ESA STUDY CONTRACT REPORT

ESA Contract No:	SUBJECT:	CONTRACTOR:
21018/07/F/VS	Diffusing Information and Collaboration Technologies in ESA - Executive Summary	Elsag Datamat spa

ESA CR( )No:	No. of Volumes: **1** This is Volume No:**1**	CONTRACTOR'S REFERENCE: DMAT

ABSTRACT:

This is the Executive Summary of Diffusing Information and Collaboration Technologies in ESA (DICTE) study, commissioned by ESA under the General Study Programme with the overall objective to '*pave the way for a practical implementation of an ESA-wide technical collaboration platform, based on an advanced ICT infrastructure (e.g., very high speed connectivity, sharing of computing and storage resources, sharing of tools, common web based services).*'.

The proposed DICTE collaborative platform is designed to be both technology and policy neutral in the form of an open Service Oriented Architecture capable of providing collaboration services to a wide variety of ESA domains.

A roadmap according to current levels of maturity for different technologies to be considered shows that in few years it could be possible to build such an infrastructure. Part of this roadmap there is also the plan for a prototype to proof some of the less mature technologies and services starting from some elements already existing,

The work described in this report was done under ESA Contract. Responsibility for the contents resides in the author or organisation that prepared it.

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Diffusing Information and Collaboration Technologies in ESA

Executive Summary

by

ELSAG DATAMAT
A Finmeccanica Company

scisys

November 2009

ESA Contract No. 21018/07/F/VS

DICTE ("Diffusing Information and Collaboration Technologies in ESA") is a project funded by the European Space Agency.

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1. INTRODUCTION

Collaboration is primarily a human issue: people need both the opportunity to collaborate, in terms of time, as well as a reason to do so, in terms of being able to benefit from it. People dealing privately with Internet are very keen on social collaboration and knowledge sharing. On the other hand people working in structured organization do not have the time to exchange knowledge and participate in information sharing activities due to their time restrictions and because of other critical reasons which are elaborated in the presented paper. This is a very important point and supports the view that while the technical infrastructure must make it easy to perform these activities there still needs to be the motivation to do it.

Within this framework, the European Space Agency, at end of 2007, awarded a project called **Diffusing Information and Collaboration Technologies in ESA (DICTE)**, commissioned by ESA under the General Study Programme with the overall objective to '*pave the way for a practical implementation of an ESA-wide technical collaboration platform, based on an advanced ICT infrastructure (e.g., very high speed connectivity, sharing of computing and storage resources, sharing of tools, common web based services).*'

The European Space Agency (ESA) is a geographically dispersed pan-European organisation with important operations, research and development divisions located in many different countries. Much of the project work involves multi-national consortia composed of ESA staff, independent scientists, academic institutions and industrial organisations working together to define and support space missions.

In the current study collaboration has been examined from the perspective of an essentially human activity that is influenced by wider cultural issues and aspects of working practices that are independent from the introduction of technology per se and which must be understood before we can reap the benefit of true collaboration.

The study has been awarded to a consortium led by Elsag Datamat spa and comprising:

- Elsag Datamat spa (ED – Italy)
- SciSys UK Ltd. (SSL – UK)

2. STUDY LOGIC AND TIMEFRAME

The approach to the project was quite straightforward:

- the first phase was focussed on the requirements' gathering and analysis, according to different Space thematic areas and communities points of view;
- after that, an analysis of the state of the art of technologies, standards, methodologies, reference architectures and services if any, etc. was performed on selected thematic areas" and communities, analysing also the relevant use cases. The goal was to derive the benefits that technologies, standards, etc. will provide and to map them to requirements and use cases;
- then, a strategic development plan towards an ESA-wide collaboration infrastructure was prepared, beginning in parallel to identify a preliminary architecture for such infrastructure (that could be seen as "step 0" of such a strategic plan) as well as to prepare a possible prototype definition implementation plan.

The key milestones of the project were the following:

- Kick Off meeting was held at ESRIN premises on November 28, 2007
- User Requirements Review meeting was held at SciSys premises on April 23, 2008
- Benefit Survey and Mapping Review meeting was held at ESRIN premises on September 11, 2008
- Architecture Design and Prototype Definition Review meeting was held at ESRIN premises on July 14, 2009
- Final Presentation meeting was held at ESRIN premises jointly with the above review on July 14, 2009

3. STUDY MAIN OUTCOMES

3.1. REQUIREMENTS ANALYSIS PHASE

The following conclusions of the requirements analysis phase, which included ESA and non-ESA senior people interviews, can be drawn.

