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ABOUT PRODUCTION-TRANSPORT PROBLEM REDUCTION TO THE TWO-LEVEL PROBLEM OF DISCRETE OPTIMIZATION AND ITS APPLICATION

In this study, the application of the production and transport task is considered to solve the problem of the distribution of the limited capacities of data transmission channels between different nodes of the computer network. A scheme is proposed for reducing the problem to a two-level continuous-discrete optimization problem. The model is formulated and numerical results are obtained to solve the problem of power distribution in the network of the information and computing center.

Key words: power distribution, production and transport task, discrete-continuous programming, two-level model, optimization.

Introduction. Many applied problems relate to the distribution of limited resources in hierarchical systems [1–7]. This, for example, can be the task of balancing the load in a homogeneous network [2], the distribution of work for parallel computers [3], the allocation of resources in the negotiation process [4], etc. The main problem here is the formalization of the problem in the form of multicriteria multi-index transport type problems with constraints in the form of linear inequalities [5–7]. In this case it is assumed that the system contains three types of elements: source, intermediate (transshipment) points and consumer (subscriber) nodes. These elements and their relations are subjects to the conditions of limited resources that affect the amount of resources circulating in the system. There are "managed" elements that determine the conditions for the "effective" functioning of the system. Each managed item defines binary relationships on a suitable allowable range of resource allocation values. Relationships are determined by the preference (goal) functions formulated for the controlled elements. Thus, in the most general case, the problem of allocating resources in a hierarchical system consists in determining the variant of the permissible resource allocation, in which the target functions of the managed elements take extreme values. Such problems can be formally represented by multicriteria problems under linear constraints and criteria whose types depend on the type of goal functions. In [6], for example, functions of piecewise linear and quadratic form are investigated. Examples of such tasks are also the transport task with intermediate stations (warehouses) [8], distribution of the load on the data transmission channels of Internet providers [5], and production planning [7].

Block optimization principles [9] simplify the analysis, solution and meaningful conclusions of many planning and management tasks. Thanks to such methods it is possible to break up the complex production-transport task (PTT) into autonomous tasks of production planning and organization of delivery of products. At the same time, naturally, there is a need for iterative harmonization of interests of production and transport systems. On the other hand, the interpretation of the results obtained in meaningful terms often allows us to determine rational approaches to the functioning of different economic and technical systems [10].

The traditional production and transport task is to determine the production and transportation plan, which minimizes the total costs associated with the organization of production and transportation of the finished product to the points of consumption.

Production-transport problem and it solution

The model of planning, production and transportation is formalized in the form of a general scheme, which contains two groups of variables [9]:

$$f(z)+g(x)\rightarrow \min, \quad (1)$$

$$Az+Bx=b, \quad (2)$$

where $x\in X$, $z\in Z$; A, B – given matrices; $f(z), g(x)$ – continuous convex functions; X, Z – some convex bounded sets.

An iterative process is proposed in [2] for solving the problem (1), (2), and at each step there are solved problems containing only one of two groups of variables:

$$f(z)-vAz\rightarrow \min, z\in Z, \quad (3)$$

and

$$g(x)\rightarrow \min \quad (4)$$

$$Bx=b-Az, \ x\in X. \quad (5)$$

The vector v in the problem (3) has an auxiliary meaning and is refined as a result of solving the problem (4), (5).

Let us assume that z^s and v^s is the approximation of the vectors z and v, obtained on iterations with the number $s=0,1,2,...$. Then iterative processes

$$z^{s+1}=(1-\lambda_s)z^s+\lambda_s\bar{z}^s, \quad (6)$$

$$v^{s+1}=(1-\lambda_s)v^s+\lambda_s\bar{v}^s, \quad (7)$$

where $0\le\lambda_s\le 1$, $\lambda_s\rightarrow 0$, $s=0,1,2,...$, $\sum_{s=0}^{\infty}\lambda_s=\infty$, $\bar{z}^s$ – solution of the problem (3) with $v=v^s$, $\bar{v}^s$ – vector of optimal conditions estimates (5) with $z=z^s$, converge, respectively, to the solution of the problem (1), (2) and to the vector of optimal conditions estimates (2) [9].

Approach to reduction of production-transport problem

Let's take a closer look at this problem in more detail. Let's assume that producers of products (the number of which is N) can use several production methods (S), each of which is characterized by different quantities of goods, as well as different cost of production and the maximum possible volume of goods of a certain type. We will assume that producers (suppliers) provide consumers (in quantity M) with one kind of goods, and the specific cost of transportation from suppliers to consumers is known. Each consumer can meet their product needs through an arbitrary set of manufacturers.

