Evaluating Disaster Recovery Plans Using Computer Aided Disaster Recovery Tools

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Abstract—Disaster recovery and business continuity research has improved significantly in the past decade; recently, with the spread of virtualization and cloud computing causing some cloud service providers to provide Disaster Recovery as a Service (DRaaS). Therefore, a need to have an open source tools to experiment with disaster recovery plans and test them in a safe and realistic environment has emerged. Recently, Computer Aided Disaster Recovery Planning Tools (CADRP) has been proposed as an open source disaster recovery design and testing environment; here, we explore CADRP to thoroughly test it and evaluate it.

Index Terms—Disaster Recovery Plan, Business continuity, RPO, RTO

I. Introduction

Computer Aided Disaster Recovery Planning Tools (CADRP) is a software tool that provides a safe environment to experiment with disaster recovery technology in a safe yet realistic environment. CADRP will allow system designer to pick an original system specification and a disaster recovery system and appropriate connection [1].

CADRP will simulate an actual running system and will provide essential evaluation of the system. Therefore, the system designer will know before hand, how well the disaster recovery system performs in terms of Recovery Point Objective (RPO) and Recovery Time Objective (RTO) [1].

TABLE I
HITACHI LEVELS OF PROTECTION [3]

Level	Level Name	Description
1	Tape Backup (offsite)	Data are packed up and taken to a remote location for storage, also called PTAM; *the "Pick-up Truck Access Method."*
2	Tape Backup (onsite)	Same as tier 1; however, the remote site has ready infrastructure capable of restoring operation to the latest backup within hours/days
3	Electronic Vaulting	backups are done via electronic vaulting, and high speed communication (no PTAM)
4	Single Disk Copy	Data are backed up more frequently; thus, better estimation of data loss and recovery time.
5	Disk Consolidation	Centralized data storage
6	Shared Disk	All nodes share all disks
7	Disk Mirroring	Typically synchronous approach
8	Remote Disk Mirroring	Can be synchronous or asynchronous
9	Complete Duplication	The whole system is duplicated with an identical system(s)

DRPs vary in their requirements and technology this has caused several researchers to propose different disaster recovery tier systems such as IBM [2], Hitachi [3], Xiaotech [4] and Novell [5].

In [3], Hitachi describes a 9-tiers DRPs classification scheme, see Table 1, below. CADRP will cover all 9 tiers indifferent designs, when the DR system is designed several factor is cost which is a main obstacle causing many factors must be taken into consideration; one important organization not to consider having a DRP. Moreover, a 2013 survey by Semantic has showed that 57% of small businesses and 47% of medium businesses don't have a DRP [6].

In the next section we shall overview CADRP; then in the following section we will test and verify the tool on several DRPs; then we will preview the results; and finally we shall conclude.

II. Computer Aided Disaster Recovery Planning

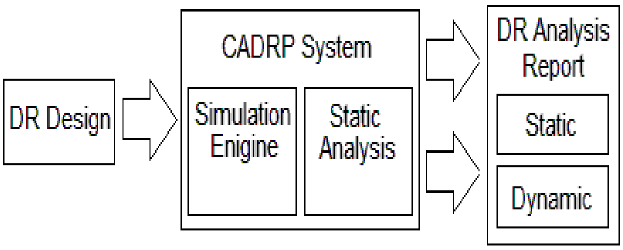

Fig.1. C**AD**RP System's Outline

Computer aided Disaster Recovery Planning (CADRP) system should accommodate disaster recovery system design ranging from the lowest tier (0) to the highest (7) on IBM tier system. CADRP should provide visual drag and drop interface. Then the system should be analyzed statically and dynamically (simulation). Figure 1 above shows an outline of the CADRP system.

