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## CLOUD Computing: Cost-Effective Risk Management with Additional Product Deployment

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### Abstract

This article addresses a discrete event CLOUD simulator and manager, CLOURAM to estimate the risk indices in large CLOUD computing environments, comparing favorably with the intractably theoretical Markov solutions or hand calculations that are limited in scope. The goal is to optimize the quality of a CLOUD operation and what countermeasures to take to minimize threats to the service quality by reserve planning of additional product capacity to be deployed. Following, cost and benefit analysis is demonstrated.

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*Keywords:* CLOUD Computing; discrete event simulation; reserve planning; product deployment; cost and benefit; breakeven.

### 1. Introduction

The CLOUD computing as the new century's paradigm change of doing business at a larger scale of computing supported by the internet of all things, must be measured, monitored and managed to see where things are leading to rather than letting it to take charge by the oft-practiced cruise control alternative. However, as often apparent from the news media describing outages as simple glitches (usually downplayed by the CLOUD hosting companies and their providers or assigned responsible managers who boast about their 99.99% availability) are not exactly stating the stark reality frankly out of commercial reasons<sup>1</sup>. Once assessed, the next question becomes as to how to manage, rather mitigate the lack of availability. One of the most predominant measures to do that is the leverage of additional product deployment. Where do we halt recruiting the additional products and what is the breakeven value of the number of additional products that need to be added extra for service so as to monitor the desired availability at best? One can certainly not achieve this cost optimization by sheer guessing or hand calculating. This research

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shows through the related software how best to achieve cost-optimal product reserve planning a process which can cost CLOUD managing or facilitating companies millions of dollars if not rightfully estimated in advance [2].

CLOUD computing, a relatively new form of computing using services provided through the largest network (Internet) has become a promising and lucrative alternative to traditional in-house IT computing services, and provides computing resources (software and hardware) on-demand. The quality of CLOUD computing services can be difficult to measure, not only qualitatively but most importantly quantitatively<sup>2</sup>. An algorithmic discrete event simulation accompanied by related statistical inference is conducted to estimate the availability indices in a CLOUD computing environment of small or large service-based systems to mimic real life operations. However, as users (companies, organizations and individual persons) turn to CLOUD computing services for their businesses and commercial operations, there is a growing concern from the security, privacy and availability perspectives as to how those services actually rate. Moreover, the federal government has approved commercial products to operate on a defense CLOUD, marking the industry's first online offerings with this level of security accessible to the military via such an environment<sup>3</sup>. If the reserve capacity (or margin) is less than a zero margin, then we have an undesired deficiency or loss of service. Once these hours (or cycles) of negative margin are added, it will constitute the expected number of hours of loss of load, LOLE. Divided by the total number of exposure units such as 8760 hours (NHRS) for a year, it will give the LOLP (Loss of Load Probability) = LOLE/NHRS. Once the LOLE is known, and its frequency ( $f$ =number of such occurrences of deficiencies per annum), then the average duration,  $d=LOLE/f$ , will indicate how long on the average a loss of service is expected to last. What are some of most significant scenarios on "What If" will be studied in subsequent sections, such as what happens when the cloud managers increase the size of the size of product capacity and at what level should they stop adding or deploying extra products to achieve an optimal ROI (Return on Investment).

## 2. CLOUD Resource Management Planning for Product Deployment

A most popular example to a what-if query as frequently executed in simulation engineering practices is the resource allocation, which is one of the most vulnerable and softest (weakest) points of the entire CLOUD computing process<sup>4</sup>. We will study the effect of the number of additional capacity deployment. In Appendix, Fig. 1 has originally displayed an unavailability index of 13.71% for 443 units originally deployed. The total number of production units is 443 available. In a new analysis, we will simulate (10000 runs or years) adding extra capacity to see where to halt for a cost-optimal decision. One may want to add or discard certain cyber-servers (or producers in general such as power plants at a power CLOUD scenario) by reorganizing the list of groups' units. One can experiment with less or more number of servers at selected capacities to see how availability may be affected. See now section III for an algorithmic analysis.

## 3. Step by Step Algorithm for CLOUD Management Planning toward Additional Product Deployment

Follow below the itemized steps to implement Product Reserve Planning.

