exchange and communication, the purpose is to realize the intelligent identification, location, tracking and monitoring and management. It is a kind of network based protocol standard and interactive dynamic global network infrastructure capability self-configuration, in the physical and virtual scope of things the characteristics of objects such as identity characteristics, the physical characteristics of the Internet, anthropomorphic characteristics, they can be connected through the integrated information network. The Internet USES information sensing devices to exchange and communicate information between any object and the Internet in accordance with agreed protocols. The purpose of this network is to realize intelligent identification, positioning, tracking, monitoring and management. The feature is that each object can be targeted, each object network can be controlled, and each spatial network can be communicated [6-7].

The contemporary view is that the Internet of things is just the past of a large number of networks and Internet connections further deepened, is their specific application of regional zoning, is the new generation of many value-added services in the broad network platform collection. In terms of technology, it is the integration of sensor, sensor network, RFID and other sensing technology, communication network technology, intelligent computing technology, etc. to achieve comprehensive perception, reliable transmission, smart Richard, is a physical world connected to the network, intelligent, hd, will become the Internet of things keywords. In recent years, Internet of things technology has been widely concerned by people. In China's 12th five-year plan, the Internet of things has been clearly cultivated and developed as a strategic emerging industry. RFID, as one of the core technologies of the Internet of things, will determine the development of the Internet of things. Based on in-depth analysis of MES reconfiguration requirements and monitoring requirements, a reconfigurable manufacturing execution system architecture based on module granularity and information granularity dimension was proposed, and the theory and

method of MES to realize rapid reconfiguration and real-time monitoring was systematically studied. Mainly from the route inspection, certificate of ownership transfer, label group reflected a country's comprehensive national strength, the sluggish recovery in the global economy today, China is more need to accelerate the development of general aviation industry, making it a pull the new growth point of China's economic development, let more people can enjoy the conveniences brought about by the general aviation industry development. And relay attacks on four aspects of the supply chain system based on RFID technology has carried on the preliminary exploration of security and privacy problem, thus put forward two new supply chain check protocol PSAM and PCOMS path, and proposes a ownership transfer scheme based on trusted third party FIT, and put forward two new label is group agreement GPO and GPI [8-9].

## 2.2 Characteristics of the Shared Network Communication Bandwidth Optimization Management Algorithm in the Internet of Things Environment

A iot environment sharing network communication with the party management algorithm, whose character is: setting the L2 control performance of networked control system with the numerical relationship , communication network based on generalized geometric convex optimization method for the numerical relationship between convex analysis and fitting, convexity, and by the numerical relationship between convex analysis and the convexity of the fitting results as constraint conditions, the overall performance of networked control systems with a massive is the weighted L2 control performance of networked control systems, resource allocation target, will share network resources optimization management Table for generalized geometric convex optimization problem, The convex optimization software package is used to obtain the global optimal solution of the optimization management problem, that is, the optimal resource allocation scheme is given, and the stability of each networked control system is realized and the optimized L2 control performance is achieved. According to the algorithm mentioned in claim 1, its characteristic is that the communication network parameters must include two communication network parameters: sampling speed and quantization accuracy. According to the algorithm mentioned in claim 2, its feature is that the selection of communication network parameters will be different for different application environments and backgrounds of industrial networked control systems [10-11]. As shown in Figure 1 for details.



**Figure 1.** A large-scale industrial networked control system based on Shared communication network in the Internet of things environment

Use a static policy to generate a defined allocation plan based on a fixed model and data, and then allocate resources to different nodes based on that plan when the task is executed. Once the policy is determined, it cannot be changed during the job run. Use static policies in S4. In the actual running environment, the flow processing operation takes a long time to execute, and the resource amount of data varies with different time. The topology structure of the job is dynamic and variable, and the static strategy is difficult to meet the new processing needs. Therefore, dynamic resource tuning algorithms are required. Storm USES a dynamic resource allocation policy to perform resource tuning online. In addition, partial data can be discarded to reduce the load on the node. Computation and memory resources unified standardized, measured by a single goal conditions, but there are still many deficiencies, because in the actual data of different flow on the different resources have different needs, so in this paper, the different parameters respectively the abstraction is a flow of processing system, the parallel for one-to-one mapping between regions, according to the real-time resource availability and load change node determines the operation which can get the maximum throughput, consider this is based on global resources, to obtain the optimal decision is very difficult. In this paper, multi-to-one mapping is implemented between parallel regions to allocate resources on a computing node to different operations on the node, and different operations use different resources [12-13].

