Core Banking System Scalability Review

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Abstract. In carrying out the digital transformation, bank has to find their optimal routes to exploit the Open Banking opportunity and minimize or manage any threat. However open Banking models will be making implication on the increasingly hit from the external parties. It will be new and more unpredictable data volumes as third parties request access to the banking system. Bank has to prepare their Banking system on the Enterprise Architecture, and one of the concerns is on the scalability. For the traditional core banking system, the platform of mainframe and other legacy technology could remain the bottleneck to agility and scalability. In this paper, scalability testing and analysis are carried out to verify whether the traditional banking core system running on the power platform can be scalable to support open banking strategy. The results found were that the core banking system could be scalable, but needed a lot of enhancement on the core banking application side, as well as capacity upgrading on the server side.

Keywords: Core Banking System, Scalability, Open Banking, Transaction Volume

1. Introduction

The disruption wave as because of the digital technology are happen in all industry now, including in the banking industry (Accenture, 2018). Some of the existing banks have begun to be affected by this digital change, but most of them already know about the changes that must be made. The digital transformation strategy in each bank can be different, especially related to the condition of the organization and its customers.

The emergence of a number of new players in the financial industry turned out to also change the pattern of services expected by customers while influencing the income they received. Existing banks must make fundamental changes, especially related to the way they operate. Their services must be ensured in very good performance including being able to quickly launch new digital innovation services.

Bank has to implement new digital initiatives including Open Banking. Open Banking is the shifting strategy from closed to open banking models (Deloitte Digital, 2017). Their banking system: data, banking product and other services functions are shared and open to other institutions and third parties with the main objective to generate the additional value.

However there are many implications after implementing Open Banking. The more integrated external parties will create more transaction volume. Bank has to prepare their Banking system on the Enterprise Architecture. It would be suddenly the number of Transaction become huge after any business deal and collaboration with third parties.

Discussing about enterprise architecture system, there are top three concerns: **Scalability, Availability and Performance**. These parameters are really strategic in determining the user experience in transactions and in long term relationship. It also directly impact to business regarding to online revenue, business growth, competitiveness and high business interest (Shailesh Kumar, 2015). For the traditional banks, the platform of mainframe and other legacy technology could remain the bottleneck to agility and scalability (MIT Technology Review Insight, 2018). Banks has to modernize IT for many years to ensure the open banking system readiness.

This paper focused on review traditional core banking system to support open banking system model. The new comprehensive methodology was created based on the previous references. It's used to test the scalability with the targeted business volume number.

2. Materials and Methods

2.1 Open Banking Implementation Challenges

There are challenges in implementation of open banking and other digital initiative. In such country such as Indonesia, it requires an adequate level of internet infrastructure in order to adopt the technology and provide the necessary support for its usage and growth. The internet infrastructure with proper band with in Indonesia is not well distributed and yet to reach many area. Bank has to also strengthen the privacy and security of data transferred over the internet network. Cybercrimes and hacking is a big reality in online banking, and this cause to a decline in trust on bank digital activities (Varda Sardana, 2018). Open banking implementation also has the impact of the additional transaction coming to the banking system. Bank has to prepare their system in the enterprise web application system (Shailesh, 2015).

2.2. Online Banking Performance Parameter

The design of Web site and online banking resulting quick response time to the users should be provided by Banks. Bank customer would be more motivated to access the web system if they have the good performance especially on the response time. (Fida Hussain Chandio *et al.*, 2017). Forrester, sponsored by Akamai Technologies (NASDAQ: AKAM) has conducted study at 2009. They released key findings at e-Commerce web site performance in correlation with behaviours of shopper. The result highlighted that the new threshold response time of web application expected by the user is in two seconds. They will abandon the online web commerce if they have to wait the response more than 3 seconds. That is the new expectation as the similar study conducted 3 years before resulted 4 seconds for the threshold.

The most variables affecting online banking customer satisfaction are: quick responsiveness, reliability of the system, efficient service, security, look and feel site (aesthetic), easy to use and user experience (Mohsen, 2015).