*Step 1:* Radio button **Product Planning** must be selected as shown in Fig. 2 below in the Appendix.

*Step 2:* **# of Product Increments** in default is given as 10, which indicates the number of product intervals required to plot a graph.

*Step 3:* **Product Multiplier** in default is given as 1 to 4, which indicates the number of components multiplied for the horizontal axis, such as 1x100MW or 4x100MW for power systems or GB units for cyber clouds.

*Step 4:* **Δ%LOLP Reduced** in default is given as 20% which indicates that if the difference between two LOLP values is greater than 20% of the starting LOLP, then the capacity value stops at the lower LOLP value. The case study is for data2000.txt

*Step 5:* **Starts at Product Value** is the initial total capacity value, it is 26237.

*Step 6:* **Starts at LOLP Value**, 0.1373 is the LOLP value for the initial total capacity value. With 10,000 runs, LOLP was 0.1375.

*Step 7:* **Stops at Product Value**, 26937 is the optimal stopping product value.

*Step 8:* **Stops at LOLP Value**, 0.1087 is the optimal stopping LOLP when less than 20% of original 0.1373 is achieved (= .10984)

*Step 9: Final Product Value*, 27237 is the total capacity at the end of the reserve product planning.

*Step 10: Final LOLP Value*, 0.100 is the LOLP value for the total capacity at the end of the entire product planning in the plot.

*Step 11: Cost* in default given as \$5000, which indicates the dollar amount investment expense to the entire Cloud operation for adding one additional MW or GB of extra production capacity.

*Step 12: Benefit* in default given as \$1,500,000.00, which indicates the dollar amount gain to the entire Cloud operation annually, as accrued by one per cent increase in Loss of Load related, for one or more products to increase production.

Now consider the same 2000 system example as follows; where the total number of producer groups available is 103 and starting total installed capacity is 26237, as in Fig. 1 where LOLP=0.1373. **Add a new group, Group Name 104 with 0 component and product value 100** for data2000.txt as shown in Fig. 2. We will examine how any additional 100MW or GB units we will add to stop at the  $\Delta$ LOLP is satisfied. For the above input, with data 2000, the stopping product value is 0.1087 in Fig. 2.

**Total Capacity Value:** is the total capacity value before incrementing product values.

**Profit/Loss:** indicates whether there is profit or loss by stopping at a break-even point.

**Break-Even Value:** indicates the \$ amount for one per cent gain required to have resulted in neither profit nor loss. This cost-benefit portfolio of Reserve Product Planning analysis will save (+) or lose (-) millions of dollars' worth for a CLOUD Resource Management. The LOLP value displayed is truncated to round off after four digits following the decimal; this is why hand calculations and software outcomes may vary slightly, also due to #simulation runs. Note,  $0.0286 \times 100\% \times 1,224,758.82$  (Break Even) = 3,3502,810.7 (~approximately same as investment dollars) due to round-off.

*Step 13: Solution* is as follows. We can also observe the final stopping LOLP value, that is, the LOLP value for stopping product addition value, which is at 26637 for above input; i.e. with 700MW or GB added. This denotes:  $700 \times \$5000 = \$3,500,000$  for investments. Also, the final LOLP value to stop at is 26937 for above input of Fig. 2 as depicted in Fig. 3's plot. " $\Delta$ LOLP = 0.0286" is the decrease in LOLP value. This denotes:  $0.0286 \times 100\% \times \$1.5M = 3,500,000$  gain. Result:  $4,290,000 - \$3,500,000 = \sim \$790,000$  (profit approximately). Fig. 2 indicates the final solution to as +\$786,558 with pennies to be exact, which is very close to  $\sim \$790,000$  as a rough hand-calculator calculation.

See similarly another example for system 1995 data as presented below in Fig. 4 and 5 in the Appendix respectively for results and plot.