Thus, the production-transport task is to determine the production plan and the plan of transportation with minimal transport costs in order to fully satisfy the demand of consumers.

We denote:

c_{ik}^p – unit cost of production of the product by the *i*-th manufacturer with the help of k-th method;

c_{ij}^t – unit cost of transportation of products from the *i*-th manufacturer to the *j*-th consumer;

b_j – the value of the demand of the *j*-th consumer;

a_{ik} – quantity of products manufactured by the *i*-th manufacturer in the *k*-th way;

z_{ik} – the intensity of the use of the *k*-th method by the manufacturer for the part of the period, which is assumed to be 1;

x_{ij} – quantity of products transported by *i*-th manufacturer to the *j*-th consumer; $i=\overline{1,N}$, $j=\overline{1,M}$, $k=\overline{1,S}$.

Then the production transport problem (1)–(2) can be written in the form of a two-level optimization problem [11]:

$$f(z)=\sum_{i=1}^{N}\sum_{k=1}^{S}c_{ik}^p z_{ik}\rightarrow \min \quad (8)$$

provided by

$$g(x)=\sum_{j=1}^{M}\sum_{i=1}^{N}c_{ij}^t x_{ij}\rightarrow \min \quad (9)$$

and constraints

$$\sum_{i=1}^{N}x_{ij}=b_j, \ j=\overline{1,M}, \quad (10)$$

$$\sum_{j=1}^{M}x_{ij}\le\sum_{k=1}^{S}a_{ik}z_{ik}, \ i=\overline{1,N}, \quad (11)$$

$$\sum_{k=1}^{S}z_{ik}\le 1, \ i=\overline{1,N}, \quad (12)$$

$$z_{ik}\ge 0, \ x_{ij}\ge 0, \ i=\overline{1,N}, \ j=\overline{1,M}, \ k=\overline{1,S}. \quad (13)$$

This means that the production and transportation of products should be organized in such a way as to ensure minimum production costs under conditions (10)–(13), in which the problem arises of obtaining a minimum-cost transportation plan (9), taking into account the restrictions (10)–(13).

Let each consumer can satisfy his need for products only at the expense of one manufacturer. Introduce the variables $y_{ij}=\begin{cases}1, \\ 0,\end{cases}$ $i=\overline{1,N}, j=\overline{1,M}$, assuming that $y_{ij}=1$, if the needs of the *j*-th consumer are satisfied by the *i*-th producer, and $y_{ij}=0$, in all other cases. Then obtain a two-level continuous-discrete linear programming problem of this type [12]:

$$f(z)=\sum_{i=1}^{N}\sum_{k=1}^{S}c_{ik}^p z_{ik}\rightarrow \min \quad (14)$$

provided by

$$g(y)=\sum_{j=1}^{M}\sum_{i=1}^{N}c_{ij}^t b_j y_{ij}\rightarrow \min \quad (15)$$

and constraints

$$\sum_{i=1}^{N}y_{ij}=1, \ j=\overline{1,M}, \quad (16)$$

$$\sum_{j=1}^{M}b_j y_{ij}\le\sum_{k=1}^{S}a_{ik}z_{ik}, \ i=\overline{1,N}, \quad (17)$$

$$\sum_{k=1}^{S}z_{ik}\le 1, \ i=\overline{1,N}, \quad (18)$$

$$z_{ik} \ge 0 \ , \ y_{ij} = \{0,1\} \ , \ i = \overline{1,N} \ , \ j = \overline{1,M} \ , \ k = \overline{1,S} \ . \quad (19)$$

It is proposed in [12] to solve continuously discrete linear programming problems according to the following scheme:

– the upper level problem (14), (16)–(19) is solved;

– the decision $k = \overline{1,S}$ is fixed;

– the lower level problem (15) – (19) is solved.

Since the value of the upper-level objective function does not depend on the decision of the lower level and vice versa, this algorithm allows finding the optimal solution and the value of the corresponding goal functions for linear programming problems of both levels. At the first step of the algorithm, an acceptable solution z^0 is obtained, which will be the optimal solution of the upper-level problem. Taking this decision into account, the third step is the optimal solution for the lower-level problem.

