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Abstract
Despite the expected benefits of global virtual teams, their performance has been spotty and management continues to search for reasons why these teams fail. This work addresses this issue by performing a longitudinal case study of two virtual teams in order to uncover why one was more successful than the other. The study found that a key factor for one team's poor performance was the entrainment of the temporal norms of both the countries and the social situations of the members that reduced the available real time meeting space to zero.

1. Introduction

A number of co-occurring factors have led to the development of global software teams. These include the exponential development and diffusion of communication and collaboration technology, the availability of well-educated software personnel in countries where the cost of labour is far below that of western countries, the growth of multi-national organisations with large amounts of investment capital, the flexibility of government policies that encouraged investment in offshore projects and the emergence of new global markets that led to an organisation's desire to establish a workforce in the emerging market countries. One answer to these changes is a team-based concept - the virtual team [12]. A virtual team is defined as a set of geographically dispersed knowledge workers that interact through interdependent communication and coordination processes. These processes are facilitated through information and communication technologies, to achieve a specific goal in an environment that is affected by physical (space and time) and social (organisation and culture) dimensions [7] [22]. Virtual teams are said to combine flexibility, responsiveness, lower labour costs, specific task foci and improved resource utilisation necessary to survive and gain competitive advantage in today's turbulent, and dynamic, global business environments [15] [16] [19] [21] [22] [24] [27]. In addition to these factors, there exists the underlying belief that much technical work can be adequately pre-specified so that virtual distributed teams are a successful and cost effective strategy [3]. However, the expected benefits from global software development teams

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have not always been achieved [4] [6]. Virtual distributed teams are found to cause significant leadership and organisational challenges, for example, a loss of trust arising from cultural misunderstandings, large communication difficulties as a result of both language differences and inexact work specifications [16] and work overloads caused by time zone differences [18]. Studies have shown that some teams work and achieve their desired goals, but that others are bogged down in problems [17]. Thus, it is important to know what causes failures in virtual teams in order to avoid such pitfalls.

This work investigates possible causes for failures through a longitudinal study of two virtual teams, one which has maintained its momentum upon becoming virtual and the other which has not. The teams have many characteristics in common, in particular, the same manager and a similar membership composition. Additionally, both teams were running successfully in face-to-face mode until relocation of the team manager caused the teams to become virtual. The case study performs an ethnographic analysis of the two teams and carries out explanation building on multiple dimensions to determine what characteristics of the teams might have led to their success and failure [10] [11] [26]. The analysis is one of hypotheses building from information captured on the organisation, communication, member characteristics and management of each team. One surprisingly simple failure factor that the analysis uncovered was the failure of the unsuccessful team to find a suitable meeting time.

The paper is organized as follows: First, a review of current research on temporal structures and norms and their entrainment of individuals is presented along with a small number of studies that have looked at the influence of time zone differences on virtual team environments. This is followed by a detailed description of the two teams involved in this case study. The data collection and explanation building approach is then described followed by a presentation of the study's findings. The implication of the findings for virtual team management follows, and the paper concludes with the limitations of the research method chosen and a statement of the research's contribution.

2. Related work

Because teams are increasingly spread over different time zones, coordination and control problems arise that are related to the decreasing amount of temporal overlap between team member's working hours [5]. This is referred to as the *temporal distance* between team units. The impact of temporal distance on personal life disruption has been found to be significant [9]. A second body of literature deals not with temporal distances but with the inherent temporal structures and norms that have been found to impact organizations. These structures and norms have been found to inadvertently interact with each other creating significant work interruptions and conflicts across organisational units [1] [2]. If such impacts are found in co-located units, it can be hypothesized that such temporal structures and norms are likely to differ widely between locations that are not temporally co-located and to therefore impact the temporal distance between members of a virtual team even more. Table 1 presents definitions and examples of temporal norms that are commonly found in organisations.