- ESA Virtual Communities are quite homogenous in the sense that in each Virtual Community we can identify a common list of actors. It is very important to have a mechanism that permits to make a correlation between the actors and the usage of the collaboration platform. This implies the necessity of definite roles with specific related policies.
- ESA Virtual Communities should address both collaboration and knowledge sharing aspects. Collaboration is strongly diffused in the case studied proposed so far. This means that people are already used and prepared to collaborate but, at he same time, we can state that a collaboration platform that integrates different collaboration aspects does not yet exist. Knowledge Sharing is felt a very important issue as well. As, for example, outlined by the CDF case study, Knowledge Sharing (what they call Knowledge Capitalization) play a key role also in situation where a very strong collaborative environment already exist. This is a very important point because it underlines that a Virtual Community is really formed by the two half of the circle that we have proposed at the beginning of this document.
- The way toward One ESA is open, people seem to be ready and, more, it seems people are really waiting for a collaboration platform that easy their daily work. Beside that, we have also verified in this first phase of the study, that many different realities live inside ESA. From one side this is a positive fact because heterogeneous and diversified ambient favour the circulation of ideas and solutions. From the other side the different realities should be stimulated not to be self-sufficient and thus to be open also to solutions coming from different areas. These considerations lead to the conclusion that, in the DICTE study, ESA itself plays a key role for the success of One ESA.

Concerning details on which are the tools/technologies Virtual Communities consider as important, Figure 1 graphically represents the results:

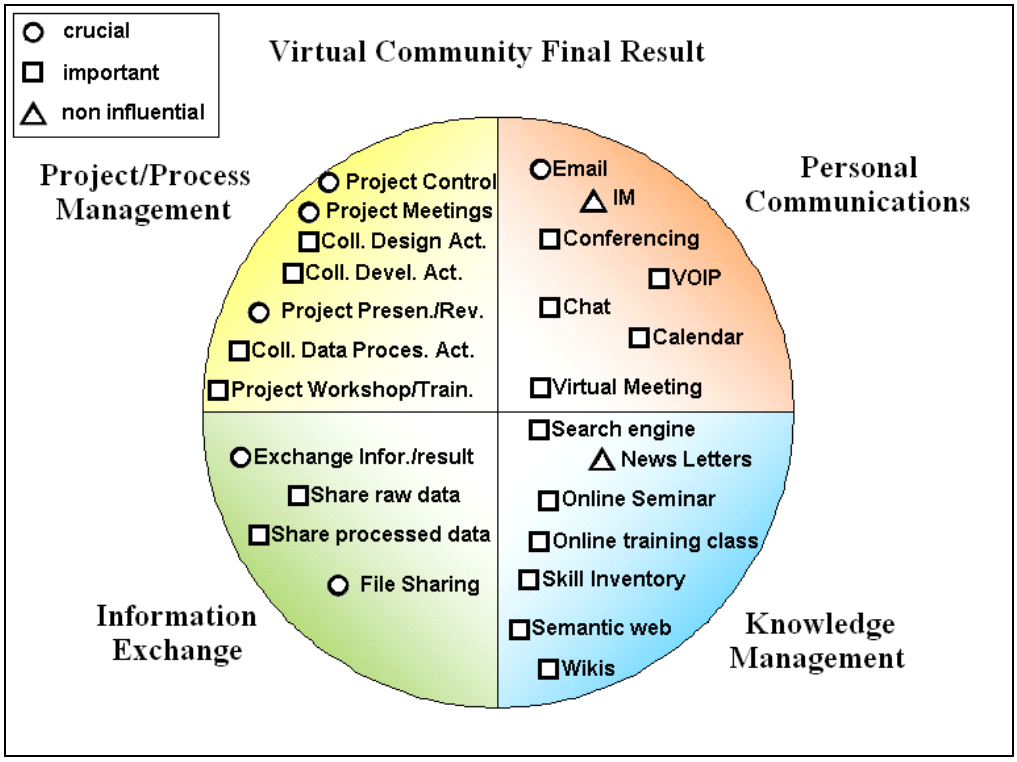

Figure 1 - Virtual Community Final Representation

3.2. BENEFIT SURVEY AND MAPPING PHASE

After having interviewed ESA and non-ESA senior people to understand the perceived benefits of collaboration and having mapped current technologies with this, these are the main findings of this phase:

- Individual objectives do not coincide with collective objectives
- Individual collaboration effort is not correctly evaluated by the high management
- Employees are reluctant to share new ideas because:
  - they fear someone else could benefits from their valuable contribution
  - they are not confident that the team can help in the development of the idea itself
- Learning how to use new collaboration tools is time consuming; people are reluctant to abandon the tools they already know
- Collaboration benefits are not easily measurable and often are not immediate

Beside the cultural limiting factors there are some technology related obstacles peculiar to ESA sites:

- Protecting sensible data and define Access Control List
- Very precise and detailed policies to be respected
- Firewall and security restrictions do not allow the use of common tools like Instant Messaging

- Open source software is not trusted

In order to select the technologies that deserve attention in this study we performed a gap analysis between the needs of the collaborative environment and the support provided by the available set of collaboration tools, establishing what technologies are missing from the combination of tools currently available but are required to create a true collaborative environment.

The selection of tools must be driven by the objective of creating a coherent environment. With this in mind tools that support 'open standards' designed to support generic interaction (collaborative behaviour) is very important with respect to interoperability.

The obvious implementation for such an environment, therefore, will be a multi-tiered system based on a Service Oriented Architecture (SOA) operating on open standards that seeks to integrate the various collaborative functions as 'services'. This provides the opportunity for services to be chained to support any desired configuration or application of the collaborative environment.

Tools and technologies have been surveyed for:

- Searching the collaborative environment, including ontologies management
- Business Intelligence & Knowledge Management
- Application/Data interoperability
- Content Management
- Semantic interoperability

As a conclusion of this phase of the study, a good collaborative system should foster a synergy among the following pillars (and the exigencies of ESA Virtual Community should drive the process of balancing the different pillars):

Strategy

The strategy that will be adopted in the design of the collaboration platform is fundamental. We can interpret *strategy* in two ways. From one side there is the necessity to have a detailed strategy, from DICTE consortium, finalized at the design of the collaboration platform. It will be fully described and justified in the "Strategic Development Plan Definition" phase. From the other side, ESA plays a key role. ESA, in fact, should enable and encourage the culture of collaboration and should spur ESA Virtual Community to use the collaboration platform. The adoption of the platform and the diffusing of the culture of collaboration cannot happen by chance but they require a strong and planned effort from ESA management.

Processes

Behind the word process there could be more then one interpretations. We can think at the system engineering process or we can think at the business and industrial process. In the DICTE context we can interpret the process as a collection of interrelated steps that aim to design the DICTE platform and enable collaboration among One ESA. In this sense, the process should define the exact steps that bring to the successful completion of the DICTE study and should not neglect any aspect of collaboration. For this reason more then one aspect of collaboration are taken into account from cultural to technological aspects.

People Organization

People that give life to ESA Virtual Community are of various types:

- Project Manager

- Group Leaders
- Engineers
- Programmers
- Scientist
- Secretary

In addition, ESA Virtual Community is formed also by people that do not work directly in ESA; they could be, at least:

- Students
- Consultants
- Stakeholders with different roles

This means that the DICTE platform should foster the possibility to manage roles. ESA management should help in the definition of predefined roles, which will be transposed in user profiles. A clear view of the standard exigencies of each user profile is necessary to construct Access Control List.

Tools/technologies

This pillar of the molecule is a very delicate one for several reasons. From one side there is the desire to choose tools/technologies that are van guarded but at the same time they should be enough stable and tested. From another side the selection of some tools/technologies rather then others will force the choice of individuals and could displease some users. In addition, the choice should be inline with ESA policies and this poses some restrictions that should be analysed in advance. Finally DICTE study should pay attention to the possibility to integrate different tools/technologies. This means that interoperability is a big issue. The platform that hosts the tools should be able to integrate tools as black boxes.

The DICTE platform, as stated in the previous paragraph, should be dynamic, flexible, customizable, etc. Beside this kind of generic features it is very important to establish what kind of platform DICTE can offers and how it can be accessed.

