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Developing Bussiness And User Measurement of the System Availability

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Abstract: *This work presents basic elements of availability measurement methodology in complex technical systems according to business and users aspect. Methodology, which is primarily related to IT1 systems, is applied to and presented as a case study of Information system of Tax administration - DIS 2003. To achieve designed objectives of implemented methodology, it is necessary to provide "common" measurement from two diferent aspects: technical and business. The measurement result is system availability level as well as clear identification of critical components that influence the IT infrastructure stability and assure service continuity provided by the system.*

Keywords: *availability, quality, IT system, IT infrastructure, IT service, user, measurement*

1. INTRODUCTION

The ***IT infrastructure*** consists of computer, information-telecommunication and additional equipment integrated in one technical entirety. The IT infrastructure provides the information system users with the support in implementation of the business processes. For the concept of providing the business processes with the support, the term ***IT service*** shall be used.

The ***IT organization*** is responsible for providing the ***IT services*** as support of the business processes and for the technical support and maintenance of the IT infrastructure as well.

The concept of information system ***User*** includes all the owners and users of business processes within the same business organization, who as supporting tool in implementation of the business processes use the information system.

The Availability of the IT Infrastructure and IT Services provided thereby as the support of business, depend on:

- ü Complexity of the IT Infrastructure and the Service projected;
- ü Reliability of the IT Infrastructure components and the Environment;
- ü IT support organization's capability to maintain and support the IT Infrastructure;
- ü Levels and quality of maintenance provided by suppliers;
- ü Quality, pattern and extent of implementation of operational Process and procedures.

2. AVAILABILITY MEASUREMENT

Availability or ***unavailability*** is the key indicator of service quality provided by the IT system, which required as the support to business processes or by the user. Availability is underpinned by the reliability and maintainability of the IT Infrastructure and by the effectiveness of the IT organization. The IT system availability depends on:

- ü Availability of components;
- ü Level and risk of failure;

- Quality of maintenance and support;
- Quality, pattern and extent of implementation of operational process and procedures;
- Security, quality and availability of data.

The final word on the quality of the IT system and services provided rests with the business processes and business in general. While the traditional IT measures may show the satisfactory "percentage" of availability target met, this does little to change the feeling of dissatisfaction if IT Service Problems have impacted the business operation.On that basis, it is recommended that a wide range of measures be produced to reflect the influence of the IT system availability on the business and User.

Availability, when measured and reported to reflect the experience of the User, provides a more representative view on overall IT Service quality. The User view of Availability is influenced by the following factors:

- The frequency of downtime;
- The duration of downtime;
- The scope of impact.

The Measurement and reporting methodology from the User's aspect should embrace all those three abovementioned factors and there are two approaches of consideration:

- *Impact by User time loss* - this is to base calculations on the duration of downtime multiplied by the number of Users impacted;
- *Impact by business processes and transactions* - this is to base calculations on the number of business transactions which were not processed during the period of downtime.

3. IMPLEMENTED METHODOLOGY OF AVAILABILITY MEASUREMENT

Where the number of users impacted by an IT failure is known, this information can be used to report the user availability as:

- User impact reported as an absolute value per Incident or reporting period;
- User productivity loss as a time based value per Incident or reporting period;
- User availability as an availability percentage (%) for the reporting period.

To determine the basic availability of a given IT Service or component as an Availability percentage (%) the following basic formula can be used:

$$A(\%) = \left[\frac{(AST - DT)\cdot \mathbf{100}}{AST}\right],$$

Where:

- A(%) - percentage of IT system and component availability;
- AST - Agreed Service Time;
- DT - actual DownTime during agreed service time.

To provide a User view of Availability, the basic Availability calculation needs to be developed:

- The user processing time (EUPT) - This calculation is based on the Agreed service time AST multiplied by the total number of users (Nuser);
- End User Downtime (EUDT) – This calculations is based on the duration of Downtime (DT) multiplied by the number of hit users (Npuser) and by summarizing all downtimes within the measured period.

