00:00:03 good evening everyone and welcome to the next lecture uh we have been discussing about virtualization mainly we've uh had a detailed discussion on what what is the difference between OS level and Hardware level virtualization let's continue the same uh yes anit uh sir I have a question like maybe um you allow me to ask assignment yeah no no no sir same to the virtualization yes please yes yeah so I just want to like uh I was just thinking to this problem statement so just think of like we have a four computers like imagine a

00:00:50 four laptop I have consisting of a different configuration like 8 GB Ram uh 16 GB RAM and then let's say 32 GB Ram and same with the hard dis having a different config what I want to do I want to make a cluster out of a them like uh let's say one server consisting of all all of them and any third party out of this network want to access my actual resources which is having beta Ram or beta CPU or beta Hardware so is that possible if yes yeah I I did not get the complete question so you are saying that you have created a

00:01:34 cluster yeah which has these heterogeneous notes right yeah and now you want your uh users or your clients yeah to access those resources Hardware resources so what is your question then so sir I I just want to confirm like uh let's say I have a uh 4 GB Ram of any computer like uh let's say laptop I I'm having which is connected to the main node or maybe main server and having a 4GB RAM and someone just want to use 8 GB Ram something so since I have a two different configuration of a laptop one is having

00:02:16 a 4GB RAM and another is a 16 GB so 8 GB somewhat around between them so is it possible for a p to access the 8GB of Ram uh over the like say you want to access a 12gb ram okay yeah now your question is uh whether they can access 8GB from here or 4GB from here or only yes yes whether you can have your VM distributed across different physical node or not uh no sir it's not distributed I'm just thinking of like it's just a clusters of computer connected together over the one Cloud maybe and sharing

00:02:59 yeah so talking about virtualization at this point right yeah okay so without virtualization it's the only Hardware resources whichever are available you can provide them as a as a service but you can combine or uh you know have multiple hosting on a single node what virtualization gives you exactly that power that limitation which you talking about if you want to create a 12gb VM and given that you have these four nodes in your data center so what you can do you can use 12 GB from here and 4 GB is

00:03:46 here okay which can be given to another VM correct so now because you are using VM you can utilize this Ram better there won't be any internal segmentation or external segmentation problem which we which you might have studied in operating system paging yes sir page size or uh is not exactly matching with the frame size then internal and external segmentation happens right yeah so same thing will happen here also because out of the pool of resources you want to VM now there can be internal segmentation or external segmentation

00:04:32 for example in this case uh let me say you have 8 GB machine 16 GB machine 32 and 64 GB yes sir now you want to create a 12gb VM so which machine you will prefer machine A B C or D ideally like it should be BCD any of like BCD but I want to just get it from combination of let's say A and B no you're are saying any of B C or D right yes it is preferred but I I I want to get this resources from A and B One Like A and B Machine I'm having so the so the question is uh if you recall again from operating

00:05:23 system which page size uh which uh you know page you should read in which frame whether it fits exactly the requirement or maybe bigger see 12 can fit in B P or D yes sir you have three options without Distributing your VM without complicating your VM you can host that VM into one of these into one of these three machines right b or d now which one you will you prefer B C or so this question is for everyone not only for anit so which one will you prefer B C or D given that you want to allocate 12 GB

00:06:10 Ram to your VM which machine you will prefer there's lot of cross talk is going on in this physical classroom pleas come back to the question so we have four machines four physical machines and the ram is written here 8 GB 16 GB 32 GB and 64 GB now uh we want to create 12gb Ram VM so which machine will you prefer which physical machine you would like PR would you 64GB the D1 definitely so if you give it to D the remaining R is 56 uh sorry 52 yeah that is the highest and then there will be more VM

00:07:16 requirement you will deduct from 52 and so on so that is your approach that you'll find where the maximum available Ram is and you pick that physical machine those who have studied operating system you can recall this algorithm the second approach is you pick the best fit approach so which one is the best fit machine B because only 4 GB Ram is getting wasted here not wasted but for another VM you have 4GB opportunity in case of D you have 52 GB opportunity for other VMS right now which one you you will prefer

00:08:09 will depend on your VM load what kind of VMS being created are you coming to this class first time okay so this question was to physical people okay so uh now your VM Lo say your general VM load requirement is say 4GB and then if you allocate this machine this VM to machine B you are left with only 4GB which we cannot allocate if you recall from our previous lecture discussion we cannot allocate 100% Ram to all the VMS we require some Ram to execute host operating system or virtualization layer

00:09:08 functionalities now this 4GB we can allocate to maybe a VM requiring 2 GB Ram that can be alloc Co allocated with this vm1 so any VM which require 2 GB Ram can be collocated with vm1 so now there are algorithms which optimize which types of VM should be collocated so thanks for asking this question today's topic is all about VM management when we say VM management it's about multiple VM management not only single VM management and we call it vmm what virtual machine management now imagine yourself as a

00:10:07 cloud service provider and your clients are asking you asking VMS from you virtual machines from you and those virtual machine can be of different configurations right and you have in your data center you have multiple heterogeneous compute nodes or computers or laptops or commodity Hardware machines now VM if we go by this shape say these two are your data uh compute nodes and the size represent the different configuration and your clients are asking for different configuration of VMS so these may be different types of