The DICTE platform will address two main aspect of collaboration: the technical and the cultural aspect as already explained.

From the technical point of view the tools highlighted in the first phase of the study “Requirements Analysis” will be integrated in the platform, at least the tool that have been classified as essential. The platform will be enough flexible to foresee the possibility to add new tools in following phases.

From the cultural point of view the platform will offer some tools that can be used to *evaluate* the collaboration of groups or individual. In such way, the high management will be able to trace the usage of the platform and also the personal willing to collaborate. This kind of data should not be seen as a control over the employee. It should be simply intended as a mean to evaluate the weakest points of the cultural aspect per se. The data should only be used to ‘measure’ the collaboration and not used in any way to incentives or spy on employees. Obviously the way this data are used by the high management should be defined in advance and it fell within the *strategy* pillar defined in the previous chapter. It is also very important that employee knows, as well as the high management, how this data will be used.

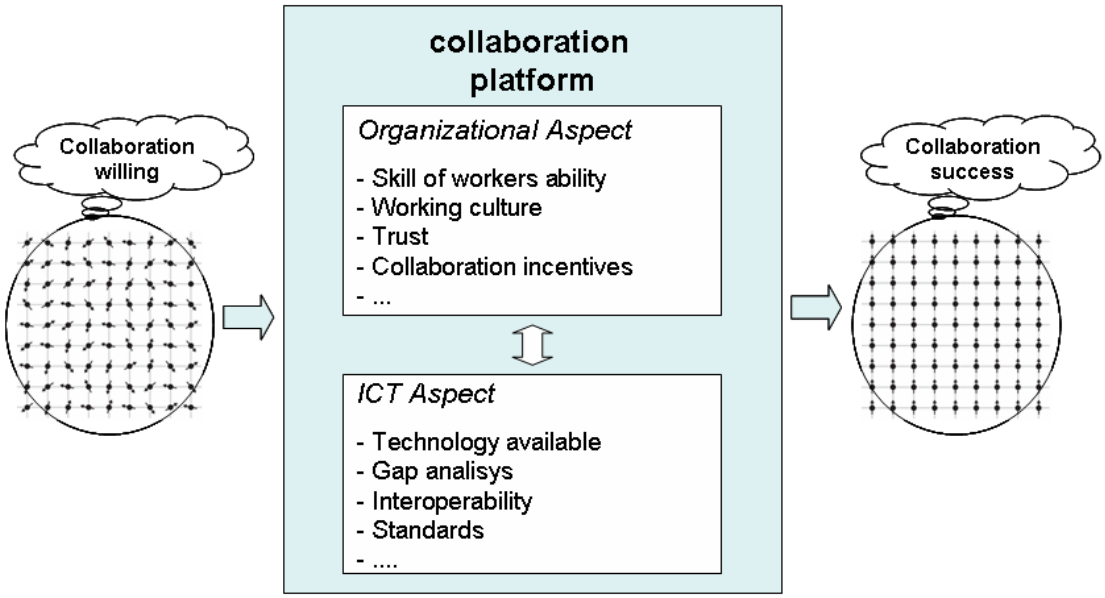

Figure 2 - Collaboration platform

Figure 2 shows that the DICTE collaboration platform should work as a magnet in order to pass from the willing to collaborate (disorder) to the effective ability to collaborate (order) considering two fundamental aspects: organizational/cultural aspect and ICT aspect.

3.3. ROADMAP TOWARDS A ONE ESA COLLABORATIVE INFRASTRUCTURE

This was the last phase of the project, when a strategic development plan towards an ESA-wide collaboration infrastructure was prepared, beginning in parallel to identify a preliminary architecture for such infrastructure (that could be seen as “step 0” of such a strategic plan) as well as to prepare a possible prototype definition implementation plan.

The main results of this phase have been the Architecture Design and the Roadmap towards an ESA collaborative infrastructure, two faces of the same aspect.

3.3.1. ARCHITECTURE DESIGN

Figure 3 illustrates a Building Block architecture for the implementation of DICTE open SOA.