A. *CADRP Design Overview*

In this part the DRP designer should design the original system and the DRP system and set the environment factors (See Fig.2): the recovery system may be absent (tier 0), or it can be a memory card, a hard disk, a tape like in lower tiers 1 to 3 or a server like in higher tiers 4 to 7; furthermore, a cloud server or storage can also be selected. Moreover, some data must be entered in order for CADRP system to analyze the DRP and generate correct reports (see Figure 3),

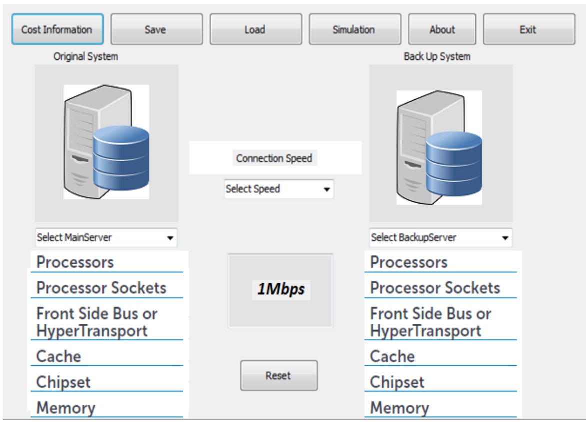

Fig.2. CADRP Design Screen

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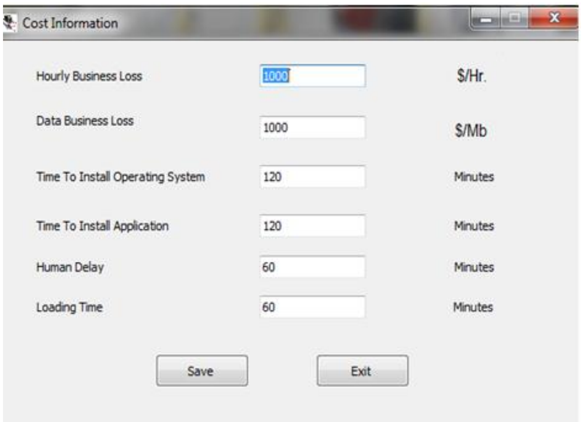

Fig.3. Some Data Collected By CADRP

these data is mainly about the environment to determine the weight of some factors, and this will help for the feasibility analysis and calculating RTO.

B. *Simulation Engine*

This module will be responsible for simulating two systems, the original system and the disaster recovery system. After the system is designed, and also the appropriate parameters entered; this module will run a hypothetical application that will run in cycles, at each cycle the original system will keep processing the current transaction depending on its CPU speed, if the transaction is fully processed then the system will process the next transaction and the old transaction will be sent to the disaster recovery back up system (it can be tape, disk, server or virtual server. So, depending on the connection speed from the original site to the backup site sometimes there is some delay; in addition to that there is a speed also for tape, disk or server to process or store the coming transactions. There is one important assumption that must be made, is to have a *sync DR* or *async DR*, each one has advantages and disadvantages, as in sync systems both systems must be in the same transaction, so the slower of the two systems will slow the other, while the async let the DR system work on its own pace, without causing the original system to wait (see Figure 4).

```
int Simulate()
{
long i=0; //transaction processed at the original system
long j=0; // transaction being transferred
long k=0; // transaction processed at the DR system
long cycle =0;
do{
  cycle++;
  Process (Orig_system, transaction[i]);
 // process portion of the transaction in this cycle
  If processed (Orig_system,transaction[i]) {i++,j=i};  // if the
transaction is completed, transfer it
  Transfer (Speed,transaction[j]);
  //transfer portion of the transaction during the current cycle
  If transferred (transaction [j]){ j++,k=j};
  // if transaction is transferred process it at DR
  Process (DR_system, transaction [k]);
  If processed (DR_system,transaction [k]){ j++,k=j};
 // if transaction is transferred process it at DR
  If (disaster_triggered) disaster =1;
  } while (disaster == 0)
RPO= k-i; // number of lost transactions
Return (RPO)
}
```

Fig.4. Basic Algorithms for Disaster Recovery Simulation Engine

On the other hand the sync DR preserves the integrity of the transaction as it will not move to the next one until it is processed and stored on both systems.

III. Testing the Tools

Here we go through the system for full test(Figures 2 through10are actual screen shots of CADRP).

A. *Disaster Recovery System Design*

CADRP interface is simple; there is an area for the original system with several options (that can be extended in a later version) and a choice of connection or transfer speed, and an option for the disaster recovery media. Certainly, the system provides save and load options, so designs can be saved to be retrieved later.