00:10:59 VMS right now the problem is analog analogous to covering the maximum area in your physical machine based on these different shapes and you need to keep some of the area for your host operating system or your hypervisor management software so say for this machine this area is occupied but by hypervisor and this machine this area is occupied now your clients can come up with their own configuration of VM so there can be n number of configurations possible with VMS so there can be more different shapes this shape or whatever you say

00:11:54 this stpe any symbol you can imagine now we want to we want to use all these symbols to cover the maximum area ultimately what we are saying that we have different types of virtual machines and want to allocate them or collocate them as much as possible why to optimize our Hardware resource allocation now if all these machines can be hosted on single physical machine that is good scenario from a service provider point of view you will be saving your electricity your maintenance cost for another M second

00:12:42 machine more the machine runs more weer and tier happens the machine will get older quickly there are higher chances of crashing Electronics device so you want to save on your operational cost including electricity and maintenance and want to host multiple VMS of erogeneous specification to a single physical machine or minimum number of physical machines so now it becomes your constraint satisfaction problem you want to optimize the uh number of uh Hardware machine you require to uh manage these

00:13:31 VMS at any moment now where these uh cloud service service provider uh takes advantage of this kind of setting uh anybody uh knows about the story of how Amazon started AWS anyone so they they are running uh they were running this uh amazon.com e-commerce business and they buil their own Data Center and one good solution architect or software architect uh was there in their team and they analyzed that the what is the utilization of their data center can anyone guess what was what percentage of utilization they were

00:14:26 having before AWS you know what is utilizer whether CPU is being used 90% or 70% or 30% or 0% many time it's 0 or 1% during your exam it goes 90% right so there's always Peak load scenario Peak load not always remains there during ignas it was Zero so now what was the a amazon.com's data center percentage utilization what could what could be the efficiency they might have been running earlier any guess I know you have not heard the story so you don't know the exact answer any guess bra probably they were running only

00:15:28 during the first are rajal says 80% give me number 30 to 40% maybe 30 to 40 there is the answer single digit okay 10% 10% just double digit okay so it was close to 177% now imagine you are running data center you are powering all the machines in your data center paying Hefty electricity bills and the utilization is only 177% so they started coming up with innovative ideas how they can reduce the loss are you you doing any programming assignment so you can close down your laptop you're doing some work with

00:16:40 me how come you are not listening me okay anyways so uh now 177% your data center utilization and you want to increase it the idea they come up with they came up with let's start renting out this facility to others who can't invest in the capital they had expensive data center not everyone can create their own data center so they started renting out as a startup they started AWS and at that time it was manual effort someone wants xyg configuration they used to you know had a uh software person who used

00:17:33 to uh do you know user space separation and give them that xyg specification and once request comes to release they used to release those resources so it was in the beginning quite a manual task then they started adopting this virtualization and started automating it so that through scripts you can control when to allocate how to allocate where to allocate and when to allocate and that automation resulted into this AWS which you can see today it's a huge company now and uh as per my knowledge amazon.com Ecom business is

00:18:28 not profit able for them AWS is giving them the major profit based on that all Amazon is running all other business and losses and uh you know eating smaller players by giving Hefty discounts and all so now they started increasing the utilization of their Hardware resources and the same idea is also applicable on your laptops out of 24 hours how many hours do you use your laptop maybe 8 hours 10 hours for rest of the time you can also start thinking renting out the facility of your laptop to someone now NASA used this

00:19:21 idea uh they had this project s sa at theate home something uh and I don't remember the full form but what they were doing is uh they had this uh very large uh images of universe which was captured by hble telescope they want to analyze these images now because your laptop is free I'm assuming you are following biological clock I'm saying your laptop is free throughout the night you keep your laptop connected with network use this applications at the at theate home NASA will be running One agent in your

00:20:12 laptop and will be using your compute power to uh analyze these large images and they did it successfully and you will get some reward in uh in turn if you give your resources to NASA they were there was some reward system this is not running now you can't monetize it now but this was past example so cloud computing is all about how to increase your resource utilization uh sir uh like yeah on the same note I just want to like curious to know in fact that how these things was working like by installing a agent what

00:20:58 was the things like like uh they have configured in such a way that a large number of computer are connected to a one network and all the hardware and the computing power is been shared across a network so what was that thing and can we also do that using our 4 five laptop having a one place you should do that should be your project it in fact that's the that's even not a assignment for this course you by default like for computer science people in IIT we don't teach we don't Focus much on teaching programming languages right we

00:21:35 assume that you must be knowing programming language and not only one language all the languages that is what our expectation is from you in the same way my expectation from all of you is you by default doing this cluster Computing okay as part of system course and today building cluster is very easy you can um try how to configure your multiple machines and run a map ruce job on multiple machines which are connected our network but that you need to create a virtual network uh on all all the machines which