#### 4. Some Further Validations of Reserve Product Planning

When stopping product value and stopping LOLP value is 0, a message indicates to simulate again with different  $\Delta$ LOLP product constraint as red-flagged in Fig. 6. This message that the analyst needs to enter a new set of feasible input values. Therefore, we can observe that unavailability decreases as the product value is increased. The CLOUD simulation should stop at a point, where there is no more return for increasing the percentage change on the LOLP. If we happen to have "Stop at Product# is 0" as an output, one may decrease the  $\Delta\%$ LOLP Reduced Value, for instance, from 65% to 40% and simulate again with the new set of input constraint values. As we can see in Fig. 6, the dialog box shows message to simulate again. Fig. 1 to Fig. 6 are all in the Appendix.

### 5. Discussions and Conclusion

A decade or two ago, start-ups had immense difficulties to march ahead with their merely invented or designed software because they had to invest large amounts of cash and/or resources to rent cyber real-estate for connectivity, security and hardware. Any delay in getting all this set-up would cost them a competitive edge in the market. These days, the same start-ups could have their products earning back the same dollars they invested due to ready-to-rent Cloud facilities within days if not hours. In contrary, Cloud computing house-managers whereas have to need to come up with a reserve planning scheme for the optimal number of maintenance crew members (studied in another article) and the number of additional products to be deployed to avoid bottlenecks in terms of supply and demand realities. Cloud computing has come to a point where SaaS (software-as-a-service) serves the need for these customers who need not know the underlying infrastructure or computing platform other than how to use some web-based application or a battery of applications to overcome the job under scrutiny<sup>5</sup>. This research paper addresses how to plan the additional deployment of products to avoid bottlenecks so as to supply what is the demanded by these multiple customers without loss of availability. The cost (for deploying additional products to raise capacity) and benefit (by lowering the LOLP=Loss of Load Probability so as to improve availability) equation greatly helps to know if the optimal process by adding extra capacity (products) is actually profitable or not.

### Appendix:

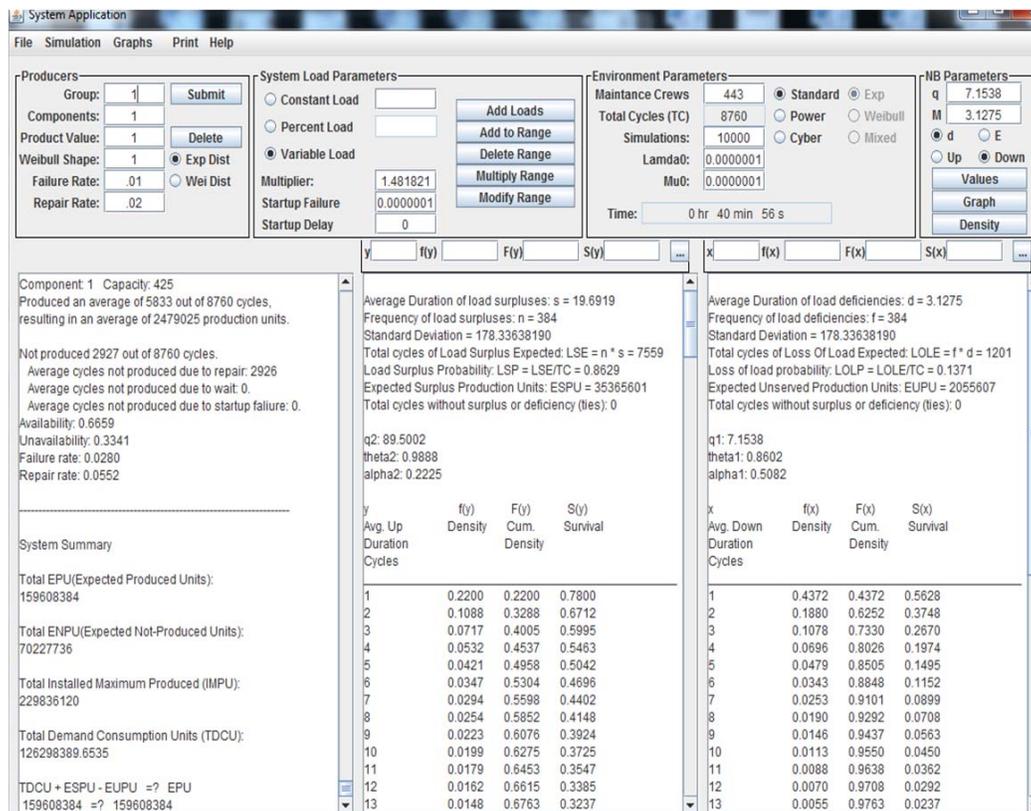


Fig.1. The simulation results (10,000 years) for a large CLOUD with 443 units and run time: 41 min.

