AMRES' Experience with Implementing the "Campus Best Practices" Model

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***Abstract*—This paper summarises the participation of AMRES, the National Research and Education Network (NREN) of Serbia in the GÉANT "Campus Best Practices" (GN3 NA3/T4) task and the experiences and the results that have been achieved by AMRES, in implementing the recommended model. Four NRENs are contributing to the task: UNINETT (Norway), CSC/Funet (Finland), CESNET (Czech Republic) and AMRES (Serbia). Of these, Serbia is the only one that is faced with solving the problem of poor technological development, the so-called 'digital divide' problem. NRENs that are faced with this problem, give their undivided attention and overall budget to the improvement of their backbone infrastructure and services, and their external NREN connections. Insufficient attention has been focused on understanding and mitigating the problems of discontinuity in the quality of infrastructure, services, and the expertise of staff. This discontinuity generally exists between the NREN backbone and the campus network. The GÉANT "Campus Best Practices" task has built upon the model developed by UNINETT in their GigaCampus Project to provide NRENs with a working model to implement Campus Best Practices as one possible solution for the problem. The aim of the task is to increase cooperation between the NRENs and between the NRENs and their member institutions, in order to arrive at common technical solutions and recommendations for campus networks. A description of the experiences recently gained at AMRES during the implementation of the adopted model, can of benefit to NRENs operating under similar conditions.**

Keywords—best practices; campus network; IT staff collaboration; digital divide

Notations

The terms used throughout this paper are defined as follows:

NRENs is used to denote ***National Research and Education Network*** organizations as well as the national networks provided by them.

Campus network is used for the local network infrastructure of all organizations served by NRENs and other research and education institutions, regardless of the type of institution or network.

Working group is used for the open forums for collaboration between network engineers at campus level, as well as their collaboration with NREN organisations.

BPD (*Best practice document*) is a summary document prepared in working groups, according to the experience of participants, and discussion about the lessons learned on a particular subject. It is absolutely vital to the success of the activity that working group send the document to public hearing and that all participants reach consensus, or nearly so, in the pursuit of their goals. The subjects of BPDs are mainly technical, and the summarized recommendations are valuable for the future of the IT community.

I. INTRODUCTION

According to current practice, the NREN is responsible for the development and provision of network services up to campus boundaries in most countries. A small number of NRENs are able to take on responsibility for the local network infrastructure within their universities, institutes or even smaller educational and research institutions, but, the institutions themselves are usually expected to take on responsibility for this segment and to be responsible for their own development. However, practice shows that when left to themselves, not all institutions have the same level of success. They are often unable to keep up with the pace at which the NREN advances. Smaller institutions, in particular, are affected. They are not always able to provide the necessary resources and/or fulfil the conditions set for some services.

On the other hand, the NREN and the individual campus networks have the same end-users. Users expect a quality service at their working location, thus within the campus. In order to satisfy the needs of end users with the number of services offered and their quality, a uniform quality of the network infrastructure and support must be achieved in the end-institutions, so that the quality of their infrastructures is as high as that of the backbone. Since the development of the infrastructure and services on the backbone and on campuses falls under different areas of responsibility, the question that is posed is whether there is a methodology, model, or measures whose application can lead to the desired goal – the harmonised development of these network segments.

An extensive study, as part of the predecessor GÉANT project, was carried out during 2006 and 2007. One of its components, the "EARNEST Report on Campus Issues" [1], was dedicated to analysing the state in the campus networks of universities in Europe. The study makes 52 recommendations, which should improve the development of campus networks

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served by the NRENs that apply them. The recommendations state what should be done, but they do not always say how to achieve it, as detailed instructions on implementation were well beyond the remit of the project.

At the same time, looking for a way to provide support and to standardise the development of university and college campuses around Norway, the Norwegian NREN, with the assistance of the relevant ministry, launched the GigaCampus project (2006-2009). Their work was aimed at increasing cooperation between institutions in order to arrive at common technical solutions and recommendations for campuses. The participation of institutions in this process was intended to include the technical staff employed in them and to encourage cooperation through participation in working groups in the various technical areas. This created a circle of experienced people from the ICT sector, who could transfer their experiences to the entire academic community in the form of national best-practice documents.