End-User Availability (EUA) can therefore be calculated in a reporting period based on the following calculation:

$$EUA(\%) = \left[\frac{(EUPT - EUDT)\cdot \mathbf{100}}{EUPT}\right].$$

Within the implementation of the measurement methodology the method of Component Failure Impact Analysis (CFIA) [4] is being used as a support to foresee and assess the impact of component failures on the IT system availability.

This aspect of the problem provides the possibility for the availability calculation to be based on the number of influenced users and/or lost user's working hours.

4. FUNCTIONAL AND TECHNICAL FEATURES OF THE IT SYSTEM

The Information system of the Tax Administration (DIS 2003 – Distributed

Information System) as a mean of the business support is designed as a distributed system with the centralized data records. From the functional aspect, the system consists of two parts, mutually integrated and connected with the network infrastructure.

In the Tax Administration's Head Office the data from all the organizational units are being received, processed and then the results of processing sent back to the dislocated organizational units. In the Head Office, the data exchange with other state authorities from the region is being performed as well.

In the Tax Administration's dislocated organizational units the data from the region (taxpayers) are being received, entered into the system and then transferred to the Head Office. The data resulting from the data processing in the Head Office are being received here as well.

Information and technical support to the information system's functioning is implemented through the three basic levels:

ü Central computer system;
ü Transport;
ü Local computer systems in dislocated organizational units.

The infrastructure of the Tax Administration's information system is based on the Information and Telecommunication network (ITC). ITC network is a highly distributed and complex technical system with respect to the high degree of organizational units' dislocations, and therefore the management, maintenance and improvement methodology is very complex.

The Tax Administration's ITC network architecture is built in a way that the system should not depend on the organizational unit network or on its internal functional organization. Currently, the system provides services for **234** information "addresses" on **167** locations represented by the Tax Administration's organizational units, where **7.457** workstations or system users are placed. The equipment specification of the ITC network and distribution through the organizational segments are shown in the chart 1.

The organizational segments	Workstation		Servers	Printers
Head Office	**454**		**104**	**163**
Regional Centers	**„Address“ RC**	**RC„Addresses“ (local office)**	**Area RC**	**Area RC**
RC Belgrade	148	2.031	138	1.305
RC Novi Sad	174	1.940	145	1.205
RC Kragujevac	106	1.252	95	775
RC Nis	250	1.102	105	653
Σ	678	6.325	483	3.938
		7.457	587	4.101

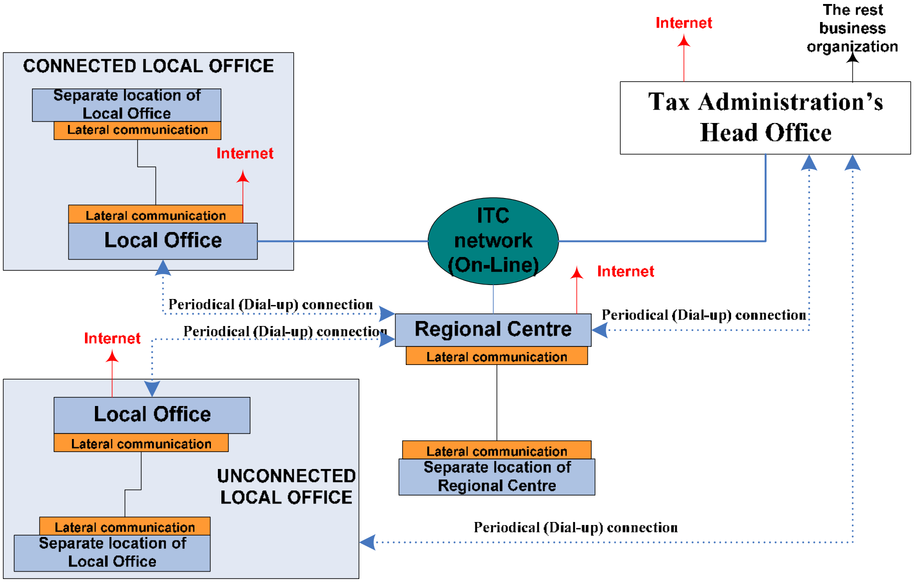
Chart 1. The equipment specification of the ITC network

The global structure of the Tax Administration's ITC network is shown in the picture 1. All dislocated organizational units analyzed from the communication channel and line aspect could be categorized in two groups: *connected* and *unconnected*.

