FORMALIZATION REPRESENTATION OF GLOBAL INFORMATION NETWORKS FOR SYNTHESIS

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In a globally, Global information network (GIN) can be presented as a variety of hosts connected with each other. The hosts are in conformity with finite system conception in OSI protocol stack [1]. Each host is directly connected to a network in GIN. The host information interchange is implemented on a protocol basis.

Separate packaged information is transmitted from one host to another through intermediate system (e.g. router). As a rule, the distance between two hosts is measured in hops. According to data [2], the average of hops in Europe is equal to 15.3, in Asia – 20.1, in North America – 16.3 and worldwide 17.8.

If GIN presentation is abstracted on a host level, it results in a graph, nodes of which are hosts, the edges – communication links between them (fig. 1, a). If to take into account that the number of hosts comes to tens-hundreds of millions over the world, GIN formalization on this level is hindered for the further synthesis.

The aggregation of network address is used to reduce dimensions in certain cases, with the usage of prefixes [1, 3]. This is a common approach which is used in all types of global networks.

The prefix in ATM networks is used to create virtual switched channels [1, 3]. In this case ATM address is divided in two parts: prefix and customer part. ATM network is responsible for prefixes declaration for ATM switch. The similar technology is also used in X.25 networks [1, 3]. All terminals which have the common prefix in the address are connected to general input switch of sub-network that conforms to prefix value.

The address network prefix is also used in IP-networks [1, 3, 4]. In these cases all hosts in certain network have the same network prefix, but they have unique host numbers. Similarly, any of two hosts located in different networks should have different network prefixes, but they can have equal host numbers. For example, the address 14.0.0.0/16 can present 256 sub-networks and 65534 hosts.

If GIN presentation is abstracted on prefix level, it results in a graph, nodes of which are address (network) prefixes which combines network host addresses, and the ribs of which are links between them (Fig. 1, b). It is natural that the number of network prefixes is considerably less than that of hosts.

The research task of complicated networks frequently comes to the task of graph decomposition. In this case network concerned is divided into separate sub-graphs (clusters). However, this method is more acceptable for homogeneous networks. Hosts and their connection which are GIN global resources are not homogeneous and distributed among various authorized organizations. In this case topological cluster boundaries will not always conform to the boundaries of network organizations (providers). This may cause serious difficulties due to discrepancy in applied protocols and network administrations. Therefore, it is appropriate to share GIN into homogeneous clusters where each cluster is an administration unit at the same time. According to OSI model, these are domains which refer to such units [5]. The terms of "Routing Domain" (RD) and "Administrative Domain" (AD) are used in this model.

Routing Domain is a set of end systems (hosts) and intermediate systems (routers) that is managed by the same routing rule [5]. The integrated routing metrics, joint measuring metrics, the equal integrated information routing protocol and equal routing computational procedure are used in this case.

Routing Domain can be divided into sub-domains (zones). The zone is a group of adjacent networks and networked hosts that are specified by network administrator. Routing

Domains provide full connection with all hosts located within their limits.

a) b)