00:22:15 are connected through public network once you have virtual Network you distribute your task uh in fact uh uh when I was PhD scholar uh when I started working on cloud during my summer PhD people don't have summer vacation so I was staying in summer not having any TA Duty so I started creating my own cloud using virtual box so virtual box is a VM platform so I go I went through virtual box manual started writing scripts not using the virtual box GUI so I I started writing a script RTS and for each script I used to give

00:23:02 button in the web interface to create VM you click on this button and to monitor VM you click on this button you will get a good nice graph so I started creating that uh uh this kind of uh virtual box management through scripts and web UI uh on the machines which I were having multiple machines and uh I start started giving that those machines to pH other PhD Scholars who want uh you know for a Computing purpose heavy Computing purpose through their laptop they can connect and run mult uh heavy softwares

00:23:43 heavy programs and uh IBM people came uh in July August sometime after summer break so my professor told me to present that work in front of them I presented they asked me how much time it took to you develop I said two months and they said that 14 months they have have spent already with their team and couldn't work out these things so that should be your design approach I'm already asking you that you imagine yourself as a cloud service provider and now you start thinking about the projects you will get many interesting

00:24:24 ideas maybe you already implemented doesn't matter this is first time for for you you have not implemented those things in your life right so take this opportunity break your systems that's the best learning what you get in a system course and okay so this brings to me assignment one many people are complaining I have already shared but I'm sharing it again many people are complaining that within their limited specification they are unable to complete the assignment one that is actually the learning of

00:25:01 assignment one that your laptop is not good enough for any big work or single system is not good enough for any kind of real word work you need cluster of systems and that's where your second assignment is leading to you you using gcp Cloud platform and if you repeat your assignment one task with with gcp it will be very simple less time taking and that's your that should be your takeaway that single uh Hardware machine is not good enough but you combine these multiple Hardware machines and use them

00:25:47 as a cluster to provide cloud services suddenly they become very powerful and it's fine if you submit incomplete assignment but justify why you were not able to complete which Hardware specification was bottleneck for you don't try to buy new laptop for doing assignment one your parents will run behind me so uh be with your machine and try to optimize I have given you multiple ideas you can use tiny OS of 28 MB also and just create a ping program install ping library and create a ping program as a micros service pinging to another

00:26:38 VM I did not specify what kind of micros service we are asking you so you can have a actually micro micro micro service running on Tiny OS your Innovation should come there for solving the assignment don't use chat GPD it will give you very bad solution solution well CH GPT assumes that it has gpus to run the VMS which you don't have if you ask chat GPT about the efficiency efficient code it it will not bother even deep SQ will also not bother about I'm not biased to chat GPT or any um these kind of models because today's

00:27:25 world is living in luxury we have large number of resources and the assignment one is asking you to solve it in your laptop with lesser number of resources so future of system engineer is lying in optimizing this cost that's what deep seek did with chat GPT or Nvidia right how many of you know what they did why US market shuted yes uh because the the sected information was passed by DSE to the China government that's I no which proed by they redesign they redesign thearchitect whole um open AI stuff so that you

00:28:17 knowes tell me what is the redesign what they do basically this is a mod design they opted for so activate any neuron or any module only if that is needed so that you know Optimum and Optimum performance can be achieved with the minimum set of competition power you are in right direction but not right there's some answer coming so uh from the US the nvdi S chip sales were stopped to other countries so deepik never got accessed to those high performance gpus and so they had to reinvent the entire thing and they were

00:28:56 able to engineer that that's why now I'm asking what reinvented or what reengineering they did with which they are able to uh shake up this whole US market okay there's some answer coming from physical classroom let me also attend those answer is they did in something with 1 fif of course so what they did actually that is my question to you reinforcement learning no they segregated Pico and n one so what they did in deep is they segregated that whatever is the core idea behind the question will

00:29:44 only okay yes some other answer is coming from physical classroom and okay so what they did is uh combining all of your answers they used modular approach and you can say they have multiple chat GPD kind of systems trained on different domain knowledge right now they optimize their resource requirement by not going for generic Ai and there a term this jna right generalized AI instead they went for Agent K if you uh evaluate deep seeks architecture from a software architecture point of view you'll find

00:31:00 very much similar to Agent K what uh that guy what's his name what's the name of this machine learning course guy Andrew and Andrew Andrew yes so Andrew and and started this asentic AI concept and that's exactly what the deeps also is doing by making it modular having different agents identify your question leads to which domain and contact that deeps smaller model so they are able to do it with lesser computational power but even that lesser computational power is not less we also started similar experiment

00:31:50 here uh not we means one of your colleague in class we Tred to train these models on my lectures which we are recording on this for this course and we wanted you to give that service so that you can use during your minor or major exam but unfortunately with our current system we are unable to do that at this point of time I wanted to have this optimization which runs on a normal commodity server class machine may not be laptop but server class machine and can entertain these 370 people at the peak load coming might be at exam

00:32:41 time so we are still trying to optimize this if it turns well we may you know share that service link with you so you can also use that service so this is all about experiments you can also try this deeps similar architecture as part of this course project and try to see if you can optimize them further make them a good agent for a particular task and maybe if you are able to solve your project through these systems Al or chat GPT model or deeps model after installing it in your in your laptop and get the solution out of these