UNINETT is having measurable success on its member campuses through this approach. Because the steps that UNINETT is taking are in line with the EARNEST recommendations, and because the approach encompasses one of the possible ways to implement them, the question which arises is whether the Norwegian experience can be applied in other countries. The methods that UNINETT is using in its work at the national level serve as a basis for defining the activities in the task (GN3 NA3/T4) of the GÉANT project, so that other similar activities can be launched in other countries. Besides Norway's UNINETT, another three countries are involved in the initial phase: Finland (CSC/Funet), Czech Republic (CESNET) and Serbia (AMRES). Of these, Serbia is the only one that is faced with solving the problem of poor technological development - the so-called 'digital divide' problem. A description of experiences recently gained at AMRES during the implementation of the adopted model can be of benefit to NRENs operating under similar conditions.

The rest of this paper is organised as follows: Chapter 2 describes, in detail, the working model of Campus Best Practice (CBP) activity, Chapter 3 is about the conditions in which the model is applied at AMRES, and Chapter 4 is about the experiences gained during the two years of implementing the model at AMRES. The paper ends with conclusions.

II. Chosen Model in GÉANT Task NA3/T4

The Campus Best Practices model shown in Fig. 1 has been created to explain the step-by-step procedure through which the NREN proceeds, in order to reach the end goal. This goal is the establishment of practices for the continual improvement of campus networks, primary services, and the level of knowledge and expertise of the engineers/technical staff, who develop and/or maintain the networks. It starts with ideas on cooperation between these staff members, as well as key ideas for achieving the goal. The sharing of knowledge and experience among the technical staff is encouraged and different forms of cooperation are included. New activities are gradually introduced, based on the results of the previous steps.

Fig. 1. Campus Best Practices model

The activities are divided into six groups so that the entire model comprises six steps, from the first simple steps to the most difficult in terms of the involvement of resources (people and money). The implementation of the first three steps can be begun with a relatively modest budget. In order to move forward to the later steps, more and more financial support is required. Bearing in mind the available budget, GÉANT has adopted a basic working model comprised of the first three steps. Although the benefits of implementing the basic model are visible, it is useful to view these steps as an introduction to the next, and be aware of the advantages of extending the activity. The steps are shown in Figure 1.

1) Organise workshops to share experiences. This is the initial step and a way to facilitate discussion on topics, as well as to present various solutions from the chosen technical areas. The technical areas that are dealt with in the GÉANT model are physical infrastructure, campus networking (redundancy, IPv6), mobility, security, network monitoring, and real-time communications (video, VoIP).

2) The next step is setting up working groups, i.e., gathering the inner circle of technical personnel at open forums for cooperation based on their interest in a specific area. Each group is dedicated to one technical area, in which there is a large number of similar topics. Participants meet two to four times per year to discuss the chosen topics. The sharing of experiences between meetings is encouraged via mailing lists, wiki pages, etc. The purpose is not simply discussion. In order for them to have real meaning, it is desirable that on the basis of experiences in individual campuses, best practices for all campuses are established and defined in the form of documents.

3) The development of documents with guidelines and recommendations for campuses is done via the iterative procedure shown in Figure 2. In order to extend the experience that is concentrated in the working groups outside these groups, the conclusions and recommendations must be put into documents. Documents do not need to be long (fifteen to thirty pages), but they must describe practical solutions adapted to the needs and capabilities of campus networks in the NREN. The real kick-start for the work of the groups should be an initial draft document, which then is improved in an iterative procedure through in-group discussions, after which the document is made available to the academic community. The collected comments and additions, which the group adopts, are incorporated into the harmonised version of the document.