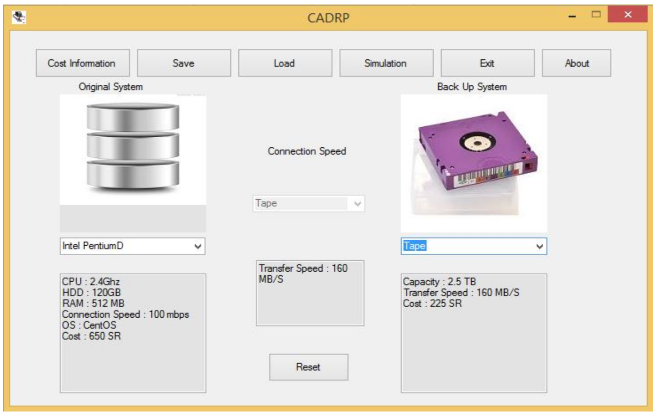

Fig.5.Using Tape as Disaster Recovery Technology

Figures 5 and 6, show how a system and a disaster recovery system can be chosen, we can see that there is a range of systems compatible with the Hitachi 9-tiers system given in Table I.

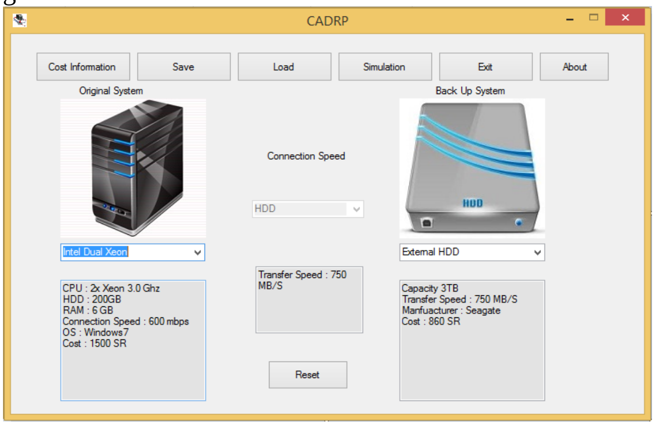

Fig.6. Using Hard Disk as Disaster Recovery Technology

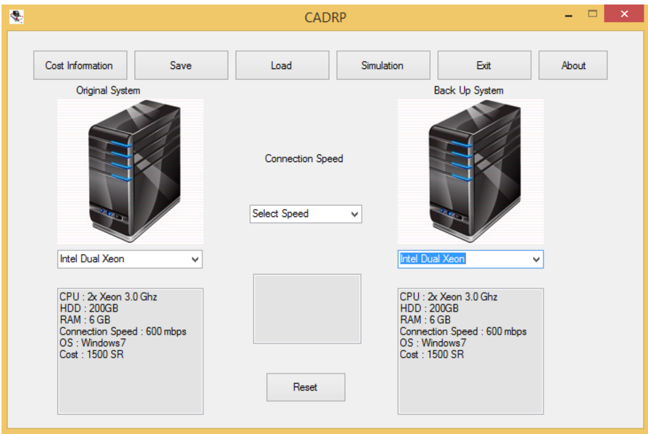

Fig.7. Using Identical Server as DR Technology

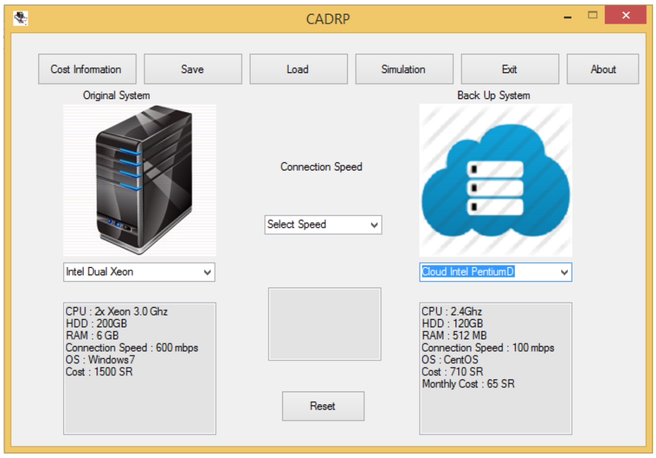

Fig.8. Using Identical Cloud Server as DR Technology

B. Running the Simulation

When the system is designed using CADRP, and we are ready to test it we can start the simulation engine. Then, the system will start to run some hypothetical application and will show the transaction processed, the one being transferred and the one successfully stored. Later, at a certain point we can stop the system and generate the simulation report (see Figure 9).