2.3. Computer Performance

Computer performance is majority determined by a combination of 2 parameters: first is throughput and the second is response time. The other aspects related with computer performance are computer power efficiency and systems availability (IBM, 2019). Computer system **response time** is the duration and elapsed time between the request of transactions submitted and the starting of a response to that transaction. At interactive users, the response time is the duration time to get the display result after clicking <enter> button. It's a critical aspect of performance as because of relation to the potential visibility of end users or customers. The computer system **throughput** is a measure of the number of work can be performed by a computer system at over the period of time.

Response time has the closely relation with throughput. As resources of computer (processors, disk, memory and etc) are used by many users and simultaneous transactions, it will result delays to individual transactions because of the similar resources are still uses by other transaction. The computer system resource that has the capability to in shared resource may cause additional response time because of the mechanism.

2.4 Transaction Type

There are 3 transaction types. The first is called **I/O-limited transactions**. It consists of a mix of considerable disk wait times. This transaction type will retrieve and get the most benefit from the good and an efficient of disk I/O subsystem (IBM, 2019). With the technology of disks, setting large disk cache, and also advance speed I/O links will do improve the throughput and response time and of these types of transactions. Application that has the characteristic on this transaction type is suggested to use SSDs as an alternative to previous technology of HDDs.

Figure 1: I/O Limited transactions type

The second type of transaction is **resource limited transaction**. It consists of a considerable mix of processor and wait activity. These transactions type gain benefit most from improving application efficiency. To improve the system, application has to cut, minimize and reduce the impact of critical shared computer resources (between program applications and threads).

Figure 2: Resource Limited transaction type

The third type is called **processor-bound transactions**. This type requires considerable processor cycles and very little I/O or wait times. The performance of the application with this type will be much better if they use higher processor frequency and also the efficiency of the processor pipeline stages. Utilizing of improved memory and processor will also generate better performance.

Figure 3: Processor-bound transaction type

2.5 System Scalability

Scalability is related to the capability of system to manage and handle the additional demand and workload without neglecting the overall efficiency (Shailesh Kumar, 2015). This capability is mandatory for the enterprise application system and its related ecosystem. It has different elements related to scalability: Application and its ecosystem, increased workload and efficiency.

Figure 5 explain the scalability layers. It's informed based on *order of contribution to scalability in the chain of request processing*. This figure highlight that the layer of enterprise application give the major impact of the overall enterprise web application system.

Figure 4: Layers of Scalability and the Impact (Shailesh, 2015)

In the online banking system, the layer of enterprise application is represented by core banking system. When talking about application system performance, one of the major parameter is application speed to response the request. Both server and enterprise applications are the main actors in generating response time (Techempower, 2016).

2.6 Scalability – Vertical or Horizontal

Open Banking models also need the elasticity. This is the degree to which a system can quickly adapt to workload changes by utilizing and upgrading resources in an on-demand manner. During the system application is running, if suddenly any additional workload system must be easy to scale up and if necessary to add the required resource.

Figure 5: Vertical and horizontal Scalability

When there is an increase in transaction volume that cannot be handled by the existing specs server, it is necessary to increase the existing server capacity. Basically there are two types of scalability: vertical and horizontal. Vertical means with the existing box of server, we add the capacity by upgrading the resources of memory, processor, storage or others depend on the specific required to upgrade. And horizontal scaling is adding the capacity by adding the number of box server. The decision to choose either vertical or horizontal is depend on the related application capability to manage the scalability. Especially for vertical, it also depends on the server technology capabilities used, can it be upgraded up to the desired capacity.

The horizontal scaling now is more popular in the open banking architecture because of several things such as below:

- It's **elastic**.
- It is **dynamic**. The existing resources can be kept still as it is and online during the additional the new server. It doesn't have the negative (risk) implication to the existing or previous server.

2.7 Scalability Testing Methodology

Figure-7 is the new testing methodology for this core banking system scalability review testing. It was modified and adjusted from the previous references of the PSR (Performance, Scalability and Reliability) testing methodology.

Figure 6: Scalability Performance Testing Methodology

2.7.1 Define Business Requirement

Bank could be lower their competitiveness if they slowly adopt the Digital Banking Technology, but it could worsen their financial performance if they adopt it aggressively (Rosnita, 2018). Thus the business team must decide to what number the system must be scalable in accordance with the business value and targeted growth. These numbers will be a reference for the IT team in designing and preparing the required system scalability.