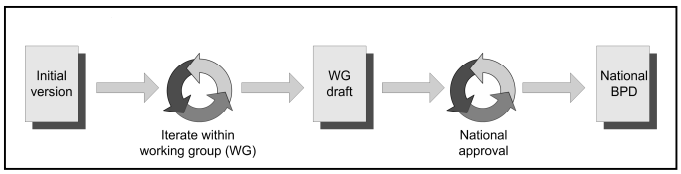

Fig. 2. Development stages of documents with recommendations

4) Organise common procurements for the needs of a larger number of the campuses is the fourth step, and is the first in a series of more demanding activities. These are conducted on the basis of the specifications contained in the documents harmonised in Step 3. These documents do not always have to contain specifications of equipment or services, but they should contain enough information to draw up specifications according to which common procurements are conducted for interested campuses. The benefits of implementing this step in the NREN are multiple. They can be seen in savings made in expenditure, the engagement of the people involved in procurement, and the achieved quality of the specification and uniformity of equipment, which further facilitates such activities as maintenance and training.

5) The provision of consulting assistance in the campus itself is the concretisation of the recommendations in real conditions in the field, where it is necessary to propose an appropriate solution, after having identified the problem. Problems which need to be solved frequently come up during the re-design of the current state of the network and during the implementation of the selected solution on campus.

6) As the largest level of support for campuses, the model envisages the inclusion of members of the working groups in the work to implement solutions on campus in line with existing recommendations and documents. During this period, the level of capability of engineers on campus is increased and also experience is gained on new documents and topics for which practise has not yet been established.

In the document [2] there is a detailed description of the model together with recommendations for all NRENs that want to begin these activities at the national level. Some of the open questions regarding the model are whether it is scalable and applicable to large NRENs, and how applicable it is in poorly developed NRENs and in conditions of poor financial support.

III. Conditions in Which the Model Was Implemented in AMRES

When the project was started, the AMRES network had approximately 150 institutions, of which the majority were faculty campuses and research institutions. The network is managed by four service centres: the computing centres of the largest state universities in Belgrade, Niš, Novi Sad and Kragujevac. AMRES' services are financed by the relevant ministry and are completely free-of-charge for all institutions and users. Depending on their geographical location, campuses are supported by their own service centre.

In the meantime, AMRES has been established as an organisation, so that the middle of the third year of the GÉANT project coincides with the start of the new period of development. In the transitional period, there were many issues that needed to be solved, so this period was not suitable for starting new practices for campuses.

For a long time, part of usual practice in AMRES was to organise of regular meetings (two or four times a year) for campus and service centre engineers. The programme of the gatherings was made up of different content: information for the community about strategic decisions, presentations on technical details of services or activities, discussions about technical and other issues, and guest lectures about innovative services and research projects by our colleagues from other countries. From these activities, Campus Best Practices was initiated.

The remaining parts of the model, described as steps 4, 5 and 6 in the previous chapter, were important to AMRES. Some of the activities in these last three steps have already been carried out, to a limited extent. For example, common procurement for campus needs have been organised several times in the past, motivated by limited resources and a desire to secure as much equipment as possible. Only the service centres are involved in choosing the technical solutions and equipment specification, so, in some way, the choices are imposed on the campuses. However, in contrast to the experiences of the more developed NRENs, the institutions in AMRES are positively affected by this, because the selected equipment is much better than the equipment their individual budgets allow them to purchase. Campuses in AMRES often consult their service centre about procuring equipment when they are unsure of the necessary technical characteristics or solutions. Service centres very frequently help institutions on campus during the implementation of chosen solutions, and most frequently, when they are establishing the most simple configurations (when a campus has just joined the academic network), or when they are implementing especially difficult configurations.

The training of technical staff on AMRES' campuses has been gradually increased through the Cisco Academy. Cisco Academies are organised in several locations in the network and are equipped with all required equipment. However, there was a lack of documentation, with which, the technical staff on campuses could acquaint themselves with current AMRES practice.