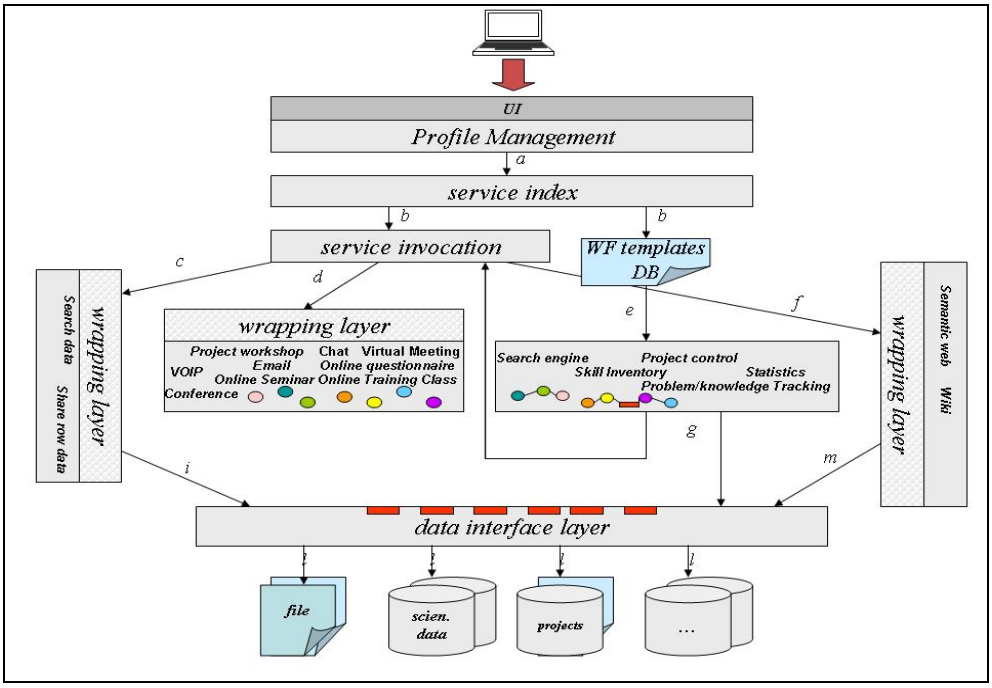

Figure 3 – DICTE Architecture Building Blocks

Reading Figure 3, the User Interface is clearly the access point to the DICTE platform. From the UI the user can choose the required service and specify any parameters. The UI service is bound to the Profile Management block which is responsible for maintaining user profiles, Virtual Organisations, etc. The Profile Management communicates with the Service Index **(a)** which is responsible to identify the chosen service and decide which kind of service it is. The service index can directly communicate with the Service Invocation **(b)** or it can communicate with the templates repository.

The Service Invocation provides a middleware capable of connecting the applications with the simple services **(c),** with the data services **(d)** and with the Semantic and Knowledge **(f)**. The Service Index, once a template is retrieved communicates with the Service Composition **(e).**

The Service Composition can invoke, via the Service Invocation, Simple Services **(g)** or/and Data Interface Layer **(g)**. The semantic & knowledge layer can directly interact with the data interface layer **(m)**. It could take advantage of the service composition if needed **(n)**. The data service layer directly relates with the data interface layer **(i)**. The data interface layer offers a web service interface that enables data storage and data retrieval and hide the type of data **(l)**.

3.3.2. STRATEGIC PLAN

Collaboration is essential to all large scale multi-national endeavours and a review of attitudes across a selected group of ESA domains reveals a good level of collaborative working within established projects. However, contributing freely to the communal knowledge base and participating in the open exchange of ideas and opinions is the basis of a more fundamental collaboration culture and relies on a higher level of participation than that implied by mere cooperation or the simple coordination of project tasks. The goal of DICTE has been towards the support of this wider collaboration culture through the provision of an appropriate technology platform.

It has always to be reminded that the technology must support the collaboration between humans and must reflect the way that they wish to relate to each other and not impose artificial restrictions or limitations on collaboration. At the same time, the extent of collaboration will depend on the individual group, project or Virtual Community situation and must not be dictated by the technology or collaborative infrastructure.

The proposed roadmap reflects the prevailing ESA culture and immediate short term objectives for collaboration: the DICTE strategic planning proposes that over the next years project activities are initiated to develop immature technologies and to demonstrate the effectiveness of these technologies in promoting the dissemination of knowledge throughout the organisation and the ability to capitalise upon the collective intelligence represented by the huge involvement in R&D, space mission design and mission operations.

