Exploring Multimedia Web Conferencing

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Internet changed the perspective on meetings and also on decision making processes. Virtualization of meetings has become a common way for collaboration among employees, customers, partners, trainees and trainers, etc. Web conferencing allows the collaboration between teams' members to achieve common goals. Without the need of travelling and meeting organization, the web conferencing applications permit the participation of people from different location. Web conferencing applications are multimedia systems that allow various remote collaborations with multiple types of resources. The paper presents an exploratory study on multimedia web conferencing systems, its advantages and disadvantages and also a use case, meant to highlight several of this technology benefits and problems.
Keywords*: multimedia web conferencing, web collaboration, virtual teams, decision support*

1 Introduction

In 80's and 90's researchers focused on "media spaces" that can provide an audio-visual communication between individuals in distinct physical locations [1][2][3][4][5]. But, even this technology is studied for decades it became widespread in the last years. The audio-video communication is more important as it is the closest thing to "being there". The success of this technology is dependent on nature of the application for which it is introduced [6] and on people involved in the use of it than on system details and features. Many audio-video communication systems are part of bigger and more complex systems. In the last years the focus in the distance collaboration field is on web collaboration systems, which are sophisticated systems that include, besides audio (usually voice over IP, but sometimes telephone too) and video communication components, tools that are aimed to support team work (e.g. application sharing, white boarding/annotation, public and private chat, information on attendees, anonymous voting, tool-availability control for moderators [7], etc.). Because the team members are working often with big amount of complex data, these systems include features that facilitate combined use of different representation formats (e.g., text, various kinds of graphics, and animations).

The use of conferencing technology continues to grow as accessibility increase and costs decline [8].

2 Virtual teams

The concept of teams and teamwork is increasingly becoming an important key to productivity and employee satisfaction in the contemporary organizations. In a way or another, every people is involved in a team [9]. In 1967, Maier [10] presented the benefits of team working, as follows:

- Teams produce a greater quantity of ideas and information than individuals acting alone;
- Teams improve understanding and acceptance among individuals involved in the process;
- Teams create higher motivation and performance levels than individuals acting alone;
- Teams offset personal biases and blind spots that hinder the decision process;
- Teams sponsor more innovative and risk-taking decision making.

There are many ways of better using teams like global networks/teams, team-based strategic planning, flexible-jobbing, the horizontal corporation and the virtual corporation.
Along with the extraordinary development of technology, Internet and with the bandwidth increasing and price lowering, from tradi-

tional teams to virtual teams was only one step which was widely made a few years ago. Virtual teams, as any team, must communicate, collaborate and work together. Virtual teams "offers unprecedented levels of flexibility and responsiveness and has the potential to revolutionize the workplace" [11]. Unlike the traditional teams, the virtual ones can cross time, distance and also organizational boundaries, using technology. The communication and the decisions made by virtual teams are enhanced by the use of multimedia technologies and Internet-based systems [8].

Virtual teams are groups that (a) are identified by their organization and members as a team, (b) are responsible for making and/or implementing decisions important to the organization's global strategy, (c) use communications technologies more than face-to-face communication. In case of a global virtual team, the members work and live in different countries. Virtual teams are particularly important to globally dispersed institutions (e.g., governmental, business or education institutions). The number of virtual teams that rarely meet in person and conduct almost all of their interaction and decision making using communications technology is increasing with every year due to globalization process [12].

Often the virtual teams are very complex, especially because the team members have often different cultural background and not only.

Duarte and Snyder identified in 1999, in a broad sense, seven types of virtual teams: networked teams, parallel teams, project or product-development teams, work or production teams, service teams, management teams and action teams.

A networked virtual team is usually identified with the organization where the membership is diffuse and fluid, with team members rotating on and off the team as their expertise is needed. Team members may not even be aware of all the individuals, work teams, or organizations in the network. The parallel virtual teams carry out special assignments, tasks, or functions that the regular organization does not want or is not equipped to perform. A parallel team is different from a networked team because it has a distinct membership that identifies it from the rest of the organization. It is clear who is on the team and who is not.

Virtual project and product-development conduct projects for users or customers for a defined period of time. Their tasks usually are nonroutine and the results, which typically are a new product, information system or organizational process, are specific and measurable. Unlike the parallel teams, the project teams usually exist for a longer period of time and have a charter to make decisions, not just recommendations.

Virtual work teams and production teams perform regular and ongoing work. Such teams usually exist in one function, such as accounting, finance, training, or research and development.