It is important to underline that all the AMRES' activities were organised as isolated activities, but not as part of a planned, implemented model that would lead to a lasting and planned process on which the campuses could rely. Other NRENs are also likely to have experiences with similar isolated activities, organised more or less frequently. It is important to underline the difference between isolated procedures and a consciously implemented model in the NREN, even when it is limited to some of the first steps. Each step is a solid foundation for the next, from which the NREN can move forward, depending on the degree of implementation of the model that the NREN is able to support.

IV. AMRES' Initial Experiences With the CBP Model

Before the start of the GÉANT project, two steps from the proposed model were completely new to AMRES: developing/using its own best-practice documents (BPDs) and organising the community into working groups for individual technical areas. Thus, the first priority for team members was to interest the on-campus engineers in these activities. The experience gained over three years of implementation of the organisational model pertains to gaining the support in its NREN community for these activities: establishment of/cooperation in working groups for technical areas and writing/using one's own BPDs.

In NRENs such as AMRES, which have not yet experienced the concept of cooperation through working groups, the successful outcome of initial activities may depend on the choice of the technical areas for which working groups are formed, and the choice of topics for the first BPDs. This is because these choices, in the initial phase, are imposed on the community. It is important to address current unresolved challenges and/or a pressing need for recommendations in a particular area. After activities have begun, and after the first positive effects within a working group have been achieved, participants can then propose topics for future BPDs. Proposals to establish groups for other areas, directed at team members, come after this, as a clear sign that the community has accepted the concept.

The AMRES criteria for the selecting technical areas were a pressing need for recommendations in a particular area, the need to transfer experience from one centre to the whole community, specific interest in a technical area expressed the campuses. Based on these criteria, three groups were formed in AMRES for physical infrastructure, network monitoring and security.

- The group for physical infrastructure was established due to the need to define recommendations for institutions that have just joined the NREN, and also for improving the infrastructure in current campuses by adopting harmonised technical solutions (for powering and cooling, for example). In this period, the inclusion of secondary schools in AMRES was planned, i.e., a potentially large number of new institutions to the network.
- The group for network monitoring was formed due to the need to transfer experience concentrated in one AMRES service centre to the community.
- The group for security was formed due to campus' interest in cooperating in order to solve a wide range of technical issues (such as firewalls, CERT, and AAI), but also due to the need to familiarise new technical staff with existing practice.

Offering insight into the experiences of other NRENs plays a special role in gaining support for Campus Best Practices activities in one's own community. AMRES used the following methods:

- *the presentation of solutions of other NRENs in order to encourage its own community to discuss its needs*

  Campus Best Practice activities have their own organisation model but also their own technical results [3]. The organisational model needs to be described briefly in the initial phase, but it is easier to use the technical solutions of other NRENs to attract the attention of the technical staff in one's own community. However, what is good practice for one NREN is not necessarily good for the NREN of another country. For example, aware that its institutions have much more modest requirements, AMRES used UNINETT's BPDs in the area of physical infrastructure to encourage discussion about its own needs and the development of its own BPDs.

- *presentations by experts from other NRENs at workshops organised for AMRES campus staff*

  Upon the adoption the CBP concept within AMRES, the special need for cooperation on current technical topics for AMRES campuses was expressed, such as wireless, eduroam®[1], or authentication infrastructure. Campus staff still do not have enough experience in these areas to form working groups to work on the creation of BPDs, but they can currently strengthen the campus community through common experience gained in mastering services in new technical areas.

At AMRES, we are of the opinion that all activities need to be planned to embrace previous positive experiences. Initially, it is necessary to identify activities in one's own network that are similar to those offered in the model in Figure 1. It is enough to choose one activity in which campus staff has had a positive experience in the past and through this activity, present to them the value of the CBP model and provide the necessary explanations. If initial positive effects are achieved, uniformity in presenting these activities and constant reference to previous events are of further help. Advice from and the support of the public relations (PR) services are desirable, but they are often not available to NRENs with a digital divide problem. Things are made easier thanks to the GÉANT CBP team members, who see themselves as the demonstrators of what is done in other countries. Recently, the team has become ready to offer support to NRENs that are interested in the model, and to organise workshops in line with their needs, as an initial activity in moving the campus community of the NREN towards the CBP concept. Training and workshops take place at national and regional level, depending on the subject concerned [6]). AMRES also contributes the task team's efforts to the organisation of workshops in South Eastern Europe.