Term	Definition	Example
Temporal Norm	Culturally unstated time lags or time usage, created and accepted by a large group of members in human society	The normal promotion time in Company A is three years; Meetings never last more than 1 hour in Company B.
Temporal Structure	Patterned organization of time, used by humans to help them manage, comprehend or coordinate their use of time. This pattern can be an individually created pattern or one agreed upon by a larger group of individuals.	Status meetings take place every Monday at 5 PM
Socio-temporal Norm	Socially-based temporal norms, adopted by a large group of individuals, usually part of a culture or sub-culture	Individuals never work on Saturday (Sabbath) in Israel

Table 1: Definitions of the terms in adaptation of Wu [25]

Im et al. [14] in his investigation of a global software development team, found that the team gradually evolved a set of temporal boundaries and time management practices that helped the team coordinate itself asynchronously and cope with locally entraining temporal structures. Edensor [8] demonstrates that nationalities have well defined temporalities that are found in the institutional times and everyday routines of each country. Thus, anytime a temporal distance crosses national boundaries, this crossing alone is likely to impact coordination simply because of team members' different senses of time and time rhythms that are found in each country. In particular, if there is a need for real-time communication, the temporal overlap is likely to be even less than the temporal distance suggests. This work will focus on the impact of nationally driven and personal temporal structures becoming an important factor in the ability for the temporally distant teams studied to establish real time meetings.

3. Research Entities

The research case is built on two virtually distributed teams, the Research Instrument team (RI-team) and the Software Development team (SD-team). The RI-team is defined as the successful team. The SD-team is labelled as the unsuccessful team. Both teams were academic research teams that met weekly in a university conference room. Both teams consisted of graduate students and a faculty member who guided the activities of the teams. The teams went virtual when the leader of the two teams took a sabbatical in Europe for one year. It was arranged to continue the once a week research meeting with each team via a voice over IP setup. The teams met virtually from May 2006 until May 2007.

3.1. The Research Instrument Team

Historically the RI-team emerged out of a doctoral research seminar. A sub group formed in January 2006, that began having additional meetings that focused on studying global software development. This sub group consisted of four members, two faculty and two graduate students. The team leader was the advisor of both graduate students. Face-to-face meetings were held weekly for two hours in a university seminar room. Occasionally, a rotational sequence between the three universities involved in the research facilitated the participation of the team members in meetings, as team members were distributed over a 200 km^2 area. The advisor met separately each week with each of the Ph.D. students. The RI-team's gender was equally divided (one female and male Ph.D. student), one female professor (the thesis advisor) and one male professor (who served as an external member on the students' thesis committees). The team was headed by the female professor with the support of the male professor. The team is dominated by American culture, with one exception; the female Ph.D. student is from mainland China although she had been in the U.S. for six years at the beginning of this study.

The key research activity of the RI-team was in conducting interviews and a survey within a Fortune 100 company. As such, this team focused much time on the development of their measurement tools, e.g., the interview guide and the survey. The original purpose of the RI-team was to generate research that formed two theses and a series of journal and conference publications. Only one of the team members is tenured so that publications in good places are very important to all team members. The team focused on one company initially but has now expanded to conduct research in multiple companies. The team continues to work together on new research questions that arose while conducting the original research.

3.2. The Software Development Team

The SD-team began its existence in November 2003. The focus of the SD-team project was to develop a portable interface that read online information to blind users, that was cheap to buy and that was easy to use. This interactive system for visually impaired/blind users would allow users to listen to online newspaper articles and books through a personal data assistant and to manage their daily schedule and address book. The research also supported two Ph.D. dissertations of team members. The advisor met separately weekly with each of the Ph.D. students. Because of additional interest in the project from two Master's students, a research team was formed to focus on developing the browsing tool in a form that was robust enough to allow a public downloadable release of the system. The team met two hours weekly in the evenings in a conference room at the university. All team members were part of the same university and lived close enough to the university to make the commute to the meeting comfortable.

This team was very social and occasionally set up additional social nights in which team members were joined by their significant others for dinner. Pizza and soda were served at all meetings and individuals took on rotating responsibility for bringing the food to the meetings. From the starting point of team formation, the SD-team consisted of five members. Two of the team members were Ph.D. students (one Chinese female and one American male). Two of the team members were Master's students (both were American males). The team leader (professor) was female. One of the Master's students was motor-disabled and came to the meeting with a special van and a motorised wheel chair.

Additional to shared tasks such as web page design and research paper writing, the team members can be divided around two centres of activities: (1) software development and (2) user interface design. The software development unit contained three individuals: a junior (male Master's student) and senior software developer (male Ph.D. student) and a web developer who was also occasionally occupied with software development tasks (male Master's student). The interface design unit consisted of a user interface designer who was occasionally occupied with web development tasks (female Ph.D. student) and the team leader (female professor).