Solving the problem of distributing the limited capacities of data transmission channels

The proposed above models of production-transport problems allow solving the problem of distributing the limited capacities of data transmission channels between various nodes of the Internet service provider's network. Suppose that there is a local computer network of the enterprise (higher education institution) that provides access to the Internet network for users. Access of users to the global network and obtaining the necessary information is made by means of several communication servers located on the territory of the information and computing center of the enterprise and connected by high-speed external communication channels with Internet providers. Server bandwidth levels lie within the bandwidth of the local network (for example, 1GB per second). Let's assume that the needs of network subscribers are known in increasing the speed of obtaining a certain amount of information. The wishes (preferences) of subscribers regarding possible volumes of increase in capacity for transferring information from the provider to the user node are specified. To implement the wishes, it is necessary to update the capacity of the switching servers of the network by deploying new, more powerful computers or by increasing the number of existing servers. In other words, it is necessary to update the server park of the Information and Computing Center (ICC), which allows increasing the total bandwidth of a group of switching servers. In this case, the value of the total server capacity, both in case of increasing the capacity of the existing computer fleet, and in the case of increasing the number of servers is assumed to be the same.

We assume that the network realizes the conditions for efficient commutation of channels (relative to their bandwidth), which are provided by programmable network devices (communication servers, routers). The structure of the network and the information distributed in it in the general case can be the most diverse. In this case, the problem of distribution of limited capacities is considered with the following limitations:

– information is distributed from the provider to subscribers (nodes) through switching servers through communication channels with bandwidth that takes into account the given bandwidth;

– each subscriber of the network is served by one switching server;

– the bandwidth for obtaining information for switching nodes and subscribers is limited both from the top (principal limitations of the provider's capabilities) and from the bottom (the minimum need for subscribers in the information received).

Obviously, the amount of payment for the use of communication channels of a certain bandwidth depends on the cost established by the providers and the used bandwidth of the external connection. Based on the available reserve bandwidth of the external connection, it is necessary to maximally increase the total bandwidth of users' communication channels by changing the total capacity of the communication servers, taking into account both the needs and wishes of subscribers (users) and the capabilities of the ICC.

Let N_1 – a set of providers of the global network, N_2 – a set of communication servers, N_3 – a set of subscribers. Through A_i^+, $i = \overline{1,N_1}$, denote the maximum bandwidth of the data channel that the provider *i* can provide, $i = \overline{1,N_1}$; B_j^+, $j = \overline{1,N_2}$, – the value of the maximum bandwidth of the data channel that the communication node *j* is capable of providing, $j = \overline{1,N_2}$; C_k^-, C_k^+, $k = \overline{1,N_3}$, – the values of the minimum and maximum bandwidth of the data channel to be provided to the subscriber *k*, $k = \overline{1,N_3}$; t_k - throughput of the *k*-th subscriber station, $k = \overline{1,N_3}$. Then, assuming that the power distribution of the communication channels satisfies the conditions of additivity and proportionality, we can consider the distribution of a limited homogeneous resource (communication channel bandwidth) with constraints of the transport type in order to find the optimal data transfer plan. This ensures the effective functioning of the system of providing Internet access to users, which consists in finding the optimal values of data transmission capacities T_i by the *i*-th information provider (provider), $i = \overline{1,N_1}$, and the optimal values of the throughput t_k of using local communication channels by the *k*-th user, $k = \overline{1,N_3}$.

Formally, the statement of this problem can be written in the form:

$$\max t_1 ; \ \max t_2 ; \dots \max t_{N_3} , \quad (20)$$

under the following conditions:

$$\sum_{k=1}^{N_3} t_k = \sum_{i=1}^{N_1} A_i^+ ; \quad (21)$$

$$T_i \le A_i^+ \ , \ i = \overline{1,N_1} \ , \quad (22)$$

$$\tau_j \le B_j^+ \ , \ j = \overline{1,N_2} \ , \quad (23)$$

$$C_k^- \le t_k \le C_k^+ \ , \ k = \overline{1,N_3} \ , \quad (24)$$

and with constraints

$$\sum_{k=1}^{N_3} C_k^- \le \sum_{i=1}^{N_1} A_i^+ \le \sum_{k=1}^{N_3} C_k^+ ; \ , \quad (25)$$

where τ_j – the transmission capacities of the communication channels provided by the *j*-th communication node, $j = \overline{1,N_2}$.