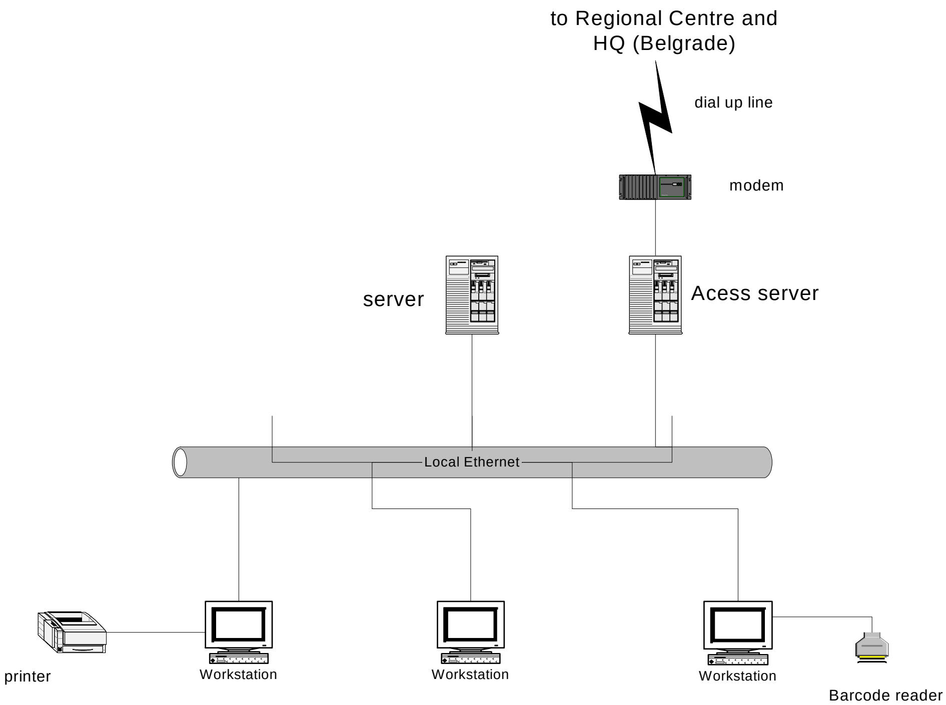
The connected organizational units, regardless the organizational hierarchy, have the direct (on-line) connection with the Tax Administration's Head Office. The local servers thereof are connected with the central server in the Tax Administration's Head Office.

The local servers of ***unconnected*** organizational units are connected with the central servers through the periodical (*Dial-up)* connection.

