BROADCAST NETWORKS ON $2^P - 1$ NODES AND MINIMUM BROADCAST NETWORK ON 127 NODES

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Abstract

Broadcast Networks on $2^p - 1$ Nodes and Minimum Broadcast Network on 127 Nodes

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Broadcasting is a basic problem of communication in usual networks. To design an optimal broadcast network on n nodes is very difficult. Numerous previous papers have investigated ways to construct networks with sparse communication lines in which broadcasting can be completed in the theoretically minimum amount of time from any originator. Minimum broadcast networks are the sparsest possible networks of this type, which have the minimum number of communication lines denoted by $B(n)$. Many previous papers also have investigated the construction of minimum broadcast networks for small values of n. Among those, a minimum broadcast network on 63 nodes is the largest. In this thesis, a new technique of constructing broadcast networks on $2^p - 1$ nodes is introduced. Furthermore, this technique is improved to construct broadcast networks on any odd number of nodes. Improved upper bounds on $B(n)$ for broadcast networks on $2^p - 1$ nodes are presented. Also, general bounds on $B(n)$ for broadcast networks on any odd number of nodes are given. Finally, all known minimum broadcast networks on $2^p - 1$ nodes are studied and common properties of them are observed. Then, careful studies of the observed properties and massive experimental work lead to the construction of a minimum broadcast network on 127 nodes. This network is proven to have 389 communication lines.

Acknowledgments

I sincerely appreciate the help of my supervisor, Dr. Hovhannes A. Harutyunyan, who has guided me along since the very beginning. I would also like to thank all the professors and staff members as well as my colleagues in Concordia University's Computer Science Department, who taught or helped me during my schooling.

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Chapter 1

Introduction

The study of communication networks is the key for designing high performance parallel and distributed computer systems. The performance of information dissemination in networks often determines their overall efficiency. Over the past several decades, a number of efforts have focused on finding effective topologies to serve as the underlying structure of communication networks in order to optimize information dissemination processes. The goals of choosing the effective topologies can be roughly categorized into performance and cost. The information spreading speed is one of the most important concerns on the performance side. On the cost side, the consideration of a minimum number of communication lines on a given network is one of the priorities. An optimal network topology uses the least number of communication lines possible without compromising the information spreading time.

Broadcasting is one of the fundamental information spreading problems of communication in usual networks. It is a process of message dissemination from one member to all other members in a network. The work of this thesis focuses on constructing effective network topologies for broadcasting.

1.1 Problem Statement

Broadcasting is an information dissemination problem in a connected network, in which one node, called the *originator*, must distribute a message to all other nodes by placing a series of calls along the communication lines of the network. Once informed, the informed nodes aid the originator in distributing the message. This is assumed to take place in discrete time units. In other words, this is the familiar point-to-point (telephone) communication model. The broadcasting is to be completed as quickly as possible, subject to the following constrains:

- Each call involves only one informed node and one of its uninformed neighbors.
- Each call requires one unit of time.
- A node can participate in only one call per unit of time.
- In one unit of time, many calls can be performed in parallel.

Formally, any network can be modeled as a graph $G = (V, E)$, where V is the set of nodes (or vertices) and E is the set of communication lines (or edges) between nodes in network G. We shall freely interchange network and graph theory terminology throughout. Two nodes $u \in V$ and $v \in V$ are adjacent if there is a communication line $l \in E$, such that $l = (u, v)$. We also say node u or v is a *neighbor* of another node.

The *degree* of a node u, $deg(u)$, is the number of neighbors of u. A *path* in a network is a sequence of communication lines and nodes, in which a message can travel from the originator node along the sequence of lines and nodes to the target node. All of the nodes and communication lines in a path are connected to one another. The number of communication lines in a path is called the *length* of the path. The length of the shortest path between two nodes is their *distance*. The *diameter* of a network is the longest distance between any two nodes. If there is at least a path between any two nodes on G, G is said to be a *connected network*. Two networks (graphs) G and H are *isomorphic* if H can be obtained from G by relabeling the nodes - that is a one-to-one correspondence between the nodes of G and those of H, such that the number of communication lines joining any pair of nodes in G is equal to the number of edges joining the corresponding pair of nodes in H. In graph theory, a *Hamilton cycle* is a cycle that passes through every vertex in a graph and a graph with such a cycle is called *Hamiltonian graph*. Typically one thinks of a Hamiltonian graph as a cycle with a number of other edges (called cords of the cycle). A *star graph* (or star network) consists of one vertex v which is incident with every edge and all other vertices incident on exactly one edge whose other vertex is v. v is said to be the center of the star graph. In a graph G, a set $S \subseteq V(G)$ is a *dominating set* if every vertex not in S has a neighbor in S. And if a node v is a member of S or v has at least a neighbor in S, v is said to be covered by S.

Given node u as an originator, we define the *broadcast time*, $b(u)$, as the minimum number of time units required to complete broadcasting from node u. It is easy to observe that for any node u in a connected network G on n nodes, $b(u) \geq \lceil log_2 n \rceil$, since during each time unit the number of informed nodes can at most be doubled. The broadcast time $b(G)$ of the network G is defined as $max\{b(u) | u \in V\}$. We define G as a *broadcast network* if $b(G) = \lceil log_2 n \rceil$.

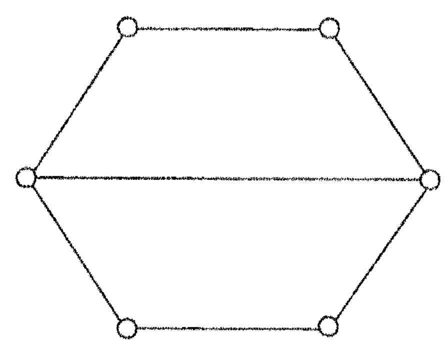


Figure 1: Example of a broadcast network.

The *broadcast function* $B(n)$ is the minimum number of communication lines in any broadcast network on n nodes. A *minimum broadcast network* or *mbn* is a broadcast network of n nodes with only $B(n)$ communication lines. Therefore, an *mbn* is the cheapest possible broadcast network architecture (have the fewest communication lines), in which broadcasting can be accomplished as fast as theoretically possible from any node.

A *broadcast protocol* (or broadcast scheme) is to demonstrate how a message is broadcasted in a network from an originator. Let node u in network G be the originator of the message. The broadcast protocol of u is a rooted spanning tree in which u is the root and all the communication lines are labeled with the transition time. In a broadcast protocol, each communication line is used exactly once and the

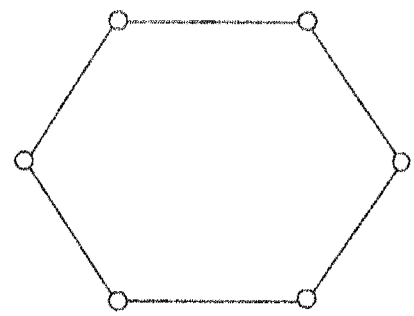


Figure 2: Example of a minimum broadcast network.

message is always transmitted from a parent to a child. Given a broadcast protocol in a broadcast network G on n nodes, a node v is *idle* at time $t \leq \lceil log_2 n \rceil$ if and only if v is aware of the message at the beginning of time unit t and v does not communicate with any of its neighbors during time unit t.

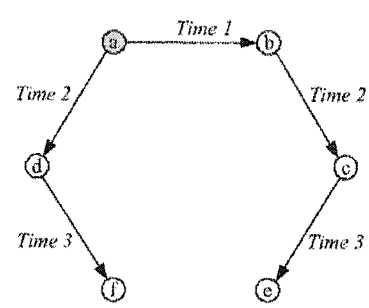
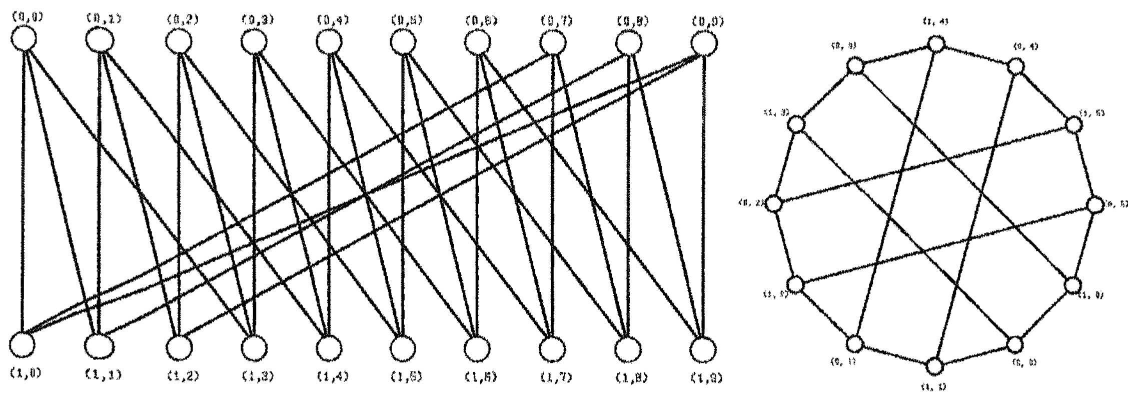


Figure 3: Example of a broadcast protocol of node a.

1.2 Modified Knödel Graph and mbn on 2^p-2 Nodes

Knödel graphs have been originally introduced in 1975 [23]. However, the family of Knödel graphs has been formally defined by Fraigniaud and Peters [14]. Since then, they have been widely studied as topologies of communication networks, mainly because of their good properties in terms of broadcasting and gossiping [4].

Definition 1. *(Knödel Graph [14]) The Knödel graph on $n \geq 2$ vertices (n is even) and of maximum degree d, $1 \leq d \leq \lfloor log_2 n \rfloor$, is denoted $W_{d,n}$. The vertices of $W_{d,n}$ are the couples $(i,\ j)$, with $i = 0,\ 1$ and $0 \leq j \leq \frac{n}{2} - 1$. For every $0 \leq j \leq \frac{n}{2} - 1$ there is an edge between vertex $(0,\ j)$ and every vertex $(1,\ j + 2^k - 1 \ mod \ \frac{n}{2})$, for $k = 0,\ 1,\ ...,\ d - 1$.*



(a) $W_{3,20}$ (b) $W_{3,12}$

Figure 4: Examples of Knödel graphs.

In this thesis, modified Knödel graphs [4] are considered. A modified Knödel graph on n nodes is isomorphic to a Knödel graph with degree of $\lfloor log_2 n \rfloor$ for any even n which is not a power of 2.

Modified Knödel graph can be formally defined in the following way [4]:

Definition 2. *(Modified Knödel Graph [4]) Let W_n denote a modified Knödel graph on n vertices (n is even and not a power of 2), $W_n = (V(W_n),\ E(W_n))$. $V(W_n) = \{(i,\ j) | i \in \{0, 1\}$ and $j \in \{0,\ 1,\ 2,\ ...,\frac{n}{2} - 1\}\}$, $E(W_n) = \{((0,\ j), (1,\ j + 2^k - 1 \ mod \ \frac{n}{2})) | k = 0,\ 1,\ ...,\ \lfloor log_2 n \rfloor - 1\}$.*

According to Definition 1, a modified Knödel graph W_n is a Knödel graph $W_{\lfloor log_2 n\rfloor,n}$ for any even n which is not a power of 2.

Modified Knödel graphs are broadcast networks [12]. Modified Knödel graphs on $2^p - 2$ nodes are minimum broadcast networks [22].

In [22], a modified Knödel graph H_p on $2^p - 2$ vertices where $p \geq 2$ is formally defined in the following way:

Definition 3. *For modified Knödel graph $H_p = (V(H_p), E(H_p))$ on $2^p - 2$ vertices where $p \geq 2$, $V(H_p) = \{0,\ 1,\ 2,\ ...,\ 2^p - 3\}$, $E(H_p) = \{(a, b) | a \in V(H_p),\ b \in V(H_p),\ a + b = 2^k - 1\ mod\ 2^p - 2\ for\ 1 \leq k \leq p - 1\}$.*

In modified Knödel graph H_p, the number of all edges is: $|E(H_p)| = (p-1)(2^{p-1} - 1)$.

In a $d-$dimensional hypercube, all the edges can be partitioned into d sets - each set corresponding to a particular dimension. To broadcast a message from any originator in a network of a hypercube structure, any informed vertex simply forwards the message to its neighbor in the t_ith dimension at each time i (where $1 \leq i \leq d$).

In a network structure of modified Knödel graph W_n, there exist similar permutations of the dimensions [4], say $(t_0, t_1, t_2, ..., t_{\lfloor log_2 n\rfloor - 1})$. The edges $((0,\ j), (1,\ j + 2^k - 1\ mod\ \frac{n}{2}))$ ($k \in \{0,\ 1,\ ...,\ \lfloor log_2 n\rfloor - 1\ \}$) may be thought of as edges in dimension k. Given such a permutation, we use the sequence of dimensions $(t_0, t_1, t_2, ..., t_{\lfloor log_2 n\rfloor - 1}, t_0)$; that is, the first dimension is repeated again at the end of the sequence. To broadcast a message from any source, any informed vertex simply forwards the message to its neighbor in the t_ith dimension at each time $i + 1$ (where $0 \leq i \leq \lfloor log_2 n\rfloor - 1$ and

$t_{\lfloor log_2 n \rfloor} = t_0$). In the last time unit, the originator is idle. Figure 5 is an example of a modified Knödel graph W_{14} and a broadcast protocol in it.

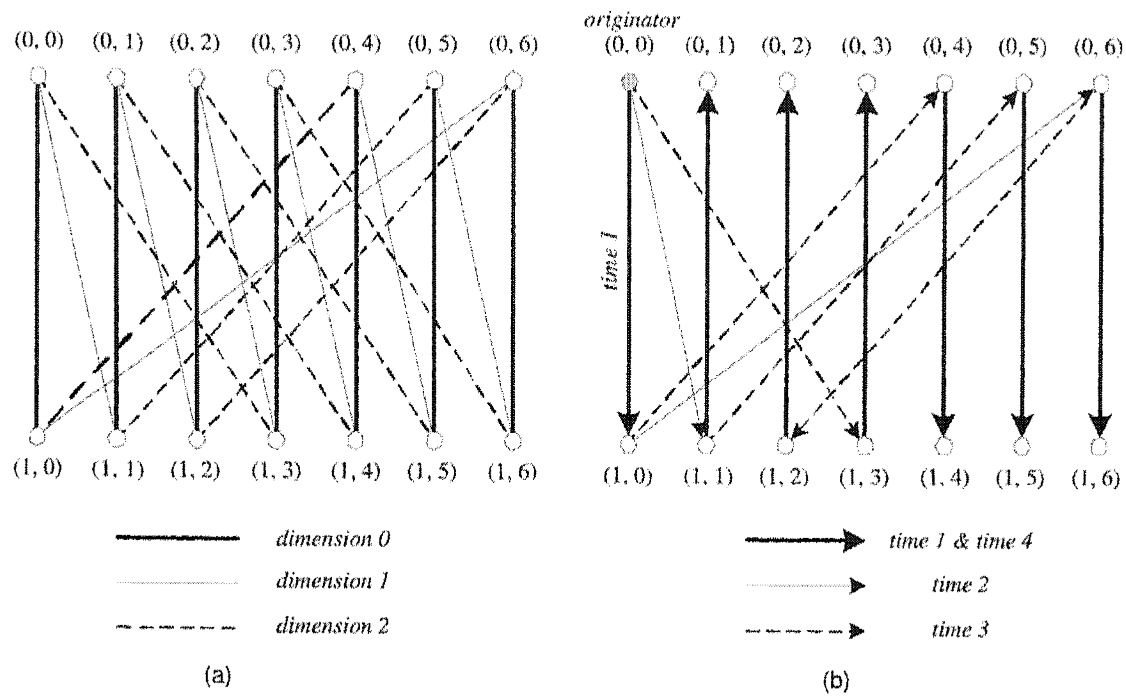


Figure 5: Example of modified Knödel graph W_{14} and a broadcast protocol in W_{14}.

Similarly, in modified Knödel graph H_p ($n = 2^p - 2$), edges (a, b) such that $a + b = 2^k - 1 \ mod \ 2^p - 2$ for $1 \leq k \leq p - 1$ may be thought of as edges in dimension k. To broadcast from an arbitrary node of H_p, all informed nodes call neighbors in dimension j at time unit j for $1 \leq j \leq p - 1$ and neighbors in dimension 1 at time p. This means that the broadcast protocol follows the sequence of dimensions (1, 2, 3, ..., $p - 1$, 1). In a broadcast protocol of any originator, at the last time unit the originator and its first informed neighbor are idle. Figure 6 is an example of a modified Knödel graph H_4 and a broadcast protocol in it.

If there is a permutation of dimensions (d_1, d_2, d_3, ..., d_p) such that the sequence

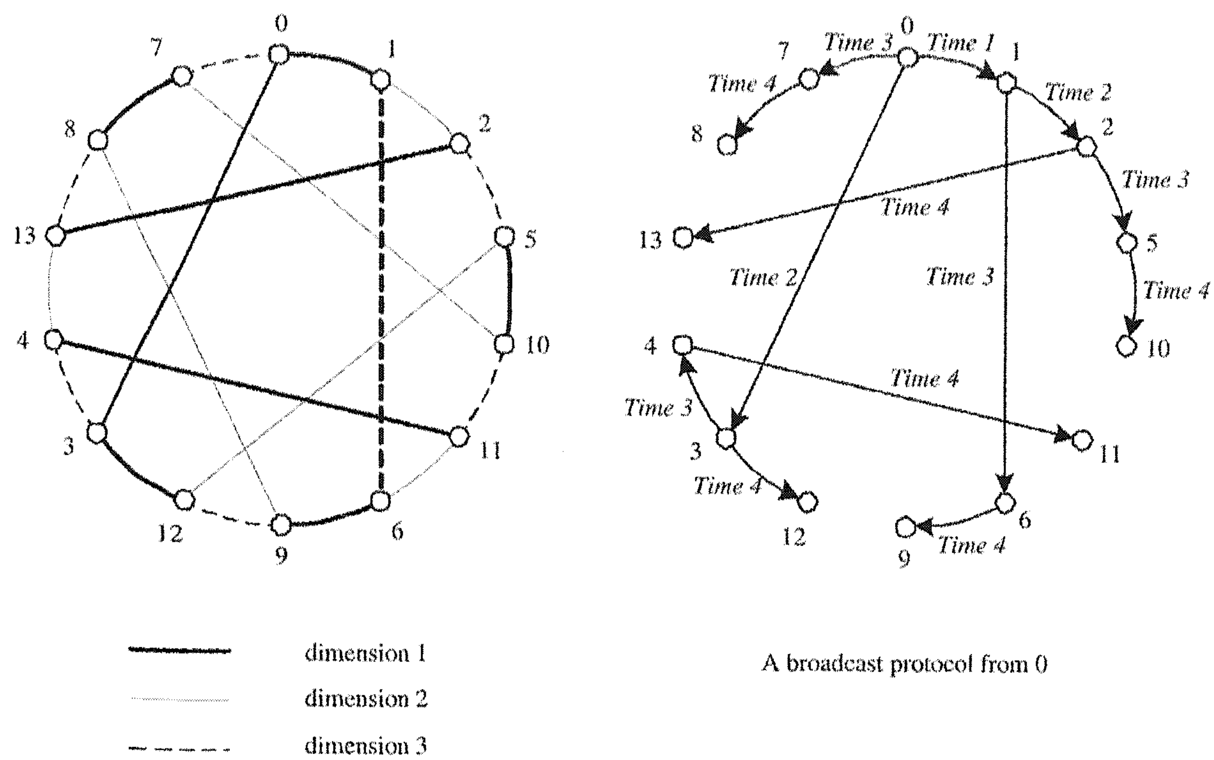


Figure 6: Example of modified Knödel graph H_4 and a broadcast protocol in H_4.

of dimensions $(d_1,\ d_2,\ d_3,\ \ldots, d_p,\ d_1)$ gives a broadcast protocol, the permutation is called a *valid permutation*. The permutation $(1,\ 2,\ \ldots,\ p-1)$ is a valid permutation in a modified Knödel graph [4].

The following lemma (Lemma 3 in [4]) will be useful in describing broadcast protocols of our new broadcast networks constructed in this thesis.

Lemma 1.

Any cyclic shift of a valid permutation followed by the initial dimension of that shift is also a valid permutation in a modified Knödel graph.

For example, in modified Knödel graph H_p, $(1,\ 2,\ 3,\ \ldots,\ k,\ k+1,\ \ldots,\ p-1)$ is a valid permutation. According to Lemma 1, $(k+1,\ k+2,\ \ldots,\ p-1,\ 1,\ 2,\ \ldots,\ k)$

is also a valid permutation. This means that the sequence $(k+1,\ k+2,\ ...,\ p-1,\ 1,\ 2,\ ...,\ k,\ k+1)$ gives a broadcast protocol in H_p. We refer to such a broadcast protocol as a *dimensional broadcast protocol* in H_p.

1.3 Previous Results

The problem of determining $b(u)$ for a node u in an arbitrary network is $NP-complete$ [21]. There is also no known method for determining $B(n)$ for an arbitrary value of n. Since this suggests that *mbns* are difficult to find, the values for $B(n)$ and constructions of *mbns* are known for some small values of n or special n. In 1979 Farley et al. [11] studied the broadcast function $B(n)$; they showed that hypercubes are *mbns* and $B(2^p) = p2^{p-1}$ for any $p \geq 0$. Khachatrian and Harutyunyan [22] and Dinneen et al. [8] proved independently that for $p \geq 2$:

$$B(2^p - 2) = (p-1)(2^{p-1} - 1)$$

Farley et al. also determined the values of $B(n)$, for $1 \leq n \leq 15$. Mitchell and Hedetniemi [26] determined the value $B(17)$ and Bernond et al. [2] established the values of $B(n)$ for $n = 18,\ 19,\ 30$ and 31. The most recent results of $B(n)$ were achieved by J. -F. Sacle [28] for $26 \leq n \leq 29$ and $58 \leq n \leq 61$. So far, the largest known constructed *mbn* is a network on 63 nodes [17, 24]. The known values of the broadcast function $B(n)$ are shown in Table 1. Some known *mbns* are demonstrated in Figure 7 [19].

Since *mbns* seem to be extremely difficult to find, many authors have devised

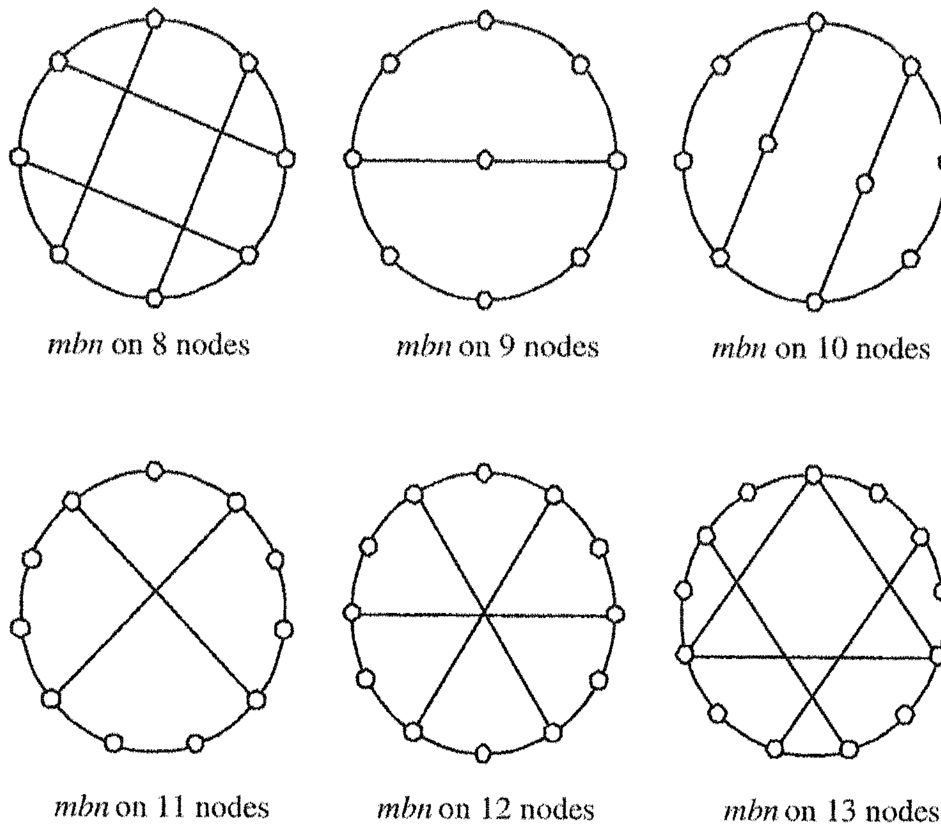


Figure 7: Examples of some minimum broadcast networks.

methods to construct broadcast networks with small numbers of edges [2, 3, 6, 7, 8, 9, 10, 15, 16, 18, 22, 25, 29, 30, 31]. The number of edges in any broadcast network on n nodes gives an upper bound on $B(n)$. Several papers have shown methods to construct broadcast networks by forming the compound of two known broadcast networks (see [3], [9], [18] and [22]). These methods are proven to be effective on n_1n_2 nodes networks, where the two known broadcast networks are on n_1 and n_2 nodes. Broadcast networks on other sizes can sometimes be formed by adding or deleting nodes from known broadcast networks (see [2] for example). Harutyunyan and Liestman [18] present a method based on compounding and then merging several

n	$B(n)$	Ref.
1	0	[11]
2	1	[11]
3	2	[11]
4	4	[11]
5	5	[11]
6	6	[11]
7	8	[11]
8	12	[11]
9	10	[11]
10	12	[11]
11	13	[11]
12	15	[11]
13	18	[11]
14	21	[11]
15	24	[11]
16	32	[11]
17	22	[26]
18	23	[2]
19	25	[2]

n	$B(n)$	Ref
20	26	[25]
21	28	[25]
22	31	[25]
26	42	[28]
27	44	[28]
28	48	[28]
29	52	[28]
30	60	[2]
31	65	[2]
32	80	[11]
58	121	[28]
59	124	[28]
60	130	[28]
61	136	[28]
62	155	[22]
63	162	[17, 24]
64	192	[11]
2^p	$p2^{p-1}$	[11]
2^p-2	$(p-1)(2^{p-1}-1)$	[22]

Table 1: The previous known $B(n)$

nodes into one that allows the construction of the best broadcast networks for almost all values of n, including many primes.

In this thesis we consider *mbns* and broadcast networks on $n = 2^p - 1$ nodes. The exact values of $B(2^p - 1)$ are known for $2 \leq p \leq 6$. Some lower and upper bounds on $B(2^p - 1)$ are also known in literature [10, 15, 17, 18, 24]. The best lower and upper bounds on $B(2^p - 1)$ are as follows [17, 18, 24]:

$\frac{p^2(2^p-1)}{2(p+1)} \leq B(2^p - 1) \leq 2^{p-1}(p - \frac{1}{2})$.

1.4 Contribution of this Thesis

This thesis focuses on constructing effective network topologies on $2^p - 1$ nodes for the broadcast problem. In this thesis, a new method is introduced to construct broadcast networks on $2^p - 1$ nodes. The basic idea of this method is to construct a broadcast network on $2^p - 1$ nodes by adding an extra node to a minimum broadcast network on $2^p - 2$ nodes, which is known as a modified Knödel graph [4]. The innovation of this method is that the added node is connected to the nodes in a dominating set of the modified Knödel graph. Dominating sets of modified Knödel graphs are studied and two kinds of dominating sets for modified Knödel graphs are proposed. The method is further generalized to construct the broadcast networks on any odd number of nodes, except in the case of $2^p + 1$ nodes. A general upper bound on $B(n)$ for any odd values of n, except $n = 2^p + 1$, is presented. Two new upper bounds on $B(2^p - 1)$ are introduced. By comparison, the new bounds are better than the best of the previous bounds.

In this thesis, the construction of minimum broadcast networks on $2^p - 1$ nodes is also investigated. All known minimum broadcast networks on $2^p - 1$ nodes are studied and common properties of them are observed. Then, the massive experimental work and careful studies of the observed properties lead to the construction of a minimum broadcast network on 127 nodes. This minimum broadcast network is the largest known constructed one. The broadcast protocols for all originators are described. It is proven that $B(127) = 389$.

Since many well known methods to construct broadcast networks are based on the known broadcast networks, such as forming the compound of two broadcast networks, the results of this thesis can be used to improve many previous construction results of broadcast networks.

1.5 Thesis Outline

The remainder of this thesis is structured as follows: In Chapter 2, a new method is introduced to construct broadcast networks on $2^p - 1$ nodes. A new upper bound on $B(2^p - 1)$ is proposed. In Chapter 3, the method described in Chapter 2 is generalized to construct broadcast networks on any odd number of nodes (except in the case of $2^p + 1$ nodes). Another new upper bound on $B(2^p - 1)$ is presented. The construction of a minimum broadcast network on 127 nodes is introduced in Chapter 4. All the broadcast protocols of the *mbn* on 127 nodes are demonstrated. Finally, in Chapter 5 the conclusions and comparisons of the results are discussed.

Chapter 2

New Construction Technique of Broadcast Networks on $2^p - 1$ Nodes

In this chapter, a new method is demonstrated to construct broadcast networks on $2^p - 1$ nodes. First, a dominating set of any modified Knödel graph on $2^p - 2$ nodes is found. This dominating set is used to construct new broadcast networks. Then, the construction technique is formally described. The constructed networks are proven to be broadcast networks as all the broadcast protocols are described. Finally, a new upper bound on $B(2^p - 1)$ is presented.

2.1 Dominating Set with 2^{p-2} Members in H_p

In this section, we will prove the existence of a dominating set with 2^{p-2} nodes in any modified Knödel graph H_p on $2^p - 2$ nodes. In this chapter, we use Definition 3 for H_p.

For $H_p = (V(H_p), E(H_p))$ and $p \geq 2$, $V(H_p) = \{0,\ 1,\ 2,\ ...,\ 2^p - 3\}$ and $E(H_p) = \{(a,\ b) | a \in V(H_p), b \in V(H_p), a + b = 2^k - 1\ mod\ 2^p - 2 \text{ for } 1 \leq k \leq p-1\}$.

Theorem 1. *Let S be a subset of $V(H_p)$ and $S = \{0,\ 2,\ 4,\ 6,\ ...\ ,\ 2^{p-2} - 2,\ 2^{p-1} + 1,\ 2^{p-1} + 3,\ ...,\ 2^{p-1} + 2^{p-2} - 1\}$. S is a dominating set of H_p.*

Proof.

Let $S = S_1 \cup S_2$, $S_1 = \{0,\ 2,\ 4,\ 6,\ ...,\ 2^{p-2} - 2\}$ and $S_2 = \{2^{p-1} + 1,\ 2^{p-1} + 3,\ ...,\ 2^{p-1} + 2^{p-2} - 1\}$.

Let $x \in V(H_p)$.

Suppose x is odd.

If $x \leq 2^{p-1} - 1$, then x can be expressed as $x = 2^{\lceil log_2 x \rceil} - r$, where r is odd and $1 \leq r \leq 2^{\lceil log_2 x \rceil - 1} - 1$. Consider node $y = r - 1$. Since $x + y = (2^{\lceil log_2 x \rceil} - r) + (r - 1) = 2^{\lceil log_2 x \rceil} - 1$ and $0 \leq \lceil log_2 x \rceil \leq p - 1$, node x is a neighbor of node y. From $1 \leq r \leq 2^{\lceil log_2 x \rceil - 1} - 1$ follows that $0 \leq r - 1 \leq 2^{\lceil log_2 x \rceil - 1} - 2 \leq 2^{p-2} - 2$. Thus, $y \in S_1$, and any odd node x, where $x \leq 2^{p-1} - 1$ has a neighbor in the dominating set S.

All the odd nodes $2^{p-1} + 1,\ 2^{p-1} + 3,\ ...,\ 2^{p-1} + 2^{p-2} - 1$ belong to S_2, and consequently to S.

It remains to consider odd nodes $2^{p-1} + 2^{p-2} + 1,\ 2^{p-1} + 2^{p-2} + 3,\ ...,\ (2^{p-1} +$

$2^{p-2}) + (2^{p-2} - 3) = 2^p - 3$. It is easy to see that $x = (2^{p-1} + 2^{p-2}) + 1$ is a neighbor of node $y = 2^{p-2} - 2 \in S_1$, because $x + y = 2^p - 1$ and $x + y = 1 \ mod \ (2^p - 2)$. Similarly, $x = 2^{p-1} + 2^{p-2} + 3$ is a neighbor of $y = 2^{p-2} - 4 \in S_1$, because $x + y = 1 \ mod \ (2^p - 2)$. In general, any node $x = (2^{p-1} + 2^{p-2}) + (2s - 1)$, where $1 \leq 2s - 1 \leq 2^{p-2} - 3$, is a neighbor of $y = 2^{p-2} - 2s \in S_1$, since $x + y = 2^p - 1$ and thus $x + y = 1 \ mod \ (2^p - 2)$. $x = (2^{p-1} + 2^{p-2}) + (2^{p-2} - 3)$ has a neighbor $y = 2 \in S_1$.