### *2.3 Operation Shared Network Communication Technology*

In recent years, by analyzing different stream data jobs, researchers have found similarities and proposed sharing methods to reduce resource waste during job execution. Stream data is continuously arriving, and results are generated at any time, which is applicable to the processing mode of sharing intermediate results. Multi-query optimization (MQO) is proposed in traditional database, which is mainly used to deal with large query load and share repetitive work in multiple queries. The solution includes materialized view and subquery sharing. Past researchers have proposed LSShare, which effectively solves MQO problems in recyclable queries by taking advantage of the same components that can be Shared in complex CPU/IO intensive queries. Hive and Pig, coded in a high-level language, abstracts data processing at a higher level, USES sql-like interface query operations, converts streaming jobs into workflows for processing. Pig recognizes and reuses the repeated subexpressions, selects the most suitable subexpressions based on the cost model, implements the optimization of filter, pushdown, etc., and then implements the Shared optimization of the job based on MQO, but the details of the optimization need to be specified artificially and cannot be implemented adaptively [14-15].

MRShare USES pipelines to represent jobs, analyzes the relationship between the input files, operations and calculation results of jobs, groups them according to similarity, establishes a model based on I/O cost control, and combines a group of similar jobs into a single job execution. But MRShare reduces the workload of a single job. Therefore, the MRShare is expanded from the analysis of a single job to the optimization of a group of jobs. By using filter sorting, the sub-space of the overall Shared space is searched selectively according to real-time execution feedback, and the local optimization strategy of operational tasks is proposed adaptively to save I/O and CPU overhead. On the basis of the above sharing, the communication between partial input scan and operation output is customized, and a new optimization plan is generated for the job partition through an optimization algorithm, and the processing technology is optimized for each group of jobs. ReStore manages the storage so that the output of the entire job can be reused, or the partial output of the customized Map/Reduce task can be used to identify additional reuse opportunities and avoid repetitive execution of redundant jobs. But ReStore cannot meet the need for streaming data to be processed online by saving intermediate results for jobs submitted at different times. To solve repetitive job optimization problems in Scope, the same logic can be applied to different data sets and the same distributed data and features can be Shared. Thus, statistics of job execution are captured and used to automatically optimize repeated jobs [16-17].

The above sharing mainly considers the characteristics of the job itself to optimize the sharing. In many applications, even if operation sharing occurs, it may not improve the efficiency of job execution, and some constraints need to be met. The execution of the workload of the sharing cycle, looking for new sharing opportunities based on the traditional sharing strategy combined with the SLA, expanding the problem into an unweighted knapsack problem, gradually removing the sub-optimal method from the Shared space, and finally finding the global sharing execution plan. Then, a distributed flow processing middleware Synergy was established

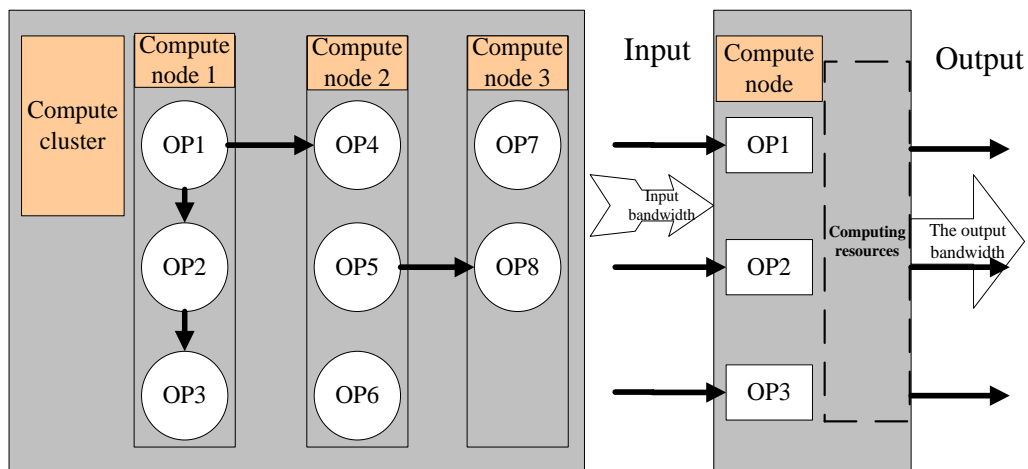
to analyze the component features with sharing-aware feature, effectively reuse data flow and processing components, meet QoS requirements, and achieve better scalability. There is a link relationship between the upstream and downstream operations of different jobs, and the demand for output bandwidth changes after sharing, and the impact of network bandwidth resources on sharing is not fully considered in these works [18-19].

