DOI:10.2298/CSIS100127033R

VPN Solutions and Network Monitoring to Support Virtual Teams Work in Virtual Enterprises

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Abstract. In order to be competitive enterprises continuously implement ICT strategies & architectures to improve manufacture, research, products quality, sales, services and costs control. All large enterprises have a local area network, a virtual private network, an Intranet and Internet, servers and workstations for operations, administration and management working together for the same objective: profits. The virtual enterprise and the virtual team's concepts are discussed in this article. This work analyzes the network architecture for geographically dispersed enterprises (seen as virtual enterprises) as support for virtual project development by virtual teams work. In addition, the paper presents an enterprise networks monitoring solution using open source software (OSS).

Keywords: Virtual Enterprise, Virtual Team, Enterprise Network, Virtual Network, Network Management.

1. Introduction

All organizations use today Internet or Internet technologies to attract, retain and cultivate relationships with customers, streamline supply-chain, manufacturing, procurement systems and automate corporate processes to deliver the right products and services to customers quickly and cost-effectively, also to capture, explore, analyze, and automate corporate processes information on customers and company operations in order to provide better business decisions [14, 29]. Development of ICT leaves much more freedom to the designers and consultants to accommodate organizations to other influences, both internal and external [11]. For business, e-service is going to be a new way to save money, to revenue growth, and faster development model. For end-users, e-services increase productivity and simplify life, take advantage of more sophisticated and specialized services on as needed basis. At the level of production-dedicated

enterprises, e-services are [13]: business-to-business (supply-side), intra-business (internal-side), and business-to-customer (customer-side).

New enterprise model architecture uses the Intranet/Internet/Extranet infrastructure [14] and technologies (see figure 1).

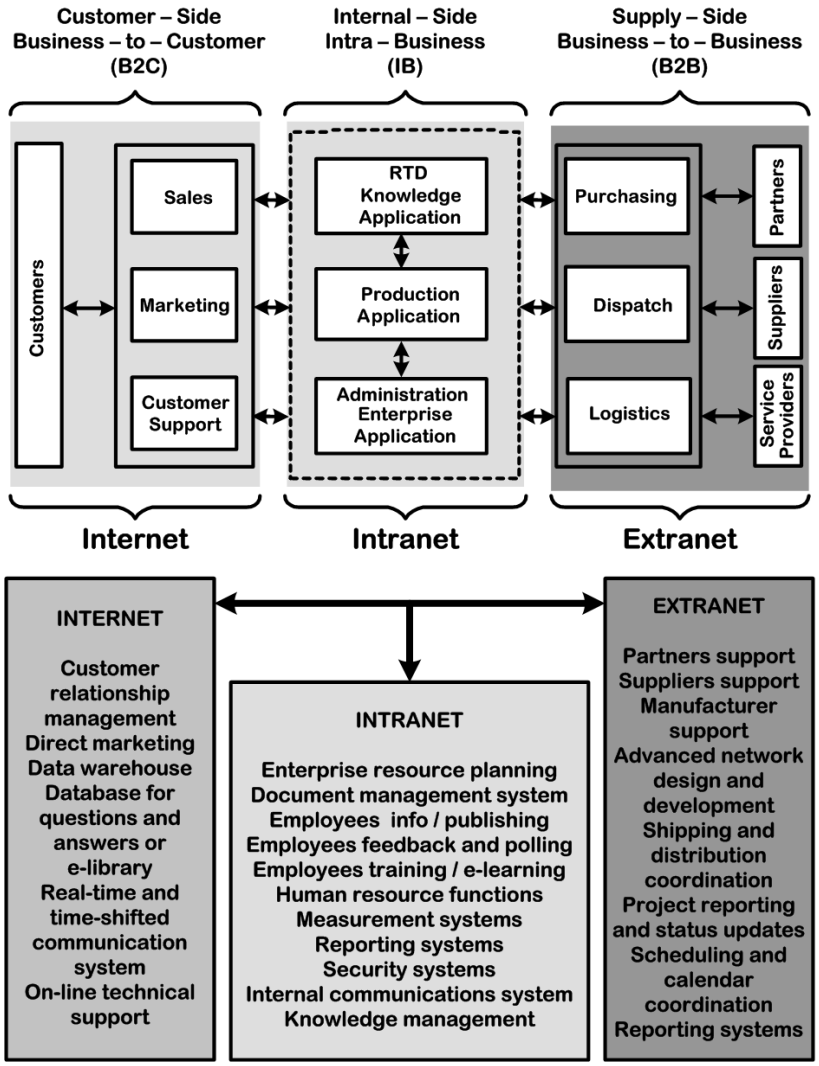

Fig. 1. The exchange of information services and goods through networks (up) and Internet/Intranet/Extranet based tools for the enterprise in the new e-economy (down)

As a general requirement for an infrastructure support the enterprises must be able to inter-operate and exchange information and knowledge in real time so that they can work as a single integrated unit, although keeping their independence/autonomy. For the future, e-services and e-business, as were

defined, require the enterprise re-thinking and re-modeling, with the system and applications design for an efficient use of new network technologies.

The perspectives of this kind of manufacturing and economy, named shortly new digital economy (e-economy), are based on the product perspective (holistic product view, product life-cycle, value-network integration, etc.), business organizational perspective (new organizational form, customers and suppliers integration, collaborating organization etc.), the technology perspective (technological building blocks, infrastructures, interoperability etc.) and the individual perspective (skills, workspaces, collaborating individual, different rolls: worker, consumer, citizen), [28].

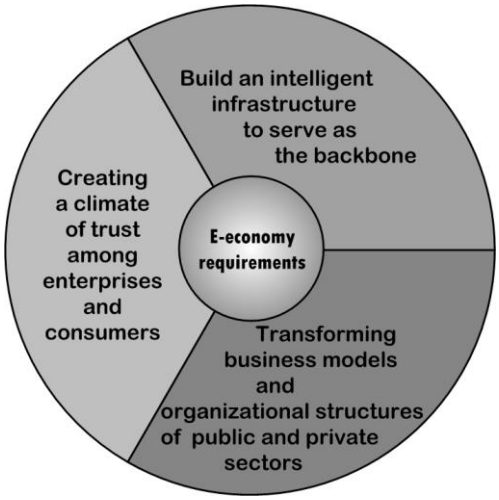

Fig. 2. The new digital economy requirements

Building an e-economy for the 21st century is a complex challenge. It requires (see figure 2):

- To transform business models and organizational structures of public and private sectors to generate continuous streams of productivity gains and product innovations, through the applications and use of ICTs;
- To create a climate of trust among consumers and businesses that fosters the growth of the e-economy in each country and internationally and creates global markets for electronic goods and services;
- To build an intelligent infrastructure to serve as the backbone of the e-economy – by encouraging investment, strengthening research, enhancing commercialization and ensuring that all persons have access to this infrastructure and know how to use it.

Developing and implementing these strategies will require partnership and collaboration among the private, public and academic sectors as well as other agencies and organizations that strive to link these together. It will require the active involvement of consumers and citizens.