Therefore, for every odd x, x is a member in S or a neighbor of at least a member in S.

Suppose x is even.

All even nodes $0, 2, 4, \ldots, 2^{p-2} - 2$ belong to S_1 and consequently belong to S.

Consider even nodes $2^{p-2}, 2^{p-2} + 2, \ldots, 2^{p-2} + (2^{p-2} - 2) = 2^{p-1} - 2$. $x = 2^{p-2}$ is a neighbor of $y = 2^{p-1} + 2^{p-2} - 1 \in S_2$, since $x + y = 2^p - 1 = 1 \ mod \ (2^p - 2)$. Similarly, $x = 2^{p-2} + 2$ is a neighbor of $y = 2^{p-1} + 2^{p-2} - 3 \in S_2$, since $x + y = 2^p - 1 = 1 \ mod \ (2^p - 2)$. In general, $x = 2^{p-2} + 2s$, where $0 \leq 2s \leq 2^{p-2} - 2$, is a neighbor of $y = 2^{p-1} + 2^{p-2} - 2s - 1$, because $x + y = 2^p - 1 = 1 \ mod \ (2^p - 2)$. Since $0 \leq 2s \leq 2^{p-2} - 2$, then $2^{p-1} + 2^{p-2} - 2^{p-2} + 2 - 1 \leq 2^{p-1} + 2^{p-2} - 2s - 1 \leq 2^{p-1} + 2^{p-2} - 1$, and so, $y = 2^{p-1} + 2^{p-2} - 2s - 1 \in S_2$. $x = 2^{p-1} - 2$ is a neighbor of $y = 2^{p-1} + 1 \in S_2$, since $x + y = 1 \ mod \ (2^p - 2)$.

It remains only to consider the case when x is even and $2^{p-1} \leq x \leq 2^p - 4$.

If $x = 2^{p-1}$ then it is a neighbor of $y = 2^{p-1} + 2^{p-2} - 3 \in S_2$, because $x + y = 2^p + 2^{p-2} - 3 = 2^{p-2} - 1 \ mod \ (2^p - 2)$. Similarly, $x = 2^{p-1} + 2$ is a neighbor of $y = 2^{p-1} + 2^{p-2} - 5 \in S_2$, since $x + y = 2^p + 2^{p-2} - 3 = 2^{p-2} - 1 \ mod \ (2^p - 2)$.

In general, any node $x = 2^{p-1} + 2s$, where $0 \leq 2s \leq 2^{p-2} - 4$, is a neighbor of $y = 2^{p-1} + 2^{p-2} - 3 - 2s \in S_2$, since $x + y = 2^{p-2} - 1 \ mod \ (2^p - 2)$.

If $x = 2^{p-1} + 2^{p-2} - 2$, it is a neighbor of $y = 2^{p-1} + 2^{p-2} - 1 \in S_2$, since $x + y = 2^{p-1} - 1 \ mod \ (2^p - 2)$. If $x = 2^{p-1} + 2^{p-2}$, it is a neighbor of $y = 2^{p-1} + 2^{p-2} - 3 \in S_2$, since $x+y = 2^{p-1} - 1 \ mod \ (2^p - 2)$. In general, any node $x = 2^{p-1} + 2s$, where $2^{p-2} - 2 \leq 2s \leq 2^{p-1} - 4$, is a neighbor of $y = 2^p - 3 - 2s$, since $x + y = 2^{p-1} - 1 \ mod \ (2^p - 2)$. Because $2^{p-2} - 2 \leq 2s \leq 2^{p-1} - 4$, $2^{p-1} + 1 \leq y \leq 2^{p-1} + 2^{p-2} - 1$. So, $y \in S_2$.

Therefore, any $x \in V(H_p)$ is a member of S or at least a neighbor of one member in S. S is a dominating set.

$\square$

Since $S = S_1 \cup S_2$ and $S_1 \cap S_2 = \phi$, $|S| = |S_1| + |S_2|$. $|S_1| = 2^{p-3}$ and $|S_2| = 2^{p-3}$. So, $|S| = 2^{p-2}$.

2.2 Construction of Broadcast Networks on $2^p - 1$ Nodes

A new method of constructing broadcast networks on $2^p - 1$ nodes is presented in this section. The basic idea of this method is to construct a network $G = (V, E)$ on $2^p - 1$ nodes by adding one extra node w to a modified Knödel graph H_p on $2^p - 2$ nodes. Additional communication lines are added to connect w with every node in a dominating set S of H_p. The construction is demonstrated in Figure 8.

Theorem 2. *Let $H_p = (V(H_P), E(H_P))$ be a modified Knödel graph on $2^p - 2$ nodes. $S = \{0,\ 2,\ 4,\ 6,\ ...,\ 2^{p-2}-2,\ 2^{p-1}+1,\ 2^{p-1}+3,\ ...,\ 2^{p-1}+2^{p-2}-1\}$ is a dominating set of H_p. Let $w \notin V(H_p)$ and $G = (V, E)$ where $V = V(H_p) \cup \{w\}$ and $E = E(H_p) \cup \{(w, v)|v \in S\}$. G is a broadcast network on $2^p - 1$ nodes.*

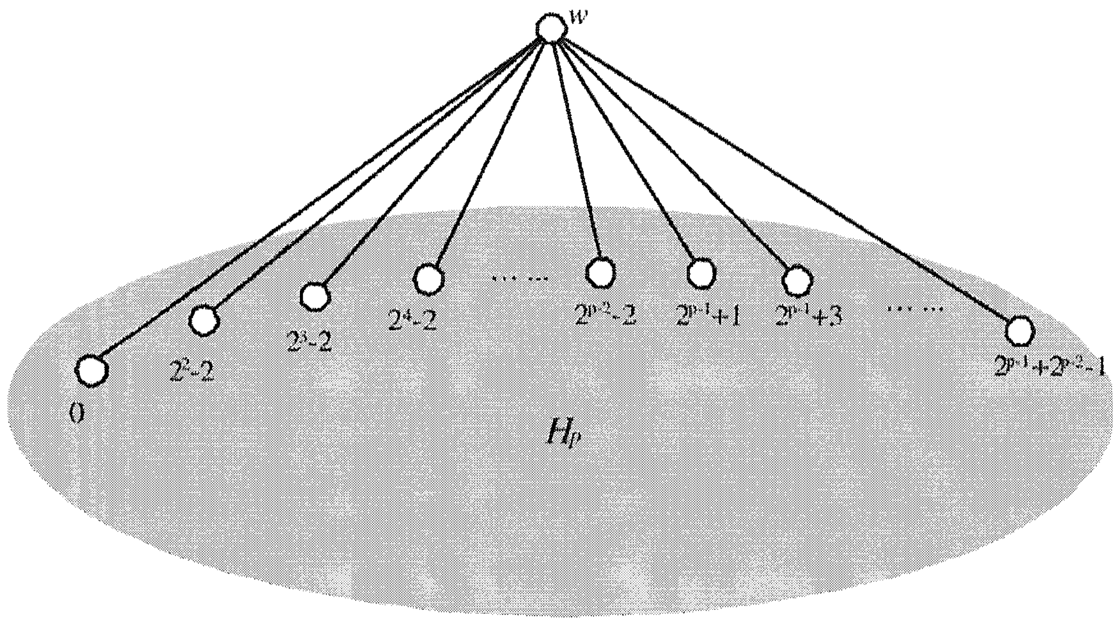


Figure 8: Demonstration of the broadcast network construction.

Proof.

To prove that G is a broadcast network, we must describe minimum time broadcast protocol for every originator $u \in V$. In network $G = (V, E)$, for any $v \in V$, $b(v) \geq \lceil log_2(2^p - 1) \rceil = p$. The minimum broadcasting time for any broadcast protocol of G is p.

If u is in dominating set S of H_p ($u \in S$), then u informs all other nodes on H_p according to the broadcast protocol of u in minimum broadcast network H_p. At the last time unit of the broadcast protocol, u is idle. Since u is a neighbor of w, w can be informed by u in the last time unit. So, at the end of time unit p, all nodes in G are informed.

If u is in H_p but not in dominating set S ($u \in V(H_p)\backslash S$), there must exist a node $v \in S$ which is a neighbor of u. $u + v = 2^i - 1$ where $1 \leq i \leq p-1$. According to Lemma 1, in H_p there must be a dimensional broadcast protocol (i, $i+1$, ..., $p-1$, 1, 2, ..., $i-1$, i) of u. Under this broadcast protocol, node $v = 2^i - 1 - u$ receives the message at time unit 1. Then at the last time unit, u and v are idle and all the nodes on H_p are informed. In G, u uses the same broadcast protocol as that in H_p. At time unit p all the nodes of G will be informed except node w. Since v is connected to w, w can be informed by v in the last time unit. So, at the end of time unit p, all nodes in G are informed.

Now we consider the last case, the broadcasting originator is node w.

First, let's consider the dimensional broadcast protocol (1, 2, ..., $p-1$, 1) from originator 1 in H_p. In H_p, node 1 is connected to 2^1-2, 2^2-2, 2^3-2, 2^4-2, 2^5-2, ..., $2^{p-2}-2$, $2^{p-1}-2$. At the first time unit, node 1 informs its neighbor in the first dimension, that is node 0. At the second time unit, node 1 informs its neighbor in the second dimension, that is node 2^2-2. And so on, at time unit $p-1$, node 1 informs node $2^{p-1}-2$. At the last time unit, $2^{p-1}-2$ informs its first dimensional neighbor, that is $2^{p-1}+1$. The broadcast protocol of node 1 on H_p is demonstrated in Figure 9.

The broadcast protocol from originator w in network G is based on the dimensional broadcast protocol $(1,\ 2,\ ...,\ p-1,\ 1)$ from originator 1 in graph H_p .

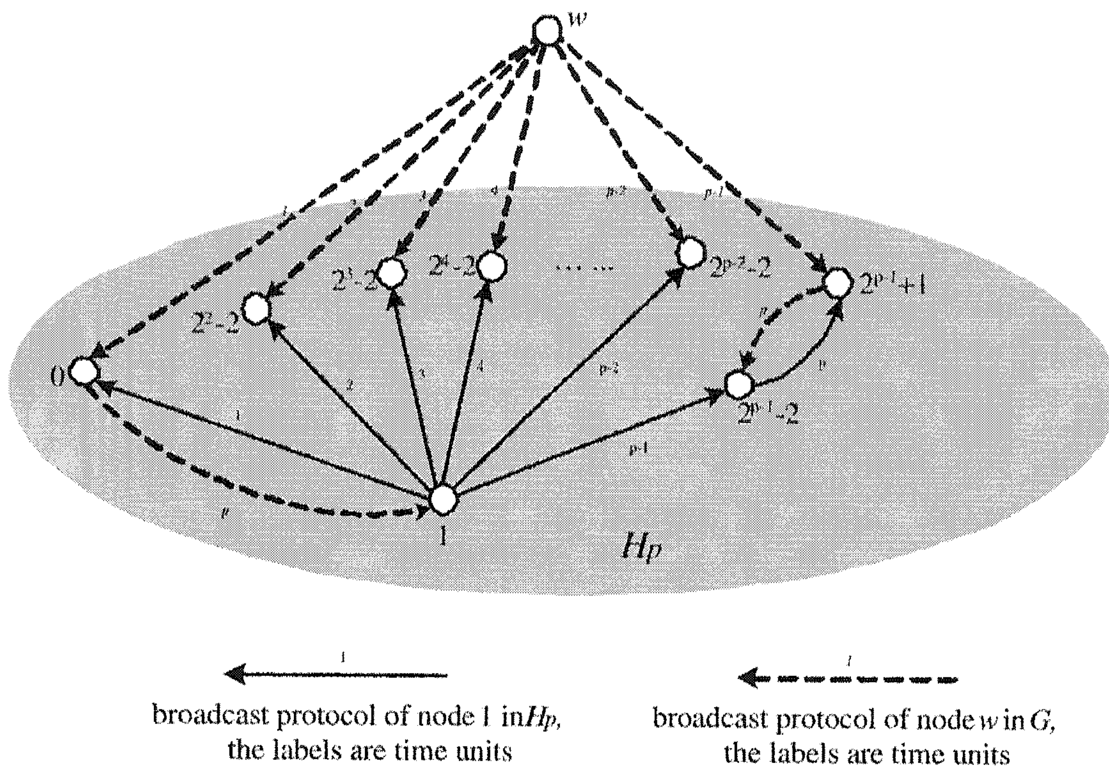


Figure 9: Demonstration of a broadcast protocol of node w.

Since $2^1-2,\ 2^2-2,\ 2^3-2,\ 2^4-2,\ 2^5-2,\ ...,\ 2^{p-3}-2,\ 2^{p-2}-2$ are in S_1, they are in dominating set S and they are neighbors of w. Therefore, w may inform these nodes at the same time units as in the broadcast protocol of node 1 on H_p, and these nodes continue the dimensional broadcasting $(1,\ 2,\ ...,\ p-1,\ 1)$ in graph H_p from originator 1.

Because node w is not directly connected to node $2^{p-1}-2$, at time unit $p-1$ node w informs node $2^{p-1}+1$ instead. Then, at time unit p, node $2^{p-1}+1$ informs node

$2^{p-1} - 2$ (see Figure 9).

According to the broadcast protocol of node 1 on H_p, at time unit p node 0 is idle. So, it can inform node 1 at time unit p, which completes the broadcasting in network G.

Therefore, all the nodes can be informed at the end of time unit p. G is a broadcast network.

□

2.3 New Upper Bound on $B(2^p - 1)$

From Theorem 2 follows the following upper bound on $B(2^p - 1)$.

Corollary 1. $B(2^p - 1) \leq 2^{p-1}(p - \frac{1}{2}) - (p - 1)$, *for* $p \geq 2$.

Proof.

Because $G = (V, E)$ is a broadcast network on $2^p - 1$ nodes, $|E|$ is a upper bound on $B(2^p - 1)$.

Since $|E| = |E(H_p)| + |\{(w, v) | v \in S\}| = B(2^p - 2) + |S|$, $B(2^p - 1) \leq B(2^p - 2) + |S|$.

Since $B(2^p - 2) = (p - 1)(2^{p-1} - 1)$ and $|S| = 2^{p-2}$, then $B(2^p - 1) \leq (p - 1)(2^{p-1} - 1) + 2^{p-2} = 2^{p-1}(p - \frac{1}{2}) - (p - 1)$. □

The best previous upper bound on $B(2^p - 1)$ was obtained by Corollary 3.4 in [18]. In the case of $2^p - 1$ nodes, it is: $B(2^p - 1) \leq 2^{p-1}(p - \frac{1}{2})$.

The new bound is a little bit better than the old one. Although there is only a small improvement in the new bound, the construction method is new. Furthermore, if there is a better (smaller) dominating set of H_p to be found, the improvement would be more significant. In the next chapter, this method is further used into more general construction and a better upper bound on $B(2^p - 1)$ is obtained.

Chapter 3

New Construction Technique of Broadcast Networks on Odd Number of Nodes

In this chapter, the method of constructing broadcast networks on $2^p - 1$ nodes in the last chapter is further generalized to construct broadcast networks on any odd number of nodes (except on $2^p + 1$ nodes). First, a dominating set for modified Knödel graph W_n is proposed. Then, the construction technique is formally described. The constructed network is proven to be a broadcast network when all the broadcast protocols are described. Finally, a general upper bound on $B(n)$ for any odd n ($n \neq 2^p + 1$) is presented. From this general bound, an improved upper bound on $B(2^p - 1)$ is proposed.

3.1 Dominating Set for Modified Knödel Graph W_n

In this section, we prove that for any modified Knödel graph W_n where $n > 2^6$, there is a dominating set with no more than $2\lceil n/10 \rceil$ members.

Let $W_n = (V(W_n),\ E(W_n))$ be a modified Knödel graph on n nodes. According to Definition 2, we have $V(W_n) = \{(x,\ y) | x \in \{0, 1\}\ and\ y \in \{0,\ 1,\ 2,\ ...,\ n/2 - 1\}\}$ and $E(W_n) = \{((0,\ y), (1,\ y + 2^k - 1\ mod\ n/2))\ |\ k = 0,\ 1,\ ...,\ \lfloor log_2 n \rfloor - 1\}$.

Theorem 3. *Let $R \subseteq V(W_n)$ and $R = \{(0,\ 5r), (1,\ 5r + 4) | 0 \le r \le \lceil n/10 \rceil - 1\}$. R is a dominating set of W_n when $\lfloor log_2 n \rfloor \ge 6$.*

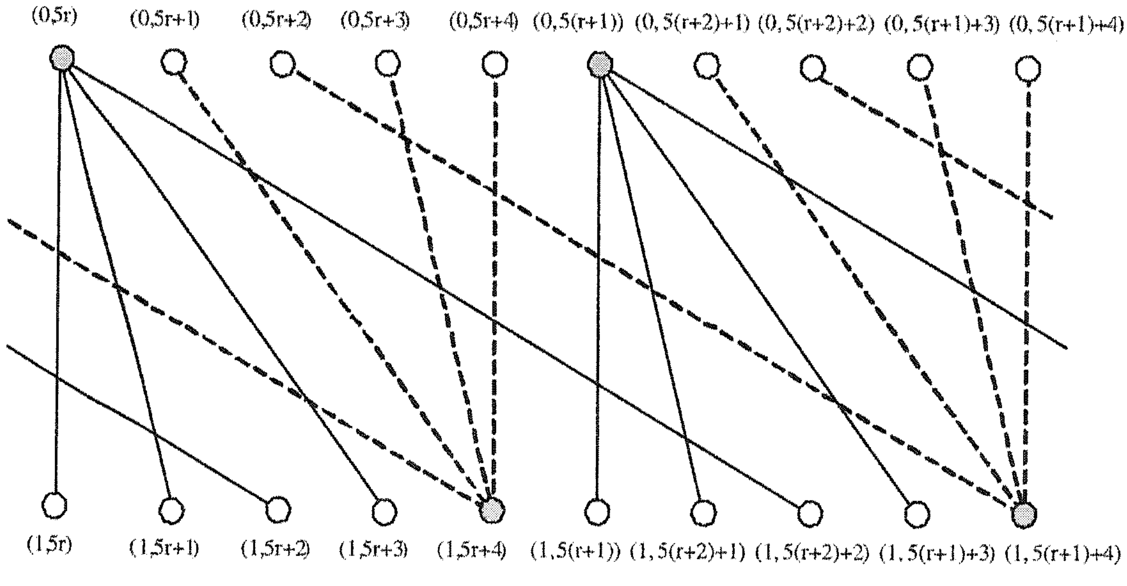


Figure 10: Demonstration of the nodes in dominating set R.

Proof.

Now we will prove that every node on W_n is a member of R or has at least one neighbor in R when $\lfloor log_2 n \rfloor \geq 6$. Figure 10 demonstrates some sample nodes in dominating set R.

Let R_0 and R_1 be subsets of R, and $R_0 = \{(0,\ 5r) | 0 \leq r \leq \lceil n/10 \rceil - 1\}$, $R_1 = \{(1,\ 5r+4) | 0 \leq r \leq \lceil n/10 \rceil - 1\}$.

For any $(x,\ y) \in V(W_n)$, x can be 0 or 1 and y can be one of the following forms: $5r$, $5r+1$, $5r+2$, $5r+3$ or $5r+4$, where $0 \leq r \leq \lceil n/10 \rceil - 1$. Then, $(x,\ y) \in \{(0,\ 5r),\ (0,\ 5r+1),\ (0,\ 5r+2),\ (0,\ 5r+3),\ (0,\ 5r+4),\ (1,\ 5r),\ (1,\ 5r+1),\ (1,\ 5r+2),\ (1,\ 5r+3),\ (1,\ 5r+4)\}$, for $0 \leq r \leq \lceil n/10 \rceil - 1$.

If $\lfloor log_2 n \rfloor \geq 4$, any node in W_n has at least 4 neighbors. In this case, node $(0,\ 5r) \in R_0$ has neighbors of $(1,\ 5r)$, $(1,\ 5r+1)$, $(1,\ 5r+3)$, $(1,\ 5r+7)$. Node $(1,\ 5r+4) \in R_1$ has neighbors of $(0,\ 5r+1)$, $(0,\ 5r+3)$, $(0,\ 5r+4)$, $(0,\ 5r-3)$.

We can see that all $(x,\ y) \in V(W_n)$ are in R or connected by at least one node in R, except for two forms of nodes $(0,\ 5r+2)$ and $(1,\ 5r+2)$.

When $1 \leq r \leq \lceil n/10 \rceil - 1$, $(1,\ 5r+2) = (1,\ 5(r-1)+7)$. Since $(1,\ 5(r-1)+7)$ is a neighbor of $(0,\ 5(r-1)) \in R_0$, $(1,\ 5r+2)$ has a neighbor in R_0.

When $0 \leq r \leq \lceil n/10 \rceil - 2$, $(0,\ 5r+2) = (0,\ 5(r+1)-3)$. Since $(0,\ 5(r+1)-3)$ is a neighbor of $(1,\ 5(r+1)+4) \in R_1$, $(0,\ 5r+2)$ has a neighbor in R_1.

So, when $\lfloor log_2 n \rfloor \geq 4$, all $(x,\ y) \in V(W_n)$ are in R or neighbors of at least one node in R, except two nodes $(1,\ 2)$ and $(0,\ 5(\lceil n/10 \rceil - 1)+2)$.

Since n is even, $n\ mod\ 10 \in \{0,\ 2,\ 4,\ 6,\ 8\}$.

Suppose $n \ mod \ 10 = 0$, we have $\lceil n/10 \rceil = n/10$.

In this case, $(1,\ 5(n/10-1)+7) = (1,\ 5(\lceil n/10 \rceil -1)+7)$. Since $(1,\ 2) = (1,\ 5(n/10-1)+7 \ mod \ (n/2))$ and $(1,\ 5(\lceil n/10 \rceil -1)+7)$ is a neighbor of node $(0,\ 5(\lceil n/10 \rceil -1)) \in R_0$, node $(1,\ 2)$ has a neighbor in R.

Also, in this case, $(0,\ 5(\lceil n/10 \rceil -1)+2) = (0,\ n/2-3)$. Since $(n/2-3)+2^3-1 = 4 \ mod \ (n/2)$, $(0,\ n/2-3)$ is a neighbor of $(1,\ 4) \in R_1$. Thus, node $(0,\ 5(\lceil n/10 \rceil -1)+2)$ has a neighbor in R.

Therefore, all nodes are covered by R. R is a dominating set of W_n when $n \ mod \ 10 = 0$ and $\lfloor log_2 n \rfloor \geq 4$.

Suppose $n \ mod \ 10 = 2$, we have $\lceil n/10 \rceil = (n-2)/10+1$.

In this case, $(1,\ 5(\lceil n/10 \rceil -1)+3) = (1,\ 2 \ mod \ (n/2))$. Since $(1,\ 5(\lceil n/10 \rceil -1)+3)$ is a neighbor of $(0,\ 5(\lceil n/10 \rceil -1)) \in R_0$, node $(1,\ 2)$ has a neighbor in R_0. So, node $(1,\ 2)$ is covered by R.

Also, in this case, $(0,\ 5(\lceil n/10 \rceil -1)+2) = (0,\ 1 \ mod \ (n/2))$. Since $(0,\ 1)$ is a neighbor of $(1,\ 4) \in R_1$, node $(0,\ 5(\lceil n/10 \rceil -1)+2)$ has a neighbor in R.

Therefore, all nodes are covered by R. R is a dominating set of W_n when $n \ mod \ 10 = 2$ and $\lfloor log_2 n \rfloor \geq 4$.

Suppose $n \ mod \ 10 = 4$, we have $\lceil n/10 \rceil = (n-4)/10+1$.

In this case, $(1,\ 2) = (1,\ 5(\lceil n/10 \rceil -1)+4 \ mod \ (n/2))$. Since $(1,\ 5(\lceil n/10 \rceil -1)+4) \in R_1$, $(1,\ 2)$ has a neighbor in R_1. So, node $(1,\ 2)$ is covered by R.

Also, in this case, $(0,\ 5(\lceil n/10 \rceil -1)+2) = (0,\ 0 \ mod \ (n/2))$. Since $(0,\ 0) \in R_0$, node $(0,\ 5(\lceil n/10 \rceil -1)+2)$ is in R_0. So, node $(0,\ 5(\lceil n/10 \rceil -1)+2)$ is covered by R.

Therefore, all nodes are covered by R. R is a dominating set of W_n when $n \ mod \ 10 = 4$ and $\lfloor log_2 n \rfloor \geq 4$.

Suppose $n \ mod \ 10 = 6$, we have $\lceil n/10 \rceil = (n-6)/10 + 1$.

Let $r' = \lceil n/10 \rceil - 3$. Then, $(0,\ 5r') \in R_0$. If $\lfloor log_2 n \rfloor \geq 5$, $(0,\ 5r')$ is a neighbor of $(1,\ 5r' + 2^4 - 1)$. Since $(1,\ 5r' + 2^4 - 1) = (1,\ 5(\lceil n/10 \rceil - 3) + 15)$ and $(1,\ 5(\lceil n/10 \rceil - 3) + 15) = (1,\ 5(((n-6)/10 + 1) - 3) + 15)$ and $(1,\ 5(((n-6)/10 + 1) - 3) + 15) = (1,\ 2 \ mod \ (n/2))$, node $(1,\ 2)$ is a neighbor of $(0,\ 5r')$. So, if $\lfloor log_2 n \rfloor \geq 5$, node $(1,\ 2)$ is covered by R.

In this case, $(0,\ 5(\lceil n/10 \rceil - 1) + 2) = (0,\ n/2 - 1)$. If $\lfloor log_2 n \rfloor \geq 5$, $(0,\ n/2 - 1)$ is connected to $(1,\ n/2 - 1 + 2^4 - 1)$. Since $(1,\ n/2 - 1 + 2^4 - 1) = (1,\ 14 \ mod \ (n/2))$ and $(1,\ 14) = (1,\ 5 \times 2 + 4) \in R_1$, node $(0,\ 5(\lceil n/10 \rceil - 1) + 2)$ is a neighbor of $(1,\ 14) \in R_1$. So, if $\lfloor log_2 n \rfloor \geq 5$, node $(0,\ 5(\lceil n/10 \rceil - 1) + 2)$ is covered by R.

Therefore, all nodes are covered by R. R is a dominating set of W_n when $n \ mod \ 10 = 6$ and $\lfloor log_2 n \rfloor \geq 5$.

Suppose $n \ mod \ 10 = 8$, we have $\lceil n/10 \rceil = (n-8)/10 + 1$.

Let $r' = \lceil n/10 \rceil - 6$. Then, $(0,\ 5r') \in R_0$. If $\lfloor log_2 n \rfloor \geq 6$, $(0,\ 5r')$ is a neighbor of $(1,\ 5r' + 2^5 - 1)$. Since $(1,\ 5r' + 2^5 - 1) = (1,\ 5(\lceil n/10 \rceil - 6) + 31)$ and $(1,\ 5(\lceil n/10 \rceil - 6) + 31) = (1,\ 5(((n-8)/10 + 1) - 6) + 31)$ and $(1,\ 5(((n-8)/10 + 1) - 6) + 31) = (1,\ 2 \ mod \ (n/2))$, $(0,\ 5r') \in R_0$ is a neighbor of $(1,\ 2)$. So, if $\lfloor log_2 n \rfloor \geq 6$, node $(1,\ 2)$ is covered by R.

If $\lfloor log_2 n \rfloor \geq 6$, $(0,\ 5(\lceil n/10 \rceil - 1) + 2)$ is a neighbor of $(1,\ 5(\lceil n/10 \rceil - 1) + 2 + 2^5 - 1)$. Since $(1,\ 5(\lceil n/10 \rceil - 1) + 2 + 2^5 - 1) = (1,\ 29 \ mod \ n/2)$ and $(1,\ 29) = (1,\ 5 \times 5 + 4) \in R_1$,

$(0,\ 5(\lceil n/10 \rceil - 1) + 2)$ is a neighbor of $(1,\ 29) \in R_1$. So, if $\lfloor log_2 n \rfloor \geq 6$, node $(0,\ 5(\lceil n/10 \rceil - 1) + 2)$ is covered by R.

Therefore, all nodes are covered by R. So, if $n\ mod\ 10 = 8$ and $\lfloor log_2 n \rfloor \geq 6$, R is a dominating set of R.

After all, for all W_n when $\lfloor log_2 n \rfloor \geq 6$, R is a dominating set of W_n.

□

It is easy to see that $|R| = 2\lceil n/10 \rceil$.

3.2 Construction of Broadcast Networks on Odd Number of Nodes

In this section, a new method of constructing broadcast networks on n nodes is presented, where n is odd, $n \neq 2^p + 1$ and $\lfloor log_2(n-1) \rfloor \geq 6$.

The basic idea of this method is similar to the construction method of broadcast networks on $2^p - 1$ nodes in the last chapter. It is to add an extra node w to a modified Knödel graph W_{n-1} on $n-1$ nodes and add additional communication lines to connect w with every node in a dominating set R of W_{n-1} $(\{(w, v) | v \in R\})$. The major difference is that other supplemental communication lines are needed in this method. These supplemental communication lines connect w to all the neighbors of one selected node in W_{n-1}. Here, the selected node is $(0, 3)$. The neighbors of $(0, 3)$ are $(1,\ 2^k{+}2\ mod\ (n{-}1)/2)$ for $k = 0,\ 1,\ ...,\ \lfloor log_2(n{-}1) \rfloor - 1$. The set of the supplemental communication lines is $\{(w,\ (1,\ 2^k{+}2\ mod\ (n{-}1)/2)) | k = 0,\ 1,\ ...,\ \lfloor log_2(n{-}1) \rfloor - 1\}$.

These supplemental communication lines are necessary in the broadcasting process originating in node w (see the proof of Theorem 4). The construction is demonstrated in Figure 11.

Since node (0, 3) has some neighbors in dominating set R, some supplemental communication lines (connecting w to the neighbors of node (0, 3)) and additional communication lines (connecting w to the nodes in R) are the same. So, less communication lines are needed to connect w with W_{n-1}. Node (0, 3) is not the only choice.

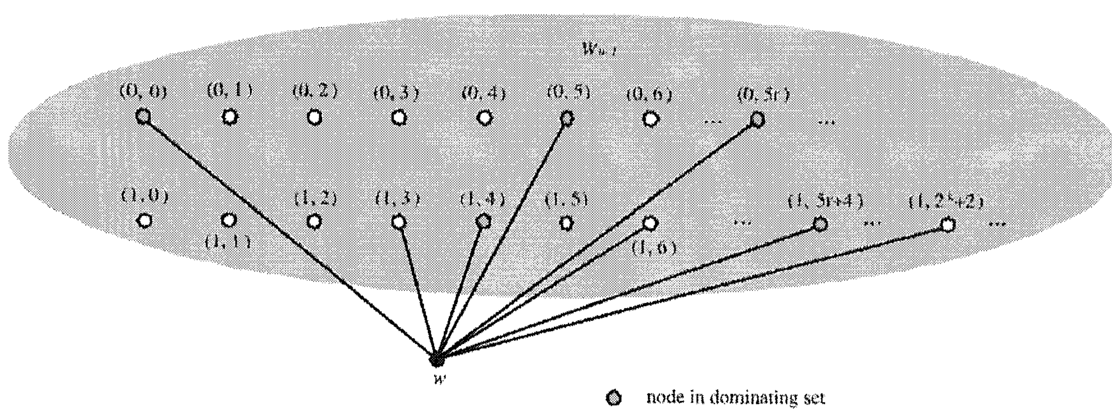


Figure 11: Demonstration of constructing broadcast network G.

Theorem 4. *Let* $W_{n-1} = (V(W_{n-1}), E(W_{n-1}))$ *be a modified Knödel graph on* $n-1$ *nodes. Let* R *be a dominating set of* W_{n-1}*. Let* $G = (V, E)$*,* $V = V(W_{n-1}) \cup \{w\}$*, and* $w \notin V(W_{n-1})$*.* $E = E(W_{n-1}) \cup \{(w, v) | v \in R\} \cup \{(w,\ (1,\ 2^k + 2 \ mod\ (n-1)/2)) | k = 0,\ 1,\ \ldots,\ \lfloor log_2(n-1) \rfloor - 1\}$*.* G *is a broadcast network.*

Proof.

To prove that G is a broadcast network, we must describe the minimum time broadcast protocol for every originator $u \in V$.

In network $G = (V, E)$, for any $v \in V$, $b(v) \geq \lceil log_2 n \rceil$. Because $n-1$ is even and not a power of 2, $\lceil log_2 n \rceil = \lceil log_2(n-1) \rceil$. The minimum broadcasting time for any broadcast protocol of G is $\lceil log_2(n-1) \rceil$.