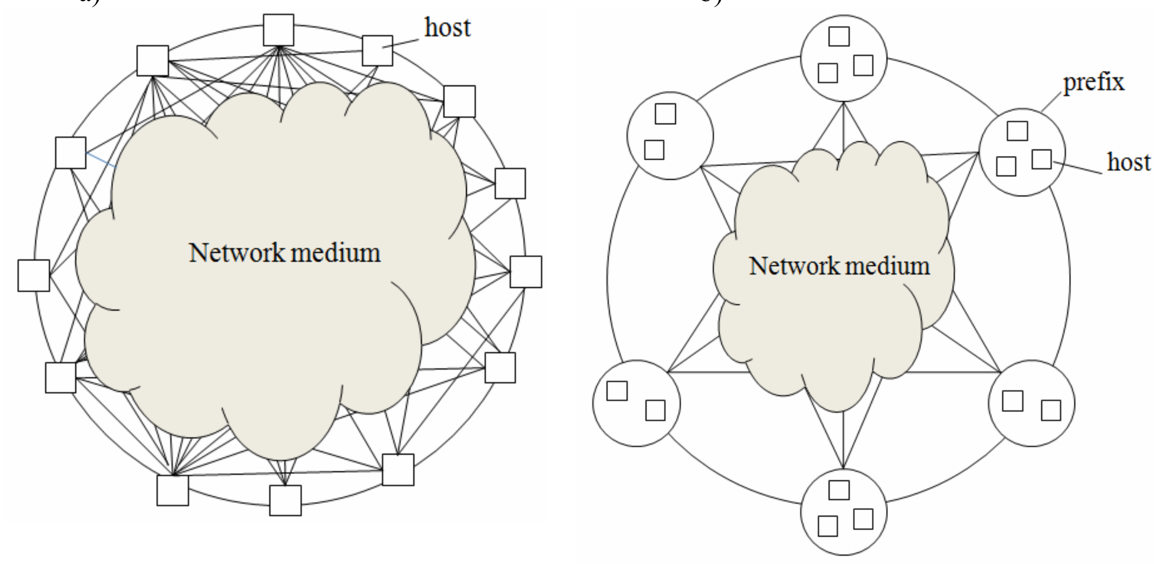

Figure 1. GIN abstraction:
a) on host level; b) on prefix level

Administrative Domain is a set of end systems (hosts) and intermediate systems (routers) and sub-networks which are managed by one organization or integrated for general administration [5].

Administrative Domain may include routing domains of single-type (Fig.2). AD and RD are equal to Internet autonomous systems [3]. In this case the considerable reduction of dimensions occurs. According to data [6], hop average is approximately equal to 3-4 in this case. This level is that of GIN presentation. Therefore, if GIN is presented on an administrative domain level, it will be a graph, the nodes of which are AD and the ribs - communication links between them (Fig. 3).

Let $\Gamma(X,L)$ be a connected GIN graph where $X=\{G_i|G_i=(V_i, E_i)\}, 1\leq i \leq |X|$ is AD sets that compose GIN and $L=\{l_{ij}\}$, G_i, $G_j \in \Gamma$ sets of direct inter-domain links that connect AD. In other words, l_{ij} is a link between i-AD and j-AD.

In its turn, each AD appears to be a graph $G_i(V_i, E_i)$,($G_i \in X$) where V_i – node (routers) sets, E_i - sets of direct inter-domain links in AD. In this case $V_i=\{v^i_1, v^i_2, ..., v^i_{ni}\}$,– sets of all nodes in G_i AD, where v^i_k - k- node of G_i AD.

Lets mark in-domain link between nodes v^i_k and v^i_l in G_i AD as e^i_{kl}. Therefore, E_i is defined as $E_i=\{e^i_{kl}\}$ of sets all communication links in G_i AD ($\forall\, v^i_k$, $v^i_l \in V_i$ for all nodes the connection has).

AD data interchange may be implemented both through traffic interchange points and directly. The Provider independently manages the interaction with the other networks. The general concept of network connectivity in GIN forms from a variety of pair-wise interaction.

The links between AD (networks) in GIN may be generally organized by two methods: directly, indirectly (through traffic interchange points or intermediate networks which simultaneously operates the functions of transit traffic transmission) [3].

In most cases indirect methods of network traffic interchange are applied with the usage of intermediate networks. It is connected with the fact that it is impossible to directly unite all networks into GIN in global virtual space. It is impossible to connect them through traffic interchange points either. At the present time there are sets of traffic interchange points which are located all over the world.

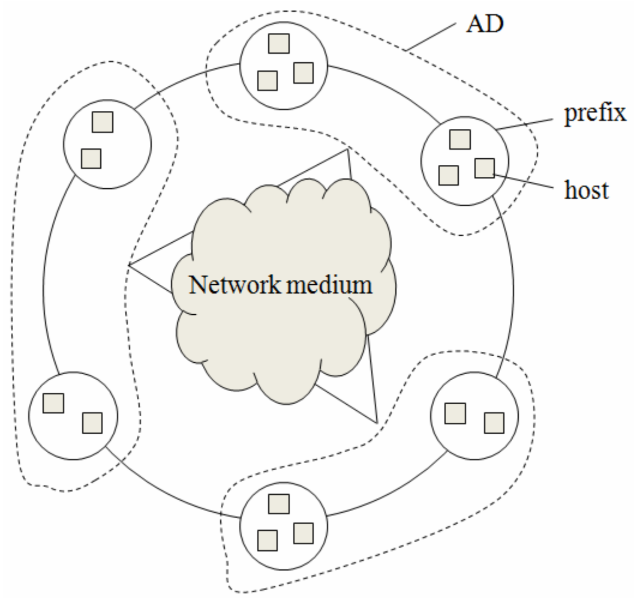

Figure 2. Administrative domain GIN

A variety of providers is connected to each traffic interchange point. For example, 327 providers (operators) are connected to London traffic interchange centre, 315 to Amsterdam traffic interchange centre, 285 to German traffic interchange centre [7].