Also, today, the critical and strategically questions are:

- What is needed to make the e-economy a priority?
- What overall strategies are needed to catalyze actions that respond successfully to the opportunities and challenges presented by the e-economy?
- Are there other factors in addition to those al-ready identified that are yet to be understood or fully harnessed, and that will enable each enterprise to benefit more fully as we progress towards a mature e-economy?
- What additional measures are needed to address the broader challenges of the e-economy?

Enterprises are now facing growing global competition and the continual success in the marketplace depends very much on how efficient and effective the companies are able to respond to customer demands. The formation of virtual enterprise network is taking up momentum to meet this challenge.

The concepts of a virtual enterprise (VE) and of virtual teams, enabled by a new generation of Internet/Intranet/Extranet - based services are discussed in this article, as a means to stay competitive and to thrive in a turbulent market. This work analyzed the network architecture for an enterprise geographically dispersed (virtual enterprise) as support for virtual private networks (VPNs) possible structures and presents a network monitoring solution using open source software.

2. Virtual Enterprise

The production process does not continue in a single company in a same geographic location. Companies feel the need to focus on their core competence and join together in virtual industrial groups, dispersed geographically to meet requirements of new products/services required in the market [29]. Also, the most classic examples of organizational network can be found in several fields of economy such as automotive – this trend is prevalent in many other areas, including agriculture and food industry. Hereby, the VE concept appears. As a definition, virtual enterprise is a temporary alliance of enterprises that aim to share resources and skills in order to respond better and faster to emerging opportunities in the market, based on a technical infrastructure and information technologies represented by communications/computer networks [6]. This concept is supported by new technologies and globalization beginning to dominate the orientation of industrial development. The functions and activities linked to the products begin to decentralize, distributing on large geographic areas. Design, production planning and marketing, production, services, etc., can be realized in any place in a country, a continent or the world, because the infrastructure facilities allow the exchange of information, goods and services. As a general requirement for infrastructure to support VE, we emphasize that companies must be able to work together, exchanging information among themselves,

goods and services in a very short time (in real time), giving the impression that works as an integrated enterprise, even if each retains its autonomy.

Data, information, knowledge and processing or storing them is distributed temporarily to global scale, using facilities offered by technologies like network developed in the last years.

Virtual enterprise is *a temporary alliance of partners* focus on their core competencies, able to ensure cooperation, the process of innovation in network and to respond rapidly to business requirements [30]. In this case, the essential features of VE are cooperation partners focus on their core competencies and innovation in network, which is characterized by [30]:

- *Innovation capacity* (in the culture of the organization, power of innovation - financial strength, strategy, market knowledge, innovation management, project management, etc.);
- *Processing capacity* (dynamic organization - dynamic structures, work flow management, new information systems, expertise and technological opportunities);
- *Cooperation Ability* (teamwork ability, mentality on removing barriers in attitude/mentality on cooperation, thinking in the network, etc.).

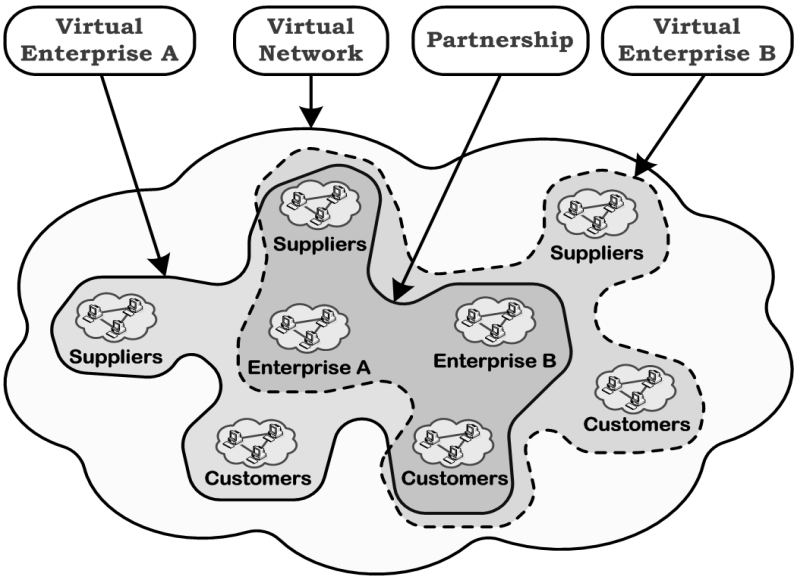

Fig. 3. The virtual enterprise partnership

Choosing partners to partnership creation (see figure 3) is very important when seeking to increase the competitiveness of the enterprise in a VE system [27] and represent a step in the process of VE forming (see figure 4).

The computers network and telecommunications, and other tools of information technology support cooperation between enterprises involved in a virtual enterprise. Modern enterprise with a virtual enterprise oriented

production type is a geographically distributed system with the following functions [18]:

- receiving orders and quick response to them;
- setting the structure on the virtual communication network;
- global planning system;
- local system planning and authorizing;
- control proactively at VE level;
- reactive control at alliance VE partner level.

These functions provide [4]:

- verifying real-time orders, in terms of opportunities for achievement (feasibility) and terms of delivery;
- VE configuration through negotiation and determination/verification of the ability to deliver products on time limits set by contract;
- establishment of order necessary to meet the order, and optimization of consumption and routes to maximize profits;
- acquisition and processing of data for monitoring the status of orders to avoid delays in delivery;
- control at the local and VE level and the manufacturer level, aiming to maintain the virtual alliance in normal operation area;
- exchange of information necessary virtual organization, to support all the functions provided;
- standard interfaces to other applications that VE interconnect.

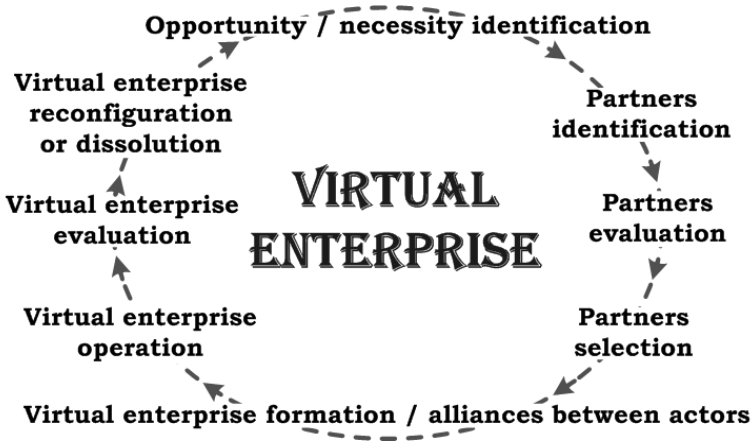

Fig. 4. The virtual enterprise framework

The idea of *virtual enterprise network* (VEN) is meant to establish a dynamic organization by the synergetic combination of dissimilar companies with different core competencies, thereby forming a *best of everything* consortium to perform a given business project to achieve maximum degree

of customer satisfaction [30]. In this context a VEN is a way for businesses to achieve virtual scale enabling them to operate as if they had more resources and capacity than they actually have.

