

# Real time enterprise management in the digitalization era

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## Abstract

This paper discusses real time control of an enterprise. The history of this concept is associated with the arrival of the real time enterprise (RTE) concept in 2002. The RTE concept has been interpreted variously, mainly in the areas of computer science and marketing. With the advent of new digital technologies and digital organizations, the RTE concept has received a new practical application in management.

This paper discusses an important characteristic of the RTE concept – real time scale and the division value of this scale. The authors have investigated the factors influencing the division value of this scale. The composition of these factors includes not only management, but also digitalization factors. We propose considering the real time scale as a time characteristic of organization adaptation to dynamics, uncertainties and complexities that are present in its environment. In this case, the division value of the real time scale is the time that characterizes the limit after which there is a loss of control in the organization.

There are two groups of factors influencing the division value of the real time scale: objective factors (for example, the speed of the actual operating processes), and subjective factors (for example, limitations on participants' knowledge of the real situation and/or their opportunistic behavior). Nevertheless, the real time scale is a real phenomenon which has objective manifestations. In a well managed organization, management always spontaneously reaches a consensus regarding the division value of the real time scale. Meanwhile, the division value of real time scale is the time division value of a real clock which is sufficient for precise planning and control of deviations from the plan.

**Key words:** digital enterprise; real time enterprise; variability; enterprise manageability; dynamics, uncertainties and complexities of environment.

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### Introduction

Due to digitalization, a “technological rearmament race” has already begun, and it is accelerating. Its main goal is not just to introduce new information technologies but to digitize businesses as well. It is shown in [1] that digitalization of enterprises creates innovative management practices in the fields of organizational, informational, and human capital. These new practices are complementary, and they are mutually enhancing each other.

Among these new practices, the most important is real time management. We have to note that real time management is not a completely new trend in traditional management. Indeed, the jobs of a manufacturing process operator or a railway freight dispatcher are examples of well-studied practices in real time management. When processes are stable, the response time of an operator or dispatcher must ensure

the process' continuity (i.e., the manufacturing must be maintained at a constant pace, or trains must move at a certain average speed). In these cases, the procedure of real time management is determined by the speed of the process.

How does digitalization change the concept of real time management? As a result of digitalization, the manufacturing processes or railway freight market conditions may be constantly changing “on the fly.” No longer can we define the change as a transition from one stable state to another. Digitalization gives us an opportunity to get a lot of new data on a manufacturing process or the state of a railway freight system, and we will be able to change everything on the fly as well. As a result, we will rarely consider the situation as a stable one; far from it, stable states may become exceptions rather than regular practice. Moreover, the changes themselves are transformed and become less predictable. For example, a railway traffic jam

used to be a threat for a freight dispatcher, and it caused delays and fines. However, when the dispatcher has more information, he has new options: first, there can be new clients requiring new routes; second, instead of a client's own trains, the dispatcher might be able to use a competitor's empty trains stuck in the jam on the same route. While this unique situation lasts, all the participants have to quickly agree, act on, and profit from it. Therefore, in the times of digitalization we have to deal with a stream of unique managerial situations rather than with regular processes.

The decision (a collaborative one!) must be made as quickly as it was made before by a dispatcher alone. What determines the procedure of RT management in this case? what does it depend on? how is it related to digitalization? Those are the questions we will try to answer in this paper.

### 1. History of the real time management concept

The real time management of an enterprise (or its separate entities) is the most important feature in a digital organization. The real time enterprise (RTE) concept has a long and rich history. This concept has already been discussed for some time, but in October 2002 it was clearly defined for the first time by Gartner's analysts [2]. According to this definition, an RTE is an enterprise that competes by using up-to date information to progressively remove delays in the management and execution of its critical business processes.