Using of the production-transport task to find the optimal solution

Introduce the notations:

x_{ijk} – the capacity of the communication channels connecting the provider with the number *i* through the intermediate communication server *j* with the consumption node *k*, $i=\overline{1,2}$, $j=\overline{1,2}$ (in the case of 2 servers) or $j=\overline{1,3}$ (in the case of 3 servers), $k=\overline{1,17}$;

A_i, $i=\overline{1,2}$, – maximum bandwidth provided by the provider for connection of communication servers (both values equal 10 Gb/s);

C_{ij}, $i=\overline{1,2}$, $j=\overline{1,2}$ ($j=\overline{1,3}$), – the bandwidth of the external communication channels, which provide the connection of the server *j* to the provider with the number *i* (all values are considered equal to the bandwidth of 10 Gb/s);

D_{jk}, $j=\overline{1,2}$ ($j=\overline{1,3}$), $k=\overline{1,17}$, – the maximum bandwidth of individual user connections *k* to the communication servers *j*, which initially is 260, 165, 150, 190, 275, 115, 175, 275, 155, 195, 125, 145, 90, 370, 180, 90, 150 MB Mb/s;

a_i, $i=\overline{1,2}$, – the cost of connecting a provider with the number *i* within the specified bandwidth of the external communication channel.

Then the mathematical model of the problem of optimal distribution of power of communication channels with the condition of optimization of consumption volumes can be considered as a transport problem with an optimality criterion taking into account the value indicators of the use of external channels,

$$\sum_{j=1}^{2}\sum_{k=1}^{17} a_i x_{ijk} \to \min \text{(in the case of 2 servers)},\ i=\overline{1,2}, \quad (26)$$

or

$$\sum_{j=1}^{3}\sum_{k=1}^{17} a_i x_{ijk} \to \min \text{(in the case of 3 servers)},\ i=\overline{1,2}, \quad (27)$$

and the constraints, which in this case are written in the form of the following system of inequalities

$$\sum_{j=1}^{2}\sum_{k=1}^{17} x_{ijk} \le A_i,\ i=\overline{1,2}, \text{(in the case of 2 servers)} \quad (28)$$

or

$$\sum_{j=1}^{3}\sum_{k=1}^{17} x_{ijk} \le A_i,\ i=\overline{1,2}, \text{(in the case of 3 servers)}; \quad (29)$$

$$\sum_{k=1}^{17} x_{ijk} \le C_{ij},\ i=\overline{1,2},\ j=\overline{1,2}\ (j=\overline{1,3}); \quad (30)$$

$$\sum_{i=1}^{2} x_{ijk} \le D_{jk},\ j=\overline{1,2}\ (j=\overline{1,3}),\ k=\overline{1,17}; \quad (31)$$

$$x_{ijk} \ge 0,\ i=\overline{1,2},\ j=\overline{1,2}\ (j=\overline{1,3}), k=\overline{1,17}; \quad (32)$$

When solving the problem of optimal distribution of power of communication channels with the criterion taking into account the value indicators of the use of external channels of the type (26)–(32), it should be noted that requests for information of all users of the Internet (consumers) are provided at the expense of only one provider (supplier) In this case, the mathematical model of the problem can be written in the form of a two-level production-transport problem (14)–(19) of the following form:

$$f(z)=\sum_{i=1}^{2} c_i z_i \to \min \quad (33)$$

provided

$$g(y)=\sum_{k=1}^{17}\sum_{j=1}^{2} b_k y_{jk} \to \min\text{(in the case of 2 servers)} \quad (34)$$

or

$$g(y)=\sum_{k=1}^{17}\sum_{j=1}^{3} b_k y_{jk} \to \min\text{(in the case of 3 servers)}$$

and constraints

$$\sum_{j=1}^{2} y_{jk}=1 \text{ (для 2 серверов)},$$

$$\sum_{j=1}^{3} y_{jk}=1 \text{ (in the case of 3 servers)},\ k=\overline{1,17}, \quad (35)$$

$$\sum_{k=1}^{17} b_k y_{jk} \le \sum_{i=1}^{2} a_i z_i,\ j=\overline{1,2} \text{ (in the case of 2 servers)},$$

$$j=\overline{1,3}, \text{(in the case of 3 servers)}, \quad (36)$$

$$\sum_{i=1}^{2} z_i = 1, \quad (37)$$

where c_i, $i=\overline{1,2}$, – is the cost of connecting the provider with the number *i* within the specified bandwidth of the external communication channel; a_i, $i=\overline{1,2}$, – bandwidth of the communication channel with the *i*-th provider (values are considered equal to 10 Gb/s); b_k, $k=\overline{1,17}$, – the maximum throughput of individual user connections *k* to the communication servers, which initially is 260, 165, 150, 190, 275, 115, 175, 275, 155, 195, 125, 145, 90, 370, 180, 90, 150 Mb/s; variables $z_i=\begin{cases}1\\0\end{cases}$, $i=\overline{1,2}$, with $z_i=1$, if the needs of consumers are provided by the *i*-th provider, and $z_i=0$, otherwise; variables $y_{jk}=\begin{cases}1\\0\end{cases}$, $k=\overline{1,17}$, $j=\overline{1,J}$, (for 2 servers), $J=3$ (for 3 servers), and $y_{jk}=1$, if the needs of the *k*-th user are provided by the *j*-th communication server, and $y_{jk}=0$, in all other cases; $i=\overline{1,J}$, $k=\overline{1,17}$.