If u is in dominating set R of W_{n-1} ($u \in R$), u informs all other nodes on W_{n-1} according to the broadcast protocol of u on broadcast network W_{n-1}. At the last time unit of the broadcast protocol, u is idle. Since u is a neighbor of w, w can be informed by u in the last time unit. So, at the end of time unit $\lceil log_2(n-1) \rceil$, all nodes on G are informed.

If u is a node in W_{n-1} and not in dominating set R of W_{n-1} ($u \in V(W_{n-1}) \backslash R$), there must exist a node $v \in R$ which is a neighbor of u. Suppose v is in the ith dimension of u, $0 \leq i \leq \lfloor log_2(n-1) \rfloor - 1$. According to Lemma 1, there must be a permutation $(i,\ i+1,\ ...,\ \lfloor log_2(n-1) \rfloor - 1,\ 0,\ 1,\ 2,\ ...,\ i-1)$ of dimensions so that a valid broadcast protocol for W_{n-1} follows the sequence $(i,\ i+1,\ ...,\ \lfloor log_2(n-1) \rfloor - 1,\ 0,\ 1,\ 2,\ ...,\ i-1,\ i)$ of dimensions. Since v is in the ith dimension of u, v is informed at time unit 1 in the broadcast protocol. At the last time unit, v is idle and all the nodes on W_{n-1} are informed. Since v is a neighbor of w, w can be informed by v in the last time unit. So, at the end of the last time unit $\lceil log_2(n-1) \rceil$, all nodes in G are informed.

If u is the added node w, it borrows the broadcast protocol from node $(0,\ 3)$ to finish the broadcasting.

First, let's see the broadcast protocol of originator $(0,\ 3)$ in W_{n-1}. In W_{n-1}, node $(0,\ 3)$ is a neighbor of $(1,\ 2^k + 2\ mod\ (n-1)/2)$, $k = 0,\ 1,\ ...,\ \lfloor log_2(n-1) \rfloor - 1$.

According to the broadcast protocol of (0, 3), (0, 3) informs these neighbors and these neighbors inform the rest of the nodes on the subtrees rooted in them. In the last time unit, (0, 3) and its first informed neighbor are idle. At the end of the last time unit, all nodes in W_{n-1} are informed.

All the neighbors of (0, 3) are shared by w. So, for the broadcast protocol of originator w in network G, node w informs all its neighbors of $(1,\ 2^k+2 \ mod\ (n-1)/2)$ $(k = 0,\ 1,\ \ldots,\ \lfloor log_2(n-1)\rfloor - 1)$ in the same time unit sequence as that in the broadcast protocol of (0, 3) in W_{n-1}. These neighbors inform the rest of the nodes on the subtrees rooted in them according to the broadcast protocol of (0, 3) in W_{n-1}. At the last time unit, the first informed neighbor is idle in the broadcast protocol of (0, 3) in W_{n-1}. Node (0, 3) can be informed by this neighbor at the last time unit in the broadcast protocol of w. So, at the end of the last time unit $\lceil log_2(n-1)\rceil$, all nodes in G are informed.

The broadcast protocol of node w in G is demonstrated in Figure 12.

Therefore, all the nodes can be informed at the end of time unit $\lceil log_2 n\rceil$. G is a broadcast network. □

3.3 Generalized Upper Bound and Improved Upper Bound on $B(2^p - 1)$

From the broadcast network G constructed in the last section, a general upper bound on $B(n)$ can be obtained, where n can be any odd number.

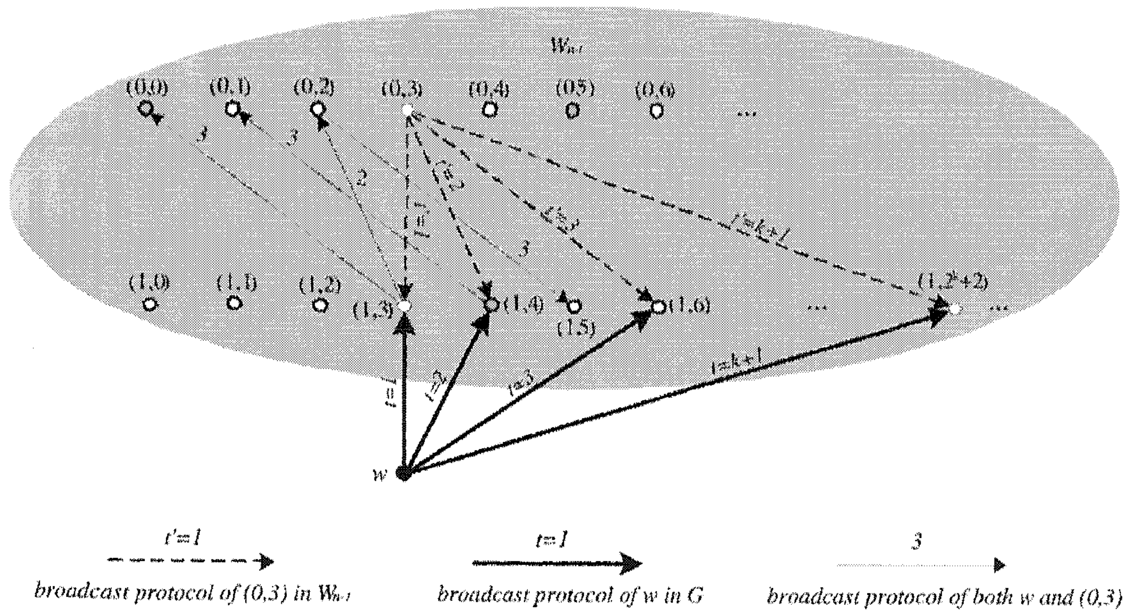


Figure 12: Demonstration of a broadcast protocol of node w in G.

Corollary 2. *For any odd* n, *where* $\lfloor log_2(n-1)\rfloor \geq 6$ *and* $n \neq 2^p + 1$,

$B(n) \leq \frac{(n+1)\lfloor log_2(n-1)\rfloor}{2} + 2\lceil\frac{n-1}{10}\rceil - \lfloor\frac{\lfloor log_2(n-1)\rfloor+2}{4}\rfloor$.

Proof.

According to Theorem 4, $G = (V,\ E)$ is a broadcast network on n nodes. Thus, $B(n) \leq |E|$.

Since $E = E(W_{n-1}) \cup \{(w,v)|v \in R\} \cup \{(w,\ (1,\ 2^k + 2\ mod\ (n-1)/2))|k = 0,\ 1,\ ...,\ \lfloor log_2(n-1)\rfloor - 1\}$, $|E| = |E(W_{n-1})| + |\{(w,v)|v \in R\} \cup \{(w,\ (1,\ 2^k + 2\ mod\ (n-1)/2))|k = 0,\ 1,\ ...,\ \lfloor log_2(n-1)\rfloor - 1\}|$.

It is easy to see that $\{(w,v)|v \in R\} \cap \{(w,\ (1,\ 2^k + 2\ mod\ (n-1)/2))|k = 0,\ 1,\ ...,\ \lfloor log_2(n-1)\rfloor - 1\} = R \cap \{(1,\ 2^k + 2\ mod\ (n-1)/2)|k = 0,\ 1,\ ...,\ \lfloor log_2(n-1)\rfloor - 1\}$.

Recall that R is a dominating set of W_{n-1} where $\lfloor log_2(n-1)\rfloor \geq 6$ (Theorem 3);

$R_1 = \{(1,\ 5r+4)|0 \le r \le \lceil (n-1)/10 \rceil - 1\}$ and $R_0 = \{(0,\ 5r)|0 \le r \le \lceil (n-1)/10 \rceil - 1\}$ and $R = R_0 \cup R_1$. We have $R \cap \{(1,\ 2^k + 2\ mod\ (n-1)/2)|k = 0,\ 1,\ ...,\ \lfloor log_2(n-1) \rfloor - 1\} = R_1 \cap \{(1,\ 2^k + 2\ mod\ (n-1)/2)|k = 0,\ 1,\ ...,\ \lfloor log_2(n-1) \rfloor - 1\}$.

After calculation, we have $|\{(1,\ 5r+4)|0 \le r \le \lceil (n-1)/10 \rceil - 1\} \cap \{(1,\ 2^k + 2\ mod\ (n-1)/2)|k = 0,\ 1,\ ...,\ \lfloor log_2(n-1) \rfloor - 1\}| \ge \lfloor \frac{\lfloor log_2(n-1) \rfloor + 2}{4} \rfloor$. Thus, $|R \cap \{(1,\ 2^k + 2\ mod\ (n-1)/2)|k = 0,\ 1,\ ...,\ \lfloor log_2(n-1) \rfloor - 1\}| \ge \lfloor \frac{\lfloor log_2(n-1) \rfloor + 2}{4} \rfloor$.

Since $|R \cup \{(1,\ 2^k + 2\ mod\ (n-1)/2)|k = 0,\ 1,\ ...,\ \lfloor log_2(n-1) \rfloor - 1\}| = |R| + |\{(1,\ 2^k + 2\ mod\ (n-1)/2)|k = 0,\ 1,\ ...,\ \lfloor log_2(n-1) \rfloor - 1\}| - |R \cap \{(1,\ 2^k + 2\ mod\ (n-1)/2)|k = 0,\ 1,\ ...,\ \lfloor log_2(n-1) \rfloor - 1\}|$, $|E| \le |E(W_{n-1})| + |R| + \lfloor log_2(n-1) \rfloor - \lfloor \frac{\lfloor log_2(n-1) \rfloor + 2}{4} \rfloor$.

Recall that for modified Knödel graph W_{n-1}, $|E(W_{n-1})| = \frac{(n-1)\lfloor log_2(n-1) \rfloor}{2}$ and $|R| = 2\lceil (n-1)/10 \rceil$.

Therefore, $|E| \le \frac{(n+1)\lfloor log_2(n-1) \rfloor}{2} + 2\lceil \frac{n-1}{10} \rceil - \lfloor \frac{\lfloor log_2(n-1) \rfloor + 2}{4} \rfloor$. So, $B(n) \le \frac{(n+1)\lfloor log_2(n-1) \rfloor}{2} + 2\lceil \frac{n-1}{10} \rceil - \lfloor \frac{\lfloor log_2(n-1) \rfloor + 2}{4} \rfloor$.

In some special cases, $\{(w,v)|v \in R\} \cap \{(w,\ (1,\ 2^k - 1\ mod\ (n-1)/2))|k = 0,\ 1,\ ...,\ \lfloor log_2(n-1) \rfloor - 1\} > \lfloor \frac{\lfloor log_2(n-1) \rfloor + 2}{4} \rfloor$, which means the upper bound may be better in these cases. Since the margin is a very small number, there should not be much improvement to the upper bound. □

For $n = 2^p - 1$, a new upper bound on $B(2^p - 1)$ follows Corollary 2.

Corollary 3. *$B(2^p - 1) \le 2^{p-1}(p-1) + 2\lceil \frac{2^{p-1}-1}{5} \rceil - \lfloor \frac{p+1}{4} \rfloor$, for $p \ge 6$.*

Proof.

Let $n = 2^p - 1$. From Corollary 2, we have $B(2^p - 1) \leq 2^{p-1}(p-1) + 2\lceil \frac{2^{p-1}-1}{5} \rceil - \lfloor \frac{p+1}{4} \rfloor$, where $\lfloor log_2(2^p - 2) \rfloor \geq 6$.

In the proof of Theorem 3, for W_{n-1} only in the case $(n-1)\ mod\ 10 = 8$, $\lfloor log_2(n-1) \rfloor \geq 6$ is needed to guarantee R to be a dominating set. In other cases, $\lfloor log_2(n-1) \rfloor \geq 5$ is sufficient for the theorem. If $n - 1 = 2^p - 2$, there is no case in which $(n-1)\ mod\ 10 = 8$. So, $\lfloor log_2(n-1) \rfloor \geq 5$ is enough for the result of Corollary 2 where $n = 2^p - 1$. That is $p \geq 6$. $\square$

This upper bound is better than the upper bound in Corollary 1 where $p \geq 7$. The results of this chapter are further discussed in Chapter 5.

Chapter 4

Minimum Broadcast Network on 127 Nodes

In this chapter, the background of the question is first briefly introduced. Then, all known *mbns* on $2^p - 1$ nodes ($3 \leq p \leq 6$) constructed by different authors are studied, and their common general structural properties are observed. The process of constructing a minimum broadcast network on 127 nodes is also demonstrated. In the last section, all the broadcast protocols of this *mbn* are described.

4.1 Background of Construction *mbn* on 127 Nodes

The construction of any *mbn* (even for small values such as $n = 23, 24, 25$) is always a difficult problem. In this thesis, we consider the problem of constructing effective broadcast networks in $n = 2^p - 1$ family. Theoretically, an *mbn* is the most economical broadcast network. Since the construction of *mbn* on 63 nodes in 1991 [17], it seemed to be natural to establish the next *mbn* in $n = 2^p - 1$ family. The smallest unknown value of $B(2^p - 1)$ is $B(127)$ for $p = 7$. In this chapter, we consider constructing an *mbn* on 127 nodes. So far, the smallest known broadcast network on 127 nodes showed $B(127) \leq 408$ (Corollary 3).

However, the search of $B(127)$ is very challenging, because of the huge number of potential broadcast networks to consider. Moreover, for $n = 127$, the number of potential broadcast protocols to consider dramatically increases compared to the case of $n = 63$ and other known *mbns*. A search among all potential structural options is impossible. Therefore, in order to minimize the amount of possible candidates to consider, the most feasible strategy is to find the possible structure of the *mbn*.

By careful study and massive experimental work, we finally constructed an *mbn* on 127 nodes and described broadcast protocols for all originators. Our result is $B(127) = 389$.

4.2 Common Structural Properties of *mbn* on $2^p - 1$ Nodes

Farley et al. 1979 [10] proposed $B(7) = 8$ (Figure 13) and $B(15) = 24$ (Figure 14(b)). Bermond et al. [2] proposed B(31) = 65 (Figure 16(a)). B(63) = 162 was constructed by Labahn [24] (Figure 17). It was also constructed in [17], but it is not known in the common literature.

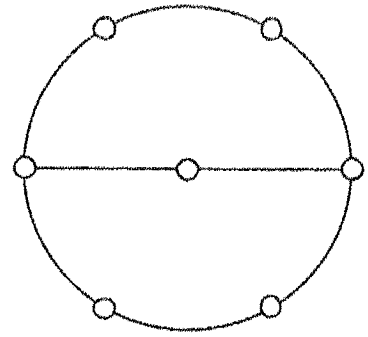


Figure 13: *mbn* on 7 nodes.

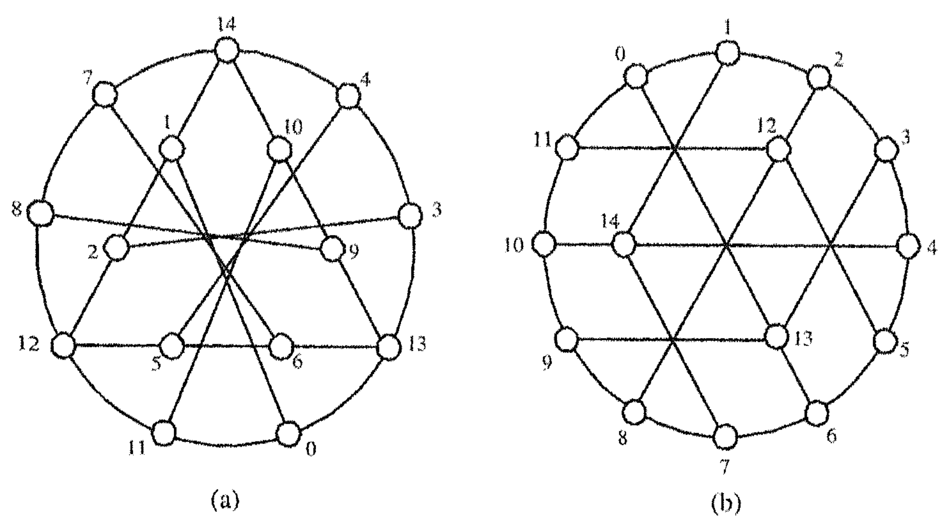


Figure 14: Isomorphic *mbns* on 15 nodes.

After careful study of all known *mbns* on $2^p - 1$ nodes, we found that they share common structural properties. All the known *mbns* ($G = (V, E)$) on $2^p - 1$ nodes ($3 \leq p \leq 6$) have nodes of two types $u \in V$ and $u' \in V$, where $deg(u) = p - 1$ and $deg(u') = p$. The number of nodes of degree p is $\lceil \frac{2^p - 1}{p+1} \rceil$. All the nodes of degree $p - 1$ form a subgraph of G, which is a Hamiltonian graph. This Hamiltonian graph usually has some additional chords, especially for the graph of a large number of nodes. Each node of degree p and its neighbors form a subgraph of G, which is a star graph with the node of degree p in the center of the star and p nodes of degree $p-1$ are leafs. That means G can be constructed by the combination of Hamiltonian graph with $\lceil \frac{2^p-1}{p+1} \rceil$ star graphs. All leafs of the star graphs are on the Hamiltonian graph. Figure 15 demonstrates the combination of a minimum broadcast network on 15 nodes.

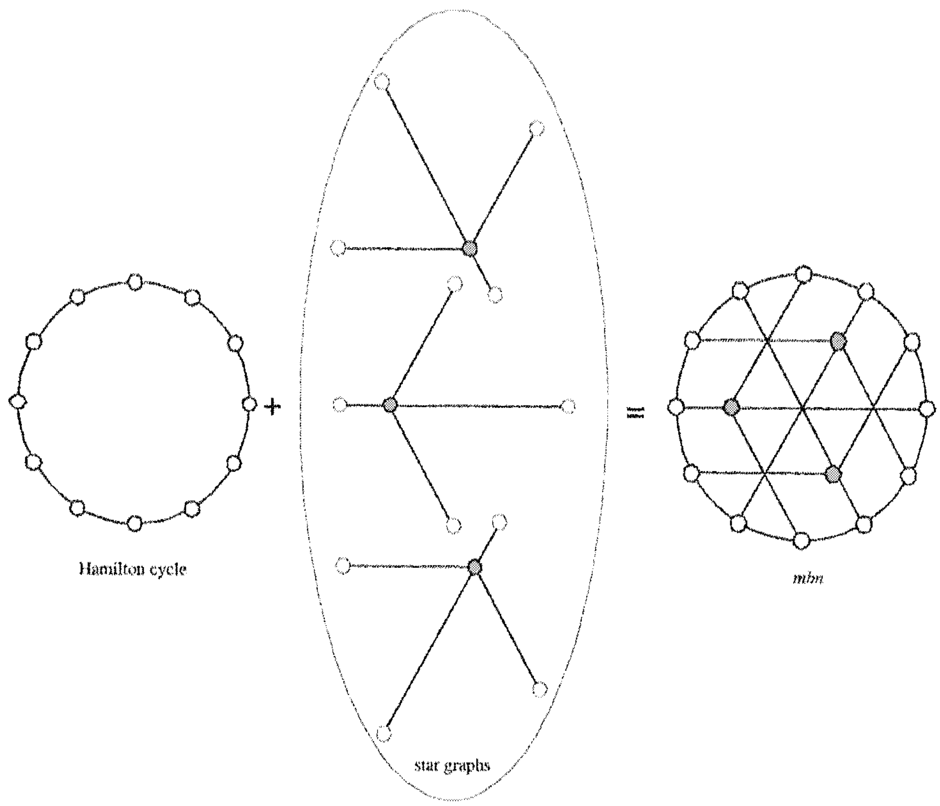
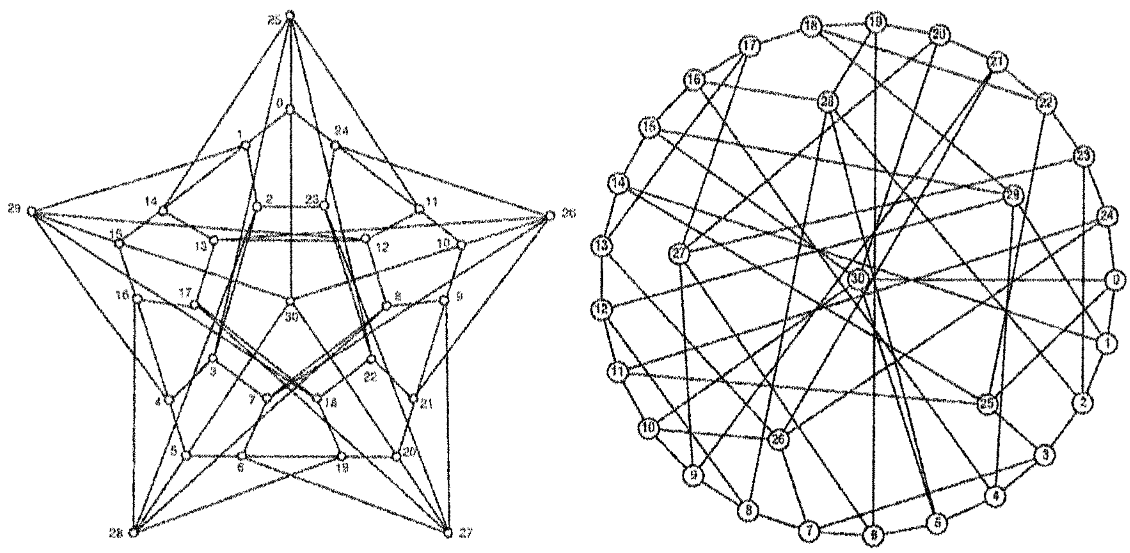


Figure 15: Combination of an *mbn* on 15 nodes.

*mbn*s on 15 and 63 nodes have the above mentioned properties. In [9], another *mbn* on 15 nodes was proposed (Figure 14(a)). We showed that this graph is isomorphic to the one from [10] (Figure 14(b)). The labeling of the nodes that shows their isomorphism is presented in Figure 14(a) and 14(b).

The *mbn* on 31 nodes proposed in [2] uses 6 pentagons with some additional communication lines between them (Figure 16(a)). We proved that this graph is



(a) (b)

Figure 16: Isomorphic *mbns* on 31 nodes.

isomorphic to the one in Figure 16(b). It is interesting to note that the graph in Figure 16(b) has the properties mentioned above. It has $\lceil \frac{2^5-1}{6} \rceil = 6$ nodes of degree 5 and 25 nodes of degree 4. Nodes of degree 4 form a subgraph that contains a Hamilton cycle. These nodes are labeled 0, 1, ... , 24. This subgraph on 25 nodes contains some additional chords that connect node i to $i+4$ or $i+12$. Also, every node of this subgraph is connected to at least one node of degree 6 (labeled as 25, 26, 27, 28, 29, 30).

The known *mbns* on 15, 31 and 63 nodes have the described structural properties. This leads us to the construction of *mbn* on 127 nodes with the same structural properties.

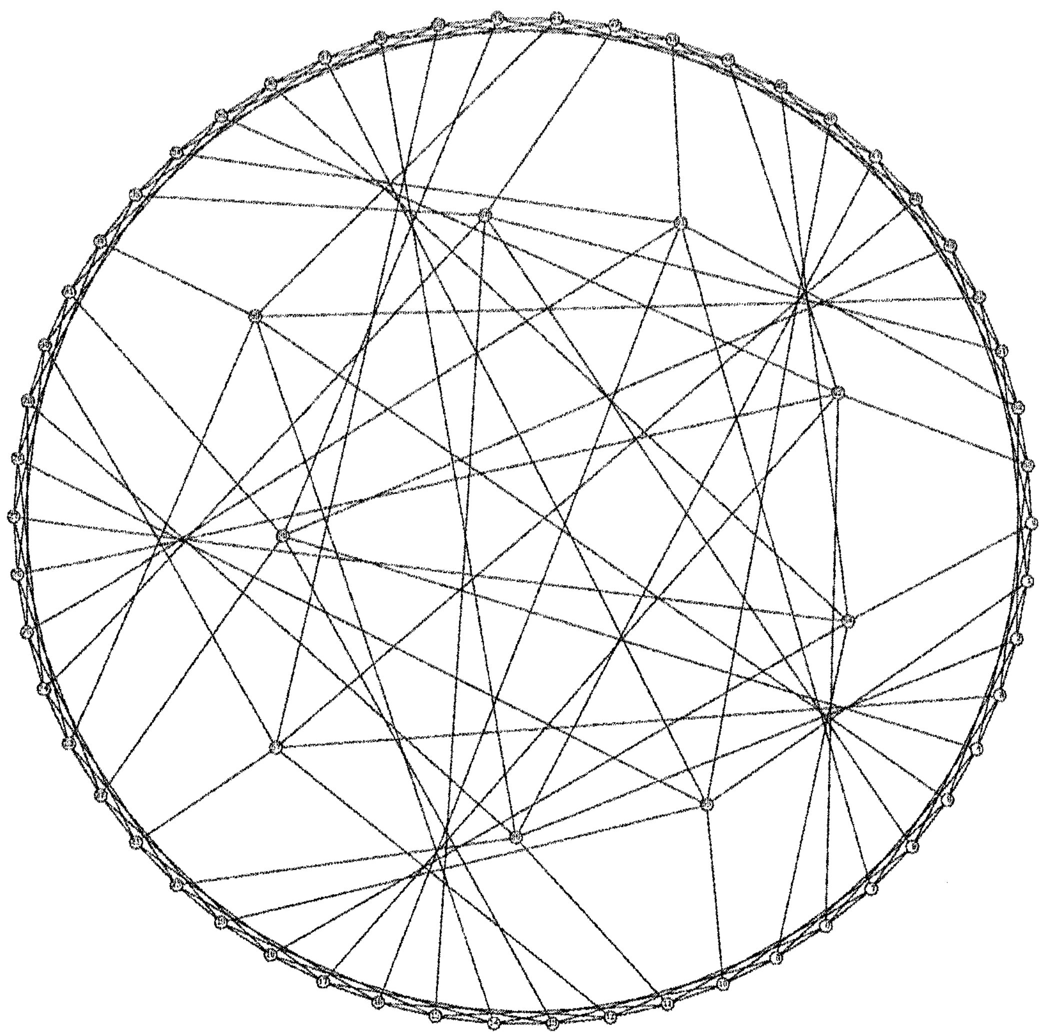


Figure 17: *mbn* on 63 nodes.

4.3 Lower Bound on $B(127)$

In this section, we will present the lower bound for any *mbn* on 127 nodes.

Let $G = (V, E)$ be a broadcast network on $n = 127$ nodes. By definition, the broadcast time of G, $b(G) = \lceil log_2 127 \rceil = 7$. If there is a node $u \in V$ and $deg(u) \leq 5$, then at the end of any broadcast originated from node u, it can inform at most $2^6 + 2^5 + 2^4 + 2^3 + 2^2 + 1 = 125$ nodes (including u). The broadcasting cannot be finished in 7 time units. Thus, every node in an *mbn* on 127 nodes must have a degree of at least 6.

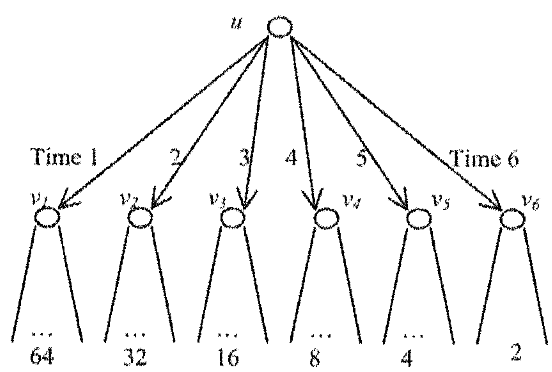


Figure 18: A broadcast protocol for a node of degree 6.

Moreover, if $deg(u) = 6$ for some node $u \in V$, then it must have a neighbor, say node v, where $deg(v) \geq 7$. To show that the last statement is correct, assume that the degree of all neighbors of u is at most 6. Consider any broadcast protocol from originator u, suppose u sends the message to its neighbor v_i at time i, for $i = 1, 2, ..., 6$. Since $deg(v_i) \leq 6$, then it can forward the message to its uninformed neighbors at time units 2, 3, 4, 5 and 6. Thus, the total number of informed nodes through node v_1 (including v_1) will be at most $2^6 - 1$ after time unit 7 (v_1 is idle at time 7). Any other neighbor v_i, i=2, 3, ..., 6, that receives the message from u at time i can broadcast at any time $i+1, i+2, ..., 7$. The total number of informed nodes from node v_i, $i =$ 2, 3, ..., 6 will be at most 2^{7-i} for $i =$ 2, 3, ..., 6. Hence, the total number of informed nodes under any broadcast protocol will be at most $(2^6 - 1) + 2^5 + 2^4 + 2^3 + 2^2 + 2^1 + 1 = 126$. Therefore, every node of degree 6 in an *mbn* on 127 nodes must have a neighbor of degree at least 7, and the neighbor of degree at least 7 must be informed during the first time unit. A valid broadcast protocol from a node of degree 6 with a neighbor of degree 7 is presented in Figure 18. The numbers in the bottom of Figure 18 are the number of nodes of the respective sub-trees.

Now, assume that there are x nodes in G with degree 7. In this case, x must meet $7x \geq 127 - x$ to guarantee that every node of degree 6 is adjacent to at least one node of degree 7. It is easy to show that the minimum possible x is 16. Therefore, an *mbn* of 127 nodes must consist at least 16 nodes of degree 7 and at most 111 nodes of degree 6. As a result, $B(127) \geq 389$. Thus, a broadcast network on 127 nodes with 389 communication lines will be an *mbn* on 127 nodes.

In [24], to construct an *mbn* on 63 nodes, Labahn gave the following lower bound on $B(2^p - 1)$:

$B(2^p - 1) \geq \frac{p^2(2^p-1)}{2(p+1)}$.

This bound is precise for $p = 6$ and in all the cases when $2^p - 1$ is divisible by $p + 1$.

To understand the structures of *mbns* on $2^p - 1$ nodes, it is important to know the degrees of all nodes. This will lead us to a more accurate lower bound on $B(2^p - 1)$ for the case of that $2^p - 1$ is not divisible by $p + 1$. Since every node of degree $p - 1$ must have a neighbor of degree p, then every node of degree p can have at most p neighbors of degree $p - 1$. Therefore, the number of nodes of degree p is at least $\frac{2^p-1}{p+1}$ or $\lceil \frac{2^p-1}{p+1} \rceil$. Thus, the following formula [17] is more accurate:

$B(2^p - 1) \geq \frac{1}{2}(\lceil \frac{2^p-1}{p+1} \rceil p + (2^p - 1 - \lceil \frac{2^p-1}{p+1} \rceil)(p - 1))$.

4.4 The Structure Algorithm

In this section, we will describe how we arrived at the right construction of the *mbn* on 127.

There is a huge number of choices in constructing a network having properties mentioned in the previous sections, but most of them are not broadcast networks. It is also impossible to search among all these options, which may take many years to finish. So, the most critical task is to narrow down the possible *mbn* structures.

In any broadcast protocol of an *mbn* on 127 nodes, every informed node informs one of its uninformed neighbors during all 7 time units, except the first informed node of degree 6, which is idle only at the last time unit. During the broadcast process, every node must have enough available uninformed neighbors. So, any pair of nodes should avoid sharing more than one common neighbor. The distance between any pair of nodes should be limited. In [13], Fraigniaud and Lazard gave the following lemma:

Lemma 2. *In any graph G of diameter D, if there exist three different vertices u, v_1 and v_2 with both v_1 and v_2 at a distance D of u, $b(G) \geq D + 1$.*

Let $G = (V, E)$ be a network on 127 nodes. We number the 127 nodes from 0 to 126 and define the following two sets of nodes in V.

$U = \{0, 1, 2, ..., 110\}$, $u \in U, deg(u) = 6$;

$U' = \{111, 112, ..., 126\}$, $u' \in U', deg(u') = 7$;

$V = U \cup U'$, therefore $V = \{0, 1, 2, ..., 126\}$.

According to the previous results, we build the communication lines according to the following strategies:

- Every $u' \in U'$ is connected to 7 different nodes in U.
- Every $u \in U$ is connected to at least one node in U'.
- 16 star-networks, which are sub-networks of G, are formed. The center node of every star graph is in U'.
- Connect the leaf nodes of the 16 different star-networks so that these sub-networks are connected to each other evenly.
- No line should connect two leaf nodes of the same star.
- The diameter of G must be at most 7, and there must be not more than one node of distance 7 (Lemma 2).

As studied in Section 4.2, every known *mbn* on $2^p - 1$ nodes ($3 \leq p \leq 6$) can be constructed by combining a Hamiltonian graph with some star subgraphs. It is natural that we expect the *mbn* on 127 nodes to share the same properties as the known *mbns* on $2^p - 1$ nodes. So, combining the construction strategies with these properties, we adopt the following algorithm to construct the *mbn* on 127 nodes.

The first part of our construction algorithm is:

- First, all nodes of degree 6 are connected one after another forming a Hamilton cycle on 111 nodes.

- Then, the 16 nodes of degree 7 are connected to the 111 nodes on the Hamilton cycle alternately. As a result, there will be one node of degree 6 connected to 2 nodes of degree 7.