During the three-year period, AMRES' efforts have resulted in the development of ten best practice documents. Of these, four have been translated to English and published along with documents produced by the NRENs of the other task members. The English documents cover topics from six

[1] eduroam is a registered trademark of TERENA, the Trans-European Research and Education Networking Association.

technical focus areas (physical infrastructure, campus networking, wireless, network monitoring, real-time communications, and security) and are available on the GÉANT and TERENA websites [3]. A mailing list has been set up to announce the publication of new BPDs [7]. AMRES BPDs are available in the Serbian language on the AMRES wiki website [4].

A lack of experience with BPDs affects the process of creating them, their content, and the quality of initial BPDs. "Wishing to explain everything" and covering many different cases, means that AMRES' initial BPDs are long (around 50 pages) and contain a lot of theory. There is no need to discourage the creation of such BPDs. They should be viewed as a good starting point from which shorter documents, focused on recommendations, will come. Time is needed to arrive at appropriate forms and quality, through group work and discussion.

In some cases, introducing campus categorisation for which appropriate solutions are proposed can lead to a reduction in the number of options considered and therefore, can result in more concise documents. Group members need time to agree on the boundaries of each category. In a NREN the size of AMRES, it has been demonstrated that defining two or three categories of campus is optimal.

AMRES is still looking for precise methods to determine the effectiveness of the initial BPDs and BPDs created after them, i.e., whether the recommendations in these BPDs were accepted and implemented on campuses. Some of the indicators are visits to the AMRES wiki pages, the number of views of the lectures recorded at workshops (which are available on the AMRES media portal [5]), and the increase in the number of institutions in AMRES that began to use certificates after the publication of the BPD, Securing Service Access with Digital Certificates ([4] and [3]).

Given the starting point for the implementation of the Campus Best Practices model in AMRES, the impression is that the implementation of the first three steps of the model is bringing large benefits to the community. Individual groups of activities from different parts of the Campus Best Practice model (in Figure 1) can be implemented separately, but it is better to follow the proposed order so that stronger support for the introduction of the increasingly more difficult activities can be gained over time in the NREN.

Establishing all six steps is undoubtedly a long-term process. The way in which the process is initiated, who is the leader of activities in the NREN, and the support gained over time in the NREN for these activities all affect its sustainability.

Compared to UNINETT, in which the process was initiated within the framework of strategic management, in the case of AMRES, the activity was adopted through participation in the GÉANT project.

Members of the GÉANT task team, mainly from one AMRES service centre (Belgrade University computing centre), are the leaders of CBP activity in AMRES. The NREN's decision to carry out CBP activities was sufficient to implement the model up to the third step. Thus, in the initial phases of adopting the model, the activity leader could also be a larger university or group of universities interested in these activities. However, the further expansion of activity is only possible with adequate financial support. The most natural leader of CBP activity for campuses in a NREN is the NREN organisation itself, because this organisation can harmonise and implement an appropriate funding model.

Figure 3 shows the connection of the leaders of activities in the NREN with the institutions that fund the NREN and the on-campus IT community. For the concept to be durable in the NREN, it is necessary to secure the support of both sides. The shaded areas represent the support given by one party to the other party. The greater the area, the greater the expressed support from the participants in the working groups or the number of positive strategic management decisions. In order to gain support, activities can at first be directed at one party or both. Different topics motivate these groups to support an activity.