As a result of this phase, a single table has been provided to give an overview of the activities that are proposed over a limited time scale after the end of the project (4 years) to support the selected eCollaboration use cases.

Table 1 is designed to provide a visual impression of the maturity (in relation to the estimated Technology Readiness Levels) of the selected enabling technologies and indicate the type of projects (Basic research, etc.) needed over the next 4 years to achieve the collaborative objectives.

In relation to the DICTE roadmap it is worth giving a special mention to the Living Labs initiative (http://www.openlivinglabs.eu/) that represents a “Validation layer” for many of the technologies and working practices discussed in this project.

The importance of the Living Lab paradigm is demonstrated in the validation of research models and designed solutions and also at the innovation level during the period when Ontologies are being developed and refined.

Technology	Y1	Y2	Y3	Y4
Enterprise Search	Basic Research	Basic Research	Basic Research	Applied Research
Collaborative Services	Prototype using Living Labs	Applied Research	Applied Research	Disseminate standard services across ESA domains
Knowledge Management	Evaluate potential tool wrt a wider scope of user requirements	Select appropriate tools for prototyping within standard environment (Living Labs)	Develop processes focussed on 'knowledge' capture rather than 'information'	Disseminate standard process across ESA domains (Living Labs)
Standard Collaborative platform	Applied Research into appropriate SOA architecture for eCollaboration platform (Living Labs)	Prototype deployment of selected services (Living Labs)	Assess metrics for collaboration use and review set of services	Prototype 'standard' set of services in standard environment in selected user groups
Unified Communications	Assess ESA goals and objectives wrt UC	Produce detailed roadmap for IT infrastructure wrt UC objectives	Assess and evaluate appropriate tools and technologies (Living Labs)	Limited release of UC available within standard environment
Contextual knowledge capture (via Web Services)	Basic Research	Assess ESA goals and objectives wrt Context Sensitive Search	Initiate some projects for applied research of technologies (Living Labs)	Prototype limited services across selected ESA user groups

Table 1 – DICTE Roadmap for the development of Enabling Technologies

Key = TRL 1 - 3, TRL 4 - 6, TRL 7 - 9

The Frascati Living Lab (FLL) initiative provides an excellent framework for the demonstration of technology transfer and many of the activities outlined in the DICTE roadmap can be realised through a development programme built around the FLL. Indeed, for the purposes of DICTE the FLL offers the opportunity for a limited implementation of a number of proposed solutions to demonstrate the dissemination of collaborative technology throughout ESA.

As a footnote it should also be recognised that the envisaged pervasive culture of collaboration needs to be provided at the ESA organisational level and will not emerge simply as a response to the introduction of any particular technology – true collaboration remains a human activity although the right technological platform can make it easier and more productive.

4. CONCLUSIONS

The DICTE study addresses the dichotomy implicit in the separate cultural and technical aspects that are essential to any form of eCollaboration. Cultural issues are shown to represent a barrier to collaboration whereby initiatives are often confined to particular groups and not made visible to the wider organization. This situation creates isolated pockets of collaboration governed by processes specific to individual business units. In turn, this lack of organizational level governance results in poor internal collaboration with groups not being aware of innovation pioneered in other places. General metrics on the success or efficiency of collaborative initiatives are either completely unknown or wildly inaccurate repressing only a piece of the picture. The culture of collaboration needs to be provided at the ESA organizational level breaking down barriers so that implementation can be achieved in shorter timescales and at lower cost.

The proposed DICTE collaborative platform is designed to be both technology and policy neutral in the form of an open Service Oriented Architecture capable of providing collaboration services to a wide variety of ESA domains.

A roadmap according to current levels of maturity for different technologies to be considered shows that in few years it could be possible to build such an infrastructure. Part of this roadmap there is also the plan for a prototype to proof some of the less mature technologies and services starting from some elements already existing, as for example the Frascati Living Lab.

At the same time and in the meanwhile, an effort to improve the culture of collaboration within ESA and across all organisations ESA work with is suggested.

The technology must support the collaboration between humans and reflect the way that they wish to relate to each other and not impose artificial restrictions or limitations on collaboration.

At the same time, the extent of collaboration will depend on the individual group, project or situation and must not be dictated by the technology or collaborative infrastructure.