- To complete the construction of *mbn* on 127 nodes, some appropriately chosen chords are added into the Hamilton cycle so that every node on the Hamilton cycle has 3 incident chords.

The main difficulty of designing an *mbn* on 127 nodes was this last step, namely to choose proper chords out of 108 candidates for every node on the cycle, such that broadcasting in 7 time units is possible from every originator. To make message dissemination as fast as possible, we decided to connect every node with a node of large distance. Hence, a chord across the half of the cycle (or almost the half) has been chosen. The other two chords may be built across the same distances. Since broadcasting is a process to increase informed nodes by powers of 2, chords across 2^i nodes or $2^i + 2^j$ ($1 \leq i \leq 5$ and $0 \leq j \leq 5 - i$) nodes may be good choices. Note that, even the search among these limited combinations is a massive job. Our construction algorithm follows:

Algorithm of the construction:

1. All nodes of degree 6 are connected one after another forming a cycle on 111 nodes;

2. all 16 nodes of degree 7 are connected to the 111 nodes on the cycle alternately and, as a result, two nodes of degree 7 connect to the same node of degree 6;

3. every node of degree 6, except the node that connects two nodes of degree 7, is connected to a node of degree 6 across half of the circle (55 nodes away on the circle, not counting the node that connects two nodes of degree 7);

4. search chords across $\pm 2^i$ nodes or $\pm(2^i+2^j)$ nodes, $1 \leq i \leq 5$ and $0 \leq j \leq 5-i$, to see if a message can be disseminated from any node to all the other nodes in 7 time units.

We finally found chords across every 18 nodes in the clockwise and counter-clockwise directions on the cycle and finished our construction of mbn on 127 nodes.

4.5 Formal Construction

In this section, we present the formal description of our broadcast network having properties from Section 4.2.

- $E_1 = \{\{0,1\},\{1,2\},...,\{u,u+1\},...,\{109,110\},\{110,0\}\}$. These lines form a cycle of 111 nodes of set U.

- $E_2 = \{\{0,18\},\{1,19\},...,\{u,u+18\},...,\{92,110\},\{93,0\},...,\{110,17\}\}$. These lines make chords across every 18 nodes on the cycle.

- $E_3 = \{\{0,55\},\{1,56\},...,\{u,u+55\},...,\{53,108\},\{54,109\}\}$. These lines make chords across half of the cycle.

- $E_4 = \{\{0,111\},\{1,112\},...,\{u,(u \ mod \ 16)+111\},...,\{110,125\}\}$. These lines connect nodes between U and U'.

- $E_5 = \{\{110, 126\}\}$. This line is a complement line, which connects node 110 to node 126.

Finally, we have the set of nodes of $G = (V,\ E)$, $V = \{0, 1, ..., 126\}$ and the set of communication lines of G:

$E = E_1 \cup E_2 \cup E_3 \cup E_4 \cup E_5$, and $|E| = 389$.

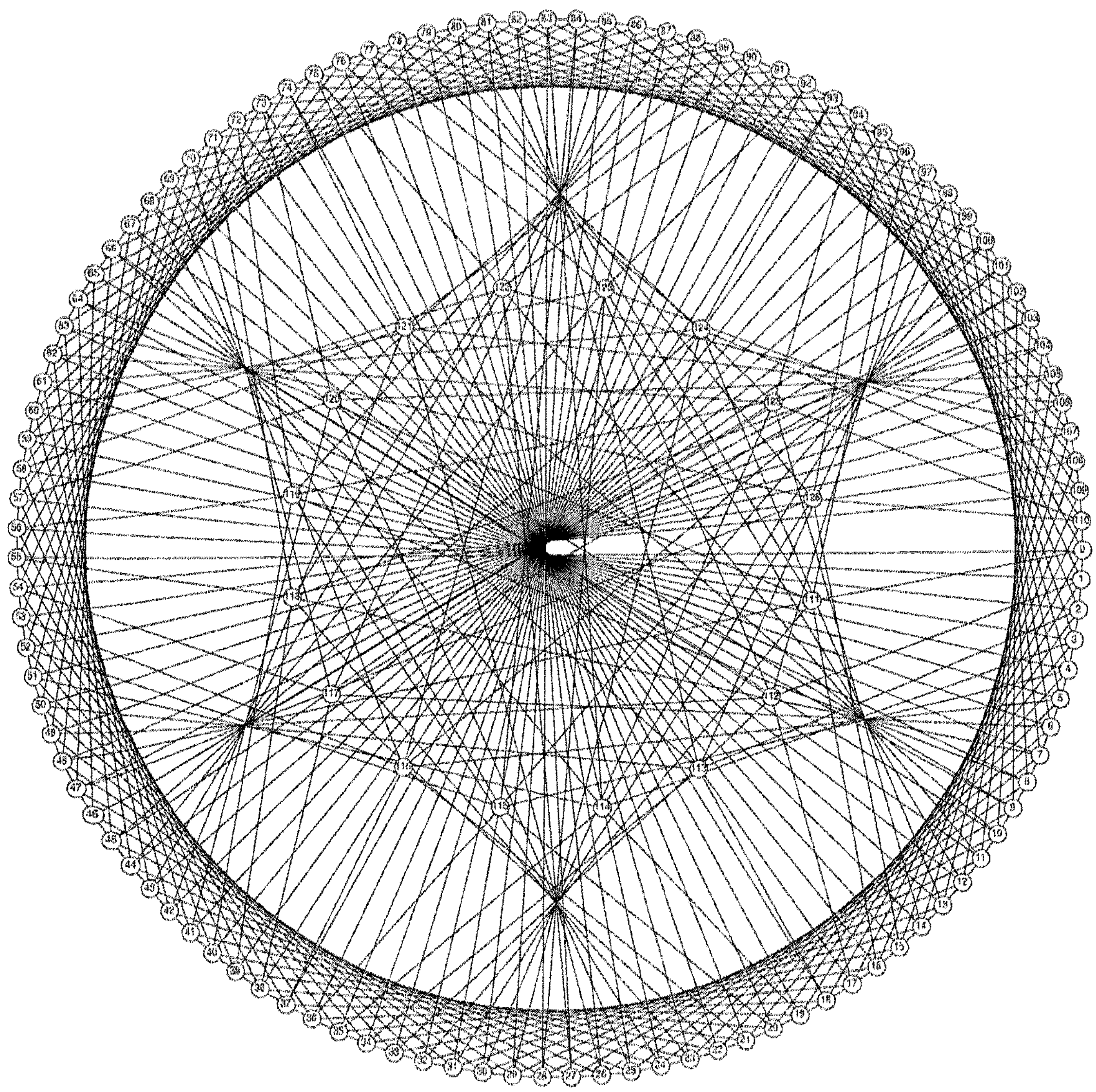


Figure 19: *mbn* on 127 nodes.

Figure 19 shows an example of the *mbn* on 127 nodes with all the aforementioned structural properties.

4.6 Broadcast Protocols

If this network G is an *mbn* on 127 nodes, G must be a broadcast network; that is, each node in the network must have a broadcast protocol that can be completed in 7 time units.

As it is proven in Section 4.3, an originator node of degree 6 must send its message to its neighbor node of degree 7 during the first time unit. It is obvious that an originator node of degree 7 can send the message during the first time unit to one of its neighbor nodes of degree 6 and share the rest of the broadcast protocol (in time units 2, 3, 4, 5, 6 and 7) with this neighbor. So, it suffices to show how information is transmitted from the 111 originator nodes of degree 6 to the rest of nodes during 7 time units.

Unfortunately, this network G is not a symmetric network. This means that the broadcast protocol of one node may not be mapped to a broadcast protocol of any other node. For each originator of degree 6, a broadcast protocol that completes broadcasting in network G after 7 time units has been found. However, more similarities between broadcast protocols from different originators have not been found. This means that every broadcast protocol must be presented individually. Figure 20 shows a broadcast protocol from originator 0. The attached Appendix demonstrates the broadcast protocols of all 111 nodes with degree of 6. The three rows of the table show that: node i is informed in time $t(i)$, and it is informed by its parent $p(i)$.

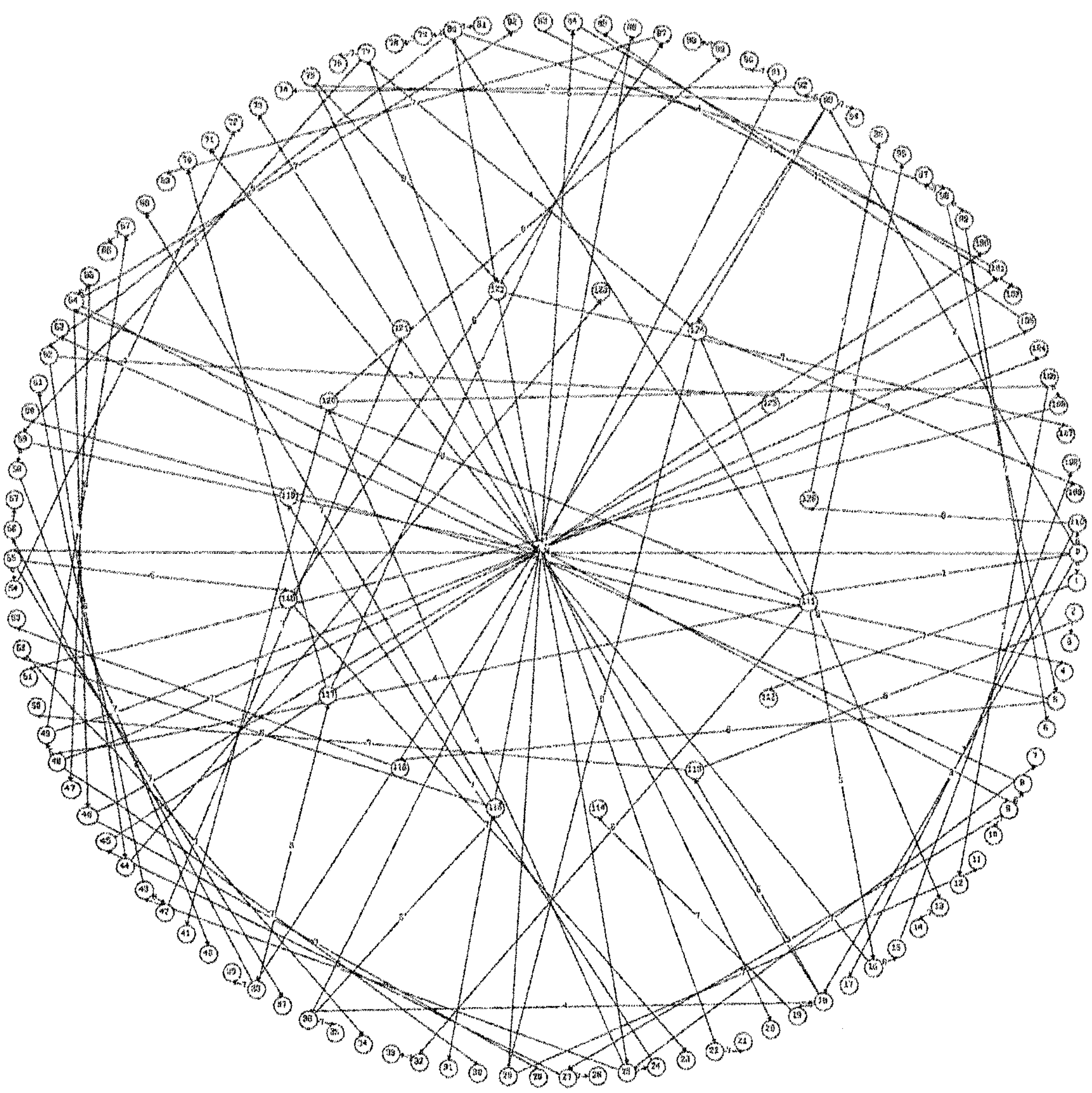


Figure 20: A broadcast protocol of node 0 in *mbn* on 127 nodes.

Chapter 5

Conclusions and Comparisons

In this thesis, the broadcast networks on $2^p - 1$ nodes are studied. A new method is proposed, which is to connect the nodes in a dominating set of a modified Knödel graph to an extra node in order to construct a new broadcast network on $2^p - 1$ nodes. So, using a smaller dominating set on a modified Knödel graph can result in a better broadcast network. In this thesis, two kinds of dominating sets (S and R) of modified Knödel graphs on $2^p - 2$ nodes are found, where $|S| = 2^{p-2}$ (in Chapter 2) and $|R| = 2\lceil\frac{2^{p-1}-1}{5}\rceil$ (in Chapter 3). When $p \geq 5$, R is smaller than S. In Table 2, the comparison shows that the improvement by using R is more significant than that of using S for large values of n.

In Chapter 3, the new method is further improved to construct broadcast networks on any odd number of nodes except $n = 2^p + 1$. Unfortunately, the modified Knödel graphs, which are the construction bases of the method, are usually not good (sparse enough) broadcast networks. So, this method cannot guarantee any constructed broadcast network to be an optimal one (compared with the previous results). However, in the case of constructing broadcast networks on $2^p - 1$ node family, this method is proven to be competent. In fact, this method can construct all the best broadcast networks of this family so far, for which the *mbns* are unknown. This may come from the fact that the broadcast networks on $2^p - 1$ nodes are constructed based on minimum broadcast networks on $2^p - 2$ nodes. Therefore, it is reasonable to believe that if based on a good (small number of communication lines) broadcast network, such as a minimum broadcast network, this method can result in a good new broadcast network.

In this thesis, two new upper bounds on $B(2^p - 1)$ are presented:

(Corollary 1) $B(2^p - 1) \leq 2^{p-1}(p - \frac{1}{2}) - (p - 1)$, for $p \geq 2$;

(Corollary 3) $B(2^p - 1) \leq 2^{p-1}(p - 1) + 2\lceil \frac{2^{p-1}-1}{5} \rceil - \lfloor \frac{p+1}{4} \rfloor$, for $p \geq 6$.

Since $\lceil \frac{2^{p-1}-1}{5} \rceil \leq \frac{2^{p-1}+3}{5}$ and $\lfloor \frac{p+1}{4} \rfloor \geq \frac{p-2}{4}$, the second upper bound can be changed into the following form: $B(2^p - 1) \leq 2^{p-1}(p - \frac{1}{2}) - (\frac{2^{p-2}}{5} + \frac{p}{4} - \frac{17}{10})$.

Compared to the best previous upper bound [18]: $B(2^p - 1) \leq 2^{p-1}(p - \frac{1}{2})$, both upper bounds are better, where $p \geq 6$. The upper bound from Corollary 3 is better than that from Corollary 1.

In Table 2, improvements of upper bounds for $n = 2^p - 1$ are given. Since for $p \leq 7$, the exact values of $B(2^p - 1)$ are known, the comparisons are presented only for $p \geq 7$. In Table 2, the column labeled H&L gives the previous best known upper bounds of [18]. The column labeled Corollary 1 gives upper bounds from Corollary 1. The column labeled Corollary 3 gives upper bounds from Corollary 3.

p	$n = 2^p - 1$	$B(n)$	H&L	Corollary 1	Corollary 3
3	7	8	-	-	-
4	15	24	-	-	-
5	31	65	-	-	-
6	63	162	-	-	-
7	127	389	416	410	408
8	255	-	960	953	946
9	511	-	2176	2168	2148
10	1023	-	4864	4855	4812
11	2047	-	10752	10742	10647
12	4095	-	23552	23541	23345
13	8191	-	51200	51188	50787
14	16383	-	110592	110579	109771
15	32767	-	237568	237554	235926
16	65535	-	507904	507889	504624
17	131071	-	1081344	1081328	1074786
18	262143	-	2293760	2293743	2280650
19	524287	-	4849664	4849646	4823445
20	1048575	-	10223616	10223597	10171183
21	2097151	-	21495808	21495788	21390945
22	4194303	-	45088768	45088747	44879049
23	8388607	-	94371840	94371818	93952404
24	16777215	-	197132288	197132265	196293422
25	33554431	-	411041792	411041768	409364064
26	67108863	-	855638016	855637991	852282568
27	134217727	-	1778384896	1778384870	1771674003

Table 2: The improvements of upper bounds on $B(2^p - 1)$.

In this thesis, some common properties of minimum broadcast networks on the $2^p - 1$ node family are observed. By using these properties, a minimum broadcast network on 127 nodes is constructed. It is the largest constructed *mbn* so far. The common properties are proven to be useful in the construction process. It is expected that the experiences of constructing the *mbn* on 127 nodes may help to create more minimum broadcast networks in the future.

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Appendix: Broadcast protocols of *mbn* on 127 nodes.

Broadcast protocol of node 0.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	-	0	113	2	59	98	99	25	9	64	9	29	105	124	13	16	111	110	0	18	75
$t(i)$	0	6	6	7	7	5	7	7	6	4	7	7	7	6	7	6	5	7	3	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	77	118	25	80	27	9	46	124	48	86	111	32	52	36	18	55	93	38	58	120
$t(i)$	7	6	7	6	3	7	5	7	5	7	7	6	7	7	7	4	7	4	7	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	25	62	27	64	65	111	48	113	106	115	116	55	0	38	56	59	77	5	43	80
$t(i)$	6	5	6	6	5	7	4	5	7	7	6	7	6	4	6	7	6	5	7	7	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	8	111	64	67	49	115	87	117	16	54	18	92	93	77	124	79	80	111	80	64	101
$t(i)$	7	3	6	7	6	7	7	7	7	7	7	7	5	7	4	7	6	2	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	29	103	117	118	89	120	91	36	93	0	93	126	111	98	80	98	45	46	84	48	49
$t(i)$	6	7	6	6	7	6	7	6	6	2	7	7	7	7	4	6	7	6	7	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	105	122	15	124	0	0	1	18	19	36	5	38	55	24	25	42	75	44	93	62	110
$t(i)$	5	6	7	7	7	5	1	7	5	7	5	6	5	5	7	4	7	6	7	3	7	6

Broadcast protocol of node 1.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	-	1	114	3	60	99	100	26	10	65	10	30	106	125	14	17	112	0	1	19
$t(i)$	5	0	6	6	7	7	5	7	7	6	4	7	7	7	6	7	6	5	7	3	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	23	78	119	26	81	28	10	47	125	49	87	112	33	53	37	19	56	94	39	59
$t(i)$	7	7	6	7	6	3	7	5	7	5	7	7	6	7	7	7	4	7	4	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	44	26	63	28	65	66	112	49	114	107	116	117	56	1	39	57	60	78	6	44
$t(i)$	7	6	5	6	6	5	7	4	5	7	7	6	7	6	4	6	7	6	5	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	81	9	112	65	68	50	116	88	118	17	55	19	93	94	78	125	80	81	112	81	65
$t(i)$	5	7	3	6	7	6	7	7	7	7	7	7	7	5	7	4	7	6	2	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	102	30	104	118	119	90	121	92	37	94	1	94	111	112	99	81	99	46	47	85	49
$t(i)$	7	6	7	6	6	7	6	7	6	6	2	7	7	7	7	4	6	7	6	7	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	121	106	123	16	125	0	1	2	19	20	37	6	39	56	25	26	43	76	45	94	63
$t(i)$	7	5	6	7	7	7	6	1	7	5	7	5	6	5	5	7	4	7	6	7	3	7

Broadcast protocol of node 2.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	2	-	2	3	98	61	25	7	120	65	66	105	14	107	126	34	18	113	1	2
$t(i)$	6	3	0	2	7	5	7	6	7	7	7	7	7	7	6	7	7	7	3	7	4

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	21	5	25	80	27	122	83	124	85	32	50	112	113	114	18	36	20	57	58	40
$t(i)$	5	7	6	7	5	7	6	5	7	7	7	5	6	6	7	4	6	5	7	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	98	43	44	28	46	66	50	113	114	51	54	36	56	1	2	3	122	5	43	80
$t(i)$	7	3	6	7	6	7	6	7	4	6	7	6	5	7	5	6	4	7	7	5	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	65	112	113	114	67	116	117	53	73	18	75	20	58	95	96	80	98	112	113	114
$t(i)$	7	6	5	5	5	7	7	7	7	7	5	7	6	7	7	7	7	4	7	7	4

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	67	87	32	33	107	121	36	37	38	1	2	3	98	113	98	99	83	101	48	119
$t(i)$	7	6	7	6	7	7	6	7	7	7	6	5	6	7	2	6	7	6	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	121	122	90	54	0	64	1	2	3	20	21	38	23	56	73	58	43	28	61	94	95
$t(i)$	6	7	5	7	7	7	7	4	1	3	7	6	6	7	6	6	5	4	7	6	7	6

Broadcast protocol of node 3.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	2	3	-	3	116	5	100	101	64	28	29	123	68	69	33	34	35	19	114	21
$t(i)$	6	6	5	0	6	6	7	7	7	7	7	7	6	6	7	7	7	6	7	6	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	40	24	42	26	121	26	83	28	125	13	111	34	35	114	35	116	20	21	58	96
$t(i)$	4	7	7	6	7	5	6	3	6	7	7	7	6	5	3	7	7	7	7	4	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	42	43	46	28	65	49	67	51	114	53	35	53	0	1	58	3	58	42	43	80
$t(i)$	4	5	7	7	5	6	7	6	7	5	6	4	7	7	7	5	2	6	7	6	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	46	83	67	114	67	51	71	53	71	72	75	57	58	59	96	78	111	80	83	114
$t(i)$	7	6	5	7	4	5	6	7	5	6	7	7	6	7	7	5	7	5	7	7	2

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	84	68	88	119	90	121	92	123	92	95	40	3	96	97	114	101	83	101	102	119
$t(i)$	6	7	7	7	6	7	6	6	5	7	7	6	3	6	7	7	6	4	5	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	121	52	123	91	17	96	65	2	3	4	21	102	103	40	57	58	27	28	61	78	47
$t(i)$	7	7	7	7	7	7	4	7	7	1	7	5	7	7	5	7	3	7	4	7	6	7

Broadcast protocol of node 4.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	93	2	20	4	-	4	5	100	7	27	28	66	123	68	69	126	17	35	113	20	115
$t(i)$	7	7	6	3	0	2	7	5	7	7	7	7	7	7	6	7	7	6	7	7	3

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	4	5	23	7	121	45	123	124	85	30	50	112	35	114	115	116	20	38	22	59
$t(i)$	7	4	5	6	6	7	6	6	6	5	7	7	7	7	5	6	7	5	6	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	42	45	100	101	29	30	67	68	52	115	116	117	54	38	58	3	4	5	124	63
$t(i)$	6	7	7	3	7	7	6	7	6	7	4	6	6	7	7	7	5	6	4	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	82	64	113	114	115	116	52	53	73	74	75	20	77	22	60	97	98	82	100	114
$t(i)$	5	6	7	6	6	5	5	6	7	7	6	5	4	7	6	7	7	7	7	4	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	116	85	69	70	107	108	36	74	75	39	96	3	4	5	100	115	100	117	85	103
$t(i)$	7	4	7	7	7	7	7	7	7	6	7	7	6	5	6	7	2	6	7	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	107	52	109	124	109	48	97	82	3	4	5	22	23	24	25	58	75	60	45	14	63
$t(i)$	7	6	5	6	5	7	7	6	5	4	1	3	5	7	7	7	6	7	5	4	7	6

Broadcast protocol of node 5.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	110	0	3	21	5	-	5	6	101	8	28	29	30	31	69	70	71	110	36	114	21
$t(i)$	6	7	7	6	3	0	2	7	5	7	7	7	7	7	7	7	7	7	6	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	4	5	6	24	8	26	46	124	125	86	31	32	113	36	115	116	117	21	39	23
$t(i)$	3	7	4	5	6	6	7	6	6	6	5	6	7	7	7	5	6	7	5	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	61	43	46	101	102	103	67	68	69	53	116	117	118	57	39	59	4	5	6	125
$t(i)$	7	6	7	7	3	7	7	7	7	6	7	4	6	7	7	6	7	5	6	4	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	46	83	65	114	115	116	117	53	54	18	75	76	21	124	23	61	98	99	83	101
$t(i)$	6	5	6	7	6	6	5	5	6	7	7	6	5	4	7	6	7	7	7	7	4

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	116	117	86	70	88	108	109	37	75	76	94	78	4	5	6	101	116	101	118	86
$t(i)$	7	7	4	7	6	7	7	7	7	7	6	7	7	6	5	6	7	2	6	6	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	51	122	53	108	125	64	97	98	83	4	5	6	23	24	25	74	59	76	61	46	63
$t(i)$	7	7	7	5	6	5	7	7	6	5	4	1	3	5	7	7	7	6	7	5	4	7

Broadcast protocol of node 6.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	93	56	20	21	5	6	-	6	7	102	9	66	13	124	32	126	71	110	0	37	38
$t(i)$	5	7	7	7	7	3	0	2	7	5	7	7	7	6	7	5	6	7	7	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	117	118	6	7	25	9	29	47	125	86	87	15	16	36	37	116	117	38	22	40
$t(i)$	6	4	7	5	4	7	6	7	6	7	7	5	7	7	7	6	5	3	7	5	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	24	61	62	124	47	102	111	50	32	52	115	54	117	118	38	120	59	60	5	6	7
$t(i)$	6	7	7	7	7	3	7	7	6	7	6	7	5	6	5	7	7	6	5	4	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	65	47	84	85	115	116	117	118	71	55	56	93	75	22	79	61	25	80	100	84
$t(i)$	7	7	5	6	7	7	7	7	5	7	7	6	6	7	7	7	6	6	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	102	116	117	118	87	120	89	109	74	38	93	40	41	112	5	6	7	102	117	102	103
$t(i)$	4	6	6	4	6	6	7	7	7	4	7	7	7	7	6	6	6	7	2	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	88	108	15	54	126	0	65	98	99	84	5	6	7	24	25	42	27	60	61	62	47
$t(i)$	7	7	7	6	6	6	6	6	7	7	5	4	1	3	7	5	7	7	7	5	6	4

Broadcast protocol of node 7.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	55	2	57	2	115	6	7	-	7	120	9	12	105	12	13	126	15	110	0	1	38
$t(i)$	6	6	5	7	7	6	5	0	6	6	7	7	5	6	7	6	7	7	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	23	118	25	7	44	28	46	84	125	32	87	32	35	53	115	36	39	118	39	40
$t(i)$	7	7	6	6	4	6	7	6	6	7	7	3	6	7	6	6	7	5	3	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	24	25	62	44	125	46	111	50	32	69	53	71	55	118	38	39	57	60	61	62	7
$t(i)$	7	7	4	7	5	7	7	7	5	6	7	5	7	5	6	4	7	7	6	5	2

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	111	64	113	68	50	87	69	118	71	120	56	57	123	78	96	61	62	82	100	84
$t(i)$	7	6	7	7	7	6	5	7	4	7	7	7	6	7	7	6	7	6	7	5	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	86	87	118	87	71	89	92	123	94	125	126	111	96	80	100	7	100	101	118	105
$t(i)$	5	7	6	2	7	6	7	7	6	7	6	7	5	7	7	7	3	6	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	105	106	109	110	125	32	33	82	51	100	5	6	7	8	25	26	75	44	29	62	110
$t(i)$	4	6	7	7	6	4	4	7	6	7	4	7	7	1	7	5	7	7	5	7	3	5

Broadcast protocol of node 8.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	110	56	3	58	3	6	7	8	-	8	121	104	13	106	13	126	15	110	0	1	21
$t(i)$	6	6	6	5	7	7	6	5	0	6	7	7	6	5	7	6	7	7	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	40	22	119	26	8	45	83	47	85	30	33	88	33	36	54	116	39	40	119	40
$t(i)$	6	6	7	7	6	4	6	7	7	6	7	6	3	7	7	6	6	7	5	3	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	97	25	26	63	45	126	47	112	51	33	51	116	72	37	119	56	40	58	42	62	63
$t(i)$	6	7	7	4	7	5	6	6	7	5	6	7	5	7	5	7	4	7	7	7	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	8	63	112	48	49	69	70	88	72	119	72	73	76	58	124	125	80	62	63	81	101
$t(i)$	2	7	7	7	7	7	6	5	7	4	6	7	7	6	7	6	7	6	6	7	5

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	116	87	88	119	88	121	90	93	124	125	126	78	112	97	114	101	8	101	102	119
$t(i)$	7	5	7	6	2	7	6	7	7	6	7	7	7	5	7	7	7	3	6	7	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	88	106	107	54	126	32	33	2	83	52	101	70	7	8	9	26	27	12	45	110	63
$t(i)$	7	4	6	7	7	4	7	4	7	6	7	4	7	7	1	7	5	7	7	5	5	3

Broadcast protocol of node 9.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	56	113	96	5	98	7	8	9	-	9	10	11	12	107	14	71	16	113	1	2
$t(i)$	7	5	6	7	7	6	7	6	2	0	3	4	5	7	5	7	6	7	7	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	23	41	119	120	8	9	10	11	31	126	33	34	89	34	91	116	56	40	119	120
$t(i)$	7	7	6	7	6	7	4	5	6	7	6	7	6	3	7	6	7	6	6	5	3

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	25	45	27	64	48	111	104	105	52	34	52	55	73	119	120	59	41	59	62	63
$t(i)$	7	7	7	5	7	7	6	7	7	6	5	7	7	6	4	7	7	5	6	7	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	8	9	64	11	12	67	51	88	89	73	120	56	122	123	124	60	97	111	63	27	28
$t(i)$	4	5	6	7	6	7	7	7	5	7	4	7	7	7	7	7	7	7	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	29	103	87	105	89	120	89	73	91	38	125	40	41	96	113	98	101	8	9	10	119
$t(i)$	7	7	7	6	6	2	7	5	7	7	7	7	4	6	5	7	7	5	6	6	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	107	89	107	108	126	96	65	34	19	36	101	102	71	8	9	10	27	28	45	14	63
$t(i)$	5	7	4	6	7	7	5	7	4	7	7	6	7	7	3	1	7	6	6	6	6	5

Broadcast protocol of node 10.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	0	57	114	97	60	24	8	9	10	-	10	11	12	15	108	111	72	19	74	75
$t(i)$	6	7	7	7	6	7	7	7	6	2	0	3	4	5	7	5	7	6	7	6	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	20	40	41	42	120	121	9	10	11	12	13	33	15	35	90	35	38	39	57	41	120
$t(i)$	7	7	7	5	7	7	7	4	5	7	7	7	6	6	3	7	7	6	5	6	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	42	123	124	28	65	47	67	51	114	53	35	53	56	57	120	121	58	42	79	44
$t(i)$	3	7	6	7	6	6	7	7	7	6	6	5	7	7	6	4	5	6	6	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	9	10	65	12	13	68	52	89	90	74	121	74	58	59	96	24	81	99	64	28
$t(i)$	6	4	5	7	6	6	7	7	7	5	7	4	5	7	7	7	6	7	6	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	29	103	104	105	106	90	121	90	123	75	95	96	97	42	97	114	99	102	9	10	11
$t(i)$	7	7	7	7	7	6	2	7	7	7	7	6	5	4	7	5	7	6	5	6	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	121	108	90	108	109	64	17	34	35	4	101	102	39	72	9	10	11	28	29	46	63
$t(i)$	6	6	7	4	6	7	5	7	7	4	7	7	7	7	7	3	1	7	5	6	7	7

Broadcast protocol of node 11.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	19	20	4	115	23	7	100	9	10	11	-	11	124	32	16	109	35	36	20	75
$t(i)$	7	7	7	7	6	7	7	6	7	6	5	0	6	7	7	7	6	7	6	6	4

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	117	41	119	120	27	122	29	11	48	30	50	34	113	34	91	36	20	57	119	59
$t(i)$	7	7	6	7	7	7	6	7	4	6	7	6	7	5	6	3	7	5	6	6	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	122	45	124	47	29	66	48	113	50	115	54	36	54	38	75	57	122	59	43	125
$t(i)$	7	5	7	6	7	6	4	7	4	5	7	6	5	7	7	5	7	4	6	6	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	111	66	11	66	50	51	88	70	73	91	75	122	75	59	60	61	111	112	113	65
$t(i)$	7	6	5	2	7	7	7	6	7	7	5	7	3	6	7	7	7	7	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	86	104	88	119	90	91	122	91	38	93	40	41	98	113	114	115	100	84	104	11
$t(i)$	6	7	5	7	5	7	6	2	7	6	7	7	7	7	6	7	5	7	7	7	3

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	105	122	109	91	109	48	65	66	51	36	53	86	39	104	73	10	11	12	29	110	110
$t(i)$	6	7	7	7	4	5	5	6	3	6	4	7	6	7	4	6	7	1	7	5	6	7