In this emerging business model of VEN, the decision support functionality, which addresses the issues such as selection of business partners, coordination in the distribution of production processes and the prediction of production problems, is an important domain to be studied. In order to achieve collaboration between different actors in the VE, there needs to be common processes supporting the distributed product development process.

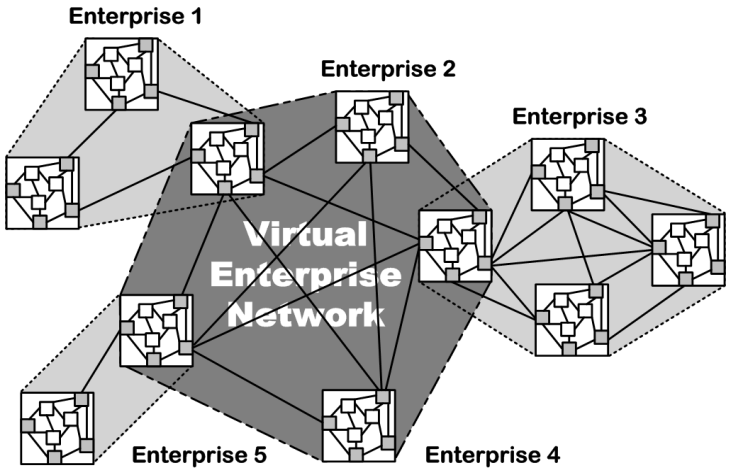

Fig. 5. The cooperative enterprise project in VEN

A virtual enterprise network (see figure 5) needs its own Private Member Collaboration System to communicate and develop its projects and bids. A hierarchical network design model breaks the complex problem of network design into smaller, more manageable problems. Each level, or tier, in the hierarchy addresses a different set of problems so that network hardware and software can be optimized to perform specific roles. Devices at the lowest tier of the hierarchy are designed to accept traffic into a network and then pass traffic up to the higher layers. The core of the network has one purpose: to provide an optimized and reliable transport structure by forwarding traffic at very high speeds. In other words, the core layer should switch packets as fast as possible. It needs its distinctive Network Business Applications such as Capability Aggregation and Tender Matching to enable it to function effectively as a co-operative in both pre-sales and contract operations. Also, it needs a Public Web Site to manage its interactions with potential customers and new members.

In this context the ingredients of VEN are presented in the figure 6. So, what is a virtual enterprise network solution [14, 28]?

- A way for businesses to achieve virtual scale enabling them to operate as if they had more resources and capacity than they actually have.

- A network of small enterprises allowing them to operate with all the resources and reach of a large enterprise but without sacrificing their speed, agility and low overheads.
- A network of enterprises enabling them to compete for bigger contacts with higher innovation and design elements with bigger customers who are prepared to have strategic partnerships with their suppliers [32].

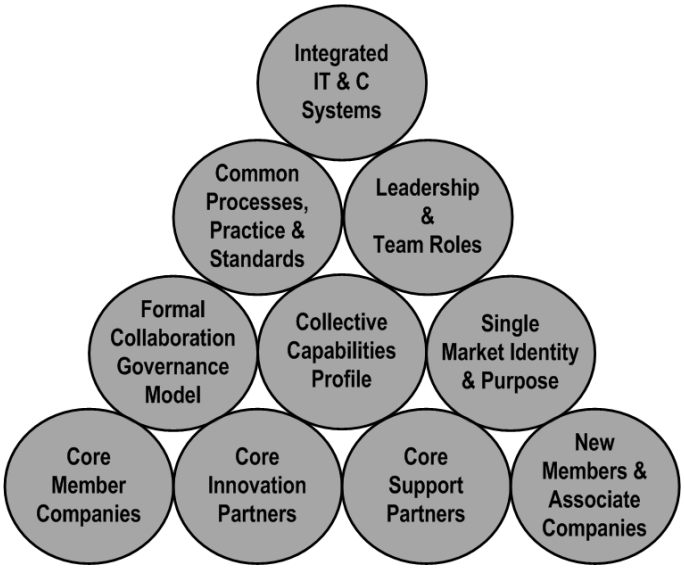

Fig. 6. The elements of VEN

Developing information and communication technologies (ICT) in recent years allowed materialization concept of virtual alliance [30], which will lead to restructuring production, goods and services, based on these new technologies and trends of markets globalization and competition.

3. Virtual Teams

The term *virtual team* is used to cover a wide range of activities and forms of technology-supported activities [3]. A Virtual team is a group of people and sub-teams who interact through interdependent tasks guided by common purpose and work across links strengthened by information, communication and transport technologies [17]. With rare exceptions [22] all organizational teams are virtually to some extent. This era is growing popularity for virtual team structures in organizations [33]. The virtual teams are the teams whose members use technology to varying degrees in working across location, temporal, and relational boundaries to accomplish an interdependent task [22]. Enterprise virtual team's members are located in more than one

physical location. This team trait has fostered extensive use of a variety of forms of computer-mediated communication that enable geographically dispersed members to coordinate their individual efforts and inputs [24].

Enterprise virtual teams work across boundaries of time and space by utilizing modern computer-driven technologies. Although virtual teamwork is a current topic in the literature on global organizations, it has been problematic to define what virtual means across multiple institutional contexts [9]. Virtual teams are groups of individuals collaborating in the execution of a specific project (see figure 7) while geographically and often temporally distributed, possibly anywhere within (and beyond) their parent organization [21]. The organizational context of a virtual team is a conglomeration of pieces related to the life worlds, organizational structures and work practices of the local organizational contexts (local sites), the distributed organizational context (global company) and the professional context (software process improvement) [5].