00:33:33 models now when they are running in your laptop and whatever task you do to optimize this things that will be also a good project for this course so those who are interested in this storm of large language model they can try these kind of projects as so if you understand what our objective is increase the resource utilization by redesigning the system architecture so can't it be the thes project as well I think that would be more sorry can be opted as a thes project M project that is up to you I can only

00:34:22 give idea yeah if you would allow of course then okay I mean this is something you know I'm planning to achieve in my organization as well to reduce the computation power for the different agent specific LM small that can the small competition power server if you if you want so my Approach would be if I want to go for any agent Ki kind of solution I will first compare it with microservice architecture and see where mlops and doops are being coming into picture where uh soft where uh engineering is coming into picture for

00:35:03 building this AI based Solutions and then approach for solution not directly jump to Agent K is like a new field for us but we have already domain knowledge for software architecture software engineering and microservices and design patterns whatnot better to adopt those information and then see how agentic AI can be achieved so if we do all these things including the quation as well so is something which you think is a good thesis project and we would assist ass yes this to cut short you uh we can have

00:35:50 a discussion on thesis project later on not during the class because this is something you know which is I mean this is the requirement in my as well so this is something I'm planning to ex this a good thesis project but we can have a discussion later on after the class I will drop you mail sir is it fine yes yes thank so let's come back to our question again amaz started with resource utilization one motive and deep seek also started with one motiv one motivation Source utilization Nvidia also started with the

00:36:33 same motivation when they started competing with Intel how to have resource utilization better for graphics processing and that's where they came up with GPU so you started also talking about resource utilization maybe you also have some uh some good idea to work upon now coming back to this uh again OS level and Hardware level virtualization and VM management now we have different types of Hardware heterogeneous not uh what is the average life of hard disk nowadays 45 days 4 to 5 years okay so four to 5 years right

00:37:35 approximate if you keep using your laptop given that you are doing some good programming stuff highly likely your laptop will crash in 3 to 5 years time right SSD has even a smaller life uh life ispan but quality is keep Improv so during my time when I started asking this question to myself at that time average hard disk life was less than 3 years so within 2 to three years laptop will crash and you need to go for recovery and change hard disk and whatnot nowadays it's still four five years by that time you yourself buy new

00:38:19 laptop nowadays so maybe imagine again imagine you are taking care of a data center where 10,000s of computing notes are there means more than 10,000 hard diss are there and by simple probability calculation if you have 15,000 uh hard disks in your data center and average life is 4 to 5 years in 1,500 days all those hard dis every day you will have some failure of hard disk around 10 to 20 or 30 mil dis are failing every day and actual data centers have much larger number of hard diss so in our last 43 minutes in

00:39:13 Facebook or Google sorry meta data center or Google data center they might have replaced few hundred hard dis already now the problem becomes difficult here you want to have a vmm virtual machine management where your compute notes keep filling in between and you don't know which compute not will fail right now and you left with only one compute note or or say you have a client ABC and they are running five virtual machines three on this physical machine two on this physical machine and suddenly the this

00:40:00 physical machine to hard dis is failed now now when uh now when you uh now with your client they are left with only three running VMS but they are expecting you expecting from you five running VMS what you will do as a cloud service sorry load balancing you will try to load balance but they are already running at 500 PM scale offloading and on loading I mean uh depending on the uh lean time I mean when I'm saying your client is already consuming 5 PM so they are using 5 PM they are not ideal m Lord is

00:41:02 already at till 500 p.m configuration level but your physical machine has failed what you will you do what will you do assume you are cloud service provider you are not individual person I need to connect the additional no immediately on the additional node yes mhm and whatever VMS are running here will migrate them to pm3 MH and for migrating these uh VMS we need to know their state right the current state at the last moment where they were so to minimize the impact on the client side so but pm2 is pm2 has stopped

00:41:59 responding you now how will you read the states of VMS to VMS using snap backup but pm2 has stopped working but we have the backup I mean the real time backup of you have backup on another physical machine right not on pm2 now you require pm4 using uh snapshots so where do you store those snapshots on hard disk on hard disk which hard on pm4 pm4 host on the host all these are host all PM means physical machine pm4 pm4 basically we would start back backing up on backing your snapshots of your VM in

00:42:54 some other physical node and whenever required you use those snapshots and use them to create the VM again those who doesn't know about snapshot and images when you create a virtual machine say you install uh ABC software and then you export that VM and create a image and if you use that image to create another VM the software which you installed in vm1 that will be pre-installed in the subsequent VMS right and snapshot is what at runtime if anything is running you take a realtime snapshot of the VM so all the

00:43:41 running state of VM is captured in that snapshot it's like creating checkpoint or restore points in our host operating system so that is also possible with VMS now you create uh snapshots and imagine the size of snapshots it will be few GBS right it will include your VM operating system image then your software which you have installed then running State okay so now you are storing them on pm4 and say uh when you generally store for archival you use some older hard disk or cheaper hard disk Solutions