The solution of continuous-discrete linear programming problems (33) – (37) occurs according to the following scheme:

– the user-server task is solved (34)–(37);

– the received solution is fixed y_{jk}, $j=\overline{1,J}$, $J=2$ (for 2 servers), $J=3$ (for 3 servers) $k=\overline{1,17}$;

– the server-provider level problem (33)–(37) is solved for this solution.

The solution of problem was carried out on the basis of a complete search of possible connections of users with communication servers. Taking into account the condition of equal capacities of network communicators in the process of obtaining the solution, it was checked

$\frac{1}{2}\sum_{s=0}^{17} C_{17}^{s} = 2^{17-1} = 2^{16}$ (for 2 servers) and $\frac{1}{2}\left(\sum_{s=0}^{17} C_{17}^{s}\left(\sum_{r=0}^{17-s} C_{17-s}^{r}\right)\right)$ (for 3 servers) connection methods.

When solving this production and transportation problem, the following results were obtained: when using 2 identical communication servers with a total capacity of 3 Gb / s, the capacity of local connections is 259, 159, 149, 166, 273, 115, 163, 274, 152, 148, 125, 144, 90, 365, 180, 89, 149 Mb / s, which coincided with the previous decisions. With the use of 3 communicators with a total capacity of 3 Gb/s, the capacity of local connections is 260, 148, 146, 190, 258, 114, 175, 266, 146, 195, 124, 143, 90, 335, 180, 89, 141 Mb/s (also coincided with previous decisions).

With the increase in the maximum values of the throughput of local connections to 280, 180, 170, 200, 290, 125, 190, 290, 170, 210, 135, 160, 100, 390, 195, 95, 165 Mb / s in case of using two communication. Optimum speeds of local connections equal to 128, 161, 160, 124, 284, 124, 152, 287, 165, 208, 134, 158, 100, 378, 194, 94, 149 Mb/s were obtained with the total throughput of 3 Gb/s, respectively, and in the case of using 3 communicators, the values of local connections 271, 146, 153, 65, 273, 123, 123, 284, 162, 206, 131, 158, 97, 378, 192, 92, 146 Mb/s, respectively.

A complete list of the results obtained for a different number of switches and their capacities is given in Table 1 (optimal solutions are highlighted).

Conclusion and discussion

In this study, the application of the production and transport task is considered to solve the problem of the distribution of the limited capacities of data transmission channels between different nodes of the computer network. A scheme is proposed for reducing the problem to a two-level continuous-discrete optimization problem. A mathematical model of the problem of power distribution of communication channels is obtained. The problem of optimal distribution of capacities with a criterion that takes into account the cost parameters of using external channels was solved, provided that requests for information from all users of the Internet (consumers) are provided at the expense of only one provider (supplier) This approach can be considered when solving various optimization problems with a hierarchical structure of the process.

Further investigation of the problem of power distribution of data transmission channels is planned to be based on the use of the traditional three-index transport problem, the use of streaming algorithms and the fuzzy approach to solving problems optimization of the distribution of limited resources. Conducting a comparative analysis of the results obtained by different methods will allow us to draw definitive conclusions about the effectiveness of the proposed approach.

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ПРО ЗВЕДЕННЯ ВИРОБНИЧО-ТРАНСПОРТНОЇ ЗАДАЧІ ДО ДВОРІВНЕВОЇ ЗАДАЧІ ОПТИМІЗАЦІЇ ТА ЇЇ ЗАСТОСУВАННЯ

Розглянуто застосування виробничо-транспортної задачі для розв'язання проблеми розподілу обмежених потужностей каналів передачі даних між різними вузлами комп'ютерної мережі. Запропоновано схему для зведення задачі до дворівневої неперервно-дискретної задачі оптимізації. Сформульовано модель і отримано чисельні результати для розв'язання проблеми розподілу потужностей у мережі інформаційно-обчислювального центру.