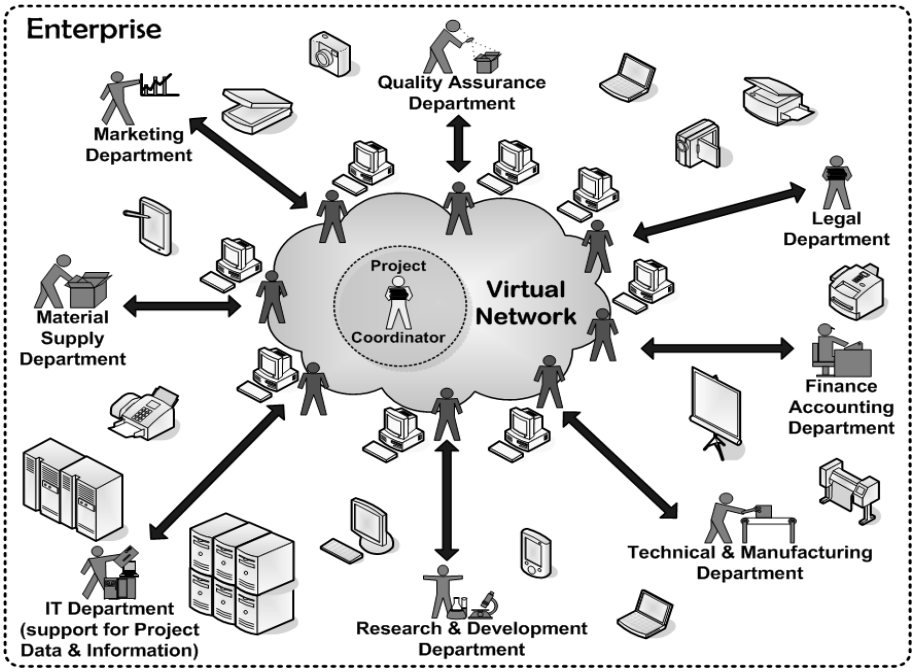

Fig. 7. The enterprise virtual team for project development

Virtual teams can be defined as groups of workers geographically, organizationally and/or time dispersed brought together by information technologies to accomplish one or more organization tasks [26]. The degree of geographic dispersion within a virtual team can vary widely from having one member located in a different location than the rest of the team to having each member located in a different country [31]. The term *virtual team* is a misnomer as although it makes reference to virtual reality and the concept of

creating a virtual space that can be experienced it also suggests that the virtual team isn't actually a team and as such can lead to a loss of performance.

In the initial stages it became clear that whilst a distributed computer based-platform could support distributed teams it could not completely replace face-to-face contact [13].

There are many different types of virtual teams (see figure 8) such as:

- *Management Teams* – comprised of managers who form teams because of their position in the organization. These teams collaborate every day and are responsible for taking decisions at the organization level.

Fig. 8. The virtual teams for project development

- *Project Teams* – are created to perform a specific task. Team members are selected depending on the role that it must fulfill in the project. These teams have a life equal to the project and are interdepartmental.
- *Research & Development Teams* – prepares and lead projects established with the management team. Between research team members should be complementary and a judicious sharing of the concrete tasks of each component to be grafted on to specialized training.
- *Production Teams* – team members regularly conducted activities at work; each member having a function within the team. Membership is defined very clearly.
- *Communities of Practitioners* – are bigger work entities, geographically dispersed (distributed), in which members participate, through Internet, guided by common goals, roles and rules – e.g. open source software project teams. These teams provide support for people working in the

same professional field and benefit from sharing experience. Membership in these teams is voluntary. The teams are focused on learning and / or knowledge development [30].

- *Concurrent Teams* – formed the short term for making recommendations for improvement of a process or system.
- *Service Teams* – created for the organization or customer support in a service – are designed to provide technical support.
- *Intervention Teams* – these teams provide answers or solutions in a very short time. They are usually activated in emergency situations.

The availability of a flexible and configurable base infrastructure is one of the main benefits of virtual teams [2]. Benefits of the virtual team's implementation at the enterprise level are presented in figure 9.

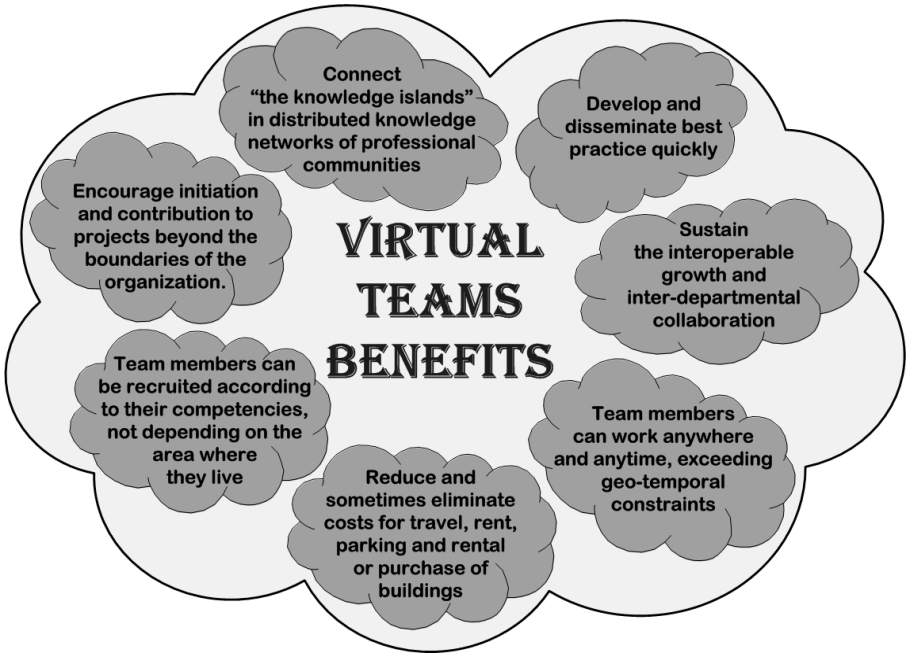

Fig. 9. The main enterprise virtual team's advantages

Virtual teams do not operate like traditional physical teams, as their requirements reflect a whole new way of communicating, working collaboratively, sharing information and mutually supporting other team members. The new technologies and approaches required to achieve this are completely alien to most of our present organizational culture. And this is why they fail. Cooperative processes are not the automatic results of implementing collaborative, real-time communication technologies, but the result of a carefully designed and systematically maintained virtual team development plan [7]. Product development is the process that covers the following: product design, production system design and product introduction

processes and start of production [19]. Product development is widely recognized as a key to corporate prosperity and is vital and needs to be developed both innovatively and steadily [8, 20].

Virtual product development through virtual teams in virtual enterprises is a temporary alliance of teams who share the skills, abilities and resources in pursuit of a project and whose cooperation is supported by computer network and appropriate tools, skills and special applications software. The ultimate objective of all product development teams is superior marketplace success of the new products [1] and services.

4. Virtual Enterprise Network Solutions

Traditional infrastructures type Internet/Intranet/Extranet have now a fast dynamic, marking the transition to new generation networks to provide higher speeds to the user (end to end), for different types of transactions and a reduction in the number of servers by passing information between two nodes.

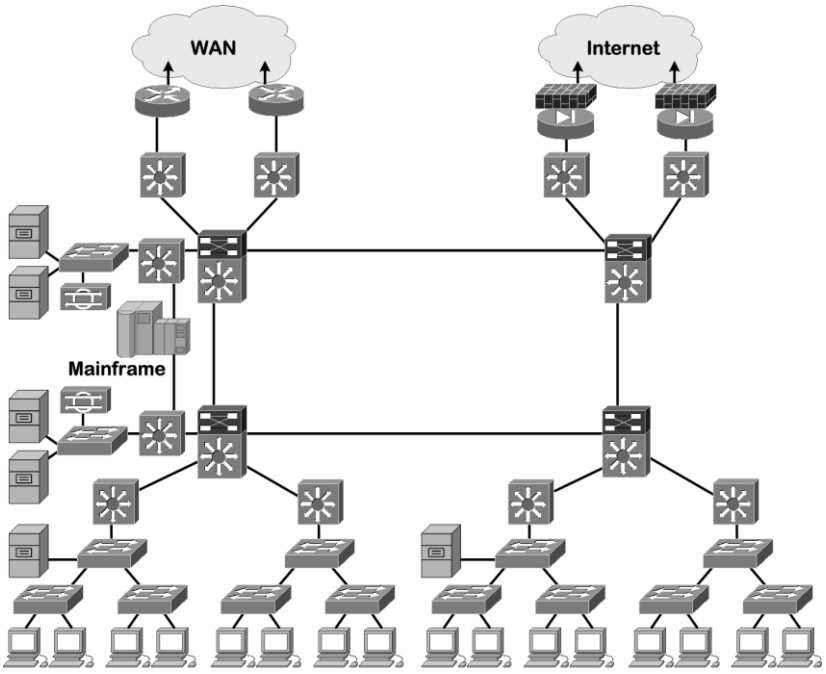

Fig. 10. A hierarchical scalable network design model

A hierarchical network design model (see figure 10) breaks the complex problem of network design into smaller, more manageable problems. A network is a chain where each link must be strong for the network to be

