LeaRN: A Collaborative Learning-Research Network for a WLCG Tier-3 Centre

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LeaRN: A Collaborative Learning-Research Network for a WLCG Tier-3 Centre

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Abstract
The Department of Modern Physics of the University of Science and Technology of China is hosting a Tier-3 centre for the ATLAS experiment. A interdisciplinary team of researchers, engineers and students are devoted to the task of receiving, storing and analysing the scientific data produced by the LHC. In order to achieve the highest performance and to develop a knowledge base shared by all members of the team, the research activities and their coordination are being supported by an array of computing systems. These systems have been designed to foster communication, collaboration and coordination among the members of the team, both face-to-face and remotely, and both in synchronous and asynchronous ways.

The result is a collaborative learning-research network whose main objectives are awareness (to get shared knowledge about other’s activities and therefore obtain synergies), articulation (to allow a project to be divided, work units to be assigned and then reintegrated) and adaptation (to adapt information technologies to the needs of the group). The main technologies involved are Communication Tools such as web publishing, revision control and wikis, Conferencing Tools such as forums, instant messaging and video conferencing and Coordination Tools, such as time management, project management and social networks. The software toolkit has been deployed by the members of the team and it has been based on free and open source software.

1. Introduction
Metcalfe’s law [1] states that the value v of a communications network is proportional to the square of the number of connected users u of the system, as shown in equation 1.

\[ v \propto u^2 \quad (1) \]

It is related to the fact that the number of unique connections in a network of a number of nodes n can be expressed mathematically as shown in equation 2.

\[ c = \frac{n(n-1)}{2} \propto n^2 \quad (2) \]

Metcalfe’s law has been intensely applied to evaluate the networking effects of technologies such as the Internet and the World Wide Web. Some authors [2] have argued that Metcalfe overestimated the value of a communication network and suggest that the value v of a general communication network of size n grows as shown in equation 3.
This would be faster than the linear growth but much slower than the quadratic growth of Metcalfe’s Law.

However, the widespread use of social network services point to the fact that the actual social utility of a network depends upon the number of nodes in contact, instead of just taking into account the total number of nodes, and thus the potential number of contacts. The quality of communication established between different nodes has to be evaluated as well, as the nodes that generate low quality content such as spam are not adding any value to the network. On the contrary, they might be substracting value from it. Therefore, a social network has to be designed to maximise the number of connections between the nodes but also the quality of these interactions, in order to achieve the highest performance and to reach the maximum value.

LeaRN is not a social network service but a collaborative work platform. Nevertheless, it shares with any of these services some basic features: is the reflection of the social relations of a group of people that share common activities, it makes a strong emphasis on web based services and its main objective is to allow members to share knowledge, interests and activities with other members. The main difference is the final target of LeaRN: despite having every user his own learning and research approach, all users work together to pursue a common goal. In this situation, the number and quality of interactions between the nodes of the network are the most important variable in the design of LeaRN.

2. Design of LeaRN

In order to maximise both the number and the quality of interactions between the nodes of the LeaRN network, an appropriate collaboration environment has to be designed. The basic characteristics of the collaborative work to be developed in the Tier-3 centre are closely related to the so-called dimensions, i.e. general attributes of collaboration that may be studied to define and improve collaboration. These dimensions depict the philosophy on which LeaRN is based.

2.1. Dimensions of collaborative work

A few general aspects have been identified [3] [4] as the core of computer supported collaborative work. Among them, the three more relevant to our interest are:

Awareness: Members of the network have to be able to get shared knowledge about other’s activities. To achieve this knowledge exchange, both a database and a communication media has to be provided. The main advantage of awareness is allowing the members of the group to access the full knowledge and the activities of the group and thus avoiding unnecessary research and duplicated work. A deeper awareness of other member’s activities allows the users to look for sinergies in their research.

Articulation: In a interdisciplinary environment, where experts of different disciplines (namely physics, engineering, computing science) combine their efforts, it is crucial to provide the necessary tools to allow projects to be divided, work units to be assigned and then reintegrated. This dimension of collaborative work requires an appropriate evaluation of manpower and an adequate way to divide and assign tasks to be performed, together with the appropriate time management.

Adaptation: A WLCG Tier-3 computing centre makes an intense use of information technologies, especially those related to data retrieving, storaging and processing. All members of the team are expected to master the computing skills needed for the normal development of the data analysing activities. Nevertheless, in the LeaRN environment, information technologies are adapted to the learning and research needs of the network.
The dimensions of awareness, articulation and adaptation define the theoretical base on which LeaRN has been designed, the first step in the setup of a computer supported collaborative environment. The second step is isolating the basic activities in which work can be devided, before deploying specific software to support the development of these activities.

2.2. Activities involved in collaborative work
LeaRN has been designed to encourage three main activities within the group: communication, collaboration and coordination. These main activities may be carried out both in the same place and remotely, and both in synchronous and asynchronous ways. Using this binomial, activities may be classified in two main categories: synchronous, if it requires the coordination in time of events or asynchronous, if coordination in time is not required.

Both synchronous and asynchronous activities may be divided into three main categories:

**Communication Tools.** Communication is understood as an exchange of information. A phone call is an example of synchronous communication while an email is an example of asynchronous one. In a collaborative environment, wiki and webpages also form part of the most common communication tools.

