--Interview 1

My research is about migration of legacy object-oriented software systems to service oriented architecture. More specifically working on service identification. We are currently aiming to have really better understanding of the used legacy migration techniques in industry. In order to study the gap between industry and Academy. So for this interview will guarantee the confidentiality of the information that you will be sharing with us, Including your identity. All results will be for research purposes.

We will have two parts the first part about migration to service oriented architecture. Second part will be about Services identification

So my name is XXX, working with a company in Germany called XXX which is Japanese service company. We are around 300,000 people, and in my case, I’m working in the application modernization department responsible for Europe and South America. The methodologies used for re-architecture is coming from Canadian company in Vancouver. Named XXX and it's part of our company now.

My first question is how to define a legacy system?

so typically what we taking care of his assistant for us is everything. This is IBM mainframe. basically most of the things which is not x86, we have OpenVMS, Isirus, Pl/1 all that stuff. it has a different meaning for some people. For some people Java is even considered as legacy. We are focusing mainly on these old technologies which are still the core parts of most businesses on this planet like insurance companies and banks.

what kind of systems did you migrate to service orientated Architecture ?

We have two approaches. One approach is rehosting and one is re-architecture in the re- hosting part we are migrating from one platform to another one without changing too much. For the re-architecture we take old language like Cobol RPG, pL1 and all at the main focus for customers today is of course is C C#.net and java

Is it in that order?

Most customer wanted to be in Java but as you know Java can't do everything. But still Java is the most important part for everybody Also Linux is very important and they are not looking too much for something in Windows.

The first approach Rehosting is it like using a new container or virtual machine to emulate Old platforms

Exactly yes

So it is virtualization

It's based on that but more like emulator. We have CICS, We have our own product x86 we support different platform, customer can move without too much changes his app from the mainframe to x86 platform.

You Mentioned in the survey that you perform migration to improve the business agility, reduce vendor unterlock, can you please explain more.

Basically, if you have something like Mainframe program you have several levels of vendor unterlock: Some systems run from CICS This is a runtime environment on IBM mainframes. If you would like to get rid of IBM which many people would like to do so because the COST is very expensive, so you have to get rid of these interlocks into CICS, so we move everything away from CICS. The second example is to get rid of any specific database calls on the mainframe. Some legacy systems have calls to Jars or DB2 to Oracle over specific IBM plugins so we would like to eliminate these vender unterlocks by doing the migration

What is your strategy to migrate legacy system to service oriented architecture?

Share the screen: So we have a specific methodology you know when you migrate to this it is an example of our of our approach that we have this is for a specific customer like in Germany for the German pension fund. So we have what we're doing basically we're analyzing 3 Levels, 3 levels of information. So we have the application code. This is the green part which is everything about the code Cobol code, PL/1 whatever it is… We have one track which is called data modernization which is all about data access. This can be flat files. This can be any databases or something. And on top of the business process. So we always put this together you know this is something unique that we are providing to our clients. So we have these three levels and we have this one which is discovery and plan what we call update analysis. We are we are importing the code in our toolset. We are looking for dependencies. We just have a look if everything is complete. Sometimes customers this is legacy code and typically customers are a little bit lazy. They don't find the code when it's very old for example. So we have to take a look that we have everything. The second one is how we define future case. How should the application look like in future. Like in service to be service oriented if this is the goal of the customer we describe everything here and Phase 2 which is a design phase. In Phase 3 is a very classic software development phase just to develop and test the code and then that's it. This is the approach.

What are the main challenges migrating legacy systems to SOA?

First of all the timeline the time it takes to project is four to five years. You know people are not ready to wait such a long time to would to want everything much faster. And one of the biggest issues is of course performance.

You mean the new technologies are less efficient?

In many cases to don't perform like what is expected from the old system

Can we have an example Please ?

So like you know it's an entrance exit transactions were put you know if like you know banks in the banks the classic banks I have one customer in Brazil. This is a bank. And they build online banking around the mainframe. OK. So whenever you look for a account balance on your mobile phone it goes as a transaction to your mainframe. And of course the customer is expecting a quick response from the system because you know otherwise if this takes too long you just you get nervous when you're on your telephone. Why does it require don't get any information. So if if you do this like in a service oriented architecture in Java it's quite difficult to ensure that you have the same response time. This is just one example you know performance is always very critical.

Why do you think that service identification in important in the migration process?