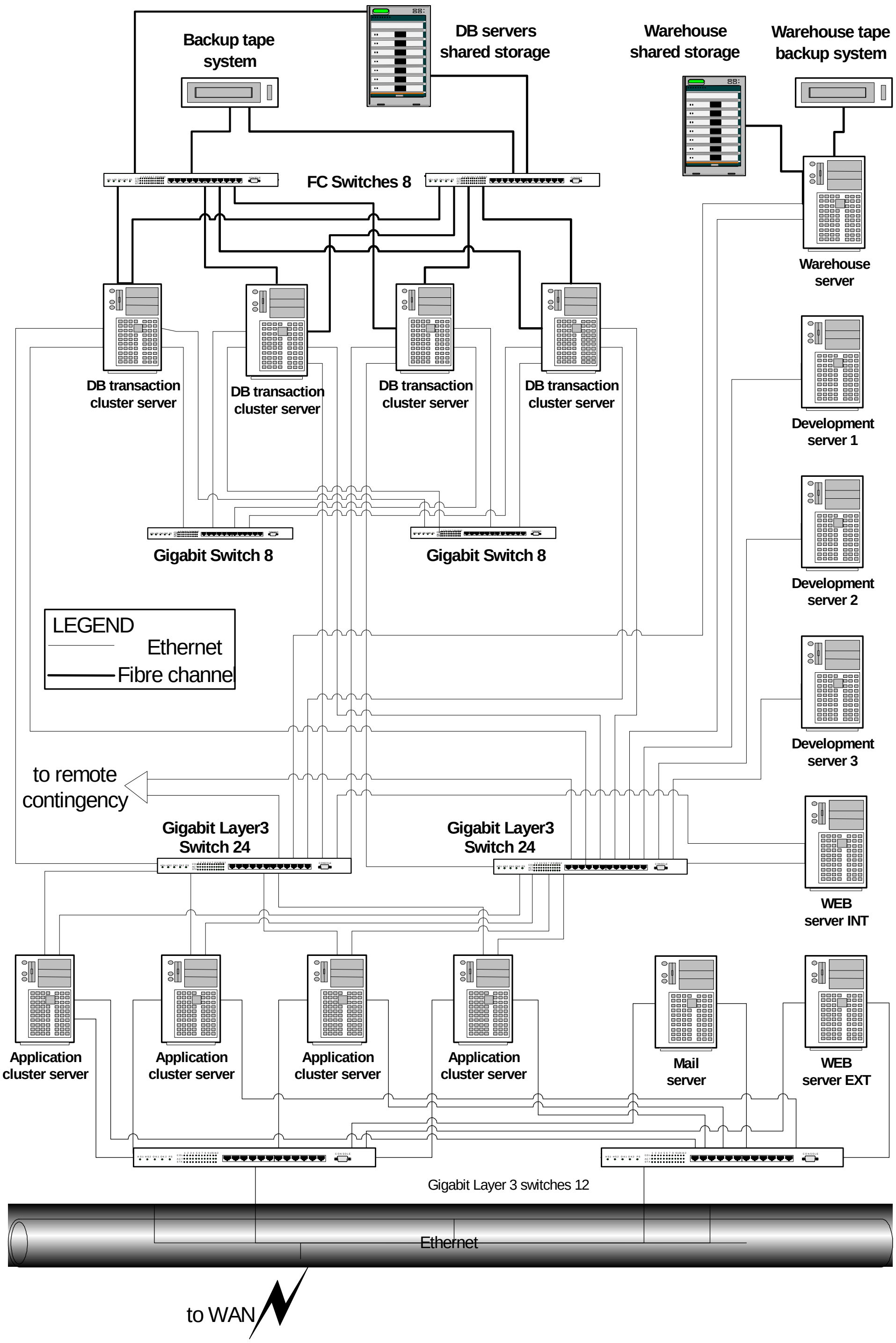
The architecture of the typical “address” is shown in the picture 2, and of the central computer system in the picture 3.



Picture 1. ITC network infrastructure



Picture 2. Typical „address“ – architecture



Picture 3. „Address“ – Head Office (central computer system)

4. DETERMINATION OF THE REAL SYSTEM AVAILABILITY LEVEL

The DIS 2003 is designed to have a separate reporting system for processes relating to its functioning. Within the reporting system, there is information on implemented processes relating to regular functions of the system, as well as on extraordinary processes mostly relating to the system component failures.

For the methodology to be implemented the other form of the system reporting will be important, which relates to identification of the system component failures and identification of the delivering service failures provided by the system. Within the information system, the system for reporting extraordinary situations through the **SMS** (**Short Massage Service**) has been established. The system for synchronization of the system time on servers with referent precise time through the **GPS** (**Global Positioning System**) receiver has been established as well. All processes in the system are being recorded and analyzed periodically, and among other things, for the purposes of adjusting the parameters of the system. The massages are being transferred through the mobile phone network (**GSM-Global System for Mobile Communications)** to the targeted phone numbers of the people from IT organization responsible for the system management and maintenance. The massage format generated by the system consists of the following:

dd.mm.yyyy, hh-mi-ss, NNNNNnnnnnnn, „massage content“

where:

- **dd.mm.yyyy –** day, month and year of the massage generation;
- **hh-mi-ss –** hour, minute and second of the massage generation;
- **NNNNNnnnnnnn –** phone number where the massage shall be transferred;
- **„massage content“ –** massage content.