Service teams are teams that are working so to offer a non-stop support to the customers.

The management teams can cross the time and distance but, unlike the other types of teams, they almost never cross the organizational boundaries. Very often the management team members are located in different places in the same country or in different countries and they are using technology to keep in touch and to work together.

The action teams offer immediate responses, often to emergency situations [13].

Greater switching of tasks, roles, or work assignments is also typical in virtual team work [14]. Leading in virtual teams is different from leading in face-to-face teams. Carte et al. [15] found that effective performance was linked with an early focus on relationship building and a later focus on task management. Jarman [16] also advised leaders to focus on teams before technology, as teams with strong relationships will overcome any technology barriers which arise [17].

Sometimes virtual team leadership takes a lot more effort in order to build relationship and to foster teamwork. In face-to-face teams, the relationship is easily build because usually team members know each other or/and they have a shared context (e.g. same company,

same city/country, similar values, similar expectations, common projects, etc.) which facilitates communication. In virtual teams, the leader has to find or create a shared context that enables team members to see that they are similar in some important aspects to others in their team, to build familiarity among team members. Psychologists have demonstrated that people need a common context in order to build new relationship [18]. The relationship building effort is also bigger because the distance decreases the team members' involvement. Studies [19] proves that "the relationship between distance and interaction frequency was well described by an inverse power function with a slope of approximately -1, consistent with the expectation that social impact is proportional to the inverse square of the distance separating two persons". Austin et al. [20] from Gartner Inc. have argued that without effective meeting discipline (i.e. structure), the multi-party web-conferencing tools with video and audio capabilities may, however, just waste more people's time across a broader geographic range than before. Thus, the leader of a virtual team has to make efforts to create a structure that fosters teamwork and helps the team regulate itself.

As opposite to face-to-face teams, in virtual teams, there is a greater level of shared leadership. Many times, in virtual teams, the members are experts who add an equal amount of value to the team. A shared leadership work better than a hierarchical leadership structure. A shared leadership does not mean that everyone has an equal say all the time - it simply means that someone has more say than the others for different aspects of the task or at different times during the task [21].

3 Web Conferencing and Web Collaboration

The web conferencing platforms are software that let users to meet together in an online forum for communication, through the Internet. The web conferencing software can be divided in two categories. One category includes the platforms that provide only audio and video conference with some structure and easier facilitation for the meeting's moderator. The second category - most of the web conference software are in this category – provide features for document and file sharing, shared desktop access, simultaneous editing and other electronic forms of communication that allow data to be shared, edited and copied during the web meeting.

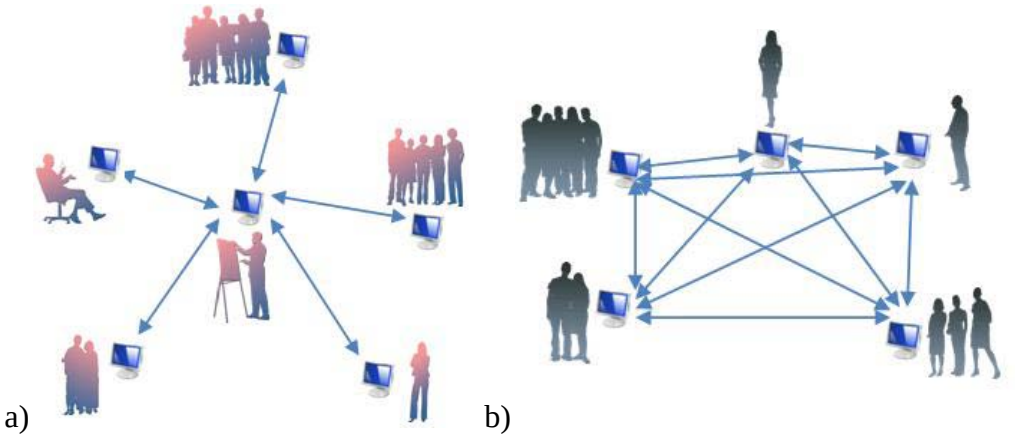
Unlike the video conferencing applications that allow a visual participation, face-to-face-like, the web conferencing platforms allow more than that. The team members can hold meetings online, combining voice and video communications with shared computer applications (e.g., shared whiteboards, desktop application sharing). It uses the wide and more powerful with every year Internet infrastructure to transmit complex data at distance. It provides the means to transmit real time video images, share "whiteboards", computer desktop or specific windows.