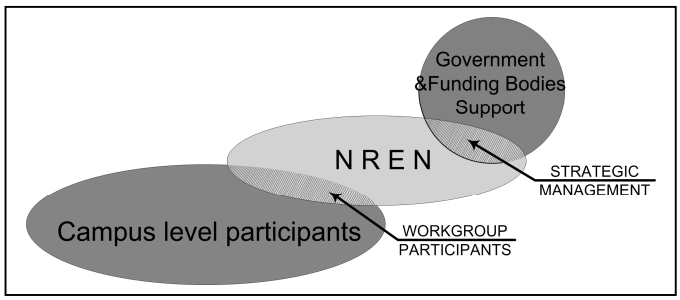

Fig. 3. The connections between campus level participants, the NREN and funding bodies

Staff members on campuses show much greater interest in the technical solutions and the results of the implementation of the model of BPDs, whereas only its organisation approach catches the attention of strategic management.

Initial activities in AMRES were directed at campuses, and through them, a wide base of potentially interested participants was included. Over the period of implementation of the model in AMRES, a solid base for the next CBP activities in this target group was formed. However, there are two facts that should be highlighted, because, in our opinion, they made the process of adopting the model more complicated:

- ***Experience is concentrated in AMRES' service centres.*** Outside the service centres, there are many more who simply expect to receive the services without being required to provide any input. Thus, it is not easy to recruit a sufficient number of members for the working groups.
- ***AMRES services are completely free-of-charge for all institutions and users.*** As long as network services cost zero euros, users on campuses do not attempt to perceive and differentiate the level of support of the NREN, i.e., every expansion of the list of obligations of the NREN to the campuses must be financed from some source. Thus, it is not easy for the NREN organisation to secure the financial support to

incorporate steps 4, 5 and 6 of the model into the established practice on campuses.

Activities to gain strategic management support in AMRES have been postponed until a later date. The situation is helped by the fact that strategic management also being directed to other sources of information, and its decisions are often based on the positive experiences of other NRENs. Significant support can be expected if the activities aimed at campuses begin to achieve the levels of success and the high profile of the NRENs in the more developed countries.

V. CONCLUSION

It is important to note the difference between the individual steps aimed at improving the state of networks on campuses and to implement the Campus Best Practice model, which will lead towards the establishment of a long-term and planned process of support for campuses, and which campuses can rely on in the future. Very little financial support is needed to begin the CBP activity, which brings large benefits to the community. In order for the CBP concept to be sustainable in the NREN, it is necessary to ensure the support of the technical staff on campuses, as well as that of the strategic management, and of the bodies that fund NREN activities. Today, a solid base for the next steps has been created at AMRES. Further implementation of the steps of the model will depend upon AMRES' capability to implement them.

Acknowledgment

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Mara Bukvić received her B.Sc and M.Sc degrees in Computer Engineering and Science from the School of Electrical Engineering, University of Belgrade, Serbia, in 1991 and 1996. She began her career as a research assistant at the Institute of Nuclear Sciences, Vinča, Serbia. In the middle of the 1990s, she joined the University of Belgrade Computer Centre as network engineer, an institution responsible for the development of AMRES, the Serbian national research and education network.

In the time period 2000-2010, Bukvić was head of a team of network engineers responsible for many major, national scale projects, i.e. implementation of the gigaAMRES 1 Gbps optical dark fibre infrastructure that encompasses 21 cities in Serbia and two cross border connections; network design of the backbone connecting 180 sites from scratch to WAN for the Republic Fund of Health Insurance, Ministry of Health; redesign of the network based on IBM SNA architecture in order to enable VoIP service including transition to the TCP/IP protocol for Customs Administration, Ministry of Finance; a physical infrastructure project for the underground floors at the headquarter building of the National Bank of Serbia with more than 3000 outlets and 120 km of cable. Until AMRES was established as a separate, legal entity in 2010, her position was recognized as equivalent to the Chief Technical Officer of AMRES.

Bukvić is a member of the Serbian Chamber of Engineers. Currently, she works as network engineer and researcher at University of Belgrade Computer Centre and her research interests comprise body area networks (BAN) and sensor networks.

Bukvić participated in the GN3 NA3/T4 Campus Best Practice task from 2009 till 2012, where she worked on the implementation of the Campus Best Practice model in Serbia, which also is the topic of this paper.

Complete BPDs available at www.terena.org/campus-bp/

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