00:44:33 because those require huge space so cheaper hard disk means slower hard disk now reading from pm4 might be slow for reading the snapshot VM snapshot of VM it might be slow process so if your pm2 is down you require some time to read the snapshot from pm4 first of all you have to locate where your snapshot is restored for pm2 machine your snapshots are stored on pm4 for another physical machine your snapshot might be stored in some other physical machine so you need to first track where your snapshots are

00:45:20 installed now storing snapshot is not straightforward task uh like say at this moment you started creating snapshot and it's a f GB file snapshot so transferring fgb will uh use some time maybe with SSD storage it still take few seconds to transfer that fgb file from one pm to another PM if I'm transferring here say 2GB file of snapshot it will use some time few seconds during those few seconds your VM is running and advancing is stage your client is using VMS continuously so their state is now

00:46:17 modified now you again take incremental snapshots so either you take hourly snapshots or quarterly snapshots or fourth night snapshots depends on your policy now with bringing the concept of database where you do recovery from failed transactions either you redo or undo you put checkpoints and all so after the checkpointing or after the snapshotting you will lost the VM state if your physical machine fails now if you really want to provide a realtime service and a smooth transparent service you need to predict when your

00:47:06 physical machine is about to fail any person from Electronics background no one will raise hand because they no question is coming okay so there are few I know so uh now tell me does these physical chips or physical instrument uh electronics instruments gives any hint if they are about to fail in advance or they just fail no there are hints like what kind of heating of the elements first temperature overheating of elements fine what else uh voltage fluctuation can be there okay EMP you can you can imagine

00:48:03 whatever happens with you during exam time that also happens with the electronics product when they working under pressure they start behaving randomly right so if we can monitor our physical machine and sense that this physical machine is having you know uh doing some random performance sometimes very high sometimes very low then you start migrating your VMS now here we are saying that we need to continuously monitor our physical machines and we are saying that you are cloud service providers you have 10,000s

00:48:49 of physical machines which you want to continuously monitor so again that's again becomes difficult task to solve so what could be the you know feasible solution for this Predictive Analytics sorry come again Predictive Analytics so suppose a new VM is installed okay and we know that after like average is around two to three years so we can go when we will start monitoring when it is near the end of life not before that something like that okay so you only monitor selected machines but newer machines also fails

00:49:38 sometimes or you can like selective monitoring mean a random sampling also with the uh machines which are new also so any good idea about random sampling have you heard about anything famous where regarding this random sampling in Cloud for testing and monitoring purpose no that I have not heard so random sampling all all of you that [Music] name the symbol for which I'm not good at drawing yeah answers are coming be louder Netflix do you think Netflix is an entertainment company it's a pure computer science

00:50:35 company so they created this video streaming services through their Data Center and they started facing this unreliability issue because video streaming has to be continuous if your VM has failed which is providing them data streaming to your your client and you require even few seconds so data streaming is stopped in between and you are out of business in case of video streaming right yes okay so uh in case of this Netflix what they did is they started creating K anyone fill in the blanks K you know Engineers are getting K right

00:51:37 okay what else K monkey those monkeys so they give their agent this name Kos monkey so what Kos monkey's duty is randomly go in their Data Center and switch off their physical machine that was that's what Kos monkeys are doing in the beginning now they their KS monkeys are also you know have become more intelligent now they are creating much Advanced Kos nowadays but they started with let's write a small program which goes to any system in the data center and switch switch it off power of the machine and their Engineers challenge is

00:52:33 to keep the video streaming life without affecting without having any lack and that's where they created this video streaming quality and they are running this K monkeys in real time in the production environment when they are actually delivering all these streaming services their Kos monkeys are still running and switching of the random machines so that was their criteria to compete with themselves so this C monkeys idea you can also create for yourself in your project if you are creating four five

00:53:15 machines randomly switch off any machine and see still your software works well or not so those are also approaches you can adopt and generally if you want to build nowadays you know uh any word scale product from these Services you will be having these kind of exhausting testing requirement which can stand up to like yours monkeys or uh uh compete with this uh Network traffic also uh in networks if you remember there was some initiative by Facebook uh on on internet providing some basic services on internet free of

00:54:06 cost but Indian government did not only Indian government any of the government did not support the idea what was the initiative base free Basics something like that yes so what they were doing is for basic Services let's have dedicated internet services because they were saying that after Ro kapaan internet is the basic need so let's have a pre free basic even the poor to poor poorest person will have access these Network Services free of cost so they were dividing Network into premium user and premium

00:54:53 users and that will result into cures but the idea was on the network side they were trying to apply this virtualization concept having a two separate kind of networks running on the internet but today's internet is self-managed self organized one of the largest system made by man running on earth right that's what internet is you can also create your own server and start hosting any services and provide to any corner of the world where internet is available so it's a self-organized self management managed most most scaled

00:55:41 system so far we have so you can also study internet and see how virtualization is supporting the internet how DNS server might be using virtualization Concepts so these can become your good original cas studies for your increasing your self understanding so what we are trying to do here is we are trying to do vmm virtual machine management by knowing the fact that these VMS are unreliable these physical machines are unreliable now we need to manage vmm arpit uh please go outside there are some inst students waiting for this