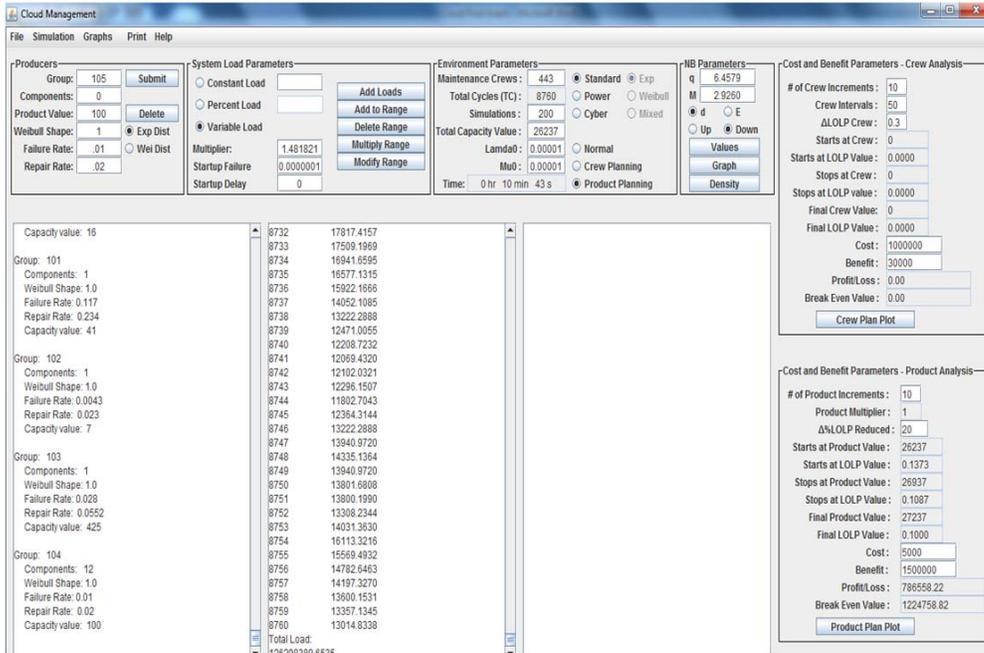


Fig. 2. The dialogue box input data example for product reserve planning for CLOURAM with 200 simulations.

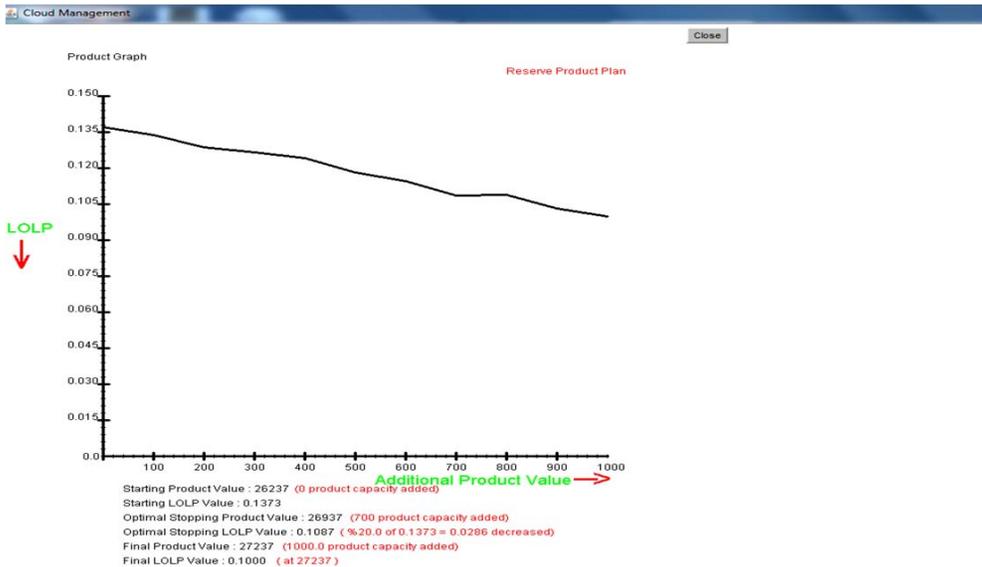


Fig. 3. Product Plot shows LOLP at 10.87% down from 13.73% for new capacity of 700 added in 2000data.tx