To ensure the scalability of traditional core banking system, there are parameters should be provided by business team: Expected response time (seconds), Target account number, Target online transaction Volume, Maximum time duration of batch process (EOD and SOD)

2.7.2 Design Architecture

The business number targeted by bank will be main reference to design the IT System Architecture. In this stage, all related components must be prepared and estimated able to cover the business number and its growth (Shailesh, 2015). As this works focus on traditional core banking system scalability, the preparation components is as follows: Design Architecture, Setup Environment, Assign Related expert, Prepare the Data and Test Script.

2.7.3 Performance Scalability Test and Enhancement

It's identified that for the end to end enterprise system architecture, application layer is the main component of which we have the control, and also giving a maximum impact on scalability (Shailesh, 2015). At the application layers, the scalability is contributed by: software, process, and hardware. The challenges on software include potential issues and bottleneck in application code. And the hardware

challenge includes the server and infrastructure components such as memory, CPU, Disk capacity and network.

2.7.4 Analyze, Conclusion and Report

All data and results in this scalability testing are collected and documented. The experts then discussed together including with other related parties and business or user team. Conclusions and suggestions must be made in accordance with the direction of strategy scalability targeted by the company (bank).

3. Results and Discussion

The research carried out was by conducting scalability testing of core banking system based on the methodology that has been made (as per explained in the previous chapter). The first step is defining the target business volume. From the current volume, it's targeted the aggressive growth at year-5 and year-10 (as per stated at table-1). The second stage was testing environment preparation before doing the detail activities of scalability testing.

At the first stage of scalability testing, the focus was finding scalability bottleneck of the current traditional core banking system. All expertises were involved in this activity. Every bottleneck found during test should be solved (application customization or hardware adjustment) and then did the repeated test. This is done back and forth and repeatedly until getting the optimal results. Figure-8 is sample profile application in one step of testing. It explains which program should be enhanced as it consumed high CPU and I/O.