In this paper, the specific operation types in the job are considered, which not only meet the sharing conditions in logic, but also introduce the resource constraint, and allocate the resources of the Shared operation by combining the network bandwidth and computing resources of the computing cluster itself. The purpose of resource allocation is to ensure the proper processing and transmission of Shared operations with a minimum of compute nodes. In flow processing, there is less work related to resource allocation, but the basic allocation strategy is similar, so we can learn from the traditional resource allocation method.

#### 2.4 Shared Network Communication System Model in the Internet of Things Environment

##### (1) Resource mapping

The flow data is analyzed and processed efficiently on a distributed cluster, during which the architecture and configuration of the cluster are very important. As shown in Figure 2, there is a set of compute nodes in the cluster, and there are multiple different operations on each compute node. Compute nodes in parallel, and operations in parallel. The solid lines with arrows represent the communication between nodes. Operations on different compute nodes can be communicated, and different operators in the same compute node can also communicate directly. In the cluster, a compute node is regarded as a host, and each host has its own configuration environment. The data flow velocity between different hosts is different, and the data flow velocity acceptable by different operations is also different. The main factors that affect the efficiency of the host are network bandwidth and computing resources. Figure 2 shows the distribution of physical resources and computing resources on compute node 1. The solid line with arrows represents the communication between nodes, the long dotted arrow represents the input bandwidth, the short dotted arrow represents the output bandwidth, and the elliptic region inside the node represents compute resources. Each operation occupies the resources of the host part [20-21].

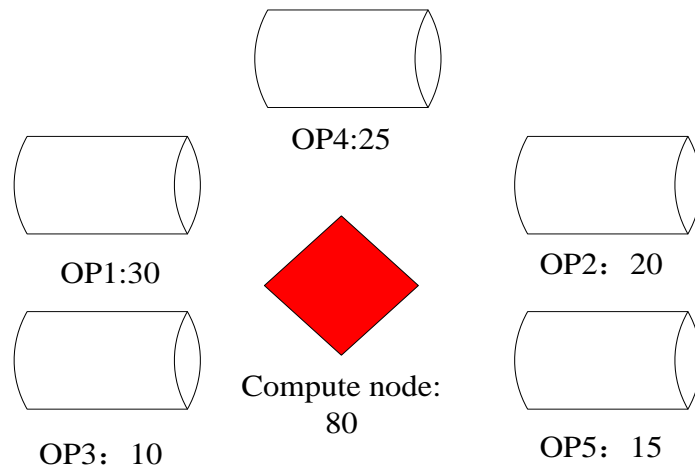


**Figure 2.** Cluster structure

##### (2) Calculate resource constraints

There are overlapping relationships between jobs, providing opportunities for sharing. After sharing, it will not increase the amount of computing resources required by the operation. Therefore, the more times the operation is Shared in the stream data, the less computing resources are required and the greater the sharing benefits are obtained. Computing resources are limited on compute nodes, and multiple operations share all the resources of a compute node. When one operation occupies all the resources, other operations can only wait and cannot run normally, reducing the real-time performance. Therefore, there is a constraint relationship between compute nodes

and operations on compute resources, and it is necessary to reasonably allocate cluster computing resources for different Shared operations before the flow jobs start processing [22-23].

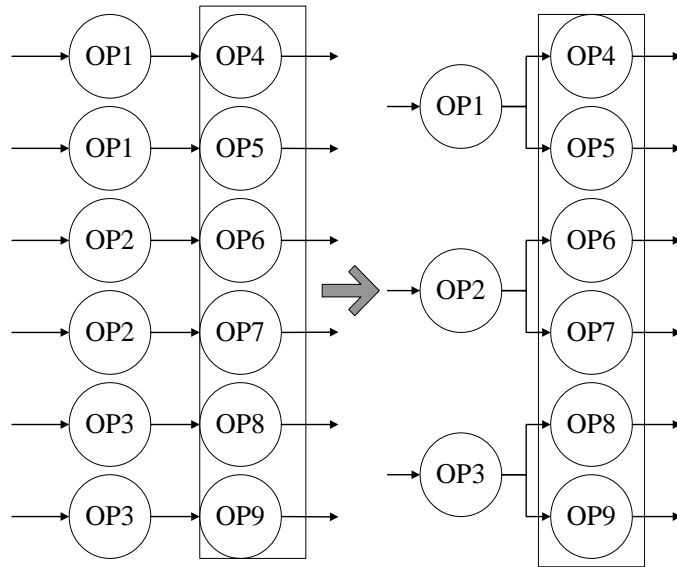


**Figure 3.** Resource allocation model

In Figure 3, 80 is the biggest computing resources, the compute nodes can provide cylindrical area representative operation, colon Numbers after the operation the normal operation of computing resources, can be seen in the Figure on the compute nodes cannot meet its demand all operation of computing resources, when multiple operating parallel computing to preempt resources, lead to one or a few can't timely perform operation, affect the real time processing.