Broadcast protocol of node 12.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	110	0	20	114	59	60	117	118	101	120	11	12	-	12	32	33	34	35	19	37	21
$t(i)$	6	7	7	6	7	7	7	7	7	6	7	5	0	6	7	7	7	7	7	6	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	21	24	42	120	121	122	123	30	12	49	87	51	35	114	37	92	39	21	58	42
$t(i)$	4	7	7	6	7	7	7	6	7	4	7	6	6	6	5	7	3	7	5	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	44	123	44	28	126	30	67	49	114	51	116	55	37	57	39	76	58	123	60	125
$t(i)$	5	6	5	7	7	6	6	4	6	4	5	7	5	4	7	6	5	6	4	6	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	9	66	67	12	67	51	52	89	54	55	92	74	123	76	125	61	62	112	81	84
$t(i)$	7	7	7	6	2	7	7	7	7	7	7	5	7	3	7	7	7	7	6	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	67	87	105	89	120	91	92	123	92	76	94	3	112	43	114	115	116	47	85	105
$t(i)$	6	5	7	5	6	5	7	6	2	7	6	7	7	7	7	7	7	6	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	105	106	123	110	92	48	49	50	67	52	37	54	55	88	105	74	11	12	13	30	110
$t(i)$	3	6	7	7	7	4	7	5	7	3	6	5	6	6	7	4	6	6	1	7	5	5

Broadcast protocol of node 13.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	93	56	95	4	115	116	24	62	119	10	121	12	13	-	13	14	34	35	36	37	38
$t(i)$	4	7	7	7	6	7	7	7	7	7	6	7	5	0	6	7	7	7	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	77	22	119	43	121	122	123	124	31	13	50	88	52	36	115	38	93	40	22	59
$t(i)$	7	4	6	6	7	7	7	7	6	7	4	6	6	6	6	5	6	3	7	5	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	61	45	124	45	126	49	31	68	50	115	52	117	0	38	56	57	77	59	124	61
$t(i)$	7	5	6	5	7	7	7	6	4	7	4	5	7	7	4	6	7	5	7	4	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	111	64	113	68	13	68	52	53	90	72	75	93	77	124	77	61	111	63	113	82
$t(i)$	6	6	7	7	6	2	7	7	7	6	7	7	5	7	3	6	7	7	7	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	29	86	68	32	106	88	121	92	93	124	93	40	78	98	43	44	115	102	117	104	86
$t(i)$	7	7	5	7	5	7	5	7	6	2	7	6	7	7	6	7	7	7	6	7	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	13	106	90	124	0	0	33	50	67	68	53	38	23	56	105	106	75	12	13	110	31
$t(i)$	6	3	7	7	7	6	5	7	5	7	3	6	5	7	5	7	4	6	6	1	7	5

Broadcast protocol of node 14.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	94	1	58	22	23	117	25	26	120	11	122	13	14	-	14	34	35	36	37	38
$t(i)$	7	4	6	7	7	7	7	7	7	7	7	6	7	5	0	6	7	7	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	23	78	42	120	44	122	123	124	125	32	14	51	89	53	37	116	39	94	41	23
$t(i)$	7	6	4	7	6	6	7	7	7	7	7	4	7	6	6	6	5	6	3	6	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	44	62	46	125	46	111	50	32	69	51	116	53	118	57	39	57	60	78	62	125
$t(i)$	6	7	5	6	5	7	7	7	6	4	6	4	5	7	7	4	6	7	5	7	4

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	63	112	65	68	69	14	69	53	54	91	73	76	94	78	125	78	111	112	83	114
$t(i)$	6	7	6	7	7	6	2	7	7	7	6	7	7	5	7	3	6	6	7	7	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	116	87	69	89	107	91	122	93	94	125	94	41	79	80	114	45	116	103	118	105
$t(i)$	7	6	7	5	7	5	7	5	7	6	2	7	7	7	7	7	7	7	7	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	107	14	107	110	125	32	1	2	51	52	69	54	39	40	57	106	107	76	13	14	15
$t(i)$	6	6	3	7	7	6	5	5	7	5	7	3	6	5	7	5	7	4	6	6	1	7

Broadcast protocol of node 15.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	2	95	58	3	60	117	118	63	8	28	29	123	14	15	-	15	18	113	74	38
$t(i)$	7	6	4	6	7	7	6	7	6	7	7	7	6	7	5	0	6	7	6	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	40	24	79	24	121	45	123	28	125	126	33	15	52	90	54	36	117	40	95	96
$t(i)$	7	6	7	4	6	7	6	5	6	7	6	7	4	6	6	6	7	5	7	3	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	24	42	123	63	47	126	47	112	51	33	70	52	117	54	119	2	40	58	61	79	61
$t(i)$	5	7	7	5	6	5	7	7	7	6	4	7	4	5	7	7	4	7	6	5	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	63	112	113	12	115	70	15	70	54	55	121	76	77	95	79	126	79	80	27	65
$t(i)$	4	7	6	7	7	7	6	2	7	7	7	6	7	6	5	7	3	6	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	84	31	88	70	34	108	90	93	38	95	126	95	42	97	6	45	46	117	104	119
$t(i)$	6	7	7	7	5	7	5	7	7	6	7	2	6	6	7	7	7	7	7	7	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	88	108	15	108	126	16	33	2	35	52	69	70	55	40	25	58	107	108	77	14	15
$t(i)$	7	6	6	3	7	7	7	5	5	7	5	7	3	6	5	7	5	7	4	7	6	1

Broadcast protocol of node 16.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	94	113	2	5	98	7	118	9	64	65	104	30	124	15	16	-	16	113	1	21
$t(i)$	7	6	6	7	7	6	7	6	6	4	7	7	6	6	7	5	0	6	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	117	118	25	80	25	9	46	28	48	126	111	34	16	53	35	116	39	118	39	23
$t(i)$	6	7	5	7	3	6	7	6	7	5	7	5	7	4	6	7	7	6	4	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	25	43	124	64	102	111	48	32	52	34	71	109	54	38	120	59	77	61	62	80
$t(i)$	7	5	7	7	5	7	4	6	7	7	6	4	6	7	7	6	7	6	7	6	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	111	64	48	49	13	70	71	16	71	120	92	57	77	124	23	80	111	80	81	114
$t(i)$	7	3	6	7	7	7	7	5	2	7	7	7	7	7	5	7	7	2	6	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	102	30	87	32	89	71	91	109	91	94	39	96	111	98	80	98	99	46	9	118	105
$t(i)$	6	7	7	6	7	6	7	5	6	7	5	7	6	7	4	5	7	7	5	7	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	105	122	53	16	109	16	17	34	99	84	53	70	71	8	25	26	43	12	109	62	15
$t(i)$	5	7	7	7	3	7	1	7	5	6	7	5	6	3	7	4	7	6	7	4	7	6

Broadcast protocol of node 17.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	110	112	1	114	22	23	99	6	63	10	65	10	123	14	125	16	17	-	17	114	21
$t(i)$	6	6	7	7	7	7	6	7	7	6	4	7	7	7	6	6	5	0	6	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	117	24	119	26	81	26	27	84	125	49	50	112	35	17	18	19	117	40	119	40
$t(i)$	6	6	6	5	7	3	6	7	7	7	6	7	5	6	4	7	7	7	5	4	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	24	44	26	63	64	65	49	112	49	33	115	35	72	54	119	58	40	60	123	79	44
$t(i)$	7	6	4	6	7	7	7	4	5	7	7	7	4	7	7	7	6	7	6	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	81	65	112	65	66	50	68	15	72	17	72	121	74	77	78	125	126	81	112	81	82
$t(i)$	5	6	3	5	7	6	7	7	5	2	7	6	7	7	6	5	6	7	2	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	103	31	88	33	71	72	90	110	0	39	126	78	112	99	81	99	100	103	10	119
$t(i)$	6	6	7	7	6	6	6	7	7	7	7	7	7	7	7	4	5	7	7	5	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	121	89	109	54	17	16	17	34	35	100	85	54	71	72	9	26	43	44	45	110	110
$t(i)$	7	7	7	7	6	3	7	1	7	5	6	7	5	7	3	7	5	7	5	7	4	5

Broadcast protocol of node 18.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	112	113	96	115	98	99	25	9	27	65	66	11	12	125	108	17	18	-	18	19
$t(i)$	6	6	7	7	5	6	7	6	7	6	7	4	6	7	7	7	7	4	0	5	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	20	4	41	25	120	81	82	27	11	48	32	50	34	113	36	18	36	37	57	41	120
$t(i)$	7	7	6	7	5	7	3	7	7	7	7	6	7	6	7	3	6	7	7	7	4

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	98	45	27	64	46	66	112	113	50	115	54	36	73	74	120	121	122	42	43	63
$t(i)$	6	5	7	5	5	7	5	7	5	7	7	7	5	7	7	6	7	7	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	82	64	113	66	115	68	117	72	73	18	73	122	75	95	23	97	98	82	113	82
$t(i)$	6	4	6	3	7	6	7	7	7	6	2	5	6	7	7	7	7	7	5	2	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	84	104	86	106	107	91	73	91	0	1	96	41	4	113	81	82	100	103	48	11
$t(i)$	6	7	6	7	7	7	7	4	6	7	7	6	5	6	4	6	6	7	7	6	5

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	107	122	109	91	17	64	17	18	19	36	5	54	7	104	73	74	27	92	109	46	110
$t(i)$	7	6	5	6	5	6	7	5	1	7	4	7	6	7	7	3	6	4	7	7	6	7

Broadcast protocol of node 19.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	19	1	114	97	116	99	6	26	10	28	12	67	31	15	108	17	18	19	-	19
$t(i)$	6	4	7	7	7	5	6	7	6	7	6	7	4	7	7	6	7	6	5	0	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	20	23	5	42	26	121	28	83	30	12	49	33	51	35	114	37	19	37	94	58	120
$t(i)$	7	7	6	7	7	5	7	3	7	6	6	7	5	7	6	7	3	6	7	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	42	99	46	28	65	47	67	51	114	51	116	55	37	74	75	121	122	123	43	125
$t(i)$	4	6	7	7	5	5	7	5	7	4	6	7	7	5	7	7	6	7	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	65	83	67	114	67	68	52	118	73	74	19	74	123	76	79	97	81	82	83	114
$t(i)$	7	6	4	7	3	6	7	7	7	7	6	2	5	6	7	7	6	7	6	5	2

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	116	85	105	33	88	91	92	74	92	1	94	95	42	5	114	82	83	47	102	49
$t(i)$	6	6	7	7	6	7	7	6	4	7	5	6	7	5	7	5	7	7	6	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	121	108	123	110	92	0	65	18	19	84	37	38	55	8	105	74	75	28	109	46	110
$t(i)$	5	7	7	5	6	5	7	7	7	1	7	4	7	6	7	6	3	6	4	7	6	7

Broadcast protocol of node 20.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	93	2	20	2	115	98	117	100	7	27	11	29	13	68	32	16	109	18	19	20	-
$t(i)$	5	6	4	7	7	7	5	6	7	6	7	6	7	4	7	7	6	7	6	5	0

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	20	21	24	6	43	27	122	29	84	31	13	50	34	52	36	115	38	20	38	95	59
$t(i)$	6	7	7	6	7	7	5	7	3	7	6	6	7	5	7	6	7	3	6	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	122	43	100	47	29	66	48	68	52	115	52	117	56	38	75	76	122	123	124	44
$t(i)$	7	4	6	7	7	5	5	7	5	7	4	6	7	7	5	7	7	6	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	65	66	84	68	115	68	69	53	119	74	75	20	75	124	77	80	98	82	83	84
$t(i)$	7	7	6	4	7	3	6	7	7	7	7	6	2	5	6	7	7	6	7	6	5

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	84	117	86	106	34	89	92	93	75	93	2	95	96	43	6	115	83	84	48	103
$t(i)$	2	6	6	7	7	6	7	7	6	4	7	5	6	7	5	7	5	7	7	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	13	122	109	124	0	0	1	66	19	20	85	38	39	56	9	106	75	76	29	110	47
$t(i)$	7	5	7	7	5	6	7	7	7	7	1	7	4	7	6	7	6	3	6	4	7	6

Broadcast protocol of node 21.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	94	3	21	3	116	7	118	101	120	28	12	30	14	69	70	17	110	0	20	21
$t(i)$	6	5	6	4	7	7	7	5	6	7	7	7	6	7	4	7	7	6	7	6	5

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	-	21	22	25	7	27	28	123	30	85	32	14	51	35	53	37	116	39	21	39	96
$t(i)$	0	6	7	7	6	7	6	5	7	3	7	6	7	7	5	7	6	6	3	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	44	123	44	125	48	30	67	49	69	53	116	53	118	57	39	76	60	123	62	125
$t(i)$	7	6	4	7	7	7	5	5	7	5	7	4	6	6	7	5	6	7	6	7	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	8	111	66	67	85	69	116	69	118	54	55	19	76	21	76	77	97	98	99	83	84
$t(i)$	7	7	7	6	4	7	3	6	7	7	7	7	7	2	5	7	7	7	7	7	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	116	85	86	89	107	35	90	93	94	76	94	3	96	99	44	101	116	84	85	49
$t(i)$	5	2	6	7	7	6	6	7	7	6	4	7	5	6	6	5	7	5	7	7	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	51	14	123	124	125	48	1	2	67	20	21	38	39	104	57	58	107	76	77	30	110
$t(i)$	7	6	5	7	7	5	6	7	7	7	7	1	7	4	7	6	7	7	3	6	4	7

Broadcast protocol of node 22.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	2	95	4	22	4	117	100	119	102	9	29	13	31	15	70	17	110	36	20	21
$t(i)$	7	6	5	6	4	7	7	7	5	6	7	6	7	6	7	4	7	6	7	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	-	22	23	26	8	45	29	124	31	86	33	15	52	34	54	38	117	40	22	40
$t(i)$	5	0	6	7	7	6	7	7	5	7	3	7	6	6	7	5	7	6	7	3	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	97	61	123	124	45	102	49	31	68	50	70	54	117	54	119	58	40	77	78	124	125
$t(i)$	7	7	7	4	6	7	7	5	5	7	5	7	4	6	7	7	5	7	7	6	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	46	112	67	68	86	70	117	70	71	55	121	76	77	22	77	126	79	82	100	84
$t(i)$	7	7	7	7	6	4	7	3	6	7	7	7	7	6	2	5	6	7	7	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	86	117	86	119	88	108	36	91	124	95	77	95	4	97	98	45	8	117	85	86
$t(i)$	6	5	2	6	6	7	7	6	7	7	7	4	6	5	6	7	5	7	5	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	105	52	15	110	126	96	49	2	3	68	21	22	87	40	41	58	11	108	77	78	31
$t(i)$	6	7	7	5	7	5	7	6	7	7	7	7	1	7	4	7	6	7	6	3	6	4

Broadcast protocol of node 23.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	0	3	96	5	23	24	118	119	120	9	104	105	31	32	16	71	16	17	37	19
$t(i)$	6	7	7	5	7	4	7	7	7	5	7	7	7	7	7	7	4	6	7	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	23	-	23	120	27	9	46	47	48	32	87	51	16	34	37	55	39	118	41	23
$t(i)$	7	6	0	5	7	7	6	7	7	7	6	3	7	5	7	7	5	7	6	7	3

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	98	45	46	125	126	111	50	32	69	34	71	53	118	55	120	59	41	78	79	125
$t(i)$	6	7	7	6	5	6	5	7	5	5	6	5	7	4	7	6	7	5	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	111	66	48	68	69	87	69	118	71	55	73	57	77	78	23	78	79	80	113	114
$t(i)$	7	7	7	6	7	6	4	7	3	7	6	7	7	7	6	2	5	6	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	103	87	118	87	71	89	122	110	94	125	96	78	96	5	98	99	116	103	118	86
$t(i)$	7	6	5	2	7	6	7	7	7	7	6	7	4	6	5	6	7	7	7	5	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	51	106	53	110	125	32	97	50	3	52	5	86	23	24	41	42	59	108	109	78	110
$t(i)$	6	6	7	6	6	4	4	7	6	6	7	6	7	1	6	4	7	6	7	7	3	5

Broadcast protocol of node 24.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	55	112	1	96	97	23	24	6	119	10	121	104	123	106	32	33	17	72	17	18	115
$t(i)$	7	5	7	7	7	7	4	6	7	7	5	7	7	7	7	7	7	4	6	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	23	24	-	24	25	28	10	47	31	126	33	88	35	17	54	38	56	40	119	42
$t(i)$	7	6	5	0	6	7	7	6	6	7	5	6	3	7	5	7	6	5	7	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	24	42	99	100	47	126	103	31	51	33	70	35	72	56	119	56	121	60	42	79	80
$t(i)$	3	6	7	7	7	4	7	6	7	5	5	6	5	6	4	7	7	7	5	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	111	112	84	49	69	70	88	70	119	72	121	74	94	95	79	24	79	112	81	114
$t(i)$	7	7	7	7	7	7	6	4	7	3	6	6	7	7	7	6	2	5	6	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	102	86	87	88	119	88	72	109	110	38	1	96	97	79	97	6	99	102	47	104	119
$t(i)$	6	7	6	5	2	7	7	7	7	7	6	6	5	4	6	5	6	7	5	6	5

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	88	52	53	54	126	80	33	98	51	52	37	6	7	24	73	42	43	60	29	78	79
$t(i)$	7	6	7	7	6	6	6	4	7	6	6	7	7	7	1	7	4	7	6	7	7	3

Broadcast protocol of node 25.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	2	57	2	97	6	24	25	26	120	121	12	105	68	13	126	17	112	73	18	75
$t(i)$	7	6	4	7	7	6	5	4	7	6	6	7	4	6	7	7	7	6	6	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	23	24	25	-	25	26	27	30	12	32	50	112	113	90	35	55	56	57	41	120
$t(i)$	7	7	6	3	0	2	6	7	7	6	7	6	7	6	5	7	7	7	7	6	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	24	25	26	44	45	126	47	50	105	114	34	54	55	73	57	120	121	58	123	43	7
$t(i)$	7	5	5	6	7	6	7	7	3	7	7	7	6	5	6	3	5	7	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	81	63	10	113	66	50	68	88	118	90	120	121	57	58	95	79	24	25	26	81	101
$t(i)$	6	7	7	5	7	5	7	7	7	7	4	7	5	6	7	7	4	6	4	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	84	87	105	87	120	121	73	123	75	95	2	41	79	113	44	7	100	9	104	105
$t(i)$	6	7	7	5	6	7	4	7	6	6	6	5	7	6	7	7	5	6	7	7	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	105	122	90	108	92	80	81	50	35	100	5	6	7	40	25	26	43	12	93	94	79
$t(i)$	2	7	7	6	7	7	7	5	4	6	7	7	7	6	7	1	3	6	5	7	7	5

Broadcast protocol of node 26.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	112	1	58	3	6	99	8	26	10	121	10	123	31	125	33	17	35	36	74	75
$t(i)$	7	6	7	6	7	7	5	7	4	7	3	4	7	7	7	7	7	6	6	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	20	117	24	25	26	-	26	83	11	29	49	33	112	89	90	35	36	56	40	119	42
$t(i)$	7	7	7	6	5	0	6	7	5	7	5	6	5	7	3	5	7	7	7	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	44	26	44	45	65	49	112	49	114	107	35	72	54	74	58	121	60	123	62	44
$t(i)$	6	7	3	6	7	7	7	4	6	6	7	7	5	7	6	7	5	7	5	7	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	81	82	10	11	114	50	51	71	72	90	72	121	74	123	124	60	80	81	26	81	114
$t(i)$	7	6	6	7	7	7	7	7	6	4	7	4	5	6	7	6	7	6	2	5	5

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	103	85	32	119	90	121	90	91	75	76	126	78	112	99	81	99	8	84	10	11
$t(i)$	6	6	7	7	7	5	2	6	7	7	7	7	7	7	7	4	6	6	7	5	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	121	89	90	54	109	64	81	82	35	100	101	6	103	8	25	26	27	44	29	62	31
$t(i)$	7	7	6	7	6	7	7	3	7	4	7	7	6	7	5	7	1	7	4	6	6	6

Broadcast protocol of node 27.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	110	94	3	4	59	4	99	8	26	27	28	122	123	14	107	70	17	112	19	114	75
$t(i)$	7	7	7	6	4	7	7	7	5	4	7	7	6	6	4	6	7	6	7	6	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	20	77	78	25	26	27	-	27	28	29	13	14	15	89	114	115	92	39	57	58	59
$t(i)$	7	6	7	7	6	3	0	2	6	7	7	7	7	7	7	6	5	7	6	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	122	26	27	28	46	47	112	68	52	107	52	36	37	57	75	59	122	123	60	125
$t(i)$	6	5	7	5	5	6	7	7	7	7	3	6	7	6	7	5	6	3	5	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	9	83	65	12	115	70	52	53	119	120	92	122	123	59	60	97	81	26	27	28
$t(i)$	6	7	6	7	7	5	7	5	7	7	7	7	4	7	5	6	7	7	4	6	4

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	86	68	88	89	107	91	122	123	75	125	77	97	4	43	81	115	46	9	102	105
$t(i)$	7	7	6	7	6	5	7	6	4	7	6	7	6	5	7	6	7	7	6	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	107	122	107	108	92	96	81	82	83	52	37	22	55	8	9	42	27	28	45	14	63
$t(i)$	6	7	2	6	7	6	7	5	7	5	4	7	7	7	6	5	7	1	3	7	5	7

Broadcast protocol of node 28.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	93	2	113	4	5	60	5	100	9	27	28	29	123	124	107	108	71	16	0	37	115
$t(i)$	6	7	6	7	6	4	7	7	6	5	4	6	7	6	7	4	6	7	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	21	78	79	26	27	28	-	28	29	126	31	15	35	53	115	116	93	40	58	59
$t(i)$	6	7	7	7	7	6	3	0	2	7	6	7	6	7	6	6	6	5	7	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	44	123	27	28	29	47	48	113	69	53	108	36	56	38	58	76	60	123	124	61
$t(i)$	7	6	5	7	5	5	6	7	7	7	7	3	7	7	6	7	5	6	3	5	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	46	10	84	66	13	116	15	53	90	72	121	93	123	124	60	61	98	82	27	28
$t(i)$	7	7	6	6	7	7	5	7	5	6	7	7	7	4	7	5	6	6	7	4	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	29	84	87	69	33	90	108	92	123	124	76	96	78	98	5	44	82	116	47	10	11
$t(i)$	4	7	7	6	7	7	5	7	6	4	7	7	6	7	5	7	6	7	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	121	108	123	108	125	80	65	82	83	84	53	38	71	8	9	10	43	28	29	46	15
$t(i)$	7	6	6	2	7	7	7	7	5	7	5	4	7	7	7	7	5	7	1	3	6	5

Broadcast protocol of node 29.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	93	0	95	4	115	6	117	62	9	102	11	29	13	124	13	14	15	18	36	1	38
$t(i)$	4	6	7	7	6	7	6	7	7	5	7	4	7	3	5	6	7	7	6	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	20	117	78	79	120	27	28	29	-	29	86	14	34	52	36	115	38	93	94	58	59
$t(i)$	7	7	7	7	7	7	6	5	0	6	7	7	7	5	7	5	7	3	7	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	61	62	124	47	29	47	48	68	52	115	54	109	56	38	75	121	122	61	124	61
$t(i)$	7	7	6	7	7	3	6	7	7	7	4	7	6	7	5	7	6	6	6	4	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	65	47	84	85	13	87	52	70	119	74	75	93	77	124	79	126	111	112	83	84
$t(i)$	7	7	5	7	6	6	7	6	7	7	7	6	5	7	6	6	5	7	7	7	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	29	84	117	86	106	88	121	122	93	124	93	126	111	96	113	44	115	102	84	102	11
$t(i)$	2	5	5	6	6	7	7	7	7	2	6	6	6	7	7	7	7	7	4	6	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	13	106	109	124	0	0	65	34	67	84	85	38	103	56	9	106	11	28	29	30	47
$t(i)$	7	4	7	7	5	7	5	6	6	7	3	7	4	7	6	6	5	5	7	1	7	4

Broadcast protocol of node 30.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	94	95	2	59	116	7	62	7	10	103	29	30	12	125	126	111	110	73	37	21
$t(i)$	7	6	5	6	7	7	7	5	6	6	5	6	4	7	6	7	5	7	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	40	78	42	43	8	9	29	30	-	30	31	34	16	53	37	116	93	94	95	40
$t(i)$	6	7	6	7	7	7	7	7	5	0	6	7	7	6	6	6	4	7	7	4	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	42	62	124	125	48	30	48	105	106	53	116	55	37	1	2	76	60	78	60	125
$t(i)$	5	6	6	6	7	7	3	6	7	7	7	5	7	5	7	7	7	6	4	7	4

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	111	66	48	85	69	116	117	16	119	55	75	93	94	78	125	78	79	80	64	84
$t(i)$	7	6	7	5	7	7	6	7	7	7	6	7	6	5	7	3	5	6	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	30	85	86	119	88	35	92	110	94	125	94	95	79	113	44	45	102	103	85	103
$t(i)$	6	2	5	7	6	7	7	7	6	4	2	3	7	7	7	7	7	7	6	4	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	105	14	123	124	125	48	49	66	3	36	85	86	23	40	41	10	11	12	93	30	95
$t(i)$	5	6	7	7	7	5	4	7	6	7	7	3	6	7	5	7	7	7	6	5	1	6

Broadcast protocol of node 31.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	110	112	95	96	97	116	117	62	63	8	9	29	30	31	32	126	111	110	17	37	2
$t(i)$	7	7	6	7	7	7	7	7	4	5	6	6	7	4	7	7	7	4	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	23	24	79	80	8	26	29	30	31	-	31	32	33	17	35	92	37	118	41	96
$t(i)$	7	7	6	5	7	6	7	7	5	3	0	2	5	7	5	6	5	6	6	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	24	44	123	63	47	126	30	31	32	69	70	71	53	118	38	39	76	58	123	124	125
$t(i)$	7	7	6	7	7	6	6	6	6	7	7	6	7	7	7	7	6	7	7	7	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	63	64	48	49	13	87	69	118	17	72	92	93	123	95	79	126	111	63	81	84
$t(i)$	3	6	7	7	7	7	5	6	5	6	7	7	7	5	7	7	4	6	5	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	30	31	32	87	71	91	92	110	124	125	126	111	79	99	81	101	116	9	85	86
$t(i)$	6	4	5	3	7	7	7	6	3	6	7	5	5	6	7	6	7	6	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	13	106	109	110	126	32	33	50	35	36	85	86	87	8	105	10	11	92	13	110	31
$t(i)$	6	6	7	7	6	2	4	6	7	7	7	5	6	4	7	7	7	7	4	5	5	1

Broadcast protocol of node 32.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	94	3	96	3	23	7	62	26	64	9	12	105	14	32	14	111	16	113	74	2
$t(i)$	7	7	6	5	7	7	7	6	7	4	7	7	5	6	4	7	5	7	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	23	118	25	80	25	9	27	30	31	32	-	32	113	34	115	38	39	118	39	120
$t(i)$	7	6	5	7	3	6	6	7	7	6	5	0	6	6	7	7	7	5	4	6	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	25	62	46	64	48	111	50	32	50	107	71	117	118	119	39	40	41	61	79	80
$t(i)$	7	5	7	7	5	7	6	7	3	6	7	7	7	7	7	7	7	7	7	6	4

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	111	66	113	68	50	87	88	118	73	120	73	122	123	95	96	80	111	80	64	82
$t(i)$	7	3	7	5	7	5	6	7	6	7	5	6	7	7	7	7	5	2	6	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	84	87	32	87	120	108	109	93	38	125	96	111	79	80	81	101	46	9	102	105
$t(i)$	6	7	7	2	5	7	7	7	7	6	6	6	4	7	7	7	7	6	5	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	105	14	107	16	125	32	33	50	51	68	69	102	87	88	25	106	43	12	13	62	31
$t(i)$	4	6	5	6	6	7	1	7	4	7	6	7	6	3	6	4	7	6	6	7	5	7

Broadcast protocol of node 33.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	112	3	4	97	116	24	25	63	8	65	10	13	106	15	33	15	112	17	114	19
$t(i)$	7	6	7	6	5	7	7	7	5	7	4	6	7	5	6	4	7	5	6	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	23	24	119	26	81	26	10	47	29	32	33	-	33	114	18	38	39	40	119	40
$t(i)$	7	7	6	5	6	3	7	7	6	7	7	5	0	6	7	7	7	6	5	4	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	44	26	63	47	65	103	112	51	33	51	108	53	118	119	120	40	4	123	62	80
$t(i)$	7	7	5	7	7	5	7	7	7	3	6	6	7	7	7	7	6	7	7	7	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	81	65	112	67	114	69	51	88	89	119	72	121	74	58	124	96	97	81	112	81	65
$t(i)$	4	7	3	7	5	7	5	6	7	6	7	5	7	7	7	7	7	5	2	6	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	67	85	88	33	88	121	90	74	92	1	126	97	112	80	81	82	8	101	10	105
$t(i)$	7	6	7	7	2	5	6	7	6	7	7	7	6	4	7	7	7	6	7	5	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	88	106	15	108	17	32	33	34	51	52	69	70	103	88	89	26	11	44	13	14	63
$t(i)$	6	4	7	5	7	7	6	1	7	4	7	6	7	6	3	6	4	7	6	6	7	6

Broadcast protocol of node 34.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	2	113	2	5	98	24	25	7	27	9	66	13	14	107	16	34	35	113	1	115
$t(i)$	6	5	3	6	6	5	7	6	7	6	7	7	7	6	5	7	4	6	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	4	41	25	120	27	82	46	28	31	126	14	34	-	34	115	36	93	40	41	120
$t(i)$	7	7	7	5	4	7	3	6	7	7	6	7	6	0	5	6	7	7	7	6	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	98	45	27	64	126	66	50	113	52	34	52	109	0	1	2	121	122	5	124	63
$t(i)$	7	6	7	5	5	7	6	7	6	7	3	6	7	7	6	7	7	7	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	82	64	113	68	115	70	52	89	90	120	75	122	77	95	79	24	25	82	113	82
$t(i)$	6	4	7	5	6	5	6	5	6	7	7	7	5	7	6	7	6	7	6	2	5

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	67	68	69	89	34	89	122	91	75	95	2	111	98	113	81	82	83	101	48	105
$t(i)$	7	7	7	7	7	2	5	6	7	6	7	4	7	7	4	7	7	6	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	107	89	107	16	17	16	33	34	35	52	53	70	71	56	89	90	27	108	45	46	95
$t(i)$	6	7	4	6	6	7	5	7	1	7	4	7	7	7	7	3	6	4	7	6	7	5

Broadcast protocol of node 35.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	112	3	114	3	116	99	8	26	27	28	122	123	14	15	108	15	35	17	114	19
$t(i)$	7	6	7	3	5	7	5	7	5	7	7	7	6	7	6	5	7	4	7	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	4	24	42	26	121	26	83	28	29	32	111	34	35	-	35	36	117	21	41	96
$t(i)$	6	7	7	6	7	4	6	3	6	7	7	6	6	5	0	6	7	7	7	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	42	99	46	28	65	47	67	49	114	53	35	53	54	74	58	3	4	123	6	44
$t(i)$	5	7	6	7	5	5	7	6	7	7	7	3	6	7	7	7	6	6	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	65	83	65	114	69	116	71	53	90	91	121	76	123	59	125	126	111	82	83	114
$t(i)$	7	6	4	7	5	6	5	7	5	7	7	6	6	5	7	7	7	7	7	5	2

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	67	68	69	33	90	35	90	110	75	76	96	3	112	99	114	82	83	101	118	119
$t(i)$	7	7	7	7	7	6	2	5	7	7	7	7	4	7	7	4	6	6	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	121	108	90	108	17	96	17	34	35	100	53	6	71	8	89	90	91	28	109	46	47
$t(i)$	7	7	7	4	6	6	5	5	7	1	7	4	6	6	6	7	3	6	4	7	6	6

Broadcast protocol of node 36.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	0	113	4	115	4	117	100	101	8	11	122	123	68	69	70	17	18	36	37	115
$t(i)$	5	6	5	6	2	7	7	5	5	7	7	6	6	7	7	6	7	6	3	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	4	22	23	7	8	45	123	124	85	49	50	15	113	36	-	36	37	38	22	59
$t(i)$	7	5	6	7	7	6	7	7	7	7	7	7	7	7	5	0	2	5	7	7	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	122	43	100	101	102	103	112	113	52	115	54	36	37	38	2	3	4	59	124	61
$t(i)$	7	5	7	4	7	7	7	6	6	6	4	7	4	7	6	7	7	3	7	6	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	63	112	67	68	115	116	52	72	54	18	19	122	77	59	96	97	98	99	100	84
$t(i)$	6	7	7	7	6	5	6	5	7	6	7	7	7	7	6	7	7	7	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	116	117	118	70	120	35	36	37	92	1	2	97	4	43	100	115	116	101	85	86
$t(i)$	6	5	6	7	7	7	6	6	4	7	7	6	6	4	6	6	3	4	6	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	51	52	90	91	92	0	97	18	35	36	37	54	7	56	41	26	59	92	45	110	95
$t(i)$	7	7	7	7	7	6	7	5	4	7	1	3	5	6	7	6	7	4	5	5	7	7