It can be identified two types of web conferencing: one-to-many and many-to-many web conferencing (Figure 1).

Typically, web-conferencing tools are designed as unidirectional tools: a member of the group sends information to multiple locations (from speaker to audience). Many other web conferencing software also offer basic bidirectional or multidimensional communication tools (such as voting, chat, instant messaging, whiteboards, video feed(s) and feedback to the presenter who can share a presentation or the display from an application on his or her desktop) [20]. The two-way conferencing allows group members to manipulate content in real time [22].

The many-to-many conferencing is named by Collins [23]: "web collaboration" systems, making no difference with the "Group Decision Support System". The web conferencing software is appropriate for meetings of groups of people that plan to have activities like training programs, products demonstrations, status reporting, application testing, data sharing or quick polling. Group Decision Support Systems (GDSS) combine a many-to-many communication paradigm with a one-to-many facilitator role. Web con-

ferencing is focused on presentations and GDSS are structured around meetings. GDSS support activities like brainstorming, list analyzing, evaluating, rating, prioritizing, allocating, categorizing, grouping, organizing, problem solving, assessing risk, strategy planning, consensus building, capturing knowledge, product development [23].



a) b)

Fig. 1. a) Web conferencing (one-to-many), b) Web collaboration (many-to-many)

Based on office meetings types, Johansen introduced in 1988 the computer support for collaborative work matrix: same time – same place, same time – different place, different time – same place and different time – different place [24]. The web collaboration platforms are designed to support the meetings that frames in the different place/any place category, no matter if the time is the same or not, if the meetings are synchronous or asynchronous.

The same time meetings are the meetings that feel and function like face-to-face meetings. The web collaboration software increase input to and support for critical business decisions. In some meetings, team member anonymity is important. The most part of collaboration software provide anonymous participation.

The asynchronous meetings ensure more timely and better informed decisions. The team members can participate at convenient times.

Now on, in this paper, we will refer as "web conferencing system" a web-based multimedia environment which combines voice and video communications with shared computer applications.

In December 2008, Info Tech [25] evaluated five wide used web conferencing applications and their producers. The evaluation was made based on following criteria: delivery and licensing, core functionality, advanced functionality and value. The first criteria was about the delivery mechanism (software as a service, on-premise) and about the licensing options (fixed-cost subscription, pay-as-you-go metered subscription, perpetual and volume licensing). Due to the software-as-a-service trend this delivery method was evaluated as a must have feature. For the second criteria, it was evaluated is the software analyzed includes *main conferencing features* as: whiteboard, screen sharing, application sharing, video, audio (VoIP), chat, session recording and files/document library. As *advanced functionality* were considered: support for webinar and tutorial creation using Microsoft PowerPoint as the business user's authoring tool or a dedicated authoring tool provided by the vendors, live support options, event management services, pooling, survey, quiz support, e-learning/distance-learning virtual classroom support, audio via the public switched telephone network, support for breakout meeting rooms and ability to reconvene in a master meeting room. Finally, it was evaluated the price against features delivered and users supported. The results of this study are presented in Table 1.

Table 1. Web Conferencing evaluation results [25]

	Adobe Acrobat Connect	**Cisco WebEx**	**Citrix Online GoToMeeting**	**IBM Lotus Sametime Unyte Meeting**	**Microsoft Live Meeting**
Delivery and Licensing	High	Medium	Low	Medium	Medium
Core Functionality	High	High	Medium	Medium	Medium
Advanced Functionality	High	High	Medium	Medium	Medium
Value	High	High	Medium	Medium	Medium
Rank	Leader	Leader	Follower	Competitor	Competitor

The conclusion of this study was that there's a very "narrow margins between vendors" and between the evaluated web conferencing software. All the products satisfy the main requests for web conferencing and the difference in one product selection is offered by the requirements for a specific category of use cases.

4 Group Decision Support Systems

The trend in the conferencing applications is the integration of different types of applications: video conferencing with audio and web conferencing applications, web conferencing with messaging applications and audio conferencing capabilities. For example IBM and also Microsoft developed products that combine Web conferencing with instant messaging [22]. Another integration trend it can be observed is: web conferencing with specific Group Decision Support tools.

The latest Group Decision Support Systems [26][27] provide features that allows the teams to review and share reference documents, presentations, create agenda, rapidly brainstorm ideas, use voting and categorizing tools to analyze problems, prioritize solutions and prepare action plans to implement agreed tasks [28]. All session output is available for distribution in structured reports.