It should be noted that unlike the work conducted with the RI-team, the two Ph.D. students on the project were working on theses that were related to the project but neither fully needed the project for the completion of their research. The major motivation for this project was to develop a usable system for the blind.

4. Research Methodology

The longitudinal case study used inductively interpretive hypothesis generation and an explanation building process following the descriptions of Glaser and Strauss [11], Yin [26] and Eisenhardt [10]. The starting point of the theory building, is as close as possible to the ideal of no theory under consideration and no hypotheses to test on the specific case [10]. For the initial semi-structured interview with the manager, an interview guideline was iteratively created. The initial interview guideline consisted of four main question types: organisational, leadership/managerial, motivational and course/process. These question types later outlined the dimensions of the analysis

framework, which developed a grouping of findings around the question types possible. The interview and discussions with the manager generated macro-organisational and -managerial information for both teams. The information was used to sharpen the dimensions of the analysis framework and to add or delete questions to create a new interview guideline. After the initial interview, findings were clustered around 12 dimensions: (1) team organisation, (2) sub team formation, (3) management style, (4) team processes, (5) communication technology, (6) member motivation, (7) amount/type planning, (8) member contributions, (9) inter-member trust, (10) socialization practices, (11) team culture and (12) time behaviours. Each conducted interview and its analysis served as input to sharpen the above dimensions and refine the interview guideline for subsequent interviews, which questioned prior found evidence.

Interviewed team members frequently used words, phrases and stories, which played a key part in the identification of the concepts and themes that integrated the data into the framework being constructed [20]. After each interview the researcher listened to the recorded interview, created transcriptions and formed hypotheses, which linked data to the prior propositions. Generated hypotheses were grouped into the dimensions of the framework as nullifying and supporting information was collected. Each forming hypotheses was marked with the team's and respondent's name, to trace the information stream. Hypotheses either explained the success or the failure of both teams. Evidence hypothesising the failure of a virtual team came primarily from SD-team interview data, while success explaining evidence was derived from RI-team interview data. In some cases, the findings in the failing team amplified findings of success in the successful team, and vice versa. This process was continued until all interviews were conducted and analysed and a level of theoretical saturation was established.

Before the beginning the analysis of the data, three assumptions needed to be clarified: (1) the assumption that one team was a success and the other a failure; (2) the assumption that the teams were similar in makeup; and (3) the assumption that the tasks accomplished by the teams were similar in complexity. The latter two assumptions need to be justified because it can be argued that inherent team differences in their composition or tasks could have caused one virtual team to fail rather than what is being argued in this paper, the impact of the non-optimized overlap of temporal norms. The first assumption needs to be justified because the failing team did not actively fail but lost momentum. Eventually the team was shut down by its leader because of the slow product output and the lack of attendance at the real-time meetings.

Success was measured in team performance, team adherence to deadlines and team member attendance at meetings. Team performance is the ability of the team to deliver timely, high-quality products [22]. The RI-team set goals and deadlines agreed upon by all members and then worked to achieve these goals. The goals were not changed. In contrast, the SD-team set initial goals and then met and changed the goals to reduce the amount of work they needed to do to meet a deadline. After a variety of meetings in which progress was halted because key team members were not in attendance, the team leader decided in a discussion with the lead system developer to put the team meetings on hold. They have not been restarted.

The two virtual teams were chosen as research units because it was believed that they had a high overlap in management and member characteristics as described in the previous section. The key differences between the teams were the following: (1) One team had two professors and the other team had two Master's students as members. It is argued that the senior software developer replaced the role of the second professor in the SD-team because of his age and 20 year expertise associated with the task of the team. (2) The teams differed in number of members but the female Ph.D. student on the SD-team rarely attended the face-to-face meetings in the final year before the project went virtual. She never attended the virtual meetings. (3) The teams had different tasks. It is

argued that both tasks required significant creativity, problem solving and detailed communication exchanges so that running either meeting virtually was difficult. The teams only differentiated in their academic orientation and work assignments. In contrast to the RI-team, where the project work was centred around two dissertation projects, the individual motivation in the SD-team was based on interest in the team task and a high level of camaraderie amongst the group members.