So we call this the business code . You know this is for the services part. Customers invested lots of time lots of money in detecting the business rules in legacy code. This is lots of mathematics you know how to calculate insurance you know the duration what the customer gets for his life insurance stuff like this. This is very important for the customer not to lose this kind of information. This kind of knowledge you know this is what we call business rules. So what to do basically. You can see my screen.

Do you mind if we take snapshots of your screen?

I can send you the presentation afterwards. this is not secret. You know if you need a little bit more information you know we also have some I have some more presentations I can send it to you, you can use whatever you like. So in our case like finding the business rules our methodology we're not doing everything automatic you know automation is maybe 70 percent of all the project. Any customer who comes to me and says he wants everything automatic you know this is him you know this doesn't work. There is no artificial intelligence maybe in hundred years there's something but you know the programmers everybody has is style to program. You know sometimes it's you, you cannot find anything that's any scripting method where you can really find out this business code automatically. So what he's doing here is basically you see here this is the approach. What are we doing with the customer. We load the source code. We look at the documentation we make application walkthroughs and we do technical walkthroughs with subject matter experts. They got to know their application. We document everything in our systems. And then at the very end which is almost at the end we do analyze thw documentation this last part. This is where we identify the business rules. We marked them in the code and we can extract them afterwards. So this is done you know sometimes there are some specific naming conditions you know and you see how many times this specific part of the code has been used. The behavior, we get from our system we get a list of recommendations. So like what I have here, what you see here we're doing it on the left hand side you see typically COBOL code and we do some whenever we will identify something you know we marked it in the code. This is in our system you know you can use a tool in development system, import code in our tool set, we mark it here we do some annotations in there. And based on this we have a list, this is the middle part, with a list of business processes or core code description. Okay. And we also document this in based out of that information we are creating are service oriented material.

So basically you look at the source code and you tried to associate this as source code to a list of the processes that you know are taking place whithin the application ?

yes. Let me check I think I have another, humm where is it... This is the process. What we have the business rules and one have signed something that you marked up in the middle you'll see the service specifications and based on the service of specifications we're creating Java services from the right side.

I find it interesting that we asked about services and you talked about business rules hahaha

I mean I mean services for me is you know does this java services you know is the reason why I asked in the beginning.

so for you I guess the definition of a service is a piece of code that executes some reuseable business logic yes and then you'll find the content of that piece of code by looking good by identifying the business rules within the system.

Yes
Okay Interesting.
Did the identification of the business rules usually success to find good services.
Yes. This is what they expected from the customer. So I can't say no that's what they expect from me.

Do you suggest any best practices for service identification?
Yes we have of course based on our projects we have our own best practices. It's also been based on the basis of our service offering.

Can you please list for us some tools that you are using for the migration and the re-engineering of legacy systems?
We have tools that you know. So basically this is our main toolkit. This is what we we said about rehosting in the beginning from mainframe. It is called Entity data T.P. and BP you see on the left hand side you see typical mainframe structure. On the right hand side you see the similar stack on an open system. So we had our COBol using all our own IP for this. We have what's called Entity data BP which is for batch processing we have something for TP which is transaction processing and this comes also with the specific migration tools. This is everything we're using for our modernization approach. So we have something for we hosting we have in the middle the green one is for me is for re-engineering or architecture or whatever you call it. And the other one is for some, we are also using some automated tools for specific parts of our project like if you want Would like to convert something from C C++ to Java We have something, if you would like to convert something from oracle forms to

java we have something like this. From web logic to jboss... We have a specific suite where we can convert whatever Java code you have in every application server we can convert from Oracle to IBM from IBM to Redhat you know and vice versa. If you're just using the tools from the vendors that it only goes into one direction so we can do it in whatever direction we needed.

If I may go back to your service identification approach You look at the business rules from the legacy code and how do you decide on the cohesion, Like you can find two pieces of business rules and how do you associate that to a single service how you perform the mapping from rules to service
Well this is in most cases a manual process because we look at this we need some subject matter experts who help us here.

So is it fair to say that you identify the services thanks to the identification of the process models So when you look at the source code you try to uncover what's the underlying processing, you identify a bunch of tasks those tasks become services then for the business content of those tasks, That's when you look at business rules and you say the business rules for this task which you had already identified through manual documentation then you perform the association from those tasks . Who then becomes service.