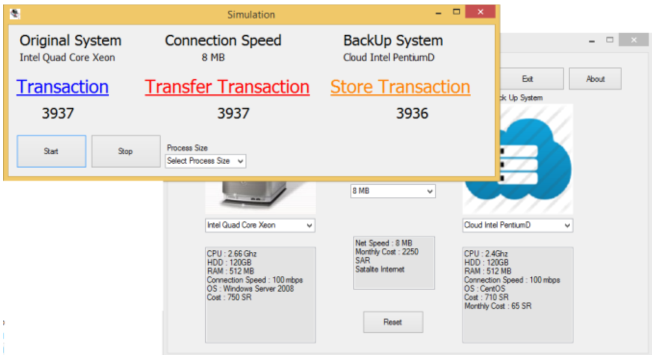

Fig.9. Running the Simulation

C. Final Report

CADRP will provide full report including most important data about the DRP; certainly, RPO and RTO and some cost analysis calculated using pre-set values given by the user.

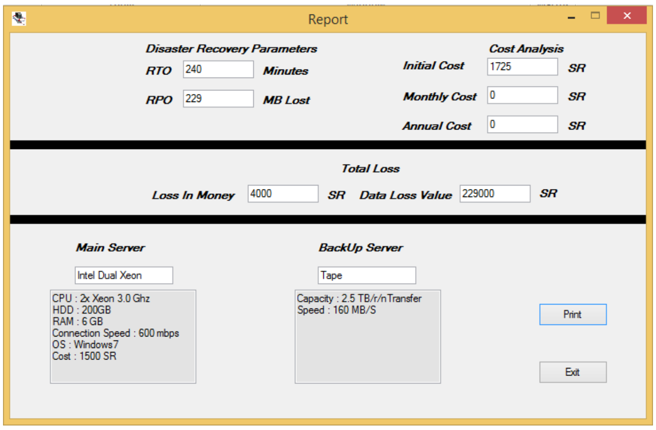

Fig.10. TheFinal Report

For example, how to estimate the direct financial loss, 1 mb can worth thousands of dollar in one environment and could be negligible in another environment. Here, Figure 8, below, shows an example of a report generated by CADRP running a system using tape for disaster recovery(see Figure 10).

IV. Test Results

Table 2, shows a typical test of the system given 12 different disaster recovery scenarios, we show the low tier systems using tape in 1 and 2. The simulation shows that the speed of the tape is a major factor as faster transfer rate saves more data.

We have also considered using an external hard disk in cases 3 and 4. Here also, the disk speed is a major factor. However, in all the cases 1 to 4, we need to setup and configure a new system causing the recovery time to be quite high at 240 for tape and 120 minutes for hard disk.

In cases 5 to 10, we used identical server for original site and for recovery site. However, we have changed the connection speed at each experiment from 256Kbps up to 100Mbps and have found significant improvement in saving more transactions (i.e. data); again this demonstrates that the connection speed is the most critical factor. Moreover, here the recovery time objective is significantly shorter because at disaster time we already have a fully functional server running and we only need to switch operation.

In cases 11 and 12 we are considering the use of cloud as a disaster recovery media. The results show that the cloud is a viable option. However, performance also depends on the quality of the connection.

TABLE II
APPROXIMATED RESULTSOF DRP AFTER RUNNING 20,000 TRANSACTIONS

Case	Disaster Recovery System	Connection speed(mbps)	Lost transactions	Lost data(mb)	RTO(minutes)
1	Tape	.25	60	30	240
2	Tape	.5	42	21	240
3	Disk	.5	48	24	120
4	Disk	1	16	8	120
5	Server	.25	95	2	0-5
6	Server	.5	49	1	0-5
7	Server	1	24	2	0-5
8	Server	2	11	1	0-5
9	Server	10	3	2	0-5
10	Server	100	1	1	0-5
11	Virtual Server	0.5	20	20	0-5
12	Virtual Server	100	1	1	0-5

V. Conclusion

CADRP is a useful tool; however, we have found several limitations that can be summarized as follows: one limitation is that there is a need to include more factors by giving the user the ability to create systems with flexibility in choosing operating systems and applications. Moreover, in CADRP there is a limitation in having two sites: original and DR, it would be more useful to have multiple DR sites running in the simulation.

Finally, we can see that the area of disaster recovery planning lacks the appropriate systems available for researchers to develop better disaster recovery plans. Therefore, future research includes studying the implications of virtualization on disaster recovery planning.

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