### (3) Bandwidth resource constraint

In operation sharing, it is possible for each operation to be Shared by multiple jobs simultaneously. Consider heterogeneous operation sharing, as shown in Figure 4. After the Shared operation is merged, the subsequent operation is placed on the same compute node. At this point, the output link of the Shared operation does not overlap and the output bandwidth remains unchanged, but the resource occupancy of all subsequent operations on the subsequent compute nodes needs to be considered uniformly. Consider homogeneous operation sharing, as shown in Figure 4. When all operations on a computing node are Shared, the input path is merged, the input bandwidth does not change, nor does the computing power of the computing node increase, and the required computing resources remain unchanged. Does not consider the placement of Shared subsequent operation conditions, the output of the data link number increases, the output bandwidth and accumulation, and the output of the compute nodes can provide bandwidth has a limit, after the share of accumulative and may be beyond the limit, causes the output bandwidth resource competition, cause congestion, data transmission can not be normal, the number of output bandwidth restricts the sharing operation. For example, suppose the compute nodes maximum network output bandwidth value is 100, after share OP1, OP2, OP3 need output bandwidth of 40, accumulation and output bandwidth of 120, itself, is greater than the compute node can provide the output of the bandwidth value 100, as a result, the compute nodes cannot allow sharing three actions occur at the same time, the only two operations can share [24-25].



**Figure 4.** Output bandwidth changes after multiple job operations with different successor operation locations are Shared

There is a problem with the example: which operation nodes are allowed to share. This paper introduces the concept of operation revenue to describe the amount of computing resources saved after each operation is Shared. So not only do you need to logically share the operations, but you also need to match the various resources of the compute nodes. Therefore, the constraint condition of operation sharing (OSC) is: given a set of stream data generated by the same source node, it is executed in a distributed computing cluster, satisfying the following conditions: each computing node can meet the demand of computing resources for all the Shared operations on it; The sum of the input/output bandwidths of all operations Shared on each compute node does not exceed the input/output bandwidths of the compute node itself.

### 3.Experiments

#### 3.1 Experimental Environment

The experimental environment of this paper is divided into hardware environment and software environment. The hardware environment includes raisecom equipment, computer and tester. Software environment including Windows system, python, TCL environment. Specific environmental equipment is shown in Table 1:

**Table 1.** Model Table

Model	Use	Using the phase
ISCOM5800	OLT	Automation long term use
ISCOM5504	OLT	Automation long term use
POS-T-SP	The beam splitter	Automation long term use

#### 3.2 Experimental Data

The purpose, quantity and cycle of the tested equipment products are shown in Table 2 below:

**Table 2.** Equipment Table

Equipment model	Use	The number of	Expected life
COM5104	ONU equipment	Greater than or equal to 1	Automation long term use

### 3.3 Experimental Steps

The beneficial effect of this experiment is: the generalized geometric convex optimization can deal with the non integer power of optimized variables complex multiply and add a constraint, and the algorithm has advantages of linear time complexity, therefore can handle under Internet environment, scale industrial networked control systems to share network resources optimization management problems, and can quickly obtain the global optimal communication bandwidth resource allocation scheme, large-scale industrial network control system to realize the Internet of things environment of overall optimal energy-saving run efficiently.

The basic processing flow of this method is as follows:

(1) To establish the numerical relation between the performance and the communication network parameters: [0011] to large-scale industrial networked control system of the closed-loop system is sTable and L2 control performance in the adequacy of the upper bound conditions into a linear matrix inequality (LMI) (LinearMatrixInequalities, LMI) and bilinear matrix inequality (LMI) (Bi - linearMatrix | Inequalities, BMI) constraints, upper bound with LMI optimization performance is obtained. Communication network parameters is contained in the above constraints, here communication network parameters include: quantitative precision, sampling rate, network transmission delay, and the arbitration mechanism of network communication protocol and packet loss, adjust some parameters, rerun the LMI optimization program, get new parameters corresponding to the L2, upper and lower bounds of the control function in L2 control performance and the communication network is set up on the numerical relations between the parameters.