Yes. That's a fair characterization of the process. Yes what you also want to, also do like in many cases you find that business rules complicated so we are looking for duplicate code and duplicate code patents and stuff like this. And then we need to decide what you take out of this. Because this code is sometimes 30 years old or 40 years old and all the programmers already retired. We have to make a choice what you what you use for your modernized application structure or architecture.
I'll give you one small example. I worked were almost 18 years ago. We were modernizing an application that was creating a data warehouse from a production database. The creation of the data warehouse used lot of businesses. So we tried to identify the business rules by looking at the SQL procedures that migrated to the production database into the data warehouse. The customer was using an application or a system called data stages. And so we said okay let's look at all of the data stage sql procedures and we found 15000 of them. I Remember we had we had a meeting to.. We were still trying to set up a process of this so we had a meeting where we said well let's go through a couple of these procedures. And so I think we had like 3 hours meeting that we spent on one procedure. Somebody did look north and said you know at this pace we're not going to get through the 15000 of them. hahaha

Well you know we do as I said before we have some for the identification you know marking up everything just goes pretty fast because we have some scripts prepared from this. We are searching for specific patents and other things. Of course you get these recommendations out of the system and this is the same if you do it like with IBM they have something similar from rational. Right. You can analyze it and you just get a list of recommendations and then you have to make your choices. It's something that's interesting or can dump it. This decision is always up to you.

OK yeah. In our case we had like 12 person committee deciding whether a piece of code is interesting or not

So you're still sitting there today hahahahaha.

Do you use any academic resource for legacy-to-soa migration or for service identification like academic/research papers or tools?

We don't do it. No we well we use people who are coming from university and we are training them to give them training and then they work in our company.

How can academic play a larger role in industrial legacy migration projects to SOA, what problems should we working on?

Academia is not looking at the problems that interest industry. there are Some specific institutes that look more at customer specific problems. The problem is that most of the people I get from university When it comes to modernization you'll need people who get interested in people one in COBOL in c and stuff like this. So I understand completely that young people are not very interested in that kind a topic because it's heavily It's boring to be honest. It's very boring stuff. They are all interested more in facebook twitter whatever Java or any fancy stuff. But the problem is this is not the core business for the customer. The core business for the customer can you can say whatever it is if it's American Express or anybody else it's still this all mainframe transaction oriented environments. This is where I would say 85 of the core applications on this planet. Everything else This is nice to have. But if it doesn't work nobody dies. If you're trying American Express your mainframe doesn't work your credit card doesn't work in whole America and on the rest of the planet. That's the problem. And there are some institutes in Germany which work for us and They are working with our customer, we are providing courses to some students in Romania and Italy also and after two years they fit to our projects.

--Interview 2 (translated from French)

What kind of services is offered by your company ?

1st : Professional services, help company to do some specific development

2nd: Legacy code analysis, they developed their own tools to analyze old code (especially mainframe, COBOL, JCL, DB2, CICS). Data flow analysis, integrate with platform knowledge. Can provide information queues from architecture analysis.

Sometimes provide versions of analysis software to the company.

3rd: Management and strategy. Selling tools to modelise business process. Help to plan strategy of the company. Strengths and weaknesses of the company. Help to align project with the need of the company.

What is your definition of a legacy system ?

System which have a value for a company but where key knowledge has been lost.

Did you participate to project of migration from legacy app to SOA architecture ?

Not really directly to SOA but with have made projects of documentation which can be used for this kind of migration.

We did it sometimes but not with our tools.

It was not legacy but wrapping of java components and API enablement.

It was an app around 100-500 000 lines of code.

Was what the problem or the reason of migration ?

Often it for integration with multiples system. They want it based on services.

Also for testatibility, it isolates different functional components, easier to test.

In the survey, I also mentioned migration from legacy system not only to SOA.

For example, we did migration for legal reason (components cannot legally use some components anymore).

What is your strategy of migration to SOA ?

It we speak of modernization (not only SOA). Our general strategy, is to use our tools with data flow analysis. Especially with mainframe with no user interface and batch processing.
With banking system, we analyze a wealth management system of 25 millions line of code.
A small part of it is visible to the customers. They receive many flows on transactions, auction flows… You can visualize it has an hourglass, lots of upstream data.
All the process not linked to the customers, many things are just input and output of data.
For example, feed are written in a queue, consumed somewhere else, write in a file, consumed somewhere else…
So for this, we work how the data are processed and where.
We have a semi-automatic approach, we have code transformation.
We have a system of documentation to make an up to date cartography.