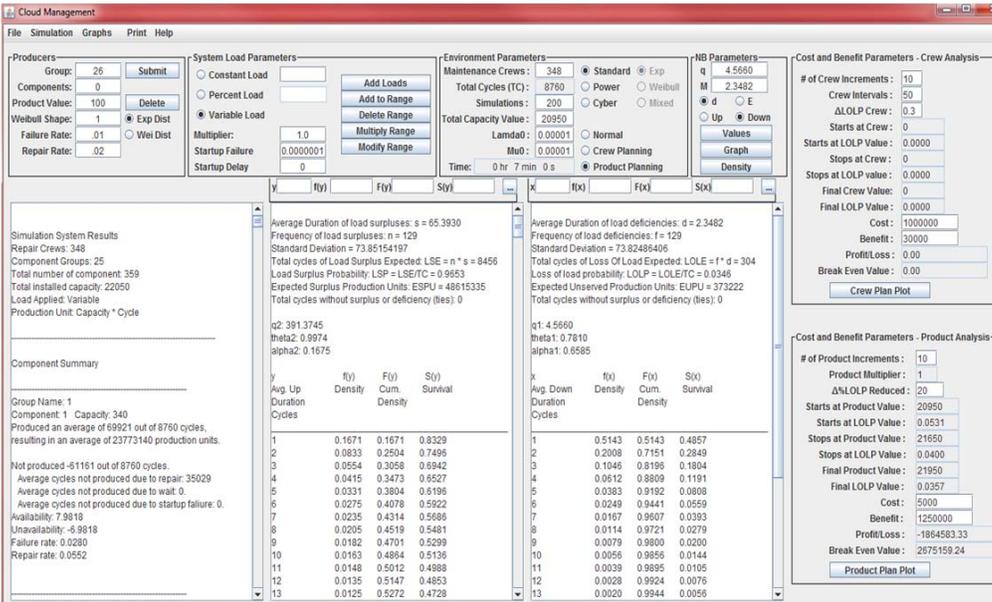


Fig. 4. Output for data1995.txt in 200 simulations with -\$1,864,583.33 (Loss)

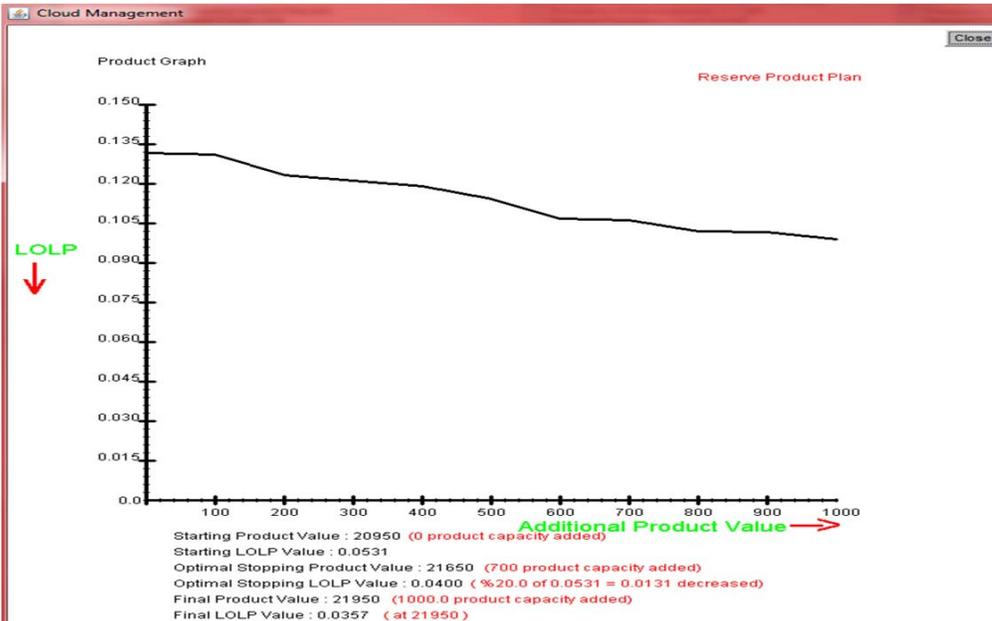


Fig. 5. Product Plot shows LOLP at 4.00% from 5.31% for a capacity of 700 added in 1995.txt