00:56:27 class just inform them that this class is till 7:30 so now coming back to question of vmm virtual machine management how to do it and like the first question will come say you have multiple physical machines right now first question will come when you want toate create a new VM on which physical machine you should create the VM a machine which is running at 70% resource utilization means their resources are consumed 70% or a machine which is running at 30% resource utilization or a fresh machine

00:57:19 which is not being utilized so far and assume that the new VM have uh require the resources which can be provided by any of these physical machine so I'm seeing 70% utilization this pm1 30 and Zer now this new VM can be hosted on any of these three machine it require only that that much resources so we which machine you will pick pm1 pm2 or pm3 pm1 70% you're also supposed to justify your answer so why pm1 why pm2 y pm3 just to avoid the lean time of other I mean if I start on the Press then of

00:58:18 course I sure if that would beely and same case with the 30% loading as well but for 70% loading I I'm pretty sure that you know if at least I would be able to utilize 100% of capacity of the BM1 and if the load increase of course I save to the the second BM which is 30% occupied so this how things would work for the propertization so uh from the prop of the resources purpose yeah let's check with our Electronics friends is it good idea to use any system with 100% or even 90% resource utilization

00:58:59 failure increases right when you overuse some not even when you use machine up to maximum capacity chances of Randomness chances of failure increases so the good rule of thumb is we generally use machines up to 70 or maximum 75% utilization and then we move to newer machine in newer machine we have two options either pm2 or pm3 so which machine you will prefer pm2 or pm3 aash has already answered kind of pm2 Sir pm2 why so already it has uh 30% and then if we add 30 to 35% then it will be under

00:59:49 um threshold uh higher threshold and also it will not utilized uh a fresh machine because it will also take a new energy consumption yes so pm3 we start it will also consume its operational expenses because physical machine if it's running it there are operational expenses whether it's hosting VM or not it doesn't matter so we will host on pm2 okay fine and it's resources goes up to say 50% now there's another VM requirement say vm3 which require say 30% resources more on which machine you will

01:00:39 lost pm1 is out of question right because 100% utilization will be achieved otherwise PM pm2 will reach to 80% will break our threshold limit of 70 75% pm3 the starting machine will consume some time but then will will be within our threshold limits so what is the good idea to save the time the moment you see pm1 is already loaded with our threshold pm2 is also closer to threshold you start pm3 at that time and keep it running because when you are competing with Netflix or AWS kind of services you need to have very less

01:01:37 downtime or almost zero downtime for this VM creation or making VM up and running and start you know contributing in the services so here you do some Predictive Analytics and identify which next machine you should start in advance so that's another aspect of emm any question any doubt so far okay now let's see how Haro is doing this multiple data node management and the same lessons can be used in our uh virtualization also uh say you have huge amount of data and that is distributed among multiple

01:02:43 data nodes say I divide my data into three parts x v y and G right now one approach says I can can store all of them in one physical machine and for replication purpose I have another applica which also shorts xyg and if you have replication Factor two means you are having two replica of each of the data then you can only support one failure and that two unrel ibly when I say unreliably say you have replication Factor two and one copy uh is down one physical machine is down you have to have rely on the second

01:03:43 copy and you don't know whether second copy is the latest one or staled one or corrupted one but whatever you have you have to rely on it but if you have replicate factor of three then you can handle how many number of failures reliably and how many number of failures unreliably so one failure reliably because if one machine fails you still have two copies which you can compare and see whether there's any uh differences or they are same if they are same good to go if there are differences then you need to find out

01:04:35 which one is the latest or oldest it depends on your requirement which one will you prefer right so similarly you require higher number of replication factor to provide more reliability and high availability in the systems so what Hardo does is it stores in this manner so it distributes it does not store all the data in one data node now for each of this partition of the data X Y and G you have two replicas right and for having two replicas I need three physical machines not only two physical machines because

01:05:31 by policy we are not storing uh all the data on all the replicas we are storing only partial data on each repca so what this partiality gives you suppose this yng this fails you have two copy of X you have two copy of Y but you have only one copy of J now you recall from your uh this uh data uh data communication course where you read about CRC cyclic redundancy check some so you can actually regenerate G using X and Y using the check sum mechanism now the generated G versus this G whether it's same or

01:06:35 not so you can reliably manage this uh two machines uh two replication factor with three machines if you want to have a par if you want to deal with partial failures so now even with replication Factor two we require three machines but what is the advantage we are getting we are now able to deal with the partial failures even when machine is failed we had partial lost of data but now we can regenerate the data from our existing copies now if you want to increase the number of uh you know reliable pH

01:07:26 failures the number of physical machines required will be also exponentially increased same concept we can use with virtual machines when you have a virtual machine uh you can store the hard disk of virtual machine I hope all of you have now bu today created 1 VM at least or tried creating so you know there's a hard disk of virtual machine virtual hard disk vhd now this vhd you can use the same vsd for two virtual machines fine vm1 also vm2 also so what this gives you is vhd is independent of your virtual machine