(2) The L2 control performance of networked control systems with communication network numerical relationship between the parameters of convex analysis and the convexity of fitting: general L2 control performance of the closed-loop system is monotonous depends on the individual communication network parameters, such as, sampling rate, the slower the L2 control performance of the closed-loop system, the quantitative precision poor L2 control performance is poor. However the L2 control performance of networked control systems is dependent on multiple communication network parameters of multivariate function, the method based on generalized geometric convex optimization principle, can deal with the non integer power of optimized variables complex multiply and add a constraint, the function is convex analysis, in addition in the case of a convex function, within the scope of the right of L2 fitting method for numerical convexity control performance.

(3) Will share the optimal management of network resources as the generalized geometric convex optimization problem, in each L2 control performance of networked control systems with communication network numerical relationship between the parameters of convex analysis and fitting as a constraint, the result of the convexity for large-scale networked control system overall performance (i.e., each weighted L2 control performance of networked control system) for resource allocation target, will share network resources optimization management statement for generalized geometric convex optimization problems.

For solving the convex optimization problem: the use of convex optimization software package for sharing network resources optimization management problems of the global optimal solution, get the optimal resource allocation scheme, and make each of the networked control system stability and achieve optimization of L2 control performance, realize large-scale industrial network control system as a whole the optimal energy efficient operation.

## 4. Discussion

### 4.1 Heterogeneous Operation Shared Network Communication Model

On the basis of analyzing the sharing of homogeneous operations, we consider the sharing of heterogeneous operations, that is, the operations with the same input and different operation types. At this point, the resource allocation method is to place these operations on the same computing node, and the input bandwidth of the operation Shared in multiple jobs, the output bandwidth and the computing resources are merged without superimposition, or the original usage. This section analyzes resource allocation issues for the subsequent operations of Shared operations, where these operations need to be considered as a whole.

$$OPR_i = \sum_r e_{ir} OPR_{ir}; \forall i, r \in \{1, \dots, q\} \quad (1)$$

$$OPR_i = \sum_r e_{ir} OPO_{ir}; \forall i, r \in \{1, \dots, q\} \quad (2)$$

$e_{ir} = 1$  means that operation  $r$  is a successor to operation  $I$ . Formula (1) calculates the resource occupancy of a subsequent operation corresponding to a Shared operation  $OPI$ ; formula (2) calculates the usage of the output bandwidth, while the input bandwidth is merged to occupy only one copy. At this point, the fourth constraint condition of operation location in the problem model in the above section is changed into:

$$\prod_r Z_{irj} = 1; \forall i \in \{1, \dots, q\}, \forall j \in \{1, \dots, m\} \quad (3)$$

$Z_{irj} = 1$  means that the successor of  $I$ ,  $r$ , is located on compute node  $j$ , and  $\prod_r Z_{irj} = 1$  means that all the successors of Shared operation  $I$  are located on one compute node.

When the topologies of multiple jobs are merged, the matching of processing power and data velocity is considered. The following conditions need to be satisfied: the input bandwidth that an operation can receive is greater than or equal to the sum of the output bandwidth of all its predecessor nodes; The output bandwidth of an operation is less than or equal to the sum of the input bandwidths received by all subsequent nodes of the operation, represented by formulas (4) and (5), respectively. Where  $POPO_{ir}$  represents the output bandwidth of the subsequent operation of operation  $I$ ,  $SOPi_{ir}$  represents the input bandwidth of the precursor operation of operation  $I$ , and  $b_{ir} = 1$  represents the precursor operation of operation  $r$ ; corresponding to the following constraints:

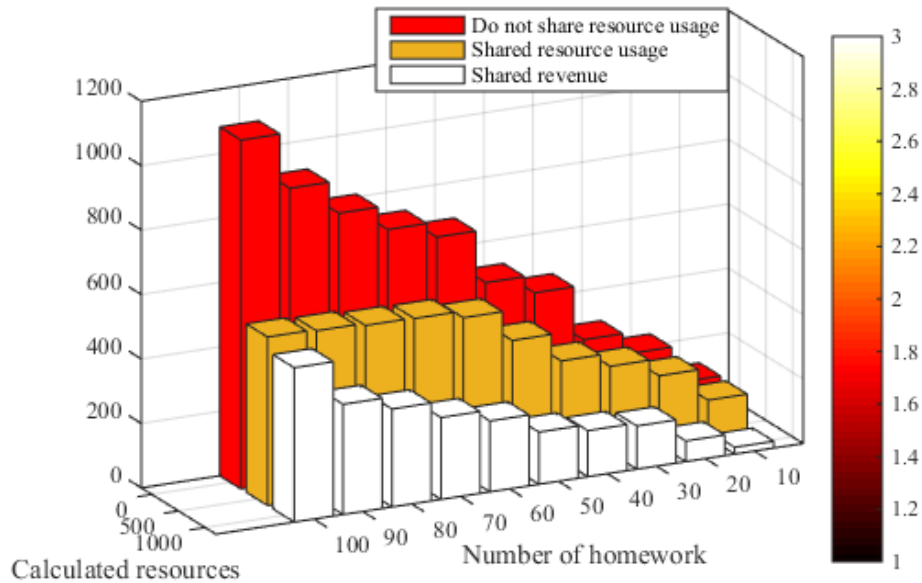
$$OPI_r \geq \sum_{i=1}^q b_{ir} POPO_{ir}; \forall r \in \{1, \dots, q\} \quad (4)$$

$$OPO_r \leq \sum_{i=1}^q e_{ir} SOPi_{ir}; \forall r \in \{1, \dots, q\} \quad (5)$$

#### 4.2 Operation Sharing Benefits

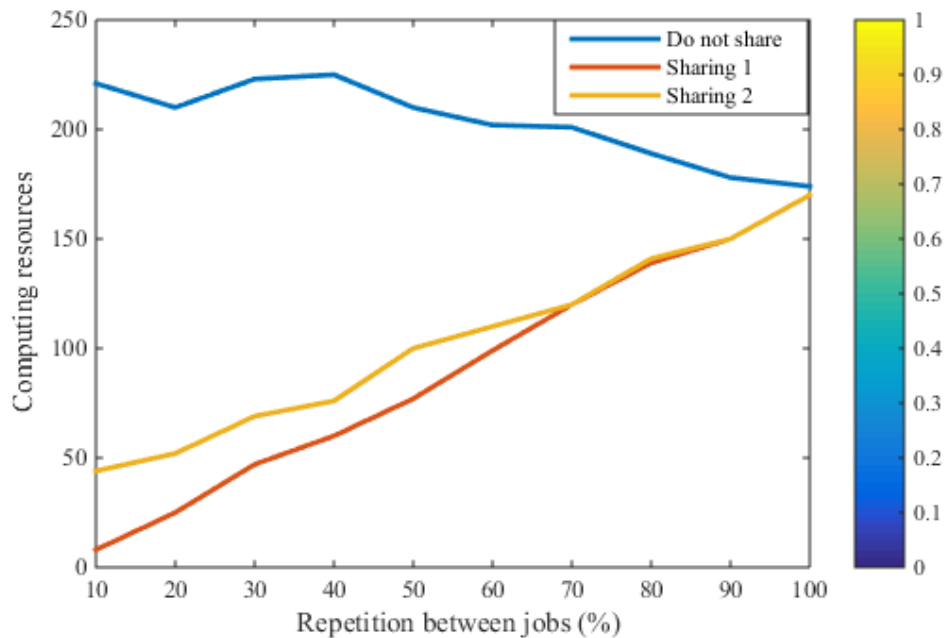
The determination of the first test result is mainly based on the amount of computing resources required during the execution of the measured stream job, which measures the resource usage of the unshared workflow and the Shared workflow respectively. As shown in Figure 5, 10 jobs are used as a group to test the resource usage of 100 jobs, the horizontal axis represents the number of jobs run, and the vertical axis represents the computing resources. Shared benefits are the computational resources saved after sharing, that is, the difference in resource usage of whether a job shares the execution. When 100 jobs run normally without sharing, the number of computing resources required is 1027. After sharing, the number of computing resources required becomes 569, saving computing resources. The more jobs that are Shared, the greater the benefit; When the number of jobs is between 80 and 90, the number of computing resources used after sharing does not change much, because the more jobs, the

greater the probability of operation sharing. The sharing saving rate is the ratio between the resource benefit after sharing and the resource usage without sharing. With the increase of jobs, the sharing saving rate keeps increasing, reaching 44.95% in 100 jobs. But at 40 jobs, the rate drops because the number of operations Shared between jobs is a small fraction of the total.