Table 2 shows collected and analyzed data sources that were used in conducting the case study. (Note: It was not possible to attend the SD-team meetings because at the time this project began, the SD-team was having trouble finding a viable meeting time for all members.

	Research Instrument team	Software Development team	
Archival records	(internet-based group), internet-based calendar and email documents (417 emails)	(internet-based group), internet-based calendar	
Interviews	semi-structured interviews (6 hours 49 minutes)	semi-structured interviews (5 hours 2 minutes)	pre-recorded semi-structured interviews (3 hours 48 minutes)
Participatory observation	seven months (30 hours)	-	

Table 2: Data sources underlying each research unit

5. Findings

One of the key difficulties that the SD-team was found to encounter was an inability to maintain momentum because they could not find a suitable meeting time. The support for this is presented in the next set of paragraphs.

Figure 1 displays the availability for virtual team meetings in the SD-team, while Figure 2 maps the individual availability/temporal structures for virtual team meetings in the RI-team. The patterns denote the type of availability of individuals. The upper time slot line shows the availability of the manager, while the line underneath displays the overall availability of the team members. Times are adjusted according to the underlying time difference of six hours between the manager and her team (GMT+5 – GMT-1). The data is derived from interviews, a shared online calendar of the team manager and meeting minutes of both teams.

Non-availability (leisure) status includes commuting, leisure and sleeping/recreation times of individuals (influenced by individual temporal structures and norms). The non-availability (work) describes the state of individuals being required to perform other job related activities and not being available for virtual meetings. Restricted availability includes situations in which individuals are able to join virtual meetings by aligning or changing personal temporal structures (e.g. daily life patterns such as; waking up earlier, going home from work earlier, etc.). RI-team members were able to adjust their work availability and occasionally their personal life availability to create a window of viable real time meetings.

The SD-team attempted to hold their weekly meeting on Friday at 7:00 (GMT+5) or on Wednesday at 18:00 (GMT+5). The graphical plot of individual availability on adjusted time zones shows that the 7:00 time was the only available time for virtual meetings (see Figure 1). The 18:00 time was tried, but since internet connectivity was weak at home for the team leader and since the bus and subway stopped running after midnight, the team leader refused to sleep in her office or pay for an expensive taxi in order to hold these meetings, in particular, since team members often came late to the midnight meeting because of traffic conditions they encountered.
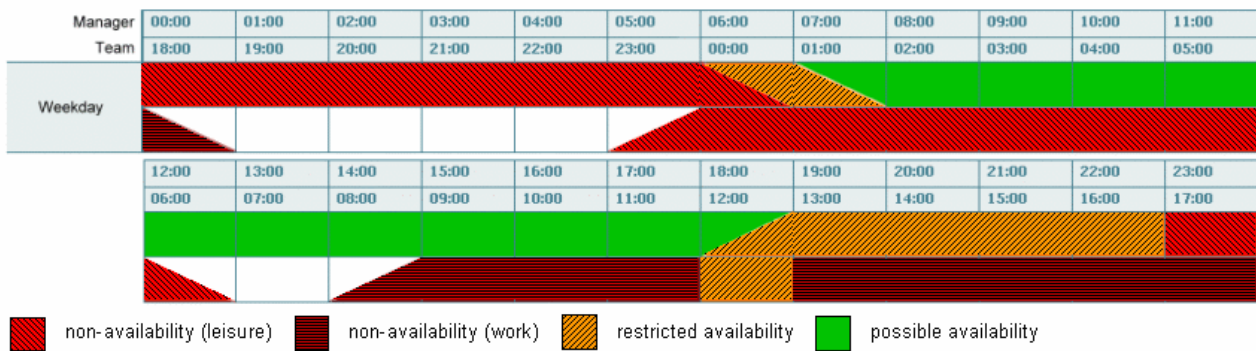
Figure 1: Availability of SD-team members on weekdays