Broadcast protocol of node 37.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	55	19	1	114	5	116	5	118	101	102	103	12	123	106	15	108	71	18	19	37	19
$t(i)$	7	4	6	7	5	3	7	5	7	7	7	7	6	7	7	4	6	7	6	2	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	4	118	25	7	44	26	83	28	85	126	33	15	35	53	37	-	37	38	39	40
$t(i)$	7	7	7	7	6	6	7	6	7	6	7	7	6	7	6	5	0	4	5	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	44	99	46	101	126	47	112	51	52	53	116	53	37	55	39	121	4	5	60	7
$t(i)$	7	7	5	7	5	6	7	6	7	5	4	2	7	3	6	7	7	6	4	6	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	46	83	67	114	115	116	52	53	73	55	19	74	123	78	60	61	98	99	81	114
$t(i)$	7	6	7	7	6	7	6	6	5	7	5	5	7	7	7	5	7	7	6	7	5

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	116	117	69	70	71	108	36	37	38	1	96	78	112	5	114	99	116	101	118	49
$t(i)$	7	5	7	7	7	7	7	7	6	7	7	7	6	7	6	4	7	4	6	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	51	52	53	108	92	16	1	2	19	36	37	38	55	56	73	74	59	108	109	30	15
$t(i)$	7	6	7	3	6	7	7	5	7	3	6	1	6	4	7	6	6	7	5	7	7	5

Broadcast protocol of node 38.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	93	56	20	4	22	23	117	118	119	8	103	29	123	124	69	70	111	16	0	37	38
$t(i)$	4	6	7	6	3	7	7	7	5	7	7	6	7	6	6	4	6	7	6	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	117	22	119	24	27	45	29	124	31	86	33	15	52	36	37	38	-	38	22	23
$t(i)$	7	2	4	6	7	7	5	7	5	7	5	7	6	7	7	6	4	0	5	6	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	97	44	45	124	45	126	111	31	49	69	115	116	117	56	38	39	40	4	78	124	125
$t(i)$	7	7	6	4	7	6	7	6	7	7	6	7	6	7	3	7	7	7	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	8	63	47	11	85	115	70	117	70	119	74	56	93	77	22	23	126	98	99	27	82
$t(i)$	6	7	7	7	7	7	5	3	6	7	7	5	6	7	5	5	7	7	7	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	102	116	117	86	70	71	121	92	93	38	93	77	95	4	97	100	115	100	117	102	86
$t(i)$	7	6	4	6	7	7	7	7	5	2	7	6	7	5	6	6	5	7	5	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	13	14	15	54	0	0	1	18	3	4	37	38	39	56	41	74	75	92	93	78	15
$t(i)$	7	7	7	7	7	7	5	7	7	7	4	5	1	6	4	7	6	7	6	3	6	5

Broadcast protocol of node 39.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	94	57	21	5	116	7	118	7	10	103	12	105	12	32	70	111	16	19	1	2
$t(i)$	7	4	6	6	7	6	6	3	5	7	5	6	5	7	7	7	6	7	7	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	21	118	23	80	8	28	46	30	125	30	87	32	33	36	115	38	39	-	39	120
$t(i)$	4	7	6	7	6	6	7	6	5	4	6	3	6	7	7	6	7	5	0	6	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	25	26	46	125	29	30	50	32	69	53	71	117	118	74	39	57	58	78	6	7
$t(i)$	7	7	7	7	5	7	7	7	5	7	7	6	7	7	7	3	5	7	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	8	111	10	113	85	86	87	69	118	71	120	73	57	94	76	125	80	111	112	100	65
$t(i)$	7	7	6	7	7	7	5	6	5	7	5	6	7	5	7	6	7	5	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	103	87	118	87	120	121	73	93	94	39	94	97	112	99	100	7	116	103	118	105
$t(i)$	7	6	6	2	7	7	7	7	7	6	2	7	7	6	7	6	4	7	7	4	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	105	106	123	124	125	32	1	50	3	100	21	38	39	40	57	58	11	76	29	94	31
$t(i)$	4	6	7	7	7	7	4	5	6	7	5	5	6	1	7	4	6	7	6	6	3	7

Broadcast protocol of node 40.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	56	95	96	59	23	24	118	119	8	11	104	11	68	15	126	17	72	73	74	2
$t(i)$	7	6	6	7	6	7	7	7	3	7	6	4	7	7	7	6	7	6	7	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	40	41	119	120	8	122	10	47	48	86	111	112	89	34	35	19	39	40	-	40
$t(i)$	6	6	6	6	5	6	7	7	7	7	7	7	6	5	6	7	7	7	3	0	2

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	25	26	63	64	65	49	104	49	33	53	71	72	56	119	120	40	41	59	62	63
$t(i)$	7	6	7	5	7	6	6	3	7	7	7	6	7	7	4	7	5	5	7	7	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	8	111	112	65	49	86	87	71	118	119	120	56	74	58	95	96	78	25	63	83	101
$t(i)$	4	6	5	7	5	6	7	7	5	5	6	5	7	6	7	6	7	7	7	7	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	67	104	118	119	120	89	122	93	94	39	40	41	112	43	100	45	8	101	104	119
$t(i)$	7	6	5	6	7	4	6	6	7	6	5	4	4	7	7	7	6	5	7	7	2

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	105	89	90	91	126	96	49	34	67	4	21	22	39	40	41	58	11	76	45	94	95
$t(i)$	6	7	7	7	7	7	5	4	7	7	7	7	7	4	1	3	7	5	7	7	7	5

Broadcast protocol of node 41.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	2	57	96	97	60	24	25	119	120	9	12	105	106	32	126	111	18	73	74	75
$t(i)$	6	7	6	6	7	7	7	7	7	3	7	6	4	7	7	7	7	7	6	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	40	41	42	120	121	9	123	11	12	49	87	112	113	90	35	36	20	40	41	-
$t(i)$	7	6	6	6	6	5	6	7	7	7	7	6	7	6	5	6	7	7	7	3	0

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	42	26	27	64	48	66	50	105	50	34	54	72	73	57	120	121	41	42	60	63
$t(i)$	2	7	6	7	5	7	6	6	3	7	7	7	6	7	7	4	7	5	5	6	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	9	112	113	66	50	87	88	72	119	120	121	57	75	59	96	97	79	26	64	65
$t(i)$	6	4	6	5	7	5	7	7	7	5	5	6	5	7	7	7	6	7	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	102	84	68	105	119	120	121	90	123	92	95	40	41	42	113	44	115	46	9	102	105
$t(i)$	6	7	7	5	6	7	4	6	6	7	7	5	4	4	7	7	7	6	5	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	105	122	90	91	0	96	97	50	35	68	101	22	23	40	41	42	59	12	61	46	95
$t(i)$	2	6	7	7	7	7	5	5	4	7	6	7	7	7	4	1	3	6	5	7	7	6

Broadcast protocol of node 42.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	112	3	58	97	98	61	25	26	120	121	10	13	106	107	33	111	112	19	74	75
$t(i)$	7	6	7	6	6	7	7	7	7	7	3	7	6	4	7	7	7	7	7	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	4	41	42	43	121	122	10	124	12	13	50	88	113	114	91	36	37	21	41	42
$t(i)$	6	7	6	6	6	6	5	6	7	7	7	7	6	7	6	5	6	7	7	7	3

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	-	42	43	27	28	65	49	67	51	106	51	35	55	73	74	58	121	122	42	43	61
$t(i)$	0	2	7	6	7	5	7	6	6	3	7	7	7	6	7	7	4	7	5	5	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	65	10	113	114	67	51	88	89	73	120	121	122	58	76	60	97	98	80	27	65
$t(i)$	7	6	4	6	5	7	5	7	7	7	5	5	6	5	7	7	7	6	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	103	85	69	106	120	121	122	91	124	93	96	41	42	43	114	45	116	47	10	103
$t(i)$	7	6	7	7	5	6	7	4	6	6	7	7	5	4	4	7	7	7	6	5	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	121	106	123	91	92	96	97	98	51	36	69	102	23	24	41	42	43	60	13	62	47
$t(i)$	7	2	6	7	7	7	6	5	5	4	7	6	7	7	7	4	1	3	6	5	7	7

Broadcast protocol of node 43.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	93	2	113	4	59	98	99	62	26	27	121	122	11	14	107	108	34	112	113	20	75
$t(i)$	7	7	6	7	6	6	7	7	7	7	7	3	7	6	4	7	7	7	7	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	77	5	42	43	44	122	123	11	125	13	14	51	89	114	115	92	37	38	22	42
$t(i)$	7	6	7	6	6	6	6	5	6	7	7	7	7	6	7	6	5	6	7	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	-	43	44	28	29	66	50	68	52	107	52	36	56	74	75	59	122	123	43	44
$t(i)$	3	0	2	7	6	7	5	7	6	6	3	7	7	7	6	7	7	4	7	5	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	65	66	11	114	115	68	52	89	90	74	121	122	123	59	77	61	98	99	81	28
$t(i)$	6	7	6	4	6	5	7	5	7	7	7	5	5	6	5	7	7	7	6	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	67	104	86	70	107	121	122	123	92	125	94	97	42	43	44	115	46	117	48	11
$t(i)$	7	7	6	7	7	5	6	7	4	6	6	7	7	5	4	4	7	7	7	6	5

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	107	122	107	124	92	48	97	98	99	52	37	70	103	24	25	42	43	44	61	14	63
$t(i)$	7	7	2	6	7	7	7	6	5	5	4	7	6	7	7	7	4	1	3	6	5	7

Broadcast protocol of node 44.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	93	94	3	114	5	60	99	100	63	27	28	122	123	12	15	108	109	35	113	114	21
$t(i)$	7	7	7	6	7	6	7	7	6	7	7	7	3	7	6	4	7	7	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	77	78	25	43	44	45	123	124	12	30	14	15	52	90	115	116	93	38	39	23
$t(i)$	6	7	6	7	6	6	6	6	5	6	7	7	7	7	6	7	6	5	6	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	44	-	44	45	29	49	67	51	69	53	108	53	37	57	75	76	60	123	124	44
$t(i)$	7	3	0	2	7	6	7	5	7	6	6	3	7	7	7	6	7	7	4	7	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	63	66	67	12	115	116	69	53	90	91	75	122	123	124	60	78	62	99	100	82
$t(i)$	5	7	7	6	4	6	5	7	5	7	7	7	5	5	6	5	7	6	6	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	29	67	68	105	87	71	108	122	123	124	93	126	95	98	43	44	45	116	47	104	49
$t(i)$	7	7	7	6	7	6	5	6	7	4	6	6	7	7	5	4	4	7	7	7	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	105	108	123	108	126	80	81	98	99	100	53	38	71	8	89	26	43	44	45	62	15
$t(i)$	5	7	7	2	6	7	7	7	6	5	5	4	7	7	7	7	7	4	1	3	7	5

Broadcast protocol of node 45.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	93	56	95	58	22	6	61	100	63	27	9	122	13	124	15	126	111	110	0	1	75
$t(i)$	4	6	7	7	7	7	5	7	7	4	7	5	7	5	7	5	6	7	6	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	77	78	6	26	27	45	27	124	29	126	31	34	52	36	115	38	93	38	22	40
$t(i)$	6	4	7	6	7	5	2	7	6	7	6	7	7	6	7	6	7	3	6	5	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	61	45	-	45	46	111	112	105	52	107	108	117	0	38	56	40	122	61	124	44
$t(i)$	7	6	5	0	6	7	7	7	7	7	5	7	6	7	5	7	6	7	7	4	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	63	64	11	85	13	68	117	16	54	120	92	93	77	124	77	126	81	63	27	82
$t(i)$	3	6	7	7	7	6	7	7	7	7	7	7	6	7	3	5	7	7	5	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	86	117	86	106	107	91	122	93	124	93	77	78	96	43	100	45	102	9	104	11
$t(i)$	7	6	5	7	7	7	7	6	5	2	7	6	6	7	7	6	4	7	6	7	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	107	122	15	124	92	0	81	18	99	100	21	38	39	24	9	26	27	44	45	62	63
$t(i)$	6	6	4	6	7	6	5	6	7	7	5	7	4	7	7	5	6	3	7	1	7	4

Broadcast protocol of node 46.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	94	1	58	59	116	7	8	101	64	28	29	30	12	125	14	111	16	19	1	75
$t(i)$	7	4	7	7	7	7	7	6	4	5	5	7	4	7	6	7	5	7	7	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	23	78	119	80	8	9	46	28	125	30	87	112	35	53	37	116	39	94	95	96
$t(i)$	7	7	6	7	7	7	6	4	6	3	5	7	7	7	6	6	5	6	3	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	44	45	46	-	46	30	31	49	69	53	116	36	118	57	39	76	60	78	62	125
$t(i)$	7	7	6	5	0	6	7	6	7	7	7	4	7	7	7	5	6	6	5	7	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	46	47	67	12	67	116	71	118	119	72	121	57	94	76	125	78	62	82	64	101
$t(i)$	7	3	7	6	5	7	6	7	6	6	7	7	6	5	7	4	7	6	7	6	5

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	30	85	118	87	88	108	109	37	94	125	94	111	112	97	100	101	46	101	10	105
$t(i)$	6	6	7	5	6	7	7	7	7	7	2	6	6	6	7	7	6	2	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	107	108	53	16	125	64	1	66	83	84	101	38	39	8	9	10	27	28	45	46	31
$t(i)$	6	7	6	5	6	7	4	5	7	7	7	3	7	4	5	7	6	7	7	7	1	7

Broadcast protocol of node 47.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	112	95	2	115	60	117	8	9	102	65	10	30	31	13	126	17	112	17	18	2
$t(i)$	7	7	4	7	7	7	7	7	6	4	5	7	6	4	7	7	7	5	6	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	20	40	24	79	120	121	9	29	47	29	126	31	32	113	36	54	38	117	40	95	96
$t(i)$	7	7	7	6	7	7	7	6	4	5	3	5	7	7	7	6	6	5	6	3	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	97	61	62	46	47	-	47	31	32	50	70	108	117	54	119	58	40	77	61	79	63
$t(i)$	7	7	7	7	6	0	5	7	6	7	7	7	4	7	7	7	5	6	6	5	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	65	47	48	68	13	68	117	72	119	120	73	76	58	95	77	126	79	63	83	65
$t(i)$	5	7	3	7	6	5	7	6	7	6	6	7	7	6	5	7	4	7	7	7	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	102	84	31	88	119	88	89	109	110	38	95	126	95	112	113	98	101	102	47	102	86
$t(i)$	5	7	6	7	5	6	7	7	7	7	7	2	6	6	6	7	7	6	2	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	13	106	109	54	126	48	65	2	67	84	37	102	39	40	9	10	59	28	29	30	47
$t(i)$	7	6	7	6	5	6	6	4	5	7	6	7	3	7	4	5	6	7	7	7	7	1

Broadcast protocol of node 48.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	112	3	96	97	116	99	118	9	64	103	66	30	31	125	33	111	112	0	18	21
$t(i)$	3	7	7	4	7	7	7	7	7	5	7	7	7	7	5	7	5	6	5	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	40	78	119	120	81	9	27	30	48	49	111	112	33	34	37	55	39	118	41	96
$t(i)$	5	7	7	7	7	7	6	7	6	3	6	7	4	6	7	7	6	7	6	6	3

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	122	45	46	47	48	-	48	49	50	51	71	55	0	57	120	3	41	78	62	125
$t(i)$	7	7	7	6	5	4	0	2	4	6	7	7	7	4	7	5	6	5	6	7	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	111	47	48	49	67	14	88	16	17	18	75	57	58	59	96	126	111	112	64	84
$t(i)$	7	4	7	6	5	6	7	7	6	7	6	7	6	7	7	5	7	6	5	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	30	85	105	33	120	89	73	110	0	125	96	111	96	80	81	82	46	103	48	49
$t(i)$	6	5	7	7	5	6	7	7	7	7	7	7	2	6	7	6	7	7	6	5	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	105	14	107	16	0	48	49	50	67	68	21	102	55	88	41	106	59	60	29	30	47
$t(i)$	5	6	6	7	7	6	1	3	7	7	7	6	7	5	6	4	7	6	7	7	4	6

Broadcast protocol of node 49.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	112	113	4	97	60	5	100	9	10	65	104	13	31	13	14	34	112	113	1	2
$t(i)$	7	3	6	7	4	6	7	7	7	6	5	6	7	4	5	7	7	5	7	5	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	4	22	42	120	121	82	10	30	31	49	50	112	113	34	35	19	56	38	119	40
$t(i)$	7	5	6	7	7	7	7	7	6	5	3	7	7	4	6	7	6	6	7	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	97	42	43	46	47	48	49	-	49	50	51	52	53	56	1	58	121	4	42	79	61
$t(i)$	3	6	7	7	6	5	4	0	2	4	5	6	7	7	4	7	5	6	5	6	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	81	65	112	48	49	50	68	52	89	17	72	19	76	58	59	79	97	111	112	113	65
$t(i)$	7	7	4	7	6	5	6	7	7	6	7	7	7	6	7	7	5	7	6	5	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	29	67	31	105	119	34	121	90	37	94	1	96	97	112	97	114	82	83	47	104	49
$t(i)$	7	7	6	7	7	5	6	7	7	7	6	7	6	2	7	7	6	7	7	7	5

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	51	14	107	124	17	48	49	50	51	68	69	86	23	56	89	42	11	60	13	30	31
$t(i)$	6	7	6	7	7	7	6	1	3	6	7	7	7	7	5	6	4	7	7	6	7	7

Broadcast protocol of node 50.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	2	113	114	5	98	5	6	101	120	11	66	105	14	32	14	15	35	113	114	2
$t(i)$	7	6	3	7	7	4	6	7	7	7	7	5	6	7	4	5	6	7	5	6	5

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	23	5	23	80	121	122	83	11	31	32	50	51	113	114	35	36	20	57	41	120
$t(i)$	7	6	5	7	7	7	7	7	6	6	5	3	6	7	4	6	7	7	7	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	98	43	44	47	48	49	50	-	50	51	52	53	54	57	2	59	122	61	43	61
$t(i)$	7	3	6	7	7	6	5	4	0	2	4	5	6	7	6	4	6	5	7	5	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	82	66	113	49	50	51	69	53	73	18	19	20	58	59	79	80	98	112	113	114
$t(i)$	7	7	7	4	7	6	5	6	7	7	6	7	6	7	7	7	6	5	7	6	5

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	30	68	32	33	90	35	122	91	75	1	2	97	98	113	98	115	83	84	48	105
$t(i)$	6	7	7	6	7	7	5	6	7	7	7	7	7	6	2	7	7	6	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	51	52	15	16	125	32	49	50	51	52	69	70	87	56	57	90	43	12	29	14	31
$t(i)$	5	7	7	7	7	7	7	6	1	3	6	7	7	7	7	5	6	4	7	7	6	7

Broadcast protocol of node 51.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	19	3	114	115	6	99	62	7	102	121	12	67	106	15	33	15	16	36	114	115
$t(i)$	7	6	6	3	7	7	4	6	7	7	7	7	5	7	7	4	5	7	6	5	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	23	24	6	24	81	122	123	84	12	32	33	51	52	114	115	36	39	21	58	42
$t(i)$	5	7	6	5	7	7	7	7	7	6	7	5	3	7	7	4	7	7	6	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	44	99	44	45	48	49	50	51	-	51	52	53	54	55	58	3	60	123	6	44
$t(i)$	6	7	3	6	7	7	6	5	4	0	2	4	5	6	7	7	4	7	5	6	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	82	83	67	114	50	51	52	70	54	91	19	20	21	78	60	61	111	99	81	114
$t(i)$	7	7	7	7	4	6	6	5	6	7	7	7	7	7	7	6	7	7	5	6	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	67	68	69	33	107	108	36	123	92	1	2	3	112	99	114	99	100	84	85	49
$t(i)$	5	6	7	7	7	7	7	5	6	7	7	7	7	7	7	2	6	7	6	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	51	52	53	16	126	32	33	50	51	52	53	70	71	40	105	58	91	44	109	30	15
$t(i)$	6	5	6	6	6	7	6	6	7	1	3	7	7	7	7	7	5	6	4	7	7	6

Broadcast protocol of node 52.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	55	0	20	4	115	116	61	100	7	120	103	122	13	68	107	33	34	35	19	37	115
$t(i)$	6	7	7	6	3	7	7	4	7	7	7	7	6	5	7	7	7	7	7	6	5

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	4	22	23	7	25	82	27	124	85	13	33	34	52	53	115	116	37	21	22	59
$t(i)$	6	5	6	7	5	6	6	7	7	7	7	5	4	3	6	7	4	7	7	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	44	45	100	45	126	111	50	51	52	-	52	53	54	57	58	59	4	59	124	7
$t(i)$	7	7	6	3	7	7	7	7	6	5	0	2	4	5	7	6	5	4	7	5	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	82	112	67	68	115	70	52	53	71	55	75	20	58	124	79	61	25	63	100	84
$t(i)$	5	7	7	7	6	4	7	6	5	6	7	7	6	7	6	7	6	7	7	5	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	116	68	32	106	34	89	92	37	92	93	77	3	4	113	100	115	100	101	85	105
$t(i)$	6	5	7	7	7	5	7	7	5	6	7	7	7	7	7	7	2	6	7	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	107	52	53	54	109	32	33	34	51	52	53	54	71	72	89	26	107	12	45	62	63
$t(i)$	6	5	4	7	6	7	6	6	6	7	1	3	7	7	7	6	7	6	7	4	7	6

Broadcast protocol of node 53.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	112	20	114	5	116	5	118	7	102	28	12	13	68	69	14	71	35	17	114	21
$t(i)$	7	7	7	6	5	3	7	5	6	7	7	7	6	4	4	7	7	4	6	7	5

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	21	5	79	7	44	26	83	30	31	13	14	34	35	53	35	116	117	118	22	23
$t(i)$	4	6	6	7	7	6	7	6	7	6	5	6	7	6	2	7	7	7	6	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	61	99	44	101	46	49	50	68	69	53	-	53	54	55	39	59	4	5	60	125
$t(i)$	7	7	5	7	6	7	7	6	5	6	5	0	4	6	7	7	7	6	4	5	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	8	65	112	67	68	69	116	69	53	71	72	73	20	21	78	60	61	81	99	83	114
$t(i)$	7	7	6	7	6	3	2	7	3	5	6	7	6	7	7	6	6	7	6	7	5

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	116	68	69	87	71	35	90	91	75	125	94	3	4	99	114	101	116	117	118	105
$t(i)$	7	6	7	5	7	6	5	6	7	7	6	7	7	7	7	4	7	5	6	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	51	52	53	54	17	32	17	50	35	52	53	54	71	72	89	90	107	108	13	14	31
$t(i)$	6	7	6	6	7	7	7	5	7	3	7	1	5	4	7	7	7	7	7	7	5	7

Broadcast protocol of node 54.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	55	56	3	114	22	6	117	118	9	102	65	10	105	106	15	70	109	35	36	18	38
$t(i)$	6	6	7	6	7	7	3	6	6	4	6	7	7	7	7	6	7	7	5	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	117	118	6	24	8	9	27	28	125	126	87	34	35	36	54	55	117	118	39	40
$t(i)$	7	5	7	5	7	7	5	6	7	7	7	7	7	6	4	3	7	6	4	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	61	45	124	47	102	47	48	113	52	53	54	-	54	55	56	57	58	61	6	63
$t(i)$	7	6	7	6	7	3	6	7	7	7	5	4	0	2	4	5	6	7	7	4	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	9	47	84	114	115	70	117	53	54	55	73	57	94	22	77	24	62	63	27	65
$t(i)$	5	7	5	7	7	7	7	4	7	6	5	6	7	7	6	7	6	7	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	102	84	117	118	70	88	72	36	110	124	39	126	95	79	99	6	7	102	117	102	103
$t(i)$	5	6	7	5	5	7	7	7	7	7	5	6	7	7	7	6	7	7	2	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	88	52	53	54	109	0	1	18	35	36	85	54	55	56	73	74	107	108	61	94	47
$t(i)$	6	6	6	6	5	6	7	7	6	5	6	7	1	3	7	7	7	7	7	5	6	4

Broadcast protocol of node 55.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	55	56	57	2	115	23	7	118	119	10	103	66	11	68	125	16	71	110	36	37	19
$t(i)$	5	7	6	7	7	6	7	3	6	6	4	6	7	7	7	7	6	7	7	5	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	40	118	119	7	25	9	10	28	29	126	111	88	35	36	37	55	56	118	119	40
$t(i)$	7	6	5	7	5	7	7	5	6	7	7	7	6	7	6	4	3	6	6	4	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	44	62	46	125	48	103	48	49	52	53	54	55	-	55	56	57	58	59	62	7
$t(i)$	7	7	6	7	6	7	3	6	7	7	6	5	4	0	2	4	5	6	7	7	4

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	111	10	48	114	115	116	71	118	54	55	56	74	58	22	23	80	25	63	64	84
$t(i)$	6	5	7	5	7	6	7	7	4	7	6	5	7	7	7	7	7	6	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	103	85	118	119	71	89	73	37	0	95	40	111	96	5	100	7	8	103	118	103
$t(i)$	6	5	7	7	5	5	7	7	7	7	7	5	6	7	7	7	6	7	7	2	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	88	89	53	54	0	48	33	66	19	36	37	38	55	56	57	74	107	28	109	62	95
$t(i)$	7	7	6	7	6	6	4	7	7	6	5	6	7	1	3	7	6	7	7	7	5	6

Broadcast protocol of node 56.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	56	57	58	3	23	24	8	119	120	11	104	67	68	15	126	71	72	36	37	38
$t(i)$	7	5	6	6	7	7	6	7	3	7	6	4	6	7	7	6	7	7	7	7	5

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	20	117	41	119	120	8	122	10	11	12	86	111	112	89	36	37	38	56	57	119	120
$t(i)$	7	7	6	5	6	5	7	7	5	7	7	7	7	7	6	5	4	3	7	7	4

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	44	26	63	45	29	49	104	49	50	53	54	55	56	-	56	57	58	59	124	63
$t(i)$	7	7	6	6	7	7	7	3	6	7	7	6	5	4	0	2	4	5	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	8	65	112	11	49	86	116	88	72	119	55	56	57	75	59	77	24	25	26	83	65
$t(i)$	4	7	5	7	5	6	7	7	6	4	7	6	5	7	6	7	7	7	7	7	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	67	104	118	119	120	72	90	74	38	1	96	41	112	97	6	101	8	103	104	119
$t(i)$	7	7	5	7	6	5	5	7	7	7	6	7	5	6	7	7	7	6	7	6	2

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	107	89	90	54	126	96	49	2	35	20	37	38	55	56	57	58	75	108	29	94	63
$t(i)$	7	7	6	6	7	7	6	4	7	7	6	6	6	6	1	3	7	6	7	6	7	5

Broadcast protocol of node 57.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	55	2	57	58	59	60	5	25	9	120	121	12	105	68	13	108	111	18	73	37	38
$t(i)$	6	7	5	6	7	6	7	7	7	3	6	7	4	6	7	7	7	7	6	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	21	41	42	120	121	9	123	30	12	32	87	112	113	90	37	38	39	57	58	120
$t(i)$	5	7	7	7	5	7	5	7	6	5	7	6	7	7	7	6	5	4	3	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	42	43	27	64	29	66	50	105	50	51	116	55	56	57	-	57	58	59	60	63
$t(i)$	4	6	7	7	7	7	7	7	3	6	7	7	7	5	4	0	2	4	5	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	9	10	113	12	50	87	117	118	73	120	56	57	58	76	96	97	25	80	27	84
$t(i)$	6	4	7	5	6	5	7	7	7	7	4	7	6	5	7	7	7	6	7	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	67	68	105	119	120	121	73	91	75	39	2	111	42	113	98	82	102	9	104	105
$t(i)$	6	7	7	5	7	7	5	5	7	7	7	6	6	5	6	7	7	7	6	7	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	105	122	90	91	0	64	97	50	3	36	21	38	39	56	57	58	59	76	109	30	95
$t(i)$	2	7	7	6	6	7	5	6	4	7	7	6	6	6	6	1	3	6	6	7	7	7

Broadcast protocol of node 58.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	93	56	57	58	3	60	7	25	119	10	121	10	11	106	107	33	17	112	73	18	75
$t(i)$	6	7	7	5	6	7	7	6	7	7	2	6	7	7	7	7	7	6	5	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	40	41	42	120	121	26	10	28	29	49	31	88	89	90	35	55	39	57	58	59
$t(i)$	6	7	7	7	5	6	7	5	6	7	6	7	6	7	6	7	7	7	5	6	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	42	43	46	47	65	47	112	49	106	51	52	55	56	57	58	-	58	59	60	61
$t(i)$	4	6	7	7	6	5	7	5	7	4	6	7	6	5	4	2	0	4	5	6	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	65	10	65	114	86	51	88	72	73	120	121	57	58	76	77	97	25	112	113	28
$t(i)$	7	6	3	7	7	7	7	7	7	6	4	7	6	3	5	7	6	7	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	103	85	118	106	120	121	73	93	94	76	94	3	42	97	114	99	102	103	10	103
$t(i)$	7	5	6	7	5	6	5	7	7	5	4	7	7	5	7	6	7	7	6	4	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	121	106	90	124	125	0	65	18	51	4	21	54	39	56	57	58	59	76	77	94	79
$t(i)$	7	3	6	7	7	7	7	4	6	5	7	7	7	6	6	3	1	7	7	6	6	7

Broadcast protocol of node 59.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	94	57	58	59	4	61	25	26	120	11	122	11	106	107	108	109	18	113	74	115
$t(i)$	7	6	7	6	5	7	7	7	6	7	7	2	6	7	7	7	7	7	6	5	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	77	41	42	43	121	122	27	11	12	126	50	51	52	34	91	19	56	40	58	59
$t(i)$	7	7	7	7	6	5	6	7	5	7	7	7	7	6	7	7	7	7	6	5	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	122	43	124	47	29	66	104	113	50	107	71	55	56	57	58	59	-	59	60	61
$t(i)$	6	4	7	7	7	6	5	7	5	6	4	7	7	6	5	4	2	0	4	5	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	65	66	11	66	115	68	52	89	73	74	121	122	58	59	77	78	98	26	113	114
$t(i)$	7	7	6	3	7	6	7	7	6	7	6	4	7	7	3	5	7	7	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	29	86	104	105	89	107	121	122	74	94	95	77	95	4	43	98	99	8	103	48	11
$t(i)$	7	6	5	7	7	5	7	5	7	7	5	4	7	6	5	6	7	7	7	6	4

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	121	122	107	91	125	48	97	66	19	52	85	86	39	40	57	58	59	60	77	78	95
$t(i)$	6	6	3	6	6	7	7	7	4	6	5	7	7	7	7	6	3	1	7	6	6	6

Broadcast protocol of node 60.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	2	95	58	59	60	5	62	26	27	121	12	123	12	107	108	15	112	19	114	75
$t(i)$	7	7	6	7	6	5	7	7	7	6	7	7	2	6	7	6	7	7	7	6	5

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	4	78	42	43	44	122	123	30	12	13	50	51	35	90	37	92	20	57	41	59
$t(i)$	7	7	6	7	7	6	5	6	7	5	7	7	7	7	6	7	6	7	7	6	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	61	123	44	28	126	30	67	105	114	51	108	53	56	57	58	59	60	-	60	61
$t(i)$	6	6	4	7	7	7	6	5	6	5	6	4	6	7	6	5	4	2	0	4	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	63	66	67	12	69	116	52	53	90	74	75	122	123	59	60	78	79	99	27	114
$t(i)$	6	7	7	6	3	7	6	7	7	7	7	6	4	7	7	3	5	7	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	67	87	105	87	88	108	122	123	75	95	96	78	96	5	44	99	100	9	48	49
$t(i)$	7	7	7	5	6	7	5	7	5	7	7	5	4	7	6	5	6	7	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	105	122	123	108	92	96	49	98	67	20	53	54	23	40	41	58	59	60	61	78	79
$t(i)$	4	7	6	3	7	7	6	6	7	4	6	5	7	7	7	7	6	3	1	7	7	6

Broadcast protocol of node 61.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	93	112	3	96	59	60	61	6	63	27	28	122	13	124	13	14	109	16	73	20	115
$t(i)$	7	7	7	6	7	6	5	7	7	7	6	7	7	2	6	7	6	7	7	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	117	5	79	43	81	45	123	124	125	13	31	51	52	34	91	38	93	21	58	42
$t(i)$	5	7	7	6	7	7	6	5	6	7	5	7	7	6	7	7	7	6	7	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	61	62	124	45	29	49	31	68	106	115	52	109	54	57	58	59	60	61	-	61
$t(i)$	5	6	7	4	7	7	7	6	5	6	5	7	4	7	7	6	5	4	2	0	4

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	63	64	67	68	13	70	117	72	54	91	75	76	123	124	60	61	79	80	100	28
$t(i)$	5	6	7	7	6	3	7	6	7	6	6	7	6	4	7	7	3	5	6	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	116	68	88	106	88	108	109	123	124	76	96	97	79	97	6	45	100	101	10	105
$t(i)$	7	7	7	6	5	7	7	5	7	5	7	7	5	4	7	6	5	6	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	13	106	123	124	109	80	97	50	99	68	21	54	87	24	41	42	59	60	61	62	79
$t(i)$	6	4	7	6	3	7	7	6	7	7	4	6	5	7	7	7	7	6	3	1	6	7