resilient. In this network computers are called host. The hosts are connected through communication subnets. The main task of the subnet is to send messages from one host to another.

Each level, or tier, in the hierarchy addresses a different set of problems so that network hardware and software can be optimized to perform specific roles. Devices at the lowest tier of the hierarchy are designed to accept traffic into a network and then pass traffic up to the higher layers.

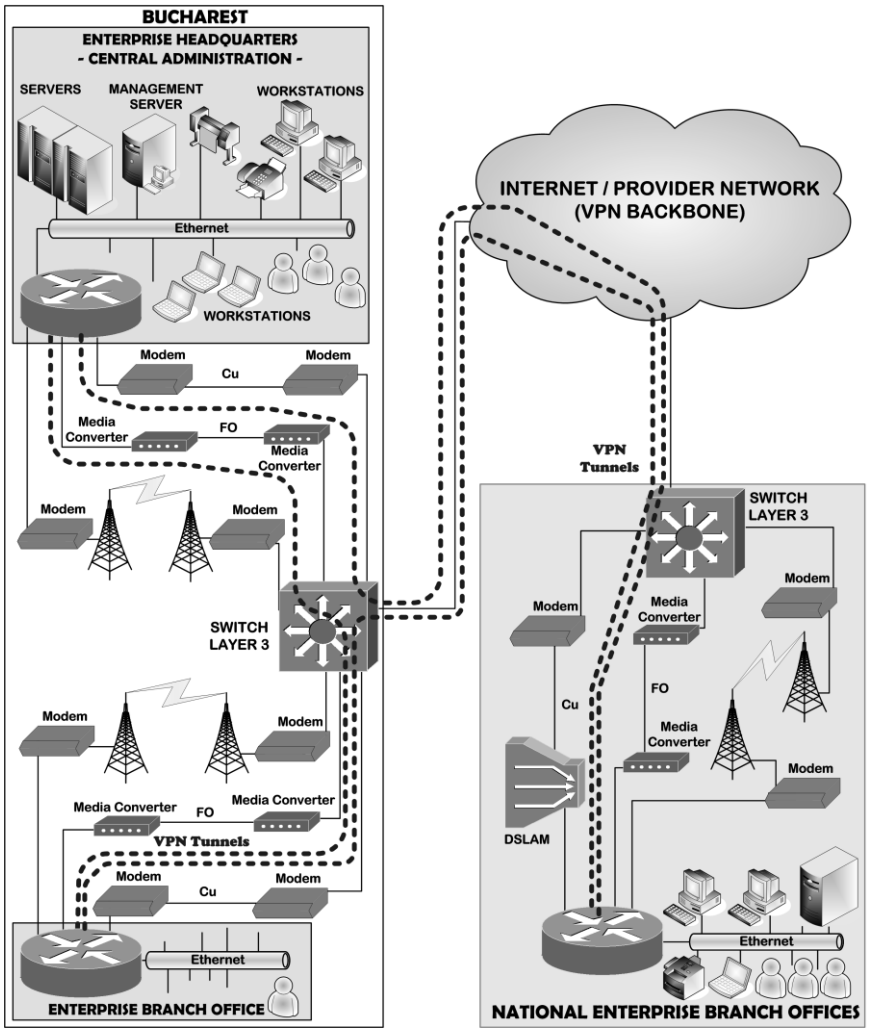

Fig. 11. A network general architecture with 3 loops (copper, fiber optic and radio), using the Internet or a provider network, for a large enterprise geographically dispersed to support transfer of large volumes of data over long distances

We purpose in figure 11 a general architecture using Internet or a provider network for a large enterprise or an industrial holding (with headquarters and branches), geographically dispersed, implemented in the PREMINV platform [30].

Large area networks (WAN – Wide Area Network, specific large enterprise or businesses geographically dispersed) were designed to solve connection problems between workstations and local networks, or only the local network where the distances are too large to be able to use a simple cable connection. Large area networks are generally required for the transfer of large volumes of data over long distances. To implement a large area networks can use the following transmission media: the public switched telephone network (PSTN), leased circuits of large bandwidth and high speed, high speed fiber optic, satellite links, radio links. A high performance backbone has an intrinsic value for ultra-fast Internet connection only if the points of connection and network users, POP (Point of Presence), providing an equivalent level of performance.

Appearance of virtual networks is related to the evolution switches. A *virtual network* is to combine a group of users regardless of their geographical position but such a manner that it flows together and to provide the best performance. The second advantage of a virtual network consists [14] of administrative solutions which accompany the products, allowing users moving from one group to another through a simple reconfiguration of the equipment. A virtual local network (VLAN) is a logical grouping of local network components without regard to their physical grouping. Common commands to create VLANs (for Cisco equipments) are the following:

```
vlan 75
 name Client_PREMINV_Provider1
vlan 76
 name Client1_PREMINV_Provider2
vlan 77
 name Client2_ PREMINV_Provider2

interface FastEthernet1/0/1
 description PREMINV_Provider1
 switchport access vlan 75
 switchport mode access

interface FastEthernet1/0/2
 description PREMINV_Provider2
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 76,77
 switchport mode trunk

interface Vlan75
 description Client_PREMINV_Provider1
 ip address 5.10.34.1 255.255.255.252

interface Vlan76
 description Client1_PREMINV_Provider2
 ip address 5.10.36.1 255.255.255.252
```

```
interface Vlan77
 description Client2_PREMINV_Provider2
 ip address 5.10.36.5 255.255.255.252
```

Benefits of virtual local networks are the following:

- In current applications, physical topologies and/or logical networks are often modified, which in many cases requires changing the structure of wired, acquisition of new data communication equipment, reconfiguration of bridge, router equipment or changing database management. Thus the definition of virtual local networks to reduce costs and efforts dedicated to the topology change.
- Substantially reduce network loading by dividing the areas of broadcast (broadcasting refers to transmitting a packet that will be received (conceptually) by every device on the network).
- Increase the level of network security by restricting the number of users in each network and the separation of broadcast domains.