During weekdays, SD-team virtual meeting times were entrained by the different restrictive schedules of each team member. Two members had just started new employment and could not meet during their workdays. A third member was constrained by the waking time of his family because his disability required family intervention. The younger team members reported that the meeting time was too early in the morning, resulting in missed meetings. In addition, the time slot was one hour, which was further shortened by connection difficulties. In comparison the RI-team meetings lasted at least two hours (see Table 3). An analysis of the team minutes of both meetings showed that the SD-Team spent much of its time in review of what had been done so that little generation of new items was done. In contrast the RI-team spent much time generating new work and task assignments to resolve problems as they came up each week. Overall, the SD-team meetings suffered from (1) a lower degree of social and personal interaction, (2) lower social facilitation, (3) decreased exercise of managerial power and (4) decreased communication among members. A 12:00 (GMT+5) meeting was tried during the lunch break of the working team members but the constraints of other meetings at their workplace made attendance unpredictable. They were also too short. Saturday meetings were proposed but family schedules of team members made these meetings untenable.

Insufficient length of meetings		
Interview evidence in the SD-team		
representative example	count accepted	count rejected
"I think (the meeting) was a little bit to short (…) we did not have much time in the morning (…) precisely one hour"	9	1
Interview evidence in the RI-team		
representative example	count accepted	count rejected
"Good length (of the meetings), there is a lot to cover (…)"	0	3
Note: The count accepted column refers to the number of interview statements that supported this evidence and the count reject column is the number of interview statements that refuted it.		

Table 3: Evidence on insufficient length of meetings

In contrast, the team member individual time schedules in the RI-team held more possibilities for holding a virtual meeting at a time acceptable to all and with a reasonable meeting length. These meetings took place on Wednesday from 9:00 – 11:00 (GMT+5) / 15:00 – 17:00 (GMT-1). In some cases, these meetings lasted three hours.
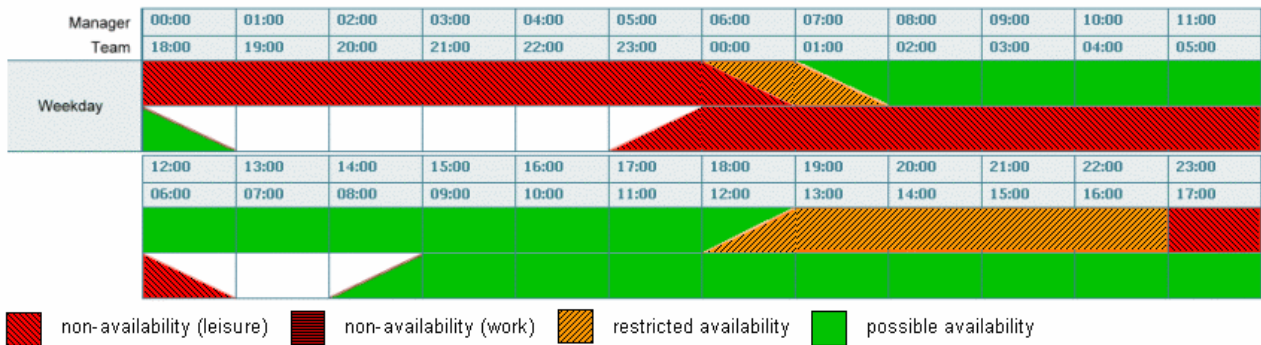
Figure 2: Availability of RI-team members on weekdays

Overall, three major differences were found between the RI-team and the SD-team in each team's willingness to establish a viable meeting time: (1) the temporal structures affecting their daily lives, (2) the volunteer character of the project that made members unwilling to adjust leisure schedules significantly and (3) low age awareness.

It is argued that the *temporal norm effects on the daily life of team members were higher in the SD-team* (see Table 4). First, more members were constrained by their work schedules because they had less flexible schedules than the RI-team. Secondly, because workday time could not be used for meetings, the personal life schedules of the SD-team began to interfere. In particular, early mornings and Saturday afternoon meetings did not map the life style of the younger team members. At least two nationally determined temporal norms also interfered, that is, the scheduling of public transportation and office closures in European countries. Table 4 lists the number of times an interview respondent indicated that a meeting time affected one's personal schedule for both the RI and SD-teams. As can be seen, the meeting time schedule was barely mentioned by the RI-team.

Meeting time schedule affecting on daily life		
Interview evidence in the SD-team		
representative example	count accepted	count rejected
"I switched my lunch hour to get to the meetings"	10	0
Interview evidence in the RI-team		
representative example	count accepted	count rejected
"It is a little bit earlier for me, but it has become a habit (meeting) so it is good for me, I got used to it"	2	1
Note: The count accepted column refers to the number of interview statements that supported this evidence and the count reject column is the number of interview statements that refuted it.		