Our strategy is to identify all the elements, give choice to analysts (how you can access data or functionality). We do identification of business rules and a bit process. Less service identification with our tools.

What were the main challenges to migrate legacy to SOA ?
Process of modernization is rarely driven by technical requirements.
Business say we have old system and budget, so should we invest in mobile application or modernization ?
A big problem, is to ensure that everyone understand the implication of such migrations.
They have hard time doing it because it is high risk, they have a working system , costly to maintain but the risk are really high.
If for example, a bank want to change their back-end to migrate As-A-Service. They want to do financial-banking-as-a-service.
So risk is the biggest challenge.

Technically, is size, complexity, lack of knowledge. Sometimes it is between 12 and 20 languages used in one system. CICS in mainframe, SQL, COBOL, Scripting languages…
To make an unified cartography is a technical challenge, that why we made our tools.

**Boss speaking*

There is always the problem of what we must represent as a service and the legacy environment. They are not on the same level. To align legacy with services is not easy.
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We can take cobol and generate java but we don't want to do transcoding, because it is not structured in the same way. We don't want to keep the base architecture.
So we want to identify what have value, process and business rules.

How does you decide of the pertinence of business process ?
We ask (the customer). We make proposition and ask customer and if it make sense.
Sometimes at technical level we have better knowledge than the customer but not from business process. Sometimes even to name element is complicated, especially on mainframe with the abbreviation, there is no namespace, lots of prefix, suffix…
So we ask business analyst.
That why the approach is semi-automatic.
We could automatize but we don't see the value of doing it at 100%.
It's more pattern matching than something else.
Let's say a technical expert tell us, in the system we will read the data from this table which is matched to this file with this file… And there is a process with some ID which represents some name in the DB…
What we do it encoding this knowledge, and scaling it, generalize it. So it work with not only one program but 20000.

So your tools are based on dataflow diagram, data mapping extracted from legacy app ?
Yes, technically. We use a KDM, a big KDM.
Some millions objects in just one database, 400 Go very compressed.
Our representation at the kdm level is mapped to micro-actions, detailed control flow.
We ignore some elements (we don't need all the informations), and some in COBOL are not really structured. We can read register for example.

END OF PART 1

Why do you think service identification is important in the migration process to SOA (bottom-up approach)?
Because it is the goal.

Is it always interesting to take the legacy architecture as a start ?

No. The code certainly, but not the architecture.
We need to re-use the existing code. 25 millions lines of code… If we want to write it again, it can take years.
So we necessary need some steps to have a working system.
It can be based on functionality to identify candidate existing services.
Some company (not us but some) also do it from mainframe screen (in green) and do some wrapping, with some converters from this to a web services.
So webservices are becoming the interface. It's just a wrapper, can be an intermediate strategy.
Not real services or useful, to have a web interfaces.

You can do identification of services, based on the data. We make the proposition to a bank, track everything that go in and out of the database. And log all the operations done in data. And put this in a database with no schema.
The idea is to do some integration based on services via on the data. To do API enablement on the data with ad-hoc request.
Let's say some data correspond to customers profile, if it's in DB2 mainframe, it can be database or indexed files. While they are written, it is possible to add track, log and update a data lake hadoop.
There is many tools to base services on this.
So this strategy of migration if more data-driven.

So there is two strategy. The idea is we want to create some level of abstraction, before creating everything from scratch.

The service are not always structured but they can start to write candidate service from this and change the back-end.

And after this you do service composition ?
To the professional service, we are doing API enablement.
It is mostly composition of services.
Architecture like micro-services. Atomic services which are only doing one things but well.
Some are just data accessors.
With the micro-services, we have others re services which have the responsibility to combine information with calling other services.
We have service of infrastructure, with some upper level to have processes.

And you do this manually ?

Yes.
We do it for modernization but not really for mainframe.
It is more identification of components or governance concerning mainframe.
We need traceability to the line of code (for example to lend money to see if the rules are followed).
It is what we do for analysis. We offer the technology so the business analyst can do it.

Do you use historical analysis of the code to identify services ?
No, not really.
We have the log of what happens in the systems (documentation, code).
We are not doing dynamic analysis (like the line in a database).
We have code, configurations files scheduler, documentations, versioning system and bug system.

We have access to this data but we don't not use them for service identification.

Do you consider some quality metrics (cohesion, granurality) to identify service ?
No.