The main objective of Group Decision Support Systems is to "make group meetings more productive by applying information technology" [29]. The use of GDSS allows groups to integrate the knowledge of all members into better decision making [30][31]. Decision making facilitation leads to higher decision quality, higher satisfaction with the process [32] and group negative behavior mitigation [33][34].

In 2006, Austin and al. [20] observed that GDSS "lack the conferencing facilities that Web-conferencing tools provide" and "to get the best of both worlds, users would have to run a GDSS tool and a Web conferencing tool during meetings". He also forecast that web-conferencing vendors will integrate GDSS capabilities into their web-conferencing products by the end of 2008. He was right! For example GroupSystems developed a free plug-in (ThinkTank™ plug-in [35]) for IBM Lotus Sametime 7.5 software in order to "instantly move from chat to <<innovate>>". This plug-in for web conferencing software Sametime provide GDSS features as brainstorming, innovation, prioritization, consensus & decision making. Also the GDSS developers think to introduce web-conferencing features in their products (e.g., Facilitate.com and WebIQ) includes web conferencing elements. Another software worth to be mentioned is Grouputer [36]. This platform "combines web conferencing with group decision support, team management tools and a process builder which together make it possible to tackle complex problems without having to be face-to-face".

Table 2. GDSS versus Web conferencing [20]

Nonrutine behaviour category	Description	GDSS Function	Web conferencing
Discovery	Finding threats and opportunities	Brainstorming, surveys and other features	Poorly suited for discovery. Provides chat, whiteboard, screen/application sharing and voting only
Innovation	Developing or adapting new process or product	Organizing and priority setting	Poorly suited
Teaming	Expertise location. Assembling the people and running a process to develop a plan	No expertise locator; discussion, decision making and other function contribute to effective teaming	No expertise locator capability; main features (chat, whiteboard, screen/application sharing) not oriented toward persistent teams
Leading	Tracking action plan status, providing leadership and management skills	Plans can carry across from meeting to meeting, but little by way of integration with other planning tools and processes; Other tools (such as project management) may be better	No specific functionality, but screen/application sharing can be useful with some project review tools
Learning	Extracting lessons learned and passing them along	GDSS functions seem to be quite useful, collectively, for conducting "post-mortem" examinations, extracting learning and planning training	Not very effective at involving the audience

GDSS fit reasonably well with five classes of nonroutine behaviour: discovery, innovation, teaming, leading and learning [20].
Table 1 confirm the Austin statement that an integration of web conferencing with group decision support tools will "enhance meeting performance and to reduce the number of dysfunctional meetings, regardless of the type of meeting" due to the "natural complementarity between Web-conferencing tools and GDSS methodology and structure".

5 Use Case

In the frame of a European educational project [37], Adobe Connect Pro software has been selected for several project management activities and outcomes dissemination. The selection was based on cost criteria: one partner already had a license of the software (for eLearning purposes). The initial aim of using web conferencing software was to disseminate the project results at European level, activity planned in the project proposal. Before the scheduled dissemination web conferencing, the organizers (the project partners) start to use the software in order to prepare the dissemination event and to avoid problems that might occur. The preliminary web meetings had the following objectives:

- To get used with the software;
- To identify software features that can be useful for the dissemination meeting;
- To elaborate an appropriate agenda;
- To detect possible technical problems (if

there are sound and video problems when the number of the participant is increasing, if the presentations are continuously without interruptions, if the screen sharing is working, etc.).

The conclusions of these preliminary web meetings were as follows:

- the systems response does not have time delays (the times to establish a connection, to "reach" the other members a shared application or screen, to "see" the others activities were less than a few seconds);
- the audio and video quality was in general good, depending on microphones and cameras quality, furniture arrangements, speakers position related to the microphone and camera, lightning.

After a detail planning, the dissemination web conferencing gather "together" a wide number of participants connected in 12 locations. The connection points were in different European countries: 2 in Finland (one was the host of the Adobe Connect Pro server), 2 in Romania, 1 in Greece, 4 in Spain, 2 in Poland and 1 in Turkey. The presentations were made from 9 of these locations. The presentations included: PowerPoint presentations, applications developed with different environments presented live and also video records with applications presentations. The feedback of the meeting was collected online at the end of the meeting and also offline using printed forms.

The web conferencing involved the use of the main Adobe Connect Pro features: screen sharing, application sharing, whiteboard, video and audio, chat, session recording, and files library.