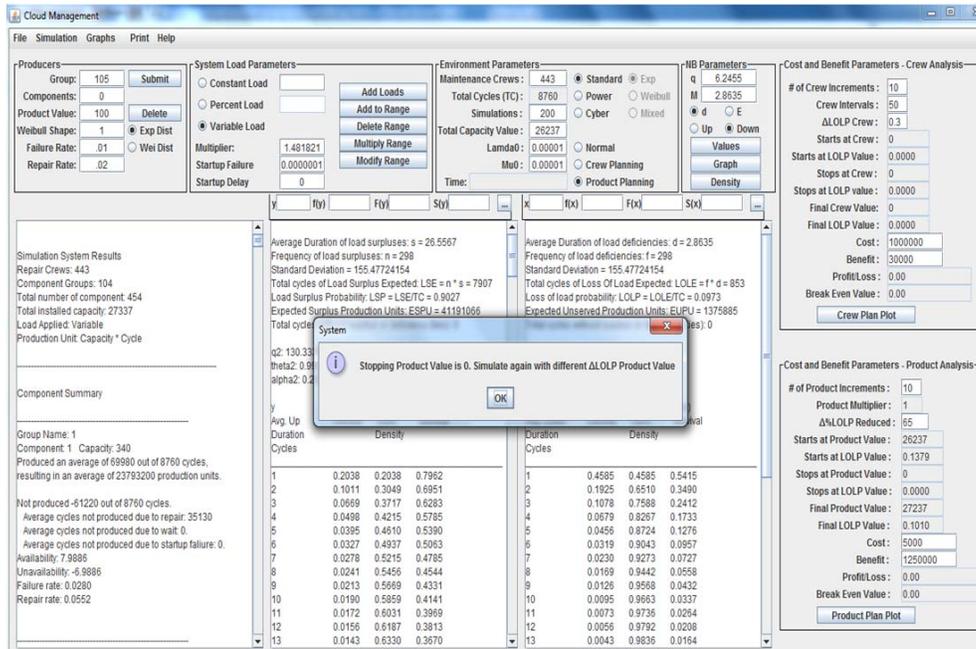


Fig. 6. Dialog box shows up message asking to simulate again due to input incompatibility.

## References

1. Worthen G, Vascellaro J. Wall Street Journal, E Mail Glitch Shows Pitfalls of Online Software – Photo: Services like Gmail run on vast computer farms. A Google center in Lenoir, N.C., B 4-5 Media and Marketing, February 26, 200
2. Sahinoglu M, Morton S. Cloud Risk-O-Meter: An Algorithm for Cloud Risk Assessment and Management. Conference of Society of Design and Process Science (SDPS), Session X1 Cloud Computing: Security and Reliability, 1:30-3:15pm, Berlin, Germany, 13 June 2012.
3. Leavitt N. Is Cloud Computing Really Ready for Prime Time. *IEEE Computer*, January issue, 15-20, 2009.
4. Sahinoglu M, Cueva-Parra L. CLOUD Computing. Invited Author (Advanced Review) for *Wiley Interdisciplinary Reviews: Computational Statistics*, New Jersey, Ed.-in-Chief: E. Wegman, Yasmin H. Said, D. W. Scott, Vol. 3, Number 1, March 2011, pp. 47-68.  
<http://authorservices.wiley.com/bauthor/onlineLibraryTPS.asp>, DOI=10.1002/wics.139&ArticleID=771921
5. Sahinoglu M. CLOUD Computing Risk Assessment and Management, Book Chapter, (Risk Assessment and Management)AcademyPublish,November <http://www.academypublish.org/book/show/title/risk-assessment-and-management>, 2012.