Why ?
We have heuristics to identify candidate for a service.
We encode some patterns to identify service or business rules.
Some metrics are implicit, because our strategy for example a rules should be totally autonomous for another business rules.
We have rules saying that how we can remove it from the system ? And how it is structured ?
This is not measure but more on structure analysis.
Like we cannot access more than 10 databases for one business rules, we can encode this but usually we do not use such values.

What are the type of patterns you use for identification ?

For example, wa had to do transformation of code and test generation for a company who did data storage. With indexed files.
We analyze the data flow, essentially it was a program called with some parameters.
So the patterns, are which programs is utilized and how the calls are structured.

We modelize the structure as a graph. And depending of the structure we will transform it in some way, of another structure in some other way…

Did the identification process usually success to get good services ?

The biggest problem is false negative.
Because, an analyst have to validate everything.
If the precision was 10% with recall of 100%, we can forget it.
Even if you find all the candidate, if won't say what to do with the results.
To ask business analyst we have to be really sure of us, that's why we are using a feedback loop.
This is what we are certain of the knowledge, and we need feedback to encode this data, to improve our patterns of detection.
For example, in KDM we encode elements with conceptual package.
So we can some different interest to the business analyst, it's kind of ontology and implementation of business rules.
The conceptual model is a logic related to table, variable, that we can reuse.
We have a big knowledge base that we try to use as best as possible.
Either we improve the heuristics or the knowledge base.

Do you suggest any best practice for SI ?

We want it to be iterative, and to include ???? (43min30s) analyst or architect.
We have a first draft, we try to make sense of it, but we present for the 10 we are of sure. Maybe it was 50 but we won't present the 50 at first.
Ar the 10 corresponding to what you want ?
And from this example, we try to automatize patterns.
Feedback loop is essential.

What do you think that academics could do concerning migration to SOA that may interest company?

In industry we have enough problem, so we do not look for the best solution (contrary to academics).
So was it important, is to try to understand what is important for this people.
Even if it's sometimes out of scope, it's good to keep an open mind on what company needs.
It sometimes hard to have feedback from company, because sometimes they consider the problem solved (even if it's not in fact).
The biggest problem is integration which imply a lot of wrapping and composition.

Industry may to be educated on API, API management, API gateways, API versioning.
They may have maintenance problem later.

In the process of services identification, do you consider the service type?
In any way, we are searching for patterns.
And we are looking for business rules or business logic.
We are doing dataflow analysis with slicing.

If it's based on the “green screen” we analyze the definition of these screen by parsing the underlying code. It will be a category of service because all categories of detection are based on a certain heuristics based on business.
For API enablement of data, we analyze the database schema or some layout of COBOL and build service from this.

--Interview 3

[00:00:47] **can you please introduce yourself**.

[00:00:50] Yeah I am XXX. I am working for XX for the last 22. Yes I was credited in engineering and I'm also pursuing my Ph.D. part time in business administration with a focus on informatics for agriculture. I am also the lead consultant for legacy modernization for XXX

[00:01:35] **So how do you define legacy systems**.

[00:01:43] Legacy systems, the meaning has evolved Over many years because like six seven years back, Legacy systems were meant to be more of the monolithic systems like mainframe systems and other things but then we have seen other systems like the client server architectures. We have also seen that in the applications which are Web based applications like Java and other things which are being developed on client server architecture, now they are bringing into cloud. So they are also being considered legacy too. So the meaning is continuously changing based on the evolving technologies in the market.

[00:03:05] **why did you do the migration of legacy systems to SOA? What were the business goals of the migration. Can you please detail case studies of migration to service oriented architecture**.

[00:03:19] Yes the primary business goal for migration is to improve time to market because of the legacy systems have been structured at X XXXX. It takes too much of time and cost to change them for any small enhancements. That was the reason. The primary reason I would say that the migration was carried out, Apart from that there are other reasons also, One thing is like the documentation of the legacy system is not so great. So the customers would like to get their data as part of the migration exercise and the other objectives are late the people who have developed for all of these applications are no longer there with the company not they have retired so that is causing that risk for them to continue with their existing architecture. So these are the three primary reasons I came across. And the other thing is the like the high maintenance cost of legacy systems. The new architecture Like cloud computing and microservices are making the cost of maintenance even less than they have currently. So that is the motivation of the customers to get out of the legacy architecture and legacy paradigms.