Even the dissemination web meeting was carefully planned, and the preliminary web meetings indicated that it will be a successful dissemination meeting, during the actual meeting with guests a problem has arisen: the audio connection was poor from time to time. The problem was not a technical one, but a human misuse. At one connection the participants kept the microphone on and the background noise affected some presentations. At the connection point that generated the sound problems there was any person who used before the collaboration system or read instruction about using it. Once the individuals from this connection point started the microphone (probably by mistake or trying to discover the platform) they didn't been aware that they are generating the sound problems. Even other participants tried to communicate with them by alternative communications ways (chat), they did not observed the messages addressed to them. Therefore, Adobe Connect was doing the job of indicating the source problem (the connection points with the microphone on were indicated by a green microphone symbol), the participants failed to find a way to communicate, to call attention to the individuals that were generating the problems. Another possible inconvenient aspect was that not always was clear who is speaking, due to an incorrect position in relation to video camera. Also it was not to easy seeing facial expressions and nonverbal gesture of the people in the foreground and impossible of those in the background.

To the feedback discussions have participated only the persons who were sit in front of the computer, the others acting more passive listeners than active participants.

This use case highlights the great importance of human factor in web collaboration success. "When Web conferencing systems don't reach their full potential, it's likely because the participants aren't sharing information, not because the technology has failed" [7].

It can be observed also the importance of team members training in using the collaboration technology. There is a strong relationship between team members' training and team performance. "Consistent training among all team members improves team performance while virtual teams characterized by diverse technology skills may experience conflict when members are unable to resolve differences and compromise on the use of a specific skill during task completion" [11].

Another observation was that the video clips, records of presentations, had the best quality of the sound and image. Previously created video records of the presentations eliminate

the emotions specific to live presentations.
In spite of all inconvenient, Adobe Connect Pro web conferencing experience was enjoyable for most of the participants and the dissemination meeting accomplished its objective.

5 Benefits and problems

Now, when "extended", "networked" and "virtual" enterprise concepts [38] are becoming very common, web conferencing software as a tool for everyday use can bring many benefits.
A first benefit is that the people can get in contact without the physical limitations of distance, time, and organizational boundaries. The use collaboration technologies and other techniques reduce travel and facility costs, lower project schedules, and improve decision-making time and communication [13]. Travelling and face-to-face meeting can be tiring and stressful and group work efficiency can be affected. Flight delays or cancellations, traffic jams on the freeway means time waste and edginess.
Another aspect is related to the meeting organization. In face-to-face meetings there is at least one person that must spend time to organize the meeting (to pull it all together, to schedule the meeting, to arrange the meeting room and so on). Web meeting are cheaper and it requests less time to organize it. For example, IBM was one of the pioneer users of a collaboration system dedicated for decision support, and report savings of 50% in man hours and 90% in project time [39][40].
The amount of resources involved in web conference is significantly reduced. The number of attendees is likely to increase, as it is often easier for people to connect online, making each meeting more efficient.
Web conferencing offers a more efficient, flexible and dynamic approach to meetings, while retaining some of the aspects of the face-to-face. The decisions costs and life cycle are diminished by reducing the tangible and intangible non-value-added expenses and activities [23]. Thus the decisions made faster, projects completed sooner, and productivity increased across the organization. Through web collaboration systems, teams share knowledge more widely, resulting in faster and more informed decisions. The company can keep in touch with the customers using video conferencing, creating more personal on-to-one relationships, encouraging a loyalty far beyond the capabilities of a traditional call centre agent. Also most services and software products offer practically unlimited capacity for simultaneous conferences as well as for the number of participants.

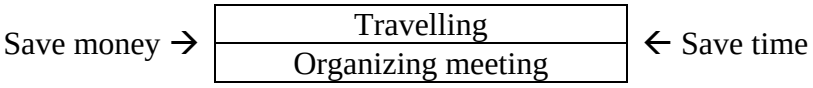


Fig. 2. Web conferencing benefits

A team work through a conferencing platform can be the way to improve the quality. Files (e.g., PowerPoint presentations), information and ideas sharing can create the feeling of being together in the same place, reducing the possible problems that can arise in non face-to-face meetings. The whiteboards, typical for many web conferencing software, provide a familiar mean to work collaborative on new ideas in the same space.
The most of the web collaboration platforms includes a rich range of features for supporting different types of meetings. These platforms have also integrated security systems in order to ensure confidential and private meetings.
Besides the drawbacks identified in the use case presented above (most of them related to the human factor) the main disadvantage of using a collaborative platform is the price, which can be very high. This disadvantage can be diminished by selecting a cheaper option or a free option of conferencing platform, which can be successfully used in many cases. The costs of the conferencing platform can be also compensated by the sav-