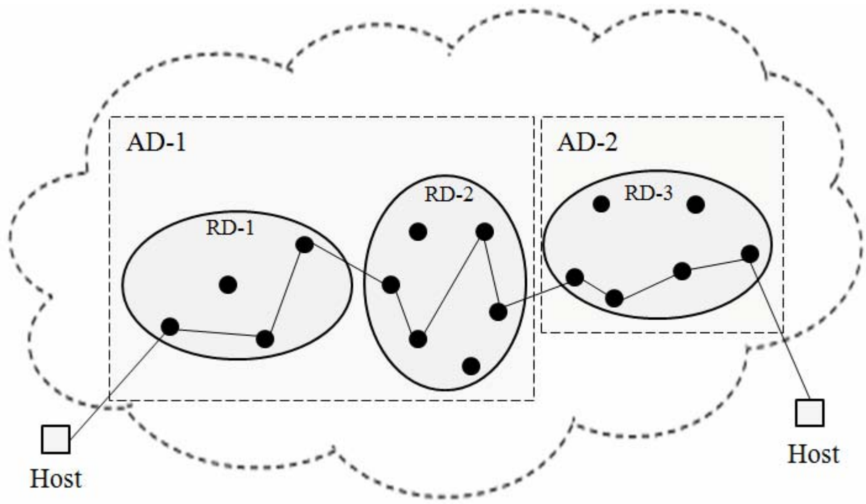

Figure 3. GIN abstraction on AD level

It is also started to widely apply direct inter-network connections in recent years, which help to connect provider networks [4]. Direct inter-network connections allow to increase the safety of network connections and to improve the level of network node scalability. Regardless of interaction model, there are generally two types of relations while network traffics interchange: transit and peering [4]. The network traffic may go through transit and peering connections within the bounds of global accessibility in GIN (Fig.4).

While transit is used, one provider agrees to transit traffic from one user to others on fixed payment. Peering is a mutually beneficial traffic interchange between two (and more) providers. Peering can be implemented through private "point to point" connection between two networks, as well as through traffic interchange point where a variety of providers interchange traffic.

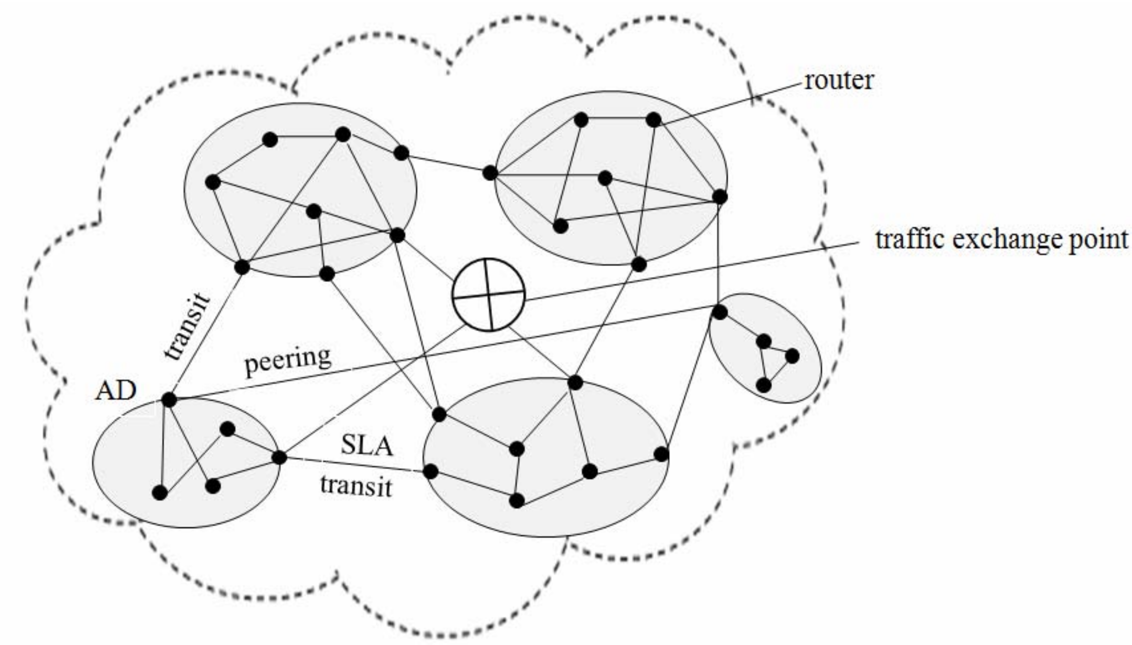

Figure 4. Framework for GIN synthesis

At an exchange of the traffic between AD it is used as a rule SLA - agreements [8]. The model on fig.4 is framework for GIN synthesis.

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