[00:05:32] **In the survey you mention that you performed the migration to improve the system reliability.**

[00:05:40] Yes.

[00:05:41] **Can you elaborate on that please?**

[00:05:45] Yes I see, what happens is when we are developing a system We will have our core data developed aspects as the latest features at that point in time. So probably you have done a system developed 20 years ago you'd have used the latest functions of the language at that time. But all the time, it The system still and the customer continue that, What happens is that those functions may not be actually able to scale to the the volumes that you have today because of the business rules and there could be more efficient functions which are available because of the developments that could replace these functions but nobody would have really bothered to use those functions. So they just keep using the same older because whenever anybody makes an enhancement they would not use the new features of that language which have evolved over time but they just keep putting patches to the existing application and that way actually reliability is not really considered. So that makes the whole process very complex and less reliable. So if you start fresh. You can make it more reliable.

[00:08:02] **Okay. Okay. It's really really interesting. And what's your approach to my agreed legacy system. So for example in the survey you mentioned that you migrated Java based Legacy systems, can you please tell me how did you do with the migration of these systems and about the system. Also can we have more information about the java legacy system.**

[00:08:40] Yeah so there's a couple of manufacturing customers, they had these applications. The data are primarily used in auto management and other things. So what happened they have developed these technologies in older architectures because when they use these systems they developed it on older hardware like 16bits architecture and architect just come the CPU perspective. But if you look at today's architecture they are like 128 or 256 bit architectures So the older systems were not able to scale up because they have the hardware limitations and they could even if we were able to add the memory and process computing because of this address limitation we are not able to scale up and unable to actually take the workload that are increasing. The entire system has to be rewritten

[00:10:15] **Did you used SOA to modernize this kind of architectures**

[00:10:20] Yes. Yes the modernized system used the SOA architecture.

[00:10:28] **What artifacts did you use for the migration. Is it the source code, the documentation, etc.?**

[00:10:38] Yes It should be multiple things. It's source code and documentation we will probably used whenever it is available because in many cases the documentation would be missing because the people who worked on that have left so the people don't know where the documentation that is one reason or second reason is that when these legacy systems have been developed they would start that the application will stay for five or ten years after which we will move away. so that kind of attitudes help prevent them to document and these applications have outlive the initial expectations or they thought it would serve for 10 years but it served for 20 or 15 years but nobody went back and then the documentation. So another that scenario What we have also come across is the executable is there but the source code is missing, in not all cases but in some cases. So we cannot really have one single approach to tell that no we use these architefats. So it varies from case to case. Some sometimes if the source code is available and documentation is not that and some of the techniques we use are to use some parser based tools to reverse engineer these applications. What these tools will do is create some documentation from the code and then that documentation is used to do the forward engineering. So there are also tools available to create applications. So using this documentation we create use cases which refer Into these tools which are called forward engineering tools. So that will help you to build the applications in an automated way. So instead of manually coding, so the tools will help these are model based engineering tools that will help to develop the applications faster.

[00:13:11] **Okay. But how reverse engineering tools will help in the migration process**

[00:13:21] The reengineering documentation will help you understand the business logic that is embedded in the legacy application. The primary reason because whenever we develop an application the primary important thing you need is business rules. And our customers do not want to lose out on the applications because there is a lot of business logic which is embedded in that application and they know how to use it but they do not know why it has been programmed around or what are the rules that are in the business application that was developed many years ago because they know it is important but they do not know why it is important. why the person who has developed really use this business rule. So that is the reason they would like to understand what are the business rules. So that is the biggest thing which will be of help in referring to this kind of reverse engineering documentation.

[00:14:33] **Okay. And how do you do define or you estimate the pertinence of the importance of a given business rule identified from the legacy system.**

[00:14:51] Yes. what we are doing is when these business rules are expected we will validated with the users who are currently using their application to understand that this rule is valid because sometimes what happens is probably a business rule have been coded coded for some specific purpose, maybe because of a business scenario or there is some government regulation which needs to be fulfilled. But today that regulation may not be still active because it would have been superseded by a new regulation or something but nobody goes back and actually rused that functionality or comment so different functionalities because even if you don't do that there is nothing wrong which is happening. So people don't want to put unnecessary effort in actually making the unnecessary code inactive. So that really will validate any second thing The you'll also understand is If the existing application is having any gaps with respect to the current business situation. So in that case he will take the additional requirements for the new application as well. So these Are tow ways in which we will identify if the business rules are complete or if you have obsolete business rules that needs to be discarded from the new SOA based application.