On the basis of the content of extraordinary massages generated and timeframe of consecutive generations thereof, the timeframe of the system element failures could be determined and identified the system element which fails with certain preciseness.

When the system detects and reports the certain failure, depending on the failure type, there is precisely defined timeframe for the next reporting. Due to that, the timeframe, within which the system elements failed, might have certain values of error. For instance, if the timeframe of reporting certain system failure lasts 30 minutes and if such failure has been reported for the first time when happened and for the second time after 30 minutes, that might mean that the duration of the failure was 31 minutes at least, and 59 minutes at most. In these cases, this type of error has to be taken into consideration when implementing the methodology of system availability determination.

To evaluate the impact of local subsystems on the availability of entire system, for the first step it is necessary to implement the method of Component Failure Impact Analysis (CFIA). The implemented analysis indicates that, in a concrete case, ***local subsystem failures have an irrelevant impact*** on the availability of entire system.

In the course of methodology implementation, the number of users influenced by the system failures should be determined. The total number of system users is being determined on the basis of equipment specification (chart 1) incorporated into the ITC network, and the number of certain subsystem users is being determined as well. The influence of certain system failures on users is being considered as with the presupposed ***error of 1%***. The error is presupposed because the number of user workstations cannot be balanced entirely with the number of users who are every time active. There are always workstations where the users are not active over the certain period of time.

Basing on the previous analyses, it could be concluded that in the implementation of methodology of user availability determination, for the real system shown, the ***key assumptions and restrictions*** should be as follows:

- Needed input data are received from the central reporting system for extraordinary processes;
- Connections of local systems with the central system do not affect the availability of entire system;
- By an analysis was identified that the failures in local dislocated subsystems had an irrelevant influence over the user availability of entire system;
- Timeframe of the system failure duration will be determined from the

system for reporting the extraordinary processes;

- Due to existence of the timeframe for reporting the failures defined in reporting system, the results from measurements will be expressed with the presupposed error;
- Input restrictions and assumptions are necessary due to the lack of availability and defects of the input data needed for determination of the system availability;
- Input restrictions and assumptions are defined in the manner of not summarizing errors or incorrectness of the results received.

No	System failure description				Failure duration	
	Date	Time	Incident descri-ption	Failed Compo-nent	Down Time	Absolute error
					[DT]	±[ΔDT]
					(min)	(min)
1	2	3	4	5	6	7
1	02.08. 2005.	11-44-06	Problem sa orionom na razvoju 5	Razvoj 5, C2	30	14
2	02.08. 2005	11-45-29	Problem sa dns.it.pu	DNS	30	14
3	04.08. 2005	16-47-18	Problem sa dns.it.pu	DNS	30	14
......	....	....	....	....	....	....
133	29.05.2006	13-10-12	Carina-restartujem se	DPO	240	60

No	User impact		End User Downtime	
	Number of users	Relative error	End User Downtime	Absolute error
	[Npuser]	[ΔrNpuser]	[EUDT]	±[ΔEUDT]
		(%)	(min)	(min)
	8	9	10	11
1	6.325	1	189.750	89.499
2	7.457	1	223.710	105.517
3	7.457	1	223.710	105.517
......	....	....	....	....
133	1	1	240	61

Agreed Service Time		Total number of users	
Agreed Service Time	Absolute error	Total numbers of users	Relative error
[AST]	±[ΔAST]	[Nuser]	[ΔrNuser]
(min)	(min)		(%)
12	13	14	15
434.880	**0,5**	**7.457**	**1**

End User Downtime-sum		User processing time	
End User Downtime-sum	Absolute error	User processing time	Absolute error
[ΣEUDT]	±[ΔΣEUDT]	[EUPT]	±[ΔEUPT]
(min)	(min)	(min)	(min)
16	17	18	19
59.775.082	**13.815.178**	**3.242.900.160**	**16.218.229**

End-User Availability		
End-User Availability	Absolute error	Relative error
[EUA]	±[ΔEUA]	±[ΔrEUA]
(%)	(%)	(%)
20	21	22
98,157	**0,435**	**0,443**

Chart 2. Process of determination of user availability of the system

The procedure of ***User availability*** determination is shown in the chart 2. The analysis was performed for the period between 02.08.2005. at 00:00 and 31.05.2006. at 24:00, amounting to 302 days or **434.880** minutes.