**Figure 5.** Sharing without constraints

As shown in Figure 6, share 1 and share 2 test the benefits of an increasing number of occurrences of a job in a set of stream data. As the repetition rate increases, so does the sharing benefit. Share 1 is an ideal situation where, except for jobs that are executed repeatedly, there are no Shared operations among other jobs. In this case, the Shared jobs are executed only once, and the Shared benefits increase linearly. Sharing 2 there are sharing situations between different jobs. At this time, sharing benefits increase not only job resources that are repeatedly executed, but also other resources that are saved by sharing operations. When the repetition rate is low, the benefit of sharing 2 is higher than that of sharing 1. Therefore, the more times the operation is Shared, the greater the sharing benefit.



**Figure 6.** Shared benefits of job repetition rate changes

(1) The impact of resource amount on the revenue of Shared network communication bandwidth

The factors influencing the sharing in the cluster are node computing resources and output bandwidth. Considering the influence of network output bandwidth, it is assumed that the output bandwidth required by each operation is 10, and the output bandwidth provided by the nodes is incremented step by step to get the results shown in Table 3. The greater the output bandwidth provided by the node, the greater the number of Shared jobs, and the greater the benefit of operation sharing. Node output bandwidth is small and the number of Shared operations is limited. When the bandwidth is 160, the benefit is only increased by 1 compared with 140, while in the test data, the least benefit of Shared work is 2. The reason is that different operation requires different output bandwidth and different sharing times.

**Table 3.** Impact of output bandwidth

Node output bandwidth	20	40	60	80	100	120	140	160	180
Number of Shared jobs	2	3	4	5	6	7	8	9	10
Revenue sharing	7	13	19	24	29	34	38	40	42

The more sharing occurs, the less computing resources are used by the job, and the system execution efficiency is limited by computing resources. As shown in Figure 7, when the number of compute nodes is small, most sharing is not allowed to occur; As the number of compute nodes increases, the number of operations that can be Shared increases, and the benefits increase. However, when the number of compute nodes reaches a value, the sharing benefit does not increase, because the number of resources occupied by the operation is certain, and the redundant compute nodes are idle, and no tasks are performed on them.

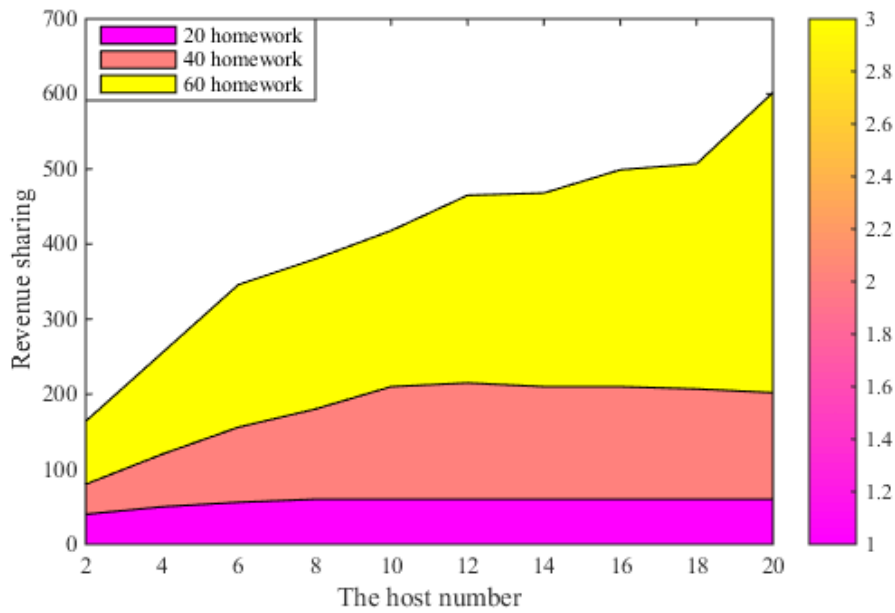
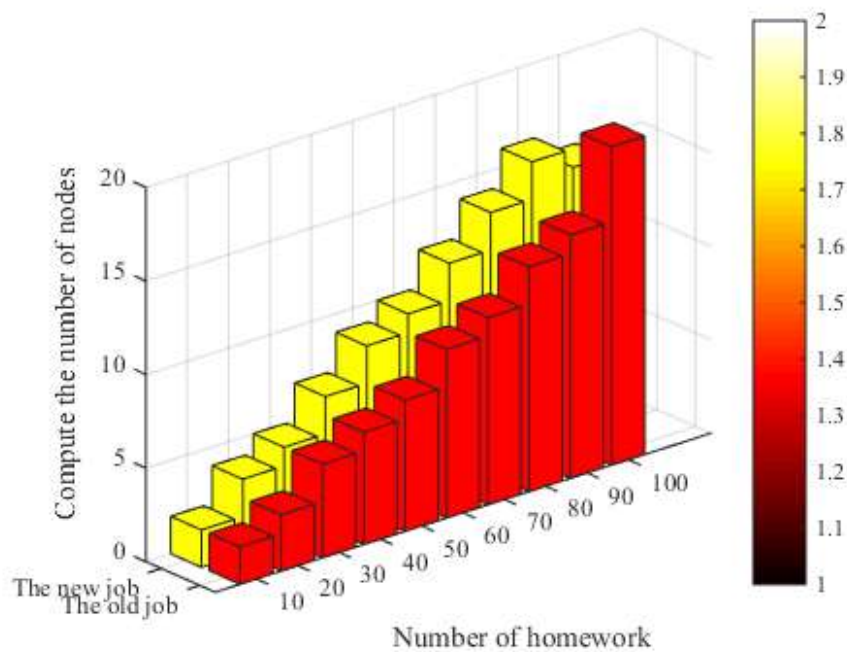