There are three important elements in this definition:

1. RTE is a relatively abstract objective to strive towards rather than a particular state of an enterprise. As Gartner's analysts noted [2], "It is unlikely that an enterprise will declare itself to have become "an RTE"... Progression is asymptotic — real world organizations will always remain inefficient in their speed of

response... Optimal RTE capability is a moving target..." In this concept, real time criteria must be relative and varying;

2. Information is necessary but not sufficient. Using up-to date information, we can move towards the target (RTE), but we will be needing more than just the information, because its use requires actions and other assets as well. Analysis of RTE's activities should be based not only on computer capital assets, but on other complementary assets as well [1];

3. Gartner's experts [2] distinguished two areas where the RTE concept may be used: execution of operational processes and activities management. They note that at the beginning, enterprises were mostly focusing on the operational processes on their way towards RTE. However, application of the RTE concepts to the expert activities of knowledge workers, as well as to management problems, could be beneficial. Therefore, Gartner's analysts state that RTE can be used under circumstances of both a routine issue and an emergency.

The RTE idea was welcomed by many organizations and experts. We can identify the following two interpretations of RTE: informational and managerial.

**Informational interpretation of RTE.** The RTE concept was first used by IT solution providers [3–16]. However, their understanding of the RTE concept was limited. They defined RTE as an organization that collects up-to-date data and provides the necessary information in real time to its employees, clients, suppliers and collaborators. In other words, all the information an enterprise possesses is real time information. Usually, supporters of this interpretation of RTE claim that this would happen when manual labor is kept to a minimum, and processes are fully automated. It is rather obvious that the informational RTE can be reached only by a large-scale deployment of informational technologies. However, the advocates of the informational interpretation of RTE do not go beyond this rather obvious idea.

**Managerial interpretation of RTE.** Some experts and organizations interpret the RTE idea in a wider sense, claiming that the whole cycle from making decisions to responding to changes should function in real time [17–19]. They define RTE as an enterprise that detects changes in operational and business conditions and ensures a quick response to those changes. Here, RT operation is assumed over the entire management cycle, from capturing an event (incident), to its analysis and decision-making, to a response action. In addition to real time acquisition of the information about current events, the real time concept relies on two more crucial stages. First, the decisions must be “real,” i.e., we have to analyze the information, understand the consequences, and work out the response - all of this in real time. Second, the proposed actions and activities should be “real,” using and adapting the existing processes and practices in real time. Therefore, the real time mode must be supported by the entire infrastructure, processes, assets and company employees. This interpretation of real time is deeper and closer to practical activities than the informational interpretation.

Let us note that there are other interpretations of RTE, but they are relatively scarce and not that important. For instance, one of them considers RTE as a concept that gathers the majority of new managerial ideas: information management, big data management, knowledge management, mobile enterprise, social enterprise, etc. In our opinion, such an excessive extension of the RTE concept is unjustified and impractical.

## 2. The RTE concept

All the experts agree that we have just begun to study the concept of real time in the RTE concept. As shown in [1], digitalization can make an enterprise very competitive. However, to take advantage of this possibility, the managers of all levels as well as the employees must make the “right” decisions. This means:

- ◆ the decisions must obey a certain set of requirements that satisfy both the solution developers and customers; such decisions must be implementable;

- ◆ the decisions must be timely;

- ◆ the decisions must be cost-effective: in their implementation, the management system must account for the costs of coordination between the decision makers and participants. The coordination costs can be calculated as the number of man-hours that participants with a certain level of proficiency spent to make and implement the decision. These costs are similar in nature to transaction costs in management [20, 21].

Digitalization provides powerful tools for making high-quality decisions and makes it possible to drastically decrease the coordination costs. Digitalization also helps to make decisions in a mode close to real time. However, even if decisions are made faster than before, this does not mean that they are necessarily timely. This problem is especially important when an organization and/or its external conditions are highly volatile. Let us discuss what is real time, and how this concept is connected with timeliness of the decisions.

The concept of real time characterizes a process of management resolution in an organization, i.e., when an event requires a managerial response. As we mentioned above, such events may constitute either a routine issue or an emergency. It takes time to resolve such a situation, and the amount of time should be appropriate to prevent a routine situation from becoming an emergency, or an emergency from becoming a crisis or even a catastrophe:

$$\delta < \tau,$$

where  $\delta$  – real time of the management resolution cycle;

$\tau$  – the acceptable timeframe for the resolution of the managerial issue.