The *virtual private network* (VPN) is a network emulated (the *virtual*) built on public infrastructure (*shared*), dedicated to a client (the *private*) to connect users in locations and to ensure similar conditions of integrity, confidentiality and quality similar with those of a private network. VPNs allows the provisioning of private network services for an organization or organizations over a public or shared infrastructure such as the Internet or service provider backbone network.

The shared service provider backbone network is known as the VPN backbone and is used to transport traffic for multiple VPNs, as well as possibly non-VPN traffic.

VPNs provisioned using technologies such as Frame Relay and Asynchronous Transfer Mode (ATM) virtual circuits (VC) have been available for a long time, but over the past few years IP and IP/Multiprotocol Label Switching (MPLS) – based VPNs have become more and more popular. VPNs may be service provider or customer provisioned and falls into one of two broad categories [12, 23]:

- *Site-to-site* VPNs connect the geographically dispersed sites of an organization or organizations
- *Remote access* VPNs connect mobile or home-based users to an organization's.

There are three primary models for VPN architectures that can be implemented at the enterprise level [30]:

- *Host-to-host* – used to protect communication between two computers. The model is most used when a small number of users must be online or is given a remote that requires protocols that are normally uncertain.
- *Host-to-gateway* – protects communications between one or more individual hosts belonging to a specific network of an organization. Host-to-gateway is used to allow hosts of unsecured networks, access to internal organization services such as email and web servers.

- *Gateway-to-gateway* – this model protects communications between two specific networks, such as organization's headquarters networks and organization's branch offices or two business partners' networks.

A VPN solution typically requires integration of several services (design, network management services, dial-up or dedicated access). Company that ensures coordination of services included in the solution is called *integrator*. Depending on the case, VPN solution integrator can be:

- customer himself (by the network administrator) ;
- one of equipment providers (e.g. equipments supplier can ensure the services integration against payment) ;
- an independent company, specializing in turnkey solutions.

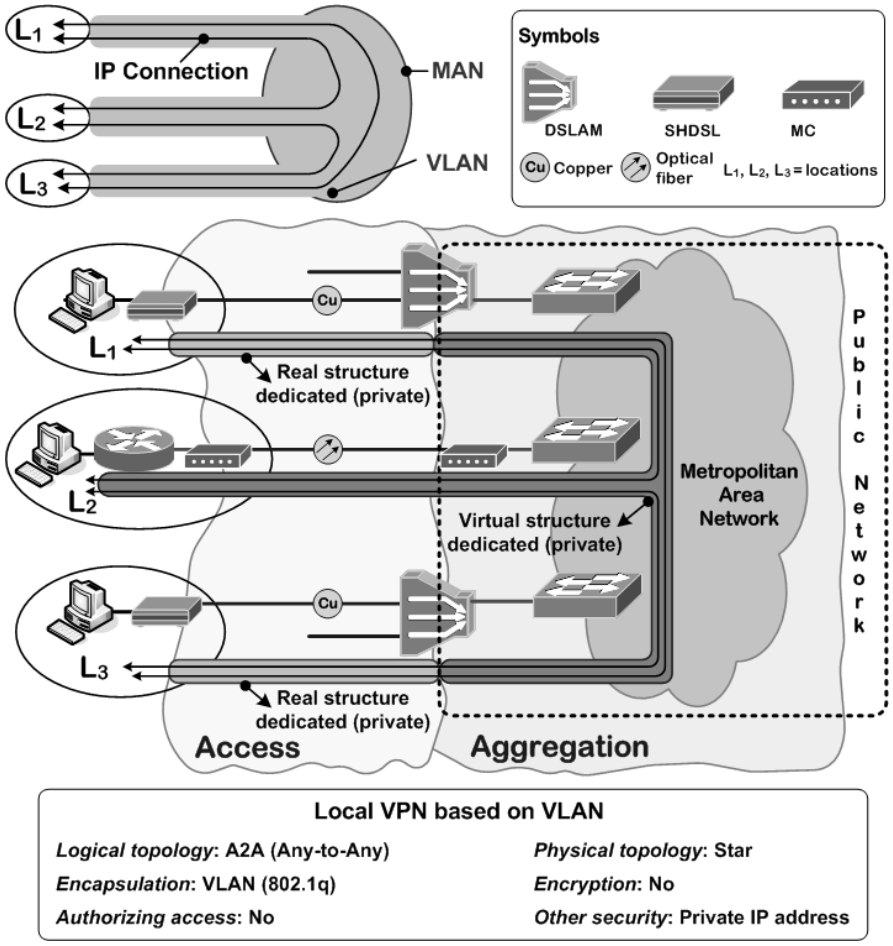

Fig. 12. Local VPN based on VLAN example

Possible solutions to implement a VPN structures for a VE system realization in a geographically dispersed enterprise can be:

- Local VPN based on VLAN (Virtual Local Area Network) – see figure 12;
- Local VPN based on IPSec (Internet Protocol Security) – see figure 13;
- VPN wide area based on IPSec;
- VPN wide area based on MPLS (Multiprotocol Label Switching);
- VPN based on PPPoL2TP (Point-to-Point Protocol over Layer 2 Tunnelling Protocol);
- UMTS (Universal Mobile Telecommunication System), etc.