[00:16:37] **What were the obstacles faced and the risks of these modernization project to SOA?**

[00:16:53] Many times what happens is the motivation or the people behind the modernization projects are IT departments and not the business b ecause business do not understand the challenges faced by the IT in managing although the ??? The application is not reliable or not Scalable but they do not see the application in the same way like the IT department and that the sponsorship or funding comes from the business and when IT goes far for funding, business doesn't understand that. So getting the sponsorship of the project will be difficult. When the application completely stops and only then they say that the business is stopping so we need a new system Otherwise if somebody goes productivity and says that now we may face these challenges. So we need proactively migrate. It could not really appreciated. So that is one and second thing is source code is missing There is no way you can actually expect the business rules unless the application developer is available and gives information. Another challenge we face is that there is some human related challenge where people who have developed these legacy applications they would have not document it. Still The knowledge is with them this continues to still continue to employ them because nobody else knows this application. Once the documentation is done they feel that their job is at risk because since it is documented anybody can manage these applications. So there are some passionate motivations behind that. So those people are not going to get the knowledge that this is necessary to migrate these applications. Other risks could be know that there would be other solutions also out in the market. there would be some products which are out in the market which relate to equaling functionality. So then you would rather use that product by configuring it that which could be much faster than actually migrating this whole application to a SOA based system.

[00:20:23] **Did the migration and modernization complete on time in general?**

[00:20:32] Not really it usually exceeds the scheduled that is planned because many times.In 80 percent of the cases it goes beyond agreed timelines.

[00:21:36] **Do you think that service identification is important in the migration of legacy systems to SOA?**

[00:21:46] hat happens is many times from a business perspective service Identification is important but then since the exercise of service identification itself is cost and time consuming so people were not late to really identify the services and take whatever is available in the legacy application because that would be easy although it is not the recommended approach. But since it is cost effective nobody would really like to identify which service is useful for modernization or take everything that is available because it is less effort.

[00:22:42] **Okay okay. You mentioned that you did service identification manually.**

[00:22:53] Yeah.

[00:22:54] **So what criteria you consider doing these manual process ?**

[00:23:00] So I think I have already discussed this. There are stuff for services identifies through the reverse engineering. So we identify the business rules that are still relevant so we ask business users to identify which functionality and which business rules and based on the inputs from the users we actually identify services because all of this still human knowledge there are no tools or machine based Of course the improvements in technology like artificial intelligence of late may have concept in the future. But it may take some time to get this whole process in the automated way. So as of today we depend on the human interventions to identify which services are relevant.

[00:24:42] **In this survey you mentioned that during the identification process you are considering four main quantity metrics which are the granularity the composibility, the self-descriptiveness and adaptation effort. But you didn't mention that you are considering as well loose coupling and high cohesion why you did not consider that during the identification process?**

[00:25:21] Major concerns that I listed on the primary driver actually because even if you don't have the loose coupling you can still go ahead actually because the primary goal in the projects that I have seen is the risk that they have like the technology is not able to scale up or the technologies and out of support by the vendor So there is a risk of The people that they developed it are not there. So the first in t end is getting this logic out from the existing systems to be newer systems. So although the features that you said like loose coupling and adaptings are desirable but since it takes more time to include those features. So the customers do not really focus on these features I'm not saying that these are not necessary but because of the business constraints that become a lower priority. But if the costumers work on modernization did me in a structured way even before they start seeing the experience these risks they have time and they definitely use all these features of loose coupling and adapting things. I have come across one modernization engagement which one of our colleagues were working on where the customers have taken it they have almost six years to modernize the application so they have used all these principles actually because they had a big portfolio of applications actually the first what they have done they have actually component based applications from their monolithic architecture And then they have used new frameworks like html files and other things and then they have made it more granular so that they can use APIs and microservices just to not discuss the efforts are not there But again it depends on how much time you can afford to make all these granular and adapting efforts things. So it depends on all the spectrums that you can now consider this features can you actually debate so much time to implement in this manner.

[00:29:34] **OK. Thank you so much. Did you use any academic resource for legacy-to-SOA migration projects.**

[00:29:40] No we didn't because academics do not see the larger picture of the real industrial problems and challenges we are facing. They are most of the the time validating on small systems and we can not apply the proposed techniques to our systems.