Note that we are talking here not only about

acquiring and processing the information and decision-making; we consider the complete cycle of resolving a managerial emergency, which includes, apart from the steps mentioned above, the implementation of the decisions as well as the corresponding changes. Therefore, we think that there is a need to study the managerial interpretation of the real time management concept more thoroughly as a complete real time resolution of a managerial incident at an enterprise.

When conditions are stable and predictable, the majority of managerial situations can be easily resolved through the following steps: information acquisition – information classification – known solution – quick response. When conditions are unique and unpredictable, more complicated and coordinated actions of the participants are required to resolve a managerial issue: information acquisition – situation evaluation – looking for and making a coordinated decision – organization of and control over the decision implementation. In the latter case, all the participants must plan their actions, hence each participant that contributes to the decision has its own time scale.

The management time scale is a certain series of time unit intervals that determine the detailization level (quants) of planning and control over the activities aimed at the resolution of a managerial situation. A single-unit interval should be determined by the dynamics of the development of the managerial situation, i.e., by the acceptable timeframe ( $\tau$ ), so that the situation will not develop into a crisis or a catastrophe.

### 3. Factors that affect the management time scale

Let us try to figure out the factors that influence a management time scale's unit interval.

The more complex a managerial situation is for its participants, the more complicated is the activity aimed at its resolution. Hence, a real

managerial situation resolution cycle ( $\delta$ ) has to contain more actions, while the acceptable timeframe ( $\tau$ ) is fixed. Therefore, the management time scale unit interval will be smaller in this case. The difficulty of a managerial situation is always determined by its participants; therefore, it has both objective and subjective components. For the sake of simplicity, we can state that the difficulty of a managerial situation is determined by the following four key factors:

**Scale.** The difficulty of a managerial situation can depend on its scale, when there are many interconnected factors to consider. In this case, the time needed to find the solutions and to resolve the situation ( $\delta$ ) is hardly predictable;

**Information.** A situation may be deemed complicated because the participants do not possess complete, reliable, or up-to-date information. They will have to look for additional information, and it is hard to predict how much time this would take. In reality, this means that the information should be found as quickly as possible, and the management time scale unit interval should be minimal;

**Human capital.** The situation may be considered to be complex either because it is unique, or the personnel have never faced this situation before (no personal experience), or they do not know who has such an experience (for example, they do not know that a competitor has had such an experience, or that organization is not willing to share it). In such situations, the participants might “reinvent the wheel” by trial and error, meaning that their possibilities to plan the activities aimed at the managerial situation resolution will be very limited. In reality, this means that the problem should be resolved as quickly as possible, and the management time scale unit interval should be minimal;

**Organizational capital.** A situation may be difficult because the participants are not authorized to resolve it, and escalation or delegation mechanisms do not work. The lack of



such skills as standard practices of team work, meaningful task formulation, planning, control, and effective communications can substantially complicate the situation. In this scenario, it is hard to manage the situation, once again meaning that the management time scale unit interval should be kept to a minimum (everything should be done as quickly as possible to create a time leeway).

When the acceptable timeframe to resolve a managerial situation ( $\delta$ ) can be decreased, this decreases the management time scale unit interval as well. A managerial situation is always caused by some key reason. Most often such reasons arise outside the organization as impending threats or new opportunities caused by external processes with their own dynamics. In the first approximation, such dynamics can be described by four key characteristics. The first one is related to the regular course of a process, with the remaining three reflecting its volatility:

- ◆ the speed of an external process (productivity);
- ◆ the extent of variation in the external process during a period of time (variations in the whole process or in its subprocesses);
- ◆ the number of variations in the external process during a period of time (two variations in the whole process or 50 variations in some subprocesses per year);
- ◆ the average speed of these subprocesses in the external process (variations in the scope of the whole process take three months on average; variations in the scope of a subprocess take about a week).

It is noteworthy that key factors causing a managerial issue may reveal themselves inside an organization as well, for example as business innovations or management initiatives, with no apparent external changes. However,

they could also be characterized by the variability parameters discussed above.