Broadcast protocol of node 62.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	94	95	4	59	60	61	62	63	8	9	29	123	14	125	14	109	110	17	37	19
$t(i)$	7	6	7	7	6	7	5	4	4	6	7	7	6	7	2	6	7	5	7	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	21	78	6	7	44	26	46	124	125	126	14	15	35	17	37	116	93	94	95	40
$t(i)$	6	7	7	7	7	6	7	7	6	7	7	4	7	7	6	7	5	7	7	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	61	62	63	125	46	111	50	32	69	51	116	109	54	119	56	76	60	61	62	-
$t(i)$	6	7	5	7	5	6	6	7	6	5	7	7	6	7	6	7	7	5	4	2	0

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	63	64	48	68	69	14	69	118	73	91	75	93	94	124	125	61	62	63	81	114
$t(i)$	3	6	7	7	7	6	3	7	7	7	6	7	6	4	7	6	6	6	5	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	116	117	32	119	107	91	109	110	124	125	94	111	79	80	44	7	8	47	118	103
$t(i)$	7	6	7	7	7	6	7	5	7	5	3	5	7	7	7	7	6	7	7	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	107	14	123	124	125	32	81	82	51	100	69	6	7	8	89	42	59	76	61	62	110
$t(i)$	7	7	5	7	4	4	5	7	7	6	7	4	6	5	5	7	7	7	5	3	1	6

Broadcast protocol of node 63.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	110	2	95	4	5	60	61	62	63	64	9	10	13	124	15	126	15	112	113	20	2
$t(i)$	7	7	4	7	6	5	7	5	4	4	6	7	7	6	7	2	6	6	6	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	117	5	25	7	8	9	46	124	125	126	33	15	16	17	18	38	117	94	95	40
$t(i)$	7	6	7	7	6	7	7	7	7	6	7	7	4	7	7	7	7	5	7	5	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	61	62	63	64	126	47	112	113	52	70	108	109	56	38	58	40	60	61	62	63
$t(i)$	6	6	7	6	6	5	7	7	7	7	5	7	7	7	6	7	6	7	4	3	2

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	-	63	64	65	66	69	70	15	70	119	120	73	93	77	95	125	126	62	63	81	65
$t(i)$	0	3	5	6	7	7	6	3	7	7	6	7	7	7	6	7	6	6	5	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	30	117	88	33	120	91	92	110	94	125	126	95	79	80	81	45	8	47	102	119
$t(i)$	7	7	7	7	6	7	7	6	5	6	5	3	7	7	7	6	7	6	6	7	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	107	108	15	110	126	64	33	2	99	52	101	70	7	8	9	42	43	92	61	62	63
$t(i)$	7	7	6	5	6	4	7	5	5	7	6	7	4	7	5	5	7	7	7	5	4	1

Broadcast protocol of node 64.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	2	113	2	115	98	99	100	9	64	65	66	30	31	32	16	111	16	113	18	115
$t(i)$	6	7	4	6	6	7	7	7	5	4	7	7	7	7	6	7	2	5	6	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	23	118	23	120	8	82	46	28	31	32	111	32	16	17	35	92	39	118	41	96
$t(i)$	7	6	5	7	7	6	6	5	7	6	5	3	7	6	6	7	7	7	6	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	98	45	46	64	46	111	48	113	69	34	71	109	118	57	2	3	4	123	124	63
$t(i)$	7	6	7	6	3	7	4	7	7	6	7	5	7	7	6	5	7	7	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	-	64	48	114	69	87	71	16	17	91	56	57	77	124	125	78	111	82	64	82
$t(i)$	6	0	5	6	7	7	5	6	3	7	7	7	7	7	6	6	7	7	7	2	5

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	103	87	32	87	71	108	109	110	0	125	96	111	112	113	100	82	8	9	48	103
$t(i)$	7	7	7	4	6	7	7	6	6	7	7	7	5	7	5	6	4	7	7	5	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	51	14	53	16	125	64	65	82	83	100	53	70	71	88	9	26	27	28	109	46	110
$t(i)$	7	7	7	6	4	5	1	6	3	6	5	7	7	4	7	6	7	7	6	5	4	7

Broadcast protocol of node 65.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	112	3	114	97	98	99	100	119	64	65	10	11	124	32	33	17	112	17	114	19
$t(i)$	7	6	6	5	7	7	7	7	7	6	4	5	7	7	7	6	5	2	7	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	77	24	119	26	81	9	83	47	29	126	33	112	35	17	35	36	56	40	95	42
$t(i)$	7	7	7	5	6	5	7	6	4	6	7	4	3	7	4	6	7	7	7	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	24	25	26	46	47	65	47	112	32	33	53	35	72	54	119	2	76	122	78	79	63
$t(i)$	6	7	7	7	5	2	7	7	6	5	6	5	6	7	6	7	7	7	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	65	-	65	114	50	51	15	16	17	72	121	93	77	95	79	126	81	112	83	65
$t(i)$	6	5	0	6	7	7	7	7	6	3	7	7	7	6	5	6	5	7	4	7	3

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	29	30	87	32	33	90	72	90	110	124	125	126	95	112	97	81	101	83	47	10	105
$t(i)$	7	7	7	5	7	6	5	7	7	6	7	4	7	5	6	6	6	5	6	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	51	106	53	16	17	64	65	66	83	52	101	102	71	72	89	10	11	28	29	46	47
$t(i)$	6	6	7	7	7	6	7	1	7	4	7	7	7	7	4	7	6	6	7	5	6	3

Broadcast protocol of node 66.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	2	113	2	3	98	5	62	63	64	65	66	11	12	13	33	111	112	113	114	2
$t(i)$	7	7	2	6	7	5	7	7	5	7	7	3	4	6	7	6	7	6	5	7	5

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	23	5	25	43	8	28	46	11	12	32	50	112	113	114	18	92	20	57	95	120
$t(i)$	7	7	6	7	6	7	7	6	7	7	7	5	5	6	6	6	7	7	5	7	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	98	43	63	64	65	66	67	113	50	34	35	36	56	57	2	57	41	61	43	63
$t(i)$	6	4	7	7	5	5	6	7	4	7	7	7	7	7	6	3	7	7	7	5	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	65	66	-	66	67	68	15	89	119	120	75	20	77	95	96	78	98	112	113	65
$t(i)$	4	3	2	0	4	6	7	7	7	7	7	7	6	7	6	6	7	7	7	7	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	84	104	32	33	120	91	122	123	94	39	2	95	96	113	98	99	83	47	48	11
$t(i)$	5	6	7	6	7	6	7	6	6	7	6	4	5	7	3	6	7	7	6	7	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	105	122	123	124	17	64	65	66	67	84	85	102	87	8	57	42	11	12	61	46	47
$t(i)$	6	7	7	7	7	7	6	4	1	5	7	7	7	7	6	4	7	5	5	6	7	7

Broadcast protocol of node 67.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	19	3	114	3	4	99	6	63	64	65	66	67	12	13	14	34	112	113	114	115
$t(i)$	7	7	7	2	6	7	5	7	7	5	7	7	3	4	6	7	6	7	6	5	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	40	24	6	26	44	9	29	47	12	13	33	51	113	114	115	19	93	21	58	96
$t(i)$	5	7	7	6	7	6	7	7	6	7	7	7	5	5	6	6	6	7	7	5	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	42	99	44	64	65	66	67	68	114	51	35	36	37	57	58	3	58	42	62	44
$t(i)$	5	6	4	7	7	5	5	6	7	4	7	7	7	7	7	6	3	7	7	7	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	65	66	67	-	67	68	69	16	90	120	121	76	21	78	96	97	79	99	113	114
$t(i)$	6	4	3	2	0	4	6	7	7	7	7	7	7	6	7	6	6	7	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	67	85	105	33	34	121	92	123	124	95	40	3	96	97	114	99	100	84	48	49
$t(i)$	6	5	6	7	6	7	6	7	6	6	7	6	4	5	7	3	6	7	7	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	51	106	123	124	125	48	65	66	67	68	85	86	103	88	9	58	43	12	13	62	47
$t(i)$	6	6	7	7	7	7	7	6	4	1	5	7	7	7	7	6	4	7	5	5	6	7

Broadcast protocol of node 68.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	112	113	4	115	4	5	100	7	64	65	66	67	68	13	14	34	35	36	114	115
$t(i)$	7	7	7	7	2	6	7	5	7	7	5	7	6	3	4	7	7	7	7	6	5

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	20	4	41	25	43	27	45	10	28	48	13	14	32	52	114	115	116	20	94	22	59
$t(i)$	7	5	7	7	6	7	6	6	7	7	7	6	7	5	5	6	7	6	7	7	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	97	122	43	100	45	65	66	67	68	69	115	52	117	118	38	58	59	4	59	62	63
$t(i)$	7	5	7	4	7	7	5	5	6	7	4	7	7	7	7	7	6	3	7	7	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	65	66	67	68	-	68	69	70	90	91	19	122	77	22	79	97	98	80	100	114
$t(i)$	5	6	4	3	2	0	4	5	7	7	7	7	7	7	6	7	6	6	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	67	68	86	70	34	35	122	93	124	125	96	41	4	97	98	115	100	101	10	49
$t(i)$	7	7	5	7	6	6	6	6	7	6	6	7	6	4	5	7	3	6	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	13	52	107	124	125	48	49	66	67	68	69	86	7	88	89	106	59	12	13	14	63
$t(i)$	7	6	6	7	7	7	6	6	6	4	1	6	6	6	7	7	7	4	7	5	5	7

Broadcast protocol of node 69.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	94	20	114	5	116	5	6	101	10	11	66	67	68	69	14	15	35	36	37	115
$t(i)$	7	7	7	7	7	2	6	7	5	7	6	5	7	6	3	4	7	7	7	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	21	5	42	24	8	28	46	11	31	49	14	15	33	53	115	116	117	21	41	23
$t(i)$	5	7	5	6	7	7	7	6	7	7	6	7	6	7	5	5	6	7	6	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	98	123	100	101	46	66	67	68	69	70	116	53	118	119	39	59	60	5	60	80
$t(i)$	5	7	7	7	4	7	7	5	5	6	7	4	7	7	7	7	7	6	3	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	46	66	67	68	69	-	69	70	71	91	92	74	123	76	23	126	98	99	113	101
$t(i)$	7	5	6	4	3	2	0	4	5	7	7	6	7	6	7	7	7	6	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	116	68	69	87	71	35	36	123	92	125	126	95	42	5	98	99	116	101	102	49
$t(i)$	7	7	7	5	7	6	6	6	5	7	6	6	7	7	4	5	6	3	6	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	51	14	53	108	125	64	65	50	67	68	69	70	87	8	89	90	107	60	13	14	15
$t(i)$	7	7	6	6	7	7	6	7	6	6	4	1	6	6	6	7	7	7	4	7	5	5

Broadcast protocol of node 70.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	55	0	95	96	22	6	117	6	7	102	11	12	67	68	69	70	15	16	36	37	115
$t(i)$	6	7	7	7	7	7	2	6	7	5	7	6	5	7	6	3	4	7	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	117	24	6	43	44	9	29	47	12	32	50	15	16	34	54	116	117	38	22	42
$t(i)$	6	5	7	5	7	7	7	7	6	7	7	6	7	6	7	6	5	6	7	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	61	99	124	45	102	47	67	68	69	70	52	117	54	55	75	40	60	61	6	61
$t(i)$	6	5	6	6	7	4	7	7	5	5	5	7	4	5	7	7	7	7	6	3	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	9	47	67	68	69	70	-	70	71	72	92	93	21	124	79	24	111	82	100	65
$t(i)$	7	6	5	6	4	3	2	0	4	6	7	7	6	7	7	7	6	7	7	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	102	116	117	69	70	71	89	90	37	124	93	126	111	112	99	6	99	100	117	102	103
$t(i)$	7	7	7	7	6	5	6	7	6	5	7	6	6	7	7	4	5	7	3	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	51	52	15	54	126	16	65	66	51	68	69	70	71	88	89	106	107	108	61	14	15
$t(i)$	7	6	6	6	7	7	5	6	7	7	6	4	1	7	7	7	7	7	7	4	7	5

Broadcast protocol of node 71.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	55	56	95	96	22	23	7	118	7	8	103	66	13	68	69	70	71	16	73	37	38
$t(i)$	7	7	7	7	7	7	7	2	6	7	5	7	6	5	7	6	3	4	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	117	118	25	7	44	45	10	30	48	13	50	15	16	17	115	55	117	118	39	23
$t(i)$	7	6	5	7	5	7	7	7	7	6	7	7	7	7	7	7	6	5	6	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	97	44	62	100	125	65	103	48	68	69	70	71	53	118	55	56	57	41	61	62	7
$t(i)$	7	6	5	6	7	7	4	7	6	5	5	5	7	4	5	6	7	7	7	6	3

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	111	10	48	68	69	70	71	-	71	72	73	74	94	78	125	80	25	112	83	101
$t(i)$	7	7	6	5	7	4	3	2	0	4	5	6	7	7	7	6	7	6	7	7	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	103	117	118	70	71	72	90	93	38	125	94	111	112	113	100	7	100	101	118	103
$t(i)$	7	6	7	7	7	6	6	7	7	6	5	6	6	6	7	7	4	5	7	3	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	51	52	53	16	17	16	17	66	51	52	69	70	71	72	89	106	43	108	109	62	110
$t(i)$	7	6	7	6	6	6	5	5	6	7	6	6	4	1	7	7	7	7	7	7	4	7

Broadcast protocol of node 72.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	56	57	96	97	23	24	8	119	8	9	104	67	14	69	70	71	72	17	18	38
$t(i)$	6	7	7	7	7	7	7	7	2	6	7	5	7	6	5	7	6	3	4	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	117	118	119	26	8	45	46	11	31	49	14	51	16	17	54	55	56	118	119	40
$t(i)$	7	7	6	5	7	5	7	7	7	7	6	7	7	7	7	7	7	6	5	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	24	44	45	63	101	126	66	104	49	69	70	71	72	73	119	56	57	58	42	62	63
$t(i)$	6	7	6	5	6	7	7	4	7	6	5	5	5	6	4	5	6	7	7	7	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	8	63	112	11	49	69	70	71	72	-	72	73	74	75	95	79	126	81	26	113	82
$t(i)$	3	7	7	6	5	7	4	3	2	0	4	5	6	7	7	7	6	7	6	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	102	84	104	118	119	71	72	73	74	94	39	126	95	112	113	114	101	8	101	102	119
$t(i)$	6	7	7	7	7	7	6	7	7	7	6	5	6	6	7	7	7	4	5	7	3

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	13	52	53	54	17	0	17	18	67	52	53	70	71	72	105	90	107	108	109	110	63
$t(i)$	6	7	6	6	6	6	7	5	5	6	7	7	6	4	1	7	7	7	7	7	7	4

Broadcast protocol of node 73.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	56	57	58	115	6	24	8	119	120	9	66	105	12	107	14	109	72	73	74	38
$t(i)$	7	7	7	7	7	7	6	7	4	3	6	6	4	7	6	7	7	4	6	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	21	41	119	120	25	9	10	11	12	30	50	112	113	17	91	55	56	57	119	120
$t(i)$	6	7	6	5	6	7	7	7	7	6	7	7	7	7	7	7	6	6	5	6	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	122	123	44	64	102	111	104	105	50	53	71	72	73	55	120	57	122	123	43	63
$t(i)$	7	6	6	7	6	7	7	7	3	6	7	6	7	4	5	4	6	7	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	8	9	64	113	68	50	87	71	72	73	-	73	74	75	124	23	24	111	80	100	101
$t(i)$	6	4	7	5	7	5	7	7	5	2	0	5	6	7	7	7	7	6	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	103	87	105	119	120	72	73	91	92	39	40	97	112	113	98	101	8	9	102	105
$t(i)$	7	7	6	5	7	7	6	3	6	7	7	7	7	6	6	7	6	5	5	6	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	105	122	107	91	17	64	17	50	51	68	37	86	55	72	73	90	91	12	109	46	110
$t(i)$	2	7	5	7	5	6	5	5	4	7	6	7	7	7	3	1	7	4	5	6	7	7

Broadcast protocol of node 74.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	19	20	58	3	116	5	25	9	120	121	10	13	106	69	108	109	18	73	74	19
$t(i)$	6	7	6	6	7	6	7	7	7	4	3	7	7	4	7	7	7	7	4	4	5

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	20	40	22	42	120	121	26	10	28	31	13	33	51	33	34	54	92	56	40	58	120
$t(i)$	7	6	7	7	5	6	7	6	7	7	6	7	5	6	7	7	7	6	7	5	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	42	123	124	47	65	103	48	51	106	51	52	72	73	74	56	121	58	123	43	44
$t(i)$	5	6	6	6	7	6	6	7	7	3	6	7	6	6	5	7	4	7	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	9	10	113	114	69	51	88	70	73	74	-	74	75	124	125	80	25	112	81	65
$t(i)$	7	6	4	7	7	6	4	6	7	5	2	0	6	7	7	7	7	6	6	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	102	116	68	88	106	120	121	73	74	92	93	2	41	112	113	98	45	102	9	10	103
$t(i)$	6	7	7	7	5	7	7	7	3	6	7	7	7	7	6	7	7	7	5	5	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	121	106	123	108	92	0	65	18	19	84	69	38	55	72	73	74	107	92	13	110	110
$t(i)$	7	2	6	5	6	5	7	5	5	6	7	5	7	7	7	3	1	7	4	5	6	7

Broadcast protocol of node 75.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	93	19	20	2	59	4	117	6	9	10	121	122	11	14	107	70	109	16	0	74	75
$t(i)$	5	6	6	7	6	7	6	7	7	6	4	3	7	6	4	6	6	7	7	4	4

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	20	21	41	23	26	121	122	27	11	29	49	14	34	52	34	35	19	93	57	39	59
$t(i)$	5	7	6	7	7	5	6	7	6	7	7	7	7	5	6	7	7	7	6	7	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	122	43	124	125	48	66	104	113	52	107	52	55	73	74	75	57	122	59	124	44
$t(i)$	6	5	6	7	6	7	6	6	7	6	3	7	7	6	6	5	7	4	7	6	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	81	46	10	11	114	13	51	52	70	73	74	75	-	75	76	125	61	111	26	113	82
$t(i)$	7	7	7	4	7	7	7	4	7	7	5	2	0	6	7	7	7	7	6	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	116	117	88	89	107	121	122	74	75	93	94	41	42	43	114	99	102	103	10	11
$t(i)$	7	7	7	7	6	5	7	7	7	3	6	7	7	7	7	6	7	7	6	5	5

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	107	122	107	124	109	0	1	66	19	20	21	70	103	56	89	74	75	108	93	14	15
$t(i)$	7	7	2	6	5	7	6	7	5	5	7	6	5	7	7	7	3	1	7	4	5	7

Broadcast protocol of node 76.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	110	94	20	21	3	60	5	118	7	10	11	122	123	12	15	108	71	110	17	1	75
$t(i)$	7	5	6	6	7	6	7	6	7	7	6	4	3	7	6	4	6	6	7	7	4

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	21	22	42	24	27	122	123	28	12	30	50	15	35	53	35	36	20	94	58	40
$t(i)$	4	5	7	6	7	7	5	6	7	6	7	7	7	7	5	6	7	7	7	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	122	123	44	125	126	49	67	105	114	53	108	53	56	74	75	76	58	123	60	125
$t(i)$	5	6	5	6	7	6	7	6	6	7	6	3	7	7	6	6	5	7	4	7	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	82	47	11	12	115	14	52	53	71	74	75	76	-	76	77	126	62	112	27	114
$t(i)$	7	7	7	7	4	7	7	7	4	7	7	5	2	0	6	7	7	7	7	6	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	67	117	118	89	90	108	122	123	75	76	94	95	42	43	44	115	100	103	104	11
$t(i)$	7	7	7	7	7	6	5	7	7	7	3	6	7	7	7	7	6	7	7	6	5

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	105	108	123	108	125	16	1	2	67	20	21	22	71	104	57	90	75	76	109	94	15
$t(i)$	5	7	7	2	6	5	7	6	7	5	5	7	6	5	7	7	7	3	1	7	4	5

Broadcast protocol of node 77.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	93	94	95	96	22	4	61	25	26	10	28	12	13	124	13	126	109	16	73	20	21
$t(i)$	7	7	7	7	6	7	6	7	7	7	6	7	6	2	7	7	5	6	7	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	77	78	79	43	44	28	123	124	125	13	31	51	16	114	54	116	117	21	22	59
$t(i)$	4	4	7	6	6	6	7	4	7	7	4	7	7	7	7	7	7	7	7	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	61	123	124	45	126	111	31	68	50	115	52	109	54	57	58	76	77	61	124	44
$t(i)$	7	5	5	5	7	6	7	6	5	6	5	7	4	6	7	6	5	5	7	4	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	111	47	67	68	13	70	117	72	54	72	92	76	77	-	77	78	79	63	64	28
$t(i)$	6	6	7	7	6	3	7	6	7	5	6	7	7	2	0	3	5	7	7	7	5

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	116	68	88	106	107	91	109	123	124	76	77	78	96	97	6	115	83	84	85	49
$t(i)$	6	6	7	7	6	7	7	6	6	6	6	6	4	6	7	7	7	7	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	13	52	123	124	109	96	17	50	83	68	21	22	55	24	41	58	59	76	77	78	31
$t(i)$	7	5	6	7	3	7	5	7	7	6	4	5	5	7	7	7	7	7	3	1	6	5

Broadcast protocol of node 78.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	94	3	96	5	23	5	8	101	64	9	29	30	31	125	14	111	72	17	1	2
$t(i)$	7	6	6	5	6	4	7	7	5	6	7	7	7	7	4	6	6	6	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	23	78	23	26	44	28	46	30	125	30	14	15	113	114	37	116	37	118	22	23
$t(i)$	7	5	2	7	7	6	7	6	6	2	5	7	7	7	7	6	5	7	6	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	42	123	44	125	46	30	31	49	69	70	71	117	118	119	39	3	60	78	60	125
$t(i)$	5	7	5	7	3	7	4	6	7	7	7	7	7	7	7	7	7	6	3	7	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	46	64	48	85	67	116	71	118	71	72	121	76	123	78	-	78	79	80	83	101
$t(i)$	7	5	7	7	5	7	6	6	4	5	7	7	7	6	6	0	5	6	7	7	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	30	85	118	87	88	108	36	123	94	125	96	78	96	5	98	101	46	84	48	103
$t(i)$	6	3	7	5	6	7	7	7	7	7	5	7	4	6	5	7	7	4	7	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	107	14	107	16	125	48	97	98	67	4	85	22	23	8	41	42	59	60	77	78	79
$t(i)$	7	7	5	6	7	7	5	7	6	6	7	4	6	3	6	7	6	7	4	7	1	7

Broadcast protocol of node 79.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	112	20	96	97	23	24	8	63	27	65	66	11	124	15	126	15	112	113	18	38
$t(i)$	7	7	7	7	7	6	7	7	6	7	7	6	7	7	7	2	6	6	6	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	23	78	79	80	81	45	46	47	125	126	31	15	16	17	54	38	117	118	41	23
$t(i)$	7	7	3	4	7	7	6	7	7	7	6	7	4	7	7	7	7	5	5	7	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	24	98	45	63	125	126	47	48	113	33	70	52	117	118	119	39	57	60	78	79	61
$t(i)$	6	7	7	5	6	3	6	7	7	7	5	7	6	7	6	6	7	6	5	5	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	63	47	65	66	115	70	15	70	71	120	56	76	94	78	79	-	79	80	81	65
$t(i)$	4	7	4	5	7	7	7	3	6	7	7	7	7	6	7	2	0	3	5	6	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	103	117	118	33	88	108	92	110	94	125	126	78	79	80	98	82	102	47	102	119
$t(i)$	7	7	7	6	6	7	7	7	6	7	5	7	6	6	4	6	7	7	5	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	107	108	15	110	126	80	33	98	99	52	5	70	23	24	41	42	59	60	61	78	79
$t(i)$	7	7	6	5	7	5	6	5	5	7	6	7	4	4	5	6	7	7	7	6	4	1

Broadcast protocol of node 80.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	112	113	96	97	98	7	25	7	8	103	66	123	31	15	16	111	16	0	18	75
$t(i)$	5	7	7	7	6	7	7	4	6	7	7	7	7	7	7	3	2	4	6	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	117	24	25	80	25	26	46	30	31	32	111	32	16	17	35	55	117	94	41	120
$t(i)$	7	6	7	5	2	6	7	7	7	6	5	3	7	5	6	7	6	7	7	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	97	25	62	44	125	48	111	50	32	50	34	108	55	73	119	120	57	4	61	62	80
$t(i)$	7	7	5	7	6	7	4	6	4	7	7	7	7	5	7	5	7	7	7	6	3

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	111	112	48	68	50	70	15	16	17	120	73	57	94	76	79	80	-	80	81	65
$t(i)$	7	7	6	6	7	5	7	4	7	7	4	6	6	6	7	7	6	0	5	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	102	86	68	32	70	34	89	73	37	0	125	126	111	98	80	81	7	100	103	48	49
$t(i)$	7	7	6	6	6	6	7	7	7	7	5	7	6	5	4	6	5	6	6	5	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	88	108	15	16	125	80	17	98	99	100	101	70	87	24	25	74	107	44	109	62	15
$t(i)$	7	7	6	5	6	7	1	5	6	7	7	7	5	7	6	3	7	7	6	7	4	6

Broadcast protocol of node 81.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	112	1	114	115	98	99	6	63	8	65	104	30	12	15	126	34	112	17	1	2
$t(i)$	7	2	4	4	7	7	4	7	5	6	7	5	6	7	6	5	7	6	7	6	5

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	117	24	6	26	81	26	27	11	125	30	33	112	33	114	35	36	39	94	58	59
$t(i)$	6	7	7	6	7	4	6	7	7	5	7	7	4	6	5	6	7	7	5	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	44	99	63	125	46	49	112	49	114	51	35	117	56	1	2	3	58	123	62	80
$t(i)$	7	7	5	6	6	7	7	3	5	6	7	7	6	6	5	7	5	6	7	7	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	81	63	112	65	49	50	68	15	118	54	55	19	20	94	95	125	126	81	-	81	114
$t(i)$	3	7	5	6	6	6	7	7	7	7	7	7	7	7	7	7	7	5	0	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	67	104	86	33	88	121	122	93	94	1	2	3	112	99	81	99	8	9	104	49
$t(i)$	7	7	6	7	5	6	6	7	7	6	3	6	7	7	6	2	7	7	7	7	4

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	88	14	90	110	126	80	81	82	99	20	21	6	39	56	89	26	11	44	45	94	63
$t(i)$	7	7	7	7	7	6	7	1	7	3	6	7	5	6	7	7	5	6	6	7	4	4

Broadcast protocol of node 82.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	2	113	2	115	4	7	100	9	64	9	66	105	31	13	126	34	112	113	20	2
$t(i)$	5	7	2	4	4	7	6	4	7	5	6	6	5	6	7	7	6	7	7	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	4	22	79	7	27	82	27	11	12	126	111	32	113	34	115	36	37	40	95	59
$t(i)$	5	6	7	7	7	5	4	7	7	6	5	6	7	4	7	5	6	7	7	5	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	98	26	100	64	46	111	50	113	50	115	116	36	118	57	2	3	4	59	124	44
$t(i)$	7	7	6	5	6	7	7	6	3	5	7	7	7	6	6	5	7	5	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	82	64	113	66	50	51	69	118	119	55	56	57	21	95	77	126	81	82	-	82
$t(i)$	7	3	7	5	7	7	6	7	7	7	7	7	7	7	6	7	6	7	5	0	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	84	31	105	87	34	89	122	93	0	95	2	3	96	113	100	82	100	101	10	49
$t(i)$	6	7	7	6	7	5	6	7	7	6	7	3	6	7	6	7	2	6	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	51	89	90	16	0	64	81	82	83	100	21	6	7	40	105	26	27	12	45	30	95
$t(i)$	4	7	7	7	7	7	4	6	1	7	3	6	7	5	6	7	7	6	7	6	7	4

Broadcast protocol of node 83.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	112	3	114	3	116	5	100	101	64	121	29	67	106	13	33	15	35	113	114	19
$t(i)$	6	7	7	2	6	6	7	7	7	7	7	6	7	5	7	6	7	7	4	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	21	78	42	24	27	82	83	84	29	13	50	51	113	114	18	116	39	21	58	96
$t(i)$	5	7	7	6	7	7	4	6	4	7	6	6	5	7	4	7	7	7	6	5	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	98	45	27	101	65	111	50	113	114	51	35	53	73	55	75	3	58	42	124	63
$t(i)$	5	7	7	6	6	7	7	7	5	3	6	5	7	6	7	7	3	7	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	82	83	84	114	67	51	52	53	71	18	121	122	58	76	96	80	111	82	83	-
$t(i)$	6	5	5	7	5	6	7	7	6	7	5	6	6	6	7	6	7	6	7	2	0

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	84	85	32	33	90	35	122	74	0	95	40	3	4	113	114	82	83	84	102	11
$t(i)$	3	6	7	7	7	7	6	7	7	7	7	6	4	7	6	7	6	4	5	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	51	106	107	124	109	96	65	82	83	68	101	102	103	40	73	58	27	28	29	46	31
$t(i)$	7	4	6	7	6	7	5	6	3	1	7	5	7	7	7	7	4	5	7	5	7	7

Broadcast protocol of node 84.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	110	19	113	4	115	4	117	6	101	102	65	122	30	68	107	14	34	16	36	114	115
$t(i)$	7	6	7	7	2	6	6	7	7	7	7	7	6	7	5	7	6	7	7	4	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	20	4	22	79	43	25	28	83	84	85	30	14	51	52	114	115	19	117	40	22	59
$t(i)$	7	5	7	7	6	7	7	4	6	4	7	6	6	5	7	4	7	7	7	6	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	97	122	99	46	28	102	66	112	51	114	115	52	36	54	74	56	76	4	59	43	125
$t(i)$	7	5	7	7	6	6	7	7	7	5	3	6	5	7	6	7	7	3	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	65	83	84	85	115	68	52	53	54	72	19	122	123	59	77	97	81	112	83	84
$t(i)$	7	6	5	5	7	5	6	7	7	6	7	5	6	6	6	7	6	7	6	7	2

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	-	84	85	86	33	34	91	36	123	75	1	96	41	4	5	114	115	83	84	85	103
$t(i)$	0	3	6	7	7	7	7	6	7	7	7	7	6	4	7	6	7	6	4	5	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	107	52	107	108	125	32	97	66	83	84	69	102	103	104	41	74	59	28	29	30	47
$t(i)$	7	7	4	6	7	6	7	5	6	3	1	7	5	7	7	7	7	4	5	7	5	7

Broadcast protocol of node 85.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	2	20	4	5	116	5	118	7	10	103	66	123	31	69	108	15	35	113	37	115
$t(i)$	7	7	6	7	6	2	7	6	7	7	6	7	7	6	7	5	6	7	6	7	4

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	21	5	23	24	44	26	29	84	85	86	31	15	52	53	115	116	20	118	119	59
$t(i)$	6	7	5	6	7	6	7	7	4	6	4	7	7	6	5	7	4	7	7	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	42	123	100	47	29	103	67	113	52	115	116	53	37	55	75	76	60	5	60	44
$t(i)$	5	7	5	7	7	6	7	6	7	7	5	3	6	5	7	6	7	6	3	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	65	66	84	85	86	116	69	53	54	55	73	20	123	124	23	97	98	99	83	84
$t(i)$	7	7	6	5	5	7	5	6	7	7	6	7	5	6	7	7	7	7	7	7	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	-	85	86	87	34	35	92	37	124	93	126	95	42	5	98	115	116	84	85	86
$t(i)$	2	0	3	6	7	7	6	7	6	6	7	6	7	6	4	6	6	7	7	4	5

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	13	108	53	108	109	16	49	98	67	84	85	70	103	104	57	90	75	60	29	30	31
$t(i)$	7	7	7	4	6	7	7	7	5	7	3	1	7	5	6	7	7	7	4	5	7	5

Broadcast protocol of node 86.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	55	19	3	21	5	6	117	6	9	102	103	104	67	31	32	16	109	16	17	114	38
$t(i)$	7	7	7	6	7	6	2	7	7	5	7	7	7	7	6	7	5	6	7	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	117	118	6	24	27	45	29	30	85	86	87	32	35	53	54	116	117	21	119	42
$t(i)$	4	7	7	5	7	7	6	7	6	4	5	4	7	7	6	7	7	5	7	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	61	45	124	64	102	30	104	49	69	53	116	117	54	38	56	76	77	61	6	61
$t(i)$	6	5	7	5	7	7	7	5	6	7	7	5	3	5	6	7	6	7	7	3	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	9	66	67	85	86	116	117	70	54	55	73	76	21	124	79	24	111	99	81	114
$t(i)$	7	6	7	6	5	6	6	6	7	6	6	7	7	5	6	7	6	7	6	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	86	-	86	87	120	72	109	110	124	125	126	111	96	99	6	101	102	117	85	86
$t(i)$	7	2	0	3	7	7	7	7	7	7	7	7	6	7	7	4	7	6	4	6	4