01:08:23 actually it's like your using one common external hard disk with two machines two laptops and using the using them simultaneously so there are different ways to do that now this vhd backup you can take in multiple data nodes and when say uh if you want to create a backup facility based on these virtual hard disk for virtual machines you ensuring that whatever is in the secondary memory or secondary storage you can provide back up up to that part because now you have back up the virtual hard disk running State you might not be

01:09:11 saving what is there in the ram of virtual machine you might be uh you know losing out but whatever data you are storing in the virtual hard disk for virtual hard disk backup you have higher availability now if VM is down you can create another VM and using the same virtual hard disk now creating this vm3 only requires if you look at computational point of view only requires a VM image to be created as an vir machine and use the existing hard disk virtual hard disk to be mounted otherwise when we uh create a fresh VM with fresh

01:10:09 virtual hard disk it takes some time right it shows some progress bar it might be faster on your system but it takes still some time because it formats the virtual hard disk in your file system NTFS or fat 32 or ext4 whatever file system you use every every task in virtual machine creation consumes time and when we say we are using the existing virtual hard disk we are saving most of our time because we don't need to install our operating system again in that VM we don't need to install our softwares

01:10:59 again in that VM because all your operating system installation and software installation happens in hard disk and that hard disk you have backed up you are just creating a VM configuration with newer Ram uh newer uh processors and attaching the holder hard disk image so that VM will be exactly same as your other VNS so any question in this doubt so when we are talking about multiple VM management we can also exploit this virtual hard disk being mounted in multiple VMS for backup purpose and take

01:11:50 backup of these virtual hard disk separately any question any doubt how many of you got this concept very few what about others how many of you got this concept of virtual hard disk creating VMS yes there was question so what is virtual hard disk who will answer the last person what is virtual hard disk wrong answer what is virtual hardk see that's why doing assignment on time is important because the subsequent lectures assume that you have gone through the assignment task how many of you have submitted

01:13:11 completed assignment one yourself so all of you know what is virtual hard disk or you just blindly follow the steps it's a secondary storage of virtual machine uh I think now I need to uh cover what do we mean by virtual storage virtual CPU virtual virtual memory this virtual memory is different from the virtual memory which we study in operating system system okay or say virtualized what do you mean by virtualized resources virtualized processor virtualized Ram virtualized hard disk virtualized Network what do we mean by

01:14:16 virtualized here is isolated subset of res subset resource isolated subset what else what else isolated partition same thing what else one more important aspect so these are resources that you're remotely controlling they are not you're not physically handling them they are that is the definition of cloud aad that is also comes with Cloud I'm only talking about virtualized resources now say uh what's your name ashutosh uh is sitting here versus virtualized Asos sitting here what is the difference it's in the digital form that

01:15:20 is in the digital form actually in the digital form um no yes it's in digital form but this is not the answer anyone else um something like abstract of Autos abst entity of Ash which looks like ash behaves like ash but is it is actually not but it is not Ash so the abstract and isolated entities of physical machine resources are provided separately they are known as virtualized resources F when you create a virtual machine you allocate some Ram you allocate some processor you allocate some hard disk

01:16:19 space in your configuration when you're are configuring it and you also provide one NIC card your network adapter whether it's net or it can be anything but ultimately you are creating a virtualized NIC card virtualized hard disk virtualized memory and virtualized processors and you are combining them together to create your one virtual machine F so your disk is virtualized and when we say abstract and isolated isolation is easy to understand say I have large hard disk I create a folder virtual hard disk is actually

01:17:14 creates a folder right each VM creates a folder I create a folder or a partition on my hard disk and allocate it to vm1 isolation is done no other process is allowed to read this folder write into this folder or execute into this folder so that also provides security fine yes ideally what happens in real word that's a separate thing I'm talking about only the virtualized resources as of now so isolation is clear by partition say another VM we create another partition and give it to vm2 from vm1 does not know whether vm2 exist on

01:18:15 same physical machine or not same with vm2 it also does not know whether it is Co located with other virtual machines because of isolation Okay now the another keyword was abstract and for abstract I mentioned about asut the virtualized Asos behaves like ashutosh but is not ashat right so vm1 has virtualized hard disk it is not actually hard disk but it behaves like hard disk and how does your hard disk behaves for your operating system you can choose the file format file system in your hard disk in

01:19:22 the same way for your VM you can choose a separate file system for your vm1 say your host operating system as NTFS but you can choose vm1 will have ext4 now actually your hard disk is NTFS but for vm1 whichever the folder that say around 20 GB is allocated here that 20gb folder on physical machine is actually implemented using NTFS but since it's an abstract entity it behaves like a full-fledged hard disk for vm1 and vm1 can decide that I need EXT f for file format so for vm1 this 20gb folder will be behave in ext4 format

01:20:27 will behave but is actually not ext4 on physical in real word it's NTFS ext4 to NTFS transformation that is was the one of the responsibility of your hypervisor right it will translate those things M those things now although it's a folder but it's a full-fledged hard disk for virtual machine that is what abstractness is giving similarly for vm2 say this is 30 GB this 30gb folder will behave as a full-fledge hard disk so when you are inside vm2 or if you are running any process inside vm2 what they will see how much hard