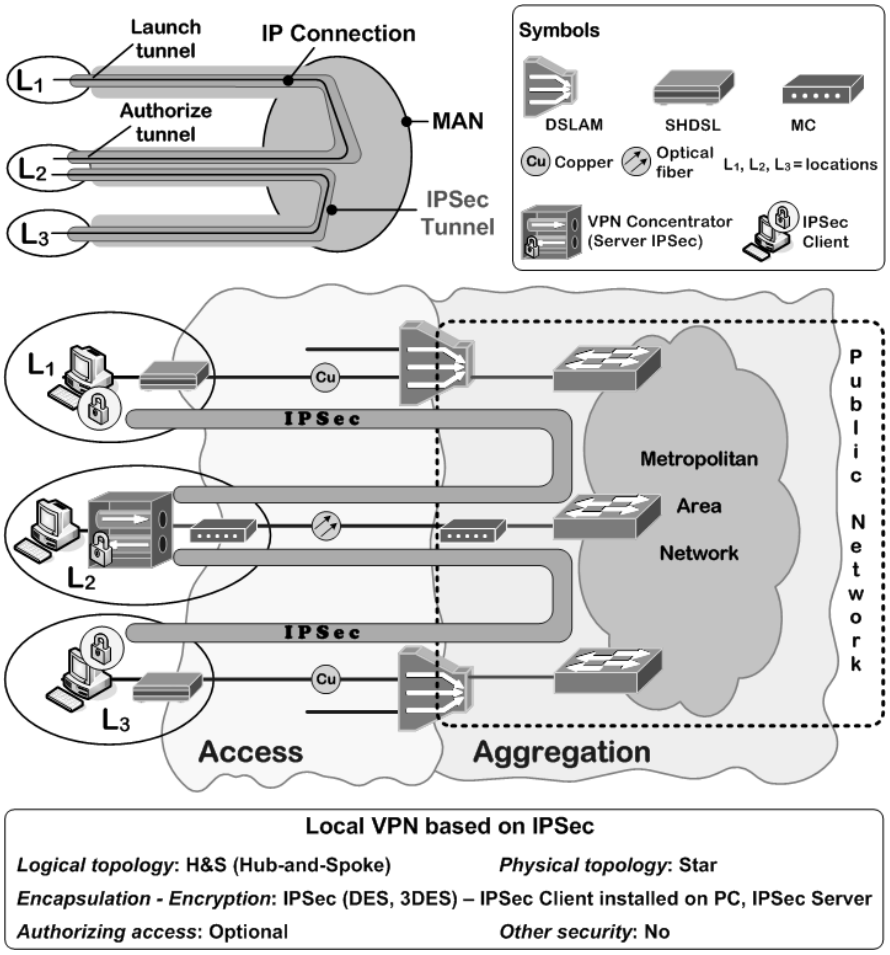

Fig. 13. Local VPN based on IPSec example

The main trend is now evolving to logic defined intranets and extranets, which will lead to the reintegration of the various networks in single logical subdivisions with no physical.

Structures that allow the approximation of this goal are virtual private networks. Newer, VPNs can be used in different ways to support business processes, is the ideal solution if it is not efficient in terms of construction

costs of a particular network for a firm with a workforce highly mobile, or for small firms that can not justify the cost of their telecommunications network.

Benefits services provided by VPN are [30]:

- the voice, video and data services convergence is done with low costs;
- Secure Remote Access to company resources;
- costs predictable and easier to budget, independent of traffic;
- the possibility of transferring any-to-any of data-voice-video applications;
- reliable support for LANs integration;
- security of data transmission;
- constant transfer rate, technological guaranteed;
- smart management solutions.

VPNs can be purchased from a telecommunications company and as an alternative they can create by using existing network infrastructure as the Internet or public switched telephone network, and software through the tunnel crossing.

The VPNs will be done according to enterprise network territorial expansion: local, metropolitan (county) and national (international).

5. Virtual Enterprise Network Monitoring

Network management represents the activities, methods, procedures, and tools (software and hardware) that pertain to the operation, administration, maintenance, and provisioning of networked systems [25]. The corporations can development permanently project with virtual teams support if have a good network management.

Proposed and implemented solution by us is to use a host and service monitor designed to inform as of network problems before your clients, end-users or managers do.

A system and network monitoring application is Nagios®. We found and took this software from the Internet by download. This software is licensed under the terms of the *GNU General Public License* Version 2 as published by the *Free Software Foundation* (GNU General Public License is a free, copy left license for software and other kinds of works). This gives you legal permission to copy, distribute and/or modify Nagios® under certain conditions.

We've installed Nagios® on a server with the following technical characteristics: 2 Dual Core Intel Xeon (TM) 3.6 GHz processors (64-bit), 2 GB RAM, 2 x 80 GB Hard Drives and Debian Linux 4.0 Operating System.

Some of the many Nagios® features include [16]:

- Monitoring of network services (SMTP, POP3, HTTP, NNTP, PING) and monitoring of host resources (processor load, disk and memory usage, running processes, log files, etc.)

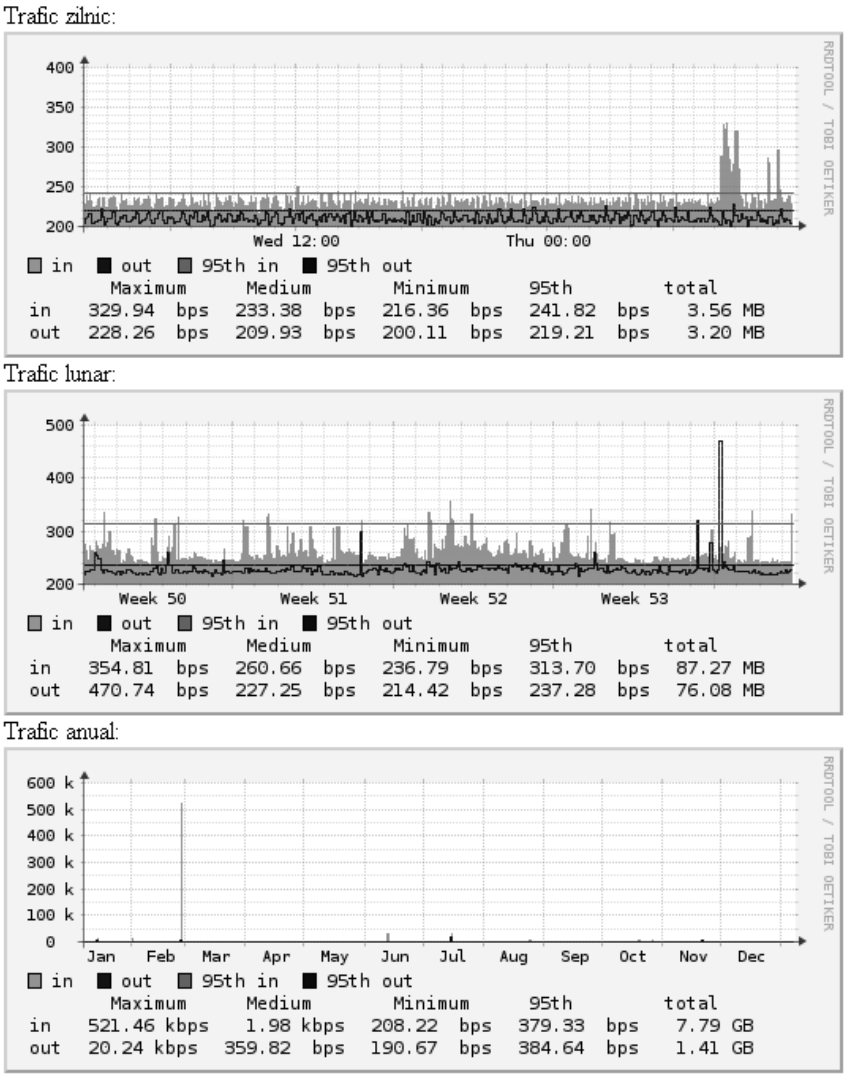

Fig. 14. The Nagios® traffic statistics for an enterprise location (daily, monthly and annual traffic)

- Monitoring of environmental factors such as temperature (see in figure 14 Nagios® traffic statistics);
- Support for implementing redundant and distributed monitoring servers;
- Simple plug-in design that allows users to easily develop their own host and service checks and ability to define network host hierarchy, allowing detection of and distinction between hosts that are down and those that is unreachable;

- Contact notifications when service or host problems occur and get resolved (via email or other user-defined method);
- Optional escalation of host and service notifications to different contact groups;
- Ability to define event handlers to be run during service or host events for proactive problem resolution;
- External command interface that allows on-the-fly modifications to be made to the monitoring and notification behavior through the use of event handlers, the web interface, and third-party applications;
- Retention of host and service status across program restarts;
- Scheduled downtime for suppressing host and service notifications during periods of planned outages and ability to acknowledge problems via the web interface;
- A Web interface – viewing current network status, notification and problem history.
- Simple authorization scheme that allows restricting what users can see and do from the web interface.