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	105	14	109	54	125	32	49	50	99	68	85	86	87	104	105	58	43	108	61	30	31
$t(i)$	5	7	7	6	4	6	5	7	7	5	7	3	1	6	6	6	7	7	7	4	5	6

Broadcast protocol of node 87.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	2	57	96	5	23	24	118	7	64	9	104	105	68	32	14	111	110	73	18	21
$t(i)$	7	7	6	7	7	6	6	5	7	5	6	6	6	7	5	7	6	6	6	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	23	118	23	24	81	82	10	11	31	32	87	32	16	17	54	55	39	118	41	23
$t(i)$	6	7	2	5	7	7	7	7	7	7	4	2	7	7	7	7	7	7	3	7	4

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	61	62	100	125	126	49	31	32	69	70	52	55	118	57	39	59	41	78	79	125
$t(i)$	6	7	7	7	7	7	7	5	6	7	6	7	6	4	7	5	7	5	7	6	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	111	112	67	68	69	87	69	118	71	55	73	76	94	76	23	78	111	80	64	114
$t(i)$	7	4	7	7	5	4	3	5	6	7	5	7	7	5	6	3	5	5	6	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	86	87	-	87	88	89	122	93	94	39	94	78	79	80	6	7	116	9	118	105
$t(i)$	7	7	6	0	5	6	7	7	7	6	4	7	6	7	7	7	6	7	7	7	5

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	88	14	107	110	125	32	49	50	67	68	69	70	87	104	105	42	59	12	77	78	31
$t(i)$	4	7	6	7	7	5	3	6	7	6	6	6	7	1	7	7	7	6	7	7	4	6

Broadcast protocol of node 88.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	112	3	58	97	6	24	25	119	8	65	10	105	106	32	33	71	112	17	74	19
$t(i)$	7	7	7	6	7	7	6	7	5	7	5	6	7	5	7	7	7	6	7	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	40	24	119	24	25	26	10	11	31	32	33	88	33	34	54	38	56	40	119	42
$t(i)$	7	6	7	2	5	6	7	7	7	6	5	4	2	6	7	7	7	6	7	3	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	24	42	43	63	101	126	66	31	51	33	70	52	53	56	119	58	40	60	42	79	80
$t(i)$	4	6	7	7	7	7	7	7	7	5	4	5	6	7	4	7	5	6	5	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	65	112	65	68	13	70	88	70	119	72	56	74	77	95	77	24	79	112	81	114
$t(i)$	6	7	4	6	7	6	7	3	5	6	7	5	7	7	5	6	3	5	5	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	30	87	88	-	88	89	90	110	94	95	40	95	79	80	81	99	8	117	118	119
$t(i)$	7	7	7	6	0	5	6	7	7	7	6	4	7	6	6	6	7	6	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	88	52	109	110	126	32	33	98	51	52	53	70	71	88	89	106	59	60	13	78	79
$t(i)$	6	4	7	7	6	5	6	3	7	6	6	7	6	6	1	7	7	7	7	7	7	4

Broadcast protocol of node 89.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	2	57	96	3	116	7	25	26	120	121	122	105	106	107	16	71	18	0	20	2
$t(i)$	5	7	4	6	7	7	7	5	7	6	6	7	7	7	7	7	6	7	6	7	5

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	21	41	25	120	25	122	27	124	48	32	111	34	89	90	91	36	56	118	58	120
$t(i)$	6	7	7	7	2	6	6	7	7	7	7	6	7	5	6	6	7	7	5	7	4

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	25	43	44	47	48	103	50	105	52	53	71	53	118	57	120	57	41	61	43	61
$t(i)$	7	4	6	7	7	6	5	7	6	7	6	4	7	7	6	3	5	6	7	5	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	81	111	10	113	85	69	70	71	89	71	120	121	57	58	59	96	80	25	80	100	101
$t(i)$	7	7	7	7	7	7	6	5	2	7	7	7	7	6	7	7	7	3	6	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	103	87	118	89	-	89	90	91	0	39	2	41	98	80	98	7	116	9	118	103
$t(i)$	7	6	7	6	6	0	3	4	7	7	7	6	5	6	5	7	6	6	7	4	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	107	89	90	91	109	80	97	34	35	20	53	70	71	88	89	90	107	76	109	62	95
$t(i)$	5	6	4	7	5	7	4	7	6	7	6	5	7	3	7	1	5	5	7	6	7	7

Broadcast protocol of node 90.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	94	57	58	3	116	7	8	26	120	121	122	11	106	125	108	17	35	17	114	75
$t(i)$	6	7	7	6	7	7	7	6	5	7	4	5	6	7	7	7	7	4	5	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	21	22	119	26	121	122	10	11	12	49	31	34	35	90	35	92	93	21	58	40
$t(i)$	5	6	7	7	7	3	7	7	7	7	6	7	7	6	2	7	7	7	7	4	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	44	26	44	125	102	49	67	51	106	53	35	72	56	57	58	121	58	42	62	44
$t(i)$	6	6	4	7	6	7	7	5	7	6	7	5	6	7	6	5	2	7	7	6	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	46	10	65	114	67	68	88	72	90	91	121	122	58	76	77	61	81	26	83	114
$t(i)$	7	7	6	7	4	6	7	7	7	5	7	7	6	3	6	7	7	7	6	7	5

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	67	104	105	89	90	-	90	91	94	76	40	95	112	43	114	99	8	103	10	119
$t(i)$	6	7	7	7	6	4	0	3	5	6	4	6	7	7	7	6	7	7	6	5	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	121	89	90	91	92	0	17	18	35	84	53	54	103	40	89	90	91	76	109	94	110
$t(i)$	6	5	7	6	6	6	7	6	7	3	7	6	7	7	5	5	1	4	7	7	5	7

Broadcast protocol of node 91.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	0	113	2	115	98	61	6	9	27	28	122	105	68	13	108	109	18	36	18	2
$t(i)$	5	6	5	6	7	5	6	7	7	6	6	4	6	5	6	7	7	6	4	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	23	5	25	43	27	122	27	11	12	86	14	34	113	36	91	36	37	118	41	120
$t(i)$	7	7	6	7	6	7	2	5	7	7	7	7	7	6	5	2	6	7	7	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	122	45	27	64	46	66	67	113	114	115	35	36	73	55	120	59	122	123	43	63
$t(i)$	7	3	6	4	6	7	7	7	7	7	6	7	7	5	7	7	7	5	7	5	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	82	64	11	66	115	68	52	72	73	91	73	122	75	59	77	61	98	82	27	28
$t(i)$	5	5	7	5	6	4	7	7	7	6	3	7	6	7	6	7	7	7	7	3	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	84	68	105	89	90	91	-	91	92	1	126	97	98	43	44	82	100	84	10	11
$t(i)$	5	7	6	7	7	6	5	0	4	7	7	7	7	6	4	7	6	7	6	7	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	13	122	123	91	92	0	17	82	35	36	5	102	55	104	73	90	91	92	45	110	63
$t(i)$	5	7	7	6	6	6	7	7	4	6	3	7	7	6	7	4	7	1	5	7	7	6

Broadcast protocol of node 92.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	55	19	20	114	5	116	99	6	9	10	28	29	123	124	125	14	109	110	73	37	38
$t(i)$	6	7	7	6	7	6	5	7	7	5	4	7	7	7	6	7	7	7	7	6	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	21	24	6	43	44	28	123	28	125	30	31	112	52	114	37	92	37	38	41	59
$t(i)$	6	7	7	6	6	7	7	2	6	5	6	7	7	7	7	7	2	5	7	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	44	123	44	28	65	30	112	49	69	70	116	55	37	74	56	3	60	123	60	125
$t(i)$	7	5	3	6	5	7	7	6	7	6	6	7	7	4	6	7	7	5	4	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	46	83	65	85	69	116	69	118	73	74	92	74	123	76	60	126	25	82	83	28
$t(i)$	7	7	4	6	7	7	4	5	7	6	5	4	7	5	7	6	6	7	7	6	3

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	116	85	118	70	120	91	92	-	92	93	126	78	79	99	44	99	46	101	10	103
$t(i)$	7	5	6	6	7	7	7	6	0	5	7	7	7	7	7	4	6	6	7	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	51	108	123	110	92	0	65	66	83	100	37	86	55	72	9	10	59	92	93	110	110
$t(i)$	7	7	7	6	6	3	7	5	7	5	7	3	7	5	7	6	7	7	1	6	4	5

Broadcast protocol of node 93.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	93	56	20	21	115	6	117	100	7	10	11	29	11	124	125	70	71	110	0	74	38
$t(i)$	3	7	7	7	7	7	6	5	7	6	5	4	7	7	7	7	7	7	7	6	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	77	22	119	7	44	9	29	124	29	30	111	32	52	36	115	38	93	38	39	42
$t(i)$	6	6	7	7	6	6	7	7	2	6	7	6	7	7	7	6	7	2	5	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	44	45	124	45	29	66	48	113	50	70	54	55	0	38	56	57	77	61	124	61
$t(i)$	6	7	5	3	7	5	6	7	6	7	6	7	5	4	4	6	7	7	5	4	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	63	47	84	66	86	68	117	70	54	55	75	93	75	124	60	61	25	26	83	84
$t(i)$	6	7	6	4	7	6	7	4	5	6	6	5	4	6	5	7	6	7	7	7	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	29	84	117	86	119	71	72	92	93	-	93	94	111	79	113	100	45	100	117	10	11
$t(i)$	3	7	5	7	6	6	7	7	6	0	5	7	7	7	7	7	4	6	7	7	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	88	89	109	124	0	0	65	66	19	84	101	38	55	56	73	74	75	76	93	94	47
$t(i)$	7	7	7	7	6	6	5	7	5	7	5	7	3	7	5	7	7	7	7	1	6	7

Broadcast protocol of node 94.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	94	57	21	22	116	7	118	101	8	11	12	30	12	125	126	71	72	0	1	75
$t(i)$	6	3	7	7	7	7	7	6	5	7	6	5	4	7	7	7	7	7	7	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	40	78	23	120	8	45	10	30	125	30	31	112	33	53	37	116	39	94	39	40
$t(i)$	6	6	6	7	7	6	6	7	7	2	6	7	6	7	7	7	6	7	2	5	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	61	45	46	125	46	30	67	49	114	51	71	55	56	1	39	57	58	78	62	125
$t(i)$	7	6	7	5	3	7	5	6	7	6	7	6	7	5	4	4	6	7	7	5	4

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	46	64	48	85	67	87	69	118	71	55	56	76	94	76	125	61	62	26	27	84
$t(i)$	7	6	7	6	4	7	6	7	4	5	6	6	5	4	6	5	7	6	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	30	85	118	87	120	72	73	93	94	-	94	95	112	80	114	101	46	101	118	11
$t(i)$	6	3	7	5	7	6	6	7	7	6	0	5	7	7	7	7	7	4	6	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	105	89	90	110	125	48	1	66	67	20	85	102	39	56	57	74	75	76	77	94	95
$t(i)$	6	7	7	7	7	6	7	5	7	5	7	5	7	3	7	5	7	7	7	7	1	6

Broadcast protocol of node 95.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	2	95	58	59	4	24	8	119	102	9	12	13	31	13	126	15	72	73	20	2
$t(i)$	7	7	3	6	6	7	7	7	6	5	7	7	5	4	7	6	7	7	6	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	40	41	79	26	121	9	46	28	31	126	31	32	113	34	18	38	117	40	95	40
$t(i)$	7	6	7	6	7	6	6	6	7	7	2	6	7	6	7	7	7	6	7	2	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	42	62	27	47	126	47	31	68	52	115	71	117	56	57	2	40	77	59	62	63
$t(i)$	6	7	6	7	5	3	7	5	7	7	6	7	7	7	5	4	4	5	7	7	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	63	47	67	49	86	68	88	72	119	72	56	57	58	95	77	126	79	63	64	65
$t(i)$	4	6	6	7	6	4	6	7	6	4	5	6	6	7	4	7	5	7	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	86	31	86	119	88	121	73	74	94	95	-	95	96	113	44	115	102	47	102	119
$t(i)$	7	6	3	7	5	6	7	7	7	7	6	0	5	7	7	7	7	7	4	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	13	89	123	124	126	96	49	2	3	68	69	86	103	40	57	58	75	12	77	46	95
$t(i)$	7	6	7	7	7	7	6	7	5	7	5	7	5	7	3	7	5	7	6	6	7	1

Broadcast protocol of node 96.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	112	95	96	97	4	7	118	9	64	9	10	11	31	125	16	111	16	0	114	2
$t(i)$	6	6	6	6	5	7	7	5	6	4	5	6	7	6	7	7	2	6	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	77	78	42	7	25	82	10	47	48	32	111	32	16	17	115	55	93	94	41	96
$t(i)$	7	7	7	7	6	7	7	7	7	7	5	4	7	5	7	7	7	7	6	7	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	97	42	43	124	64	48	111	112	49	50	34	71	53	118	1	39	121	60	78	60	61
$t(i)$	4	6	7	7	6	6	5	4	6	7	7	5	6	6	7	7	7	7	5	6	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	111	112	65	49	13	70	71	16	71	120	92	122	94	95	96	97	111	112	64	65
$t(i)$	7	3	5	6	5	7	7	6	3	7	7	7	7	7	5	4	7	7	7	5	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	67	31	32	89	34	91	109	93	94	95	96	-	96	97	100	82	46	9	118	49
$t(i)$	7	7	7	6	7	6	7	5	6	5	4	3	0	2	6	7	6	7	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	87	121	106	109	16	109	96	97	98	67	4	53	54	71	8	41	42	91	108	77	78	95
$t(i)$	7	6	7	6	4	7	1	3	7	6	6	7	7	4	7	6	5	6	7	6	6	7

Broadcast protocol of node 97.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	110	112	113	96	97	98	5	8	119	10	65	10	11	12	32	126	17	112	17	1	115
$t(i)$	7	6	6	6	6	5	7	7	5	6	4	5	6	7	6	7	7	2	6	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	4	78	79	43	8	26	83	11	48	49	33	112	33	17	18	116	56	94	95	42
$t(i)$	7	7	7	7	7	6	7	7	7	7	7	5	4	7	5	7	7	7	7	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	97	98	43	44	125	65	49	112	113	50	51	35	72	54	119	2	40	122	61	79	61
$t(i)$	5	4	6	7	7	6	6	5	4	6	7	7	5	6	6	7	7	7	7	5	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	65	112	113	66	50	14	71	72	17	72	121	93	123	95	96	97	98	112	113	65
$t(i)$	7	7	3	5	6	5	7	7	6	3	7	7	7	7	7	5	4	7	7	7	5

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	67	68	32	33	90	35	92	110	94	95	96	97	-	97	98	101	83	47	10	119
$t(i)$	7	7	7	7	6	7	6	7	5	6	5	4	3	0	2	6	7	6	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	88	122	107	110	17	96	97	98	99	68	5	54	55	72	9	42	43	92	109	78	79
$t(i)$	7	7	6	7	6	4	7	1	3	7	6	6	7	7	4	7	6	5	6	7	6	6

Broadcast protocol of node 98.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	0	113	114	97	98	99	6	9	120	11	66	11	12	13	33	111	18	113	18	2
$t(i)$	4	7	6	6	6	6	5	7	7	5	6	4	5	6	7	6	7	7	2	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	4	5	79	80	44	9	27	84	12	49	50	34	113	34	18	19	117	57	95	96
$t(i)$	7	7	7	7	7	7	6	7	7	7	7	7	5	4	7	5	7	7	7	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	98	99	44	45	126	66	50	113	114	51	52	36	73	55	120	3	41	123	62	80
$t(i)$	7	5	4	6	7	7	6	6	5	4	6	7	7	5	6	6	7	7	7	7	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	63	66	113	114	67	51	15	72	73	18	73	122	94	124	96	97	98	99	113	114
$t(i)$	6	7	7	3	5	6	5	7	7	6	3	7	7	7	7	7	5	4	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	67	68	69	33	34	91	36	93	0	95	96	97	98	-	98	99	102	84	48	11
$t(i)$	5	7	7	7	7	6	7	6	7	5	6	5	4	3	0	2	6	7	6	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	120	51	89	123	108	0	80	97	98	99	100	69	6	55	56	73	10	43	44	93	110	79
$t(i)$	7	7	7	6	7	6	6	7	1	3	7	6	6	7	7	4	7	6	5	6	7	6

Broadcast protocol of node 99.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	19	1	114	115	98	99	100	7	10	121	12	67	12	13	14	34	112	19	114	19
$t(i)$	6	4	7	6	6	6	6	5	6	7	5	7	4	5	6	7	7	7	7	2	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	4	5	6	80	81	45	10	28	85	13	50	51	35	114	35	19	20	57	41	96
$t(i)$	7	7	7	7	7	7	7	6	7	6	7	7	7	5	4	7	5	7	7	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	97	44	99	100	45	65	30	67	51	114	115	52	53	56	74	56	121	58	42	62	44
$t(i)$	6	7	5	4	6	7	7	6	6	5	4	6	7	7	5	6	6	7	7	7	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	81	111	112	67	114	115	68	52	70	71	74	19	74	94	76	96	97	98	99	100	114
$t(i)$	6	7	6	7	3	5	6	5	6	7	7	3	6	6	7	7	7	5	4	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	67	68	69	89	34	35	90	37	124	1	94	97	98	99	-	99	100	101	85	49
$t(i)$	7	5	7	7	7	6	6	7	6	7	5	7	5	4	3	0	2	6	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	121	52	109	124	0	80	81	98	99	100	37	70	7	8	105	74	75	92	45	46	63
$t(i)$	6	7	7	7	6	7	6	5	7	1	3	7	7	7	7	7	4	7	7	5	7	7

Broadcast protocol of node 100.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	2	20	2	115	116	99	100	101	8	11	122	13	68	13	14	15	35	113	20	115
$t(i)$	7	6	4	7	6	6	6	6	5	6	7	5	7	4	5	6	7	7	7	7	2

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	20	4	5	6	7	81	82	46	11	29	86	14	51	52	36	115	36	20	21	58	42
$t(i)$	6	7	7	7	7	7	7	7	6	7	6	7	7	7	5	4	7	5	7	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	97	98	45	100	101	46	66	31	68	52	115	116	53	54	57	75	57	122	59	43	63
$t(i)$	6	6	7	5	4	6	7	7	6	6	5	4	6	7	7	5	6	6	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	82	112	113	68	115	116	69	53	71	72	75	20	75	95	77	97	98	99	100	101
$t(i)$	6	6	7	6	7	3	5	6	5	6	7	7	3	6	6	7	7	7	5	4	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	115	116	68	69	70	90	35	36	91	38	125	2	95	98	99	100	-	100	101	102	86
$t(i)$	7	7	5	7	7	7	6	6	7	6	7	5	7	5	4	3	0	2	6	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	13	122	53	110	125	64	81	82	99	100	101	38	71	8	9	106	75	76	93	46	47
$t(i)$	7	6	7	7	7	6	7	6	5	7	1	3	7	7	7	7	7	4	7	7	5	7

Broadcast protocol of node 101.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	55	2	3	21	3	116	7	8	101	8	121	12	123	14	125	126	111	110	113	20	21
$t(i)$	7	7	6	4	7	6	5	4	3	5	7	7	5	5	4	7	7	7	7	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	21	78	6	7	8	9	46	47	125	13	14	32	52	53	37	116	37	21	39	40
$t(i)$	2	7	7	6	6	7	6	7	7	7	7	6	7	7	6	7	4	6	5	6	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	24	25	45	46	101	46	47	48	51	69	51	116	53	37	38	58	76	58	59	6	63
$t(i)$	7	7	7	6	2	5	6	7	7	4	6	5	7	5	7	7	5	6	7	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	46	64	67	12	69	116	69	70	119	55	73	76	21	76	125	78	79	82	83	101
$t(i)$	5	4	7	7	6	7	3	5	7	7	6	7	6	3	7	5	6	7	7	5	4

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	116	87	69	70	88	35	92	123	75	39	96	3	96	5	114	101	-	101	102	103
$t(i)$	7	7	7	6	6	7	7	7	6	7	7	7	5	6	7	7	6	0	5	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	51	14	123	124	125	64	97	82	83	100	101	102	7	8	9	106	27	76	13	46	63
$t(i)$	7	5	7	7	7	6	6	7	6	6	7	1	7	7	6	7	6	7	4	6	3	6

Broadcast protocol of node 102.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	1	56	3	4	22	4	117	8	9	102	9	10	11	124	13	126	15	16	17	20	38
$t(i)$	7	6	7	6	4	7	7	5	4	3	5	6	7	5	6	4	5	6	7	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	117	22	23	7	8	9	10	47	48	126	14	15	52	34	54	38	117	40	22	59
$t(i)$	7	2	6	7	6	6	7	7	7	7	7	7	7	6	7	7	7	4	6	5	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	25	45	124	47	102	47	48	49	52	70	116	117	54	38	120	59	77	61	79	7
$t(i)$	7	7	7	6	6	2	5	6	7	7	4	7	5	6	5	7	7	5	7	6	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	8	65	47	65	85	13	70	117	70	71	55	56	76	77	22	77	126	79	82	64	84
$t(i)$	7	5	4	6	7	7	7	3	5	6	7	7	7	6	3	7	5	7	7	6	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	102	84	117	86	70	71	72	122	110	124	39	40	97	4	97	98	101	102	-	102	103
$t(i)$	4	5	6	7	6	7	7	7	7	7	7	7	7	5	6	7	7	6	0	5	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	107	52	15	16	126	64	65	66	83	84	85	102	103	88	9	26	107	108	77	46	47
$t(i)$	7	7	5	6	7	6	7	7	7	7	7	6	1	7	7	6	7	6	7	4	7	3

Broadcast protocol of node 103.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	112	3	4	5	23	5	118	9	10	103	10	11	14	125	16	111	110	113	37	21
$t(i)$	7	7	7	6	5	4	6	7	5	4	3	5	7	7	6	7	6	7	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	23	118	23	80	8	9	10	84	48	49	87	34	35	53	115	55	39	118	39	23
$t(i)$	6	7	2	6	6	6	7	7	7	7	7	7	7	6	5	7	6	5	4	7	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	24	25	26	63	64	48	103	48	49	50	53	71	55	118	38	120	59	41	78	60	63
$t(i)$	7	7	7	6	7	6	2	5	6	7	7	4	7	5	7	7	7	6	5	7	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	111	66	48	66	86	70	71	118	71	72	92	93	123	78	23	78	111	80	64	65
$t(i)$	5	4	5	4	7	7	7	6	3	5	7	7	7	7	6	3	7	5	7	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	103	85	118	119	71	72	90	110	38	125	77	41	4	5	6	82	8	103	-	103
$t(i)$	5	4	6	6	7	7	6	7	6	6	7	7	7	7	7	7	7	7	6	0	5

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	121	122	53	108	125	48	65	66	35	84	85	102	103	104	9	10	11	60	45	78	47
$t(i)$	7	7	7	6	7	5	3	6	6	7	6	7	7	1	6	6	6	6	6	7	4	7

Broadcast protocol of node 104.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	55	112	95	4	5	6	24	6	119	10	11	104	11	12	125	126	17	72	73	1	21
$t(i)$	7	6	7	7	6	5	4	7	7	5	4	3	5	7	7	7	7	6	7	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	39	40	24	119	24	25	9	10	11	85	49	50	112	113	36	54	36	37	40	119	42
$t(i)$	6	6	7	2	6	7	6	7	7	7	7	7	7	7	7	5	6	7	5	4	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	24	42	99	27	64	65	49	104	49	50	51	54	72	56	119	56	40	41	61	79	63
$t(i)$	5	7	7	7	7	7	6	2	5	6	7	6	4	6	5	7	7	7	7	5	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	65	112	67	49	67	116	117	72	119	72	73	74	123	22	79	24	81	112	81	65
$t(i)$	6	5	4	5	4	6	7	7	7	3	5	6	7	7	7	7	3	7	5	6	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	86	104	86	119	88	121	122	110	124	39	126	97	79	5	6	82	83	9	104	-
$t(i)$	7	5	4	7	6	7	7	7	7	7	7	6	7	6	7	6	7	7	7	6	0

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	105	106	53	54	126	48	49	66	67	68	85	86	103	104	105	10	11	12	61	110	79
$t(i)$	5	6	7	7	7	5	7	3	6	7	7	6	6	7	1	7	6	6	6	6	6	4

Broadcast protocol of node 105.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	0	57	58	115	6	7	25	7	120	28	12	105	68	13	33	111	16	113	74	115
$t(i)$	6	7	7	7	7	7	5	4	6	7	7	7	3	6	7	7	5	7	7	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	20	117	24	25	120	25	82	123	30	12	86	50	51	113	34	91	55	37	40	41	120
$t(i)$	7	7	7	6	2	7	7	5	7	5	6	7	6	6	7	7	5	6	7	5	4

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	41	25	62	44	28	65	66	50	105	50	51	54	55	73	55	120	57	41	42	43	80
$t(i)$	6	5	6	7	6	6	6	6	2	5	7	7	6	4	7	5	6	7	7	7	5

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	62	46	66	113	12	50	68	88	89	73	120	73	122	123	76	125	80	25	82	113	65
$t(i)$	7	7	5	4	6	4	7	7	7	7	3	5	7	6	7	7	7	3	6	5	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	66	86	87	105	87	120	121	73	74	38	95	40	111	98	80	81	7	8	47	48	105
$t(i)$	7	7	5	4	6	6	7	6	6	7	7	6	7	7	6	7	7	7	7	7	6

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	-	105	106	123	16	92	80	49	50	67	68	37	6	87	104	105	106	43	12	109	30	31
$t(i)$	0	5	7	7	6	7	4	7	3	7	5	7	6	7	7	1	6	6	4	7	6	7

Broadcast protocol of node 106.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	18	112	1	58	59	6	7	8	26	8	121	10	13	106	69	33	34	112	17	114	38
$t(i)$	7	6	7	7	7	7	6	5	4	6	6	7	7	3	7	7	7	5	6	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	116	21	41	25	26	121	26	29	124	31	13	87	51	52	114	35	116	56	38	39	42
$t(i)$	6	7	7	7	6	2	7	7	5	7	5	7	6	6	6	7	7	5	6	7	5

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	42	26	63	45	29	66	67	51	106	51	52	55	56	74	56	121	58	42	60	44
$t(i)$	4	7	5	6	7	6	6	7	7	2	5	7	7	6	4	7	5	6	6	7	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	81	63	47	67	114	13	51	69	70	17	74	121	74	75	124	77	126	81	26	83	114
$t(i)$	5	7	7	5	4	6	4	6	7	7	7	3	5	6	6	7	7	6	3	6	5

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	67	87	88	106	88	121	122	74	75	76	96	41	112	80	81	82	8	9	85	119
$t(i)$	7	6	6	5	4	7	7	7	6	7	7	7	6	7	7	7	7	7	7	7	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	-	106	107	124	92	48	81	66	51	68	69	86	7	88	105	106	107	44	13	62	31
$t(i)$	6	0	5	7	7	7	7	4	7	3	7	5	7	7	6	7	1	6	7	4	7	6

Broadcast protocol of node 107.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	55	19	113	114	59	116	61	8	26	10	11	122	11	106	107	108	71	72	73	114	2
$t(i)$	7	7	5	7	6	7	7	7	6	7	6	2	7	6	5	6	7	7	7	6	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	76	77	22	42	26	121	122	123	11	29	13	14	51	89	34	91	36	56	118	119	42
$t(i)$	7	6	7	6	7	4	7	7	4	7	7	7	7	6	7	5	7	7	7	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	121	122	123	44	47	29	66	104	113	106	107	108	53	73	55	58	121	122	59	43	63
$t(i)$	5	5	5	6	7	6	5	7	7	4	6	5	7	5	6	7	6	4	7	6	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	81	65	66	11	66	69	51	52	89	73	91	121	122	123	59	77	24	111	26	113	82
$t(i)$	6	7	6	3	7	7	6	7	5	6	4	7	6	6	5	7	7	7	5	6	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	29	84	104	88	106	107	108	122	91	75	125	2	95	4	43	44	115	102	84	48	11
$t(i)$	5	7	6	7	5	4	7	3	7	7	7	6	7	7	7	7	7	7	6	7	5

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	106	107	-	107	91	109	48	81	66	51	36	53	86	71	88	89	106	107	108	45	14	15
$t(i)$	7	2	0	3	6	7	6	7	4	5	6	6	7	6	6	7	3	1	4	7	6	7

Broadcast protocol of node 108.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	110	56	20	114	115	60	117	62	9	27	11	12	123	12	107	108	109	72	73	74	115
$t(i)$	7	7	7	5	7	6	7	7	7	6	7	6	2	7	6	5	6	7	7	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	3	77	78	23	43	27	122	123	124	12	30	14	15	52	90	35	92	37	57	119	120
$t(i)$	7	7	6	7	6	7	4	7	7	4	7	7	7	7	6	7	5	7	7	7	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	43	122	123	124	45	48	30	67	105	114	107	108	109	54	74	56	59	122	123	60	44
$t(i)$	7	5	5	5	6	7	6	5	7	7	4	6	5	7	5	6	7	6	4	7	6

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	64	82	66	67	12	67	70	52	53	90	74	92	122	123	124	60	78	25	112	27	114
$t(i)$	7	6	7	6	3	7	7	6	7	5	6	4	7	6	6	5	7	7	7	5	6

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	83	30	85	105	89	107	108	109	123	92	76	126	3	96	5	44	45	116	103	85	49
$t(i)$	7	5	7	6	7	5	4	7	3	7	7	7	6	7	7	7	7	7	7	6	7

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	12	107	108	-	108	92	16	49	82	67	52	37	54	87	72	89	90	107	108	109	46	15
$t(i)$	5	7	2	0	3	6	7	6	7	4	5	6	6	7	6	6	7	3	1	4	7	6

Broadcast protocol of node 109.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	111	0	113	4	115	60	61	6	63	64	11	29	11	124	13	16	109	16	73	18	115
$t(i)$	6	7	7	7	5	7	6	7	6	7	6	4	7	6	7	6	2	7	6	7	7

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	117	118	42	120	8	45	29	124	29	30	111	32	16	34	91	55	117	118	41	120
$t(i)$	7	6	7	7	7	7	7	7	2	6	7	4	7	5	7	7	7	7	6	7	6

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	60	44	45	124	47	29	66	104	32	50	53	71	109	54	119	39	59	122	61	124	61
$t(i)$	6	7	6	3	6	5	7	7	5	7	7	6	4	6	7	7	7	6	5	4	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	45	82	47	84	66	115	68	15	16	54	91	73	93	75	124	79	80	111	63	100	82
$t(i)$	5	6	7	5	6	6	7	7	4	7	4	7	6	7	7	7	6	5	7	5	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	29	84	85	32	87	71	91	109	110	124	93	126	111	4	80	100	45	100	84	10	11
$t(i)$	3	6	7	6	7	7	6	3	7	5	7	7	7	6	7	7	4	6	7	7	5

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	50	105	122	109	-	109	16	97	34	67	84	101	54	71	104	73	90	91	108	109	46	110
$t(i)$	6	7	7	6	0	5	3	7	6	7	4	7	5	5	6	5	7	5	7	1	7	6

Broadcast protocol of node 110.

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$p(i)$	110	94	95	2	97	116	24	100	101	102	11	104	30	31	125	126	17	110	0	18	2
$t(i)$	3	7	4	7	7	7	6	7	7	6	7	6	7	6	5	6	7	5	5	7	6

i	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
$p(i)$	22	40	78	79	24	121	28	46	47	125	126	14	88	113	17	18	92	20	40	95	42
$t(i)$	7	6	7	4	7	7	7	5	6	4	5	7	7	7	6	6	7	7	7	3	7

i	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
$p(i)$	24	42	123	46	125	126	30	31	113	69	107	54	109	0	55	58	40	77	61	79	125
$t(i)$	5	6	7	7	3	4	6	7	6	7	7	7	5	4	6	7	5	6	7	6	7

i	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
$p(i)$	126	46	47	48	85	50	116	15	118	119	55	56	93	77	95	125	126	79	112	64	84
$t(i)$	7	6	7	7	7	7	6	7	6	7	7	7	7	7	5	6	3	7	7	7	7

i	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
$p(i)$	85	30	117	118	119	71	91	109	110	0	95	126	95	79	43	6	101	46	47	102	119
$t(i)$	6	5	7	7	6	7	7	6	6	6	6	2	7	5	7	7	6	4	5	7	5

i	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
$p(i)$	104	13	14	109	110	-	0	97	2	35	36	101	54	55	40	9	58	59	28	29	110	110
$t(i)$	7	7	6	7	4	0	7	6	5	7	7	5	6	5	4	7	6	7	6	7	2	1