01:21:27 disk they have full how much the capacity hard disk has 30 GB in total and their operating system might occupy some space so usable space might be 28 GB or 24 GB depending on what operating system you are using in your vm2 so your total hard disk remains 30 GB and for vm2 when you are installing operating system you can decide which file system you want to install in this 30gb of virtual hard disk now this is virtual for us but not virtual for vm2 vm2 lives in only in this limited word which has only 30 GB hard disk full

01:22:25 size that's all and it does not know if someone else is also running on the same physical machine and if tomorrow I migrate vm2 to another physical machine vm2 does not bother about moving you know running on pm1 or pm2 it doesn't matter for them what matter is whatever that entity they were having earlier they should be migrated to new physical machine and now what do we mean by migration of virtual machines migrating this folder it's their hard disk we need to migrate to some other physical machine then virtual machine will have

01:23:21 RAM and if it's a live migration we also want to migrate the live state of the ram the register values cash values and all to the new physical machines VMS so that's the migration part so we can have live migration or offline migration offline migration is easy to do but takes more time live migration is difficult to do but takes less um it also takes more time but from user perspective user will not have any downtime but for offline migration user will have downtime during the migration part I explained this using the hard

01:24:14 disk the same imagination you can apply on your RAM right say you have 8 GB Ram and each VM is using say 2 GB Ram right this diagram is right no why sorry say horse TOS has this R now is it correct diagram sorry if they are running say vm1 given 2GB vm2 is also given 2 GB host is also say taking 2 GB and 2 GB is free is it correct Dynamic resource will be allocated dynamically F unlike your processor or hard disk which are allocated at configuration time in hard disk you have no option to dynamically

01:25:43 allocate but if you have a static allocation then it's the previous one is true Ram is so we promise vm1 up to 2 gb Ram and we promise VM to up to 2 gb Ram but if at run time our host operating system using say 6 GB Ram say are watching very high definition movie and using 6gb Ram then you won't be able to give enough RAM to both the VMS now there will be race around condition now there can be Deadlocks so would be the P start on the virtual hard disk in this case if I won't get the enough RAM for my

01:26:39 V uh see virtual hard disk is your secondary storage but at memory right no I'm asking if I want get the two GB Ram if this is something required by my BM and I don't get because this is already occupied by the host BM in this case the P will start and that's supposed to be uh between the uh with the virtual hard right not the actual physical hard disk virtual hard disk is also on your physical hard disk yes but again they say something isolated right this is is isolated but Ram is not isolated

01:27:24 yeah so in this case uh P has supposed to be done right if I'm not getting enough RAM get on a hard disk right Ram is a separate yeah I know I know so what would happen so in this case my BM would start okay same thing will happen if you start to heavy processes in your laptop and you start laptop will start having race around condition Deadlocks and then ultimately we'll hang that's what happens if we use heavy processes simultaneously right so same thing will happen with this state if your VM is unable to get Ram

01:28:16 but all these process what is VM it's a process running on host operating system and it requires 2 GB Ram it's asking for more RAM and but your OS is unable to give Ram now there will be quick time sharing of ram between all these processes and that will be visible in your user lag user will see there's a time lag in the response time and if you keep using it your system tend to hang okay we'll continue our discussion from here in the next class so some people are waiting outside for next class sir for our virtual machine I

01:28:59 found that that uh message is coming there is no space left in your virtual machine and it is not because you have given less hard dis space to your VM and are installing heavy operating system in it so that could be one of the possible yes

Summary

This lecture covers virtualization types, resource optimization, VM management challenges, and strategies for handling hardware failures.

Highlights

🔄 Virtualization Types: Discusses OS-level vs. hardware-level virtualization.

💻 Cluster Creation: Explores creating clusters with varied configurations for resource access.

📈 Resource Optimization: Highlights the importance of maximizing resource utilization in the industry.

🧠 AI Innovations: Introduces Agent K as a potential thesis topic related to AI.

⚙️ VM Management Challenges: Addresses difficulties in managing VMs during hardware failures.

🔍 Predictive Analytics: Discusses using analytics to monitor physical machine health.

🔄 Migration Strategies: Covers live and offline migration to minimize client impact.

Key Insights

🔄 Understanding Virtualization: OS-level virtualization provides a lightweight approach, while hardware-level virtualization offers greater isolation, impacting performance and resource management.

💻 Cluster Configurations: Creating clusters with different machine configurations enables flexible resource sharing, enhancing computing efficiency and user access.

📈 Importance of Resource Utilization: Optimizing resources is essential for reducing costs and improving performance, as demonstrated by industry leaders like DeepMind and NVIDIA.

🧠 Innovative AI Projects: The introduction of Agent K highlights the intersection of AI and virtualization, suggesting new research opportunities in resource management.

⚙️ Managing Hardware Failures: Effective VM management strategies are crucial to ensure service continuity, especially during hardware malfunctions in data centers.

🔍 Predictive Monitoring: Implementing predictive analytics can proactively identify machine health issues, allowing for timely interventions and reducing potential downtime.

🔄 Migration Techniques: Understanding live and offline migration techniques is essential for minimizing disruption to clients during maintenance or failures, ensuring seamless service delivery.