ings with travel expenses.
There are also several risk factors that can influence the success of the virtual meetings. Miscommunication problems, increased conflict and lower cohesion [41] are more likely to occur in default of face-to-face interaction. In order to maintain the advantage of increased productivity, the team members must know their tasks and their position in the entire project as a whole [42]. Leaders can promote clarity, ensuring all members are clear on the organisation's goals and the team's goals, its working processes, schedules and deadlines [43]. Also non-contributing behaviour in groups is a persistent problem that lowers satisfaction [41].
In terms of deliverability there can be web collaboration systems as a service or as a package (server-based).
Usually the web conferencing systems are offered as a service, hosted vendors or producer. The advantage of this delivery system is that the company doesn't have to invest money to install and host a server for the web collaboration software. The team members access the system through a web browser and start to use it right away without worrying about system installing or maintenance. Service-based web collaboration costs considerably less than buying a server-based system. Usually the service-based systems are more applicable to occasionally users. The costs for frequently use can rise up than buying a server-based system. Another possible problem is that can create security vulnerabilities.

Table 3. Web conferencing advantages and disadvantages

	Advantages		**Disadvantages**	
	General	Service based vs. Server based	General	Service based vs. Server based
Service-based web conferencing	- Travelling time and money savings - Efficiency - Flexibility - Increased productivity across dispersed workforces and teams - Less resources	- Low costs for occasionally users - Minimizes the likelihood of incompatible software - The service provider upkeep the application	- High costs - Extra effort to build relationship - Possible "deserters" - Non-contributing team members - Miscommunication problems are more likely to occur - Logistics difficulties - Information overload may be a burden to participant	- High costs for occasionally users - Security risks - overall performance may be slower
Server-based web conferencing	- Reduced decision cycle time - Shared leadership - Worker talent not limited to one location - Time differences can be exploited - Practically unlimited participants	- Low costs for frequent users - Full control - Integration with the organization software system - More secure		- High costs for occasionally users - Use customer's bandwidth

Some web conferencing systems are server-based systems that companies can run themselves on their internal network, dedicated servers, or network appliances. An advantage

of server-based systems is an enhanced security, control over collaborative operations, and integration with existing communications infrastructures. Another advantage is that the server-based system can be integrated into the company software system. Because the system is installed and hosted in the company the system is more secure. The operations based on a company's single system result in less potential vulnerability than operations involving both service providers' and users' systems. Using a server-based system could be a problem for small business because the collaboration meetings use the company's bandwidth [44]. Also the company must have member stuff that knows to administer and manage server-based systems. The costs for server-based systems include not only the system itself but also the equipment and the maintenance. But the service-based systems involve costs during the all time of system use and the server-based system involves an initial investment and then only the maintenance costs, which usually are not high. Table 3 presents a list of the main advantages and disadvantages following two aspects: (1) web conferencing versus face-to-face meetings and (2) service-based web conferencing systems versus server-based conferencing systems.

6 Conclusions

Latest technological advances are providing new ways of structuring, processing, and distributing work and communication activities to overcome boundaries of time and space. Virtual teams are the solution for improving productivity and employee satisfaction. But virtual teams are working quite different than face-to-face teams, requiring a lot more effort in leadership in order to build relationship and to foster teamwork. Virtual teams are working in collaborative environments [45] (e.g., web conferencing and web collaboration environments).

The trend in the conferencing applications is the integration of different types of applications: video conferencing with audio and web conferencing applications, web conferencing with messaging applications and audio conferencing capabilities, web conferencing with specific Group Decision Support tools.

There are many benefits of using virtual teams and web collaboration technologies. The paper presented a list of these advantages and a series of disadvantages.

The most important benefits identified are related to expenses and time saving. Web conferencing can reduce travel and facility costs, but also can lower project schedules, and improve decision-making time and communication.

The paper includes also a use case of a web conferencing platform (Adobe Connect Pro) for a dissemination seminar. The use case highlights the human factor importance in the exploitation at full potential of the conferencing technology.

In terms of delivery method, the web conferencing tools are service based or server-based. The opportunities of selecting one of the two options are presented.

Web conferencing software can provide real time, internet-based collaboration and became a more widely adopted alternative to replace, partially or totally, face-to-face meetings.

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