In response to external changes, the enterprise management makes certain decisions<sup>1</sup>. We can obtain an estimate of the acceptable timeframe ( $\tau$ ) to resolve the situation in the scope of this managerial decision. This estimate has both objective and subjective components. In reality, the acceptable timeframe of the situation resolution is usually decreased (this can be described by the catchphrase “this should have been done yesterday”). This is caused by three main factors:

1. The increase in the speed of external processes, their volatility, and the growth of innovational activity within the organization itself objectively require resolving any managerial issues faster, meaning that the acceptable timeframe ( $\tau$ ) to resolve the issue should be decreased;
2. The acceptable timeframe ( $\tau$ ) to resolve a managerial situation is decreased because of the uncertainty in the evaluation of the situation. The participants in a managerial situation may not possess enough knowledge or information to correctly evaluate the scope and difficulty of the factors that caused the situation. In this case, the participants will have to overestimate the required time to have a margin of security, thus decreasing the acceptable timeframe ( $\tau$ );
3. An uncertainty in the evaluation of a managerial situation (for instance, an underestimated scale of a disaster) leads to erroneous estimates of the acceptable timeframe ( $\tau$ ). When the participants realize their mistake, they will need more time to correct them, and the situation’s resolution will occur under stricter time constraints, thus narrowing the acceptable timeframe ( $\tau$ ).

For mature businesses under professional management, emergency situations should be rare. The majority of managerial activities are related to routine situations, which have a local scale, their causation is well-known, the

<sup>1</sup> We assume that ignoring the situation and not taking action at all is also a managerial decision

experience of their resolution has been accumulated, and all the necessary information can be found quickly. Based on a stream of routine managerial situations, such organizations set rules, regulations, standards, and organizational structures. In particular, they set a particular timeframe to resolve a routine managerial situation, thus setting the time management unit interval.

Unlike emergency managerial situations, the routine ones do not cause a strong pressure to decrease the management time scale unit interval. Nevertheless, we have to remember that all the managerial situations in an organization are intertwined; it is hard to predict which situation might escalate or defuse; a routine situation may become an emergency, and vice versa. Therefore, the management time scale unit intervals must be constant for the entire stream. Since a management system should always be ready for emergency events, the management time scale unit interval should be determined by the resolution cycle ( $\delta$ ) of the most complicated situation the organization has ever dealt with. This does not mean that routine issues must be resolved at the same speed as emergency situations. Of course, different managerial situations should have different timeframes. However, we think that a system that manages an entire stream of events should have the same timescale, and the resolution of all the situations should be planned accounting for the management time scale unit intervals. This leads us to the definition of the real time management scale.

#### 4. The real time management scale

The real time management scale is a scale where a single-unit interval is sufficient to resolve the most complicated managerial situation the organization has ever dealt with. A single-unit interval on this scale is determined as the time necessary for the resolution of this managerial situation ( $\delta$ ) divided by the number of stages in the resolution cycle.

Sometimes a complicated managerial situation can be resolved easily and elegantly. However, this does not mean that the unit interval of the real time management scale must be increased. First, the real time management scale describes the entire stream of managerial situations. Therefore, for this elegant solution to increase the unit interval on the scale, such elegant solutions must become a regular management practice. Second, when the solution has not been found yet, a good manager should base any decisions on the most pessimistic scenario.

We can say that an organization resolves all the managerial situations they are aware of in a timely manner when a routine situation never becomes a crisis. Therefore, this scale reflects the organization's real time. In this context "real" means that the time corresponds to a certain external reality, is appropriate to the environment, and reflects the external conditions. We can define the term real time only in the context of a link between the process of object management and the object's environment. We have to emphasize that this only concerns the environment known to the management and the external conditions they are aware of. This relates to the note mentioned above that the real time criteria are relative and volatile. It is impossible to develop an real time management scale in advance for all unknown future managerial situations. Of course, the unit interval of an real time management scale can be decreased proactively to respond to more complicated managerial situations. However, there is no way of knowing if this response would correspond to the real time criteria.