Ключові слова: розподіл потужностей, виробничо-транспортна задача, дискретно-неперервне програмування, дворівнева модель, оптимізація.

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О СВЕДЕНИИ ПРОИЗВОДСТВЕННО-ТРАНСПОРТНОЙ ЗАДАЧИ К ДВУХУРОВНЕВОЙ ЗАДАЧЕ ОПТИМИЗАЦИИ И ЕЕ ПРИМЕНЕНИЕ

Рассмотрено применение производственно-транспортной задачи для решения проблемы распределения ограниченных мощностей каналов передачи данных между различными узлами компьютерной сети. Предложена схема для сведения задачи к двухуровне-

вой непрерывно-дискретной задаче оптимизации. Сформулирована модель и получены численные результаты для решения проблемы распределения мощностей в сети информационно-вычислительного центра.

Ключевые слова: распределение мощностей, производственно-транспортная задача, дискретно-непрерывное программирование, двухуровневая модель, оптимизация.

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Table 1.

User's																	*Total Request*		
																	2 servers		
260	165	150	190	275	115	175	275	155	195	125	145	90	370	180	90	150	**3105**		Current demands
256	146	145	35	260	114	136	268	145	0	124	143	90	340	103	89	146	2540	-195	Cap B1,B2=1270
259	140	144	90	273	115	125	274	143	0	124	143	90	365	179	89	147	2700	-195	Cap B1,B2=1350
259	156	148	119	270	115	157	273	151	53	124	144	89	360	144	89	149	2800	-142	Cap B1,B2=1400
256	156	148	154	260	115	157	268	150	123	124	144	90	340	178	89	148	2900	-72	Cap B1,B2=1450
259	159	149	166	273	115	163	274	152	148	125	144	90	365	180	89	149	3000	-47	Cap B1,B2=1500
280	180	170	200	290	125	190	290	170	210	135	160	100	390	195	95	165	**3345**		MAX demands
128	161	160	124	284	124	152	287	165	208	134	158	100	378	194	94	149	3000	-152	Cap B1,B2=1500
279	170	165	160	285	125	170	288	168	130	134	159	100	380	194	94	149	3150	-80	Cap B1,B2=1575
280	173	166	143	289	125	176	289	168	210	135	159	100	388	166	94	149	3210	-57	Cap B1,B2=1605
278	173	167	173	281	125	176	286	168	209	135	159	100	373	193	94	150	3240	-27	Cap B1,B2=1620
279	175	168	180	285	125	180	288	169	209	135	159	100	380	194	94	150	3270	-20	Cap B1,B2=1635
279	176	168	185	287	125	182	289	169	210	135	160	100	385	194	94	150	3288	-15	Cap B1,B2=1644
280	177	168	188	289	125	184	289	169	210	135	160	100	388	194	94	150	3300	-15	Cap B1,B2=1650
280	178	169	199	289	125	187	290	170	210	135	160	100	388	188	94	150	3312	-15	Cap B1,B2=1656
																	3 servers		
260	165	150	190	275	115	175	275	155	195	125	145	90	370	180	90	150	**3105**		Current demands
260	148	146	190	258	114	175	266	146	195	124	143	90	335	180	89	141	3000	-35	Cap B1,B2,B3=1000
256	163	149	190	275	114	170	266	154	195	125	145	90	353	180	90	145	3060	-17	Cap B1,B2,B3=1020
260	165	150	190	271	115	175	273	155	195	123	145	90	363	180	90	150	3090	-7	Cap B1,B2,B3=1030
259	165	150	190	275	114	175	275	155	194	125	145	89	369	180	89	150	3099	-1	Cap B1,B2,B3=1033
280	180	170	200	290	125	190	290	170	210	135	160	100	390	195	95	165	**3345**		MAX demands
280	146	153	65	273	123	123	284	162	206	131	158	97	378	192	92	146	**3000**	-135	Cap B1,B2,B3=1000
278	154	157	199	273	123	138	281	169	209	132	153	99	355	195	94	141	3150	-52	Cap B1,B2,B3=1050
278	148	154	199	278	124	189	284	162	209	133	156	99	365	195	94	143	3210	-32	Cap B1,B2,B3=1070
280	168	164	200	280	124	165	285	167	210	134	158	100	370	195	95	145	3240	-25	Cap B1,B2,B3=1080
270	179	169	195	283	125	188	286	169	205	135	159	99	375	193	94	146	3270	-19	Cap B1,B2,B3=1090