Figure 7. Calculating the impact of resources on Shared benefits

(2) Online adjustment effect of resource allocation

After the end of system resource allocation, different jobs run according to the same data path. When the topological structure of the job changes or the resource demand changes, the original resource allocation scheme may not be able to meet the demand. As shown in Figure 8, the resource demand of the operation of the new job is higher than that of the old job.



**Figure 8.** Comparison of new and old job resource requirements

In the test in the previous section, it was found that the sorting 5 used less comparison times. Figure 8 tested the change in comparison times required by the quick adjustment algorithm and the redistribution algorithm and the sharing loss of the fast adjustment algorithm when the output bandwidth resource increased by 5 and 10 units. Cost is the resource demand after rapid adjustment, while 2cost represents the resource demand during redistribution. The data from the above section tests are used as a baseline to observe changes in resource requirements. The operation is run according to the original allocation scheme. When the resource changes, it will no longer meet the new output bandwidth demand. The pruning method can only allocate a small part of operational resources, and the sharing loss is small, which is more advantageous than redistribution. Compared with redistribution, the comparison times of resource allocation of pruning Shared operation are relatively small, so the method of pruning is more efficient when the increase of cost is not large. However, when the demand changes greatly, the original topology cannot support the existing job processing, and the cost of comparison is relatively high, so the resources need to be re-allocated.

**5. Conclusions**

With the development of Internet of things technology, single wireless communication cannot meet the demand of differentiated information transmission, and more and more wireless communication networks share more and more modes. In view of the wireless network protocol is various, different structure, the phenomenon of incompatible with each other, based on the analysis of the existing wireless communication, on the basis of international standards, through the wireless network protocol standard specification in each layer decomposition, retain the inherent characteristics of wireless network layer specification, definitions can be integrated layer specification, design new type of network architecture and protocol stack. This paper involves a Shared network communication bandwidth detection, the method of one node in network, and network nodes between two scheduled transmission rate, read a network node 2 sent to the network node data flow information, determine the delay time between two nodes and packet loss rate, latency and packet loss rate compared with the preset threshold data, determine if transmission rate is lower than the threshold value is to supplement. When using this method of bandwidth detection in Shared network communication, it can quickly complete the detection of network bandwidth, and compensate the network bandwidth, so as to ensure that users can have a good communication experience when using.

The parameters of the communication network in the algorithm must include the quantization precision and the sampling rate. The communication network parameters selected by different industry networked control systems are different, which need to be determined according to the application environment and background of industry networked control systems. For example, some industrial networked control systems select sampling rate, quantization accuracy and network transmission delay as communication network parameters, while some industrial networked control systems select sampling rate, quantization accuracy, network transmission delay, arbitration mechanism of network communication protocol and packet loss as communication network parameters.

Based on Internet of things application system layer has access to the Internet in the information demand, for wireless heterogeneous networked measurement and control system of several existing problems, puts forward the method to construct the new wireless communication content networking architecture, because the network protocol stack is a huge system function, and the author's ability to effectively, hard to avoid in the design process of some problems on details and comprehensive analysis and research in this paper, a new type of wireless communication network architecture of the protocol stack, the application layer function design, does not take into account a variety of wireless network in the 2.4 GHz spectrum interference problems, late need to improve.

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