Table 4: Discussion on meeting time affecting on daily life

The second source of meeting scheduling conflict was *the nature of the temporal structure constraints on the SD-team members*. All but one member worked full time jobs and thus, their focus was on serving their employer first and the team, second. Work meetings and the use of work computers entrained members to not meet during the workday (8:00 to 18:00 GMT+5). In contrast, RI-team members were academics and the project was closely aligned to the team members' careers. Therefore, RI-team members could join virtual meetings during their official work hours without having to adapt their personal schedules for team meetings.

The third assumed reason is based on the *higher age distribution in the SD-team*. As the schedules for team meetings were significantly dominated by the manager and senior software developer, the time patterns agreed upon did not match the temporal norms of the younger members. The mismatch of scheduled virtual meetings and individual daily life patterns resulted in a low virtual meeting attendance.

Low meeting attendance was also caused by frequent changes in virtual meeting days and times in an attempt to find a suitable slot. Team members were not able to adjust personal schedules to the

frequently changing virtual meeting patterns. RI-team members, in contrast, were able to adjust and align individual temporal structures on the basis of a frequent and regular meeting pattern.

6. Implication for the management of virtual teams

The above described findings suggest implications for the management of virtual teams. Although employees are unlikely to skip scheduled meetings, these meetings are likely to interact with existing temporal structures and norms in an employee's life and create significant time burdens on the temporally dislocated meeting attendee. In short, an individual may be there in body, but not in mind if the temporal disruption is large enough. Therefore, managers need to gain an awareness of the temporal structures and social-temporal norms of non-collocated sites in order to guarantee acceptable meeting time overlaps. Temporally entraining structures and social-temporal norms such as public transportation schedules, personal, local and national celebrations, school schedules, traffic congestion patterns and family sleep patterns can result in severe constraints on real time meeting times. In addition, individual daily life patterns vary because of gender, age and social group also affecting meeting attentiveness. Indeed, if anyone wishes to test this latter statement, all this person has to do is ask their graduate student to meet at 7:00. Virtual meetings for which attendance is voluntary are likely to wither if no satisfactory overlaps can be found for meetings between members.

One attempt to overcome the low temporal overlaps that occur because of large temporal distances is the creation of a bridge that helps to span the time zones [13] [18]. However, as indicated in this study, it is not just the workday overlap that establishes the acceptable meeting times but a large collection of temporal norms that vary nationally and can readily reduce this overlap to zero.

7. Conclusion

The hypothesis that highly constrained meeting opportunities in the failing team provides one explanation why this team did not succeed. The main contribution of the underlying work displays the negative impact of non-optimized adjustments of temporal norms, structures and socio-temporal norms between virtual team members. One recommendation for managers who plan and conduct virtual meetings on a global scale is to align (meeting) time profiles of team members to support critical minimum length meetings, meeting regularity and also minimal disruption of national established norms.

This study is not without its limitations. First, it is a single case study of two teams run by one manager. These teams may have been unique because of their manager or because of the individuals that formed the teams. Thus, generalisations to globally distributed teams in industry may not be applicable. Second, the teams had student members. The students on the teams were Ph.D. or Master's students, who had worked in industry previously, but there are good arguments made that students have different goals and are thus, not representative for industry settings [23]. However we argue that because the students had full time professional jobs and because all but one of the students was over 30, that they were representative of typical industry workers. But the volunteer character of the SD-team project differentiates this team's temporal structures and norms from that of industry-embedded teams. Industry-embedded teams are aligned to temporal structures and norms through the corporate culture, e.g. office attendance between 9:00 and 17:00, which generates a common temporal frame and decreases problems with temporal entrainments. Third, the interest in understanding why teams fail comes from the issues in running globally distributed software teams. The teams studied were predominantly North American. Even foreign student members of the team had been accustomed to North American culture and socio-temporal norms, for some time. Thus, these teams did not represent the potential cultural conflicts that are predicted to happen in temporal norms and structures in global teams. Even so, this paper is the first to show the role of non-optimized temporal structures as a failure factor in virtual teams in a detailed analysis.

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