Also, Nagios® can do [25]:

- The connections state verification by PING command at monitored equipments;
- The loops state verification by OSFP routing protocol state monitoring;
- For monitored equipments configurations does default intervals saves.

We implemented Nagios® to a large enterprise which has its headquarters in Bucharest and branch offices (agencies) in the country – in big as well as in medium and small cities.

All enterprise locations have a local area network and communicate among themselves through a virtual private network. In each location were made two or three loops – one copper, one optical fiber and/or radio. To implement this application we have used over a hundred locations. In figure 15 are presented the locations monitored for this large enterprise – we eliminated the beneficiary name for advertising reason. We realized more scripts as support for different operations.

An example is *OSPF Verifying*. Generally, specific settings for OSPF (Open Shortest Path First – a dynamic routing protocol developed for Internet Protocol networks) [10], settings associated interfaces (example is for Cisco equipments) are:

```
router ospf 1
 network 5.10.34.0 0.0.0.255 area 34
 network 5.10.36.0 0.0.0.255 area 36
```

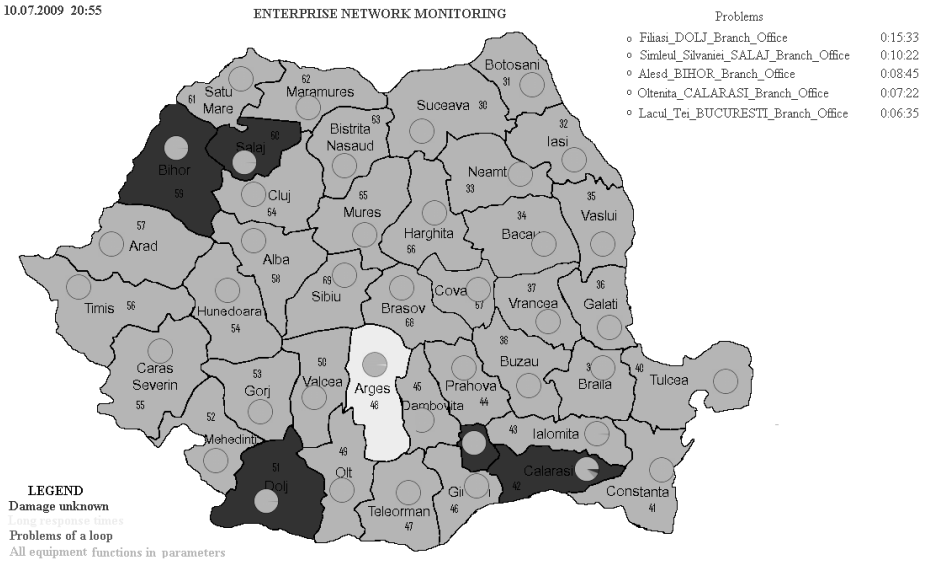

Fig. 15. Status for an enterprise geographically dispersed network - the local Enterprise Agencies of Bihor, Calarasi, Dolj & Salaj Counties are down and the local Agency of Arges County have long response times.

Using *OSPF Verifying* script below (realized in PHP programming language) we can monitor the OSPF Protocol status – generally used in locations that have at least 2 loops and prioritization is done by OSPF (if OSPF Protocol is upended for a provider loop monitoring system with loop UP).

```
<?php
unset($res_ospf);
$ip=$argv[2];
$comm=$argv[4];
$vec=$argv[6];
list($ip_v,$neighbor)=explode(':',$neigh);
$ip_v=trim($ip_v);$neighbor=trim($neighbor);
//echo "$ip\n$ip_v\n$comm \n$neighbor \n\n";
exec(" snmpwalk -v 1 -c $comm $ip
.1.3.6.1.2.1.14.10.1.6.$ip_v.0 ",$res_ospf);
$car=trim(substr($res_ospf[0],strlen($res_ospf[0])-1));
if(!strncmp($res_ospf[0],'Time',3)){$car='0';}
if($car==='8'){
    echo "Link to $neighbor is Up: Link OK ! \n";
}else{
    echo "Link to $neighbor is DOWN !!!\n";
}
?>
```

6. Conclusions

Considering future product development as collaboration and communication oriented we implemented in the PREMINV platform [15] a solution based on a virtual network concept using consistent collaboration integrated data sets and tools [13].

As a general requirement for this infrastructure support the companies must be able to inter-operate and exchange data, information and knowledge in real time so that they can work as a single integrated unit, although keeping their independence/autonomy.

A complete redesign of an existing enterprise would represent a not justifiable effort as companies are not replacing easily their running systems. A better strategy is to try to separate the internal functionalities from the network-related ones and develop the necessary mappings to legacy systems, to correspond to the new aggregator model for modern electronic system. In applying this strategy a virtual team could be formed with members located in different geographic locations. A virtual local area network is created for each project in the PREMINV platform. In addition to the team's full-time members, the team also includes contributing members who are recruited for specific components of the project. As such, a core group is responsible for leading the project and a sub-group is involved in specific components of the project while the full time employees from the central core of the team, experts in the different problems of the project (control systems, mechanic systems, electronic systems, programmer's etc.) are also team members. Today, in order to survive, whether small, medium or large organizations are composed of one or many enterprises (holding) it is necessary to learn from the past, supervise the present and plan the future.

The benefits of using Web Service technology as a core IT platform for the PREMINV comprises minimized processing times and costs and the improvement of the following features:

- *functionality* (system supporting and/or fully automating product development);
- *process*;
- *integration* (system to (internal or external) system communication);
- *usability* (effortless communication between the human user and the system);
- *security* (protection of the enterprise knowledge);
- *flexibility* (easily adjustable to a fast-changing business environment).

The decision support system presented in this paper includes two main modules: an information (classification and retrieval) module and a decision inference module. These modules implicitly guide users to follow systematic decision procedures to structure a problem, collect information, develop a model and analyze a decision step by step. The input/output interface provides an interactive mechanism for communication between users at the

client sites and the other components in the system. The database manages the domain knowledge embodied in the system.

The overall developed system infrastructure was based on object-oriented and agent technology. Every agent can communicate with other software agents to smooth out the decision process. When an agent conducts a decision support activity, it consults the knowledge base located in various sectors of a platform.

A solution for a large enterprise geographically dispersed network monitoring using open source software (Nagios®) has been presented in this paper. For an enterprise, network monitoring is a critical and very important function, which can save significant resources, increase network performance, employee productivity and maintenance cost of infrastructure.

This software (Nagios®) can be developed and implemented at a corporate level but also in a company that provides telecommunication services.

This work was realized at the UPB-PREMINV Research Centre. The validation of this solution by a case study in the PROGPROC research project was meant to determine the conceptual model for a new organization type integrating the virtual enterprise medium and outsourcing shared resources from UPB-PREMINV research centre to industrial partners.

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Received: January 27, 2010; Accepted: September 15, 2010.