**Conferencing Tools.** Also referred to as collaboration, conferencing is understood as an interactive work in which participants collaborate to achieve a common goal. Instant messaging and video conferencing allow synchronous conferencing while a forum is a place where asynchronous conferencing is developed.

**Coordination Tools.** Coordination is understood as the integration of diverse work elements to follow a common itinerary. The main tools involved in coordination activities are time management, project management and social networks.

3. Implementation and Deployment of LeaRN
Implementation is the third step in the development of the LeaRN network. This last step consists in the deployment of a software suite that maximises awareness, allows articulation of work and adaptation of information technologies to the needs of their users. This suite includes the necessary tools to guarantee communication, conferencing and coordination among the members of the team, as shown on Figure 1.

The LeaRN platform has been deployed locally in a computer, integrated in the local cluster but visible only to the intranet users and accessible by any member of the team through username and password. Despite being considered part of the cluster and being connected to the local email and web server, the access to the LeaRN server is restricted to the users of the local domain for security reasons.

**Communication.** LeaRN allows a steady flux of information between the members of the Tier-3 Centre. One of the most important achievements of LeaRN is to allow the sharing of information without the need of face-to-face synchronous communication, by using tools such web publishing and wikis. Using the LeaRN platform, any member of the team (researchers, engineers, students) is aware of the tasks being carried out in the research group. This approach has been especially applied to a quick deployment of the computing cluster and the software (operating system, middleware, etc), making possible an easier organisation of workgroups where each individual has a overall perspective of the deployment of the Tier-3 Centre, which is a complex task, but also a exact knowledge of the responsibilities of each member of the team, so sharing information and asking for help or advice is much easier than before.
Figure 1. Depiction of LeaRN.

Conferencing. The improvement in the conferencing activities is one of the main assets of the application of the LeaRN toolkit to the deployment of the Tier-3 Centre. Some activities, as usual meetings to present the weekly work to the supervisors have been improved with a continuous support for the research activity, based on several tools: a) broadcasting of the meetings via videoconference to allow remote assistance, b) publication of any past meeting, especially talks, along with slides, photographs and papers in the LeaRN website as a webinar for students, c) deployment of a forum and a IM system where posted questions can be instantly answered by more experienced members of the team, without waiting till next meeting and therefore affecting the performance of the students, and d) use of shared applications to raise awareness of the progress of the deployment of the Tier-3 facilities and software.

Coordination. Coordination is achieved by integrating in LeaRN two main tools: project management software (used to set a schedule and a progress evaluation scheme, usually including Gantt charts and PERT network charts, along with the project information) and revision control tools (used to organise the software development and deployment activities, especially where a large number of engineers and students are involved). Both tools are integrated in the LeaRN website and available to those users involved in a given project. Finally, social software is being used as a common framework, as long as it provides a way to improve synchronous and asynchronous communication between the members of the team, a conferencing environment and especially a way to foster coordination without the necessity of a rigid hierarchy.

4. Results and Impact of LeaRN

LeaRN goes beyond the quantitative approach stated by the aforementioned Metcalfe’s law, and helps to maximise the interaction between the nodes of the network, namely researchers, engineers and students, providing the necessary tools to achieve the highest quality in these interactions, as it might be expected of a project that follows the ideas behind social networks to achieve its target of collaborative research. The main results can be summarised as follows:
Awareness: LeaRN is allowing the members of the research team to get more and more information about the activities performed both by the group and by each of its members. Publication of progress reports, research techniques and partial results are no more viewed as a weakness, but as an opportunity to look for possible synergies, new project ideas and any possible improvement of the current work procedures, which is a quite important asset in a multicultural research environment.

Articulation: LeaRN is making easier to evaluate the workload of the Tier-3 cluster project and find the more efficient way to split it into different tasks to be assigned without losing a continuous communication, conferencing and coordination interaction between the members assigned to the different areas of the project, until the project will be completed. Moreover, LeaRN helps to achieve a fair distribution fo the workload of the project, adapted both to the previous workload of each member of the team and his or her research interests.

Adaptation: LeaRN is an example of the adaptation of information technologies to the needs of a team. A number of software applications have been identified and each of them has been given a particular use, always related to the research activities, instead of using just an application for the whole research project, with would interfere with the idea of articulation, as the training and the need of every member of the team are different and should be taken into account.

5. Conclusions and Further Work
The main outcome of the deployment of LeaRN is an increased efficiency in the research procedures linked to the deployment of USTC’s Tier-3 Centre, that is leading to a better use of the manpower and an increased capacity to study and tackle new research projects, particularly small but promising side projects that could not be considered before. This approach helps to achieve better overall results for a rather small research team.

LeaRN has shown itself as a powerful tool to boost collaborative work between the members of the team. The software applications that implement communication, conferencing and coordination activities provive the necessary toolkit to build a knowledge base where information is shared and learning and research initiatives are understood as a common effort based on collaboration and coordinated to achieve a common target. This knowledge base is an important advantage in an international and multicultural environment such as USTC is.

The deployment of this toolkit allowed the members of the team to perform their research activities in a more efficient way, eliminating unnecessary redundant activities, especially in the areas of software developing, documentation and communication. LeaRN is currently used in all the tasks related to the data analysis and computing activities of USTC’s contribution to WLCG and also in other research projects such as NEMO (USTC’s network monitoring software for high-performance computing, also deployed in the Tier-3 cluster). Further development of LeaRN will include interaction with more social software platforms as well as the integration of docent activities such as summer schools and courses.

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