MI complex instruction	Library name	Program name	Module name	Number of threads	Inline CPU percent of total	Inline elapsed time percent of total	Times called	Calls made	MI complex instruction count	Inline CPU usecs	Cumulative CPU usecs	Inline elapsed usecs
	QSYS	QCMD	QCMD	417	.0000	.0001	0	416	10	149,2890	475,575,686.3770	55,10
	VLKMYI	VPRCSTRES	VPRCSTRES	360	.8436	.1983	0	258,945	2	4,034,569.0390	342,137,951.2990	114,6
	VLKMYI	VFMFASTRES	VFMFASTRES	342	1.4667	.4182	20,027	439,017	79,694	7,014,487.5450	302,714,003.1510	241,8
	VLKMYI	VMTBALO	VMTBALO	342	1.2563	.3865	19,941	477,652	59,770	6,008,178.4080	206,841,942.3460	223,4
	QSYS	QDMCOPEN	QDMCOPEN	Q> 347	2.9751	3.5532	458,215	936,365	4,661,912	14,037,501.8830	171,791,179.0330	2,054
	VLKMYI	VDRV	VDRV	V> 20	6.7642	.4002	0	394,127	0	32,350,107.0170	106,573,172.0620	231,4
	VLKMYI	CLDRV	CLDRV	C> 20	0	.0000	0	20	0	0	106,573,172.0620	941,3
	QSYS	QDBOPEN	QDBOPEN	Q> 347	1.9617	2.9047	458,186	2,928,863	2,072,362	9,382,046.9560	73,652,876.3120	1,679
	VLKMYI	VCONVB	VCONVB	V> 19	13.4244	3.0069	3,869,197	0	0	64,203,062.8910	64,203,062.8910	1,738
	VLKMYI	VVLBAL	VVLBAL	V> 342	12.2280	.5767	111,436	0	0	58,481,187.0610	58,481,187.0610	333,4
	QSYS	QDMCLOSE	QDMCLOSE	Q> 347	.6980	.1629	19,885	178,932	59,646	3,338,437.5800	50,616,683.3290	94,17
	QSYS	QDMCLOSE	QDMCLOSE	Q> 347	1.3098	2.3150	417,357	417,354	3,736,263	6,264,392.7440	41,302,797.5440	1,338
	DESCR			347	6.9097	.7321	457,035	0	0	33,046,112.2350	33,046,112.2350	423,3
	VLKMYI	VVLCDR	VVLCDR	342	.3323	.2051	19,907	278,527	59,700	1,589,394.1210	31,857,167.5020	118,5
	QSYS	QDBGETKY	QDBGETKY	355	.9373	.9224	498,689	121,615	935,865	4,482,645.8500	27,714,537.5340	533,4
	CRTDOBJ			346	5.2080	.6639	458,199	0	0	24,907,432.1690	24,907,432.1690	383,9
	VLKMYI	VLLIB	VLLIB	342	.1847	.2583	19,939	418,731	21	883,192.7690	22,178,922.5470	149,3
	VLKMYI	VVLACT	VVLACT	342	.1604	.1191	19,887	139,218	59,690	767,303.1290	21,999,903.9530	68,86
	QSYS	QDBXREF	QDBXNOSYNA	346	1.1946	.7650	458,159	916,316	0	5,713,434.4830	20,577,383.6880	442,3
	QSYS	QLRMAIN	QLRMAIN	342	.5914	.6128	218,951	258,823	577,497	2,828,183.7120	19,419,087.8520	354,3
	VISIO>	DGAVBL	DGAVBL	342	.1650	.0989	19,881	119,271	39,759	789,286.5770	19,157,662.9270	57,16
	VLKMYI	VLKFM20	VLKFM20	342	2.1386	.2553	39,642	118,922	39,639	10,228,170.6330	17,669,568.2540	147,6
	SETCR			358	3.4885	.5459	498,728	0	0	16,684,012.3930	16,684,012.3930	315,6
	QSYS	QDBGGENSP	QDBGGOBJLN	354	.3056	.7215	458,171	0	916,341	1,461,405.2670	14,531,928.4560	417,2
	QSYS	QWCCRCRC	QWCCRCRC	342	.4977	.4449	99,381	198,765	496,906	2,380,507.8250	13,425,696.5260	257,2
	QSYS	QCADRV	QCADRV	346	.5533	.5618	159,585	478,793	319,175	2,646,019.8970	13,142,304.3050	324,8
	VLKMYI	VLOG	VLOG	8	.3272	.1617	0	258,472	0	1,564,832.1420	12,940,596.6030	390,0
	QSYS	QDBGENSP	QDBGGOBJLN	346	.3573	.6773	458,303	0	0	1,333,481.8300	13,017,336.5950	380,0

Figure-7: I/O and CPU consumption of Programs at Core Banking system

There were many major customization done at core banking application, and also several adjustment and server setting. It's including utilize SSD disk technology that's resulted 3 times speed performance of the system.

Table-1 explained the target business volume and the detail core banking system scalability testing result.

Table-1: Core Banking System Scalability Testing – Target Business and Result

Scenario	Target Business		Achievement		Server Spec
	# Account	TPS	Online Transaction Response time	Batch duration for End Of Day Process	Power 870
Volume-1 (Year-2)	10 M	5,600	< 200 milliseconds	56 minutes	4-cores, Memory 64GB, SSD 24x387 GB
Volume-2 (Year-5)	17 M	8,600	< 200 milliseconds	1 hour 25 minutes	6-cores, Memory 64GB, SSD 24x387 GB
Volume-3 (Year-10)	50 M	13,000	< 200 milliseconds	1 hour 31 minutes	12-cores, Memory 128GB, SSD 24x387 GB

4. Conclusion

Regarding to implementation of open banking models, bank has to review their core banking system scalability. It's reminded by MIT (MIT Technology Review Insight 2018), that bank with traditional core banking system platform might be has more challenges in this scalability. This paper has concluded that:

1. Traditional core banking system running on power platform can be scalable to support open banking strategy. But it is vertical scalability and need enhancement in the core banking application.
2. The detail enhancement of core banking application may vary and differ from one bank to another. It can be identified after scalability performance testing is conducted.
3. The response time of core banking to support online banking can be targeted not more than 250 milliseconds.
4. The scaling of power server depends on the target business volume. The upgrading server specification especially is on number of CPU, memory and disk technology and capacity.

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