According to the calculations, the value of the user system availability with the absolute error is as follows:

[EUA] ± [ΔEUA] = 98,157 % ± [0,435]% ;

Or if considered the relative error:

[EUA] ± [ΔrEUA] = 98,157 % ± [0,443]% .

5. COMMENTS ON RESULTS

The initial assumptions and restrictions in implementation of the User system availability determination point out a ***lack of development of tools for availability management***. In the current system of failure recording, it is necessary to enhance the data availability level, as well as to project and implement the tools for analysis.

In accordance with the initial assumptions implemented, the resulting issues might be considered as satisfactory, but the conclusions on confidence level cannot be drawn. If we analyze the resulting value, regarding the high level of complexity and distributiveness of the system, the conclusion will be that the system ***has a high User availability level***.

The greatest benefit of the implemented methodology is a possibility to identify critical elements of the system, by the technical improvement of which is possible to affect the availability level. Repeating of methodology implementation could, after technical and technological system improvements have been implemented, identify the impact on changes of the availability level.

6. IDENTIFICATION OF CRITICAL SYSTEM ELEMENTS

By the implemented analysis and implementation of presented methodology, the conditions for identifying the most critical system elements from the availability aspect have been met. Here, these elements will be listed logically, starting from the most critical one:

ü *ITC network*

A high percentage (46%) of the system “addresses” is connected by the periodical modem

communications. This is very unfavorable from the availability aspect of data incorporated into the system. Both critical and risk level of the ITC network increase dramatically, by increase of the business requirement level for shorter timeframe of data availability from all the "addresses" and abbreviation of timeframe needed for transfer to the central system.

- ***Computer and communication equipment***

  The chart 1 shows the equipment specification integrated into the ITC network. From the total number of workstations and servers, 54% belong to older technological generation, older than three years or more. Replacement of this equipment by a new one is very important from reliability aspect, and the most important is to have equipment of the last technological generation in the central computer system. The risks result from the lack of reliability relating to old equipment and from the difficult maintenance.

- ***IT organization***

  The critical and risk issues result from the lack of IT organization development. It is caused by the absence of clearly defined business processes and procedures, which need to be implemented in operations. Neither there are clearly defined standards for development of technical support system or development of tools for availability management.

- ***Tools for availability management***

  The risks result from inadequacy or absence of automated tools for data collection, which are criteria for tracking, analyzing and managing the system availability.

By the identification and analysis of critical elements the conditions for implementation of technical and technological improvements that will provide the implementation of the availability management processes have been met.

7. CONCLUSIONS

The benefits of implemented methodology can be summarized as follows***:***

- Provides a measurement result which can be understood by both business and technical aspect;
- Can more easily identify degrading levels of service to enable the IT support organization to be proactive;
- It makes the benefits from improvement of the IT infrastructure availability visible that are presented through the business improvements.

The possible problems of implemented methodology can be summarized as follows:

- How to relate business processes to Incidents, especially if no end-to-end monitoring is available;
- An absolute measure, e.g. IT structure availability can show a downward trend even when the overall availability improves;
- Not defined owner of measurements and data resulting from measurement;
- Integration and mapping of this measurement data with IT component Availability data.

REFERENCES:

[1] ***Project – Development of unique information and telecommunication network of the Tax Administration –** project documentation, Tax Administration – Head Office, Belgrade, 2005

[2] ***Project study - Unique information and telecommunication network of the Tax Administration –** project documentation, Tax Administration – Head Office, Belgrade, 2005.

[3] ***Information system DIS 2003** - technical documentation, Tax Administration – Head Office, Belgrade, 2002-2005.

[4] ***ITIL (Information Technology Infrastructure Library), Office for Government Commerce–OGC, British Government, London, GB, 1990.
[5] ***BS 15000 – I:2002 (IT service management), British Standard Institute-BSI, Office for Government Commerce–OGC, IT Service Management Forum-itSMF, London, GB, 2002.

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