We can say that the organization's real time management scale is a time parameter that reflects how the organization adapts to the dynamics and complexity of its environment. A unit interval on this scale corresponds to the limit where the management starts to lose control over the organization.

### 5. The real time scale and digitalization

Classical automation of regular stable business processes helped to make the majority of routine situations standard and exclude them from the overall stream of managerial situations. This created conditions for the management to reduce the timeframe of the resolution cycle ( $\delta$ ). However, this timeframe was not reduced substantially, because the actual practice of the implementation of the resolution decisions – even though the decisions themselves were made faster – remained the same; also, strong incentives to decrease the timeframe of the management resolution cycle ( $\tau$ ) were scarce. This is why classical automation had practically no effect on the real time management scale. Effects were noticeable when automation led to a productivity increase in standard operational processes.

Digitalization drastically changes the stream of managerial situations and gives the management strong incentives to substantially reduce the acceptable timeframe of resolution of managerial situations ( $\tau$ ).

**Increase in the density of the stream of incidents and emergency situations.** As digitalization expands, the number of digital twins of real objects increases. These twins serve as big data sources. The data appear as soon as an event is automatically registered, and the data volume increases substantially. The sensitivity of an enterprise's management to external changes grows; as the volume of information increases, the participants can see risks and possibilities they have not seen before. Now they need to adequately respond to them ( $\tau$ ). This means that the number of managerial issues, as well as the percentage of complicated emergency situations, will increase; this calls for the unit interval of the RT management scale to be decreased.

**Increased complexity of an enterprise informational model.** As data volume increases, digitalization provides the participants with

efficient tools for intellectual analytics, which allows them to find new connections and trends. However, these new connections and trends can only be revealed if the participants improve their skills and use more complicated decision-making models. For example, when a switch is made from the business processes scale to the scale of value chains, all the participants must update their way of thinking to embrace this new scale. In this case, the number of participants in managerial situations will increase, and the situations will become more complicated. The growth in complexity and uncertainty once again leads to a smaller value of the acceptable timeframe ( $\tau$ ) of managerial situations.

**The increase in the number of internal initiatives on changes.** As digitalization expands, more participants will be involved into activities related to business innovations or management initiatives. This means that the volatility initiated by the organization or a value chain must increase. The more local the initiative is, the easier it is to manage it, and the closer it will be to a routine managerial situation. We have to comprehend that new initiatives on different scales will join the general stream of managerial situations. This will expand the stream and can potentially lead to an increase in the number of complex emergency situations due to the complexity of the connections between the elements. Again, there is a trend to decrease both the acceptable timeframe ( $\tau$ ) and the unit interval of the real time management scale.

**Escalation of market competition.** The phase when the digitalization leaders on the market are “skimming cream” will be short. Solution developers and consultants will quickly introduce new technologies to the competitors. This will lead to a management “arms race” aimed at decreasing the market-average values of  $\tau$  and  $\delta$ . This, in turn, will create a new powerful incentive to decrease the unit interval of the RT management scale.



Digital organizations are just starting to appear, and we can assume that, as the digitalization scope and depth expand, the unit interval of the real time management scale will be decreased. This means that when the digital economy becomes a reality the operational and managerial processes, as well as the pace of life, will accelerate.

### Conclusion

The real time management scale is a characteristic time parameter that shows how an organization adapts to the dynamics and complexity of its environment. The unit interval of the real time management scale sets limits to the unit intervals of incoming signals and the acceptable lag of a response to changes. There-

fore, the unit interval of the real time management scale determines the limits of the possibilities of managing situations.

Figuratively speaking, under classical automation, the clock in the central control room of an enterprise reflects the real management time of manufacturing processes. In a digital enterprise, the real management time is reflected by the clocks in the negotiation rooms where decisions are made. The negotiation rooms may be real as well as virtual. It is of utmost importance though that the clocks in those rooms be synchronized.

We can assume that the expansion of digitalization in scope and depth will cause a decrease of the unit time interval of the real time management scale. ■

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